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# AmebaDocs

發 F 0.0.1

Ameba IoT

2022 年 02 月 10 日





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我们支持 3 个独立的软件开发平台（SDK），它们分别是瑞昱 **Arduino SDK**, **Standard SDK** 和 **MicroPython SDK**.

所有的快速入门手册、範例演示、教程、API 参考文档、相关资源下载和数据手册都可以在下方链接中找到。



# CHAPTER 1

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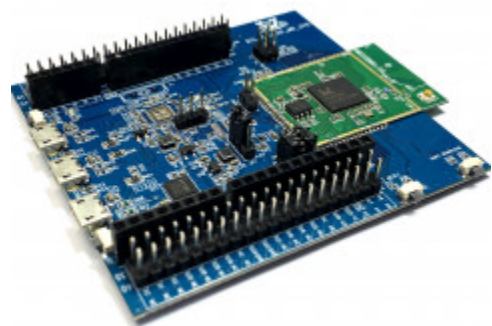
## Arduino SDK

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Arduino SDK 現在已經支援下列三款開發板：

### 1.1 AMB21 (RTL8722DM)

Welcome to AMB21 Arduino online documentation.



## 1.1.1 Getting Started

### Ameba ARDUINO: Getting Started with AMB21

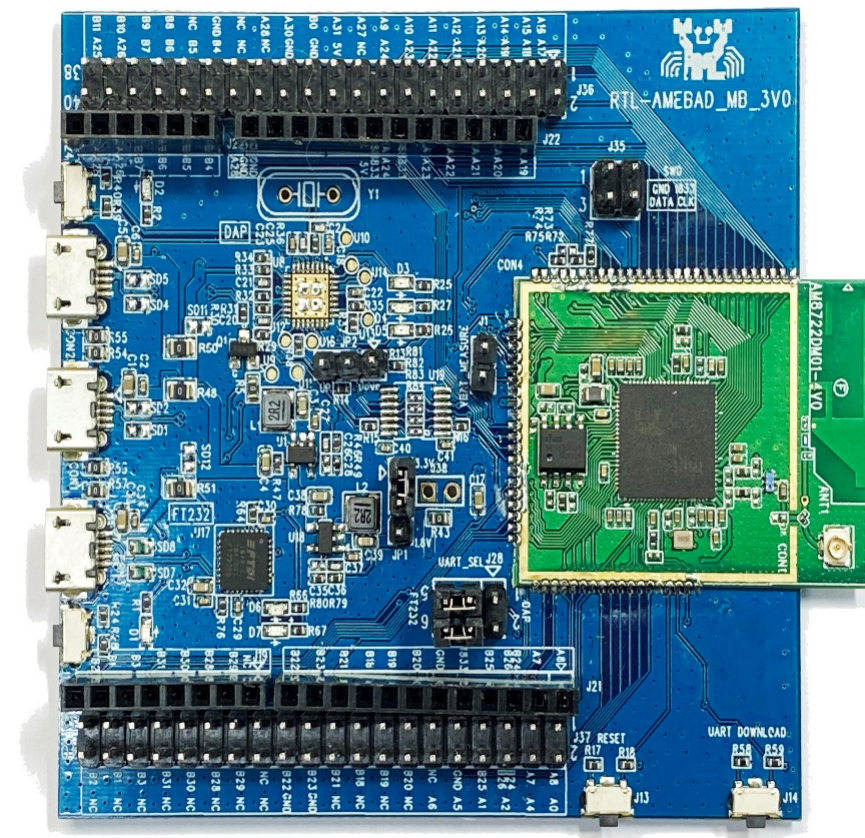
#### Required Environment

AMB21 board currently supports Windows OS 32-bits and 64-bits (WIN7/8/10), Linux OS (Ubuntu 18 LTS/20 LTS/latest) and macOS operating systems. Please use the latest OS version to have the best experiences. In this documentation, please use the latest version Arduino IDE (at least version 1.8.12).

#### Introduction to AmebaD[AMB21 / AMB22]

Ameba is an easy-to-program platform for developing all kind of IoT applications. AmebaD is equipped with various peripheral interfaces, including WiFi, GPIO INT, I2C, UART, SPI, PWM, ADC. Through these interfaces, AmebaD can connect with electronic components such as LED, switches, manometer, hygrometer, PM2.5 dust sensors, ...etc.

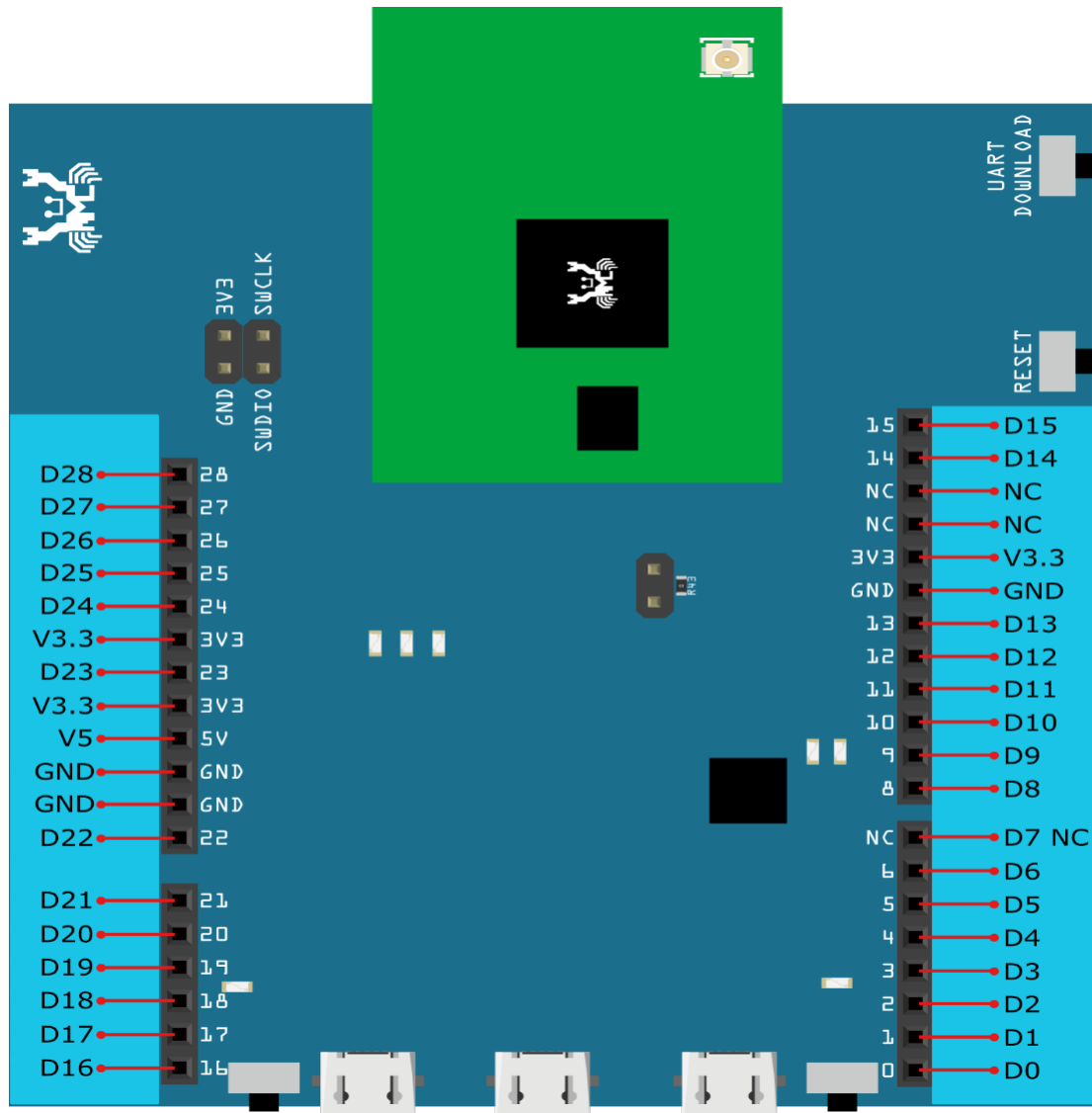
The collected data can be uploaded via WiFi and be utilized by applications on smart devices to realize IoT implementation.



AMB21 and Arduino Uno have similar size, as shown in the above figure, and the pins on AMB21 are compatible with Arduino Uno.

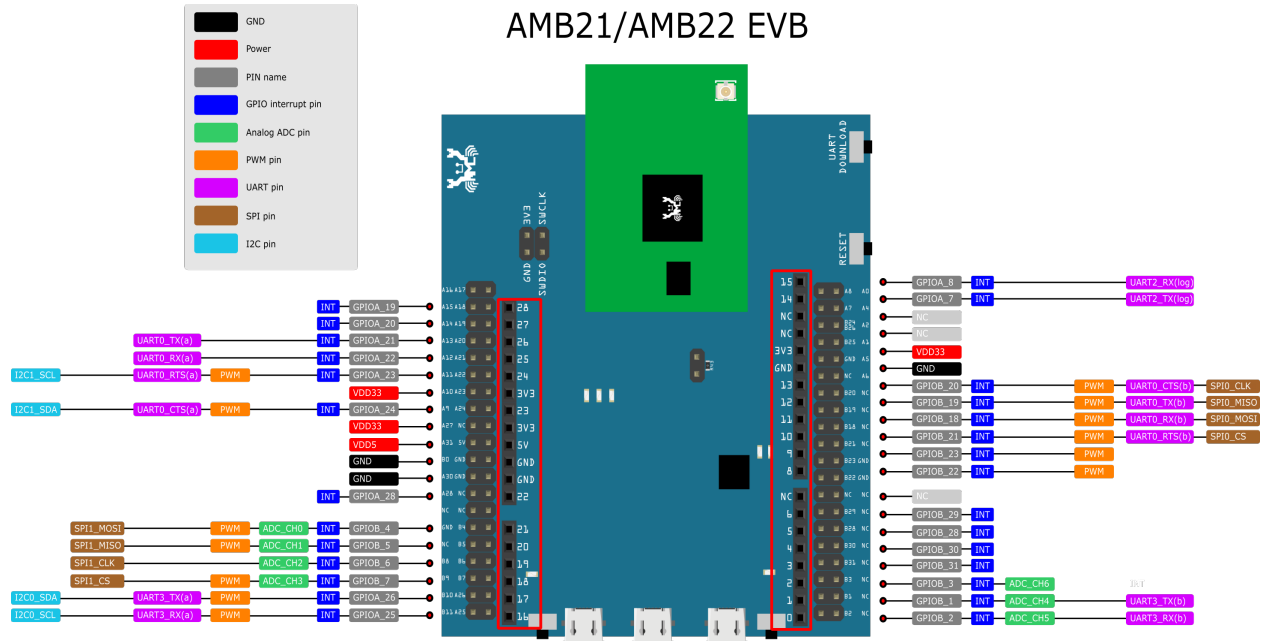
AMB21 uses Micro USB to supply power, which is common in many smart devices.

Please refer to the following figure and table for the pin diagram and function of AMB21.



#	PIN name	GPIO	ADC	PWM	UART	SPI	I2C
D00	GPIOB_2	✓	ADC5		UART3_RX(b)		
D01	GPIOB_1	✓	ADC4		UART3_TX(b)		
D02	GPIOB_3	✓	ADC6				
D03	GPIOB_31	✓					
D04	GPIOB_30	✓					
D05	GPIOB_28	✓					
D06	GPIOB_29	✓					
D07	NC						
D08	GPIOB_22	✓		✓			
D09	GPIOB_23	✓		✓			
D10	GPIOB_21	✓		✓	UART0_RTS(b)	SPI0_CS	
D11	GPIOB_18	✓		✓	UART0_RX(b)	SPI0_MOSI	
D12	GPIOB_19	✓		✓	UART0_TX(b)	SPI0_MISO	
D13	GPIOB_20	✓		✓	UART0_CTS(b)	SPI0_CLK	
D14	GPIOA_7	✓			UART2_TX(log)		
D15	GPIOA_8	✓			UART2_RX(log)		
D16	GPIOA_25	✓		✓	UART3_RX(a)	I2C0_SCL	
D17	GPIOA_26	✓		✓	UART3_TX(a)	I2C0_SDA	
D18	GPIOB_7	✓	ADC3	✓		SPI1_CS	
D19	GPIOB_6	✓	ADC2			SPI1_CLK	
D20	GPIOB_5	✓	ADC1	✓		SPI1_MISO	
D21	GPIOB_4	✓	ADC0	✓		SPI1_MOSI	
D22	GPIOA_28	✓					
D23	GPIOA_24	✓		✓	UART0_CTS(a)	I2C1_SDA	
D24	GPIOA_23	✓		✓	UART0_RTS(a)	I2C1_SCL	
D25	GPIOA_22	✓			UART0_RX(a)		
D26	GPIOA_21	✓			UART0_TX(a)		
D27	GPIOA_20	✓					
D28	GPIOA_19	✓					

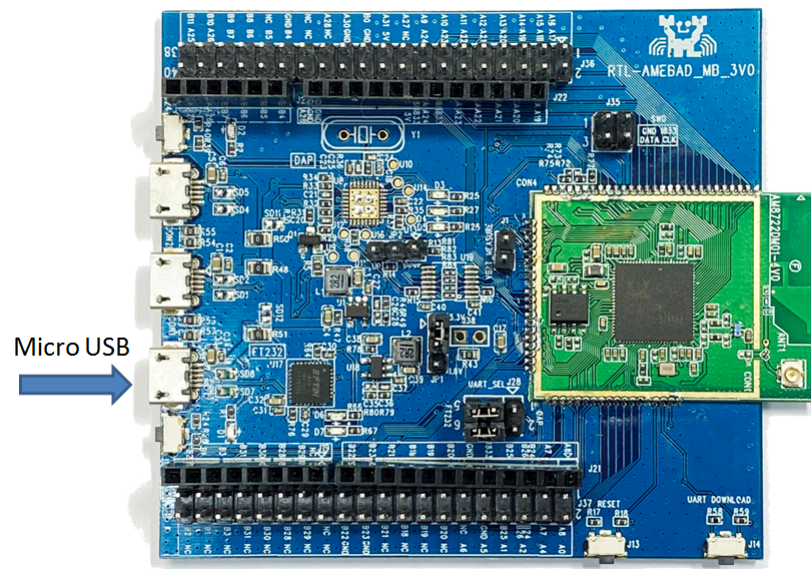




## Setting up Development Environment

### Step 1. Installing the Driver

First, connect AMB21 to the computer via Micro USB:

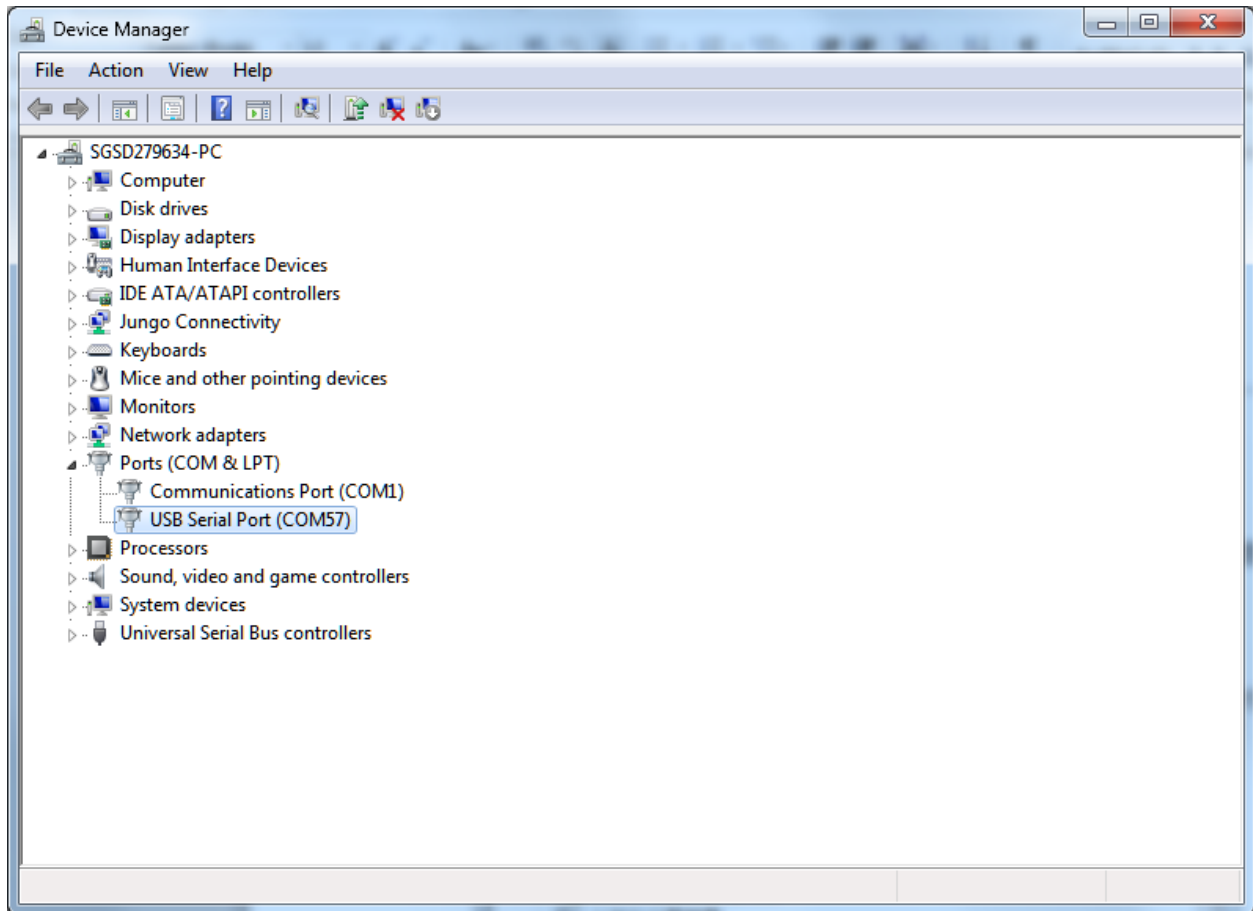


If this is the first time you connect AMB21 to your computer, the USB driver for AMB21 will be automatic installed.

If you have driver issue of connect board to your computer please go to [here](#) for USB driver.

You can check the COM port number in Device Manager of your computer:

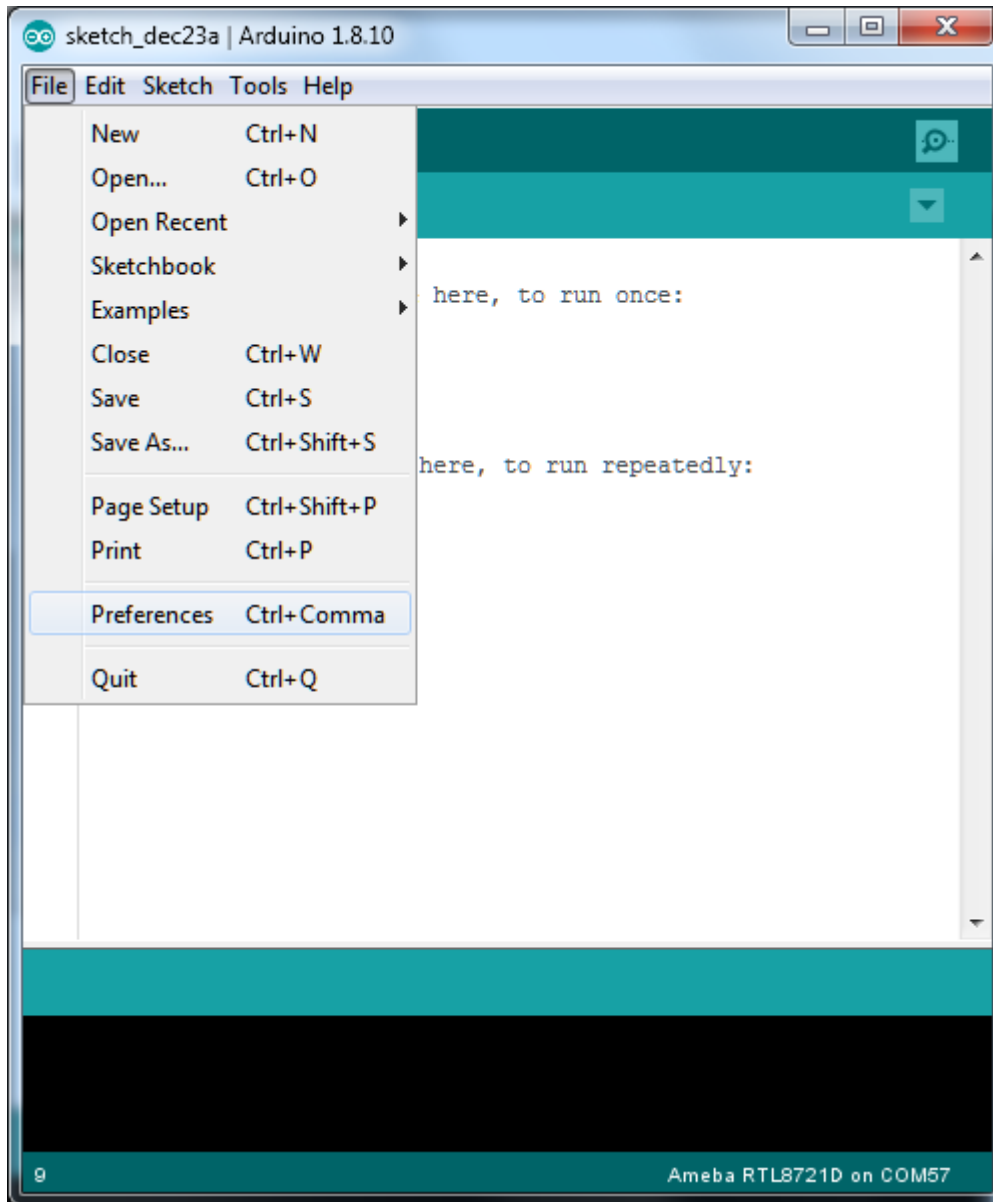
### 1.1. AMB21 (RTL8722DM)



## Step 2. Set up Arduino IDE

From version 1.6.5, Arduino IDE supports third-party hardware. Therefore, we can use Arduino IDE to develop applications on AMB21, and the examples of Arduino can run on AMB21 too. Arduino IDE can be downloaded in the [Arduino website](#).

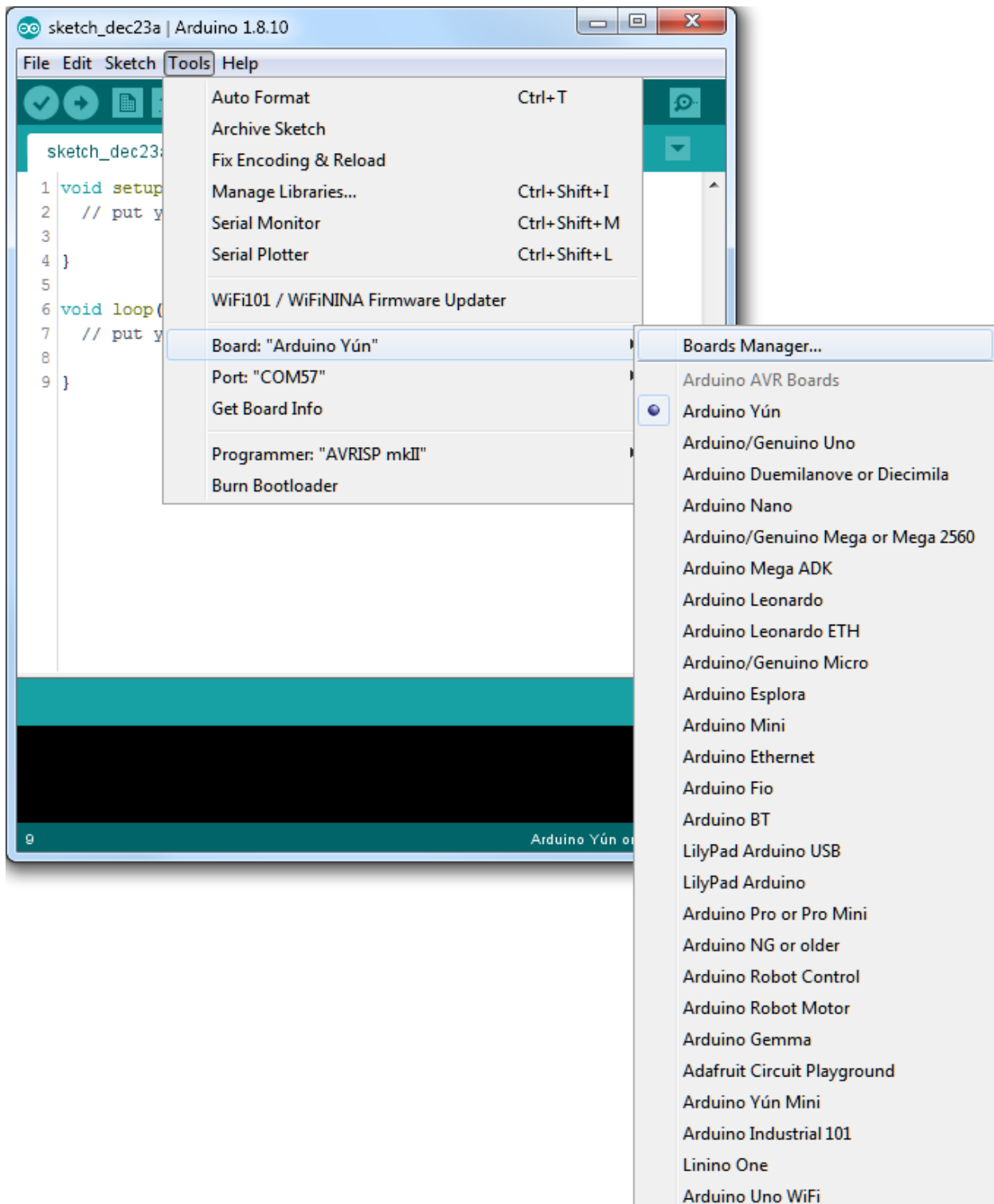
When the installation is finished, open Arduino IDE. To set up AMB21 correctly in Arduino IDE, go to “File” -> “Preferences” .



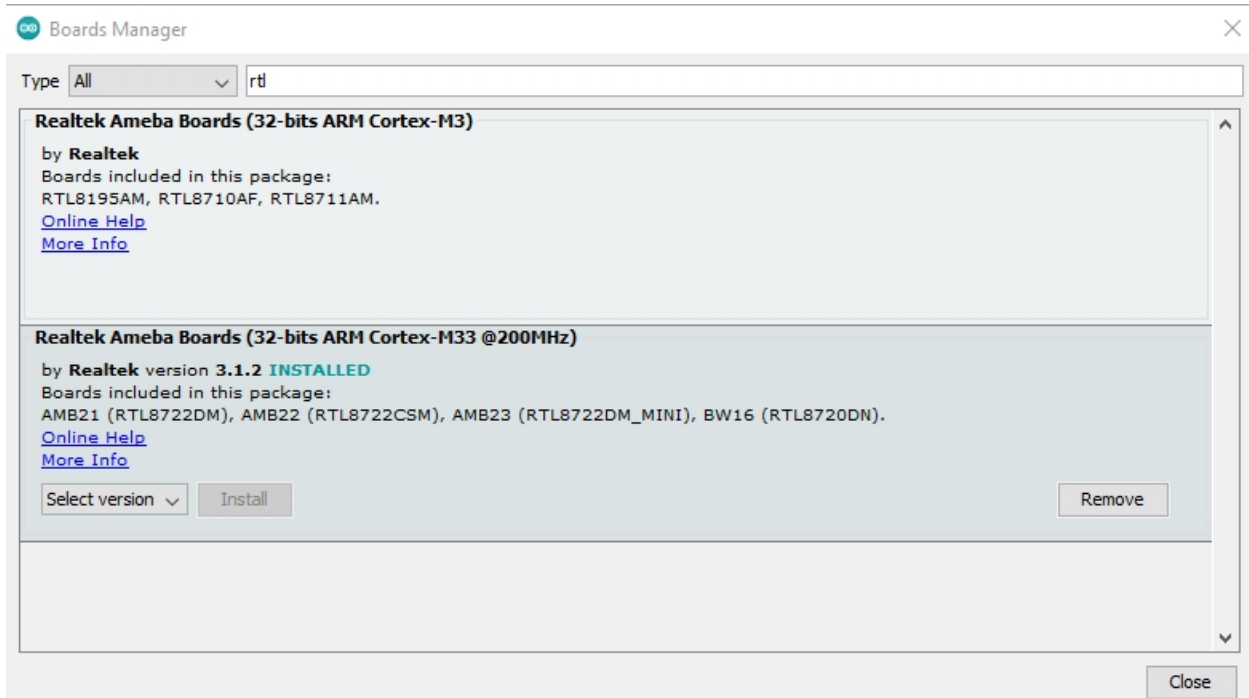
And paste the following URL into “Additional Boards Manager URLs” field:

```
https://github.com/ambiot/ambd_arduino/raw/master/Arduino_package/package_realtek.com_amebad_index.json
```

Next, go to “Tools” -> “Board” -> “Boards Manager” :



The “Boards Manager” requires about 10~20 seconds to refresh all hardware files (if the network is in bad condition, it may take longer). Every time the new hardware is connected, we need to reopen the Board Manager. So, we close the “Boards Manager”, and then open it again. Find “Realtek AmebaD Boards (32-bits ARM Cortex-M33 @200MHz)” in the list, click “Install”, then the Arduino IDE starts to download required files for AMB21.



If you are facing GitHub downloading issue, please refer to the following link at [Download/Software Development Kit](#). There are 3 sections:

1. “AmebaD\_Arduino\_patch1\_SDK”, please select at least 1 of the SDKs. There are 5 latest released SDK options.
2. “AmebaD\_Arduino\_patch2\_Tools”, please select according to your operation system. There are Windows, Linux and MacOS.
3. “AmebaD\_Arduino\_Source\_Code”, this section is optional download only wants to refer the latest source code.

Download the files selected, then unzip (patch1 and patch2 are compulsory). There are “Install.doc” / “Install.pdf” for you to refer installation steps. According to your system, please run the installation tool in the “Offline\_SDK\_installation\_tool” folder.

After the installation tool running successfully, you may open Arduino IDE and proceed to “Tools”->“Board”->“Boards Manager...”. Try to find “Realtek AmebaD Boards (32-bits ARM Cortex-M33 @200MHz)” in the list, click “Install”, then the Arduino IDE starts to download required files for AMB21.

Finally, we select AMB21 as current connected board in “Tools”->“Board”->“Ameba ARM (32-bits) Boards”->“AMB21”:

sketch\_may14a | Arduino 1.8.12

File Edit Sketch Tools Help

The screenshot shows the Arduino IDE interface. The 'Tools' menu is open, displaying various options. The 'Board: "RTL8722DM/RTL8722CSM"' option is highlighted. The 'Boards Manager...' window is also open, showing a list of available boards. The 'RTL8722DM/RTL8722CSM' board is selected under the 'Ameba ARM (32-bits) Boards' category.

Tools menu options:

- Auto Format (Ctrl+T)
- Archive Sketch
- Fix Encoding & Reload
- Manage Libraries... (Ctrl+Shift+I)
- Serial Monitor (Ctrl+Shift+M)
- Serial Plotter (Ctrl+Shift+L)
- WiFi101 / Wi-FiNINA Firmware Updater
- Board: "RTL8722DM/RTL8722CSM" (selected)
- Port
- Get Board Info
- Programmer: "AVRISP mkII"
- Burn Bootloader

Boards Manager... options:

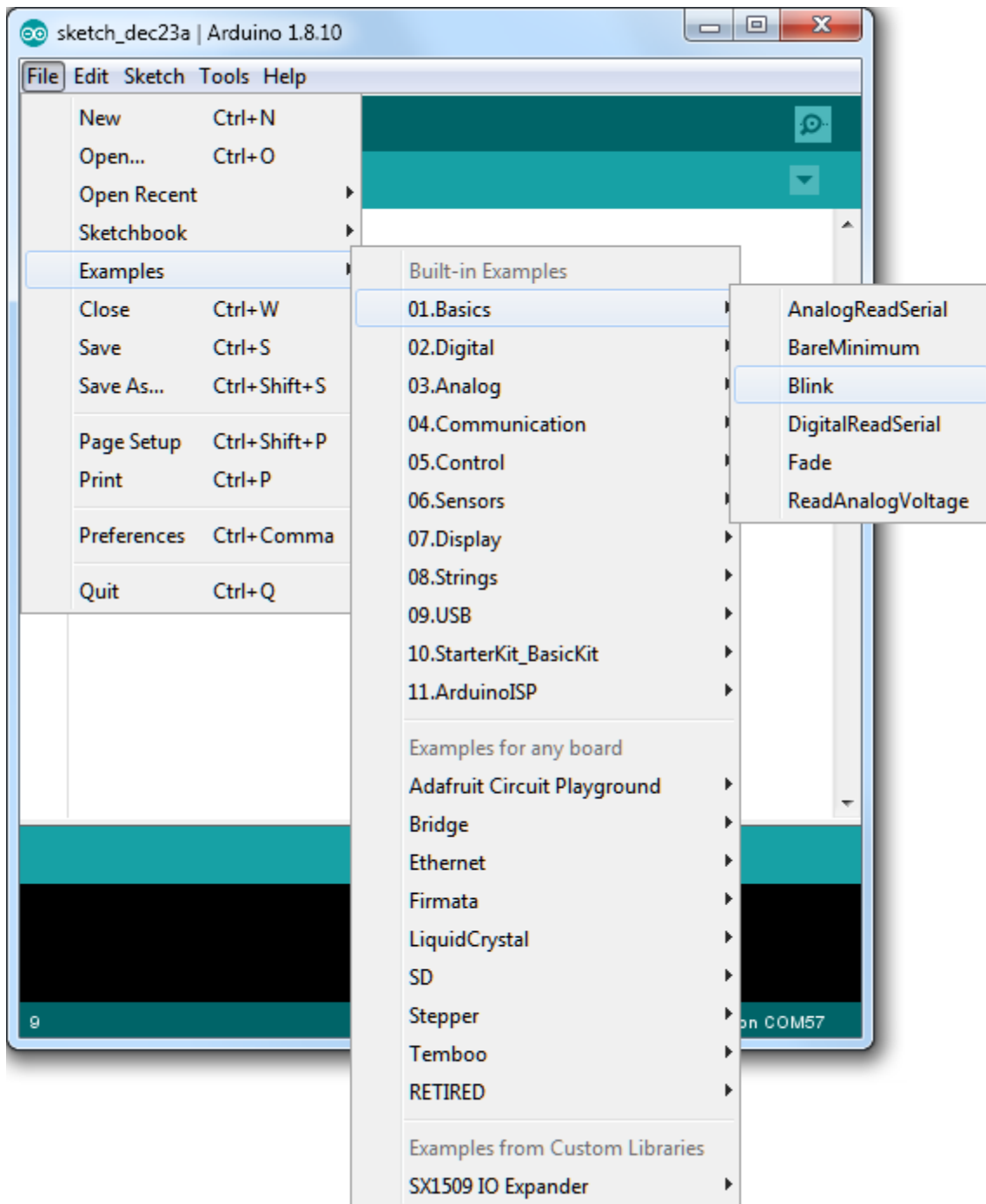
- Arduino Mega or Mega 2560
- Arduino Mega ADK
- Arduino Leonardo
- Arduino Leonardo ETH
- Arduino Micro
- Arduino Esplora
- Arduino Mini
- Arduino Ethernet
- Arduino Fio
- Arduino BT
- LilyPad Arduino USB
- LilyPad Arduino
- Arduino Pro or Pro Mini
- Arduino NG or older
- Arduino Robot Control
- Arduino Robot Motor
- Arduino Gemma
- Adafruit Circuit Playground
- Arduino Yún Mini
- Arduino Industrial 101
- Linino One
- Arduino Uno WiFi
- Ameba ARM (32-bits) Boards
- RTL8722DM/RTL8722CSM (selected)

## Try the First Example

### Step 1. Compile & Upload

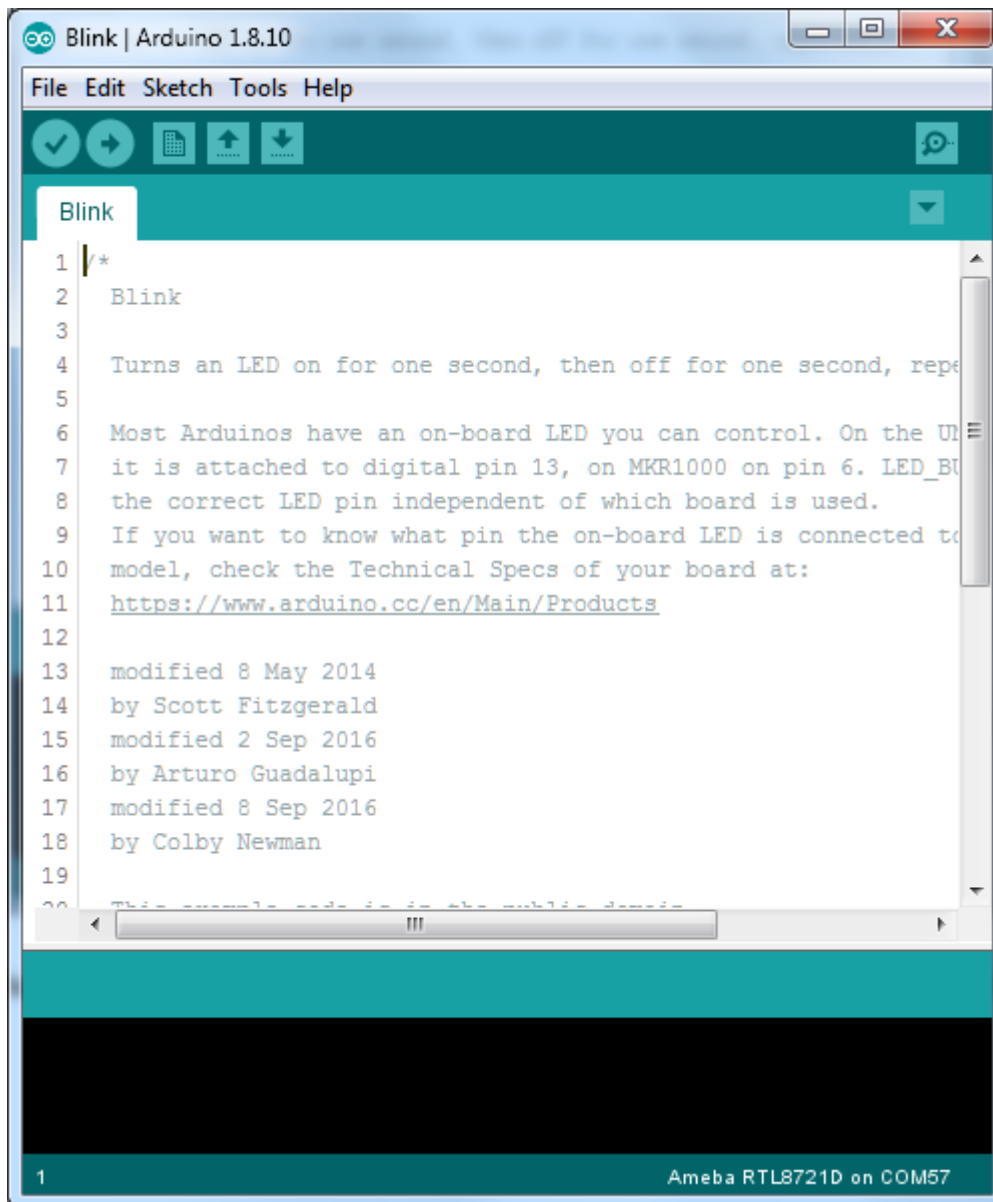
Arduino IDE provides many built-in examples, which can be compiled, uploaded and run directly on the boards. Here, we take the “Blink” example as the first try.

Open “File” -> “Examples” -> “01.Basics” -> “Blink” :

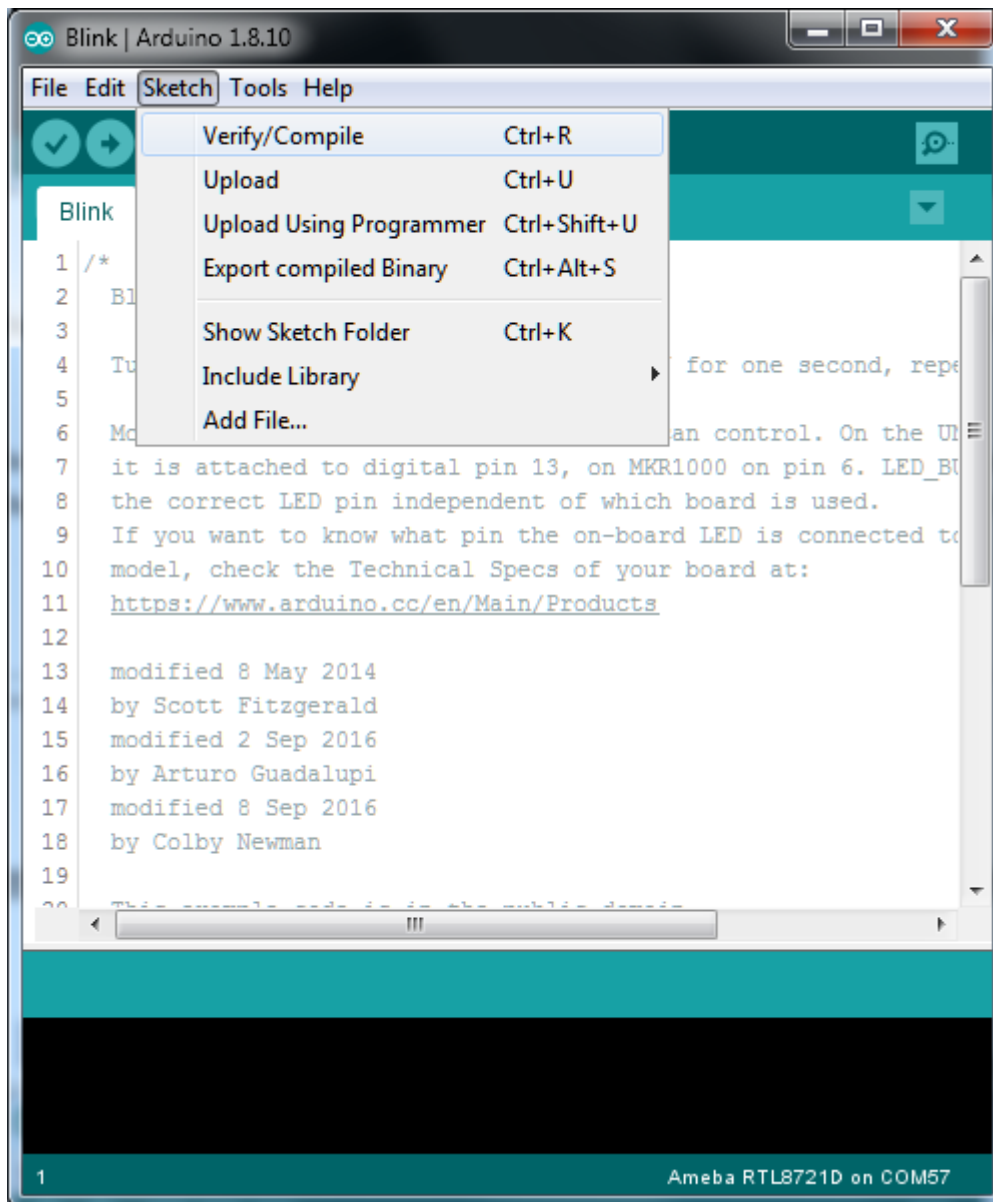


Arduino IDE opens a new window with the complete sample code.

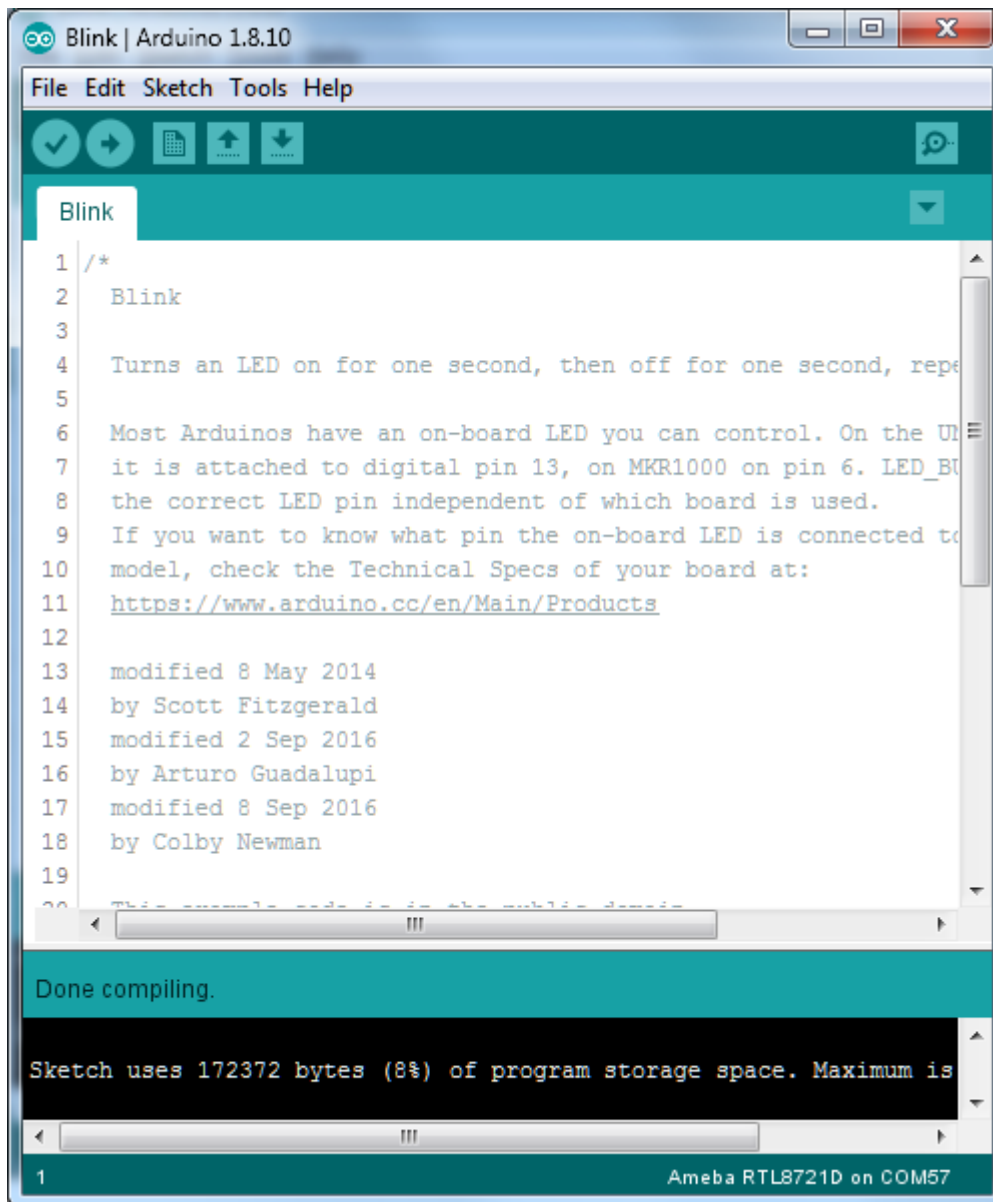




Next, we compile the sample code directly; click “Sketch” -> “Verify/Compile”



Arduino IDE prints the compiling messages in the bottom area of the IDE window. When the compilation is finished, you will get the message similar to the following figure:



Afterwards, we will upload the compiled code to AMB21.

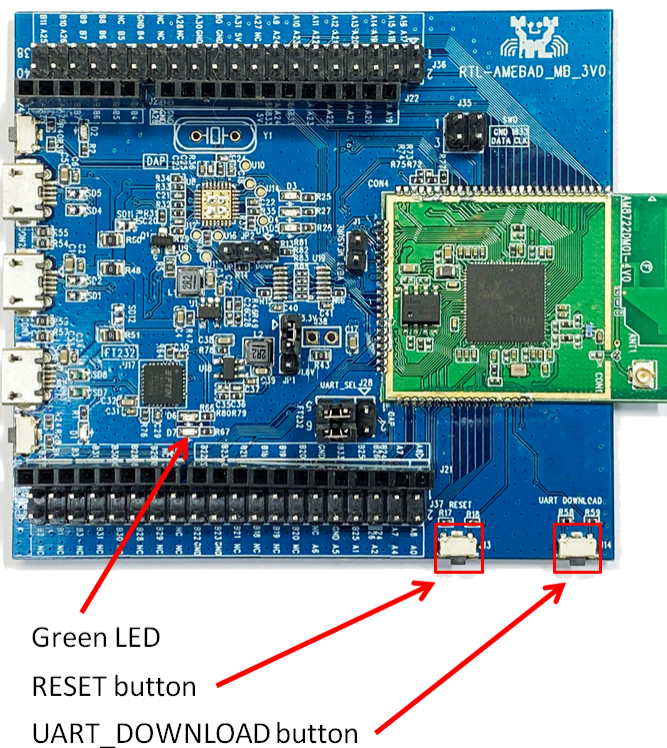
Please make sure AMB21 is connected to your computer, then click “Sketch” -> “Upload” .

The Arduino IDE will compile first then upload. During the uploading process, users are required to enter the upload mode of the board. Arduino IDE will wait 5s for DEV board to enter the upload mode.

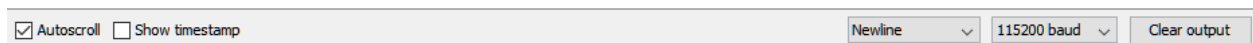
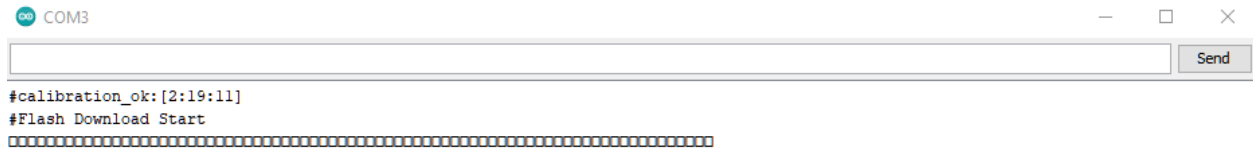
```
Uploading...

Sketch uses 172372 bytes (8%) of program storage space. Maximum is 2097152 bytes.
  1 file(s) copied.
Please enter the upload mode (wait 5s)
05
04
03
02
01
```

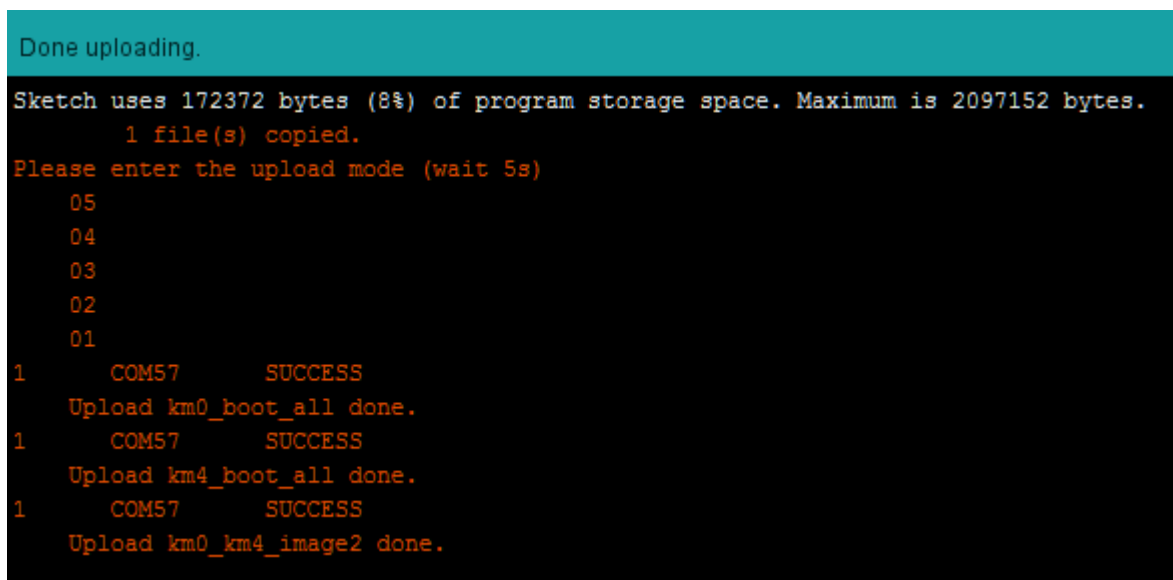
To enter the upload mode, first press and hold the *UART\_DOWNLOAD* button, then press the *RESET* button. If success, you should see the LED flashing on the DEV board.



It is optional for users to check if the board entered the upload mode. Open serial monitor/terminal and look for “#Flash Download Start”. Note, it is normal that some serial terminals may show unknown characters as following picture.



Again, during the uploading procedure the IDE prints messages. Uploading procedure takes considerably longer time (about 30 seconds to 1 minute). When upload completed, the “Done uploading” message is printed.



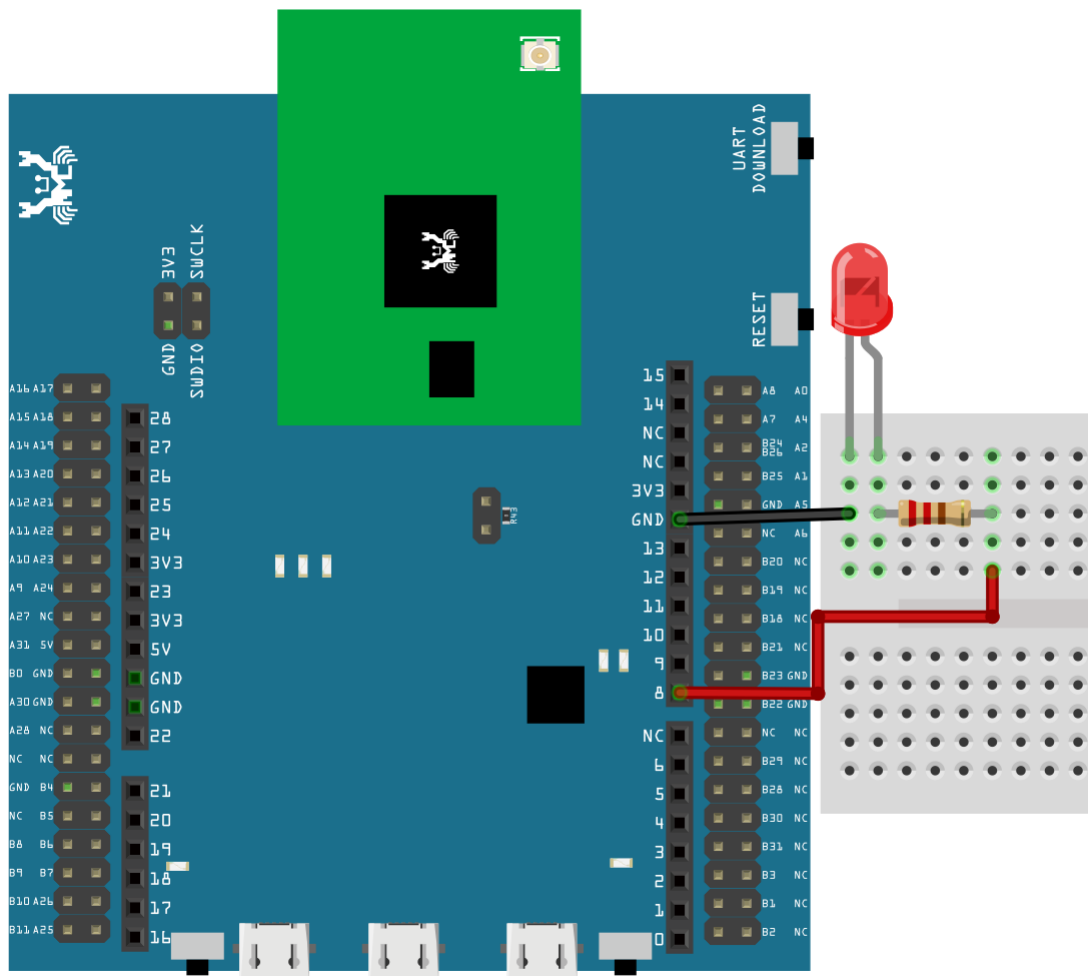
## Step 2.Run the Blink example

In each example, Arduino not only provides sample code, but also detailed documentation, including wiring diagram, sample code explanation, technical details, ...etc. These examples can be directly used on AMB21.

So, we find the detailed information of the [Blink example](#).

In short, this example makes LED blinks, and it uses GPIO pin 08 (refer to the pin diagram D08). Then we connect the LED and resistance as the following figure:

(NOTE: In an LED, the longer pin is the positive pole, and shorter pin is the negative pole. So we connect the longer pin to D08, and connect the shorter pin to GND. In addition, please use a resistor with suitable resistance in series between LED and GND to protect LED)



Finally, press the *RESET* button, and you can see the *LED* blinking.

**(End)**

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備 F: If you face any issue, please refer to the FAQ and Trouble shooting sections on [../support/index](#) page.

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## 1.1.2 Release History

### Version 3.1.2 - 2021/12/28

- Feature:
    - Update SimpleWebServerWiFi example
    - Support BW16
  - API Updates:
    - Update Wlan related naming from 「AmebaWiFi」 become 「WiFi」
    - Update RTC library for minor bug fix
  - Misc:
    - Update all Fritzing files for new name updates
    - AMB21, AMB22, AMB23, and BW16
- 

### Version 3.1.1 - 2021/12/25

- Feature:
  - Add BLE HID and examples
  - BLEHIDGamepad, BLEHIDKeyboard, and BLEHIDMouse
  - Update PowerSave examples
  - Support RTL8722DM MINI and RTL8720DN/BW16
  - Enable LwIP hostname edit
- API Updates:
  - Update API for PowerSave
  - Update ameba\_d\_tools 1.0.7 for all 3 platforms
  - Support RTL8720DN/BW16 and RTL8722DM MINI

- Add more Aon wake up pins
  - Update API for IR
  - Removed requirement to define both IR TX and RX pins in IRDevice::begin
  - Removed previous limit on number of time durations IRDevice::send can accept
  - Update GPIO Int
  - Enable INPUT\_IRQ\_CHANGE
  - Add definition inside wiring\_constants.h and wiring\_digital.c, also complete the TODO part for attachInterrupt() as well
  - Update UART, for RTL8720DN/BW16 not showing log issue
  - Fix wrong attribute permissions for characteristic CCCD descriptor. Remove unused variable warnings
  - Update GTimer, for the internal timer ID validation test
  - Updated SPI connection for RTL8720DN/BW16
  - Update Google\_Cloud\_IoT example with new Google TLS cert
  - Update Analog Pin remove A0 and A1
  - Update Platform.txt for Windows OS with User Name having a space in between
  - Update all libs
  - Misc:
    - Update AmebaEink.zip, SPI connection for RTL8720DN/BW16
    - Add Autoflash\_patch folder
    - Update the Fritzing of RTL8720DN/BW16, remove A0 and A1
- 

## Version 3.1.0 - 2021/11/05

- Feature:
  - Support board RTL8720DN(BW16)
  - Add WiFiControlCar example
  - Add Arduboy zip library
  - Add WPA3 support
  - Add Amebad\_HMI\_MQTT zip library
  - Add support for IPV6 wiht 4 examples
  - WLAN lib update
  - Minor bug fix



- API Updates:
  - Support Microsoft Azure IoT cloud
  - Enable “strlen” from rom
  - Add “#define yield” for compilation
  - Update PubSubClient lib
  - Update APIs for RTL8720DN(BW16) (SPI, I2C, Fatfs, Audiocodec and UART)
  - Update jtag enable functions
  - Update wifi security option
  - Remove the unused libs lib\_wifi\_fw.a lib\_wifi\_ucps\_fw.a
  - Update watchdog
  - Update AudioCodec
  - Pin mapping updates
  - Remove unused marcos
  - RTL8720DN(BW16) related naming update for all examples
  - Update PowerSave
- Misc
  - Add RTL8720DN\_BW16 frizting folder
  - Move RTL8720DN\_BW16 frizting files to correct folder
  - Rename folder name to short the length of path
  - Add Offline\_SDK\_installation\_tool (Windows, Linux and MacOS)
  - Update linux tools for compatibility issue
  - Update RTL8722DM MINI and RTL8720DN(BW16) Fritzting and Pinmux
  - Update ameba\_d\_tools V1.0.6
  - Add Image\_Releated folder
  - Correct the core from Cortex-M4 to Cortex-M33

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#### Version 3.0.11 - 2021/10/26

- Feature:
  - Add example, FatfsSDIO - Read and open HTML file from SD card
- API Updates:
  - RTL8720DN/BW16 related compatibility update for all examples

- Misc
    - Update RTL8722DM MINI and RTL8720DN Fritzing and Pinmux
- 

#### Version 3.0.10 - 2021/09/22

- Feature:
    - Add AudioCodec wav examples
  - API Updates:
    - Pin mapping updates for RTL8722DM MINI
    - Remove unused marcos
    - Update platform.txt for bin files process
    - rollback for “wifi.h” update
    - Minor bug fix patch
- 

#### Version 3.0.9 - 2021/09/13

- API Updates:
    - Pin mapping updates
    - Remove unused marcos
    - “wifi.h” related files change to “Amebawifi.h”
- 

#### Version 3.0.8 - 2021/05/06

- Feature:
  - Add RTL8722DM\_mini board
  - Add fatfs for SD card
  - Add AudioCodec
  - Add TensorFlow lite support with examples
  - Add zip libraries for TensorFlow lite support
  - Update SDK for supporting Arduino IDE 2.0
  - Update wlan lib
- API Updates:
  - Update zip libraries of Eink

- ADC updates, Change calculation method to use EFUSE calibration parameters and SDK formula to improve accuracy
  - writing\_analog updates, minor bug fix and support for mini board
  - SPI updates, minor bug fix and support for mini board
  - I2S updates, minor bug fix and support for mini board
  - IRDevice updates, minor bug fix
- 

**Version 3.0.7 - 2020/11/19**

- Feature:
    - Add AmebaIRDevice example IRSendSONY
    - Update Ameba Arduino IRDevice API
    - Update Ameba Arduino SSL related API
    - Update Ameba Arduino Wlan API to support static IP function
- 

**Version 3.0.6 - 2020/10/28**

- Feature:
    - Add Ameba RTC support
    - Add AmebaRTC example RTC and RTCArm
    - Add Ameba Watchdog support
    - Add AmebaWatchdog example WatchdogTimer
    - Update Ameba BLE support
    - Add AmebaBLE example BLEUartService, DHT\_over\_BLEUart
    - Update Ameba Wlan library
    - Update Ameba Wlan SDK structure, add AP mode hidden SSID support
- 

**Version 3.0.5 - 2020/09/09**

- Feature:
    - Build in tool updates V1.0.4
    - Add zip lib AmebaEink
    - Add AmebaEink example EinkDisplayImage, EinkDisplayQR, and EinkDisplayText
    - Add google cloud examples
-

- Update Amazon AWS related examples
  - Add power save support
  - Add AmebaPowerSave example TicklessMode, DeepSleepMode, DeepSleep\_DHT\_LCD\_Example, and DeepSleep\_DHT\_Eink\_Example
- 

**Version 3.0.4 - 2020/07/27**

- Feature:
    - Update BLE library. Add example BLEBatteryClient and BLEWifiConfig
    - Update from polarssl to mbedtls 2.4.0
- 

**Version 3.0.3 - 2020/07/03**

- Feature:
    - Build in Image tool updates V1.0.3
    - Upload log clean up
- 

**Version 3.0.2 - 2020/06/30**

- Feature:
    - Windows, Linux and macOS X support
    - Build in Image tool updates
- 

**Version 3.0.1 - 2020/05/15**

- Feature:
    - Official release of AmebaD Arduino SDK
    - warning cleaning
    - I2C lib updates
- 

**Version 3.0.0 - 2020/05/01**

- Feature:
  - Support Boards Manager and Arduino IDE development
  - WiFi scan AP, connect to AP, TCP Server/Client, including 5G
  - Bluetooth, BLE
  - GPIO digital in/out and interrupt

- ADC analog in/out (0 ~ 3.3V)
- PWM getting analog results with digital means
- SPI master and slave mode
- UART 1 for log, 2 for customize usage
- I2C master mode

### 1.1.3 Peripherals & Examples

#### Basic Examples

AMB21 (RTL8722DM/CSM) Supported ARDUINO built-in example table

There are many built-in examples in Arduino. In the table below, we list all examples that are compatible with Ameba.

Please refer to the following link to set up Ameba for Arduino IDE.

<https://www.amebaiot.com/en/amebad-arduino-getting-started/>

Please refer to the following link for Arduino built-in example details.

<https://www.arduino.cc/en/Tutorial/BuiltInExamples/>

Category	Name	Comment	Remarks
01. Basics	AnalogReadSerial	Connect potentiometer to 3.3V.	ADC pin options A0, A
	BareMinimum		
	Blink	Pin LED_BUILTIN sets to pin D8.	
	DigitalReadSerial		
	Fade		
	ReadAnalogVoltage		ADC pin options A0, A
02. Digital	BlinkWithoutDelay	Pin LED_BUILTIN sets to pin D8.	
	Button	Connect LED to pin D13.	
	Debounce	Connect LED to pin D13.	
	Digital InputPullup	Connect LED to pin D13.	
	StateChange Detection	Connect LED to pin D13.	
	toneKeyboard		
	toneMelody		
	toneMultiple		

表格 1 - 繼續上一頁

Category	Name	Comment	Remarks
	tonePitch Follower		
03. Analog	Analog InOutSerial		ADC pin options A0, A
	AnalogInput	Connect LED to pin D13.	ADC pin options A0, A
	Analog Write Mega		
	Calibration	Connect another LED to pin D13.	ADC pin options A0, A
	Fading		
	Smoothing		ADC pin options A0, A
04. Communication	ASCIITable		
	Dimmer		
	Graph	Connect potentiometer to 3.3V.	ADC pin options A0, A
	Midi	Use Serial1 and pin D26, or use Serial2 and pin D17.	
	MultiSerial		
	PhysicalPixel		
	Read ASCIIString		
	SerialCallResponse		ADC pin options A0, A
	SerialCallResponse ASCII		ADC pin options A0, A
	SerialEvent		
	Serial Passthrough		Serial options, Serial1 on
	Virtual ColorMixer		ADC pin options A0, A
05. Control	Arrays	Use pins D1, D2, D3, D4, D5, D6.	
	ForLoop Iteration	Use pins D1, D2, D3, D4, D5, D6.	
	IfStatement Conditional		ADC pin options A0, A
	switchCase		ADC pin options A0, A
	switchCase2	Use pins D1, D2, D3, D4, D5, D6.	
	While Statement Conditional	Connect another LED to pin D13.	ADC pin options A0, A
06. Display	barGraph	Use another pin to replace pin D7.	ADC pin options A0, A
	RowColumn Scanning		ADC pin options A0, A
07. Strings	Character Analysis		
	StringAddition Operator		
	StringAppend Operator		
	String CaseChanges		
	String Characters		
	StringComparision Operators		ADC pin options A0, A
	StringIndexOf		
	StringLength		
	StringLengthTrim		
	StringReplace		

表格 1 - 繼續上一頁

Category	Name	Comment	Remarks
	StringStartsWith EndsWith		
	StringSubstring		
	StringToInt		

## Network Examples

### BLE - BLE Battery Service

#### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

#### Example

##### Introduction

BLE connections use a server client model. The server contains the data of interest, while the client connects to the server to read the data. Commonly, a Bluetooth peripheral device acts as a server, while a Bluetooth central device acts as a client. Servers can contain many services, with each service containing a some set of data. Clients can send requests to read or write some data and can also subscribe to notifications so that the server can send data updates to a client.

In this example, a basic battery service is set up on the Ameba Bluetooth stack. A mobile phone is used to connect to the Ameba peripheral device and read the battery data.

##### Procedure

Ensure that the following Bluetooth apps are installed on your mobile phone. These apps will show you the raw data sent by Ameba and allow you to interact with the data.

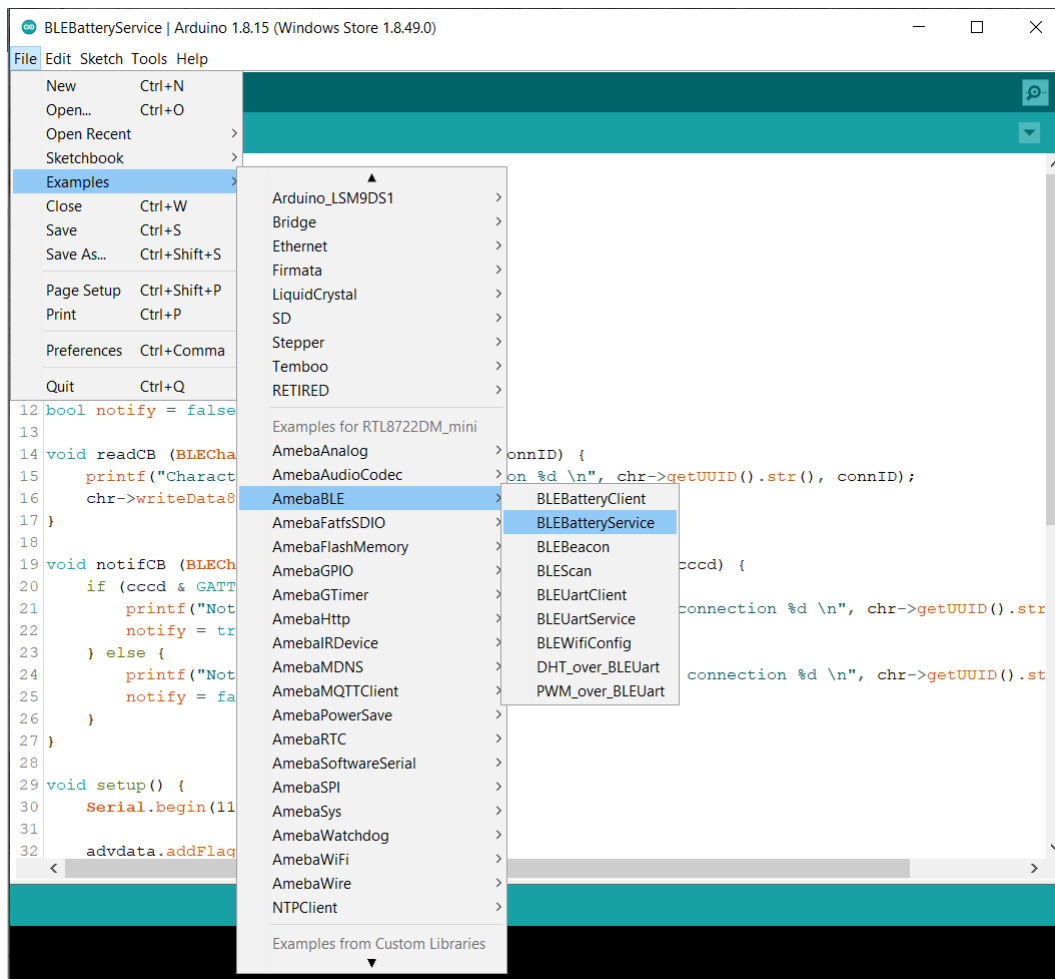
The recommended application is nRF connect, and is available at the links below:

- Android: <https://play.google.com/store/apps/details?id=no.nordicsemi.android.mcp>
- iOS : <https://apps.apple.com/us/app/nrf-connect/id1054362403>

LightBlue is an alternative application that can also be used, but has less features:

- Android: <https://play.google.com/store/apps/details?id=com.punchthrough.lightblueexplorer>
- iOS : <https://apps.apple.com/us/app/lightblue/id557428110>

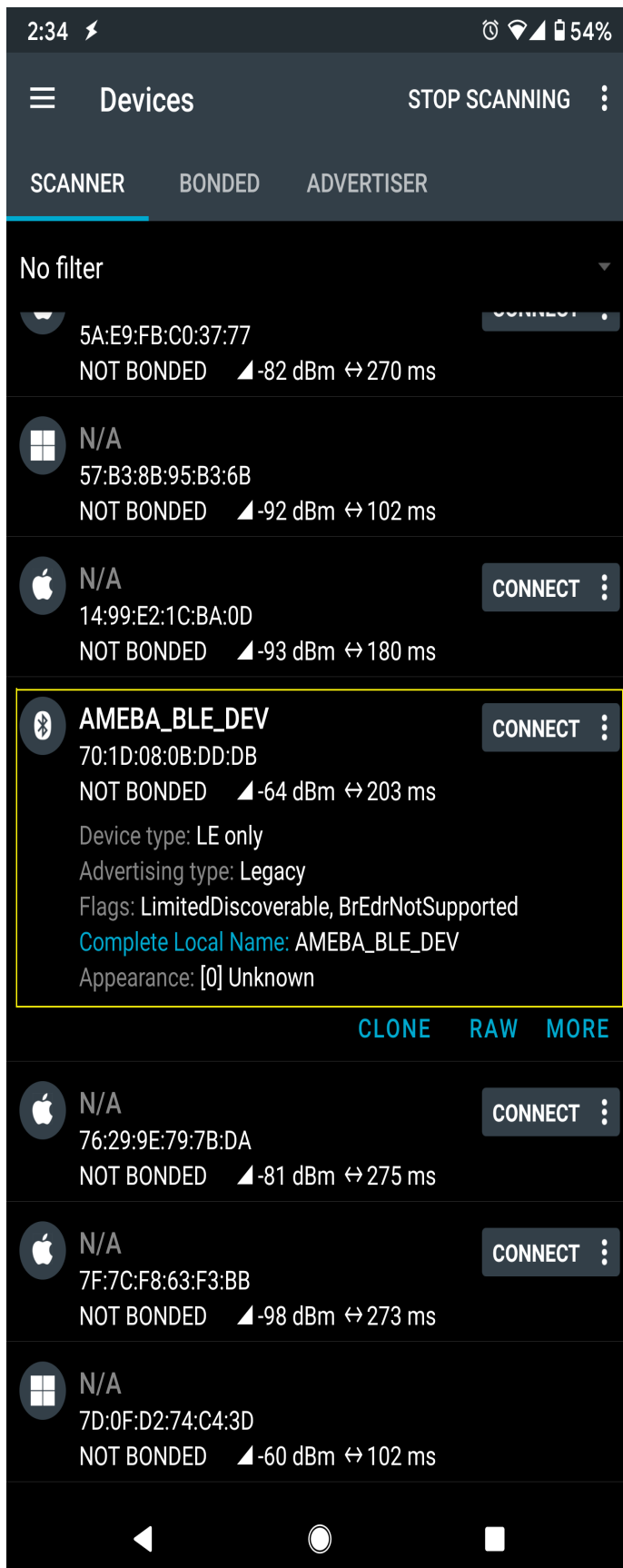
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEBatteryService”



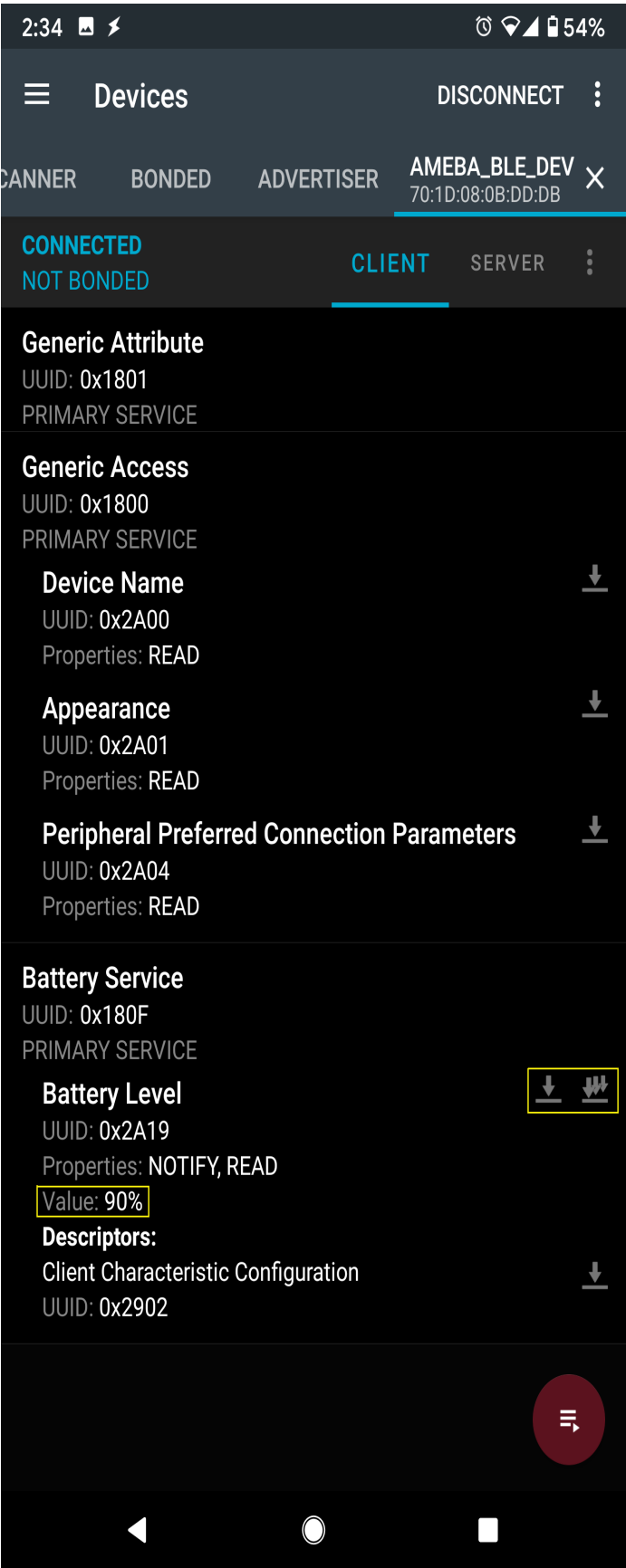
Upload the code and press the reset button on Ameba once the upload is finished.

On your mobile phone, open the Bluetooth app and scan for the Bluetooth signal broadcast by Ameba, it should appear as a device named “AMEBA\_BLE\_DEV” .

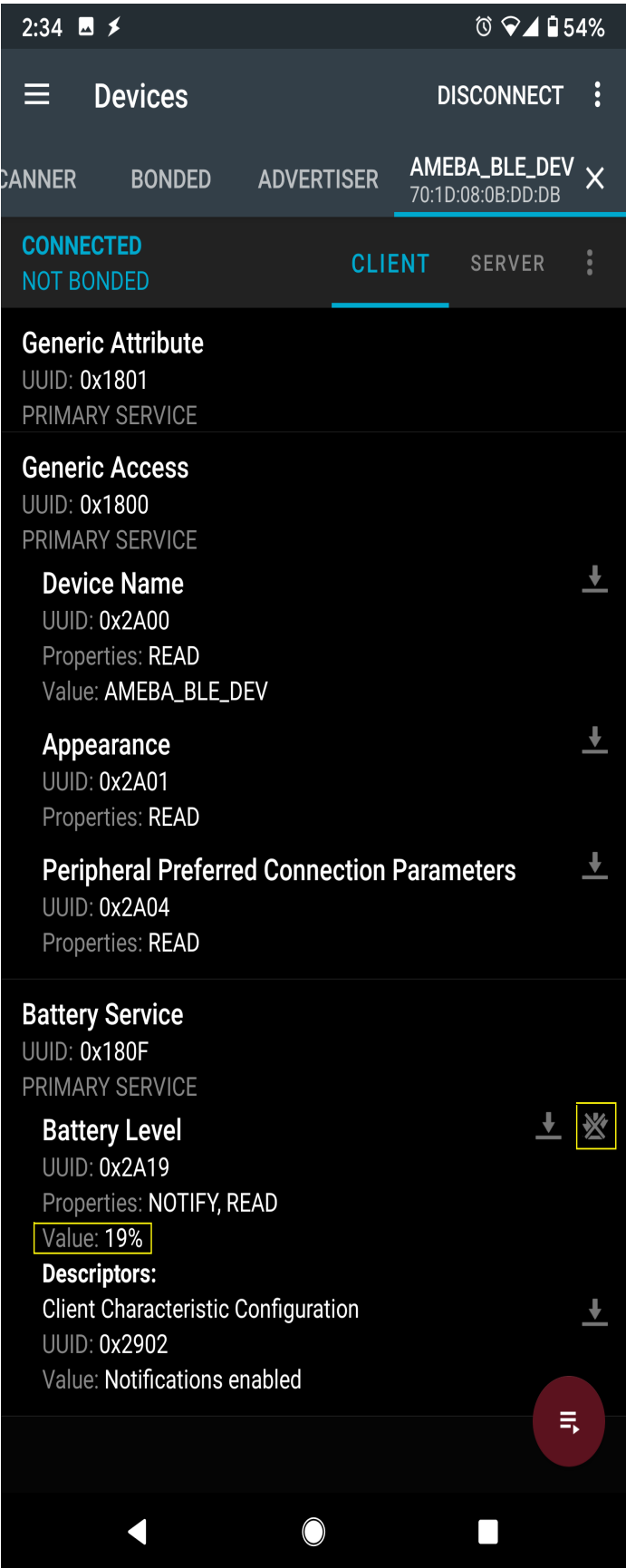




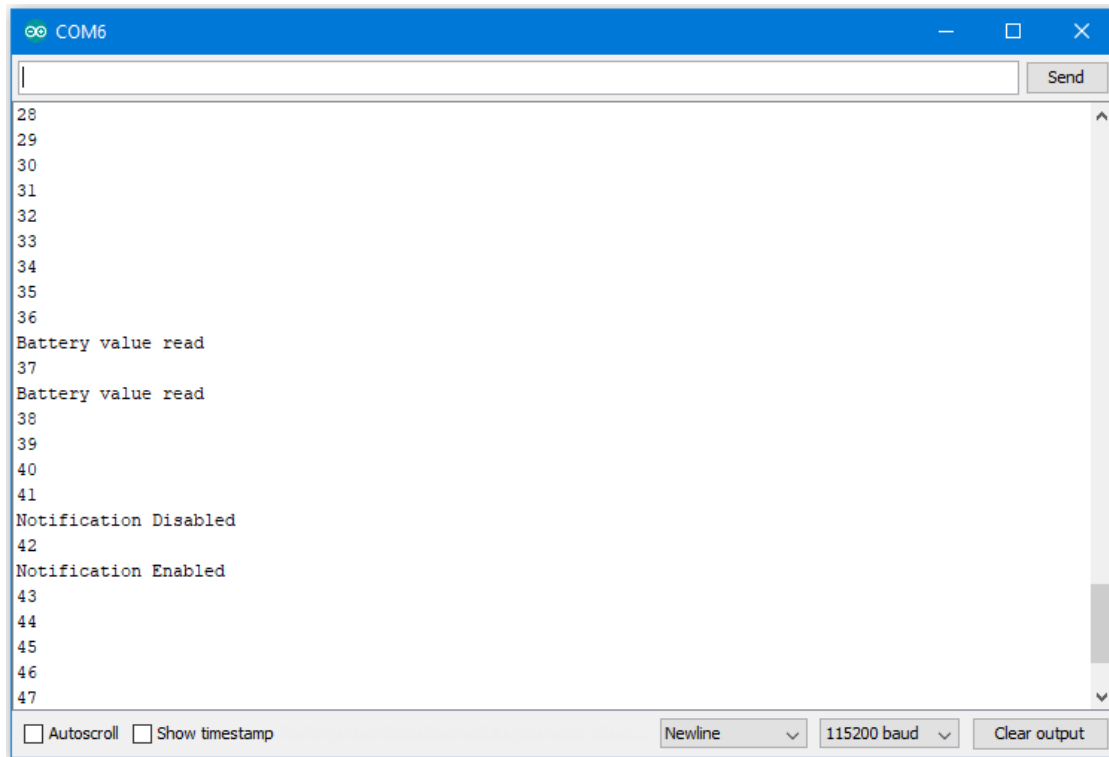
Connect to the Ameba Bluetooth device, and a list of available services should appear. Click on the battery service to expand it, and you can see the battery level data value. The arrows highlighted in the box on the right are used to read data and subscribe to notifications. Click on the single arrow to read the battery level value, and a 90% value will appear.



Click on the triple arrow to subscribe to updates on the battery level value, and the battery value will start updating by itself.



The serial monitor will show the sketch increasing the battery level every second. When you click on either of the arrows, the sketch running on the Ameba will be notified, and will print out the action taken.



## Code Reference

BLEService and BLECharacteristic classes are used to create and define the battery service to run on the Bluetooth device.

`BLE.configAdvert() -> setAdvType(GAP_ADTYPE_ADV_IND)` is used to set the advertisement type to a general undirected advertisement that allows for connections.

`setReadCallback()` and `setCCCDCallback()` is used to register functions that will be called when the battery level data is read, or notification is enabled by the user.

`BLE.configServer(1)` is used to tell the Bluetooth stack that there will be one service running.

`addService()` registers the battery service to the Bluetooth stack.

## BLE –BLE Beacon

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

## Example

### Introduction

A BLE beacon broadcasts its identity to nearby Bluetooth devices, to enable the other devices to determine their location relative to the beacon, and to perform actions based on information broadcasted by the beacon.

Example applications of beacons include indoor positioning system, location-based advertising and more.

From the definition of its purpose as a broadcast device, a BLE beacon thus cannot be connected to, and can only send information in its Bluetooth advertisement packets.

There are several BLE beacon protocols. The Ameba BLEBeacon library supports the iBeacon and AltBeacon protocols.

### Procedure

First, you need to install some Bluetooth apps on your mobile phone. These apps will show you the raw data sent by Ameba and allow you to interact with the data.

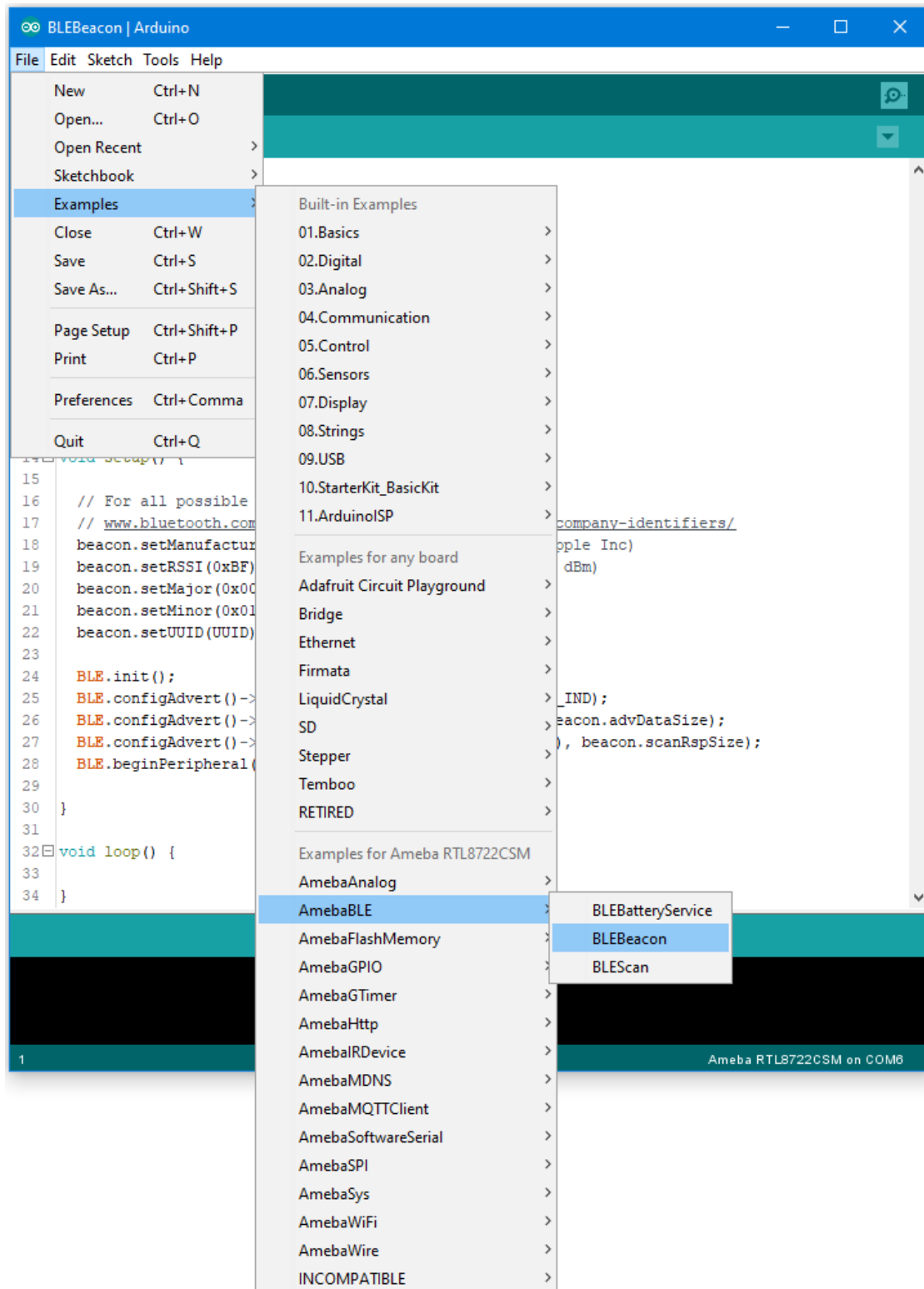
The recommended application is nRF connect, and is available at the links below:

- **Android** : <https://play.google.com/store/apps/details?id=no.nordicsemi.android.mcp>
- **iOS** : <https://apps.apple.com/us/app/nrf-connect/id1054362403>

LightBlue is an alternative application that can also be used, but has less features:

- **Android** : <https://play.google.com/store/apps/details?id=com.punchthrough.lightblueexplorer>
- **iOS** : <https://apps.apple.com/us/app/lightblue/id557428110>

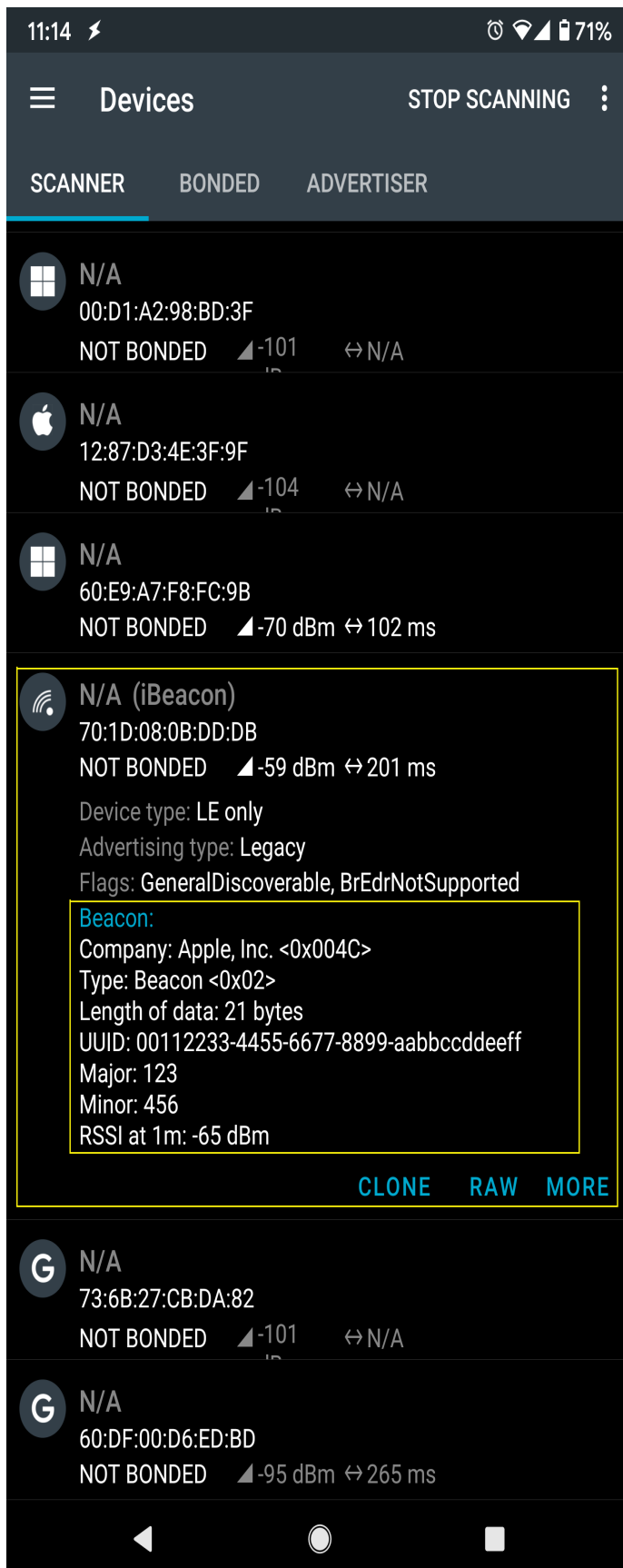
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEBeacon”



Upload the code and press the reset button on Ameba once the upload is finished.

On your mobile phone, open the Bluetooth app and scan for the beacon signal broadcast by Ameba.





If you happen to be in an environment with multiple BLE beacons, you can tap the entries to expand them, and verify that the beacon data is identical to the data in the sketch.

## Code Reference

`setRssi()` is used to set the received signal strength indicator (rssi) data field for a beacon. The specification states that this should be the received signal strength from the beacon at a 1 meter distance. With no method to measure this, it is set to -65dBm as an estimate.

`setMajor()` and `setMinor()` are used to set the two data fields. The purpose of these data are left for the manufacturer of the beacon to define, and can be used in any way.

`setUUID()` is used to give the beacon a universally unique identifier (UUID). This is a 128-bit number usually expressed as a hexadecimal string. It is used to identify each unique beacon, and can be randomly generated for free online.

The BLEBeacon library includes both `iBeacon` and `AltBeacon` classes, replace line 6 `iBeacon` with `altBeacon` to create an `AltBeacon` instead. The data fields are mostly the same, with only minor changes, please look at the header files for more details.

`BLE.init()` is used to allocate memory and prepare Ameba for starting the Bluetooth stack.

`BLE.configAdvert()` is used to configure the Bluetooth advertisement settings, to which we pass the beacon data and set the device as non-connectable.

`BLE.beginPeripheral()` starts Ameba in Bluetooth peripheral mode, after which it will begin to advertise with the beacon data provided.

## BLE –BLE Scan

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

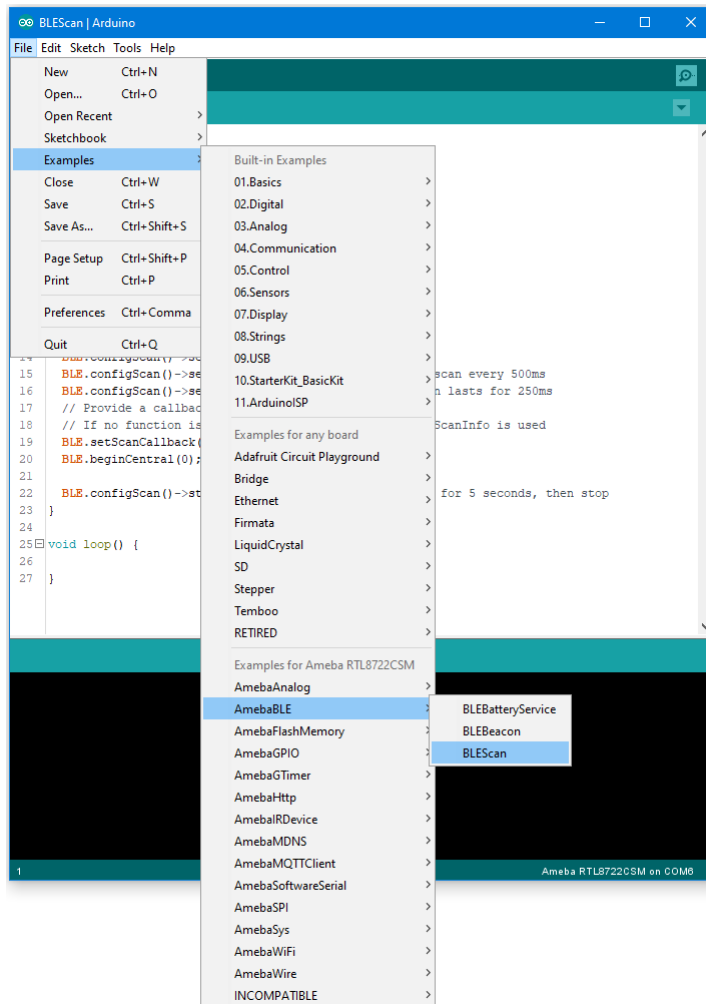
### Example

#### Introduction

This example configures the Ameba as a Bluetooth central device, uses the scan functionality to scan for other Bluetooth devices, and prints out the results to the serial monitor.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEScan”



Upload the code and press the reset button on Ameba once the upload is finished.

Open the Arduino serial monitor, and you should see the scan results of nearby Bluetooth devices formatted and printed out.

```

COM6
Send

#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
local bd addr: 0x70:1d:08:0b:dd:db
GAP scan start

Scan Data 1
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 79:c1:1f:ed:21:75 | -94
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 2
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 4c:19:13:18:f4:b5 | -98
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 3
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 59:aa:dd:87:da:83 | -62
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 4
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | random        | c7:b9:7f:1e:fb:28 | -96
GAP_ADTYPE_FLAGS: 0x5
GAP_ADTYPE_SERVICE_DATA: UUID 0xfffe, len 4

Scan Data 5
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | random        | 6b:37:ce:55:75:65 | -92
GAP_ADTYPE_FLAGS: 0x1a
GAP_ADTYPE_POWER_LEVEL: 0xc
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x4c, len 7

Scan Data 6
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | public        | 68:9e:19:cb:ef:a9 | -78
GAP_ADTYPE_FLAGS: 0x6
GAP_ADTYPE_128BIT_XXX: 0x1bc5ffa0020062abe411f254e005dbd4
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0xc90, len 2

Scan Data 7
ADVType          | AddrType      | BT_Addr        | rssi
SCAN_RSP         | public        | 68:9e:19:cb:ef:a9 | -78

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

If you have the Bluetooth app nRF Connect installed, you can also use it to send out Bluetooth advertisements for the Ameba to pick up.

## Code Reference

`setScanMode(GAP_SCAN_MODE_ACTIVE)` is used to set the scan mode. Active scanning will request for an additional scan response data packet from a device when it is found. Passive scanning will only look at the advertisement data, and not request for additional data.

`setScanInterval()` and `setScanWindow()` are used to set the frequency and duration of scans in milliseconds. A scan will start every interval duration, and each scan will last for the scan window duration. The scan window duration should be lesser or equal to the scan interval. Set a short interval to discover devices rapidly, set a long interval to conserve power.

`setScanCallback(scanFunction)` is used to register a function to be called when scan results are received. This can be used to set a user function for additional processing of scan data, such as looking for a specific device. If no function is registered, the scan results are formatted and printed to the serial monitor by default.

`beginCentral(0)` is used to start the Bluetooth stack in Central mode. The argument 0 is used to indicate that no clients will be operating in central mode.

`startScan(5000)` is used to start the scanning process for a specified duration of 5000 milliseconds. The scan will repeat according to the set scan interval and scan window values. After 5000 milliseconds, the scan process will stop, and will be ready to be started again.

## BLE –Battery Client

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

#### Introduction

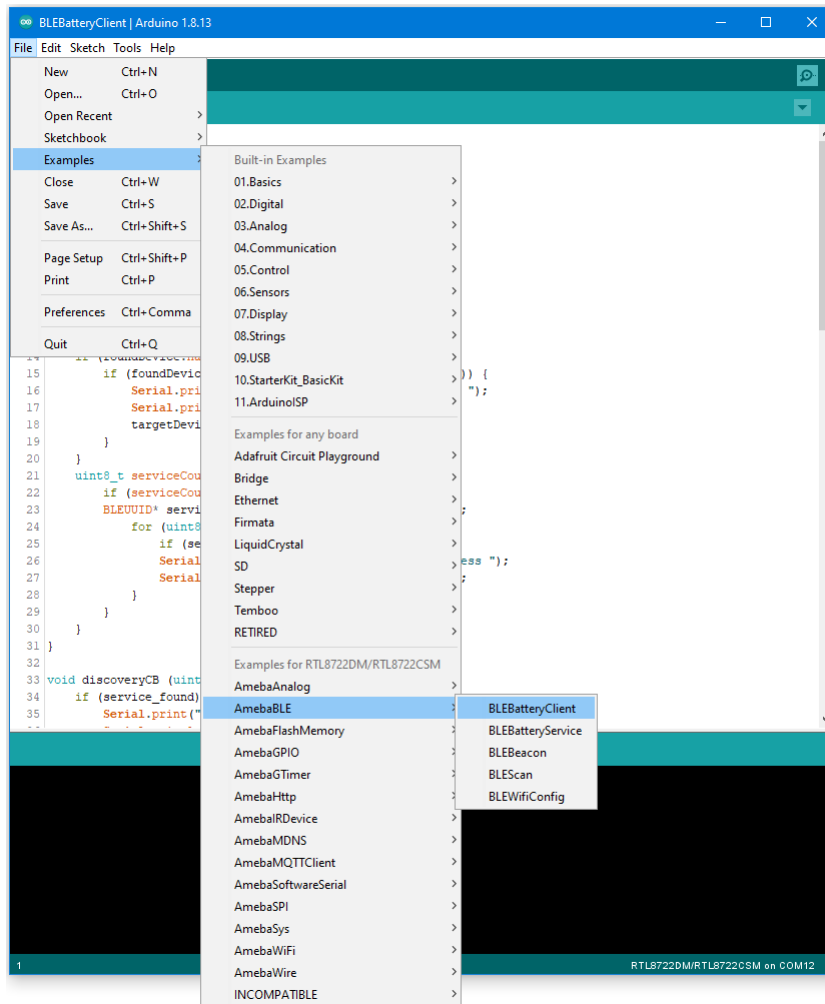
BLE connections use a server client model. The server contains the data of interest, while the client connects to the server to read the data. Commonly, a Bluetooth peripheral device acts as a server, while a Bluetooth central device acts as a client. Servers can contain many services, with each service containing a some set of data. Clients can send requests to read or write some data and can also subscribe to notifications so that the server can send data updates to a client.

In this example, a basic battery client is set up on the Ameba Bluetooth stack. The client connects to another Ameba board running the corresponding BLE battery service to read the battery level data.

#### Procedure

On the first Ameba board, upload the BLEBatteryService example code and let it run.

For the second Ameba board, open the example “Files” -> “Examples” -> “AmebaBLE” -> “BLEBatteryClient” .



Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor and observe the log messages as the Ameba board with the battery client scans, connects, and reads data from the Ameba board with the battery service.

```

COM9
[21:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:fe:d2
[BLE Device] GAP scan start
Found Ameba BLE Device at address 70:1D:08:0B:DD:DB
Found Battery Service at address 70:1D:08:0B:DD:DB
[BLE Device] GAP scan stop
[BLE Device] Connected conn_id 0
BLE connected to device at 0
Battery service found on connection id: 0
Battery level read callback for connection id: 0 Battery level: 90
Notifications Enabled
Notification received for connection id: 0 Battery level: 9
Notification received for connection id: 0 Battery level: 10
Notification received for connection id: 0 Battery level: 11
Notification received for connection id: 0 Battery level: 12
Notification received for connection id: 0 Battery level: 13
Battery level read callback for connection id: 0 Battery level: 90
Notification received for connection id: 0 Battery level: 14
Notification received for connection id: 0 Battery level: 15
Notification received for connection id: 0 Battery level: 16
Notification received for connection id: 0 Battery level: 17
Notification received for connection id: 0 Battery level: 18
Notifications Disabled
Autoscroll Show timestamp Newline 115200 baud Clear output

```

Highlighted in yellow, the Ameba board with the battery client first scans for advertising BLE devices with the advertised device name “AMEBA\_BLE\_DEV” and the advertised service UUID of 0x180F representing the battery service.

After finding the target device, the Ameba board with the battery client forms a BLE connection and searches for a battery service on the connected device, highlighted in blue.

With the client connected to the service, the battery client begins to read data using both regular data reads and notifications, highlighted in green.

## Code Reference

BLEClient is used to create a client object to discover services and characteristics on the connected device.

- `setNotifyCallback()` is used to register a function that will be called when a battery level notification is received.
- `BLE.configClient()` is used to configure the Bluetooth stack for client operation.
- `addClient(connID)` creates a new BLEClient object that corresponds to the connected device.

## BLE –WiFi Configuration Service

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

## Example

### Introduction

In this example, a WiFi configuration service is set up on the Ameba Bluetooth stack. A mobile phone with the configuration app connects to the Ameba device using BLE and configures the Ameba to connect to the correct WiFi access point.

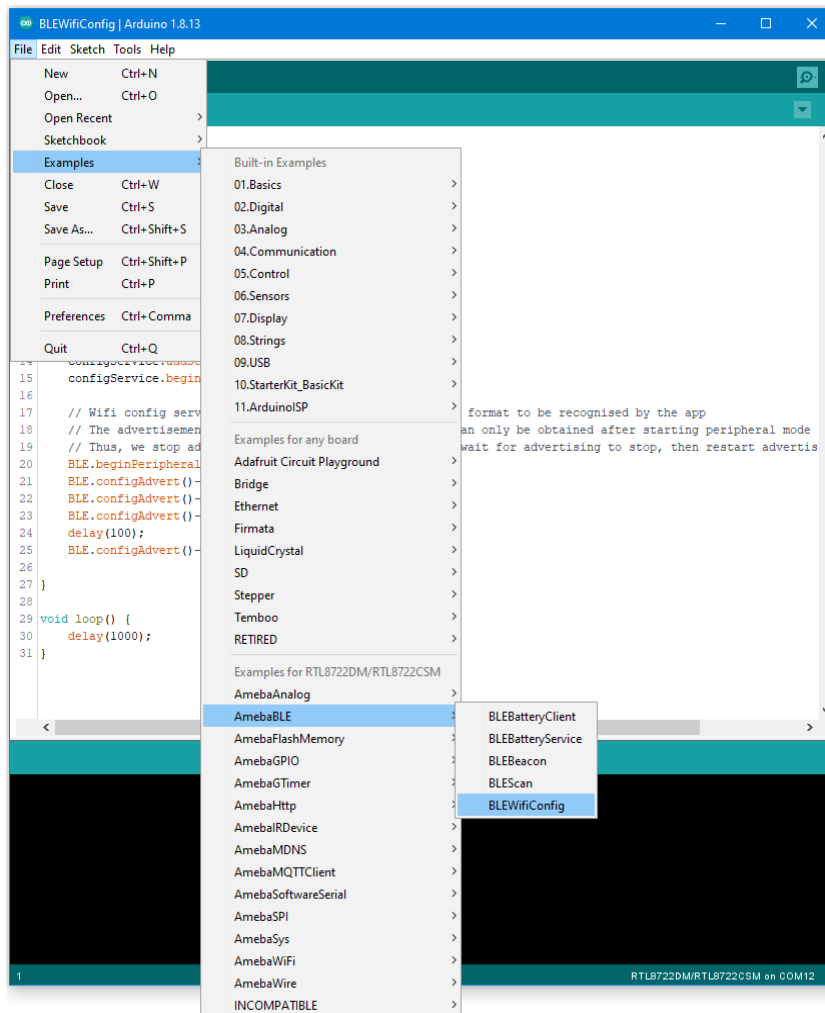
### Procedure

Ensure that the Realtek WiFi configuration app is installed on your mobile phone, it is available at:

–Google Play Store: <https://play.google.com/store/apps/details?id=com.rtk.btconfig>

–Apple App Store: <https://apps.apple.com/sg/app/easy-wifi-config/id1194919510>

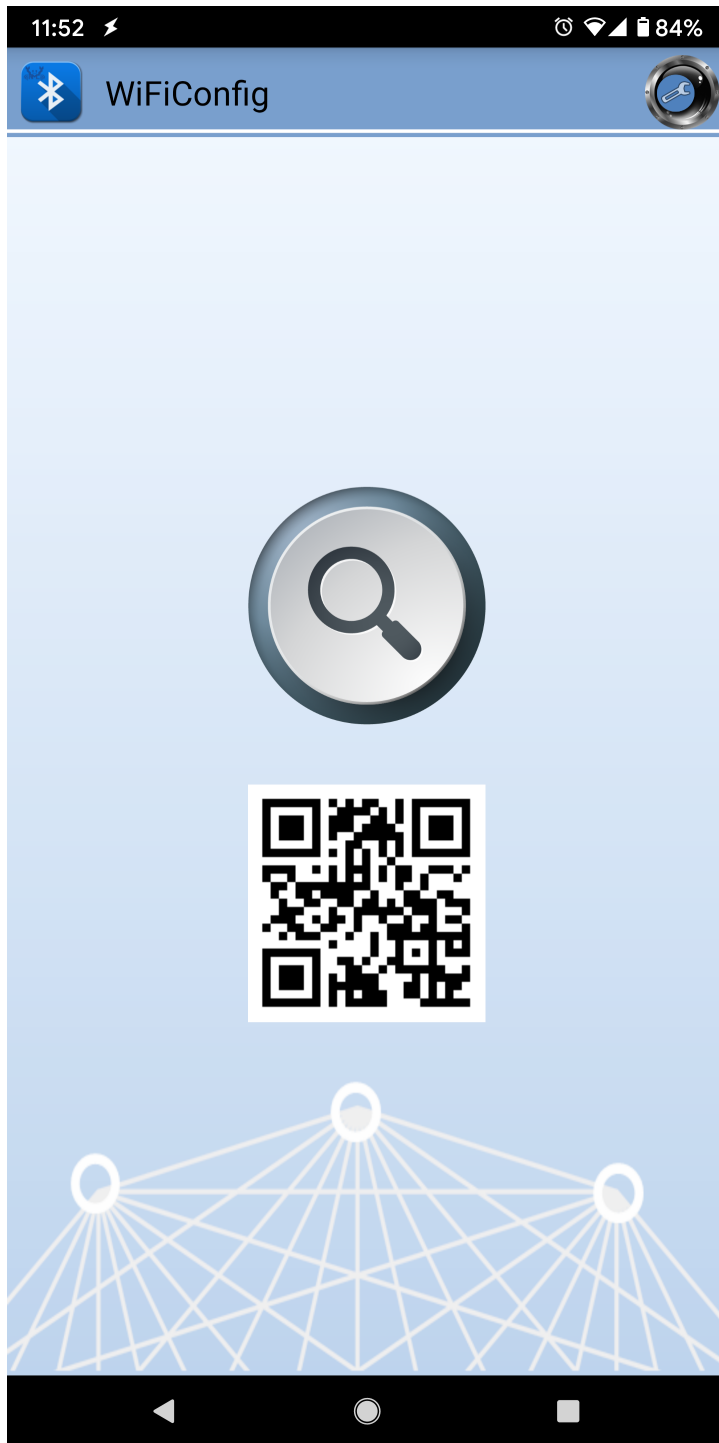
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEWifiConfigService” .



Upload the code and press the reset button on Ameba once the upload is finished.

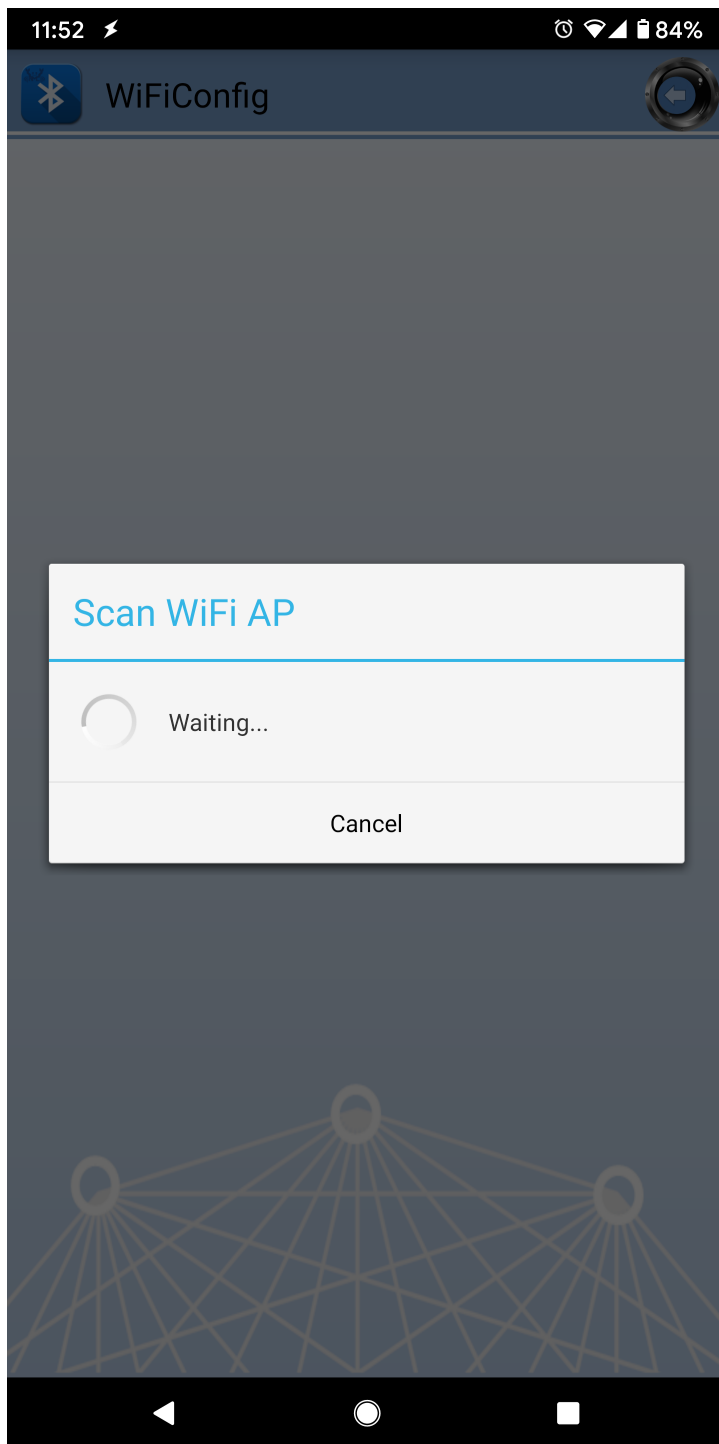


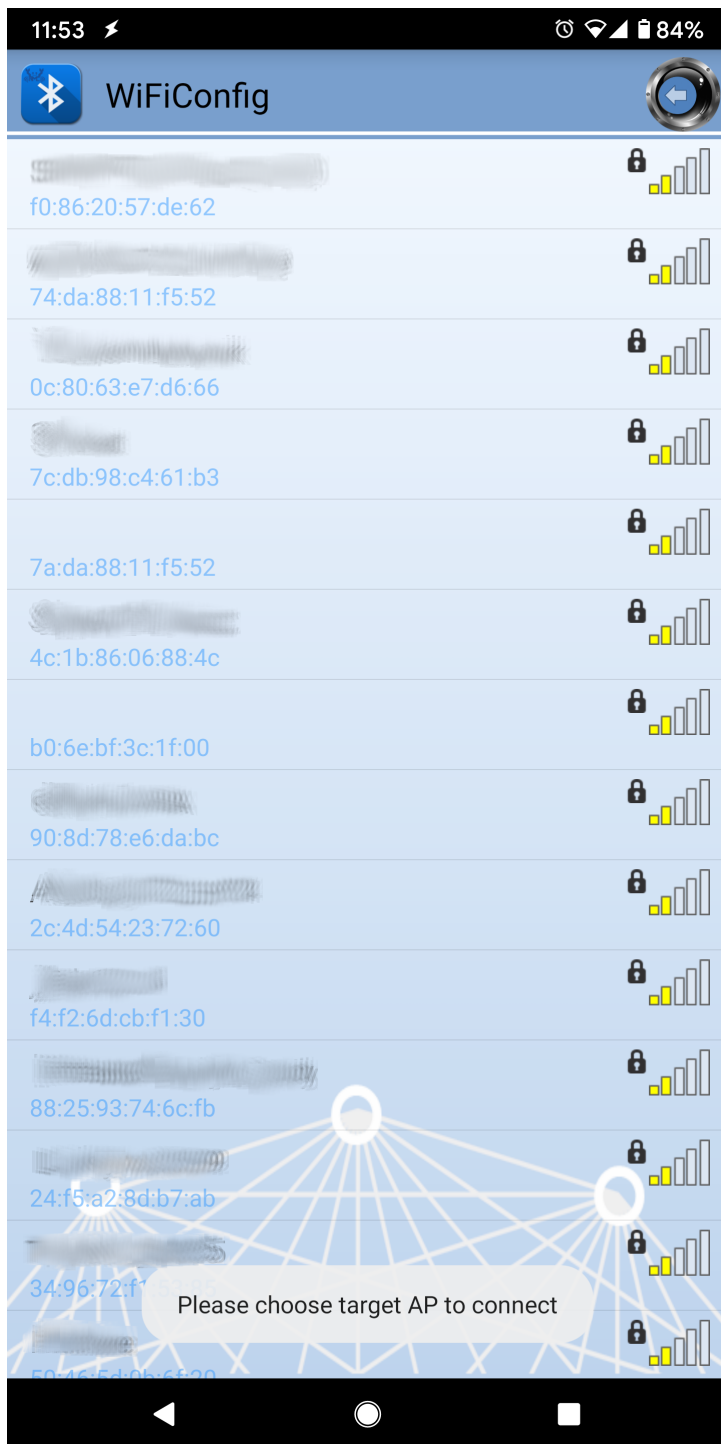
On your mobile phone, open the Realtek WiFiConfig app and tap the round button to scan for Ameba boards.



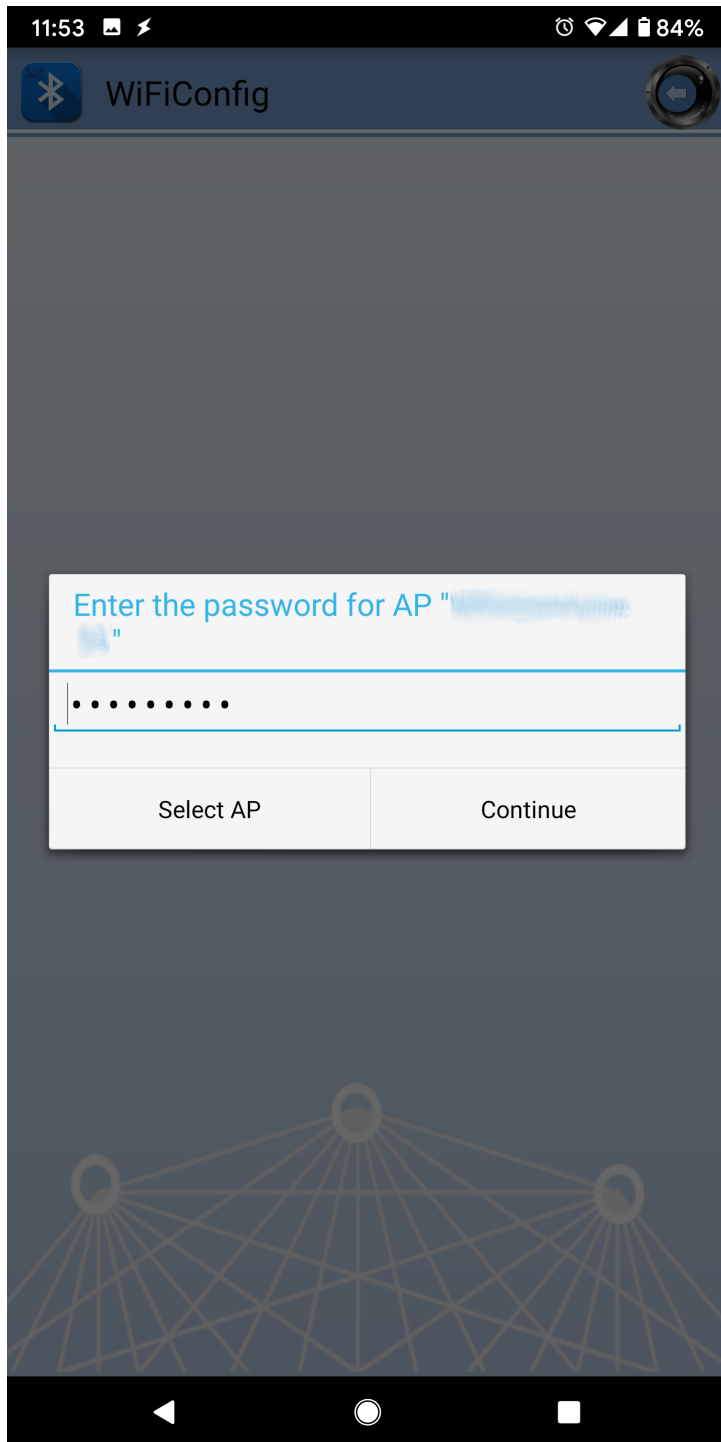
Select the correct Ameba board from the scan results. The app will connect to the Ameba board and ask the board to scan for WiFi networks and send the scan results back to the app using BLE.



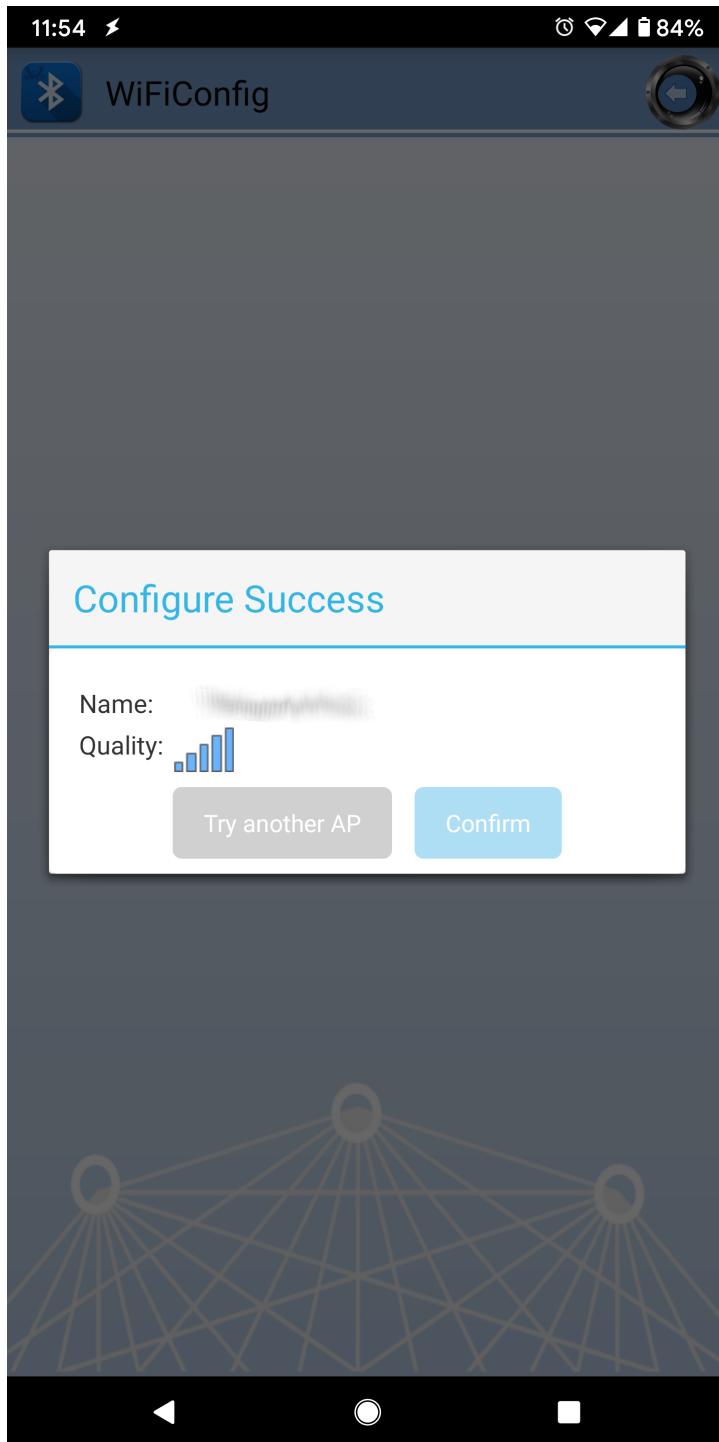




If your phone is currently connected to a WiFi network, the app will ask for the WiFi password to connect the Ameba board to the same WiFi network. Tap “Select AP” to choose another WiFi network, or enter the password and tap continue to connect Ameba to the selected WiFi network.



After the Ameba board connects to the WiFi network, the following message will be shown. Tap “Try another AP” to connect to another WiFi network or tap “Confirm” to keep the current WiFi network and disconnect BLE from the Ameba board.



### Code Reference

BLEWifiConfigService is used to create an instance of the WiFi configuration service to run on the Bluetooth device.

`BLE.configAdvert() -> setAdvType(configService.advData())` is used to set the correct advertisement data necessary for the phone app to find the Ameba Bluetooth device.

## BLE –BLE UART Client

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

### Example

#### Introduction

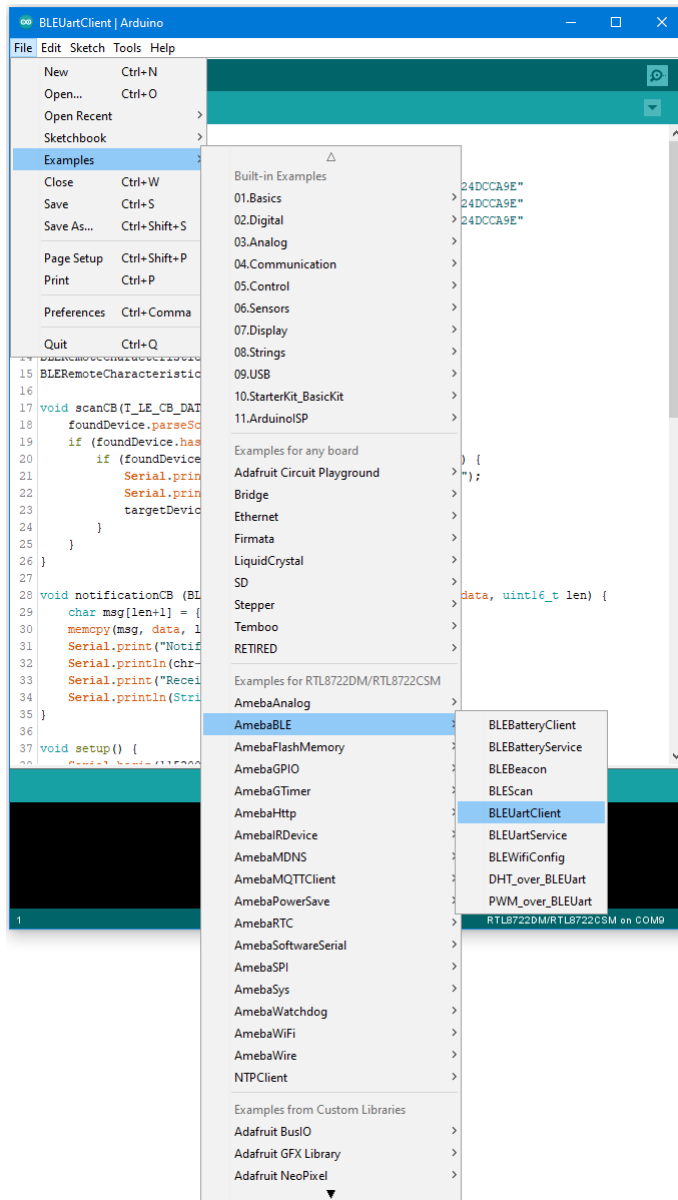
In this example, two RTL8722 boards are connected using BLE. One board runs a BLE UART service, while the other connects to the service using a client and both boards are able to communicate with text messages over the UART service.

#### Procedure

On the first board, upload the BLE UART service example code. Refer to the example guide for detailed instructions.

For the second board, open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEUartClient”

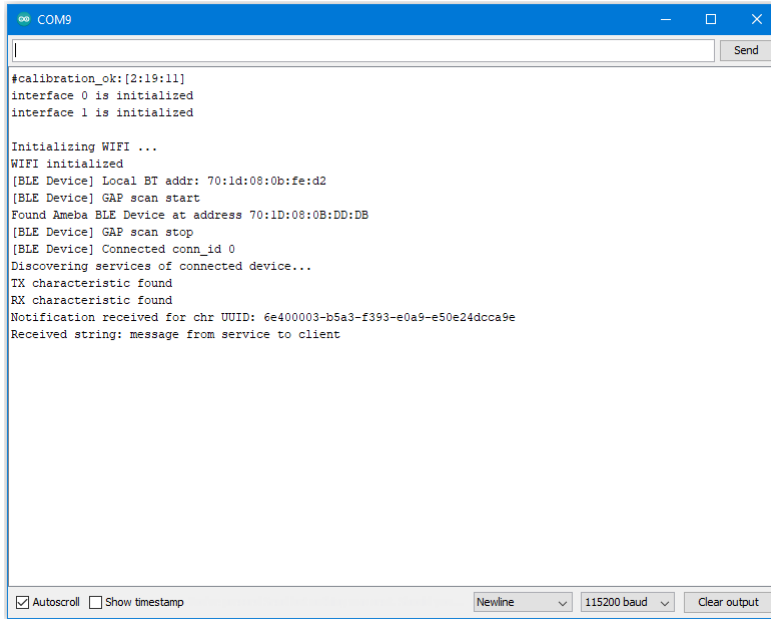
.



Upload the code and press the reset button on Ameba once the upload is finished.

Reset the UART service board first, wait for the BLE advertisement process to begin, and reset the UART client board. The client board should scan, discover, and connect to the service board. After connecting, the client board will verify that the correct UART service exists on the service board, before enabling notifications on the TX characteristic. Any message typed in the serial terminal will be sent to the other board using the UART service.





```
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:fe:d2
[BLE Device] GAP scan start
Found Ambeba BLE Device at address 70:1D:08:0B:DD:DB
[BLE Device] GAP scan stop
[BLE Device] Connected conn_id 0
Discovering services of connected device...
TX characteristic found
RX characteristic found
Notification received for chr UUID: 6e400003-b5a3-f393-e0a9-e50e24dcca9e
Received string: message from service to client
```

## Code Reference

The `BLEClient` class is used to discover the services that exist on a connected BLE device. The discovery process will create `BLERemoteService`, `BLERemoteCharacteristic` and `BLERemoteDescriptor` objects corresponding to the services, characteristics and descriptors that exist on the connected device. These objects can then be used to read and write data to the connected device.

## BLE –BLE UART Service

### Materials

- AmbebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS smartphone

### Example

#### Introduction

With BLE, application data is sent and received using the GATT system. GATT uses services, characteristics, and attributes to organise data and control how the data can be read from and written to. The Bluetooth SIG specification for BLE includes several predefined services for common applications, but users are free to implement custom services and characteristics to best fit their data structure and application needs

In this example, the `BLEService` and `BLECharacteristic` classes are used to implement a custom service for transmitting ASCII characters similar to regular UART. This custom service is the Nordic UART Service, which is supported in several smartphone apps.

## Procedure

Ensure that a compatible BLE UART app is installed on your smartphone, it is available at:

–Google Play Store:

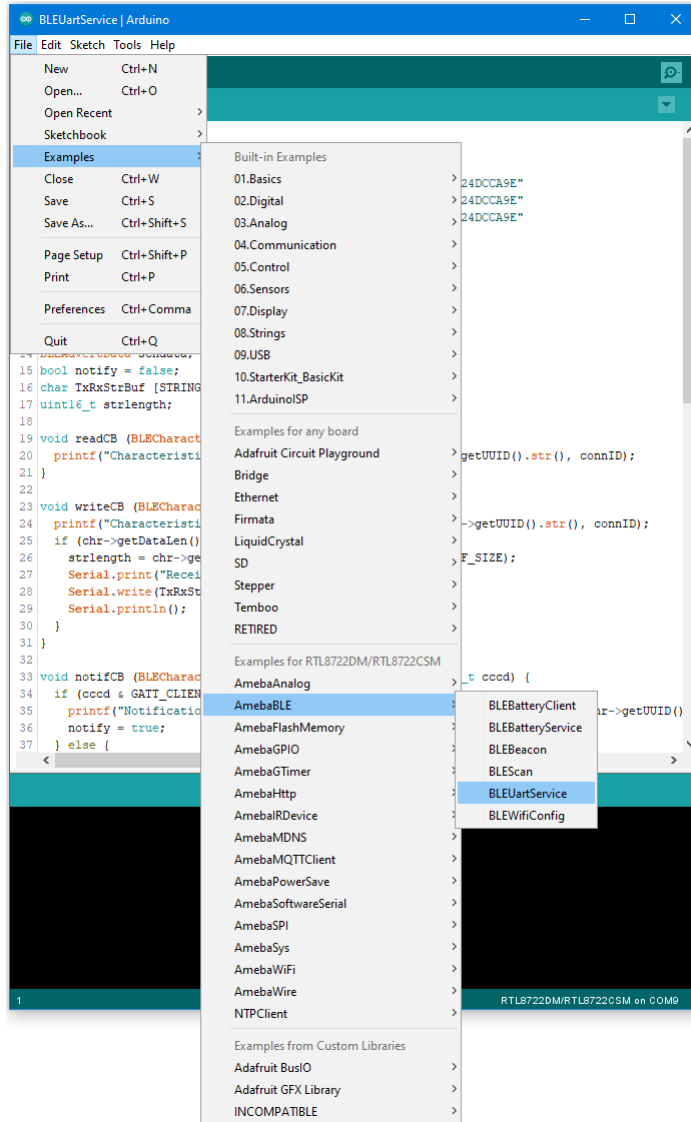
<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connect>

[https://play.google.com/store/apps/details?id=de.kai\\_morich.serial\\_bluetooth\\_terminal](https://play.google.com/store/apps/details?id=de.kai_morich.serial_bluetooth_terminal)

–Apple App Store:

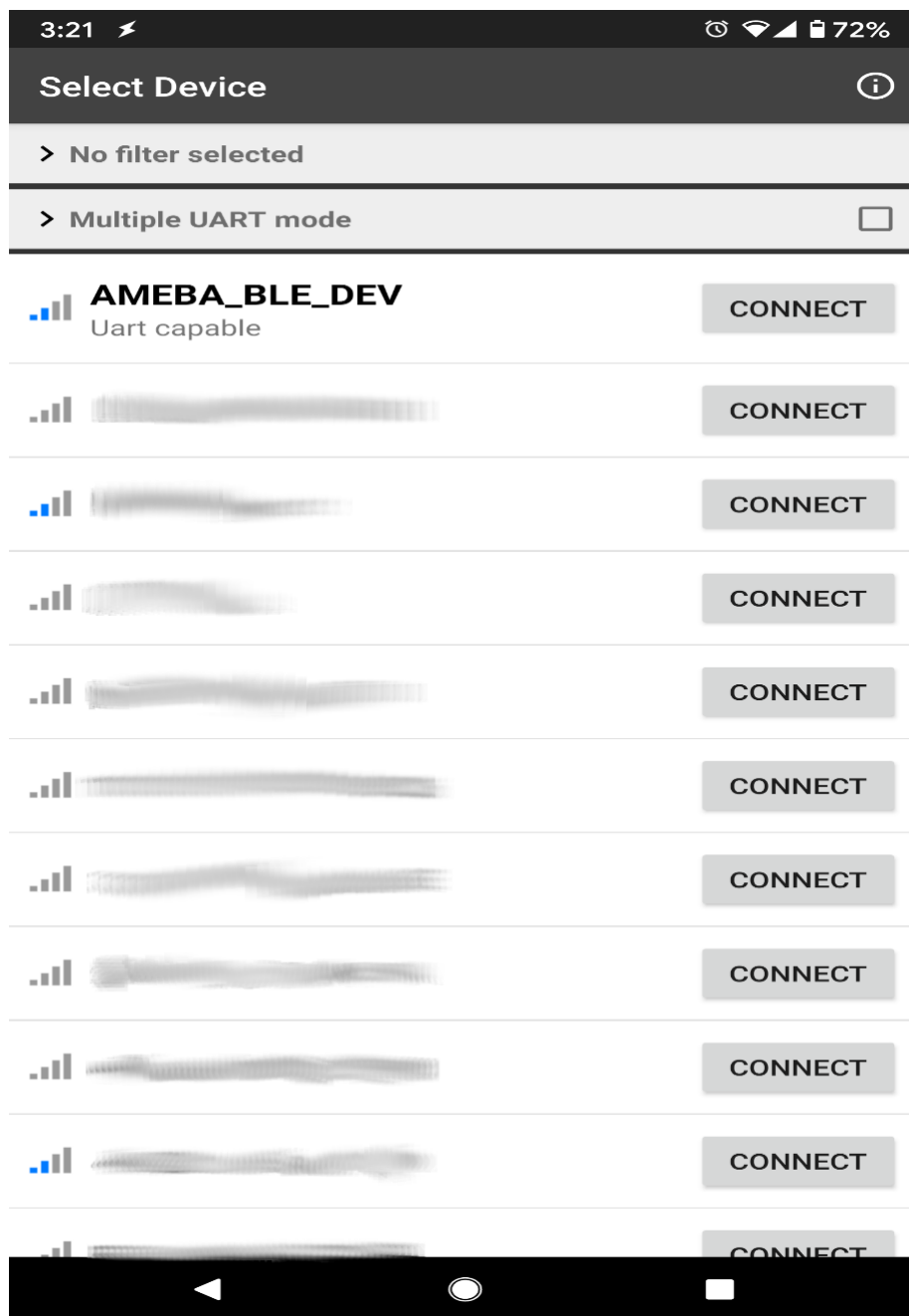
<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

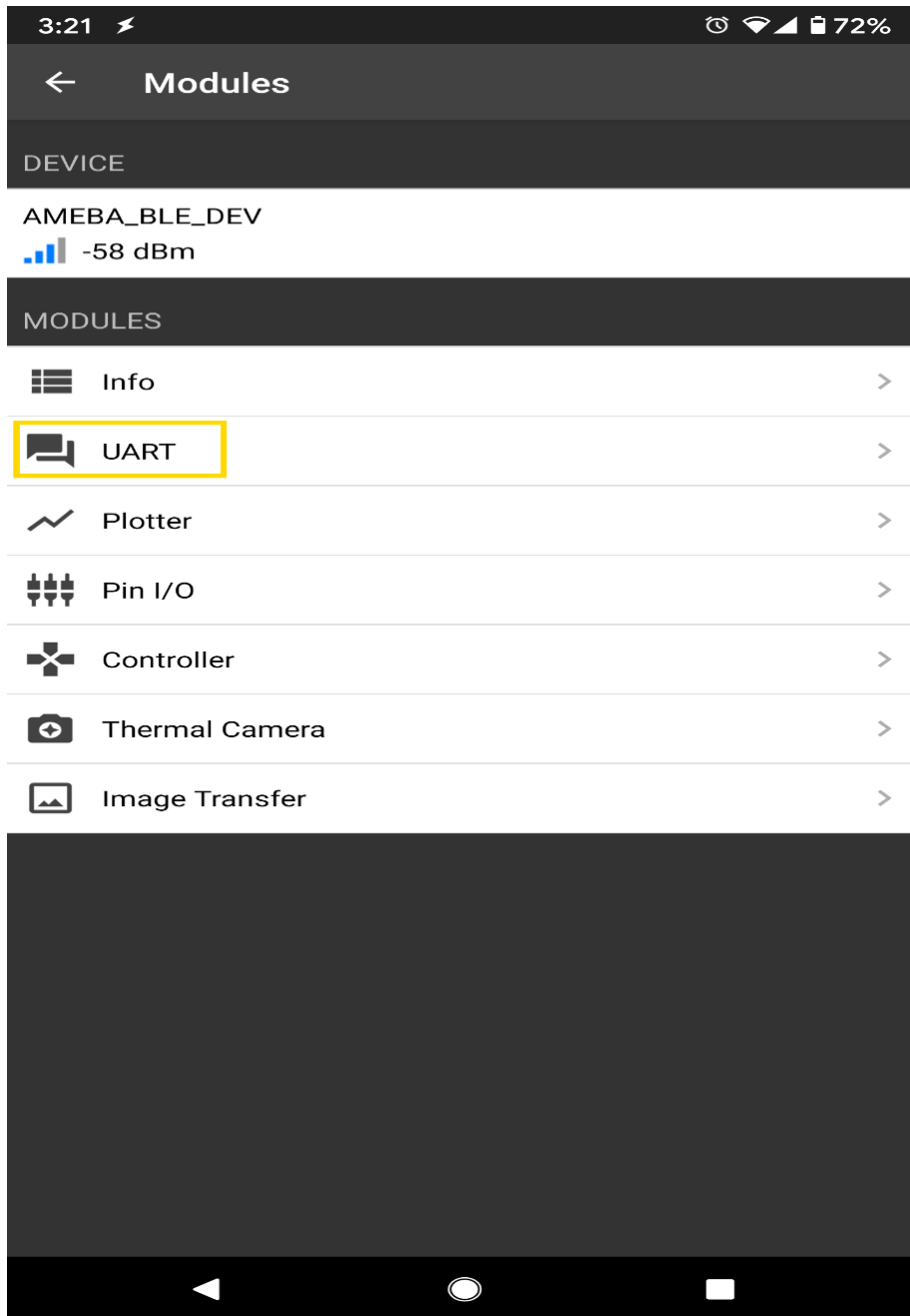
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEUartService” .



Upload the code and press the reset button on Ameba once the upload is finished.

Open the app on your smartphone, scan and connect to the Ameba board shown as “AMEBA\_BLE\_DEV” and choose the UART function in the app. Note that the BLE UART service on the Ameba board will only work with the UART and Plotter functions in the Bluefruit Connect app, other functions (Pin I/O, Image Transfer) require other BLE services that are not included in this example.





In the UART terminal section of the app, enter a message and click send. You should see the message appear in the Arduino serial monitor.

In the Arduino serial monitor, enter a message and click send. The message will appear in the smartphone app.



**message from app to Ameba**  
message from Ameba to smartphone app



```

COM9
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:ferd2
[BLE Device] GAP adv start
[BLE Device] GAP adv stopped: because connection created
[BLE Device] BT Connected
Notifications enabled on Characteristic 6e400003-b5a3-f393-e0a9-e50e24dcca9e for connection 0
Characteristic 6e400002-b5a3-f393-e0a9-e50e24dcca9e write by connection 0 :
Received string: message from app to Ameba

```

## Code Reference

The `BLECharacteristic` class is used to create two characteristics, one for receive (Rx) and one for transmit (Tx), and added to a service created with the `BLEService` class.

The required read/write/notify properties are set for each characteristic using the `set__Property()` methods, and callback functions are registered using the `set__Callback()` methods. The required buffer size is also set for each characteristic so that it has enough memory to store a complete string.

When data is written to the receive characteristic, the registered callback function is called, which prints out the received data as a string to the serial monitor.

When data is received on the serial port, it is copied into the transmit characteristic buffer, and the `notify()` method is used to inform the connected device of the new data.

## BLE –DHT over BLE UART

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21
- Android / iOS smartphone

## Example

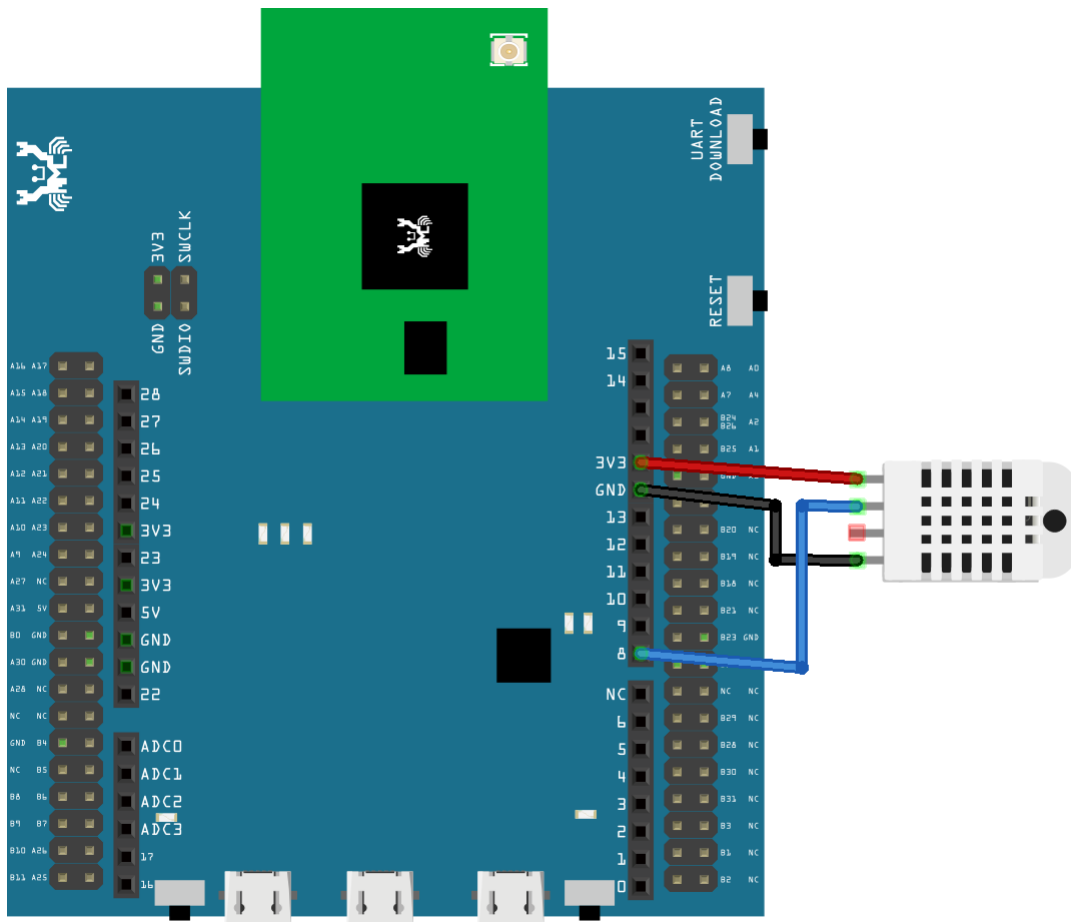
### Introduction

In this example, the data obtained from a DHT temperature and humidity sensor are transmitted over a BLE UART service to a smartphone. Refer to the other examples for detailed explanations of using the DHT sensor and the BLE UART service.

### Procedure

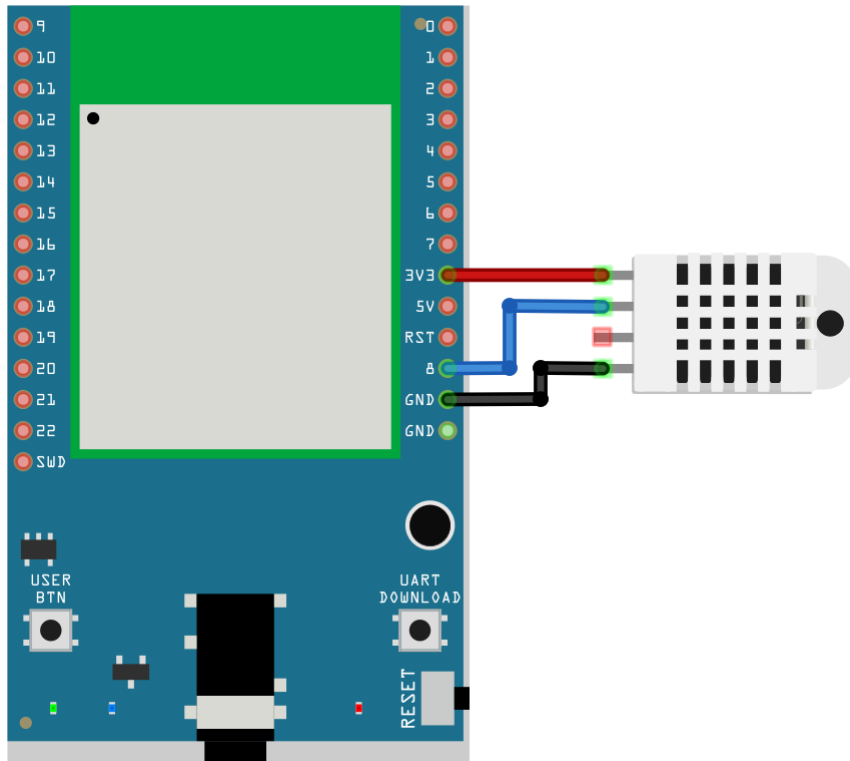
Connect the DHT sensor to the Ameba board following the diagram.

AMB21 / AMB22:

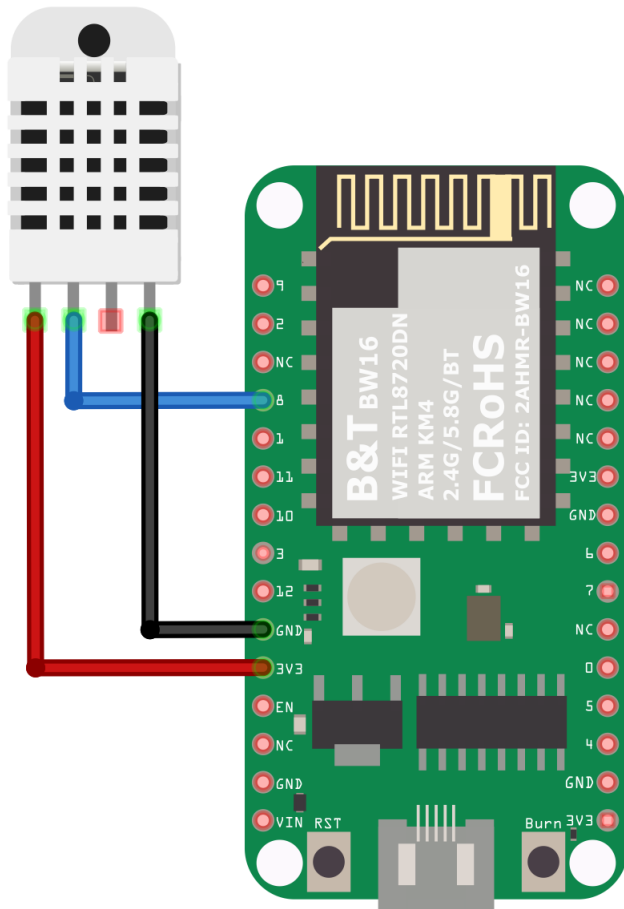


AMB23:





**BW16:**



Ensure that a compatible BLE UART app is installed on your smartphone, it is available at:

- Google Play Store:

<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connecta>>[https://play.google.com/store/apps/details?id=de.kai\\_morich.serial\\_bluetooth\\_terminal](https://play.google.com/store/apps/details?id=de.kai_morich.serial_bluetooth_terminal)

- Apple App Store:

<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “DHT\_over\_BLEUart” .

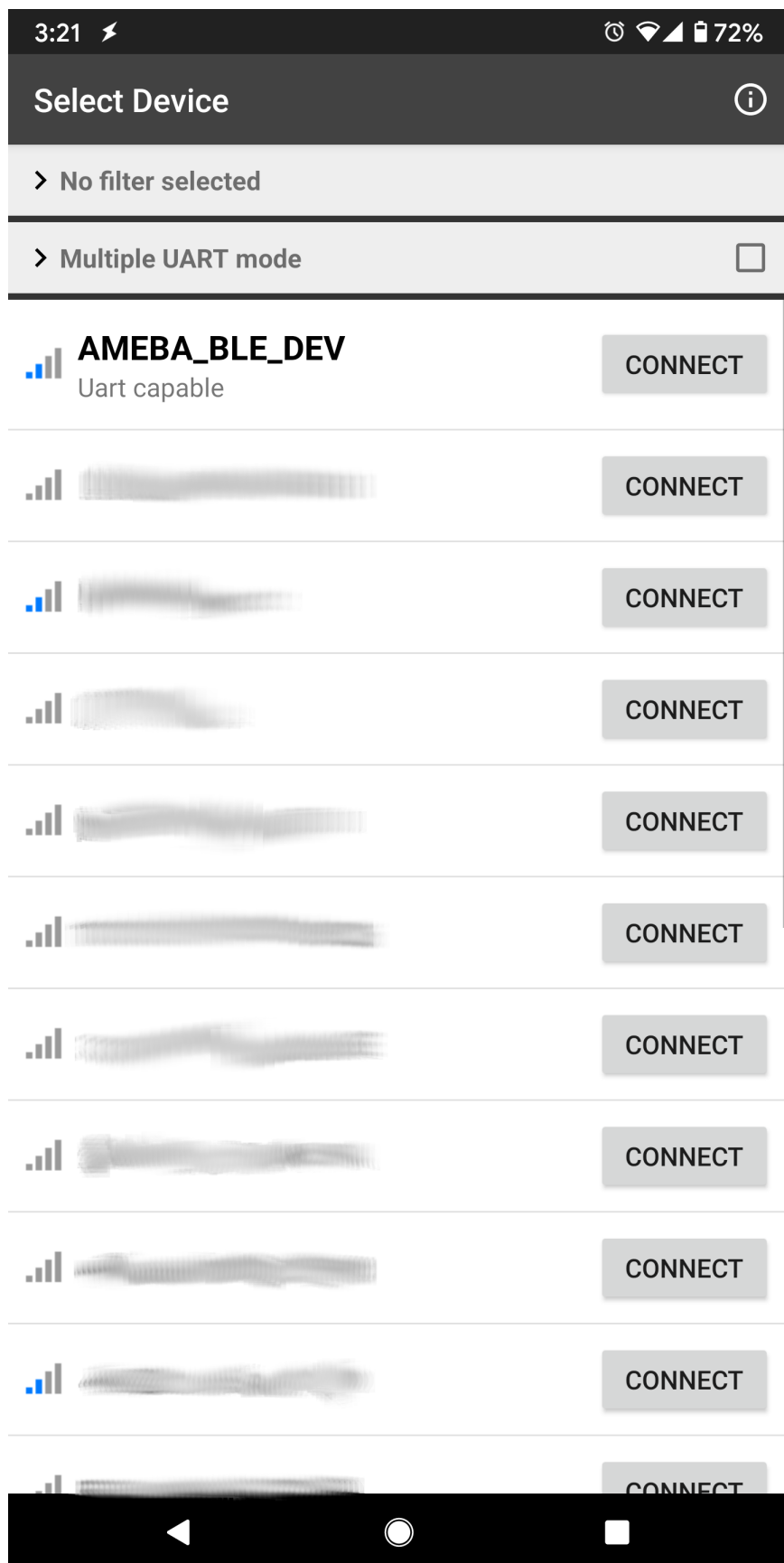
```

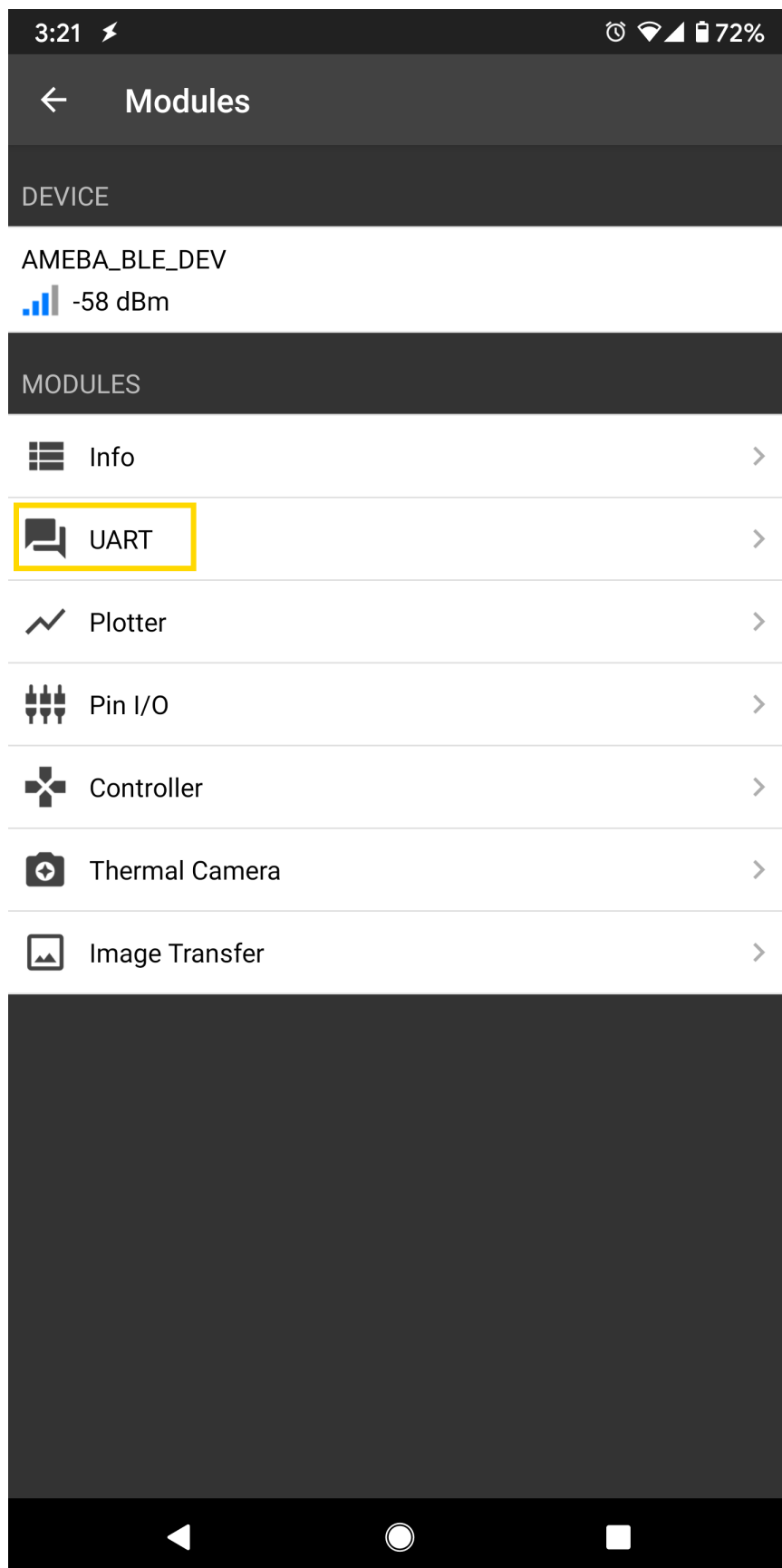
DHT_over_BLEUart
1
2 #include "BLEDevice.h"
3 #include "DHT.h"
4
5 #define UART_SERVICE_UUID    "6E400001-B5A3-F393-E0A9-E50E24DCCA9E"
6 #define CHARACTERISTIC_UUID_RX "6E400002-B5A3-F393-E0A9-E50E24DCCA9E"
7 #define CHARACTERISTIC_UUID_TX "6E400003-B5A3-F393-E0A9-E50E24DCCA9E"
8
9 #define STRING_BUF_SIZE 100
10
11 // The digital pin we're connected to.
12 #define DHTPIN 8
13
14 // Uncomment whatever type you're using!
15 #define DHITYPE DHT11 // DHT 11
16 // #define DHITYPE DHT22 // DHT 22 (AM2302), AM2321
17 // #define DHITYPE DHT21 // DHT 21 (AM2301)
18
19 DHT dht(DHTPIN, DHITYPE);
20
21 BLEService uartService(UART_SERVICE_UUID);
22 BLECharacteristic Rx(CHARACTERISTIC_UUID_RX);
23 BLECharacteristic Tx(CHARACTERISTIC_UUID_TX);
24 BLEAdvertData advdata;
25 BLEAdvertData scndata;
26 bool notify = false;
27 char TxRxStrBuf [STRING_BUF_SIZE] = {0};
28 uint16_t strlength;
29
30 void writeCB (BLECharacteristic* chr, uint8_t connID) {
31     printf("Characteristic %s write by connection %d :\n", chr->getUUID().str(), connID);
32     if (chr->getDataLen() > 0) {
33         strlength = chr->getData((uint8_t*)TxRxStrBuf, STRING_BUF_SIZE);
34         Serial.print("Received string: ");
35         Serial.write(TxRxStrBuf, strlength);
36         Serial.println();
37     }
38 }
39
40 void notifCB (BLECharacteristic* chr, uint8_t connID, uint16_t cccd) {
41     if (cccd & GATT_CLIENT_CHAR_CONFIG_NOTIFY) {
42         printf("Notifications enabled on Characteristic %s for connection %d \n", chr->getUUID().str(), connID);
43     }
44 }
45
46 void setup() {
47     Serial.begin(115200);
48     while (!Serial) continue;
49     Serial.println("DHT over BLE UART");
50     uartService.setName("DHT over BLE UART");
51     uartService.addCharacteristic(Rx);
52     uartService.addCharacteristic(Tx);
53     advdata.setServiceUuid(uartService.getUuid());
54     advdata.setIncludeName(true);
55     advdata.setIncludeTxPower(true);
56     scndata.setServiceUuid(uartService.getUuid());
57     scndata.setIncludeName(true);
58     scndata.setIncludeTxPower(true);
59     BLEDevice::init("AMEBA_BLE_DEV");
60     uartService.startAdvertising(advdata, scndata);
61     dht.begin();
62 }
63
64 void loop() {
65     if (dht.isDataAvailable()) {
66         float temperature = dht.temperature();
67         float humidity = dht.humidity();
68         Serial.print("Temperature: ");
69         Serial.print(temperature);
70         Serial.print(" Humidity: ");
71         Serial.print(humidity);
72         Serial.println();
73     }
74 }

```

Upload the code and press the reset button on Ameba once the upload is finished.

Open the app on your smartphone, scan and connect to the Ameba board shown as “AMEBA\_BLE\_DEV” and choose the UART function in the app.

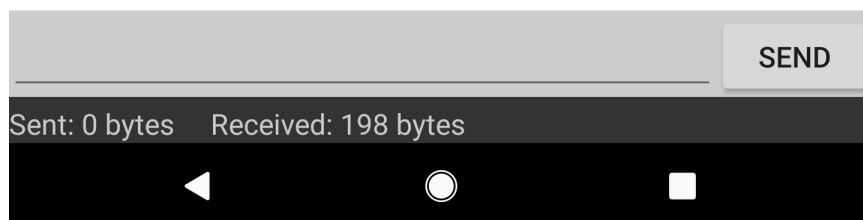




After starting the UART function, notifications should be received every 5 seconds containing the measured temperature and humidity.



Humidity: 59% Temperature: 27°C  
Humidity: 59% Temperature: 27°C  
Humidity: 62% Temperature: 27°C  
Humidity: 67% Temperature: 27°C  
Humidity: 69% Temperature: 27°C  
Humidity: 88% Temperature: 27°C



## BLE –PWM over BLE UART

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- RGB LED
- Android / iOS smartphone

### Example

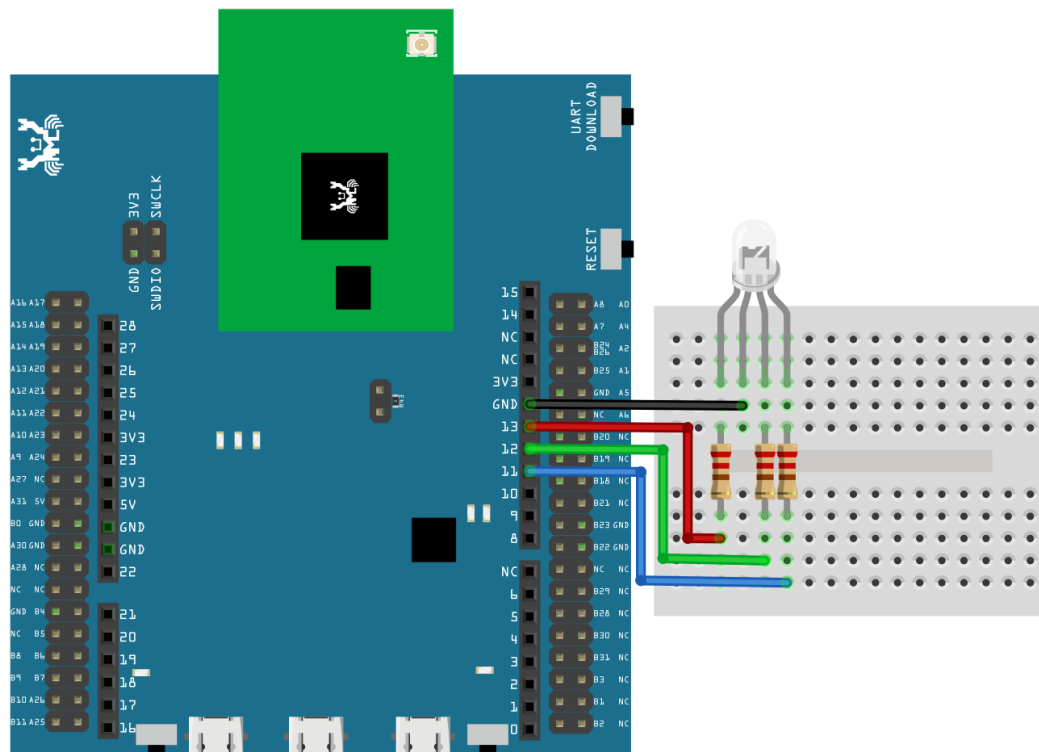
#### Introduction

In this example, a smartphone app is used to transmit commands over BLE UART to control the PWM outputs and change the color of a RGB LED. Refer to the other example guides for detailed explanations of the BLE UART service.

#### Procedure

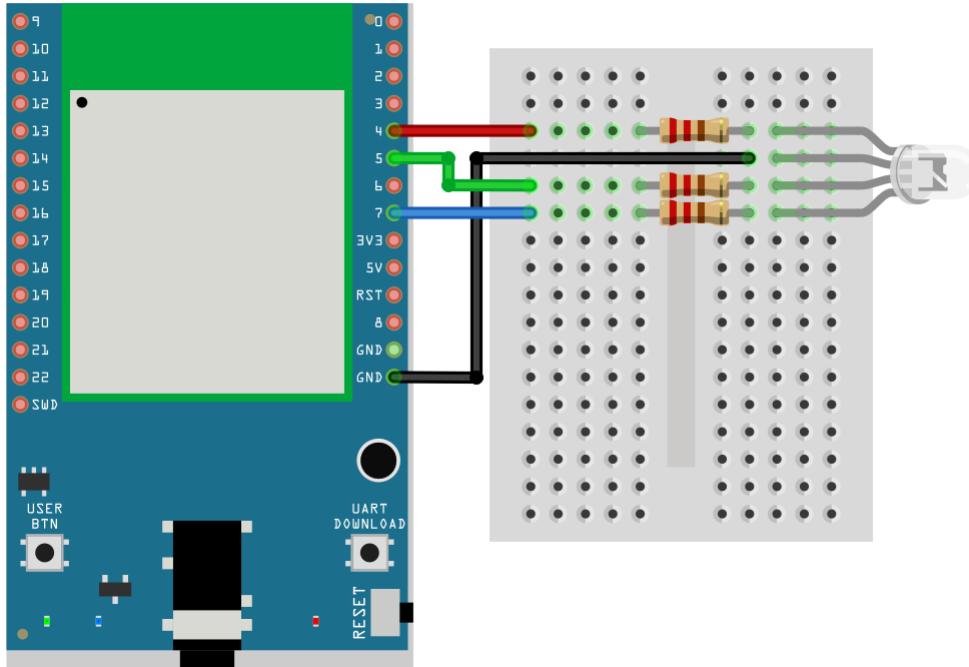
Connect the RGB LED to the RTL8722 board following the diagram, the common LED pin may need to connect to 3.3V or GND depending on the type of LED (common anode / common cathode).

#### AMB21 /AMB22:

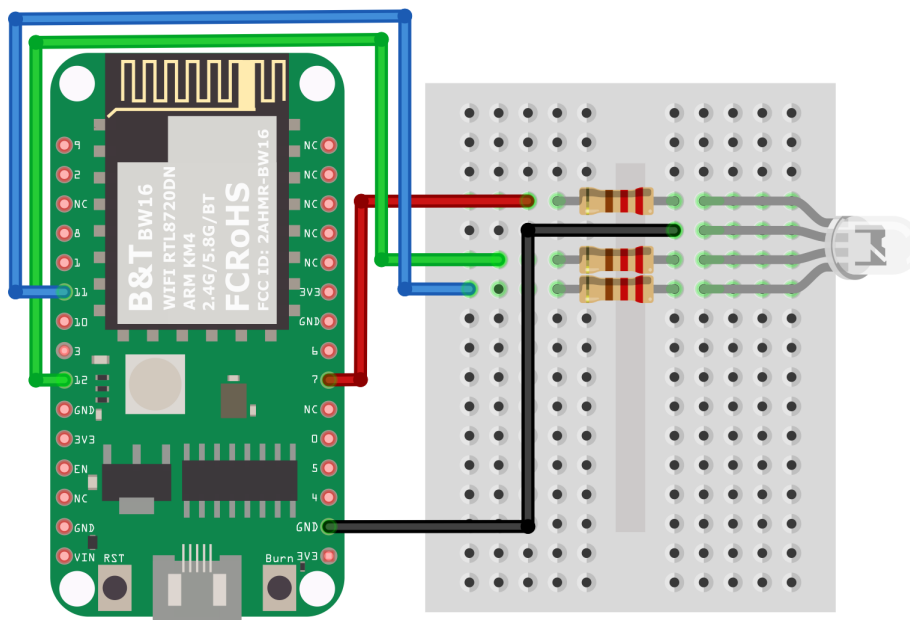




## AMB23:



## BW16:



Ensure that the required app is installed on your smartphone, it is available at:

–Google Play Store:

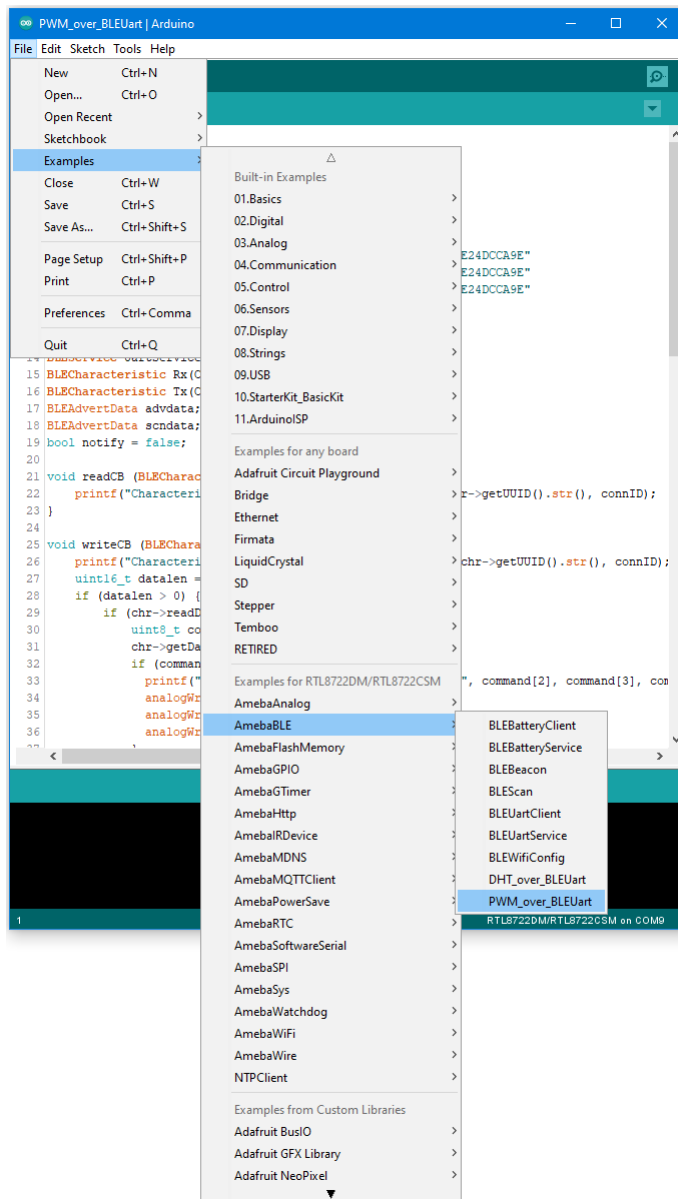
<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connect>

–Apple App Store:

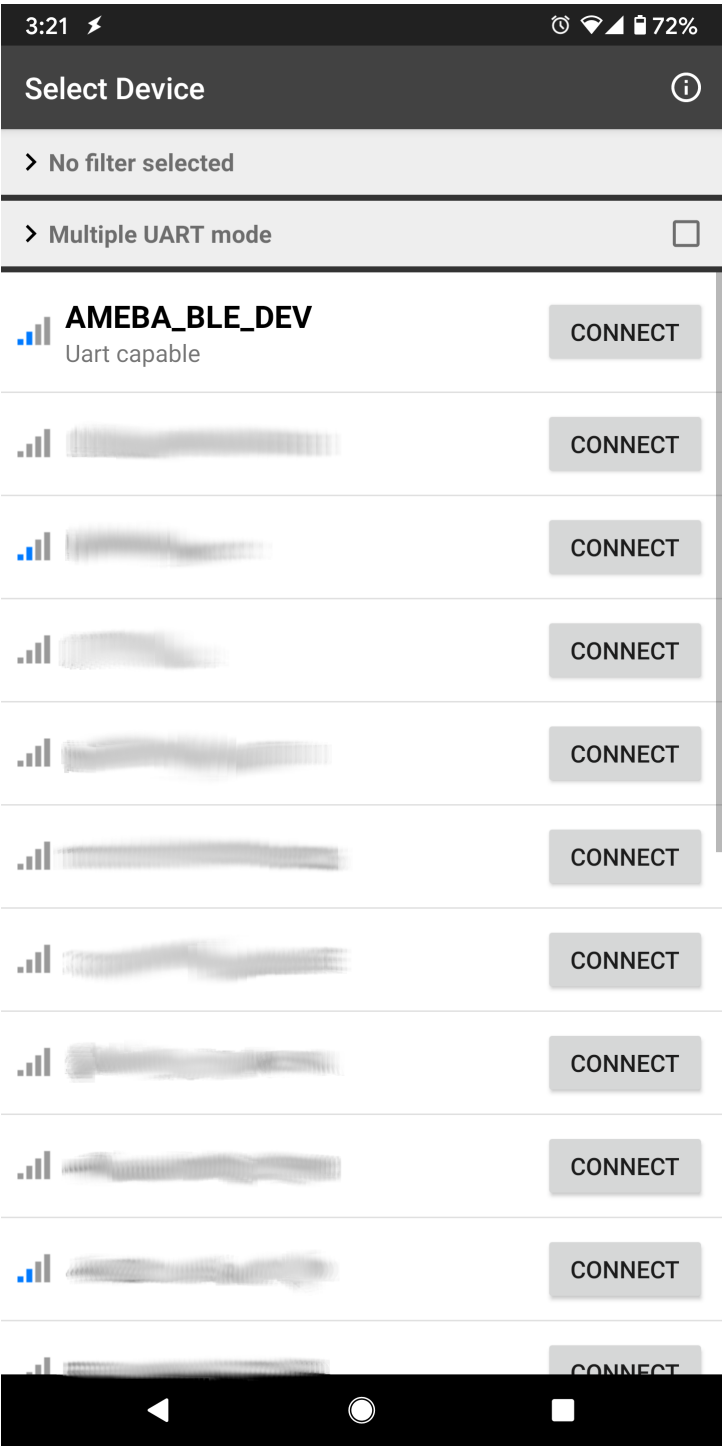
<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

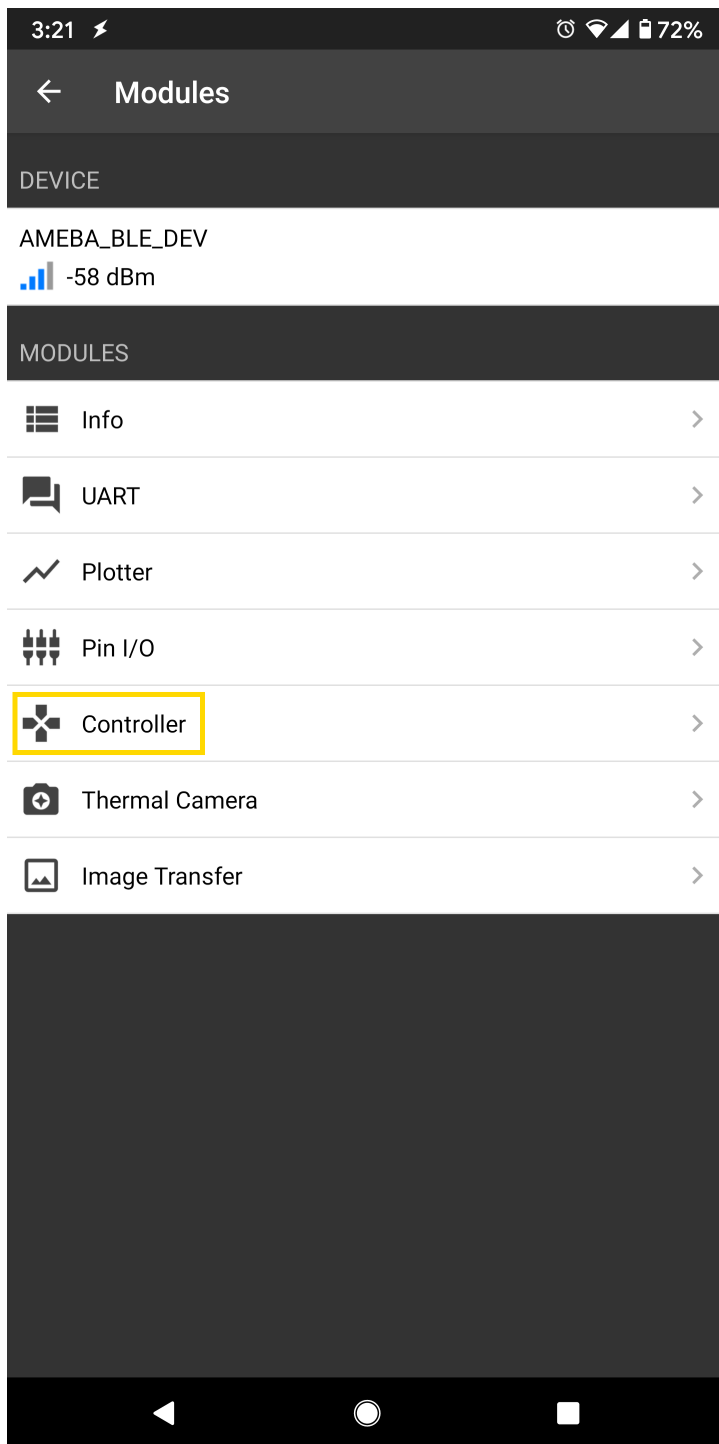
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “PWM\_over\_BLEUart” .

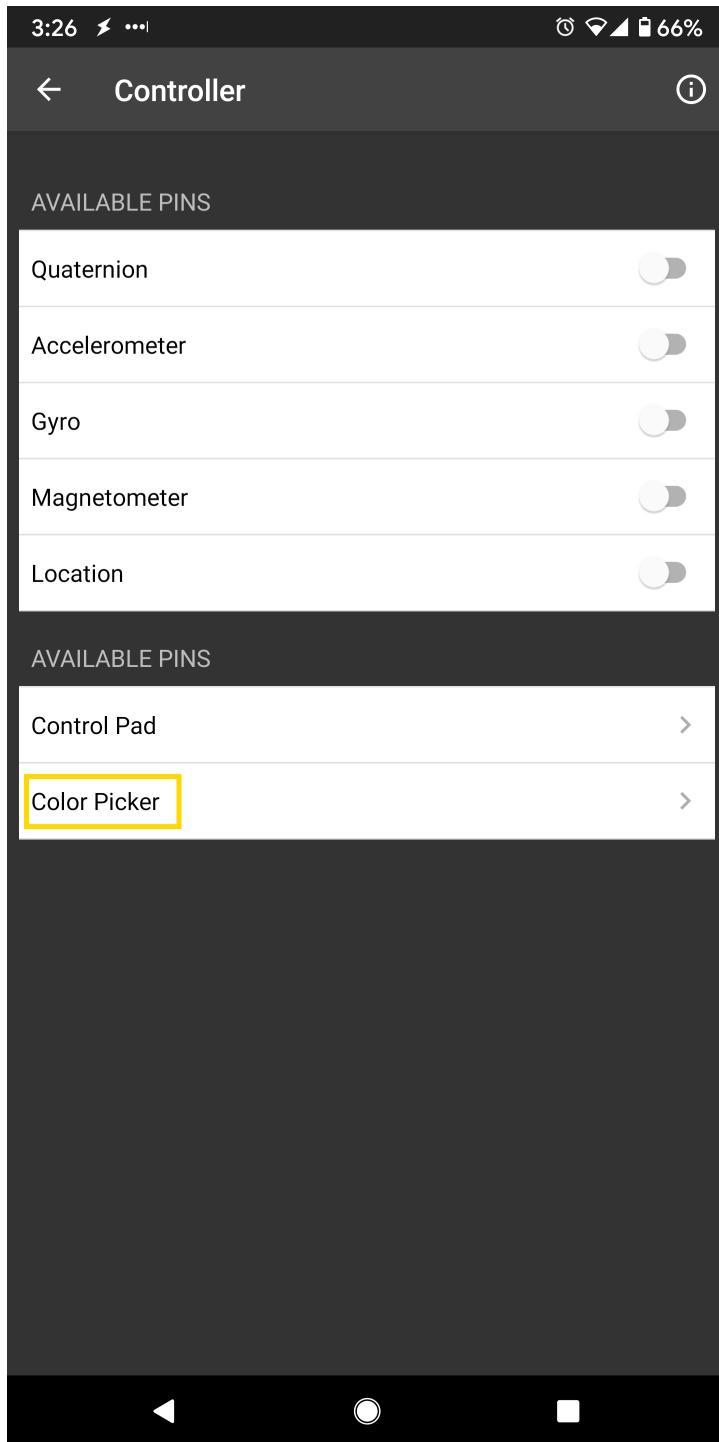
Upload the code and press the reset button on Ameba once the upload is finished.



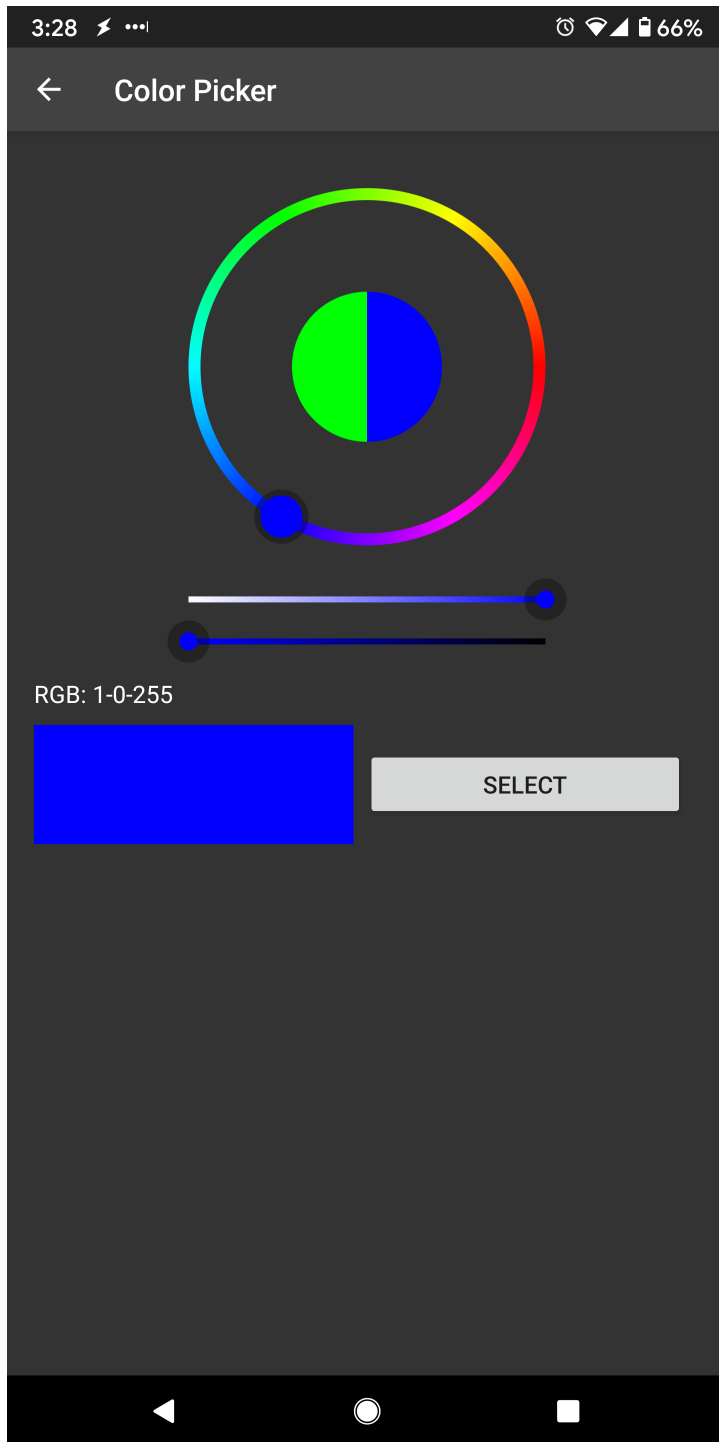
Open the app on your smartphone, scan and connect to the board shown as “AMEBA\_BLE\_DEV” and choose the controller -> color picker function in the app.







Using the color selection wheel, saturation, and brightness sliders, choose a desired color and click select to send the RGB values to the board. You should see the RGB LED change to the matching color.



### Code Reference

The RGB values are sent as three consecutive bytes prefixed by “!C” characters. The “!” exclamation mark is used to indicate that the following data is a command, and the “C” character is used to indicate that the data is RGB values. The received UART message is checked in the callback function for “!C” first, otherwise it is treated as a regular message

and printed to the serial terminal.

## BLE - HID Gamepad

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- BLE capable host device [Windows / Linux / MacOS / Android]

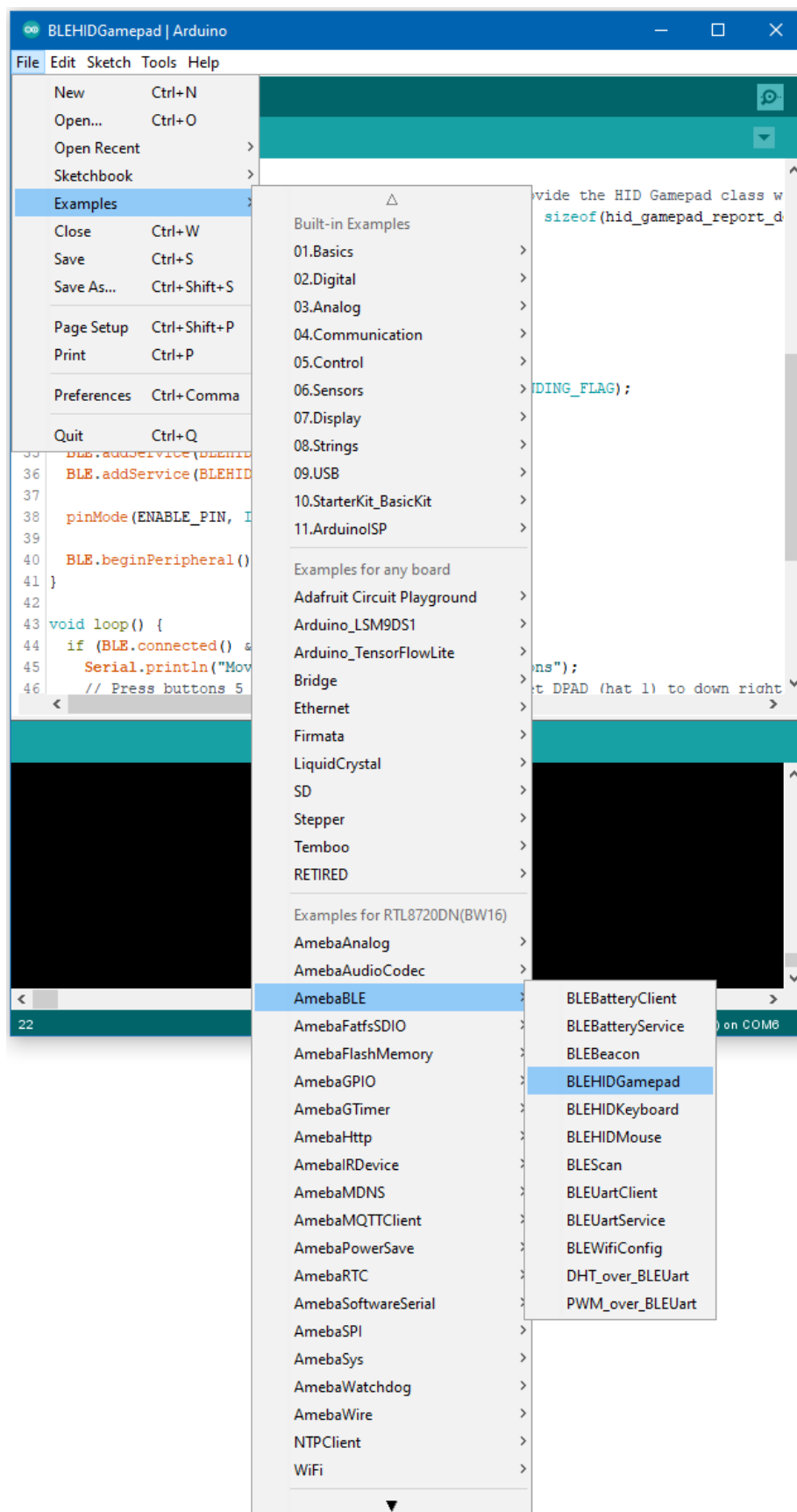
### Example

#### Introduction

In this example, the RTL8722 board emulates a HID gamepad connected using BLE.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> BLEHIDGamepad.



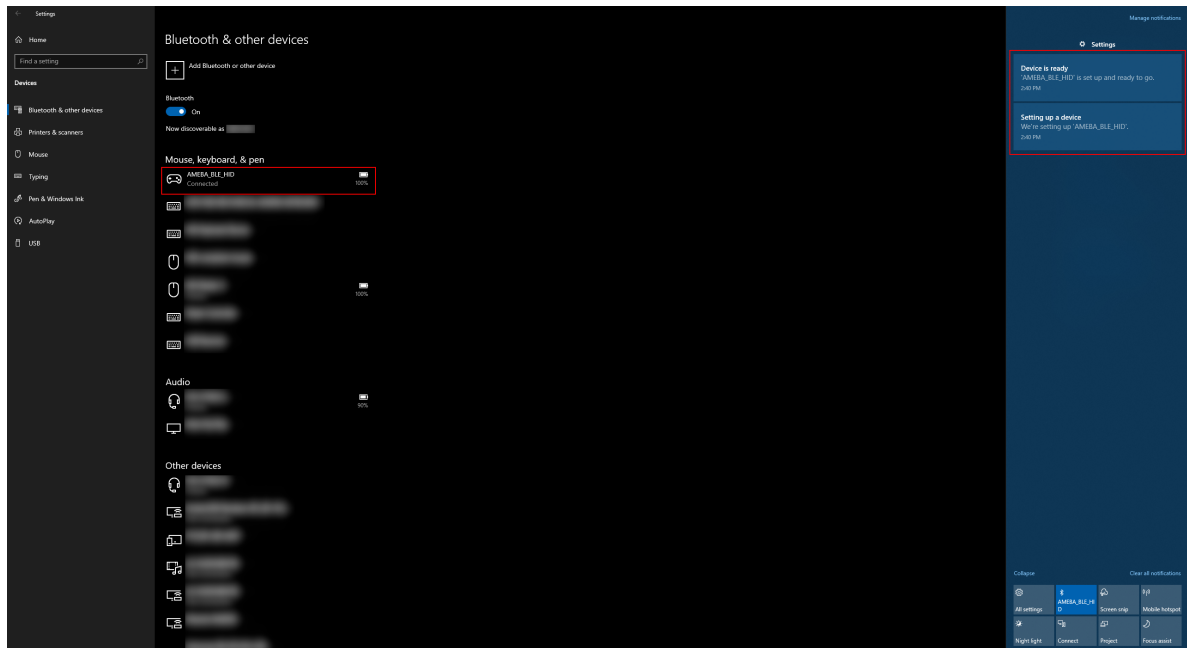


Upload the code and press the reset button once the upload is finished.

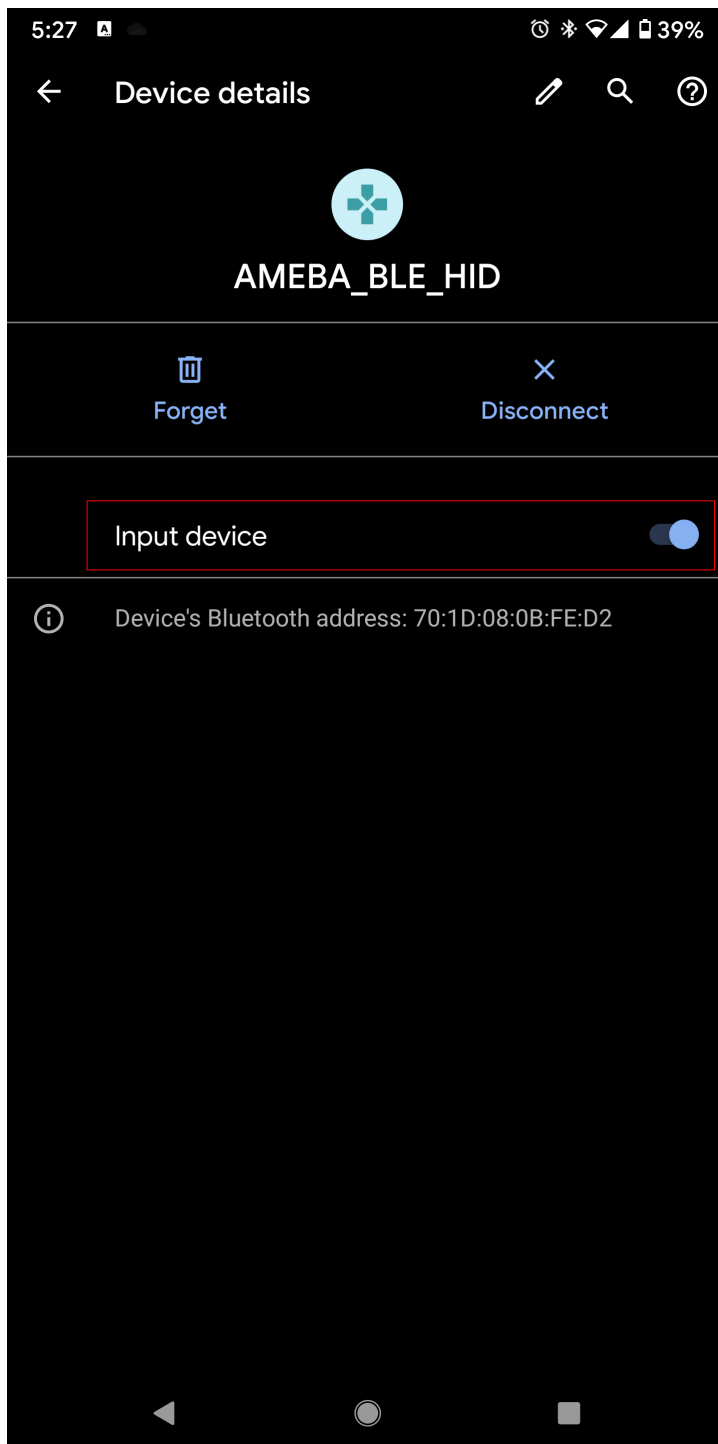
Immediately after reset, the board will begin BLE advertising as “AMEBA\_BLE\_HID” . On your host device, go to the Bluetooth settings menu, scan, and connect to the board.

You should ensure that the connection process is completed before proceeding.

On Windows, ensure that any driver installation is finished, and the board shows up in the Bluetooth menu under the “Mouse, keyboard & pen” category.

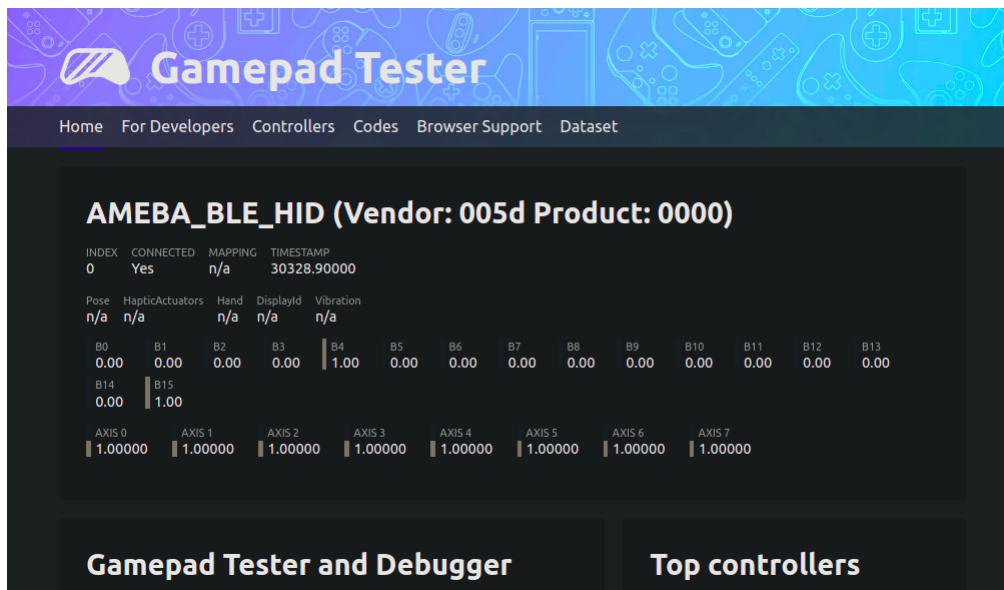


On Android, ensure that “Input device” is enabled for the board.

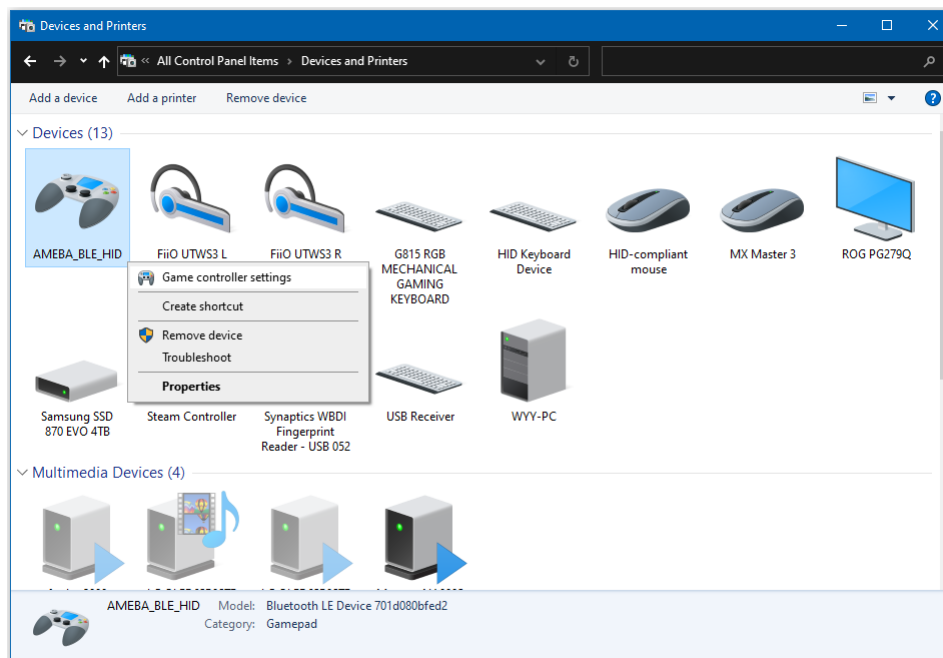


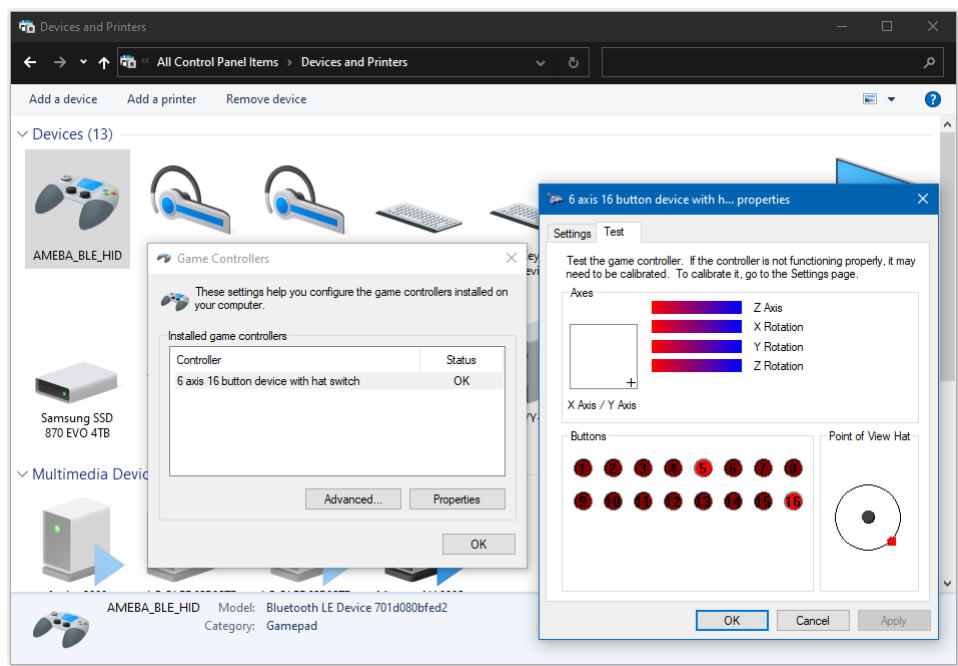
After the Bluetooth connection process is completed, the board is ready to send gamepad input to the host device. Connect digital pin 8 to 3.3V to start sending input, and connect to GND to stop.

To view the input, open a browser window and go to [Gamepad Tester](#). The connected gamepad device should show up here, and some of the buttons and axes should show changing values.

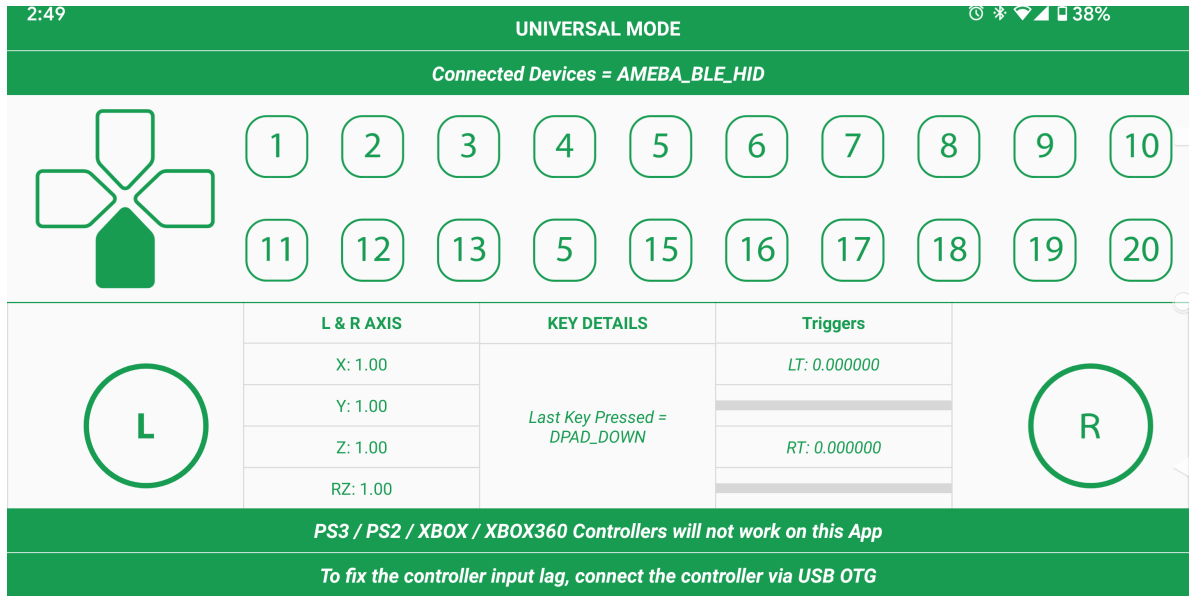


On Windows, gamepad input can also be viewed by going to “Control Panel” -> “Devices and Printers” -> “AMEBA\_BLE\_HID” -> “Game Controller Settings” -> “Properties”. The buttons and axes should also show changing values here.





On Android, gamepad testing apps such as [Andriod Gamepad Tester](#) can also be used to view the gamepad input.



Code Reference

By default, the board emulates a gamepad with an 8-direction hat switch (d-pad), 6 analog axes and 16 buttons. How the inputs are interpreted is dependent on the host device, and the button ordering may differ between devices. Also, some axes or buttons may be disabled or missing on certain host devices.

## BLE - HID Keyboard

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- BLE capable host device [Windows / Linux / MacOS / Android]

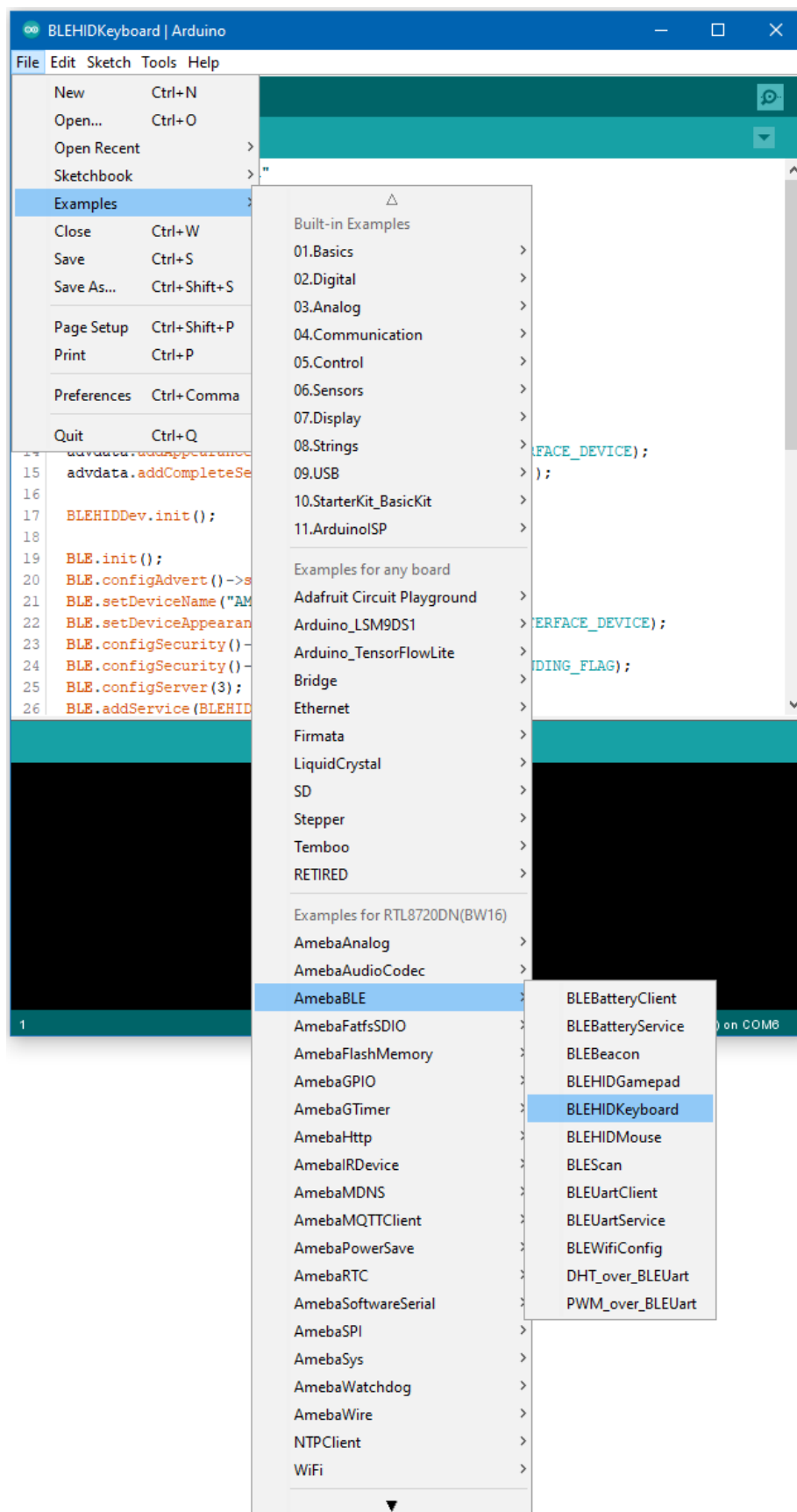
### Example

#### Introduction

In this example, the RTL8722 board emulates a HID keyboard connected using BLE.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> BLEHIDKeyboard.

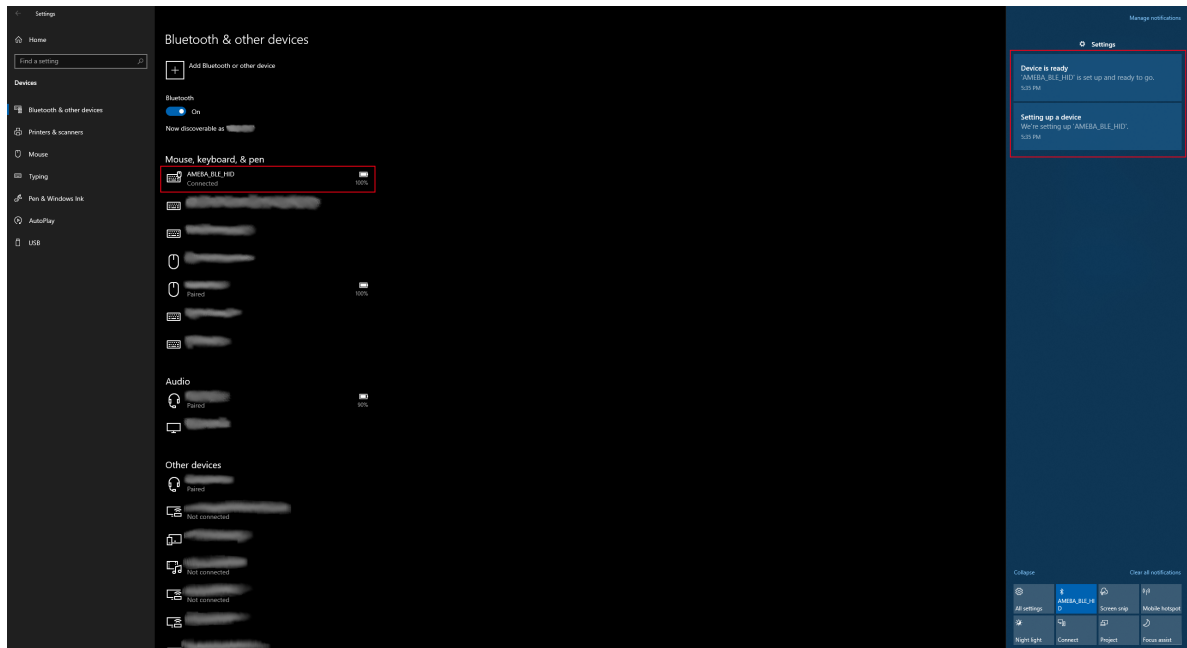


Upload the code and press the reset button once the upload is finished.

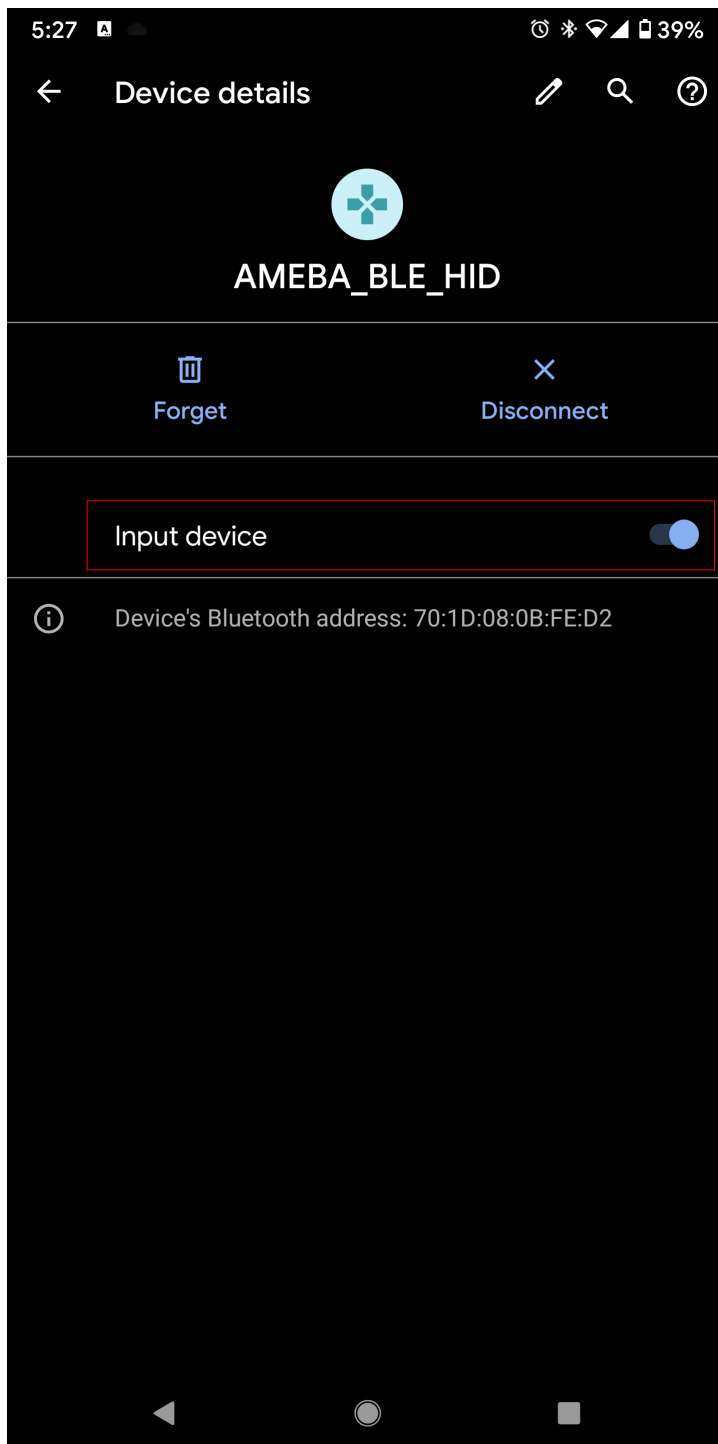
Immediately after reset, the board will begin BLE advertising as “AMEBA\_BLE\_HID” . On your host device, go to the Bluetooth settings menu, scan, and connect to the board.

You should ensure that the connection process is completed before proceeding.

On Windows, ensure that any driver installation is finished, and the board shows up in the Bluetooth menu under the “Mouse, keyboard & pen” category.



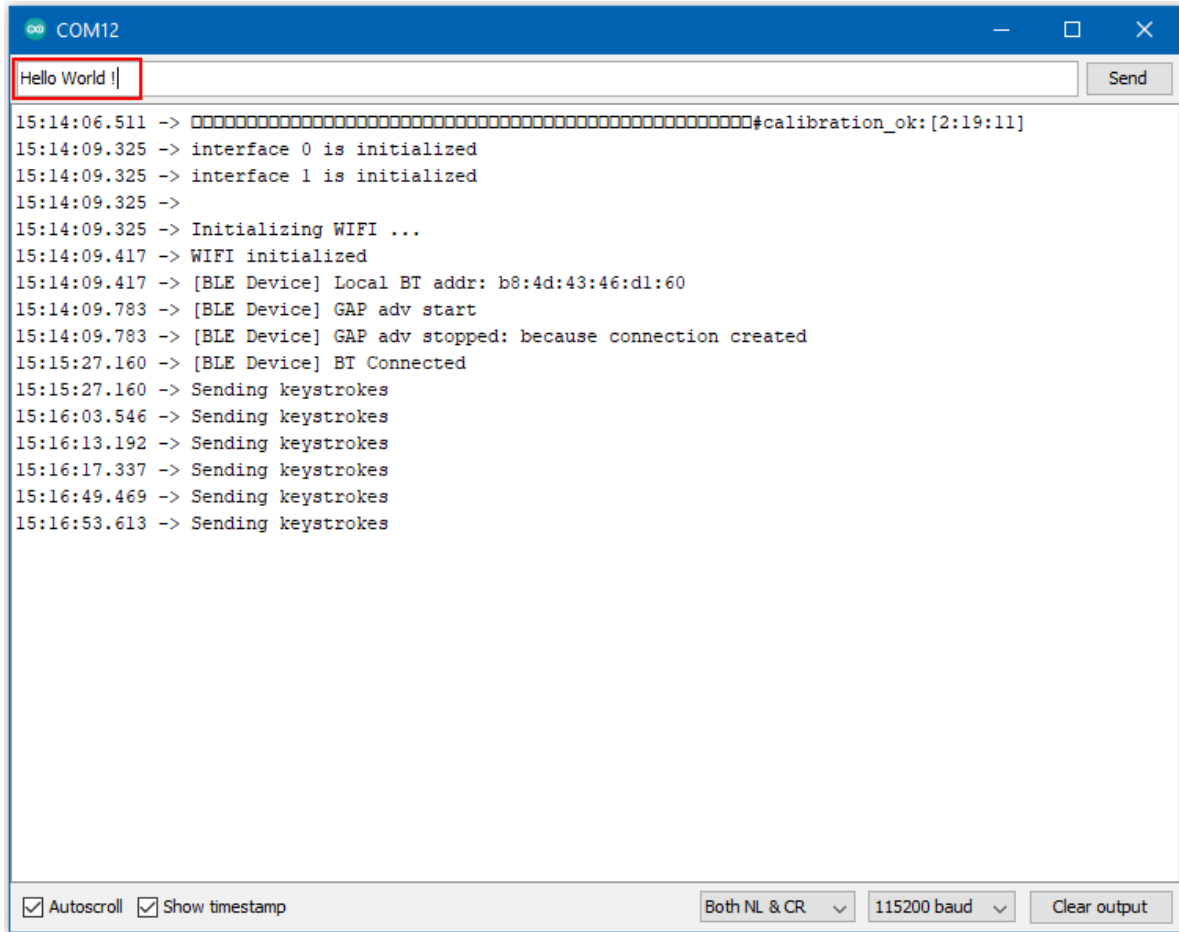
On Android, ensure that “Input device” is enabled for the board.



After the Bluetooth connection process is completed, the board is ready to send mouse input to the host device. Connect digital pin 8 to 3.3V to start sending input, and connect to GND to stop.

You should see the text “Hello World !” typed out and deleted repeatedly.





```

COM12
Hello World !
15:14:06.511 -> #####calibration_ok:[2:19:11]
15:14:09.325 -> interface 0 is initialized
15:14:09.325 -> interface 1 is initialized
15:14:09.325 ->
15:14:09.325 -> Initializing WIFI ...
15:14:09.417 -> WIFI initialized
15:14:09.417 -> [BLE Device] Local BT addr: b8:4d:43:46:d1:60
15:14:09.783 -> [BLE Device] GAP adv start
15:14:09.783 -> [BLE Device] GAP adv stopped: because connection created
15:15:27.160 -> [BLE Device] BT Connected
15:15:27.160 -> Sending keystrokes
15:16:03.546 -> Sending keystrokes
15:16:13.192 -> Sending keystrokes
15:16:17.337 -> Sending keystrokes
15:16:49.469 -> Sending keystrokes
15:16:53.613 -> Sending keystrokes

☒ Autoscroll ☒ Show timestamp
Both NL & CR 115200 baud Clear output

```

## BLE - HID Mouse

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- BLE capable host device [Windows / Linux / MacOS / Android]

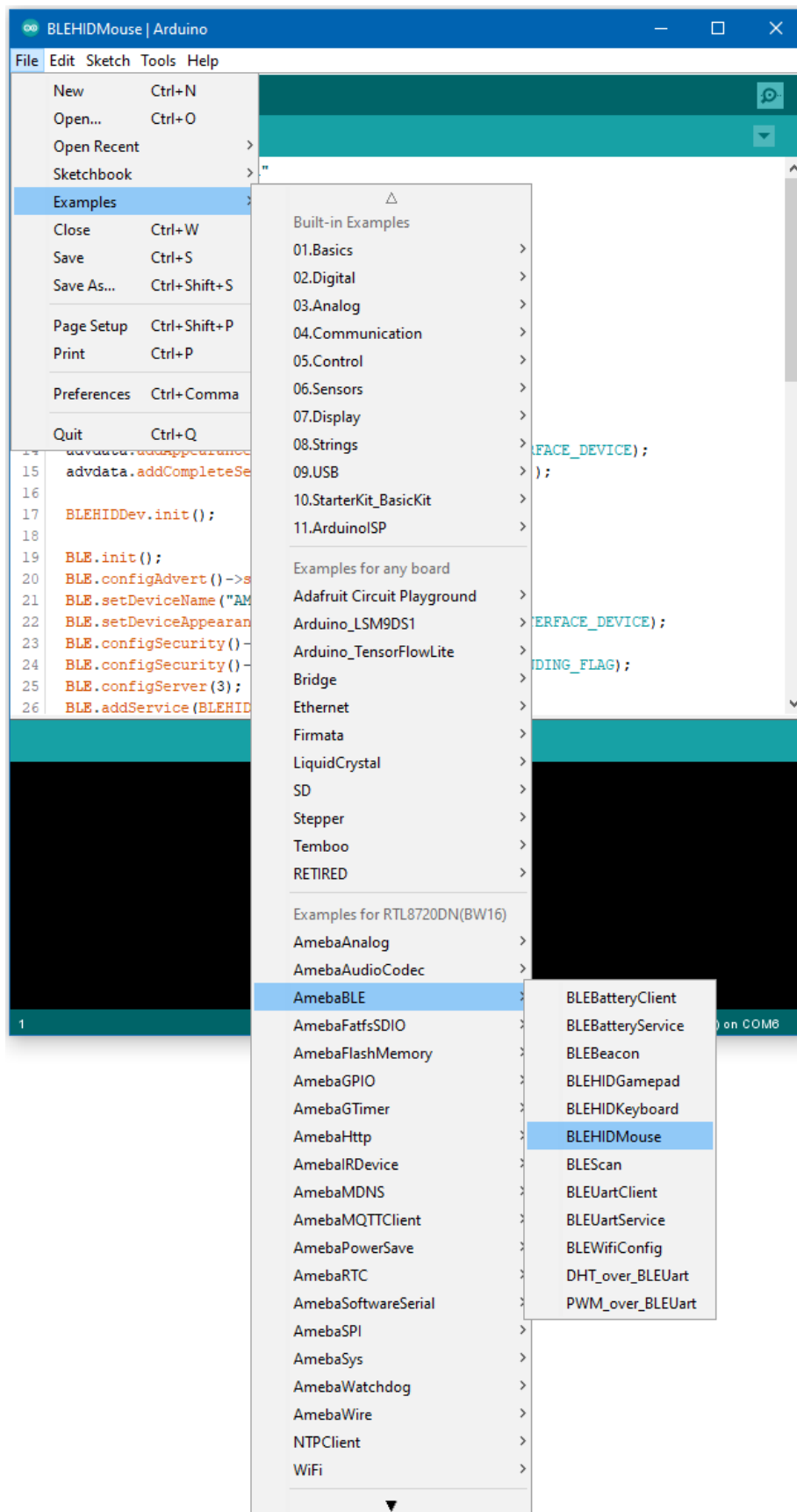
### Example

#### Introduction

In this example, the RTL8722 board emulates a HID mouse connected using BLE.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEHIDMouse” .



Upload the code and press the reset button once the upload is finished.

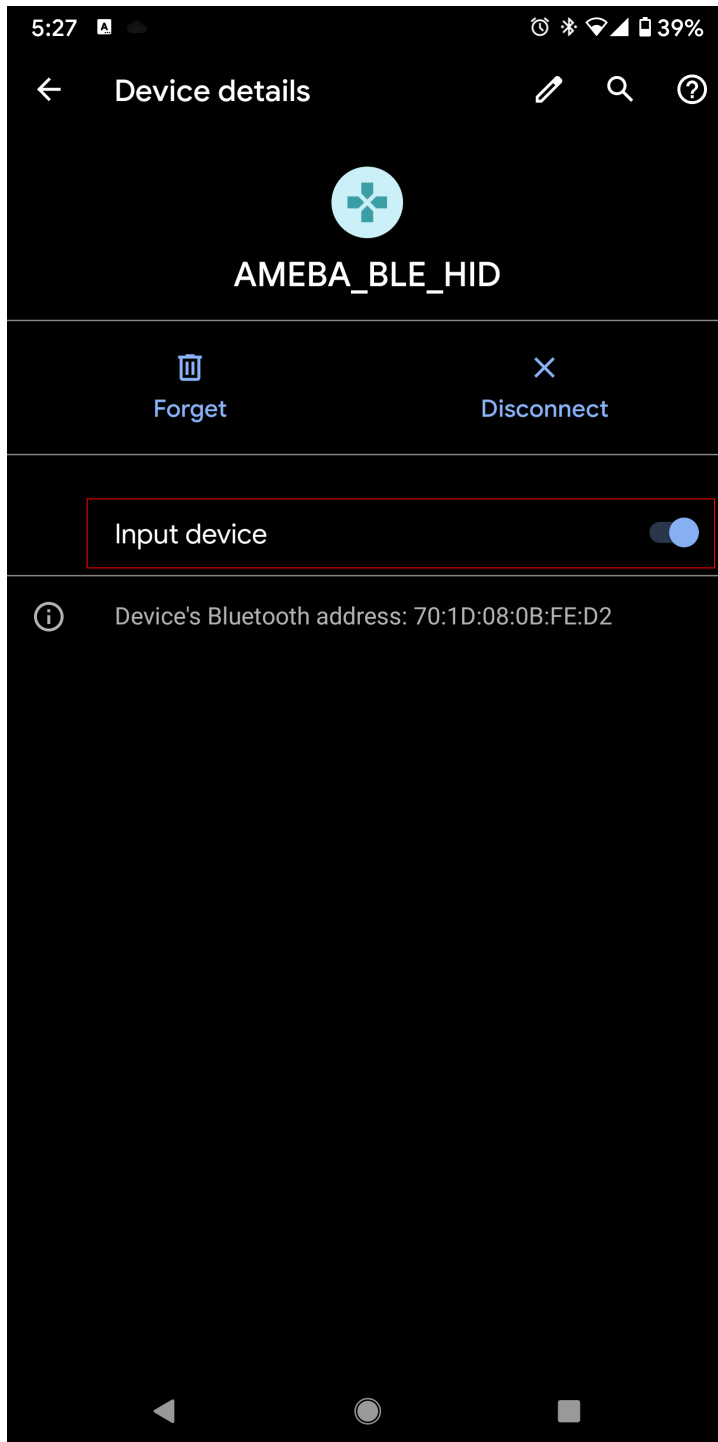
Immediately after reset, the board will begin BLE advertising as “AMEBA\_BLE\_HID” . On your host device, go to the Bluetooth settings menu, scan, and connect to the board.

You should ensure that the connection process is completed before proceeding.

On Windows, ensure that any driver installation is finished, and the board shows up in the Bluetooth menu under the “Mouse, keyboard & pen” category.



On Android, ensure that “Input device” is enabled for the board.



After the Bluetooth connection process is completed, the board is ready to send mouse input to the host device. Connect digital pin 8 to 3.3V to start sending input, and connect to GND to stop.

You should see the mouse cursor move around four points in a square, performing right and left clicks, and scrolling up and down.

## Code Reference

How the mouse input is interpreted is dependent on the host system. Some systems, such as mobile operating systems, may not support all mouse button input functions.

## HTTP - Retrieve HTTP websites from the Internet

### Materials

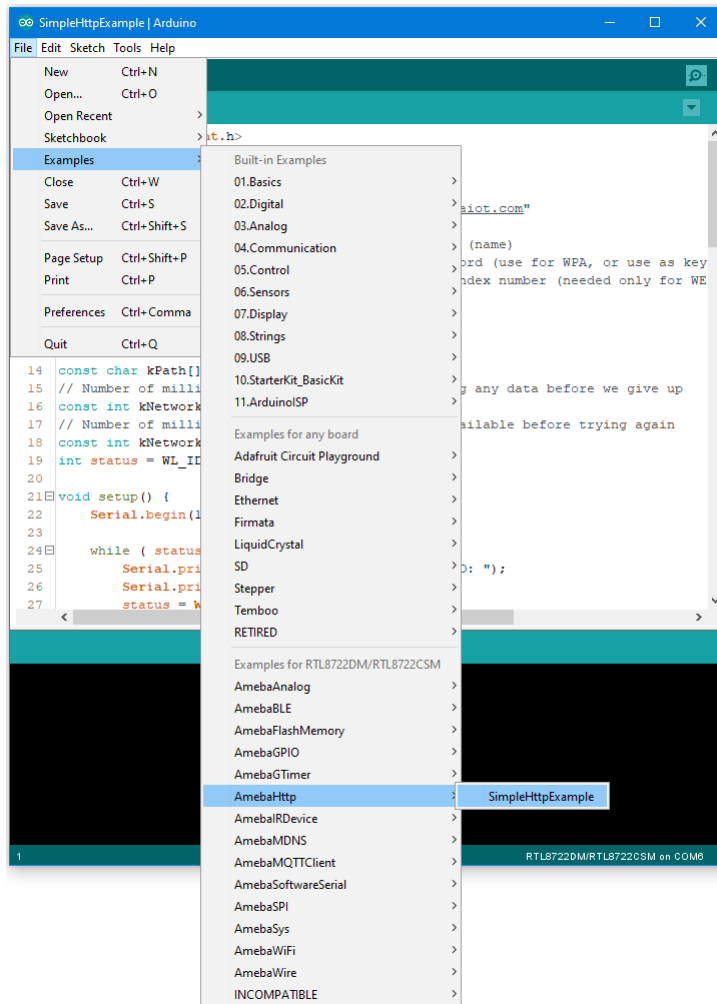
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

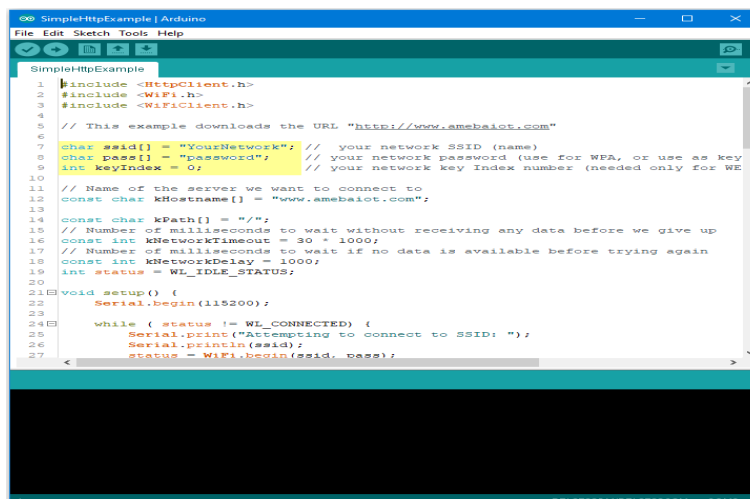
In this example, the HttpClient library is used to retrieve a webpage using the HTTP protocol.

First, make sure that the correct Ameba development board is selected in “Tools” -> “Board”

Then open “File” -> “Examples” -> “AmebaHttp” -> “SimpleHttpExample”



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.



Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor in the Arduino IDE and you can see the information retrieved from the website.

```

COM4

Interface 0 IP address : 172.25.24.188Connected to wifi
SSID: RealEZ
IP Address: 172.25.24.188
signal strength (RSSI):-56 dBm

Connect to Server successful!
startedRequest ok
Got status code: 200
Content length is: 0

Body returned follows:
<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en-SG"><head><meta content=
document.documentElement.addEventListener("submit",function(b){var a;if(a=b.target){var c=a.getAttribute
var a=window.location,b=a.href.indexOf("#");if(0<=b){var c=a.href.substring(b+1);/^(|s)q=/.test(c)}s-l==
</style><style>body,td,a,p,h{font-family:arial,sans-serif}body{margin:0;overflow-y:scroll}#gog{padding:
if (!iesg){document.f.q.focus();document.gbqf.q.focus();}
}
})();</script><div id="mngr"><div id="gbar"><nobr><b class="gbl">Search</b><a class="gbl" href="http://www.g
else top.location="/doodles/";})();</script><input value="AAPIEIEAAAAAKjAd2Cy4lLwKhgib7of5MoLQmLDRW2G
setTimeout(function(){var b=document;var a="SCRIPT";"application/xhtml+xml"===b.contentType&&(a=a.toLowe
function _F_installCss(c){
(function(){google.spjs=false;google.snet=true;google.em=[];google.emm=false;})();(function(){var pnc='
<
>

☒ Autoscroll ☐ Show timestamp
No line ending 9600 baud Clear output

```

## Code Reference

Use `WiFi.begin()` to establish WiFi connection:

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiClient` to create a client to handle the WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiClient>

Use HTTPClient to create a client to handle the HTTP connection.

Use `http.get()` to send a GET request to the website.

## HTTP - Set up Server to Control LED

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Breadboard x 1
- LED x 1
- 1K $\Omega$  Resistor x 1

### Procedure

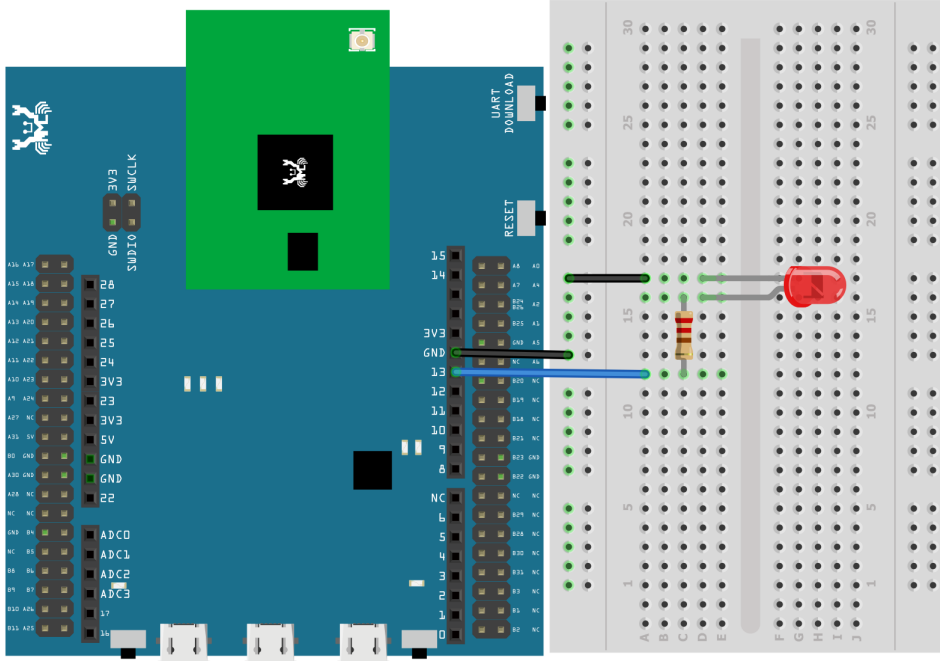
In this example, we connect Ameba to WiFi and use Ameba as server, the user can control the LED on/off through a webpage.

First, connect Ameba with the LED.

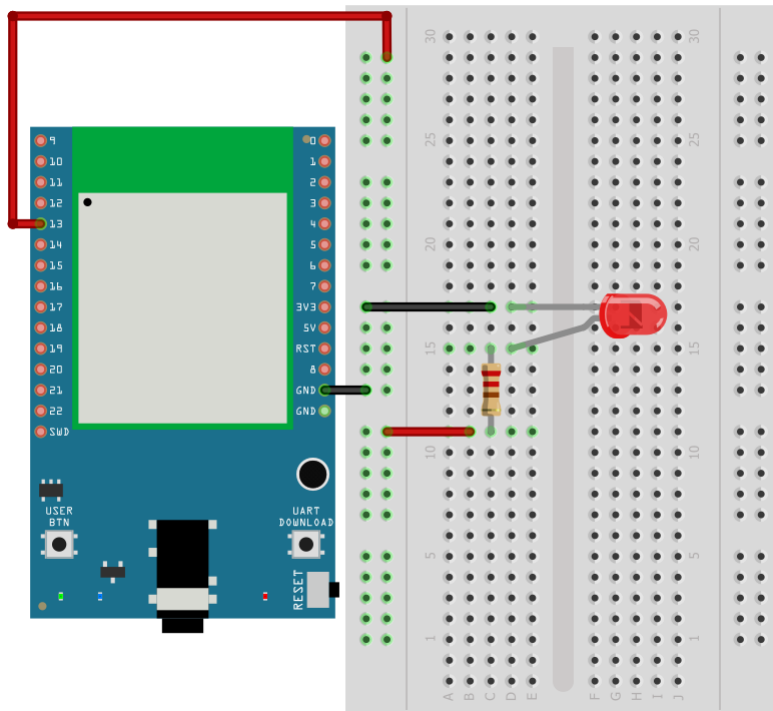
In a LED, the longer pin is the positive pole, and the shorter pin is the negative pole. So, we connect the shorter pin to GND and connect the longer pin to D13. Additionally, to avoid the electric current exceeds the tolerance of the LED and causes damage, we connect a resistance on the positive pole.

**AMB21 / AMB22** Wiring Diagram:

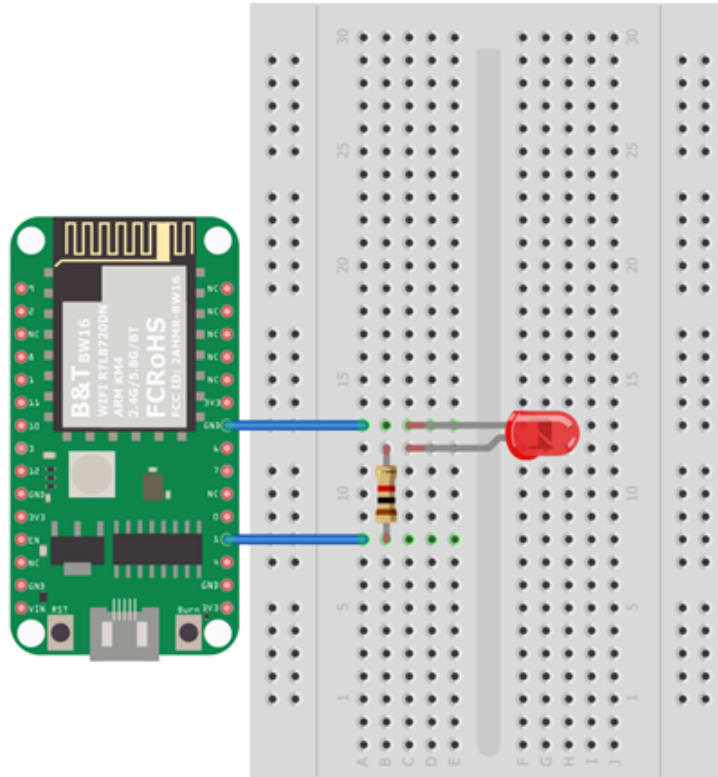


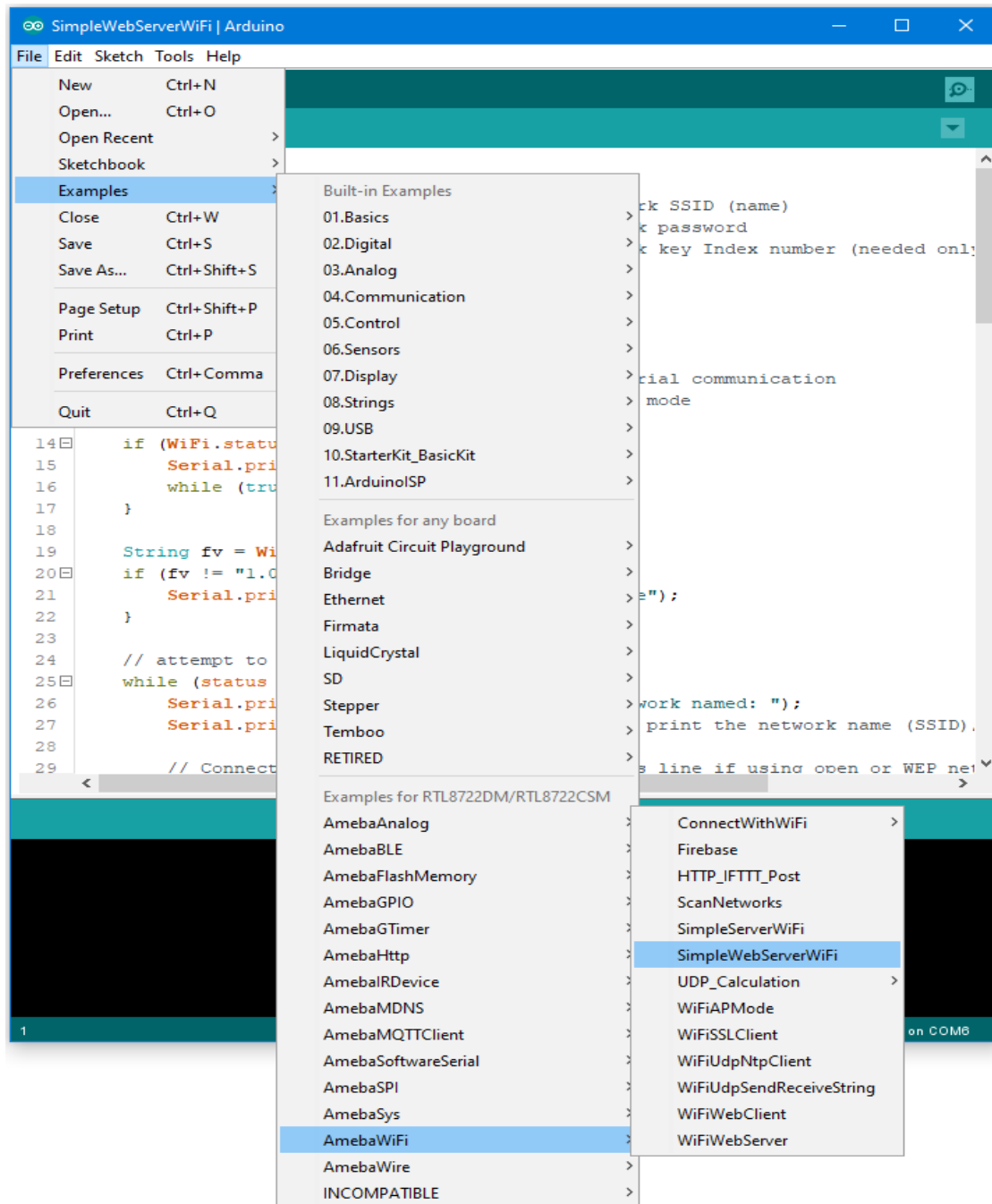


### AMB23 Wiring Diagram:



### BW16 Wiring Diagram:





In the sample code, modify the highlighted snippet to corresponding information.

```

SimpleWebServerWiFi | Arduino
File Edit Sketch Tools Help

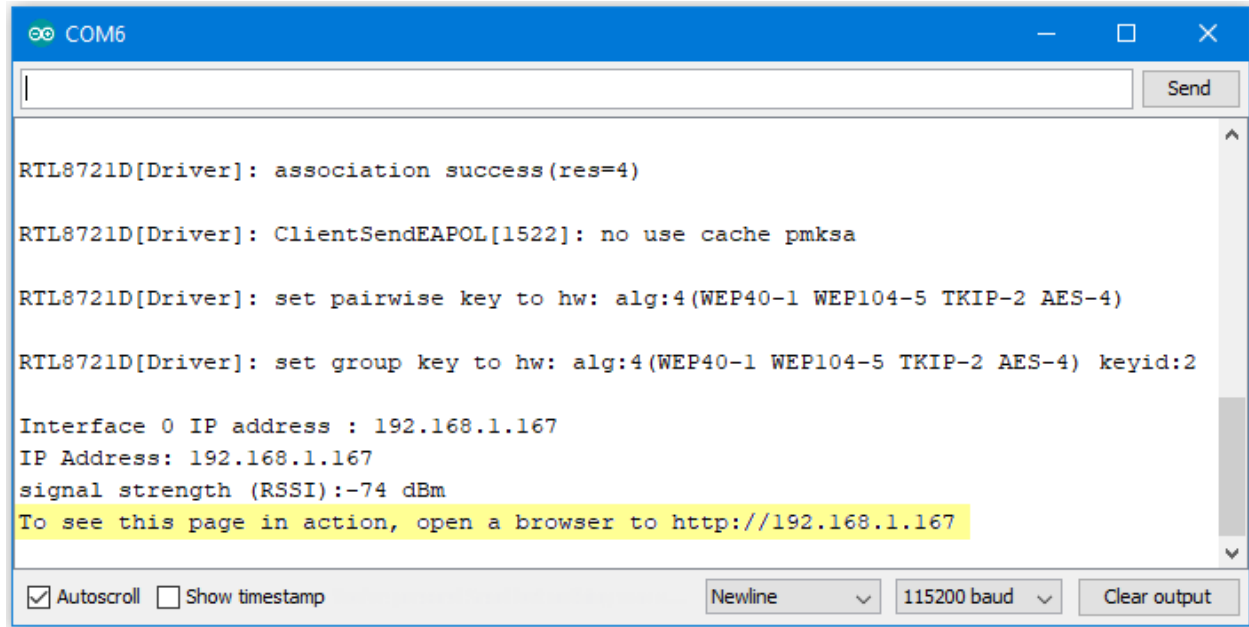
SimpleWebServerWiFi
1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; // your network SSID (name)
4 char pass[] = "Password"; // your network password
5 int keyIndex = 0; // your network key Index number (needed only)
6
7 int status = WL_IDLE_STATUS;
8 WiFiServer server(80);
9
10 void setup() {
11     Serial.begin(115200); // initialize serial communication
12     pinMode(13, OUTPUT); // set the LED pin mode
13     // check for the presence of the shield:
14     if (WiFi.status() == WL_NO_SHIELD) {
15         Serial.println("WiFi shield not present");
16         while (true); // don't continue
17     }
18
19     String fv = WiFi.firmwareVersion();
20     if (fv != "1.0.0") {
21         Serial.println("Please upgrade the firmware");
22     }
23
24     // attempt to connect to Wifi network:
25     while (status != WL_CONNECTED) {
26         Serial.print("Attempting to connect to Network named: ");
27         Serial.println(ssid); // print the network name (SSID)
28
29         // Connect to WPA/WPA2 network. Change this line if using open or WEP network

```

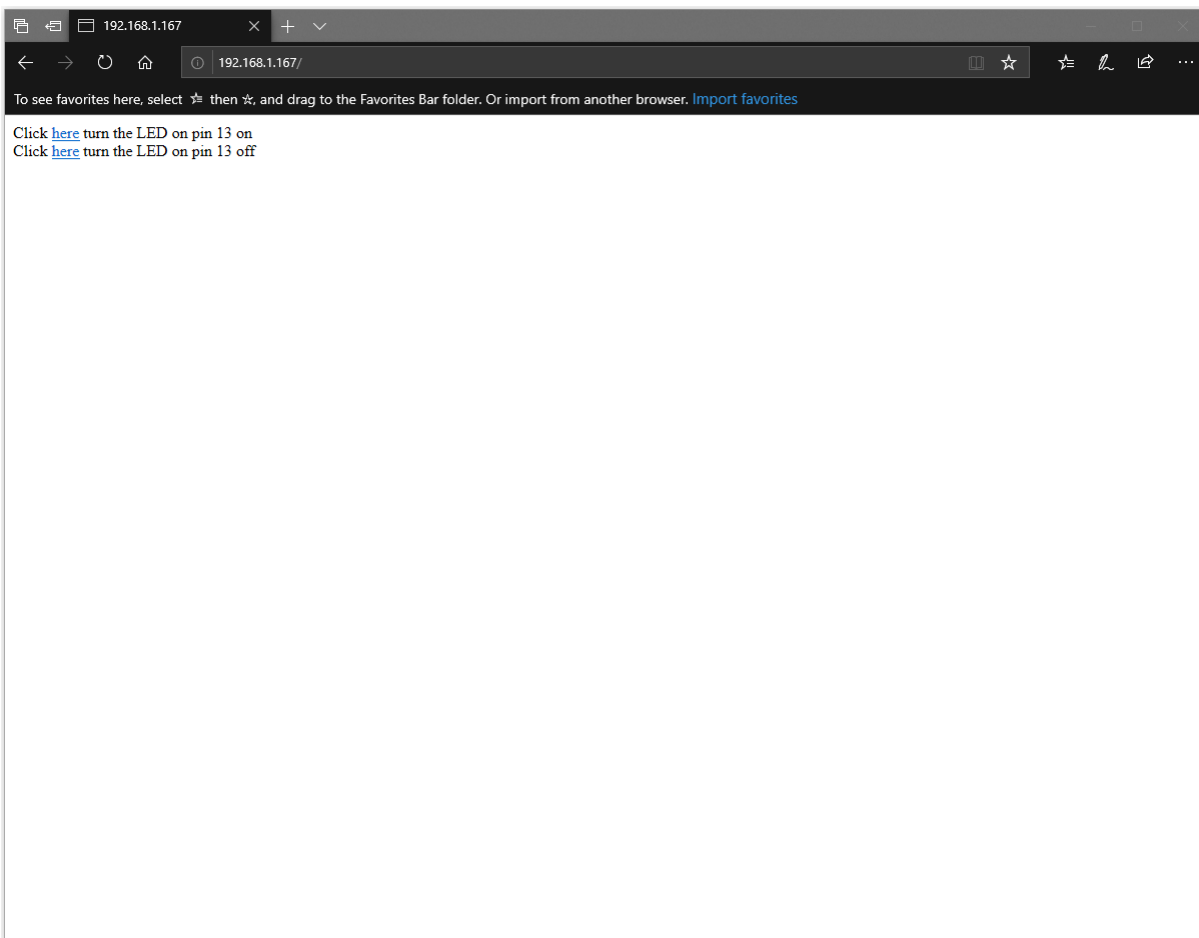
Upload the code and press the reset button on Ameba. When the connection is established, you will see the message:

"To see this page in action, open a browser to <http://xxx.xxx.xxx.xxx>"

in the Arduino IDE as shown in the figure:



Next, open the browser of a computer or a cell phone under the same WiFi domain, enter the address in the message.



In the webpage, you can turn on/off the LED.

## Code Reference

Use `WiFi.begin()` to establish WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiServer server()` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.connected()` to get whether or not the client is connected.

<https://www.arduino.cc/en/Reference/WiFiClientConnected>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.print()` to print data to the server that a client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientPrint>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

## HTTP - Set up Server to Get the Ameba Status

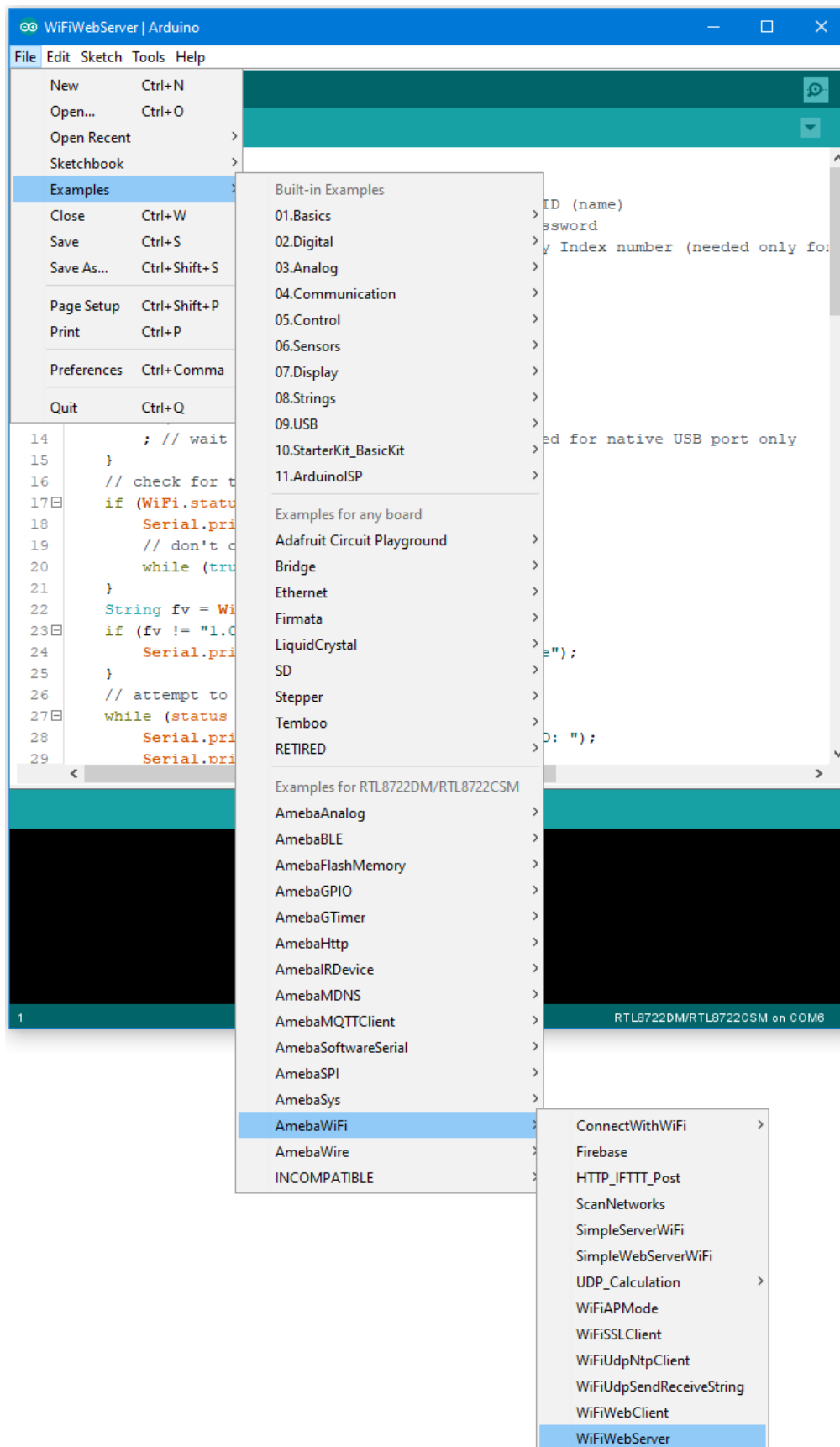
### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

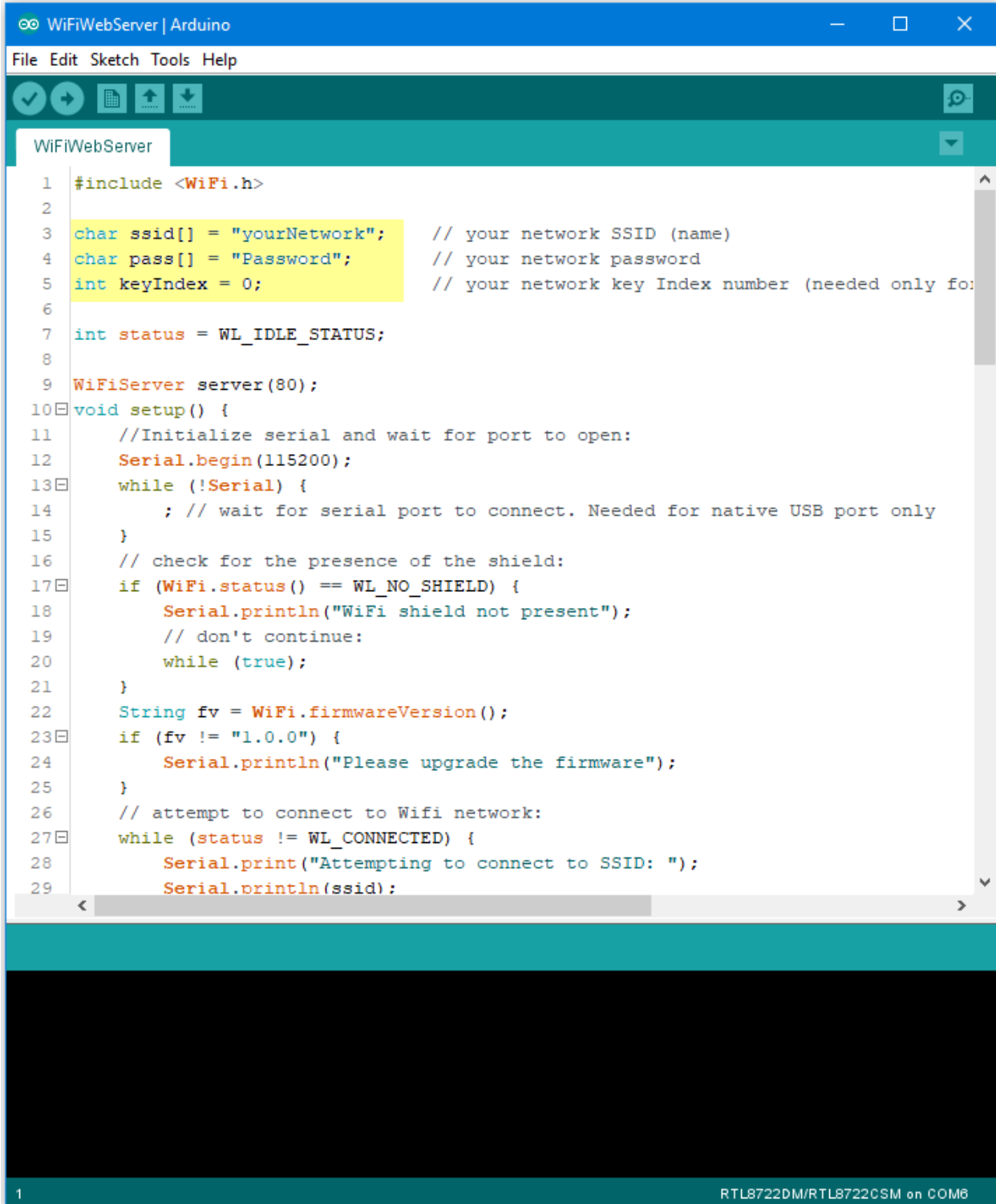
In this example, we connect Ameba to WiFi and use Ameba as server to send message to connected client.

First, open “File” -> “Examples” -> “AmebaWiFi” -> “WiFiWebServer”





In the sample code, modify the highlighted snippet and enter the required information (ssid, password, key index) required to connect to your WiFi network.

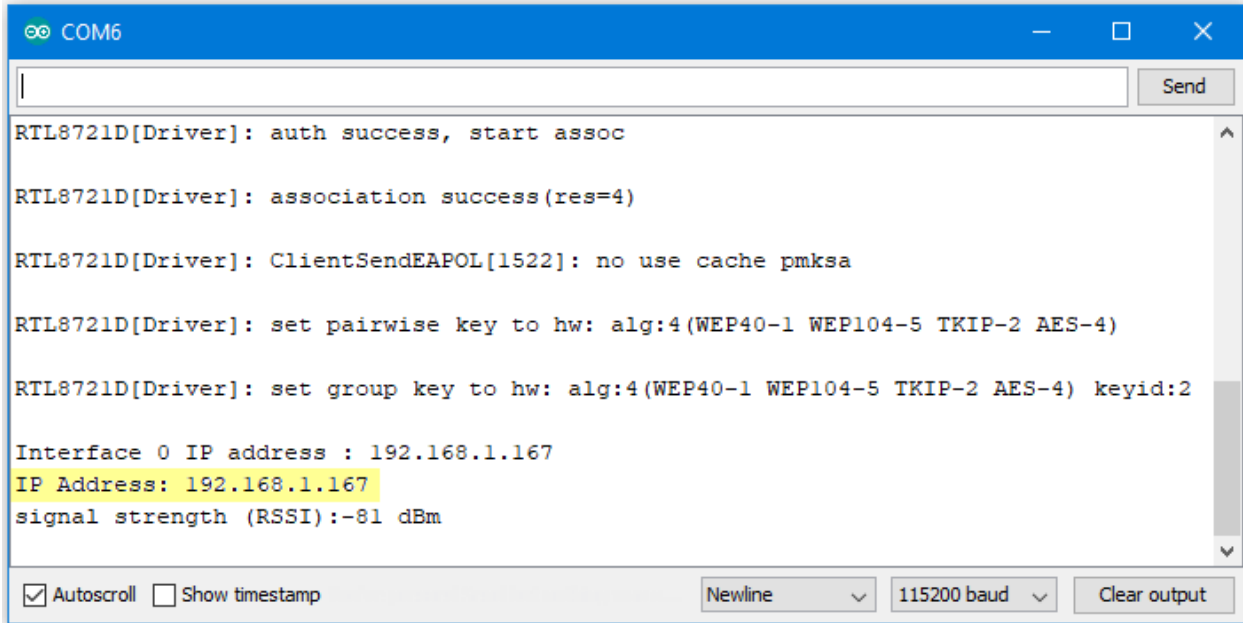


```

1  #include <WiFi.h>
2
3  char ssid[] = "yourNetwork";    // your network SSID (name)
4  char pass[] = "Password";       // your network password
5  int keyIndex = 0;               // your network key Index number (needed only for
6
7  int status = WL_IDLE_STATUS;
8
9  WiFiServer server(80);
10 void setup() {
11     //Initialize serial and wait for port to open:
12     Serial.begin(115200);
13     while (!Serial) {
14         ; // wait for serial port to connect. Needed for native USB port only
15     }
16     // check for the presence of the shield:
17     if (WiFi.status() == WL_NO_SHIELD) {
18         Serial.println("WiFi shield not present");
19         // don't continue:
20         while (true);
21     }
22     String fv = WiFi.firmwareVersion();
23     if (fv != "1.0.0") {
24         Serial.println("Please upgrade the firmware");
25     }
26     // attempt to connect to Wifi network:
27     while (status != WL_CONNECTED) {
28         Serial.print("Attempting to connect to SSID: ");
29         Serial.println(ssid);

```

Upload the code and press the reset button on Ameba. After connecting to WiFi, Ameba starts to run as server. The IP of the server is shown in the serial monitor, and port is 80.



```
COM6

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

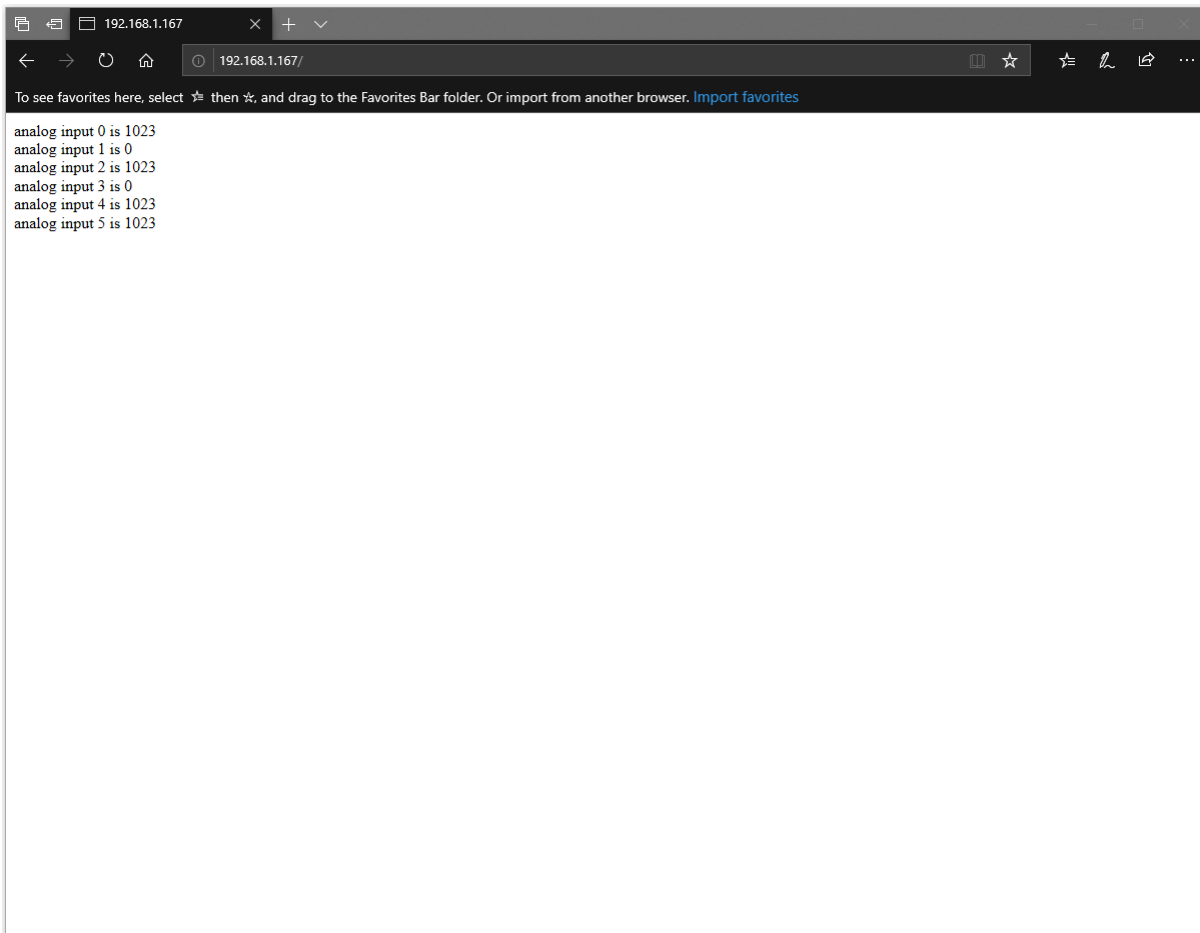
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-81 dBm

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output
```

We connect to the server in a browser, and we can see the data sent from the server.



```
192.168.1.167

analog input 0 is 1023
analog input 1 is 0
analog input 2 is 1023
analog input 3 is 0
analog input 4 is 1023
analog input 5 is 1023
```

## Code Reference

Use `WiFi.begin()` to establish WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiServer server()` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.connected()` to check whether or not the client is connected.

<https://www.arduino.cc/en/Reference/WiFiClientConnected>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.print()` to print data to the server that a client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientPrint>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

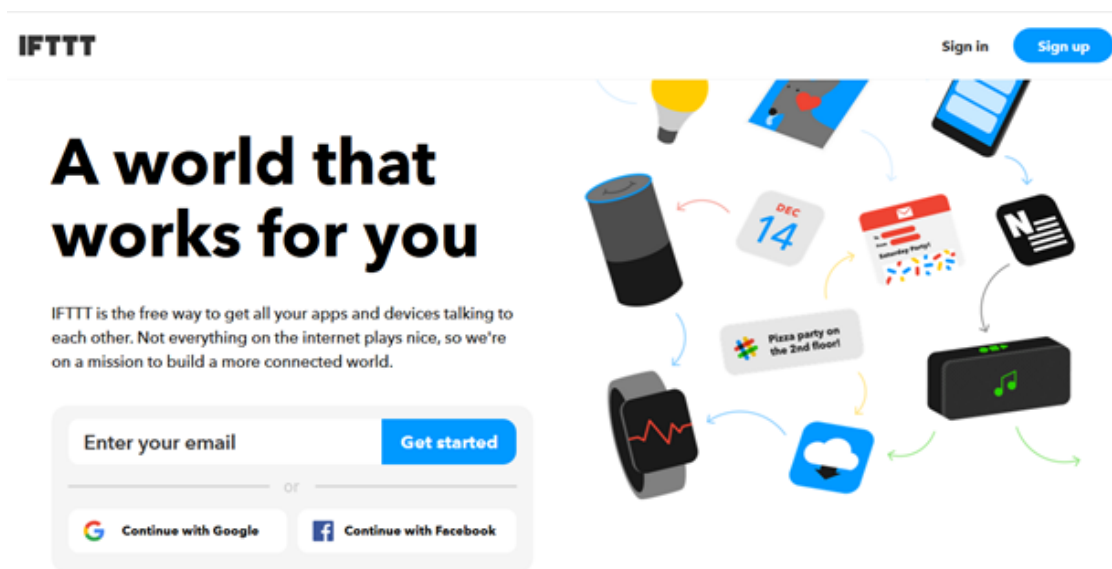
## HTTP - Use IFTTT for Web Service

### Introduction to IFTTT

IFTTT, known as If This Then That, is a website and mobile app and free web-based service to create the applets, or the chains of simple conditional statements. The applet is triggered by changes that occur within other web services such as Gmail, Facebook, Telegram, Instagram, Pinterest etc.

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- An account from <https://ifttt.com/> , in order to access IFTTT service\*



---

備<sub>F</sub>: Upon log in, there are several cloud and online services that are integrated with IFTTT platforms.

---

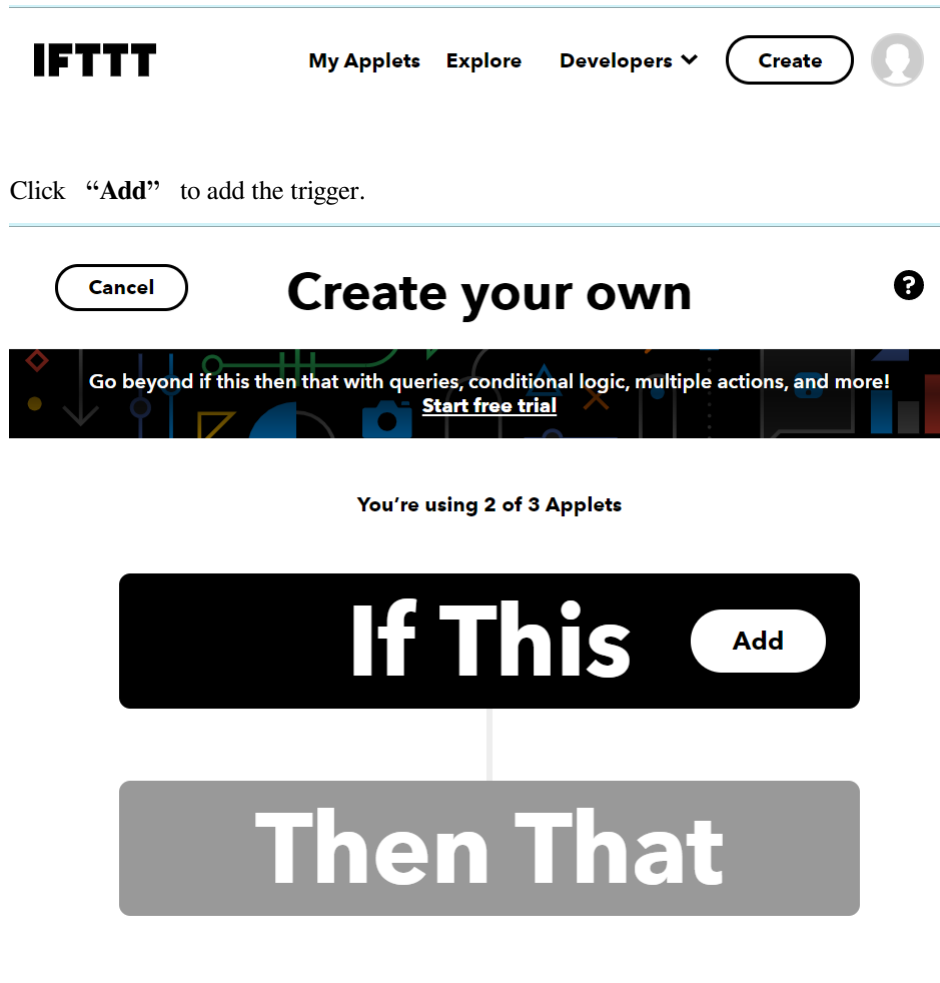
### Example

- Generate Applet from IFTTT

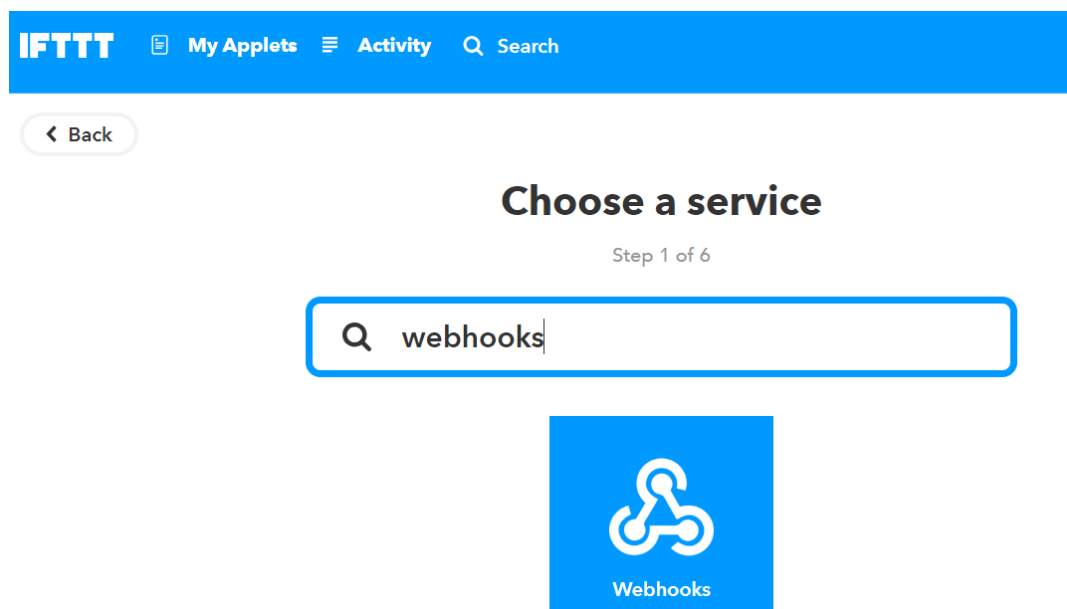
In this example, we obtain an example of IFTTT Applet to send email to specified recipient.

To run the example, HTTP POST feature of the Ameba is used to post a simple webhook service that is received by IFTTT platform and in turn be used to trigger a response (sending an email).

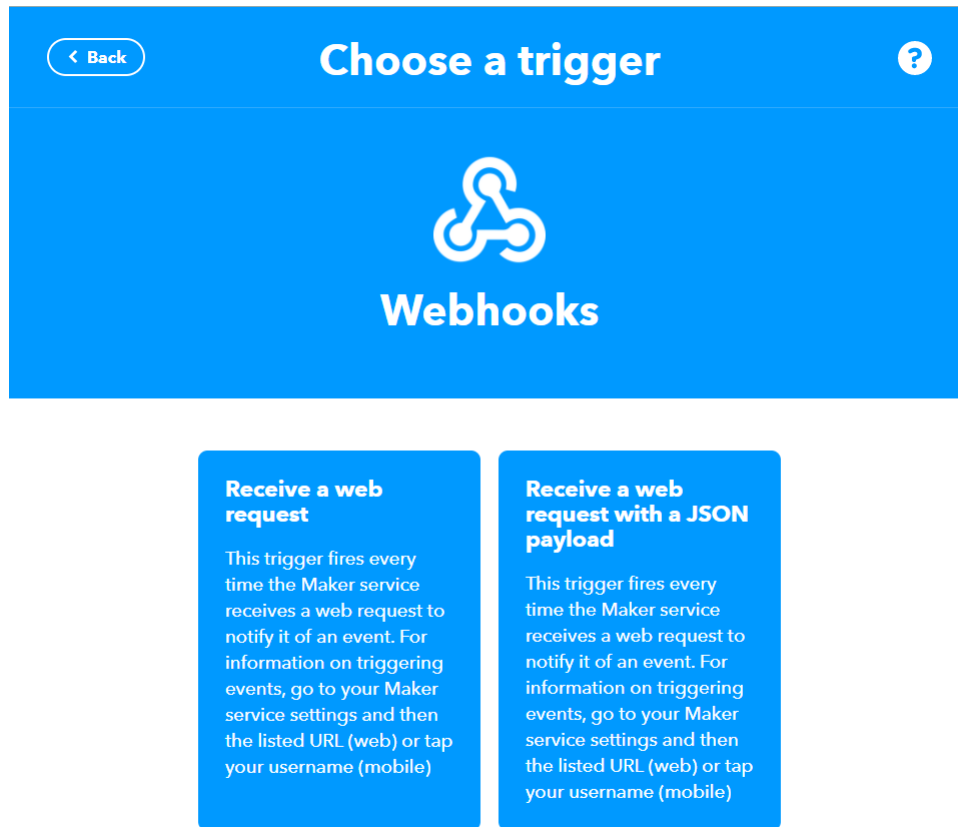
After logging in <https://ifttt.com/>, click **Create** from the top bar.



Choose Webhooks service as shown below. Alternatively, search the service by typing into the search bar.



After that, the available triggers will appear. Choose Receive a Web request.



Next, an Event Name is required to identify the trigger successfully. In this example, set the Event name as “test\_event” .

< Back

## Complete trigger fields

?

### Receive a web request

This trigger fires every time the Maker service receives a web request to notify it of an event. For information on triggering events, go to your Maker service settings and then the listed URL (web) or tap your username (mobile)

**Event Name**

test\_event

The name of the event, like "button\_pressed" or "front\_door\_opened"

Create trigger

Next, click **Add** in Then That field to create the action service taken in response to the last trigger.

Cancel

## Create your own

?

Go beyond if this then that with queries, conditional logic, multiple actions, and more! [Start free trial](#)

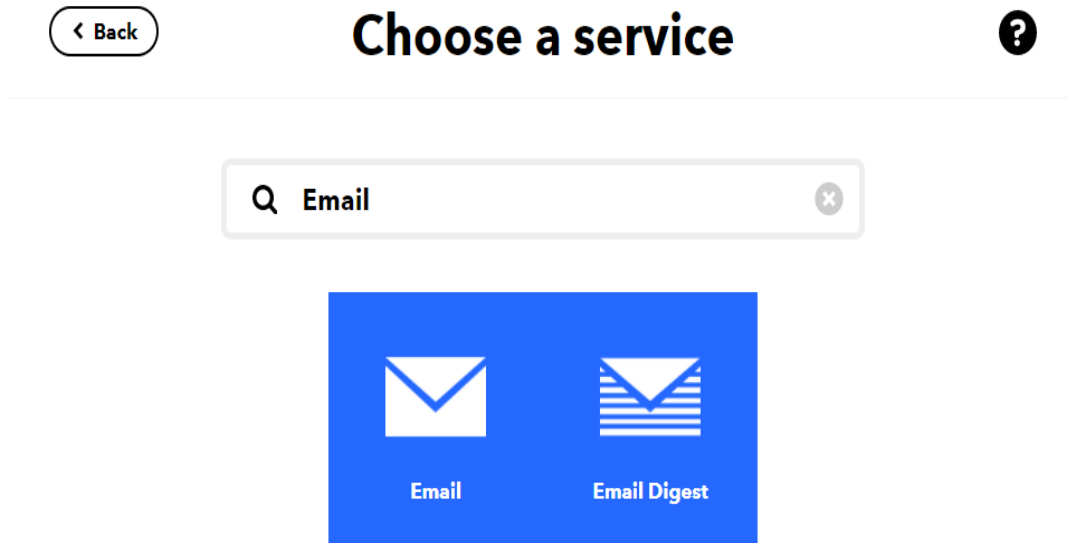
You're using 2 of 3 Applets

If Receive a web request [Edit](#) [Delete](#)

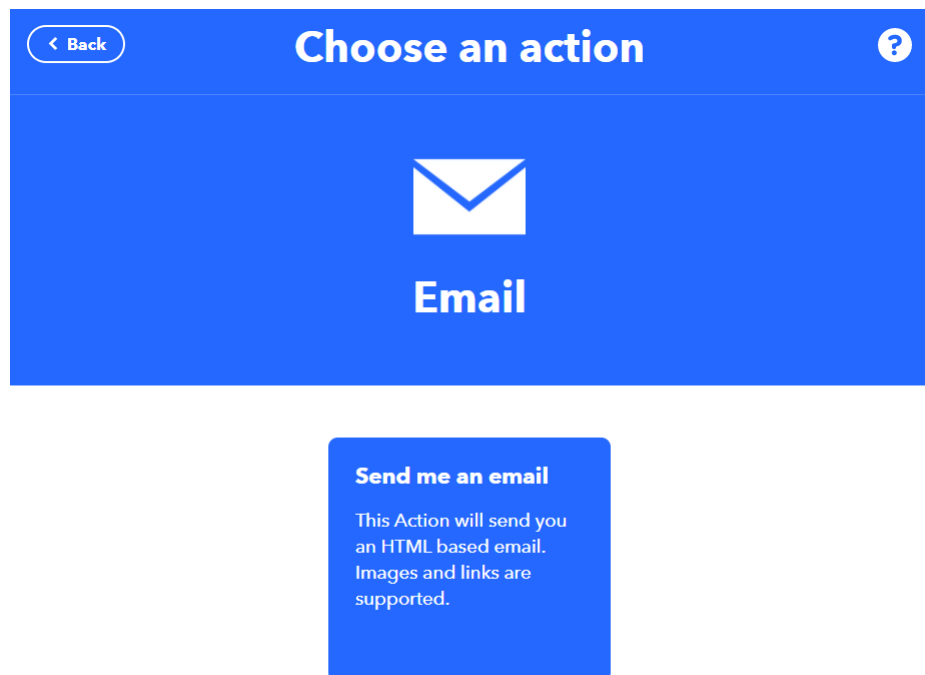
+

Then That [Add](#)

Choose Email as the action service.



Click on Send me an email.



Under the template of **Send me an Email**, the contents of the email, such as subject and body is editable. Click **Create Action** to complete the action. Take note that **Email service** is offered to the



email address registered under IFTTT account.

The screenshot shows the IFTTT 'Complete action fields' interface for the 'Send me an email' action. The background is blue. At the top, there's a 'Back' button and a question mark icon. Below the title, there's an envelope icon and the text 'Send me an email'. A note states: 'This Action will send you an HTML based email. Images and links are supported.' The 'Subject' field contains the text: 'The event named " **EventName** " occurred on the Maker Webhooks service'. Below it is an 'Add ingredient' button. The 'Body' field contains the text: 'What: **EventName** <br> When: **OccurredAt** <br> Extra Data: **Value1** , **Value2** , **Value3** ,'. Below it is another 'Add ingredient' button. At the bottom, there is a large blue button labeled 'Create action'.

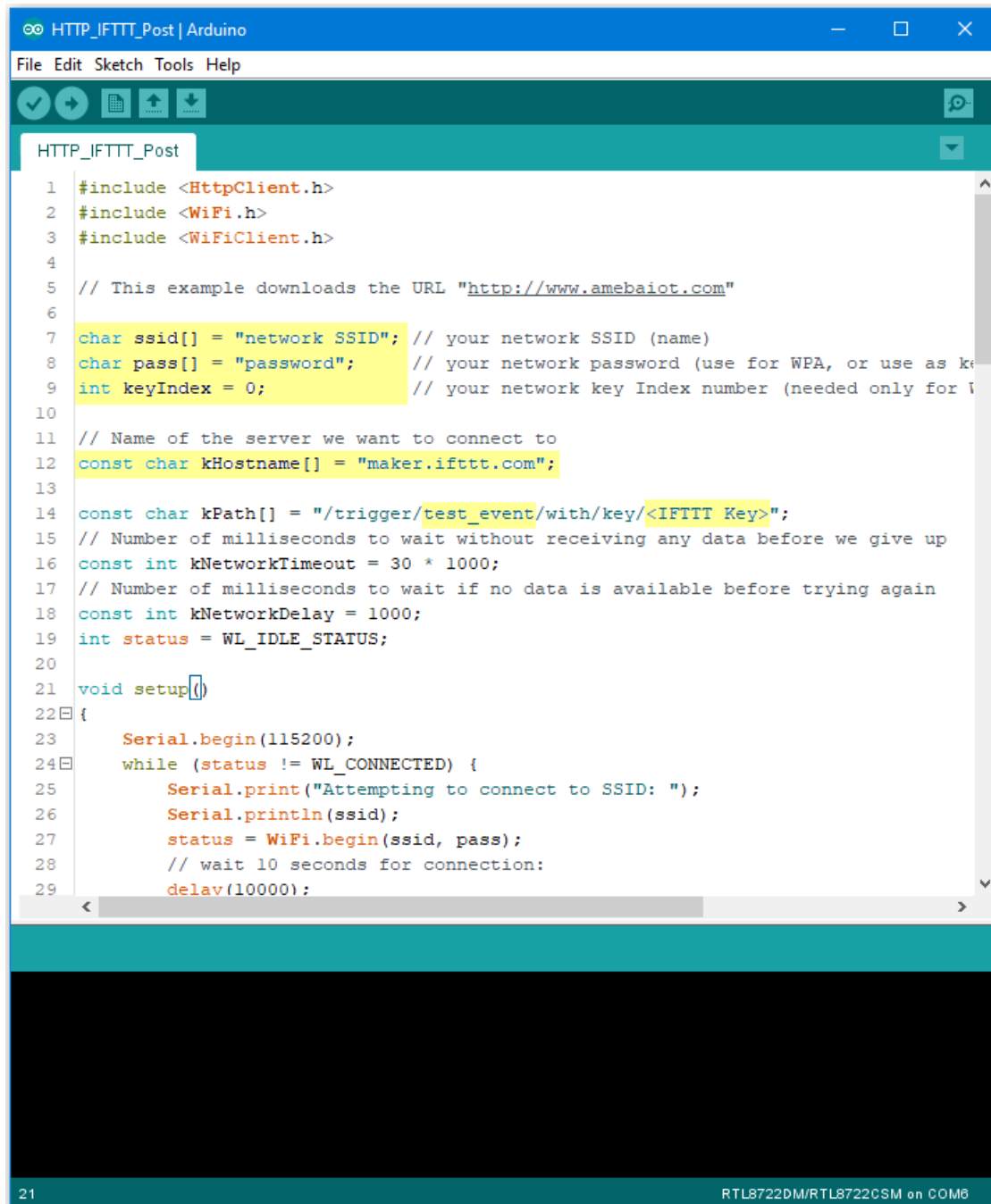
- Post the Trigger via Ameba

Once the Applet is ready in the IFTTT dashboard, the example program can be flashed onto the Ameba board to post the HTTP request.

Open the example code in “File” -> “Examples” -> “AmebaWiFi” -> “HTTP\_IFTTT\_Post”

In the example program, edit the following 3 items inside the code to make the program work.

1. The WiFi credentials to connect to the Wi-Fi hotspot or access point of desirable choice.
2. Under the Host name field, enter the host name of the IFTTT service “maker.ifttt.com” .
3. Under the Path name field, enter the Event name and key field “/trigger/Event name/with/key/Key Field”
  - Event name: The event name should be the same as the one specified in the IFTTT applet. In this example, the event name is “test\_event” .
  - Key Field: Available under webhook service in individual IFTTT account. See the next step for the steps to obtain the Key Field.



```
1 #include <HttpClient.h>
2 #include <WiFi.h>
3 #include <WiFiClient.h>
4
5 // This example downloads the URL "http://www.amebaiot.com"
6
7 char ssid[] = "network SSID"; // your network SSID (name)
8 char pass[] = "password";     // your network password (use for WPA, or use as key for WEP)
9 int keyIndex = 0;              // your network key Index number (needed only for WEP)
10
11 // Name of the server we want to connect to
12 const char kHostname[] = "maker.ifttt.com";
13
14 const char kPath[] = "/trigger/test_event/with/key/<IFTTT Key>";
15 // Number of milliseconds to wait without receiving any data before we give up
16 const int kNetworkTimeout = 30 * 1000;
17 // Number of milliseconds to wait if no data is available before trying again
18 const int kNetworkDelay = 1000;
19 int status = WL_IDLE_STATUS;
20
21 void setup()
22 {
23     Serial.begin(115200);
24     while (status != WL_CONNECTED) {
25         Serial.print("Attempting to connect to SSID: ");
26         Serial.println(ssid);
27         status = WiFi.begin(ssid, pass);
28         // wait 10 seconds for connection:
29         delay(10000);
30     }
31 }
```

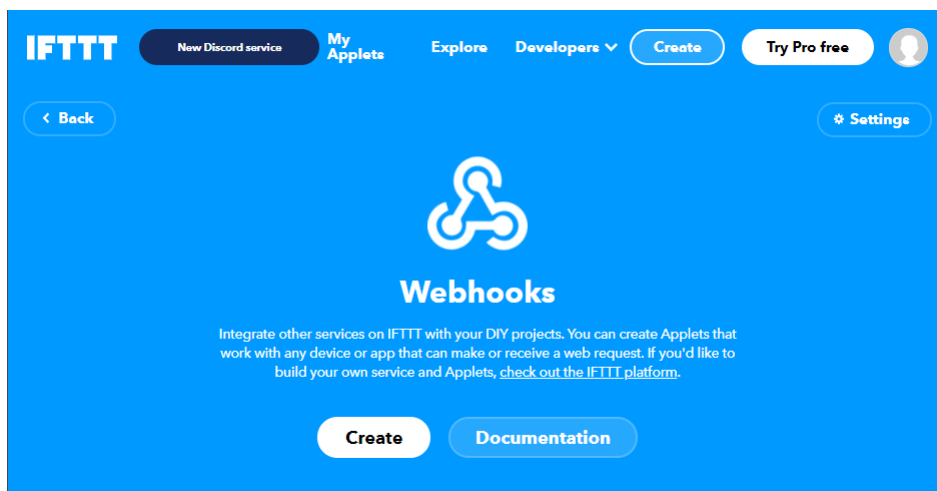
21

RTL8722DM/RTL8722CSM on COM8

To obtain a key from documentation tab of the Webhooks, find the webhook service in the Explore tab.



On the Webhooks service page, click on the Documentation tab.

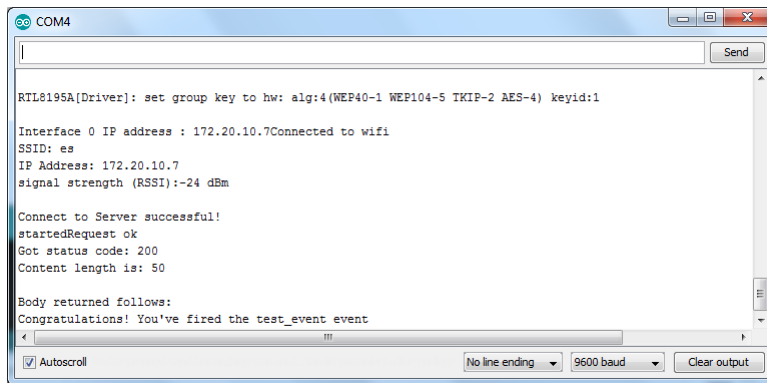


The key can be found in the documentation page. Also, information on how HTTP request can be used.

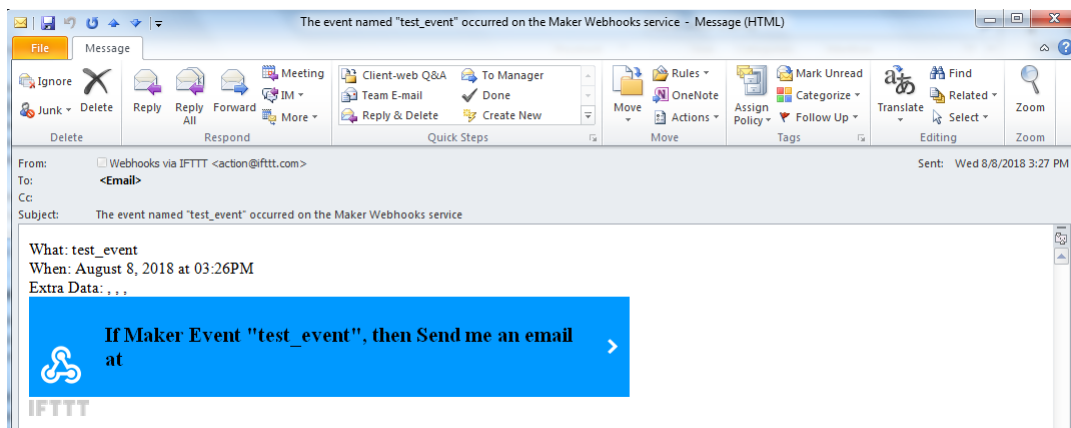


Once the example is ready, connect to Ameba board via USB Cable.

On the Arduino IDE, compile the code and upload the code onto Ameba and press the reset button. After the event has been successfully fired, “Congratulations! You have fired the test\_event event” can be seen on the serial monitor and an email reminder for this event will be delivered.



Thereafter an email is sent to recipient email account registered at IFTTT Applet and email notification will be received.



## IPv6 –Ameba as IPv6 Server/Client over TCP

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

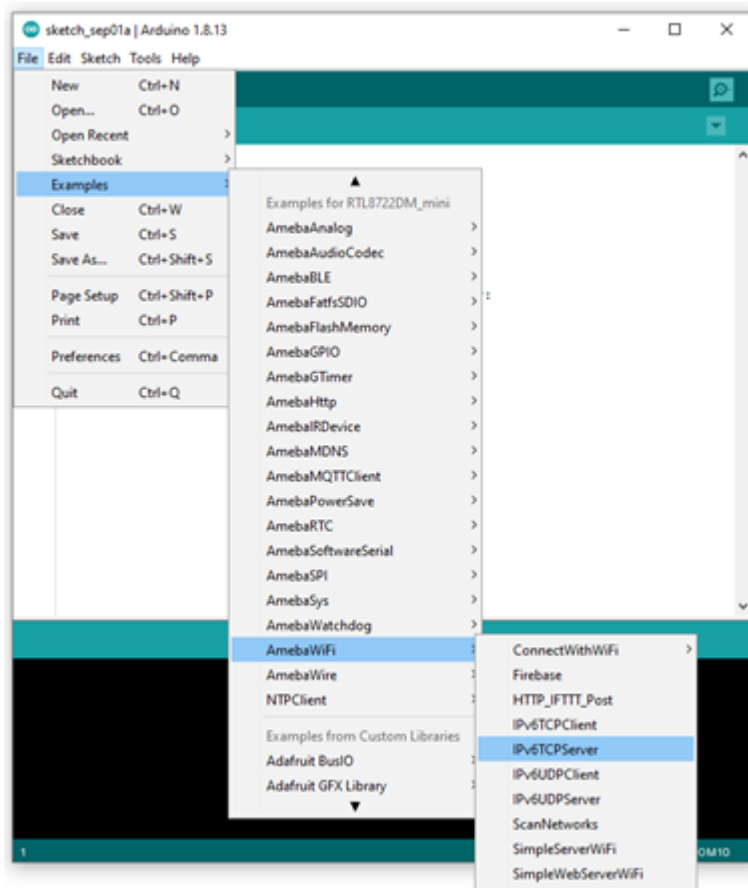
### Example

#### Introduction

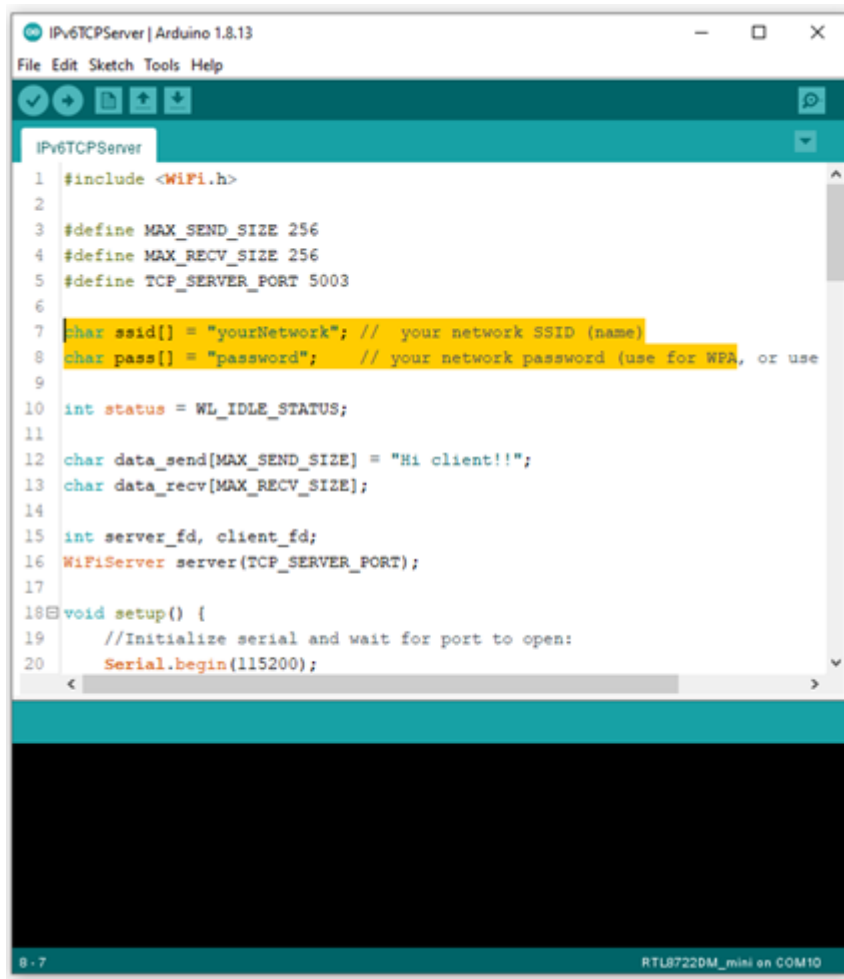
This example shows how Ameba can communicate on the local network using Internet Protocol version 6 over TCP. Note that this example only works after you have set up the server and then configure the client accordingly.

#### Procedure

Step 1. IPv6TCPServer Open the example, “Files” -> “Examples” -> “AmebaWiFi” -> “IPv6TCPServer” .



In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.

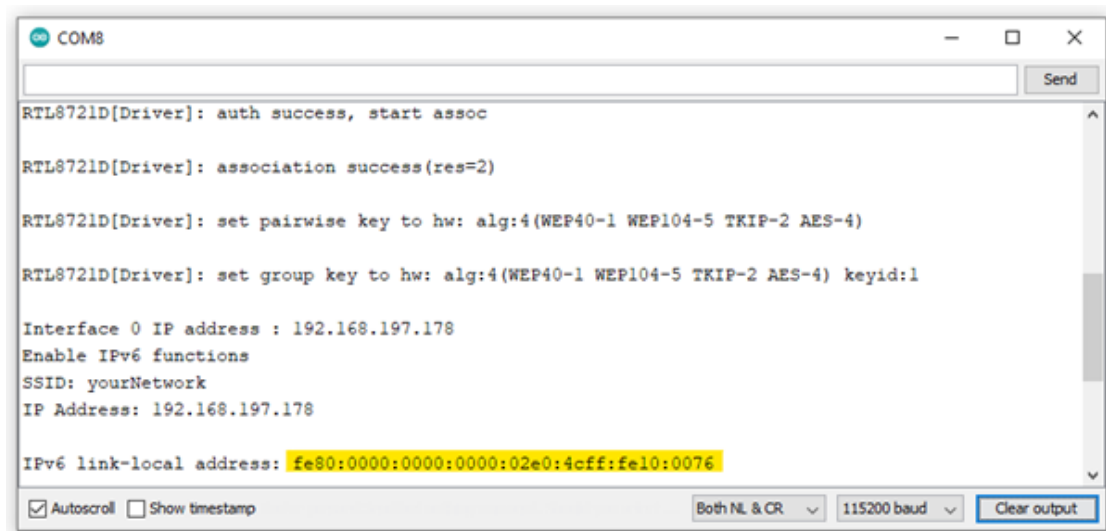


```

1  #include <WiFi.h>
2
3  #define MAX_SEND_SIZE 256
4  #define MAX_RECV_SIZE 256
5  #define TCP_SERVER_PORT 5003
6
7  char ssid[] = "yourNetwork"; // your network SSID (name)
8  char pass[] = "password";    // your network password (use for WPA, or use
9
10 int status = WL_IDLE_STATUS;
11
12 char data_send[MAX_SEND_SIZE] = "Hi client!!";
13 char data_recv[MAX_RECV_SIZE];
14
15 int server_fd, client_fd;
16 WiFiServer server(TCP_SERVER_PORT);
17
18 void setup() {
19     //Initialize serial and wait for port to open:
20     Serial.begin(115200);

```

Next, upload the code and press the reset button on Ameba once the upload is finished. Open Serial Monitor and copy the IPv6 address of the Server (the highlighted area) for later use,



```

COM8

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=2)

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

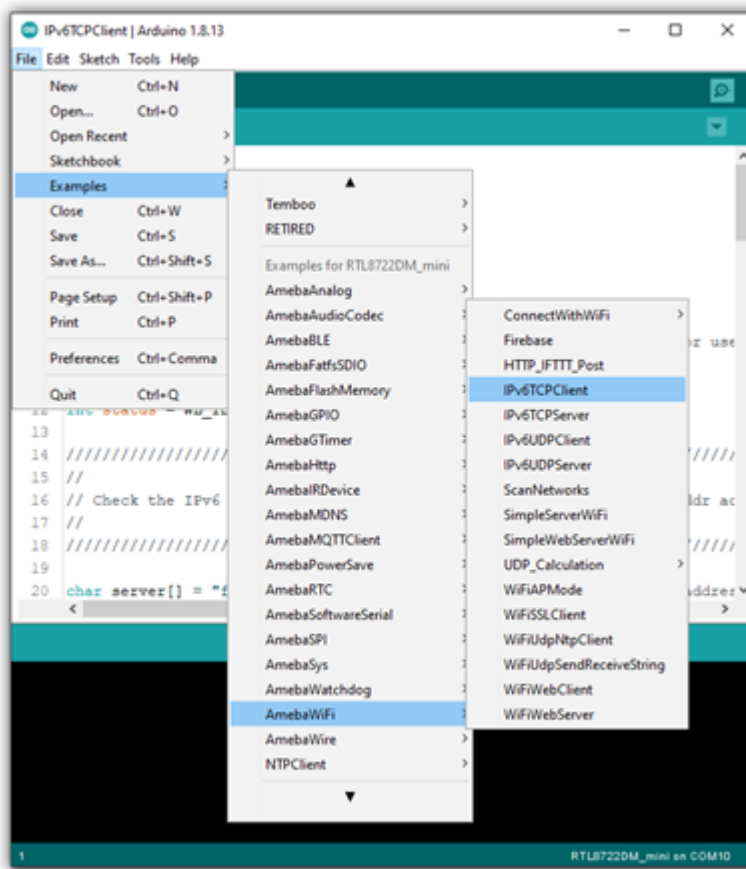
Interface 0 IP address : 192.168.197.178
Enable IPv6 functions
SSID: yourNetwork
IP Address: 192.168.197.178

IPv6 link-local address: fe80:0000:0000:0000:02e0:4cff:fe10:0076

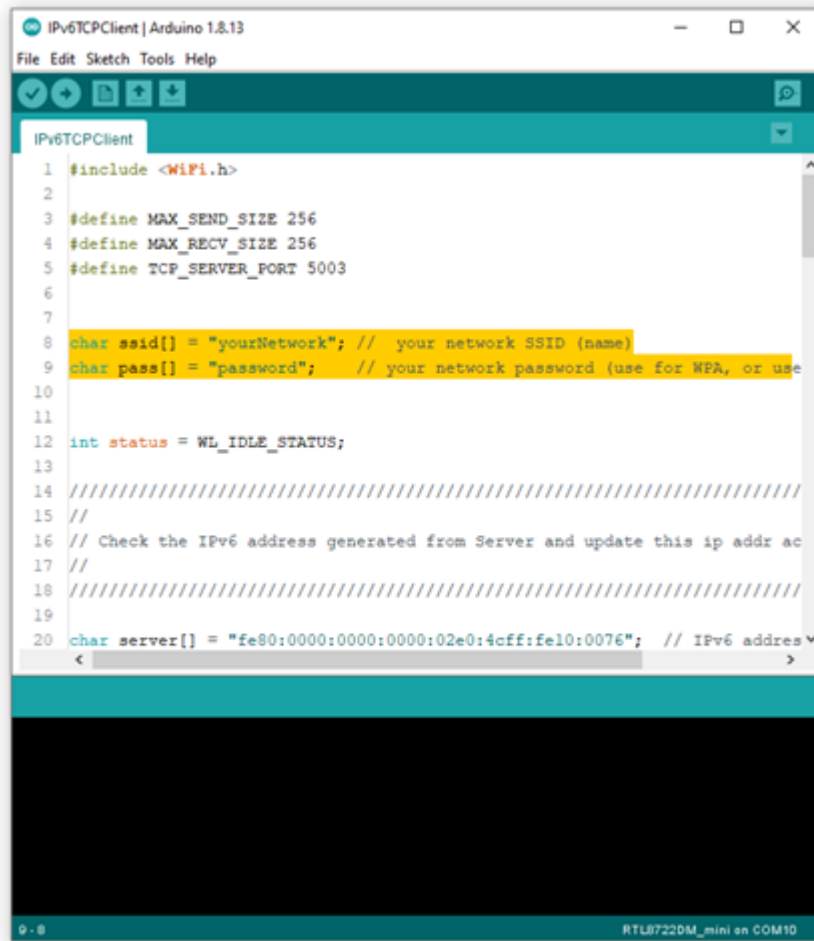
```

Step 2. IPv6TCPClient Now take the second Ameba D and open another example, “Files” -> “Examples” ->

“AmebaWiFi” -> “IPv6TCPClient”.



In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5 #define TCP_SERVER_PORT 5003
6
7
8 char ssid[] = "yourNetwork"; // your network SSID (name)
9 char pass[] = "password"; // your network password (use for WPA, or use
10
11
12 int status = WL_IDLE_STATUS;
13
14 ///////////////////////////////////////////////////////////////////
15 //
16 // Check the IPv6 address generated from Server and update this ip addr ac
17 //
18 ///////////////////////////////////////////////////////////////////
19
20 char server[] = "fe80:0000:0000:0000:02e0:4cff:fe10:0076"; // IPv6 address
```

From the previous step, we have obtained the Server' s IPv6 address, now we copy the server' s IPv6 address to "IPv6TCPCClient" example in the highlighted area below,



```

1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5 #define TCP_SERVER_PORT 5003
6
7
8 char ssid[] = "yourNetwork"; // your network SSID (name)
9 char pass[] = "password";    // your network password (use for WPA, or use as key for WEP)
10
11
12 int status = WL_IDLE_STATUS;
13
14 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
15 //
16 // Check the IPv6 address generated from Server and update this ip addr accordingly !! //
17 //
18 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
19
20 char server[] = "fe80:0000:0000:0000:02e0:4cff:fe10:0074"; // IPv6 address of server board
21 char data_recv[MAX_RECV_SIZE];
22 char data_send[MAX_SEND_SIZE] = "Hi Server!!";
23

```

Image tool closed!  
Upload Image done.

20 RTL8722DM/RTL8722C5M on COM10

Next, upload the code and press the reset button on Ameba once the upload is finished.

Open Serial Monitor on the port to the second Ameba D, you should see server and client are sending text message to each other at the same time.

```

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

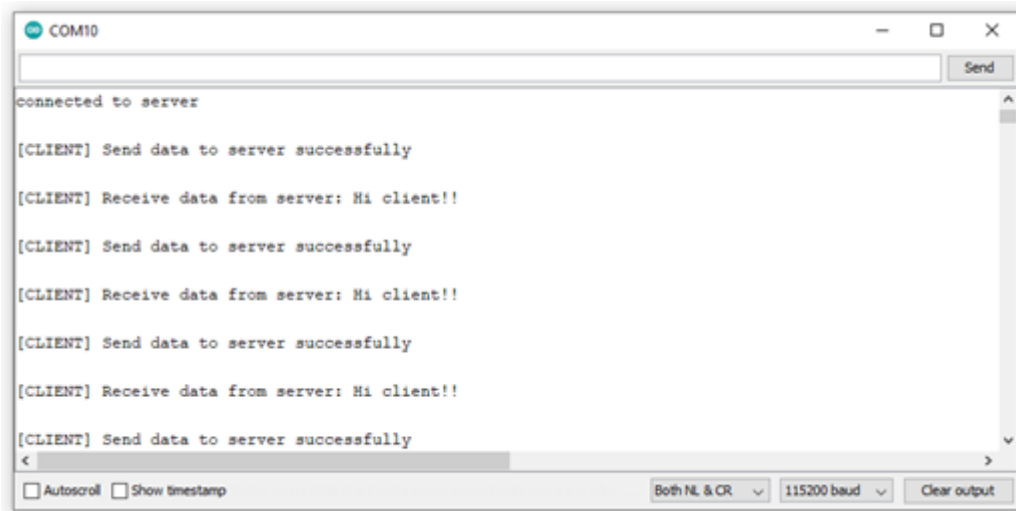
[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

```

☐ Autoscroll ☐ Show timestamp Both NL & CR 115200 baud Clear output



## IPv6 –Ameba as IPv6 Server/Client over UDP

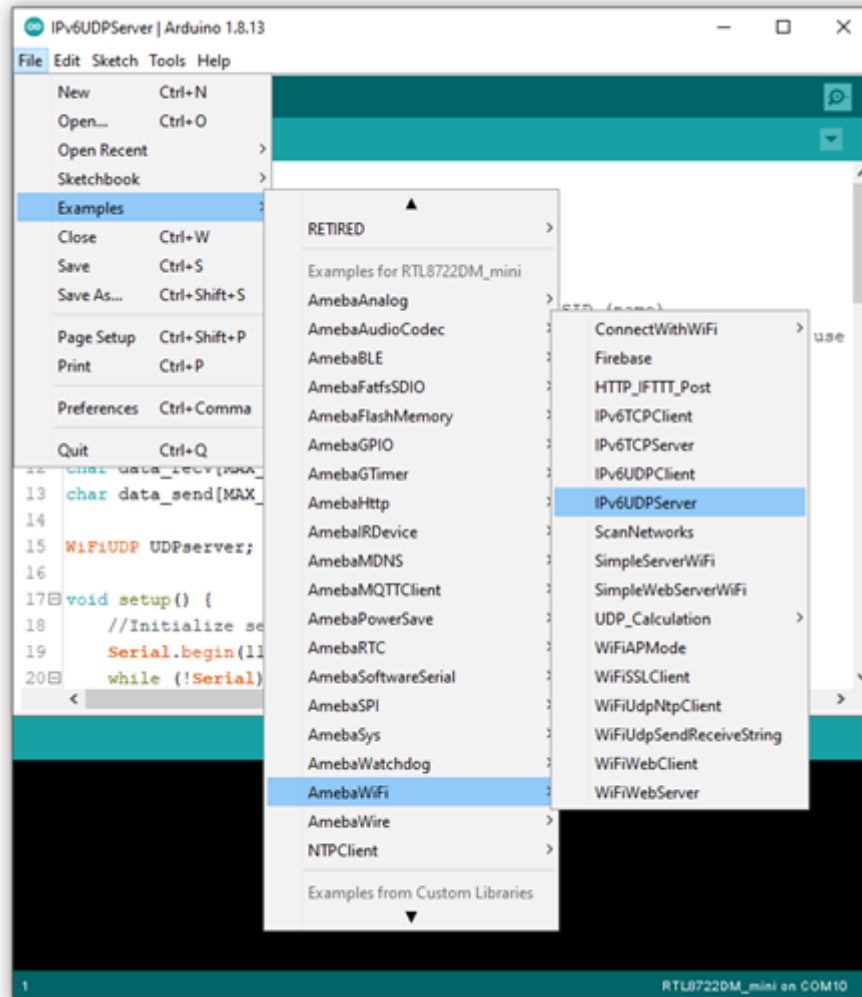
### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

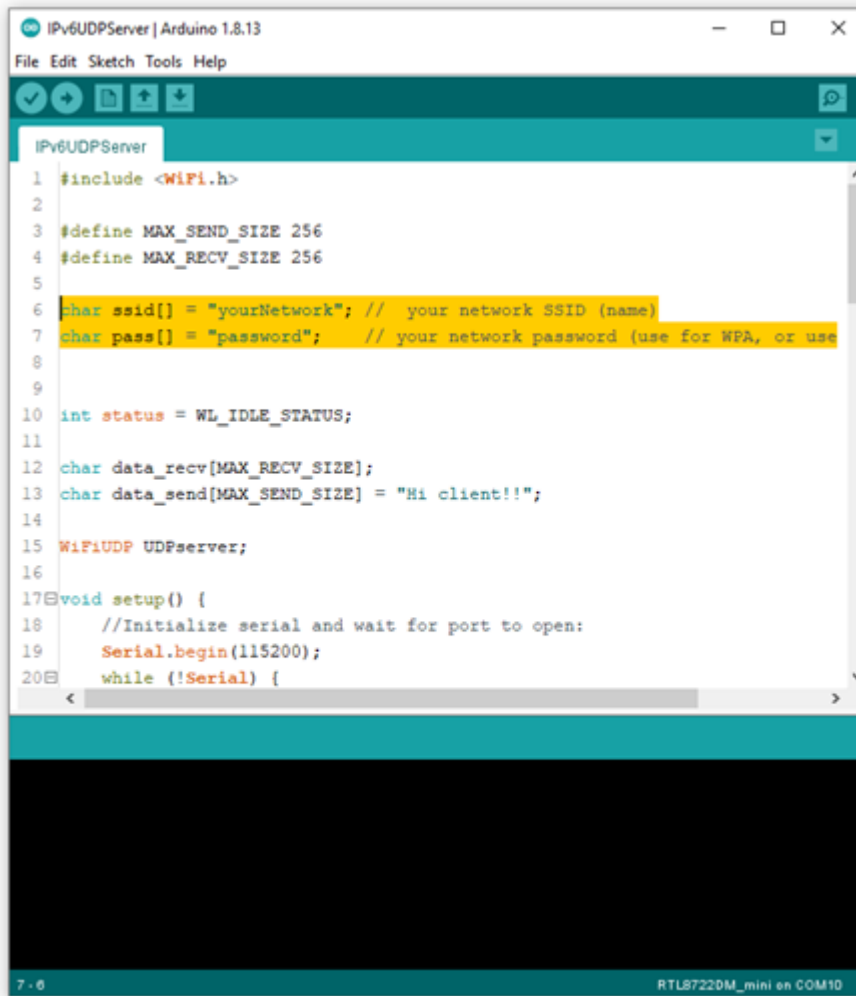
### Example

#### Introduction

This example shows how Ameba can communicate on the local network using Internet Protocol version 6 over UDP. Note that this example only works after you have set up the server and then configure the client accordingly.

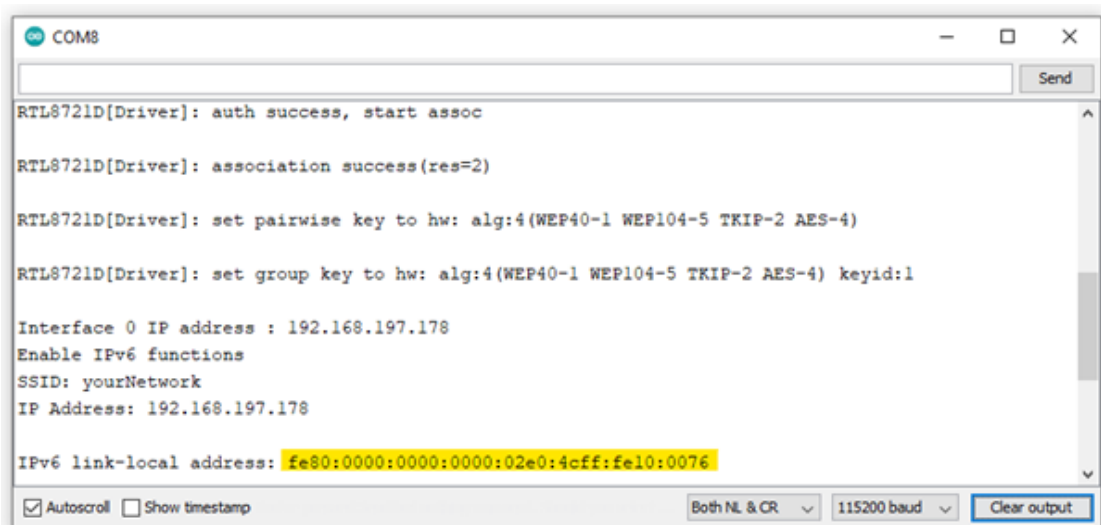


In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5
6 char ssid[] = "yourNetwork"; // your network SSID (name)
7 char pass[] = "password"; // your network password (use for WPA, or use
8
9
10 int status = WL_IDLE_STATUS;
11
12 char data_recv[MAX_RECV_SIZE];
13 char data_send[MAX_SEND_SIZE] = "Hi client!!";
14
15 WiFiUDP UDPServer;
16
17 void setup() {
18   //Initialize serial and wait for port to open:
19   Serial.begin(115200);
20   while (!Serial) {
```

Next, upload the code and press the reset button on Ameba once the upload is finished. Open Serial Monitor and copy the IPv6 address of the Server (the highlighted area) for later use,

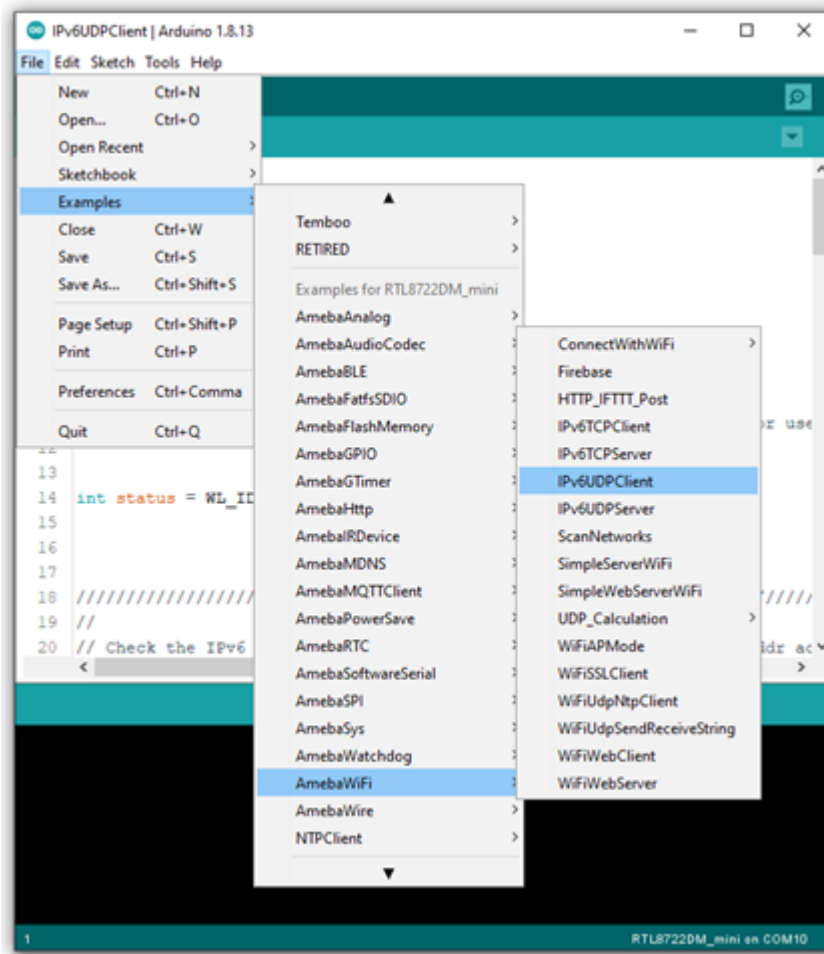


```
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=2)
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

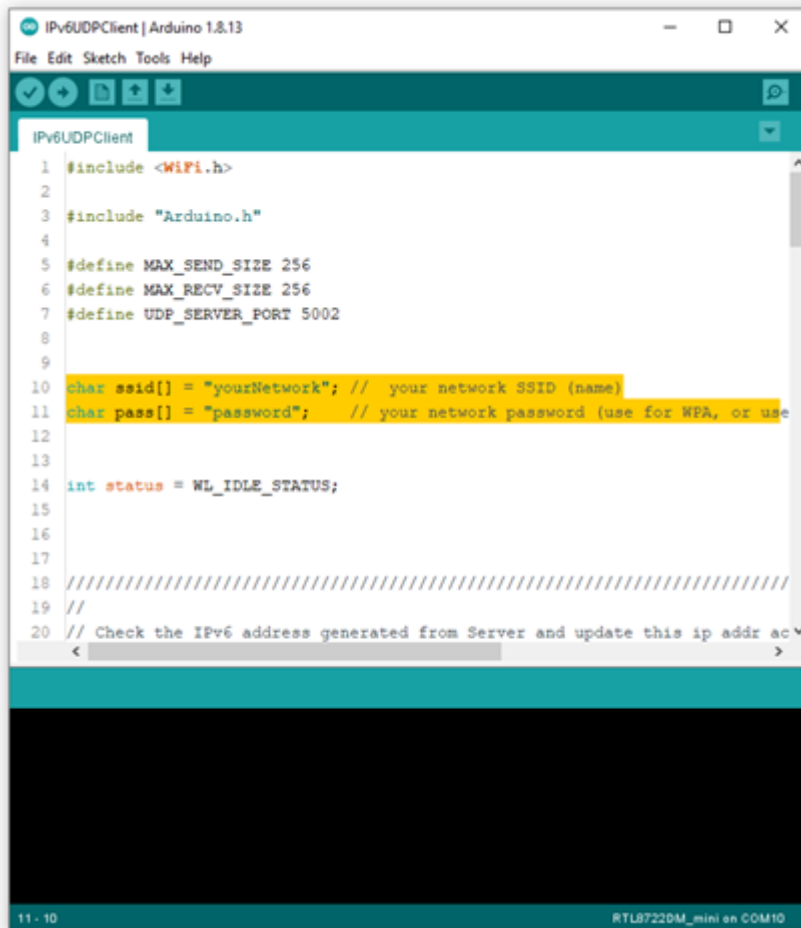
Interface 0 IP address : 192.168.197.178
Enable IPv6 functions
SSID: yourNetwork
IP Address: 192.168.197.178

IPv6 link-local address: fe80:0000:0000:0000:02e0:4c00:fe10:0076
```

Step 2. IPv6UDPCliEnt Now take the second Ameba D and open another example, “Files” -> “Examples” -> “AmebaWiFi” -> “IPv6UDPCliEnt” .

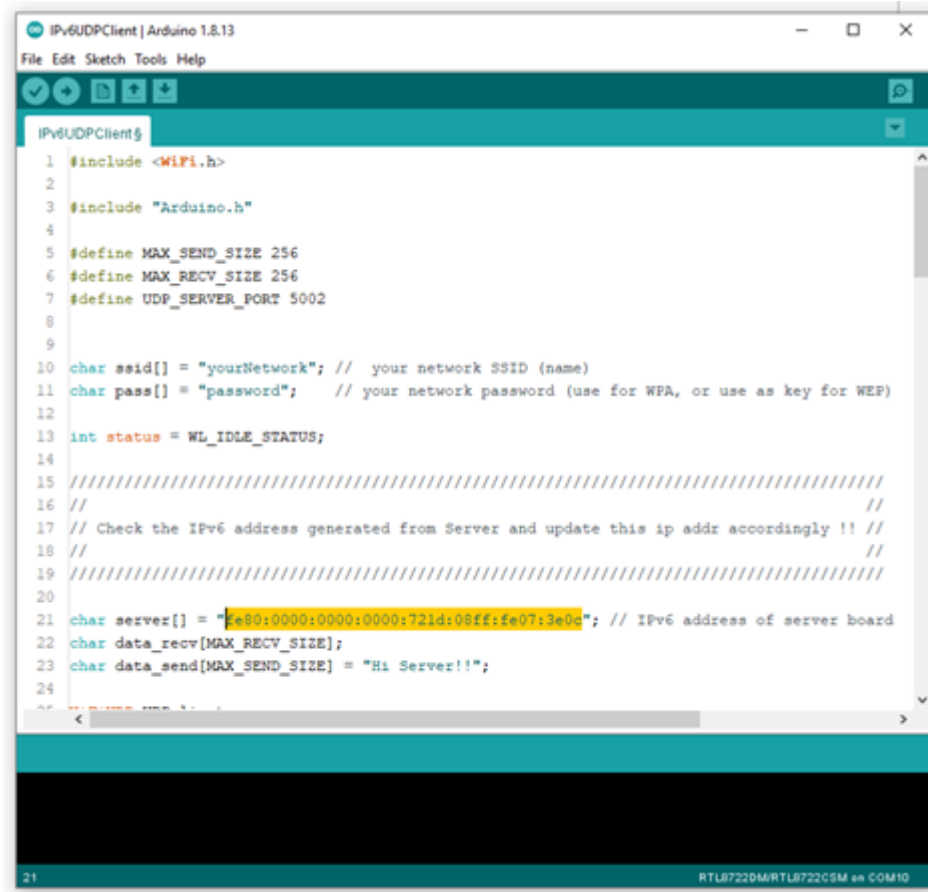


In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #include "Arduino.h"
4
5 #define MAX_SEND_SIZE 256
6 #define MAX_RECV_SIZE 256
7 #define UDP_SERVER_PORT 5002
8
9
10 char ssid[] = "yourNetwork"; // your network SSID (name)
11 char pass[] = "password"; // your network password (use for WPA, or use
12
13
14 int status = WL_IDLE_STATUS;
15
16
17
18 ///////////////////////////////////////////////////
19 //
20 // Check the IPv6 address generated from Server and update this ip addr ac
21 < >
```

From the previous step, we have obtained the Server' s IPv6 address, now we copy the server' s IPv6 address to "IPv6UDPClient" example in the highlighted area below,



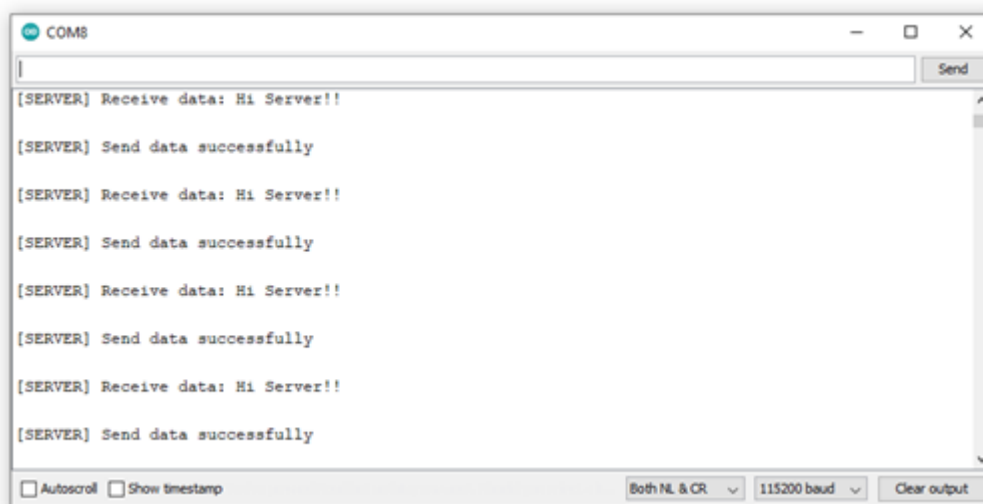
```

1  #include <WiFi.h>
2
3  #include "Arduino.h"
4
5  #define MAX_SEND_SIZE 256
6  #define MAX_RECV_SIZE 256
7  #define UDP_SERVER_PORT 5002
8
9
10 char ssid[] = "yourNetwork"; // your network SSID (name)
11 char pass[] = "password"; // your network password (use for WPA, or use as key for WEP)
12
13 int status = WL_IDLE_STATUS;
14
15 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
16 //
17 // Check the IPv6 address generated from Server and update this ip addr accordingly !! //
18 //
19 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
20
21 char server[] = "fe80:0000:0000:0000:721d:08ff:fe07:3e0d"; // IPv6 address of server board
22 char data_recv[MAX_RECV_SIZE];
23 char data_send[MAX_SEND_SIZE] = "Hi Server!!";
24
25

```

Next, upload the code and press the reset button on Ameba once the upload is finished.

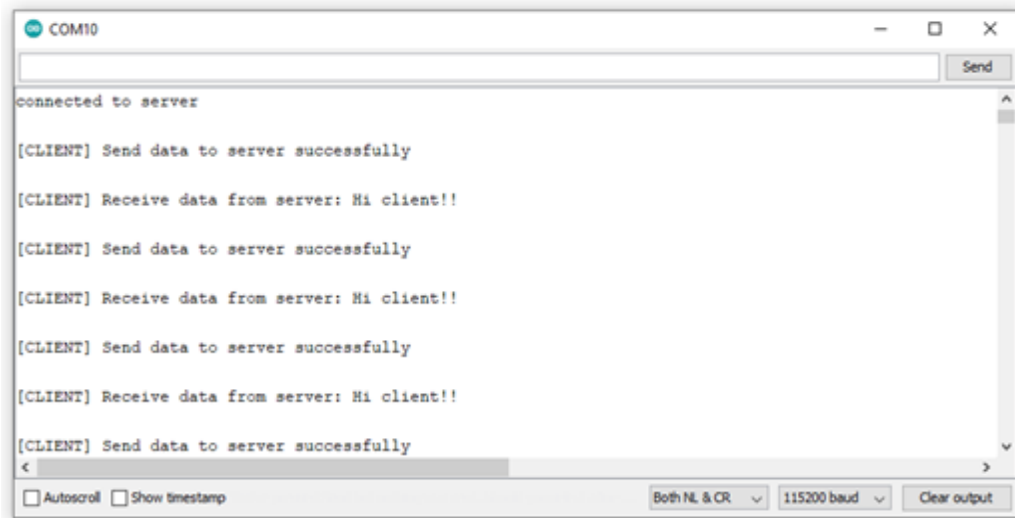
Open Serial Monitor on the port to the second Ameba D, you should see server and client are sending text message to each other at the same time.



```

[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully

```



## MDNS - Set up mDNS Client on Arduino IDE

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

mDNS (Multicast DNS) is a protocol used in the local area network. It delivers the network information like IP address and provided services to others. mDNS is based on the UDP protocol, and it sends packets to 224.0.0.251 with port 5353 under IPv4 address. The naming style for the service follows the format: **{Instance Name}.{Protocol Name}.{Domain}**

- Instance Name: used to identify the name of the service
- Protocol Name: Divided into two parts, the front end is in regard to the name of the service, and it adds baseline as a prefix. The rear end is in regard to the transport protocol name it used, and it also adds baseline as a prefix
- Domain: Local area network in normal cases

For example, Arduino IDE adopts the naming for the mDNS service which is used in OTA as following: **MyAmeba.\_arduino.\_tcp.local**

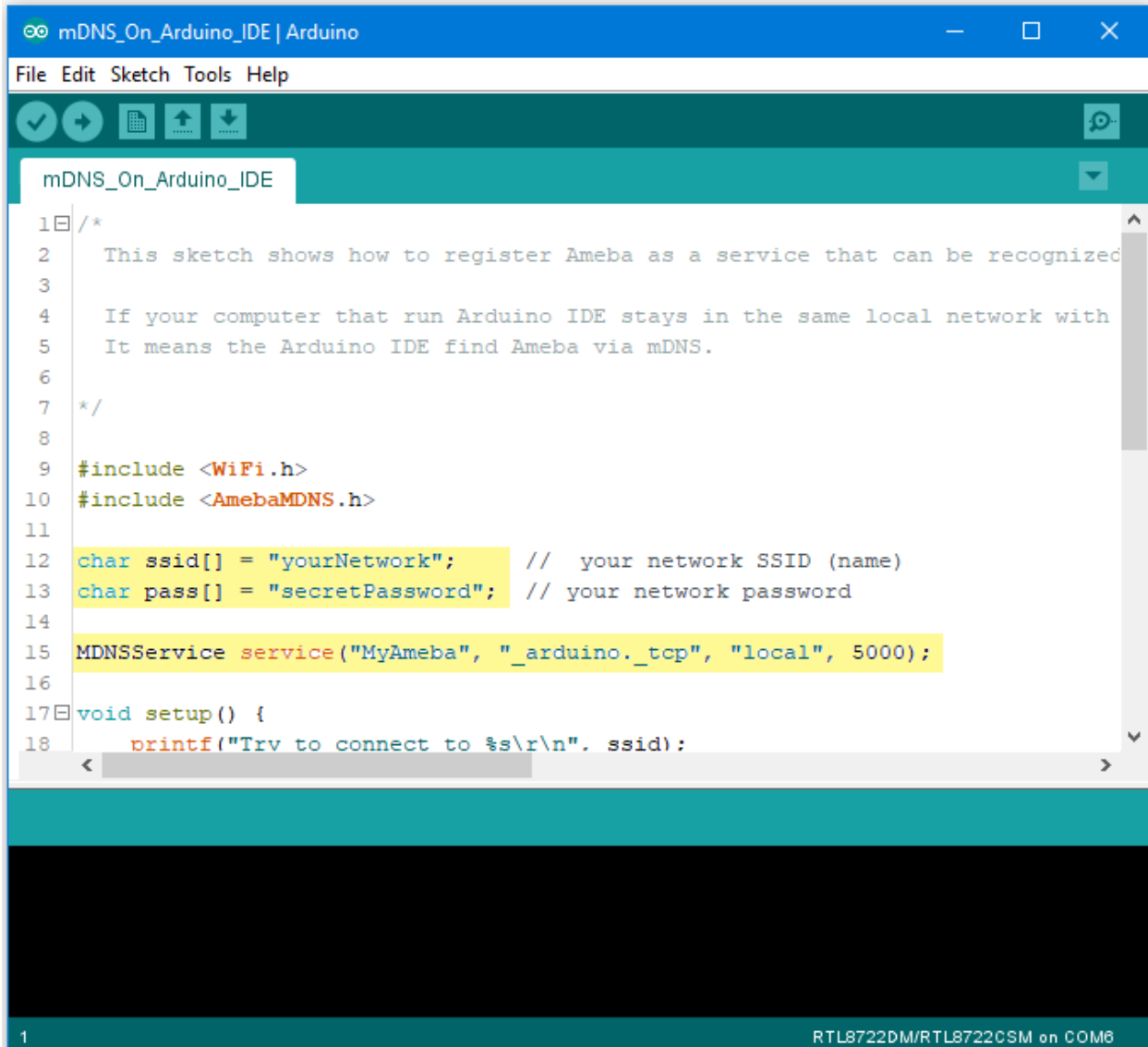
Among the naming example, “MyAmeba” can identify the Ameba device name and the name “MyAmeba” is changeable. “\_arduino.\_tcp” is the protocol that Arduino IDE adopts, and the Domain is set as local in common.

Open the example, “File” -> “Examples” -> “AmebaMDNS” -> “mdns\_on\_arduino\_ide”

You need to input ssid and password of the AP because the example will use WiFi connection.



And you can find out the naming of the service at the place where it declares MDNS Service. The example uses the default name “MyAmeba” and the name is changeable.

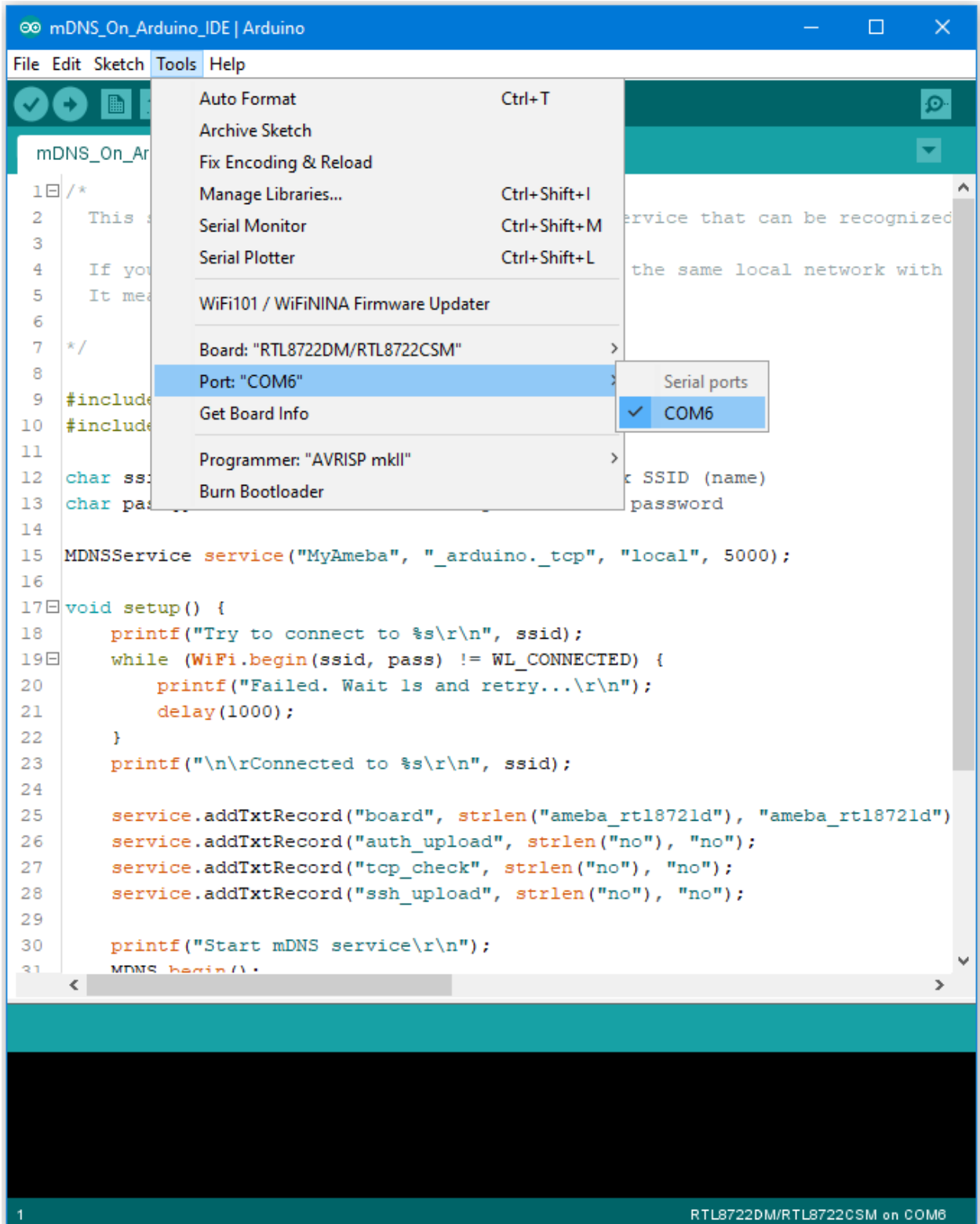


```

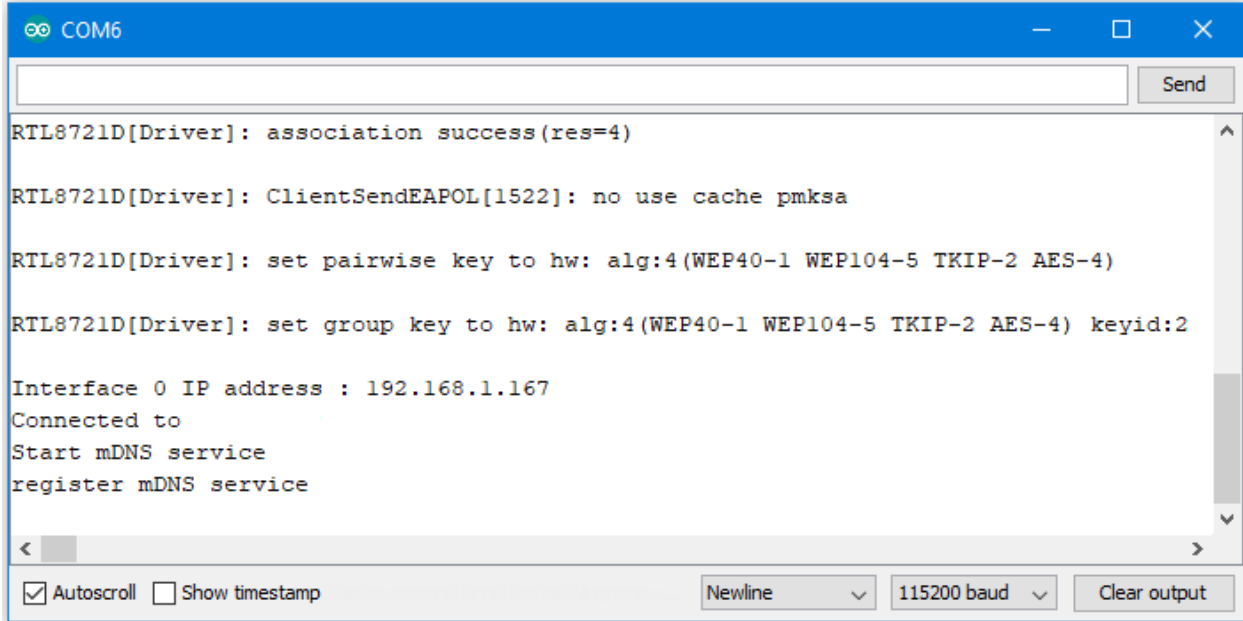
1  /*
2   This sketch shows how to register Ameba as a service that can be recognized
3
4   If your computer that run Arduino IDE stays in the same local network with
5   It means the Arduino IDE find Ameba via mDNS.
6
7  */
8
9  #include <WiFi.h>
10 #include <AmebaMDNS.h>
11
12 char ssid[] = "yourNetwork"; // your network SSID (name)
13 char pass[] = "secretPassword"; // your network password
14
15 MDNSService service("MyAmeba", "_arduino._tcp", "local", 5000);
16
17 void setup() {
18     printf("Try to connect to %s\r\n", ssid);

```

Next, go to ( “Tools” -> “Port” ), and you can find out at least one Serial Port. This port is simulated by Ameba board via USB. Choose this port and upload the compiled code to



After uploading the code, press the reset button on Ameba and waiting for Ameba to connect with AP and activate the mDNS service after a while. You can see the Log at the bottom of the Serial Monitor.



```
COM6
RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

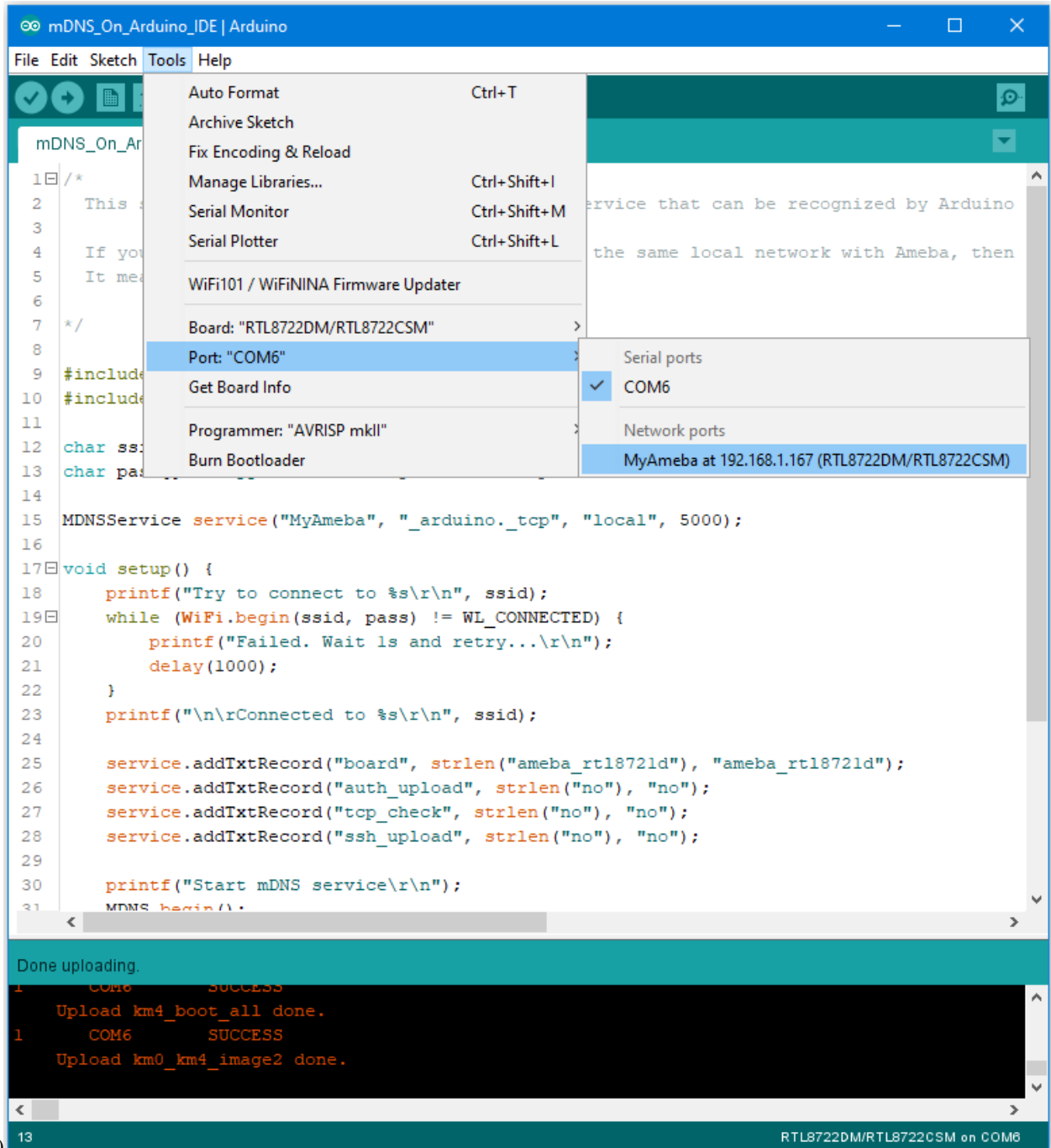
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
Connected to
Start mDNS service
register mDNS service

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output
```

Then you can find out the added item “Network Ports” “**MyAmeba at 192.168.1.167 (Ameba RTL8722DM/RTL8722CSM)**”, “MyAmeba” is the device name we set up, and “IP” is the IP address that AP assigned to Ameba, the IP address should be the same with the IP shown in the Serial Monitor. Last, “Ameba RTL8722DM/RTL8722CSM” is the type name of the board, and it means that Ameba can let Arduino IDE identify the mDNS service successfully.(We still can not use the Internet to upload the code, and we will explain this part in the OTA exam-



ple.)

If you cannot find the Network ports on your Arduino IDE, please check:

- Does your computer in the same local area network with the Ameba?
- Restart the Arduino IDE, and it will find the mDNS service again
- Check the Log in Serial Monitor if the Ameba connects to the AP and activate mDNS service successfully

## Code Reference

The program set up the mDNS service in the beginning, the first parameter is Instance Name, and it is changeable in this example. The second parameter is the protocol that the service used, and it would be “\_arduino.\_tcp” for Arduino IDE. The third parameter is Domain, and it would be “local” in common. The fourth parameter is the port number for the service, it is 5000 here and we doesn’ t use it in the example.

```
MDNSService service("MyAmeba", "_arduino._tcp", "local", 5000);
```

After connected to the network, we set up some text fields for the service. For the following example, “board” is the name of the field, “ameba\_rtl8721d” is the value of the field. “board” is used to let Arduino IDE check installed SDK to see if it exists known device or not. We will use the name of the device if there is known device, users can change “ameba\_rtl8721d” to “yun” or other names to find out what’ s the difference if interested.

```
service.addTxtRecord("board", strlen("ameba_rtl8721d"), "ameba_rtl8721d");
```

Then we add three text fields “auth\_upload” , “tcp\_check” , and “ssh\_upload” , this example does not activate these services.

```
service.addTxtRecord("auth_upload", strlen("no"), "no");
service.addTxtRecord("tcp_check", strlen("no"), "no");
service.addTxtRecord("ssh_upload", strlen("no"), "no");
```

Next we activate MDNS

```
MDNS.begin();
```

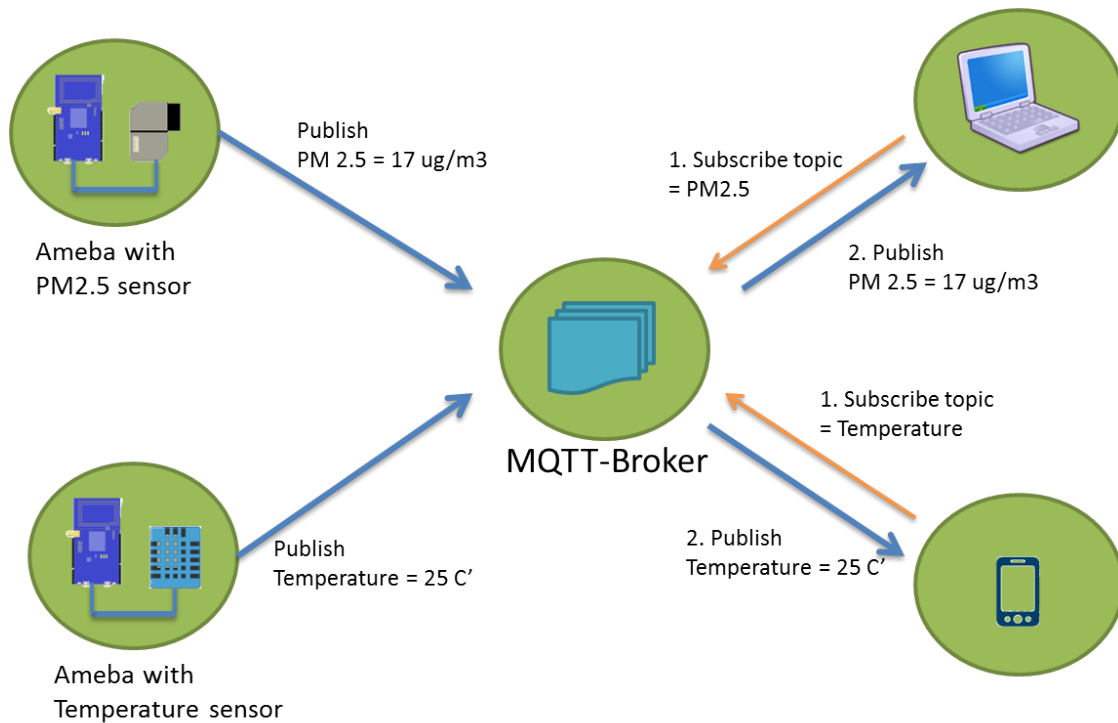
and register to the mDNS service.

```
MDNS.registerService(service);
```

## MQTT - Set up MQTT Client to Communicate with Broker

### Intro to MQTT

MQTT (Message Queuing Telemetry Transport) is a protocol proposed by IBM and Eurotech. The introduction in [MQTT Official Website](#): MQTT is a machine-to-machine (M2M)/” Internet of Things” connectivity protocol. It was designed as an extremely lightweight publish/subscribe messaging transport. We can say MQTT is a protocol designed for IoT. MQTT is based on TCP/IP and transmits/receives data via publish/subscribe. Please refer to the figure below:



In the operation of MQTT, there are several roles:

- **Publisher:** Usually publishers are the devices equipped with sensors (ex. Ameba). Publishers uploads the data of the sensors to MQTT-Broker, which serves as a database with MQTT service.
- **Subscriber:** Subscribers are referred to the devices which receive and observe messages, such as a laptop or a mobile phone.
- **Topic:** Topic is used to categorized the messages, for example the topic of a message can be “PM2.5” or “Temperature” . Subscribers can choose messages of which topics they want to receive.

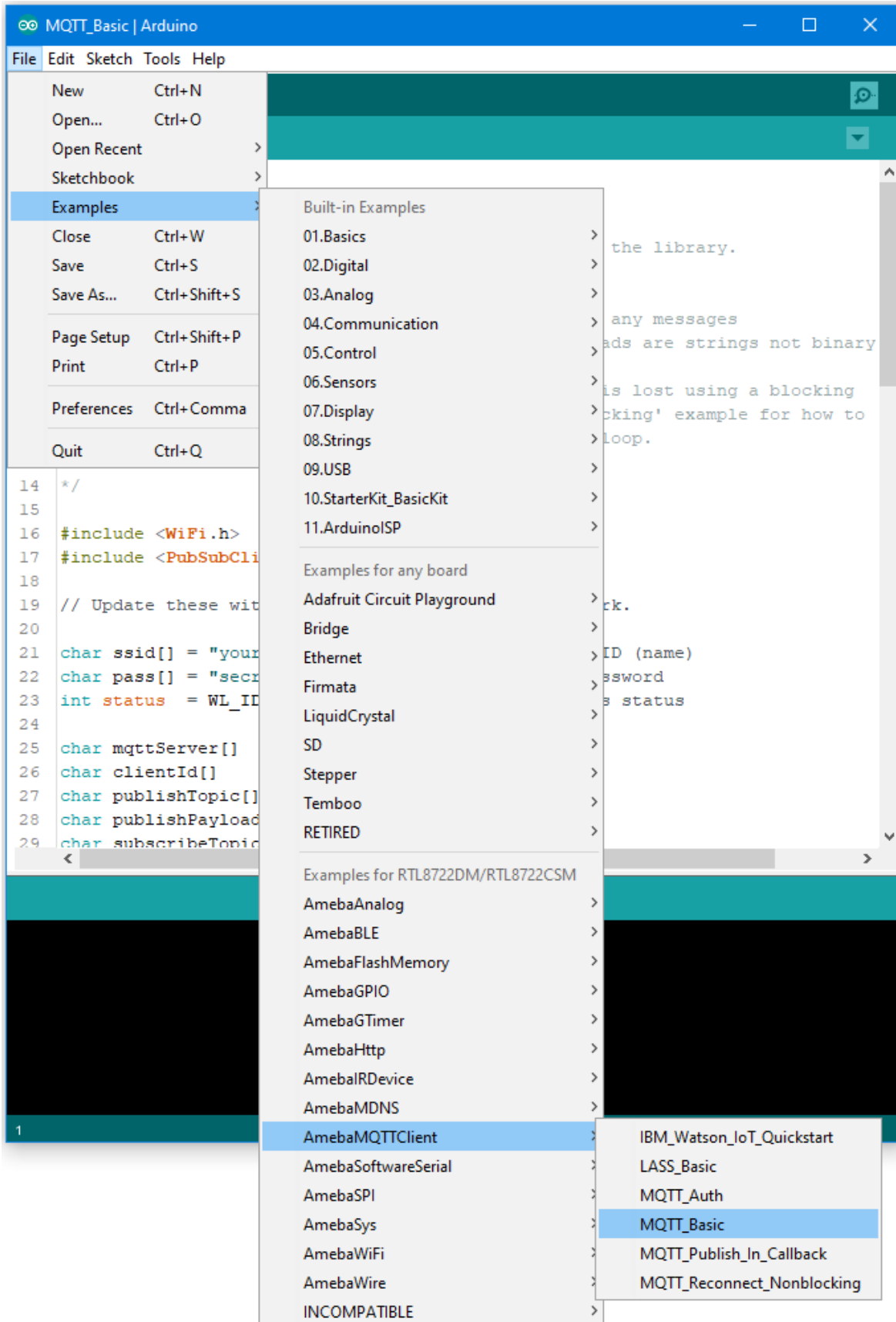
## Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

## Example

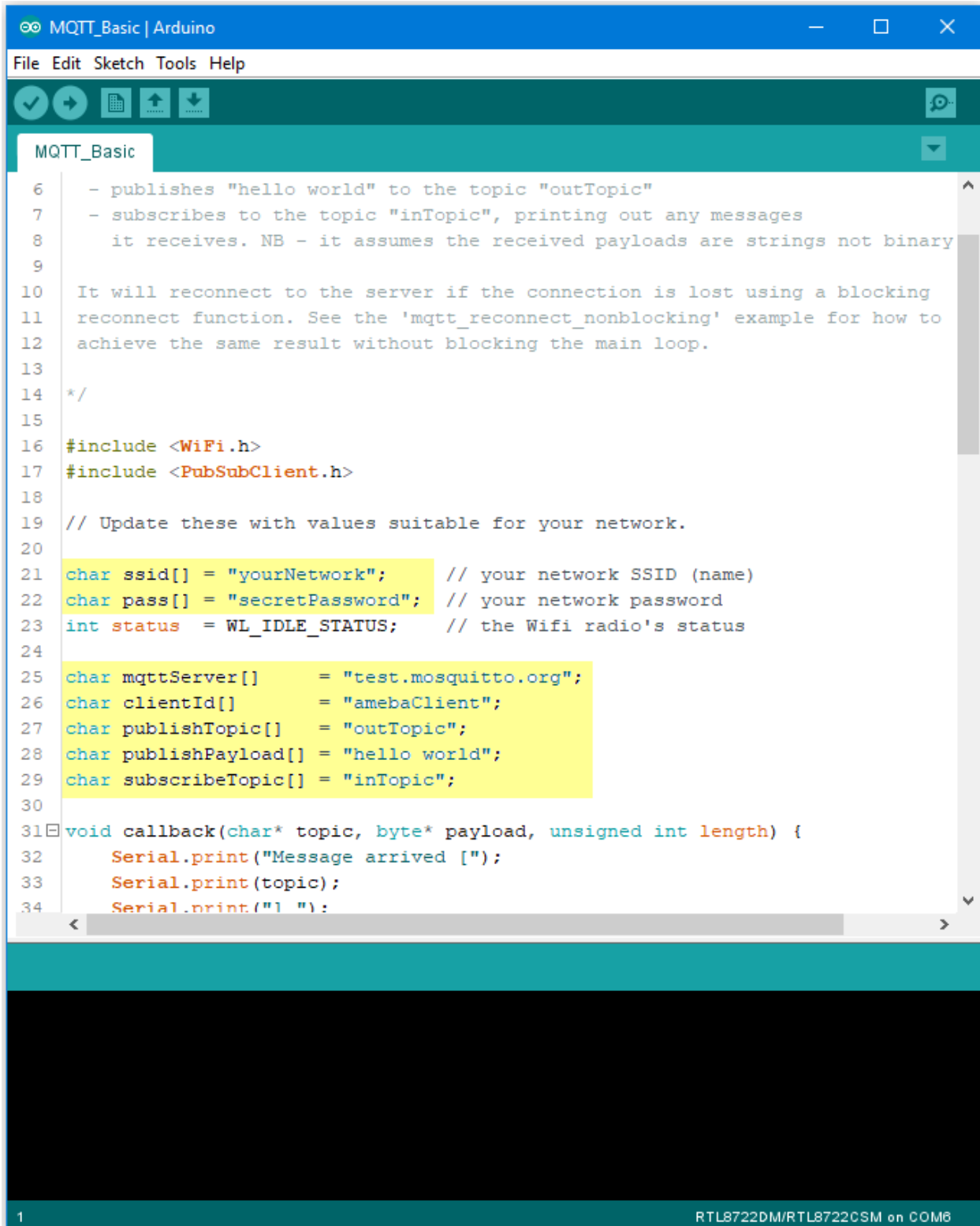
In this example, we connect Ameba to MQTT-Broker. Then send messages as publisher and receive messages from MQTT-Broker as subscriber.

Open the MQTT example “File” -> “Examples” -> “AmebaMQTTClient” -> “MQTT\_Basic”



Please modify some WiFi-related parameters.

And some information related to MQTT:



```

MQTT_Basic | Arduino
File Edit Sketch Tools Help

MQTT_Basic

6   - publishes "hello world" to the topic "outTopic"
7   - subscribes to the topic "inTopic", printing out any messages
8     it receives. NB - it assumes the received payloads are strings not binary
9
10  It will reconnect to the server if the connection is lost using a blocking
11  reconnect function. See the 'mqtt_reconnect_nonblocking' example for how to
12  achieve the same result without blocking the main loop.
13
14  */
15
16  #include <WiFi.h>
17  #include <PubSubClient.h>
18
19  // Update these with values suitable for your network.
20
21  char ssid[] = "yourNetwork"; // your network SSID (name)
22  char pass[] = "secretPassword"; // your network password
23  int status = WL_IDLE_STATUS; // the Wifi radio's status
24
25  char mqttServer[] = "test.mosquitto.org";
26  char clientId[] = "amebaClient";
27  char publishTopic[] = "outTopic";
28  char publishPayload[] = "hello world";
29  char subscribeTopic[] = "inTopic";
30
31  void callback(char* topic, byte* payload, unsigned int length) {
32    Serial.print("Message arrived [");
33    Serial.print(topic);
34    Serial.print("] ");
  
```

1 RTL8722DM/RTL8722CSM on COM8



The “mqttServer” refers to the MQTT-Broker, we use the free MQTT sandbox “test.mosquitto.org” for testing.

- “clientId” is an identifier for MQTT-Broker to identify the connected device.
- “publishTopic” is the topic of the published message, we use “outTopic” in the example. The devices subscribe to “outTopic” will receive the message.
- “publishPayload” is the content to be published.
- “subscribeTopic” is to tell MQTT-broker which topic we want to subscribe to.

Next, compile the code and upload it to Ameba. Press the reset button, then open the serial monitor

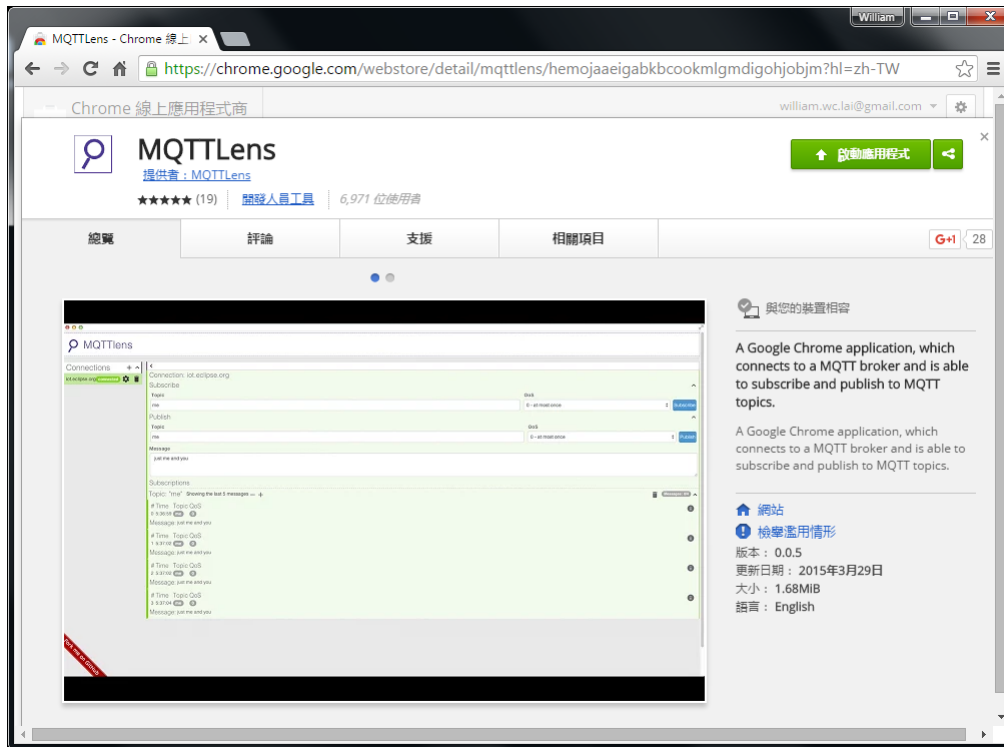
```

RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=4)
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2
Interface 0 IP address : 192.168.1.167Attempting MQTT connection...
Connect to Server successfully!
connected
  
```

After Ameba is connected to MQTT server, it sends the message “hello world” to “outTopic” .

To see the message, we need another MQTT client.

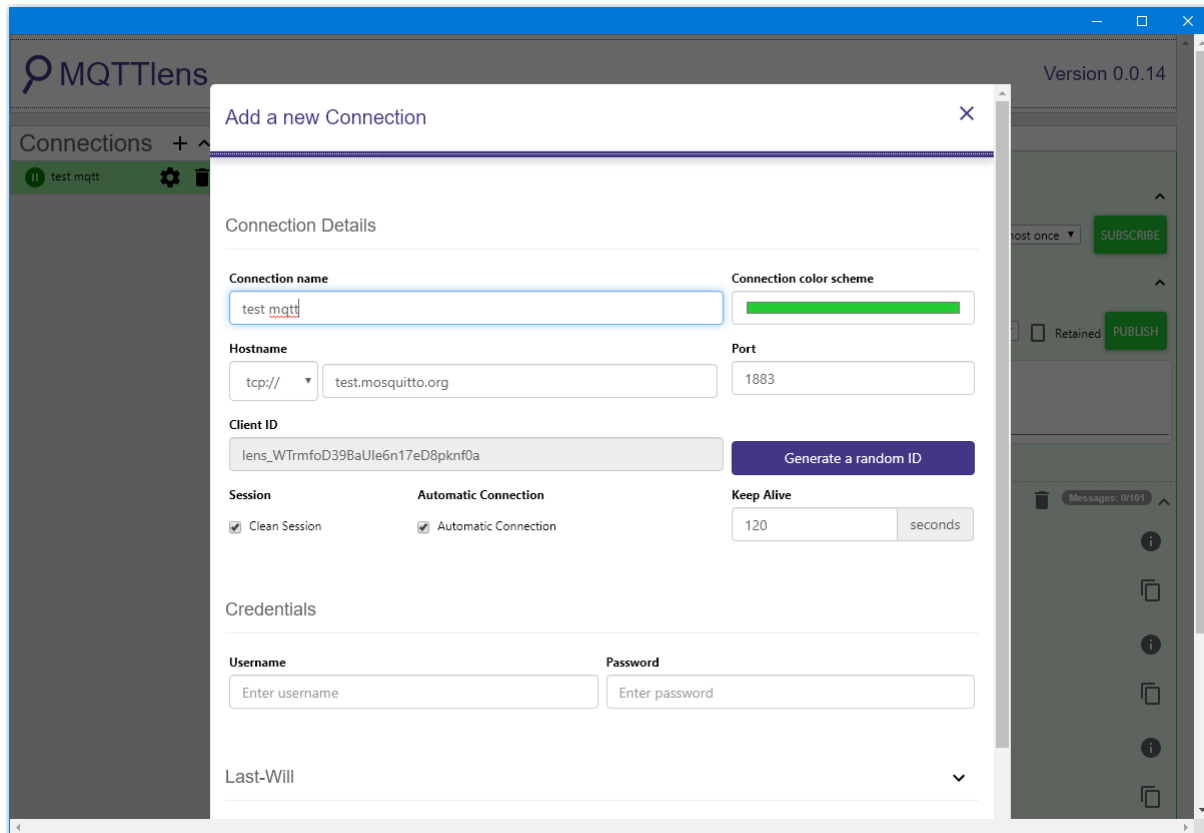
Here we use a chrome plugin “MQTTLens” to be the MQTT client. You can find it in google webstore.



Install and open the MQTTLens, click “+” next to “Connection” on the left, and fill in the required information

- **Connection Name:** Used to identify the connection, you can choose a name you like.
- **Hostname:** The MQTT-Broker server, here we use “iot.eclipse.org”
- **Client ID:** We use the default randomly generated ID.

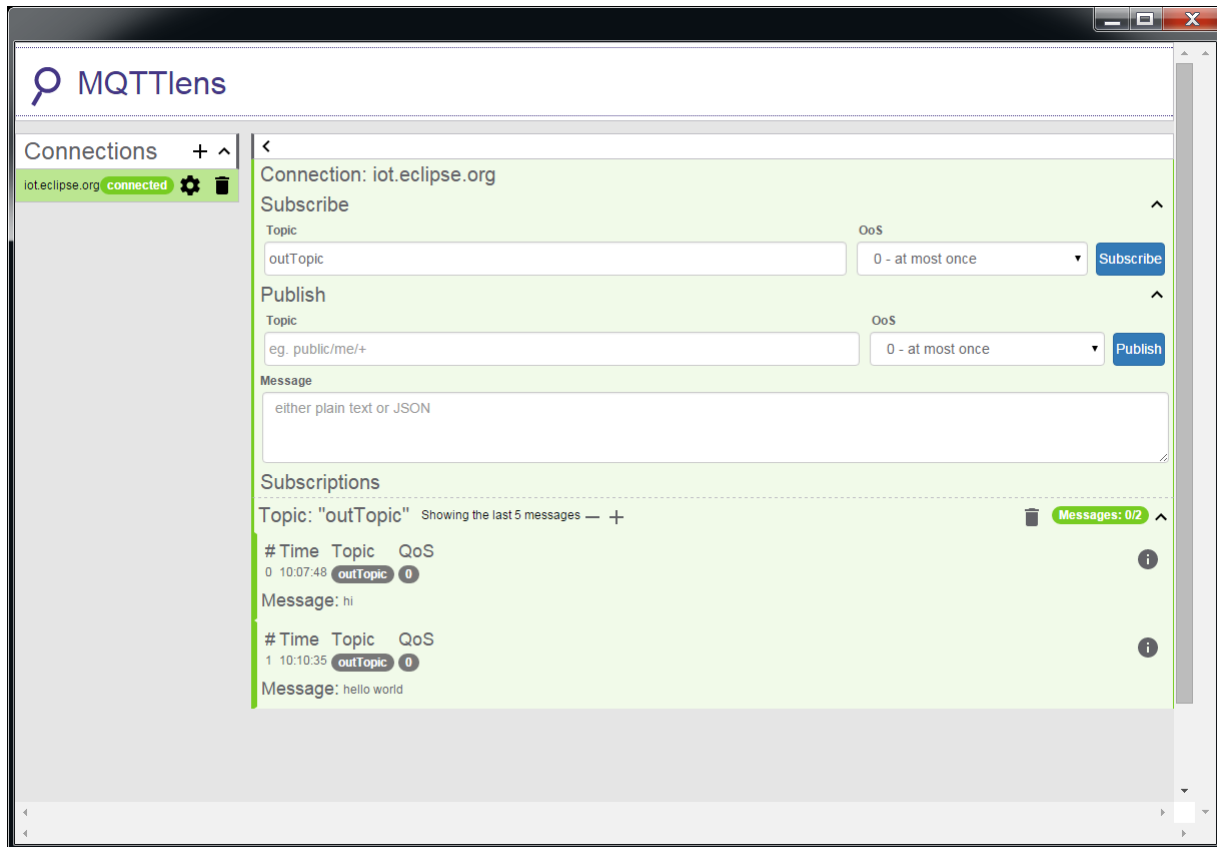
Then click “CREATE CONNECTION” .



Since we have not registered the topic we want to listen to, we would not receive any messages now.

Fill in “outTopic” in the “Topic” field and click “Subscribe” .

Wait for Ameba to send next message (or you can press the reset button). Then you can see the “hello world” message show up.



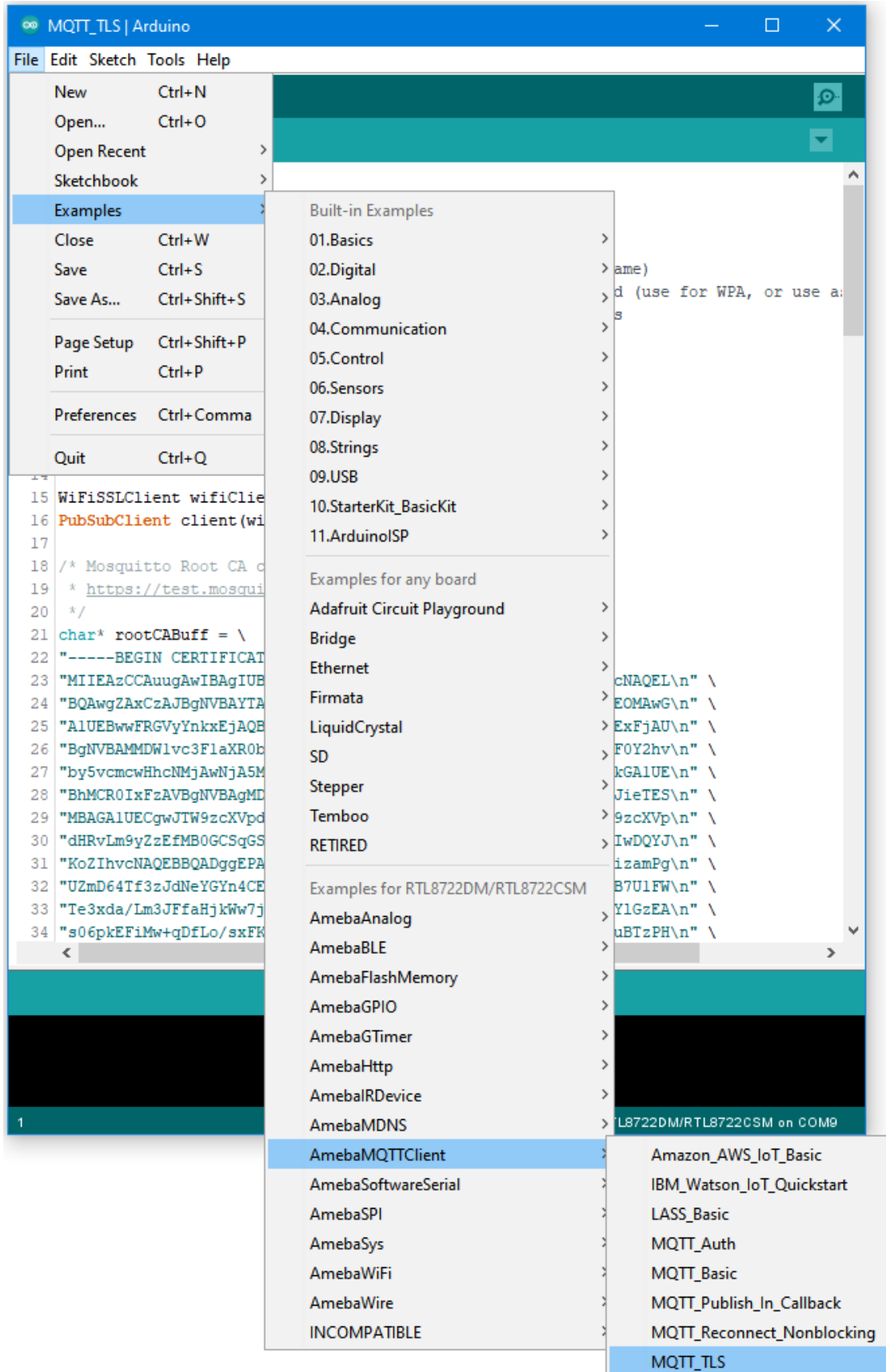
## MQTT - Set up MQTT Client over TLS

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we connect Ameba to a MQTT broker using TLS authentication. Then send messages as a publisher and receive messages from as a subscriber. Open the MQTT example “File” -> “Examples” -> “AmebaMQTTClient” -> “MQTT\_TLS”



Please modify the WiFi-related parameters to connect to your WiFi network.

Modify the MQTT parameters to fit your application:

```

MQTT_TLS | Arduino
File Edit Sketch Tools Help

MQTT_TLS
1 #include <WiFi.h>
2 #include <PubSubClient.h>
3
4 // Update these with values suitable for your network.
5 char ssid[] = "yourNetwork"; // your network SSID (name)
6 char pass[] = "yourPassword"; // your network password (use for WPA, or use a:
7 int status = WL_IDLE_STATUS; // the Wifi radio's status
8
9 char mqttServer[] = "test.mosquitto.org";
10 char clientId[] = "amebaClient";
11 char publishTopic[] = "outTopic";
12 char publishPayload[] = "hello world";
13 char subscribeTopic[] = "inTopic";
14
15 WiFiSSLClient wifiClient;
16 PubSubClient client(wifiClient);
17
18 /* Mosquitto Root CA can be download here:
19 * https://test.mosquitto.org/
20 */
21 char* rootCABuff = \
22 "-----BEGIN CERTIFICATE-----\n" \
23 "MIIEAzCCAaugAwIBAgIUBYlh1CGvdj4NhBXkZ/uLUZNILAwWDQYJKoZIhvcNAQEL\n" \
24 "BQAwZAXCZAJBgNVBAYTAkdCMRcwFQYDVQQIDA5Vbm10ZWQgS2luZ2RvbTEOMAwG\n" \
25 "AlUEBwwFRGVyYnkvEjAQBgNVBAoMCUlv3FlaXR0bzELMAkGA1UECwwCQ0ExFjAU\n" \
26 "BgNVBAMMDWlv3FlaXR0by5vcmcxH2AdBgkqhkiG9w0BCQEWElJvZ2VyQG90Y2hv\n" \
27 "by5vcmcwHhcNMjAwNjA3MTEwNjM5WjcNMzAwNjA3MTEwNjM5WjCBkDELMAkGA1UE\n" \
28 "BhMCR0IxZmFzAVBgNVBAGMD1VuaXRlZCBLaW5nZG9tMQ4wDAYDVQQHDAVEZXJieTES\n" \
29 "MBAGA1UECgwJTW9zcXVpdHRvMQswCQYDVQQLDAJDQTEWMBQGA1UEAwNBW9zcXVp\n" \
30 "dHRvLm9yZzEfMB0GCSqGSIb3DQEJARYQcm9nZXJAYXRjaG9vLm9yZzCCASIwDQYJ\n" \
31 "KoZIhvcNAQEBBQADggEPADCCAQoCggEBAME0HKmIzfTOwkKLT3THHe+ObdizamPg\n" \
32 "UZmD64Tf3zJdNeYGYn4CEXbyP6fy3tWc8S2boW6dZrH8SdFf9uo320GJA9B7U1FW\n" \
33 "Te3xda/Lm3JFFaHjKw7jBwcauQZjpGINHapHRlpiCZsquAthOgxW9SgDgYlGzEA\n" \
34 "s06pkEFiMw+qDfLo/sxFKB6vQ1FekMeCymjLCbNwPJyqyHmPwio/PDMruBTzPH\n"

```

1 RTL8722DM/RTL8722CSM on COM9

The “mqttServer” refers to the MQTT-Broker, we use the free MQTT sandbox “test.mosquitto.org” for testing.

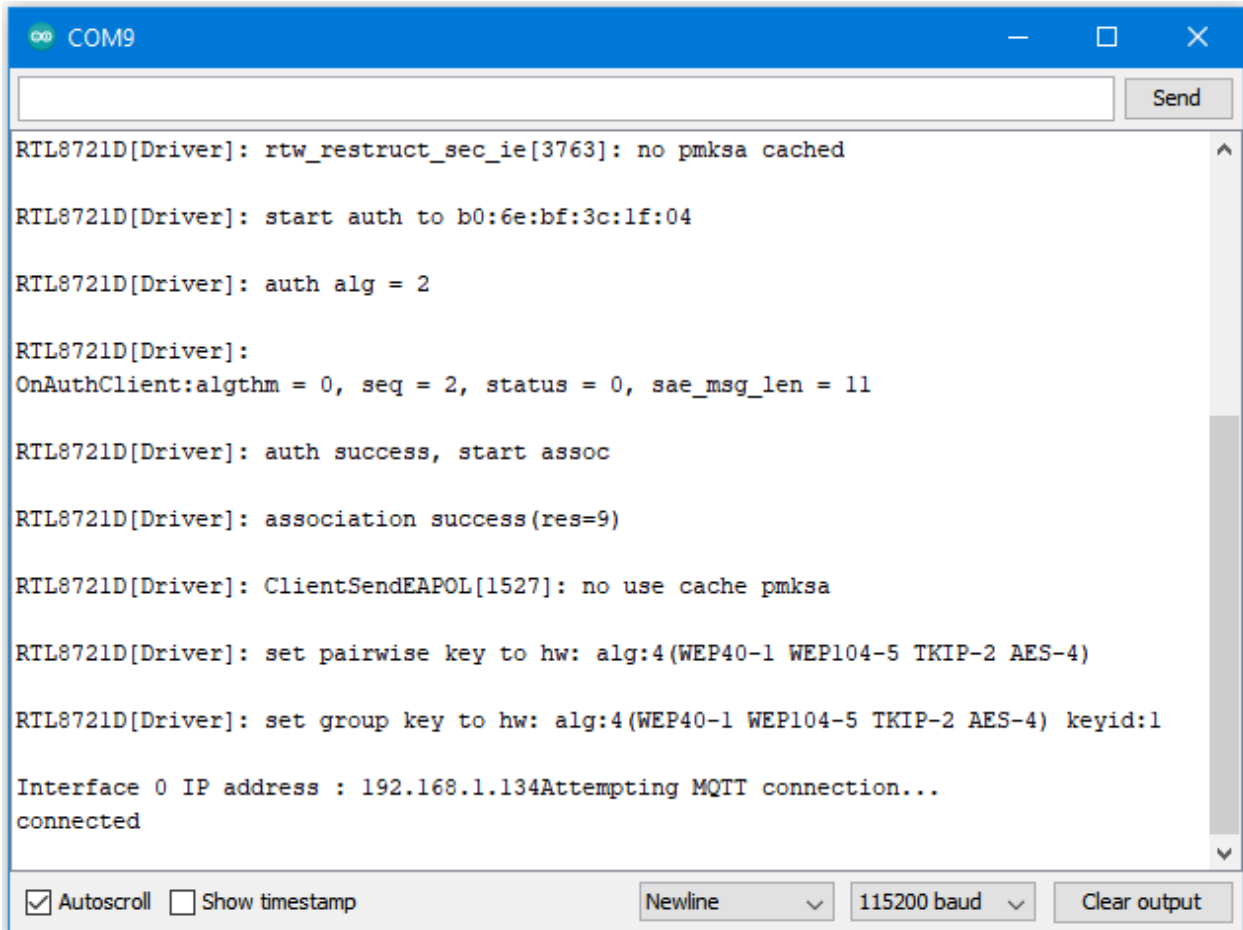
“clientId” is an identifier for MQTT-Broker to identify the connected device.

“publishTopic” is the topic of the published message, we use “outTopic” in the example. The devices subscribe to “outTopic” will receive the message.

“publishPayload” is the content to be published.

“subscribeTopic” is to tell MQTT-broker which topic we want to subscribe to.

Next, compile the code and upload it to Ameba. Press the reset button, then open the serial monitor



```

COM9
Send

RTL8721D[Driver]: rtw_restruct_sec_ie[3763]: no pmksa cached

RTL8721D[Driver]: start auth to b0:6e:bf:3c:1f:04

RTL8721D[Driver]: auth alg = 2

RTL8721D[Driver]:
OnAuthClient:alghm = 0, seq = 2, status = 0, sae_msg_len = 11

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=9)

RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.1.134Attempting MQTT connection...
connected

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

After Ameba is connected to MQTT server, it sends the message “hello world” to “outTopic” . To see the message, use another MQTT client. Refer to the MQTT\_Basic example guide on how to setup a PC-based MQTT client.

If you wish to use TLS client authentication in addition to server authentication, you will need to generate an OpenSSL private key and obtain a signed certificate from the server. For testing purposes, signed certificates can be obtained from test.mosquitto.org by following the guide at <https://test.mosquitto.org/ssl/>.

Replace the character strings “certificateBuff” and “privateKeyBuff” with your signed certificate and OpenSSL private key, ensuring that they are formatted the same way as the shown in the example code. Also uncomment the highlighted code to enable client authentication, and to change the MQTT port number.



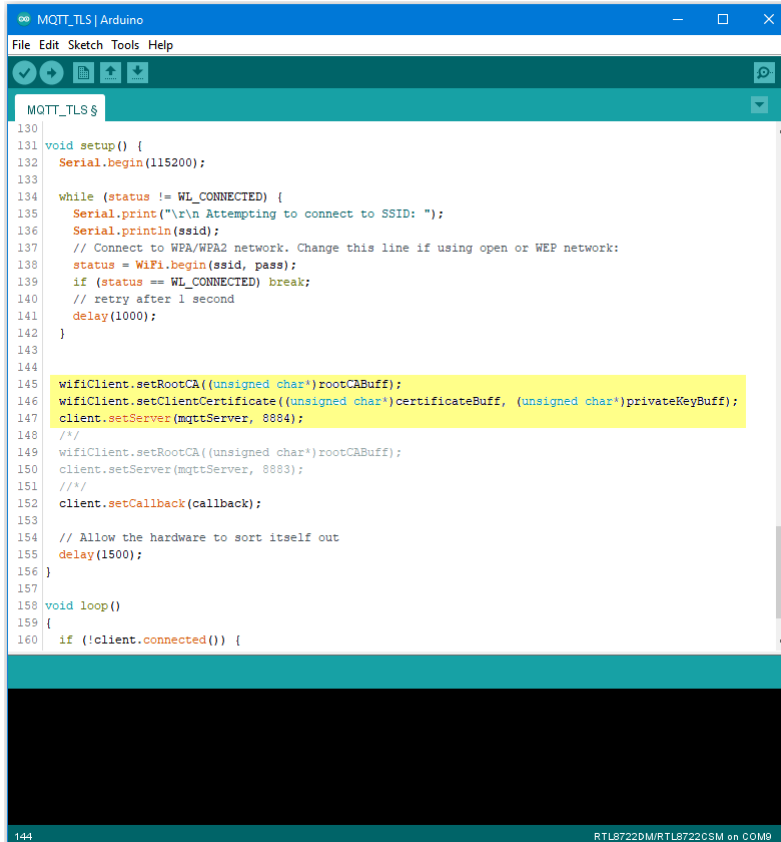
```

MQTT_TLS | Arduino
File Edit Sketch Tools Help

MQTT_TLS
45 "-----END CERTIFICATE-----\n";
46
47 char* certificateBuff = \
48 "-----BEGIN CERTIFICATE-----\n" \
49 "MIIDjTCCAnWgAwIBAgIBADANBgkqhkiG9w0BAQsFADCBkDELMAkGA1UEBhMCR0Ix\n" \
50 "FzAVBgNVBAGMD1VuaXRlZCBLaW5nZG9tMQ4wDAYDVQQHDAVEZXJieTESMBAGAlUE\n" \
51 "CgwJTW9zcXVpdHRvMQswCQYDVQQLDAJQTEWMBQGA1UEAwNBW9zcXVpdHRvLm9y\n" \
52 "ZzEfMB0GCSqGSIb3DQEJARYQcm9nZXJAYXRjaG9vLm9yZzAeFw0yMDA3MTcxMDM0\n" \
53 "MjRaFw0yMDEwMTUxMDM0MjRaMGcxZzAJBgNVBAYTA1NHMRIwEAYDVQQIDAlTaW5n\n" \
54 "YXBvcnUxZjAQBgNVBACMCVnpbmdhcG9yZTEQMA4GA1UECgwHUmVhbHRlZEMMAoG\n" \
55 "AlUECwWDU0QzMRAdDgYDVQDDAdhdXJpY2FsMIIIBIjANBgkqhkiG9w0BAQEFAAO\n" \
56 "AQ8AMIIBCGKCAQEA moglck7TyKdDw/943tfGLvwY/rz6DCZkosOQCYEZhjMSjX4M\n" \
57 "BNcCU/rhwm8EP+luYZfHrdsijalMuSUGUOi9Ylt+SqzYLvvgLi8+h3LIGiGvqghs\n" \
58 "97iyWNulWfWEMqBxjRVAI7/+u3b/lZtkz9UBN7+/y4jGLTsaW4IRQ5qCwt58ov+Q\n" \
59 "QU2PYS8qMlCRTxaokXOiLnBkxsOTq+aKLTdlx8nHjXSNCnOPjzzc4pq7rMjGyzq5\n" \
60 "edrO/pX9yFjD+wTGyssdnhTBgL8xTsx7mfDfpgdT/Bk7wZWQyfLosssdYLGqU6MN\n" \
61 "8wIl3wmqBymHAeFkihMBf4kDlglWLYZuziBWSwIDAQABoxowGDAJBgNVHRMEAjAA\n" \
62 "MAsGAlUdDwQEAwIF4DANBgkqhkiG9w0BAQsFAAOCAQEASqd/fRlpuUgehZMjzRNO\n" \
63 "RADV/gjX/UkWhlu66HbWhPDTuu5Nesms79bR7IbnP0umdt8nYdrW/ersTTFYkEv\n" \
64 "7rV6xlatPjXhuzlbwYeRSglcG+3cjiyFmMr2tlaVHMPXzfHBBEwOvbqIonPQnEe9\n" \
65 "6X0j/10xKMdsVKCb9OpAqlfDd4199M6t1TJiqaZ6OVAGpJ/ga0LNU0MNHPU8s68X\n" \
66 "ODZA8GwI0lkQUxUkrmaYmth3R4A3uIYfs4ff9u71TgT9wtnwQftacHhVAmF+hQpW\n" \
67 "luJqKtHI/Ox0Mya0YlaONZavT3WgtxnRmEdAv6gn9WNfko6qr98AqGijX2VZpjRf\n" \
68 "oQ==\n" \
69 "-----END CERTIFICATE-----\n";
70
71 char* privateKeyBuff = \
72 "-----BEGIN RSA PRIVATE KEY-----\n" \
73 "MIIEpAIBAAKCAQEA moglck7TyKdDw/943tfGLvwY/rz6DCZkosOQCYEZhjMSjX4M\n" \
74 "BNcCU/rhwm8EP+luYZfHrdsijalMuSUGUOi9Ylt+SqzYLvvgLi8+h3LIGiGvqghs\n"

```

1 RTL8722DM/RTL8722CSM on COM9



```

MQTT_TLS $
130
131 void setup() {
132   Serial.begin(115200);
133
134   while (status != WL_CONNECTED) {
135     Serial.print("\r\n Attempting to connect to SSID: ");
136     Serial.println(ssid);
137     // Connect to WPA/WPA2 network. Change this line if using open or WEP network:
138     status = WiFi.begin(ssid, pass);
139     if (status == WL_CONNECTED) break;
140     // retry after 1 second
141     delay(1000);
142   }
143
144
145   wifiClient.setRootCA((unsigned char*)rootCABuff);
146   wifiClient.setClientCertificate((unsigned char*)certificateBuff, (unsigned char*)privateKeyBuff);
147   client.setServer(mqttServer, 8884);
148   /*
149   wifiClient.setRootCA((unsigned char*)rootCABuff);
150   client.setServer(mqttServer, 8883);
151   /*
152   client.setCallback(callback);
153
154   // Allow the hardware to sort itself out
155   delay(1500);
156 }
157
158 void loop()
159 {
160   if (!client.connected()) {

```

## MQTT - Use Amazon AWS IoT Shadow Service

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

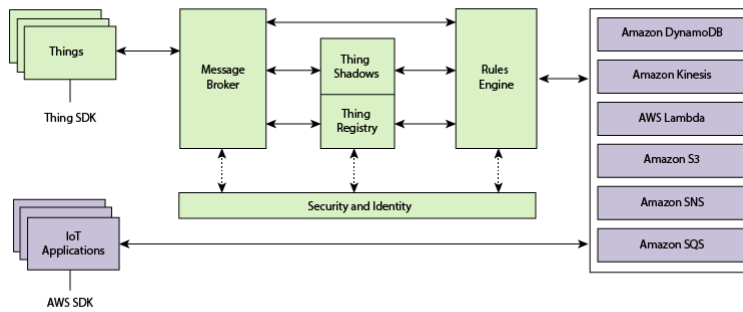
### Example

#### Introduction

Amazon AWS IoT is a cloud IoT service platform:

Amazon AWS IoT is a platform that enables you to connect devices to AWS Services and other devices, secure data and interactions, process and act upon device data, and enable applications to interact with devices even when they are offline. (<https://aws.amazon.com/iot/how-it-works/>)

The service architecture of AWS IoT:



(Picture from <http://docs.aws.amazon.com/iot/latest/developerguide/aws-iot-how-it-works.html> )

In the architecture, Ameba belongs to the upper-left “Things” block. A TLS secure channel will be established between “Things” and the MQTT Message Broker. Afterwards, “Things” and “Message Broker” communicate using MQTT Protocol via this secure channel. Behind the “Message Broker”, the “Thing Shadows” keeps messages temporarily when Ameba is offline, and sends the control message to Ameba next time it is connected. The “Rules Engine” allows you to place restrictions to the behavior of Things or to connect Things to other services of Amazon.

## AWS Management Console

First, create an account and sign up for AWS IoT [service:https://aws.amazon.com/](https://aws.amazon.com/)

Afterwards, log in to the Amazon Management Console and click “IoT Core” found under services -> Internet of Things.

Then you will enter the home page of AWS IoT. To offer the best service quality, Amazon offers servers in different regions for users to choose from.

Click the region dropdown menu at the upper-right:

Ameba Arduino: [RTL819] x AWS IoT x

Secure | https://us-east-2.console.aws.amazon.com/iot/home?region=us-east-2#/home

aws Services Resource Groups testteam Ohio Support

# AWS IoT

AWS IoT is a managed cloud platform that lets connected devices - cars, light bulbs, sensor grids, and more - easily and securely interact with cloud applications and other devices.

[Get started](#)

### Connect and manage your devices

Connect devices to the cloud using the protocol that best fits your requirements - HTTP, MQTT, or WebSocket. Devices can communicate with each other even if they are using different protocols.

[Learn more](#)

### Process and act upon device data

Filter, transform, and act upon data from devices on the fly, based on business rules. AWS IoT can be easily integrated with AWS services like Amazon DynamoDB, Amazon Kinesis, Amazon Machine Learning, and AWS Lambda.

[Learn more](#)

### Read and set device state at any time

AWS IoT stores the latest state of a device so that it can be read or set anytime, even when the device is offline.

[Learn more](#)

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Choose a nearby region.

**AWS IoT**

AWS IoT is a managed cloud platform that lets connected devices like light bulbs, sensor grids, and more - easily and securely interact with cloud applications and other devices.

[Get started](#)

**Regions:**

- US East (N. Virginia)
- US East (Ohio)**
- US West (N. California)
- US West (Oregon)
- Asia Pacific (Mumbai)
- Asia Pacific (Seoul)
- Asia Pacific (Singapore)**
- Asia Pacific (Sydney)
- Asia Pacific (Tokyo)
- Canada (Central)
- EU (Frankfurt)
- EU (Ireland)
- EU (London)
- EU (Paris)
- South America (São Paulo)

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Filter, transform, and act upon data from devices on the fly, based on business rules. AWS IoT can be easily integrated with AWS services like Amazon DynamoDB, Amazon Kinesis, Amazon Machine Learning, and AWS Lambda.

[Learn more](#)

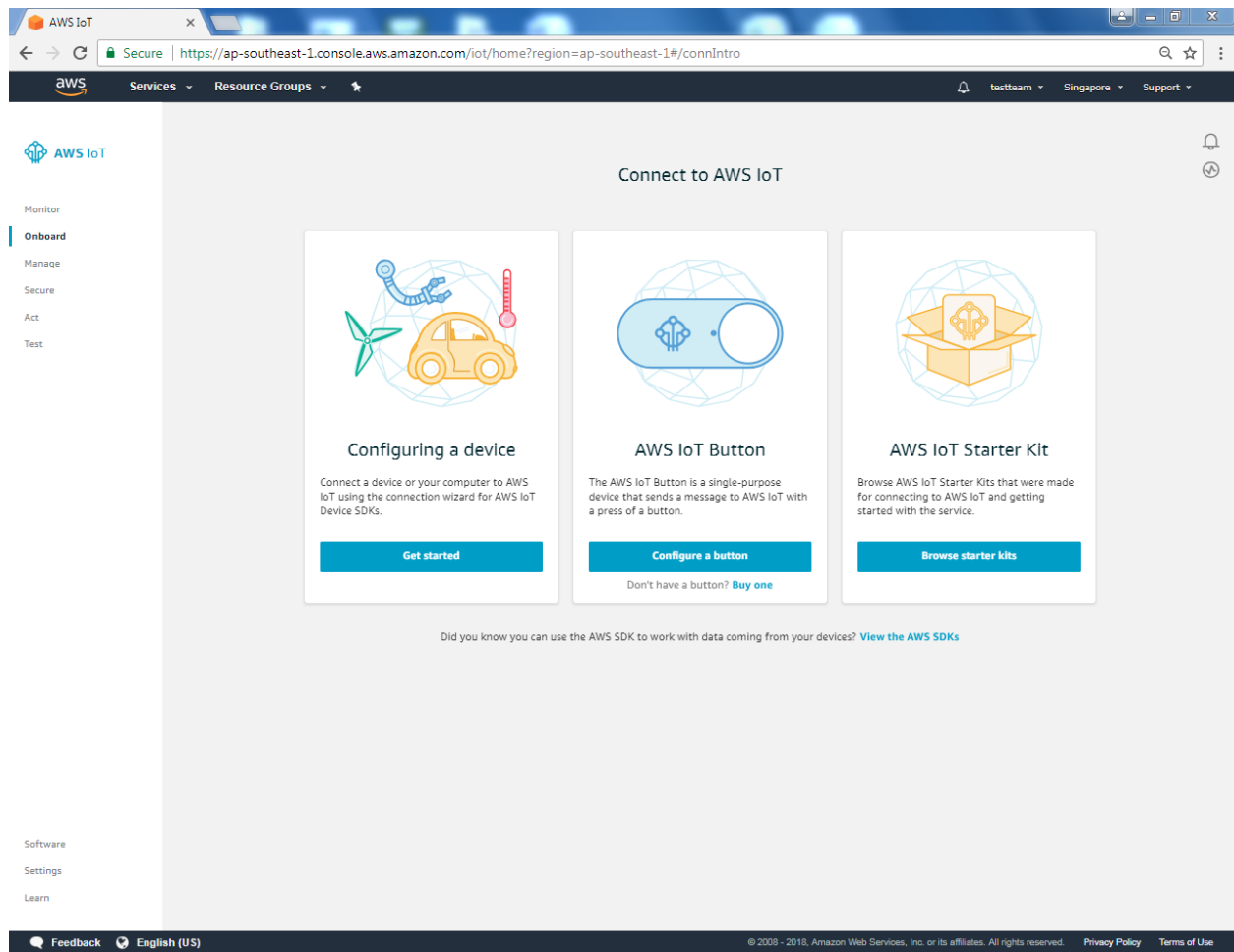
**Read and set device state at any time**

AWS IoT stores the latest state of a device so that it can be read or set anytime, even when the device is offline.

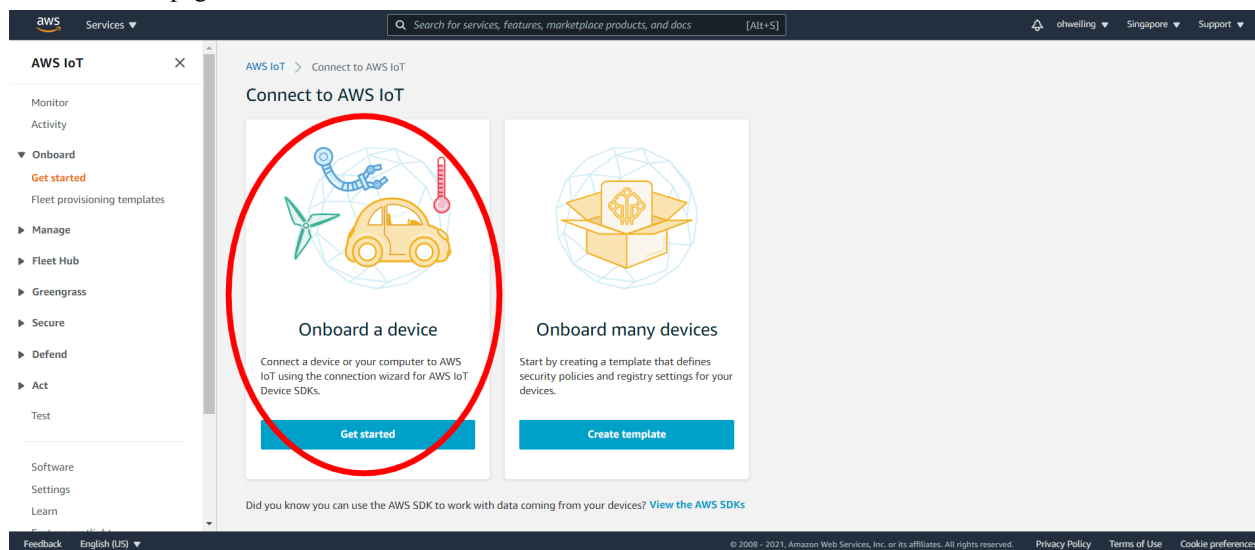
[Learn more](#)

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Then from Services, go to Onboard then Get Started.



Enter the main page of AWS IoT. Under the Onboard a device, click Get started.



## Click Create single thing

**Create things** [info](#)

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

**Number of things to create**

☒ **Create single thing**  
Create a thing resource to register a device. Provision the certificate and policy necessary to allow the device to connect to AWS IoT.

☐ **Create many things**  
Create a task that creates multiple thing resources to register devices and provision the resources those devices require to connect to AWS IoT.

[Cancel](#) [Next](#)

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Fill in “ameba” on the name field. Attributes represent the status of Ameba.

**Specify thing properties** [info](#)

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

**Thing properties** [info](#)

**Thing name**

ameba

Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

**Additional configurations**

You can use these configurations to add detail that can help you to organize, manage, and search your things.

- ▶ **Thing type - optional**
- ▶ **Searchable thing attributes - optional**
- ▶ **Thing groups - optional**
- ▶ **Billing group - optional**

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Under the searchable thing attributes. The value of the attributes can be updated directly by Ameba or by the control side and control side can request Ameba to set the attribute to desired value.

Here we add an attribute named “led” with value “0” and click “Next” .

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

**Thing properties** [Info](#)

**Thing name**

ameba

Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

**Additional configurations**

You can use these configurations to add detail that can help you to organize, manage, and search your things.

▶ **Thing type - optional**

▼ **Searchable thing attributes - optional**

Add searchable attributes to allow your thing to be grouped and searched without using fleet indexing.

Searchable attribute	Value - optional	
led	0	Remove

[Add new attribute](#)

You can add up to 2 more attributes.

▶ **Thing groups - optional**

▶ **Billing group - optional**

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Click Skip creating a certificate at this time and then Create thing

**Configure device certificate - optional** [Info](#)

A device requires a certificate to connect to AWS IoT. You can choose how you to register a certificate for your device now, or you can create and register a certificate for your device later. Your device won't be able to connect to AWS IoT until it has an active certificate with an appropriate policy.

**Device certificate**

☐ Auto-generate a new certificate (recommended)  
Generate a certificate, public key, and private key using AWS IoT's certificate authority.

☐ Use my certificate  
Use a certificate signed by your own certificate authority.

☐ Upload CSR  
Register your CA and use your own certificates on one or many devices.

☒ Skip creating a certificate at this time  
You can create a certificate for this thing and attach a policy to the certificate at a later time.

Cancel Previous **Create thing**

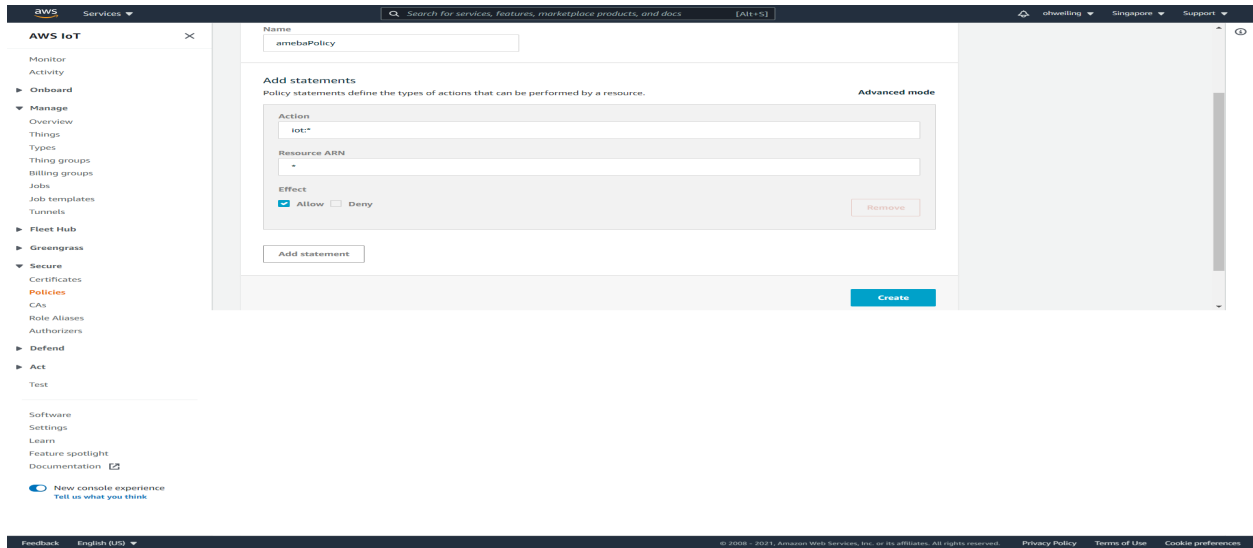
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Next, click Policy, and create a policy. Policy is used to restrict the functions that a “thing” can do, it can limit the MQTT actions or specific topic that can be performed. Learn more about policy:

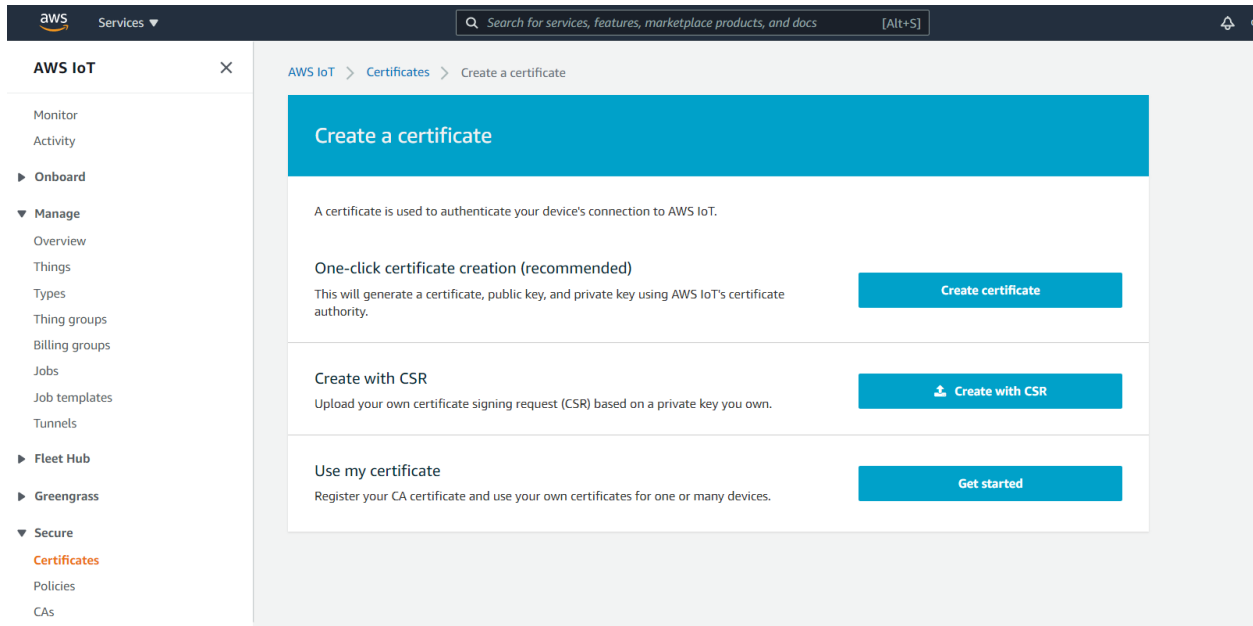
<http://docs.aws.amazon.com/iot/latest/developerguide/authorization.html>

Here we do not place policy on Ameba. Fill in “amebaPolicy” in the Name field, “iot:” in Action field and “\*” in resources field. Then “Allow” . Finally, click “Create” .

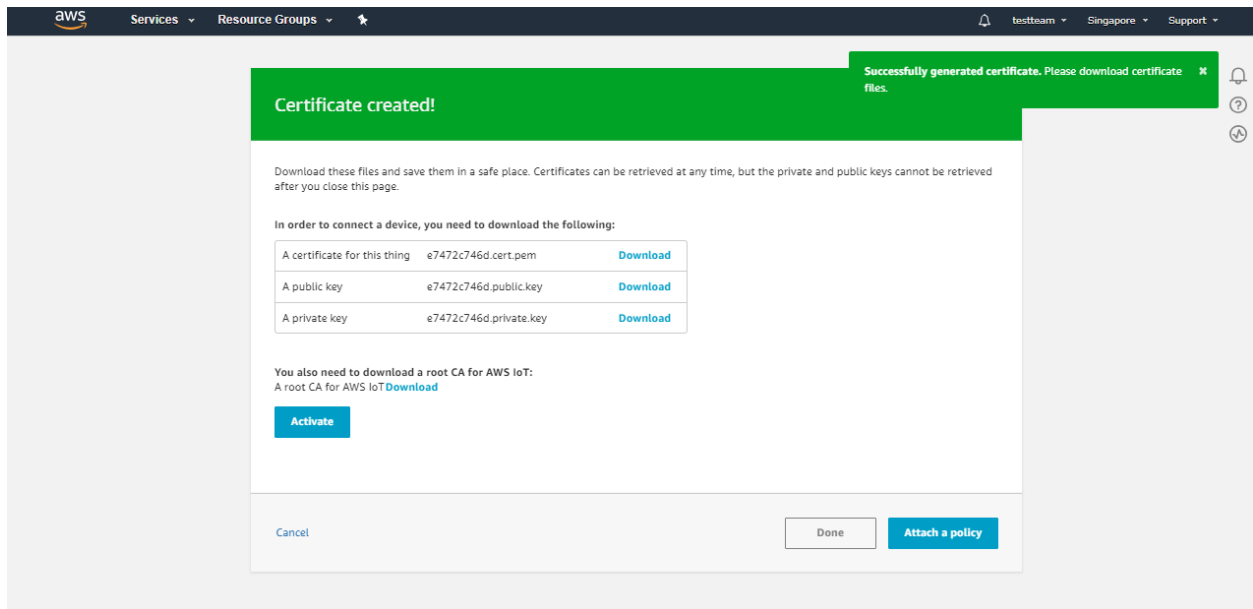




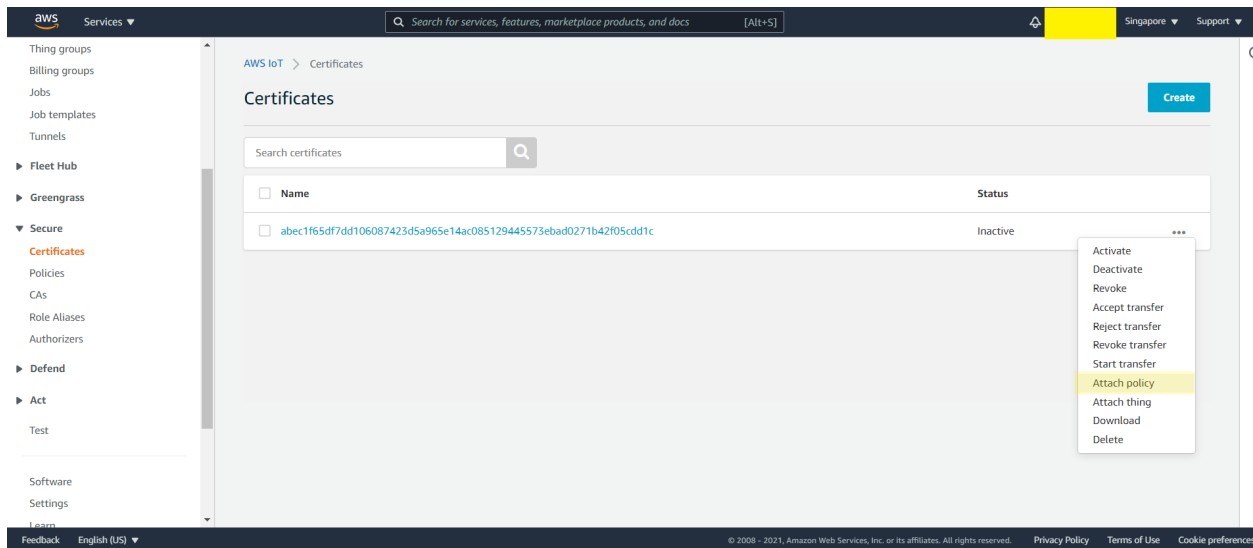
Next, we have to setup the TLS certificate. You can choose to user-defined or generate a certificate by AWS IoT. In this example we click Create Certificate to generate a TLS certificate.



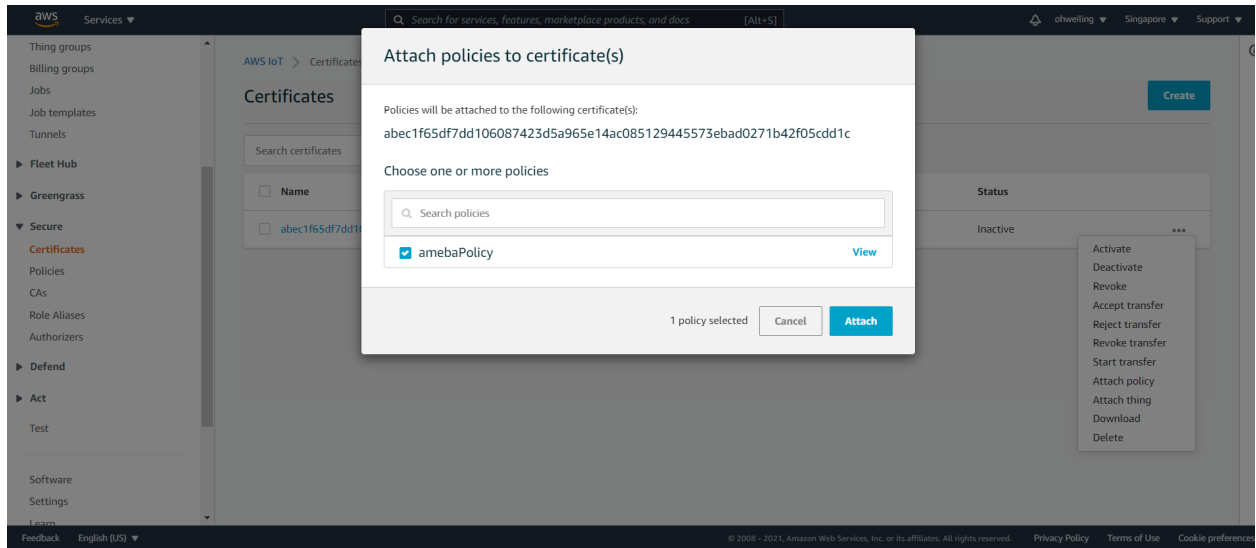
You can see 4 Links. Please download each of the link, “public key” , “private key” , “Certificate” and “rootCA” . After downloading the 4 files, click Done and go back to the certificate main page.



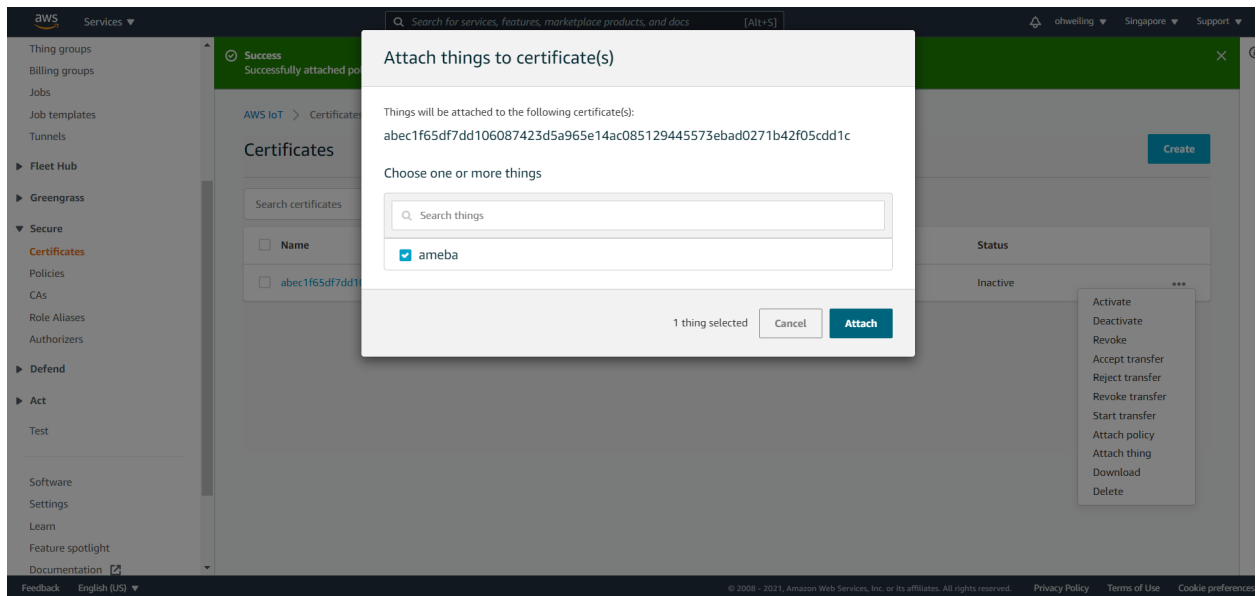
Click Attach a policy in the Actions dropdown menu.



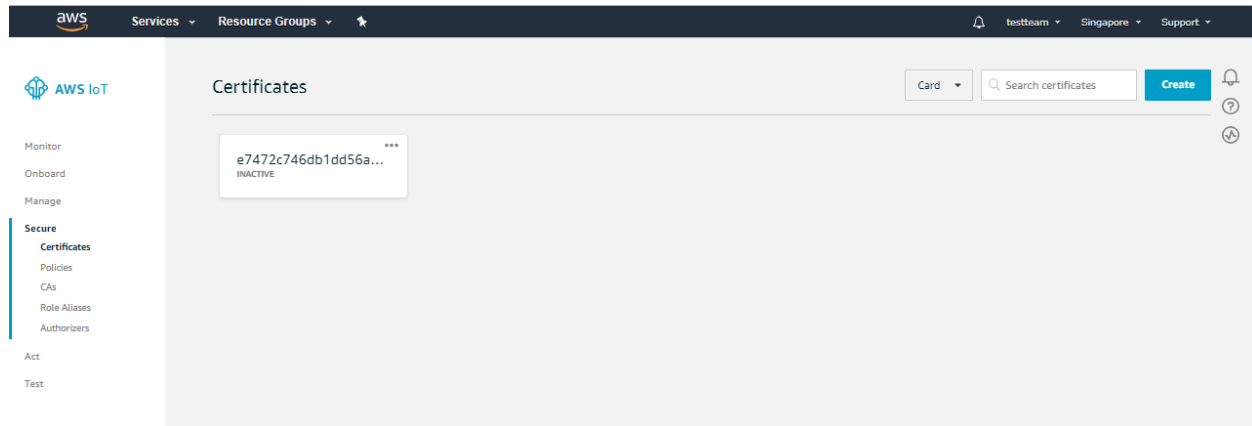
Choose amebaPolicy and click attach.



Then go back to the “Actions” drop-down menu at the top right of the certificates homepage, click on “Attach thing” , select the thing “ameba” you just created when the window below appears, then click on “Attach”

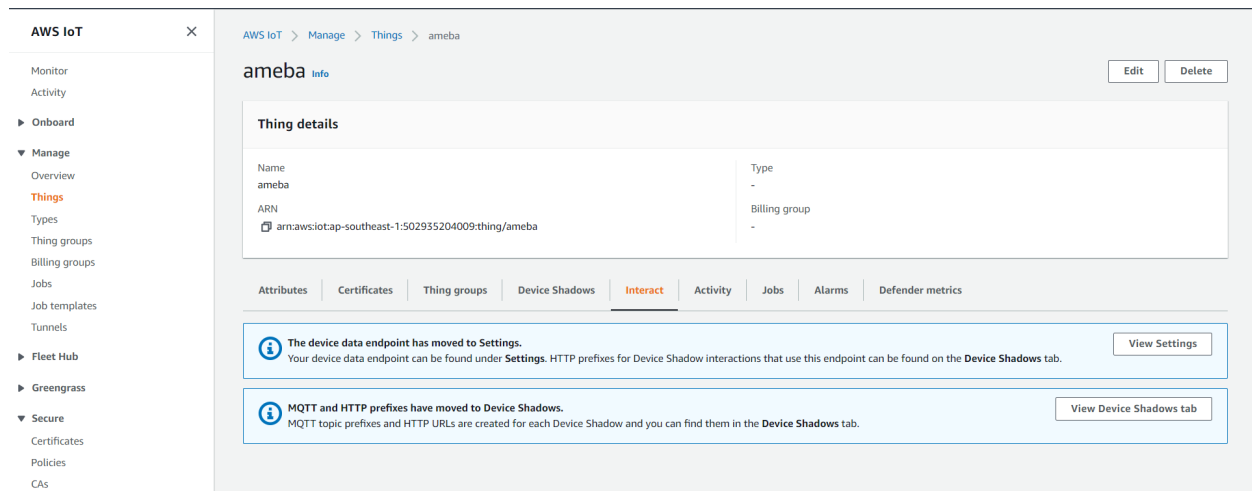


Go back to certificate main page and click Certificate and click Activate in the Actions drop down menu.



Next, click Manage, and click Things, then click “ameba” the thing we created just now.

Click on Interact and View settings.



Find out the information of Rest API Endpoint to set Amazon Alexa:

- REST API endpoint: In the value “<https://a1a7004baosggy.iot.us-east-1.amazonaws.com/things/ameba/shadow>”, the part “a1a7004baosggy.iot.us-east-1.amazonaws.com” is the MQTT Broker server address.
- MQTT topic: The value “\$aws/things/ameba/shadow/update” represents the MQTT topic we will use in the AWS IoT Shadow service (if we use MQTT only, without AWS IoT Shadow service, then we can specify other topic name). It is recommended to use “\$aws/things/ameba/shadow/update” here.

## Ameba setting

Open “File” -> “Examples” -> “AmebaMQTTClient” -> “Amazon\_AWS\_IoT\_Basic”

In the sample code, modify the highlighted snippet to reflect your WiFi network settings.

```

1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork";      // your network SSID (name)
10 char pass[] = "yourPassword";     // your network password (use for WPA, or use e
11 int status = WL_IDLE_STATUS;      // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

```

Then fill in the “thing” name “ameba” .

```

1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork";      // your network SSID (name)
10 char pass[] = "yourPassword";     // your network password (use for WPA, or use a
11 int status = WL_IDLE_STATUS;      // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

```

23

RTL8722DM/RTL8722C5M on COM9

And the MQTT Broker server address we found earlier in AWS IoT.

```

1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork";      // your network SSID (name)
10 char pass[] = "yourPassword";     // your network password (use for WPA, or use a
11 int status  = WL_IDLE_STATUS;     // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

```

23

RTL8722DM/RTL8722C5M on COM9

Next, fill in the root CA used in TLS. Download and make sure the downloaded root CA contents conforms to the root CA used in the sketch.



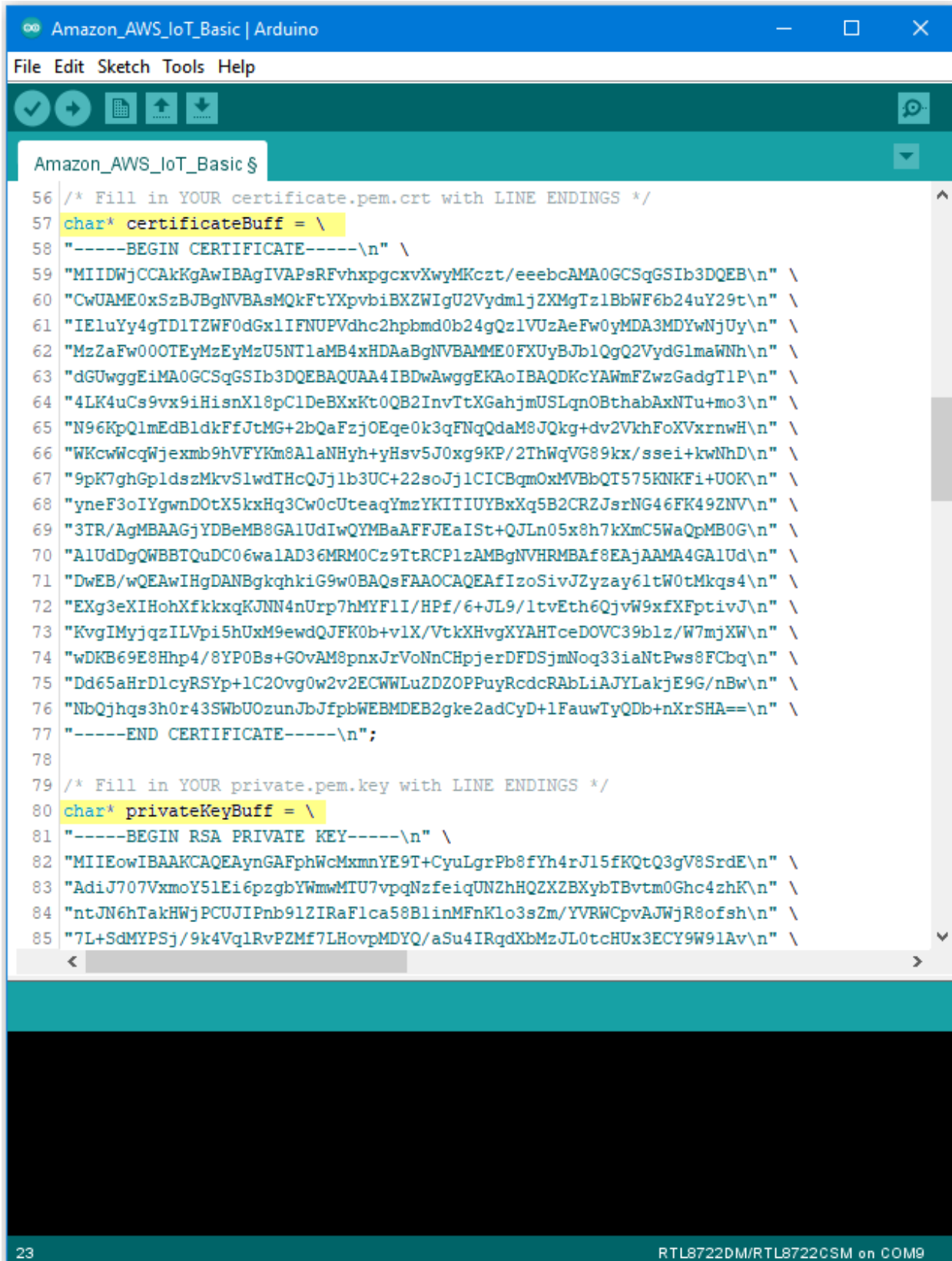
```
Amazon_AWS_IoT_Basic | Arduino
File Edit Sketch Tools Help

Amazon_AWS_IoT_Basic $
26 "$aws/things/" THING_NAME "/shadow/get/accepted",
27 "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:
31 * https://docs.aws.amazon.com/iot/latest/developerguide/server-authentication.html
32 */
33 char* rootCABuff = \
34 // Amazon Root CA 1 RSA 2048
35 "-----BEGIN CERTIFICATE-----\n" \
36 "MIIDQTCCAimgAwIBAgITBmyfz5m/jAo54vB4ikPmljZbyjANBgkqhkiG9w0BAQsF\n" \
37 "ADA5MQswCQYDVQQGEwJVUzEPMA0GA1UEChMGQWlhbm9uMRkwFwYDVQQDEwBBbWV6\n" \
38 "b24gUm9vdCBDQSAxMB4XDTE1MDUyNjAwMDAwMFoXDTE1MDUyNjAwMDAwMFowOTEL\n" \
39 "MAkGA1UEBhMCVVMxDTANBgNVBAoTBkFtYXNjaWwvZEMBCGA1UEAxMQQWlhbm9uIFJv\n" \
40 "b3QgQ0EgMTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALJ4gHHKXj\n" \
41 "ca9HgFB0fW7Y14h29Jlo9lghYPl0hAEvrAIthtOgQ3pOsqTQNroBvo3bSMgHFzZM\n" \
42 "906II8c+6zflRn4SWiw3te5djgdYZ6k/oI2peVKVuRF4fn9tBb6dNqcmzU5L/qw\n" \
43 "IFAGbHrQgLKm+a/sRxmPUDgH3KKHOVj4utWp+UhnMJbulHheb4mjUcAwhmahRWa6\n" \
44 "VOUjw5H5SNz/0egwLX0tdHA114gk957EWW67c4cX8jJGKLhD+rcdqsq08p8kDiL\n" \
45 "93FcXmn/6pUCyziKrlA4b9v7LWIbxcceVOF34GfID5yHI9Y/QCB/IIDEgEw+OyQm\n" \
46 "jgSubJrIgg0CAwEAAaNCMEAwDwYDVR0TAQH/BAUwAwEB/zAOBgNVHQ8BAf8EBAMC\n" \
47 "AYYwHQYDVR0OBBYEFIQYzIU07LwMlJQuCFmcx7IQTgoIMA0GCSqGSIb3DQEBCwUA\n" \
48 "A4IBAQCY8jdaQZChGsV2USggNiM0ruYou6r41K5IpDB/G/wkjUu0yKGX9rbxenDI\n" \
49 "U5PMCCjmmCXPI6T53iHTfIUJRu6adTrCC2qJeHZERxhlbIlBjtt/msv0tadQlwUs\n" \
50 "N+gDS63pYaACbvXy8MWy7Vu33PqUXHeeE6V/Uq2V8viT096LXFvKWlJbYK8U90vv\n" \
51 "o/ufQJvMT8QtPHR8jrdkPSHCa2XV4cdFyQzRlbdZwgJcJmApzyMZFo6IQ6XU\n" \
52 "5MsI+yMRQ+hDKXJioaldXgjUkK642M4UwtBV8ob2xJNDd2ZhwLnoQdeXeGADbkpy\n" \
53 "rqXRfboQnoZsG4q5WTP468SQvvG5\n" \
54 "-----END CERTIFICATE-----\n";
55
```

Next, fill in the certificate we created in the AWS IoT Console (i.e., client certificate), usually its file name ends with “-certificate.pem.crt” (e.g., “efae24a533-certificate.pem.crt” ). Open the certificate with a text editor, and adjust its format as follows to use in the sketch:

- Add the new line character “\n” at the end of each line.
- Add double-quote at the beginning and the end of each line.
- To concatenate each line as a string, add “” at the end of each line.
- The last line ends with semicolon.

Adjust the format of the private key in the same way and add it to privateKeyBuff.



```

Amazon_AWS_IoT_Basic $
56 /* Fill in YOUR certificate.pem.crt with LINE ENDINGS */
57 char* certificateBuff = \
58 "-----BEGIN CERTIFICATE-----\n" \
59 "MIIDWjCCAKKgAwIBAgIVAPsRFvnxpgcxvXwyMKczt/eeebcAMA0GCSqGSIb3DQEBA\n" \
60 "CwUAME0xSzBjBGNVBAzMQkFtYXpviBXZWIGU2VydmljZXMgTz1BbWF6b24uY29t\n" \
61 "IEluYy4gTD1TZWF0dGx1IFNUPVdhc2hpbmd0b24gQz1VUzAeFw0yMDA3MDYwNjUy\n" \
62 "MzZaFw00OTYyMzYyMzU5NTlaMB4xHDAaBgNVBAMME0FXUyBjblQgQ2VydGlmaw\n" \
63 "dGUwgGElMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAoIBAQDKcYAWmFZwzGadgT1P\n" \
64 "4LK4uCs9vx9iHisnXl8pC1DeBXxKt0QB2InvTtXGahjmUSLqnOBthabAxNTu+mo3\n" \
65 "N96KpQlmedBldkFfJtMG+2bQaFzjOEqe0k3qFNqQdaM8JQkg+dv2VkhFoXVxrnw\n" \
66 "WKcwWcqWjexmb9hVFYKm8AlaNHyh+yHsv5J0xg9KP/2ThWqVG89kx/ssei+kwN\n" \
67 "9pK7ghGpldszKmkvSlwdTHcQJj1b3UC+22soJj1CICBqmOxMVBbQT575KNKFi+U\n" \
68 "yneF3oIYgwnDotX5kxHq3Cw0cUteaYmzYKITIUYBxXq5B2CRZJsrNG46FK492N\n" \
69 "3TR/AgMBAAGjYDBeMB8GA1UdIwQYMBaAFFJEaISt+QJLn05x8h7kXmC5WaQpMB\n" \
70 "AlUdDgQWBBTQuDC06walAD36MRM0Cz9TtRCPlzAMBgNVHRMBAf8EAjAAMA4GA1U\n" \
71 "dEB/wQEAwIHgDANBgkqhkiG9w0BAQsFAAOCAQEAFIzoSivJZyay6ltW0tMkqs4\n" \
72 "EXg3eXIHohXfkkxqKJNN4nUrp7hMYfII/HPf/6+JL9/ltvEth6QjvW9xfXFptiv\n" \
73 "KvgIMyjqzILVpi5hUxM9ewdQJFK0b+v1X/VtkXHvgXYAHTceDOVC39blz/W7mjX\n" \
74 "wDKB69E8Hhp4/8YP0Bs+GOvAM8pnxJrVoNnCHpjerDFDSjmNoq33iaNtPws8FCbq\n" \
75 "Dd65aHrDlcyRSYp+lC2Ovg0w2v2ECWWLuZDZOPPuyRcdcrAbLiAJYLakjE9G/nBw\n" \
76 "NbQjhqs3h0r43SWbU0zunJbJfpbWEBMDEB2gke2adCyD+lFauwTyQDb+nXrSHA==\n" \
77 "-----END CERTIFICATE-----\n";
78
79 /* Fill in YOUR private.pem.key with LINE ENDINGS */
80 char* privateKeyBuff = \
81 "-----BEGIN RSA PRIVATE KEY-----\n" \
82 "MIIEowIBAAKCAQEAynGAFphWcMxmnyE9T+CyuLgrPb8fYh4rJl5fKQtQ3gV8SrdE\n" \
83 "AdiJ707VxmoY51Ei6pzgbYWmwMTU7vpqNzfeiqUNZhHQ2XZBXybTBvtm0Ghc4zhK\n" \
84 "ntJN6hTakHWjPCUJIPnb9lZIRaFlca58BlinMFnKlo3sZm/YVRWCpvAJWjR8ofsh\n" \
85 "7L+SdMYPSj/9k4VqlRvPZMf7LHovpMDYQ/aSu4IRqdXbMzJL0tcHUx3ECY9W91Av\n"

```

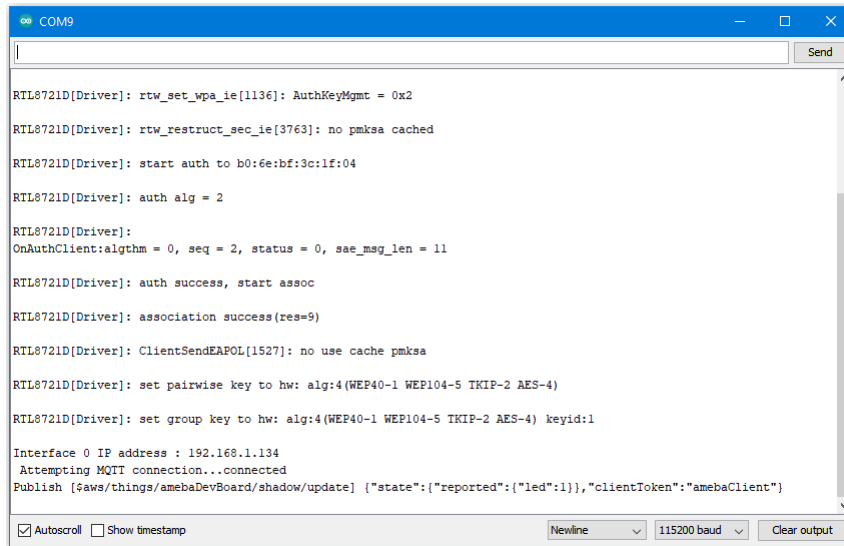
23

RTL8722DM/RTL87220SM on COM9

## Compile and run

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in the Arduino IDE and observe as Ameba connects to the AWS IoT server and sends updates on the LED state variable.



```

RTL8721D[Driver]: rtw_set_wpa_ie[1136]: AuthKeyMgmt = 0x2
RTL8721D[Driver]: rtw_restruct_sec_ie[3763]: no pmksa cached
RTL8721D[Driver]: start auth to b0:6e:bf:3c:1f:04
RTL8721D[Driver]: auth alg = 2
RTL8721D[Driver]:
OnAuthClient:alghth = 0, seq = 2, status = 0, sae_msg_len = 11
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=9)
RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1
Interface 0 IP address : 192.168.1.134
Attempting MQTT connection...connected
Publish [aws/things/amebaDevBoard/shadow/update] {"state":{"reported":{"led":1}}, "clientToken":"amebaClient"}
  
```

## Alternatives

Ameba can also retrieve the current LED status variable from the AWS shadow. This is done by sending a message to the “shadow/get” topic. Refer to the `Amazon_AWS_IoT_with_ACK` example code for more information.

## Code Reference

Change led state:

In this example, we use GPIO interface to control the led. We set `led_pin` to 10 and `led_state` to 1 by default in the sample code.

```
pinMode(led_pin, OUTPUT);
digitalWrite(led_pin, led_state);
```

Set up certificate:

Note that we use the `WiFiSSLClient` type of `wifiClient`.

```
WiFiSSLClient wifiClient;
```

WiFiSSLClient inherits Client, so it can be passed as the parameter of PubSubClient constructor.

Next, set up TLS certificate required in connection.

```
wifiClient.setRootCA((unsigned char*)rootCABuff);
wifiClient.setClientCertificate((unsigned char*)certificateBuff, (unsigned_
↳char*)privateKeyBuff);
```

Configure MQTT Broker server

Then MQTT PubClient set MQTT Broker server to connect

```
client.setServer(mqttServer, 8883);
client.setCallback(callback);
```

Connect to MQTT Broker server:

In loop(), call reconnect() function and try to connect to MQTT Broker server and do the certificate verification.

```
while (!client.connected()) {
```

Subscribe & Publish

Next, subscribe to topics.

```
for (int i=0; i<5; i++) {
    client.subscribe(subscribeTopic[i]);
}
```

There are some common topics:

“\$aws/things/ameba/shadow/update/accepted” ,

“\$aws/things/ameba/shadow/update/rejected” ,

“\$aws/things/ameba/shadow/update/delta” ,  
“\$aws/things/ameba/shadow/get/accepted” ,  
“\$aws/things/ameba/shadow/get/rejected”

Related documentation:

<http://docs.aws.amazon.com/iot/latest/developerguide/thing-shadow-data-flow.html>

Then publish current status::

```
sprintf(publishPayload,  
"\state\":{\"reported\":{\"led\":%d}},\clientToken\":\"%s\"",  
led_state, clientId);
```

```
client.publish(publishTopic, publishPayload);
```

Listen to topic and make response:

In the callback function, we listen to the 5 subscribed topics and check if there are messages of “/shadow/get/accepted” :

```
if (strstr(topic, "/shadow/get/accepted") != NULL) {
```

If there is, the message is from the control side. If the attribute state in the message is different from current state, publish the new state.

```
updateLedState(desired_led_state);
```

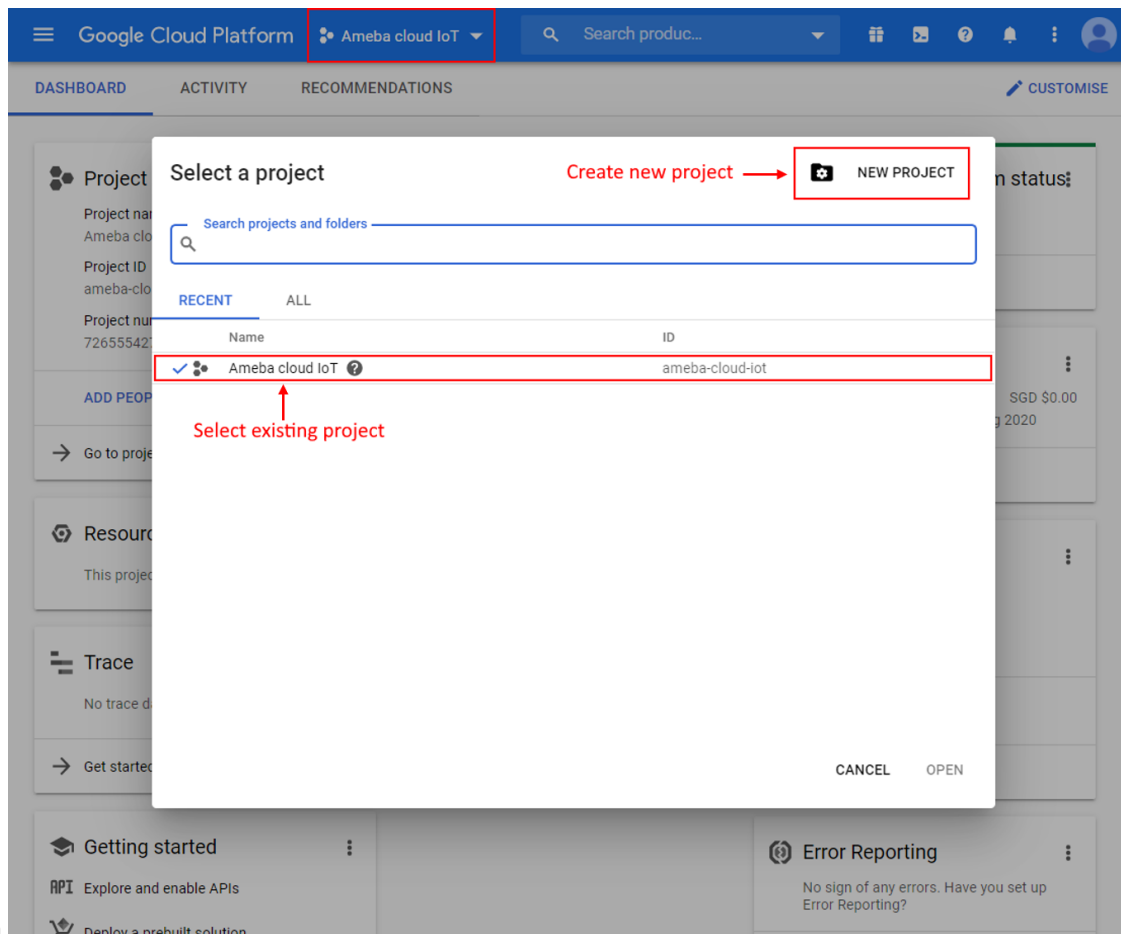
## MQTT - Use Google Cloud IoT

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Google Cloud IoT Configuration

1. Select or create a Cloud Platform project In the Google Cloud Console, select an existing project or create a new project. You will need a **Project ID** to use with



Ameba.

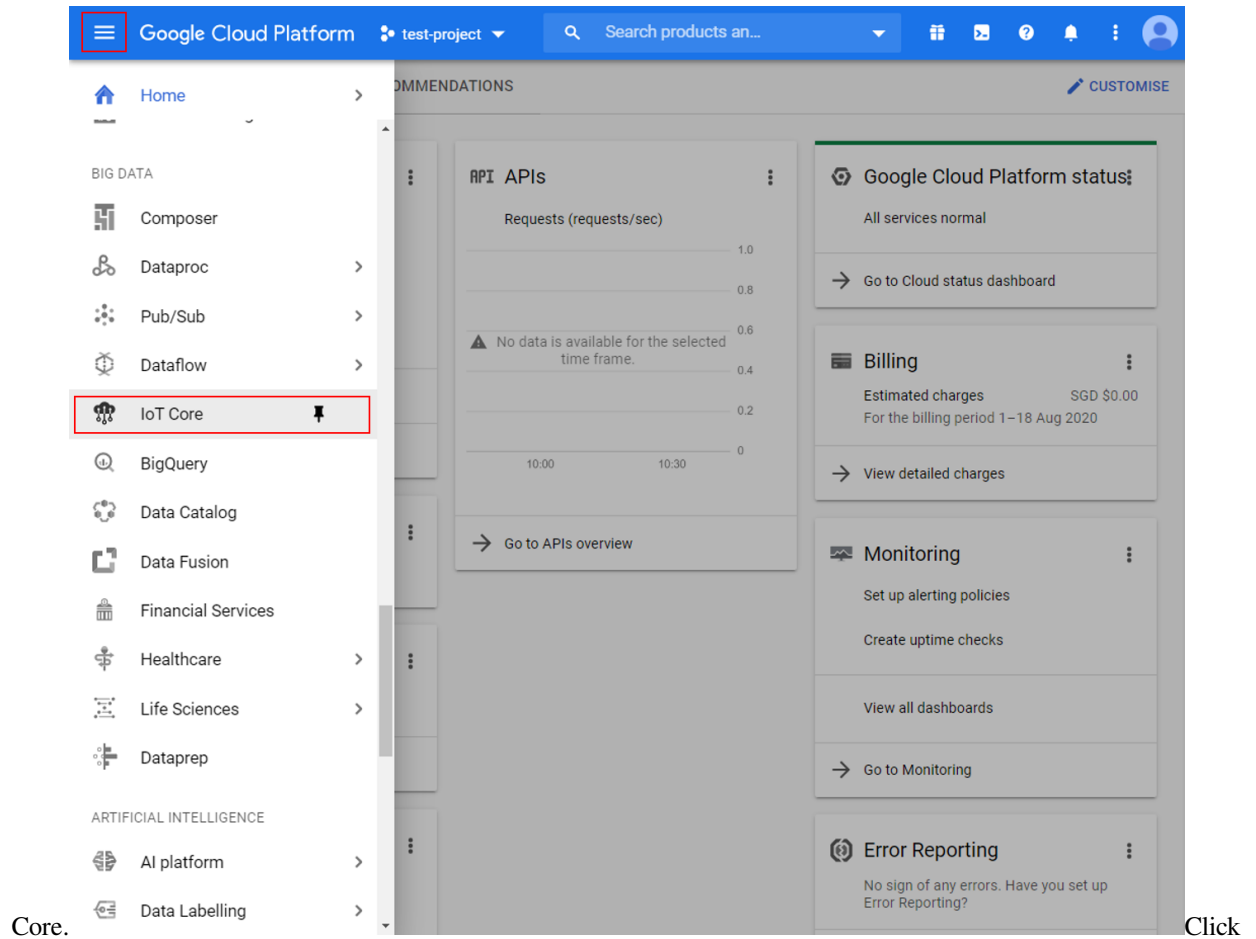
If

creating a new project, enter a project name, and take note of the **Project ID** generated.

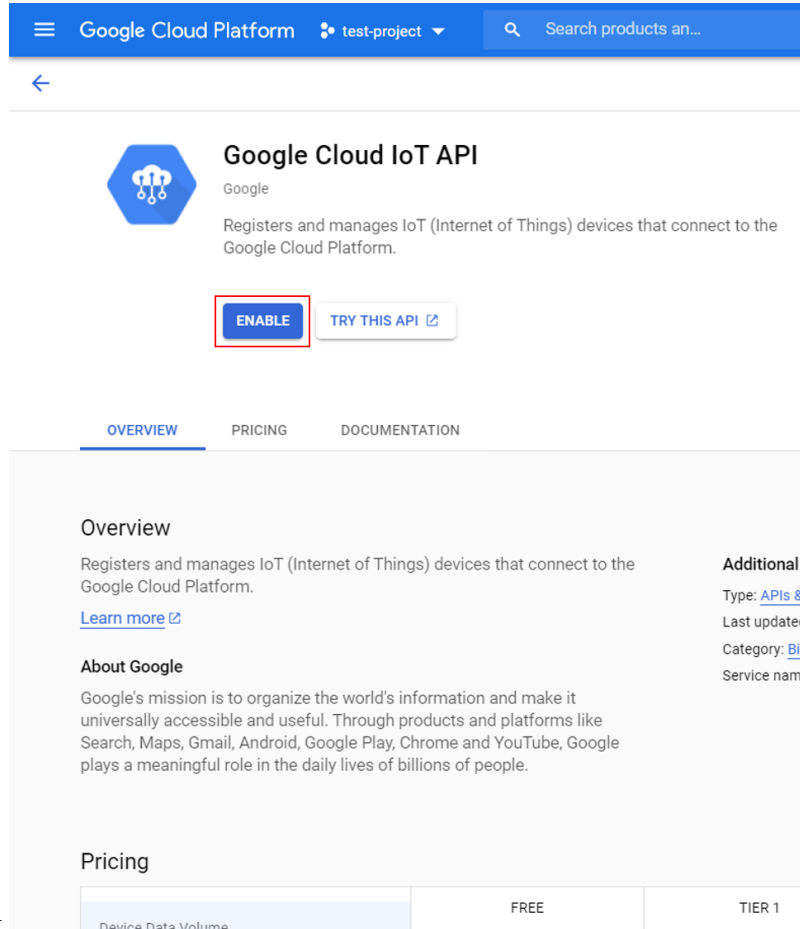
The screenshot shows the 'New Project' form in the Google Cloud Platform console. At the top, there is a warning about project quotas. Below the warning, there is a 'Project name' field with the value 'test-project'. Below the name field, there is a 'Project ID' field with the value 'test-project-286902'. Below the ID field, there is a 'Location' field with the value 'No organisation'. At the bottom, there are 'CREATE' and 'CANCEL' buttons. The 'CREATE' button is highlighted.

2.

Enable billing for your project Billing needs to be enabled for your project to use Google Cloud Platform features. Follow the guide in Google cloud documentation to enable billing. <https://cloud.google.com/billing/docs/how-to/modify-project> 3. Enable the Cloud IoT Core API In Google Cloud console, click on the top left menu button and search for IoT







The screenshot shows the Google Cloud IoT API page. At the top, there's a blue header with the Google Cloud Platform logo, a dropdown menu for 'test-project', and a search bar. Below the header, the page title 'Google Cloud IoT API' is displayed, followed by the Google logo and a description: 'Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.' A red box highlights the 'ENABLE' button, with a 'TRY THIS API' button next to it. Below the buttons, there are tabs for 'OVERVIEW', 'PRICING', and 'DOCUMENTATION'. The 'OVERVIEW' tab is selected, showing an 'Overview' section with a description, a 'Learn more' link, and an 'About Google' section. The 'PRICING' tab is also visible, showing a table with columns for 'Device Data Volume', 'FREE', and 'TIER 1'.

Google Cloud IoT API

Google

Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.

**ENABLE** TRY THIS API

OVERVIEW PRICING DOCUMENTATION

**Overview**

Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.

[Learn more](#)

**About Google**

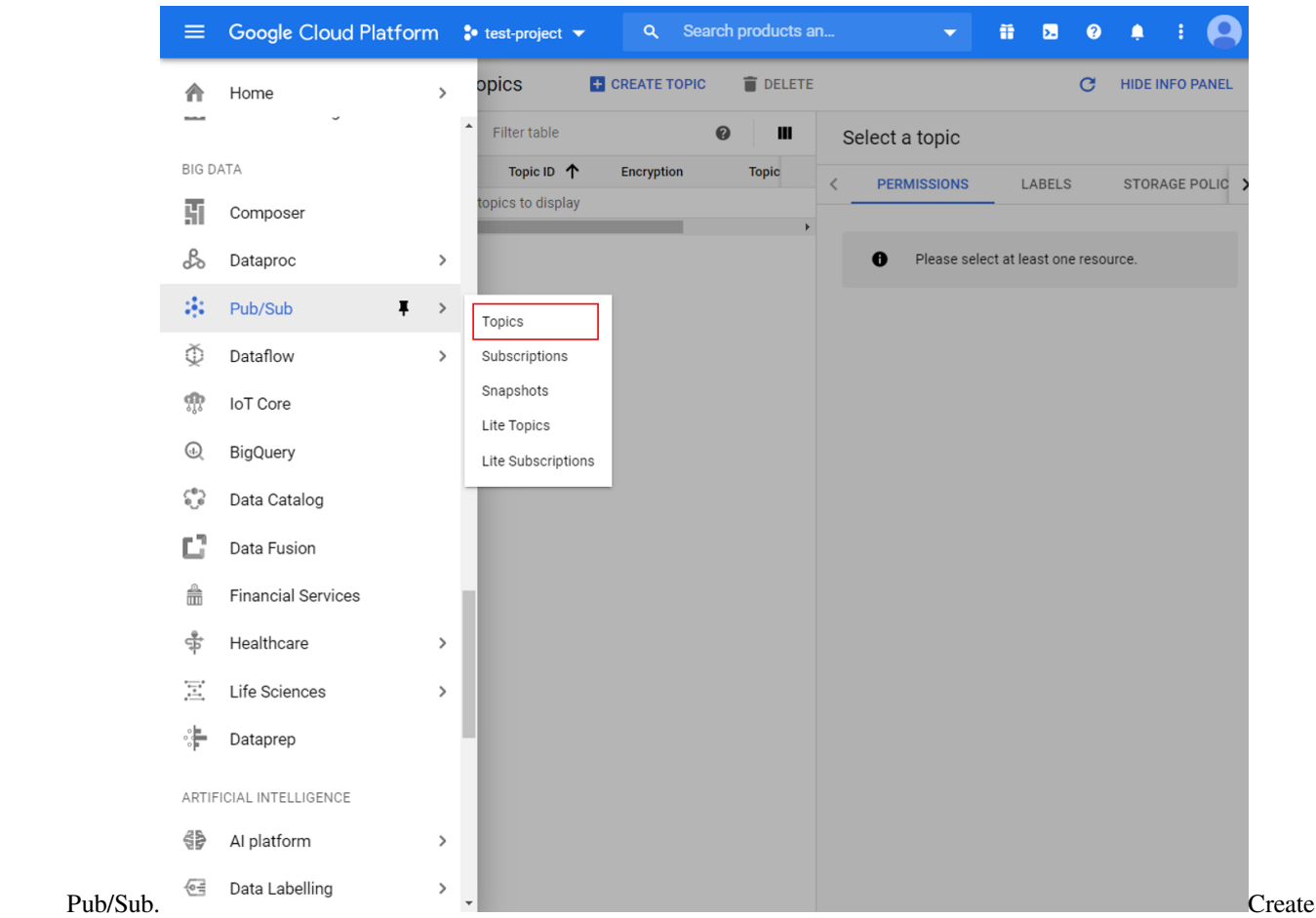
Google's mission is to organize the world's information and make it universally accessible and useful. Through products and platforms like Search, Maps, Gmail, Android, Google Play, Chrome and YouTube, Google plays a meaningful role in the daily lives of billions of people.

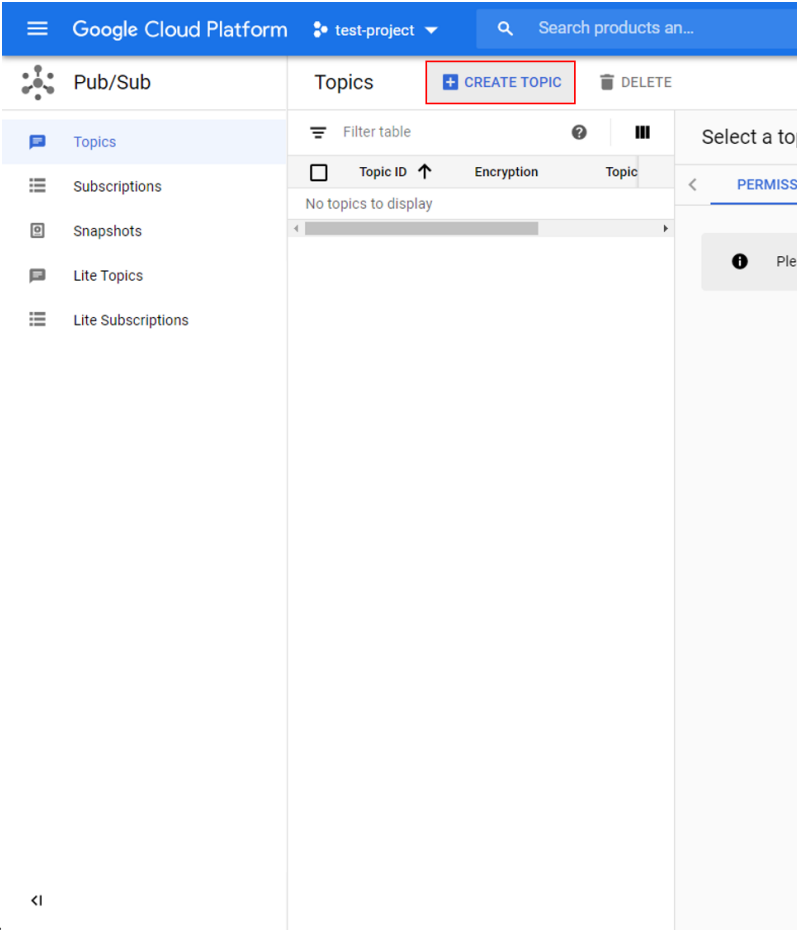
**Pricing**

Device Data Volume	FREE	TIER 1

enable to activate Google Cloud IoT API for your project.

Create a Cloud Pub/Sub topic In Google Cloud console, click on the top left menu button and search for





a new topic for your project and give it a suitable topic ID.  
the topic is created, go to the permissions tab of the info panel, and add “cloud-iot@system.gserviceaccount.com” with the role of “Pub/Sub Publisher” .

Google Cloud Platform

test-project

Search products and resources

Pub/Sub

Topics

Subscriptions

Snapshots

Lite Topics

Lite Subscriptions

Topics

CREATE TOPIC

DELETE

SHOW INFO PANEL

Filter table

Topic ID	Encryption	Topic name	Labels
<input checked="" type="checkbox"/> test-topic	Google-managed	projects/test-project-286902/topics/test-topic	-

Google Cloud Platform

Pub/Sub

Topics

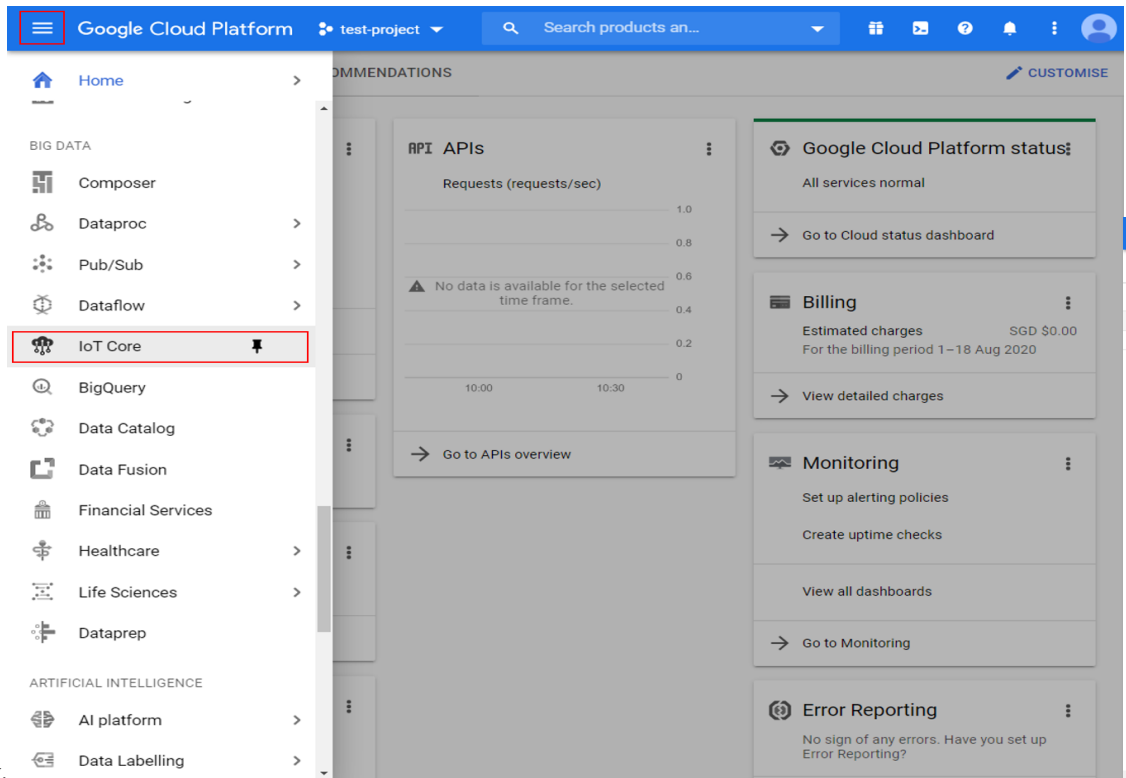
Subscriptions

Snapshots

Lite Topics

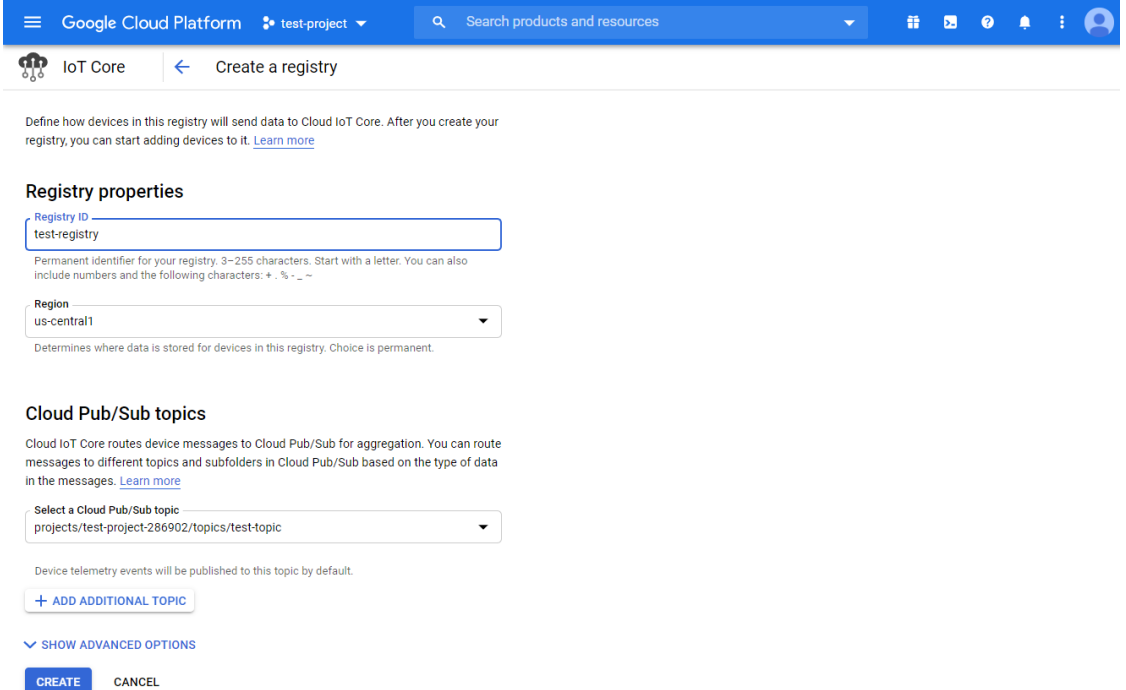
Lite Subscriptions

a device registry Go back to the IoT Core settings page and create a new reg-



istry.

a suitable **Registry ID** and in which to store data. Remember the **\*\*Registry ID** and **Region** for use with Ameba later. For the Pub/Sub topic, select the topic created in the previous

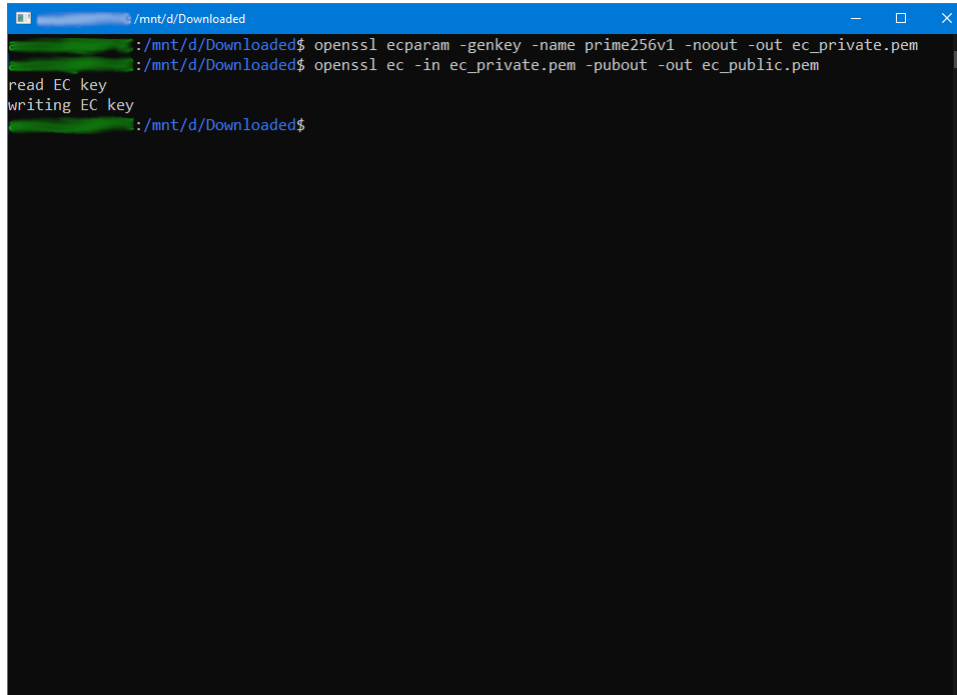


step. 6.

Create a public/private key pair Using Openssl in a terminal in Windows/Linux/MacOs, run the following commands to generate a private and public key pair. Two files will be created by these commands,

“ec\_private.pem” containing the private key, and “ec\_public.pem” containing the public key.

```
$ openssl ecparam -genkey -name prime256v1 -noout -out ec_private.pem
$ openssl ec -in ec_private.pem -pubout -out ec_public.pem
```

A screenshot of a terminal window with a blue title bar. The terminal shows the execution of two OpenSSL commands. The first command generates a private key, and the second command generates a public key from the private key. The output of the second command shows the reading and writing of the EC key. The terminal background is black, and the text is white.

```
/mnt/d/Downloaded$ openssl ecparam -genkey -name prime256v1 -noout -out ec_private.pem
/mnt/d/Downloaded$ openssl ec -in ec_private.pem -pubout -out ec_public.pem
read EC key
writing EC key
/mnt/d/Downloaded$
```

Run the next command to extract out the private key, and remember the highlighted string of hexadecimal numbers for use with Ameba later.

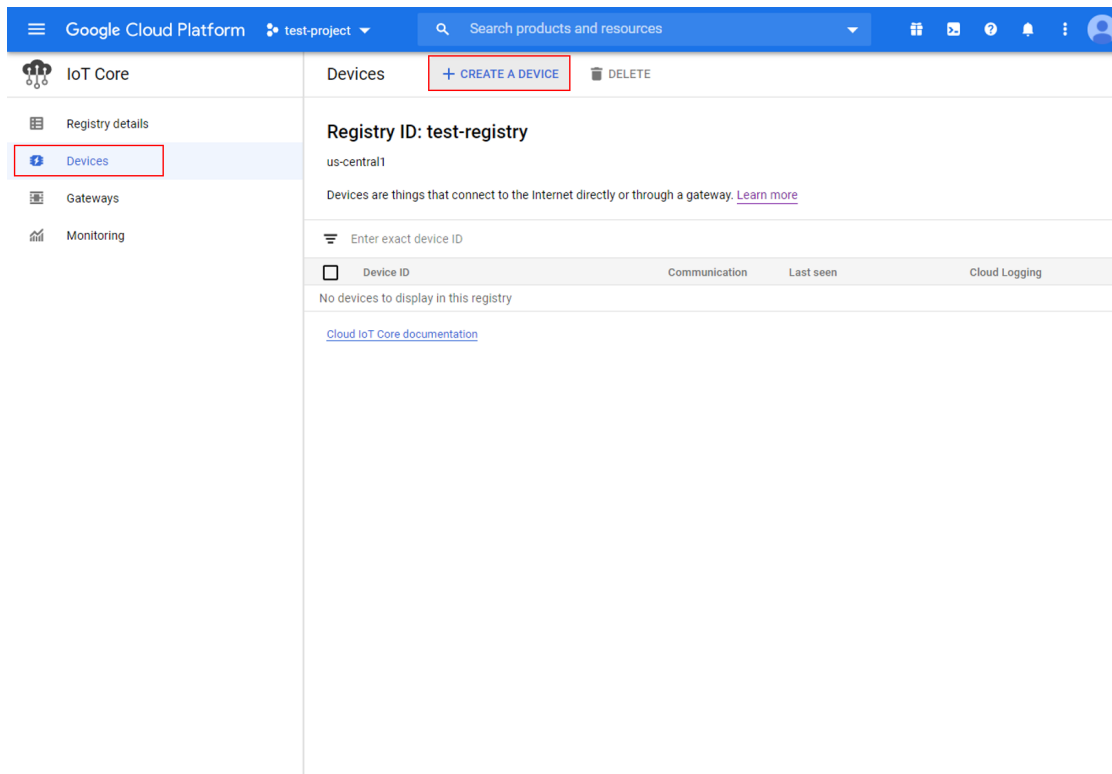
```
$ openssl ec -in ec_private.pem -noout -text
```

```

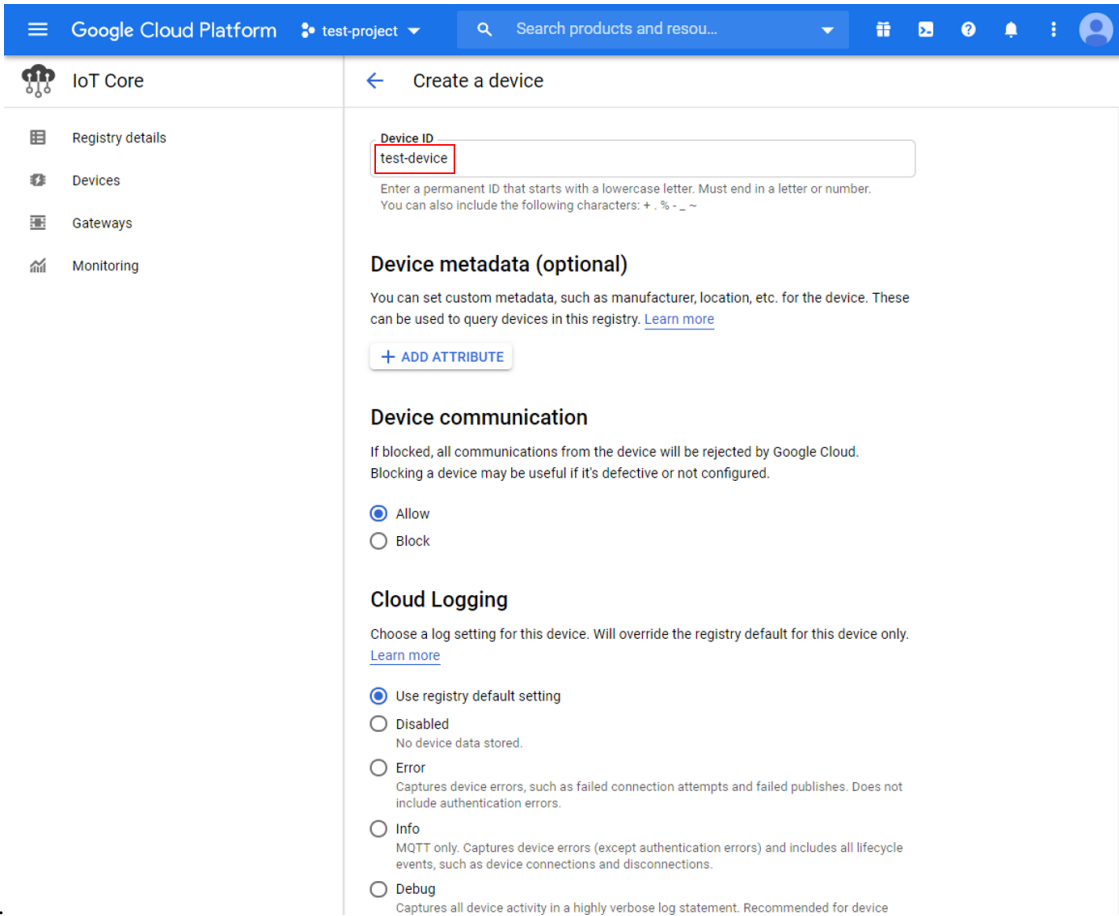
/mnt/d/Downloaded$ openssl ec -in ec_private.pem -noout -text
read EC key
Private-Key: (256 bit)
priv:
    f9:93:86:98:66:b0:f0:34:79:c5:fe:c9:82:50:0d:
    76:f2:ad:c6:2e:23:b9:af:02:c0:1c:d4:11:65:81:
    0a:fb
pub:
    04:29:8f:09:db:9c:d6:e2:b2:05:b8:11:c0:b5:f7:
    90:2a:7c:42:42:3e:db:ec:2d:05:88:b3:8b:14:09:
    9e:de:2d:ec:1b:da:7f:ae:6a:8d:31:55:e1:22:0c:
    d8:94:63:a2:4a:79:09:6f:57:68:76:61:72:9e:e3:
    22:23:93:fd:a6
ASN1 OID: prime256v1
NIST CURVE: P-256
/mnt/d/Downloaded$

```

7. Create a device Go back to the IoT Core settings page and create a new device.



Give the device a suitable **Device ID** and remember it for use with Ameba



later. In the authentication section of the additional options, upload the previously generated “ec\_public.pem” public



Google Cloud Platform test-project Search products and resou...

IoT Core

- Registry details
- Devices
- Gateways
- Monitoring

Create a device

No device data stored.

☐ Error  
Captures device errors, such as failed connection attempts and failed publishes. Does not include authentication errors.

☐ Info  
MQTT only. Captures device errors (except authentication errors) and includes all lifecycle events, such as device connections and disconnections.

☐ Debug  
Captures all device activity in a highly verbose log statement. Recommended for device troubleshooting.

**Authentication (optional)**

Specify the public key that will be used to authenticate this device. You can leave the key empty, but devices will not be able to connect to Google Cloud without a key. [Learn more](#)

**Input method**

☐ Enter manually

☒ Upload

Public key format  
ES256

Public key value  
ec\_public.pem  [BROWSE](#)

File content must be in PEM format

Public key expiry date (optional)

☐ Expires on:

Date HKT

COMMUNICATION, CLOUD LOGGING, AUTHENTICATION

key.

8.

Create a Cloud Pub/Sub subscription To observe messages sent by Ameba, create a subscription in

Google Cloud Platform

test-project

Search products and resou...

Pub/Sub

Topics

Subscriptions

Snapshots

Lite Topics

Lite Subscriptions

Subscriptions

CREATE SUBSCRIPTION

DELETE

SHOW INFO PANEL

Filter table

Subscription ID

Delivery type

Topic name

Subscription name

Acknowledge deac

No subscriptions to display

Pub/Sub.

Choose

a suitable subscription ID and select the previously created topic.

## Example

Open the example in “File” -> “Examples” -> “AmebaMQTTClient” -> “Google\_Cloud\_IoT”.

Google Cloud Platform test-project Search products and resou...

Pub/Sub

- Topics
- Subscriptions**
- Snapshots
- Lite Topics
- Lite Subscriptions

Create subscription

A subscription directs messages on a topic to subscribers. Messages are delivered to subscribers immediately, or subscribers can pull messages as needed.

Subscription ID \*  
test-subscription

Subscription name: projects/test-project-286902/subscriptions/test-subscription

Select a Cloud Pub/Sub topic \*

Type to filter

test-project-286902

projects/test-project-286902/topics/test-topic

SWITCH PROJECT CREATE A TOPIC ENTER TOPIC NAME

☒ Expire after this many days of inactivity (up to 365)

31 Days

A subscription is inactive if there is no subscriber activity such as open pulls or successful pushes.

☐ Never expire  
The subscription will never expire, no matter the activity.

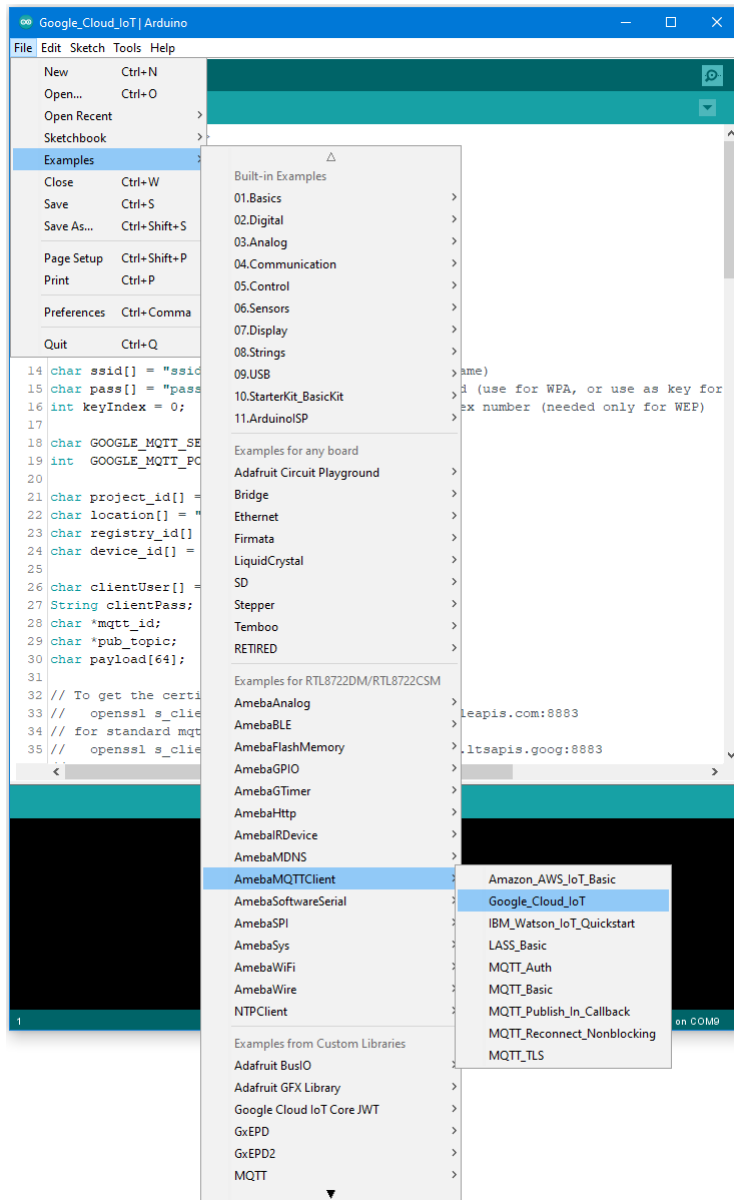
**Acknowledgement deadline** ⓘ

Deadline time is from 10 seconds to 600 seconds

10 Seconds

**Subscription filter** BETA

If a filter syntax is provided, subscribers will only receive messages that match the filter. [Learn more](#)



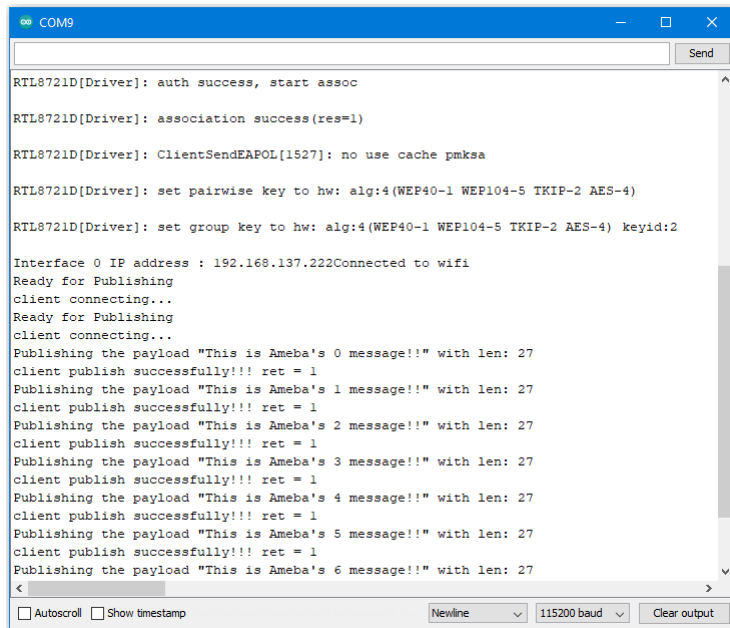
Enter the required information in the highlighted sections below.

```

9  WiFiSSLClient wifiClient;
10 PubSubClient client(wifiClient);
11 WiFiUDP udpClient;
12 NTPClient timeClient(udpClient);
13
14 char ssid[] = "ssid";          // your network SSID (name)
15 char pass[] = "pass";          // your network password (use for WPA, or use as key for
16 int keyIndex = 0;              // your network key Index number (needed only for WEP)
17
18 char GOOGLE_MQTT_SERVER[] = "mqtt.googleapis.com";
19 int  GOOGLE_MQTT_PORT = 8883;
20
21 char project_id[] = "project-id";
22 char location[] = "us-central1";
23 char registry_id[] = "my-registry";
24 char device_id[] = "ameba-device";
25
26 char clientUser[] = "unused";
27 String clientPass;
28 char *mqtt_id;
29 char *pub_topic;
30 char payload[64];
31 NN_DIGIT priv_key[9];
32
33 // To get the private key run (where private-key.pem is the ec private key
34 // used to create the certificate uploaded to google cloud iot):
35 // openssl ec -in <private-key.pem> -noout -text
36 // and copy priv: part.
37 // The key length should be exactly the same as the key length below (32 pairs
38 // of hex digits). If it's bigger and it starts with "00:" delete the "00:". If
39 // it's smaller add "00:" to the start. If it's too big or too small something
40 // is probably wrong with your key.
41 char *private_key_str =
42 "57:e1:c0:3b:e5:cd:2f:42:fb:14:4f:a9:1e:3f:0a:"
43 "65:22:4c:f0:ac:0f:a0:82:e1:73:71:ae:76:70:48:"
44 "68:fe";
45

```

In the yellow section, enter the SSID and password required to connect to your WiFi network. In the green section, enter the Project ID, server Region, Registry ID and Device ID previously configured in Google Cloud console. In the blue section, enter the hexadecimal string previously extracted from the private key. Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor and observe as Ameba connects and sends messages to Google Cloud IoT.



```

COM9
Send

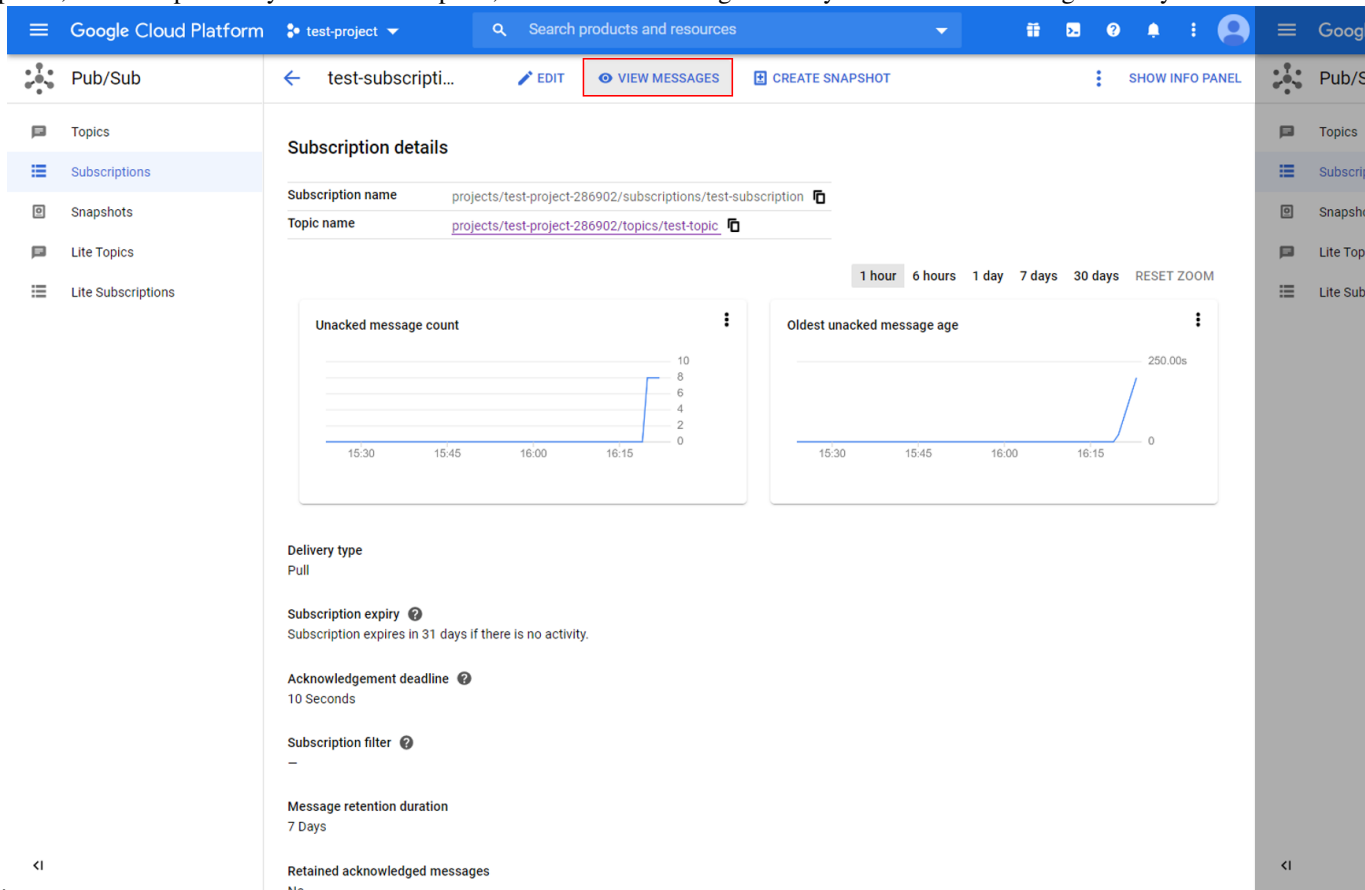
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=1)
RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.137.222Connected to wifi
Ready for Publishing
client connecting...
Ready for Publishing
client connecting...
Publishing the payload "This is Ameba's 0 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 1 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 2 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 3 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 4 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 5 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 6 message!!" with len: 27

```

In Google Cloud console, go to Pub/Sub

subscriptions, select the previously created subscription, and click view messages. Here you can view the messages sent by



Google Cloud Platform test-project Search products and resources

Pub/Sub test-subscri... EDIT VIEW MESSAGES CREATE SNAPSHOT SHOW INFO PANEL

Topics Subscriptions Snapshots Lite Topics Lite Subscriptions

Subscription details

Subscription name projects/test-project-286902/subscriptions/test-subscription

Topic name projects/test-project-286902/topics/test-topic

1 hour 6 hours 1 day 7 days 30 days RESET ZOOM

Unacked message count

Oldest unacked message age

Delivery type Pull

Subscription expiry ? Subscription expires in 31 days if there is no activity.

Acknowledgement deadline ? 10 Seconds

Subscription filter ? -

Message retention duration 7 Days

Retained acknowledged messages

Ameba.

## Code Reference

In `setup()`, we set up RootCA which is required to form a TLS connection with Google's servers.

```
wifiClient.setRootCA((unsigned char*)rootCABuff);
```

In `loop()`, each loop checks the Internet status and re-connect to it when the environment has a problem.

```
if (WiFi.status() != WL_CONNECTED) {
    while (WiFi.begin(ssid, pass) != WL_CONNECTED)
    {
        delay(1000);
    }
    Serial.println("Connected to wifi");
}
```

To publish messages, `mqtt_id`, `clientPass` and `pub_topic` are required. `mqtt_id` is generated by printing the project ID, server location, registry ID and device ID in the required format:

```
mqtt_id = (char *)malloc(strlen("projects/") + strlen(project_id) + strlen("/locations/us-central1/registries/") + strlen(registry_id) + strlen("/devices/") + strlen(device_id) + 1);
sprintf(mqtt_id, "projects/%s/locations/us-central1/registries/%s/devices/%s", project_id, registry_id, device_id);
```

`clientPass` is generated using a JSON web token (JWT) generator function, which requires the project ID and current time, and signs it with the private key:

```
clientPass = CreateJwt(project_id, timeClient.getEpochTime(), priv_key);
```

`pub_topic` is generated by printing the project ID and topic in the required format:

```
pub_topic = (char *)malloc(strlen("/devices/") + strlen(device_id) + strlen("/events") + 1);
sprintf(pub_topic, "/devices/%s/events", device_id);
```

MQTT Server setting:

```
client.setServer(GOOGLE_MQTT_SERVER, GOOGLE_MQTT_PORT);
client.setPublishQos(MQTTQOS1);
client.waitForAck(true);
```

Connect to google cloud and publish messages:

```
if (client.connect(mqtt_id, clientUser, clientPass.c_str())){
    // ...
}
```

(繼續下一頁)

(繼續上一頁)

```
    for(int i = 0; i < count; i++){
        // ...
        sprintf(payload, "This is Ameba's %d message!!", i);
        ret = client.publish(pub_topic, payload);
        // ...
    }
    // ...
    client.disconnect();
}
free(mqtt_id);
free(pub_topic);
```

## MQTT - Upload PM2.5 Data to LASS System

### Intro to LASS

The LASS stands for “Location Aware Sensor System” . It is an open project and was started only for the interest of public welfare. Find detailed introduction [here](#).

Practically, LASS is based on MQTT protocol to collect all kinds of uploaded data, and for those who need these data can subscribe top as well.

Find more LASS information at their [official hackpad](#).

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- PlanTower PMS3003 or PMS5003 x1

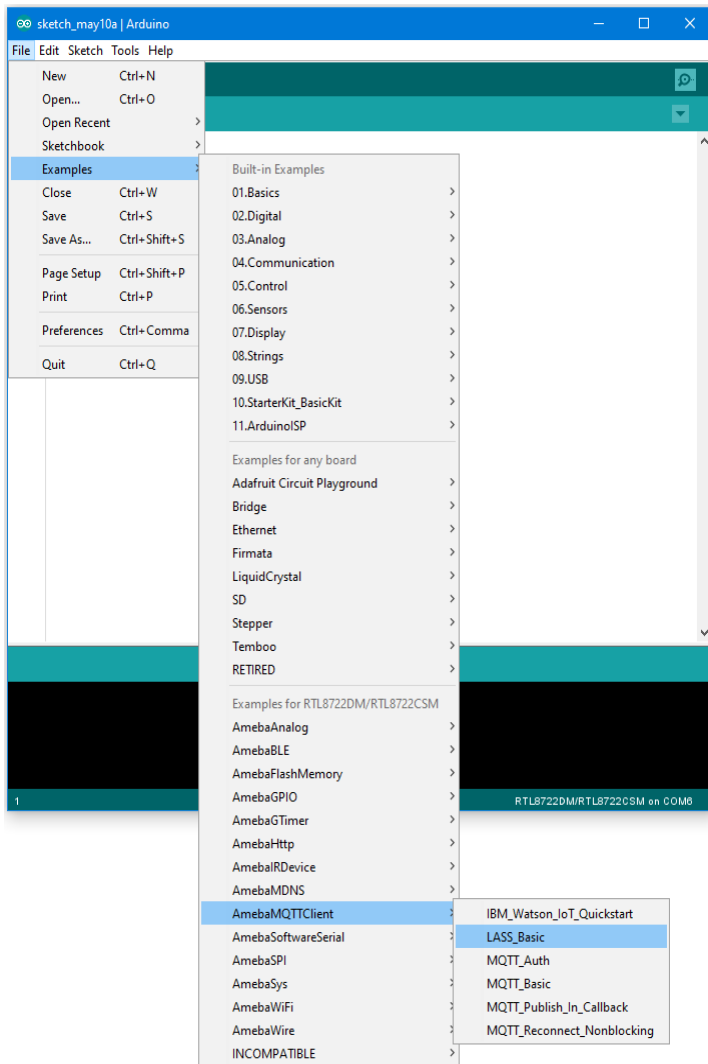
### Example

In this example, we use applications mentioned at our website, including:

- **MQTT**: a MQTT-Broker to connect to LASS. The Client is “FT1\_0XXXX” , the XXXX are the four last digits of Ameba’ s Wi-Fi MAC, and the outTopic is “LASS/Test/Pm25Ameba/**clientID** “, where clientID is the actual Ameba’ s MQTT client ID.
- **NTP**: uploaded data must have time notation
- **PM2.5**: uploaded data includes PM2.5 information

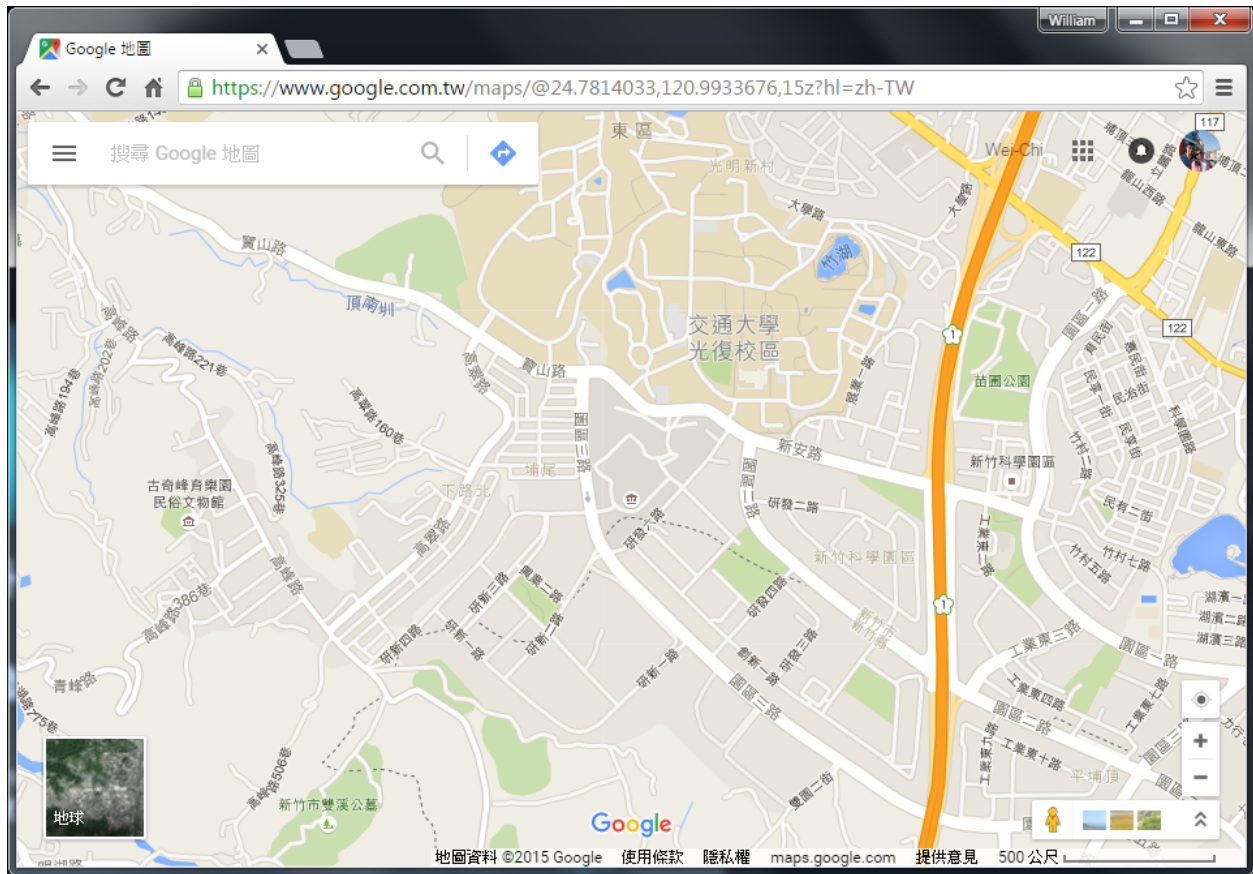


Open the example. “File” -> “Examples” -> “AmebaMQTTClient” -> “lass\_basic”



This example requires internet connection, so make sure you fill in SSID and PASS into AP information that you wish to connect.

Also, LASS requires GPS information. There is no GPS sensor included in this example, so you must manually provide GPS information. Use Google Map to find the coordinates you plan to place your Ameba. You can see in this example that the latitude is 24.7814033, and the longitude is 120.9933676



Fill in GPS info at `gps_lat` and `gps_lon`.

```

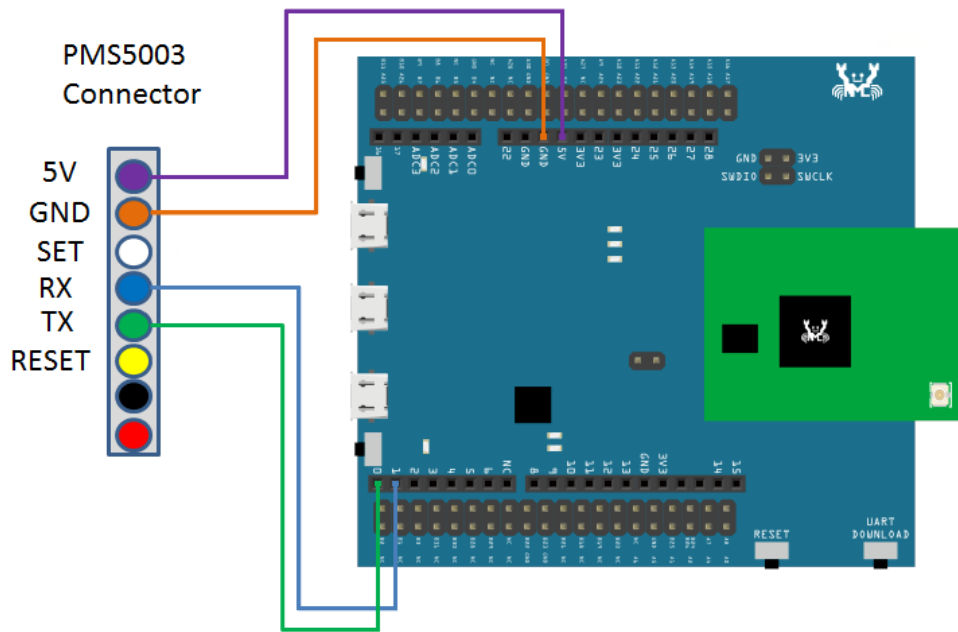
1  /*
2   This example demonstrate how to upload sensor data to MQTT server of LASS.
3   It include features:
4       (1) Connect to WiFi
5       (2) Retrieve NTP time with WiFiUDP
6       (3) Get PM 2.5 value from PMS3003 air condition sensor with UART
7       (4) Connect to MQTT server and try reconnect when disconnect
8
9   You can find more information at this site:
10
11   https://lass.hackpad.com/LASS-README-DtZ5T6DXLbu
12
13  */
14
15  #include <WiFi.h>
16  #include <PubSubClient.h>
17  #include <WiFiUdp.h>
18  #include <PMS3003.h>
19
20  char ssid[] = "yourNetwork"; // your network SSID (name)
21  char pass[] = "secretPassword"; // your network password
22  int keyIndex = 0; // your network key Index number (needed onl
23
24  char gps_lat[] = "24.7814033"; // device's gps latitude
25  char gps_lon[] = "120.9933676"; // device's gps longitude
26
27  char server[] = "gpssensor.ddns.net"; // the MQTT server of LASS
28  char clientId[17] = ""; // client id for MQTT
29  char outTopic[20] = "LASS/Test/PM25/live"; // MQTT publish topic
30

```

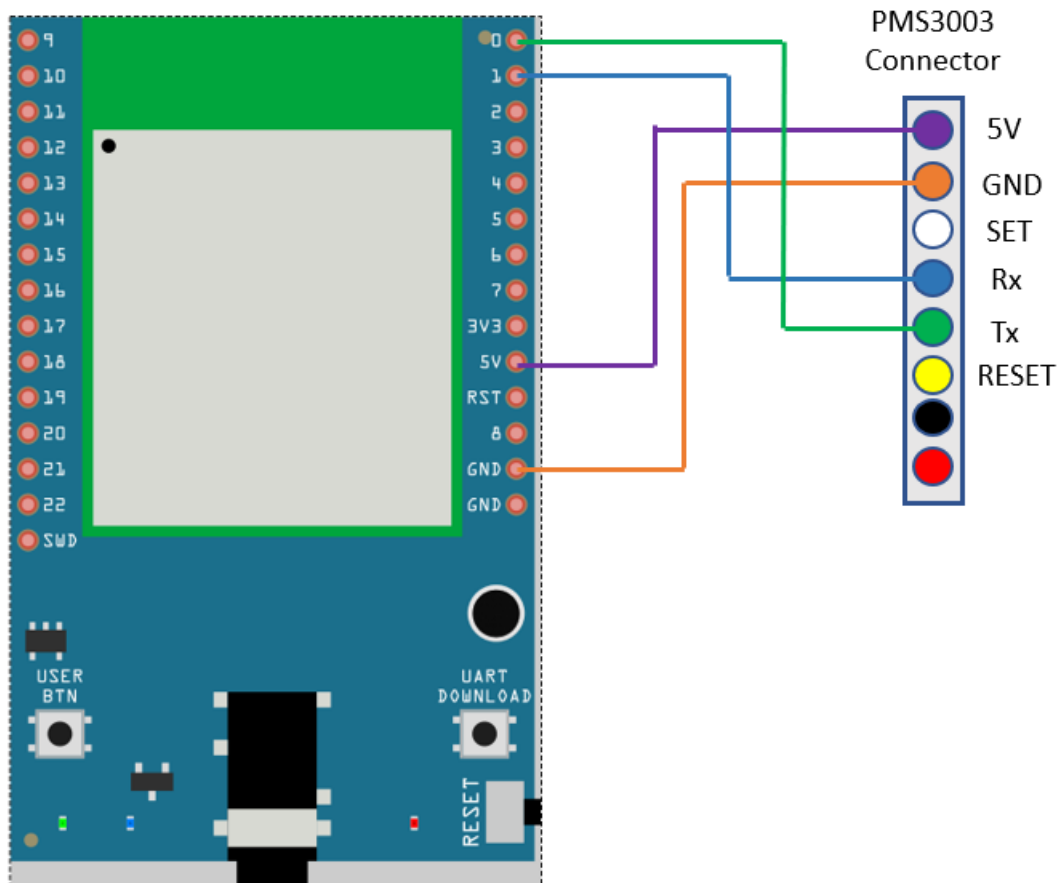
1 RTL8722DM/RTL8722CSM on COM6

Then connect sensors according to UART-PlanTower PMS3003 wiring example.

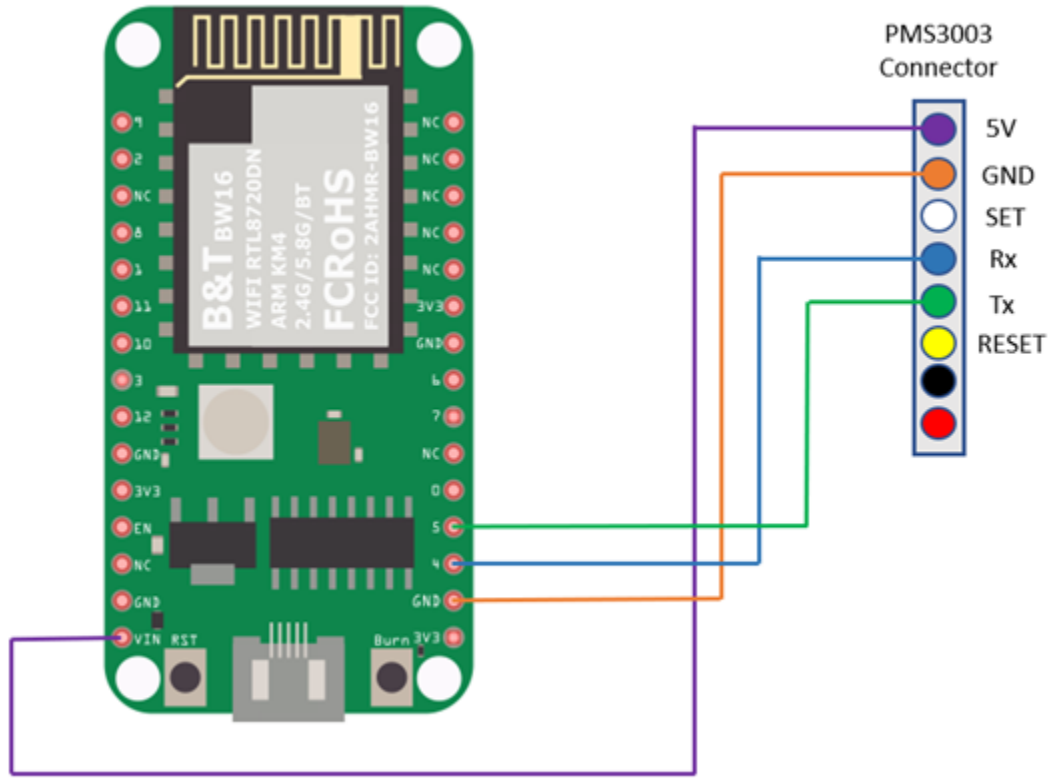
**AMB21 / AMB22:**



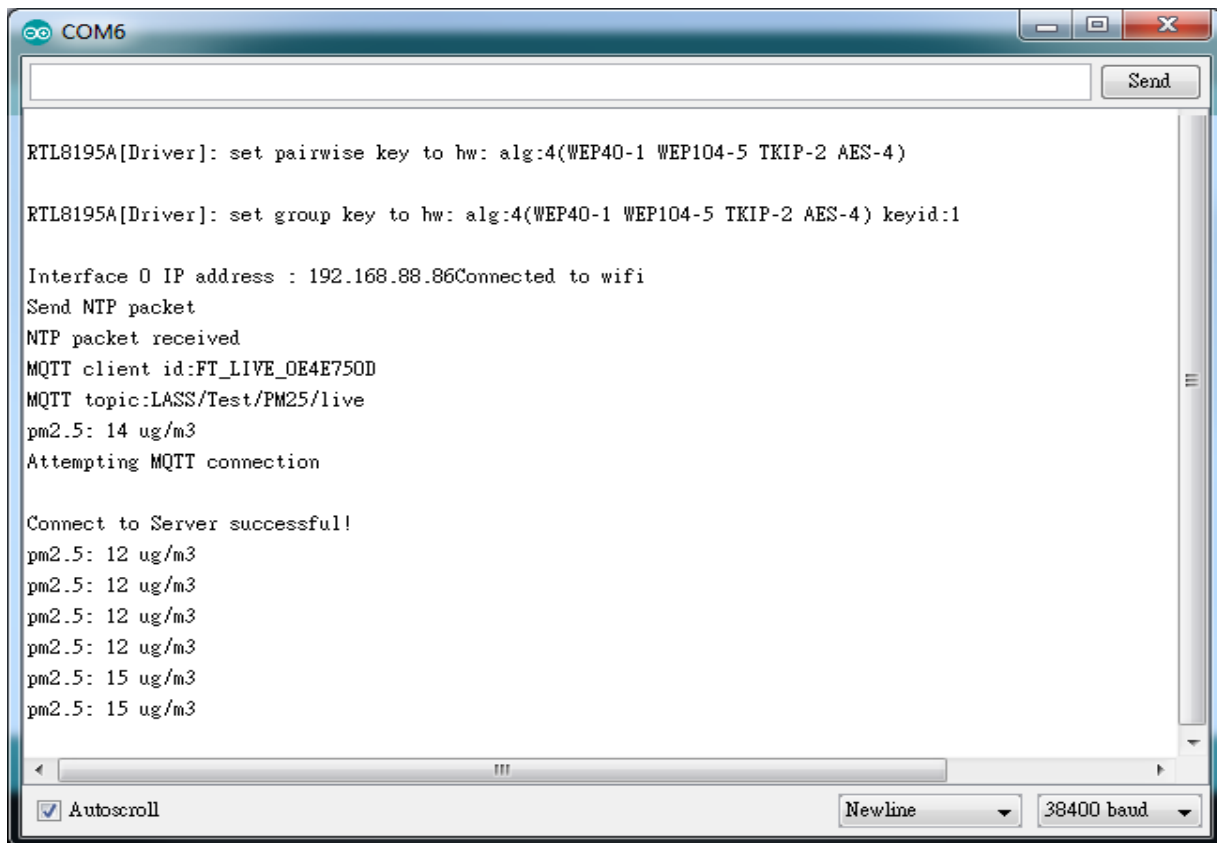
AMB23:



BW16:



Compile the code and upload it to Ameba. After pressing the Reset button, Ameba will attempt to read PM2.5 data every minute and upload it to LASS MQTT-Broker. Open Serial Monitor to see the uploaded data, including client id, topic, and current PM2.5 status.



```
COM6

RTL8195A[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.88.86Connected to wifi
Send NTP packet
NTP packet received
MQTT client id:FT_LIVE_OE4E750D
MQTT topic:LASS/Test/PM25/live
pm2.5: 14 ug/m3
Attempting MQTT connection

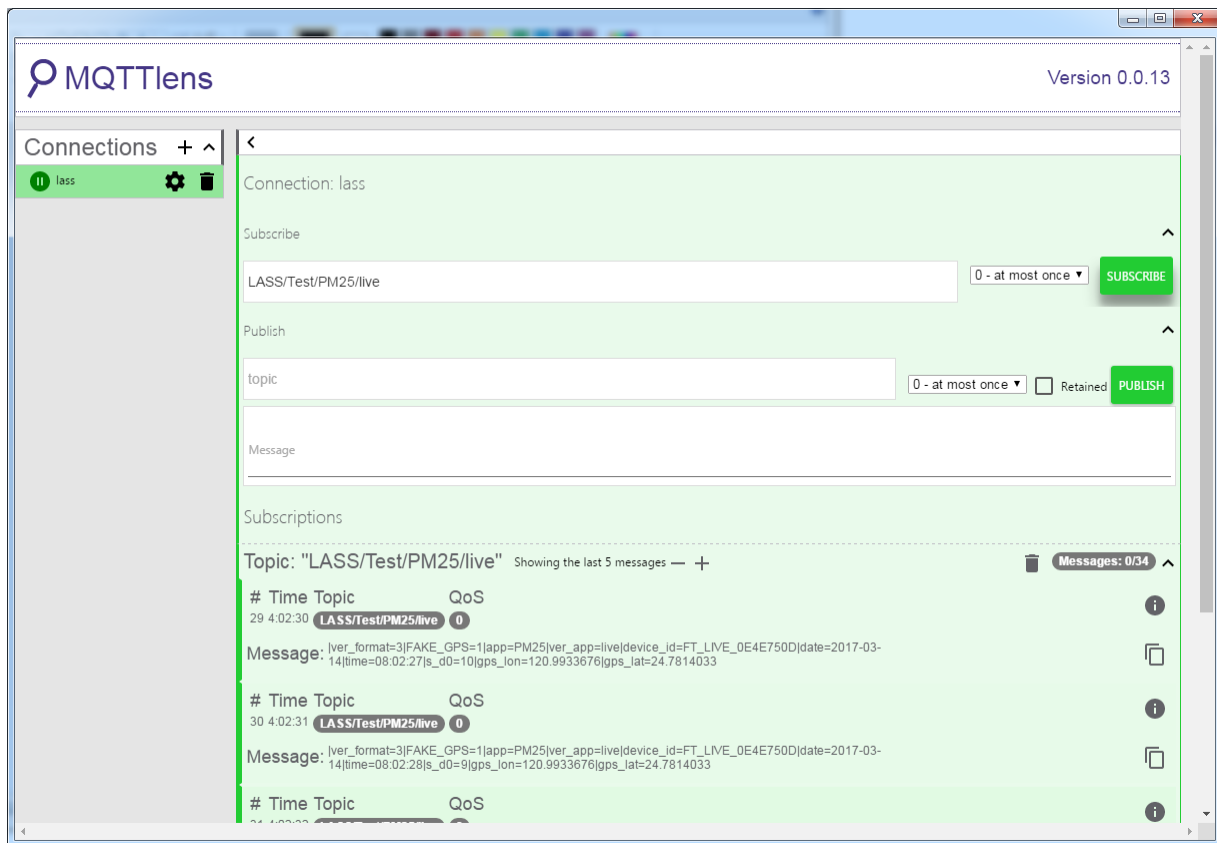
Connect to Server successful!
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 15 ug/m3
pm2.5: 15 ug/m3

Autoscroll Newline 38400 baud
```

We can also use MQTTlens to verify if the data is properly uploaded.

Enter “gpssensor.ddns.net” as the MQTT-Broker server and “LASS/Test/PM25/live” as the subscribe topic to receive data.

The time uses UTC format, and the PM2.5 data stores in s\_d0. In the figure, s\_d0 = 9 represents that the PM2.5 is 9, meaning that the entire publish/subscribe process is working successfully.



## NTP - Retrieve Universal Time (UTC) by NTPClient library

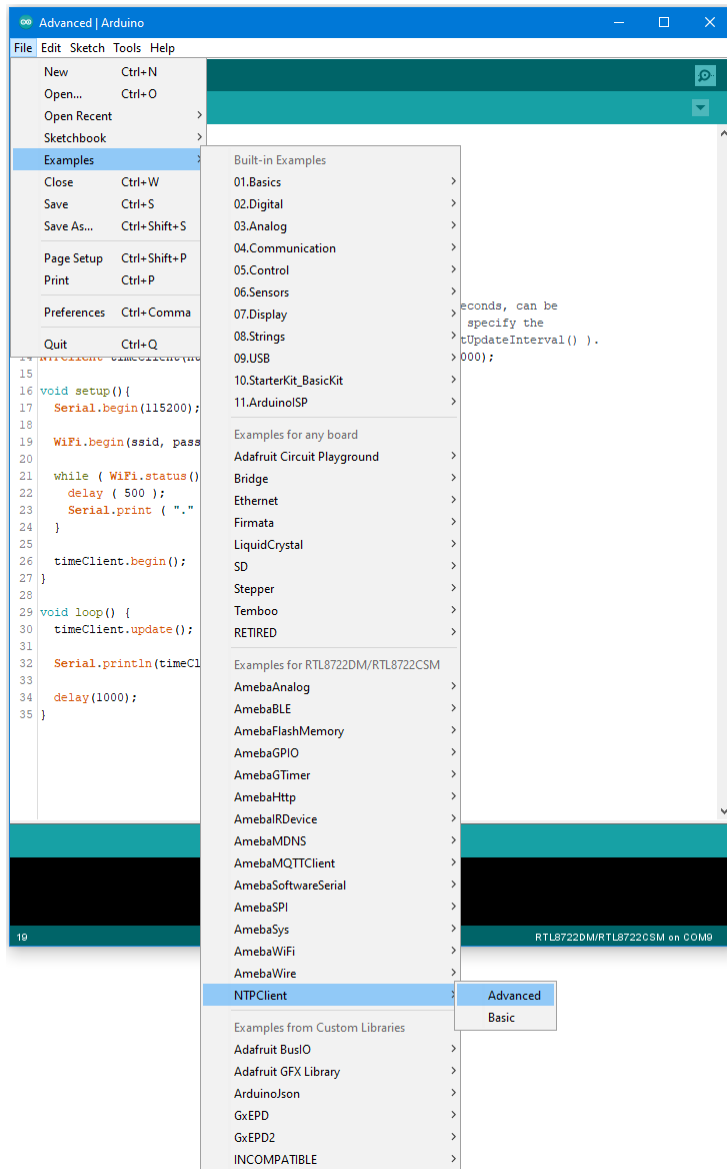
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we use an NTP client to sync with NTP servers using UDP and keep track of time locally. Open the example. “File” -> “Examples” -> “NTPClient” -> “Advanced”



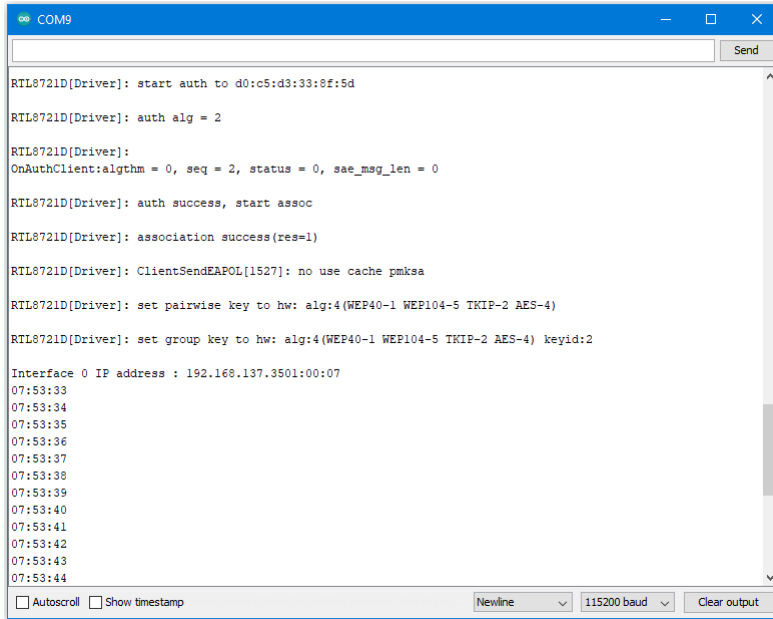


Modify the highlighted code section (ssid, password) to connect to your WiFi network.



```
1 #include <NTPClient.h>
2 #include <WiFi.h>
3 #include <WiFiUdp.h>
4
5 char ssid[] = "<SSID>";
6 char pass[] = "<PASS>";
7
8
9 WiFiUDP ntpUDP;
10
11 // You can specify the time server pool and the offset (in seconds, can be
12 // changed later with setTimeOffset() ). Additionally you can specify the
13 // update interval (in milliseconds, can be changed using setUpdateInterval() ).
14 NTPClient timeClient(ntpUDP, "europe.pool.ntp.org", 3600, 60000);
15
16 void setup() {
17   Serial.begin(115200);
18
19   WiFi.begin(ssid, pass);
20
21   while ( WiFi.status() != WL_CONNECTED ) {
22     delay ( 500 );
23     Serial.print ( "." );
24   }
25
26   timeClient.begin();
27 }
28
29 void loop() {
30   timeClient.update();
31
32   Serial.println(timeClient.getFormattedTime());
33
34   delay(1000);
35 }
```

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi, gets the UTC time from the NTP server, and prints out the current time with time zone offset to the serial monitor.



## Code Reference

Configure NTP client:

The NTPClient needs to use a UDP client for communications. A WiFiUDP client is declared and passed to the NTPClient constructor, along with an NTP server address, time zone offset in seconds, and update interval in milliseconds. If detailed configuration is not needed, just passing in the UDP client is also sufficient, refer to the “NTPClient” -> “Basic” example.

```
WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP, "europe.pool.ntp.org", 3600, 60000);
```

Start NTP client:

After connecting to WiFi, the NTPClient is started using the `begin()` function, which causes the client to sync with the NTP server and get the UTC time.

```
WiFiUDP ntpUDP;
timeClient.begin();
```

Get local time:

`getFormattedTime()` is used to format the received UTC time into the local time zone. `update()` is called every loop so that the NTPClient will sync with the NTP server once every update interval.

```
timeClient.update();  
timeClient.getFormattedTime();
```

## WiFi - Approximate UDP Receive Delay

### Materials

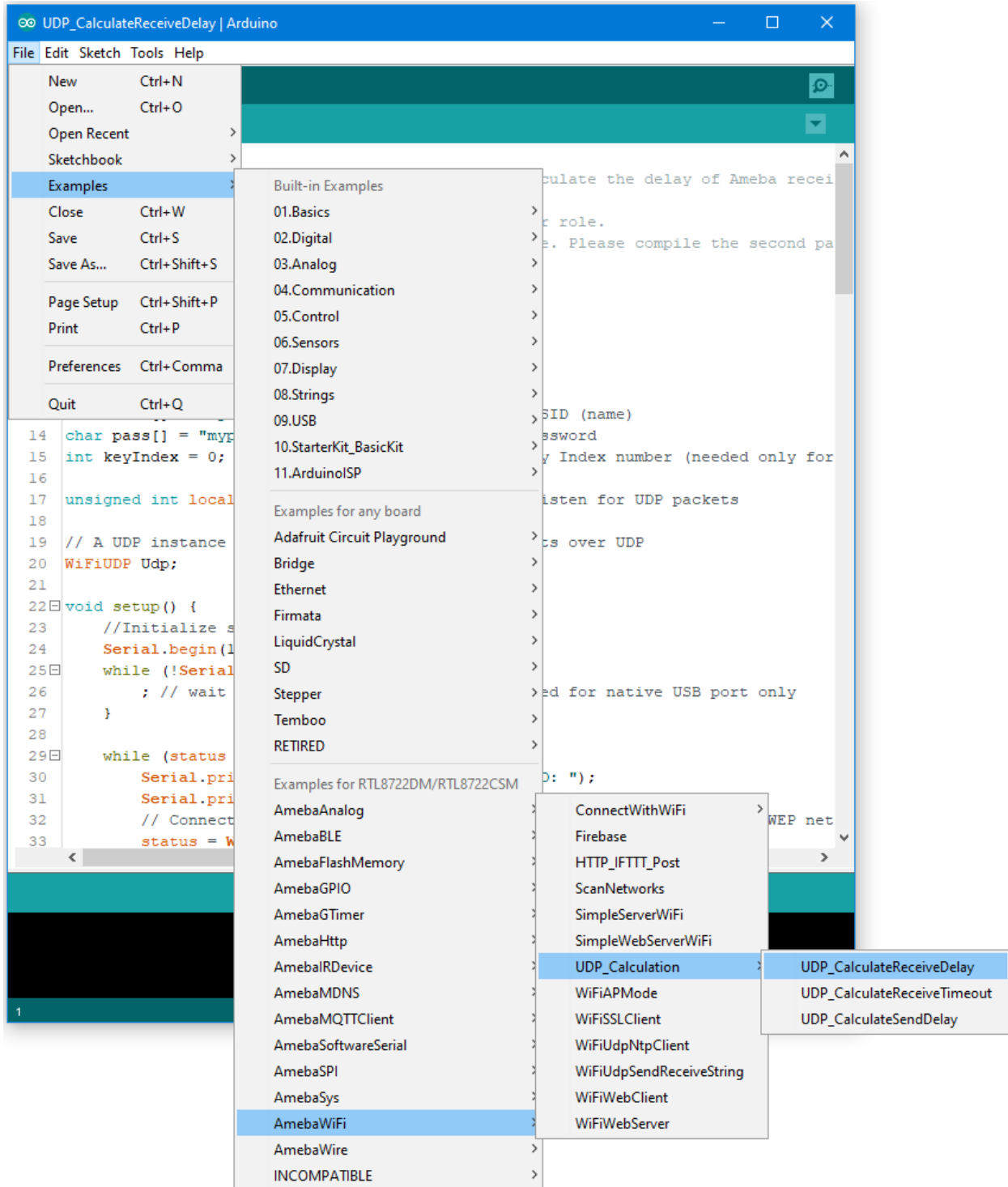
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to receive UDP packets from a computer and calculates the UDP receive delay.

### Ameba Preparation

Open the “CalculateUdpReceiveDelay” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation” -> “CalculateUdpReceiveDelay”.



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.

```

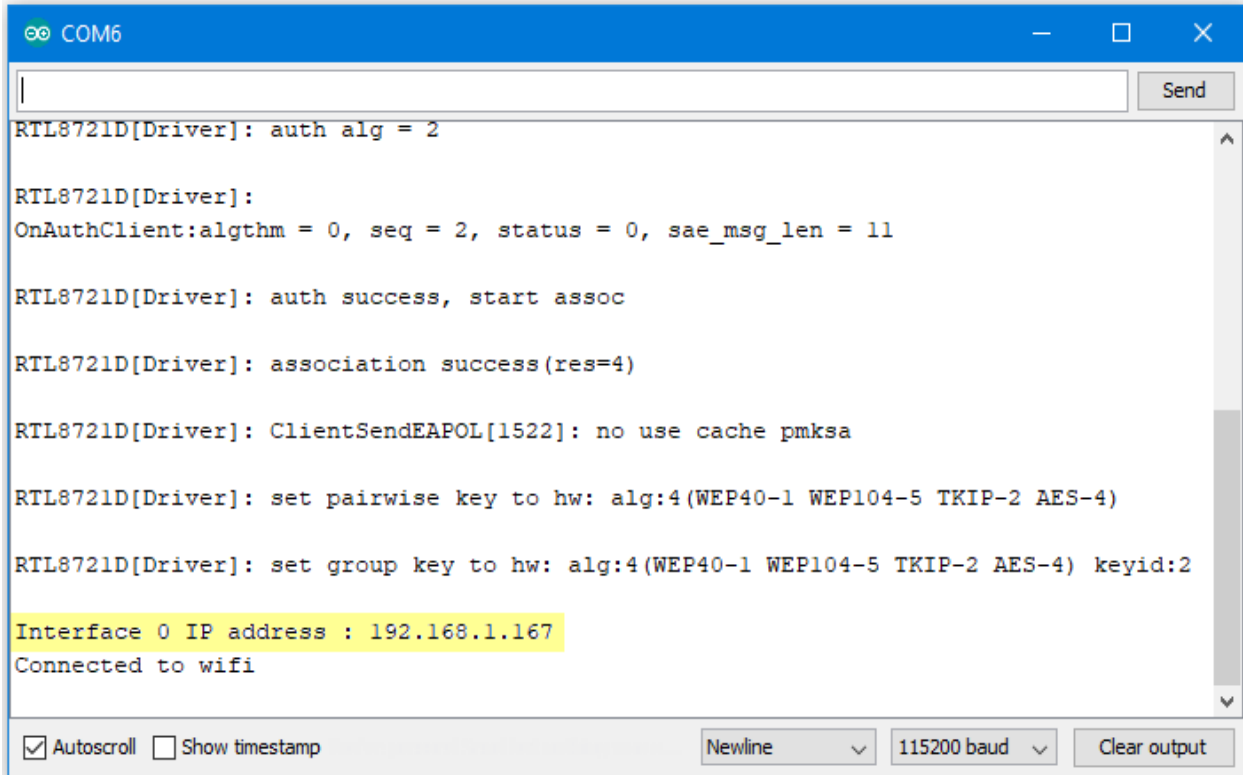
1  /*
2   This sketch provide a simple way to roughly calculate the delay of Ameba recei
3   The source code is separate into two parts.
4   The first part is Ameba code which play receiver role.
5   The second part is PC code wich play sender role. Please compile the second pa
6  */
7
8  #include <WiFi.h>
9  #include <WiFiUdp.h>
10 #include <stdio.h>
11
12 int status = WL_IDLE_STATUS;
13 char ssid[] = "mynetwork"; // your network SSID (name)
14 char pass[] = "mypassword"; // your network password
15 int keyIndex = 0; // your network key Index number (needed only for
16
17 unsigned int localPort = 5001; // local port to listen for UDP packets
18
19 // A UDP instance to let us send and receive packets over UDP
20 WiFiUDP Udp;
21
22 void setup() {
23     //Initialize serial and wait for port to open:
24     Serial.begin(115200);
25     while (!Serial) {
26         ; // wait for serial port to connect. Needed for native USB port only
27     }
28
29     while (status != WL_CONNECTED) {
30         Serial.print("Attempting to connect to SSID: ");
31         Serial.println(ssid);
32         // Connect to WPA/WPA2 network. Change this line if using open or WEP net
33         status = WiFi.begin(ssid, pass);

```

1

RTL8722DM/RTL8722CSM on COM8

Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor in Arduino IDE and take note of the IP address assigned to Ameba.



```
COM6
|
Send
RTL8721D[Driver]: auth alg = 2
RTL8721D[Driver]:
OnAuthClient:alghm = 0, seq = 2, status = 0, sae_msg_len = 11
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=4)
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2
Interface 0 IP address : 192.168.1.167
Connected to wifi
Autoscroll Show timestamp Newline 115200 baud Clear output
```

## Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpReceiveDelay” Arduino example, copy the code from the bottom between “#if 0” and “#endif” , into a new text file, change the hostname to the IP address assigned to Ameba, and rename the file to “UdpReceiveDelay.cpp” .

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <netinet/in.h>
6  #include <arpa/inet.h>
7  #include <sys/time.h>
8  #include <unistd.h>
9
10 #define BUFSIZE 1024
11
12 char *hostname = "172.25.24.243";
13 int portno = 5001;
14
15 long base_current_time = 0;
16 long get_current_time_with_ms (void)
17 {
18     struct timeval tv;
19
20     gettimeofday(&tv, NULL);
21
22     long millisecondsSinceEpoch =
23         (long)(tv.tv_sec) * 1000 +
24         (long)(tv.tv_usec) / 1000;
25
26     if (base_current_time == 0) {
27         base_current_time = millisecondsSinceEpoch;
28         return 0;
29     } else {
30         return millisecondsSinceEpoch - base_current_time;
31     }
32 }

```

length: 1,666 lines: 67 Ln: 12 Col: 1 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpReceiveDelay.cpp”, and use the command “g++ UdpReceiveDelay.cpp -o UdpDelay” to compile the code. A file named “UdpDelay.exe” will be created in the same directory.

### Running the Example

Reset the Ameba, wait for the WiFi to connect, and check that the IP address remains the same. On the computer, run the UdpDelay.exe file, and the computer will begin to send packets to Ameba. Once 10000 packets have been received, Ameba will calculate the average delay and print out the result to the serial monitor. It may take up to a few minutes for 10000 packets to be sent.



```

COM6
Send

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
Connected to wifi
data count: 10000      average delay: 95.47 ms
data count: 20000      average delay: 198.96 ms
data count: 30000      average delay: 272.98 ms

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

```

## WiFi - Approximate UDP Sending Delay

### Materials

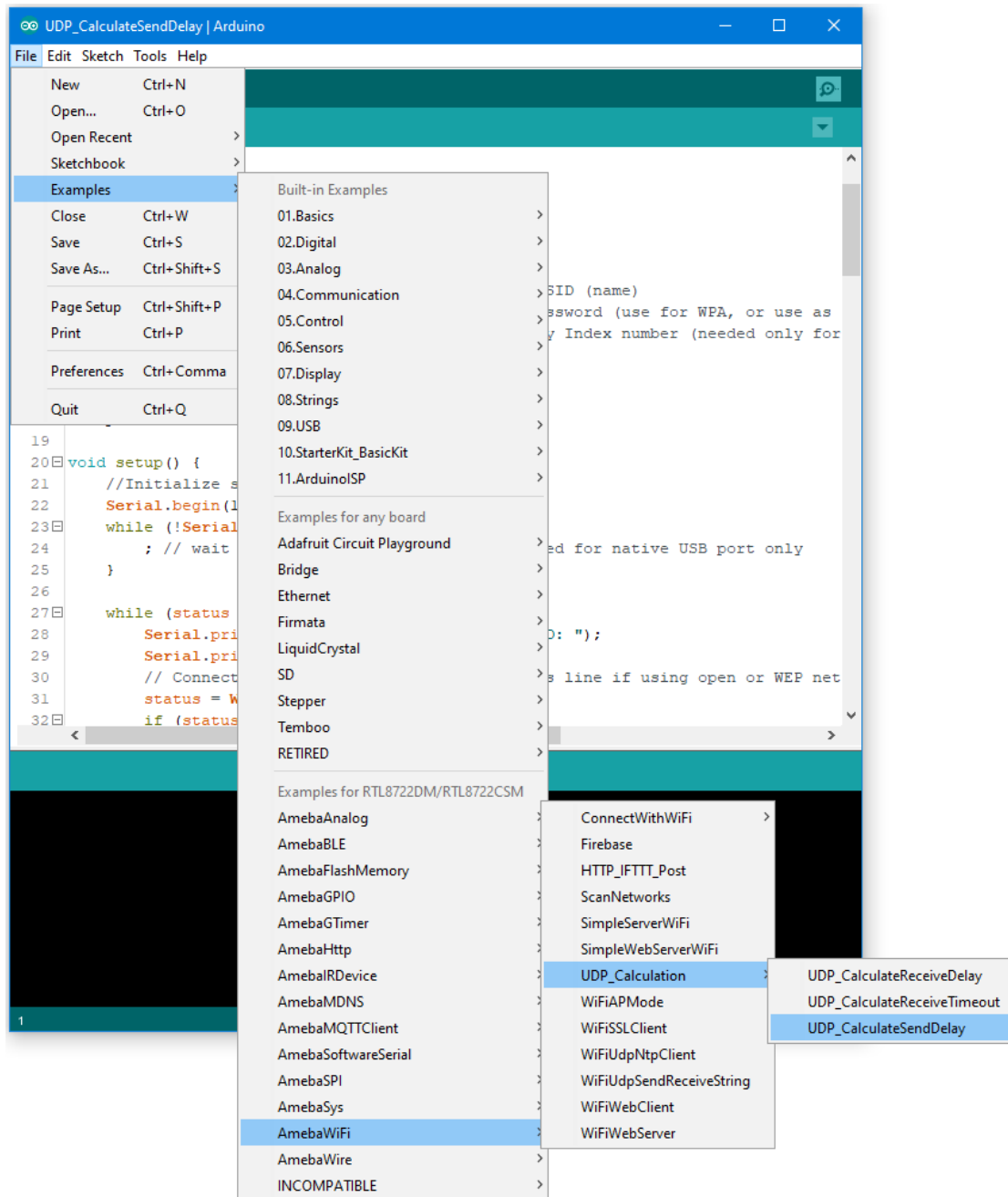
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to send UDP packets to a computer and calculates the UDP sending delay.

### Ameba Preparation

Open the “CalculateUdpSendDelay” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation ” -> “CalculateUdpSendDelay” .



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.

The server variable also needs to be changed to match the IP address of your computer. You can find the IP address using the “ipconfig” command in a terminal window.

```

6  */
7
8  #include <WiFi.h>
9  #include <WiFiUdp.h>
10
11 int status = WL_IDLE_STATUS;
12 char ssid[] = "mynetwork";    // your network SSID (name)
13 char pass[] = "mypassword";   // your network password (use for WPA, or use as
14 int keyIndex = 0;             // your network key Index number (needed only for
15
16 WiFiUDP Udp;
17 char server[] = "192.168.1.65";
18 int port = 5001;
19
20 void setup() {
21     //Initialize serial and wait for port to open:
22     Serial.begin(115200);
23     while (!Serial) {
24         ; // wait for serial port to connect. Needed for native USB port only
25     }
26
27     while (status != WL_CONNECTED) {
28         Serial.print("Attempting to connect to SSID: ");
29         Serial.println(ssid);
30         // Connect to WPA/WPA2 network. Change this line if using open or WEP net
31         status = WiFi.begin(ssid, pass);
32         if (status == WL_CONNECTED) {

```

## Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpSendDelay” Arduino example, copy the code from the bottom between “#if 0” and “#endif”, into a new text file and rename the file to “UdpSendDelay.cpp”.

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <arpa/inet.h>
6  #include <sys/time.h>
7
8  #define BUFSIZE 1024
9  #define PORT 5001
10
11 long get_current_time_with_ms (void)
12 {
13     struct timeval tv;
14
15     gettimeofday(&tv, NULL);
16
17     long millisecondsSinceEpoch =
18         (long) (tv.tv_sec) * 1000 +
19         (long) (tv.tv_usec) / 1000;
20
21     return millisecondsSinceEpoch;
22 }
23
24 long early_diff = 0;
25
26 long ameba_epoch = 0;
27 long sys_epoch = 0;
28
29 long datacount = 0;
30 long total_shift = 0;
31
32 void process_data(char *buf) {

```

length: 2,706 lines: 110 Ln: 110 Col: 2 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpSendDelay.cpp”, and use the command “g++ UdpSendDelay.cpp -o UdpDelay” to compile the code. A file named “UdpDelay.exe” will be created in the same directory.

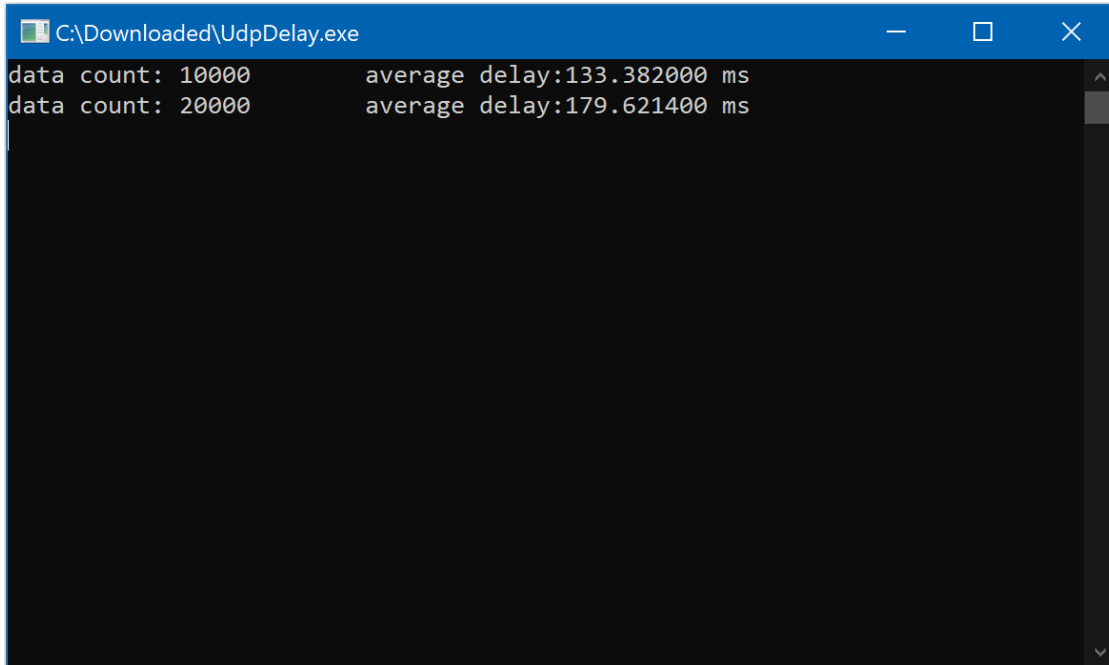
### Running the Example

First, on the computer, run the UdpDelay.exe file, and the computer will begin to listen for packets from Ameba.

Next, compile and upload the code from the Arduino IDE to Ameba and press the reset button when the upload is complete.

The Ameba will begin to send UDP packets to the computer. Once 10000 packets have been received, the computer will calculate the average delay and print out the result.

It will take some time for 10000 packets to be sent.



```
C:\Downloaded\UdpDelay.exe
data count: 10000      average delay:133.382000 ms
data count: 20000      average delay:179.621400 ms
```

## WiFi - Approximate UDP Receive Timeout

### Materials

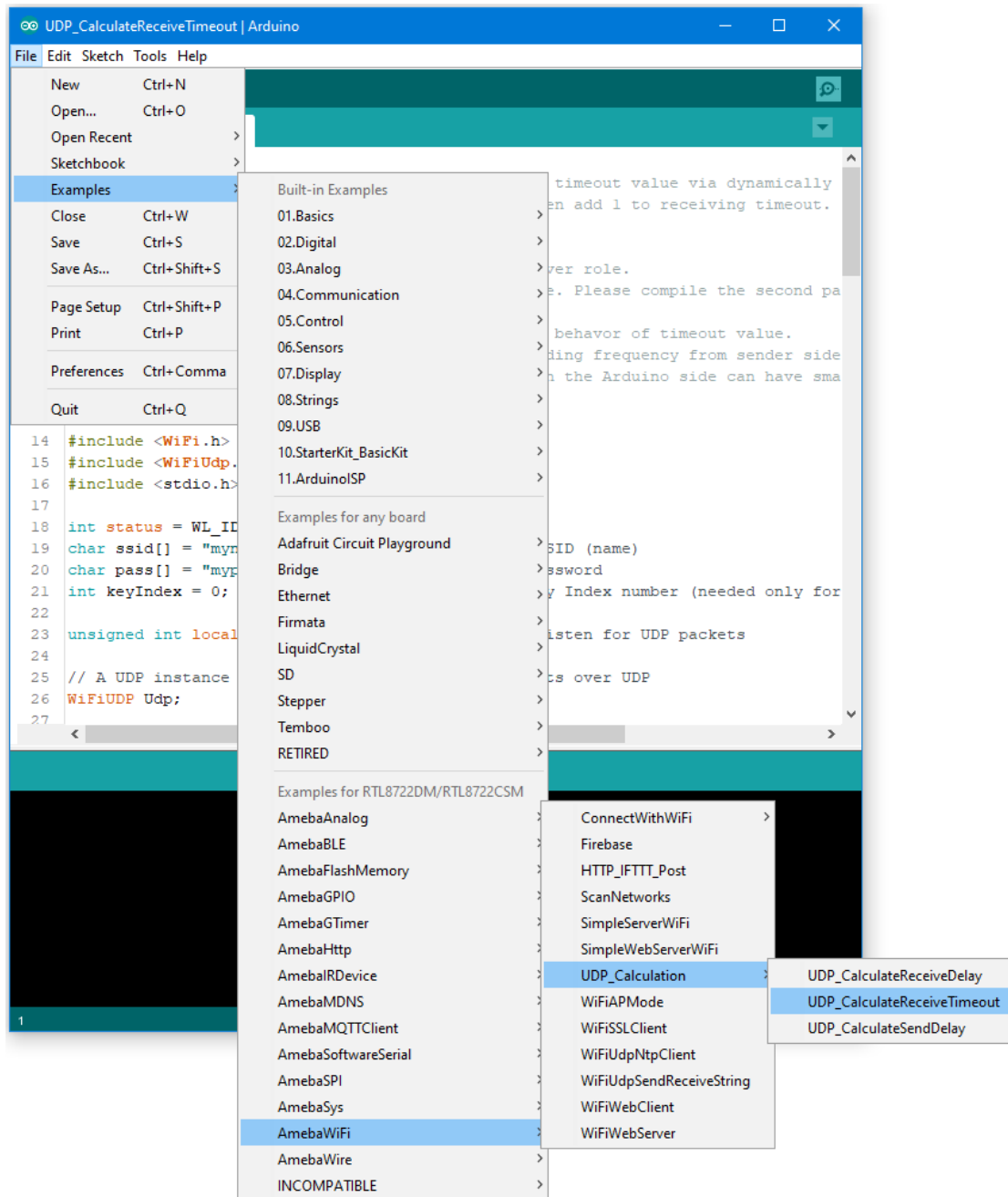
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

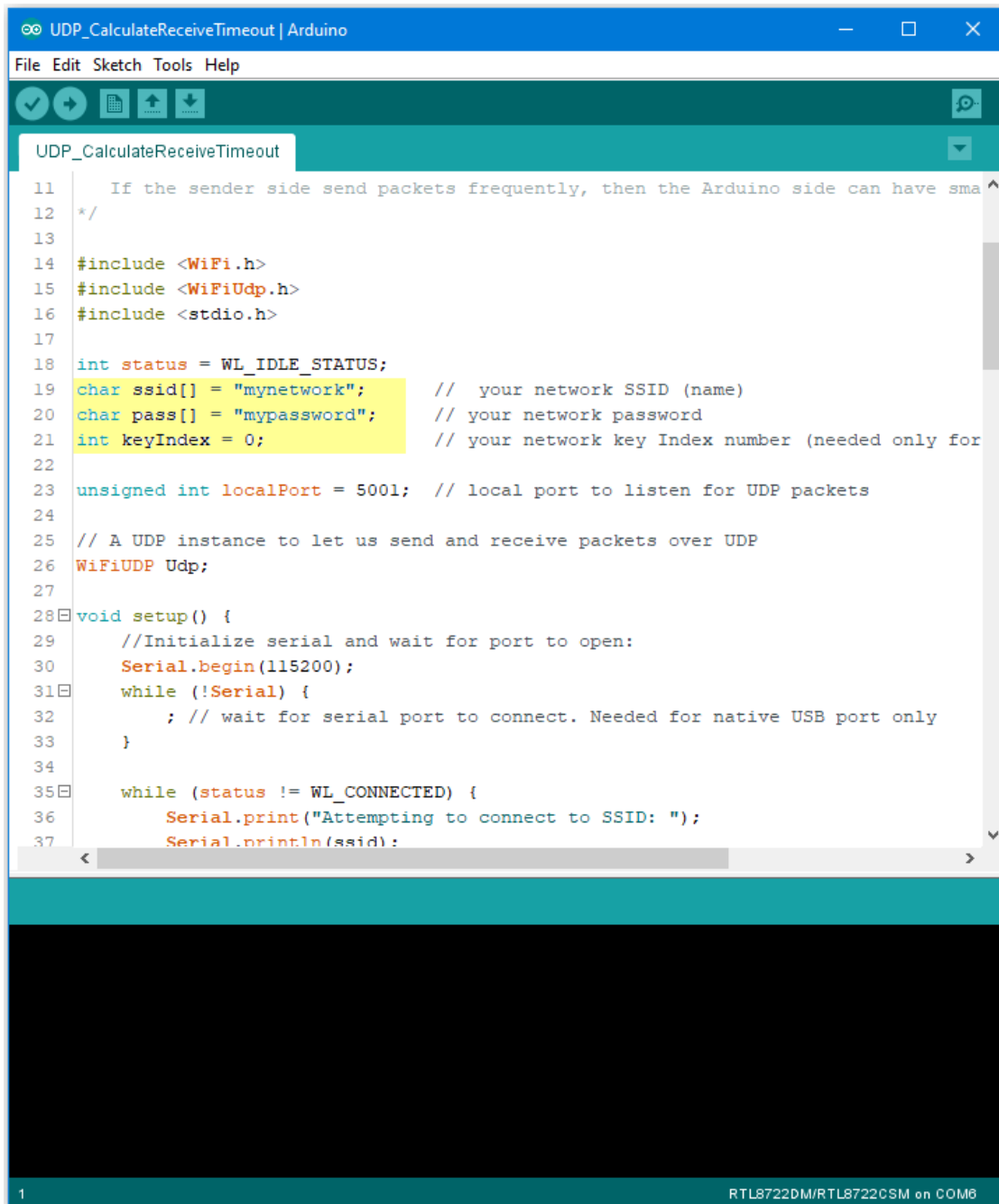
This example uses Ameba to receive UDP packets from a computer and calculates the allowed UDP receive timeout setting.

### Ameba Preparation

Open the “CalculateUdpReceiveTimeout” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation ” -> “CalculateUdpReceiveTimeout” .



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.



```

UDP_CalculateReceiveTimeout | Arduino
File Edit Sketch Tools Help

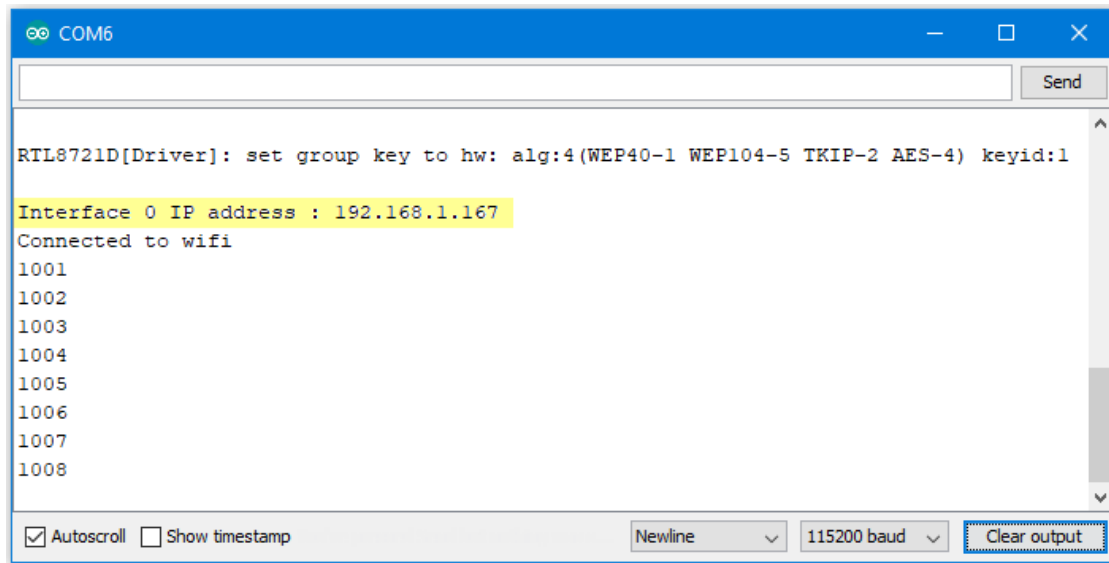
UDP_CalculateReceiveTimeout

11   If the sender side send packets frequently, then the Arduino side can have sma
12   */
13
14   #include <WiFi.h>
15   #include <WiFiUdp.h>
16   #include <stdio.h>
17
18   int status = WL_IDLE_STATUS;
19   char ssid[] = "mynetwork"; // your network SSID (name)
20   char pass[] = "mypassword"; // your network password
21   int keyIndex = 0; // your network key Index number (needed only for
22
23   unsigned int localPort = 5001; // local port to listen for UDP packets
24
25   // A UDP instance to let us send and receive packets over UDP
26   WiFiUDP Udp;
27
28   void setup() {
29       //Initialize serial and wait for port to open:
30       Serial.begin(115200);
31       while (!Serial) {
32           ; // wait for serial port to connect. Needed for native USB port only
33       }
34
35       while (status != WL_CONNECTED) {
36           Serial.print("Attempting to connect to SSID: ");
37           Serial.println(ssid);

```

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in Arduino IDE and take note of the IP address assigned to Ameba.



The screenshot shows a terminal window titled "COM6" with a blue header bar. The output text is as follows:

```
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1  
Interface 0 IP address : 192.168.1.167  
Connected to wifi  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008
```

The line "Interface 0 IP address : 192.168.1.167" is highlighted in yellow. At the top right of the window is a "Send" button. At the bottom, there are checkboxes for "Autoscroll" (checked) and "Show timestamp" (unchecked), followed by a "Newline" dropdown menu, a "115200 baud" dropdown menu, and a "Clear output" button.

## Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpReceiveTimeout” Arduino example, copy the code from the bottom between “#if 0” and “#endif” , into a new text file, change the hostname to the IP address assigned to Ameba, and rename the file to “UdpReceiveTimeout.cpp” .



```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <netinet/in.h>
6  #include <arpa/inet.h>
7  #include <unistd.h>
8
9  #define BUFSIZE 16
10
11 char *hostname = "192.168.1.213";
12 int portno = 5001;
13
14 int main(int argc, char **argv) {
15     int sockfd, n;
16     struct sockaddr_in serveraddr;
17     int serverlen = sizeof(serveraddr);
18     char buf[BUFSIZE];
19     int counter = 0;
20
21     /* socket: create the socket */
22     sockfd = socket(AF_INET, SOCK_DGRAM, 0);
23     if (sockfd < 0) {
24         printf("ERROR opening socket\r\n");
25         return -1;
26     }
27
28     /* build the server's Internet address */
29     memset(&serveraddr, 0, sizeof(serveraddr));
30     serveraddr.sin_family = AF_INET;
31     serveraddr.sin_addr.s_addr = inet_addr(hostname);
32     serveraddr.sin_port = htons(portno);

```

length: 1,246 lines: 49 Ln: 11 Col: 5 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpReceiveTimeout.cpp”, and use the command “g++ UdpReceiveTimeout.cpp -o UdpTimeout” to compile the code. A file named “UdpTimeout.exe” will be created in the same directory.

### Running the Example

Reset the Ameba, wait for the WiFi to connect, and check that the IP address remains the same. On the computer, run the UdpTimeout.exe file, and the computer will begin to send packets continuously to Ameba.

The timeout value is set to 1000ms initially. For each packet received successfully, Ameba decreases the timeout value. The next packet must be received within the timeout period, otherwise Ameba registers a failed packet and increases the timeout value. Open the serial monitor and observe the timeout value converge to a minimum value.

## WiFi - Connect to WiFi networks

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Procedure

There three common encryption type in WiFi connection. The first one is “OPEN” , which means there is no password needed to connect to this network. The second type of encryption is WPA, which requires the correct password to access. The third type is WEP, which requires a hexadecimal password and a keyindex.

In the following, we will give a brief introduction on how to establish WiFi connection with these three types of encryption on Ameba.

First, make sure the correct Ameba development board is selected in “Tools” -> “Board” .

- Open (WiFi connection without password)

Open the “ConnectNoEncryption” example in “File” -> “Examples” -> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectNoEncryption”



```

1  /*
2
3  This example connects to an unencrypted Wifi network.
4  Then it prints the MAC address of the Wifi shield,
5  the IP address obtained, and other network details.
6
7  Circuit:
8  * Wifi shield attached
9
10 created 13 July 2010
11 by dlf (Metodo2 srl)
12 modified 31 May 2012
13 by Tom Igoe
14 */
15 #include <WiFi.h>
16
17 char ssid[] = "yourNetwork"; // the name of your network
18 int status = WL_IDLE_STATUS; // the Wifi radio's status
19
20 void setup() {
21   //Initialize serial and wait for port to open:
22   Serial.begin(115200);
23   while (!Serial) {
24     ; // wait for serial port to connect. Needed for native USB port only
25   }
26
27   // check for the presence of the shield:

```

In the sample code, modify “ssid” to be the same as the WiFi SSID to be connected to.

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’re connected to the networkSSID: XXXXX”, and the information of this WiFi connection is printed in the serial monitor every 10 seconds.

```

COM6
Interface 0 IP address : 192.168.43.32
You're connected to the networkSSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-55
Encryption Type:0
IP Address: 192.168.43.32
192.168.43.32
MAC address: 70:1D:8:4:55:32
NetMask: 255.255.255.0
Gateway: 192.168.43.235
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-55
Encryption Type:0
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-58
Encryption Type:0
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-57
Encryption Type:0

```

- WiFi connection with WPA encryption

Open the “ConnectWithWPA” example in “File” -> “Examples” -> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectWithWPA”

```

ConnectWithWPA | Arduino
File Edit Sketch Tools Help
ConnectWithWPA
1 /*
2
3 This example connects to an unencrypted Wifi network.
4 Then it prints the MAC address of the Wifi shield,
5 the IP address obtained, and other network details.
6
7 Circuit:
8 * Wifi shield attached
9
10 created 13 July 2010
11 by dlf (Metodo2 srl)
12 modified 31 May 2012
13 by Tom Igoe
14 */
15 #include <WiFi.h>
16
17 char ssid[] = "yourNetwork"; // your network SSID (name)
18 char pass[] = "secretPassword"; // your network password
19 int status = WL_IDLE_STATUS; // the Wifi radio's status
20
21 void setup() {
22 //Initialize serial and wait for port to open:
23 Serial.begin(115200);
24 while (!Serial) {
25 ; // wait for serial port to connect. Needed for native USB port only
26 }
27
28 // ...
29 }
30

```

In the sample code, modify “ssid” to the WiFi SSID to be connected to and “pass” to the network password.

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’ re connected to the networkSSID: XXXXX” , and the information of this WiFi connection is printed in the serial monitor every 10 seconds.

- WiFi connection with WEP encryption

Open the “ConnectWithWEP” example in “File” -> “Examples”  
-> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectWithWEP”

```
1  ConnectWithWEP | Arduino
File Edit Sketch Tools Help

[Icons]

ConnectWithWEP

16
17 Circuit:
18 * WiFi shield attached
19
20 created 13 July 2010
21 by dlf (Metodo2 srl)
22 modified 31 May 2012
23 by Tom Igoe
24 */
25 #include <WiFi.h>
26
27 char ssid[] = "yourNetwork";           // your network SSID (name)
28 char key[] = "D0D0DEADF00DABBADEAFBEADED"; // your network key
29 int keyIndex = 0;                       // your network key Index number
30 int status = WL_IDLE_STATUS;           // the Wifi radio's status
31
32 void setup() {
33   //Initialize serial and wait for port to open:
34   Serial.begin(115200);
35   while (!Serial) {
36     ; // wait for serial port to connect. Needed for native USB port only
37   }
38
39   // check for the presence of the shield:
40   if (WiFi.status() == WL_NO_SHIELD) {
41     Serial.println("WiFi shield not present");
42     // don't continue:
43   }
44 }
```

In the sample code, modify “ssid” to the SSID to be connected, “key” to the hexadecimal password, “keyIndex” to your key index number.

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’re connected to the networkSSID: XXXXX” , and the information of this WiFi connection is printed in the IDE every 10 seconds.

## Code Reference

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.encryptionType()` to get the encryption type of the WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiEncryptionType>

Use `WiFi.BSSID()` to get the MAC address of the router you are connected to.

<https://www.arduino.cc/en/Reference/WiFiBSSID>

To get the information of Ameba:

Use `WiFi.macAddress()` to get the MAC address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiMACAddress>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFi.subnetMask()` to get the subnet mask.

<https://www.arduino.cc/en/Reference/WiFiSubnetMask>

Use `WiFi.gatewayIP()` to get the WiFi shield's gateway IP address.

<https://www.arduino.cc/en/Reference/WiFiGatewayIP>

## Comparison with Arduino

In the Arduino platform, we need to add an extra WiFi shield to be the WiFi module to realize the WiFi connection.

And we must `#include` to use SPI to communicate with WiFi module.

However, Ameba is already equipped with WiFi module. Therefore, `#include` is not needed.

## WiFi - Retrieve Universal Time (UTC) by UDP

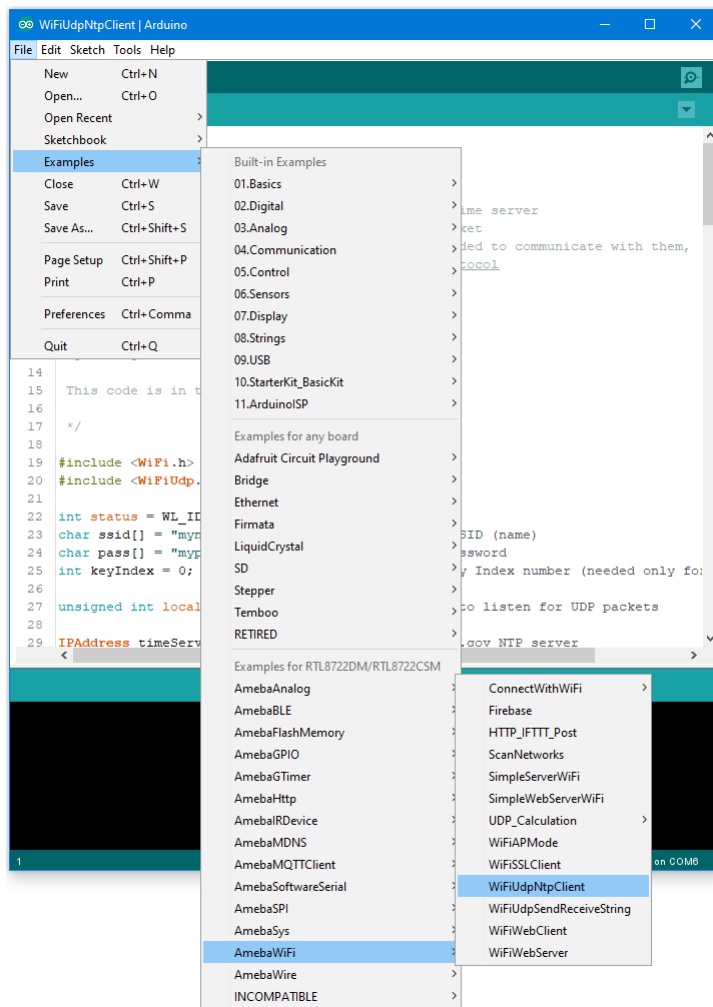
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we connect Ameba to WiFi. Then send NTP (Network Time Protocol, RFC 1305) request to NTP server using UDP. After receiving the NTP request, the NTP server replies current UTC (Coordinated Universal Time) packet. We will parse the UTC packet to show current UTC time in the serial monitor.

Open the example: “File” -> “Examples” -> “AmebaWiFi” -> “WiFiUdpNtpClient”



Modify the highlighted code section (`ssid`, `password`, `keyindex`) to connect to your WiFi network.

```

11  by Michael Margolis
12  modified 9 Apr 2012
13  by Tom Igoe
14
15  This code is in the public domain.
16
17  */
18
19  #include <WiFi.h>
20  #include <WiFiUdp.h>
21
22  int status = WL_IDLE_STATUS;
23  char ssid[] = "mynetwork"; // your network SSID (name)
24  char pass[] = "mypassword"; // your network password
25  int keyIndex = 0; // your network key Index number (needed only for
26
27  unsigned int localPort = 2390; // local port to listen for UDP packets
28
29  IPAddress timeServer(129, 6, 15, 28); // time.nist.gov NTP server
30
31  const int NTP_PACKET_SIZE = 48; // NTP time stamp is in the first 48 bytes of the
32
33  byte packetBuffer[ NTP_PACKET_SIZE]; //buffer to hold incoming and outgoing packets
34
35  // A UDP instance to let us send and receive packets over UDP
36  WiFiUDP Udp;
37
38  void setup() {
39    // Open serial communications and wait for port to open:

```

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi and sends NTP request packet to NTP server “129.6.15.28” .

We parse the replied packet and show UTC time in serial monitor:

```

Interface 0 IP address : 192.168.1.167Connected to wifi
IP Address: 192.168.1.167
signal strength (RSSI):-80 dBm

Starting connection to server...
1
packet received
Seconds since Jan 1 1900 = 3798154620
Unix time = 1589165820
The UTC time is 2:57:00
1
packet received
Seconds since Jan 1 1900 = 3798154631
Unix time = 1589165831
The UTC time is 2:57:11
1

```

## WiFi - Scan the surrounding WiFi networks

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Antenna x 1
- AmebaD `[[:raw-html:<p style=」 color:#1A76B4;」 >AMB21(RTL8722DM/CSM)</p>‘ / AMB23(RTL8722DM_MINI) / BW16(RTL8729DN)] x 1`

### Example

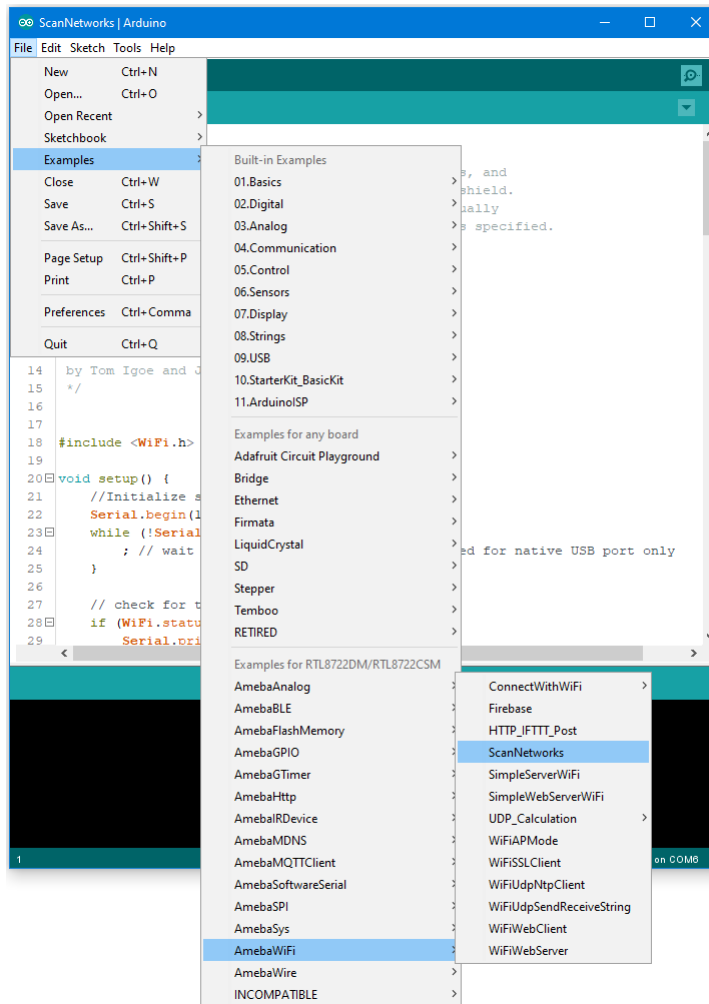
In this example, we use Ameba to scan available WiFi hotspots in the surroundings, and prints the SSID, encryption type, signal strength information of each detected hotspot.

First, make sure the correct Ameba development board is selected in Arduino IDE: “Tools” -> “Board”

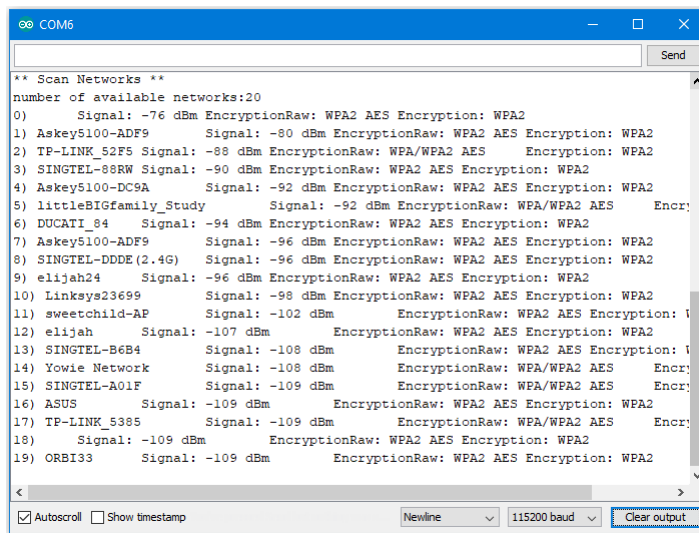
Open the “ScanNetworks” example in “File” -> “Examples” -> “AmebaWiFi” ->

“ScanNetworks” :





Then upload the sample code and press the reset button on Ameba. Afterwards, you can see “\*\*Scan Networks\*\*” message appears, with the detected WiFi hotspots and the information of each hotspot.



## Code Reference

- First we use `WiFi.macAddress(mac)` to get the MAC address of Ameba: <https://www.arduino.cc/en/Reference/WiFiMACAddress>
- Then we use `WiFi.scanNetworks()` to detect WiFi hotspots: <https://www.arduino.cc/en/Reference/WiFiScanNetworks>
- To get information of detected WiFi hotspot: We use `WiFi.SSID(thisNet)` to retrieve SSID of a network: <https://www.arduino.cc/en/Reference/WiFiSSID> We use `WiFi.RSSI(thisNet)` to get the signal strength of the connection to the router: <https://www.arduino.cc/en/Reference/WiFiRSSI>
- We use `WiFi.encryptionType(thisNet)` to get the encryption type of the network: <https://www.arduino.cc/en/Reference/WiFiEncryptionType>

## Comparison with Arduino

In the Arduino platform, we need to add an extra WiFi shield to be the WiFi module to realize the WiFi connection. And we must `#include` to use SPI to communicate with WiFi module.

However, Ameba is already equipped with WiFi module. Therefore, `#include` is not needed.

## WiFi - Set up Server to communicate

### Materials

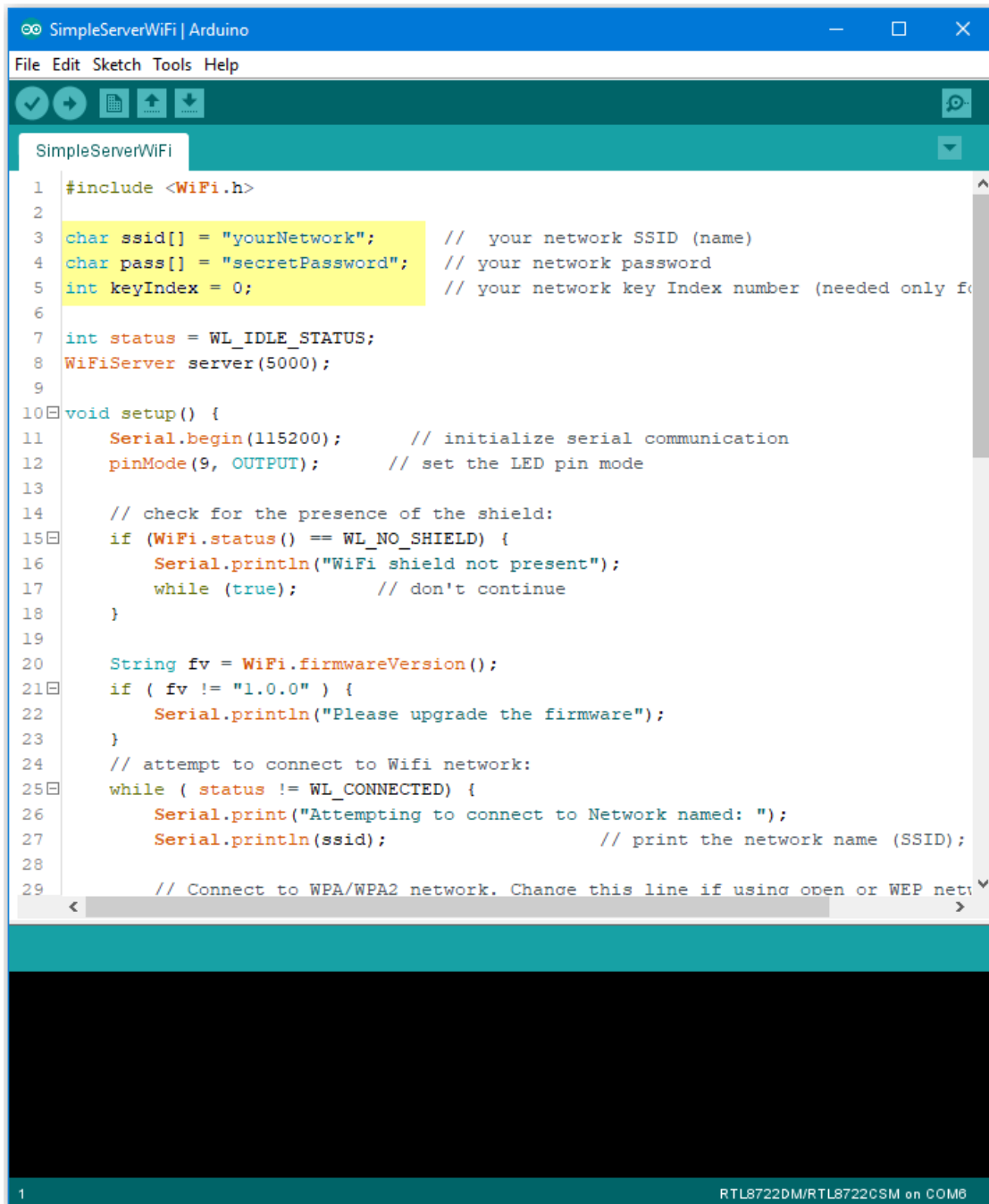
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Laptop (Make sure it is connected to the same network domain as Ameba, and tcp tools are installed.)

### Example

In this example, we first connect Ameba to WiFi, then we use Ameba as server to communicate with client.

First, we make sure the correct Ameba development board is set in “Tools” -> “Board”

Then, open the Simple WiFi Server example in “File” -> “Examples” -> “AmebaWiFi” -> “SimpleServerWiFi”

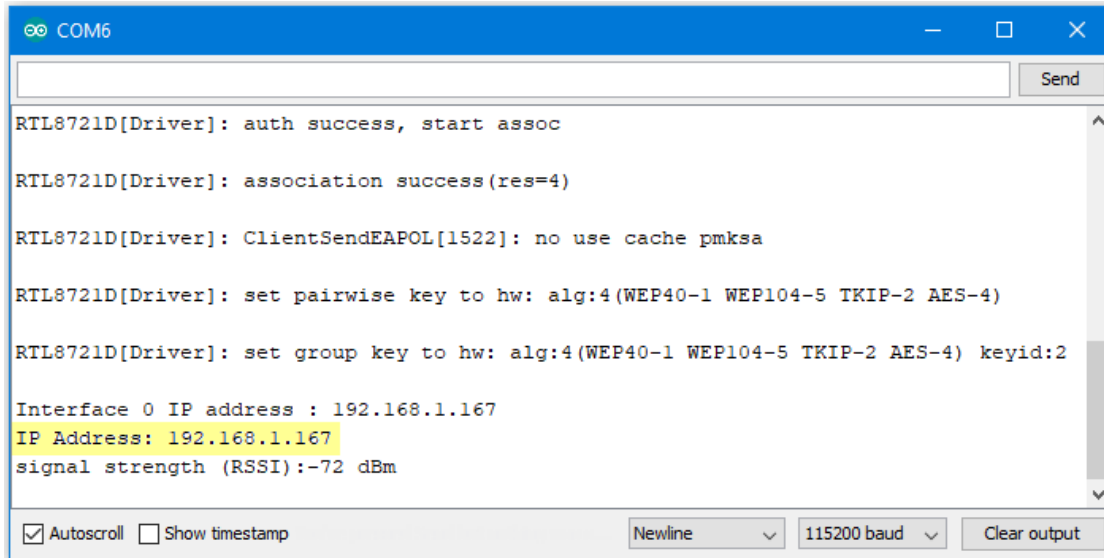


```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; // your network SSID (name)
4 char pass[] = "secretPassword"; // your network password
5 int keyIndex = 0; // your network key Index number (needed only for WEP)
6
7 int status = WL_IDLE_STATUS;
8 WiFiServer server(5000);
9
10 void setup() {
11     Serial.begin(115200); // initialize serial communication
12     pinMode(9, OUTPUT); // set the LED pin mode
13
14     // check for the presence of the shield:
15     if (WiFi.status() == WL_NO_SHIELD) {
16         Serial.println("WiFi shield not present");
17         while (true); // don't continue
18     }
19
20     String fv = WiFi.firmwareVersion();
21     if ( fv != "1.0.0" ) {
22         Serial.println("Please upgrade the firmware");
23     }
24     // attempt to connect to Wifi network:
25     while ( status != WL_CONNECTED) {
26         Serial.print("Attempting to connect to Network named: ");
27         Serial.println(ssid); // print the network name (SSID);
28
29         // Connect to WPA/WPA2 network. Change this line if using open or WEP network

```

In the sample code, modify the highlighted parameters and enter the ssid and password for your WiFi connection.



```

COM6
Send

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

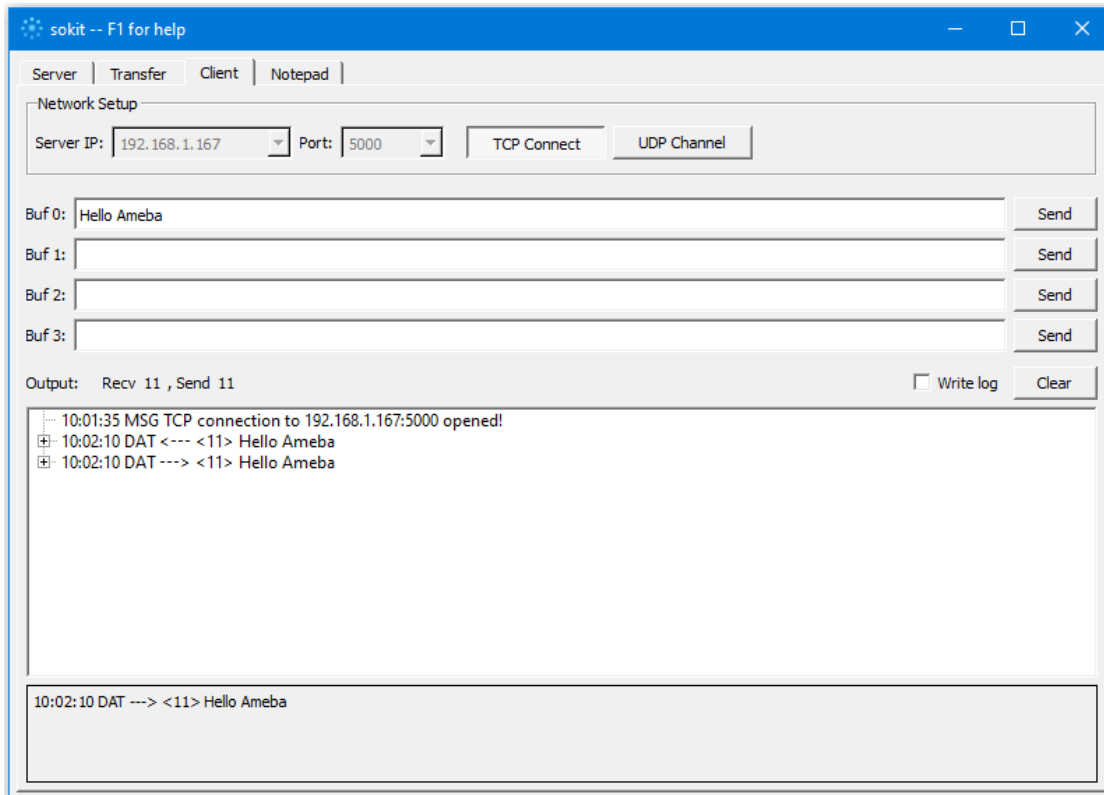
Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-72 dBm

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

Next, upload the code, then press the reset button on Ameba. At this moment, you will see the connection information is displayed in the console.

Next, we use the socket tool in the laptop to be the client and connect to the IP address of the Ameba board shown in the connection information at port 5000. (Note: The socket tool we used in this example is “sokit” )



```

sokit -- F1 for help
Server | Transfer | Client | Notepad |
Network Setup
Server IP: 192.168.1.167 Port: 5000 TCP Connect UDP Channel
Buf 0: Hello Ameba Send
Buf 1: Send
Buf 2: Send
Buf 3: Send
Output: Recv 11 , Send 11 Write log Clear
10:01:35 MSG TCP connection to 192.168.1.167:5000 opened!
10:02:10 DAT <--- <11> Hello Ameba
10:02:10 DAT ---> <11> Hello Ameba
10:02:10 DAT ---> <11> Hello Ameba

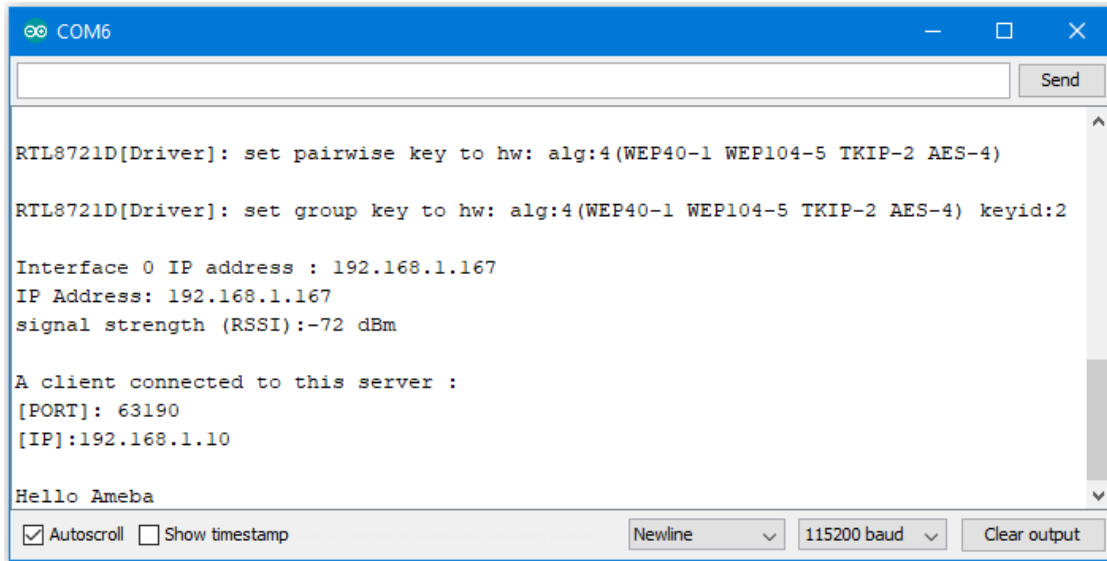
```

Click on the “Client” tab to choose the client mode, specify the IP and port of the server, then click “TCP Connect” .

If the connection is established successfully, the server shows a message: “A client connected to this Server” , and the

IP and port of the connected client.

In this example, when the client and server are connected and the client sends a string to Ameba server, the Ameba server returns the identical string back to the client.



```

COM6

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-72 dBm

A client connected to this server :
[PORT]: 63190
[IP]:192.168.1.10

Hello Ameba
  
```

The string sent to server is returned and showed at the client side.

## Code Reference

Use `WiFi.begin()` to establish WiFi connection;

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the Ameba WiFi shield's IP address.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Create server and transmitting data:

Use `Server(port)` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.read()` to read the next byte received from the server.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.write()` to write data to the server.

<https://www.arduino.cc/en/Reference/WiFiClientWrite>

Use `client.stop()` to disconnect from the server.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

## WiFi - Set up Client to Retrieve Google Search Information

### Materials

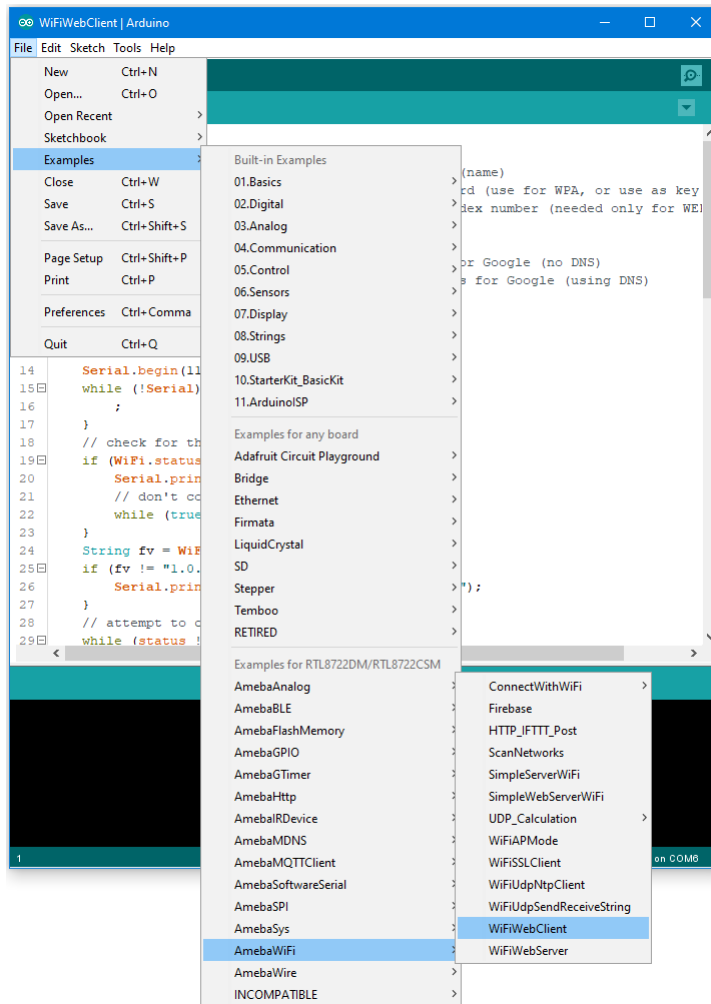
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

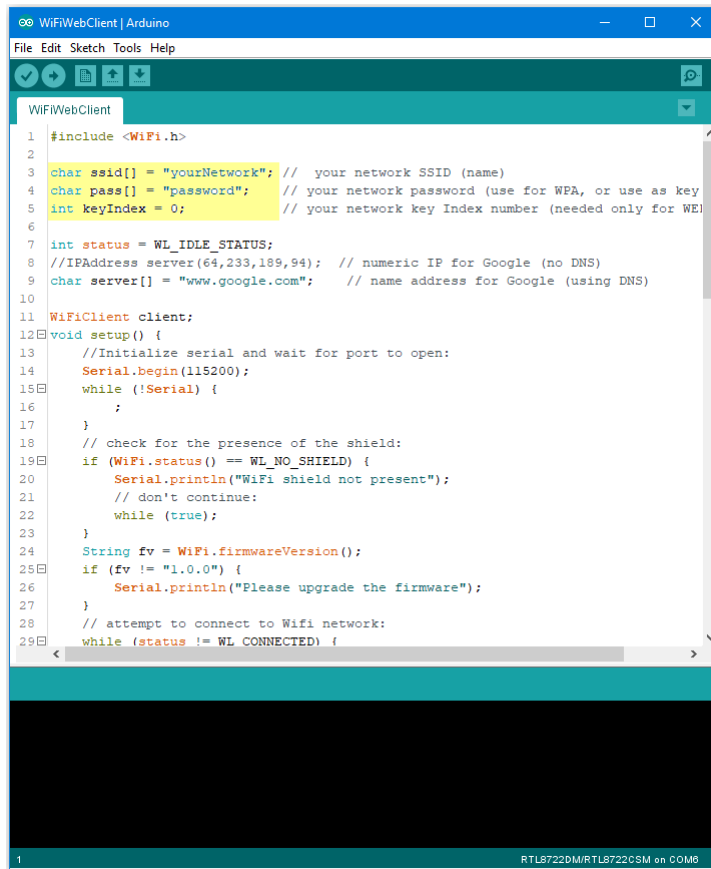
In this example, we use Ameba to be a web client to retrieve information from the Internet.

First, make sure the correct Ameba development board is selected in “Tools” -> “Board”

Then open “File” -> “Examples” -> “AmebaWiFi” -> “WiFiWebClient”



In the sample code, modify the highlighted snippet and enter the required information (ssid, password, key index) required to connect to your WiFi network.

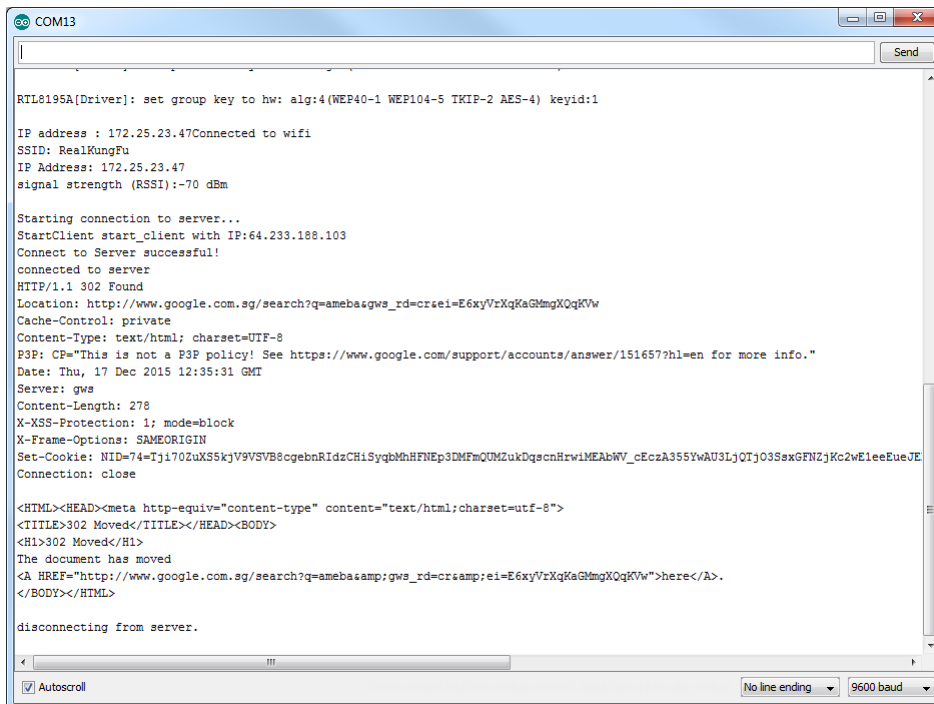


```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; // your network SSID (name)
4 char pass[] = "password"; // your network password (use for WPA, or use as key
5 int keyIndex = 0; // your network key Index number (needed only for WE
6
7 int status = WL_IDLE_STATUS;
8 //IPAddress server(64,233,189,94); // numeric IP for Google (no DNS)
9 char server[] = "www.google.com"; // name address for Google (using DNS)
10
11 WiFiClient client;
12 void setup() {
13     //Initialize serial and wait for port to open:
14     Serial.begin(115200);
15     while (!Serial) {
16         ;
17     }
18     // check for the presence of the shield:
19     if (WiFi.status() == WL_NO_SHIELD) {
20         Serial.println("WiFi shield not present");
21         // don't continue:
22         while (true);
23     }
24     String fv = WiFi.firmwareVersion();
25     if (fv != "1.0.0") {
26         Serial.println("Please upgrade the firmware");
27     }
28     // attempt to connect to Wifi network:
29     while (status != WL_CONNECTED) {

```

Upload the code and press the reset button on Ameba. Then you can see the information retrieved from Google is shown in the Arduino serial monitor.



```

RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

IP address : 172.25.23.47Connected to wifi
SSID: RealKungFu
IP Address: 172.25.23.47
signal strength (RSSI): -70 dBm

Starting connection to server...
StartClient start_client with IP:64.233.188.103
Connect to Server successful!
connected to server
HTTP/1.1 302 Found
Location: http://www.google.com.sg/search?q=amebas&gws_rd=cr&ei=E6xyVrXqKaGmngXQqKVw
Cache-Control: private
Content-Type: text/html; charset=UTF-8
P3P: CP="This is not a P3P policy! See https://www.google.com/support/accounts/answer/151657?hl=en for more info."
Date: Thu, 17 Dec 2015 12:35:31 GMT
Server: gws
Content-Length: 278
X-XSS-Protection: 1; mode=block
X-Frame-Options: SAMEORIGIN
Set-Cookie: NID=74=Tji70ZuX55kjV9VSVB8cgebnRIdzChISyqkMhHFNEp3DMFmQUMZukDqscnHrwiMEAbWV_cEcA355YwAU3LjQTjO3SsxGFNZjKc2wE1eeEueJE
Connection: close

<HTML><HEAD><meta http-equiv="content-type" content="text/html; charset=utf-8">
<TITLE>302 Moved</TITLE></HEAD><BODY>
<H1>302 Moved</H1>
The document has moved
<A HREF="http://www.google.com.sg/search?q=amebas&gws_rd=cr&ei=E6xyVrXqKaGmngXQqKVw">here</A>
</BODY></HTML>

disconnecting from server.

```



## Code Reference

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection: Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiClient()` to create a client.

<https://www.arduino.cc/en/Reference/WiFiClient>

Use `client.connect()` to connect to the IP address and port specified.

<https://www.arduino.cc/en/Reference/WiFiClientConnect>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

## WiFi - Set up UDP Server to Communicate

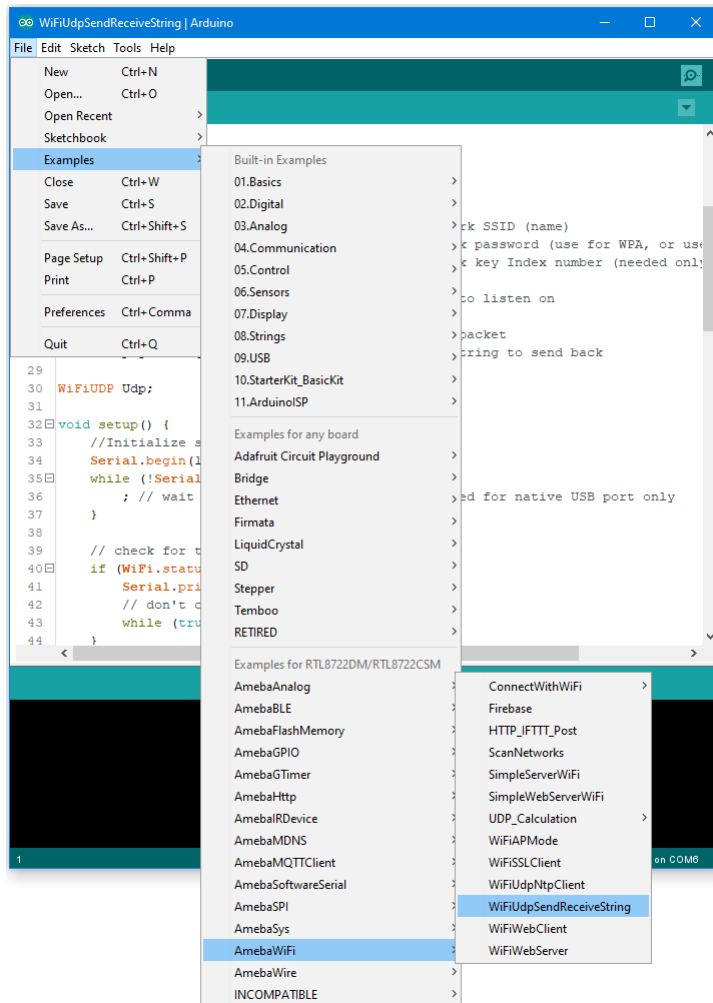
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

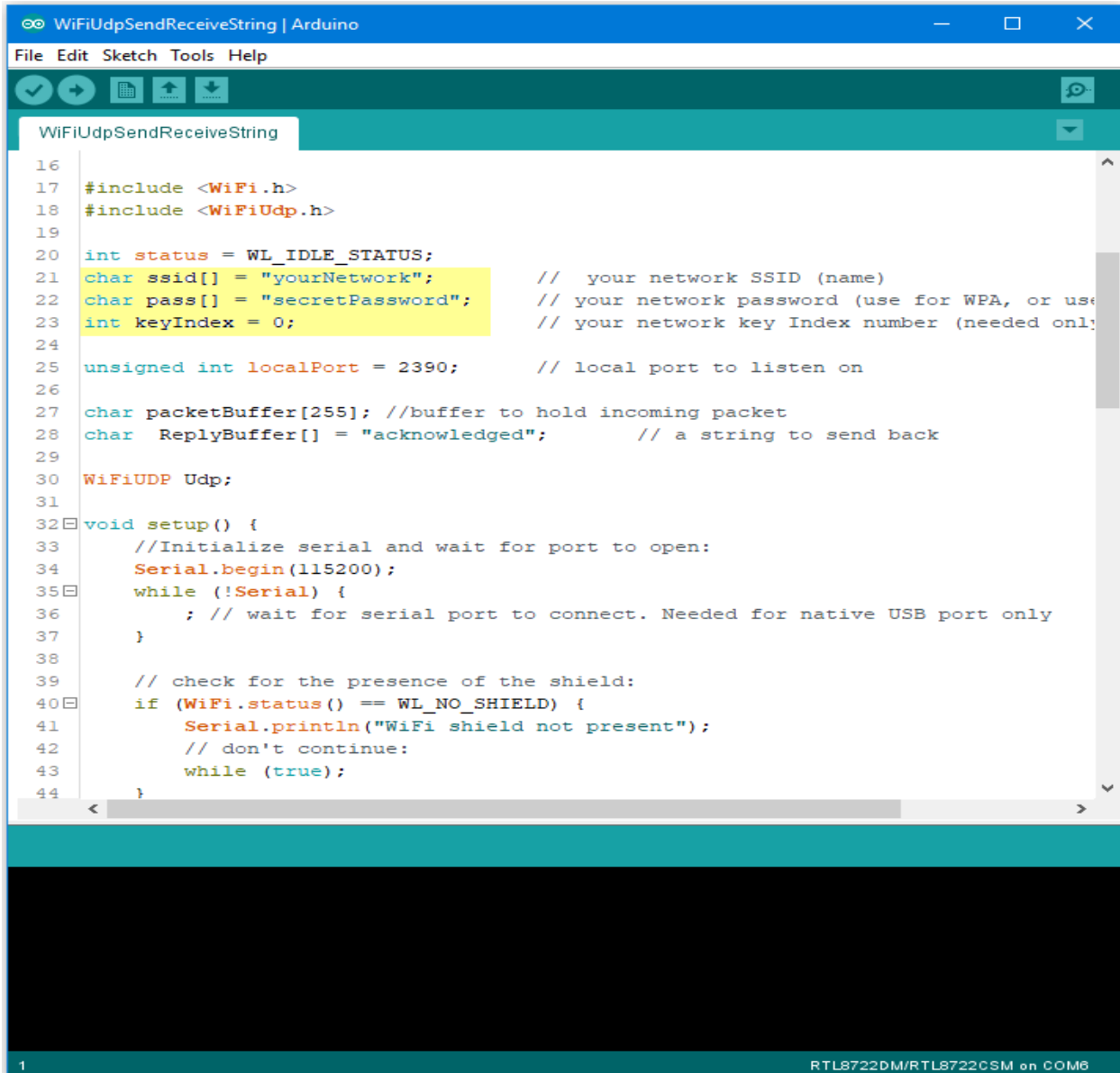
### Example

In this example, we connect Ameba to WiFi and use Ameba to be an UDP server. When Ameba receives a message from UDP client, it replies “acknowledged” message to client.

Open the WiFi Web Server example. “File” -> “Examples” -> “AmebaWiFi” -> “WiFiUdpSendReceiveString”



Modify the highlighted code section (ssid, password, keyindex) to connect to your WiFi network.



```

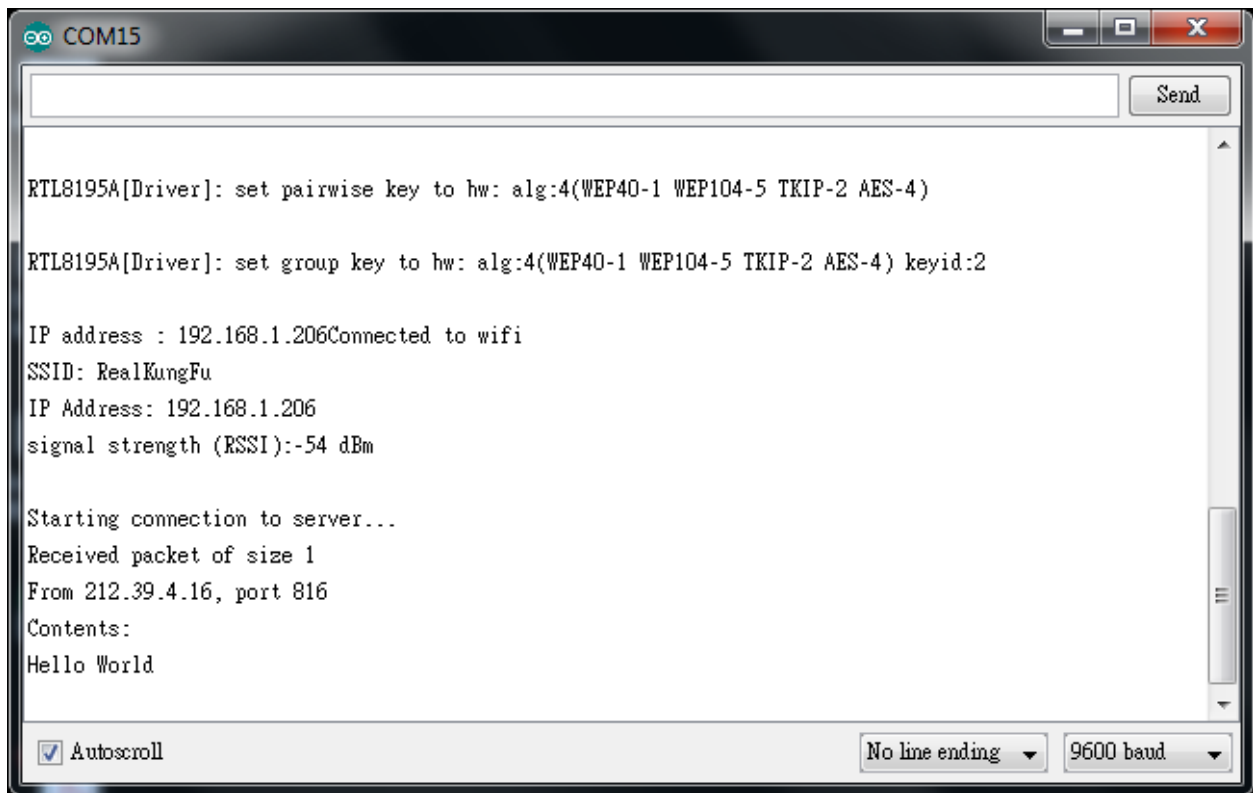
16
17 #include <WiFi.h>
18 #include <WiFiUdp.h>
19
20 int status = WL_IDLE_STATUS;
21 char ssid[] = "yourNetwork"; // your network SSID (name)
22 char pass[] = "secretPassword"; // your network password (use for WPA, or use
23 int keyIndex = 0; // your network key Index number (needed only)
24
25 unsigned int localPort = 2390; // local port to listen on
26
27 char packetBuffer[255]; //buffer to hold incoming packet
28 char ReplyBuffer[] = "acknowledged"; // a string to send back
29
30 WiFiUDP Udp;
31
32 void setup() {
33     //Initialize serial and wait for port to open:
34     Serial.begin(115200);
35     while (!Serial) {
36         ; // wait for serial port to connect. Needed for native USB port only
37     }
38
39     // check for the presence of the shield:
40     if (WiFi.status() == WL_NO_SHIELD) {
41         Serial.println("WiFi shield not present");
42         // don't continue:
43         while (true);
44     }

```

1

RTL8722DM/RTL8722CSM on COM8

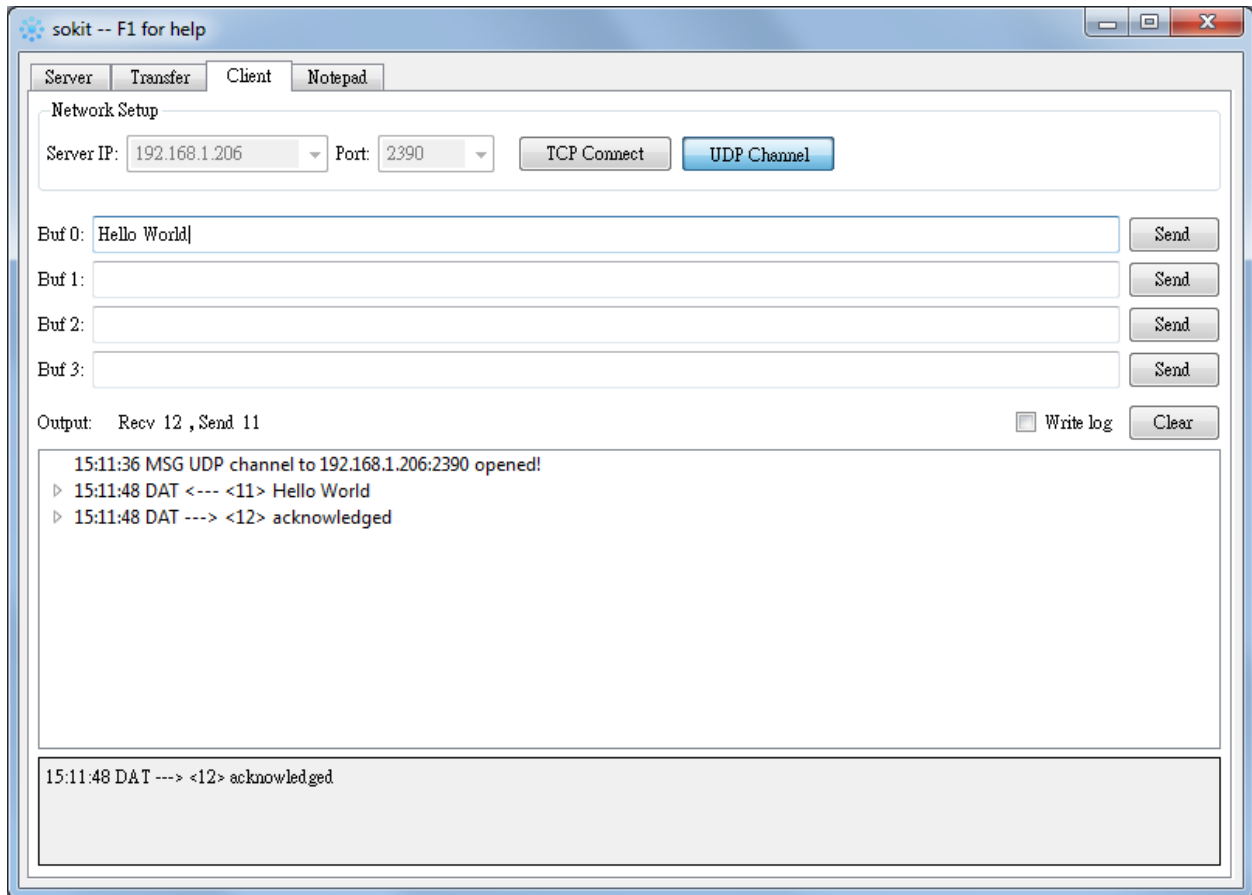
Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi and starts the UDP server with port 2390. After the UDP server starts service, Ameba prints the “Starting connection to server” message and waits for client connection.



As to the UDP client, we use “sokit” program in the computer to connect to UDP server.

Choose client mode and fill in the IP of UDP server (which is the IP of Ameba) and port 2390, then click “UDP Connect” .

After the connection is established, fill in “Hello World” in the Buf 0 field in sokit and click “Send” . Then you can see the Ameba UDP server replies “acknowledged” .



## Code Reference

Refer to the Arduino tutorial for detailed information about this example.

<https://www.arduino.cc/en/Tutorial/WiFiSendReceiveUDPString>

First, use `begin()` to open an UDP port on Ameba.

<https://www.arduino.cc/en/Reference/WiFiUDPBgin>

Use `parsePacket()` to wait for data from client.

<https://www.arduino.cc/en/Reference/WiFiUDPParsePacket>

When a connection is established, use `remoteIP()` and `remotePort()` to get the IP and port of the client.

<https://www.arduino.cc/en/Reference/WiFiUDPRemoteIP>

Then use `read()` to read the data sent by client.

<https://www.arduino.cc/en/Reference/WiFiUDPRead>

To send reply, use `beginPacket()`, `write()`, `end()`.

<https://www.arduino.cc/en/Reference/WiFiUDPBeginPacket>

<https://www.arduino.cc/en/Reference/WiFiUDPWrite>

<https://www.arduino.cc/en/Reference/WiFiUDPEndPacket>

## WiFi - Set up WiFi AP Mode

In AP mode, Ameba can accept at most 3 station connections, and can be set to open mode or WPA2 mode.

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we turn on the AP mode of Ameba and connect station to Ameba.

Open the WiFi AP example, “File” -> “Examples” -> “AmebaWiFi” -> “WiFiAPMode”

```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; //Set the AP's SSID
4 char pass[] = "Password"; //Set the AP's password
5 char channel[] = "1"; //Set the AP's channel
6 int status = WL_IDLE_STATUS; // the Wifi radio's status
7
8 void setup() {
9     //Initialize serial and wait for port to open:
10    Serial.begin(115200);
11    while (!Serial) {
12        ; // wait for serial port to connect. Needed for native USB port only
13    }
14
15    // check for the presence of the shield:
16    if (WiFi.status() == WL_NO_SHIELD) {
17        Serial.println("WiFi shield not present");
18        while (true);
19    }
20    String fw = WiFi.firmwareVersion();
21    if (fw != "1.0.0") {
22        Serial.println("Please upgrade the firmware");
23    }
24
25    // attempt to start AP:
26    while (status != WL_CONNECTED) {
27        Serial.print("Attempting to start AP with SSID: ");
28        Serial.println(ssid);
29        status = WiFi.apbegin(ssid, pass, channel);
30        delay(10000);

```

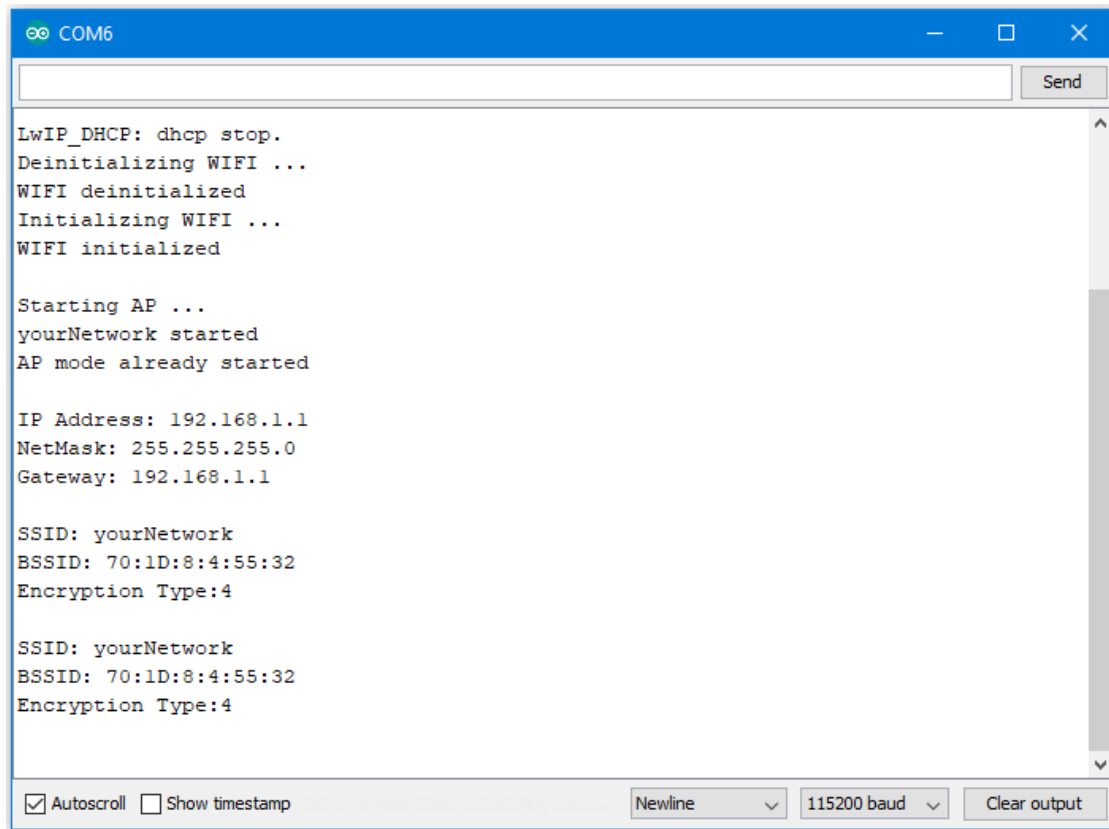
In the highlighted code snippet, fill in your SSID, PASSWORD and CHANNEL.

The code highlighted in green is the API we used to turn on the AP mode in security mode.

If you want to turn on the AP mode in open mode, please modify the code to

```
status = WiFi.apbegin(ssid, channel);
```

Then upload the sample code and press reset, and you can see related information shown in serial monitor.



The screenshot shows a serial monitor window with a blue title bar labeled 'COM6'. The window contains a text area with the following log output:

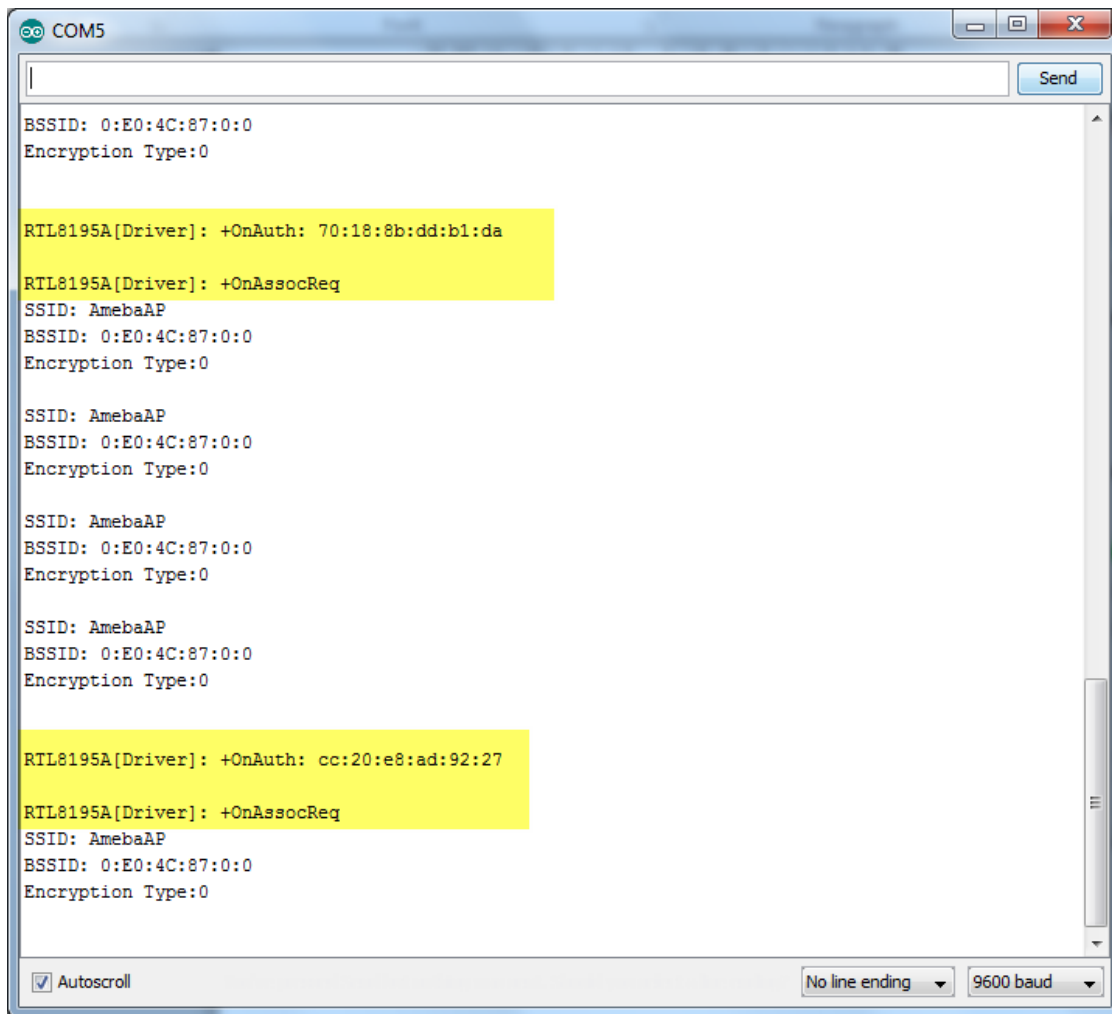
```
LwIP_DHCP: dhcp stop.  
Deinitializing WIFI ...  
WIFI deinitialized  
Initializing WIFI ...  
WIFI initialized  
  
Starting AP ...  
yourNetwork started  
AP mode already started  
  
IP Address: 192.168.1.1  
NetMask: 255.255.255.0  
Gateway: 192.168.1.1  
  
SSID: yourNetwork  
BSSID: 70:1D:8:4:55:32  
Encryption Type:4  
  
SSID: yourNetwork  
BSSID: 70:1D:8:4:55:32  
Encryption Type:4
```

At the bottom of the window, there is a control bar with the following elements from left to right:

- Two checkboxes: ☒ Autoscroll and ☐ Show timestamp.
- A dropdown menu currently set to 'Newline'.
- A dropdown menu currently set to '115200 baud'.
- A 'Clear output' button.

In the figure below, we show the messages shown in serial monitor when two stations connect to Ameba AP in open mode:





In the figure below, we show the messages shown in serial monitor when a station connects to Ameba AP in security mode:

```

COM5
Send

SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

RTL8195A[Driver]: +OnAuth: 70:18:8b:dd:b1:da
RTL8195A[Driver]: +OnAssocReq
RTL8195A[Driver]: ap mode 4-1
RTL8195A[Driver]: ap mode 4-2
RTL8195A[Driver]: ap mode 4-3
RTL8195A[Driver]: ap mode 4-4

RTL8195A[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) for 70:18:8b:dd:b1:da
RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1
SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

☒ Autoscroll
No line ending 9600 baud

```

## WiFi - Set up SSL Client for HTTPS Communication

### Materials

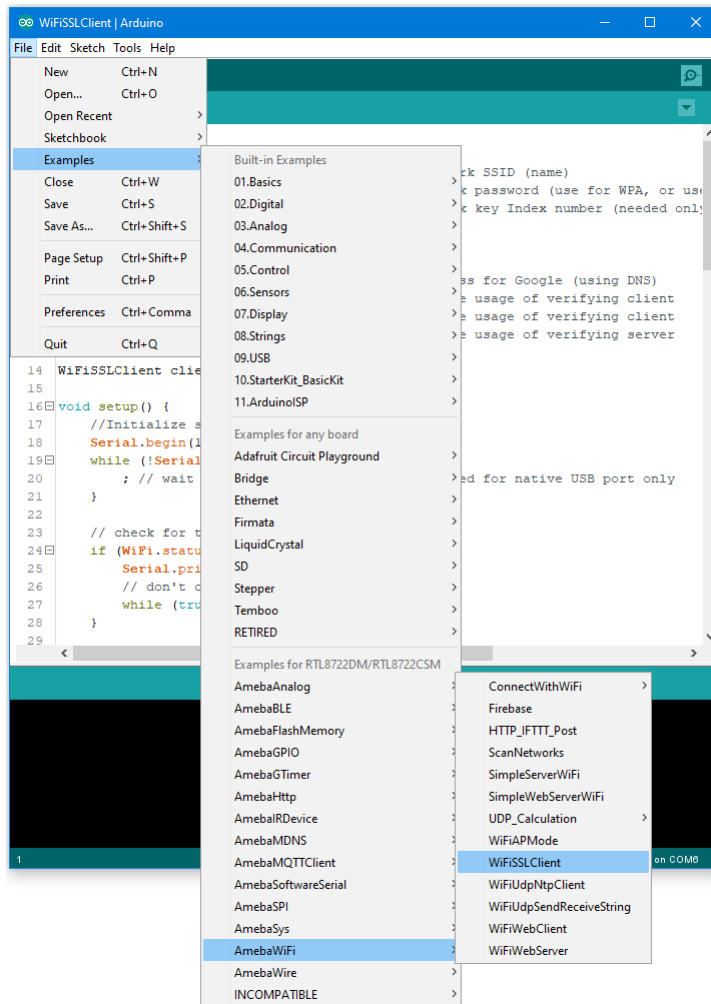
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

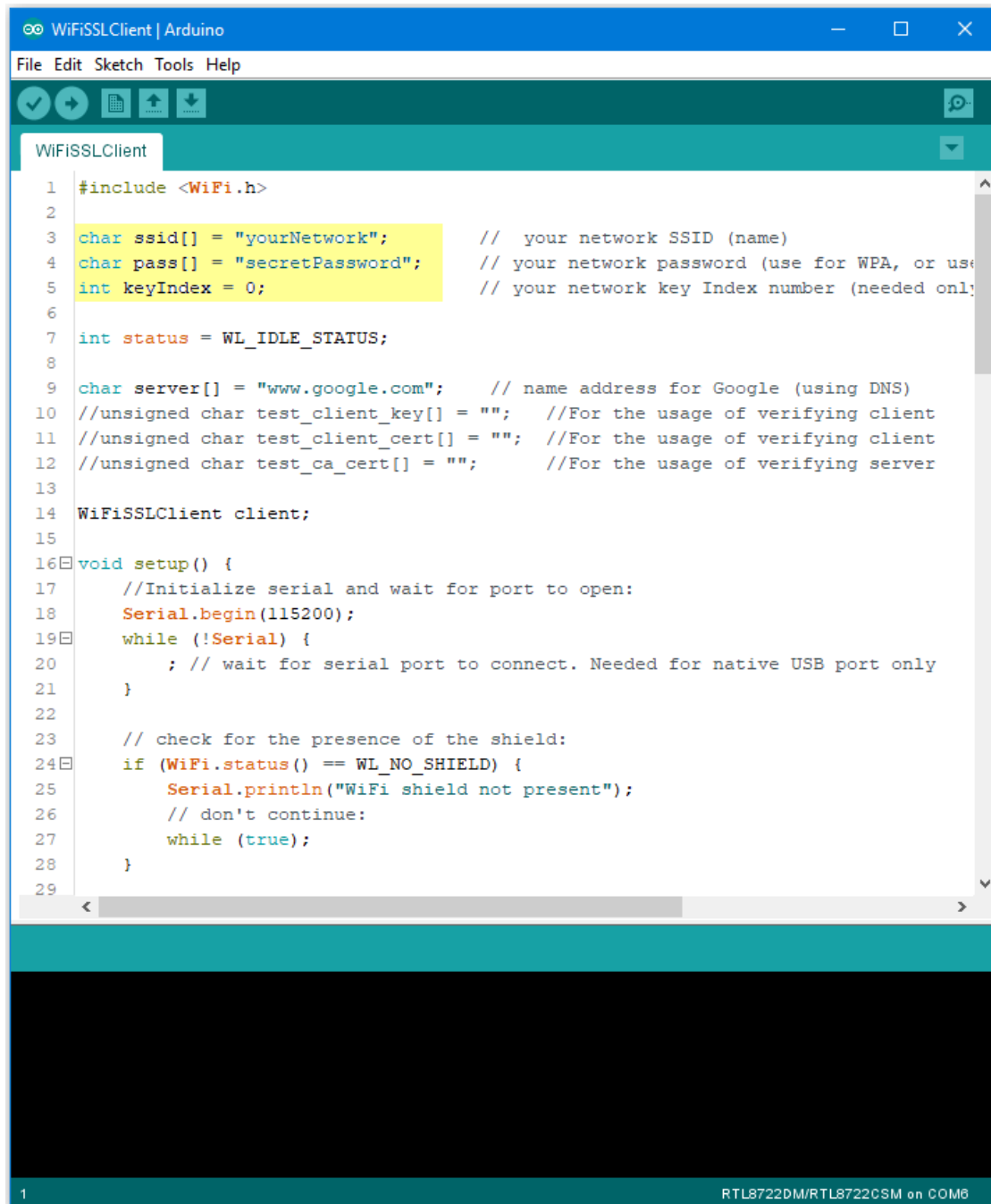
This example uses Ameba to securely retrieve information from the internet using SSL. SSL is an acronym for Secure Sockets Layer. It is a cryptographic protocol designed to provide communications security over a computer network, by encrypting the messages passed between server and client.

Open the “WiFiSSLClient” example in “File” -> “Examples” -> “AmebaWiFi” -> “WiFiSSLClient”

.



In the sample code, modify the highlighted snippet to reflect your WiFi network settings.

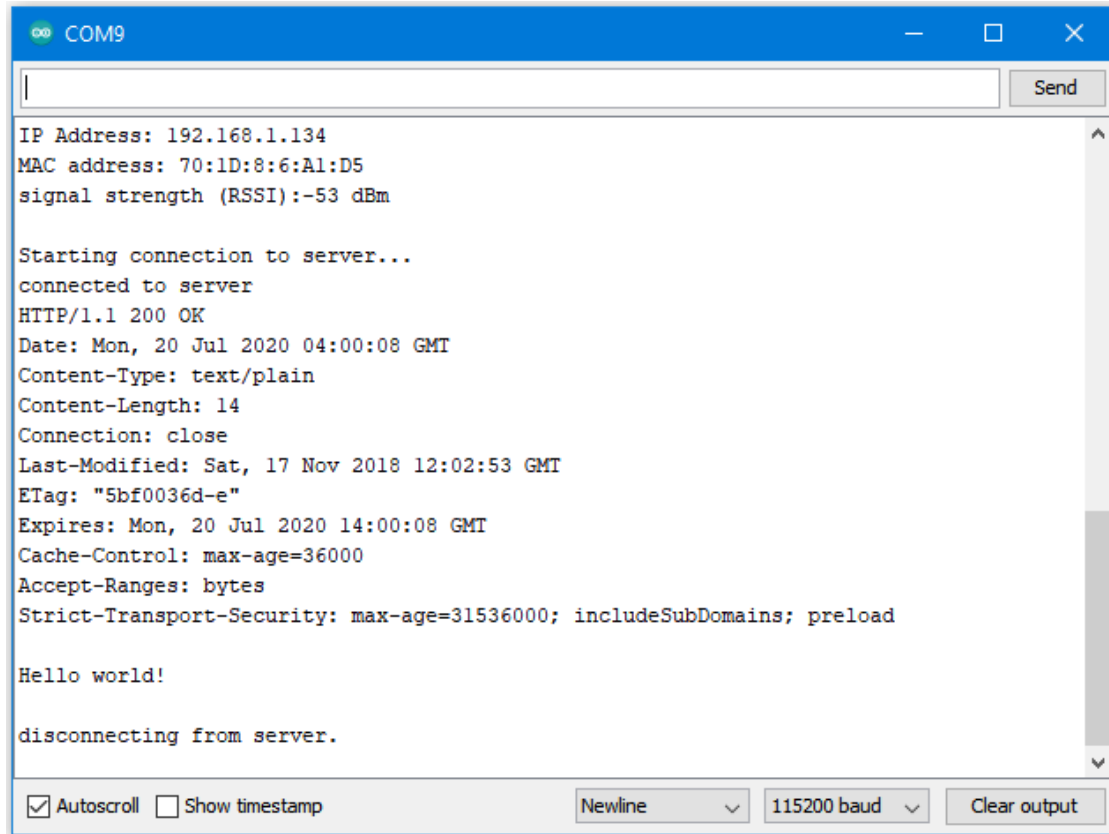


```
1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork";    // your network SSID (name)
4 char pass[] = "secretPassword"; // your network password (use for WPA, or use
5 int keyIndex = 0;               // your network key Index number (needed only)
6
7 int status = WL_IDLE_STATUS;
8
9 char server[] = "www.google.com"; // name address for Google (using DNS)
10 //unsigned char test_client_key[] = ""; //For the usage of verifying client
11 //unsigned char test_client_cert[] = ""; //For the usage of verifying client
12 //unsigned char test_ca_cert[] = ""; //For the usage of verifying server
13
14 WiFiSSLClient client;
15
16 void setup() {
17     //Initialize serial and wait for port to open:
18     Serial.begin(115200);
19     while (!Serial) {
20         ; // wait for serial port to connect. Needed for native USB port only
21     }
22
23     // check for the presence of the shield:
24     if (WiFi.status() == WL_NO_SHIELD) {
25         Serial.println("WiFi shield not present");
26         // don't continue:
27         while (true);
28     }
29 }
```

1 RTL8722DM/RTL8722CSM on COM8

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in the Arduino IDE and observe as Ameba retrieves a text file from [os.mbed.com](https://os.mbed.com).



The screenshot shows a terminal window titled "COM9" with a blue header bar. The terminal displays the following text:

```
IP Address: 192.168.1.134
MAC address: 70:1D:8:6:A1:D5
signal strength (RSSI):-53 dBm

Starting connection to server...
connected to server
HTTP/1.1 200 OK
Date: Mon, 20 Jul 2020 04:00:08 GMT
Content-Type: text/plain
Content-Length: 14
Connection: close
Last-Modified: Sat, 17 Nov 2018 12:02:53 GMT
ETag: "5bf0036d-e"
Expires: Mon, 20 Jul 2020 14:00:08 GMT
Cache-Control: max-age=36000
Accept-Ranges: bytes
Strict-Transport-Security: max-age=31536000; includeSubDomains; preload

Hello world!

disconnecting from server.
```

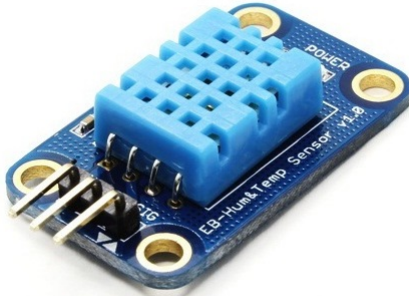

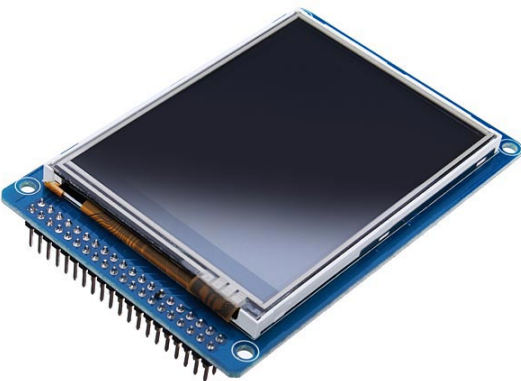


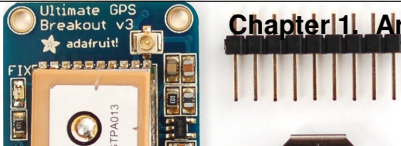
At the bottom of the window, there are controls: a checked "Autoscroll" checkbox, an unchecked "Show timestamp" checkbox, a "Newline" dropdown menu, a "115200 baud" dropdown menu, and a "Clear output" button.

## Code Reference

Use “WiFiSSLClient client;” to create a client that uses SSL. After creation, the client can be used in the same way as a regular client.

Components Used

表格 2: Components used in Examples

	
DHT11_DHT22 Humidity & temperature sensor	HC_SR04 Distance measurement function
	
ILI9341 TFT LCD TFT LCD display with SPI interface	PMS3003/5003 Air quality sensor that detects concentration of micro particulate matters
	

## Peripheral Examples

### AmebaMotors - Use Ameba as Server to Control Motors

#### Introduction to AmebaMotors

AmebaMotors is a library which provides API related to controlling motors. Please download the library: [AmebaMotors](#)  
And add the library to Ameba: <https://www.arduino.cc/en/Guide/Libraries#toc4>

#### Materials

- AmebaD [AMB21 / AMB22] x 1
- L298N H-Bridge x 1
- 4-wheel motorcar or 2-wheel motorcar+Universal wheel

#### Example

##### Procedure

In this example, we connect Ameba to WiFi and use Ameba as server, the user can control a 4-wheel/2-wheel motorcar through a webpage.

First, connect Ameba to the L298N H-Bridge and the motorcar.

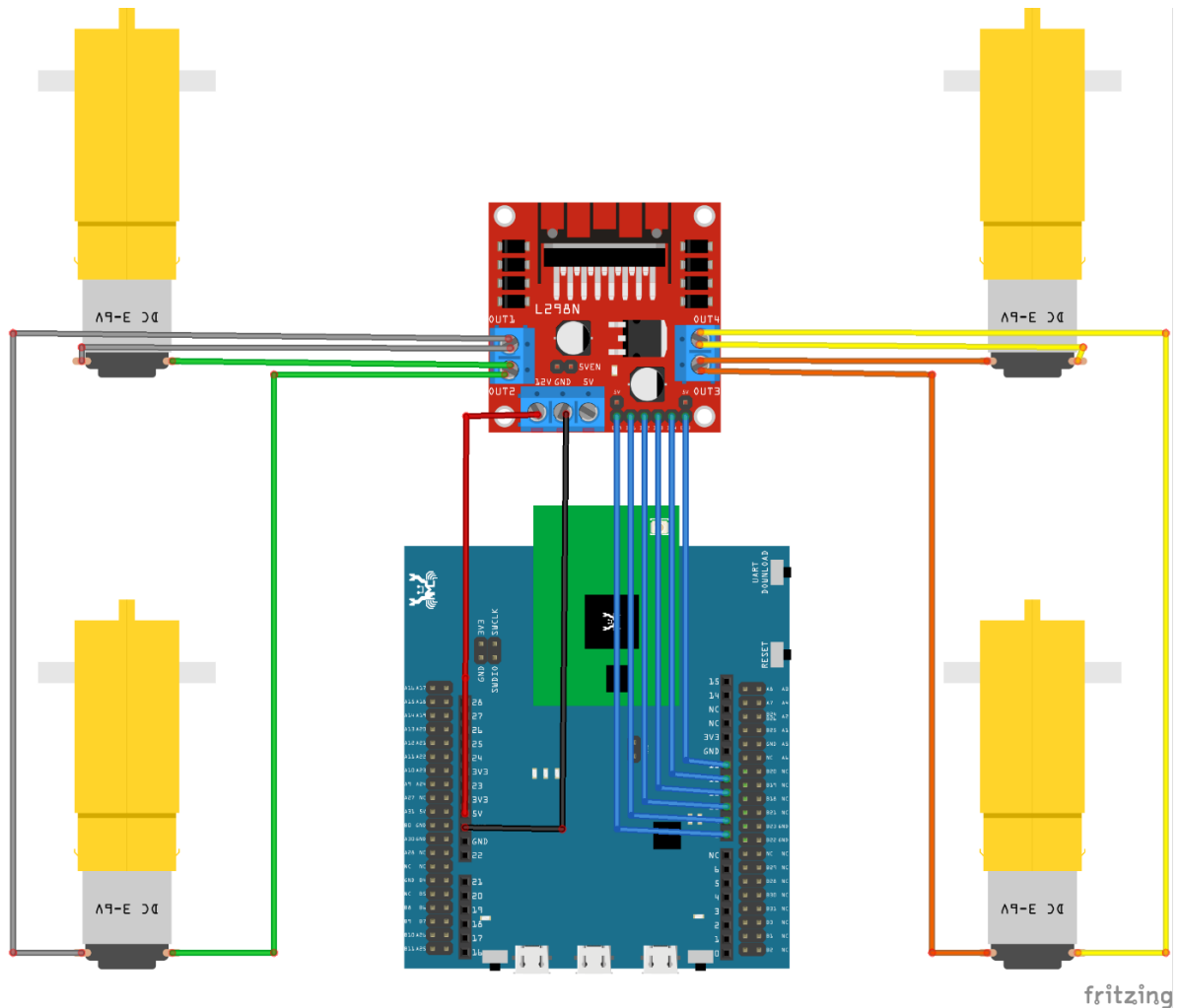
To know more about motor movement and the technical details of the L298N H-Bridge, please check out this [link](https://www.amebaiot.com/en/ameba-arduino-amebamotors-basic/) <<https://www.amebaiot.com/en/ameba-arduino-amebamotors-basic/>>.

Open the example, “Files” -> “Examples” -> “AmebaWiFi” -> “WiFiControlCar” .

You will see we use the following pins in the example:

ENA	IN1	IN2	IN3	IN4	ENB
8	9	10	11	12	13

Wiring:



## 備F:

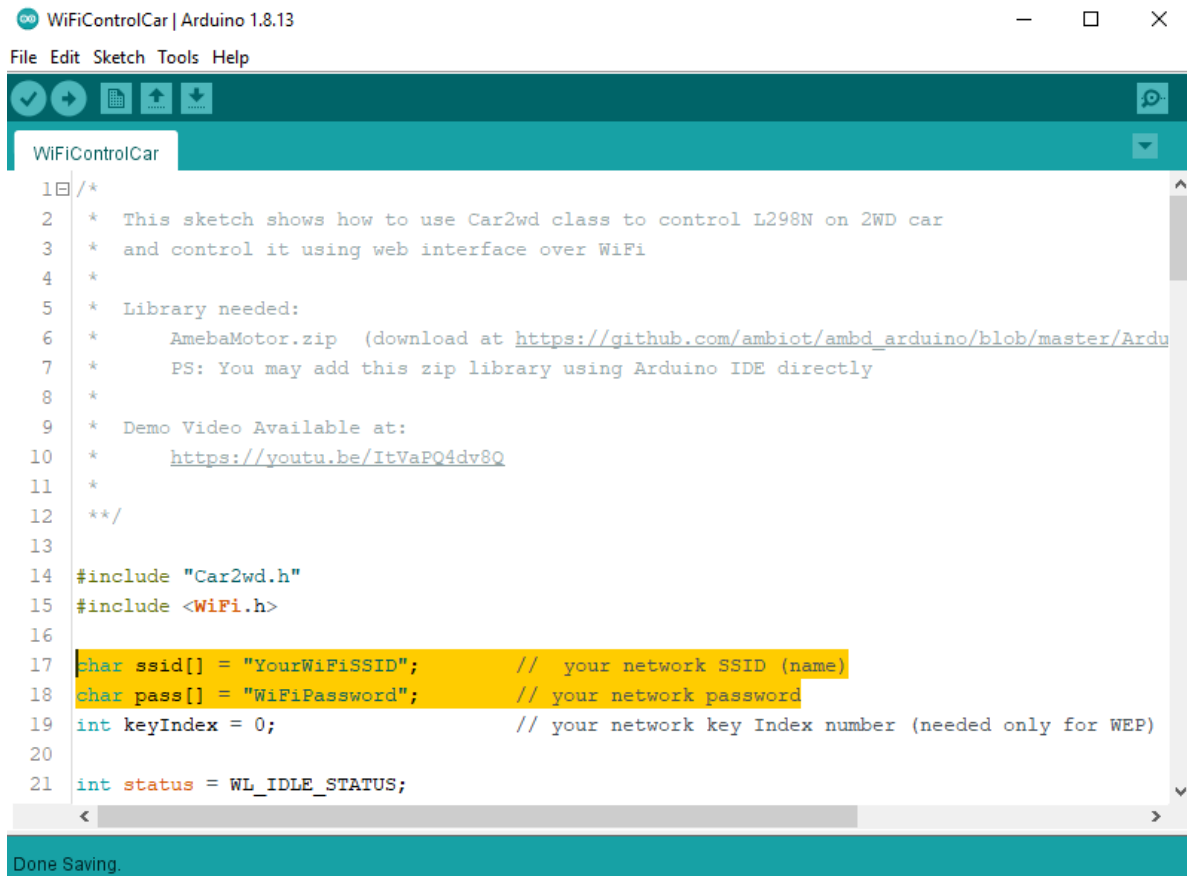
- We connect Ameba 5V to L298N +12V to supply power. However, not every L298N accepts 5V power supply, if this does not work, please connect L298N +12V to other power supply (e.g., +12V) and use L298N +5V to supply power to Ameba.
- The correct wiring of the motor depends on each model (may be opposite). Please run the test program first, make sure it runs correctly before assembling the motorcar.
- For convenience purposes, it's recommended to use Dupont line to organize the wiring of motors and L298N.

Every time you modify your program, please remember to unplug the power of L298N to avoid the motor running unexpectedly. Connect Ameba to power, upload the program, and then connect L298N to power when you are going to test the program.



Then, upload the code to Ameba

In the sample code, modify the highlighted snippet to corresponding information.

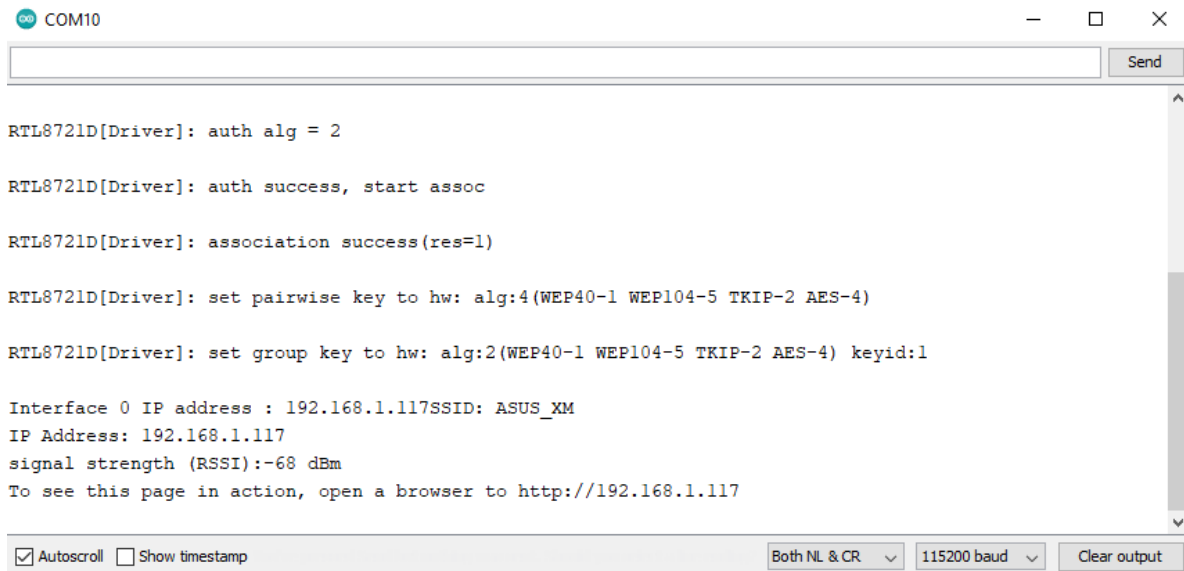


```

WiFiControlCar | Arduino 1.8.13
File Edit Sketch Tools Help
WiFiControlCar
1 // *
2 * This sketch shows how to use Car2wd class to control L298N on 2WD car
3 * and control it using web interface over WiFi
4 *
5 * Library needed:
6 *   AmebaMotor.zip (download at https://github.com/ambiot/ambd\_arduino/blob/master/Ardu
7 *   PS: You may add this zip library using Arduino IDE directly
8 *
9 * Demo Video Available at:
10 *   https://youtu.be/ItVaPQ4dv8Q
11 *
12 **/
13
14 #include "Car2wd.h"
15 #include <WiFi.h>
16
17 char ssid[] = "YourWiFiSSID"; // your network SSID (name)
18 char pass[] = "WiFiPassword"; // your network password
19 int keyIndex = 0; // your network key Index number (needed only for WEP)
20
21 int status = WL_IDLE_STATUS;
  
```

Done Saving.

Upload the code and press the reset button on Ameba. When the connection is established, you will see the message “To see this page in action, open a browser to <http://xxx.xxx.xxx.xxx>” in the Arduino IDE, as shown in the figure:



```
COM10

RTL8721D[Driver]: auth alg = 2

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=1)

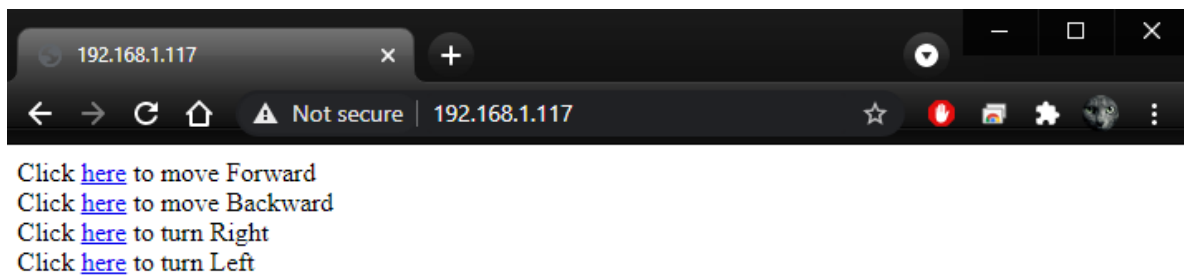
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:2(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.1.117SSID: ASUS_XM
IP Address: 192.168.1.117
signal strength (RSSI):-68 dBm
To see this page in action, open a browser to http://192.168.1.117

☒ Autoscroll ☐ Show timestamp Both NL & CR 115200 baud Clear output
```

Next, open the browser of a computer or a cell phone under the same WiFi domain, enter the address in the message.



In the webpage, you can press the corresponding button to control the motor car in any of the 4 directions.

## Demo Video

## Code Reference

Use `WiFi.begin()` to establish WiFi connection. <https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network. <https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection. <https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba. <https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiServer server()` to create a server that listens on the specified port. <https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections. <https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading. <https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.connected()` to get whether or not the client is connected. <https://www.arduino.cc/en/Reference/WiFiClientConnected>

Use `client.println()` to print data followed by a carriage return and newline. <https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.print()` to print data to the server that a client is connected to. <https://www.arduino.cc/en/Reference/WiFiClientPrint>

Use `client.available()` to return the number of bytes available for reading. <https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to. <https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to. <https://www.arduino.cc/en/Reference/WiFiClientStop>

## Audio Codec –Basic Input Output

### Materials

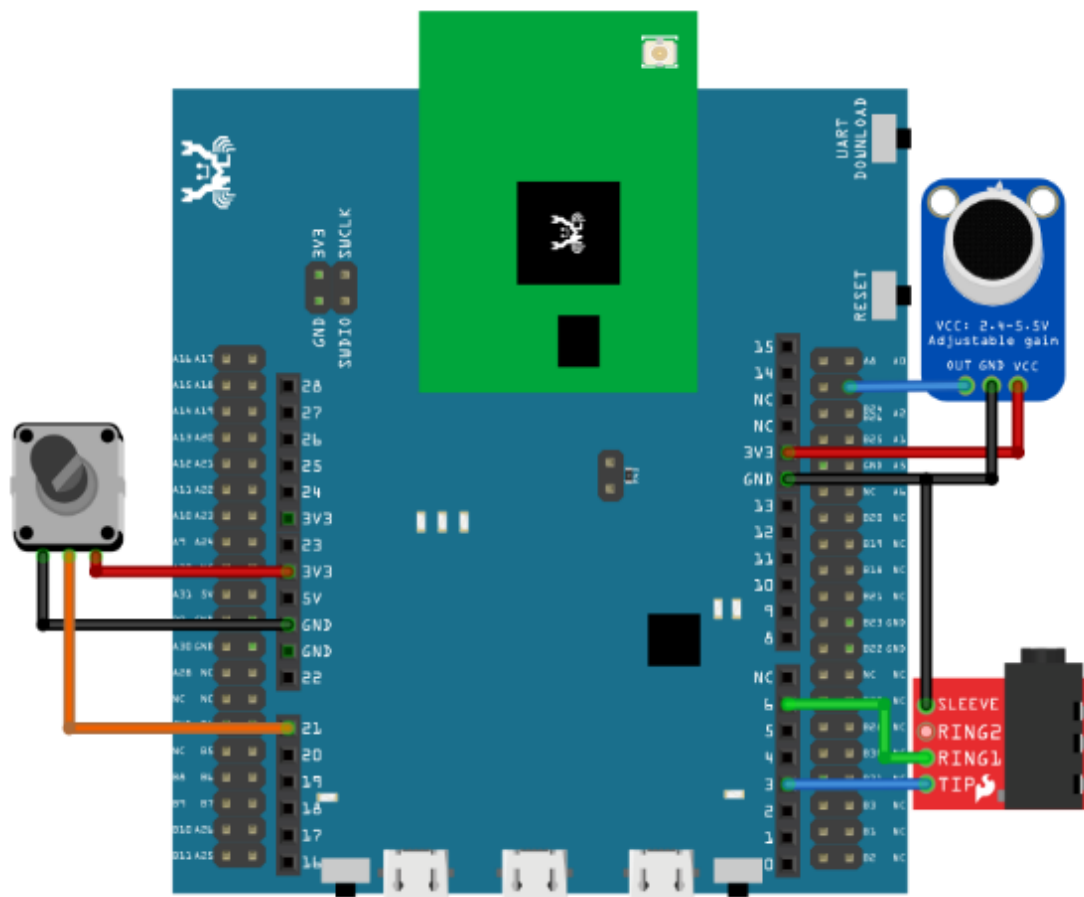
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Potentiometer x 1
- Analog microphone x 1 (e.g., Adafruit 1063 / 1064)
- 3.5mm TRS/TRRS breakout x 1 (e.g., Adafruit 2791 / Sparkfun 11570)

### Example

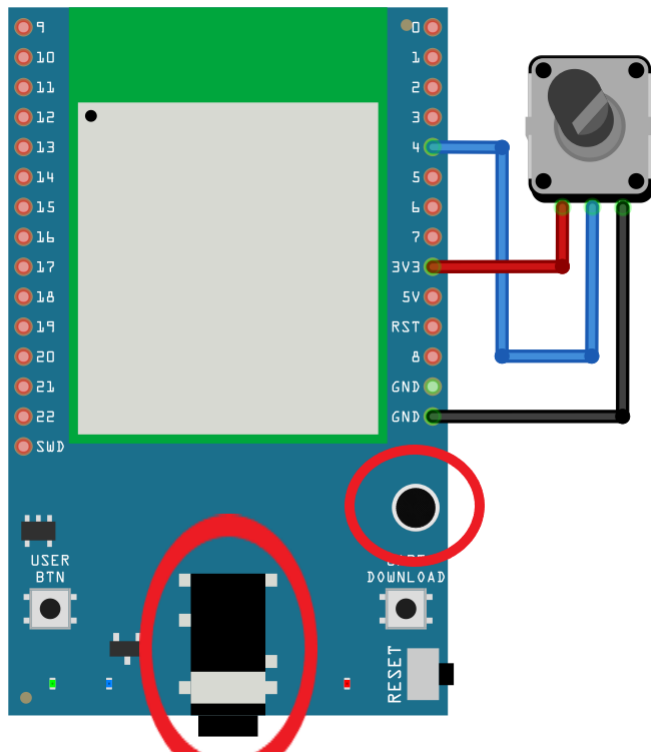
### Procedure

Connect the potentiometer, microphone and 3.5mm connector to the RTL8722 board following the diagram.

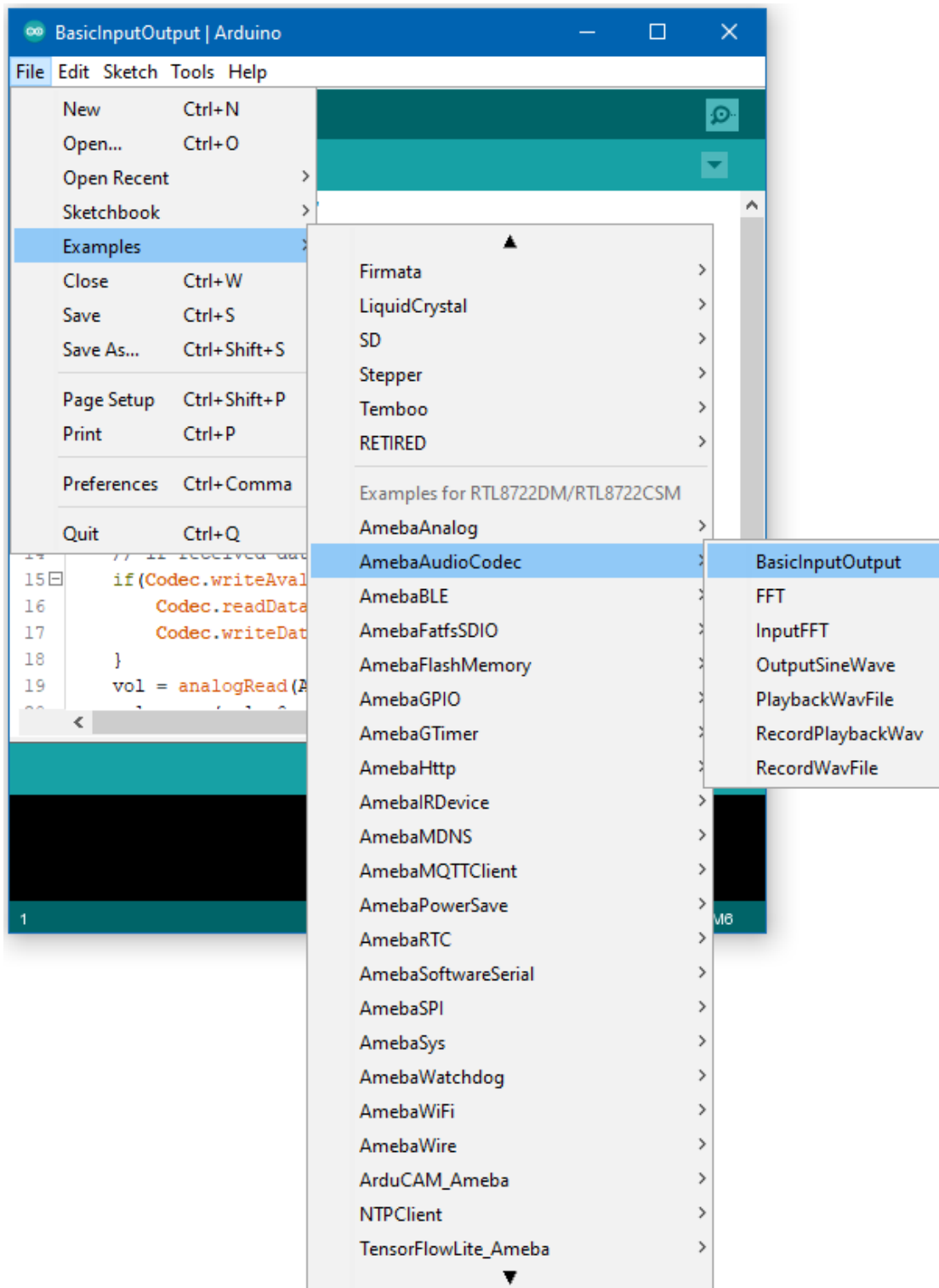
**AMB21 / AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



Open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "BasicInputOutput".



Upload the code and press the reset button on Ameba once the upload is finished.

Connect a pair of wired headphones to the 3.5mm audio jack, blow at the microphone, and you should hear the sounds picked-up by the microphone replayed in the headphones. Adjust the potentiometer and the output volume will change as well. Note: if you are using a microphone with an amplifier included, such as Adafruit 1063, the amplifier can lead to

the microphone picking up more noise.

## Audio Codec - FFT

### Materials

- AmebaD [AMB21 / AMB22 / AMB23] x 1

### Example

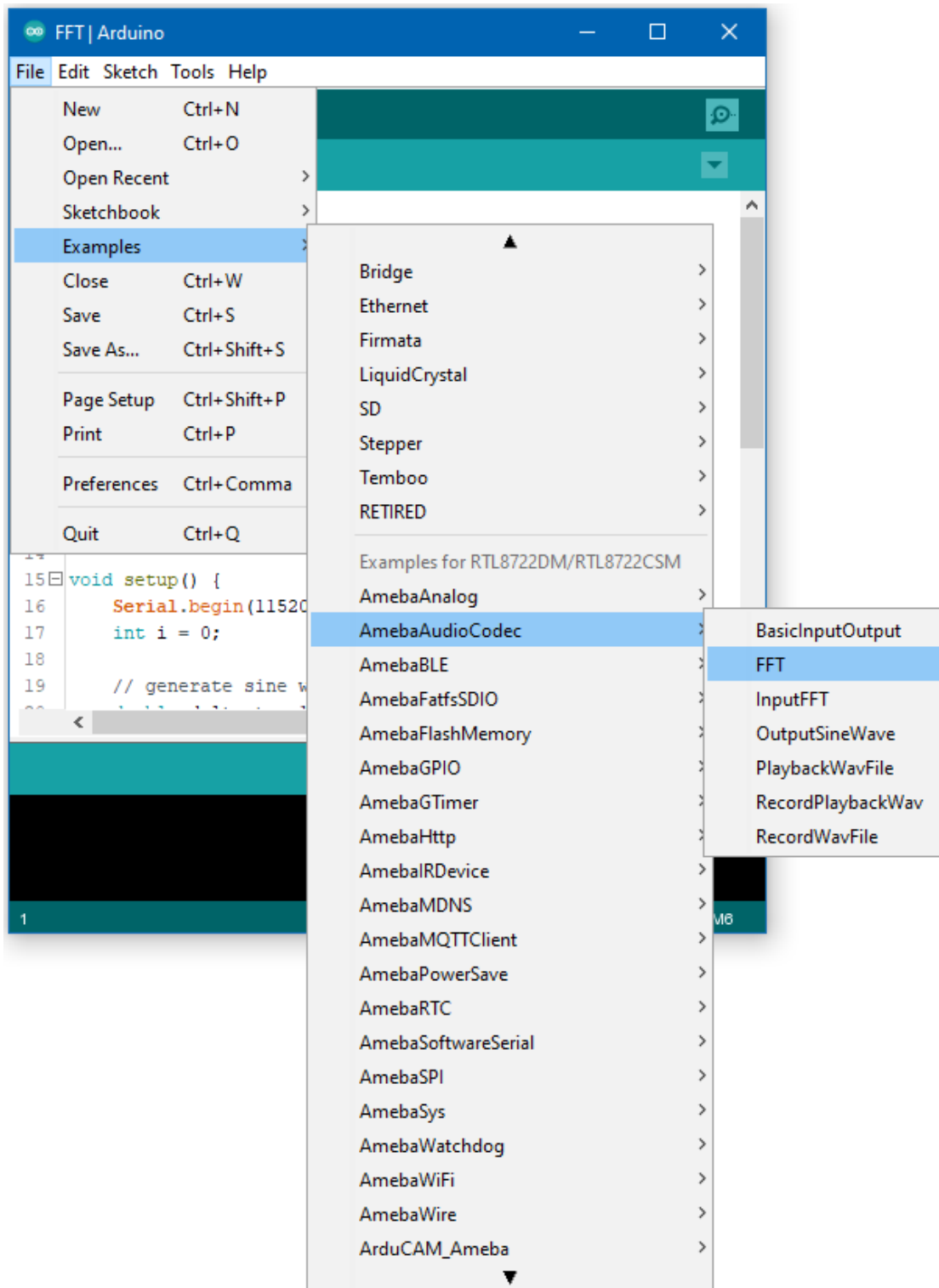
### Introduction

This example shows how to use the `AudioCodec_FFT` class to calculate the fast Fourier transform of a signal to extract the frequencies present in the signal.

### Procedure

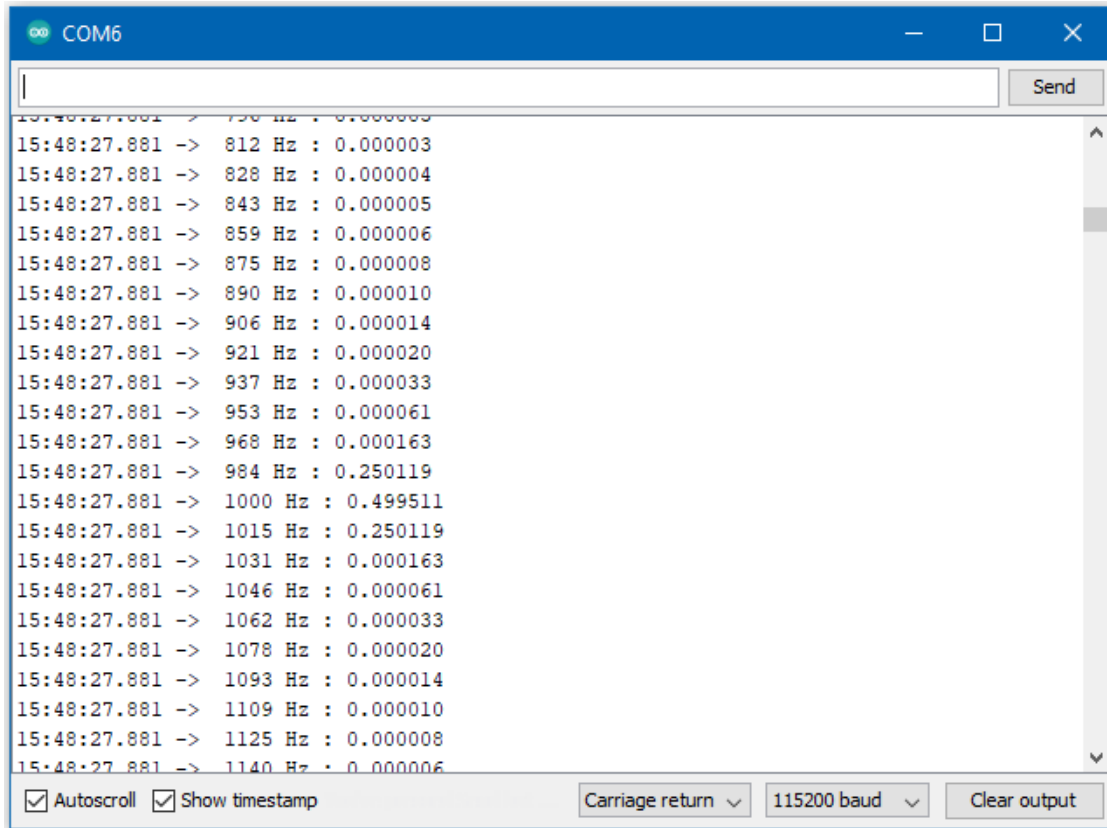
Open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "FFT" .





Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor, and the output results of the AudioCodec\_FFT calculation will be displayed.



## Audio Codec - Input FFT

### Materials

- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Analog microphone x 1 (e.g., Adafruit 1063 / 1064)

### Example

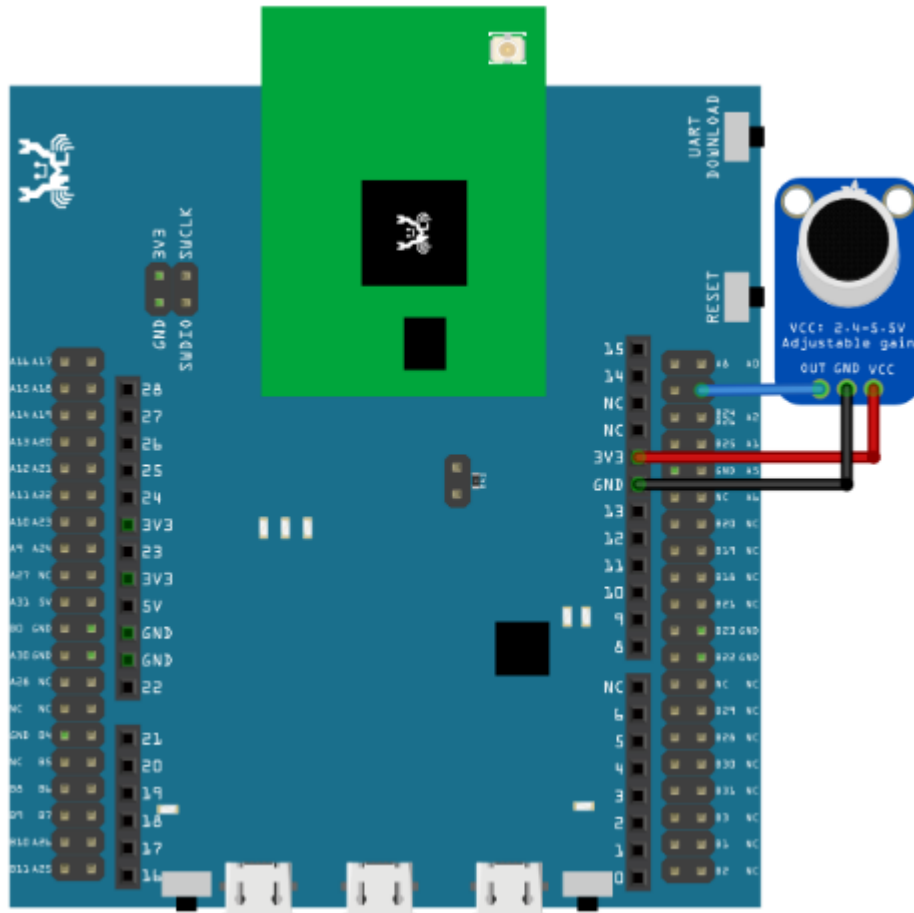
### Introduction

This example shows how to use the FFT class to calculate the fast Fourier transform of the audio signal recorded by the microphone.

### Procedure

Connect the microphone to the RTL8722 board following the diagram.

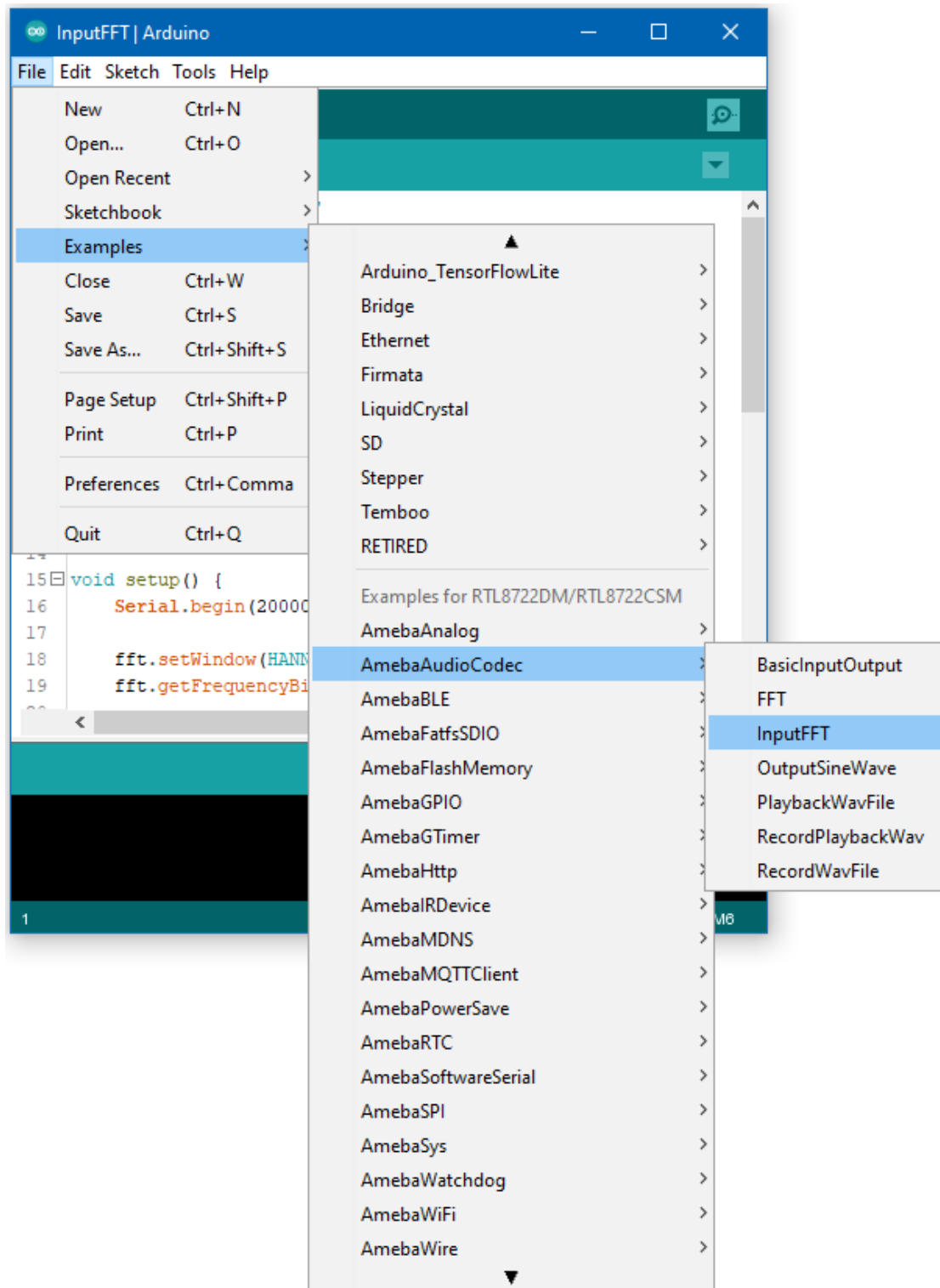
### AMB21 / AMB22 Wiring Diagram:



### AMB23 Wiring Diagram:

As AMB23 have a built in microphone on the board, there is no need for any external microphone.

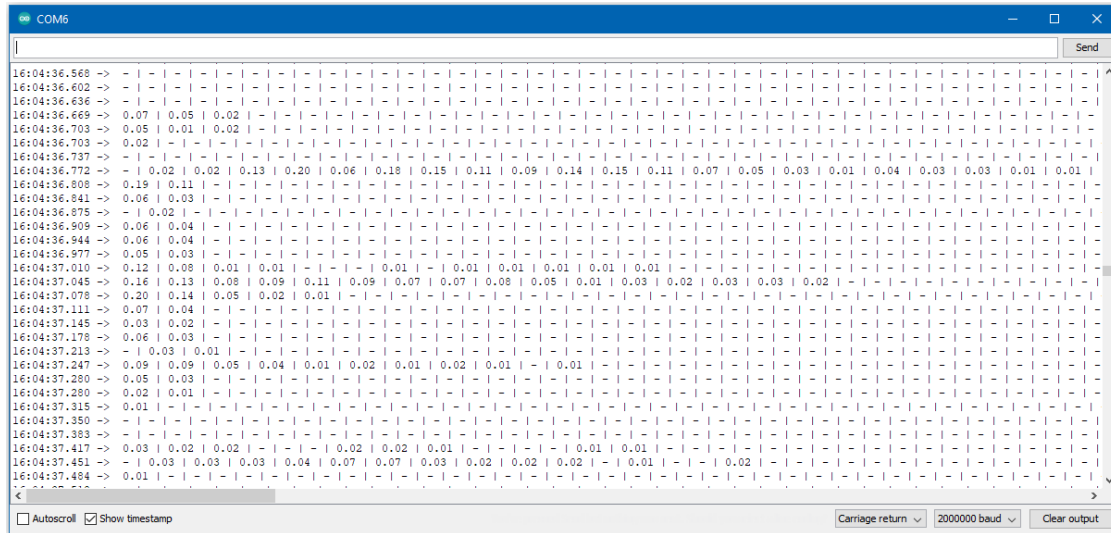
Next, open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "InputFFT".



Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor and change the baud rate to 2000000. A stream of FFT results of audio samples will be displayed. Try playing music or use a smartphone app to generate a sine wave into the microphone, and you should be

able to see the FFT output change.



## Audio Codec –Output Sine Wave

### Materials

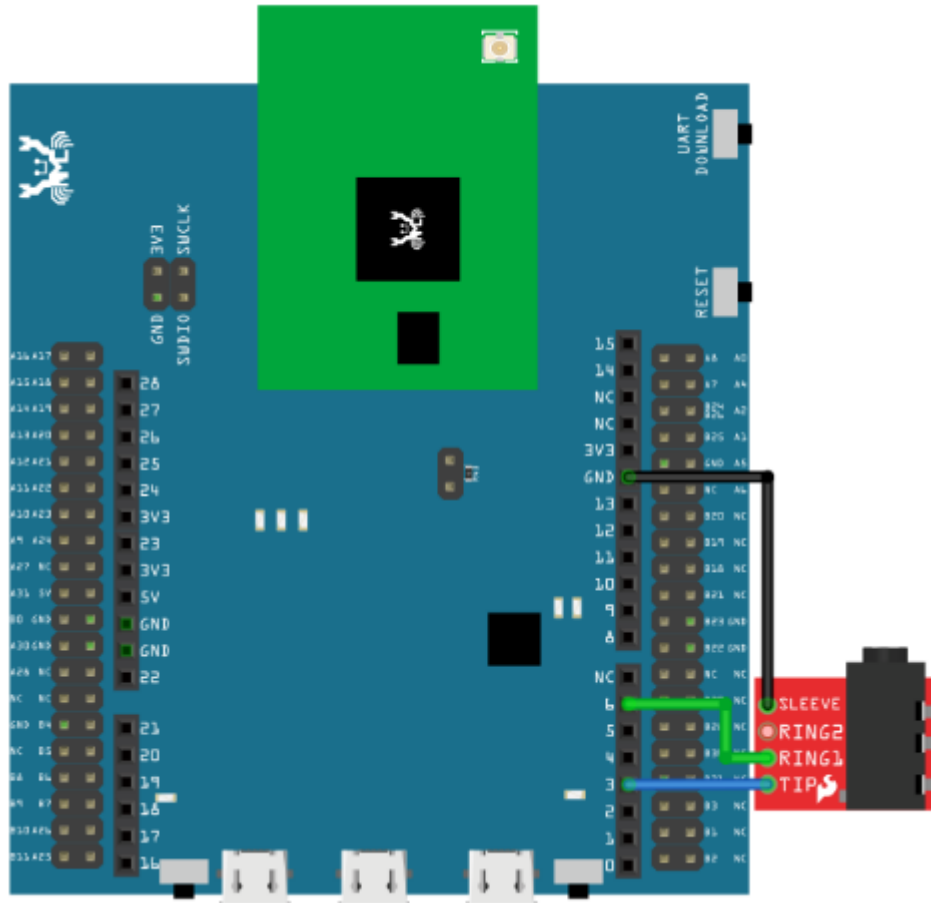
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- 3.5mm TRS/TRRS breakout x 1 (e.g., Adafruit 2791 / Sparkfun 11570)

### Example

### Procedure

#### AMB21 / AMB22 Wiring Diagram:

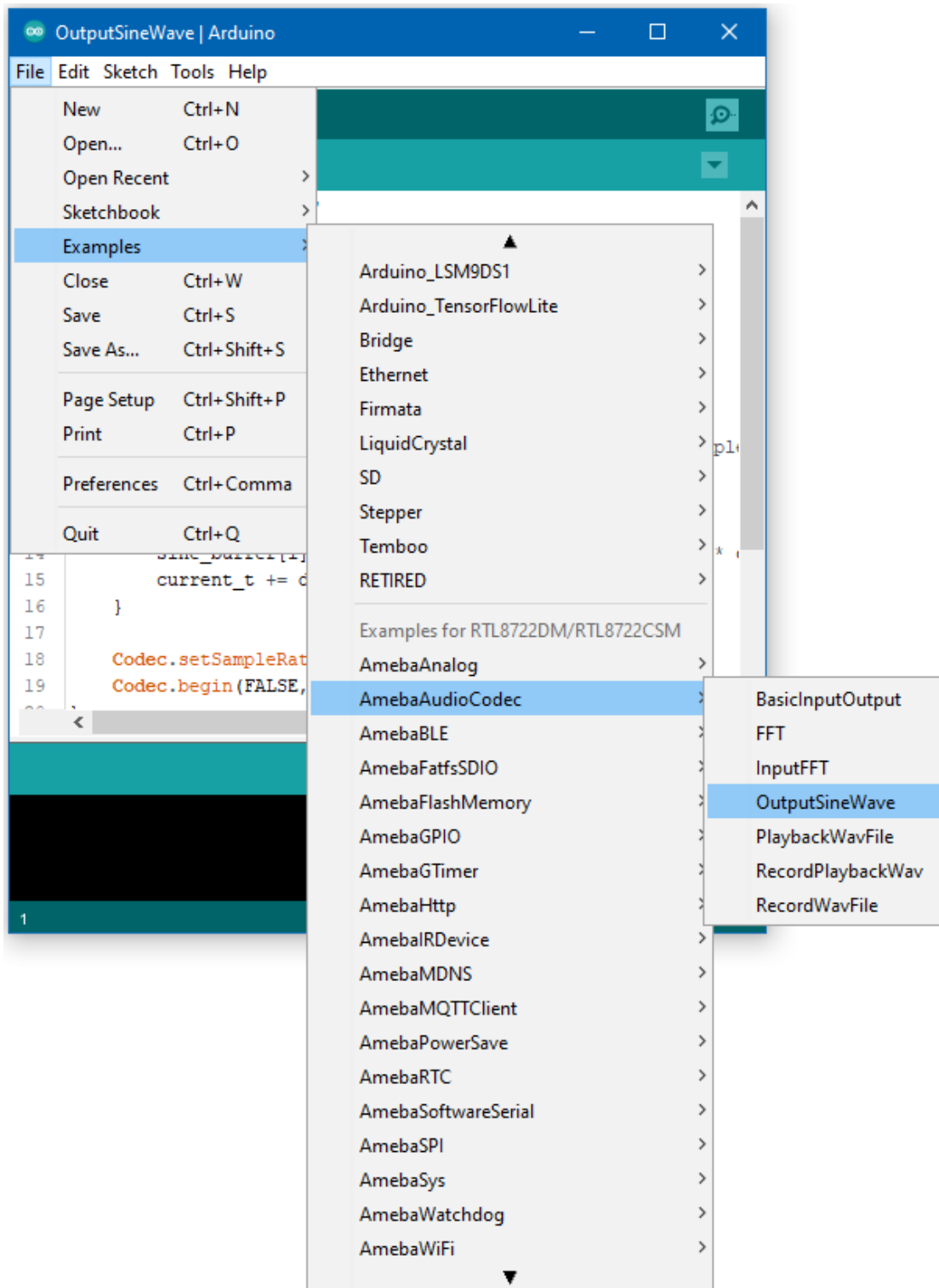
Connect the 3.5mm connector to the RTL8722 board following the diagram.



### AMB23 Wiring Diagram:

As AMB23 have a built in microphone on the board, there is no need for any external microphone.

Open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "OutputSineWave".



Upload the code and press the reset button on Ameba once the upload is finished.

Connect a pair of wired headphones to the 3.5mm audio jack and you should hear the generate single sinusoidal tone.

## E-Paper - Display Images

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

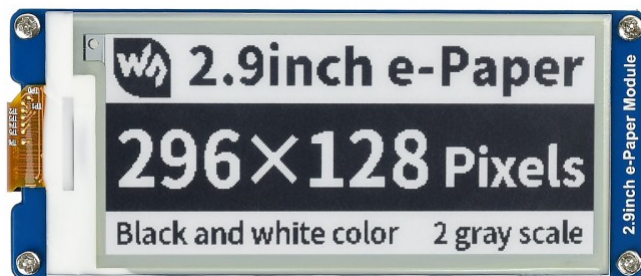
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc... are supplied with each panel.

You may refer to the official [2.9inch e-Paper HAT \(D\) datasheet](#) to know more information about this module.

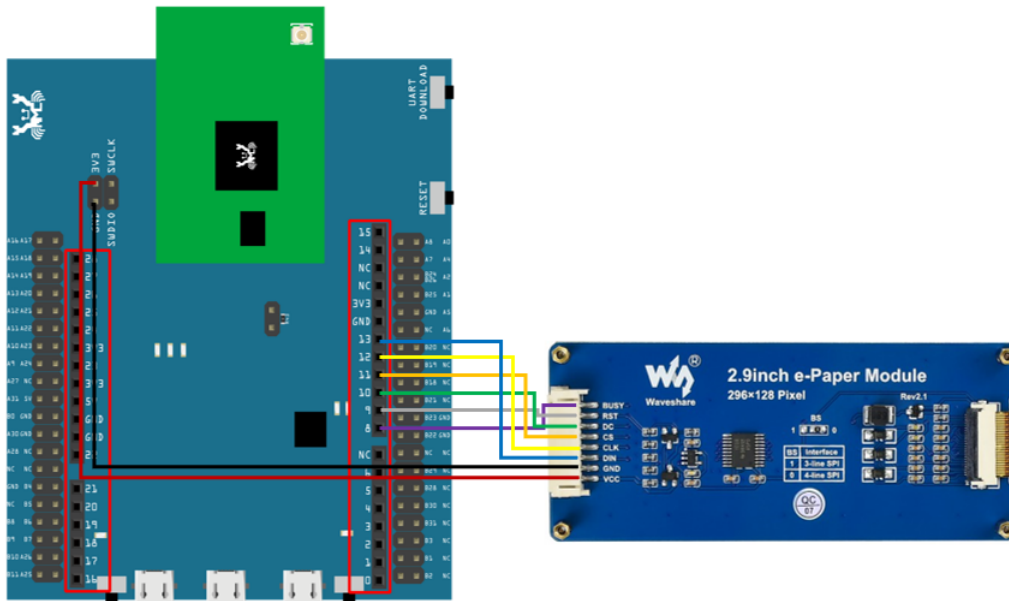
Front view of the e-Paper Module:



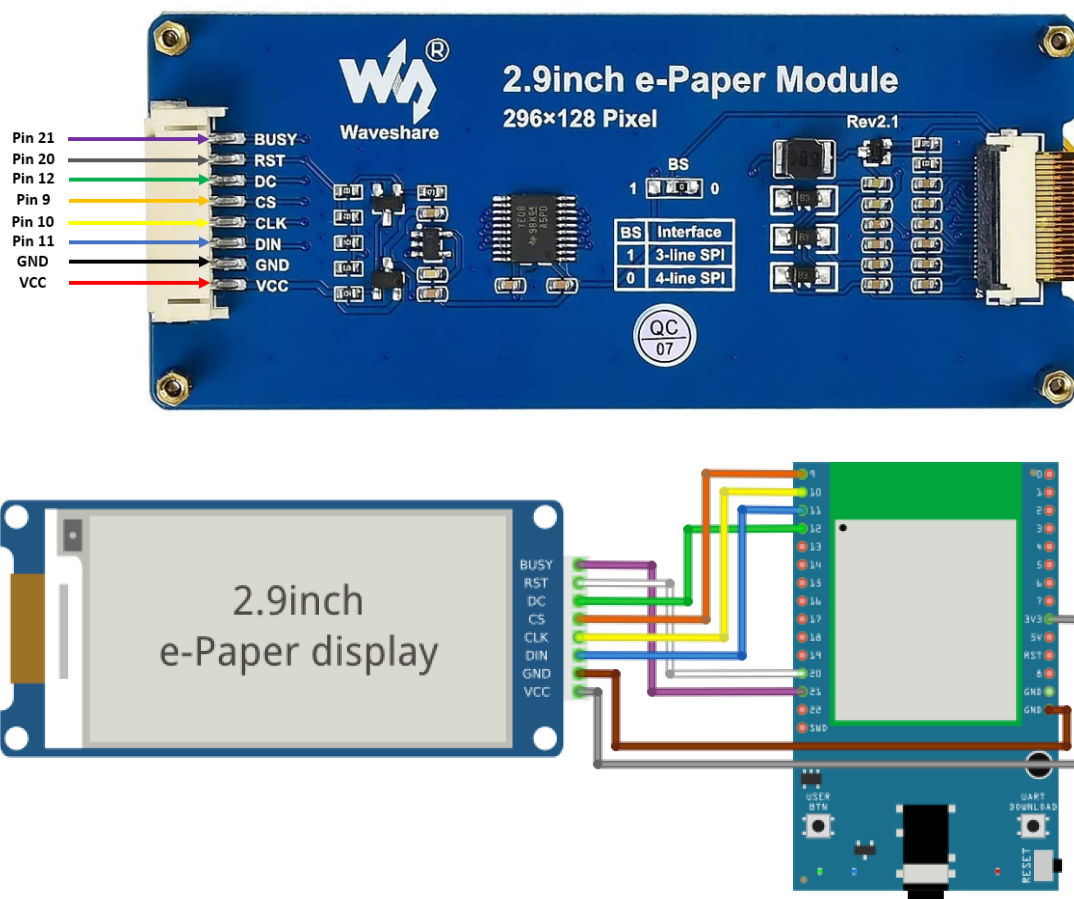
AMB21 / AMB22 Wiring Diagram:



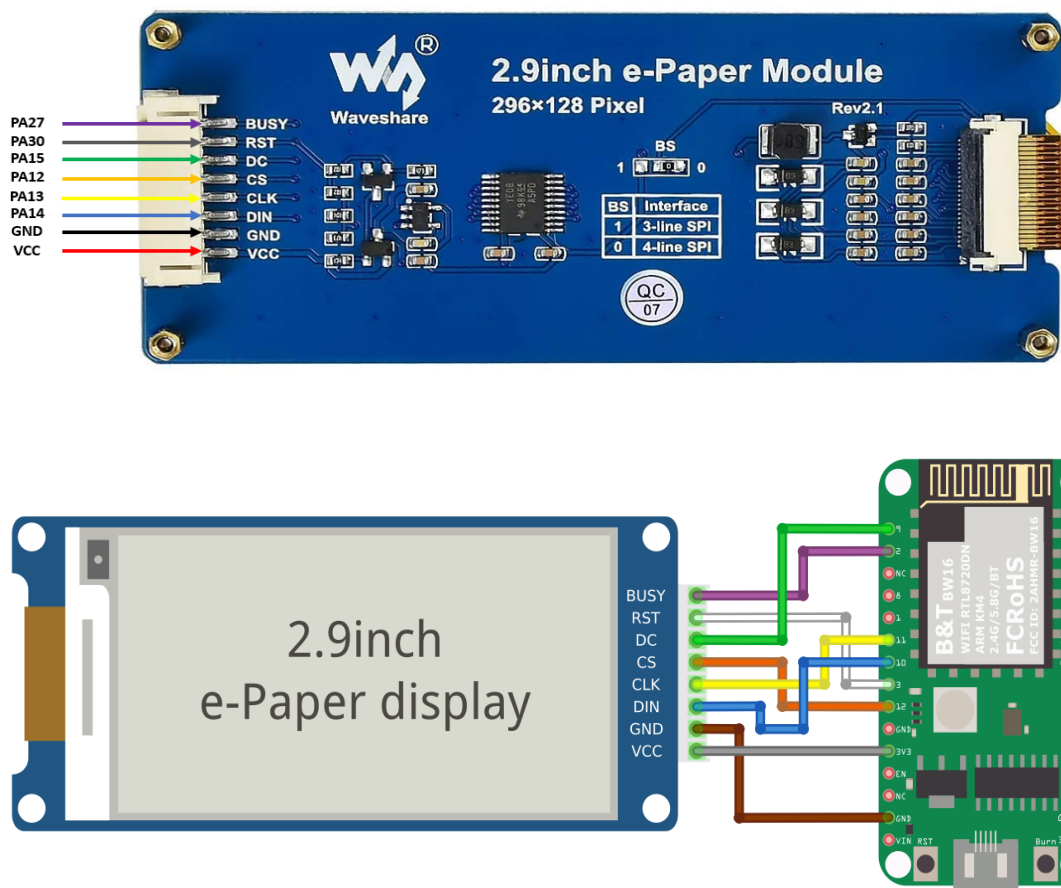




AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Firstly, you need to prepare a picture/photo in the format of 296×128 pixels. We can easily find a photo resizing tool online, for example, the [Online Image Resizer](#).

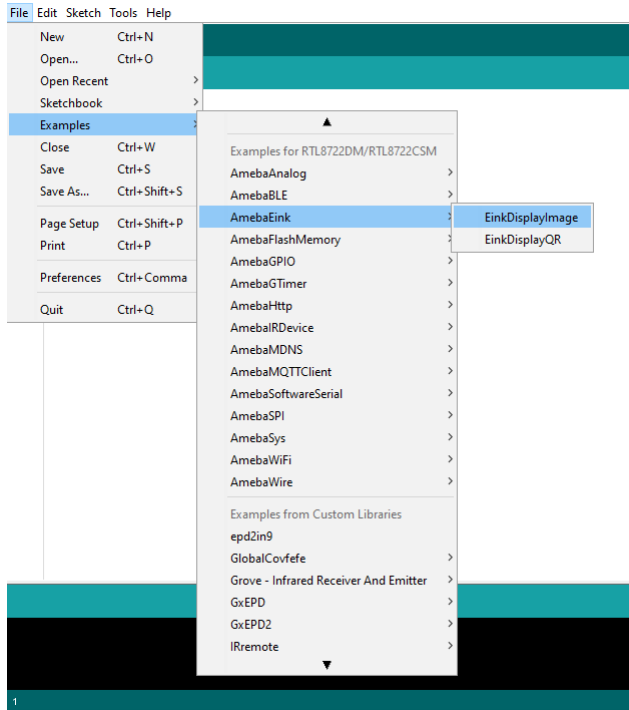
Following the instructions on the website, then download the generated image in JPG format.

Secondly, we use the [Image2LCD](#) tool to transfer the downloaded 296×128 image into hexadecimal codes. You can visit this [YouTube](#) link to get detailed instructions.

Download the E Ink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries)

Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” → “Examples” → “AmebaEink” → “EinkDisplayImage” :



Press the reset button after uploading the sample code, you will need to wait for around 1-2 seconds for the e-Paper module to fresh its screen. Then the screen will start to display an image for 5 seconds first, then 3 different QR codes will be displayed every 5 seconds (showing in the screenshot below, you may scan the QR codes and find out more information if you wish to). Lastly, a gif which comes in form of 3 frames will be displayed for a few seconds.



## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

[2] Provide the link to how to generate a QR code on the E-paper module: <https://eugeniopace.org/qr-code/arduino/eink/2019/07/01/qr-code-on-arduino.html>

## E-Paper - Display Text

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

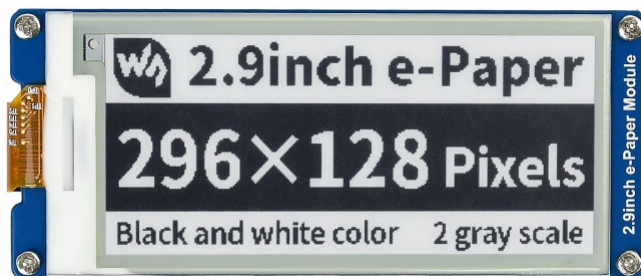
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc... are supplied with each panel.

You may refer to the official [2.9inch e-Paper HAT \(D\) datasheet](#) to know more information about this module.

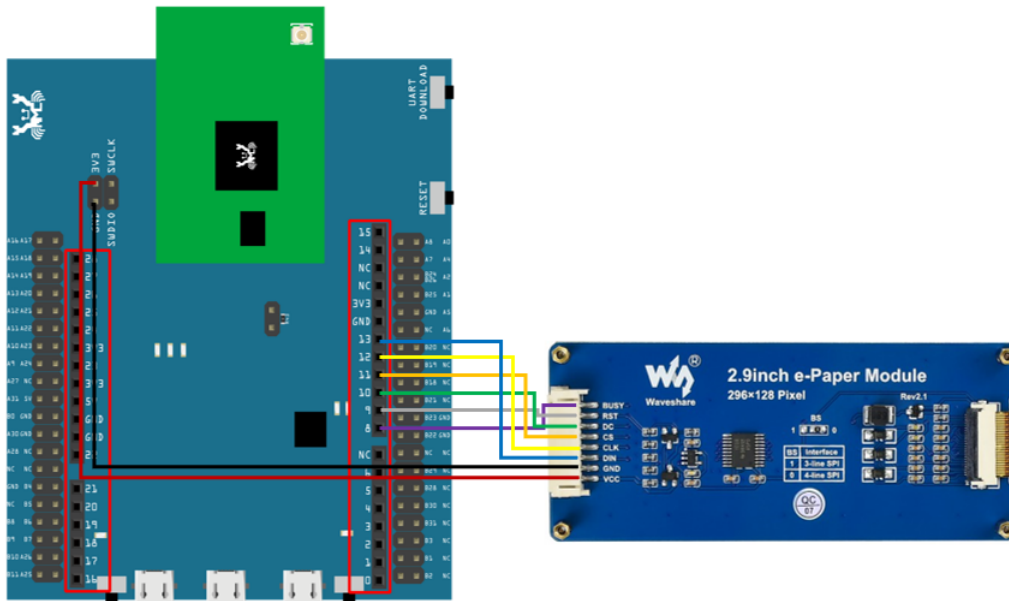
Front view of the e-Paper Module:



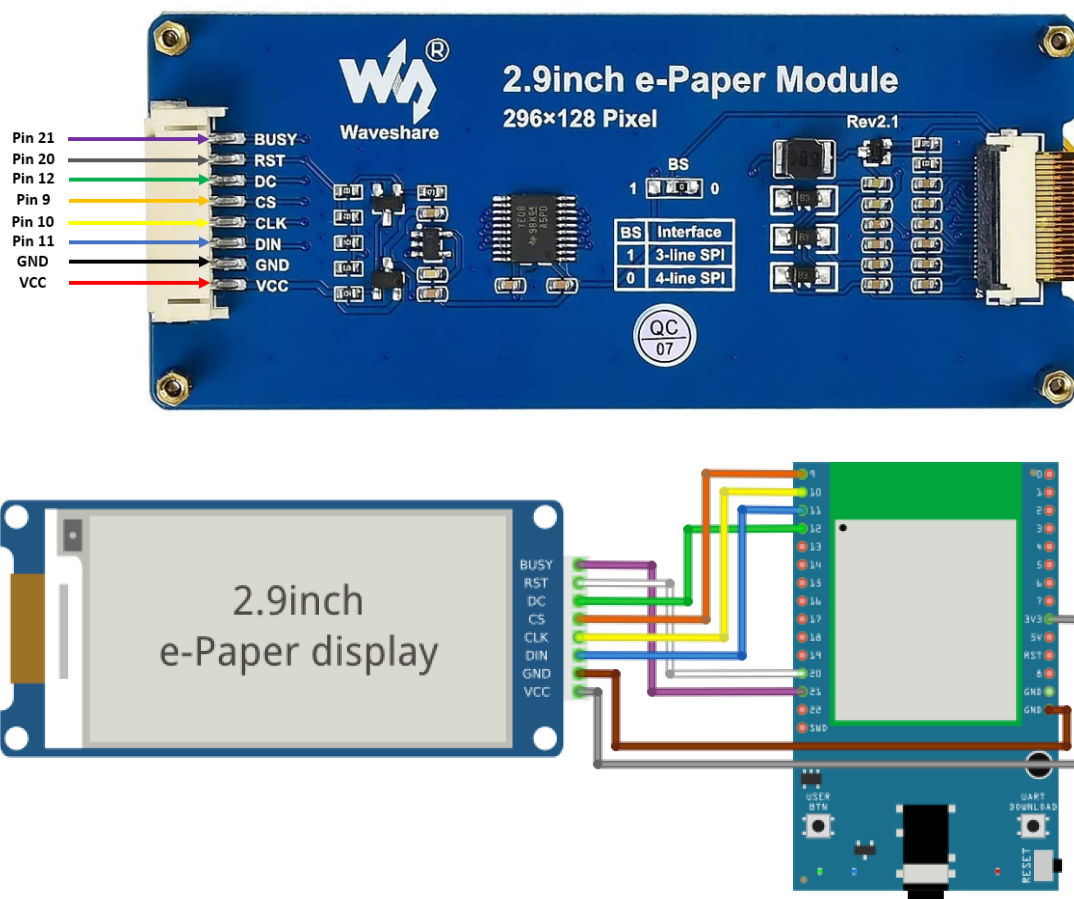
AMB21 / AMB22 Wiring Diagram:



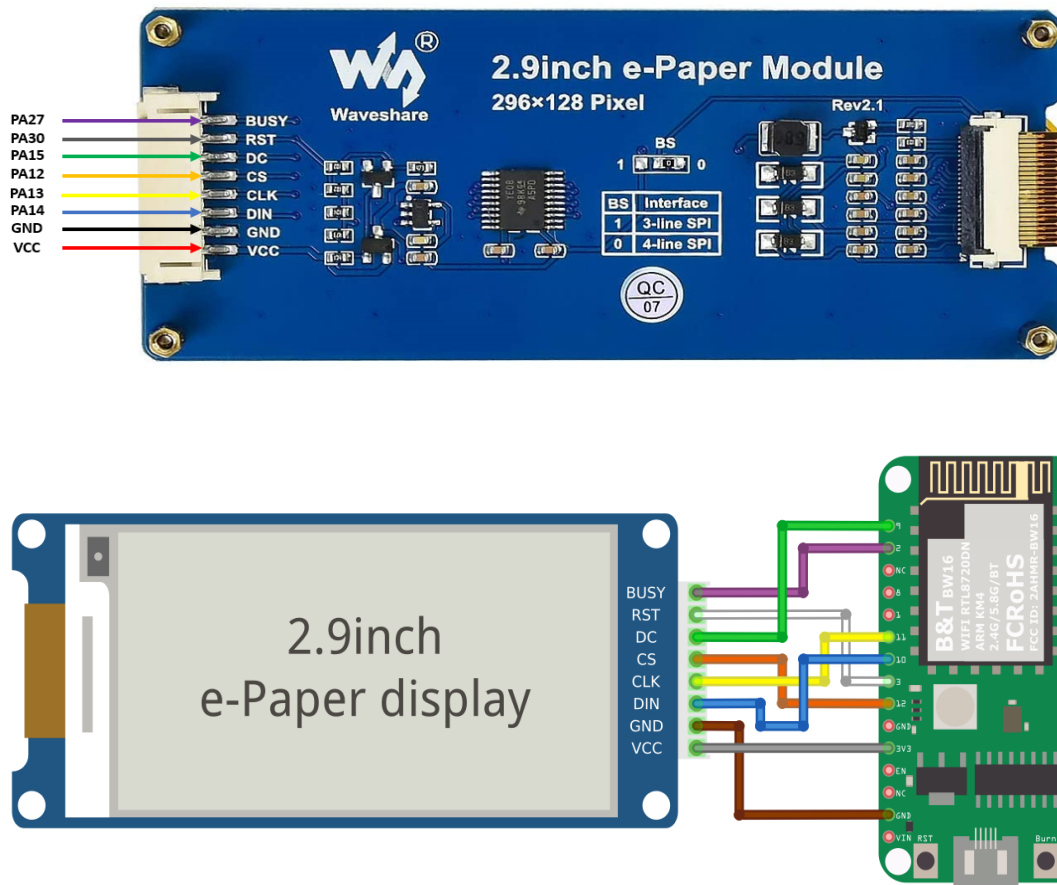




AMB23 Wiring Diagram:



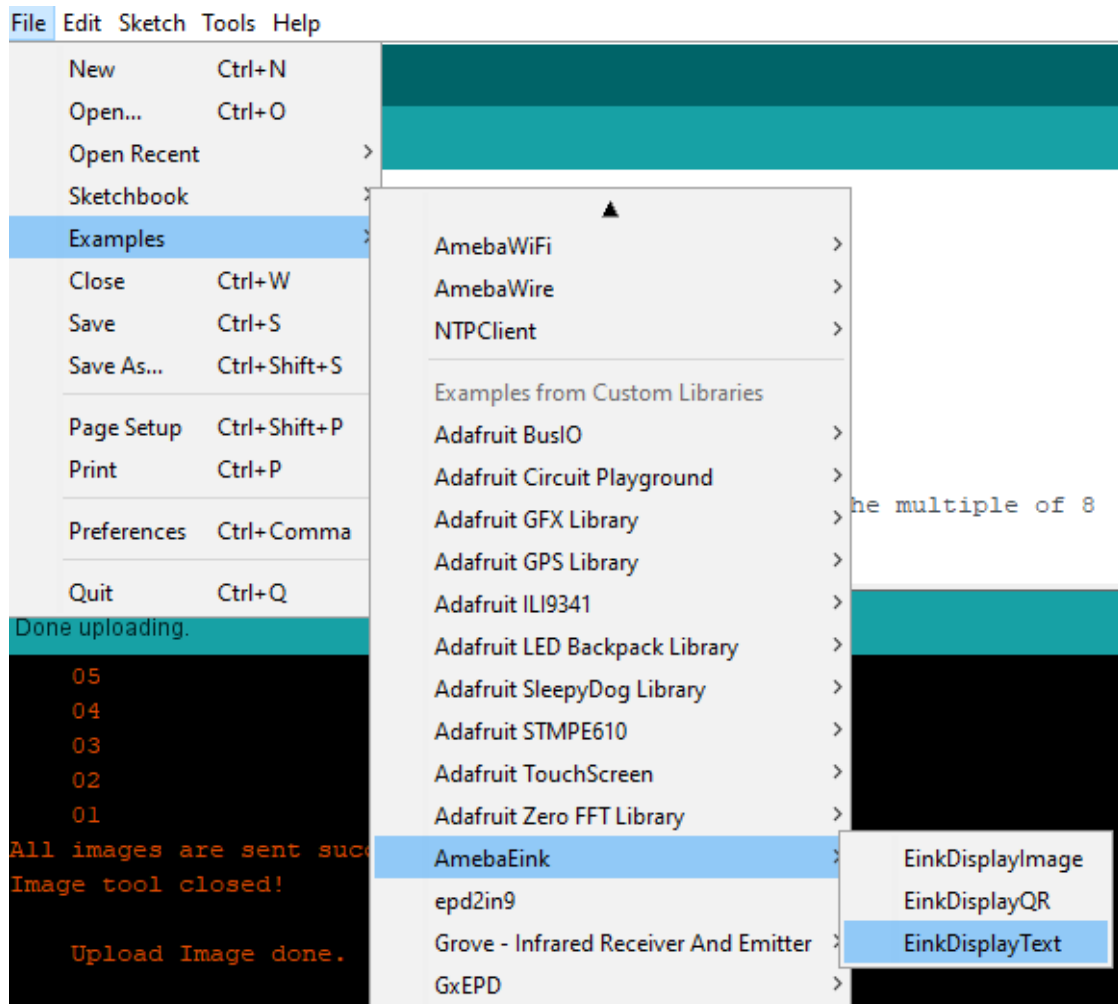
BW16 Wiring Diagram:



Download the E Ink zip library, AmebaEink.zip, at

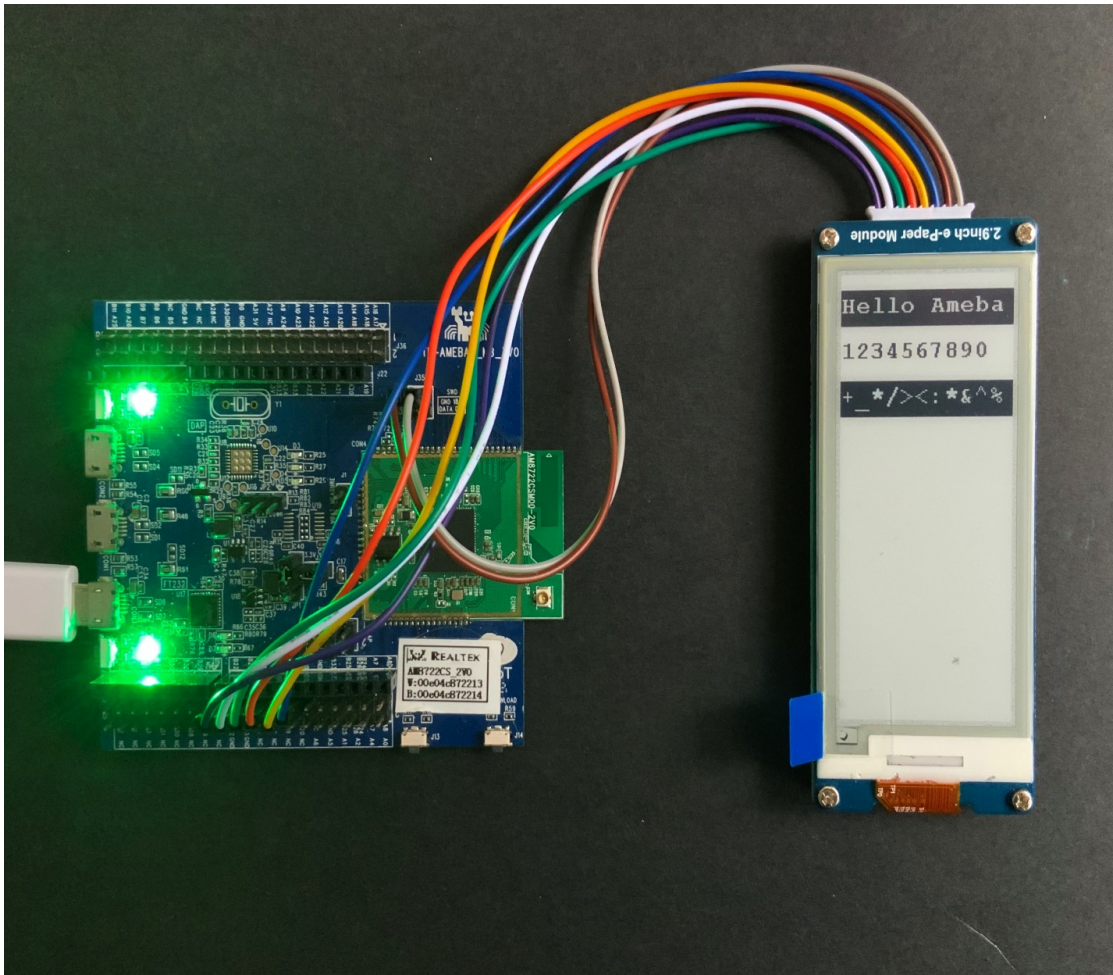
[https://github.com/ambiot/amdb\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/amdb_arduino/tree/master/Arduino_zip_libraries)

Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” -> “Examples” -> “AmebaEink” -> “EinkDisplayText” :



Upload the code to the board and press the Reset button after the uploading is done. You will find these texts displayed on the board:





## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

## E-Paper - Display User-generated QR Code

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

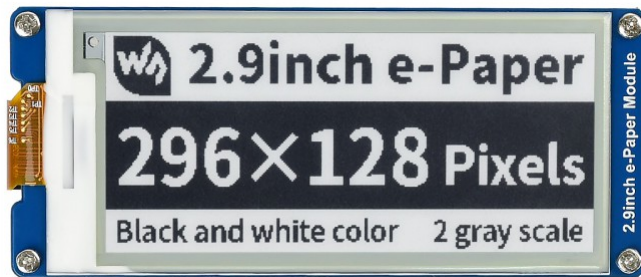
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc...are supplied with each panel.

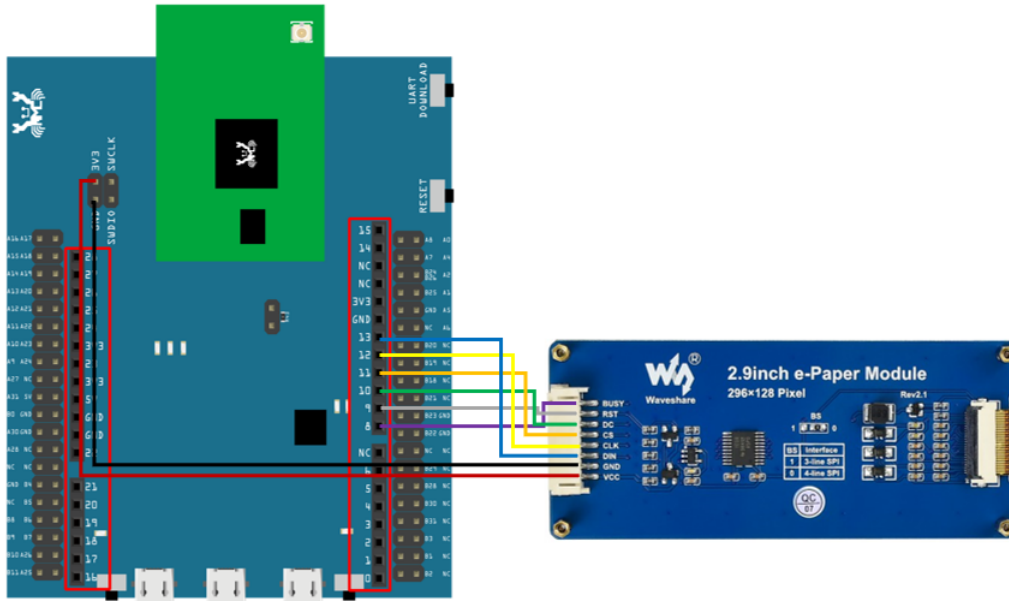
You may refer to the official [2.9inch e-Paper HAT \(D\)](#) datasheet to know more information about this module.

Front view of the e-Paper Module:

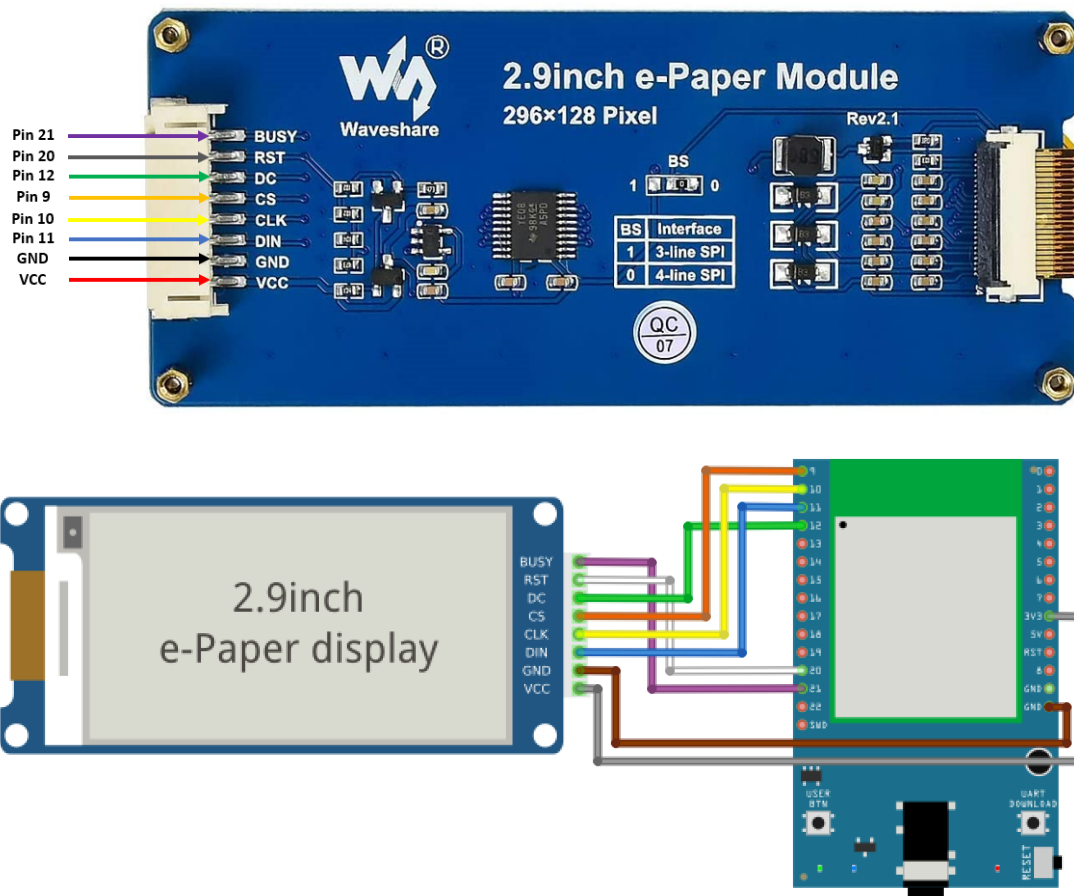


AMB21 / AMB22 Wiring Diagram:

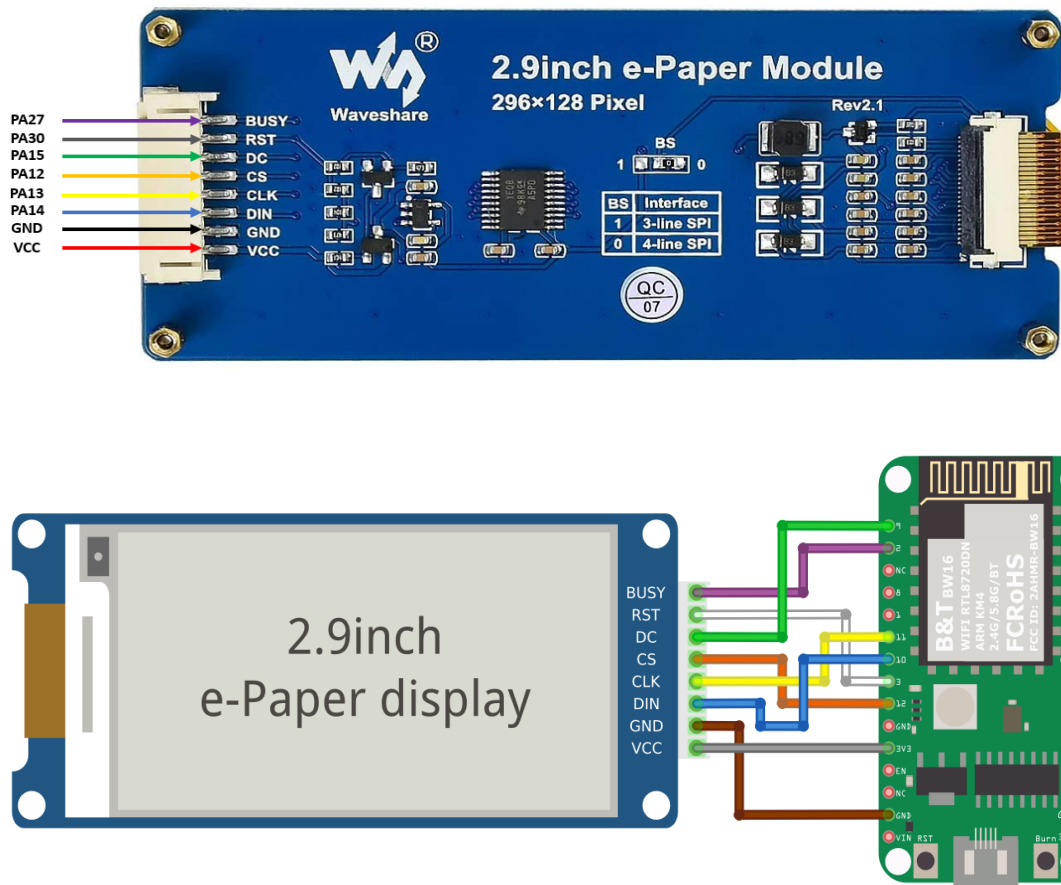




AMB23 Wiring Diagram:



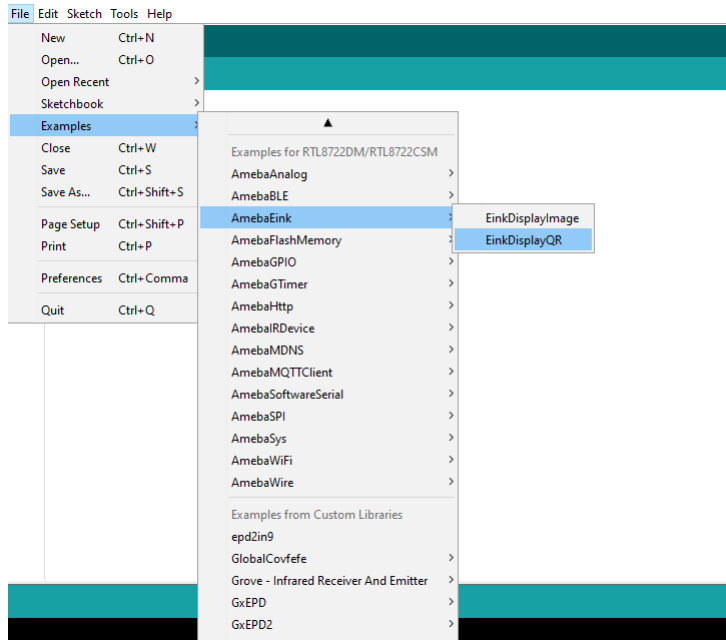
BW16 Wiring Diagram:



Download the Eink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries)

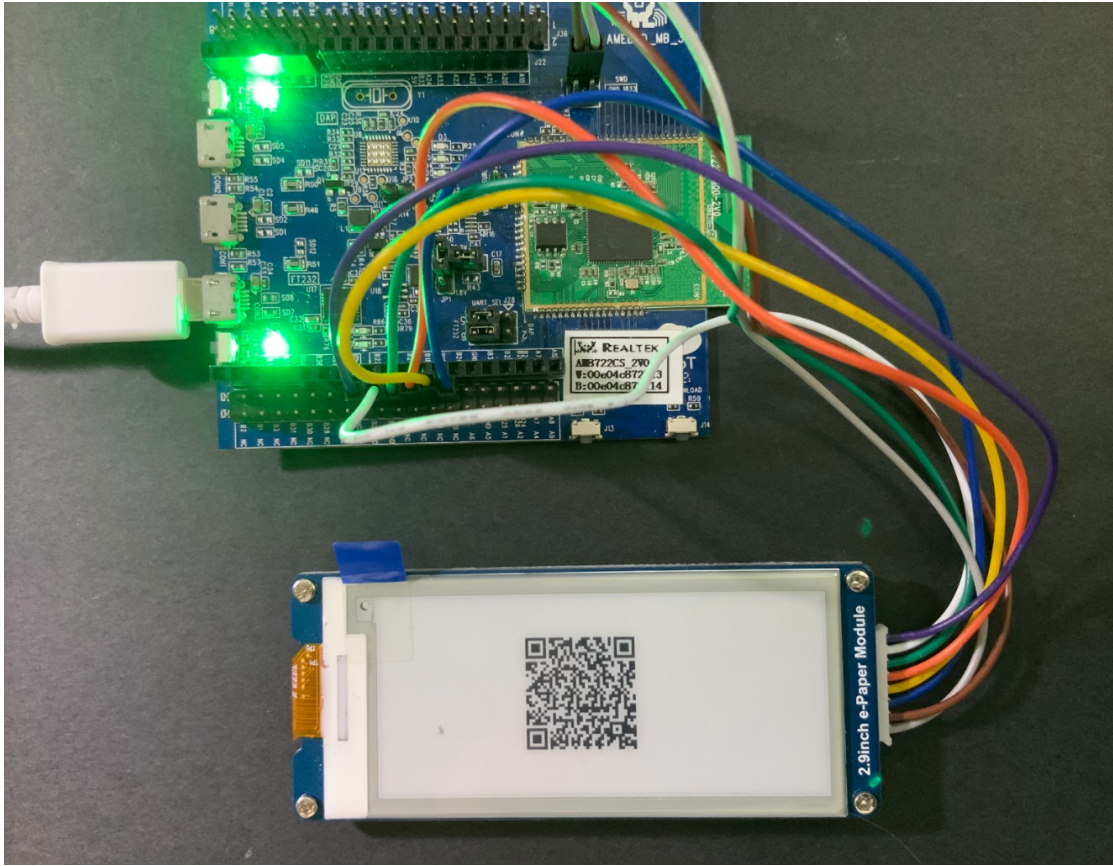
Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” → “Examples” →



“AmebaEink” → “DisplayQR” :

Modify the URL in the loop() section as your wish, after that, verify and upload the code to the Ameba board. Upon successfully upload the sample code and press the reset button, a QR code generated based on the URL of your input will be shown on the E-Paper module. The QR code showing below leads to our Ameba IoT official website: [Ameba ARDUINO](#)





## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

[2] Provide the link to how to generate a QR code on the E-paper module: <https://eugeniopace.org/qrcode/arduino/eink/2019/07/01/qrcode-on-arduino.html>

[3] A simple library for generating QR codes in C, optimized for processing and memory-constrained systems: <https://github.com/ricmoo/QRCode#data-capacities>

## Flash Memory - Store data in FlashEEProm

### Preparation

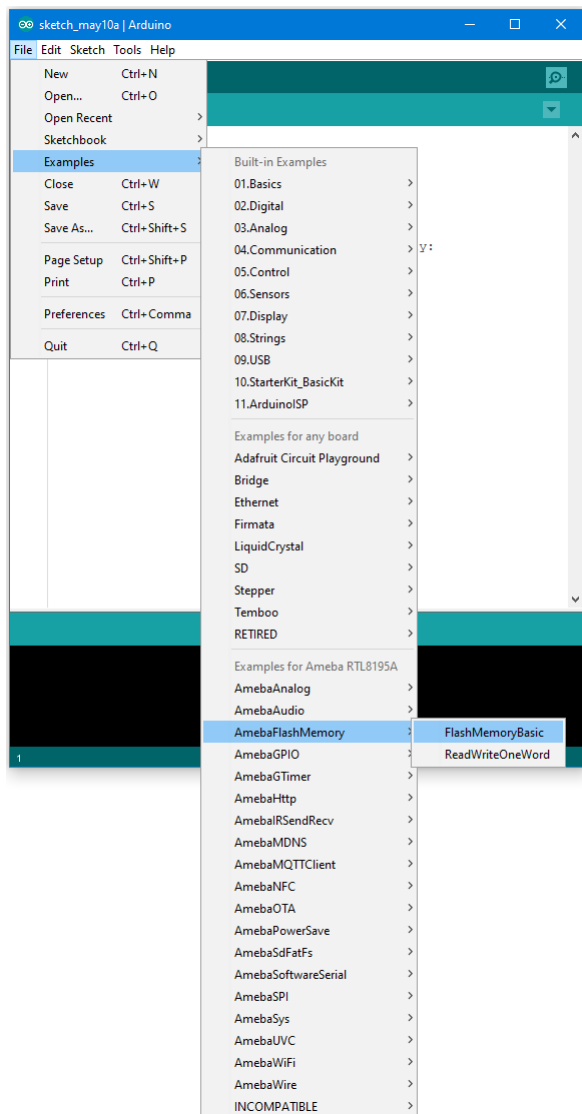
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

## Example

Ameba provides Flash Memory component for data storage and the data can be preserved when the power is off if necessary, e.g., compiled program. To avoid the memory space overlapped with the program on Ameba, the Flash API uses the tail part of the address space, with sector size 4K.

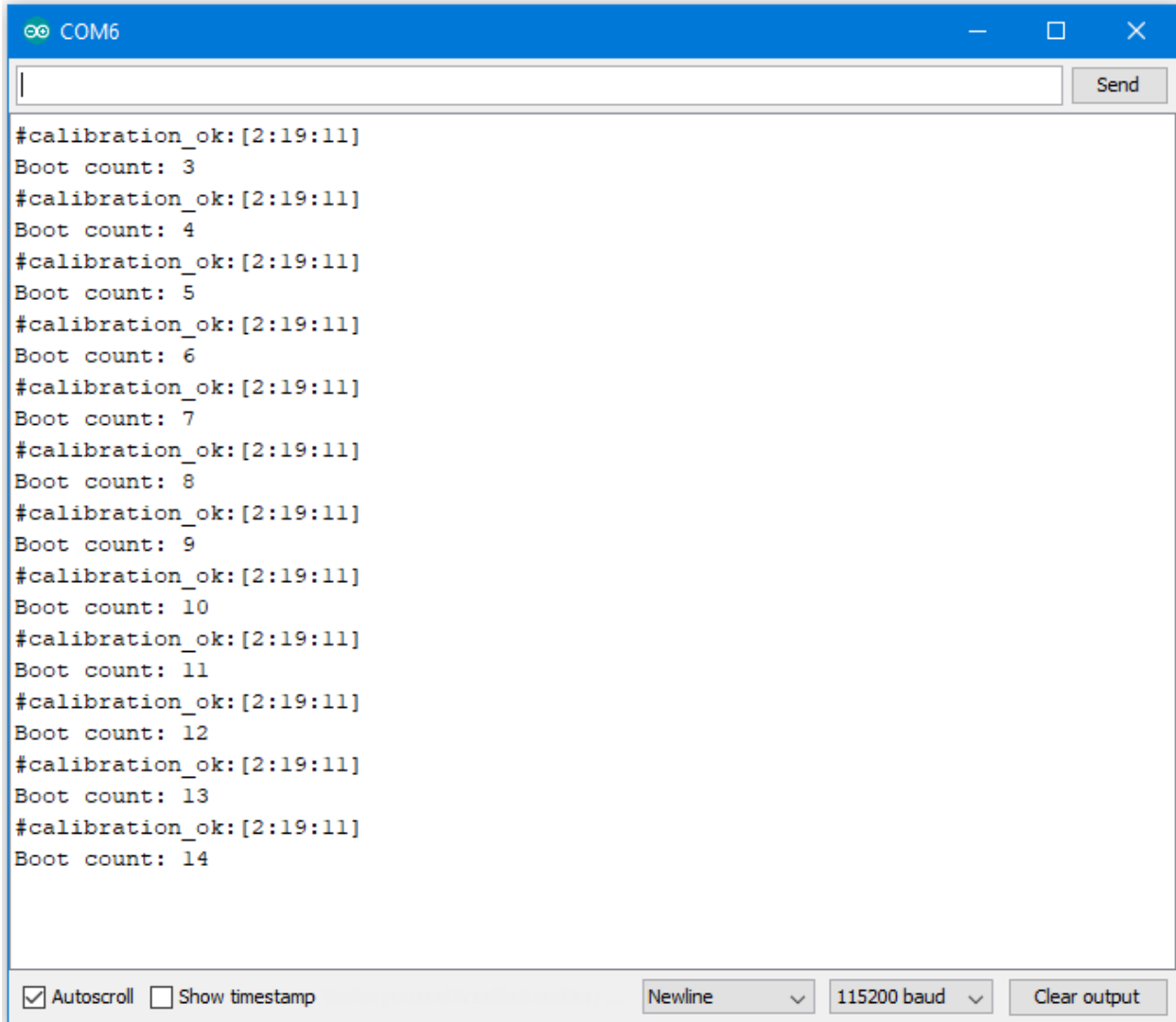
In this example, we store the value of boot times in flash memory. Every time Ameba reboots, it reads the boot times from flash, increases the value by 1, and writes it back to flash memory.

First open the example, “File” -> “Example” -> “AmebaFlashMemory” -> “FlashMemoryBasic”



Compile and upload to Ameba, then press the reset button.

Open the Serial Monitor, press the reset button for a few times. Then you can see the boot times value increases.



```
#calibration_ok:[2:19:11]
Boot count: 3
#calibration_ok:[2:19:11]
Boot count: 4
#calibration_ok:[2:19:11]
Boot count: 5
#calibration_ok:[2:19:11]
Boot count: 6
#calibration_ok:[2:19:11]
Boot count: 7
#calibration_ok:[2:19:11]
Boot count: 8
#calibration_ok:[2:19:11]
Boot count: 9
#calibration_ok:[2:19:11]
Boot count: 10
#calibration_ok:[2:19:11]
Boot count: 11
#calibration_ok:[2:19:11]
Boot count: 12
#calibration_ok:[2:19:11]
Boot count: 13
#calibration_ok:[2:19:11]
Boot count: 14
```

## Code Reference

By default, the Flash Memory API uses address 0xFF000~0xFFFFF to store data.

There is limitation when writing to flash memory. That is, you can not directly write data to the same address you used in last write. To do that correctly, you need erase the sector first. The Flash API of Ameba uses a 4K SRAM to record the user modification and do the erase/write task together.

Use `FlashMemory.read()` to read from Flash memory.

Use `FlashMemory.buf[0] = 0x00;` to manipulate the 4K buf.

Use `FlashMemory.update()`; to update the data in buf to Flash Memory.



## Flash Memory - Use Flash Memory Larger Than 4K

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

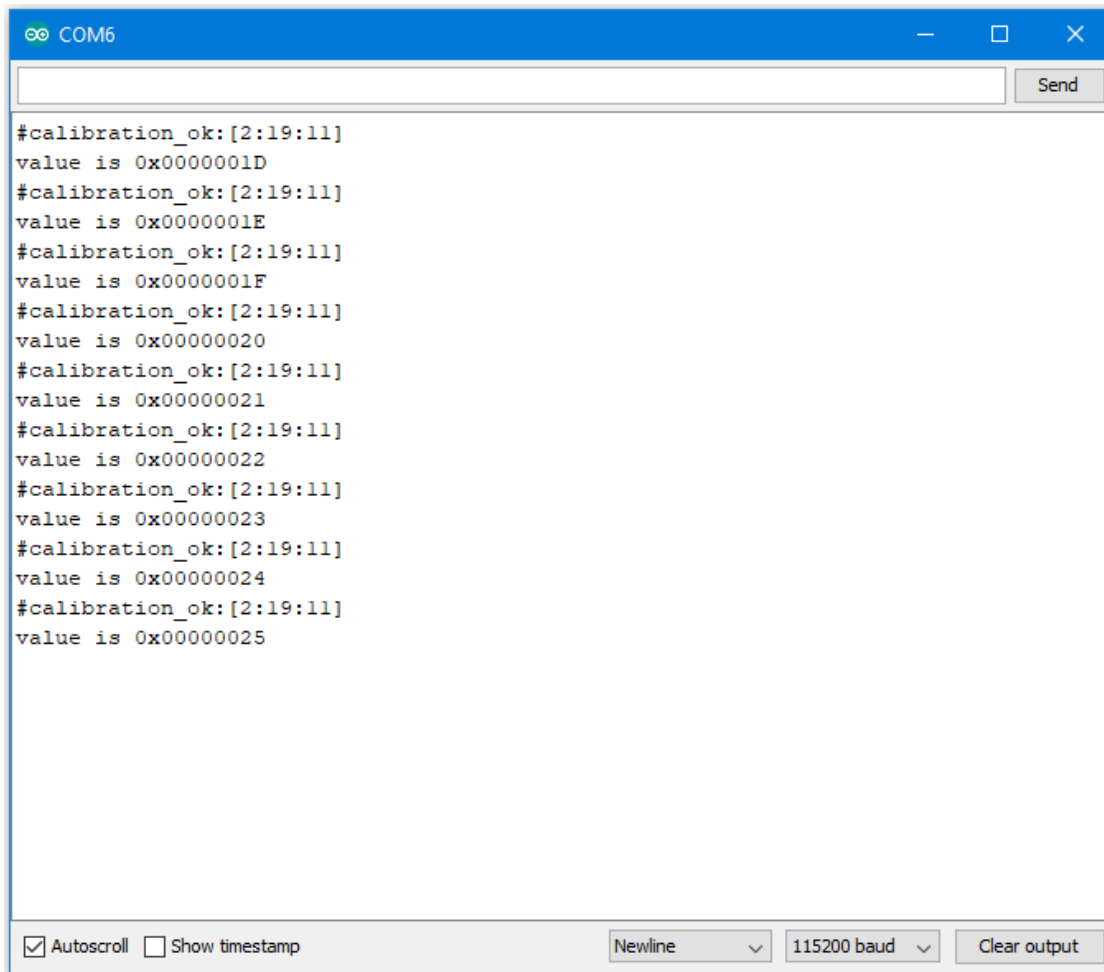
### Example

Flash Memory API uses memory of 4K bytes, which is normally sufficient for most application. However, larger memory can be provided by specifying a specific memory address and required size.

First, open the sample code in “File” -> “Examples” -> “AmebaFlashMemory” -> “ReadWriteOneWord”

In this example, we specify the starting address of flash memory is 0xFC000 and size is 0x4000 (The default starting address is 0xFF000 and size is 0x1000).

Then calculate correct address according to the specified offset and perform read/write operation. In the sample code we use offset 0x3F00, that is,  $0xFC000 + 0x3F00 = 0xFFFF00$  in flash. We set the value to 0 at first, then increase by 1 every time Ameba reboots.



## Code Reference

We can use the flash api we used in previous flash memory example, but we need to use `begin()` function to specify the desired starting address and memory size.

```
FlashMemory.begin(0xFC000, 0x4000);
```

Use `readWord()` to read the value stored in a memory address. In the example, we read the value stored in memory offset `0x3F00`, that is `0xFC000 + 0x3F00 = 0xFFFF00`. `readWord()` function reads a 32-bit value and returns it.

```
value = FlashMemory.readWord(0x3F00);
```

Use `writeWord()` to write to a memory address. The first argument is the memory offset, the second argument is the value to write to memory.

```
FlashMemory.writeWord(0x3F0C, value);
```

## GPIO - Measure Distance By Ultrasound Module

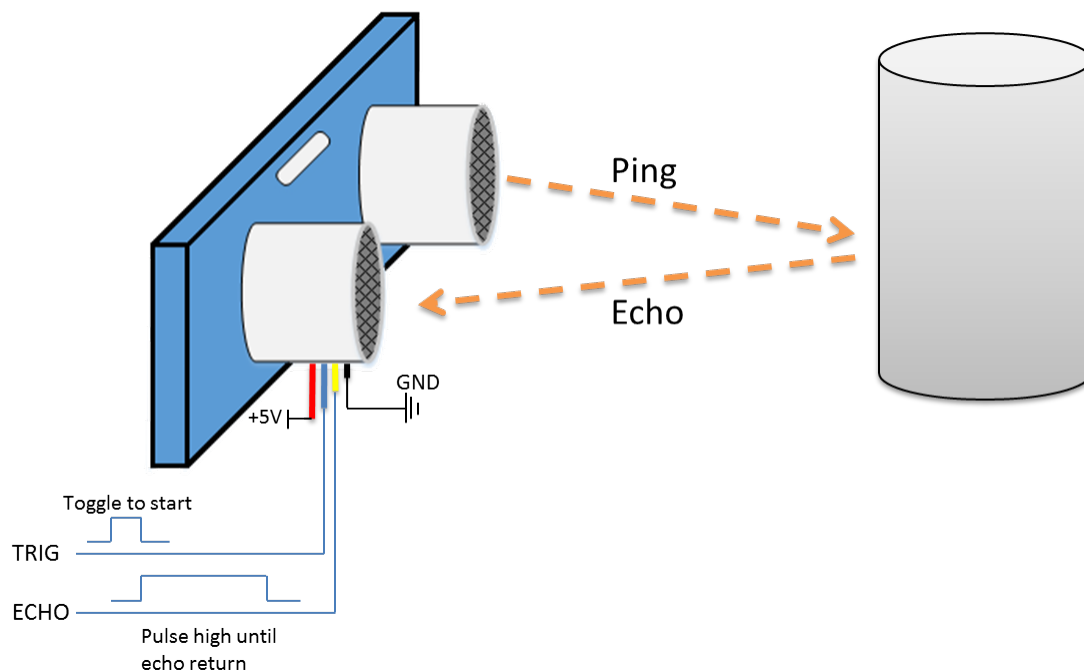
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- HC-SR04 Ultrasonic x 1
- Dropping resistor or Level converter

### Example

HC-SR04 is a module that uses ultrasound to measure the distance. It looks like a pair of eyes in its appearance, therefore it' s often installed onto robot-vehicle or mechanical bugs to be their eyes.

The way it works is that first we “toggle high” the TRIG pin (that is to pull high then pull low). The HC-SR04 would send eight 40kHz sound wave signal and pull high the ECHO pin. When the sound wave returns back, it pull low the ECHO pin.

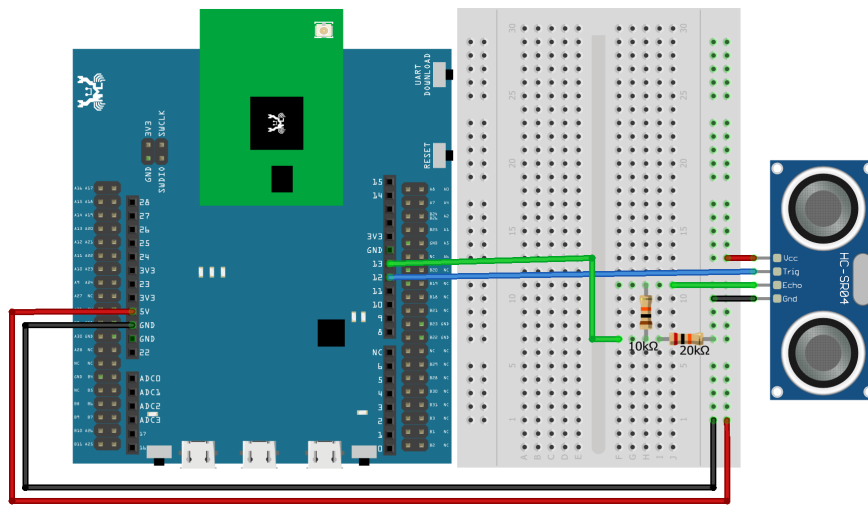


Assume the velocity of sound is 340 m/s, the time it takes for the sound to advance 1 cm in the air is  $340 \times 100 \times 10^{-6} = 29 \mu\text{s}$ .

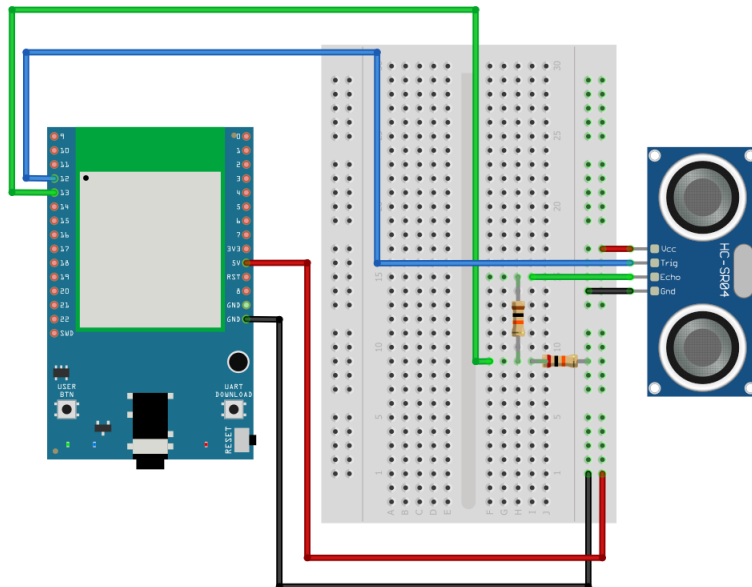
The sound wave actually travels twice the distance between HC-SR04 and the object, therefore the distance can be calculated by  $(\text{time}/29) / 2 = \text{time} / 58$ .

The working voltage of HC-SR04 is 5V. When we pull high the ECHO pin to 5V, the voltage might cause damage to the GPIO pin of Ameba. To avoid this situation, we need to drop the voltage as follows:

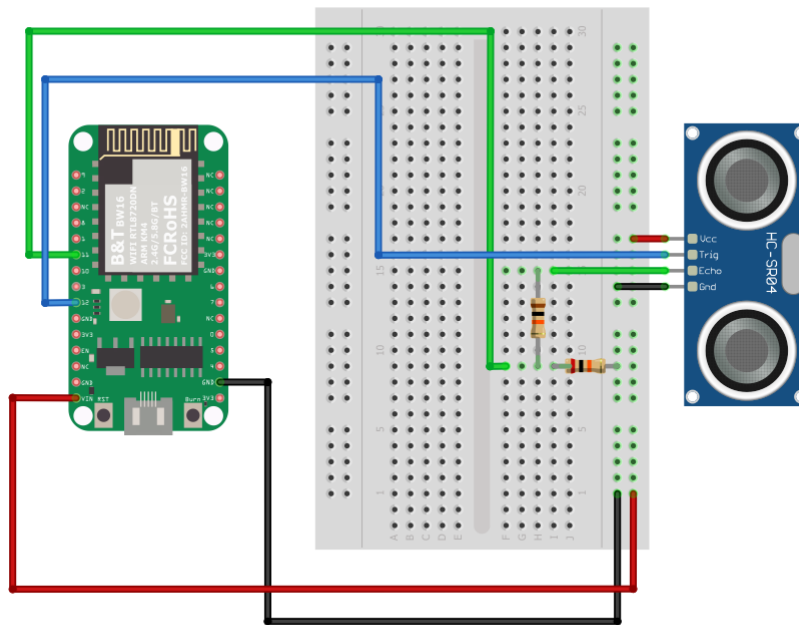
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



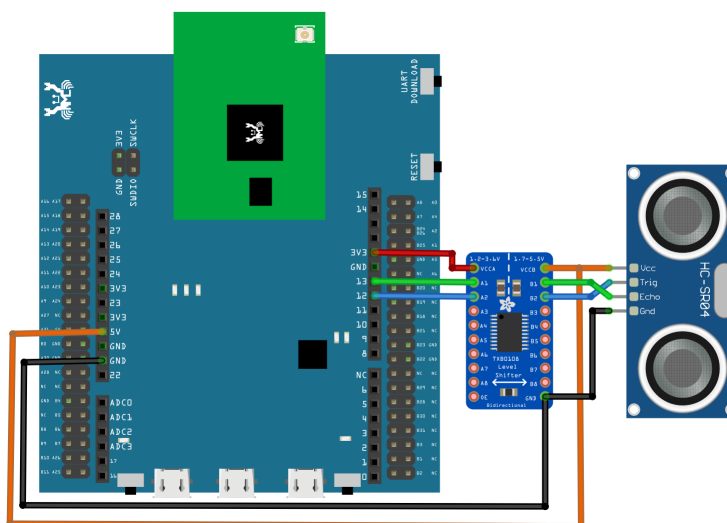
BW16 Wiring Diagram:



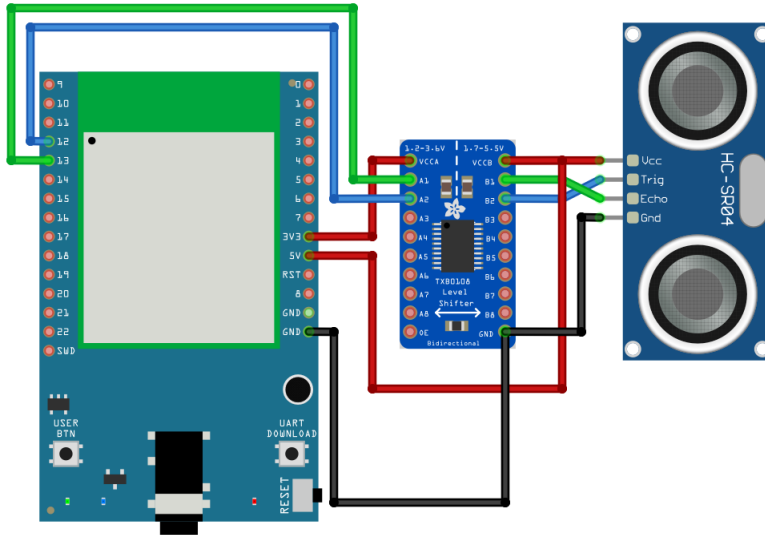
We pick the resistors with resistance 1:2, in the example we use  $10k\Omega$  and  $20k\Omega$ .

If you do not have resistors in hand, you can use level converter instead. The TXB0108 8 channel level converter is a suitable example:

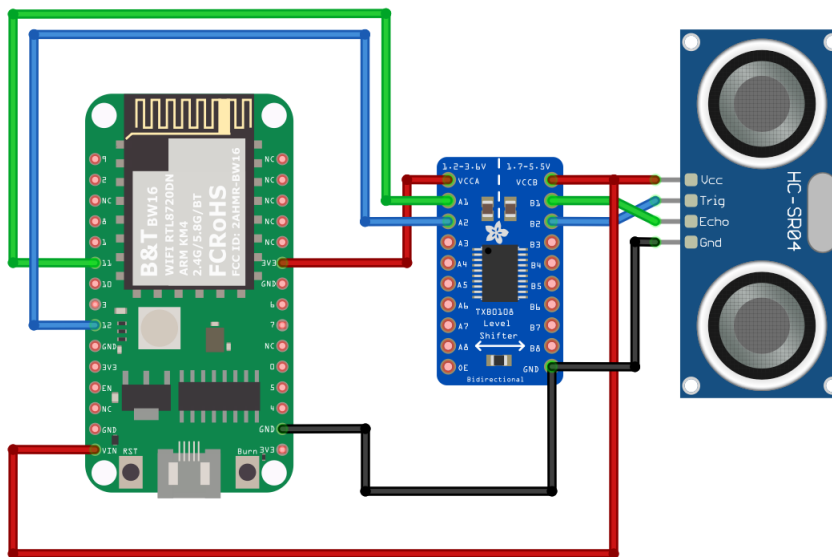
AMB21 / AMB22 Wiring Diagram:



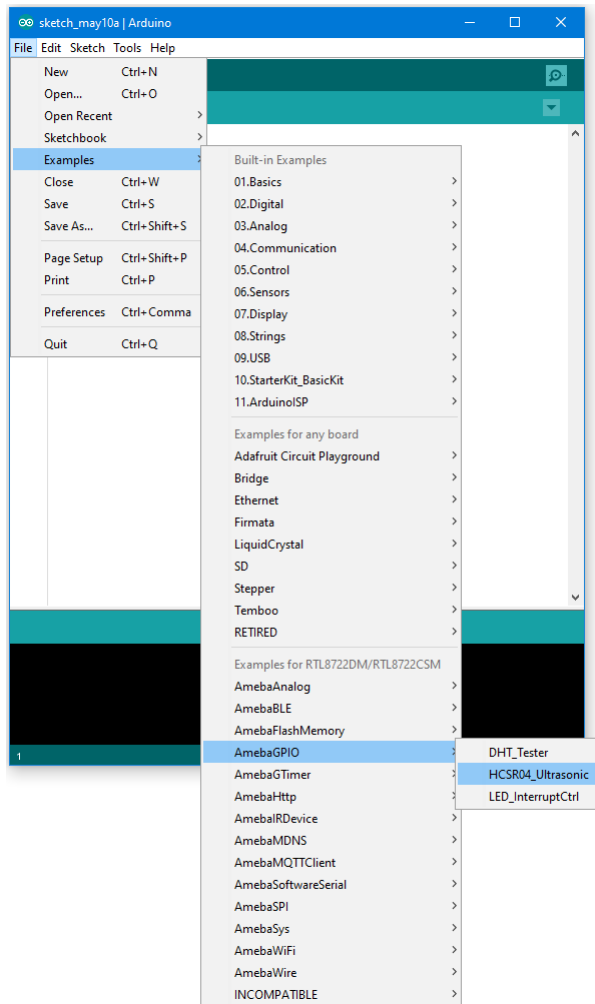
AMB23 Wiring Diagram:



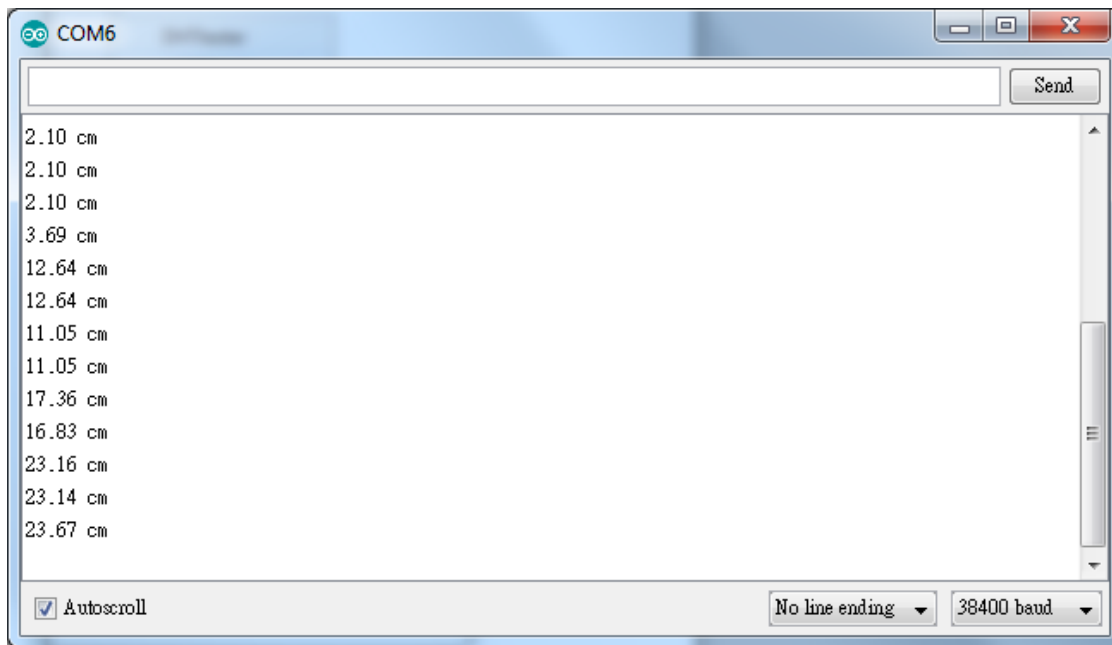
BW16 Wiring Diagram:



Next, open the sample code in “File” -> “Examples” -> “AmebaGPIO” -> “HCSR04\_Ultrasonic”



Compile and upload to Ameba, then press the reset button. Open the Serial Monitor, the calculated result is output to serial monitor every 2 seconds.



Note that the HCSR04 module uses the reflection of sound wave to calculate the distance, thus the result can be affected by the surface material of the object (e.g., harsh surface tends to cause scattering of sound wave, and soft surface may cause the sound wave to be absorbed).

### Code Reference

Before the measurement starts, we need to pull high the TRIG pin for 10us and then pull low. By doing this, we are telling the HC-SR04 that we are about to start the measurement:

```
digitalWrite(trigger_pin, HIGH);  
delayMicroseconds(10);  
digitalWrite(trigger_pin, LOW);
```

Next, use `pulseIn` to measure the time when the ECHO pin is pulled high.

```
duration = pulseIn (echo_pin, HIGH);
```

Finally, use the formula to calculate the distance.

```
distance = duration / 58;
```



## GPIO - Measure Temperature and Humidity

### Preparation

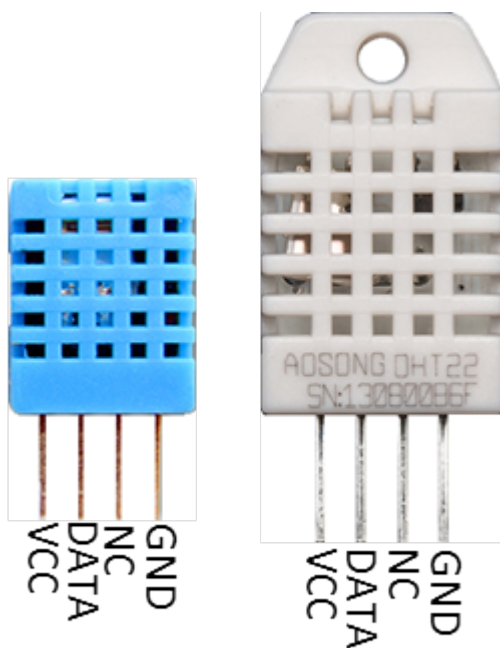
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21

### Example

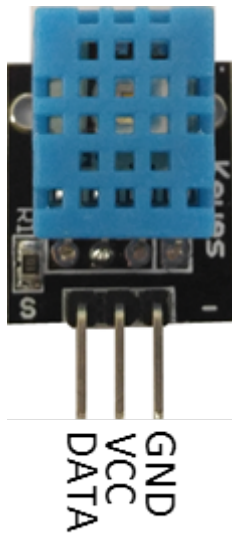
DHT11 is a temperature and humidity sensor which operates at voltage 3.3V~5V. At room temperature, the measurable range of the humidity is 20% ~ 90%RH with  $\pm 5\%$ RH precision, the measurable range of the temperature is 0 ~ 50°C with  $\pm 2^\circ\text{C}$  precision.

Another choice of temperature and humidity sensor is DHT22 sensor, which has better precision. Its measurable range of the humidity is 0%~100%RH with  $\pm 5\%$ RH precision, the measurable range of the temperature is -40~125 °C with  $\pm 0.2^\circ\text{C}$  precision.

There are 4 pins on the sensor:

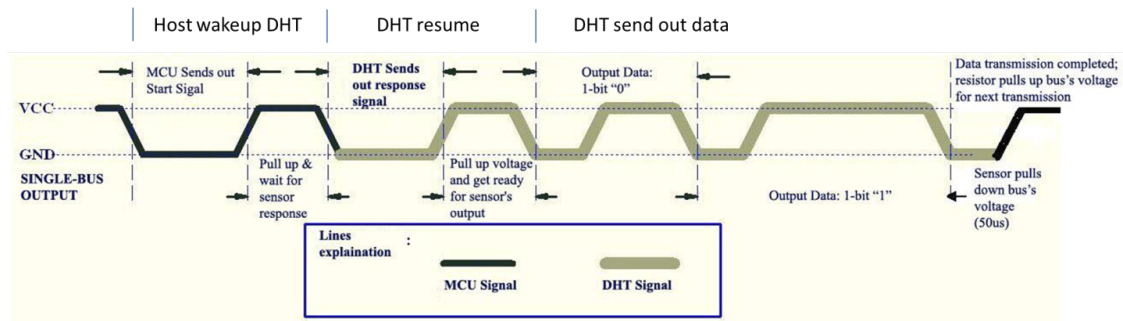


Since one of the 4 pins has no function, there are temperature/humidity sensors with only 3 pins on the market:

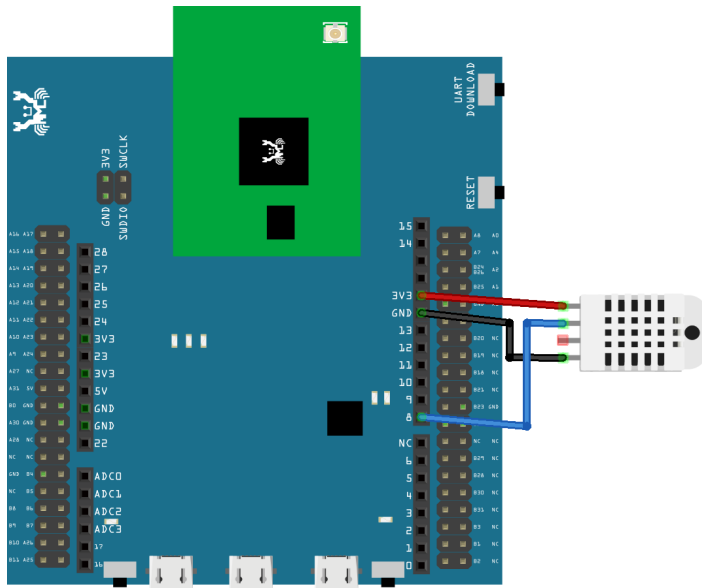


DHT is normally in the sleeping mode. To get the temperature/humidity data, please follow the steps:

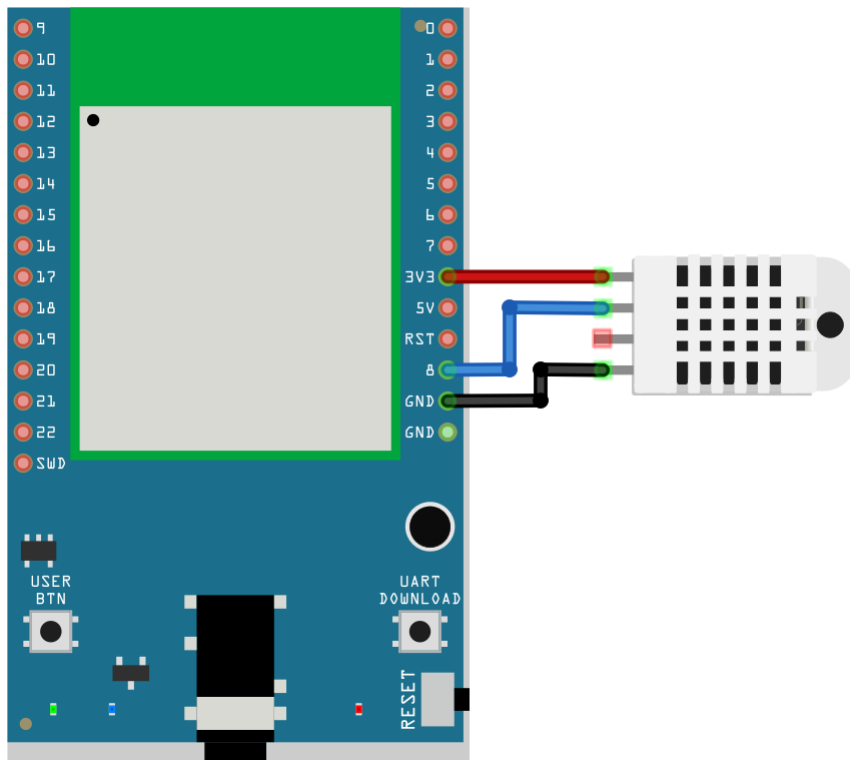
1. Awake DHT: Ameba toggles low its DATA pin of GPIO. Now the DATA pin of GPIO serves as digital out to Ameba.
2. DHT response: DHT also toggle low its DATA pin of GPIO. Now the DATA pin of GPIO serves as digital in for Ameba.
3. DHT sends data: DHT sends out the temperature/humidity data (which has size 5 bytes) in a bit by bit manner. To represent each bit, DHT first pull low the DATA GPIO pin for a while and then pull high. If the duration of high is smaller than low, it stands for bit 0. Otherwise it stands for bit 1.



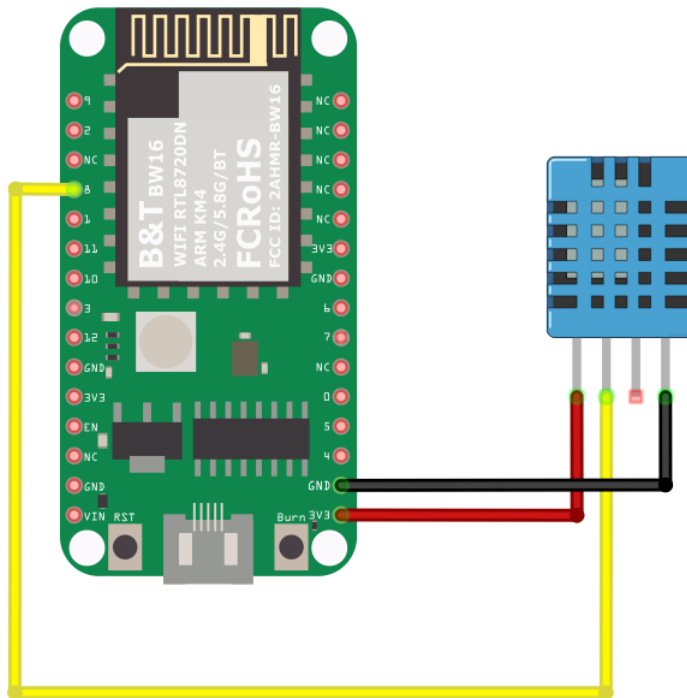
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the sample code in “Files” -> “Examples” -> “AmebaGPIO” -> “DHT\_Tester” . Compile and upload to Ameba, then press the reset button. The result would be shown on the Serial Monitor.

```

COM6
#calibration_ok:[2:19:11]
DHTxx test!
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 91.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.93 *C 78.68 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 92.00 %      Temperature: 28.00 *C 82.40 *F  Heat index: 34.46 *C 94.03 *F

```

## Code Reference

Use `dht.readHumidity()` read the humidity value, and use `dht.readTemperature()` to read the temperature value.

Every time we read the temperature/humidity data, Ameba uses the buffered temperature/humidity data unless it found the data has expired (i.e., has not been updated for over 2 seconds). If the data is expired, Ameba issues a request to DHT to read the latest data.

## GPIO - Use GPIO Interrupt To Control LED

### Preparation

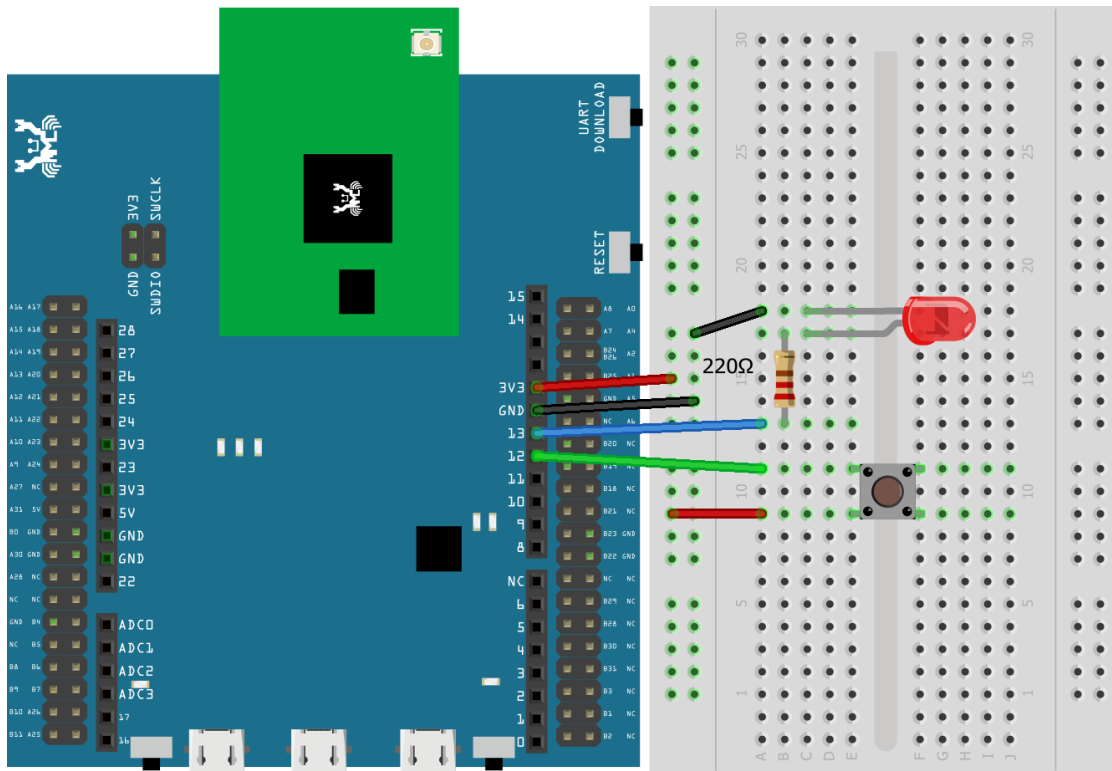
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- LED x 1
- Button x 1

## Example

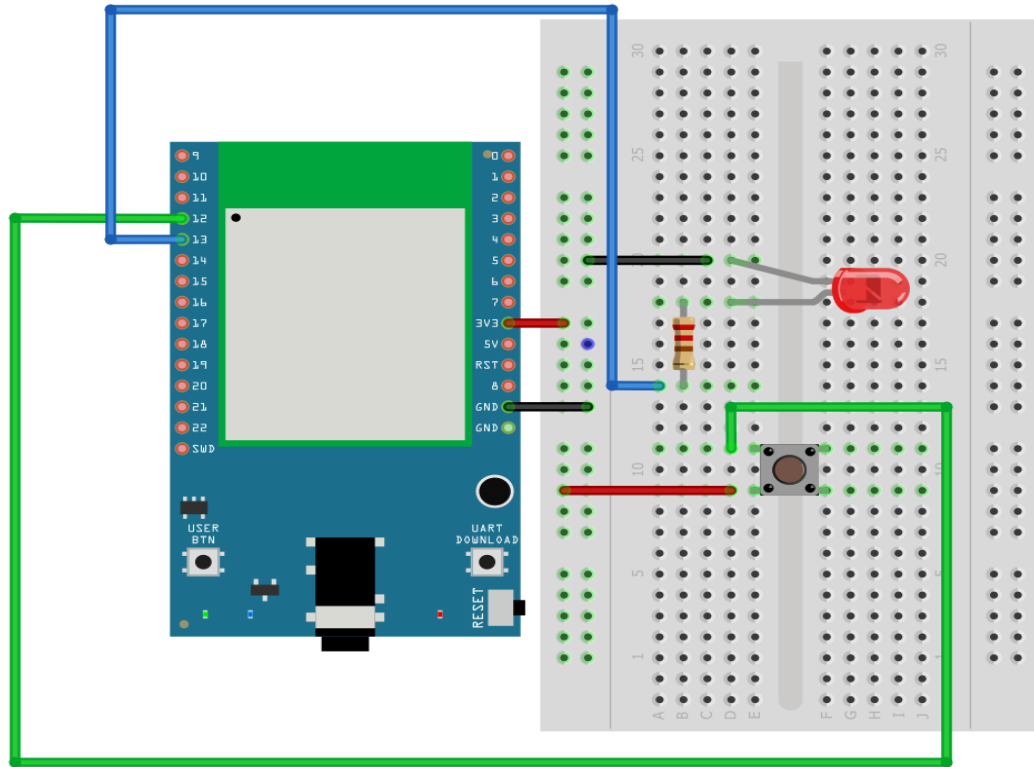
In this example, we use a button to trigger interrupt and control the LED. When we press and release the button, the LED dims, press and release the button again, and the LED lights. Note that in the Arduino example “Button and LED”, LED only lights when the button is pressed and hold, when we release the button, the LED dims.

Open the example, “Files” -> “Examples” -> “AmebaGPIO” -> “LED\_InterruptCtrl”

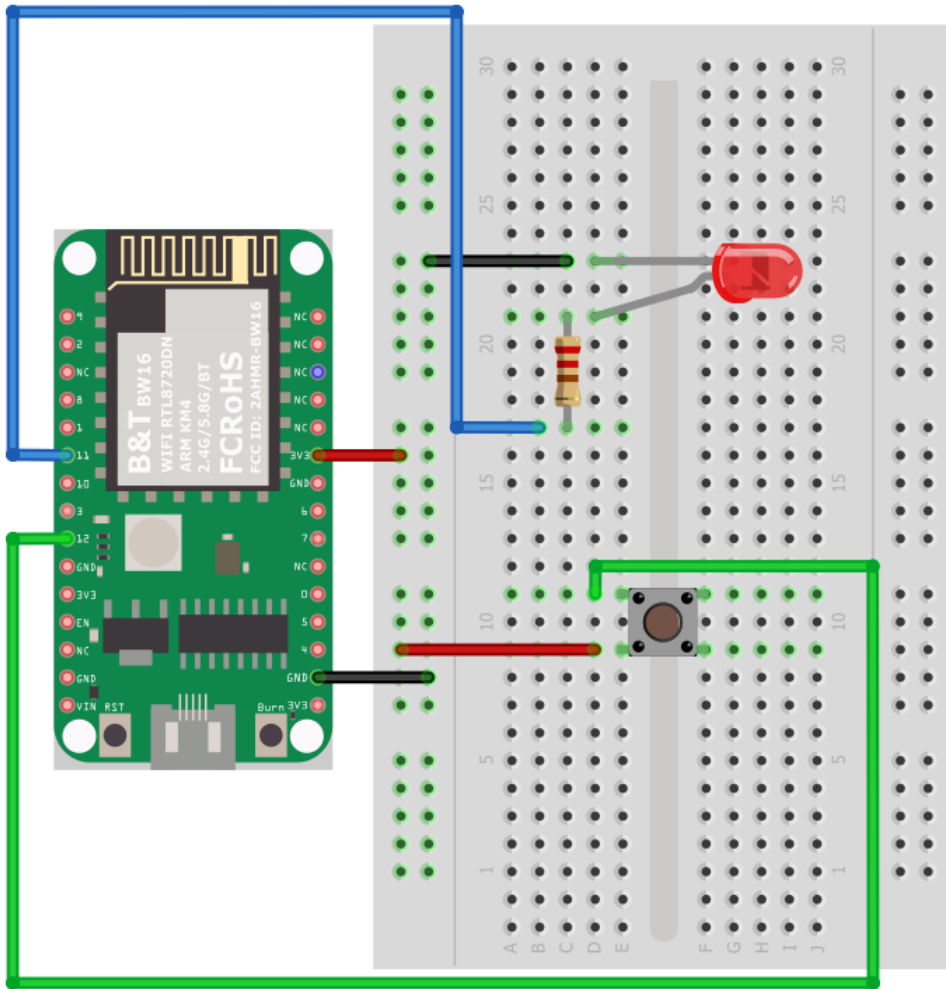
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



**BW16** Wiring Diagram:



Compile and upload the program, press reset.

The LED lights at first. Press and release the button, then the LED should dim. Press again, then the LED should light.

## Code Reference

In

```
setup()
```

we set Pin 12 to



```
INPUT_IRQ_RISE
```

, this means that an interrupt occurs when the voltage of this pin changes from GND to 3V3. Therefore, we connect the other side of the button to 3V3, so as to trigger interrupt event when the button is pressed.

```
pinMode(button, INPUT_IRQ_RISE);
```

On the other hand, we can set pin 12 to

```
INPUT_IRQ_FALL
```

, this means that an interrupt occurs when the voltage of this pin changes from 3V3 to GND. In this case, the other side of the button is connected to GND. Next, we need to specify the function to be executed to handle the interrupt:

```
digitalSetIrqHandler(button, button_handler);
```

The second parameter is a function pointer, with prototype:

```
void button_handler(uint32_t id, uint32_t event)
```

In this handler, every time we press and release the button, we trigger an interrupt, and change the status of the LED.

## GTimer - Using The Periodic GTimer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

Ameba provides 4 hardware GTimer for users to use. The timers' resolutions are at microseconds scale.

The timer can be set to be periodic or for single use. The periodic timers reset periodically, and the single-use timers do not.

Open the example, "File" -> "Examples" -> "AmebaGTimer" -> "TimerPeriodical".

Compile and upload to Ameba, and press reset.

In the Serial Monitor, you can see the counter value is increased periodically.

## Code Reference

The first argument of `begin()` is the timer id (0~3).

The second argument is the value of the timer (in microseconds). In the example, we fill in `1000000us = 1s`.

The third argument specifies the function to call when the time is up. In the example, we call the “myhandler” function to increase the counter value by 1 and print the counter value to serial monitor.

```
GTimer.begin(0, 1 * 1000 * 1000, myhandler);
```

The GTimer is periodic by default, therefore “myhandler” function is called every second. When we want to stop the GTimer, use `stop()`:

```
GTimer.stop(0);
```

## GTimer - Using the One-Time Gtimer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we will use 4 One-Time GTimer, and pass user data to each timer.

Open the example “File” -> “Examples” -> “AmebaGTimer” -> “TimerOneshot”. Compile and upload to Ameba, and press reset. Then you can see the 4 timer log printed to the serial monitor in series.

## Code Reference

The first argument of `begin()` is the Timer ID (0~3). The second argument is the value of the timer (in microseconds). In the example, we fill in `1000000us = 1s`. The third argument specifies the function to call when the time is up. The fourth argument is to set whether this timer is a periodic timer, we use “false” here to begin a single-use timer. The fifth argument is the user data, we give 0 here to represent that this is timer 0.

```
GTimer.begin(0, 1 * 1000 * 1000, myhandler, false, 0);
```

Next, we set up the second timer, which has timer value 2 seconds, and user data 1. And other timers are set similarly.

```
GTimer.begin(1, 2 * 1000 * 1000, myhandler, false, 1);
```

In myhandler function, we print the user data to serial monitor. Since the 4 timers are separately set to count for 1, 2, 3, 4 seconds, from 1 second to 4 second, the user data of each timer are printed on the serial monitor in order. After 4 second, no log will be printed.

## I2C - Send Data to Arduino UNO

### Introduction of I2C

There are two roles in the operation of I2C, one is “master” , the other is “slave” . Only one master is allowed and can be connected to many slaves. Each slave has its unique address, which is used in the communication between master and the slave. I2C uses two pins, one is for data transmission (SDA), the other is for the clock (SCL). Master uses the SCL to inform slave of the upcoming data transmission, and the data is transmitted through SDA. The I2C example was named “Wire” in the Arduino example.

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Arduino UNO x 1

### Example

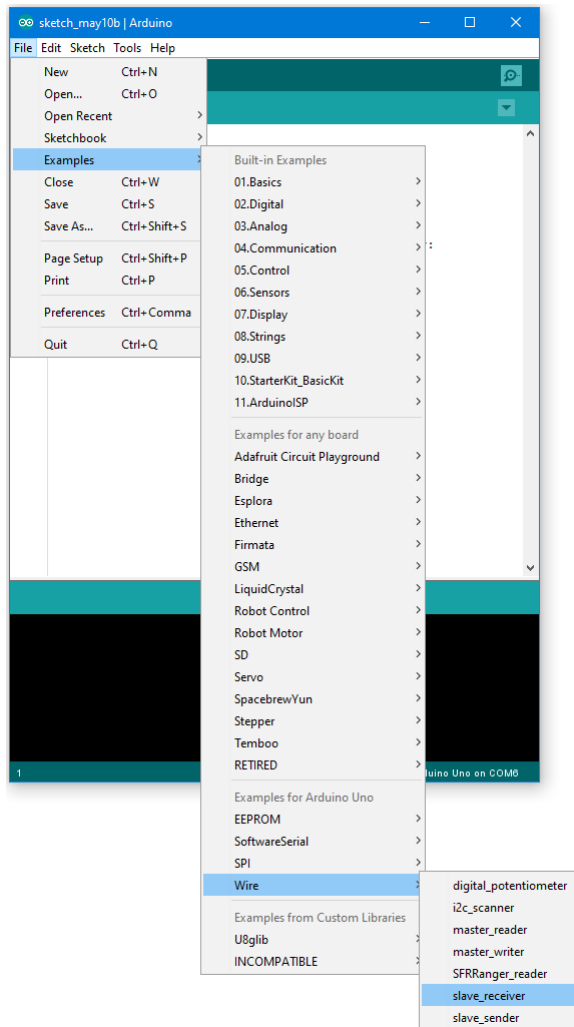
In this example, we use Ameba as the I2C master writer, and use Arduino as the I2C slave receiver.

When the I2C slave receives string sent from I2C master, it prints the received string.

- Setting up Arduino Uno to be I2C Slave

First, select Arduino in the Arduino IDE in “Tools” -> “Board” -> “Arduino Uno”

Open the “Slave Receiver” example in “Examples” -> “Wire” -> “slave\_receiver” :



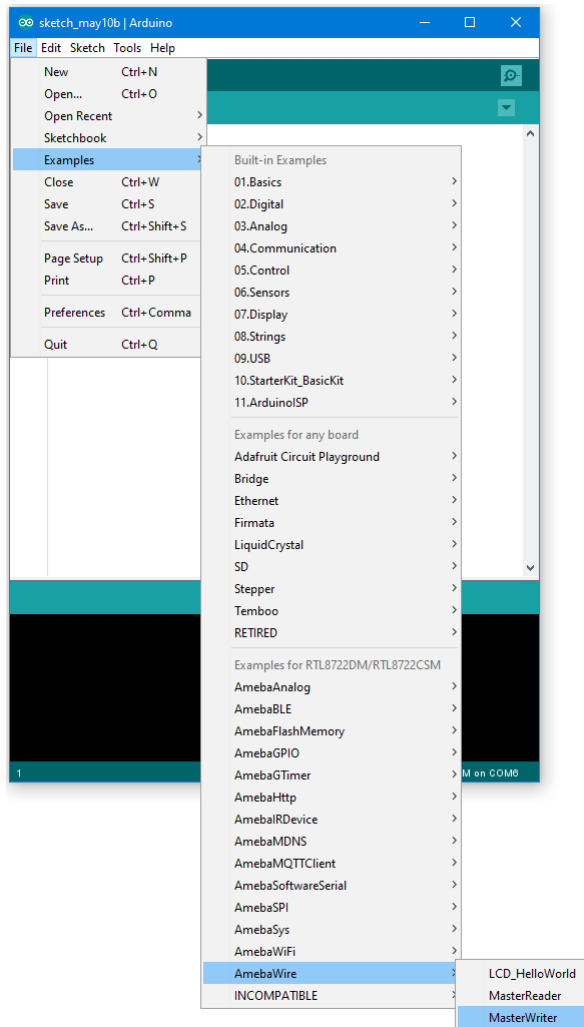
Then click “Sketch” -> “Upload” to compile and upload the example to Arduino Uno.

- Setting up Ameba to be I2C Master

Next, open another window of Arduino IDE, make sure to choose your Ameba development board in the IDE:

“Tools” -> “Board”

Then open the “Master Writer” example in “File” -> “Examples” -> “AmebaWire” -> “MasterWriter”

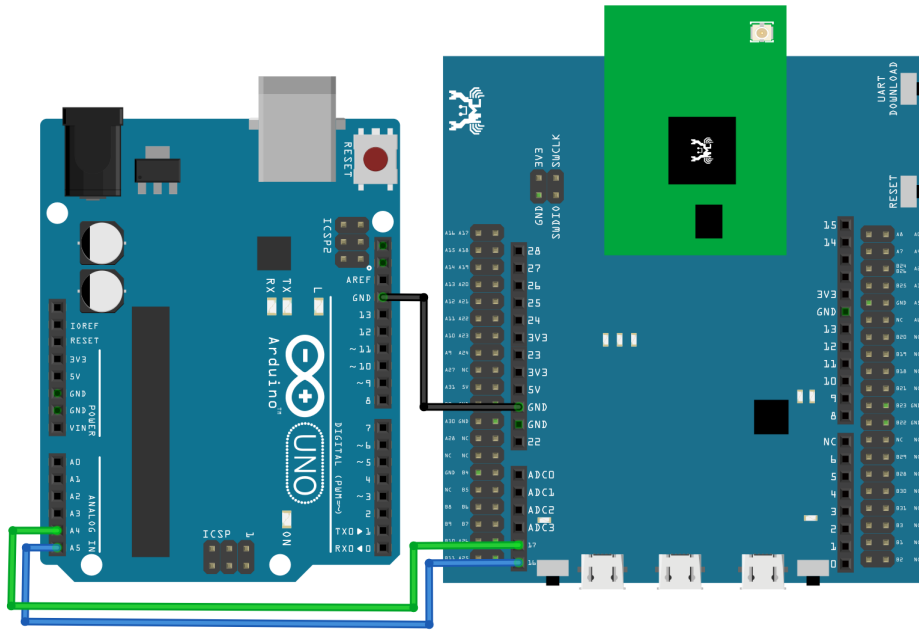


- Wiring

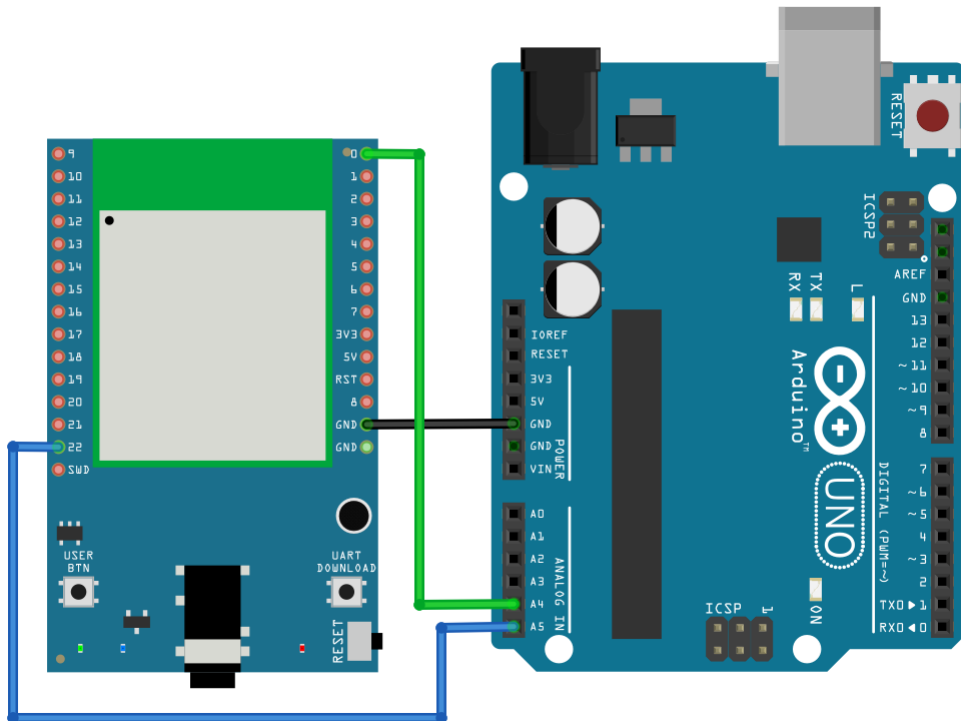
The Arduino example uses A4 as the I2C SDA and A5 as the I2C SCL.

Another important thing is that the GND pins of Arduino and Ameba should be connected to each other.

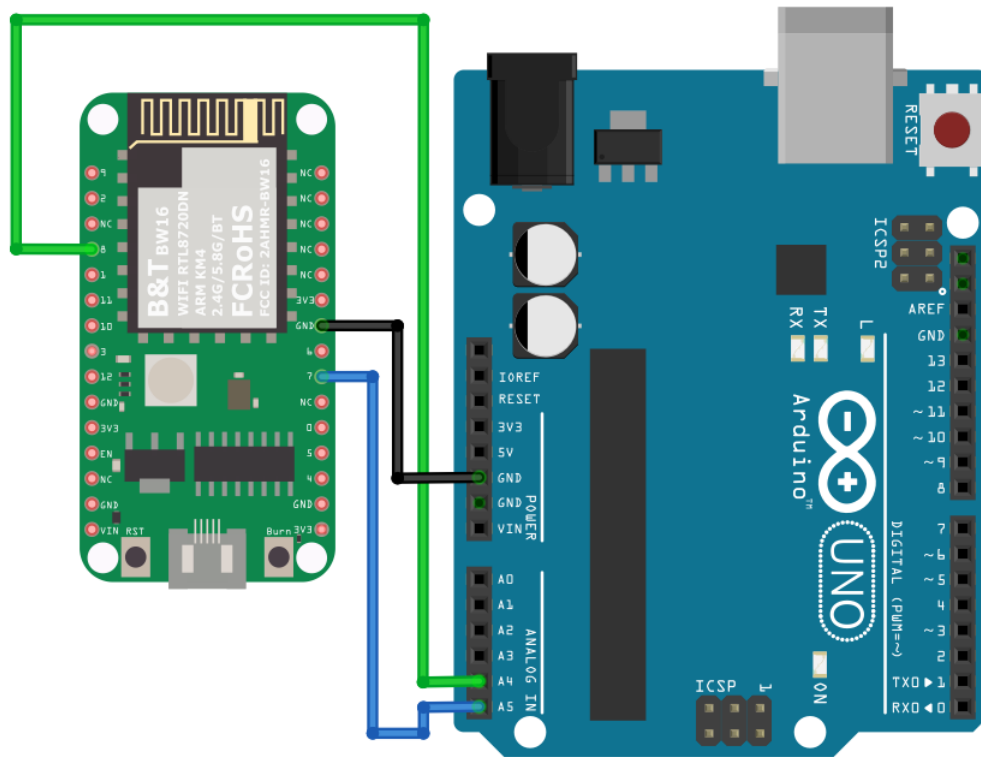
**AMB21/ AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



BW16 Wiring Diagram:

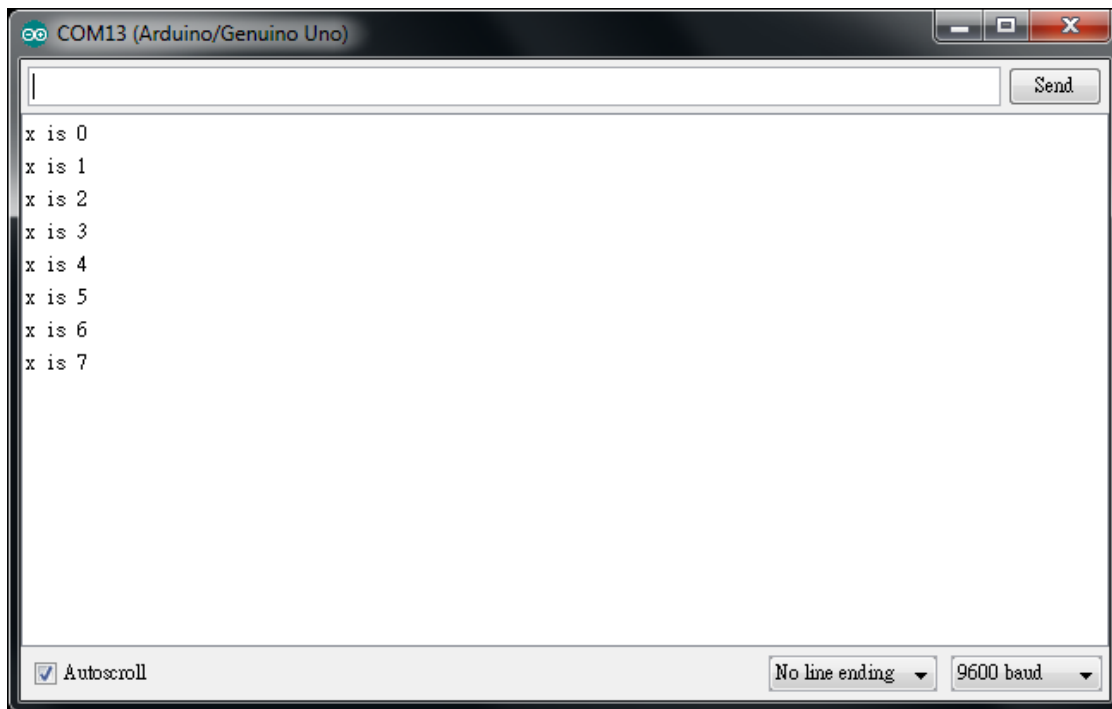


Open the Arduino IDE of the Arduino Uno and open the serial monitor ( “Tools” -> “Serial Monitor” ).

In the Serial Monitor, you can see the messages printed from Arduino Uno.

Next, press the reset button on Arduino Uno. Now the Arduino Uno is waiting for the connection from I2C Master.

We press the reset button on Ameba to start to send messages. Then observe the serial monitor, you can see the messages show up every half second.



## Code Reference

You can find detailed information of this example in the documentation of Arduino:

<https://www.arduino.cc/en/Tutorial/MasterWriter>

First use `Wire.begin()/Wire.begin(address)` to join the I2C bus as a master or slave, in the Master case the address is not required.

<https://www.arduino.cc/en/Reference/WireBegin>

Next, the Master uses `Wire.beginTransmission(address)` to begin a transmission to the I2C slave with the given address:

<https://www.arduino.cc/en/Reference/WireBeginTransmission>

Uses `Wire.write()` to send data, and finally use `Wire.endTransmission()` to end a transmission to a Slave and transmits the bytes that were queued:

<https://www.arduino.cc/en/Reference/WireEndTransmission>



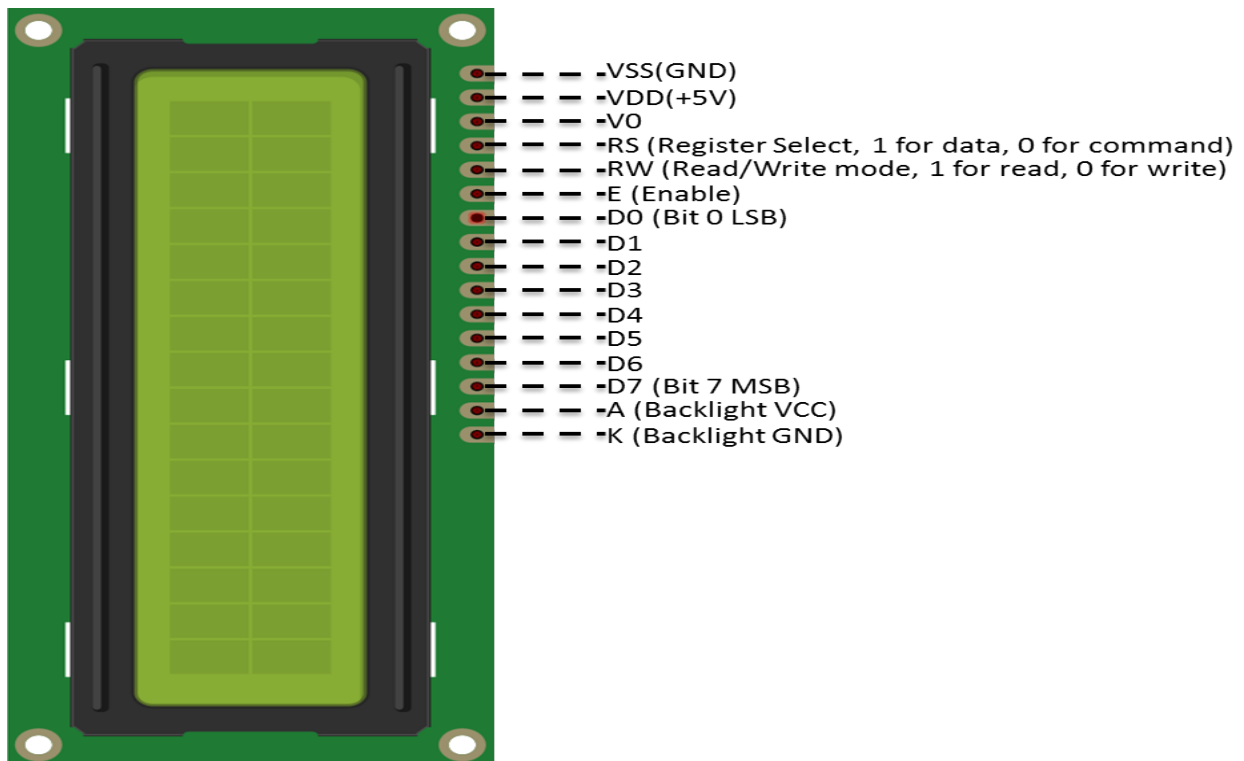
## I2C - Display Data On LCD Screen

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- I2C 2×16 LCD

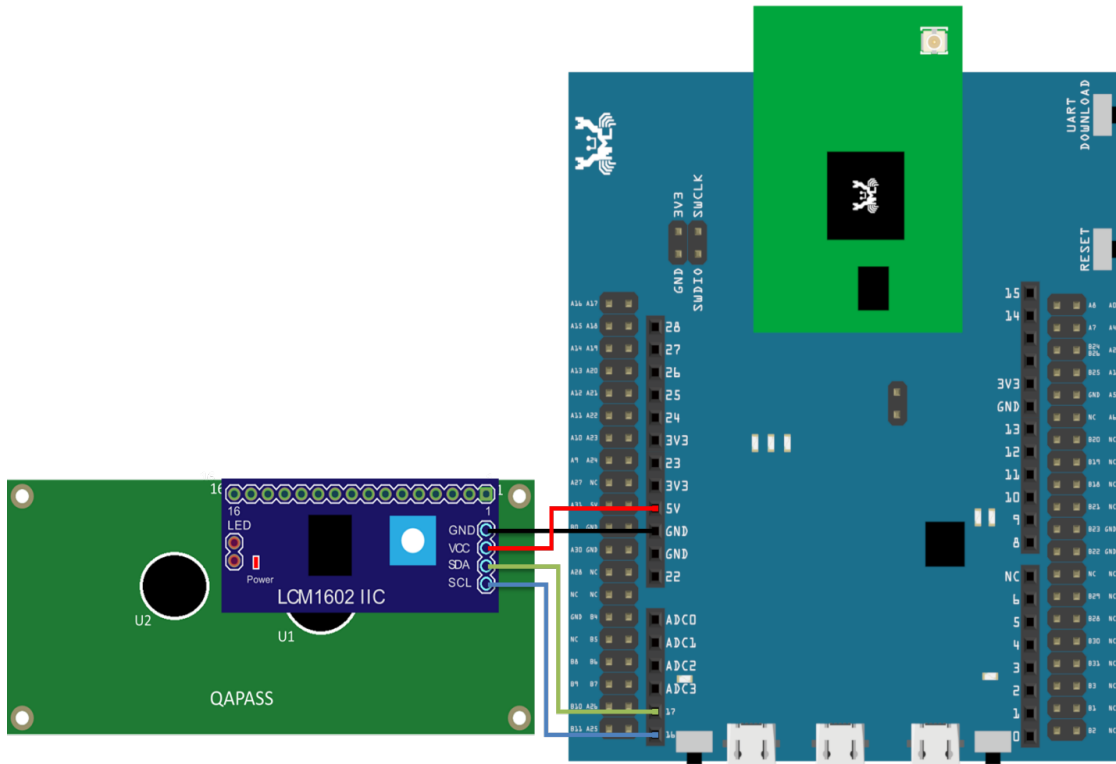
### Example

Normally there are many pins on an LCD display, as shown in below figure.

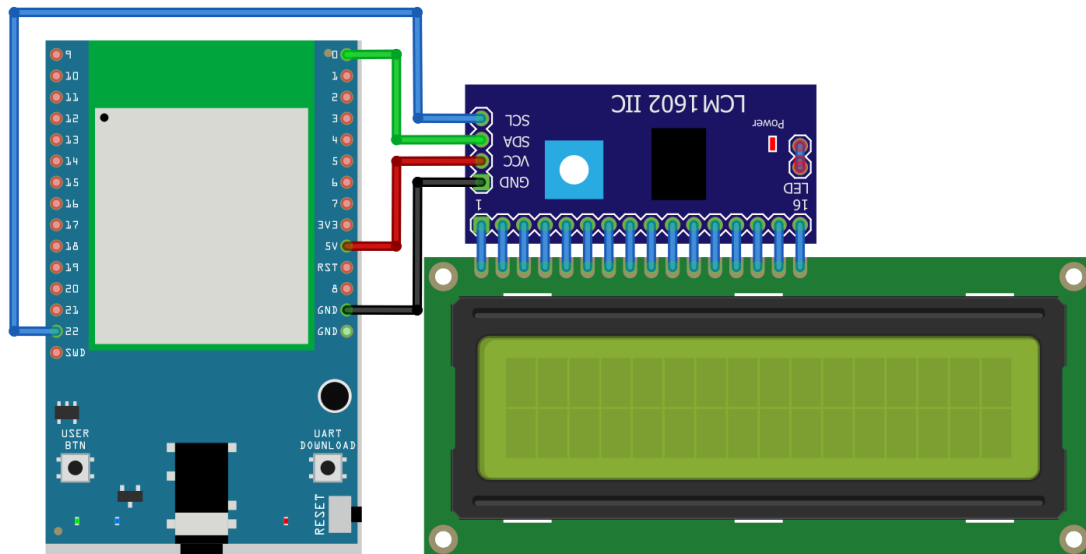


An LCD display can be equipped with an additional processing chip to process the data. The processing chip can connect to a microcontroller using the I2C interface.

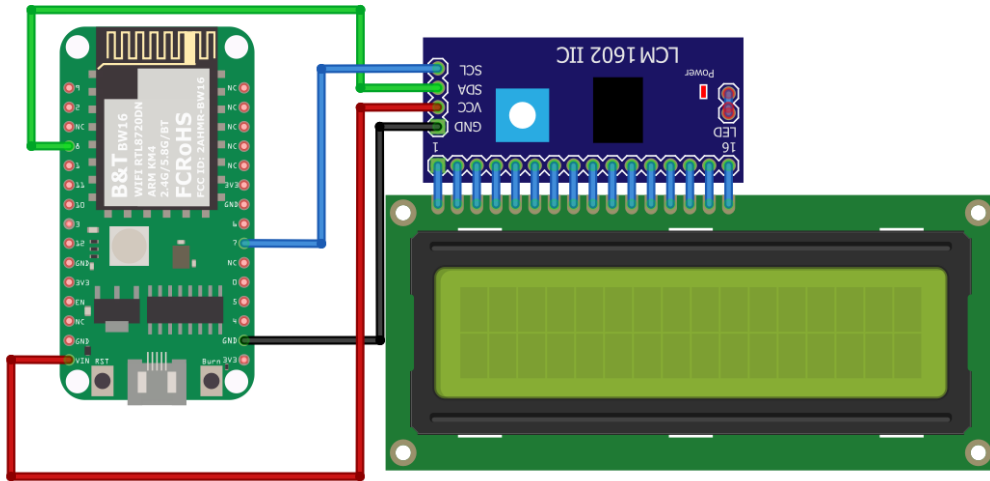
**AMB21 / AMB22 Wiring Diagram:**



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the example in “File” -> “Examples” -> “AmebaWire” -> “LCD\_HelloWorld” .

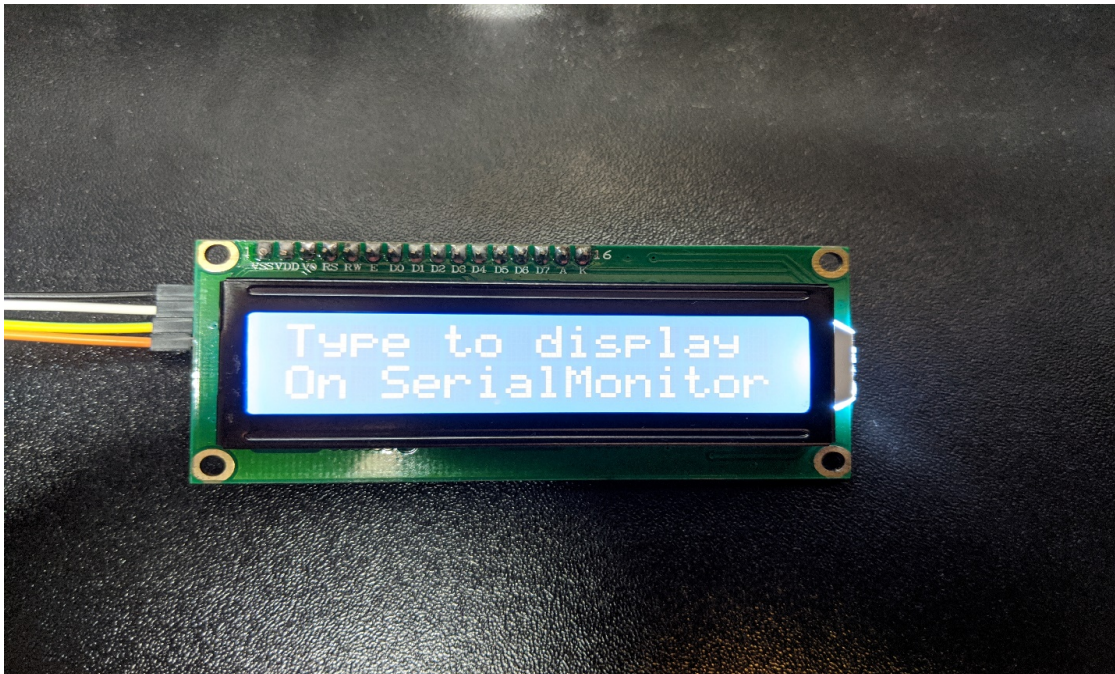
Compile and upload to Ameba, then press the reset button.

Then you can see “Hello World” in the first line, and “Ameba” in the second line displayed on the LCD screen.



After 8 seconds, you can input to the Serial Monitor the string you would like to display on the LCD.





For example, we enter “123456789” and press “Send” :



### Code Reference

The required settings of each model of LCD might be different, the constructor we use in this example is:

```
LiquidCrystal_I2C(uint8_t lcd_Addr, uint8_t En, uint8_t Rw, uint8_t Rs,  
                  uint8_t d4, uint8_t d5, uint8_t d6, uint8_t d7,
```

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(繼續上一頁)

```
uint8_t backlighPin, t_backlighPol pol);
```

And the setting parameters are as follows:

```
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Set the LCD I2C
↪address
```

The first parameter 0x27 is the address of I2C. Each of the following 8 parameters represents the meaning of each bit in a byte, i.e., En is bit 2, Rw is bit 1, Rs is bit 0, d4 is bit 4, and so forth.

Call `backlight()` to light the screen,

Call `setCursor(0, 0)` to set the position of the cursor.

LCD inherits the Print class, so we can use `lcd.print()` to output string on the screen.

## I2C - Receive Data from Arduino UNO

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Arduino UNO x 1

### Example

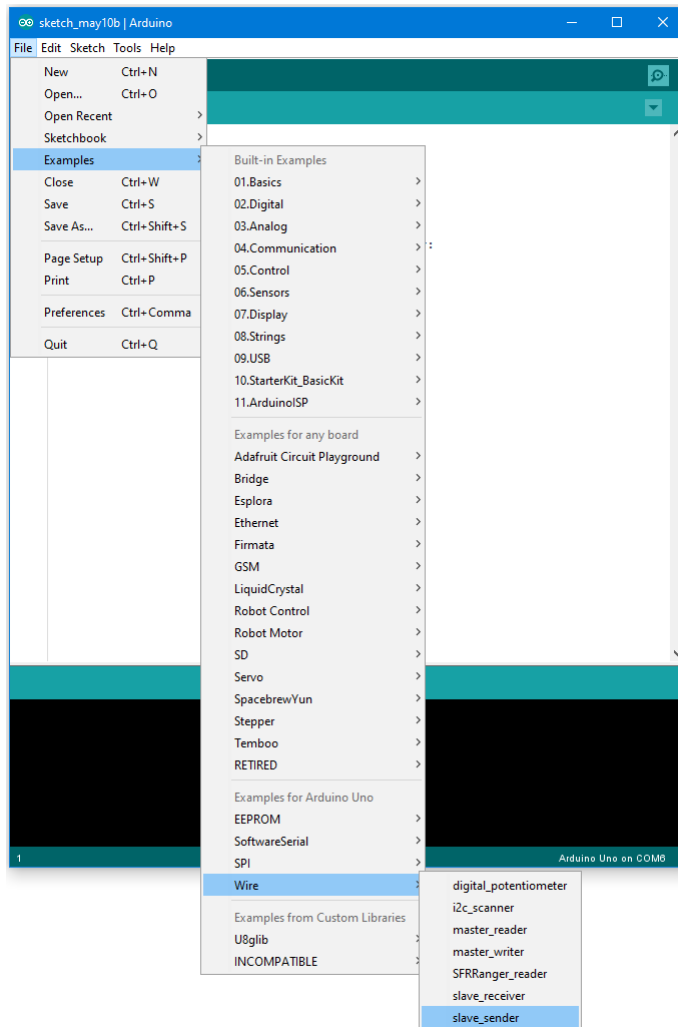
In the previous example “I2C –Communicate with Arduino UNO via I2C” , Ameba, the I2C master, transmits data to the Arduino UNO, the I2C slave.

As to this example, Ameba is the I2C master, and receives data from the Arduino UNO, which is the I2C slave.

- Setting up Arduino Uno to be I2C Slave

First, select Arduino in the Arduino IDE in “Tools” -> “Board” -> “Arduino Uno” :

Open “Examples” -> “Wire” -> “slave\_sender”

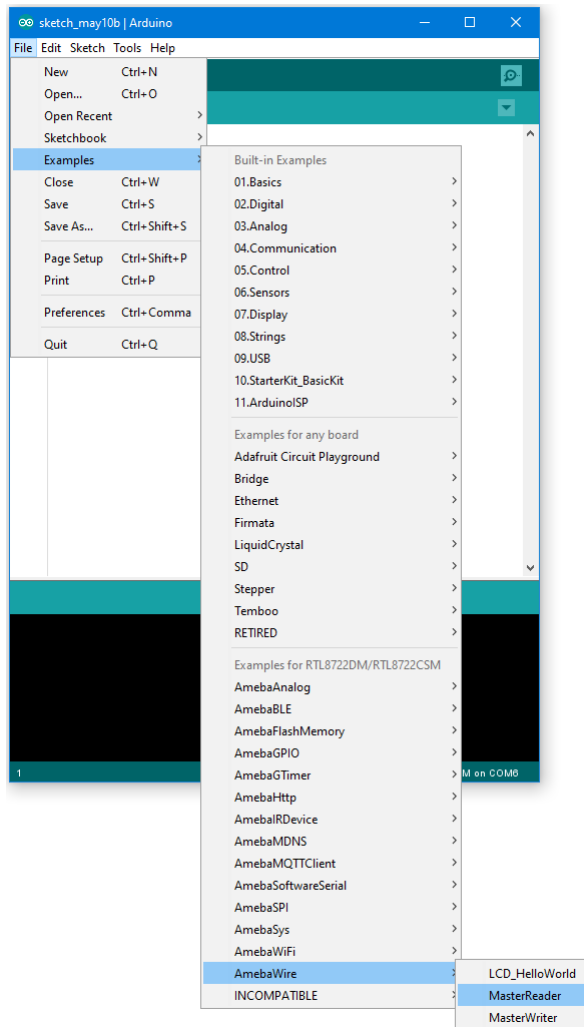


Then click “Sketch” -> “Upload” to compile and upload the example to Arduino Uno.

- **Setting up Ameba to be I2C Master**

Next, open another window of Arduino IDE, make sure to choose your Ameba development board in the IDE: “Tools” -> “Board”

Open “File” -> “Examples” -> “AmebaWire” -> “MasterReader”



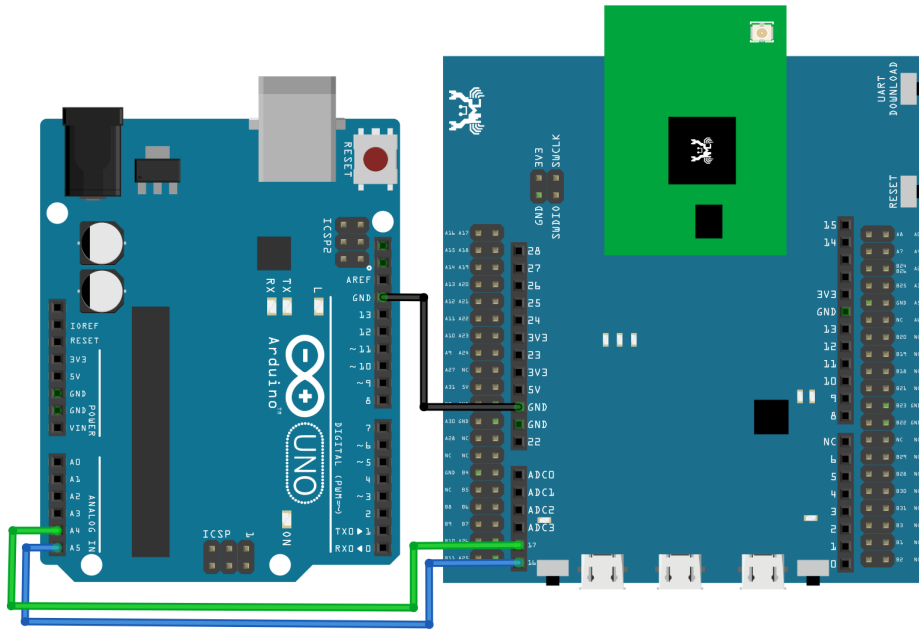
Click “Sketch” -> “Upload” to compile and upload the example to Ameba.

- **Wiring**

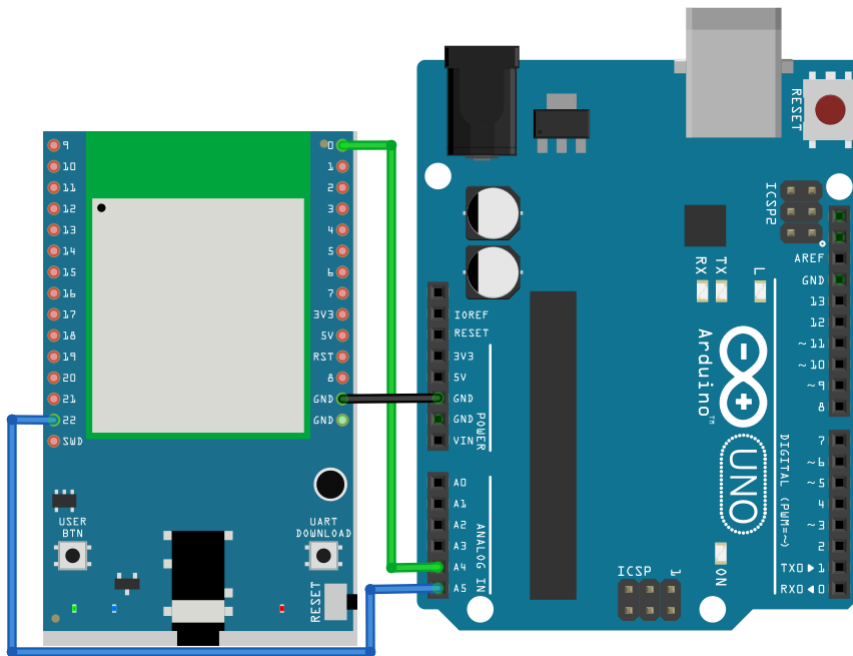
The Arduino example uses A4 as the I2C SDA and A5 as the I2C SCL.

Another important thing is that the GND pins of Arduino and Ameba should be connected to each other.

**AMB21 / AMB22 Wiring Diagram:**

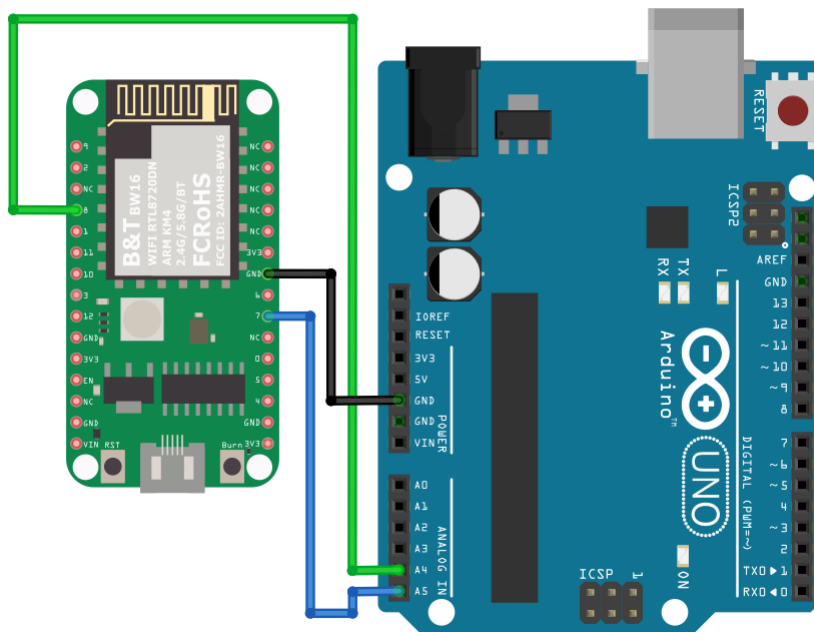


AMB23 Wiring Diagram:



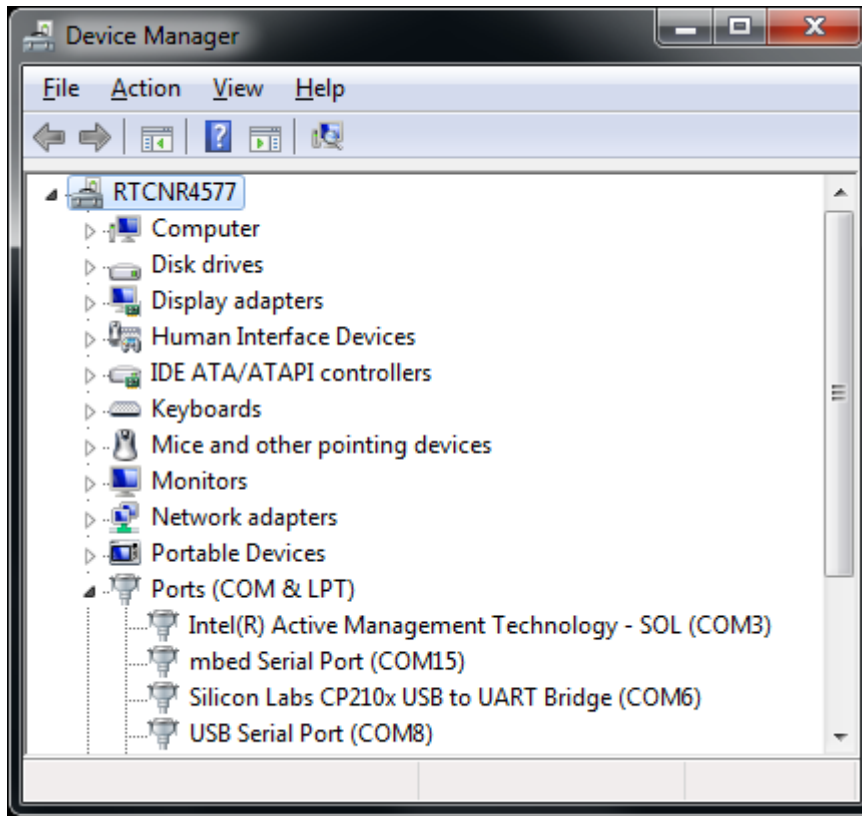
BW16 Wiring Diagram:





Next, we will observe the data receive by Ameba in the Serial Monitor.

(Note: If you do not know which port the Ameba development board is connected to, please find it in the Device Manager of Windows first. Ameba is connected as “mbed Serial Port”. For example, if you find mbed Serial Port (COM15) means Ameba is connected to port COM15.)



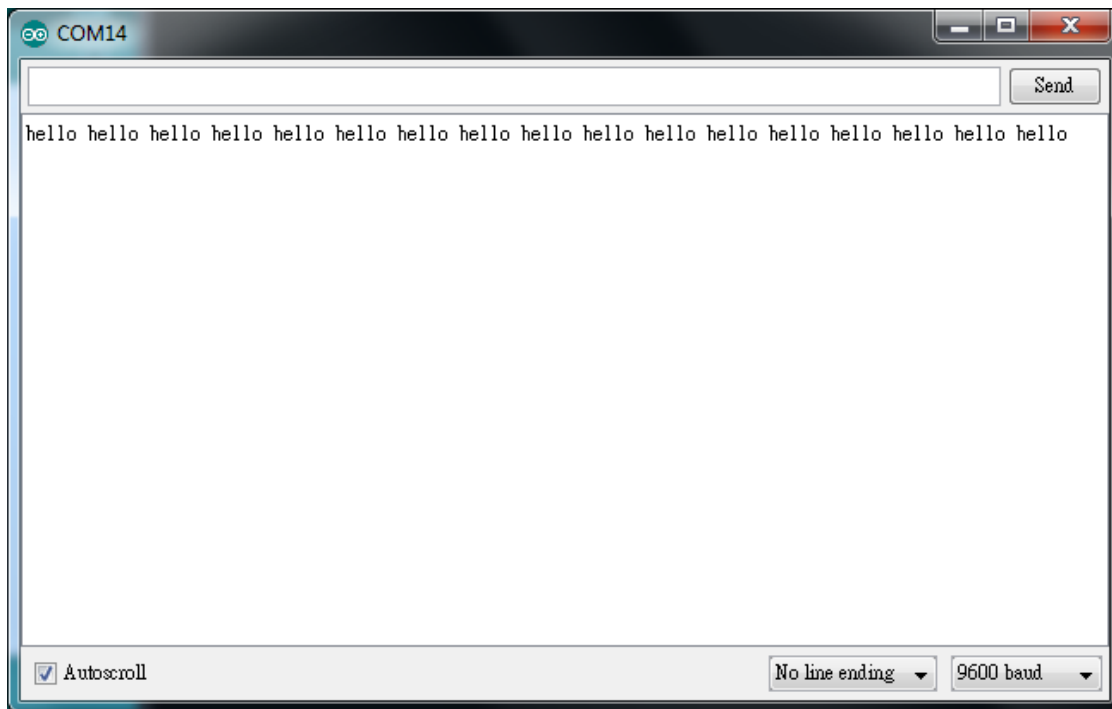
We select the port in “Tools” -> “Port” -> “COM15” (the port connected to Ameba)

Open the Arduino IDE window of the Ameba, go to “Tools” -> “Serial Monitor” to display the messages printed by Ameba.

Press the reset button on Arduino Uno, Arduino Uno now waits for connection from I2C master.

Then press the reset button on Ameba, Ameba will start to receive messages from Arduino Uno. And you can see the “hello ” message printed every half second in serial monitor.

(NOTE: If the message does not show in the Serial Monitor of Ameba, please close and open the serial monitor again.)



## Code Reference

You can find detailed information of this example in the documentation of Arduino:

<https://www.arduino.cc/en/Tutorial/MasterReader>

First use `Wire.begin()` / `Wire.begin(address)` to join the I2C bus as a master or slave, in the Master case the address is not required.

<https://www.arduino.cc/en/Reference/WireBegin>

Next, the Master uses `Wire.requestFrom()` to specify from which Slave to request data.

<https://www.arduino.cc/en/Reference/WireRequestFrom>

## IR - Transmit IR NEC Raw Data And Decode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16 ] x 2
- Grove –Infrared Emitter x1 (Figure 1)
- Grove –Infrared Receiver x1 (Figure 2)

### Example

In this example, we use two Ameba RTL8722 modules that connecting with an infrared (IR) Emitter and an IR Receiver separately to transmit and receive IR NEC Raw data.



Figure 1: Grove –Infrared Receiver

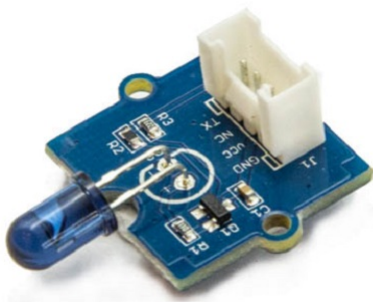


Figure 2: Grove –Infrared Emitter

On the transmission side, the transmitter will send IR NEC raw data. The raw data can be seen as consecutive durations of “marks” and “spaces” (Figure 3) in microseconds (us).

- Mark: a specific period of sending pulses
- Space: a specific period of sending nothing

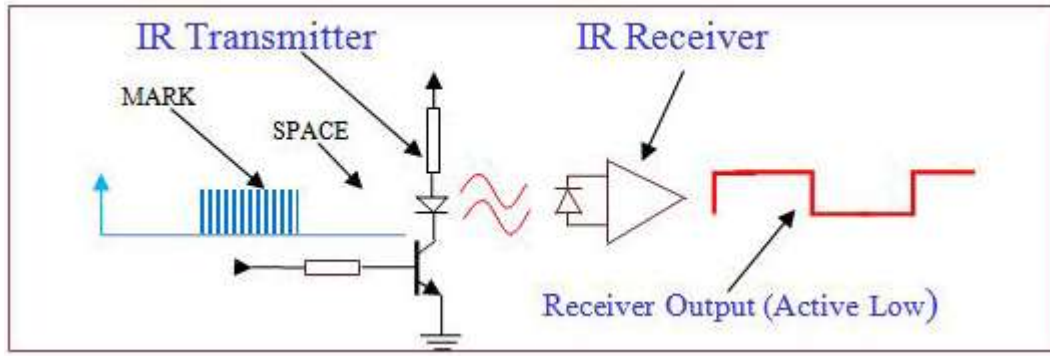


Figure 3: A typical IR transmission and reception setup implementation

For more details, please refer to SB-Projects' topic of [IR Remote Control Theory](#) to learn the theory of IR remote controls operation and a collection of IR protocol descriptions. In this example, we are going to use NEC (Now Renesas, also known as Japanese Format) as the transmission protocol.

### NEC Features

- 8-bit address and 8-bit command length.
- Extended mode available, doubling the address size.
- Address and command are transmitted twice for reliability.
- Pulse distance modulation.
- The carrier frequency of 38kHz.
- Bit time of 1.125ms or 2.25ms.

### Modulation

NEC protocol uses Pulse Distance Encoding of the bits for data communication (Figure 4). A logical "1" is represented by total duration of 2250us, with 560us of "marks" and (2250-560) us of "spaces" . While logical "0" is represented by total duration of 1120us, with 560us "marks" and (1120-560) us of "spaces" .

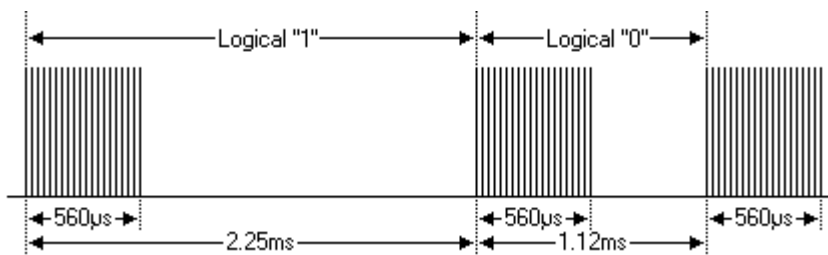


Figure 4: Modulation of NEC

Since a total number of 32-bit data together with the header and the end-bit will be transferred (Figure 5). If we separate the data in the time-frame (in us), there will be  $(2 + 32) \times 2 + 1 = 69$  “marks” / “spaces” to be transmitted (Figure 6), which forms the raw NEC data we would like to transmit in our Arduino “\*.ino” file. This part of the code can be modified by users. Details of how to obtain raw data code for your remote devices, you may refer to [Ken Shirriff’s blog](#), where it provides multiple libraries provided online.

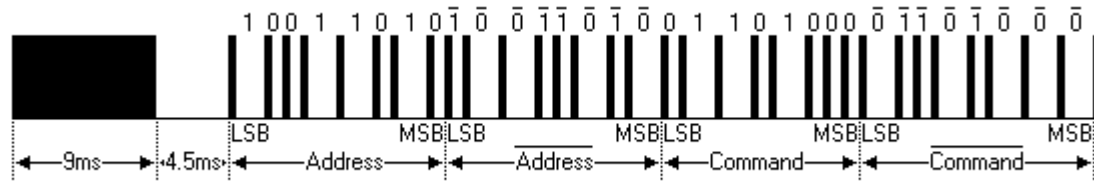


Figure 5: Sample of a Full NEC Data (in logic1 or 0)

```

9000, 4500, // starting bit
560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, 560, // address
560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, // ~address
560, 560, 560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, // data
560, 1690, 560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, //~data
560 // stoping bit

```

Figure 6: Sample of a Full NEC RAW Data (in us)

Figure 7 and 8 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8722 board.

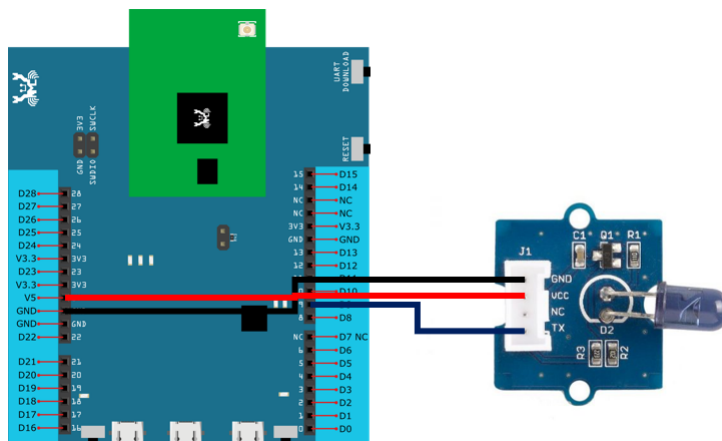


Figure 7: Pin configuration of IR Emitter and AMB21/AMB22

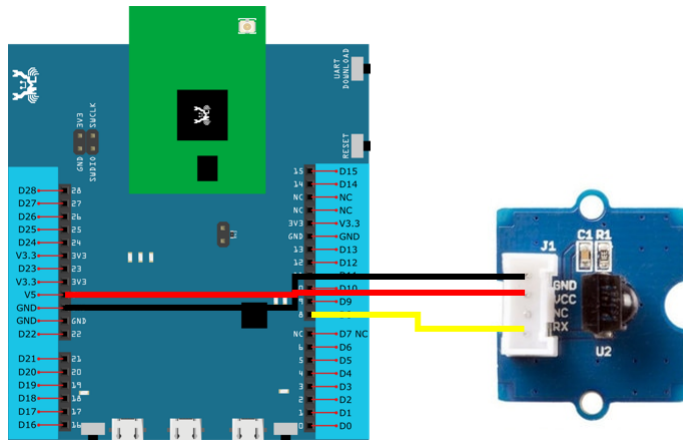


Figure 8: Pin configuration of the IR Receiver and Ameba RTL8722

Figure 9 and Figure 10 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8722DM MINI.

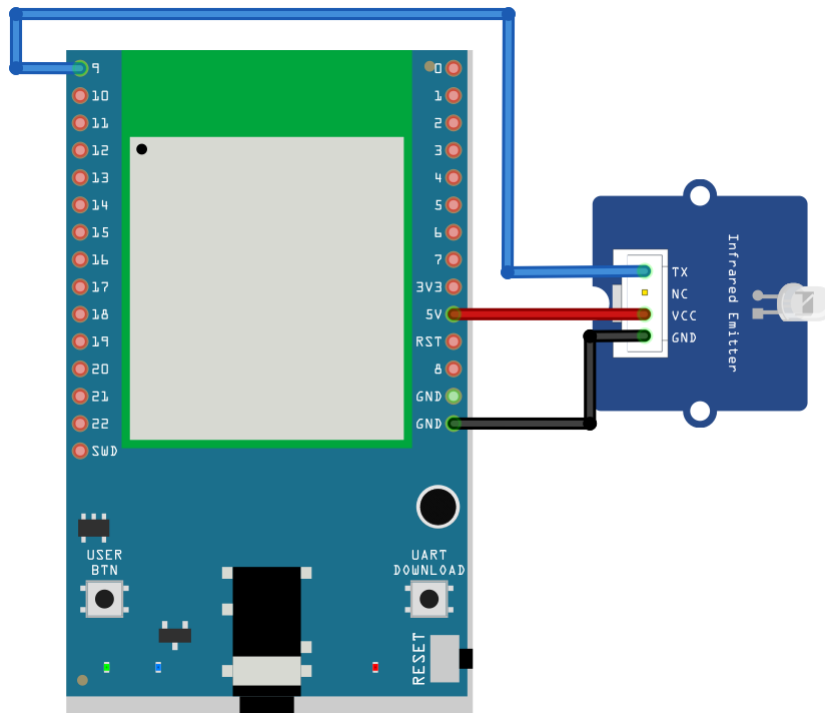


Figure 9: Pin configuration of IR Emitter and AMB23

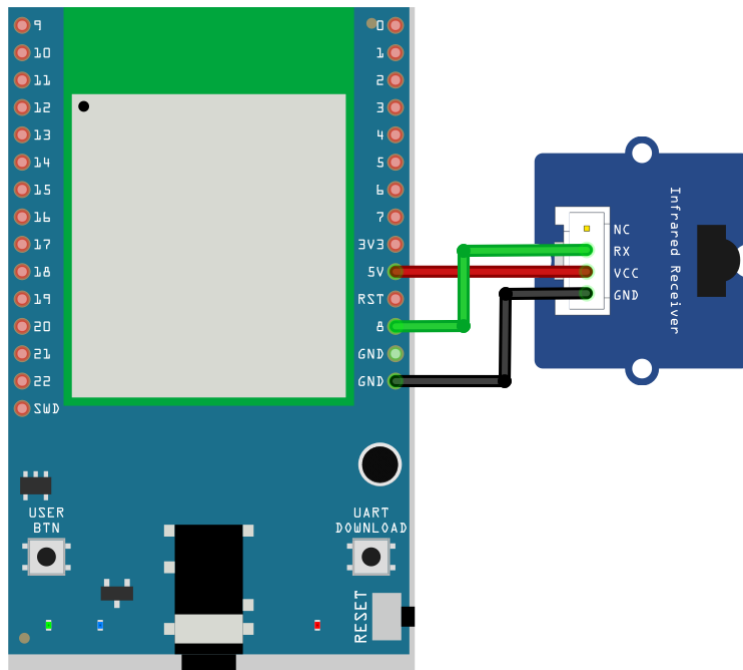


Figure 10: Pin configuration of the IR Receiver and AMB23

Figure 11 and Figure 12 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8720DN (BW16).

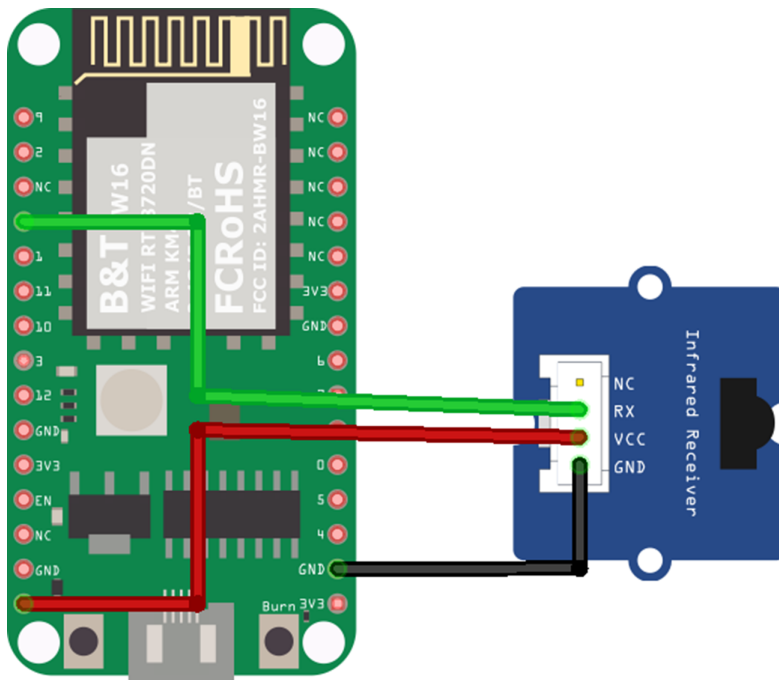


Figure 11: Pin configuration of IR Emitter and BW16



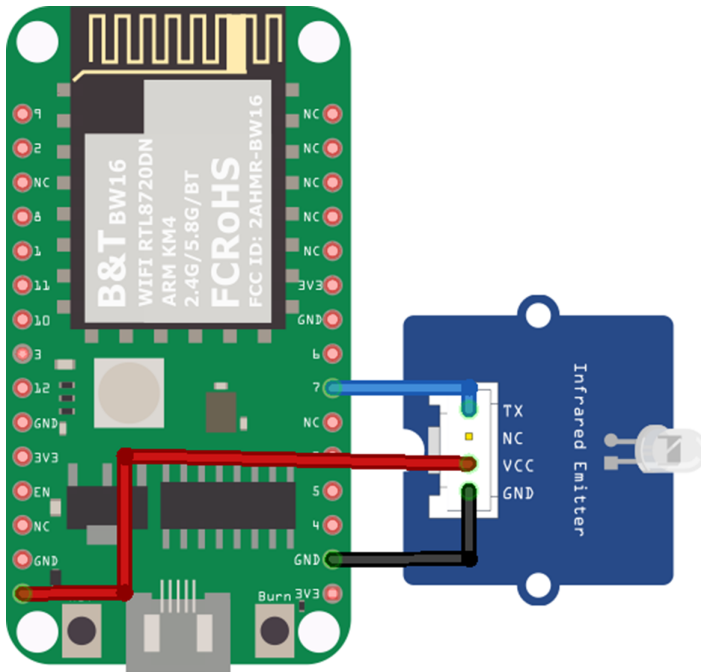


Figure 12: Pin configuration of IR Receiver and BW16

After the connection is being set up correctly, we will move to the coding part for this example. First, make sure the correct Ameba development board is selected in Arduino IDE: “Tools” -> “Board” .

Open the “IRSendRAW” example in “File” -> “Examples” -> “AmebaIRDevice” -> “IRSendRAW” (Figure 11) and upload to 1st board connected with IR Emitter:

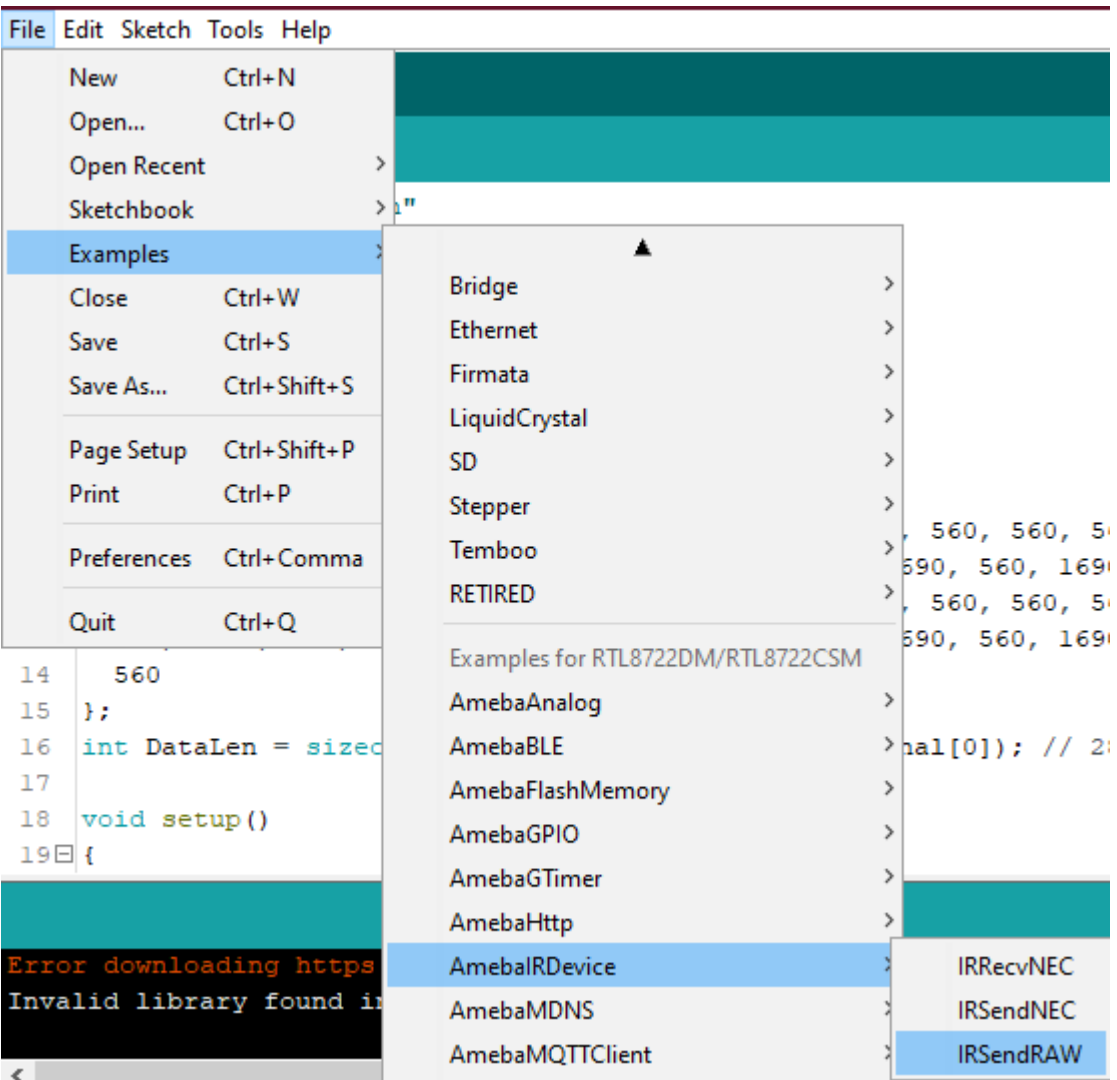


Figure 13: Example Location of IRSendRaw and IRRecvNEC

After successfully upload the sample code for IRSendRaw, you might need to upload the IRRecvNEC example for the 2nd board connected with IR Receiver from “File” -> “Examples” -> “AmebaIRDevice” -> “IRRecvNEC” .

After opening the serial monitor on the IR Receiver side and press the reset buttons on two boards, the data “48” will be received every 3 seconds (due to the delays () function, not compulsory to wait). After decoding the signal from the receiving Pin D8 and transmitting Pin D9 with Logic Analyser and Pulse View (Figure 10), the result is also shown as “48” after decoding the receiving data with IR NEC Protocol.

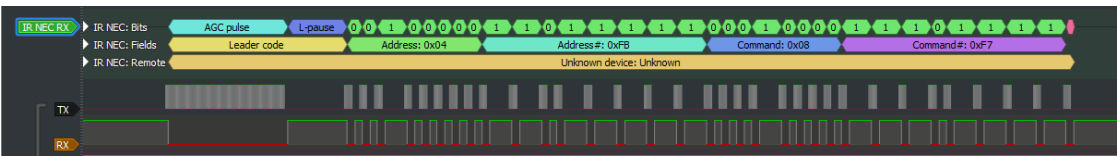


Figure 14: Pulse View results from sending and receiving pin

## Code Reference

[1] Seeed Official website for Grove –Infrared Receiver

[https://wiki.seeedstudio.com/Grove-Infrared\\_Receiver/](https://wiki.seeedstudio.com/Grove-Infrared_Receiver/)

[2] Seed Official website for Grove –Infrared Emitter

[https://wiki.seeedstudio.com/Grove-Infrared\\_Emitter/](https://wiki.seeedstudio.com/Grove-Infrared_Emitter/)

[3] Ken SHirriff’ s blog on A Multi-Protocol Infrared Remote Library for the Arduino

<http://www.righ.to.com/2009/08/multi-protocol-infrared-remote-library.html>

[4] SB-Projects: IR Remote Control Project

<https://www.sbprojects.net/knowledge/ir/index.php>

## Power Save - Deep Sleep Mode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

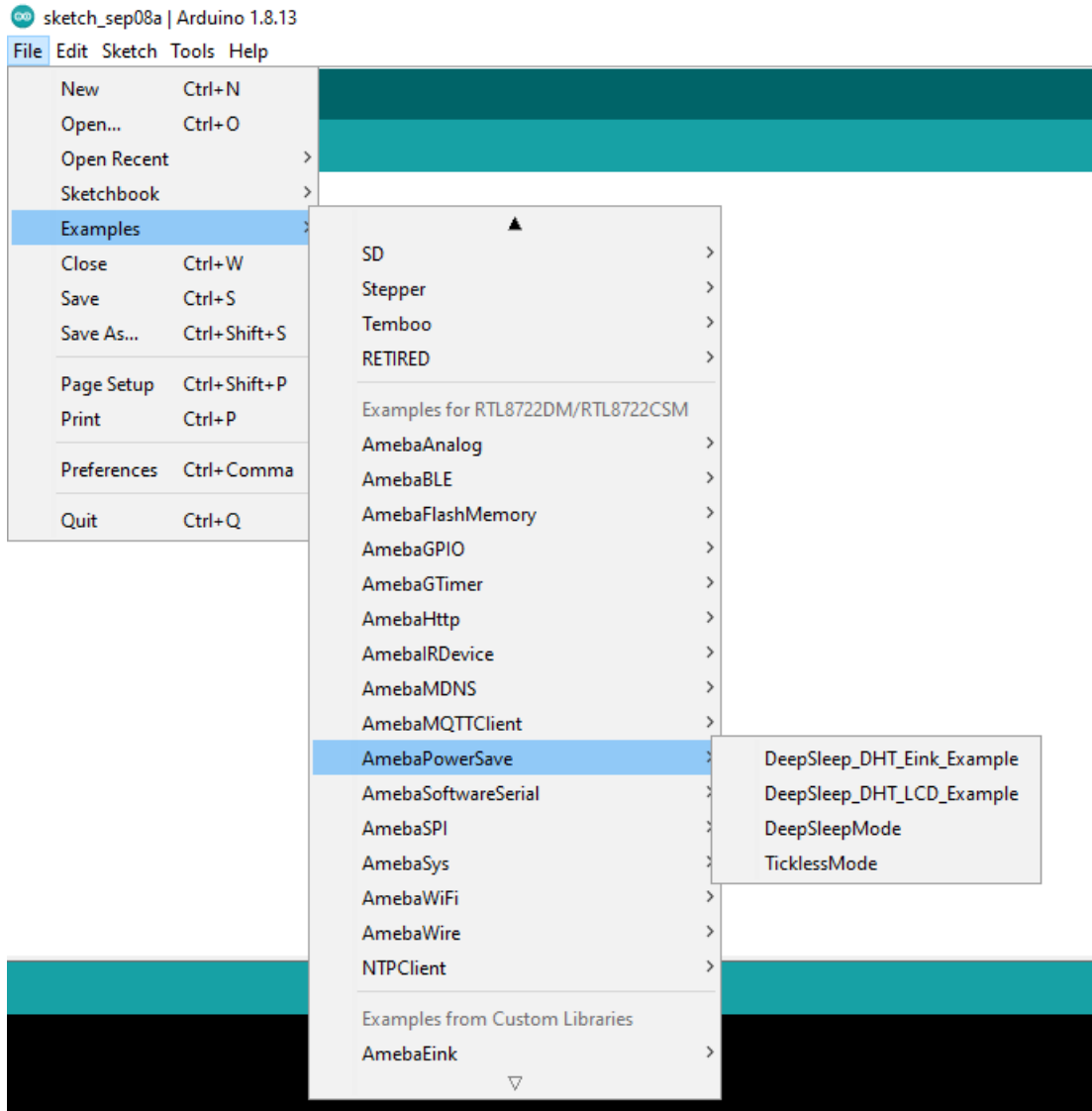
### Example

#### Introduction

Ameba-D supports 2 low power modes which are deepsleep mode and sleep mode. Deep Sleep mode turns off more power domain than sleep mode. The power consumption of Deep Sleep mode is around 7 $\mu$ A to 8 $\mu$ A as compared to normal state which is around 22mA. This example describes how to enter Deep Sleep mode and configure the wakeup source

#### Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleepMode”



Set condition values as picture below.

“DS\_WAKEUP\_SOURCE” is used to set the wake-up source, user can chose 3 wake up sources now,

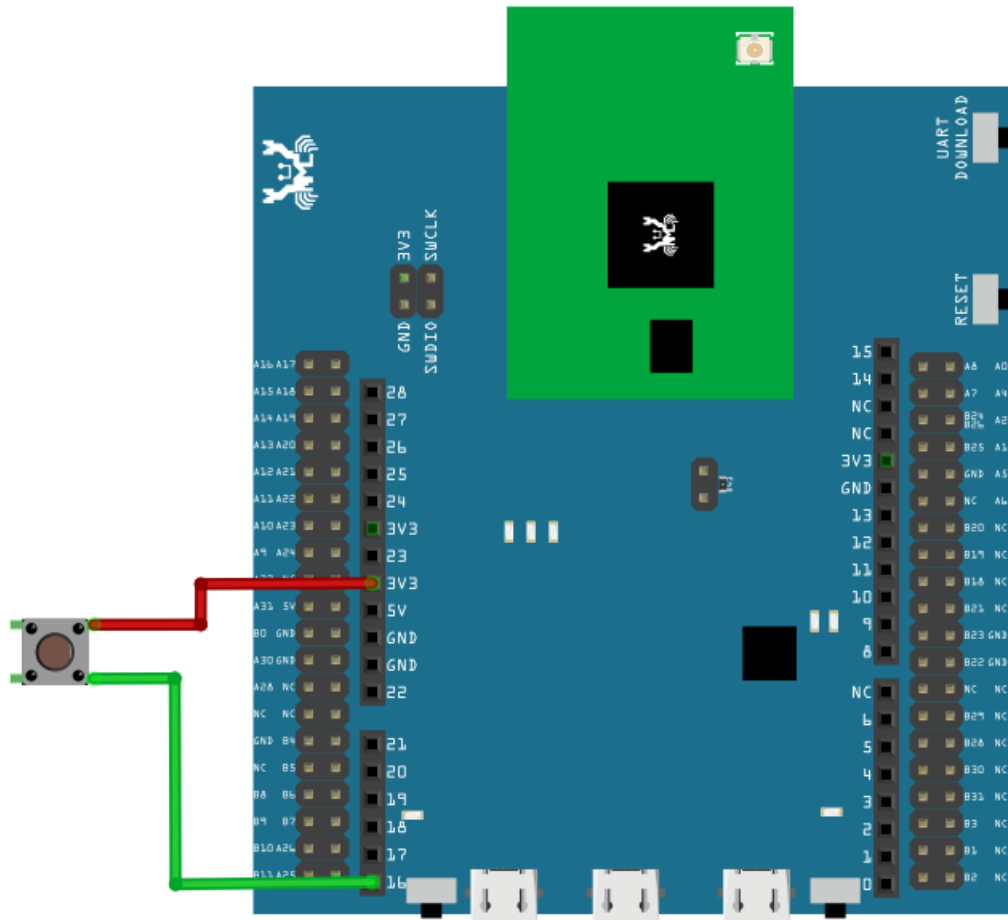
```
AON Timer (SET_DS_AON_TIMER_WAKEUP);
AON GPIO pins (SET_AONWAKEPIN_WAKEUP);
RTC Timer (SET_DS_RTC_WAKEUP);
```

### Using AON Timer as wakeup source

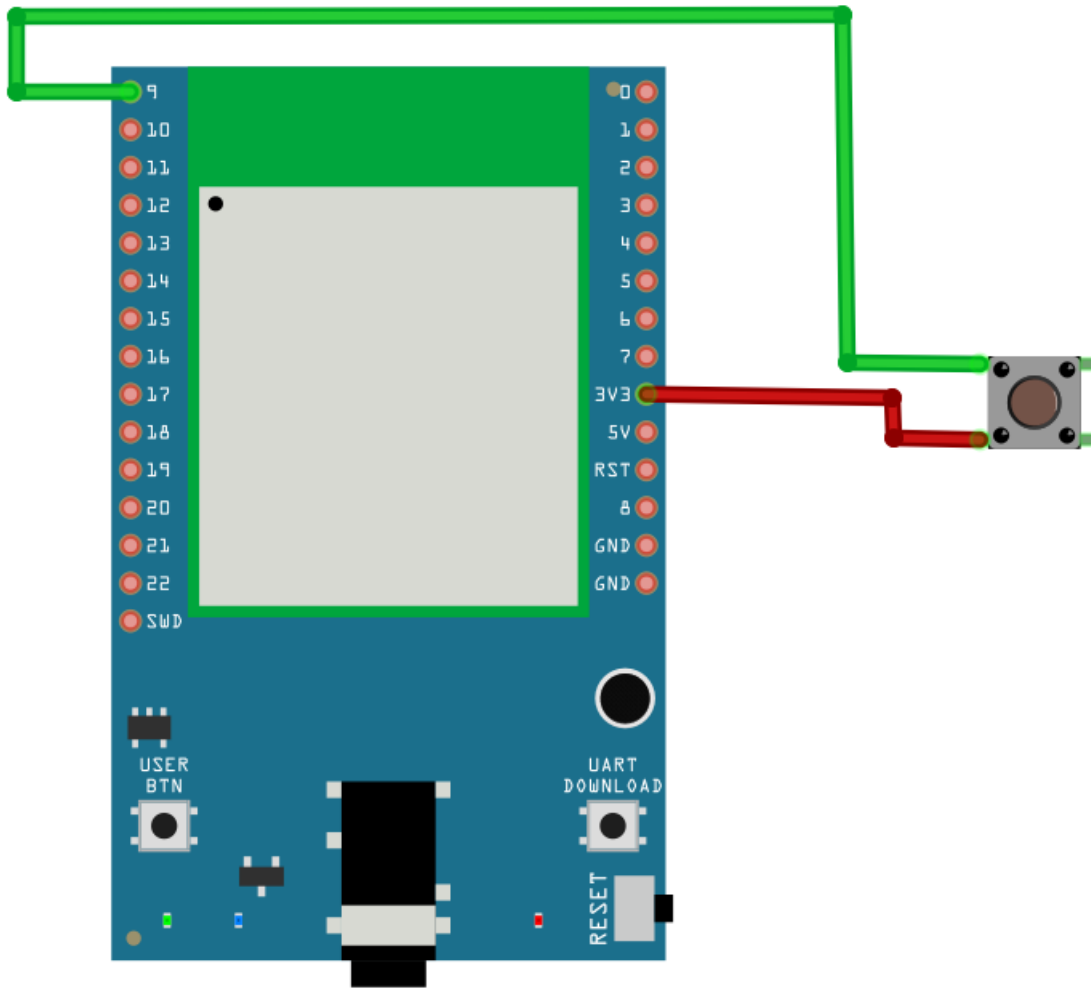
AON Timer can be set from 0 to 32760000ms range by AON\_TIMER\_SLEEP\_DURATION

## Using AON GPIO pins as wakeup source

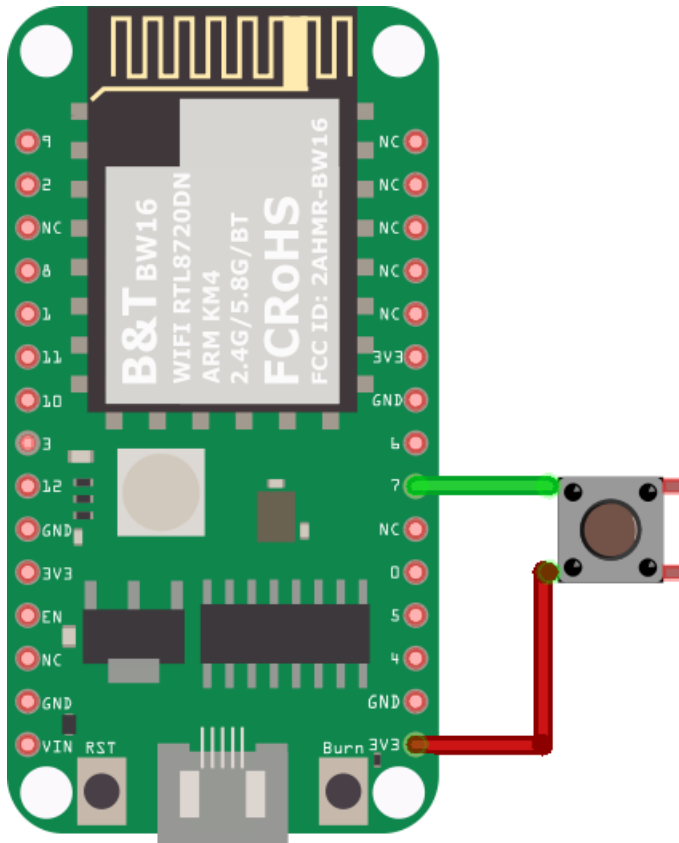
For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).



For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).



For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).



These AON pins can be set by using `SET_AON_GPIO_WAKEUP_GPIOA25` or the pin that you want to use as shown in the picture below

DeepSleepMode | Arduino 1.8.16 (Windows Store 1.8.51.0)

File Edit Sketch Tools Help

```

8 |
9 //For RTL8722DM only the AON GPIO pins listed below should be selected
10 //SET_AON_GPIO_WAKEUP_GPIOA25 // D16
11 //SET_AON_GPIO_WAKEUP_GPIOA26 // D17
12 //SET_AON_GPIO_WAKEUP_GPIOA21 // D26
13 //SET_AON_GPIO_WAKEUP_GPIOA20 // D27
14 //SET_AON_GPIO_WAKEUP_GPIOA19 // D28
15 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
16 //SET_AON_GPIO_WAKEUP_GPIOA12 // D9
17 //SET_AON_GPIO_WAKEUP_GPIOA13 // D10
18 //SET_AON_GPIO_WAKEUP_GPIOA14 // D11
19 //SET_AON_GPIO_WAKEUP_GPIOA15 // D12
20 //SET_AON_GPIO_WAKEUP_GPIOA16 // D13
21 //SET_AON_GPIO_WAKEUP_GPIOA18 // D15
22 //SET_AON_GPIO_WAKEUP_GPIOA19 // D16
23 //SET_AON_GPIO_WAKEUP_GPIOA21 // D18
24 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA25 // D7
26 //SET_AON_GPIO_WAKEUP_GPIOA26 // D8
27 //SET_AON_GPIO_WAKEUP_GPIOA15 // D9
28 //SET_AON_GPIO_WAKEUP_GPIOA14 // D10
29 //SET_AON_GPIO_WAKEUP_GPIOA13 // D11
30 //SET_AON_GPIO_WAKEUP_GPIOA12 // D12

```

### Using RTC Timer as wakeup source

RTC Timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC

DeepSleepMode | Arduino 1.8.16 (Windows Store 1.8.51.0)

File Edit Sketch Tools Help

```

33 |
34 #define AON_TIMER_SLEEP_DURATION 5000
35 #define DS_RTC_ALARM_DAY 0
36 #define DS_RTC_ALARM_HOUR 0
37 #define DS_RTC_ALARM_MIN 0
38 #define DS_RTC_ALARM_SEC 10

```

When all the condition values are set, the system will run and switch between normal and deep sleep mode which is controlled by the wakeup source. The serial monitor will display the switching log as shown below.



## AON Timer

COM42

Send

```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON timer.
MODS
#
Deep sleep wakeupt!
Aontimer wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON timer.
MODS
#
Deep sleep wakeupt!
Aontimer wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON timer.
MODS
```

☒ Autoscrol ☐ Show timestamp    Newline    115200 baud    Clear output

## AON GPIO Pin

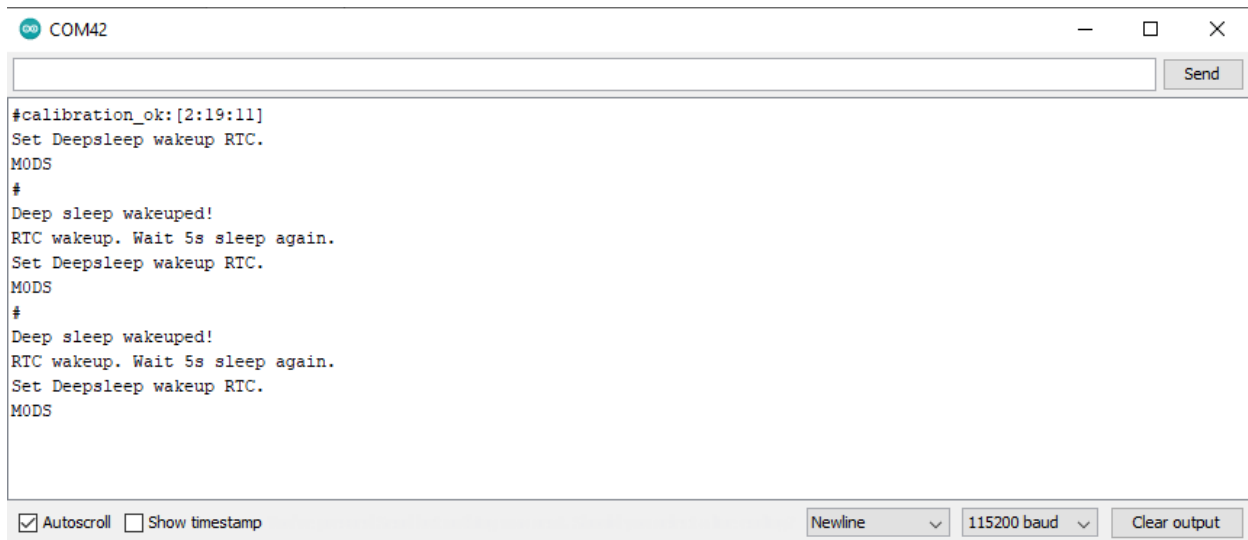
COM5

Send

```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupt!
AonWakepin wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupt!
AonWakepin wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupt!
AonWakepin wakeup. Wait 5s sleep again.
```

☒ Autoscrol ☐ Show timestamp    No line ending    115200 baud    Clear output

## RTC Timer



```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup RTC.
MODS
#
Deep sleep wakeupid!
RTC wakeup. Wait 5s sleep again.
Set Deepsleep wakeup RTC.
MODS
#
Deep sleep wakeupid!
RTC wakeup. Wait 5s sleep again.
Set Deepsleep wakeup RTC.
MODS
```

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Deep Sleep for DHT and E-paper

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21 x 1
- LCD I2C screen x 1

### Example

#### Introduction

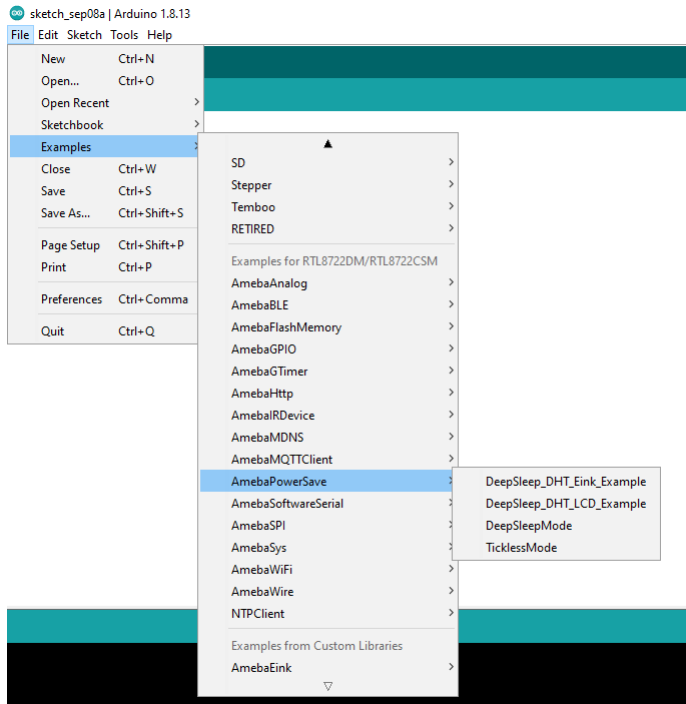
Ameba-D supports low power modes which are deepsleep mode. Deepsleep mode turns off most of the system power domain. The power consumptions of core module in DeepSleep Mode is around 7uA to 8uA compare to normal state around 22mA. This example gives demo of system switch between “working” and “sleep” (power save).Using DHT sensor to read data and display on Eink screen when system is awake. After 5 seconds system auto enter DeepSleep Mode for power save. System will wake up by wakeup source.( Aon timer, Aon Pins or RTC timer).

#### Procedure

Download the E Ink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries). Then install the AmebaEink.zip.

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleep\_DHT\_Eink\_Example”



Set condition values as picture below.

DS\_WAKEUP\_SOURCE is used to set the wake-up source, user can chose 3 wake up sources now,

```
AON timer (SET_DS_AON_TIMER_WAKEUP);
AON pins (SET_AON_WAKEPIN_WAKEUP);
RTC timer (SET_DS_RTC_WAKEUP);
```

### Using AON Timer as wakeup source

AON timer can be set from 0 to 32760000 range (unit ms) by AON\_TIMER\_SLEEP\_DURATION

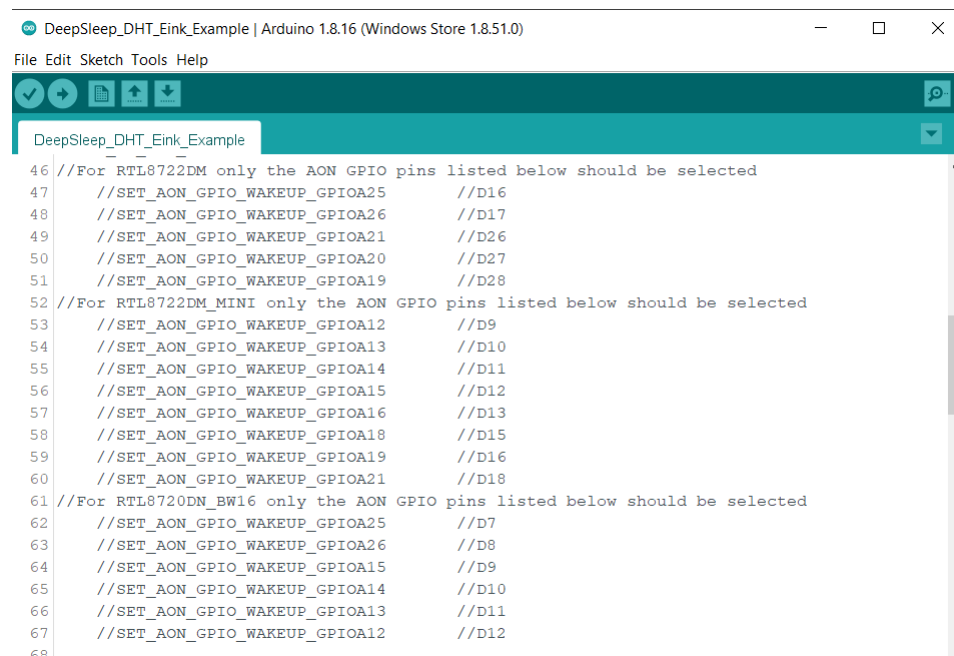
### Using AON GPIO pins as wakeup source

For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).

For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).

These AON pins can be set by using SET\_AON\_GPIO\_WAKEUP\_GPIOA25 or the pin that you want to use as shown in the picture below.



```

46 //For RTL8722DM only the AON GPIO pins listed below should be selected
47 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
48 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
49 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
50 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
51 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
52 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
53 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
54 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
55 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
56 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
57 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
58 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
59 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
60 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
61 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
62 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
63 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
64 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
65 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
66 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
67 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12

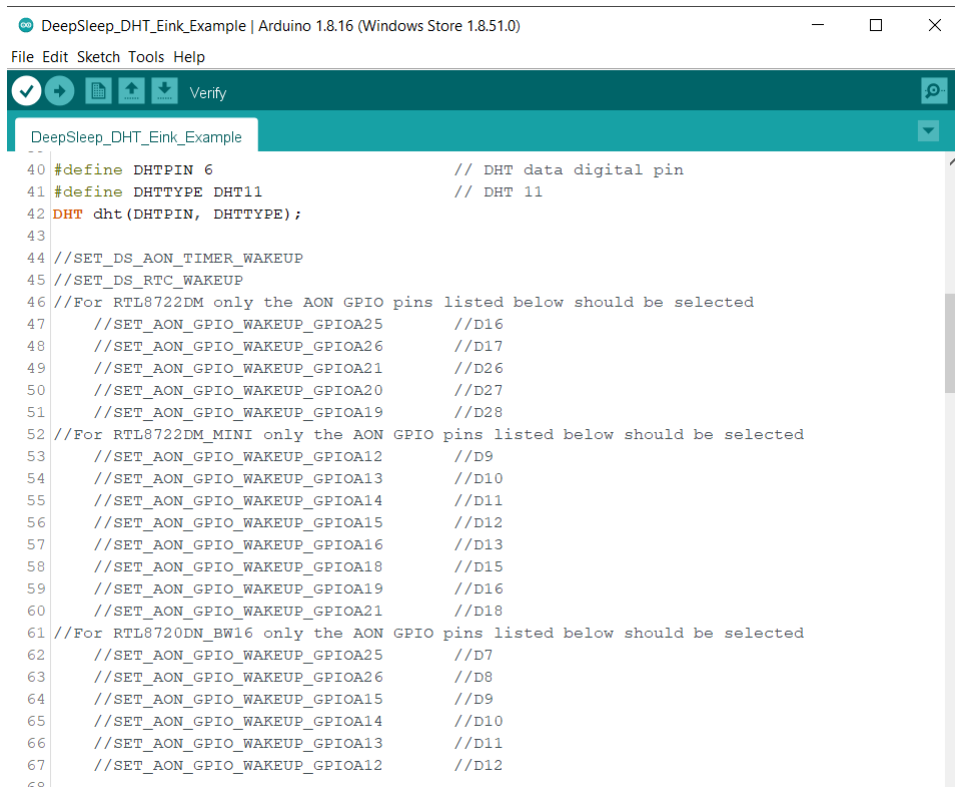
```

### Using RTC Timer as wakeup source

RTC timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC

DHTPIN is used to set DHT sensor data pin. User can choose any GPIO pins.

DHTTYPE is used to set DHT sensor type. (DHT11, DHT22 and DHT33)



```

DeepSleep_DHT_Eink_Example | Arduino 1.8.16 (Windows Store 1.8.51.0)
File Edit Sketch Tools Help
Verify
DeepSleep_DHT_Eink_Example
40 #define DHTPIN 6 // DHT data digital pin
41 #define DHTTYPE DHT11 // DHT 11
42 DHT dht(DHTPIN, DHTTYPE);
43
44 //SET_DS_AON_TIMER_WAKEUP
45 //SET_DS_RTC_WAKEUP
46 //For RTL8722DM only the AON GPIO pins listed below should be selected
47 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
48 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
49 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
50 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
51 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
52 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
53 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
54 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
55 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
56 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
57 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
58 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
59 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
60 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
61 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
62 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
63 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
64 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
65 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
66 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
67 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
68

```

When finished the condition values setting, system will run and switch between normal working mode and deepsleep mode controlled by wakeup source. Eink screen will display the temperature and humidity data measured from DHT sensor when system is awake.

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Deep Sleep for DHT and LCD

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21 x 1
- LCD I2C screen x 1

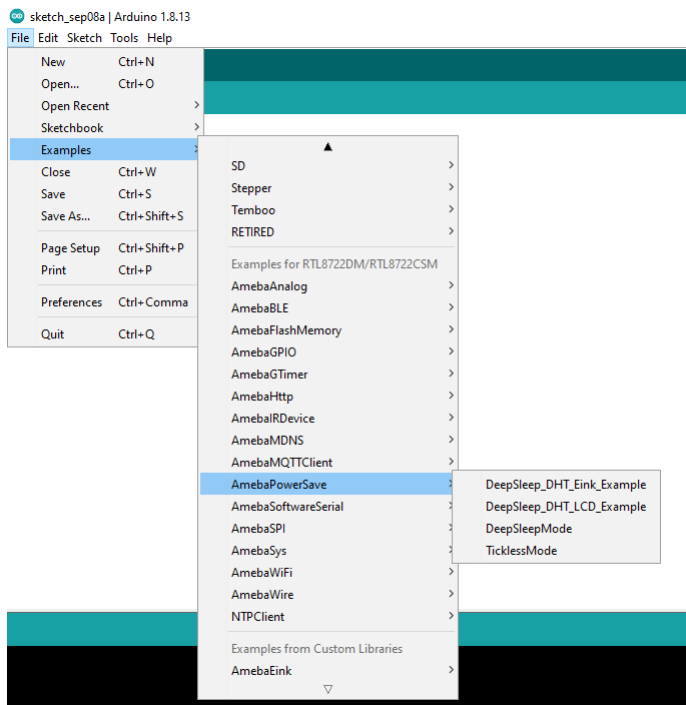
### Example

#### Introduction

Ameba-D supports low power modes which are deepsleep mode. Deepsleep mode turns off most of the system power domain. The power consumptions of core module in DeepSleep Mode is around 7uA to 8uA compare to normal state around 22mA. This example gives demo of system switch between “working” and “sleep” (power save). Using DHT sensor to read data and display on LCD screen when system is awake. After 5 seconds system auto enter DeepSleep Mode for power save. System will wake up by wakeup source.( Aon timer, Aon Pins or RTC timer).

## Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleep\_DHT\_LCD\_Example”



Set condition values as picture below.

DS\_WAKEUP\_SOURCE is used to set the wake-up source, user can chose 3 wake up sources now,

```
AON timer (SET_DS_AON_TIMER_WAKEUP);
AON pins (SET_AON_WAKEPIN_WAKEUP);
RTC timer (SET_DS_RTC_WAKEUP);
```

## Using AON Timer as wakeup source

AON timer can be set from 0 to 32760000 range (unit ms) by AON\_TIMER\_SLEEP\_DURATION

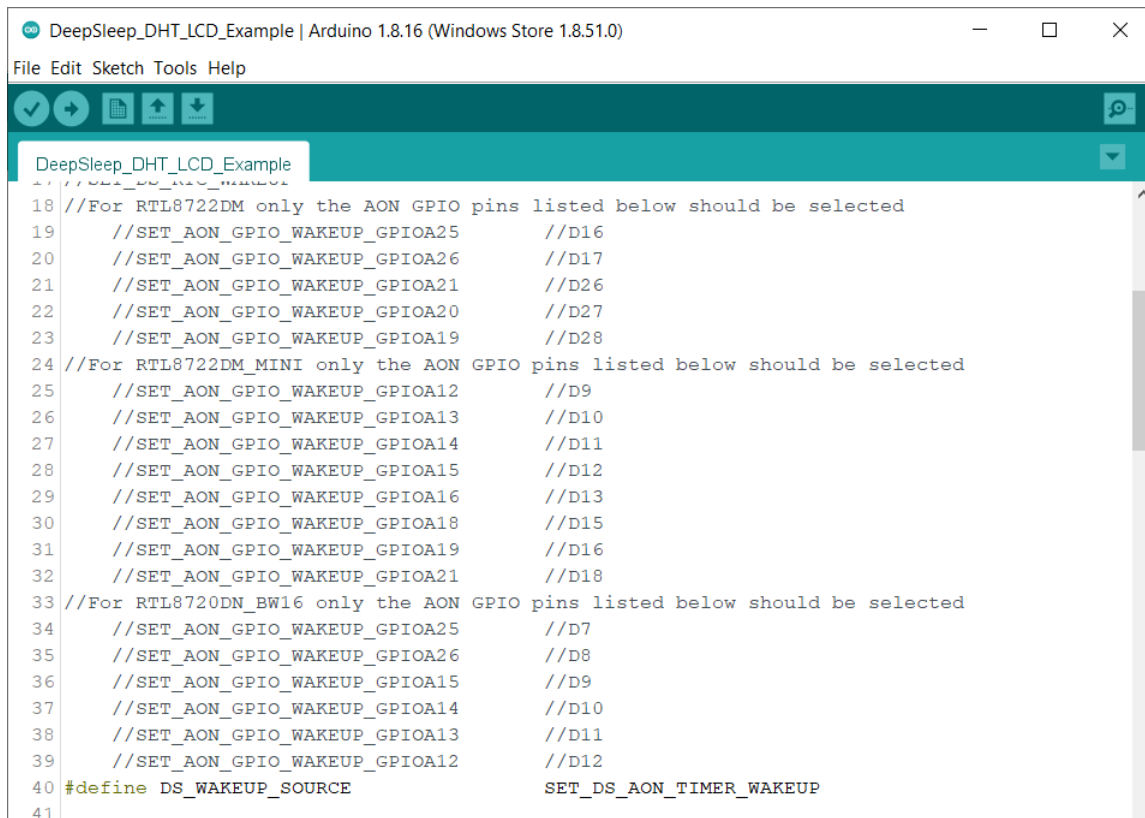
### Using AON GPIO pins as wakeup source

For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).

For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).

These AON pins can be set by using SET\_AON\_GPIO\_WAKEUP\_GPIOA25 or the pin that you want to use as shown in the picture below.



```

DeepSleep_DHT_LCD_Example | Arduino 1.8.16 (Windows Store 1.8.51.0)
File Edit Sketch Tools Help
DeepSleep_DHT_LCD_Example
18 //For RTL8722DM only the AON GPIO pins listed below should be selected
19 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
20 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
21 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
22 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
23 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
24 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
26 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
27 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
28 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
29 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
30 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
31 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
32 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
33 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
34 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
35 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
36 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
37 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
38 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
39 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
40 #define DS_WAKEUP_SOURCE SET_DS_AON_TIMER_WAKEUP
41

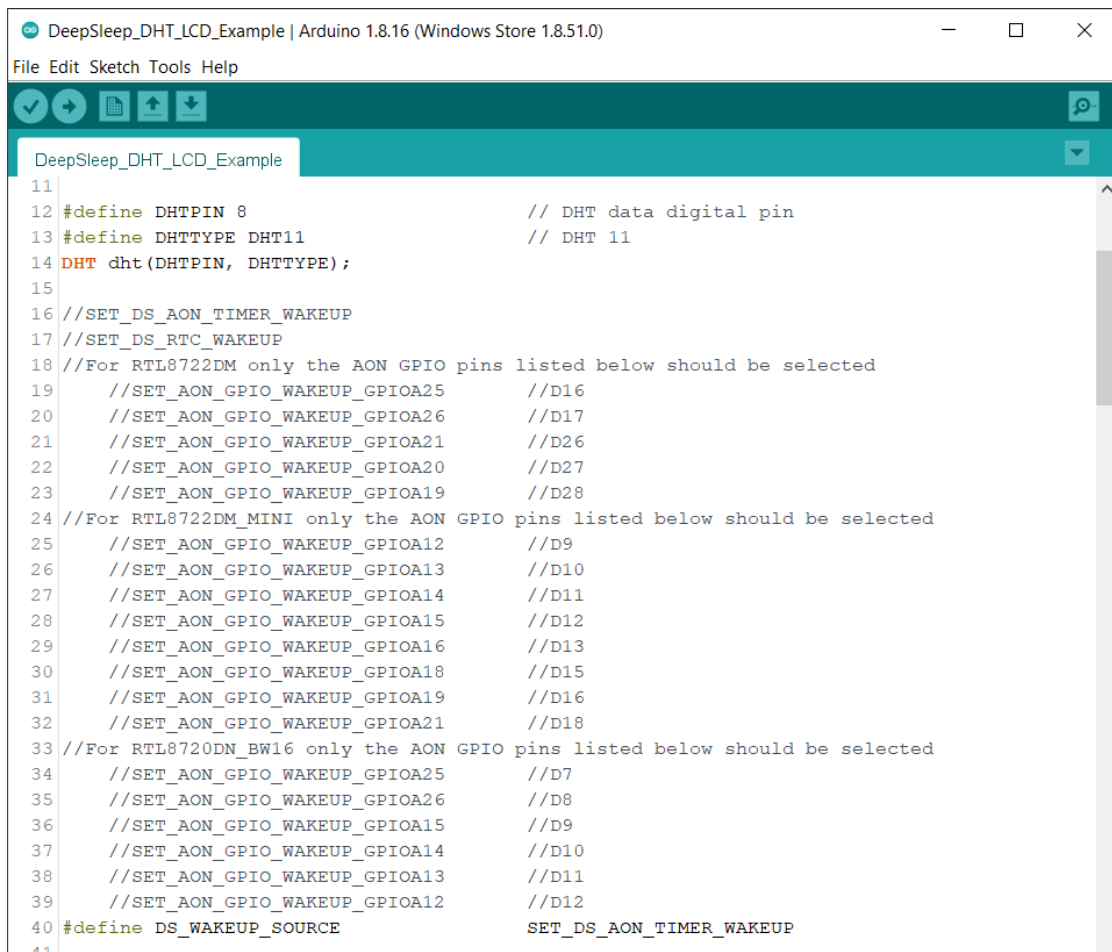
```

### Using RTC Timer as wakeup source

RTC timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC

DHTPIN is used to set DHT sensor data pin. User can choose any GPIO pins.

DHTTYPE is used to set DHT sensor type. (DHT11, DHT22 and DHT33)



```

11
12 #define DHTPIN 8 // DHT data digital pin
13 #define DHTTYPE DHT11 // DHT 11
14 DHT dht(DHTPIN, DHTTYPE);
15
16 //SET_DS_AON_TIMER_WAKEUP
17 //SET_DS_RTC_WAKEUP
18 //For RTL8722DM only the AON GPIO pins listed below should be selected
19 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
20 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
21 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
22 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
23 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
24 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
26 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
27 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
28 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
29 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
30 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
31 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
32 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
33 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
34 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
35 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
36 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
37 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
38 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
39 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
40 #define DS_WAKEUP_SOURCE SET_DS_AON_TIMER_WAKEUP
41

```

When finished the condition values setting, system will run and switch between normal working mode and deepsleep mode controlled by wakeup source. LCD screen will display the temperature and humidity data measured from DHT sensor when system is awake.

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.



## Power Save - Tickless Mode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

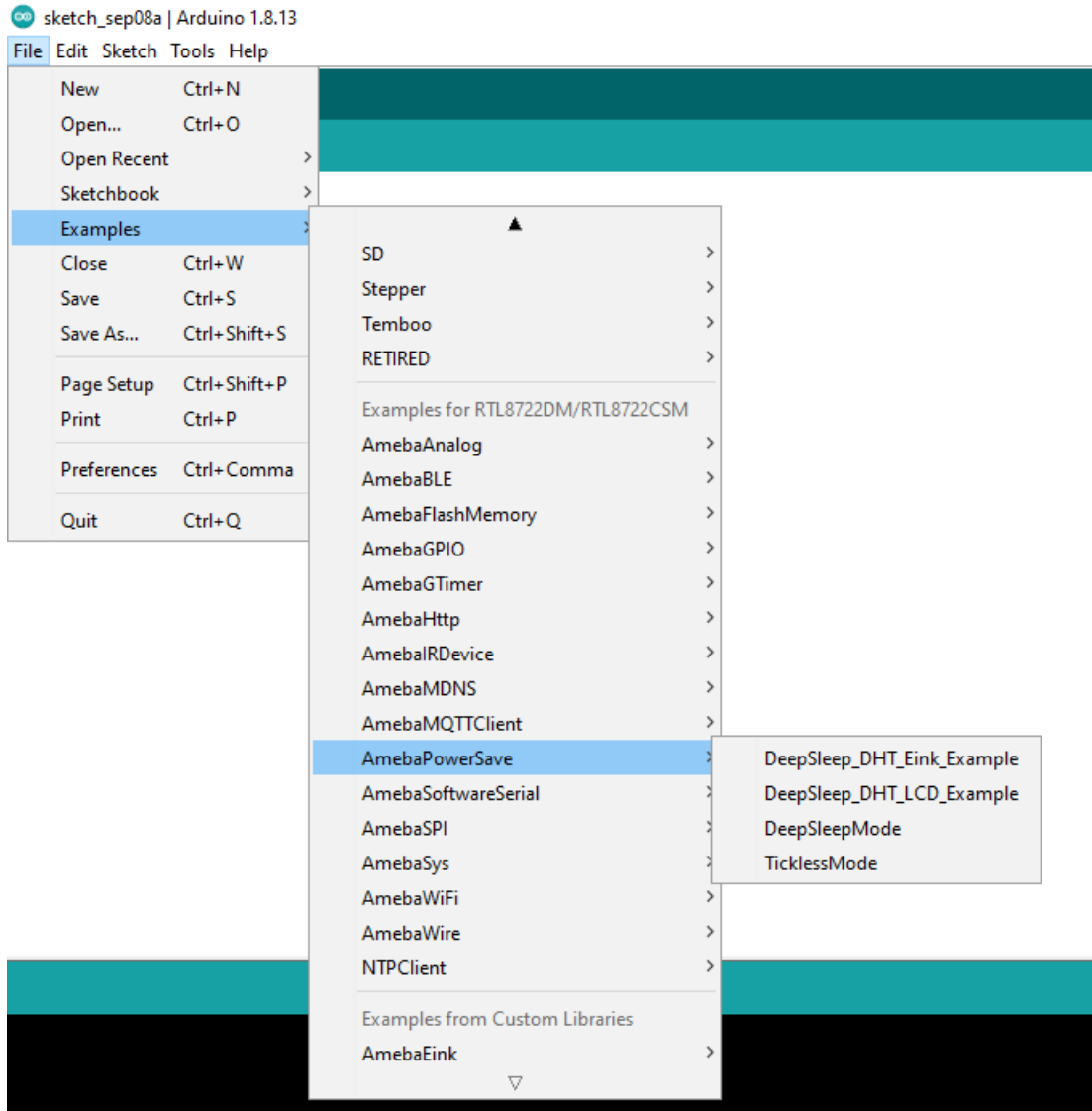
### Example

#### Introduction

Ameba-D supports two low power modes which are deepsleep mode and sleep mode. The power consumptions of Tickless Sleep Mode is around 28uA to 30uA compare to normal state around 15mA. This example describes how to use freertos tickless with uart interruptable interface.

#### Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “TicklessMode”



Set condition values as picture below.

“TL\_WAKEUP\_SOURCE” is used to set the wake-up source, user can chose 3 wake up sources now,

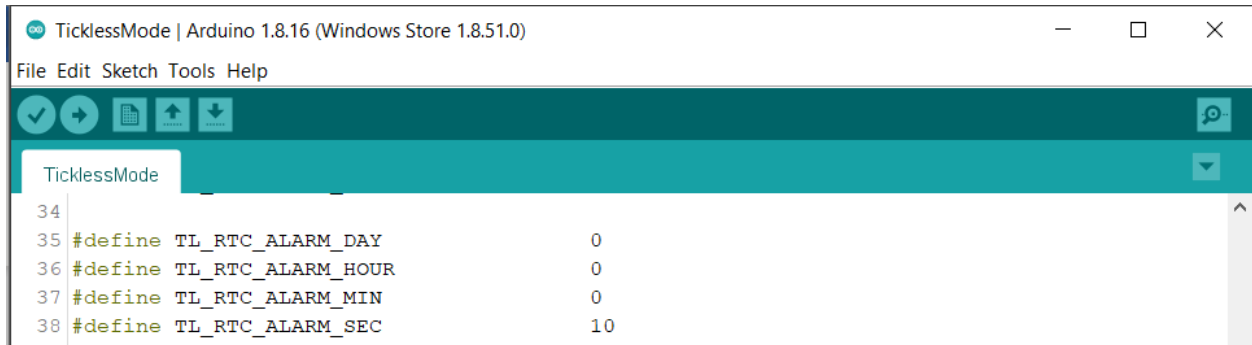
```
LOGUART (SET_TL_UART_WAKEUP) ;
RTC Timer (SET_TL_RTC_WAKEUP) ;
AON pins (SET_AON_WAKEPIN_WAKEUP) ;
```

### Using LOGUART as wakeup source

When the LOGUART is selected as the wakeup source, the “TL\_Suspend\_function” will enter sleep mode. And then it is kept alive for 13s then enter sleep mode. To wakeup, press enter.

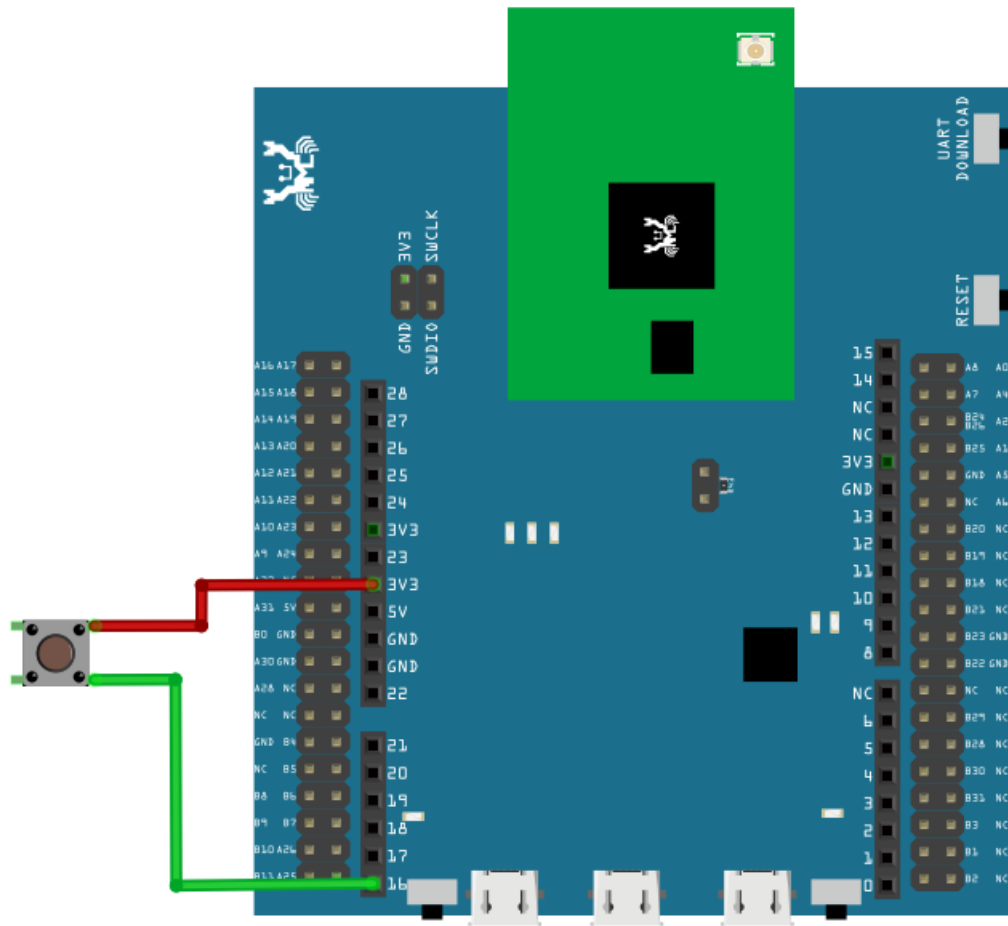
### Using RTC Timer as wakeup source

RTC Timer wakeup system is by setting alarm. The alarm has 4 values to be set, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC.

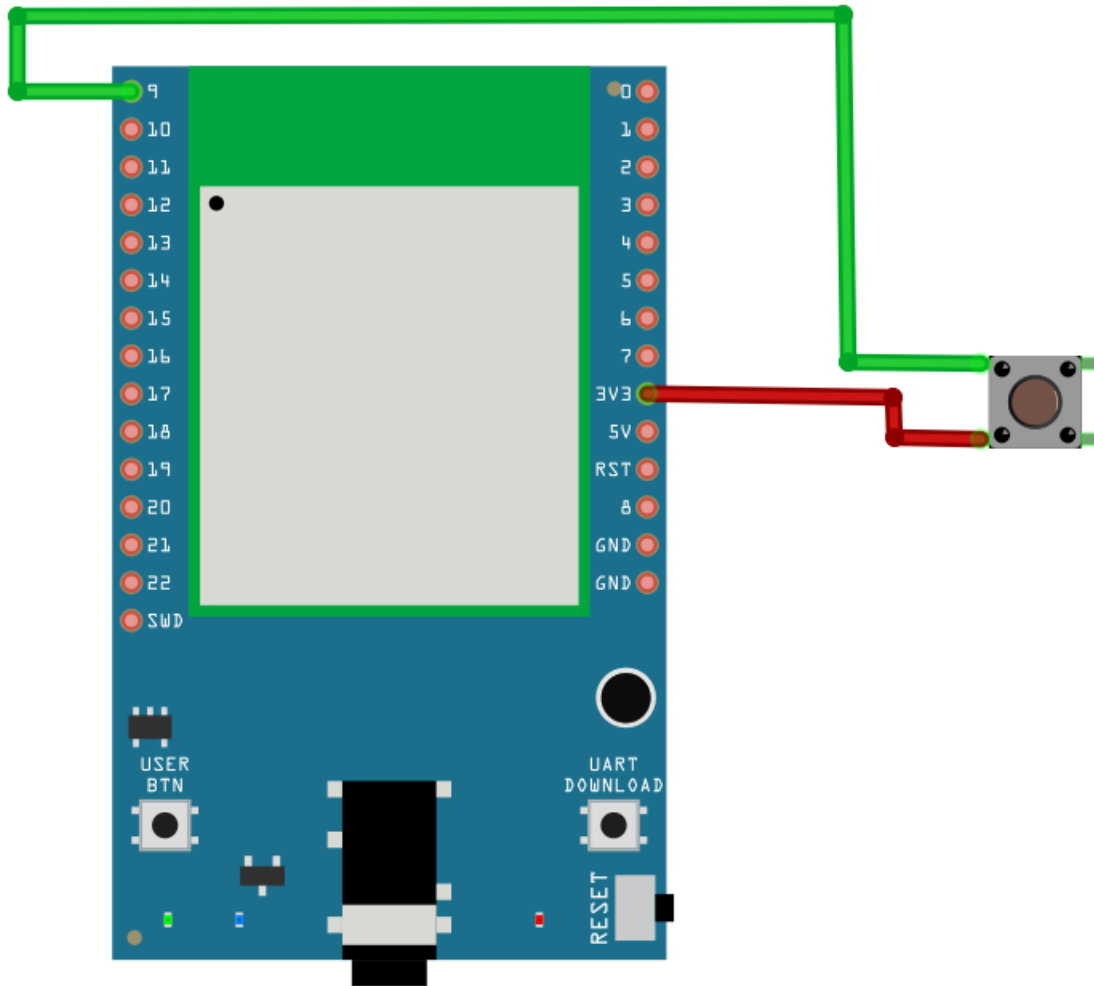


### Using AON GPIO pins as wakeup source

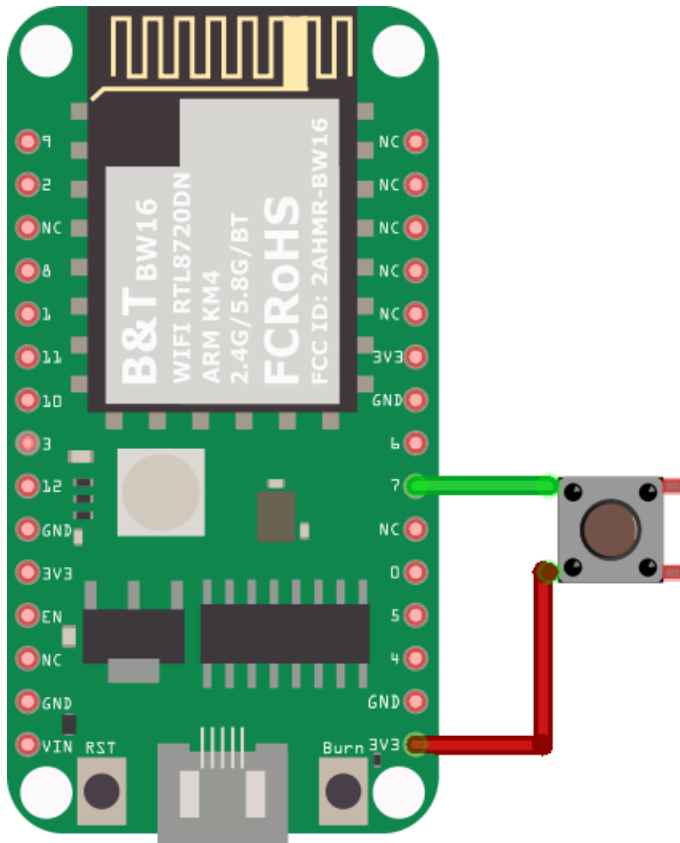
For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

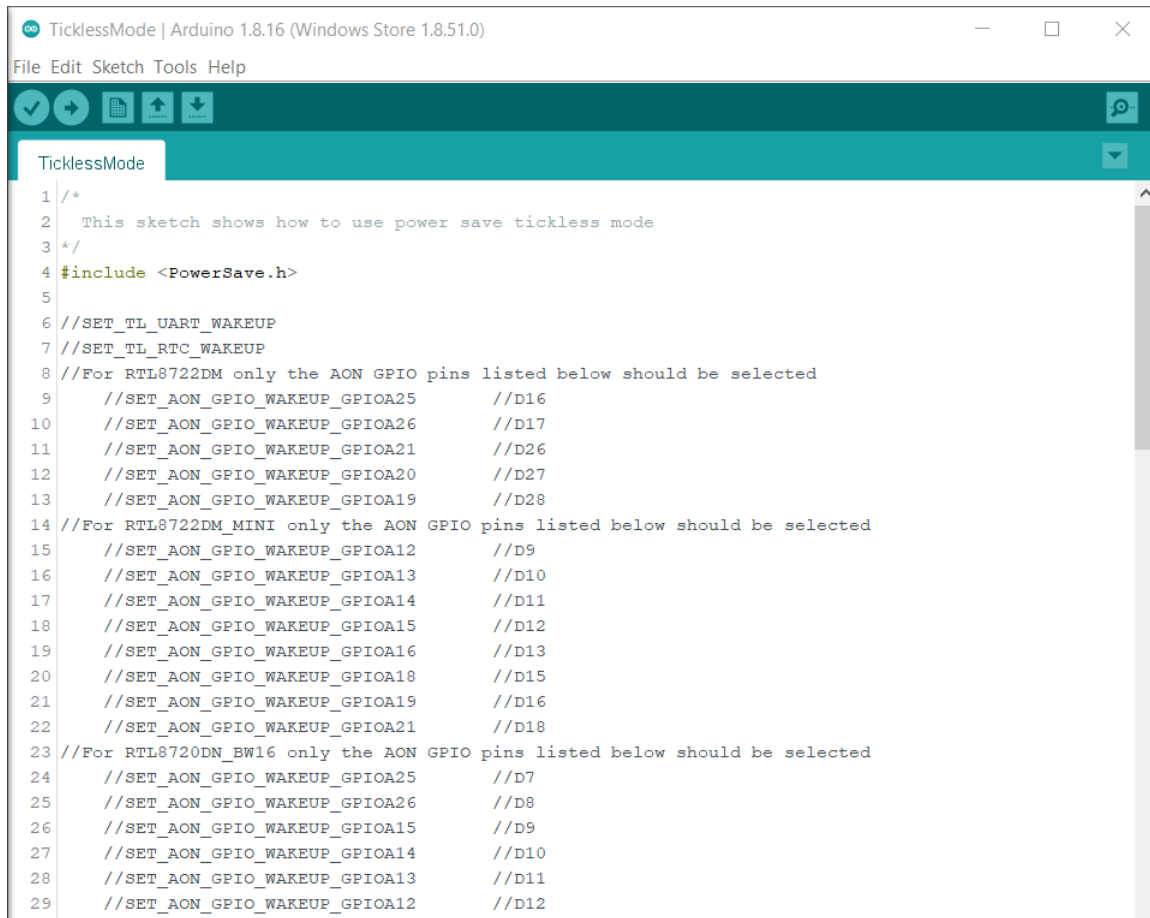


For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).



For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).





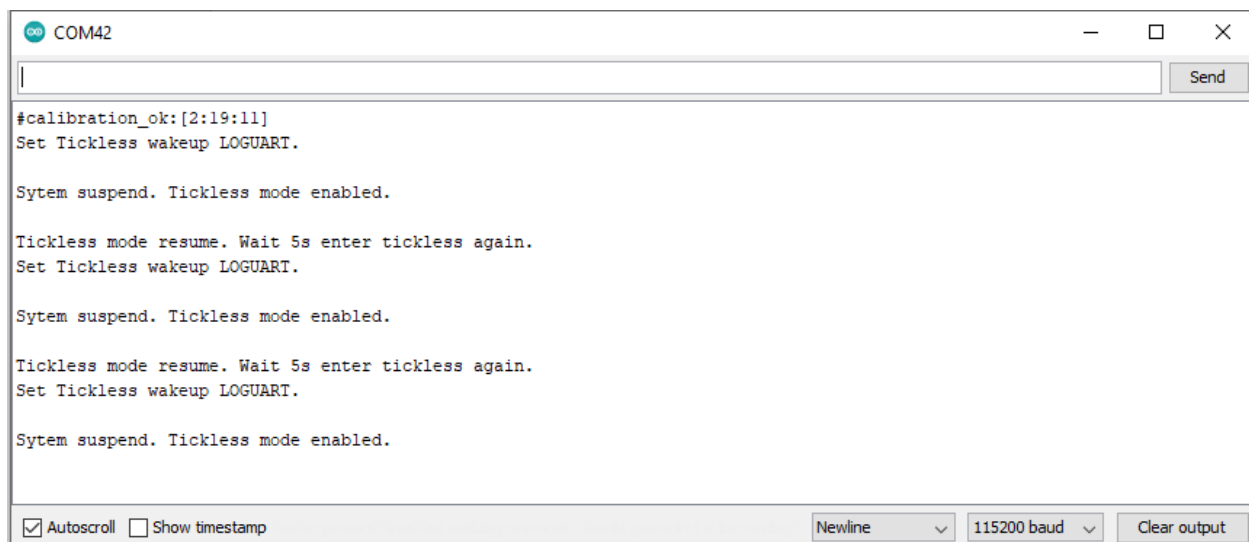
```

1 /*
2  This sketch shows how to use power save tickless mode
3  */
4  #include <PowerSave.h>
5
6  //SET_TL_UART_WAKEUP
7  //SET_TL_RTC_WAKEUP
8  //For RTL8722DM only the AON GPIO pins listed below should be selected
9      //SET_AON_GPIO_WAKEUP_GPIOA25      //D16
10     //SET_AON_GPIO_WAKEUP_GPIOA26      //D17
11     //SET_AON_GPIO_WAKEUP_GPIOA21      //D26
12     //SET_AON_GPIO_WAKEUP_GPIOA20      //D27
13     //SET_AON_GPIO_WAKEUP_GPIOA19      //D28
14  //For RTL8722DM MINI only the AON GPIO pins listed below should be selected
15     //SET_AON_GPIO_WAKEUP_GPIOA12      //D9
16     //SET_AON_GPIO_WAKEUP_GPIOA13      //D10
17     //SET_AON_GPIO_WAKEUP_GPIOA14      //D11
18     //SET_AON_GPIO_WAKEUP_GPIOA15      //D12
19     //SET_AON_GPIO_WAKEUP_GPIOA16      //D13
20     //SET_AON_GPIO_WAKEUP_GPIOA18      //D15
21     //SET_AON_GPIO_WAKEUP_GPIOA19      //D16
22     //SET_AON_GPIO_WAKEUP_GPIOA21      //D18
23  //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
24     //SET_AON_GPIO_WAKEUP_GPIOA25      //D7
25     //SET_AON_GPIO_WAKEUP_GPIOA26      //D8
26     //SET_AON_GPIO_WAKEUP_GPIOA15      //D9
27     //SET_AON_GPIO_WAKEUP_GPIOA14      //D10
28     //SET_AON_GPIO_WAKEUP_GPIOA13      //D11
29     //SET_AON_GPIO_WAKEUP_GPIOA12      //D12

```

TL\_SYSACTIVE\_TIME is for setting time duration of the system to keep alive. (Unit ms)

## LOGUART



```

#calibration_ok:[2:19:11]
Set Tickless wakeup LOGUART.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup LOGUART.

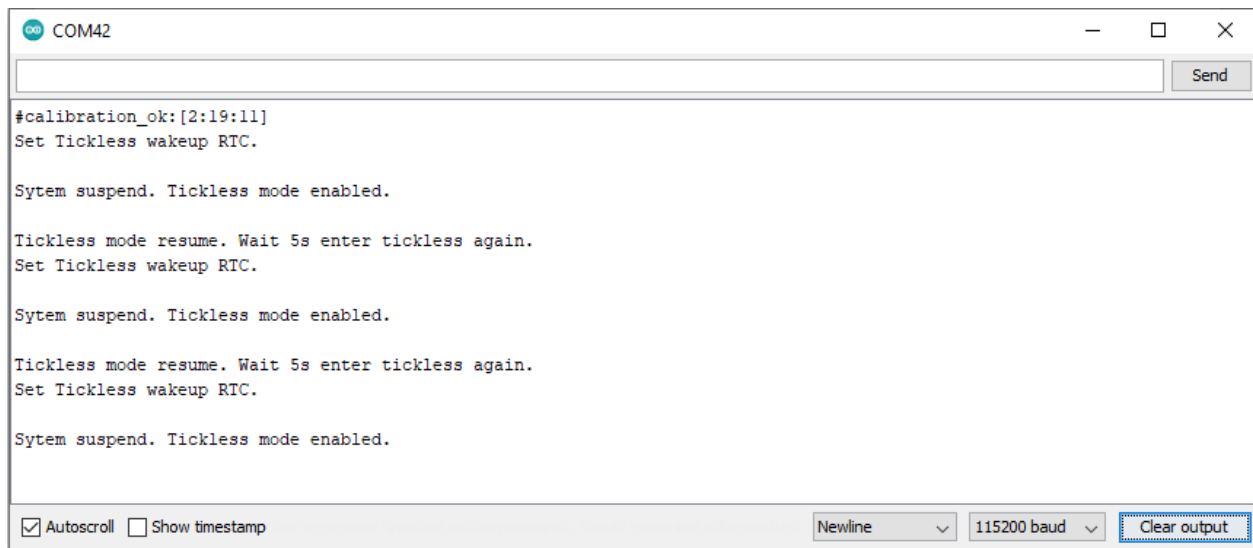
System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup LOGUART.

System suspend. Tickless mode enabled.

```

## RTC Timer



```
#calibration_ok:[2:19:11]
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.

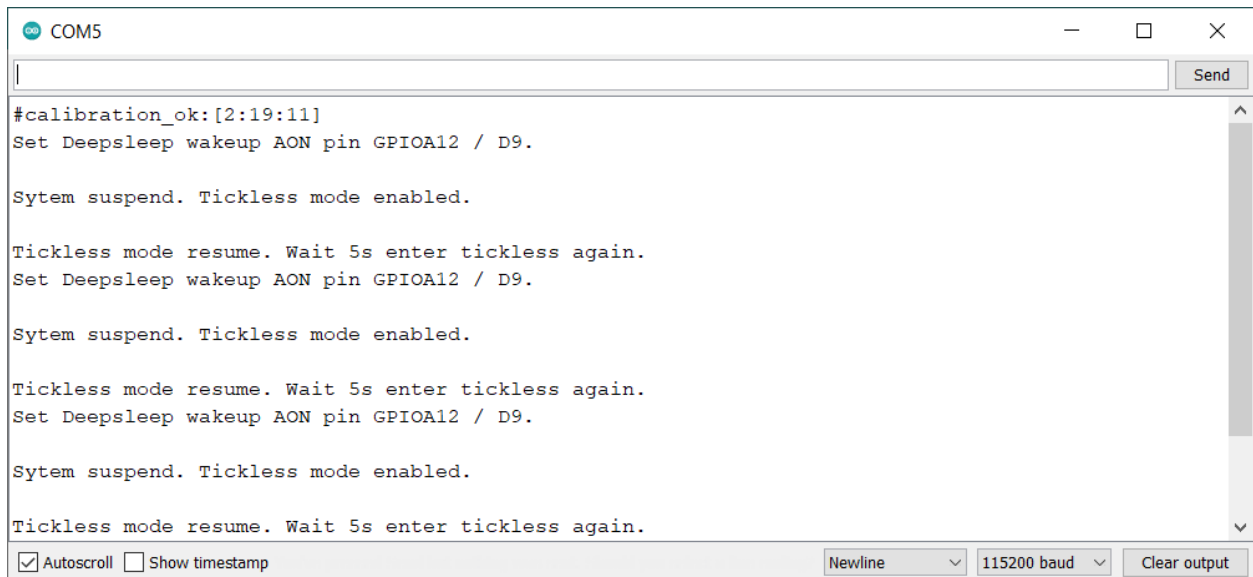
Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.
```

## AON GPIO Pins



```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
```

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.



## PWM - Play Music by Buzzer

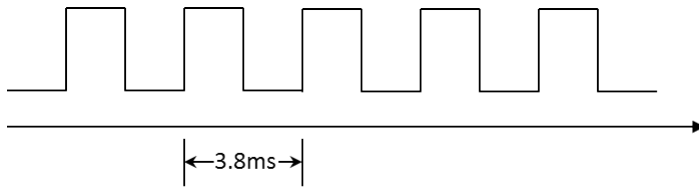
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Buzzer x 1

### Example

A sound is composed of volume, tone and timbre. Volume is determined by the amplitude of the sound wave. Tone is determined by the frequency of the sound wave. Timbre is determined by the waveform of the sound wave.

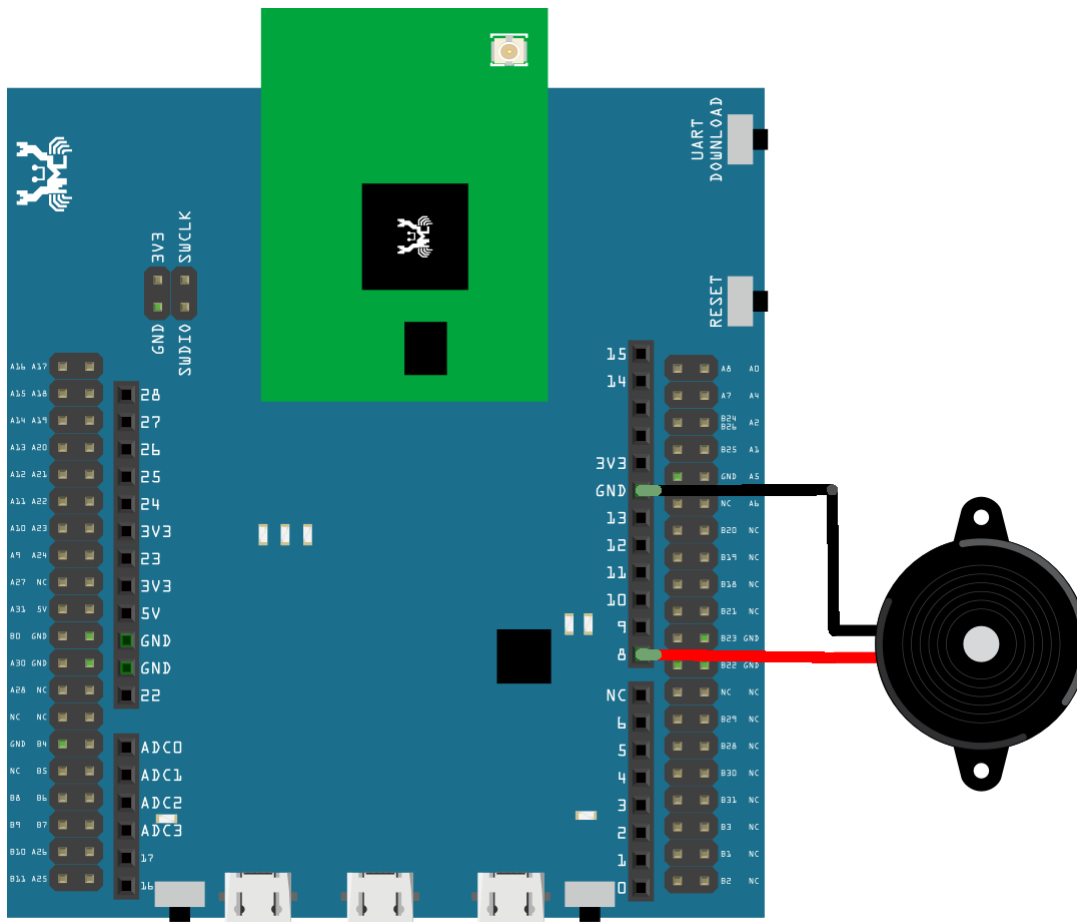
In this example, we use PWM to control the buzzer to emit sound with desired tone. As PWM outputs square wave, if we wish to emit tone C4 (frequency=262Hz), we have to make PWM to output square wave with wavelength  $1/262 = 3.8\text{ms}$ :



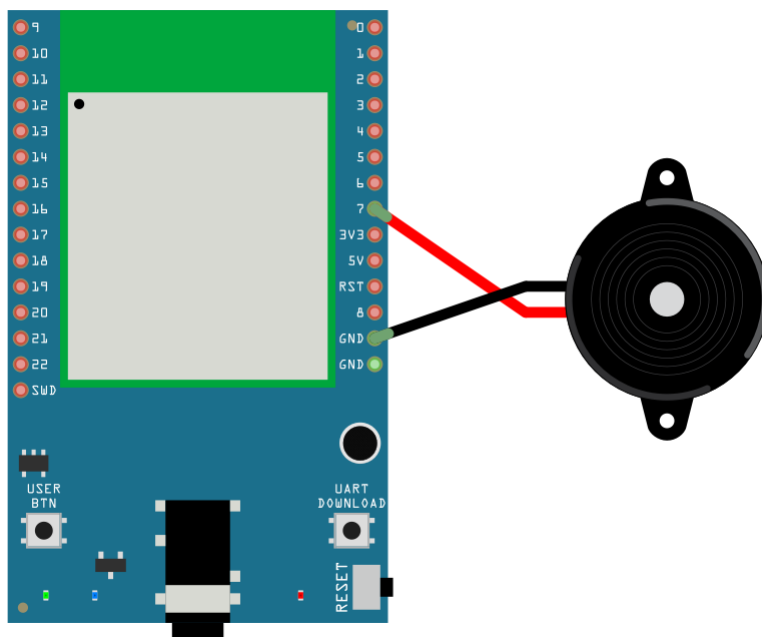
We use PWM to output sound wave with different frequency, so as to play music by the buzzer.

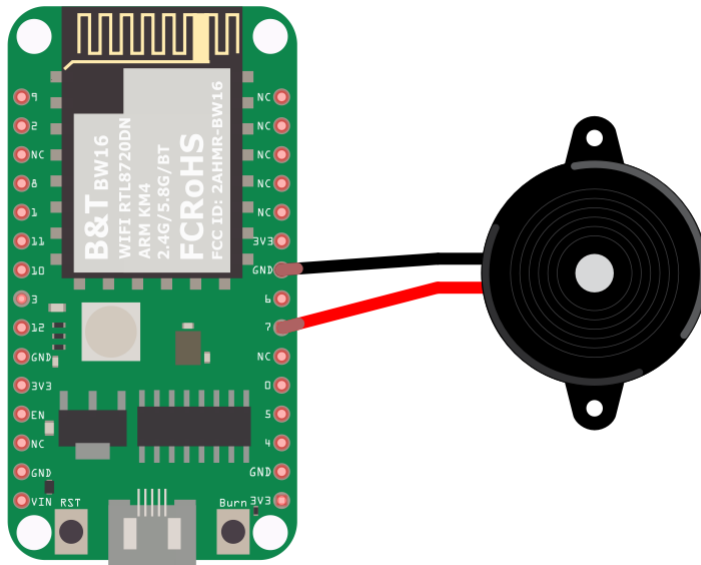
Connect the buzzer to the PWM output pin shown in the following diagrams.

**AMB21 / AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



**BW16 Wiring Diagram:**

Open the example code in “Examples” -> “AmebaAnalog” -> “TonePlayMelody”  
 Compile and upload to Ameba, press the reset button. Then you can hear the buzzer playing music.

**Code Reference**

Ameba implement the `tone()` and `noTone()` API of Arduino:

<https://www.arduino.cc/en/Reference/Tone>

<https://www.arduino.cc/en/Reference/NoTone>

In the sample code, we initiate a melody array, which stores the tones to make. Another array, `noteDurations`, contains the length of each tone, 4 represents quarter note (equals to  $3000\text{ms}/4 = 750\text{ms}$ , and plus an extra 30% time pause), 8 represents eighth note.

## PWM - Servo Control

## Preparation

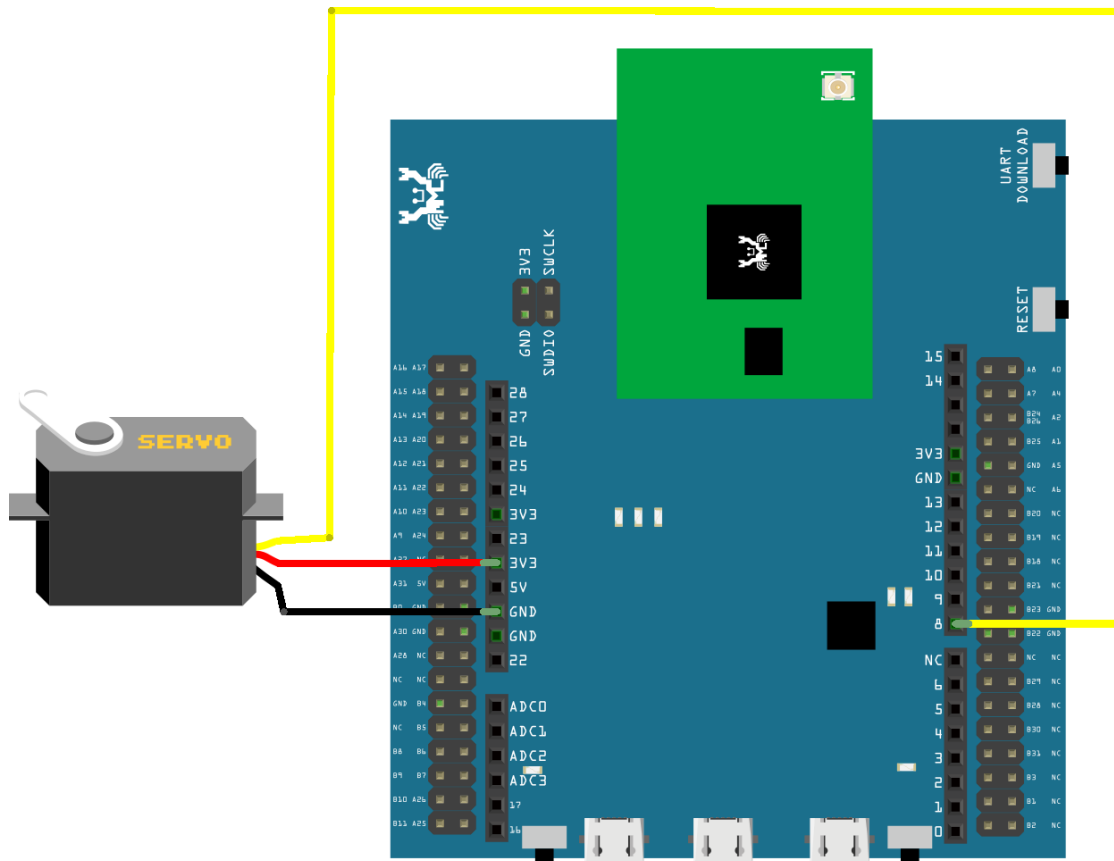
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Servo x 1 (Ex. Tower Pro SG90)

### Example

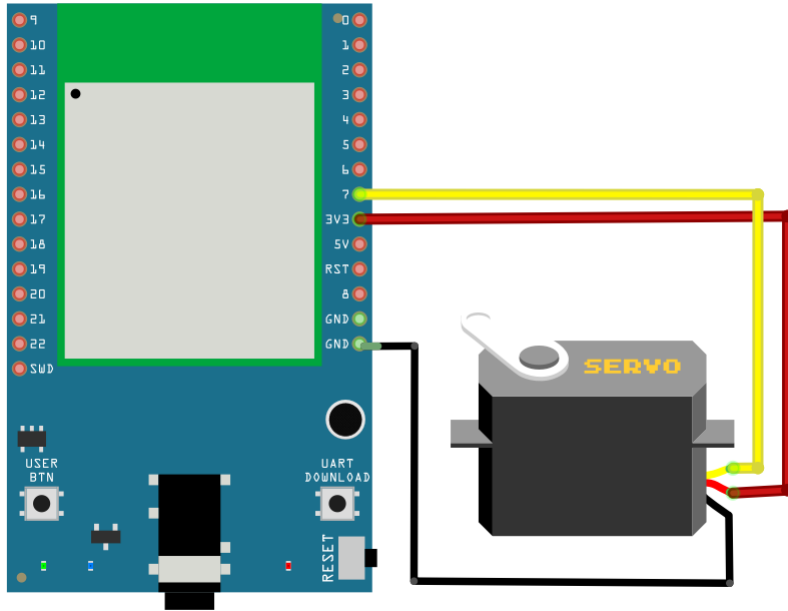
A typical servo has 3 wires, the red wire is for power, black or brown one should be connected to GND, and the other one is for signal data. We use PWM signal to control the rotation angle of the axis of the servo. The frequency of the signal is 50Hz, that is length 20ms. Each servo defines its pulse bandwidth, which is usually 1ms~2ms.

To control the rotation angle, for example if 1ms-length pulse rotates the axis to degree 0, then 1.5 ms pulse rotates the axis to 90 degrees, and 2 ms pulse rotates the axis to 180 degrees. Furthermore, a servo defines the “dead bandwidth”, which stands for the required minimum difference of the length of two consecutive pulse for the servo to work.

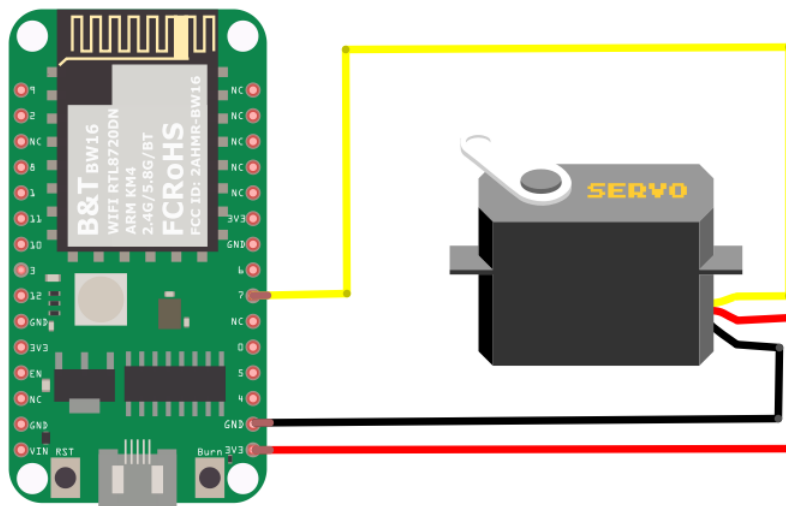
### AMB21 / AMB22 Wiring Diagram:



### AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the example, “File” -> “Examples” -> “AmebaAnalog” -> “ServoSweep”

This example makes the servo to rotate from degree 0 to 180, and then rotate back to degree 0.

## Code Reference

The Servo API of Ameba is similar to the API of Arduino. To distinguish from the original API of Arduino, we name the header file “AmebaServo.h” and the Class “AmebaServo” , the usage is identical to the Arduino API.

The default pulse bandwidth of Arduino Servo is 0.5ms~2.4ms, which is the same as Tower Pro SG90. Therefore, we set the attached pin directly:

```
myservo.attach(9);
```

Next, rotate the axis to desired position:

```
myservo.write(pos);
```

## RTC - Simple RTC

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

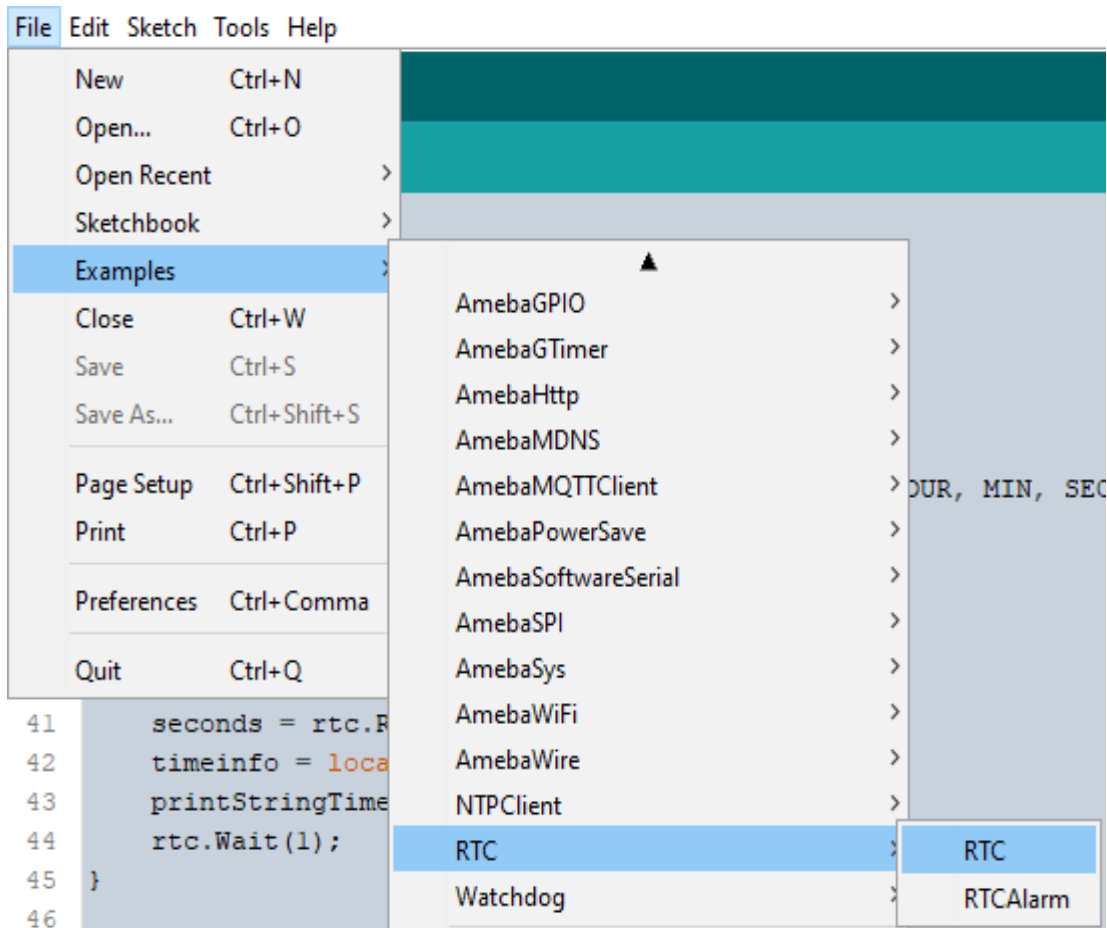
### Example

This example demonstrates how to use the RTC library methods. This function describes how to use the RTC API. The RTC function is implemented by an independent BCD timer/counter.

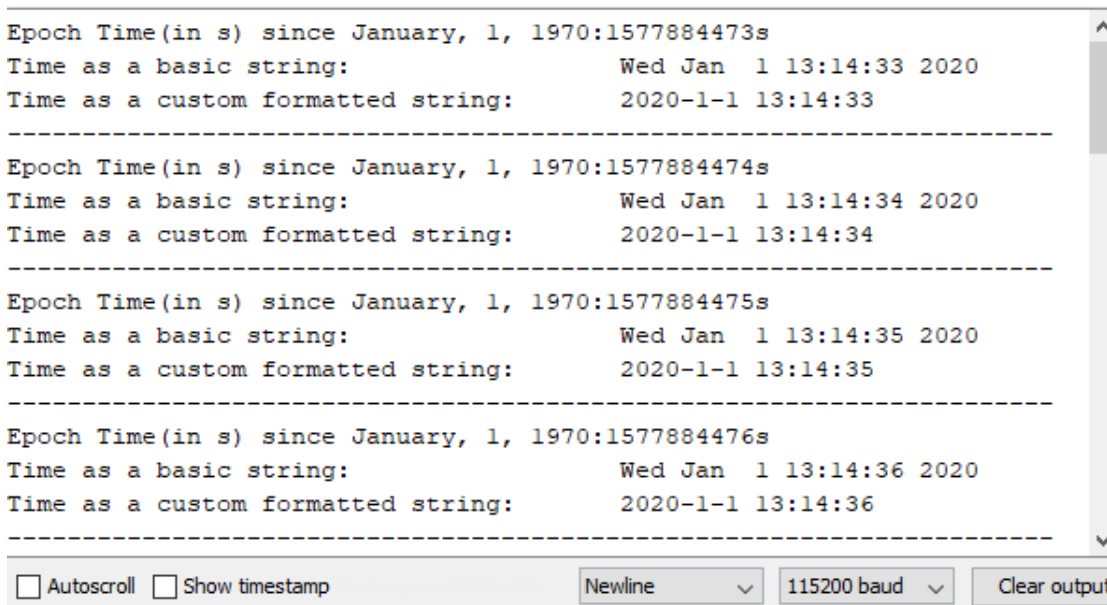
Select the correct Ameba development board from the Arduino IDE: 「Tools」 -> 「Board」 .

Then open the “RTC” example from:

"File" -> "Examples" -> "AmebaRTC" -> "RTC":



Upon successfully upload the sample code and press the reset button, this example will print out time information since the user initialized time every second in the Serial Monitor.



## Code Reference

[1] Simple RTC example from Arduino Tutorials:

<https://www.arduino.cc/en/Tutorial/SimpleRTC>

## RTC - Simple RTC Alarm

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

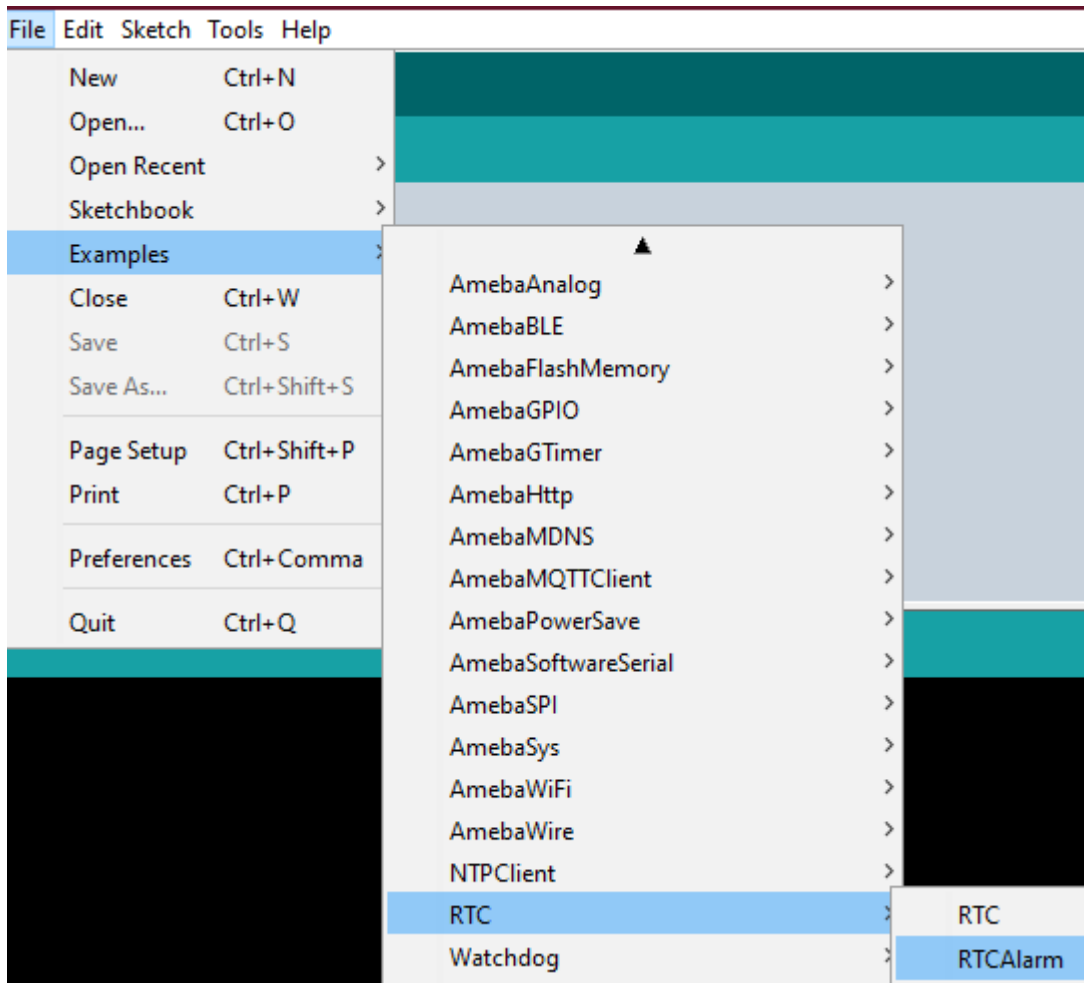
### Example

This example demonstrates how to use the RTC library methods to create a RTC Alarm, so that to do some tasks when an alarm is matched. In particular, the RTC time is set at 16:00:00 and an alarm at 16:00:10. When the time matches, “Alarm Match” information will be printed on the serial monitor.

First, select the correct Ameba development board from the Arduino IDE: “Tools” -> “Board” .

Then open the 「RTCArm」 example from: “File” -> “Examples” -> “RTC” -> “RTCArm” :





In the example, the RTC time is set at 16:00:00 and an alarm is set at 16:00:10. Upon successfully upload the sample code and press the reset button. When the alarm time (10 seconds) is reached the attached interrupt function will print the following information: “Alarm Matched!” showing in this figure below.

```
#Flash Download Start
=====
Time:      2020-1-1 16:1:0
Time:      2020-1-1 16:1:1
Time:      2020-1-1 16:1:2
Time:      2020-1-1 16:1:3
Time:      2020-1-1 16:1:4
Time:      2020-1-1 16:1:5
Time:      2020-1-1 16:1:6
Time:      2020-1-1 16:1:7
Time:      2020-1-1 16:1:8
Time:      2020-1-1 16:1:9
==== Alarm Matched ====
```

☒ Autoscroll ☐ Show timestamp    Newline    115200 baud    Clear output

## SPI –Print Image And Text On LCD Screen

If you are not familiar with SPI, please read [Introduction to SPI](#) first.

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- ILI9341 TFT LCD with SPI interface x 1

### Example

We have tested the following two models of ILI9341 TFT LCD with SPI interface:

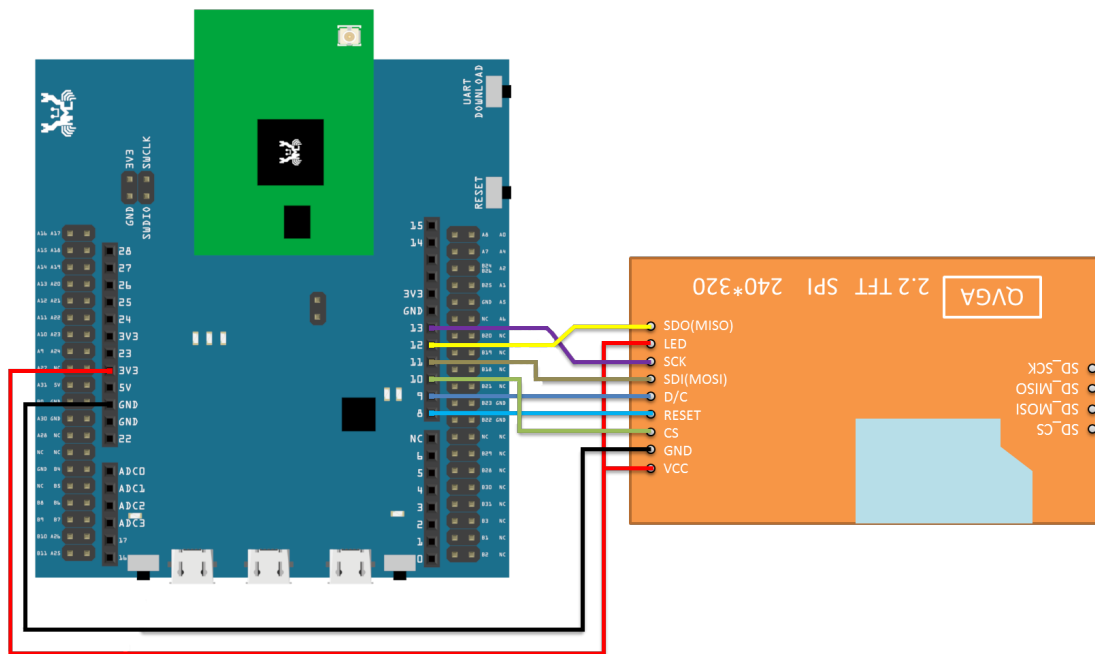
- Adafruit 2.8" TFT LCD (with touch screen)
  - <https://www.adafruit.com/products/1651>
  - <https://learn.adafruit.com/adafruit-2-8-tft-touch-shield-v2?view=all>
- QVGA 2.2" TFT LCD
  - [http://www.lcdwiki.com/2.2inch\\_SPI\\_Module\\_ILI9341\\_SKU:MSP2202](http://www.lcdwiki.com/2.2inch_SPI_Module_ILI9341_SKU:MSP2202)

Common pins in ILI9341 TFT LCD with SPI interface:

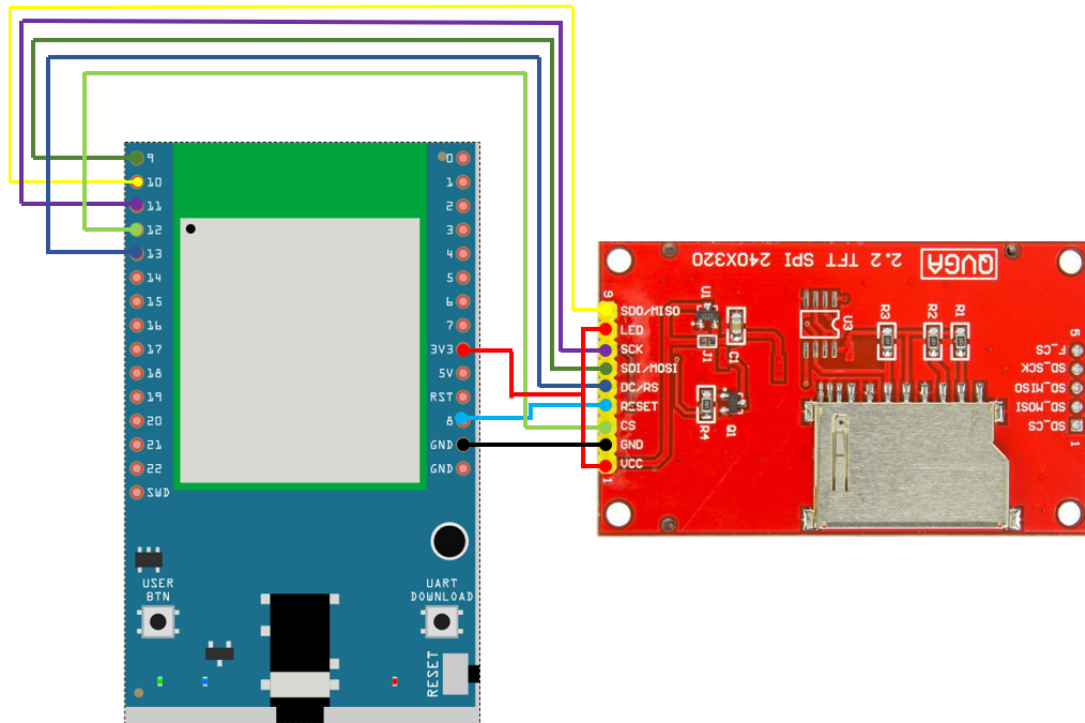
- MOSI: Standard SPI Pin
- MISO: Standard SPI Pin
- SLK: Standard SPI Pin

- CS: Standard SPI Pin
- RESET: Used to reboot LCD.
- D/C: Data/Command. When it is at Low, the signal transmitted are commands, otherwise the data transmitted are data.
- LED (or BL): Adapt the screen backlight. Can be controlled by PWM or connected to VCC for 100% backlight.
- VCC: Connected to 3V or 5V, depends on its spec.
- GND: Connected to GND.

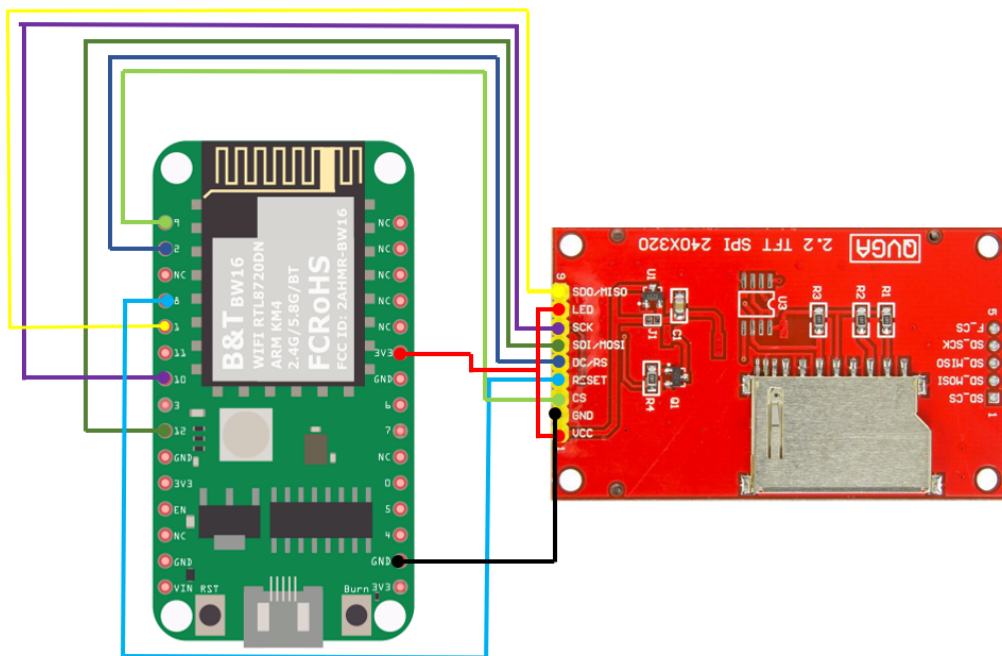
AMB21/ AMB22 and QVGA TFT LCD Wiring Diagram:



AMB23 and QVGA TFT LCD Wiring Diagram:



BW16 and QVGA TFT LCD Wiring Diagram:

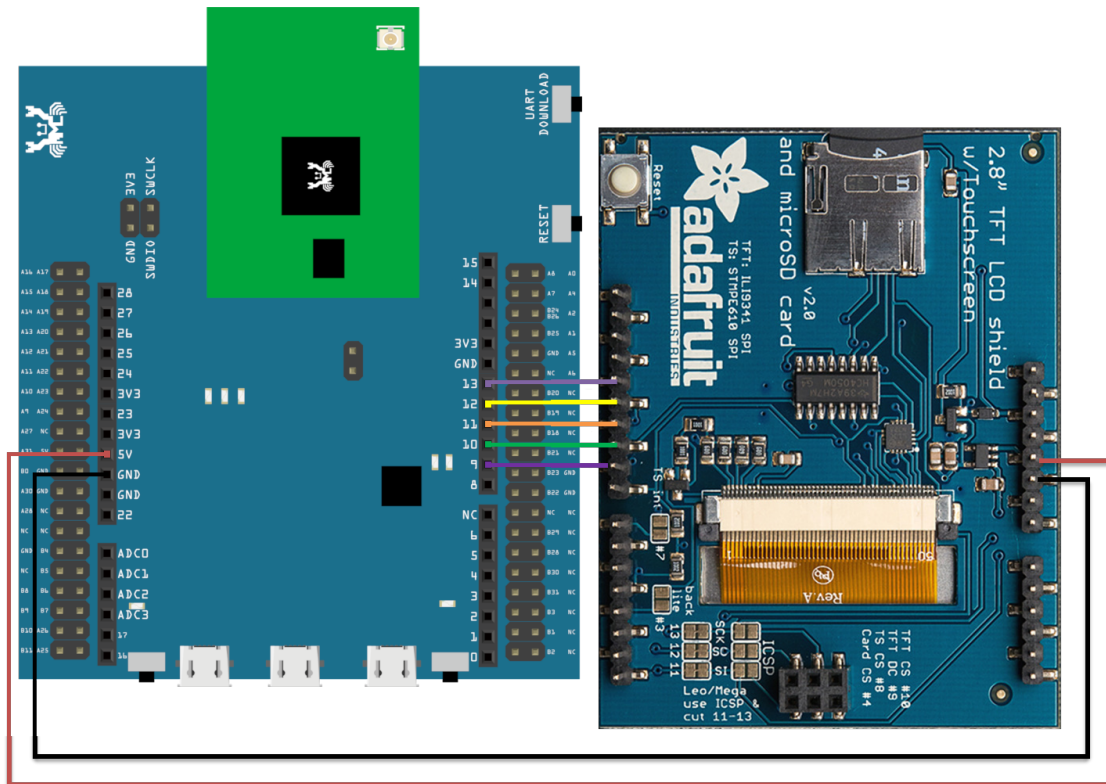


Wiring example of Adafruit 2.8" TFT LCD touch shield:

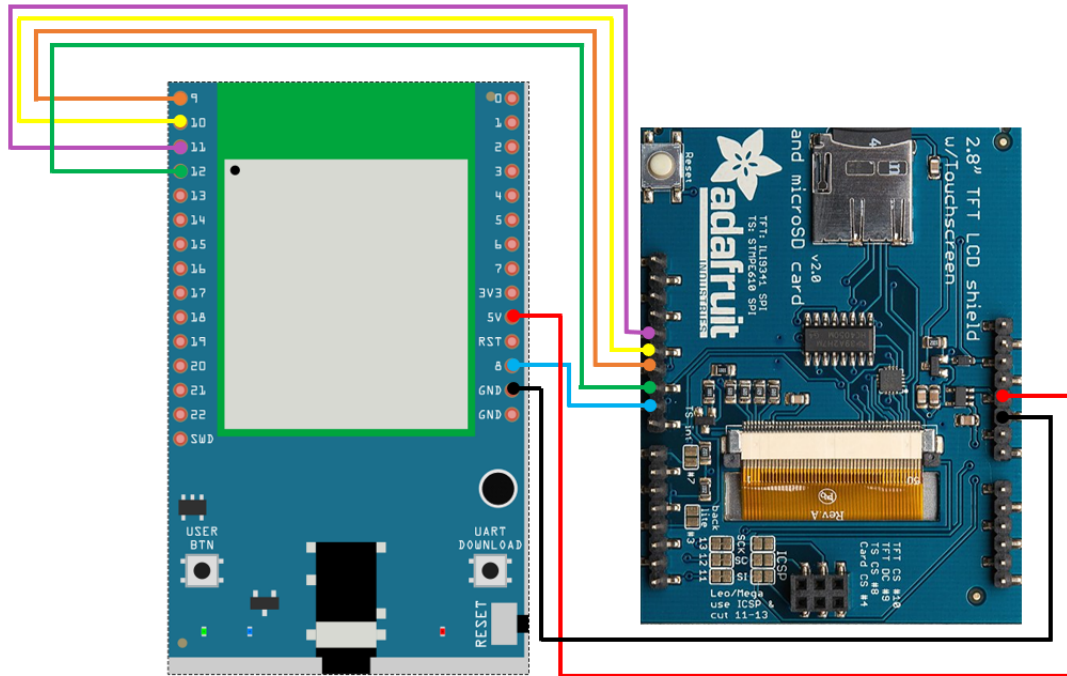
Please note that this shield model enables the backlight by default and pin 8 is not for backlight, and the VCC should be connected to 5V.

## AMB21 / AMB22 and Adafruit 2.8" TFT LCD touch shield Wiring Diagram:

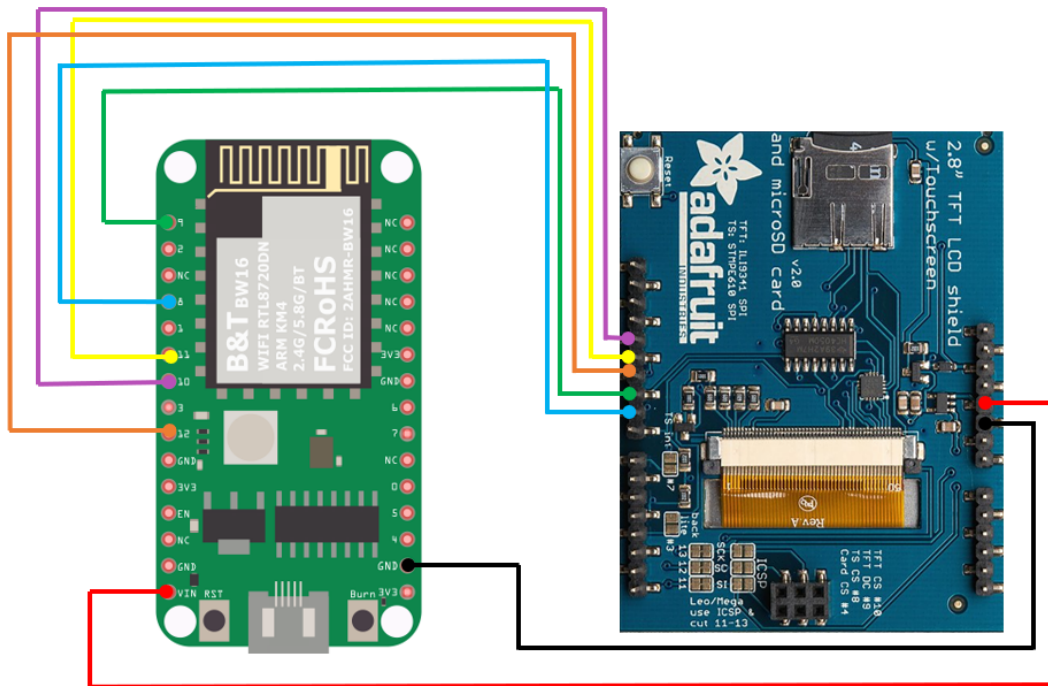
Please note that this shield model enables the backlight by default and pin 8 is not for backlight, and the VCC should be connected to 5V.



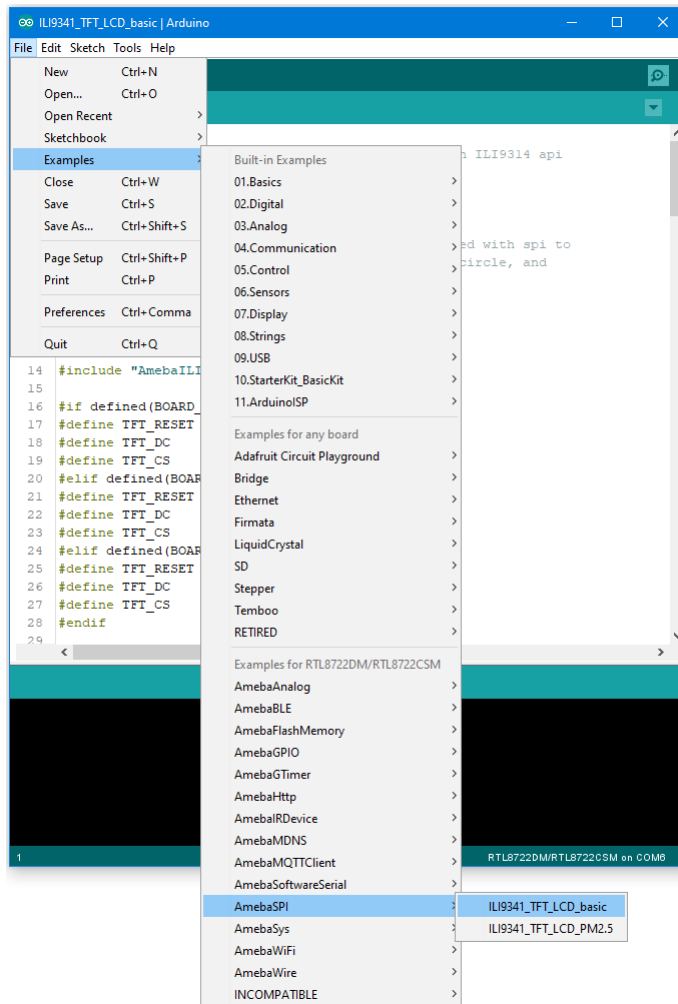
## AMB23 and Adafruit 2.8" TFT LCD touch shield Wiring Diagram:



BW16 and Adafruit 2.8 inch TFT LCD touch shield Wiring Diagram:

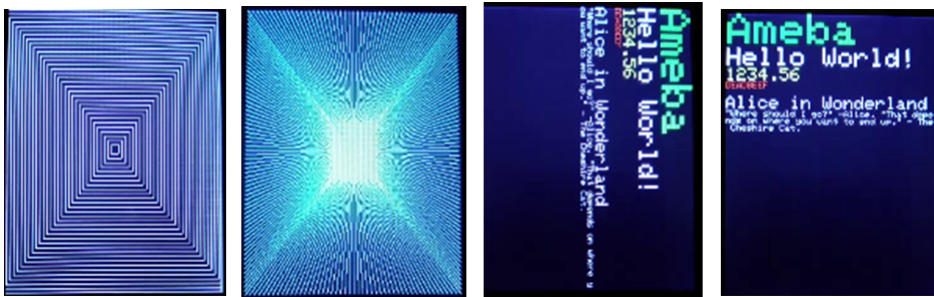


Open the example, “Files” -> “Examples” -> “AmebaSPI” -> “ILI9341\_TFT\_LCD\_basic”



Compile and upload to Ameba, then press the reset button.

Then you can see some display tests appear on the LCD screen, such as displaying different colors, drawing vertical and horizontal lines, drawing circles, etc. ...



## Code Reference

- **RGB 16-bit**

ILI9341 uses RGB 16-bit to display colors. Different from RGB 24-bit, it uses 5 bits for red, 6 bits for green, 5 bits for blue. For example, the RGB 24-bit representation of sky blue is 0x87CEFF, that is in binary:

- Red: 0x87 = B10000111
- Green: 0xCE = B11001110
- Blue: 0xFF = B11111111

and converted to RGB 16-bit:

- Red: B10000
- Green: B110011
- Blue: B11111

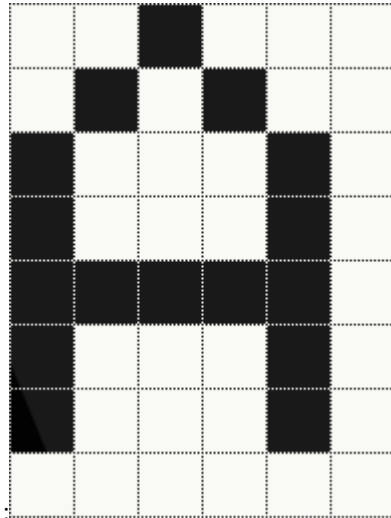
Then concatenate them, which forms B1000011001111111 = 0x867F

- **Drawing of ILI9341**

- First you must specify the range of the rectangle to draw, then pass the 2-byte RGB 16-bit color to ILI9341 corresponding to each pixel one by one, in this way ILI9341 fills each color to each pixel.
- You still must specify the drawing range even though the range covers only one pixel.
- From the rules we mentioned above, we can conclude that drawing vertical or horizontal lines are faster than diagonal lines.

- **Printing text on ILI9341**

- In our API, each character is 5×7 but each character is printed to size 6×8 (its right side and below are left blank), so as to separate from next character. For example, the character “A”



- The font size represents the dot size. For example, if the font size is 2, each dot in the character is a 2×2 rectangle



- **Screen rotation**

- ILI9341 provides 0, 90, 180, 270 degrees screen rotation.
- If the original width is 240 and original height is 320, when the screen rotates 90 degrees, the width becomes 320 and the height becomes 240.

## **SPI –Show PM2.5 Concentration On ILI9341 TFT LCD**

If you are not familiar with SPI, please read [Introduction to SPI](#) first.

### **Preparation**

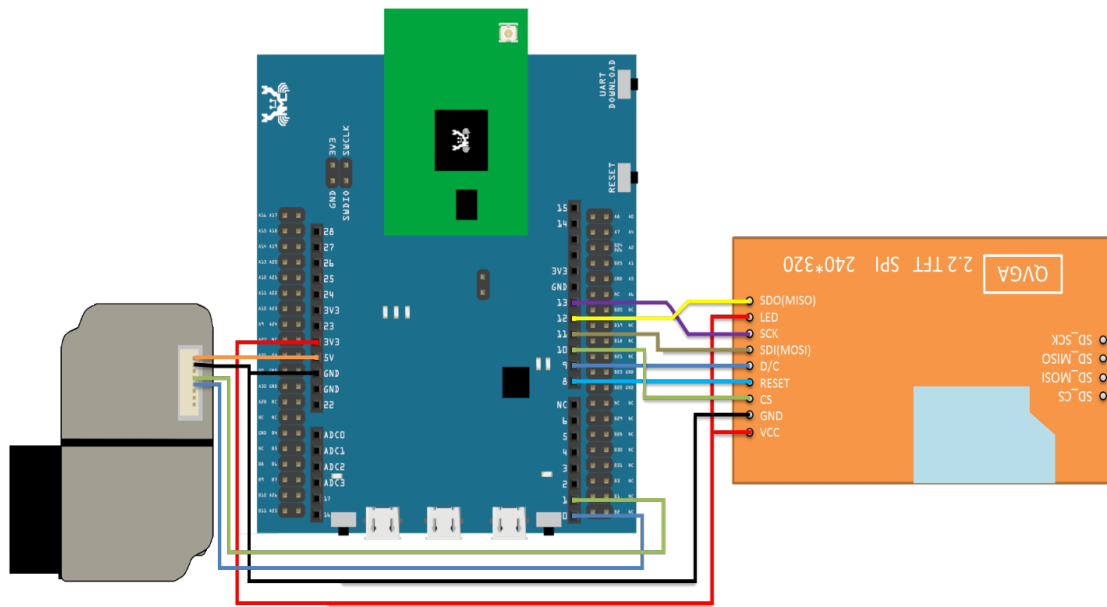
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- ILI9341 TFT LCD with SPI interface x 1
- Plantower PMS3003 or PMS5003 x 1

### **Example**

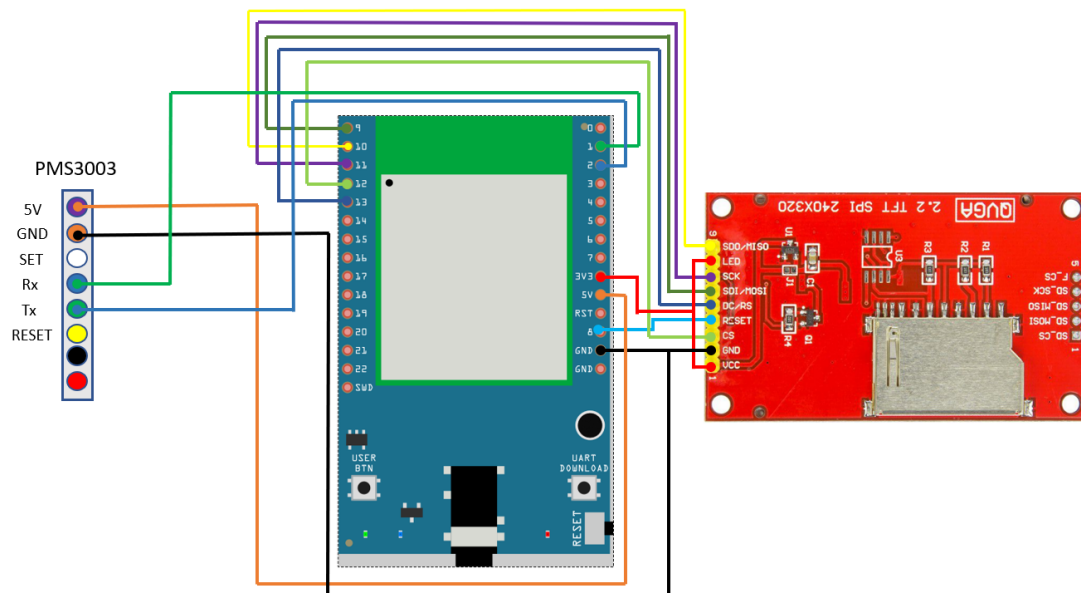
This example extends previous PM2.5 example to show the PM2.5 concentration on the LCD.

**AMB21 / AMB22 and QVGA TFT LCD Wiring Diagram:**

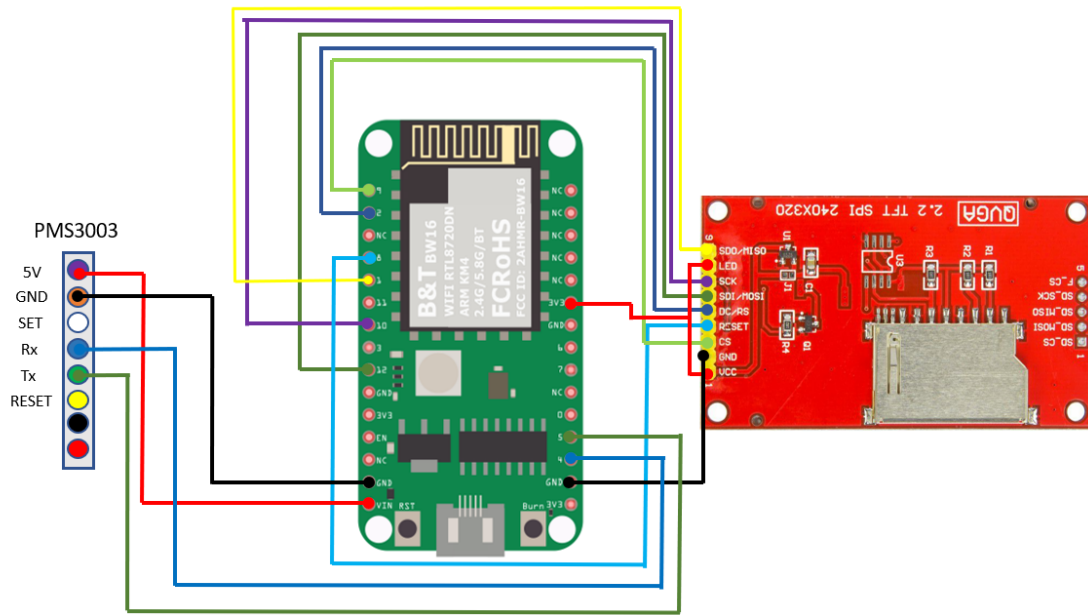
(Note: PMS3003/PMS5003 sensor requires 5V voltage)



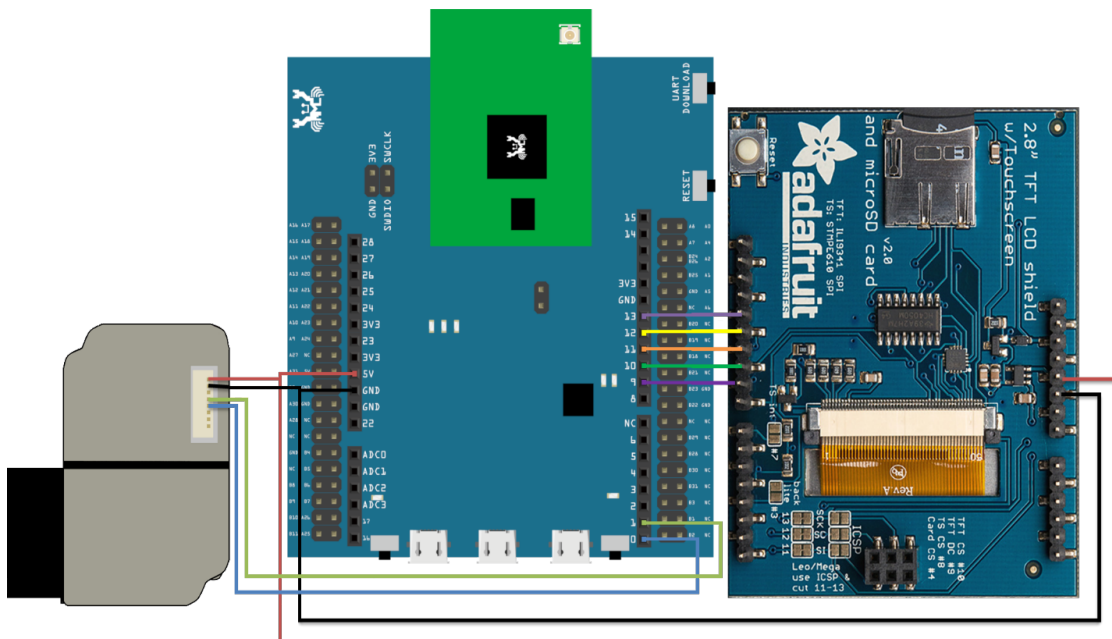
AMB23 and QVGA TFT LCD Wiring Diagram:



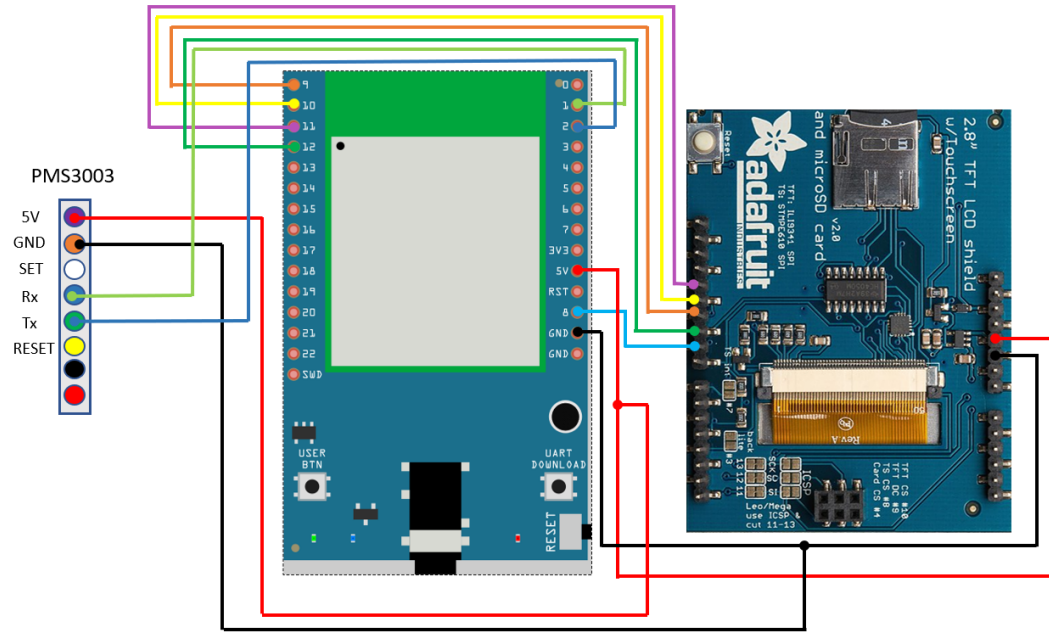
BW16 and QVGA TFT LCD Wiring Diagram:



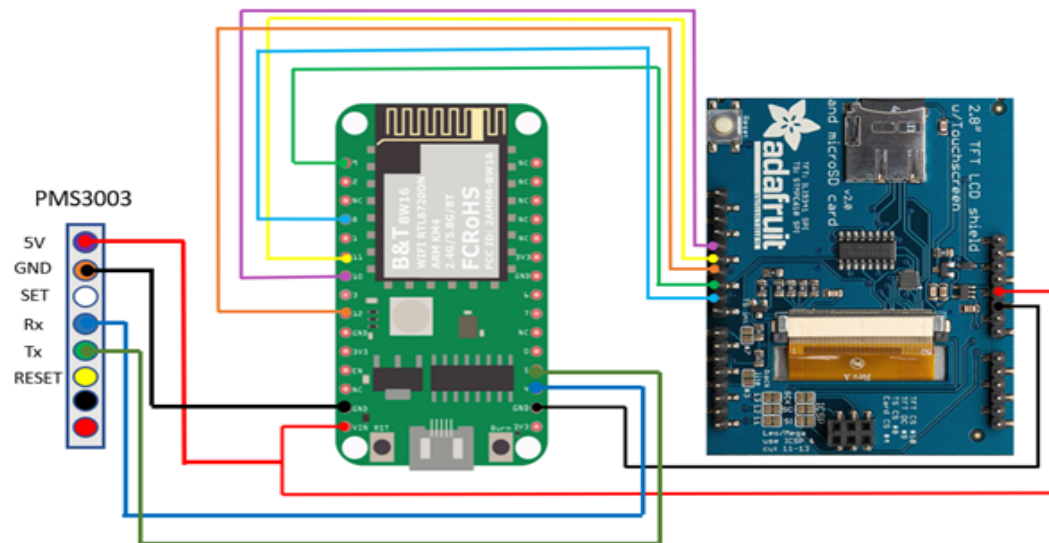
AMB21 / AMB22 and Adafruit 2.8" TFT LCD Wiring Diagram:



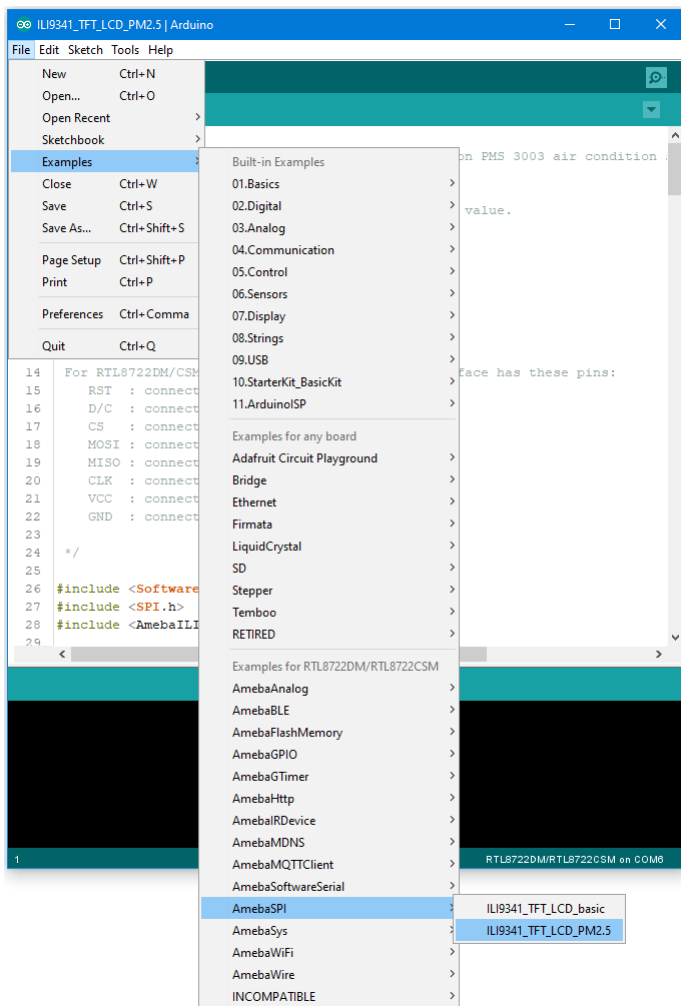
AMB23 and and Adafruit 2.8" TFT LCD Wiring Diagram:



BW16 and and Adafruit 2.8" TFT LCD Wiring Diagram:

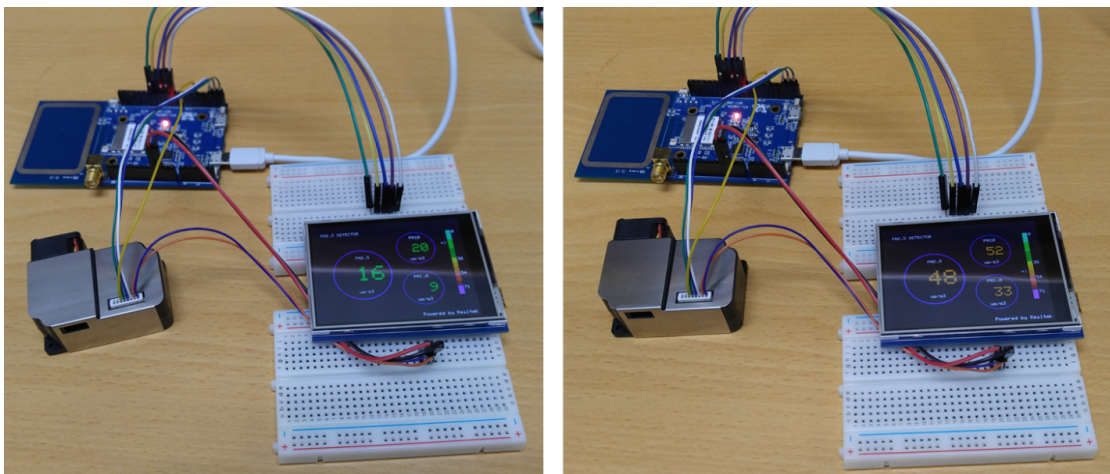


Open the example, "Files" -> "Examples" -> "AmebaSPI" -> "PM25\_on\_ILI9341\_TFT\_LCD"



Compile and upload to Ameba, then press the reset button.

Then you can see the concentration value of PM1.0, PM2.5 and PM10 on the LCD.



## Code Reference

In this example, first rotate the screen by 90 degrees, and draw the static components such as the circles, the measuring scale, and the title text. After the concentration value is detected, it is printed inside the circle.

## TensorFlow Lite - Hello World

### Materials

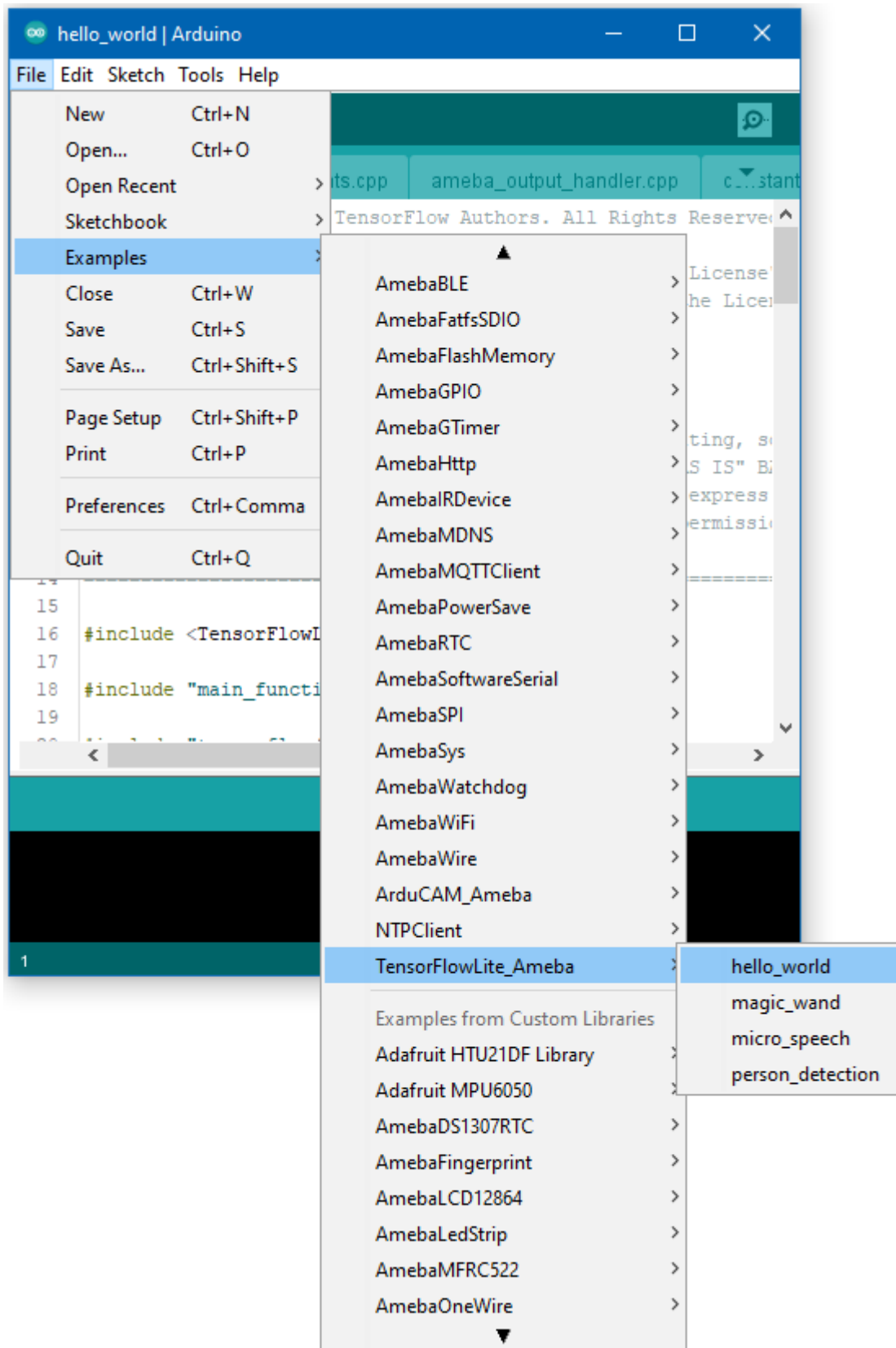
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- LED x 1

### Example

#### Procedure

Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at [https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries). Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it. Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

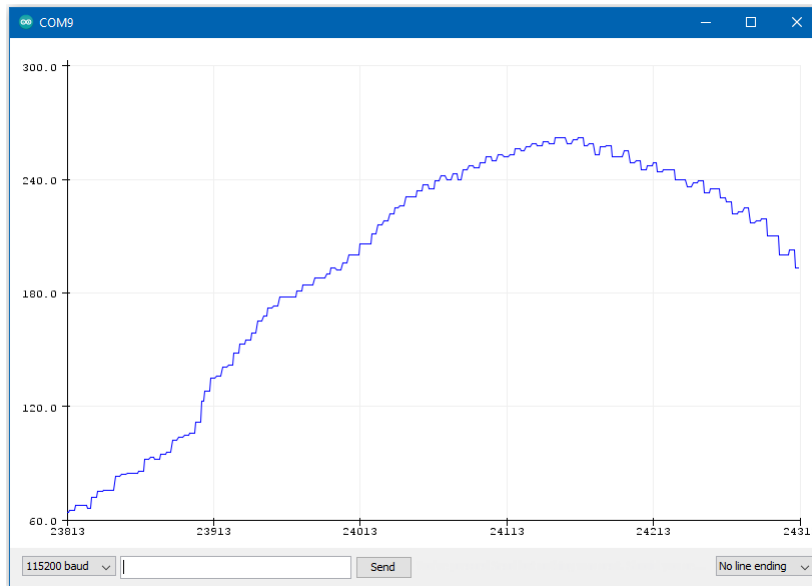
Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "hello\_world".



Upload the code and press the reset button on Ameba once the upload is finished.

Connect the LED to digital pin 10 and ground, ensuring that the polarity is correct. You should see the LED fade in and out rapidly.

In the Arduino serial plotter, you can see the output value of the Tensorflow model plotted as a graph, it should resemble a sine wave.



## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## TensorFlow Lite - Magic Wand

### Materials

- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Adafruit LSM9DS1 accelerometer
- LED x 2

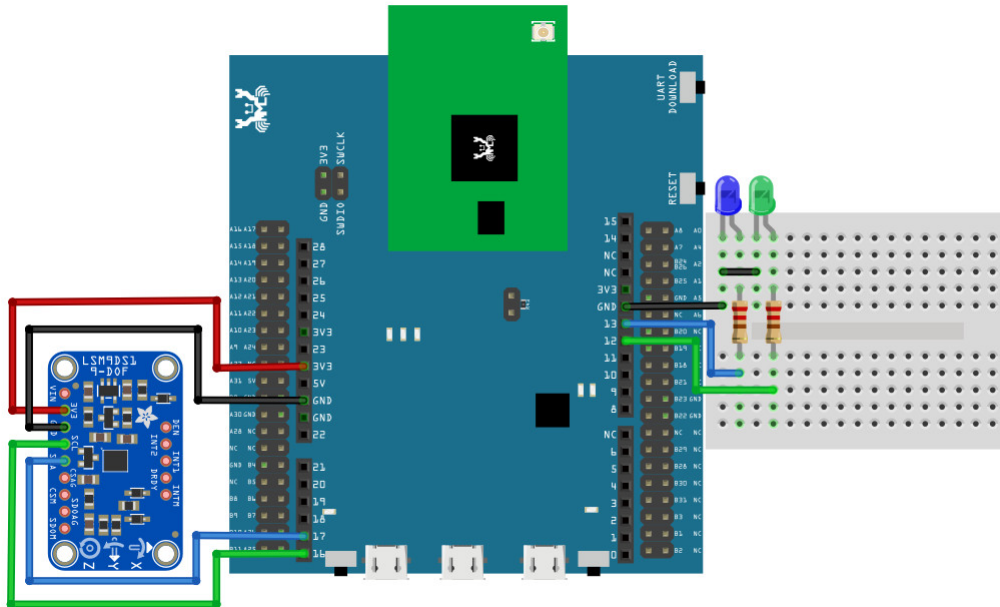
### Example

### Procedure

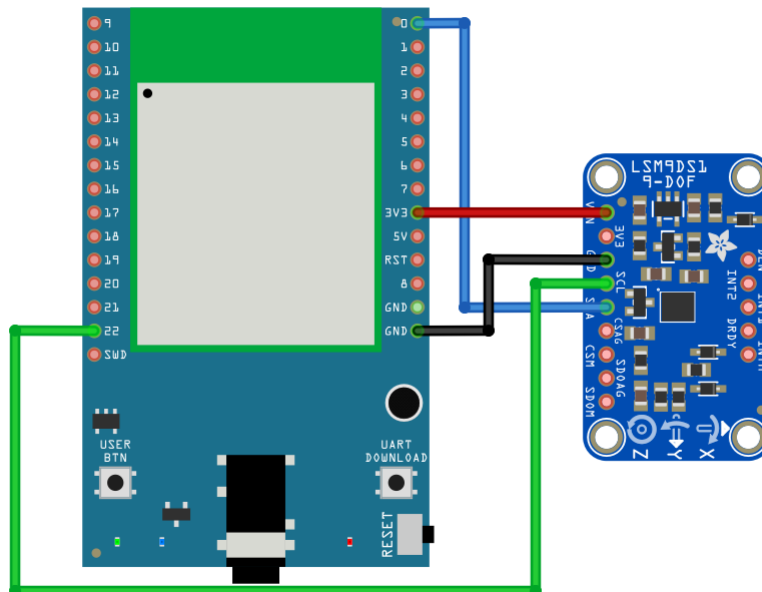


**AMB21\* / AMB22 Wiring Diagram:**

Connect the accelerometer and LEDs to the RTL8722 board following the diagram.

**AMB23 Wiring Diagram:**

For RTL8722DM MINI, we will use the onboard LEDs on the board itself.



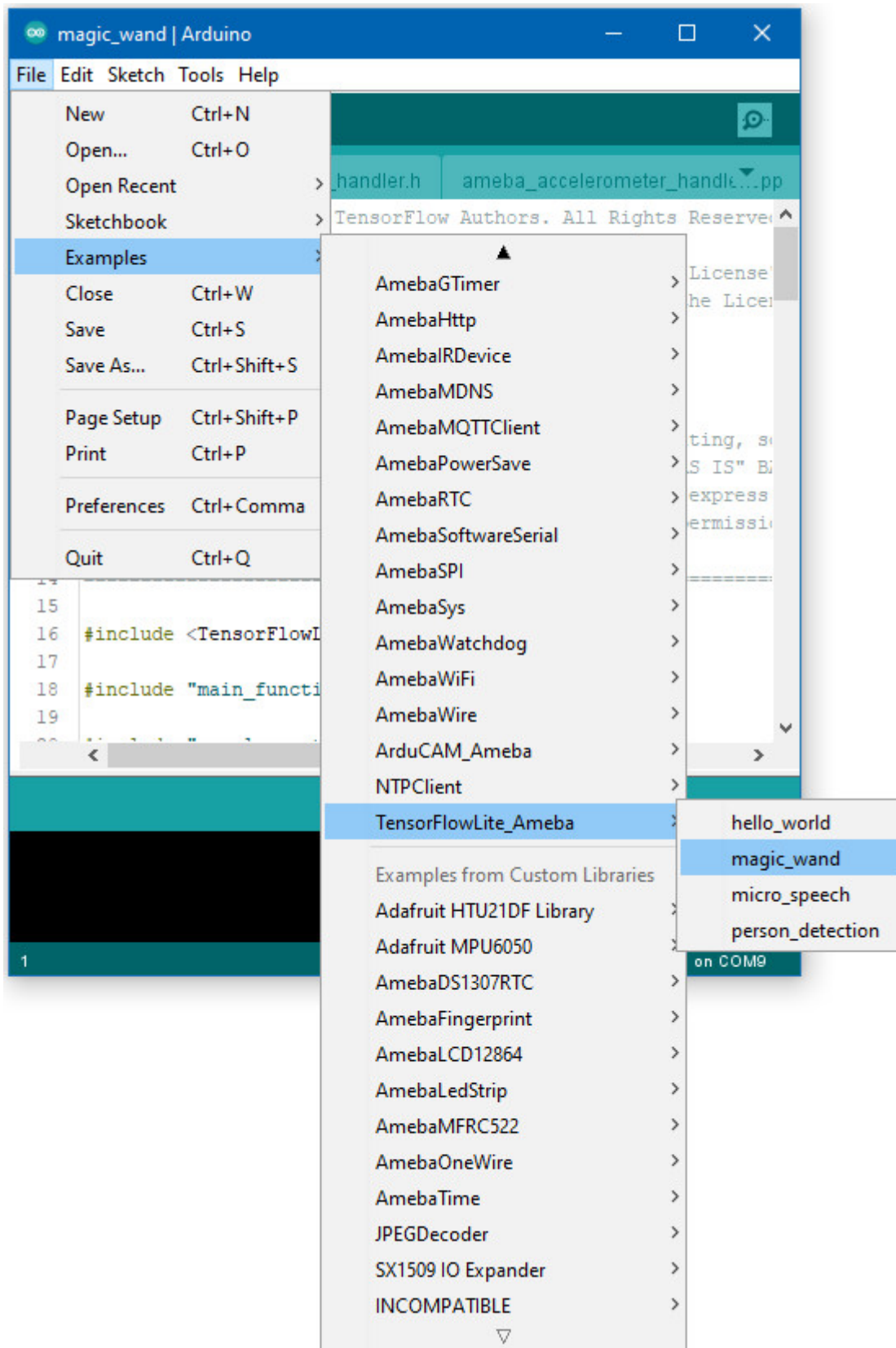
Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at [https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries).

Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it.

Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

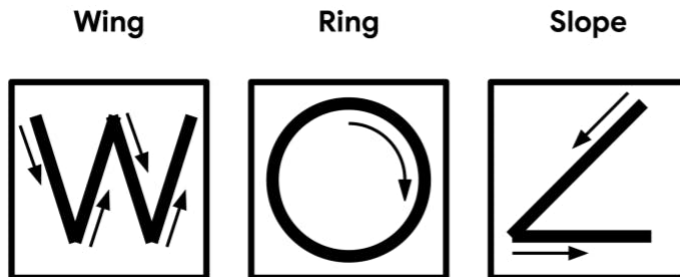
In the Arduino IDE library manager, install the Arduino\_LSM9DS1 library. This example has been tested with version 1.1.0 of the LSM9DS1 library.

Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "magic\_wand" .



Upload the code and press the reset button on Ameba once the upload is finished.

Holding the accelerometer steady, with the positive x-axis pointing to the right and the positive z-axis pointing upwards, move it following the shapes as shown, moving it in a smooth motion over 1 to 2 seconds, avoiding any sharp movements.



If the movement is recognised by the Tensorflow Lite model, you should see the same shape output to the Arduino serial monitor. Different LEDs will light up corresponding to different recognized gestures.

Note that the wing shape is easy to achieve, while the slope and ring shapes tend to be harder to get right.

The screenshot shows a serial monitor window titled 'COM9'. The output displays timestamps and the recognized gesture name, followed by a pattern of asterisks representing the gesture shape.

```

12:12:38.969 ->
12:12:50.459 -> SLOPE:
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> * * * * *
12:12:50.459 ->
12:13:21.201 -> WING:
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 ->

```

At the bottom of the window, there are controls for 'Autoscroll' (checked), 'Show timestamp' (checked), 'Carriage return' (dropdown), '115200 baud' (dropdown), and 'Clear output' (button).

## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## TensorFlow Lite - Micro Speech

### Preparation

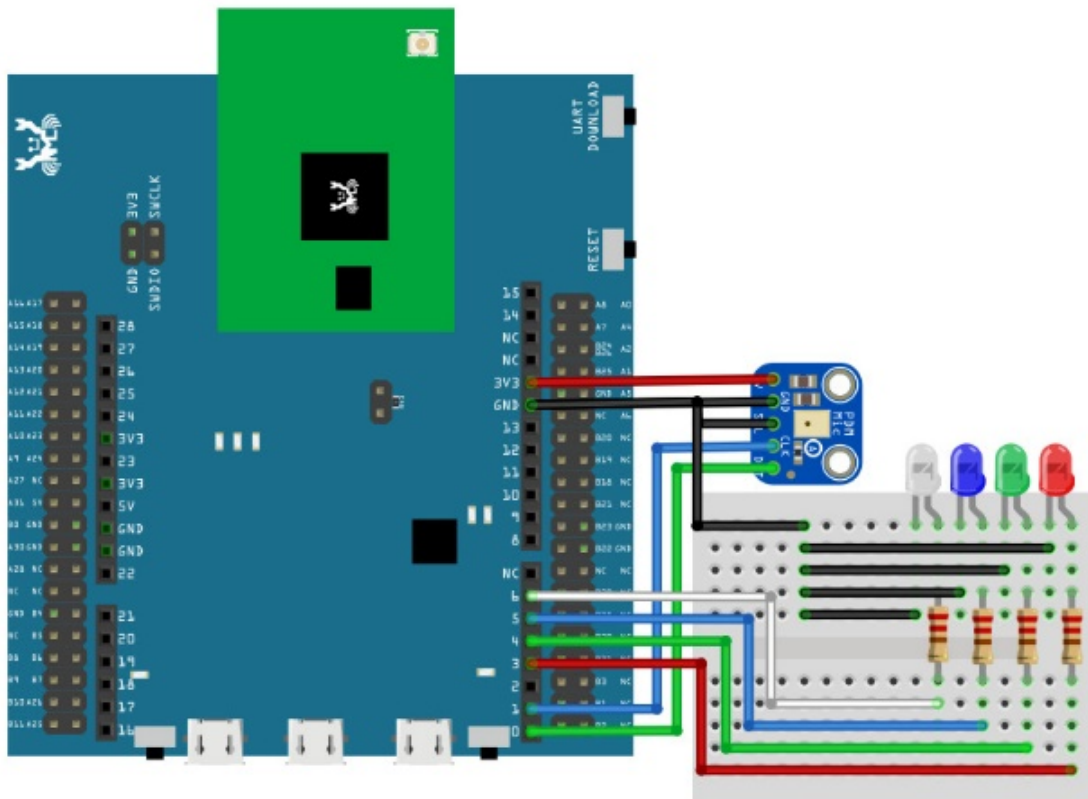
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Adafruit PDM MEMS microphone
- LED x 4

### Example

### Procedure

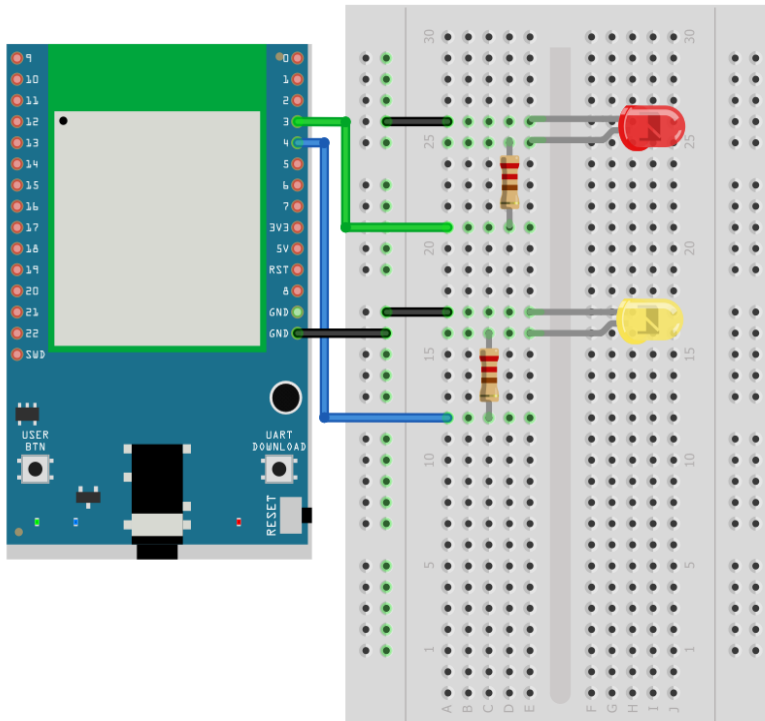
#### AMB21 / AMB22 Wiring Diagram:

Connect the microphone and LEDs to the RTL8722 board following the diagram.



**AMB23** Wiring Diagram:

As RTL8722DM MINI have a built in microphone on the board, there is no need for any external microphone. For the LEDs, we will only connect two LEDs and then use the two onboard LEDs (Blue and Green).



Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at

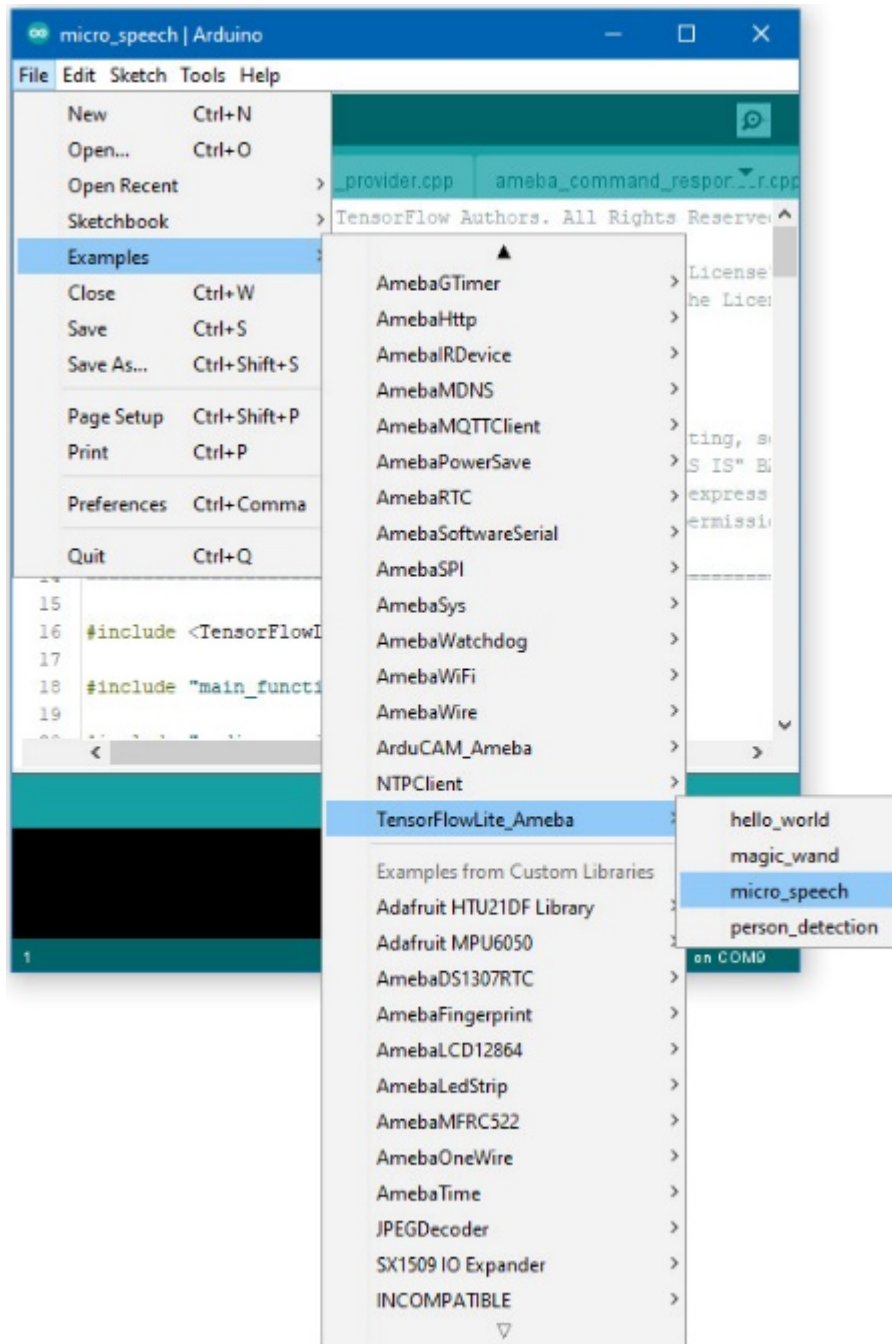
[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries).

Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it.

Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "micro\_speech"

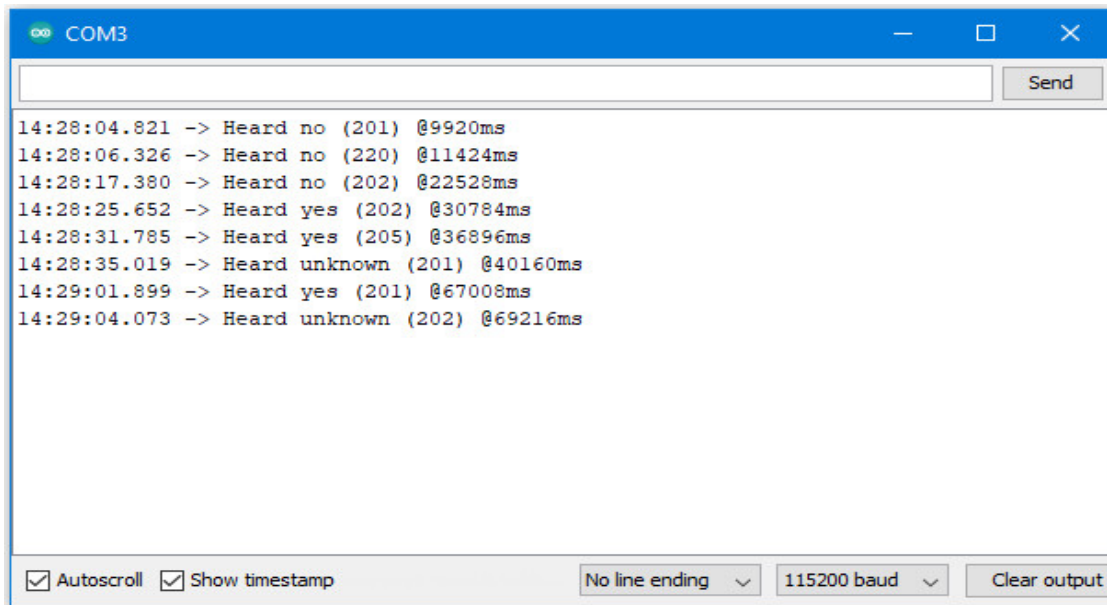
.



Upload the code and press the reset button on Ameba once the upload is finished.

Once it is running, you should see one of the LEDs flashing, indicating that it is processing audio. Saying the word 「yes」 will cause the green LED to light up. Saying the word “no” will cause the red LED to light up. If the word is not recognized, the blue LED will light up.

The inference results are also output to the Arduino serial monitor, which appear as follows:



```
COM3
14:28:04.821 -> Heard no (201) @9920ms
14:28:06.326 -> Heard no (220) @11424ms
14:28:17.380 -> Heard no (202) @22528ms
14:28:25.652 -> Heard yes (202) @30784ms
14:28:31.785 -> Heard yes (205) @36896ms
14:28:35.019 -> Heard unknown (201) @40160ms
14:29:01.899 -> Heard yes (201) @67008ms
14:29:04.073 -> Heard unknown (202) @69216ms
```

☒ Autoscroll ☒ Show timestamp No line ending 115200 baud Clear output

If you are having trouble in getting the words recognized, here are some tips:

- Ensure that your surroundings are quiet with minimal noise.
- Experiment with varying the distance of the microphone, starting with it at an arm's length.
- Experiment with different tones and volume when saying the words.
- Depending on how you pronounce the words, the characteristics of the microphone used, getting one keyword recognized may be easier than the other.

## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## TensorFlow Lite - Person Detection

### Materials

- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Arducam Mini 2MP Plus OV2640 SPI Camera Module x 1
- LED x 3

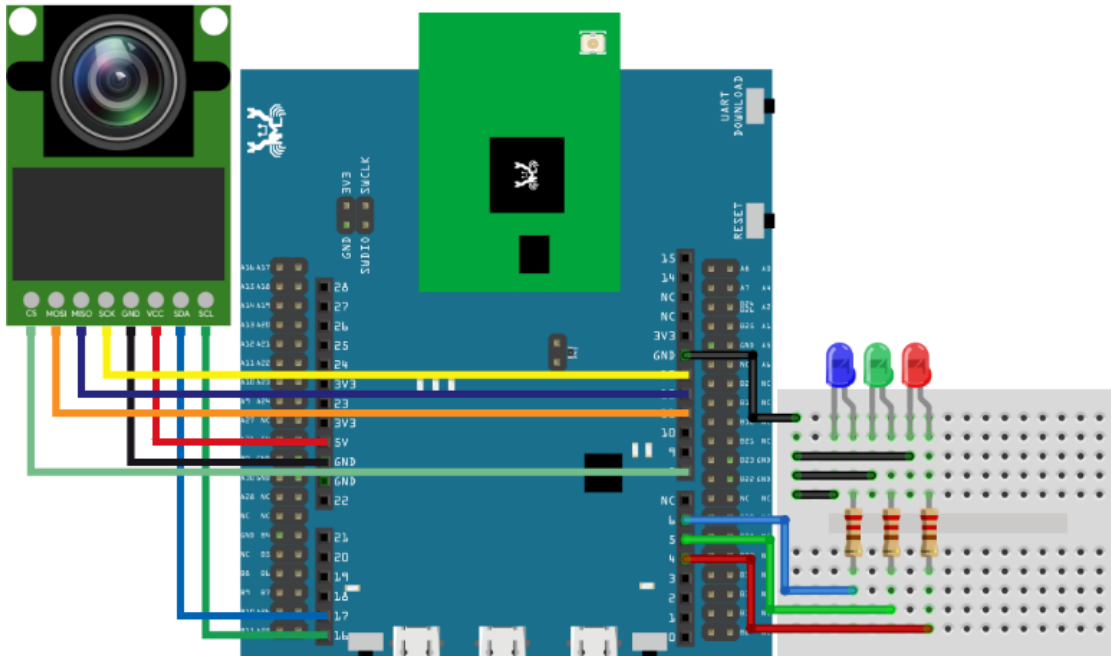
### Example



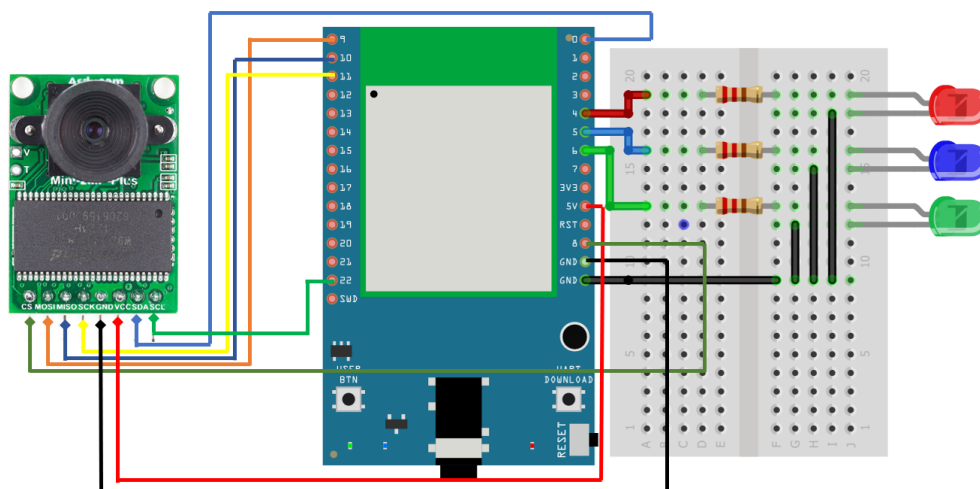
## Procedure

### AMB21 / AMB22 Wiring Diagram:

Connect the camera and LEDs to the RTL8722 board following the diagram.



### AMB23 Wiring Diagram:



Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries).

Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it. Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

You will also need to install the Ameba\_ArduCAM library, found together with the TensorFlow Lite library.

In the Arduino IDE library manager, install the JPEGDecoder library. This example has been tested with version 1.8.0 of the JPEGDecoder library.

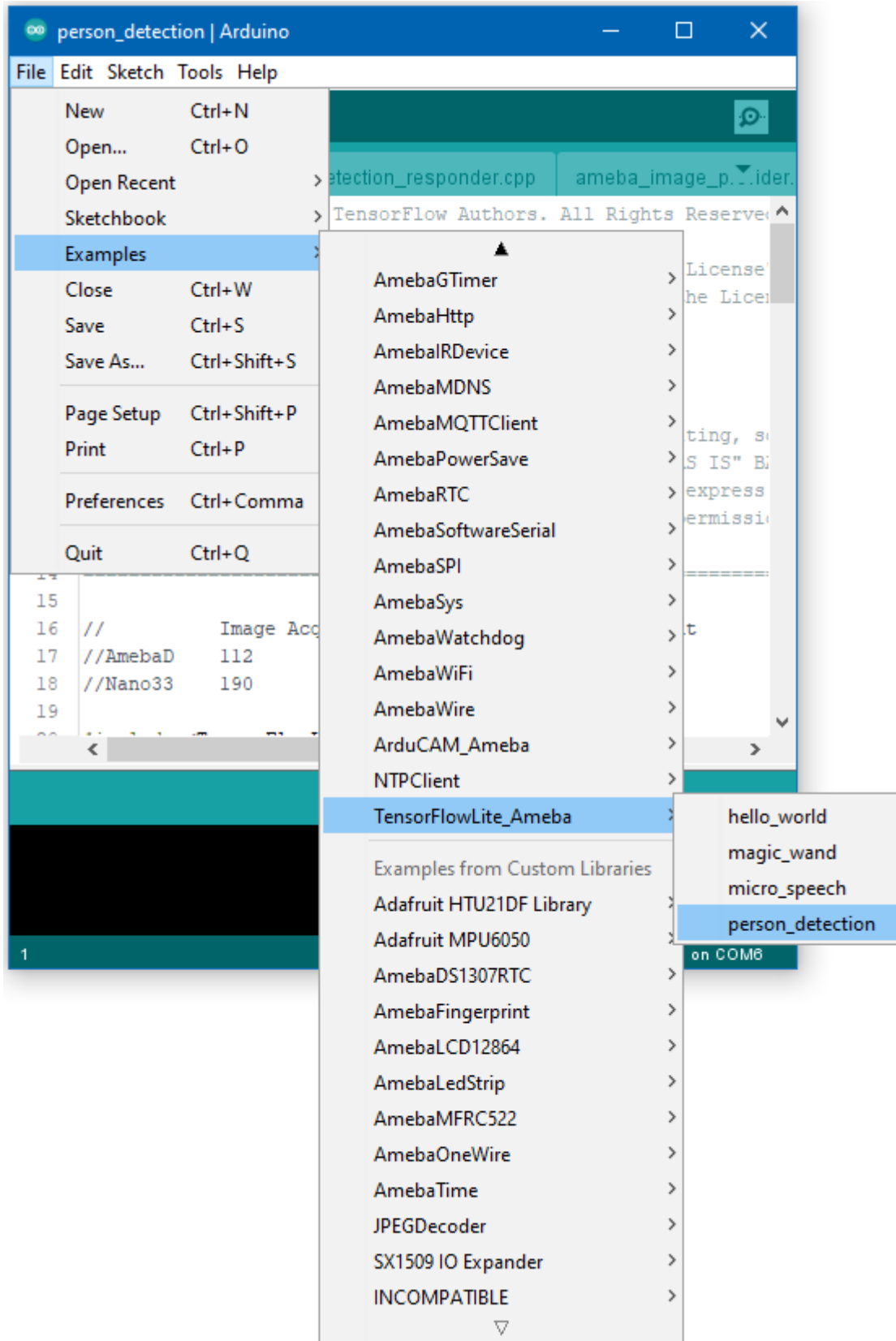
Once the library has installed, you will need to configure it to disable some optional components that are not compatible with the RTL8722DM. Open the following file:

```
Arduino/libraries/JPEGDecoder/src/User_Config.h
```

Make sure that both `#define LOAD_SD_LIBRARY` and `#define LOAD_SDFAT_LIBRARY` are commented out, as shown in this excerpt from the file:

```
//#define LOAD_SD_LIBRARY // Default SD Card library
//#define LOAD_SDFAT_LIBRARY // Use SdFat library instead, so SD Card SPI can be bit-
↳bashed
```

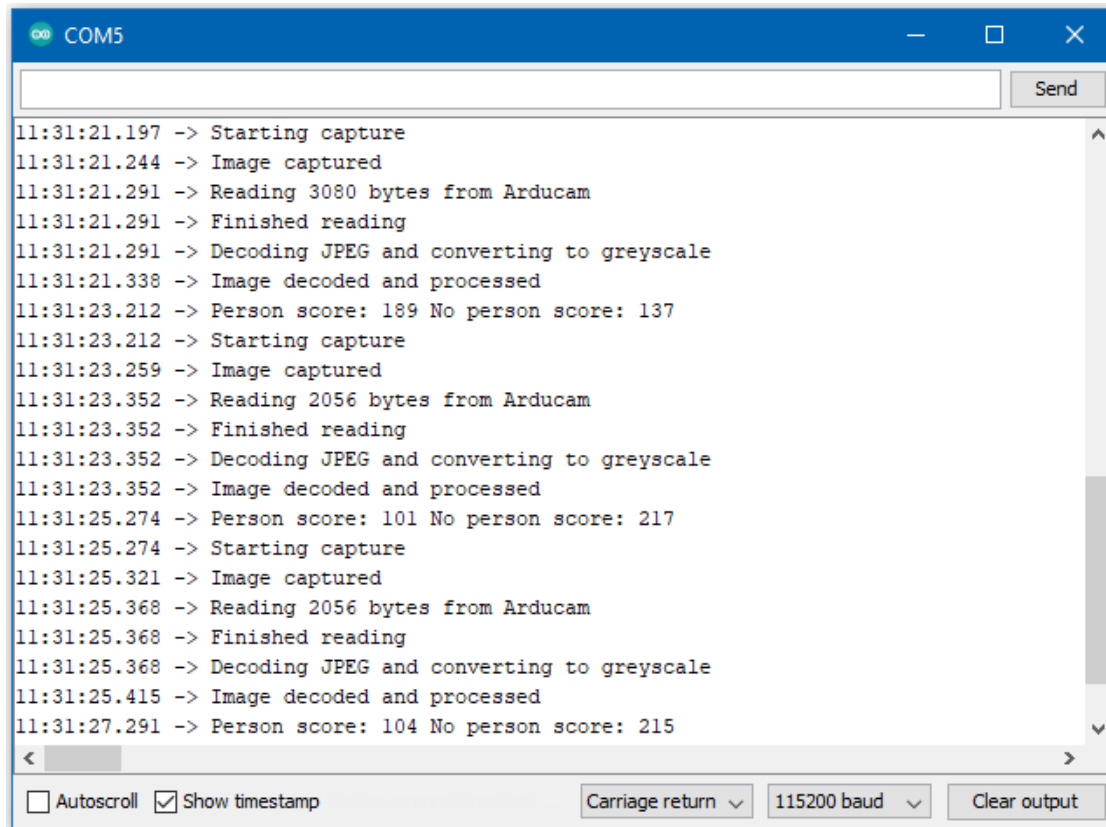
Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "person\_detection".



Upload the code and press the reset button on Ameba once the upload is finished.

Once it is running, you should see the blue LED flashing once every few seconds, indicating that it has finished processing an image. The red LED will light up if it determines that there is no person in the previous image captured, and the green LED will light up if it determines that there is a person.

The inference results are also output to the Arduino serial monitor, which appear as follows:



The screenshot shows the Arduino Serial Monitor window titled "COM5". The output text is as follows:

```
11:31:21.197 -> Starting capture
11:31:21.244 -> Image captured
11:31:21.291 -> Reading 3080 bytes from Arducam
11:31:21.291 -> Finished reading
11:31:21.291 -> Decoding JPEG and converting to greyscale
11:31:21.338 -> Image decoded and processed
11:31:23.212 -> Person score: 189 No person score: 137
11:31:23.212 -> Starting capture
11:31:23.259 -> Image captured
11:31:23.352 -> Reading 2056 bytes from Arducam
11:31:23.352 -> Finished reading
11:31:23.352 -> Decoding JPEG and converting to greyscale
11:31:23.352 -> Image decoded and processed
11:31:25.274 -> Person score: 101 No person score: 217
11:31:25.274 -> Starting capture
11:31:25.321 -> Image captured
11:31:25.368 -> Reading 2056 bytes from Arducam
11:31:25.368 -> Finished reading
11:31:25.368 -> Decoding JPEG and converting to greyscale
11:31:25.415 -> Image decoded and processed
11:31:27.291 -> Person score: 104 No person score: 215
```

At the bottom of the window, there are controls: ☐ Autoscroll, ☒ Show timestamp, a dropdown menu set to "Carriage return", a dropdown menu set to "115200 baud", and a "Clear output" button.

## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## UART - Communicate with PC over USB to Serial Module

### Introduction of UART

UART uses two wire, one for transmitting and the other one for receiving, so the data transmission is bidirectional. The communication uses a predefined frequency (baud rate) to transmit data. In Arduino, UART is called "Serial". There is only one hardware UART on Arduino Uno and it is primarily used to read the

log and messages printed by Arduino (so it is also called “Log UART” ). If we use the hardware UART for other purposes, the Log UART does not have resources to function. To provide more UART connections, it is possible to use a GPIO pin to simulate the behavior of UART with a software approach, this is called Software Serial. Ameba is equipped with several hardware UART ports, but it is also compatible with the Software Serial library.

## Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- USB to TTL Adapter x 1

## Example

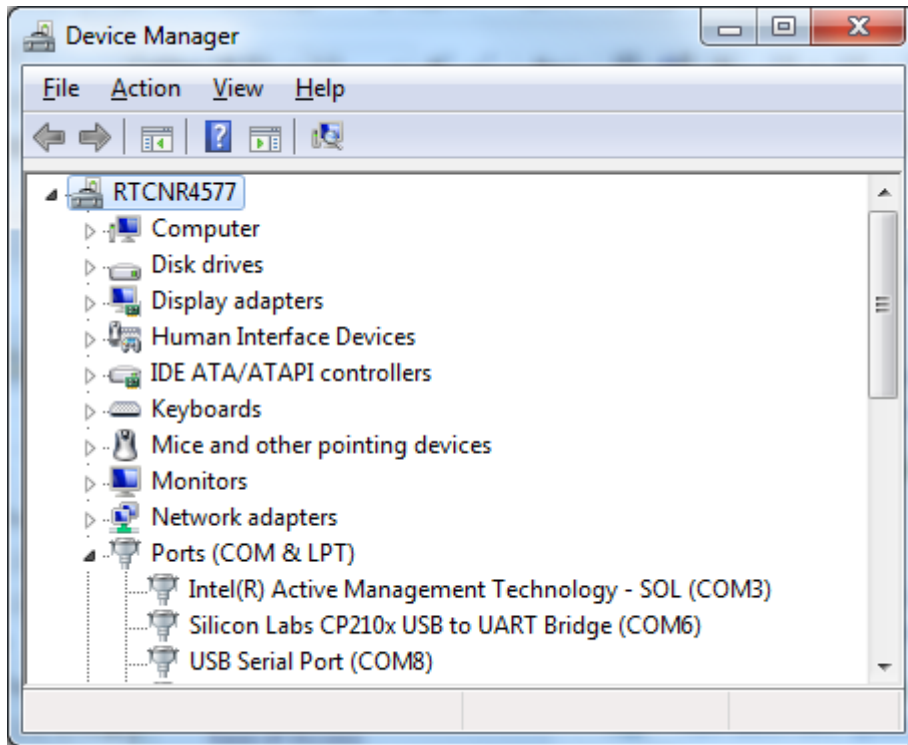
In this example, we use UART to connect USB to TTL adapter to Ameba.

USB to TTL adapter sends data to Ameba, the data would be returned by Ameba, and showed on the screen.

- **Install USB to TTL Adapter**

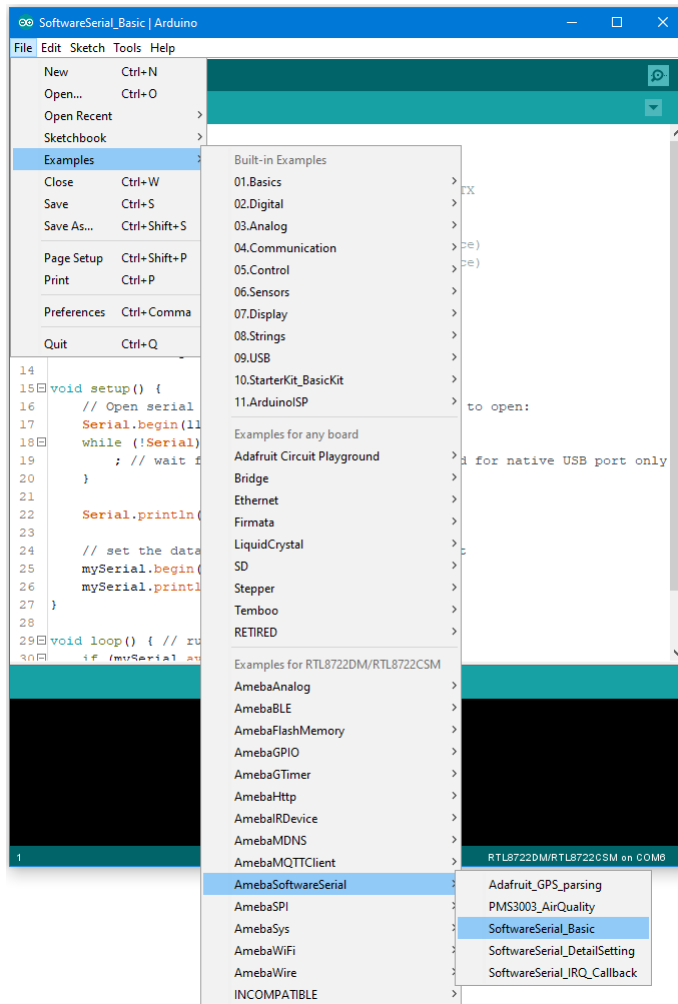
USB to TTL adapter converts USB to serial interface. Normally, there are at least 4 pins on the adapter, that is 3V3 (or 5V), GND, TX and RX. Generally, installing the driver for the USB to TTL adapter would be required before using it. If the adapter uses the chip of FTDI, Windows will search and install the driver automatically, otherwise, you may need to install corresponding driver yourself.

Afterwards, open device manager. You can find corresponding serial port number of the USB to TTL adapter:



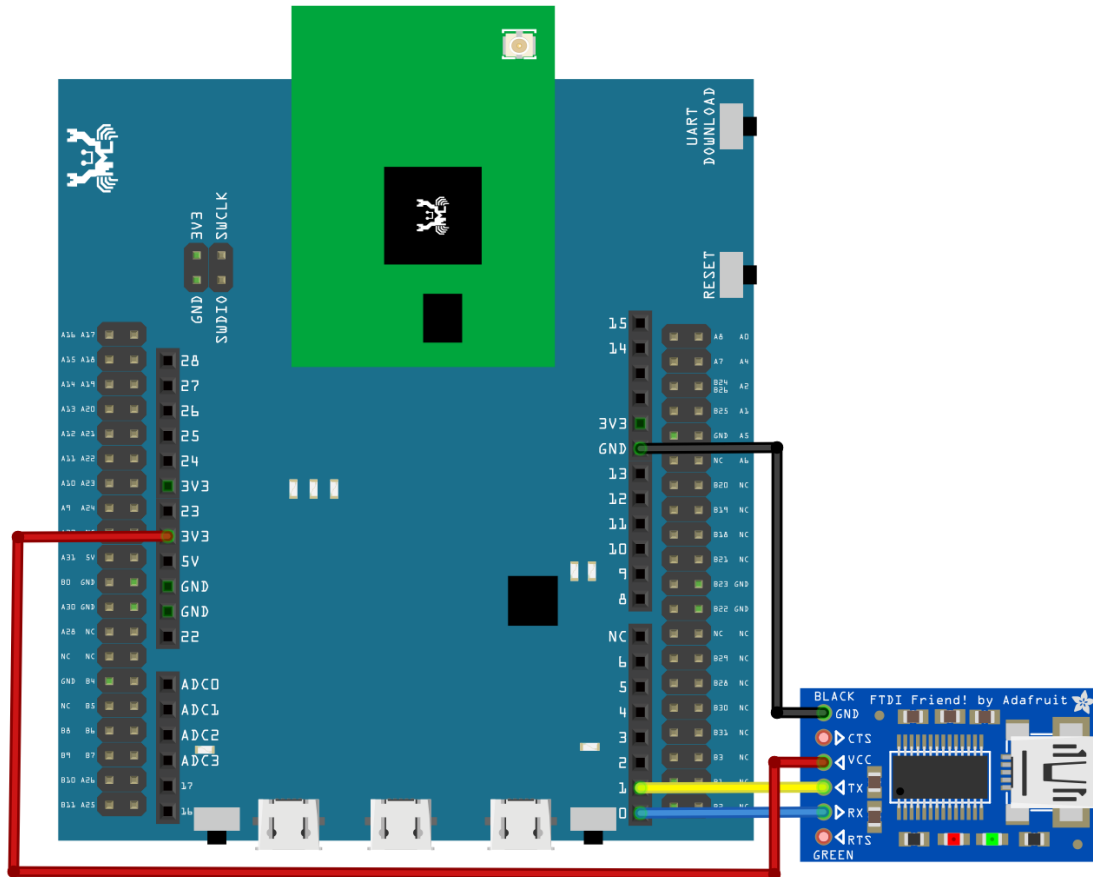
- Executing the Example

Open the “SoftwareSerialExample” example in “File” -> “Examples” -> “AmebaSoftwareSerial”  
-> “SoftwareSerial\_Basic” :



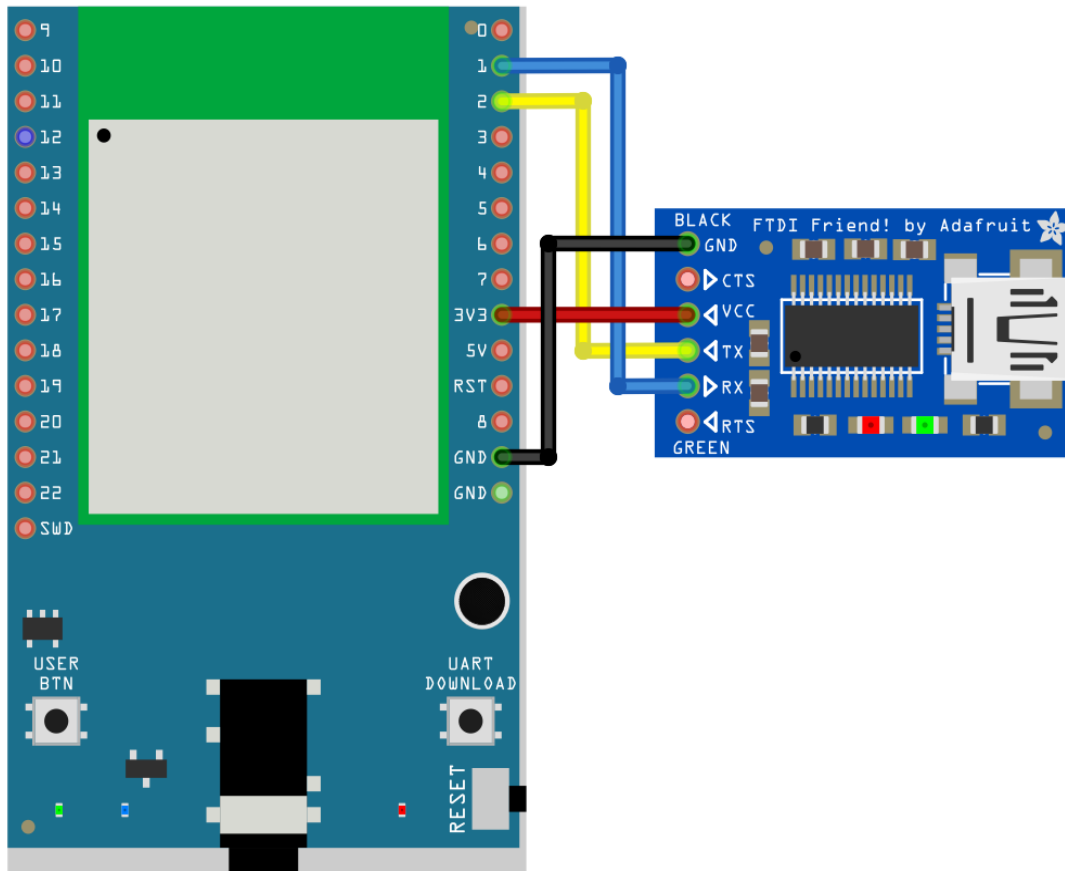
Connect the wire as the following diagrams show. The TX pin of USB to TTL adapter is connected to the RX of Ameba, and the RX pin of USB to TTL adapter is connected to the TX of Ameba.

**AMB21 / AMB22 Wiring Diagram:**

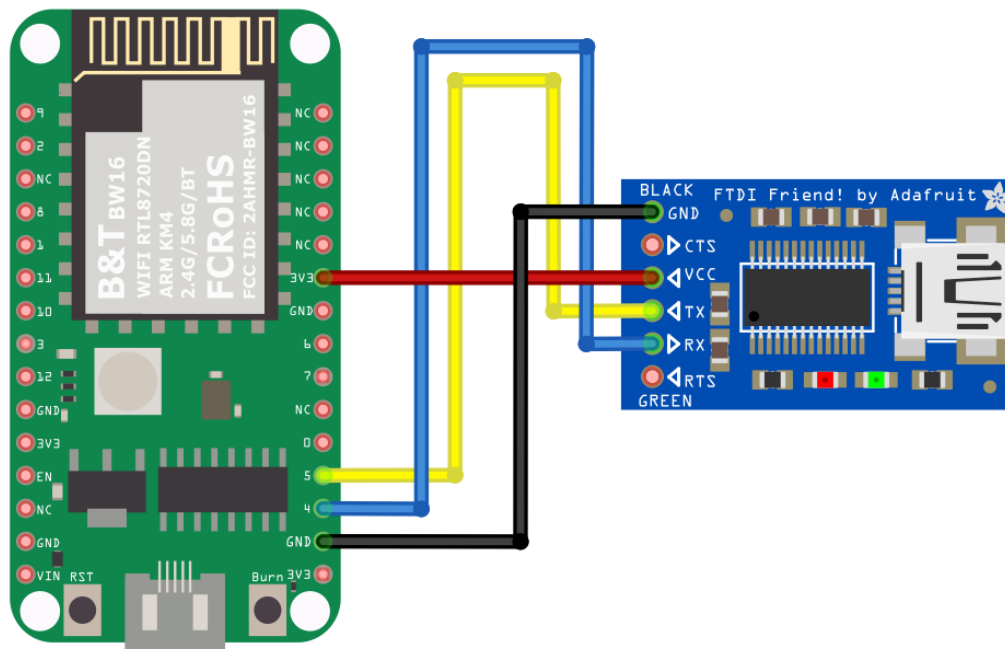


AMB23 Wiring Diagram:

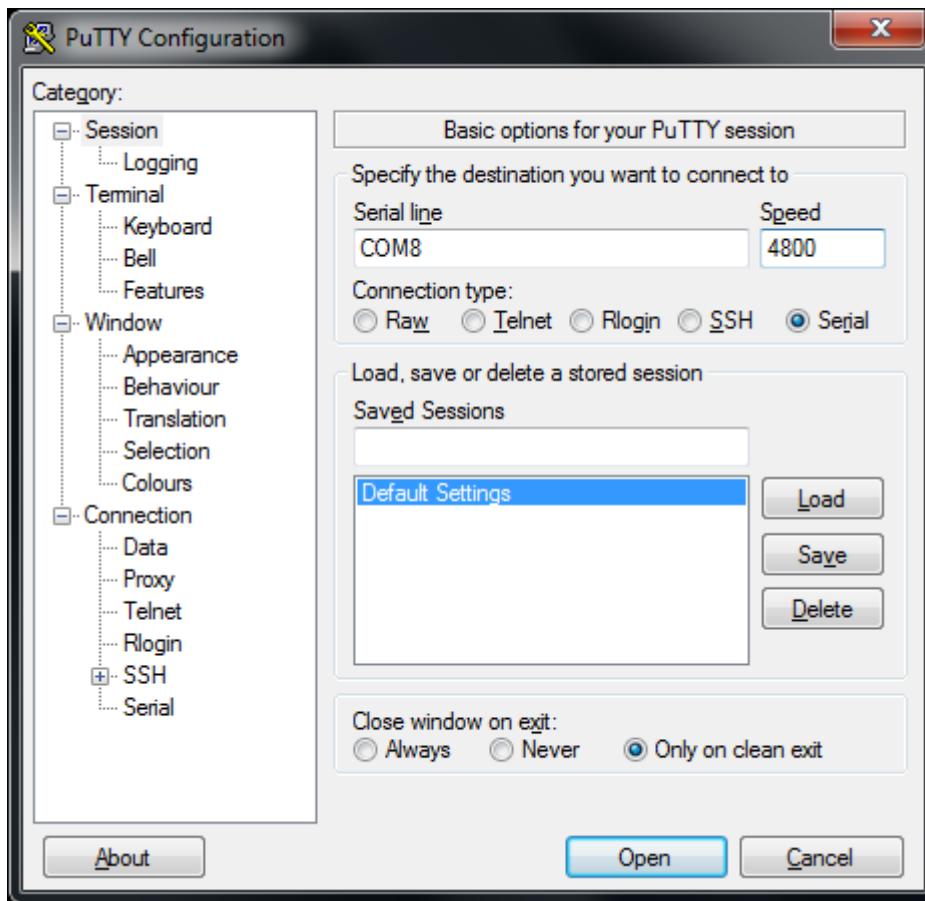




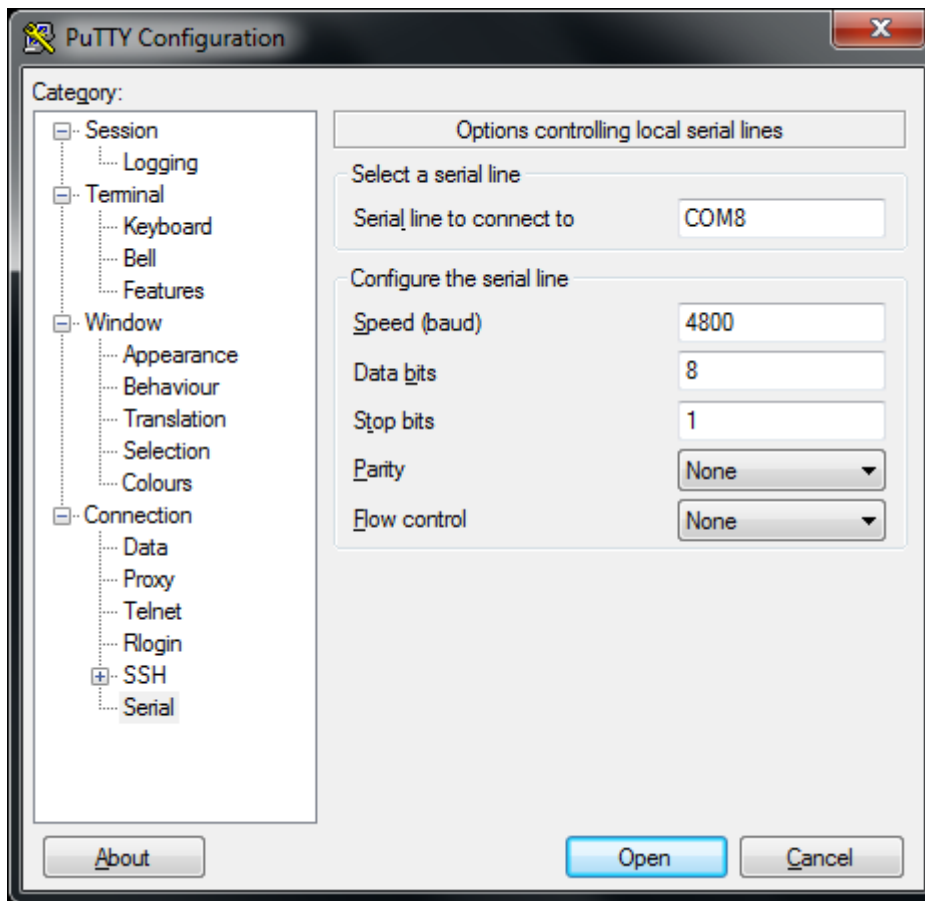
**BW16** Wiring Diagram:



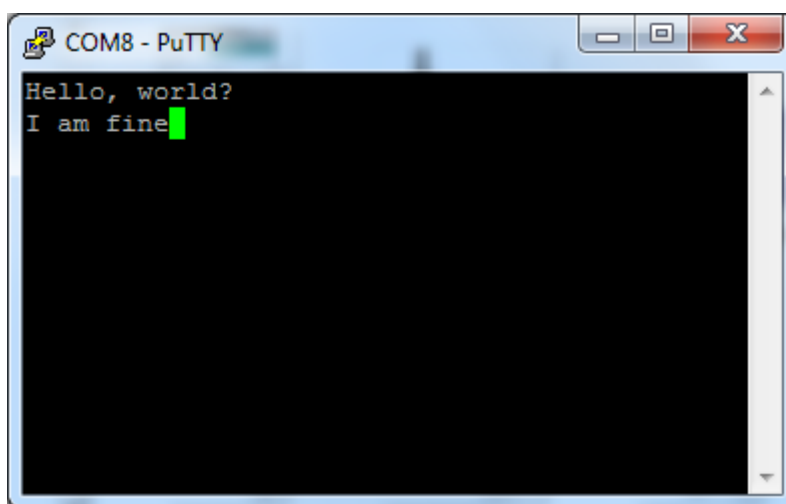
Next, open a serial port terminal, such as Putty or Tera Term. (Putty is used in this example). Open the Putty window, choose “Serial” in connection type, and specify the port number of the USB to TTL adapter (e.g. COM8). In the speed field, fill in the baud rate of this connection. Note that both sides of the connection should use the same baud rate. In this example we set baud rate 4800.



Next, select “Serial” on the left side. Set data bits to 8, stop bits to 1, parity to none, and flow control to none.



Then click Open and press the reset button on Ameba. You can see the “Hello, world?” message appears in Putty. If characters are typed into Putty, the input characters would be sent to Serial RX of Ameba by TX of USB to TTL Adapter, and returned by Serial TX of Ameba. Finally, RX of USB to TTL Adapter receives the returned characters and prints them in Putty. Therefore, if you insert “I am fine” , you will get something like this:



## Code Reference

First, use `SoftwareSerial::begin(speed)` to set the baud rate for the serial communication:

<https://www.arduino.cc/en/Reference/SoftwareSerialBegin>

Use `write()` to send data, and use `SoftwareSerial::available()` to get the number of bytes available for reading from a software serial port:

<https://www.arduino.cc/en/Reference/SoftwareSerialAvailable>

If there are data available to read, use `read()` to read from serial port.

## UART - Retrieve GPS Position

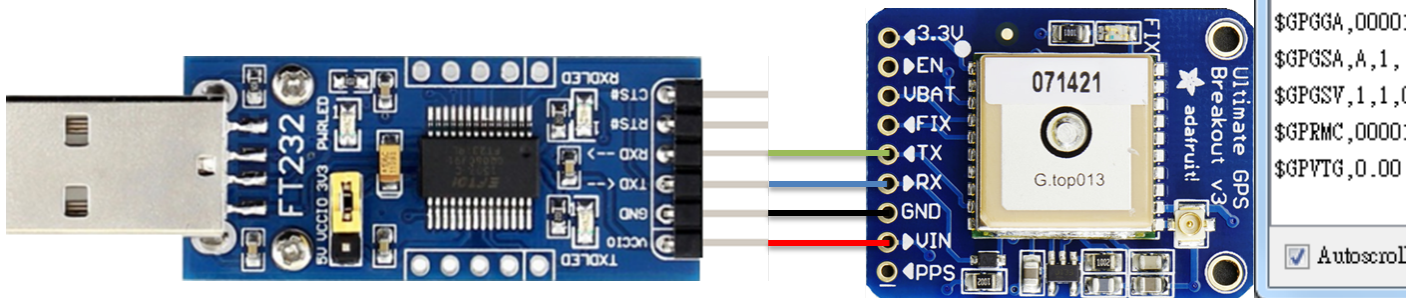
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Adafruit Ultimate GPS Breakout x 1 (Refer to official document)

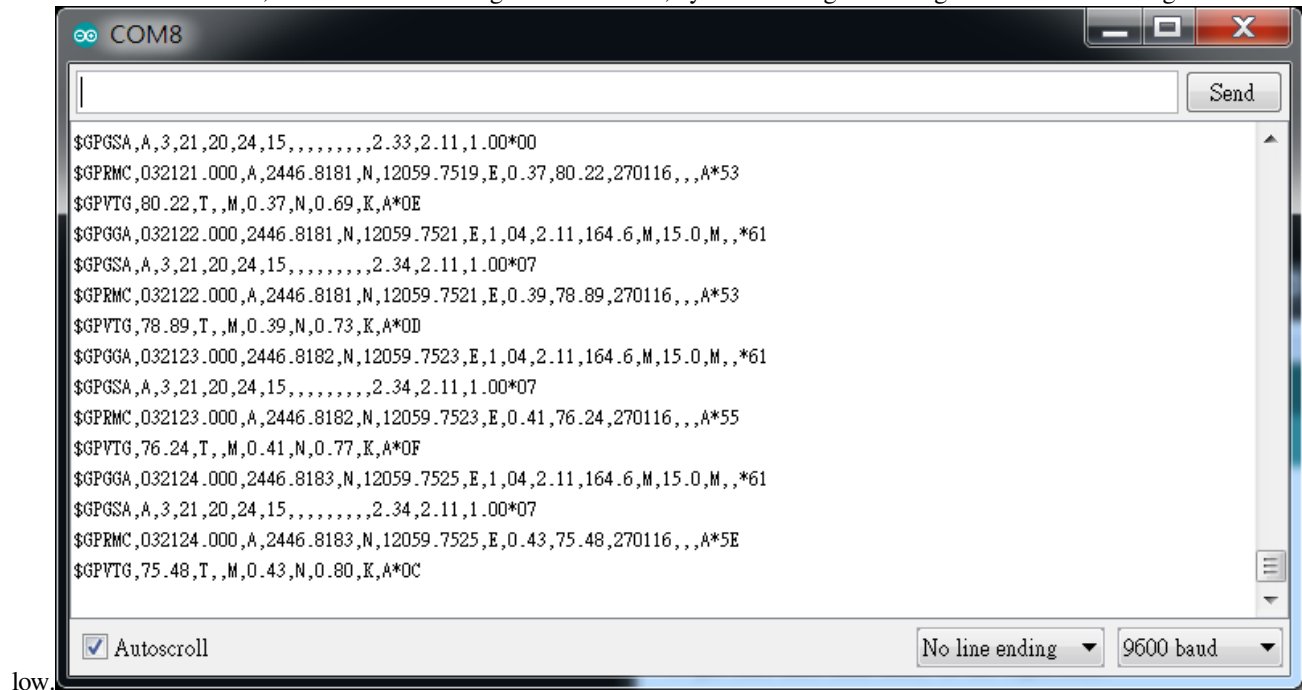
### Example

In this example, we use Adafruit Ultimate GPS Breakout. Its data format is pure text, so we can connect it to USB to TTL Adapter and observe the out-

put.



It follows the NMEA sentence format (refer to <http://aprs.gids.nl/nmea/>) The GPS signal is weak in indoor environment. The status that the GPS signal is not received is called “not fix”. Bring the GPS module outdoors, when the GPS signal is “fix”, you would get message similar to the figure below.



In this example we are only interested in the “\$GPRMC (Global Positioning Recommended Minimum Coordinates)” :  
**\$GPRMC,032122.000,A,2446.8181,N,12059.7251,E,0.37,80.22,270116,,,A\*53**

Each field is separated by a comma.

- First field is the GMT time (Greenwich Mean Time), that is 032122.000 in this example. The time format is HH:MM:SS.SSS, i.e., 03:21:22.000. Note that the time zone and the daylight-saving time adjustment should be handled on your own.
- Second field represents the status code
  - V: Void (Invalid)
  - A: Active, meaning the GPS signal is fix.
- The third to sixth fields represent the geolocation

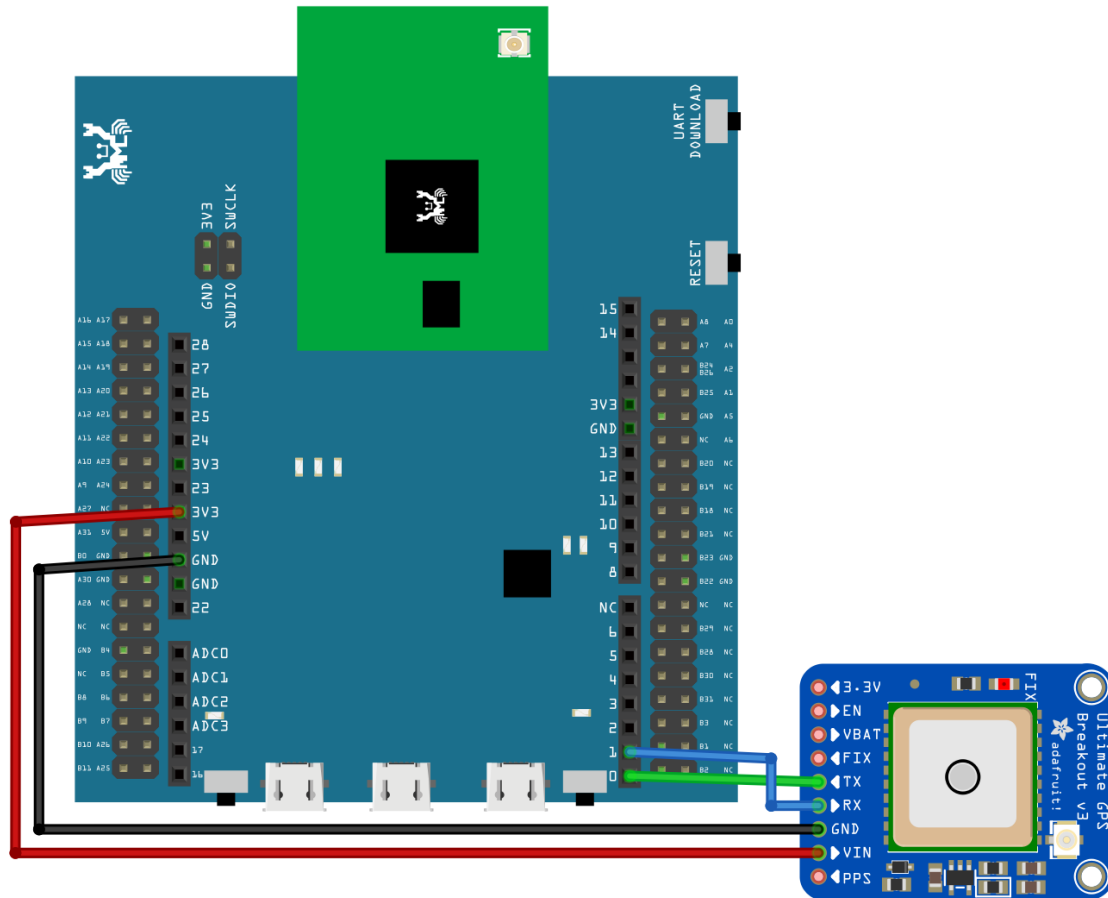
In this example, 2446.8181,N represents 24 degrees 46.8181 minutes north latitude, and 12059.7251,E represents 120 degrees 59.7251 minutes east longitude.

We can search **+24 46.8181'** , **+120 59.7251'** in Google map to check whether the position is cor-



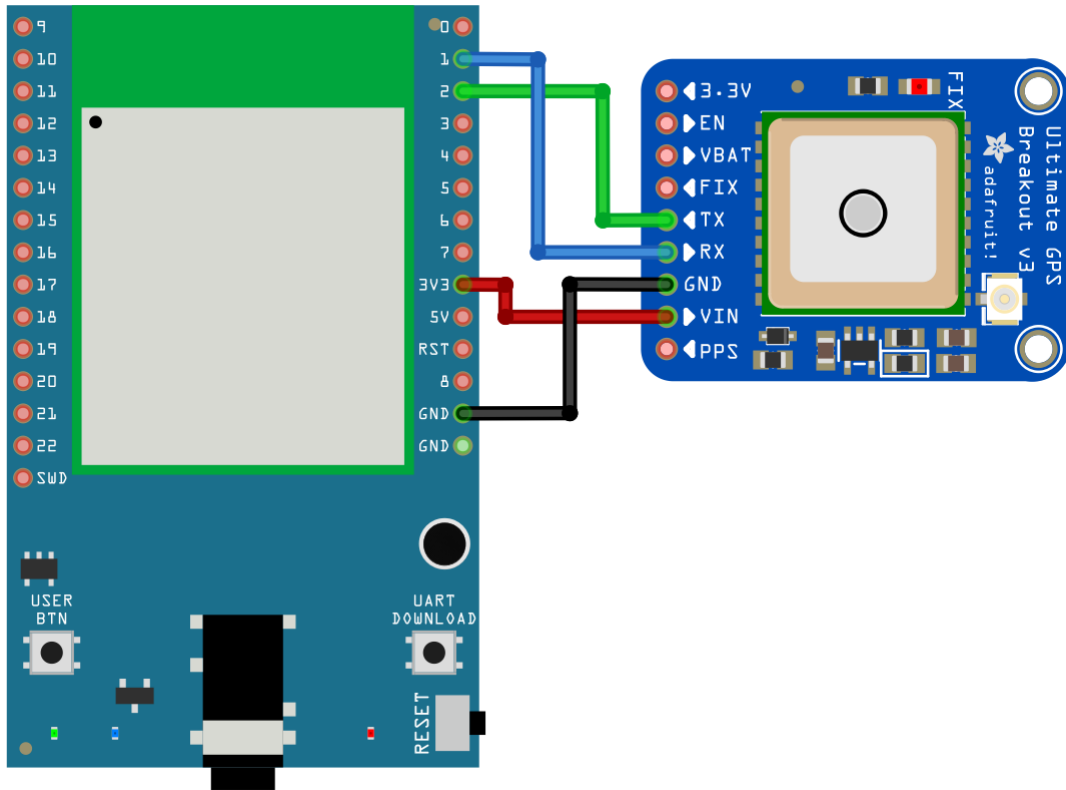
- The seventh field is relative speed(knot). 1 knot = 1.852km/hr, in this example the relative speed is 0.39 knot.
- The eighth field is the moving angle, which is calculated by its moving orbit.
- The ninth field is the date with format ddMMyy. In this example, “270116” stands for day 27, January, year 2016.
- The last field is checksum. In the example we have \*53 as checksum.

**AMB21 / AMB22** Wiring Diagram:

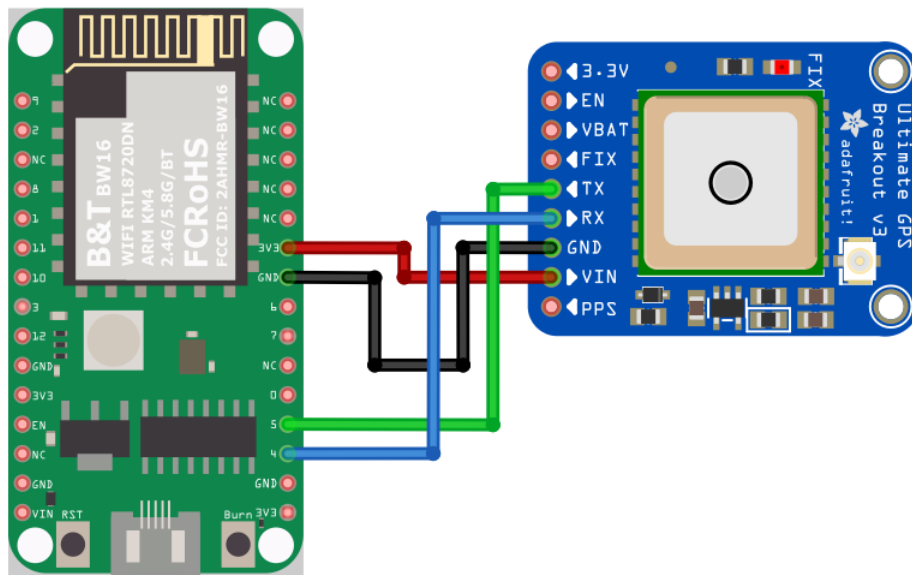


AMB23 Wiring Diagram:





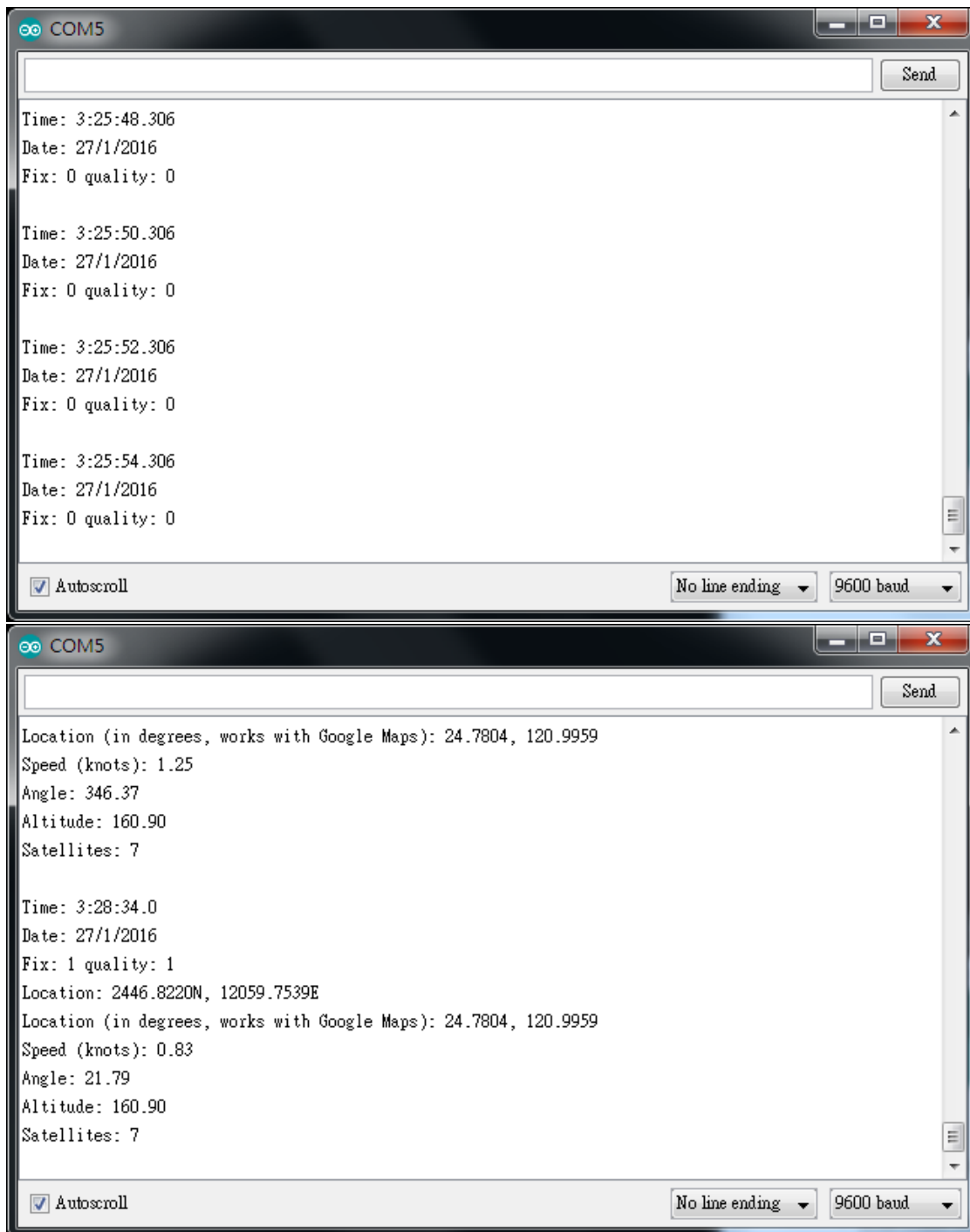
AMB23 Wiring Diagram:



Open the example in “Files” -> “Examples” -> “AmebaSoftwareSerial” -> “Adafruit\_GPS\_parsing” .

Compile and upload to Ameba, then press the reset button.

The result will be output to Serial Monitor:



## UART –Set Callback Function For UART Communications

### Materials

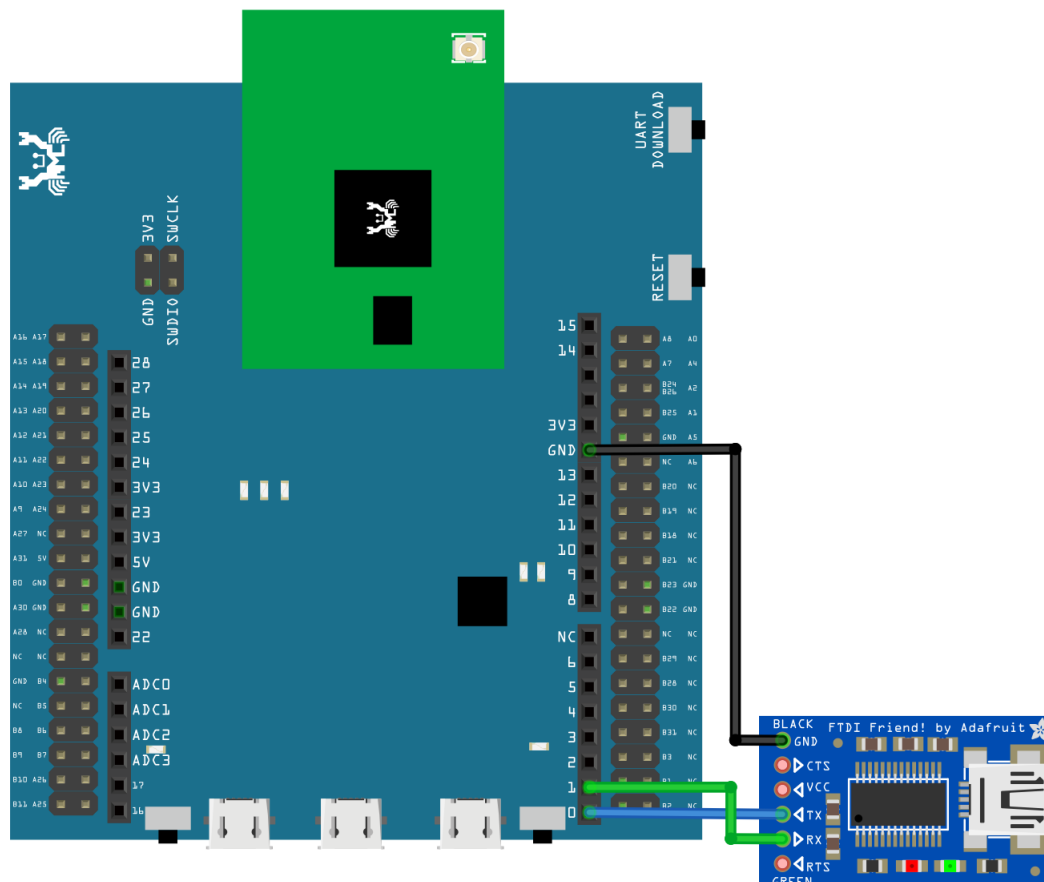
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- USB to TTL Adapter x 1

### Example

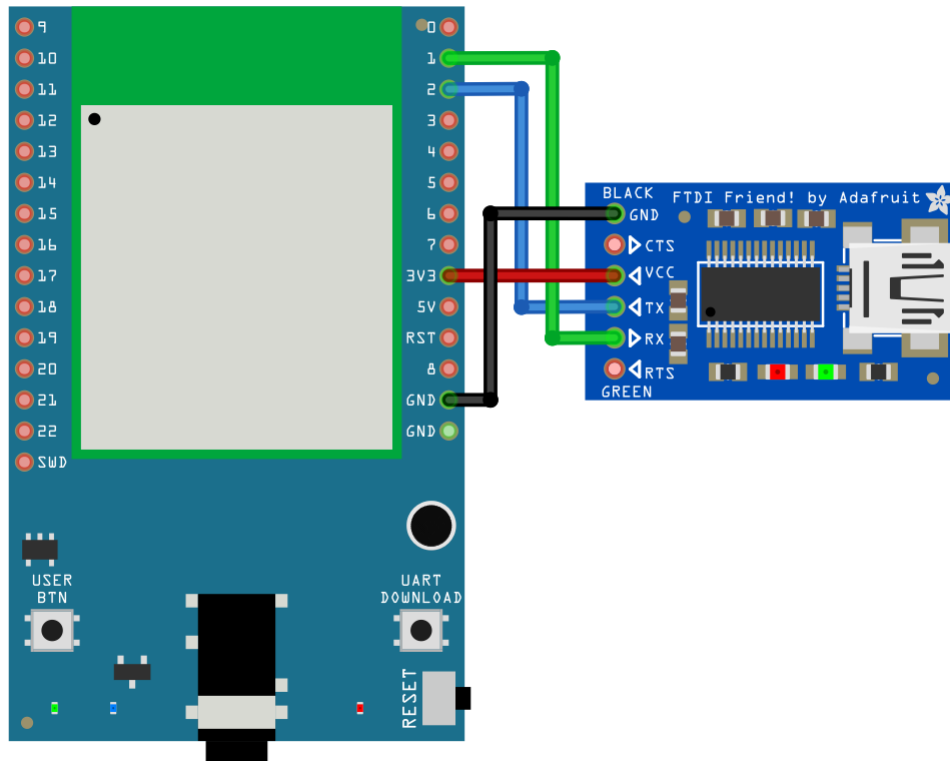
This example shows how to set a callback function for UART communication to process the UART data.

A USB to TTL adapter is required for this example. Ensure that you have the driver installed and connect it to the Ameba board as shown.

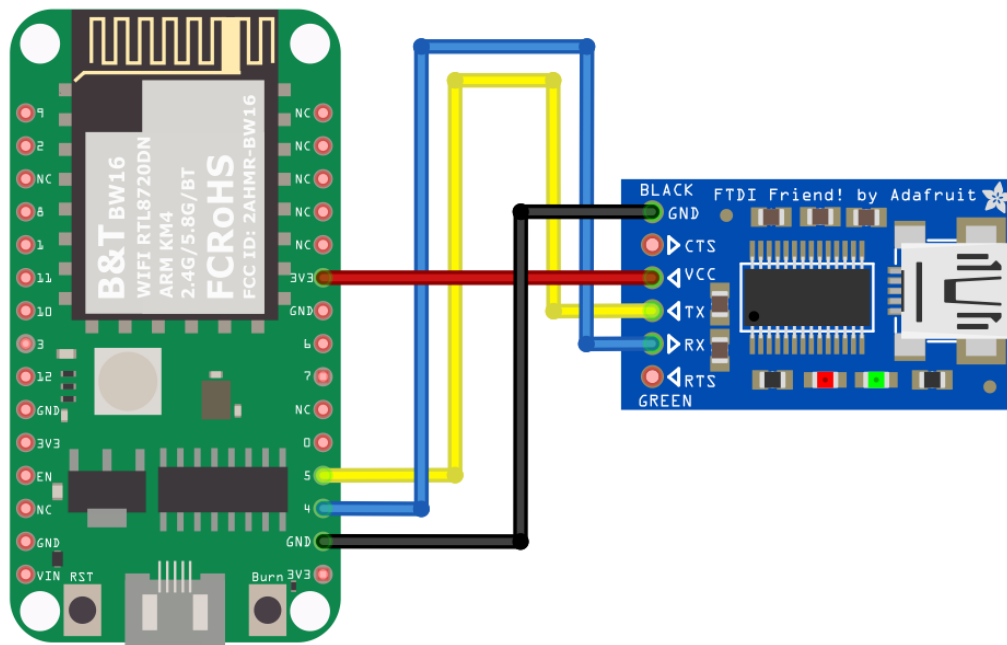
AMB21 / AMB22 Wiring Diagram:



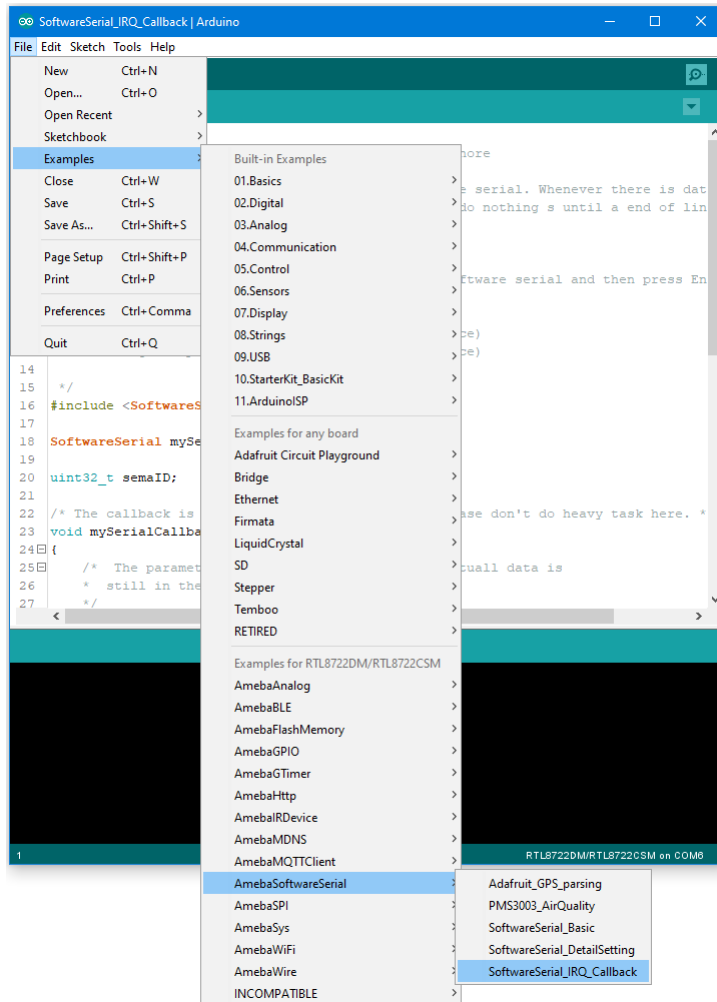
AMB23 Wiring Diagram:



BW16 Wiring Diagram:



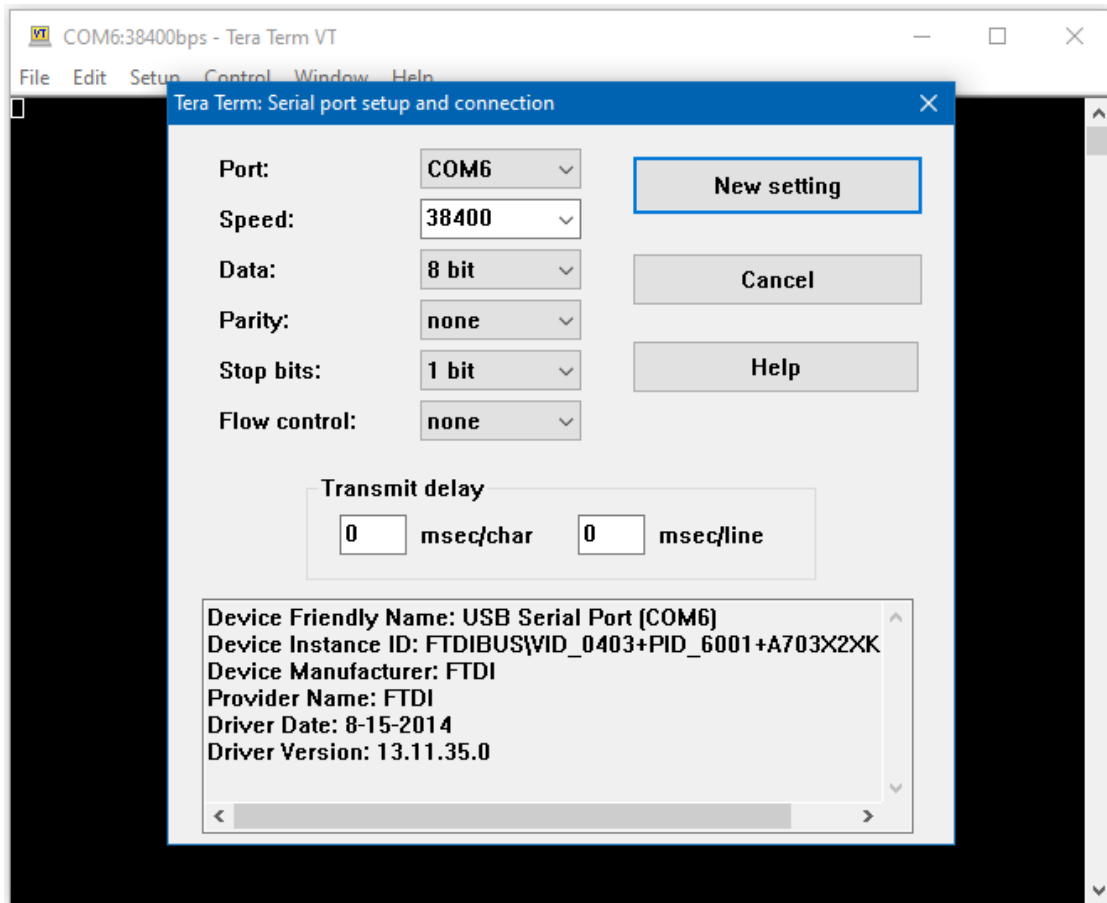
Open the example in “File” -> “Examples” -> “AmebaSoftwareSerial” -> “SoftwareSerial\_Irq\_Callback”



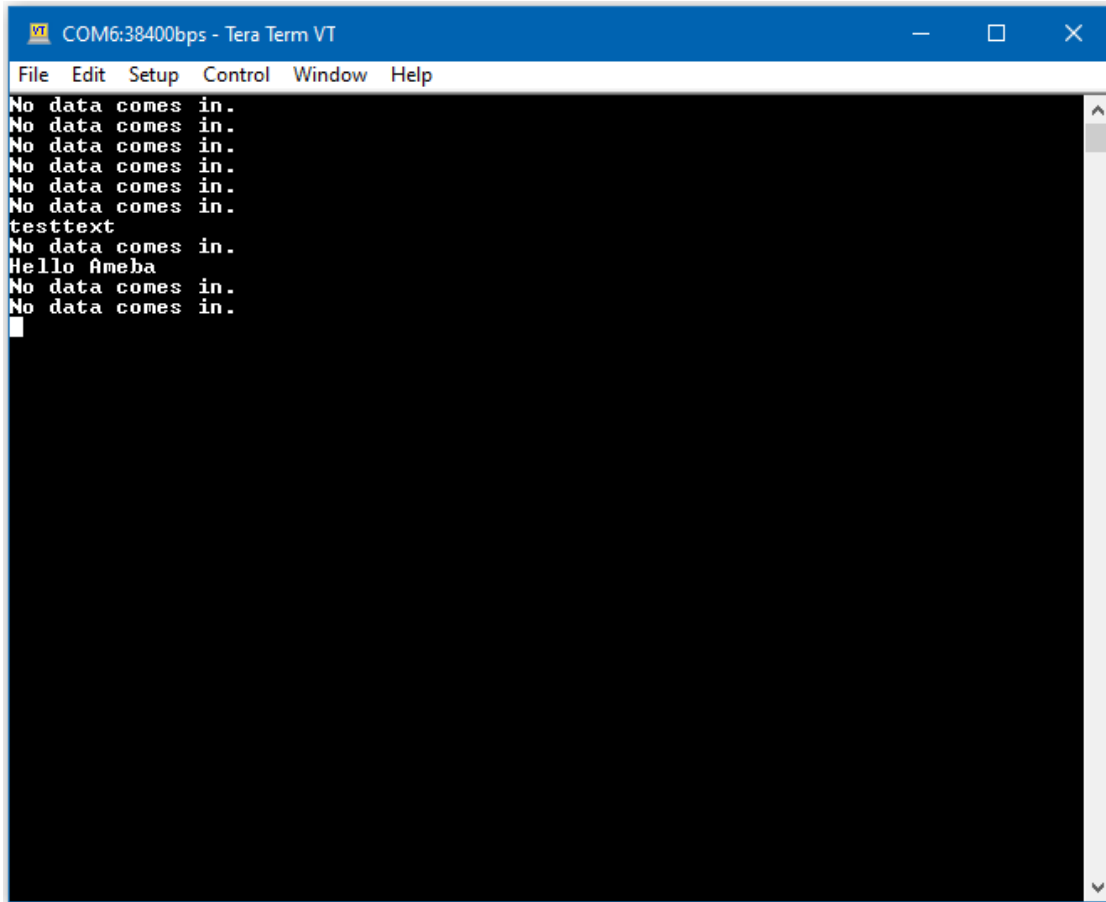
Upload the code and press the reset button on Ameba once the upload is finished.

Next, using a terminal program, such as TeraTerm or PuTTY, open a serial port and configure it according to the settings. Make sure the serial port number corresponds to the USB to TTL adapter.

- Speed: 38400
- Data: 8 bit
- Parity: none
- Stop bits: 1 bit
- Flow control: none



Once the serial port is open, type in the terminal and press the enter key, and you will see the corresponding output.

A screenshot of a Tera Term VT window titled 'COM6:38400bps - Tera Term VT'. The window has a menu bar with 'File', 'Edit', 'Setup', 'Control', 'Window', and 'Help'. The main area is a black terminal with white text. The text shows a sequence of 'No data comes in.' messages, followed by 'testtext', and then 'Hello Ameba'. The window has standard Windows-style window controls (minimize, maximize, close) in the top right corner and a vertical scrollbar on the right side.

```
COM6:38400bps - Tera Term VT
File Edit Setup Control Window Help
No data comes in.
No data comes in.
No data comes in.
No data comes in.
No data comes in.
No data comes in.
testtext
No data comes in.
Hello Ameba
No data comes in.
No data comes in.
```

## Code Reference

`mySerial.setAvailableCallback(mySerialCallback)` ; is used to set the function `mySerialCallback` as a callback function for software serial. When a new character is received, the callback function checks if the character corresponds to the enter key, and releases the semaphore if it is true, which in turn allows the main loop to print out all the previously received characters.

## UART - PM2.5 Concentration in The Air

### Preparation

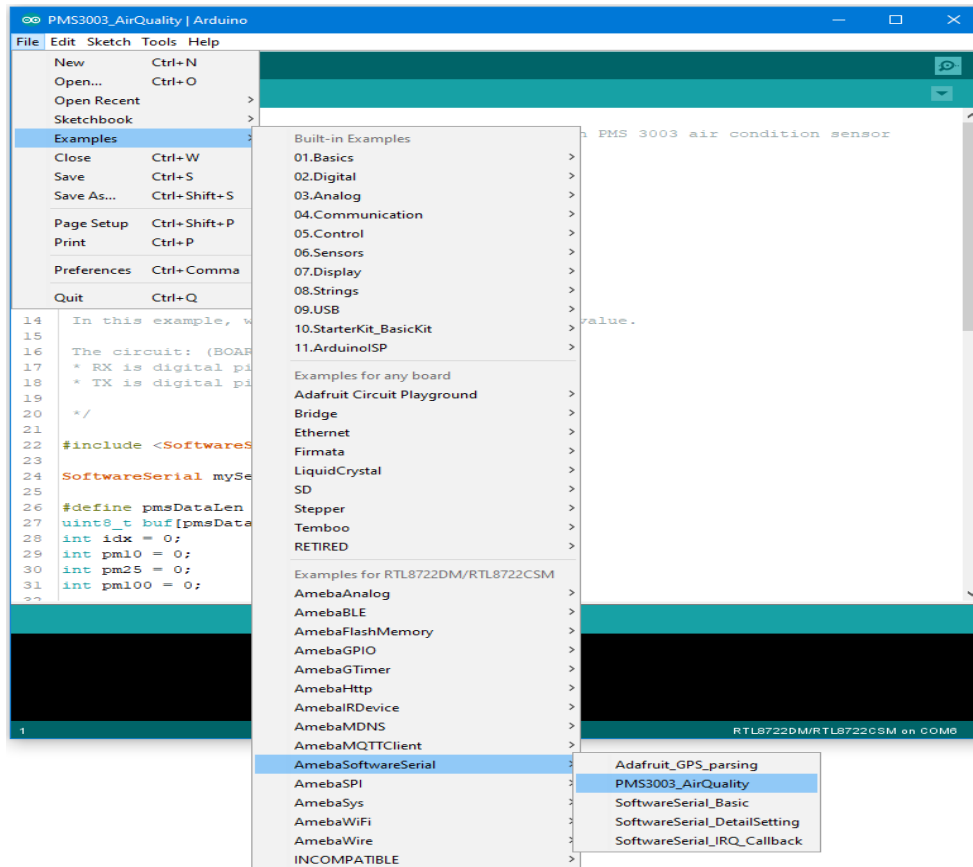
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- PlanTower PMS3003 or PMS5003 x 1

### Example

PMS3003 (or PMS5003) is a sensor of air quality, it can detect the concentration of those 0.3 to 10 micrometer particulate matters in the air. The sensor output its data via UART.

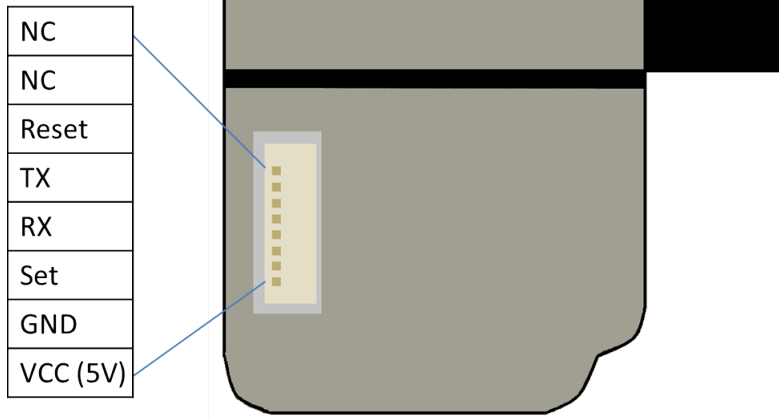
The PMS3003 (or PMS5003) sensor detects the concentration value of PM 1.0, PM 2.5, PM 10. Take PM 2.5 for example, it stands for the fine particles with a diameter of 2.5 micrometers or less.

Open the example in “File”-> “Examples”-> “AmebaSoftwareSerial”-> “PMS3003\_AirQuality”



There are 8 pins in PMS3003:



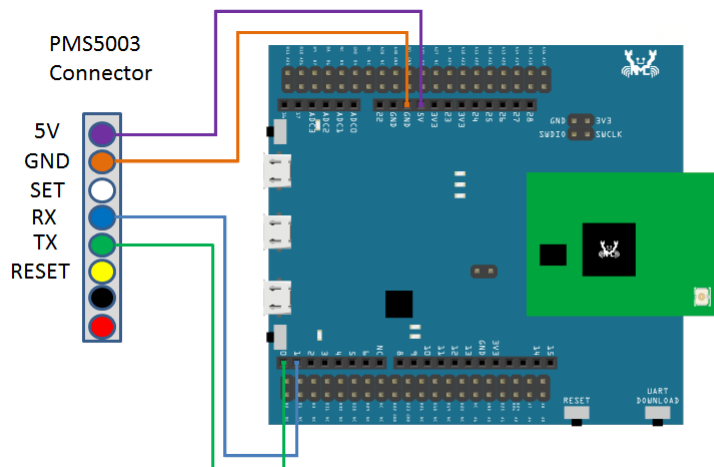


PMS3003 requires 5V power, but the working voltage of its IC is 3.3V. Therefore, the working voltage of Reset, TX, RX, Set are 3.3V as well. If the “Set” pin is pulled to high, the PMS3003 is put to operating mode. If the “Set” pin is pulled low, the PMS3003 is put to standby mode.

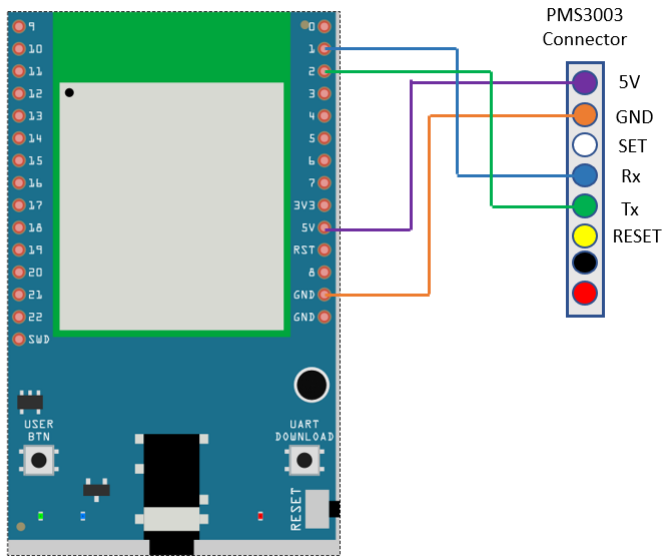
TX/RX pins are for UART connection. Under operating mode, PMS3003 outputs the data it reads continuously. Each data is of 32 bytes, please refer to the following article for detailed data format information:

[https://www.dfrobot.com/wiki/index.php?title=PM2.5\\_laser\\_dust\\_sensor\\_SKU:SEN0177\\_RTL8722](https://www.dfrobot.com/wiki/index.php?title=PM2.5_laser_dust_sensor_SKU:SEN0177_RTL8722)

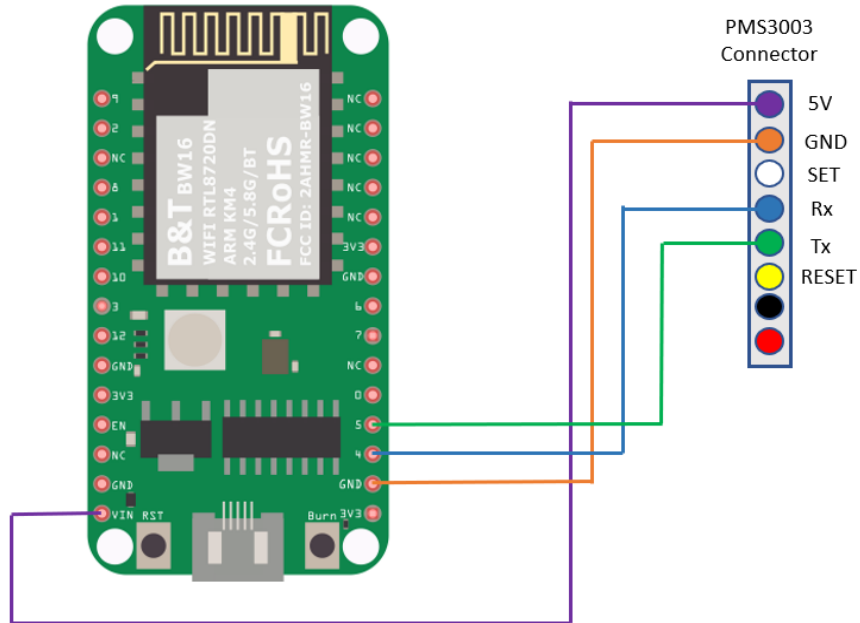
**AMB21 / AMB22 Wiring Diagram:**



**AMB23 Wiring Diagram:**

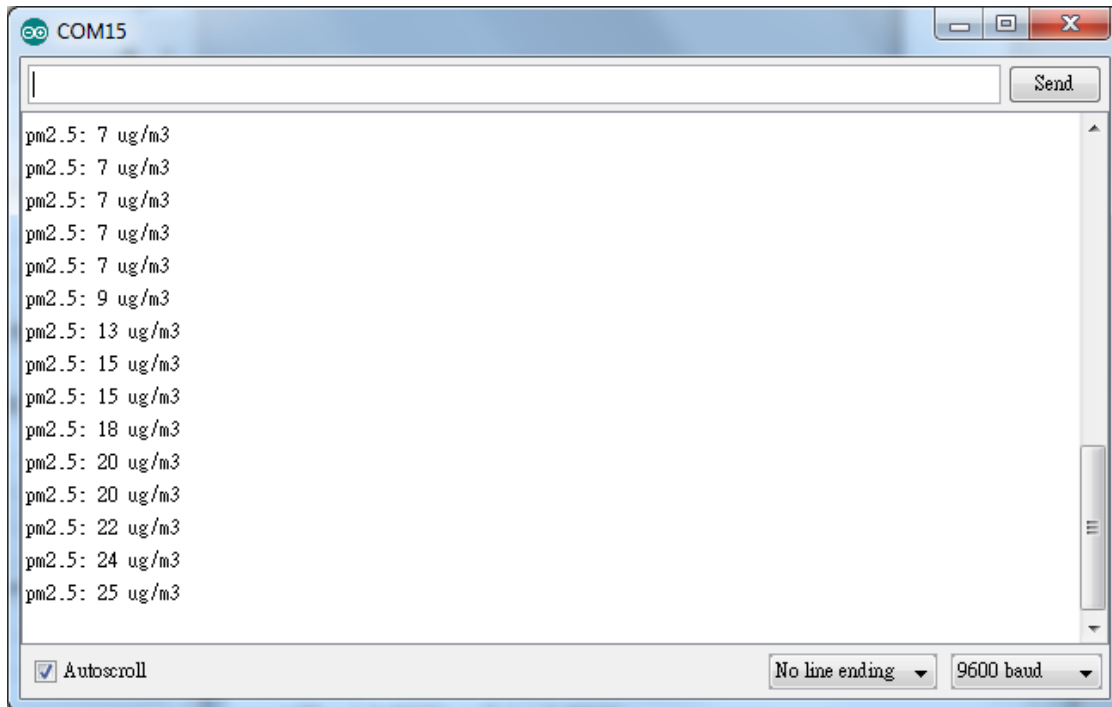


BW16 Wiring Diagram:



In this example, we do not use the “Set” and “Reset” pins.

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba starts to output the PM 2.5 data to serial monitor.



## Watchdog - Simple WDG Timer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

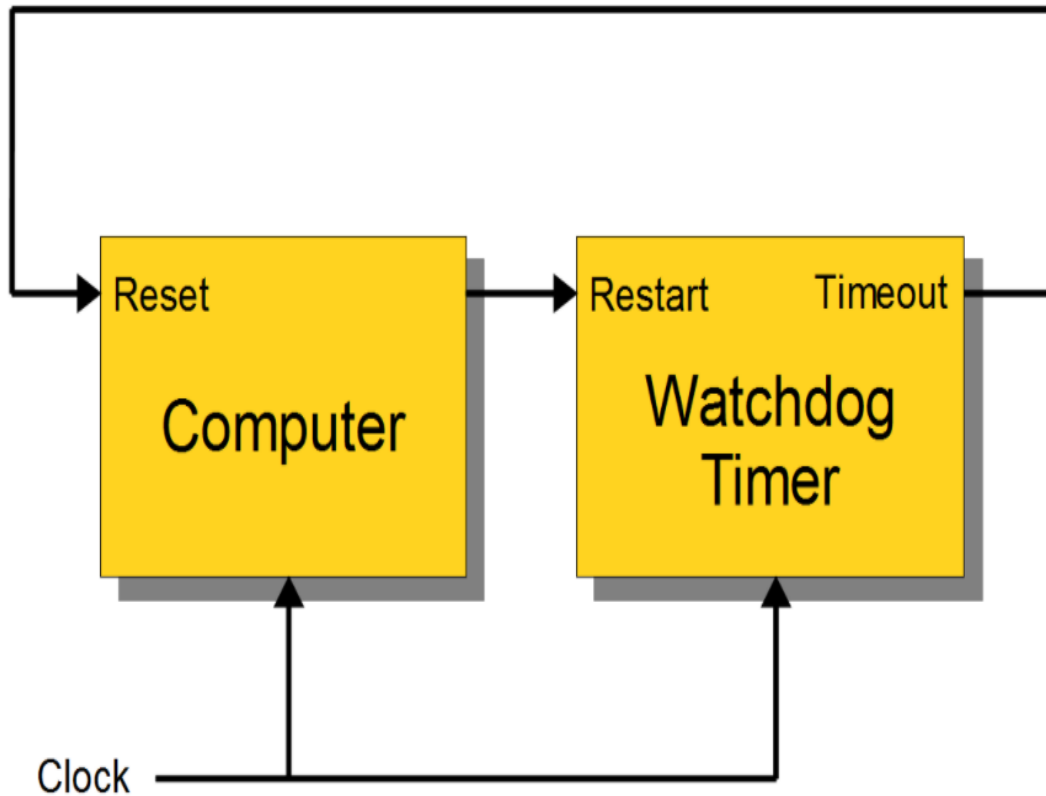
### Example

In this example, we will use this simple watchdog timer example runs on the Ameba RTL8722 module to illustrate how to use the watchdog API. Before we get into the details of the example, let's briefly go through the definition of Watchdog as well as its working principles.

### Watchdog

Watchdog Timer (WDT) is a hardware timer that is used to detect the occurrence of a software fault, then automatically generates a system reset or a watchdog interrupt on the expiry of a programmed period.

In layman terms, imagine in the situation while your micro-controller is confused in an infinity loop, or any case like the micro-controller hang while performing some tasks. The normal troubleshooting method would be to press the reset button and jump out of the infinity loop. However, is it practically impossible to do press on the button all time, therefore, the watchdog timer that embedded inside the micro-controller would help with this situation.



### Feed the Dog

If you have a dog in your home. You need to feed that dog at a regular interval. if you can't feed one day, it will bite you! And likewise, this is the working logic behind the watchdog timer.

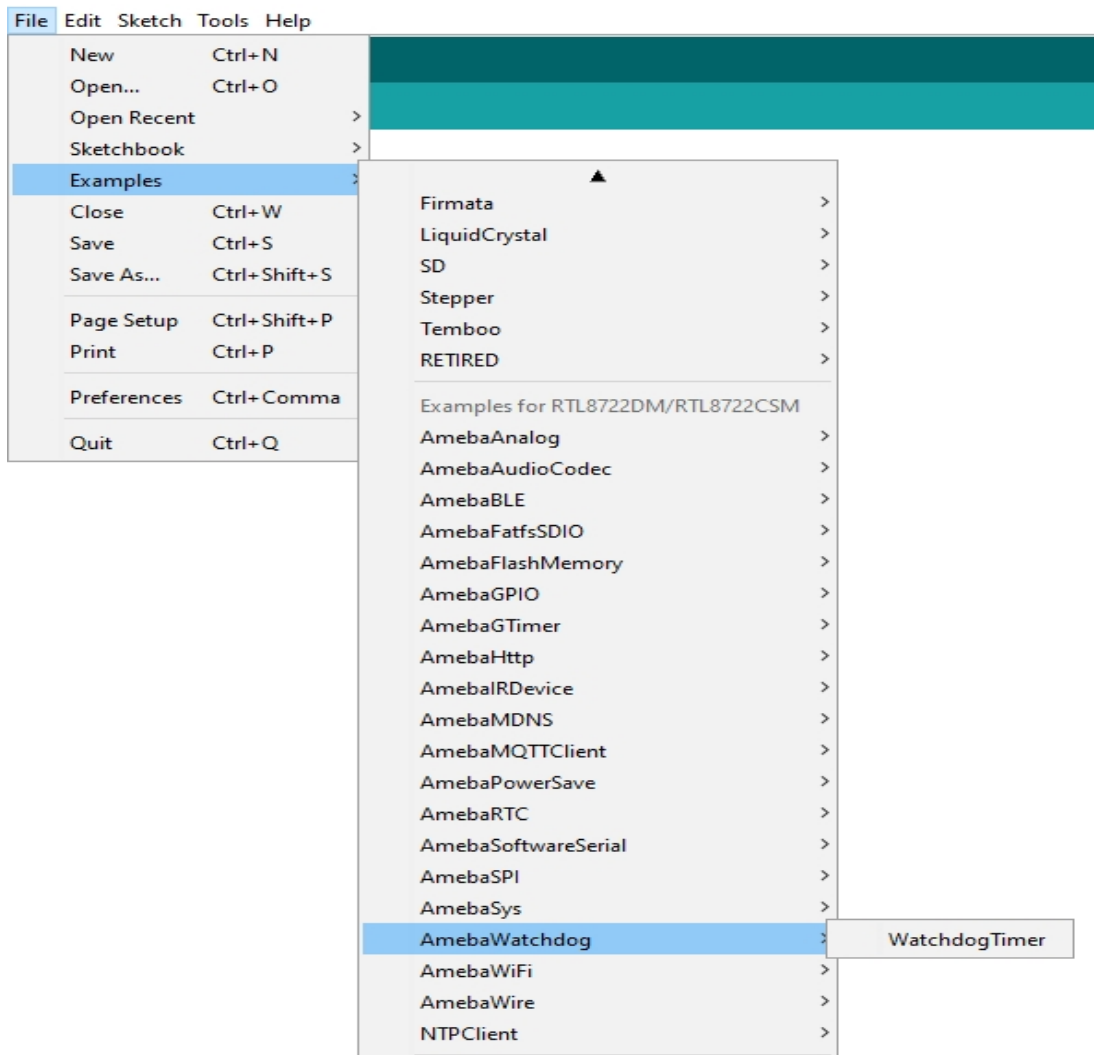
In our example, we created 2 tasks that contain some loop that runs repeatedly, one is called “Small\_Task” and the other is called “Big\_Task” . We are enabling the watchdog timer is loaded with an initial value (5 seconds) greater than the total delay in the “Small\_Task” , but shorter than the “Big\_Task” .

For the successful case, the watchdog is being refreshed/feed within 5 seconds, however, for the failed case, the loop is under processing and the watchdog is not being fresh after 5 seconds, which triggers the watchdog (dog barks), an interrupt is generated to reset the processor. Likewise, the watchdog timer protects the micro-controller from the hanging case.


Then we move to the coding part for this example, for this example, you will only need the RTL8722CSM/RTL8722DM/RTL8722DM MINI Board itself.

Firstly, make sure the correct Ameba development board is selected in Arduino IDE: “Tools” -> “Board” ->

“RTL8722CSM/RTL8722DM” (or “RTL8722DM MINI” ). Then open the “Watchdog Timer” example in “File” -> “Examples” -> “AmebaWatchdog” -> “Watchdog Timer” :



Upon successfully upload the sample code, open the serial monitor, and press the reset button. You will find that the “Small\_Task” can refresh the watchdog within the 5 seconds (initialized in the watchdog timer). However, the “Big\_Task” will not be able to refresh the watchdog within 5 seconds, which the watchdog “barks” then the microcontroller reset.

 COM10

```
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
```

COM10

```
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
watchdog barks!!!
doing dummy task #6
doing dummy task #7
doing dummy task #8
doing dummy task #9
doing dummy task #10
Big_Task finished refresh watchdog.
```

## Community Examples

Welcome to share your examples under the **Community Examples** section if you have completed a project using the Ameba boards.

To make contributions, please visit our official [GitHub Wiki](#) page.



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**小訣竅:** Welcome to share your examples under the **Community Examples** section if you have completed a project using the Ameba boards

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## 1.1.4 Board HDK

### EVB

- **HDK-AMEBAD\_MB\_4V2**
    - Layout
    - Schematic
- 

- **HDK-AMEBAD\_MB\_4V0**
    - Layout
    - Schematic
- 

### RTL8722DM Module

- **HDK-AM8722DM01\_6V2\_WI LPF**
    - Layout
    - Schematic
- 

- **HDK-AM8722DM01\_6V1\_WI LPF**
    - Layout
    - Schematic
- 

- **HDK-AM8722DM01\_4V1**
    - Layout
    - Schematic
- 

## 1.1.5 API Documents

### RTL8722DM ARDUINO Online API Documents



## Analog

### Class AmebaServo

#### AmebaServo Class

##### Description

Defines a class of manipulating servo motors connected to Arduino pins.

##### Syntax

```
class AmebaServo
```

##### Members

Public Constructors	
AmebaServo::AmebaServo	Constructs an AmebaServo object.
Public Methods	
AmebaServo::attach	Attach the given pin to the next free channel.
AmebaServo::detach	Detach the servo.
AmebaServo::write	Write value, if the value is < 200 it's treated as an angle, otherwise as pulse-width in microseconds.
AmebaServo::writeMicroseconds	Write pulse width in microseconds.
AmebaServo::read	Output current pulse width as an angle between 0 and 180 degrees.
AmebaServo::readMicroseconds	Output current pulse width in microseconds for this servo.
AmebaServo::attached	Check if the servo is attached.

#### AmebaServo::attach

##### Description

Attach the given pin to the next free channel, sets pinMode (including minimum and maximum values for writes), returns channel number, or 0 if failure.

##### Syntax

```
uint8_t attach(int pin);

uint8_t attach(int pin, int min, int max);
```

##### Parameters

pin: The Arduino pin number to be attached.

min: Minimum values for writes.

max: Maximum values for writes.

## Returns

The function returns channel number or 0

## Example Code

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree.

列表 1: ServoSweep.ino

```
1  /* Sweep
2  by BARRAGAN < http://barraganstudio.com >
3  This example code is in the public domain.
4  modified 8 Nov 2013
5  by Scott Fitzgerald
6  http://www.arduino.cc/en/Tutorial/Sweep
7  refined 2016/03/18 by Realtek
8  */
9
10 #include "AmebaServo.h"
11
12 // create servo object to control a servo
13 // 4 servo objects can be created correspond to PWM pins
14
15 AmebaServo myservo;
16
17 // variable to store the servo position
18 int pos = 0;
19
20 void setup() {
21   #if defined(BOARD_RTL8195A)
22     // attaches the servo on pin 9 to the servo object
23     myservo.attach(9);
24   #elif defined(BOARD_RTL8710)
25     // attaches the servo on pin 13 to the servo object
26     myservo.attach(13);
27   #elif defined(BOARD_RTL8721D)
28     // attaches the servo on pin 8 to the servo object
29     myservo.attach(8);
30   #else
31     // attaches the servo on pin 9 to the servo object
```

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(繼續上一頁)

```

32     myservo.attach(9);
33 #endif
34 }
35
36 void loop() {
37     // goes from 0 degrees to 180 degrees in steps of 1 degree
38     for (pos = 0; pos <= 180; pos += 1) {
39         // tell servo to go to position in variable 'pos'
40         myservo.write(pos);
41         // waits 15ms for the servo to reach the position
42         delay(15);
43     }
44     // goes from 180 degrees to 0 degrees
45     for (pos = 180; pos >= 0; pos -= 1) {
46         // tell servo to go to position in variable 'pos'
47         myservo.write(pos);
48         // waits 15ms for the servo to reach the position
49         delay(15);
50     }
51 }

```

## Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

## AmebaServo::detach

### Description

Detach the servo.

### Syntax

```
void AmebaServo::detach(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::write****Description**

Write an integer value to the function, if the value is < 200, it's being treated as an angle, otherwise as pulse-width in microseconds.

**Syntax**

```
void AmebaServo::write(int value);
```

**Parameters**

value: The value < 200 its treated as an angle; otherwise as pulse width in microseconds.

**Returns**

The function returns nothing.

**Example Code**

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree. Please refer to code in “AmebaServo:: attach” section.

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::writeMicroseconds****Description**

Write pulse width to the servo in microseconds.

**Syntax**

```
void AmebaServo::writeMicroseconds(int value);
```

**Parameters**

value: Write value the pulse width in microseconds.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::read**

**Description**

The function reads current pulse width and returns as an angle between 0 and 180 degrees.

**Syntax**

```
int AmebaServo::read(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The pulse width as an angle between 0 ~ 180 degrees.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::readMicroseconds****Description**

The function returns a Boolean value “true” if this servo is attached, otherwise returns “false” .

**Syntax**

```
int AmebaServo::readMicroseconds(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns current servo pulse width in microseconds.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::attached****Description**

It returns true if this servo is attached, otherwise false.

**Syntax**

```
bool AmebaServo::attached(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a Boolean value as true or false.

### Example Code

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree. Please refer to code in “AmebaServo:: attach” section.

### Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

---

## AudioCodec

### Class AudioCodec

#### Description

A class used for general control and management of the hardware audio codec functions.

#### Syntax

```
class AudioCodec
```

#### Members

#### Public Constructors

The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named Codec.

#### Public Methods

AudioCodec::begin	Configure and start the audio codec for transmit and receive operation
AudioCodec::end	Stop all audio codec operation
Au- dioCodec::getBufferSize	Get the byte size of a single page of the audio codec buffer
AudioCodec::setSampleRate	Configure the audio codec transmit and receive sampling rate
AudioCodec::setBitDepth	Configure the audio codec transmit and receive bit depth (bits per sample)
Au- dioCodec::setChannelCount	Configure the audio codec transmit and receive channel count
Au- dioCodec::setInputMicType	Configure for analog or digital input microphone type
Au- dioCodec::setInputLRMux	Configure input left right channel multiplexing
AudioCodec::setDMicBoost	Configure boost gain for digital microphone input
AudioCodec::setAMicBoost	Configure boost gain for analog microphone input
AudioCodec::setADCGain	Configure gain of ADC used to acquire analog input
AudioCodec::muteInput	Mute input audio data stream
Au- dioCodec::setOutputVolume	Configure output audio volume
AudioCodec::muteOutput	Mute output audio
AudioCodec::writeAvailable	Check for free buffer page available for data write
AudioCodec::writeDataPage	Write audio data to an available buffer page
AudioCodec::readAvailable	Check for buffer page with new data available for read
AudioCodec::readDataPage	Read audio data from a ready buffer page
Au- dioCodec::setWriteCallback	Set a callback function to be notified when a free buffer page is available for write
Au- dioCodec::setReadCallback	Set a callback function to be notified when a buffer page with new data is available for read

**AudioCodec::begin****Description**

Configure and start the audio codec for transmit and receive operation.

**Syntax**

```
void begin(bool input, bool output);
```

**Parameters**

input: enable audio codec data input

output: enable audio codec data output

**Returns**

The function returns nothing.

#### **Example Code**

Example: BasicInputOutput

#### **Notes and Warnings**

#### **AudioCodec::end**

##### **Description**

Stop all audio codec operation.

##### **Syntax**

```
void end();
```

##### **Parameters**

The function requires no input parameter.

##### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

#### **AudioCodec::getBufferPageSize**

##### **Description**

Get the byte size of a single page of the audio codec buffer.

##### **Syntax**

```
uint32_t getBufferPageSize();
```

##### **Parameters**

The function requires no input parameter.

##### **Returns**

The size of a audio codec buffer page, in number of bytes.

#### **Example Code**

NA

#### **Notes and Warnings**

The AudioCodec class includes a transmit and receive buffer to store audio sample data while transferring to and from the DAC output and ADC input. The buffer is divided into pages of fixed size, and audio data can be read and written



one page at a time. Depending on the configured bit depth (bits per audio sample) and channel count, a buffer page may contain a different number of audio samples.

### **AudioCodec::setSampleRate**

#### **Description**

Configure the audio codec transmit and receive sampling rate.

#### **Syntax**

```
void setSampleRate(uint32_t sampleRate);
```

#### **Parameters**

sampleRate: desired audio codec sampling rate in Hz. Default value of 48000. Supported values: 8000, 16000, 32000, 44100, 48000, 88200, 96000.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: BasicInputOutput

#### **Notes and Warnings**

High sample rates above 48000Hz will require frequent buffer reads and writes to keep up with the large amount of data input and output. If there is insufficient processing time dedicated to this task, audio quality will be degraded.

### **AudioCodec::setBitDepth**

#### **Description**

Configure the audio codec transmit and receive bit depth (bits per sample).

#### **Syntax**

```
void setBitDepth(uint8_t bitDepth);
```

#### **Parameters**

bitDepth: desired number of bits per sample. Default value of 16. Supported values: 8, 16, 24.

#### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

Setting a bit depth of 24 bits per sample will require 32 bits (4 bytes) of buffer space for storing each sample, with the most significant byte ignored.

**AudioCodec::setChannelCount****Description**

Configure the audio codec transmit and receive channel count.

**Syntax**

```
void setChannelCount(uint8_t monoStereo);
```

**Parameters**

monoStereo: number of channels. Default value of 1. Supported values: 1, 2.

**Returns**

The function returns nothing.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::setInputMicType****Description**

Configure for analog or digital input microphone type.

**Syntax**

```
Void setInputMicType(Mic_Type micType);
```

**Parameters**

micType: Input microphone type. Default value ANALOGMIC. Valid values:

- ANALOGMIC –microphone with an analog output
- PDMMIC –digital microphone with a PDM output

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

For analog single-ended output, connect to PA\_4 for the left channel and PA\_2 for the right channel.

For digital PDM output, connect the PDM clock to PB\_1 and PDM data to PB\_2.

**AudioCodec::setInputLRMux****Description**

Configure input left right channel multiplexing.

### Syntax

```
void setInputLRMux(uint32_t mux);
```

### Parameters

mux: desired left right audio channel multiplexing setting. Default value RX\_CH\_LR. Valid values:

- RX\_CH\_LR
- RX\_CH\_RL
- RX\_CH\_LL
- RX\_CH\_RR

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

In mono channel mode, both RX\_CH\_LR and RX\_CH\_LL will result in the audio codec sampling input data from the left channel microphone. Similarly, both RX\_CH\_RL and RX\_CH\_RR will result in the audio codec sampling input data from the right channel microphone.

In stereo channel mode, RX\_CH\_RL will switch the positions of input data sampled from the microphones. RX\_CH\_RR and RX\_CH\_LL will result in duplicated samples from the right and left microphones respectively.\*\* \*\*

### AudioCodec::setDMicBoost

#### Description

Configure boost gain for digital microphone input.

#### Syntax

```
void setDMicBoost(uint32_t leftBoost, uint32_t rightBoost);
```

#### Parameters

leftBoost: boost gain for left channel digital microphone input

rightBoost: boost gain for right channel digital microphone input

Valid boost gain values:

- 0 : 0dB
- 1 : 12dB
- 2 : 24dB

- 3 : 36dB

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

#### AudioCodec::setAMicBoost

### Description

Configure boost gain for analog microphone input.

### Syntax

```
void setAMicBoost(uint32_t leftBoost, uint32_t rightBoost);
```

### Parameters

leftBoost: boost gain for left channel analog microphone input

rightBoost: boost gain for right channel analog microphone input

Valid boost gain values:

- 0 : 0dB
- 1 : 20dB
- 2 : 30dB
- 3 : 40dB

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Only use this function if additional gain is required after using setADCGain function.

#### AudioCodec::setADCGain

### Description

Configure gain of ADC used to acquire analog input.

### Syntax

```
void setADCGain(uint32_t leftGain, uint32_t rightGain);
```

**Parameters**

leftGain: Gain for left channel ADC

rightGain: Gain for right channel ADC

Valid value range is from 0x00 to 0x7f. Gain increases by 0.375dB for every increment in value:

- 0x00 : -17.625dB
- 0x01 : -17.25dB
- 0x2f : 0dB
- 0x30 : 0.375dB
- 0x7f : 30dB

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::muteInput****Description**

Mute input audio data stream.

**Syntax**

```
void muteInput(uint8_t leftMute, uint8_t rightMute);
```

**Parameters**

leftMute: 1 to mute left channel input, 0 to unmute

rightMute: 1 to mute right channel input, 0 to unmute

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::setOutputVolume****Description**

Configure output audio volume.

### Syntax

```
void setOutputVolume(uint8_t leftVol, uint8_t rightVol);
```

### Parameters

leftVol: left channel output volume

rightVol: right channel output volume

Valid value ranges from 0 to 100, corresponding to a volume of -65.625dB to 0dB.

### Returns

The function returns nothing.

### Example Code

Example: BasicInputOutput

### Notes and Warnings

#### AudioCodec::muteOutput

### Description

Mute output audio.

### Syntax

```
void muteOutput(uint8_t leftMute, uint8_t rightMute);
```

### Parameters

leftMute: 1 to mute left channel output, 0 to unmute

rightMute: 1 to mute right channel output, 0 to unmute

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

#### AudioCodec::writeAvaliable

### Description

Check for free buffer page available for data write.

### Syntax

```
bool writeAvaliable();
```

### Parameters

The function requires no input parameter.

**Returns**

Returns true if there is a buffer page that is available for writing data into. Returns false if all buffer pages are full.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::writeDataPage****Description**

Write audio data to an available buffer page.

**Syntax**

```
uint32_t writeDataPage(int8_t* src, uint32_t len);  
uint32_t writeDataPage(int16_t* src, uint32_t len);
```

**Parameters**

src: pointer to array containing audio samples to write to audio codec.

len: number of audio samples in array.

**Returns**

The function returns the number of audio samples written to the audio codec.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::readAvaliable****Description**

Check for buffer page with new data available for read.

**Syntax**

```
bool readAvaliable();
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns true if there is a buffer page with new data that is ready for reading data from. Returns false if all buffer pages are empty.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::readDataPage****Description**

Read audio data from a ready buffer page.

**Syntax**

```
uint32_t readDataPage(int8_t* dst, uint32_t len);  
uint32_t readDataPage(int16_t* dst, uint32_t len);
```

**Parameters**

dst: pointer to array to contain audio samples read from audio codec.

len: number of audio samples to read.

**Returns**

The function returns the number of audio samples read from the audio codec.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::setWriteCallback****Description**

Set a callback function to be notified when a free buffer page is available for write.

**Syntax**

```
void setWriteCallback(void (writeCB)(**void*));
```

**Parameters**

writeCB: function to be called when a buffer page becomes available for data write. Takes no arguments and returns nothing

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**



After starting the audio codec with `AudioCodec::begin()`, the callback function will be called each time the audio codec finishes outputting the data in a buffer page.

### **AudioCodec::setReadCallback**

#### **Description**

Set a callback function to be notified when a buffer page with new data is available for read.

#### **Syntax**

```
void setReadCallback(void (readCB)(**void*));
```

#### **Parameters**

`readCB`: function to be called when a buffer page with new data becomes available for data read. Takes no arguments and returns nothing

#### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

After starting the audio codec with `AudioCodec::begin()`, the callback function will be called each time the audio codec fills up a buffer page with newly acquired audio samples.

## **Class FFT**

#### **Description**

A class used for performing FFT calculations with real-number inputs and outputs.

#### **Syntax**

```
class FFT
```

#### **Members**

#### **Public Constructors**

FFT::FFT	Create an instance of the FFT class
----------	-------------------------------------

#### **Public Methods**

FFT::setWindow	Configure the window function used in FFT calculations
FFT::calculate	Calculate FFT for an input array of values
FFT::getFrequencyBins	Get the FFT output frequency bins
FFT::getFFTSize	Get the size of FFT output for a given input size

## FFT::FFT

### Description

Create a FFT class object.

### Syntax

```
void FFT();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: FFT

### Notes and Warnings

#### FFT::setWindow

### Description

Configure the window function used in FFT calculations.

### Syntax

```
void setWindow(FFTWindow_t window, uint16_t sampleCount);
```

### Parameters

window: The window function to be used in FFT calculations. Valid values: None, Hann, Hamming.

sampleCount: Number of sample datapoints in the input.

### Returns

The function returns nothing.

### Example Code

Example: FFT

### Notes and Warnings

The window function is used to reduce the effects of discontinuities that occur when the input signal has frequencies that do not fit an integer number of periods in the sample datapoints.

More information on FFTs and window functions can be seen at:

<https://download.ni.com/evaluation/pxi/Understanding%20FFTs%20and%20Windowing.pdf>

[https://en.wikipedia.org/wiki/Window\\_function](https://en.wikipedia.org/wiki/Window_function)

## **FFT::Calculate**

### **Description**

Calculate FFT for an input array of values.

### **Syntax**

```
void calculate(float* inputBuf, float* outputBuf, uint16_t sampleCount);
```

```
void calculate(int16_t* inputBuf, float* outputBuf, uint16_t sampleCount);
```

### **Parameters**

inputBuf: pointer to an array of sampleCount size, containing input sample datapoints, in float or uint16\_t format.

outputBuf: pointer to a float array of sampleCount/2 size, for containing FFT output.

sampleCount: number of sample datapoints in the input array, valid values: 16, 32, 64, 128, 256, 512, 1024, 2048.

### **Returns**

The function returns nothing.

### **Example Code**

Example:FFT

### **Notes and Warnings**

Large sample counts will require a longer time for FFT calculations, but will also return a result with higher frequency resolution.

## **FFT::getFrequencyBins**

### **Description**

Get the FFT output frequency bins.

### **Syntax**

```
void getFrequencyBins(uint16_t* outputBuf, uint16_t sampleCount, uint32_t sampleRate);
```

### **Parameters**

outputBuf: pointer to a uint16\_t array of sampleCount/2 size, for containing the calculated center frequency of each FFT output element.

### **Returns**

The function returns nothing.

### Example Code

Example: FFT

Notes and Warnings NA

---

### FFT::getFFTSIZE

#### Description

Get the size of FFT output for a given input size.

#### Syntax

```
uint16_t getFFTSIZE(uint16_t sampleCount);
```

#### Parameters

sampleCount: number of input sample datapoints.

#### Returns

The function returns the FFT output size for the given sampleCount, which is sampleCount/2.

### Example Code

NA

Notes and Warnings NA

## Class PlaybackWav

#### Description

A class used for control and playback of .wav file format audio data.

#### Syntax

```
class PlaybackWav
```

#### Members

#### Public Constructors

PlaybackWav::PlaybackWav	Create an instance of the PlaybackWav class
--------------------------	---

#### Public Methods

PlaybackWav::openFile	Open a .wav file for playback
PlaybackWav::closeFile	Close a previously opened file
PlaybackWav::fileOpened	Check if a .wav file is already opened
PlaybackWav::getSampleRate	Get the sample rate of the .wav file
PlaybackWav::getChannelCount	Get the number of audio channels in the .wav file
PlaybackWav::getBitDepth	Get the bit depth of each sample in the .wav file
PlaybackWav::getLengthMillis	Get the playback length of the .wav file in milliseconds
PlaybackWav::getPositionMillis	Get the current playback position in milliseconds
PlaybackWav::setPositionMillis	Set the current playback position in milliseconds
PlaybackWav::millisToBytes	Convert a playback duration to equivalent number of bytes
PlaybackWav::bytesToMillis	Convert number of bytes to an equivalent playback duration
PlaybackWav::readAudioData	Read audio data from the .wav file

**PlaybackWav::PlaybackWav****Description**

Create a PlaybackWav class object.

**Syntax**

```
void PlaybackWav(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PlaybackWav::fileOpened****Description**

Check if a .wav file is already opened.

**Syntax**

```
bool fileOpened(void);
```

**Parameters**

The function requires no input parameter.

#### Returns

The function returns true if a .wav file is already open, false otherwise.

#### Example Code

Example: RecordPlaybackWav

#### Notes and Warnings

NA

---

### PlaybackWav::getSampleRate

#### Description

Get the sample rate of the .wav file.

#### Syntax

```
uint32_t getSampleRate(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns sampling rate encoded in the .wav file header.

#### Example Code

Example: PlaybackWavFile

#### Notes and Warnings

NA

---

### PlaybackWav::getChannelCount

#### Description

Get the number of audio channels in the .wav file.

#### Syntax

```
uint16_t getChannelCount(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns channel count encoded in the .wav file header.

**Example Code**

Example: PlaybackWavFile

**Notes and Warnings**

NA

---

**PlaybackWav::getBitDepth****Description**

Get the bit depth of each sample in the .wav file.

**Syntax**

```
uint16_t getBitDepth(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns bit depth encoded in the .wav file header.

**Example Code**

Example: PlaybackWavFile

**Notes and Warnings**

NA

---

**PlaybackWav::getLengthMillis****Description**

Get the playback length of the .wav file in milliseconds.

**Syntax**

```
uint32_t getLengthMillis(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the total playback length of the currently open .wav file in milliseconds.

**Example Code**

Example: PlaybackWavFile

**Notes and Warnings**

NA

---

### **PlaybackWav::getPositionMillis**

#### **Description**

Get the current playback position in milliseconds.

#### **Syntax**

```
uint32_t getPositionMillis(void);
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns the current playback position of the currently open .wav file in milliseconds.

#### **Example Code**

Example: PlaybackWavFile

#### **Notes and Warnings**

NA

---

### **PlaybackWav::setPositionMillis**

#### **Description**

Set the current playback position in milliseconds.

#### **Syntax**

```
void setPositionMillis(uint32_t pos);
```

#### **Parameters**

pos: The desired playback position expressed in milliseconds.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PlaybackWavFile

#### **Notes and Warnings**

Any changes to playback position will only take effect on the next call to PlaybackWav::readAudioData. If the desired playback position is beyond the total playback length of the file, the playback position will be set to the end of file, and no audio data will be output on subsequent data reads.

---



**PlaybackWav::millisToBytes****Description**

Convert a playback duration to equivalent number of bytes.

**Syntax**

```
uint32_t millisToBytes(uint32_t ms);
```

**Parameters**

ms: playback duration in milliseconds.

**Returns**

The function returns the number of bytes that is equivalent to the input playback duration, converted using the current sample rate, number of channels and bit depth.

**Example Code**

NA

**Notes and Warnings**

NA

---

**PlaybackWav::bytesToMillis****Description**

Convert number of bytes to an equivalent playback duration.

**Syntax**

```
uint32_t bytesToMillis(uint32_t bytes);
```

**Parameters**

bytes: playback duration in number of bytes.

**Returns**

The function returns the time duration in milliseconds that is equivalent to the input number of bytes, converted using the current sample rate, number of channels and bit depth.

**Example Code**

NA

**Notes and Warnings**

NA

---

**PlaybackWav::readAudioData**

**Description**

Read audio data from the .wav file.

**Syntax**

- `uint32_t readAudioData(int8_t* dst, uint32_t len);`
- `uint32_t readAudioData(int16_t* dst, uint32_t len);`

**Parameters**

- `dst`: pointer to array to store data read from .wav file.
- `len`: number of audio samples to read from .wav file.

**Returns**

The function returns number of audio samples read.

**Example Code**

Example: `PlaybackWavFile`

**Notes and Warnings**

NA

**Class RecordWav****Description**

A class used for control and recording of .wav file format audio data.

**Syntax**

```
class RecordWav
```

**Members****Public Constructors**

<code>RecordWav::RecordWav</code>	Create an instance of the <code>RecordWav</code> class
-----------------------------------	--

**Public Methods**

RecordWav::openFile	Open a .wav file for playback
RecordWav::closeFile	Close a previously opened file
RecordWav::fileOpened	Check if a .wav file is already opened
RecordWav::setSampleRate	Get the sample rate of the .wav file
RecordWav::setChannelCount	Set the number of audio channels in the .wav file
RecordWav::setBitDepth	Set the bit depth of each sample in the .wav file
RecordWav::getLengthMillis	Get the current record length of the .wav file in milliseconds
RecordWav::millisToBytes	Convert a playback duration to equivalent number of bytes
RecordWav::bytesToMillis	Convert number of bytes to an equivalent playback duration
RecordWav::writeAudioData	Write audio data to the .wav file

**RecordWav::RecordWav****Description**

Create a RecordWav class object.

**Syntax**

```
void RecordWav(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

NA

**RecordWav::openFile****Description**

Open a .wav file for recording.

**Syntax**

```
void openFile(const char* absFilepath);
```

**Parameters**

absFilepath: the filepath of the .wav file to open.

### Returns

The function returns nothing.

### Example Code

Example: RecordWavFile

### Notes and Warnings

NA

---

## RecordWav::closeFile

### Description

Close a previously opened file.

### Syntax

```
void closeFile(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: RecordWavFile

### Notes and Warnings

Any open .wav files should be closed after recording is complete, otherwise, loss of recorded audio data may occur.

---

## RecordWav::fileOpened

### Description

Check if a .wav file is already opened.

### Syntax

```
bool fileOpened(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns true if a .wav file is already open, false otherwise.

### Example Code

Example: RecordWavFile

### Notes and Warnings

NA

---

## RecordWav::setSampleRate

### Description

Set the recording sample rate of the .wav file.

### Syntax

```
void setSampleRate(uint32_t sampleRate);
```

### Parameters

sampleRate: The desired recording sample rate.

### Returns

The function returns nothing.

### Example Code

Example: RecordWavFile

### Notes and Warnings

NA

---

## RecordWav::setChannelCount

### Description

Set the number of recording audio channels in the .wav file.

### Syntax

```
void setChannelCount(uint16_t channelCount);
```

### Parameters

channelCount: number of recording audio channels.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

---

---

## RecordWav::setBitDepth

### Description

Set the recording bit depth of each sample in the .wav file.

### Syntax

```
void setBitDepth(uint16_t bitDepth);
```

### Parameters

bitDepth: number of bits per sample.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

---

## RecordWav::getLengthMillis

### Description

Get the current recorded length of the .wav file in milliseconds.

### Syntax

```
uint32_t getLengthMillis(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the current recorded length of the currently open .wav file in milliseconds.

### Example Code

NA

### Notes and Warnings

NA

---

## RecordWav::millisToBytes

### Description

Convert a playback duration to equivalent number of bytes.

**Syntax**

```
uint32_t millisToBytes(uint32_t ms);
```

**Parameters**

ms: playback duration in milliseconds.

**Returns**

The function returns the number of bytes that is equivalent to the input playback duration, converted using the current sample rate, number of channels and bit depth.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::bytesToMillis****Description**

Convert number of bytes to an equivalent playback duration.

**Syntax**

```
uint32_t bytesToMillis(uint32_t bytes);
```

**Parameters**

bytes: playback duration in number of bytes.

**Returns**

The function returns the time duration in milliseconds that is equivalent to the input number of bytes, converted using the current sample rate, number of channels and bit depth.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::writeAudioData****Description**

Write audio data to the .wav file.

**Syntax**

```
uint32_t writeAudioData(int8_t* src, uint32_t len); uint32_t writeAudioData(int16_t* src, uint32_t len);
```

**Parameters**

src: pointer to array containing data to write to .wav file. len: number of audio samples to write to .wav file.

**Returns**

The function returns number of audio samples written.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

NA

---

**BLE****Class BLEAddr****BLEAddr Class****Description**

A class used for managing Bluetooth addresses.

**Syntax**

```
class BLEAddr
```

**Members**

Public Constructors	
BLEAddr::BLEAddr	Constructs a BLEAddr object
Public Methods	
BLEAddr::str	Get the Bluetooth address represented as a formatted string
BLEAddr::data	Get the Bluetooth address represented as an integer array

**BLEAddr::BLEAddr****Description**



Constructs a BLEAddr object.

### Syntax

```
BLEAddr::BLEAddr(void);  
BLEAddr::BLEAddr(uint8_t (&addr)[6]);  
BLEAddr::BLEAddr(const char* str);
```

### Parameters

addr: An array of 6 bytes containing the desired Bluetooth address.

str: A character string representing the desired Bluetooth address.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

When expressed as a string, the Bluetooth address should be written as 6 bytes in hexadecimal format, using a colon “:” to separate the bytes is acceptable (example –00:11:22:33:EE:FF).

### BLEAddr::str

### Description

Get the Bluetooth address represented as a formatted string.

### Syntax

```
const char* str(void);
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns a pointer to a character string containing the hexadecimal representation of the Bluetooth address.

**Example Code**

Example: BLEScan

**Notes and Warnings**

The Bluetooth address expressed as a string will be written as 6 bytes in hexadecimal format, with a colon “:” separating the bytes (example –00:11:22:33:EE:FF).

**BLEAddr::data****Description**

Get the Bluetooth address represented as an integer array.

**Syntax**

```
uint8_t* data(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a pointer to a 6 byte array containing the Bluetooth address.

**Example Code**

NA

**Notes and Warnings**

The Bluetooth address is stored with MSB at array index [5].

## Class BLEAdvert

### BLEAdvert Class

#### Description

A class used for managing BLE advertising settings.

#### Syntax

```
class BLEAdvert
```

#### Members

##### Public Constructors

No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using `BLEDevice::configAdvert()`.

Public Methods	
<code>BLEAdvert::updateAdvertParams</code>	Update the current BLE advertisement settings to the lower Bluetooth stack
<code>BLEAdvert::startAdv</code>	Start BLE advertising
<code>BLEAdvert::stopAdv</code>	Stop BLE advertising
<code>BLEAdvert::setAdvType</code>	Set the BLE advertising type
<code>BLEAdvert::setMinInterval</code>	Set the BLE advertising minimum interval
<code>BLEAdvert::setMaxInterval</code>	Set the BLE advertising maximum interval
<code>BLEAdvert::setAdvData</code>	Set BLE advertising data
<code>BLEAdvert::setScanRspData</code>	Set BLE scan response data

### BLEAdvert::updateAdvertParams

#### Description

Update the lower Bluetooth stack with the current advertising settings.

#### Syntax

```
void updateAdvertParams(void);
```

#### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Please use the other class member functions to set the BLE advertising parameters first before using this function.

### BLEAdvert::startAdv

### Description

Start BLE advertising.

### Syntax

```
void startAdv(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This function is provided for flexibility in controlling and updating BLE advertising parameters. You should avoid using this function to directly start the BLE advertising process without first registering the necessary callback and handler functions. Call `BLEDevice::beginPeripheral()` to register the necessary functions and start advertising for the first time.

## **BLEAdvert::stopAdv**

### **Description**

Stop BLE advertising.

### **Syntax**

```
void stopAdv(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

This function is provided for flexibility in controlling and updating BLE advertising parameters. You should avoid using this function to directly stop the BLE advertising process. Call `BLEDevice::end()` to stop advertising and free up used resources.

## **BLEAdvert::setAdvType**

### **Description**

Set the BLE advertising type.

**Syntax**

```
void setAdvType(uint8_t advType);
```

**Parameters**

advType: the desired advertisement type. Valid values:

- 0 = GAP\_ADTYPE\_ADV\_IND : connectable undirected advertisement
- 1 = GAP\_ADTYPE\_ADV\_HDC\_DIRECT\_IND : connectable high duty cycle directed
- 2 = GAP\_ADTYPE\_ADV\_SCAN\_IND : scannable undirected advertisement
- 3 = GAP\_ADTYPE\_ADV\_NONCONN\_IND : Non-connectable undirected advertisement
- 4 = GAP\_ADTYPE\_ADV\_LDC\_DIRECT\_IND : connectable low duty cycle directed advertisement

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

Call this function with the GAP\_ADTYPE\_ADV\_IND argument if connection requests should be allowed, and GAP\_ADTYPE\_ADV\_NONCONN\_IND if all connection requests should be rejected.

**BLEAdvert::setMinInterval****Description**

Set the minimum BLE advertising interval.

**Syntax**

```
void setMinInterval(uint16_t minInt_ms);
```

**Parameters**

minInt\_ms: the desired advertisement minimum interval, expressed in milliseconds. The valid values for the interval are from 20ms to 10240ms.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

BLE advertisements will repeat with an interval between the set minimum and maximum intervals. Set a shorter interval for the BLE device to be discovered rapidly and set a longer interval to conserve power.

**BLEAdvert::setMaxInterval****Description**

Set the maximum BLE advertising interval.

**Syntax**

```
void setMaxInterval(uint16_t minInt_ms);
```

**Parameters**

minInt\_ms: the desired advertisement maximum interval, expressed in milliseconds. The valid values for the interval are from 20ms to 10240ms.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

BLE advertisements will repeat with an interval between the set minimum and maximum intervals. Set a shorter interval for the BLE device to be discovered rapidly and set a longer interval to conserve power.

**BLEAdvert::setAdvData****Description**

Set BLE advertising data.

**Syntax**

```
void setAdvData(BLEAdvertData adData);  
void setAdvData(uint8_t* pData, uint8_t size);
```

**Parameters**

adData: scan response data formatted in a BLEAdvertData class object

pData: pointer to a byte array containing the required scan response data.

size: number of bytes the scan response data contains, maximum of 31 bytes.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

N/A

**BLEAdvert::setScanRspData****Description**

Set BLE scan response data.

**Syntax**

```
void setScanRspData(BLEAdvertData adData);  
void setScanRspData(uint8_t* pData, uint8_t size);
```



**Parameters**

adData: scan response data formatted in a BLEAdvertData class object

pData: pointer to a byte array containing the required scan response data.

size: number of bytes the scan response data contains, maximum of 31 bytes.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

N/A

**Class BLEAdvertData****BLEAdvertData Class****Description**

A class used for managing BLE advertising data.

**Syntax**

```
class BLEAdvertData
```

**Members**

Public Constructors	
BLEAdvertData::BLEAdvertData	Constructs a BLEAdvertData object

Public Methods	
BLEAdvertData::clear	Clear all advertising data
BLEAdvertData::addData	Add binary advertising data
BLEAdvertData::addFlags	Add flags to advertising data
BLEAdvertData::addPartialServices	Add partial services to advertising data
BLEAdvertData::addCompleteServices	Add complete services to advertising data
BLEAdvertData::addAppearance	Add device appearance to advertising data
BLEAdvertData::addShortName	Add short device name to advertising data
BLEAdvertData::addCompleteName	Add complete device name to advertising data
BLEAdvertData::parseScanInfo	Parse advertising data received from a scan
BLEAdvertData::hasFlags	Check if received data includes advertising flags
BLEAdvertData::hasUUID	Check if received data includes UUIDs
BLEAdvertData::hasName	Check if received data includes device name
BLEAdvertData::hasManufacturer	Check if received data includes manufacturer data
BLEAdvertData::getAdvType	Get advertising type of received data
BLEAdvertData::getAddrType	Get Bluetooth address type of received data
BLEAdvertData::getAddr	Get Bluetooth address of received data
BLEAdvertData::getRSSI	Get RSSI of received data
BLEAdvertData::getFlags	Get advertising flags of received data
BLEAdvertData::getServiceCount	Get number of advertised services in received data
BLEAdvertData::getServiceList	Get array of advertised services in received data
BLEAdvertData::getName	Get advertised device name in received data
BLEAdvertData::getTxPower	Get advertised transmission power in received data
BLEAdvertData::getAppearance	Get advertised device appearance in received data
BLEAdvertData::getManufacturer	Get advertised manufacturer in received data
BLEAdvertData::getManufacturerDataLength	Get length of manufacturer data in received data
BLEAdvertData::getManufacturerData	Get advertised manufacturer data in received data

## BLEAdvertData::BLEAdvertData

### Description

Constructs a BLEAdvertData object.

### Syntax

```
BLEAdvertData::BLEAdvertData(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This class is used for managing BLE advertising data for two primary uses. First is to assemble advertising data for broadcasting as advertising packets. Second is to process and split up the advertising data received from a scan into separate types.

### BLEAdvertData::clear

### Description

Clear all advertising data currently saved in class object.

### Syntax

```
void clear(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## **BLEAdvertData::addData**

### **Description**

Add binary advertising data.

### **Syntax**

```
void addData(const uint8_t* data, uint8_t size);
```

### **Parameters**

data: pointer to array containing desired advertising data.

size: number of bytes in array.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

This function is provided for flexibility in adding BLE advertising data. Other functions should be used for adding advertising data if possible, as this function does not perform any checks on the validity of the data.

## **BLEAdvertData::addFlags**

### **Description**

Add flags to advertising data.

### **Syntax**

```
uint8_t addFlags(uint8_t flags);
```

### Parameters

flags: desired flags to add to advertising data. Valid values:

- GAP\_ADTYPE\_FLAGS\_LIMITED
- GAP\_ADTYPE\_FLAGS\_GENERAL
- GAP\_ADTYPE\_FLAGS\_BREDR\_NOT\_SUPPORTED
- GAP\_ADTYPE\_FLAGS\_SIMULTANEOUS\_LE\_BREDR\_CONTROLLER
- GAP\_ADTYPE\_FLAGS\_SIMULTANEOUS\_LE\_BREDR\_HOST

### Returns

Current total size of advertising data.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

NA

## BLEAdvertData::addPartialServices

### Description

Add partial list of service UUIDs to advertising data.

### Syntax

```
uint8_t addPartialServices(BLEUUID uuid);
```

### Parameters

uuid: the desired UUID contained in BLEUUID class object.

### Returns

Current total size of advertising data.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::addCompleteServices****Description**

Add complete list of service UUIDs to advertising data.

**Syntax**

```
uint8_t addCompleteServices(BLEUUID uuid);  
uint8_t addCompleteServices(uint8_t uuidBitLength);
```

**Parameters**

uuid: the desired UUID contained in BLEUUID class object.

uuidBitLength: UUID bit length for which a blank entry is to be added. Valid values: 16, 32, 128.

**Returns**

Current total size of advertising data.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

uuidBitLength is used when it is desired to add a blank entry to the advertisement data, used to indicate that no services with UUIDs of a certain length are available.

**BLEAdvertData::addAppearance**

**Description**

Add device appearance to advertising data.

**Syntax**

```
uint8_t addAppearance(uint16_t appearance);
```

**Parameters**

appearance: the desired device appearance.

**Returns**

Current total size of advertising data.

**Example Code**

NA

**Notes and Warnings**

Refer to Bluetooth specifications for a full list of device appearance values.

**BLEAdvertData::addShortName****Description**

Add shortened device name to advertising data.

**Syntax**

```
uint8_t addShortName(const char* str);
```

**Parameters**

str: character string containing desired device name.

**Returns**

Current total size of advertising data.

### Example Code

NA

### Notes and Warnings

NA

## BLEAdvertData::addCompleteName

### Description

Add complete device name to advertising data.

### Syntax

```
uint8_t addCompleteName(const char* str);
```

### Parameters

str: character string containing desired device name.

### Returns

Current total size of advertising data.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

NA

## BLEAdvertData::parseScanInfo

### Description

Parse advertising data received from a scan.



**Syntax**

```
void parseScanInfo(T_LE_CB_DATA *p_data);
```

**Parameters**

p\_data: pointer to advertising data received from a Bluetooth scan.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

Advertising data fields of parsed receive data can be access using member functions starting with “has” and “get” .

**BLEAdvertData::hasFlags****Description**

Check if received data includes advertising flags.

**Syntax**

```
bool hasFlags(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

True if flags are present in received advertising data.

**Example Code**

NA

## Notes and Warnings

NA

## BLEAdvertData::hasUUID

### Description

Check if received data includes service UUIDs.

### Syntax

```
bool hasUUID(void);
```

### Parameters

The function requires no input parameter.

### Returns

True if service UUIDs are present in received advertising data.

### Example Code

NA

## Notes and Warnings

NA

## BLEAdvertData::hasName

### Description

Check if received data includes device name.

### Syntax

```
bool hasName(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

True if device name is present in received advertising data.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

NA

**BLEAdvertData::hasManufacturer****Description**

Check if received data includes manufacturer specific data.

**Syntax**

```
bool hasManufacturer(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

True if manufacturer specific data is present in received advertising data.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::getAdvType****Description**

Get advertising type of received data.

**Syntax**

```
T_GAP_ADV_EVT_TYPE getAdvType(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertising type of received advertising data.

**Example Code**

NA

**Notes and Warnings**

Possible types:

- GAP\_ADV\_EVT\_TYPE\_UNDIRECTED
- GAP\_ADV\_EVT\_TYPE\_DIRECTED
- GAP\_ADV\_EVT\_TYPE\_SCANNABLE
- GAP\_ADV\_EVT\_TYPE\_NON\_CONNECTABLE
- GAP\_ADV\_EVT\_TYPE\_SCAN\_RSP

**BLEAdvertData::getAddrType****Description**

Get Bluetooth address type of received data.

**Syntax**

```
T_GAP_REMOTE_ADDR_TYPE getAddrType(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Bluetooth address type of received data.

**Example Code**

NA

**Notes and Warnings**

Possible types:

- GAP\_REMOTE\_ADDR\_LE\_PUBLIC
- GAP\_REMOTE\_ADDR\_LE\_RANDOM

**BLEAdvertData::getRSSI****Description**

Get received signal strength indicator (RSSI) of received data.

**Syntax**

```
Int8_t getRSSI(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Received signal strength.

### Example Code

NA

### Notes and Warnings

NA

## BLEAdvertData::getFlags

### Description

Get advertising flags of received data.

### Syntax

```
uint8_t getFlags(void);
```

### Parameters

The function requires no input parameter.

### Returns

Advertising flags present in received advertising data, expressed as a single byte.

### Example Code

NA

### Notes and Warnings

NA

## BLEAdvertData::getServiceCount

### Description

Get number of advertised services in received data.

**Syntax**

```
uint8_t getServiceCount(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Number of advertised service UUIDs in received data.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

NA

**BLEAdvertData::getServiceList****Description**

Get list of advertised service UUIDs in received data.

**Syntax**

```
BLEUUID* getServiceList(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Pointer to a BLEUUID array containing all advertised service UUIDs.

**Example Code**

Example: BLEBatteryClient

## Notes and Warnings

NA

## BLEAdvertData::getName

### Description

Get advertised device name in received data.

### Syntax

```
String getName(void);
```

### Parameters

The function requires no input parameter.

### Returns

Advertised device name contained in a String class object.

### Example Code

Example: BLEBatteryClient

## Notes and Warnings

NA

## BLEAdvertData::getTxPower

### Description

Get advertised transmission power in received data.

### Syntax

```
int8_t getTxPower(void);
```



**Parameters**

The function requires no input parameter.

**Returns**

Advertised transmission power.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::getAppearance****Description**

Get advertised device appearance in received data.

**Syntax**

```
uint16_t getAppearance(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertised device appearance.

**Example Code**

NA

**Notes and Warnings**

Refer to Bluetooth specifications for full list of device appearance values.

## **BLEAdvertData::getManufacturer**

### **Description**

Get advertised manufacturer in received data.

### **Syntax**

```
uint16_t getManufacturer(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

Advertised manufacturer.

### **Example Code**

NA

### **Notes and Warnings**

Refer to Bluetooth specifications for full list of manufacturer codes.

## **BLEAdvertData::getManufacturerDataLength**

### **Description**

Get length of manufacturer data in received data.

### **Syntax**

```
uint8_t getManufacturerDataLength(void);
```

### **Parameters**

The function requires no input parameter.

**Returns**

Number of bytes of manufacturer data present in received advertising data.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::getManufacturerData****Description**

Get manufacturer data in received data.

**Syntax**

```
uint8_t* getManufacturerData(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Pointer to array containing manufacturer data.

**Example Code**

NA

**Notes and Warnings**

NA

## Class BLEBeacon

### iBeacon Class

#### Description

A class used for managing iBeacon BLE advertising data.

#### Syntax

```
class iBeacon
```

#### Members

Public Constructors	
iBeacon::iBeacon	Create an instance of iBeacon advertising data
Public Methods	
iBeacon::getManufacturerId	Get current manufacturer ID value
iBeacon::getUUID	Get current UUID value
iBeacon::getMajor	Get current Major value
iBeacon::getMinor	Get current Minor value
iBeacon::getRSSI	Get current RSSI value
iBeacon::setManufacturerId	Set manufacturer ID value
iBeacon::setUUID	Set UUID value
iBeacon::setMajor	Set Major value
iBeacon::setMinor	Set Minor value
iBeacon::setRSSI	Set RSSI value
iBeacon::getAdvData	Get current advertising data
iBeacon::getScanRsp	Get current scan response data

### altBeacon Class

#### Description

A class used for managing altBeacon BLE advertising data.

#### Syntax

```
class altBeacon
```

## Members

Public Constructors	
altBeacon::altBeacon	Create an instance of altBeacon advertising data
Public Methods	
altBeacon::getManufacturerId	Get current manufacturer ID value
altBeacon::getUUID	Get current UUID value
altBeacon::getMajor	Get current Major value
altBeacon::getMinor	Get current Minor value
altBeacon::getRSSI	Get current RSSI value
altBeacon::getRSVD	Get current Reserved value
altBeacon::setManufacturerId	Set manufacturer ID value
altBeacon::setUUID	Set UUID value
altBeacon::setMajor	Set Major value
altBeacon::setMinor	Set Minor value
altBeacon::setRSSI	Set RSSI value
altBeacon::setRSVD	Set Reserved value
altBeacon::getAdvData	Get current advertising data
altBeacon::getScanRsp	Get current scan response data

## iBeacon::iBeacon

### Description

Create an iBeacon object.

### Syntax

```
void iBeacon(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “BLEBeacon.h” to use this class function.

### altBeacon::altBeacon

#### Description

Create an altBeacon object.

#### Syntax

```
void altBeacon(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

NA

### Notes and Warnings

Include “BLEBeacon.h” to use this class function.

### iBeacon::getManufacturerId

### altBeacon::getManufacturerId

#### Description

Get current Manufacturer ID value.

#### Syntax

```
uint16_t getManufacturerId(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

A 16-bit unsigned integer containing the current Company ID.

**Example Code**

NA

**Notes and Warnings**

Refer to <https://www.bluetooth.com/specifications/assigned-numbers/company-identifiers/> for the full list of assigned Bluetooth company identifiers.

**iBeacon::getUUID****altBeacon::getUUID****Description**

Get the current UUID value.

**Syntax**

```
void getUUID(uint8_t* UUID);
```

**Parameters**

UUID: pointer to a 16 element uint8\_t array, current UUID will be copied into the array.

**Returns**

The function returns nothing.

**Example Code**

NA

### Notes and Warnings

UUID is a 128-bit number used to uniquely identify a beacon. It is commonly expressed as a 32-character hexadecimal string. UUIDs can be generated at <https://www.uuidgenerator.net/>.

### iBeacon::getMajor

### altBeacon::getMajor

### Description

Get current Major value.

### Syntax

```
uint16_t getMajor(void);
```

### Parameters

The function requires no input parameter.

### Returns

A 16-bit unsigned integer containing the current Major value.

### Example Code

NA

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::getMinor

### altBeacon::getMinor



**Description**

Get current Minor value.

**Syntax**

```
uint16_t getMinor(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

A 16-bit unsigned integer containing the current Minor value.

**Example Code**

NA

**Notes and Warnings**

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

**iBeacon::getRSSI****altBeacon::getRSSI****Description**

Get the current RSSI value.

**Syntax**

```
int8_t getRSSI(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

An 8-bit signed integer containing the currently set RSSI value.

**Example Code**

NA

**Notes and Warnings**

The beacon RSSI value is the received signal strength at 1 meter. This can be used to estimate the distance to the beacon. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

**iBeacon::setManufacturerId****altBeacon::setManufacturerId****Description**

Set Manufacturer ID value.

**Syntax**

```
void setManufacturerId(uint16_t id);
```

**Parameters**

id: desired Manufacturer ID

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

**Notes and Warnings**

Refer to <https://www.bluetooth.com/specifications/assigned-numbers/company-identifiers/> for the full list of assigned Bluetooth company identifiers.

**iBeacon::setUUID****altBeacon::setUUID****Description**

Set UUID value.

**Syntax**

```
void setUUID(uint8_t* UUID);  
void setUUID(const char* UUID);
```

**Parameters**

uint8\_t\* UUID: pointer to a 16 element uint8\_t array containing the desired UUID

const char\* UUID: desired UUID expressed as a character string

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

**Notes and Warnings**

UUID is a 128-bit number used to uniquely identify a beacon. It is commonly expressed as a 32-character hexadecimal string. UUIDs can be generated at <https://www.uuidgenerator.net/>.

**iBeacon::setMajor****altBeacon::setMajor****Description**

Set Major value.

**Syntax**

```
void setMajor(uint16_t major);
```

### Parameters

major: desired Major value

### Returns

The function returns nothing.

### Example Code

Example: BLEBeacon

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::setMinor

### altBeacon::setMinor

### Description

Set Minor value.

### Syntax

```
void setMinor(uint16_t minor);
```

### Parameters

minor: desired Minor value

### Returns

The function returns nothing.

### Example Code

Example: BLEBeacon

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::setRSSI

### altBeacon::setRSSI

### Description

Set RSSI value.

### Syntax

```
void setRSSI(int8_t RSSI);
```

### Parameters

RSSI: desired RSSI value

### Returns

The function returns nothing.

### Example Code

Example: BLEBeacon

### Notes and Warnings

The beacon RSSI value is the received signal strength at 1 meter. This can be used to estimate the distance to the beacon. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::getAdvData

### altBeacon::getAdvData

### Description

Get current beacon advertising data.

### Syntax

```
uint8_t* getAdvData(void);
```

### Parameters

The function requires no input parameter.

### Returns

A uint8\_t pointer to the structure containing beacon advertising data.

### Example Code

NA

### Notes and Warnings

Avoid changing the beacon data through the returned pointer, use the member functions instead.

### iBeacon::getScanRsp

### altBeacon::getScanRsp

### Description

Get current beacon advertising scan response data.

### Syntax

```
uint8_t* getScanRsp(void);
```

### Parameters

The function requires no input parameter.

### Returns

A uint8\_t pointer to the structure containing beacon advertising scan response data.

### Example Code

NA

### Notes and Warnings

Avoid changing the beacon data through the returned pointer, use the member functions instead.

### altBeacon::getRSVD

#### Description

Get current Reserved value.

#### Syntax

```
uint8_t getRSVD(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

An 8-bit unsigned integer containing the current Reserved value.

### Example Code

NA

### Notes and Warnings

Reserved for use by the manufacturer to implement special features. The interpretation of this value is to be defined by the manufacturer and is to be evaluated based on the MFG ID value. Refer to <https://altbeacon.org/> for more information.

## altBeacon::setRSVD

### Description

Set Reserved value.

### Syntax

```
void setRSVD(uint8_t rsvd);
```

### Parameters

rsvd: desired Reserved value

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Reserved for use by the manufacturer to implement special features. The interpretation of this value is to be defined by the manufacturer and is to be evaluated based on the MFG ID value. Refer to <https://altbeacon.org/> for more information.

## Class BLECharacteristic

### BLECharacteristic Class

#### Description

A class used for creating and managing BLE GATT characteristics.

#### Syntax

```
class BLECharacteristic
```

#### Members



<b>Public Constructors</b>	
BLEC haracteristic::BLECharacteristic	Constructs a BLECharacteristic object
<b>Public Methods</b>	
BLECharacteristic::setUUID	Set the characteristic UUID
BLECharacteristic::getUUID	Get the characteristic UUID
BLECharacteristic::setBufferLen	Set the size of the internal data buffer
BLECharacteristic::getBufferLen	Get the current size of the internal data buffer
BLECharacteristic::setReadProperty	Get the current size of the internal data bufferSet the characteristic r
BLECharacteristic::setWriteProperty	Set the characteristic write property
BLEC haracteristic::setNotifyProperty	Set the characteristic notify property
BLECha racteristic::setIndicateProperty	Set the characteristic indicate property
BLECharacteristic::setProperties	Set the characteristic properties
BLECharacteristic::getProperties	Get the characteristic properties
BLECharacteristic::readString	Read the characteristic data buffer as a String object
BLECharacteristic::readData8	Read the characteristic data buffer as an unsigned 8-bit integer
BLECharacteristic::readData16	Read the characteristic data buffer as an unsigned 16-bit integer
BLECharacteristic::readData32	Read the characteristic data buffer as an unsigned 32-bit integer
BLECharacteristic::writeString	Write data to the characteristic data buffer as a String object or char
BLECharacteristic::writeData8	Write data to the characteristic data buffer as an unsigned 8-bit integ
BLECharacteristic::writeData16	Write data to the characteristic data buffer as an unsigned 16-bit inte
BLECharacteristic::writeData32	Write data to the characteristic data buffer as an unsigned 16-bit inte
BLECharacteristic::setData	Write data to the characteristic data buffer
BLECharacteristic::getData	Read data from the characteristic data buffer
BLECharacteristic::getDataBuff	Get a pointer to the characteristic data buffer
BLECharacteristic::getDataLen	Get the number of bytes of data in the characteristic data buffer
BLECharacteristic::notify	Send a notification to a connected device
BLECharacteristic::indicate	Send an indication to a connected device
BLEC haracteristic::setUserDescriptor	Add a user description descriptor to characteristic
BLECha racteristic::setFormatDescriptor	Add a data format descriptor to characteristic
BLECharacteristic::Add a data format descriptor to characteristic	Set a user function as a read callback
BLECharacteristic::setWriteCallback	Set a user function as a write callback
BLECharacteristic::setCCCDCallback	Set a user function as a CCCD write callback

## BLECharacteristic::BLECharacteristic

### Description

Constructs a BLECharacteristic object.

### Syntax

```
BLECharacteristic::BLECharacteristic(BLEUUID uuid);  
BLECharacteristic::BLECharacteristic(const char* uuid);
```

### Parameters

uuid: characteristic UUID, expressed as a BLEUUID class object or a character array

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLECharacteristic::setUUID

### Description

Set the characteristic UUID.

### Syntax

```
void setUUID(BLEUUID uuid);
```

### Parameters

uuid: the new characteristic UUID, expressed with a BLEUUID class object

### Returns

The function returns nothing.

### Example Code

NA

**Notes and Warnings**

NA

**BLECharacteristic::getUUID****Description**

Get the characteristic UUID.

**Syntax**

```
BLEUUID getUUID();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the characteristic UUID in a BLEUUID class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::setBufferLen****Description**

Set the size of the internal data buffer of the characteristic.

**Syntax**

```
void setBufferLen(uint16_t max_len);
```

**Parameters**

max\_len: number of bytes to resize the internal buffer to

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

Characteristic data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

## BLECharacteristic::getBufferLen

### Description

Get the size of the characteristic internal buffer.

### Syntax

```
uint16_t getBufferLen();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the currently set internal buffer size.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::setReadProperty

**Description**

Set the characteristic read property.

**Syntax**

```
void setReadProperty(bool value);
```

**Parameters**

value: TRUE to allow connected devices to read characteristic data

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLECharacteristic::setWriteProperty****Description**

Set the characteristic write property.

**Syntax**

```
void setWriteProperty(bool value);
```

**Parameters**

value: TRUE to allow connected devices to write characteristic data

**Returns**

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLECharacteristic::setNotifyProperty

### Description

Set the characteristic notify property.

### Syntax

```
void setNotifyProperty(bool value);
```

### Parameters

value: TRUE to allow connected devices to enable receiving characteristic data notifications.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

Enabling this property will add a CCCD descriptor to the characteristic.

## BLECharacteristic::setIndicateProperty

### Description

Set the characteristic indicate property.

### Syntax

```
void setIndicateProperty(bool value);
```

**Parameters**

value: TRUE to allow connected devices to enable receiving characteristic data indications.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Enabling this property will add a CCCD descriptor to the characteristic.

**BLECharacteristic::setProperties****Description**

Set the characteristic properties.

**Syntax**

```
void setProperties(uint8_t value);
```

**Parameters**

value: desired characteristic properties

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

### **BLECharacteristic::getProperties**

#### **Description**

Get the currently set characteristic properties.

#### **Syntax**

```
uint8_t getProperties();
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns the currently set characteristic properties expressed as an unsigned 8-bit integer.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

### **BLECharacteristic::readString**

#### **Description**

Read the data in the characteristic internal buffer, expressed as a String class object.

#### **Syntax**

```
String readString();
```

#### **Parameters**

The function requires no input parameter.



**Returns**

The function returns the data in the characteristic internal buffer expressed as a String class object.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

Non-ASCII data may result in unexpected characters in the string.

**BLECharacteristic::readData8****Description**

Read the data in the characteristic internal buffer, expressed as an unsigned 8-bit integer.

**Syntax**

```
uint8_t readData8();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic internal buffer expressed as a uint8\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::readData16****Description**

Read the data in the characteristic internal buffer, expressed as an unsigned 16-bit integer.

### Syntax

```
uint16_t readData16();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic internal buffer expressed as a uint16\_t value.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::readData32

### Description

Read the data in the characteristic internal buffer, expressed as an unsigned 32-bit integer.

### Syntax

```
uint32_t readData32();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic internal buffer expressed as a uint32\_t value.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::readData32

### Description

Write data to the characteristic data buffer as a String object or character array.

### Syntax

```
bool writeString(String str);  
bool writeString(const char* str);
```

### Parameters

str: the data to write to the characteristic buffer, expressed as a String class object or a char array.

### Returns

The function returns TRUE if write data is successful.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLECharacteristic::writeData8

### Description

Write data to the characteristic data buffer as an unsigned 8-bit integer.

### Syntax

```
bool writeData8(uint8_t num);
```

### Parameters

num: the data to write to the characteristic buffer expressed as an unsigned 8-bit integer.

### Returns

The function returns TRUE if write data is successful.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

NA

## BLECharacteristic::writeData16

### Description

Write data to the characteristic data buffer as an unsigned 16-bit integer.

### Syntax

```
bool writeData16(uint16_t num);
```

### Parameters

num: the data to write to the characteristic buffer expressed as an unsigned 16-bit integer.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## **BLECharacteristic::writeData32**

### **Description**

Write data to the characteristic data buffer as a 32-bit integer.

### **Syntax**

```
bool writeData32(uint32_t num);
```

```
bool writeData32(int num);
```

### **Parameters**

num: the data to write to the characteristic buffer expressed as a 32-bit integer.

### **Returns**

The function returns TRUE if write data is successful.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **BLECharacteristic::setData**

### **Description**

Write data to the characteristic data buffer.

### **Syntax**

```
bool setData(uint8_t* data, uint16_t datalen);
```

### **Parameters**

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::getData

### Description

Read data from the characteristic data buffer.

### Syntax

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

### Parameters

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

### Returns

The function returns the number of bytes read.

### Example Code

NA

### Notes and Warnings

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

## BLECharacteristic::getDataBuff

### Description

Get a pointer to the characteristic data buffer.

### Syntax

```
uint8_t* getDataBuff();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a pointer to the uint8\_t array used as the characteristic internal buffer.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::getDataLen

### Description

Get the number of bytes of data in the characteristic data buffer.

### Syntax

```
uint16_t getDataLen
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the number of bytes of data in the internal buffer.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::notify

### Description

Send a notification to a connected device.

### Syntax

```
void notify(uint8_t conn_id);
```

### Parameters

conn\_id: the connection ID for the device to send a notification to.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLECharacteristic::indicate

### Description

Send an indication to a connected device.



**Syntax**

```
void indicate(uint8_t conn_id);
```

**Parameters**

conn\_id: the connection ID for the device to send an indication to.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::setUserDescriptor****Description**

Add a user description descriptor attribute (UUID 0x2901) to the characteristic.

**Syntax**

```
void setUserDescriptor(const char* description);
```

**Parameters**

description: the desired user description string expressed in a char array.

**Returns**

The function returns nothing.

**Example Code**

NA

## Notes and Warnings

NA

## BLECharacteristic::setFormatDescriptor

### Description

Add a data format descriptor attribute (UUID 0x2904) to the characteristic.

### Syntax

```
void setFormatDescriptor(uint8_t format, uint8_t exponent, uint16_t unit, uint16_t description);
```

### Parameters

format: refer to <https://www.bluetooth.com/specifications/assigned-numbers/format-types/> for the valid values and associated format types.

exponent: base-10 exponent to be applied to characteristic data value.

unit: refer to <https://btprodspecificationrefs.blob.core.windows.net/assigned-values/16-bit%20UUID%20Numbers%20Document.pdf> for the valid values and associated units.

descriptor: refer to <https://www.bluetooth.com/specifications/assigned-numbers/gatt-namespace-descriptors/> for the valid values and associated descriptors.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## BLECharacteristic::setReadCallback

### Description

Set a user function to be called when the characteristic data is read by a connected device.

**Syntax**

```
void setReadCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing data read

conn\_id: connection ID of connected device that read characteristic data

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLECharacteristic::setWriteCallback****Description**

Set a user function to be called when the characteristic data is written by a connected device.

**Syntax**

```
void setWriteCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing written data.

conn\_id: connection ID of connected device that wrote characteristic data.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLECharacteristic::setCCCDCallback

### Description

Set a user function to be called when a connected device modifies the characteristic CCCD to enable or disable notifications or indications.

### Syntax

```
void setCCCDCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id, uint16_t ccc_bits));
```

### Parameters

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing written data.

conn\_id: connection ID of connected device that wrote characteristic data.

ccc\_bits: the new CCCD data bits after modification by the connected device

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## Class BLEClient

### BLEClient Class

#### Description

A class used for discovering and accessing BLE GATT services on a connected remote device.

#### Syntax

```
class BLEClient
```

#### Members

##### Public Constructors

No public constructor is available for this class. You can get a pointer to an instance of this class using BLEDevice::addClient().

Public Methods	
BLEClient::connected	Check if the corresponding remote device for the client is connected
BLEClient::discoverServices	Start service discovery process for connected device
BLEClient::discoveryDone	Determine if service discovery process has been completed
BLEClient::printServices	Format and print discovered services to serial port
BLEClient::getService	Get a specific service on the remote device
BLEClient::getConnId	
BLEClient::getClientId	Get corresponding client ID
BLEClient::setDisconnectCallback	Set a user function to be called when the remote device is disconnected

### BLEClient::connected

#### Description

Check if the remote device associated with the client is still connected.

#### Syntax

```
bool connected();
```

#### Parameters

The function requires no input parameter.

### Returns

The function returns TRUE if the remote device is connected.

### Example Code

NA

### Notes and Warnings

NA

## BLEClient::discoverServices

### Description

Start the service discovery process for the connected remote device.

### Syntax

```
void discoverServices();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartClient

### Notes and Warnings

NA

**BLEClient::discoveryDone****Description**

Check if the service discovery process has been completed.

**Syntax**

```
bool discoveryDone();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns TRUE if the service discovery process has been completed successfully, FALSE if the service discovery process failed, is still in progress, or has yet to start.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

**BLEClient::printServices****Description**

Print out a formatted list of discovered services to the serial port.

**Syntax**

```
void printServices();
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEClient::getService

### Description

Get a service with the specified UUID on the remote device.

### Syntax

```
BLERemoteService* getService(const char* uuid);
```

```
BLERemoteService* getService(BLEUUID uuid);
```

### Parameters

uuid: the desired service UUID, expressed as a character array or a BLEUUID object.

### Returns

The function returns the found service as a BLERemoteService object pointer, otherwise nullptr is returned if a service with the UUID is not found.

### Example Code

Example: BLEUartClient

### Notes and Warnings

NA



**BLEClient::getConnId****Description**

Get the connection ID associated with the remote device.

**Syntax**

```
uint8_t getConnId;
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the connection ID for the connected remote device.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEClient::getClientId****Description**

Get the client ID for the BLEClient object.

**Syntax**

```
T_CLIENT_ID getClientId();;
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns the BLEClient object's client ID.

### Example Code

NA

### Notes and Warnings

The client ID is used when calling internal GATT client API.

## BLEClient::setDisconnectCallback

### Description

Set a user function as a callback function when the remote device is disconnected.

### Syntax

```
void setDisconnectCallback(void (*fCallback) (BLEClient* client));
```

### Parameters

fCallback: A user callback function that returns void and takes one argument.

client: A pointer to the BLEClient object corresponding to the disconnected remote device

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The user callback function will be called after the remote device has disconnected, before the characteristics, services and client associated with the remote device are deleted.

## Class BLEConnect

### BLEConnect Class

#### Description

A class used for managing BLE connection settings.

#### Syntax

```
class BLEConnect
```

#### Members

##### Public Constructors

No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using `BLEDevice::configConnection`.

Public Methods	
<code>BLEConnect::connect</code>	Connect to a target BLE device
<code>BLEConnect::disconnect</code>	Disconnect from a target BLE device
<code>BLEConnect::setScanInterval</code>	Set the BLE scanning interval when connecting
<code>BLEConnect::setScanWindow</code>	Set the BLE scanning window when connecting
<code>BLEConnect::setConnInterval</code>	Set the BLE connection interval duration
<code>BLEConnect::setConnLatency</code>	Set the BLE connection slave latency
<code>BLEConnect::setConnTimeout</code>	Set the BLE connection timeout value
<code>BLEConnect::updateConnParams</code>	Send new BLE connection parameters to a connected device
<code>BLEConnect::getConnInfo</code>	Get connection information
<code>BLEConnect::getConnAddr</code>	Get the Bluetooth address for a certain connection
<code>BLEConnect::getConnId</code>	Get the connection ID for a certain device

### BLEConnect::connect

#### Description

Connect to a target BLE device.

#### Syntax

```
bool connect(char* btAddr, T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);
```

```
bool connect(uint8_t (&btAddr)[6], T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);  
bool connect(BLEAdvertData targetDevice, uint16_t scanTimeout);  
bool connect(BLEAddr destAddr, T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);
```

### Parameters

char\* btAddr: target device Bluetooth address expressed as a character string.

uint8\_t (&btAddr): target device Bluetooth address contained in a 6 byte array.

destAddr: target device Bluetooth address contained in BLEAddr class object.

targetDevice: advertising data packet scanned from target device.

destAddrType: Bluetooth address type of target device. Valid values:

–GAP\_REMOTE\_ADDR\_LE\_PUBLIC

–GAP\_REMOTE\_ADDR\_LE\_RANDOM

scan timeout: duration in milliseconds for which to look for target device before giving up.

### Returns

True if connection successful, false if connection failed.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

NA

## BLEConnect::disconnect

### Description

Disconnect from a target BLE device.

### Syntax

```
bool disconnect(uint8_t connId);
```

### Parameters

connId: connection ID for target device.

**Returns**

True if operation successful, false if otherwise.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEConnect::setScanInterval****Description**

Set the BLE scan interval when searching for a target device to connect to.

**Syntax**

```
void setScanInterval(uint16_t scanInt_ms);
```

**Parameters**

scanInt\_ms: scan interval in milliseconds. Value range of 3 to 10240.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## BLEConnect::setScanWindow

### Description

Set the BLE scan window when searching for a target device to connect to.

### Syntax

```
void setScanWindow(uint16_t scanWindow_ms);
```

### Parameters

scanWindow\_ms: scan window in milliseconds. Value range of 3 to 10240.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::setConnInterval

### Description

Set the BLE connection interval value.

### Syntax

```
void setConnInterval(uint16_t min_ms, uint16_t max_ms);
```

### Parameters

min\_ms: minimum acceptable connection interval in milliseconds. Value range of 8 to 4000.

max\_ms: maximum acceptable connection interval in milliseconds. Value range of 8 to 4000.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The BLE connection interval defines the period between successive connection events between a connected central and peripheral device. Even if there is no data to exchange, a connection event is required to maintain the connection. max\_ms should be larger than or equal to min\_ms.

**BLEConnect::setConnLatency****Description**

Set the BLE connection slave latency value.

**Syntax**

```
void setConnLatency(uint16_t latency);
```

**Parameters**

latency: Connection slave latency value. Value range of 0 to 499.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The BLE connection slave latency defines the number of successive connection events a connected peripheral device can ignore without being considered as disconnected by the central device.

## **BLEConnect::setConnTimeout**

### **Description**

Set the BLE connection timeout value.

### **Syntax**

```
void setConnTimeout(uint16_t timeout_ms);
```

### **Parameters**

timeout\_ms: connection timeout in milliseconds. Value range of 100 to 32000.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

The BLE connection timeout defines the duration after a failed connection events before a peripheral or central device considers the connection broken.

## **BLEConnect::updateConnParams**

### **Description**

Update a connected device with new connection parameters.

### **Syntax**

```
void updateConnParams(uint8_t conn_id);
```

### **Parameters**

conn\_id: connection ID of target device to update connection parameters.



**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Update a connected device with previously set connection interval, slave latency and timeout values. The connected device may reject the new values if it is unable to conform to them.

**BLEConnect::getConnInfo****Description**

Get connection information.

**Syntax**

```
bool getConnInfo(uint8_t connId, T_GAP_CONN_INFO *pConnInfo);
```

**Parameters**

connId: connection ID to get connection information from.

pConnInfo: pointer to T\_GAP\_CONN\_INFO structure to store obtained connection information.

**Returns**

True if operation success, false if operation failed.

**Example Code**

NA

**Notes and Warnings**

NA

## BLEConnect::getConnAddr

### Description

Get the Bluetooth address for a certain connection.

### Syntax

```
bool getConnAddr(uint8_t connId, uint8_t* addr, uint8_t* addrType);
```

### Parameters

connId: connection ID to get address information for

addr: pointer to 6 byte array to store retrieved Bluetooth address

addrType: pointer to uint8\_t variable to store retrieved Bluetooth address type

### Returns

True if operation success, false if operation failed.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::getConnId

### Description

Get the connection ID for a certain device.

### Syntax

```
int8_t getConnId(char* btAddr, uint8_t addrType);
```

```
int8_t getConnId(uint8_t* btAddr, uint8_t addrType);
```

```
int8_t getConnId(BLEAdvertData targetDevice);
```

**Parameters**

char\* btAddr: target device Bluetooth address expressed as a character string.

uint8\_t\* btAddr: pointer to a 6 byte array containing target device Bluetooth address.

targetDevice: advertising data packet scanned from target device.

addrType: Bluetooth address type of target device. Valid values:

–GAP\_REMOTE\_ADDR\_LE\_PUBLIC

–GAP\_REMOTE\_ADDR\_LE\_RANDOM

**Returns**

The function returns the requested connection ID. Returns -1 if failed to obtain connection ID.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

NA

**Class BLEDevice****BLEDevice Class****Description**

A class used for general control and management of BLE functions.

**Syntax**

```
class BLEDevice
```

**Members****Public Constructors**

The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named BLE.

Public Methods	
BLEDevice::init	Allocate resources required for BLE functionality
BLEDevice::deinit	Free resources used by BLE functionality
BLEDevice::connected	Check if a BLE device is connected
BLEDevice::setDeviceName	Set BLE GAP device name
BLEDevice::setDeviceAppearance	Set BLE GAP device appearance
BLEDevice::configAdvert	Configure BLE advertising parameters
BLEDevice::configScan	Configure BLE scan parameters
BLEDevice::setScanCallback	Set callback function for BLE scans
BLEDevice::beginCentral	Start BLE stack in central mode
BLEDevice::beginPeripheral	Start BLE stack in peripheral mode
BLEDevice::end	Stop BLE stack
BLEDevice::configServer	Configure BLE stack for services
BLEDevice::addService	Add a service to the BLE stack
BLEDevice::configClient	Configure BLE stack for clients
BLEDevice::addClient	Add a client to the BLE stack
BLEDevice::getLocalAddr	Get local device Bluetooth address

## BLEDevice::init

### Description

Allocate resources required for BLE functionality.

### Syntax

```
void init(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

**Notes and Warnings**

Call this member function first before using any other member functions in the BLEDevice class.

**BLEDevice::deinit****Description**

Free up resources used for BLE functionality.

**Syntax**

```
void deinit(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Call this member function last after all other BLE operations are stopped.

**BLEDevice::connected****Description**

Check if a BLE device is connected.

**Syntax**

```
bool connected(void);
```

### Parameters

The function requires no input parameter.

### Returns

TRUE if another BLE device is connected, FALSE if no BLE device is connected.

### Example Code

NA

### Notes and Warnings

NA

## BLEDevice::setDeviceName

### Description

Set the BLE GAP device name.

### Syntax

```
void setDeviceName(String devName);
```

### Parameters

devName: desired device name contained in an Arduino String object

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The GAP device name has a maximum length of 39 characters. Other devices can see this name after a BLE connection is established. This name is separate and different from the device name sent in a BLE advertisement, the names should be the same but are not required.

## **BLEDevice::setDeviceAppearance**

### **Description**

Set the BLE GAP device appearance.

### **Syntax**

```
void setDeviceAppearance(uint16_t devAppearance);
```

### **Parameters**

devAppearance: desired device appearance expressed as a 16-bit unsigned integer.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Refer to Bluetooth SIG assigned device appearances at <https://www.bluetooth.com/specifications/gatt/characteristics/>.

## **BLEDevice::configAdvert**

### **Description**

Configure BLE advertising parameters.

### **Syntax**

```
BLEAdvert* configAdvert(void);
```

### Parameters

The function requires no input parameter.

### Returns

A pointer to a BLEAdvert class instance for configuring BLE advertising parameters.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

Use this member function instead of creating a BLEAdvert class instance manually.

## BLEDevice::configScan

### Description

Configure BLE scanning parameters.

### Syntax

```
BLEScan* configScan(void);
```

### Parameters

The function requires no input parameter.

### Returns

A pointer to a BLEScan class instance for configuring BLE scanning parameters.

### Example Code

Example: BLEScan



```

#include 「BLEDevice.h」

#include 「BLEScan.h」

int dataCount = 0;

void scanFunction(T_LE_CB_DATA* p_data) {
    printf(「 rnScan Data %drn」 , ++dataCount);
    BLE.configScan()->printScanInfo(p_data);
}

void setup() {
    BLE.init();
    BLE.configScan()->setScanMode(GAP_SCAN_MODE_ACTIVE);
    BLE.configScan()->setScanInterval(500); // Start a scan every 500ms
    BLE.configScan()->setScanWindow(250); // Each scan lasts for 250ms
    // Provide a callback function to process scan data.
    // If no function is provided, default BLEScan::printScanInfo is used
    BLE.setScanCallback(scanFunction);
    BLE.beginCentral(0);
    BLE.configScan()->startScan(5000); // Repeat scans for 5 seconds, then stop
}

void loop() {
}

```

### Notes and Warnings

Use this member function instead of creating a BLEScan class instance manually.

### BLEDevice::setScanCallback

#### Description

Set a callback function for processing BLE scan results.

#### Syntax

```
void setScanCallback(void (scanCB)(T_LE_CB_DATA));
```

### Parameters

scanCB: a function that returns nothing and takes in a scan data pointer of type T\_LE\_CB\_DATA\*

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

### Notes and Warnings

Use this member function to set a callback function that will be called for each BLE device scan result found.

## BLEDevice::beginCentral

### Description

Start the BLE stack in central mode.

### Syntax

```
void beginCentral(uint8_t connCount);
```

### Parameters

connCount: maximum number of allowed connected devices. If no argument is provided, default to maximum allowed connected devices for specific board.

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

The function returns nothing.

### Notes and Warnings

Use this member function to start the device in BLE central mode, after other BLE parameters are set correctly.

## BLEDevice::beginPeripheral

### Description

Start the BLE stack in peripheral mode.

### Syntax

```
void beginPeripheral(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

Use this member function to start the device in BLE peripheral mode, after other BLE parameters are set correctly.

## BLEDevice::end

### Description

Stop the BLE stack.

### Syntax

```
void end(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Use this member function to stop the device operating in either BLE peripheral mode or BLE central mode.

## BLEDevice::configServer

### Description

Configure the BLE stack for services.

### Syntax

```
void configServer(uint8_t maxServiceCount);
```

### Parameters

maxServiceCount: Maximum number of services that will run on the device

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

## Notes and Warnings

Use this member function before adding any service to the BLE stack.

## BLEDevice::addService

### Description

Add a new service to the BLE stack.

### Syntax

```
void addService(BLEService& newService);
```

### Parameters

newService: the service to be added, defined using a BLEService class object.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

## Notes and Warnings

N/A

## BLEDevice::configClient

### Description

Configure the BLE stack for clients.

### Syntax

```
void configClient();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

Use this member function before adding any client to the BLE stack.

## BLEDevice::addClient

### Description

Add a new client to the BLE stack.

### Syntax

```
BLEClient* addClient(uint8_t connId);
```

### Parameters

connId: the connection ID of the connected device to create a client for.

### Returns

The function returns a pointer to a BLEClient class object, corresponding to the device with the specified connection ID, which can be used to access the services and characteristics on the connected device.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

Only one client should be added per connected device.

The BLEClient object and any service, characteristic, descriptor associated with the connected device will be deleted when the device is disconnected.

## **BLEDevice::getLocalAddr**

### **Description**

Get local device Bluetooth address.

### **Syntax**

```
void getLocalAddr(uint8_t (&addr)[GAP_BD_ADDR_LEN]);
```

### **Parameters**

addr: 6 byte array to store local device Bluetooth address.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Local device address is only available after starting in central or peripheral mode. This function will return all zeros for the address if central or peripheral mode is not in operation.

## **Class BLEHIDDevice**

### **BLEHIDDevice Class**

#### **Description**

A class used for creating and managing HID over GATT Profile (HOGP) services.

#### **Syntax**

```
class BLEHIDDevice
```

## Members

### Public Constructors

The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named BLEHIDDev.

Public Methods	
BLEHIDDevice::init	Initialize the HID Device Profile by creating the required services
BLEHIDDevice::setNumOutputReport	Configure the number of HID output reports
BLEHIDDevice::setNumInputReport	Configure the number of HID input reports
BLEHIDDevice::setReportMap	Configure the HID report map
BLEHIDDevice::inputReport	Send a HID input report
BLEHIDDevice::setOutputReportCallback	Set a user callback function for receiving HID output reports
BLEHIDDevice::bootKeyboardReport	Send a HID boot keyboard input report
BLEHIDDevice::setHidInfo	Set HID info of the HID service
BLEHIDDevice::setBattLevel	Set battery level info of the Battery service
BLEHIDDevice::setPNPInfo	Set PNP information of the Device Information service
BLEHIDDevice::setManufacturerString	Set manufacturer information of the Device Information service
BLEHIDDevice::setModelString	Set model information of the Device Information service
BLEHIDDevice::hidService	Get reference to HID service
BLEHIDDevice::devInfoService	Get reference to Device Information service
BLEHIDDevice::battService	Get reference to Battery service

### BLEHIDDevice::init

### Description

Initialize the HID Device profile by creating the required services.

### Syntax

```
void init(void);
```

### Parameters

The function requires no input parameter.



**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDGamepad

**Notes and Warnings**

The HID Device object should be initialized before any HID reports can be sent.

**BLEHIDDevice::setNumOutputReport****Description**

Configure the number of HID output reports.

**Syntax**

```
void setNumOutputReport (uint8_t numOutputReports);
```

**Parameters**

numOutputReports: number of output reports

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The number of output reports should be configured before BLEHIDDevice init() function is called.

**BLEHIDDevice::setNumInputReport****Description**

Configure the number of HID input reports.

### Syntax

```
void setNumInputReport (uint8_t numInputReports);
```

### Parameters

numInputReports: number of input reports

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The number of input reports should be configured before BLEHIDDevice init() function is called.

## BLEHIDDevice::setReportMap

### Description

Configure the HID report map characteristic with a HID report descriptor.

### Syntax

```
void setReportMap (uint8_t* report_map, uint16_t len);
```

### Parameters

report\_map: pointer to HID report descriptor

len: HID report descriptor length in bytes

### Returns

The function returns nothing.

## Example Code

Example: BLEHIDGamepad

## Notes and Warnings

The HID report map characteristic can only be configured after BLEHIDDevice init() function is called.

## BLEHIDDevice::inputReport

### Description

Send a HID input report.

### Syntax

```
void inputReport (uint8_t reportID, uint8_t* data, uint16_t len, uint8_t conn_id);
```

### Parameters

reportID: HID report ID of input report

data: pointer to HID input report data to send

len: length of HID input report data in bytes

conn\_id: connection ID of device to send HID report to

### Returns

The function returns nothing.

## Example Code

NA

## Notes and Warnings

HID input reports can only be sent after BLEHIDDevice init() function has been called.

## BLEHIDDevice::setOutputReportCallback

### Description

Set a user callback function for receiving HID output report data.

**Syntax**

```
void setOutputReportCallback (uint8_t reportID, void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

reportID: HID report ID of output report to link callback function with

chr: BLECharacteristic class object containing received HID output report data

conn\_id: connection ID of device which sent HID report data

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Setting a user callback function for output reports can only occur after BLEHIDDevice init() function has been called.

**BLEHIDDevice::bootKeyboardReport****Description**

Send a HID boot keyboard input report.

**Syntax**

```
void bootKeyboardReport (uint8_t* data, uint16_t len, uint8_t conn_id);
```

**Parameters**

data: pointer to HID input report data to send

len: length of HID input report data in bytes

conn\_id: connection ID of device to send HID report to

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

By default, the HID service Protocol Mode characteristic has boot mode disabled. To send boot keyboard input reports, the Protocol Mode characteristic needs to have boot mode enabled.

**BLEHIDDevice::setHidInfo****Description**

Set data of the HID Info characteristic of the HID service.

**Syntax**

```
void setHidInfo (uint16_t bcd, uint8_t country, uint8_t flags);
```

**Parameters**

bcd: 16-bit unsigned integer representing version number of base USB HID Specification implemented by HID Device

country: 8-bit integer identifying country HID Device hardware is localized for. Most hardware is not localized (value 0x00).

flags: Bit flags indicating remote-wake capability and advertising when bonded but not connected.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

For detailed information on the characteristic, refer to Bluetooth SIG HID Service specifications.

## **BLEHIDDevice::setBattLevel**

### **Description**

Set battery level data of the Battery service.

### **Syntax**

```
void setBattLevel (uint8_t level);
```

### **Parameters**

level: battery level expressed as % of full charge

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Battery level is set to 100% by default. For detailed information refer to Bluetooth SIG Battery service specifications.

## **BLEHIDDevice::setPNPInfo**

### **Description**

Set PNP data of the Device Information service.

### **Syntax**

```
void setPNPInfo (uint8_t sig, uint16_t vid, uint16_t pid, uint16_t version);
```

### **Parameters**

sig: The Vendor ID Source field designates which organization assigned the value used in the Vendor ID field value.

vid: The Vendor ID field is intended to uniquely identify the vendor of the device.

pid: The Product ID field is intended to distinguish between different products made by the vendor.

version: The Product Version field is a numeric expression identifying the device release number in Binary-Coded Decimal.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

By default, sig and vid are configured to indicate Realtek as the vendor. For detailed information refer to Bluetooth SIG Device Information service specifications.

## BLEHIDDevice::setManufacturerString

### Description

Set manufacturer information of the Device Information service.

### Syntax

```
void setManufacturerString (const char* manufacturer);
```

### Parameters

manufacturer: pointer to character string containing manufacturer name info.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Manufacturer is set to “Realtek” by default. For detailed information refer to Bluetooth SIG Device Information service specifications.

## **BLEHIDDevice::setModelString**

### **Description**

Set model information of the Device Information service.

### **Syntax**

```
void setModelString (const char* model);
```

### **Parameters**

model: pointer to character string containing device model info.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Model is set to “Ameba\_BLE\_HID” by default. For detailed information refer to Bluetooth SIG Device Information service specifications.

## **BLEHIDDevice::hidService**

### **Description**

Get reference to HID service

### **Syntax**

```
BLEService& hidService ();
```

### **Parameters**

The function requires no input parameter.



**Returns**

The function returns a reference to the BLEService class object for the HID service.

**Example Code**

Example: BLEHIDMouse

**Notes and Warnings**

NA

**BLEHIDDevice::devInfoService****Description**

Get reference to Device Information service

**Syntax**

```
BLEService& devInfoService ();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a reference to the BLEService class object for the Device Information service.

**Example Code**

Example: BLEHIDMouse

**Notes and Warnings**

NA

**BLEHIDDevice::battService****Description**

Get reference to Battery service

### Syntax

```
BLEService& battService ();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a reference to the BLEService class object for the Battery service.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## Class BLEHIDGamepad

### BLEHIDGamepad Class

#### Description

A class used for creating and managing a BLE HID Gamepad.

#### Syntax

```
class BLEHIDGamepad
```

#### Members

Public Constructors	
BLEHIDGamepad::BLEHIDGamepad	Constructs a BLEHIDGamepad object
Public Methods	
BLEHIDGamepad::setReportID	Set HID report ID for the HID Gamepad
BLEHIDGamepad::gamepadReport	Send a HID Gamepad report
BLEHIDGamepad::buttonPress	Send a HID Gamepad report indicating buttons pressed
BLEHIDGamepad::buttonRelease	Send a HID Gamepad report indicating buttons released
BLEHIDGamepad::buttonReleaseAll	Send a HID Gamepad report indicating no buttons pressed
BLEHIDGamepad::setHat	Send a HID Gamepad report indicating hat switch position
BLEHIDGamepad::setAxes	Send a HID Gamepad report indicating position of all axes
BLEHIDGamepad::setLeftStick	Send a HID Gamepad report indicating position of axes corresponding to left analog stick
BLEHIDGamepad::setRightStick	Send a HID Gamepad report indicating position of axes corresponding to right analog stick
BLEHIDGamepad::setTriggers	Send a HID Gamepad report indicating position of axes corresponding to triggers

## BLEHIDGamepad::BLEHIDGamepad

### Description

Constructs a BLE object

### Syntax

```
BLEHIDGamepad::BLEHIDGamepad();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

By default, the BLEHIDGamepad class assumes the HID report descriptor implements a gamepad device with 16 buttons, 6 16-bit axes and an 8-direction hat switch. This class will not work if a different gamepad report descriptor is implemented.

## BLEHIDGamepad::setReportID

### Description

Set HID report ID for the HID Gamepad.

### Syntax

```
void setReportID (uint8_t reportID);
```

### Parameters

reportID: The report ID for the gamepad device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

HID report ID should start at 1. Some systems may consider a report ID of 0 as invalid.

## BLEHIDGamepad::gamepadReport

### Description

Send a HID Gamepad report.

### Syntax

```
void gamepadReport (hid_gamepad_report_t* report);
void gamepadReport (uint16_t buttons, uint8_t hat, int16_t x, int16_t y, int16_t z, int16_t Rz, int16_t Rx, int16_t Ry);
```

### Parameters

report: pointer to gamepad report structure containing data on all inputs

buttons: bitmap indicating state of each button. 1 = pressed, 0 = released.

hat: position of hat switch. Valid values:

–GAMEPAD\_HAT\_CENTERED = 0

–GAMEPAD\_HAT\_UP = 1

–GAMEPAD\_HAT\_UP\_RIGHT = 2

–GAMEPAD\_HAT\_RIGHT = 3

–GAMEPAD\_HAT\_DOWN\_RIGHT = 4

–GAMEPAD\_HAT\_DOWN = 5

–GAMEPAD\_HAT\_DOWN\_LEFT = 6

–GAMEPAD\_HAT\_LEFT = 7

–GAMEPAD\_HAT\_UP\_LEFT = 8

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

## Notes and Warnings

NA

## BLEHIDGamepad::buttonPress

### Description

Send a HID Gamepad report indicating buttons pressed.

### Syntax

```
void buttonPress (uint16_t buttons);
```

### Parameters

buttons: bitmap indicating buttons pressed. 1 = pressed.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## BLEHIDGamepad::buttonRelease

### Description

Send a HID Gamepad report indicating buttons released.

### Syntax

```
void buttonRelease (uint16_t buttons);
```

### Parameters

buttons: bitmap indicating buttons released. 1 = released.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDGamepad::buttonReleaseAll****Description**

Send a HID Gamepad report indicating no buttons pressed.

**Syntax**

```
void buttonReleaseAll (void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDGamepad

**Notes and Warnings**

NA

## BLEHIDGamepad::setHat

### Description

Send a HID Gamepad report indicating hat switch position.

### Syntax

```
void setHat (uint8_t hat);
```

### Parameters

hat: position of hat switch. Valid values:

- GAMEPAD\_HAT\_CENTERED = 0
- GAMEPAD\_HAT\_UP = 1
- GAMEPAD\_HAT\_UP\_RIGHT = 2
- GAMEPAD\_HAT\_RIGHT = 3
- GAMEPAD\_HAT\_DOWN\_RIGHT = 4
- GAMEPAD\_HAT\_DOWN = 5
- GAMEPAD\_HAT\_DOWN\_LEFT = 6
- GAMEPAD\_HAT\_LEFT = 7
- GAMEPAD\_HAT\_UP\_LEFT = 8

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA



## BLEHIDGamepad::setAxes

### Description

Send a HID Gamepad report indicating position of all axes.

### Syntax

```
void setAxes (int16_t x, int16_t y, int16_t z, int16_t Rz, int16_t Rx, int16_t Ry);
```

### Parameters

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

NA

## BLEHIDGamepad::setLeftStick

### Description

Send a HID Gamepad report indicating position of axes corresponding to left analog stick.

### Syntax

```
void setLeftStick (int16_t x, int16_t y);
```

### Parameters

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDGamepad::setRightStick

### Description

Send a HID Gamepad report indicating position of axes corresponding to right analog stick.

### Syntax

```
void setLeftStick (int16_t z, int16_t Rz);
```

### Parameters

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDGamepad::setTriggers

### Description

Send a HID Gamepad report indicating position of axes corresponding to triggers.

### Syntax

```
void setTriggers (int16_t Rx, int16_t Ry);
```

### Parameters

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Class BLEHIDKeyboard

### BLEHIDKeyboard Class

#### Description

A class used for creating and managing a BLE HID Keyboard.

#### Syntax

```
class BLEHIDKeyboard
```

#### Members

<b>Public Constructors</b>	
BLEHIDKeybo ard::BLEHIDKeyboard	Constructs a BLEHIDKeyboard object
<b>Public Methods</b>	
BLEHIDKe yboard::setReportID	Set HID report ID for the HID Keyboard and HID consumer control
BLEHIDKeybo ard::consumerReport	Send a HID Consumer report
BLEHIDKeybo ard::keyboardReport	Send a HID Keyboard report
BLEHIDKeyb oard::consumerPress	Send a HID Consumer report indicating button pressed
BLEHIDKeyboa rd::consumerRelease	Send a HID Consumer report indicating button released
BLEHI DKeyboard::keypress	Send a HID Keyboard report indicating keys pressed
BLEHIDK eyboard::keyRelease	Send a HID Keyboard report indicating keys released
BLEHIDKeyb oard::keyReleaseAll	Send a HID Keyboard report indicating no keys pressed
BLEHIDKey board::keyCharPress	Send a HID Keyboard report indicating keys pressed to output an ASCII character
BLEHIDKe yboard::keySequence	Send a HID Keyboard report indicating keys pressed to output an ASCII string

## BLEHIDKeyboard::BLEHIDKeyboard

### Description

Constructs a BLEHIDKeyboard object.

### Syntax

```
BLEHIDKeyboard::BLEHIDKeyboard();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDKeyboard

## Notes and Warnings

NA

## BLEHIDKeyboard::setReportID

### Description

Set HID report ID for the HID Keyboard and HID consumer control.

### Syntax

```
void setReportID (uint8_t reportIDKeyboard, uint8_t reportIDConsumer);
```

### Parameters

reportIDKeyboard: The report ID for the HID keyboard device, corresponding to the HID report descriptor.

reportIDConsumer: The report ID for the HID consumer control device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## BLEHIDKeyboard::consumerReport

### Description

Send a HID Consumer report.

### Syntax

```
void consumerReport (uint16_t usage_code);
```

### Parameters

usage\_code: HID consumer control usage code for the button pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keyboardReport

### Description

Send a HID Keyboard report.

### Syntax

```
void keyboardReport (void);  
void keyboardReport (uint8_t modifiers, uint8_t keycode[6]);
```

### Parameters

modifiers: bitmap indicating key modifiers pressed (CTRL, ALT, SHIFT).  
keycode: byte array indicating keys pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::consumerPress

### Description

Send a HID Consumer report indicating button pressed.

### Syntax

```
void consumerPress (uint16_t usage_code);
```

### Parameters

usage\_code: HID consumer control usage code for the button pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::consumerRelease

### Description

Send a HID Consumer report indicating button released.

### Syntax

```
void consumerRelease (void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keypress

### Description

Send a HID Keyboard report indicating keys pressed.

### Syntax

```
void keyPress (uint16_t key);
```

### Parameters

key: HID keycode for key pressed, value ranges from 0x00 to 0xE7.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDKeyboard

### Notes and Warnings

NA

## BLEHIDKeyboard::keyRelease

### Description

Send a HID Keyboard report indicating keys released.

### Syntax

```
void keyRelease (uint16_t key);
```



**Parameters**

key: HID keycode for key pressed, value ranges from 0x00 to 0xE7.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDKeyboard::keyReleaseAll****Description**

Send a HID Keyboard report indicating no keys pressed.

**Syntax**

```
void keyReleaseAll(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDKeyboard

**Notes and Warnings**

NA

## BLEHIDKeyboard::keyCharPress

### Description

Send a HID Keyboard report indicating keys pressed to output an ASCII character.

### Syntax

```
void keyCharPress (char ch);
```

### Parameters

ch: ASCII character to output.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keySequence

### Description

Send a HID Keyboard report indicating keys pressed to output an ASCII string.

### Syntax

```
void keySequence (const char* str, uint16_t delayTime);  
void keySequence (String str, uint16_t delayTime);
```

### Parameters

str: pointer to character string to output

str: String object containing character string to output

delayTime: time delay between key press and release, in milliseconds. Default value of 5.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDKeyboard

**Notes and Warnings**

NA

**Class BLEHIDMouse****BLEHIDMouse Class****Description**

A class used for creating and managing a BLE HID Mouse.

**Syntax**

```
class BLEHIDMouse
```

**Members**

<b>Public Constructors</b>	
BLE HIDMouse::BLEHIDMouse	Constructs a BLEHIDMouse object
<b>Public Methods</b>	
BLE HIDMouse::setReportID	Set HID report ID for the HID Mouse
BLE HIDMouse::mouseReport	Send a HID Mouse report
BL EHIDMouse::mousePress	Send a HID Mouse report indicating buttons pressed
BLEH IDMouse::mouseRelease	Send a HID Mouse report indicating buttons released
BLEHIDM ouse::mouseReleaseAll	Send a HID Mouse report indicating no buttons pressed
B LEHIDMouse::mouseMove	Send a HID Mouse report indicating mouse movement
BLE HIDMouse::mouseScroll	Send a HID Mouse report indicating mouse scroll wheel movement

## **BLEHIDMouse::BLEHIDMouse**

### **Description**

Constructs a BLEHIDMouse object.

### **Syntax**

```
BLEHIDMouse::BLEHIDMouse();
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

Example: BLEHIDMouse

### **Notes and Warnings**

NA

## **BLEHIDMouse::setReportID**

### **Description**

Set HID report ID for the HID Mouse.

### **Syntax**

```
void setReportID (uint8_t reportID);
```

### **Parameters**

reportID: The report ID for the HID mouse device, corresponding to the HID report descriptor.

### **Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDMouse::mouseReport****Description**

Send a HID Mouse report.

**Syntax**

```
void mouseReport (hid_mouse_report_t* report);  
void mouseReport (uint8_t buttons, int8_t x, int8_t y, int8_t scroll);
```

**Parameters**

report: pointer to mouse report structure containing data on mouse inputs

buttons: bitmap indicating state of each button. 1 = pressed, 0 = released.

x: mouse x-axis movement. Integer value from -127 to 127.

y: mouse y-axis movement. Integer value from -127 to 127.

scroll: mouse scroll wheel movement. Integer value from -127 to 127.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## BLEHIDMouse::mousePress

### Description

Send a HID Mouse report indicating buttons pressed.

### Syntax

```
void mousePress (uint8_t buttons);
```

### Parameters

buttons: bitmap indicating buttons pressed. 1 = pressed.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::mouseRelease

### Description

Send a HID Mouse report indicating buttons released.

### Syntax

```
void mouseRelease (uint8_t buttons);
```

### Parameters

buttons: bitmap indicating buttons released. 1 = released.

### Returns

The function returns nothing.

**Example Code**

Example: BLEHIDMouse

**Notes and Warnings**

NA

**BLEHIDMouse::mouseReleaseAll****Description**

Send a HID Mouse report indicating no buttons pressed.

**Syntax**

```
void mouseReleaseAll(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDMouse::mouseMove****Description**

Send a HID Mouse report indicating mouse movement.

**Syntax**

```
void mouseMove (int8_t x, int8_t y);
```

### Parameters

x: mouse x-axis movement. Integer value from -127 to 127.

y: mouse y-axis movement. Integer value from -127 to 127.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::mouseScroll

### Description

Send a HID Mouse report indicating mouse scroll wheel movement.

### Syntax

```
void mouseScroll (int8_t scroll);
```

### Parameters

scroll: mouse scroll wheel movement. Integer value from -127 to 127.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA



## Class BLERemoteCharacteristic

### BLERemoteCharacteristic Class

#### Description

A class used for managing BLE GATT characteristics on connected remote devices.

#### Syntax

```
class BLERemoteCharacteristic
```

#### Members

Public Constructors
No public constructor is available for this class. You can get a pointer to an instance of this class using BLERemoteService::getCharacteristic().

Public Methods	
BLERemoteCharacteristic::getDescriptor	Get a specific descriptor on the remote device
BLERemoteCharacteristic::getUUID	Get the characteristic UUID
BLERemoteCharacteristic::setBufferLen	Set the size of the internal data buffer
BLERemoteCharacteristic::getBufferLen	Get the current size of the internal data buffer
BLERemoteCharacteristic::canRead	Determine if characteristic has read property enabled
BLERemoteCharacteristic::canWrite	Determine if characteristic has write property enabled
BLERemoteCharacteristic::canNotify	Determine if characteristic has notify property enabled
BLERemoteCharacteristic::canIndicate	Determine if characteristic has indicate property enabled
BLERemoteCharacteristic::getProperties	Get the characteristic properties
BLERemoteCharacteristic::readString	Read the characteristic data buffer as a String object
BLERemoteCharacteristic::readData8	Read the characteristic data buffer as an unsigned 8-bit integer
BLERemoteCharacteristic::readData16	Read the characteristic data buffer as an unsigned 16-bit integer
BLERemoteCharacteristic::readData32	Read the characteristic data buffer as an unsigned 32-bit integer
BLERemoteCharacteristic::writeString	Write data to the characteristic as a String object or character array
BLERemoteCharacteristic::writeData8	Write data to the characteristic as an unsigned 8-bit integer
BLERemoteCharacteristic::writeData16	Write data to the characteristic as an unsigned 16-bit integer
BLERemoteCharacteristic::writeData32	Write data to the characteristic as an unsigned 16-bit integer
BLERemoteCharacteristic::setData	Write data to the characteristic
BLERemoteCharacteristic::getData	Read data from the characteristic
BLERemoteCharacteristic::enableNotifyIndicate	Enable notification or indication for the characteristic
BLERemoteCharacteristic::disableNotifyIndicate	Disable notification and indication for the characteristic
BLERemoteCharacteristic::setNotifyCallback	Set a user function as a notification callback

## BLERemoteCharacteristic::getDescriptor

### Description

Get a descriptor with the specified UUID on the remote device.

### Syntax

```
BLERemoteDescriptor* getDescriptor(const char* uuid);
BLERemoteDescriptor* getDescriptor(BLEUUID uuid);
```

### Parameters

uuid: the desired descriptor UUID, expressed as a character array or a BLEUUID object

**Returns**

The function returns the found descriptor as a BLERemoteDescriptor object pointer, otherwise nullptr is returned if a descriptor with the UUID is not found.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::getUUID****Description**

Get the characteristic UUID.

**Syntax**

```
BLEUUID getUUID();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the characteristic UUID as a BLEUUID class object.

**Example Code**

NA

**Notes and Warnings**

NA

## BLERemoteCharacteristic::setBufferLen

### Description

Set the size of the internal data buffer of the characteristic.

### Syntax

```
void setBufferLen(uint16_t max_len);
```

### Parameters

max\_len: number of bytes to resize the internal buffer to.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartClient

### Notes and Warnings

Characteristic data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

## BLERemoteCharacteristic::getBufferLen

### Description

Get the size of the characteristic internal buffer.

### Syntax

```
uint16_t getBufferLen();
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns the currently set internal buffer size.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::canRead****Description**

Determine if characteristic has read property enabled.

**Syntax**

```
bool canRead();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns TRUE if the read property for the characteristic is enabled.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::canWrite**

### Description

Determine if characteristic has write property enabled.

### Syntax

```
bool canWrite();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns TRUE if the write property for the characteristic is enabled.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::canNotify

### Description

Determine if characteristic has notify property enabled.

### Syntax

```
bool canNotify();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns TRUE if the notify property for the characteristic is enabled.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::canIndicate****Description**

Determine if characteristic has indicate property enabled.

**Syntax**

```
bool canIndicate();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns TRUE if the indicate property for the characteristic is enabled.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::getProperties****Description**

Get the characteristic properties.

### Syntax

```
uint16_t getProperties();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the characteristic properties.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::readString

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as a String class object.

### Syntax

```
String readString();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic buffer expressed as a String class object.

### Example Code

Example: BLEUartClient



## Notes and Warnings

NA

## BLERemoteCharacteristic::readData8

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 8-bit integer.

### Syntax

```
uint8_t readData8();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic buffer expressed as a uint8\_t value.

### Example Code

Example: BLEBatteryClient

## Notes and Warnings

NA

## BLERemoteCharacteristic::readData16

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 16-bit integer.

### Syntax

```
uint16_t readData16();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic buffer expressed as a uint16\_t value.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::readData32

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 32-bit integer.

### Syntax

```
uint32_t readData32();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic buffer expressed as a uint32\_t value.

### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteCharacteristic::writeString

#### Description

Write data to the remote device characteristic as a String object or character array.

#### Syntax

```
bool writeString(String str);  
bool writeString(const char* str);
```

#### Parameters

str: the data to write to the remote characteristic, expressed as a String class object or a char array.

#### Returns

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteCharacteristic::writeData8

#### Description

Write data to the remote device characteristic as an unsigned 8-bit integer.

### Syntax

```
bool writeData8(uint8_t num);
```

### Parameters

num: the data to write to the characteristic buffer expressed as an unsigned 8-bit integer.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::writeData16

### Description

Write data to the remote device characteristic as an unsigned 16-bit integer.

### Syntax

```
bool writeData16(uint16_t num);
```

### Parameters

num: the data to write to the characteristic buffer expressed as an unsigned 16-bit integer.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::writeData32****Description**

Write data to the remote device characteristic as a 32-bit integer.

**Syntax**

```
bool writeData32(uint32_t num);
```

```
bool writeData32(int num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as a 32-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::setData****Description**

Write data to the remote device characteristic.

**Syntax**

```
bool setData(uint8_t* data, uint16_t datalen);
```

#### Parameters

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

#### Returns

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteCharacteristic::getData

#### Description

Request for characteristic data from the remote device and read the data in the buffer.

#### Syntax

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

#### Parameters

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

#### Returns

The function returns the number of bytes read.

#### Example Code

NA

### Notes and Warnings

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

## BLERemoteCharacteristic::enableNotifyIndicate

### Description

Enable the remote device to send notifications or indications for the characteristic.

### Syntax

```
void enableNotifyIndicate(bool notify = 1);
```

### Parameters

notify: TRUE to enable notifications, FALSE to enable indications.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartClient

### Notes and Warnings

NA

## BLERemoteCharacteristic::disableNotifyIndicate

### Description

Disable receiving notifications and indications for the characteristic from the remote device.

### Syntax

```
void disableNotifyIndicate();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::setNotifyCallback

### Description

Set a user function to be called when the characteristic receives a notification from the remote device.

### Syntax

```
void setNotifyCallback(void (*fCallback) (BLERemoteCharacteristic* chr, uint8_t* data, uint16_t length));
```

### Parameters

fCallback: A user callback function that returns void and takes three arguments.

chr: pointer to BLERemoteCharacteristic object associated with notification.

data: pointer to byte array containing notification data.

length: number of bytes of notification data in array.

### Returns

The function returns nothing.



## Example Code

Example: BLEUartClient

## Notes and Warnings

NA

## Class BLERemoteDescriptor

### BLERemoteDescriptor Class

#### Description

A class used for managing BLE GATT descriptors on connected remote devices.

#### Syntax

```
class BLERemoteDescriptor
```

#### Members

##### Public Constructors

No public constructor is available for this class. You can get a pointer to an instance of this class using `BLERemoteCharacteristic::getDescriptor()`.

Public Methods	
<code>BLERemoteDescriptor::getUUID</code>	Get the descriptor UUID
<code>BLERemoteDescriptor::setBufferLen</code>	Set the size of the internal data buffer
<code>BLERemoteDescriptor::getBufferLen</code>	Get the current size of the internal data buffer
<code>BLERemoteDescriptor::readString</code>	Read the descriptor data buffer as a String object
<code>BLERemoteDescriptor::readData8</code>	Read the descriptor data buffer as an unsigned 8-bit integer
<code>BLERemoteDescriptor::readData16</code>	Read the descriptor data buffer as an unsigned 16-bit integer
<code>BLERemoteDescriptor::readData32</code>	Read the descriptor data buffer as an unsigned 32-bit integer
<code>BLERemoteDescriptor::writeString</code>	Write data to the descriptor as a String object or character array
<code>BLERemoteDescriptor::writeData8</code>	Write data to the descriptor as an unsigned 8-bit integer
<code>BLERemoteDescriptor::writeData16</code>	Write data to the descriptor as an unsigned 16-bit integer
<code>BLERemoteDescriptor::writeData32</code>	Write data to the descriptor as an unsigned 16-bit integer
<code>BLERemoteDescriptor::setData</code>	Write data to the descriptor
<code>BLERemoteDescriptor::getData</code>	Read data from the descriptor

## **BLERemoteDescriptor::getUUID**

### **Description**

Get the descriptor UUID.

### **Syntax**

```
BLEUUID getUUID();
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns the descriptor UUID as a BLEUUID class object.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **BLERemoteDescriptor::setBufferLen**

### **Description**

Set the size of the internal data buffer of the descriptor.

### **Syntax**

```
void setBufferLen(uint16_t max_len);
```

### **Parameters**

max\_len: number of bytes to resize the internal buffer to.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Descriptor data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

**BLERemoteDescriptor::getBufferLen****Description**

Get the size of the descriptor internal buffer.

**Syntax**

```
uint16_t getBufferLen();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the currently set internal buffer size.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::readString**

### Description

Request for descriptor data from the remote device and read the data in the buffer, expressed as a String class object.

### Syntax

```
String readString();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the descriptor buffer expressed as a String class object.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::readData8

### Description

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 8-bit integer.

### Syntax

```
uint8_t readData8();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the descriptor buffer expressed as a uint8\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::readData16****Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 16-bit integer.

**Syntax**

```
uint16_t readData16();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a uint16\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::readData32**

**Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 32-bit integer.

**Syntax**

```
uint32_t readData32();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a uint32\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::writeString****Description**

Write data to the remote device descriptor as a String object or character array.

**Syntax**

```
bool writeString(String str);  
bool writeString(const char* str);
```

**Parameters**

str: the data to write to the remote descriptor, expressed as a String class object or a char array.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::writeData8****Description**

Write data to the remote device descriptor as an unsigned 8-bit integer.

**Syntax**

```
bool writeData8(uint8_t num);
```

**Parameters**

num: the data to write to the descriptor buffer expressed as an unsigned 8-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::writeData16**

### Description

Write data to the remote device descriptor as an unsigned 16-bit integer.

### Syntax

```
bool writeData16(uint16_t num);
```

### Parameters

num: the data to write to the descriptor buffer expressed as an unsigned 16-bit integer.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::writeData32

### Description

Write data to the remote device descriptor as a 32-bit integer.

### Syntax

```
bool writeData32(uint32_t num);  
bool writeData32(int num);
```

### Parameters

num: the data to write to the descriptor buffer expressed as a 32-bit integer.

### Returns



The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::setData****Description**

Write data to the remote device descriptor.

**Syntax**

```
bool setData(uint8_t* data, uint16_t datalen);
```

**Parameters**

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::getData**

**Description**

Request for descriptor data from the remote device and read the data in the buffer.

**Syntax**

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

**Parameters**

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

**Returns**

The function returns the number of bytes read.

**Example Code**

NA

**Notes and Warnings**

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

**Class BLERemoteService****BLERemoteService Class****Description**

A class used for managing BLE GATT services on connected remote devices.

**Syntax**

```
class BLERemoteService
```

**Members**

**Public Constructors**

No public constructor is available for this class. You can get a pointer to an instance of this class using BLE-Client::getService().

Public Methods	
BLERemoteService::getUUID	Get the service UUID
BLE RemoteService::getCharacteristic	Get a specific characteristic on the remote device

**BLERemoteService::getUUID****Description**

Get the service UUID.

**Syntax**

```
BLEUUID getUUID();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the service UUID as a BLEUUID class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteService::getCharacteristic****Description**

Get a characteristic with the specified UUID on the remote device.

**Syntax**

```
BLERemoteCharacteristic* getCharacteristic (const char* uuid);  
BLERemoteCharacteristic* getCharacteristic (BLEUUID uuid);
```

**Parameters**

uuid: the desired characteristic UUID, expressed as a character array or a BLEUUID object.

**Returns**

The function returns the found characteristic as a BLERemoteCharacteristic object pointer, otherwise nullptr is returned if a characteristic with the UUID is not found.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

**Class BLEScan****BLEScan Class****Description**

A class used for managing BLE scanning settings.

**Syntax**

```
class BLEScan
```

**Members**

Public Constructors
No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using BLEDevice::configScan

Public Methods	
BLEScan::updateScanParams	Update the current BLE advertisement settings to the lower Bluetooth stack
BLEScan::startScan	Start a BLE scan
BLEScan::stopScan	Stop a BLE scan
BLEScan::setScanMode	Set the BLE scanning mode
BLEScan::setScanInterval	Set the BLE scanning interval
BLEScan::setScanWindow	Set the BLE scanning window
BLEScan::setScanDuplicateFilter	Set the BLE scan duplicate filter
BLEScan::scanInProgress	Check if a scan is currently in progress
BLEScan::printScanInfo	Print out scanned information

**BLEScan::updateScanParams****Description**

Update the lower Bluetooth stack with the current scan settings.

**Syntax**

```
void updateScanParams(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

Stop any scans in progress first before using this function.

**BLEScan::startScan**

### Description

Start BLE scanning.

### Syntax

```
void startScan();  
void startScan(uint32_t scanDuration_ms);
```

### Parameters

scanDuration: BLE scan will stop after scanDuration milliseconds.

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

### Notes and Warnings

Set the scan parameters first before starting a scan. BLE scans will occur continuously for the duration set with `BLEDevice::setScanWindow()` and will repeat with a time interval set with `BLEDevice::setScanInterval()`. Call this member function without an argument to start scanning until `BLEDevice::stopScan()` is called.

## BLEScan::stopScan

### Description

Stop BLE scanning.

### Syntax

```
void stopScan(void);
```

### Parameters

The function requires no input paramter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEScan::setScanMode****Description**

Set the BLE scan mode.

**Syntax**

```
void setScanMode(uint8_t scanMode);
```

**Parameters**

scanMode: GAP\_SCAN\_MODE\_PASSIVE for passive scanning, GAP\_SCAN\_MODE\_ACTIVE for active scanning

**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

Active scanning will request for scan response packets after discovering an advertising device. Passive scanning will only capture advertising data packets.

## **BLEScan::setScanInterval**

### **Description**

Set the BLE scan interval.

### **Syntax**

```
void setScanInterval(uint16_t scanInt_ms);
```

### **Parameters**

scanInt\_ms: scan interval in milliseconds. Value range of 3 to 10240.

### **Returns**

The function returns nothing.

### **Example Code**

Example: BLEScan

### **Notes and Warnings**

A BLE scan will repeat with a time interval set with this member function.

## **BLEScan::setScanWindow**

### **Description**

Set the BLE scan window.

### **Syntax**

```
void setScanWindow(uint16_t scanWindow_ms);
```

### **Parameters**

scanWindow\_ms: scan window in milliseconds. Value range of 3 to 10240.



**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

A BLE scan will scan continuously for a window duration set with this member function. The scan window should be less than or equal to the scan interval.

**BLEScan::setScanDuplicateFilter****Description**

Set the scan duplicate filter.

**Syntax**

```
void setScanDuplicateFilter(bool dupeFilter);
```

**Parameters**

dupeFilter: TRUE to enable duplicate filtering.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Enabling duplicate filters will ignore scan results for devices already discovered previously.

## **BLEScan::scanInProgress**

### **Description**

Set the scan duplicate filter.

### **Syntax**

```
bool scanInProgress(void);
```

### **Parameters**

The function requires no input paramter.

### **Returns**

TRUE if BLE scanning is in progress.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **BLEScan::printScanInfo**

### **Description**

Parse and print out scanned information.

### **Syntax**

```
void printScanInfo(T_LE_CB_DATA* p_data);
```

### **Parameters**

p\_data: pointer to scan data of type T\_LE\_CB\_DATA\*

## Returns

The function returns nothing.

## Example Code

Example: BLEScan

## Notes and Warnings

Use this member function to parse the various fields of received advertisement data packets and print the results out to the serial monitor.

## Class BLEService

### BLEService Class

### Description

A class used for creating and managing BLE GATT services.

### Syntax

```
class BLEService
```

### Members

Public Constructors	
BLEService::BLEService	Constructs a BLEService object
Public Methods	
BLEService::setUUID	Set service UUID
BLEService::getUUID	Get service UUID
BLEService::addCharacteristic	Add a characteristic to service
BLEService::getCharacteristic	Get a previously added characteristic

### BLEService::BLEService

### Description

Constructs a BLEService object.

### Syntax

```
BLEService::BLEService(BLEUUID uuid);  
BLEService::BLEService(const char* uuid);
```

### Parameters

uuid: service UUID, expressed as a BLEUUID class object or a character array

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLEService::setUUID

### Description

Set the service UUID.

### Syntax

```
void setUUID(BLEUUID uuid);
```

### Parameters

uuid: service UUID, expressed as a BLEUUID class object.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEService::getUUID

### Description

Get the service UUID.

### Syntax

```
BLEUUID getUUID();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the service UUID in a BLEUUID class object.

### Example Code

NA

### Notes and Warnings

NA

## BLEService::addCharacteristic

### Description

Add a characteristic to the service.

### Syntax

```
void addCharacteristic(BLECharacteristic& newChar);
```

### Parameters

newChar: the BLECharacteristic to add to the service.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLEService::getCharacteristic

### Description

Get a previously added characteristic.

### Syntax

```
BLECharacteristic* getCharacteristic(uint8_t charIndex);
```

### Parameters

charIndex: position index of characteristic.

### Returns

The function returns a pointer to the BLECharacteristic at the requested position index.

### Example Code

NA

**Notes and Warnings**

NA

**Class BLEUUID****BLEUUID Class****Description**

A class used for creating and managing UUIDs.

**Syntax**

```
class BLEUUID
```

**Members**

<b>Public Constructors</b>	
BLEUUID::BLEUUID	Create a UUID object
<b>Public Methods</b>	
BLEUUID::str	Get the character string representation of UUID
BLEUUID::data	Get the binary representation of UUID
BLEUUID::length	Get the length of UUID

**BLEUUID::BLEUUID****Description**

Create a UUID object from a UUID character string

**Syntax**

```
BLEUUID();
BLEUUID(const char* str);
BLEUUID(uint8_t* data, uint8_t length);
```

**Parameters**

str: UUID character string used to created object

data: pointer to byte array containing the desired UUID

length: number of bytes in array containing the desired UUID. Valid values of 2, 4 or 16

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

## BLEUUID::str

### Description

Get the character string representation of UUID

### Syntax

```
const char* str(void);
```

### Parameters

The function requires no input parameter.

### Returns

Pointer to a character string representation of the UUID

### Example Code

NA

### Notes and Warnings

## BLEUUID::data



**Description**

Get the binary representation of UUID

**Syntax**

```
const uint8_t* data(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Pointer to an unsigned 8-bit integer array containing the UUID expressed in binary form

**Example Code**

NA

**Notes and Warnings**

Returned pointer is of const uint8\_t\* type and will not allow changing of the data.

**BLEUUID::length****Description**

Get the length of UUID

**Syntax**

```
uint8_t length(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Length of the UUID, in terms of bytes

## Example Code

NA

## Notes and Warnings

A 4-character UUID will be 16 bits / 2 bytes long.

A 32-character UUID will be 128 bits / 16 bytes long.

## Class BLEWifiConfigService

### BLEWifiConfigService Class

#### Description

A class used for managing a BLE WiFi configuration service running on the device.

#### Syntax

```
class BLEWifiConfigService
```

#### Members

Public Constructors	
BLEWifiCon figService::BLEWifiConfigService	Only one instance of this class should be created

Public Methods	
BLEWifiConfigService::begin	Start background thread to process WiFi configuration commands
BLEWifiConfigService::end	Stop background thread processing WiFi configuration commands
BLEWifiConfigService::addService	Add the service to the BLE stack
BLEWifiConfigService::advData	Get advertising data correctly formatted for WiFi configuration service

### BLEWifiConfigService::BLEWifiConfigService

#### Description

Create an instance of the BLEWifiConfigService object.

#### Syntax

```
void BLEWifiConfigService ();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEWifiConfig

**Notes and Warnings**

Only one instance of this class / service should be created.

**BLEWifiConfigService::begin****Description**

Start background thread to process WiFi configuration commands.

**Syntax**

```
void begin();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEWifiConfig

## Notes and Warnings

NA

## BLEWifiConfigService::end

### Description

Stop background thread processing WiFi configuration commands.

### Syntax

```
void end();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

## Example Code

NA

## Notes and Warnings

NA

## BLEWifiConfigService::addService

### Description

Add the WiFi configuration service to the BLE stack.

### Syntax

```
void addService();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEWifiConfig

**Notes and Warnings**

NA

**BLEWifiConfigService::advData****Description**

Get advertising data correctly formatted for WiFi configuration service.

**Syntax**

```
BLEAdvertData advData();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a BLEAdvertData object that contains the required advertising data fields for the WiFi configuration service to work.

**Example Code**

Example: BLEWifiConfig

**Notes and Warnings**

The advertisement data needs to be correctly formatted for the corresponding smartphone app to recognise the device. WiFi configuration service advertisement data requires the local BT address, and should be called only after peripheral mode is started and may also require stopping and restarting the advertising process.

## EPDIF

### Class EpdIF

#### EpdIf Class

#### Description

A class used to control the electronic paper display internal functions.

#### Syntax

```
class EpdIf
```

#### Members

##### Public Constructors

A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named EpdIf.

##### Public Methods

Epdlf::EPD_Dis_Part	Put an image buffer to the frame memory, but not updating the display
Epdlf::EPD_SetFrame	Put display data to the frame memory, usually used for setup text display functions
Epdlf::EPD_SetRAMValue_BaseMap	To read image data stored in the RAM, but not display on the screen
Epdlf::EPD_SetFrameMemory	To read image data stored in the buffer, but not display on the screen
Epdlf::EPD_UpdateDisplay	Update the display
Epdlf::EPD_ClearScreen_White	Clear the frame memory with the White color, but not updating the display
Epdlf::EPD_ClearScreen_Black	Clear the frame memory with the Black color, but not updating the display
Epdlf::EPD_Busy	Wait until the Busy pin goes to low, which is the idle state
Epdlf::EPD_Reset	Used for the Epaper module reset. Often used to awaken the module in deep sleep
Epdlf::EPD_Sleep	After this command is transmitted, the chip would enter the deep-sleep mode to save power

**EpdIf:: EPD\_Dis\_Part****Description**

Put an image buffer to the frame memory, but not updating the display.

**Syntax**

```
void EPD_Dis_Part(unsigned int x_start, unsigned int y_start, const unsigned char* datas, unsigned int PART_COLUMN, unsigned int PART_LINE);
```

**Parameters**

x\_start: starting position of the x-axis

y\_start: starting position of the y-axis

datas: data to be displayed on the e-paper module

PART\_COLUMN: height of the display area

PART\_LINE: width of the display area

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**EpdIf:: EPD\_SetFrame****Description**

Put display data to the frame memory, usually used for setup text display functions.

**Syntax**

```
void EPD_SetFrame(const unsigned char* image_buffer, int x, int y, int image_width, int image_height);
```

### Parameters

image\_buffer: the buffer which stores the data to be displayed on the e-paper module, usually used to display texts.

x: starting position of the x-axis

y: starting position of the y-axis

image\_width: width of the display area

image\_height: height of the display area

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### EpdIf:: EPD\_SetRAMValue\_BaseMap

### Description

To read image data stored in the RAM, but not display on the screen.

### Syntax

```
void EPD_SetRAMValue_BaseMap(const unsigned char* datas);
```

### Parameters

datas: contains the black and white information that forms the image stored in RAM

### Returns

The function returns nothing.

### Example Code

NA



**Notes and Warnings**

NA

**EpdIf:: EPD\_SetFrameMemory****Description**

To read image data stored in the buffer but not display on the screen.

**Syntax**

```
void EPD_SetFrameMemory(const unsigned char* image_buffer);
```

**Parameters**

image\_buffer: the buffer where stores the image data in hexadecimal numbers

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**EpdIf:: EPD\_UpdateDisplay****Description**

Update the ePaper display module. Always combined used with functions set the frames.

**Syntax**

```
void EPD_UpdateDisplay(void);
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

There are 2 memory areas embedded in the e-paper display but once this function is called, then the next action of SetFrameMemory or ClearScreen will set the other memory area.

### EpdIf:: EPD\_ClearScreen\_White

### Description

Clear the frame memory with the White color.

### Syntax

```
void EpdIf::EPD_ClearScreen_White(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

**EpdIf:: EPD\_ClearScreen\_Black****Description**

Clear the frame memory with the Black color.

**Syntax**

```
void EpdIf::EPD_ClearScreen_Black(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

**EpdIf:: EPD\_Busy****Description**

Wait until the busy\_pin goes to low, which is the idle state.

**Syntax**

```
void EpdIf::EPD_Busy(void);
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

### EpdIf:: EPD\_Reset

#### Description

This command will let the E-paper module reset, it is often used to awaken the module in while it' s in the deep sleep mode, you will find more details in the function EpdIf:: EPD\_Sleep().

#### Syntax

```
void EpdIf::EPD_Reset(void);
```

#### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### EpdIf::EPD\_Sleep

**Description**

After this command is transmitted, the chip would enter the deep-sleep mode to save power. The deep sleep mode would return to standby by hardware reset. You can use EPD::Init() to awaken the E-paper module.

**Syntax**

```
void EpdIf::EPD_Sleep(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

---

**FatfsSDCard****Class SdFatFs****Description**

Defines a class of SD FAT File system.

**Syntax**

```
class SdFatFs
```

**Members****Public Constructors**

SdFatFs::SdFatFs Constructs a SdFatFs object

SdFatFs::~~SdFatFs Destructs a SdFatFs object

**Public Methods**

SdFatFs::begin	Initialize SD FAT File System
SdFatFs::end	Deinitialize SD FAT File System
SdFatFs::*getRootPath	Get the root path of the SD FAT File System
SdFatFs::readDir	List items under a specific folder
SdFatFs::mkdir	Create folder
SdFatFs::rm	Remove folder or file
SdFatFs::isDir	Check if a specific path is a directory
SdFatFs::isFile	Check if a specific path is a file
SdFatFs::getLastModTime	Get the last modified time for a file or directory
SdFatFs::setLastModTime	Set the last modified time for a file or directory
SdFatFs::status	Return the current status of SD
SdFatFs::open	Open a file

**SdFatFs::begin****Description**

Initialize SD FAT File System.

**Syntax**

```
int SdFatFs::begin(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::end****Description**

De-initialize SD FAT File System.

**Syntax**

```
int SdFatFs::end(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::\*getRootPath****Description**

Get the root path of the SD FAT File System. The logical volume character is starting from ‘0’, so the root path would like “0:” .

**Syntax**

```
char *SdFatFs::getRootPath(void);
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns the root path.

### Example Code

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::readDir

### Description

List items under a specific folder. List items under a specific folder and store the result in the buffer that user specified. Each item is separated by ‘0’ .

### Syntax

```
int SdFatFs::readDir(char *path, char *result_buf, unsigned int bufsize);
```

### Parameters

path: The absolute directory path to be listed.

result\_buf: The buffer to be stored results.

bufsize: The size of result\_buf. If results exceed this size, then the results larger than this size would be discarded.

### Returns

Returns “0” if success, else returns a negative value.

### Example Code

Example: get\_file\_attribute; list\_root\_files

### Notes and Warnings

Include “SdFatFs.h” to use the class function.



## **SdFatFs::mkdir**

### **Description**

Create folder.

### **Syntax**

```
int SdFatFs::mkdir(char *absolute_path);
```

### **Parameters**

absolute\_path: The absolute directory path to be created

### **Returns**

Returns “0” if success, else returns a negative value.

### **Example Code**

Example: create\_folder

### **Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## **SdFatFs::rm**

### **Description**

Remove folder or file.

### **Syntax**

```
int SdFatFs::rm(char *absolute_path);
```

### **Parameters**

absolute\_path: The absolute directory or file path to be deleted

### Returns

Returns “0” if success, else returns a negative value.

### Example Code

NA

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

### SdFatFs::isDir

#### Description

Check if a specific path is a directory.

#### Syntax

```
unsigned char SdFatFs::isDir(char *absolute_path);
```

#### Parameters

absolute\_path: The absolute path to be queried

#### Returns

The function returns “1” if it is a directory, else returns “0” .

### Example Code

Example: get\_file\_attribute

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

### SdFatFs::isFile

**Description**

Check if a specific path is a file.

**Syntax**

```
unsigned char SdFatFs::isFile(char *absolute_path);
```

**Parameters**

absolute\_path: The absolute path to be queried

**Returns**

The function returns “1” if it is a directory, else returns “0” .

**Example Code**

Example: get\_file\_attribute

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::getLastModTime****Description**

Get the last modified time for a file or directory.

**Syntax**

```
int SdFatFs::getLastModTime(char *absolute_path, uint16_t *year, uint16_t *month, uint16_t *date, uint16_t *hour, uint16_t *minute, uint16_t *second);
```

**Parameters**

absolute\_path: The absolute path to be queried.

year: The value of the year.

month: The value of the month.

date: The value of the date.

hour: The value of an hour.

minute: The value of a minute.

second: field “second” contains no valid information in the current version.

### Returns

The function returns “0” if success, otherwise returns a negative value for failure.

### Example Code

Example: last\_modified\_time

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::setLastModTime

### Description

Set the last modified time for a file or directory. Ameba doesn't have built-in RTC. So we manually change file/directory last modified time.

### Syntax

```
int SdFatFs::setLastModTime(char *absolute_path, uint16_t year, uint16_t month, uint16_t date, uint16_t hour,
uint16_t minute, uint16_t second);
```

### Parameters

absolute\_path: The absolute path to be queried.

year: The value of the year.

month: The value of the month.

date: The value of the date.

hour: The value of an hour.

minute: The value of a minute.

second: field “second” contains no valid information in the current version.

**Returns**

The function returns “0” if success, otherwise returns a negative value for failure.

**Example Code**

Example: last\_modified\_time

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::open****Description**

Open a file.

**Syntax**

```
SdFatFile SdFatFs::open(char *absolute_path);
```

**Parameters**

absolute\_path: The path to a file.

**Returns**

The file object is an instance of SdFatFile.

**Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::status**

### Description

Return the current status of SD.

### Syntax

```
int SdFatFs::status(void);
```

### Parameters

The function requires no input parameter.

### Returns

Function returns “1” if ready to use, else return “0” if the status is inactivating or abnormal.

### Example Code

NA.

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## Class SdFatFile

### Description

Defines a class of SD FAT File.

### Syntax

```
class SdFatFile
```

### Members

<b>Public Constructors</b>	
<code>SdFatFile::SdFatFile</code>	Constructs a <code>SdFatFile</code> object
<code>SdFatFile::~SdFatFile</code>	Destructs a <code>SdFatFile</code> object
<b>Public Methods</b>	
<code>SdFatFile::write</code>	Write 1 byte/bytes to file
<code>SdFatFile::read</code>	Read 1 byte/bytes from the file
<code>SdFatFile::peek</code>	Read 1 byte from file without move curser
<code>SdFatFile::available</code>	Check if the cursor is at EOF (End-Of-File)
<code>SdFatFile::bool</code>	Check if file is opened
<code>SdFatFile::seek</code>	Change cursor to a specific position
<code>SdFatFile::close</code>	Close file

**SdFatFile::write****Description**

Write 1 byte or bytes to the file.

**Syntax**

```
size_t SdFatFile::write(uint8_t c);
size_t SdFatFile::write(const uint8_t *buf, size_t size);
```

**Parameters**

`c`: The character to be written.

`buf`: The buffer to be written.

`size`: The length of buffer to be written.

**Returns**

The function returns the number of byte count that has been successfully written to the file.

**Example Code**

NA.

**Notes and Warnings**

Include “`SdFatFile.h`” to use the class function.

**SdFatFile:: read****Description**

Read 1 byte or bytes from the file.

**Syntax**

```
int SdFatFile::read(void);
```

```
int SdFatFile::read(void *buf, uint16_t nbyte);
```

**Parameters**

buf: The buffer to store the content.

nbyte: The buffer size. (Or can be regarded as the desired length to read).

**Returns**

The function returns a read character or the read size of the buffer.

**Example Code**

```
1. #include 「FatFs_SD.h」  
2.  
3. char dirname[] = 「testdir」 ;  
4. char filename[] = 「test.txt」 ;  
5. char write_content[] = 「hello world!」 ;  
6.  
7. FatFsSD fs;  
8.  
9. void setup() {  
10. char buf[128];  
11. char absolute_filename[128];  
12.  
13. fs.begin();  
14.
```



```

15. sprintf(absolute_filename, 「%s%s」 , fs.getRootPath(), dirname);
16. fs.mkdir(absolute_filename);
17. printf(「create dir at \」 %s”rn」 , absolute_filename);
18.
19. sprintf(absolute_filename, 「%s%s/%s」 , fs.getRootPath(), dirname, filename);
20. SdFatFile file = fs.open(absolute_filename);
21. file.println(write_content);
22. file.close();
23. printf(「create file at \」 %s”rn」 , absolute_filename);
24.
25. printf(「read back from \」 %s”rn」 , absolute_filename);
26. file = fs.open(absolute_filename);
27.
28. memset(buf, 0, sizeof(buf));
29. file.read(buf, sizeof(buf));
30.
31. file.close();
32. printf(「==== content ====rn」 );
33. printf(「%s」 , buf);
34. printf(「==== end ====rn」 );
35.
36. fs.end();
37. }
38.
39. void loop() {
40. delay(1000);
41. }
42.

```

Example: create\_folder;

This example shows how to create a folder and open a file under it.

```
1. #include 「FatFs_SD.h」
2.
3. char filename[] = 「test.txt」 ;
4. char write_content[] = 「hello world!」 ;
5.
6. FatFsSD fs;
7.
8. void setup() {
9.   char buf[128];
10.  char absolute_filename[128];
11.
12.  fs.begin();
13.
14.  printf( 「write something to \」 %s”rn」 , filename);
15.  sprintf(absolute_filename, 「%s%s」 , fs.getRootPath(), filename);
16.  SdFatFile file = fs.open(absolute_filename);
17.
18.  file.println(write_content);
19.
20.  file.close();
21.  printf( 「write finishrn」 );
22.
23.  printf( 「read back from \」 %s”rn」 , filename);
24.  file = fs.open(absolute_filename);
25.
26.  memset(buf, 0, sizeof(buf));
27.  file.read(buf, sizeof(buf));
28.
```

```
29. file.close();
30. printf(「==== content ====rn」);
31. printf(「%s」, buf);
32. printf(「==== end ====rn」);
33.
34. fs.end();
35. }
36.
37. void loop() {
38.   delay(1000);
39. }
40.
```

Example: file\_read\_write;

This example shows how to open/close files and perform read/write to it.

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: peek

#### Description

Read one byte from the file without moving the curser.

#### Syntax

```
int SdFatFile::peek(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the read character as an integer number.

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: available

#### Description

Check if the cursor is at EOF.

#### Syntax

```
int SdFatFile::available(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns “0” if the cursor is at EOF, else returns “1” .

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: flush

#### Description

It is a nop. This is an inherited function from class Stream. And it does not affect SD File.

**Syntax**

```
void SdFatFile::flush(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “SdFatFile.h” to use the class function.

**SdFatFile:: seek****Description**

Change cursor to a specific position.

**Syntax**

```
int SdFatFile::seek(uint32_t pos);
```

**Parameters**

pos: The desired position.

**Returns**

The function returns 0 if success otherwise returns a negative value.

**Example Code**

NA

## Notes and Warnings

Include “SdFatFile.h” in order to use the class function.

## SdFatFile:: close

### Description

Close file.

### Syntax

```
int SdFatFile::close(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns 0 if runs successfully otherwise it returns a negative value.

### Example Code

Example: last\_modified\_time;

The example shows how to get and set last modified time of a file.

Example: create\_folder;

This example shows how to create a folder and open a file under it. The details of the code can be found in the section of SdFatFile:: read.

Example: file\_read\_write;

This example shows how to open/close files and perform read/write to it. The details of the code can be found in the section of SdFatFile:: read.

1. #include <FatFs\_SD.h>
- 2.
3. FatFsSD fs;
- 4.
5. char filename[] = 「test.txt」 ;

```
6.
7. void setup() {
8.   char absolute_filename[128];
9.
10.  uint16_t year = 2021;
11.  uint16_t month = 4;
12.  uint16_t date = 4;
13.  uint16_t hour = 12;
14.  uint16_t minute = 12;
15.  uint16_t second = 12;
16.
17.  fs.begin();
18.
19.  sprintf(absolute_filename, 「%s%s」, fs.getRootPath(), filename);
20.  SdFatFile file = fs.open(absolute_filename);
21.  file.close();
22.
23.  fs.setLastModTime(absolute_filename, year, month, date, hour, minute, second);
24.
25.  fs.getLastModTime(absolute_filename, &year, &month, &date, &hour, &minute, &second);
26.  printf(「filename:」"%s"rn」, absolute_filename);
27.  printf(「time mod:%04d/%02d/%02d %02d:%02d:%02drn」, year, month, date, hour, minute, second);
28.
29.  fs.end();
30. }
31.
32. void loop() {
33.   delay(1000);
34. }
35.
```

## Notes and Warnings

Include “SdFatFile.h” in order to use the class function.

---

## FlashMemory

### Class EpdIF

#### FlashMemoryClass Class

#### Description

Defines a class of Flash memory API

#### Syntax

```
class FlashMemoryClass
```

#### Members

Public Constructors	
FlashMemoryClass::FlashMemoryClass	Constructs a FlashMemoryClass object
FlashMemoryClass::~FlashMemoryClass	Deconstructs a FlashMemoryClass object
Public Methods	
FlashMemoryClass::begin	Initialize/Re-initialize the base address and size
FlashMemoryClass::read	Read the content to buf
FlashMemoryClass::update	Write buf back to flash memory
FlashMemoryClass::readWord	Read 4 bytes from flash memory
FlashMemoryClass::writeWord	Write 4 bytes into flash memory
FlashMemoryClass::buf_size	The buf size
FlashMemoryClass::*buf	The buf to be operated

#### FlashMemoryClass::FlashMemoryClass

#### Description

Constructs a FlashMemoryClass object.



**Syntax**

```
FlashMemoryClass(unsigned int _base_address, unsigned int _buf_size);
```

**Parameters**

\_base\_address: The base address to operate.

\_buf\_size: The buf size for mirror a copy to reduce flash memory operation

**Returns**

The function returns nothing.

**Example Code**

Example: FflashMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Direct read from flash memory is allowed. To write data into flash memory, each bit on flash memory can only change from '1' to '0' and it cannot change from '0' to '1'. To make sure the data are correctly written we do erase the flash memory sector before write data on it.

```
#include <FlashMemory.h>
```

```
void setup() {
  FlashMemory.read();

  if (FlashMemory.buf[0] == 0xFF) {
    FlashMemory.buf[0] = 0x00;
    FlashMemory.update();
    Serial.println( "write count to 0" );
  } else {
    FlashMemory.buf[0]++;
    FlashMemory.update();
    Serial.print( "Boot count: ");
    Serial.println(FlashMemory.buf[0]);
  }
}
```

```
}  
  
void loop() {  
  delay(1000);  
}
```

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

```
#include <FlashMemory.h>  
  
void setup() {  
  unsigned int value;  
  
  /* request flash size 0x4000 from 0xFC000 */  
  FlashMemory.begin(0xFC000, 0x4000);  
  
  /* read one word (32-bit) from 0xFC000 plus offset 0x3F00 */  
  value = FlashMemory.readWord(0x3F00);  
  printf(「value is 0x%08Xrn」, value);  
  
  if (value == 0xFFFFFFFF) {  
    value = 0;  
  } else {  
    value++;  
  }  
  
  /* write one word (32-bit) to 0xFC000 plus offset 0x3F00 */  
  FlashMemory.writeWord(0x3F00, value);  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::begin

### Description

Initialize/Re-initialize the base address and size. The base address shell aligns with the size of 0x1000. And the size shell is multiple of 0x1000.

### Syntax

```
void begin(unsigned int _base_address, unsigned int _buf_size);
```

### Parameters

\_base\_address: The base address

\_buf\_size: The desired work size

### Returns

The function returns nothing.

### Example Code

Example: FleshMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit). Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::read

### Description

Read the content to buf. Read flash memory into the buf. The size would be 0x1000.

### Syntax

```
void read(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: FleshMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::update

### Description

Write buf back to flash memory. Write flash memory with the content of the buffer. The size is 0x1000.

### Syntax

```
void update(bool erase = true);
```

### Parameters

erase: By default, it is true and erases flash memory before writing to it

### Returns

The function returns nothing.

### Example Code

Example: `FleshMemory_Basic`

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of `"FlashMemoryClass:: FlashMemoryClass"` .

### Notes and Warnings

Include `"FlashMemory.h"` to use the class function.

### FlashMemoryClass::readWord

#### Description

Read 4 bytes from flash memory. Read 4 byte from specific offset based on base address.

#### Syntax

```
unsigned int readWord(unsigned int offset);
```

#### Parameters

offset: The offset according to the base address

#### Returns

The read data with a size of 4 bytes

### Example Code

Example: `ReadWriteOneWord`

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

Details of the example codes can be found in the previous section of `"FlashMemoryClass:: FlashMemoryClass"` .

### Notes and Warnings

Include `"FlashMemory.h"` to use the class function.

## FlashMemoryClass::writeWord

### Description

Write 4 bytes into flash memory. It will try to write 4 bytes first. If the read data differ from the write data, then we buffer the sector of flash memory, erase it, and write correct data back to it.

### Syntax

```
void writeWord(unsigned int offset, unsigned int data);
```

### Parameters

offset: The offset according to the base address

data: The data to be written

### Returns

The function returns nothing.

### Example Code

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::buf\_size

### Description

The buf size (It can be regarded as work size).

### Syntax

```
unsigned int buf_size;
```

### Example Code

Example: FlashMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

### FlashMemoryClass::\*buf

#### Description

The buf to be operated. Modify buf won't change the content of the buf. It needs an update to write back to flash memory.

#### Syntax

```
unsigned char *buf;
```

### Example Code

NA

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

---

## GPIO

### Class DHT

#### DHT Class

##### Description

Defines a class of using DHT temperature & humidity sensors

##### Syntax

```
class DHT
```

##### Members

Public Constructors	
DHT::DHT	Constructs a DHT object
Public Methods	
DHT::begin	Initialize the DHT sensor
DHT::readTemperature	Read temperature(Fahrenheit or Celcius) from the DHT sensor
DHT::convertCtoF	Convert a value from Celcius to Fahrenheit
DHT::convertFtoC	Convert a value from Fahrenheit to Celcius
DHT::readHumidity	Read humidity(%) from the DHT sensor
DHT::computeHeatIndex	Compute the HeatIndex from the readings (Using both Rothfusz and Steadman' s equations)
DHT::read	Check if the sensor is readable

#### DHT::DHT

##### Description

Constructs a DHT object.

##### Syntax

```
DHT::DHT(uint8_t pin, uint8_t type, uint8_t count)
```

##### Parameters

pin: The Arduino digital PIN connected



type: The DHT sensor type(DHT11, DHT22, or DHT21)

count: The count is now ignored as the DHT reading algorithm adjusts itself based on the speed of the processor

### Returns

The function returns nothing.

### Example Code

Example:DHTTester

The code demos basic testing for various DHT humidity & temperature sensors.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

```
// Example testing sketch for various DHT humidity/temperature sensors
// Written by ladyada, public domain

#include 「DHT.h」

// The digital pin we're connected to.

#define DHTPIN 8

// Uncomment whatever type you're using!

#define DHTTYPE DHT11 // DHT 11

// #define DHTTYPE DHT22 // DHT 22 (AM2302), AM2321
// #define DHTTYPE DHT21 // DHT 21 (AM2301)

// Connect pin 1 (on the left) of the sensor to +5V

// NOTE: If using a board with 3.3V logic like an Arduino Due connect pin 1
// to 3.3V instead of 5V!

// Connect pin 2 of the sensor to whatever your DHTPIN is

// Connect pin 4 (on the right) of the sensor to GROUND

// Connect a 10K resistor from pin 2 (data) to pin 1 (power) of the sensor

// Initialize DHT sensor.

// Note that older versions of this library took an optional third parameter to
// tweak the timings for faster processors. This parameter is no longer needed
```

```
// as the current DHT reading algorithm adjusts itself to work on faster procs.
```

```
DHT dht(DHTPIN, DHTTYPE);
```

```
void setup() {
```

```
  Serial.begin(115200);
```

```
  Serial.println(「DHTxx test!」);
```

```
  dht.begin();
```

```
}
```

```
void loop() {
```

```
  // Wait a few seconds between measurements.
```

```
  delay(2000);
```

```
  // Reading temperature or humidity takes about 250 milliseconds!
```

```
  // Sensor readings may also be up to 2 seconds 『old』 (its a very slow sensor)
```

```
  float h = dht.readHumidity();
```

```
  // Read temperature as Celsius (the default)
```

```
  float t = dht.readTemperature();
```

```
  // Read temperature as Fahrenheit (isFahrenheit = true)
```

```
  float f = dht.readTemperature(true);
```

```
  // Check if any reads failed and exit early (to try again).
```

```
  if (isnan(h) || isnan(t) || isnan(f)) {
```

```
    Serial.println(「Failed to read from DHT sensor!」);
```

```
    return;
```

```
  }
```

```
  // Compute heat index in Fahrenheit (the default)
```

```
  float hif = dht.computeHeatIndex(f, h);
```

```
  // Compute heat index in Celsius (isFahreheit = false)
```

```
  float hic = dht.computeHeatIndex(t, h, false);
```

```
  Serial.print(「Humidity: 」);
```

```
  Serial.print(h);
```

```
  Serial.print(「 %t」);
```

```
  Serial.print(「Temperature: 」);
```

```
Serial.print(t);  
Serial.print(「 *C  」);  
Serial.print(f);  
Serial.print(「 *Ft」 );  
Serial.print(「 Heat index:  」);  
Serial.print(hic);  
Serial.print(「 *C  」);  
Serial.print(hif);  
Serial.println(「 *F」 );  
}
```

### **DHT::begin**

#### **Description**

Initialize the DHT sensor.

#### **Syntax**

```
void DHT::begin(void);
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

#### **Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

## **DHT::readTemperature**

### **Description**

Read temperature(Fahrenheit or Celcius) from the DHT sensor.

### **Syntax**

```
float DHT::readTemperature(bool S, bool force);
```

### **Parameters**

S: Temperature scale, True is Fahrenheit and False is Celcius

force: Index of checking sensor readability, default is False

### **Returns**

The function returns the current temperature as a float value.

### **Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### **Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

## **DHT::convertCtoF**

### **Description**

Convert a value from Celcius to Fahrenheit.

### **Syntax**

```
float DHT::convertCtoF(float c);
```

**Parameters**

c: The value in Celcius

**Returns**

The function returns the temperature in Fahrenheit as a float number.

**Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

**Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

**DHT::convertFtoC****Description**

Convert a value from Fahrenheit to Celcius.

**Syntax**

```
float DHT::convertFtoC(float f);
```

**Parameters**

f: The value in Fahrenheit

**Returns**

The function returns the temperature in Celcius as a float number.

**Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

## Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

## DHT::computeHeatIndex

### Description

Compute the HeatIndex from the readings (Using both Rothfusz and Steadman’ s equations). More details refer to [http://www.wpc.ncep.noaa.gov/html/heatindex\\_equation.shtml](http://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml) .

### Syntax

float DHT::computeHeatIndex(float temperature, float percentHumidity, bool isFahrenheit);

### Parameters

temperature: The temperature value

percentHumidity: The humidity percent value

isFahrenheit: True, temperature value in Fahrenheit (Default); False, temperature value in Celcius

### Returns

The function returns the heat index in Fahrenheit or Celsius as a float value.

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

## Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

## DHT::readHumidity

### Description

Reading temperature or humidity from the DHT sensor and return as a float value(%).

### Syntax

```
float DHT::readHumidity(bool force);
```

### Parameters

force: Ignored.

### Returns

The function returns current humidity in a float number (in %).

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function. Reading temperature or humidity takes about 250 milliseconds! Sensor readings may also be up to 2 seconds.

### DHT::read

### Description

Check if the sensor is readable.

### Syntax

```
boolean DHT::read(bool force);
```

### Parameters

force: Index of whether checking the sensor was read less than two seconds ago or not. False, checking; True, not checking.

**Returns**

Return the last correct measurement of the sensor. False, low means not readable; True, high means readable.

**Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

**Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

**Class HttpClient****InterruptLock Class****Description**

Defines a class of turning off/on interrupts temporarily

**Syntax**

```
class InterruptLock
```

**Members**

Public Constructors	
InterruptLock::InterruptLock	Constructs a InterruptLock object
InterruptLock::~~ InterruptLock	Deconstructs a InterruptLock object



## GTimer

### Class EpdIF

#### GTimerClass Class

##### Description

GTimer is a hardware timer and this class is to operate it. The GTimer occupy same resource as PWM. Please make sure the timer is not conflict with you PWM index.

##### Syntax

```
class GTimerClass
```

##### Members

Public Constructors	
GTimerClass::GTimerClass	Constructs a GTimerClass object
Public Methods	
GTimerClass::begin	Initialize a timer and start it immediately
GTimerClass::stop	Stop a specific timer
GTimerClass::reload	Reload a specific timer
GTimerClass::read_us	Read current countdown value

#### GTimerClass::begin

##### Description

Initialize a timer and start it immediately.

##### Syntax

```
void GTimerClass::begin(uint32_t timerid, uint32_t duration_us, void (*handler)(uint32_t), bool periodical, uint32_t userdata);
```

##### Parameters

timerid: There are 5 valid GTimer with timer id 0~4.

duration\_us: The duration of the timer. The time unit is microsecond and the precision is 32768Hz.

periodical: By default, the timer would keep periodically countdown and reload which means the handler would periodically be invoked.

userdate: The user data brings to the handler.

## Returns

The function returns nothing.

## Example Code

Example: TimerOneshot

```
/*  
  
This sketch shows how to use several hardware timers in invoke handler only once for each timer.  
  
*/  
  
#include <GTimer.h>  
  
void myhandler(uint32_t data) {  
  Serial.print(「I am timer!」 );  
  Serial.println(data);  
}  
  
void setup() {  
  // Open serial communications and wait for port to open:  
  Serial.begin(115200);  
  
  while (!Serial) {  
    ; // wait for serial port to connect. Needed for native USB port only  
  }  
  
  // timerid 0, period 1s, invoke myhandler, invoke only once, user data is 0  
  GTimer.begin(0, 1 * 1000 * 1000, myhandler, false, 0);  
  
  // timerid 1, period 2s, invoke myhandler, invoke only once, user data is 1  
  GTimer.begin(1, 2 * 1000 * 1000, myhandler, false, 1);  
  
  GTimer.begin(2, 3 * 1000 * 1000, myhandler, false, 2);  
  
  GTimer.begin(3, 4 * 1000 * 1000, myhandler, false, 3);  
}
```

```
void loop() {
  delay(1000);
}
```

Example: TimerPeriodical

```
/*
```

This sketch shows how to use hardware timer and invoke interrupt handler periodically

```
*/
```

```
#include <GTimer.h>
```

```
int counter = 0;
```

```
void myhandler(uint32_t data) {
```

```
  counter++;
```

```
  Serial.print(「counter:  」);
```

```
  Serial.println(counter);
```

```
  if (counter >= 10) {
```

```
    Serial.println(「stop timer」 );
```

```
    GTimer.stop(0);
```

```
  }
```

```
}
```

```
void setup() {
```

```
  // Open serial communications and wait for port to open:
```

```
  Serial.begin(115200);
```

```
  while (!Serial) {
```

```
    ; // wait for serial port to connect. Needed for native USB port only
```

```
  }
```

```
  // timerid 0, period 1s, invoke myhandler
```

```
  GTimer.begin(0, (1 * 1000 * 1000), myhandler);
```

```
}
```

```
void loop() {
```

```
  delay(1000);
```

```
}
```

## Notes and Warnings

Include “GTimer.h” to use the class function.

## GTimerClass::stop

### Description

Stop a specific timer

### Syntax

```
void GTimerClass::stop(uint32_t timerid);
```

### Parameters

timerid: Stop the timer with this timer id

### Returns

The function returns nothing.

### Example Code

Example: TimerPeriodical, please refer to GTimerClass:: begin for more details.

## Notes and Warnings

Include “GTimer.h” to use the class function.

## GTimerClass::reload

### Description

Reload a specific timer. The GTimer is a countdown timer. Reload it would make it discard the current countdown value and restart countdown based on the duration.

### Syntax

```
void GTimerClass::reload(uint32_t timerid, uint32_t duration_us);
```

**Parameters**

timerid: The timer to be modified

duration\_us: The updated duration in unit of microseconds

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “GTimer.h” to use the class function.

**GTimerClass::read\_us****Description**

Read the current countdown value

**Syntax**

```
uint64_t GTimerClass::read_us(uint32_t timerid);
```

**Parameters**

timerid: The timer to be read

**Returns**

The function returns the current countdown value.

**Example Code**

NA

## Notes and Warnings

Include “GTimer.h” to use the class function.

---

## Http

### Class HttpClient

#### HttpClient Class

#### Description

Defines a class of using HttpClient

#### Syntax

```
class HttpClient
```

#### Members

Public Constructors	
HttpClient::HttpClient	Constructs a HttpClient object
Public Methods	
HttpClient::beginRequest	Start a more complex request
HttpClient::endRequest	End a more complex request
HttpClient::get	Connect to the server and start to send a GET request
HttpClient::post	Connect to the server and start to send a POST request
HttpClient::put	Connect to the server and start to send a PUT request
HttpClient::startRequest	Connect to the server and start to send the request
HttpClient::sendHeader	Send an additional header line
HttpClient::sendBasicAuth	Send a basic authentication header
HttpClient::finishRequest	Finish sending the HTTP request
HttpClient::responseStatusCode	Get the HTTP status code contained in the response
HttpClient::readHeader	Read the next character of the response headers
HttpClient::skipResponseHeaders	Skip any response headers to get to the body
HttpClient::endOfHeadersReached	Test whether all of the response headers have been consumed
HttpClient::endOfBodyReached	Test whether the end of the body has been reached
HttpClient::contentLength	Return the length of the body

## HttpClient::HttpClient

### Description

Constructs a HttpClient object. If Macro “PROXY\_ENABLED” is defined, currently disabled as introduces a dependency on DNS.h in Ethernet.

### Syntax

```
HttpClient::HttpClient(Client& aClient, const char* aProxy = NULL, uint16_t aProxyPort = 0);
```

```
HttpClient::HttpClient(Client& aClient);
```

### Parameters

aClient: The object of class WiFiClient.

aProxy: The proxy name. The default proxy name is “NULL” .

aProxyPort: The proxy port. The default value for the proxy port is 0.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrate how to download the content from URL indicated in kHostname[].

```
#include <HttpClient.h>
```

```
#include <WiFi.h>
```

```
#include <WiFiClient.h>
```

```
char ssid[] = 「YourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「password」 ; // your network password (use for WPA, or use as key for WEP)
```

```
int keyIndex = 0; // your network key Index number (needed only for WEP)
```

```
// Name of the server we want to connect to
```

```
const char kHostname[] = 「www.google.com」 ;
```

```
const char kPath[] = 「/」 ;
```

```
// Number of milliseconds to wait without receiving any data before we give up
```

```
const int kNetworkTimeout = 30*1000;

// Number of milliseconds to wait if no data is available before trying again

const int kNetworkDelay = 1000;

int status = WL_IDLE_STATUS;

void setup() {
  Serial.begin(9600);

  while ( status != WL_CONNECTED) {
    Serial.print( 「 Attempting to connect to SSID: 」);
    Serial.println(ssid);
    status = WiFi.begin(ssid, pass);
    // wait 10 seconds for connection:
    delay(10000);
  }
  Serial.println( 「 Connected to wifi 」 );
  printWifiStatus();
}

void loop() {
  int err =0;
  WiFiClient c;
  HttpClient http(c);
  err = http.get(kHostname, kPath);
  if (err == 0)
  {
    Serial.println( 「 startedRequest ok 」 );
    err = http.responseStatusCode();
    if (err >= 0)
    {
      Serial.print( 「 Got status code: 」);
      Serial.println(err);
      // Usually you'd check that the response code is 200 or a
```



```

// similar 「success」 code (200-299) before carrying on,
// but we' ll print out whatever response we get
err = http.skipResponseHeaders();

if (err >= 0)
{
    int bodyLen = http.contentLength();
    Serial.print(「Content length is: 」);
    Serial.println(bodyLen);
    Serial.println();
    Serial.println(「Body returned follows:」);
    // Now we' ve got to the body, so we can print it out
    unsigned long timeoutStart = millis();

    char c;

    // Whilst we haven' t timed out & haven' t reached the end of the body
    while ( (http.connected() || http.available()) &&
        ((millis() - timeoutStart) < kNetworkTimeout) )
    {
        if (http.available())
        {
            c = http.read();
            // Print out this character
            Serial.print(c);
            bodyLen--;
            // We read something, reset the timeout counter
            timeoutStart = millis();
        }
        else
        {
            // We haven' t got any data, so let' s pause to allow some to arrive
            delay(kNetworkDelay);

```

```
}  
}  
}  
else  
{  
  Serial.print(「Failed to skip response headers:  」);  
  Serial.println(err);  
}  
}  
else  
{  
  Serial.print(「Getting response failed:  」);  
  Serial.println(err);  
}  
}  
else  
{  
  Serial.print(「Connect failed:  」);  
  Serial.println(err);  
}  
  
http.stop();  
  
// And just stop, now that we've tried a download  
while(1);  
}  
  
void printWifiStatus() {  
  // print the SSID of the network you're attached to:  
  Serial.print(「SSID:  」);  
  Serial.println(WiFi.SSID());  
  
  // print your WiFi shield's IP address:  
  IPAddress ip = WiFi.localIP();
```

```
Serial.print(「IP Address: 」);  
Serial.println(ip);  
// print the received signal strength:  
long rssi = WiFi.RSSI();  
Serial.print(「signal strength (RSSI):」 );  
Serial.print(rssi);  
Serial.println(「 dBm」 );  
}
```

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::beginRequest

#### Description

Start a more complex request. Use this when you need to send additional headers in the request, but you will also need to call endRequest() when you are finished.

#### Syntax

```
void HttpClient::beginRequest(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

## Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::endRequest

### Description

End a more complex request. Use this when you need to have sent additional headers in the request, but you will also need to call beginRequest() at the start.

### Syntax

```
void HttpClient::endRequest(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

## Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::get

### Description

Connect to the server and start to send a “GET” request. If the input parameter contains “aServerAddress” , the connection will not perform a DNS lookup and just purely connect to the given IP address.

### Syntax

```

int HttpClient::get(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent =
NULL);
int HttpClient::get(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
int HttpClient::get(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char*
aURLPath, const char* aUserAgent = NULL);
int HttpClient::get(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char*
aUserAgent = NULL);

```

### Parameters

aServerName: The name of the server being connected to. If aServerName is “NULL” , the “Host” header line will not be sent.

aServerPort: The port on which server connected.

aURLPath: The URL to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

### Returns

Return 0 if successful, otherwise indicates an error occurs.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::post

### Description

Connect to the server and start to send a “POST” request. If the input parameter has “aServerAddress” , connects doesn’t perform a DNS lookup and just connects to the given IP address.

**Syntax**

```
int HttpClient::post(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::post(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::post(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::post(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
```

**Parameters**

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

**Returns**

Return 0 if successful, otherwise indicates an error occurs.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::put****Description**

Connect to the server and start to send a PUT request. If the input parameter has “aServerAddress” , connects doesn’t perform a DNS lookup and just connects to the given IP address.

**Syntax**

```
int HttpClient::put(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent =
NULL);
int HttpClient::put(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
int HttpClient::put(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char*
aURLPath, const char* aUserAgent = NULL);
int HttpClient::put(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char*
aUserAgent = NULL);
```

**Parameters**

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’ t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

**Returns**

Return 0 if successful, otherwise indicates an error occurs.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::startRequest****Description**

Connect to the server and start to send the request.

**Syntax**

```
int HttpClient::startRequest(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aHttpMethod, const char* aUserAgent);
```

```
int HttpClient::startRequest(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aHttpMethod, const char* aUserAgent);
```

### Parameters

aServerAddress: IP address of the server to connect to.

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aHttpMethod: Type of HTTP request to make, e.g. “GET” , “POST” , etc.

aUserAgent: User-Agent string to send. If NULL the default user-agent kUserAgent will be sent.

### Returns

Return 0 if successful, else error.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::sendHeader

#### Description

The function sends an additional header line.

The function void HttpClient:: sendHeader(const char\* aHeader);can only be called in between the calls to startRequest and finishRequest.

The other 2 functions void HttpClient::sendHeader(const char\* aHeaderName, const char\* aHeaderValue); and void HttpClient::sendHeader(const char\* aHeaderName, const int aHeaderValue); are alternate form the previous one, which takes the header name and content as separately (as strings or integer). For example, to send an XXXXXX header, user might call sendHeader( “XXXXXX” , “Something” ) or sendHeader( “XXXXXX” , 123).And the call will add the “: ” in the log to separate different header in the case of multiple headers.



**Syntax**

```
void HttpClient::sendHeader(const char* aHeader);  
void HttpClient::sendHeader(const char* aHeaderName, const char* aHeaderValue);  
void HttpClient::sendHeader(const char* aHeaderName, const int aHeaderValue);
```

**Parameters**

aHeader: Header line to send, in its entirety (but without the trailing CRLF. E.g. “Authorization: Basic YQDDCAIGES” .

aHeaderName: Type of header being sent.

aHeaderValue: Value for that header.

**Returns**

The function returns nothing.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::sendBasicAuth****Description**

The function sends a basic authentication header which will encode the given username and password, and send them in a suitable header line for doing Basic Authentication.

**Syntax**

```
void HttpClient::sendBasicAuth(const char* aUser, const char* aPassword);
```

**Parameters**

aUser: Username for the authorization.

aPassword: Password for the user aUser.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::finishRequest

### Description

Finish sending the HTTP request. The function sends a blank line to signify the end of the request.

### Syntax

```
void HttpClient::finishRequest(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::responseStatusCode

### Description

Get the HTTP status code contained in the response. For example, “200” for successful requests, “404” for file not found, etc.

### Syntax

```
int HttpClient::responseStatusCode(void);
```

### Parameters

The function requires no input parameter.

### Returns

Return 0 if successful, else error.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::readHeader

### Description

The function reads the next character of the response headers. This functions the same as read() but to be used when reading through the headers which are slightly less efficient. The user might check whether the end of the headers has been reached by calling endOfHeadersReached(), although after that point this will still return data as read() would.

**Syntax**

```
int HttpClient::readHeader(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return the next character of the response headers.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::skipResponseHeaders****Description**

Skip any response headers to get to the body. Use this if you don't want to do any special processing of the headers returned in the response. You can also use it after you've found all of the headers you're interested in, and just want to get on with processing the body.

**Syntax**

```
int HttpClient::skipResponseHeaders(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return 0 if successful, else error.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::endOfHeadersReached

#### Description

Test whether all of the response headers have been consumed.

#### Syntax

```
bool HttpClient::endOfHeadersReached(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

Return true if we are now processing the response body, else false.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::endOfBodyReached

**Description**

Test whether the end of the body has been reached. It only works if the Content-Length header was returned by the server.

**Syntax**

```
bool HttpClient::endOfBodyReached(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return true if we are now at the end of the body, else false.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::contentLength****Description**

The function returns the length of the body.

**Syntax**

```
int HttpClient::contentLength(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return Length of the body, in bytes, or kNoContentLengthHeader if no Content-Length header was returned by the server.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**IRDevice****Class HttpClient****IRDevice Class****Description**

A class used for managing, sending, and receiving data using IR.

**Syntax**

```
class IRDevice
```

**Members**

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named IR.	

Public Methods	
IRDevice::getFreq	Get the current IR modulation frequency
IRDevice::begin	Allocate resources and start the IR device with a custom frequency
IRDevice::end	Stop the IR device operations and free up resources
IRDevice::send	Send IR raw data
IRDevice::beginNEC	Allocate resources and start the IR device with a frequency suitable for the NEC protocol
IRDevice::sendNEC	Send data using the NEC protocol
IRDevice::recvNEC	Receive data using the NEC protocol

## IRDevice::getFreq

### Description

Get the current IR modulation frequency.

### Syntax

```
uint32_t getFreq(void);
```

### Parameters

The function requires no input parameter.

### Returns

Currently set IR modulation frequency in Hertz.

### Example Code

NA

### Notes and Warnings

NA

## IRDevice::begin

### Description



Allocate resources and start the IR device with a custom frequency.

**Syntax**

```
void begin(uint8_t receivePin, uint8_t transmitPin, uint32_t irMode, uint32_t freq);
```

**Parameters**

receivePin: pin on which IR sensor is connected. Hardware IR receiver is available at pins 3, 8, 17.

transmitPin: pin on which IR LED is connected. Hardware IR transmitter is available at pins 6, 9, 16.

irMode: transmit or receive mode. Valid values: IR\_MODE\_TX, IR\_MODE\_RX

freq: IR modulation frequency in Hertz

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

IR device can only operate in either transmit or receive mode.

**IRDevice::end****Description**

Stop the IR device operations and free up resources.

**Syntax**

```
void end(void);
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## IRDevice::send

### Description

Send IR raw data.

### Syntax

```
void send(const unsigned int buf[ ], uint16_t len);
```

### Parameters

buf[ ] : IR raw signals (in us) in an array form.

len: total length of the IR raw signal array.

### Returns

The function returns nothing.

### Example Code

```
#include 「IRDevice.h」

// User defined txPin, rxPin and carrier frequency

#define IR_RX_PIN 8

#define IR_TX_PIN 9

#define CARRIER_FREQ 38000

unsigned int irRawSignal[] = {
```

```

9000, 4500, // starting bit

560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, 560, // address 00100000 : 4

560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, 560, 1690, // ~ address 11011111

560, 560, 560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, // data 00010000 : 8

560, 1690, 560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, //~ data 11101111

560 // stoping bit

};

int DataLen = sizeof(irRawSignal) / sizeof(irRawSignal[0]); // 284/ 4 = 71

void setup()

{

Serial.begin(115200);

IR.begin(IR_RX_PIN, IR_TX_PIN, IR_MODE_TX, CARRIER_FREQ);

}

void loop()

{

IR.send(irRawSignal, DataLen);

Serial.println(「 Finished Sending NEC Raw Data…」 );

delay(3000);

}

```

## Notes and Warnings

IR Raw Data array contains information in the form of consecutive microseconds (us). For more details, please refer to: <http://www.righ.to.com/2009/08/multi-protocol-infrared-remote-library.html>.

## IRDevice::beginNEC

### Description

Allocate resources and start the IR device with a frequency suitable for the NEC protocol.

### Syntax

```
void beginNEC(uint8_t receivePin, uint8_t transmitPin, uint32_t irMode);
```

### Parameters

receivePin: pin on which IR sensor is connected. Hardware IR receiver is available at pins 3, 8, 17.

transmitPin: pin on which IR LED is connected. Hardware IR transmitter is available at pins 6, 9, 16.

irMode: transmit or receive mode. Valid values: IR\_MODE\_TX, IR\_MODE\_RX

### Returns

The function returns nothing.

### Example Code

Example: IRRecvNEC

```
#include 「IRDevice.h」

uint8_t adr = 0;
uint8_t cmd = 0;
void setup() {
  //Initialize serial and wait for port to open:
  Serial.begin(115200);

  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }

  IR.beginNEC(8, 9, IR_MODE_RX); // configure for NEC IR protocol
}

void loop() {
  if (IR.recvNEC(adr, cmd, 1000)) {
    Serial.print(「Received 」);
    Serial.print(adr);
    Serial.print(cmd);
    Serial.println();
  } else {
```

```
Serial.println(「Received nothing, timed out」);  
}  
//IR.end();  
}
```

### Notes and Warnings

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

### IRDevice::sendNEC

#### Description

Send data using the NEC protocol.

#### Syntax

```
void sendNEC(uint8_t adr, uint8_t cmd);
```

#### Parameters

adr: 8-bit address to transmit

cmd: 8-bit command to transmit

#### Returns

The function returns nothing.

#### Example Code

Example: IRSendNEC

```
#include 「IRDevice.h」  
  
uint8_t adr = 0;  
uint8_t cmd = 0;  
  
void setup() {
```

```
//Initialize serial and wait for port to open:
Serial.begin(115200);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

IR.beginNEC(8, 9, IR_MODE_TX); // configure for NEC IR protocol

}

void loop() {

if (cmd++ >=255) {

adr++;

}

IR.sendNEC(adr, cmd);

Serial.print(「Sent  」);

Serial.print(adr);

Serial.print(cmd);

Serial.println();

//IR.end(); // Call this method to stop IR device and free up the pins for other uses

}
```

### Notes and Warnings

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

### IRDevice::recvNEC

#### Description

Receive data using the NEC protocol.

#### Syntax

```
void recvNEC(uint8_t& adr, uint8_t& cmd uint32_t timeout);
```

**Parameters**

adr: variable to store received NEC address

cmd: variable to store received NEC command

timeout: time duration to wait for an incoming transmission

**Returns**

The function returns “1” if data has been received, returns “0” if no data has been received.

**Example Code**

Example: IRRecvNEC

Details of the code can be found in the previous section of IRDevice::beginNEC.

**Notes and Warnings**

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

**MDNS****Class HttpClient****MDNSClass Class****Description**

A class used for registering and removing MDNS service records.

**Syntax**

```
class MDNSClass
```

**Members**

Public Constructors	
The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named MDNS.	

Public Methods	
MDNSClass::begin	Start MDNS operations
MDNSClass::end	Stop MDNS operations
MDNSClass::registerService	Add a service record
MDNSClass::deregisterService	Remove service record
MDNSClass::updateService	Update service record

## MDNSClass::begin

### Description

Start MDNS operations to begin responding to MDNS queries.

### Syntax

```
void begin(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

This example shows how to register Ameba as a service that can be recognized by Arduino IDE. If both of the PC runs Arduino IDE and the Ameba board are connecting to the same local network. Then you can find Ameba in “Tools” -> “Port” -> “Arduino at 192.168.1.238 (Ameba RTL8195A), which means the Arduino IDE find Ameba via mDNS.

```
#include <WiFi.h>
```

```
#include <AmebaMDNS.h>
```

```
char ssid[] = 「yourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「secretPassword」 ; // your network password
```

```
MDNSService service( 「MyAmeba」 , 「_arduino._tcp」 , 「local」 , 5000);
```

```
void setup() {
```



```

printf(「Try to connect to %srn」, ssid);

while (WiFi.begin(ssid, pass) != WL_CONNECTED) {

printf(「Failed. Wait 1s and retry...rn」);

delay(1000);

}

printf(「Connected to %srn」, ssid);

service.addTxtRecord(「board」, strlen(「ameba_rtl8195a」), 「ameba_rtl8195a」);

service.addTxtRecord(「auth_upload」, strlen(「no」), 「no」);

service.addTxtRecord(「tcp_check」, strlen(「no」), 「no」);

service.addTxtRecord(「ssh_upload」, strlen(「no」), 「no」);

printf(「Start mDNS servicern」);

MDNS.begin();

printf(「register mDNS servicern」);

MDNS.registerService(service);

}

void loop() {

// put your main code here, to run repeatedly:

delay(1000);

}

```

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

### MDNSClass::end

#### Description

Stop MDNS operations and stop responding to MDNS queries.

#### Syntax

```
void end(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

### MDNSClass::registerService

### Description

Add a service record to be included in MDNS responses.

### Syntax

```
void register service(MDNSService service);
```

### Parameters

service: MDNSService class object with required MDNS service data

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

Details of the code can be found in the previous section of MDNSClass:: begin.

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::deregisterService

### Description

Remove a service record from MDNS responses.

### Syntax

```
void deregisterService(MDNSService service);
```

### Parameters

service: MDNSService class object to be removed

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

Details of the code can be found in the previous section of MDNSClass:: begin.

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::updateService

### Description

Update a service record.

### Syntax

```
void updateService(MDNSService service, unsigned int ttl);
```

### Parameters

service: MDNSService class object to be updated

ttl: time-to-live(TTL) for service

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

**Class HttpClient****MDNSService Class****Description**

A class used for creating MDNS service records.

**Syntax**

```
class MDNSService
```

**Members**

Public Constructors	
MDNSService::MDNSService	Create a MDNS service record
Public Methods	
MDNSService::addTxtRecord	Add text to MDNS service record

**MDNSService::MDNSService****Description**

Create a MDNS service record.

**Syntax**

```
MDNSService(char* name, char* service_type, char* domain, unsigned short port, int bufsize);
```

**Parameters**

name: device name

service\_type: MDNS service type

domain: host domain

port: network port

bufsize: size of buffer for MDNS text record

**Returns**

The function returns nothing.

**Example Code**

Example: mDNS\_On\_Arduino\_IDE

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

**MDNSService::addTxtRecord****Description**

Add text to MDNS service record.

**Syntax**

```
int addTextRecord(char* key, int value_len, char* value);
```

**Parameters**

key: record type expressed as character string

value\_len: length of value string

value: record value expressed as character string

**Returns**

0 if add record successful

### Example Code

Example: mDNS\_On\_Arduino\_IDE

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

---

## MQTTClient

### Class PMUClass

### PubSubClient Class

### Description

Defines a class of MQTT implementation for Ameba.

### Syntax

```
class PubSubClient
```

### Members

<b>Public Constructors</b>	
PubSubClient::PubSubClient	Constructs a PubSubClient object
<b>Public Methods</b>	
PubSubClient::setServer	Set MQTT server address and port
PubSubClient::setCallback	Set callback function
PubSubClient::setClient	Set WiFi client
PubSubClient::setStream	Set data stream
PubSubClient::connect	Attempt to connect to server
PubSubClient::disconnect	Disconnect from current session
PubSubClient::publish	Publish a message to server
PubSubClient::publish_P	Same as above
PubSubClient::subscribe	Subscribe to a topic
PubSubClient::unsubscribe	Unsubscribe to a topic
PubSubClient::loop	Keep MQTT session alive and process any queuing tasks
PubSubClient::connected	Check if client still connected
PubSubClient::state	Return connection state

## PubSubClient::PubSubClient

### Description

Constructs a PubSubClient object and, if applicable, sets server address, port, callback function, data stream and wifi client.

### Syntax

```

PubSubClient::PubSubClient();
PubSubClient::PubSubClient(Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(IPAddress, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
PubSubClient::PubSubClient(uint8_t *, uint16_t, Client& client);
PubSubClient::PubSubClient(uint8_t *, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(uint8_t *, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
PubSubClient::PubSubClient(uint8_t *, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
PubSubClient::PubSubClient(const char*, uint16_t, Client& client);
PubSubClient::PubSubClient(const char*, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(const char*, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);

```

```
PubSubClient::PubSubClient(const char*, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
```

### Parameters

client: the network client to use, for example WiFiClient

IPAddress: MQTT server address

port: port for MQTT, usually 1883 for unencrypted connection

MQTT\_CALLBACK\_SIGNATURE: callback function for MQTT

Stream: a stream to write received messages to

### Returns

The function returns nothing.

### Example Code

Example: MQTT\_Basic

```
#include <WiFi.h>

#include <PubSubClient.h>

// Update these with values suitable for your network.

char ssid[] = 「yourNetwork」 ; // your network SSID (name)
char pass[] = 「secretPassword」 ; // your network password
int status = WL_IDLE_STATUS; // the Wifi radio's status

char mqttServer[] = 「test.mosquitto.org」 ;
char clientId[] = 「amebaClient」 ;
char publishTopic[] = 「outTopic」 ;
char publishPayload[] = 「hello world」 ;
char subscribeTopic[] = 「inTopic」 ;

void callback(char* topic, byte* payload, unsigned int length) {
  Serial.print(「Message arrived [」);
  Serial.print(topic);
  Serial.print(「 ]」);

  for (int i=0;i<length;i++) {
```



```

Serial.print((char)payload[i]);
}
Serial.println();
}

WiFiClient wifiClient;
PubSubClient client(wifiClient);

void reconnect() {
// Loop until we' re reconnected

while (!client.connected()) {
Serial.print(「 Attempting MQTT connection… 」 );
// Attempt to connect

if (client.connect(clientId)) {
Serial.println(「 connected 」 );

// Once connected, publish an announcement…
client.publish(publishTopic, publishPayload);
// …and resubscribe
client.subscribe(subscribeTopic);
} else {
Serial.print(「 failed, rc= 」 );
Serial.print(client.state());
Serial.println(「 try again in 5 seconds 」 );

// Wait 5 seconds before retrying
delay(5000);
}
}
}

void setup()
{
Serial.begin(38400);

while (status != WL_CONNECTED) {

```

```
Serial.print( " Attempting to connect to SSID:  ");
Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:
status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:
delay(10000);

}

client.setServer(mqttServer, 1883);

client.setCallback(callback);

// Allow the hardware to sort itself out
delay(1500);

}

void loop()
{
  if (!client.connected()) {
    reconnect();
  }
  client.loop();
}
```

## Notes and Warnings

PubSubClient::PubSubClient(Client& client) would suffice for normal MQTT connection

## PubSubClient::setServer

### Description

Sets the server details.

### Syntax

PubSubClient& PubSubClient::setServer(uint8\_t \* ip, uint16\_t port)

PubSubClient& PubSubClient::setServer(IPAddress ip, uint16\_t port)

PubSubClient& PubSubClient::setServer(const char \* domain, uint16\_t port)

### Parameters

ip: the address of the server

port: the port to connect to, default 1883

domain: the address of the server

### Returns

The client instance, allowing the function to be chained

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::setCallback

### Description

Sets the message callback function.

### Syntax

PubSubClient& PubSubClient::setCallback(MQTT\_CALLBACK\_SIGNATURE)

### Parameters

MQTT\_CALLBACK\_SIGNATURE: a pointer to a message callback function called when a message arrives for a subscription created by this client.

### Returns

The client instance, allowing the function to be chained.

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::setClient

#### Description

Sets the network client instance to use.

#### Syntax

```
PubSubClient& PubSubClient::setClient(Client& client)
```

#### Parameters

client: the network client to use, for example WiFiClient

#### Returns

The client instance, allowing the function to be chained

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::setStream

#### Description

Sets the stream to write received messages to.

#### Syntax

```
PubSubClient& PubSubClient::setStream(Stream& stream)
```

**Parameters**

stream: a stream to write received messages to

**Returns**

The client instance, allowing the function to be chained.

**Example Code**

NA

**Notes and Warnings**

NA

**PubSubClient::connect****Description**

Connects the client to the server.

**Syntax**

```
boolean PubSubClient::connect(const char *id)
```

```
boolean PubSubClient::connect(const char *id, const char *user, const char *pass)
```

```
boolean PubSubClient::connect(const char *id, const char* willTopic, uint8_t willQos, boolean willRetain, const char* willMessage)
```

```
boolean PubSubClient::connect(const char *id, const char *user, const char *pass, const char* willTopic, uint8_t willQos, boolean willRetain, const char* willMessage)
```

**Parameters**

id: Client ID, a unique string identifier

user: Username for authentication, default NULL

pass: Password for authentication, default NULL

willTopic: the topic to be used by the will message

willQoS: the quality of service to be used by the will message

willRetain: whether the will should be published with the retain flag

willMessage: the payload of the will message

### Returns

True –connection succeeded

False –connection failed

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

Client ID is required and should always be unique else connection might be rejected by the server.

### PubSubClient::disconnect

### Description

Disconnect the client

### Syntax

```
void PubSubClient::disconnect(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::publish

## Description

Publishes a message to the specified topic.

## Syntax

```
boolean PubSubClient::publish(const char* topic, const char* payload)
```

```
boolean PubSubClient::publish(const char* topic, const char* payload, boolean retained)
```

```
boolean PubSubClient::publish(const char* topic, const uint8_t* payload, unsigned int plength)
```

```
boolean PubSubClient::publish(const char* topic, const uint8_t* payload, unsigned int plength, boolean retained)
```

## Parameters

topic: the topic to publish to

payload: the message to publish

plength: the length of the payload. Required if payload is a byte[]

retained: whether the message should be retained

–false –not retained

–true –retained

## Returns

False –publish failed, either connection lost or message too large

True –publish succeeded

## Example Code

Example: MQTT\_Basic

## Notes and Warnings

Default max packet size is 128 bytes.

## PubSubClient::publish\_P

## Description

Publishes a message stored in PROGMEM to the specified topic.

## Syntax

boolean PubSubClient::publish\_P(const char\* topic, const uint8\_t\* payload, unsigned int plength, boolean retained)

### Parameters

topic: the topic to publish to

payload: the message to publish

plength: the length of the payload. Required if payload is a byte[]

retained: whether the message should be retained

–false –not retained

–true –retained

### Returns

False –publish failed, either connection lost or message too large

True –publish succeeded

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::subscribe

### Description

Subscribes to messages published to the specified topic.

### Syntax

boolean PubSubClient::subscribe(const char\* topic)

boolean PubSubClient::subscribe(const char\* topic, uint8\_t qos)

### Parameters

topic: the topic to subscribe to

qos: the qos to subscribe at



**Returns**

False –sending the subscribe failed, either connection lost or message too large

True –sending the subscribe succeeded

**Example Code**

Example: MQTT\_Basic

**Notes and Warnings**

NA

**PubSubClient::unsubscribe****Description**

Unsubscribes from the specified topic.

**Syntax**

boolean PubSubClient::unsubscribe(const char\* topic)

**Parameters**

topic: the topic to unsubscribe to

**Returns**

False –sending the unsubscribe failed, either connection lost or message too large

True –sending the unsubscribe succeeded

**Example Code**

NA

**Notes and Warnings**

NA

**PubSubClient::loop**

### Description

A must method called regularly to allow the client to process incoming messages and maintain its connection to the server.

### Syntax

```
boolean PubSubClient::loop(void)
```

### Parameters

The function requires no input parameter.

### Returns

False –the client is no longer connected

True –the client is still connected

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

A required method that should not be blocked for too long.

## PubSubClient::connected

### Description

Checks whether the client is connected to the server.

### Syntax

```
boolean PubSubClient::connected(void)
```

### Parameters

The function requires no input parameter.

### Returns

False –the client is not connected

True –the client is connected

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::state

#### Description

Returns the current state of the client. If a connection attempt fails, this can be used to get more information about the failure.

All of the values have corresponding constants defined in PubSubClient.h.

#### Syntax

```
int PubSubClient::state(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

-4 : MQTT\_CONNECTION\_TIMEOUT –the server didn’ t respond within the keepalive time

-3 : MQTT\_CONNECTION\_LOST –the network connection was broken

-2 : MQTT\_CONNECT\_FAILED –the network connection failed

-1 : MQTT\_DISCONNECTED –the client is disconnected cleanly

0 : MQTT\_CONNECTED –the client is connected

1 : MQTT\_CONNECT\_BAD\_PROTOCOL –the server doesn’ t support the requested version of MQTT

2 : MQTT\_CONNECT\_BAD\_CLIENT\_ID –the server rejected the client identifier

3 : MQTT\_CONNECT\_UNAVAILABLE –the server was unable to accept the connection

4 : MQTT\_CONNECT\_BAD\_CREDENTIALS –the username/password were rejected

5 : MQTT\_CONNECT\_UNAUTHORIZED –the client was not authorized to connect

## Example Code

Example: MQTT\_Basic

## Notes and Warnings

NA

## Readme

The Ameba MQTT related APIs and examples are works based on the [PubSubClient libraries](#) written by Nicholas O'Leary

These include,

- `PubSubClient.cpp`
- `PubSubClient.h`

These libraries are under MIT License.

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## NTPClient

### Readme

The NTPClient library is based on the NTPClient library written by Fabrice Weinberg, which can be found at <https://github.com/arduino-libraries/NTPClient>.

These include,

- `NTPClient.cpp`
- `NTPClient.h`

These libraries are licensed under MIT License.

---

## PowerSave

### Class PMUClass

#### PMUClass Class

#### Description

Defines a class of using Power Save API

#### Syntax

```
class PMUClass
```

#### Members

Public Constructors	
PMUClass::PMUClass	Constructs a PMUClass object
Public Methods	
PMUCLASS::begin	Initialize the PMUCLASS and select sleep mode
PMUCLASS::AONTimerDuration	Set the duration of AON Timer
PMUCLASS::AONTimerCmd	Disable the AON Timer for power save usage
PMUCLASS::RTCWakeSetup	Set up RTC Timer for power save usage
PMUCLASS::enable	Enable power save deep sleep mode
PMUCLASS::AONWakeReason	Check AON wakeup source
PMUCLASS::WakePinCheck	Check AON GPIO pin wakeup source
PMUCLASS::AONWakeClear	Clear all the AON wakeup source
PMUCLASS::DsleepWakeStatusGet	Check if deepsleep mode is set
PMUCLASS::TL_sysactive_time	Tickless mode system active time
PMUCLASS::TL_wakelock	Tickless mode wake lock, select acquire of release
PMUCLASS::DS_AON_TIMER_WAKEUP	Return the Wakeup source
PMUCLASS::DS_RTC_WAKEUP	Return the Wakeup source
PMUCLASS::TL_UART_WAKEUP	Return the Wakeup source
PMUCLASS::TL_RTC_WAKEUP	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA12	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA13	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA14	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA15	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA16	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA17	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA18	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA19	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA20	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA21	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA25	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA26	Return the Wakeup source

## PMUCLASS::PMUCLASS

### Description

Constructs a PMUCLASS object.

### Syntax

```
PMUCLASS::PMUCLASS(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::begin****Description**

Initialize the PMUCLASS and select sleep mode.

**Syntax**

```
void PMUClass::begin(uint32_t sleep_mode);
```

**Parameters**

sleep\_mode: Selection value, “11” enters the DeepSleep Mode, “22” enters the Tickless Mode

**Returns**

The function returns nothing.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONTimerDuration

### Description

Set the duration of AON Timer

### Syntax

```
void PMUClass::AONTimerDuration(uint32_t duration_ms);
```

### Parameters

duration\_ms: Timer duration between 0 to 32760000ms.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONTimerCmd

### Description

Disable the AON timer for power save usage.

### Syntax

```
void PMUClass::AONTimerCmd(void);
```

### Parameters

c: The value in Celcius.

### Returns

The function returns nothing.



**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::RTCWakeSetup****Description**

Set up the RTC timer for power save usage.

**Syntax**

```
void PMUClass::RTCWakeSetu(uint32_t duration_d, uint32_t duration_h, uint32_t duration_m, uint32_t duration_s);
```

**Parameters**

duration\_d: Set alarm for number of days from 0.

duration\_h: Set alarm for number of hours from 0.

duration\_m: Set alarm for number of minutes from 0.

duration\_s: Set alarm for number of seconds from 0.

**Returns**

The function returns nothing.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::enable

### Description

Enable power save deep sleep mode

### Syntax

```
void PMUClass::enable(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONWakeReason

### Description

Check the AON wakeup source

### Syntax

```
uint32_t PMUClass::AONWakeReason(void);
```

### Parameters

The function requires no input parameter.

### Returns

Returns the value of wakeup deepsleep source. “11” for AON pin, “22” for AON timer, “33” for RTC timer and “0” for none.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::WakePinCheck

### Description

Check which AON GPIO pins are the wakeup source

### Syntax

```
int PMUClass::WakePinCheck(void);
```

### Parameters

The function requires no input parameter.

### Returns

Return the pin number for indicating Arduino pin names.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONWakeClear

### Description

Clear all AON Wakeup source.

### Syntax

```
void PMUClass::AONWakeClear(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::DsleepWakeStatusGet

### Description

Check if deepsleep mode is set.

### Syntax

```
bool PMUClass::DsleepWakeStatusGet(void);
```

### Parameters

The function requires no input parameter.

### Returns

Return TRUE when enter DeepSleep Mode or FALSE for negative.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::TL\_sysactive\_time****Description**

Tickless mode system active time.

**Syntax**

```
void PMUClass::TL_sysactive_time(uint32_t duration_ms);
```

**Parameters**

duration\_ms: Set the duration of system active time. The unit is in milliseconds.

**Returns**

The function returns nothing.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::TL\_wakelock****Description**

Tickless mode wake lock, select acquire or release.

**Syntax**

```
void PMUClass::TL_wakelock(uint32_t select_lock);
```

### Parameters

select\_lock: Wake lock selection value, “1” for acquire or “0” for release.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::DS\_AON\_TIMER\_WAKEUP

### Description

Return the Wakeup source for DeepSleep Mode.

### Syntax

```
void PMUClass::DS_AON_TIMER_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON Timer as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::DS\_RTC\_WAKEUP

### Description

Return the Wakeup source for DeepSleep Mode.

### Syntax

```
void PMUClass::DS_RTC_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns RTC as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_UART\_WAKEUP

### Description

Return the Wakeup source for Tickless Mode.

### Syntax

```
void PMUClass::TL_UART_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns LOGUART as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_RTC\_WAKEUP

### Description

Return the Wakeup source for Tickless Mode.

### Syntax

```
void PMUClass::TL_RTC_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns RTC as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA12

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA12(void);
```



**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA12 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA13****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA13(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA13 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA14

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA14(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA14 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA15

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA15(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA15 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA16****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA16(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA16 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA17****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA17(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA17 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA18

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA18(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA18 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA19

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA19(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA19 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA20

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA20(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA20 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA21

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA21(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA21 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA25

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA25(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA25 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA26****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA26(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA26 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## RTC

### Class RTC

#### RTC Class

##### Description

A class used for displaying date and time and alarm configuration using RTC, the independent BCD (Binary-Coded-Decimal) timer.

##### Syntax

```
class RTC
```

##### Members

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named RTC.	

Public Methods	
RTC:: Init	Initializes the RTC device, including the Clock, the RTC registers, and other functions
RTC:: DeInit	Deinitialize the RTC device
RTC:: Write	Set the specified timestamp in seconds to RTC
RTC:: Read	Get the current timestamp in seconds from RTC
RTC:: Wait	Wait for 1 second
RTC:: SetEpoch	Convert human-readable time to epoch time

#### RTC::Init

##### Description

Initializes the RTC device, including the Clock, the RTC registers, and other functions.

##### Syntax

```
void RTC::Init(void);
```

##### Parameters



The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: RTC

```

/*
 * This function describes how to use the RTC API.
 * The RTC function is implemented by an independent BCD timer/counter.
 * This example will print out the time information every second.
 */

#include <stdio.h>
#include <time.h>
#include 「rtc.h」
#define YEAR 2020
#define MONTH 9
#define DAY 10
#define HOUR 20
#define MIN 30
#define SEC 40

/* Create an rtc object */
RTC rtc;

int32_t seconds;

struct tm *timeinfo;

void setup() {
  Serial.begin(115200);
  rtc.Init(); // initialize RTC
}

```

```
void loop() {  
  // step 1: convert user time to epoch  
  int epochTime = humanReadableToEpoch(YEAR, MONTH, DAY, HOUR, MIN, SEC);  
  // step 2: write epoch time to rtc  
  rtc.Write(epochTime);  
  while (1) {  
    seconds = rtc.Read();  
    printf(「Epoch Time (in s) since January 1, 1970 = %dsn」, seconds);  
    printf(「Time as a basic string = %s」, ctime(&seconds));  
    timeinfo = localtime(&seconds);  
    printf(「Time as a custom formatted string = %d-%d-%d %d:%d:%dn」,   
    (timeinfo->tm_year + 1900), (timeinfo->tm_mon + 1), timeinfo->tm_mday, timeinfo->tm_hour,   
    timeinfo->tm_min, timeinfo->tm_sec);  
    Serial.println();  
    rtc.wait(1);  
  }  
}  
  
// convert human readable time to epoch time  
int humanReadableToEpoch(int year, int month, int day, int hour, int min, int sec) {  
  struct tm t;  
  time_t t_of_day;  
  t.tm_year = year - 1900; // Year - 1970  
  t.tm_mon = month - 1; // Month, where 0 = jan  
  t.tm_mday = day; // Day of the month  
  t.tm_hour = hour;  
  t.tm_min = min;  
  t.tm_sec = sec;  
  t.tm_isdst = -1; // Is DST on? 1 = yes, 0 = no, -1 = unknown  
  t_of_day = mktime(&t);  
  // printf(「seconds since the Epoch: %dn」, (long)t_of_day);  
}
```

```
return t_of_day;  
}
```

### Notes and Warnings

NA

### RTC::DeInit

#### Description

Deinitializes the RTC device.

#### Syntax

```
void RTC::DeInit(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC:: Write

#### Description

Set the specified timestamp in seconds to RTC. Seconds from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS) to specified date and time which is to be set.

### Syntax

```
void RTC::Write(int t);
```

### Parameters

Parameters

t: Seconds from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS) to specified date and time which is to be set.

### Returns

The function returns nothing.

### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC::Read

### Description

Get the current timestamp in seconds from RTC. The current timestamp in seconds which is calculated from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS).

### Syntax

```
int32_t RTC::Read(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the current timestamp in seconds which is calculated from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS).

**Example Code**

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

**Notes and Warnings**

NA

**RTC:: Wait****Description**

Send IR raw data.

**Syntax**

```
void RTC::wait(float s);
```

**Parameters**

s: unit microseconds (1 us)

**Returns**

The function returns nothing.

**Example Code**

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

**Notes and Warnings**

NA

**RTC:: SetEpoch****Description**

Convert human-readable time to epoch time

### Syntax

```
int RTC:: SetEpoch(int year, int month, int day, int hour, int min, int sec);
```

### Parameters

year: user input year

month: user input month

day: user input day

hour: user input hour

min: user input minutes

sec: user input seconds

### Returns

The function returns epoch time in seconds for RTC use.

### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

---

## SoftwareSerial

### Class Adafruit\_GPS

#### Adafruit\_GPS Class

### Description

Defines a class to use GPS module on Ameba.

### Syntax

```
class Adafruit_GPS
```

## Members

<b>Public Constructors</b>	
Adafruit_GPS::Adafruit_GPS	Constructs an Adafruit_GPS object
<b>Public Methods</b>	
Adafruit_GPS::begin	Initialize serial communication
*Adafruit_GPS:: lastNMEA	Returns the last NMEA line received and unsets the received flag
Adafruit_GPS:: newNMEAreceived	Check to see if a new NMEA line has been received
Adafruit_GPS:: common_init	Initialization code used by all constructor types
Adafruit_GPS:: sendCommand	Send a command to the GPS device
Adafruit_GPS:: pause	Pause/unpause receiving new data
Adafruit_GPS:: parseHex	Read a Hex value and return the decimal equivalent
Adafruit_GPS:: read	Read one character from the GPS device
Adafruit_GPS:: parse	Parse an NMEA string
Adafruit_GPS:: wakeup	Wake the sensor up
Adafruit_GPS:: standby	Standby Mode Switches
Adafruit_GPS::waitForSentence	Wait for a specified sentence from the device
Adafruit_GPS::LOCUS_StartLogger	Start the LOCUS logger
Adafruit_GPS::LOCUS_StopLogger	Stop the LOCUS logger
Adafruit_GPS::LOCUS_ReadStatus	Read the logger status

### Adafruit\_GPS::Adafruit\_GPS

#### Description

Constructs an Adafruit\_GPS object and initialize serial using a SoftSerial object.

#### Syntax

```
Adafruit_GPS::Adafruit_GPS(SoftwareSerial *ser)
```

```
Adafruit_GPS::Adafruit_GPS(HardwareSerial *ser)
```

#### Parameters

ser: a Serial instance

#### Returns

The function returns nothing.

**Example Code**

Example: Adafruit\_GPS\_parsing

This example code from Adafruit demonstrates GPS modules using MTK3329/MTK3339 driver. This code shows how to listen to the GPS module in an interrupt which allows the program to have more ‘freedom’ –just parse when a new NMEA sentence is available! Then access data when desired.

```
#include <Adafruit_GPS.h>

#include <SoftwareSerial.h>

// If you're using a GPS module:

// Connect the GPS Power pin to 3.3V

// Connect the GPS Ground pin to ground

// Connect the GPS TX (transmit) pin to Digital 0

// Connect the GPS RX (receive) pin to Digital 1

#if defined(BOARD_RTL8195A)

SoftwareSerial mySerial(0, 1);

#elif defined(BOARD_RTL8710)

SoftwareSerial mySerial(17, 5); // RTL8710 need change GPS TX/RX to pin 17 and 5

#else

SoftwareSerial mySerial(0, 1);

#endif

Adafruit_GPS GPS(&mySerial);

// Set GPSECHO to 『false』 to turn off echoing the GPS data to the Serial console

// Set to 『true』 if you want to debug and listen to the raw GPS sentences.

#define GPSECHO false

void setup()

{

Serial.begin(38400);

Serial.println(「Adafruit GPS library basic test!」);

// 9600 NMEA is the default baud rate for Adafruit MTK GPS's- some use 4800

GPS.begin(9600);

// uncomment this line to turn on RMC (recommended minimum) and GGA (fix data) including altitude
```



```

GPS.sendCommand(PMTK_SET_NMEA_OUTPUT_RMCGGA);

// uncomment this line to turn on only the 「minimum recommended」 data
//GPS.sendCommand(PMTK_SET_NMEA_OUTPUT_RMONLY);

// For parsing data, we don't suggest using anything but either RMC only or RMC+GGA since
// the parser doesn't care about other sentences at this time

// Set the update rate

GPS.sendCommand(PMTK_SET_NMEA_UPDATE_1HZ); // 1 Hz update rate

// For the parsing code to work nicely and have time to sort thru the data, and
// print it out we don't suggest using anything higher than 1 Hz

// Request updates on antenna status, comment out to keep quiet

GPS.sendCommand(PGCMD_ANTENNA);

delay(1000);

// Ask for firmware version

mySerial.println(PMTK_Q_RELEASE);

}

uint32_t timer = millis();

void loop() // run over and over again
{
    // in case you are not using the interrupt above, you'll
    // need to 「hand query」 the GPS, not suggested :(
    // read data from the GPS in the 「main loop」

    char c = GPS.read();

    // if you want to debug, this is a good time to do it!

    if (GPSECHO)

    if (c) Serial.print(c);

    // if a sentence is received, we can check the checksum, parse it...

    if (GPS.newNMEAreceived()) {
        // a tricky thing here is if we print the NMEA sentence, or data
        // we end up not listening and catching other sentences!
        // so be very wary if using OUTPUT_ALLDATA and trying to print out data

```

```
//Serial.println(GPS.lastNMEA()); // this also sets the newNMEAreceived() flag to false
if (!GPS.parse(GPS.lastNMEA())) // this also sets the newNMEAreceived() flag to false
return; // we can fail to parse a sentence in which case we should just wait for another
}

// if millis() or timer wraps around, we'll just reset it
if (timer > millis()) timer = millis();

// approximately every 2 seconds or so, print out the current stats
if (millis() - timer > 2000) {
  timer = millis(); // reset the timer

  Serial.print("\nTime: ");
  Serial.print(GPS.hour, DEC); Serial.print( ":");
  Serial.print(GPS.minute, DEC); Serial.print( ":");
  Serial.print(GPS.seconds, DEC); Serial.print( ".");
  Serial.println(GPS.milliseconds);

  Serial.print("Date: ");
  Serial.print(GPS.day, DEC); Serial.print( "/");
  Serial.print(GPS.month, DEC); Serial.print( "/20");
  Serial.println(GPS.year, DEC);

  Serial.print("Fix: "); Serial.print((int)GPS.fix);
  Serial.print(" quality: "); Serial.println((int)GPS.fixquality);
  if (GPS.fix) {
    Serial.print("Location: ");
    Serial.print(GPS.latitude, 4); Serial.print(GPS.lat);
    Serial.print(", ");
    Serial.print(GPS.longitude, 4); Serial.println(GPS.lon);

    Serial.print("Location (in degrees, works with Google Maps): ");
    Serial.print(GPS.latitudeDegrees, 4);
    Serial.print(", ");
    Serial.println(GPS.longitudeDegrees, 4);

    Serial.print("Speed (knots): "); Serial.println(GPS.speed);
```

```
Serial.print(「Angle:  」); Serial.println(GPS.angle);  
Serial.print(「Altitude:  」); Serial.println(GPS.altitude);  
Serial.print(「Satellites:  」); Serial.println((int)GPS.satellites);  
}  
}  
}
```

### Notes and Warnings

IMPORTANT: SoftSerial is using hardware serial so pin mapping cannot be altered.

### Adafruit\_GPS::begin

#### Description

Initialize serial communication

#### Syntax

```
void Adafruit_GPS::begin(uint16_t baud)
```

#### Parameters

baud: serial baud rate

#### Returns

The function returns nothing.

#### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

## **\*Adafruit\_GPS::lastNMEA**

### **Description**

Returns the last NMEA line received and unsets the received flag

### **Syntax**

char \*Adafruit\_GPS::lastNMEA(void)

### **Parameters**

The function requires no input parameter.

### **Returns**

Pointer to the last line string

### **Example Code**

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### **Notes and Warnings**

NA

## **Adafruit\_GPS::newNMEAreceived**

### **Description**

Check to see if a new NMEA line has been received

### **Syntax**

boolean Adafruit\_GPS::newNMEAreceived(void)

### **Parameters**

The function requires no input parameter.

**Returns**

True if received, false if not

**Example Code**

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

**Notes and Warnings**

NA

**Adafruit\_GPS::common\_init****Description**

Initialization code used by all constructor types

**Syntax**

```
void Adafruit_GPS::common_init(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## Adafruit\_GPS::sendCommand

### Description

Send a command to the GPS device

### Syntax

```
void Adafruit_GPS::sendCommand(const char *str)
```

### Parameters

str: Pointer to a string holding the command to send

### Returns

The function returns nothing.

### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

## Adafruit\_GPS::pause

### Description

Pause/unpause receiving new data

### Syntax

```
void Adafruit_GPS::pause(boolean p)
```

### Parameters

p: True = pause, false = unpause

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**Adafruit\_GPS::parseHex****Description**

Read a Hex value and return the decimal equivalent

**Syntax**

```
uint8_t Adafruit_GPS::parseHex(char c)
```

**Parameters**

c: Hex value

**Returns**

The decimal equivalent of the Hex value

**Example Code**

NA

**Notes and Warnings**

NA

**Adafruit\_GPS::read**

### Description

Read one character from the GPS device

### Syntax

```
char Adafruit_GPS::read(void)
```

### Parameters

The function requires no input parameter.

### Returns

The character that we received, or 0 if nothing was available

### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

## Adafruit\_GPS::parse

### Description

Parse an NMEA string

### Syntax

```
boolean Adafruit_GPS::parse(char *nmea)
```

### Parameters

nmea: an NMEA string

### Returns



True if we parsed it, false if it has invalid data

### Example Code

Example: Adafruit\_GPS\_parsing

### Notes and Warnings

NA

## Adafruit\_GPS::wakeup

### Description

Wake the sensor up

### Syntax

boolean Adafruit\_GPS::wakeup(void)

### Parameters

The function requires no input parameter.

### Returns

True if woken up, false if not in standby or failed to wake

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::standby

## Description

Standby Mode Switches

## Syntax

boolean Adafruit\_GPS::standby(void)

## Parameters

The function requires no input parameter.

## Returns

False if already in standby, true if it entered standby

## Example Code

NA

## Notes and Warnings

NA

## Adafruit\_GPS::waitForSentence

### Description

Wait for a specified sentence from the device

### Syntax

boolean Adafruit\_GPS::waitForSentence(const char \*wait4me, uint8\_t max)

### Parameters

wait4me: Pointer to a string holding the desired response

max: How long to wait, default is MAXWAITSENTENCE

### Returns

True if we got what we wanted, false otherwise

#### **Example Code**

NA

#### **Notes and Warnings**

NA

### **Adafruit\_GPS::LOCUS\_StartLogger**

#### **Description**

Start the LOCUS logger

#### **Syntax**

boolean Adafruit\_GPS::LOCUS\_StartLogger(void)

#### **Parameters**

The function requires no input parameter.

#### **Returns**

True on success, false if it failed

#### **Example Code**

NA

#### **Notes and Warnings**

NA

### **Adafruit\_GPS::LOCUS\_StopLogger**

### Description

Stop the LOCUS logger

### Syntax

```
boolean Adafruit_GPS::LOCUS_StopLogger(void)
```

### Parameters

The function requires no input parameter.

### Returns

True on success, false if it failed

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::LOCUS\_ReadStatus

### Description

Read the logger status

### Syntax

```
boolean Adafruit_GPS::LOCUS_ReadStatus(void)
```

### Parameters

The function requires no input parameter.

### Returns

True if we read the data, false if there was no response

**Example Code**

NA

**Notes and Warnings**

NA

**Class HttpClient****PMS3003 Class****Description**

Defines a class to work with PMS3003 air quality sensor on Ameba.

**Syntax**

```
class PMS3003
```

**Members**

<b>Public Constructors</b>	
PMS3003::PMS3003	Constructs a PMS3003 object
<b>Public Methods</b>	
PMS3003::begin	Initialize hardware UART
PMS3003::end	Free allocated space thus stopping UART
PMS3003::get_pm1p0_cf1	Get PM1.0 under correction factor = 1
PMS3003:: get_pm2p5_cf1	Get PM2.5 under correction factor = 1
PMS3003:: get_pm10_cf1	Get PM10 under correction factor = 1
PMS3003:: get_pm1p0_air	Get PM1.0 air quality
PMS3003:: get_pm2p5_air	Get PM2.5 air quality
PMS3003:: get_pm10_air	Get PM10 air quality
PMS3003:update_cache	Updates the cache memory
PMS3003::pms3003_handle_interrupt	Set up the serial event handler

**PMS3003::PMS3003****Description**

Constructs a PMS3003 object and initialize the pin mapping.

### Syntax

```
PMS3003::PMS3003(int _rx, int _tx, int _set, int _reset)
```

### Parameters

\_rx: RX pin of UART

\_tx: TX pin of UART

\_set: Set pin

\_reset: Reset pin

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::begin

### Description

Initialize hardware UART and allocate space for serial buffer

### Syntax

```
void PMS3003::begin(void)
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::end****Description**

Free serial buffer space and stop UART

**Syntax**

```
void PMS3003::end(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm1p0\_cf1**

### Description

Get PM1.0 under correction factor = 1

### Syntax

```
int PMS3003::get_pm1p0_cf1(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value “pm1p0\_cf1” as an integer.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::get\_pm2p5\_cf1

### Description

Get PM2.5 under correction factor = 1

### Syntax

```
int PMS3003::get_pm2p5_cf1(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value of “pm2p5\_cf1” as an integer.



**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm10\_cf1****Description**

Get PM10 under correction factor = 1

**Syntax**

```
int PMS3003::get_pm10_cf1(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm10\_cf1” as an integer.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm1p0\_air****Description**

Get PM1.0 air quality

### Syntax

```
int PMS3003::get_pm1p0_air(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value of “pm1p0\_air” as an integer.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::get\_pm2p5\_air

### Description

Get PM2.5 air quality

### Syntax

```
int PMS3003::get_pm2p5_air(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value of “pm2p5\_air” as an integer.

### Example Code

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm10\_air****Description**

Get PM10 air quality

**Syntax**

```
int PMS3003::get_pm10_air(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm10\_air” as an integer.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::pms3003\_handle\_interrupt****Description**

Set up the serial event handler

**Syntax**

```
void pms3003_handle_interrupt(uint32_t id, uint32_t event)
```

**Parameters**

id: device identifier

event: Serial event for handling incoming data

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::update\_cache****Description**

Serves the function of updating cache memory. One package has 32 bytes. Illustrate the formate by using below raw data: 42 4d 00 1c 00 1b 00 21 00 29 00 1a 00 21 00 29 2b fb 04 be 00 6b 00 10 00 04 00 04 67 00 04 46

42 4d : header signature

00 1c : frame length, 0x001c = 28 bytes (not include header and this field)

00 1b : PM1.0 under CF=1

00 21 : PM2.5 under CF=1

00 29 : PM10 under CF=1

00 1a : PM1.0 under air

00 21 : PM2.5 under air

00 29 : PM10 under air

2b fb : number of pariticle, diameter size 0.3 um in 0.1 liter air

04 be : number of pariticle, diameter size 0.5 um in 0.1 liter air

00 6b : number of pariticle, diameter size 1.0 um in 0.1 liter air

00 10 : number of pariticle, diameter size 2.5 um in 0.1 liter air

00 04 : number of pariticle, diameter size 5.0 um in 0.1 liter air

00 04 : number of pariticle, diameter size 10 um in 0.1 liter air

67 : serial number

00 : error code

04 46 :

checksum,0x42+0x4d+0x00+0x1c+0x00+0x1b+0x00+0x21+0x00+0x29+0x00+0x1a+0x00+0x21+0x00+0x29+  
0x2b+0xfb+0x04+0xbe+0x00+0x6b+0x00+0x10+0x00+0x04+0x00+0x04+0x67+0x00 = 0x0446

### Syntax

```
void PMS3003::update_cache(void)
```

### Parameters

The function requires no input parameters.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Class SoftwareSerial

### SoftwareSerial Class

### Description

Defines a class of software serial implementation for Ameba.

### Syntax

```
class SoftwareSerial
```

### Members

<b>Public Constructors</b>	
SoftwareSerial::SoftwareSerial	Constructs a SoftwareSerial object
<b>Public Methods</b>	
SoftwareSerial::begin	Sets the speed (baud rate) for the serial communication
SoftwareSerial::listen	Enables the selected software serial port to listen
SoftwareSerial::end	Same as stopListening
SoftwareSerial::stopListening	Stop listening on the port
SoftwareSerial::peek	Return a character that was received on the RX pin of the software serial port
SoftwareSerial::write	Prints data to the transmit pin of the software serial port as raw bytes
SoftwareSerial::read	Return a character that was received on the RX pin of the software serial port
SoftwareSerial::available	Get the number of bytes (characters) available for reading from a software serial port
SoftwareSerial::flush	Flush the received buffer
SoftwareSerial::setBufferSize	Set buffer size
SoftwareSerial::setAvailableCallback	Set available callback
SoftwareSerial::handle_interrupt	Private methods handles interrupt

## SoftwareSerial::SoftwareSerial

### Description

Constructs a SoftwareSerial object and sets RX and TX pin, and inverse logic.

### Syntax

```
SoftwareSerial::SoftwareSerial(uint8_t receivePin, uint8_t transmitPin, bool inverse_logic /* = false */)

```

### Parameters

receivePin: the pin on which to receive serial data

transmitPin: the pin on which to transmit serial data

inverse\_logic: is used to invert the sense of incoming bits

### Returns

The function returns nothing.

### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX.

```

/*
The circuit: (BOARD RTL8195A)
* RX is digital pin 0 (connect to TX of other devices)
* TX is digital pin 1 (connect to RX of other devices)
*/

#include <SoftwareSerial.h>

#if defined(BOARD_RTL8195A)
SoftwareSerial mySerial(0, 1); // RX, TX
#elif defined(BOARD_RTL8710)
SoftwareSerial mySerial(17, 5); // RX, TX
#else
SoftwareSerial mySerial(0, 1); // RX, TX
#endif

void setup() {
// Open serial communications and wait for port to open:
Serial.begin(57600);

while (!Serial) {
; // wait for serial port to connect. Needed for native USB port only
}

Serial.println(「Goodnight moon!」);

// set the data rate for the SoftwareSerial port
mySerial.begin(4800);
mySerial.println(「Hello, world?」);
}

void loop() { // run over and over
if (mySerial.available()) {
mySerial.write(mySerial.read());
}
}

```

```
}
```

### Notes and Warnings

Software Serial is using hardware serial thus DO NOT change the default pins

### SoftwareSerial::begin

#### Description

Sets the speed (baud rate) for the serial communication

#### Syntax

```
void SoftwareSerial::begin(long speed)
```

```
void SoftwareSerial::begin(long speed, int data_bits, int parity, int stop_bits)
```

```
void SoftwareSerial::begin(long speed, int data_bits, int parity, int stop_bits, int flowctrl, int rtsPin, int ctsPin)
```

#### Parameters

speed: the baud rate

data\_bits: number of data bits, 8 bits(default) or 7 bits

stop\_bits: number of stop bits, 1 bit(default), 1.5 bits or 2 bits

flowctrl: flow control pin

rtsPin: request to send pin

ctsPin: clear to send pin

#### Returns

The function returns nothing.

#### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial\_Basic:: SoftwareSerial.

### Notes and Warnings



NA

## **SoftwareSerial::listen**

### **Description**

Enables the selected software serial port to listen

### **Syntax**

```
bool SoftwareSerial::listen(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

Returns true if it replaces another

### **Example Code**

NA

### **Notes and Warnings**

NA

## **SoftwareSerial::end**

### **Description**

Same as stopListening

### **Syntax**

```
void SoftwareSerial::end(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::isListening

### Description

Tests to see if requested software serial port is actively listening

### Syntax

```
bool SoftwareSerial::isListening(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “True” if the port is listening.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::stopListening

### Description

Stop listening on the port

### Syntax

```
bool SoftwareSerial::stopListening(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “True” if listening on the port is stopped.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::peek

### Description

Return a character that was received on the RX pin of the software serial port

### Syntax

```
int SoftwareSerial::peek(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the character read, or returns “-1” if none is available.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::write

### Description

Prints data to the transmit pin of the software serial port as raw bytes

### Syntax

```
size_t SoftwareSerial::write(uint8_t b)
```

### Parameters

b: byte to be written

### Returns

The function returns the number of bytes written.

### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial: SoftwareSerial.

### Notes and Warnings

NA

## **SoftwareSerial::read**

### **Description**

Return a character that was received on the RX pin of the software serial port

### **Syntax**

```
int SoftwareSerial::read(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns the character read, or -1 if none is available.

### **Example Code**

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial: SoftwareSerial.

### **Notes and Warnings**

NA

## **SoftwareSerial::available**

### **Description**

Get the number of bytes available for reading from a software serial port

### **Syntax**

int SoftwareSerial::available(void)

### Parameters

The function requires no input parameter.

### Returns

The function returns the number of bytes available to read.

### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial:: SoftwareSerial.

### Notes and Warnings

NA

## SoftwareSerial::flush

### Description

Flush the received buffer

### Syntax

void SoftwareSerial::flush(void)

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::setBufferSize

### Description

Set buffer size

### Syntax

```
void SoftwareSerial::setBufferSize(uint32_t buffer_size)
```

### Parameters

buffer\_size: the size of the serial buffer

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::setAvailableCallback

### Description

Set available callback

## Syntax

```
void SoftwareSerial::setAvailableCallback(void (*callback)(char c))
```

## Parameters

\*callback: user-defined serial callback function

## Returns

The function returns nothing.

## Example Code

Example: SoftwareSerialIrqCallback

This example demonstrates the software serial testing using IRQ callback and semaphore. Set callback function “mySerialCallback” to software serial. Whenever there is data comes in, “mySerialCallback” is invoked. In this sketch, it does nothing until the end of the line. And then it sends a semaphore. The loop() uses a non-busy loop to wait for the semaphore. To test this sketch, you need to type something on software serial and then press Enter.

```
/*  
  
The circuit: (BOARD RTL8195A)  
  
RX is digital pin 0 (connect to TX of other devices)  
TX is digital pin 1 (connect to RX of other devices)  
  
*/  
  
#include <SoftwareSerial.h>  
  
#if defined(BOARD_RTL8195A)  
SoftwareSerial mySerial(0, 1); // RX, TX  
#elif defined(BOARD_RTL8710)  
SoftwareSerial mySerial(17, 5); // RX, TX  
#else  
SoftwareSerial mySerial(0, 1); // RX, TX  
#endif  
  
uint32_t semaID;  
  
// The callback is hooking at UART IRQ handler and please don't do heavy task here.  
  
void mySerialCallback(char c)
```



```

{
/* The parameter c is only for peeking. The actual data is
* still in the buffer of SoftwareSerial.
*/
if (c == 『r』 || c == 『n』 ) {
os_semaphore_release(semaID);
}
}

void setup() {
// use 1 count for binary semaphore
semaID = os_semaphore_create(1);

// There is a token in the semaphore, clear it.
os_semaphore_wait(semaID, 0xFFFFFFFF);

// set the data rate for the SoftwareSerial port
mySerial.begin(38400);
mySerial.setAvailableCallback(mySerialCallback);
}

void loop() { // run over and over
// wait semaphore for 5s timeout
if (os_semaphore_wait(semaID, 5 * 1000)) {
// we got data before timeout
while(mySerial.available()) {
mySerial.print((char)mySerial.read());
}
mySerial.println();
} else {
mySerial.println( 「No data comes in.」 );
}
}
}

```

## Notes and Warnings

NA

## SoftwareSerial::handle\_interrupt

### Description

A private method handles the interrupt

### Syntax

```
void handle_interrupt(uint32_t id, uint32_t event)
```

### Parameters

id: the interrupt id

event: interrupt event

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## Readme

The Ameba Software Serial related APIs and examples are works based on libraries formerly known as `NewSoftSerial.h` by Mikal Hart (<http://arduiniiana.org/libraries/newsoftserial>).

These include,

- `SoftwareSerial.cpp`
- `SoftwareSerial.h`

These libraries are under GNU Lesser General Public License.

---

The Ameba GPS related APIs and examples are works based on Adafruit GPS library written by Limor Fried/Ladyada for Adafruit Industries (<http://www.adafruit.com/products/746>).

These include,

- Adafruit\_GPS.cpp
- Adafruit\_GPS.h

These libraries are under BSD License.

---

## SPI

### Class AmebaILI9341

#### AmebaILI9341 Class

##### Description

Defines a class to use ILI9341 TFT SPI display for Ameba.

##### Syntax

```
class AmebaILI9341
```

##### Members

<b>Public Constructors</b>	
AmebaILI9341::AmebaILI9341	Constructs an AmebaILI9341 object
<b>Public Methods</b>	
AmebaILI9341::begin	Initialize SPI, pin mapping and screen configuration
AmebaILI9341::setAddress	Initialize image size and position
AmebaILI9341::writecommand	SPI transfer a command
AmebaILI9341::writedata	SPI transfer a piece of data
AmebaILI9341::setRotation	Set screen orientation
AmebaILI9341::fillScreen	Fill the screen with a color
AmebaILI9341::clr	Clear screen
AmebaILI9341::fillRectangle	Fill a rectangular space with a color
AmebaILI9341::drawPixel	Turn on a pixel on the screen
AmebaILI9341::drawChar	To print a character on the screen
AmebaILI9341::drawLine	Draw line on the screen
AmebaILI9341::drawRectangle	Draw a rectangle on the screen
AmebaILI9341::drawCircle	Draw a circle on the screen
AmebaILI9341::write	Same as drawChar
AmebaILI9341::getWidth	Return the width 240
AmebaILI9341::getHeight	Return the height 320
AmebaILI9341::setCursor	Set cursor to the desired position
AmebaILI9341::setForeground	Set foreground color
AmebaILI9341::setBackground	Set background color
AmebaILI9341::setFontSize	Set character font size
AmebaILI9341::reset	Reset pin to High or Low

## AmebaILI9341::AmebaILI9341

### Description

Constructs an AmebaILI9341 object and set CS, DC and RESET pins .

### Syntax

```
AmebaILI9341::AmebaILI9341(int csPin, int dcPin, int resetPin)
```

### Parameters

csPin: pin for Chip Select dcPin: pin for Data/Command resetPin: pin for Reset

### Returns

The function returns nothing.

### Example Code

Example: : PM25\_ON\_ILI9341\_TFT\_LCD

This example demonstrates how to read pm2.5 value on PMS 3003 air-condition sensor and display it on ILI9341 TFT LCD.

```
/*
```

PMS 3003 pin map is as follow:

PIN1 :VCC, connect to 5V

PIN2 :GND

PIN3 :SET, 0:Standby mode, 1:operating mode

PIN4 :RXD :Serial RX

PIN5 :TXD :Serial TX

PIN6 :RESET

PIN7 :NC

PIN8 :NC

In this example, we only use Serial to get PM 2.5 value.

The circuit:

\* RX is digital pin 0 (connect to TX of PMS 3003)

\* TX is digital pin 1 (connect to RX of PMS 3003)

For RTL8195A ILI9341 TFT LCD with SPI interface has these pins:

D/C : connect to pin 9

CS : connect to pin 10

MOSI : connect to pin 11

MISO : connect to pin 12

CLK : connect to pin 13

VCC : connect to 3V3

GND : connect to GND

```
*/
```

```
#include 「SoftwareSerial.h」
```

```
#include 「SPI.h」
```

```
#include 「AmebaILI9341.h」
```

```
#if defined(BOARD_RTL8195A)
```

```
SoftwareSerial mySerial(0, 1); // RX, TX
```

```
#define TFT_RESET 8

#define TFT_DC 9

#define TFT_CS 10

#elif defined(BOARD_RTL8710)

SoftwareSerial mySerial(17, 5); // RX, TX

// IMPORTANT: Due to limit pin, we do not connect TFT_RESET pin.

#define TFT_RESET 0xFFFFFFFF

#define TFT_DC 2

#define TFT_CS 10

#endif

AmebaILI9341 tft = AmebaILI9341(TFT_CS, TFT_DC, TFT_RESET);

#define ILI9341_SPI_FREQUENCY 20000000

#define pmsDataLen 32

uint8_t buf[pmsDataLen];

int idx = 0;

int pm10 = 0;

int last_pm25 = 0;

int pm25 = 0;

int pm100 = 0;

uint16_t pm25color[] = {

    0x9FF3,

    0x37E0,

    0x3660,

    0xFFE0,

    0xFE60,

    0xFCC0,

    0xFB2C,

    0xF800,

    0x9800,

    0xC99F
```

```
};

void setup() {
  Serial.begin(57600);

  mySerial.begin(9600); // PMS 3003 UART has baud rate 9600

  SPI.setDefaultFrequency(ILI9341_SPI_FREQUENCY);

  tft.begin();

  drawPictureFrames();
}

void loop() { // run over and over
  uint8_t c;

  idx = 0;

  memset(buf, 0, pmsDataLen);

  while (true) {
    while (c != 0x42) {
      while (!mySerial.available());

      c = mySerial.read();
    }

    while (!mySerial.available());

    c = mySerial.read();

    if (c == 0x4d) {
      // now we got a correct header

      buf[idx++] = 0x42;

      buf[idx++] = 0x4d;

      break;
    }
  }

  while (idx != pmsDataLen) {
    while(!mySerial.available());

    buf[idx++] = mySerial.read();
  }
}
```

```
pm10 = ( buf[10] << 8 ) | buf[11];
last_pm25 = pm25;
pm25 = ( buf[12] << 8 ) | buf[13];
pm100 = ( buf[14] << 8 ) | buf[15];
updateValueToTftScreen();
}

void drawPictureFrames() {
tft.setRotation(1);

tft.clr();

tft.setFontSize(1);

// Upper title
tft.setFontSize(1);
tft.setCursor(20,20);
tft.print( 「PM2.5 DETECTOR」 );

// PM 2.5 Circle Frame
tft.drawCircle(100,130,60, ILI9341_BLUE);
tft.drawCircle(100,130,61, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(90,85);
tft.print( 「PM2.5」 );
tft.setFontSize(1);
tft.setCursor(90,170);
tft.print( 「um/m3」 );

// PM 10 Circle Frame
tft.drawCircle(220,70,40, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(210,40);
tft.print( 「PM10」 );
tft.setFontSize(1);
tft.setCursor(205,95);
```



```

tft.print(「um/m3」);
// PM 1.0 Circle Frame
tft.drawCircle(220,170,40, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(205,140);
tft.print(「PM1.0」);
tft.setFontSize(1);
tft.setCursor(205,195);
tft.print(「um/m3」);
// right side bar, referenced from: http://taqm.epa.gov.tw/taqm/tw/
tft.fillRect(290, 30+ 0*2, 10, 12*2, pm25color[0]); // 0~11
tft.fillRect(290, 30+12*2, 10, 12*2, pm25color[1]); // 12-23
tft.fillRect(290, 30+24*2, 10, 12*2, pm25color[2]); // 24-35
tft.fillRect(290, 30+36*2, 10, 6*2, pm25color[3]); // 36-41
tft.fillRect(290, 30+42*2, 10, 6*2, pm25color[4]); // 42-47
tft.fillRect(290, 30+48*2, 10, 6*2, pm25color[5]); // 48-53
tft.fillRect(290, 30+54*2, 10, 6*2, pm25color[6]); // 54-58
tft.fillRect(290, 30+59*2, 10, 6*2, pm25color[7]); // 59-64
tft.fillRect(290, 30+65*2, 10, 6*2, pm25color[8]); // 65-70
tft.fillRect(290, 30+71*2, 10, 10*2, pm25color[9]); // >=71
tft.setCursor(302, 30);
tft.setFontSize(1);
tft.print(「0」);
tft.setCursor(302, 30+36*2);
tft.print(「36」);
tft.setCursor(302, 30+54*2);
tft.print(「54」);
tft.setCursor(302, 30+71*2);
tft.print(「71」);
// bottom right text

```

```
tft.setCursor(210,230);
tft.setFontSize(1);
tft.print(「Powered by Realtek」);
updateValueToTftScreen();
}

void updateValueToTftScreen() {
tft.setCursor(60, 111);
tft.setFontSize(5);
tft.setForeground( getPm25Color(pm25) );
if (pm25 < 10) {
tft.print(「」);
} else if (pm25 < 100) {
tft.print(「」);
}
tft.print(pm25);
tft.setCursor(195,60);
tft.setFontSize(3);
if (pm100 < 10) {
tft.print(「」);
} else if (pm100 < 100) {
tft.print(「」);
}
tft.print(pm100);
tft.setCursor(198,160);
if (pm10 < 10) {
tft.print(「」);
} else if (pm10 < 100) {
tft.print(「」);
}
tft.print(pm10);
```

```
tft.setFontSize(1);

tft.setForeground(ILI9341_WHITE);

if (last_pm25 > 80) {
tft.fillRect(275, 80*2+30-3, 12, 8, ILI9341_BLACK);
} else {
tft.fillRect(275, last_pm25*2+30-3, 12, 8, ILI9341_BLACK);
}

if (pm25 > 80) {
tft.setCursor(275, 80*2+30-3);
} else {
tft.setCursor(275, pm25*2+30-3);
}

tft.print(「=>」);
}

uint16_t getPm25Color(int v) {
if (v < 12) {
return pm25color[0];
} else if (v < 24) {
return pm25color[1];
} else if (v < 36) {
return pm25color[2];
} else if (v < 42) {
return pm25color[3];
} else if (v < 48) {
return pm25color[4];
} else if (v < 54) {
return pm25color[5];
} else if (v < 59) {
return pm25color[6];
} else if (v < 65) {
```

```
return pm25color[7];  
} else if (v < 71) {  
return pm25color[8];  
} else {  
return pm25color[9];  
}  
}
```

### Notes and Warnings

NA

### AmebaILI9341::begin

#### Description

Initialize hardware SPI, pin mapping and screen configuration

#### Syntax

```
void AmebaILI9341::begin(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

This method is required to run first before other operations on the display.

### AmebaILI9341::setAddress

#### Description

Initialize image size and positioning on the display

#### Syntax

```
void AmebaILI9341::setAddress(uint16_t x0, uint16_t y0, uint16_t x1, uint16_t y1)
```

#### Parameters

x0: leftmost coordinate of the image y0: top coordinate of the image x1: rightmost coordinate of the image y1: bottom coordinate of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Do not use this to set the cursor, use the “setCursor” method instead.

**AmebaILI9341::writecommand****Description**

Write a single-byte command to display

**Syntax**

```
void AmebaILI9341::writecommand(uint8_t command)
```

**Parameters**

command: a single byte command

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::writedata****Description**

Write 1 byte of data to display

**Syntax**

```
void AmebaILI9341::writedata(uint8_t data)
```

**Parameters**

data: 1 byte data

**Returns**

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Only use this method to write 1 byte at a time.

### AmebaILI9341::setRotation

#### Description

Setting screen orientation, “0” for no rotation, “1” for 90 degrees rotation and so on so forth.

#### Syntax

void AmebaILI9341::setRotation(uint8\_t m)/span> **Parameters**

m: one of the 4 rotation modes -> “0” for no rotation, “1” for 90<sup>0</sup>, “2” for 180<sup>0</sup>, “3” for 270<sup>0</sup>

#### Returns

The function returns nothing.

### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

if m=4, it’ s equivalent to mode 0, and m=5 for mode 1, m=6 for mode 2 so on so forth.

### AmebaILI9341::fillScreen

#### Description

Fill the entire screen with one color

#### Syntax

void AmebaILI9341::fillScreen(uint16\_t color)

#### Parameters

color: a 16-bit color reference defined in AmebaILI9341.h

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Refer to AmebaILI9341.h for available colors.

**AmebaILI9341::clr****Description**

Fill the entire screen with a certain background-color

**Syntax**

```
void AmebaILI9341::clr(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341

**Notes and Warnings**

background-color can be set by calling setBackground method.

**AmebaILI9341::fillRectangle****Description**

Fill a rectangular space with a color on the screen

**Syntax**

```
void AmebaILI9341::fillRectangle(int16_t x, int16_t y, int16_t w, int16_t h, uint16_t color)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image w: width of the image h: height of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

**Notes and Warnings**

NA

**AmebaILI9341::drawPixel**

**Description**

Turn on a pixel on the screen

**Syntax**

```
void AmebaILI9341::drawPixel(int16_t x, int16_t y, uint16_t color)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::drawChar****Description**

Draw character on the screen

**Syntax**

```
void AmebaILI9341::drawChar(unsigned char c) void AmebaILI9341::drawChar(int16_t x, int16_t y, unsigned char c, uint16_t _fontcolor, uint16_t _background, uint8_t _fontsize)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image c: a character \_fontcolor: font color \_background: background color \_fontsize: font size

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

In the actual example, the Print method is used to print a string of character on the screen instead of using this method.

**AmebaILI9341::drawLine****Description**

Draw a straight line on the screen

**Syntax**



```
void AmebaILI9341::drawLine(int16_t x0, int16_t y0, int16_t x1, int16_t y1) void AmebaILI9341::drawLine(int16_t x0, int16_t y0, int16_t x1, int16_t y1, uint16_t color)
```

#### Parameters

x0: leftmost coordinate of the image y0: top coordinate of the image x1: leftmost coordinate of the image y1: top coordinate of the image color: the color of the image

#### Returns

The function returns nothing.

#### Example Code

NA

#### Notes and Warnings

NA

### AmebaILI9341::drawRectangle

#### Description

Draw a rectangular shape on the screen

#### Syntax

```
void AmebaILI9341::drawRectangle(int16_t x, int16_t y, int16_t w, int16_t h) void AmebaILI9341::drawRectangle(int16_t x, int16_t y, int16_t w, int16_t h, uint16_t color)
```

#### Parameters

x: leftmost coordinate of the image y: top coordinate of the image w: width of the image h: height of the image color: the color of the image

#### Returns

The function returns nothing.

#### Example Code

NA

#### Notes and Warnings

NA

### AmebaILI9341::drawCircle

#### Description

Draw a circular shape on the screen

#### Syntax

```
void AmebaILI9341::drawCircle(int16_t x0, int16_t y0, int16_t r) void AmebaILI9341::drawCircle(int16_t x0, int16_t y0, int16_t r, uint16_t color)
```

### Parameters

x0: leftmost coordinate of the image y0: top coordinate of the image r: radius of the image color: the color of the image

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “AmebaServo.h” to use the class function.

### AmebaILI9341::write

#### Description

Same as drawChar, write a character on the screen

#### Syntax

```
size_t AmebaILI9341::write(uint8_t c)
```

#### Parameters

c: a character to be written on the screen

#### Returns

Number of bytes written

### Example Code

NA

### Notes and Warnings

This an inherited method from Print class and is seldom used.

### AmebaILI9341::getWidth

#### Description

Get the width of the image

#### Syntax

```
int16_t AmebaILI9341::getWidth(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

Width of the image

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::getHeight****Description**

Get the height of the image

**Syntax**

```
int16_t AmebaILI9341::getHeight(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

Height of the image

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::setCursor****Description**

Set the cursor to a specific position on the screen

**Syntax**

```
void AmebaILI9341::setCursor(int16_t x, int16_t y)
```

**Parameters**

x: coordinate on the x-axis y: coordinate on the y-axis

**Returns**

The function returns nothing.

**Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

**Notes and Warnings**

NA

### **AmebaILI9341::setForeground**

#### **Description**

Set foreground color

#### **Syntax**

```
void AmebaILI9341::setForeground(uint16_t color)
```

#### **Parameters**

color: one of the colors available in AmebaILI9341.h

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

#### **Notes and Warnings**

NA

### **AmebaILI9341::setBackground**

#### **Description**

Set background color

#### **Syntax**

```
void AmebaILI9341::setBackground(uint16_t _background)
```

#### **Parameters**

\_background: one of the colors available in AmebaILI9341.h

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

#### **Notes and Warnings**

NA

### **AmebaILI9341::setFontSize**

**Description**

Set the font size of the characters printed on the screen.

**Syntax**

```
void AmebaILI9341::setFontSize(uint8_t size)
```

**Parameters**

size: font size, default 1 for smallest, 5 for largest font size

**Returns**

The function returns nothing.

**Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

**Notes and Warnings**

NA

**AmebaILI9341::reset****Description**

Reset the pin to High or Low

**Syntax**

```
void AmebaILI9341::reset(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## Class SPISettings\_SPIClass

### SPISettings Class

#### Description

Defines a class to set SPI parameters.

#### Syntax

```
class SPISettings
```

#### Members

Public Constructors	
SPISettings::SPISettings	Create a SPISettings object and set SPI clock speed, bit order and data mode

### SPISettings::SPISettings

#### Description

Construct an object and configure SPI parameters —clock speed, bit order and data model to the preferred default value.

#### Syntax

```
SPISettings YourObject(uint32_t clock, BitOrder bitOrder, uint8_t dataMode);
```

#### Parameters

clock: SPI clock speed, default is 4000000

bitOrder: order of bit stream, MSB first or LSB first, default is MSBFIRST

dataMode: There are 4 modes -> SPI\_MODE0~3, default is SPI\_MODE0

#### Returns

The function returns nothing.

#### Example Code

NA

## Notes and Warnings

This class seldom used alone, it is always used with `beginTransaction()` as a parameter in `SPIClass`.

## SPIClass Class

### Description

Defines a class of SPI implementation for Ameba.

### Syntax

```
class SPIClass
```

### Members

Public Constructors	
<code>SPIClass::SPIClass</code>	Constructs an SPI object
Public Methods	
<code>SPIClass::transfer</code>	Transfer data through SPI
<code>SPIClass::transfer16</code>	Transfer a 16-bits data through SPI
<code>SPIClass::beginTransaction</code>	Set slave select pin and SPI initial settings
<code>SPIClass::endTransaction</code>	Stop SPI transaction
<code>SPIClass::begin</code>	Associate each SPI pin to Ameba pin using ameba HAL APIs
<code>SPIClass::end</code>	Stop SPI master mode
<code>SPIClass::setBitOrder</code>	Set MSB first or LSB first
<code>SPIClass::setDataMode</code>	Set to one of the four data modes
<code>SPIClass::setClockDivider</code>	Set to correct clock speed (no effect on Ameba)
<code>SPIClass::setDefaultFrequency</code>	Set default SPI frequency

## SPIClass::SPIClass

### Description

Construct an SPI object, create a pointer to the object, and attach “MOSI, MISO, CLK, and SS” to each pin on Ameba.

### Syntax

```
SPIClass(void *pSpiObj, int mosi, int miso, int clk, int ss);
```

**Parameters**

pSpiObj: SPI pointer to the object

mosi: master out slave in

miso: master in slave out

clk: clock

ss: slave select

**Returns**

The function returns nothing.

**Example Code**

```
SPIClass SPI((void *)&spi_obj0), 11, 12, 13, 10);
```

**Notes and Warnings**

2 SPI objects are created in the library for 2 different hardware SPI on Ameba (if applicable), use “SPI” for first hardware SPI and “SPI1” for the second.

**SPIClass::transfer****Description**

Calling HAL API to send data in the buffer to the slave

**Syntax**

```
byte SPIClass::transfer (byte _pin, uint8_t _data, SPITransferMode _mode);
```

```
byte SPIClass::transfer (uint8_t _data, SPITransferMode _mode);
```

```
void SPIClass::transfer (byte _pin, void *_buf, size_t _count, SPITransferMode _mode);
```

```
void SPIClass::transfer (void *_buf, size_t _count, SPITransferMode _mode);
```

**Parameters**

\_pin: Slave select pin

\_data: Actual data being sent over

\_mode: SPI transfer mode



\_count: number of bytes of data

\_buf: data buffer

### Returns

Void or “0” in case of error, “d” in case success

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::transfer16

### Description

Same as “transfer” method above except data being of 16-bits.

### Syntax

```
uint16_t SPIClass::transfer16(byte _pin, uint16_t _data, SPITransferMode _mode)
```

```
uint16_t SPIClass::transfer16(uint16_t _data, SPITransferMode _mode)
```

### Parameters

\_pin: Slave select pin

\_data: Actual data being sent over

\_mode: SPI transfer mode

### Returns

The data being transferred

### Example Code

NA

## Notes and Warnings

NA

## SPIClass::beginTransaction

### Description

Set slave select pin and initialize SPI with default settings using SPISettings class.

### Syntax

```
void SPIClass::beginTransaction(uint8_t pin, SPISettings settings)
```

```
void SPIClass::beginTransaction(SPISettings settings)
```

### Parameters

pin: slave select pin

settings: an object of SPISettings class

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

Refer to SPISettings class for details of the initial settings.

## SPIClass::endTransaction

### Description

Set slave select pin to 1 and stop SPI transaction.

**Syntax**

```
void SPIClass::endTransaction(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**SPIClass::begin****Description**

Calling HAL APIs to initialize SPI pins to physical Ameba pins and set SPI format and frequency

**Syntax**

```
void SPIClass::begin(void)
```

```
void SPIClass::begin(int ss)
```

**Parameters**

void or ss: slave select

**Returns**

The function returns nothing.

**Example Code**

NA

### Notes and Warnings

This is a required method to use SPI on Ameba.

### SPIClass::end

#### Description

Free hardware SPI from any activity.

#### Syntax

```
void SPIClass::end(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### SPIClass::setBitOrder

#### Description

A specific method to set bit order to either MSB first or LSB first and set slave select pin.

**Syntax**

```
void SPIClass::setBitOrder(uint8_t _pin, BitOrder _bitOrder)
void SPIClass::setBitOrder(BitOrder _order)
```

**Parameters**

\_pin: slave select  
\_bitOrder: bit order -> either MSB first or LSB first  
\_order: same as above

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**SPIClass::setDataMode****Description**

A specific method to set data mode to one of the 4 modes (default: SPI\_MODE0) and set slave select pin.

**Syntax**

```
void SPIClass::setDataMode(uint8_t _pin, uint8_t _mode)
void SPIClass::setDataMode(uint8_t _mode)
```

**Parameters**

\_pin: slave select  
\_mode: one of the 4 modes (default: SPI\_MODE0)

**Returns**

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::setClockDivider

### Description

A specific method to set to divider in order to get correct clock speed

### Syntax

```
void SPIClass::setClockDivider(uint8_t _pin, uint8_t _divider)
```

```
void SPIClass::setClockDivider(uint8_t _div)
```

### Parameters

\_pin: slave select

\_divider: clock divider

\_div: same as above

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This function does not affect the Ameba board.

## **SPIClass::setDefaultFrequency**

### **Description**

A specific method to set default SPI frequency

### **Syntax**

```
void SPIClass::setDefaultFrequency(int _frequency)
```

### **Parameters**

`_frequency`: the default SPI frequency

### **Returns**

The function returns nothing.

### **Example Code**

Example: PM25\_on\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### **Notes and Warnings**

Take note that `defaultFrequency = _frequency`.

## **Readme**

The Ameba SPI related APIs and examples are works based on SPI Master library for arduino written by Cristian Maglie <c.maglie@arduino.cc> and Paul Stoffregen <paul@pjrc.com> (Transaction API).

These include,

SPI.cpp

SPI.h

These libraries are under GNU Lesser General Public License, version 2.1.

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## Sys

### Wiring\_OS\_API

#### Wiring OS API

##### Description

A wrapper to CMSIS (Cortex Microcontroller Software Interface Standard) OS API which serve as a RTOS to create multi-threaded application with real-time behaviour.

##### Syntax

NA

##### Members

Public Methods	
os_thread_create_arduino	Create a thread and add it to Active Threads and set it to state READY
os_thread_get_id_arduino	Return the thread ID of the current running thread
os_thread_terminate_arduino	Terminate execution of a thread and remove it from Active Threads
os_thread_yield_arduino	Pass control to next thread that is in state READY
os_thread_set_priority_arduino	Change priority of an active thread
os_thread_get_priority_arduino	Get current priority of an active thread
os_signal_set_arduino	Set the specified Signal Flags of an active thread
os_signal_clear_arduino	Clear the specified Signal Flags of an active thread
os_signal_wait_arduino	Wait for one or more Signal Flags to become signaled for the current RUNNING thread
os_timer_create_arduino	Create a timer
os_timer_start_arduino	Start or restart a timer
os_timer_stop_arduino	Stop the timer
os_timer_delete_arduino	Delete a timer that was created by os_timer_create
os_semaphore_create_arduino	Create and Initialize a Semaphore object used for managing resources
os_semaphore_wait_arduino	Wait until a Semaphore token becomes available
os_semaphore_release_arduino	Release a Semaphore token
os_semaphore_delete_arduino	Delete a Semaphore that was created by os_semaphore_create
os_get_free_heap_size_arduino	Return the available heap memory space when called

##### os\_thread\_create\_arduino



## Description

Create a thread and add it to Active Threads and set it to state READY.

## Syntax

```
uint32_t os_thread_create_arduino (void (*task)(const void *argument), void *argument, int priority, uint32_t stack_size);
```

## Parameters

task: task Function pointer which is the thread body. It should not run into the end of function unless os\_thread\_terminate is invoked

argument: the data pointer which brings to task

priority: The underlying os is FreeRTOS. It executes tasks with highest priority which are not in idle state.

stack\_size: The stack\_size is used as memory heap only for this task.

## Returns

The thread id which is used in thread operation and signalling.

## Example Code

NA

## Notes and Warnings

NA

## os\_thread\_get\_id\_arduino

## Description

Return the thread ID of the current running thread

## Syntax

```
uint32_t os_thread_get_id_arduino (void);
```

## Parameters

The function requires no input parameter.

### Returns

Current thread id which calls `os_thread_get_id`.

### Example Code

NA

### Notes and Warnings

NA

## `os_thread_terminate_arduino`

### Description

Terminate execution of a thread and remove it from Active Threads

### Syntax

```
uint32_t os_thread_terminate_arduino (uint32_t thread_id);
```

### Parameters

`thread_id`: Terminate the thread with specific `thread_id`

### Returns

`os_status` code

### Example Code

NA

### Notes and Warnings

Thread should not ended without terminate first.

## os\_thread\_yield\_arduino

### Description

Pass control to next thread that is in state READY

### Syntax

```
uint32_t os_thread_yield_arduino (void);
```

### Parameters

The function requires no input parameter.

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

By default, the minimal execution unit is 1 millisecond. In a scenario that if a thread with smaller want to handout execution right to a thread with higher priority immediately without waiting for the ending of current 1 millisecond, then invoke os\_thread\_yield can transfer exection right to OS' s idle task and check which is the next execution thread.

## os\_thread\_set\_priority\_arduino

### Description

Change priority of an active thread

### Syntax

```
uint32_t os_thread_set_priority_arduino (uint32_t thread_id, int priority);
```

### Parameters

thread\_id: The target thread with the thread id to be changed  
priority: The updated priority

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## os\_thread\_get\_priority\_arduino

### Description

Get current priority of an active thread

### Syntax

```
uint32_t os_thread_get_priority_arduino (uint32_t thread_id);
```

### Parameters

thread\_id: The target thread with the thread id to be searched

### Returns

os\_priority

### Example Code

NA

### Notes and Warnings

NA

## **os\_signal\_set\_arduino**

### **Description**

Set the specified Signal Flags of an active thread

### **Syntax**

```
int32_t os_signal_set_arduino (uint32_t thread_id, int32_t signals);
```

### **Parameters**

thread\_id: Send signal to a thread with the thread id

signals: the signals to be send

### **Returns**

os\_status code

### **Example Code**

NA

### **Notes and Warnings**

NA

## **os\_signal\_clear\_arduino**

### **Description**

Clear the specified Signal Flags of an active thread

### **Syntax**

```
int32_t os_signal_clear_arduino (uint32_t thread_id, int32_t signals);
```

### Parameters

thread\_id: Clear signal to a thread with the thread id

signals: The signals to be clear

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_signal\_wait\_arduino

### Description

Wait for one or more Signal Flags to become signaled for the current RUNNING thread

### Syntax

```
os_event_t os_signal_wait_arduino (int32_t signals, uint32_t millisec);
```

### Parameters

signals: the signals to be wait

millisec: the timeout value if no signal comes in. Fill in 0xFFFFFFFF for infinite wait

### Returns

os\_status code

### Example Code

NA

**Notes and Warnings**

NA

**os\_timer\_create\_arduino****Description**

Create a timer

**Syntax**

```
uint32_t os_timer_create_arduino (void (*callback)(void const *argument), uint8_t isPeriodic, void *argument);
```

**Parameters**

callback: The function to be invoke when timer timeout

isPeriodic: OS\_TIMER\_ONCE or OS\_TIMER\_PERIODIC

argument: The argument that is bring into callback function

**Returns**

timer id

**Example Code**

NA

**Notes and Warnings**

NA

**os\_timer\_start\_arduino****Description**

Start or restart a timer

### Syntax

```
uint32_t os_timer_start_arduino (uint32_t timer_id, uint32_t millisec);
```

### Parameters

timer\_id: The timer id obtained from by os\_timer\_create

millisec: The delays after timer starts

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_timer\_stop\_arduino

### Description

Stop the timer

### Syntax

```
uint32_t os_timer_stop_arduino (uint32_t timer_id);
```

### Parameters

timer\_id: The timer id obtained from by os\_timer\_create

### Returns

os\_status code

### Example Code



NA

### Notes and Warnings

NA

## os\_timer\_delete\_arduino

### Description

Delete a timer that was created by os\_timer\_create

### Syntax

```
uint32_t os_timer_delete_arduino (uint32_t timer_id);
```

### Parameters

timer\_id: The timer id obtained from by os\_timer\_create

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_semaphore\_create\_arduino

### Description

Create and Initialize a Semaphore object used for managing resources

### Syntax

```
uint32_t os_semaphore_create_arduino (int32_t count);
```

### Parameters

count: The number of available resources

### Returns

semaphore ID

### Example Code

NA

### Notes and Warnings

NA

## os\_semaphore\_wait\_arduino

### Description

Wait until a Semaphore token becomes available

### Syntax

```
int32_t os_semaphore_wait_arduino (uint32_t semaphore_id, uint32_t millisec);
```

### Parameters

semaphore\_id: semaphore id obtained from os\_semaphore\_create

millisec: timeout value

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_semaphore\_release\_arduino

### Description

Release a Semaphore token

### Syntax

```
uint32_t os_semaphore_release_arduino (uint32_t semaphore_id);
```

### Parameters

semaphore\_id: semaphore id obtained from os\_semaphore\_create

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_semaphore\_delete\_arduino

### Description

Delete a Semaphore that was created by os\_semaphore\_create

### Syntax

```
uint32_t os_semaphore_delete_arduino (uint32_t semaphore_id);
```

### Parameters

semaphore\_id: semaphore id obtained from os\_semaphore\_create

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_get\_free\_heap\_size\_arduino

### Description

Return the available heap memory space when called

### Syntax

```
size_t os_get_free_heap_size_arduino(void);
```

### Parameters

The function requires no input parameter.

### Returns

current free heap size

### Example Code

Example: MemInfo

**Notes and Warnings**

NA

**WDT****Class WDT****WDT Class****Description**

A class used for initializing, starting, stopping watchdog timer.

**Syntax**

```
class WDT
```

**Members**

<b>Public Constructors</b>	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named WDT.	

<b>Public Methods</b>	
WDT:: InitWatchdog	Initializes the watchdog, include time setting, and mode register
WDT:: StartWatchdog	Start the watchdog counting
WDT:: StopWatchdog	Stop the watchdog counting
WDT:: RefreshWatchdog	Refresh the watchdog counting to prevent WDT timeout
WDT:: InitWatchdogIRQ	Switch the watchdog timer to interrupt mode and register a watchdog timer timeout interrupt handler

**WDT:: InitWatchdog****Description**

Initializes the watchdog, include time setting, and mode register.

**Syntax**

```
void InitWatchdog(uint32_t timeout_ms);
```

**Parameters**

timeout\_ms: the watch-dog timer timeout value in millisecond (ms). The default action after watchdog timer timeout is to reset the whole system.

**Returns**

The function returns nothing.

**Example Code**

Example: WatchdogTimer

```
/*
 * This example describes how to use watchdog api.
 * In this example, watchdog is setup to 5s timeout.
 * Watchdog won't bark if we refresh it before timeout in smallTask.
 * The timer is also reloaded after refresh.
 * Otherwise, while running bigTask, watchdog will restart system in default or call callback function if registered.
 */
#include 「wdt.h」

#define RUN_CALLBACK_IF_WATCHDOG_BARKS (0)

WDT wdt;

void setup() {
  Serial.begin(115200);

  wdt.InitWatchdog(5000); // setup 5s watchdog

  #if RUN_CALLBACK_IF_WATCHDOG_BARKS

  wdt.InitWatchdogIRQ(my_watchdog_irq_handler, 0);

  #else

  // system would restart in default when watchdog barks

  #endif
```

```

wdt.StartWatchdog(); // enable watchdog timer

successfulTask();

failedTask();

while (1)
;
}

void loop() {
}

void successfulTask(void) {
Serial.println(「 ...doing small task... 」 );
for (int i = 0; i < 50000000; i++) // dummy task
asm(「 nop」 );
Serial.println(「 refresh watchdogn」 );
wdt.RefreshWatchdog();
}

/*
* Doing this task will lead to failed refresh the
* watchdog timer within the time limits of 5 seconds
*/

void failedTask(void) {
Serial.println(「 ...doing big task... 」 );
for (int i = 0; i < 10; i++) {
Serial.print(「 doing dummy task #」 );
Serial.println(i, DEC);
for (int j = 0; j < 50000000; j++) // dummy task
asm(「 nop」 );
}
Serial.println(「 refresh watchdogn」 );
wdt.RefreshWatchdog();
}

```

```
void my_watchdog_irq_handler(uint32_t id) {  
    printf(「 watchdog barks!!!rn」 );  
    WDG_Cmd(DISABLE);  
}
```

### Notes and Warnings

NA

### WDT:: StartWatchdog

#### Description

Start the watchdog counting.

#### Syntax

```
void StartWatchdog(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

### Notes and Warnings

NA

### WDT:: StopWatchdog

#### Description



Stop the watchdog counting.

**Syntax**

```
void StopWatchdog(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

**Notes and Warnings**

NA

**WDT:: RefreshWatchdog****Description**

Refresh the watchdog counting to prevent WDT timeout.

**Syntax**

```
void RefreshWatchdog(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

### Example Code

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

### Notes and Warnings

NA

## WDT:: InitWatchdogIRQ

### Description

Switch the watchdog timer to interrupt mode and register a watchdog timer timeout interrupt handler. The interrupt handler will be called when the watchdog timer is timeout.

### Syntax

```
void WDT::InitWatchdogIRQ(wdt_irq_handler handler, uint32_t id)
```

### Parameters

handler: the callback function for WDT timeout interrupt.

id: the parameter for the callback function

### Returns

The function returns nothing.

### Example Code

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

### Notes and Warnings

NA

## WiFi

### Class WiFi

#### WiFiClass Class

#### Description

Defines a class of WiFi and network implementation for Ameba.

#### Syntax

```
class WiFiClass
```

#### Members

Public Constructors	
WiFiClass::WiFiClass	Constructs a WiFiClass object and initializes the WiFi libraries and network settings
Public Methods	
WiFiClass::firmwareVersion	Get firmware version
WiFiClass:: begin	Start Wifi connection for OPEN networks
WiFiClass:: config	Configure network IP settings
WiFiClass:: setDNS	Set the DNS server IP address to use
WiFiClass:: disconnect	Disconnect from the network
WiFiClass:: macAddress	Get the interface MAC address
WiFiClass:: localIP	Get the interface IP address
WiFiClass:: subnetMask	Get the interface subnet mask address
WiFiClass:: gatewayIP	Get the gateway IP address
WiFiClass:: SSID	Return the current SSID associated with the network
WiFiClass:: BSSID	Return the current BSSID associated with the network
WiFiClass:: RSSI	Return the current RSSI (Received Signal Strength in dBm) associated with the network
WiFiClass:: encryption-Type	Return the Encryption Type associated with the network
WiFiClass:: scanNetworks	Start scan WiFi networks available
WiFiClass:: SSID	Return the SSID discovered during the network scan
WiFiClass:: encryption-Type	Return the encryption type of the networks discovered during the scanNetworks
WiFiClass:: encryption-TypeEx	Return the security type and encryption type of the networks discovered during the scanNetworks
WiFiClass:: RSSI	Return the RSSI of the networks discovered during the scanNetworks
WiFiClass:: status	Return Connection status
WiFiClass:: hostByName	Resolve the given hostname to an IP address
WiFiClass:: apbegin	Start AP mode
WiFiClass:: disablePower-Save	Disable power-saving mode

**WiFiClass::WiFiClass****Description**

Constructs a WiFiClass object and initializes the WiFi libraries and network settings.

**Syntax**

```
WiFiClass::WiFiClass()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

An instance of WiFiClass is created as WiFi inside WiFi.h and is extern for direct use.

**WiFiClass::firmwareVersion****Description**

Get firmware version

**Syntax**

```
char* WiFiClass::firmwareVersion()
```

**Parameters**

The function requires no input parameter.

**Returns**

WiFi firmware version

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details.

```
#include <WiFi.h>
```

```
// char ssid[] = 「yourNetwork」 ; // your network SSID (name)
// char pass[] = 「secretPassword」 ; // your network password
char ssid[] = 「SINGTEL-D45F」 ; // your network SSID (name)
char pass[] = 「mooxuteeth」 ; // your network key
int status = WL_IDLE_STATUS; // the Wifi radio's status

void setup() {

//Initialize serial and wait for port to open:
Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:
if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don't continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to WPA SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network:

status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:

delay(10000);

}
```

```
// you' re connected now, so print out the data:
Serial.print( 「You' re connected to the network」 );
printCurrentNet();
printWifiData();
}

void loop() {

// check the network connection once every 10 seconds:
delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield' s IP address:
IPAddress ip = WiFi.localIP();
Serial.print( 「IP Address: 」);
Serial.println(ip);
Serial.println(ip);

// print your MAC address:
byte mac[6];
WiFi.macAddress(mac);
Serial.print( 「MAC address: 」);
Serial.print(mac[0], HEX);
Serial.print( 「:」 );
Serial.print(mac[1], HEX);
Serial.print( 「:」 );
Serial.print(mac[2], HEX);
Serial.print( 「:」 );
Serial.print(mac[3], HEX);
Serial.print( 「:」 );
Serial.print(mac[4], HEX);
Serial.print( 「:」 );
```

```
Serial.println(mac[5], HEX);

}

void printCurrentNet() {

// print the SSID of the network you' re attached to:

Serial.print(「SSID: 」);

Serial.println(WiFi.SSID());

// print the MAC address of the router you' re attached to:

byte bssid[6];

WiFi.BSSID(bssid);

Serial.print(「BSSID: 」);

Serial.print(bssid[5], HEX);

Serial.print(「:」 );

Serial.print(bssid[4], HEX);

Serial.print(「:」 );

Serial.print(bssid[3], HEX);

Serial.print(「:」 );

Serial.print(bssid[2], HEX);

Serial.print(「:」 );

Serial.print(bssid[1], HEX);

Serial.print(「:」 );

Serial.println(bssid[0], HEX);

// print the received signal strength:

long rssi = WiFi.RSSI();

Serial.print(「 signal strength (RSSI):」 );

Serial.println(rssi);

// print the encryption type:

byte encryption = WiFi.encryptionType();

Serial.print(「Encryption Type:」 );

Serial.println(encryption, HEX);

Serial.println();
```



```
}
```

### Notes and Warnings

NA

### WiFiClass::begin

#### Description

Start Wifi connection for OPEN networks

#### Syntax

```
int WiFiClass::begin(char* ssid)
int WiFiClass::begin(char* ssid, uint8_t key_idx, const char *key)
int WiFiClass::begin(char* ssid, const char *passphrase)
```

#### Parameters

ssid: Pointer to the SSID string

key\_idx: The key index to set. Valid values are 0-3.

key: Key input buffer.

passphrase: Passphrase. Valid characters in a passphrase must be between ASCII 32-126 (decimal).

#### Returns

WiFi status

#### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

### Notes and Warnings

NA

## WiFiClass::config

### Description

Configure network settings for the WiFi network

### Syntax

```
void WiFiClass::config(IPAddress local_ip)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server, IPAddress gateway)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server, IPAddress gateway, IPAddress subnet)
```

### Parameters

local\_ip: Local device IP address to use on the network  
dns\_server: IP address of the DNS server to use  
gateway: IP address of the gateway device on the network  
subnet: Subnet mask for the network, expressed as a IP address

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This will disable the DHCP client when connecting to a network, and will require the network accepts a static IP. The configured IP addresses will also apply to AP mode, but the DHCP server will not be disabled in AP mode.

## WiFiClass::setDNS

### Description

Configure the IP address of the DNS server to use

### Syntax

```
void WiFiClass::setDNS(IPAddress dns_server1)
void WiFiClass::setDNS(IPAddress dns_server1, IPAddress dns_server2)
```

**Parameters**

dns\_server1: IP address of DNS server to use

dns\_server2: IP address of DNS server to use

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiClass::disconnect****Description**

Disconnect from the network

**Syntax**

```
int WiFiClass::disconnect()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns one value of wl\_status\_t enum as an integer.

**Example Code**

NA

## Notes and Warnings

NA

## WiFiClass::macAddress

### Description

Get the interface MAC address

### Syntax

```
uint8_t* WiFiClass::macAddress(uint8_t* mac)
```

### Parameters

mac: an array to store MAC address

### Returns

The function returns a pointer to uint8\_t array with length WL\_MAC\_ADDR\_LENGTH.

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

## Notes and Warnings

NA

## WiFiClass::localIP

### Description

Get the interface IP address

### Syntax

IPAddress WiFiClass::localIP()

### Parameters

The function requires no input parameter.

### Returns

Ip address value

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of WiFiClass:: firmwareVersion.

### Notes and Warnings

NA

## WiFiClass::subnetMask

### Description

Get the interface subnet mask address

### Syntax

IPAddress WiFiClass::subnetMask()

### Parameters

The function requires no input parameter.

### Returns

subnet mask address value

### Example Code

Example: ConnectNoEncryption

This example demonstrates how to connect to an unencrypted WiFi network and prints the MAC address of the WiFi shield, the IP address obtained, and other network details.

```
#include <WiFi.h>

char ssid[] = 「SINGTEL-D45F_5G」 ; // the name of your network
int status = WL_IDLE_STATUS; // the Wifi radio' s status

void setup() {
  //Initialize serial and wait for port to open:
  Serial.begin(9600);

  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }

  // check for the presence of the shield:
  if (WiFi.status() == WL_NO_SHIELD) {
    Serial.println( 「WiFi shield not present」 );
    // don' t continue:
    while (true);
  }

  String fv = WiFi.firmwareVersion();
  if (fv != 「1.1.0」 ) {
    Serial.println( 「Please upgrade the firmware」 );
  }

  // attempt to connect to Wifi network:
  while (status != WL_CONNECTED) {
    Serial.print( 「Attempting to connect to open SSID: 」);
    Serial.println(ssid);
    status = WiFi.begin(ssid);

    // wait 10 seconds for connection:
    delay(10000);
  }
```

```
// you' re connected now, so print out the data:
Serial.print( 「You' re connected to the network」 );
printCurrentNet();
printWifiData();
}

void loop() {

// check the network connection once every 10 seconds:
delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield' s IP address:
IPAddress ip = WiFi.localIP();
Serial.print( 「IP Address: 」);
Serial.println(ip);
Serial.println(ip);

// print your MAC address:
byte mac[6];
WiFi.macAddress(mac);
Serial.print( 「MAC address: 」);
Serial.print(mac[0], HEX);
Serial.print( 「:」 );
Serial.print(mac[1], HEX);
Serial.print( 「:」 );
Serial.print(mac[2], HEX);
Serial.print( 「:」 );
Serial.print(mac[3], HEX);
Serial.print( 「:」 );
Serial.print(mac[4], HEX);
Serial.print( 「:」 );
```

```
Serial.println(mac[5], HEX);

// print your subnet mask:
IPAddress subnet = WiFi.subnetMask();

Serial.print(「NetMask: 」);

Serial.println(subnet);

// print your gateway address:
IPAddress gateway = WiFi.gatewayIP();

Serial.print(「Gateway: 」);

Serial.println(gateway);

}

void printCurrentNet() {

// print the SSID of the network you' re attached to:
Serial.print(「SSID: 」);

Serial.println(WiFi.SSID());

// print the MAC address of the router you' re attached to:
byte bssid[6];

WiFi.BSSID(bssid);

Serial.print(「BSSID: 」);

Serial.print(bssid[5], HEX);

Serial.print(「:」 );

Serial.print(bssid[4], HEX);

Serial.print(「:」 );

Serial.print(bssid[3], HEX);

Serial.print(「:」 );

Serial.print(bssid[2], HEX);

Serial.print(「:」 );

Serial.print(bssid[1], HEX);

Serial.print(「:」 );

Serial.println(bssid[0], HEX);

// print the received signal strength:
```



```
long rssi = WiFi.RSSI();  
Serial.print( 「 signal strength (RSSI):」 );  
Serial.println(rssi);  
  
// print the encryption type:  
byte encryption = WiFi.encryptionType();  
Serial.print( 「 Encryption Type:」 );  
Serial.println(encryption, HEX);  
}
```

### Notes and Warnings

NA

### WiFiClass::gatewayIP

#### Description

Get the gateway IP address

#### Syntax

```
IPAddress WiFiClass::gatewayIP()
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the value of the gateway IP address.

#### Example Code

Example: ConnectNoEncryption

This example demonstrates how to connect to an unencrypted WiFi network and prints the MAC address of the WiFi shield, the IP address obtained, and other network details. Details of the code can be found in the section of WiFiClass::subnetMask.

## Notes and Warnings

NA

## WiFiClass::SSID

### Description

Return the current SSID associated with the network

### Syntax

```
char* WiFiClass::SSID()
```

### Parameters

The function requires no input parameter.

### Returns

The function returns current SSID associate with the network.

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

## Notes and Warnings

NA

## WiFiClass::BSSID

### Description

Return the current BSSID associated with the network

### Syntax

```
uint8_t* WiFiClass::BSSID(uint8_t* bssid)
```

### Parameters

bssid: an array to store bssid

### Returns

pointer to uint8\_t array with length WL\_MAC\_ADDR\_LENGTH

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

### Notes and Warnings

NA

## WiFiClass::RSSI

### Description

Return the current RSSI (Received Signal Strength in dBm) associated with the network

### Syntax

```
int32_t WiFiClass::RSSI()
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a signed-value signal strength

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

### Notes and Warnings

NA

### WiFiClass::encryptionType

#### Description

Return the Encryption Type associated with the network

#### Syntax

```
uint8_t WiFiClass::encryptionType()
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns one unsigned integer value of `wl_enc_type` enum.

### Example Code

Example: ConnectWithWPA

### Notes and Warnings

NA

### WiFiClass::scanNetworks

#### Description

Start scan WiFi networks available

**Syntax**

```
int8_t WiFiClass::scanNetworks()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the number of discovered networks as an integer.

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified.

```
#include <WiFi.h>
```

```
void setup() {
```

```
//Initialize serial and wait for port to open:
```

```
Serial.begin(9600);
```

```
while (!Serial) {
```

```
; // wait for serial port to connect. Needed for native USB port only
```

```
}
```

```
// check for the presence of the shield:
```

```
if (WiFi.status() == WL_NO_SHIELD) {
```

```
Serial.println( "WiFi shield not present" );
```

```
// don't continue:
```

```
while (true);
```

```
}
```

```
String fv = WiFi.firmwareVersion();
```

```
if (fv != "1.1.0" ) {
```

```
Serial.println( "Please upgrade the firmware" );
```

```
}
```

```
// Print WiFi MAC address:

printMacAddress();

}

void loop() {
  // scan for existing networks:
  Serial.println(「Scanning available networks…」);
  listNetworks();
  delay(10000);
}

void printMacAddress() {
  // the MAC address of your Wifi shield
  byte mac[6];

  // print your MAC address:
  WiFi.macAddress(mac);
  Serial.print(「MAC: 」);
  Serial.print(mac[0], HEX);
  Serial.print(「:」);
  Serial.print(mac[1], HEX);
  Serial.print(「:」);
  Serial.print(mac[2], HEX);
  Serial.print(「:」);
  Serial.print(mac[3], HEX);
  Serial.print(「:」);
  Serial.print(mac[4], HEX);
  Serial.print(「:」);
  Serial.println(mac[5], HEX);
}

void listNetworks() {
  // scan for nearby networks:
  Serial.println(「 * Scan Networks *」);
```

```

int numSsid = WiFi.scanNetworks();

if (numSsid == -1) {
  Serial.println(「 Couldn't get a wifi connection」 );

  while (true);
}

// print the list of networks seen:
Serial.print(「 number of available networks:」 );
Serial.println(numSsid);

// print the network number and name for each network found:
for (int thisNet = 0; thisNet < numSsid; thisNet++) {
  Serial.print(thisNet);
  Serial.print(「 」 );
  Serial.print(WiFi.SSID(thisNet));
  Serial.print(「 tSignal: 」 );
  Serial.print(WiFi.RSSI(thisNet));
  Serial.print(「 dBm」 );
  Serial.print(「 tEncryptionRaw: 」 );
  printEncryptionTypeEx(WiFi.encryptionTypeEx(thisNet));
  Serial.print(「 tEncryption: 」 );
  printEncryptionType(WiFi.encryptionType(thisNet));
}
}

void printEncryptionTypeEx(uint32_t thisType) {
  /* Arduino wifi api use encryption type to mapping to security type.
  * This function demonstrate how to get more richful information of security type.
  */

  switch (thisType) {
  case SECURITY_OPEN:
    Serial.print(「 Open」 );
    break;

```

```
case SECURITY_WEP_PSK:
Serial.print( 「WEP」 );
break;
case SECURITY_WPA_TKIP_PSK:
Serial.print( 「WPA TKIP」 );
break;
case SECURITY_WPA_AES_PSK:
Serial.print( 「WPA AES」 );
break;
case SECURITY_WPA2_AES_PSK:
Serial.print( 「WPA2 AES」 );
break;
case SECURITY_WPA2_TKIP_PSK:
Serial.print( 「WPA2 TKIP」 );
break;
case SECURITY_WPA2_MIXED_PSK:
Serial.print( 「WPA2 Mixed」 );
break;
case SECURITY_WPA_WPA2_MIXED:
Serial.print( 「WPA/WPA2 AES」 );
break;
}
}

void printEncryptionType(int thisType) {
// read the encryption type and print out the name:
switch (thisType) {
case ENC_TYPE_WEP:
Serial.println( 「WEP」 );
break;
case ENC_TYPE_TKIP:
```



```
Serial.println(「WPA」);  
break;  
case ENC_TYPE_CCMP:  
Serial.println(「WPA2」);  
break;  
case ENC_TYPE_NONE:  
Serial.println(「None」);  
break;  
case ENC_TYPE_AUTO:  
Serial.println(「Auto」);  
break;  
}  
}
```

## Notes and Warnings

NA

## WiFiClass::SSID

### Description

Return the SSID discovered during the network scan

### Syntax

```
char* WiFiClass::SSID(uint8_t networkItem)
```

### Parameters

networkItem: specify from which network item want to get the information

### Returns

The function returns ssid string of the specified item on the networks scanned a list.

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::encryptionType****Description**

Return the encryption type of the networks discovered during the `scanNetworks`

**Syntax**

```
uint8_t WiFiClass::encryptionType(uint8_t networkItem)
```

**Parameters**

`networkItem`: specify from which network item want to get the information

**Returns**

encryption type (enum `wl_enc_type`) of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::encryptionTypeEx**

**Description**

Return the security type and encryption type of the networks discovered during the scanNetworks

**Syntax**

```
uint32_t WiFiClass::encryptionTypeEx(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

security and encryption type of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of WiFiClass:: scanNetworks.

**Notes and Warnings**

NA

**WiFiClass::RSSI****Description**

Return the RSSI of the networks discovered during the scanNetworks

**Syntax**

```
int32_t WiFiClass::RSSI(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

signed value of RSSI of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::status****Description**

Return Connection status

**Syntax**

```
uint8_t WiFiClass::status()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns one of the values defined in `wl_status_t` as an unsigned integer.

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

**Notes and Warnings**

NA

## **WiFiClass::hostByName**

### **Description**

Resolve the given hostname to an IP address

### **Syntax**

```
int WiFiClass::hostByName(const char* aHostname, IPAddress& aResult)
```

### **Parameters**

aHostname: Name to be resolved

aResult: IPAddress structure to store the returned IP address

### **Returns**

The function returns “1” if aIPAddrString was successfully converted to an IP address,else otherwise, it will return as an error code.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **WiFiClass::apbegin**

### **Description**

Start AP mode

### **Syntax**

```
int WiFiClass::apbegin(char* ssid, char* channel)
```

```
int WiFiClass::apbegin(char* ssid, char* password, char* channel)
```

**Parameters**

ssid: SSID of the AP network

channel: AP' s channel, default 1

password: AP' s password

**Returns**

The function will return the WiFi status.

**Example Code**

Example: WiFiAPMode

**#include**

```
char ssid[] = 「yourNetwork」 ;//Set the AP' s SSID

char pass[] = 「Password」 ;//Set the AP' s password

char channel[] = 「1」 ;//Set the AP' s channel

int status = WL_IDLE_STATUS; // the Wifi radio' s status

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}
```

```
// attempt to start AP:

while (status != WL_CONNECTED) {

Serial.print(「 Attempting to start AP with SSID: 」);

Serial.println(ssid);

status = WiFi.apbegin(ssid, pass, channel);

delay(10000);

}

//AP MODE already started:

Serial.println(「 AP mode already started」 );

Serial.println();

printWifiData();

printCurrentNet();

}

void loop() {

// check the network connection once every 10 seconds:

delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield's IP address:

IPAddress ip = WiFi.localIP();

Serial.print(「 IP Address: 」);

Serial.println(ip);

// print your subnet mask:

IPAddress subnet = WiFi.subnetMask();

Serial.print(「 NetMask: 」);

Serial.println(subnet);

// print your gateway address:

IPAddress gateway = WiFi.gatewayIP();

Serial.print(「 Gateway: 」);
```

```
Serial.println(gateway);

Serial.println();

}

void printCurrentNet() {
// print the SSID of the AP:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());
// print the MAC address of AP:
byte bssid[6];
WiFi.BSSID(bssid);
Serial.print(「BSSID: 」);
Serial.print(bssid[0], HEX);
Serial.print(「:」 );
Serial.print(bssid[1], HEX);
Serial.print(「:」 );
Serial.print(bssid[2], HEX);
Serial.print(「:」 );
Serial.print(bssid[3], HEX);
Serial.print(「:」 );
Serial.print(bssid[4], HEX);
Serial.print(「:」 );
Serial.println(bssid[5], HEX);
// print the encryption type:
byte encryption = WiFi.encryptionType();
Serial.print(「Encryption Type:」 );
Serial.println(encryption, HEX);
Serial.println();
}
```

## Notes and Warnings



NA

## **WiFiClass::disablePowerSave**

### **Description**

Disable power-saving mode

### **Syntax**

```
int WiFiClass::disablePowerSave()
```

### **Parameters**

The function requires no input parameter.

### **Returns**

1 if disable success, 0 if failed

### **Example Code**

NA

### **Notes and Warnings**

NA

## **Class WiFiClient**

### **WiFiClient Class**

### **Description**

Defines a class of WiFi Client implementation for Ameba.

### **Syntax**

```
class WiFiClient
```

## Members

Public Constructors	
WiFiClient::WiFiClient	Constructs a WiFiClient instance that connects to the specified IP address and port.
Public Methods	
WiFiClient::connect	Connect to the IP address and port
WiFiClient::write	Write a single byte into the packet
WiFiClient::available	Number of bytes remaining in the current packet
WiFiClient::read	Read a single byte from the current packet
WiFiClient:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiClient:: flush	Finish reading the current packet
WiFiClient::stop	Stop client connection
WiFiClient::connected	Check if client is connected, return 1 if connected, 0 if not
WiFiClient::setRecvTimeout	Set receiving timeout

## WiFiClient::WiFiClient

### Description

Constructs a WiFiClient instance that connects to the specified IP address and port.

### Syntax

```
WiFiClient::WiFiClient()
```

```
WiFiClient::WiFiClient(uint8_t sock)
```

### Parameters

sock: socket state, default -1.

### Returns

The function returns nothing.

### Example Code

Example: WiFiWebClient

```
#include <WiFi.h>
```

```
char ssid[] = 「yourNetwork」 ; // your network SSID (name)
```

```

char pass[] = 「password」 ; // your network password (use for WPA, or use as key for WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

//IPAddress server(64,233,189,94); // numeric IP for Google (no DNS)

char server[] = 「www.google.com」 ; // name address for Google (using DNS)

WiFiClient client;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

;

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don' t continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:

delay(10000);

```

```
}

Serial.println(「Connected to wifi」);

printWifiStatus();

Serial.println(「nStarting connection to server...」);

// if you get a connection, report back via serial:

if (client.connect(server, 80)) {

  Serial.println(「connected to server」);

  // Make a HTTP request:

  client.println(「GET /search?q=ameba HTTP/1.1」);

  client.println(「Host: www.google.com」);

  client.println(「Connection: close」);

  client.println();

}

}

void loop() {

  // if there are incoming bytes available

  // from the server, read them and print them:

  while (client.available()) {

    char c = client.read();

    Serial.write(c);

  }

  // if the server's disconnected, stop the client:

  if (!client.connected()) {

    Serial.println();

    Serial.println(「disconnecting from server.」);

    client.stop();

    // do nothing forevermore:

    while (true);

  }

}
```

```

void printWifiStatus() {
// print the SSID of the network you're attached to:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());
// print your WiFi shield's IP address:
IPAddress ip = WiFi.localIP();
Serial.print(「IP Address: 」);
Serial.println(ip);
// print the received signal strength:
long rssi = WiFi.RSSI();
Serial.print(「signal strength (RSSI):」 );
Serial.print(rssi);
Serial.println(「 dBm」 );
}

```

## Notes and Warnings

NA

## WiFiClient::connect

### Description

Connect to the IP address and port

### Syntax

```

int WiFiClient::connect(IPAddress ip, uint16_t port)
int WiFiClient::connect(const char *host, uint16_t port)

```

### Parameters

ip: IP address

host: Host name

port: the port to listen on

### Returns

Returns “1” : if successful

Returns “0” : if failed

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

### WiFiClient::write

### Description

Write a single byte into the packet

### Syntax

size\_t WiFiClient::write(uint8\_t byte)

size\_t WiFiClient::write(const uint8\_t \*buf, size\_t size)

### Parameters

byte: the outgoing byte

buf: the outgoing message

size: the size of the buffer

### Returns

The function returns single byte into the packet or returns bytes size from buffer into the packet.

### Example Code

NA

### Notes and Warnings

NA

## WiFiClient::available

### Description

Number of bytes remaining in the current packet

### Syntax

```
int WiFiClient::available(void)
```

### Parameters

The function requires no input parameter.

### Returns

- Function returns the number of bytes available in the current packet

Function returns 0: if no data available

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::read

### Description

Read a single byte from the current packet

### Syntax

```
int WiFiClient::read()
int WiFiClient::read(unsigned char* buf, size_t size)
int WiFiClient::read(char *buf, size_t size)
```

### Parameters

buf: buffer to hold incoming packets (char\*)  
size: maximum size of the buffer (int)

### Returns

size: the size of the buffer  
-1: if no buffer is available

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::peek

### Description

Return the next byte from the current packet without moving on to the next byte

### Syntax

```
int WiFiClient::peek(void)
```

### Parameters

The function requires no input parameter.

### Returns

b: the next byte or character



-1: if none is available

### **Example Code**

NA

### **Notes and Warnings**

NA

## **WiFiClient::flush**

### **Description**

Finish reading the current packet

### **Syntax**

```
void WiFiClient::flush(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **WiFiClient::stop**

### Description

Disconnect from the server. Stop client connection

### Syntax

```
void WiFiClient::stop(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::connected

### Description

Check if client is connected, return 1 if connected, 0 if not.

### Syntax

```
uint8_t WiFiClient::connected(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “1” if connected, returns “0” if not connected.

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::setRecvTimeout

### Description

Set receiving timeout

### Syntax

```
int WiFiClient::setRecvTimeout(int timeout)
```

### Parameters

timeout: timeout in seconds

### Returns

0

### Example Code

NA

### Notes and Warnings

NA

## Class WiFiServer

### WiFiServer Class

#### Description

Defines a class of WiFi server implementation for Ameba.

#### Syntax

```
class WiFiServer
```

#### Members

Public Constructors	
WiFiServer::WiFiServer(uint16_t port)	Constructs a WiFiServer object and creates a server that listens for incoming connections on the specified port
Public Methods	
WiFiServer::available()	Gets a client that is connected to the server and has data available for reading. The connection persists when the returned client object goes out of scope; you can close it by calling the client.stop()
WiFiServer::begin()	Tells the server to begin listening for incoming connections
WiFiServer::write(const uint8_t* data, size_t len)	Write data to all the clients connected to a server

### WiFiServer::WiFiServer

#### Description

Constructs a WiFiServer object and creates a server that listens for incoming connections on the specified port.

#### Syntax

```
WiFiServer::WiFiServer(uint16_t port)
```

#### Parameters

port: The port number being connected to.

**Returns**

The function returns nothing.

**Example Code**

Example: SimpleServerWiFi

```
#include <WiFi.h>

char ssid[] = 「yourNetwork」 ; // your network SSID (name)

char pass[] = 「secretPassword」 ; // your network password

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

WiFiServer server(5000);

void setup() {

  Serial.begin(9600); // initialize serial communication

  pinMode(9, OUTPUT); // set the LED pin mode

  // check for the presence of the shield:

  if (WiFi.status() == WL_NO_SHIELD) {

    Serial.println( 「WiFi shield not present」 );

    while (true); // don' t continue

  }

  String fv = WiFi.firmwareVersion();

  if ( fv != 「1.1.0」 )

    Serial.println( 「Please upgrade the firmware」 );

  // attempt to connect to Wifi network:

  while ( status != WL_CONNECTED) {

    Serial.print( 「Attempting to connect to Network named: 」);

    Serial.println(ssid); // print the network name (SSID);

    // Connect to WPA/WPA2 network. Change this line if using open or WEP network:

    status = WiFi.begin(ssid, pass);

    // wait 10 seconds for connection:
```

```
delay(10000);

}

server.begin(); // start the tcp server on port 5000

printWifiStatus(); // you're connected now, so print out the status

}

char buffer[256];

void loop() {
  WiFiClient client = server.available();

  while (client.connected()) {
    memset(buffer, 0, 256);

    int n = client.read(((uint8_t*)(&buffer[0]), sizeof(buffer)););

    if (n > 0) {
      for (int i=0; i<n; i++) {
        Serial.print(buffer[i]);
      }

      n = client.write(buffer, n);

      if (n <= 0) break;
    }
  }

  client.stop();
}

void printWifiStatus() {
  // print the SSID of the network you're attached to:
  Serial.print(「SSID: 」);
  Serial.println(WiFi.SSID());

  // print your WiFi shield's IP address:
  IPAddress ip = WiFi.localIP();
  Serial.print(「IP Address: 」);
  Serial.println(ip);

  // print the received signal strength:
```

```
long rssi = WiFi.RSSI();  
Serial.print(「 signal strength (RSSI):」 );  
Serial.print(rssi);  
Serial.println(「 dBm」 );  
}
```

### Notes and Warnings

NA

## WiFiServer::available

### Description

Gets a client that is connected to the server and has data available for reading. The connection persists when the returned client object goes out of scope; you can close it by calling the client.stop().

### Syntax

WiFiClient WiFiServer::available(uint8\_t\* status)

### Parameters

status: WiFi availability status

### Returns

A Client object; if no Client has data available for reading, this object will evaluate to false in an if-statement

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## WiFiServer::begin

### Description

Tells the server to begin listening for incoming connections

### Syntax

```
void WiFiServer::begin(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## WiFiServer::write

### Description

Write data to all the clients connected to a server

### Syntax

```
size_t WiFiServer::write(uint8_t b)  
size_t WiFiServer::write(const uint8_t *buf, size_t size)
```

### Parameters



b: byte to be written

buf: data buffer

size: Size of the data in the buffer

### Returns

The function returns the number of bytes written. It is not necessary to read this.

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## Class WiFiSSLClient

### WiFiSSLClient Class

### Description

Defines a class of WiFi Secure Socket Layer Client implementation for Ameba.

### Syntax

```
class WiFiSSLClient
```

### Members

Public Constructors	
WiFiSSLClient::WiFiSSLClient	Constructs a WiFiSSLClient instance that always connects in SSL to the specified IP address and port
Public Methods	
WiFiSSLClient::connect	Connect to the IP address and port
WiFiSSLClient::write	Write a single byte into the packet
WiFiSSLClient::available	Number of bytes remaining in the current packet
WiFiSSLClient::read	Read a single byte from the current packet
WiFiSSLClient:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiSSLClient:: flush	Finish reading the current packet
WiFiSSLClient::stop	Stop SSL client connection
WiFiSSLClient::connected	Check if SSL client is connected, return 1 if connected, 0 if not
WiFiSSLClient:: setRootCA	Set Root CA for authentication
WiFiSSLClient:: set-ClientCertificate	Set certificate of the client
WiFiSSLClient::setRecvTimeout	Set receiving timeout
WiFiSSLClient::setPreSharedKey	Set the pre shared key (PSK) to use for authentication

**WiFiSSLClient::WiFiSSLClient****Description**

Constructs a WiFiSSLClient instance that always connects in SSL to the specified IP address and port.

**Syntax**

WiFiSSLClient::WiFiSSLClient(void)

WiFiSSLClient::WiFiSSLClient(uint8\_t sock)

**Parameters**

sock: socket state, default -1

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiSSLClient

```

#include

char ssid[] = 「yourNetwork」 ;// your network SSID (name)

char pass[] = 「secretPassword」 ;// your network password (use for WPA, or WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

char server[] = 「www.google.com」 ;// name address for Google (using DNS)

//unsigned char test_client_key[] = 「」 ;//For the usage of verifying client
//unsigned char test_client_cert[] = 「」 ;//For the usage of verifying client
//unsigned char test_ca_cert[] = 「」 ;//For the usage of verifying server

WiFiSSLClient client;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don' t continue:

while (true);

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid,pass);

// wait 10 seconds for connection:

delay(10000);

```

```
}

Serial.println(「Connected to wifi」);

printWifiStatus();

Serial.println(「nStarting connection to server...」);

// if you get a connection, report back via serial:

if (client.connect(server, 443)) { //client.connect(server, 443, test_ca_cert, test_client_cert, test_client_key)

Serial.println(「connected to server」);

// Make a HTTP request:

client.println(「GET /search?q=realtek HTTP/1.0」);

client.println(「Host: www.google.com」);

client.println(「Connection: close」);

client.println();

}

else

Serial.println(「connected to server failed」);

}

void loop() {

// if there are incoming bytes available

// from the server, read them and print them:

while (client.available()) {

char c = client.read();

Serial.write(c);

}

// if the server's disconnected, stop the client:

if (!client.connected()) {

Serial.println();

Serial.println(「disconnecting from server.」);

client.stop();

// do nothing forevermore:

while (true);
```

```
}  
}  
  
void printWifiStatus() {  
    // print the SSID of the network you're attached to:  
    Serial.print( "SSID: ");  
    Serial.println(WiFi.SSID());  
  
    // print your WiFi shield's IP address:  
    IPAddress ip = WiFi.localIP();  
    Serial.print( "IP Address: ");  
    Serial.println(ip);  
  
    // print your MAC address:  
    byte mac[6];  
    WiFi.macAddress(mac);  
    Serial.print( "MAC address: ");  
    Serial.print(mac[0], HEX);  
    Serial.print( ":" );  
    Serial.print(mac[1], HEX);  
    Serial.print( ":" );  
    Serial.print(mac[2], HEX);  
    Serial.print( ":" );  
    Serial.print(mac[3], HEX);  
    Serial.print( ":" );  
    Serial.print(mac[4], HEX);  
    Serial.print( ":" );  
    Serial.println(mac[5], HEX);  
  
    // print the received signal strength:  
    long rssi = WiFi.RSSI();  
    Serial.print( "signal strength (RSSI):" );  
    Serial.print(rssi);  
    Serial.println( " dBm" );  
}
```

```
}
```

## Notes and Warnings

NA

## WiFiSSLClient::connect

### Description

Connect to the IP address and port.

### Syntax

```
int WiFiSSLClient::connect(IPAddress ip, uint16_t port)
```

```
int WiFiSSLClient::connect(const char *host, uint16_t port)
```

```
int WiFiSSLClient::connect(const char* host, uint16_t port, unsigned char* rootCABuff, unsigned char* cli_cert, unsigned char* cli_key)
```

```
int WiFiSSLClient::connect(IPAddress ip, uint16_t port, unsigned char* rootCABuff, unsigned char* cli_cert, unsigned char* cli_key)
```

### Parameters

ip: IP address

host: Host name

port: the port to listen on

rootCABuff: buffer that store root CA

cli\_cert: buffer that store client certificate

cli\_key buffer that store client key pair

### Returns

1: if successful

0: if failed

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

**Notes and Warnings**

NA

**WiFiSSLClient::write****Description**

Write a single byte into the packet

**Syntax**

```
size_t WiFiSSLClient::write(uint8_t byte)
```

```
size_t WiFiSSLClient::write(const uint8_t *buf, size_t size)
```

**Parameters**

byte: the outgoing byte

buf: the outgoing message

size: the size of the buffer

**Returns**

The function returns single -byte into the packet or turns bytes size from the buffer into the packet.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiSSLClient::available****Description**

Number of bytes remaining in the current packet

**Syntax**

int WiFiSSLClient::available(void)

### Parameters

The function requires no input parameter.

### Returns

The function returns the number of bytes available in the current packet; else return “0:” if no data available.

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

### Notes and Warnings

NA

## WiFiSSLClient::read

### Description

Read a single byte from the current packet

### Syntax

int WiFiSSLClient::read()

int WiFiSSLClient::read(unsigned char\* buf, size\_t size)

### Parameters

buf: buffer to hold incoming packets (char\*)

size: maximum size of the buffer (int)

### Returns

size: the size of the buffer

-1: if no buffer is available



**Example Code**

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

**Notes and Warnings**

NA

**WiFiSSLClient::peek****Description**

Return the next byte from the current packet without moving on to the next byte.

**Syntax**

```
int WiFiSSLClient::peek(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

b: the next byte or character

-1: if none is available

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiSSLClient::flush****Description**

Finish reading the current packet

### Syntax

`void WiFiSSLClient::flush(void)`

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### WiFiSSLClient::stop

### Description

Disconnect from the server. Stop SSL client connection

### Syntax

`void WiFiSSLClient::stop(void)`

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::connected

### Description

Check if SSL client is connected, return 1 if connected, 0 if not.

### Syntax

```
uint8_t WiFiSSLClient::connected(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “1” if connected, returns “0” if not connected.

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::setRootCA

### Description

Set Root CA for authentication

### Syntax

```
void WiFiSSLClient::setRootCA(unsigned char *rootCA)
```

### Parameters

rootCA: a string of rootCA

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiSSLClient::setClientCertificate

### Description

Set certificate of client

### Syntax

```
void WiFiSSLClient::setClientCertificate(unsigned char *client_ca, unsigned char *private_key)
```

### Parameters

client\_ca: Client certificate

private\_key: client's private key pair

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiSSLClient::setRecvTimeout

### Description

Set receiving timeout

### Syntax

```
int WiFiSSLClient::setRecvTimeout(int timeout)
```

### Parameters

timeout: timeout in seconds

### Returns

The function returns “0” .

### Example Code

NA

### Notes and Warnings

NA

## WiFiSSLClient::setPreSharedKey

### Description

Set the pre shared key (PSK) to use for authentication

### Syntax

```
void WiFiSSLClient::setPreSharedKey(unsigned char *pskIdent, unsigned char *psKey)
```

### Parameters

pskIdent: identity for PSK

psKey: Pre shared key

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Do not set a root CA and client certificate if PSK should be used for authentication. If root CA, client certificate and PSK are all set, certificate based authentication will be used.

## Class WiFiUdp

### WiFiUDP Class

#### Description

Defines a class of WiFi UDP implementation for Ameba.

#### Syntax

```
class WiFiUDP
```

#### Members

<b>Public Constructors</b>	
WiFiUDP::WiFiUDP	Constructs a WiFiUDP instance of the WiFi UDP class that can send and receive UDP messages
<b>Public Methods</b>	
WiFiUDP:: begin	initialize, start listening on the specified port. Returns 1 if successful, 0 if there are no sockets available to use
WiFiUDP:: stop	Finish with the UDP socket
WiFiUDP:: begin-Packet	Start building up a packet to send to the remote host-specific in IP and port
WiFiUDP:: endPacket	Finish off this packet and send it
WiFiUDP:: write	Write a single byte into the packet
WiFiUDP:: writeImmediately	Send packet immediately from the buffer
WiFiUDP:: parsePacket	Start processing the next available incoming packet
WiFiUDP::available	Number of bytes remaining in the current packet
WiFiUDP::read	Read a single byte from the current packet
WiFiUDP:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiUDP:: flush	Finish reading the current packet
WiFiUDP:: remoteIP	Return the IP address of the host who sent the current incoming packet
WiFiUDP:: remotePort	Return the port of the host who sent the current incoming packet
WiFiUDP:: setRecv-Timeout	Set receiving timeout

## WiFiUDP::WiFiUDP

### Description

Constructs a WiFiUDP instance of the WiFi UDP class that can send and receive UDP messages.

### Syntax

```
WiFiUDP::WiFiUDP(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort.

```
#include <WiFi.h>

#include <WiFiUdp.h>

int status = WL_IDLE_STATUS;

char ssid[] = 「yourNetwork」 ; // your network SSID (name)

char pass[] = 「secretPassword」 ; // your network password (use for WPA, or use as key for WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

unsigned int localPort = 2390; // local port to listen on

char packetBuffer[255]; //buffer to hold incoming packet

char ReplyBuffer[] = 「acknowledged」 ; // a string to send back

WiFiUDP Udp;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don't continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}
```



```

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「 Attempting to connect to SSID:  」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid,pass);

// wait 10 seconds for connection:

delay(10000);

}

Serial.println( 「 Connected to wifi 」 );

printWifiStatus();

Serial.println(「 nStarting connection to server... 」 );

// if you get a connection, report back via serial:

Udp.begin(localPort);

}

void loop() {

// if there' s data available, read a packet

int packetSize = Udp.parsePacket();

if (packetSize) {

Serial.print( 「 Received packet of size  」);

Serial.println(packetSize);

Serial.print( 「 From  」);

IPAddress remoteIp = Udp.remoteIP();

Serial.print(remoteIp);

Serial.print(「 , port  」);

Serial.println(Udp.remotePort());

// read the packet into packetBuffer

int len = Udp.read(packetBuffer, 255);

if (len > 0) {

packetBuffer[len] = 0;

```

```
}  
  
Serial.println(「Contents:」);  
  
Serial.println(packetBuffer);  
  
// send a reply, to the IP address and port that sent us the packet we received  
Udp.beginPacket(Udp.remoteIP(), Udp.remotePort());  
  
Udp.write(ReplyBuffer);  
  
Udp.endPacket();  
  
}  
  
}  
  
void printWifiStatus() {  
  // print the SSID of the network you're attached to:  
  Serial.print(「SSID: 」);  
  Serial.println(WiFi.SSID());  
  
  // print your WiFi shield's IP address:  
  IPAddress ip = WiFi.localIP();  
  Serial.print(「IP Address: 」);  
  Serial.println(ip);  
  
  // print the received signal strength:  
  long rssi = WiFi.RSSI();  
  Serial.print(「signal strength (RSSI):」);  
  Serial.print(rssi);  
  Serial.println(「 dBm」);  
}
```

### Notes and Warnings

This constructor does not take in any parameter, thus use another method to set up the IP address and port number.

### WiFiUDP::begin

**Description**

Initialize, start listening on the specified port. Returns 1 if successful, 0 if there are no sockets available to use.

**Syntax**

```
uint8_t WiFiUDP::begin(uint16_t port)
```

**Parameters**

port: the local port to listen on

**Returns**

1: if successful

0: if there are no sockets available to use

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

**Notes and Warnings**

NA

**WiFiUDP::stop****Description**

Disconnect from the server. Release any resource being used during the UDP session.

**Syntax**

```
void WiFiUDP::stop(void)
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiUDP::beginPacket

### Description

Start building up a packet to send to the remote host-specific in IP and port.

### Syntax

```
int WiFiUDP::beginPacket(const char *host, uint16_t port)
```

```
int WiFiUDP::beginPacket(IPAddress ip, uint16_t port)
```

### Parameters

host: hostname

port: port number

ip: IP address

### Returns

1: if successful

0: if there was a problem with the supplied IP address or port

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

**Notes and Warnings**

NA

**WiFiUDP::endPacket****Description**

Finish off this packet and send it

**Syntax**

```
int WiFiUDP::endPacket(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

1: if the packet was sent successfully

0: if there was an error

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

**Notes and Warnings**

NA

**WiFiUDP::write****Description**

Write a single byte into the packet.

### Syntax

size\_t WiFiUDP::write(uint8\_t byte)

size\_t WiFiUDP::write(const uint8\_t \*buffer, size\_t size)

### Parameters

byte: the outgoing byte

buffer: the outgoing message

size: the size of the buffer

### Returns

single-byte into the packet

bytes size from the buffer into the packet

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

## WiFiUDP::writeImmediately

### Description

Send packet immediately from the buffer

### Syntax

size\_t WiFiUDP::writeImmediately(const uint8\_t \*buffer, size\_t size)

### Parameters

buffer: the outgoing message

size: the size of the buffer

**Returns**

single-byte into the packet

bytes size from the buffer into the packet

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::parsePacket****Description**

Start processing the next available incoming packet

**Syntax**

```
int WiFiUDP::parsePacket(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the size of the packet in bytes or returns “0:” if no packets are available.

**Example Code**

Example: WiFiUdpSendReceiveString

**Notes and Warnings**

NA

## WiFiUDP::available

### Description

Number of bytes remaining in the current packet.

### Syntax

```
int WiFiUDP::available(void)
```

### Parameters

The function requires no input parameter.

### Returns

the number of bytes available in the current packet

0: if parsePacket hasn't been called yet

### Example Code

NA

### Notes and Warnings

NA

## WiFiUDP::read

### Description

Read a single byte from the current packet

### Syntax

```
int WiFiUDP::read()
```

```
int WiFiUDP::read(unsigned char* buffer, size_t len)
```



**Parameters**

buffer: buffer to hold incoming packets (char\*)

len: maximum size of the buffer (int)

**Returns**

size: the size of the buffer

-1: if no buffer is available

**Example Code**

Example: WiFiUdpSendReceiveString

his example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

**Notes and Warnings**

NA

**WiFiUDP::peek****Description**

Return the next byte from the current packet without moving on to the next byte

**Syntax**

int WiFiUDP::peek(void)

**Parameters**

The function requires no input parameter.

**Returns**

b: the next byte or character

-1: if none is available

### Example Code

NA

### Notes and Warnings

NA

## WiFiUDP::flush

### Description

Finish reading the current packet

### Syntax

```
void WiFiUDP::flush(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiUDP::remoteIP

### Description

Return the IP address of the host who sent the current incoming packet

**Syntax**

IPAddress WiFiUDP::remoteIP(void)

**Parameters**

The function requires no input parameter.

**Returns**

IP address connecting to

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

**Notes and Warnings**

NA

**WiFiUDP::remotePort****Description**

Return the port of the host who sent the current incoming packet

**Syntax**

uint16\_t WiFiUDP::remotePort(void)

**Parameters**

The function requires no input parameter.

**Returns**

The remote port connecting to

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

### WiFiUDP::setRecvTimeout

#### Description

Set receiving timeout

#### Syntax

```
void WiFiUDP::setRecvTimeout(int timeout)
```

#### Parameters

timeout in seconds

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Readme

The Ameba WiFi related APIs and examples are works based on Arduino WiFi shield libraries (<https://www.arduino.cc/en/Reference/WiFi>).

These include,

- `WiFi.cpp`
- `WiFi.h`
- `WiFiServer.cpp`
- `WiFiServer.h`
- `WiFiUdp.cpp`
- `WiFiUdp.h`

These libraries are under GNU Lesser General Public License, either version 2.1 of the License, or (at your option) any later version.

---

## Wire

### Class TwoWire

#### TwoWire Class

#### Description

Defines a class of I2C API

#### Syntax

```
class TwoWire
```

#### Members

Public Constructors	
TwoWire::TwoWire	Constructs a TwoWire object
Public Methods	
TwoWire::begin	Initialize I2C master/slave
TwoWire::setClock	Set I2C frequency
TwoWire::beginTransaction	Begin I2C transmission
TwoWire::endTransmission	End I2C transmission
TwoWire::requestFrom	Set I2C requestFrom
TwoWire::write	Write data to I2C
TwoWire::available	Check if I2C is available
TwoWire::read	Read data from I2C
TwoWire::peek	Read peek from I2C
TwoWire::flush	Do nothing, use, and transmission(..) to force data transfer
TwoWire::onReceive	Callback function when I2C on receive
TwoWire::onRequest	Callback function when I2C on request

## TwoWire::TwoWire

### Description

Constructs a TwoWire object.

### Syntax

```
TwoWire::TwoWire (uint32_t dwSDAPin, uint32_t dwSCLPin);
```

### Parameters

dwSDAPin: The Arduino PIN to be set as an SDA pin.

dwSCLPin: The Arduino PIN to be set as an SCL pin.

### Returns

The function returns nothing.

### Example Code

Example: MasterWriter

This example demonstrates the use of the wire library writes to an I2C/TWI slave device.

```

#include <Wire.h>

void setup() {
  Wire.begin(); // join i2c bus (address optional for master)
}

byte x = 0;

void loop() {
  Wire.beginTransmission(8); // transmit to device #8
  Wire.write( " x is "); // sends five bytes
  Wire.write(x); // sends one byte
  Wire.endTransmission(); // stop transmitting
  x++;
  delay(500);
}

```

Example: MasterReader

```

#include <Wire.h>

void setup() {
  Wire.begin(); // join i2c bus (address optional for master)
  Serial.begin(9600); // start serial for output
}

void loop() {
  Wire.requestFrom(8, 6); // request 6 bytes from slave device #8
  while (Wire.available()) { // slave may send less than requested
    char c = Wire.read(); // receive a byte as character
    Serial.print(c); // print the character
  }
  delay(500);
}

```

This example demonstrates the use of the wire library reads data from an I2C/TWI slave device.

## Notes and Warnings

Include “Wire.h” to use the class function.

## **TwoWire::begin**

### **Description**

Initialize I2C master/slave.

### **Syntax**

```
void TwoWire::begin (void);  
void TwoWire::begin (uint8_t address = 0);  
void TwoWire::begin (int address);
```

### **Parameters**

void: Set the I2C master mode.

address: Set the I2C master mode with slave address value.

### **Returns**

The function returns nothing.

### **Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### **Notes and Warnings**

Include “Wire.h” to use the class function.

## **TwoWire::setClock**

### **Description**

Set I2C frequency.



**Syntax**

```
void TwoWire::setClock(uint32_t frequency);
```

**Parameters**

frequency: The frequency values.

**Returns**

The function returns nothing.

**Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

**Notes and Warnings**

Include “Wire.h” to use the class function.

**TwoWire::beginTransmission****Description**

Begin I2C transmission.

**Syntax**

```
void TwoWire::beginTransmission (uint8_t address);
```

```
void TwoWire::beginTransmission (int address);
```

**Parameters**

address: The transmission address.

**Returns**

The function returns nothing.

**Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

**Notes and Warnings**

Include “Wire.h” to use the class function.

**TwoWire::endTransmission****Description**

End I2C transmission. Originally, ‘endTransmission’ was an f(void) function. It has been modified to take one parameter indicating whether or not a STOP should be performed on the bus. Calling endTransmission(false) allows a sketch to perform a repeated start.

WARNING: Nothing in the library keeps track of whether the bus tenure has been properly ended with a STOP. It is very possible to leave the bus in a hung state if no call to endTransmission(true) is made. Some I2C devices will behave oddly if they do not see a STOP.

If the input parameter is void, this provides backward compatibility with the original definition, and expected behavior, of endTransmission.

**Syntax**

```
uint8_t TwoWire::endTransmission (uint8_t sendStop);
```

```
uint8_t TwoWire::endTransmission (void);
```

**Parameters**

sendStop: True to end the transmission

**Returns**

Return 0 if successful, else error.

**Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::requestFrom

### Description

Set I2C requestFrom.

### Syntax

```
uint8_t TwoWire::requestFrom (uint8_t address, uint8_t quantity, uint8_t sendStop);  
uint8_t TwoWire::requestFrom (uint8_t address, uint8_t quantity);  
uint8_t TwoWire::requestFrom(int address, int quantity);  
uint8_t TwoWire::requestFrom (int address, int quantity, int sendStop);
```

### Parameters

address: I2C read address.

quantity: I2C read quantity.

sendStop: True to end the transmission.

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

**TwoWire::write****Description**

Write data to I2C.

**Syntax**

```
size_t TwoWire::write (uint8_t data);  
size_t TwoWire::write (const uint8_t *data, size_t quantity);
```

**Parameters**

data: The data to be transmitted.

quantity: The quantity of data.

**Returns**

Return 0 if successful, else error.

**Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

**Notes and Warnings**

Include “Wire.h” to use the class function.

**TwoWire::available****Description**

Check if I2C is available.

**Syntax**

```
int TwoWire::available (void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return 0 if successful, else error.

**Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

**Notes and Warnings**

Include “Wire.h” to use the class function.

**TwoWire::read****Description**

Read data from I2C

**Syntax**

```
int TwoWire::read (void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The read data from the receive buffer.

**Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::peek

#### Description

Read peek from I2C.

#### Syntax

```
int TwoWire::peek (void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The peek data read from the receive buffer.

#### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::flush

#### Description

Do nothing, use endTransmission(..) to force data transfer.

#### Syntax

```
void TwoWire::flush (void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

### Notes and Warnings

Include “Wire.h” in order to use the class function.

## TwoWire::onReceive

### Description

Callback function when I2C on receive.

### Syntax

```
void TwoWire::onReceive (void(*function)(int));
```

### Parameters

function: The callback function.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

## Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::onRequest

### Description

Callback function when I2C on request.

### Syntax

```
void TwoWire::onRequest (void(*function)(void));
```

### Parameters

function: The callback function

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

## Notes and Warnings

Include “Wire.h” to use the class function.

## Wire\_Readme

The Ameba LCD related api and example are works based on “New LiquidCrystal library” (<https://bitbucket.org/fmalpartida/new-liquidcrystal/>).

These include,

LCD.h

LCD.cpp



I2CIO.h

I2CIO.cpp

LiquidCrystal\_I2C.h

LiquidCrystal\_I2C.cpp

examples/LcdHelloWorld/LcdHelloWorld.ino

These files inherit the licence of “New LiquidCrystal Library” which are under a Creative Commons Attribution-ShareAlike 3.0 Unported License. CC BY-SA 3.0.

## 1.1.6 Resources

### Links

- [AmebaD Arduino Github](#)
- [Arduino Website](#)

## 1.1.7 Support

### FAQ

---

#### Where to buy Ameba RTL8722DM Board?

Refer to [Purchase link](#).

---

---

#### Which Bluetooth standards are supported by RTL8722CSM/RTL8722DM?

Both boards support BLE 5.0. Classic Bluetooth (BR/EDR) is not supported.

---

---

#### Which BLE roles are supported?

RTL8722CSM/RTL8722DM can operate as either a BLE Central or BLE Peripheral device.

---

---

#### Are all pins on RTL8722CSM/RTL8722DM usable?

No, those marked NC are not connected to any pin and thus unusable.

---

---

**Is XIP (execute in place) supported on RTL8722CSM/RTL8722DM?**

Yes, it is supported.

---

---

**Does RTL8722CSM support 5G WiFi?**

No. Only RTL8722DM supports dual band 2.4G + 5G WiFi. RTL8722CSM only supports single band 2.4G WiFi.

---

---

**How to enter the download mode?**

Press and hold the UART DOWNLOAD button. Then Press the RESET button and release both UART DOWNLOAD and RESET buttons.

---

---

**Trouble shooting**

---

**RTL8722CSM/RTL8722DM cannot be found as a Bluetooth device.**

Please make sure the antenna is connected properly. Check your code for the correct Bluetooth configurations.

---

---

**My code is not behaving as I expected.**

Try to debug your program using `printf()` and `Serial.print()` statements. If the issue persists, you can ask for help at [Forums](#)

---

---

**Why is there no output on my serial terminal after connecting to RTL8722CSM/RTL8722DM UART?**

RTL8722CSM/RTL8722DM is by default configured at 115200 baudrate, please check if your serial terminal is configured to 115200.

---

---

**My program is not being downloaded into RTL8722CSM/RTL8722DM?**

---

**Please follow the procedure for the correct downloading:**

1. Enter the download mode. The on-board Green LED will blink when entered download mode.
  2. When downloading the image into board the on-board Red LED will blink
  3. After a successful download, you will see log like this “All images sent successfully” .
- 

**Sometimes WiFi signal is weak?**

The default antenna for RTL8722CSM/RTL8722DM uses the I-Pex Connector. Please change/connect the I-Pex Connector antenna.

---

**Why is my board not powering up?**

Please make sure the connector J38 beside resistor R43 is connected. The connector is used to link the power to IC.

---

**If you have driver issue to connect board to your computer?**

Please go to <https://ftdichip.com/drivers/> for USB driver.

---

## 1.2 AMB23 (RTL8722DM MINI)

Welcome to AMB23 Arduino online documentation.



## 1.2.1 Getting Started

### Ameba ARDUINO: Getting Started with AMB23

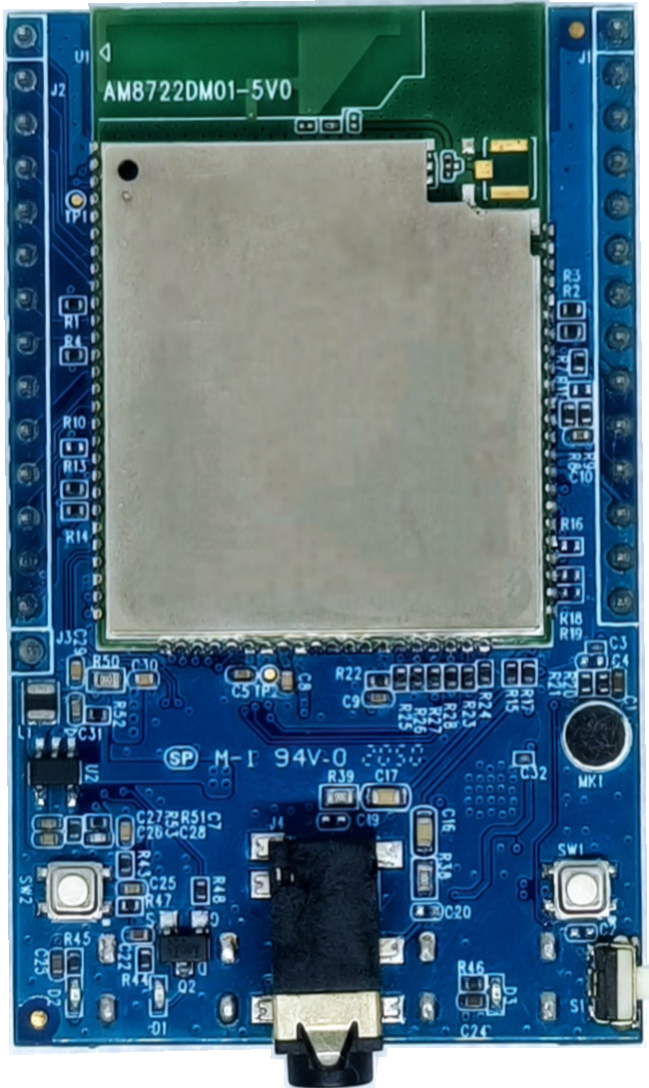
#### Required Environment

AMB23 board currently supports Windows OS 32-bits and 64-bits (WIN7/8/10), Linux OS (Ubuntu 18 LTS/20 LTS/latest) and macOS operating systems. Please use the latest OS version to have the best experiences. In this documentation, please use the latest version Arduino IDE (at least version 1.8.12).

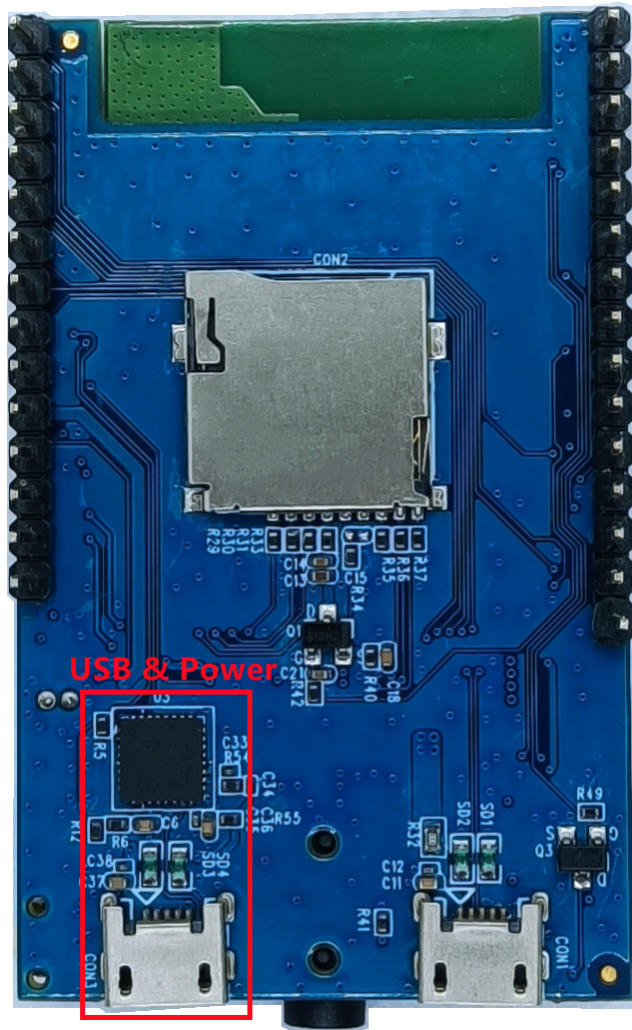
#### Introduction to AmebaD[AMB23]

Ameba is an easy-to-program platform for developing all kind of IoT applications. AmebaD is equipped with various peripheral interfaces, including WiFi, GPIO INT, I2C, UART, SPI, PWM, ADC. Through these interfaces, AmebaD can connect with electronic components such as LED, switches, manometer, hygrometer, PM2.5 dust sensors, ...etc.

The collected data can be uploaded via WiFi and be utilized by applications on smart devices to realize IoT implementation.



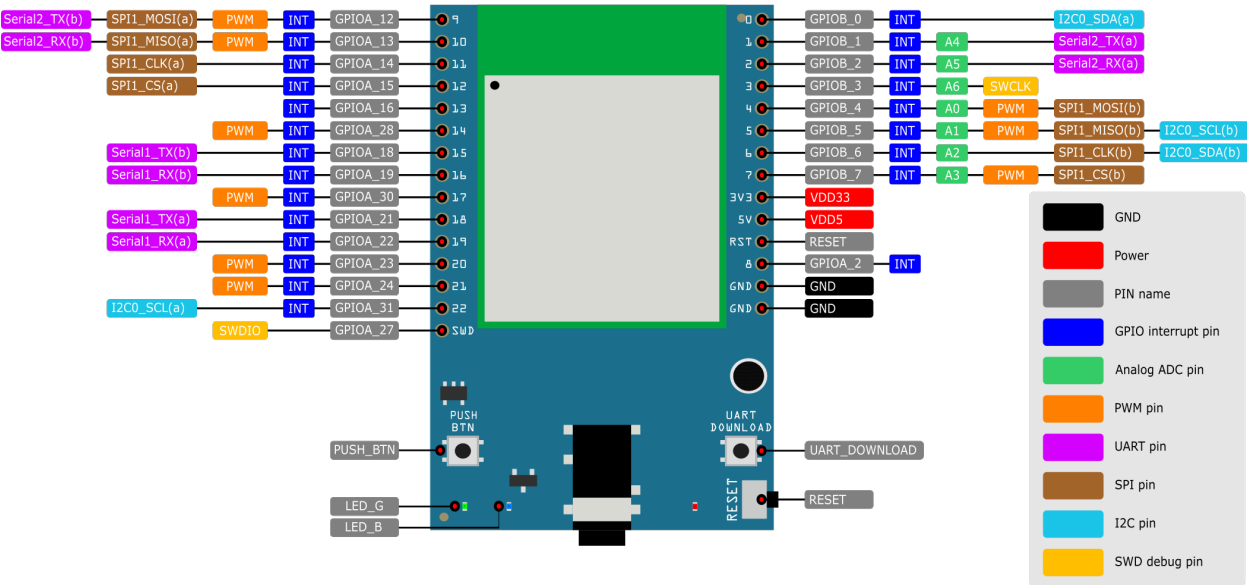
AMB23 has smaller size than Arduino Uno, as shown in the above figure.



AMB23 uses Micro USB to supply power, which is common in many smart devices.

Please refer to the following figure and table for the pin diagram and function of AMB23.

# AMB23 EVB



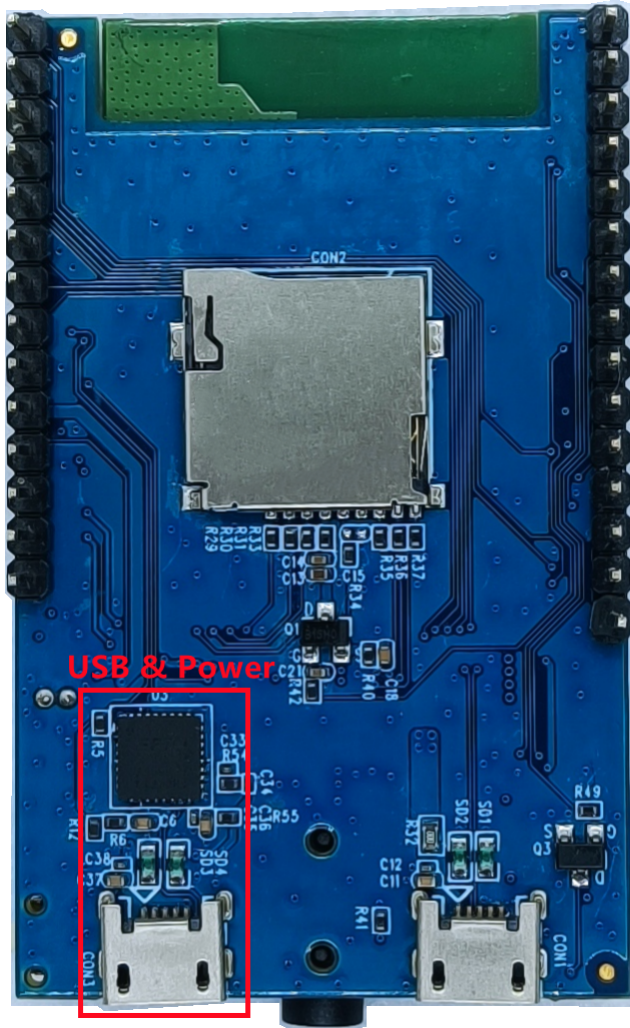
#	PIN name	GPIO INT	ADC	PWM	UART	SPI	I2C
D0	GPIOB_0	✓					I2C0 SDA
D1	GPIOB_1	✓	A4		Serial2_TX		
D2	GPIOB_2	✓	A5		Serial2_RX		
D3	GPIOB_3	✓	A6				
D4	GPIOB_4	✓	A0	✓			
D5	GPIOB_5	✓	A1	✓			I2C0 SCL
D6	GPIOB_6	✓	A2				I2C0 SDA
D7	GPIOB_7	✓	A3	✓			
D8	GPIOA_2	✓					
D9	GPIOA_12	✓		✓	Serial2_TX	SPI1_MOSI	
D10	GPIOA_13	✓		✓	Serial2_RX	SPI1_MISO	
D11	GPIOA_14	✓				SPI1_CLK	
D12	GPIOA_15	✓				SPI1_CS	
D13	GPIOA_16	✓					
D14	GPIOA_28	✓		✓			
D15	GPIOA_18	✓			Serial1_TX		
D16	GPIOA_19	✓			Serial1_RX		
D17	GPIOA_30	✓		✓			
D18	GPIOA_21	✓			Serial1_TX		
D19	GPIOA_22	✓			Serial1_RX		
D20	GPIOA_23	✓		✓			
D21	GPIOA_24	✓		✓			
D22	GPIOA_31	✓					I2C0 SCL

## Setting up Development Environment

### Step 1. Installing the Driver

First, connect AMB23 to the computer via Micro USB (same as power):

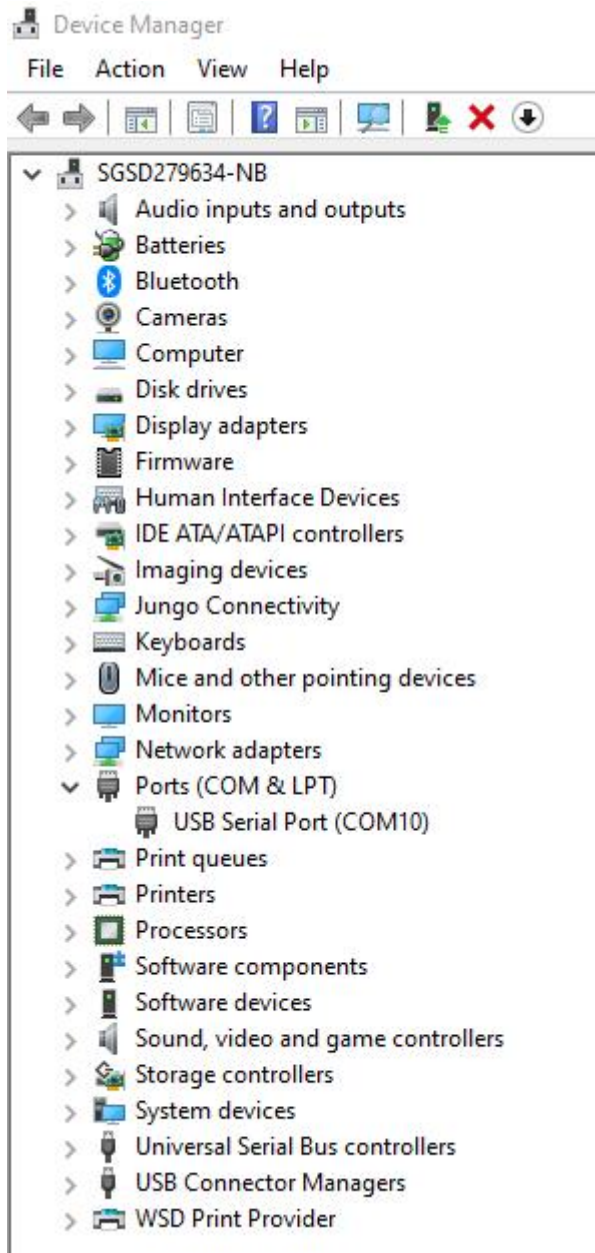




If this is the first time you connect AMB23 to your computer, the USB driver for AMB23 will be automatic installed.

If you have driver issue of connect board to your computer please go to [here](#) for USB driver.

You can check the COM port number in Device Manager of your computer:



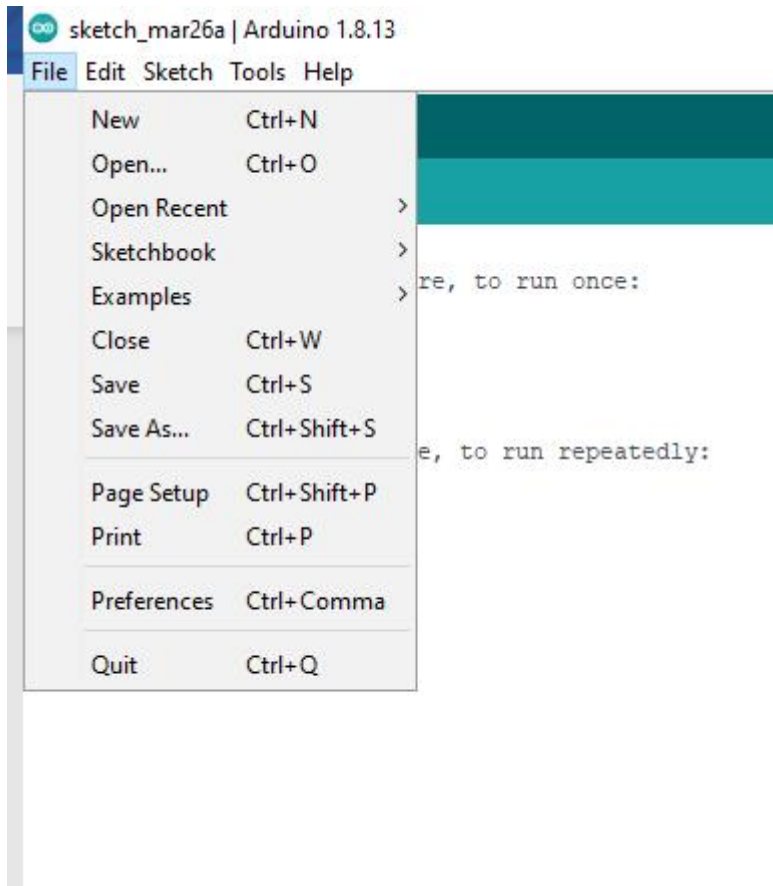
## Step 2. Set up Arduino IDE

From version 1.6.5, Arduino IDE supports third-party hardware. Therefore, we can use Arduino IDE to develop applications on AMB23, and the examples of Arduino can run on AMB23 too. Refer to [basic example link](#).

Arduino IDE can be downloaded in the Arduino website:

<https://www.arduino.cc/en/Main/Software>

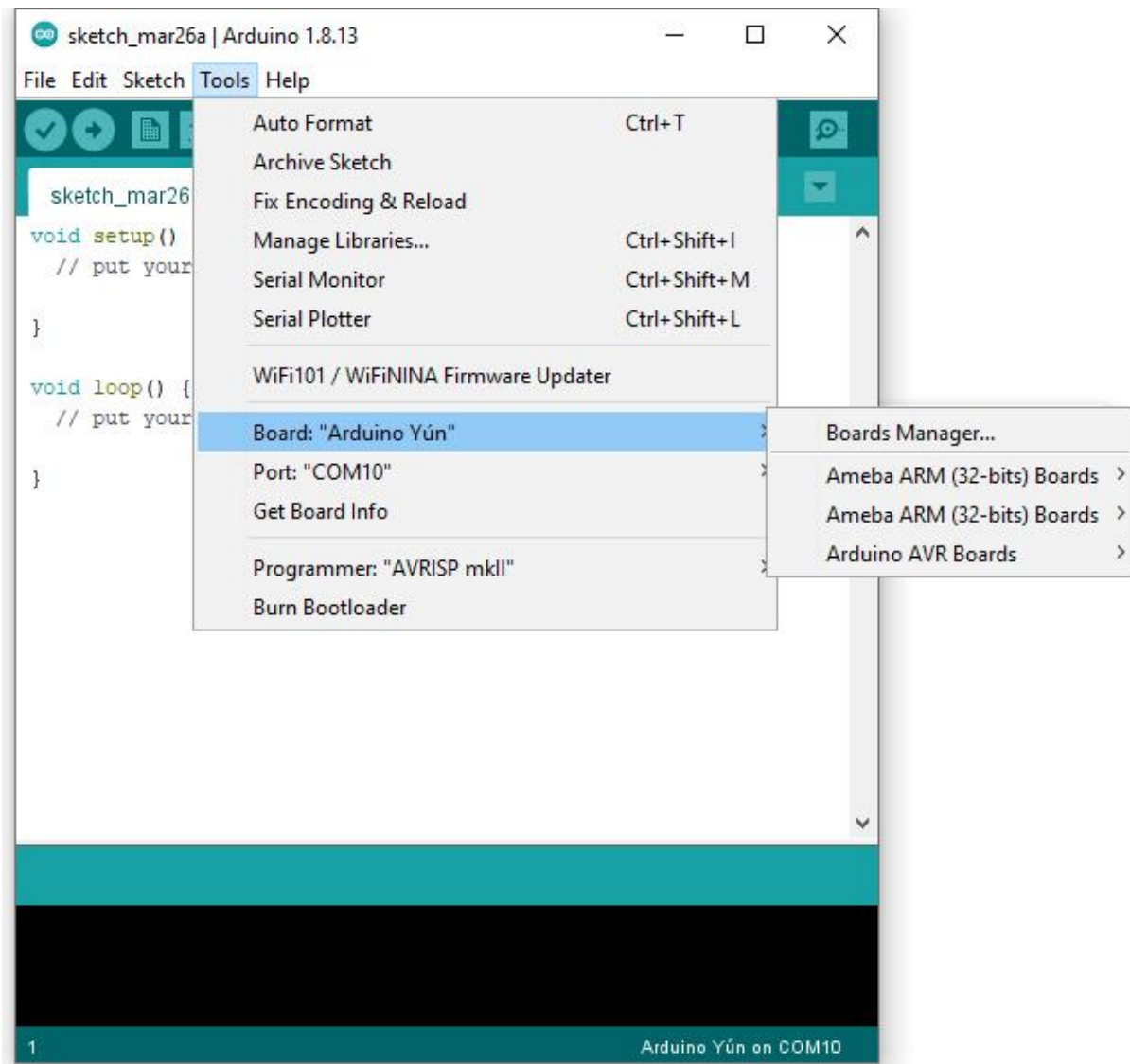
When the installation is finished, open Arduino IDE. To set up AMB23 correctly in Arduino IDE, go to “File” -> “Preferences” .



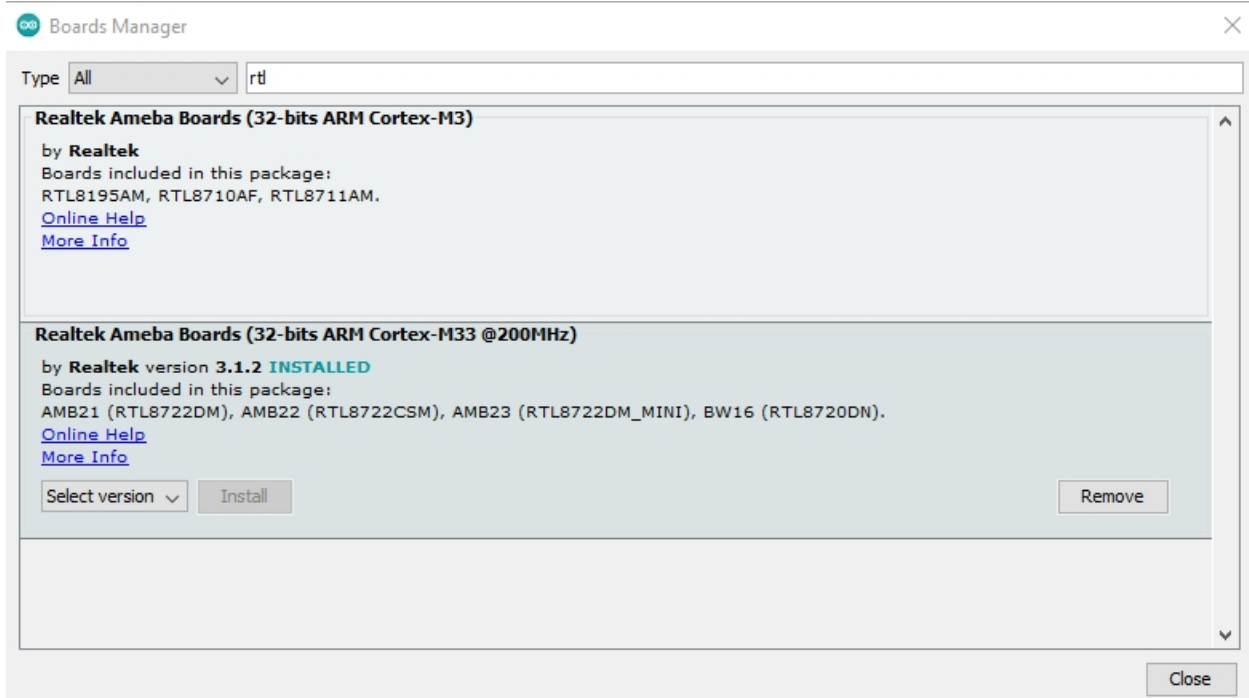
And paste the following URL into “*Additional Boards Manager URLs*” field:

```
https://github.com/ambiot/ambd_arduino/raw/master/Arduino_package/package_realtek.com_amebad_index.json
```

Next, go to “*Tools*” -> “*Board*” -> “*Boards Manager*” :



The “*Boards Manager*” requires about 10~20 seconds to refresh all hardware files (if the network is in bad condition, it may take longer). Every time the new hardware is connected, we need to reopen the Board Manager. So, we close the “*Boards Manager*”, and then open it again. Find “*Realtek AmebaD Boards (32-bits ARM Cortex-M33 @200MHz)*” in the list, click “*Install*”, then the Arduino IDE starts to download required files for AmebaD.



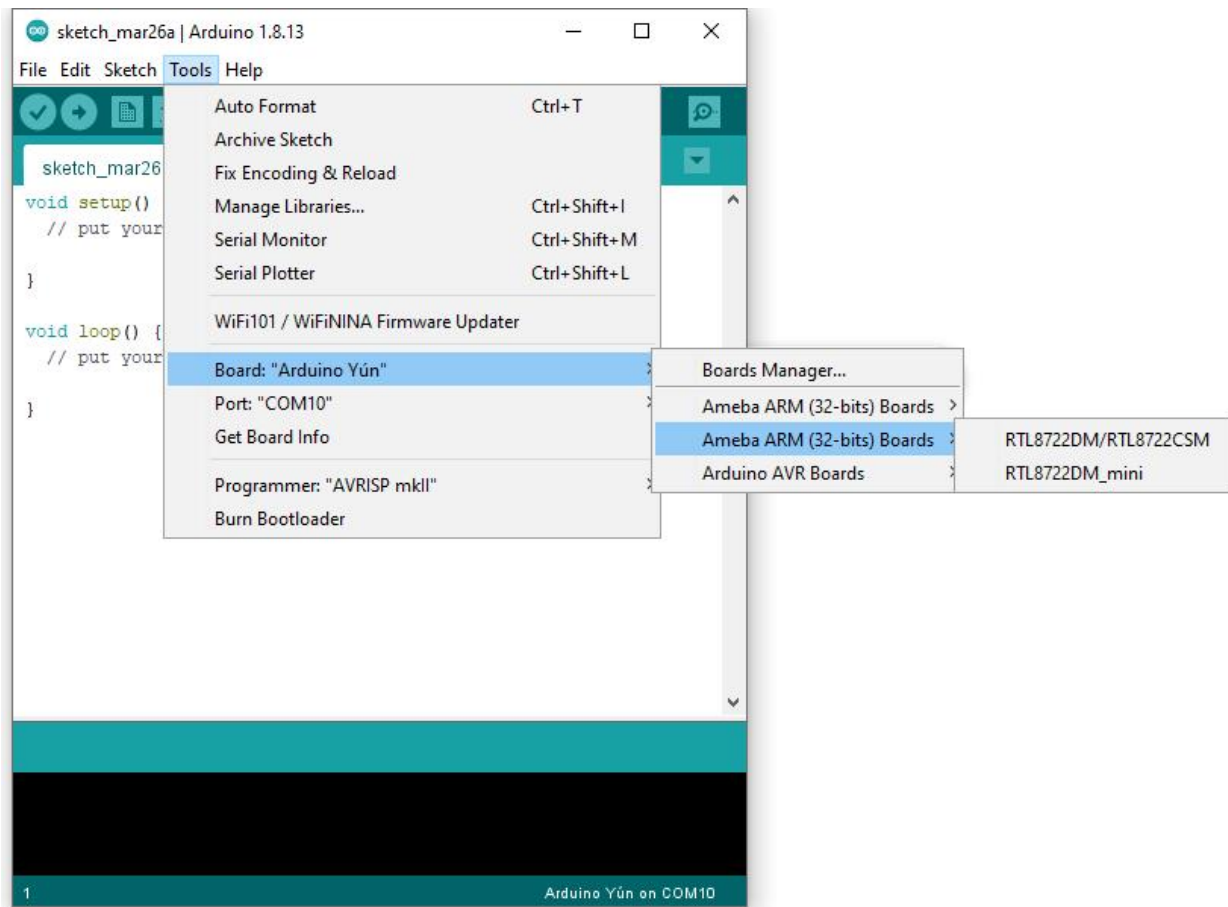
If you are facing GitHub downloading issue, please refer to the following link at [Download/Software Development Kit](#). There are 3 sections:

1. “AmebaD\_Arduino\_patch1\_SDK” , please select at least 1 of the SDKs. There are 5 latest released SDK options.
2. “AmebaD\_Arduino\_patch2\_Tools” , please select according to your operation system. There are Windows, Linux and MacOS.
3. “AmebaD\_Arduino\_Source\_Code” , this section is optional download only wants to refer the latest source code.

Download the files selected, then unzip (patch1 and patch2 are compulsory). There are “Install.doc” / “Install.pdf” for you to refer installation steps. According to your system, please run the installation tool in the “Offline\_SDK\_installation\_tool” folder.

After the installation tool running successfully, you may open Arduino IDE and proceed to “Tools”-> “Board”-> “Boards Manager...”. Try to find “Realtek AmebaD Boards (32-bits ARM Cortex-M33 @200MHz)” in the list, click “Install” , then the Arduino IDE starts to download required files for AmebaD.

Finally, we select AmebaD as current connected board in “Tools”-> “Board”-> “Ameba ARM (32-bits) Boards”-> “RTL8722DM MINI”:

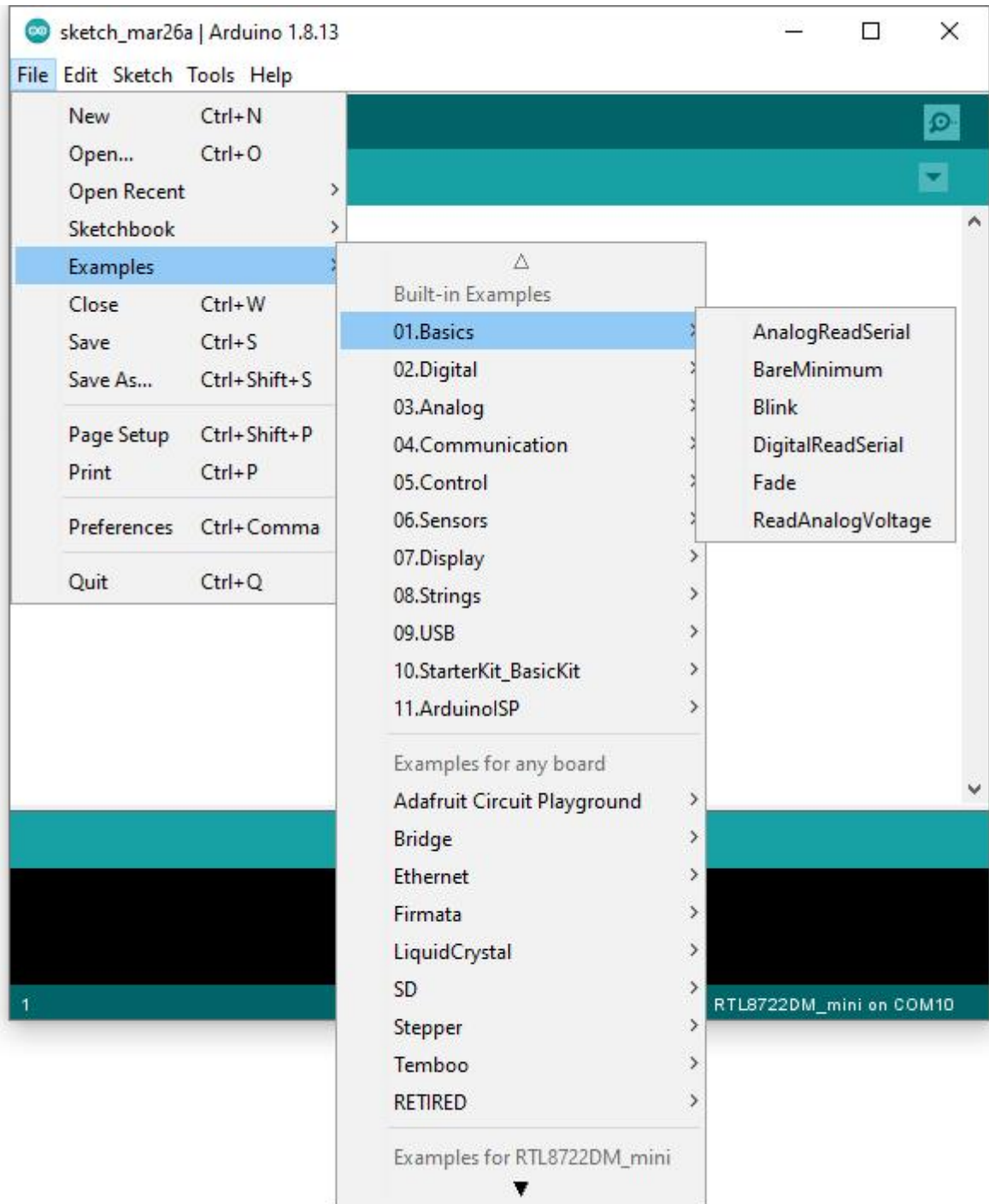


## Try the First Example

### Step 1. Compile & Upload

Arduino IDE provides many built-in examples, which can be compiled, uploaded and run directly on the boards. Here, we take the “Blink” example as the first try.

Open “File” -> “Examples” -> “01.Basics” -> “Blink” :



Arduino IDE opens a new window with the complete sample code.



```

Blink | Arduino 1.8.13
File Edit Sketch Tools Help

Blink $
If you want to know what pin the on-board LED is connected to on your Arduino
model, check the Technical Specs of your board at:
https://www.arduino.cc/en/Main/Products

modified 8 May 2014
by Scott Fitzgerald
modified 2 Sep 2016
by Arturo Guadalupi
modified 8 Sep 2016
by Colby Newman

This example code is in the public domain.

http://www.arduino.cc/en/Tutorial/Blink
*/

// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000); // wait for a second
  digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW
  delay(1000); // wait for a second
}

28 RTL8722DM_mini on COM10

```

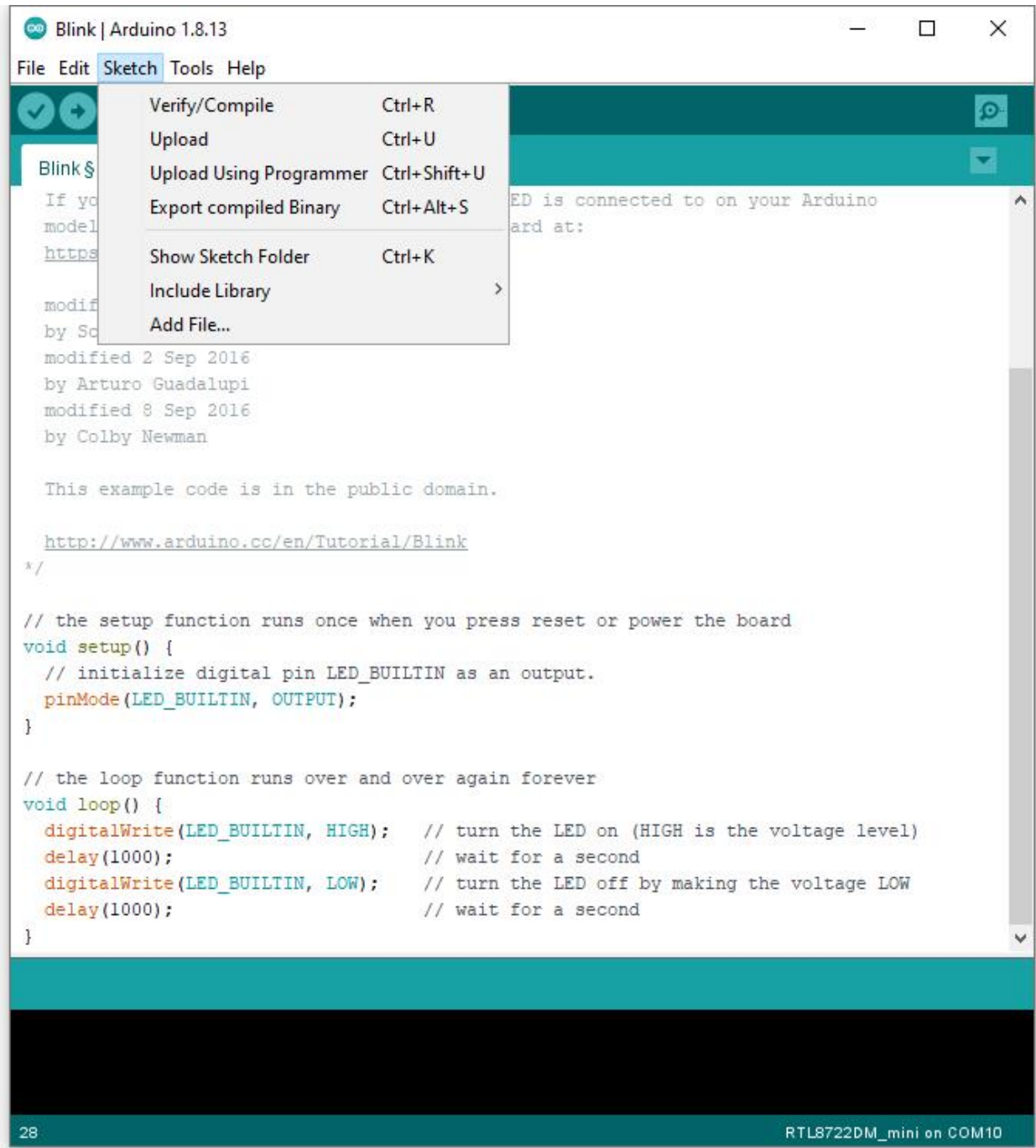
There are onboard LED of AMB23, the default “LED\_BUILTIN” is blue onboard LED.

Change “LED\_BUILTIN” to “LED\_B” or “LED\_G” for different colour. Onboard LEDs options LED\_B and LED\_G (blue and green).





Next, we compile the sample code directly; click “Sketch” -> “Verify/Compile”



Arduino IDE prints the compiling messages in the bottom area of the IDE window. When the compilation is finished, you will get the message similar to the following figure:

```

Blink | Arduino 1.8.13
File Edit Sketch Tools Help

Blink $
If you want to know what pin the on-board LED is connected to on your Arduino
model, check the Technical Specs of your board at:
https://www.arduino.cc/en/Main/Products

modified 8 May 2014
by Scott Fitzgerald
modified 2 Sep 2016
by Arturo Guadalupi
modified 8 Sep 2016
by Colby Newman

This example code is in the public domain.

http://www.arduino.cc/en/Tutorial/Blink
*/

// the setup function runs once when you press reset or power the board
void setup() {
  // initialize digital pin LED_BUILTIN as an output.
  pinMode(LED_BUILTIN, OUTPUT);
}

// the loop function runs over and over again forever
void loop() {
  digitalWrite(LED_BUILTIN, HIGH); // turn the LED on (HIGH is the voltage level)
  delay(1000); // wait for a second
  digitalWrite(LED_BUILTIN, LOW); // turn the LED off by making the voltage LOW
  delay(1000); // wait for a second
}

Done compiling.

Sketch uses 192928 bytes (9%) of program storage space. Maximum is 2097152 bytes.

28 RTL8722DM_mini on COM10

```

Afterwards, we will upload the compiled code to AMB23.

Please make sure AMB23 is connected to your computer, then click “Sketch” -> “Upload” .

The Arduino IDE will compile first then upload. During the uploading process, users are required to enter the upload mode of the board. Arduino IDE will wait 5s for DEV board to enter the upload mode.

The screenshot shows the Arduino IDE interface. The top menu bar includes File, Edit, Sketch, Tools, and Help. Below the menu is a toolbar with icons for checking, uploading, and downloading. The main text area displays the 'Blink' sketch, which includes a description of the LED behavior, a list of supported Arduino boards (UNO, MEGA, ZERO, MKR1000), and a link to the Arduino website for technical specifications. The sketch is attributed to Scott Fitzgerald (2014), Arturo Guadalupi (2016), and Colby Newman (2016). Below the sketch, a status bar indicates 'Done uploading.' and 'Sketch uses 192928 bytes (9%) of program storage space. Maximum is 2097152 bytes.' The bottom status bar shows '28' and 'RTL8722DM\_mini on COM10'.

```

Blink
-----

Turns an LED on for one second, then off for one second, repeatedly.

Most Arduinos have an on-board LED you can control. On the UNO, MEGA and ZERO
it is attached to digital pin 13, on MKR1000 on pin 6. LED_BUILTIN is set to
the correct LED pin independent of which board is used.
If you want to know what pin the on-board LED is connected to on your Arduino
model, check the Technical Specs of your board at:
https://www.arduino.cc/en/Main/Products

modified 8 May 2014
by Scott Fitzgerald
modified 2 Sep 2016
by Arturo Guadalupi
modified 8 Sep 2016
by Colby Newman

This example code is in the public domain.

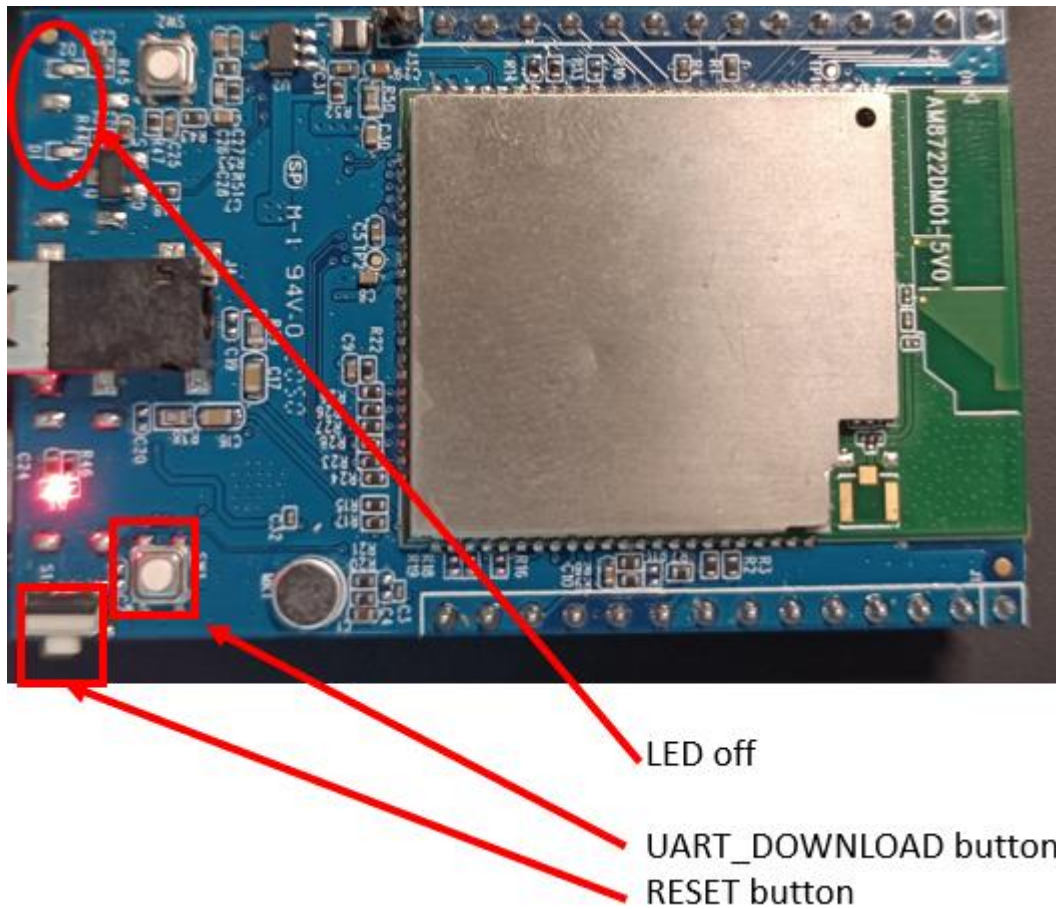
Done uploading.

Sketch uses 192928 bytes (9%) of program storage space. Maximum is 2097152 bytes.
Please enter the upload mode (wait 5s)
05
04
03
02
01
Uploading.....
All images are sent successfully!
Image tool closed!
Upload Image done.

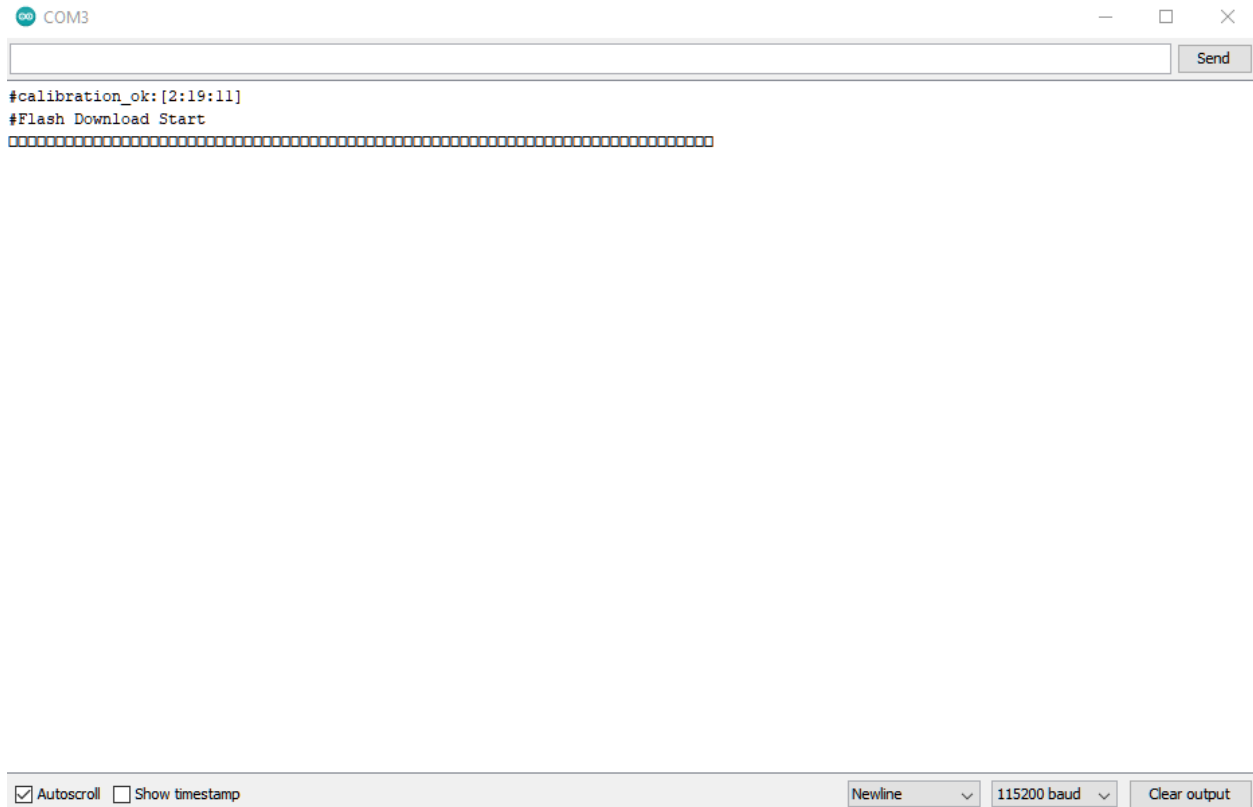
28
RTL8722DM_mini on COM10

```

To enter the upload mode, first press and hold the *UART\_DOWNLOAD* button, then press the *RESET* button. If success, you should see the onboard green LED and blue LED all turned off.



It is optional for users to check if the board entered the upload mode. Open serial monitor/terminal and look for “#Flash Download Start” . Note, it is normal that some serial terminals may show unknown characters as following picture.



Again, during the uploading procedure the IDE prints messages. Uploading procedure takes considerably longer time (about 30 seconds to 1 minute). When upload completed, the “Done uploading” message is printed.

## Step 2.Run the Blink example

In each example, Arduino not only provides sample code, but also detailed documentation, including wiring diagram, sample code explanation, technical details, …etc. These examples can be directly used on AMB23.

So, we find the detailed information of the 「Blink」 example:

<https://www.arduino.cc/en/Tutorial/BuiltInExamples/Blink>

In short, for AMB23, the example can be run on both onboard LEDs (green or blue) or external LED (use any GPIO pins for signal output).

Finally, press the *RESET* button, and you can see the *LED* blinking.

**(End)**

---

備F: If you face any issue, please refer to the FAQ and Trouble shooting sections on ../../support/index page.

---

## 1.2.2 Peripherals & Examples

### Basic Examples

AMB23 (RTL8722DM\_MINI) Supported ARDUINO built-in example table

There are many built-in examples in Arduino. In the table below, we list all examples that are compatible with Ameba.

Please refer to the following link to set up Ameba for Arduino IDE.

<https://www.amebaiot.com/en/amebad-mini-arduino-getting-started/>

Please refer to the following link for Arduino built-in example details.

<https://www.arduino.cc/en/Tutorial/BuiltInExamples//>

Category	Name	Comment
01. Basics	AnalogRead Serial	Connect potentiometer to 3.3V.
	Bare Minimum	
	Blink	Pin LED_BUILTIN sets to LED_B
	DigitalRead Serial	
	Fade	Replace 「led = 9;」 by a PWM pin (D4, D5, D7, D12, D13, D14, D17, D20, or D21).
	ReadAnalog Voltage	
02. Digital	BlinkWithout Delay	The onboard blue LED (LED_B) has been used.
	Button	
	Debounce	
	DigitalInput Pullup	
	StateChange Detection	
	toneKeyboard	Replace 「tone(8, notes[thisSensor], 20);」 by a PWM pin (D4, D5, D7, D12, D13, D14, D17, D20, or D21).
	toneMelody	
	tone Multiple	
	tonePitch Follower	
03. Analog	AnalogIn OutSerial	Replace 「analogOutPin = 9;」 by a PWM pin (D4, D5, D7, D12, D13, D14, D17, D20, or D21).
	AnalogInput	
	Analog Write Mega	Use PWM pins D4, D5, D7, D12, D13, D14, D17, D20, or D21.
	Calibration	
	Fading	Replace 「ledPin = 9;」 by a PWM pin (D4, D5, D7, D12, D13, D14, D17, D20, or D21).
	Smoothing	

Category	Name	Comment
04. Communication	ASCIITable	
	Dimmer	
	Graph	Connect potentiometer to 3.3V.
	Midi	Use Serial1 and pin D18, or use Serial2 and pin D1.
	MultiSerial	
	Physical Pixel	
	ReadASCII String	Use PWM pin for LED (D4, D5, D7, D12, D13, D14, D17, D20, or D21).
	SerialCall Response	
	Serial CallResponse ASCII	
	SerialEvent	
	SerialPassthrough	
	VirtualColor Mixer	
05. Control	Arrays	Use pins D1, D2, D3, D4, D5, D6.
	ForLoop Iteration	Use pins D1, D2, D3, D4, D5, D6.
	IfStatement Conditional	
	switchCase	
	switchCase2	Use pins D1, D2, D3, D4, D5, D6.
	WhileStatement Conditional	Replace 「ledPin = 9;」 by a PWM pin (D4, D5, D7, D12, D13, D14, D17, D20, or D21).
06. Display	barGraph	
	RowColumn Scanning	
07. Strings	Character Analysis	
	String Addition Operator	
	String Append Operator	
	StringCase Changes	
	String Characters	
	String Comparison Operators	
	String IndexOf	
	String Length	
	StringLength Trim	
	String Replace	
	String StartsWith EndsWith	
	String Substring	
	String ToInt	



## Network Examples

### BLE - BLE Battery Service

#### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

#### Example

##### Introduction

BLE connections use a server client model. The server contains the data of interest, while the client connects to the server to read the data. Commonly, a Bluetooth peripheral device acts as a server, while a Bluetooth central device acts as a client. Servers can contain many services, with each service containing a some set of data. Clients can send requests to read or write some data and can also subscribe to notifications so that the server can send data updates to a client.

In this example, a basic battery service is set up on the Ameba Bluetooth stack. A mobile phone is used to connect to the Ameba peripheral device and read the battery data.

##### Procedure

Ensure that the following Bluetooth apps are installed on your mobile phone. These apps will show you the raw data sent by Ameba and allow you to interact with the data.

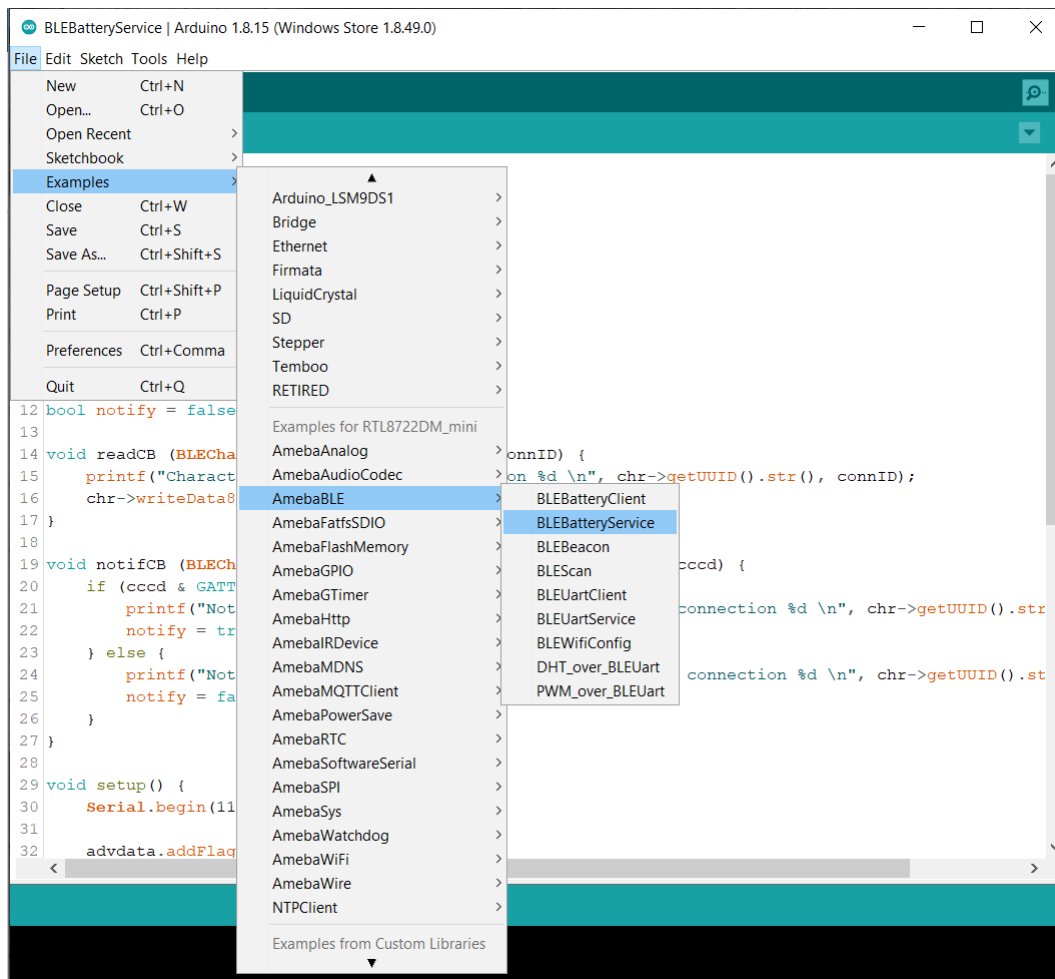
The recommended application is nRF connect, and is available at the links below:

- Android: <https://play.google.com/store/apps/details?id=no.nordicsemi.android.mcp>
- iOS : <https://apps.apple.com/us/app/nrf-connect/id1054362403>

LightBlue is an alternative application that can also be used, but has less features:

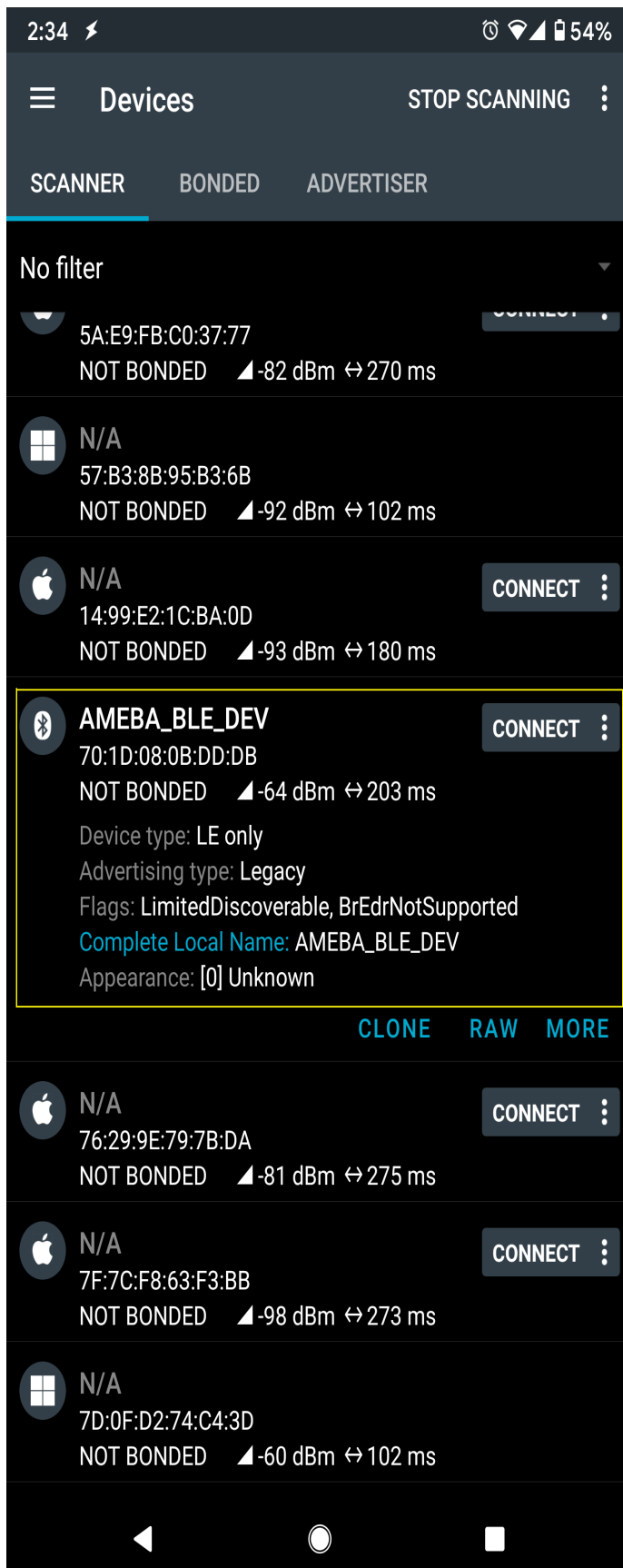
- Android: <https://play.google.com/store/apps/details?id=com.punchthrough.lightblueexplorer>
- iOS : <https://apps.apple.com/us/app/lightblue/id557428110>

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEBatteryService”

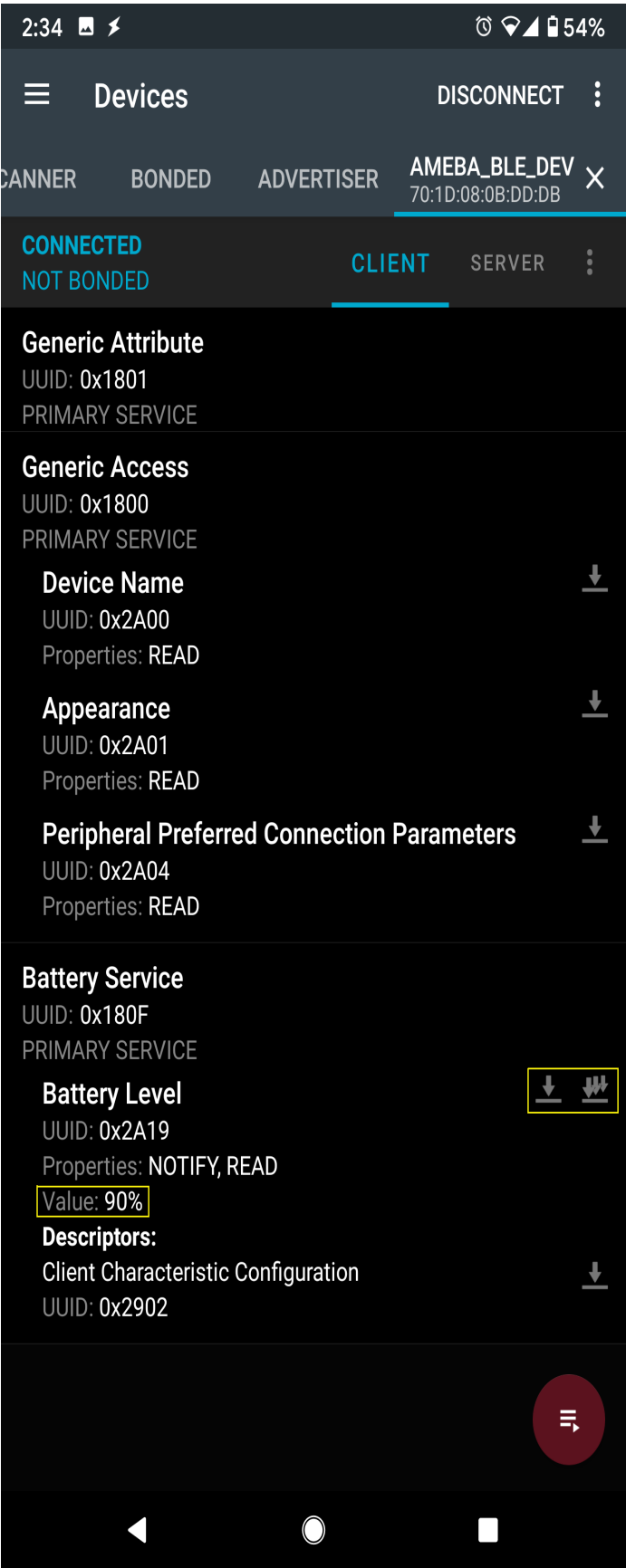


Upload the code and press the reset button on Ameba once the upload is finished.

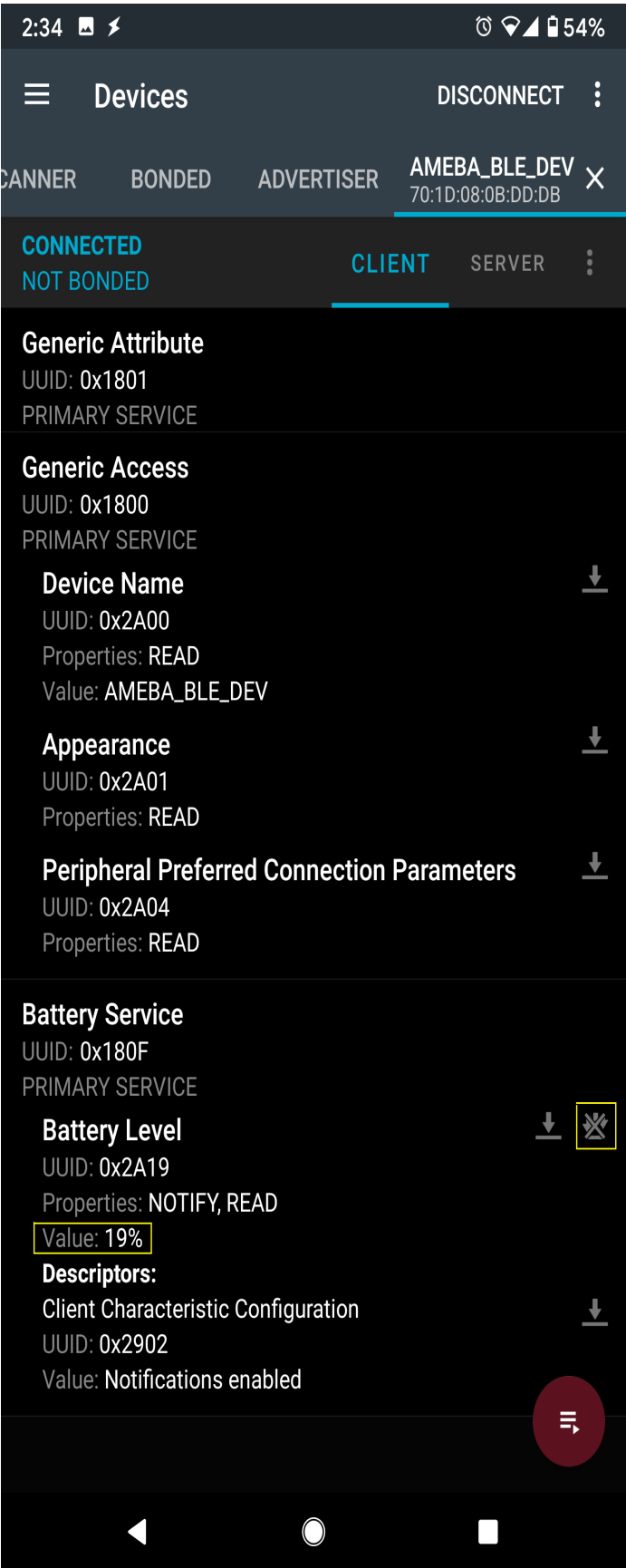
On your mobile phone, open the Bluetooth app and scan for the Bluetooth signal broadcast by Ameba, it should appear as a device named “AMEBA\_BLE\_DEV” .



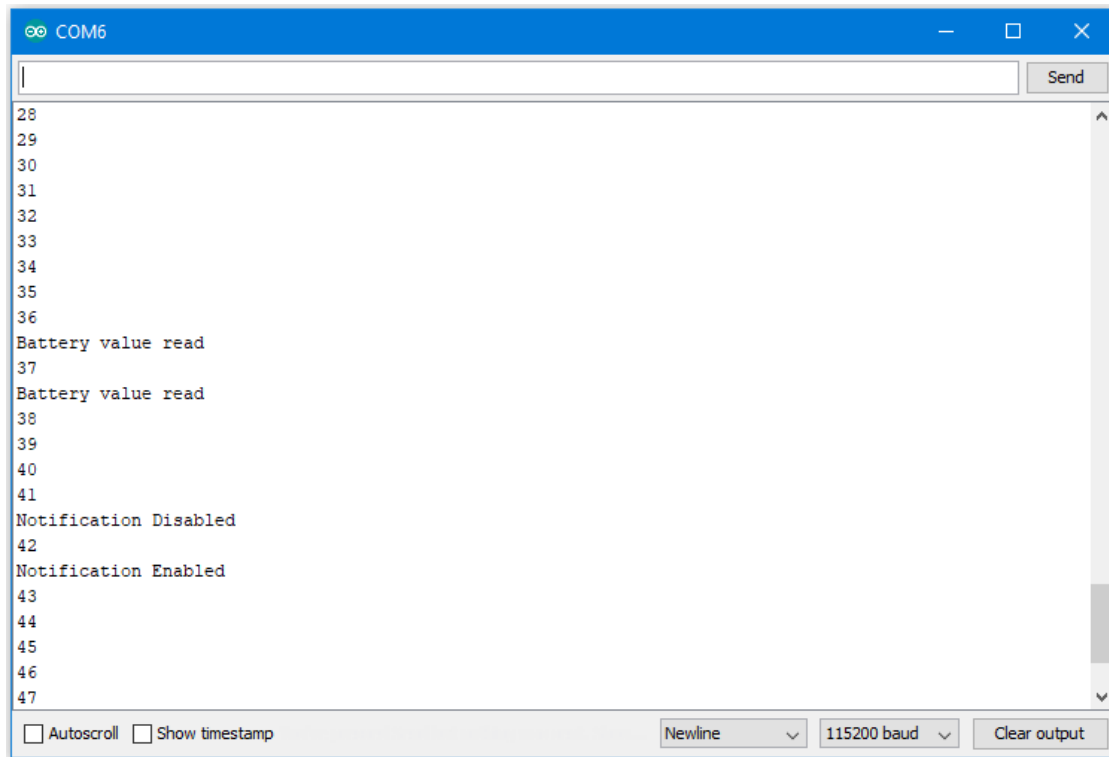
Connect to the Ameba Bluetooth device, and a list of available services should appear. Click on the battery service to expand it, and you can see the battery level data value. The arrows highlighted in the box on the right are used to read data and subscribe to notifications. Click on the single arrow to read the battery level value, and a 90% value will appear.



Click on the triple arrow to subscribe to updates on the battery level value, and the battery value will start updating by itself.



The serial monitor will show the sketch increasing the battery level every second. When you click on either of the arrows, the sketch running on the Ameba will be notified, and will print out the action taken.



## Code Reference

BLEService and BLECharacteristic classes are used to create and define the battery service to run on the Bluetooth device.

`BLE.configAdvert() -> setAdvType(GAP_ADTYPE_ADV_IND)` is used to set the advertisement type to a general undirected advertisement that allows for connections.

`setReadCallback()` and `setCCCDCallback()` is used to register functions that will be called when the battery level data is read, or notification is enabled by the user.

`BLE.configServer(1)` is used to tell the Bluetooth stack that there will be one service running.

`addService()` registers the battery service to the Bluetooth stack.

## BLE –BLE Beacon

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone



## Example

### Introduction

A BLE beacon broadcasts its identity to nearby Bluetooth devices, to enable the other devices to determine their location relative to the beacon, and to perform actions based on information broadcasted by the beacon.

Example applications of beacons include indoor positioning system, location-based advertising and more.

From the definition of its purpose as a broadcast device, a BLE beacon thus cannot be connected to, and can only send information in its Bluetooth advertisement packets.

There are several BLE beacon protocols. The Ameba BLEBeacon library supports the iBeacon and AltBeacon protocols.

### Procedure

First, you need to install some Bluetooth apps on your mobile phone. These apps will show you the raw data sent by Ameba and allow you to interact with the data.

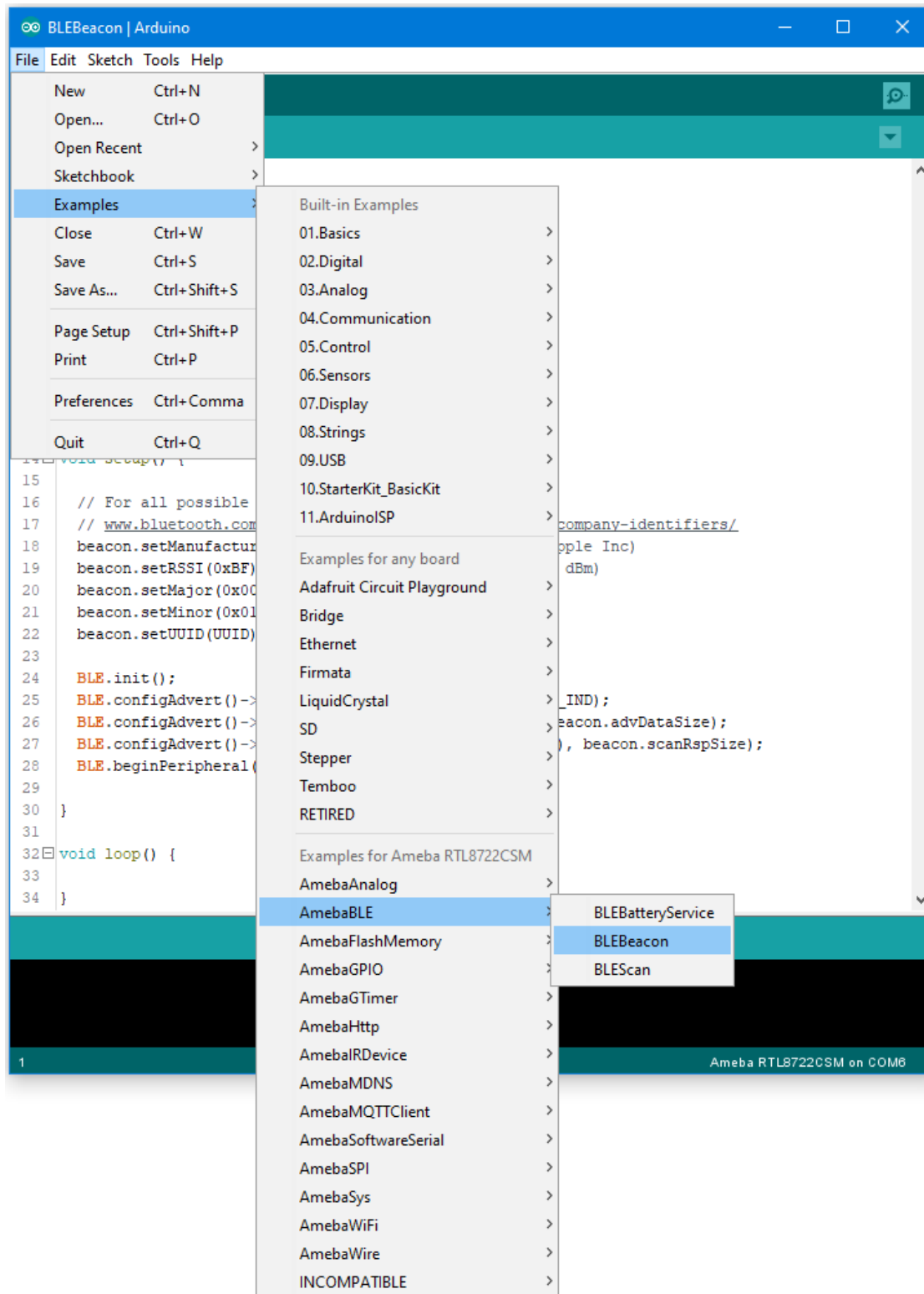
The recommended application is nRF connect, and is available at the links below:

- **Android** : <https://play.google.com/store/apps/details?id=no.nordicsemi.android.mcp>
- **iOS** : <https://apps.apple.com/us/app/nrf-connect/id1054362403>

LightBlue is an alternative application that can also be used, but has less features:

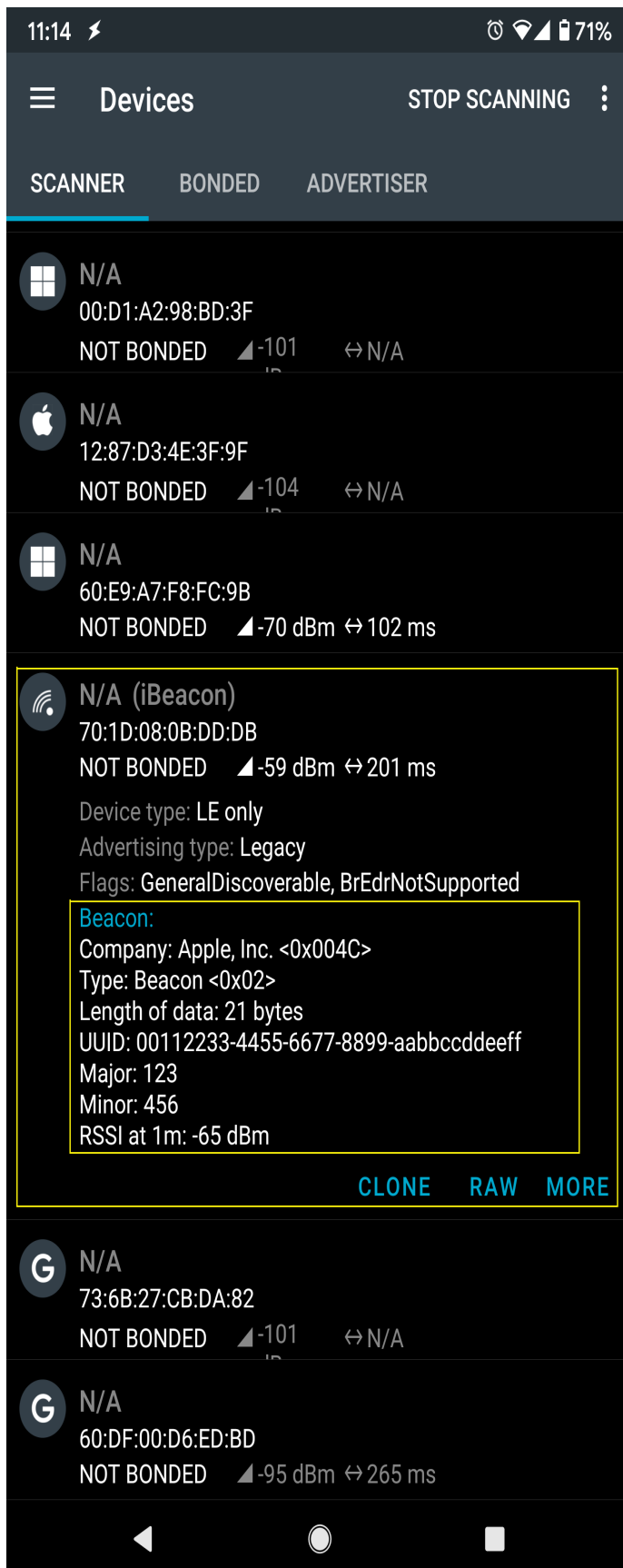
- **Android** : <https://play.google.com/store/apps/details?id=com.punchthrough.lightblueexplorer>
- **iOS** : <https://apps.apple.com/us/app/lightblue/id557428110>

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEBeacon”



Upload the code and press the reset button on Ameba once the upload is finished.

On your mobile phone, open the Bluetooth app and scan for the beacon signal broadcast by Ameba.



If you happen to be in an environment with multiple BLE beacons, you can tap the entries to expand them, and verify that the beacon data is identical to the data in the sketch.

## Code Reference

`setRssi()` is used to set the received signal strength indicator (rssi) data field for a beacon. The specification states that this should be the received signal strength from the beacon at a 1 meter distance. With no method to measure this, it is set to -65dBm as an estimate.

`setMajor()` and `setMinor()` are used to set the two data fields. The purpose of these data are left for the manufacturer of the beacon to define, and can be used in any way.

`setUUID()` is used to give the beacon a universally unique identifier (UUID). This is a 128-bit number usually expressed as a hexadecimal string. It is used to identify each unique beacon, and can be randomly generated for free online.

The BLEBeacon library includes both `iBeacon` and `AltBeacon` classes, replace line 6 `iBeacon` with `altBeacon` to create an `AltBeacon` instead. The data fields are mostly the same, with only minor changes, please look at the header files for more details.

`BLE.init()` is used to allocate memory and prepare Ameba for starting the Bluetooth stack.

`BLE.configAdvert()` is used to configure the Bluetooth advertisement settings, to which we pass the beacon data and set the device as non-connectable.

`BLE.beginPeripheral()` starts Ameba in Bluetooth peripheral mode, after which it will begin to advertise with the beacon data provided.

## BLE –BLE Scan

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

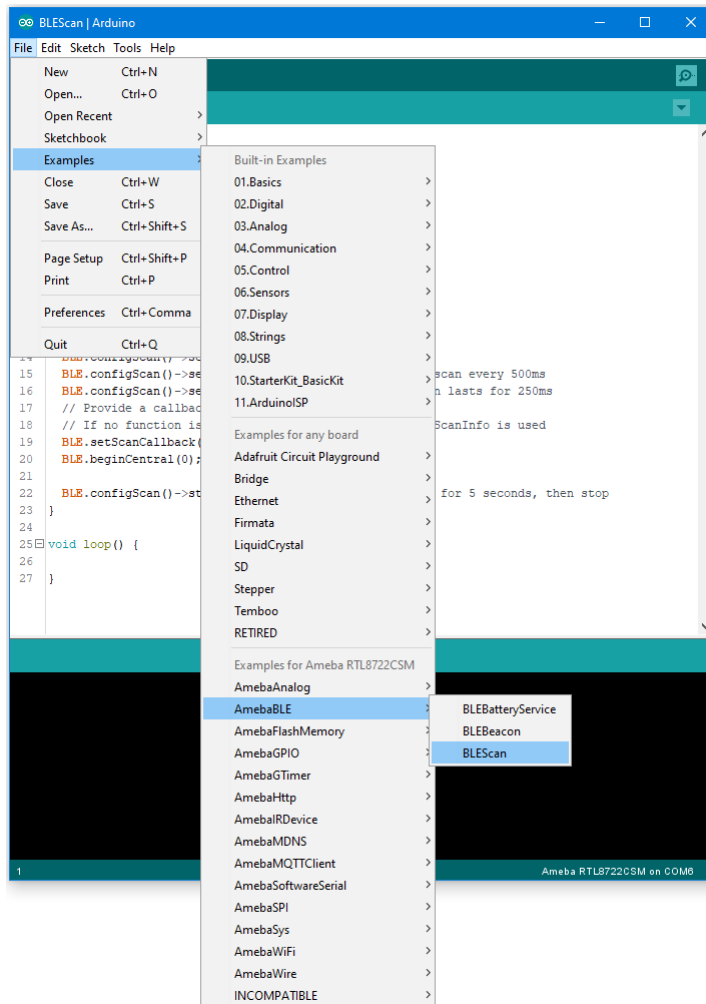
### Example

#### Introduction

This example configures the Ameba as a Bluetooth central device, uses the scan functionality to scan for other Bluetooth devices, and prints out the results to the serial monitor.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEScan”



Upload the code and press the reset button on Ameba once the upload is finished.

Open the Arduino serial monitor, and you should see the scan results of nearby Bluetooth devices formatted and printed out.

```

COM6
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
local bd addr: 0x70:1d:08:0b:dd:db
GAP scan start

Scan Data 1
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 79:c1:1f:ed:21:75 | -94
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 2
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 4c:19:13:18:f4:b5 | -98
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 3
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 59:aa:dd:87:da:83 | -62
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 4
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | random        | c7:b9:7f:1e:fb:28 | -96
GAP_ADTYPE_FLAGS: 0x5
GAP_ADTYPE_SERVICE_DATA: UUID 0xfffe, len 4

Scan Data 5
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | random        | 6b:37:ce:55:75:65 | -92
GAP_ADTYPE_FLAGS: 0x1a
GAP_ADTYPE_POWER_LEVEL: 0xc
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x4c, len 7

Scan Data 6
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | public        | 68:9e:19:cb:ef:a9 | -78
GAP_ADTYPE_FLAGS: 0x6
GAP_ADTYPE_128BIT_XXX: 0x1bc5ffa0020062abe411f254e005dbd4
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0xc90, len 2

Scan Data 7
ADVType          | AddrType      | BT_Addr        | rssi
SCAN_RSP         | public        | 68:9e:19:cb:ef:a9 | -78

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

If you have the Bluetooth app nRF Connect installed, you can also use it to send out Bluetooth advertisements for the Ameba to pick up.

## Code Reference

`setScanMode(GAP_SCAN_MODE_ACTIVE)` is used to set the scan mode. Active scanning will request for an additional scan response data packet from a device when it is found. Passive scanning will only look at the advertisement data, and not request for additional data.

`setScanInterval()` and `setScanWindow()` are used to set the frequency and duration of scans in milliseconds. A scan will start every interval duration, and each scan will last for the scan window duration. The scan window duration should be lesser or equal to the scan interval. Set a short interval to discover devices rapidly, set a long interval to conserve power.

`setScanCallback(scanFunction)` is used to register a function to be called when scan results are received. This can be used to set a user function for additional processing of scan data, such as looking for a specific device. If no function is registered, the scan results are formatted and printed to the serial monitor by default.

`beginCentral(0)` is used to start the Bluetooth stack in Central mode. The argument 0 is used to indicate that no clients will be operating in central mode.

`startScan(5000)` is used to start the scanning process for a specified duration of 5000 milliseconds. The scan will repeat according to the set scan interval and scan window values. After 5000 milliseconds, the scan process will stop, and will be ready to be started again.

## BLE –Battery Client

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

#### Introduction

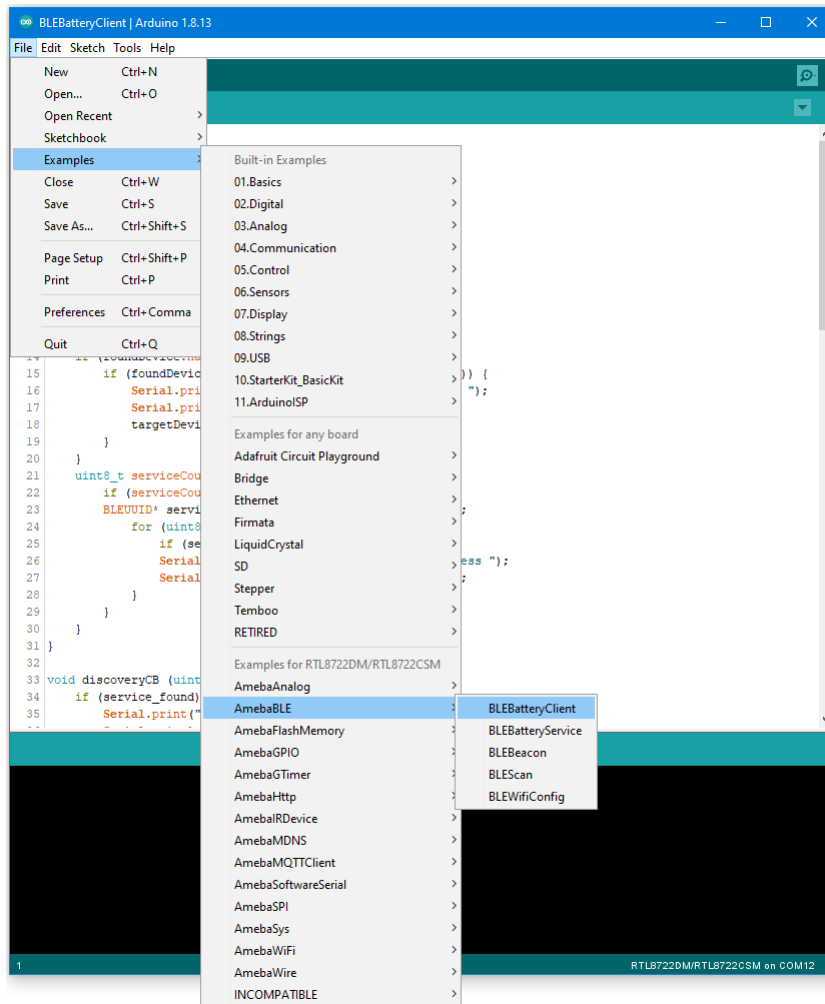
BLE connections use a server client model. The server contains the data of interest, while the client connects to the server to read the data. Commonly, a Bluetooth peripheral device acts as a server, while a Bluetooth central device acts as a client. Servers can contain many services, with each service containing a some set of data. Clients can send requests to read or write some data and can also subscribe to notifications so that the server can send data updates to a client.

In this example, a basic battery client is set up on the Ameba Bluetooth stack. The client connects to another Ameba board running the corresponding BLE battery service to read the battery level data.

#### Procedure

On the first Ameba board, upload the BLEBatteryService example code and let it run.

For the second Ameba board, open the example “Files” -> “Examples” -> “AmebaBLE” -> “BLEBatteryClient” .



Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor and observe the log messages as the Ameba board with the battery client scans, connects, and reads data from the Ameba board with the battery service.



```

COM9
[21:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:fe:d2
[BLE Device] GAP scan start
Found Ameba BLE Device at address 70:1D:08:0B:DD:DB
Found Battery Service at address 70:1D:08:0B:DD:DB
[BLE Device] GAP scan stop
[BLE Device] Connected conn_id 0
BLE connected to device at 0
Battery service found on connection id: 0
Battery level read callback for connection id: 0 Battery level: 90
Notifications Enabled
Notification received for connection id: 0 Battery level: 9
Notification received for connection id: 0 Battery level: 10
Notification received for connection id: 0 Battery level: 11
Notification received for connection id: 0 Battery level: 12
Notification received for connection id: 0 Battery level: 13
Battery level read callback for connection id: 0 Battery level: 90
Notification received for connection id: 0 Battery level: 14
Notification received for connection id: 0 Battery level: 15
Notification received for connection id: 0 Battery level: 16
Notification received for connection id: 0 Battery level: 17
Notification received for connection id: 0 Battery level: 18
Notifications Disabled
Autoscroll Show timestamp Newline 115200 baud Clear output

```

Highlighted in yellow, the Ameba board with the battery client first scans for advertising BLE devices with the advertised device name “AMEBA\_BLE\_DEV” and the advertised service UUID of 0x180F representing the battery service.

After finding the target device, the Ameba board with the battery client forms a BLE connection and searches for a battery service on the connected device, highlighted in blue.

With the client connected to the service, the battery client begins to read data using both regular data reads and notifications, highlighted in green.

## Code Reference

BLEClient is used to create a client object to discover services and characteristics on the connected device.

- `setNotifyCallback()` is used to register a function that will be called when a battery level notification is received.
- `BLE.configClient()` is used to configure the Bluetooth stack for client operation.
- `addClient(connID)` creates a new BLEClient object that corresponds to the connected device.

## BLE –WiFi Configuration Service

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

## Example

### Introduction

In this example, a WiFi configuration service is set up on the Ameba Bluetooth stack. A mobile phone with the configuration app connects to the Ameba device using BLE and configures the Ameba to connect to the correct WiFi access point.

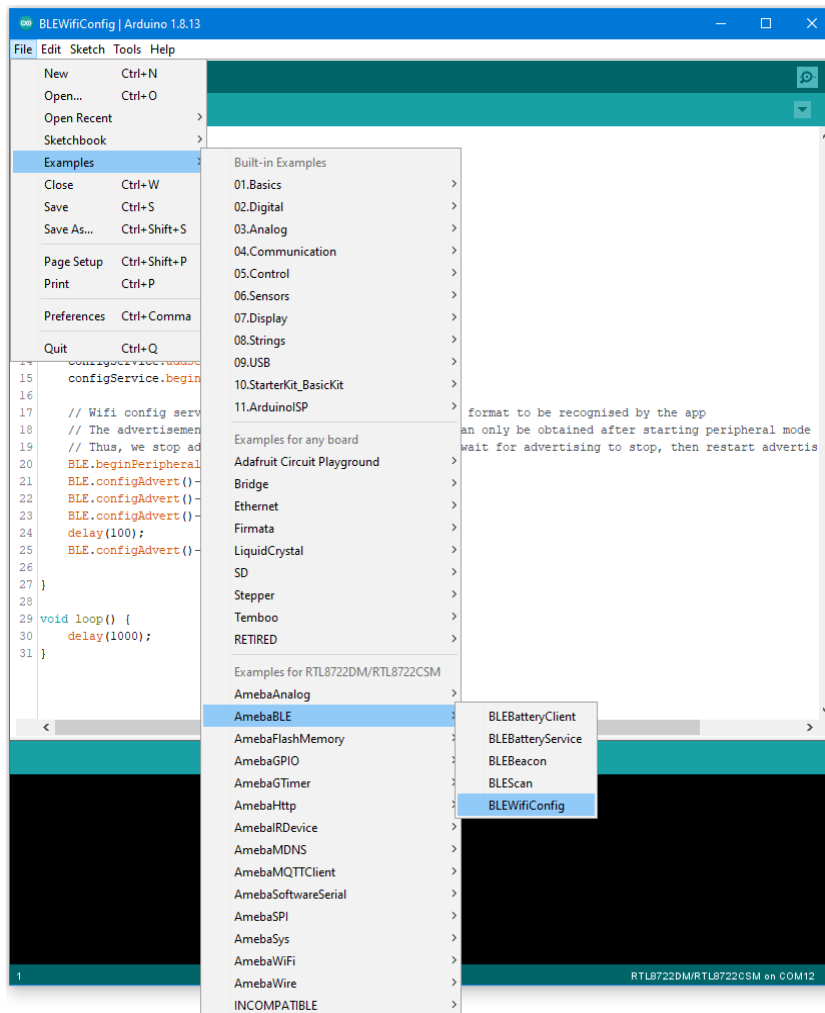
### Procedure

Ensure that the Realtek WiFi configuration app is installed on your mobile phone, it is available at:

–Google Play Store: <https://play.google.com/store/apps/details?id=com.rtk.btconfig>

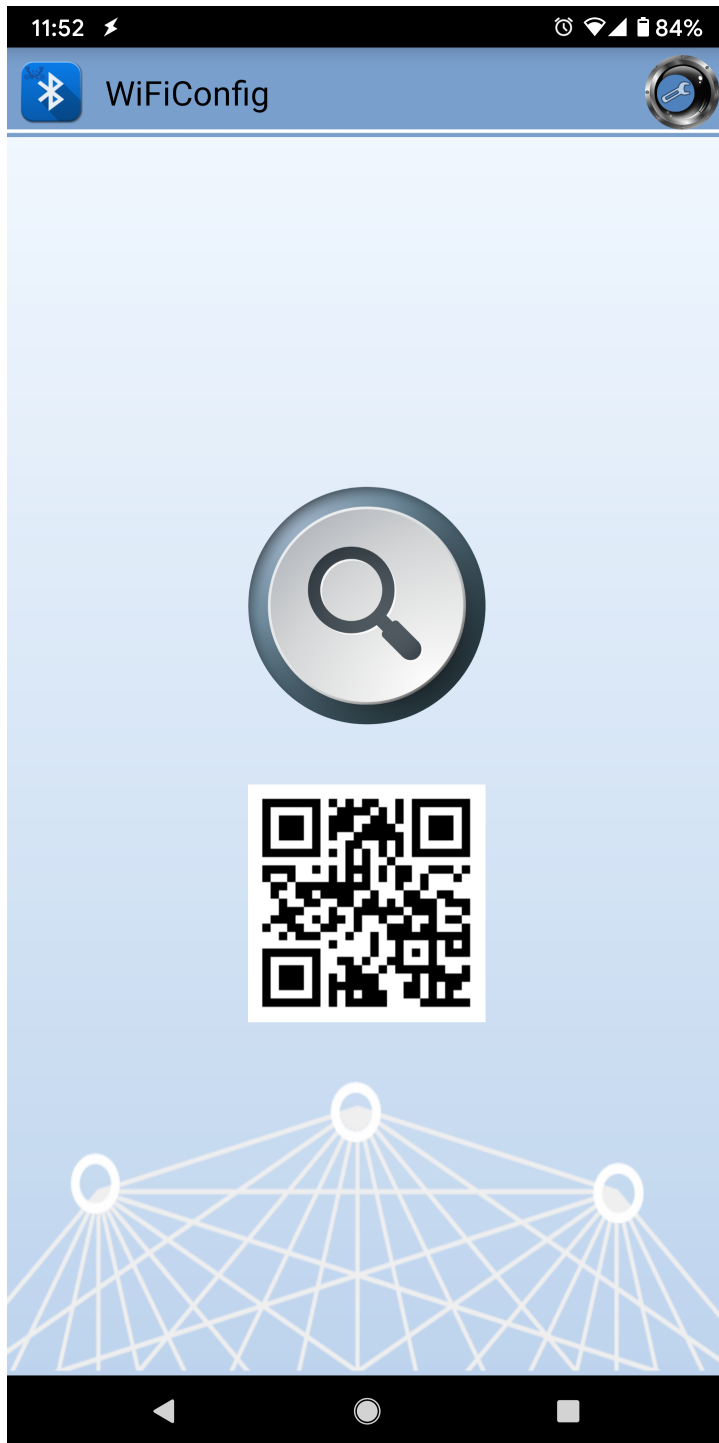
–Apple App Store: <https://apps.apple.com/sg/app/easy-wifi-config/id1194919510>

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEWifiConfigService” .



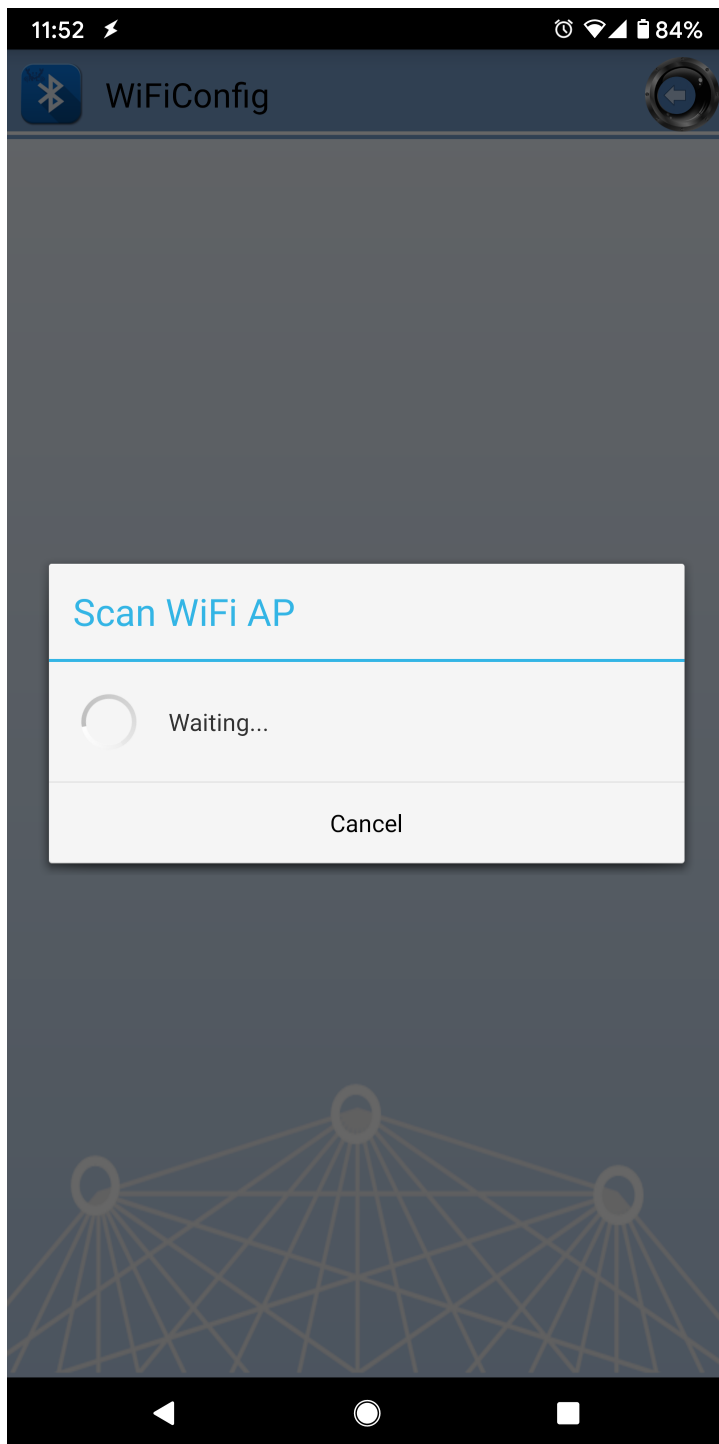
Upload the code and press the reset button on Ameba once the upload is finished.

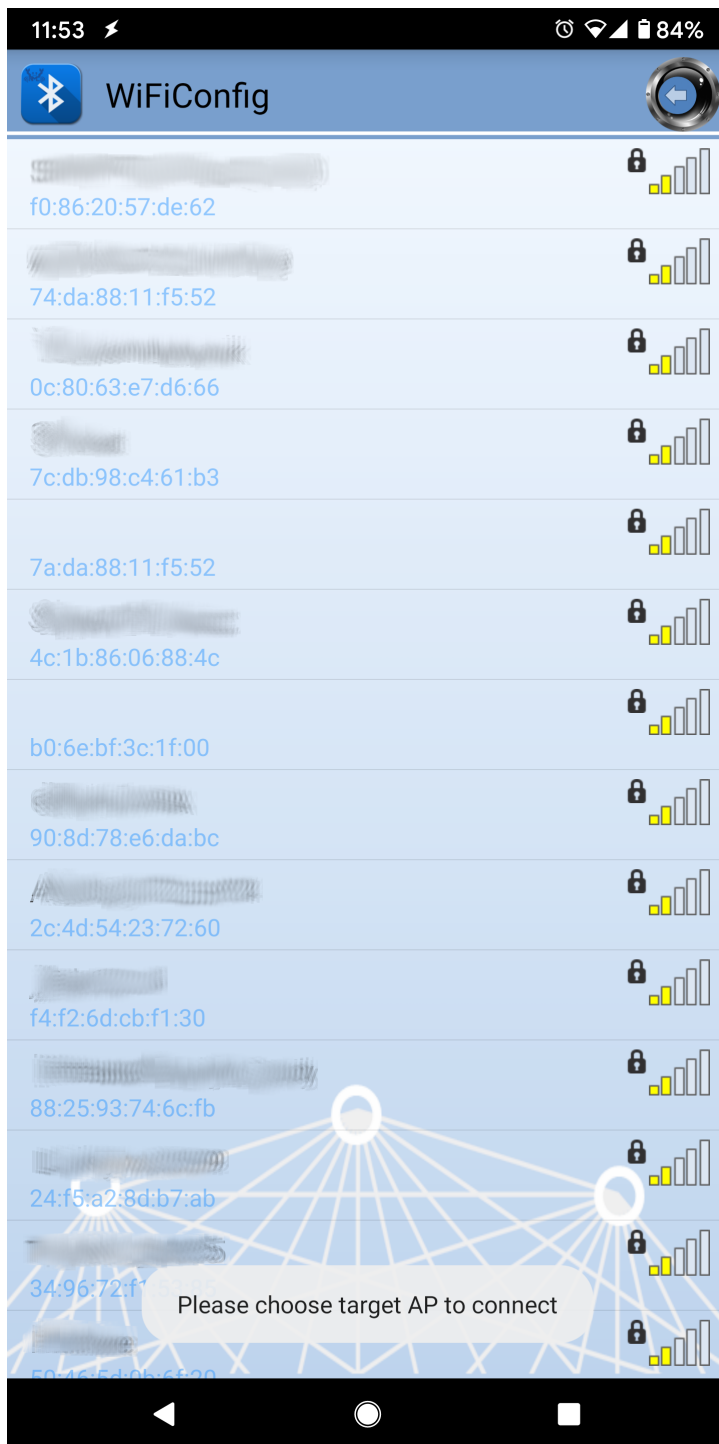
On your mobile phone, open the Realtek WiFiConfig app and tap the round button to scan for Ameba boards.



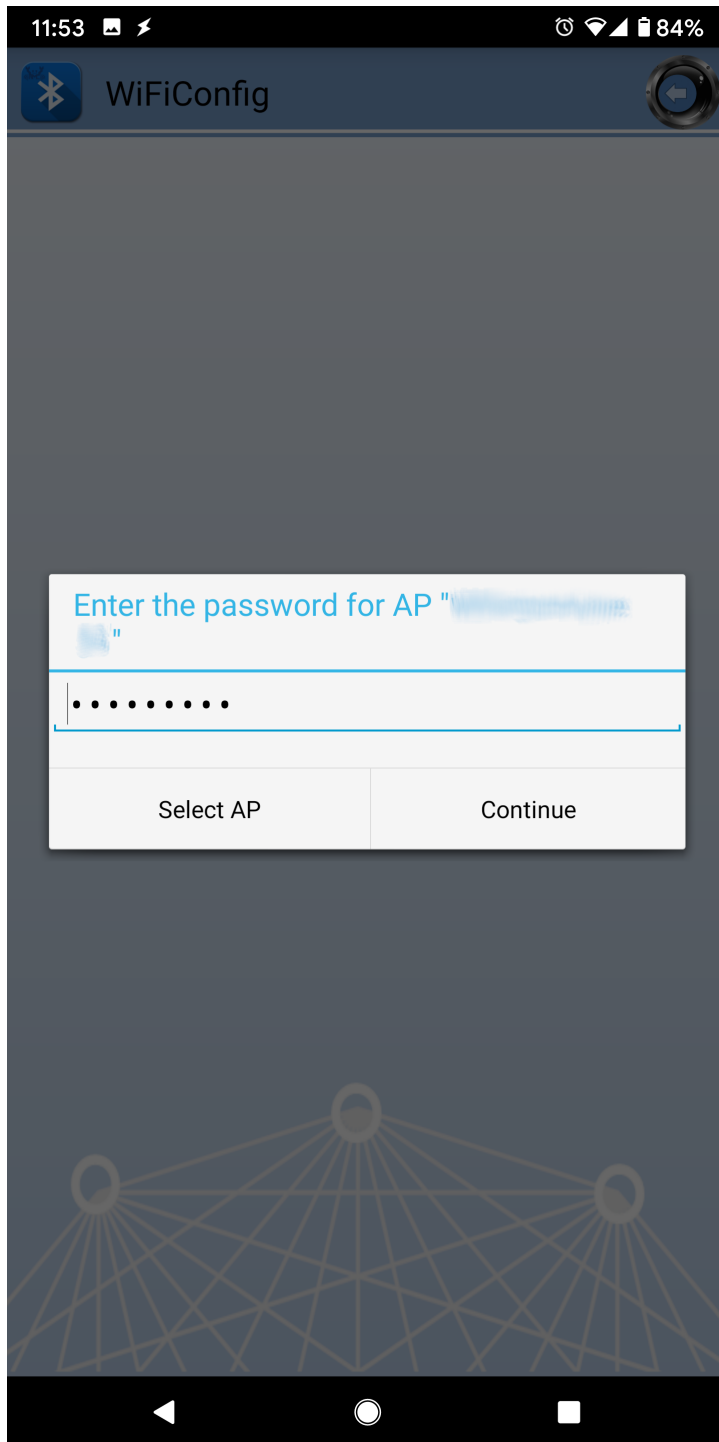
Select the correct Ameba board from the scan results. The app will connect to the Ameba board and ask the board to scan for WiFi networks and send the scan results back to the app using BLE.



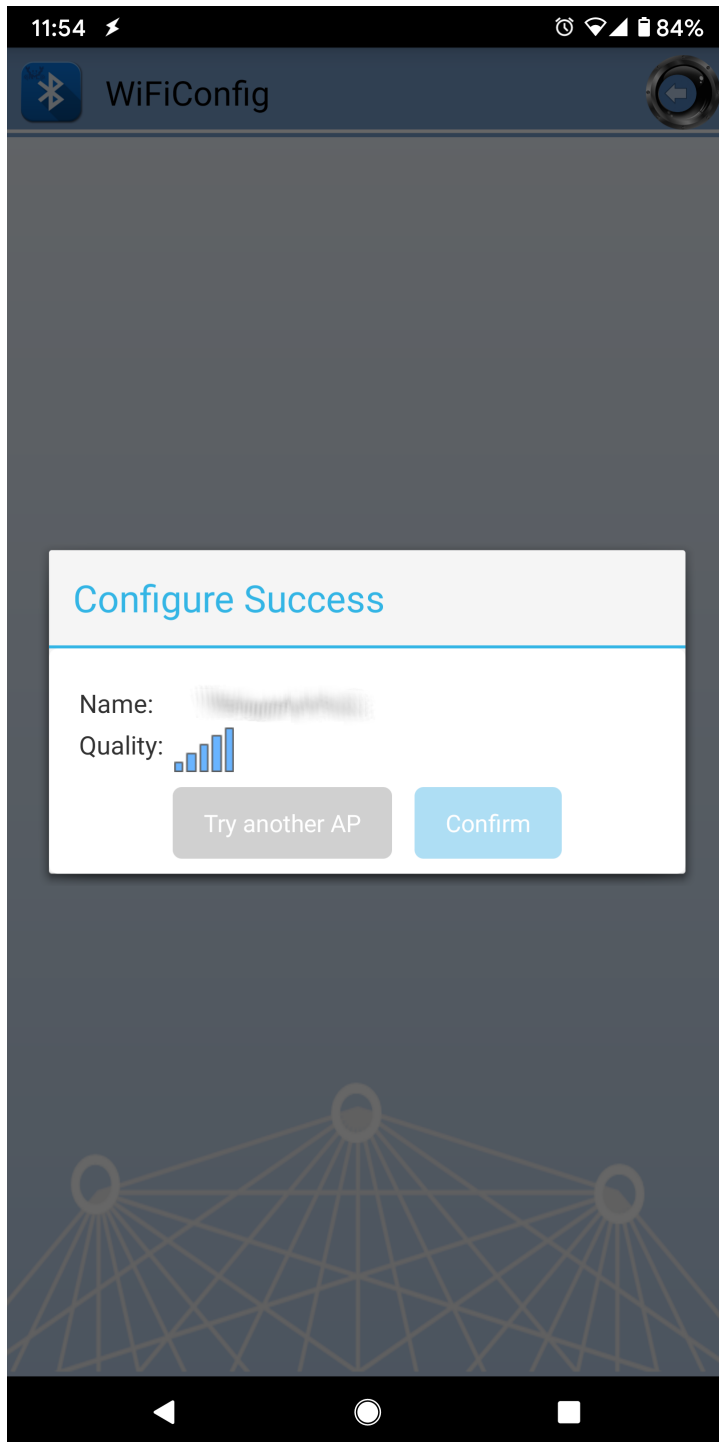




If your phone is currently connected to a WiFi network, the app will ask for the WiFi password to connect the Ameba board to the same WiFi network. Tap “Select AP” to choose another WiFi network, or enter the password and tap continue to connect Ameba to the selected WiFi network.



After the Ameba board connects to the WiFi network, the following message will be shown. Tap “Try another AP” to connect to another WiFi network or tap “Confirm” to keep the current WiFi network and disconnect BLE from the Ameba board.



### Code Reference

`BLEWifiConfigService` is used to create an instance of the WiFi configuration service to run on the Bluetooth device.

`BLE.configAdvert() -> setAdvType(configService.advData())` is used to set the correct advertisement data necessary for the phone app to find the Ameba Bluetooth device.



## BLE –BLE UART Client

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

### Example

#### Introduction

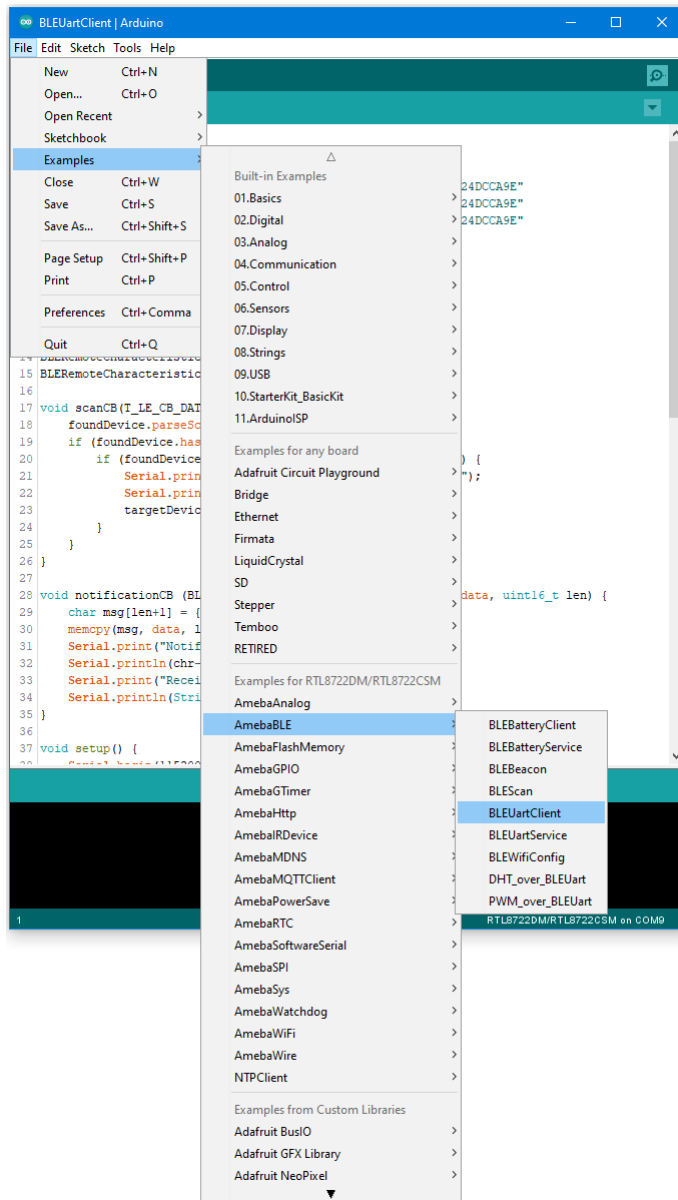
In this example, two RTL8722 boards are connected using BLE. One board runs a BLE UART service, while the other connects to the service using a client and both boards are able to communicate with text messages over the UART service.

#### Procedure

On the first board, upload the BLE UART service example code. Refer to the example guide for detailed instructions.

For the second board, open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEUartClient”

.



Upload the code and press the reset button on Ameba once the upload is finished.

Reset the UART service board first, wait for the BLE advertisement process to begin, and reset the UART client board. The client board should scan, discover, and connect to the service board. After connecting, the client board will verify that the correct UART service exists on the service board, before enabling notifications on the TX characteristic. Any message typed in the serial terminal will be sent to the other board using the UART service.

```

COM9
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:fe:d2
[BLE Device] GAP scan start
Found Ambeba BLE Device at address 70:1D:08:0B:DD:DB
[BLE Device] GAP scan stop
[BLE Device] Connected conn_id 0
Discovering services of connected device...
TX characteristic found
RX characteristic found
Notification received for chr UUID: 6e400003-b5a3-f393-e0a9-e50e24dcca9e
Received string: message from service to client
  
```

## Code Reference

The `BLEClient` class is used to discover the services that exist on a connected BLE device. The discovery process will create `BLERemoteService`, `BLERemoteCharacteristic` and `BLERemoteDescriptor` objects corresponding to the services, characteristics and descriptors that exist on the connected device. These objects can then be used to read and write data to the connected device.

## BLE –BLE UART Service

### Materials

- AmbebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS smartphone

### Example

#### Introduction

With BLE, application data is sent and received using the GATT system. GATT uses services, characteristics, and attributes to organise data and control how the data can be read from and written to. The Bluetooth SIG specification for BLE includes several predefined services for common applications, but users are free to implement custom services and characteristics to best fit their data structure and application needs

In this example, the `BLEService` and `BLECharacteristic` classes are used to implement a custom service for transmitting ASCII characters similar to regular UART. This custom service is the Nordic UART Service, which is supported in several smartphone apps.

## Procedure

Ensure that a compatible BLE UART app is installed on your smartphone, it is available at:

–Google Play Store:

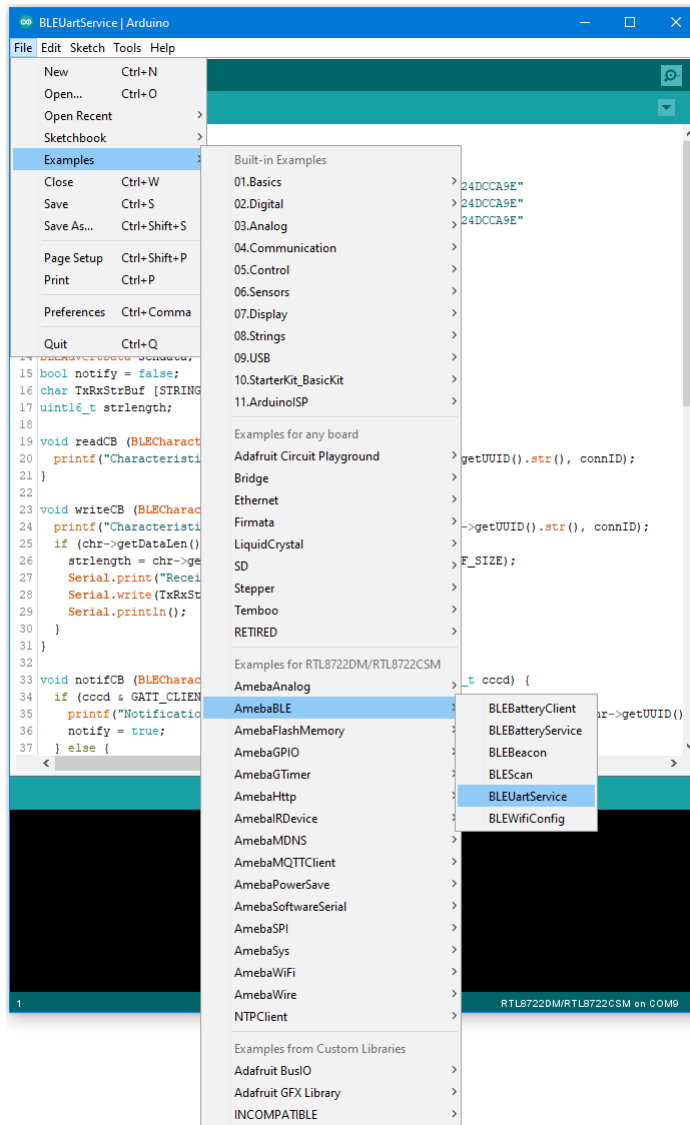
<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connect>

[https://play.google.com/store/apps/details?id=de.kai\\_morich.serial\\_bluetooth\\_terminal](https://play.google.com/store/apps/details?id=de.kai_morich.serial_bluetooth_terminal)

–Apple App Store:

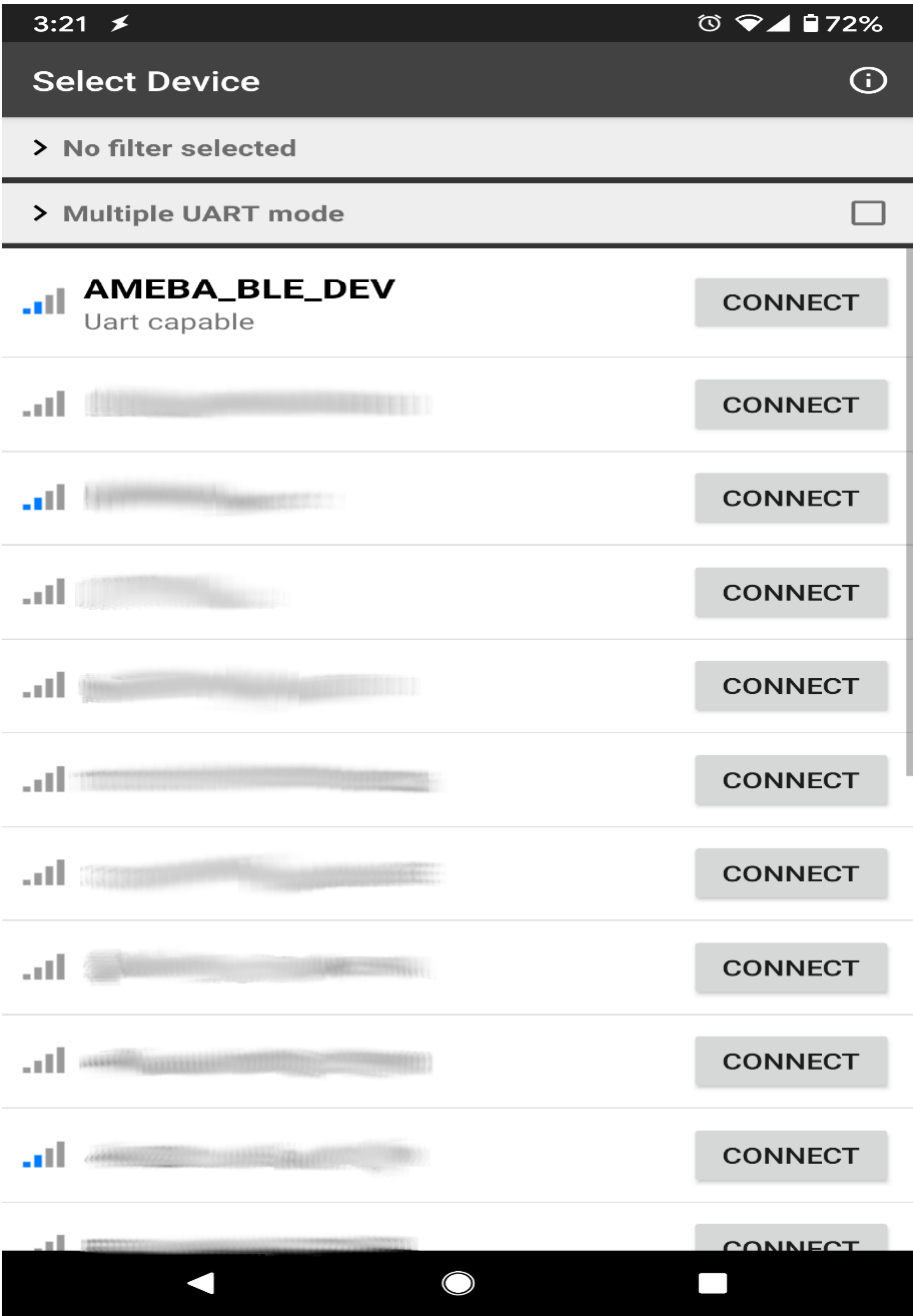
<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

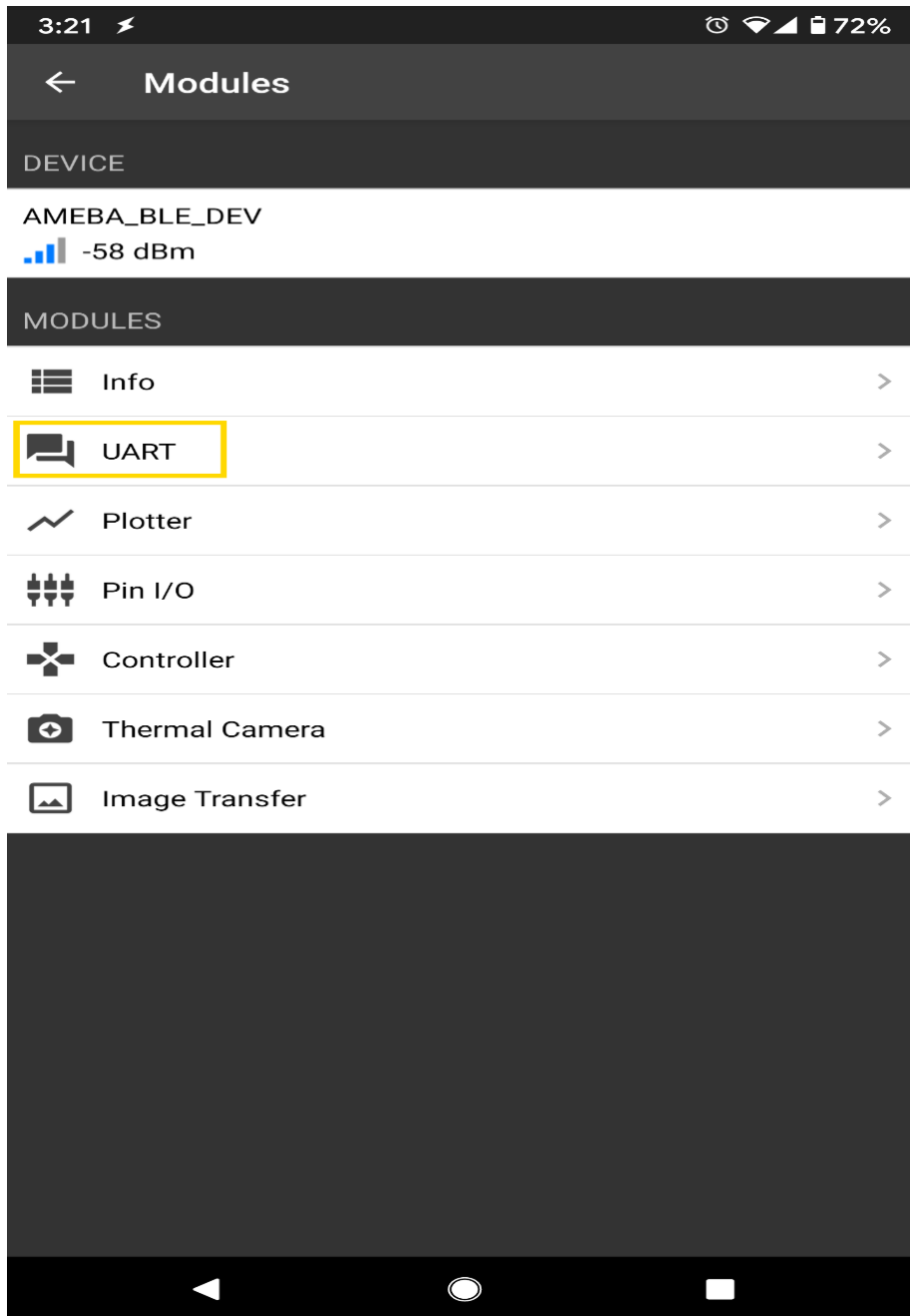
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEUartService” .



Upload the code and press the reset button on Ameba once the upload is finished.

Open the app on your smartphone, scan and connect to the Ameba board shown as “AMEBA\_BLE\_DEV” and choose the UART function in the app. Note that the BLE UART service on the Ameba board will only work with the UART and Plotter functions in the Bluefruit Connect app, other functions (Pin I/O, Image Transfer) require other BLE services that are not included in this example.



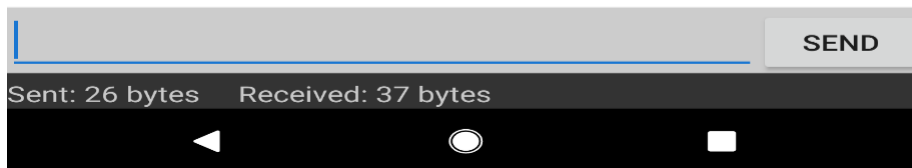


In the UART terminal section of the app, enter a message and click send. You should see the message appear in the Arduino serial monitor.

In the Arduino serial monitor, enter a message and click send. The message will appear in the smartphone app.



**message from app to Ameba**  
message from Ameba to smartphone app





```

COM9
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:ferd2
[BLE Device] GAP adv start
[BLE Device] GAP adv stopped: because connection created
[BLE Device] BT Connected
Notifications enabled on Characteristic 6e400003-b5a3-f393-e0a9-e50e24dcca9e for connection 0
Characteristic 6e400002-b5a3-f393-e0a9-e50e24dcca9e write by connection 0 :
Received string: message from app to Ameba

```

## Code Reference

The `BLECharacteristic` class is used to create two characteristics, one for receive (Rx) and one for transmit (Tx), and added to a service created with the `BLEService` class.

The required read/write/notify properties are set for each characteristic using the `set__Property()` methods, and callback functions are registered using the `set__Callback()` methods. The required buffer size is also set for each characteristic so that it has enough memory to store a complete string.

When data is written to the receive characteristic, the registered callback function is called, which prints out the received data as a string to the serial monitor.

When data is received on the serial port, it is copied into the transmit characteristic buffer, and the `notify()` method is used to inform the connected device of the new data.

## BLE –DHT over BLE UART

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21
- Android / iOS smartphone

## Example

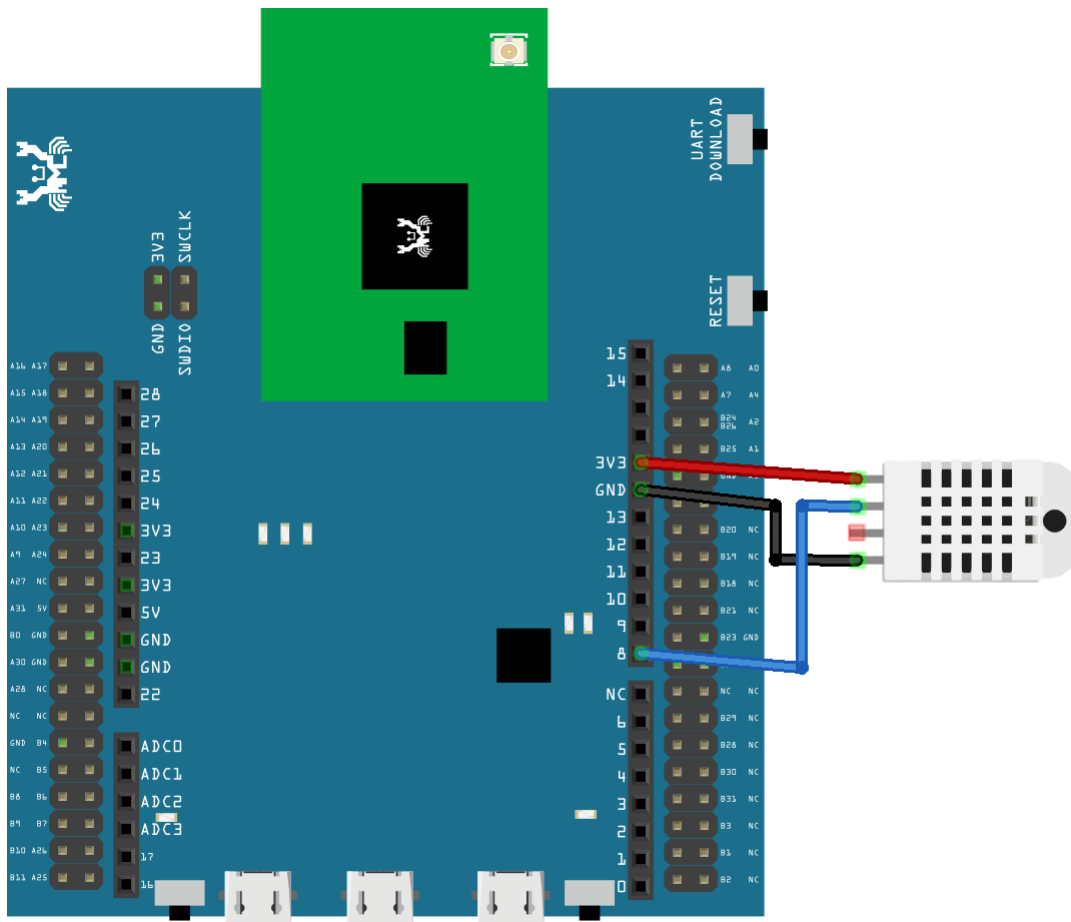
### Introduction

In this example, the data obtained from a DHT temperature and humidity sensor are transmitted over a BLE UART service to a smartphone. Refer to the other examples for detailed explanations of using the DHT sensor and the BLE UART service.

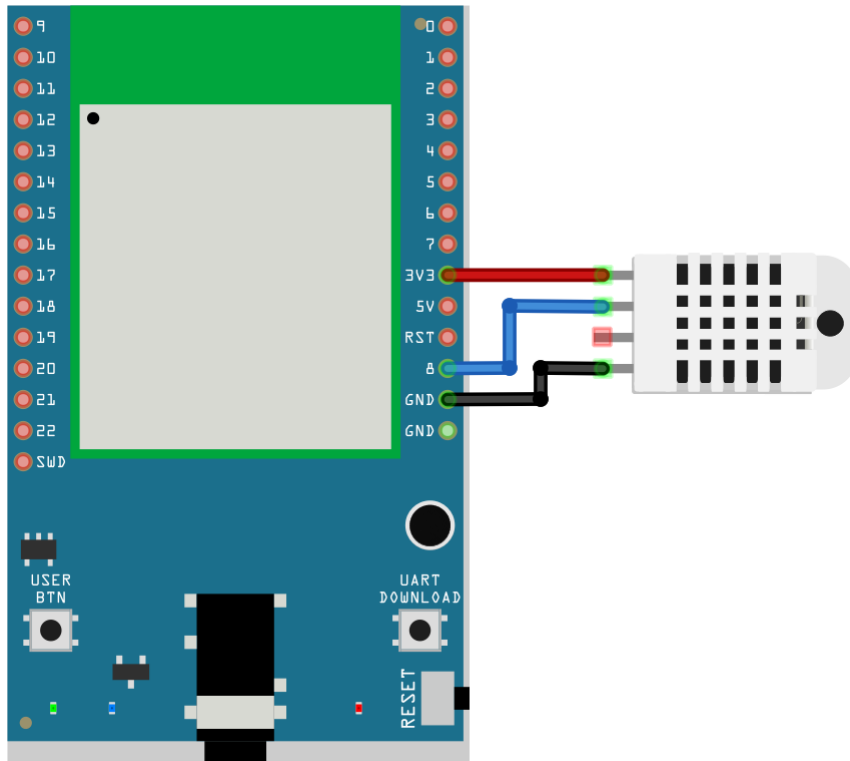
### Procedure

Connect the DHT sensor to the Ameba board following the diagram.

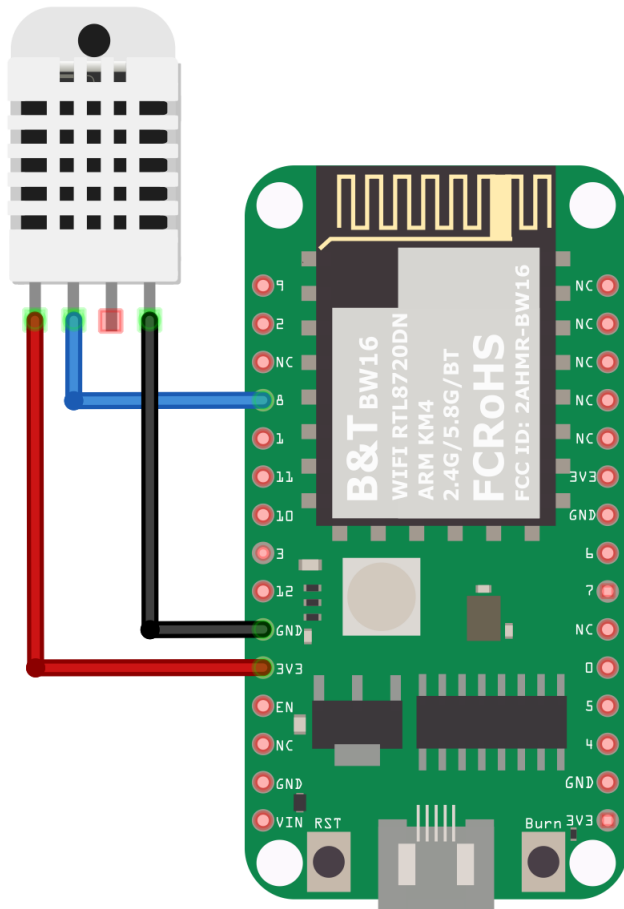
AMB21 / AMB22:



AMB23:



**BW16:**



Ensure that a compatible BLE UART app is installed on your smartphone, it is available at:

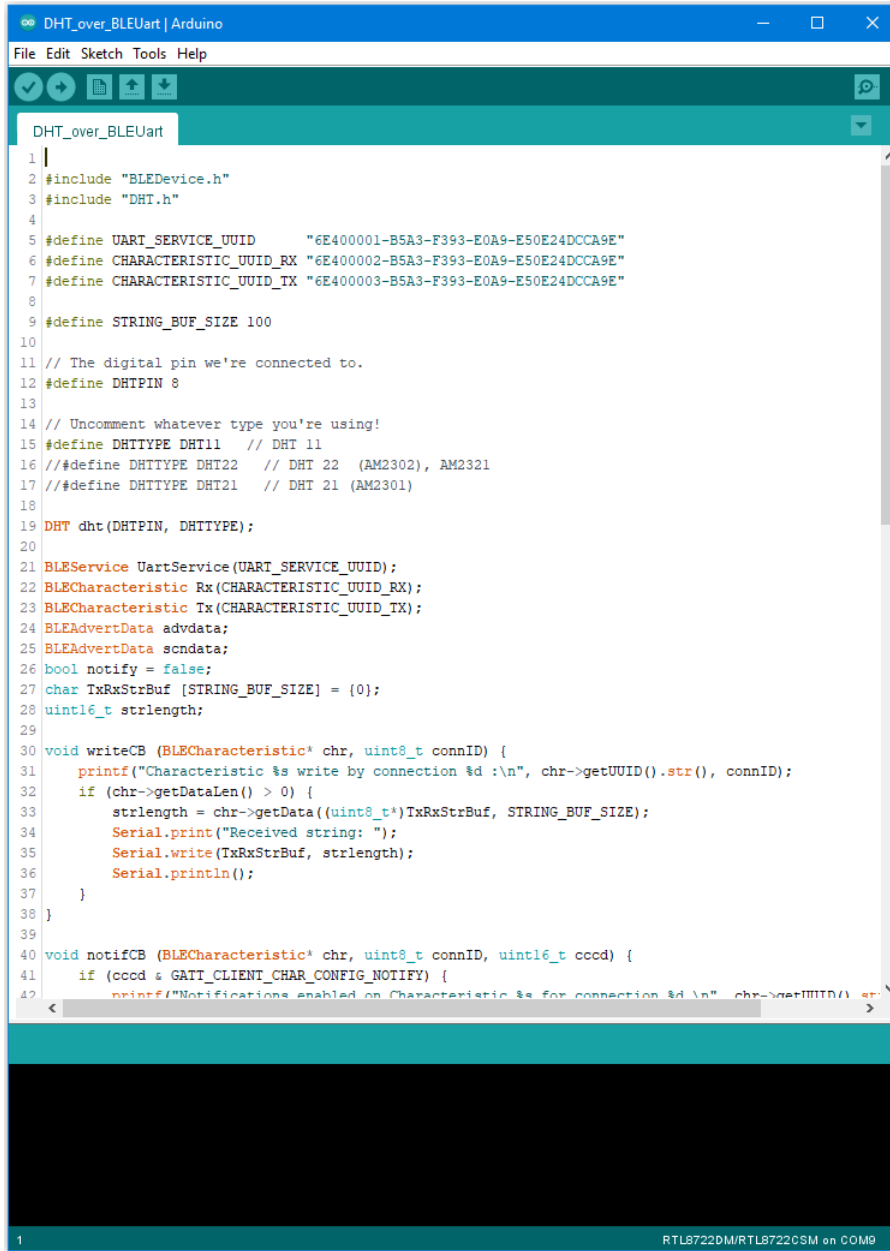
- Google Play Store:

<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connecta>>[https://play.google.com/store/apps/details?id=de.kai\\_morich.serial\\_bluetooth\\_terminal](https://play.google.com/store/apps/details?id=de.kai_morich.serial_bluetooth_terminal)

- Apple App Store:

<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “DHT\_over\_BLEUart” .



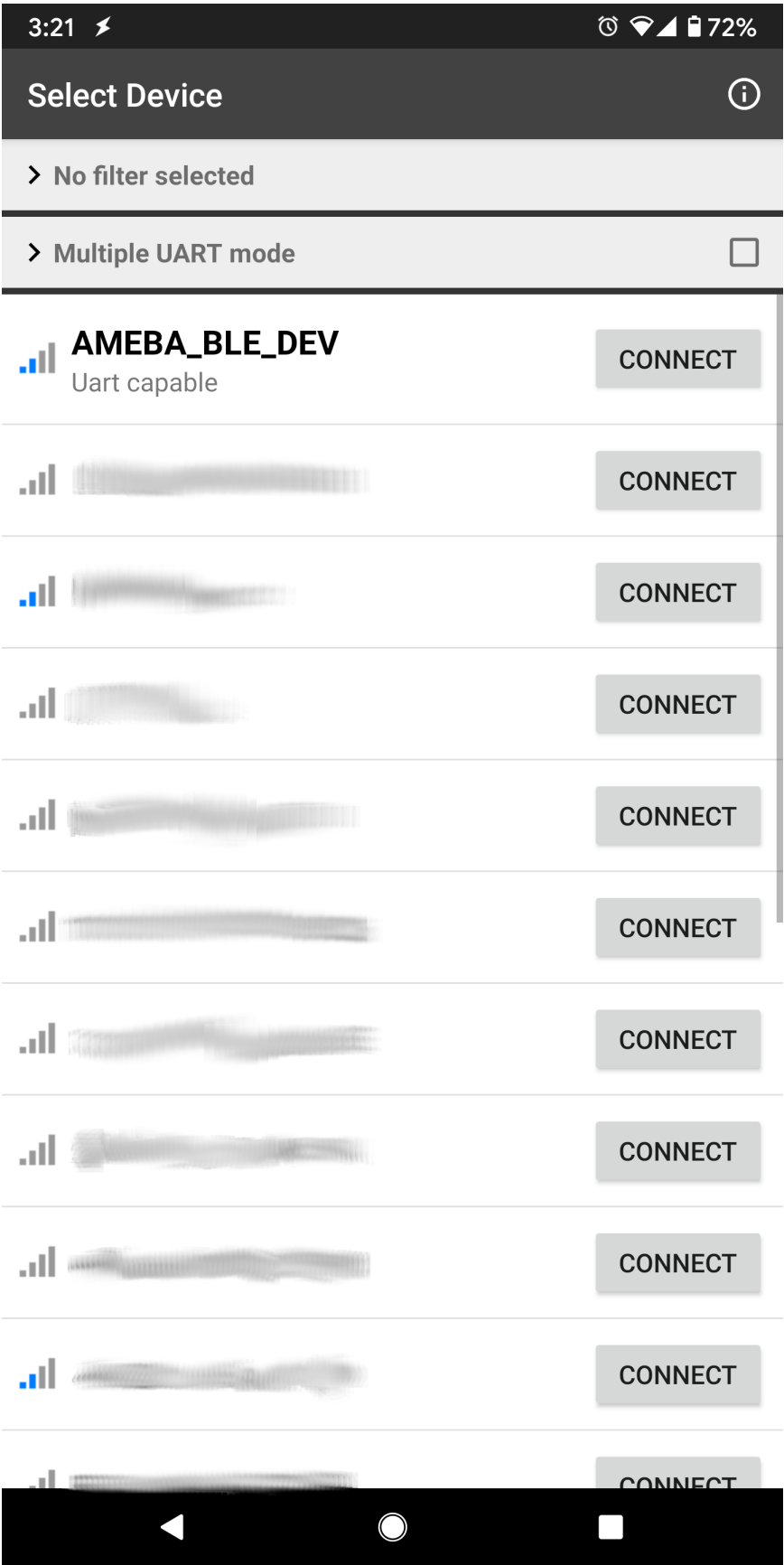
```

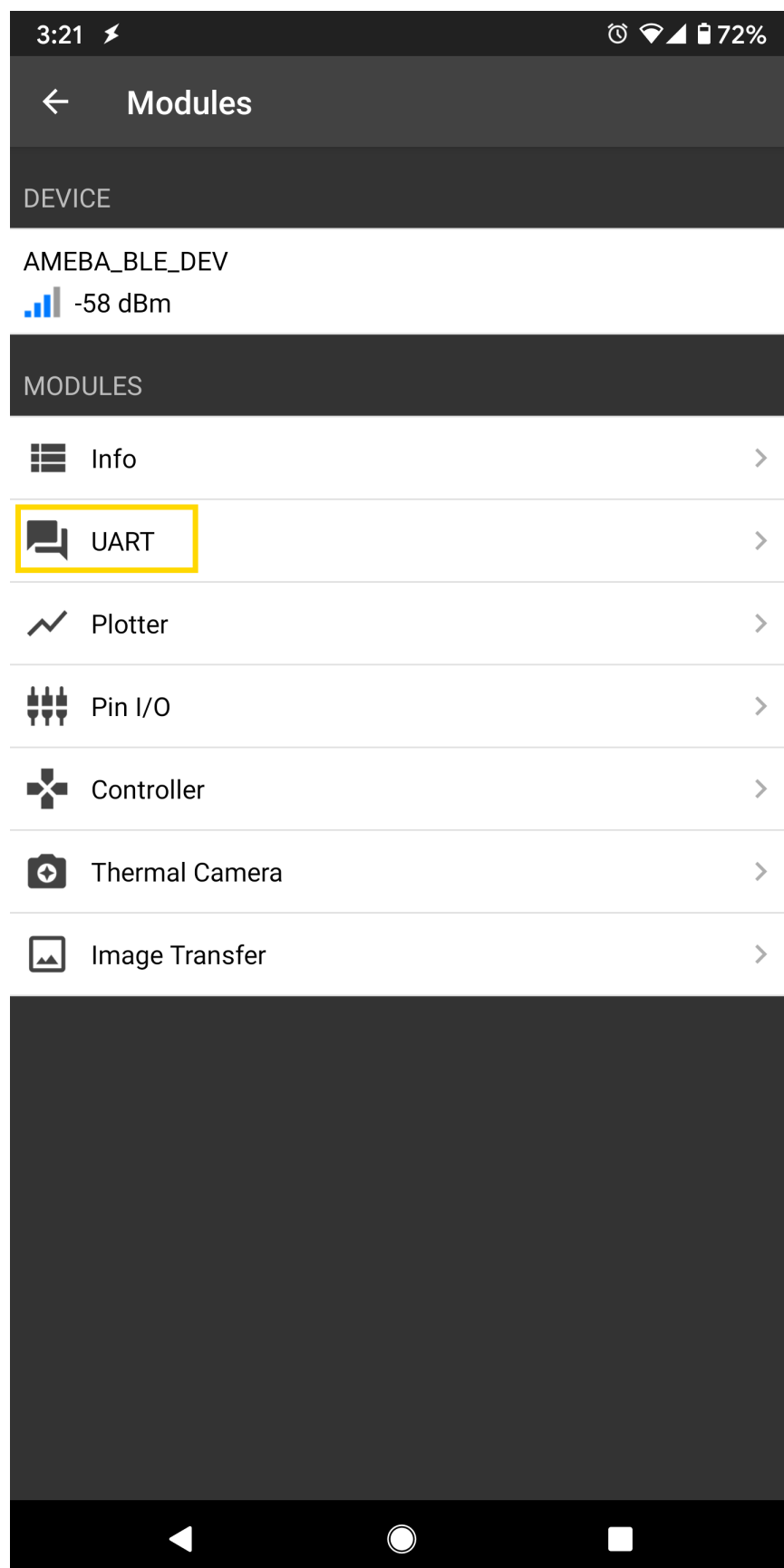
DHT_over_BLEUart
1 |
2 #include "BLEDevice.h"
3 #include "DHT.h"
4
5 #define UART_SERVICE_UUID "6E400001-B5A3-F393-E0A9-E50E24DCCA9E"
6 #define CHARACTERISTIC_UUID_RX "6E400002-B5A3-F393-E0A9-E50E24DCCA9E"
7 #define CHARACTERISTIC_UUID_TX "6E400003-B5A3-F393-E0A9-E50E24DCCA9E"
8
9 #define STRING_BUF_SIZE 100
10
11 // The digital pin we're connected to.
12 #define DHTPIN 8
13
14 // Uncomment whatever type you're using!
15 #define DHITYPE DHT11 // DHT 11
16 // #define DHITYPE DHT22 // DHT 22 (AM2302), AM2321
17 // #define DHITYPE DHT21 // DHT 21 (AM2301)
18
19 DHT dht(DHTPIN, DHITYPE);
20
21 BLEService uartService(UART_SERVICE_UUID);
22 BLECharacteristic Rx(CHARACTERISTIC_UUID_RX);
23 BLECharacteristic Tx(CHARACTERISTIC_UUID_TX);
24 BLEAdvertData advdata;
25 BLEAdvertData scndata;
26 bool notify = false;
27 char TxRxStrBuf [STRING_BUF_SIZE] = {0};
28 uint16_t strlength;
29
30 void writeCB (BLECharacteristic* chr, uint8_t connID) {
31     printf("Characteristic %s write by connection %d :\n", chr->getUUID().str(), connID);
32     if (chr->getDataLen() > 0) {
33         strlength = chr->getData((uint8_t*)TxRxStrBuf, STRING_BUF_SIZE);
34         Serial.print("Received string: ");
35         Serial.write(TxRxStrBuf, strlength);
36         Serial.println();
37     }
38 }
39
40 void notifCB (BLECharacteristic* chr, uint8_t connID, uint16_t cccd) {
41     if (cccd & GATT_CLIENT_CHAR_CONFIG_NOTIFY) {
42         printf("Notifications enabled on Characteristic %s for connection %d\n", chr->getUUID().str(), connID);
43     }
44 }
45
46 void setup() {
47     Serial.begin(115200);
48     while (!Serial) continue;
49     uartService.setName("DHT_BLE");
50     uartService.addCharacteristic(Rx);
51     uartService.addCharacteristic(Tx);
52     advdata.setTxPower(10);
53     advdata.addServiceUUID(uartService.getUUID());
54     advdata.addCharacteristicUUID(Rx.getUUID());
55     advdata.addCharacteristicUUID(Tx.getUUID());
56     scndata.setTxPower(10);
57     scndata.addServiceUUID(uartService.getUUID());
58     scndata.addCharacteristicUUID(Rx.getUUID());
59     scndata.addCharacteristicUUID(Tx.getUUID());
60     BLEDevice::init("AMEBA_BLE_DEV");
61     uartService.startAdvertising(advdata, scndata);
62     dht.begin();
63 }
64
65 void loop() {
66     if (dht.isDataAvailable()) {
67         float temp = dht.temperature();
68         float hum = dht.humidity();
69         Serial.print("Temp: ");
70         Serial.print(temp);
71         Serial.print(" Hum: ");
72         Serial.print(hum);
73         Serial.println();
74     }
75 }

```

Upload the code and press the reset button on Ameba once the upload is finished.

Open the app on your smartphone, scan and connect to the Ameba board shown as “AMEBA\_BLE\_DEV” and choose the UART function in the app.





After starting the UART function, notifications should be received every 5 seconds containing the measured temperature and humidity.





## BLE –PWM over BLE UART

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- RGB LED
- Android / iOS smartphone

### Example

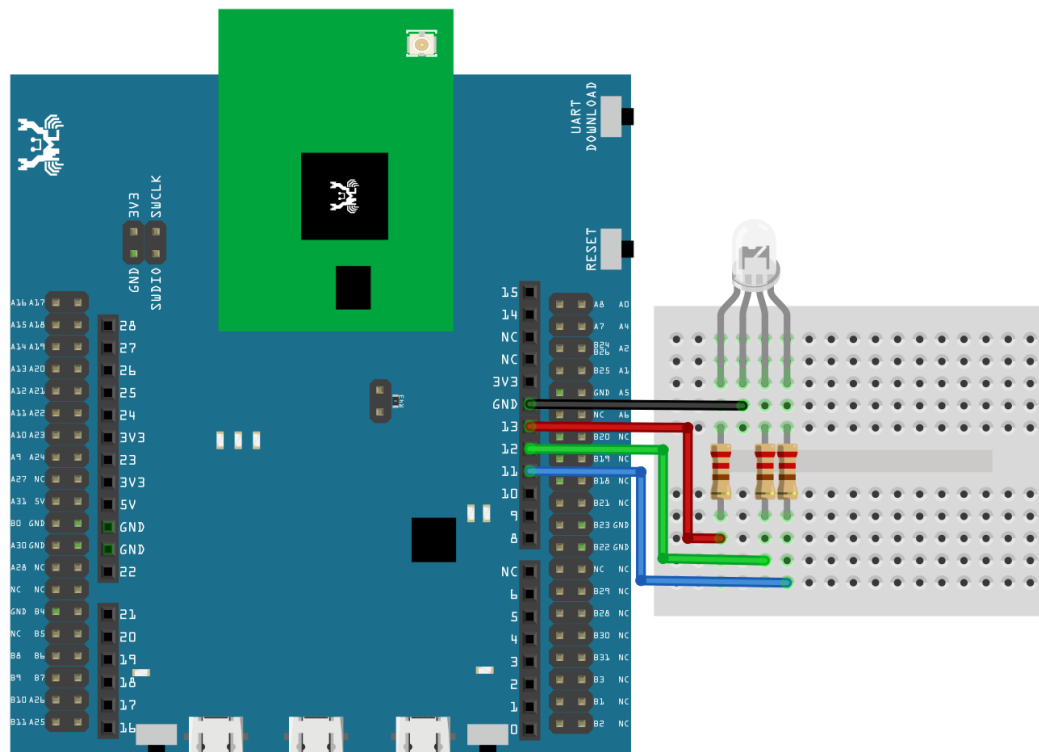
#### Introduction

In this example, a smartphone app is used to transmit commands over BLE UART to control the PWM outputs and change the color of a RGB LED. Refer to the other example guides for detailed explanations of the BLE UART service.

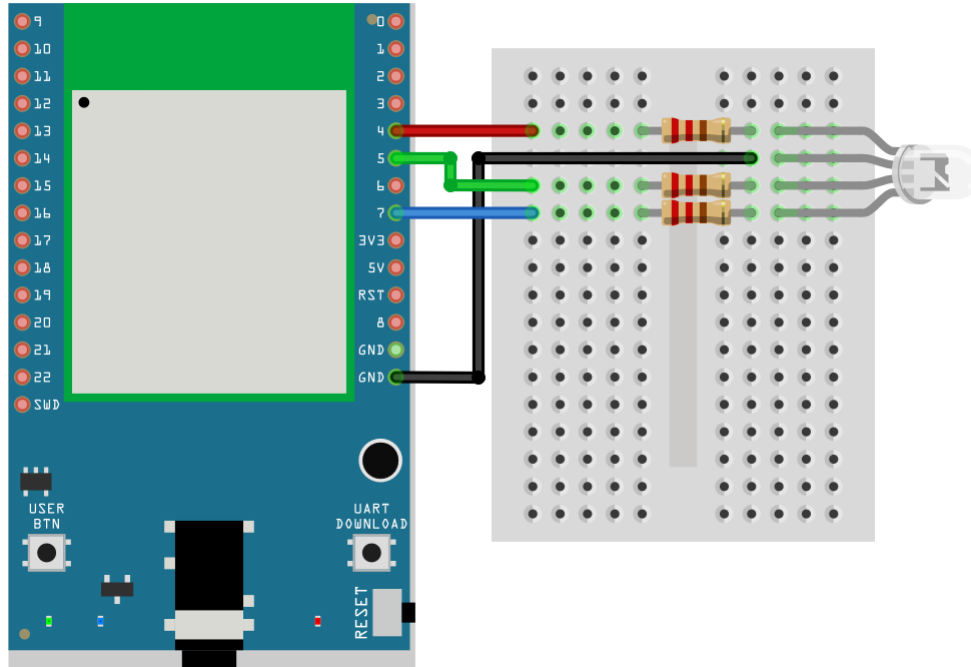
#### Procedure

Connect the RGB LED to the RTL8722 board following the diagram, the common LED pin may need to connect to 3.3V or GND depending on the type of LED (common anode / common cathode).

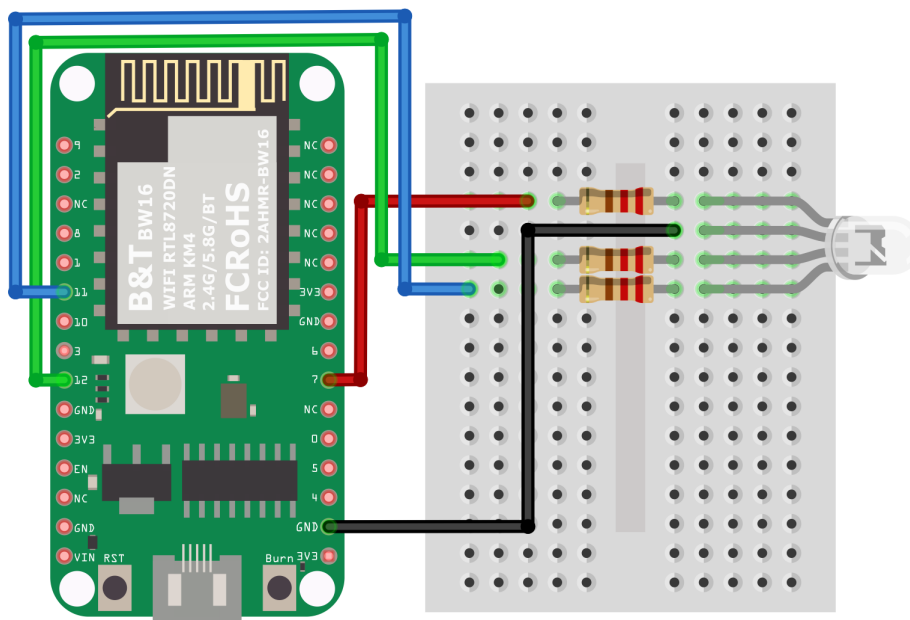
**AMB21 /AMB22:**



**AMB23:**



**BW16:**



Ensure that the required app is installed on your smartphone, it is available at:

- Google Play Store:

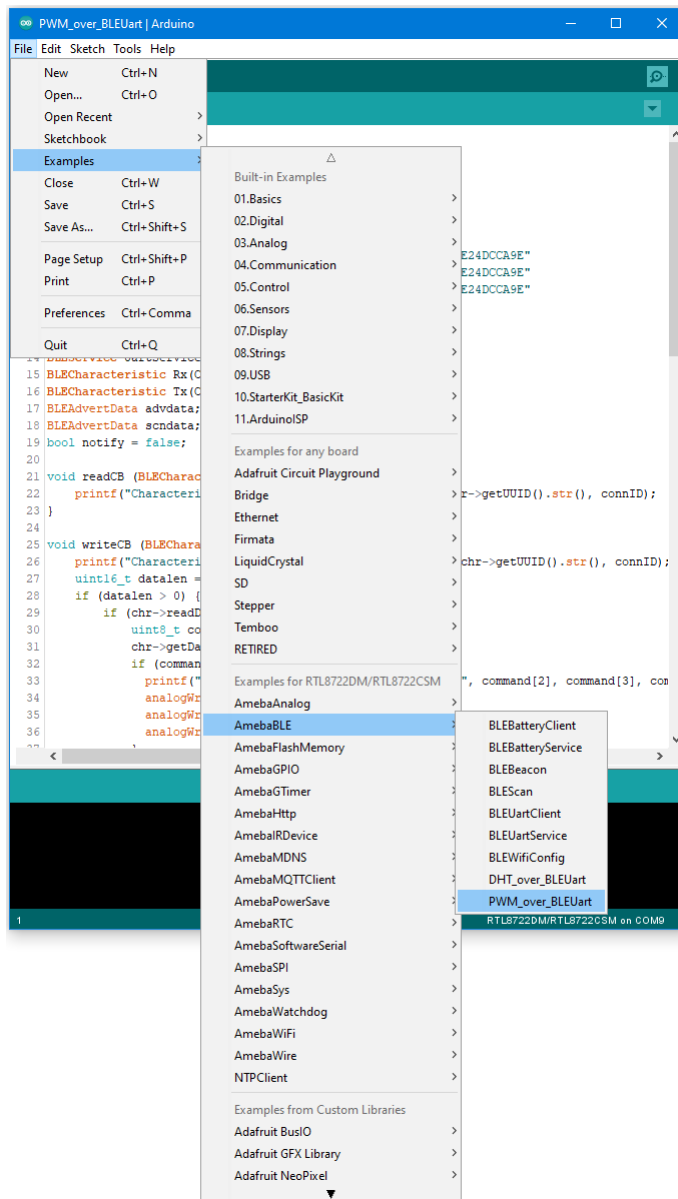
<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connect>

–Apple App Store:

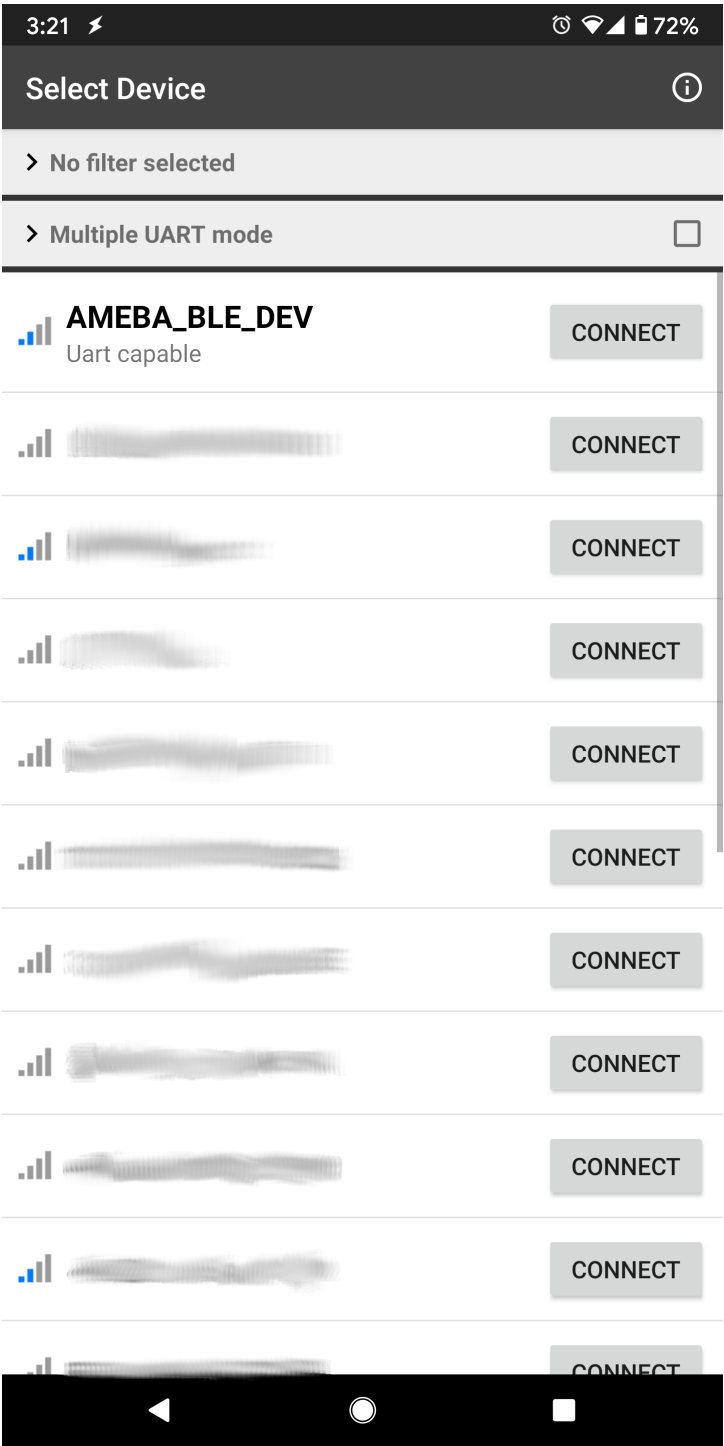
<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

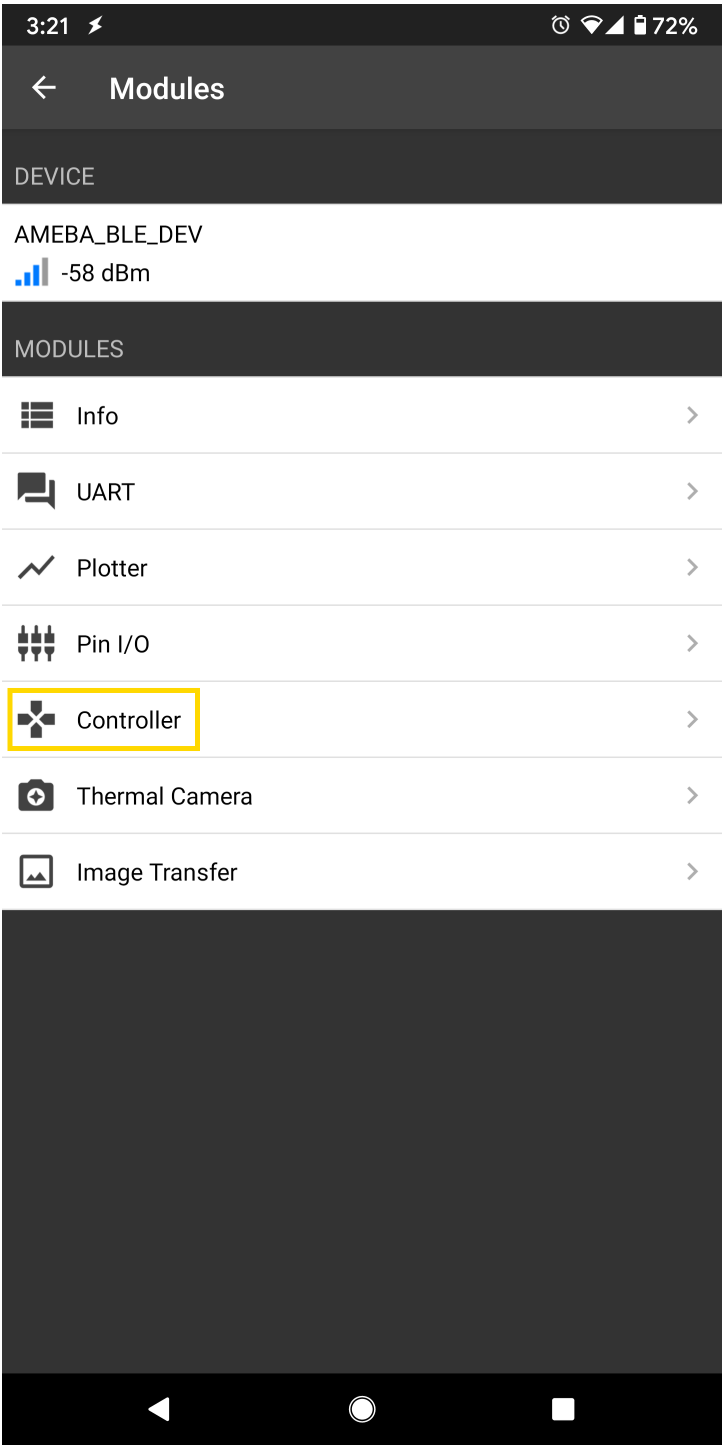
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “PWM\_over\_BLEUart” .

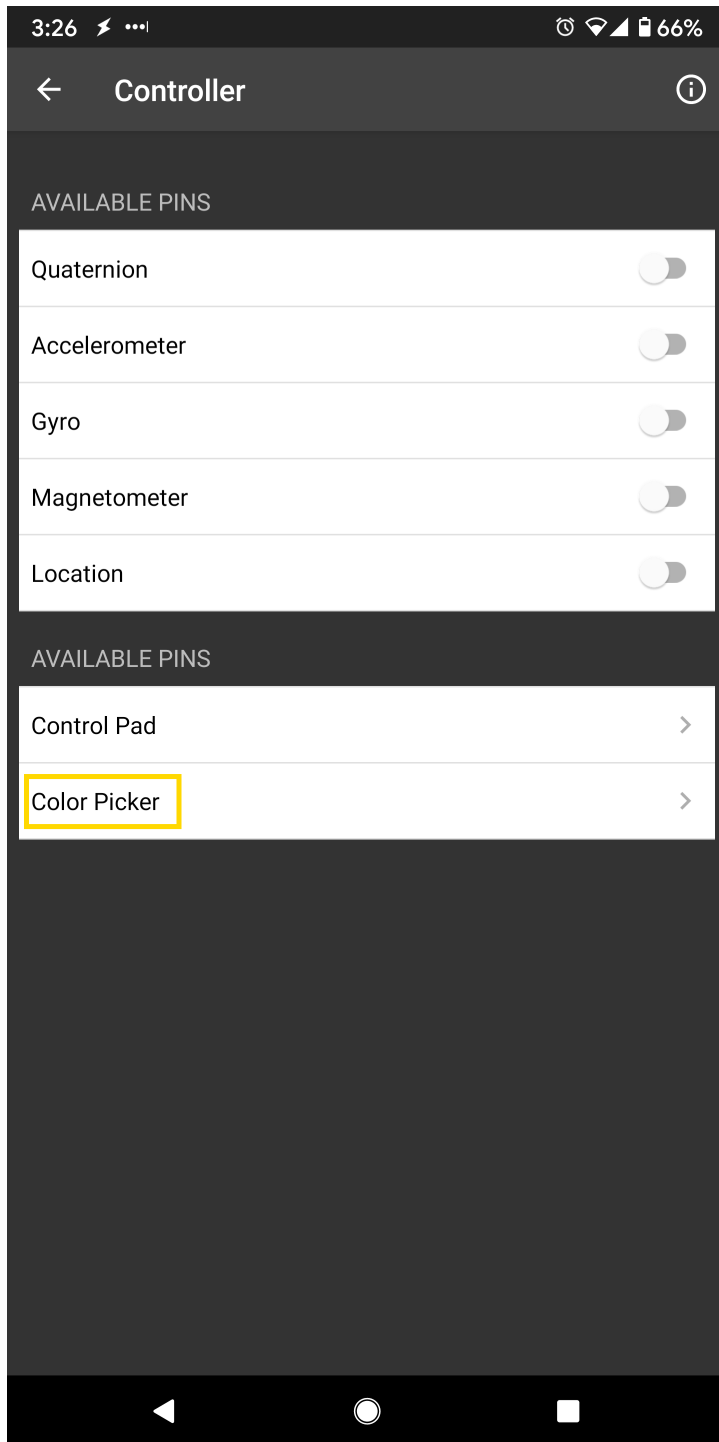
Upload the code and press the reset button on Ameba once the upload is finished.



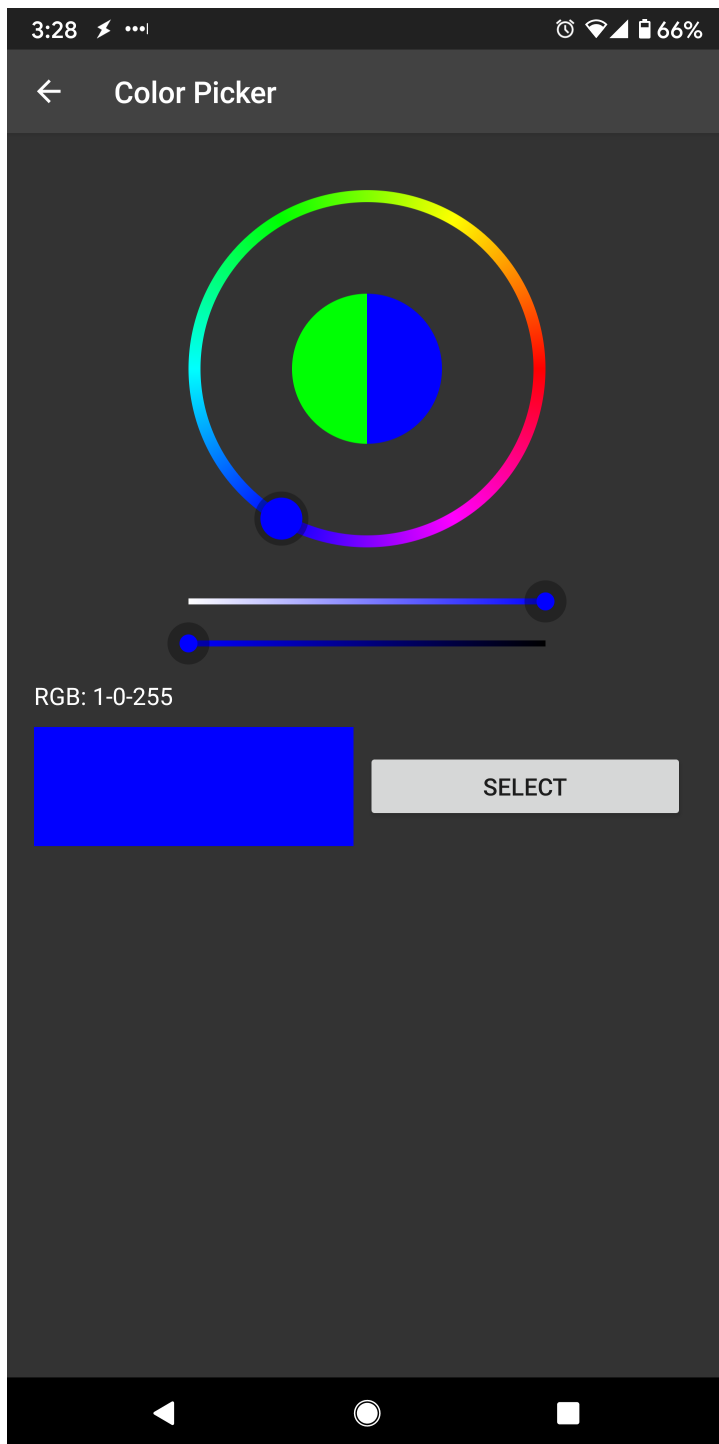
Open the app on your smartphone, scan and connect to the board shown as “AMEBA\_BLE\_DEV” and choose the controller -> color picker function in the app.







Using the color selection wheel, saturation, and brightness sliders, choose a desired color and click select to send the RGB values to the board. You should see the RGB LED change to the matching color.



### Code Reference

The RGB values are sent as three consecutive bytes prefixed by “!C” characters. The “!” exclamation mark is used to indicate that the following data is a command, and the “C” character is used to indicate that the data is RGB values. The received UART message is checked in the callback function for “!C” first, otherwise it is treated as a regular message



and printed to the serial terminal.

## BLE - HID Gamepad

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- BLE capable host device [Windows / Linux / MacOS / Android]

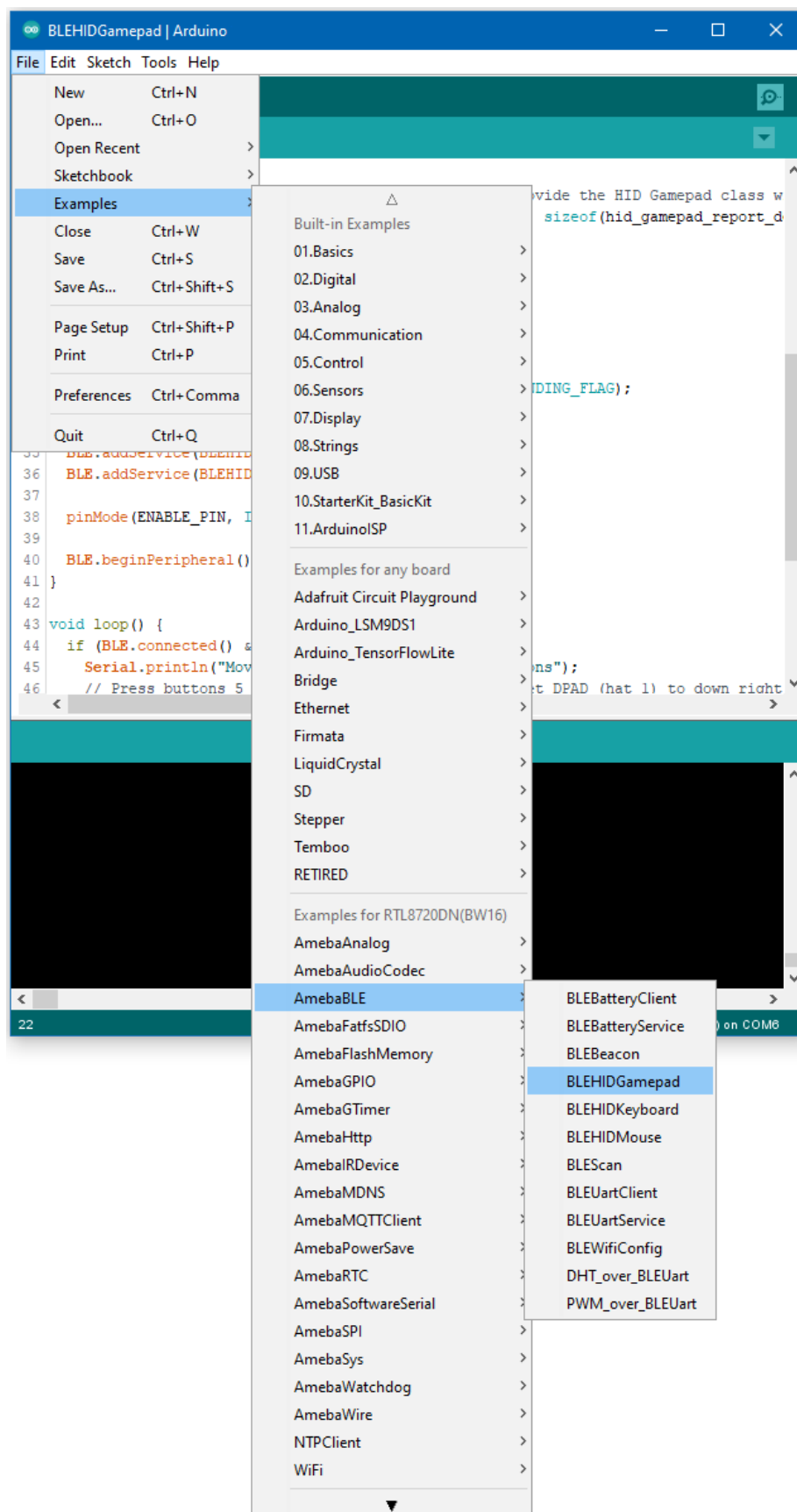
### Example

#### Introduction

In this example, the RTL8722 board emulates a HID gamepad connected using BLE.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> BLEHIDGamepad.

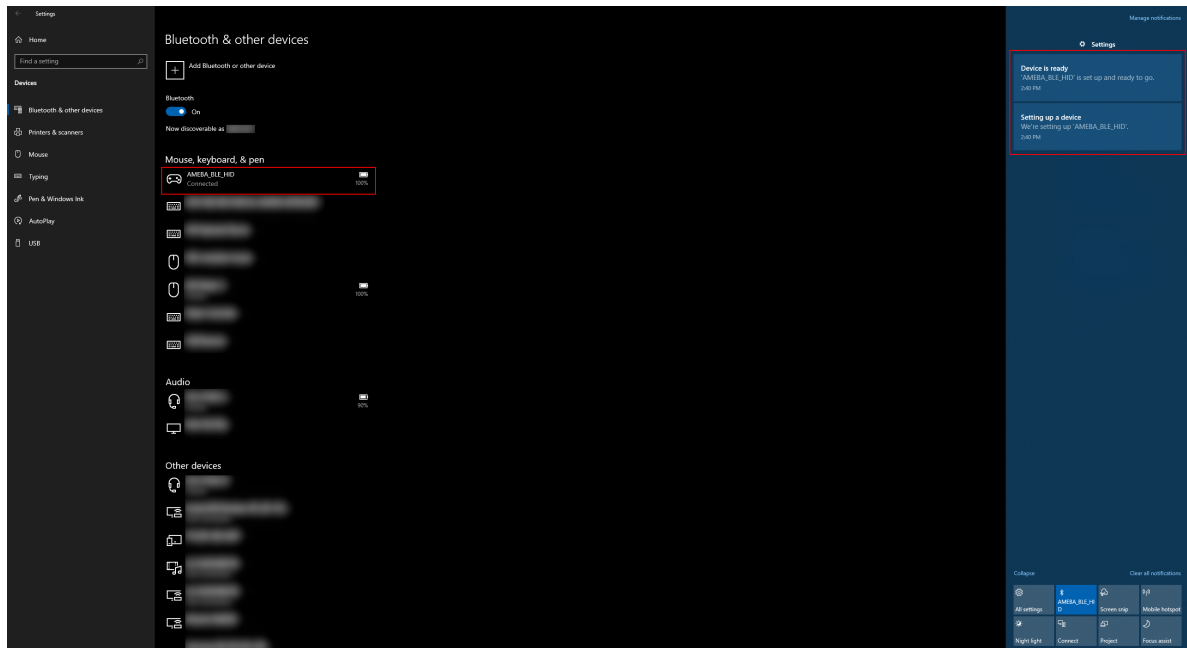


Upload the code and press the reset button once the upload is finished.

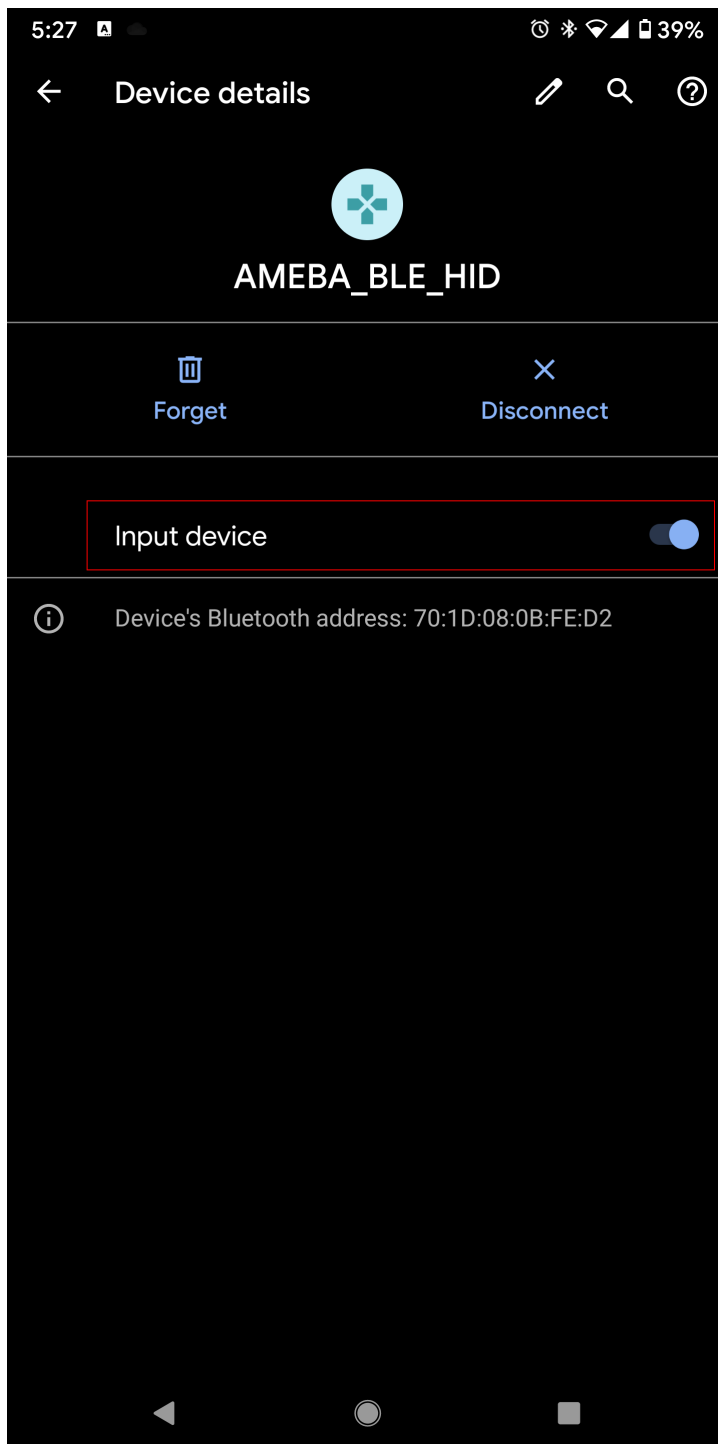
Immediately after reset, the board will begin BLE advertising as “AMEBA\_BLE\_HID” . On your host device, go to the Bluetooth settings menu, scan, and connect to the board.

You should ensure that the connection process is completed before proceeding.

On Windows, ensure that any driver installation is finished, and the board shows up in the Bluetooth menu under the “Mouse, keyboard & pen” category.

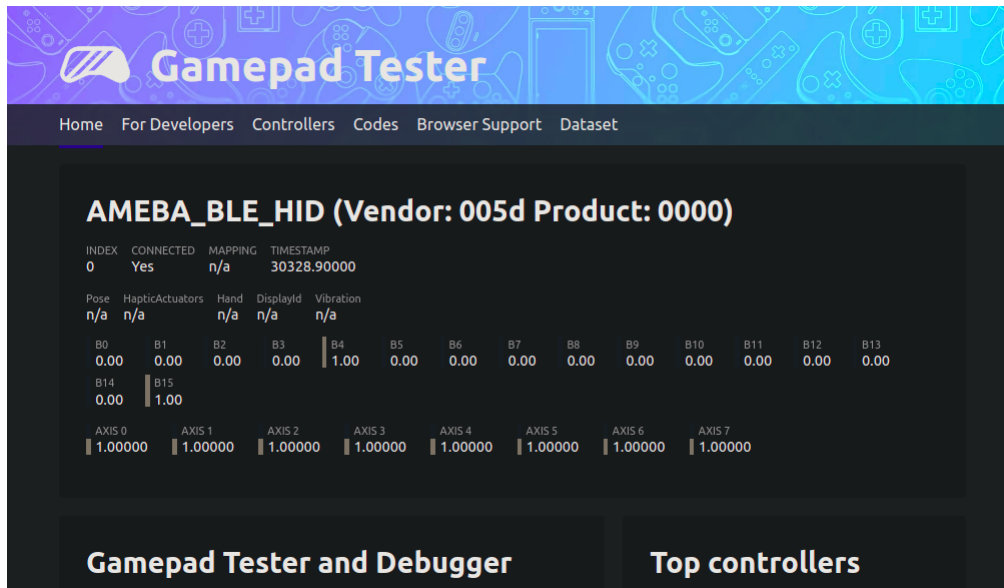


On Android, ensure that “Input device” is enabled for the board.

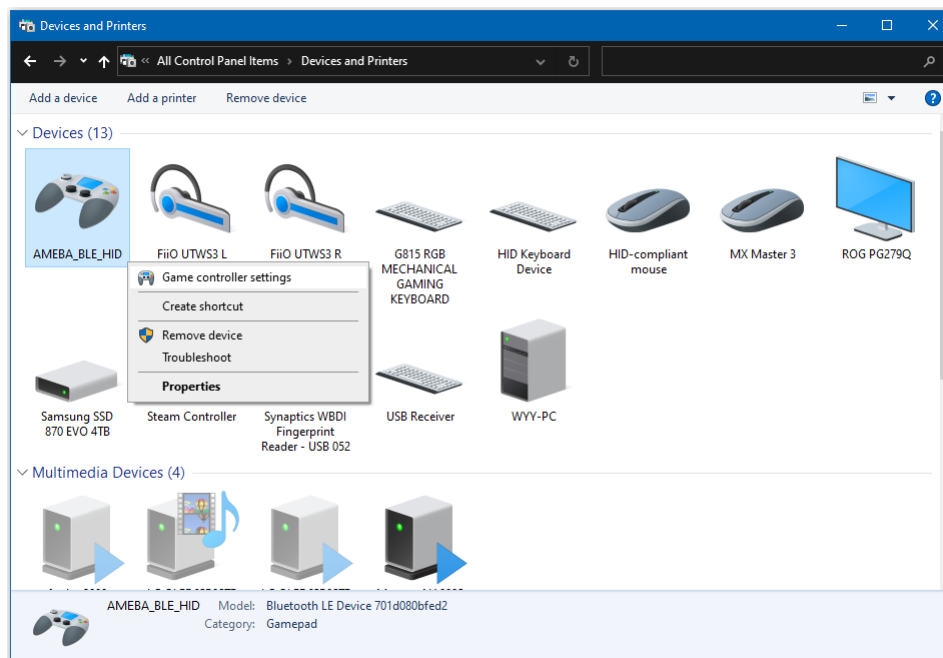


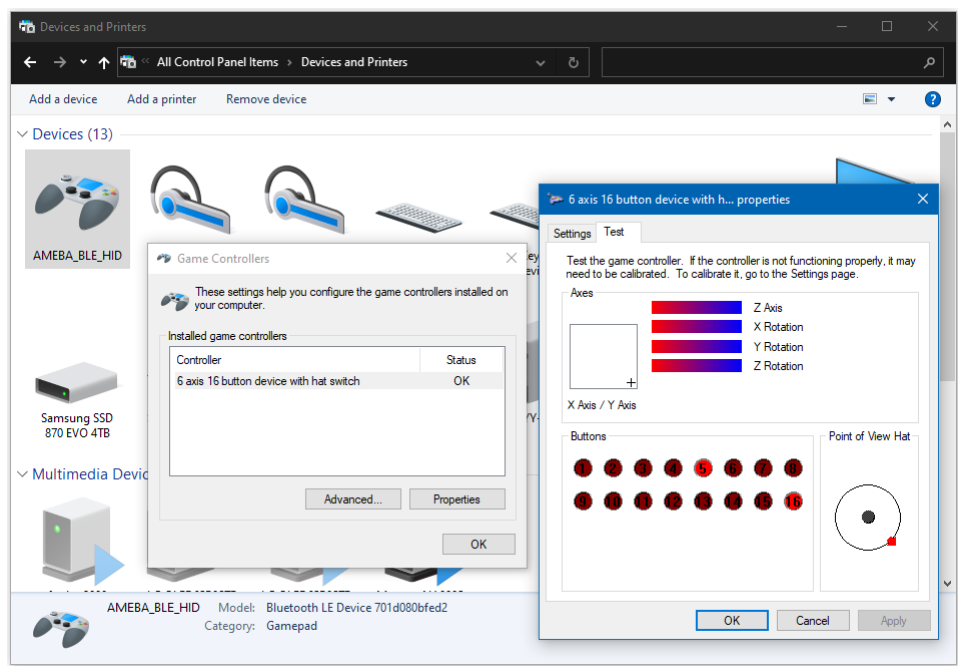
After the Bluetooth connection process is completed, the board is ready to send gamepad input to the host device. Connect digital pin 8 to 3.3V to start sending input, and connect to GND to stop.

To view the input, open a browser window and go to [Gamepad Tester](#). The connected gamepad device should show up here, and some of the buttons and axes should show changing values.

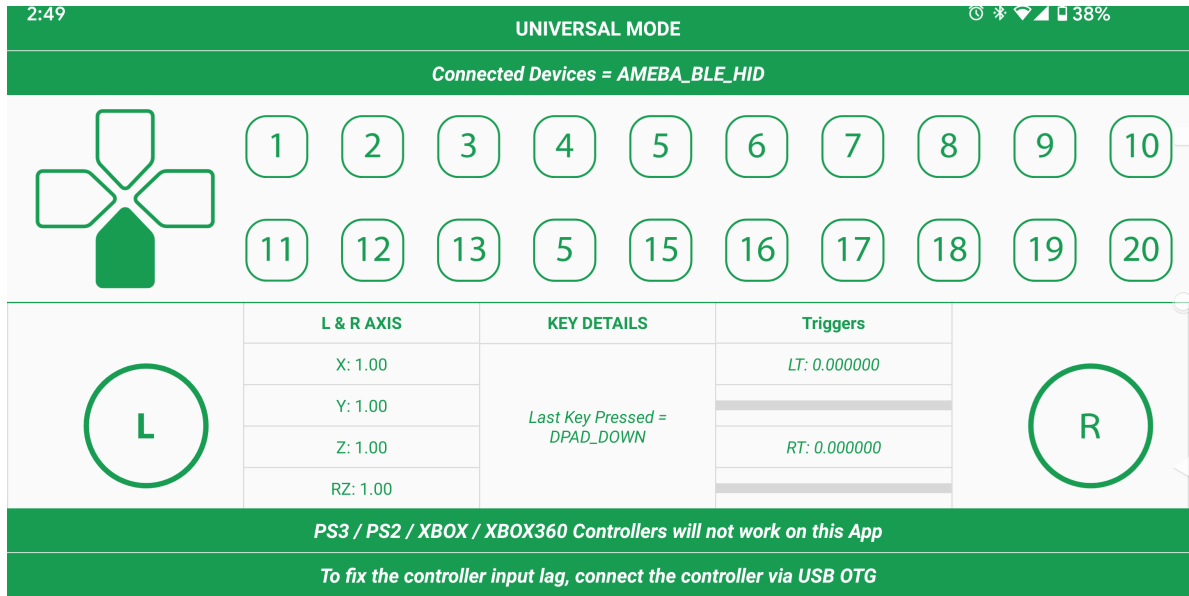


On Windows, gamepad input can also be viewed by going to “Control Panel” -> “Devices and Printers” -> “AMEBA\_BLE\_HID” -> “Game Controller Settings” -> “Properties” . The buttons and axes should also show changing values here.





On Android, gamepad testing apps such as [Andriod Gamepad Tester](#) can also be used to view the gamepad input.



Code Reference

By default, the board emulates a gamepad with an 8-direction hat switch (d-pad), 6 analog axes and 16 buttons. How the inputs are interpreted is dependent on the host device, and the button ordering may differ between devices. Also, some axes or buttons may be disabled or missing on certain host devices.

## BLE - HID Keyboard

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- BLE capable host device [Windows / Linux / MacOS / Android]

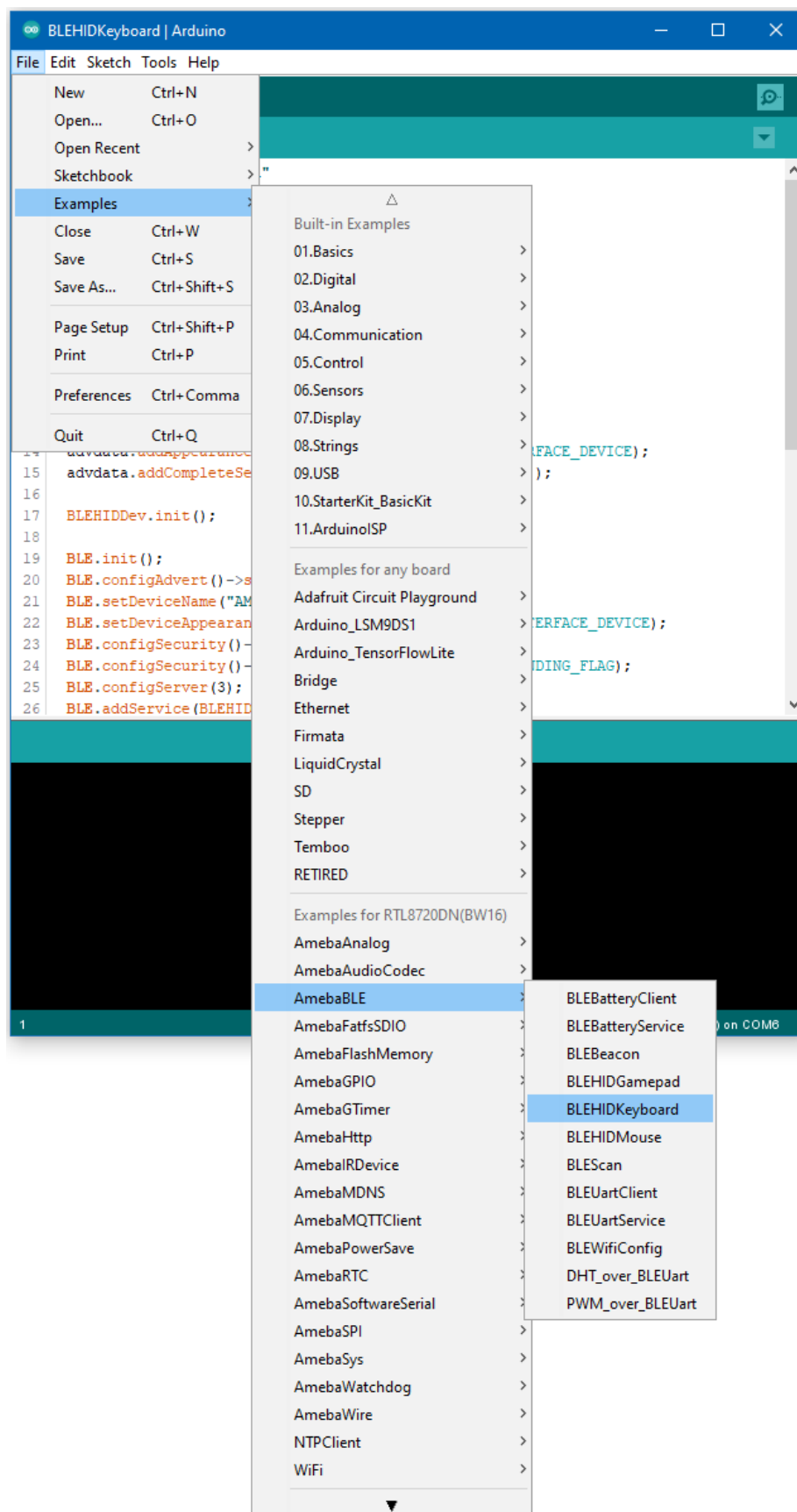
### Example

#### Introduction

In this example, the RTL8722 board emulates a HID keyboard connected using BLE.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> BLEHIDKeyboard.





Upload the code and press the reset button once the upload is finished.

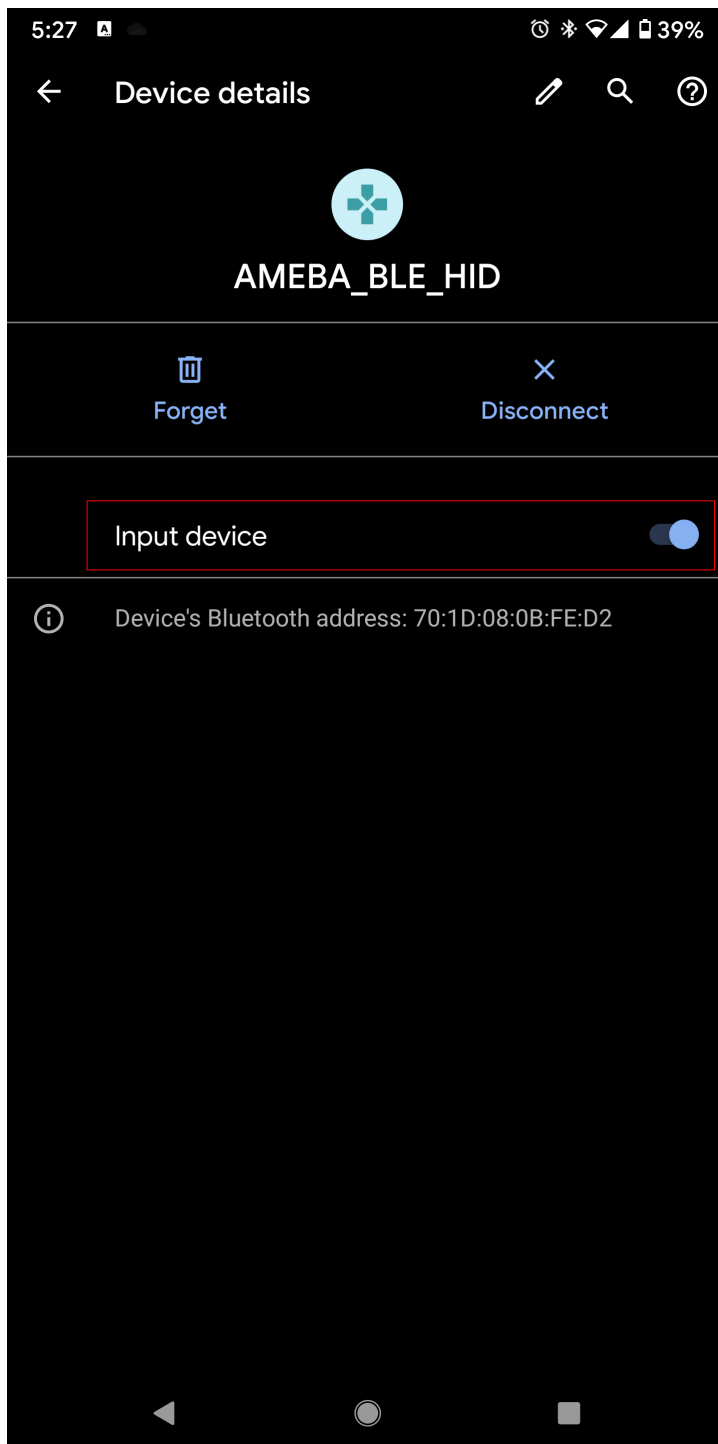
Immediately after reset, the board will begin BLE advertising as “AMEBA\_BLE\_HID” . On your host device, go to the Bluetooth settings menu, scan, and connect to the board.

You should ensure that the connection process is completed before proceeding.

On Windows, ensure that any driver installation is finished, and the board shows up in the Bluetooth menu under the “Mouse, keyboard & pen” category.



On Android, ensure that “Input device” is enabled for the board.



After the Bluetooth connection process is completed, the board is ready to send mouse input to the host device. Connect digital pin 8 to 3.3V to start sending input, and connect to GND to stop.

You should see the text “Hello World !” typed out and deleted repeatedly.

```

COM12
Hello World !
15:14:06.511 -> #####calibration_ok:[2:19:11]
15:14:09.325 -> interface 0 is initialized
15:14:09.325 -> interface 1 is initialized
15:14:09.325 ->
15:14:09.325 -> Initializing WIFI ...
15:14:09.417 -> WIFI initialized
15:14:09.417 -> [BLE Device] Local BT addr: b8:4d:43:46:d1:60
15:14:09.783 -> [BLE Device] GAP adv start
15:14:09.783 -> [BLE Device] GAP adv stopped: because connection created
15:15:27.160 -> [BLE Device] BT Connected
15:15:27.160 -> Sending keystrokes
15:16:03.546 -> Sending keystrokes
15:16:13.192 -> Sending keystrokes
15:16:17.337 -> Sending keystrokes
15:16:49.469 -> Sending keystrokes
15:16:53.613 -> Sending keystrokes

☒ Autoscroll ☒ Show timestamp
Both NL & CR 115200 baud Clear output

```

## BLE - HID Mouse

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- BLE capable host device [Windows / Linux / MacOS / Android]

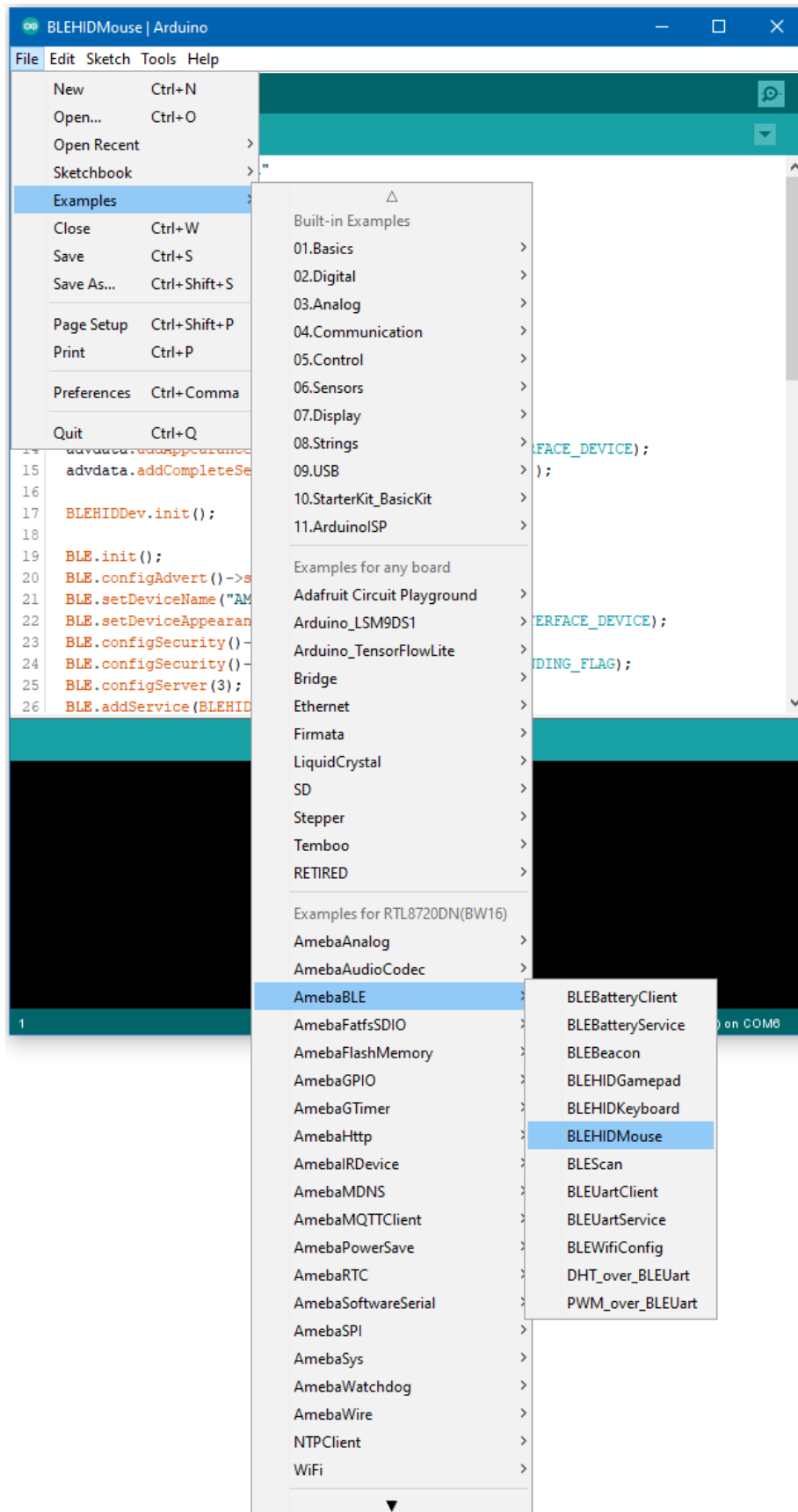
### Example

#### Introduction

In this example, the RTL8722 board emulates a HID mouse connected using BLE.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEHIDMouse” .



Upload the code and press the reset button once the upload is finished.

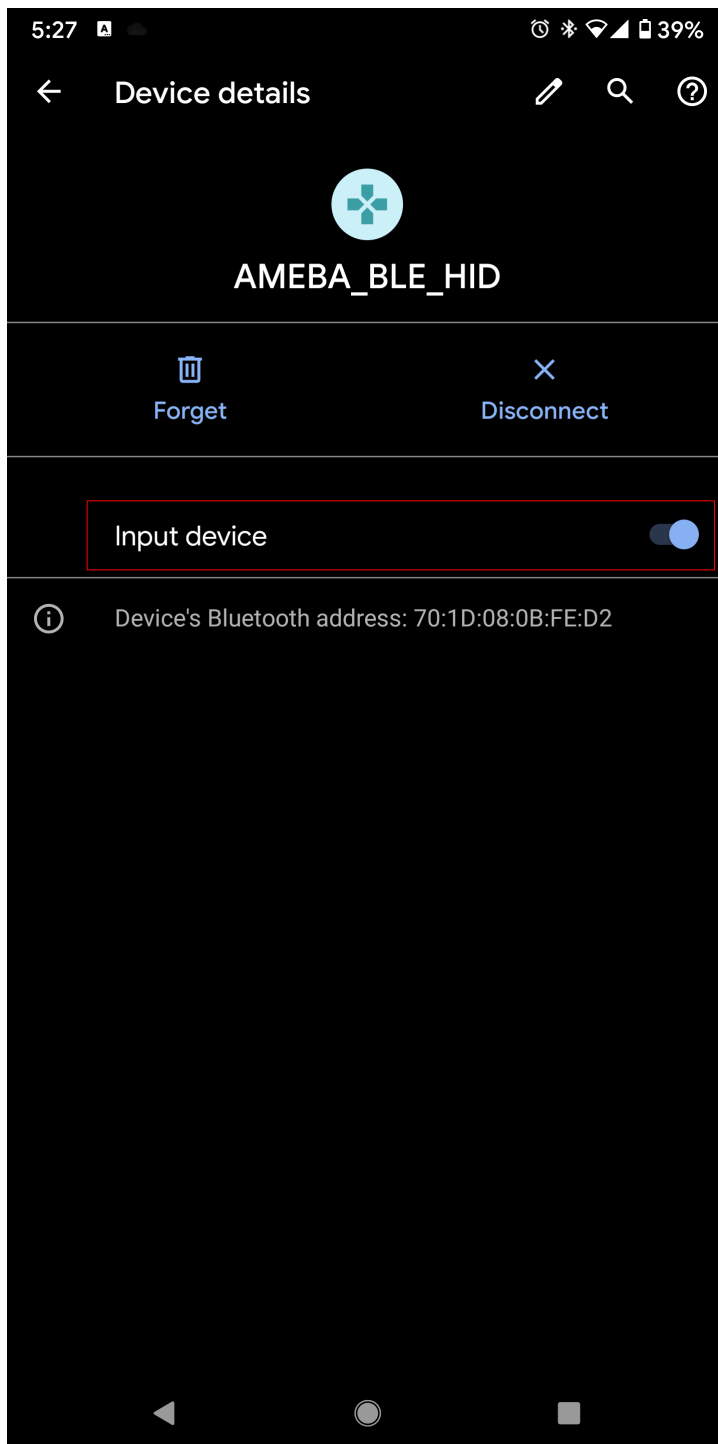
Immediately after reset, the board will begin BLE advertising as “AMEBA\_BLE\_HID” . On your host device, go to the Bluetooth settings menu, scan, and connect to the board.

You should ensure that the connection process is completed before proceeding.

On Windows, ensure that any driver installation is finished, and the board shows up in the Bluetooth menu under the “Mouse, keyboard & pen” category.



On Android, ensure that “Input device” is enabled for the board.



After the Bluetooth connection process is completed, the board is ready to send mouse input to the host device. Connect digital pin 8 to 3.3V to start sending input, and connect to GND to stop.

You should see the mouse cursor move around four points in a square, performing right and left clicks, and scrolling up and down.

## Code Reference

How the mouse input is interpreted is dependent on the host system. Some systems, such as mobile operating systems, may not support all mouse button input functions.

## HTTP - Retrieve HTTP websites from the Internet

### Materials

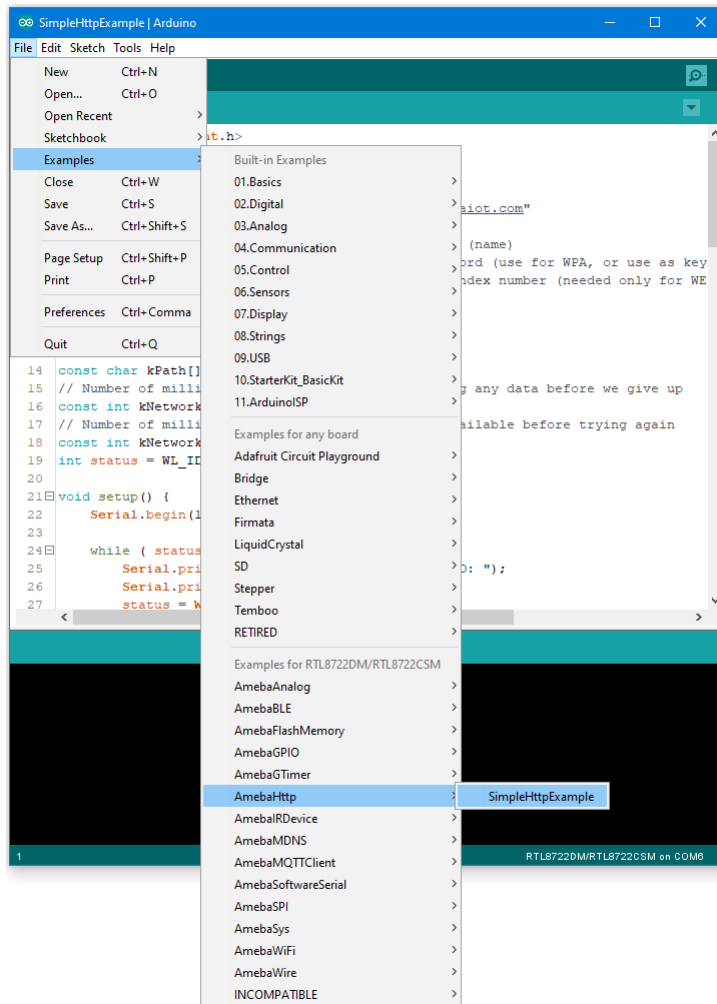
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

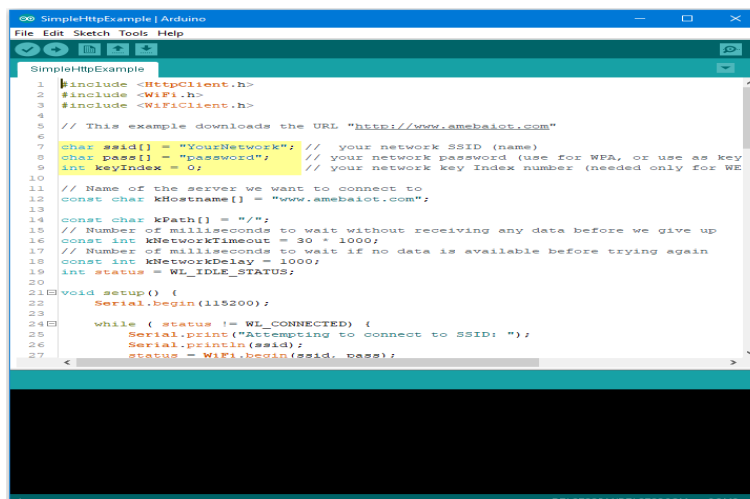
In this example, the HttpClient library is used to retrieve a webpage using the HTTP protocol.

First, make sure that the correct Ameba development board is selected in “Tools” -> “Board”

Then open “File” -> “Examples” -> “AmebaHttp” -> “SimpleHttpExample”



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.





Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor in the Arduino IDE and you can see the information retrieved from the website.

```

COM4

Interface 0 IP address : 172.25.24.188Connected to wifi
SSID: RealEZ
IP Address: 172.25.24.188
signal strength (RSSI):-56 dBm

Connect to Server successful!
startedRequest ok
Got status code: 200
Content length is: 0

Body returned follows:
<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en-SG"><head><meta content=
document.documentElement.addEventListener("submit",function(b){var a;if(a=b.target){var c=a.getAttribute
var a=window.location,b=a.href.indexOf("#");if(0<=b){var c=a.href.substring(b+1);/(^|s)q=/.test(c)&&l==
</style><style>body,td,a,p,h{font-family:arial,sans-serif}body{margin:0;overflow-y:scroll}#gog{padding:
if (!iesg){document.f&&document.f.q.focus();document.gbqf&&document.gbqf.q.focus();}
}
})();</script><div id="mnqb"><div id=gbar><nobr><b class=gbl>Search</b><a class=gbl href="http://www.g
else top.location='/doodles/';})();</script><input value="AAPIEIEAAAAAKjAd2Cy4lLwKhgibG7of5MoLQmLDRW2G
setTimeout(function(){var b=document;var a="SCRIPT";"application/xhtml+xml"===b.contentType&&(a=a.toLowe
function _F_installCss(c){
(function(){google.spjs=false;google.snet=true;google.em=[];google.emm=false;})();(function(){var pnc='
<

```

## Code Reference

Use `WiFi.begin()` to establish WiFi connection:

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiClient` to create a client to handle the WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiClient>

Use HTTPClient to create a client to handle the HTTP connection.

Use `http.get()` to send a GET request to the website.

## HTTP - Set up Server to Control LED

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Breadboard x 1
- LED x 1
- 1K $\Omega$  Resistor x 1

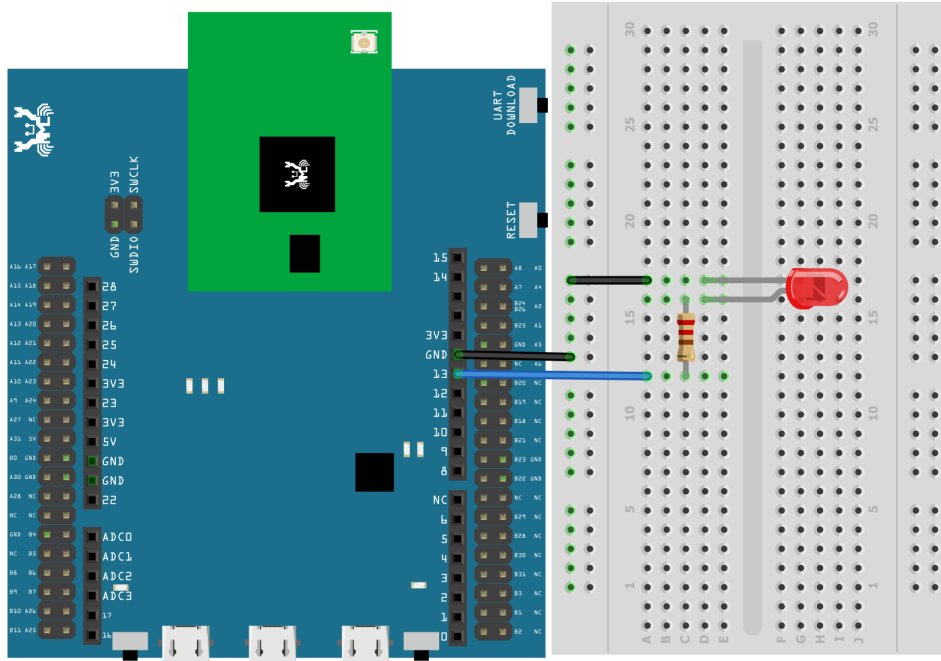
### Procedure

In this example, we connect Ameba to WiFi and use Ameba as server, the user can control the LED on/off through a webpage.

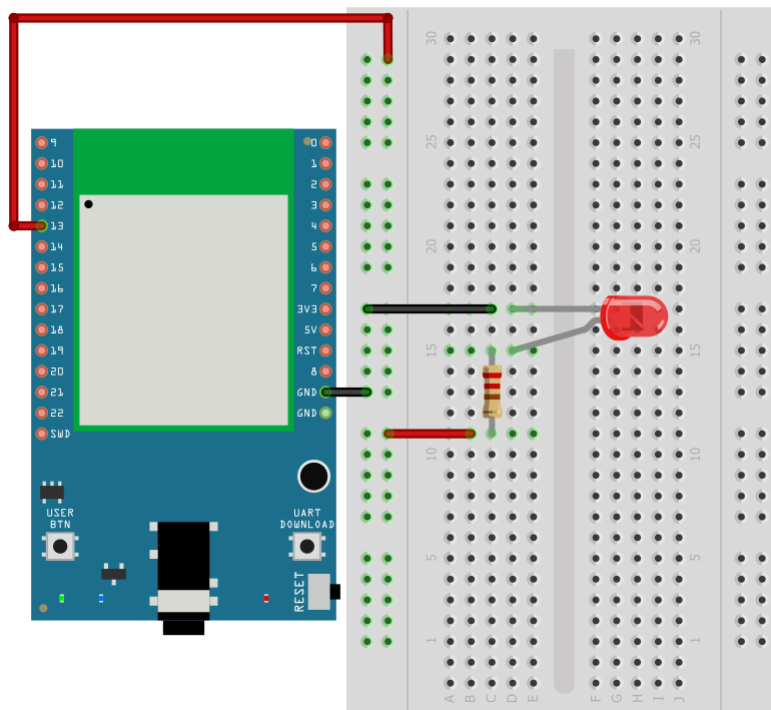
First, connect Ameba with the LED.

In a LED, the longer pin is the positive pole, and the shorter pin is the negative pole. So, we connect the shorter pin to GND and connect the longer pin to D13. Additionally, to avoid the electric current exceeds the tolerance of the LED and causes damage, we connect a resistance on the positive pole.

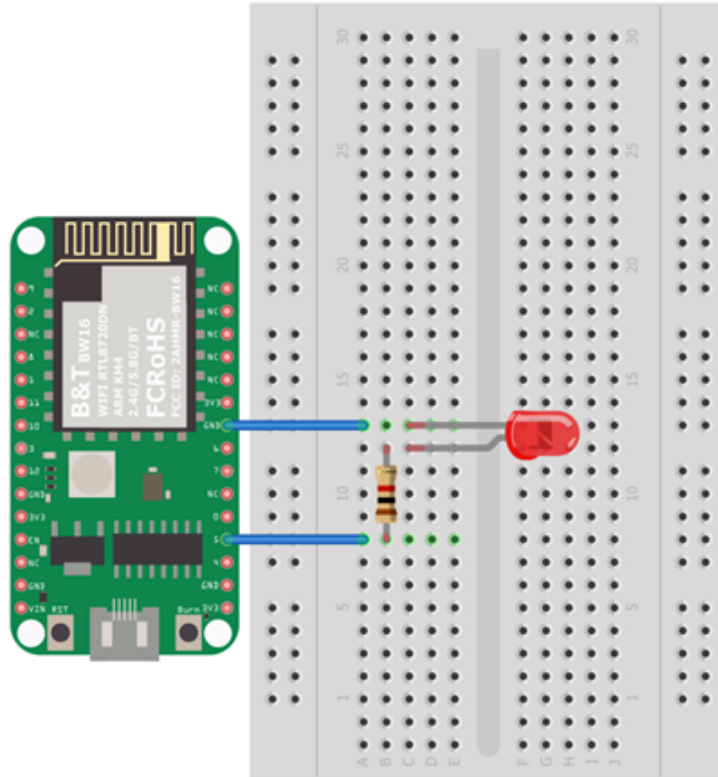
**AMB21 / AMB22** Wiring Diagram:



AMB23 Wiring Diagram:

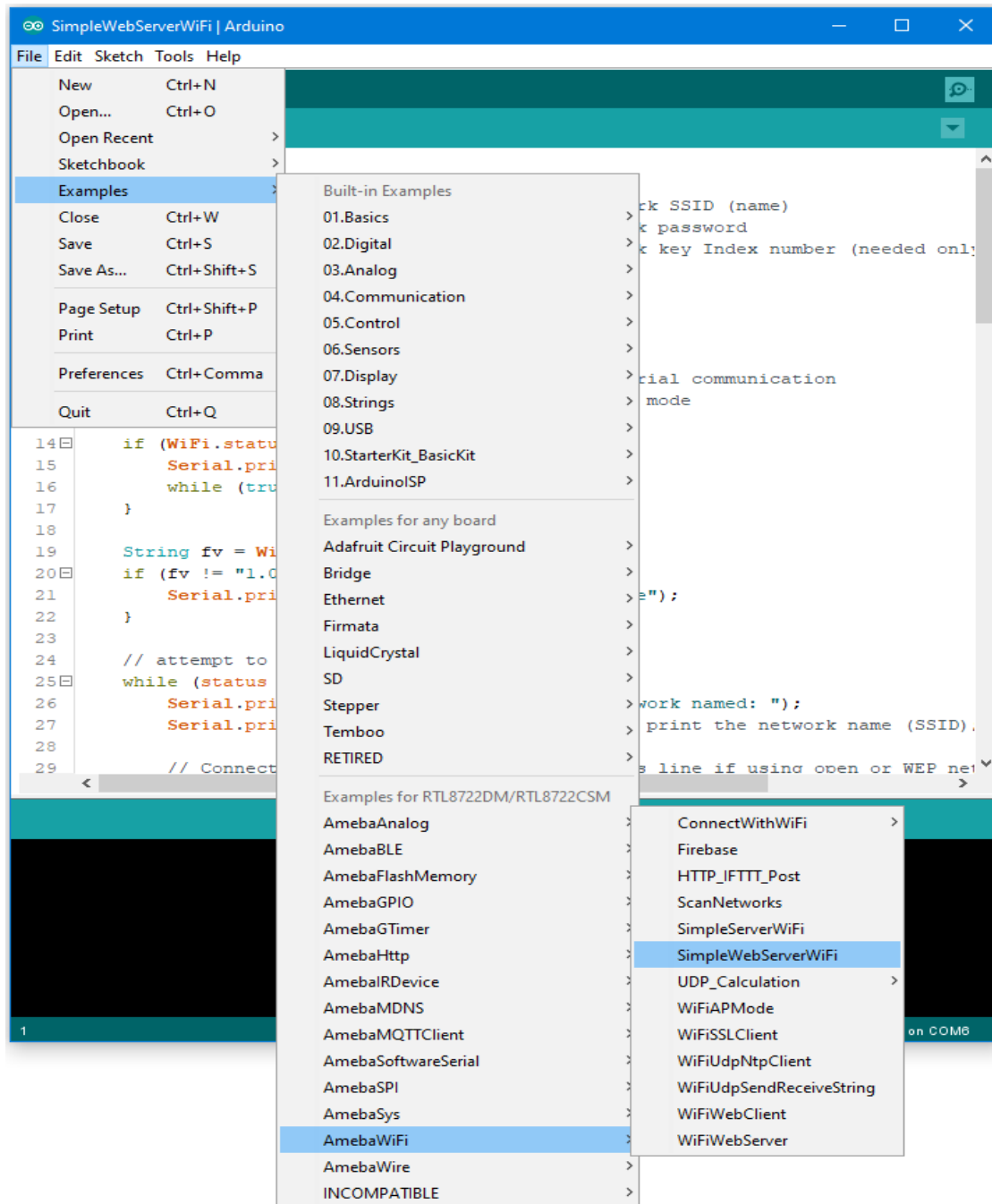


BW16 Wiring Diagram:

**Note:**

For BW16 board, you may consider to re-define 「LED\_PIN」 macro to **10** for built-in green LED, or **11** for blue built-in LED, or **12** for red built-in LED to avoid using extra components.

Then open “File” -> “Examples” -> “AmebaWiFi” -> “SimpleWebServerWiFi”



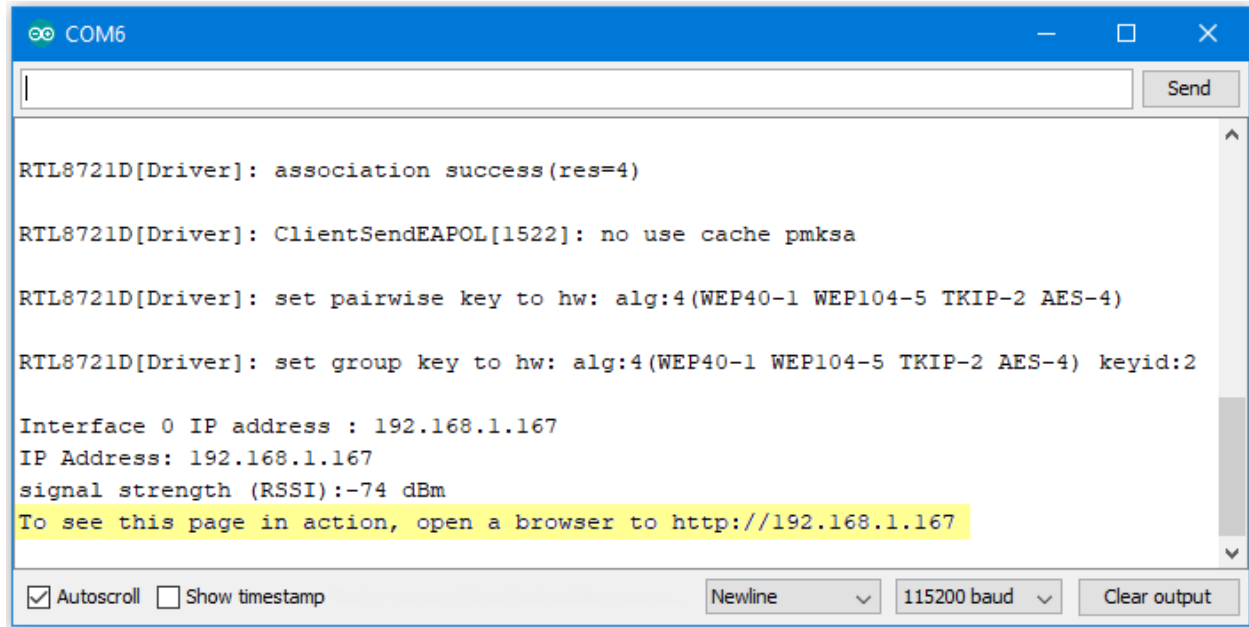
In the sample code, modify the highlighted snippet to corresponding information.

The bottom status bar shows '1' and 'RTL8722DM/RTL8722CSM on COM8'."/>

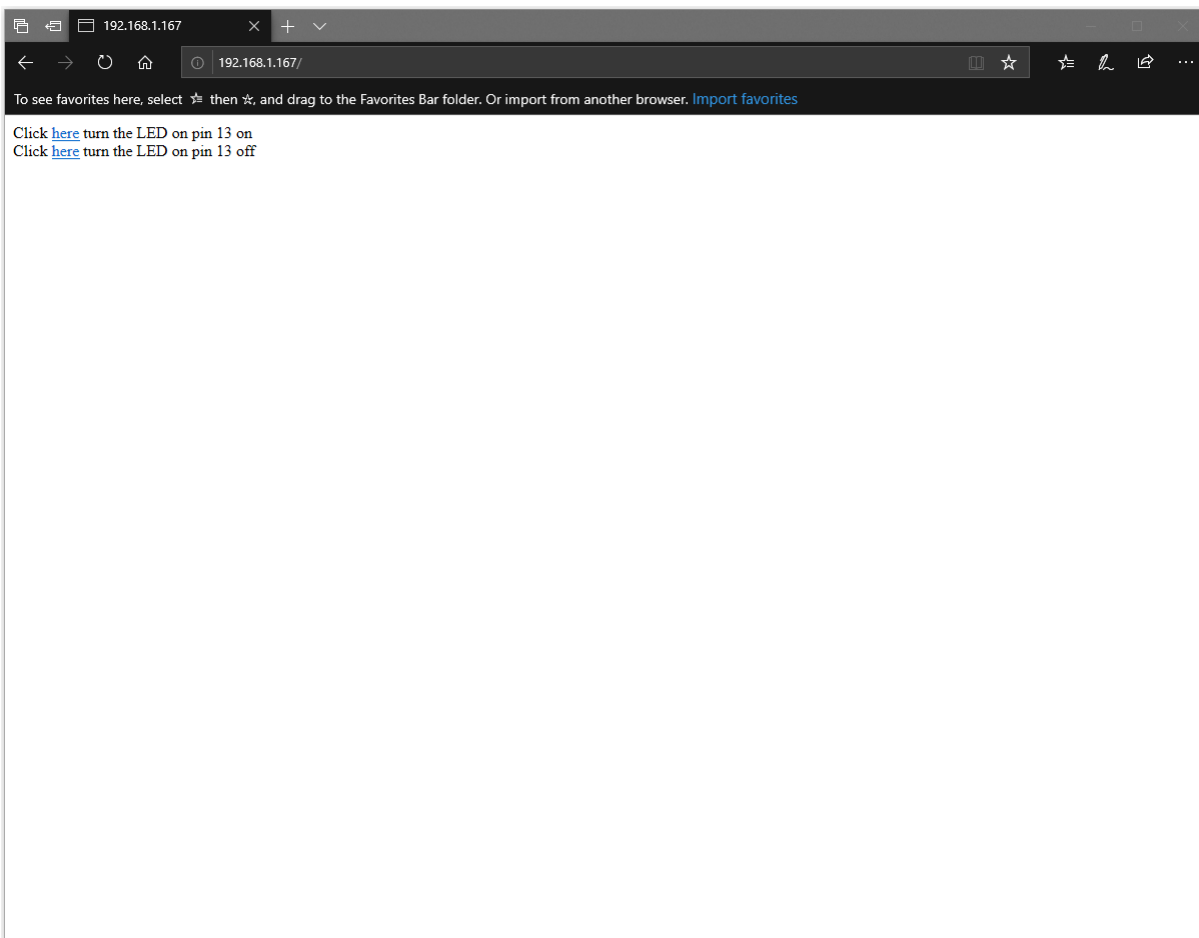
Upload the code and press the reset button on Ameba. When the connection is established, you will see the message:

"To see this page in action, open a browser to `http://xxx.xxx.xxx.xxx`"

in the Arduino IDE as shown in the figure:



Next, open the browser of a computer or a cell phone under the same WiFi domain, enter the address in the message.



In the webpage, you can turn on/off the LED.

## Code Reference

Use `WiFi.begin()` to establish WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiServer server()` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.connected()` to get whether or not the client is connected.

<https://www.arduino.cc/en/Reference/WiFiClientConnected>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.print()` to print data to the server that a client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientPrint>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>



## HTTP - Set up Server to Get the Ameba Status

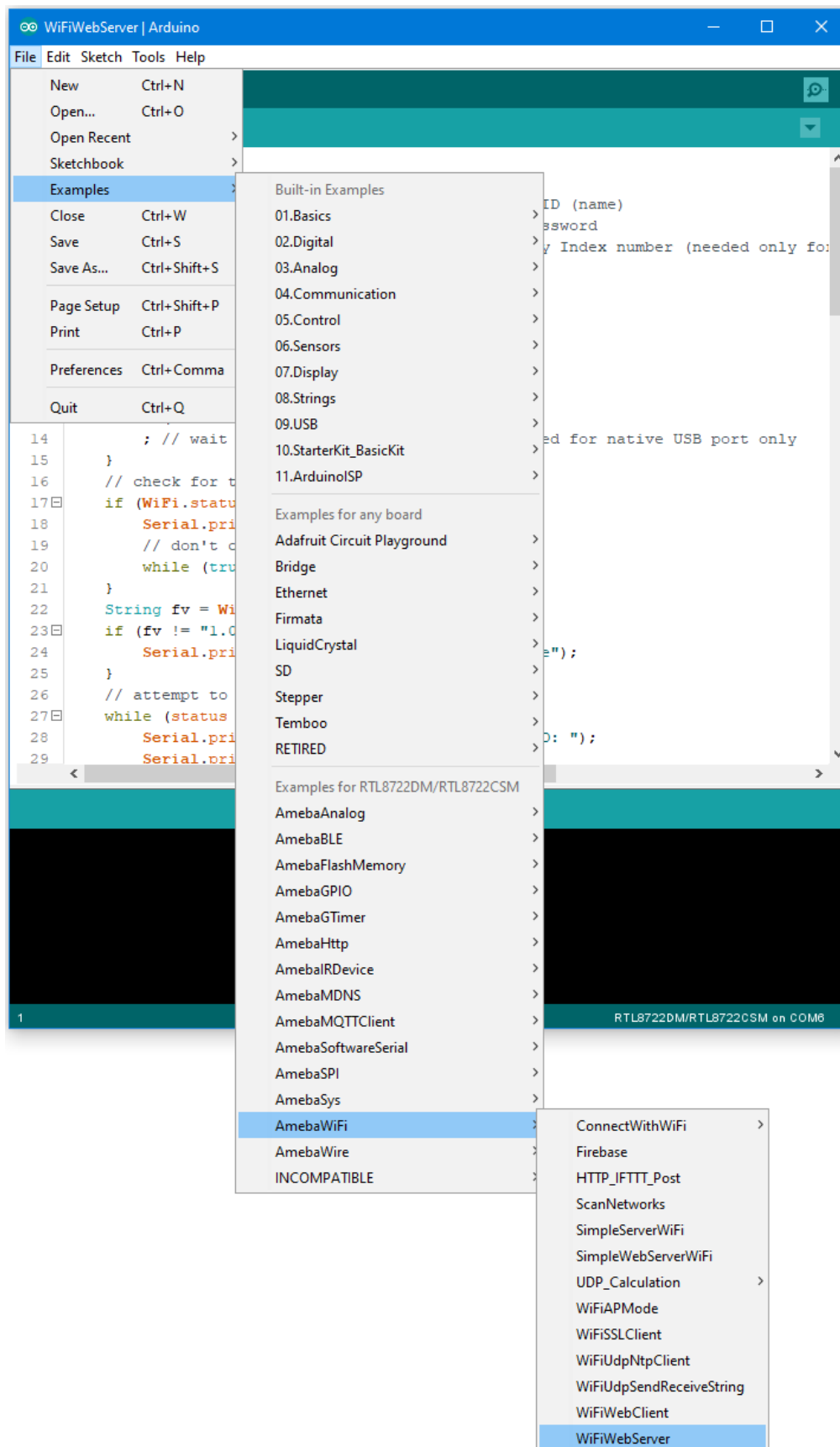
### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

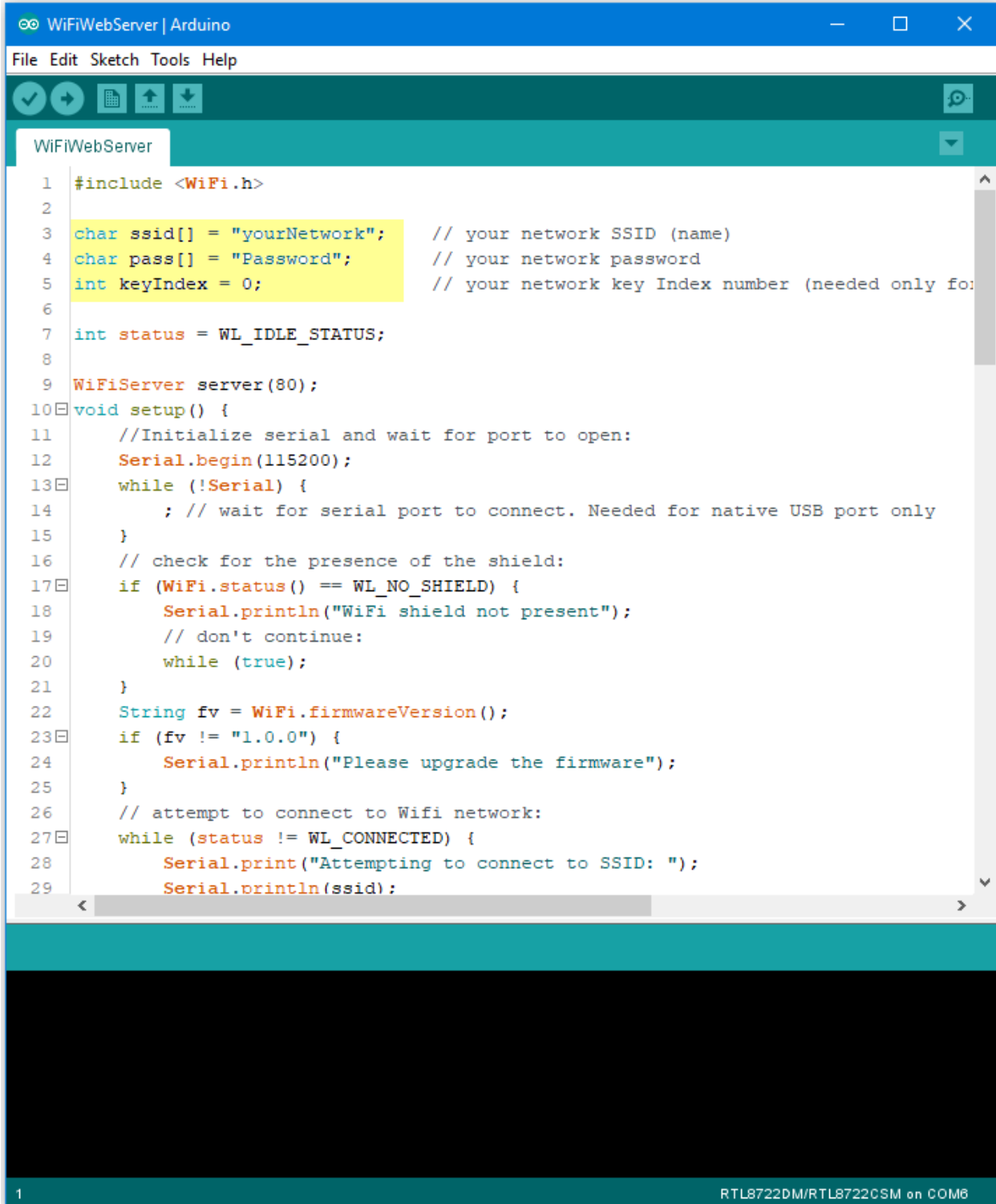
### Example

In this example, we connect Ameba to WiFi and use Ameba as server to send message to connected client.

First, open “File” -> “Examples” -> “AmebaWiFi” -> “WiFiWebServer”



In the sample code, modify the highlighted snippet and enter the required information (ssid, password, key index) required to connect to your WiFi network.

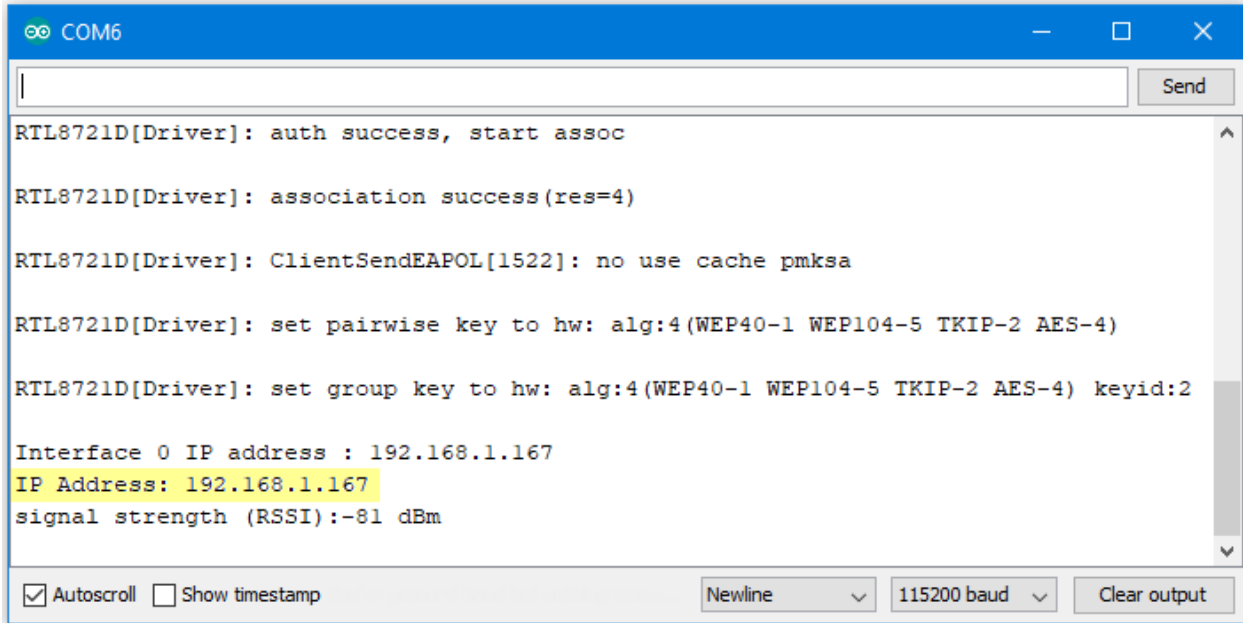


```

1  #include <WiFi.h>
2
3  char ssid[] = "yourNetwork";    // your network SSID (name)
4  char pass[] = "Password";       // your network password
5  int keyIndex = 0;               // your network key Index number (needed only for
6
7  int status = WL_IDLE_STATUS;
8
9  WiFiServer server(80);
10 void setup() {
11     //Initialize serial and wait for port to open:
12     Serial.begin(115200);
13     while (!Serial) {
14         ; // wait for serial port to connect. Needed for native USB port only
15     }
16     // check for the presence of the shield:
17     if (WiFi.status() == WL_NO_SHIELD) {
18         Serial.println("WiFi shield not present");
19         // don't continue:
20         while (true);
21     }
22     String fv = WiFi.firmwareVersion();
23     if (fv != "1.0.0") {
24         Serial.println("Please upgrade the firmware");
25     }
26     // attempt to connect to Wifi network:
27     while (status != WL_CONNECTED) {
28         Serial.print("Attempting to connect to SSID: ");
29         Serial.println(ssid);

```

Upload the code and press the reset button on Ameba. After connecting to WiFi, Ameba starts to run as server. The IP of the server is shown in the serial monitor, and port is 80.



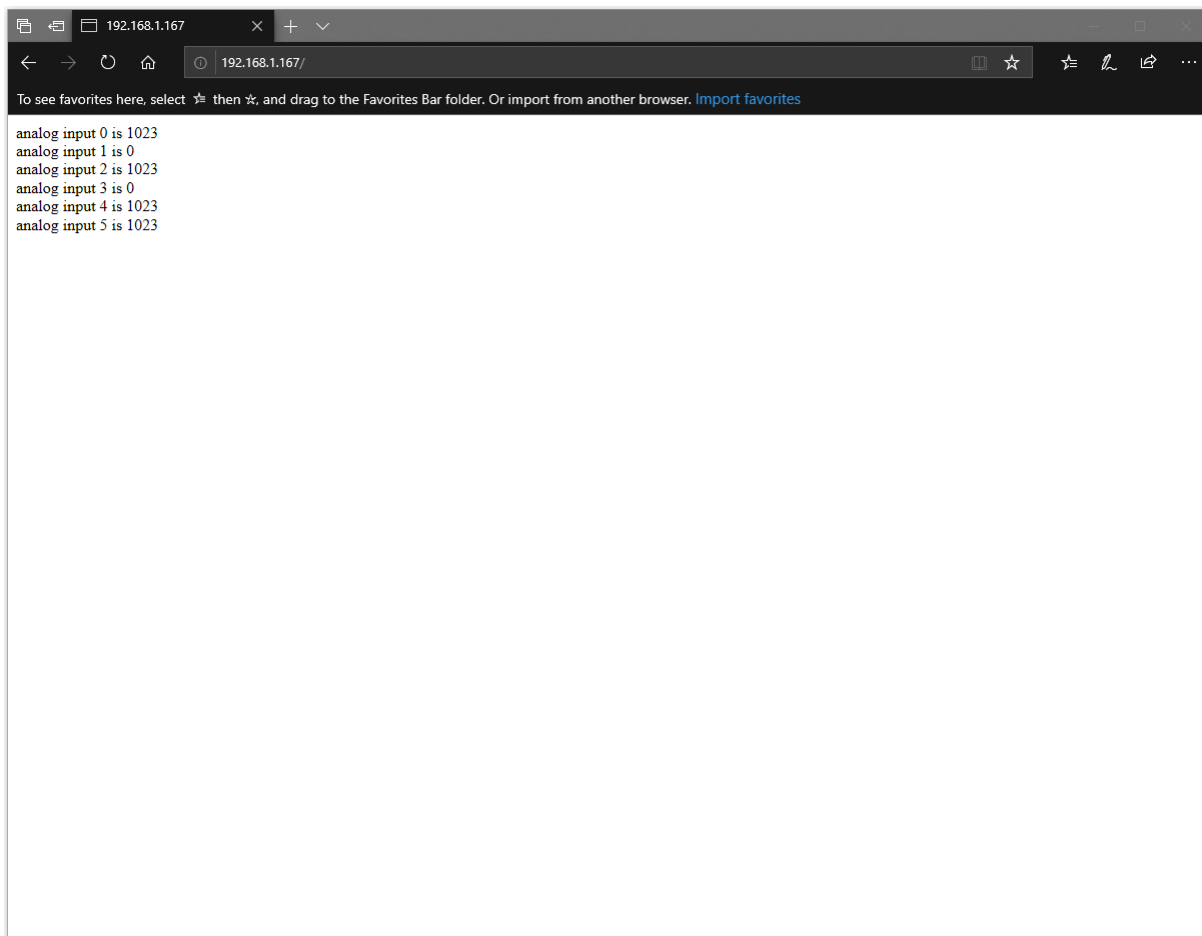
COM6

Send

```
RTL8721D[Driver]: auth success, start assoc  
RTL8721D[Driver]: association success(res=4)  
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa  
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)  
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2  
Interface 0 IP address : 192.168.1.167  
IP Address: 192.168.1.167  
signal strength (RSSI):-81 dBm
```

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

We connect to the server in a browser, and we can see the data sent from the server.



192.168.1.167

192.168.1.167/

To see favorites here, select ☆ then ☆, and drag to the Favorites Bar folder. Or import from another browser. [Import favorites](#)

```
analog input 0 is 1023  
analog input 1 is 0  
analog input 2 is 1023  
analog input 3 is 0  
analog input 4 is 1023  
analog input 5 is 1023
```

## Code Reference

Use `WiFi.begin()` to establish WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiServer server()` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.connected()` to check whether or not the client is connected.

<https://www.arduino.cc/en/Reference/WiFiClientConnected>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.print()` to print data to the server that a client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientPrint>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

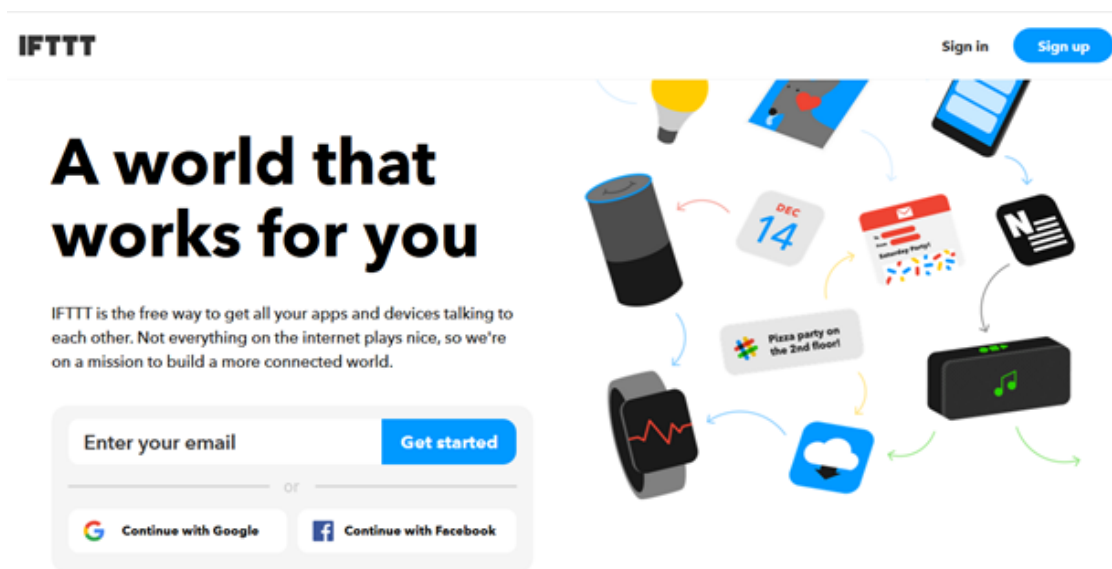
## HTTP - Use IFTTT for Web Service

### Introduction to IFTTT

IFTTT, known as If This Then That, is a website and mobile app and free web-based service to create the applets, or the chains of simple conditional statements. The applet is triggered by changes that occur within other web services such as Gmail, Facebook, Telegram, Instagram, Pinterest etc.

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- An account from <https://ifttt.com/> , in order to access IFTTT service\*



---

備<sup>註</sup>: Upon log in, there are several cloud and online services that are integrated with IFTTT platforms.

---

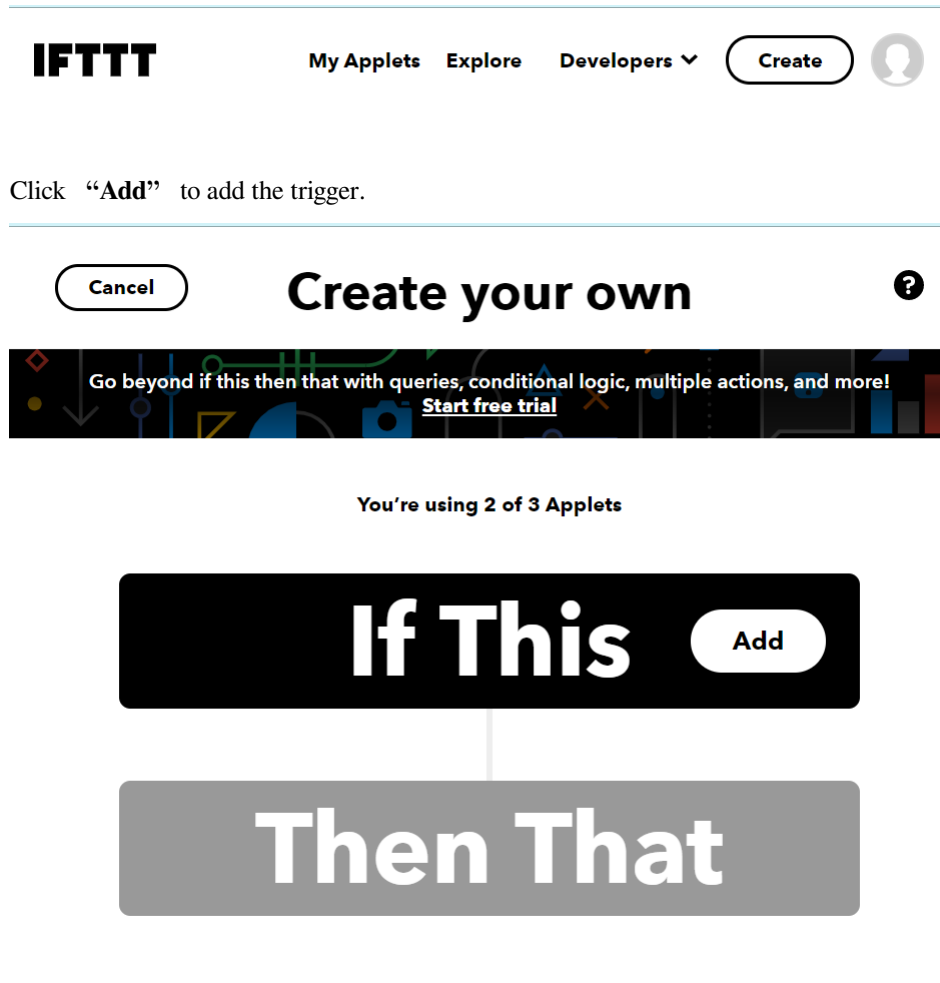
### Example

- Generate Applet from IFTTT

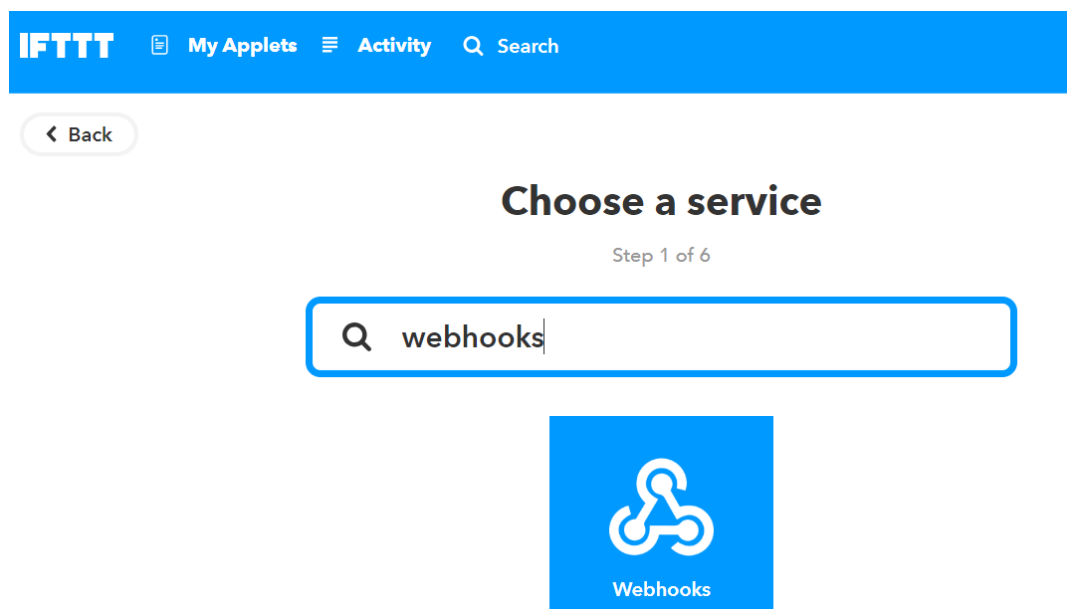
In this example, we obtain an example of IFTTT Applet to send email to specified recipient.

To run the example, HTTP POST feature of the Ameba is used to post a simple webhook service that is received by IFTTT platform and in turn be used to trigger a response (sending an email).

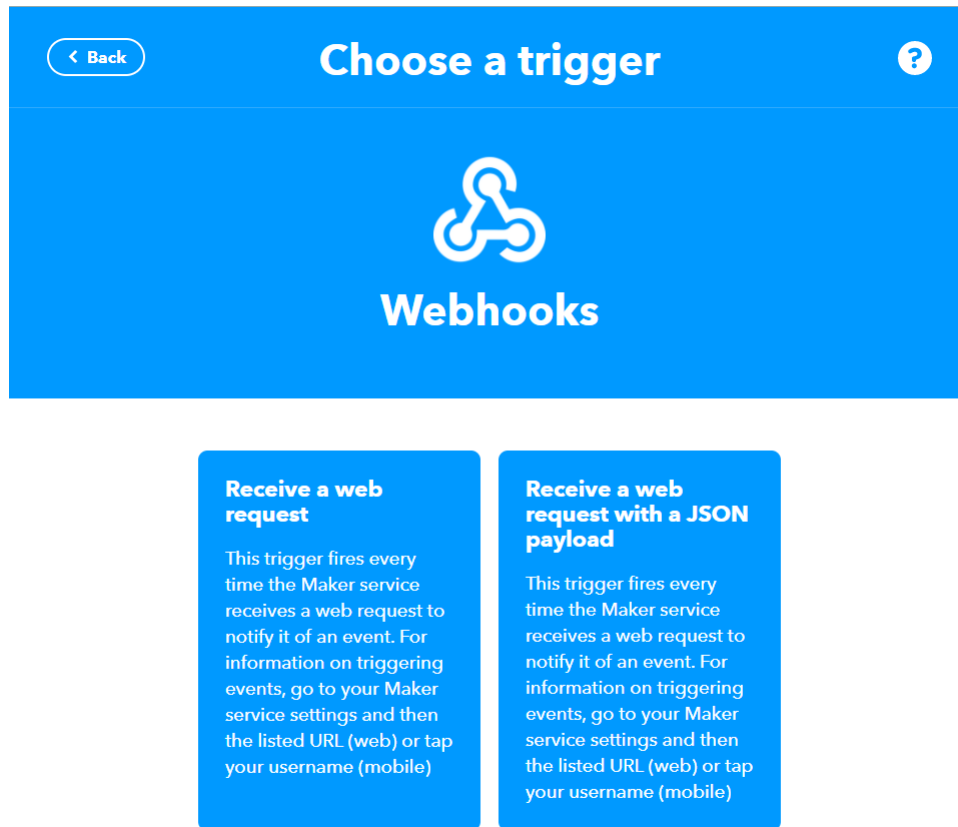
After logging in <https://ifttt.com/>, click **Create** from the top bar.



Choose Webhooks service as shown below. Alternatively, search the service by typing into the search bar.



After that, the available triggers will appear. Choose Receive a Web request.



Next, an Event Name is required to identify the trigger successfully. In this example, set the Event name as “test\_event” .



< Back

## Complete trigger fields

### Receive a web request

This trigger fires every time the Maker service receives a web request to notify it of an event. For information on triggering events, go to your Maker service settings and then the listed URL (web) or tap your username (mobile)

**Event Name**

test\_event

The name of the event, like "button\_pressed" or "front\_door\_opened"

Create trigger


Next, click **Add** in Then That field to create the action service taken in response to the last trigger.

Cancel

## Create your own

Go beyond if this then that with queries, conditional logic, multiple actions, and more! [Start free trial](#)

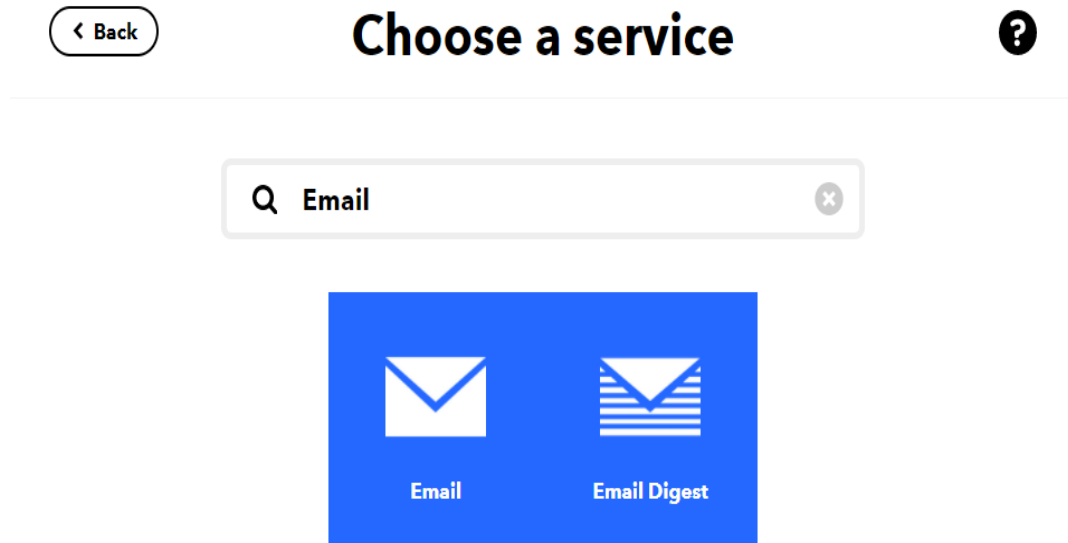
You're using 2 of 3 Applets

If  Receive a web request [Edit](#) [Delete](#)

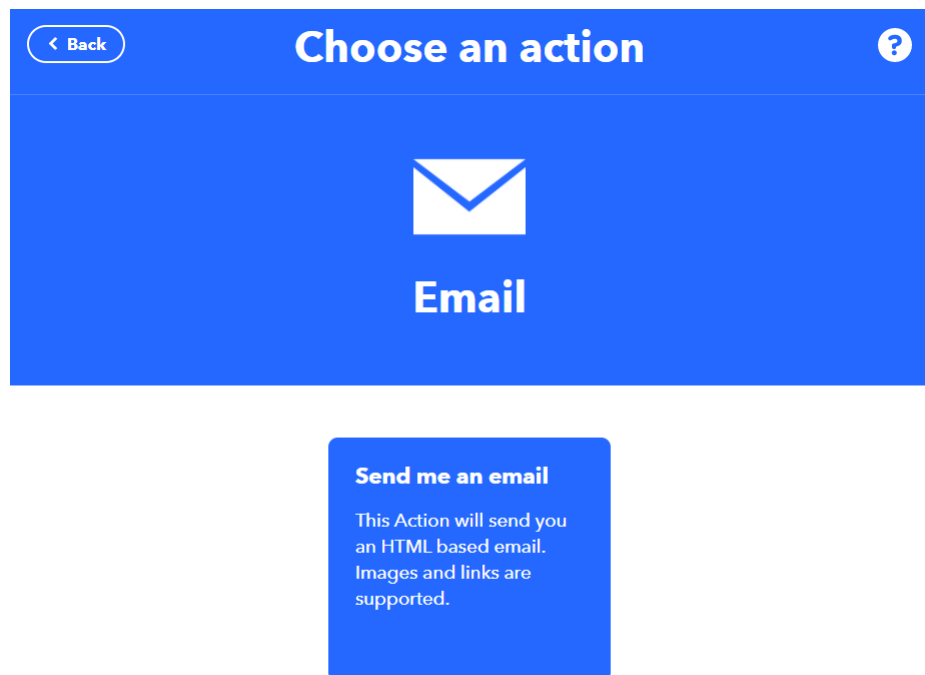
+

Then That [Add](#)

Choose Email as the action service.



Click on Send me an email.



Under the template of **Send me an Email**, the contents of the email, such as subject and body is editable. Click **Create Action** to complete the action. Take note that **Email service** is offered to the

email address registered under IFTTT account.

The screenshot shows the IFTTT 'Complete action fields' interface for the 'Send me an email' action. The background is blue. At the top, there is a 'Back' button and a question mark icon. Below the title, there is an envelope icon and the text 'Send me an email'. A note states: 'This Action will send you an HTML based email. Images and links are supported.' The 'Subject' field contains the text: 'The event named " **EventName** " occurred on the Maker Webhooks service'. Below the subject field is an 'Add ingredient' button. The 'Body' field contains the text: 'What: **EventName** <br> When: **OccurredAt** <br> Extra Data: **Value1** , **Value2** , **Value3** ,'. Below the body field is another 'Add ingredient' button. At the bottom, there is a large blue button labeled 'Create action'.

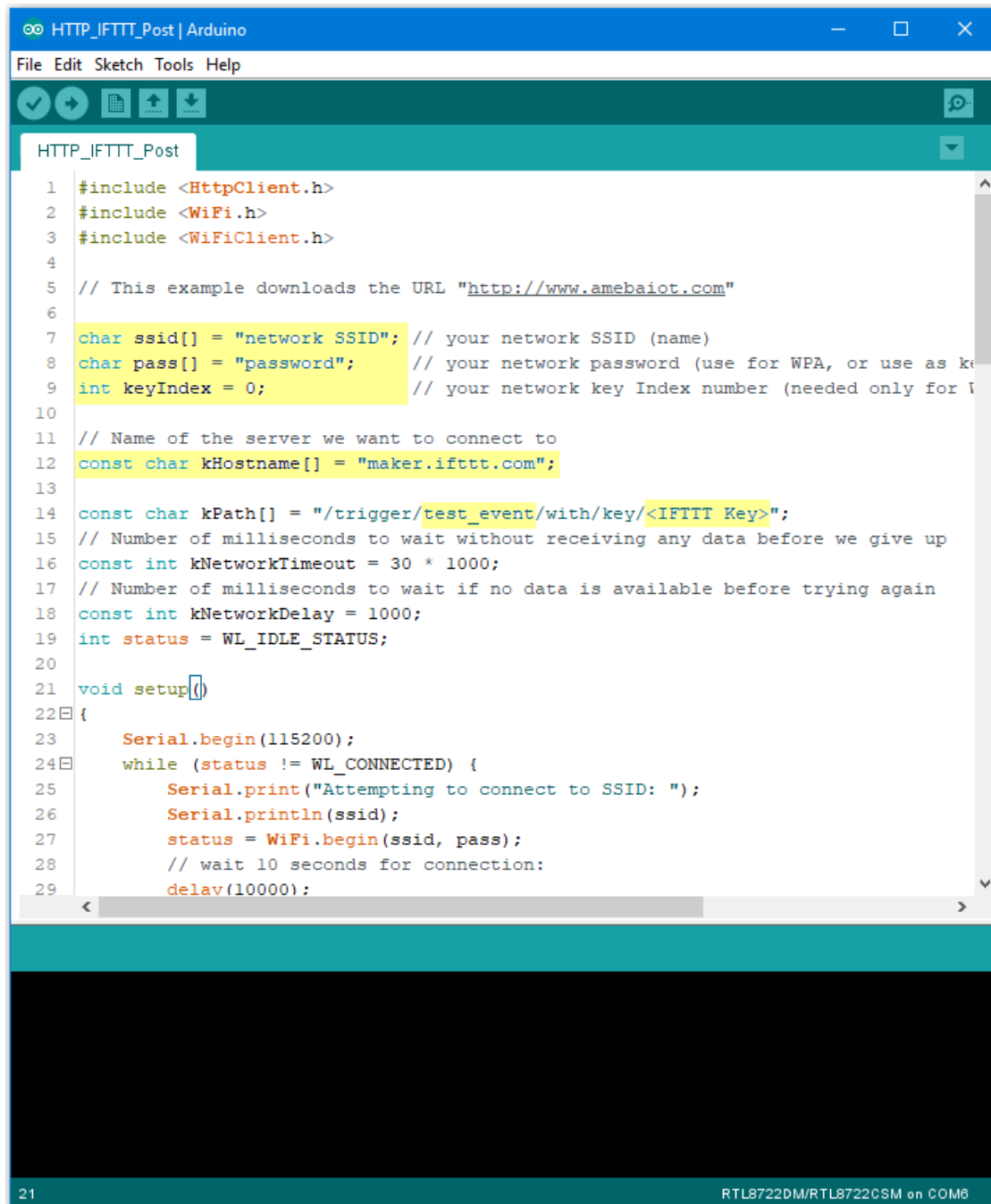
- Post the Trigger via Ameba

Once the Applet is ready in the IFTTT dashboard, the example program can be flashed onto the Ameba board to post the HTTP request.

Open the example code in “File” -> “Examples” -> “AmebaWiFi” -> “HTTP\_IFTTT\_Post”

In the example program, edit the following 3 items inside the code to make the program work.

1. The WiFi credentials to connect to the Wi-Fi hotspot or access point of desirable choice.
2. Under the Host name field, enter the host name of the IFTTT service “maker.ifttt.com” .
3. Under the Path name field, enter the Event name and key field “/trigger/Event name/with/key/Key Field”
  - Event name: The event name should be the same as the one specified in the IFTTT applet. In this example, the event name is “test\_event” .
  - Key Field: Available under webhook service in individual IFTTT account. See the next step for the steps to obtain the Key Field.



```
1 #include <HttpClient.h>
2 #include <WiFi.h>
3 #include <WiFiClient.h>
4
5 // This example downloads the URL "http://www.amebaiot.com"
6
7 char ssid[] = "network SSID"; // your network SSID (name)
8 char pass[] = "password"; // your network password (use for WPA, or use as key for WEP)
9 int keyIndex = 0; // your network key Index number (needed only for WEP)
10
11 // Name of the server we want to connect to
12 const char kHostname[] = "maker.ifttt.com";
13
14 const char kPath[] = "/trigger/test_event/with/key/<IFTTT Key>";
15 // Number of milliseconds to wait without receiving any data before we give up
16 const int kNetworkTimeout = 30 * 1000;
17 // Number of milliseconds to wait if no data is available before trying again
18 const int kNetworkDelay = 1000;
19 int status = WL_IDLE_STATUS;
20
21 void setup()
22 {
23     Serial.begin(115200);
24     while (status != WL_CONNECTED) {
25         Serial.print("Attempting to connect to SSID: ");
26         Serial.println(ssid);
27         status = WiFi.begin(ssid, pass);
28         // wait 10 seconds for connection:
29         delay(10000);
30     }
31 }
```

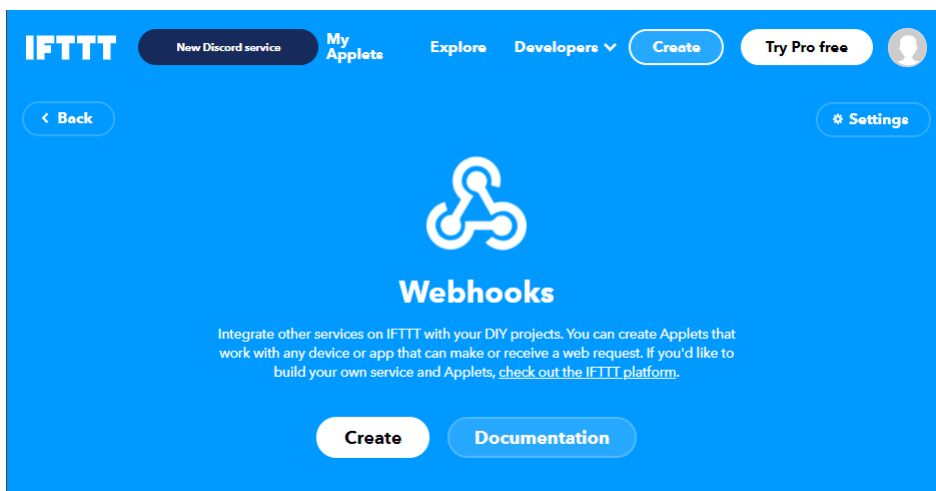
21

RTL8722DM/RTL8722CSM on COM8

To obtain a key from documentation tab of the Webhooks, find the webhook service in the Explore tab.



On the Webhooks service page, click on the Documentation tab.

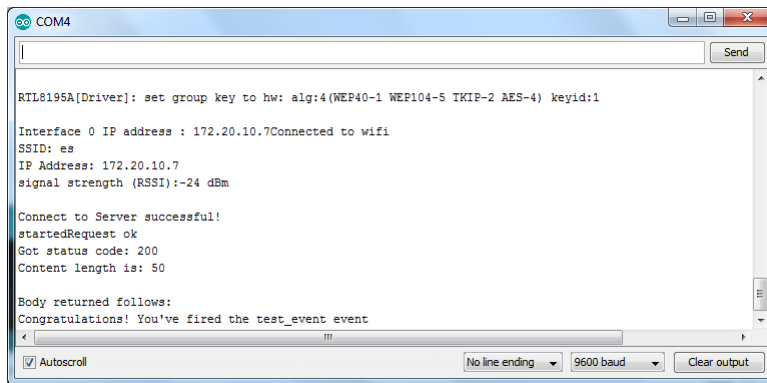


The key can be found in the documentation page. Also, information on how HTTP request can be used.

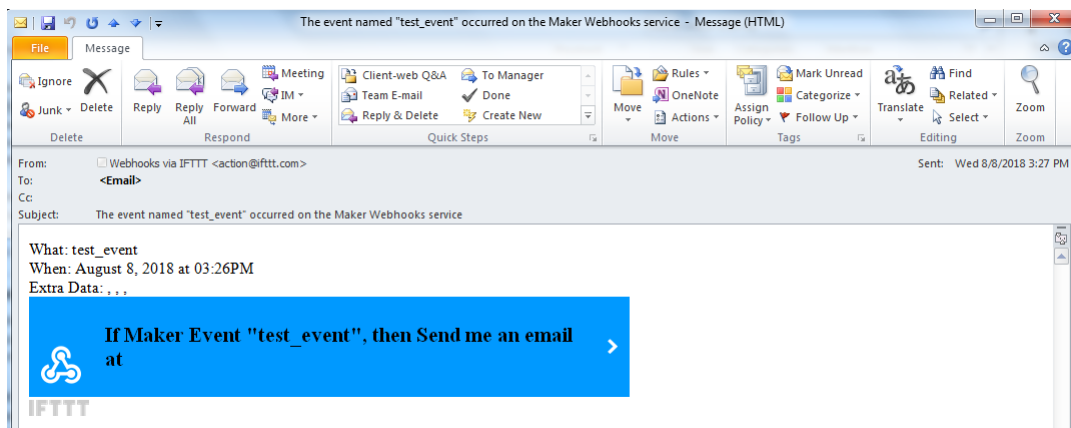


Once the example is ready, connect to Ameba board via USB Cable.

On the Arduino IDE, compile the code and upload the code onto Ameba and press the reset button. After the event has been successfully fired, “Congratulations! You have fired the test\_event event” can be seen on the serial monitor and an email reminder for this event will be delivered.



Thereafter an email is sent to recipient email account registered at IFTTT Applet and email notification will be received.



## IPv6 –Ameba as IPv6 Server/Client over TCP

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

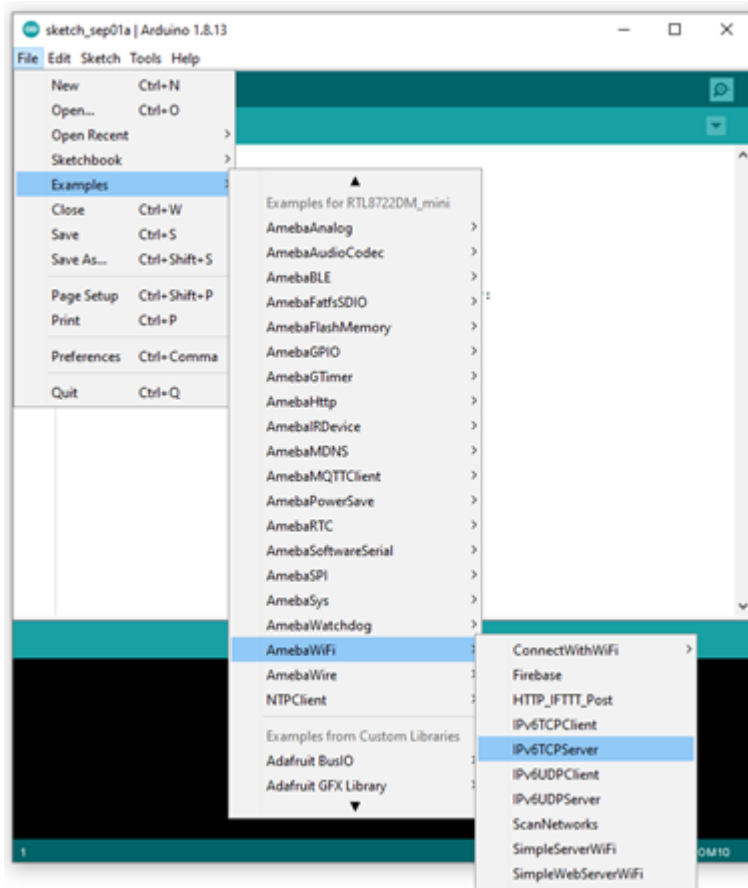
### Example

#### Introduction

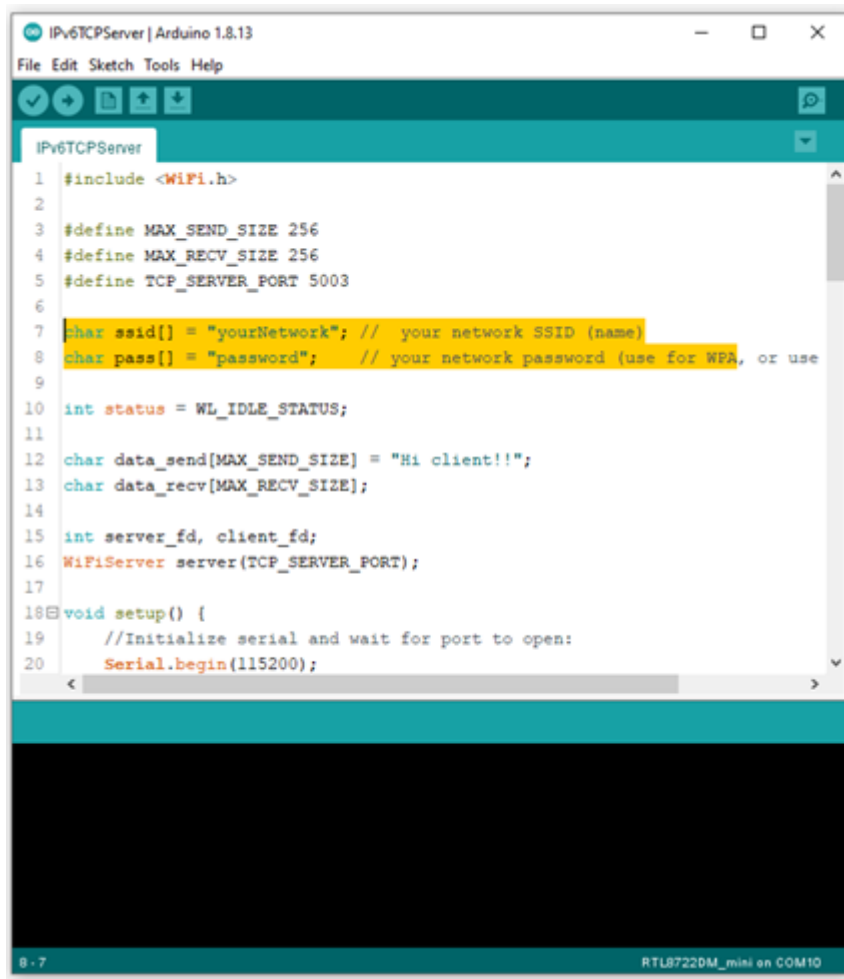
This example shows how Ameba can communicate on the local network using Internet Protocol version 6 over TCP. Note that this example only works after you have set up the server and then configure the client accordingly.

#### Procedure

Step 1. IPv6TCPServer Open the example, “Files” -> “Examples” -> “AmebaWiFi” -> “IPv6TCPServer” .



In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.

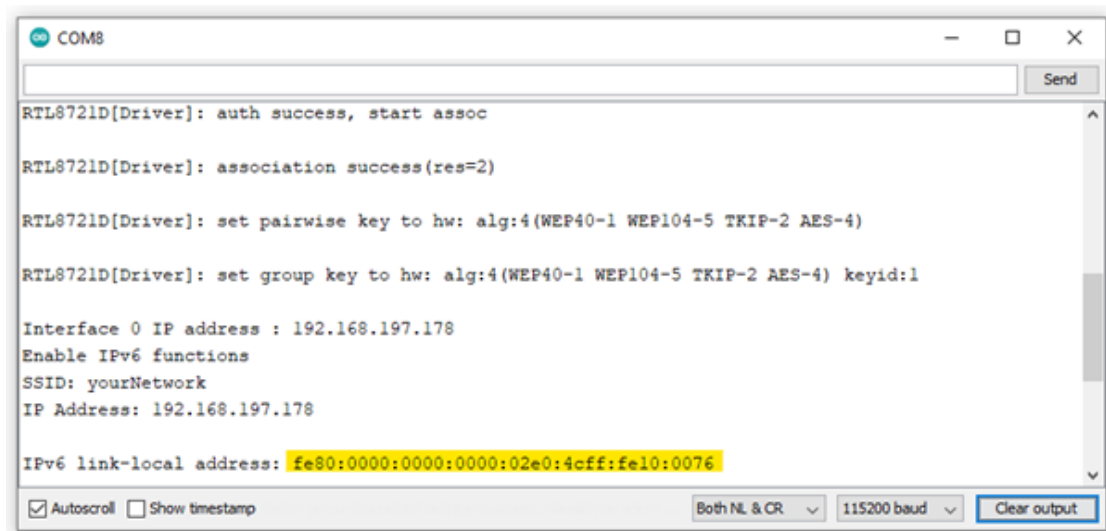


```

1  #include <WiFi.h>
2
3  #define MAX_SEND_SIZE 256
4  #define MAX_RECV_SIZE 256
5  #define TCP_SERVER_PORT 5003
6
7  char ssid[] = "yourNetwork"; // your network SSID (name)
8  char pass[] = "password";    // your network password (use for WPA, or use
9
10 int status = WL_IDLE_STATUS;
11
12 char data_send[MAX_SEND_SIZE] = "Hi client!!";
13 char data_recv[MAX_RECV_SIZE];
14
15 int server_fd, client_fd;
16 WiFiServer server(TCP_SERVER_PORT);
17
18 void setup() {
19     //Initialize serial and wait for port to open:
20     Serial.begin(115200);

```

Next, upload the code and press the reset button on Ameba once the upload is finished. Open Serial Monitor and copy the IPv6 address of the Server (the highlighted area) for later use,



```

COM8

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=2)

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.197.178
Enable IPv6 functions
SSID: yourNetwork
IP Address: 192.168.197.178

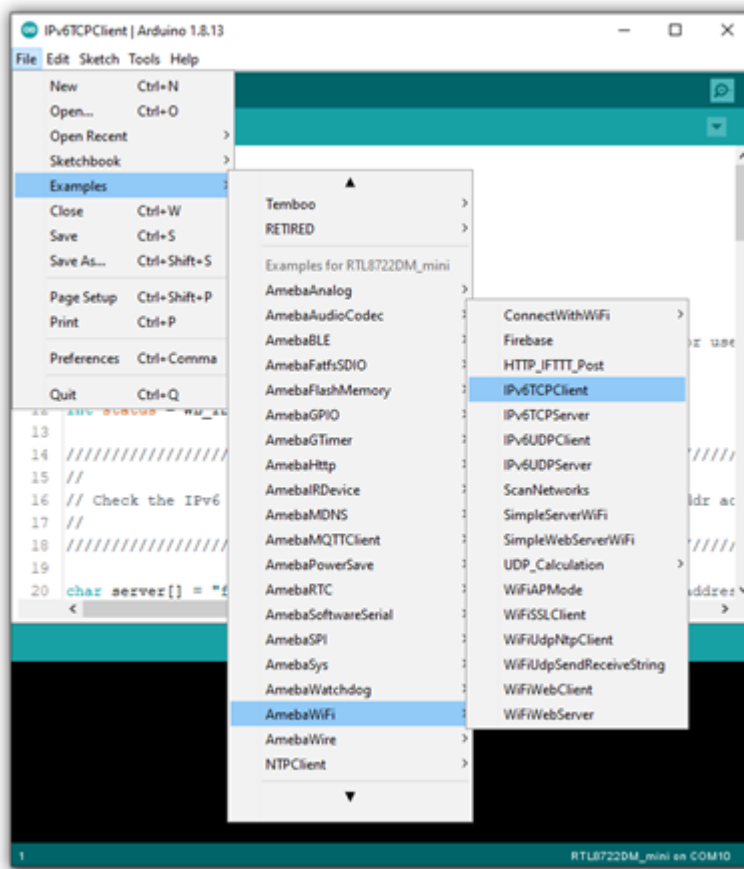
IPv6 link-local address: fe80:0000:0000:0000:02e0:4cff:fe10:0076

```

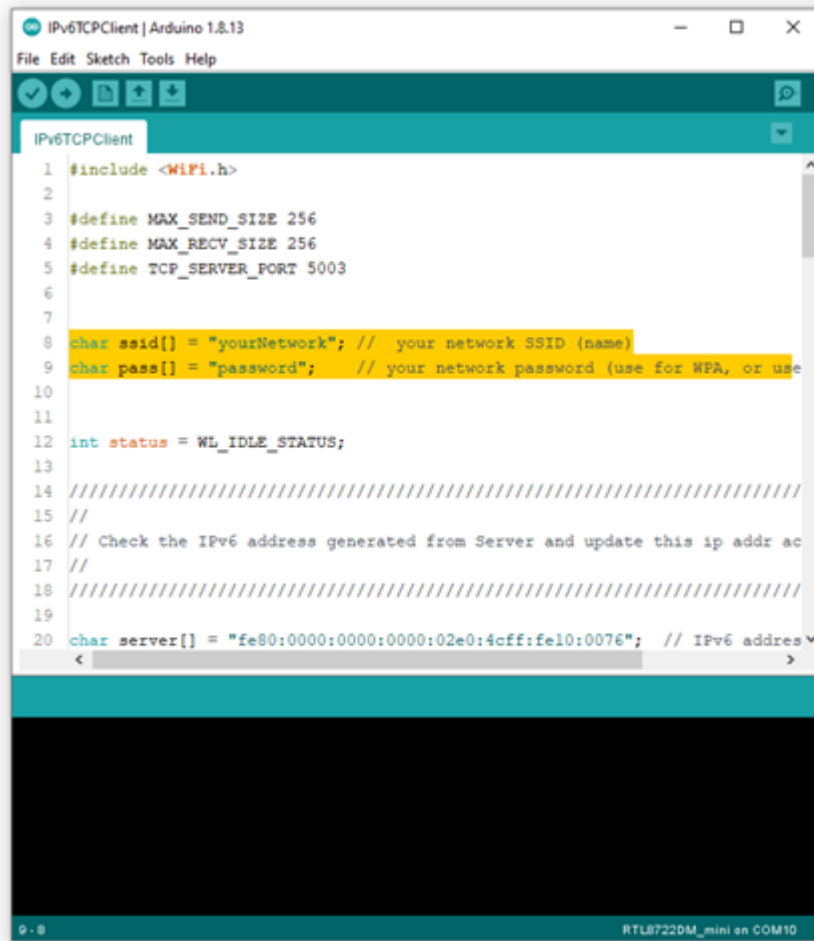
Step 2. IPv6TCPClient Now take the second Ameba D and open another example, “Files” -> “Examples” ->



“AmebaWiFi” -> “IPv6TCPClient”.



In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5 #define TCP_SERVER_PORT 5003
6
7
8 char ssid[] = "yourNetwork"; // your network SSID (name)
9 char pass[] = "password"; // your network password (use for WPA, or use
10
11
12 int status = WL_IDLE_STATUS;
13
14 ///////////////////////////////////////////////////////////////////
15 //
16 // Check the IPv6 address generated from Server and update this ip addr ac
17 //
18 ///////////////////////////////////////////////////////////////////
19
20 char server[] = "fe80:0000:0000:0000:02e0:4cff:fe10:0076"; // IPv6 address
21
```

From the previous step, we have obtained the Server' s IPv6 address, now we copy the server' s IPv6 address to "IPv6TCPCClient" example in the highlighted area below,

```

1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5 #define TCP_SERVER_PORT 5003
6
7
8 char ssid[] = "yourNetwork"; // your network SSID (name)
9 char pass[] = "password";    // your network password (use for WPA, or use as key for WEP)
10
11
12 int status = WL_IDLE_STATUS;
13
14 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
15 //
16 // Check the IPv6 address generated from Server and update this ip addr accordingly !! //
17 //
18 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
19
20 char server[] = "fe80:0000:0000:0000:02e0:4c00:fe10:0074"; // IPv6 address of server board
21 char data_recv[MAX_RECV_SIZE];
22 char data_send[MAX_SEND_SIZE] = "Hi Server!!";
23

```

Image tool closed!  
Upload Image done.

20 RTL8722DM/RTL8722C5M on COM10

Next, upload the code and press the reset button on Ameba once the upload is finished.

Open Serial Monitor on the port to the second Ameba D, you should see server and client are sending text message to each other at the same time.

```

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

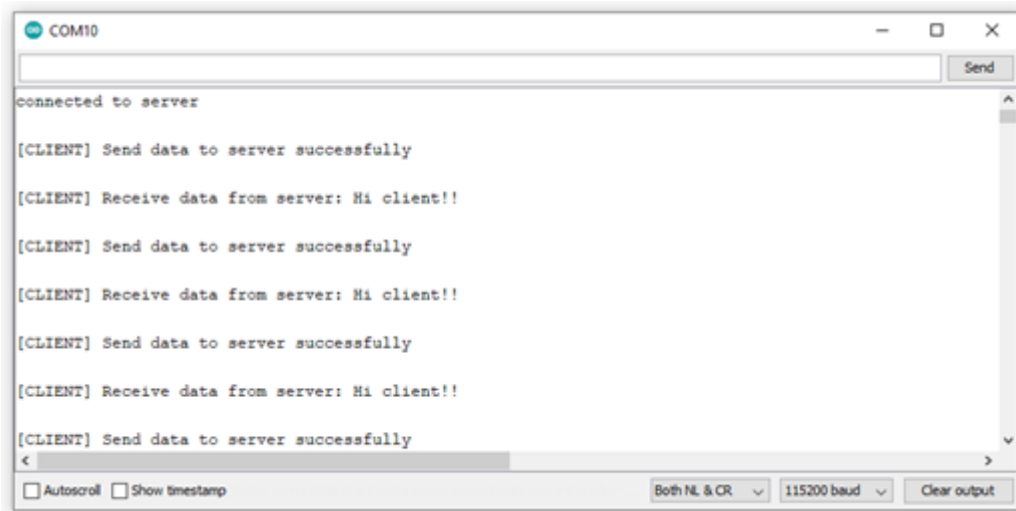
[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

```

☐ Autoscroll ☐ Show timestamp Both NL & CR 115200 baud Clear output



## IPv6 –Ameba as IPv6 Server/Client over UDP

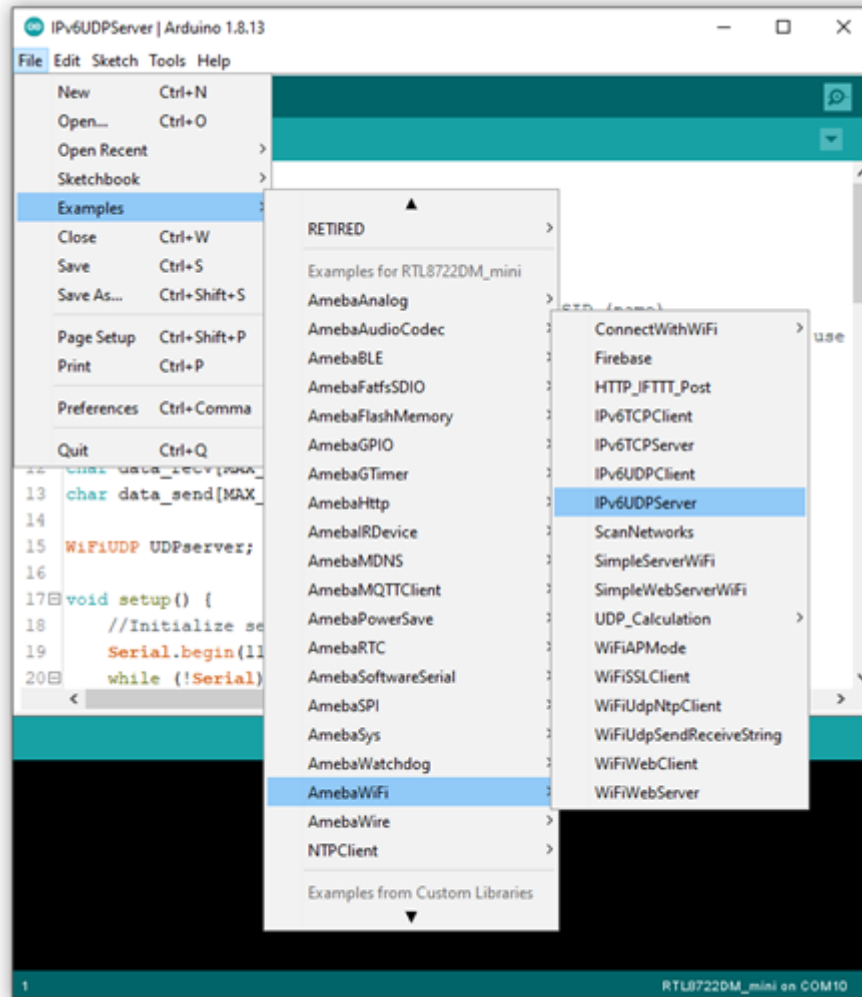
### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

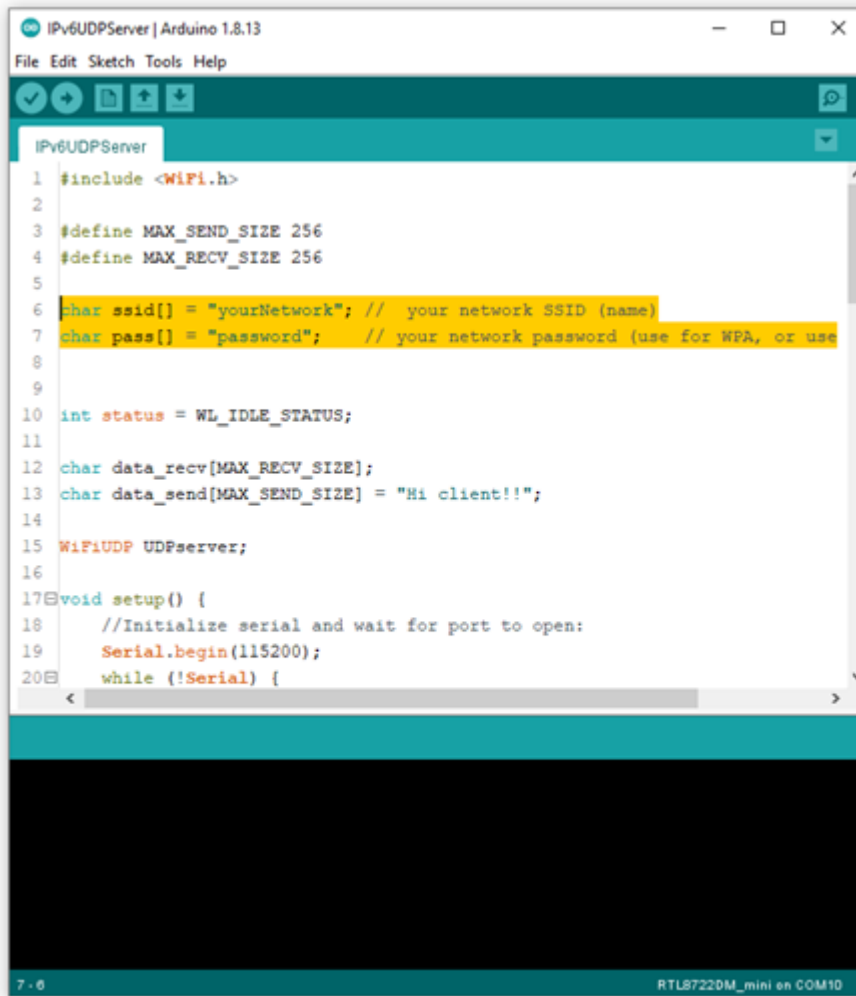
### Example

#### Introduction

This example shows how Ameba can communicate on the local network using Internet Protocol version 6 over UDP. Note that this example only works after you have set up the server and then configure the client accordingly.

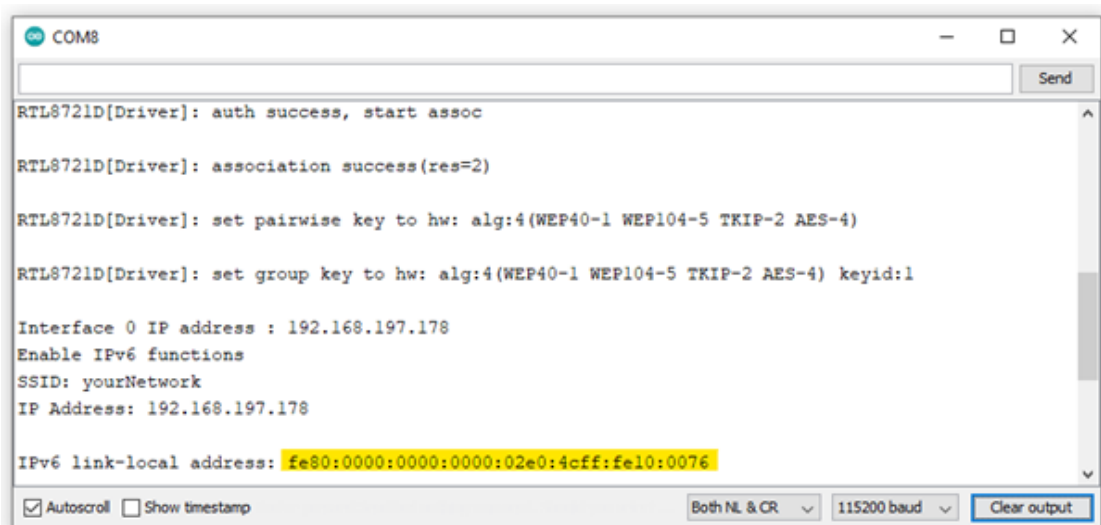


In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5
6 char ssid[] = "yourNetwork"; // your network SSID (name)
7 char pass[] = "password"; // your network password (use for WPA, or use
8
9
10 int status = WL_IDLE_STATUS;
11
12 char data_recv[MAX_RECV_SIZE];
13 char data_send[MAX_SEND_SIZE] = "Hi client!!";
14
15 WiFiUDP UDPServer;
16
17 void setup() {
18   //Initialize serial and wait for port to open:
19   Serial.begin(115200);
20   while (!Serial) {
```

Next, upload the code and press the reset button on Ameba once the upload is finished. Open Serial Monitor and copy the IPv6 address of the Server (the highlighted area) for later use,

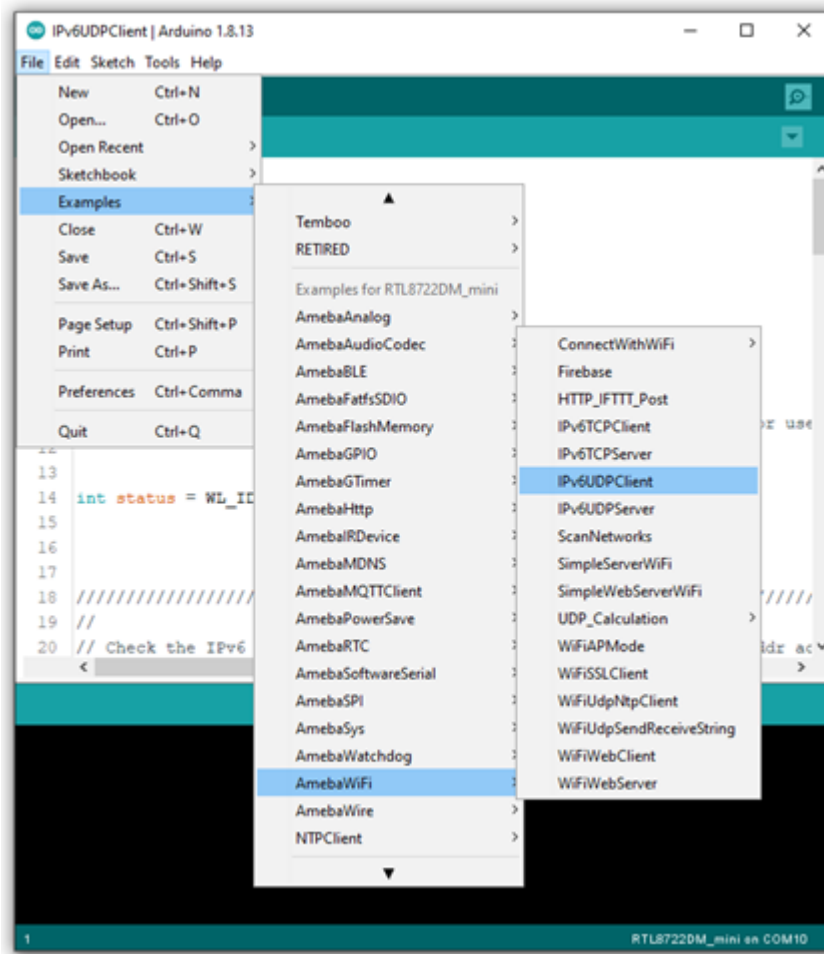


```
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=2)
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

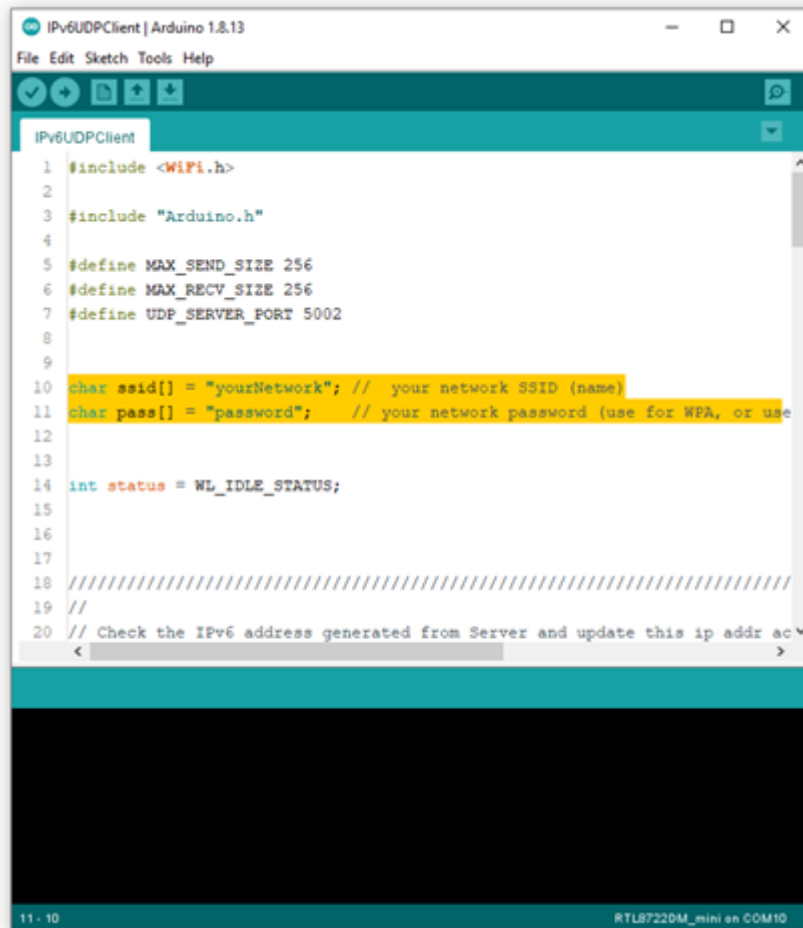
Interface 0 IP address : 192.168.197.178
Enable IPv6 functions
SSID: yourNetwork
IP Address: 192.168.197.178

IPv6 link-local address: fe80:0000:0000:0000:02e0:4c00:fe10:0076
```

Step 2. IPv6UDPCliEnt Now take the second Ameba D and open another example, “Files” -> “Examples” -> “AmebaWiFi” -> “IPv6UDPCliEnt” .



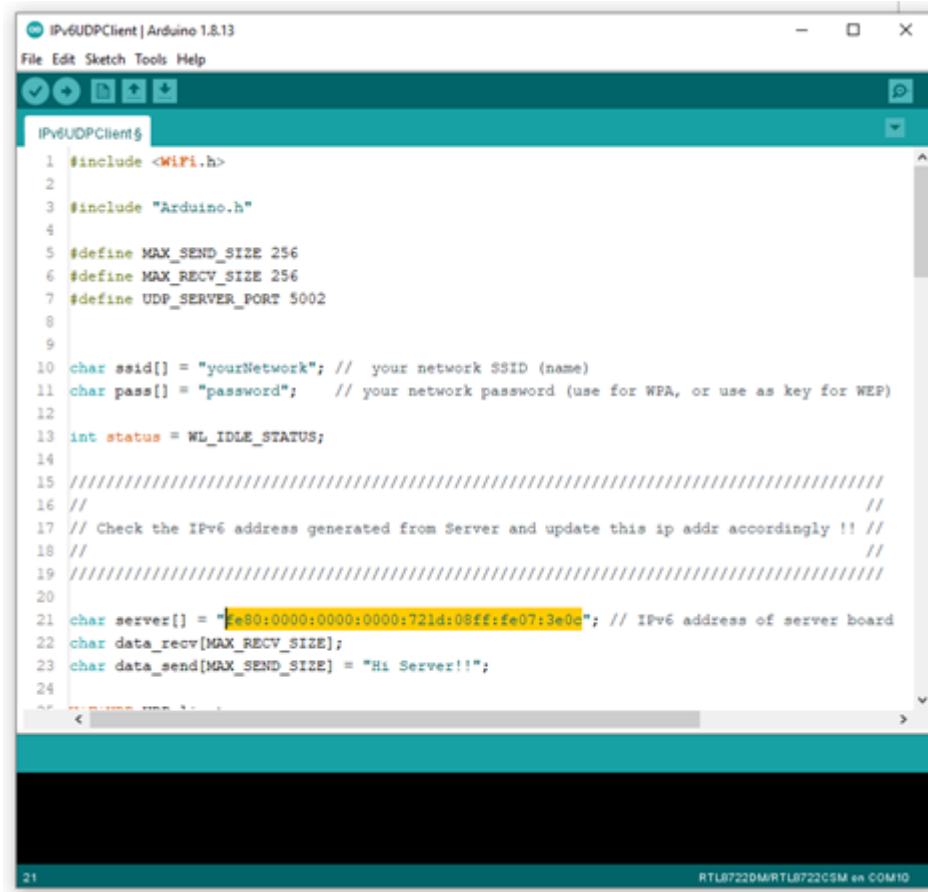
In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #include "Arduino.h"
4
5 #define MAX_SEND_SIZE 256
6 #define MAX_RECV_SIZE 256
7 #define UDP_SERVER_PORT 5002
8
9
10 char ssid[] = "yourNetwork"; // your network SSID (name)
11 char pass[] = "password"; // your network password (use for WPA, or use
12
13
14 int status = WL_IDLE_STATUS;
15
16
17
18 ///////////////////////////////////////////////////
19 //
20 // Check the IPv6 address generated from Server and update this ip addr ac
21 < >
```

From the previous step, we have obtained the Server' s IPv6 address, now we copy the server' s IPv6 address to "IPv6UDPCClient" example in the highlighted area below,





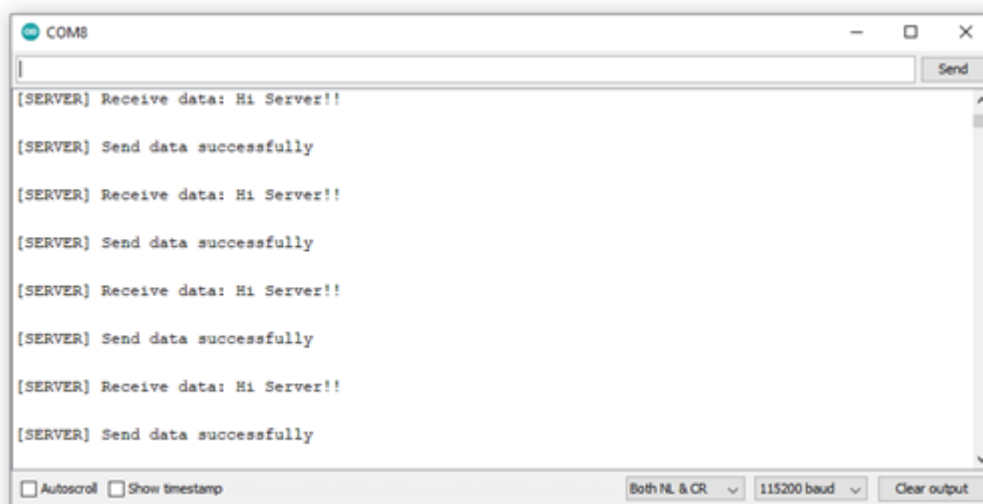
```

1  #include <WiFi.h>
2
3  #include "Arduino.h"
4
5  #define MAX_SEND_SIZE 256
6  #define MAX_RECV_SIZE 256
7  #define UDP_SERVER_PORT 5002
8
9
10 char ssid[] = "yourNetwork"; // your network SSID (name)
11 char pass[] = "password"; // your network password (use for WPA, or use as key for WEP)
12
13 int status = WL_IDLE_STATUS;
14
15 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
16 //
17 // Check the IPv6 address generated from Server and update this ip addr accordingly !! //
18 //
19 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
20
21 char server[] = "fe80:0000:0000:0000:721d:08ff:fe07:3e04"; // IPv6 address of server board
22 char data_recv[MAX_RECV_SIZE];
23 char data_send[MAX_SEND_SIZE] = "Hi Server!!";
24
25

```

Next, upload the code and press the reset button on Ameba once the upload is finished.

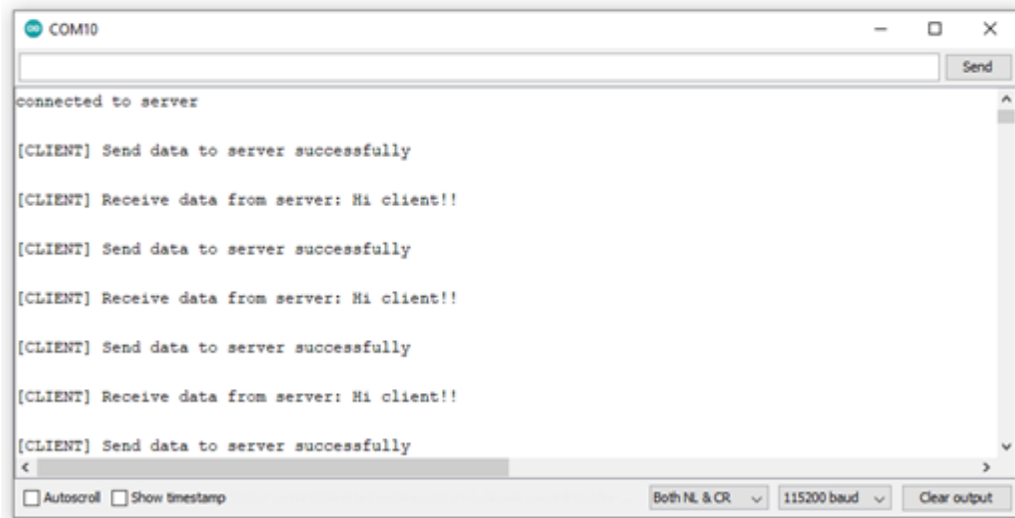
Open Serial Monitor on the port to the second Ameba D, you should see server and client are sending text message to each other at the same time.



```

[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully

```



## MDNS - Set up mDNS Client on Arduino IDE

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

mDNS (Multicast DNS) is a protocol used in the local area network. It delivers the network information like IP address and provided services to others. mDNS is based on the UDP protocol, and it sends packets to 224.0.0.251 with port 5353 under IPv4 address. The naming style for the service follows the format: **{Instance Name}.{Protocol Name}.{Domain}**

- Instance Name: used to identify the name of the service
- Protocol Name: Divided into two parts, the front end is in regard to the name of the service, and it adds baseline as a prefix. The rear end is in regard to the transport protocol name it used, and it also adds baseline as a prefix
- Domain: Local area network in normal cases

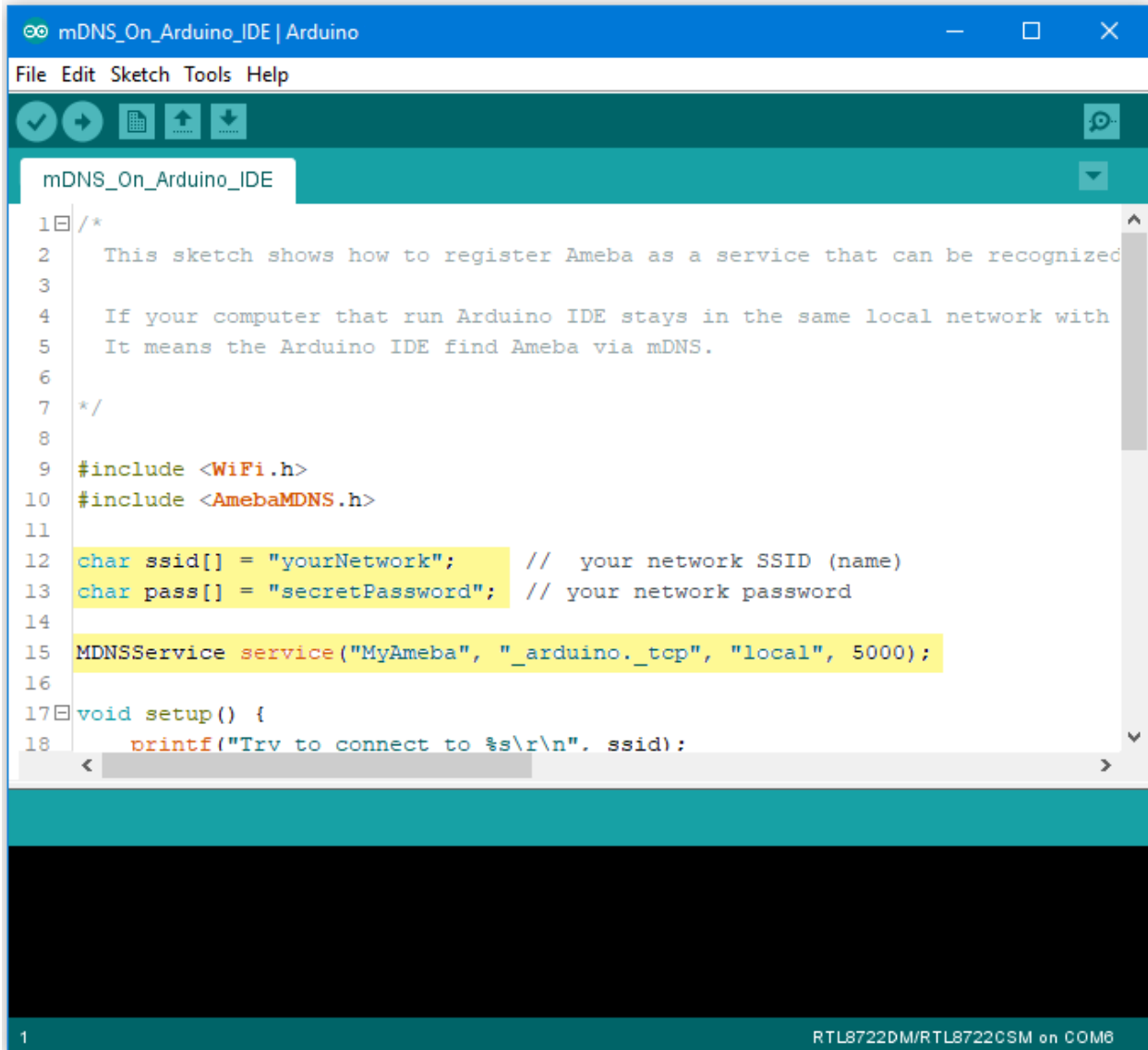
For example, Arduino IDE adopts the naming for the mDNS service which is used in OTA as following: **MyAmeba.\_arduino.\_tcp.local**

Among the naming example, “MyAmeba” can identify the Ameba device name and the name “MyAmeba” is changeable. “\_arduino.\_tcp” is the protocol that Arduino IDE adopts, and the Domain is set as local in common.

Open the example, “File” -> “Examples” -> “AmebaMDNS” -> “mdns\_on\_arduino\_ide”

You need to input ssid and password of the AP because the example will use WiFi connection.

And you can find out the naming of the service at the place where it declares MDNS Service. The example uses the default name “MyAmeba” and the name is changeable.

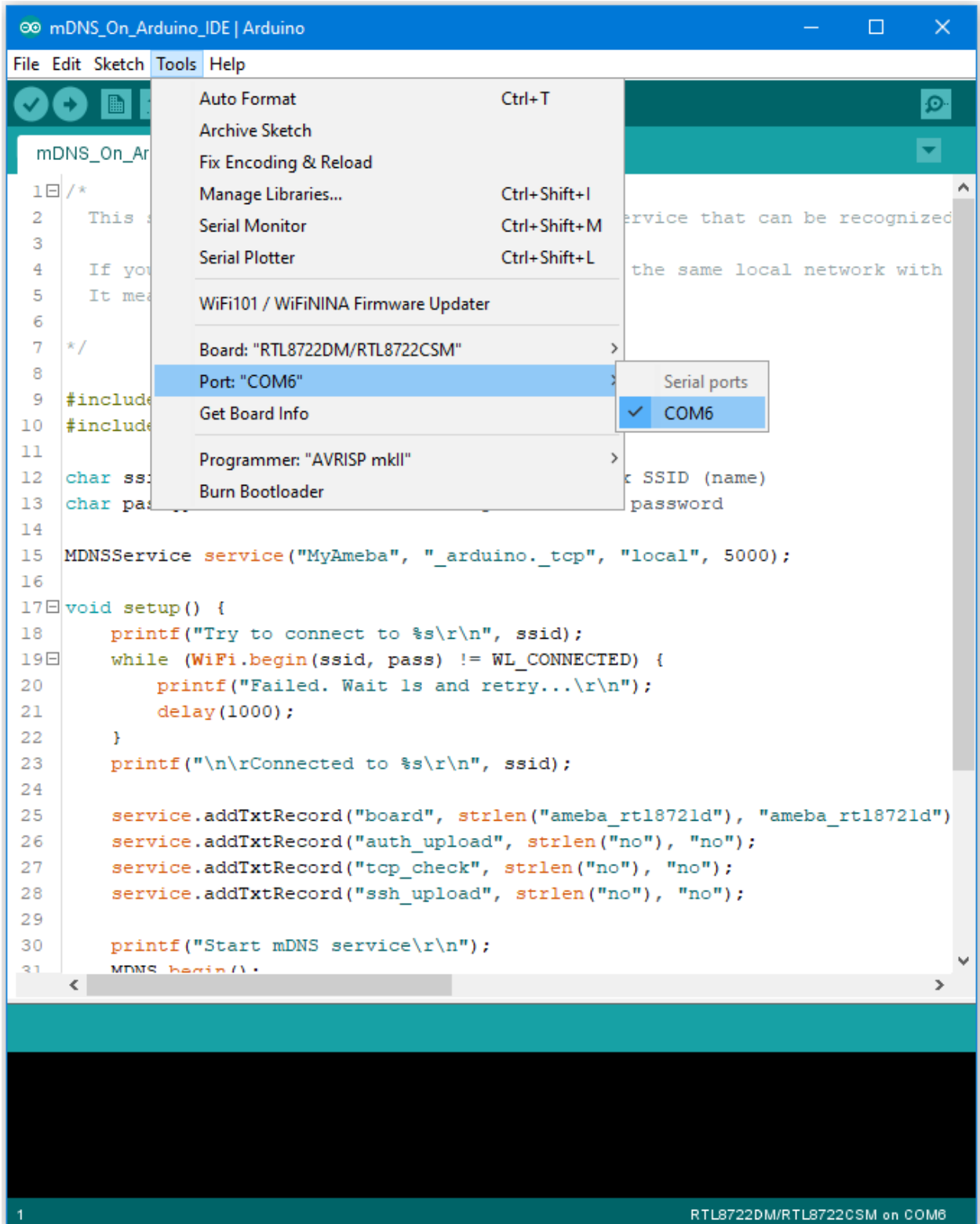


```

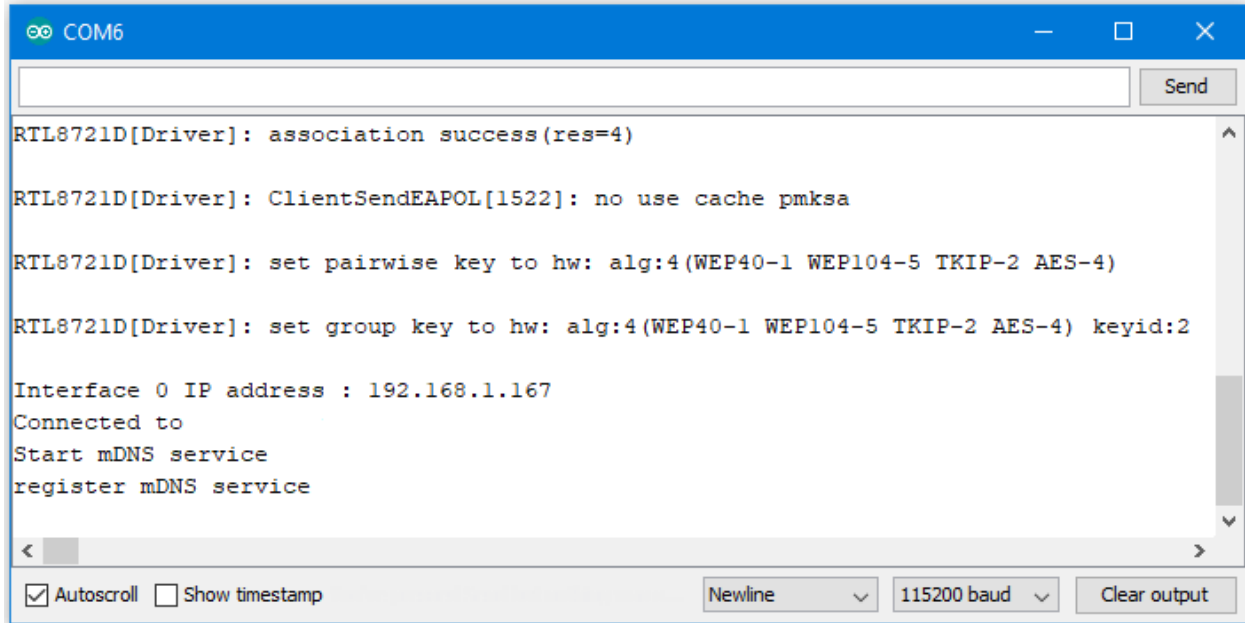
1  /*
2   This sketch shows how to register Ameba as a service that can be recognized
3
4   If your computer that run Arduino IDE stays in the same local network with
5   It means the Arduino IDE find Ameba via mDNS.
6
7  */
8
9  #include <WiFi.h>
10 #include <AmebaMDNS.h>
11
12 char ssid[] = "yourNetwork"; // your network SSID (name)
13 char pass[] = "secretPassword"; // your network password
14
15 MDNSService service("MyAmeba", "_arduino._tcp", "local", 5000);
16
17 void setup() {
18     printf("Trv to connect to %s\r\n", ssid);

```

Next, go to ( “Tools” -> “Port” ), and you can find out at least one Serial Port. This port is simulated by Ameba board via USB. Choose this port and upload the compiled code to



After uploading the code, press the reset button on Ameba and waiting for Ameba to connect with AP and activate the mDNS service after a while. You can see the Log at the bottom of the Serial Monitor.



```
RTL8721D[Driver]: association success(res=4)

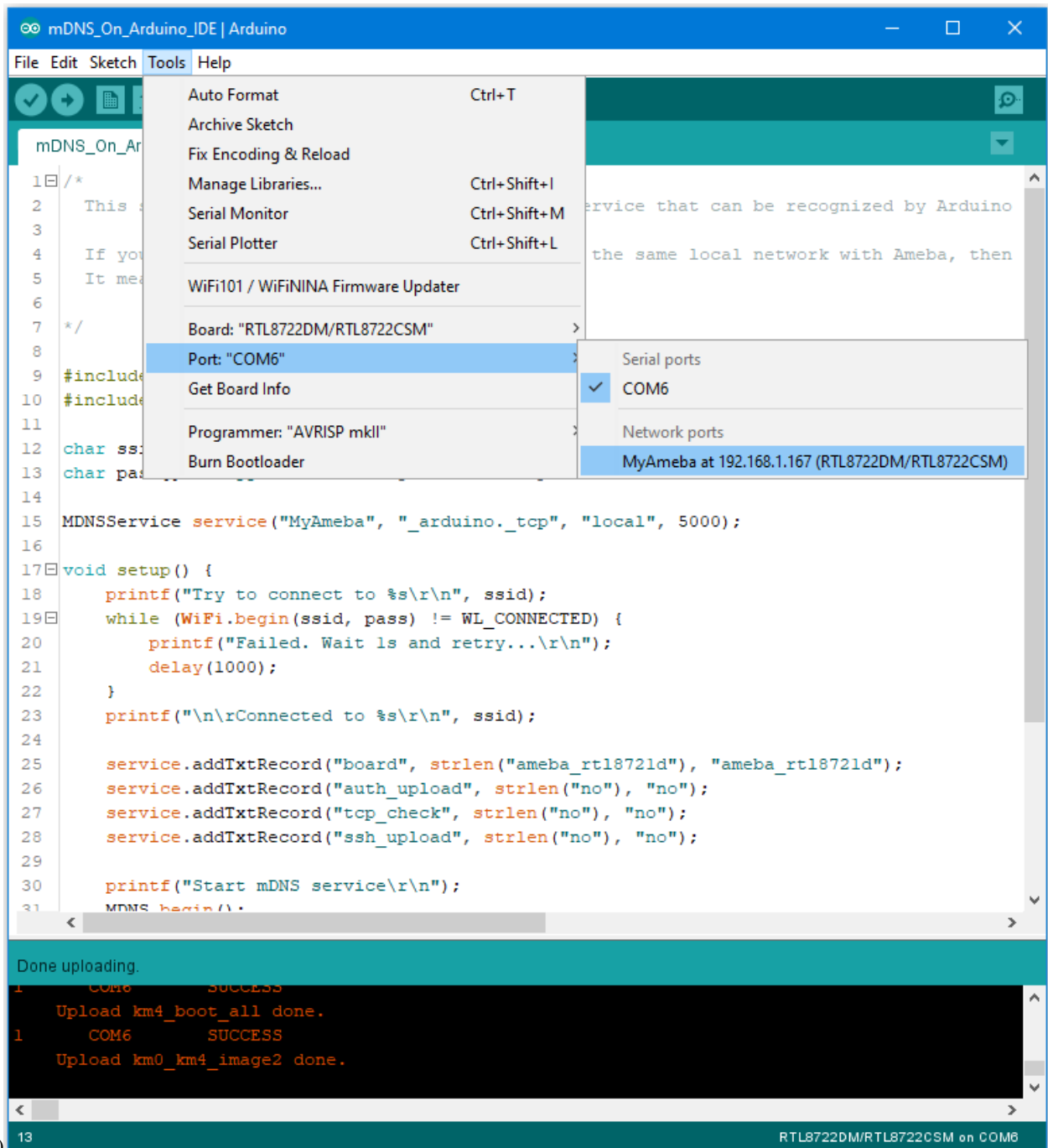
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
Connected to
Start mDNS service
register mDNS service
```

Then you can find out the added item “Network Ports” “**MyAmeba at 192.168.1.167 (Ameba RTL8722DM/RTL8722CSM)**”, “MyAmeba” is the device name we set up, and “IP” is the IP address that AP assigned to Ameba, the IP address should be the same with the IP shown in the Serial Monitor. Last, “Ameba RTL8722DM/RTL8722CSM” is the type name of the board, and it means that Ameba can let Arduino IDE identify the mDNS service successfully.(We still can not use the Internet to upload the code, and we will explain this part in the OTA exam-



ple.)

If you cannot find the Network ports on your Arduino IDE, please check:

- Does your computer in the same local area network with the Ameba?
- Restart the Arduino IDE, and it will find the mDNS service again
- Check the Log in Serial Monitor if the Ameba connects to the AP and activate mDNS service successfully

## Code Reference

The program set up the mDNS service in the beginning, the first parameter is Instance Name, and it is changeable in this example. The second parameter is the protocol that the service used, and it would be “\_arduino.\_tcp” for Arduino IDE. The third parameter is Domain, and it would be “local” in common. The fourth parameter is the port number for the service, it is 5000 here and we doesn't use it in the example.

```
MDNSService service("MyAmeba", "_arduino._tcp", "local", 5000);
```

After connected to the network, we set up some text fields for the service. For the following example, “board” is the name of the field, “ameba\_rtl8721d” is the value of the field. “board” is used to let Arduino IDE check installed SDK to see if it exists known device or not. We will use the name of the device if there is known device, users can change “ameba\_rtl8721d” to “yun” or other names to find out what's the difference if interested.

```
service.addTxtRecord("board", strlen("ameba_rtl8721d"), "ameba_rtl8721d");
```

Then we add three text fields “auth\_upload”, “tcp\_check”, and “ssh\_upload”, this example does not activate these services.

```
service.addTxtRecord("auth_upload", strlen("no"), "no");
service.addTxtRecord("tcp_check", strlen("no"), "no");
service.addTxtRecord("ssh_upload", strlen("no"), "no");
```

Next we activate MDNS

```
MDNS.begin();
```

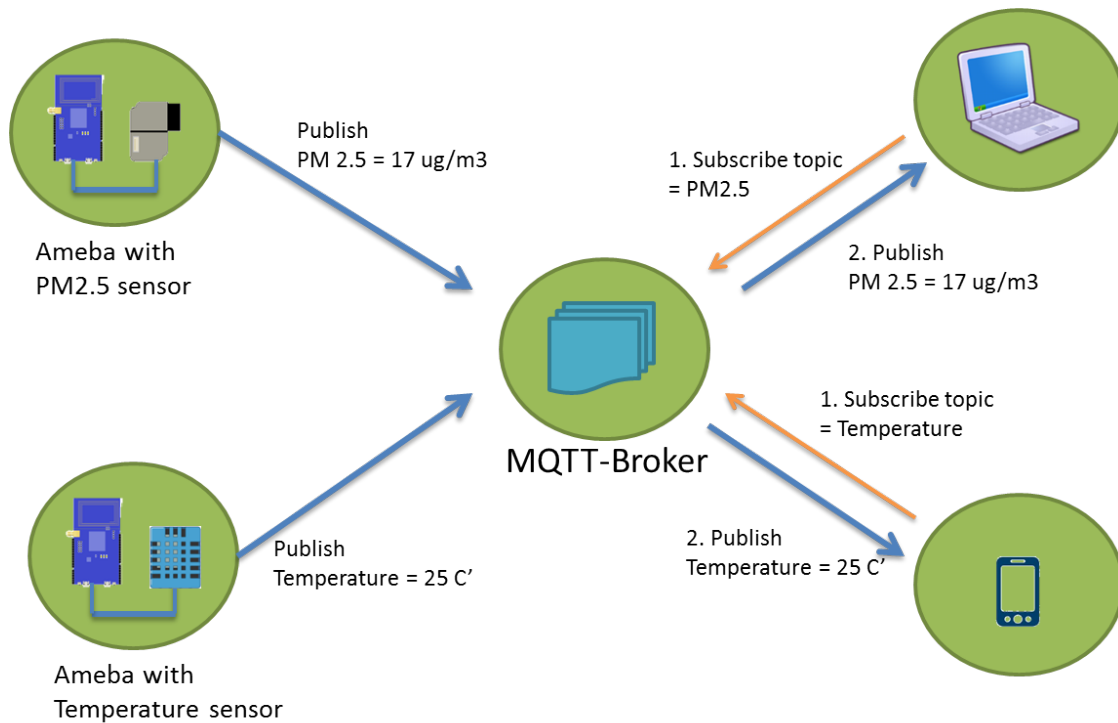
and register to the mDNS service.

```
MDNS.registerService(service);
```

## MQTT - Set up MQTT Client to Communicate with Broker

### Intro to MQTT

MQTT (Message Queuing Telemetry Transport) is a protocol proposed by IBM and Eurotech. The introduction in [MQTT Official Website](#): MQTT is a machine-to-machine (M2M)/” Internet of Things” connectivity protocol. It was designed as an extremely lightweight publish/subscribe messaging transport. We can say MQTT is a protocol designed for IoT. MQTT is based on TCP/IP and transmits/receives data via publish/subscribe. Please refer to the figure below:



In the operation of MQTT, there are several roles:

- **Publisher:** Usually publishers are the devices equipped with sensors (ex. Ameba). Publishers upload the data of the sensors to MQTT-Broker, which serves as a database with MQTT service.
- **Subscriber:** Subscribers are referred to the devices which receive and observe messages, such as a laptop or a mobile phone.
- **Topic:** Topic is used to categorize the messages, for example the topic of a message can be “PM2.5” or “Temperature”. Subscribers can choose messages of which topics they want to receive.

## Preparation

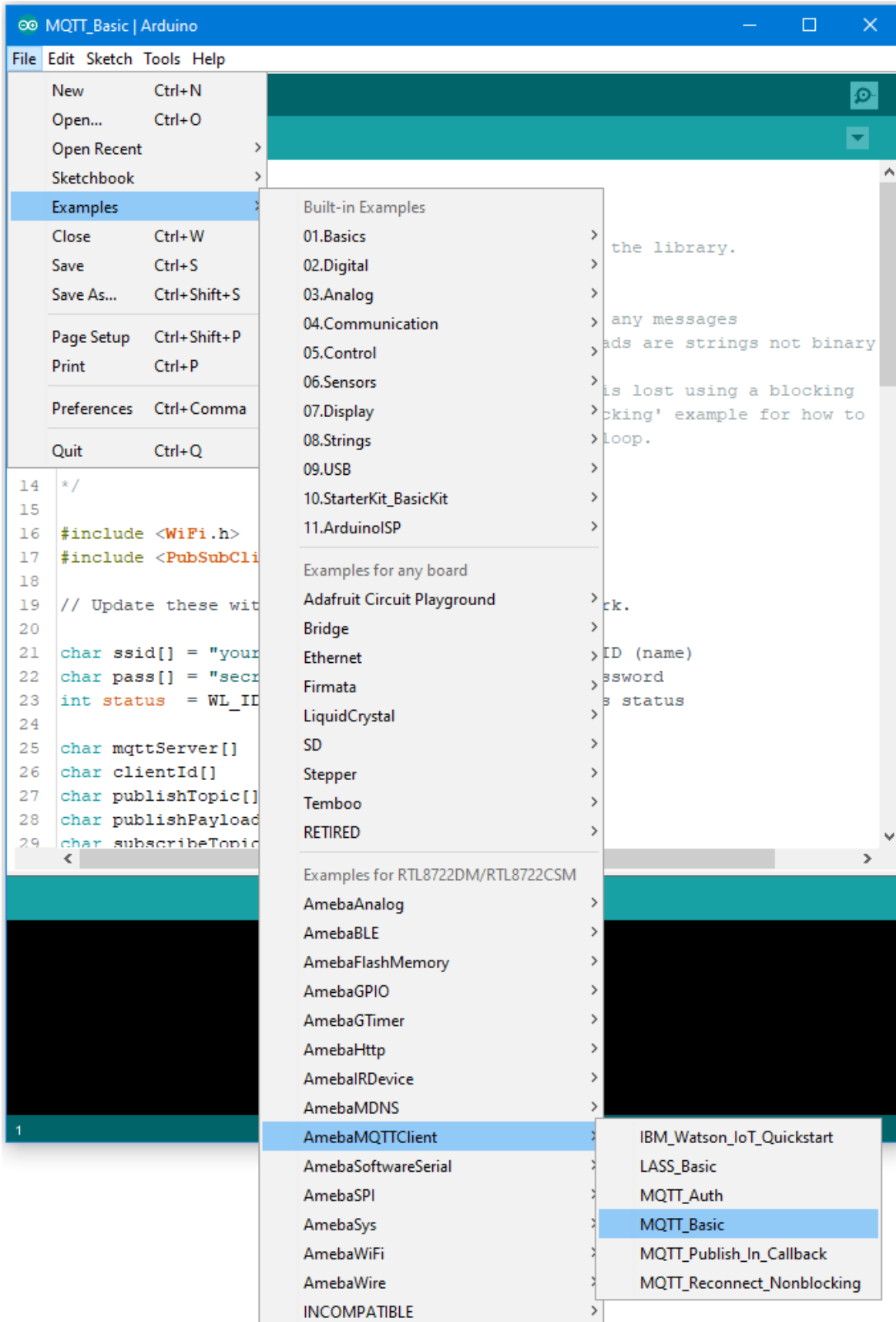
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

## Example

In this example, we connect Ameba to MQTT-Broker. Then send messages as publisher and receive messages from MQTT-Broker as subscriber.

Open the MQTT example “File” -> “Examples” -> “AmebaMQTTClient” -> “MQTT\_Basic”





Please modify some WiFi-related parameters.

And some information related to MQTT:

```

MQTT_Basic | Arduino
File Edit Sketch Tools Help

MQTT_Basic

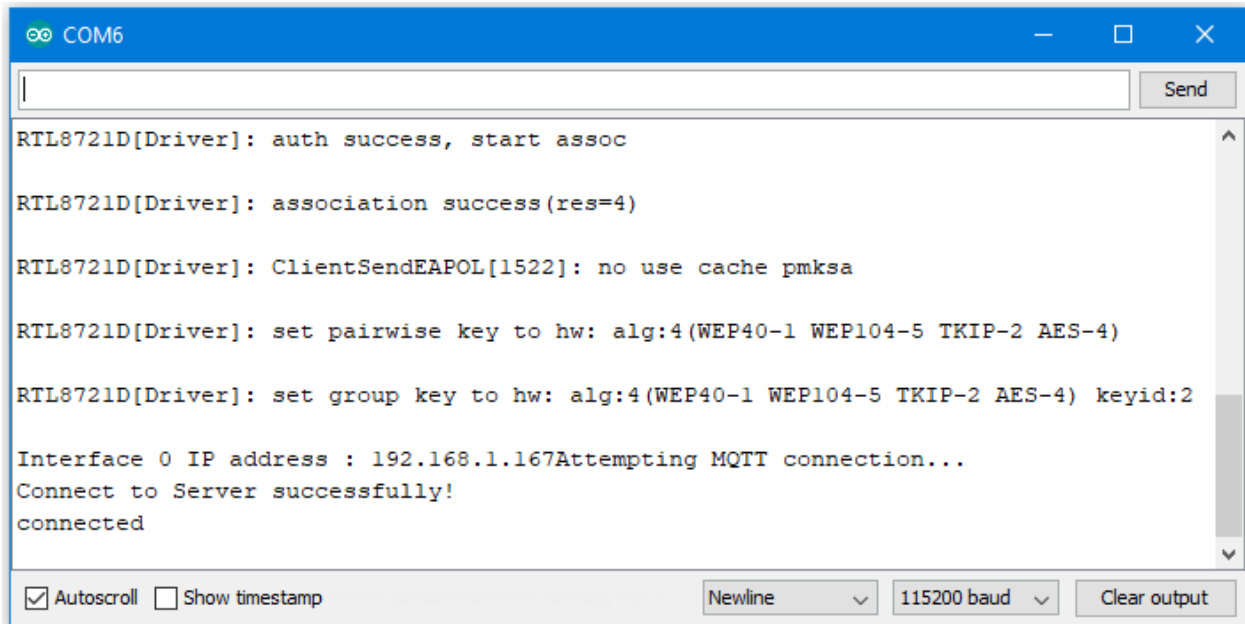
6   - publishes "hello world" to the topic "outTopic"
7   - subscribes to the topic "inTopic", printing out any messages
8     it receives. NB - it assumes the received payloads are strings not binary
9
10  It will reconnect to the server if the connection is lost using a blocking
11  reconnect function. See the 'mqtt_reconnect_nonblocking' example for how to
12  achieve the same result without blocking the main loop.
13
14  */
15
16  #include <WiFi.h>
17  #include <PubSubClient.h>
18
19  // Update these with values suitable for your network.
20
21  char ssid[] = "yourNetwork";    // your network SSID (name)
22  char pass[] = "secretPassword"; // your network password
23  int status  = WL_IDLE_STATUS;   // the Wifi radio's status
24
25  char mqttServer[] = "test.mosquitto.org";
26  char clientId[]   = "amebaClient";
27  char publishTopic[] = "outTopic";
28  char publishPayload[] = "hello world";
29  char subscribeTopic[] = "inTopic";
30
31  void callback(char* topic, byte* payload, unsigned int length) {
32    Serial.print("Message arrived [");
33    Serial.print(topic);
34    Serial.print("] ");
  
```

1 RTL8722DM/RTL8722CSM on COM8

The “mqttServer” refers to the MQTT-Broker, we use the free MQTT sandbox “test.mosquitto.org” for testing.

- “clientId” is an identifier for MQTT-Broker to identify the connected device.
- “publishTopic” is the topic of the published message, we use “outTopic” in the example. The devices subscribe to “outTopic” will receive the message.
- “publishPayload” is the content to be published.
- “subscribeTopic” is to tell MQTT-broker which topic we want to subscribe to.

Next, compile the code and upload it to Ameba. Press the reset button, then open the serial monitor



```

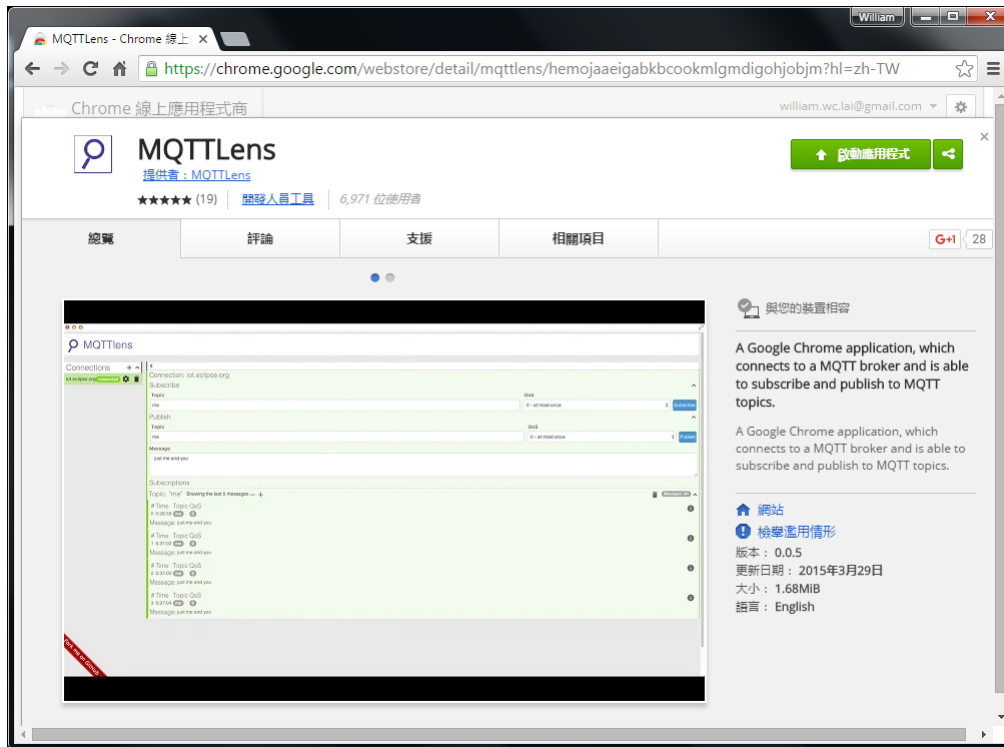
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=4)
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2
Interface 0 IP address : 192.168.1.167Attempting MQTT connection...
Connect to Server successfully!
connected

```

After Ameba is connected to MQTT server, it sends the message “hello world” to “outTopic” .

To see the message, we need another MQTT client.

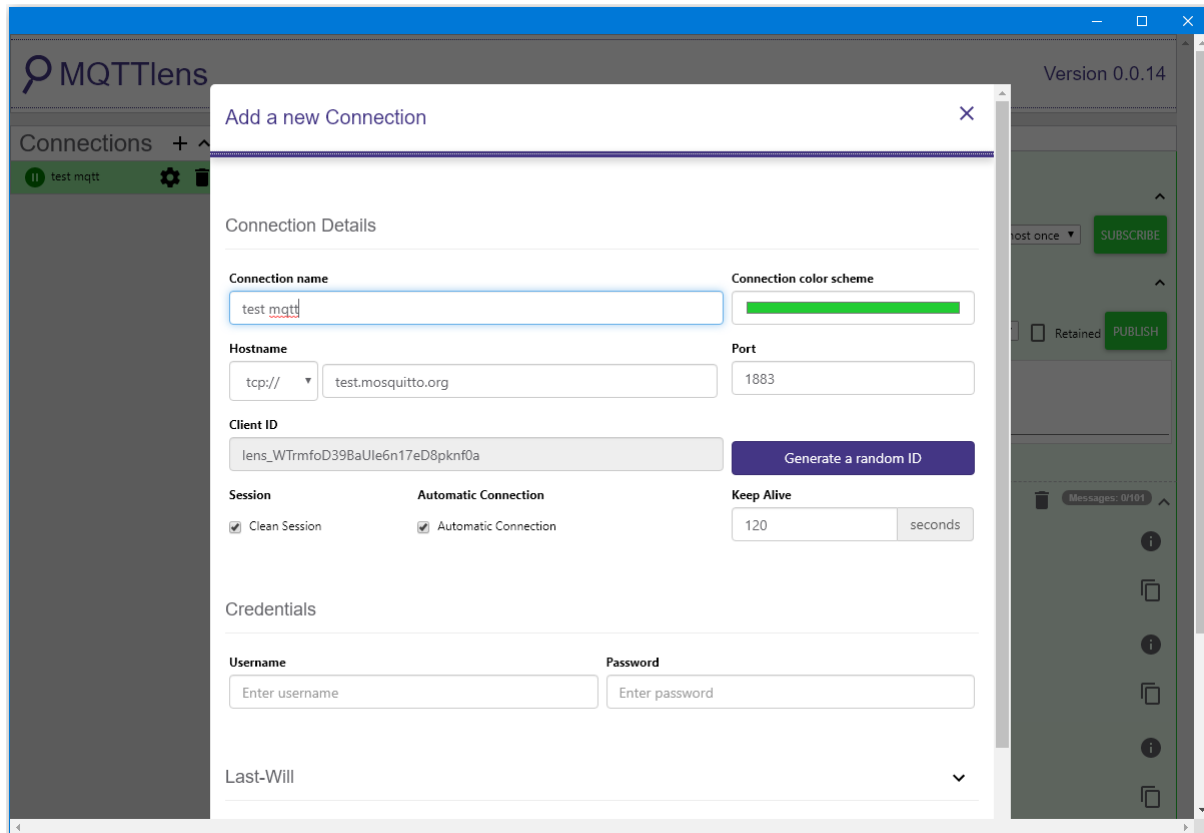
Here we use a chrome plugin “MQTTLens” to be the MQTT client. You can find it in google webstore.



Install and open the MQTTLens, click “+” next to “Connection” on the left, and fill in the required information

- **Connection Name:** Used to identify the connection, you can choose a name you like.
- **Hostname:** The MQTT-Broker server, here we use “iot.eclipse.org”
- **Client ID:** We use the default randomly generated ID.

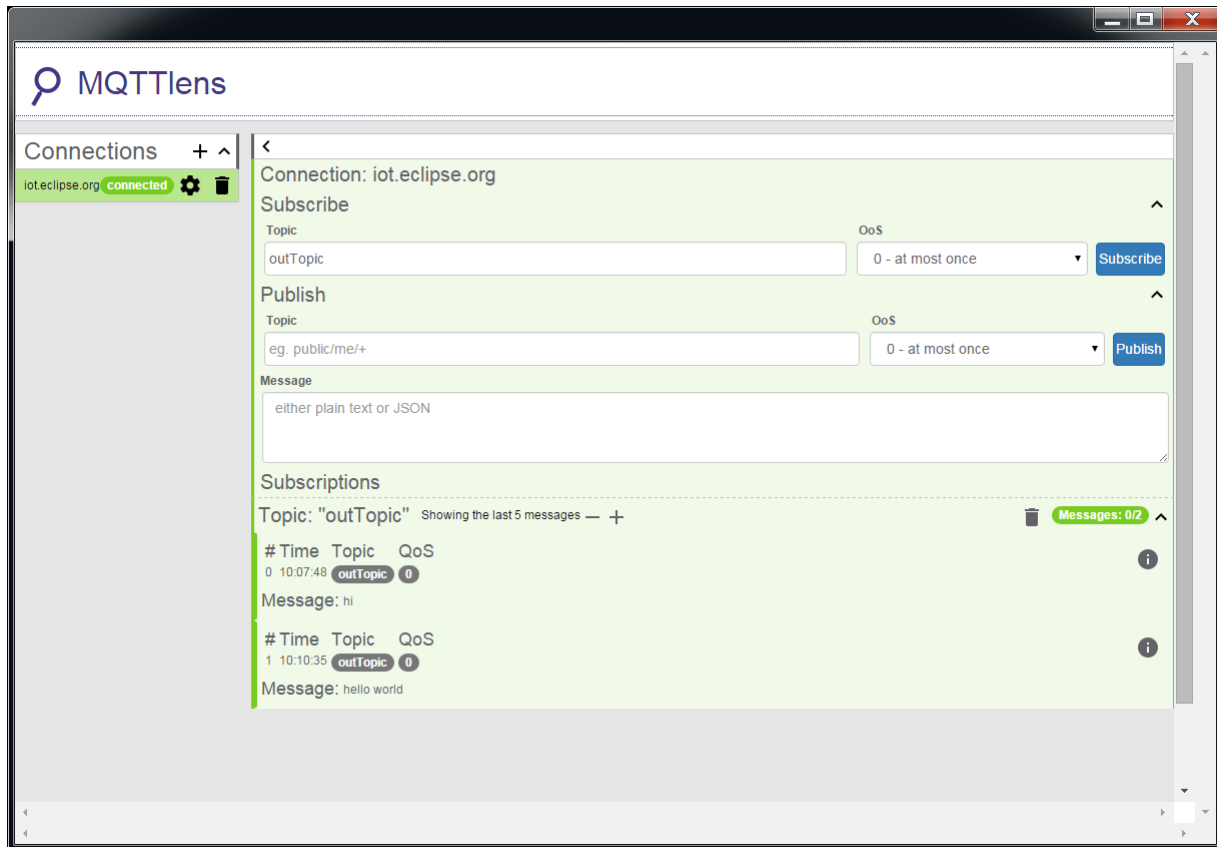
Then click “CREATE CONNECTION” .



Since we have not registered the topic we want to listen to, we would not receive any messages now.

Fill in “outTopic” in the “Topic” field and click “Subscribe” .

Wait for Ameba to send next message (or you can press the reset button). Then you can see the “hello world” message show up.



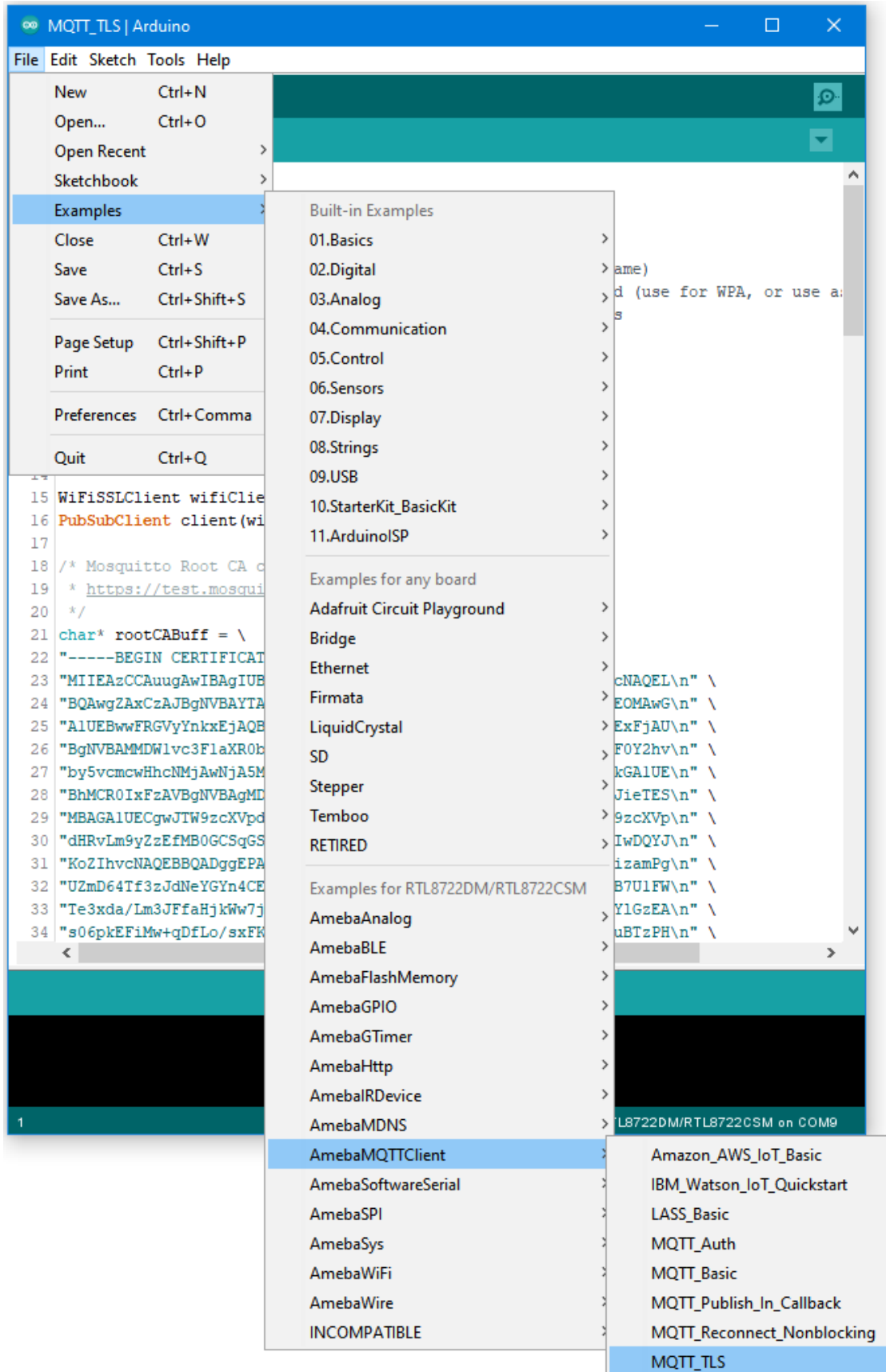
## MQTT - Set up MQTT Client over TLS

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we connect Ameba to a MQTT broker using TLS authentication. Then send messages as a publisher and receive messages from as a subscriber. Open the MQTT example “File” -> “Examples” -> “AmebaMQTTClient” -> “MQTT\_TLS”



Please modify the WiFi-related parameters to connect to your WiFi network.

Modify the MQTT parameters to fit your application:

```
MQTT_TLS | Arduino
File Edit Sketch Tools Help

MQTT_TLS

1 #include <WiFi.h>
2 #include <PubSubClient.h>
3
4 // Update these with values suitable for your network.
5 char ssid[] = "yourNetwork"; // your network SSID (name)
6 char pass[] = "yourPassword"; // your network password (use for WPA, or use a
7 int status = WL_IDLE_STATUS; // the Wifi radio's status
8
9 char mqttServer[] = "test.mosquitto.org";
10 char clientId[] = "amebaClient";
11 char publishTopic[] = "outTopic";
12 char publishPayload[] = "hello world";
13 char subscribeTopic[] = "inTopic";
14
15 WiFiSSLClient wifiClient;
16 PubSubClient client(wifiClient);
17
18 /* Mosquitto Root CA can be download here:
19 * https://test.mosquitto.org/
20 */
21 char* rootCABuff = \
22 "-----BEGIN CERTIFICATE-----\n" \
23 "MIIEAzCCAuugAwIBAgIUByYh1CGvdj4NhBXkZ/uLUZNI LAwDQYJKoZIhvcNAQEL\n" \
24 "BQAwGZAxCzAJBgNVBAYTAkdCMRcwFQYDVQQIDAA5Vbml0ZWQgS2luZ2RvbTEOMAwG\n" \
25 "A1UEBwwFRGVyYnRkEjAQBgNVBAQoMCU1vc3FlaXR0bzELMAkGA1UECwwCQ0ExFjAU\n" \
26 "BgNVBAMMDWlvc3FlaXR0by5vcmcxHzAdBgkqhkiG9w0BCQEWEHJvZ2VyQG0Y2hv\n" \
27 "by5vcmcwHhcNMjAwNjA5MTEwNjM5WheNMzAwNjA3MTEwNjM5WjCBkDELMAkGA1UE\n" \
28 "BhmCR0IxPzAVBgNVBAGMD1VuaXRlZCBLaW5nZG9tMQ4wDAYDVQQHDAVEZXXJieTES\n" \
29 "MBAGA1UECgwJTW9zcXVpdHRvMQswCQYDVQQLDAJDQTEWMBQGA1UEAwNbW9zcXVp\n" \
30 "dHRvLm9yZzEfMB0GCSqGSIb3DQEJARYQcm9nZXJAYXRjaG9vLm9yZzCCASIwDQYJ\n" \
31 "KoZIhvcNAQEBBQADggEPADCCAQoCggEBAME0HKmIzftOwkKLT3THHe+ObdizamPg\n" \
32 "UZmD64Tf3zJdNeYGYn4CEXbyP6fy3tWcS2boW6dzrH8SdFf9uo320GJA9B7U1FW\n" \
33 "Te3xda/Lm3JffaHjKw7jBwcauQZjpGINHapHRlpiCZsquAthOgxW9SgDgY1GzEA\n" \
34 "s06pkEfIMw+qDfLo/sxFKB6vQlFekMeCymjLCbNwPjYqyhFmPwio/PDMruBTzPH\n" \
```



The “mqttServer” refers to the MQTT-Broker, we use the free MQTT sandbox “test.mosquitto.org” for testing.

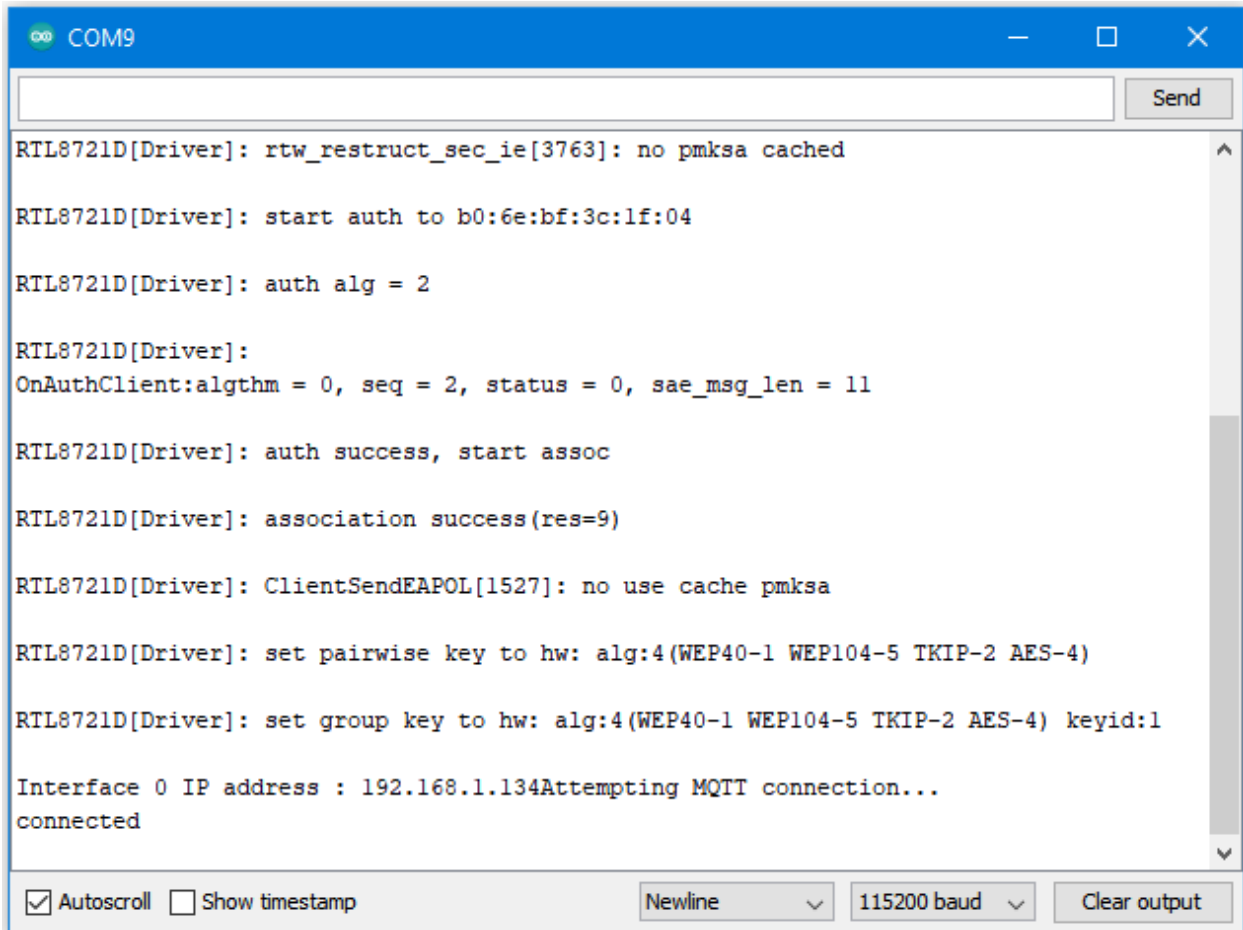
“clientId” is an identifier for MQTT-Broker to identify the connected device.

“publishTopic” is the topic of the published message, we use “outTopic” in the example. The devices subscribe to “outTopic” will receive the message.

“publishPayload” is the content to be published.

“subscribeTopic” is to tell MQTT-broker which topic we want to subscribe to.

Next, compile the code and upload it to Ameba. Press the reset button, then open the serial monitor



```

COM9
Send

RTL8721D[Driver]: rtw_restruct_sec_ie[3763]: no pmksa cached

RTL8721D[Driver]: start auth to b0:6e:bf:3c:1f:04

RTL8721D[Driver]: auth alg = 2

RTL8721D[Driver]:
OnAuthClient:alghm = 0, seq = 2, status = 0, sae_msg_len = 11

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=9)

RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.1.134Attempting MQTT connection...
connected

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

After Ameba is connected to MQTT server, it sends the message “hello world” to “outTopic” . To see the message, use another MQTT client. Refer to the MQTT\_Basic example guide on how to setup a PC-based MQTT client.

If you wish to use TLS client authentication in addition to server authentication, you will need to generate an OpenSSL private key and obtain a signed certificate from the server. For testing purposes, signed certificates can be obtained from test.mosquitto.org by following the guide at <https://test.mosquitto.org/ssl/>.

Replace the character strings “certificateBuff” and “privateKeyBuff” with your signed certificate and OpenSSL private key, ensuring that they are formatted the same way as the shown in the example code. Also uncomment the highlighted code to enable client authentication, and to change the MQTT port number.

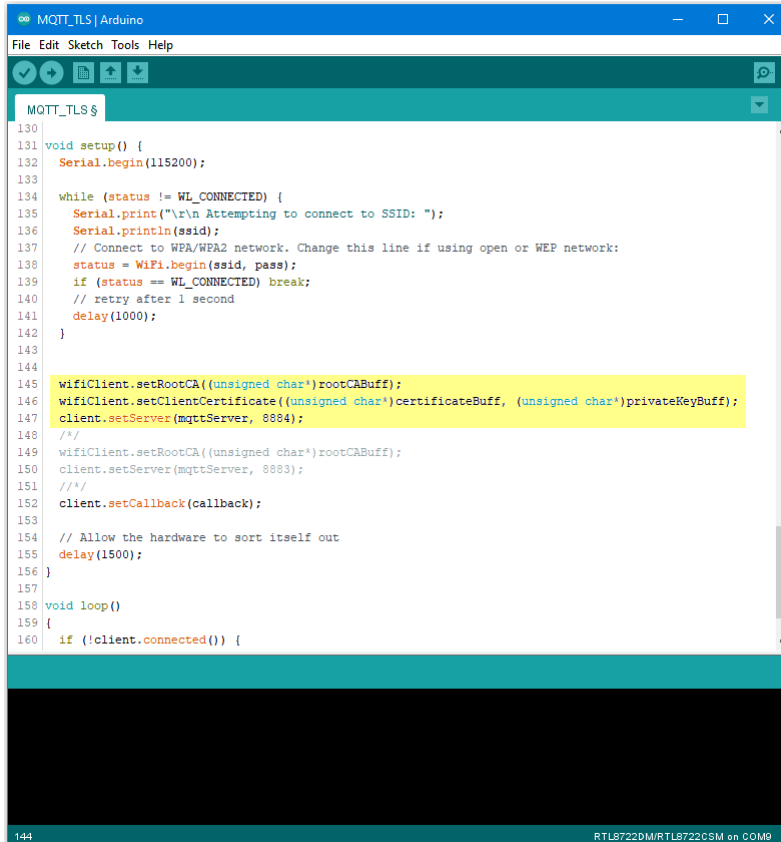
```

MQTT_TLS | Arduino
File Edit Sketch Tools Help

MQTT_TLS
45 "-----END CERTIFICATE-----\n";
46
47 char* certificateBuff = \
48 "-----BEGIN CERTIFICATE-----\n" \
49 "MIIDjTCCAnWgAwIBAgIBADANBgkqhkiG9w0BAQsFADCBkDELMAkGA1UEBhMCR0Ix\n" \
50 "FzAVBgNVBAGMD1VuaXRlZCBLaW5nZG9tMQ4wDAYDVQQHDAVEZXJieTESMBAGAlUE\n" \
51 "CgwJTW9zcXVpdHRvMQswCQYDVQQLDAJDTQTEWMBQGA1UEAwNBW9zcXVpdHRvLm9y\n" \
52 "ZzEfMB0GCsqGSIB3DQEJARYQcm9nZXJAYXRjaG9vLm9yZzAeFw0yMDA3MTcxMDM0\n" \
53 "MjRaFw0yMDEwMTUxMDM0MjRaMGcxZzAJBgNVBAYTA1NHMRIwEAYDVQQIDAlTaW5n\n" \
54 "YXBvcnUxZjAQBgNVBACMCVnpbmdhcG9yZTEQMA4GA1UECgwHUmVhbHRlZEMMAoG\n" \
55 "AlUECwWU0QzMRAdDgYDVQDDAdhdXJpY2FsMIIIBIjANBgkqhkiG9w0BAQEFAAO\n" \
56 "AQ8AMIIBCGKCAQEA moglck7TyKdDw/943tfGLvwY/rz6DCZkosOQCYEZhjMSjX4M\n" \
57 "BNcCU/rhwm8EP+luYZfHrdsijalMuSUGUOi9Ylt+SqzYLvvgLi8+h3LIGiGvqghs\n" \
58 "97iyWNUlWfWEMqBxjRVAI7/+u3b/lZtkz9UBN7+/y4jGLTsaW4IRQ5qCwt58ov+Q\n" \
59 "QU2PYS8qMlCRTxaokXOiLnBkxsOTq+aKLTdlx8nHjXSNCnOPjz zc4pq7rMjGyzq5\n" \
60 "edrO/pX9yFjD+wTgyssdnhTBgL8xTsx7mfDfpgdT/Bk7wZWQyfLosssdYLGqU6MN\n" \
61 "8wIl3wmqBymHAeFkihMBf4kDlglWLYZuziBWSwIDAQABoxowGDAJBgNVHRMEAjAA\n" \
62 "MAsGAlUdDwQEAwIF4DANBgkqhkiG9w0BAQsFAAOCAQEASqd/fRlpuUgehZMjzRNO\n" \
63 "RADV/gjX/UkWhlu66HbWhPDTuu5Nesms79bR7IbnP0umdt8nYdrW/ersTTFYkEv\n" \
64 "7rV6xlatPjXhuzlbwYeRSglcG+3cjiyFmMr2tlaVHMPXzfHBBEwOvbqIonPQnEe9\n" \
65 "6X0j/10xKMdsVKCb9OpAqlfDd4199M6t1TJiqaZ6OVAGpJ/ga0LNU0MNHPU8s68X\n" \
66 "ODZA8GwI0lkQUxUkrmaYmth3R4A3uIYfs4ff9u71TgT9wtnwQftacHhVAmF+hQpW\n" \
67 "luJqKtHI/Ox0Mya0YlaONZavT3WgtxnRmEdAv6gn9WNfko6qr98AqGijX2VZpjRf\n" \
68 "oQ==\n" \
69 "-----END CERTIFICATE-----\n";
70
71 char* privateKeyBuff = \
72 "-----BEGIN RSA PRIVATE KEY-----\n" \
73 "MIIEpAIBAAKCAQEA moglck7TyKdDw/943tfGLvwY/rz6DCZkosOQCYEZhjMSjX4M\n" \
74 "BNcCU/rhwm8EP+luYZfHrdsijalMuSUGUOi9Ylt+SqzYLvvgLi8+h3LIGiGvqghs\n"

```

1 RTL8722DM/RTL8722CSM on COM9



```

MQTT_TLS $
130
131 void setup() {
132   Serial.begin(115200);
133
134   while (status != WL_CONNECTED) {
135     Serial.print("\r\n Attempting to connect to SSID: ");
136     Serial.println(ssid);
137     // Connect to WPA/WPA2 network. Change this line if using open or WEP network:
138     status = WiFi.begin(ssid, pass);
139     if (status == WL_CONNECTED) break;
140     // retry after 1 second
141     delay(1000);
142   }
143
144
145   wifiClient.setRootCA((unsigned char*)rootCABuff);
146   wifiClient.setClientCertificate((unsigned char*)certificateBuff, (unsigned char*)privateKeyBuff);
147   client.setServer(mqttServer, 8884);
148   /*
149   wifiClient.setRootCA((unsigned char*)rootCABuff);
150   client.setServer(mqttServer, 8883);
151   /*
152   client.setCallback(callback);
153
154   // Allow the hardware to sort itself out
155   delay(1500);
156 }
157
158 void loop()
159 {
160   if (!client.connected()) {

```

## MQTT - Use Amazon AWS IoT Shadow Service

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

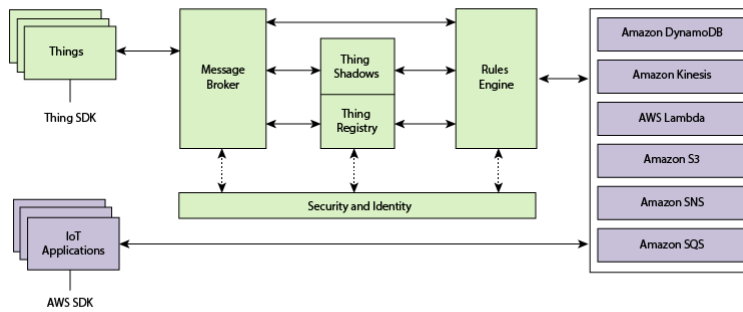
### Example

#### Introduction

Amazon AWS IoT is a cloud IoT service platform:

Amazon AWS IoT is a platform that enables you to connect devices to AWS Services and other devices, secure data and interactions, process and act upon device data, and enable applications to interact with devices even when they are offline. (<https://aws.amazon.com/iot/how-it-works/>)

The service architecture of AWS IoT:



(Picture from <http://docs.aws.amazon.com/iot/latest/developerguide/aws-iot-how-it-works.html> )

In the architecture, Ameba belongs to the upper-left “Things” block. A TLS secure channel will be established between “Things” and the MQTT Message Broker. Afterwards, “Things” and “Message Broker” communicate using MQTT Protocol via this secure channel. Behind the “Message Broker”, the “Thing Shadows” keeps messages temporarily when Ameba is offline, and sends the control message to Ameba next time it is connected. The “Rules Engine” allows you to place restrictions to the behavior of Things or to connect Things to other services of Amazon.

## AWS Management Console

First, create an account and sign up for AWS IoT [service:https://aws.amazon.com/](https://aws.amazon.com/)

Afterwards, log in to the Amazon Management Console and click “IoT Core” found under services -> Internet of Things.

Then you will enter the home page of AWS IoT. To offer the best service quality, Amazon offers servers in different regions for users to choose from.

Click the region dropdown menu at the upper-right:

Ameba Arduino: [RTL819] x AWS IoT x

Secure | https://us-east-2.console.aws.amazon.com/iot/home?region=us-east-2#/home

aws Services Resource Groups testteam Ohio Support

## AWS IoT

AWS IoT is a managed cloud platform that lets connected devices - cars, light bulbs, sensor grids, and more - easily and securely interact with cloud applications and other devices.

[Get started](#)

### Connect and manage your devices

Connect devices to the cloud using the protocol that best fits your requirements - HTTP, MQTT, or WebSocket. Devices can communicate with each other even if they are using different protocols.

[Learn more](#)

### Process and act upon device data

Filter, transform, and act upon data from devices on the fly, based on business rules. AWS IoT can be easily integrated with AWS services like Amazon DynamoDB, Amazon Kinesis, Amazon Machine Learning, and AWS Lambda.

[Learn more](#)

### Read and set device state at any time

AWS IoT stores the latest state of a device so that it can be read or set anytime, even when the device is offline.

[Learn more](#)

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Choose a nearby region.

**AWS IoT**

AWS IoT is a managed cloud platform that lets connected devices like light bulbs, sensor grids, and more - easily and securely interact with cloud applications and other devices.

[Get started](#)

**Connect and manage your devices**

Connect devices to the cloud using the protocol that best fits your requirements - HTTP, MQTT, or WebSocket. Devices can communicate with each other even if they are using different protocols.

[Learn more](#)

**Process and act upon device data**

Filter, transform, and act upon data from devices on the fly, based on business rules. AWS IoT can be easily integrated with AWS services like Amazon DynamoDB, Amazon Kinesis, Amazon Machine Learning, and AWS Lambda.

[Learn more](#)

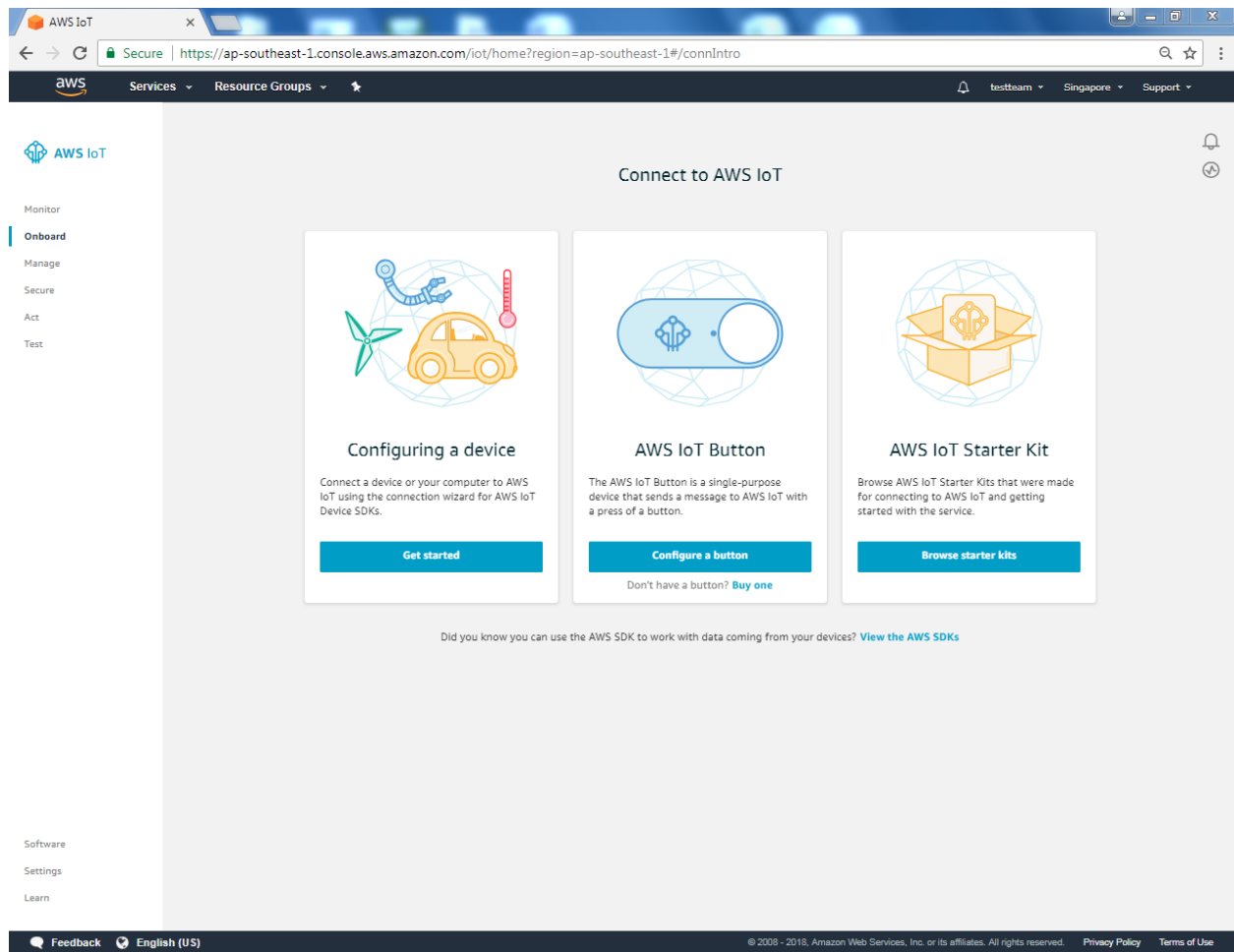
**Read and set device state at any time**

AWS IoT stores the latest state of a device so that it can be read or set anytime, even when the device is offline.

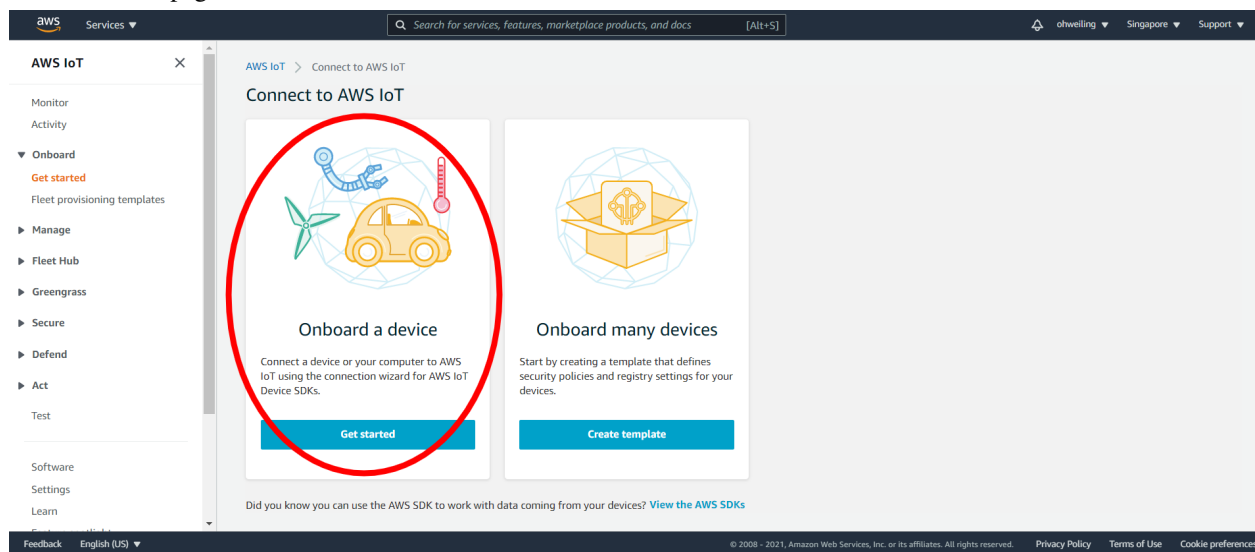
[Learn more](#)

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Then from Services, go to Onboard then Get Started.



Enter the main page of AWS IoT. Under the Onboard a device, click Get started.





## Click Create single thing

**Create things** [info](#)

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

**Number of things to create**

☒ **Create single thing**  
Create a thing resource to register a device. Provision the certificate and policy necessary to allow the device to connect to AWS IoT.

☐ **Create many things**  
Create a task that creates multiple thing resources to register devices and provision the resources those devices require to connect to AWS IoT.

[Cancel](#) [Next](#)

Fill in “ameba” on the name field. Attributes represent the status of Ameba.

**Specify thing properties** [info](#)

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

**Thing properties** [info](#)

**Thing name**

ameba

Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

**Additional configurations**  
You can use these configurations to add detail that can help you to organize, manage, and search your things.

- ▶ **Thing type - optional**
- ▶ **Searchable thing attributes - optional**
- ▶ **Thing groups - optional**
- ▶ **Billing group - optional**

Under the searchable thing attributes. The value of the attributes can be updated directly by Ameba or by the control side and control side can request Ameba to set the attribute to desired value.

Here we add an attribute named “led” with value “0” and click “Next” .

AWS Services

Search for services, features, marketplace products, and docs [Alt+S]

ohwelling Singapore Support

Step 2 - optional  
Configure device certificate

Step 3 - optional  
Attach policies to certificate

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

### Thing properties [Info](#)

**Thing name**

ameba

Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

### Additional configurations

You can use these configurations to add detail that can help you to organize, manage, and search your things.

▶ Thing type - optional

▼ Searchable thing attributes - optional

Add searchable attributes to allow your thing to be grouped and searched without using fleet indexing.

Searchable attribute	Value - optional	
led	0	Remove

[Add new attribute](#)

You can add up to 2 more attributes.

▶ Thing groups - optional

▶ Billing group - optional

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Click Skip creating a certificate at this time and then Create thing

AWS IoT > Manage > Things > Create things > Create single thing

Step 1  
Specify thing properties

Step 2 - optional  
Configure device certificate

### Configure device certificate - optional [Info](#)

A device requires a certificate to connect to AWS IoT. You can choose how you to register a certificate for your device now, or you can create and register a certificate for your device later. Your device won't be able to connect to AWS IoT until it has an active certificate with an appropriate policy.

#### Device certificate

☐ Auto-generate a new certificate (recommended)  
Generate a certificate, public key, and private key using AWS IoT's certificate authority.

☐ Use my certificate  
Use a certificate signed by your own certificate authority.

☐ Upload CSR  
Register your CA and use your own certificates on one or many devices.

☒ Skip creating a certificate at this time  
You can create a certificate for this thing and attach a policy to the certificate at a later time.

Cancel Previous **Create thing**

Feedback English (US)

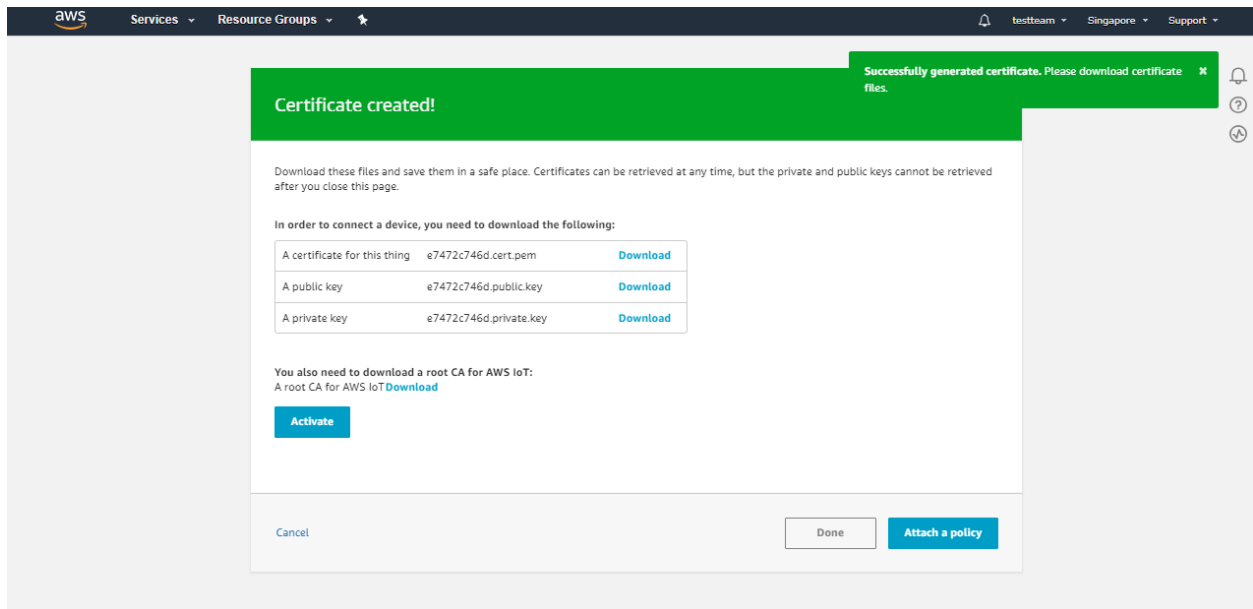
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Next, click Policy, and create a policy. Policy is used to restrict the functions that a “thing” can do, it can limit the MQTT actions or specific topic that can be performed. Learn more about policy:

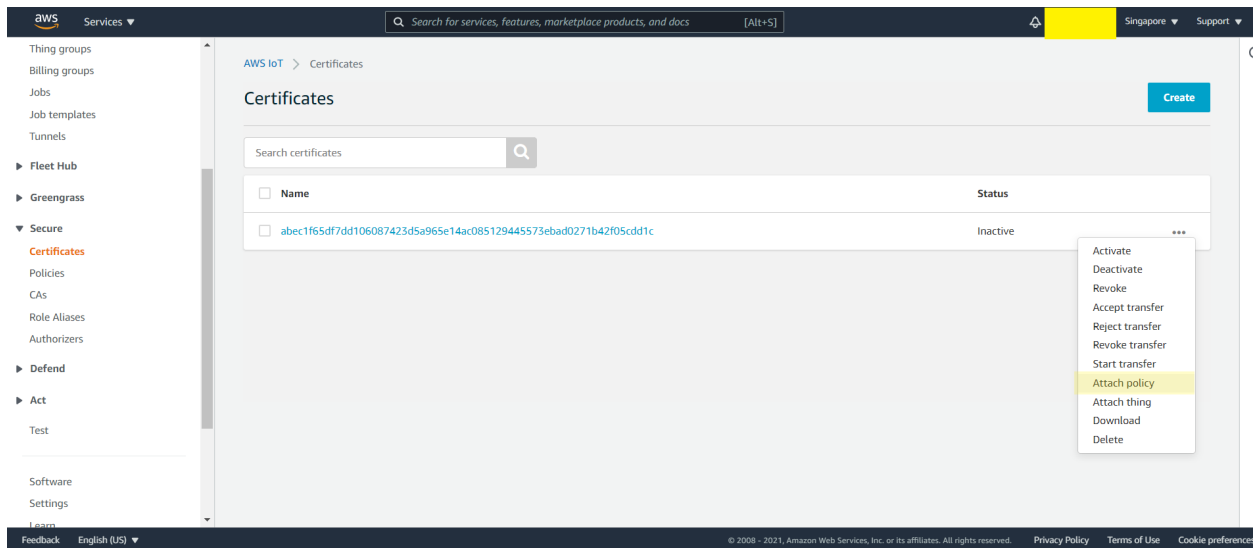
<http://docs.aws.amazon.com/iot/latest/developerguide/authorization.html>

Here we do not place policy on Ameba. Fill in “amebaPolicy” in the Name field, “iot:” in Action field and “\*” in resources field. Then “Allow”. Finally, click “Create”.

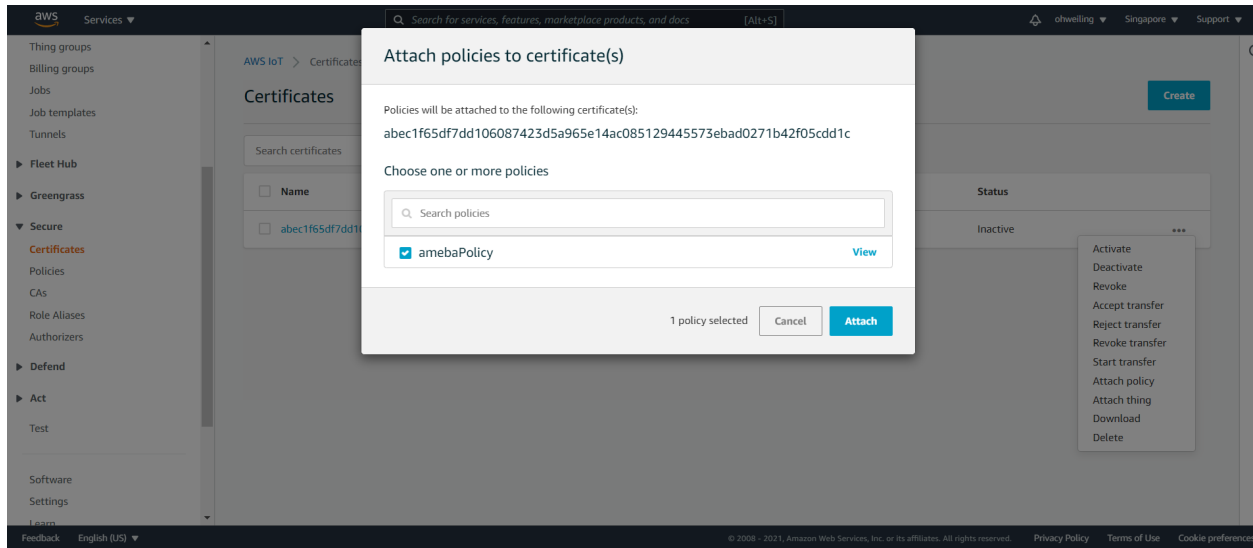




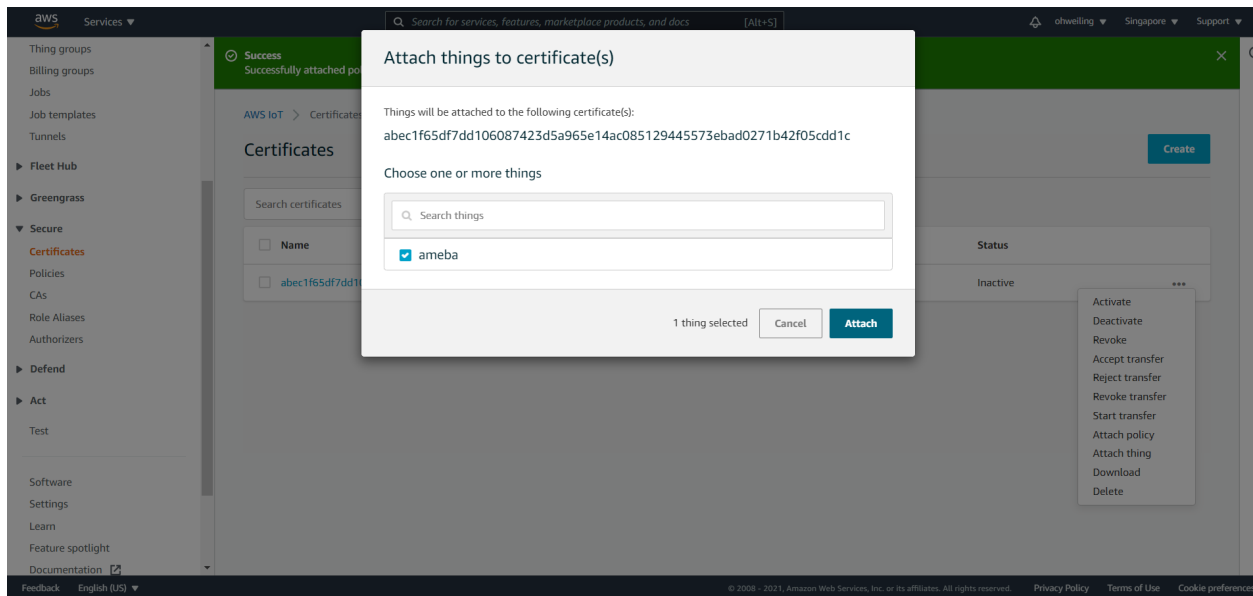
Click Attach a policy in the Actions dropdown menu.



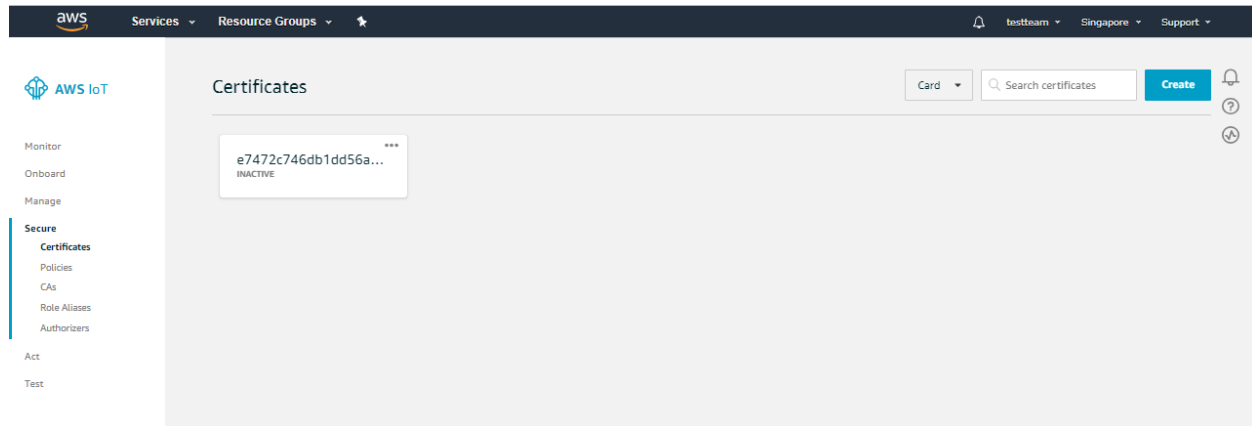
Choose amebaPolicy and click attach.



Then go back to the “Actions” drop-down menu at the top right of the certificates homepage, click on “Attach thing” , select the thing “ameba” you just created when the window below appears, then click on “Attach”

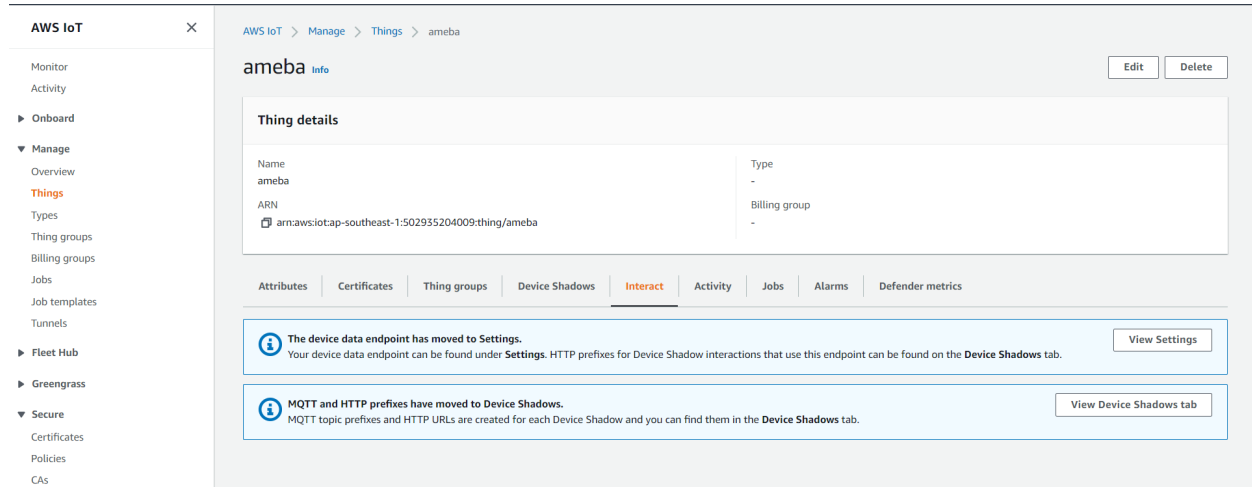


Go back to certificate main page and click Certificate and click Activate in the Actions drop down menu.



Next, click Manage, and click Things, then click “ameba” the thing we created just now.

Click on Interact and View settings.



Find out the information of Rest API Endpoint to set Amazon Alexa:

- REST API endpoint: In the value “<https://a1a7004baosgyy.iot.us-east-1.amazonaws.com/things/ameba/shadow>”, the part “a1a7004baosgyy.iot.us-east-1.amazonaws.com” is the MQTT Broker server address.
- MQTT topic: The value “\$aws/things/ameba/shadow/update” represents the MQTT topic we will use in the AWS IoT Shadow service (if we use MQTT only, without AWS IoT Shadow service, then we can specify other topic name). It is recommended to use “\$aws/things/ameba/shadow/update” here.

## Ameba setting

Open “File” -> “Examples” -> “AmebaMQTTClient” -> “Amazon\_AWS\_IoT\_Basic”

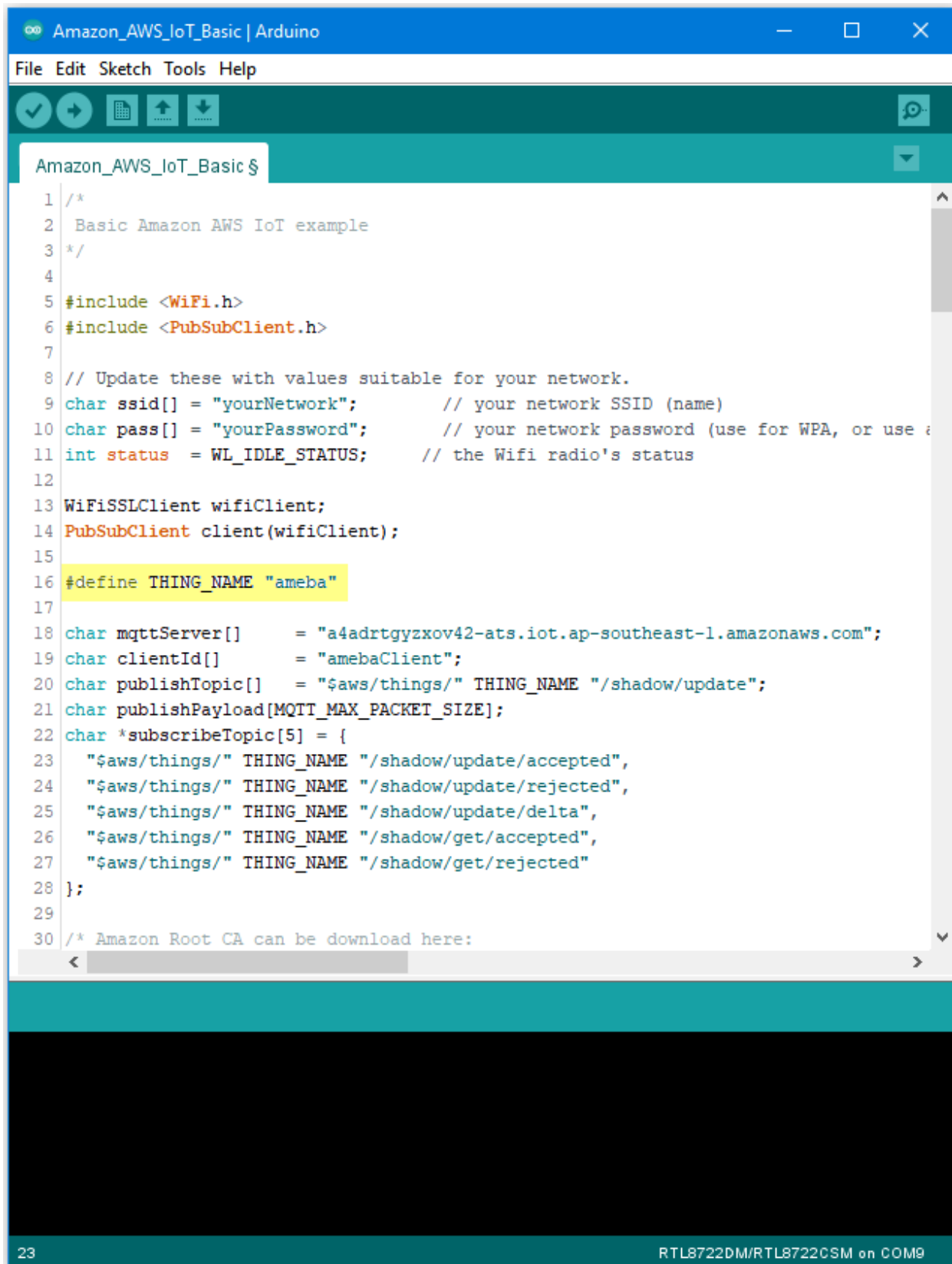
In the sample code, modify the highlighted snippet to reflect your WiFi network settings.

```

1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork"; // your network SSID (name)
10 char pass[] = "yourPassword"; // your network password (use for WPA, or use e
11 int status = WL_IDLE_STATUS; // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

```

Then fill in the “thing” name “ameba” .



```

1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork";      // your network SSID (name)
10 char pass[] = "yourPassword";     // your network password (use for WPA, or use a
11 int status = WL_IDLE_STATUS;      // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

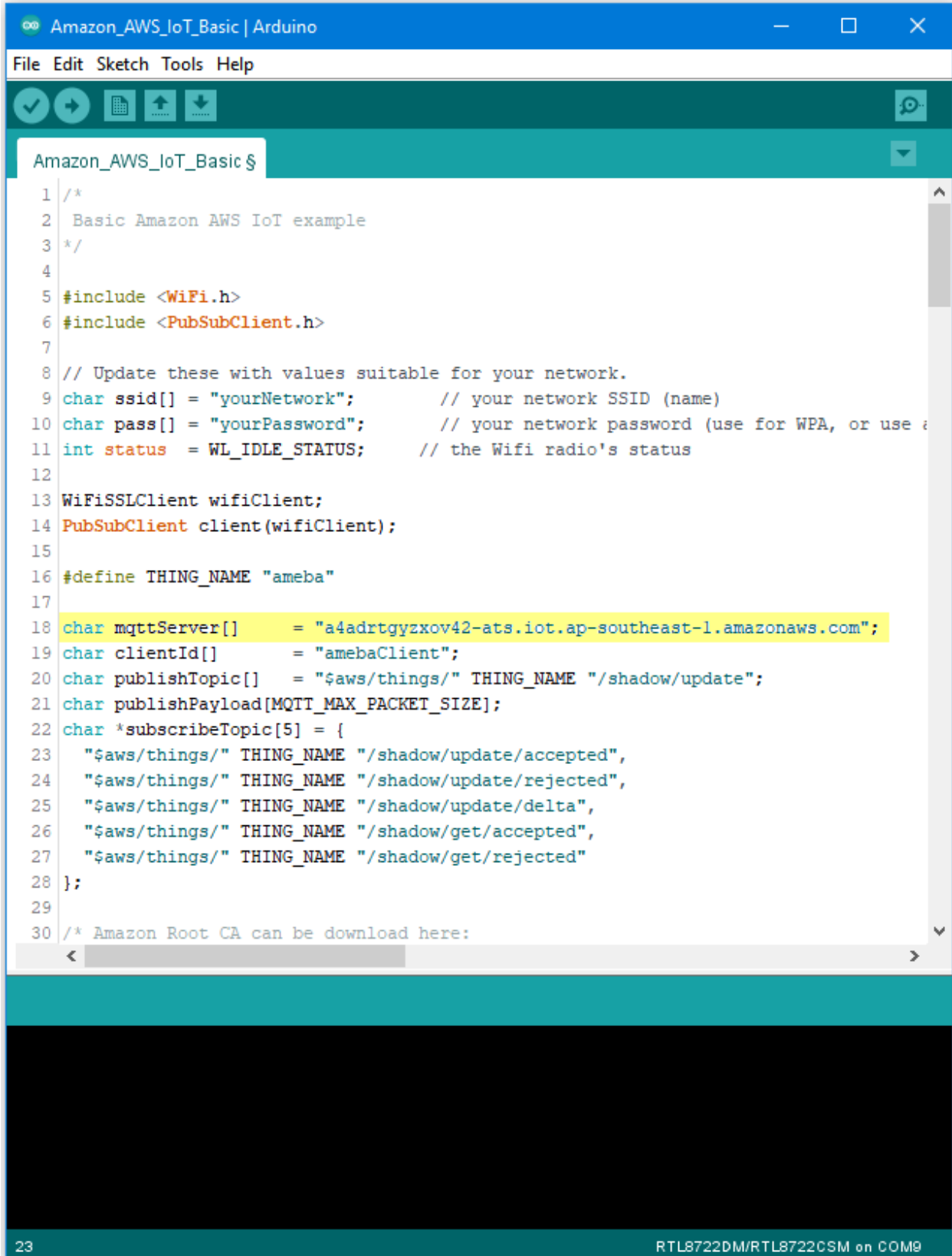
```

23

RTL8722DM/RTL8722C5M on COM9



And the MQTT Broker server address we found earlier in AWS IoT.



```

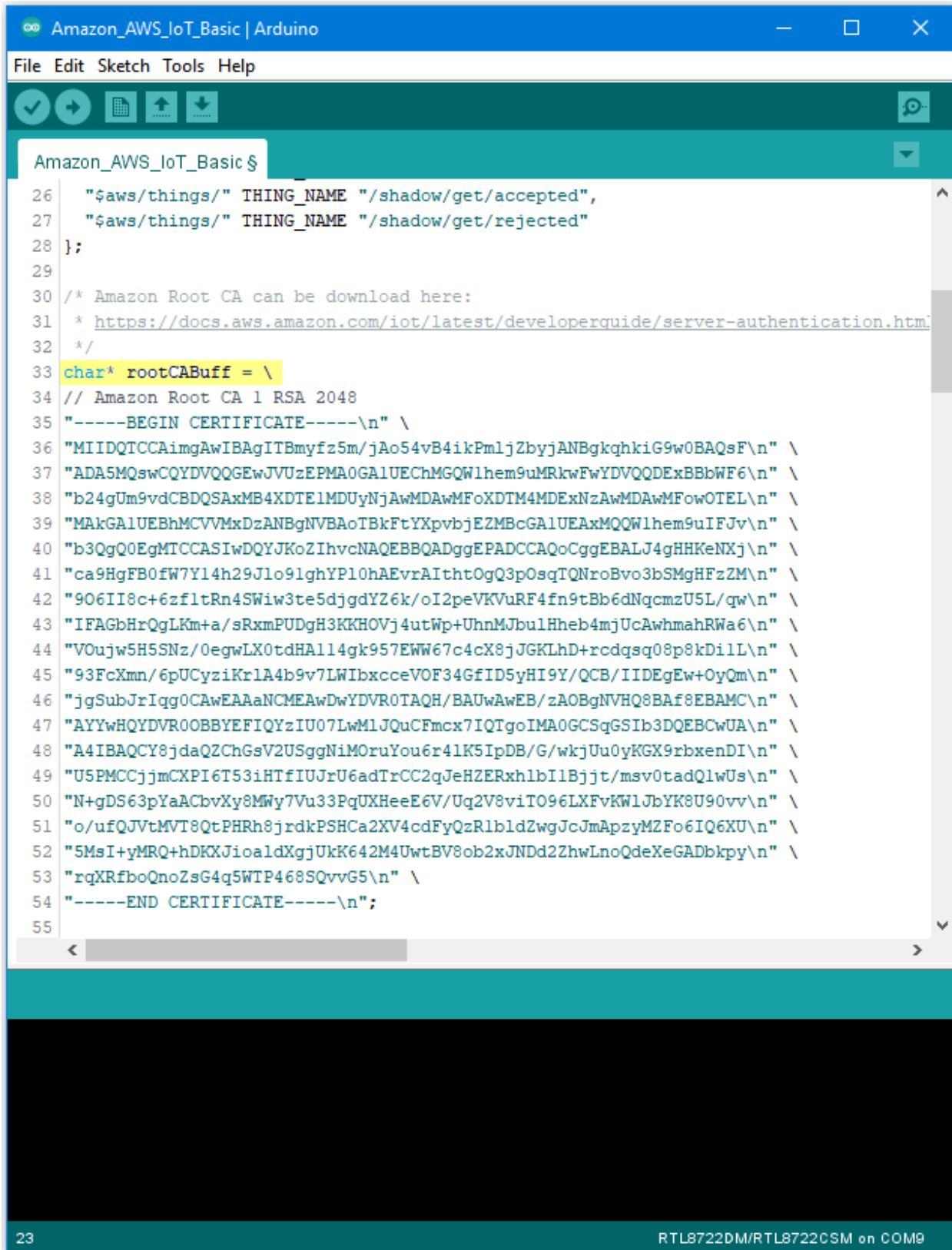
1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork";      // your network SSID (name)
10 char pass[] = "yourPassword";     // your network password (use for WPA, or use a
11 int status = WL_IDLE_STATUS;      // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
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20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

```

23

RTL8722DM/RTL8722C5M on COM9

Next, fill in the root CA used in TLS. Download and make sure the downloaded root CA contents conforms to the root CA used in the sketch.



```

Amazon_AWS_IoT_Basic | Arduino
File Edit Sketch Tools Help

Amazon_AWS_IoT_Basic $
26  "$aws/things/" THING_NAME "/shadow/get/accepted",
27  "$aws/things/" THING_NAME "/shadow/get/rejected"
28  };
29
30  /* Amazon Root CA can be download here:
31   * https://docs.aws.amazon.com/iot/latest/developerguide/server-authentication.htm
32   */
33  char* rootCABuff = \
34  // Amazon Root CA 1 RSA 2048
35  "-----BEGIN CERTIFICATE-----\n" \
36  "MIIDQTCCAimgAwIBAgITBmyfz5m/jAo54vB4ikPmljZbyjANBgkqhkiG9w0BAQsF\n" \
37  "ADA5MQswCQYDVQQGEwJVUzEPMA0GA1UEChMGMGQwLhem9uMRkwFwYDVQQDExBBbWF6\n" \
38  "b24gUm9vdCBDQSAxMB4XDTE1MDUyNjAwMDAwMFoXDTE1MDUyNjAwMDAwMFowOTEL\n" \
39  "MAkGA1UEBhMCVVMxMC4zANBgNVBAoTBkFtYXNjaWZlbnRlbnRlbnRlbnRlbnRlbnRl\n" \
40  "b3QgQ0EgMTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALJ4gHHKeNXj\n" \
41  "ca9HgFB0fW7Y14h29Jlo9lghYP10hAEvrAithtOgQ3pOsqTQNroBvo3bSMgHFzZM\n" \
42  "906II8c+6zfltRn4SWiw3te5djgdYZ6k/oI2peVKVuRF4fn9tBb6dNqcmzU5L/qw\n" \
43  "IFAGbHrQgLKm+a/sRxmPUDgH3KKHOVj4utWp+UhnMJbulHheb4mjUcAwhmahRWa6\n" \
44  "VOujw5H5SNz/0egwLX0tdHA114gk957EWW67c4cX8jJGKLhD+rcdqsq08p8kDilL\n" \
45  "93FcXmn/6pUCyziKrlA4b9v7LWIbxcceVOF34GfID5yHI9Y/QCB/IIDEgEw+OyQm\n" \
46  "jgSubJrIqq0CAwEAaNCMEAwDwYDVR0TAQH/BAUwAwEB/zAOBgNVHQ8BAf8EBAMC\n" \
47  "AYYwHQYDVR0OBBYEFIQYzIU07LwMlJQuCFmcx7IQTgoIMA0GCSqGSIb3DQEBCwUA\n" \
48  "A4IBAQCjY8jdaQZChGsV2USggNiMOruYou6r4lK5IpDB/G/wkjUu0yKGX9rbxenDI\n" \
49  "U5PMCCjjmCXPI6T53iHTfIUJrU6adTrCC2qJeH2ERxhlb1lBjtt/msv0tadQ1wUs\n" \
50  "N+gDS63pYaACbvXy8MWy7Vu33PqUXHeeE6V/Uq2V8viT096LXFvKW1JbYK8U90vv\n" \
51  "o/ufQJVtMVT8QtPHRh8jrdkPSHCa2XV4cdFyQzR1bldZwgJcJmApzyMZFo6IQ6XU\n" \
52  "5MsI+yMRQ+hDKXJioaldXgjUkK642M4UwtBV8ob2xJNDd2ZhwLnoQdeXeGADbkpy\n" \
53  "rqXRfboQnoZsG4q5WTP468SQvvG5\n" \
54  "-----END CERTIFICATE-----\n";
55

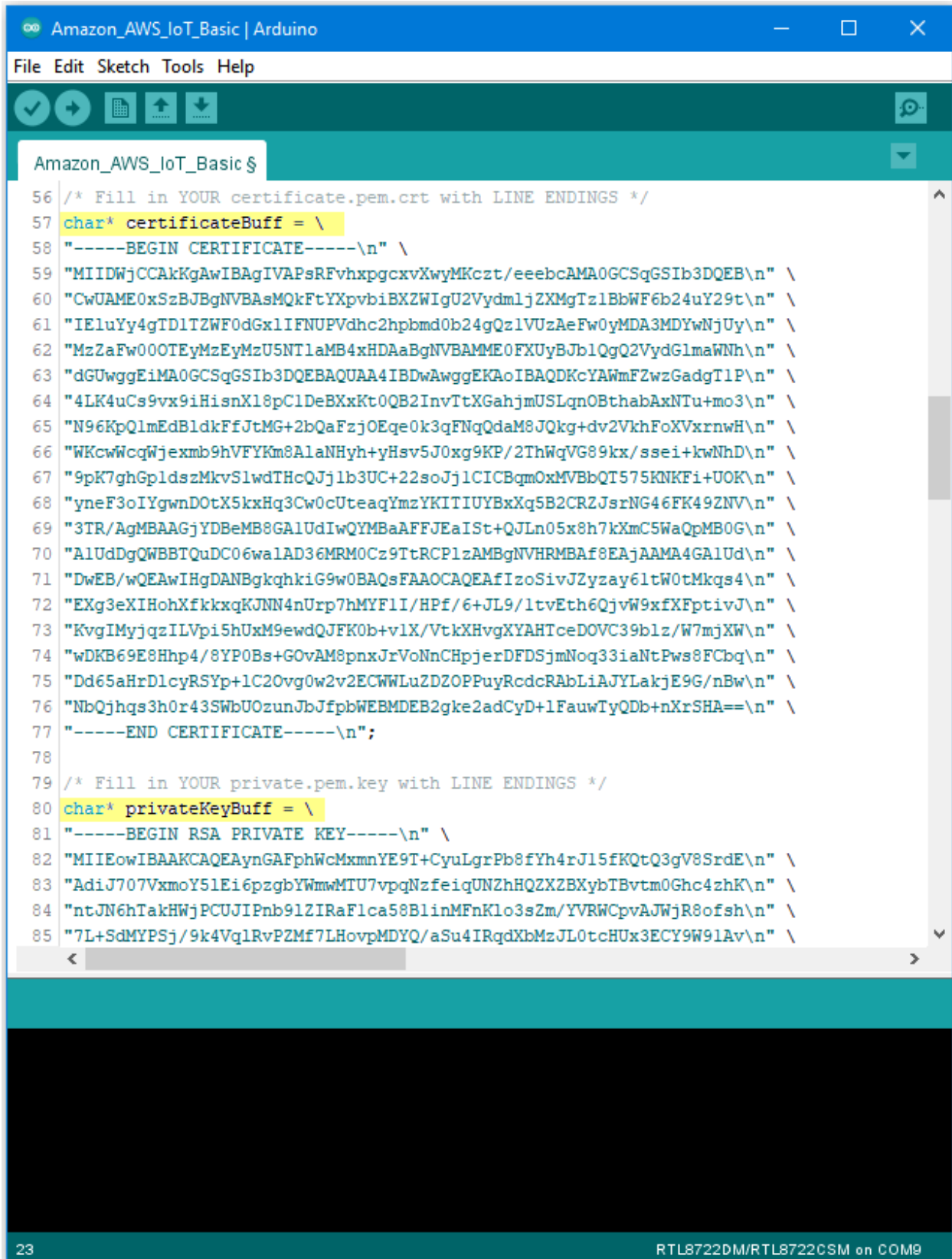
```

23 RTL8722DM/RTL8722CSM on COM9

Next, fill in the certificate we created in the AWS IoT Console (i.e., client certificate), usually its file name ends with “-certificate.pem.crt” (e.g., “efae24a533-certificate.pem.crt” ). Open the certificate with a text editor, and adjust its format as follows to use in the sketch:

- Add the new line character “\n” at the end of each line.
- Add double-quote at the beginning and the end of each line.
- To concatenate each line as a string, add “” at the end of each line.
- The last line ends with semicolon.

Adjust the format of the private key in the same way and add it to privateKeyBuff.



```

Amazon_AWS_IoT_Basic $
56 /* Fill in YOUR certificate.pem.crt with LINE ENDINGS */
57 char* certificateBuff = \
58 "-----BEGIN CERTIFICATE-----\n" \
59 "MIIDWjCCAKKgAwIBAgIVAPsRFvnxpgcxvXwyMKczt/eeebcAMA0GCSqGSIb3DQEBA\n" \
60 "CwUAME0xSzBjBjBjNVBAsMQkFtYXpviBXZWIGU2VydmljZXMgTz1BbWF6b24uY29t\n" \
61 "IEluYy4gTD1TZWF0dGx1IFNUPVdhc2hpbmd0b24gQz1VUzAeFw0yMDA3MDYwNjUy\n" \
62 "MzZaFw00OTYyMzYyMzU5NTlaMB4xHDAaBgNVBAMME0FXUyBjblQgQ2VydGlmaw\n" \
63 "dGUwgGSIb3DQEBAQUAA4IBDwAwggEKAoIBAQDKcYAWmFZwzGadgT1P\n" \
64 "4LK4uCs9vx9iHisnXl8pC1DeBXxKt0QB2InvTtXGahjmUSLqnOBthabAxNTu+mo3\n" \
65 "N96KpQlmedBldkFfJtMG+2bQaFzjOEge0k3qFNqQdaM8JQkg+dv2VkhFoXVxrnwH\n" \
66 "WKcwWcqWjexmb9hVFYKm8AlaNHyh+yHsv5J0xg9KP/2ThWqVG89kx/ssei+kwN\n" \
67 "9pK7ghGpldszKmkvSlwdTHcQJj1b3UC+22soJj1CICBqmOxMVBbQT575KNKFi+U\n" \
68 "yneF3oIYgwnDotX5kxHq3Cw0cUteaYmzYKITIUYBxXq5B2CRZJsrNG46FK492NV\n" \
69 "3TR/AgMBAAGjYDBeMB8GA1UdIwQYMBaAFFJEaISt+QJLn05x8h7kXmC5WaQpMB0G\n" \
70 "AlUdDgQWBBTQuDC06walAD36MRM0Cz9TtRCPlzAMBgNVHRMBAf8EAjAAMA4GA1Ud\n" \
71 "DwEB/wQEAwIHgDANBgkqhkiG9w0BAQsFAAOCAQEAfIzoSivJZyay6ltW0tMkqs4\n" \
72 "EXg3eXIhohXfkkxqKJNN4nUrp7hMYfII/HPf/6+JL9/ltvEth6QjvW9xfXFptivJ\n" \
73 "KvgIMyjqzILVpi5hUxM9ewdQJFK0b+v1X/VtkXHvgXYAHTceDOVC39blz/W7mjXW\n" \
74 "wDKB69E8Hhp4/8YP0Bs+GOvAM8pnxJrVoNnCHpjerDFDSjmNoq33iaNtPws8FCbq\n" \
75 "Dd65aHrDlcyRSYp+lC2Ovg0w2v2ECWWLuZDZOPPuyRcdcrAbLiAJYLakjE9G/nBw\n" \
76 "NbQjhqs3h0r43SWbU0zunJbJfpbWEBMDEB2gke2adCyD+lFauwTyQDb+nXrSHA==\n" \
77 "-----END CERTIFICATE-----\n";
78
79 /* Fill in YOUR private.pem.key with LINE ENDINGS */
80 char* privateKeyBuff = \
81 "-----BEGIN RSA PRIVATE KEY-----\n" \
82 "MIIEowIBAAKCAQEAynGAFphWcMxmnyE9T+CyuLgrPb8fYh4rJl5fKQtQ3gV8SrdE\n" \
83 "AdiJ707VxmoY51Ei6pzgbYWmwMTU7vpqNzfeiqUNZhHQ2XZBXybTBvtm0Ghc4zhK\n" \
84 "ntJN6hTakHWjPCUJIPnb9lZIRaFlca58BlinMFnKlo3sZm/YVRWCpvAJWjR8ofsh\n" \
85 "7L+SdMYPSj/9k4VqlRvPZMf7LHovpMDYQ/aSu4IRqdXbMzJL0tcHUx3ECY9W91Av\n"

```

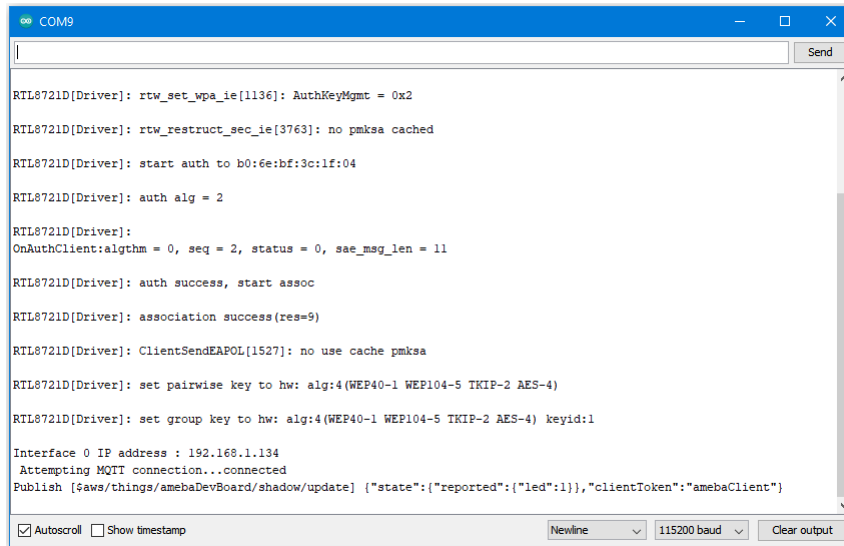
23

RTL8722DM/RTL8722CSM on COM9

## Compile and run

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in the Arduino IDE and observe as Ameba connects to the AWS IoT server and sends updates on the LED state variable.



```

RTL8721D[Driver]: rtw_set_wpa_ie[1136]: AuthKeyMgmt = 0x2
RTL8721D[Driver]: rtw_restruct_sec_ie[3763]: no pmksa cached
RTL8721D[Driver]: start auth to b0:6e:bf:3c:1f:04
RTL8721D[Driver]: auth alg = 2
RTL8721D[Driver]:
OnAuthClient:alghm = 0, seq = 2, status = 0, sae_msg_len = 11
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=9)
RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1
Interface 0 IP address : 192.168.1.134
Attempting MQTT connection...connected
Publish [aws/things/amebaDevBoard/shadow/update] {"state":{"reported":{"led":1}}, "clientToken":"amebaClient"}

```

## Alternatives

Ameba can also retrieve the current LED status variable from the AWS shadow. This is done by sending a message to the “shadow/get” topic. Refer to the Amazon\_AWS\_IoT\_with\_ACK example code for more information.

## Code Reference

Change led state:

In this example, we use GPIO interface to control the led. We set led\_pin to 10 and led\_state to 1 by default in the sample code.

```
pinMode(led_pin, OUTPUT);
digitalWrite(led_pin, led_state);
```

Set up certificate:

Note that we use the WiFiSSLClient type of wifiClient.

```
WiFiSSLClient wifiClient;
```

WiFiSSLClient inherits Client, so it can be passed as the parameter of PubSubClient constructor.

Next, set up TLS certificate required in connection.

```
wifiClient.setRootCA((unsigned char*)rootCABuff);
wifiClient.setClientCertificate((unsigned char*)certificateBuff, (unsigned_
↳char*)privateKeyBuff);
```

Configure MQTT Broker server

Then MQTT PubClient set MQTT Broker server to connect

```
client.setServer(mqttServer, 8883);
client.setCallback(callback);
```

Connect to MQTT Broker server:

In loop(), call reconnect() function and try to connect to MQTT Broker server and do the certificate verification.

```
while (!client.connected()) {
```

Subscribe & Publish

Next, subscribe to topics.

```
for (int i=0; i<5; i++) {
    client.subscribe(subscribeTopic[i]);
}
```

There are some common topics:

“\$aws/things/ameba/shadow/update/accepted” ,

“\$aws/things/ameba/shadow/update/rejected” ,

“\$aws/things/ameba/shadow/update/delta” ,  
“\$aws/things/ameba/shadow/get/accepted” ,  
“\$aws/things/ameba/shadow/get/rejected”

Related documentation:

<http://docs.aws.amazon.com/iot/latest/developerguide/thing-shadow-data-flow.html>

Then publish current status::

```
sprintf(publishPayload,
"\state\":{\"reported\":{\"led\":%d}},\clientToken\":\"%s\"}",
led_state, clientId);
```

```
client.publish(publishTopic, publishPayload);
```

Listen to topic and make response:

In the callback function, we listen to the 5 subscribed topics and check if there are messages of “/shadow/get/accepted” :

```
if (strstr(topic, "/shadow/get/accepted") != NULL) {
```

If there is, the message is from the control side. If the attribute state in the message is different from current state, publish the new state.

```
updateLedState(desired_led_state);
```

## MQTT - Use Google Cloud IoT

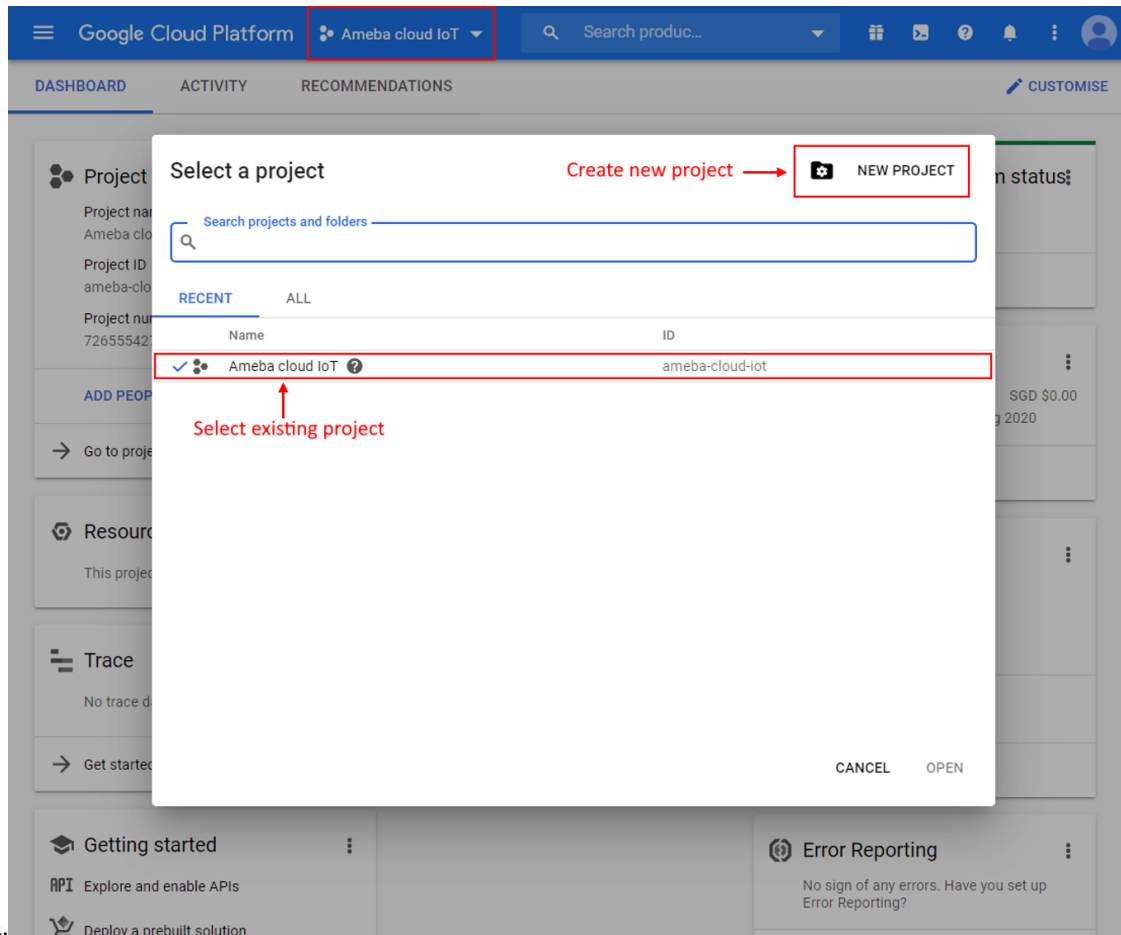
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Google Cloud IoT Configuration

1. Select or create a Cloud Platform project In the Google Cloud Console, select an existing project or create a new project. You will need a **Project ID** to use with





Ameba.

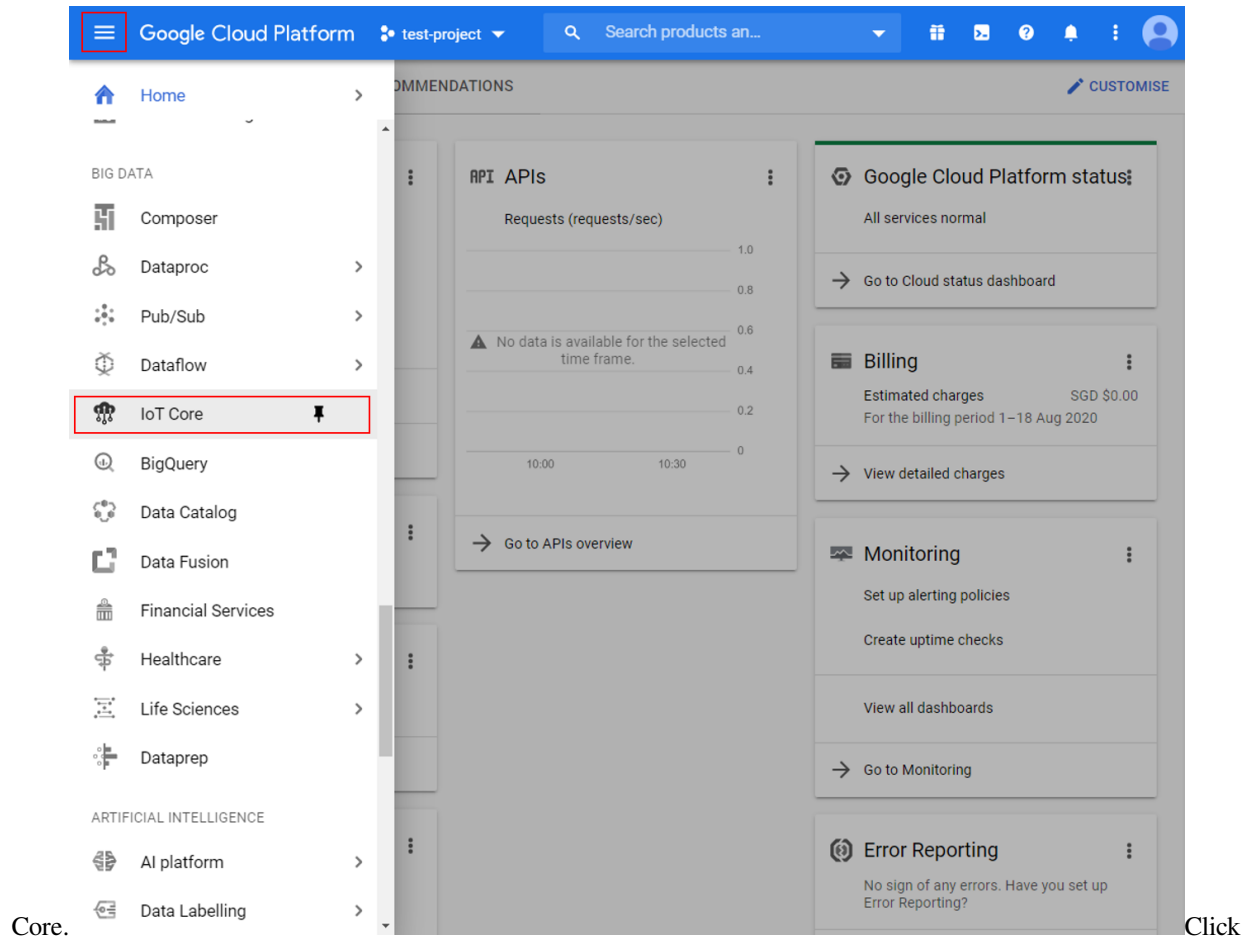
If

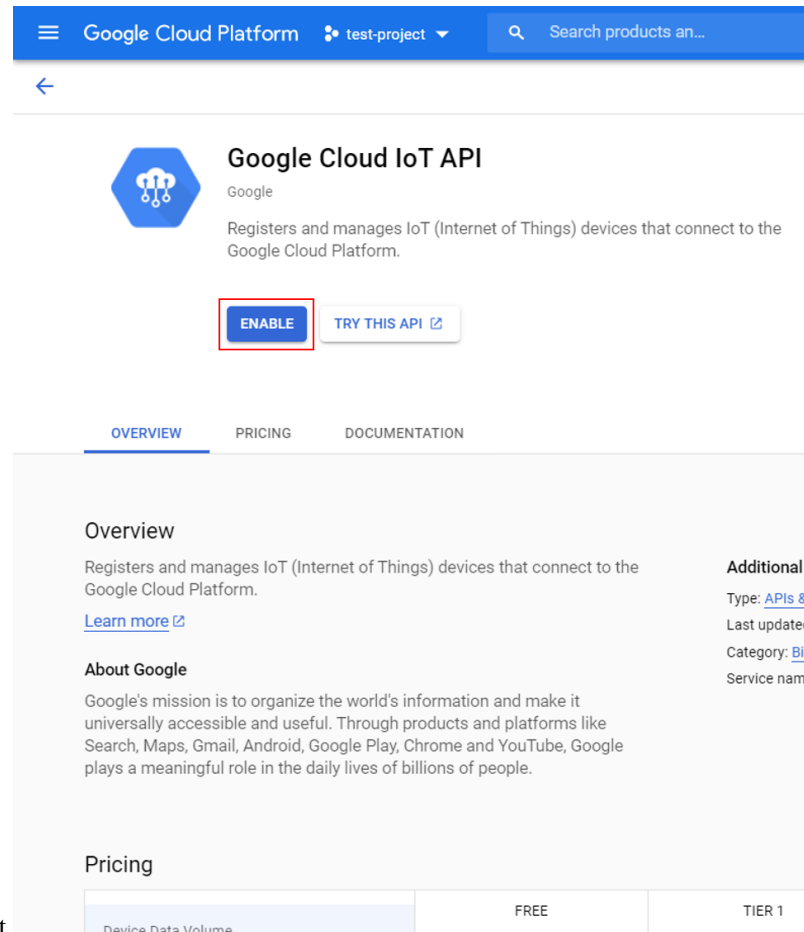
creating a new project, enter a project name, and take note of the **Project ID** generated.

The screenshot shows the 'New Project' form in the Google Cloud Platform console. The form includes a warning about project quotas, a 'Project name' field with the value 'test-project', a 'Project ID' field with the value 'test-project-286902', and a 'Location' field with the value 'No organisation'. The 'CREATE' button is highlighted.

2.

Enable billing for your project Billing needs to be enabled for your project to use Google Cloud Platform features. Follow the guide in Google cloud documentation to enable billing. <https://cloud.google.com/billing/docs/how-to/modify-project> 3. Enable the Cloud IoT Core API In Google Cloud console, click on the top left menu button and search for IoT





Google Cloud Platform test-project Search products an...

Google Cloud IoT API

Google

Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.

**ENABLE** TRY THIS API

OVERVIEW PRICING DOCUMENTATION

**Overview**

Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.

[Learn more](#)

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Google's mission is to organize the world's information and make it universally accessible and useful. Through products and platforms like Search, Maps, Gmail, Android, Google Play, Chrome and YouTube, Google plays a meaningful role in the daily lives of billions of people.

**Pricing**

Device Data Volume	FREE	TIER 1

**Additional**

Type: [APIs & Services](#)

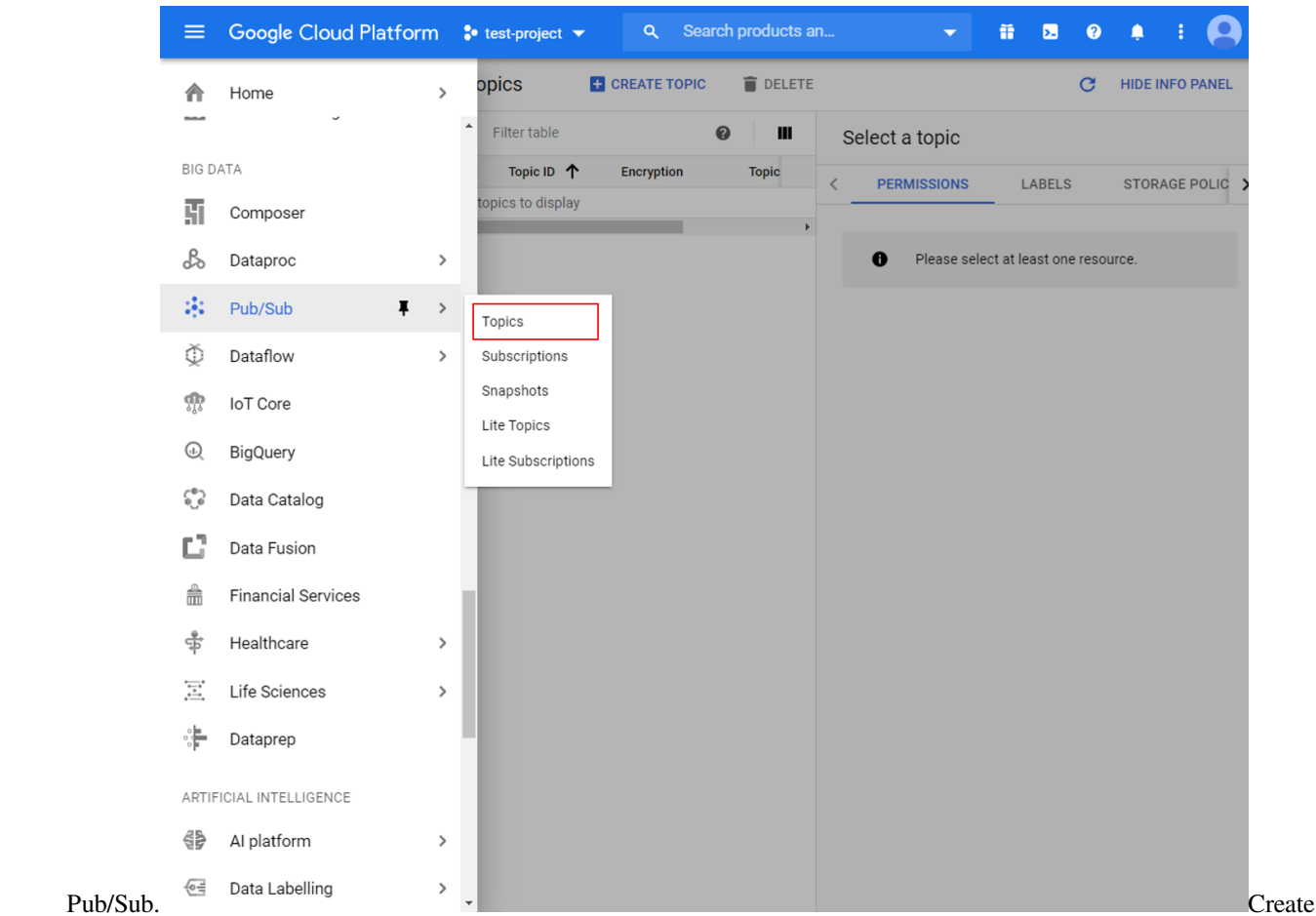
Last updated: [2020-08-10](#)

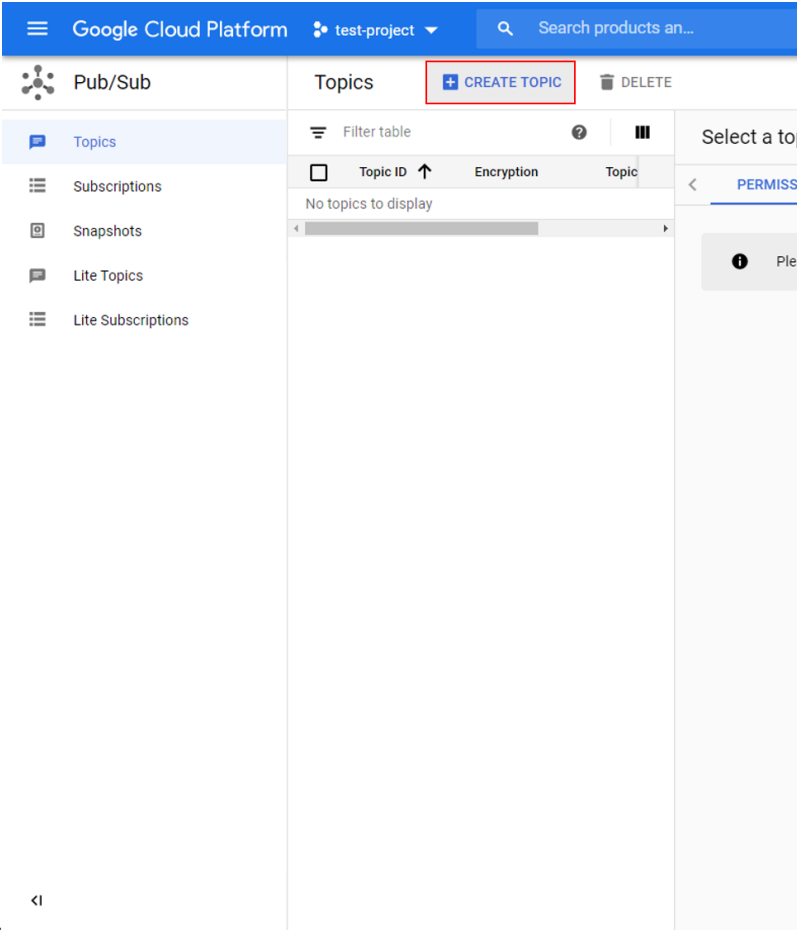
Category: [APIs & Services](#)

Service name: [google-cloud-iot](#)

enable to activate Google Cloud IoT API for your project.

Create a Cloud Pub/Sub topic In Google Cloud console, click on the top left menu button and search for





a new topic for your project and give it a suitable topic ID.  
the topic is created, go to the permissions tab of the info panel, and add “cloud-iot@system.gserviceaccount.com” with the role of “Pub/Sub Publisher” .

Google Cloud Platform

test-project

Search products and resources

Pub/Sub

Topics

CREATE TOPIC

DELETE

SHOW INFO PANEL

Filter table

Topic ID	Encryption	Topic name	Labels
<input checked="" type="checkbox"/> test-topic	Google-managed	projects/test-project-286902/topics/test-topic	—

Google Cloud Platform

Pub/Sub

Topics

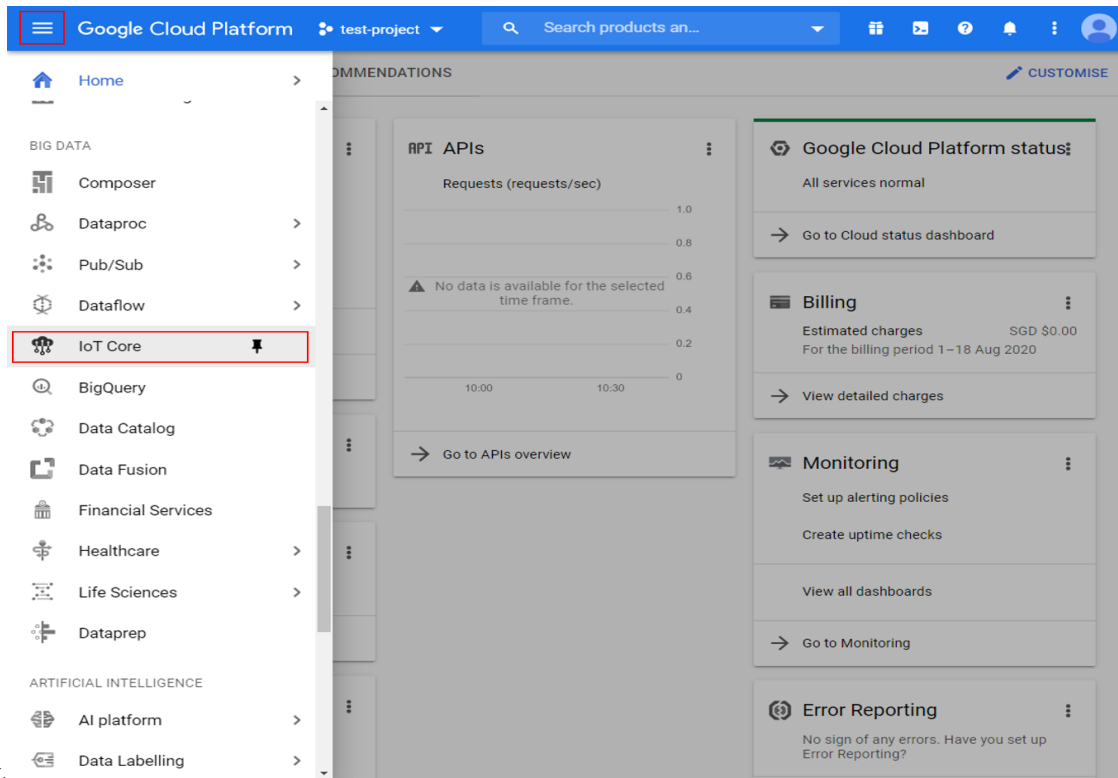
Subscriptions

Snapshots

Lite Topics

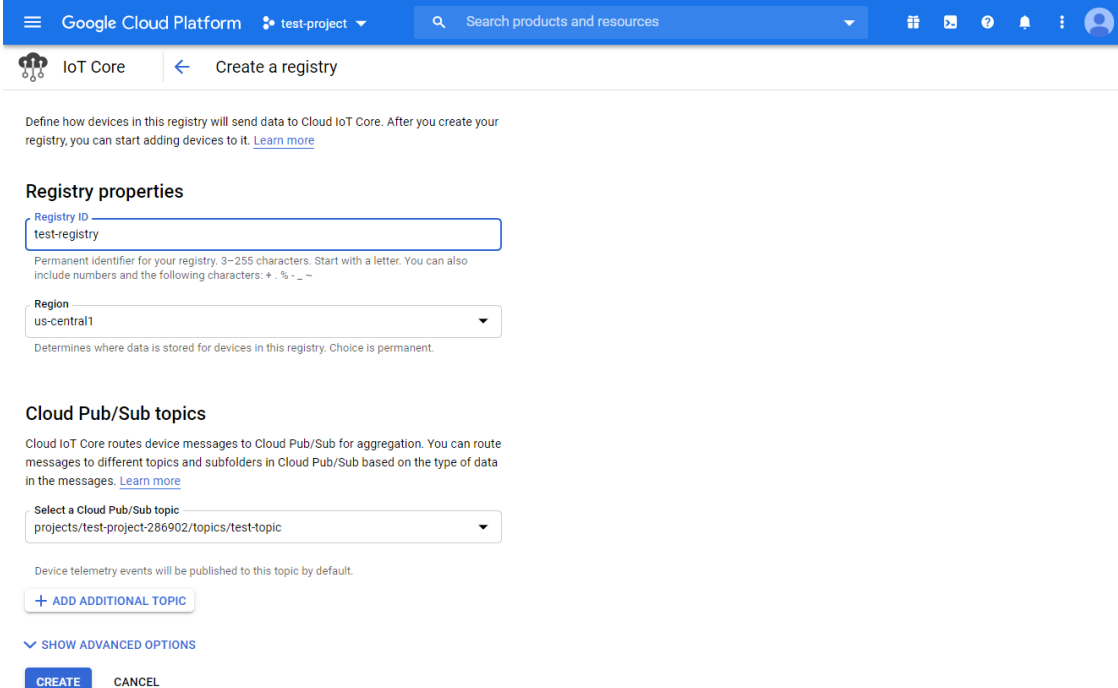
Lite Subscriptions

a device registry Go back to the IoT Core settings page and create a new reg-



istry.

a suitable **Registry ID** and in which to store data. Remember the **\*\*Registry ID** and **Region** for use with Ameba later. For the Pub/Sub topic, select the topic created in the previous

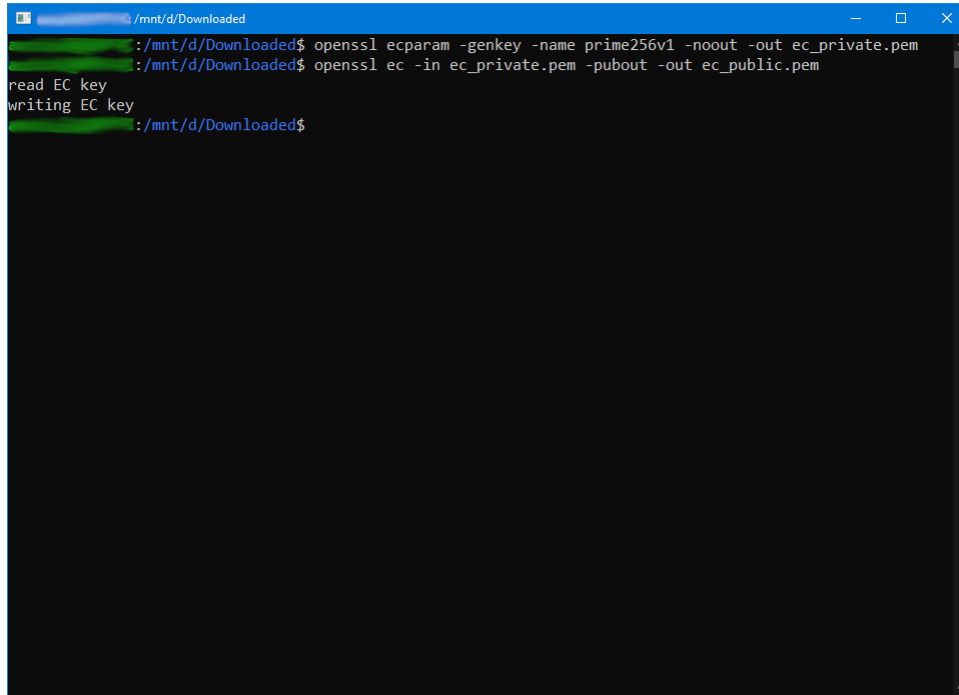


step. 6.

Create a public/private key pair Using Openssl in a terminal in Windows/Linux/MacOs, run the following commands to generate a private and public key pair. Two files will be created by these commands,

“ec\_private.pem” containing the private key, and “ec\_public.pem” containing the public key.

```
$ openssl ecparam -genkey -name prime256v1 -noout -out ec_private.pem
$ openssl ec -in ec_private.pem -pubout -out ec_public.pem
```

A screenshot of a terminal window with a blue title bar. The terminal shows the execution of two OpenSSL commands. The first command generates a private key, and the second command generates a public key from the private key. The output of the second command shows the public key being written to a file. The terminal prompt is `:/mnt/d/Downloaded$`.

```
:/mnt/d/Downloaded$ openssl ecparam -genkey -name prime256v1 -noout -out ec_private.pem
:/mnt/d/Downloaded$ openssl ec -in ec_private.pem -pubout -out ec_public.pem
read EC key
writing EC key
:/mnt/d/Downloaded$
```

Run the next command to extract out the private key, and remember the highlighted string of hexadecimal numbers for use with Ameba later.

```
$ openssl ec -in ec_private.pem -noout -text
```

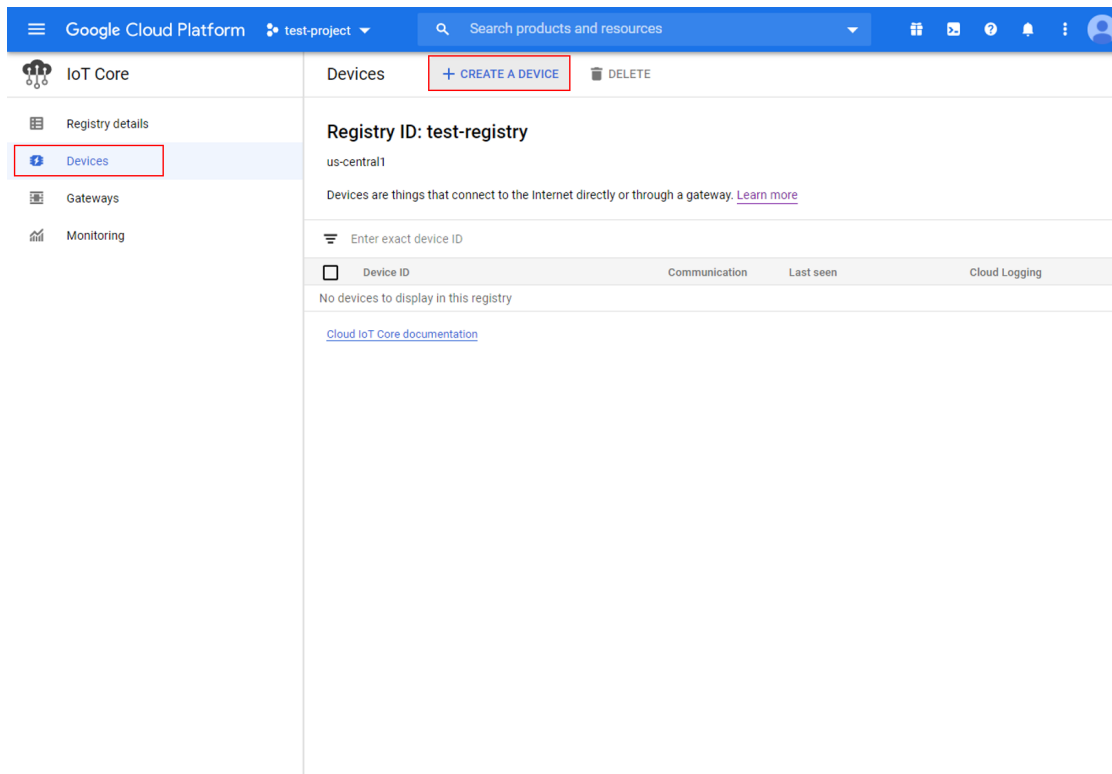


```

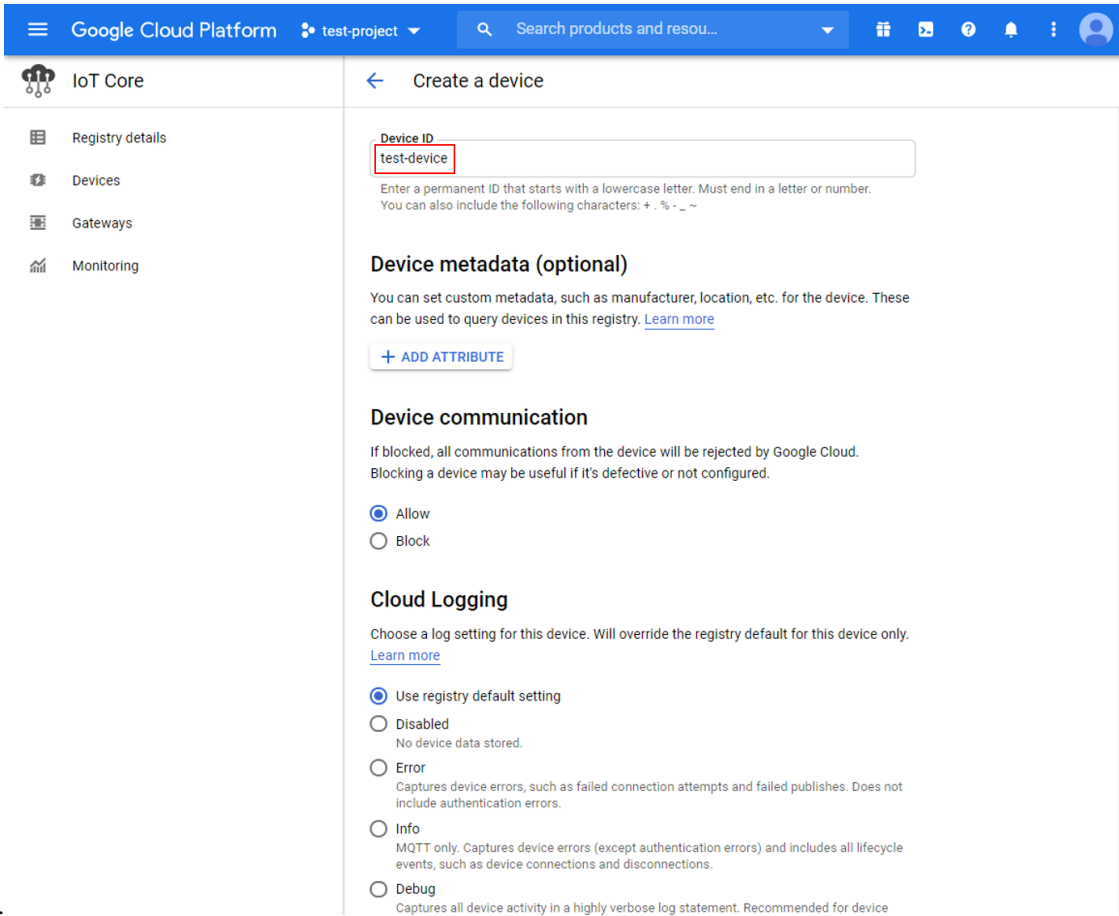
/mnt/d/Downloaded$ openssl ec -in ec_private.pem -noout -text
read EC key
Private-Key: (256 bit)
priv:
    f9:93:86:98:66:b0:f0:34:79:c5:fe:c9:82:50:0d:
    76:f2:ad:c6:2e:23:b9:af:02:c0:1c:d4:11:65:81:
    0a:fb
pub:
    04:29:8f:09:db:9c:d6:e2:b2:05:b8:11:c0:b5:f7:
    90:2a:7c:42:42:3e:db:ec:2d:05:88:b3:8b:14:09:
    9e:de:2d:ec:1b:da:7f:ae:6a:8d:31:55:e1:22:0c:
    d8:94:63:a2:4a:79:09:6f:57:68:76:61:72:9e:e3:
    22:23:93:fd:a6
ASN1 OID: prime256v1
NIST CURVE: P-256
/mnt/d/Downloaded$

```

7. Create a device Go back to the IoT Core settings page and create a new device.



Give the device a suitable **Device ID** and remember it for use with Ameba



later. In the authentication section of the additional options, upload the previously generated “ec\_public.pem” public

Google Cloud Platform test-project Search products and resou...

IoT Core

- Registry details
- Devices
- Gateways
- Monitoring

Create a device

No device data stored.

☐ Error  
Captures device errors, such as failed connection attempts and failed publishes. Does not include authentication errors.

☐ Info  
MQTT only. Captures device errors (except authentication errors) and includes all lifecycle events, such as device connections and disconnections.

☐ Debug  
Captures all device activity in a highly verbose log statement. Recommended for device troubleshooting.

**Authentication (optional)**

Specify the public key that will be used to authenticate this device. You can leave the key empty, but devices will not be able to connect to Google Cloud without a key. [Learn more](#)

**Input method**

☐ Enter manually

☒ Upload

Public key format  
ES256

Public key value  
ec\_public.pem  [BROWSE](#)

File content must be in PEM format

Public key expiry date (optional)

☐ Expires on:

Date HKT

^ COMMUNICATION, CLOUD LOGGING, AUTHENTICATION

key.

8.

Create a Cloud Pub/Sub subscription To observe messages sent by Ameba, create a subscription in

Google Cloud Platform

test-project

Search products and resou...

Pub/Sub

Topics

Subscriptions

Snapshots

Lite Topics

Lite Subscriptions

Subscriptions

CREATE SUBSCRIPTION

DELETE

SHOW INFO PANEL

Filter table

Subscription ID

Delivery type

Topic name

Subscription name

Acknowledge deac

No subscriptions to display

Pub/Sub.

Choose

a suitable subscription ID and select the previously created topic.

## Example

Open the example in “File” -> “Examples” -> “AmebaMQTTClient” -> “Google\_Cloud\_IoT”.

Google Cloud Platform test-project Search products and resou...

Pub/Sub

- Topics
- Subscriptions**
- Snapshots
- Lite Topics
- Lite Subscriptions

Create subscription

A subscription directs messages on a topic to subscribers. Messages are delivered to subscribers immediately, or subscribers can pull messages as needed.

Subscription ID \*  
test-subscription

Subscription name: projects/test-project-286902/subscriptions/test-subscription

Select a Cloud Pub/Sub topic \*

Type to filter

test-project-286902

projects/test-project-286902/topics/test-topic

SWITCH PROJECT CREATE A TOPIC ENTER TOPIC NAME

☒ Expire after this many days of inactivity (up to 365)

31 Days

A subscription is inactive if there is no subscriber activity such as open pulls or successful pushes.

☐ Never expire

The subscription will never expire, no matter the activity.

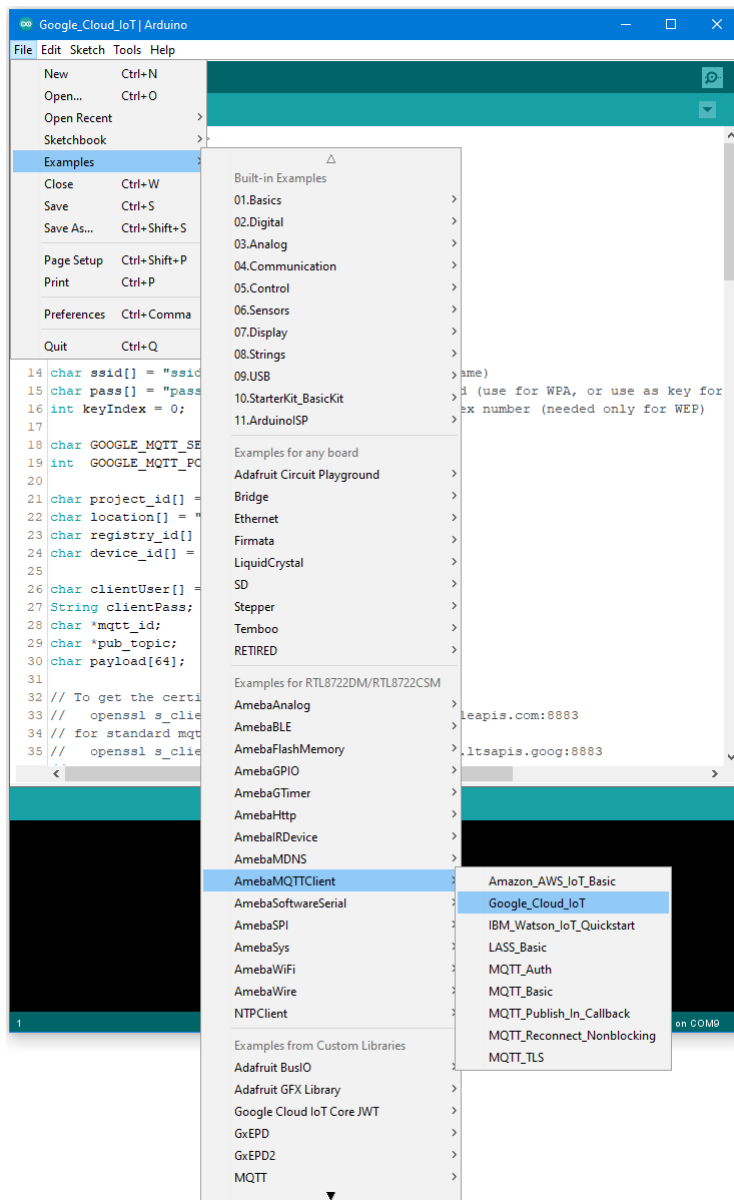
**Acknowledgement deadline**

Deadline time is from 10 seconds to 600 seconds

10 Seconds

**Subscription filter** BETA

If a filter syntax is provided, subscribers will only receive messages that match the filter. [Learn more](#)



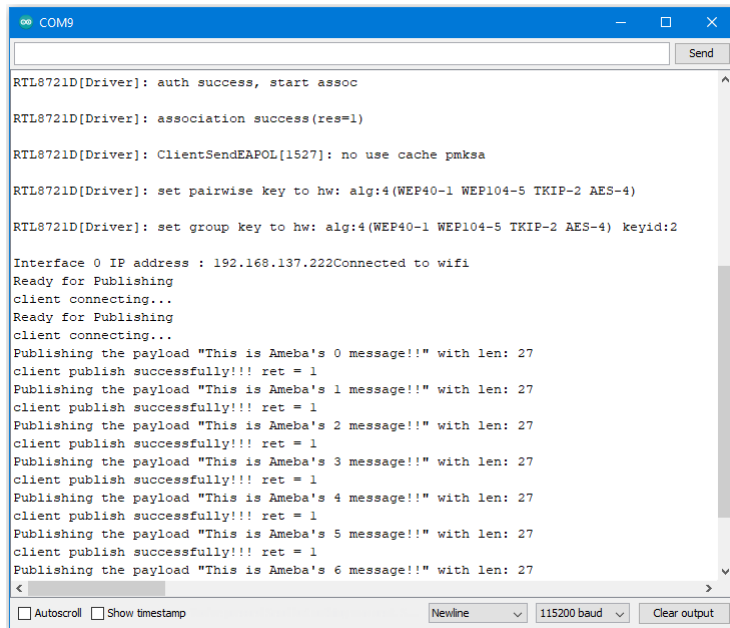
Enter the required information in the highlighted sections below.

```

9  WiFiSSLClient wifiClient;
10 PubSubClient client(wifiClient);
11 WiFiUDP udpClient;
12 NTPClient timeClient(udpClient);
13
14 char ssid[] = "ssid";           // your network SSID (name)
15 char pass[] = "pass";          // your network password (use for WPA, or use as key for
16 int keyIndex = 0;              // your network key Index number (needed only for WEP)
17
18 char GOOGLE_MQTT_SERVER[] = "mqtt.googleapis.com";
19 int  GOOGLE_MQTT_PORT = 8883;
20
21 char project_id[] = "project-id";
22 char location[] = "us-central1";
23 char registry_id[] = "my-registry";
24 char device_id[] = "ameba-device";
25
26 char clientUser[] = "unused";
27 String clientPass;
28 char *mqtt_id;
29 char *pub_topic;
30 char payload[64];
31 NN_DIGIT priv_key[9];
32
33 // To get the private key run (where private-key.pem is the ec private key
34 // used to create the certificate uploaded to google cloud iot):
35 // openssl ec -in <private-key.pem> -noout -text
36 // and copy priv: part.
37 // The key length should be exactly the same as the key length below (32 pairs
38 // of hex digits). If it's bigger and it starts with "00:" delete the "00:". If
39 // it's smaller add "00:" to the start. If it's too big or too small something
40 // is probably wrong with your key.
41 char *private_key_str =
42 "57:e1:c0:3b:e5:cd:2f:42:fb:14:4f:a9:1e:3f:0a:"
43 "65:22:4c:f0:ac:0f:a0:82:e1:73:71:ae:76:70:48:"
44 "68:fe";
45

```

In the yellow section, enter the SSID and password required to connect to your WiFi network. In the green section, enter the Project ID, server Region, Registry ID and Device ID previously configured in Google Cloud console. In the blue section, enter the hexadecimal string previously extracted from the private key. Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor and observe as Ameba connects and sends messages to Google Cloud IoT.



```

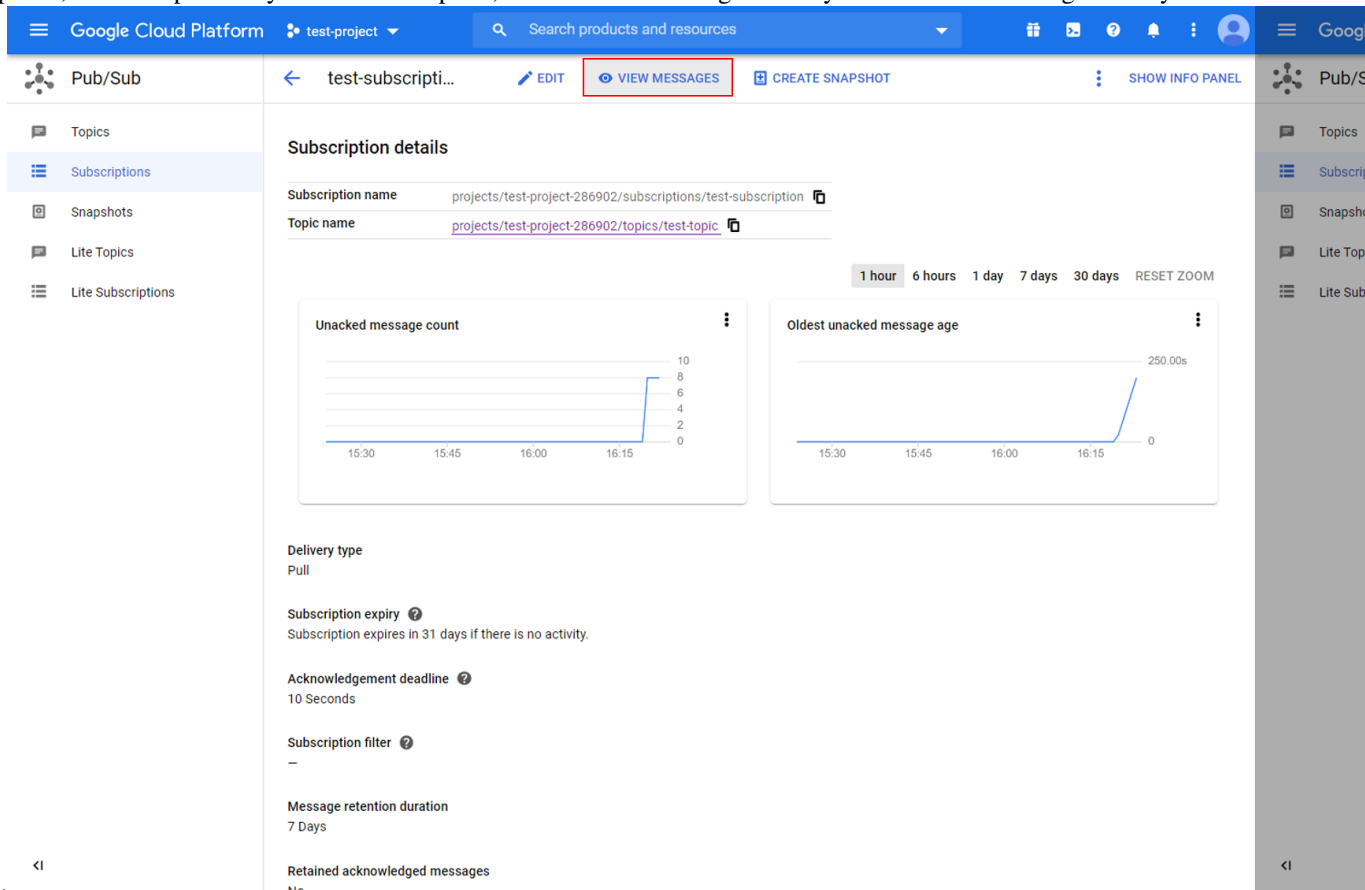
COM9
Send

RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=1)
RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.137.222Connected to wifi
Ready for Publishing
client connecting...
Ready for Publishing
client connecting...
Publishing the payload "This is Ameba's 0 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 1 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 2 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 3 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 4 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 5 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 6 message!!" with len: 27

```

In Google Cloud console, go to Pub/Sub  
subscriptions, select the previously created subscription, and click view messages. Here you can view the messages sent by



Google Cloud Platform test-project Search products and resources

Pub/Sub test-subscripti... EDIT VIEW MESSAGES CREATE SNAPSHOT SHOW INFO PANEL

Topics Subscriptions Snapshots Lite Topics Lite Subscriptions

### Subscription details

Subscription name projects/test-project-286902/subscriptions/test-subscription

Topic name projects/test-project-286902/topics/test-topic

1 hour 6 hours 1 day 7 days 30 days RESET ZOOM

**Unacked message count**

**Oldest unacked message age**

Delivery type  
Pull

Subscription expiry ?  
Subscription expires in 31 days if there is no activity.

Acknowledgement deadline ?  
10 Seconds

Subscription filter ?  
-

Message retention duration  
7 Days

Retained acknowledged messages

Ameba.



## Code Reference

In `setup()`, we set up RootCA which is required to form a TLS connection with Google's servers.

```
wifiClient.setRootCA((unsigned char*)rootCABuff);
```

In `loop()`, each loop checks the Internet status and re-connect to it when the environment has a problem.

```
if (WiFi.status() != WL_CONNECTED) {
    while (WiFi.begin(ssid, pass) != WL_CONNECTED)
    {
        delay(1000);
    }
    Serial.println("Connected to wifi");
}
```

To publish messages, `mqtt_id`, `clientPass` and `pub_topic` are required. `mqtt_id` is generated by printing the project ID, server location, registry ID and device ID in the required format:

```
mqtt_id = (char *)malloc(strlen("projects/") + strlen(project_id) + strlen("/locations/us-central1/registries/") + strlen(registry_id) + strlen("/devices/") + strlen(device_id) + 1);
sprintf(mqtt_id, "projects/%s/locations/us-central1/registries/%s/devices/%s", project_id, registry_id, device_id);
```

`clientPass` is generated using a JSON web token (JWT) generator function, which requires the project ID and current time, and signs it with the private key:

```
clientPass = CreateJwt(project_id, timeClient.getEpochTime(), priv_key);
```

`pub_topic` is generated by printing the project ID and topic in the required format:

```
pub_topic = (char *)malloc(strlen("/devices/") + strlen(device_id) + strlen("/events") + 1);
sprintf(pub_topic, "/devices/%s/events", device_id);
```

MQTT Server setting:

```
client.setServer(GOOGLE_MQTT_SERVER, GOOGLE_MQTT_PORT);
client.setPublishQos(MQTTQOS1);
client.waitForAck(true);
```

Connect to google cloud and publish messages:

```
if (client.connect(mqtt_id, clientUser, clientPass.c_str())){
    // ...
}
```

(繼續下一頁)

(繼續上一頁)

```
    for(int i = 0; i < count; i++){
        // ...
        sprintf(payload, "This is Ameba's %d message!!", i);
        ret = client.publish(pub_topic, payload);
        // ...
    }
    // ...
    client.disconnect();
}
free(mqtt_id);
free(pub_topic);
```

## MQTT - Upload PM2.5 Data to LASS System

### Intro to LASS

The LASS stands for “Location Aware Sensor System” . It is an open project and was started only for the interest of public welfare. Find detailed introduction [here](#).

Practically, LASS is based on MQTT protocol to collect all kinds of uploaded data, and for those who need these data can subscribe top as well.

Find more LASS information at their [official hackpad](#).

### Preparation

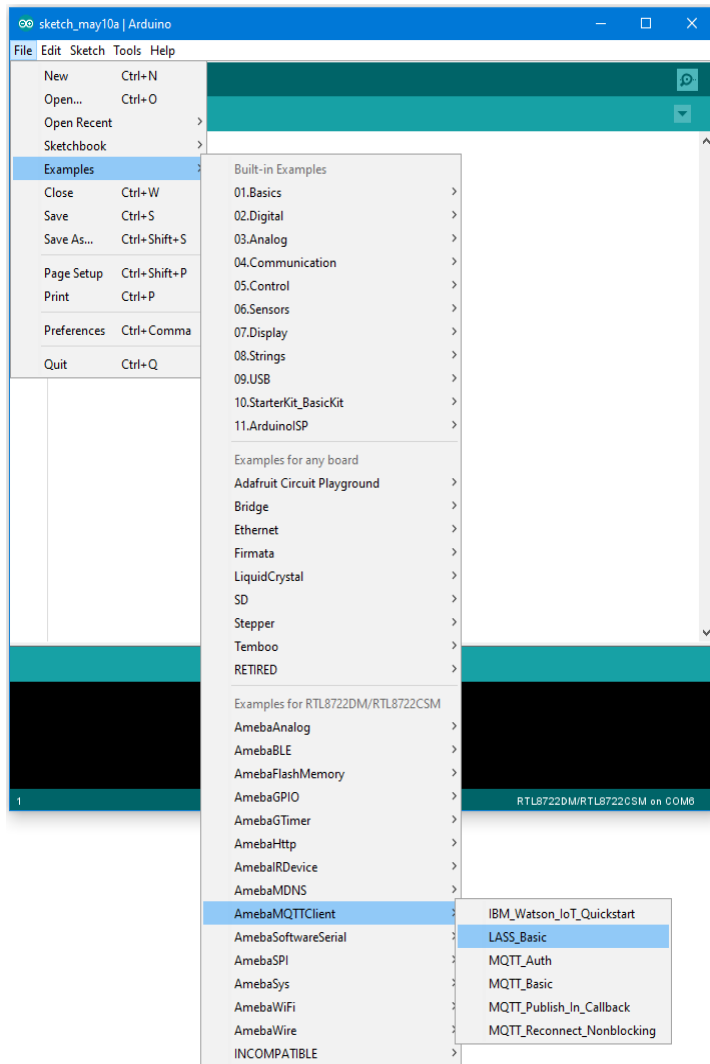
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- PlanTower PMS3003 or PMS5003 x1

### Example

In this example, we use applications mentioned at our website, including:

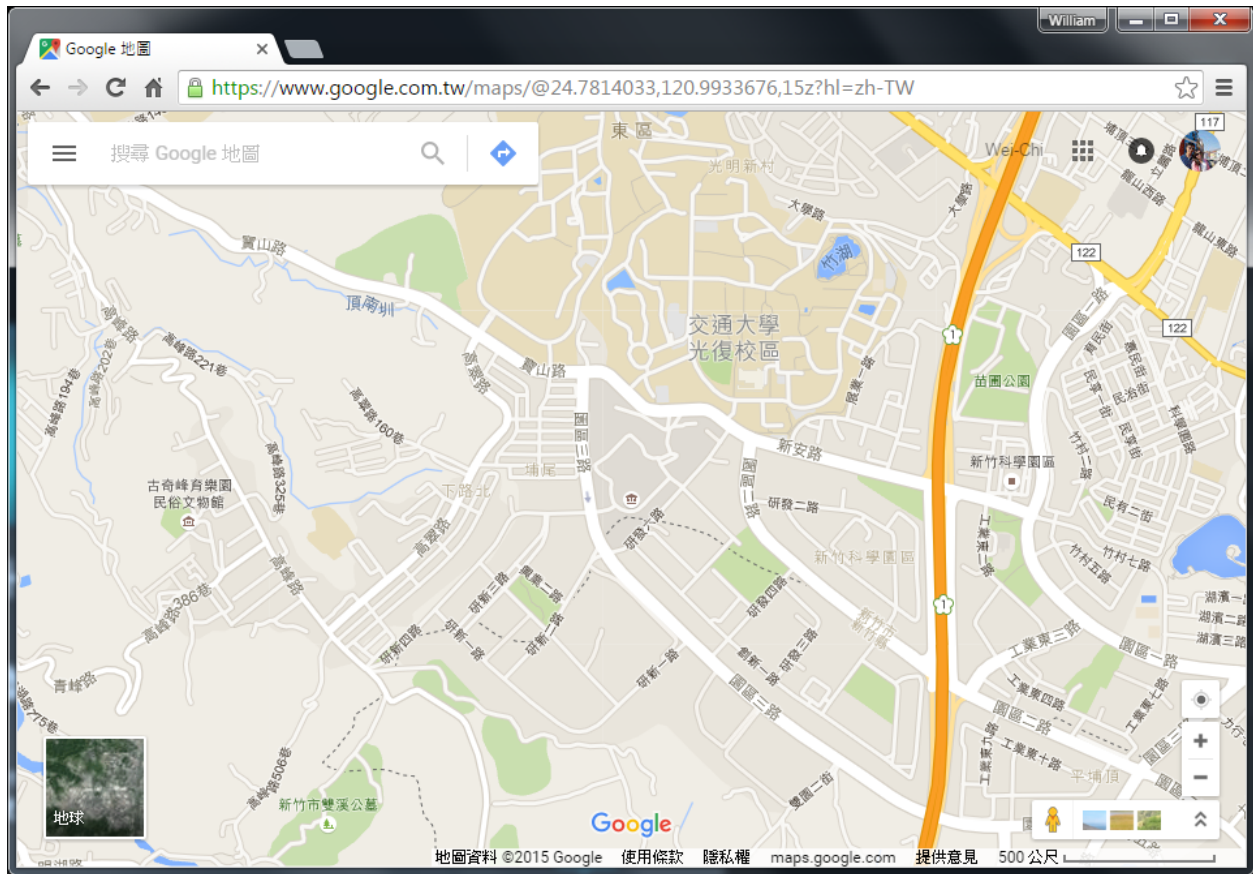
- **MQTT**: a MQTT-Broker to connect to LASS. The Client is “FT1\_0XXXX” , the XXXX are the four last digits of Ameba’ s Wi-Fi MAC, and the outTopic is “LASS/Test/Pm25Ameba/**clientID** “, where clientID is the actual Ameba’ s MQTT client ID.
- **NTP**: uploaded data must have time notation
- **PM2.5**: uploaded data includes PM2.5 information

Open the example. “File” -> “Examples” -> “AmebaMQTTClient” -> “lass\_basic”



This example requires internet connection, so make sure you fill in SSID and PASS into AP information that you wish to connect.

Also, LASS requires GPS information. There is no GPS sensor included in this example, so you must manually provide GPS information. Use Google Map to find the coordinates you plan to place your Ameba. You can see in this example that the latitude is 24.7814033, and the longitude is 120.9933676



Fill in GPS info at `gps_lat` and `gps_lon`.

```

1  /*
2   This example demonstrate how to upload sensor data to MQTT server of LASS.
3   It include features:
4       (1) Connect to WiFi
5       (2) Retrieve NTP time with WiFiUDP
6       (3) Get PM 2.5 value from PMS3003 air condition sensor with UART
7       (4) Connect to MQTT server and try reconnect when disconnect
8
9   You can find more information at this site:
10
11   https://lass.hackpad.com/LASS-README-DtZ5T6DXLbu
12
13  */
14
15  #include <WiFi.h>
16  #include <PubSubClient.h>
17  #include <WiFiUdp.h>
18  #include <PMS3003.h>
19
20  char ssid[] = "yourNetwork"; // your network SSID (name)
21  char pass[] = "secretPassword"; // your network password
22  int keyIndex = 0; // your network key Index number (needed onl
23
24  char gps_lat[] = "24.7814033"; // device's gps latitude
25  char gps_lon[] = "120.9933676"; // device's gps longitude
26
27  char server[] = "gpssensor.ddns.net"; // the MQTT server of LASS
28  char clientId[17] = ""; // client id for MQTT
29  char outTopic[20] = "LASS/Test/PM25/live"; // MQTT publish topic
30

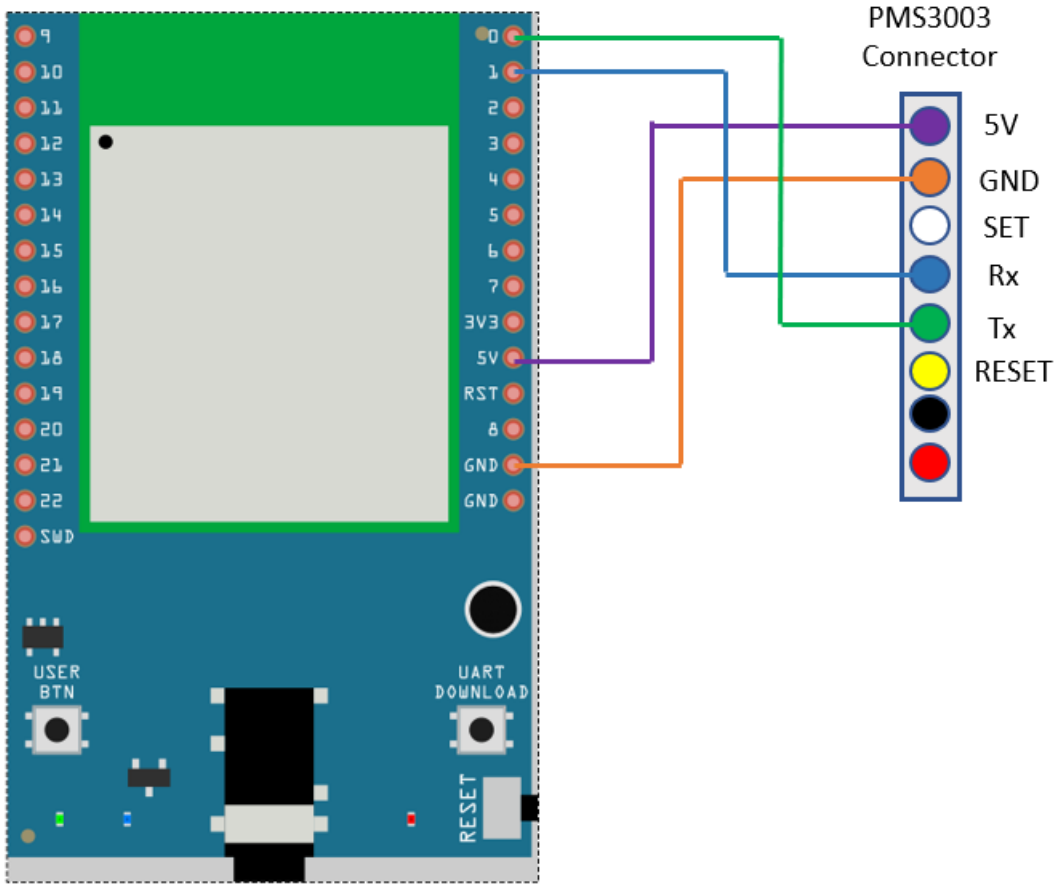
```

1 RTL8722DM/RTL8722CSM on COM6

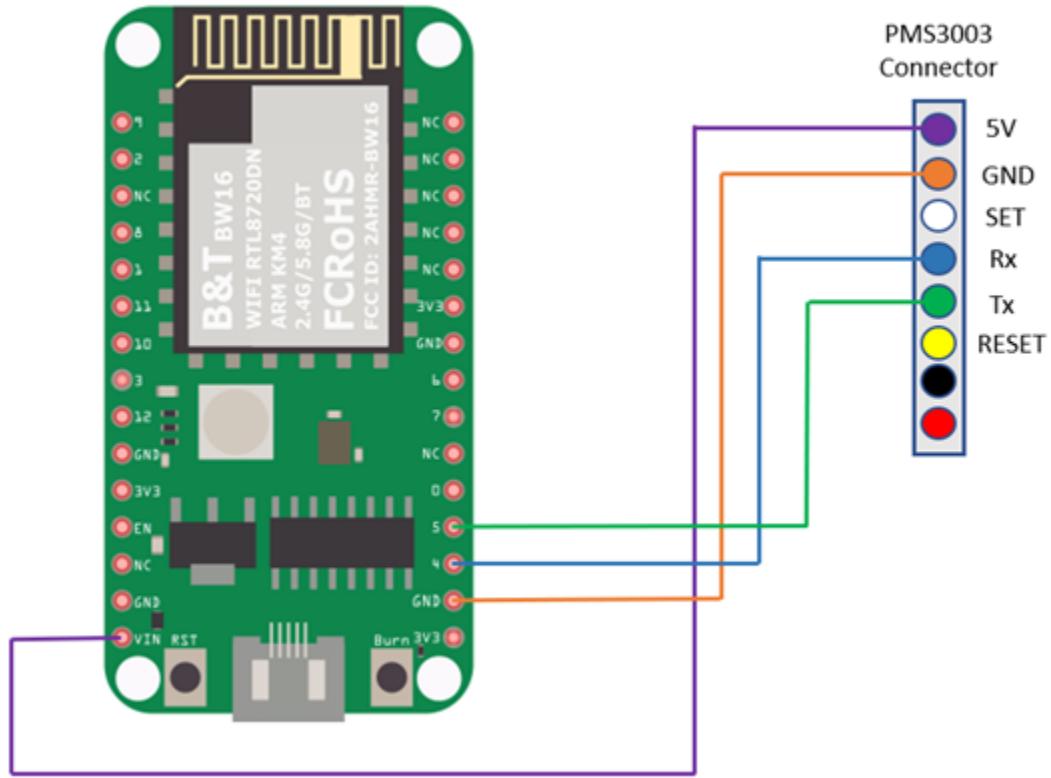
Then connect sensors according to UART-PlanTower PMS3003 wiring example.

AMB21 / AMB22:





BW16:



Compile the code and upload it to Ameba. After pressing the Reset button, Ameba will attempt to read PM2.5 data every minute and upload it to LASS MQTT-Broker. Open Serial Monitor to see the uploaded data, including client id, topic, and current PM2.5 status.



```
COM6

RTL8195A[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.88.86Connected to wifi
Send NTP packet
NTP packet received
MQTT client id:FT_LIVE_OE4E750D
MQTT topic:LASS/Test/PM25/live
pm2.5: 14 ug/m3
Attempting MQTT connection

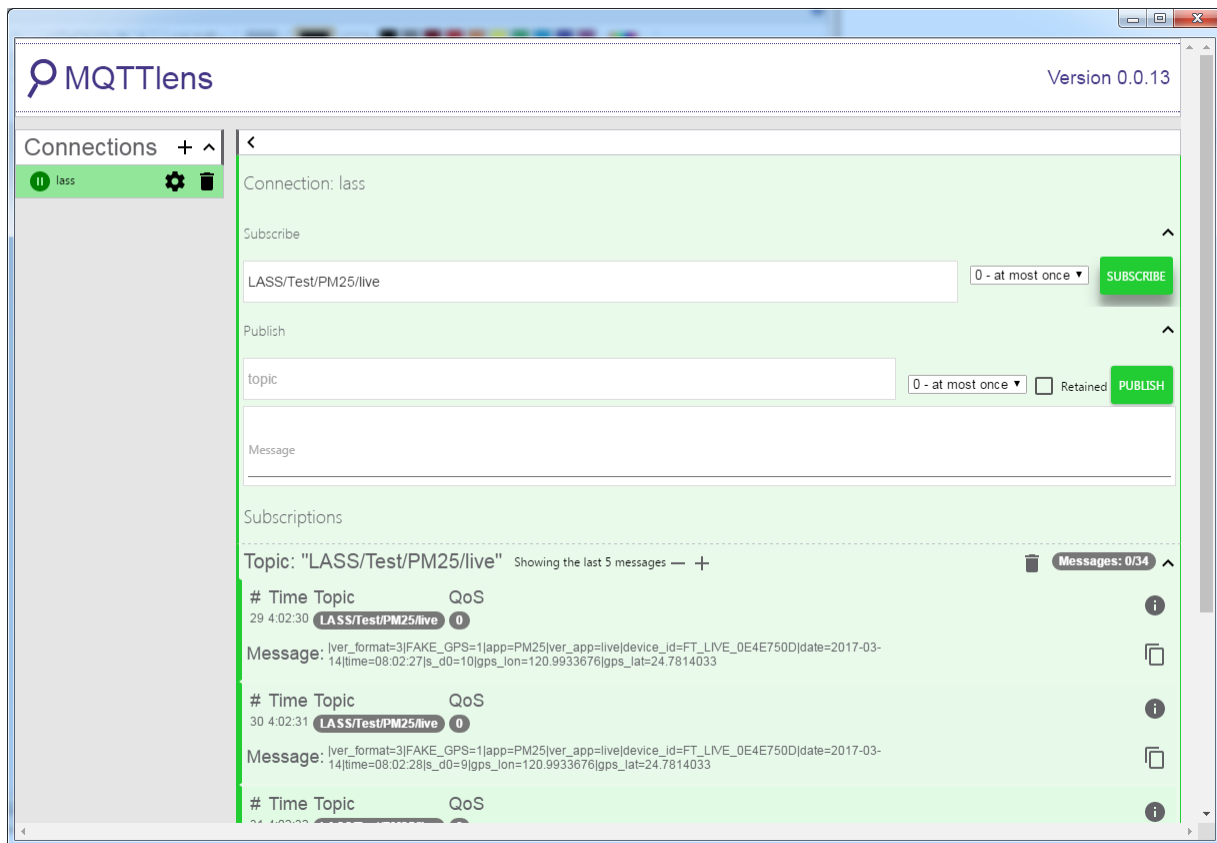
Connect to Server successful!
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 15 ug/m3
pm2.5: 15 ug/m3

Autoscroll Newline 38400 baud
```

We can also use MQTTlens to verify if the data is properly uploaded.

Enter “gpssensor.ddns.net” as the MQTT-Broker server and “LASS/Test/PM25/live” as the subscribe topic to receive data.

The time uses UTC format, and the PM2.5 data stores in s\_d0. In the figure, s\_d0 = 9 represents that the PM2.5 is 9, meaning that the entire publish/subscribe process is working successfully.



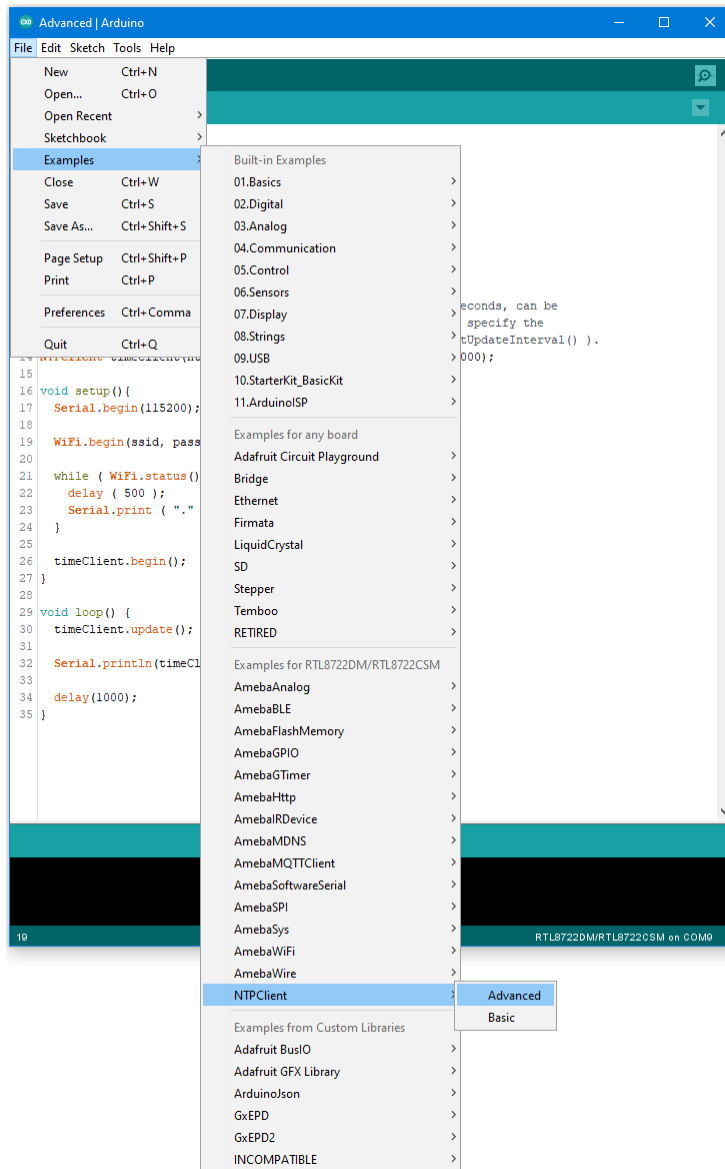
## NTP - Retrieve Universal Time (UTC) by NTPClient library

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we use an NTP client to sync with NTP servers using UDP and keep track of time locally. Open the example. “File” -> “Examples” -> “NTPClient” -> “Advanced”

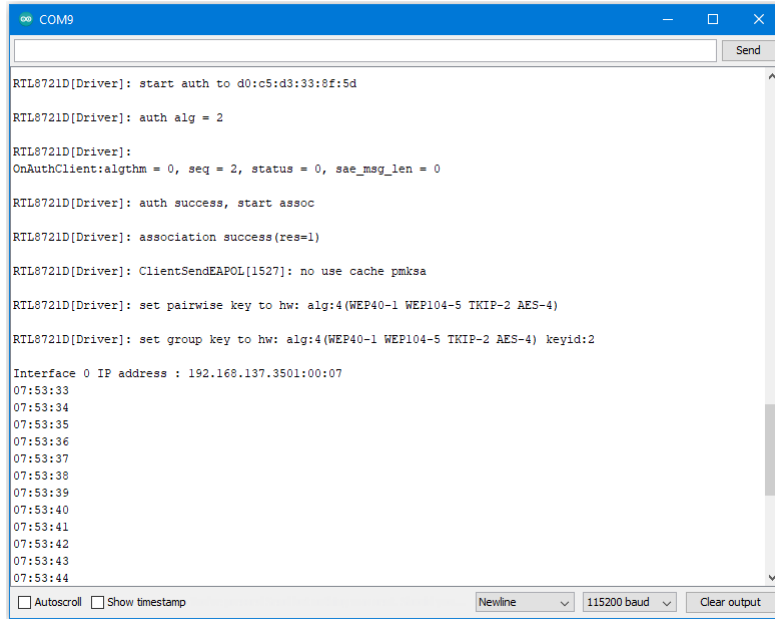


Modify the highlighted code section (ssid, password) to connect to your WiFi network.



```
1 #include <NTPClient.h>
2 #include <WiFi.h>
3 #include <WiFiUdp.h>
4
5 char ssid[] = "<SSID>";
6 char pass[] = "<PASS>";
7
8
9 WiFiUDP ntpUDP;
10
11 // You can specify the time server pool and the offset (in seconds, can be
12 // changed later with setTimeOffset() ). Additionally you can specify the
13 // update interval (in milliseconds, can be changed using setUpdateInterval() ).
14 NTPClient timeClient(ntpUDP, "europe.pool.ntp.org", 3600, 60000);
15
16 void setup() {
17   Serial.begin(115200);
18
19   WiFi.begin(ssid, pass);
20
21   while ( WiFi.status() != WL_CONNECTED ) {
22     delay ( 500 );
23     Serial.print ( "." );
24   }
25
26   timeClient.begin();
27 }
28
29 void loop() {
30   timeClient.update();
31
32   Serial.println(timeClient.getFormattedTime());
33
34   delay(1000);
35 }
```

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi, gets the UTC time from the NTP server, and prints out the current time with time zone offset to the serial monitor.



## Code Reference

Configure NTP client:

The NTPClient needs to use a UDP client for communications. A WiFiUDP client is declared and passed to the NTPClient constructor, along with an NTP server address, time zone offset in seconds, and update interval in milliseconds. If detailed configuration is not needed, just passing in the UDP client is also sufficient, refer to the “NTPClient” -> “Basic” example.

```

WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP, "europe.pool.ntp.org", 3600, 60000);

```

Start NTP client:

After connecting to WiFi, the NTPClient is started using the `begin()` function, which causes the client to sync with the NTP server and get the UTC time.

```

WiFiUDP ntpUDP;
timeClient.begin();

```

Get local time:

`getFormattedTime()` is used to format the received UTC time into the local time zone. `update()` is called every loop so that the NTPClient will sync with the NTP server once every update interval.

```
timeClient.update();  
timeClient.getFormattedTime();
```

## WiFi - Approximate UDP Receive Delay

### Materials

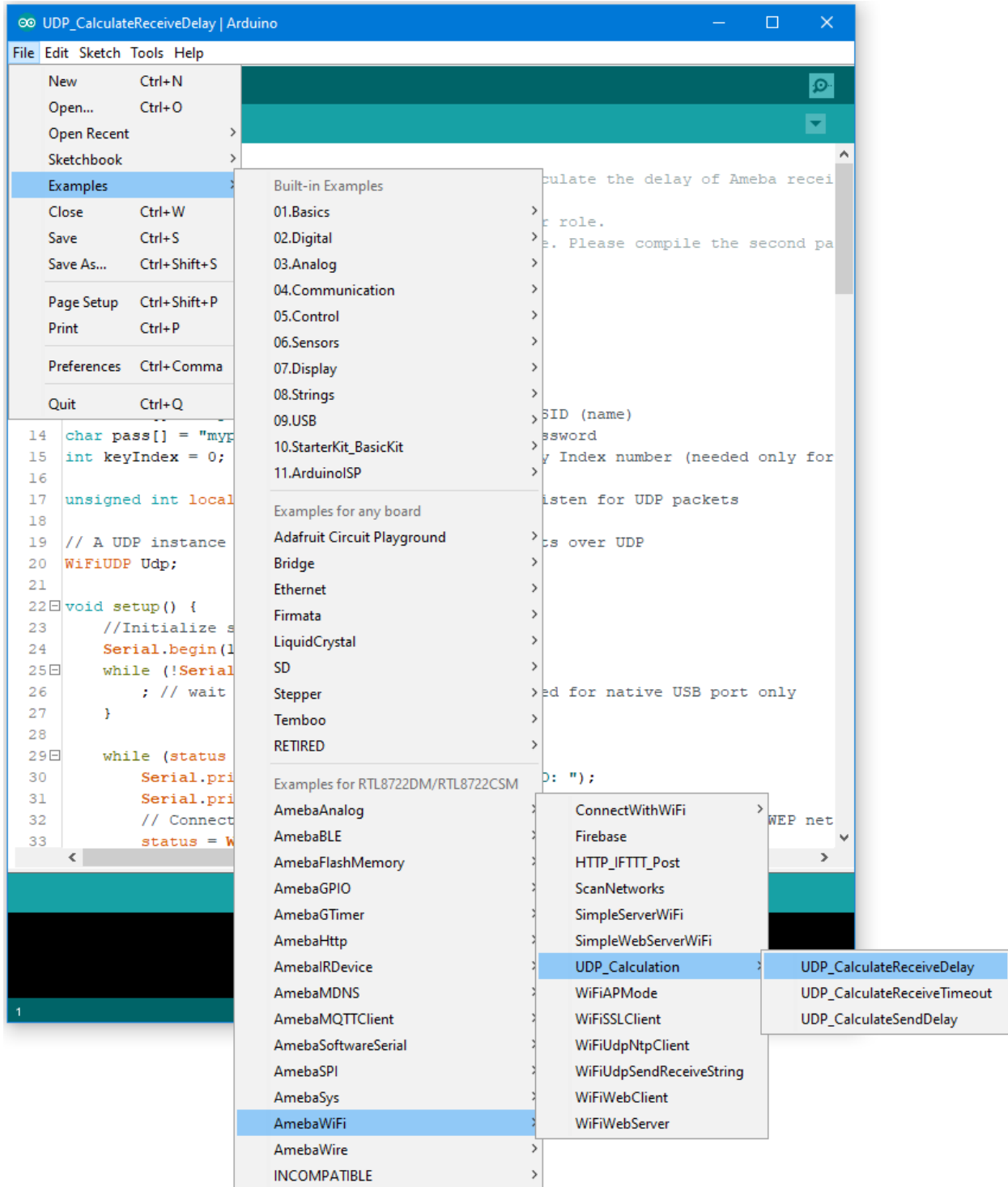
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to receive UDP packets from a computer and calculates the UDP receive delay.

### Ameba Preparation

Open the “CalculateUdpReceiveDelay” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation” -> “CalculateUdpReceiveDelay”.



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.

```

1  /*
2   This sketch provide a simple way to roughly calculate the delay of Ameba recei
3   The source code is separate into two parts.
4   The first part is Ameba code which play receiver role.
5   The second part is PC code wich play sender role. Please compile the second pa
6  */
7
8  #include <WiFi.h>
9  #include <WiFiUdp.h>
10 #include <stdio.h>
11
12 int status = WL_IDLE_STATUS;
13 char ssid[] = "mynetwork"; // your network SSID (name)
14 char pass[] = "mypassword"; // your network password
15 int keyIndex = 0; // your network key Index number (needed only for
16
17 unsigned int localPort = 5001; // local port to listen for UDP packets
18
19 // A UDP instance to let us send and receive packets over UDP
20 WiFiUDP Udp;
21
22 void setup() {
23     //Initialize serial and wait for port to open:
24     Serial.begin(115200);
25     while (!Serial) {
26         ; // wait for serial port to connect. Needed for native USB port only
27     }
28
29     while (status != WL_CONNECTED) {
30         Serial.print("Attempting to connect to SSID: ");
31         Serial.println(ssid);
32         // Connect to WPA/WPA2 network. Change this line if using open or WEP net
33         status = WiFi.begin(ssid, pass);

```

1

RTL8722DM/RTL8722CSM on COM8

Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor in Arduino IDE and take note of the IP address assigned to Ameba.



```

COM6
| Send
RTL8721D[Driver]: auth alg = 2

RTL8721D[Driver]:
OnAuthClient:alghm = 0, seq = 2, status = 0, sae_msg_len = 11

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
Connected to wifi

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

## Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpReceiveDelay” Arduino example, copy the code from the bottom between “#if 0” and “#endif” , into a new text file, change the hostname to the IP address assigned to Ameba, and rename the file to “UdpReceiveDelay.cpp” .

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <netinet/in.h>
6  #include <arpa/inet.h>
7  #include <sys/time.h>
8  #include <unistd.h>
9
10 #define BUFSIZE 1024
11
12 char *hostname = "172.25.24.243";
13 int portno = 5001;
14
15 long base_current_time = 0;
16 long get_current_time_with_ms (void)
17 {
18     struct timeval tv;
19
20     gettimeofday(&tv, NULL);
21
22     long millisecondsSinceEpoch =
23         (long)(tv.tv_sec) * 1000 +
24         (long)(tv.tv_usec) / 1000;
25
26     if (base_current_time == 0) {
27         base_current_time = millisecondsSinceEpoch;
28         return 0;
29     } else {
30         return millisecondsSinceEpoch - base_current_time;
31     }
32 }

```

length: 1,666 lines: 67 Ln: 12 Col: 1 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpReceiveDelay.cpp”, and use the command “g++ UdpReceiveDelay.cpp -o UdpDelay” to compile the code. A file named “UdpDelay.exe” will be created in the same directory.

### Running the Example

Reset the Ameba, wait for the WiFi to connect, and check that the IP address remains the same. On the computer, run the UdpDelay.exe file, and the computer will begin to send packets to Ameba. Once 10000 packets have been received, Ameba will calculate the average delay and print out the result to the serial monitor. It may take up to a few minutes for 10000 packets to be sent.

```

COM6
Send

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
Connected to wifi
data count: 10000      average delay: 95.47 ms
data count: 20000      average delay: 198.96 ms
data count: 30000      average delay: 272.98 ms

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

## WiFi - Approximate UDP Sending Delay

### Materials

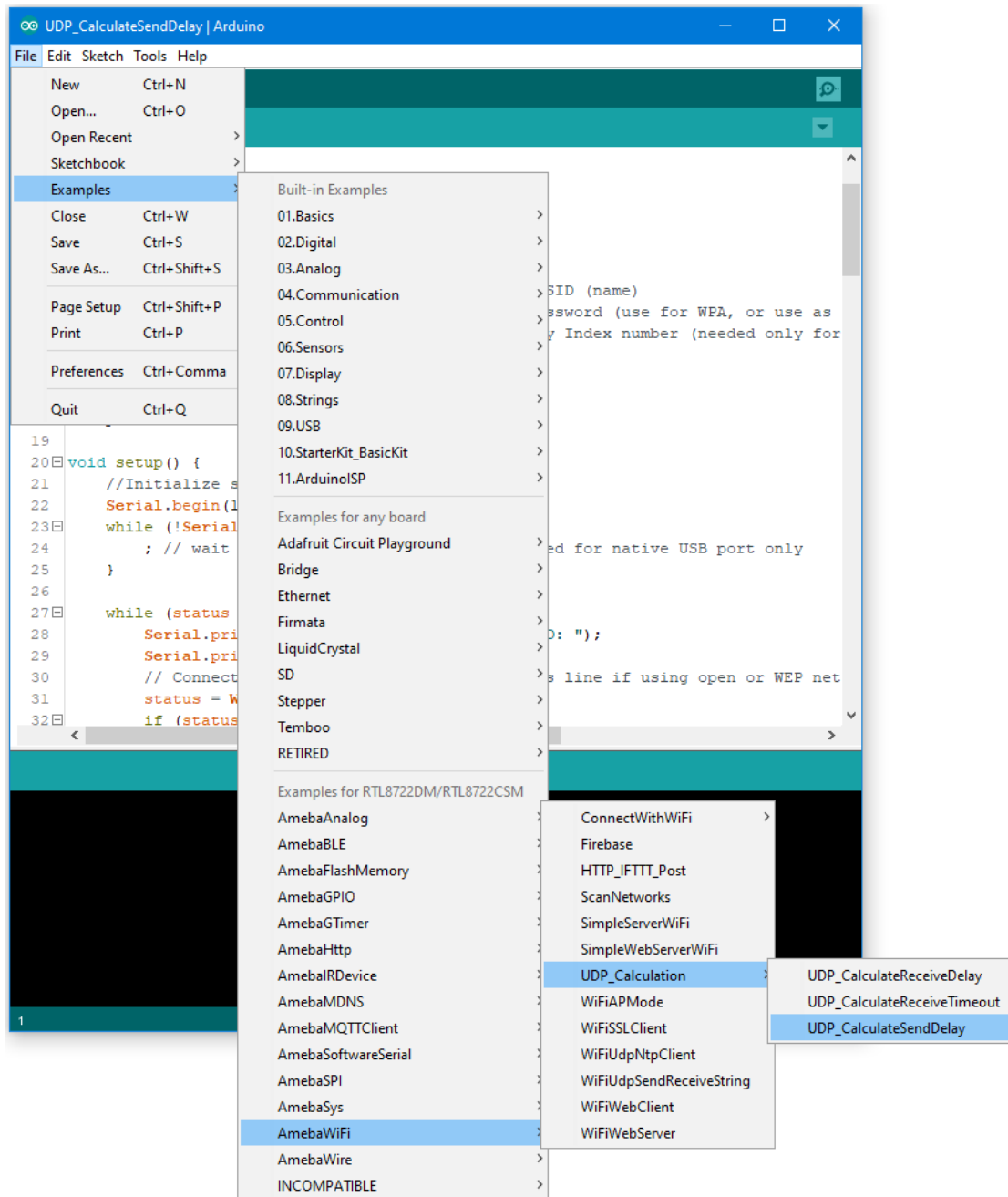
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to send UDP packets to a computer and calculates the UDP sending delay.

### Ameba Preparation

Open the “CalculateUdpSendDelay” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation ” -> “CalculateUdpSendDelay” .



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.

The server variable also needs to be changed to match the IP address of your computer. You can find the IP address using the “ipconfig” command in a terminal window.

```

6  */
7
8  #include <WiFi.h>
9  #include <WiFiUdp.h>
10
11 int status = WL_IDLE_STATUS;
12 char ssid[] = "mynetwork";    // your network SSID (name)
13 char pass[] = "mypassword";   // your network password (use for WPA, or use as
14 int keyIndex = 0;             // your network key Index number (needed only for
15
16 WiFiUDP Udp;
17 char server[] = "192.168.1.65";
18 int port = 5001;
19
20 void setup() {
21     //Initialize serial and wait for port to open:
22     Serial.begin(115200);
23     while (!Serial) {
24         ; // wait for serial port to connect. Needed for native USB port only
25     }
26
27     while (status != WL_CONNECTED) {
28         Serial.print("Attempting to connect to SSID: ");
29         Serial.println(ssid);
30         // Connect to WPA/WPA2 network. Change this line if using open or WEP net
31         status = WiFi.begin(ssid, pass);
32         if (status == WL_CONNECTED) {

```

### Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpSendDelay” Arduino example, copy the code from the bottom between “#if 0” and “#endif” , into a new text file and rename the file to “UdpSendDelay.cpp” .

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <arpa/inet.h>
6  #include <sys/time.h>
7
8  #define BUFSIZE 1024
9  #define PORT 5001
10
11 long get_current_time_with_ms (void)
12 {
13     struct timeval tv;
14
15     gettimeofday(&tv, NULL);
16
17     long millisecondsSinceEpoch =
18         (long) (tv.tv_sec) * 1000 +
19         (long) (tv.tv_usec) / 1000;
20
21     return millisecondsSinceEpoch;
22 }
23
24 long early_diff = 0;
25
26 long ameba_epoch = 0;
27 long sys_epoch = 0;
28
29 long datacount = 0;
30 long total_shift = 0;
31
32 void process_data(char *buf) {

```

length: 2,706 lines: 110 Ln: 110 Col: 2 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpSendDelay.cpp”, and use the command “g++ UdpSendDelay.cpp -o UdpDelay” to compile the code. A file named “UdpDelay.exe” will be created in the same directory.

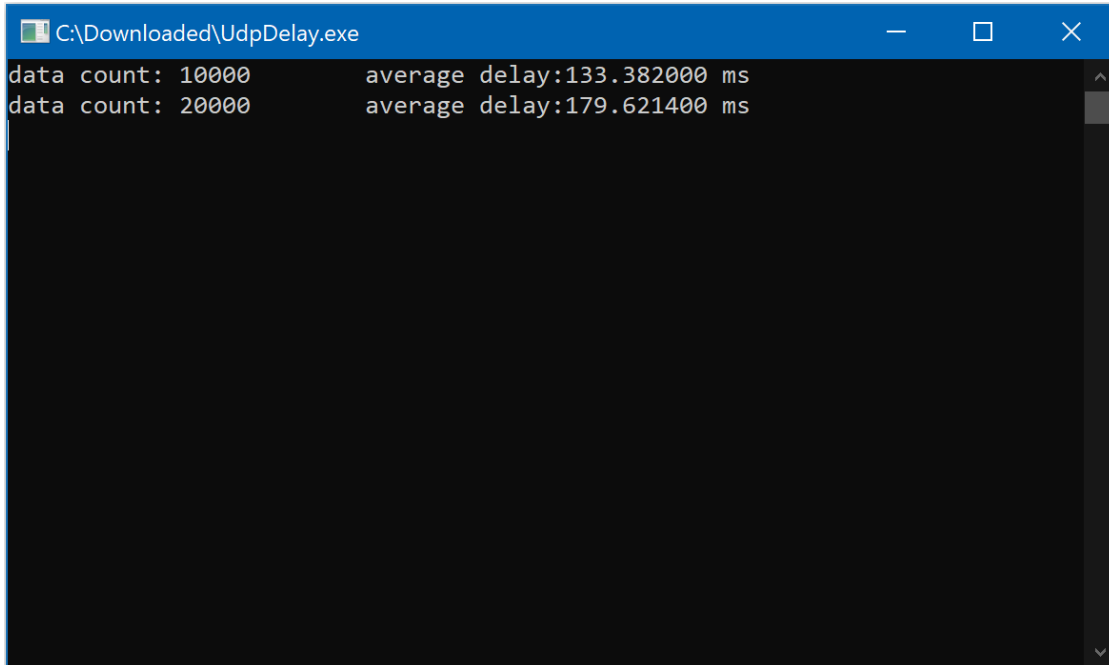
### Running the Example

First, on the computer, run the UdpDelay.exe file, and the computer will begin to listen for packets from Ameba.

Next, compile and upload the code from the Arduino IDE to Ameba and press the reset button when the upload is complete.

The Ameba will begin to send UDP packets to the computer. Once 10000 packets have been received, the computer will calculate the average delay and print out the result.

It will take some time for 10000 packets to be sent.



```
C:\Downloaded\UdpDelay.exe
data count: 10000      average delay:133.382000 ms
data count: 20000      average delay:179.621400 ms
```

## WiFi - Approximate UDP Receive Timeout

### Materials

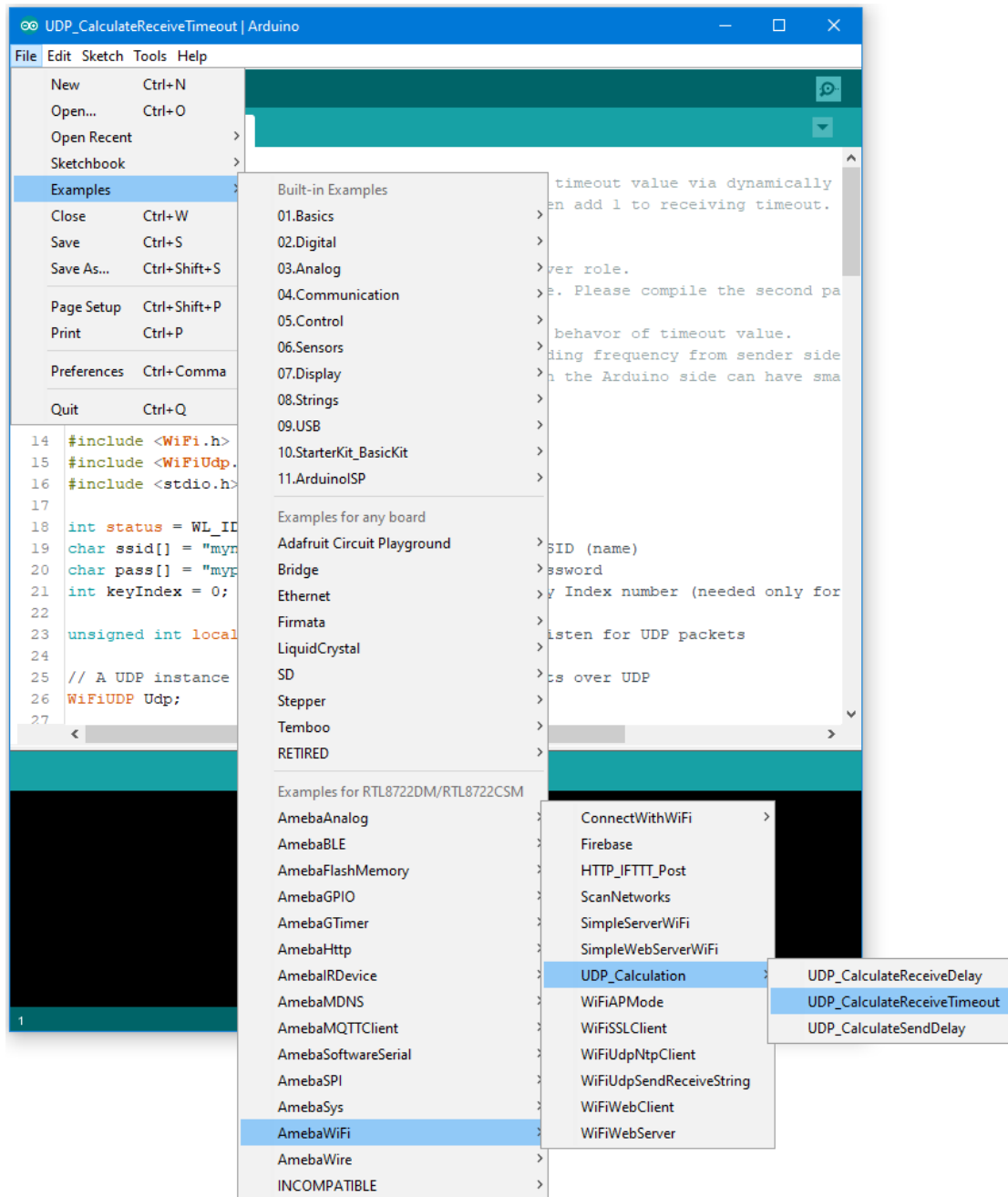
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to receive UDP packets from a computer and calculates the allowed UDP receive timeout setting.

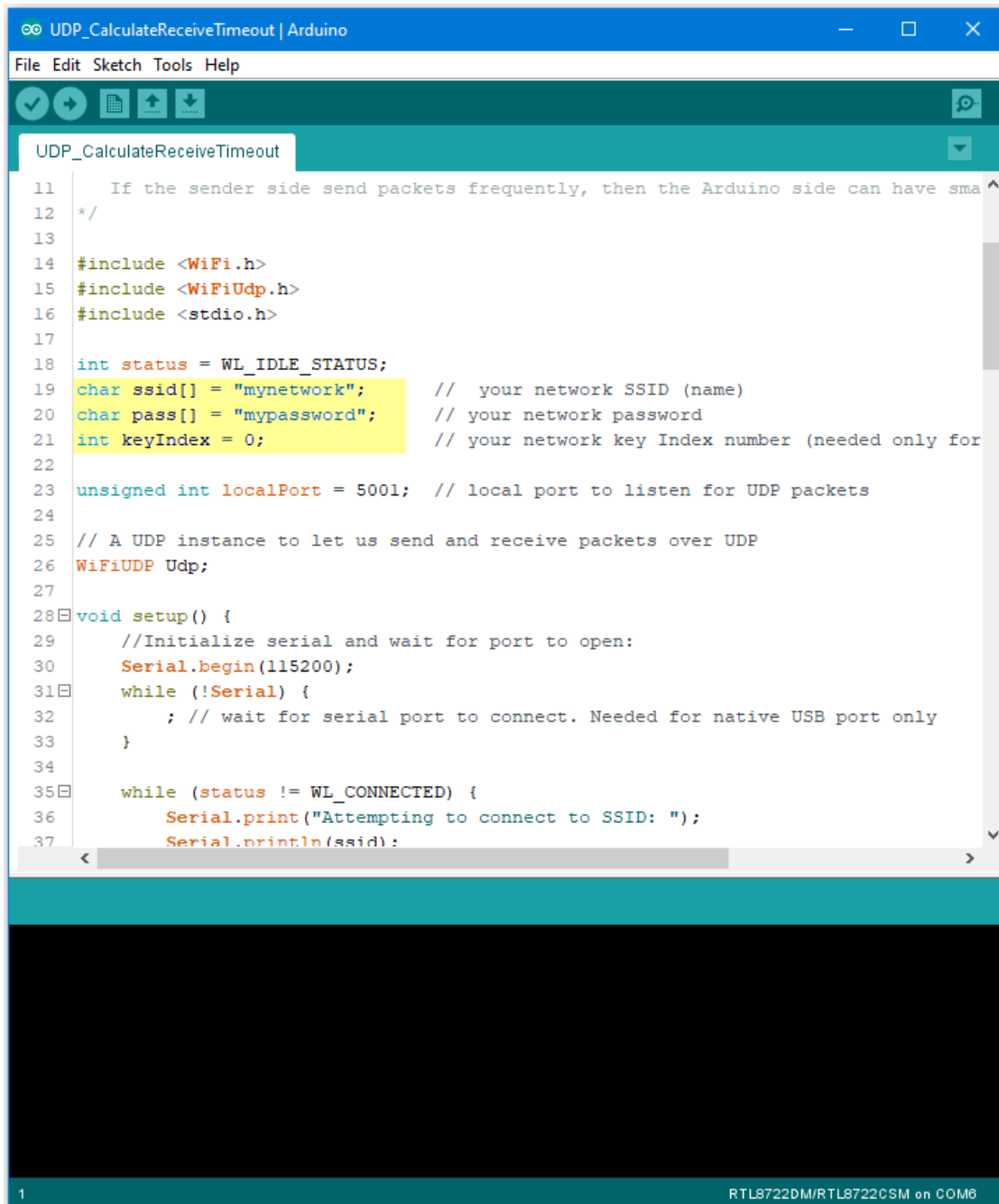
### Ameba Preparation

Open the “CalculateUdpReceiveTimeout” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation ” -> “CalculateUdpReceiveTimeout” .



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.





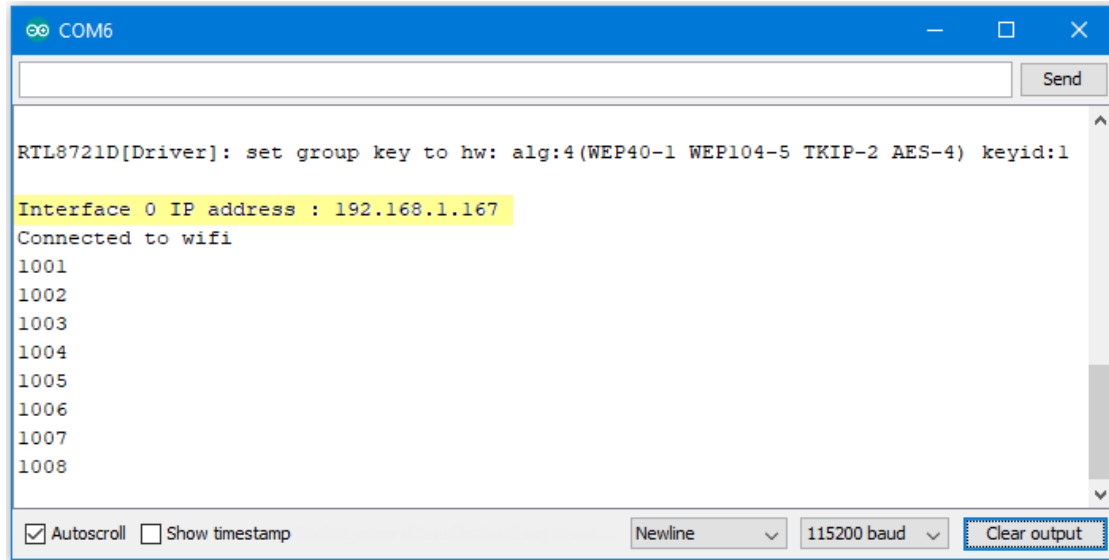
```

11  // If the sender side send packets frequently, then the Arduino side can have sma
12  */
13
14  #include <WiFi.h>
15  #include <WiFiUdp.h>
16  #include <stdio.h>
17
18  int status = WL_IDLE_STATUS;
19  char ssid[] = "mynetwork"; // your network SSID (name)
20  char pass[] = "mypassword"; // your network password
21  int keyIndex = 0; // your network key Index number (needed only for
22
23  unsigned int localPort = 5001; // local port to listen for UDP packets
24
25  // A UDP instance to let us send and receive packets over UDP
26  WiFiUDP Udp;
27
28  void setup() {
29    //Initialize serial and wait for port to open:
30    Serial.begin(115200);
31    while (!Serial) {
32      ; // wait for serial port to connect. Needed for native USB port only
33    }
34
35    while (status != WL_CONNECTED) {
36      Serial.print("Attempting to connect to SSID: ");
37      Serial.println(ssid);

```

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in Arduino IDE and take note of the IP address assigned to Ameba.



The screenshot shows a terminal window titled "COM6" with a blue header bar. The output text is as follows:

```
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1  
Interface 0 IP address : 192.168.1.167  
Connected to wifi  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008
```

The line "Interface 0 IP address : 192.168.1.167" is highlighted in yellow. At the bottom of the window, there are controls: a checked "Autoscroll" checkbox, an unchecked "Show timestamp" checkbox, a "Newline" dropdown menu, a "115200 baud" dropdown menu, and a "Clear output" button.

## Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpReceiveTimeout” Arduino example, copy the code from the bottom between “#if 0” and “#endif” , into a new text file, change the hostname to the IP address assigned to Ameba, and rename the file to “UdpReceiveTimeout.cpp” .

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <netinet/in.h>
6  #include <arpa/inet.h>
7  #include <unistd.h>
8
9  #define BUFSIZE 16
10
11 char *hostname = "192.168.1.213";
12 int portno = 5001;
13
14 int main(int argc, char **argv) {
15     int sockfd, n;
16     struct sockaddr_in serveraddr;
17     int serverlen = sizeof(serveraddr);
18     char buf[BUFSIZE];
19     int counter = 0;
20
21     /* socket: create the socket */
22     sockfd = socket(AF_INET, SOCK_DGRAM, 0);
23     if (sockfd < 0) {
24         printf("ERROR opening socket\r\n");
25         return -1;
26     }
27
28     /* build the server's Internet address */
29     memset(&serveraddr, 0, sizeof(serveraddr));
30     serveraddr.sin_family = AF_INET;
31     serveraddr.sin_addr.s_addr = inet_addr(hostname);
32     serveraddr.sin_port = htons(portno);

```

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Next, open a Cygwin terminal, change the working directory to the location of “UdpReceiveTimeout.cpp”, and use the command “g++ UdpReceiveTimeout.cpp -o UdpTimeout” to compile the code. A file named “UdpTimeout.exe” will be created in the same directory.

### Running the Example

Reset the Ameba, wait for the WiFi to connect, and check that the IP address remains the same. On the computer, run the UdpTimeout.exe file, and the computer will begin to send packets continuously to Ameba.

The timeout value is set to 1000ms initially. For each packet received successfully, Ameba decreases the timeout value. The next packet must be received within the timeout period, otherwise Ameba registers a failed packet and increases the timeout value. Open the serial monitor and observe the timeout value converge to a minimum value.

## WiFi - Connect to WiFi networks

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Procedure

There three common encryption type in WiFi connection. The first one is “OPEN” , which means there is no password needed to connect to this network. The second type of encryption is WPA, which requires the correct password to access. The third type is WEP, which requires a hexadecimal password and a keyindex.

In the following, we will give a brief introduction on how to establish WiFi connection with these three types of encryption on Ameba.

First, make sure the correct Ameba development board is selected in “Tools” -> “Board” .

- Open (WiFi connection without password)

Open the “ConnectNoEncryption” example in “File” -> “Examples” -> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectNoEncryption”



```
1 /*
2
3 This example connects to an unencrypted Wifi network.
4 Then it prints the MAC address of the Wifi shield,
5 the IP address obtained, and other network details.
6
7 Circuit:
8 * Wifi shield attached
9
10 created 13 July 2010
11 by dlf (Metodo2 srl)
12 modified 31 May 2012
13 by Tom Igoe
14 */
15 #include <WiFi.h>
16
17 char ssid[] = "yourNetwork"; // the name of your network
18 int status = WL_IDLE_STATUS; // the Wifi radio's status
19
20 void setup() {
21 //Initialize serial and wait for port to open:
22 Serial.begin(115200);
23 while (!Serial) {
24 // wait for serial port to connect. Needed for native USB port only
25 }
26
27 // check for the presence of the shield:
28 if (WiFi.status() == WL_NO_SHIELD) {
29 Serial.println("WiFi shield not present. aborting...");
30 delay(10000);
31 return;
32 }
33
34 Serial.println("WiFi started successfully");
35 }
```

In the sample code, modify “ssid” to be the same as the WiFi SSID to be connected to.

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’re connected to the networkSSID: XXXXX”, and the information of this WiFi connection is printed in the serial monitor every 10 seconds.

```

COM6
Interface 0 IP address : 192.168.43.32
You're connected to the networkSSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-55
Encryption Type:0
IP Address: 192.168.43.32
192.168.43.32
MAC address: 70:1D:8:4:55:32
NetMask: 255.255.255.0
Gateway: 192.168.43.235
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-55
Encryption Type:0
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-58
Encryption Type:0
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-57
Encryption Type:0
Autoscroll Show timestamp Newline 115200 baud Clear output

```

- WiFi connection with WPA encryption

Open the “ConnectWithWPA” example in “File” -> “Examples”  
 -> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectWithWPA”

```

ConnectWithWPA
1 /*
2
3  This example connects to an unencrypted Wifi network.
4  Then it prints the  MAC address of the Wifi shield,
5  the IP address obtained, and other network details.
6
7  Circuit:
8  * Wifi shield attached
9
10 created 13 July 2010
11 by dlf (Metodo2 srl)
12 modified 31 May 2012
13 by Tom Igoe
14 */
15 #include <WiFi.h>
16
17 char ssid[] = "yourNetwork"; // your network SSID (name)
18 char pass[] = "secretPassword"; // your network password
19 int status = WL_IDLE_STATUS; // the Wifi radio's status
20
21 void setup() {
22   //Initialize serial and wait for port to open:
23   Serial.begin(115200);
24   while (!Serial) {
25     ; // wait for serial port to connect. Needed for native USB port only
26   }
27
28   // ...
29 }
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31 // ...
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```

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’ re connected to the networkSSID: XXXXX” , and the information of this WiFi connection is printed in the serial monitor every 10 seconds.

- WiFi connection with WEP encryption

Open the “ConnectWithWEP” example in “File” -> “Examples”  
-> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectWithWEP”

```
ConnectWithWEP

16
17 Circuit:
18 * WiFi shield attached
19
20 created 13 July 2010
21 by dlf (Metodo2 srl)
22 modified 31 May 2012
23 by Tom Igoe
24 */
25 #include <WiFi.h>
26
27 char ssid[] = "yourNetwork"; // your network SSID (name)
28 char key[] = "D0D0DEADF00DABBADEAFBEADED"; // your network key
29 int keyIndex = 0; // your network key Index number
30 int status = WL_IDLE_STATUS; // the Wifi radio's status
31
32 void setup() {
33 //Initialize serial and wait for port to open:
34 Serial.begin(115200);
35 while (!Serial) {
36 ; // wait for serial port to connect. Needed for native USB port only
37 }
38
39 // check for the presence of the shield:
40 if (WiFi.status() == WL_NO_SHIELD) {
41 Serial.println("WiFi shield not present");
42 // don't continue:
43 }
```

In the sample code, modify “ssid” to the SSID to be connected, “key” to the hexadecimal password, “keyIndex” to your key index number.

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’re connected to the networkSSID: XXXXX” , and the information of this WiFi connection is printed in the IDE every 10 seconds.

## Code Reference

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.encryptionType()` to get the encryption type of the WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiEncryptionType>

Use `WiFi.BSSID()` to get the MAC address of the router you are connected to.

<https://www.arduino.cc/en/Reference/WiFiBSSID>

To get the information of Ameba:

Use `WiFi.macAddress()` to get the MAC address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiMACAddress>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFi.subnetMask()` to get the subnet mask.

<https://www.arduino.cc/en/Reference/WiFiSubnetMask>

Use `WiFi.gatewayIP()` to get the WiFi shield's gateway IP address.

<https://www.arduino.cc/en/Reference/WiFiGatewayIP>

## Comparison with Arduino

In the Arduino platform, we need to add an extra WiFi shield to be the WiFi module to realize the WiFi connection.

And we must `#include` to use SPI to communicate with WiFi module.

However, Ameba is already equipped with WiFi module. Therefore, `#include` is not needed.

## WiFi - Retrieve Universal Time (UTC) by UDP

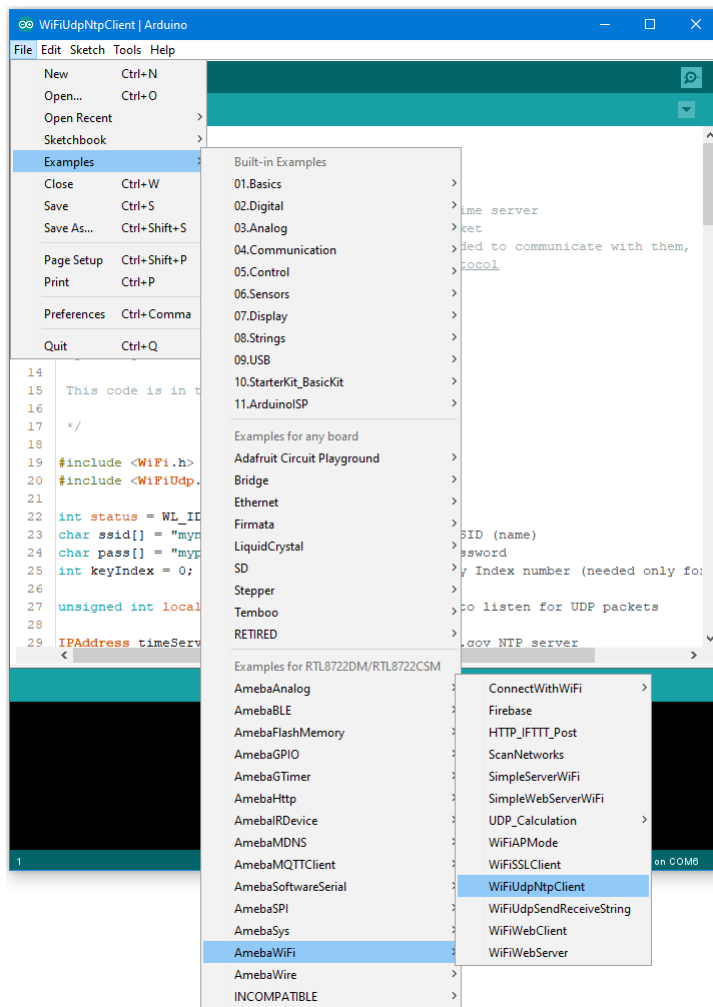
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we connect Ameba to WiFi. Then send NTP (Network Time Protocol, RFC 1305) request to NTP server using UDP. After receiving the NTP request, the NTP server replies current UTC (Coordinated Universal Time) packet. We will parse the UTC packet to show current UTC time in the serial monitor.

Open the example: “File” -> “Examples” -> “AmebaWiFi” -> “WiFiUdpNtpClient”



Modify the highlighted code section (ssid, password, keyindex) to connect to your WiFi network.



```

11  by Michael Margolis
12  modified 9 Apr 2012
13  by Tom Igoe
14
15  This code is in the public domain.
16
17  */
18
19  #include <WiFi.h>
20  #include <WiFiUdp.h>
21
22  int status = WL_IDLE_STATUS;
23  char ssid[] = "mynetwork"; // your network SSID (name)
24  char pass[] = "mypassword"; // your network password
25  int keyIndex = 0; // your network key Index number (needed only for
26
27  unsigned int localPort = 2390; // local port to listen for UDP packets
28
29  IPAddress timeServer(129, 6, 15, 28); // time.nist.gov NTP server
30
31  const int NTP_PACKET_SIZE = 48; // NTP time stamp is in the first 48 bytes of the
32
33  byte packetBuffer[ NTP_PACKET_SIZE]; //buffer to hold incoming and outgoing packets
34
35  // A UDP instance to let us send and receive packets over UDP
36  WiFiUDP Udp;
37
38  void setup() {
39    // Open serial communications and wait for port to open:

```

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi and sends NTP request packet to NTP server “129.6.15.28” .

We parse the replied packet and show UTC time in serial monitor:

```

Interface 0 IP address : 192.168.1.167Connected to wifi
IP Address: 192.168.1.167
signal strength (RSSI):-80 dBm

Starting connection to server...
1
packet received
Seconds since Jan 1 1900 = 3798154620
Unix time = 1589165820
The UTC time is 2:57:00
1
packet received
Seconds since Jan 1 1900 = 3798154631
Unix time = 1589165831
The UTC time is 2:57:11
1

```

## WiFi - Scan the surrounding WiFi networks

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Antenna x 1
- AmebaD `[[:raw-html:‘<p style=」 color:#1A76B4;」 >AMB21(RTL8722DM/CSM)</p>‘ / AMB23(RTL8722DM_MINI) / BW16(RTL8729DN)] x 1`

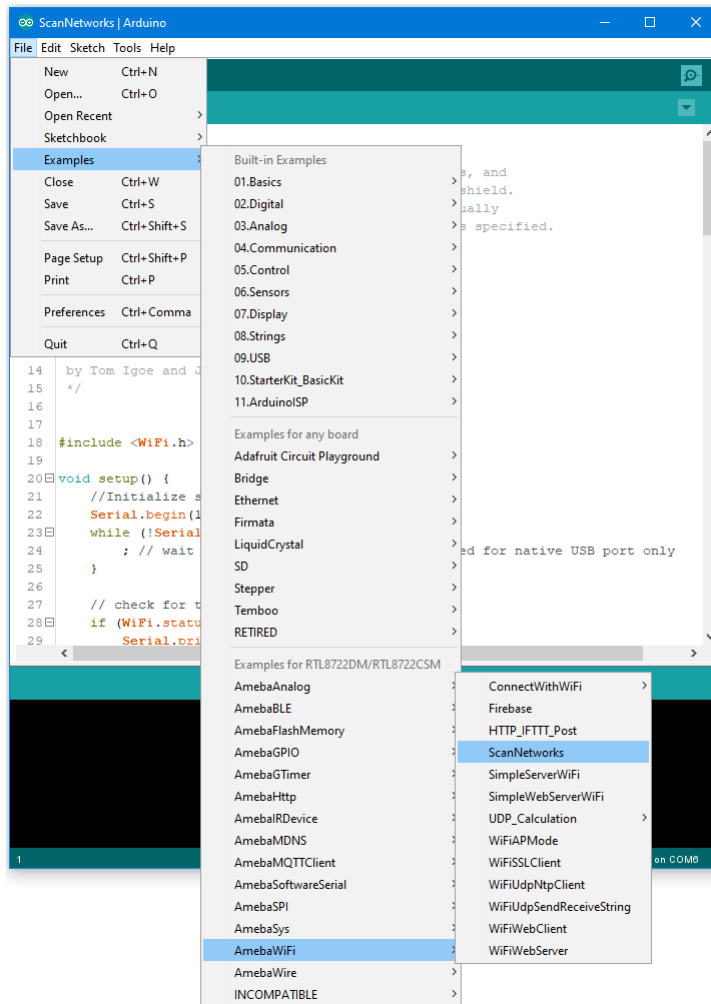
### Example

In this example, we use Ameba to scan available WiFi hotspots in the surroundings, and prints the SSID, encryption type, signal strength information of each detected hotspot.

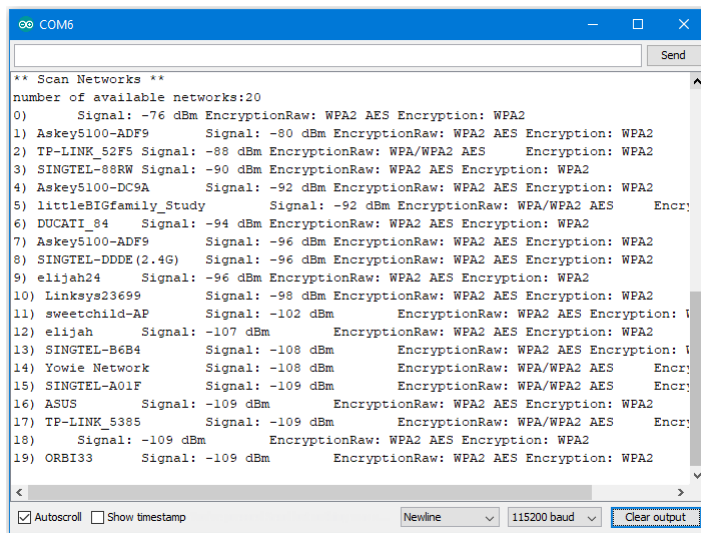
First, make sure the correct Ameba development board is selected in Arduino IDE: “Tools” -> “Board”

Open the “ScanNetworks” example in “File” -> “Examples” -> “AmebaWiFi” ->

“ScanNetworks” :



Then upload the sample code and press the reset button on Ameba. Afterwards, you can see “\*\*Scan Networks\*\*” message appears, with the detected WiFi hotspots and the information of each hotspot.



## Code Reference

- First we use `WiFi.macAddress(mac)` to get the MAC address of Ameba: <https://www.arduino.cc/en/Reference/WiFiMACAddress>
- Then we use `WiFi.scanNetworks()` to detect WiFi hotspots: <https://www.arduino.cc/en/Reference/WiFiScanNetworks>
- To get information of detected WiFi hotspot: We use `WiFi.SSID(thisNet)` to retrieve SSID of a network: <https://www.arduino.cc/en/Reference/WiFiSSID> We use `WiFi.RSSI(thisNet)` to get the signal strength of the connection to the router: <https://www.arduino.cc/en/Reference/WiFiRSSI>
- We use `WiFi.encryptionType(thisNet)` to get the encryption type of the network: <https://www.arduino.cc/en/Reference/WiFiEncryptionType>

## Comparison with Arduino

In the Arduino platform, we need to add an extra WiFi shield to be the WiFi module to realize the WiFi connection. And we must `#include` to use SPI to communicate with WiFi module.

However, Ameba is already equipped with WiFi module. Therefore, `#include` is not needed.

## WiFi - Set up Server to communicate

### Materials

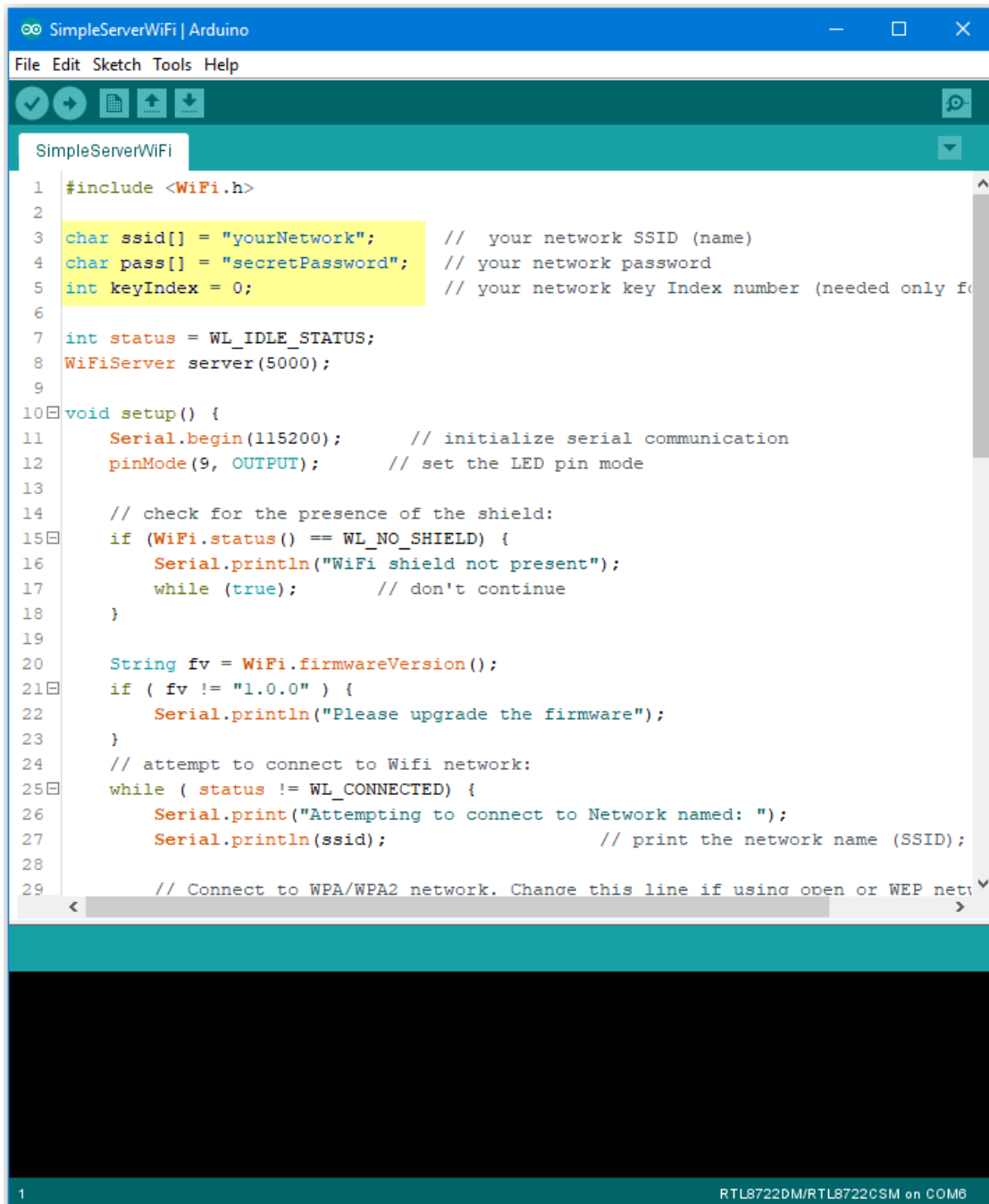
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Laptop (Make sure it is connected to the same network domain as Ameba, and tcp tools are installed.)

### Example

In this example, we first connect Ameba to WiFi, then we use Ameba as server to communicate with client.

First, we make sure the correct Ameba development board is set in “Tools” -> “Board”

Then, open the Simple WiFi Server example in “File” -> “Examples” -> “AmebaWiFi” -> “SimpleServerWiFi”

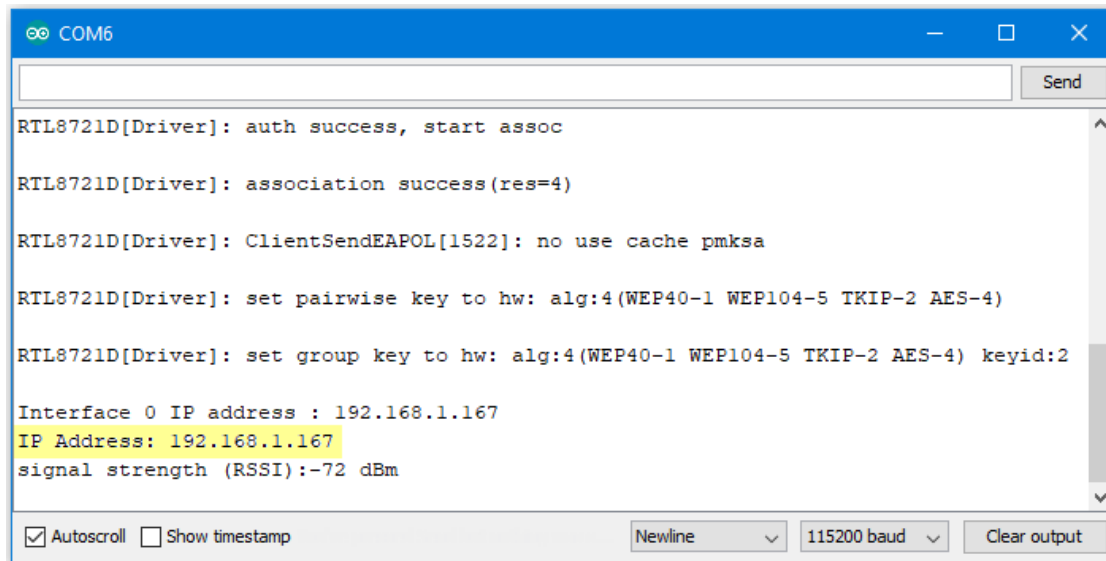


```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; // your network SSID (name)
4 char pass[] = "secretPassword"; // your network password
5 int keyIndex = 0; // your network key Index number (needed only for WEP)
6
7 int status = WL_IDLE_STATUS;
8 WiFiServer server(5000);
9
10 void setup() {
11     Serial.begin(115200); // initialize serial communication
12     pinMode(9, OUTPUT); // set the LED pin mode
13
14     // check for the presence of the shield:
15     if (WiFi.status() == WL_NO_SHIELD) {
16         Serial.println("WiFi shield not present");
17         while (true); // don't continue
18     }
19
20     String fv = WiFi.firmwareVersion();
21     if ( fv != "1.0.0" ) {
22         Serial.println("Please upgrade the firmware");
23     }
24     // attempt to connect to Wifi network:
25     while ( status != WL_CONNECTED) {
26         Serial.print("Attempting to connect to Network named: ");
27         Serial.println(ssid); // print the network name (SSID);
28
29         // Connect to WPA/WPA2 network. Change this line if using open or WEP network

```

In the sample code, modify the highlighted parameters and enter the ssid and password for your WiFi connection.



```

COM6
Send

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

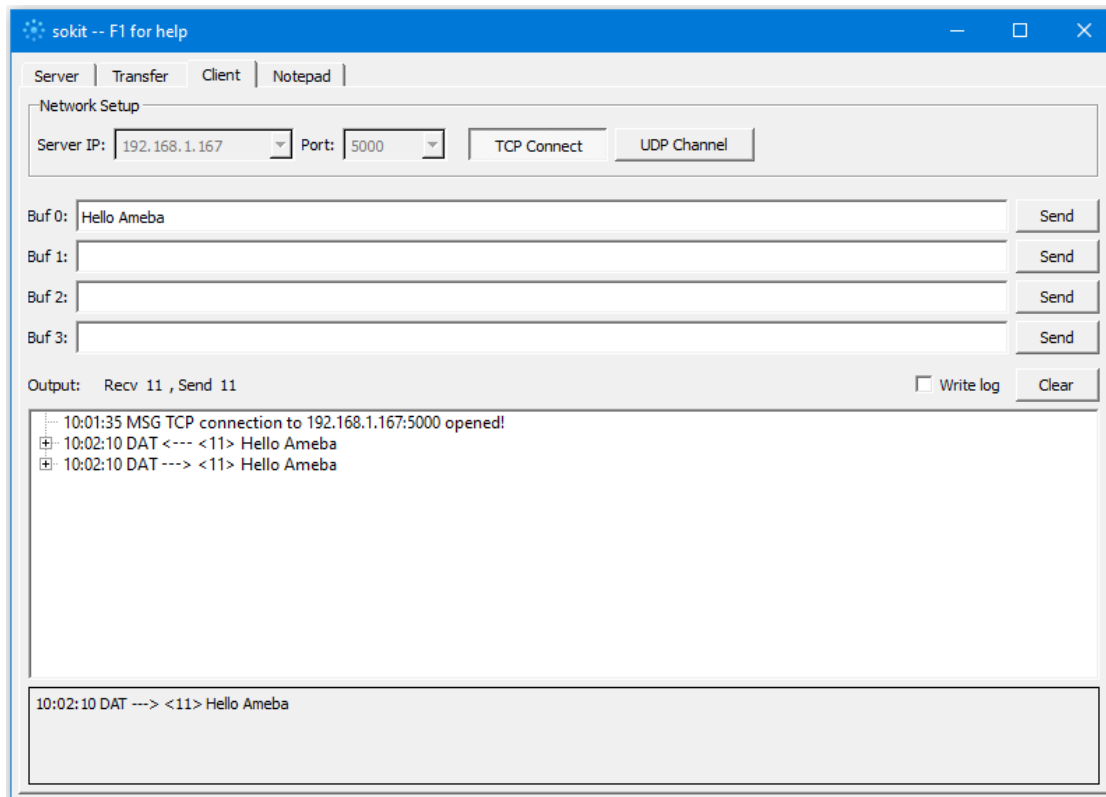
Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-72 dBm

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

Next, upload the code, then press the reset button on Ameba. At this moment, you will see the connection information is displayed in the console.

Next, we use the socket tool in the laptop to be the client and connect to the IP address of the Ameba board shown in the connection information at port 5000. (Note: The socket tool we used in this example is “sokit” )



```

sokit -- F1 for help
Server | Transfer | Client | Notepad |
Network Setup
Server IP: 192.168.1.167 Port: 5000 TCP Connect UDP Channel
Buf 0: Hello Ameba Send
Buf 1: Send
Buf 2: Send
Buf 3: Send
Output: Recv 11 , Send 11 Write log Clear
10:01:35 MSG TCP connection to 192.168.1.167:5000 opened!
10:02:10 DAT <--- <11> Hello Ameba
10:02:10 DAT ---> <11> Hello Ameba
10:02:10 DAT ---> <11> Hello Ameba

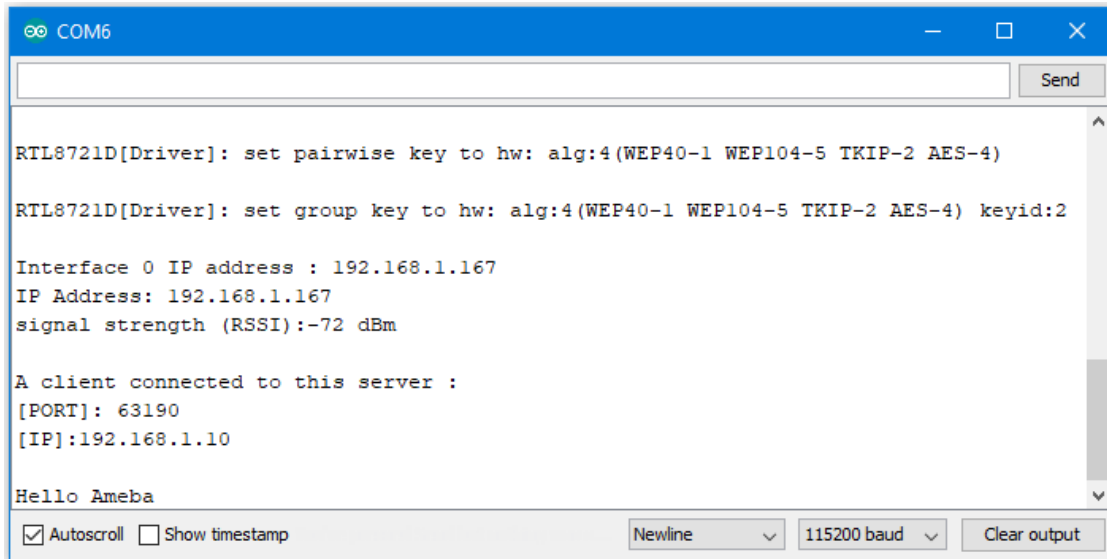
```

Click on the “Client” tab to choose the client mode, specify the IP and port of the server, then click “TCP Connect” .

If the connection is established successfully, the server shows a message: “A client connected to this Server” , and the

IP and port of the connected client.

In this example, when the client and server are connected and the client sends a string to Ameba server, the Ameba server returns the identical string back to the client.



```

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-72 dBm

A client connected to this server :
[PORT]: 63190
[IP]:192.168.1.10

Hello Ameba
  
```

The string sent to server is returned and showed at the client side.

## Code Reference

Use `WiFi.begin()` to establish WiFi connection;

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the Ameba WiFi shield's IP address.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Create server and transmitting data:

Use `Server(port)` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.read()` to read the next byte received from the server.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.write()` to write data to the server.

<https://www.arduino.cc/en/Reference/WiFiClientWrite>

Use `client.stop()` to disconnect from the server.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

## WiFi - Set up Client to Retrieve Google Search Information

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

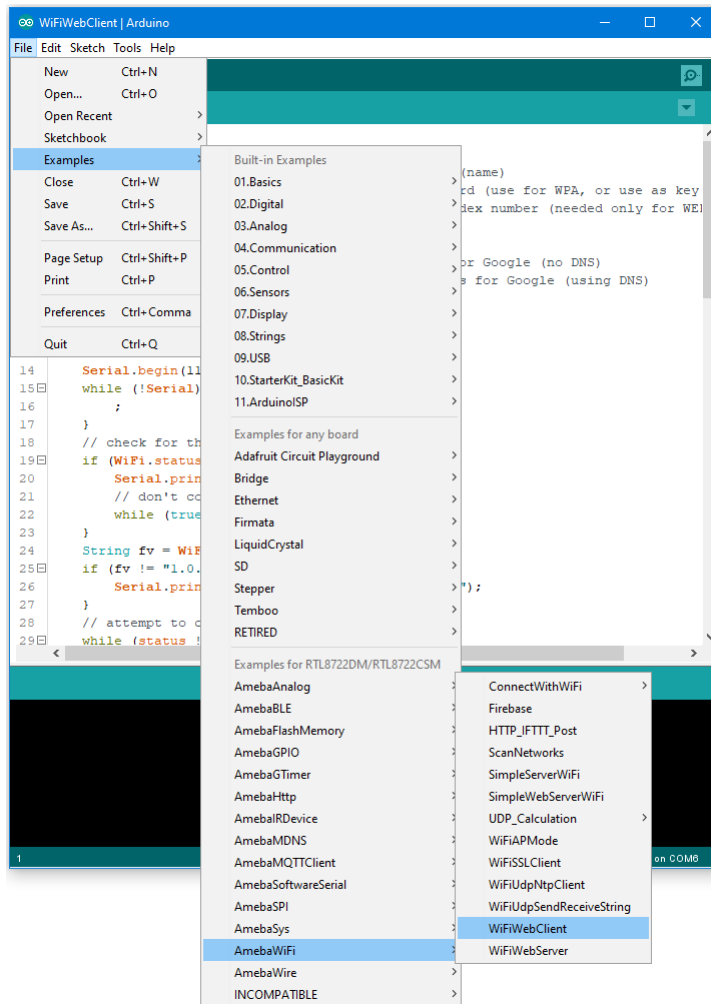
### Example

In this example, we use Ameba to be a web client to retrieve information from the Internet.

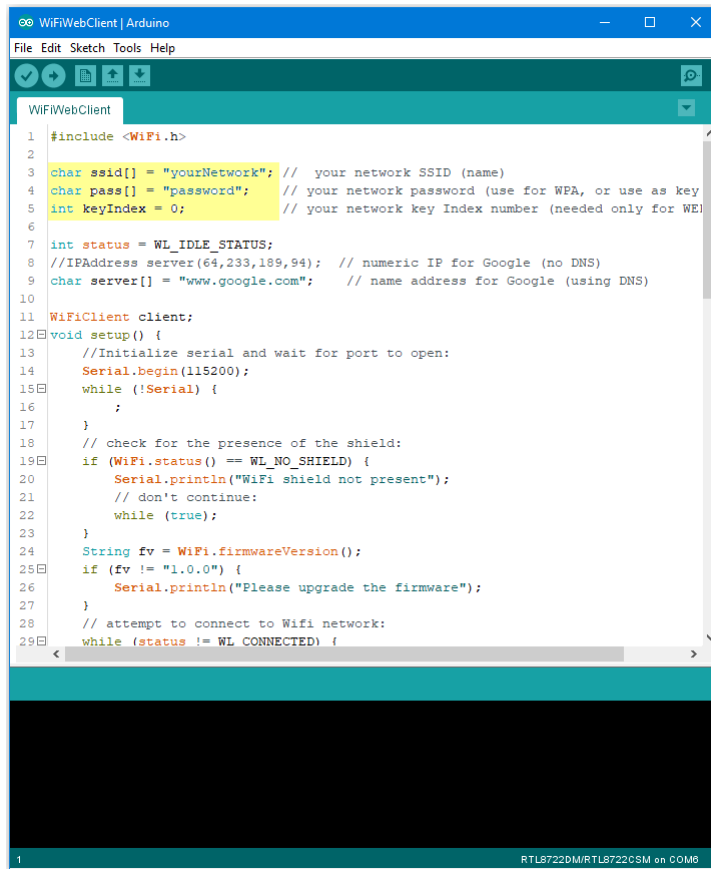
First, make sure the correct Ameba development board is selected in “Tools” -> “Board”

Then open “File” -> “Examples” -> “AmebaWiFi” -> “WiFiWebClient”





In the sample code, modify the highlighted snippet and enter the required information (ssid, password, key index) required to connect to your WiFi network.

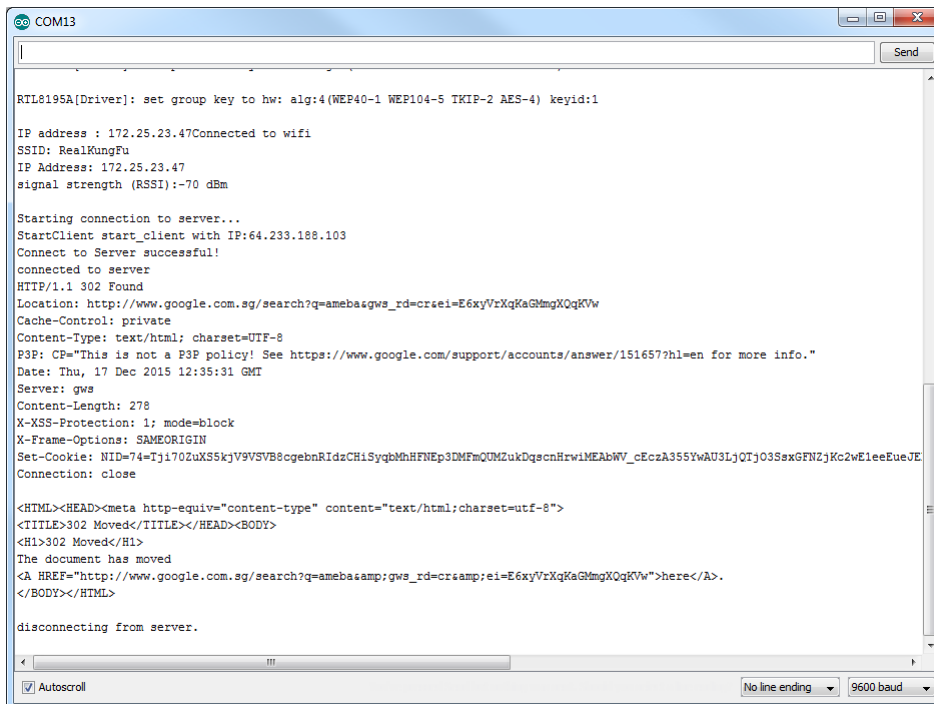


```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; // your network SSID (name)
4 char pass[] = "password"; // your network password (use for WPA, or use as key
5 int keyIndex = 0; // your network key Index number (needed only for WE
6
7 int status = WL_IDLE_STATUS;
8 //IPAddress server(64,233,189,94); // numeric IP for Google (no DNS)
9 char server[] = "www.google.com"; // name address for Google (using DNS)
10
11 WiFiClient client;
12 void setup() {
13     //Initialize serial and wait for port to open:
14     Serial.begin(115200);
15     while (!Serial) {
16         ;
17     }
18     // check for the presence of the shield:
19     if (WiFi.status() == WL_NO_SHIELD) {
20         Serial.println("WiFi shield not present");
21         // don't continue:
22         while (true);
23     }
24     String fv = WiFi.firmwareVersion();
25     if (fv != "1.0.0") {
26         Serial.println("Please upgrade the firmware");
27     }
28     // attempt to connect to Wifi network:
29     while (status != WL_CONNECTED) {

```

Upload the code and press the reset button on Ameba. Then you can see the information retrieved from Google is shown in the Arduino serial monitor.



```

RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

IP address : 172.25.23.47Connected to wifi
SSID: RealKungFu
IP Address: 172.25.23.47
signal strength (RSSI): -70 dBm

Starting connection to server...
StartClient start_client with IP:64.233.188.103
Connect to Server successful!
connected to server
HTTP/1.1 302 Found
Location: http://www.google.com.sg/search?q=amebas&gws_rd=cr&ei=E6xyVrXqKaGmngXQqKVw
Cache-Control: private
Content-Type: text/html; charset=UTF-8
P3P: CP="This is not a P3P policy! See https://www.google.com/support/accounts/answer/151657?hl=en for more info."
Date: Thu, 17 Dec 2015 12:35:31 GMT
Server: gws
Content-Length: 278
X-XSS-Protection: 1; mode=block
X-Frame-Options: SAMEORIGIN
Set-Cookie: NID=74=Tji70ZuX55kjV9VSVB8cgebnRIdzChISyqkMhHFNEp3DMFmQUMZukDqscnHrwiMEAbWV_cEcA355YwAU3LjQTj03SsxGFNZjKc2wE1eeEueJE
Connection: close

<HTML><HEAD><meta http-equiv="content-type" content="text/html; charset=utf-8">
<TITLE>302 Moved</TITLE></HEAD><BODY>
<H1>302 Moved</H1>
The document has moved
<A HREF="http://www.google.com.sg/search?q=amebas&gws_rd=cr&ei=E6xyVrXqKaGmngXQqKVw">here</A>.
</BODY></HTML>

disconnecting from server.

```

## Code Reference

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection: Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiClient()` to create a client.

<https://www.arduino.cc/en/Reference/WiFiClient>

Use `client.connect()` to connect to the IP address and port specified.

<https://www.arduino.cc/en/Reference/WiFiClientConnect>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

## WiFi - Set up UDP Server to Communicate

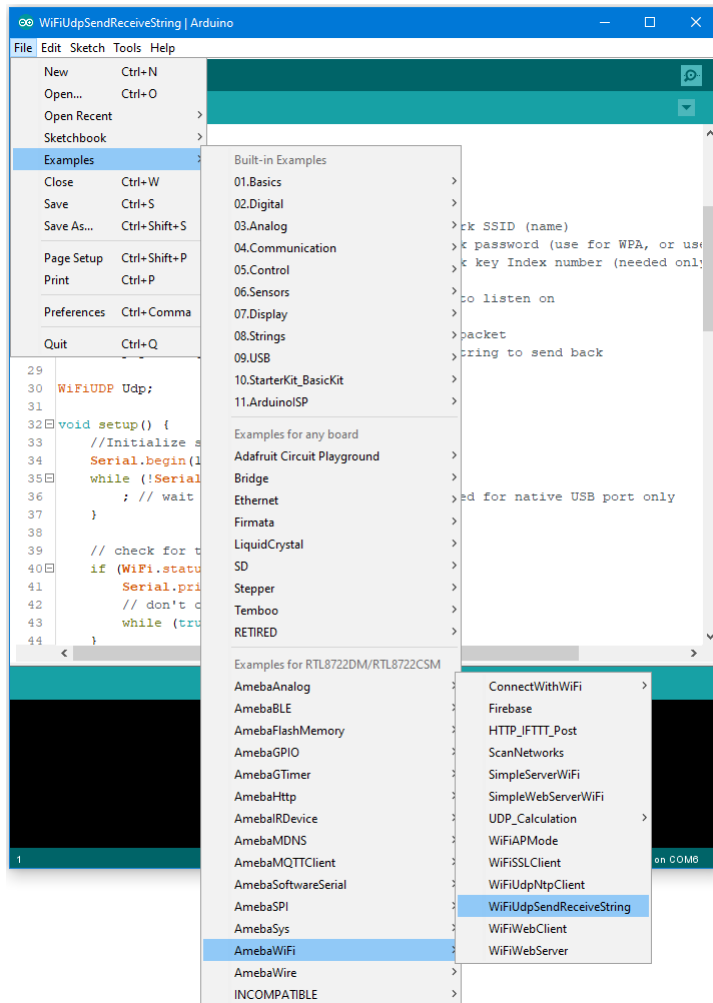
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we connect Ameba to WiFi and use Ameba to be an UDP server. When Ameba receives a message from UDP client, it replies “acknowledged” message to client.

Open the WiFi Web Server example. “File” -> “Examples” -> “AmebaWiFi” -> “WiFiUdpSendReceiveString”



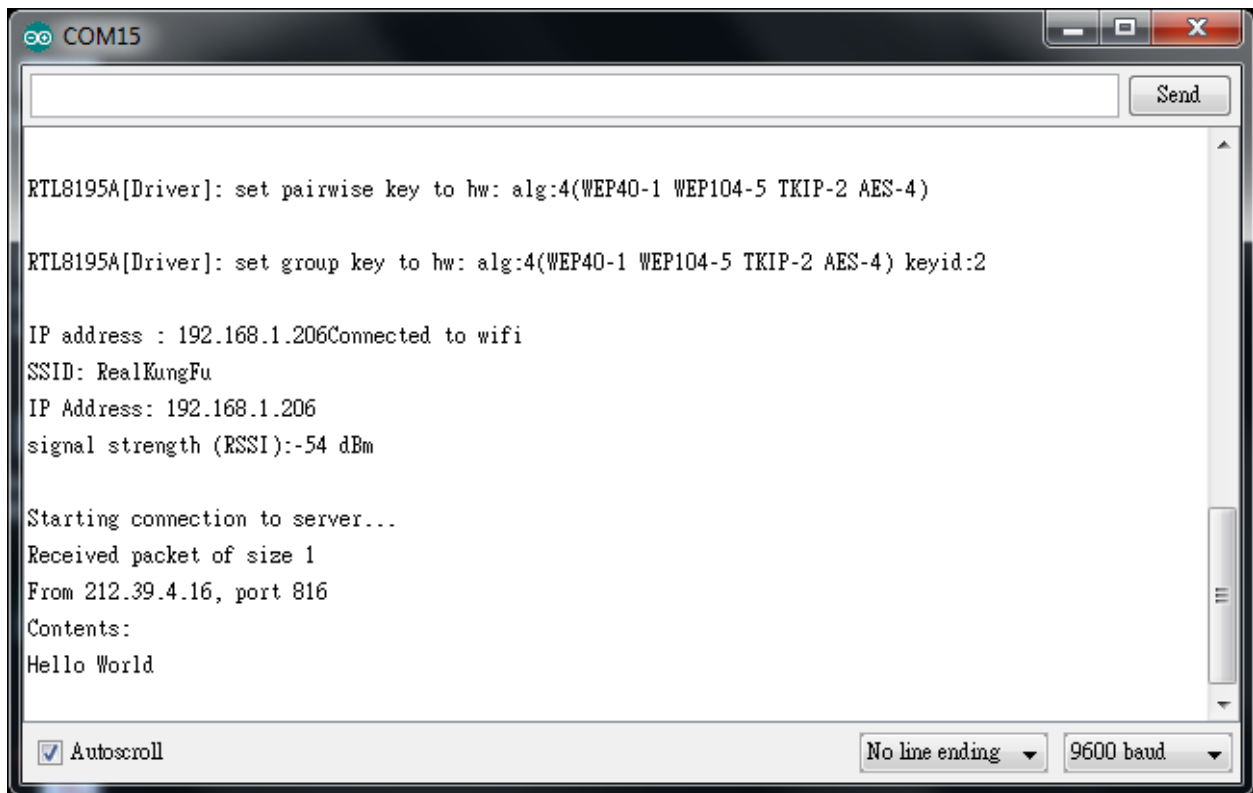
Modify the highlighted code section (ssid, password, keyindex) to connect to your WiFi network.

```

WiFiUdpSendReceiveString | Arduino
File Edit Sketch Tools Help

WiFiUdpSendReceiveString
16
17 #include <WiFi.h>
18 #include <WiFiUdp.h>
19
20 int status = WL_IDLE_STATUS;
21 char ssid[] = "yourNetwork"; // your network SSID (name)
22 char pass[] = "secretPassword"; // your network password (use for WPA, or use
23 int keyIndex = 0; // your network key Index number (needed only)
24
25 unsigned int localPort = 2390; // local port to listen on
26
27 char packetBuffer[255]; //buffer to hold incoming packet
28 char ReplyBuffer[] = "acknowledged"; // a string to send back
29
30 WiFiUDP Udp;
31
32 void setup() {
33     //Initialize serial and wait for port to open:
34     Serial.begin(115200);
35     while (!Serial) {
36         ; // wait for serial port to connect. Needed for native USB port only
37     }
38
39     // check for the presence of the shield:
40     if (WiFi.status() == WL_NO_SHIELD) {
41         Serial.println("WiFi shield not present");
42         // don't continue:
43         while (true);
44     }
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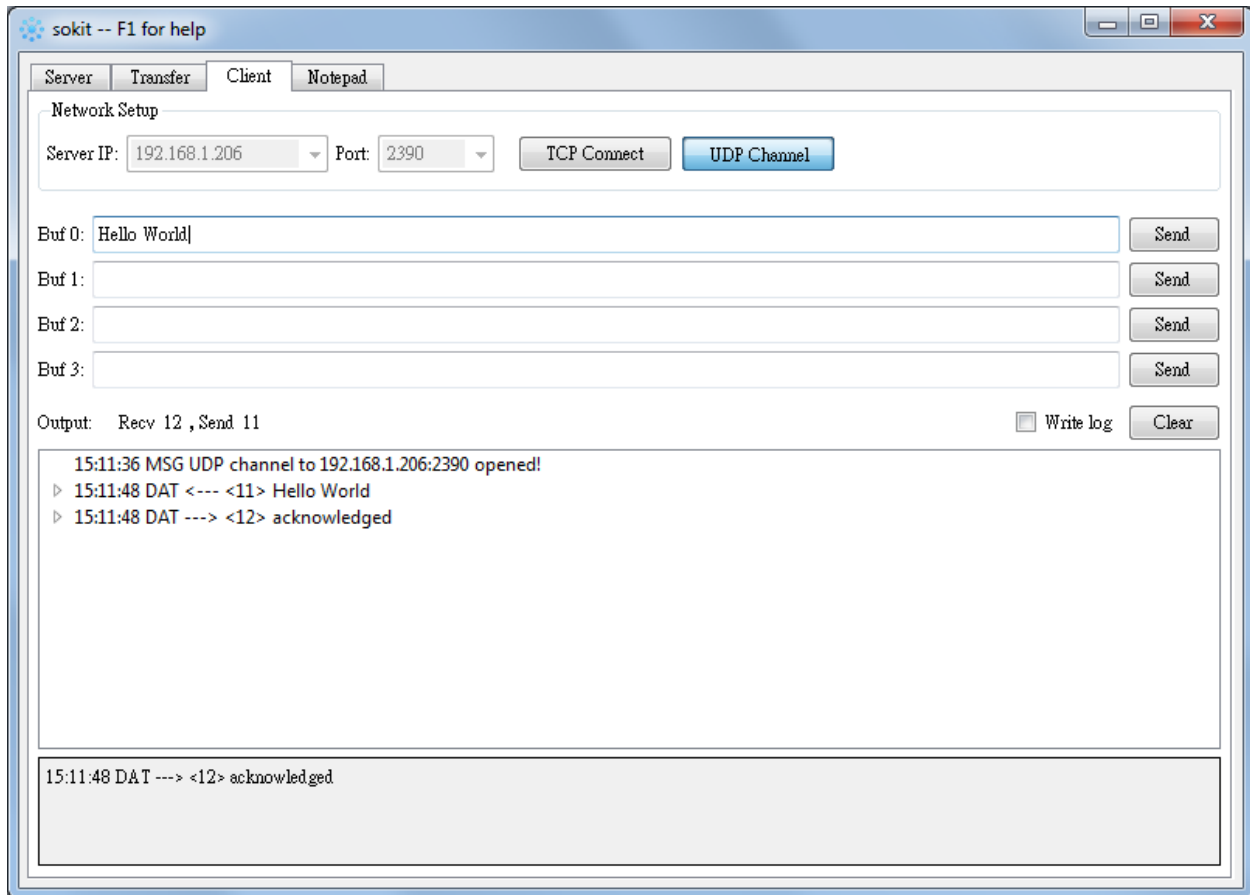
```



As to the UDP client, we use “sokit” program in the computer to connect to UDP server.

Choose client mode and fill in the IP of UDP server (which is the IP of Ameba) and port 2390, then click “UDP Connect” .

After the connection is established, fill in “Hello World” in the Buf 0 field in sokit and click “Send” . Then you can see the Ameba UDP server replies “acknowledged” .



## Code Reference

Refer to the Arduino tutorial for detailed information about this example.

<https://www.arduino.cc/en/Tutorial/WiFiSendReceiveUDPString>

First, use `begin()` to open an UDP port on Ameba.

<https://www.arduino.cc/en/Reference/WiFiUDPBgin>

Use `parsePacket()` to wait for data from client.

<https://www.arduino.cc/en/Reference/WiFiUDPParsePacket>

When a connection is established, use `remoteIP()` and `remotePort()` to get the IP and port of the client.

<https://www.arduino.cc/en/Reference/WiFiUDPRemoteIP>

Then use `read()` to read the data sent by client.

<https://www.arduino.cc/en/Reference/WiFiUDPRead>

To send reply, use `beginPacket()`, `write()`, `end()`.

<https://www.arduino.cc/en/Reference/WiFiUDPBeginPacket>

<https://www.arduino.cc/en/Reference/WiFiUDPWrite>

<https://www.arduino.cc/en/Reference/WiFiUDPEndPacket>

## WiFi - Set up WiFi AP Mode

In AP mode, Ameba can accept at most 3 station connections, and can be set to open mode or WPA2 mode.

### Preparation

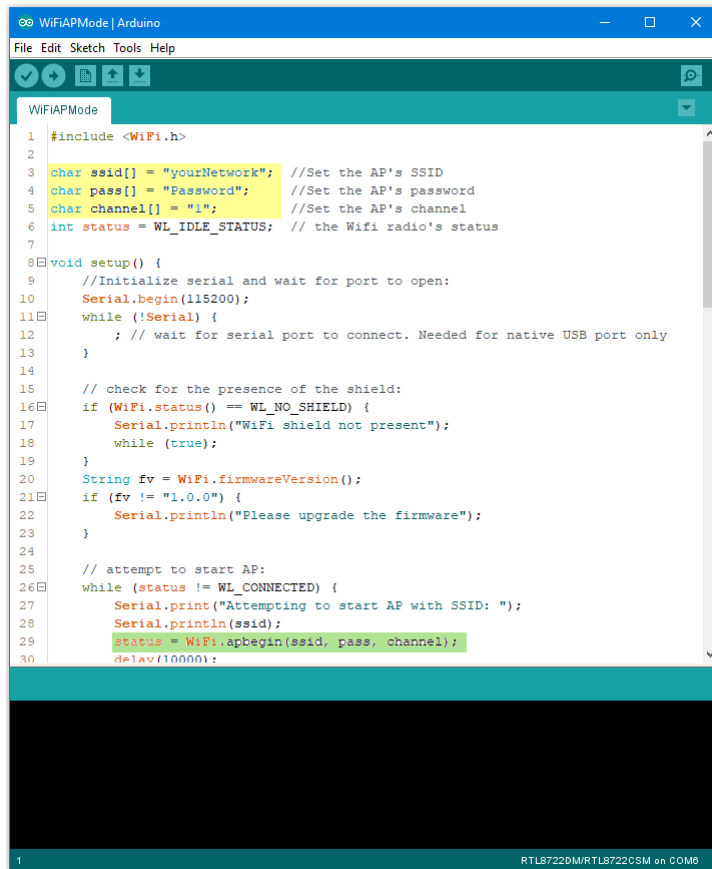
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we turn on the AP mode of Ameba and connect station to Ameba.

Open the WiFi AP example, “File” -> “Examples” -> “AmebaWiFi” -> “WiFiAPMode”





```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; //Set the AP's SSID
4 char pass[] = "Password"; //Set the AP's password
5 char channel[] = "1"; //Set the AP's channel
6 int status = WL_IDLE_STATUS; // the Wifi radio's status
7
8 void setup() {
9     //Initialize serial and wait for port to open:
10    Serial.begin(115200);
11    while (!Serial) {
12        ; // wait for serial port to connect. Needed for native USB port only
13    }
14
15    // check for the presence of the shield:
16    if (WiFi.status() == WL_NO_SHIELD) {
17        Serial.println("WiFi shield not present");
18        while (true);
19    }
20    String fw = WiFi.firmwareVersion();
21    if (fw != "1.0.0") {
22        Serial.println("Please upgrade the firmware");
23    }
24
25    // attempt to start AP:
26    while (status != WL_CONNECTED) {
27        Serial.print("Attempting to start AP with SSID: ");
28        Serial.println(ssid);
29        status = WiFi.softAPSecure(ssid, pass, channel);
30        delay(10000);

```

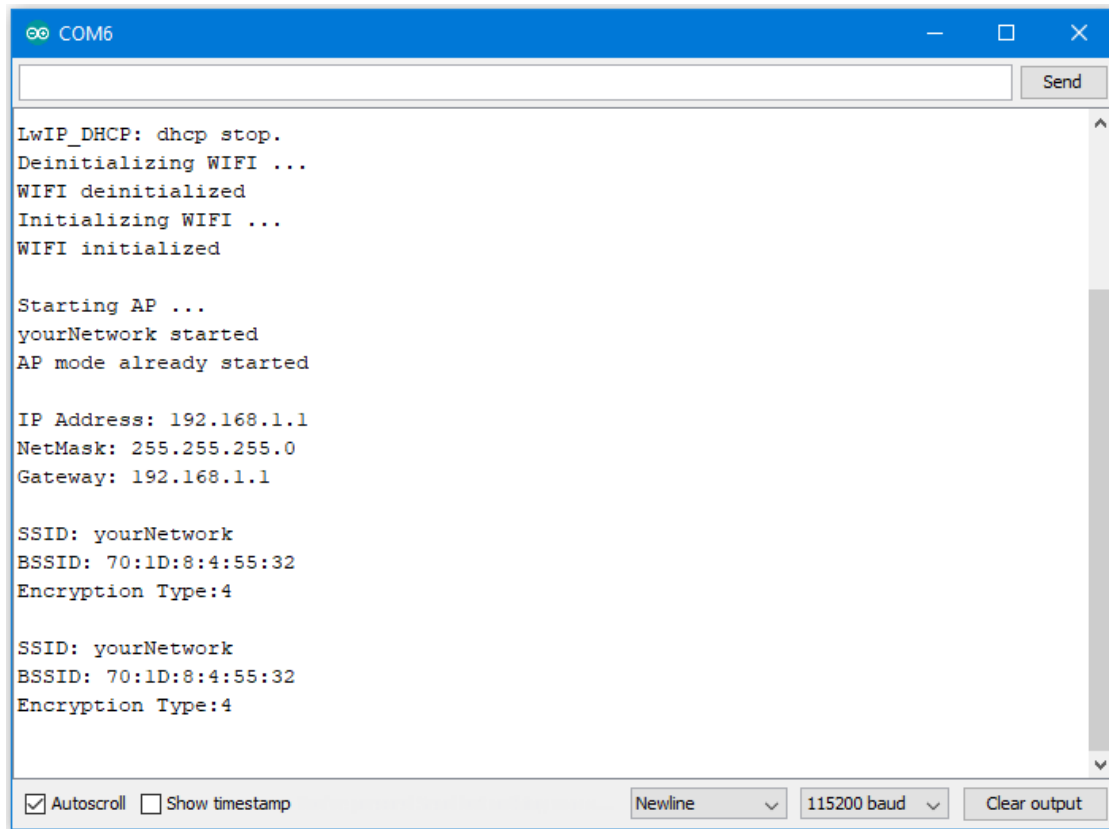
In the highlighted code snippet, fill in your SSID, PASSWORD and CHANNEL.

The code highlighted in green is the API we used to turn on the AP mode in security mode.

If you want to turn on the AP mode in open mode, please modify the code to

```
status = WiFi.softAP(ssid, channel);
```

Then upload the sample code and press reset, and you can see related information shown in serial monitor.



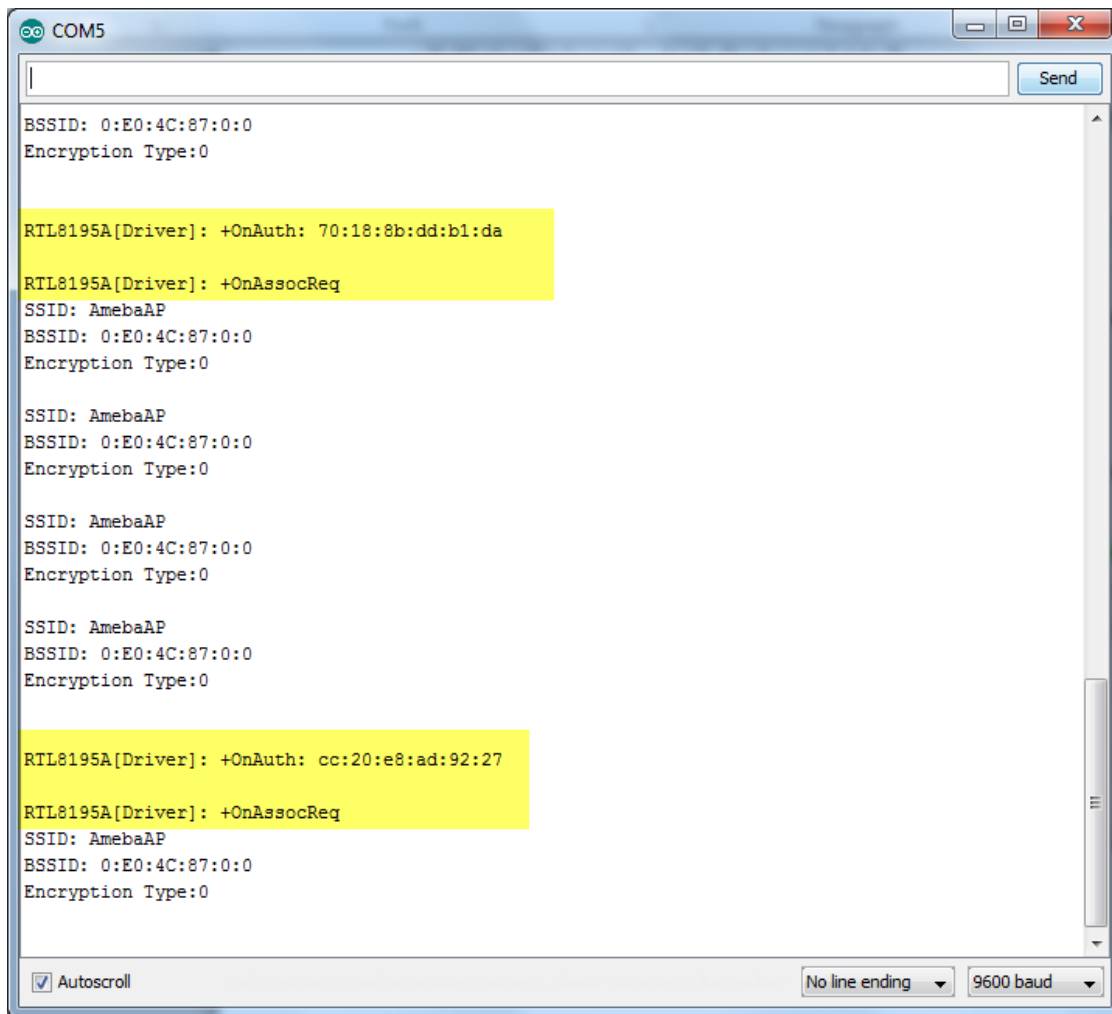
The screenshot shows a serial monitor window with a blue title bar labeled 'COM6'. The window contains a text area with the following log output:

```
LwIP_DHCP: dhcp stop.  
Deinitializing WIFI ...  
WIFI deinitialized  
Initializing WIFI ...  
WIFI initialized  
  
Starting AP ...  
yourNetwork started  
AP mode already started  
  
IP Address: 192.168.1.1  
NetMask: 255.255.255.0  
Gateway: 192.168.1.1  
  
SSID: yourNetwork  
BSSID: 70:1D:8:4:55:32  
Encryption Type:4  
  
SSID: yourNetwork  
BSSID: 70:1D:8:4:55:32  
Encryption Type:4
```

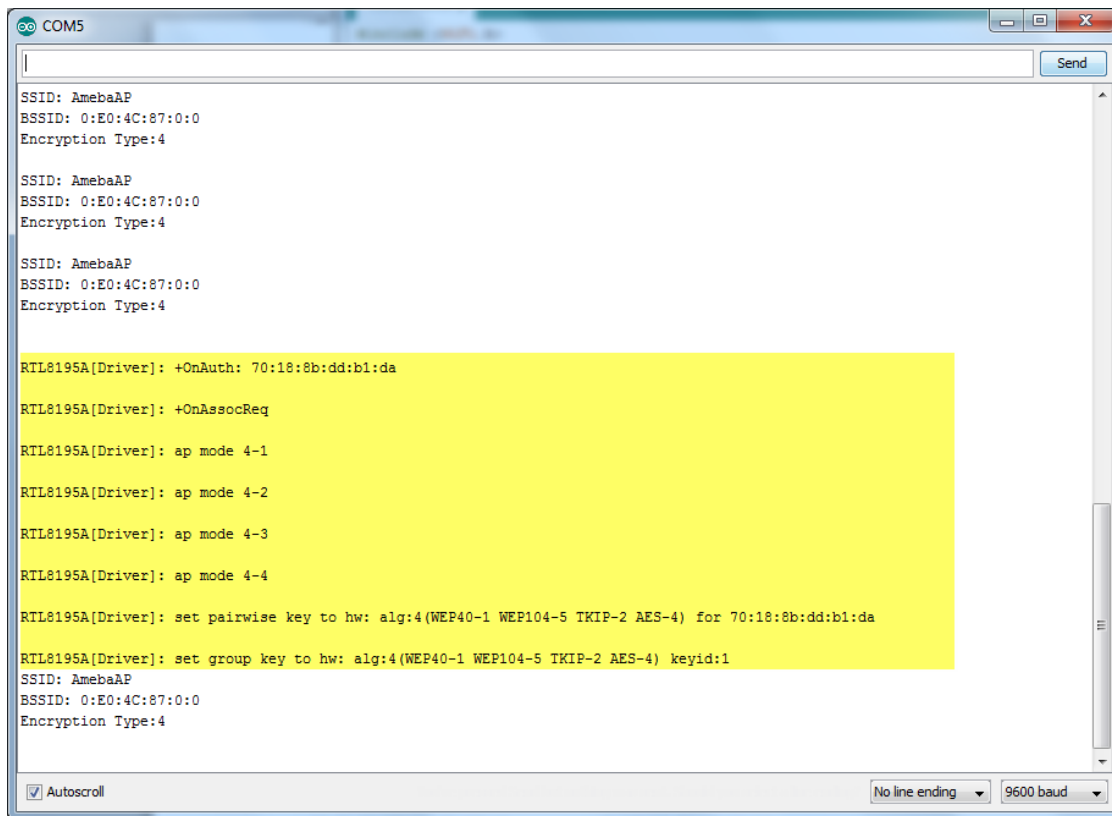
At the bottom of the window, there is a control bar with the following elements from left to right:

- Two checkboxes: ☒ Autoscroll and ☐ Show timestamp.
- A dropdown menu currently set to 'Newline'.
- A dropdown menu currently set to '115200 baud'.
- A 'Clear output' button.

In the figure below, we show the messages shown in serial monitor when two stations connect to Ameba AP in open mode:



In the figure below, we show the messages shown in serial monitor when a station connects to Ameba AP in security mode:



## WiFi - Set up SSL Client for HTTPS Communication

### Materials

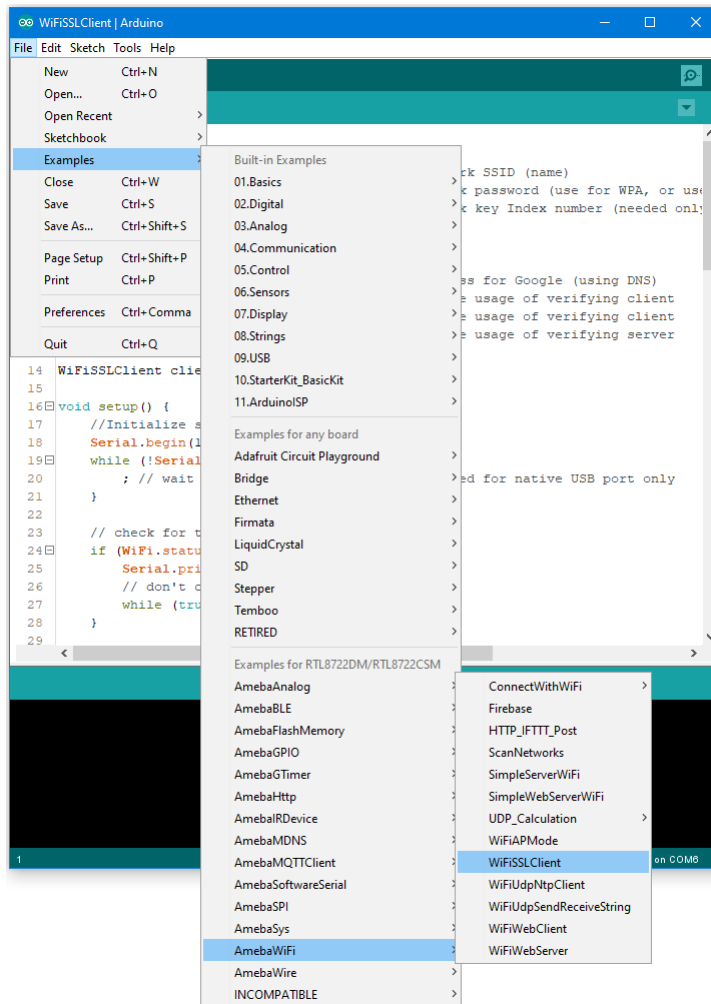
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

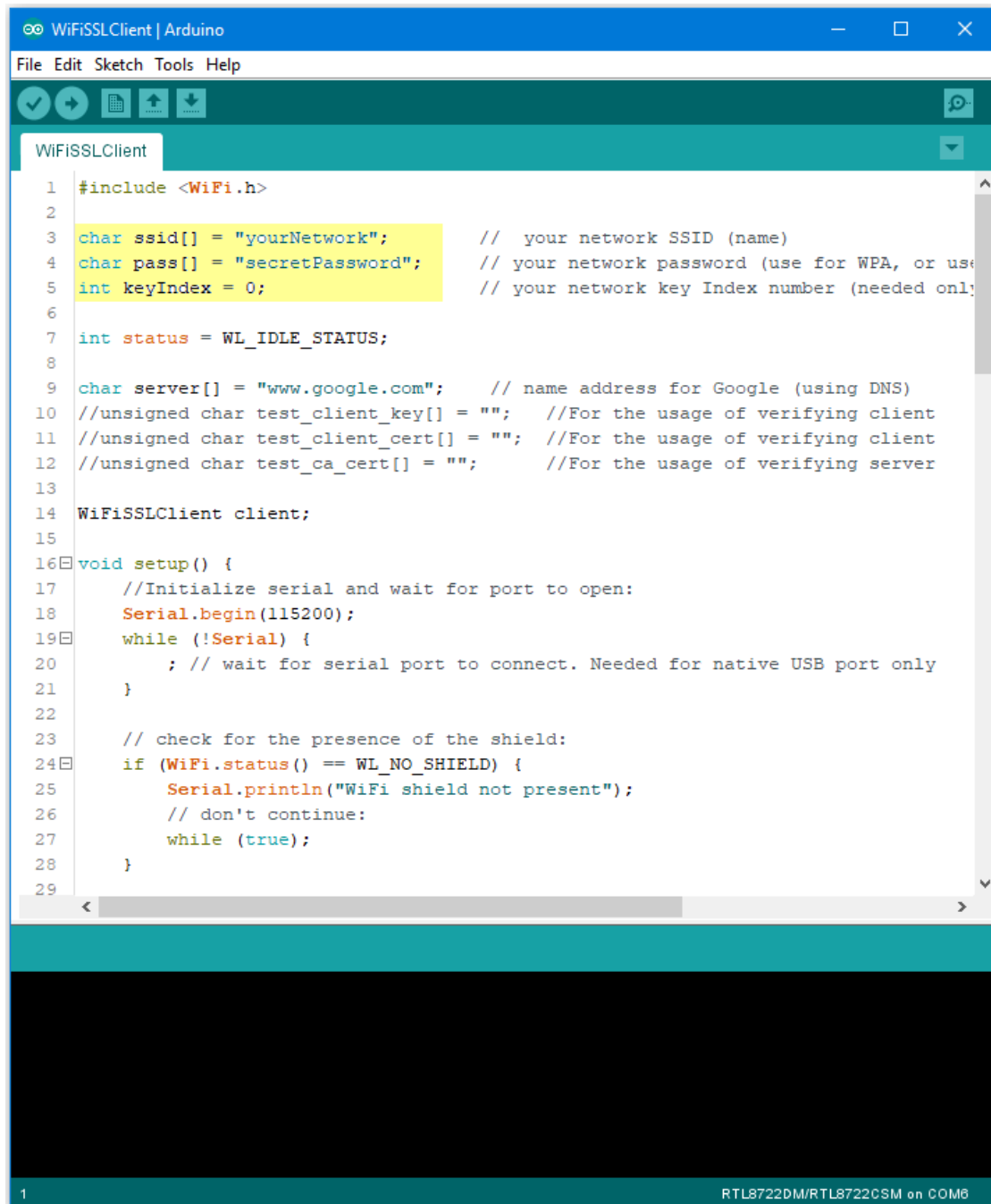
This example uses Ameba to securely retrieve information from the internet using SSL. SSL is an acronym for Secure Sockets Layer. It is a cryptographic protocol designed to provide communications security over a computer network, by encrypting the messages passed between server and client.

Open the “WiFiSSLClient” example in “File” -> “Examples” -> “AmebaWiFi” -> “WiFiSSLClient”

.



In the sample code, modify the highlighted snippet to reflect your WiFi network settings.

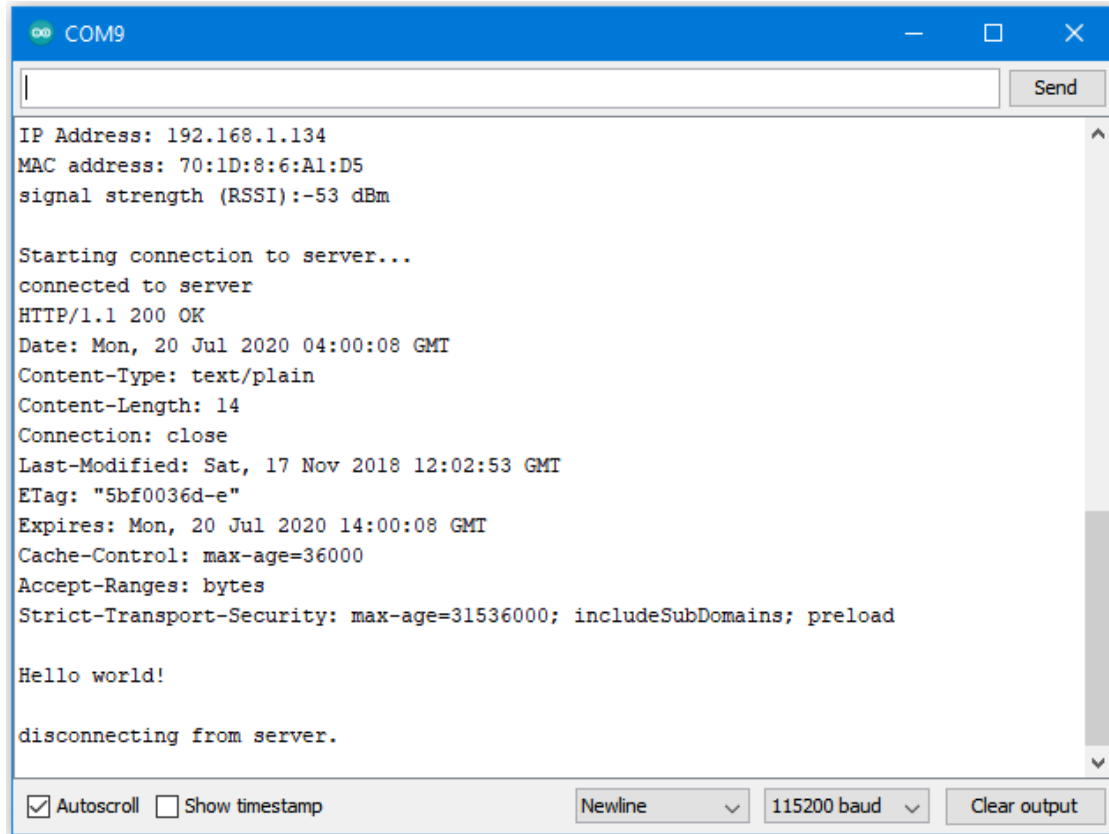


```
1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork";    // your network SSID (name)
4 char pass[] = "secretPassword"; // your network password (use for WPA, or use
5 int keyIndex = 0;               // your network key Index number (needed only
6
7 int status = WL_IDLE_STATUS;
8
9 char server[] = "www.google.com"; // name address for Google (using DNS)
10 //unsigned char test_client_key[] = ""; //For the usage of verifying client
11 //unsigned char test_client_cert[] = ""; //For the usage of verifying client
12 //unsigned char test_ca_cert[] = ""; //For the usage of verifying server
13
14 WiFiSSLClient client;
15
16 void setup() {
17     //Initialize serial and wait for port to open:
18     Serial.begin(115200);
19     while (!Serial) {
20         ; // wait for serial port to connect. Needed for native USB port only
21     }
22
23     // check for the presence of the shield:
24     if (WiFi.status() == WL_NO_SHIELD) {
25         Serial.println("WiFi shield not present");
26         // don't continue:
27         while (true);
28     }
29 }
```

1 RTL8722DM/RTL8722CSM on COM8

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in the Arduino IDE and observe as Ameba retrieves a text file from [os.mbed.com](https://os.mbed.com).



```
COM9

IP Address: 192.168.1.134
MAC address: 70:1D:8:6:A1:D5
signal strength (RSSI):-53 dBm

Starting connection to server...
connected to server
HTTP/1.1 200 OK
Date: Mon, 20 Jul 2020 04:00:08 GMT
Content-Type: text/plain
Content-Length: 14
Connection: close
Last-Modified: Sat, 17 Nov 2018 12:02:53 GMT
ETag: "5bf0036d-e"
Expires: Mon, 20 Jul 2020 14:00:08 GMT
Cache-Control: max-age=36000
Accept-Ranges: bytes
Strict-Transport-Security: max-age=31536000; includeSubDomains; preload

Hello world!

disconnecting from server.
```

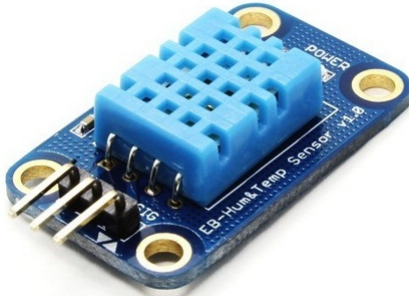

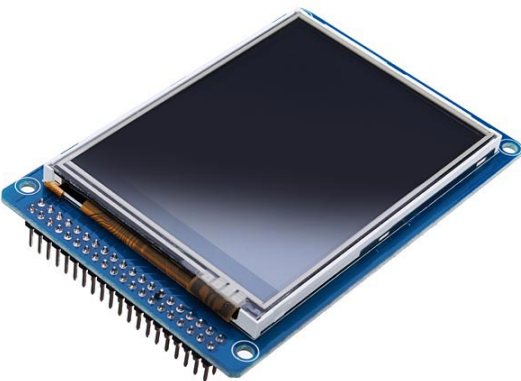


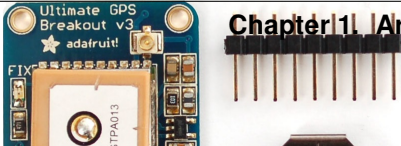
☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

## Code Reference

Use “WiFiSSLClient client;” to create a client that uses SSL. After creation, the client can be used in the same way as a regular client.

Components Used

表格 5: Components used in Examples

	
DHT11_DHT22 Humidity & temperature sensor	HC_SR04 Distance measurement function
	
ILI9341 TFT LCD TFT LCD display with SPI interface	PMS3003/5003 Air quality sensor that detects concentration of micro particulate matters
	



## Peripheral Examples

### Audio Codec –Basic Input Output

#### Materials

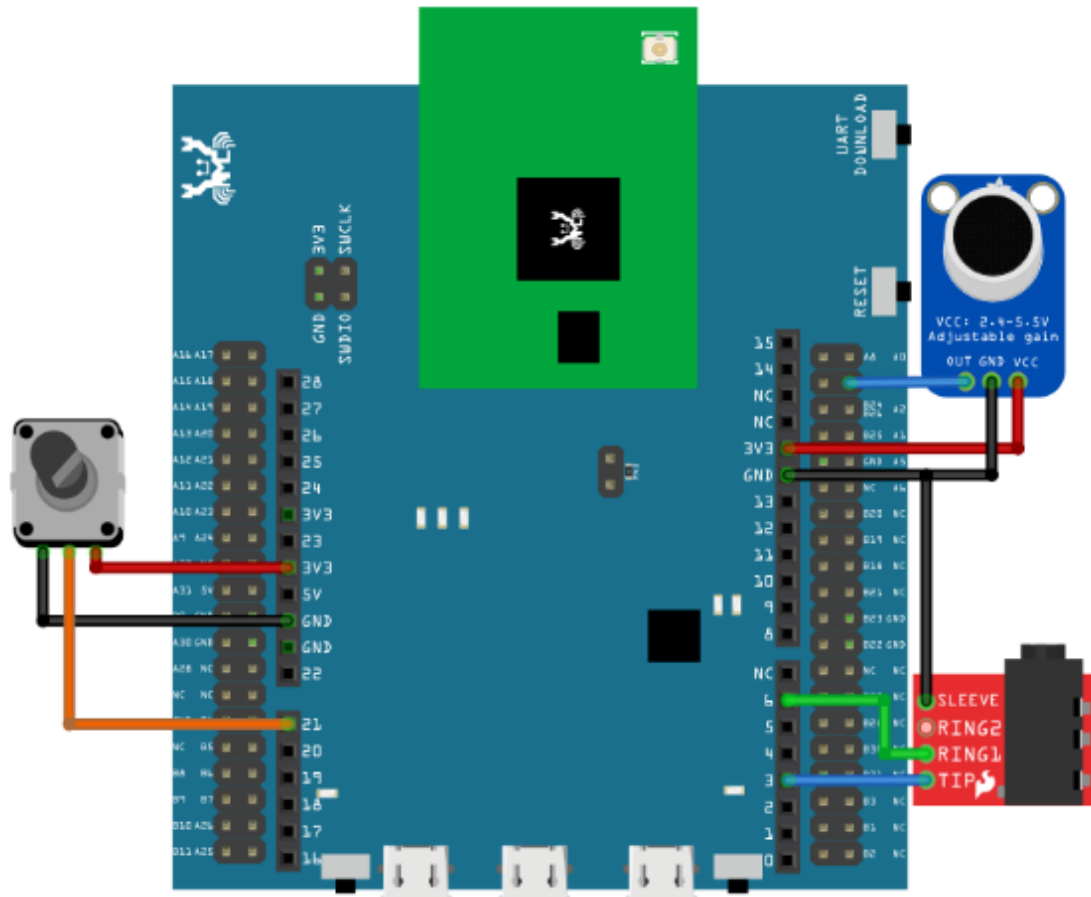
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Potentiometer x 1
- Analog microphone x 1 (e.g., Adafruit 1063 / 1064)
- 3.5mm TRS/TRRS breakout x 1 (e.g., Adafruit 2791 / Sparkfun 11570)

#### Example

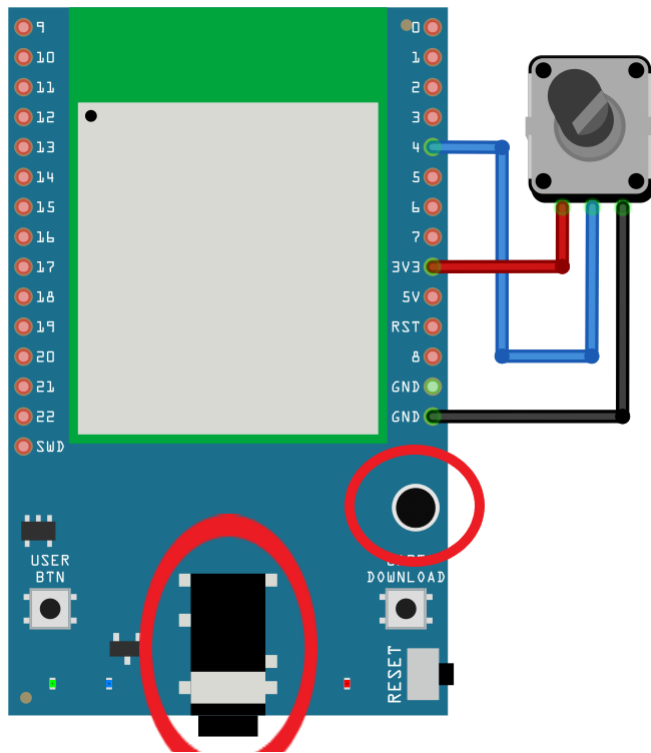
#### Procedure

Connect the potentiometer, microphone and 3.5mm connector to the RTL8722 board following the diagram.

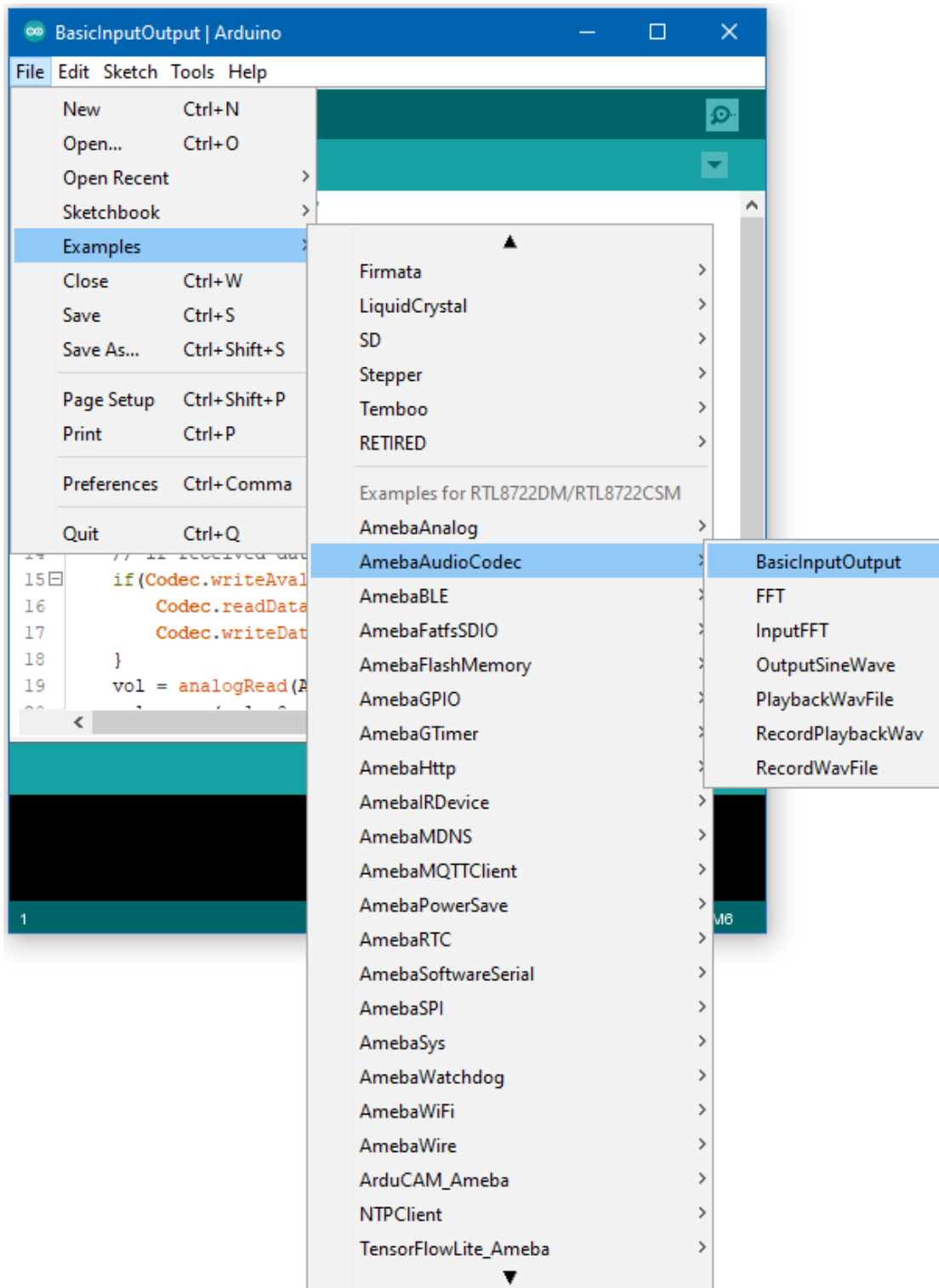
**AMB21 / AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



Open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "BasicInputOutput".



Upload the code and press the reset button on Ameba once the upload is finished.

Connect a pair of wired headphones to the 3.5mm audio jack, blow at the microphone, and you should hear the sounds picked-up by the microphone replayed in the headphones. Adjust the potentiometer and the output volume will change as well. Note: if you are using a microphone with an amplifier included, such as Adafruit 1063, the amplifier can lead to

the microphone picking up more noise.

## Audio Codec - FFT

### Materials

- AmebaD [AMB21 / AMB22 / AMB23] x 1

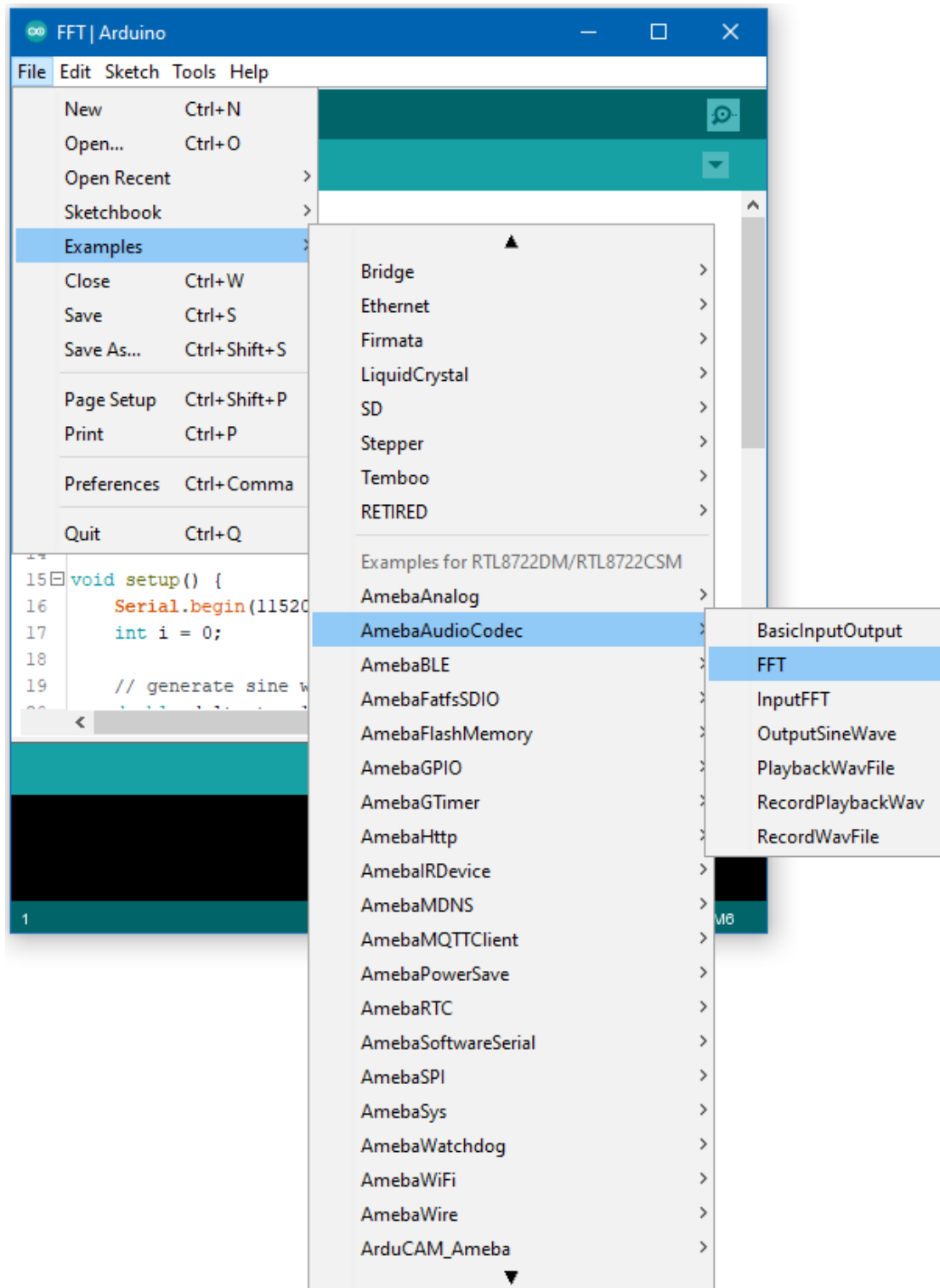
### Example

### Introduction

This example shows how to use the AudioCodec\_FFT class to calculate the fast Fourier transform of a signal to extract the frequencies present in the signal.

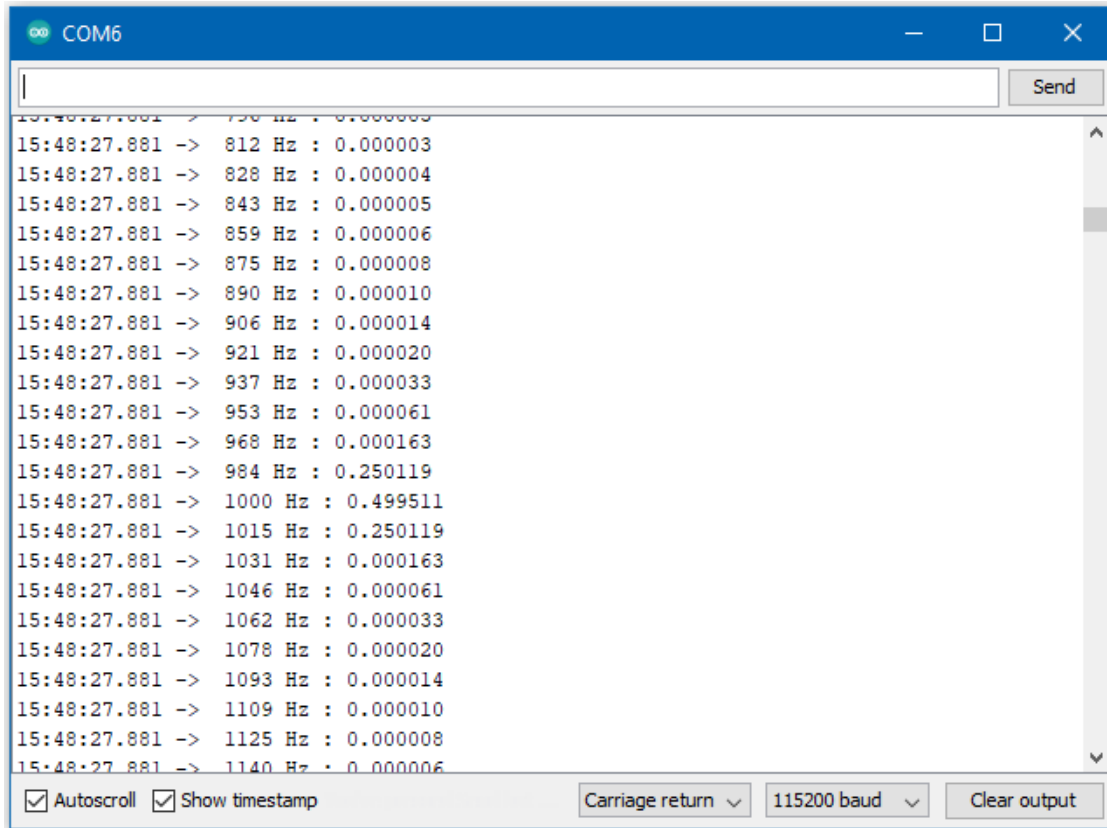
### Procedure

Open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "FFT" .



Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor, and the output results of the AudioCodec\_FFT calculation will be displayed.



## Audio Codec - Input FFT

### Materials

- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Analog microphone x 1 (e.g., Adafruit 1063 / 1064)

### Example

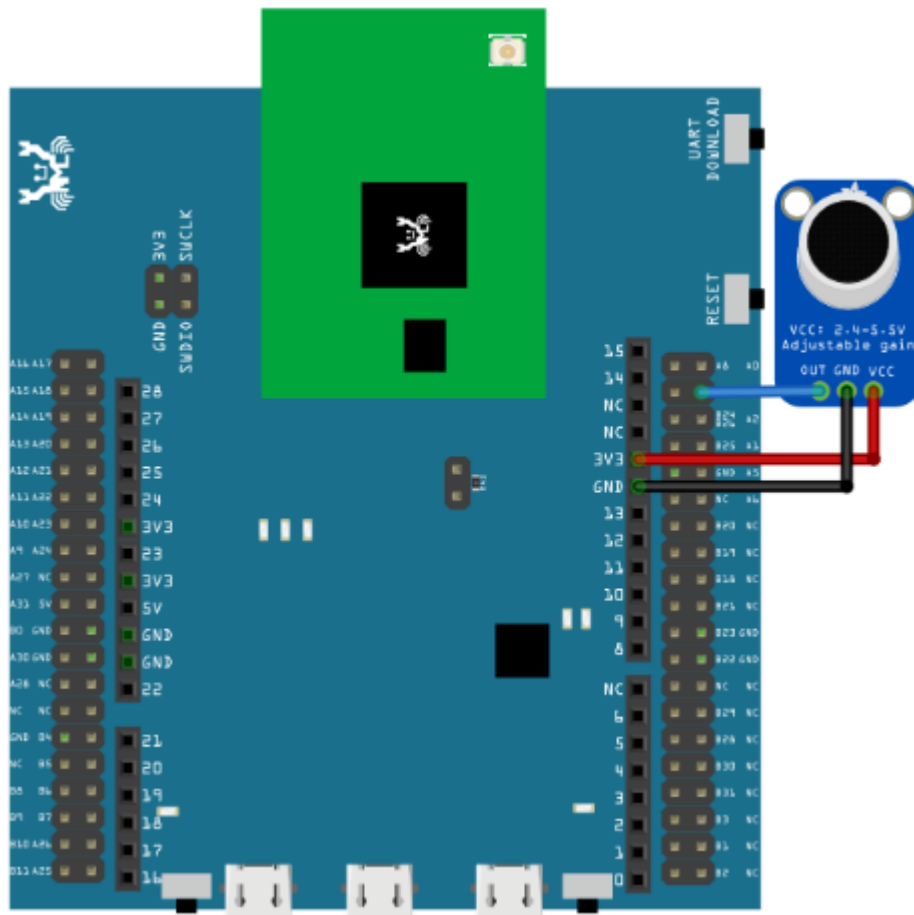
### Introduction

This example shows how to use the FFT class to calculate the fast Fourier transform of the audio signal recorded by the microphone.

### Procedure

Connect the microphone to the RTL8722 board following the diagram.

## AMB21 / AMB22 Wiring Diagram:

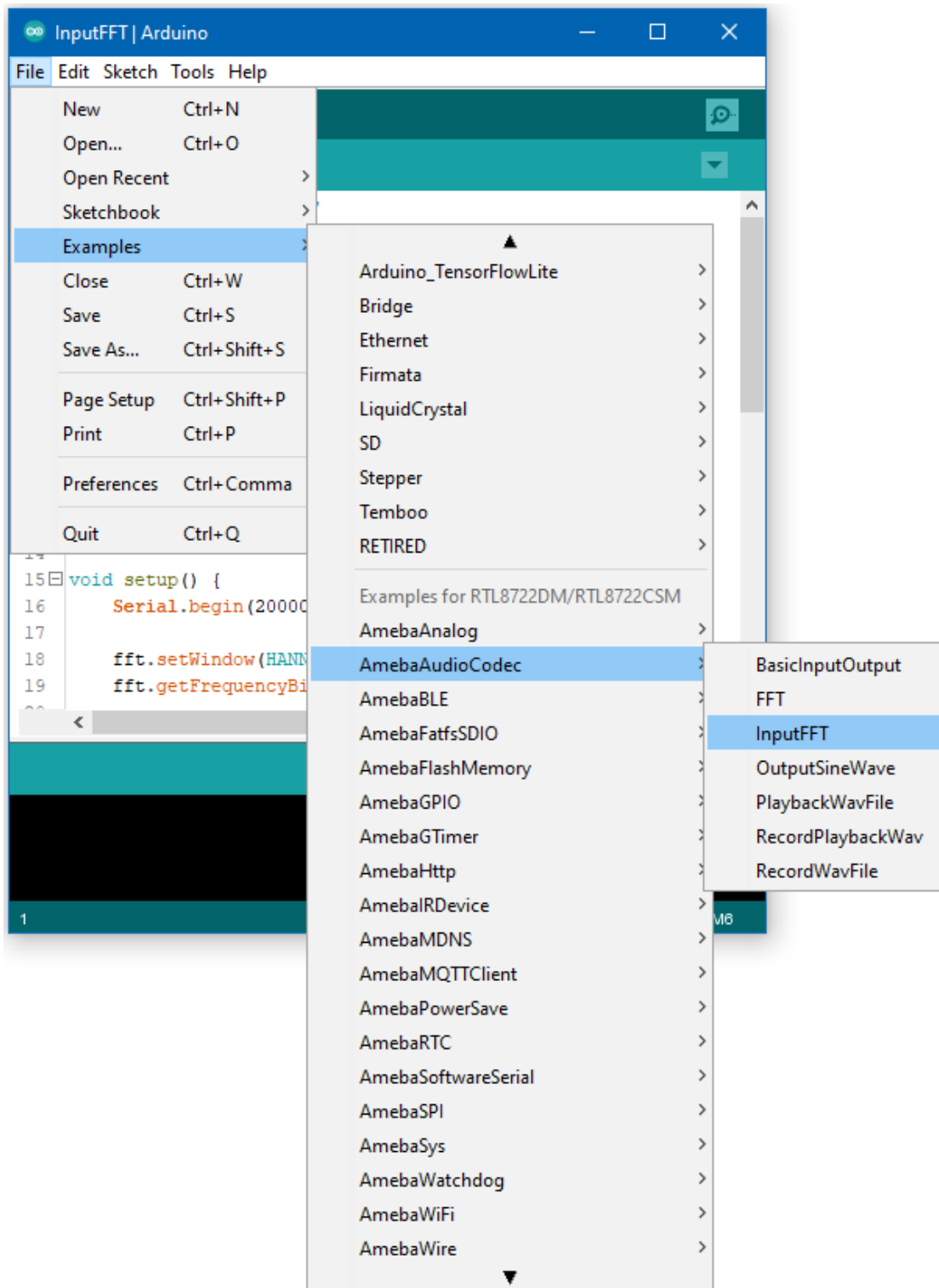


## AMB23 Wiring Diagram:

As AMB23 have a built in microphone on the board, there is no need for any external microphone.

Next, open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "InputFFT".

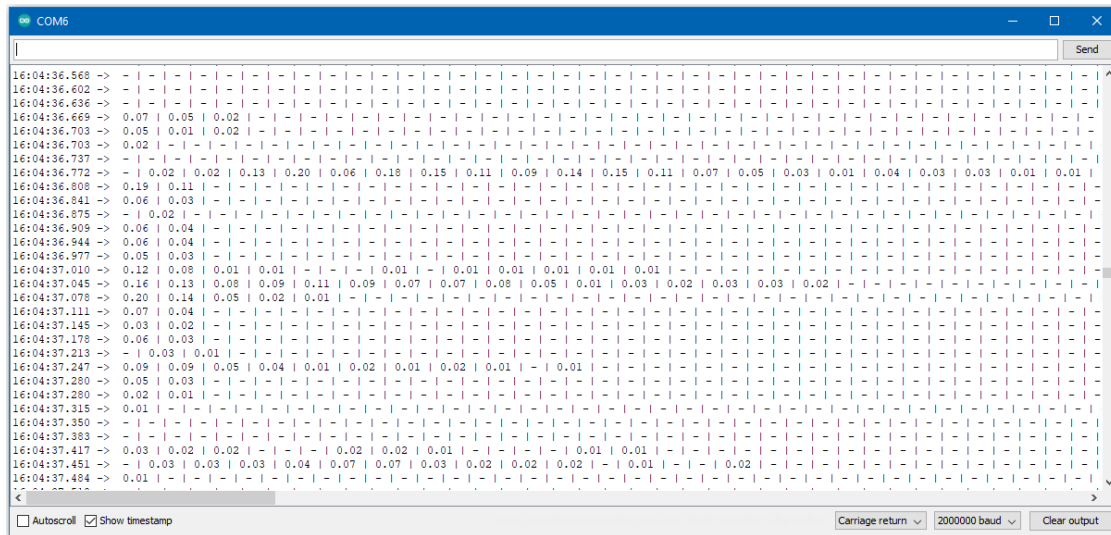




Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor and change the baud rate to 2000000. A stream of FFT results of audio samples will be displayed. Try playing music or use a smartphone app to generate a sine wave into the microphone, and you should be

able to see the FFT output change.



## Audio Codec –Output Sine Wave

### Materials

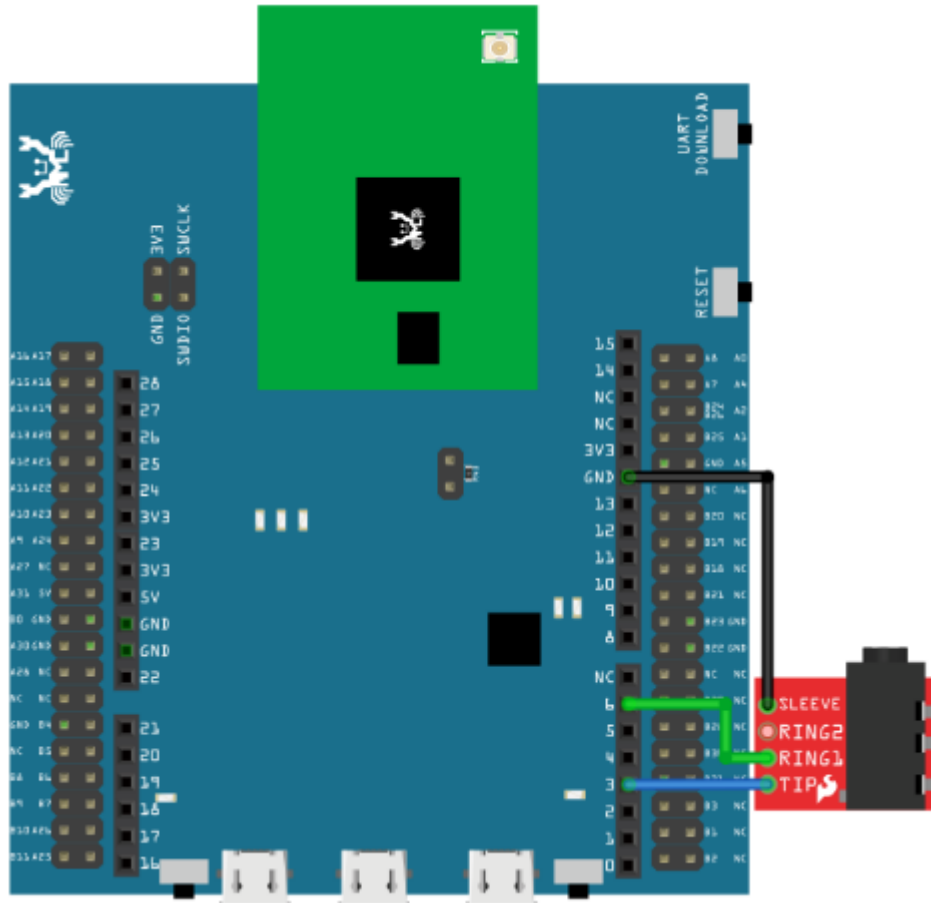
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- 3.5mm TRS/TRRS breakout x 1 (e.g., Adafruit 2791 / Sparkfun 11570)

### Example

### Procedure

#### AMB21 / AMB22 Wiring Diagram:

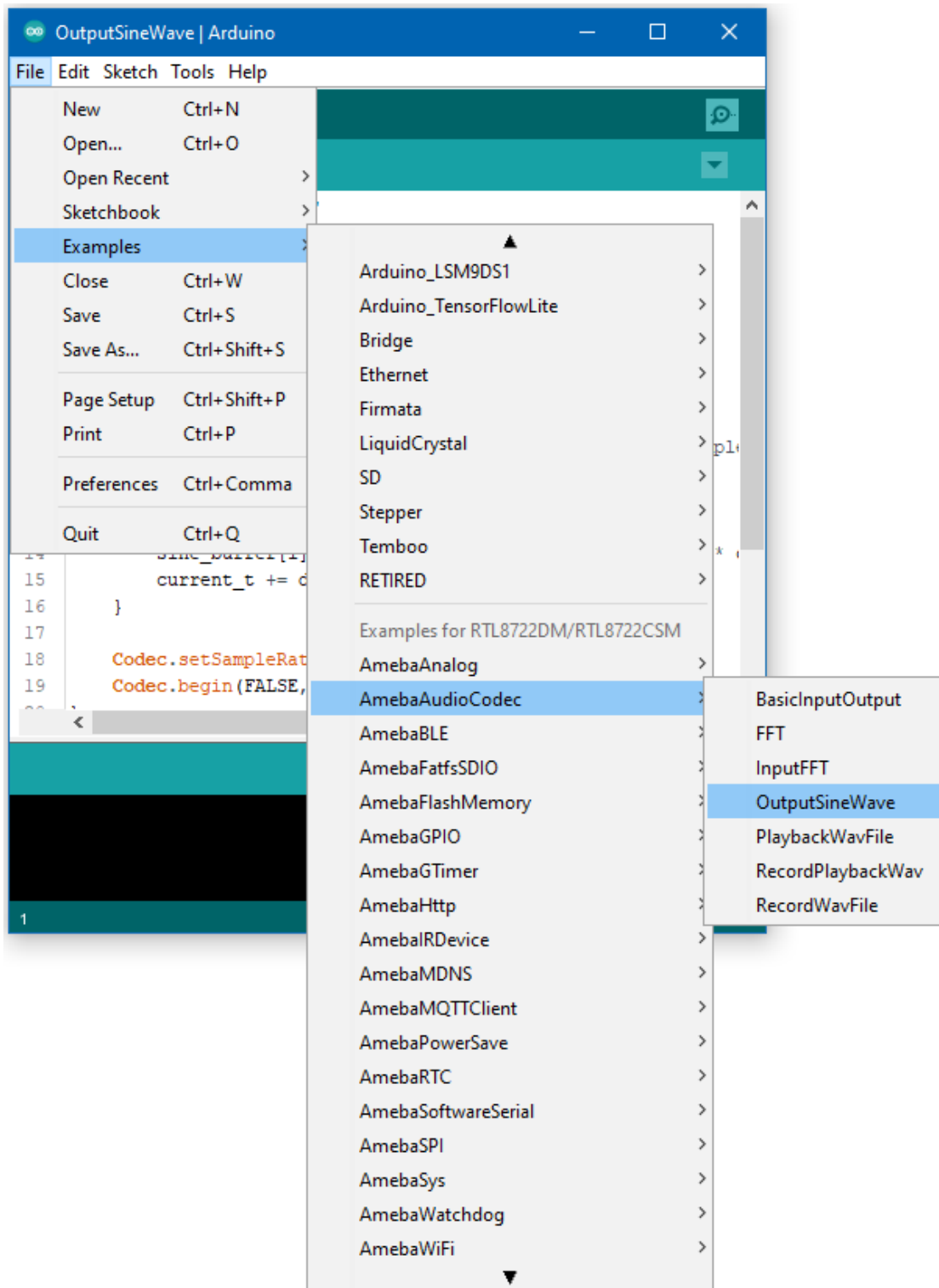
Connect the 3.5mm connector to the RTL8722 board following the diagram.



**AMB23 Wiring Diagram:**

As AMB23 have a built in microphone on the board, there is no need for any external microphone.

Open the example, "Files" -> "Examples" -> "AmebaAudioCodec" -> "OutputSineWave".



Upload the code and press the reset button on Ameba once the upload is finished.

Connect a pair of wired headphones to the 3.5mm audio jack and you should hear the generate single sinusoidal tone.

## Audio Codec –Play and Record Wav Files

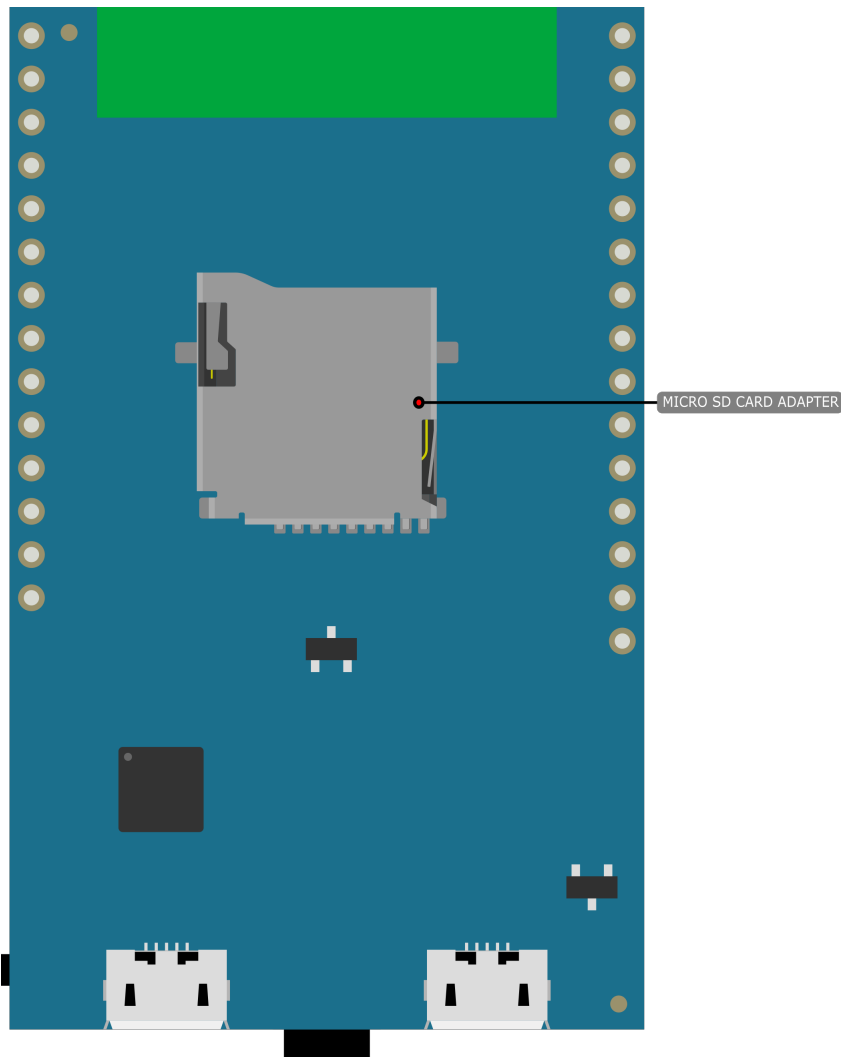
### Materials

- AmebaD [AMB23] x 1
- MicroSD card

### Example

#### Procedure

As AMB23 have a built in microphone on the board, there is no need for any external microphone. Copy a sample wav file into the MicroSD card for demo. (In this example, the sample name is “Test\_Audio\_48khz\_16bit\_stereo.wav” . ) Then insert the MicroSD card into the adapter at the back of the board.



Example 01 PlaybackWavFile Open the example, “Files” -> “Examples” -> “AmebaAudioCodec” -> “PlaybackWavFile” .

 PlaybackWavFile | Arduino 1.8.13

File Edit Sketch Tools Help



```
#include "FatFs_SD.h"
#include "PlaybackWav.h"
#include "AudioCodec.h"

char filename[] = "Test_Audio_48khz_16bit_stereo.wav";

#define BUFFERSIZE 512
int16_t buffer[BUFFERSIZE] = {0};

FatFsSD fs;
PlaybackWav playWav;

// Callback function to feed audio codec with additional data
void writeCBFunc() {
    if(Codec.writeAvaliable()) {
        playWav.readAudioData(buffer, BUFFERSIZE);
        Codec.writeDataPage(buffer, BUFFERSIZE);
    }
}
```

Upload the code and press the reset button on Ameba once the upload is finished. Insert earphone/speaker into the onboard jack for playing the sample sound.

Example 02 RecordWavFile Open the example, “Files” -> “Examples” -> “AmebaAudioCodec” -> “RecordWavFile” .



```

RecordWavFile | Arduino 1.8.13
File Edit Sketch Tools Help

RecordWavFile

#include "FatFs_SD.h"
#include "RecordWav.h"
#include "AudioCodec.h"

#define RECORDBTN 9
#define SAMPLERATE 48000

#define BUFFERSIZE 512
int16_t buffer[BUFFERSIZE] = {0};

char filename[] = "Test_Recording_48khz_16bit_mono.wav";
char absolute_filename[128];

FatFsSD fs;
RecordWav recWav;

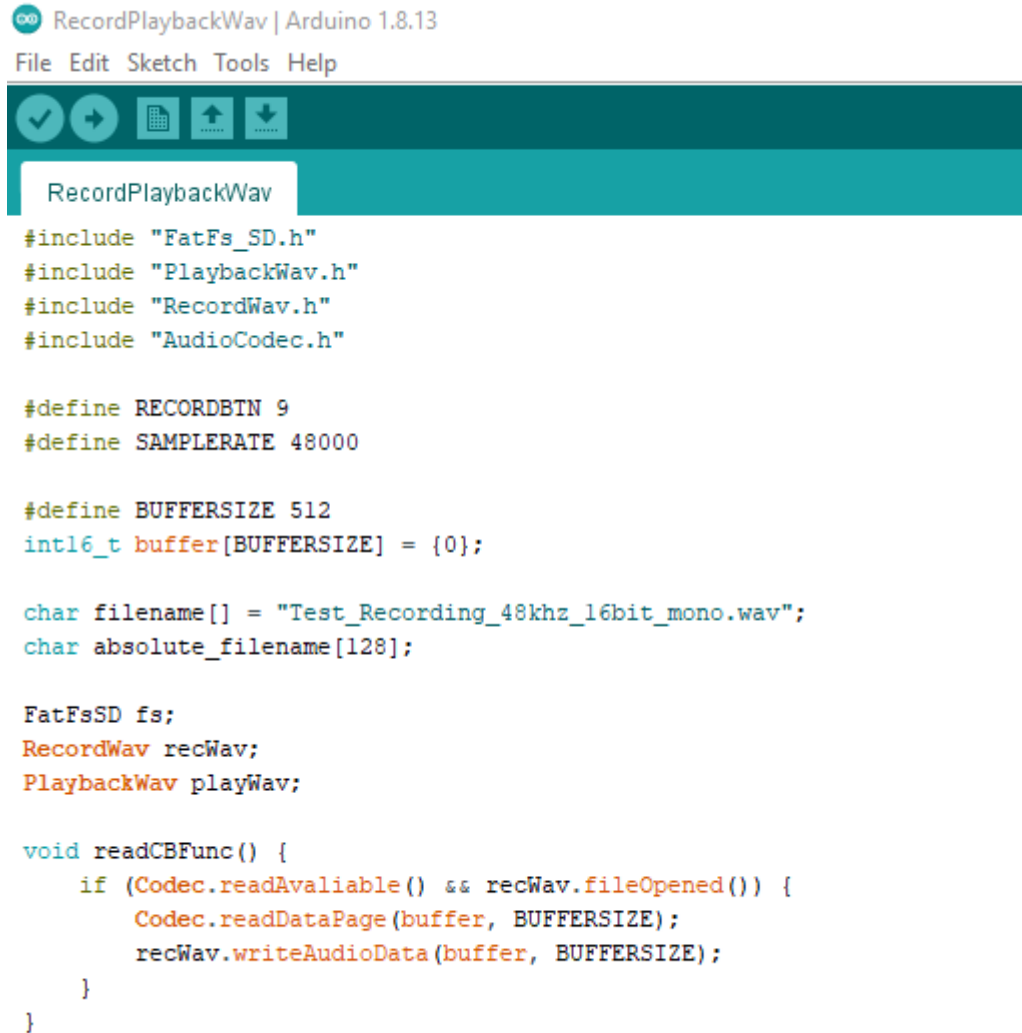
```

Define a GPIO/button(Input high to active) for “RECORDBTN” . Define the “filename[]” for name of the storage wav file. In this example the name is “Test\_Recording\_48khz\_16bit\_mono.wav” .

Upload the code and press the reset button on Ameba once the upload is finished.

Input high to “RECORDBTN” , then record voice by on board mic. When input is low the record stops. The recorded voice will be stored in “Test\_Recording\_48khz\_16bit\_mono.wav” that located at MicroSD card.

Example 03 RecordPlaybackWav Open the example, “Files” -> “Examples” -> “AmebaAudioCodec” -> “RecordPlaybackWav” .



This example is a combination of Example01 and Example02. You can record by Example02 then play it by jack as the method of Example01.

Define a GPIO/button(Input high to active) for “RECORDBTN” . Define the “filename[]” for name of the storage wav file. In this example the name is

“Test\_Recording\_48khz\_16bit\_mono.wav” .

Upload the code and press the reset button on Ameba once the upload is finished.

Input high to “RECORDBTN” , then record voice by on board mic. When input is low the record stops. The recorded voice will be stored in

“Test\_Recording\_48khz\_16bit\_mono.wav” that located at MicroSD card.

Insert earphone/speaker into the onboard jack for playing the sample sound.



## E-Paper - Display Images

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

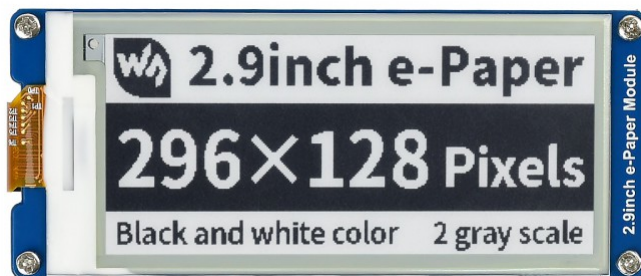
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc... are supplied with each panel.

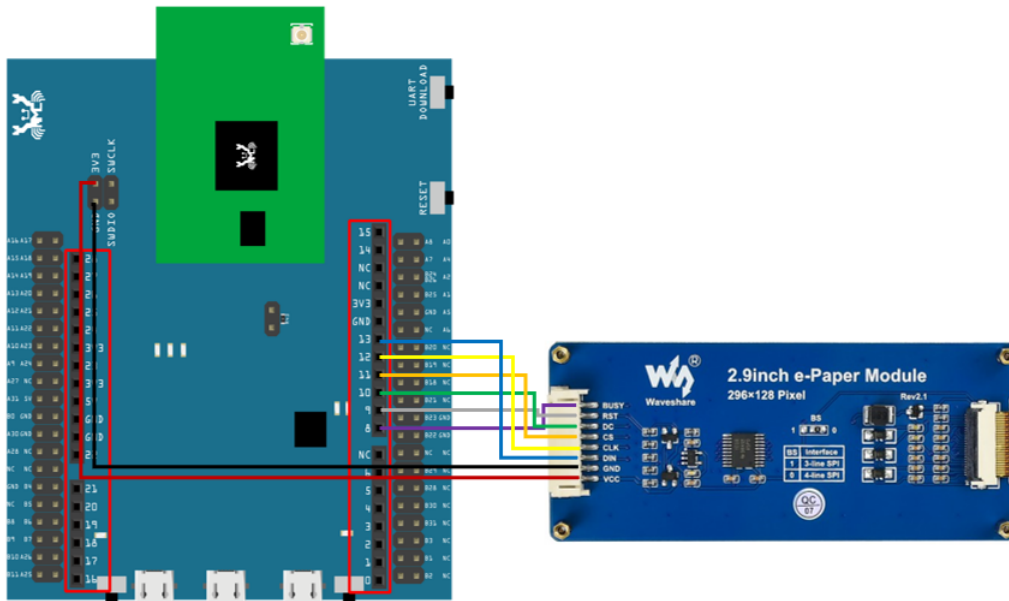
You may refer to the official [2.9inch e-Paper HAT \(D\) datasheet](#) to know more information about this module.

Front view of the e-Paper Module:

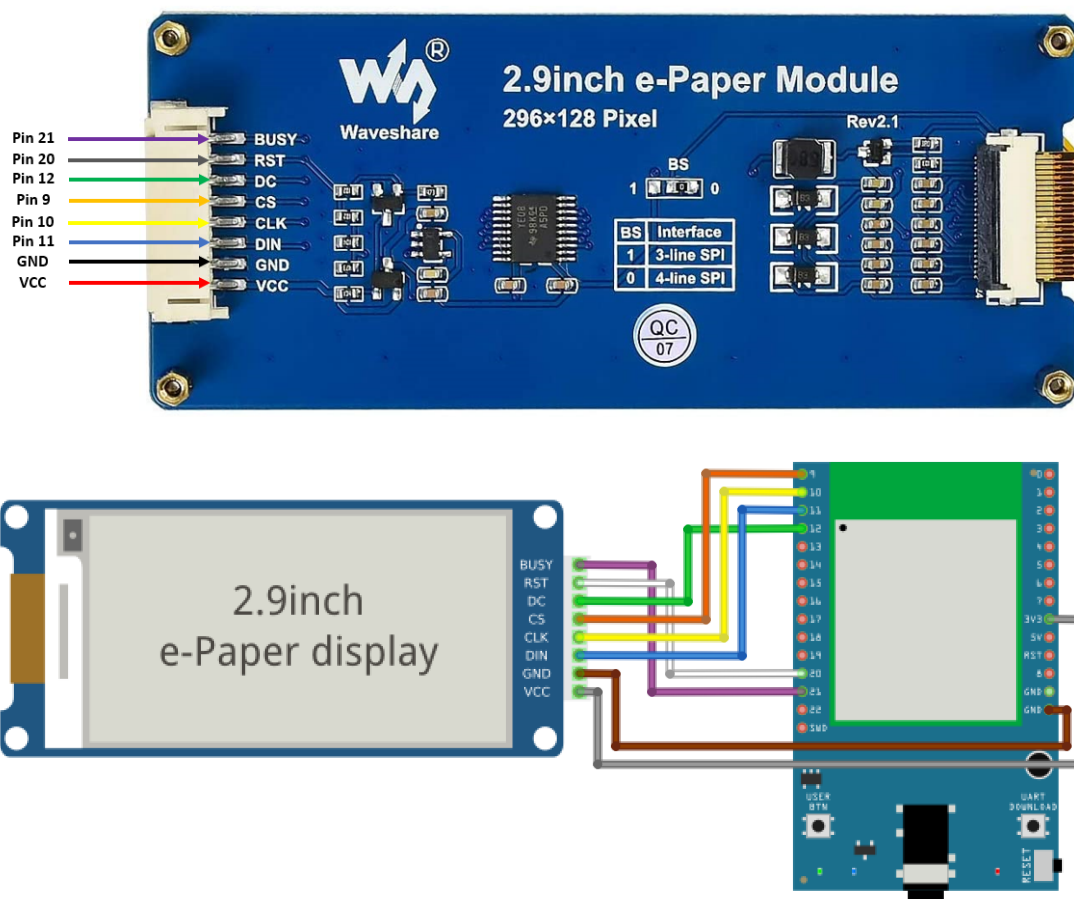


AMB21 / AMB22 Wiring Diagram:

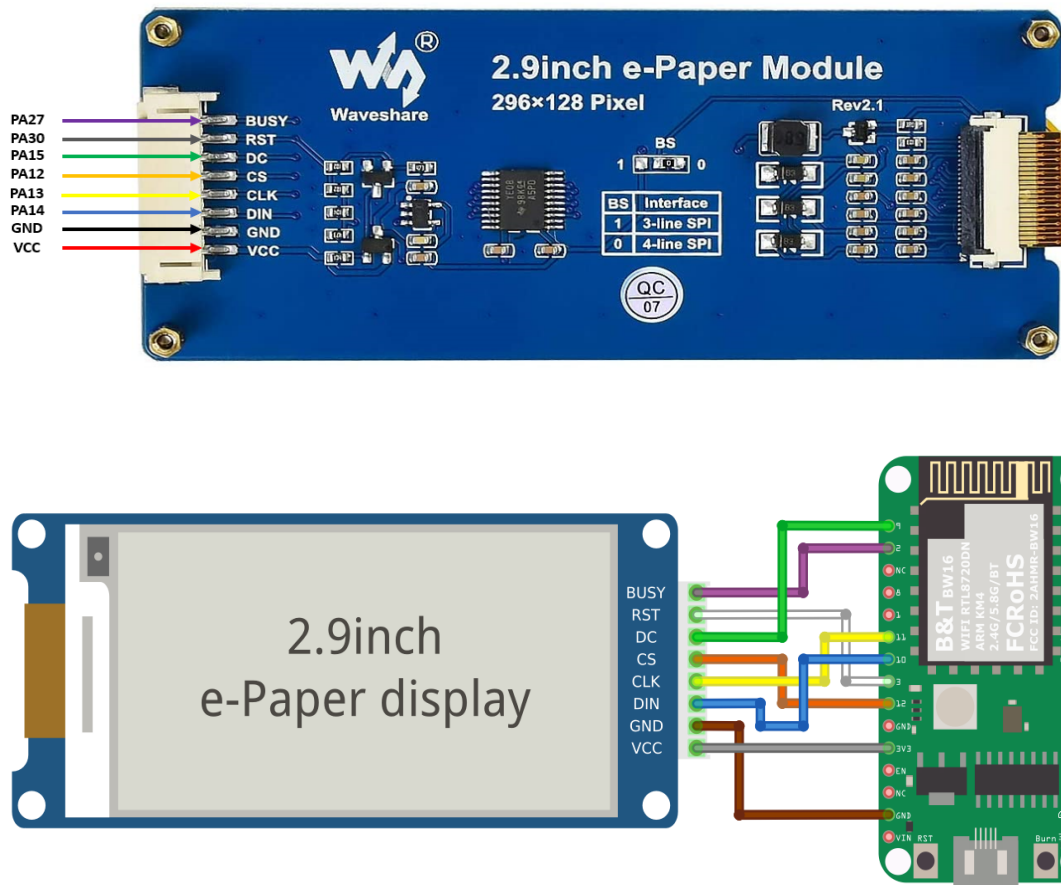




AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Firstly, you need to prepare a picture/photo in the format of 296×128 pixels. We can easily find a photo resizing tool online, for example, the [Online Image Resizer](#).

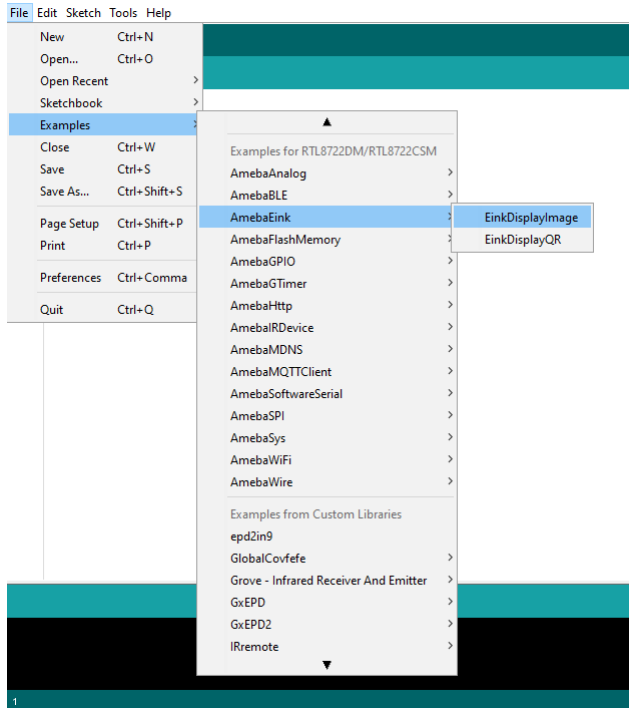
Following the instructions on the website, then download the generated image in JPG format.

Secondly, we use the [Image2LCD](#) tool to transfer the downloaded 296×128 image into hexadecimal codes. You can visit this [YouTube](#) link to get detailed instructions.

Download the Eink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries)

Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” → “Examples” → “AmebaEink” → “EinkDisplayImage” :



Press the reset button after uploading the sample code, you will need to wait for around 1-2 seconds for the e-Paper module to fresh its screen. Then the screen will start to display an image for 5 seconds first, then 3 different QR codes will be displayed every 5 seconds (showing in the screenshot below, you may scan the QR codes and find out more information if you wish to). Lastly, a gif which comes in form of 3 frames will be displayed for a few seconds.



## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

[2] Provide the link to how to generate a QR code on the E-paper module: <https://eugeniopace.org/qr/arduino/eink/2019/07/01/qr-code-on-arduino.html>



## E-Paper - Display Text

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

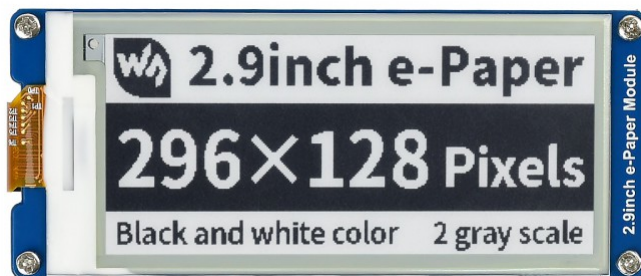
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc... are supplied with each panel.

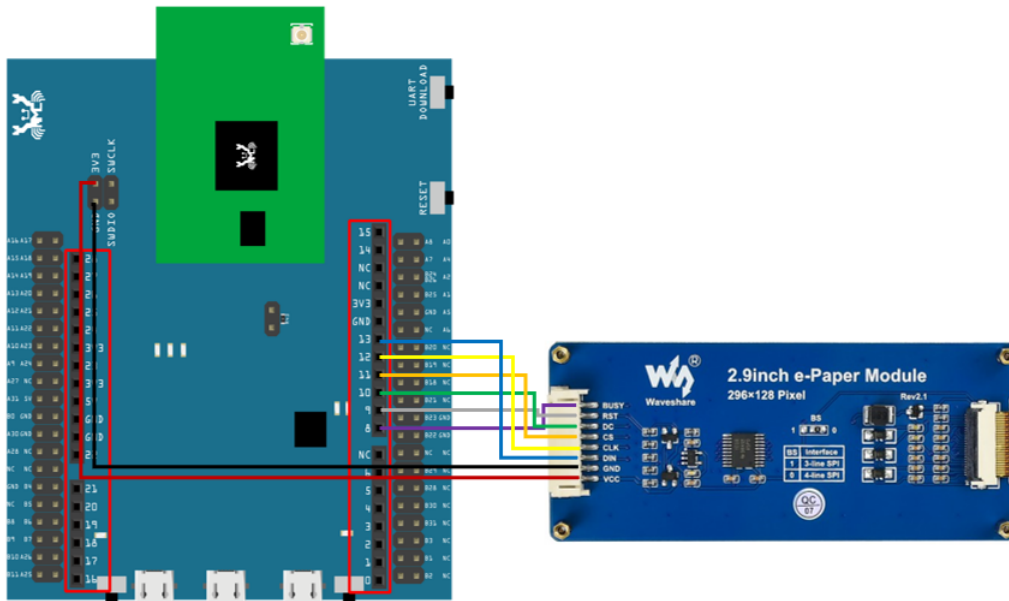
You may refer to the official [2.9inch e-Paper HAT \(D\) datasheet](#) to know more information about this module.

Front view of the e-Paper Module:

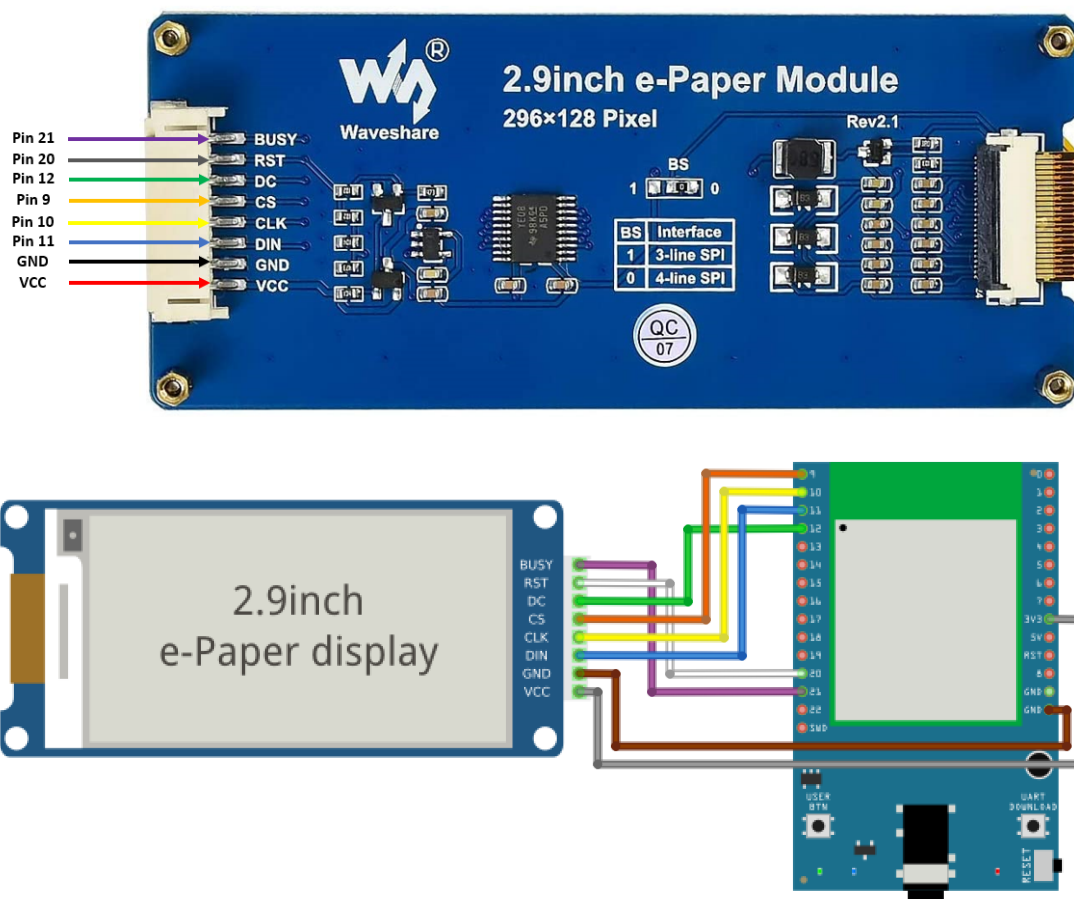


AMB21 / AMB22 Wiring Diagram:

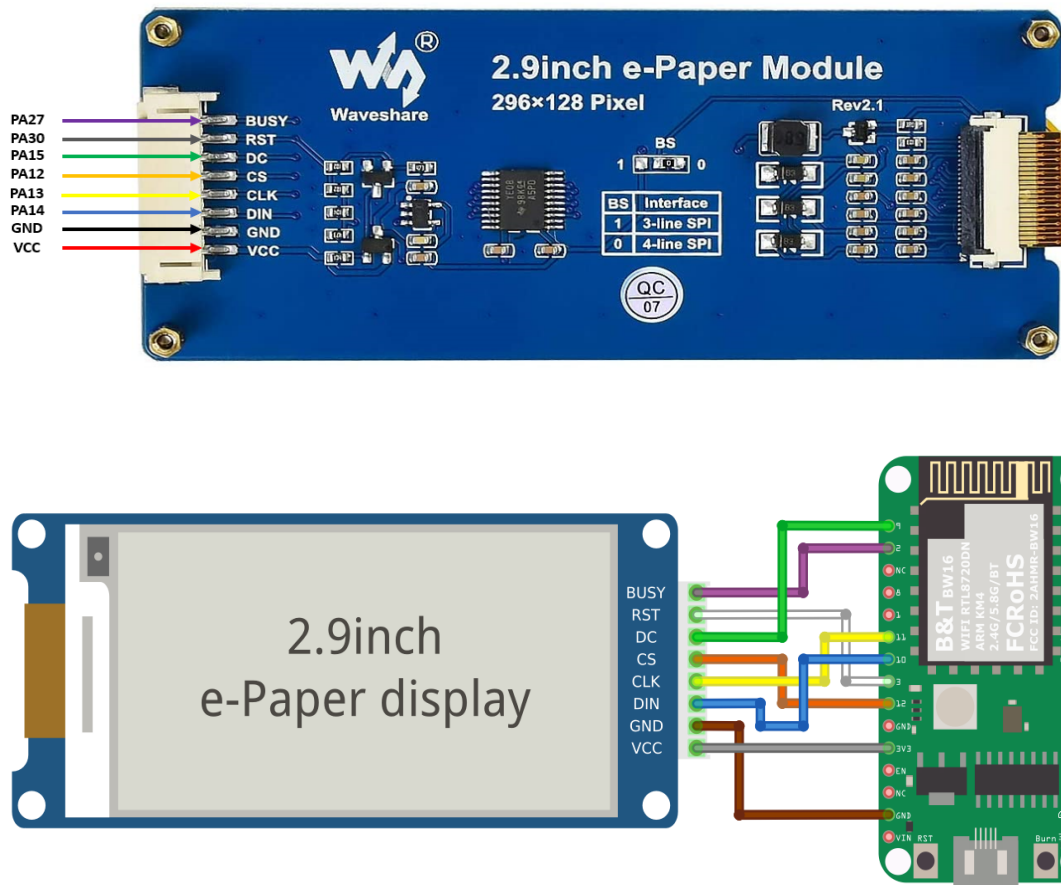




AMB23 Wiring Diagram:



BW16 Wiring Diagram:

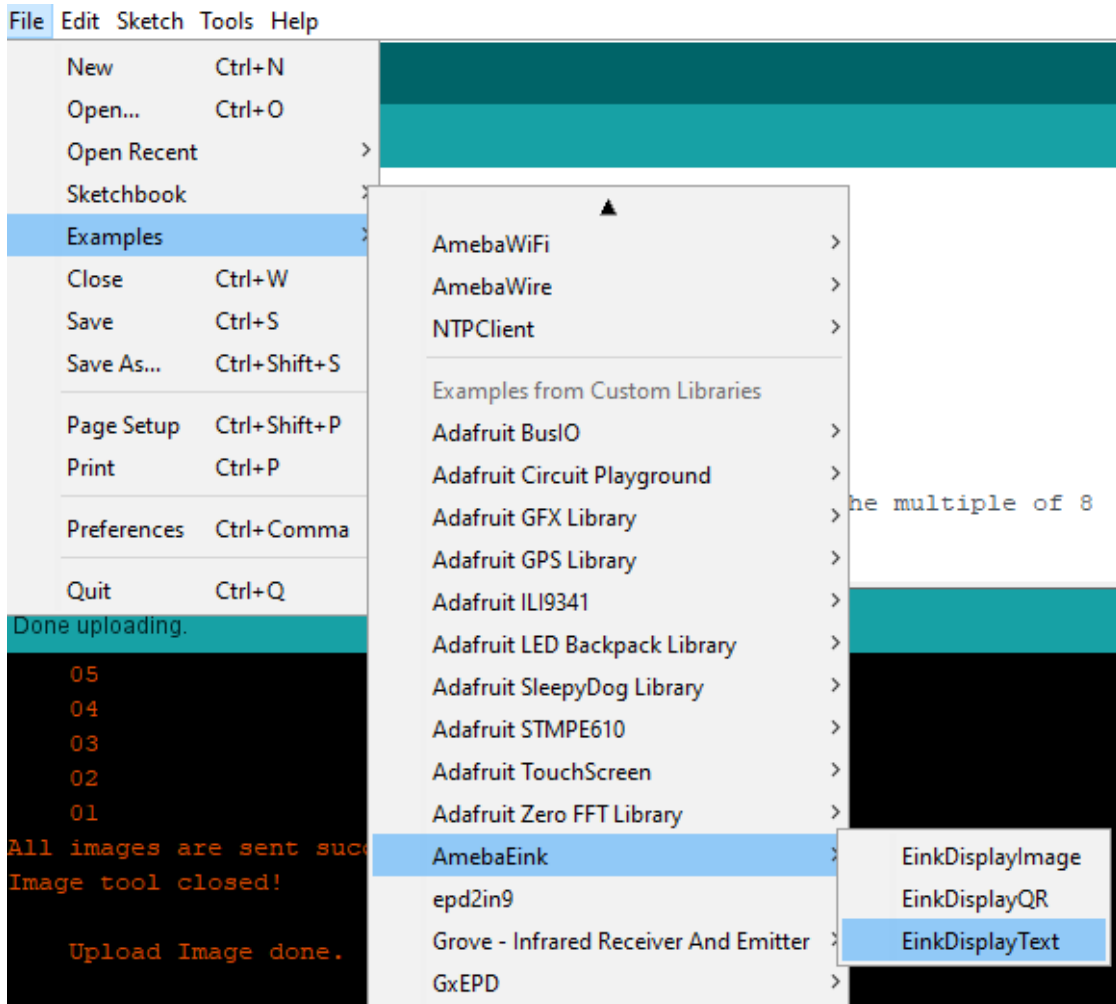


Download the E Ink zip library, AmebaEink.zip, at

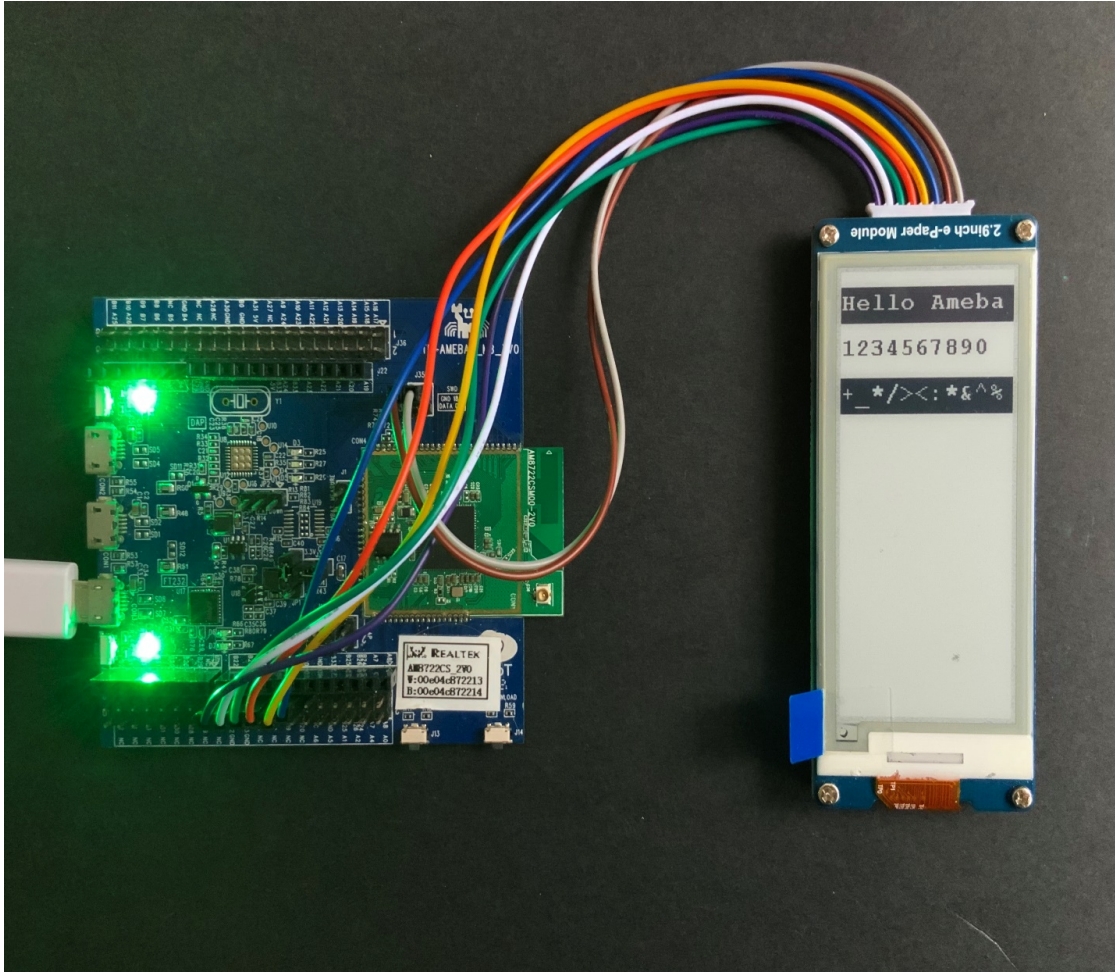
[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries)

Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” -> “Examples” -> “AmebaEink” -> “EinkDisplayText” :





Upload the code to the board and press the Reset button after the uploading is done. You will find these texts displayed on the board:



## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

## E-Paper - Display User-generated QR Code

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

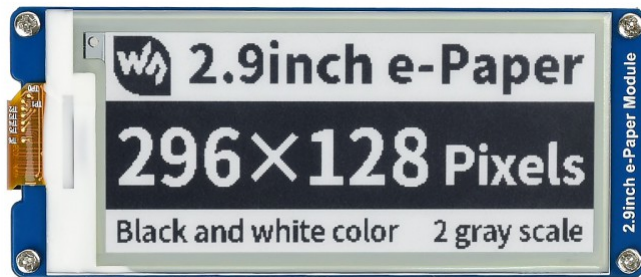
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc...are supplied with each panel.

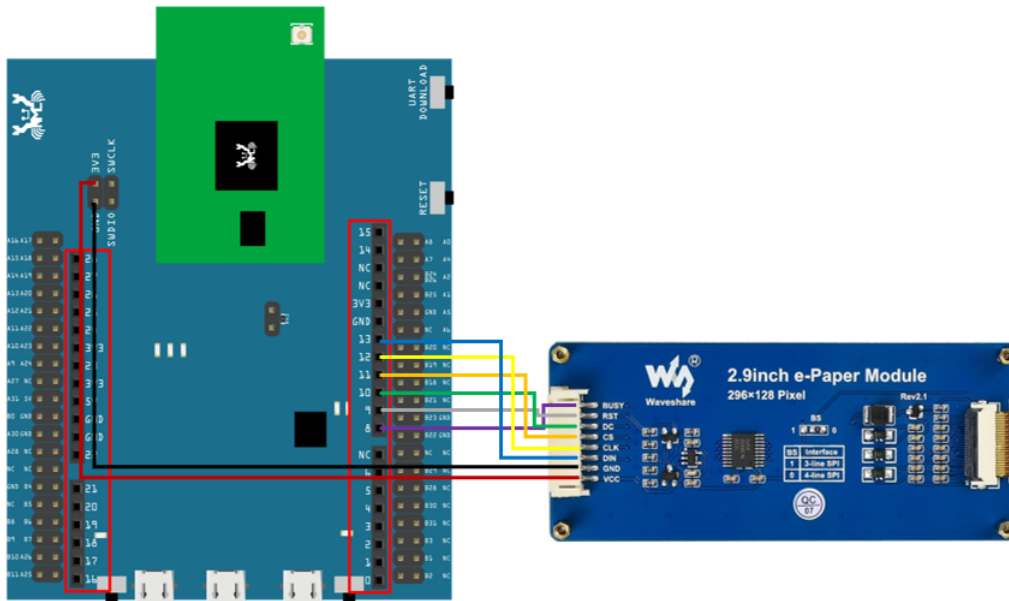
You may refer to the official [2.9inch e-Paper HAT \(D\)](#) datasheet to know more information about this module.

Front view of the e-Paper Module:

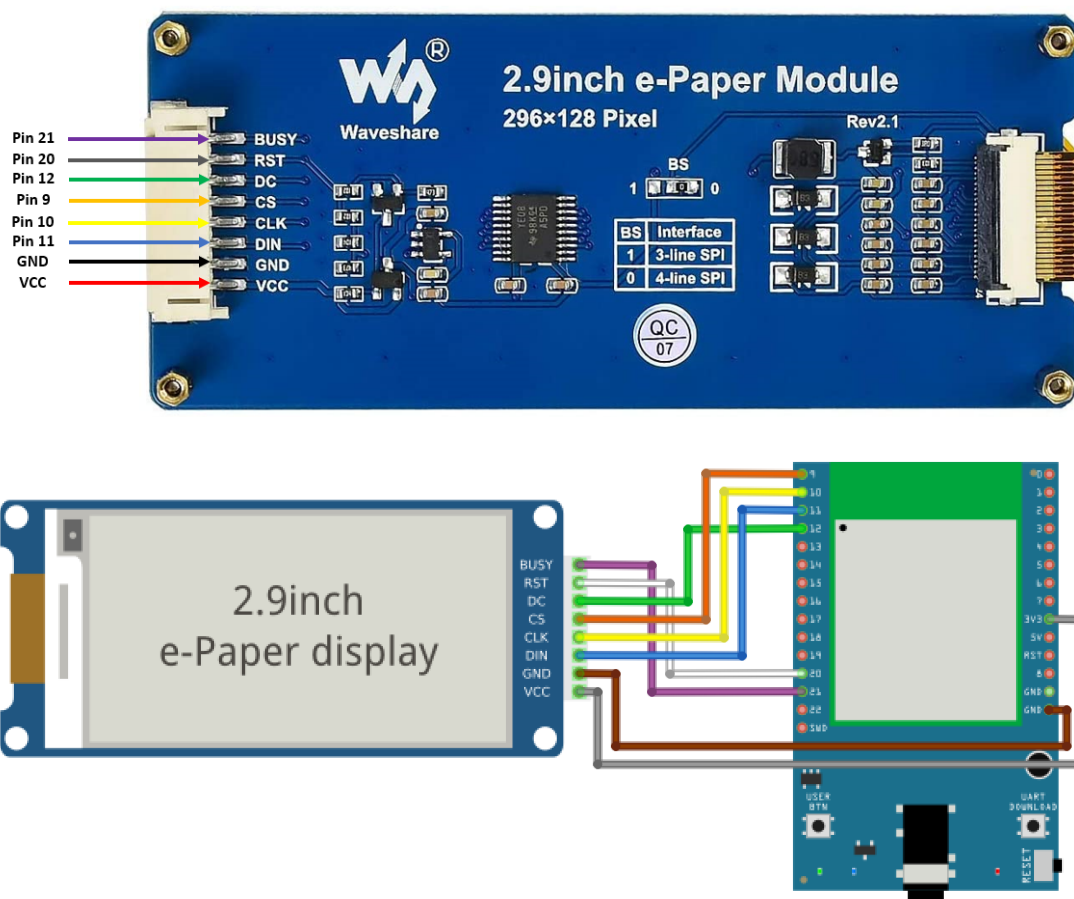


AMB21 / AMB22 Wiring Diagram:

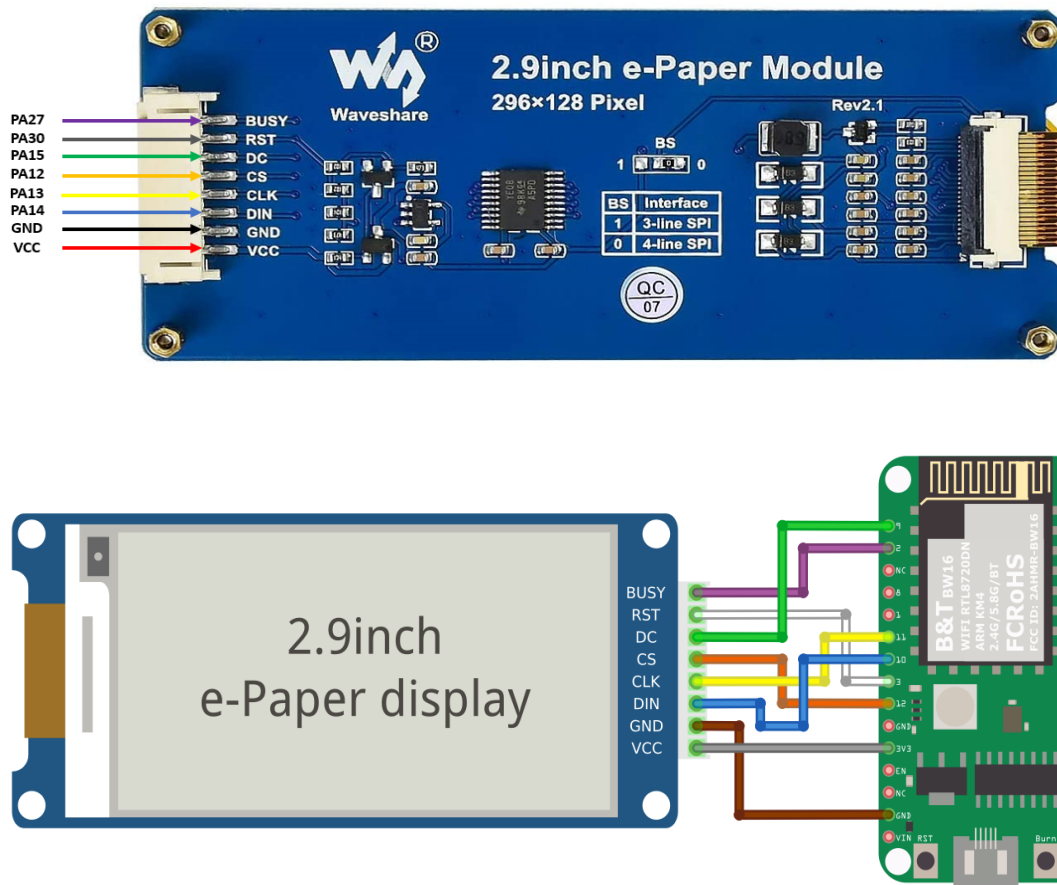




AMB23 Wiring Diagram:



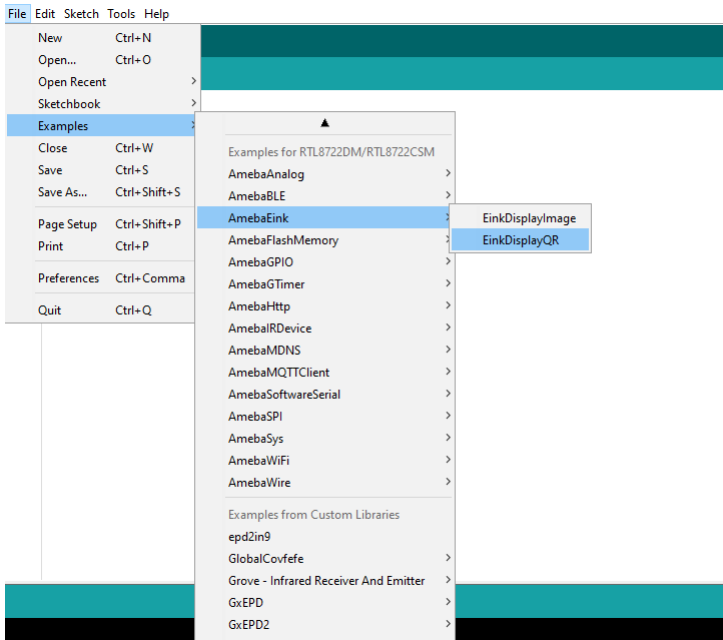
BW16 Wiring Diagram:



Download the Eink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries)

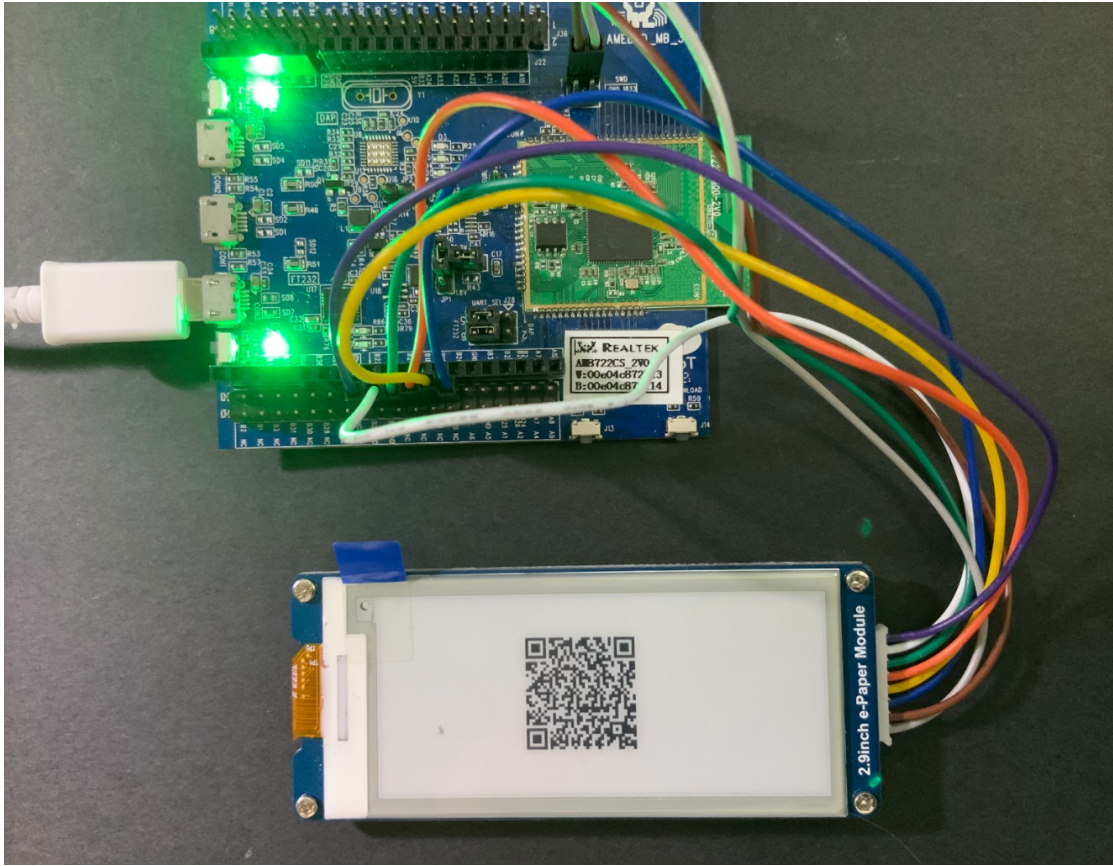
Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” → “Examples” →



“AmebaEink” → “DisplayQR” :

Modify the URL in the loop() section as your wish, after that, verify and upload the code to the Ameba board. Upon successfully upload the sample code and press the reset button, a QR code generated based on the URL of your input will be shown on the E-Paper module. The QR code showing below leads to our Ameba IoT official website: [Ameba ARDUINO](#)





## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

[2] Provide the link to how to generate a QR code on the E-paper module: <https://eugeniopace.org/qrcode/arduino/eink/2019/07/01/qrcode-on-arduino.html>

[3] A simple library for generating QR codes in C, optimized for processing and memory-constrained systems: <https://github.com/ricmoo/QRCode#data-capacities>

## FatfsSDIO –File system in SD card

### Materials

- AmebaD [AMB23] x 1
- MicroSD card

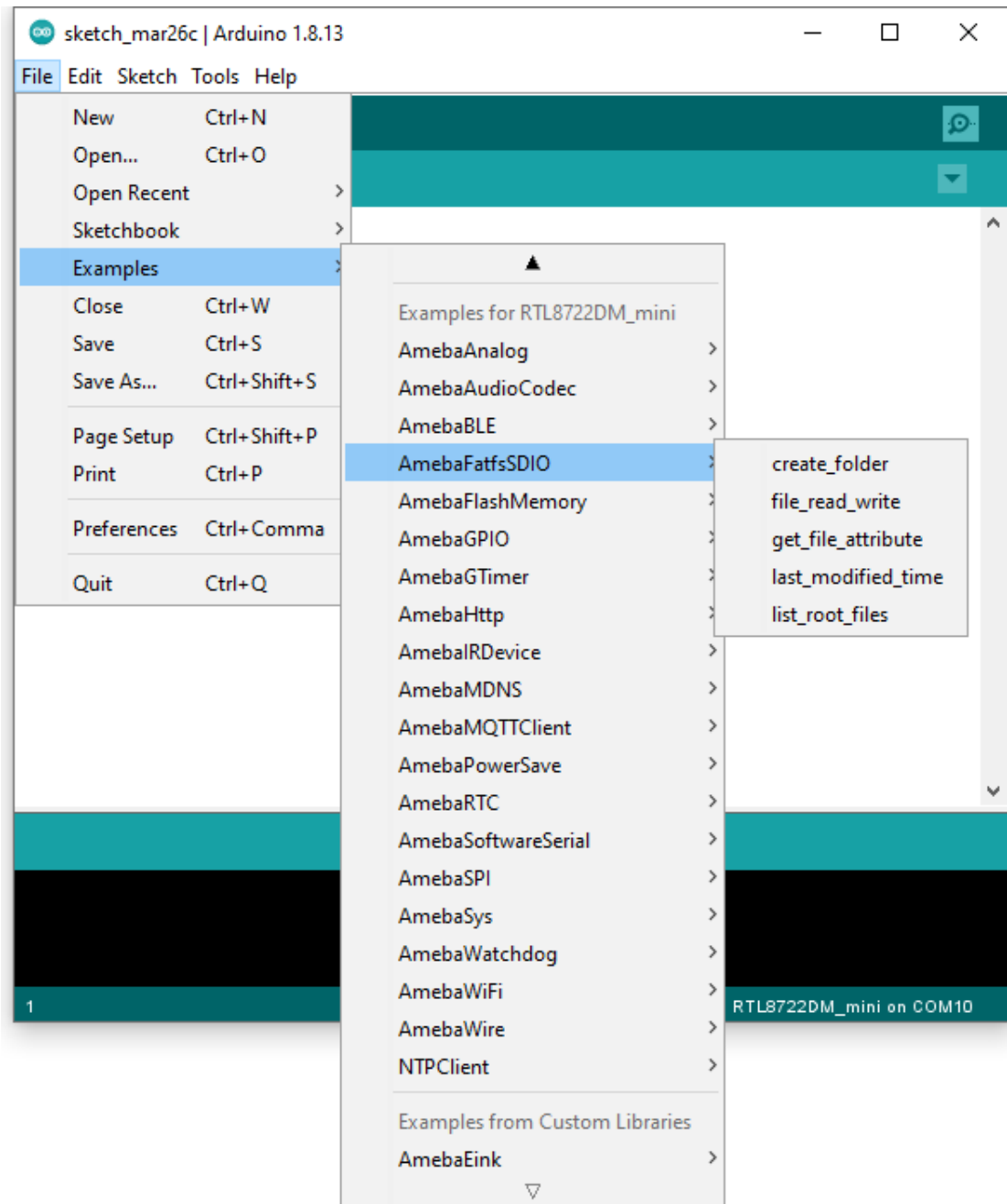
## Example

### Procedure

Insert a MicroSD card into the onboard SD card reader of RTL8722DM MINI board.

### Example 01 create\_folder

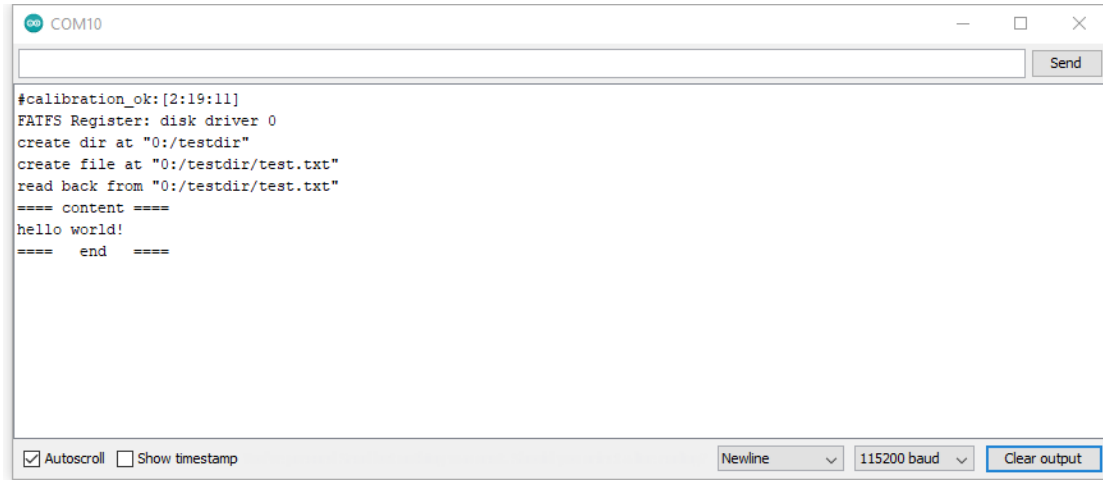
Open the example, "Files" -> "Examples" -> "AmebaFatfsSDIO" -> "create\_folder".





Upload the code and press the reset button on Ameba once the upload is finished.

In the sample code, we first create a folder “testdir”, then text file “test.txt” with content “hello world!”. Read the file and print content to serial monitor.



Next, insert SD card into card reader, and check whether the operations succeeded.

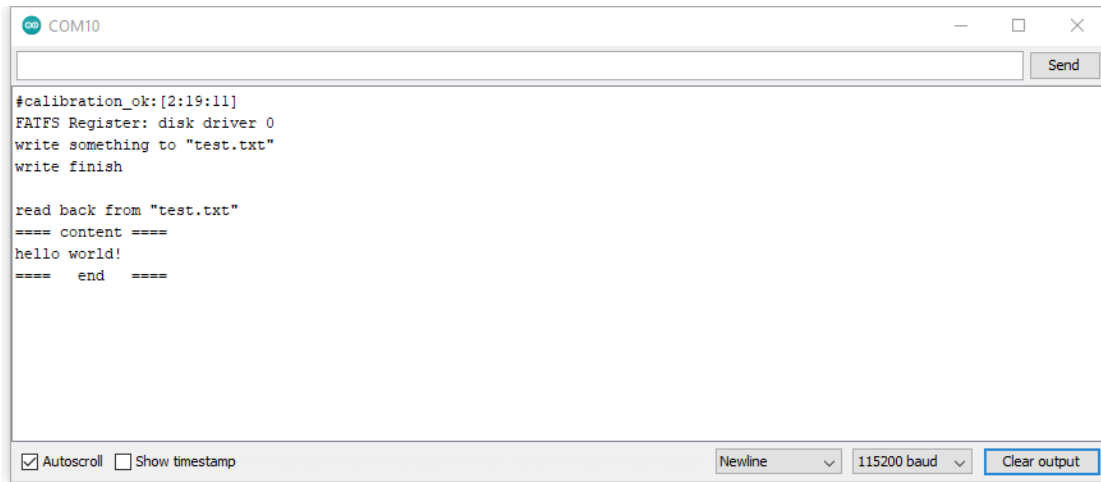


### Example 02 file\_read\_write

Open the example, "Files" -> "Examples" -> “AmebaFatfsSDIO” -> “file\_read\_write” .

Upload the code and press the reset button on Ameba once the upload is finished.

In the sample code, we create text file “test.txt” with content “hello world!”. Read the file and print content to serial monitor.



```

COM10
Send

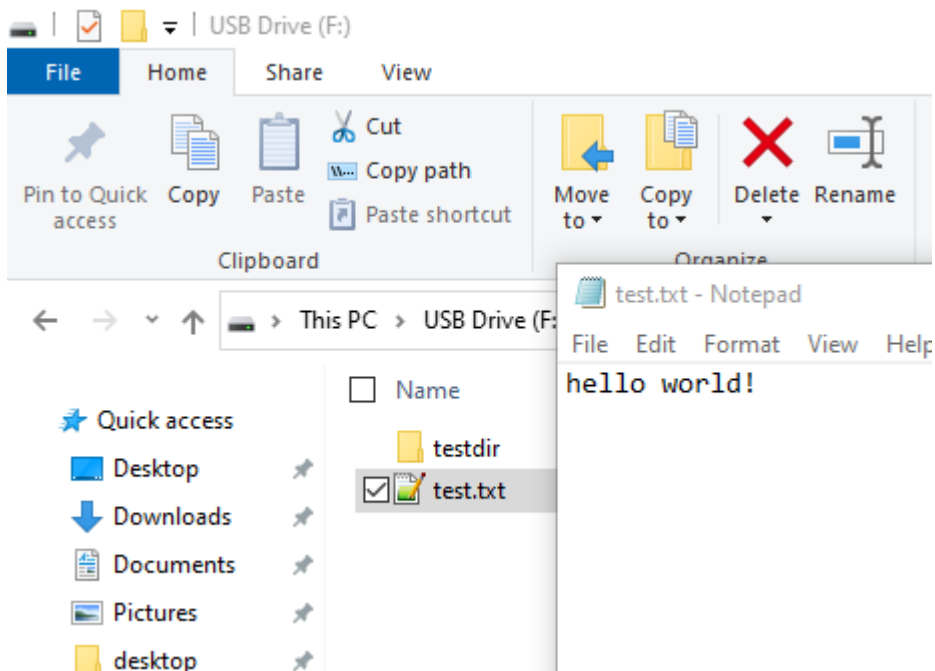
#calibration_ok:[2:19:11]
FATFS Register: disk driver 0
write something to "test.txt"
write finish

read back from "test.txt"
==== content ====
hello world!
===== end =====

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

Next, insert SD card into card reader, and check whether the operations succeeded.



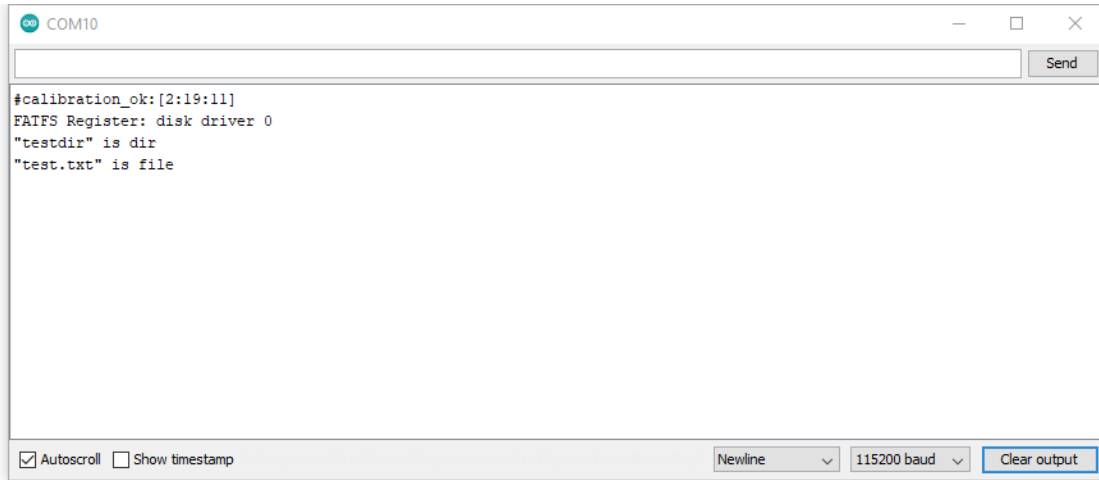
### Example 03 get\_file\_attribute

Open the example, "Files" -> "Examples" -> "AmebaFatfsSDIO" -> "get\_file\_attribute"

.

Upload the code and press the reset button on Ameba once the upload is finished.

In the sample code, system will print put all file attribute to serial monitor.



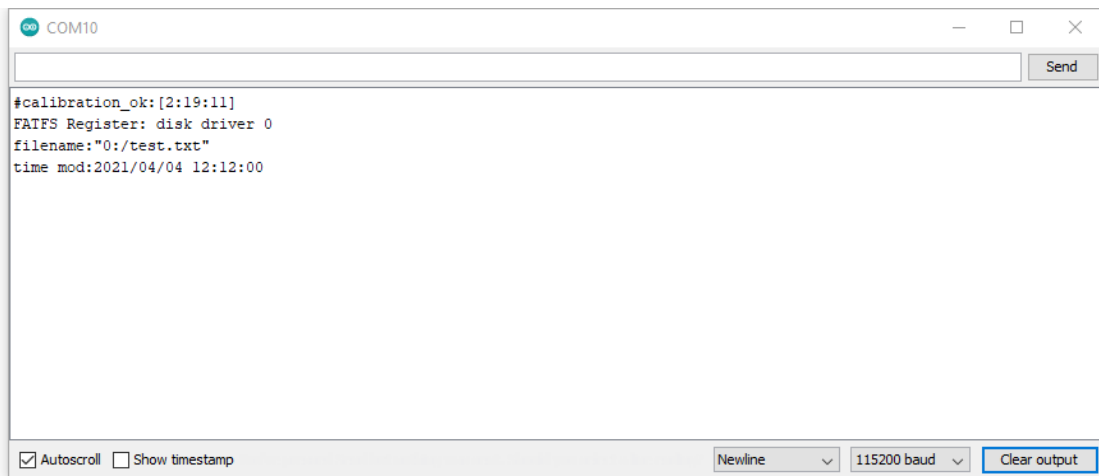
Next, insert SD card into card reader, and check whether the operations succeeded. In this case, we already know the attribute should be folder “testdir” and text file “test.txt” by refer the above pictures.

#### Example 04 last\_modified\_time

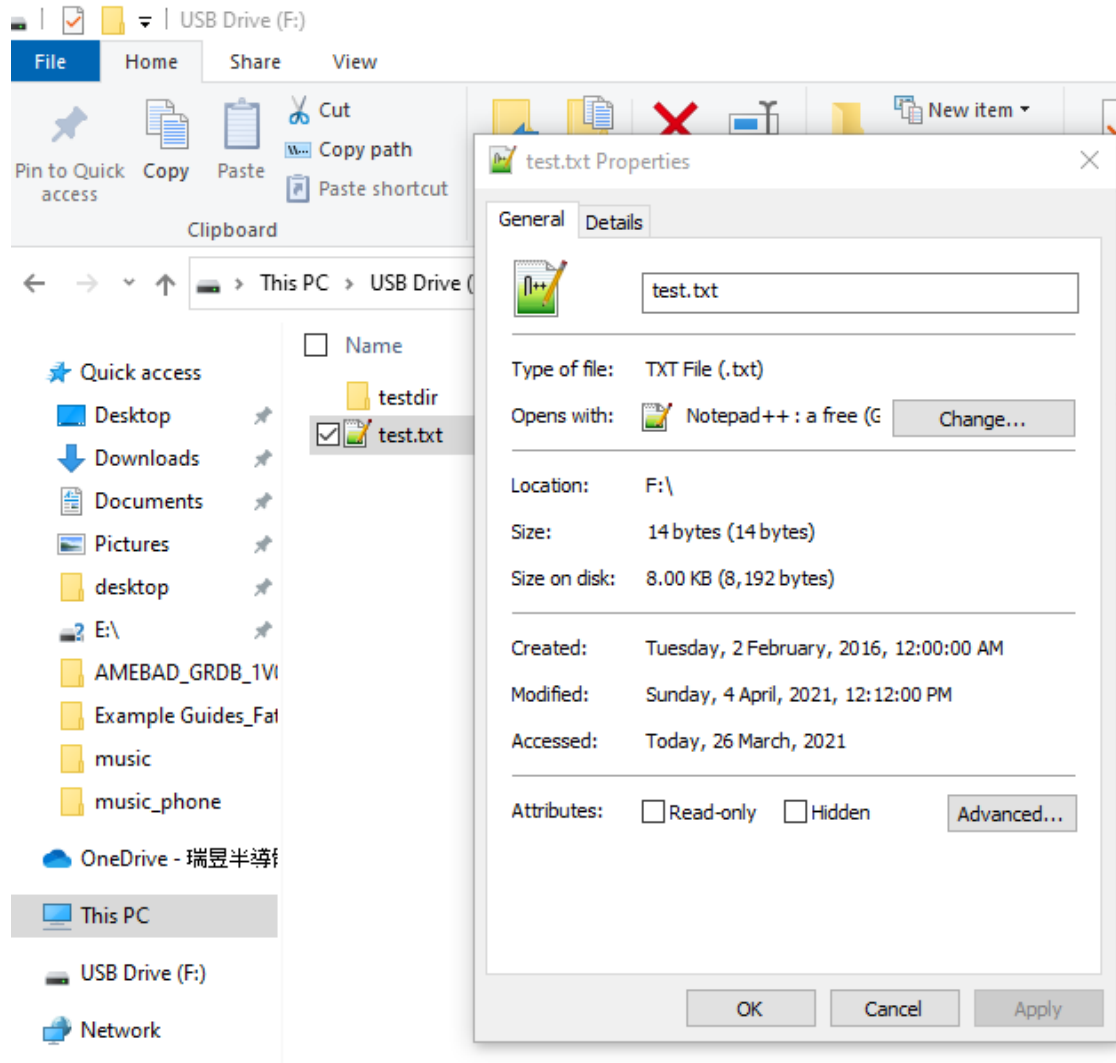
Open the example, "Files" -> "Examples" -> “AmebaFatfsSDIO” -> “last\_modified\_time” .

Upload the code and press the reset button on Ameba once the upload is finished.

In the sample code, system will print put the target file last modified time to serial monitor.



Next, insert SD card into card reader, and check whether the operations succeeded.

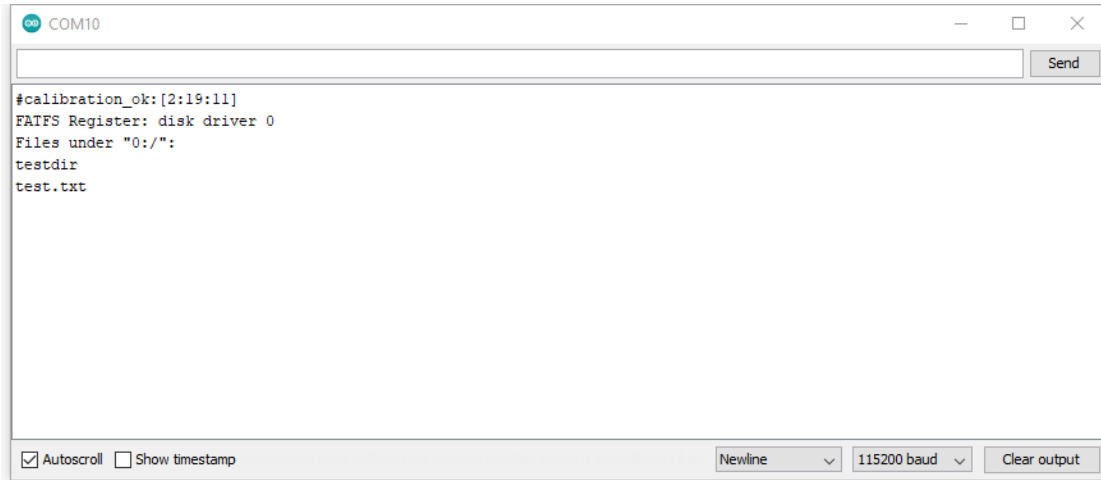


### Example 05 list\_root\_files

Open the example, "Files" -> "Examples" -> "AmebaFatfsSDIO" -> "list\_root\_files".

Upload the code and press the reset button on Ameba once the upload is finished.

In the sample code, system will print put all root file to serial monitor.



Next, insert SD card into card reader, and check whether the operations succeeded. In this case, we already know the root files folder “testdir” and text file “test.txt” by refer the above pictures.

## FatfsSDIO –Read And Open HTML File From SD Card

### Materials

- AmebaD [AMB23] x 1
- MicroSD card

### Example

Insert the MicroSD card into your computer and copy the HTML file to your SD card (Note: put the file at outside and do not put it inside of any folder in the SD card). Here is a HTML sample for testing, “Web\_test.html” .

SDHC (D:)		Search SDHC (D:)		
<input type="checkbox"/> Name	Date modified	Type	Size	
testdir	2/2/2016 12:00 am	File folder		
ch_m.txt	9/3/2021 6:25 pm	Text Document	1 KB	
ch_p.txt	9/3/2021 6:22 pm	Text Document	1 KB	
freq_power.txt	9/3/2021 3:42 pm	Text Document	1 KB	
test.txt	2/2/2016 12:00 am	Text Document	1 KB	
vol_m.txt	9/3/2021 6:19 pm	Text Document	1 KB	
vol_p.txt	9/3/2021 6:16 pm	Text Document	1 KB	
<input checked="" type="checkbox"/> Web_test.html	21/9/2021 10:26 am	Chrome HTML Docu...	1 KB	

Then insert the MicroSD card into the onboard SD card reader of RTL8722DM MINI board.

Open the example, “Files” -> “Examples” -> “AmebaFatfsSDIO” -> “read\_html\_from\_SD\_card”

Upload the code and press the reset button on Ameba once the upload is finished. When the connection is established, you should be able to see the message “To see this page in action, open a browser to <http://xxx.xxx.xxx.xxx>” in the serial monitor as shown in the figure:

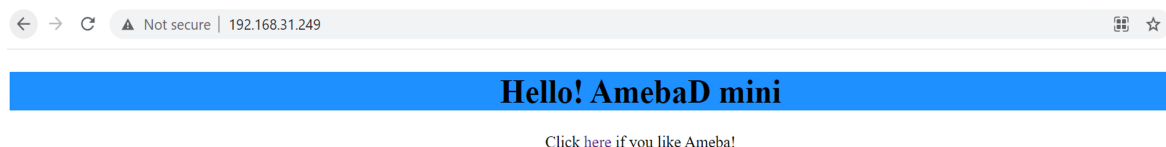
```

COM7
14:23:18.630 ->
14:23:18.676 -> RTL8721D[Driver]:
14:23:18.676 -> OnAuthClient:algthm = 0, seq = 2, status = 0, sae_msg_len = 0
14:23:18.676 ->
14:23:18.676 -> RTL8721D[Driver]: auth success, start assoc
14:23:18.676 ->
14:23:18.722 -> RTL8721D[Driver]: association success(res=6)
14:23:18.722 ->
14:23:18.863 -> RTL8721D[Driver]: ClientSendEAPOL[1600]: no use cache pmksa
14:23:18.909 ->
14:23:18.909 -> RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
14:23:18.909 ->
14:23:18.909 -> RTL8721D[Driver]: set group key to hw: alg:2(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1
14:23:18.909 ->
14:23:19.704 -> Interface 0 IP address : 192.168.31.249
14:23:29.701 -> SSID: xiaomi_test
14:23:29.701 -> IP Address: 192.168.31.249
14:23:29.701 -> signal strength (RSSI):-55 dBm
14:23:29.701 -> To see this page in action, open a browser to http://192.168.31.249
14:23:29.701 -> FATFS Register: disk driver 0
14:23:29.701 ->

```

☒ Autoscroll ☒ Show timestamp Newline 115200 baud Clear output

Next, open the address stated in serial monitor in the browser of your laptop or cell phone under the same WiFi domain. You will see the following display in your browser:



Now you have successfully read and opened the html file saved in your SD card.

## Flash Memory - Store data in FlashEEProm

### Preparation

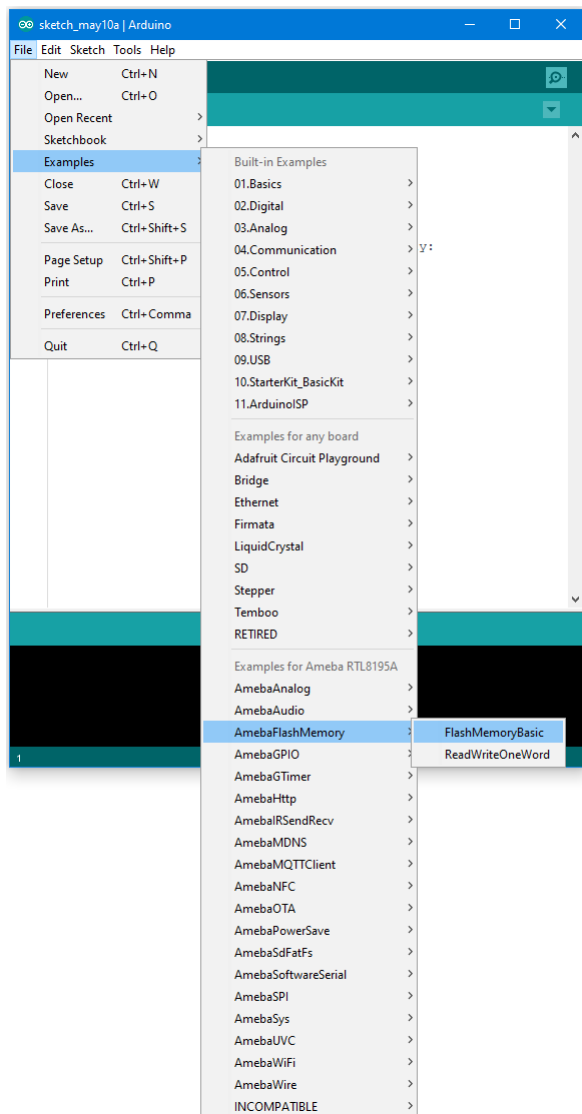
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

Ameba provides Flash Memory component for data storage and the data can be preserved when the power is off if necessary, e.g., compiled program. To avoid the memory space overlapped with the program on Ameba, the Flash API uses the tail part of the address space, with sector size 4K.

In this example, we store the value of boot times in flash memory. Every time Ameba reboots, it reads the boot times from flash, increases the value by 1, and writes it back to flash memory.

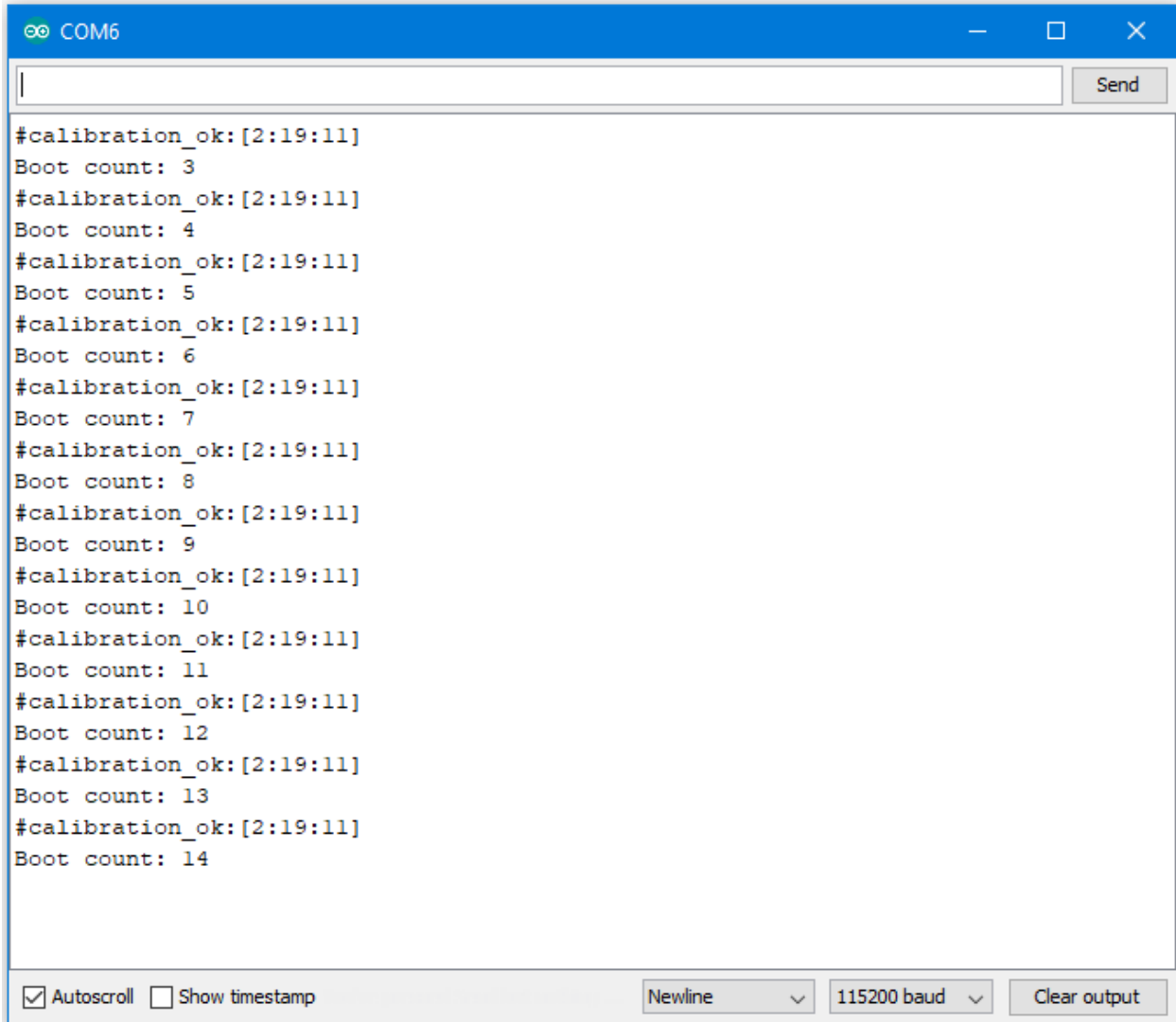
First open the example, “File” -> “Example” -> “AmebaFlashMemory” -> “FlashMemoryBasic”



Compile and upload to Ameba, then press the reset button.

Open the Serial Monitor, press the reset button for a few times. Then you can see the boot times value increases.





The screenshot shows a terminal window titled "COM6" with a blue header bar. The window contains a text area with the following output:

```
#calibration_ok:[2:19:11]
Boot count: 3
#calibration_ok:[2:19:11]
Boot count: 4
#calibration_ok:[2:19:11]
Boot count: 5
#calibration_ok:[2:19:11]
Boot count: 6
#calibration_ok:[2:19:11]
Boot count: 7
#calibration_ok:[2:19:11]
Boot count: 8
#calibration_ok:[2:19:11]
Boot count: 9
#calibration_ok:[2:19:11]
Boot count: 10
#calibration_ok:[2:19:11]
Boot count: 11
#calibration_ok:[2:19:11]
Boot count: 12
#calibration_ok:[2:19:11]
Boot count: 13
#calibration_ok:[2:19:11]
Boot count: 14
```

At the top of the text area is a text input field and a "Send" button. At the bottom of the window is a control bar with the following elements from left to right:

- ☒ Autoscroll
- ☐ Show timestamp
- Newline (dropdown menu)
- 115200 baud (dropdown menu)
- Clear output (button)

## Code Reference

By default, the Flash Memory API uses address 0xFF000~0xFFFFF to store data.

There is limitation when writing to flash memory. That is, you can not directly write data to the same address you used in last write. To do that correctly, you need erase the sector first. The Flash API of Ameba uses a 4K SRAM to record the user modification and do the erase/write task together.

Use `FlashMemory.read()` to read from Flash memory.

Use `FlashMemory.buf[0] = 0x00;` to manipulate the 4K buf.

Use `FlashMemory.update()` ; to update the data in buf to Flash Memory.

## Flash Memory - Use Flash Memory Larger Than 4K

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

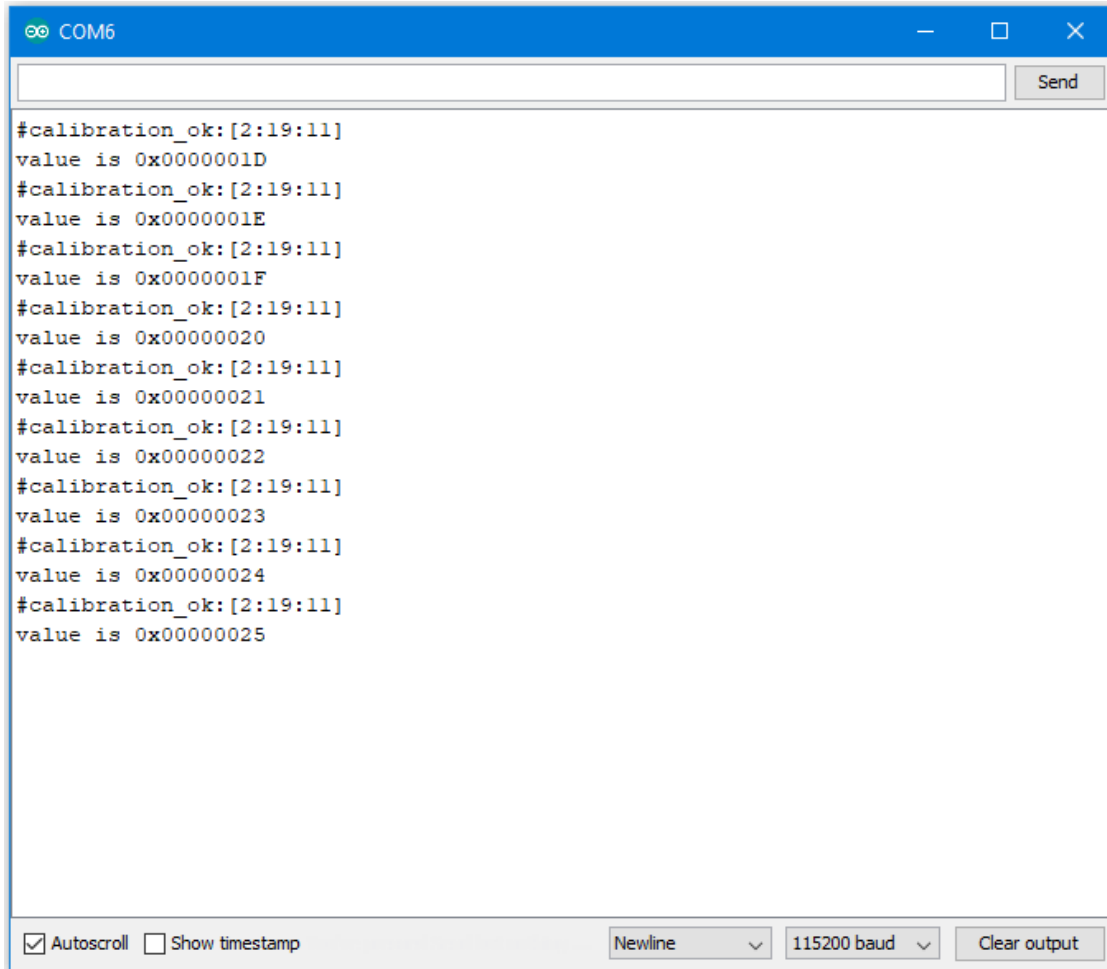
### Example

Flash Memory API uses memory of 4K bytes, which is normally sufficient for most application. However, larger memory can be provided by specifying a specific memory address and required size.

First, open the sample code in “File” -> “Examples” -> “AmebaFlashMemory” -> “ReadWriteOneWord”

In this example, we specify the starting address of flash memory is 0xFC000 and size is 0x4000 (The default starting address is 0xFF000 and size is 0x1000).

Then calculate correct address according to the specified offset and perform read/write operation. In the sample code we use offset 0x3F00, that is,  $0xFC000 + 0x3F00 = 0xFFFF00$  in flash. We set the value to 0 at first, then increase by 1 every time Ameba reboots.



## Code Reference

We can use the flash api we used in previous flash memory example, but we need to use `begin()` function to specify the desired starting address and memory size.

```
FlashMemory.begin(0xFC000, 0x4000);
```

Use `readWord()` to read the value stored in a memory address. In the example, we read the value stored in memory offset `0x3F00`, that is `0xFC000 + 0x3F00 = 0xFFFF00`. `readWord()` function reads a 32-bit value and returns it.

```
value = FlashMemory.readWord(0x3F00);
```

Use `writeWord()` to write to a memory address. The first argument is the memory offset, the second argument is the value to write to memory.

```
FlashMemory.writeWord(0x3F0C, value);
```

## GPIO - Measure Distance By Ultrasound Module

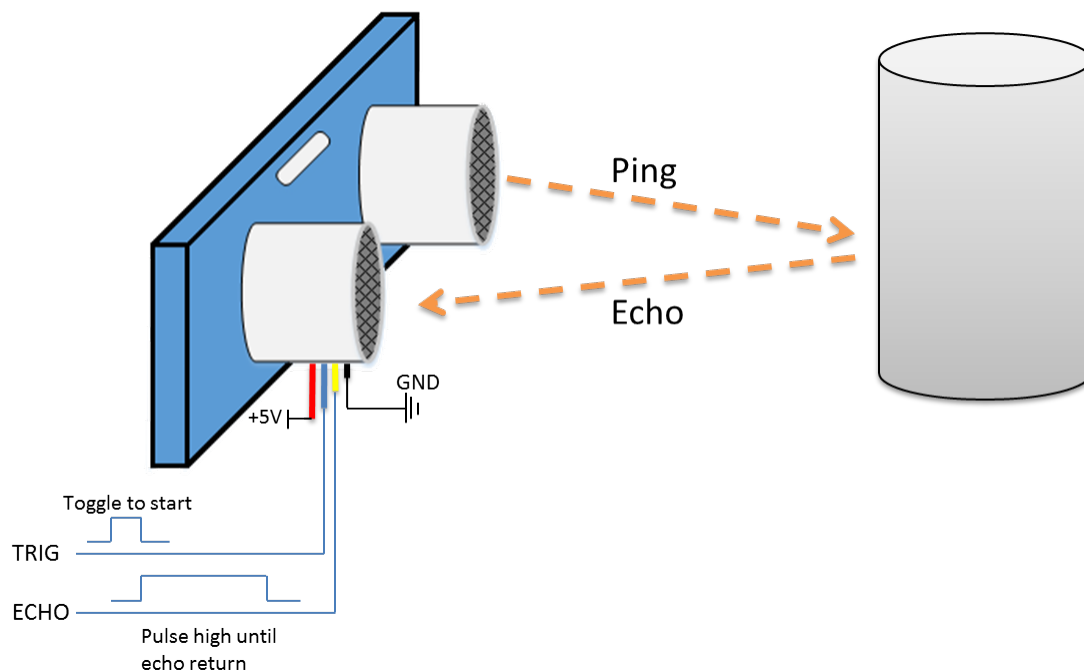
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- HC-SR04 Ultrasonic x 1
- Dropping resistor or Level converter

### Example

HC-SR04 is a module that uses ultrasound to measure the distance. It looks like a pair of eyes in its appearance, therefore it's often installed onto robot-vehicle or mechanical bugs to be their eyes.

The way it works is that first we “toggle high” the TRIG pin (that is to pull high then pull low). The HC-SR04 would send eight 40kHz sound wave signal and pull high the ECHO pin. When the sound wave returns back, it pull low the ECHO pin.

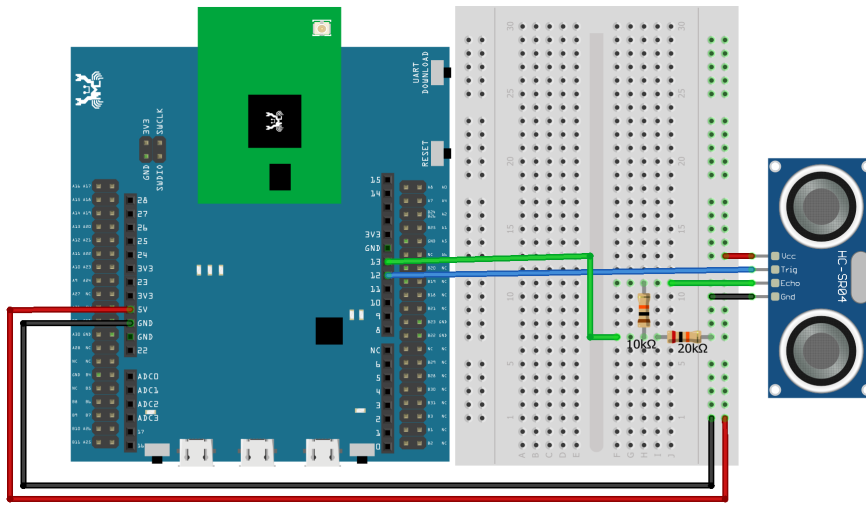


Assume the velocity of sound is 340 m/s, the time it takes for the sound to advance 1 cm in the air is  $340 \times 100 \times 10^{-6} = 29 \mu\text{s}$ .

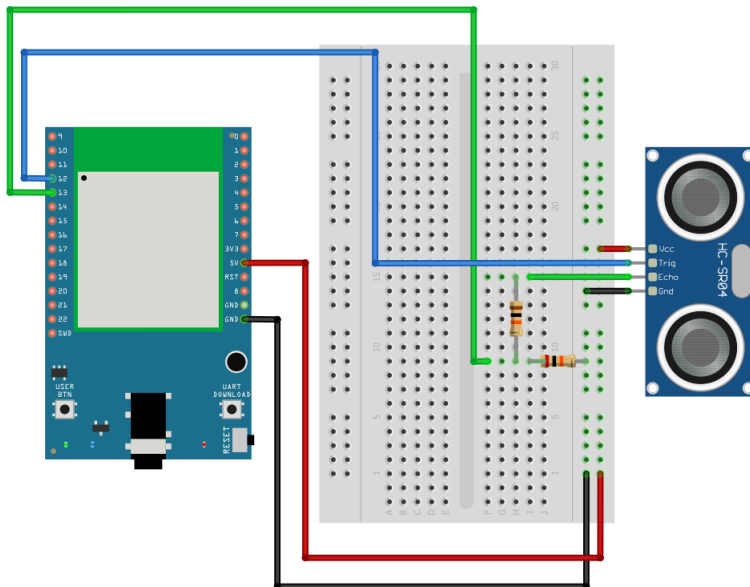
The sound wave actually travels twice the distance between HC-SR04 and the object, therefore the distance can be calculated by  $(\text{time}/29) / 2 = \text{time} / 58$ .

The working voltage of HC-SR04 is 5V. When we pull high the ECHO pin to 5V, the voltage might cause damage to the GPIO pin of Ameba. To avoid this situation, we need to drop the voltage as follows:

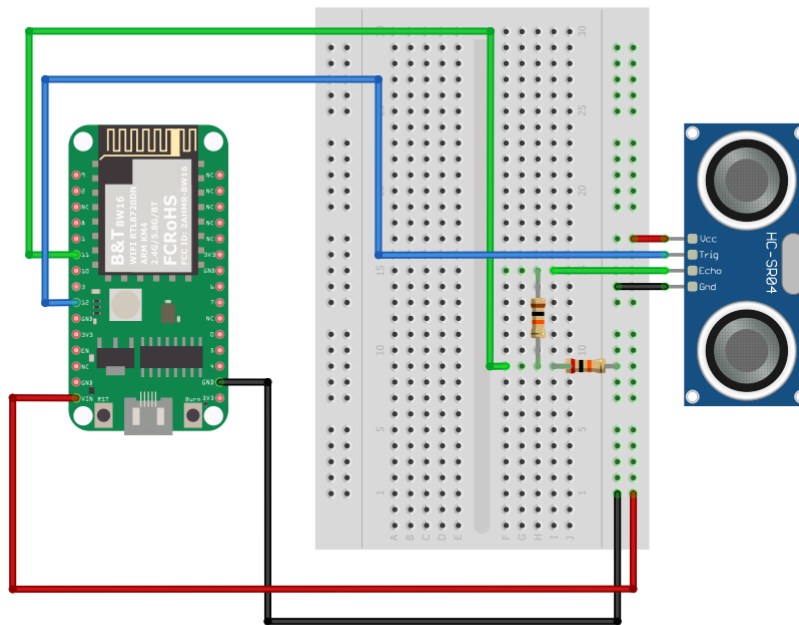
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



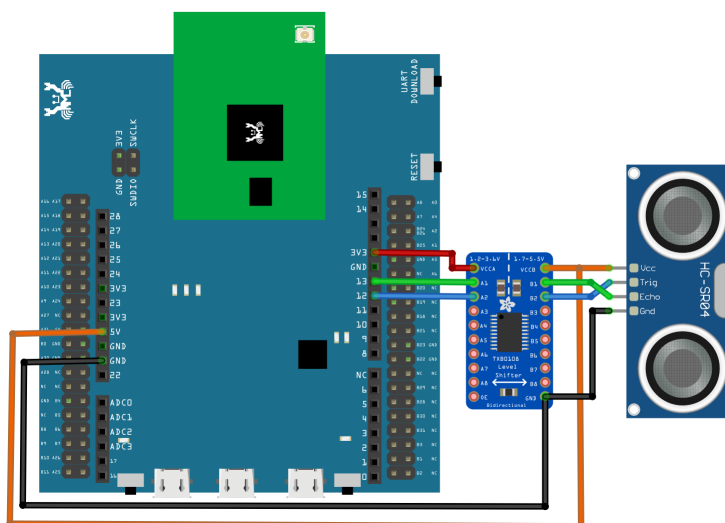
BW16 Wiring Diagram:



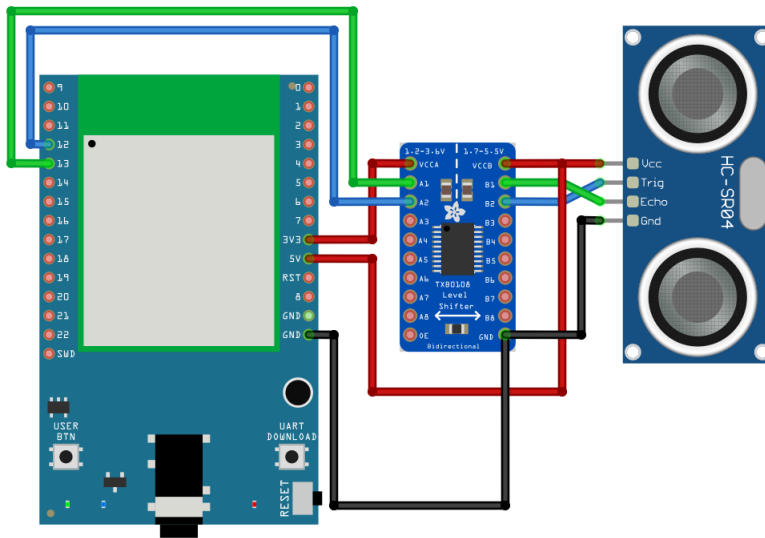
We pick the resistors with resistance 1:2, in the example we use  $10k\Omega$  and  $20k\Omega$ .

If you do not have resistors in hand, you can use level converter instead. The TXB0108 8 channel level converter is a suitable example:

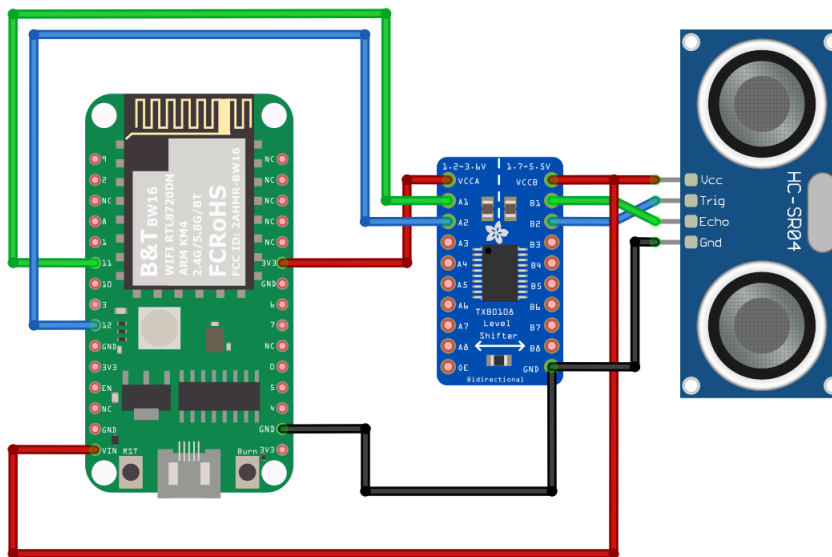
AMB21 / AMB22 Wiring Diagram:



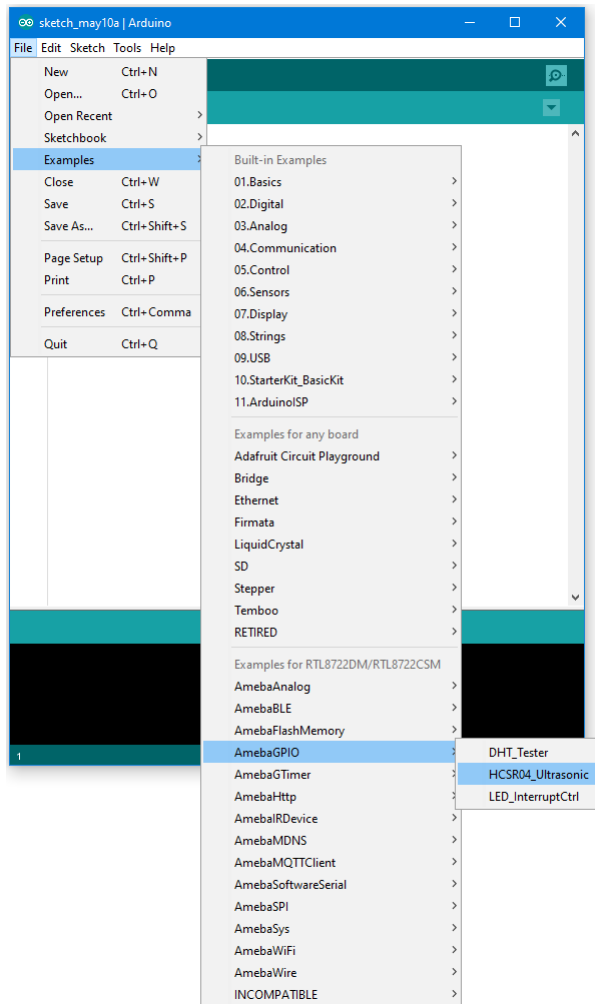
AMB23 Wiring Diagram:



BW16 Wiring Diagram:

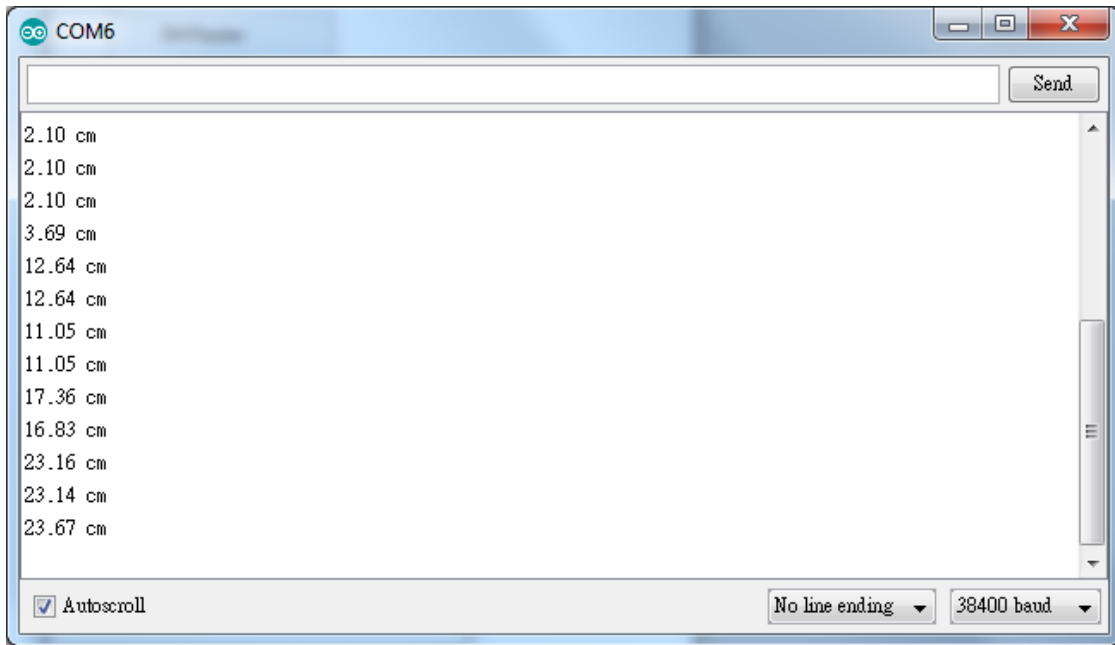


Next, open the sample code in “File” -> “Examples” -> “AmebaGPIO” -> “HCSR04\_Ultrasonic”



Compile and upload to Ameba, then press the reset button. Open the Serial Monitor, the calculated result is output to serial monitor every 2 seconds.





Note that the HCSR04 module uses the reflection of sound wave to calculate the distance, thus the result can be affected by the surface material of the object (e.g., harsh surface tends to cause scattering of sound wave, and soft surface may cause the sound wave to be absorbed).

### Code Reference

Before the measurement starts, we need to pull high the TRIG pin for 10us and then pull low. By doing this, we are telling the HC-SR04 that we are about to start the measurement:

```
digitalWrite(trigger_pin, HIGH);
delayMicroseconds(10);
digitalWrite(trigger_pin, LOW);
```

Next, use pulseIn to measure the time when the ECHO pin is pulled high.

```
duration = pulseIn (echo_pin, HIGH);
```

Finally, use the formula to calculate the distance.

```
distance = duration / 58;
```

## GPIO - Measure Temperature and Humidity

### Preparation

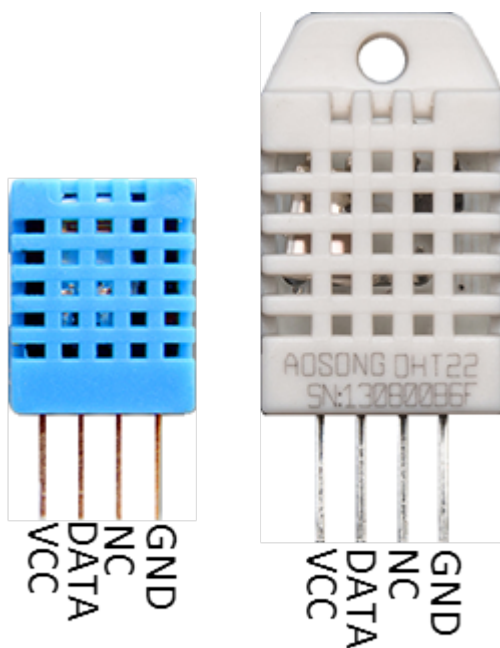
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21

### Example

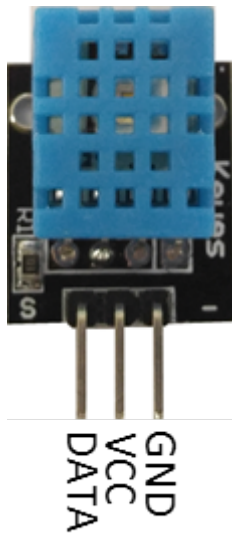
DHT11 is a temperature and humidity sensor which operates at voltage 3.3V~5V. At room temperature, the measurable range of the humidity is 20% ~ 90%RH with  $\pm 5\%$ RH precision, the measurable range of the temperature is 0 ~ 50°C with  $\pm 2^\circ\text{C}$  precision.

Another choice of temperature and humidity sensor is DHT22 sensor, which has better precision. Its measurable range of the humidity is 0%~100%RH with  $\pm 5\%$ RH precision, the measurable range of the temperature is -40~125 °C with  $\pm 0.2^\circ\text{C}$  precision.

There are 4 pins on the sensor:

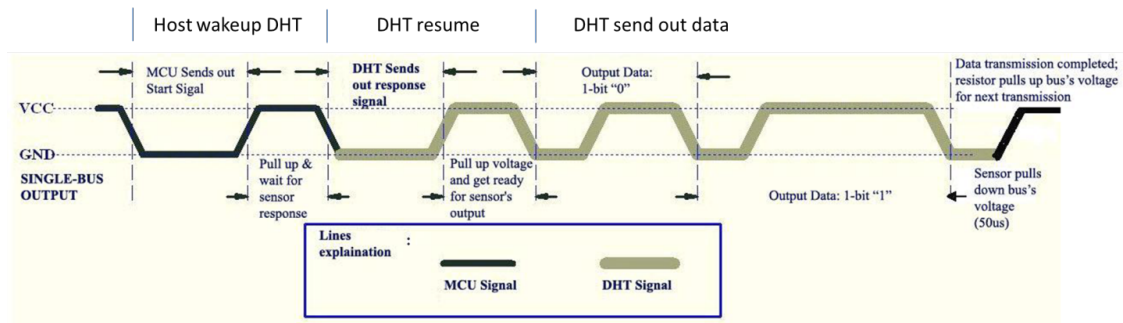


Since one of the 4 pins has no function, there are temperature/humidity sensors with only 3 pins on the market:

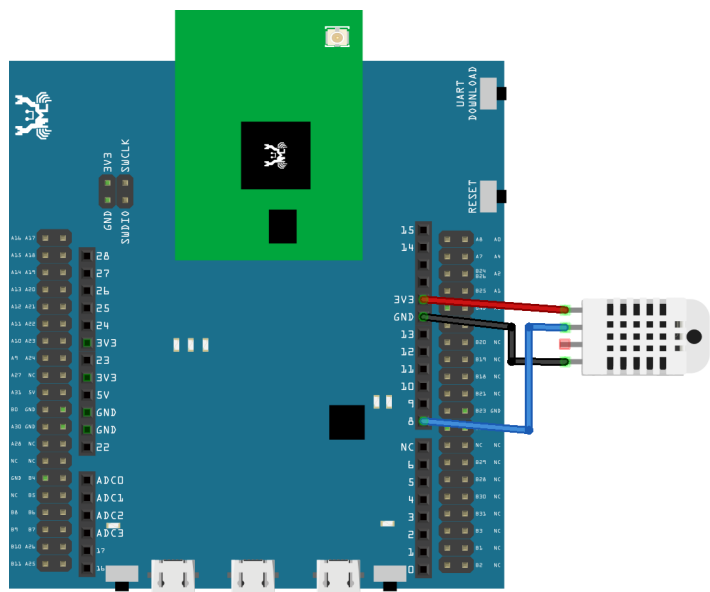


DHT is normally in the sleeping mode. To get the temperature/humidity data, please follow the steps:

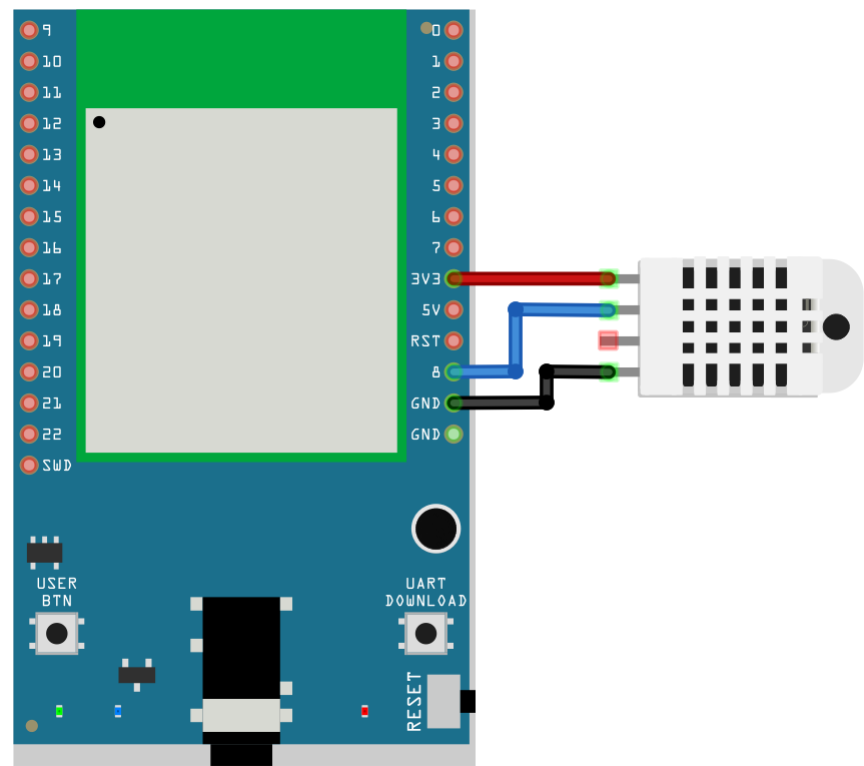
1. Awake DHT: Ameba toggles low its DATA pin of GPIO. Now the DATA pin of GPIO serves as digital out to Ameba.
2. DHT response: DHT also toggle low its DATA pin of GPIO. Now the DATA pin of GPIO serves as digital in for Ameba.
3. DHT sends data: DHT sends out the temperature/humidity data (which has size 5 bytes) in a bit by bit manner. To represent each bit, DHT first pull low the DATA GPIO pin for a while and then pull high. If the duration of high is smaller than low, it stands for bit 0. Otherwise it stands for bit 1.



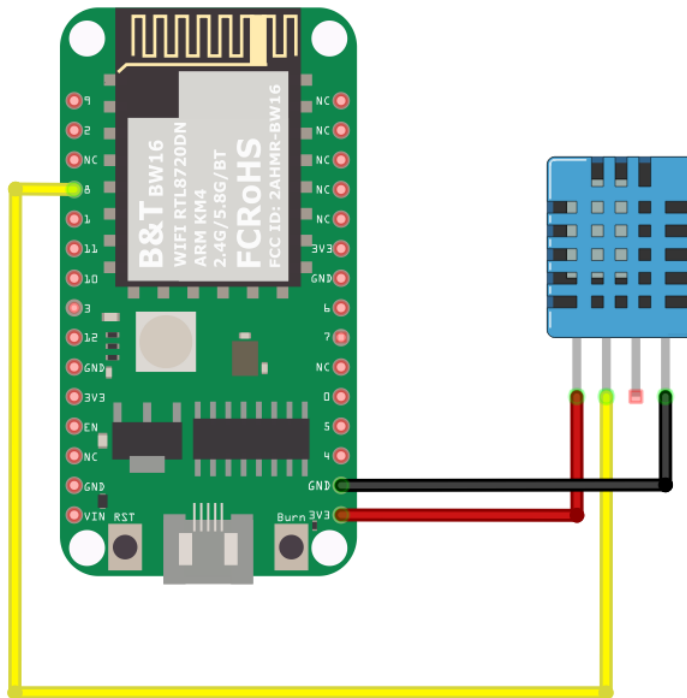
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the sample code in “Files” -> “Examples” -> “AmebaGPIO” -> “DHT\_Tester” . Compile and upload to Ameba, then press the reset button. The result would be shown on the Serial Monitor.

```

COM6
#calibration_ok:[2:19:11]
DHTxx test!
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 91.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.93 *C 78.68 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 92.00 %      Temperature: 28.00 *C 82.40 *F  Heat index: 34.46 *C 94.03 *F

```

☒ Autoscroll ☐ Show timestamp    Newline    115200 baud    Clear output

## Code Reference

Use `dht.readHumidity()` read the humidity value, and use `dht.readTemperature()` to read the temperature value.

Every time we read the temperature/humidity data, Ameba uses the buffered temperature/humidity data unless it found the data has expired (i.e., has not been updated for over 2 seconds). If the data is expired, Ameba issues a request to DHT to read the latest data.

## GPIO - Use GPIO Interrupt To Control LED

### Preparation

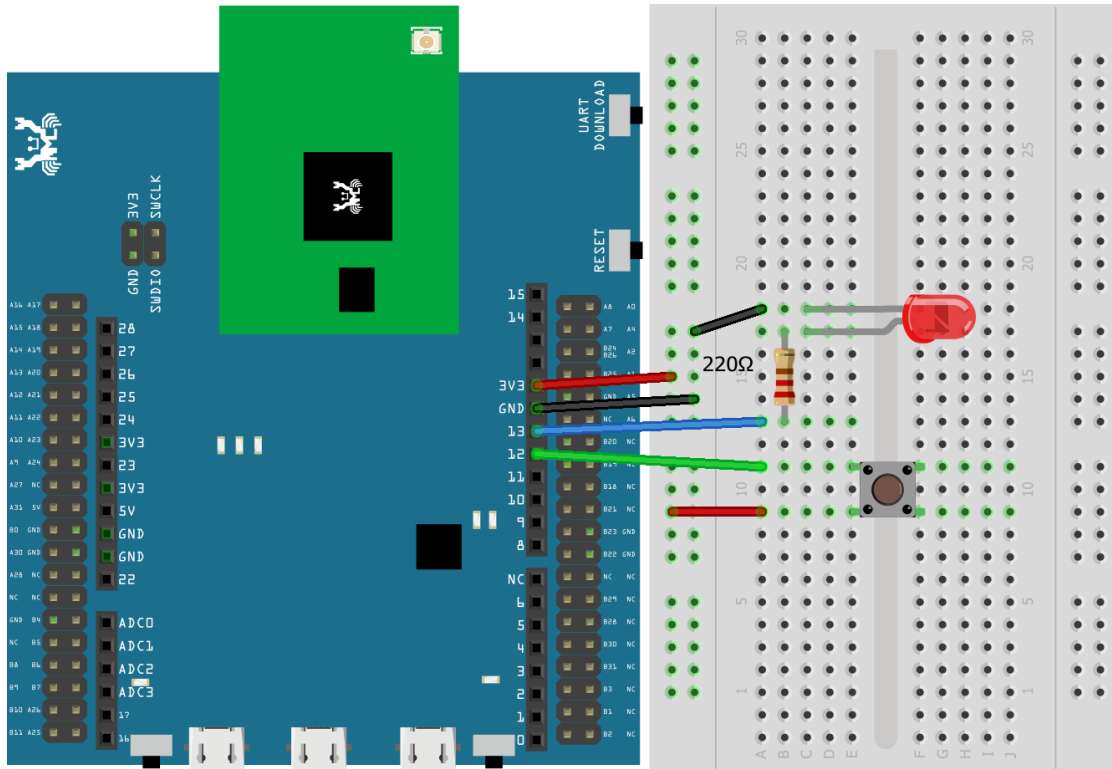
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- LED x 1
- Button x 1

## Example

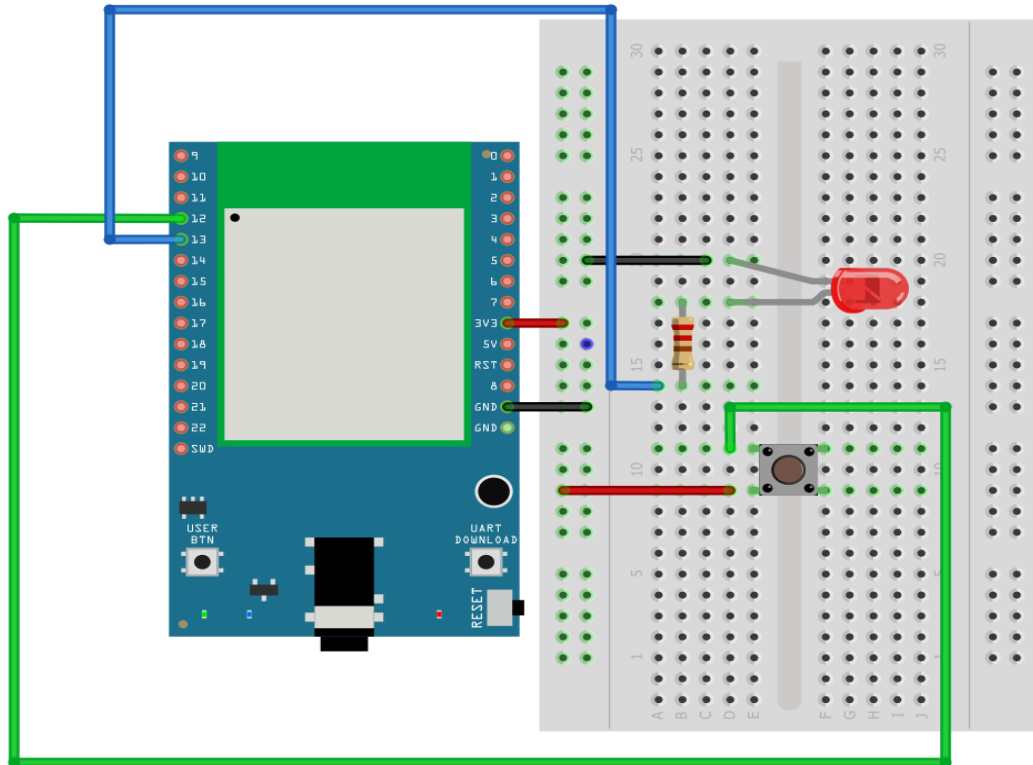
In this example, we use a button to trigger interrupt and control the LED. When we press and release the button, the LED dims, press and release the button again, and the LED lights. Note that in the Arduino example “Button and LED”, LED only lights when the button is pressed and hold, when we release the button, the LED dims.

Open the example, “Files” -> “Examples” -> “AmebaGPIO” -> “LED\_InterruptCtrl”

AMB21 / AMB22 Wiring Diagram:

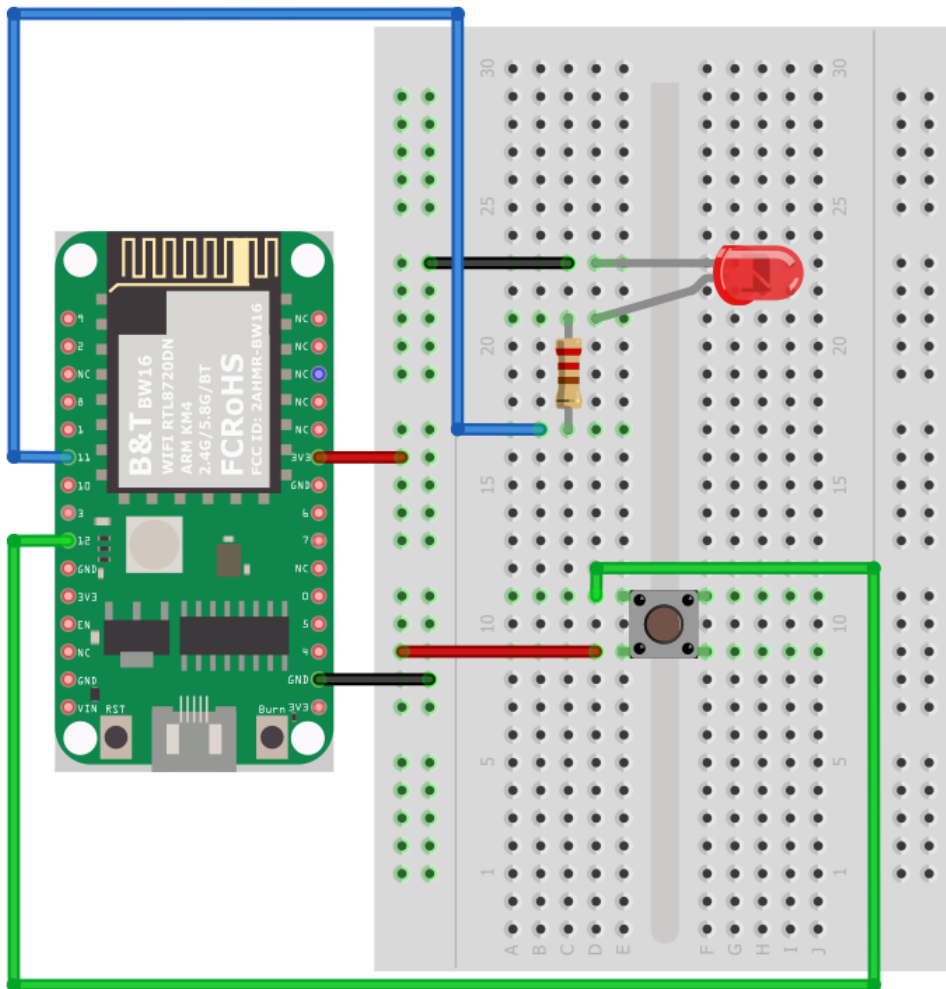


AMB23 Wiring Diagram:



**BW16** Wiring Diagram:





Compile and upload the program, press reset.

The LED lights at first. Press and release the button, then the LED should dim. Press again, then the LED should light.

### Code Reference

In

```
setup()
```

we set Pin 12 to

```
INPUT_IRQ_RISE
```

, this means that an interrupt occurs when the voltage of this pin changes from GND to 3V3. Therefore, we connect the other side of the button to 3V3, so as to trigger interrupt event when the button is pressed.

```
pinMode(button, INPUT_IRQ_RISE);
```

On the other hand, we can set pin 12 to

```
INPUT_IRQ_FALL
```

, this means that an interrupt occurs when the voltage of this pin changes from 3V3 to GND. In this case, the other side of the button is connected to GND. Next, we need to specify the function to be executed to handle the interrupt:

```
digitalSetIrqHandler(button, button_handler);
```

The second parameter is a function pointer, with prototype:

```
void button_handler(uint32_t id, uint32_t event)
```

In this handler, every time we press and release the button, we trigger an interrupt, and change the status of the LED.

## GTimer - Using The Periodic GTimer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

Ameba provides 4 hardware GTimer for users to use. The timers' resolutions are at microseconds scale.

The timer can be set to be periodic or for single use. The periodic timers reset periodically, and the single-use timers do not.

Open the example, "File" -> "Examples" -> "AmebaGTimer" -> "TimerPeriodical".

Compile and upload to Ameba, and press reset.

In the Serial Monitor, you can see the counter value is increased periodically.

## Code Reference

The first argument of `begin()` is the timer id (0~3).

The second argument is the value of the timer (in microseconds). In the example, we fill in  $1000000\text{us} = 1\text{s}$ .

The third argument specifies the function to call when the time is up. In the example, we call the “myhandler” function to increase the counter value by 1 and print the counter value to serial monitor.

```
GTimer.begin(0, 1 * 1000 * 1000, myhandler);
```

The GTimer is periodic by default, therefore “myhandler” function is called every second. When we want to stop the GTimer, use `stop()`:

```
GTimer.stop(0);
```

## GTimer - Using the One-Time Gtimer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we will use 4 One-Time GTimer, and pass user data to each timer.

Open the example “File” -> “Examples” -> “AmebaGTimer” -> “TimerOneshot”. Compile and upload to Ameba, and press reset. Then you can see the 4 timer log printed to the serial monitor in series.

## Code Reference

The first argument of `begin()` is the Timer ID (0~3). The second argument is the value of the timer (in microseconds). In the example, we fill in  $1000000\text{us} = 1\text{s}$ . The third argument specifies the function to call when the time is up. The fourth argument is to set whether this timer is a periodic timer, we use “false” here to begin a single-use timer. The fifth argument is the user data, we give 0 here to represent that this is timer 0.

```
GTimer.begin(0, 1 * 1000 * 1000, myhandler, false, 0);
```

Next, we set up the second timer, which has timer value 2 seconds, and user data 1. And other timers are set similarly.

```
GTimer.begin(1, 2 * 1000 * 1000, myhandler, false, 1);
```

In myhandler function, we print the user data to serial monitor. Since the 4 timers are separately set to count for 1, 2, 3, 4 seconds, from 1 second to 4 second, the user data of each timer are printed on the serial monitor in order. After 4 second, no log will be printed.

## I2C - Send Data to Arduino UNO

### Introduction of I2C

There are two roles in the operation of I2C, one is “master” , the other is “slave” . Only one master is allowed and can be connected to many slaves. Each slave has its unique address, which is used in the communication between master and the slave. I2C uses two pins, one is for data transmission (SDA), the other is for the clock (SCL). Master uses the SCL to inform slave of the upcoming data transmission, and the data is transmitted through SDA. The I2C example was named “Wire” in the Arduino example.

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Arduino UNO x 1

### Example

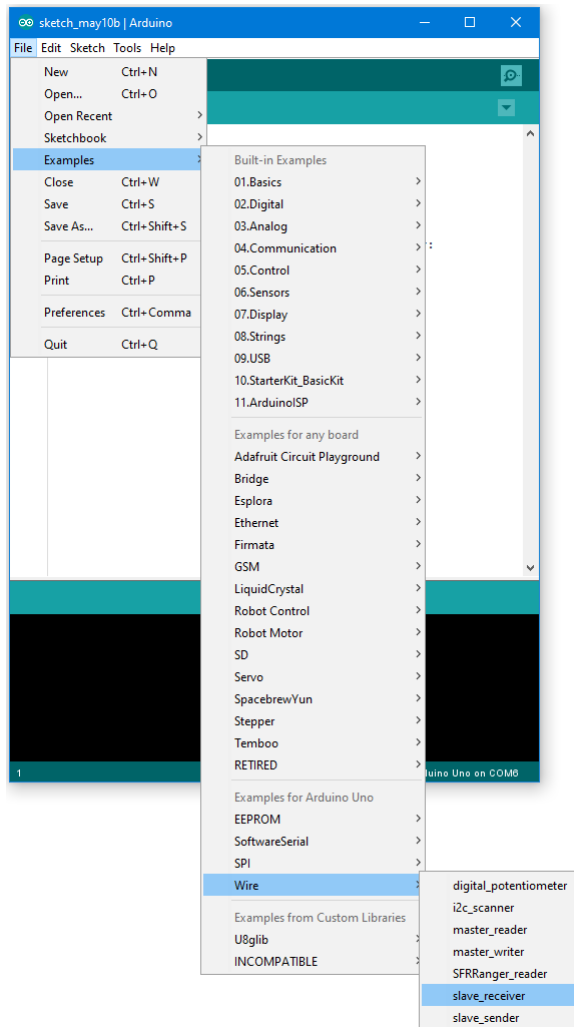
In this example, we use Ameba as the I2C master writer, and use Arduino as the I2C slave receiver.

When the I2C slave receives string sent from I2C master, it prints the received string.

- Setting up Arduino Uno to be I2C Slave

First, select Arduino in the Arduino IDE in “Tools” -> “Board” -> “Arduino Uno”

Open the “Slave Receiver” example in “Examples” -> “Wire” -> “slave\_receiver” :



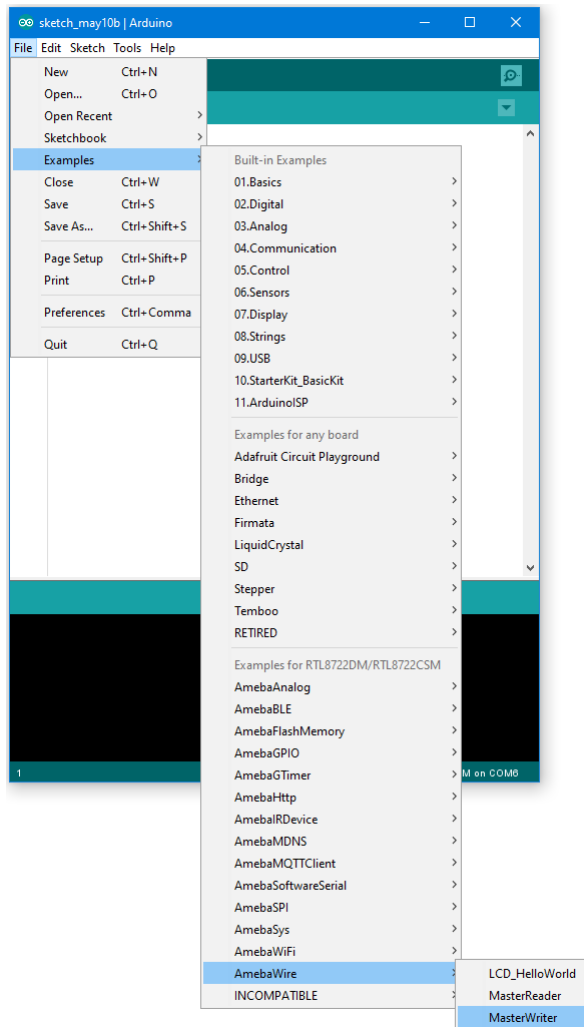
Then click “Sketch” -> “Upload” to compile and upload the example to Arduino Uno.

- Setting up Ameba to be I2C Master

Next, open another window of Arduino IDE, make sure to choose your Ameba development board in the IDE:

“Tools” -> “Board”

Then open the “Master Writer” example in “File” -> “Examples” -> “AmebaWire” -> “MasterWriter”

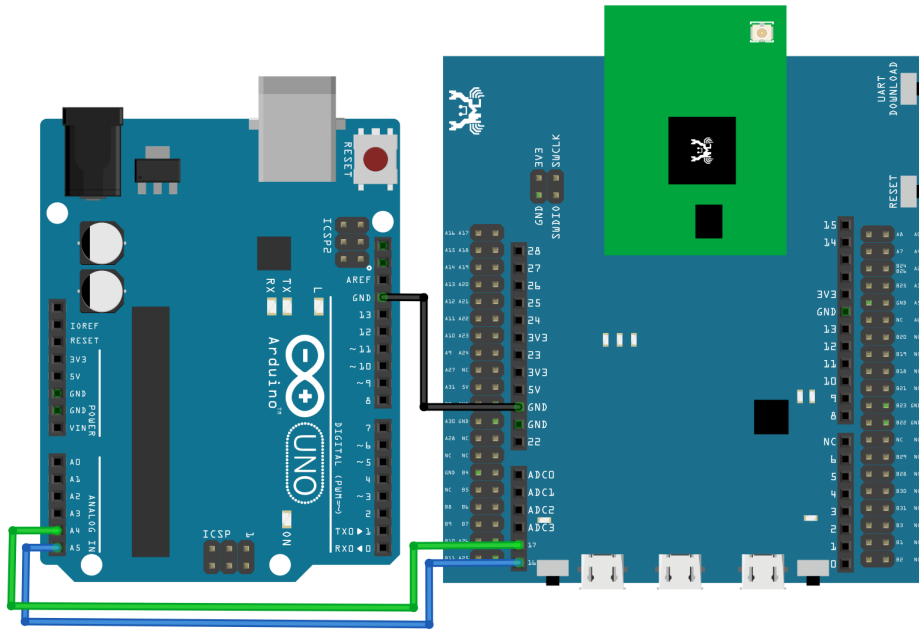


- Wiring

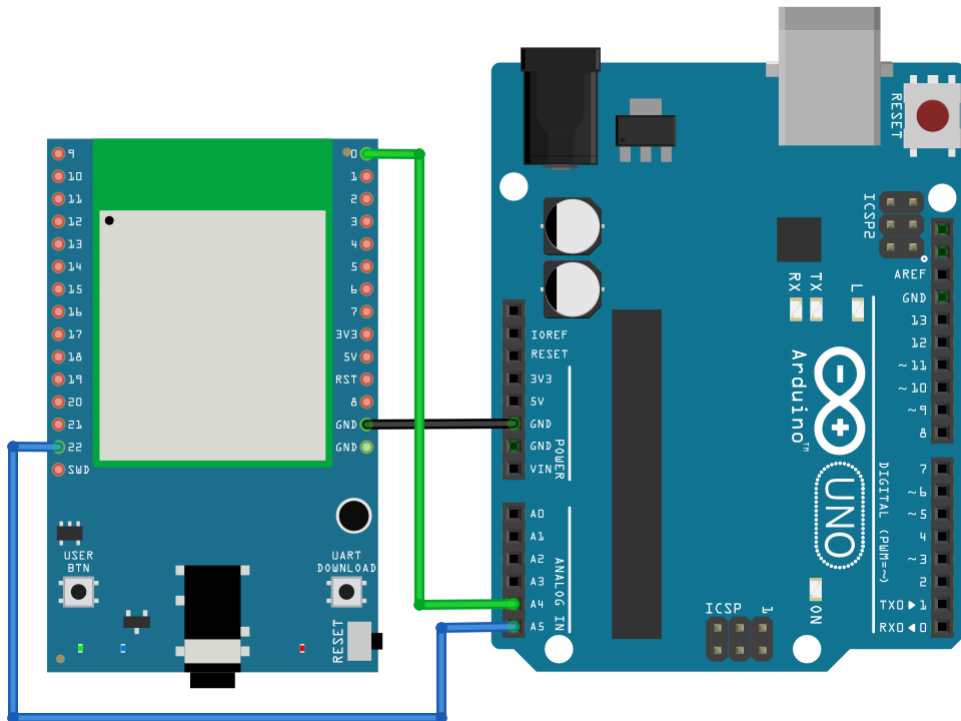
The Arduino example uses A4 as the I2C SDA and A5 as the I2C SCL.

Another important thing is that the GND pins of Arduino and Ameba should be connected to each other.

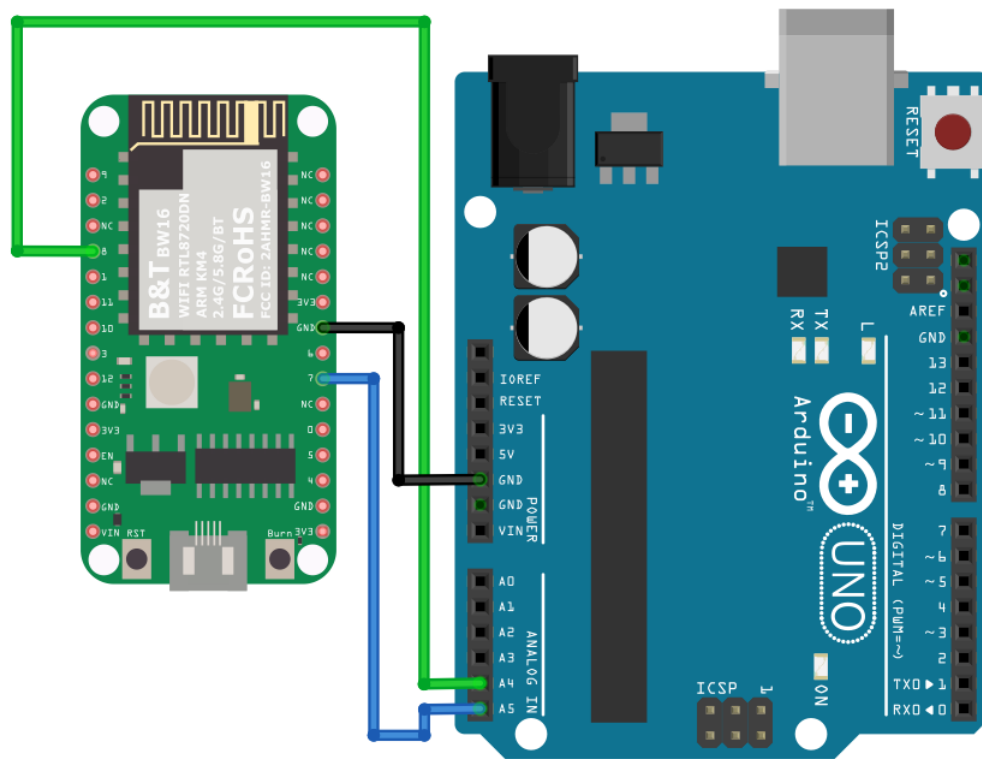
**AMB21/ AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



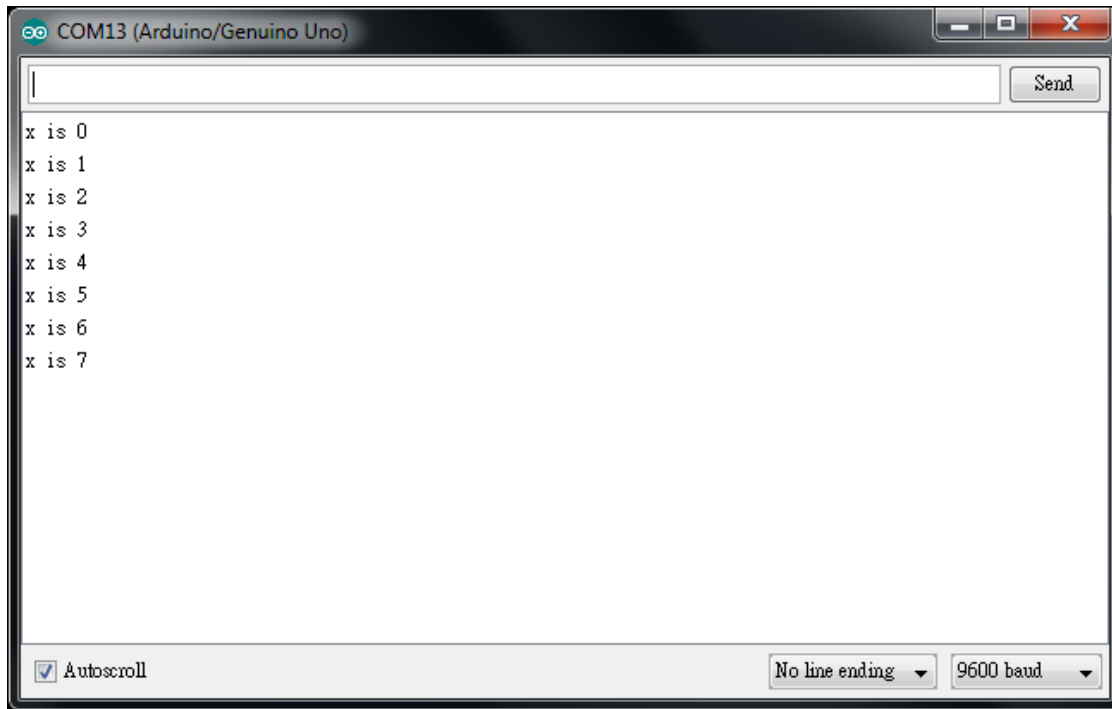
Open the Arduino IDE of the Arduino Uno and open the serial monitor ( “Tools” -> “Serial Monitor” ).

In the Serial Monitor, you can see the messages printed from Arduino Uno.

Next, press the reset button on Arduino Uno. Now the Arduino Uno is waiting for the connection from I2C Master.

We press the reset button on Ameba to start to send messages. Then observe the serial monitor, you can see the messages show up every half second.





## Code Reference

You can find detailed information of this example in the documentation of Arduino:

<https://www.arduino.cc/en/Tutorial/MasterWriter>

First use `Wire.begin()/Wire.begin(address)` to join the I2C bus as a master or slave, in the Master case the address is not required.

<https://www.arduino.cc/en/Reference/WireBegin>

Next, the Master uses `Wire.beginTransmission(address)` to begin a transmission to the I2C slave with the given address:

<https://www.arduino.cc/en/Reference/WireBeginTransmission>

Uses `Wire.write()` to send data, and finally use `Wire.endTransmission()` to end a transmission to a Slave and transmits the bytes that were queued:

<https://www.arduino.cc/en/Reference/WireEndTransmission>

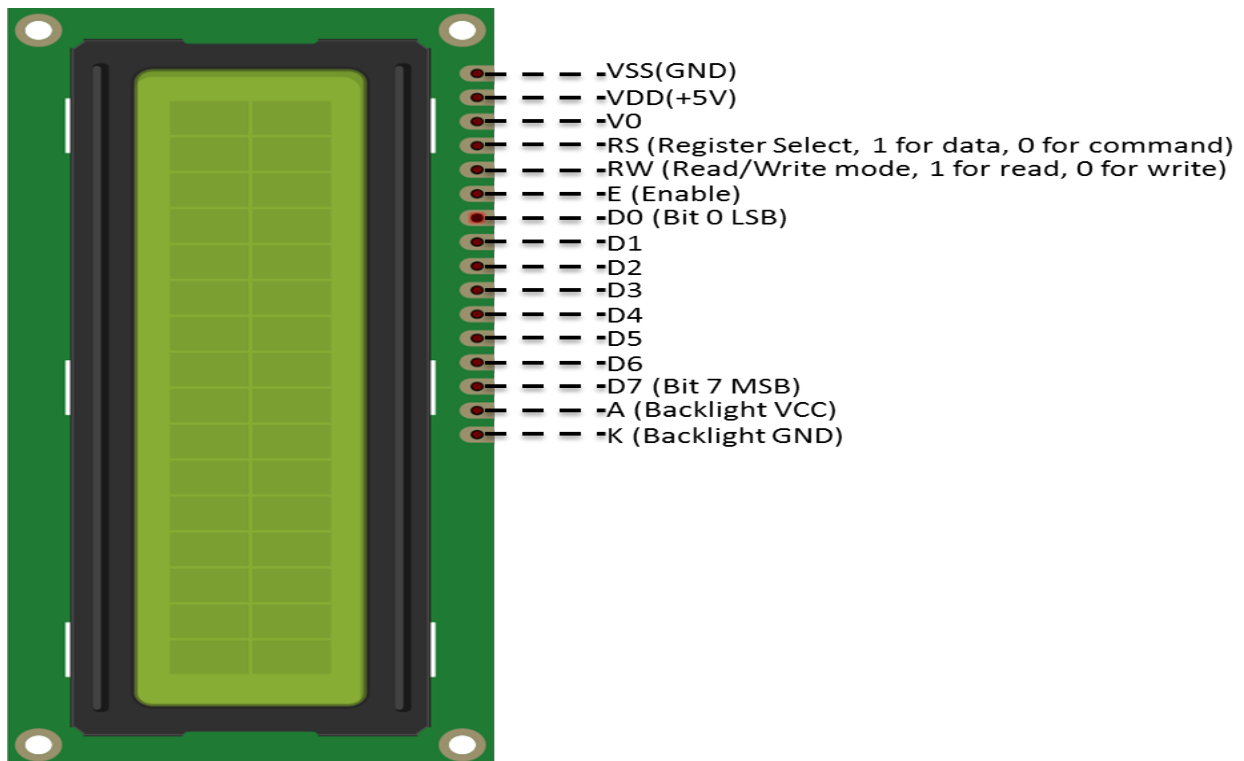
## I2C - Display Data On LCD Screen

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- I2C 2×16 LCD

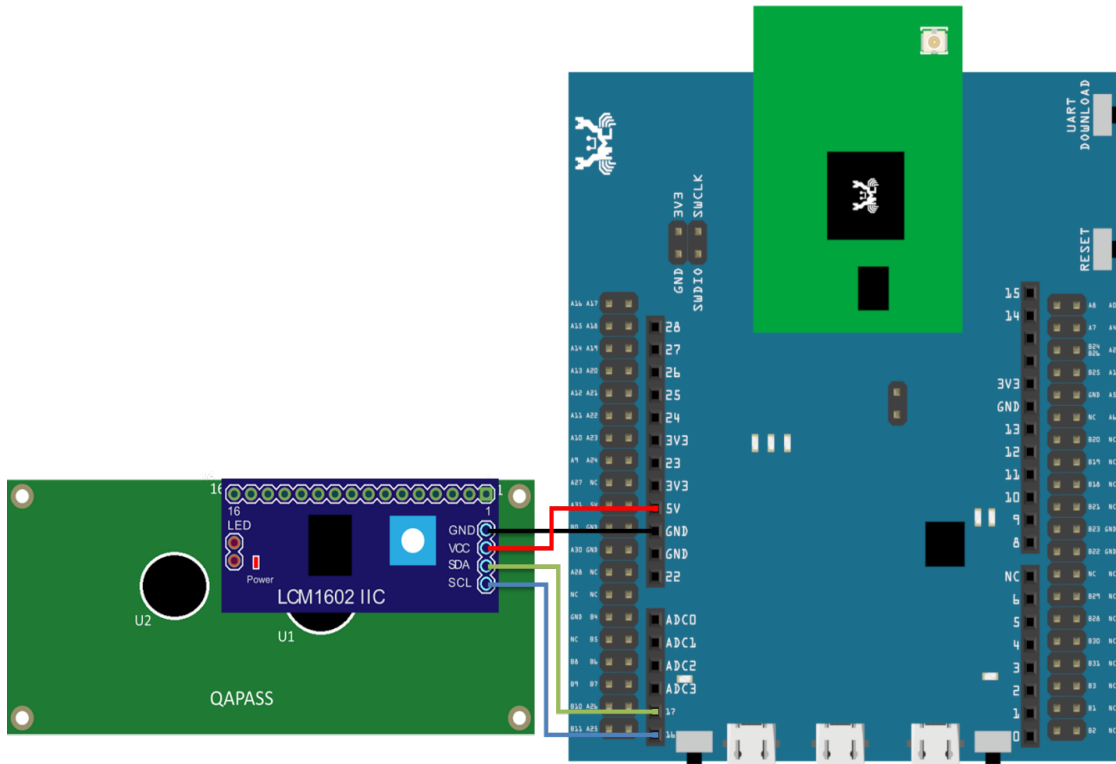
### Example

Normally there are many pins on an LCD display, as shown in below figure.

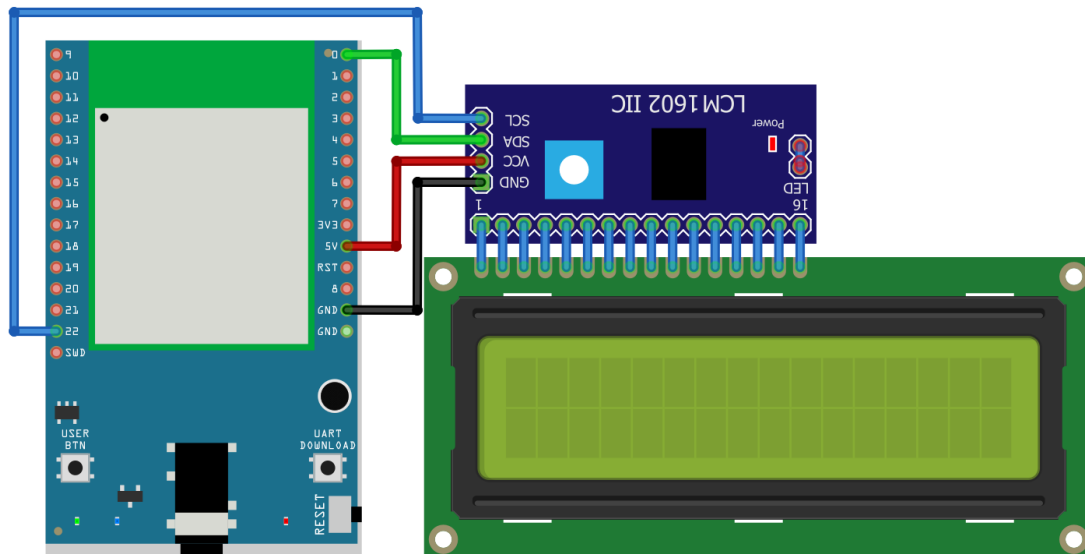


An LCD display can be equipped with an additional processing chip to process the data. The processing chip can connect to a microcontroller using the I2C interface.

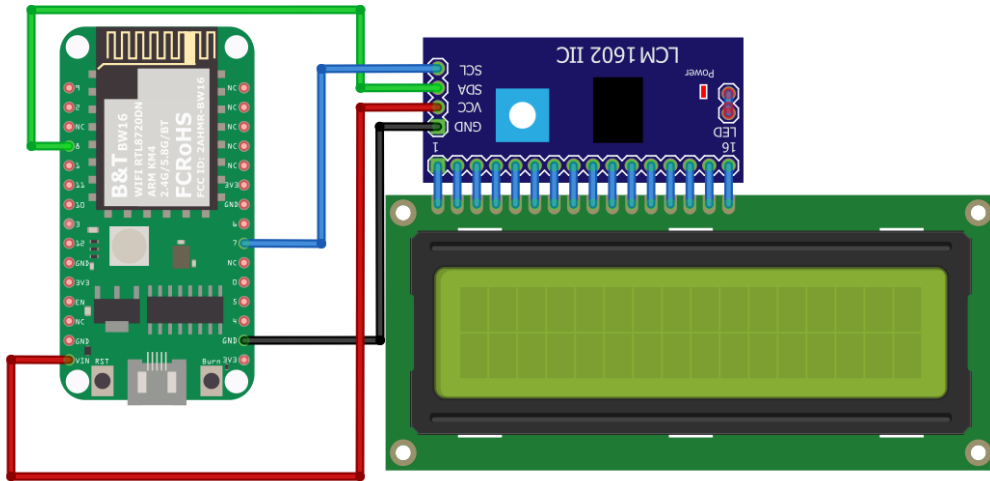
**AMB21 / AMB22 Wiring Diagram:**



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the example in “File” -> “Examples” -> “AmebaWire” -> “LCD\_HelloWorld” .

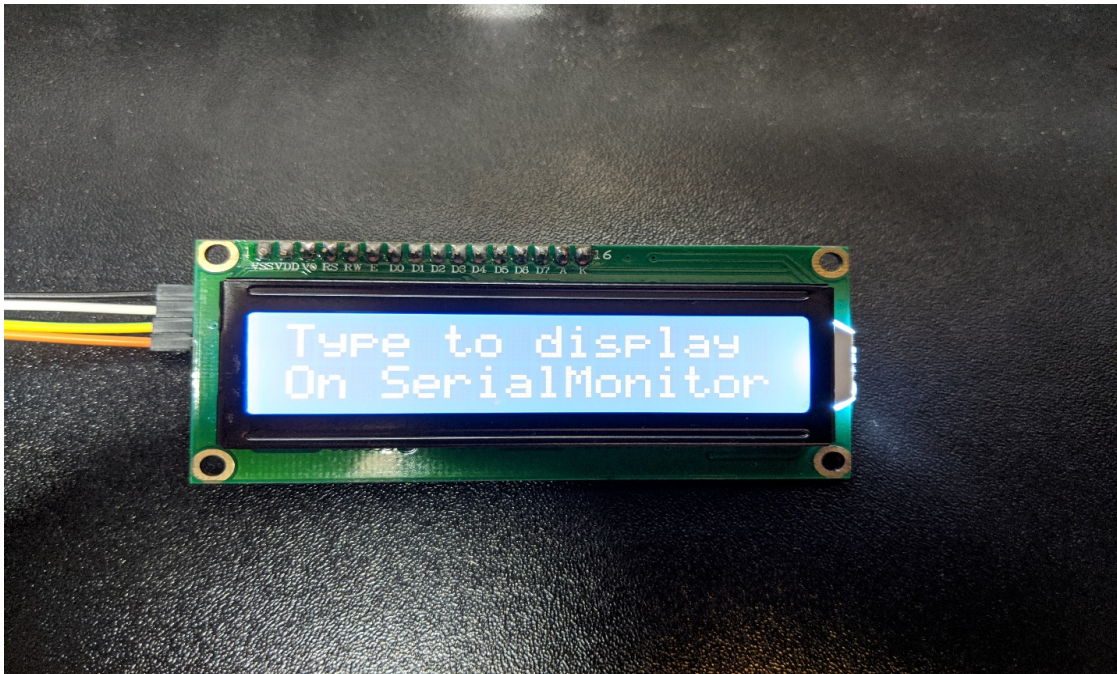
Compile and upload to Ameba, then press the reset button.

Then you can see “Hello World” in the first line, and “Ameba” in the second line displayed on the LCD screen.



After 8 seconds, you can input to the Serial Monitor the string you would like to display on the LCD.





For example, we enter “123456789” and press “Send” :



### Code Reference

The required settings of each model of LCD might be different, the constructor we use in this example is:

```
LiquidCrystal_I2C(uint8_t lcd_Addr, uint8_t En, uint8_t Rw, uint8_t Rs,
                  uint8_t d4, uint8_t d5, uint8_t d6, uint8_t d7,
```

(繼續下一頁)

(繼續上一頁)

```
uint8_t backlighPin, t_backlighPol pol);
```

And the setting parameters are as follows:

```
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Set the LCD I2C  
↪address
```

The first parameter 0x27 is the address of I2C. Each of the following 8 parameters represents the meaning of each bit in a byte, i.e., En is bit 2, Rw is bit 1, Rs is bit 0, d4 is bit 4, and so forth.

Call `backlight()` to light the screen,

Call `setCursor(0, 0)` to set the position of the cursor.

LCD inherits the Print class, so we can use `lcd.print()` to output string on the screen.

## I2C - Receive Data from Arduino UNO

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Arduino UNO x 1

### Example

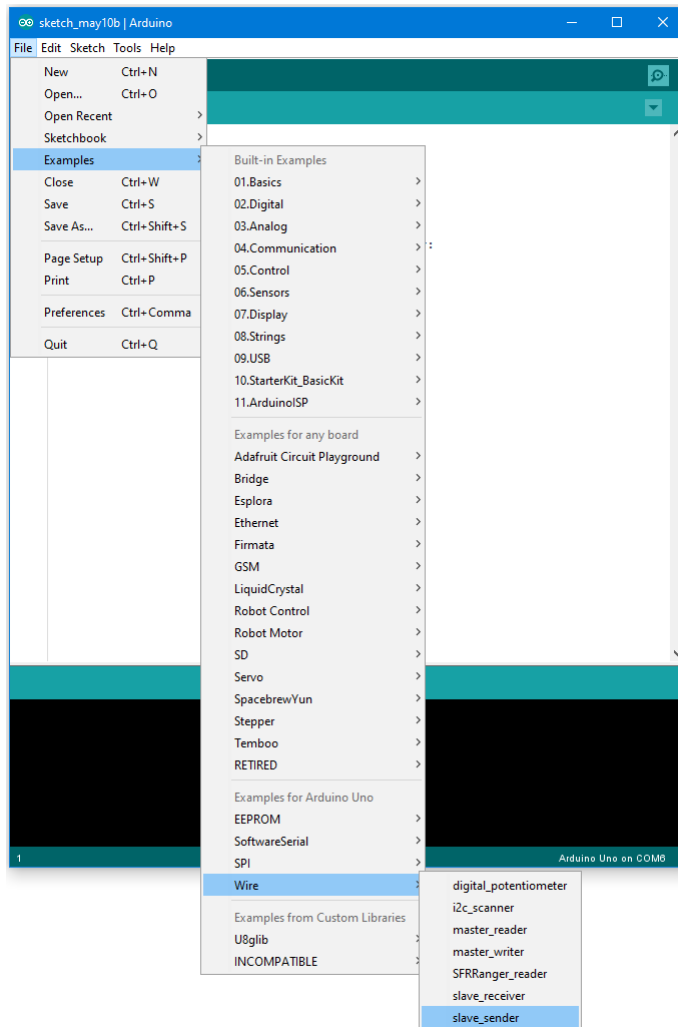
In the previous example “I2C –Communicate with Arduino UNO via I2C” , Ameba, the I2C master, transmits data to the Arduino UNO, the I2C slave.

As to this example, Ameba is the I2C master, and receives data from the Arduino UNO, which is the I2C slave.

- **Setting up Arduino Uno to be I2C Slave**

First, select Arduino in the Arduino IDE in “Tools” -> “Board” -> “Arduino Uno” :

Open “Examples” -> “Wire” -> “slave\_sender”

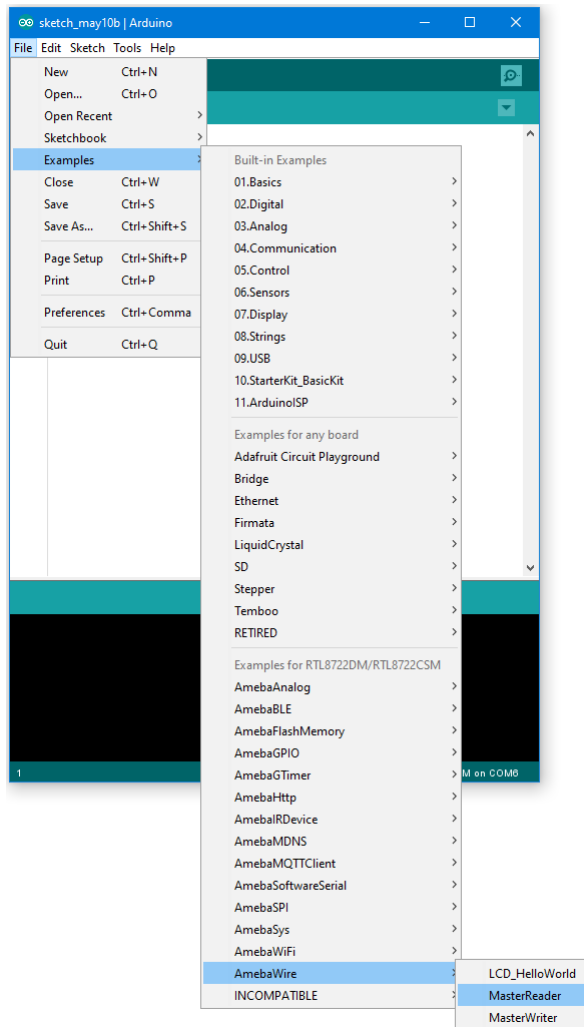


Then click “Sketch” -> “Upload” to compile and upload the example to Arduino Uno.

- **Setting up Ameba to be I2C Master**

Next, open another window of Arduino IDE, make sure to choose your Ameba development board in the IDE: “Tools” -> “Board”

Open “File” -> “Examples” -> “AmebaWire” -> “MasterReader”



Click “Sketch” -> “Upload” to compile and upload the example to Ameba.

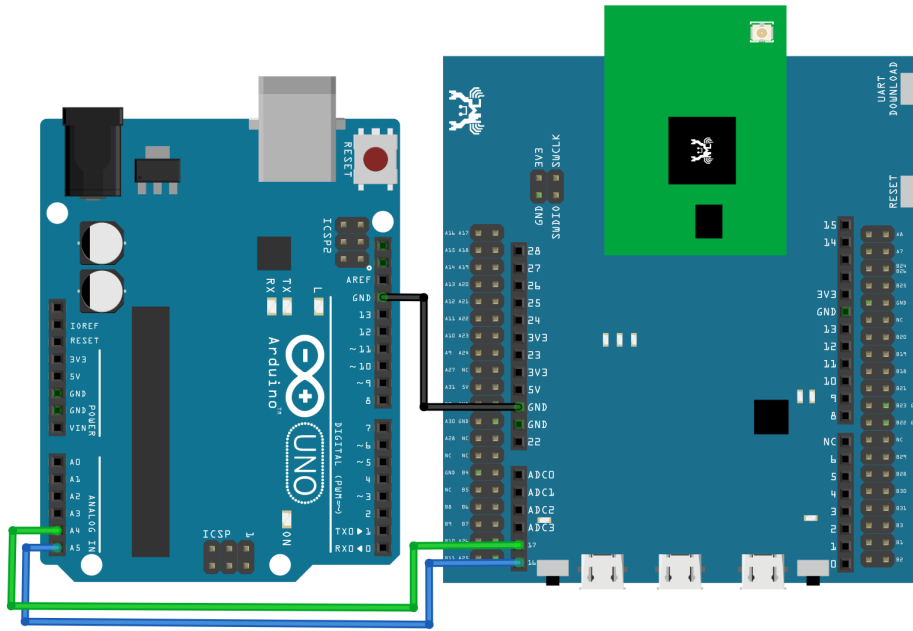
- **Wiring**

The Arduino example uses A4 as the I2C SDA and A5 as the I2C SCL.

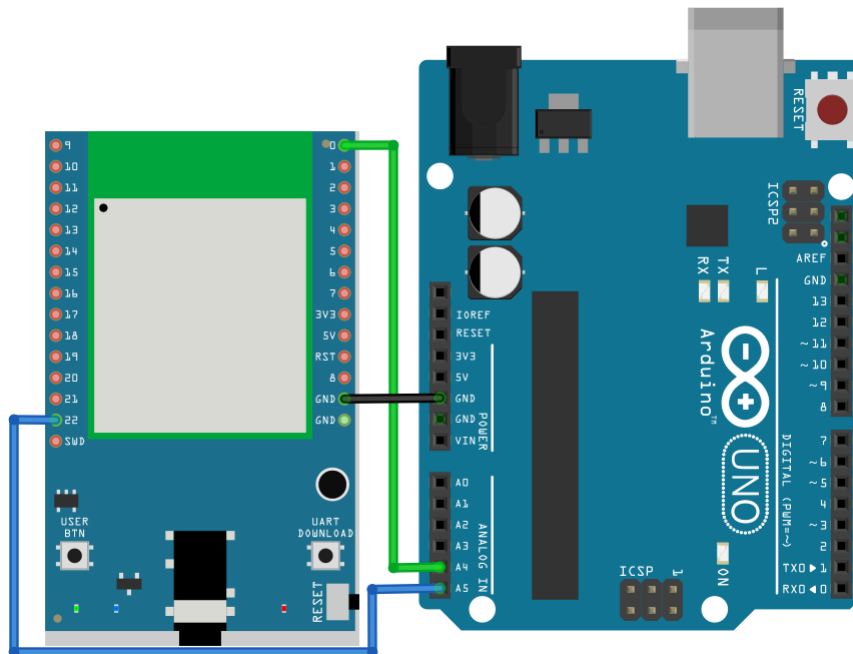
Another important thing is that the GND pins of Arduino and Ameba should be connected to each other.

**AMB21 / AMB22 Wiring Diagram:**

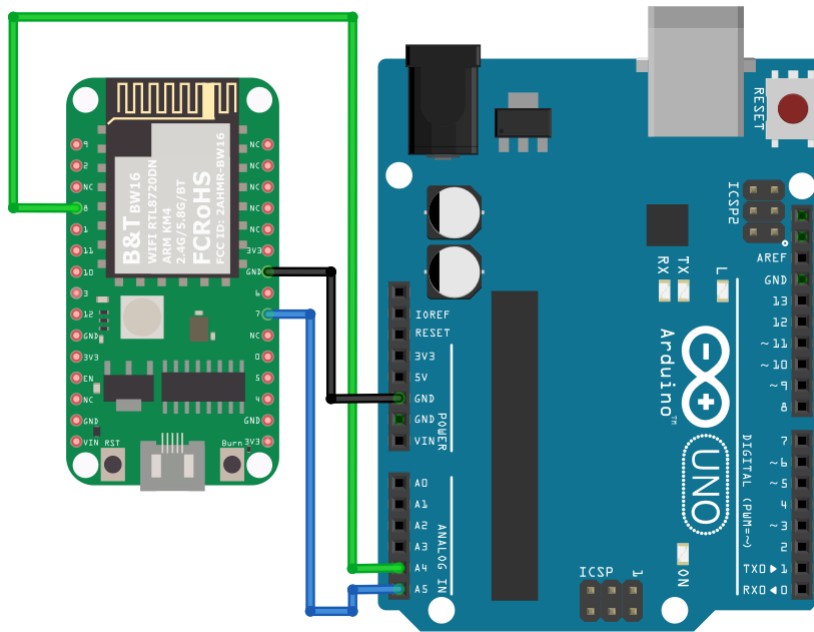




AMB23 Wiring Diagram:

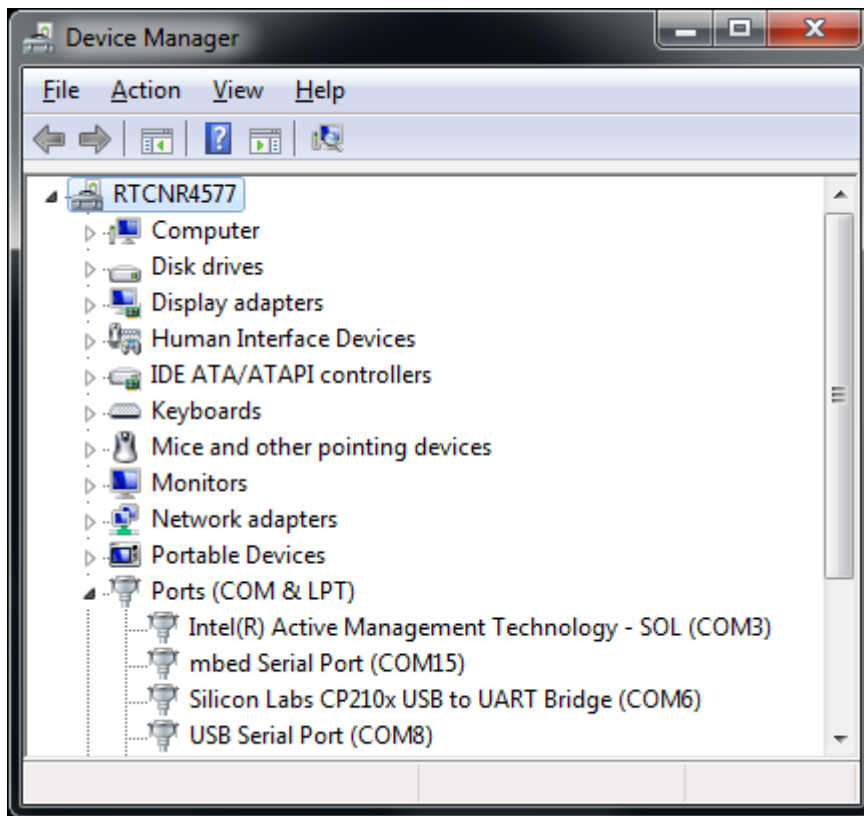


BW16 Wiring Diagram:



Next, we will observe the data receive by Ameba in the Serial Monitor.

(Note: If you do not know which port the Ameba development board is connected to, please find it in the Device Manager of Windows first. Ameba is connected as “mbed Serial Port” . For example, if you find mbed Serial Port (COM15) means Ameba is connected to port COM15.)



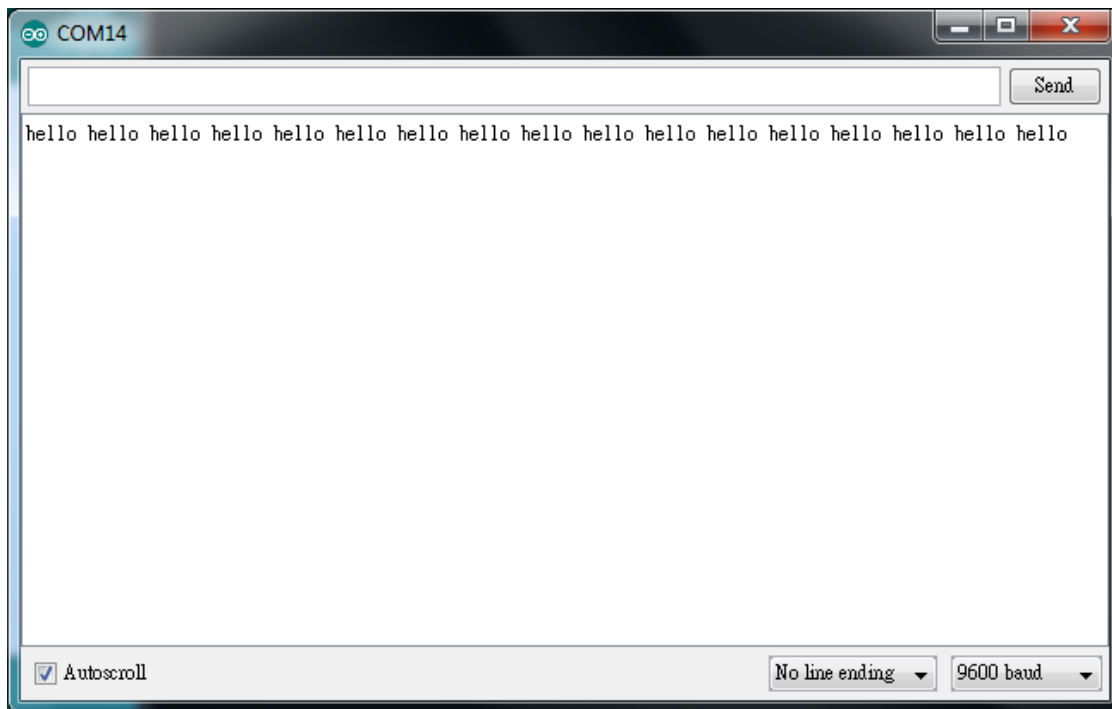
We select the port in “Tools” -> “Port” -> “COM15” (the port connected to Ameba)

Open the Arduino IDE window of the Ameba, go to “Tools” -> “Serial Monitor” to display the messages printed by Ameba.

Press the reset button on Arduino Uno, Arduino Uno now waits for connection from I2C master.

Then press the reset button on Ameba, Ameba will start to receive messages from Arduino Uno. And you can see the “hello ” message printed every half second in serial monitor.

(NOTE: If the message does not show in the Serial Monitor of Ameba, please close and open the serial monitor again.)



## Code Reference

You can find detailed information of this example in the documentation of Arduino:

<https://www.arduino.cc/en/Tutorial/MasterReader>

First use `Wire.begin()` / `Wire.begin(address)` to join the I2C bus as a master or slave, in the Master case the address is not required.

<https://www.arduino.cc/en/Reference/WireBegin>

Next, the Master uses `Wire.requestFrom()` to specify from which Slave to request data.

<https://www.arduino.cc/en/Reference/WireRequestFrom>

## IR - Transmit IR NEC Raw Data And Decode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16 ] x 2
- Grove –Infrared Emitter x1 (Figure 1)
- Grove –Infrared Receiver x1 (Figure 2)

### Example

In this example, we use two Ameba RTL8722 modules that connecting with an infrared (IR) Emitter and an IR Receiver separately to transmit and receive IR NEC Raw data.



Figure 1: Grove –Infrared Receiver

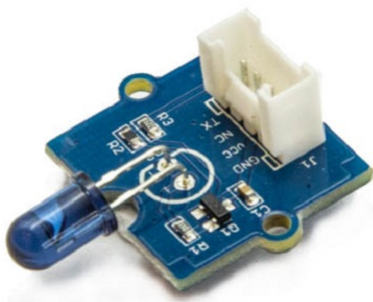


Figure 2: Grove –Infrared Emitter

On the transmission side, the transmitter will send IR NEC raw data. The raw data can be seen as consecutive durations of “marks” and “spaces” (Figure 3) in microseconds (us).

- Mark: a specific period of sending pulses
- Space: a specific period of sending nothing

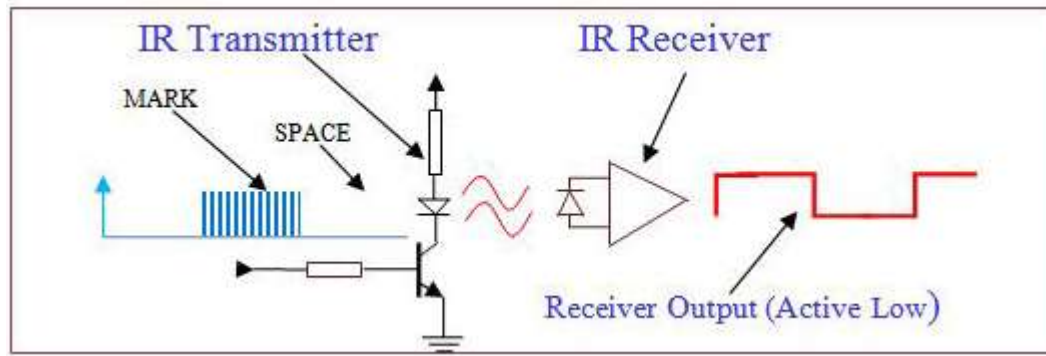


Figure 3: A typical IR transmission and reception setup implementation

For more details, please refer to SB-Projects' topic of [IR Remote Control Theory](#) to learn the theory of IR remote controls operation and a collection of IR protocol descriptions. In this example, we are going to use NEC (Now Renesas, also known as Japanese Format) as the transmission protocol.

### NEC Features

- 8-bit address and 8-bit command length.
- Extended mode available, doubling the address size.
- Address and command are transmitted twice for reliability.
- Pulse distance modulation.
- The carrier frequency of 38kHz.
- Bit time of 1.125ms or 2.25ms.

### Modulation

NEC protocol uses Pulse Distance Encoding of the bits for data communication (Figure 4). A logical "1" is represented by total duration of 2250us, with 560us of "marks" and (2250-560) us of "spaces" . While logical "0" is represented by total duration of 1120us, with 560us "marks" and (1120-560) us of "spaces" .

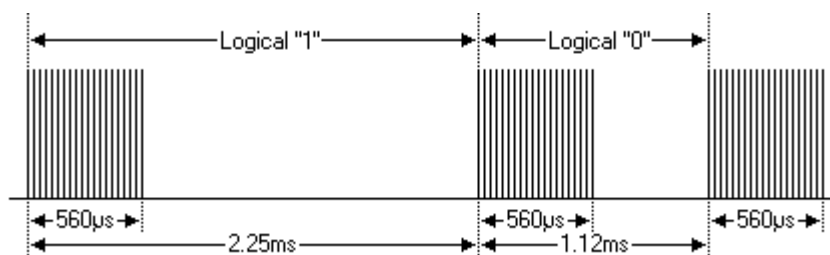


Figure 4: Modulation of NEC

Since a total number of 32-bit data together with the header and the end-bit will be transferred (Figure 5). If we separate the data in the time-frame (in us), there will be  $(2 + 32) \times 2 + 1 = 69$  “marks” / “spaces” to be transmitted (Figure 6), which forms the raw NEC data we would like to transmit in our Arduino “\*.ino” file. This part of the code can be modified by users. Details of how to obtain raw data code for your remote devices, you may refer to [Ken Shirriff’s blog](#), where it provides multiple libraries provided online.

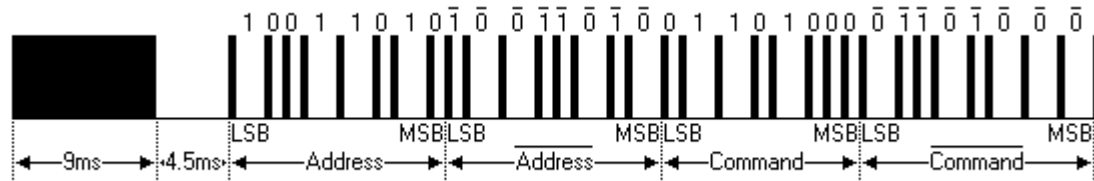


Figure 5: Sample of a Full NEC Data (in logic1 or 0)

```

9000, 4500, // starting bit
560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, 560, // address
560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, // ~address
560, 560, 560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, // data
560, 1690, 560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, //~data
560 // stoping bit

```

Figure 6: Sample of a Full NEC RAW Data (in us)

Figure 7 and 8 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8722 board.

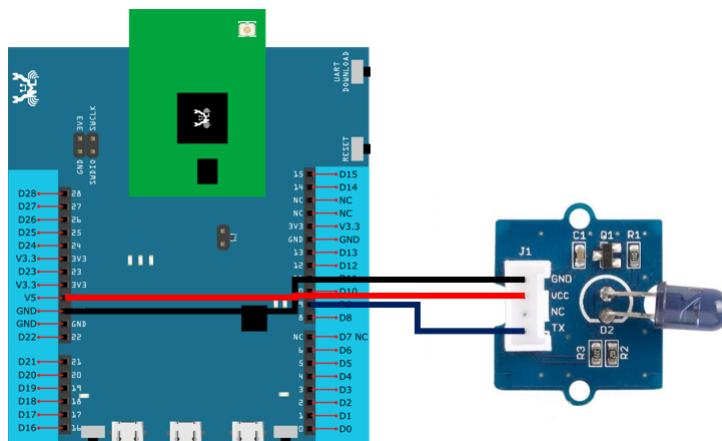


Figure 7: Pin configuration of IR Emitter and AMB21/AMB22

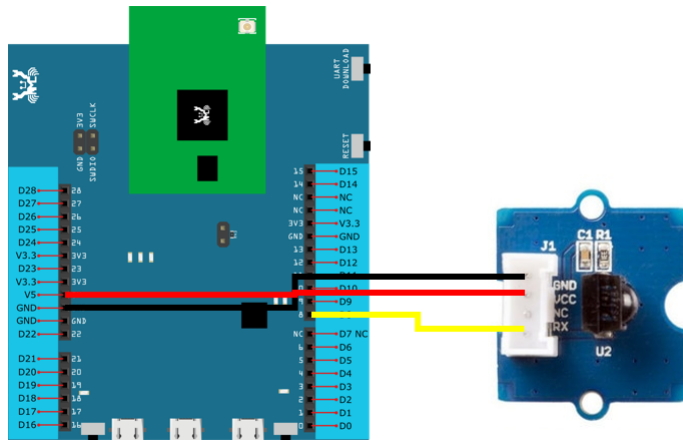


Figure 8: Pin configuration of the IR Receiver and Ameba RTL8722

Figure 9 and Figure 10 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8722DM MINI.

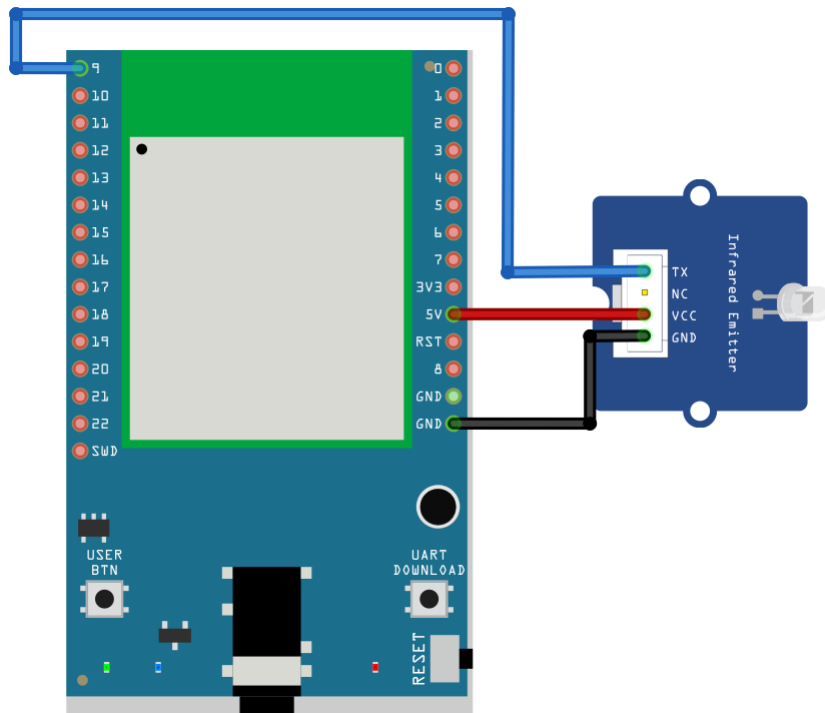


Figure 9: Pin configuration of IR Emitter and AMB23



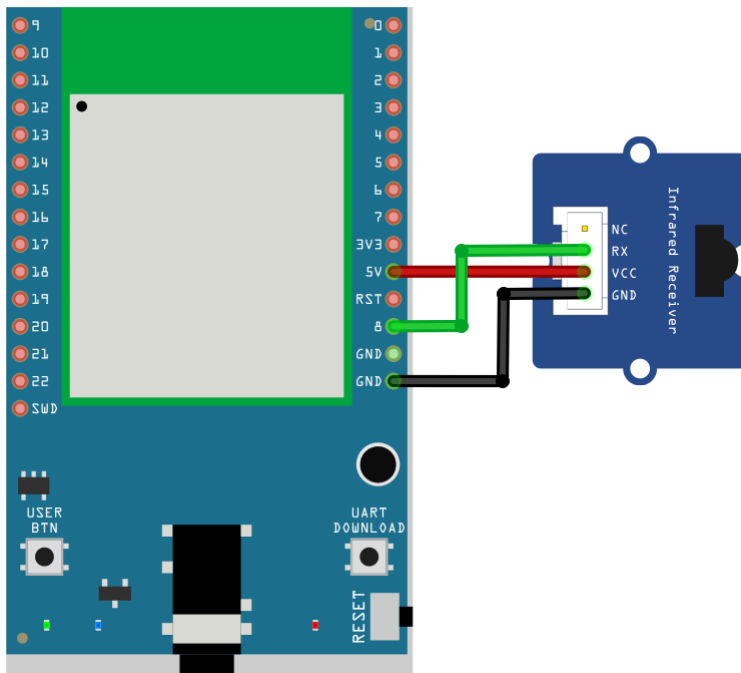


Figure 10: Pin configuration of the IR Receiver and AMB23

Figure 11 and Figure 12 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8720DN (BW16).

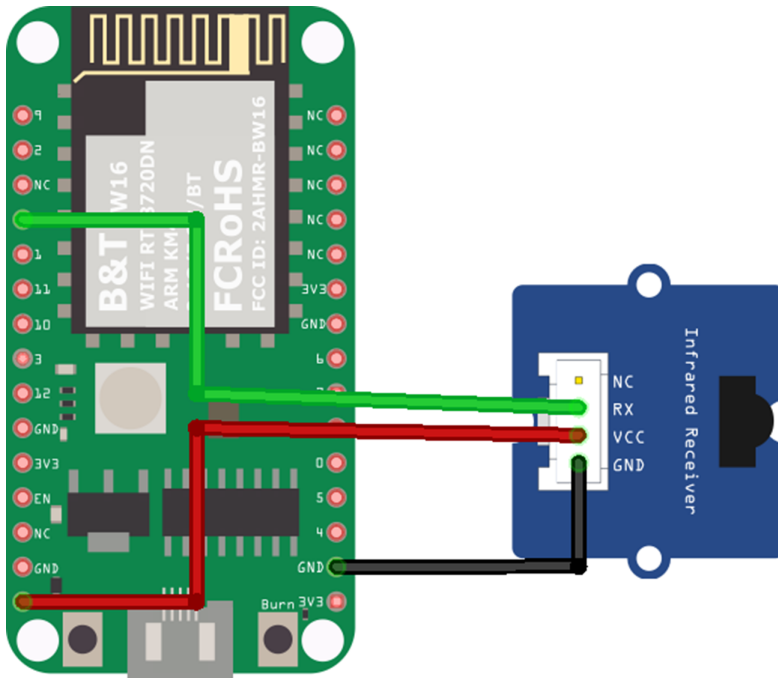


Figure 11: Pin configuration of IR Emitter and BW16

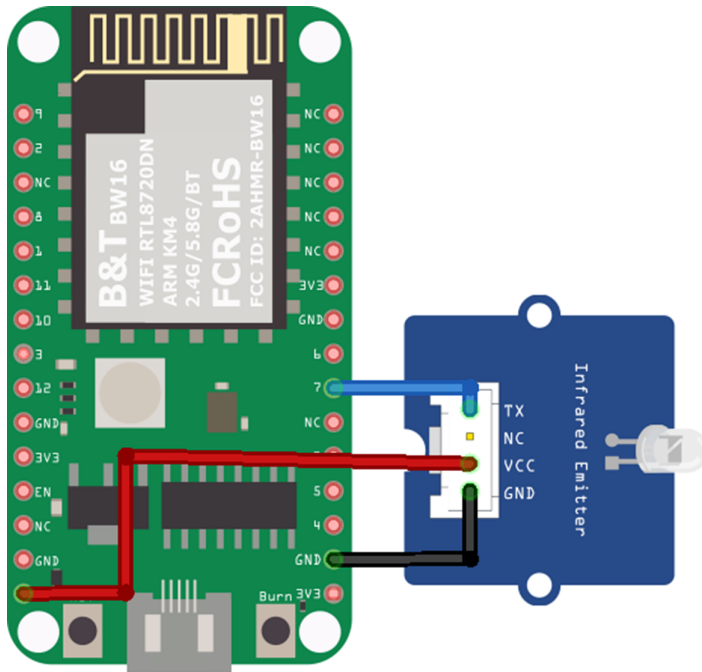


Figure 12: Pin configuration of IR Receiver and BW16

After the connection is being set up correctly, we will move to the coding part for this example. First, make sure the correct Ameba development board is selected in Arduino IDE: “Tools” -> “Board” .

Open the “IRSendRAW” example in “File” -> “Examples” -> “AmebaIRDevice” -> “IRSendRAW” (Figure 11) and upload to 1st board connected with IR Emitter:

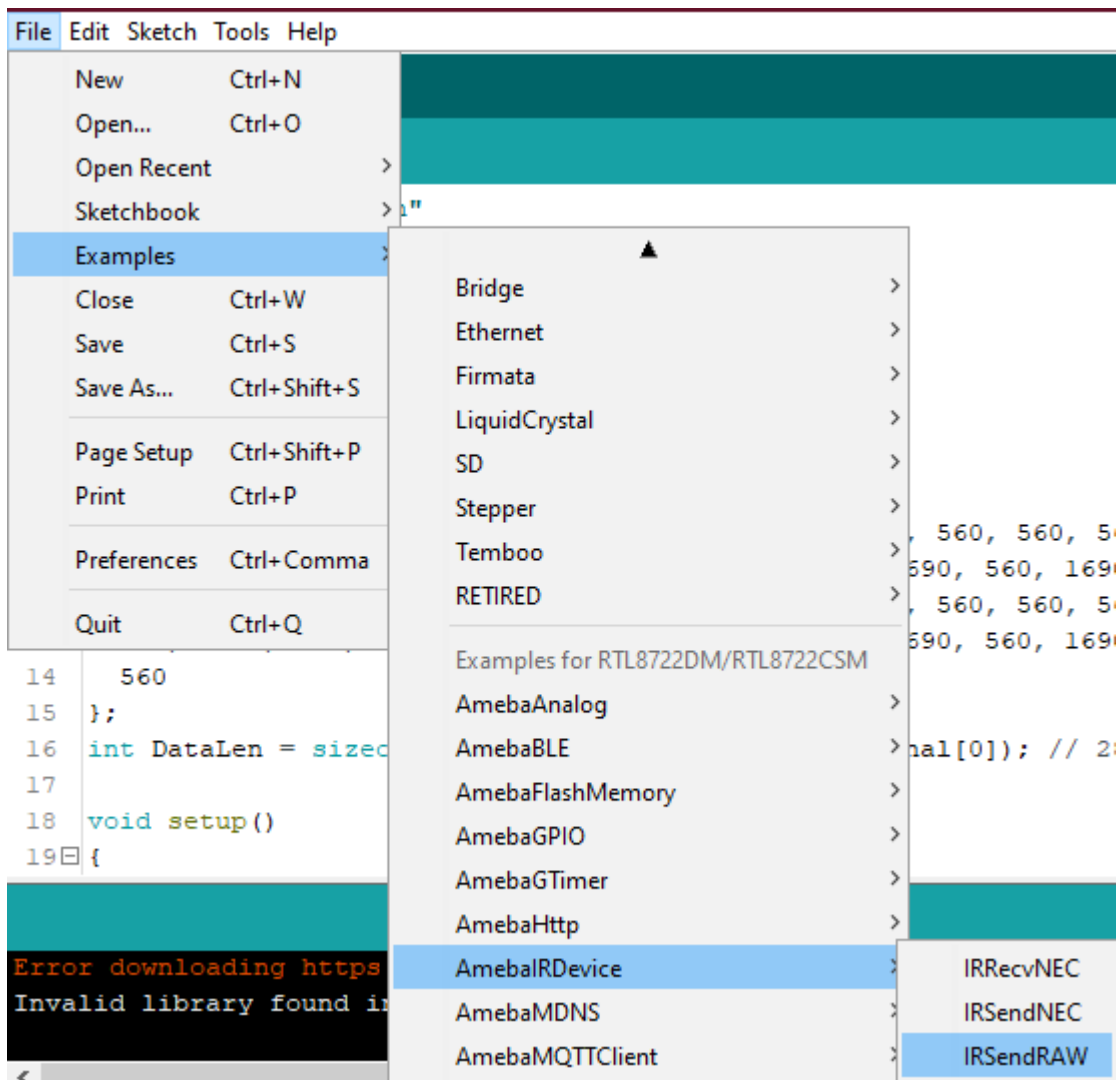


Figure 13: Example Location of IRSendRaw and IRRecvNEC

After successfully upload the sample code for IRSendRaw, you might need to upload the IRRecvNEC example for the 2nd board connected with IR Receiver from “File” -> “Examples” -> “AmebaIRDevice” -> “IRRecvNEC”

After opening the serial monitor on the IR Receiver side and press the reset buttons on two boards, the data “48” will be received every 3 seconds (due to the delays () function, not compulsory to wait). After decoding the signal from the receiving Pin D8 and transmitting Pin D9 with Logic Analyser and Pulse View (Figure 10), the result is also shown as “48” after decoding the receiving data with IR NEC Protocol.

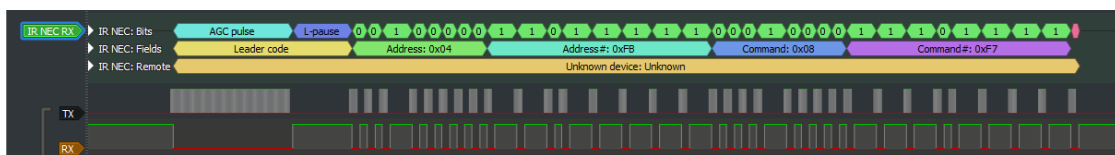


Figure 14: Pulse View results from sending and receiving pin

## Code Reference

[1] Seeed Official website for Grove –Infrared Receiver

[https://wiki.seeedstudio.com/Grove-Infrared\\_Receiver/](https://wiki.seeedstudio.com/Grove-Infrared_Receiver/)

[2] Seed Official website for Grove –Infrared Emitter

[https://wiki.seeedstudio.com/Grove-Infrared\\_Emitter/](https://wiki.seeedstudio.com/Grove-Infrared_Emitter/)

[3] Ken SHirriff’ s blog on A Multi-Protocol Infrared Remote Library for the Arduino

<http://www.righ.to.com/2009/08/multi-protocol-infrared-remote-library.html>

[4] SB-Projects: IR Remote Control Project

<https://www.sbprojects.net/knowledge/ir/index.php>

## Power Save - Deep Sleep Mode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

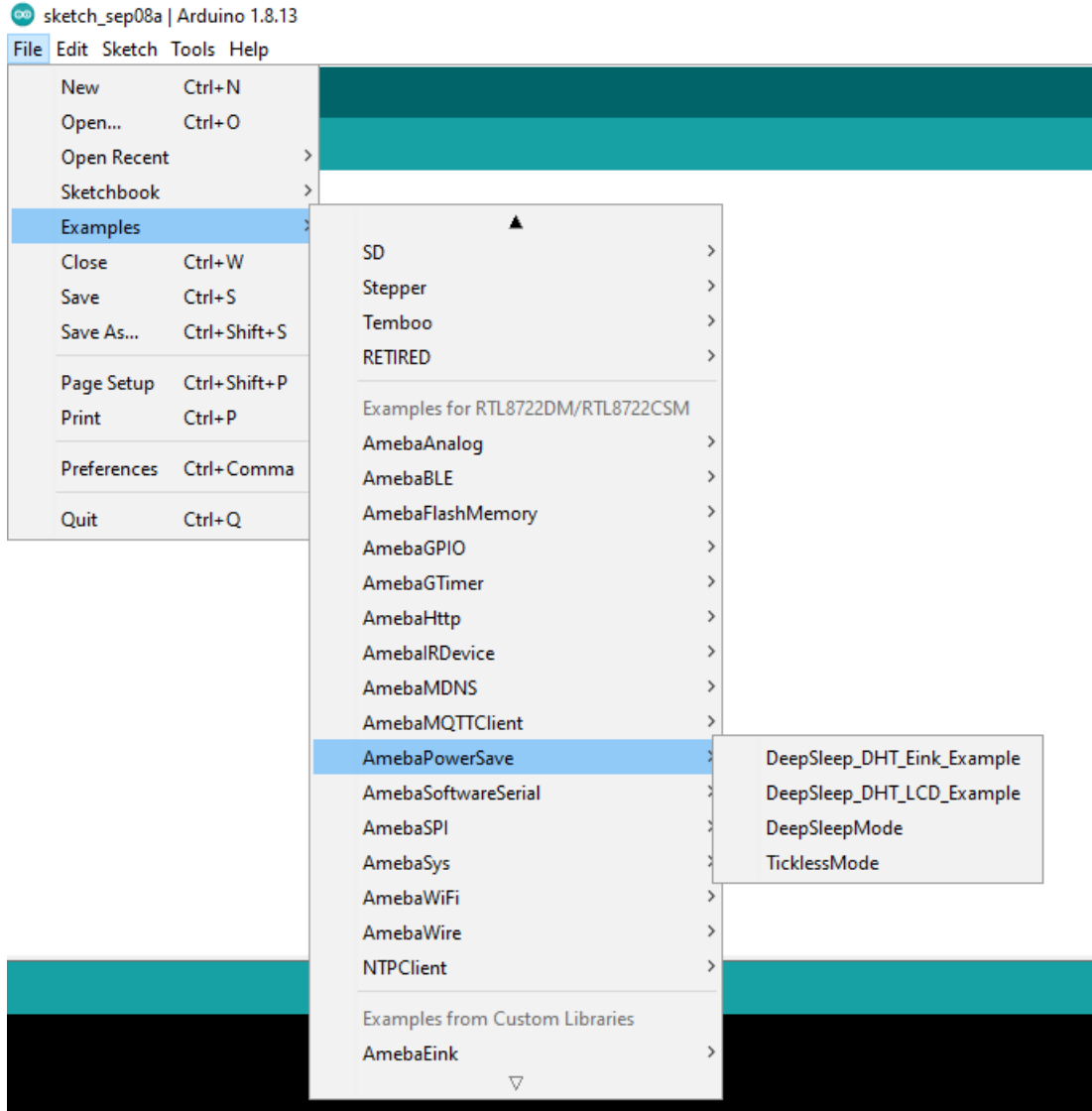
### Example

#### Introduction

Ameba-D supports 2 low power modes which are deepsleep mode and sleep mode. Deep Sleep mode turns off more power domain than sleep mode. The power consumption of Deep Sleep mode is around 7 $\mu$ A to 8 $\mu$ A as compared to normal state which is around 22mA. This example describes how to enter Deep Sleep mode and configure the wakeup source

#### Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleepMode”



Set condition values as picture below.

“DS\_WAKEUP\_SOURCE” is used to set the wake-up source, user can chose 3 wake up sources now,

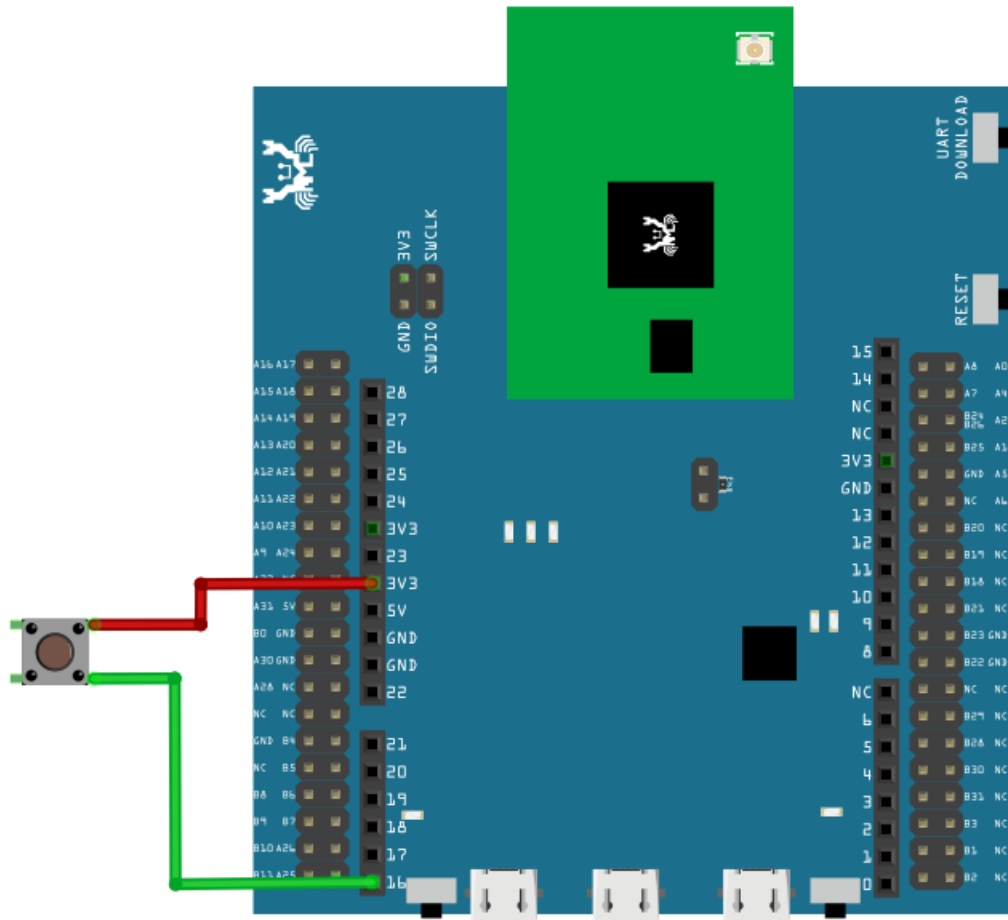
```
AON Timer (SET_DS_AON_TIMER_WAKEUP);
AON GPIO pins (SET_AONWAKEPIN_WAKEUP);
RTC Timer (SET_DS_RTC_WAKEUP);
```

### Using AON Timer as wakeup source

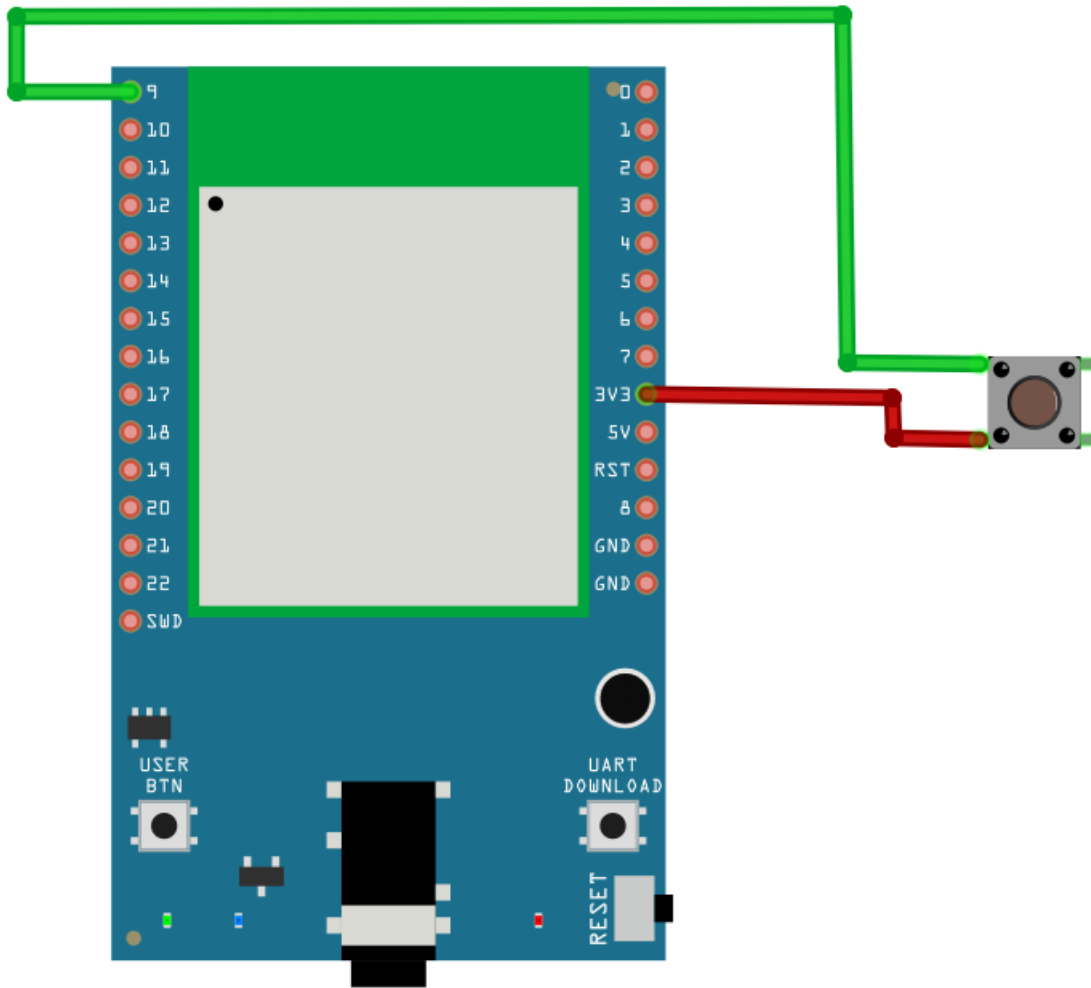
AON Timer can be set from 0 to 32760000ms range by AON\_TIMER\_SLEEP\_DURATION

### Using AON GPIO pins as wakeup source

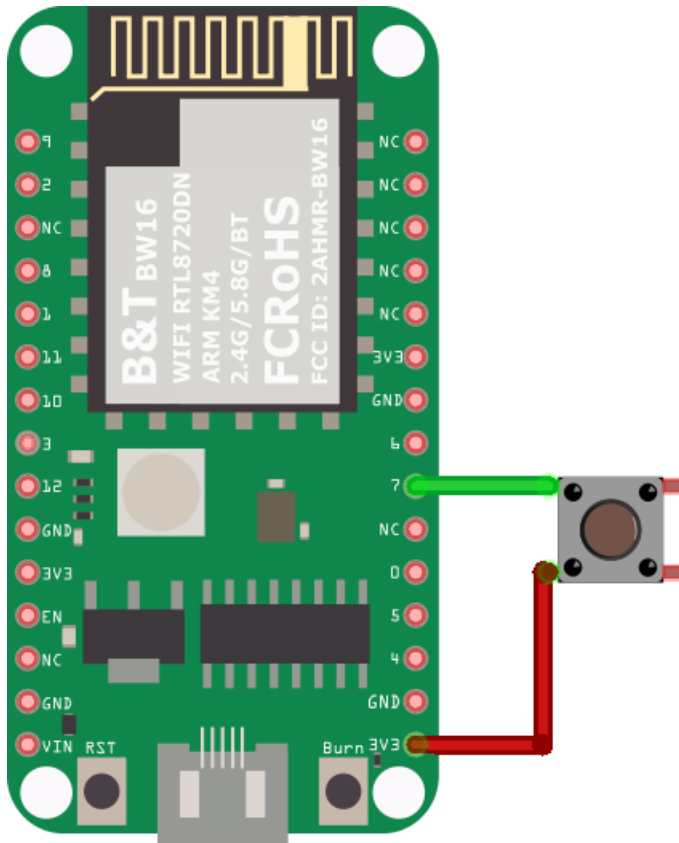
For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).



For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).



For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).



These AON pins can be set by using `SET_AON_GPIO_WAKEUP_GPIOA25` or the pin that you want to use as shown in the picture below



DeepSleepMode | Arduino 1.8.16 (Windows Store 1.8.51.0)

File Edit Sketch Tools Help

```

8
9 //For RTL8722DM only the AON GPIO pins listed below should be selected
10 //SET_AON_GPIO_WAKEUP_GPIOA25 // D16
11 //SET_AON_GPIO_WAKEUP_GPIOA26 // D17
12 //SET_AON_GPIO_WAKEUP_GPIOA21 // D26
13 //SET_AON_GPIO_WAKEUP_GPIOA20 // D27
14 //SET_AON_GPIO_WAKEUP_GPIOA19 // D28
15 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
16 //SET_AON_GPIO_WAKEUP_GPIOA12 // D9
17 //SET_AON_GPIO_WAKEUP_GPIOA13 // D10
18 //SET_AON_GPIO_WAKEUP_GPIOA14 // D11
19 //SET_AON_GPIO_WAKEUP_GPIOA15 // D12
20 //SET_AON_GPIO_WAKEUP_GPIOA16 // D13
21 //SET_AON_GPIO_WAKEUP_GPIOA18 // D15
22 //SET_AON_GPIO_WAKEUP_GPIOA19 // D16
23 //SET_AON_GPIO_WAKEUP_GPIOA21 // D18
24 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA25 // D7
26 //SET_AON_GPIO_WAKEUP_GPIOA26 // D8
27 //SET_AON_GPIO_WAKEUP_GPIOA15 // D9
28 //SET_AON_GPIO_WAKEUP_GPIOA14 // D10
29 //SET_AON_GPIO_WAKEUP_GPIOA13 // D11
30 //SET_AON_GPIO_WAKEUP_GPIOA12 // D12

```

### Using RTC Timer as wakeup source

RTC Timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC

DeepSleepMode | Arduino 1.8.16 (Windows Store 1.8.51.0)

File Edit Sketch Tools Help

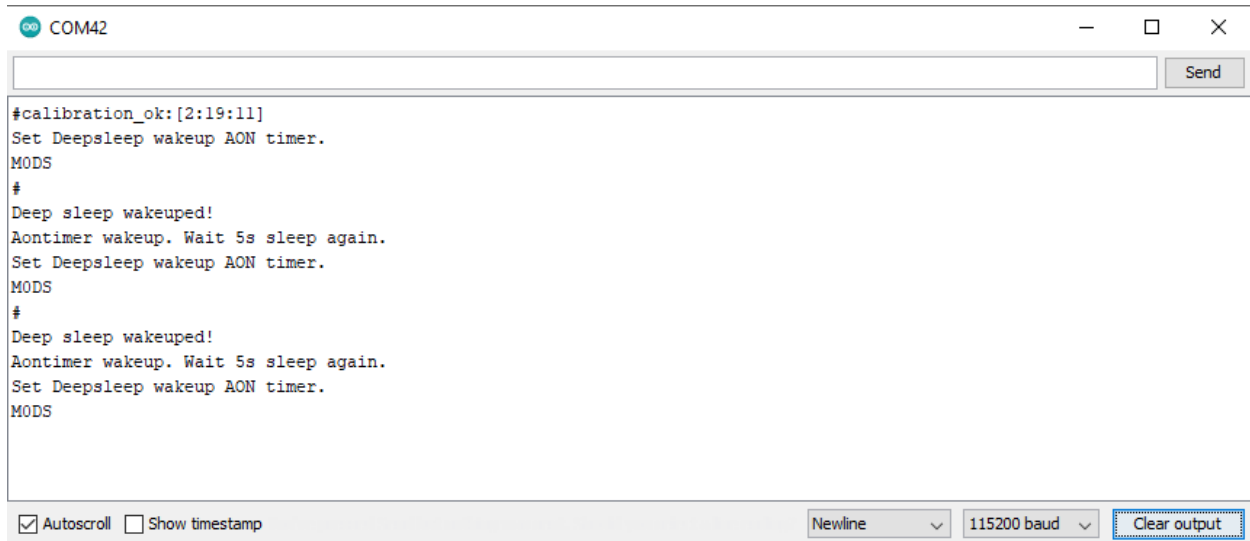
```

33
34 #define AON_TIMER_SLEEP_DURATION      5000
35 #define DS_RTC_ALARM_DAY              0
36 #define DS_RTC_ALARM_HOUR            0
37 #define DS_RTC_ALARM_MIN              0
38 #define DS_RTC_ALARM_SEC              10

```

When all the condition values are set, the system will run and switch between normal and deep sleep mode which is controlled by the wakeup source. The serial monitor will display the switching log as shown below.

## AON Timer

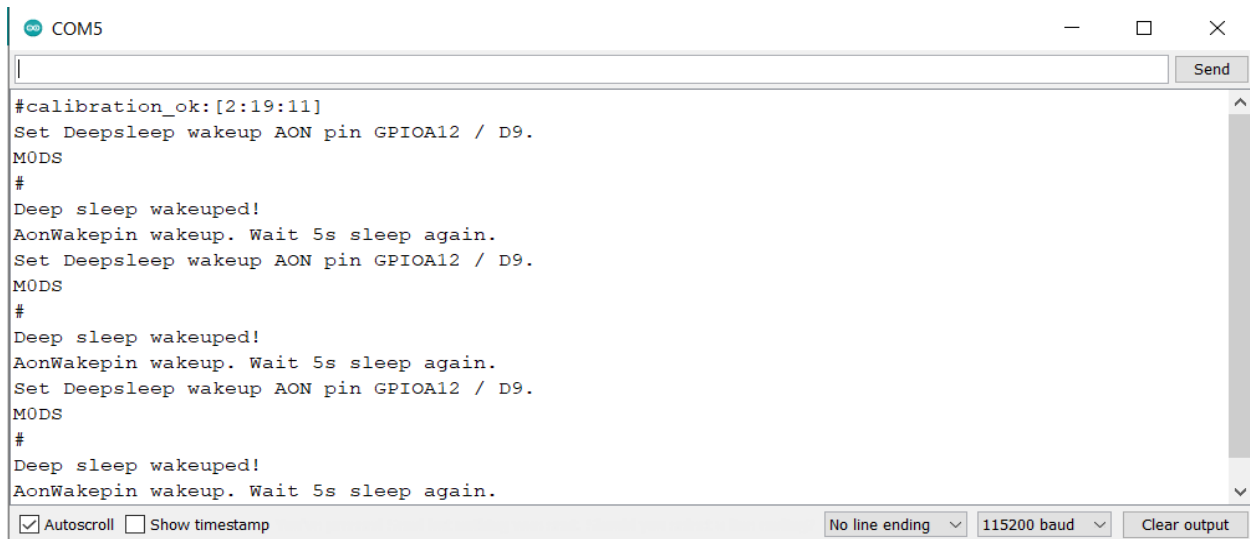


The screenshot shows a serial terminal window titled 'COM42'. The output text is as follows:

```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON timer.
MODS
#
Deep sleep wakeupt!
Aontimer wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON timer.
MODS
#
Deep sleep wakeupt!
Aontimer wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON timer.
MODS
```

At the bottom of the window, there are controls: ☒ Autoscroll, ☐ Show timestamp, a 'Newline' dropdown menu, a '115200 baud' dropdown menu, and a 'Clear output' button.

## AON GPIO Pin

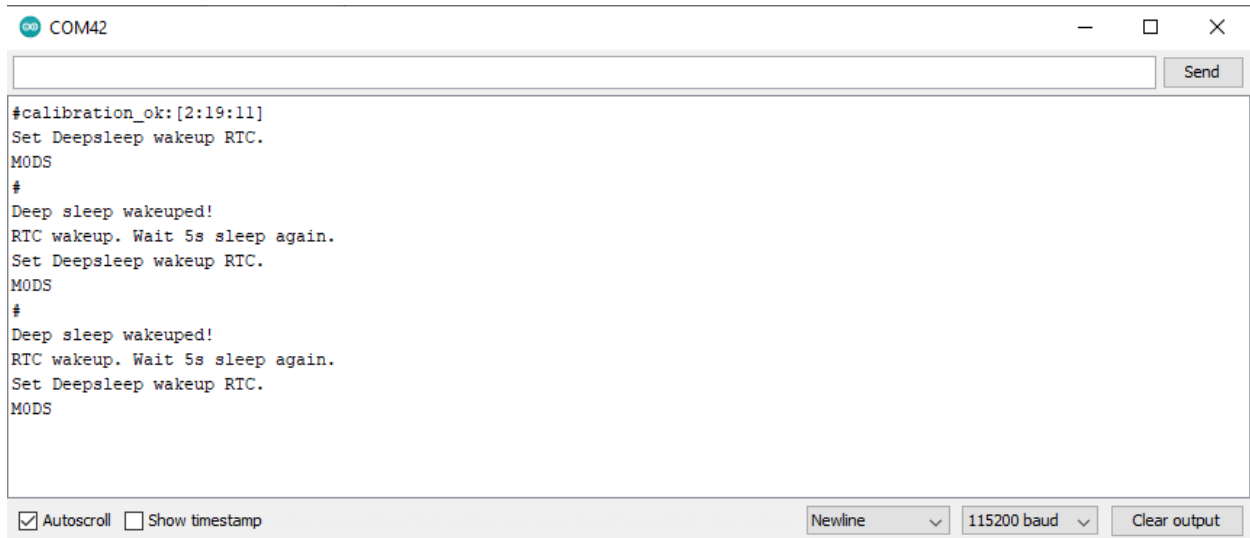


The screenshot shows a serial terminal window titled 'COM5'. The output text is as follows:

```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupt!
AonWakepin wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupt!
AonWakepin wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupt!
AonWakepin wakeup. Wait 5s sleep again.
```

At the bottom of the window, there are controls: ☒ Autoscroll, ☐ Show timestamp, a 'No line ending' dropdown menu, a '115200 baud' dropdown menu, and a 'Clear output' button.

## RTC Timer



```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup RTC.
MODS
#
Deep sleep wakeuped!
RTC wakeup. Wait 5s sleep again.
Set Deepsleep wakeup RTC.
MODS
#
Deep sleep wakeuped!
RTC wakeup. Wait 5s sleep again.
Set Deepsleep wakeup RTC.
MODS
```

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Deep Sleep for DHT and E-paper

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21 x 1
- LCD I2C screen x 1

### Example

#### Introduction

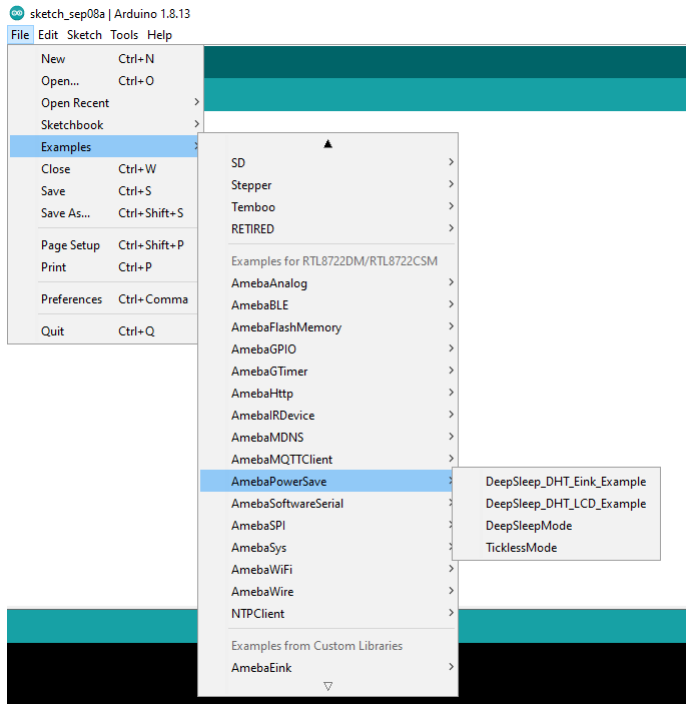
Ameba-D supports low power modes which are deepsleep mode. Deepsleep mode turns off most of the system power domain. The power consumptions of core module in DeepSleep Mode is around 7uA to 8uA compare to normal state around 22mA. This example gives demo of system switch between “working” and “sleep” (power save). Using DHT sensor to read data and display on E-ink screen when system is awake. After 5 seconds system auto enter DeepSleep Mode for power save. System will wake up by wakeup source.( Aon timer, Aon Pins or RTC timer).

#### Procedure

Download the Eink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries). Then install the AmebaEink.zip.

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleep\_DHT\_Eink\_Example”



Set condition values as picture below.

DS\_WAKEUP\_SOURCE is used to set the wake-up source, user can chose 3 wake up sources now,

```
AON timer (SET_DS_AON_TIMER_WAKEUP);
AON pins (SET_AON_WAKEPIN_WAKEUP);
RTC timer (SET_DS_RTC_WAKEUP);
```

### Using AON Timer as wakeup source

AON timer can be set from 0 to 32760000 range (unit ms) by AON\_TIMER\_SLEEP\_DURATION

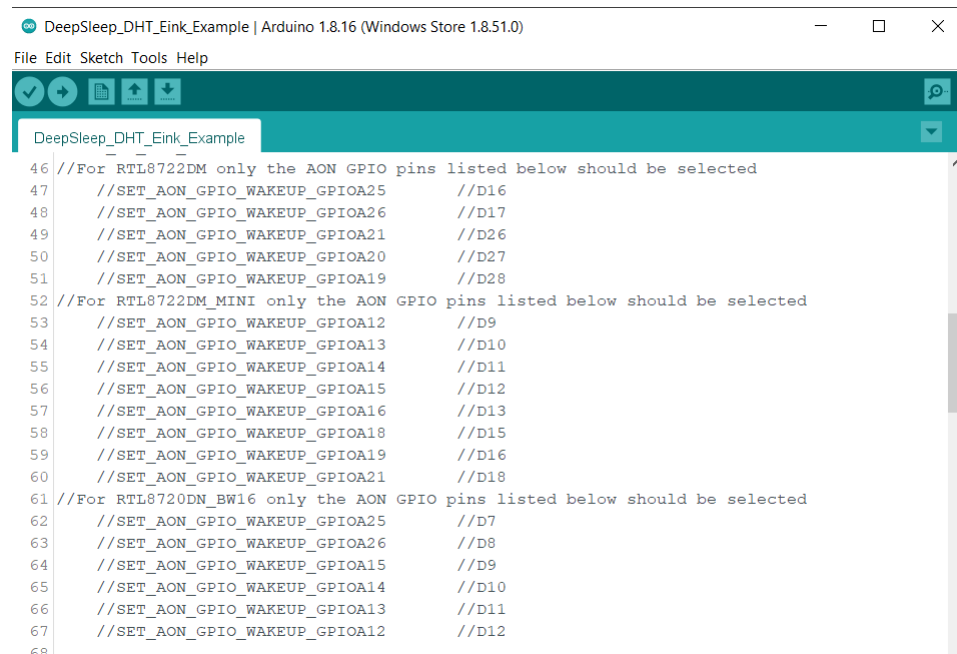
### Using AON GPIO pins as wakeup source

For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).

For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).

These AON pins can be set by using SET\_AON\_GPIO\_WAKEUP\_GPIOA25 or the pin that you want to use as shown in the picture below.



```

46 //For RTL8722DM only the AON GPIO pins listed below should be selected
47 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
48 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
49 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
50 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
51 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
52 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
53 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
54 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
55 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
56 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
57 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
58 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
59 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
60 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
61 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
62 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
63 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
64 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
65 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
66 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
67 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12

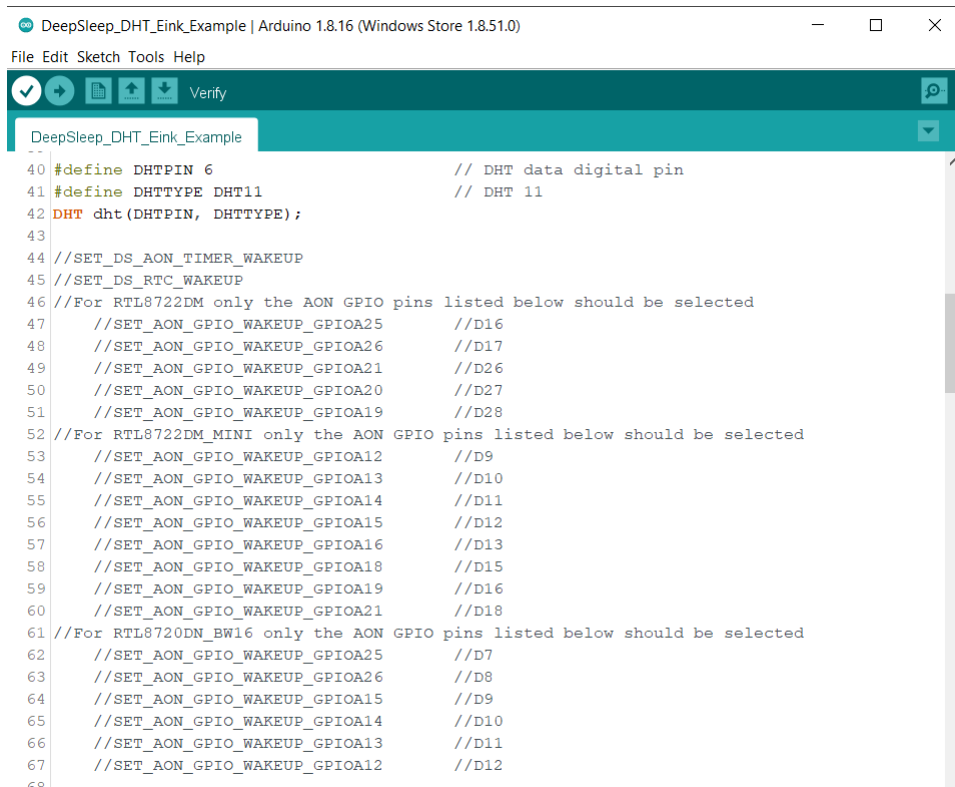
```

### Using RTC Timer as wakeup source

RTC timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC

DHTPIN is used to set DHT sensor data pin. User can choose any GPIO pins.

DHTTYPE is used to set DHT sensor type. (DHT11, DHT22 and DHT33)



```

DeepSleep_DHT_Eink_Example | Arduino 1.8.16 (Windows Store 1.8.51.0)
File Edit Sketch Tools Help
Verify
DeepSleep_DHT_Eink_Example
40 #define DHTPIN 6 // DHT data digital pin
41 #define DHTTYPE DHT11 // DHT 11
42 DHT dht(DHTPIN, DHTTYPE);
43
44 //SET_DS_AON_TIMER_WAKEUP
45 //SET_DS_RTC_WAKEUP
46 //For RTL8722DM only the AON GPIO pins listed below should be selected
47 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
48 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
49 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
50 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
51 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
52 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
53 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
54 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
55 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
56 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
57 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
58 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
59 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
60 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
61 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
62 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
63 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
64 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
65 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
66 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
67 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
68

```

When finished the condition values setting, system will run and switch between normal working mode and deepsleep mode controlled by wakeup source. Eink screen will display the temperature and humidity data measured from DHT sensor when system is awake.

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Deep Sleep for DHT and LCD

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21 x 1
- LCD I2C screen x 1

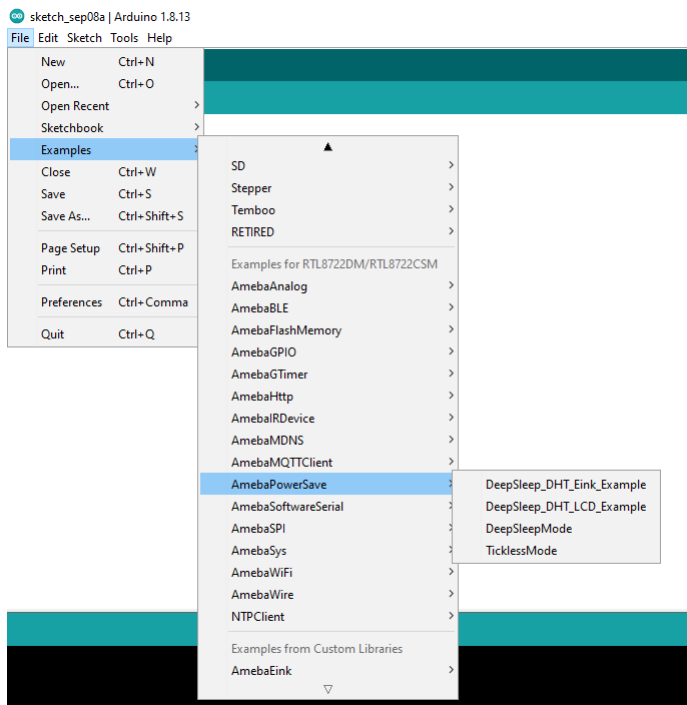
### Example

### Introduction

Ameba-D supports low power modes which are deepsleep mode. Deepsleep mode turns off most of the system power domain. The power consumptions of core module in DeepSleep Mode is around 7uA to 8uA compare to normal state around 22mA. This example gives demo of system switch between “working” and “sleep” (power save). Using DHT sensor to read data and display on LCD screen when system is awake. After 5 seconds system auto enter DeepSleep Mode for power save. System will wake up by wakeup source.( Aon timer, Aon Pins or RTC timer).

## Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleep\_DHT\_LCD\_Example”



Set condition values as picture below.

DS\_WAKEUP\_SOURCE is used to set the wake-up source, user can chose 3 wake up sources now,

```
AON timer (SET_DS_AON_TIMER_WAKEUP);
AON pins (SET_AON_WAKEPIN_WAKEUP);
RTC timer (SET_DS_RTC_WAKEUP);
```

## Using AON Timer as wakeup source

AON timer can be set from 0 to 32760000 range (unit ms) by AON\_TIMER\_SLEEP\_DURATION

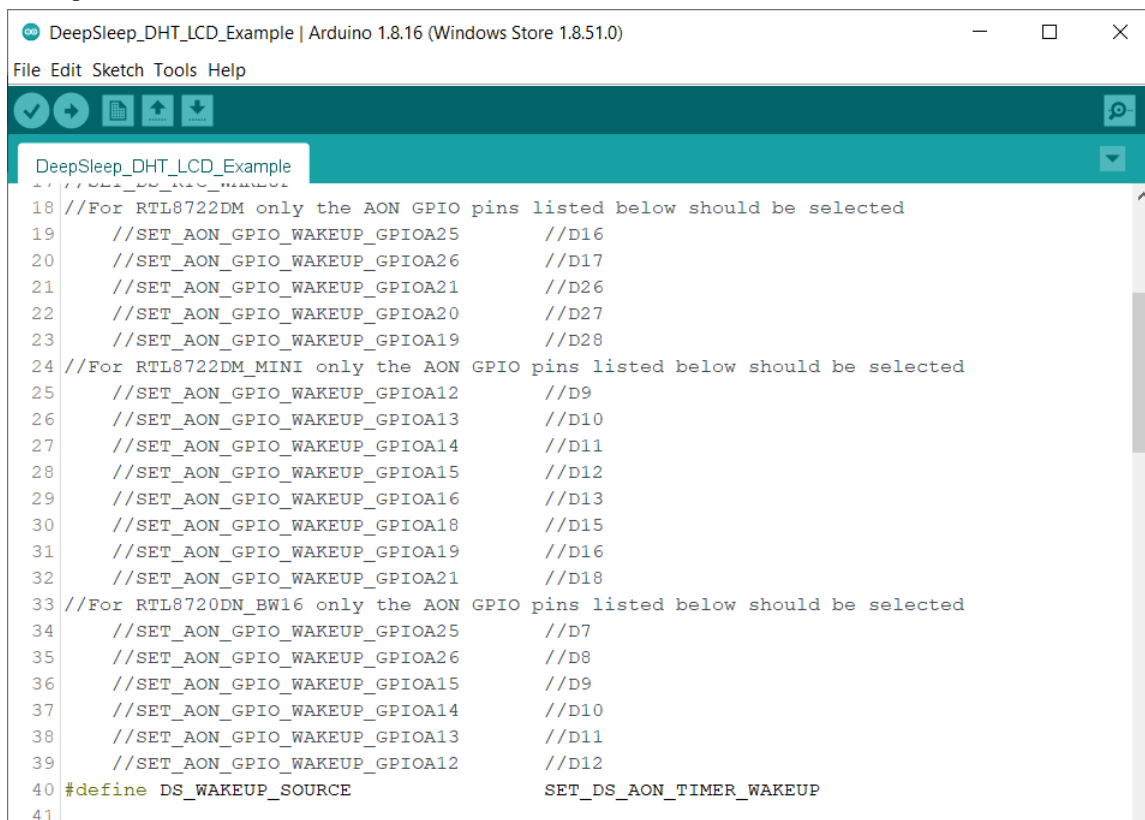
### Using AON GPIO pins as wakeup source

For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).

For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).

These AON pins can be set by using SET\_AON\_GPIO\_WAKEUP\_GPIOA25 or the pin that you want to use as shown in the picture below.



```

DeepSleep_DHT_LCD_Example | Arduino 1.8.16 (Windows Store 1.8.51.0)
File Edit Sketch Tools Help
DeepSleep_DHT_LCD_Example
18 //For RTL8722DM only the AON GPIO pins listed below should be selected
19 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
20 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
21 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
22 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
23 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
24 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
26 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
27 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
28 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
29 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
30 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
31 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
32 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
33 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
34 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
35 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
36 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
37 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
38 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
39 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
40 #define DS_WAKEUP_SOURCE SET_DS_AON_TIMER_WAKEUP
41

```

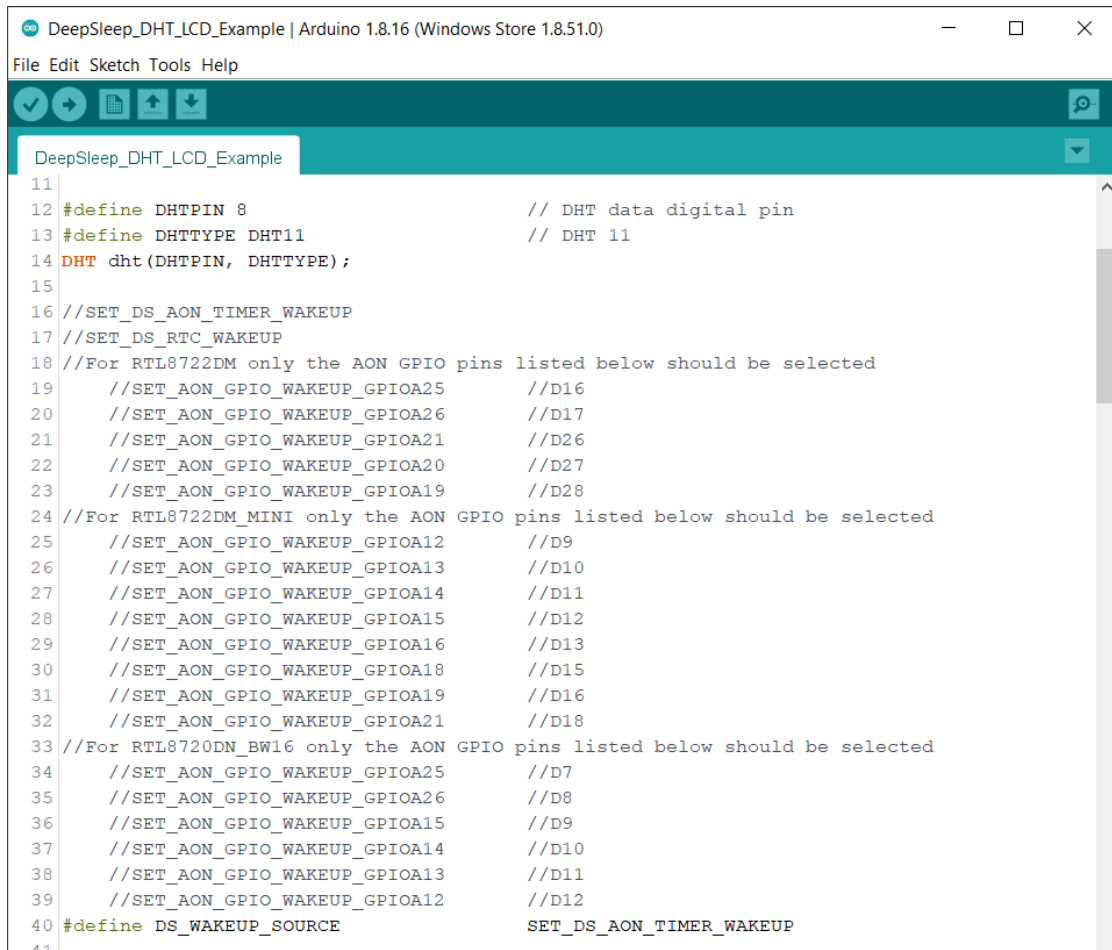
### Using RTC Timer as wakeup source

RTC timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC



DHTPIN is used to set DHT sensor data pin. User can choose any GPIO pins.

DHTTYPE is used to set DHT sensor type. (DHT11, DHT22 and DHT33)



```

11
12 #define DHTPIN 8 // DHT data digital pin
13 #define DHTTYPE DHT11 // DHT 11
14 DHT dht(DHTPIN, DHTTYPE);
15
16 //SET_DS_AON_TIMER_WAKEUP
17 //SET_DS_RTC_WAKEUP
18 //For RTL8722DM only the AON GPIO pins listed below should be selected
19 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
20 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
21 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
22 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
23 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
24 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
26 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
27 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
28 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
29 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
30 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
31 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
32 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
33 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
34 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
35 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
36 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
37 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
38 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
39 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
40 #define DS_WAKEUP_SOURCE SET_DS_AON_TIMER_WAKEUP
41

```

When finished the condition values setting, system will run and switch between normal working mode and deepsleep mode controlled by wakeup source. LCD screen will display the temperature and humidity data measured from DHT sensor when system is awake.

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Tickless Mode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

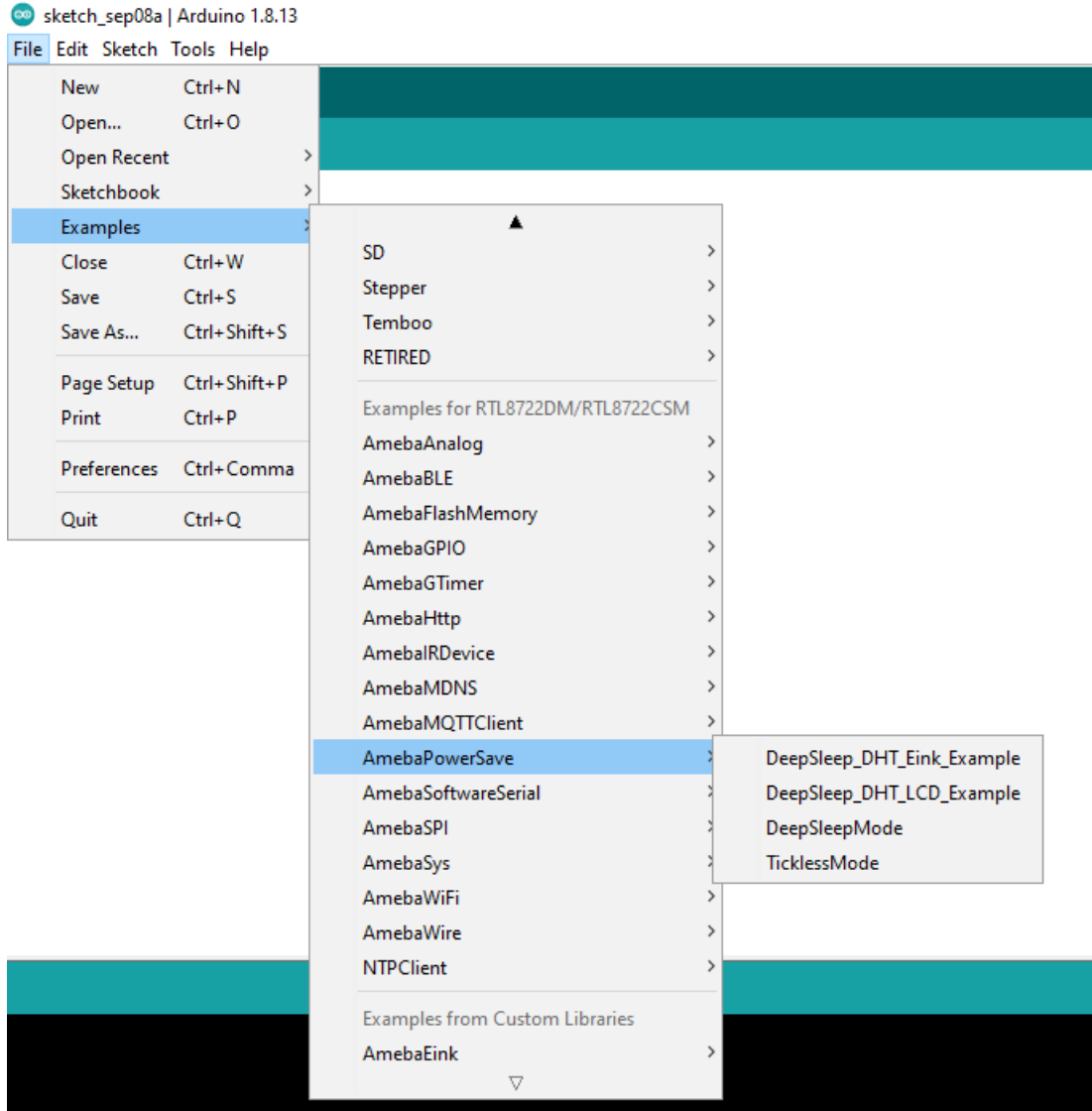
### Example

#### Introduction

Ameba-D supports two low power modes which are deepsleep mode and sleep mode. The power consumptions of Tickless Sleep Mode is around 28uA to 30uA compare to normal state around 15mA. This example describes how to use freertos tickless with uart interruptable interface.

#### Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “TicklessMode”



Set condition values as picture below.

“TL\_WAKEUP\_SOURCE” is used to set the wake-up source, user can chose 3 wake up sources now,

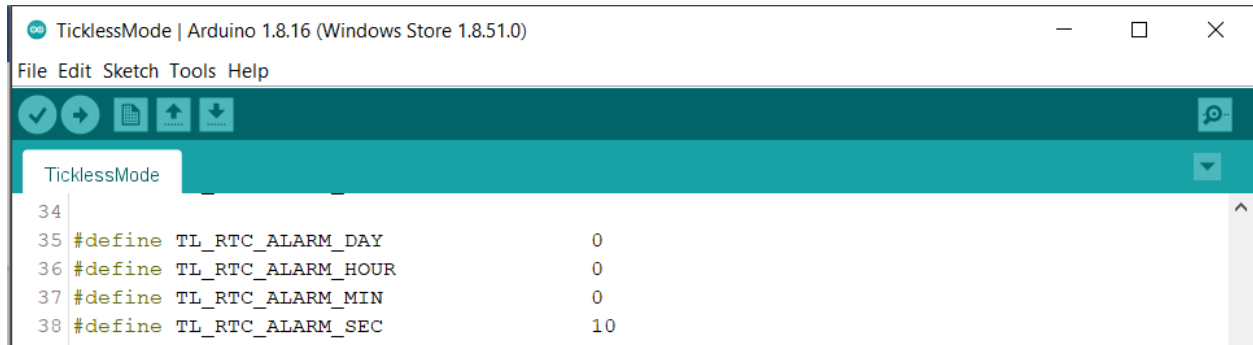
```
LOGUART (SET_TL_UART_WAKEUP) ;
RTC Timer (SET_TL_RTC_WAKEUP) ;
AON pins (SET_AON_WAKEPIN_WAKEUP) ;
```

### Using LOGUART as wakeup source

When the LOGUART is selected as the wakeup source, the “TL\_Suspend\_function” will enter sleep mode. And then it is kept alive for 13s then enter sleep mode. To wakeup, press enter.

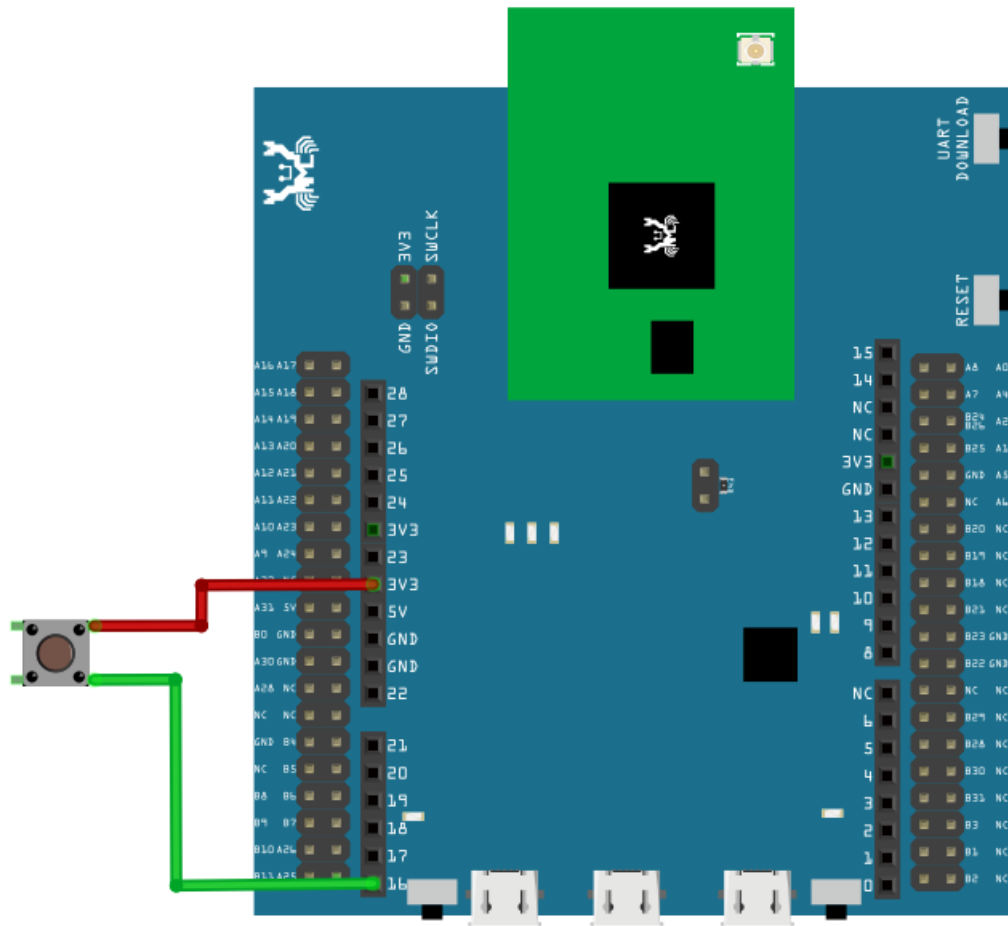
### Using RTC Timer as wakeup source

RTC Timer wakeup system is by setting alarm. The alarm has 4 values to be set, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC.

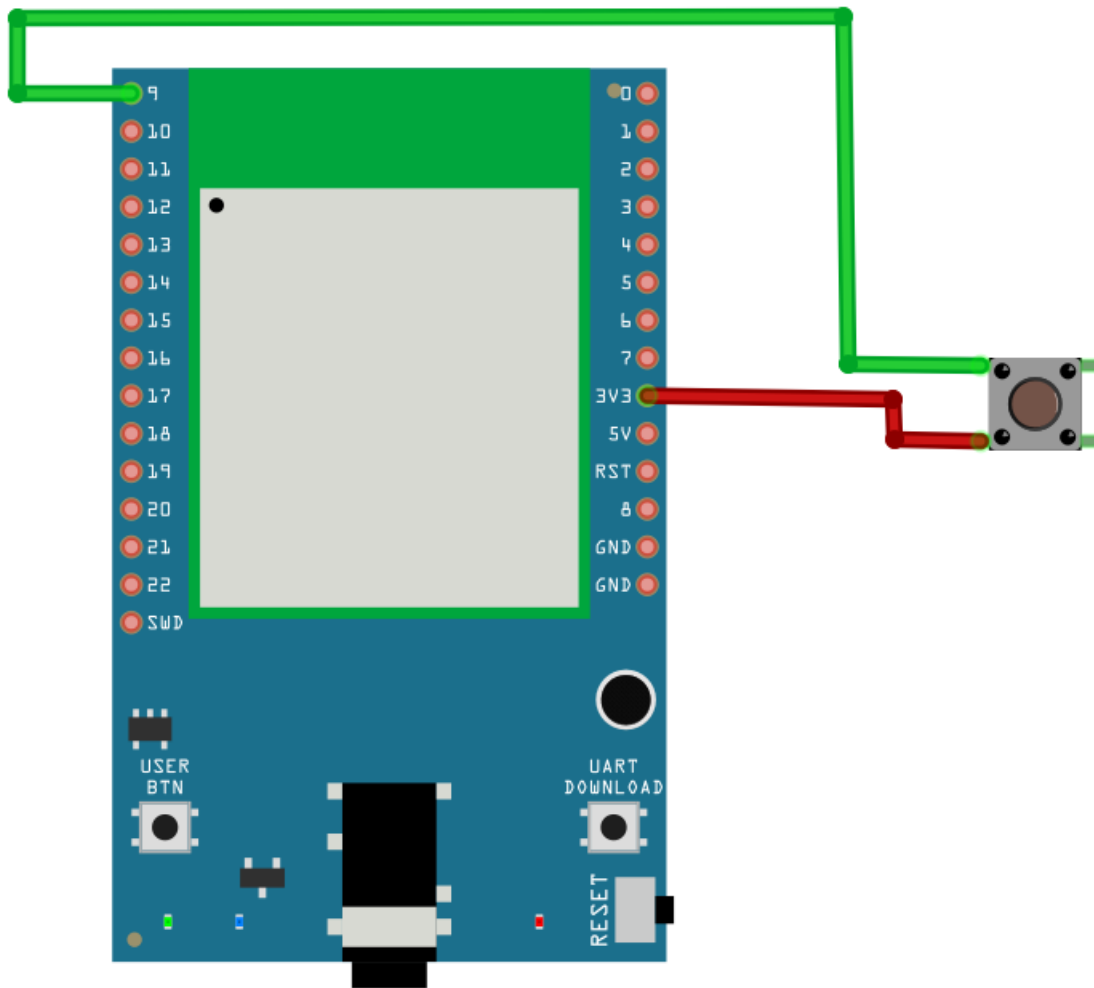


### Using AON GPIO pins as wakeup source

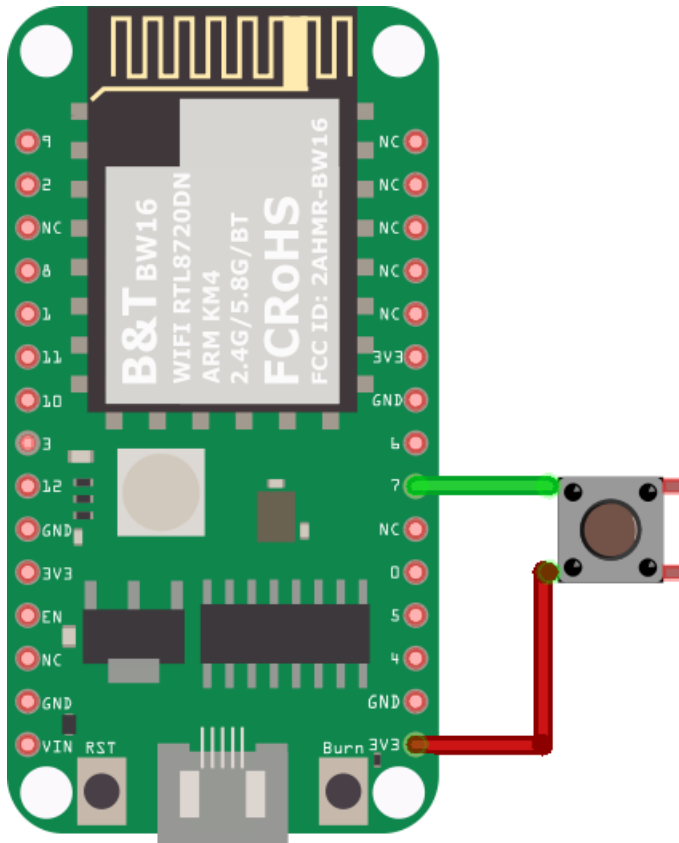
For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).



For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).



For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).



TL\_SYSACTIVE\_TIME is for setting time duration of the system to keep alive. (Unit ms)

## LOGUART

## RTC Timer



```
#calibration_ok:[2:19:11]
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.
```

☒ Autoscroll ☐ Show timestamp    Newline    115200 baud    Clear output

## AON GPIO Pins

```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
```

☒ Autoscroll ☐ Show timestamp    Newline    115200 baud    Clear output

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## PWM - Play Music by Buzzer

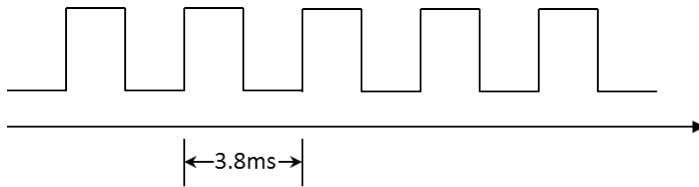
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Buzzer x 1

### Example

A sound is composed of volume, tone and timbre. Volume is determined by the amplitude of the sound wave. Tone is determined by the frequency of the sound wave. Timbre is determined by the waveform of the sound wave.

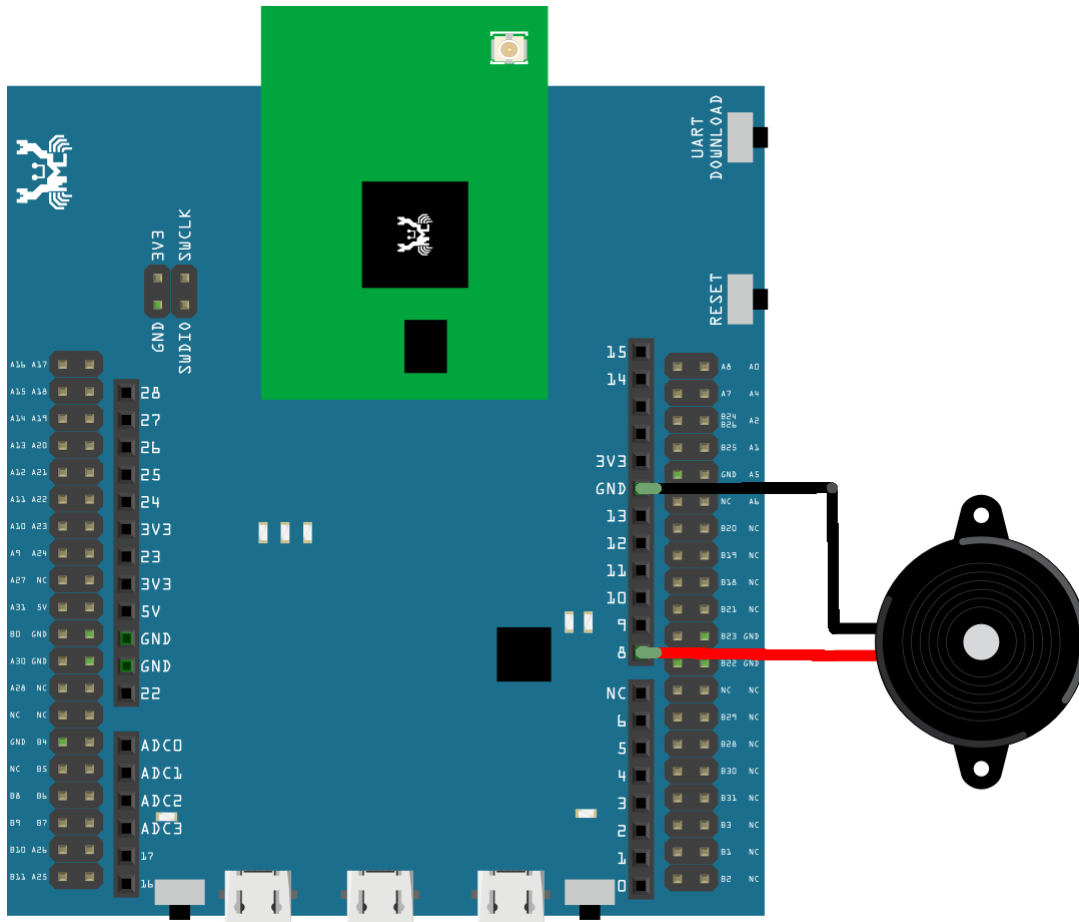
In this example, we use PWM to control the buzzer to emit sound with desired tone. As PWM outputs square wave, if we wish to emit tone C4 (frequency=262Hz), we have to make PWM to output square wave with wavelength  $1/262 = 3.8\text{ms}$ :



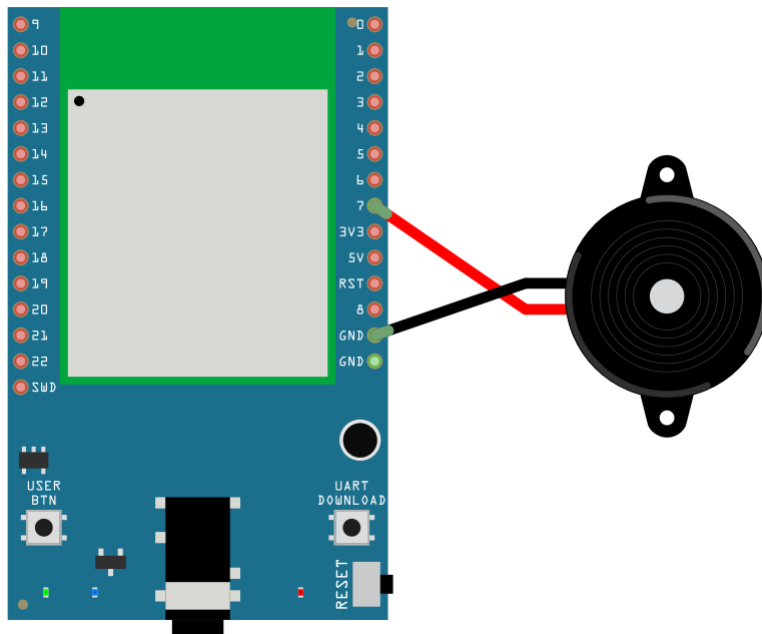
We use PWM to output sound wave with different frequency, so as to play music by the buzzer.

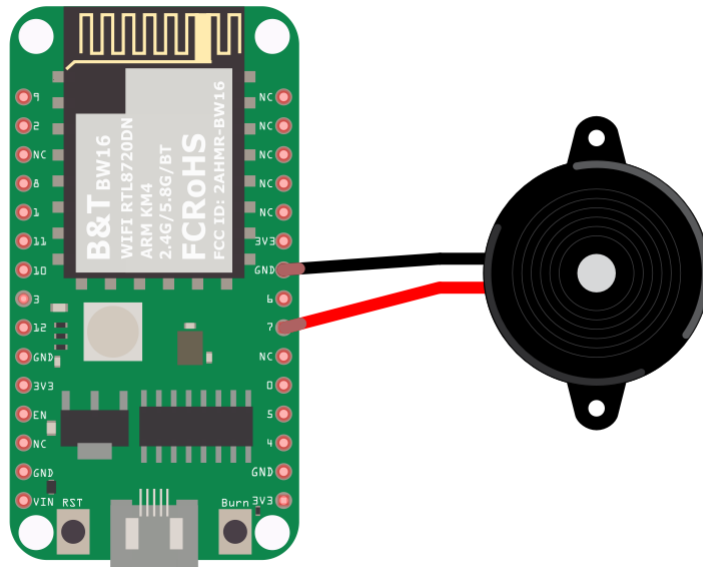
Connect the buzzer to the PWM output pin shown in the following diagrams.

**AMB21 / AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



**BW16 Wiring Diagram:**

Open the example code in “Examples” -> “AmebaAnalog” -> “TonePlayMelody”  
Compile and upload to Ameba, press the reset button. Then you can hear the buzzer playing music.

**Code Reference**

Ameba implement the `tone()` and `noTone()` API of Arduino:

<https://www.arduino.cc/en/Reference/Tone>

<https://www.arduino.cc/en/Reference/NoTone>

In the sample code, we initiate a melody array, which stores the tones to make. Another array, `noteDurations`, contains the length of each tone, 4 represents quarter note (equals to  $3000\text{ms}/4 = 750\text{ms}$ , and plus an extra 30% time pause), 8 represents eighth note.

## PWM - Servo Control

### Preparation

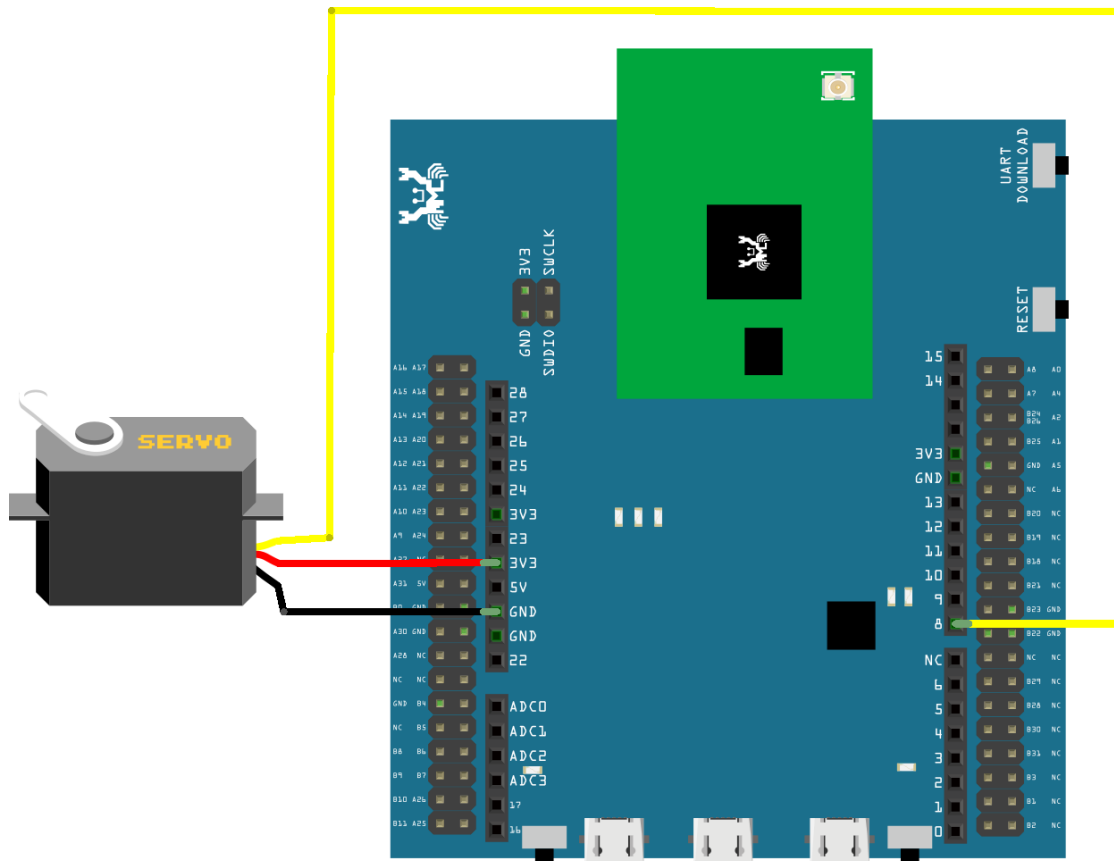
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Servo x 1 (Ex. Tower Pro SG90)

### Example

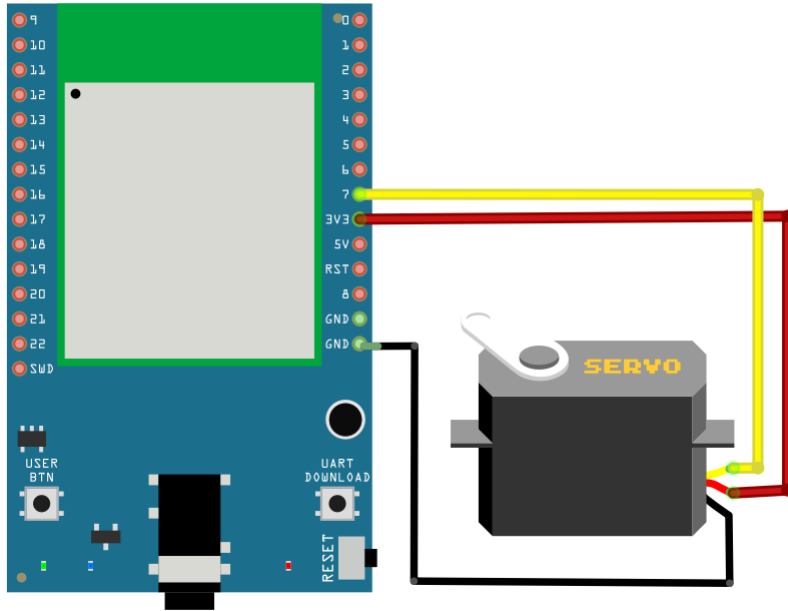
A typical servo has 3 wires, the red wire is for power, black or brown one should be connected to GND, and the other one is for signal data. We use PWM signal to control the rotation angle of the axis of the servo. The frequency of the signal is 50Hz, that is length 20ms. Each servo defines its pulse bandwidth, which is usually 1ms~2ms.

To control the rotation angle, for example if 1ms-length pulse rotates the axis to degree 0, then 1.5 ms pulse rotates the axis to 90 degrees, and 2 ms pulse rotates the axis to 180 degrees. Furthermore, a servo defines the “dead bandwidth”, which stands for the required minimum difference of the length of two consecutive pulse for the servo to work.

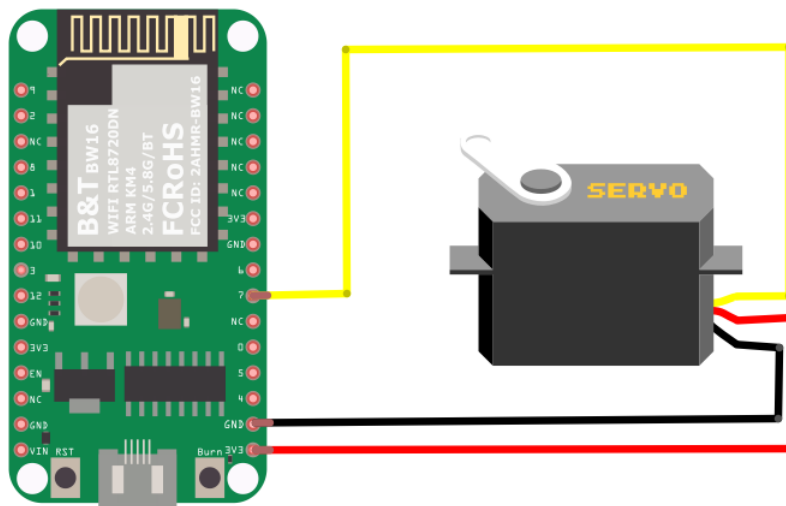
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the example, “File” -> “Examples” -> “AmebaAnalog” -> “ServoSweep”

This example makes the servo to rotate from degree 0 to 180, and then rotate back to degree 0.

## Code Reference

The Servo API of Ameba is similar to the API of Arduino. To distinguish from the original API of Arduino, we name the header file “AmebaServo.h” and the Class “AmebaServo” , the usage is identical to the Arduino API.

The default pulse bandwidth of Arduino Servo is 0.5ms~2.4ms, which is the same as Tower Pro SG90. Therefore, we set the attached pin directly:

```
myservo.attach(9);
```

Next, rotate the axis to desired position:

```
myservo.write(pos);
```

## RTC - Simple RTC

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

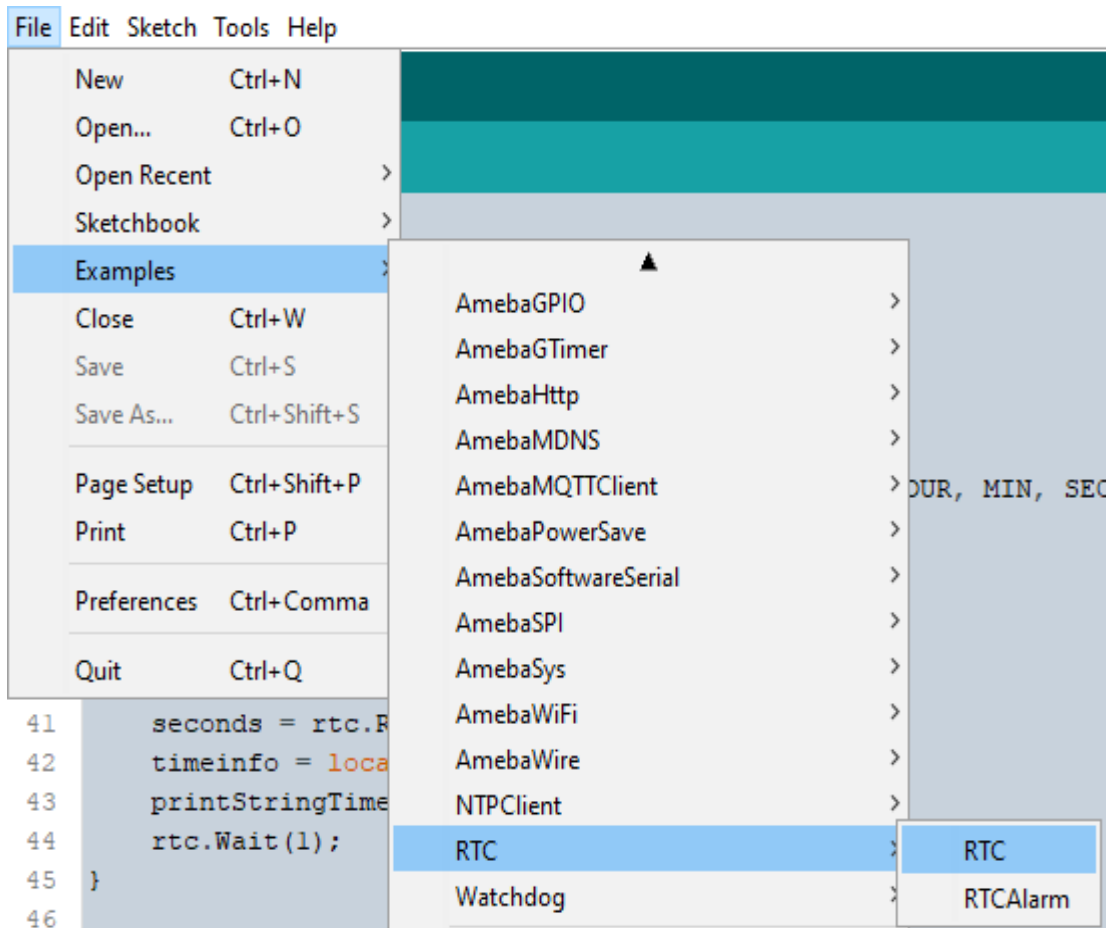
### Example

This example demonstrates how to use the RTC library methods. This function describes how to use the RTC API. The RTC function is implemented by an independent BCD timer/counter.

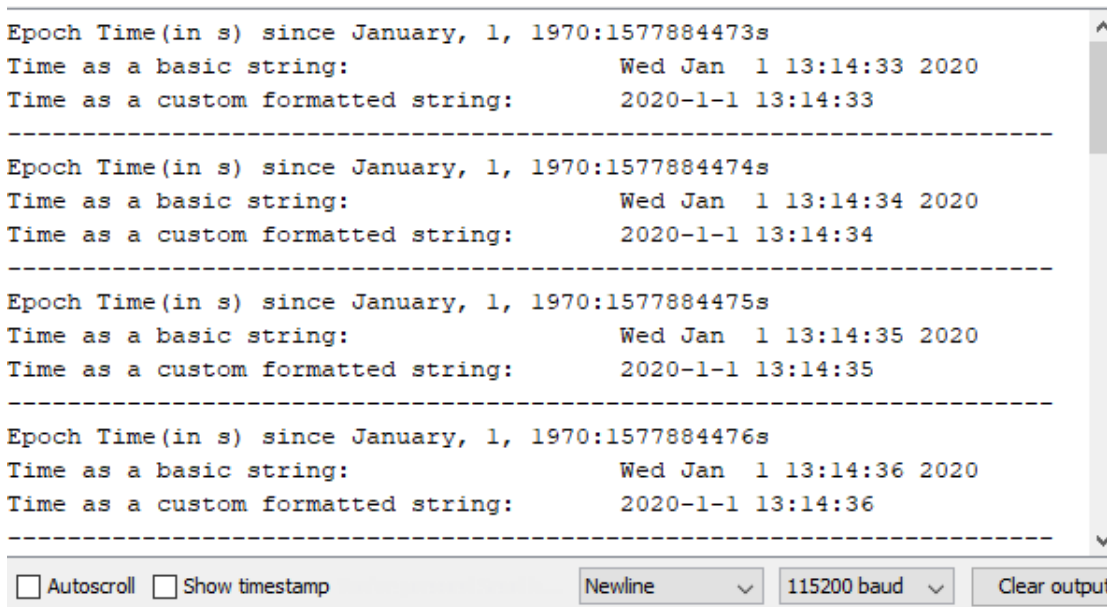
Select the correct Ameba development board from the Arduino IDE: 「Tools」 -> 「Board」 .

Then open the “RTC” example from:

"File" -> "Examples" -> "AmebaRTC" -> "RTC":



Upon successfully upload the sample code and press the reset button, this example will print out time information since the user initialized time every second in the Serial Monitor.





## Code Reference

[1] Simple RTC example from Arduino Tutorials:

<https://www.arduino.cc/en/Tutorial/SimpleRTC>

## RTC - Simple RTC Alarm

### Materials

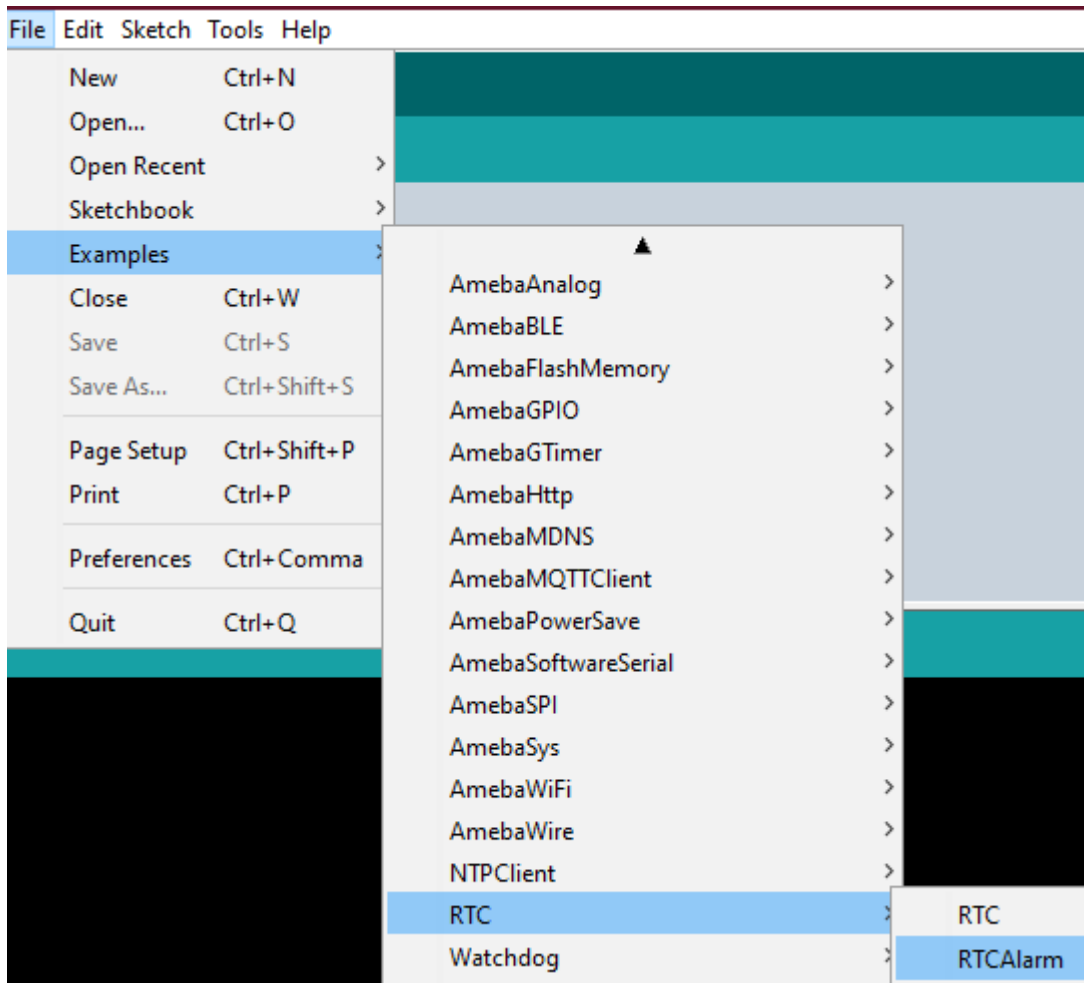
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

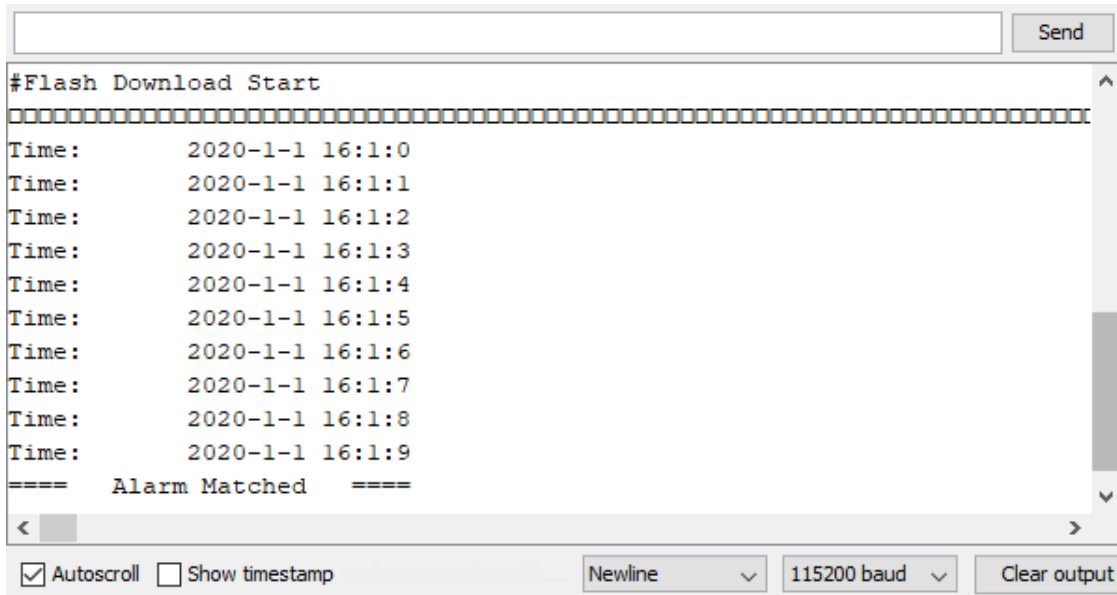
This example demonstrates how to use the RTC library methods to create a RTC Alarm, so that to do some tasks when an alarm is matched. In particular, the RTC time is set at 16:00:00 and an alarm at 16:00:10. When the time matches, “Alarm Match” information will be printed on the serial monitor.

First, select the correct Ameba development board from the Arduino IDE: “Tools” -> “Board” .

Then open the 「RTCArm」 example from: “File” -> “Examples” -> “RTC” -> “RTCArm” :



In the example, the RTC time is set at 16:00:00 and an alarm is set at 16:00:10. Upon successfully upload the sample code and press the reset button. When the alarm time (10 seconds) is reached the attached interrupt function will print the following information: “Alarm Matched!” showing in this figure below.



## SPI –Print Image And Text On LCD Screen

If you are not familiar with SPI, please read [Introduction to SPI](#) first.

## Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- ILI9341 TFT LCD with SPI interface x 1

### Example

We have tested the following two models of ILI9341 TFT LCD with SPI interface:

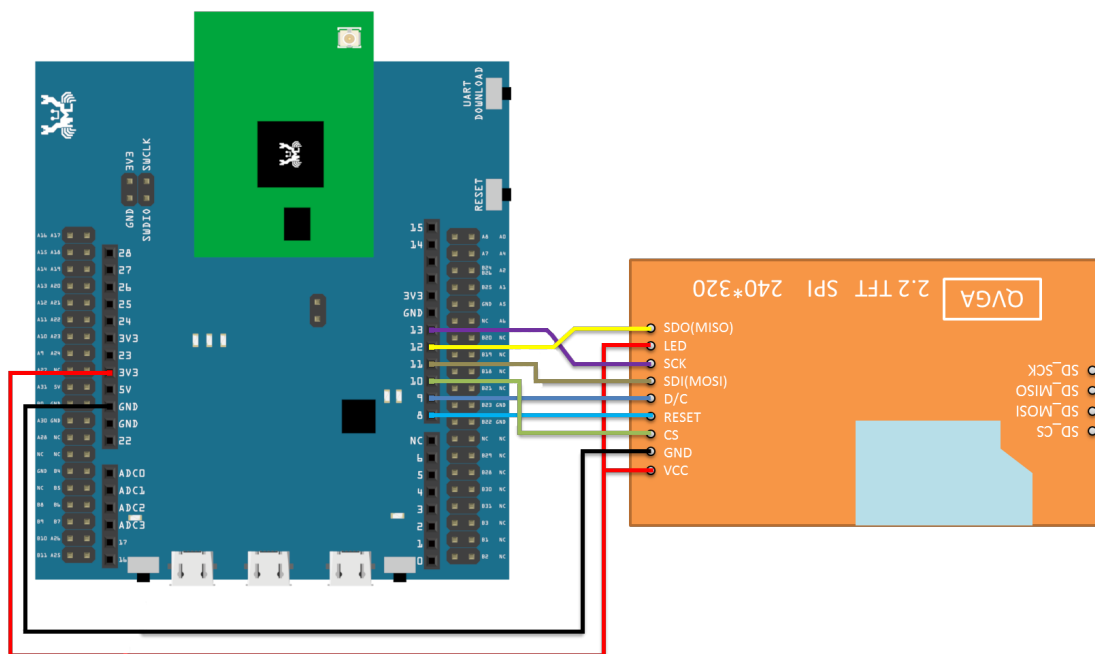
- Adafruit 2.8" TFT LCD (with touch screen)
  - <https://www.adafruit.com/products/1651>
  - <https://learn.adafruit.com/adafruit-2-8-tft-touch-shield-v2?view=all>
- QVGA 2.2" TFT LCD
  - [http://www.lcdwiki.com/2.2inch\\_SPI\\_Module\\_ILI9341\\_SKU:MSP2202](http://www.lcdwiki.com/2.2inch_SPI_Module_ILI9341_SKU:MSP2202)

Common pins in ILI9341 TFT LCD with SPI interface:

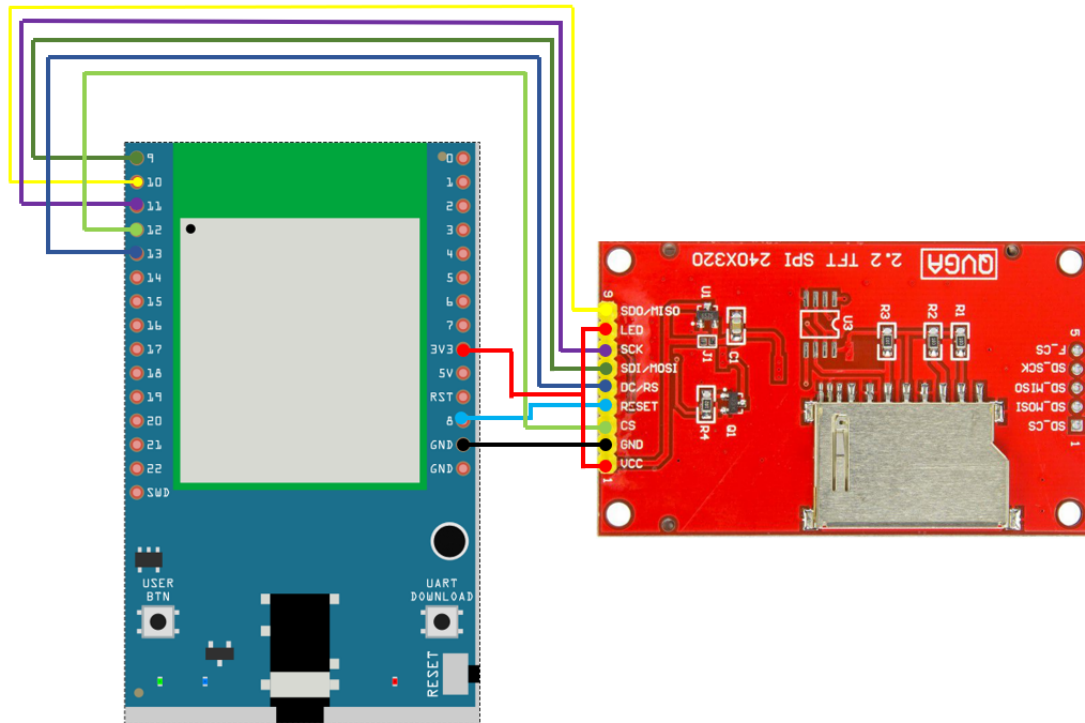
- MOSI: Standard SPI Pin
- MISO: Standard SPI Pin
- SLK: Standard SPI Pin

- CS: Standard SPI Pin
- RESET: Used to reboot LCD.
- D/C: Data/Command. When it is at Low, the signal transmitted are commands, otherwise the data transmitted are data.
- LED (or BL): Adapt the screen backlight. Can be controlled by PWM or connected to VCC for 100% backlight.
- VCC: Connected to 3V or 5V, depends on its spec.
- GND: Connected to GND.

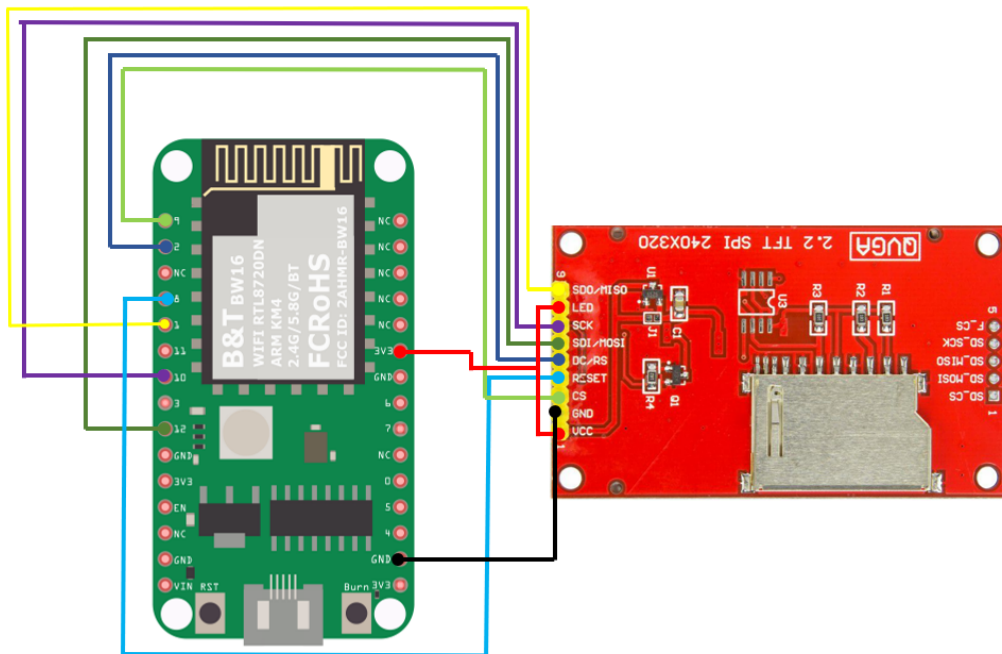
#### AMB21/ AMB22 and QVGA TFT LCD Wiring Diagram:



#### AMB23 and QVGA TFT LCD Wiring Diagram:



**BW16 and QVGA TFT LCD Wiring Diagram:**

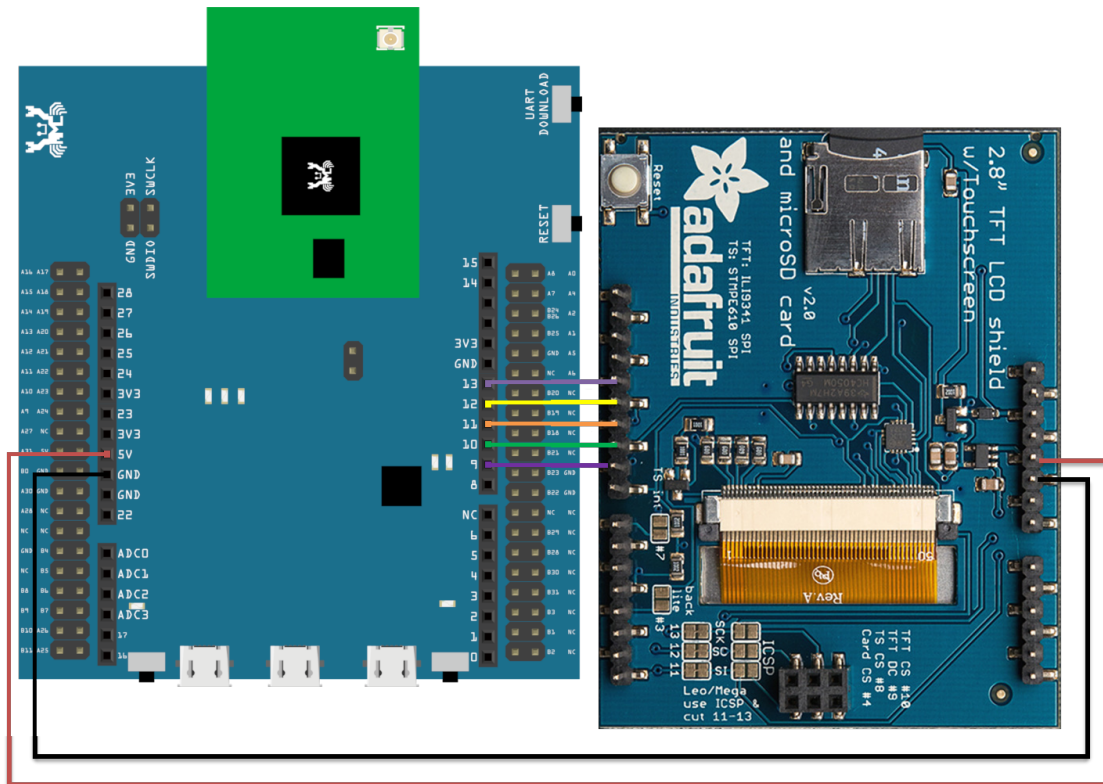


Wiring example of Adafruit 2.8" TFT LCD touch shield:

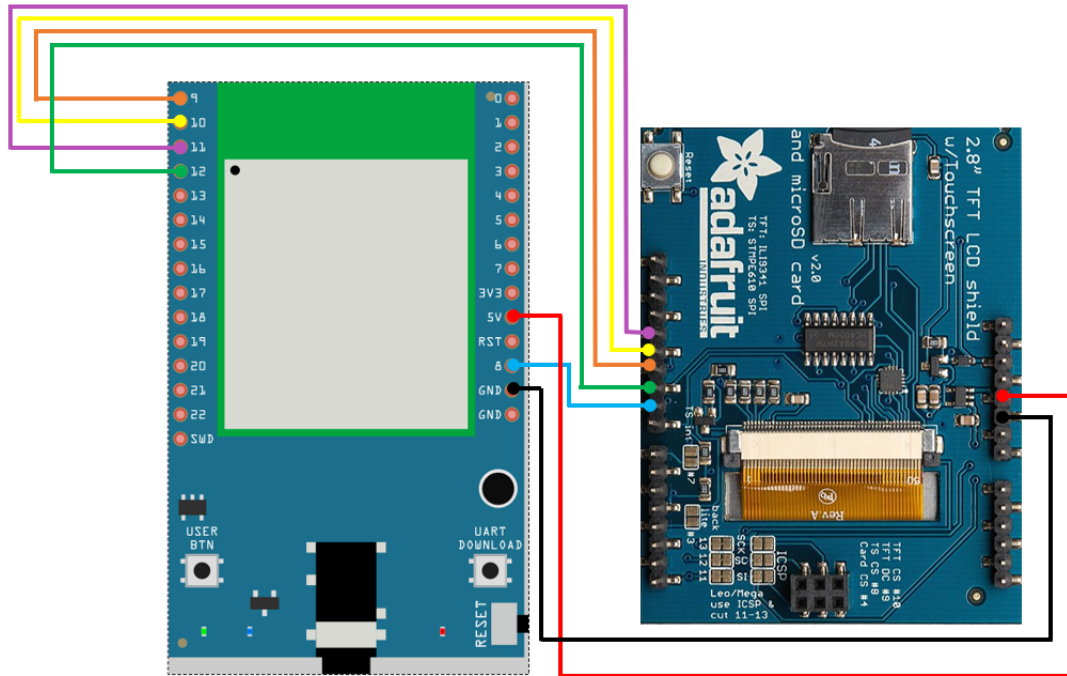
Please note that this shield model enables the backlight by default and pin 8 is not for backlight, and the VCC should be connected to 5V.

## AMB21 / AMB22 and Adafruit 2.8" TFT LCD touch shield Wiring Diagram:

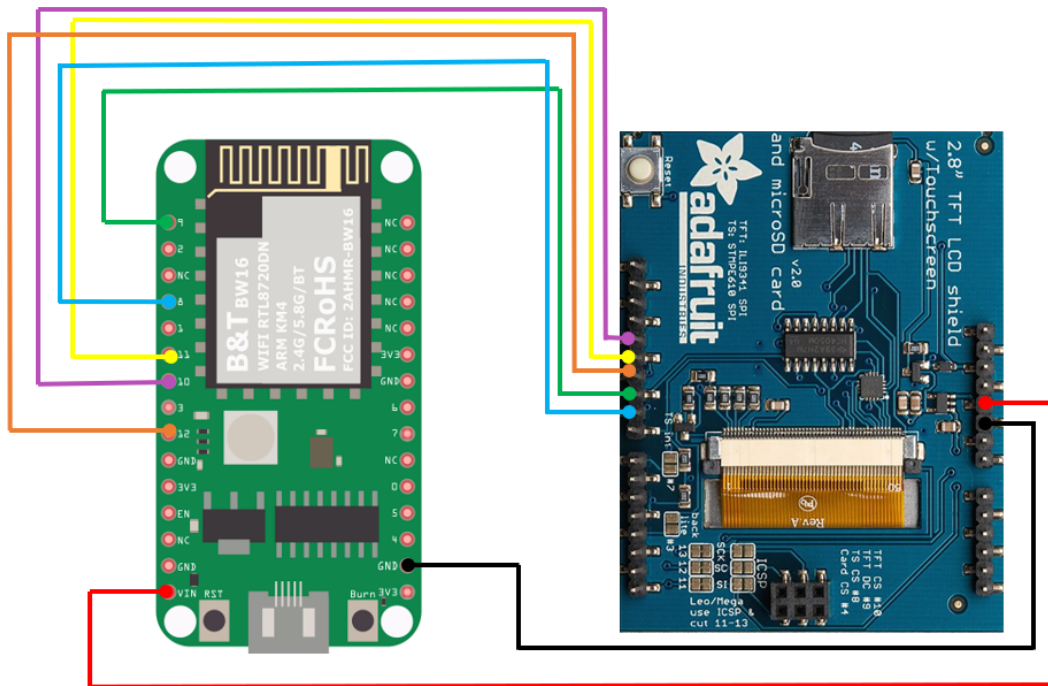
Please note that this shield model enables the backlight by default and pin 8 is not for backlight, and the VCC should be connected to 5V.



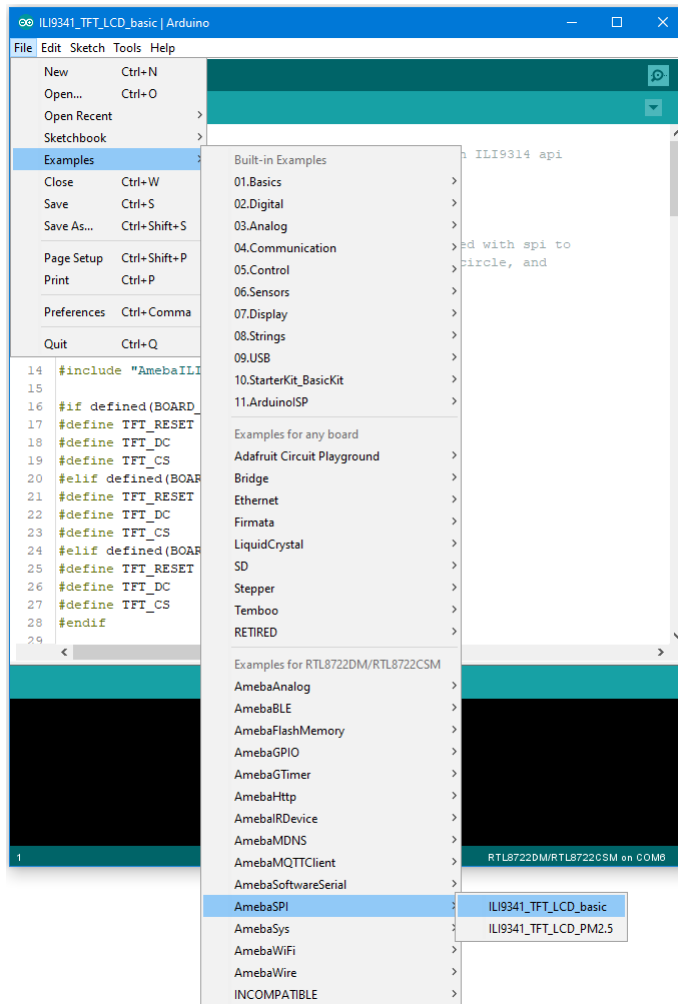
## AMB23 and Adafruit 2.8" TFT LCD touch shield Wiring Diagram:



BW16 and Adafruit 2.8 inch TFT LCD touch shield Wiring Diagram:

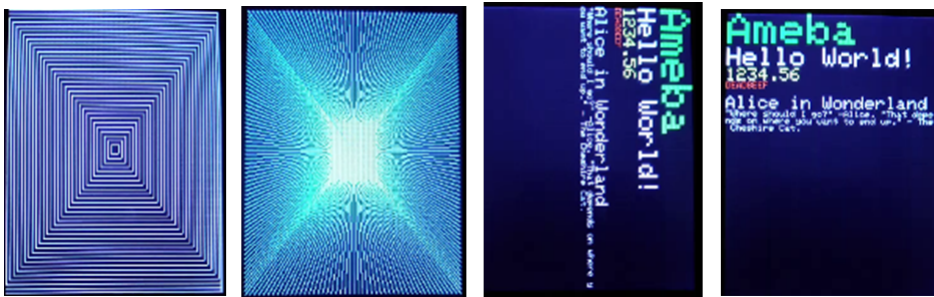


Open the example, “Files” -> “Examples” -> “AmebaSPI” -> “ILI9341\_TFT\_LCD\_basic”



Compile and upload to Ameba, then press the reset button.

Then you can see some display tests appear on the LCD screen, such as displaying different colors, drawing vertical and horizontal lines, drawing circles, etc. ...



## Code Reference



- **RGB 16-bit**

ILI9341 uses RGB 16-bit to display colors. Different from RGB 24-bit, it uses 5 bits for red, 6 bits for green, 5 bits for blue. For example, the RGB 24-bit representation of sky blue is 0x87CEFF, that is in binary:

- Red: 0x87 = B10000111
- Green: 0xCE = B11001110
- Blue: 0xFF = B11111111

and converted to RGB 16-bit:

- Red: B10000
- Green: B110011
- Blue: B11111

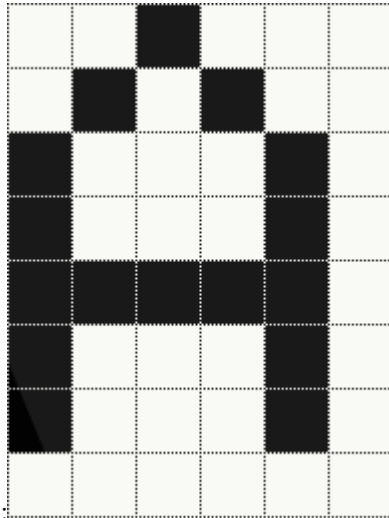
Then concatenate them, which forms B1000011001111111 = 0x867F

- **Drawing of ILI9341**

- First you must specify the range of the rectangle to draw, then pass the 2-byte RGB 16-bit color to ILI9341 corresponding to each pixel one by one, in this way ILI9341 fills each color to each pixel.
- You still must specify the drawing range even though the range covers only one pixel.
- From the rules we mentioned above, we can conclude that drawing vertical or horizontal lines are faster than diagonal lines.

- **Printing text on ILI9341**

- In our API, each character is 5×7 but each character is printed to size 6×8 (its right side and below are left blank), so as to separate from next character. For example, the character “A”



- The font size represents the dot size. For example, if the font size is 2, each dot in the character is a 2×2 rectangle

- **Screen rotation**

- ILI9341 provides 0, 90, 180, 270 degrees screen rotation.
- If the original width is 240 and original height is 320, when the screen rotates 90 degrees, the width becomes 320 and the height becomes 240.

## **SPI –Show PM2.5 Concentration On ILI9341 TFT LCD**

If you are not familiar with SPI, please read [Introduction to SPI](#) first.

### **Preparation**

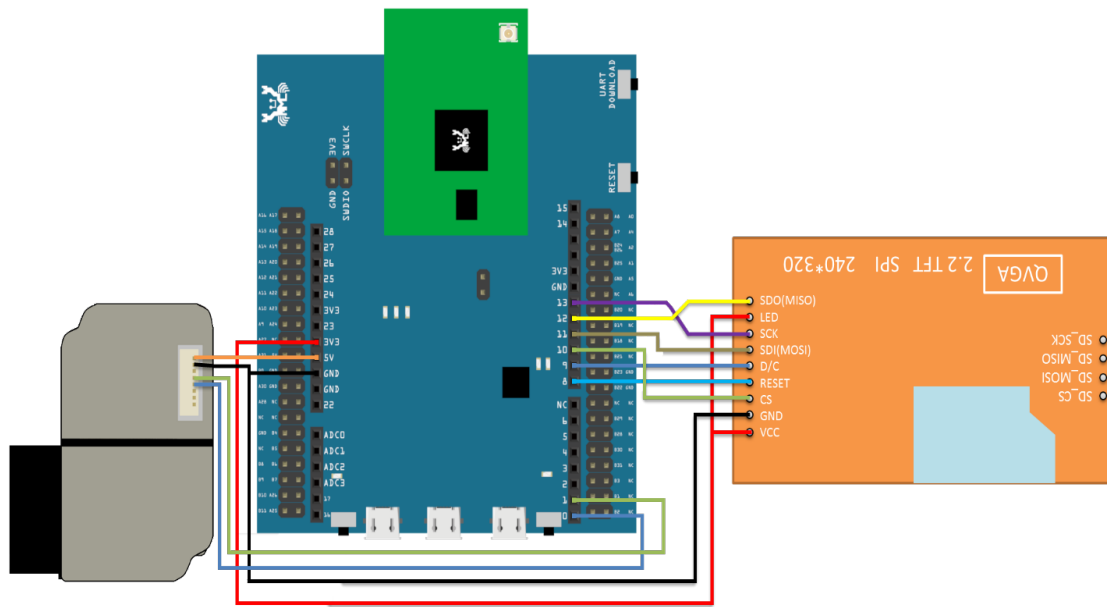
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- ILI9341 TFT LCD with SPI interface x 1
- Plantower PMS3003 or PMS5003 x 1

### **Example**

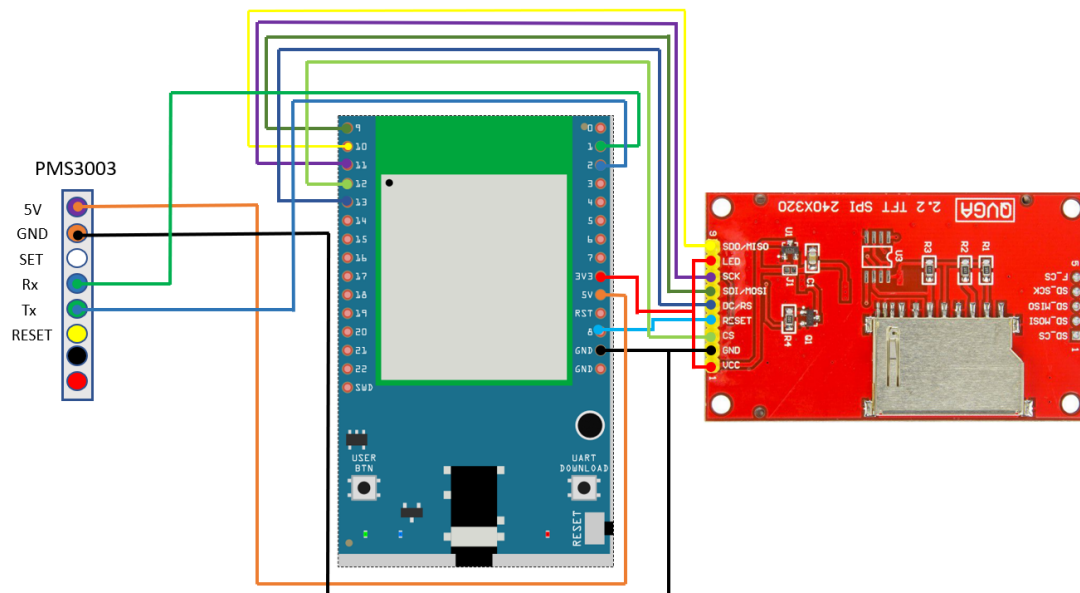
This example extends previous PM2.5 example to show the PM2.5 concentration on the LCD.

**AMB21 / AMB22 and QVGA TFT LCD Wiring Diagram:**

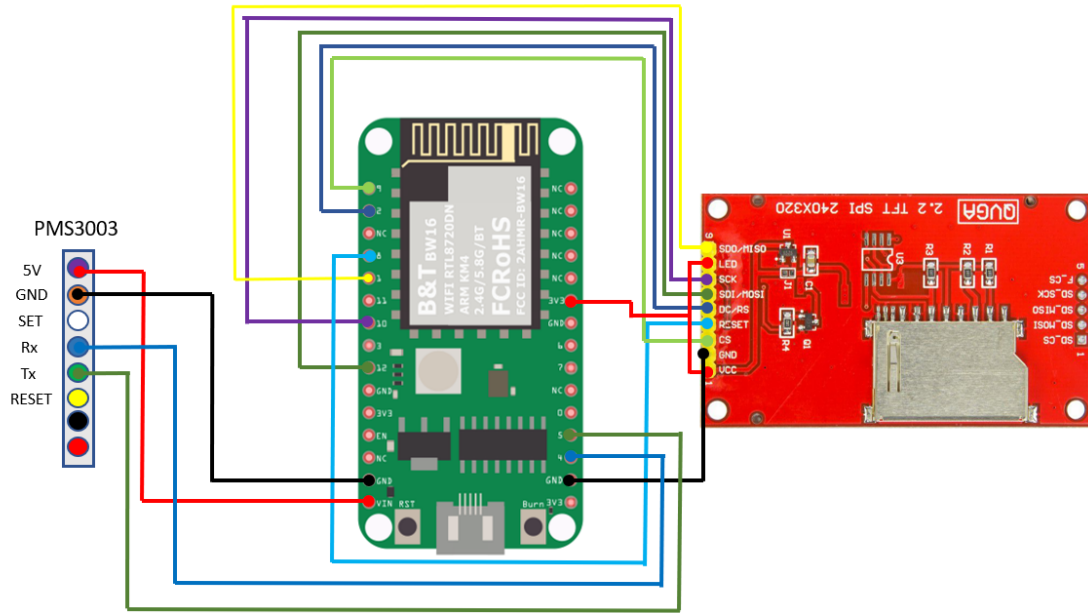
(Note: PMS3003/PMS5003 sensor requires 5V voltage)



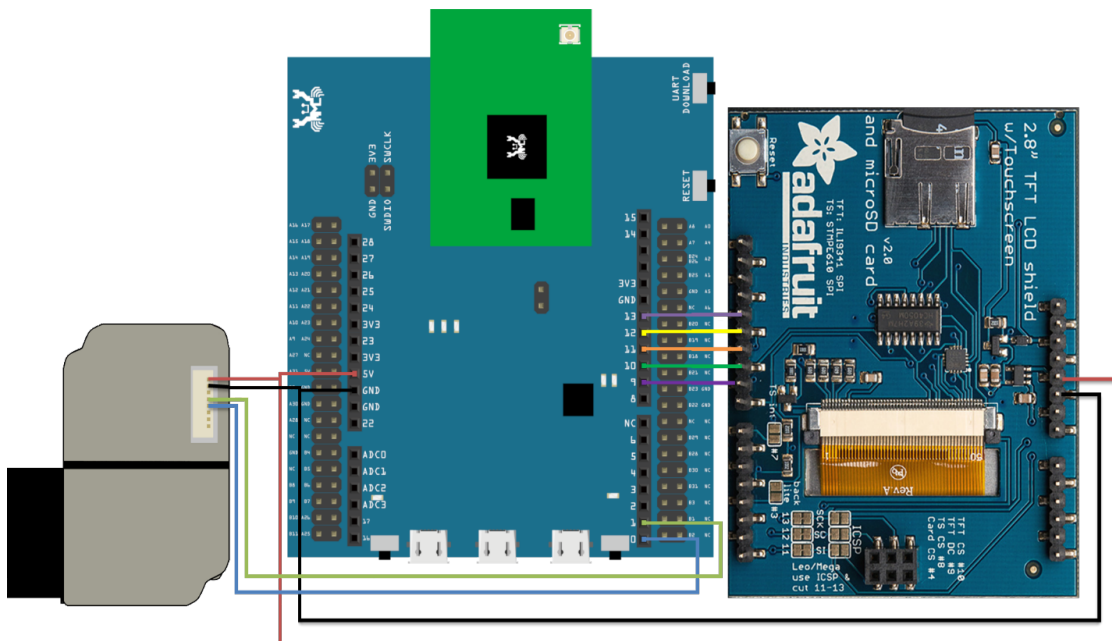
AMB23 and QVGA TFT LCD Wiring Diagram:



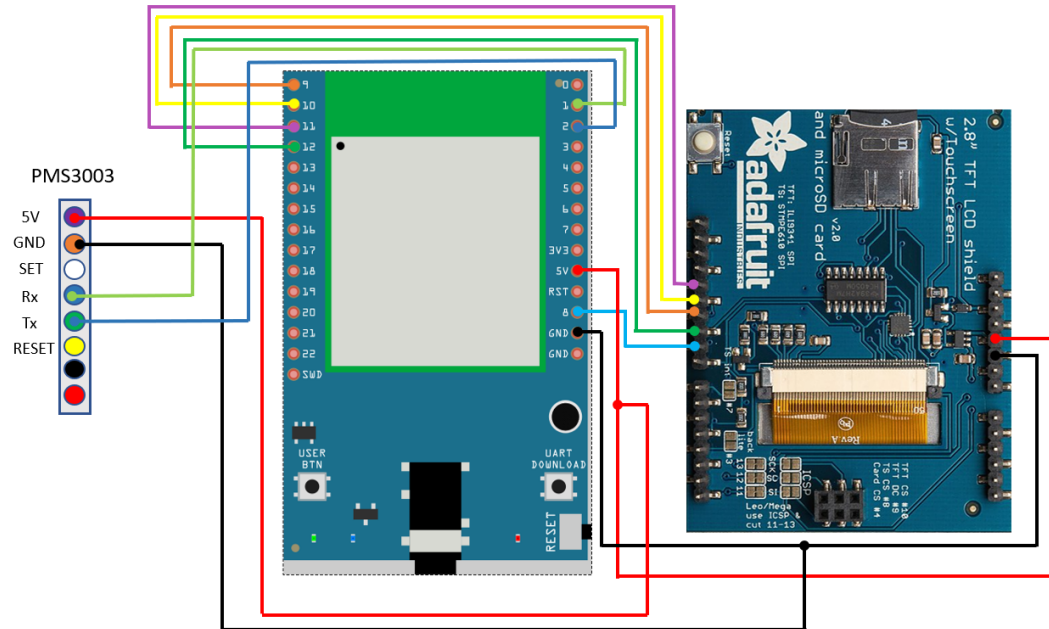
BW16 and QVGA TFT LCD Wiring Diagram:



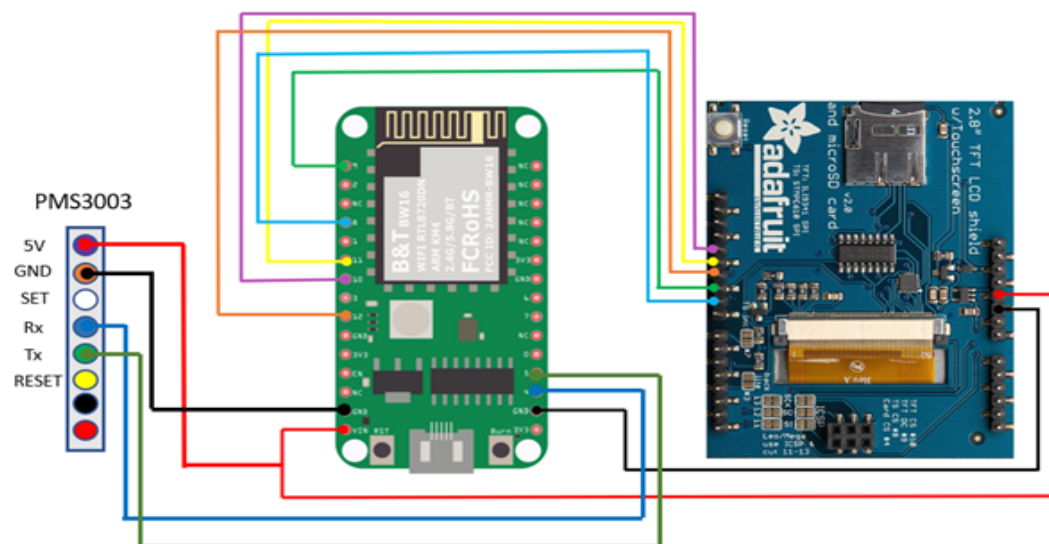
AMB21 / AMB22 and Adafruit 2.8" TFT LCD Wiring Diagram:



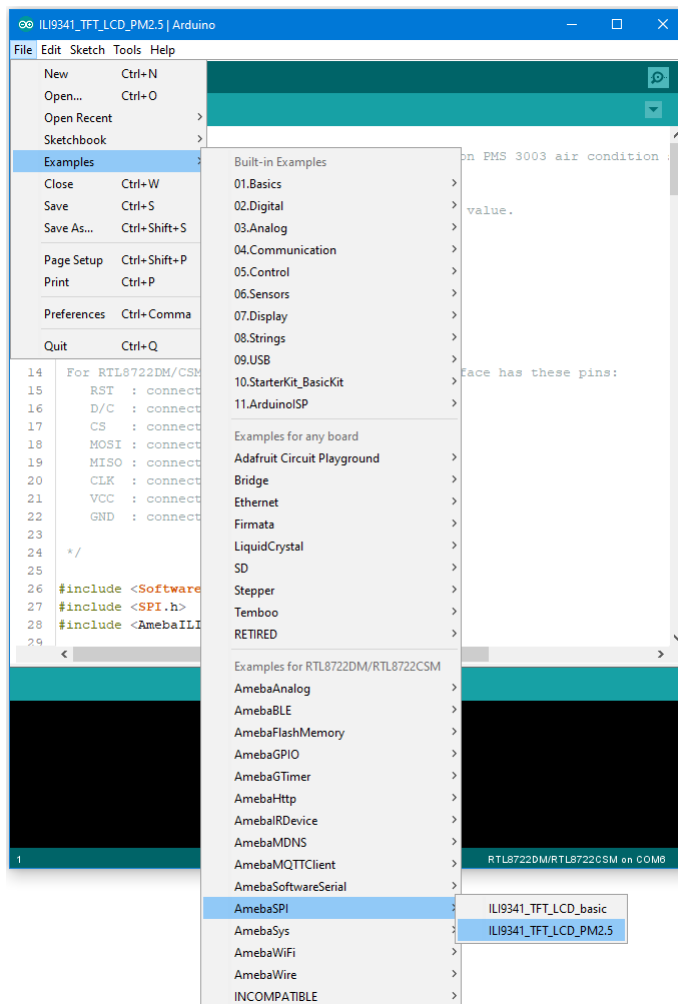
AMB23 and and Adafruit 2.8" TFT LCD Wiring Diagram:



**BW16 and and Adafruit 2.8" TFT LCD Wiring Diagram:**

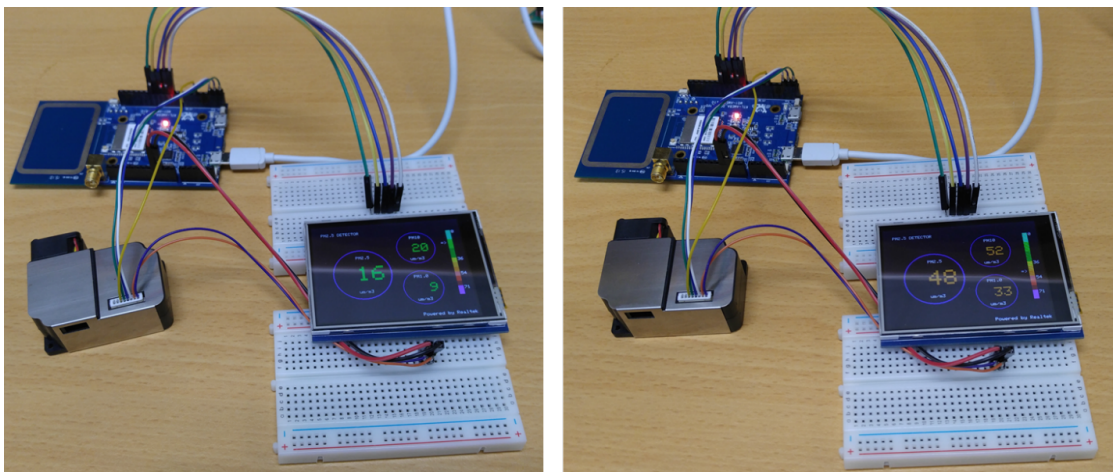


Open the example, "Files" -> "Examples" -> "AmebaSPI" -> "PM25\_on\_ILI9341\_TFT\_LCD"



Compile and upload to Ameba, then press the reset button.

Then you can see the concentration value of PM1.0, PM2.5 and PM10 on the LCD.



## Code Reference

In this example, first rotate the screen by 90 degrees, and draw the static components such as the circles, the measuring scale, and the title text. After the concentration value is detected, it is printed inside the circle.

## TensorFlow Lite - Hello World

### Materials

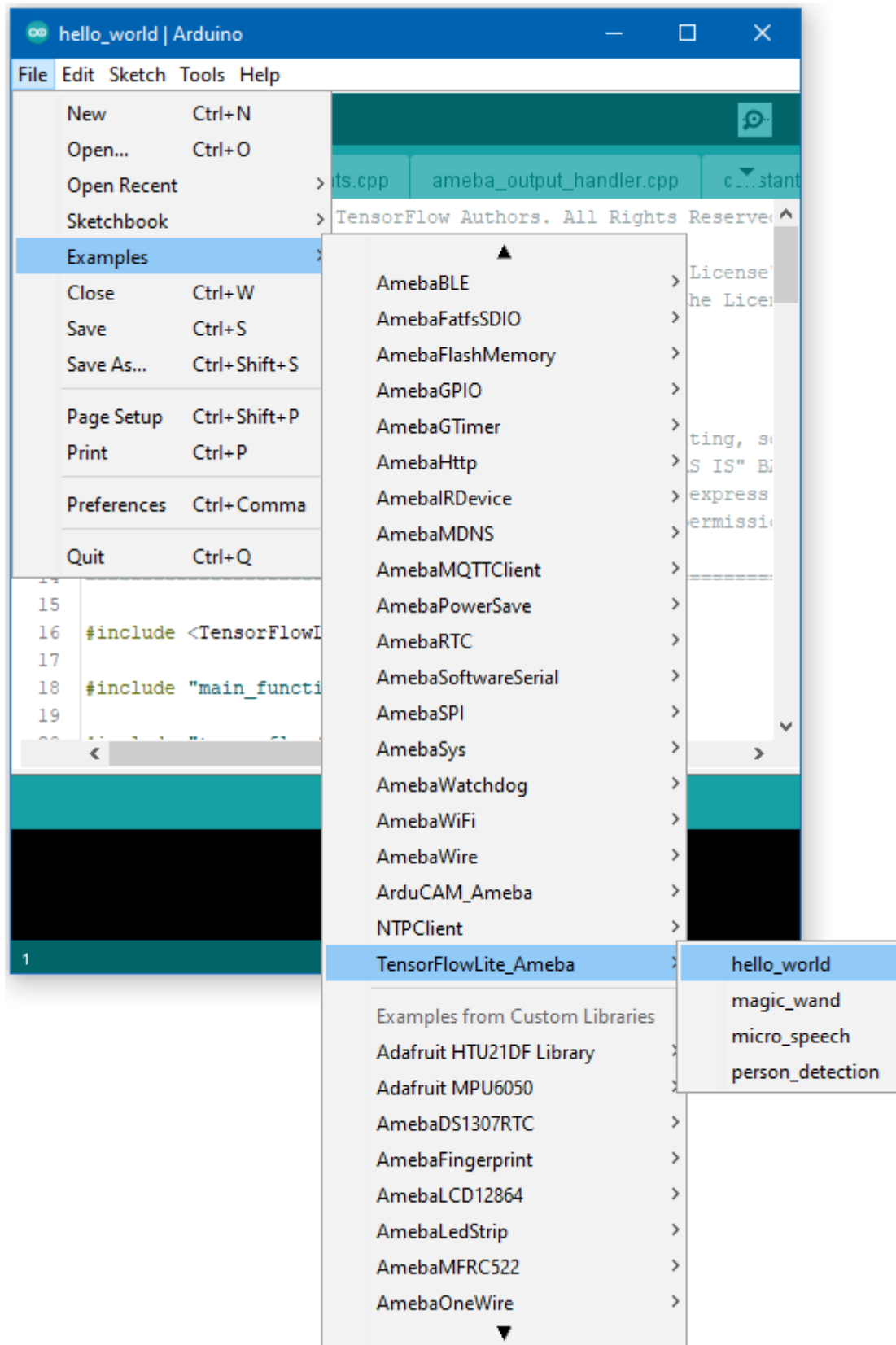
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- LED x 1

### Example

#### Procedure

Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at [https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries). Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it. Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "hello\_world".

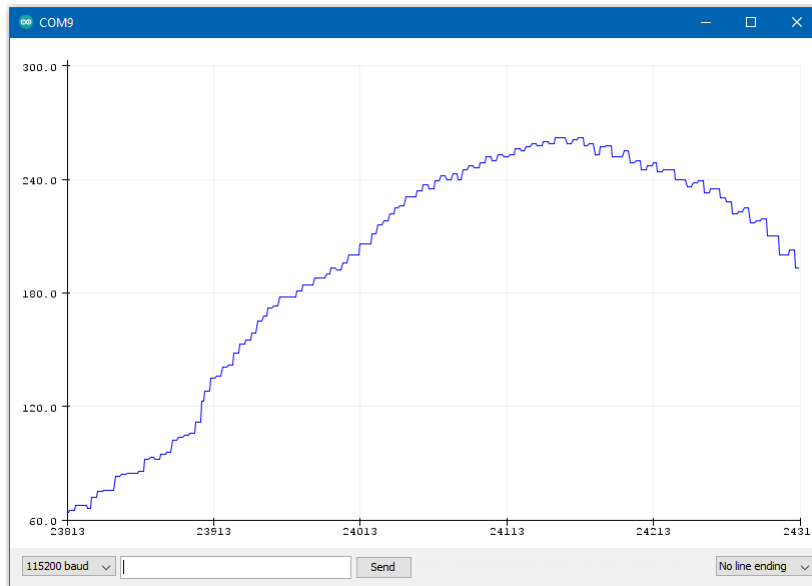




Upload the code and press the reset button on Ameba once the upload is finished.

Connect the LED to digital pin 10 and ground, ensuring that the polarity is correct. You should see the LED fade in and out rapidly.

In the Arduino serial plotter, you can see the output value of the Tensorflow model plotted as a graph, it should resemble a sine wave.



## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## TensorFlow Lite - Magic Wand

### Materials

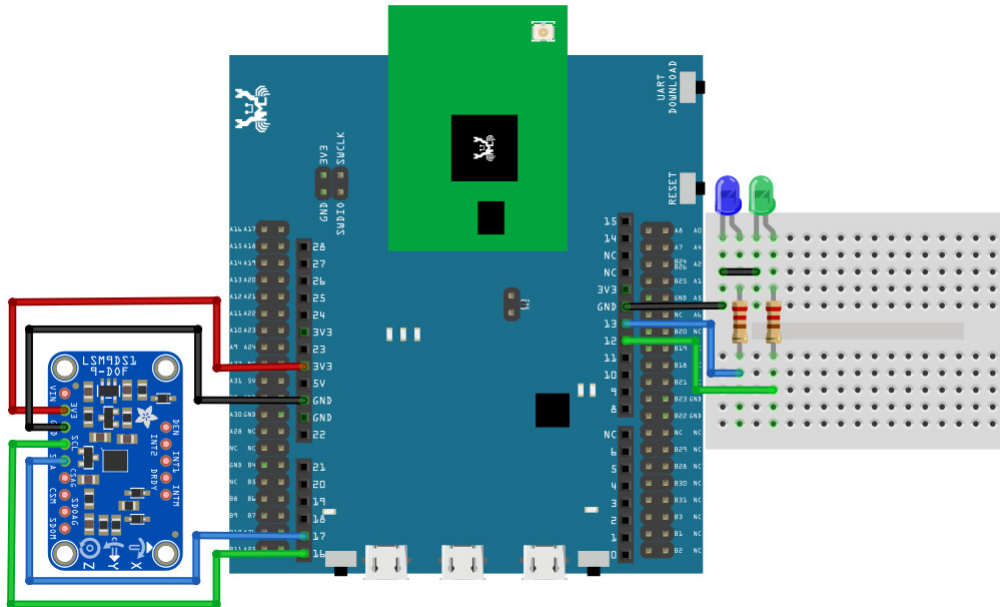
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Adafruit LSM9DS1 accelerometer
- LED x 2

### Example

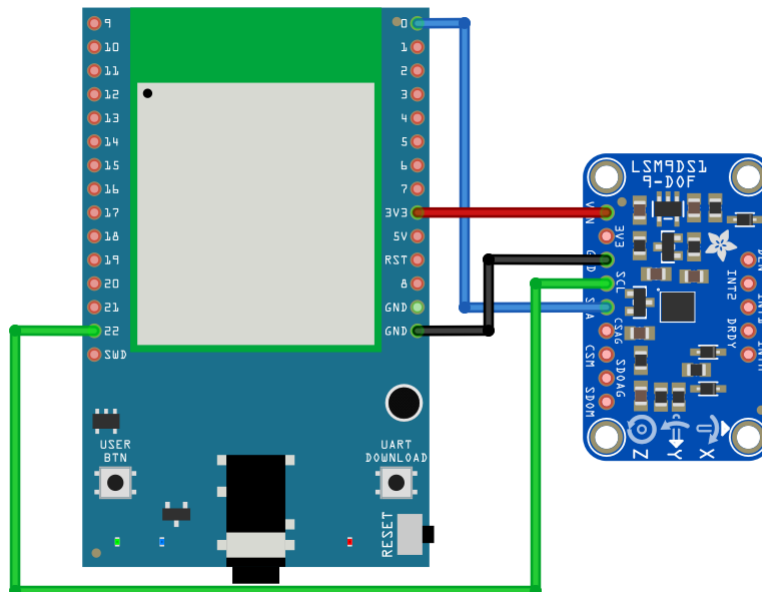
### Procedure

**AMB21\* / AMB22 Wiring Diagram:**

Connect the accelerometer and LEDs to the RTL8722 board following the diagram.

**AMB23 Wiring Diagram:**

For RTL8722DM MINI, we will use the onboard LEDs on the board itself.



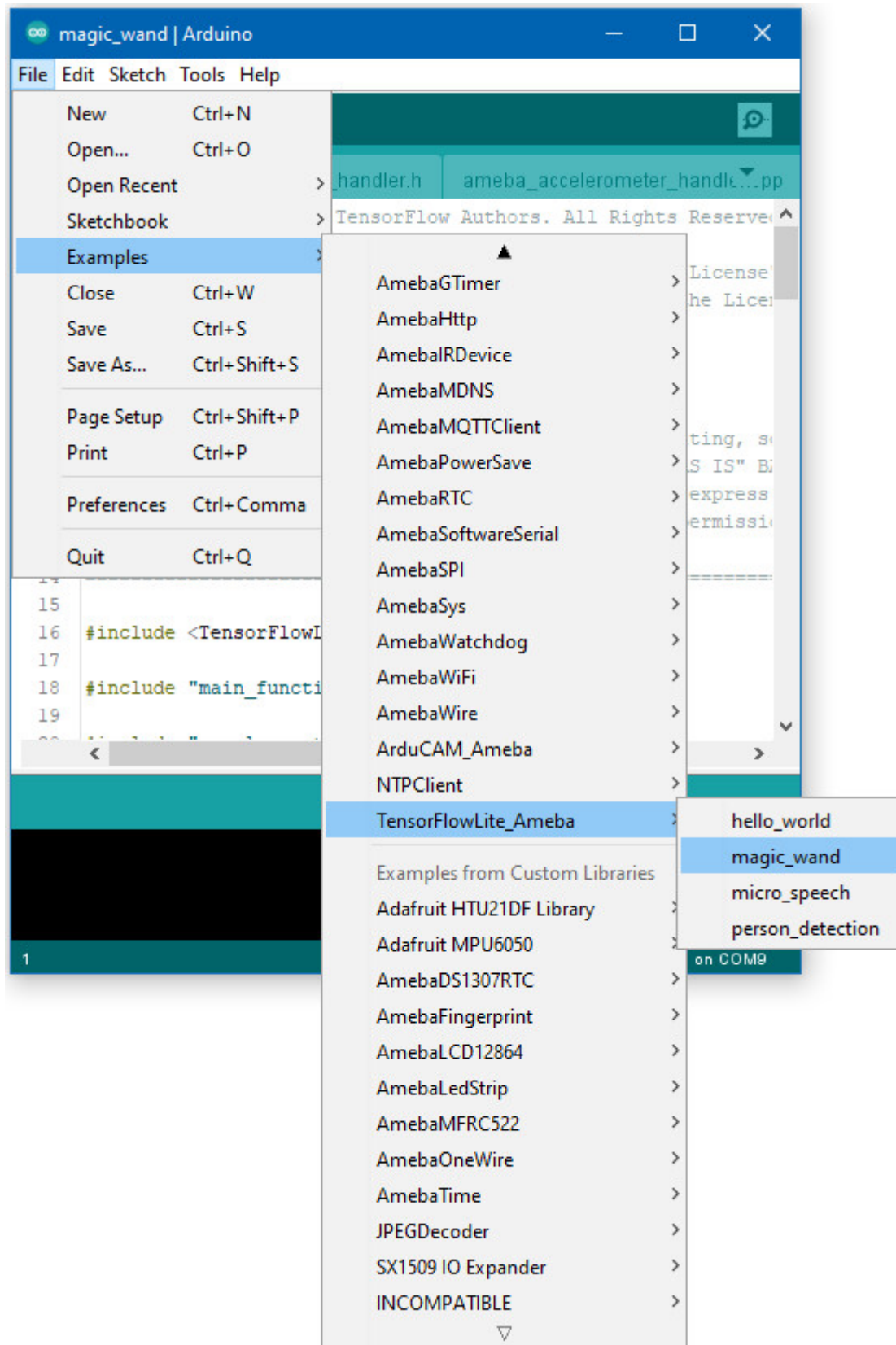
Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at [https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries).

Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it.

Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

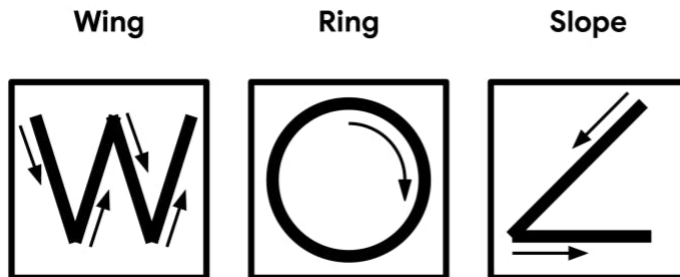
In the Arduino IDE library manager, install the Arduino\_LSM9DS1 library. This example has been tested with version 1.1.0 of the LSM9DS1 library.

Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "magic\_wand" .



Upload the code and press the reset button on Ameba once the upload is finished.

Holding the accelerometer steady, with the positive x-axis pointing to the right and the positive z-axis pointing upwards, move it following the shapes as shown, moving it in a smooth motion over 1 to 2 seconds, avoiding any sharp movements.



If the movement is recognised by the Tensorflow Lite model, you should see the same shape output to the Arduino serial monitor. Different LEDs will light up corresponding to different recognized gestures.

Note that the wing shape is easy to achieve, while the slope and ring shapes tend to be harder to get right.

The screenshot shows a serial monitor window titled 'COM9'. It displays a series of timestamps and gestures recognized by the model. The gestures are 'SLOPE' and 'WING'. The 'SLOPE' gesture is recognized multiple times, followed by a row of asterisks. The 'WING' gesture is also recognized multiple times, followed by a row of asterisks. The window has a 'Send' button at the top right and a 'Clear output' button at the bottom right. The bottom status bar shows 'Autoscroll' and 'Show timestamp' checked, 'Carriage return' set to 'v', and '115200 baud'.

```

12:12:38.969 ->
12:12:50.459 -> SLOPE:
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> *
12:12:50.459 -> * * * * *
12:12:50.459 ->
12:13:21.201 -> WING:
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 -> * * * * *
12:13:21.201 ->

```

## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## TensorFlow Lite - Micro Speech

### Preparation

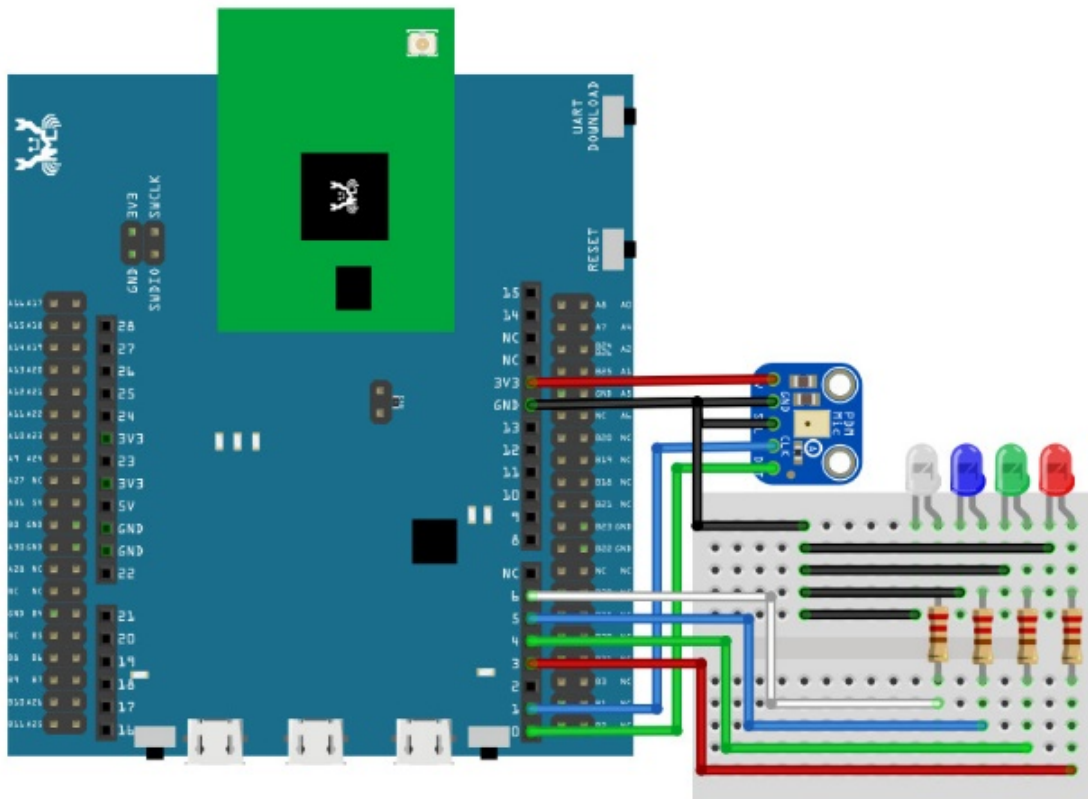
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Adafruit PDM MEMS microphone
- LED x 4

### Example

### Procedure

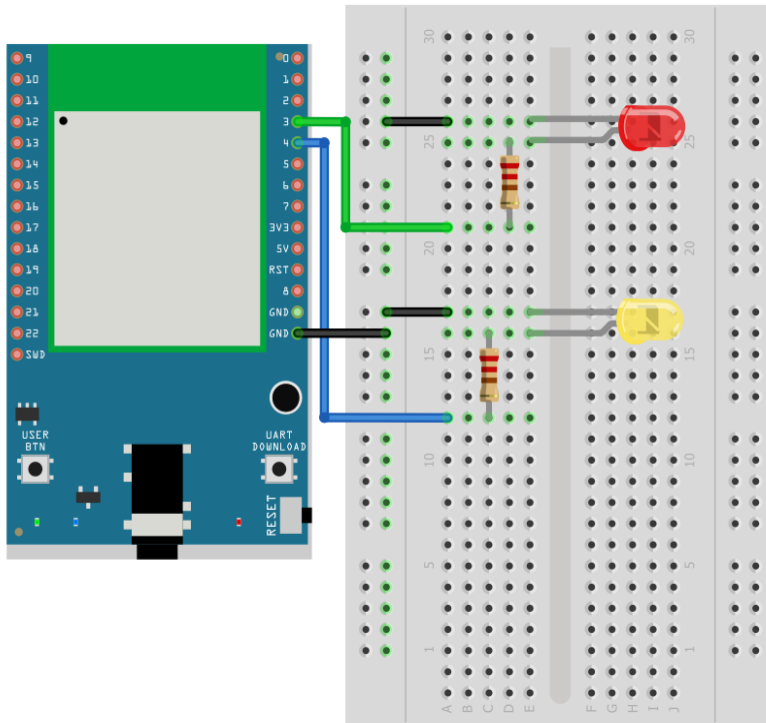
#### AMB21 / AMB22 Wiring Diagram:

Connect the microphone and LEDs to the RTL8722 board following the diagram.



**AMB23 Wiring Diagram:**

As RTL8722DM MINI have a built in microphone on the board, there is no need for any external microphone. For the LEDs, we will only connect two LEDs and then use the two onboard LEDs (Blue and Green).



Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at

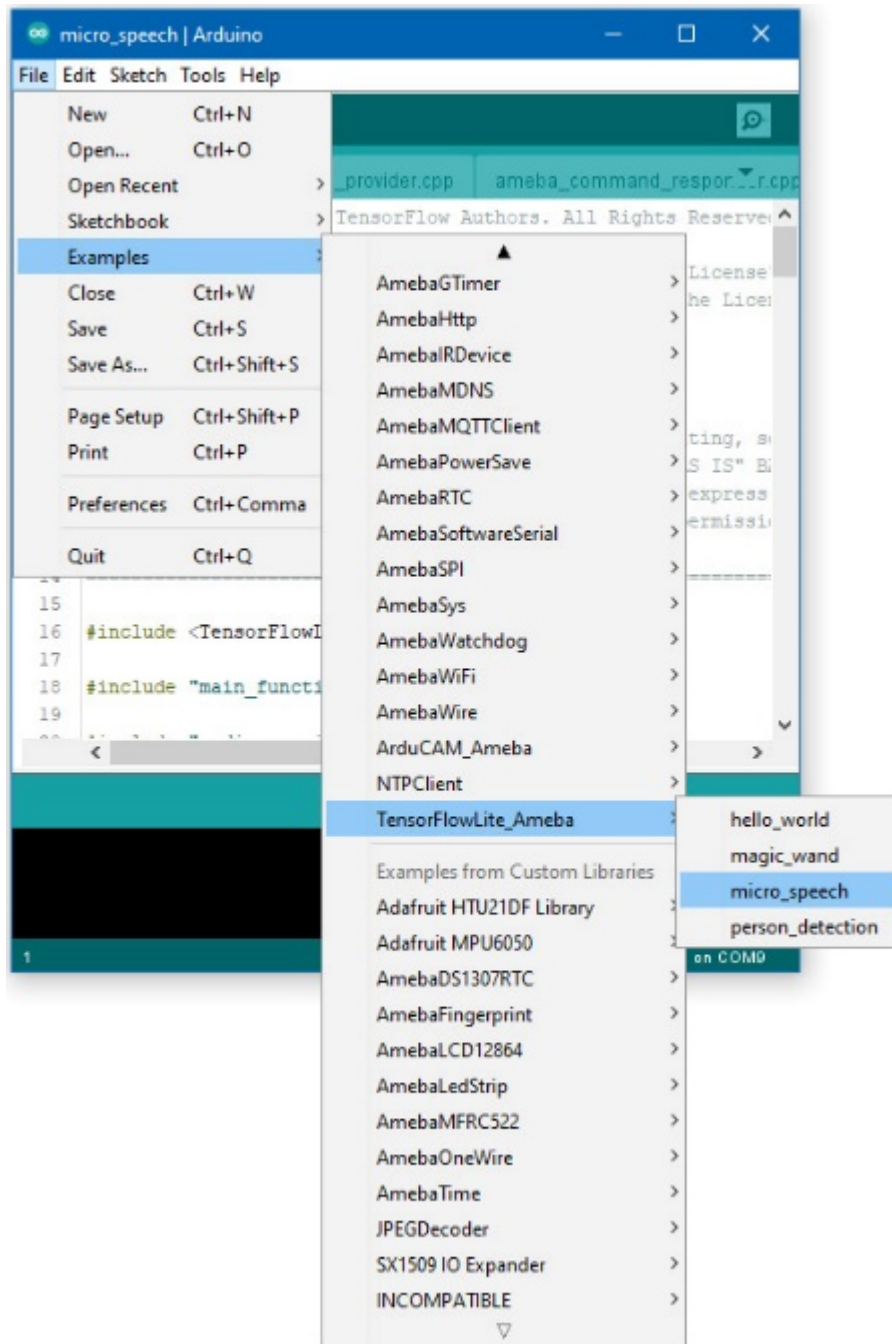
[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries).

Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it.

Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "micro\_speech"

.

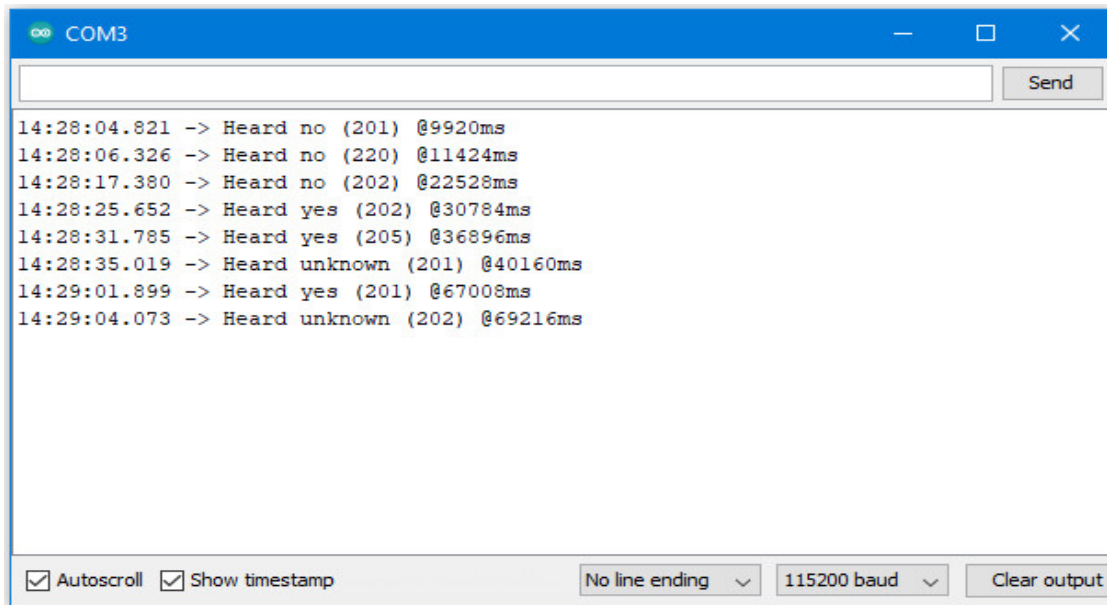


Upload the code and press the reset button on Ameba once the upload is finished.

Once it is running, you should see one of the LEDs flashing, indicating that it is processing audio. Saying the word 「yes」 will cause the green LED to light up. Saying the word “no” will cause the red LED to light up. If the word is not recognized, the blue LED will light up.

The inference results are also output to the Arduino serial monitor, which appear as follows:





If you are having trouble in getting the words recognized, here are some tips:

- Ensure that your surroundings are quiet with minimal noise.
- Experiment with varying the distance of the microphone, starting with it at an arm's length.
- Experiment with different tones and volume when saying the words.
- Depending on how you pronounce the words, the characteristics of the microphone used, getting one keyword recognized may be easier than the other.

## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## TensorFlow Lite - Person Detection

### Materials

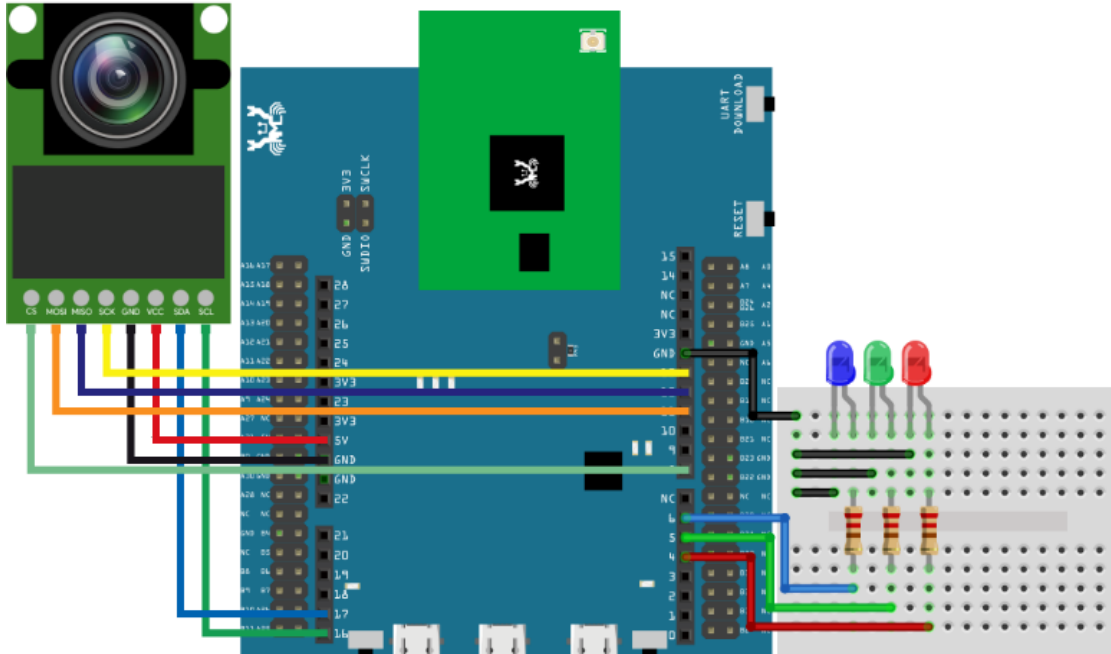
- AmebaD [AMB21 / AMB22 / AMB23] x 1
- Arducam Mini 2MP Plus OV2640 SPI Camera Module x 1
- LED x 3

### Example

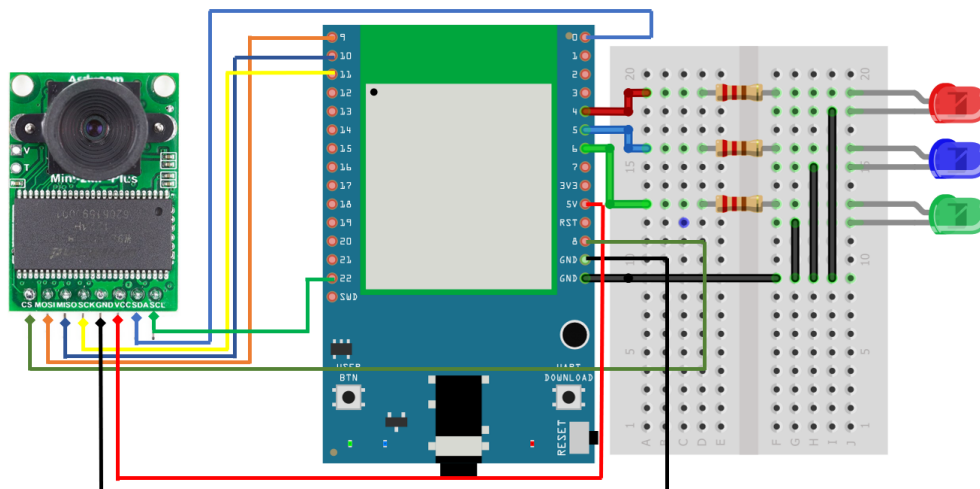
## Procedure

### AMB21 / AMB22 Wiring Diagram:

Connect the camera and LEDs to the RTL8722 board following the diagram.



### AMB23 Wiring Diagram:



Download the Ameba customized version of TensorFlow Lite for Microcontrollers library at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries).

Follow the instructions at <https://www.arduino.cc/en/guide/libraries> to install it. Ensure that the patch files found at [https://github.com/ambiot/ambd\\_arduino/tree/master/Ameba\\_misc/](https://github.com/ambiot/ambd_arduino/tree/master/Ameba_misc/) are also installed.

You will also need to install the Ameba\_ArduCAM library, found together with the TensorFlow Lite library.

In the Arduino IDE library manager, install the JPEGDecoder library. This example has been tested with version 1.8.0 of the JPEGDecoder library.

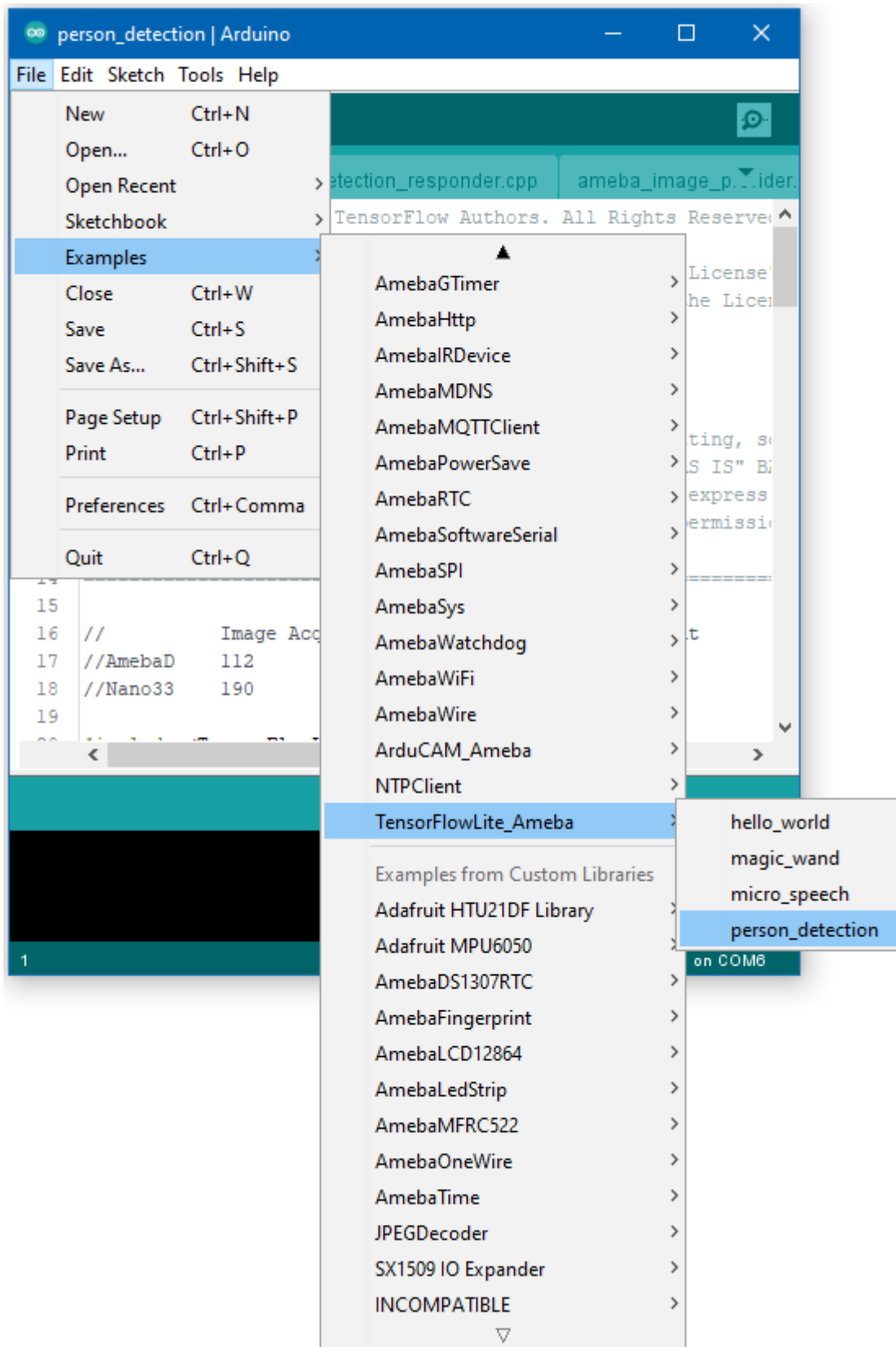
Once the library has installed, you will need to configure it to disable some optional components that are not compatible with the RTL8722DM. Open the following file:

```
Arduino/libraries/JPEGDecoder/src/User_Config.h
```

Make sure that both `#define LOAD_SD_LIBRARY` and `#define LOAD_SDFAT_LIBRARY` are commented out, as shown in this excerpt from the file:

```
//#define LOAD_SD_LIBRARY // Default SD Card library
//#define LOAD_SDFAT_LIBRARY // Use SdFat library instead, so SD Card SPI can be bit-
↳bashed
```

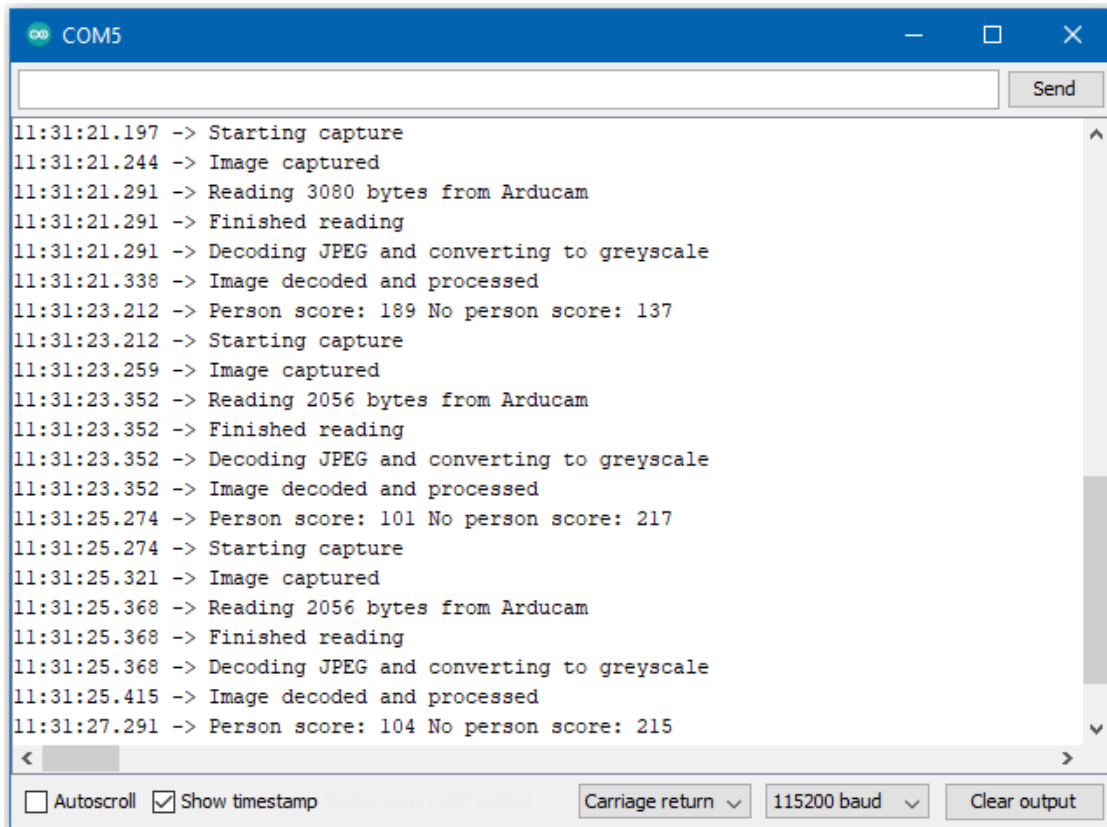
Open the example, "Files" -> "Examples" -> "TensorFlowLite\_Ameba" -> "person\_detection".



Upload the code and press the reset button on Ameba once the upload is finished.

Once it is running, you should see the blue LED flashing once every few seconds, indicating that it has finished processing an image. The red LED will light up if it determines that there is no person in the previous image captured, and the green LED will light up if it determines that there is a person.

The inference results are also output to the Arduino serial monitor, which appear as follows:



```

11:31:21.197 -> Starting capture
11:31:21.244 -> Image captured
11:31:21.291 -> Reading 3080 bytes from Arducam
11:31:21.291 -> Finished reading
11:31:21.291 -> Decoding JPEG and converting to greyscale
11:31:21.338 -> Image decoded and processed
11:31:23.212 -> Person score: 189 No person score: 137
11:31:23.212 -> Starting capture
11:31:23.259 -> Image captured
11:31:23.352 -> Reading 2056 bytes from Arducam
11:31:23.352 -> Finished reading
11:31:23.352 -> Decoding JPEG and converting to greyscale
11:31:23.352 -> Image decoded and processed
11:31:25.274 -> Person score: 101 No person score: 217
11:31:25.274 -> Starting capture
11:31:25.321 -> Image captured
11:31:25.368 -> Reading 2056 bytes from Arducam
11:31:25.368 -> Finished reading
11:31:25.368 -> Decoding JPEG and converting to greyscale
11:31:25.415 -> Image decoded and processed
11:31:27.291 -> Person score: 104 No person score: 215

```

## Code Reference

More information on TensorFlow Lite for Microcontrollers can be found at: <https://www.tensorflow.org/lite/microcontrollers>

## UART - Communicate with PC over USB to Serial Module

### Introduction of UART

UART uses two wire, one for transmitting and the other one for receiving, so the data transmission is bidirectional. The communication uses a predefined frequency (baud rate) to transmit data. In Arduino, UART is called “Serial”. There is only one hardware UART on Arduino Uno and it is primarily used to read the

log and messages printed by Arduino (so it is also called “Log UART” ). If we use the hardware UART for other purposes, the Log UART does not have resources to function. To provide more UART connections, it is possible to use a GPIO pin to simulate the behavior of UART with a software approach, this is called Software Serial. Ameba is equipped with several hardware UART ports, but it is also compatible with the Software Serial library.

## Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- USB to TTL Adapter x 1

## Example

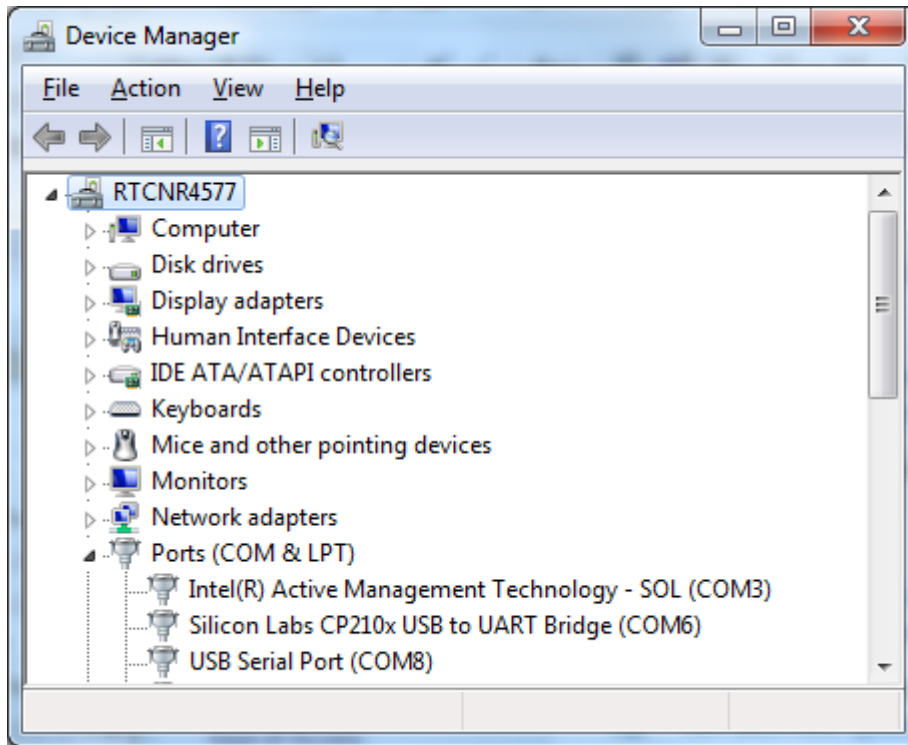
In this example, we use UART to connect USB to TTL adapter to Ameba.

USB to TTL adapter sends data to Ameba, the data would be returned by Ameba, and showed on the screen.

- **Install USB to TTL Adapter**

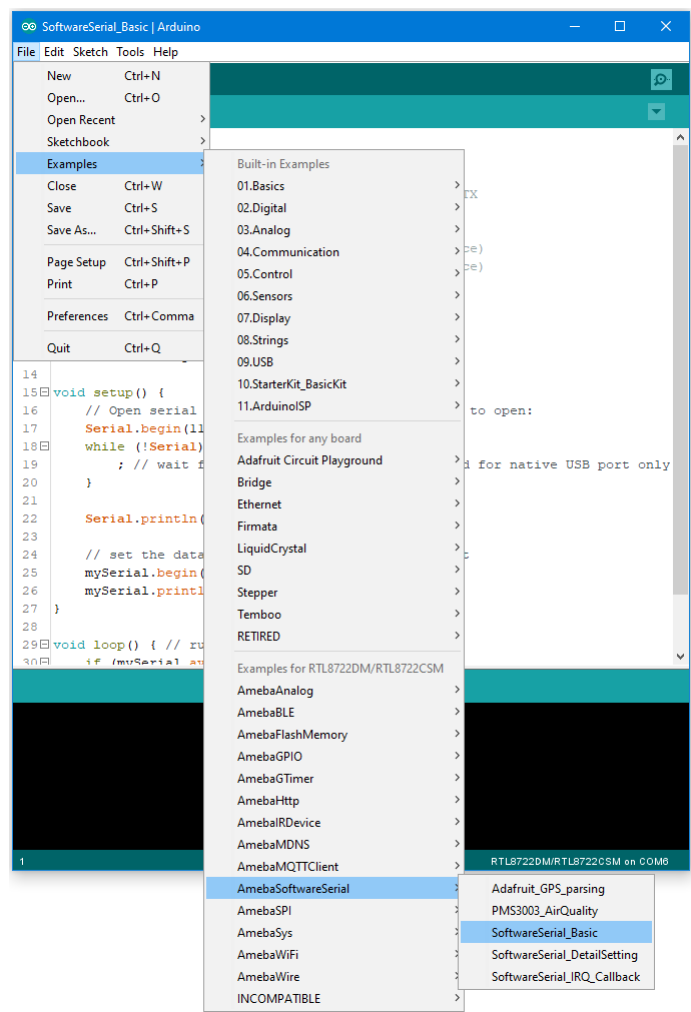
USB to TTL adapter converts USB to serial interface. Normally, there are at least 4 pins on the adapter, that is 3V3 (or 5V), GND, TX and RX. Generally, installing the driver for the USB to TTL adapter would be required before using it. If the adapter uses the chip of FTDI, Windows will search and install the driver automatically, otherwise, you may need to install corresponding driver yourself.

Afterwards, open device manager. You can find corresponding serial port number of the USB to TTL adapter:



- Executing the Example

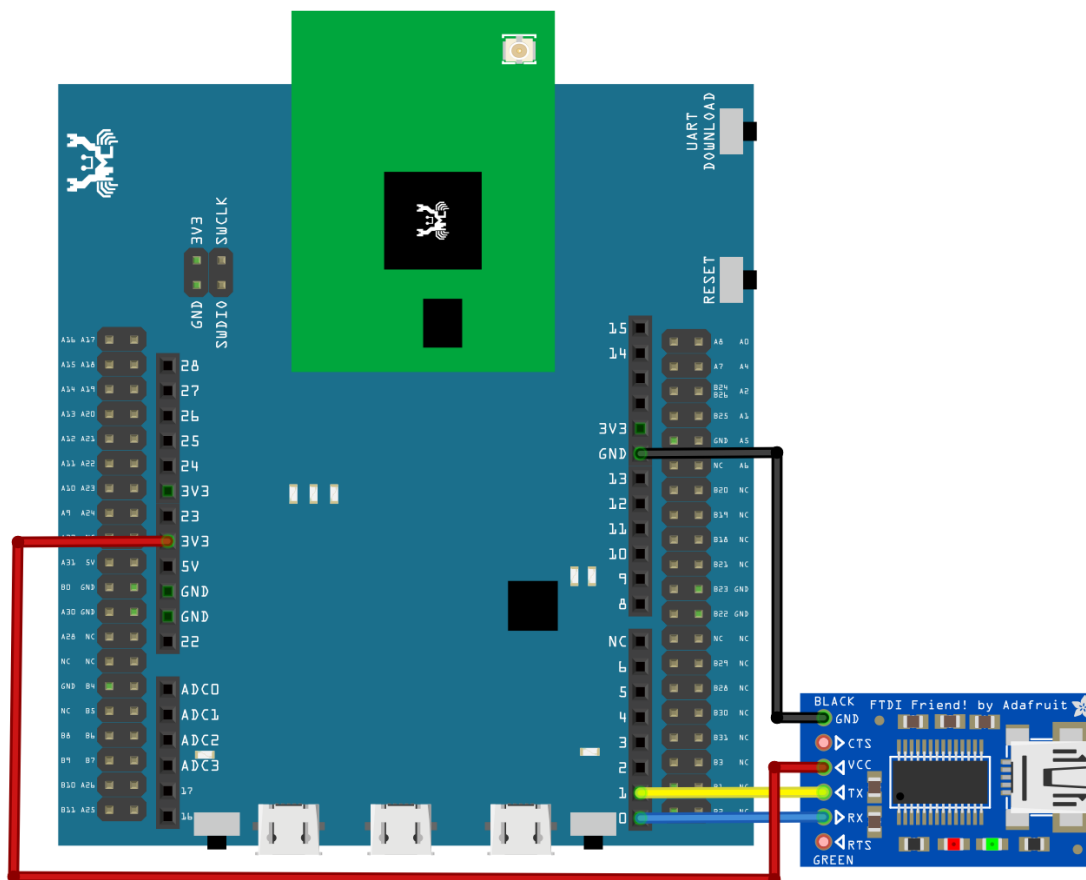
Open the “SoftwareSerialExample” example in “File” -> “Examples” -> “AmebaSoftwareSerial”  
-> “SoftwareSerial\_Basic” :



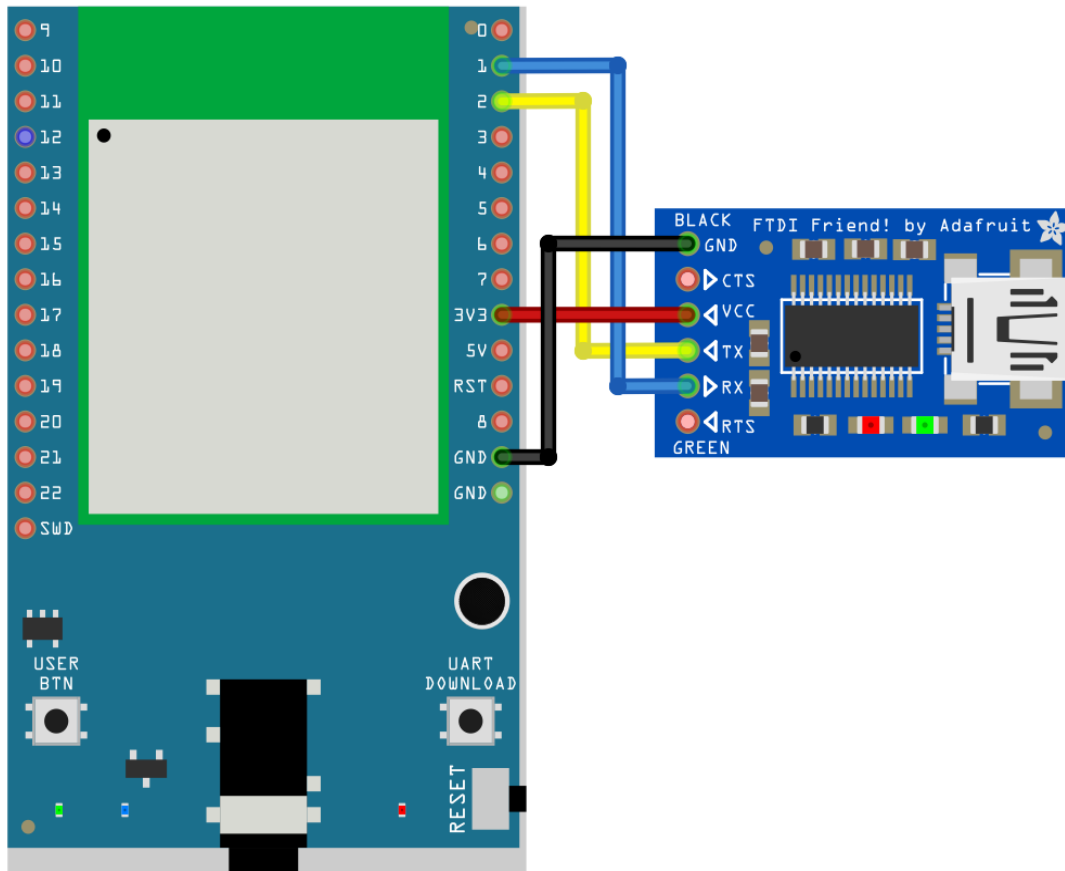
Connect the wire as the following diagrams show. The TX pin of USB to TTL adapter is connected to the RX of Ameba, and the RX pin of USB to TTL adapter is connected to the TX of Ameba.

AMB21 / AMB22 Wiring Diagram:

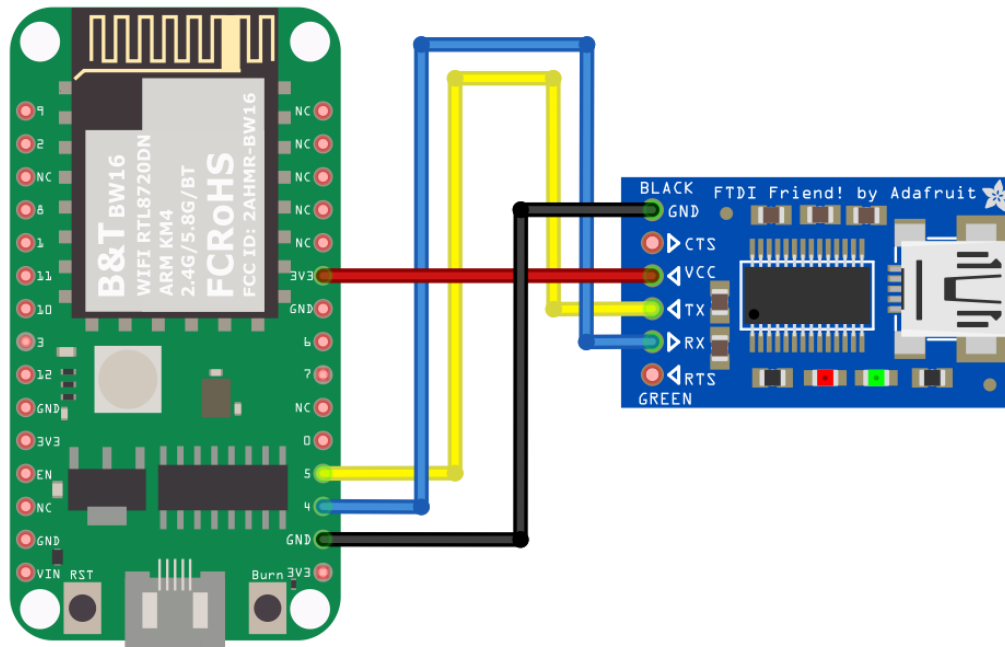




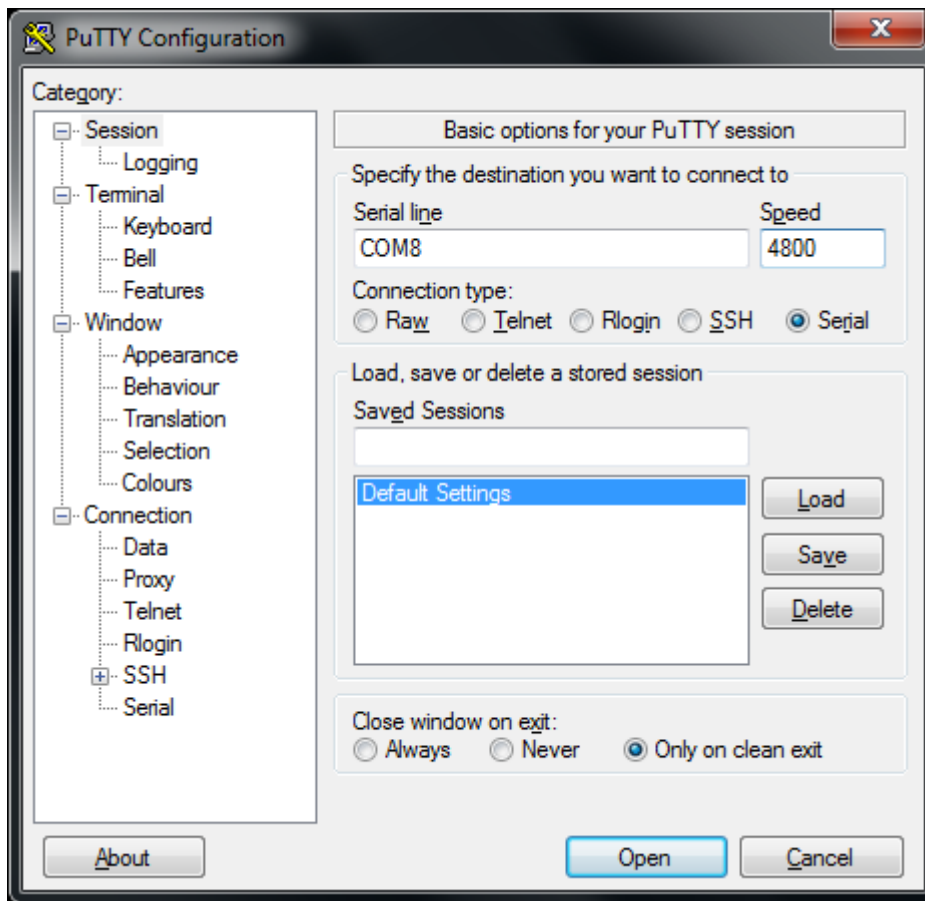
AMB23 Wiring Diagram:



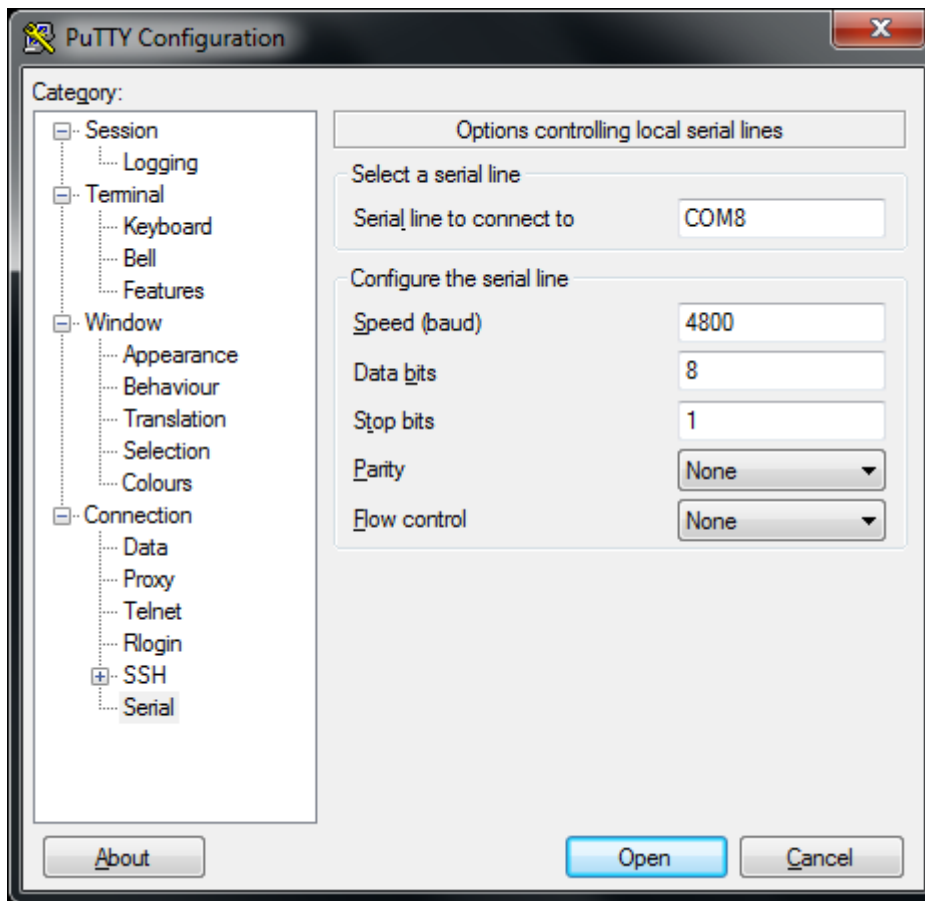
**BW16** Wiring Diagram:



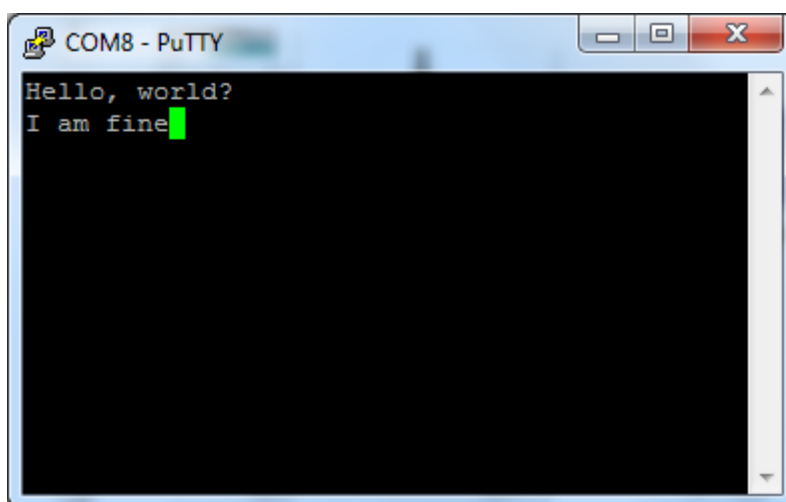
Next, open a serial port terminal, such as Putty or Tera Term. (Putty is used in this example). Open the Putty window, choose “Serial” in connection type, and specify the port number of the USB to TTL adapter (e.g. COM8). In the speed field, fill in the baud rate of this connection. Note that both sides of the connection should use the same baud rate. In this example we set baud rate 4800.



Next, select “Serial” on the left side. Set data bits to 8, stop bits to 1, parity to none, and flow control to none.



Then click Open and press the reset button on Ameba. You can see the “Hello, world?” message appears in Putty. If characters are typed into Putty, the input characters would be sent to Serial RX of Ameba by TX of USB to TTL Adapter, and returned by Serial TX of Ameba. Finally, RX of USB to TTL Adapter receives the returned characters and prints them in Putty. Therefore, if you insert “I am fine” , you will get something like this:



## Code Reference

First, use `SoftwareSerial::begin(speed)` to set the baud rate for the serial communication:

<https://www.arduino.cc/en/Reference/SoftwareSerialBegin>

Use `write()` to send data, and use `SoftwareSerial::available()` to get the number of bytes available for reading from a software serial port:

<https://www.arduino.cc/en/Reference/SoftwareSerialAvailable>

If there are data available to read, use `read()` to read from serial port.

## UART - Retrieve GPS Position

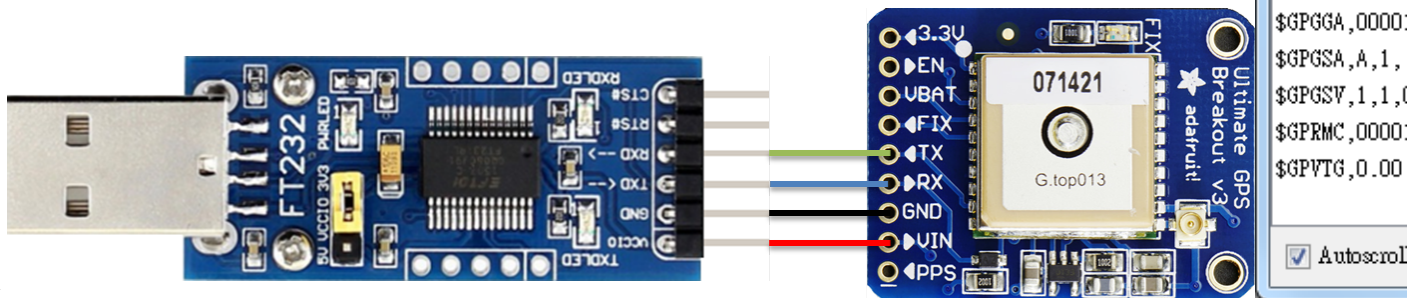
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Adafruit Ultimate GPS Breakout x 1 (Refer to official document)

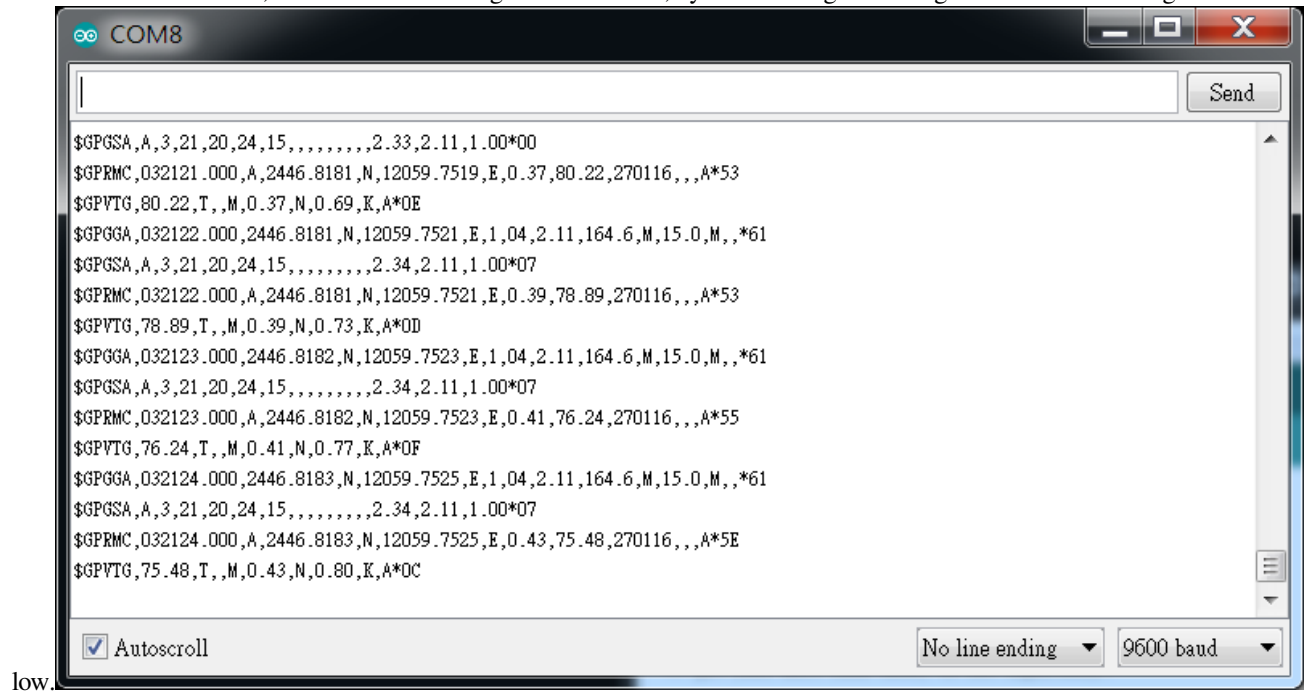
### Example

In this example, we use Adafruit Ultimate GPS Breakout. Its data format is pure text, so we can connect it to USB to TTL Adapter and observe the out-

put.



It follows the NMEA sentence format (refer to <http://aprs.gids.nl/nmea/>) The GPS signal is weak in indoor environment. The status that the GPS signal is not received is called “not fix”. Bring the GPS module outdoors, when the GPS signal is “fix”, you would get message similar to the figure below.



In this example we are only interested in the “\$GPRMC (Global Positioning Recommended Minimum Coordinates)” :  
**\$GPRMC,032122.000,A,2446.8181,N,12059.7251,E,0.39,78.89,270116,,A\*53**

Each field is separated by a comma.

- First field is the GMT time (Greenwich Mean Time), that is 032122.000 in this example. The time format is HH:MM:SS.SSS, i.e., 03:21:22.000. Note that the time zone and the daylight-saving time adjustment should be handled on your own.
- Second field represents the status code
  - V: Void (Invalid)
  - A: Active, meaning the GPS signal is fix.
- The third to sixth fields represent the geolocation

In this example, 2446.8181,N represents 24 degrees 46.8181 minutes north latitude, and 12059.7251,E represents 120 degrees 59.7251 minutes east longitude.

We can search **+24 46.8181'** , **+120 59.7251'** in Google map to check whether the position is cor-

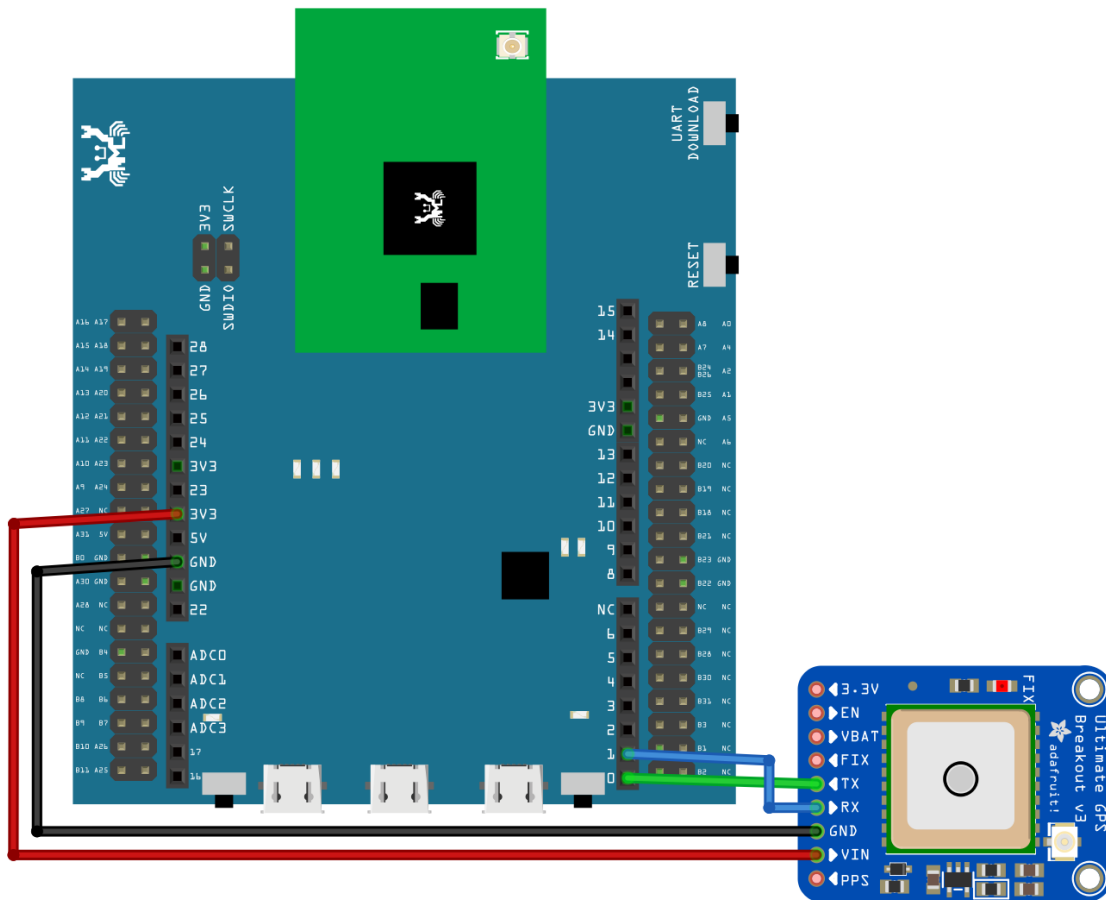


rect.

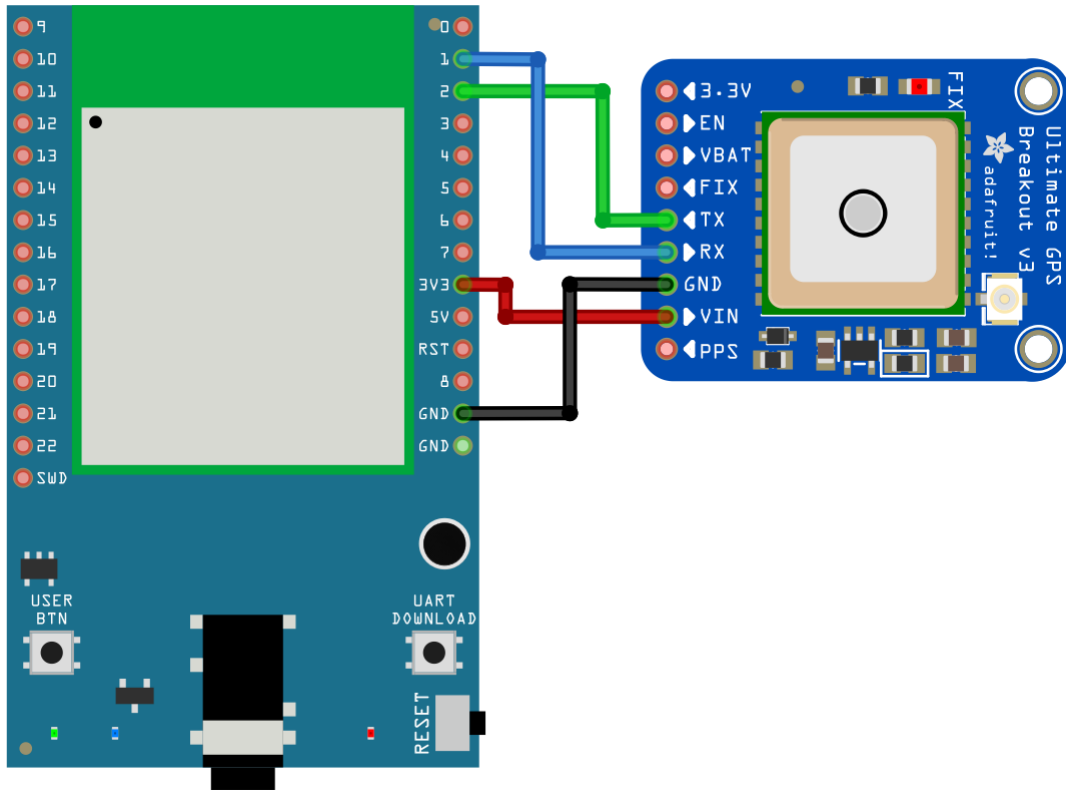
- The seventh field is relative speed(knot). 1 knot = 1.852km/hr, in this example the relative speed is 0.39 knot.
- The eighth field is the moving angle, which is calculated by its moving orbit.
- The ninth field is the date with format ddMMyy. In this example, “270116” stands for day 27, January, year 2016.
- The last field is checksum. In the example we have \*53 as checksum.

**AMB21 / AMB22** Wiring Diagram:

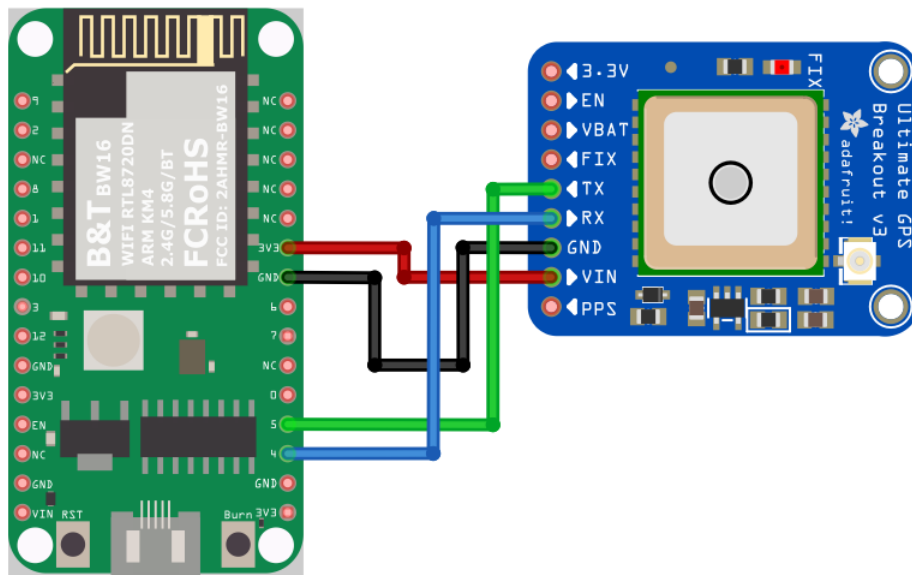




### AMB23 Wiring Diagram:



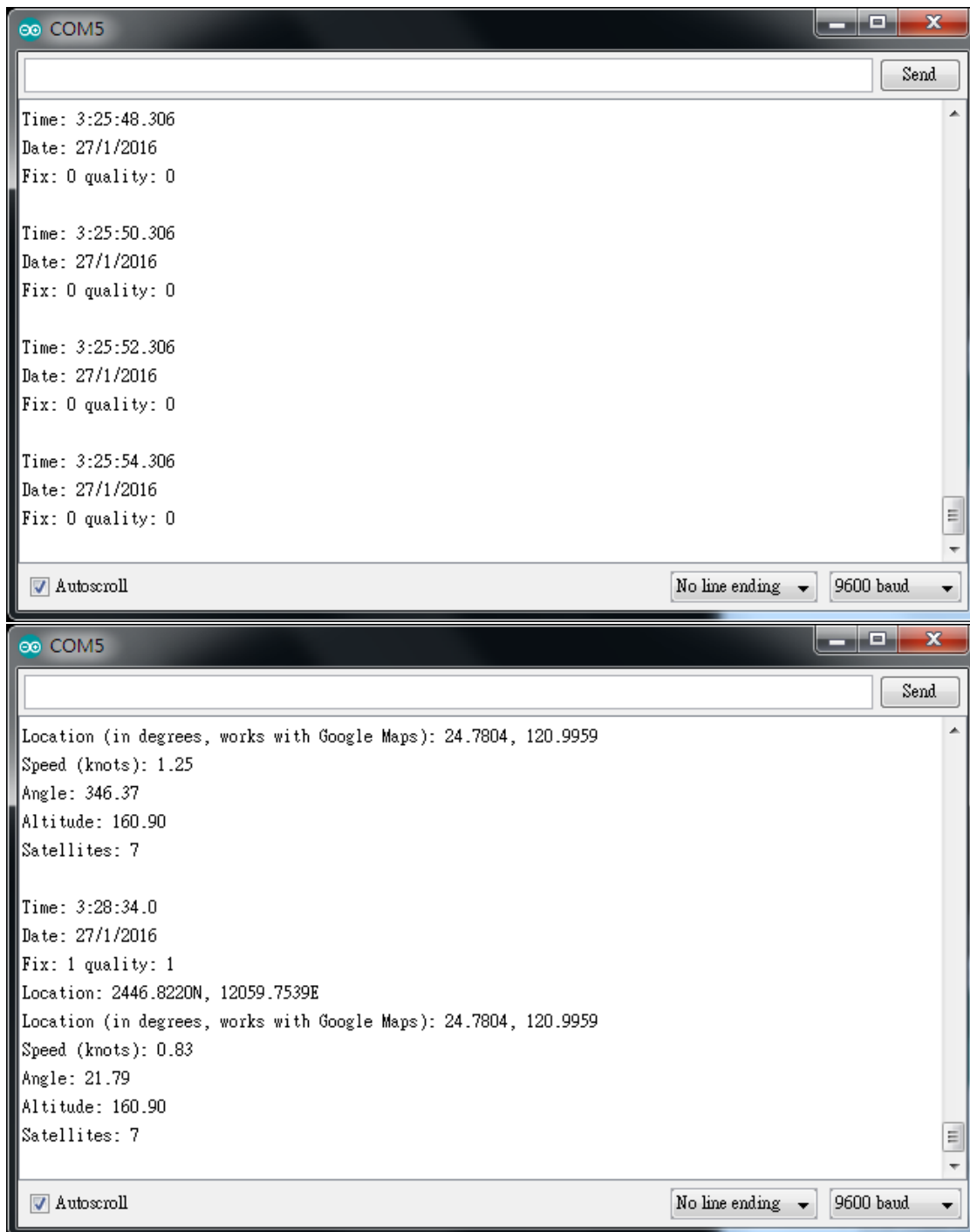
AMB23 Wiring Diagram:



Open the example in “Files” -> “Examples” -> “AmebaSoftwareSerial” -> “Adafruit\_GPS\_parsing” .

Compile and upload to Ameba, then press the reset button.

The result will be output to Serial Monitor:



## UART –Set Callback Function For UART Communications

### Materials

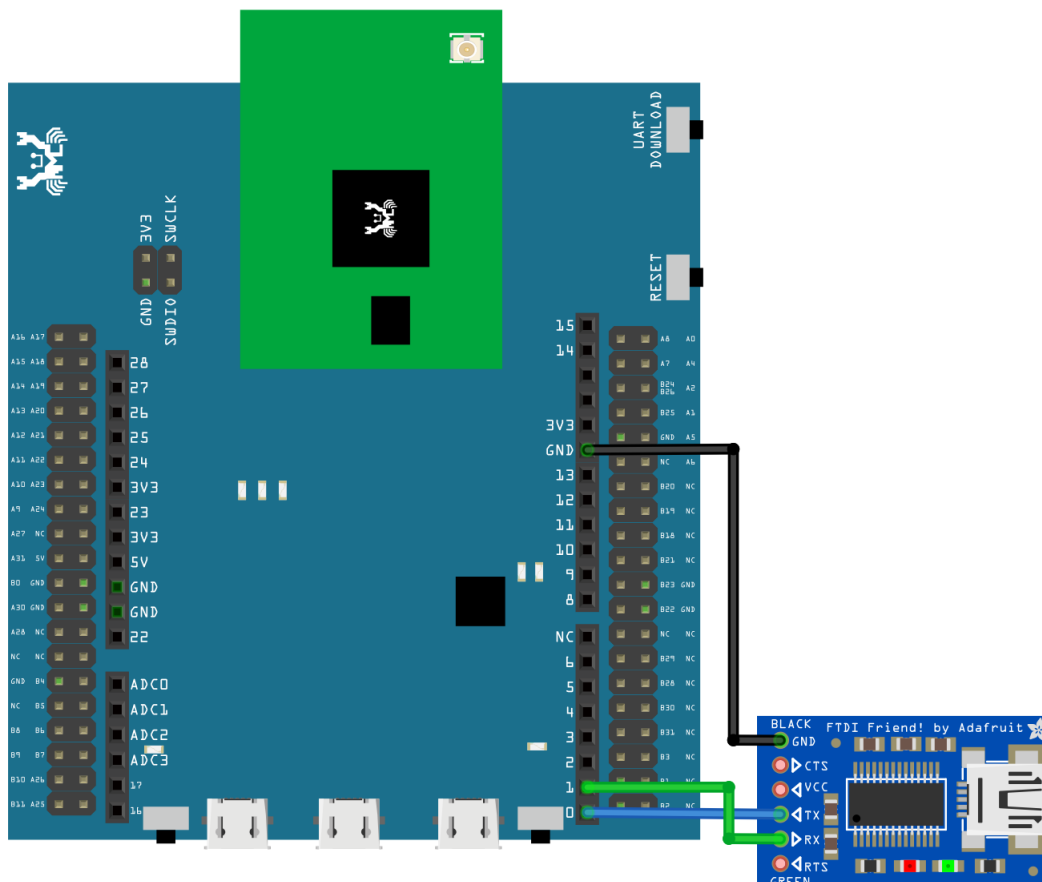
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- USB to TTL Adapter x 1

### Example

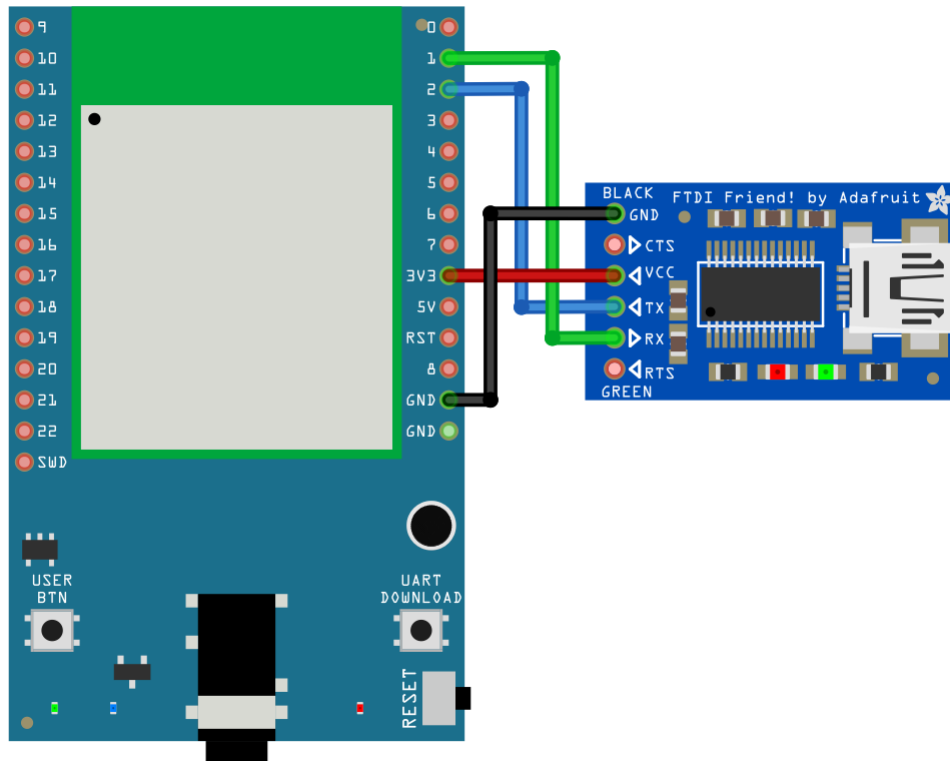
This example shows how to set a callback function for UART communication to process the UART data.

A USB to TTL adapter is required for this example. Ensure that you have the driver installed and connect it to the Ameba board as shown.

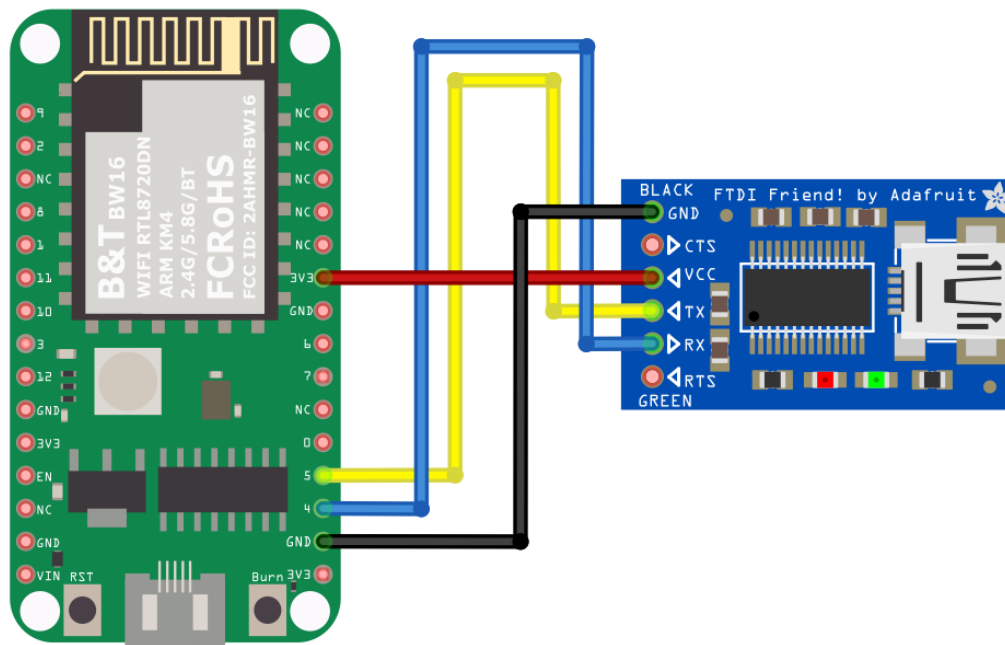
AMB21 / AMB22 Wiring Diagram:



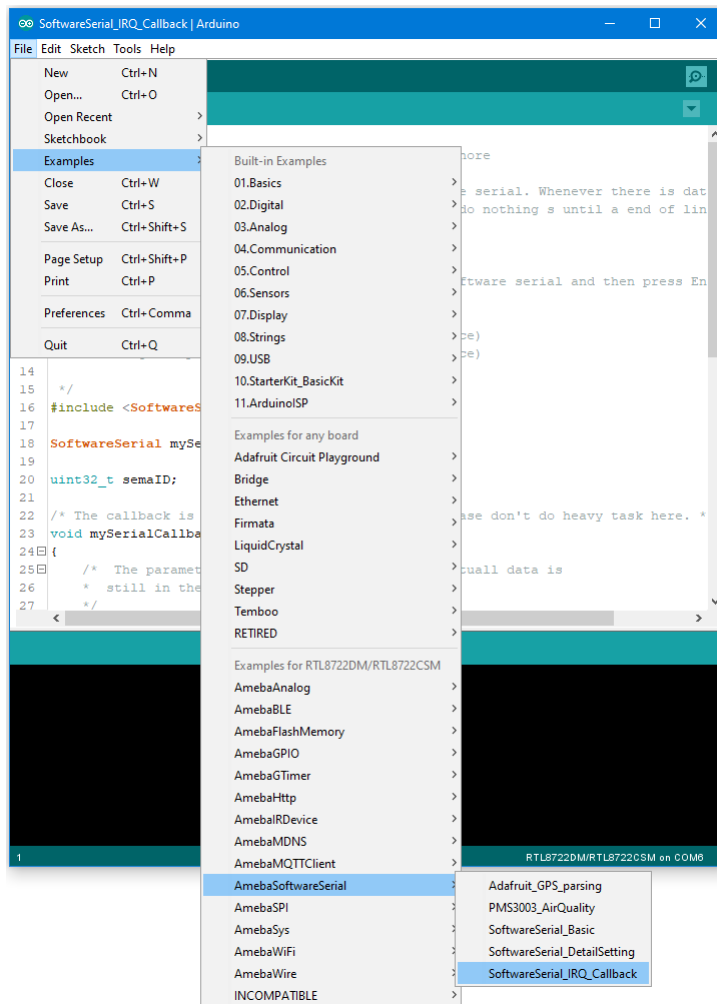
AMB23 Wiring Diagram:



BW16 Wiring Diagram:



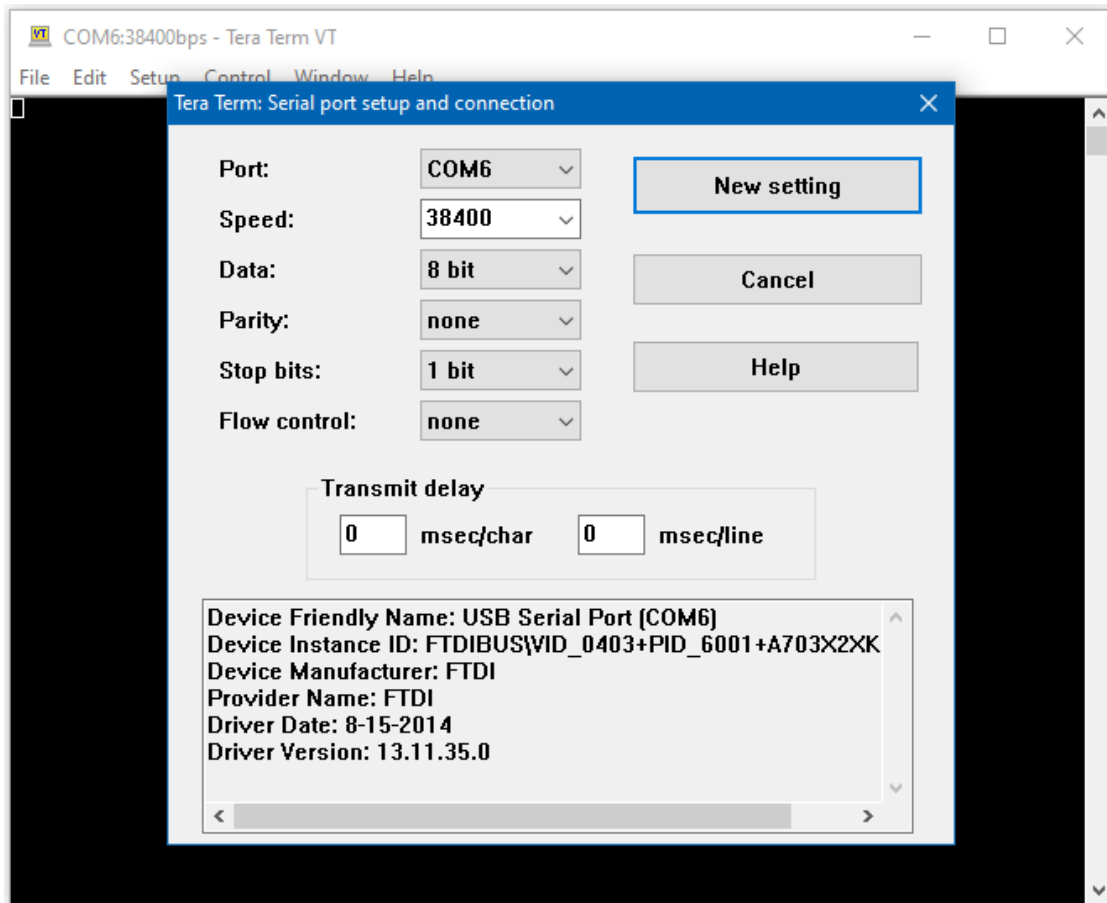
Open the example in “File” -> “Examples” -> “AmebaSoftwareSerial” -> “SoftwareSerial\_Irq\_Callback”



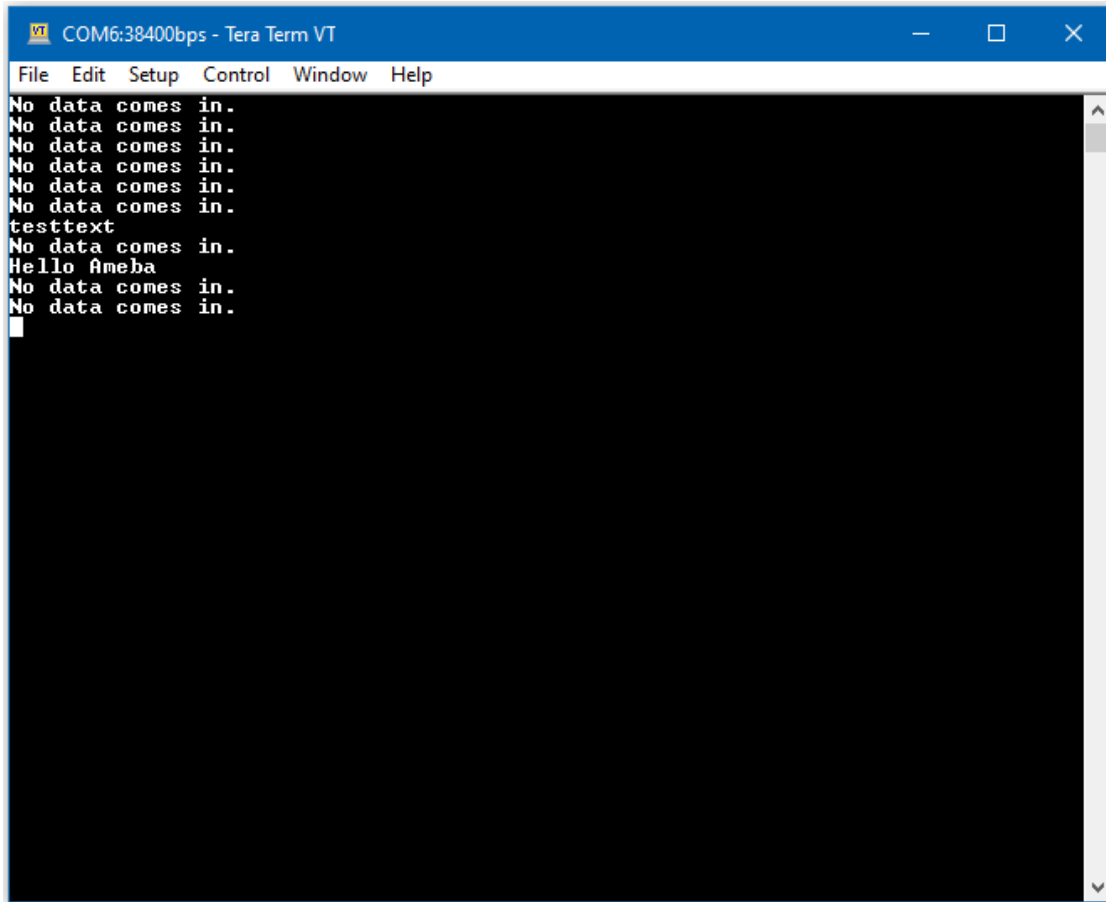
Upload the code and press the reset button on Ameba once the upload is finished.

Next, using a terminal program, such as TeraTerm or PuTTY, open a serial port and configure it according to the settings. Make sure the serial port number corresponds to the USB to TTL adapter.

- Speed: 38400
- Data: 8 bit
- Parity: none
- Stop bits: 1 bit
- Flow control: none



Once the serial port is open, type in the terminal and press the enter key, and you will see the corresponding output.



### Code Reference

`mySerial.setAvailableCallback(mySerialCallback)` ; is used to set the function `mySerialCallback` as a callback function for software serial. When a new character is received, the callback function checks if the character corresponds to the enter key, and releases the semaphore if it is true, which in turn allows the main loop to print out all the previously received characters.

## UART - PM2.5 Concentration in The Air

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- PlanTower PMS3003 or PMS5003 x 1

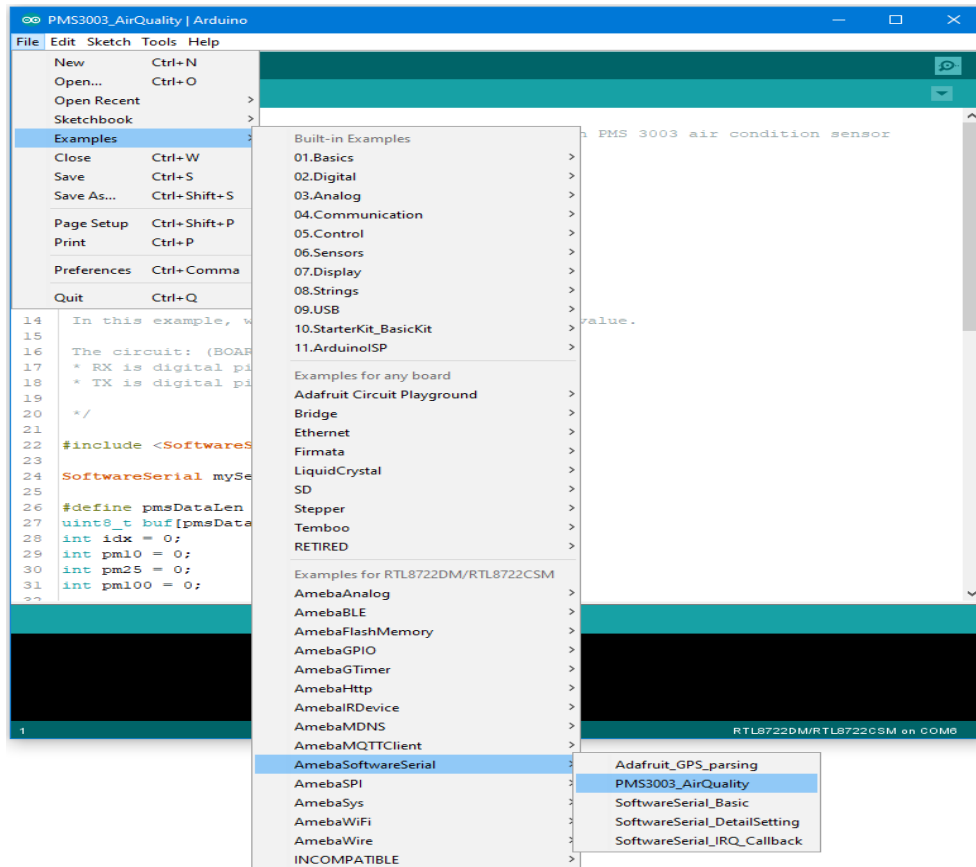
### Example



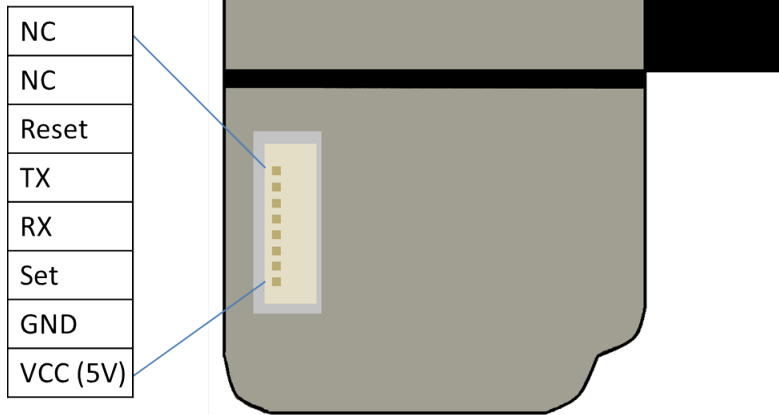
PMS3003 (or PMS5003) is a sensor of air quality, it can detect the concentration of those 0.3 to 10 micrometer particulate matters in the air. The sensor output its data via UART.

The PMS3003 (or PMS5003) sensor detects the concentration value of PM 1.0, PM 2.5, PM 10. Take PM 2.5 for example, it stands for the fine particles with a diameter of 2.5 micrometers or less.

Open the example in “File”-> “Examples”-> “AmebaSoftwareSerial”-> “PMS3003\_AirQuality”



There are 8 pins in PMS3003:

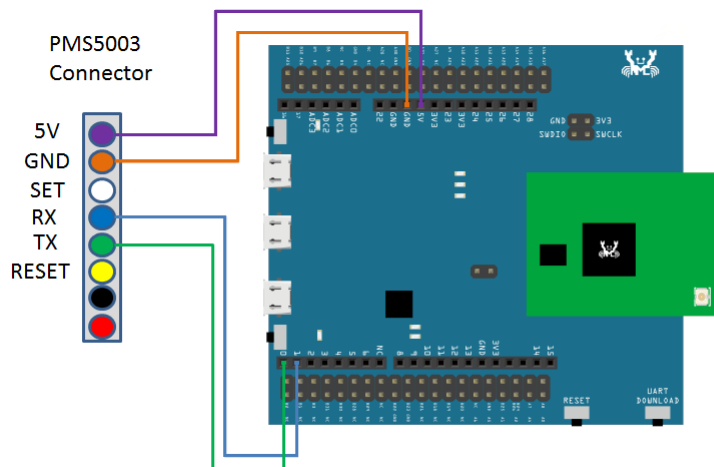


PMS3003 requires 5V power, but the working voltage of its IC is 3.3V. Therefore, the working voltage of Reset, TX, RX, Set are 3.3V as well. If the “Set” pin is pulled to high, the PMS3003 is put to operating mode. If the “Set” pin is pulled low, the PMS3003 is put to standby mode.

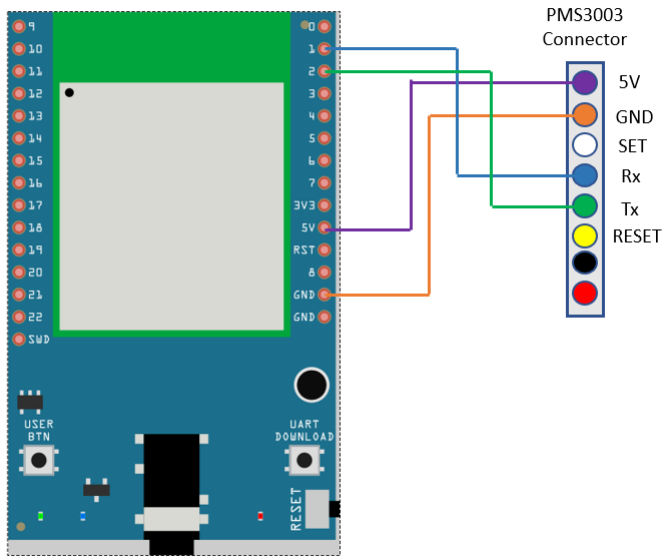
TX/RX pins are for UART connection. Under operating mode, PMS3003 outputs the data it reads continuously. Each data is of 32 bytes, please refer to the following article for detailed data format information:

[https://www.dfrobot.com/wiki/index.php?title=PM2.5\\_laser\\_dust\\_sensor\\_SKU:SEN0177\\_RTL8722](https://www.dfrobot.com/wiki/index.php?title=PM2.5_laser_dust_sensor_SKU:SEN0177_RTL8722)

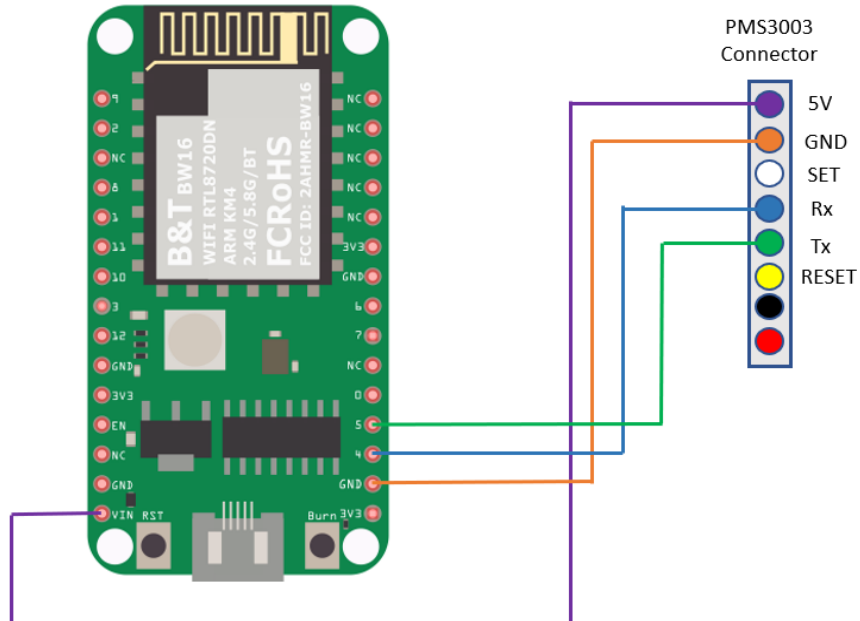
**AMB21 / AMB22 Wiring Diagram:**



**AMB23 Wiring Diagram:**

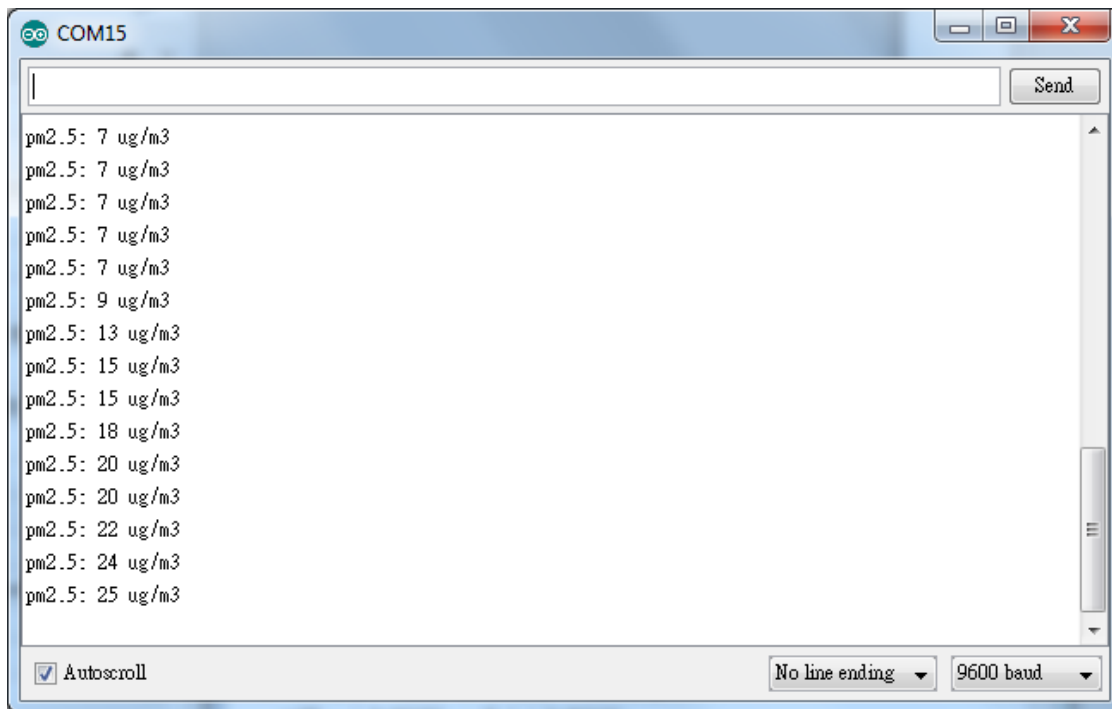


**BW16 Wiring Diagram:**



In this example, we do not use the “Set” and “Reset” pins.

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba starts to output the PM 2.5 data to serial monitor.



## Watchdog - Simple WDG Timer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

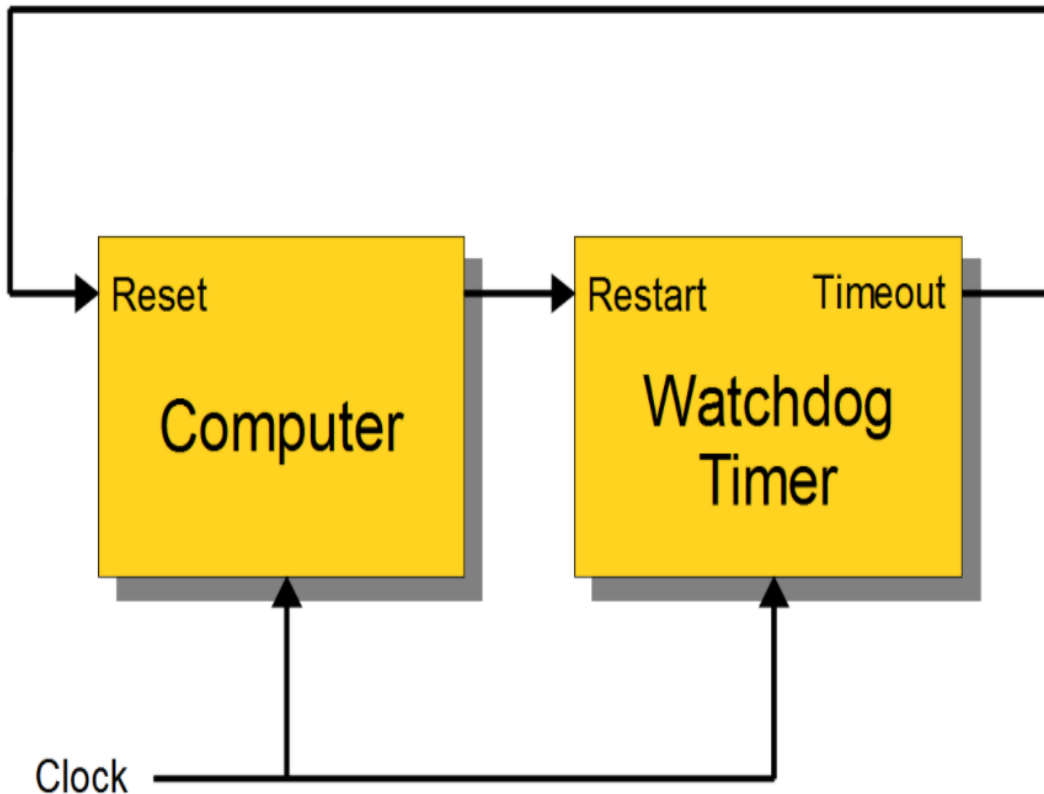
### Example

In this example, we will use this simple watchdog timer example runs on the Ameba RTL8722 module to illustrate how to use the watchdog API. Before we get into the details of the example, let's briefly go through the definition of Watchdog as well as its working principles.

### Watchdog

Watchdog Timer (WDT) is a hardware timer that is used to detect the occurrence of a software fault, then automatically generates a system reset or a watchdog interrupt on the expiry of a programmed period.

In layman terms, imagine in the situation while your micro-controller is confused in an infinity loop, or any case like the micro-controller hang while performing some tasks. The normal troubleshooting method would be to press the reset button and jump out of the infinity loop. However, is it practically impossible to do press on the button all time, therefore, the watchdog timer that embedded inside the micro-controller would help with this situation.



### Feed the Dog

If you have a dog in your home. You need to feed that dog at a regular interval. if you can't feed one day, it will bite you! And likewise, this is the working logic behind the watchdog timer.

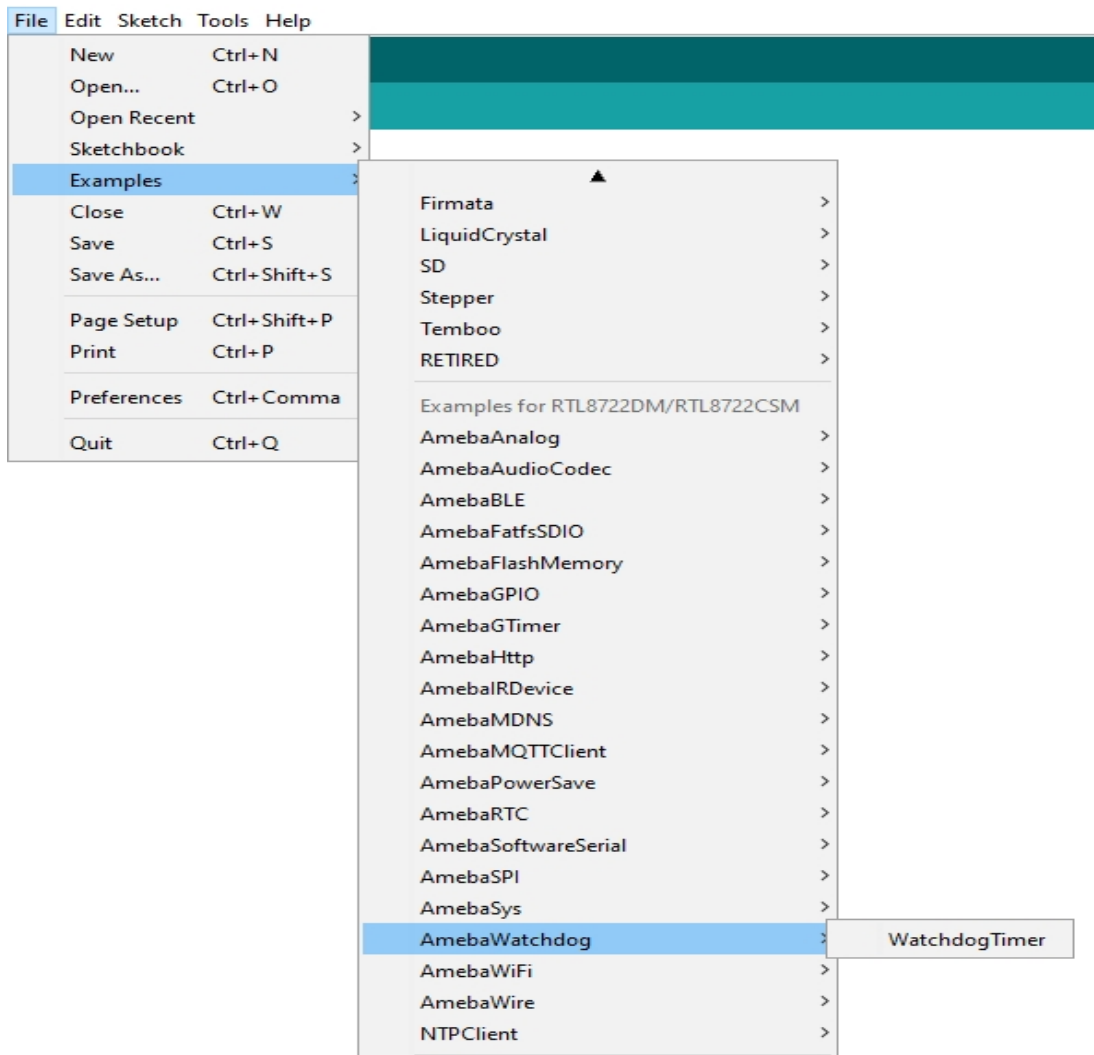
In our example, we created 2 tasks that contain some loop that runs repeatedly, one is called "Small\_Task" and the other is called "Big\_Task". We are enabling the watchdog timer is loaded with an initial value (5 seconds) greater than the total delay in the "Small\_Task", but shorter than the "Big\_Task".

For the successful case, the watchdog is being refreshed/feed within 5 seconds, however, for the failed case, the loop is under processing and the watchdog is not being fresh after 5 seconds, which triggers the watchdog (dog barks), an interrupt is generated to reset the processor. Likewise, the watchdog timer protects the micro-controller from the hanging case.

Then we move to the coding part for this example, for this example, you will only need the RTL8722CSM/RTL8722DM/RTL8722DM MINI Board itself.

Firstly, make sure the correct Ameba development board is selected in Arduino IDE: "Tools" -> "Board" ->

“RTL8722CSM/RTL8722DM” (or “RTL8722DM MINI” ). Then open the “Watchdog Timer” example in “File” -> “Examples” -> “AmebaWatchdog” -> “Watchdog Timer” :



Upon successfully upload the sample code, open the serial monitor, and press the reset button. You will find that the “Small\_Task” can refresh the watchdog within the 5 seconds (initialized in the watchdog timer). However, the “Big\_Task” will not be able to refresh the watchdog within 5 seconds, which the watchdog “barks” then the microcontroller reset.

## COM10

```

#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1

```

COM10

```
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
watchdog barks!!!
doing dummy task #6
doing dummy task #7
doing dummy task #8
doing dummy task #9
doing dummy task #10
Big_Task finished refresh watchdog.
```

## Community Examples

Welcome to share your examples under the **Community Examples** section if you have completed a project using the Ameba boards.

To make contributions, please visit our official [GitHub Wiki](#) page.

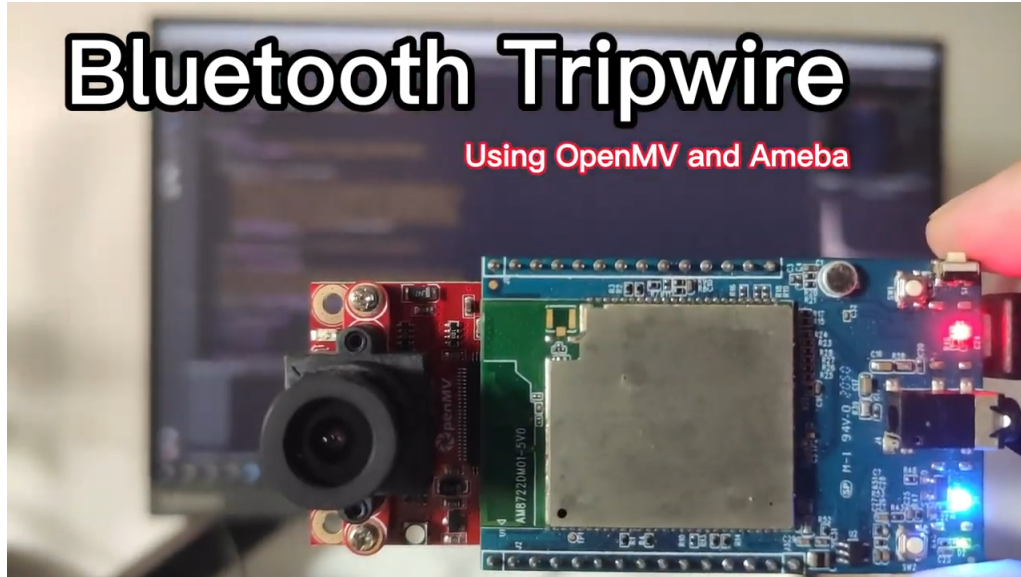




## OpenMV Bluetooth TripWire

CONTRIBUTED BY: SIMON XI (<https://github.com/xidameng>)

Hi if you haven't watched the demo video, feel free to play this short clip below to see what it's capable of.



### Introduction

This project took the inspiration from the another open-source project **daytripper** ([link 1](#)) which uses 2 separate devices to detect movement and control your PC to switch Apps. However, I think if we go with the Computer Vision solution instead, we might reduce the number of hardware to just 1, and we can even push it a little further by adding some more cool features like face recognition, speed detection and even more.

That's how I came up with this idea –using **OpenMV**, which is littler and easier to deploy, and a **IoT Microcontroller**, in this case Ameba RTL8722DM\_MINI, together we can achieve the same function as **daytripper** and more.

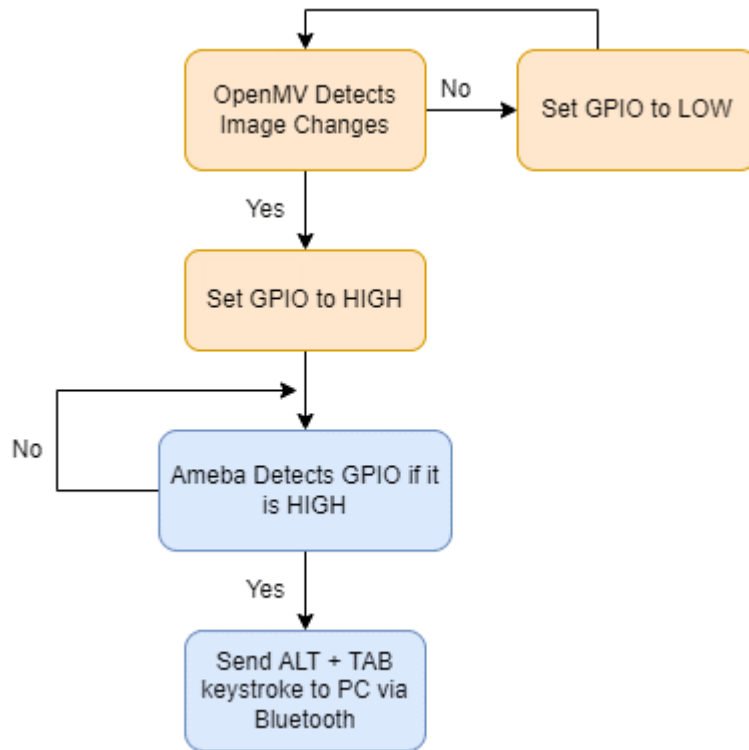
### Components

1. AMB23 (RTL8722DM MINI) dev board x1
2. OpenMV( any model) dev board x1

Connection is simple, just connect P0 pin on OpenMV to pin 9 on Ameba Board.

## Function Flow

This is how it works,



## Code

### OpenMV

```

# Advanced Frame Differencing Example
#
# This example demonstrates using frame differencing with your OpenMV Cam. This
# example is advanced because it preforms a background update to deal with the
# background image changing overtime.

import sensor, image, pyb, os, time
from pyb import Pin

p_out = Pin('P0', Pin.OUT_PP)
p_out.low()

TRIGGER_THRESHOLD = 5

BG_UPDATE_FRAMES = 50 # How many frames before blending.

```

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```

BG_UPDATE_BLEND = 128 # How much to blend by... ([0-256]==[0.0-1.0]).

sensor.reset() # Initialize the camera sensor.
sensor.set_pixformat(sensor.RGB565) # or sensor.RGB565
sensor.set_framesize(sensor.QVGA) # or sensor.QQVGA (or others)
sensor.skip_frames(time = 2000) # Let new settings take affect.
sensor.set_auto_whitebal(False) # Turn off white balance.
clock = time.clock() # Tracks FPS.

# Take from the main frame buffer's RAM to allocate a second frame buffer.
# There's a lot more RAM in the frame buffer than in the MicroPython heap.
# However, after doing this you have a lot less RAM for some algorithms...
# So, be aware that it's a lot easier to get out of RAM issues now. However,
# frame differencing doesn't use a lot of the extra space in the frame buffer.
# But, things like AprilTags do and won't work if you do this...
extra_fb = sensor.alloc_extra_fb(sensor.width(), sensor.height(), sensor.RGB565)

print("About to save background image...")
sensor.skip_frames(time = 2000) # Give the user time to get ready.
extra_fb.replace(sensor.snapshot())
print("Saved background image - Now frame differencing!")

triggered = False

frame_count = 0
while(True):
    clock.tick() # Track elapsed milliseconds between snapshots().
    img = sensor.snapshot() # Take a picture and return the image.

    frame_count += 1
    if (frame_count > BG_UPDATE_FRAMES):
        frame_count = 0
        # Blend in new frame. We're doing 256-alpha here because we want to
        # blend the new frame into the background. Not the background into the
        # new frame which would be just alpha. Blend replaces each pixel by
        # ((NEW*(alpha))+(OLD*(256-alpha)))/256. So, a low alpha results in
        # low blending of the new image while a high alpha results in high
        # blending of the new image. We need to reverse that for this update.
        img.blend(extra_fb, alpha=(256-BG_UPDATE_BLEND))
        extra_fb.replace(img)

    # Replace the image with the "abs(NEW-OLD)" frame difference.
    img.difference(extra_fb)

```

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```

hist = img.get_histogram()
# This code below works by comparing the 99th percentile value (e.g. the
# non-outlier max value against the 90th percentile value (e.g. a non-max
# value. The difference between the two values will grow as the difference
# image seems more pixels change.
diff = hist.get_percentile(0.99).l_value() - hist.get_percentile(0.98).l_value()
triggered = diff > TRIGGER_THRESHOLD

if triggered == True:
    p_out.high()
else:
    p_out.low()

print(clock.fps(), triggered) # Note: Your OpenMV Cam runs about half as fast while
# connected to your computer. The FPS should increase once disconnected.

```

## AMB23

```

#include "BLEHIDDevice.h"
#include "BLEHIDKeyboard.h"
#include "BLEDevice.h"

BLEHIDKeyboard keyboardDev;
BLEAdvertData advdata;

#define ENABLE_PIN 9

void setup() {
  Serial.begin(115200);
  advdata.addFlags();
  advdata.addCompleteName("AMEBA_BLE_HID");
  advdata.addAppearance(GAP_GATT_APPEARANCE_HUMAN_INTERFACE_DEVICE);
  advdata.addCompleteServices(BLEUUID(HID_SERVICE_UUID));

  BLEHIDDev.init();

  BLE.init();
  BLE.configAdvert()->setAdvData(advdata);
  BLE.setDeviceName("AMEBA_BLE_HID");
  BLE.setDeviceAppearance(GAP_GATT_APPEARANCE_HUMAN_INTERFACE_DEVICE);

```

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(繼續上一頁)

```

BLE.configSecurity()->setPairable(true);
BLE.configSecurity()->setAuthFlags(GAP_AUTHEN_BIT_BONDING_FLAG);
BLE.configServer(3);
BLE.addService(BLEHIDDev.hidService());
BLE.addService(BLEHIDDev.battService());
BLE.addService(BLEHIDDev.devInfoService());

pinMode(ENABLE_PIN, INPUT);

BLE.beginPeripheral();
}

int flag = 0;

void loop() {
if (BLE.connected() && digitalRead(ENABLE_PIN) && flag == 0) {
    Serial.println("Sending keystrokes");
    keyboardDev.keyReleaseAll();
    delay(100);
    keyboardDev.keyPress(HID_KEY_ALT_LEFT);
    delay(100);
    keyboardDev.keyPress(HID_KEY_TAB);
    keyboardDev.keyReleaseAll();
    delay(100);
    flag = 1;
} else {
    flag = 0;
    delay(100);
}
}
}

```

## Conclusion

This project is not perfect as it's done in a rush, so if anyone wants to perfect it you may go ahead and change my code however you like, or leave a comment below if you have a question or want to discuss something with me~

Until next time, happy coding.

---

**小訣竅：** Welcome to share your examples under the **Community Examples** section if you have completed a project using the Ameba boards

---

## 1.2.3 Release History

### Version 3.1.2 - 2021/12/28

- Feature:
    - Update SimpleWebServerWiFi example
    - Support BW16
  - API Updates:
    - Update Wlan related naming from 「AmebaWiFi」 become 「WiFi」
    - Update RTC library for minor bug fix
  - Misc:
    - Update all Fritzing files for new name updates
    - AMB21, AMB22, AMB23, and BW16
- 

### Version 3.1.1 - 2021/12/25

- Feature:
  - Add BLE HID and examples
  - BLEHIDGamepad, BLEHIDKeyboard, and BLEHIDMouse
  - Update PowerSave examples
  - Support RTL8722DM MINI and RTL8720DN/BW16
  - Enable LwIP hostname edit
- API Updates:
  - Update API for PowerSave
  - Update ameba\_d\_tools 1.0.7 for all 3 platforms
  - Support RTL8720DN/BW16 and RTL8722DM MINI
  - Add more Aon wake up pins
  - Update API for IR
  - Removed requirement to define both IR TX and RX pins in IRDevice::begin
  - Removed previous limit on number of time durations IRDevice::send can accept
  - Update GPIO Int
  - Enable INPUT\_IRQ\_CHANGE

- Add definition inside wiring\_constants.h and wiring\_digital.c, also complete the TODO part for attachInterrupt() as well
  - Update UART, for RTL8720DN/BW16 not showing log issue
  - Fix wrong attribute permissions for characteristic CCCD descriptor. Remove unused variable warnings
  - Update GTimer, for the internal timer ID validation test
  - Updated SPI connection for RTL8720DN/BW16
  - Update Google\_Cloud\_IoT example with new Google TLS cert
  - Update Analog Pin remove A0 and A1
  - Update Platform.txt for Windows OS with User Name having a space in between
  - Update all libs
  - Misc:
    - Update AmebaEink.zip, SPI connection for RTL8720DN/BW16
    - Add Autoflash\_patch folder
    - Update the Fritzing of RTL8720DN/BW16, remove A0 and A1
- 

#### Version 3.1.0 - 2021/11/05

- Feature:
  - Support board RTL8720DN(BW16)
  - Add WiFiControlCar example
  - Add Arduboy zip library
  - Add WPA3 support
  - Add Amebad\_HMI\_MQTT zip library
  - Add support for IPV6 wiht 4 examples
  - WLAN lib update
  - Minor bug fix
- API Updates:
  - Support Microsoft Azure IoT cloud
  - Enable “strlen” from rom
  - Add “#define yield” for compilation
  - Update PubSubClient lib
  - Update APIs for RTL8720DN(BW16) (SPI, I2C, Fatfs, Audiocodec and UART)

- Update jtag enable functions
  - Update wifi security option
  - Remove the unused libs lib\_wifi\_fw.a lib\_wifi\_ucps\_fw.a
  - Update watchdog
  - Update AudioCodec
  - Pin mapping updates
  - Remove unused marcos
  - RTL8720DN(BW16) related naming update for all examples
  - Update PowerSave
  - Misc
    - Add RTL8720DN\_BW16 fritzing folder
    - Move RTL8720DN\_BW16 fritzing files to correct folder
    - Rename folder name to short the length of path
    - Add Offline\_SDK\_installation\_tool (Windows, Linux and MacOS)
    - Update linux tools for compatibility issue
    - Update RTL8722DM MINI and RTL8720DN(BW16) Fritzing and Pinmux
    - Update ameba\_d\_tools V1.0.6
    - Add Image\_Related folder
    - Correct the core from Cortex-M4 to Cortex-M33
- 

#### Version 3.0.11 - 2021/10/26

- Feature:
    - Add example, FatfsSDIO - Read and open HTML file from SD card
  - API Updates:
    - RTL8720DN/BW16 related compatibility update for all examples
  - Misc
    - Update RTL8722DM MINI and RTL8720DN Fritzing and Pinmux
- 

#### Version 3.0.10 - 2021/09/22

- Feature:
  - Add AudioCodec wav examples



- API Updates:
    - Pin mapping updates for RTL8722DM MINI
    - Remove unused marcos
    - Update platform.txt for bin files process
    - rollback for “wifi.h” update
    - Minor bug fix patch
- 

#### **Version 3.0.9 - 2021/09/13**

- API Updates:
    - Pin mapping updates
    - Remove unused marcos
    - “wifi.h” related files change to “Amebawifi.h”
- 

#### **Version 3.0.8 - 2021/05/06**

- Feature:
  - Add RTL8722DM\_mini board
  - Add fatfs for SD card
  - Add AudioCodec
  - Add TensorFlow lite support with examples
  - Add zip libraries for TensorFlow lite support
  - Update SDK for supporting Arduino IDE 2.0
  - Update wlan lib
- API Updates:
  - Update zip libraries of Eink
  - ADC updates, Change calculation method to use EFUSE calibration parameters and SDK formula to improve accuracy
  - writing\_analog updates, minor bug fix and support for mini board
  - SPI updates, minor bug fix and support for mini board
  - I2S updates, minor bug fix and support for mini board
  - IRDevice updates, minor bug fix

---

**Version 3.0.7 - 2020/11/19**

- Feature:
    - Add AmebaIRDevice example IRSendSONY
    - Update Ameba Arduino IRDevice API
    - Update Ameba Arduino SSL related API
    - Update Ameba Arduino Wlan API to support static IP function
- 

**Version 3.0.6 - 2020/10/28**

- Feature:
    - Add Ameba RTC support
    - Add AmebaRTC example RTC and RTCArm
    - Add Ameba Watchdog support
    - Add AmebaWatchdog example WatchdogTimer
    - Update Ameba BLE support
    - Add AmebaBLE example BLEUartService, DHT\_over\_BLEUart
    - Update Ameba Wlan library
    - Update Ameba Wlan SDK structure, add AP mode hidden SSID support
- 

**Version 3.0.5 - 2020/09/09**

- Feature:
    - Build in tool updates V1.0.4
    - Add zip lib AmebaEink
    - Add AmebaEink example EinkDisplayImage, EinkDisplayQR, and EinkDisplayText
    - Add google cloud examples
    - Update Amazon AWS related examples
    - Add power save support
    - Add AmebaPowerSave example TicklessMode, DeepSleepMode, DeepSleep\_DHT\_LCD\_Example, and DeepSleep\_DHT\_Eink\_Example
- 

**Version 3.0.4 - 2020/07/27**

- Feature:
    - Update BLE library. Add example BLEBatteryClient and BLEWifiConfig
    - Update from polarssl to mbedtls 2.4.0
- 

**Version 3.0.3 - 2020/07/03**

- Feature:
    - Build in Image tool updates V1.0.3
    - Upload log clean up
- 

**Version 3.0.2 - 2020/06/30**

- Feature:
    - Windows, Linux and macOS X support
    - Build in Image tool updates
- 

**Version 3.0.1 - 2020/05/15**

- Feature:
    - Official release of AmebaD Arduino SDK
    - warning cleaning
    - I2C lib updates
- 

**Version 3.0.0 - 2020/05/01**

- Feature:
  - Support Boards Manager and Arduino IDE development
  - WiFi scan AP, connect to AP, TCP Server/Client, including 5G
  - Bluetooth, BLE
  - GPIO digital in/out and interrupt
  - ADC analog in/out (0 ~ 3.3V)
  - PWM getting analog results with digital means
  - SPI master and slave mode
  - UART 1 for log, 2 for customize usage
  - I2C master mode

## 1.2.4 Board HDK

- Layout
- Schematic

## 1.2.5 API Documents

### RTL8722DM ARDUINO Online API Documents

#### Analog

#### Class AmebaServo

#### AmebaServo Class

##### Description

Defines a class of manipulating servo motors connected to Arduino pins.

##### Syntax

```
class AmebaServo
```

##### Members

Public Constructors	
AmebaServo::AmebaServo	Constructs an AmebaServo object.
Public Methods	
AmebaServo::attach	Attach the given pin to the next free channel.
AmebaServo::detach	Detach the servo.
AmebaServo::write	Write value, if the value is < 200 it's treated as an angle, otherwise as pulse-width in microseconds.
AmebaServo::writeMicroseconds	Write pulse width in microseconds.
AmebaServo::read	Output current pulse width as an angle between 0 and 180 degrees.
AmebaServo::readMicroseconds	Output current pulse width in microseconds for this servo.
AmebaServo::attached	Check if the servo is attached.

## AmebaServo::attach

### Description

Attach the given pin to the next free channel, sets pinMode (including minimum and maximum values for writes), returns channel number, or 0 if failure.

### Syntax

```
uint8_t attach(int pin);

uint8_t attach(int pin, int min, int max);
```

### Parameters

pin: The Arduino pin number to be attached.

min: Minimum values for writes.

max: Maximum values for writes.

### Returns

The function returns channel number or 0

### Example Code

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree.

列表 2: ServoSweep.ino

```

1  /* Sweep
2  by BARRAGAN < http://barraganstudio.com >
3  This example code is in the public domain.
4  modified 8 Nov 2013
5  by Scott Fitzgerald
6  http://www.arduino.cc/en/Tutorial/Sweep
7  refined 2016/03/18 by Realtek
8  */
9
10 #include "AmebaServo.h"
11
12 // create servo object to control a servo
13 // 4 servo objects can be created correspond to PWM pins
14
15 AmebaServo myservo;
16
```

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```
17 // variable to store the servo position
18 int pos = 0;
19
20 void setup() {
21   #if defined(BOARD_RTL8195A)
22     // attaches the servo on pin 9 to the servo object
23     myservo.attach(9);
24   #elif defined(BOARD_RTL8710)
25     // attaches the servo on pin 13 to the servo object
26     myservo.attach(13);
27   #elif defined(BOARD_RTL8721D)
28     // attaches the servo on pin 8 to the servo object
29     myservo.attach(8);
30   #else
31     // attaches the servo on pin 9 to the servo object
32     myservo.attach(9);
33   #endif
34 }
35
36 void loop() {
37   // goes from 0 degrees to 180 degrees in steps of 1 degree
38   for (pos = 0; pos <= 180; pos += 1) {
39     // tell servo to go to position in variable 'pos'
40     myservo.write(pos);
41     // waits 15ms for the servo to reach the position
42     delay(15);
43   }
44   // goes from 180 degrees to 0 degrees
45   for (pos = 180; pos >= 0; pos -= 1) {
46     // tell servo to go to position in variable 'pos'
47     myservo.write(pos);
48     // waits 15ms for the servo to reach the position
49     delay(15);
50   }
51 }
```

## Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

## AmebaServo::detach

### Description

Detach the servo.

### Syntax

```
void AmebaServo::detach(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

## AmebaServo::write

### Description

Write an integer value to the function, if the value is < 200, it’ s being treated as an angle, otherwise as pulse-width in microseconds.

### Syntax

```
void AmebaServo::write(int value);
```

### Parameters

value: The value < 200 its treated as an angle; otherwise as pulse width in microseconds.

### Returns

The function returns nothing.

### Example Code

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree. Please refer to code in “AmebaServo:: attach” section.

### Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

## AmebaServo::writeMicroseconds

### Description

Write pulse width to the servo in microseconds.

### Syntax

```
void AmebaServo::writeMicroseconds(int value);
```

### Parameters

value: Write value the pulse width in microseconds.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

### AmebaServo::read

#### Description

The function reads current pulse width and returns as an angle between 0 and 180 degrees.

#### Syntax

```
int AmebaServo::read(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The pulse width as an angle between 0 ~ 180 degrees.

#### Example Code

NA

### Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

### AmebaServo::readMicroseconds

#### Description

The function returns a Boolean value “true” if this servo is attached, otherwise returns “false” .

#### Syntax

```
int AmebaServo::readMicroseconds(void);
```



**Parameters**

The function requires no input parameter.

**Returns**

The function returns current servo pulse width in microseconds.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::attached****Description**

It returns true if this servo is attached, otherwise false.

**Syntax**

```
bool AmebaServo::attached(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a Boolean value as true or false.

**Example Code**

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree. Please refer to code in “AmebaServo:: attach” section.

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

---

**AudioCodec****Class AudioCodec****Description**

A class used for general control and management of the hardware audio codec functions.

**Syntax**

class AudioCodec

## Members

### Public Constructors

The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named Codec.

### Public Methods

AudioCodec::begin	Configure and start the audio codec for transmit and receive operation
AudioCodec::end	Stop all audio codec operation
Au- dioCodec::getBufferPageSize	Get the byte size of a single page of the audio codec buffer
AudioCodec::setSampleRate	Configure the audio codec transmit and receive sampling rate
AudioCodec::setBitDepth	Configure the audio codec transmit and receive bit depth (bits per sample)
Au- dioCodec::setChannelCount	Configure the audio codec transmit and receive channel count
Au- dioCodec::setInputMicType	Configure for analog or digital input microphone type
Au- dioCodec::setInputLRMux	Configure input left right channel multiplexing
AudioCodec::setDMicBoost	Configure boost gain for digital microphone input
AudioCodec::setAMicBoost	Configure boost gain for analog microphone input
AudioCodec::setADCGain	Configure gain of ADC used to acquire analog input
AudioCodec::muteInput	Mute input audio data stream
Au- dioCodec::setOutputVolume	Configure output audio volume
AudioCodec::muteOutput	Mute output audio
AudioCodec::writeAvaliable	Check for free buffer page available for data write
AudioCodec::writeDataPage	Write audio data to an available buffer page
AudioCodec::readAvaliable	Check for buffer page with new data available for read
AudioCodec::readDataPage	Read audio data from a ready buffer page
Au- dioCodec::setWriteCallback	Set a callback function to be notified when a free buffer page is available for write
Au- dioCodec::setReadCallback	Set a callback function to be notified when a buffer page with new data is available for read

### AudioCodec::begin

#### Description

Configure and start the audio codec for transmit and receive operation.

**Syntax**

```
void begin(bool input, bool output);
```

**Parameters**

input: enable audio codec data input

output: enable audio codec data output

**Returns**

The function returns nothing.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::end****Description**

Stop all audio codec operation.

**Syntax**

```
void end();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::getBufferPageSize****Description**

Get the byte size of a single page of the audio codec buffer.

**Syntax**

```
uint32_t getBufferPageSize();
```

**Parameters**

The function requires no input parameter.

**Returns**

The size of a audio codec buffer page, in number of bytes.

### Example Code

NA

### Notes and Warnings

The AudioCodec class includes a transmit and receive buffer to store audio sample data while transferring to and from the DAC output and ADC input. The buffer is divided into pages of fixed size, and audio data can be read and written one page at a time. Depending on the configured bit depth (bits per audio sample) and channel count, a buffer page may contain a different number of audio samples.

### AudioCodec::setSampleRate

#### Description

Configure the audio codec transmit and receive sampling rate.

#### Syntax

```
void setSampleRate(uint32_t sampleRate);
```

#### Parameters

sampleRate: desired audio codec sampling rate in Hz. Default value of 48000. Supported values: 8000, 16000, 32000, 44100, 48000, 88200, 96000.

#### Returns

The function returns nothing.

### Example Code

Example: BasicInputOutput

### Notes and Warnings

High sample rates above 48000Hz will require frequent buffer reads and writes to keep up with the large amount of data input and output. If there is insufficient processing time dedicated to this task, audio quality will be degraded.

### AudioCodec::setBitDepth

#### Description

Configure the audio codec transmit and receive bit depth (bits per sample).

#### Syntax

```
void setBitDepth(uint8_t bitDepth);
```

#### Parameters

bitDepth: desired number of bits per sample. Default value of 16. Supported values: 8, 16, 24.

#### Returns

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Setting a bit depth of 24 bits per sample will require 32 bits (4 bytes) of buffer space for storing each sample, with the most significant byte ignored.

**AudioCodec::setChannelCount****Description**

Configure the audio codec transmit and receive channel count.

**Syntax**

```
void setChannelCount(uint8_t monoStereo);
```

**Parameters**

monoStereo: number of channels. Default value of 1. Supported values: 1, 2.

**Returns**

The function returns nothing.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::setInputMicType****Description**

Configure for analog or digital input microphone type.

**Syntax**

```
Void setInputMicType(Mic_Type micType);
```

**Parameters**

micType: Input microphone type. Default value ANALOGMIC. Valid values:

- ANALOGMIC –microphone with an analog output
- PDMMIC –digital microphone with a PDM output

**Returns**

The function returns nothing.

**Example Code**

NA

## Notes and Warnings

For analog single-ended output, connect to PA\_4 for the left channel and PA\_2 for the right channel.

For digital PDM output, connect the PDM clock to PB\_1 and PDM data to PB\_2.

## AudioCodec::setInputLRMux

### Description

Configure input left right channel multiplexing.

### Syntax

```
void setInputLRMux(uint32_t mux);
```

### Parameters

mux: desired left right audio channel multiplexing setting. Default value RX\_CH\_LR. Valid values:

- RX\_CH\_LR
- RX\_CH\_RL
- RX\_CH\_LL
- RX\_CH\_RR

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

In mono channel mode, both RX\_CH\_LR and RX\_CH\_LL will result in the audio codec sampling input data from the left channel microphone. Similarly, both RX\_CH\_RL and RX\_CH\_RR will result in the audio codec sampling input data from the right channel microphone.

In stereo channel mode, RX\_CH\_RL will switch the positions of input data sampled from the microphones. RX\_CH\_RR and RX\_CH\_LL will result in duplicated samples from the right and left microphones respectively.\*\* \*\*

## AudioCodec::setDMicBoost

### Description

Configure boost gain for digital microphone input.

### Syntax

```
void setDMicBoost(uint32_t leftBoost, uint32_t rightBoost);
```

### Parameters

leftBoost: boost gain for left channel digital microphone input

rightBoost: boost gain for right channel digital microphone input

Valid boost gain values:

- 0 : 0dB
- 1 : 12dB
- 2 : 24dB
- 3 : 36dB

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

#### AudioCodec::setAMicBoost

### Description

Configure boost gain for analog microphone input.

### Syntax

```
void setAMicBoost(uint32_t leftBoost, uint32_t rightBoost);
```

### Parameters

leftBoost: boost gain for left channel analog microphone input

rightBoost: boost gain for right channel analog microphone input

Valid boost gain values:

- 0 : 0dB
- 1 : 20dB
- 2 : 30dB
- 3 : 40dB

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Only use this function if additional gain is required after using setADCGain function.

**AudioCodec::setADCGain****Description**

Configure gain of ADC used to acquire analog input.

**Syntax**

```
void setADCGain(uint32_t leftGain, uint32_t rightGain);
```

**Parameters**

leftGain: Gain for left channel ADC

rightGain: Gain for right channel ADC

Valid value range is from 0x00 to 0x7f. Gain increases by 0.375dB for every increment in value:

- 0x00 : -17.625dB
- 0x01 : -17.25dB
- 0x2f : 0dB
- 0x30 : 0.375dB
- 0x7f : 30dB

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::muteInput****Description**

Mute input audio data stream.

**Syntax**

```
void muteInput(uint8_t leftMute, uint8_t rightMute);
```

**Parameters**

leftMute: 1 to mute left channel input, 0 to unmute

rightMute: 1 to mute right channel input, 0 to unmute

**Returns**

The function returns nothing.

**Example Code**



NA

## Notes and Warnings

### AudioCodec::setOutputVolume

#### Description

Configure output audio volume.

#### Syntax

```
void setOutputVolume(uint8_t leftVol, uint8_t rightVol);
```

#### Parameters

leftVol: left channel output volume

rightVol: right channel output volume

Valid value ranges from 0 to 100, corresponding to a volume of -65.625dB to 0dB.

#### Returns

The function returns nothing.

#### Example Code

Example: BasicInputOutput

## Notes and Warnings

### AudioCodec::muteOutput

#### Description

Mute output audio.

#### Syntax

```
void muteOutput(uint8_t leftMute, uint8_t rightMute);
```

#### Parameters

leftMute: 1 to mute left channel output, 0 to unmute

rightMute: 1 to mute right channel output, 0 to unmute

#### Returns

The function returns nothing.

#### Example Code

NA

## Notes and Warnings

### AudioCodec::writeAvaliable

**Description**

Check for free buffer page available for data write.

**Syntax**

```
bool writeAvaliable();
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns true if there is a buffer page that is available for writing data into. Returns false if all buffer pages are full.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::writeDataPage****Description**

Write audio data to an available buffer page.

**Syntax**

```
uint32_t writeDataPage(int8_t* src, uint32_t len);  
uint32_t writeDataPage(int16_t* src, uint32_t len);
```

**Parameters**

src: pointer to array containing audio samples to write to audio codec.

len: number of audio samples in array.

**Returns**

The function returns the number of audio samples written to the audio codec.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::readAvaliable****Description**

Check for buffer page with new data available for read.

**Syntax**

```
bool readAvaliable();
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns true if there is a buffer page with new data that is ready for reading data from. Returns false if all buffer pages are empty.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::readDataPage****Description**

Read audio data from a ready buffer page.

**Syntax**

```
uint32_t readDataPage(int8_t* dst, uint32_t len);  
uint32_t readDataPage(int16_t* dst, uint32_t len);
```

**Parameters**

dst: pointer to array to contain audio samples read from audio codec.

len: number of audio samples to read.

**Returns**

The function returns the number of audio samples read from the audio codec.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::setWriteCallback****Description**

Set a callback function to be notified when a free buffer page is available for write.

**Syntax**

```
void setWriteCallback(void (writeCB)(**void*));
```

**Parameters**

writeCB: function to be called when a buffer page becomes available for data write. Takes no arguments and returns nothing

**Returns**

The function returns nothing.

### Example Code

NA

### Notes and Warnings

After starting the audio codec with `AudioCodec::begin()`, the callback function will be called each time the audio codec finishes outputting the data in a buffer page.

### AudioCodec::setReadCallback

#### Description

Set a callback function to be notified when a buffer page with new data is available for read.

#### Syntax

```
void setReadCallback(void (readCB)(**void*));
```

#### Parameters

`readCB`: function to be called when a buffer page with new data becomes available for data read. Takes no arguments and returns nothing

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

After starting the audio codec with `AudioCodec::begin()`, the callback function will be called each time the audio codec fills up a buffer page with newly acquired audio samples.

## Class FFT

### Description

A class used for performing FFT calculations with real-number inputs and outputs.

### Syntax

```
class FFT
```

### Members

### Public Constructors

FFT::FFT	Create an instance of the FFT class
----------	-------------------------------------

**Public Methods**

FFT::setWindow	Configure the window function used in FFT calculations
FFT::calculate	Calculate FFT for an input array of values
FFT::getFrequencyBins	Get the FFT output frequency bins
FFT::getFFTSIZE	Get the size of FFT output for a given input size

**FFT::FFT****Description**

Create a FFT class object.

**Syntax**

```
void FFT();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: FFT

**Notes and Warnings****FFT::setWindow****Description**

Configure the window function used in FFT calculations.

**Syntax**

```
void setWindow(FFTWindow_t window, uint16_t sampleCount);
```

**Parameters**

window: The window function to be used in FFT calculations. Valid values: None, Hann, Hamming.

sampleCount: Number of sample datapoints in the input.

**Returns**

The function returns nothing.

**Example Code**

Example: FFT

**Notes and Warnings**

The window function is used to reduce the effects of discontinuities that occur when the input signal has frequencies that do not fit an integer number of periods in the sample datapoints.

More information on FFTs and window functions can be seen at:

<https://download.ni.com/evaluation/pxi/Understanding%20FFTs%20and%20Windowing.pdf>

[https://en.wikipedia.org/wiki/Window\\_function](https://en.wikipedia.org/wiki/Window_function)

## **FFT::Calculate**

### **Description**

Calculate FFT for an input array of values.

### **Syntax**

```
void calculate(float* inputBuf, float* outputBuf, uint16_t sampleCount);
```

```
void calculate(int16_t* inputBuf, float* outputBuf, uint16_t sampleCount);
```

### **Parameters**

inputBuf: pointer to an array of sampleCount size, containing input sample datapoints, in float or uint16\_t format.

outputBuf: pointer to a float array of sampleCount/2 size, for containing FFT output.

sampleCount: number of sample datapoints in the input array, valid values: 16, 32, 64, 128, 256, 512, 1024, 2048.

### **Returns**

The function returns nothing.

### **Example Code**

Example:FFT

### **Notes and Warnings**

Large sample counts will require a longer time for FFT calculations, but will also return a result with higher frequency resolution.

## **FFT::getFrequencyBins**

### **Description**

Get the FFT output frequency bins.

### **Syntax**

```
void getFrequencyBins(uint16_t* outputBuf, uint16_t sampleCount, uint32_t sampleRate);
```

### **Parameters**

outputBuf: pointer to a uint16\_t array of sampleCount/2 size, for containing the calculated center frequency of each FFT output element.

### **Returns**

The function returns nothing.

### Example Code

Example: FFT

Notes and Warnings NA

—

### FFT::getFFTSIZE

#### Description

Get the size of FFT output for a given input size.

#### Syntax

```
uint16_t getFFTSIZE(uint16_t sampleCount);
```

#### Parameters

sampleCount: number of input sample datapoints.

#### Returns

The function returns the FFT output size for the given sampleCount, which is sampleCount/2.

### Example Code

NA

Notes and Warnings NA

## Class PlaybackWav

#### Description

A class used for control and playback of .wav file format audio data.

#### Syntax

```
class PlaybackWav
```

#### Members

#### Public Constructors

PlaybackWav::PlaybackWav	Create an instance of the PlaybackWav class
--------------------------	---

#### Public Methods

PlaybackWav::openFile	Open a .wav file for playback
PlaybackWav::closeFile	Close a previously opened file
PlaybackWav::fileOpened	Check if a .wav file is already opened
PlaybackWav::getSampleRate	Get the sample rate of the .wav file
PlaybackWav::getChannelCount	Get the number of audio channels in the .wav file
PlaybackWav::getBitDepth	Get the bit depth of each sample in the .wav file
PlaybackWav::getLengthMillis	Get the playback length of the .wav file in milliseconds
PlaybackWav::getPositionMillis	Get the current playback position in milliseconds
PlaybackWav::setPositionMillis	Set the current playback position in milliseconds
PlaybackWav::millisToBytes	Convert a playback duration to equivalent number of bytes
PlaybackWav::bytesToMillis	Convert number of bytes to an equivalent playback duration
PlaybackWav::readAudioData	Read audio data from the .wav file

---

## **PlaybackWav::PlaybackWav**

### **Description**

Create a PlaybackWav class object.

### **Syntax**

```
void PlaybackWav(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

NA

---

## **PlaybackWav::fileOpened**

### **Description**

Check if a .wav file is already opened.

### **Syntax**

```
bool fileOpened(void);
```

### **Parameters**



The function requires no input parameter.

**Returns**

The function returns true if a .wav file is already open, false otherwise.

**Example Code**

Example: RecordPlaybackWav

**Notes and Warnings**

NA

---

**PlaybackWav::getSampleRate****Description**

Get the sample rate of the .wav file.

**Syntax**

```
uint32_t getSampleRate(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns sampling rate encoded in the .wav file header.

**Example Code**

Example: PlaybackWavFile

**Notes and Warnings**

NA

---

**PlaybackWav::getChannelCount****Description**

Get the number of audio channels in the .wav file.

**Syntax**

```
uint16_t getChannelCount(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns channel count encoded in the .wav file header.

### Example Code

Example: PlaybackWavFile

### Notes and Warnings

NA

---

## PlaybackWav::getBitDepth

### Description

Get the bit depth of each sample in the .wav file.

### Syntax

```
uint16_t getBitDepth(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns bit depth encoded in the .wav file header.

### Example Code

Example: PlaybackWavFile

### Notes and Warnings

NA

---

## PlaybackWav::getLengthMillis

### Description

Get the playback length of the .wav file in milliseconds.

### Syntax

```
uint32_t getLengthMillis(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the total playback length of the currently open .wav file in milliseconds.

### Example Code

Example: PlaybackWavFile

### Notes and Warnings

NA

---

### **PlaybackWav::getPositionMillis**

#### **Description**

Get the current playback position in milliseconds.

#### **Syntax**

```
uint32_t getPositionMillis(void);
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns the current playback position of the currently open .wav file in milliseconds.

#### **Example Code**

Example: PlaybackWavFile

#### **Notes and Warnings**

NA

---

### **PlaybackWav::setPositionMillis**

#### **Description**

Set the current playback position in milliseconds.

#### **Syntax**

```
void setPositionMillis(uint32_t pos);
```

#### **Parameters**

pos: The desired playback position expressed in milliseconds.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PlaybackWavFile

#### **Notes and Warnings**

Any changes to playback position will only take effect on the next call to PlaybackWav::readAudioData. If the desired playback position is beyond the total playback length of the file, the playback position will be set to the end of file, and no audio data will be output on subsequent data reads.

---

### **PlaybackWav::millisToBytes**

#### **Description**

Convert a playback duration to equivalent number of bytes.

#### **Syntax**

```
uint32_t millisToBytes(uint32_t ms);
```

#### **Parameters**

ms: playback duration in milliseconds.

#### **Returns**

The function returns the number of bytes that is equivalent to the input playback duration, converted using the current sample rate, number of channels and bit depth.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

---

### **PlaybackWav::bytesToMillis**

#### **Description**

Convert number of bytes to an equivalent playback duration.

#### **Syntax**

```
uint32_t bytesToMillis(uint32_t bytes);
```

#### **Parameters**

bytes: playback duration in number of bytes.

#### **Returns**

The function returns the time duration in milliseconds that is equivalent to the input number of bytes, converted using the current sample rate, number of channels and bit depth.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

---

### **PlaybackWav::readAudioData**

**Description**

Read audio data from the .wav file.

**Syntax**

- `uint32_t readAudioData(int8_t* dst, uint32_t len);`
- `uint32_t readAudioData(int16_t* dst, uint32_t len);`

**Parameters**

- `dst`: pointer to array to store data read from .wav file.
- `len`: number of audio samples to read from .wav file.

**Returns**

The function returns number of audio samples read.

**Example Code**

Example: `PlaybackWavFile`

**Notes and Warnings**

NA

**Class RecordWav****Description**

A class used for control and recording of .wav file format audio data.

**Syntax**

`class RecordWav`

**Members****Public Constructors**

<code>RecordWav::RecordWav</code>	Create an instance of the <code>RecordWav</code> class
-----------------------------------	--

**Public Methods**

RecordWav::openFile	Open a .wav file for playback
RecordWav::closeFile	Close a previously opened file
RecordWav::fileOpened	Check if a .wav file is already opened
RecordWav::setSampleRate	Get the sample rate of the .wav file
RecordWav::setChannelCount	Set the number of audio channels in the .wav file
RecordWav::setBitDepth	Set the bit depth of each sample in the .wav file
RecordWav::getLengthMillis	Get the current record length of the .wav file in milliseconds
RecordWav::millisToBytes	Convert a playback duration to equivalent number of bytes
RecordWav::bytesToMillis	Convert number of bytes to an equivalent playback duration
RecordWav::writeAudioData	Write audio data to the .wav file

---

## **RecordWav::RecordWav**

### **Description**

Create a RecordWav class object.

### **Syntax**

```
void RecordWav(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

Example: RecordWavFile

### **Notes and Warnings**

NA

---

## **RecordWav::openFile**

### **Description**

Open a .wav file for recording.

### **Syntax**

```
void openFile(const char* absFilepath);
```

### **Parameters**

absFilepath: the filepath of the .wav file to open.

**Returns**

The function returns nothing.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

NA

---

**RecordWav::closeFile****Description**

Close a previously opened file.

**Syntax**

```
void closeFile(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

Any open .wav files should be closed after recording is complete, otherwise, loss of recorded audio data may occur.

---

**RecordWav::fileOpened****Description**

Check if a .wav file is already opened.

**Syntax**

```
bool fileOpened(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns true if a .wav file is already open, false otherwise.

**Example Code**

Example: RecordWavFile

### Notes and Warnings

NA

---

## RecordWav::setSampleRate

### Description

Set the recording sample rate of the .wav file.

### Syntax

```
void setSampleRate(uint32_t sampleRate);
```

### Parameters

sampleRate: The desired recording sample rate.

### Returns

The function returns nothing.

### Example Code

Example: RecordWavFile

### Notes and Warnings

NA

---

## RecordWav::setChannelCount

### Description

Set the number of recording audio channels in the .wav file.

### Syntax

```
void setChannelCount(uint16_t channelCount);
```

### Parameters

channelCount: number of recording audio channels.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

---



**RecordWav::setBitDepth****Description**

Set the recording bit depth of each sample in the .wav file.

**Syntax**

```
void setBitDepth(uint16_t bitDepth);
```

**Parameters**

bitDepth: number of bits per sample.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::getLengthMillis****Description**

Get the current recorded length of the .wav file in milliseconds.

**Syntax**

```
uint32_t getLengthMillis(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the current recorded length of the currently open .wav file in milliseconds.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::millisToBytes****Description**

Convert a playback duration to equivalent number of bytes.

**Syntax**

```
uint32_t millisToBytes(uint32_t ms);
```

**Parameters**

ms: playback duration in milliseconds.

**Returns**

The function returns the number of bytes that is equivalent to the input playback duration, converted using the current sample rate, number of channels and bit depth.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::bytesToMillis****Description**

Convert number of bytes to an equivalent playback duration.

**Syntax**

```
uint32_t bytesToMillis(uint32_t bytes);
```

**Parameters**

bytes: playback duration in number of bytes.

**Returns**

The function returns the time duration in milliseconds that is equivalent to the input number of bytes, converted using the current sample rate, number of channels and bit depth.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::writeAudioData****Description**

Write audio data to the .wav file.

**Syntax**

```
uint32_t writeAudioData(int8_t* src, uint32_t len); uint32_t writeAudioData(int16_t* src, uint32_t len);
```

**Parameters**

src: pointer to array containing data to write to .wav file. len: number of audio samples to write to .wav file.

**Returns**

The function returns number of audio samples written.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

NA

**BLE****Class BLEAddr****BLEAddr Class****Description**

A class used for managing Bluetooth addresses.

**Syntax**

```
class BLEAddr
```

**Members**

<b>Public Constructors</b>	
BLEAddr::BLEAddr	Constructs a BLEAddr object
<b>Public Methods</b>	
BLEAddr::str	Get the Bluetooth address represented as a formatted string
BLEAddr::data	Get the Bluetooth address represented as an integer array

**BLEAddr::BLEAddr****Description**

Constructs a BLEAddr object.

**Syntax**

```
BLEAddr::BLEAddr(void);  
BLEAddr::BLEAddr(uint8_t (&addr)[6]);  
BLEAddr::BLEAddr(const char* str);
```

**Parameters**

addr: An array of 6 bytes containing the desired Bluetooth address.

str: A character string representing the desired Bluetooth address.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

When expressed as a string, the Bluetooth address should be written as 6 bytes in hexadecimal format, using a colon “:” to separate the bytes is acceptable (example –00:11:22:33:EE:FF).

**BLEAddr::str****Description**

Get the Bluetooth address represented as a formatted string.

**Syntax**

```
const char* str(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a pointer to a character string containing the hexadecimal representation of the Bluetooth address.

**Example Code**

Example: BLEScan

**Notes and Warnings**

The Bluetooth address expressed as a string will be written as 6 bytes in hexadecimal format, with a colon “:” separating the bytes (example –00:11:22:33:EE:FF).

**BLEAddr::data****Description**

Get the Bluetooth address represented as an integer array.

**Syntax**

```
uint8_t* data(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a pointer to a 6 byte array containing the Bluetooth address.

**Example Code**

NA

**Notes and Warnings**

The Bluetooth address is stored with MSB at array index [5].

## Class BLEAdvert

### BLEAdvert Class

#### Description

A class used for managing BLE advertising settings.

#### Syntax

```
class BLEAdvert
```

#### Members

Public Constructors
No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using BLEDevice::configAdvert().

Public Methods	
BLEAdvert::updateAdvertParams	Update the current BLE advertisement settings to the lower Bluetooth stack
BLEAdvert::startAdv	Start BLE advertising
BLEAdvert::stopAdv	Stop BLE advertising
BLEAdvert::setAdvType	Set the BLE advertising type
BLEAdvert::setMinInterval	Set the BLE advertising minimum interval
BLEAdvert::setMaxInterval	Set the BLE advertising maximum interval
BLEAdvert::setAdvData	Set BLE advertising data
BLEAdvert::setScanRspData	Set BLE scan response data

### BLEAdvert::updateAdvertParams

#### Description

Update the lower Bluetooth stack with the current advertising settings.

#### Syntax

```
void updateAdvertParams(void);
```

#### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Please use the other class member functions to set the BLE advertising parameters first before using this function.

**BLEAdvert::startAdv****Description**

Start BLE advertising.

**Syntax**

```
void startAdv(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

This function is provided for flexibility in controlling and updating BLE advertising parameters. You should avoid using this function to directly start the BLE advertising process without first registering the necessary callback and handler functions. Call `BLEDevice::beginPeripheral()` to register the necessary functions and start advertising for the first time.

## **BLEAdvert::stopAdv**

### **Description**

Stop BLE advertising.

### **Syntax**

```
void stopAdv(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

This function is provided for flexibility in controlling and updating BLE advertising parameters. You should avoid using this function to directly stop the BLE advertising process. Call `BLEDevice::end()` to stop advertising and free up used resources.

## **BLEAdvert::setAdvType**

### **Description**

Set the BLE advertising type.



**Syntax**

```
void setAdvType(uint8_t advType);
```

**Parameters**

advType: the desired advertisement type. Valid values:

- 0 = GAP\_ADTYPE\_ADV\_IND : connectable undirected advertisement
- 1 = GAP\_ADTYPE\_ADV\_HDC\_DIRECT\_IND : connectable high duty cycle directed
- 2 = GAP\_ADTYPE\_ADV\_SCAN\_IND : scannable undirected advertisement
- 3 = GAP\_ADTYPE\_ADV\_NONCONN\_IND : Non-connectable undirected advertisement
- 4 = GAP\_ADTYPE\_ADV\_LDC\_DIRECT\_IND : connectable low duty cycle directed advertisement

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

Call this function with the GAP\_ADTYPE\_ADV\_IND argument if connection requests should be allowed, and GAP\_ADTYPE\_ADV\_NONCONN\_IND if all connection requests should be rejected.

**BLEAdvert::setMinInterval****Description**

Set the minimum BLE advertising interval.

**Syntax**

```
void setMinInterval(uint16_t minInt_ms);
```

**Parameters**

minInt\_ms: the desired advertisement minimum interval, expressed in milliseconds. The valid values for the interval are from 20ms to 10240ms.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

BLE advertisements will repeat with an interval between the set minimum and maximum intervals. Set a shorter interval for the BLE device to be discovered rapidly and set a longer interval to conserve power.

**BLEAdvert::setMaxInterval****Description**

Set the maximum BLE advertising interval.

**Syntax**

```
void setMaxInterval(uint16_t minInt_ms);
```

**Parameters**

minInt\_ms: the desired advertisement maximum interval, expressed in milliseconds. The valid values for the interval are from 20ms to 10240ms.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

BLE advertisements will repeat with an interval between the set minimum and maximum intervals. Set a shorter interval for the BLE device to be discovered rapidly and set a longer interval to conserve power.

## BLEAdvert::setAdvData

### Description

Set BLE advertising data.

### Syntax

```
void setAdvData(BLEAdvertData adData);  
void setAdvData(uint8_t* pData, uint8_t size);
```

### Parameters

adData: scan response data formatted in a BLEAdvertData class object  
pData: pointer to a byte array containing the required scan response data.  
size: number of bytes the scan response data contains, maximum of 31 bytes.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

N/A

## BLEAdvert::setScanRspData

### Description

Set BLE scan response data.

### Syntax

```
void setScanRspData(BLEAdvertData adData);  
void setScanRspData(uint8_t* pData, uint8_t size);
```

**Parameters**

adData: scan response data formatted in a BLEAdvertData class object

pData: pointer to a byte array containing the required scan response data.

size: number of bytes the scan response data contains, maximum of 31 bytes.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

N/A

**Class BLEAdvertData****BLEAdvertData Class****Description**

A class used for managing BLE advertising data.

**Syntax**

```
class BLEAdvertData
```

**Members**

Public Constructors	
BLEAdvertData::BLEAdvertData	Constructs a BLEAdvertData object

Public Methods	
BLEAdvertData::clear	Clear all advertising data
BLEAdvertData::addData	Add binary advertising data
BLEAdvertData::addFlags	Add flags to advertising data
BLEAdvertData::addPartialServices	Add partial services to advertising data
BLEAdvertData::addCompleteServices	Add complete services to advertising data
BLEAdvertData::addAppearance	Add device appearance to advertising data
BLEAdvertData::addShortName	Add short device name to advertising data
BLEAdvertData::addCompleteName	Add complete device name to advertising data
BLEAdvertData::parseScanInfo	Parse advertising data received from a scan
BLEAdvertData::hasFlags	Check if received data includes advertising flags
BLEAdvertData::hasUUID	Check if received data includes UUIDs
BLEAdvertData::hasName	Check if received data includes device name
BLEAdvertData::hasManufacturer	Check if received data includes manufacturer data
BLEAdvertData::getAdvType	Get advertising type of received data
BLEAdvertData::getAddrType	Get Bluetooth address type of received data
BLEAdvertData::getAddr	Get Bluetooth address of received data
BLEAdvertData::getRSSI	Get RSSI of received data
BLEAdvertData::getFlags	Get advertising flags of received data
BLEAdvertData::getServiceCount	Get number of advertised services in received data
BLEAdvertData::getServiceList	Get array of advertised services in received data
BLEAdvertData::getName	Get advertised device name in received data
BLEAdvertData::getTxPower	Get advertised transmission power in received data
BLEAdvertData::getAppearance	Get advertised device appearance in received data
BLEAdvertData::getManufacturer	Get advertised manufacturer in received data
BLEAdvertData::getManufacturerDataLength	Get length of manufacturer data in received data
BLEAdvertData::getManufacturerData	Get advertised manufacturer data in received data

## BLEAdvertData::BLEAdvertData

### Description

Constructs a BLEAdvertData object.

### Syntax

```
BLEAdvertData::BLEAdvertData(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This class is used for managing BLE advertising data for two primary uses. First is to assemble advertising data for broadcasting as advertising packets. Second is to process and split up the advertising data received from a scan into separate types.

### BLEAdvertData::clear

#### Description

Clear all advertising data currently saved in class object.

#### Syntax

```
void clear(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### **BLEAdvertData::addData**

#### **Description**

Add binary advertising data.

#### **Syntax**

```
void addData(const uint8_t* data, uint8_t size);
```

#### **Parameters**

data: pointer to array containing desired advertising data.

size: number of bytes in array.

#### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

This function is provided for flexibility in adding BLE advertising data. Other functions should be used for adding advertising data if possible, as this function does not perform any checks on the validity of the data.

### **BLEAdvertData::addFlags**

#### **Description**

Add flags to advertising data.

#### **Syntax**

```
uint8_t addFlags(uint8_t flags);
```

### Parameters

flags: desired flags to add to advertising data. Valid values:

- GAP\_ADTYPE\_FLAGS\_LIMITED
- GAP\_ADTYPE\_FLAGS\_GENERAL
- GAP\_ADTYPE\_FLAGS\_BREDR\_NOT\_SUPPORTED
- GAP\_ADTYPE\_FLAGS\_SIMULTANEOUS\_LE\_BREDR\_CONTROLLER
- GAP\_ADTYPE\_FLAGS\_SIMULTANEOUS\_LE\_BREDR\_HOST

### Returns

Current total size of advertising data.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

NA

## BLEAdvertData::addPartialServices

### Description

Add partial list of service UUIDs to advertising data.

### Syntax

```
uint8_t addPartialServices(BLEUUID uuid);
```

### Parameters

uuid: the desired UUID contained in BLEUUID class object.

### Returns

Current total size of advertising data.



**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::addCompleteServices****Description**

Add complete list of service UUIDs to advertising data.

**Syntax**

```
uint8_t addCompleteServices(BLEUUID uuid);  
uint8_t addCompleteServices(uint8_t uuidBitLength);
```

**Parameters**

uuid: the desired UUID contained in BLEUUID class object.

uuidBitLength: UUID bit length for which a blank entry is to be added. Valid values: 16, 32, 128.

**Returns**

Current total size of advertising data.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

uuidBitLength is used when it is desired to add a blank entry to the advertisement data, used to indicate that no services with UUIDs of a certain length are available.

**BLEAdvertData::addAppearance**

### Description

Add device appearance to advertising data.

### Syntax

```
uint8_t addAppearance(uint16_t appearance);
```

### Parameters

appearance: the desired device appearance.

### Returns

Current total size of advertising data.

### Example Code

NA

### Notes and Warnings

Refer to Bluetooth specifications for a full list of device appearance values.

## BLEAdvertData::addShortName

### Description

Add shortened device name to advertising data.

### Syntax

```
uint8_t addShortName(const char* str);
```

### Parameters

str: character string containing desired device name.

### Returns

Current total size of advertising data.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::addCompleteName****Description**

Add complete device name to advertising data.

**Syntax**

```
uint8_t addCompleteName(const char* str);
```

**Parameters**

str: character string containing desired device name.

**Returns**

Current total size of advertising data.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLEAdvertData::parseScanInfo****Description**

Parse advertising data received from a scan.

### Syntax

```
void parseScanInfo(T_LE_CB_DATA *p_data);
```

### Parameters

p\_data: pointer to advertising data received from a Bluetooth scan.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

Advertising data fields of parsed receive data can be access using member functions starting with “has” and “get” .

### BLEAdvertData::hasFlags

### Description

Check if received data includes advertising flags.

### Syntax

```
bool hasFlags(void);
```

### Parameters

The function requires no input parameter.

### Returns

True if flags are present in received advertising data.

### Example Code

NA

**Notes and Warnings**

NA

**BLEAdvertData::hasUUID****Description**

Check if received data includes service UUIDs.

**Syntax**

```
bool hasUUID(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

True if service UUIDs are present in received advertising data.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::hasName****Description**

Check if received data includes device name.

**Syntax**

```
bool hasName(void);
```

### Parameters

The function requires no input parameter.

### Returns

True if device name is present in received advertising data.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

NA

## BLEAdvertData::hasManufacturer

### Description

Check if received data includes manufacturer specific data.

### Syntax

```
bool hasManufacturer(void);
```

### Parameters

The function requires no input parameter.

### Returns

True if manufacturer specific data is present in received advertising data.

### Example Code

NA

### Notes and Warnings

NA

**BLEAdvertData::getAdvType****Description**

Get advertising type of received data.

**Syntax**

```
T_GAP_ADV_EVT_TYPE getAdvType(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertising type of received advertising data.

**Example Code**

NA

**Notes and Warnings**

Possible types:

- GAP\_ADV\_EVT\_TYPE\_UNDIRECTED
- GAP\_ADV\_EVT\_TYPE\_DIRECTED
- GAP\_ADV\_EVT\_TYPE\_SCANNABLE
- GAP\_ADV\_EVT\_TYPE\_NON\_CONNECTABLE
- GAP\_ADV\_EVT\_TYPE\_SCAN\_RSP

**BLEAdvertData::getAddrType****Description**

Get Bluetooth address type of received data.

### Syntax

```
T_GAP_REMOTE_ADDR_TYPE getAddrType(void);
```

### Parameters

The function requires no input parameter.

### Returns

Bluetooth address type of received data.

### Example Code

NA

### Notes and Warnings

Possible types:

- GAP\_REMOTE\_ADDR\_LE\_PUBLIC
- GAP\_REMOTE\_ADDR\_LE\_RANDOM

### BLEAdvertData::getRSSI

### Description

Get received signal strength indicator (RSSI) of received data.

### Syntax

```
Int8_t getRSSI(void);
```

### Parameters

The function requires no input parameter.

### Returns

Received signal strength.



**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::getFlags****Description**

Get advertising flags of received data.

**Syntax**

```
uint8_t getFlags(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertising flags present in received advertising data, expressed as a single byte.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::getServiceCount****Description**

Get number of advertised services in received data.

### Syntax

```
uint8_t getServiceCount(void);
```

### Parameters

The function requires no input parameter.

### Returns

Number of advertised service UUIDs in received data.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

NA

## BLEAdvertData::getServiceList

### Description

Get list of advertised service UUIDs in received data.

### Syntax

```
BLEUUID* getServiceList(void);
```

### Parameters

The function requires no input parameter.

### Returns

Pointer to a BLEUUID array containing all advertised service UUIDs.

### Example Code

Example: BLEBatteryClient

**Notes and Warnings**

NA

**BLEAdvertData::getName****Description**

Get advertised device name in received data.

**Syntax**

```
String getName(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertised device name contained in a String class object.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

NA

**BLEAdvertData::getTxPower****Description**

Get advertised transmission power in received data.

**Syntax**

```
int8_t getTxPower(void);
```

### Parameters

The function requires no input parameter.

### Returns

Advertised transmission power.

### Example Code

NA

### Notes and Warnings

NA

## BLEAdvertData::getAppearance

### Description

Get advertised device appearance in received data.

### Syntax

```
uint16_t getAppearance(void);
```

### Parameters

The function requires no input parameter.

### Returns

Advertised device appearance.

### Example Code

NA

### Notes and Warnings

Refer to Bluetooth specifications for full list of device appearance values.

**BLEAdvertData::getManufacturer****Description**

Get advertised manufacturer in received data.

**Syntax**

```
uint16_t getManufacturer(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertised manufacturer.

**Example Code**

NA

**Notes and Warnings**

Refer to Bluetooth specifications for full list of manufacturer codes.

**BLEAdvertData::getManufacturerDataLength****Description**

Get length of manufacturer data in received data.

**Syntax**

```
uint8_t getManufacturerDataLength(void);
```

**Parameters**

The function requires no input parameter.

### Returns

Number of bytes of manufacturer data present in received advertising data.

### Example Code

NA

### Notes and Warnings

NA

## BLEAdvertData::getManufacturerData

### Description

Get manufacturer data in received data.

### Syntax

```
uint8_t* getManufacturerData(void);
```

### Parameters

The function requires no input parameter.

### Returns

Pointer to array containing manufacturer data.

### Example Code

NA

### Notes and Warnings

NA

## Class BLEBeacon

### iBeacon Class

#### Description

A class used for managing iBeacon BLE advertising data.

#### Syntax

```
class iBeacon
```

#### Members

Public Constructors	
iBeacon::iBeacon	Create an instance of iBeacon advertising data
Public Methods	
iBeacon::getManufacturerId	Get current manufacturer ID value
iBeacon::getUUID	Get current UUID value
iBeacon::getMajor	Get current Major value
iBeacon::getMinor	Get current Minor value
iBeacon::getRSSI	Get current RSSI value
iBeacon::setManufacturerId	Set manufacturer ID value
iBeacon::setUUID	Set UUID value
iBeacon::setMajor	Set Major value
iBeacon::setMinor	Set Minor value
iBeacon::setRSSI	Set RSSI value
iBeacon::getAdvData	Get current advertising data
iBeacon::getScanRsp	Get current scan response data

### altBeacon Class

#### Description

A class used for managing altBeacon BLE advertising data.

#### Syntax

```
class altBeacon
```

## Members

Public Constructors	
altBeacon::altBeacon	Create an instance of altBeacon advertising data
Public Methods	
altBeacon::getManufacturerId	Get current manufacturer ID value
altBeacon::getUUID	Get current UUID value
altBeacon::getMajor	Get current Major value
altBeacon::getMinor	Get current Minor value
altBeacon::getRSSI	Get current RSSI value
altBeacon::getRSVD	Get current Reserved value
altBeacon::setManufacturerId	Set manufacturer ID value
altBeacon::setUUID	Set UUID value
altBeacon::setMajor	Set Major value
altBeacon::setMinor	Set Minor value
altBeacon::setRSSI	Set RSSI value
altBeacon::setRSVD	Set Reserved value
altBeacon::getAdvData	Get current advertising data
altBeacon::getScanRsp	Get current scan response data

## iBeacon::iBeacon

### Description

Create an iBeacon object.

### Syntax

```
void iBeacon(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA



**Notes and Warnings**

Include “BLEBeacon.h” to use this class function.

**altBeacon::altBeacon****Description**

Create an altBeacon object.

**Syntax**

```
void altBeacon(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “BLEBeacon.h” to use this class function.

**iBeacon::getManufacturerId****altBeacon::getManufacturerId****Description**

Get current Manufacturer ID value.

**Syntax**

```
uint16_t getManufacturerId(void);
```

### Parameters

The function requires no input parameter.

### Returns

A 16-bit unsigned integer containing the current Company ID.

### Example Code

NA

### Notes and Warnings

Refer to <https://www.bluetooth.com/specifications/assigned-numbers/company-identifiers/> for the full list of assigned Bluetooth company identifiers.

### iBeacon::getUUID

### altBeacon::getUUID

### Description

Get the current UUID value.

### Syntax

```
void getUUID(uint8_t* UUID);
```

### Parameters

UUID: pointer to a 16 element uint8\_t array, current UUID will be copied into the array.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

UUID is a 128-bit number used to uniquely identify a beacon. It is commonly expressed as a 32-character hexadecimal string. UUIDs can be generated at <https://www.uuidgenerator.net/>.

### iBeacon::getMajor

### altBeacon::getMajor

### Description

Get current Major value.

### Syntax

```
uint16_t getMajor(void);
```

### Parameters

The function requires no input parameter.

### Returns

A 16-bit unsigned integer containing the current Major value.

### Example Code

NA

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::getMinor

### altBeacon::getMinor

### Description

Get current Minor value.

### Syntax

```
uint16_t getMinor(void);
```

### Parameters

The function requires no input parameter.

### Returns

A 16-bit unsigned integer containing the current Minor value.

### Example Code

NA

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

## iBeacon::getRSSI

## altBeacon::getRSSI

### Description

Get the current RSSI value.

### Syntax

```
int8_t getRSSI(void);
```

### Parameters

The function requires no input parameter.

**Returns**

An 8-bit signed integer containing the currently set RSSI value.

**Example Code**

NA

**Notes and Warnings**

The beacon RSSI value is the received signal strength at 1 meter. This can be used to estimate the distance to the beacon. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

**iBeacon::setManufacturerId****altBeacon::setManufacturerId****Description**

Set Manufacturer ID value.

**Syntax**

```
void setManufacturerId(uint16_t id);
```

**Parameters**

id: desired Manufacturer ID

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

**Notes and Warnings**

Refer to <https://www.bluetooth.com/specifications/assigned-numbers/company-identifiers/> for the full list of assigned Bluetooth company identifiers.

**iBeacon::setUUID****altBeacon::setUUID****Description**

Set UUID value.

**Syntax**

```
void setUUID(uint8_t* UUID);  
void setUUID(const char* UUID);
```

**Parameters**

uint8\_t\* UUID: pointer to a 16 element uint8\_t array containing the desired UUID

const char\* UUID: desired UUID expressed as a character string

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

**Notes and Warnings**

UUID is a 128-bit number used to uniquely identify a beacon. It is commonly expressed as a 32-character hexadecimal string. UUIDs can be generated at <https://www.uuidgenerator.net/>.

**iBeacon::setMajor****altBeacon::setMajor****Description**

Set Major value.

**Syntax**

```
void setMajor(uint16_t major);
```

**Parameters**

major: desired Major value

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

**Notes and Warnings**

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

**iBeacon::setMinor****altBeacon::setMinor****Description**

Set Minor value.

**Syntax**

```
void setMinor(uint16_t minor);
```

**Parameters**

minor: desired Minor value

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::setRSSI

### altBeacon::setRSSI

### Description

Set RSSI value.

### Syntax

```
void setRSSI(int8_t RSSI);
```

### Parameters

RSSI: desired RSSI value

### Returns

The function returns nothing.

### Example Code

Example: BLEBeacon

### Notes and Warnings

The beacon RSSI value is the received signal strength at 1 meter. This can be used to estimate the distance to the beacon. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::getAdvData

### altBeacon::getAdvData



**Description**

Get current beacon advertising data.

**Syntax**

```
uint8_t* getAdvData(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

A uint8\_t pointer to the structure containing beacon advertising data.

**Example Code**

NA

**Notes and Warnings**

Avoid changing the beacon data through the returned pointer, use the member functions instead.

**iBeacon::getScanRsp****altBeacon::getScanRsp****Description**

Get current beacon advertising scan response data.

**Syntax**

```
uint8_t* getScanRsp(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

A uint8\_t pointer to the structure containing beacon advertising scan response data.

### Example Code

NA

### Notes and Warnings

Avoid changing the beacon data through the returned pointer, use the member functions instead.

### altBeacon::getRSVD

#### Description

Get current Reserved value.

#### Syntax

```
uint8_t getRSVD(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

An 8-bit unsigned integer containing the current Reserved value.

### Example Code

NA

### Notes and Warnings

Reserved for use by the manufacturer to implement special features. The interpretation of this value is to be defined by the manufacturer and is to be evaluated based on the MFG ID value. Refer to <https://altbeacon.org/> for more information.

## **altBeacon::setRSVD**

### **Description**

Set Reserved value.

### **Syntax**

```
void setRSVD(uint8_t rsvd);
```

### **Parameters**

rsvd: desired Reserved value

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Reserved for use by the manufacturer to implement special features. The interpretation of this value is to be defined by the manufacturer and is to be evaluated based on the MFG ID value. Refer to <https://altbeacon.org/> for more information.

## **Class BLECharacteristic**

### **BLECharacteristic Class**

#### **Description**

A class used for creating and managing BLE GATT characteristics.

#### **Syntax**

```
class BLECharacteristic
```

#### **Members**

<b>Public Constructors</b>	
BLEC haracteristic::BLECharacteristic	Constructs a BLECharacteristic object
<b>Public Methods</b>	
BLECharacteristic::setUUID	Set the characteristic UUID
BLECharacteristic::getUUID	Get the characteristic UUID
BLECharacteristic::setBufferLen	Set the size of the internal data buffer
BLECharacteristic::getBufferLen	Get the current size of the internal data buffer
BLECharacteristic::setReadProperty	Get the current size of the internal data bufferSet the characteristic r
BLECharacteristic::setWriteProperty	Set the characteristic write property
BLEC haracteristic::setNotifyProperty	Set the characteristic notify property
BLECha racteristic::setIndicateProperty	Set the characteristic indicate property
BLECharacteristic::setProperties	Set the characteristic properties
BLECharacteristic::getProperties	Get the characteristic properties
BLECharacteristic::readString	Read the characteristic data buffer as a String object
BLECharacteristic::readData8	Read the characteristic data buffer as an unsigned 8-bit integer
BLECharacteristic::readData16	Read the characteristic data buffer as an unsigned 16-bit integer
BLECharacteristic::readData32	Read the characteristic data buffer as an unsigned 32-bit integer
BLECharacteristic::writeString	Write data to the characteristic data buffer as a String object or char
BLECharacteristic::writeData8	Write data to the characteristic data buffer as an unsigned 8-bit integer
BLECharacteristic::writeData16	Write data to the characteristic data buffer as an unsigned 16-bit integer
BLECharacteristic::writeData32	Write data to the characteristic data buffer as an unsigned 16-bit integer
BLECharacteristic::setData	Write data to the characteristic data buffer
BLECharacteristic::getData	Read data from the characteristic data buffer
BLECharacteristic::getDataBuff	Get a pointer to the characteristic data buffer
BLECharacteristic::getDataLen	Get the number of bytes of data in the characteristic data buffer
BLECharacteristic::notify	Send a notification to a connected device
BLECharacteristic::indicate	Send an indication to a connected device
BLEC haracteristic::setUserDescriptor	Add a user description descriptor to characteristic
BLECha racteristic::setFormatDescriptor	Add a data format descriptor to characteristic
BLECharacteristic::Add a data format descriptor to characteristic	Set a user function as a read callback
BLECharacteristic::setWriteCallback	Set a user function as a write callback
BLECharacteristic::setCCCDCallback	Set a user function as a CCCD write callback

**BLECharacteristic::BLECharacteristic****Description**

Constructs a BLECharacteristic object.

**Syntax**

```
BLECharacteristic::BLECharacteristic(BLEUUID uuid);  
BLECharacteristic::BLECharacteristic(const char* uuid);
```

**Parameters**

uuid: characteristic UUID, expressed as a BLEUUID class object or a character array

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::setUUID****Description**

Set the characteristic UUID.

**Syntax**

```
void setUUID(BLEUUID uuid);
```

**Parameters**

uuid: the new characteristic UUID, expressed with a BLEUUID class object

**Returns**

The function returns nothing.

**Example Code**

NA

## Notes and Warnings

NA

## BLECharacteristic::getUUID

### Description

Get the characteristic UUID.

### Syntax

```
BLEUUID getUUID();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the characteristic UUID in a BLEUUID class object.

### Example Code

NA

## Notes and Warnings

NA

## BLECharacteristic::setBufferLen

### Description

Set the size of the internal data buffer of the characteristic.

### Syntax

```
void setBufferLen(uint16_t max_len);
```

### Parameters

max\_len: number of bytes to resize the internal buffer to

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

Characteristic data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

**BLECharacteristic::getBufferLen****Description**

Get the size of the characteristic internal buffer.

**Syntax**

```
uint16_t getBufferLen();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the currently set internal buffer size.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::setReadProperty**

### Description

Set the characteristic read property.

### Syntax

```
void setReadProperty(bool value);
```

### Parameters

value: TRUE to allow connected devices to read characteristic data

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

NA

## BLECharacteristic::setWriteProperty

### Description

Set the characteristic write property.

### Syntax

```
void setWriteProperty(bool value);
```

### Parameters

value: TRUE to allow connected devices to write characteristic data

### Returns

The function returns nothing.



**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::setNotifyProperty****Description**

Set the characteristic notify property.

**Syntax**

```
void setNotifyProperty(bool value);
```

**Parameters**

value: TRUE to allow connected devices to enable receiving characteristic data notifications.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

Enabling this property will add a CCCD descriptor to the characteristic.

**BLECharacteristic::setIndicateProperty****Description**

Set the characteristic indicate property.

**Syntax**

```
void setIndicateProperty(bool value);
```

### Parameters

value: TRUE to allow connected devices to enable receiving characteristic data indications.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Enabling this property will add a CCCD descriptor to the characteristic.

## BLECharacteristic::setProperties

### Description

Set the characteristic properties.

### Syntax

```
void setProperties(uint8_t value);
```

### Parameters

value: desired characteristic properties

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### **BLECharacteristic::getProperties**

#### **Description**

Get the currently set characteristic properties.

#### **Syntax**

```
uint8_t getProperties();
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns the currently set characteristic properties expressed as an unsigned 8-bit integer.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

### **BLECharacteristic::readString**

#### **Description**

Read the data in the characteristic internal buffer, expressed as a String class object.

#### **Syntax**

```
String readString();
```

#### **Parameters**

The function requires no input parameter.

### Returns

The function returns the data in the characteristic internal buffer expressed as a String class object.

### Example Code

Example: BLEUartService

### Notes and Warnings

Non-ASCII data may result in unexpected characters in the string.

## BLECharacteristic::readData8

### Description

Read the data in the characteristic internal buffer, expressed as an unsigned 8-bit integer.

### Syntax

```
uint8_t readData8();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic internal buffer expressed as a uint8\_t value.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::readData16

### Description

Read the data in the characteristic internal buffer, expressed as an unsigned 16-bit integer.

**Syntax**

```
uint16_t readData16();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic internal buffer expressed as a uint16\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::readData32****Description**

Read the data in the characteristic internal buffer, expressed as an unsigned 32-bit integer.

**Syntax**

```
uint32_t readData32();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic internal buffer expressed as a uint32\_t value.

**Example Code**

NA

### Notes and Warnings

NA

## BLECharacteristic::readData32

### Description

Write data to the characteristic data buffer as a String object or character array.

### Syntax

```
bool writeString(String str);  
bool writeString(const char* str);
```

### Parameters

str: the data to write to the characteristic buffer, expressed as a String class object or a char array.

### Returns

The function returns TRUE if write data is successful.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLECharacteristic::writeData8

### Description

Write data to the characteristic data buffer as an unsigned 8-bit integer.

### Syntax

```
bool writeData8(uint8_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 8-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLECharacteristic::writeData16****Description**

Write data to the characteristic data buffer as an unsigned 16-bit integer.

**Syntax**

```
bool writeData16(uint16_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 16-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

## **BLECharacteristic::writeData32**

### **Description**

Write data to the characteristic data buffer as a 32-bit integer.

### **Syntax**

```
bool writeData32(uint32_t num);
```

```
bool writeData32(int num);
```

### **Parameters**

num: the data to write to the characteristic buffer expressed as a 32-bit integer.

### **Returns**

The function returns TRUE if write data is successful.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **BLECharacteristic::setData**

### **Description**

Write data to the characteristic data buffer.

### **Syntax**

```
bool setData(uint8_t* data, uint16_t datalen);
```

### **Parameters**



data: pointer to byte array containing desired data

datalen: number of bytes of data to write

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::getData

### Description

Read data from the characteristic data buffer.

### Syntax

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

### Parameters

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

### Returns

The function returns the number of bytes read.

### Example Code

NA

### Notes and Warnings

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

## BLECharacteristic::getDataBuff

### Description

Get a pointer to the characteristic data buffer.

### Syntax

```
uint8_t* getDataBuff();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a pointer to the uint8\_t array used as the characteristic internal buffer.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::getDataLen

### Description

Get the number of bytes of data in the characteristic data buffer.

### Syntax

```
uint16_t getDataLen
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the number of bytes of data in the internal buffer.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::notify****Description**

Send a notification to a connected device.

**Syntax**

```
void notify(uint8_t conn_id);
```

**Parameters**

conn\_id: the connection ID for the device to send a notification to.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::indicate****Description**

Send an indication to a connected device.

### Syntax

```
void indicate(uint8_t conn_id);
```

### Parameters

conn\_id: the connection ID for the device to send an indication to.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::setUserDescriptor

### Description

Add a user description descriptor attribute (UUID 0x2901) to the characteristic.

### Syntax

```
void setUserDescriptor(const char* description);
```

### Parameters

description: the desired user description string expressed in a char array.

### Returns

The function returns nothing.

### Example Code

NA

**Notes and Warnings**

NA

**BLECharacteristic::setFormatDescriptor****Description**

Add a data format descriptor attribute (UUID 0x2904) to the characteristic.

**Syntax**

```
void setFormatDescriptor(uint8_t format, uint8_t exponent, uint16_t unit, uint16_t description);
```

**Parameters**

format: refer to <https://www.bluetooth.com/specifications/assigned-numbers/format-types/> for the valid values and associated format types.

exponent: base-10 exponent to be applied to characteristic data value.

unit: refer to <https://btprodspecificationrefs.blob.core.windows.net/assigned-values/16-bit%20UUID%20Numbers%20Document.pdf> for the valid values and associated units.

descriptor: refer to <https://www.bluetooth.com/specifications/assigned-numbers/gatt-namespace-descriptors/> for the valid values and associated descriptors.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::setReadCallback****Description**

Set a user function to be called when the characteristic data is read by a connected device.

**Syntax**

```
void setReadCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing data read

conn\_id: connection ID of connected device that read characteristic data

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLECharacteristic::setWriteCallback****Description**

Set a user function to be called when the characteristic data is written by a connected device.

**Syntax**

```
void setWriteCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing written data.

conn\_id: connection ID of connected device that wrote characteristic data.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::setCCCDCallback****Description**

Set a user function to be called when a connected device modifies the characteristic CCCD to enable or disable notifications or indications.

**Syntax**

```
void setCCCDCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id, uint16_t ccc_bits));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing written data.

conn\_id: connection ID of connected device that wrote characteristic data.

ccc\_bits: the new CCCD data bits after modification by the connected device

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

## Class BLEClient

### BLEClient Class

#### Description

A class used for discovering and accessing BLE GATT services on a connected remote device.

#### Syntax

```
class BLEClient
```

#### Members

Public Constructors
No public constructor is available for this class. You can get a pointer to an instance of this class using BLEDevice::addClient().

Public Methods	
BLEClient::connected	Check if the corresponding remote device for the client is connected
BLEClient::discoverServices	Start service discovery process for connected device
BLEClient::discoveryDone	Determine if service discovery process has been completed
BLEClient::printServices	Format and print discovered services to serial port
BLEClient::getService	Get a specific service on the remote device
BLEClient::getConnId	
BLEClient::getClientId	Get corresponding client ID
BLEClient::setDisconnectCallback	Set a user function to be called when the remote device is disconnected

### BLEClient::connected

#### Description

Check if the remote device associated with the client is still connected.

#### Syntax

```
bool connected();
```

#### Parameters



The function requires no input parameter.

**Returns**

The function returns TRUE if the remote device is connected.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEClient::discoverServices****Description**

Start the service discovery process for the connected remote device.

**Syntax**

```
void discoverServices();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

## **BLEClient::discoveryDone**

### **Description**

Check if the service discovery process has been completed.

### **Syntax**

```
bool discoveryDone();
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns TRUE if the service discovery process has been completed successfully, FALSE if the service discovery process failed, is still in progress, or has yet to start.

### **Example Code**

Example: BLEUartClient

### **Notes and Warnings**

NA

## **BLEClient::printServices**

### **Description**

Print out a formatted list of discovered services to the serial port.

### **Syntax**

```
void printServices();
```

### **Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEClient::getService****Description**

Get a service with the specified UUID on the remote device.

**Syntax**

```
BLERemoteService* getService(const char* uuid);
```

```
BLERemoteService* getService(BLEUUID uuid);
```

**Parameters**

uuid: the desired service UUID, expressed as a character array or a BLEUUID object.

**Returns**

The function returns the found service as a BLERemoteService object pointer, otherwise nullptr is returned if a service with the UUID is not found.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

## **BLEClient::getConnId**

### **Description**

Get the connection ID associated with the remote device.

### **Syntax**

```
uint8_t getConnId;
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns the connection ID for the connected remote device.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **BLEClient::getClientId**

### **Description**

Get the client ID for the BLEClient object.

### **Syntax**

```
T_CLIENT_ID getClientId();
```

### **Parameters**

The function requires no input parameter.

**Returns**

The function returns the BLEClient object's client ID.

**Example Code**

NA

**Notes and Warnings**

The client ID is used when calling internal GATT client API.

**BLEClient::setDisconnectCallback****Description**

Set a user function as a callback function when the remote device is disconnected.

**Syntax**

```
void setDisconnectCallback(void (*fCallback) (BLEClient* client));
```

**Parameters**

fCallback: A user callback function that returns void and takes one argument.

client: A pointer to the BLEClient object corresponding to the disconnected remote device

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The user callback function will be called after the remote device has disconnected, before the characteristics, services and client associated with the remote device are deleted.

## Class BLEConnect

### BLEConnect Class

#### Description

A class used for managing BLE connection settings.

#### Syntax

```
class BLEConnect
```

#### Members

Public Constructors
No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using BLEDevice::configConnection.

Public Methods	
BLEConnect::connect	Connect to a target BLE device
BLEConnect::disconnect	Disconnect from a target BLE device
BLEConnect::setScanInterval	Set the BLE scanning interval when connecting
BLEConnect::setScanWindow	Set the BLE scanning window when connecting
BLEConnect::setConnInterval	Set the BLE connection interval duration
BLEConnect::setConnLatency	Set the BLE connection slave latency
BLEConnect::setConnTimeout	Set the BLE connection timeout value
BLEConnect::updateConnParams	Send new BLE connection parameters to a connected device
BLEConnect::getConnInfo	Get connection information
BLEConnect::getConnAddr	Get the Bluetooth address for a certain connection
BLEConnect::getConnId	Get the connection ID for a certain device

### BLEConnect::connect

#### Description

Connect to a target BLE device.

#### Syntax

```
bool connect(char* btAddr, T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);
```

```
bool connect(uint8_t (&btAddr)[6], T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);  
bool connect(BLEAdvertData targetDevice, uint16_t scanTimeout);  
bool connect(BLEAddr destAddr, T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);
```

### Parameters

char\* btAddr: target device Bluetooth address expressed as a character string.

uint8\_t (&btAddr): target device Bluetooth address contained in a 6 byte array.

destAddr: target device Bluetooth address contained in BLEAddr class object.

targetDevice: advertising data packet scanned from target device.

destAddrType: Bluetooth address type of target device. Valid values:

–GAP\_REMOTE\_ADDR\_LE\_PUBLIC

–GAP\_REMOTE\_ADDR\_LE\_RANDOM

scan timeout: duration in milliseconds for which to look for target device before giving up.

### Returns

True if connection successful, false if connection failed.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

NA

## BLEConnect::disconnect

### Description

Disconnect from a target BLE device.

### Syntax

```
bool disconnect(uint8_t connId);
```

### Parameters

connId: connection ID for target device.

### Returns

True if operation successful, false if otherwise.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::setScanInterval

### Description

Set the BLE scan interval when searching for a target device to connect to.

### Syntax

```
void setScanInterval(uint16_t scanInt_ms);
```

### Parameters

scanInt\_ms: scan interval in milliseconds. Value range of 3 to 10240.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA



## BLEConnect::setScanWindow

### Description

Set the BLE scan window when searching for a target device to connect to.

### Syntax

```
void setScanWindow(uint16_t scanWindow_ms);
```

### Parameters

scanWindow\_ms: scan window in milliseconds. Value range of 3 to 10240.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::setConnInterval

### Description

Set the BLE connection interval value.

### Syntax

```
void setConnInterval(uint16_t min_ms, uint16_t max_ms);
```

### Parameters

min\_ms: minimum acceptable connection interval in milliseconds. Value range of 8 to 4000.

max\_ms: maximum acceptable connection interval in milliseconds. Value range of 8 to 4000.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The BLE connection interval defines the period between successive connection events between a connected central and peripheral device. Even if there is no data to exchange, a connection event is required to maintain the connection. max\_ms should be larger than or equal to min\_ms.

### BLEConnect::setConnLatency

### Description

Set the BLE connection slave latency value.

### Syntax

```
void setConnLatency(uint16_t latency);
```

### Parameters

latency: Connection slave latency value. Value range of 0 to 499.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The BLE connection slave latency defines the number of successive connection events a connected peripheral device can ignore without being considered as disconnected by the central device.

## **BLEConnect::setConnTimeout**

### **Description**

Set the BLE connection timeout value.

### **Syntax**

```
void setConnTimeout(uint16_t timeout_ms);
```

### **Parameters**

timeout\_ms: connection timeout in milliseconds. Value range of 100 to 32000.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

The BLE connection timeout defines the duration after a failed connection events before a peripheral or central device considers the connection broken.

## **BLEConnect::updateConnParams**

### **Description**

Update a connected device with new connection parameters.

### **Syntax**

```
void updateConnParams(uint8_t conn_id);
```

### **Parameters**

conn\_id: connection ID of target device to update connection parameters.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Update a connected device with previously set connection interval, slave latency and timeout values. The connected device may reject the new values if it is unable to conform to them.

## BLEConnect::getConnInfo

### Description

Get connection information.

### Syntax

```
bool getConnInfo(uint8_t connId, T_GAP_CONN_INFO *pConnInfo);
```

### Parameters

connId: connection ID to get connection information from.

pConnInfo: pointer to T\_GAP\_CONN\_INFO structure to store obtained connection information.

### Returns

True if operation success, false if operation failed.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::getConnAddr

### Description

Get the Bluetooth address for a certain connection.

### Syntax

```
bool getConnAddr(uint8_t connId, uint8_t* addr, uint8_t* addrType);
```

### Parameters

connId: connection ID to get address information for

addr: pointer to 6 byte array to store retrieved Bluetooth address

addrType: pointer to uint8\_t variable to store retrieved Bluetooth address type

### Returns

True if operation success, false if operation failed.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::getConnId

### Description

Get the connection ID for a certain device.

### Syntax

```
int8_t getConnId(char* btAddr, uint8_t addrType);
```

```
int8_t getConnId(uint8_t* btAddr, uint8_t addrType);
```

```
int8_t getConnId(BLEAdvertData targetDevice);
```

**Parameters**

char\* btAddr: target device Bluetooth address expressed as a character string.

uint8\_t\* btAddr: pointer to a 6 byte array containing target device Bluetooth address.

targetDevice: advertising data packet scanned from target device.

addrType: Bluetooth address type of target device. Valid values:

–GAP\_REMOTE\_ADDR\_LE\_PUBLIC

–GAP\_REMOTE\_ADDR\_LE\_RANDOM

**Returns**

The function returns the requested connection ID. Returns -1 if failed to obtain connection ID.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

NA

**Class BLEDevice****BLEDevice Class****Description**

A class used for general control and management of BLE functions.

**Syntax**

```
class BLEDevice
```

**Members**

Public Constructors
The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named BLE.

Public Methods	
BLEDevice::init	Allocate resources required for BLE functionality
BLEDevice::deinit	Free resources used by BLE functionality
BLEDevice::connected	Check if a BLE device is connected
BLEDevice::setDeviceName	Set BLE GAP device name
BLEDevice::setDeviceAppearance	Set BLE GAP device appearance
BLEDevice::configAdvert	Configure BLE advertising parameters
BLEDevice::configScan	Configure BLE scan parameters
BLEDevice::setScanCallback	Set callback function for BLE scans
BLEDevice::beginCentral	Start BLE stack in central mode
BLEDevice::beginPeripheral	Start BLE stack in peripheral mode
BLEDevice::end	Stop BLE stack
BLEDevice::configServer	Configure BLE stack for services
BLEDevice::addService	Add a service to the BLE stack
BLEDevice::configClient	Configure BLE stack for clients
BLEDevice::addClient	Add a client to the BLE stack
BLEDevice::getLocalAddr	Get local device Bluetooth address

**BLEDevice::init****Description**

Allocate resources required for BLE functionality.

**Syntax**

```
void init(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

### Notes and Warnings

Call this member function first before using any other member functions in the BLEDevice class.

### BLEDevice::deinit

#### Description

Free up resources used for BLE functionality.

#### Syntax

```
void deinit(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

NA

### Notes and Warnings

Call this member function last after all other BLE operations are stopped.

### BLEDevice::connected

#### Description

Check if a BLE device is connected.

#### Syntax

```
bool connected(void);
```



**Parameters**

The function requires no input parameter.

**Returns**

TRUE if another BLE device is connected, FALSE if no BLE device is connected.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEDevice::setDeviceName****Description**

Set the BLE GAP device name.

**Syntax**

```
void setDeviceName(String devName);
```

**Parameters**

devName: desired device name contained in an Arduino String object

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The GAP device name has a maximum length of 39 characters. Other devices can see this name after a BLE connection is established. This name is separate and different from the device name sent in a BLE advertisement, the names should be the same but are not required.

## **BLEDevice::setDeviceAppearance**

### **Description**

Set the BLE GAP device appearance.

### **Syntax**

```
void setDeviceAppearance(uint16_t devAppearance);
```

### **Parameters**

devAppearance: desired device appearance expressed as a 16-bit unsigned integer.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Refer to Bluetooth SIG assigned device appearances at <https://www.bluetooth.com/specifications/gatt/characteristics/>.

## **BLEDevice::configAdvert**

### **Description**

Configure BLE advertising parameters.

### **Syntax**

```
BLEAdvert* configAdvert(void);
```

### Parameters

The function requires no input parameter.

### Returns

A pointer to a BLEAdvert class instance for configuring BLE advertising parameters.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

Use this member function instead of creating a BLEAdvert class instance manually.

## BLEDevice::configScan

### Description

Configure BLE scanning parameters.

### Syntax

```
BLEScan* configScan(void);
```

### Parameters

The function requires no input parameter.

### Returns

A pointer to a BLEScan class instance for configuring BLE scanning parameters.

### Example Code

Example: BLEScan

```
#include 「BLEDevice.h」

#include 「BLEScan.h」

int dataCount = 0;

void scanFunction(T_LE_CB_DATA* p_data) {
    printf(「 rnScan Data %drn」 , ++dataCount);
    BLE.configScan()->printScanInfo(p_data);
}

void setup() {
    BLE.init();
    BLE.configScan()->setScanMode(GAP_SCAN_MODE_ACTIVE);
    BLE.configScan()->setScanInterval(500); // Start a scan every 500ms
    BLE.configScan()->setScanWindow(250); // Each scan lasts for 250ms
    // Provide a callback function to process scan data.
    // If no function is provided, default BLEScan::printScanInfo is used
    BLE.setScanCallback(scanFunction);
    BLE.beginCentral(0);
    BLE.configScan()->startScan(5000); // Repeat scans for 5 seconds, then stop
}

void loop() {
}
```

### Notes and Warnings

Use this member function instead of creating a BLEScan class instance manually.

### BLEDevice::setScanCallback

#### Description

Set a callback function for processing BLE scan results.

#### Syntax

```
void setScanCallback(void (scanCB)(T_LE_CB_DATA));
```

### Parameters

scanCB: a function that returns nothing and takes in a scan data pointer of type T\_LE\_CB\_DATA\*

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

### Notes and Warnings

Use this member function to set a callback function that will be called for each BLE device scan result found.

## BLEDevice::beginCentral

### Description

Start the BLE stack in central mode.

### Syntax

```
void beginCentral(uint8_t connCount);
```

### Parameters

connCount: maximum number of allowed connected devices. If no argument is provided, default to maximum allowed connected devices for specific board.

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

The function returns nothing.

### Notes and Warnings

Use this member function to start the device in BLE central mode, after other BLE parameters are set correctly.

### BLEDevice::beginPeripheral

#### Description

Start the BLE stack in peripheral mode.

#### Syntax

```
void beginPeripheral(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: BLEBatteryService

### Notes and Warnings

Use this member function to start the device in BLE peripheral mode, after other BLE parameters are set correctly.

### BLEDevice::end

#### Description

Stop the BLE stack.

**Syntax**

```
void end(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Use this member function to stop the device operating in either BLE peripheral mode or BLE central mode.

**BLEDevice::configServer****Description**

Configure the BLE stack for services.

**Syntax**

```
void configServer(uint8_t maxServiceCount);
```

**Parameters**

maxServiceCount: Maximum number of services that will run on the device

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

## Notes and Warnings

Use this member function before adding any service to the BLE stack.

## BLEDevice::addService

### Description

Add a new service to the BLE stack.

### Syntax

```
void addService(BLEService& newService);
```

### Parameters

newService: the service to be added, defined using a BLEService class object.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

## Notes and Warnings

N/A

## BLEDevice::configClient

### Description

Configure the BLE stack for clients.

### Syntax

```
void configClient();
```



**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

Use this member function before adding any client to the BLE stack.

**BLEDevice::addClient****Description**

Add a new client to the BLE stack.

**Syntax**

```
BLEClient* addClient(uint8_t connId);
```

**Parameters**

connId: the connection ID of the connected device to create a client for.

**Returns**

The function returns a pointer to a BLEClient class object, corresponding to the device with the specified connection ID, which can be used to access the services and characteristics on the connected device.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

Only one client should be added per connected device.

The BLEClient object and any service, characteristic, descriptor associated with the connected device will be deleted when the device is disconnected.

## **BLEDevice::getLocalAddr**

### **Description**

Get local device Bluetooth address.

### **Syntax**

```
void getLocalAddr(uint8_t (&addr)[GAP_BD_ADDR_LEN]);
```

### **Parameters**

addr: 6 byte array to store local device Bluetooth address.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Local device address is only available after starting in central or peripheral mode. This function will return all zeros for the address if central or peripheral mode is not in operation.

## **Class BLEHIDDevice**

### **BLEHIDDevice Class**

#### **Description**

A class used for creating and managing HID over GATT Profile (HOGP) services.

#### **Syntax**

```
class BLEHIDDevice
```

## Members

### Public Constructors

The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named BLEHIDDev.

Public Methods	
BLEHIDDevice::init	Initialize the HID Device Profile by creating the required services
BLEHIDDevice::setNumOutputReport	Configure the number of HID output reports
BLEHIDDevice::setNumInputReport	Configure the number of HID input reports
BLEHIDDevice::setReportMap	Configure the HID report map
BLEHIDDevice::inputReport	Send a HID input report
BLEHIDDevice::setOutputReportCallback	Set a user callback function for receiving HID output reports
BLEHIDDevice::bootKeyboardReport	Send a HID boot keyboard input report
BLEHIDDevice::setHidInfo	Set HID info of the HID service
BLEHIDDevice::setBattLevel	Set battery level info of the Battery service
BLEHIDDevice::setPNPInfo	Set PNP information of the Device Information service
BLEHIDDevice::setManufacturerString	Set manufacturer information of the Device Information service
BLEHIDDevice::setModelString	Set model information of the Device Information service
BLEHIDDevice::hidService	Get reference to HID service
BLEHIDDevice::devInfoService	Get reference to Device Information service
BLEHIDDevice::battService	Get reference to Battery service

### BLEHIDDevice::init

### Description

Initialize the HID Device profile by creating the required services.

### Syntax

```
void init(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

The HID Device object should be initialized before any HID reports can be sent.

### BLEHIDDevice::setNumOutputReport

#### Description

Configure the number of HID output reports.

#### Syntax

```
void setNumOutputReport (uint8_t numOutputReports);
```

#### Parameters

numOutputReports: number of output reports

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The number of output reports should be configured before BLEHIDDevice init() function is called.

### BLEHIDDevice::setNumInputReport

#### Description

Configure the number of HID input reports.

**Syntax**

```
void setNumInputReport (uint8_t numInputReports);
```

**Parameters**

numInputReports: number of input reports

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The number of input reports should be configured before BLEHIDDevice init() function is called.

**BLEHIDDevice::setReportMap****Description**

Configure the HID report map characteristic with a HID report descriptor.

**Syntax**

```
void setReportMap (uint8_t* report_map, uint16_t len);
```

**Parameters**

report\_map: pointer to HID report descriptor

len: HID report descriptor length in bytes

**Returns**

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

The HID report map characteristic can only be configured after BLEHIDDevice init() function is called.

### BLEHIDDevice::inputReport

#### Description

Send a HID input report.

#### Syntax

```
void inputReport (uint8_t reportID, uint8_t* data, uint16_t len, uint8_t conn_id);
```

#### Parameters

reportID: HID report ID of input report

data: pointer to HID input report data to send

len: length of HID input report data in bytes

conn\_id: connection ID of device to send HID report to

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

HID input reports can only be sent after BLEHIDDevice init() function has been called.

### BLEHIDDevice::setOutputReportCallback

#### Description

Set a user callback function for receiving HID output report data.

**Syntax**

```
void setOutputReportCallback (uint8_t reportID, void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

reportID: HID report ID of output report to link callback function with

chr: BLECharacteristic class object containing received HID output report data

conn\_id: connection ID of device which sent HID report data

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Setting a user callback function for output reports can only occur after BLEHIDDevice init() function has been called.

**BLEHIDDevice::bootKeyboardReport****Description**

Send a HID boot keyboard input report.

**Syntax**

```
void bootKeyboardReport (uint8_t* data, uint16_t len, uint8_t conn_id);
```

**Parameters**

data: pointer to HID input report data to send

len: length of HID input report data in bytes

conn\_id: connection ID of device to send HID report to

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

By default, the HID service Protocol Mode characteristic has boot mode disabled. To send boot keyboard input reports, the Protocol Mode characteristic needs to have boot mode enabled.

**BLEHIDDevice::setHidInfo****Description**

Set data of the HID Info characteristic of the HID service.

**Syntax**

```
void setHidInfo (uint16_t bcd, uint8_t country, uint8_t flags);
```

**Parameters**

bcd: 16-bit unsigned integer representing version number of base USB HID Specification implemented by HID Device

country: 8-bit integer identifying country HID Device hardware is localized for. Most hardware is not localized (value 0x00).

flags: Bit flags indicating remote-wake capability and advertising when bonded but not connected.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

For detailed information on the characteristic, refer to Bluetooth SIG HID Service specifications.



## **BLEHIDDevice::setBattLevel**

### **Description**

Set battery level data of the Battery service.

### **Syntax**

```
void setBattLevel (uint8_t level);
```

### **Parameters**

level: battery level expressed as % of full charge

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Battery level is set to 100% by default. For detailed information refer to Bluetooth SIG Battery service specifications.

## **BLEHIDDevice::setPNPInfo**

### **Description**

Set PNP data of the Device Information service.

### **Syntax**

```
void setPNPInfo (uint8_t sig, uint16_t vid, uint16_t pid, uint16_t version);
```

### **Parameters**

sig: The Vendor ID Source field designates which organization assigned the value used in the Vendor ID field value.

vid: The Vendor ID field is intended to uniquely identify the vendor of the device.

pid: The Product ID field is intended to distinguish between different products made by the vendor.

version: The Product Version field is a numeric expression identifying the device release number in Binary-Coded Decimal.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

By default, sig and vid are configured to indicate Realtek as the vendor. For detailed information refer to Bluetooth SIG Device Information service specifications.

## BLEHIDDevice::setManufacturerString

### Description

Set manufacturer information of the Device Information service.

### Syntax

```
void setManufacturerString (const char* manufacturer);
```

### Parameters

manufacturer: pointer to character string containing manufacturer name info.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Manufacturer is set to “Realtek” by default. For detailed information refer to Bluetooth SIG Device Information service specifications.

## **BLEHIDDevice::setModelString**

### **Description**

Set model information of the Device Information service.

### **Syntax**

```
void setModelString (const char* model);
```

### **Parameters**

model: pointer to character string containing device model info.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Model is set to “Ameba\_BLE\_HID” by default. For detailed information refer to Bluetooth SIG Device Information service specifications.

## **BLEHIDDevice::hidService**

### **Description**

Get reference to HID service

### **Syntax**

```
BLEService& hidService ();
```

### **Parameters**

The function requires no input parameter.

### Returns

The function returns a reference to the BLEService class object for the HID service.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDDevice::devInfoService

### Description

Get reference to Device Information service

### Syntax

```
BLEService& devInfoService ();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a reference to the BLEService class object for the Device Information service.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDDevice::battService

### Description

Get reference to Battery service

### Syntax

```
BLEService& battService ();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a reference to the BLEService class object for the Battery service.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## Class BLEHIDGamepad

### BLEHIDGamepad Class

#### Description

A class used for creating and managing a BLE HID Gamepad.

#### Syntax

```
class BLEHIDGamepad
```

#### Members

Public Constructors	
BLEHIDGame pad::BLEHIDGamepad	Constructs a BLEHIDGamepad object
Public Methods	
BLEHIDGamepad::setReportID	Set HID report ID for the HID Gamepad
BLEHIDGame pad::gamepadReport	Send a HID Gamepad report
BLEHIDGamepad::buttonPress	Send a HID Gamepad report indicating buttons pressed
BLEHIDGame pad::buttonRelease	Send a HID Gamepad report indicating buttons released
BLEHIDGamepad::buttonReleaseAll	Send a HID Gamepad report indicating no buttons pressed
BLEHIDGamepad::setHat	Send a HID Gamepad report indicating hat switch position
BLEHIDGamepad::setAxes	Send a HID Gamepad report indicating position of all axes
BLEHIDGamepad::setLeftStick	Send a HID Gamepad report indicating position of axes corresponding to left analog stick
BLEHIDGamepad::setRightStick	Send a HID Gamepad report indicating position of axes corresponding to right analog stick
BLEHIDGamepad::setTriggers	Send a HID Gamepad report indicating position of axes corresponding to triggers

## BLEHIDGamepad::BLEHIDGamepad

### Description

Constructs a BLE object

### Syntax

```
BLEHIDGamepad::BLEHIDGamepad();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

By default, the BLEHIDGamepad class assumes the HID report descriptor implements a gamepad device with 16 buttons, 6 16-bit axes and an 8-direction hat switch. This class will not work if a different gamepad report descriptor is implemented.

## BLEHIDGamepad::setReportID

### Description

Set HID report ID for the HID Gamepad.

### Syntax

```
void setReportID (uint8_t reportID);
```

### Parameters

reportID: The report ID for the gamepad device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

HID report ID should start at 1. Some systems may consider a report ID of 0 as invalid.

## BLEHIDGamepad::gamepadReport

### Description

Send a HID Gamepad report.

### Syntax

```
void gamepadReport (hid_gamepad_report_t* report);  
void gamepadReport (uint16_t buttons, uint8_t hat, int16_t x, int16_t y, int16_t z, int16_t Rz, int16_t Rx, int16_t Ry);
```

### Parameters

report: pointer to gamepad report structure containing data on all inputs

buttons: bitmap indicating state of each button. 1 = pressed, 0 = released.

hat: position of hat switch. Valid values:

–GAMEPAD\_HAT\_CENTERED = 0

–GAMEPAD\_HAT\_UP = 1

–GAMEPAD\_HAT\_UP\_RIGHT = 2

–GAMEPAD\_HAT\_RIGHT = 3

–GAMEPAD\_HAT\_DOWN\_RIGHT = 4

–GAMEPAD\_HAT\_DOWN = 5

–GAMEPAD\_HAT\_DOWN\_LEFT = 6

–GAMEPAD\_HAT\_LEFT = 7

–GAMEPAD\_HAT\_UP\_LEFT = 8

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad



**Notes and Warnings**

NA

**BLEHIDGamepad::buttonPress****Description**

Send a HID Gamepad report indicating buttons pressed.

**Syntax**

```
void buttonPress (uint16_t buttons);
```

**Parameters**

buttons: bitmap indicating buttons pressed. 1 = pressed.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDGamepad::buttonRelease****Description**

Send a HID Gamepad report indicating buttons released.

**Syntax**

```
void buttonRelease (uint16_t buttons);
```

**Parameters**

buttons: bitmap indicating buttons released. 1 = released.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDGamepad::buttonReleaseAll

### Description

Send a HID Gamepad report indicating no buttons pressed.

### Syntax

```
void buttonReleaseAll (void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

NA

## BLEHIDGamepad::setHat

### Description

Send a HID Gamepad report indicating hat switch position.

### Syntax

```
void setHat (uint8_t hat);
```

### Parameters

hat: position of hat switch. Valid values:

- GAMEPAD\_HAT\_CENTERED = 0
- GAMEPAD\_HAT\_UP = 1
- GAMEPAD\_HAT\_UP\_RIGHT = 2
- GAMEPAD\_HAT\_RIGHT = 3
- GAMEPAD\_HAT\_DOWN\_RIGHT = 4
- GAMEPAD\_HAT\_DOWN = 5
- GAMEPAD\_HAT\_DOWN\_LEFT = 6
- GAMEPAD\_HAT\_LEFT = 7
- GAMEPAD\_HAT\_UP\_LEFT = 8

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDGamepad::setAxes

### Description

Send a HID Gamepad report indicating position of all axes.

### Syntax

```
void setAxes (int16_t x, int16_t y, int16_t z, int16_t Rz, int16_t Rx, int16_t Ry);
```

### Parameters

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

NA

## BLEHIDGamepad::setLeftStick

### Description

Send a HID Gamepad report indicating position of axes corresponding to left analog stick.

### Syntax

```
void setLeftStick (int16_t x, int16_t y);
```

**Parameters**

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDGamepad::setRightStick****Description**

Send a HID Gamepad report indicating position of axes corresponding to right analog stick.

**Syntax**

```
void setLeftStick (int16_t z, int16_t Rz);
```

**Parameters**

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## BLEHIDGamepad::setTriggers

### Description

Send a HID Gamepad report indicating position of axes corresponding to triggers.

### Syntax

```
void setTriggers (int16_t Rx, int16_t Ry);
```

### Parameters

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Class BLEHIDKeyboard

### BLEHIDKeyboard Class

#### Description

A class used for creating and managing a BLE HID Keyboard.

#### Syntax

```
class BLEHIDKeyboard
```

#### Members

<b>Public Constructors</b>	
BLEHIDKeyboard ard::BLEHIDKeyboard	Constructs a BLEHIDKeyboard object
<b>Public Methods</b>	
BLEHIDKeyboard::setReportID	Set HID report ID for the HID Keyboard and HID consumer control
BLEHIDKeyboard::consumerReport	Send a HID Consumer report
BLEHIDKeyboard::keyboardReport	Send a HID Keyboard report
BLEHIDKeyboard::consumerPress	Send a HID Consumer report indicating button pressed
BLEHIDKeyboard::consumerRelease	Send a HID Consumer report indicating button released
BLEHIDKeyboard::keypress	Send a HID Keyboard report indicating keys pressed
BLEHIDKeyboard::keyRelease	Send a HID Keyboard report indicating keys released
BLEHIDKeyboard::keyReleaseAll	Send a HID Keyboard report indicating no keys pressed
BLEHIDKeyboard::keyCharPress	Send a HID Keyboard report indicating keys pressed to output an ASCII character
BLEHIDKeyboard::keySequence	Send a HID Keyboard report indicating keys pressed to output an ASCII string

## BLEHIDKeyboard::BLEHIDKeyboard

### Description

Constructs a BLEHIDKeyboard object.

### Syntax

```
BLEHIDKeyboard::BLEHIDKeyboard();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDKeyboard

## Notes and Warnings

NA

## BLEHIDKeyboard::setReportID

### Description

Set HID report ID for the HID Keyboard and HID consumer control.

### Syntax

```
void setReportID (uint8_t reportIDKeyboard, uint8_t reportIDConsumer);
```

### Parameters

reportIDKeyboard: The report ID for the HID keyboard device, corresponding to the HID report descriptor.

reportIDConsumer: The report ID for the HID consumer control device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## BLEHIDKeyboard::consumerReport

### Description

Send a HID Consumer report.

### Syntax

```
void consumerReport (uint16_t usage_code);
```

### Parameters



usage\_code: HID consumer control usage code for the button pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keyboardReport

### Description

Send a HID Keyboard report.

### Syntax

```
void keyboardReport (void);  
void keyboardReport (uint8_t modifiers, uint8_t keycode[6]);
```

### Parameters

modifiers: bitmap indicating key modifiers pressed (CTRL, ALT, SHIFT).  
keycode: byte array indicating keys pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::consumerPress

### Description

Send a HID Consumer report indicating button pressed.

### Syntax

```
void consumerPress (uint16_t usage_code);
```

### Parameters

usage\_code: HID consumer control usage code for the button pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::consumerRelease

### Description

Send a HID Consumer report indicating button released.

### Syntax

```
void consumerRelease (void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDKeyboard::keypress****Description**

Send a HID Keyboard report indicating keys pressed.

**Syntax**

```
void keyPress (uint16_t key);
```

**Parameters**

key: HID keycode for key pressed, value ranges from 0x00 to 0xE7.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDKeyboard

**Notes and Warnings**

NA

**BLEHIDKeyboard::keyRelease****Description**

Send a HID Keyboard report indicating keys released.

**Syntax**

```
void keyRelease (uint16_t key);
```

### Parameters

key: HID keycode for key pressed, value ranges from 0x00 to 0xE7.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keyReleaseAll

### Description

Send a HID Keyboard report indicating no keys pressed.

### Syntax

```
void keyReleaseAll(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDKeyboard

### Notes and Warnings

NA

## BLEHIDKeyboard::keyCharPress

### Description

Send a HID Keyboard report indicating keys pressed to output an ASCII character.

### Syntax

```
void keyCharPress (char ch);
```

### Parameters

ch: ASCII character to output.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keySequence

### Description

Send a HID Keyboard report indicating keys pressed to output an ASCII string.

### Syntax

```
void keySequence (const char* str, uint16_t delayTime);  
void keySequence (String str, uint16_t delayTime);
```

### Parameters

str: pointer to character string to output

str: String object containing character string to output

delayTime: time delay between key press and release, in milliseconds. Default value of 5.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDKeyboard

**Notes and Warnings**

NA

**Class BLEHIDMouse****BLEHIDMouse Class****Description**

A class used for creating and managing a BLE HID Mouse.

**Syntax**

```
class BLEHIDMouse
```

**Members**

Public Constructors	
BLE HIDMouse::BLEHIDMouse	Constructs a BLEHIDMouse object
Public Methods	
BLE HIDMouse::setReportID	Set HID report ID for the HID Mouse
BLE HIDMouse::mouseReport	Send a HID Mouse report
BL EHIDMouse::mousePress	Send a HID Mouse report indicating buttons pressed
BLEH IDMouse::mouseRelease	Send a HID Mouse report indicating buttons released
BLEHIDM ouse::mouseReleaseAll	Send a HID Mouse report indicating no buttons pressed
B LEHIDMouse::mouseMove	Send a HID Mouse report indicating mouse movement
BLE HIDMouse::mouseScroll	Send a HID Mouse report indicating mouse scroll wheel movement

## BLEHIDMouse::BLEHIDMouse

### Description

Constructs a BLEHIDMouse object.

### Syntax

```
BLEHIDMouse::BLEHIDMouse();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::setReportID

### Description

Set HID report ID for the HID Mouse.

### Syntax

```
void setReportID (uint8_t reportID);
```

### Parameters

reportID: The report ID for the HID mouse device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDMouse::mouseReport

### Description

Send a HID Mouse report.

### Syntax

```
void mouseReport (hid_mouse_report_t* report);  
void mouseReport (uint8_t buttons, int8_t x, int8_t y, int8_t scroll);
```

### Parameters

report: pointer to mouse report structure containing data on mouse inputs

buttons: bitmap indicating state of each button. 1 = pressed, 0 = released.

x: mouse x-axis movement. Integer value from -127 to 127.

y: mouse y-axis movement. Integer value from -127 to 127.

scroll: mouse scroll wheel movement. Integer value from -127 to 127.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA



## BLEHIDMouse::mousePress

### Description

Send a HID Mouse report indicating buttons pressed.

### Syntax

```
void mousePress (uint8_t buttons);
```

### Parameters

buttons: bitmap indicating buttons pressed. 1 = pressed.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::mouseRelease

### Description

Send a HID Mouse report indicating buttons released.

### Syntax

```
void mouseRelease (uint8_t buttons);
```

### Parameters

buttons: bitmap indicating buttons released. 1 = released.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::mouseReleaseAll

### Description

Send a HID Mouse report indicating no buttons pressed.

### Syntax

```
void mouseReleaseAll(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDMouse::mouseMove

### Description

Send a HID Mouse report indicating mouse movement.

### Syntax

```
void mouseMove (int8_t x, int8_t y);
```

**Parameters**

x: mouse x-axis movement. Integer value from -127 to 127.

y: mouse y-axis movement. Integer value from -127 to 127.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDMouse

**Notes and Warnings**

NA

**BLEHIDMouse::mouseScroll****Description**

Send a HID Mouse report indicating mouse scroll wheel movement.

**Syntax**

```
void mouseScroll (int8_t scroll);
```

**Parameters**

scroll: mouse scroll wheel movement. Integer value from -127 to 127.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDMouse

**Notes and Warnings**

NA

## Class BLERemoteCharacteristic

### BLERemoteCharacteristic Class

#### Description

A class used for managing BLE GATT characteristics on connected remote devices.

#### Syntax

```
class BLERemoteCharacteristic
```

#### Members

Public Constructors
No public constructor is available for this class. You can get a pointer to an instance of this class using BLERemoteService::getCharacteristic().

Public Methods	
BLERemoteCharacteristic::getDescriptor	Get a specific descriptor on the remote device
BLERemoteCharacteristic::getUUID	Get the characteristic UUID
BLERemoteCharacteristic::setBufferLen	Set the size of the internal data buffer
BLERemoteCharacteristic::getBufferLen	Get the current size of the internal data buffer
BLERemoteCharacteristic::canRead	Determine if characteristic has read property enabled
BLERemoteCharacteristic::canWrite	Determine if characteristic has write property enabled
BLERemoteCharacteristic::canNotify	Determine if characteristic has notify property enabled
BLERemoteCharacteristic::canIndicate	Determine if characteristic has indicate property enabled
BLERemoteCharacteristic::getProperties	Get the characteristic properties
BLERemoteCharacteristic::readString	Read the characteristic data buffer as a String object
BLERemoteCharacteristic::readData8	Read the characteristic data buffer as an unsigned 8-bit integer
BLERemoteCharacteristic::readData16	Read the characteristic data buffer as an unsigned 16-bit integer
BLERemoteCharacteristic::readData32	Read the characteristic data buffer as an unsigned 32-bit integer
BLERemoteCharacteristic::writeString	Write data to the characteristic as a String object or character array
BLERemoteCharacteristic::writeData8	Write data to the characteristic as an unsigned 8-bit integer
BLERemoteCharacteristic::writeData16	Write data to the characteristic as an unsigned 16-bit integer
BLERemoteCharacteristic::writeData32	Write data to the characteristic as an unsigned 16-bit integer
BLERemoteCharacteristic::setData	Write data to the characteristic
BLERemoteCharacteristic::getData	Read data from the characteristic
BLERemoteCharacteristic::enableNotifyIndicate	Enable notification or indication for the characteristic
BLERemoteCharacteristic::disableNotifyIndicate	Disable notification and indication for the characteristic
BLERemoteCharacteristic::setNotifyCallback	Set a user function as a notification callback

## BLERemoteCharacteristic::getDescriptor

### Description

Get a descriptor with the specified UUID on the remote device.

### Syntax

```
BLERemoteDescriptor* getDescriptor(const char* uuid);
```

```
BLERemoteDescriptor* getDescriptor(BLEUUID uuid);
```

### Parameters

uuid: the desired descriptor UUID, expressed as a character array or a BLEUUID object

### Returns

The function returns the found descriptor as a BLERemoteDescriptor object pointer, otherwise nullptr is returned if a descriptor with the UUID is not found.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::getUUID

### Description

Get the characteristic UUID.

### Syntax

```
BLEUUID getUUID();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the characteristic UUID as a BLEUUID class object.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::setBufferLen

### Description

Set the size of the internal data buffer of the characteristic.

### Syntax

```
void setBufferLen(uint16_t max_len);
```

### Parameters

max\_len: number of bytes to resize the internal buffer to.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartClient

### Notes and Warnings

Characteristic data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

## BLERemoteCharacteristic::getBufferLen

### Description

Get the size of the characteristic internal buffer.

### Syntax

```
uint16_t getBufferLen();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the currently set internal buffer size.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::canRead

### Description

Determine if characteristic has read property enabled.

### Syntax

```
bool canRead();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns TRUE if the read property for the characteristic is enabled.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::canWrite



**Description**

Determine if characteristic has write property enabled.

**Syntax**

```
bool canWrite();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns TRUE if the write property for the characteristic is enabled.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::canNotify****Description**

Determine if characteristic has notify property enabled.

**Syntax**

```
bool canNotify();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns TRUE if the notify property for the characteristic is enabled.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::canIndicate

### Description

Determine if characteristic has indicate property enabled.

### Syntax

```
bool canIndicate();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns TRUE if the indicate property for the characteristic is enabled.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::getProperties

### Description

Get the characteristic properties.

**Syntax**

```
uint16_t getProperties();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the characteristic properties.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::readString****Description**

Request for characteristic data from the remote device and read the data in the buffer, expressed as a String class object.

**Syntax**

```
String readString();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic buffer expressed as a String class object.

**Example Code**

Example: BLEUartClient

## Notes and Warnings

NA

## BLERemoteCharacteristic::readData8

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 8-bit integer.

### Syntax

```
uint8_t readData8();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic buffer expressed as a uint8\_t value.

### Example Code

Example: BLEBatteryClient

## Notes and Warnings

NA

## BLERemoteCharacteristic::readData16

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 16-bit integer.

**Syntax**

```
uint16_t readData16();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic buffer expressed as a uint16\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::readData32****Description**

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 32-bit integer.

**Syntax**

```
uint32_t readData32();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic buffer expressed as a uint32\_t value.

**Example Code**

NA

#### Notes and Warnings

NA

### BLERemoteCharacteristic::writeString

#### Description

Write data to the remote device characteristic as a String object or character array.

#### Syntax

```
bool writeString(String str);  
bool writeString(const char* str);
```

#### Parameters

str: the data to write to the remote characteristic, expressed as a String class object or a char array.

#### Returns

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteCharacteristic::writeData8

#### Description

Write data to the remote device characteristic as an unsigned 8-bit integer.

**Syntax**

```
bool writeData8(uint8_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 8-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::writeData16****Description**

Write data to the remote device characteristic as an unsigned 16-bit integer.

**Syntax**

```
bool writeData16(uint16_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 16-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

## Notes and Warnings

NA

## BLERemoteCharacteristic::writeData32

### Description

Write data to the remote device characteristic as a 32-bit integer.

### Syntax

```
bool writeData32(uint32_t num);
```

```
bool writeData32(int num);
```

### Parameters

num: the data to write to the characteristic buffer expressed as a 32-bit integer.

### Returns

The function returns TRUE if write data is successful.

## Example Code

NA

## Notes and Warnings

NA

## BLERemoteCharacteristic::setData

### Description

Write data to the remote device characteristic.

### Syntax



```
bool setData(uint8_t* data, uint16_t datalen);
```

**Parameters**

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::getData****Description**

Request for characteristic data from the remote device and read the data in the buffer.

**Syntax**

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

**Parameters**

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

**Returns**

The function returns the number of bytes read.

**Example Code**

NA

### Notes and Warnings

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

## BLERemoteCharacteristic::enableNotifyIndicate

### Description

Enable the remote device to send notifications or indications for the characteristic.

### Syntax

```
void enableNotifyIndicate(bool notify = 1);
```

### Parameters

notify: TRUE to enable notifications, FALSE to enable indications.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartClient

### Notes and Warnings

NA

## BLERemoteCharacteristic::disableNotifyIndicate

### Description

Disable receiving notifications and indications for the characteristic from the remote device.

**Syntax**

```
void disableNotifyIndicate();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::setNotifyCallback****Description**

Set a user function to be called when the characteristic receives a notification from the remote device.

**Syntax**

```
void setNotifyCallback(void (*fCallback) (BLERemoteCharacteristic* chr, uint8_t* data, uint16_t length));
```

**Parameters**

fCallback: A user callback function that returns void and takes three arguments.

chr: pointer to BLERemoteCharacteristic object associated with notification.

data: pointer to byte array containing notification data.

length: number of bytes of notification data in array.

**Returns**

The function returns nothing.

## Example Code

Example: BLEUartClient

## Notes and Warnings

NA

## Class BLERemoteDescriptor

### BLERemoteDescriptor Class

#### Description

A class used for managing BLE GATT descriptors on connected remote devices.

#### Syntax

```
class BLERemoteDescriptor
```

#### Members

Public Constructors
No public constructor is available for this class. You can get a pointer to an instance of this class using BLERemoteCharacteristic::getDescriptor().

Public Methods	
BLERemoteDescriptor::getUUID	Get the descriptor UUID
BLERemoteDescriptor::setBufferLen	Set the size of the internal data buffer
BLERemoteDescriptor::getBufferLen	Get the current size of the internal data buffer
BLERemoteDescriptor::readString	Read the descriptor data buffer as a String object
BLERemoteDescriptor::readData8	Read the descriptor data buffer as an unsigned 8-bit integer
BLERemoteDescriptor::readData16	Read the descriptor data buffer as an unsigned 16-bit integer
BLERemoteDescriptor::readData32	Read the descriptor data buffer as an unsigned 32-bit integer
BLERemoteDescriptor::writeString	Write data to the descriptor as a String object or character array
BLERemoteDescriptor::writeData8	Write data to the descriptor as an unsigned 8-bit integer
BLERemoteDescriptor::writeData16	Write data to the descriptor as an unsigned 16-bit integer
BLERemoteDescriptor::writeData32	Write data to the descriptor as an unsigned 16-bit integer
BLERemoteDescriptor::setData	Write data to the descriptor
BLERemoteDescriptor::getData	Read data from the descriptor

**BLERemoteDescriptor::getUUID****Description**

Get the descriptor UUID.

**Syntax**

```
BLEUUID getUUID();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the descriptor UUID as a BLEUUID class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::setBufferLen****Description**

Set the size of the internal data buffer of the descriptor.

**Syntax**

```
void setBufferLen(uint16_t max_len);
```

**Parameters**

max\_len: number of bytes to resize the internal buffer to.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Descriptor data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

## BLERemoteDescriptor::getBufferLen

### Description

Get the size of the descriptor internal buffer.

### Syntax

```
uint16_t getBufferLen();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the currently set internal buffer size.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::readString

**Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as a String class object.

**Syntax**

```
String readString();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a String class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::readData8****Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 8-bit integer.

**Syntax**

```
uint8_t readData8();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a uint8\_t value.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::readData16

#### Description

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 16-bit integer.

#### Syntax

```
uint16_t readData16();
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the data in the descriptor buffer expressed as a uint16\_t value.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::readData32



**Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 32-bit integer.

**Syntax**

```
uint32_t readData32();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a uint32\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::writeString****Description**

Write data to the remote device descriptor as a String object or character array.

**Syntax**

```
bool writeString(String str);  
bool writeString(const char* str);
```

**Parameters**

str: the data to write to the remote descriptor, expressed as a String class object or a char array.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::writeData8

### Description

Write data to the remote device descriptor as an unsigned 8-bit integer.

### Syntax

```
bool writeData8(uint8_t num);
```

### Parameters

num: the data to write to the descriptor buffer expressed as an unsigned 8-bit integer.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::writeData16

**Description**

Write data to the remote device descriptor as an unsigned 16-bit integer.

**Syntax**

```
bool writeData16(uint16_t num);
```

**Parameters**

num: the data to write to the descriptor buffer expressed as an unsigned 16-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::writeData32****Description**

Write data to the remote device descriptor as a 32-bit integer.

**Syntax**

```
bool writeData32(uint32_t num);  
bool writeData32(int num);
```

**Parameters**

num: the data to write to the descriptor buffer expressed as a 32-bit integer.

**Returns**

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::setData

#### Description

Write data to the remote device descriptor.

#### Syntax

```
bool setData(uint8_t* data, uint16_t datalen);
```

#### Parameters

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

#### Returns

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::getData

**Description**

Request for descriptor data from the remote device and read the data in the buffer.

**Syntax**

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

**Parameters**

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

**Returns**

The function returns the number of bytes read.

**Example Code**

NA

**Notes and Warnings**

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

**Class BLERemoteService****BLERemoteService Class****Description**

A class used for managing BLE GATT services on connected remote devices.

**Syntax**

```
class BLERemoteService
```

**Members**

**Public Constructors**

No public constructor is available for this class. You can get a pointer to an instance of this class using BLE-Client::getService().

Public Methods	
BLERemoteService::getUUID	Get the service UUID
BLE RemoteService::getCharacteristic	Get a specific characteristic on the remote device

**BLERemoteService::getUUID****Description**

Get the service UUID.

**Syntax**

```
BLEUUID getUUID();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the service UUID as a BLEUUID class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteService::getCharacteristic****Description**

Get a characteristic with the specified UUID on the remote device.

**Syntax**

```
BLERemoteCharacteristic* getCharacteristic (const char* uuid);
BLERemoteCharacteristic* getCharacteristic (BLEUUID uuid);
```

**Parameters**

uuid: the desired characteristic UUID, expressed as a character array or a BLEUUID object.

**Returns**

The function returns the found characteristic as a BLERemoteCharacteristic object pointer, otherwise nullptr is returned if a characteristic with the UUID is not found.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

**Class BLEScan****BLEScan Class****Description**

A class used for managing BLE scanning settings.

**Syntax**

```
class BLEScan
```

**Members****Public Constructors**

No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using BLEDevice::configScan

Public Methods	
BLEScan::updateScanParams	Update the current BLE advertisement settings to the lower Bluetooth stack
BLEScan::startScan	Start a BLE scan
BLEScan::stopScan	Stop a BLE scan
BLEScan::setScanMode	Set the BLE scanning mode
BLEScan::setScanInterval	Set the BLE scanning interval
BLEScan::setScanWindow	Set the BLE scanning window
BLEScan::setScanDuplicateFilter	Set the BLE scan duplicate filter
BLEScan::scanInProgress	Check if a scan is currently in progress
BLEScan::printScanInfo	Print out scanned information

### **BLEScan::updateScanParams**

#### **Description**

Update the lower Bluetooth stack with the current scan settings.

#### **Syntax**

```
void updateScanParams(void);
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: BLEScan

#### **Notes and Warnings**

Stop any scans in progress first before using this function.

### **BLEScan::startScan**



**Description**

Start BLE scanning.

**Syntax**

```
void startScan();  
void startScan(uint32_t scanDuration_ms);
```

**Parameters**

scanDuration: BLE scan will stop after scanDuration milliseconds.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

Set the scan parameters first before starting a scan. BLE scans will occur continuously for the duration set with BLEDevice::setScanWindow() and will repeat with a time interval set with BLEDevice::setScanInterval(). Call this member function without an argument to start scanning until BLEDevice::stopScan() is called.

**BLEScan::stopScan****Description**

Stop BLE scanning.

**Syntax**

```
void stopScan(void);
```

**Parameters**

The function requires no input paramter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEScan::setScanMode

### Description

Set the BLE scan mode.

### Syntax

```
void setScanMode(uint8_t scanMode);
```

### Parameters

scanMode: GAP\_SCAN\_MODE\_PASSIVE for passive scanning, GAP\_SCAN\_MODE\_ACTIVE for active scanning

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

### Notes and Warnings

Active scanning will request for scan response packets after discovering an advertising device. Passive scanning will only capture advertising data packets.

## **BLEScan::setScanInterval**

### **Description**

Set the BLE scan interval.

### **Syntax**

```
void setScanInterval(uint16_t scanInt_ms);
```

### **Parameters**

scanInt\_ms: scan interval in milliseconds. Value range of 3 to 10240.

### **Returns**

The function returns nothing.

### **Example Code**

Example: BLEScan

### **Notes and Warnings**

A BLE scan will repeat with a time interval set with this member function.

## **BLEScan::setScanWindow**

### **Description**

Set the BLE scan window.

### **Syntax**

```
void setScanWindow(uint16_t scanWindow_ms);
```

### **Parameters**

scanWindow\_ms: scan window in milliseconds. Value range of 3 to 10240.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

A BLE scan will scan continuously for a window duration set with this member function. The scan window should be less than or equal to the scan interval.

**BLEScan::setScanDuplicateFilter****Description**

Set the scan duplicate filter.

**Syntax**

```
void setScanDuplicateFilter(bool dupeFilter);
```

**Parameters**

dupeFilter: TRUE to enable duplicate filtering.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Enabling duplicate filters will ignore scan results for devices already discovered previously.

**BLEScan::scanInProgress****Description**

Set the scan duplicate filter.

**Syntax**

```
bool scanInProgress(void);
```

**Parameters**

The function requires no input paramter.

**Returns**

TRUE if BLE scanning is in progress.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEScan::printScanInfo****Description**

Parse and print out scanned information.

**Syntax**

```
void printScanInfo(T_LE_CB_DATA* p_data);
```

**Parameters**

p\_data: pointer to scan data of type T\_LE\_CB\_DATA\*

**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

Use this member function to parse the various fields of received advertisement data packets and print the results out to the serial monitor.

**Class BLEService****BLEService Class****Description**

A class used for creating and managing BLE GATT services.

**Syntax**

```
class BLEService
```

**Members**

Public Constructors	
BLEService::BLEService	Constructs a BLEService object
Public Methods	
BLEService::setUUID	Set service UUID
BLEService::getUUID	Get service UUID
BLEService::addCharacteristic	Add a characteristic to service
BLEService::getCharacteristic	Get a previously added characteristic

**BLEService::BLEService****Description**

Constructs a BLEService object.

**Syntax**

```
BLEService::BLEService(BLEUUID uuid);  
BLEService::BLEService(const char* uuid);
```

**Parameters**

uuid: service UUID, expressed as a BLEUUID class object or a character array

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLEService::setUUID****Description**

Set the service UUID.

**Syntax**

```
void setUUID(BLEUUID uuid);
```

**Parameters**

uuid: service UUID, expressed as a BLEUUID class object.

**Returns**

The function returns nothing.

**Example Code**

NA

#### Notes and Warnings

NA

### BLEService::getUUID

#### Description

Get the service UUID.

#### Syntax

```
BLEUUID getUUID();
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the service UUID in a BLEUUID class object.

#### Example Code

NA

#### Notes and Warnings

NA

### BLEService::addCharacteristic

#### Description

Add a characteristic to the service.



**Syntax**

```
void addCharacteristic(BLECharacteristic& newChar);
```

**Parameters**

newChar: the BLECharacteristic to add to the service.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLEService::getCharacteristic****Description**

Get a previously added characteristic.

**Syntax**

```
BLECharacteristic* getCharacteristic(uint8_t charIndex);
```

**Parameters**

charIndex: position index of characteristic.

**Returns**

The function returns a pointer to the BLECharacteristic at the requested position index.

**Example Code**

NA

## Notes and Warnings

NA

## Class BLEUUID

### BLEUUID Class

#### Description

A class used for creating and managing UUIDs.

#### Syntax

```
class BLEUUID
```

#### Members

Public Constructors	
BLEUUID::BLEUUID	Create a UUID object
Public Methods	
BLEUUID::str	Get the character string representation of UUID
BLEUUID::data	Get the binary representation of UUID
BLEUUID::length	Get the length of UUID

### BLEUUID::BLEUUID

#### Description

Create a UUID object from a UUID character string

#### Syntax

```
BLEUUID();  
BLEUUID(const char* str);  
BLEUUID(uint8_t* data, uint8_t length);
```

#### Parameters

str: UUID character string used to created object

data: pointer to byte array containing the desired UUID

length: number of bytes in array containing the desired UUID. Valid values of 2, 4 or 16

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****BLEUUID::str****Description**

Get the character string representation of UUID

**Syntax**

```
const char* str(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Pointer to a character string representation of the UUID

**Example Code**

NA

**Notes and Warnings****BLEUUID::data**

### Description

Get the binary representation of UUID

### Syntax

```
const uint8_t* data(void);
```

### Parameters

The function requires no input parameter.

### Returns

Pointer to an unsigned 8-bit integer array containing the UUID expressed in binary form

### Example Code

NA

### Notes and Warnings

Returned pointer is of const uint8\_t\* type and will not allow changing of the data.

## BLEUUID::length

### Description

Get the length of UUID

### Syntax

```
uint8_t length(void);
```

### Parameters

The function requires no input parameter.

### Returns

Length of the UUID, in terms of bytes

**Example Code**

NA

**Notes and Warnings**

A 4-character UUID will be 16 bits / 2 bytes long.

A 32-character UUID will be 128 bits / 16 bytes long.

**Class BLEWifiConfigService****BLEWifiConfigService Class****Description**

A class used for managing a BLE WiFi configuration service running on the device.

**Syntax**

```
class BLEWifiConfigService
```

**Members**

Public Constructors	
BLEWifiCon figService::BLEWifiConfigService	Only one instance of this class should be created

Public Methods	
BLEWifiConfigService::begin	Start background thread to process WiFi configuration commands
BLEWifiConfigService::end	Stop background thread processing WiFi configuration commands
BLEWifiConfigService::addService	Add the service to the BLE stack
BLEWifiConfigService::advData	Get advertising data correctly formatted for WiFi configuration service

**BLEWifiConfigService::BLEWifiConfigService****Description**

Create an instance of the BLEWifiConfigService object.

**Syntax**

```
void BLEWifiConfigService ();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEWifiConfig

### Notes and Warnings

Only one instance of this class / service should be created.

### BLEWifiConfigService::begin

### Description

Start background thread to process WiFi configuration commands.

### Syntax

```
void begin();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEWifiConfig

**Notes and Warnings**

NA

**BLEWifiConfigService::end****Description**

Stop background thread processing WiFi configuration commands.

**Syntax**

```
void end();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEWifiConfigService::addService****Description**

Add the WiFi configuration service to the BLE stack.

**Syntax**

```
void addService();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEWifiConfig

### Notes and Warnings

NA

## BLEWifiConfigService::advData

### Description

Get advertising data correctly formatted for WiFi configuration service.

### Syntax

```
BLEAdvertData advData();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a BLEAdvertData object that contains the required advertising data fields for the WiFi configuration service to work.

### Example Code

Example: BLEWifiConfig

### Notes and Warnings



The advertisement data needs to be correctly formatted for the corresponding smartphone app to recognise the device. WiFi configuration service advertisement data requires the local BT address, and should be called only after peripheral mode is started and may also require stopping and restarting the advertising process.

## EPDIF

### Class EpdIF

#### EpdIf Class

#### Description

A class used to control the electronic paper display internal functions.

#### Syntax

```
class EpdIf
```

#### Members

##### Public Constructors

A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named EpdIf.

##### Public Methods

EpdIf::EPD_Dis_Part	Put an image buffer to the frame memory, but not updating the display
EpdIf::EPD_SetFrame	Put display data to the frame memory, usually used for setup text display functions
EpdIf::EPD_SetRAMValue_BaseMap	To read image data stored in the RAM, but not display on the screen
EpdIf::EPD_SetFrameMemory	To read image data stored in the buffer, but not display on the screen
EpdIf::EPD_UpdateDisplay	Update the display
EpdIf::EPD_ClearScreen_White	Clear the frame memory with the White color, but not updating the display
EpdIf::EPD_ClearScreen_Black	Clear the frame memory with the Black color, but not updating the display
EpdIf::EPD_Busy	Wait until the Busy pin goes to low, which is the idle state
EpdIf::EPD_Reset	Used for the Epaper module reset. Often used to awaken the module in deep sleep
EpdIf::EPD_Sleep	After this command is transmitted, the chip would enter the deep-sleep mode to save power

## **EpdIf:: EPD\_Dis\_Part**

### **Description**

Put an image buffer to the frame memory, but not updating the display.

### **Syntax**

```
void EPD_Dis_Part(unsigned int x_start, unsigned int y_start, const unsigned char* datas, unsigned int PART_COLUMN, unsigned int PART_LINE);
```

### **Parameters**

x\_start: starting position of the x-axis

y\_start: starting position of the y-axis

datas: data to be displayed on the e-paper module

PART\_COLUMN: height of the display area

PART\_LINE: width of the display area

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **EpdIf:: EPD\_SetFrame**

### **Description**

Put display data to the frame memory, usually used for setup text display functions.

### **Syntax**

```
void EPD_SetFrame(const unsigned char* image_buffer, int x, int y, int image_width, int image_height);
```

**Parameters**

image\_buffer: the buffer which stores the data to be displayed on the e-paper module, usually used to display texts.

x: starting position of the x-axis

y: starting position of the y-axis

image\_width: width of the display area

image\_height: height of the display area

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**EpdIf:: EPD\_SetRAMValue\_BaseMap****Description**

To read image data stored in the RAM, but not display on the screen.

**Syntax**

```
void EPD_SetRAMValue_BaseMap(const unsigned char* datas);
```

**Parameters**

datas: contains the black and white information that forms the image stored in RAM

**Returns**

The function returns nothing.

**Example Code**

NA

## Notes and Warnings

NA

## EpdIf:: EPD\_SetFrameMemory

### Description

To read image data stored in the buffer but not display on the screen.

### Syntax

```
void EPD_SetFrameMemory(const unsigned char* image_buffer);
```

### Parameters

image\_buffer: the buffer where stores the image data in hexadecimal numbers

### Returns

The function returns nothing.

## Example Code

NA

## Notes and Warnings

NA

## EpdIf:: EPD\_UpdateDisplay

### Description

Update the ePaper display module. Always combined used with functions set the frames.

### Syntax

```
void EPD_UpdateDisplay(void);
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

There are 2 memory areas embedded in the e-paper display but once this function is called, then the next action of SetFrameMemory or ClearScreen will set the other memory area.

**EpdIf:: EPD\_ClearScreen\_White****Description**

Clear the frame memory with the White color.

**Syntax**

```
void EpdIf::EPD_ClearScreen_White(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

## **EpdIf:: EPD\_ClearScreen\_Black**

### **Description**

Clear the frame memory with the Black color.

### **Syntax**

```
void EpdIf::EPD_ClearScreen_Black(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

## **EpdIf:: EPD\_Busy**

### **Description**

Wait until the busy\_pin goes to low, which is the idle state.

### **Syntax**

```
void EpdIf::EPD_Busy(void);
```

### **Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

**EpdIf:: EPD\_Reset****Description**

This command will let the E-paper module reset, it is often used to awaken the module in while it' s in the deep sleep mode, you will find more details in the function EpdIf:: EPD\_Sleep().

**Syntax**

```
void EpdIf::EPD_Reset(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**EpdIf::EPD\_Sleep**

### Description

After this command is transmitted, the chip would enter the deep-sleep mode to save power. The deep sleep mode would return to standby by hardware reset. You can use EPD:: Init() to awaken the E-paper module.

### Syntax

```
void EpdIf::EPD_Sleep(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

---

## FatfsSDCard

### Class SdFatFs

#### Description

Defines a class of SD FAT File system.

#### Syntax

```
class SdFatFs
```

#### Members

##### Public Constructors

SdFatFs::SdFatFs Constructs a SdFatFs object

SdFatFs::~~SdFatFs Destructs a SdFatFs object



**Public Methods**

SdFatFs::begin	Initialize SD FAT File System
SdFatFs::end	Deinitialize SD FAT File System
SdFatFs::*getRootPath	Get the root path of the SD FAT File System
SdFatFs::readDir	List items under a specific folder
SdFatFs::mkdir	Create folder
SdFatFs::rm	Remove folder or file
SdFatFs::isDir	Check if a specific path is a directory
SdFatFs::isFile	Check if a specific path is a file
SdFatFs::getLastModTime	Get the last modified time for a file or directory
SdFatFs::setLastModTime	Set the last modified time for a file or directory
SdFatFs::status	Return the current status of SD
SdFatFs::open	Open a file

**SdFatFs::begin****Description**

Initialize SD FAT File System.

**Syntax**

```
int SdFatFs::begin(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## **SdFatFs::end**

### **Description**

De-initialize SD FAT File System.

### **Syntax**

```
int SdFatFs::end(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

Returns “0” if success, else returns a negative value.

### **Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

### **Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## **SdFatFs::\*getRootPath**

### **Description**

Get the root path of the SD FAT File System. The logical volume character is starting from ‘0’, so the root path would like “0:” .

### **Syntax**

```
char *SdFatFs::getRootPath(void);
```

### **Parameters**

The function requires no input parameter.

**Returns**

The function returns the root path.

**Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::readDir****Description**

List items under a specific folder. List items under a specific folder and store the result in the buffer that user specified. Each item is separated by ‘0’ .

**Syntax**

```
int SdFatFs::readDir(char *path, char *result_buf, unsigned int bufsize);
```

**Parameters**

path: The absolute directory path to be listed.

result\_buf: The buffer to be stored results.

bufsize: The size of result\_buf. If results exceed this size, then the results larger than this size would be discarded.

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

Example: get\_file\_attribute; list\_root\_files

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## **SdFatFs::mkdir**

### **Description**

Create folder.

### **Syntax**

```
int SdFatFs::mkdir(char *absolute_path);
```

### **Parameters**

absolute\_path: The absolute directory path to be created

### **Returns**

Returns “0” if success, else returns a negative value.

### **Example Code**

Example: create\_folder

### **Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## **SdFatFs::rm**

### **Description**

Remove folder or file.

### **Syntax**

```
int SdFatFs::rm(char *absolute_path);
```

### **Parameters**

absolute\_path: The absolute directory or file path to be deleted

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

NA

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::isDir****Description**

Check if a specific path is a directory.

**Syntax**

```
unsigned char SdFatFs::isDir(char *absolute_path);
```

**Parameters**

absolute\_path: The absolute path to be queried

**Returns**

The function returns “1” if it is a directory, else returns “0” .

**Example Code**

Example: get\_file\_attribute

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::isFile**

### Description

Check if a specific path is a file.

### Syntax

```
unsigned char SdFatFs::isFile(char *absolute_path);
```

### Parameters

absolute\_path: The absolute path to be queried

### Returns

The function returns “1” if it is a directory, else returns “0” .

### Example Code

Example: get\_file\_attribute

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::getLastModTime

### Description

Get the last modified time for a file or directory.

### Syntax

```
int SdFatFs::getLastModTime(char *absolute_path, uint16_t *year, uint16_t *month, uint16_t *date, uint16_t *hour, uint16_t *minute, uint16_t *second);
```

### Parameters

absolute\_path: The absolute path to be queried.

year: The value of the year.

month: The value of the month.

date: The value of the date.

hour: The value of an hour.

minute: The value of a minute.

second: field “second” contains no valid information in the current version.

### Returns

The function returns “0” if success, otherwise returns a negative value for failure.

### Example Code

Example: last\_modified\_time

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::setLastModTime

### Description

Set the last modified time for a file or directory. Ameba doesn't have built-in RTC. So we manually change file/directory last modified time.

### Syntax

```
int SdFatFs::setLastModTime(char *absolute_path, uint16_t year, uint16_t month, uint16_t date, uint16_t hour,
uint16_t minute, uint16_t second);
```

### Parameters

absolute\_path: The absolute path to be queried.

year: The value of the year.

month: The value of the month.

date: The value of the date.

hour: The value of an hour.

minute: The value of a minute.

second: field “second” contains no valid information in the current version.

### Returns

The function returns “0” if success, otherwise returns a negative value for failure.

### Example Code

Example: last\_modified\_time

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::open

### Description

Open a file.

### Syntax

```
SdFatFile SdFatFs::open(char *absolute_path);
```

### Parameters

absolute\_path: The path to a file.

### Returns

The file object is an instance of SdFatFile.

### Example Code

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::status



**Description**

Return the current status of SD.

**Syntax**

```
int SdFatFs::status(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Function returns “1” if ready to use, else return “0” if the status is inactivating or abnormal.

**Example Code**

NA.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**Class SdFatFile****Description**

Defines a class of SD FAT File.

**Syntax**

```
class SdFatFile
```

**Members**

Public Constructors	
SdFatFile::SdFatFile	Constructs a SdFatFile object
SdFatFile::~SdFatFile	Destructs a SdFatFile object
Public Methods	
SdFatFile::write	Write 1 byte/bytes to file
SdFatFile::read	Read 1 byte/bytes from the file
SdFatFile::peek	Read 1 byte from file without move curser
SdFatFile::available	Check if the cursor is at EOF (End-Of-File)
SdFatFile::bool	Check if file is opened
SdFatFile::seek	Change cursor to a specific position
SdFatFile::close	Close file

### SdFatFile::write

#### Description

Write 1 byte or bytes to the file.

#### Syntax

```
size_t SdFatFile::write(uint8_t c);
```

```
size_t SdFatFile::write(const uint8_t *buf, size_t size);
```

#### Parameters

c: The character to be written.

buf: The buffer to be written.

size: The length of buffer to be written.

#### Returns

The function returns the number of byte count that has been successfully written to the file.

#### Example Code

NA.

#### Notes and Warnings

Include “SdFatFile.h” to use the class function.

**SdFatFile:: read****Description**

Read 1 byte or bytes from the file.

**Syntax**

```
int SdFatFile::read(void);
```

```
int SdFatFile::read(void *buf, uint16_t nbyte);
```

**Parameters**

buf: The buffer to store the content.

nbyte: The buffer size. (Or can be regarded as the desired length to read).

**Returns**

The function returns a read character or the read size of the buffer.

**Example Code**

```
1. #include 「FatFs_SD.h」
2.
3. char dirname[] = 「testdir」 ;
4. char filename[] = 「test.txt」 ;
5. char write_content[] = 「hello world!」 ;
6.
7. FatFsSD fs;
8.
9. void setup() {
10. char buf[128];
11. char absolute_filename[128];
12.
13. fs.begin();
14.
```

```
15. sprintf(absolute_filename, 「%s%s」 , fs.getRootPath(), dirname);
16. fs.mkdir(absolute_filename);
17. printf(「create dir at \」 %s”rn」 , absolute_filename);
18.
19. sprintf(absolute_filename, 「%s%s/%s」 , fs.getRootPath(), dirname, filename);
20. SdFatFile file = fs.open(absolute_filename);
21. file.println(write_content);
22. file.close();
23. printf(「create file at \」 %s”rn」 , absolute_filename);
24.
25. printf(「read back from \」 %s”rn」 , absolute_filename);
26. file = fs.open(absolute_filename);
27.
28. memset(buf, 0, sizeof(buf));
29. file.read(buf, sizeof(buf));
30.
31. file.close();
32. printf(「==== content ====rn」 );
33. printf(「%s」 , buf);
34. printf(「==== end ====rn」 );
35.
36. fs.end();
37. }
38.
39. void loop() {
40. delay(1000);
41. }
42.
```

Example: create\_folder;

This example shows how to create a folder and open a file under it.

```
1. #include 「FatFs_SD.h」
2.
3. char filename[] = 「test.txt」 ;
4. char write_content[] = 「hello world!」 ;
5.
6. FatFsSD fs;
7.
8. void setup() {
9.   char buf[128];
10.  char absolute_filename[128];
11.
12.  fs.begin();
13.
14.  printf(「write something to \」 %s\rn」 , filename);
15.  sprintf(absolute_filename, 「%s%s」 , fs.getRootPath(), filename);
16.  SdFatFile file = fs.open(absolute_filename);
17.
18.  file.println(write_content);
19.
20.  file.close();
21.  printf(「write finish\rn\rn」 );
22.
23.  printf(「read back from \」 %s\rn」 , filename);
24.  file = fs.open(absolute_filename);
25.
26.  memset(buf, 0, sizeof(buf));
27.  file.read(buf, sizeof(buf));
28.
```

```
29. file.close();
30. printf(「==== content ====rn」 );
31. printf(「%s」 , buf);
32. printf(「==== end ====rn」 );
33.
34. fs.end();
35. }
36.
37. void loop() {
38. delay(1000);
39. }
40.
```

Example: file\_read\_write;

This example shows how to open/close files and perform read/write to it.

## Notes and Warnings

Include “SdFatFile.h” to use the class function.

## SdFatFile:: peek

### Description

Read one byte from the file without moving the curser.

### Syntax

```
int SdFatFile::peek(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the read character as an integer number.

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: available

### Description

Check if the cursor is at EOF.

### Syntax

```
int SdFatFile::available(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “0” if the cursor is at EOF, else returns “1” .

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: flush

### Description

It is a nop. This is an inherited function from class Stream. And it does not affect SD File.

### Syntax

```
void SdFatFile::flush(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: seek

### Description

Change cursor to a specific position.

### Syntax

```
int SdFatFile::seek(uint32_t pos);
```

### Parameters

pos: The desired position.

### Returns

The function returns 0 if success otherwise returns a negative value.

### Example Code

NA



## Notes and Warnings

Include “SdFatFile.h” in order to use the class function.

## SdFatFile:: close

### Description

Close file.

### Syntax

```
int SdFatFile::close(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns 0 if runs successfully otherwise it returns a negative value.

### Example Code

Example: last\_modified\_time;

The example shows how to get and set last modified time of a file.

Example: create\_folder;

This example shows how to create a folder and open a file under it. The details of the code can be found in the section of SdFatFile:: read.

Example: file\_read\_write;

This example shows how to open/close files and perform read/write to it. The details of the code can be found in the section of SdFatFile:: read.

1. #include <FatFs\_SD.h>
- 2.
3. FatFsSD fs;
- 4.
5. char filename[] = 「test.txt」 ;

```
6.
7. void setup() {
8.   char absolute_filename[128];
9.
10.  uint16_t year = 2021;
11.  uint16_t month = 4;
12.  uint16_t date = 4;
13.  uint16_t hour = 12;
14.  uint16_t minute = 12;
15.  uint16_t second = 12;
16.
17.  fs.begin();
18.
19.  sprintf(absolute_filename, 「%s%s」, fs.getRootPath(), filename);
20.  SdFatFile file = fs.open(absolute_filename);
21.  file.close();
22.
23.  fs.setLastModTime(absolute_filename, year, month, date, hour, minute, second);
24.
25.  fs.getLastModTime(absolute_filename, &year, &month, &date, &hour, &minute, &second);
26.  printf(「filename:」"%s"rn」, absolute_filename);
27.  printf(「time mod:%04d/%02d/%02d %02d:%02d:%02drn」, year, month, date, hour, minute, second);
28.
29.  fs.end();
30. }
31.
32. void loop() {
33.   delay(1000);
34. }
35.
```

**Notes and Warnings**

Include “SdFatFile.h” in order to use the class function.

**FlashMemory****Class EpdIF****FlashMemoryClass Class****Description**

Defines a class of Flash memory API

**Syntax**

```
class FlashMemoryClass
```

**Members**

<b>Public Constructors</b>	
FlashMemoryClass::FlashMemoryClass	Constructs a FlashMemoryClass object
FlashMemoryClass::~FlashMemoryClass	Deconstructs a FlashMemoryClass object
<b>Public Methods</b>	
FlashMemoryClass::begin	Initialize/Re-initialize the base address and size
FlashMemoryClass::read	Read the content to buf
FlashMemoryClass::update	Write buf back to flash memory
FlashMemoryClass::readWord	Read 4 bytes from flash memory
FlashMemoryClass::writeWord	Write 4 bytes into flash memory
FlashMemoryClass::buf_size	The buf size
FlashMemoryClass::*buf	The buf to be operated

**FlashMemoryClass::FlashMemoryClass****Description**

Constructs a FlashMemoryClass object.

## Syntax

FlashMemoryClass(unsigned int \_base\_address, unsigned int \_buf\_size);

## Parameters

\_base\_address: The base address to operate.

\_buf\_size: The buf size for mirror a copy to reduce flash memory operation

## Returns

The function returns nothing.

## Example Code

Example: FflashMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Direct read from flash memory is allowed. To write data into flash memory, each bit on flash memory can only change from '1' to '0' and it cannot change from '0' to '1'. To make sure the data are correctly written we do erase the flash memory sector before write data on it.

```
#include <FlashMemory.h>
```

```
void setup() {  
  FlashMemory.read();  
  if (FlashMemory.buf[0] == 0xFF) {  
    FlashMemory.buf[0] = 0x00;  
    FlashMemory.update();  
    Serial.println(「write count to 0」);  
  } else {  
    FlashMemory.buf[0]++;  
    FlashMemory.update();  
    Serial.print(「Boot count: 」);  
    Serial.println(FlashMemory.buf[0]);  
  }  
}
```

```

}

void loop() {
  delay(1000);
}

```

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

```

#include <FlashMemory.h>

void setup() {
  unsigned int value;

  /* request flash size 0x4000 from 0xFC000 */
  FlashMemory.begin(0xFC000, 0x4000);

  /* read one word (32-bit) from 0xFC000 plus offset 0x3F00 */
  value = FlashMemory.readWord(0x3F00);
  printf(「value is 0x%08X\rn」, value);
  if (value == 0xFFFFFFFF) {
    value = 0;
  } else {
    value++;
  }

  /* write one word (32-bit) to 0xFC000 plus offset 0x3F00 */
  FlashMemory.writeWord(0x3F00, value);
}

void loop() {
  // put your main code here, to run repeatedly:
}

```

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

**FlashMemoryClass::begin****Description**

Initialize/Re-initialize the base address and size. The base address shell aligns with the size of 0x1000. And the size shell is multiple of 0x1000.

**Syntax**

```
void begin(unsigned int _base_address, unsigned int _buf_size);
```

**Parameters**

\_base\_address: The base address

\_buf\_size: The desired work size

**Returns**

The function returns nothing.

**Example Code**

Example: FleshMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit). Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

**Notes and Warnings**

Include “FlashMemory.h” to use the class function.

**FlashMemoryClass::read****Description**

Read the content to buf. Read flash memory into the buf. The size would be 0x1000.

**Syntax**

```
void read(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: FleshMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

**Notes and Warnings**

Include “FlashMemory.h” to use the class function.

**FlashMemoryClass::update****Description**

Write buf back to flash memory. Write flash memory with the content of the buffer. The size is 0x1000.

**Syntax**

```
void update(bool erase = true);
```

**Parameters**

erase: By default, it is true and erases flash memory before writing to it

**Returns**

The function returns nothing.

**Example Code**

Example: `FleshMemory_Basic`

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of `"FlashMemoryClass:: FlashMemoryClass"` .

**Notes and Warnings**

Include `"FlashMemory.h"` to use the class function.

**FlashMemoryClass::readWord****Description**

Read 4 bytes from flash memory. Read 4 byte from specific offset based on base address.

**Syntax**

```
unsigned int readWord(unsigned int offset);
```

**Parameters**

offset: The offset according to the base address

**Returns**

The read data with a size of 4 bytes

**Example Code**

Example: `ReadWriteOneWord`

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

Details of the example codes can be found in the previous section of `"FlashMemoryClass:: FlashMemoryClass"` .

**Notes and Warnings**

Include `"FlashMemory.h"` to use the class function.



## FlashMemoryClass::writeWord

### Description

Write 4 bytes into flash memory. It will try to write 4 bytes first. If the read data differ from the write data, then we buffer the sector of flash memory, erase it, and write correct data back to it.

### Syntax

```
void writeWord(unsigned int offset, unsigned int data);
```

### Parameters

offset: The offset according to the base address

data: The data to be written

### Returns

The function returns nothing.

### Example Code

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::buf\_size

### Description

The buf size (It can be regarded as work size).

### Syntax

```
unsigned int buf_size;
```

### Example Code

Example: FlashMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

### FlashMemoryClass::\*buf

### Description

The buf to be operated. Modify buf won't change the content of the buf. It needs an update to write back to flash memory.

### Syntax

```
unsigned char *buf;
```

### Example Code

NA

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

---

## GPIO

### Class DHT

#### DHT Class

##### Description

Defines a class of using DHT temperature & humidity sensors

##### Syntax

```
class DHT
```

##### Members

Public Constructors	
DHT::DHT	Constructs a DHT object
Public Methods	
DHT::begin	Initialize the DHT sensor
DHT::readTemperature	Read temperature(Fahrenheit or Celcius) from the DHT sensor
DHT::convertCtoF	Convert a value from Celcius to Fahrenheit
DHT::convertFtoC	Convert a value from Fahrenheit to Celcius
DHT::readHumidity	Read humidity(%) from the DHT sensor
DHT::computeHeatIndex	Compute the HeatIndex from the readings (Using both Rothfusz and Steadman' s equations)
DHT::read	Check if the sensor is readable

#### DHT::DHT

##### Description

Constructs a DHT object.

##### Syntax

```
DHT::DHT(uint8_t pin, uint8_t type, uint8_t count)
```

##### Parameters

pin: The Arduino digital PIN connected

type: The DHT sensor type(DHT11, DHT22, or DHT21)

count: The count is now ignored as the DHT reading algorithm adjusts itself based on the speed of the processor

### Returns

The function returns nothing.

### Example Code

Example:DHTTester

The code demos basic testing for various DHT humidity & temperature sensors.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

```
// Example testing sketch for various DHT humidity/temperature sensors
// Written by ladyada, public domain

#include 「DHT.h」

// The digital pin we' re connected to.

#define DHTPIN 8

// Uncomment whatever type you' re using!

#define DHTTYPE DHT11 // DHT 11

// #define DHTTYPE DHT22 // DHT 22 (AM2302), AM2321

// #define DHTTYPE DHT21 // DHT 21 (AM2301)

// Connect pin 1 (on the left) of the sensor to +5V

// NOTE: If using a board with 3.3V logic like an Arduino Due connect pin 1
// to 3.3V instead of 5V!

// Connect pin 2 of the sensor to whatever your DHTPIN is

// Connect pin 4 (on the right) of the sensor to GROUND

// Connect a 10K resistor from pin 2 (data) to pin 1 (power) of the sensor

// Initialize DHT sensor.

// Note that older versions of this library took an optional third parameter to
// tweak the timings for faster processors. This parameter is no longer needed
```

```

// as the current DHT reading algorithm adjusts itself to work on faster procs.
DHT dht(DHTPIN, DHTTYPE);

void setup() {
  Serial.begin(115200);
  Serial.println(「DHTxx test!」);
  dht.begin();
}

void loop() {
  // Wait a few seconds between measurements.
  delay(2000);

  // Reading temperature or humidity takes about 250 milliseconds!
  // Sensor readings may also be up to 2 seconds 『old』 (its a very slow sensor)

  float h = dht.readHumidity();

  // Read temperature as Celsius (the default)
  float t = dht.readTemperature();

  // Read temperature as Fahrenheit (isFahrenheit = true)
  float f = dht.readTemperature(true);

  // Check if any reads failed and exit early (to try again).
  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println(「Failed to read from DHT sensor!」);
    return;
  }

  // Compute heat index in Fahrenheit (the default)
  float hif = dht.computeHeatIndex(f, h);

  // Compute heat index in Celsius (isFahreheit = false)
  float hic = dht.computeHeatIndex(t, h, false);

  Serial.print(「Humidity: 」);
  Serial.print(h);
  Serial.print(「 %t」);

  Serial.print(「Temperature: 」);

```

```
Serial.print(t);  
Serial.print(" *C ");  
Serial.print(f);  
Serial.print(" *Ft ");  
Serial.print(" Heat index: ");  
Serial.print(hic);  
Serial.print(" *C ");  
Serial.print(hif);  
Serial.println(" *F ");  
}
```

**DHT::begin****Description**

Initialize the DHT sensor.

**Syntax**

```
void DHT::begin(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

**Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

## **DHT::readTemperature**

### **Description**

Read temperature(Fahrenheit or Celcius) from the DHT sensor.

### **Syntax**

```
float DHT::readTemperature(bool S, bool force);
```

### **Parameters**

S: Temperature scale, True is Fahrenheit and False is Celcius

force: Index of checking sensor readability, default is False

### **Returns**

The function returns the current temperature as a float value.

### **Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### **Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

## **DHT::convertCtoF**

### **Description**

Convert a value from Celcius to Fahrenheit.

### **Syntax**

```
float DHT::convertCtoF(float c);
```

### Parameters

c: The value in Celcius

### Returns

The function returns the temperature in Fahrenheit as a float number.

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

### DHT::convertFtoC

### Description

Convert a value from Fahrenheit to Celcius.

### Syntax

```
float DHT::convertFtoC(float f);
```

### Parameters

f: The value in Fahrenheit

### Returns

The function returns the temperature in Celcius as a float number.

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.



### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

### DHT::computeHeatIndex

#### Description

Compute the HeatIndex from the readings (Using both Rothfusz and Steadman’ s equations). More details refer to [http://www.wpc.ncep.noaa.gov/html/heatindex\\_equation.shtml](http://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml) .

#### Syntax

float DHT::computeHeatIndex(float temperature, float percentHumidity, bool isFahrenheit);

#### Parameters

temperature: The temperature value

percentHumidity: The humidity percent value

isFahrenheit: True, temperature value in Fahrenheit (Default); False, temperature value in Celcius

#### Returns

The function returns the heat index in Fahrenheit or Celsius as a float value.

#### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

### DHT::readHumidity

#### Description

Reading temperature or humidity from the DHT sensor and return as a float value(%).

### Syntax

```
float DHT::readHumidity(bool force);
```

### Parameters

force: Ignored.

### Returns

The function returns current humidity in a float number (in %).

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function. Reading temperature or humidity takes about 250 milliseconds! Sensor readings may also be up to 2 seconds.

### DHT::read

### Description

Check if the sensor is readable.

### Syntax

```
boolean DHT::read(bool force);
```

### Parameters

force: Index of whether checking the sensor was read less than two seconds ago or not. False, checking; True, not checking.

**Returns**

Return the last correct measurement of the sensor. False, low means not readable; True, high means readable.

**Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

**Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

**Class HttpClient****InterruptLock Class****Description**

Defines a class of turning off/on interrupts temporarily

**Syntax**

class InterruptLock

**Members**

Public Constructors	
InterruptLock::InterruptLock	Constructs a InterruptLock object
InterruptLock::~~ InterruptLock	Deconstructs a InterruptLock object

## GTimer

### Class EpdIF

#### GTimerClass Class

##### Description

GTimer is a hardware timer and this class is to operate it. The GTimer occupy same resource as PWM. Please make sure the timer is not conflict with you PWM index.

##### Syntax

```
class GTimerClass
```

##### Members

Public Constructors	
GTimerClass::GTimerClass	Constructs a GTimerClass object
Public Methods	
GTimerClass::begin	Initialize a timer and start it immediately
GTimerClass::stop	Stop a specific timer
GTimerClass::reload	Reload a specific timer
GTimerClass::read_us	Read current countdown value

#### GTimerClass::begin

##### Description

Initialize a timer and start it immediately.

##### Syntax

```
void GTimerClass::begin(uint32_t timerid, uint32_t duration_us, void (*handler)(uint32_t), bool periodical, uint32_t userdata);
```

##### Parameters

timerid: There are 5 valid GTimer with timer id 0~4.

duration\_us: The duration of the timer. The time unit is microsecond and the precision is 32768Hz.

periodical: By default, the timer would keep periodically countdown and reload which means the handler would periodically be invoked.

userdata: The user data brings to the handler.

## Returns

The function returns nothing.

## Example Code

Example: TimerOneshot

```
/*
This sketch shows how to use several hardware timers in invoke handler only once for each timer.
*/
#include <GTimer.h>

void myhandler(uint32_t data) {
  Serial.print(「I am timer!」);
  Serial.println(data);
}

void setup() {
  // Open serial communications and wait for port to open:
  Serial.begin(115200);

  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }

  // timerid 0, period 1s, invoke myhandler, invoke only once, user data is 0
  GTimer.begin(0, 1 * 1000 * 1000, myhandler, false, 0);

  // timerid 1, period 2s, invoke myhandler, invoke only once, user data is 1
  GTimer.begin(1, 2 * 1000 * 1000, myhandler, false, 1);

  GTimer.begin(2, 3 * 1000 * 1000, myhandler, false, 2);

  GTimer.begin(3, 4 * 1000 * 1000, myhandler, false, 3);
}
```

```
void loop() {  
  delay(1000);  
}
```

Example: TimerPeriodical

/\*

This sketch shows how to use hardware timer and invoke interrupt handler periodically

\*/

```
#include <GTimer.h>
```

```
int counter = 0;
```

```
void myhandler(uint32_t data) {
```

```
  counter++;
```

```
  Serial.print(「counter:  」);
```

```
  Serial.println(counter);
```

```
  if (counter >= 10) {
```

```
    Serial.println(「stop timer」 );
```

```
    GTimer.stop(0);
```

```
  }
```

```
}
```

```
void setup() {
```

```
  // Open serial communications and wait for port to open:
```

```
  Serial.begin(115200);
```

```
  while (!Serial) {
```

```
    ; // wait for serial port to connect. Needed for native USB port only
```

```
  }
```

```
  // timerid 0, period 1s, invoke myhandler
```

```
  GTimer.begin(0, (1 * 1000 * 1000), myhandler);
```

```
}
```

```
void loop() {
```

```
  delay(1000);
```

```
}
```

**Notes and Warnings**

Include “GTimer.h” to use the class function.

**GTimerClass::stop****Description**

Stop a specific timer

**Syntax**

```
void GTimerClass::stop(uint32_t timerid);
```

**Parameters**

timerid: Stop the timer with this timer id

**Returns**

The function returns nothing.

**Example Code**

Example: TimerPeriodical, please refer to GTimerClass:: begin for more details.

**Notes and Warnings**

Include “GTimer.h” to use the class function.

**GTimerClass::reload****Description**

Reload a specific timer. The GTimer is a countdown timer. Reload it would make it discard the current countdown value and restart countdown based on the duration.

**Syntax**

```
void GTimerClass::reload(uint32_t timerid, uint32_t duration_us);
```

### Parameters

timerid: The timer to be modified

duration\_us: The updated duration in unit of microseconds

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “GTimer.h” to use the class function.

## GTimerClass::read\_us

### Description

Read the current countdown value

### Syntax

```
uint64_t GTimerClass::read_us(uint32_t timerid);
```

### Parameters

timerid: The timer to be read

### Returns

The function returns the current countdown value.

### Example Code

NA



## Notes and Warnings

Include “GTimer.h” to use the class function.

## Http

### Class HttpClient

#### HttpClient Class

#### Description

Defines a class of using HttpClient

#### Syntax

```
class HttpClient
```

#### Members

Public Constructors	
HttpClient::HttpClient	Constructs a HttpClient object
Public Methods	
HttpClient::beginRequest	Start a more complex request
HttpClient::endRequest	End a more complex request
HttpClient::get	Connect to the server and start to send a GET request
HttpClient::post	Connect to the server and start to send a POST request
HttpClient::put	Connect to the server and start to send a PUT request
HttpClient::startRequest	Connect to the server and start to send the request
HttpClient::sendHeader	Send an additional header line
HttpClient::sendBasicAuth	Send a basic authentication header
HttpClient::finishRequest	Finish sending the HTTP request
HttpClient::responseStatusCode	Get the HTTP status code contained in the response
HttpClient::readHeader	Read the next character of the response headers
HttpClient::skipResponseHeaders	Skip any response headers to get to the body
HttpClient::endOfHeadersReached	Test whether all of the response headers have been consumed
HttpClient::endOfBodyReached	Test whether the end of the body has been reached
HttpClient::contentLength	Return the length of the body

## HttpClient::HttpClient

### Description

Constructs a HttpClient object. If Macro “PROXY\_ENABLED” is defined, currently disabled as introduces a dependency on DNS.h in Ethernet.

### Syntax

```
HttpClient::HttpClient(Client& aClient, const char* aProxy = NULL, uint16_t aProxyPort = 0);
```

```
HttpClient::HttpClient(Client& aClient);
```

### Parameters

aClient: The object of class WiFiClient.

aProxy: The proxy name. The default proxy name is “NULL” .

aProxyPort: The proxy port. The default value for the proxy port is 0.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrate how to download the content from URL indicated in kHostname[].

```
#include <HttpClient.h>
```

```
#include <WiFi.h>
```

```
#include <WiFiClient.h>
```

```
char ssid[] = 「YourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「password」 ; // your network password (use for WPA, or use as key for WEP)
```

```
int keyIndex = 0; // your network key Index number (needed only for WEP)
```

```
// Name of the server we want to connect to
```

```
const char kHostname[] = 「www.google.com」 ;
```

```
const char kPath[] = 「/」 ;
```

```
// Number of milliseconds to wait without receiving any data before we give up
```

```

const int kNetworkTimeout = 30*1000;

// Number of milliseconds to wait if no data is available before trying again

const int kNetworkDelay = 1000;

int status = WL_IDLE_STATUS;

void setup() {
  Serial.begin(9600);

  while ( status != WL_CONNECTED) {
    Serial.print( 「 Attempting to connect to SSID: 」);
    Serial.println(ssid);
    status = WiFi.begin(ssid, pass);
    // wait 10 seconds for connection:
    delay(10000);
  }
  Serial.println( 「 Connected to wifi 」 );
  printWifiStatus();
}

void loop() {
  int err =0;
  WiFiClient c;
  HttpClient http(c);
  err = http.get(kHostname, kPath);
  if (err == 0)
  {
    Serial.println( 「 startedRequest ok 」 );
    err = http.responseStatusCode();
    if (err >= 0)
    {
      Serial.print( 「 Got status code: 」);
      Serial.println(err);
      // Usually you'd check that the response code is 200 or a

```

```
// similar 「success」 code (200-299) before carrying on,
// but we' ll print out whatever response we get
err = http.skipResponseHeaders();

if (err >= 0)
{
    int bodyLen = http.contentLength();
    Serial.print( 「Content length is: 」);
    Serial.println(bodyLen);
    Serial.println();
    Serial.println( 「Body returned follows:」 );
    // Now we' ve got to the body, so we can print it out
    unsigned long timeoutStart = millis();

    char c;

    // Whilst we haven' t timed out & haven' t reached the end of the body
    while ( (http.connected() || http.available()) &&
        ((millis() - timeoutStart) < kNetworkTimeout) )
    {
        if (http.available())
        {
            c = http.read();
            // Print out this character
            Serial.print(c);
            bodyLen--;
            // We read something, reset the timeout counter
            timeoutStart = millis();
        }
        else
        {
            // We haven' t got any data, so let' s pause to allow some to arrive
            delay(kNetworkDelay);
        }
    }
}
```

```
}  
}  
}  
else  
{  
  Serial.print(「Failed to skip response headers:  」);  
  Serial.println(err);  
}  
}  
else  
{  
  Serial.print(「Getting response failed:  」);  
  Serial.println(err);  
}  
}  
else  
{  
  Serial.print(「Connect failed:  」);  
  Serial.println(err);  
}  
  
http.stop();  
  
// And just stop, now that we' ve tried a download  
while(1);  
}  
  
void printWifiStatus() {  
  // print the SSID of the network you' re attached to:  
  Serial.print(「SSID:  」);  
  Serial.println(WiFi.SSID());  
  
  // print your WiFi shield' s IP address:  
  IPAddress ip = WiFi.localIP();
```

```
Serial.print(「IP Address: 」);  
Serial.println(ip);  
// print the received signal strength:  
long rssi = WiFi.RSSI();  
Serial.print(「signal strength (RSSI):」 );  
Serial.print(rssi);  
Serial.println(「 dBm」 );  
}
```

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::beginRequest

#### Description

Start a more complex request. Use this when you need to send additional headers in the request, but you will also need to call endRequest() when you are finished.

#### Syntax

```
void HttpClient::beginRequest(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

## Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::endRequest

### Description

End a more complex request. Use this when you need to have sent additional headers in the request, but you will also need to call beginRequest() at the start.

### Syntax

```
void HttpClient::endRequest(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

## Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::get

### Description

Connect to the server and start to send a “GET” request. If the input parameter contains “aServerAddress” , the connection will not perform a DNS lookup and just purely connect to the given IP address.

### Syntax

```
int HttpClient::get(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::get(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::get(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::get(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
```

### Parameters

aServerName: The name of the server being connected to. If aServerName is “NULL” , the “Host” header line will not be sent.

aServerPort: The port on which server connected.

aURLPath: The URL to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

### Returns

Return 0 if successful, otherwise indicates an error occurs.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::post

#### Description

Connect to the server and start to send a “POST” request. If the input parameter has “aServerAddress” , connects doesn’t perform a DNS lookup and just connects to the given IP address.



**Syntax**

```
int HttpClient::post(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
  
int HttpClient::post(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);  
  
int HttpClient::post(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
  
int HttpClient::post(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
```

**Parameters**

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’ t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

**Returns**

Return 0 if successful, otherwise indicates an error occurs.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::put****Description**

Connect to the server and start to send a PUT request. If the input parameter has “aServerAddress” , connects doesn’ t perform a DNS lookup and just connects to the given IP address.

**Syntax**

```
int HttpClient::put(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::put(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::put(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::put(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
```

**Parameters**

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

**Returns**

Return 0 if successful, otherwise indicates an error occurs.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::startRequest****Description**

Connect to the server and start to send the request.

**Syntax**

```
int HttpClient::startRequest(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char*
aHttpMethod, const char* aUserAgent);
int HttpClient::startRequest(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const
char* aURLPath, const char* aHttpMethod, const char* aUserAgent);
```

### Parameters

aServerAddress: IP address of the server to connect to.

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aHttpMethod: Type of HTTP request to make, e.g. “GET” , “POST” , etc.

aUserAgent: User-Agent string to send. If NULL the default user-agent kUserAgent will be sent.

### Returns

Return 0 if successful, else error.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::sendHeader

#### Description

The function sends an additional header line.

The function void HttpClient:: sendHeader(const char\* aHeader);can only be called in between the calls to startRequest and finishRequest.

The other 2 functions void HttpClient::sendHeader(const char\* aHeaderName, const char\* aHeaderValue); and void HttpClient::sendHeader(const char\* aHeaderName, const int aHeaderValue); are alternate form the previous one, which takes the header name and content as separately (as strings or integer). For example, to send an XXXXXX header, user might call sendHeader( “XXXXXX” , “Something” ) or sendHeader( “XXXXXX” , 123).And the call will add the “: ” in the log to separate different header in the case of multiple headers.

**Syntax**

```
void HttpClient::sendHeader(const char* aHeader);  
void HttpClient::sendHeader(const char* aHeaderName, const char* aHeaderValue);  
void HttpClient::sendHeader(const char* aHeaderName, const int aHeaderValue);
```

**Parameters**

aHeader: Header line to send, in its entirety (but without the trailing CRLF. E.g. “Authorization: Basic YQDDCAIGES” .

aHeaderName: Type of header being sent.

aHeaderValue: Value for that header.

**Returns**

The function returns nothing.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::sendBasicAuth****Description**

The function sends a basic authentication header which will encode the given username and password, and send them in a suitable header line for doing Basic Authentication.

**Syntax**

```
void HttpClient::sendBasicAuth(const char* aUser, const char* aPassword);
```

**Parameters**

aUser: Username for the authorization.

aPassword: Password for the user aUser.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::finishRequest

#### Description

Finish sending the HTTP request. The function sends a blank line to signify the end of the request.

#### Syntax

```
void HttpClient::finishRequest(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::responseStatusCode****Description**

Get the HTTP status code contained in the response. For example, “200” for successful requests, “404” for file not found, etc.

**Syntax**

```
int HttpClient::responseStatusCode(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return 0 if successful, else error.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::readHeader****Description**

The function reads the next character of the response headers. This functions the same as read() but to be used when reading through the headers which are slightly less efficient. The user might check whether the end of the headers has been reached by calling endOfHeadersReached(), although after that point this will still return data as read() would.

**Syntax**

```
int HttpClient::readHeader(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return the next character of the response headers.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::skipResponseHeaders****Description**

Skip any response headers to get to the body. Use this if you don't want to do any special processing of the headers returned in the response. You can also use it after you've found all of the headers you're interested in, and just want to get on with processing the body.

**Syntax**

```
int HttpClient::skipResponseHeaders(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return 0 if successful, else error.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::endOfHeadersReached

#### Description

Test whether all of the response headers have been consumed.

#### Syntax

```
bool HttpClient::endOfHeadersReached(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

Return true if we are now processing the response body, else false.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::endOfBodyReached



**Description**

Test whether the end of the body has been reached. It only works if the Content-Length header was returned by the server.

**Syntax**

```
bool HttpClient::endOfBodyReached(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return true if we are now at the end of the body, else false.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::contentLength****Description**

The function returns the length of the body.

**Syntax**

```
int HttpClient::contentLength(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return Length of the body, in bytes, or kNoContentLengthHeader if no Content-Length header was returned by the server.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

---

**IRDevice****Class HttpClient****IRDevice Class****Description**

A class used for managing, sending, and receiving data using IR.

**Syntax**

```
class IRDevice
```

**Members**

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named IR.	

Public Methods	
IRDevice::getFreq	Get the current IR modulation frequency
IRDevice::begin	Allocate resources and start the IR device with a custom frequency
IRDevice::end	Stop the IR device operations and free up resources
IRDevice::send	Send IR raw data
IRDevice::beginNEC	Allocate resources and start the IR device with a frequency suitable for the NEC protocol
IRDevice::sendNEC	Send data using the NEC protocol
IRDevice::recvNEC	Receive data using the NEC protocol

**IRDevice::getFreq****Description**

Get the current IR modulation frequency.

**Syntax**

```
uint32_t getFreq(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Currently set IR modulation frequency in Hertz.

**Example Code**

NA

**Notes and Warnings**

NA

**IRDevice::begin****Description**

Allocate resources and start the IR device with a custom frequency.

### Syntax

```
void begin(uint8_t receivePin, uint8_t transmitPin, uint32_t irMode, uint32_t freq);
```

### Parameters

receivePin: pin on which IR sensor is connected. Hardware IR receiver is available at pins 3, 8, 17.

transmitPin: pin on which IR LED is connected. Hardware IR transmitter is available at pins 6, 9, 16.

irMode: transmit or receive mode. Valid values: IR\_MODE\_TX, IR\_MODE\_RX

freq: IR modulation frequency in Hertz

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

IR device can only operate in either transmit or receive mode.

### IRDevice::end

### Description

Stop the IR device operations and free up resources.

### Syntax

```
void end(void);
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**IRDevice::send****Description**

Send IR raw data.

**Syntax**

```
void send(const unsigned int buf[ ], uint16_t len);
```

**Parameters**

buf[ ] : IR raw signals (in us) in an array form.

len: total length of the IR raw signal array.

**Returns**

The function returns nothing.

**Example Code**

```
#include 「IRDevice.h」

// User defined txPin, rxPin and carrier frequency

#define IR_RX_PIN 8

#define IR_TX_PIN 9

#define CARRIER_FREQ 38000

unsigned int irRawSignal[] = {
```

```
9000, 4500, // starting bit

560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, 560, // address 00100000 : 4

560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, 560, 1690, // ~ address 11011111

560, 560, 560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, // data 00010000 : 8

560, 1690, 560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, //~ data 11101111

560 // stoping bit

};

int DataLen = sizeof(irRawSignal) / sizeof(irRawSignal[0]); // 284/ 4 = 71

void setup()

{

  Serial.begin(115200);

  IR.begin(IR_RX_PIN, IR_TX_PIN, IR_MODE_TX, CARRIER_FREQ);

}

void loop()

{

  IR.send(irRawSignal, DataLen);

  Serial.println(「 Finished Sending NEC Raw Data…」 );

  delay(3000);

}
```

### Notes and Warnings

IR Raw Data array contains information in the form of consecutive microseconds (us). For more details, please refer to:  
<http://www.rightho.com/2009/08/multi-protocol-infrared-remote-library.html>.

### IRDevice::beginNEC

#### Description

Allocate resources and start the IR device with a frequency suitable for the NEC protocol.

#### Syntax

```
void beginNEC(uint8_t receivePin, uint8_t transmitPin, uint32_t irMode);
```

### Parameters

receivePin: pin on which IR sensor is connected. Hardware IR receiver is available at pins 3, 8, 17.

transmitPin: pin on which IR LED is connected. Hardware IR transmitter is available at pins 6, 9, 16.

irMode: transmit or receive mode. Valid values: IR\_MODE\_TX, IR\_MODE\_RX

### Returns

The function returns nothing.

### Example Code

Example: IRRecvNEC

```
#include 「IRDevice.h」

uint8_t adr = 0;
uint8_t cmd = 0;
void setup() {
  //Initialize serial and wait for port to open:
  Serial.begin(115200);

  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }

  IR.beginNEC(8, 9, IR_MODE_RX); // configure for NEC IR protocol
}

void loop() {
  if (IR.recvNEC(adr, cmd, 1000)) {
    Serial.print(「Received 」);
    Serial.print(adr);
    Serial.print(cmd);
    Serial.println();
  } else {
```

```
Serial.println(「Received nothing, timed out」);  
  
}  
  
//IR.end();  
  
}
```

### Notes and Warnings

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

### IRDevice::sendNEC

#### Description

Send data using the NEC protocol.

#### Syntax

```
void sendNEC(uint8_t adr, uint8_t cmd);
```

#### Parameters

adr: 8-bit address to transmit

cmd: 8-bit command to transmit

#### Returns

The function returns nothing.

#### Example Code

Example: IRSendNEC

```
#include 「IRDevice.h」  
  
uint8_t adr = 0;  
  
uint8_t cmd = 0;  
  
void setup() {
```



```

//Initialize serial and wait for port to open:
Serial.begin(115200);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

IR.beginNEC(8, 9, IR_MODE_TX); // configure for NEC IR protocol

}

void loop() {

if (cmd++ >=255) {

adr++;

}

IR.sendNEC(adr, cmd);

Serial.print(「Sent  」);

Serial.print(adr);

Serial.print(cmd);

Serial.println();

//IR.end(); // Call this method to stop IR device and free up the pins for other uses

}

```

### Notes and Warnings

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

### IRDevice::recvNEC

#### Description

Receive data using the NEC protocol.

#### Syntax

```
void recvNEC(uint8_t& adr, uint8_t& cmd uint32_t timeout);
```

**Parameters**

adr: variable to store received NEC address

cmd: variable to store received NEC command

timeout: time duration to wait for an incoming transmission

**Returns**

The function returns “1” if data has been received, returns “0” if no data has been received.

**Example Code**

Example: IRRecvNEC

Details of the code can be found in the previous section of IRDevice::beginNEC.

**Notes and Warnings**

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

---

**MDNS****Class HttpClient****MDNSClass Class****Description**

A class used for registering and removing MDNS service records.

**Syntax**

```
class MDNSClass
```

**Members**

Public Constructors	
The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named MDNS.	

Public Methods	
MDNSClass::begin	Start MDNS operations
MDNSClass::end	Stop MDNS operations
MDNSClass::registerService	Add a service record
MDNSClass::deregisterService	Remove service record
MDNSClass::updateService	Update service record

**MDNSClass::begin****Description**

Start MDNS operations to begin responding to MDNS queries.

**Syntax**

```
void begin(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: mDNS\_On\_Arduino\_IDE

This example shows how to register Ameba as a service that can be recognized by Arduino IDE. If both of the PC runs Arduino IDE and the Ameba board are connecting to the same local network. Then you can find Ameba in “Tools” -> “Port” -> “Arduino at 192.168.1.238 (Ameba RTL8195A), which means the Arduino IDE find Ameba via mDNS.

```
#include <WiFi.h>
```

```
#include <AmebaMDNS.h>
```

```
char ssid[] = 「yourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「secretPassword」 ; // your network password
```

```
MDNSService service( 「MyAmeba」 , 「_arduino._tcp」 , 「local」 , 5000);
```

```
void setup() {
```

```
printf(「Try to connect to %srn」, ssid);

while (WiFi.begin(ssid, pass) != WL_CONNECTED) {

printf(「Failed. Wait 1s and retry…rn」);

delay(1000);

}

printf(「Connected to %srn」, ssid);

service.addTxtRecord(「board」, strlen(「ameba_rtl8195a」), 「ameba_rtl8195a」);

service.addTxtRecord(「auth_upload」, strlen(「no」), 「no」);

service.addTxtRecord(「tcp_check」, strlen(「no」), 「no」);

service.addTxtRecord(「ssh_upload」, strlen(「no」), 「no」);

printf(「Start mDNS servicern」);

MDNS.begin();

printf(「register mDNS servicern」);

MDNS.registerService(service);

}

void loop() {

// put your main code here, to run repeatedly:

delay(1000);

}
```

## Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::end

### Description

Stop MDNS operations and stop responding to MDNS queries.

### Syntax

```
void end(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

**MDNSClass::registerService****Description**

Add a service record to be included in MDNS responses.

**Syntax**

```
void register service(MDNSService service);
```

**Parameters**

service: MDNSService class object with required MDNS service data

**Returns**

The function returns nothing.

**Example Code**

Example: mDNS\_On\_Arduino\_IDE

Details of the code can be found in the previous section of MDNSClass:: begin.

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::deregisterService

### Description

Remove a service record from MDNS responses.

### Syntax

```
void deregisterService(MDNSService service);
```

### Parameters

service: MDNSService class object to be removed

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

Details of the code can be found in the previous section of MDNSClass:: begin.

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::updateService

### Description

Update a service record.

### Syntax

```
void updateService(MDNSService service, unsigned int ttl);
```

### Parameters

service: MDNSService class object to be updated

ttl: time-to-live(TTL) for service

## Returns

The function returns nothing.

## Example Code

NA

## Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## Class HttpClient

### MDNSService Class

## Description

A class used for creating MDNS service records.

## Syntax

```
class MDNSService
```

## Members

Public Constructors	
MDNSService::MDNSService	Create a MDNS service record
Public Methods	
MDNSService::addTxtRecord	Add text to MDNS service record

### MDNSService::MDNSService

## Description

Create a MDNS service record.

## Syntax

```
MDNSService(char* name, char* service_type, char* domain, unsigned short port, int bufsize);
```

### Parameters

name: device name

service\_type: MDNS service type

domain: host domain

port: network port

bufsize: size of buffer for MDNS text record

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSService::addTxtRecord

### Description

Add text to MDNS service record.

### Syntax

```
int addTextRecord(char* key, int value_len, char* value);
```

### Parameters

key: record type expressed as character string

value\_len: length of value string

value: record value expressed as character string

### Returns

0 if add record successful



**Example Code**

Example: mDNS\_On\_Arduino\_IDE

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

---

**MQTTClient****Class PMUClass****PubSubClient Class****Description**

Defines a class of MQTT implementation for Ameba.

**Syntax**

```
class PubSubClient
```

**Members**

Public Constructors	
PubSubClient::PubSubClient	Constructs a PubSubClient object
Public Methods	
PubSubClient::setServer	Set MQTT server address and port
PubSubClient::setCallback	Set callback function
PubSubClient::setClient	Set WiFi client
PubSubClient::setStream	Set data stream
PubSubClient::connect	Attempt to connect to server
PubSubClient::disconnect	Disconnect from current session
PubSubClient::publish	Publish a message to server
PubSubClient::publish_P	Same as above
PubSubClient::subscribe	Subscribe to a topic
PubSubClient::unsubscribe	Unsubscribe to a topic
PubSubClient::loop	Keep MQTT session alive and process any queuing tasks
PubSubClient::connected	Check if client still connected
PubSubClient::state	Return connection state

## PubSubClient::PubSubClient

### Description

Constructs a PubSubClient object and, if applicable, sets server address, port, callback function, data stream and wifi client.

### Syntax

```
PubSubClient::PubSubClient();
PubSubClient::PubSubClient(Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(IPAddress, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
PubSubClient::PubSubClient(uint8_t *, uint16_t, Client& client);
PubSubClient::PubSubClient(uint8_t *, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(uint8_t *, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
PubSubClient::PubSubClient(uint8_t *, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
PubSubClient::PubSubClient(const char*, uint16_t, Client& client);
PubSubClient::PubSubClient(const char*, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(const char*, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
```

```
PubSubClient::PubSubClient(const char*, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
```

### Parameters

client: the network client to use, for example WiFiClient

IPAddress: MQTT server address

port: port for MQTT, usually 1883 for unencrypted connection

MQTT\_CALLBACK\_SIGNATURE: callback function for MQTT

Stream: a stream to write received messages to

### Returns

The function returns nothing.

### Example Code

Example: MQTT\_Basic

```
#include <WiFi.h>

#include <PubSubClient.h>

// Update these with values suitable for your network.

char ssid[] = 「yourNetwork」 ; // your network SSID (name)
char pass[] = 「secretPassword」 ; // your network password
int status = WL_IDLE_STATUS; // the Wifi radio's status

char mqttServer[] = 「test.mosquitto.org」 ;
char clientId[] = 「amebaClient」 ;
char publishTopic[] = 「outTopic」 ;
char publishPayload[] = 「hello world」 ;
char subscribeTopic[] = 「inTopic」 ;

void callback(char* topic, byte* payload, unsigned int length) {
  Serial.print(「Message arrived [」);
  Serial.print(topic);
  Serial.print(「 ]」);

  for (int i=0;i<length;i++) {
```

```
Serial.print((char)payload[i]);
}
Serial.println();
}

WiFiClient wifiClient;
PubSubClient client(wifiClient);

void reconnect() {
// Loop until we're reconnected
while (!client.connected()) {
Serial.print(「 Attempting MQTT connection…」 );
// Attempt to connect
if (client.connect(clientId)) {
Serial.println(「 connected」 );
// Once connected, publish an announcement...
client.publish(publishTopic, publishPayload);
// ...and resubscribe
client.subscribe(subscribeTopic);
} else {
Serial.print(「 failed, rc=」 );
Serial.print(client.state());
Serial.println(「 try again in 5 seconds」 );
// Wait 5 seconds before retrying
delay(5000);
}
}
}

void setup()
{
Serial.begin(38400);

while (status != WL_CONNECTED) {
```

```

Serial.print( " Attempting to connect to SSID:  ");
Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:
status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:
delay(10000);

}

client.setServer(mqttServer, 1883);

client.setCallback(callback);

// Allow the hardware to sort itself out
delay(1500);

}

void loop()
{
  if (!client.connected()) {
    reconnect();
  }
  client.loop();
}

```

## Notes and Warnings

PubSubClient::PubSubClient(Client& client) would suffice for normal MQTT connection

## PubSubClient::setServer

### Description

Sets the server details.

### Syntax

PubSubClient& PubSubClient::setServer(uint8\_t \* ip, uint16\_t port)

PubSubClient& PubSubClient::setServer(IPAddress ip, uint16\_t port)

PubSubClient& PubSubClient::setServer(const char \* domain, uint16\_t port)

### Parameters

ip: the address of the server

port: the port to connect to, default 1883

domain: the address of the server

### Returns

The client instance, allowing the function to be chained

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::setCallback

### Description

Sets the message callback function.

### Syntax

PubSubClient& PubSubClient::setCallback(MQTT\_CALLBACK\_SIGNATURE)

### Parameters

MQTT\_CALLBACK\_SIGNATURE: a pointer to a message callback function called when a message arrives for a subscription created by this client.

### Returns

The client instance, allowing the function to be chained.

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::setClient

#### Description

Sets the network client instance to use.

#### Syntax

```
PubSubClient& PubSubClient::setClient(Client& client)
```

#### Parameters

client: the network client to use, for example WiFiClient

#### Returns

The client instance, allowing the function to be chained

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::setStream

#### Description

Sets the stream to write received messages to.

#### Syntax

```
PubSubClient& PubSubClient::setStream(Stream& stream)
```

### Parameters

stream: a stream to write received messages to

### Returns

The client instance, allowing the function to be chained.

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::connect

### Description

Connects the client to the server.

### Syntax

boolean PubSubClient::connect(const char \*id)

boolean PubSubClient::connect(const char \*id, const char \*user, const char \*pass)

boolean PubSubClient::connect(const char \*id, const char\* willTopic, uint8\_t willQos, boolean willRetain, const char\* willMessage)

boolean PubSubClient::connect(const char \*id, const char \*user, const char \*pass, const char\* willTopic, uint8\_t willQos, boolean willRetain, const char\* willMessage)

### Parameters

id: Client ID, a unique string identifier

user: Username for authentication, default NULL

pass: Password for authentication, default NULL

willTopic: the topic to be used by the will message

willQoS: the quality of service to be used by the will message

willRetain: whether the will should be published with the retain flag

willMessage: the payload of the will message



**Returns**

True –connection succeeded

False –connection failed

**Example Code**

Example: MQTT\_Basic

**Notes and Warnings**

Client ID is required and should always be unique else connection might be rejected by the server.

**PubSubClient::disconnect****Description**

Disconnect the client

**Syntax**

```
void PubSubClient::disconnect(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PubSubClient::publish**

**Description**

Publishes a message to the specified topic.

**Syntax**

`boolean PubSubClient::publish(const char* topic, const char* payload)`

`boolean PubSubClient::publish(const char* topic, const char* payload, boolean retained)`

`boolean PubSubClient::publish(const char* topic, const uint8_t* payload, unsigned int plength)`

`boolean PubSubClient::publish(const char* topic, const uint8_t* payload, unsigned int plength, boolean retained)`

**Parameters**

topic: the topic to publish to

payload: the message to publish

plength: the length of the payload. Required if payload is a byte[]

retained: whether the message should be retained

–false –not retained

–true –retained

**Returns**

False –publish failed, either connection lost or message too large

True –publish succeeded

**Example Code**

Example: MQTT\_Basic

**Notes and Warnings**

Default max packet size is 128 bytes.

**PubSubClient::publish\_P****Description**

Publishes a message stored in PROGMEM to the specified topic.

**Syntax**

boolean PubSubClient::publish\_P(const char\* topic, const uint8\_t\* payload, unsigned int plength, boolean retained)

### Parameters

topic: the topic to publish to

payload: the message to publish

plength: the length of the payload. Required if payload is a byte[]

retained: whether the message should be retained

–false –not retained

–true –retained

### Returns

False –publish failed, either connection lost or message too large

True –publish succeeded

### Example Code

NA

### Notes and Warnings

NA

## PubSubClient::subscribe

### Description

Subscribes to messages published to the specified topic.

### Syntax

boolean PubSubClient::subscribe(const char\* topic)

boolean PubSubClient::subscribe(const char\* topic, uint8\_t qos)

### Parameters

topic: the topic to subscribe to

qos: the qos to subscribe at

### Returns

False –sending the subscribe failed, either connection lost or message too large

True –sending the subscribe succeeded

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::unsubscribe

### Description

Unsubscribes from the specified topic.

### Syntax

boolean PubSubClient::unsubscribe(const char\* topic)

### Parameters

topic: the topic to unsubscribe to

### Returns

False –sending the unsubscribe failed, either connection lost or message too large

True –sending the unsubscribe succeeded

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::loop

**Description**

A must method called regularly to allow the client to process incoming messages and maintain its connection to the server.

**Syntax**

```
boolean PubSubClient::loop(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

False –the client is no longer connected

True –the client is still connected

**Example Code**

Example: MQTT\_Basic

**Notes and Warnings**

A required method that should not be blocked for too long.

**PubSubClient::connected****Description**

Checks whether the client is connected to the server.

**Syntax**

```
boolean PubSubClient::connected(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

False –the client is not connected

True –the client is connected

### **Example Code**

Example: MQTT\_Basic

### **Notes and Warnings**

NA

### **PubSubClient::state**

#### **Description**

Returns the current state of the client. If a connection attempt fails, this can be used to get more information about the failure.

All of the values have corresponding constants defined in PubSubClient.h.

#### **Syntax**

int PubSubClient::state(void)

#### **Parameters**

The function requires no input parameter.

#### **Returns**

-4 : MQTT\_CONNECTION\_TIMEOUT –the server didn’ t respond within the keepalive time

-3 : MQTT\_CONNECTION\_LOST –the network connection was broken

-2 : MQTT\_CONNECT\_FAILED –the network connection failed

-1 : MQTT\_DISCONNECTED –the client is disconnected cleanly

0 : MQTT\_CONNECTED –the client is connected

1 : MQTT\_CONNECT\_BAD\_PROTOCOL –the server doesn’ t support the requested version of MQTT

2 : MQTT\_CONNECT\_BAD\_CLIENT\_ID –the server rejected the client identifier

3 : MQTT\_CONNECT\_UNAVAILABLE –the server was unable to accept the connection

4 : MQTT\_CONNECT\_BAD\_CREDENTIALS –the username/password were rejected

5 : MQTT\_CONNECT\_UNAUTHORIZED –the client was not authorized to connect

## Example Code

Example: MQTT\_Basic

## Notes and Warnings

NA

## Readme

The Ameba MQTT related APIs and examples are works based on the [PubSubClient libraries](#) written by Nicholas O'Leary

These include,

- `PubSubClient.cpp`
- `PubSubClient.h`

These libraries are under MIT License.

---

## NTPClient

### Readme

The NTPClient library is based on the NTPClient library written by Fabrice Weinberg, which can be found at <https://github.com/arduino-libraries/NTPClient>.

These include,

- `NTPClient.cpp`
- `NTPClient.h`

These libraries are licensed under MIT License.

---

## PowerSave

### Class PMUClass

#### PMUClass Class

#### Description

Defines a class of using Power Save API

#### Syntax

```
class PMUClass
```

#### Members



<b>Public Constructors</b>	
PMUClass::PMUClass	Constructs a PMUClass object
<b>Public Methods</b>	
PMUCLASS::begin	Initialize the PMUCLASS and select sleep mode
PMUCLASS::AONTimerDuration	Set the duration of AON Timer
PMUCLASS::AONTimerCmd	Disable the AON Timer for power save usage
PMUCLASS::RTCWakeSetup	Set up RTC Timer for power save usage
PMUCLASS::enable	Enable power save deep sleep mode
PMUCLASS::AONWakeReason	Check AON wakeup source
PMUCLASS::WakePinCheck	Check AON GPIO pin wakeup source
PMUCLASS::AONWakeClear	Clear all the AON wakeup source
PMUCLASS::DsleepWakeStatusGet	Check if deepsleep mode is set
PMUCLASS::TL_sysactive_time	Tickless mode system active time
PMUCLASS::TL_wakelock	Tickless mode wake lock, select acquire of release
PMUCLASS::DS_AON_TIMER_WAKEUP	Return the Wakeup source
PMUCLASS::DS_RTC_WAKEUP	Return the Wakeup source
PMUCLASS::TL_UART_WAKEUP	Return the Wakeup source
PMUCLASS::TL_RTC_WAKEUP	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA12	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA13	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA14	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA15	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA16	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA17	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA18	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA19	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA20	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA21	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA25	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA26	Return the Wakeup source

## PMUCLASS::PMUCLASS

### Description

Constructs a PMUCLASS object.

### Syntax

```
PMUCLASS::PMUCLASS(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::begin

### Description

Initialize the PMUCLASS and select sleep mode.

### Syntax

```
void PMUClass::begin(uint32_t sleep_mode);
```

### Parameters

sleep\_mode: Selection value, “11” enters the DeepSleep Mode, “22” enters the Tickless Mode

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONTimerDuration

### Description

Set the duration of AON Timer

### Syntax

```
void PMUClass::AONTimerDuration(uint32_t duration_ms);
```

### Parameters

duration\_ms: Timer duration between 0 to 32760000ms.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONTimerCmd

### Description

Disable the AON timer for power save usage.

### Syntax

```
void PMUClass::AONTimerCmd(void);
```

### Parameters

c: The value in Celcius.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::RTCWakeSetup

### Description

Set up the RTC timer for power save usage.

### Syntax

```
void PMUClass::RTCWakeSetu(uint32_t duration_d, uint32_t duration_h, uint32_t duration_m, uint32_t duration_s);
```

### Parameters

duration\_d: Set alarm for number of days from 0.

duration\_h: Set alarm for number of hours from 0.

duration\_m: Set alarm for number of minutes from 0.

duration\_s: Set alarm for number of seconds from 0.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::enable

### Description

Enable power save deep sleep mode

### Syntax

```
void PMUClass::enable(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONWakeReason

### Description

Check the AON wakeup source

### Syntax

```
uint32_t PMUClass::AONWakeReason(void);
```

### Parameters

The function requires no input parameter.

### Returns

Returns the value of wakeup deepsleep source. “11” for AON pin, “22” for AON timer, “33” for RTC timer and “0” for none.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::WakePinCheck

### Description

Check which AON GPIO pins are the wakeup source

### Syntax

```
int PMUClass::WakePinCheck(void);
```

### Parameters

The function requires no input parameter.

### Returns

Return the pin number for indicating Arduino pin names.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONWakeClear

### Description

Clear all AON Wakeup source.

### Syntax

```
void PMUClass::AONWakeClear(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::DsleepWakeStatusGet

### Description

Check if deepsleep mode is set.

### Syntax

```
bool PMUClass::DsleepWakeStatusGet(void);
```

### Parameters

The function requires no input parameter.

### Returns

Return TRUE when enter DeepSleep Mode or FALSE for negative.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_sysactive\_time

### Description

Tickless mode system active time.

### Syntax

```
void PMUClass::TL_sysactive_time(uint32_t duration_ms);
```

### Parameters

duration\_ms: Set the duration of system active time. The unit is in milliseconds.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_wakelock

### Description

Tickless mode wake lock, select acquire or release.

### Syntax

```
void PMUClass::TL_wakelock(uint32_t select_lock);
```



**Parameters**

select\_lock: Wake lock selection value, “1” for acquire or “0” for release.

**Returns**

The function returns nothing.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::DS\_AON\_TIMER\_WAKEUP****Description**

Return the Wakeup source for DeepSleep Mode.

**Syntax**

```
void PMUClass::DS_AON_TIMER_WAKEUP(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON Timer as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::DS\_RTC\_WAKEUP

### Description

Return the Wakeup source for DeepSleep Mode.

### Syntax

```
void PMUClass::DS_RTC_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns RTC as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_UART\_WAKEUP

### Description

Return the Wakeup source for Tickless Mode.

### Syntax

```
void PMUClass::TL_UART_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns LOGUART as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::TL\_RTC\_WAKEUP****Description**

Return the Wakeup source for Tickless Mode.

**Syntax**

```
void PMUClass::TL_RTC_WAKEUP(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns RTC as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA12****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA12(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA12 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA13****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA13(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA13 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA14

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA14(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA14 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA15

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA15(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA15 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA16

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA16(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA16 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA17

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA17(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA17 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA18****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA18(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA18 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA19

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA19(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA19 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA20

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA20(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA20 pin as the wakeup source and output it on the Serial monitor.



**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA21****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA21(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA21 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA25****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA25(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA25 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA26

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA26(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA26 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## RTC

### Class RTC

#### RTC Class

##### Description

A class used for displaying date and time and alarm configuration using RTC, the independent BCD (Binary-Coded-Decimal) timer.

##### Syntax

```
class RTC
```

##### Members

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named RTC.	

Public Methods	
RTC:: Init	Initializes the RTC device, including the Clock, the RTC registers, and other functions
RTC:: DeInit	Deinitialize the RTC device
RTC:: Write	Set the specified timestamp in seconds to RTC
RTC:: Read	Get the current timestamp in seconds from RTC
RTC:: Wait	Wait for 1 second
RTC:: SetEpoch	Convert human-readable time to epoch time

#### RTC::Init

##### Description

Initializes the RTC device, including the Clock, the RTC registers, and other functions.

##### Syntax

```
void RTC::Init(void);
```

##### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: RTC

```
/*
 * This function describes how to use the RTC API.
 * The RTC function is implemented by an independent BCD timer/counter.
 * This example will print out the time information every second.
 */

#include <stdio.h>
#include <time.h>
#include 「rtc.h」
#define YEAR 2020
#define MONTH 9
#define DAY 10
#define HOUR 20
#define MIN 30
#define SEC 40

/* Create an rtc object */
RTC rtc;

int32_t seconds;

struct tm *timeinfo;

void setup() {
  Serial.begin(115200);
  rtc.Init(); // initialize RTC
}
```

```

void loop() {
// step 1: convert user time to epoch
int epochTime = humanReadableToEpoch(YEAR, MONTH, DAY, HOUR, MIN, SEC);

// step 2: write epoch time to rtc
rtc.Write(epochTime);

while (1) {
seconds = rtc.Read();

printf(「Epoch Time (in s) since January 1, 1970 = %dsn」, seconds);

printf(「Time as a basic string = %s」, ctime(&seconds));

timeinfo = localtime(&seconds);

printf(「Time as a custom formatted string = %d-%d-%d %d:%d:%dn」,
(timeinfo->tm_year + 1900), (timeinfo->tm_mon + 1), timeinfo->tm_mday, timeinfo->tm_hour,
timeinfo->tm_min, timeinfo->tm_sec);

Serial.println();

rtc.wait(1);
}
}

// convert human readable time to epoch time
int humanReadableToEpoch(int year, int month, int day, int hour, int min, int sec) {
struct tm t;
time_t t_of_day;

t.tm_year = year - 1900; // Year - 1970
t.tm_mon = month - 1; // Month, where 0 = jan
t.tm_mday = day; // Day of the month
t.tm_hour = hour;
t.tm_min = min;
t.tm_sec = sec;

t.tm_isdst = -1; // Is DST on? 1 = yes, 0 = no, -1 = unknown
t_of_day = mktime(&t);

// printf(「seconds since the Epoch: %dn」, (long)t_of_day);

```

```
return t_of_day;  
}
```

### Notes and Warnings

NA

### RTC::DeInit

#### Description

Deinitializes the RTC device.

#### Syntax

```
void RTC::DeInit(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC:: Write

#### Description

Set the specified timestamp in seconds to RTC. Seconds from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS) to specified date and time which is to be set.

**Syntax**

```
void RTC::Write(int t);
```

**Parameters**

Parameters

t: Seconds from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS) to specified date and time which is to be set.

**Returns**

The function returns nothing.

**Example Code**

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

**Notes and Warnings**

NA

**RTC::Read****Description**

Get the current timestamp in seconds from RTC. The current timestamp in seconds which is calculated from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS).

**Syntax**

```
int32_t RTC::Read(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the current timestamp in seconds which is calculated from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS).

### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC:: Wait

#### Description

Send IR raw data.

#### Syntax

```
void RTC::wait(float s);
```

#### Parameters

s: unit microseconds (1 us)

#### Returns

The function returns nothing.

### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC:: SetEpoch

#### Description

Convert human-readable time to epoch time



**Syntax**

```
int RTC:: SetEpoch(int year, int month, int day, int hour, int min, int sec);
```

**Parameters**

year: user input year

month: user input month

day: user input day

hour: user input hour

min: user input minutes

sec: user input seconds

**Returns**

The function returns epoch time in seconds for RTC use.

**Example Code**

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

**Notes and Warnings**

NA

---

**SoftwareSerial****Class Adafruit\_GPS****Adafruit\_GPS Class****Description**

Defines a class to use GPS module on Ameba.

**Syntax**

```
class Adafruit_GPS
```

## Members

<b>Public Constructors</b>	
Adafruit_GPS::Adafruit_GPS	Constructs an Adafruit_GPS object
<b>Public Methods</b>	
Adafruit_GPS::begin	Initialize serial communication
*Adafruit_GPS:: lastNMEA	Returns the last NMEA line received and unsets the received flag
Adafruit_GPS:: newNMEAreceived	Check to see if a new NMEA line has been received
Adafruit_GPS:: common_init	Initialization code used by all constructor types
Adafruit_GPS:: sendCommand	Send a command to the GPS device
Adafruit_GPS:: pause	Pause/unpause receiving new data
Adafruit_GPS:: parseHex	Read a Hex value and return the decimal equivalent
Adafruit_GPS:: read	Read one character from the GPS device
Adafruit_GPS:: parse	Parse an NMEA string
Adafruit_GPS:: wakeup	Wake the sensor up
Adafruit_GPS:: standby	Standby Mode Switches
Adafruit_GPS::waitForSentence	Wait for a specified sentence from the device
Adafruit_GPS::LOCUS_StartLogger	Start the LOCUS logger
Adafruit_GPS::LOCUS_StopLogger	Stop the LOCUS logger
Adafruit_GPS::LOCUS_ReadStatus	Read the logger status

## Adafruit\_GPS::Adafruit\_GPS

### Description

Constructs an Adafruit\_GPS object and initialize serial using a SoftSerial object.

### Syntax

```
Adafruit_GPS::Adafruit_GPS(SoftwareSerial *ser)
```

```
Adafruit_GPS::Adafruit_GPS(HardwareSerial *ser)
```

### Parameters

ser: a Serial instance

### Returns

The function returns nothing.

**Example Code**

Example: Adafruit\_GPS\_parsing

This example code from Adafruit demonstrates GPS modules using MTK3329/MTK3339 driver. This code shows how to listen to the GPS module in an interrupt which allows the program to have more ‘freedom’ –just parse when a new NMEA sentence is available! Then access data when desired.

```
#include <Adafruit_GPS.h>

#include <SoftwareSerial.h>

// If you're using a GPS module:

// Connect the GPS Power pin to 3.3V

// Connect the GPS Ground pin to ground

// Connect the GPS TX (transmit) pin to Digital 0

// Connect the GPS RX (receive) pin to Digital 1

#if defined(BOARD_RTL8195A)

SoftwareSerial mySerial(0, 1);

#elif defined(BOARD_RTL8710)

SoftwareSerial mySerial(17, 5); // RTL8710 need change GPS TX/RX to pin 17 and 5

#else

SoftwareSerial mySerial(0, 1);

#endif

Adafruit_GPS GPS(&mySerial);

// Set GPSECHO to 『false』 to turn off echoing the GPS data to the Serial console

// Set to 『true』 if you want to debug and listen to the raw GPS sentences.

#define GPSECHO false

void setup()

{

Serial.begin(38400);

Serial.println( 「 Adafruit GPS library basic test! 」 );

// 9600 NMEA is the default baud rate for Adafruit MTK GPS's- some use 4800

GPS.begin(9600);

// uncomment this line to turn on RMC (recommended minimum) and GGA (fix data) including altitude
```

```
GPS.sendCommand(PMTK_SET_NMEA_OUTPUT_RMCGGA);

// uncomment this line to turn on only the 「minimum recommended」 data
//GPS.sendCommand(PMTK_SET_NMEA_OUTPUT_RMONLY);

// For parsing data, we don't suggest using anything but either RMC only or RMC+GGA since
// the parser doesn't care about other sentences at this time
// Set the update rate

GPS.sendCommand(PMTK_SET_NMEA_UPDATE_1HZ); // 1 Hz update rate

// For the parsing code to work nicely and have time to sort thru the data, and
// print it out we don't suggest using anything higher than 1 Hz

// Request updates on antenna status, comment out to keep quiet
GPS.sendCommand(PGCMD_ANTENNA);

delay(1000);

// Ask for firmware version

mySerial.println(PMTK_Q_RELEASE);

}

uint32_t timer = millis();

void loop() // run over and over again
{
    // in case you are not using the interrupt above, you'll
    // need to 「hand query」 the GPS, not suggested :(
    // read data from the GPS in the 「main loop」

    char c = GPS.read();

    // if you want to debug, this is a good time to do it!

    if (GPSECHO)
    if (c) Serial.print(c);

    // if a sentence is received, we can check the checksum, parse it...
    if (GPS.newNMEAreceived()) {
        // a tricky thing here is if we print the NMEA sentence, or data
        // we end up not listening and catching other sentences!
        // so be very wary if using OUTPUT_ALLDATA and trying to print out data
```

```

//Serial.println(GPS.lastNMEA()); // this also sets the newNMEAreceived() flag to false
if (!GPS.parse(GPS.lastNMEA())) // this also sets the newNMEAreceived() flag to false
return; // we can fail to parse a sentence in which case we should just wait for another
}

// if millis() or timer wraps around, we'll just reset it
if (timer > millis()) timer = millis();

// approximately every 2 seconds or so, print out the current stats
if (millis() - timer > 2000) {
timer = millis(); // reset the timer

Serial.print("\nTime: ");

Serial.print(GPS.hour, DEC); Serial.print( " ");

Serial.print(GPS.minute, DEC); Serial.print( " ");

Serial.print(GPS.seconds, DEC); Serial.print( ".");

Serial.println(GPS.milliseconds);

Serial.print( "Date: ");

Serial.print(GPS.day, DEC); Serial.print( "/");

Serial.print(GPS.month, DEC); Serial.print( "/20");

Serial.println(GPS.year, DEC);

Serial.print( "Fix: "); Serial.print((int)GPS.fix);

Serial.print( " quality: "); Serial.println((int)GPS.fixquality);

if (GPS.fix) {

Serial.print( "Location: ");

Serial.print(GPS.latitude, 4); Serial.print(GPS.lat);

Serial.print( " , ");

Serial.print(GPS.longitude, 4); Serial.println(GPS.lon);

Serial.print( "Location (in degrees, works with Google Maps): ");

Serial.print(GPS.latitudeDegrees, 4);

Serial.print( " , ");

Serial.println(GPS.longitudeDegrees, 4);

Serial.print( "Speed (knots): "); Serial.println(GPS.speed);

```

```
Serial.print(「Angle:  」); Serial.println(GPS.angle);  
Serial.print(「Altitude:  」); Serial.println(GPS.altitude);  
Serial.print(「Satellites:  」); Serial.println((int)GPS.satellites);  
}  
}  
}
```

### Notes and Warnings

IMPORTANT: SoftSerial is using hardware serial so pin mapping cannot be altered.

### Adafruit\_GPS::begin

#### Description

Initialize serial communication

#### Syntax

```
void Adafruit_GPS::begin(uint16_t baud)
```

#### Parameters

baud: serial baud rate

#### Returns

The function returns nothing.

#### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

## **\*Adafruit\_GPS::lastNMEA**

### **Description**

Returns the last NMEA line received and unsets the received flag

### **Syntax**

```
char *Adafruit_GPS::lastNMEA(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

Pointer to the last line string

### **Example Code**

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### **Notes and Warnings**

NA

## **Adafruit\_GPS::newNMEAreceived**

### **Description**

Check to see if a new NMEA line has been received

### **Syntax**

```
boolean Adafruit_GPS::newNMEAreceived(void)
```

### **Parameters**

The function requires no input parameter.

### Returns

True if received, false if not

### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

### Adafruit\_GPS::common\_init

### Description

Initialization code used by all constructor types

### Syntax

```
void Adafruit_GPS::common_init(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA



## Adafruit\_GPS::sendCommand

### Description

Send a command to the GPS device

### Syntax

```
void Adafruit_GPS::sendCommand(const char *str)
```

### Parameters

str: Pointer to a string holding the command to send

### Returns

The function returns nothing.

### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

## Adafruit\_GPS::pause

### Description

Pause/unpause receiving new data

### Syntax

```
void Adafruit_GPS::pause(boolean p)
```

### Parameters

p: True = pause, false = unpause

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::parseHex

### Description

Read a Hex value and return the decimal equivalent

### Syntax

```
uint8_t Adafruit_GPS::parseHex(char c)
```

### Parameters

c: Hex value

### Returns

The decimal equivalent of the Hex value

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::read

**Description**

Read one character from the GPS device

**Syntax**

```
char Adafruit_GPS::read(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The character that we received, or 0 if nothing was available

**Example Code**

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

**Notes and Warnings**

NA

**Adafruit\_GPS::parse****Description**

Parse an NMEA string

**Syntax**

```
boolean Adafruit_GPS::parse(char *nmea)
```

**Parameters**

nmea: an NMEA string

**Returns**

True if we parsed it, false if it has invalid data

### Example Code

Example: Adafruit\_GPS\_parsing

### Notes and Warnings

NA

## Adafruit\_GPS::wakeup

### Description

Wake the sensor up

### Syntax

boolean Adafruit\_GPS::wakeup(void)

### Parameters

The function requires no input parameter.

### Returns

True if woken up, false if not in standby or failed to wake

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::standby

**Description**

Standby Mode Switches

**Syntax**

boolean Adafruit\_GPS::standby(void)

**Parameters**

The function requires no input parameter.

**Returns**

False if already in standby, true if it entered standby

**Example Code**

NA

**Notes and Warnings**

NA

**Adafruit\_GPS::waitForSentence****Description**

Wait for a specified sentence from the device

**Syntax**

boolean Adafruit\_GPS::waitForSentence(const char \*wait4me, uint8\_t max)

**Parameters**

wait4me: Pointer to a string holding the desired response

max: How long to wait, default is MAXWAITSENTENCE

**Returns**

True if we got what we wanted, false otherwise

#### **Example Code**

NA

#### **Notes and Warnings**

NA

### **Adafruit\_GPS::LOCUS\_StartLogger**

#### **Description**

Start the LOCUS logger

#### **Syntax**

boolean Adafruit\_GPS::LOCUS\_StartLogger(void)

#### **Parameters**

The function requires no input parameter.

#### **Returns**

True on success, false if it failed

#### **Example Code**

NA

#### **Notes and Warnings**

NA

### **Adafruit\_GPS::LOCUS\_StopLogger**

**Description**

Stop the LOCUS logger

**Syntax**

boolean Adafruit\_GPS::LOCUS\_StopLogger(void)

**Parameters**

The function requires no input parameter.

**Returns**

True on success, false if it failed

**Example Code**

NA

**Notes and Warnings**

NA

**Adafruit\_GPS::LOCUS\_ReadStatus****Description**

Read the logger status

**Syntax**

boolean Adafruit\_GPS::LOCUS\_ReadStatus(void)

**Parameters**

The function requires no input parameter.

**Returns**

True if we read the data, false if there was no response

**Example Code**

NA

**Notes and Warnings**

NA

**Class HttpClient****PMS3003 Class****Description**

Defines a class to work with PMS3003 air quality sensor on Ameba.

**Syntax**

```
class PMS3003
```

**Members**

Public Constructors	
PMS3003::PMS3003	Constructs a PMS3003 object
Public Methods	
PMS3003::begin	Initialize hardware UART
PMS3003::end	Free allocated space thus stopping UART
PMS3003::get_pm1p0_cf1	Get PM1.0 under correction factor = 1
PMS3003:: get_pm2p5_cf1	Get PM2.5 under correction factor = 1
PMS3003:: get_pm10_cf1	Get PM10 under correction factor = 1
PMS3003:: get_pm1p0_air	Get PM1.0 air quality
PMS3003:: get_pm2p5_air	Get PM2.5 air quality
PMS3003:: get_pm10_air	Get PM10 air quality
PMS3003:update_cache	Updates the cache memory
PMS3003::pms3003_handle_interrupt	Set up the serial event handler

**PMS3003::PMS3003****Description**



Constructs a PMS3003 object and initialize the pin mapping.

**Syntax**

```
PMS3003::PMS3003(int _rx, int _tx, int _set, int _reset)
```

**Parameters**

\_rx: RX pin of UART

\_tx: TX pin of UART

\_set: Set pin

\_reset: Reset pin

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::begin****Description**

Initialize hardware UART and allocate space for serial buffer

**Syntax**

```
void PMS3003::begin(void)
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### PMS3003::end

### Description

Free serial buffer space and stop UART

### Syntax

```
void PMS3003::end(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### PMS3003::get\_pm1p0\_cf1

**Description**

Get PM1.0 under correction factor = 1

**Syntax**

```
int PMS3003::get_pm1p0_cf1(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value “pm1p0\_cf1” as an integer.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm2p5\_cf1****Description**

Get PM2.5 under correction factor = 1

**Syntax**

```
int PMS3003::get_pm2p5_cf1(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm2p5\_cf1” as an integer.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::get\_pm10\_cf1

### Description

Get PM10 under correction factor = 1

### Syntax

```
int PMS3003::get_pm10_cf1(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value of “pm10\_cf1” as an integer.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::get\_pm1p0\_air

### Description

Get PM1.0 air quality

**Syntax**

```
int PMS3003::get_pm1p0_air(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm1p0\_air” as an integer.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm2p5\_air****Description**

Get PM2.5 air quality

**Syntax**

```
int PMS3003::get_pm2p5_air(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm2p5\_air” as an integer.

**Example Code**

NA

## Notes and Warnings

NA

## PMS3003::get\_pm10\_air

### Description

Get PM10 air quality

### Syntax

```
int PMS3003::get_pm10_air(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value of “pm10\_air” as an integer.

### Example Code

NA

## Notes and Warnings

NA

## PMS3003::pms3003\_handle\_interrupt

### Description

Set up the serial event handler

### Syntax

```
void pms3003_handle_interrupt(uint32_t id, uint32_t event)
```

**Parameters**

id: device identifier

event: Serial event for handling incoming data

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::update\_cache****Description**

Serves the function of updating cache memory. One package has 32 bytes. Illustrate the formate by using below raw data: 42 4d 00 1c 00 1b 00 21 00 29 00 1a 00 21 00 29 2b fb 04 be 00 6b 00 10 00 04 00 04 67 00 04 46

42 4d : header signature

00 1c : frame length, 0x001c = 28 bytes (not include header and this field)

00 1b : PM1.0 under CF=1

00 21 : PM2.5 under CF=1

00 29 : PM10 under CF=1

00 1a : PM1.0 under air

00 21 : PM2.5 under air

00 29 : PM10 under air

2b fb : number of pariticle, diameter size 0.3 um in 0.1 liter air

04 be : number of pariticle, diameter size 0.5 um in 0.1 liter air

00 6b : number of pariticle, diameter size 1.0 um in 0.1 liter air

00 10 : number of pariticle, diameter size 2.5 um in 0.1 liter air

00 04 : number of pariticle, diameter size 5.0 um in 0.1 liter air

00 04 : number of pariticle, diameter size 10 um in 0.1 liter air

67 : serial number

00 : error code

04 46 :

checksum,0x42+0x4d+0x00+0x1c+0x00+0x1b+0x00+0x21+0x00+0x29+0x00+0x1a+0x00+0x21+0x00+0x29+  
0x2b+0xfb+0x04+0xbe+0x00+0x6b+0x00+0x10+0x00+0x04+0x00+0x04+0x67+0x00 = 0x0446

### Syntax

```
void PMS3003::update_cache(void)
```

### Parameters

The function requires no input parameters.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Class SoftwareSerial

### SoftwareSerial Class

#### Description

Defines a class of software serial implementation for Ameba.

#### Syntax

```
class SoftwareSerial
```

#### Members



<b>Public Constructors</b>	
SoftwareSerial::SoftwareSerial	Constructs a SoftwareSerial object
<b>Public Methods</b>	
SoftwareSerial::begin	Sets the speed (baud rate) for the serial communication
SoftwareSerial::listen	Enables the selected software serial port to listen
SoftwareSerial::end	Same as stopListening
SoftwareSerial::stopListening	Stop listening on the port
SoftwareSerial::peek	Return a character that was received on the RX pin of the software serial port
SoftwareSerial::write	Prints data to the transmit pin of the software serial port as raw bytes
SoftwareSerial::read	Return a character that was received on the RX pin of the software serial port
SoftwareSerial::available	Get the number of bytes (characters) available for reading from a software serial port
SoftwareSerial::flush	Flush the received buffer
SoftwareSerial::setBufferSize	Set buffer size
SoftwareSerial::setAvailableCallback	Set available callback
SoftwareSerial::handle_interrupt	Private methods handles interrupt

## SoftwareSerial::SoftwareSerial

### Description

Constructs a SoftwareSerial object and sets RX and TX pin, and inverse logic.

### Syntax

```
SoftwareSerial::SoftwareSerial(uint8_t receivePin, uint8_t transmitPin, bool inverse_logic /* = false */)
```

### Parameters

receivePin: the pin on which to receive serial data

transmitPin: the pin on which to transmit serial data

inverse\_logic: is used to invert the sense of incoming bits

### Returns

The function returns nothing.

### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX.

```
/*  
The circuit: (BOARD RTL8195A)  
* RX is digital pin 0 (connect to TX of other devices)  
* TX is digital pin 1 (connect to RX of other devices)  
*/  
  
#include <SoftwareSerial.h>  
  
#if defined(BOARD_RTL8195A)  
SoftwareSerial mySerial(0, 1); // RX, TX  
  
#elif defined(BOARD_RTL8710)  
SoftwareSerial mySerial(17, 5); // RX, TX  
  
#else  
SoftwareSerial mySerial(0, 1); // RX, TX  
  
#endif  
  
void setup() {  
  // Open serial communications and wait for port to open:  
  Serial.begin(57600);  
  
  while (!Serial) {  
    ; // wait for serial port to connect. Needed for native USB port only  
  }  
  
  Serial.println(「Goodnight moon!」);  
  
  // set the data rate for the SoftwareSerial port  
  mySerial.begin(4800);  
  mySerial.println(「Hello, world?」);  
}  
  
void loop() { // run over and over  
  if (mySerial.available()) {  
    mySerial.write(mySerial.read());  
  }  
}
```

```
}
```

### Notes and Warnings

Software Serial is using hardware serial thus DO NOT change the default pins

### SoftwareSerial::begin

#### Description

Sets the speed (baud rate) for the serial communication

#### Syntax

```
void SoftwareSerial::begin(long speed)
```

```
void SoftwareSerial::begin(long speed, int data_bits, int parity, int stop_bits)
```

```
void SoftwareSerial::begin(long speed, int data_bits, int parity, int stop_bits, int flowctrl, int rtsPin, int ctsPin)
```

#### Parameters

speed: the baud rate

data\_bits: number of data bits, 8 bits(default) or 7 bits

stop\_bits: number of stop bits, 1 bit(default), 1.5 bits or 2 bits

flowctrl: flow control pin

rtsPin: request to send pin

ctsPin: clear to send pin

#### Returns

The function returns nothing.

#### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial\_Basic:: SoftwareSerial.

### Notes and Warnings

NA

## SoftwareSerial::listen

### Description

Enables the selected software serial port to listen

### Syntax

```
bool SoftwareSerial::listen(void)
```

### Parameters

The function requires no input parameter.

### Returns

Returns true if it replaces another

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::end

### Description

Same as stopListening

### Syntax

```
void SoftwareSerial::end(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**SoftwareSerial::isListening****Description**

Tests to see if requested software serial port is actively listening

**Syntax**

```
bool SoftwareSerial::isListening(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns “True” if the port is listening.

**Example Code**

NA

**Notes and Warnings**

NA

## SoftwareSerial::stopListening

### Description

Stop listening on the port

### Syntax

```
bool SoftwareSerial::stopListening(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “True” if listening on the port is stopped.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::peek

### Description

Return a character that was received on the RX pin of the software serial port

### Syntax

```
int SoftwareSerial::peek(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the character read, or returns “-1” if none is available.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::write

### Description

Prints data to the transmit pin of the software serial port as raw bytes

### Syntax

```
size_t SoftwareSerial::write(uint8_t b)
```

### Parameters

b: byte to be written

### Returns

The function returns the number of bytes written.

### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial:: SoftwareSerial.

### Notes and Warnings

NA

## **SoftwareSerial::read**

### **Description**

Return a character that was received on the RX pin of the software serial port

### **Syntax**

```
int SoftwareSerial::read(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns the character read, or -1 if none is available.

### **Example Code**

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial: SoftwareSerial.

### **Notes and Warnings**

NA

## **SoftwareSerial::available**

### **Description**

Get the number of bytes available for reading from a software serial port

### **Syntax**



```
int SoftwareSerial::available(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the number of bytes available to read.

**Example Code**

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial:: SoftwareSerial.

**Notes and Warnings**

NA

**SoftwareSerial::flush****Description**

Flush the received buffer

**Syntax**

```
void SoftwareSerial::flush(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

#### Notes and Warnings

NA

### SoftwareSerial::setBufferSize

#### Description

Set buffer size

#### Syntax

```
void SoftwareSerial::setBufferSize(uint32_t buffer_size)
```

#### Parameters

buffer\_size: the size of the serial buffer

#### Returns

The function returns nothing.

#### Example Code

NA

#### Notes and Warnings

NA

### SoftwareSerial::setAvailableCallback

#### Description

Set available callback

## Syntax

```
void SoftwareSerial::setAvailableCallback(void (*callback)(char c))
```

## Parameters

\*callback: user-defined serial callback function

## Returns

The function returns nothing.

## Example Code

Example: SoftwareSerialIrqCallback

This example demonstrates the software serial testing using IRQ callback and semaphore. Set callback function “mySerialCallback” to software serial. Whenever there is data comes in, “mySerialCallback” is invoked. In this sketch, it does nothing until the end of the line. And then it sends a semaphore. The loop() uses a non-busy loop to wait for the semaphore. To test this sketch, you need to type something on software serial and then press Enter.

```
/*
```

```
The circuit: (BOARD RTL8195A)
```

```
RX is digital pin 0 (connect to TX of other devices)
```

```
TX is digital pin 1 (connect to RX of other devices)
```

```
*/
```

```
#include <SoftwareSerial.h>
```

```
#if defined(BOARD_RTL8195A)
```

```
SoftwareSerial mySerial(0, 1); // RX, TX
```

```
#elif defined(BOARD_RTL8710)
```

```
SoftwareSerial mySerial(17, 5); // RX, TX
```

```
#else
```

```
SoftwareSerial mySerial(0, 1); // RX, TX
```

```
#endif
```

```
uint32_t semaID;
```

```
// The callback is hooking at UART IRQ handler and please don't do heavy task here.
```

```
void mySerialCallback(char c)
```

```
{
/* The parameter c is only for peeking. The actual data is
* still in the buffer of SoftwareSerial.
*/
if (c == 『r』 || c == 『n』 ) {
os_semaphore_release(semaID);
}
}

void setup() {
// use 1 count for binary semaphore
semaID = os_semaphore_create(1);

// There is a token in the semaphore, clear it.
os_semaphore_wait(semaID, 0xFFFFFFFF);

// set the data rate for the SoftwareSerial port
mySerial.begin(38400);
mySerial.setAvailableCallback(mySerialCallback);
}

void loop() { // run over and over
// wait semaphore for 5s timeout
if (os_semaphore_wait(semaID, 5 * 1000)) {
// we got data before timeout
while(mySerial.available()) {
mySerial.print((char)mySerial.read());
}
mySerial.println();
} else {
mySerial.println( 「No data comes in.」 );
}
}
```

## Notes and Warnings

NA

## SoftwareSerial::handle\_interrupt

### Description

A private method handles the interrupt

### Syntax

```
void handle_interrupt(uint32_t id, uint32_t event)
```

### Parameters

id: the interrupt id

event: interrupt event

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## Readme

The Ameba Software Serial related APIs and examples are works based on libraries formerly known as `NewSoftSerial.h` by Mikal Hart (<http://arduiniiana.org/libraries/newsoftserial>).

These include,

- `SoftwareSerial.cpp`
- `SoftwareSerial.h`

These libraries are under GNU Lesser General Public License.

---

The Ameba GPS related APIs and examples are works based on Adafruit GPS library written by Limor Fried/Ladyada for Adafruit Industries (<http://www.adafruit.com/products/746>).

These include,

- Adafruit\_GPS.cpp
- Adafruit\_GPS.h

These libraries are under BSD License.

---

## SPI

### Class AmebaILI9341

#### AmebaILI9341 Class

##### Description

Defines a class to use ILI9341 TFT SPI display for Ameba.

##### Syntax

```
class AmebaILI9341
```

##### Members

<b>Public Constructors</b>	
<code>AmebaILI9341::AmebaILI9341</code>	Constructs an AmebaILI9341 object
<b>Public Methods</b>	
<code>AmebaILI9341::begin</code>	Initialize SPI, pin mapping and screen configuration
<code>AmebaILI9341::setAddress</code>	Initialize image size and position
<code>AmebaILI9341::writecommand</code>	SPI transfer a command
<code>AmebaILI9341::writedata</code>	SPI transfer a piece of data
<code>AmebaILI9341::setRotation</code>	Set screen orientation
<code>AmebaILI9341::fillScreen</code>	Fill the screen with a color
<code>AmebaILI9341::clr</code>	Clear screen
<code>AmebaILI9341::fillRectangle</code>	Fill a rectangular space with a color
<code>AmebaILI9341::drawPixel</code>	Turn on a pixel on the screen
<code>AmebaILI9341::drawChar</code>	To print a character on the screen
<code>AmebaILI9341::drawLine</code>	Draw line on the screen
<code>AmebaILI9341::drawRectangle</code>	Draw a rectangle on the screen
<code>AmebaILI9341::drawCircle</code>	Draw a circle on the screen
<code>AmebaILI9341::write</code>	Same as drawChar
<code>AmebaILI9341::getWidth</code>	Return the width 240
<code>AmebaILI9341::getHeight</code>	Return the height 320
<code>AmebaILI9341::setCursor</code>	Set cursor to the desired position
<code>AmebaILI9341::setForeground</code>	Set foreground color
<code>AmebaILI9341::setBackground</code>	Set background color
<code>AmebaILI9341::setFontSize</code>	Set character font size
<code>AmebaILI9341::reset</code>	Reset pin to High or Low

## AmebaILI9341::AmebaILI9341

### Description

Constructs an AmebaILI9341 object and set CS, DC and RESET pins .

### Syntax

```
AmebaILI9341::AmebaILI9341(int csPin, int dcPin, int resetPin)
```

### Parameters

csPin: pin for Chip Select dcPin: pin for Data/Command resetPin: pin for Reset

### Returns

The function returns nothing.

### Example Code

Example: : PM25\_ON\_ILI9341\_TFT\_LCD

This example demonstrates how to read pm2.5 value on PMS 3003 air-condition sensor and display it on ILI9341 TFT LCD.

/\*

PMS 3003 pin map is as follow:

PIN1 :VCC, connect to 5V

PIN2 :GND

PIN3 :SET, 0:Standby mode, 1:operating mode

PIN4 :RXD :Serial RX

PIN5 :TXD :Serial TX

PIN6 :RESET

PIN7 :NC

PIN8 :NC

In this example, we only use Serial to get PM 2.5 value.

The circuit:

\* RX is digital pin 0 (connect to TX of PMS 3003)

\* TX is digital pin 1 (connect to RX of PMS 3003)

For RTL8195A ILI9341 TFT LCD with SPI interface has these pins:

D/C : connect to pin 9

CS : connect to pin 10

MOSI : connect to pin 11

MISO : connect to pin 12

CLK : connect to pin 13

VCC : connect to 3V3

GND : connect to GND

\*/

**#include** 「SoftwareSerial.h」

**#include** 「SPI.h」

**#include** 「AmebaILI9341.h」

**#if defined**(BOARD\_RTL8195A)

SoftwareSerial mySerial(0, 1); // RX, TX



```

#define TFT_RESET 8

#define TFT_DC 9

#define TFT_CS 10

#elif defined(BOARD_RTL8710)

SoftwareSerial mySerial(17, 5); // RX, TX

// IMPORTANT: Due to limit pin, we do not connect TFT_RESET pin.

#define TFT_RESET 0xFFFFFFFF

#define TFT_DC 2

#define TFT_CS 10

#endif

AmebaILI9341 tft = AmebaILI9341(TFT_CS, TFT_DC, TFT_RESET);

#define ILI9341_SPI_FREQUENCY 20000000

#define pmsDataLen 32

uint8_t buf[pmsDataLen];

int idx = 0;

int pm10 = 0;

int last_pm25 = 0;

int pm25 = 0;

int pm100 = 0;

uint16_t pm25color[] = {

0x9FF3,

0x37E0,

0x3660,

0xFFE0,

0xFE60,

0xFCC0,

0xFB2C,

0xF800,

0x9800,

0xC99F

```

```
};

void setup() {
  Serial.begin(57600);

  mySerial.begin(9600); // PMS 3003 UART has baud rate 9600

  SPI.setDefaultFrequency(ILI9341_SPI_FREQUENCY);

  tft.begin();

  drawPictureFrames();
}

void loop() { // run over and over
  uint8_t c;

  idx = 0;

  memset(buf, 0, pmsDataLen);

  while (true) {
    while (c != 0x42) {
      while (!mySerial.available());

      c = mySerial.read();
    }

    while (!mySerial.available());

    c = mySerial.read();

    if (c == 0x4d) {
      // now we got a correct header

      buf[idx++] = 0x42;

      buf[idx++] = 0x4d;

      break;
    }
  }

  while (idx != pmsDataLen) {
    while(!mySerial.available());

    buf[idx++] = mySerial.read();
  }
}
```

```
pm10 = ( buf[10] << 8 ) | buf[11];
last_pm25 = pm25;
pm25 = ( buf[12] << 8 ) | buf[13];
pm100 = ( buf[14] << 8 ) | buf[15];
updateValueToTftScreen();
}

void drawPictureFrames() {
tft.setRotation(1);
tft.clr();
tft.setFontSize(1);
// Upper title
tft.setFontSize(1);
tft.setCursor(20,20);
tft.print( 「PM2.5 DETECTOR」 );
// PM 2.5 Circle Frame
tft.drawCircle(100,130,60, ILI9341_BLUE);
tft.drawCircle(100,130,61, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(90,85);
tft.print( 「PM2.5」 );
tft.setFontSize(1);
tft.setCursor(90,170);
tft.print( 「um/m3」 );
// PM 10 Circle Frame
tft.drawCircle(220,70,40, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(210,40);
tft.print( 「PM10」 );
tft.setFontSize(1);
tft.setCursor(205,95);
```

```
tft.print(「um/m3」);
// PM 1.0 Circle Frame
tft.drawCircle(220,170,40, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(205,140);
tft.print(「PM1.0」);
tft.setFontSize(1);
tft.setCursor(205,195);
tft.print(「um/m3」);
// right side bar, referenced from: http://taqm.epa.gov.tw/taqm/tw/
tft.fillRect(290, 30+ 0*2, 10, 12*2, pm25color[0]); // 0~11
tft.fillRect(290, 30+12*2, 10, 12*2, pm25color[1]); // 12-23
tft.fillRect(290, 30+24*2, 10, 12*2, pm25color[2]); // 24-35
tft.fillRect(290, 30+36*2, 10, 6*2, pm25color[3]); // 36-41
tft.fillRect(290, 30+42*2, 10, 6*2, pm25color[4]); // 42-47
tft.fillRect(290, 30+48*2, 10, 6*2, pm25color[5]); // 48-53
tft.fillRect(290, 30+54*2, 10, 6*2, pm25color[6]); // 54-58
tft.fillRect(290, 30+59*2, 10, 6*2, pm25color[7]); // 59-64
tft.fillRect(290, 30+65*2, 10, 6*2, pm25color[8]); // 65-70
tft.fillRect(290, 30+71*2, 10, 10*2, pm25color[9]); // >=71
tft.setCursor(302, 30);
tft.setFontSize(1);
tft.print(「0」);
tft.setCursor(302, 30+36*2);
tft.print(「36」);
tft.setCursor(302, 30+54*2);
tft.print(「54」);
tft.setCursor(302, 30+71*2);
tft.print(「71」);
// bottom right text
```

```
tft.setCursor(210,230);
tft.setFontSize(1);
tft.print(「Powered by Realtek」);
updateValueToTftScreen();
}

void updateValueToTftScreen() {
tft.setCursor(60, 111);
tft.setFontSize(5);
tft.setForeground( getPm25Color(pm25) );
if (pm25 < 10) {
tft.print(「」);
} else if (pm25 < 100) {
tft.print(「」);
}
tft.print(pm25);
tft.setCursor(195,60);
tft.setFontSize(3);
if (pm100 < 10) {
tft.print(「」);
} else if (pm100 < 100) {
tft.print(「」);
}
tft.print(pm100);
tft.setCursor(198,160);
if (pm10 < 10) {
tft.print(「」);
} else if (pm10 < 100) {
tft.print(「」);
}
tft.print(pm10);
```

```
tft.setFontSize(1);

tft.setForeground(ILI9341_WHITE);

if (last_pm25 > 80) {
  tft.fillRect(275, 80*2+30-3, 12, 8, ILI9341_BLACK);
} else {
  tft.fillRect(275, last_pm25*2+30-3, 12, 8, ILI9341_BLACK);
}

if (pm25 > 80) {
  tft.setCursor(275, 80*2+30-3);
} else {
  tft.setCursor(275, pm25*2+30-3);
}

tft.print(「=>」);
}

uint16_t getPm25Color(int v) {
  if (v < 12) {
    return pm25color[0];
  } else if (v < 24) {
    return pm25color[1];
  } else if (v < 36) {
    return pm25color[2];
  } else if (v < 42) {
    return pm25color[3];
  } else if (v < 48) {
    return pm25color[4];
  } else if (v < 54) {
    return pm25color[5];
  } else if (v < 59) {
    return pm25color[6];
  } else if (v < 65) {
```

```

return pm25color[7];
} else if (v < 71) {
return pm25color[8];
} else {
return pm25color[9];
}
}

```

### Notes and Warnings

NA

### AmebaILI9341::begin

#### Description

Initialize hardware SPI, pin mapping and screen configuration

#### Syntax

```
void AmebaILI9341::begin(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

This method is required to run first before other operations on the display.

### AmebaILI9341::setAddress

#### Description

Initialize image size and positioning on the display

#### Syntax

```
void AmebaILI9341::setAddress(uint16_t x0, uint16_t y0, uint16_t x1, uint16_t y1)
```

#### Parameters

x0: leftmost coordinate of the image y0: top coordinate of the image x1: rightmost coordinate of the image y1: bottom coordinate of the image

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Do not use this to set the cursor, use the “setCursor” method instead.

### AmebaILI9341::writecommand

#### Description

Write a single-byte command to display

#### Syntax

```
void AmebaILI9341::writecommand(uint8_t command)
```

#### Parameters

command: a single byte command

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### AmebaILI9341::writedata

#### Description

Write 1 byte of data to display

#### Syntax

```
void AmebaILI9341::writedata(uint8_t data)
```

#### Parameters

data: 1 byte data

#### Returns

The function returns nothing.



**Example Code**

NA

**Notes and Warnings**

Only use this method to write 1 byte at a time.

**AmebaILI9341::setRotation****Description**

Setting screen orientation, “0” for no rotation, “1” for 90 degrees rotation and so on so forth.

**Syntax**

void AmebaILI9341::setRotation(uint8\_t m)/span> **Parameters**

m: one of the 4 rotation modes -> “0” for no rotation, “1” for 90<sup>0</sup>, “2” for 180<sup>0</sup>, “3” for 270<sup>0</sup>

**Returns**

The function returns nothing.

**Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

**Notes and Warnings**

if m=4, it’ s equivalent to mode 0, and m=5 for mode 1, m=6 for mode 2 so on so forth.

**AmebaILI9341::fillScreen****Description**

Fill the entire screen with one color

**Syntax**

void AmebaILI9341::fillScreen(uint16\_t color)

**Parameters**

color: a 16-bit color reference defined in AmebaILI9341.h

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Refer to AmebaILI9341.h for available colors.

## **AmebaILI9341::clr**

### **Description**

Fill the entire screen with a certain background-color

### **Syntax**

```
void AmebaILI9341::clr(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341

### **Notes and Warnings**

background-color can be set by calling setBackground method.

## **AmebaILI9341::fillRectangle**

### **Description**

Fill a rectangular space with a color on the screen

### **Syntax**

```
void AmebaILI9341::fillRectangle(int16_t x, int16_t y, int16_t w, int16_t h, uint16_t color)
```

### **Parameters**

x: leftmost coordinate of the image y: top coordinate of the image w: width of the image h: height of the image color: the color of the image

### **Returns**

The function returns nothing.

### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### **Notes and Warnings**

NA

## **AmebaILI9341::drawPixel**

**Description**

Turn on a pixel on the screen

**Syntax**

```
void AmebaILI9341::drawPixel(int16_t x, int16_t y, uint16_t color)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::drawChar****Description**

Draw character on the screen

**Syntax**

```
void AmebaILI9341::drawChar(unsigned char c) void AmebaILI9341::drawChar(int16_t x, int16_t y, unsigned char c, uint16_t _fontcolor, uint16_t _background, uint8_t _fontsize)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image c: a character \_fontcolor: font color \_background: background color \_fontsize: font size

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

In the actual example, the Print method is used to print a string of character on the screen instead of using this method.

**AmebaILI9341::drawLine****Description**

Draw a straight line on the screen

**Syntax**

```
void AmebaILI9341::drawLine(int16_t x0, int16_t y0, int16_t x1, int16_t y1) void AmebaILI9341::drawLine(int16_t x0, int16_t y0, int16_t x1, int16_t y1, uint16_t color)
```

**Parameters**

x0: leftmost coordinate of the image y0: top coordinate of the image x1: leftmost coordinate of the image y1: top coordinate of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::drawRectangle****Description**

Draw a rectangular shape on the screen

**Syntax**

```
void AmebaILI9341::drawRectangle(int16_t x, int16_t y, int16_t w, int16_t h) void AmebaILI9341::drawRectangle(int16_t x, int16_t y, int16_t w, int16_t h, uint16_t color)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image w: width of the image h: height of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::drawCircle****Description**

Draw a circular shape on the screen

**Syntax**

```
void AmebaILI9341::drawCircle(int16_t x0, int16_t y0, int16_t r) void AmebaILI9341::drawCircle(int16_t x0, int16_t y0, int16_t r, uint16_t color)
```

**Parameters**

x0: leftmost coordinate of the image y0: top coordinate of the image r: radius of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “AmebaServo.h” to use the class function.

**AmebaILI9341::write****Description**

Same as drawChar, write a character on the screen

**Syntax**

```
size_t AmebaILI9341::write(uint8_t c)
```

**Parameters**

c: a character to be written on the screen

**Returns**

Number of bytes written

**Example Code**

NA

**Notes and Warnings**

This an inherited method from Print class and is seldom used.

**AmebaILI9341::getWidth****Description**

Get the width of the image

**Syntax**

```
int16_t AmebaILI9341::getWidth(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

Width of the image

### Example Code

NA

### Notes and Warnings

NA

### AmebaILI9341::getHeight

#### Description

Get the height of the image

#### Syntax

```
int16_t AmebaILI9341::getHeight(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

Height of the image

### Example Code

NA

### Notes and Warnings

NA

### AmebaILI9341::setCursor

#### Description

Set the cursor to a specific position on the screen

#### Syntax

```
void AmebaILI9341::setCursor(int16_t x, int16_t y)
```

#### Parameters

x: coordinate on the x-axis y: coordinate on the y-axis

#### Returns

The function returns nothing.

### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

NA

### **AmebaILI9341::setForeground**

#### **Description**

Set foreground color

#### **Syntax**

```
void AmebaILI9341::setForeground(uint16_t color)
```

#### **Parameters**

color: one of the colors available in AmebaILI9341.h

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

#### **Notes and Warnings**

NA

### **AmebaILI9341::setBackground**

#### **Description**

Set background color

#### **Syntax**

```
void AmebaILI9341::setBackground(uint16_t _background)
```

#### **Parameters**

\_background: one of the colors available in AmebaILI9341.h

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

#### **Notes and Warnings**

NA

### **AmebaILI9341::setFontSize**

### Description

Set the font size of the characters printed on the screen.

### Syntax

```
void AmebaILI9341::setFontSize(uint8_t size)
```

### Parameters

size: font size, default 1 for smallest, 5 for largest font size

### Returns

The function returns nothing.

### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

NA

### AmebaILI9341::reset

#### Description

Reset the pin to High or Low

#### Syntax

```
void AmebaILI9341::reset(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

NA

#### Notes and Warnings

NA



## Class SPISettings\_SPIClass

### SPISettings Class

#### Description

Defines a class to set SPI parameters.

#### Syntax

```
class SPISettings
```

#### Members

Public Constructors	
SPISettings::SPISettings	Create a SPISettings object and set SPI clock speed, bit order and data mode

### SPISettings::SPISettings

#### Description

Construct an object and configure SPI parameters —clock speed, bit order and data model to the preferred default value.

#### Syntax

```
SPISettings YourObject(uint32_t clock, BitOrder bitOrder, uint8_t dataMode);
```

#### Parameters

clock: SPI clock speed, default is 4000000

bitOrder: order of bit stream, MSB first or LSB first, default is MSBFIRST

dataMode: There are 4 modes -> SPI\_MODE0~3, default is SPI\_MODE0

#### Returns

The function returns nothing.

#### Example Code

NA

## Notes and Warnings

This class seldom used alone, it is always used with `beginTransaction()` as a parameter in `SPIClass`.

## SPIClass Class

### Description

Defines a class of SPI implementation for Ameba.

### Syntax

```
class SPIClass
```

### Members

Public Constructors	
<code>SPIClass::SPIClass</code>	Constructs an SPI object
Public Methods	
<code>SPIClass::transfer</code>	Transfer data through SPI
<code>SPIClass::transfer16</code>	Transfer a 16-bits data through SPI
<code>SPIClass::beginTransaction</code>	Set slave select pin and SPI initial settings
<code>SPIClass::endTransaction</code>	Stop SPI transaction
<code>SPIClass::begin</code>	Associate each SPI pin to Ameba pin using ameba HAL APIs
<code>SPIClass::end</code>	Stop SPI master mode
<code>SPIClass::setBitOrder</code>	Set MSB first or LSB first
<code>SPIClass::setDataMode</code>	Set to one of the four data modes
<code>SPIClass::setClockDivider</code>	Set to correct clock speed (no effect on Ameba)
<code>SPIClass::setDefaultFrequency</code>	Set default SPI frequency

## SPIClass::SPIClass

### Description

Construct an SPI object, create a pointer to the object, and attach “MOSI, MISO, CLK, and SS” to each pin on Ameba.

### Syntax

```
SPIClass(void *pSpiObj, int mosi, int miso, int clk, int ss);
```

**Parameters**

pSpiObj: SPI pointer to the object

mosi: master out slave in

miso: master in slave out

clk: clock

ss: slave select

**Returns**

The function returns nothing.

**Example Code**

```
SPIClass SPI((void *)&spi_obj0), 11, 12, 13, 10);
```

**Notes and Warnings**

2 SPI objects are created in the library for 2 different hardware SPI on Ameba (if applicable), use “SPI” for first hardware SPI and “SPI1” for the second.

**SPIClass::transfer****Description**

Calling HAL API to send data in the buffer to the slave

**Syntax**

```
byte SPIClass::transfer (byte _pin, uint8_t _data, SPITransferMode _mode);
```

```
byte SPIClass::transfer (uint8_t _data, SPITransferMode _mode);
```

```
void SPIClass::transfer (byte _pin, void *_buf, size_t _count, SPITransferMode _mode);
```

```
void SPIClass::transfer (void *_buf, size_t _count, SPITransferMode _mode);
```

**Parameters**

\_pin: Slave select pin

\_data: Actual data being sent over

\_mode: SPI transfer mode

\_count: number of bytes of data

\_buf: data buffer

### Returns

Void or “0” in case of error, “d” in case success

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::transfer16

### Description

Same as “transfer” method above except data being of 16-bits.

### Syntax

uint16\_t SPIClass::transfer16(byte \_pin, uint16\_t \_data, SPITransferMode \_mode)

uint16\_t SPIClass::transfer16(uint16\_t \_data, SPITransferMode \_mode)

### Parameters

\_pin: Slave select pin

\_data: Actual data being sent over

\_mode: SPI transfer mode

### Returns

The data being transferred

### Example Code

NA

**Notes and Warnings**

NA

**SPIClass::beginTransaction****Description**

Set slave select pin and initialize SPI with default settings using SPISettings class.

**Syntax**

```
void SPIClass::beginTransaction(uint8_t pin, SPISettings settings)
```

```
void SPIClass::beginTransaction(SPISettings settings)
```

**Parameters**

pin: slave select pin

settings: an object of SPISettings class

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Refer to SPISettings class for details of the initial settings.

**SPIClass::endTransaction****Description**

Set slave select pin to 1 and stop SPI transaction.

### Syntax

```
void SPIClass::endTransaction(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::begin

### Description

Calling HAL APIs to initialize SPI pins to physical Ameba pins and set SPI format and frequency

### Syntax

```
void SPIClass::begin(void)
```

```
void SPIClass::begin(int ss)
```

### Parameters

void or ss: slave select

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This is a required method to use SPI on Ameba.

### SPIClass::end

#### Description

Free hardware SPI from any activity.

#### Syntax

```
void SPIClass::end(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### SPIClass::setBitOrder

#### Description

A specific method to set bit order to either MSB first or LSB first and set slave select pin.

### Syntax

```
void SPIClass::setBitOrder(uint8_t _pin, BitOrder _bitOrder)
void SPIClass::setBitOrder(BitOrder _order)
```

### Parameters

\_pin: slave select  
\_bitOrder: bit order -> either MSB first or LSB first  
\_order: same as above

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::setDataMode

### Description

A specific method to set data mode to one of the 4 modes (default: SPI\_MODE0) and set slave select pin.

### Syntax

```
void SPIClass::setDataMode(uint8_t _pin, uint8_t _mode)
void SPIClass::setDataMode(uint8_t _mode)
```

### Parameters

\_pin: slave select  
\_mode: one of the 4 modes (default: SPI\_MODE0)

### Returns



The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**SPIClass::setClockDivider****Description**

A specific method to set to divider in order to get correct clock speed

**Syntax**

```
void SPIClass::setClockDivider(uint8_t _pin, uint8_t _divider)
```

```
void SPIClass::setClockDivider(uint8_t _div)
```

**Parameters**

\_pin: slave select

\_divider: clock divider

\_div: same as above

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

This function does not affect the Ameba board.

## **SPIClass::setDefaultFrequency**

### **Description**

A specific method to set default SPI frequency

### **Syntax**

```
void SPIClass::setDefaultFrequency(int _frequency)
```

### **Parameters**

\_frequency: the default SPI frequency

### **Returns**

The function returns nothing.

### **Example Code**

Example: PM25\_on\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### **Notes and Warnings**

Take note that defaultFrequency = \_frequency.

## **Readme**

The Ameba SPI related APIs and examples are works based on SPI Master library for arduino written by Cristian Maglie <c.maglie@arduino.cc> and Paul Stoffregen <paul@pjrc.com> (Transaction API).

These include,

SPI.cpp

SPI.h

These libraries are under GNU Lesser General Public License, version 2.1.

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## Sys

### Wiring\_OS\_API

#### Wiring OS API

##### Description

A wrapper to CMSIS (Cortex Microcontroller Software Interface Standard) OS API which serve as a RTOS to create multi-threaded application with real-time behaviour.

##### Syntax

NA

##### Members

Public Methods	
os_thread_create_arduino	Create a thread and add it to Active Threads and set it to state READY
os_thread_get_id_arduino	Return the thread ID of the current running thread
os_thread_terminate_arduino	Terminate execution of a thread and remove it from Active Threads
os_thread_yield_arduino	Pass control to next thread that is in state READY
os_thread_set_priority_arduino	Change priority of an active thread
os_thread_get_priority_arduino	Get current priority of an active thread
os_signal_set_arduino	Set the specified Signal Flags of an active thread
os_signal_clear_arduino	Clear the specified Signal Flags of an active thread
os_signal_wait_arduino	Wait for one or more Signal Flags to become signaled for the current RUNNING thread
os_timer_create_arduino	Create a timer
os_timer_start_arduino	Start or restart a timer
os_timer_stop_arduino	Stop the timer
os_timer_delete_arduino	Delete a timer that was created by os_timer_create
os_semaphore_create_arduino	Create and Initialize a Semaphore object used for managing resources
os_semaphore_wait_arduino	Wait until a Semaphore token becomes available
os_semaphore_release_arduino	Release a Semaphore token
os_semaphore_delete_arduino	Delete a Semaphore that was created by os_semaphore_create
os_get_free_heap_size_arduino	Return the available heap memory space when called

##### os\_thread\_create\_arduino

## Description

Create a thread and add it to Active Threads and set it to state READY.

## Syntax

```
uint32_t os_thread_create_arduino (void (*task)(const void *argument), void *argument, int priority, uint32_t stack_size);
```

## Parameters

task: task Function pointer which is the thread body. It should not run into the end of function unless os\_thread\_terminate is invoked

argument: the data pointer which brings to task

priority: The underlying os is FreeRTOS. It executes tasks with highest priority which are not in idle state.

stack\_size: The stack\_size is used as memory heap only for this task.

## Returns

The thread id which is used in thread operation and signalling.

## Example Code

NA

## Notes and Warnings

NA

## os\_thread\_get\_id\_arduino

### Description

Return the thread ID of the current running thread

### Syntax

```
uint32_t os_thread_get_id_arduino (void);
```

### Parameters

The function requires no input parameter.

**Returns**

Current thread id which calls `os_thread_get_id`.

**Example Code**

NA

**Notes and Warnings**

NA

**`os_thread_terminate_arduino`****Description**

Terminate execution of a thread and remove it from Active Threads

**Syntax**

```
uint32_t os_thread_terminate_arduino (uint32_t thread_id);
```

**Parameters**

`thread_id`: Terminate the thread with specific `thread_id`

**Returns**

`os_status` code

**Example Code**

NA

**Notes and Warnings**

Thread should not ended without terminate first.

## os\_thread\_yield\_arduino

### Description

Pass control to next thread that is in state READY

### Syntax

```
uint32_t os_thread_yield_arduino (void);
```

### Parameters

The function requires no input parameter.

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

By default, the minimal execution unit is 1 millisecond. In a scenario that if a thread with smaller want to handout execution right to a thread with higher priority immediately without waiting for the ending of current 1 millisecond, then invoke os\_thread\_yield can transfer exection right to OS' s idle task and check which is the next execution thread.

## os\_thread\_set\_priority\_arduino

### Description

Change priority of an active thread

### Syntax

```
uint32_t os_thread_set_priority_arduino (uint32_t thread_id, int priority);
```

### Parameters

thread\_id: The target thread with the thread id to be changed

priority: The updated priority

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## os\_thread\_get\_priority\_arduino

### Description

Get current priority of an active thread

### Syntax

```
uint32_t os_thread_get_priority_arduino (uint32_t thread_id);
```

### Parameters

thread\_id: The target thread with the thread id to be searched

### Returns

os\_priority

### Example Code

NA

### Notes and Warnings

NA

## **os\_signal\_set\_arduino**

### **Description**

Set the specified Signal Flags of an active thread

### **Syntax**

```
int32_t os_signal_set_arduino (uint32_t thread_id, int32_t signals);
```

### **Parameters**

thread\_id: Send signal to a thread with the thread id

signals: the signals to be send

### **Returns**

os\_status code

### **Example Code**

NA

### **Notes and Warnings**

NA

## **os\_signal\_clear\_arduino**

### **Description**

Clear the specified Signal Flags of an active thread

### **Syntax**

```
int32_t os_signal_clear_arduino (uint32_t thread_id, int32_t signals);
```



**Parameters**

thread\_id: Clear signal to a thread with the thread id

signals: The signals to be clear

**Returns**

os\_status code

**Example Code**

NA

**Notes and Warnings**

NA

**os\_signal\_wait\_arduino****Description**

Wait for one or more Signal Flags to become signaled for the current RUNNING thread

**Syntax**

```
os_event_t os_signal_wait_arduino (int32_t signals, uint32_t millisec);
```

**Parameters**

signals: the signals to be wait

millisec: the timeout value if no signal comes in. Fill in 0xFFFFFFFF for infinite wait

**Returns**

os\_status code

**Example Code**

NA

## Notes and Warnings

NA

## os\_timer\_create\_arduino

### Description

Create a timer

### Syntax

```
uint32_t os_timer_create_arduino (void (*callback)(void const *argument), uint8_t isPeriodic, void *argument);
```

### Parameters

callback: The function to be invoke when timer timeout

isPeriodic: OS\_TIMER\_ONCE or OS\_TIMER\_PERIODIC

argument: The argument that is bring into callback function

### Returns

timer id

### Example Code

NA

## Notes and Warnings

NA

## os\_timer\_start\_arduino

### Description

Start or restart a timer

**Syntax**

```
uint32_t os_timer_start_arduino (uint32_t timer_id, uint32_t millisec);
```

**Parameters**

timer\_id: The timer id obtained from by os\_timer\_create

millisec: The delays after timer starts

**Returns**

os\_status code

**Example Code**

NA

**Notes and Warnings**

NA

**os\_timer\_stop\_arduino****Description**

Stop the timer

**Syntax**

```
uint32_t os_timer_stop_arduino (uint32_t timer_id);
```

**Parameters**

timer\_id: The timer id obtained from by os\_timer\_create

**Returns**

os\_status code

**Example Code**

NA

#### Notes and Warnings

NA

### os\_timer\_delete\_arduino

#### Description

Delete a timer that was created by os\_timer\_create

#### Syntax

```
uint32_t os_timer_delete_arduino (uint32_t timer_id);
```

#### Parameters

timer\_id: The timer id obtained from by os\_timer\_create

#### Returns

os\_status code

#### Example Code

NA

#### Notes and Warnings

NA

### os\_semaphore\_create\_arduino

#### Description

Create and Initialize a Semaphore object used for managing resources

**Syntax**

```
uint32_t os_semaphore_create_arduino (int32_t count);
```

**Parameters**

count: The number of available resources

**Returns**

semaphore ID

**Example Code**

NA

**Notes and Warnings**

NA

**os\_semaphore\_wait\_arduino****Description**

Wait until a Semaphore token becomes available

**Syntax**

```
int32_t os_semaphore_wait_arduino (uint32_t semaphore_id, uint32_t millisec);
```

**Parameters**

semaphore\_id: semaphore id obtained from os\_semaphore\_create

millisec: timeout value

**Returns**

os\_status code

**Example Code**

NA

### Notes and Warnings

NA

## os\_semaphore\_release\_arduino

### Description

Release a Semaphore token

### Syntax

```
uint32_t os_semaphore_release_arduino (uint32_t semaphore_id);
```

### Parameters

semaphore\_id: semaphore id obtained from os\_semaphore\_create

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_semaphore\_delete\_arduino

### Description

Delete a Semaphore that was created by os\_semaphore\_create

**Syntax**

```
uint32_t os_semaphore_delete_arduino (uint32_t semaphore_id);
```

**Parameters**

semaphore\_id: semaphore id obtained from os\_semaphore\_create

**Returns**

os\_status code

**Example Code**

NA

**Notes and Warnings**

NA

**os\_get\_free\_heap\_size\_arduino****Description**

Return the available heap memory space when called

**Syntax**

```
size_t os_get_free_heap_size_arduino(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

current free heap size

**Example Code**

Example: MemInfo

## Notes and Warnings

NA

---

## WDT

### Class WDT

#### WDT Class

#### Description

A class used for initializing, starting, stopping watchdog timer.

#### Syntax

```
class WDT
```

#### Members

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named WDT.	

Public Methods	
WDT:: InitWatchdog	Initializes the watchdog, include time setting, and mode register
WDT:: StartWatchdog	Start the watchdog counting
WDT:: StopWatchdog	Stop the watchdog counting
WDT:: RefreshWatchdog	Refresh the watchdog counting to prevent WDT timeout
WDT:: InitWatchdogIRQ	Switch the watchdog timer to interrupt mode and register a watchdog timer timeout interrupt handler

#### WDT:: InitWatchdog

#### Description

Initializes the watchdog, include time setting, and mode register.



**Syntax**

```
void InitWatchdog(uint32_t timeout_ms);
```

**Parameters**

timeout\_ms: the watch-dog timer timeout value in millisecond (ms). The default action after watchdog timer timeout is to reset the whole system.

**Returns**

The function returns nothing.

**Example Code**

Example: WatchdogTimer

```
/*
 * This example describes how to use watchdog api.
 * In this example, watchdog is setup to 5s timeout.
 * Watchdog won't bark if we refresh it before timeout in smallTask.
 * The timer is also reloaded after refresh.
 * Otherwise, while running bigTask, watchdog will restart system in default or call callback function if registered.
 */
#include 「wdt.h」

#define RUN_CALLBACK_IF_WATCHDOG_BARKS (0)

WDT wdt;

void setup() {
  Serial.begin(115200);

  wdt.InitWatchdog(5000); // setup 5s watchdog

  #if RUN_CALLBACK_IF_WATCHDOG_BARKS
    wdt.InitWatchdogIRQ(my_watchdog_irq_handler, 0);
  #else
    // system would restart in default when watchdog barks
  #endif
```

```
wdt.StartWatchdog(); // enable watchdog timer

successfulTask();

failedTask();

while (1)

;

}

void loop() {

}

void successfulTask(void) {

Serial.println(「 ……doing small task……」 );

for (int i = 0; i < 50000000; i++) // dummy task

asm(「 nop」 );

Serial.println(「 refresh watchdogn」 );

wdt.RefreshWatchdog();

}

/*

* Doing this task will lead to failed refresh the

* watchdog timer within the time limits of 5 seconds

*/

void failedTask(void) {

Serial.println(「 ……doing big task……」 );

for (int i = 0; i < 10; i++) {

Serial.print(「 doing dummy task #」 );

Serial.println(i, DEC);

for (int j = 0; j < 50000000; j++) // dummy task

asm(「 nop」 );

}

Serial.println(「 refresh watchdogn」 );

wdt.RefreshWatchdog();

}
```

```
void my_watchdog_irq_handler(uint32_t id) {  
    printf(「 watchdog barks!!!rn」 );  
    WDG_Cmd(DISABLE);  
}
```

### Notes and Warnings

NA

## WDT:: StartWatchdog

### Description

Start the watchdog counting.

### Syntax

```
void StartWatchdog(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

### Notes and Warnings

NA

## WDT:: StopWatchdog

### Description

Stop the watchdog counting.

### Syntax

```
void StopWatchdog(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

### Notes and Warnings

NA

## WDT:: RefreshWatchdog

### Description

Refresh the watchdog counting to prevent WDT timeout.

### Syntax

```
void RefreshWatchdog(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

**Example Code**

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

**Notes and Warnings**

NA

**WDT:: InitWatchdogIRQ****Description**

Switch the watchdog timer to interrupt mode and register a watchdog timer timeout interrupt handler. The interrupt handler will be called when the watchdog timer is timeout.

**Syntax**

```
void WDT::InitWatchdogIRQ(wdt_irq_handler handler, uint32_t id)
```

**Parameters**

handler: the callback function for WDT timeout interrupt.

id: the parameter for the callback function

**Returns**

The function returns nothing.

**Example Code**

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

**Notes and Warnings**

NA

## WiFi

### Class WiFi

#### WiFiClass Class

#### Description

Defines a class of WiFi and network implementation for Ameba.

#### Syntax

```
class WiFiClass
```

#### Members

<b>Public Constructors</b>	
WiFiClass::WiFiClass	Constructs a WiFiClass object and initializes the WiFi libraries and network settings
<b>Public Methods</b>	
WiFi- Class::firmwareVersion	Get firmware version
WiFiClass:: begin	Start Wifi connection for OPEN networks
WiFiClass:: config	Configure network IP settings
WiFiClass:: setDNS	Set the DNS server IP address to use
WiFiClass:: disconnect	Disconnect from the network
WiFiClass:: macAddress	Get the interface MAC address
WiFiClass:: localIP	Get the interface IP address
WiFiClass:: subnetMask	Get the interface subnet mask address
WiFiClass:: gatewayIP	Get the gateway IP address
WiFiClass:: SSID	Return the current SSID associated with the network
WiFiClass:: BSSID	Return the current BSSID associated with the network
WiFiClass:: RSSI	Return the current RSSI (Received Signal Strength in dBm) associated with the network
WiFiClass:: encryption- Type	Return the Encryption Type associated with the network
WiFiClass:: scanNetworks	Start scan WiFi networks available
WiFiClass:: SSID	Return the SSID discovered during the network scan
WiFiClass:: encryption- Type	Return the encryption type of the networks discovered during the scanNetworks
WiFiClass:: encryption- TypeEx	Return the security type and encryption type of the networks discovered during the scanNetworks
WiFiClass:: RSSI	Return the RSSI of the networks discovered during the scanNetworks
WiFiClass:: status	Return Connection status
WiFiClass:: hostByName	Resolve the given hostname to an IP address
WiFiClass:: apbegin	Start AP mode
WiFiClass:: disablePower- Save	Disable power-saving mode

## WiFiClass::WiFiClass

### Description

Constructs a WiFiClass object and initializes the WiFi libraries and network settings.

### Syntax

```
WiFiClass::WiFiClass()
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

An instance of WiFiClass is created as WiFi inside WiFi.h and is extern for direct use.

### WiFiClass::firmwareVersion

### Description

Get firmware version

### Syntax

```
char* WiFiClass::firmwareVersion()
```

### Parameters

The function requires no input parameter.

### Returns

WiFi firmware version

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details.

```
#include <WiFi.h>
```



```

// char ssid[] = 「yourNetwork」 ; // your network SSID (name)
// char pass[] = 「secretPassword」 ; // your network password
char ssid[] = 「SINGTEL-D45F」 ; // your network SSID (name)
char pass[] = 「mooxuteeth」 ; // your network key
int status = WL_IDLE_STATUS; // the Wifi radio's status

void setup() {

//Initialize serial and wait for port to open:
Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:
if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don't continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to WPA SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network:

status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:

delay(10000);

}

```

```
// you' re connected now, so print out the data:
Serial.print( 「You' re connected to the network」 );
printCurrentNet();
printWifiData();
}

void loop() {

// check the network connection once every 10 seconds:
delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield' s IP address:
IPAddress ip = WiFi.localIP();
Serial.print( 「IP Address: 」);
Serial.println(ip);
Serial.println(ip);

// print your MAC address:
byte mac[6];
WiFi.macAddress(mac);
Serial.print( 「MAC address: 」);
Serial.print(mac[0], HEX);
Serial.print( 「:」 );
Serial.print(mac[1], HEX);
Serial.print( 「:」 );
Serial.print(mac[2], HEX);
Serial.print( 「:」 );
Serial.print(mac[3], HEX);
Serial.print( 「:」 );
Serial.print(mac[4], HEX);
Serial.print( 「:」 );
```

```
Serial.println(mac[5], HEX);
}

void printCurrentNet() {
// print the SSID of the network you' re attached to:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());

// print the MAC address of the router you' re attached to:
byte bssid[6];
WiFi.BSSID(bssid);
Serial.print(「BSSID: 」);
Serial.print(bssid[5], HEX);
Serial.print(「:」);
Serial.print(bssid[4], HEX);
Serial.print(「:」);
Serial.print(bssid[3], HEX);
Serial.print(「:」);
Serial.print(bssid[2], HEX);
Serial.print(「:」);
Serial.print(bssid[1], HEX);
Serial.print(「:」);
Serial.println(bssid[0], HEX);

// print the received signal strength:
long rssi = WiFi.RSSI();
Serial.print(「signal strength (RSSI):」);
Serial.println(rssi);

// print the encryption type:
byte encryption = WiFi.encryptionType();
Serial.print(「Encryption Type:」);
Serial.println(encryption, HEX);
Serial.println();
```

```
}
```

## Notes and Warnings

NA

## WiFiClass::begin

### Description

Start Wifi connection for OPEN networks

### Syntax

```
int WiFiClass::begin(char* ssid)
int WiFiClass::begin(char* ssid, uint8_t key_idx, const char *key)
int WiFiClass::begin(char* ssid, const char *passphrase)
```

### Parameters

ssid: Pointer to the SSID string

key\_idx: The key index to set. Valid values are 0-3.

key: Key input buffer.

passphrase: Passphrase. Valid characters in a passphrase must be between ASCII 32-126 (decimal).

### Returns

WiFi status

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

## Notes and Warnings

NA

## WiFiClass::config

### Description

Configure network settings for the WiFi network

### Syntax

```
void WiFiClass::config(IPAddress local_ip)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server, IPAddress gateway)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server, IPAddress gateway, IPAddress subnet)
```

### Parameters

local\_ip: Local device IP address to use on the network  
dns\_server: IP address of the DNS server to use  
gateway: IP address of the gateway device on the network  
subnet: Subnet mask for the network, expressed as a IP address

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This will disable the DHCP client when connecting to a network, and will require the network accepts a static IP. The configured IP addresses will also apply to AP mode, but the DHCP server will not be disabled in AP mode.

## WiFiClass::setDNS

### Description

Configure the IP address of the DNS server to use

### Syntax

```
void WiFiClass::setDNS(IPAddress dns_server1)
void WiFiClass::setDNS(IPAddress dns_server1, IPAddress dns_server2)
```

### Parameters

dns\_server1: IP address of DNS server to use

dns\_server2: IP address of DNS server to use

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiClass::disconnect

### Description

Disconnect from the network

### Syntax

```
int WiFiClass::disconnect()
```

### Parameters

The function requires no input parameter.

### Returns

The function returns one value of wl\_status\_t enum as an integer.

### Example Code

NA

**Notes and Warnings**

NA

**WiFiClass::macAddress****Description**

Get the interface MAC address

**Syntax**

```
uint8_t* WiFiClass::macAddress(uint8_t* mac)
```

**Parameters**

mac: an array to store MAC address

**Returns**

The function returns a pointer to uint8\_t array with length WL\_MAC\_ADDR\_LENGTH.

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

**Notes and Warnings**

NA

**WiFiClass::localIP****Description**

Get the interface IP address

**Syntax**

IPAddress WiFiClass::localIP()

### Parameters

The function requires no input parameter.

### Returns

Ip address value

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of WiFiClass:: firmwareVersion.

### Notes and Warnings

NA

### WiFiClass::subnetMask

### Description

Get the interface subnet mask address

### Syntax

IPAddress WiFiClass::subnetMask()

### Parameters

The function requires no input parameter.

### Returns

subnet mask address value

### Example Code



Example: ConnectNoEncryption

This example demonstrates how to connect to an unencrypted WiFi network and prints the MAC address of the WiFi shield, the IP address obtained, and other network details.

```
#include <WiFi.h>

char ssid[] = 「SINGTEL-D45F_5G」 ; // the name of your network
int status = WL_IDLE_STATUS; // the Wifi radio' s status

void setup() {
  //Initialize serial and wait for port to open:
  Serial.begin(9600);

  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }

  // check for the presence of the shield:
  if (WiFi.status() == WL_NO_SHIELD) {
    Serial.println(「WiFi shield not present」 );
    // don' t continue:
    while (true);
  }

  String fv = WiFi.firmwareVersion();
  if (fv != 「1.1.0」 ) {
    Serial.println(「Please upgrade the firmware」 );
  }

  // attempt to connect to Wifi network:

  while (status != WL_CONNECTED) {
    Serial.print(「Attempting to connect to open SSID: 」);
    Serial.println(ssid);
    status = WiFi.begin(ssid);

    // wait 10 seconds for connection:
    delay(10000);
  }
```

```
// you' re connected now, so print out the data:
Serial.print( 「You' re connected to the network」 );
printCurrentNet();
printWifiData();
}

void loop() {

// check the network connection once every 10 seconds:
delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield' s IP address:
IPAddress ip = WiFi.localIP();
Serial.print( 「IP Address: 」);
Serial.println(ip);
Serial.println(ip);

// print your MAC address:
byte mac[6];
WiFi.macAddress(mac);
Serial.print( 「MAC address: 」);
Serial.print(mac[0], HEX);
Serial.print( 「:」 );
Serial.print(mac[1], HEX);
Serial.print( 「:」 );
Serial.print(mac[2], HEX);
Serial.print( 「:」 );
Serial.print(mac[3], HEX);
Serial.print( 「:」 );
Serial.print(mac[4], HEX);
Serial.print( 「:」 );
```

```
Serial.println(mac[5], HEX);

// print your subnet mask:
IPAddress subnet = WiFi.subnetMask();

Serial.print(「NetMask: 」);

Serial.println(subnet);

// print your gateway address:
IPAddress gateway = WiFi.gatewayIP();

Serial.print(「Gateway: 」);

Serial.println(gateway);

}

void printCurrentNet() {

// print the SSID of the network you' re attached to:
Serial.print(「SSID: 」);

Serial.println(WiFi.SSID());

// print the MAC address of the router you' re attached to:
byte bssid[6];

WiFi.BSSID(bssid);

Serial.print(「BSSID: 」);

Serial.print(bssid[5], HEX);

Serial.print(「:」 );

Serial.print(bssid[4], HEX);

Serial.print(「:」 );

Serial.print(bssid[3], HEX);

Serial.print(「:」 );

Serial.print(bssid[2], HEX);

Serial.print(「:」 );

Serial.print(bssid[1], HEX);

Serial.print(「:」 );

Serial.println(bssid[0], HEX);

// print the received signal strength:
```

```
long rssi = WiFi.RSSI();  
Serial.print(「signal strength (RSSI):」 );  
Serial.println(rssi);  
  
// print the encryption type:  
byte encryption = WiFi.encryptionType();  
Serial.print(「Encryption Type:」 );  
Serial.println(encryption, HEX);  
}
```

### Notes and Warnings

NA

### WiFiClass::gatewayIP

#### Description

Get the gateway IP address

#### Syntax

```
IPAddress WiFiClass::gatewayIP()
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the value of the gateway IP address.

#### Example Code

Example: ConnectNoEncryption

This example demonstrates how to connect to an unencrypted WiFi network and prints the MAC address of the WiFi shield, the IP address obtained, and other network details. Details of the code can be found in the section of `WiFiClass::subnetMask`.

**Notes and Warnings**

NA

**WiFiClass::SSID****Description**

Return the current SSID associated with the network

**Syntax**

```
char* WiFiClass::SSID()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns current SSID associate with the network.

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

**Notes and Warnings**

NA

**WiFiClass::BSSID****Description**

Return the current BSSID associated with the network

**Syntax**

uint8\_t\* WiFiClass::BSSID(uint8\_t\* bssid)

### Parameters

bssid: an array to store bssid

### Returns

pointer to uint8\_t array with length WL\_MAC\_ADDR\_LENGTH

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of WiFiClass:: firmwareVersion.

### Notes and Warnings

NA

## WiFiClass::RSSI

### Description

Return the current RSSI (Received Signal Strength in dBm) associated with the network

### Syntax

int32\_t WiFiClass::RSSI()

### Parameters

The function requires no input parameter.

### Returns

The function returns a signed-value signal strength

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

### Notes and Warnings

NA

### WiFiClass::encryptionType

#### Description

Return the Encryption Type associated with the network

#### Syntax

```
uint8_t WiFiClass::encryptionType()
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns one unsigned integer value of `wl_enc_type` enum.

### Example Code

Example: ConnectWithWPA

### Notes and Warnings

NA

### WiFiClass::scanNetworks

#### Description

Start scan WiFi networks available

**Syntax**

```
int8_t WiFiClass::scanNetworks()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the number of discovered networks as an integer.

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified.

```
#include <WiFi.h>
```

```
void setup() {
```

```
//Initialize serial and wait for port to open:
```

```
Serial.begin(9600);
```

```
while (!Serial) {
```

```
; // wait for serial port to connect. Needed for native USB port only
```

```
}
```

```
// check for the presence of the shield:
```

```
if (WiFi.status() == WL_NO_SHIELD) {
```

```
Serial.println(「WiFi shield not present」);
```

```
// don't continue:
```

```
while (true);
```

```
}
```

```
String fv = WiFi.firmwareVersion();
```

```
if (fv != 「1.1.0」) {
```

```
Serial.println(「Please upgrade the firmware」);
```

```
}
```



```
// Print WiFi MAC address:

printMacAddress();

}

void loop() {
// scan for existing networks:
Serial.println(「Scanning available networks…」);
listNetworks();
delay(10000);
}

void printMacAddress() {
// the MAC address of your Wifi shield
byte mac[6];
// print your MAC address:
WiFi.macAddress(mac);
Serial.print(「MAC: 」);
Serial.print(mac[0], HEX);
Serial.print(「:」);
Serial.print(mac[1], HEX);
Serial.print(「:」);
Serial.print(mac[2], HEX);
Serial.print(「:」);
Serial.print(mac[3], HEX);
Serial.print(「:」);
Serial.print(mac[4], HEX);
Serial.print(「:」);
Serial.println(mac[5], HEX);
}

void listNetworks() {
// scan for nearby networks:
Serial.println(「 * Scan Networks *」);
```

```
int numSsid = WiFi.scanNetworks();

if (numSsid == -1) {
  Serial.println(「Couldn't get a wifi connection」);
  while (true);
}

// print the list of networks seen:
Serial.print(「number of available networks:」);
Serial.println(numSsid);

// print the network number and name for each network found:
for (int thisNet = 0; thisNet < numSsid; thisNet++) {
  Serial.print(thisNet);
  Serial.print(「」);
  Serial.print(WiFi.SSID(thisNet));
  Serial.print(「SSID: 」);
  Serial.print(WiFi.RSSI(thisNet));
  Serial.print(「RSSI dBm」);
  Serial.print(「EncryptionRaw: 」);
  printEncryptionTypeEx(WiFi.encryptionTypeEx(thisNet));
  Serial.print(「Encryption: 」);
  printEncryptionType(WiFi.encryptionType(thisNet));
}
}

void printEncryptionTypeEx(uint32_t thisType) {
  /* Arduino wifi api use encryption type to mapping to security type.
  * This function demonstrate how to get more richful information of security type.
  */

  switch (thisType) {
  case SECURITY_OPEN:
    Serial.print(「Open」);
    break;
```

```
case SECURITY_WEP_PSK:
Serial.print( 「WEP」 );
break;
case SECURITY_WPA_TKIP_PSK:
Serial.print( 「WPA TKIP」 );
break;
case SECURITY_WPA_AES_PSK:
Serial.print( 「WPA AES」 );
break;
case SECURITY_WPA2_AES_PSK:
Serial.print( 「WPA2 AES」 );
break;
case SECURITY_WPA2_TKIP_PSK:
Serial.print( 「WPA2 TKIP」 );
break;
case SECURITY_WPA2_MIXED_PSK:
Serial.print( 「WPA2 Mixed」 );
break;
case SECURITY_WPA_WPA2_MIXED:
Serial.print( 「WPA/WPA2 AES」 );
break;
}
}
void printEncryptionType(int thisType) {
// read the encryption type and print out the name:
switch (thisType) {
case ENC_TYPE_WEP:
Serial.println( 「WEP」 );
break;
case ENC_TYPE_TKIP:
```

```
Serial.println( 「WPA」 );  
break;  
case ENC_TYPE_CCMP:  
Serial.println( 「WPA2」 );  
break;  
case ENC_TYPE_NONE:  
Serial.println( 「None」 );  
break;  
case ENC_TYPE_AUTO:  
Serial.println( 「Auto」 );  
break;  
}  
}
```

### **Notes and Warnings**

NA

### **WiFiClass::SSID**

#### **Description**

Return the SSID discovered during the network scan

#### **Syntax**

```
char* WiFiClass::SSID(uint8_t networkItem)
```

#### **Parameters**

networkItem: specify from which network item want to get the information

#### **Returns**

The function returns ssid string of the specified item on the networks scanned a list.

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::encryptionType****Description**

Return the encryption type of the networks discovered during the `scanNetworks`

**Syntax**

```
uint8_t WiFiClass::encryptionType(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

encryption type (enum `wl_enc_type`) of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::encryptionTypeEx**

**Description**

Return the security type and encryption type of the networks discovered during the scanNetworks

**Syntax**

```
uint32_t WiFiClass::encryptionTypeEx(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

security and encryption type of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of WiFiClass:: scanNetworks.

**Notes and Warnings**

NA

**WiFiClass::RSSI****Description**

Return the RSSI of the networks discovered during the scanNetworks

**Syntax**

```
int32_t WiFiClass::RSSI(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

signed value of RSSI of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::status****Description**

Return Connection status

**Syntax**

```
uint8_t WiFiClass::status()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns one of the values defined in `wl_status_t` as an unsigned integer.

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

**Notes and Warnings**

NA

## WiFiClass::hostByName

### Description

Resolve the given hostname to an IP address

### Syntax

```
int WiFiClass::hostByName(const char* aHostname, IPAddress& aResult)
```

### Parameters

aHostname: Name to be resolved

aResult: IPAddress structure to store the returned IP address

### Returns

The function returns “1” if aIPAddrString was successfully converted to an IP address,else otherwise, it will return as an error code.

### Example Code

NA

### Notes and Warnings

NA

## WiFiClass::apbegin

### Description

Start AP mode

### Syntax

```
int WiFiClass::apbegin(char* ssid, char* channel)
```

```
int WiFiClass::apbegin(char* ssid, char* password, char* channel)
```



**Parameters**

ssid: SSID of the AP network

channel: AP' s channel, default 1

password: AP' s password

**Returns**

The function will return the WiFi status.

**Example Code**

Example: WiFiAPMode

**#include**

```

char ssid[] = 「yourNetwork」 ; //Set the AP' s SSID

char pass[] = 「Password」 ; //Set the AP' s password

char channel[] = 「1」 ; //Set the AP' s channel

int status = WL_IDLE_STATUS; // the Wifi radio' s status

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

```

```
// attempt to start AP:

while (status != WL_CONNECTED) {

Serial.print(「 Attempting to start AP with SSID: 」);

Serial.println(ssid);

status = WiFi.apbegin(ssid, pass, channel);

delay(10000);

}

//AP MODE already started:

Serial.println(「 AP mode already started」 );

Serial.println();

printWifiData();

printCurrentNet();

}

void loop() {

// check the network connection once every 10 seconds:

delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield's IP address:

IPAddress ip = WiFi.localIP();

Serial.print(「 IP Address: 」);

Serial.println(ip);

// print your subnet mask:

IPAddress subnet = WiFi.subnetMask();

Serial.print(「 NetMask: 」);

Serial.println(subnet);

// print your gateway address:

IPAddress gateway = WiFi.gatewayIP();

Serial.print(「 Gateway: 」);
```

```
Serial.println(gateway);

Serial.println();

}

void printCurrentNet() {
// print the SSID of the AP:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());
// print the MAC address of AP:
byte bssid[6];
WiFi.BSSID(bssid);
Serial.print(「BSSID: 」);
Serial.print(bssid[0], HEX);
Serial.print(「:」 );
Serial.print(bssid[1], HEX);
Serial.print(「:」 );
Serial.print(bssid[2], HEX);
Serial.print(「:」 );
Serial.print(bssid[3], HEX);
Serial.print(「:」 );
Serial.print(bssid[4], HEX);
Serial.print(「:」 );
Serial.println(bssid[5], HEX);
// print the encryption type:
byte encryption = WiFi.encryptionType();
Serial.print(「Encryption Type:」 );
Serial.println(encryption, HEX);
Serial.println();
}
```

## Notes and Warnings

NA

## WiFiClass::disablePowerSave

### Description

Disable power-saving mode

### Syntax

```
int WiFiClass::disablePowerSave()
```

### Parameters

The function requires no input parameter.

### Returns

1 if disable success, 0 if failed

### Example Code

NA

### Notes and Warnings

NA

## Class WiFiClient

### WiFiClient Class

### Description

Defines a class of WiFi Client implementation for Ameba.

### Syntax

```
class WiFiClient
```

## Members

Public Constructors	
WiFiClient::WiFiClient	Constructs a WiFiClient instance that connects to the specified IP address and port.
Public Methods	
WiFiClient::connect	Connect to the IP address and port
WiFiClient::write	Write a single byte into the packet
WiFiClient::available	Number of bytes remaining in the current packet
WiFiClient::read	Read a single byte from the current packet
WiFiClient:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiClient:: flush	Finish reading the current packet
WiFiClient::stop	Stop client connection
WiFiClient::connected	Check if client is connected, return 1 if connected, 0 if not
WiFiClient::setRecvTimeout	Set receiving timeout

### WiFiClient::WiFiClient

#### Description

Constructs a WiFiClient instance that connects to the specified IP address and port.

#### Syntax

```
WiFiClient::WiFiClient()
```

```
WiFiClient::WiFiClient(uint8_t sock)
```

#### Parameters

sock: socket state, default -1.

#### Returns

The function returns nothing.

#### Example Code

Example: WiFiWebClient

```
#include <WiFi.h>
```

```
char ssid[] = 「yourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「password」 ; // your network password (use for WPA, or use as key for WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

//IPAddress server(64,233,189,94); // numeric IP for Google (no DNS)

char server[] = 「www.google.com」 ; // name address for Google (using DNS)

WiFiClient client;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

;

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don' t continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:

delay(10000);
```

```

}

Serial.println(「Connected to wifi」);

printWifiStatus();

Serial.println(「nStarting connection to server...」);

// if you get a connection, report back via serial:

if (client.connect(server, 80)) {

    Serial.println(「connected to server」);

    // Make a HTTP request:

    client.println(「GET /search?q=ameba HTTP/1.1」);

    client.println(「Host: www.google.com」);

    client.println(「Connection: close」);

    client.println();

}

}

void loop() {

    // if there are incoming bytes available

    // from the server, read them and print them:

    while (client.available()) {

        char c = client.read();

        Serial.write(c);

    }

    // if the server' s disconnected, stop the client:

    if (!client.connected()) {

        Serial.println();

        Serial.println(「disconnecting from server.」);

        client.stop();

        // do nothing forevermore:

        while (true);

    }

}

```

```
void printWifiStatus() {  
  // print the SSID of the network you're attached to:  
  Serial.print( "SSID: ");  
  Serial.println(WiFi.SSID());  
  // print your WiFi shield's IP address:  
  IPAddress ip = WiFi.localIP();  
  Serial.print( "IP Address: ");  
  Serial.println(ip);  
  // print the received signal strength:  
  long rssi = WiFi.RSSI();  
  Serial.print( "signal strength (RSSI):" );  
  Serial.print(rssi);  
  Serial.println( " dBm" );  
}
```

## Notes and Warnings

NA

## WiFiClient::connect

### Description

Connect to the IP address and port

### Syntax

```
int WiFiClient::connect(IPAddress ip, uint16_t port)  
int WiFiClient::connect(const char *host, uint16_t port)
```

### Parameters

ip: IP address

host: Host name

port: the port to listen on



**Returns**

Returns “1” : if successful

Returns “0” : if failed

**Example Code**

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

**Notes and Warnings**

NA

**WiFiClient::write****Description**

Write a single byte into the packet

**Syntax**

size\_t WiFiClient::write(uint8\_t byte)

size\_t WiFiClient::write(const uint8\_t \*buf, size\_t size)

**Parameters**

byte: the outgoing byte

buf: the outgoing message

size: the size of the buffer

**Returns**

The function returns single byte into the packet or returns bytes size from buffer into the packet.

**Example Code**

NA

**Notes and Warnings**

NA

## WiFiClient::available

### Description

Number of bytes remaining in the current packet

### Syntax

```
int WiFiClient::available(void)
```

### Parameters

The function requires no input parameter.

### Returns

- Function returns the number of bytes available in the current packet

Function returns 0: if no data available

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::read

### Description

Read a single byte from the current packet

### Syntax

```
int WiFiClient::read()  
int WiFiClient::read(unsigned char* buf, size_t size)  
int WiFiClient::read(char *buf, size_t size)
```

### Parameters

buf: buffer to hold incoming packets (char\*)  
size: maximum size of the buffer (int)

### Returns

size: the size of the buffer  
-1: if no buffer is available

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::peek

### Description

Return the next byte from the current packet without moving on to the next byte

### Syntax

```
int WiFiClient::peek(void)
```

### Parameters

The function requires no input parameter.

### Returns

b: the next byte or character

-1: if none is available

### Example Code

NA

### Notes and Warnings

NA

## WiFiClient::flush

### Description

Finish reading the current packet

### Syntax

```
void WiFiClient::flush(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiClient::stop

**Description**

Disconnect from the server. Stop client connection

**Syntax**

```
void WiFiClient::stop(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

**Notes and Warnings**

NA

**WiFiClient::connected****Description**

Check if client is connected, return 1 if connected, 0 if not.

**Syntax**

```
uint8_t WiFiClient::connected(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns “1” if connected, returns “0” if not connected.

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::setRecvTimeout

### Description

Set receiving timeout

### Syntax

```
int WiFiClient::setRecvTimeout(int timeout)
```

### Parameters

timeout: timeout in seconds

### Returns

0

### Example Code

NA

### Notes and Warnings

NA

## Class WiFiServer

### WiFiServer Class

#### Description

Defines a class of WiFi server implementation for Ameba.

#### Syntax

```
class WiFiServer
```

#### Members

Public Constructors	
WiFiServer::WiFiServer(uint16_t port)	Constructs a WiFiServer object and creates a server that listens for incoming connections on the specified port
Public Methods	
WiFiServer::available()	Gets a client that is connected to the server and has data available for reading. The connection persists when the returned client object goes out of scope; you can close it by calling the client.stop()
WiFiServer::begin()	Tells the server to begin listening for incoming connections
WiFiServer::write(const uint8_t* data, size_t len)	Write data to all the clients connected to a server

### WiFiServer::WiFiServer

#### Description

Constructs a WiFiServer object and creates a server that listens for incoming connections on the specified port.

#### Syntax

```
WiFiServer::WiFiServer(uint16_t port)
```

#### Parameters

port: The port number being connected to.

## Returns

The function returns nothing.

## Example Code

Example: SimpleServerWiFi

```
#include <WiFi.h>

char ssid[] = 「yourNetwork」 ; // your network SSID (name)

char pass[] = 「secretPassword」 ; // your network password

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

WiFiServer server(5000);

void setup() {

  Serial.begin(9600); // initialize serial communication

  pinMode(9, OUTPUT); // set the LED pin mode

  // check for the presence of the shield:

  if (WiFi.status() == WL_NO_SHIELD) {

    Serial.println( 「WiFi shield not present」 );

    while (true); // don' t continue

  }

  String fv = WiFi.firmwareVersion();

  if ( fv != 「1.1.0」 )

    Serial.println( 「Please upgrade the firmware」 );

  // attempt to connect to Wifi network:

  while ( status != WL_CONNECTED) {

    Serial.print( 「Attempting to connect to Network named: 」);

    Serial.println(ssid); // print the network name (SSID);

    // Connect to WPA/WPA2 network. Change this line if using open or WEP network:

    status = WiFi.begin(ssid, pass);

    // wait 10 seconds for connection:
```



```

delay(10000);
}

server.begin(); // start the tcp server on port 5000

printWifiStatus(); // you're connected now, so print out the status
}

char buffer[256];

void loop() {
  WiFiClient client = server.available();

  while (client.connected()) {
    memset(buffer, 0, 256);

    int n = client.read((uint8_t*)&buffer[0], sizeof(buffer));

    if (n > 0) {
      for (int i=0; i<n; i++) {
        Serial.print(buffer[i]);
      }

      n = client.write(buffer, n);

      if (n <= 0) break;
    }
  }

  client.stop();
}

void printWifiStatus() {
  // print the SSID of the network you're attached to:
  Serial.print(「SSID: 」);
  Serial.println(WiFi.SSID());

  // print your WiFi shield's IP address:
  IPAddress ip = WiFi.localIP();
  Serial.print(「IP Address: 」);
  Serial.println(ip);

  // print the received signal strength:

```

```
long rssi = WiFi.RSSI();  
Serial.print(「 signal strength (RSSI):」 );  
Serial.print(rssi);  
Serial.println(「 dBm」 );  
}
```

### Notes and Warnings

NA

## WiFiServer::available

### Description

Gets a client that is connected to the server and has data available for reading. The connection persists when the returned client object goes out of scope; you can close it by calling the client.stop().

### Syntax

WiFiClient WiFiServer::available(uint8\_t\* status)

### Parameters

status: WiFi availability status

### Returns

A Client object; if no Client has data available for reading, this object will evaluate to false in an if-statement

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## WiFiServer::begin

### Description

Tells the server to begin listening for incoming connections

### Syntax

```
void WiFiServer::begin(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## WiFiServer::write

### Description

Write data to all the clients connected to a server

### Syntax

```
size_t WiFiServer::write(uint8_t b)  
size_t WiFiServer::write(const uint8_t *buf, size_t size)
```

### Parameters

b: byte to be written

buf: data buffer

size: Size of the data in the buffer

### Returns

The function returns the number of bytes written. It is not necessary to read this.

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## Class WiFiSSLClient

### WiFiSSLClient Class

#### Description

Defines a class of WiFi Secure Socket Layer Client implementation for Ameba.

#### Syntax

```
class WiFiSSLClient
```

#### Members

<b>Public Constructors</b>	
WiFiSSLClient::WiFiSSLClient	Constructs a WiFiSSLClient instance that always connects in SSL to the specified IP address and port
<b>Public Methods</b>	
WiFiSSLClient::connect	Connect to the IP address and port
WiFiSSLClient::write	Write a single byte into the packet
WiFiSSLClient::available	Number of bytes remaining in the current packet
WiFiSSLClient::read	Read a single byte from the current packet
WiFiSSLClient:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiSSLClient:: flush	Finish reading the current packet
WiFiSSLClient::stop	Stop SSL client connection
WiFiSSLClient::connected	Check if SSL client is connected, return 1 if connected, 0 if not
WiFiSSLClient:: setRootCA	Set Root CA for authentication
WiFiSSLClient:: set-ClientCertificate	Set certificate of the client
WiFiSSLClient::setRecvTimeout	Set receiving timeout
WiFiSSLClient::setPreSharedKey	Set the pre shared key (PSK) to use for authentication

**WiFiSSLClient::WiFiSSLClient****Description**

Constructs a WiFiSSLClient instance that always connects in SSL to the specified IP address and port.

**Syntax**

```
WiFiSSLClient::WiFiSSLClient(void)
```

```
WiFiSSLClient::WiFiSSLClient(uint8_t sock)
```

**Parameters**

sock: socket state, default -1

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiSSLClient

**#include**

```
char ssid[] = 「yourNetwork」 ;// your network SSID (name)

char pass[] = 「secretPassword」 ;// your network password (use for WPA, or WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

char server[] = 「www.google.com」 ;// name address for Google (using DNS)

//unsigned char test_client_key[] = 「」 ;//For the usage of verifying client
//unsigned char test_client_cert[] = 「」 ;//For the usage of verifying client
//unsigned char test_ca_cert[] = 「」 ;//For the usage of verifying server

WiFiSSLClient client;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don' t continue:

while (true);

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid,pass);

// wait 10 seconds for connection:

delay(10000);
```

```

}

Serial.println(「Connected to wifi」);

printWifiStatus();

Serial.println(「nStarting connection to server...」);

// if you get a connection, report back via serial:

if (client.connect(server, 443)) { //client.connect(server, 443, test_ca_cert, test_client_cert, test_client_key)

Serial.println(「connected to server」);

// Make a HTTP request:

client.println(「GET /search?q=realtek HTTP/1.0」);

client.println(「Host: www.google.com」);

client.println(「Connection: close」);

client.println();

}

else

Serial.println(「connected to server failed」);

}

void loop() {

// if there are incoming bytes available

// from the server, read them and print them:

while (client.available()) {

char c = client.read();

Serial.write(c);

}

// if the server' s disconnected, stop the client:

if (!client.connected()) {

Serial.println();

Serial.println(「disconnecting from server.」);

client.stop();

// do nothing forevermore:

while (true);

```

```
}  
}  
  
void printWifiStatus() {  
    // print the SSID of the network you're attached to:  
    Serial.print( "SSID: ");  
    Serial.println(WiFi.SSID());  
  
    // print your WiFi shield's IP address:  
    IPAddress ip = WiFi.localIP();  
    Serial.print( "IP Address: ");  
    Serial.println(ip);  
  
    // print your MAC address:  
    byte mac[6];  
    WiFi.macAddress(mac);  
    Serial.print( "MAC address: ");  
    Serial.print(mac[0], HEX);  
    Serial.print( ":");  
    Serial.print(mac[1], HEX);  
    Serial.print( ":");  
    Serial.print(mac[2], HEX);  
    Serial.print( ":");  
    Serial.print(mac[3], HEX);  
    Serial.print( ":");  
    Serial.print(mac[4], HEX);  
    Serial.print( ":");  
    Serial.println(mac[5], HEX);  
  
    // print the received signal strength:  
    long rssi = WiFi.RSSI();  
    Serial.print( "signal strength (RSSI):");  
    Serial.print(rssi);  
    Serial.println(" dBm");  
}
```



```
}
```

## Notes and Warnings

NA

## WiFiSSLClient::connect

### Description

Connect to the IP address and port.

### Syntax

```
int WiFiSSLClient::connect(IPAddress ip, uint16_t port)
```

```
int WiFiSSLClient::connect(const char *host, uint16_t port)
```

```
int WiFiSSLClient::connect(const char* host, uint16_t port, unsigned char* rootCABuff, unsigned char* cli_cert, unsigned char* cli_key)
```

```
int WiFiSSLClient::connect(IPAddress ip, uint16_t port, unsigned char* rootCABuff, unsigned char* cli_cert, unsigned char* cli_key)
```

### Parameters

ip: IP address

host: Host name

port: the port to listen on

rootCABuff: buffer that store root CA

cli\_cert: buffer that store client certificate

cli\_key buffer that store client key pair

### Returns

1: if successful

0: if failed

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::write

### Description

Write a single byte into the packet

### Syntax

```
size_t WiFiSSLClient::write(uint8_t byte)
```

```
size_t WiFiSSLClient::write(const uint8_t *buf, size_t size)
```

### Parameters

byte: the outgoing byte

buf: the outgoing message

size: the size of the buffer

### Returns

The function returns single -byte into the packet or turns bytes size from the buffer into the packet.

### Example Code

NA

## Notes and Warnings

NA

## WiFiSSLClient::available

### Description

Number of bytes remaining in the current packet

### Syntax

```
int WiFiSSLClient::available(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the number of bytes available in the current packet; else return “0:” if no data available.

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

### Notes and Warnings

NA

## WiFiSSLClient::read

### Description

Read a single byte from the current packet

### Syntax

```
int WiFiSSLClient::read()
```

```
int WiFiSSLClient::read(unsigned char* buf, size_t size)
```

### Parameters

buf: buffer to hold incoming packets (char\*)

size: maximum size of the buffer (int)

### Returns

size: the size of the buffer

-1: if no buffer is available

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

### Notes and Warnings

NA

### WiFiSSLClient::peek

#### Description

Return the next byte from the current packet without moving on to the next byte.

#### Syntax

```
int WiFiSSLClient::peek(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

b: the next byte or character

-1: if none is available

### Example Code

NA

### Notes and Warnings

NA

### WiFiSSLClient::flush

#### Description

Finish reading the current packet

**Syntax**

```
void WiFiSSLClient::flush(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiSSLClient::stop****Description**

Disconnect from the server. Stop SSL client connection

**Syntax**

```
void WiFiSSLClient::stop(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::connected

### Description

Check if SSL client is connected, return 1 if connected, 0 if not.

### Syntax

```
uint8_t WiFiSSLClient::connected(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “1” if connected, returns “0” if not connected.

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::setRootCA

### Description

Set Root CA for authentication

### Syntax

```
void WiFiSSLClient::setRootCA(unsigned char *rootCA)
```

**Parameters**

rootCA: a string of rootCA

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiSSLClient::setClientCertificate****Description**

Set certificate of client

**Syntax**

```
void WiFiSSLClient::setClientCertificate(unsigned char *client_ca, unsigned char *private_key)
```

**Parameters**

client\_ca: Client certificate

private\_key: client's private key pair

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## WiFiSSLClient::setRecvTimeout

### Description

Set receiving timeout

### Syntax

```
int WiFiSSLClient::setRecvTimeout(int timeout)
```

### Parameters

timeout: timeout in seconds

### Returns

The function returns “0” .

### Example Code

NA

### Notes and Warnings

NA

## WiFiSSLClient::setPreSharedKey

### Description

Set the pre shared key (PSK) to use for authentication

### Syntax

```
void WiFiSSLClient::setPreSharedKey(unsigned char *pskIdent, unsigned char *psKey)
```

### Parameters

pskIdent: identity for PSK

psKey: Pre shared key



**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Do not set a root CA and client certificate if PSK should be used for authentication. If root CA, client certificate and PSK are all set, certificate based authentication will be used.

**Class WiFiUdp****WiFiUDP Class****Description**

Defines a class of WiFi UDP implementation for Ameba.

**Syntax**

```
class WiFiUDP
```

**Members**

<b>Public Constructors</b>	
WiFiUDP::WiFiUDP	Constructs a WiFiUDP instance of the WiFi UDP class that can send and receive UDP messages
<b>Public Methods</b>	
WiFiUDP:: begin	initialize, start listening on the specified port. Returns 1 if successful, 0 if there are no sockets available to use
WiFiUDP:: stop	Finish with the UDP socket
WiFiUDP:: begin-Packet	Start building up a packet to send to the remote host-specific in IP and port
WiFiUDP:: endPacket	Finish off this packet and send it
WiFiUDP:: write	Write a single byte into the packet
WiFiUDP:: writeImmediately	Send packet immediately from the buffer
WiFiUDP:: parsePacket	Start processing the next available incoming packet
WiFiUDP::available	Number of bytes remaining in the current packet
WiFiUDP::read	Read a single byte from the current packet
WiFiUDP:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiUDP:: flush	Finish reading the current packet
WiFiUDP:: remoteIP	Return the IP address of the host who sent the current incoming packet
WiFiUDP:: remotePort	Return the port of the host who sent the current incoming packet
WiFiUDP:: setRecv-Timeout	Set receiving timeout

**WiFiUDP::WiFiUDP****Description**

Constructs a WiFiUDP instance of the WiFi UDP class that can send and receive UDP messages.

**Syntax**

```
WiFiUDP::WiFiUDP(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort.

```
#include <WiFi.h>

#include <WiFiUdp.h>

int status = WL_IDLE_STATUS;

char ssid[] = 「yourNetwork」 ; // your network SSID (name)

char pass[] = 「secretPassword」 ; // your network password (use for WPA, or use as key for WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

unsigned int localPort = 2390; // local port to listen on

char packetBuffer[255]; //buffer to hold incoming packet

char ReplyBuffer[] = 「acknowledged」 ; // a string to send back

WiFiUDP Udp;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don't continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

}
```

```
// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「 Attempting to connect to SSID:  」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid,pass);

// wait 10 seconds for connection:

delay(10000);

}

Serial.println( 「 Connected to wifi 」 );

printWifiStatus();

Serial.println(「 nStarting connection to server... 」 );

// if you get a connection, report back via serial:

Udp.begin(localPort);

}

void loop() {

// if there' s data available, read a packet

int packetSize = Udp.parsePacket();

if (packetSize) {

Serial.print( 「 Received packet of size  」);

Serial.println(packetSize);

Serial.print( 「 From  」);

IPAddress remoteIp = Udp.remoteIP();

Serial.print(remoteIp);

Serial.print(「 , port  」);

Serial.println(Udp.remotePort());

// read the packet into packetBuffer

int len = Udp.read(packetBuffer, 255);

if (len > 0) {

packetBuffer[len] = 0;
```

```

}

Serial.println(「Contents:」);

Serial.println(packetBuffer);

// send a reply, to the IP address and port that sent us the packet we received
Udp.beginPacket(Udp.remoteIP(), Udp.remotePort());

Udp.write(ReplyBuffer);

Udp.endPacket();

}

}

void printWifiStatus() {
// print the SSID of the network you're attached to:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());

// print your WiFi shield's IP address:
IPAddress ip = WiFi.localIP();
Serial.print(「IP Address: 」);
Serial.println(ip);

// print the received signal strength:
long rssi = WiFi.RSSI();
Serial.print(「signal strength (RSSI):」);
Serial.print(rssi);
Serial.println(「 dBm」);
}

```

### Notes and Warnings

This constructor does not take in any parameter, thus use another method to set up the IP address and port number.

### WiFiUDP::begin

### Description

Initialize, start listening on the specified port. Returns 1 if successful, 0 if there are no sockets available to use.

### Syntax

```
uint8_t WiFiUDP::begin(uint16_t port)
```

### Parameters

port: the local port to listen on

### Returns

1: if successful

0: if there are no sockets available to use

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

## WiFiUDP::stop

### Description

Disconnect from the server. Release any resource being used during the UDP session.

### Syntax

```
void WiFiUDP::stop(void)
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::beginPacket****Description**

Start building up a packet to send to the remote host-specific in IP and port.

**Syntax**

```
int WiFiUDP::beginPacket(const char *host, uint16_t port)
```

```
int WiFiUDP::beginPacket(IPAddress ip, uint16_t port)
```

**Parameters**

host: hostname

port: port number

ip: IP address

**Returns**

1: if successful

0: if there was a problem with the supplied IP address or port

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

## Notes and Warnings

NA

## WiFiUDP::endPacket

### Description

Finish off this packet and send it

### Syntax

```
int WiFiUDP::endPacket(void)
```

### Parameters

The function requires no input parameter.

### Returns

1: if the packet was sent successfully

0: if there was an error

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

## Notes and Warnings

NA

## WiFiUDP::write

### Description

Write a single byte into the packet.



**Syntax**

size\_t WiFiUDP::write(uint8\_t byte)

size\_t WiFiUDP::write(const uint8\_t \*buffer, size\_t size)

**Parameters**

byte: the outgoing byte

buffer: the outgoing message

size: the size of the buffer

**Returns**

single-byte into the packet

bytes size from the buffer into the packet

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

**Notes and Warnings**

NA

**WiFiUDP::writeImmediately****Description**

Send packet immediately from the buffer

**Syntax**

size\_t WiFiUDP::writeImmediately(const uint8\_t \*buffer, size\_t size)

**Parameters**

buffer: the outgoing message

size: the size of the buffer

### Returns

single-byte into the packet

bytes size from the buffer into the packet

### Example Code

NA

### Notes and Warnings

NA

## WiFiUDP::parsePacket

### Description

Start processing the next available incoming packet

### Syntax

```
int WiFiUDP::parsePacket(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the size of the packet in bytes or returns “0:” if no packets are available.

### Example Code

Example: WiFiUdpSendReceiveString

### Notes and Warnings

NA

## WiFiUDP::available

### Description

Number of bytes remaining in the current packet.

### Syntax

```
int WiFiUDP::available(void)
```

### Parameters

The function requires no input parameter.

### Returns

the number of bytes available in the current packet

0: if parsePacket hasn't been called yet

### Example Code

NA

### Notes and Warnings

NA

## WiFiUDP::read

### Description

Read a single byte from the current packet

### Syntax

```
int WiFiUDP::read()
```

```
int WiFiUDP::read(unsigned char* buffer, size_t len)
```

### Parameters

buffer: buffer to hold incoming packets (char\*)

len: maximum size of the buffer (int)

### Returns

size: the size of the buffer

-1: if no buffer is available

### Example Code

Example: WiFiUdpSendReceiveString

his example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

## WiFiUDP::peek

### Description

Return the next byte from the current packet without moving on to the next byte

### Syntax

```
int WiFiUDP::peek(void)
```

### Parameters

The function requires no input parameter.

### Returns

b: the next byte or character

-1: if none is available

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::flush****Description**

Finish reading the current packet

**Syntax**

```
void WiFiUDP::flush(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::remoteIP****Description**

Return the IP address of the host who sent the current incoming packet

### Syntax

IPAddress WiFiUDP::remoteIP(void)

### Parameters

The function requires no input parameter.

### Returns

IP address connecting to

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

## WiFiUDP::remotePort

### Description

Return the port of the host who sent the current incoming packet

### Syntax

uint16\_t WiFiUDP::remotePort(void)

### Parameters

The function requires no input parameter.

### Returns

The remote port connecting to

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

### WiFiUDP::setRecvTimeout

#### Description

Set receiving timeout

#### Syntax

```
void WiFiUDP::setRecvTimeout(int timeout)
```

#### Parameters

timeout in seconds

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Readme

The Ameba WiFi related APIs and examples are works based on Arduino WiFi shield libraries (<https://www.arduino.cc/en/Reference/WiFi>).

These include,

- `WiFi.cpp`
- `WiFi.h`
- `WiFiServer.cpp`
- `WiFiServer.h`
- `WiFiUdp.cpp`
- `WiFiUdp.h`

These libraries are under GNU Lesser General Public License, either version 2.1 of the License, or (at your option) any later version.

---

## Wire

### Class TwoWire

#### TwoWire Class

#### Description

Defines a class of I2C API

#### Syntax

```
class TwoWire
```

#### Members



<b>Public Constructors</b>	
TwoWire::TwoWire	Constructs a TwoWire object
<b>Public Methods</b>	
TwoWire::begin	Initialize I2C master/slave
TwoWire::setClock	Set I2C frequency
TwoWire::beginTransaction	Begin I2C transmission
TwoWire::endTransmission	End I2C transmission
TwoWire::requestFrom	Set I2C requestFrom
TwoWire::write	Write data to I2C
TwoWire::available	Check if I2C is available
TwoWire::read	Read data from I2C
TwoWire::peek	Read peek from I2C
TwoWire::flush	Do nothing, use, and transmission(..) to force data transfer
TwoWire::onReceive	Callback function when I2C on receive
TwoWire::onRequest	Callback function when I2C on request

**TwoWire::TwoWire****Description**

Constructs a TwoWire object.

**Syntax**

```
TwoWire::TwoWire (uint32_t dwSDAPin, uint32_t dwSCLPin);
```

**Parameters**

dwSDAPin: The Arduino PIN to be set as an SDA pin.

dwSCLPin: The Arduino PIN to be set as an SCL pin.

**Returns**

The function returns nothing.

**Example Code**

Example: MasterWriter

This example demonstrates the use of the wire library writes to an I2C/TWI slave device.

```
#include <Wire.h>

void setup() {
  Wire.begin(); // join i2c bus (address optional for master)
}

byte x = 0;

void loop() {
  Wire.beginTransmission(8); // transmit to device #8
  Wire.write(「 x is 」); // sends five bytes
  Wire.write(x); // sends one byte
  Wire.endTransmission(); // stop transmitting
  x++;
  delay(500);
}
```

Example: MasterReader

```
#include <Wire.h>

void setup() {
  Wire.begin(); // join i2c bus (address optional for master)
  Serial.begin(9600); // start serial for output
}

void loop() {
  Wire.requestFrom(8, 6); // request 6 bytes from slave device #8
  while (Wire.available()) { // slave may send less than requested
    char c = Wire.read(); // receive a byte as character
    Serial.print(c); // print the character
  }
  delay(500);
}
```

This example demonstrates the use of the wire library reads data from an I2C/TWI slave device.

## Notes and Warnings

Include “Wire.h” to use the class function.

## **TwoWire::begin**

### **Description**

Initialize I2C master/slave.

### **Syntax**

```
void TwoWire::begin (void);  
void TwoWire::begin (uint8_t address = 0);  
void TwoWire::begin (int address);
```

### **Parameters**

void: Set the I2C master mode.

address: Set the I2C master mode with slave address value.

### **Returns**

The function returns nothing.

### **Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### **Notes and Warnings**

Include “Wire.h” to use the class function.

## **TwoWire::setClock**

### **Description**

Set I2C frequency.

### Syntax

```
void TwoWire::setClock(uint32_t frequency);
```

### Parameters

frequency: The frequency values.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::beginTransmission

### Description

Begin I2C transmission.

### Syntax

```
void TwoWire::beginTransmission (uint8_t address);
```

```
void TwoWire::beginTransmission (int address);
```

### Parameters

address: The transmission address.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::endTransmission

### Description

End I2C transmission. Originally, ‘endTransmission’ was an f(void) function. It has been modified to take one parameter indicating whether or not a STOP should be performed on the bus. Calling endTransmission(false) allows a sketch to perform a repeated start.

WARNING: Nothing in the library keeps track of whether the bus tenure has been properly ended with a STOP. It is very possible to leave the bus in a hung state if no call to endTransmission(true) is made. Some I2C devices will behave oddly if they do not see a STOP.

If the input parameter is void, this provides backward compatibility with the original definition, and expected behavior, of endTransmission.

### Syntax

```
uint8_t TwoWire::endTransmission (uint8_t sendStop);
```

```
uint8_t TwoWire::endTransmission (void);
```

### Parameters

sendStop: True to end the transmission

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::requestFrom

### Description

Set I2C requestFrom.

### Syntax

```
uint8_t TwoWire::requestFrom (uint8_t address, uint8_t quantity, uint8_t sendStop);  
uint8_t TwoWire::requestFrom (uint8_t address, uint8_t quantity);  
uint8_t TwoWire::requestFrom(int address, int quantity);  
uint8_t TwoWire::requestFrom (int address, int quantity, int sendStop);
```

### Parameters

address: I2C read address.

quantity: I2C read quantity.

sendStop: True to end the transmission.

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::write

### Description

Write data to I2C.

### Syntax

```
size_t TwoWire::write (uint8_t data);  
size_t TwoWire::write (const uint8_t *data, size_t quantity);
```

### Parameters

data: The data to be transmitted.

quantity: The quantity of data.

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::available

### Description

Check if I2C is available.

### Syntax

```
int TwoWire::available (void);
```

### Parameters

The function requires no input parameter.

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::read

### Description

Read data from I2C

### Syntax

```
int TwoWire::read (void);
```

### Parameters

The function requires no input parameter.

### Returns

The read data from the receive buffer.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.



### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::peek

#### Description

Read peek from I2C.

#### Syntax

```
int TwoWire::peek (void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The peek data read from the receive buffer.

#### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::flush

#### Description

Do nothing, use endTransmission(..) to force data transfer.

#### Syntax

`void TwoWire::flush (void);`

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

### Notes and Warnings

Include “Wire.h” in order to use the class function.

## TwoWire::onReceive

### Description

Callback function when I2C on receive.

### Syntax

`void TwoWire::onReceive (void(*function)(int));`

### Parameters

function: The callback function.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::onRequest

#### Description

Callback function when I2C on request.

#### Syntax

```
void TwoWire::onRequest (void(*function)(void));
```

#### Parameters

function: The callback function

#### Returns

The function returns nothing.

#### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### Wire\_Readme

The Ameba LCD related api and example are works based on “New LiquidCrystal library” (<https://bitbucket.org/fmalpartida/new-liquidcrystal/>).

These include,

LCD.h

LCD.cpp

I2CIO.h

I2CIO.cpp

LiquidCrystal\_I2C.h

LiquidCrystal\_I2C.cpp

examples/LcdHelloWorld/LcdHelloWorld.ino

These files inherit the licence of “New LiquidCrystal Library” which are under a Creative Commons Attribution-ShareAlike 3.0 Unported License. CC BY-SA 3.0.

## 1.2.6 Resources

### Links

- [AmebaD Arduino Github](#)
- [Arduino Website](#)

## 1.2.7 Support

### FAQ

---

#### Where to buy Ameba RTL8722DM Board?

Refer to [Purchase link](#).

---

---

#### Which Bluetooth standards are supported by RTL8722CSM/RTL8722DM?

Both boards support BLE 5.0. Classic Bluetooth (BR/EDR) is not supported.

---

---

#### Which BLE roles are supported?

RTL8722CSM/RTL8722DM can operate as either a BLE Central or BLE Peripheral device.

---

---

#### Are all pins on RTL8722CSM/RTL8722DM usable?

No, those marked NC are not connected to any pin and thus unusable.

---

---

**Is XIP (execute in place) supported on RTL8722CSM/RTL8722DM?**

Yes, it is supported.

---

---

**Does RTL8722CSM support 5G WiFi?**

No. Only RTL8722DM supports dual band 2.4G + 5G WiFi. RTL8722CSM only supports single band 2.4G WiFi.

---

---

**How to enter the download mode?**

Press and hold the UART DOWNLOAD button. Then Press the RESET button and release both UART DOWNLOAD and RESET buttons.

---

---

**Trouble shooting**

---

**RTL8722CSM/RTL8722DM cannot be found as a Bluetooth device.**

Please make sure the antenna is connected properly. Check your code for the correct Bluetooth configurations.

---

---

**My code is not behaving as I expected.**

Try to debug your program using `printf()` and `Serial.print()` statements. If the issue persists, you can ask for help at [Forums](#)

---

---

**Why is there no output on my serial terminal after connecting to RTL8722CSM/RTL8722DM UART?**

RTL8722CSM/RTL8722DM is by default configured at 115200 baudrate, please check if your serial terminal is configured to 115200.

---

---

**My program is not being downloaded into RTL8722CSM/RTL8722DM?**

**Please follow the procedure for the correct downloading:**

1. Enter the download mode. The on-board Green LED will blink when entered download mode.
  2. When downloading the image into board the on-board Red LED will blink
  3. After a successful download, you will see log like this “All images sent successfully” .
- 

---

**Sometimes WiFi signal is weak?**

The default antenna for RTL8722CSM/RTL8722DM uses the I-Pex Connector. Please change/connect the I-Pex Connector antenna.

---

---

**Why is my board not powering up?**

Please make sure the connector J38 beside resistor R43 is connected. The connector is used to link the power to IC.

---

---

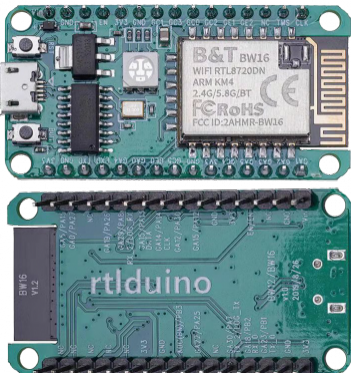
**If you have driver issue to connect board to your computer?**

Please go to <https://ftdichip.com/drivers/> for USB driver.

---

## 1.3 BW16 (RTL8720DN) by Ai-Thinker

Welcome to BW16 (RTL8720DN) online documentation.



### 1.3.1 Getting Started

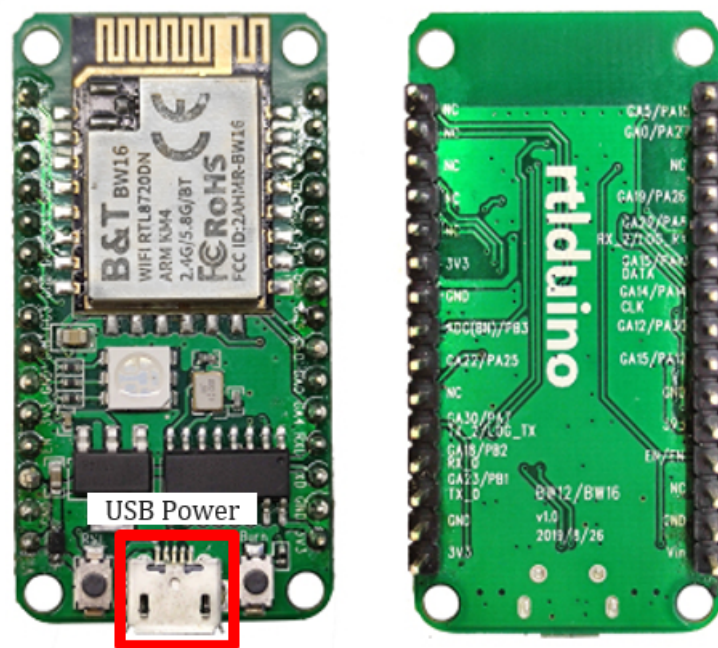
#### Ameba ARDUINO: Getting Started with BW16

##### Required Environment

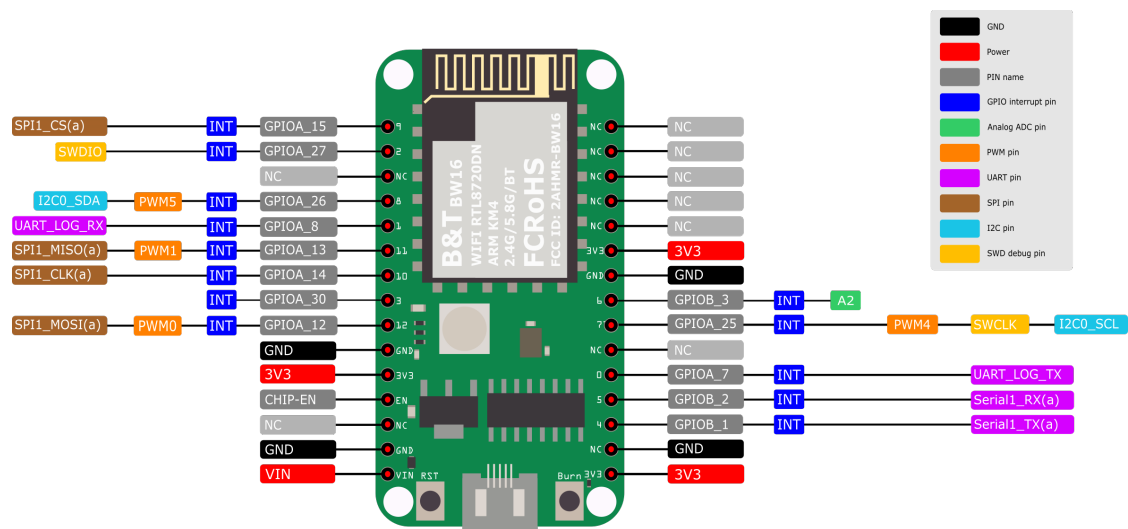
BW16 Dual-Band Wi-Fi board currently supports Windows XP/7/8/10 32-bits and 64-bits operating systems. In this documentation, please use Arduino IDE with version 1.8.15 or later.

##### Introduction to BW16

Realtek RTL8720DN is a Wi-Fi and Bluetooth IC that supports 2.4GHz and 5GHz dual bands for Wi-Fi communication, and Bluetooth Low Energy (BLE) 5.0. BW16 is a module manufactured by B&T, this module is a highly integrated Wi-Fi and Bluetooth module with the RTL8720DN as the main SoC (System on Chip), it can be regarded as an SoC for the Wi-Fi and Bluetooth application with typical SBCs.



BW16 has a smaller size than AMB21 and AMB23 as shown in the above figure. It uses Micro USB to supply power, which is common in many smart devices. Please refer to the following figure and table for the pin diagram and function of BW16.

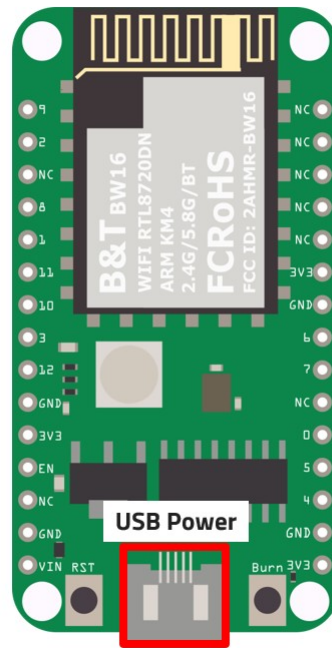


#	PIN name	GPIO	ADC	PWM	UART	SPI	I2C
D0(PA7)	GPIOA_7	✓			UART_LOG_TX		
D1(PA8)	GPIOA_8	✓			UART_LOG_RX		
D2(PA27)	GPIOA_27	✓					
D3(PA30)	GPIOA_30	✓					
D4(PB1)	GPIOB_1	✓			Serial_TX		
D5(PB2)	GPIOB_2	✓			Serial_RX		
D6(PB3)	GPIOB_3	✓	A2				
D7(PA25)	GPIOA_25				✓		I2C0_CLK
D8(PA26)	GPIOA_26	✓		✓			I2C0_SDA
D9(PA15)	GPIOA_15	✓				SPI_CS	
D10(PA14)	GPIOA_14	✓				SPI_CLK	
D11(PA13)	GPIOA_13	✓		✓		SPI_MISO	
D12(PA12)	GPIOA_12	✓		✓		SPI_MOSI	

Setting up Development Environment



## Step 1. Installing the Driver

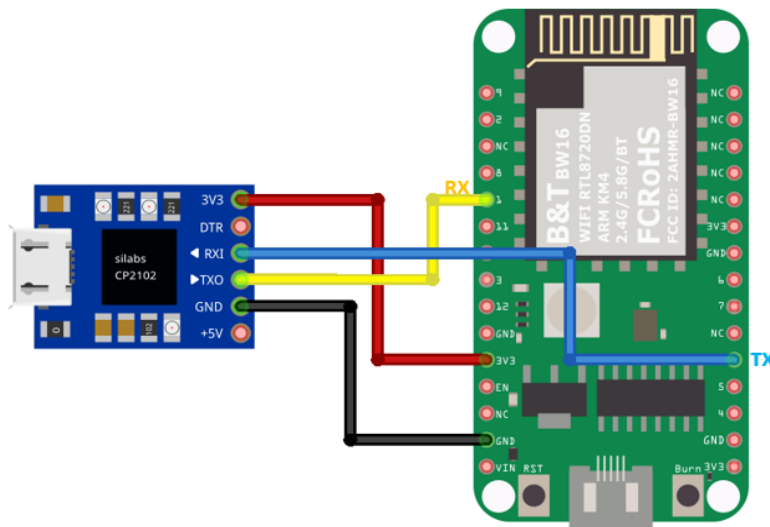


**First, connect BW16 to the computer via Micro USB:**

If this is the first time you connect BW16 to your computer, here is something that you might take note of:

From the pinmap above, we know D0 and D1 pins are used for program uploading. However, according to the schematic design of AI Thinker, the onboard USB-to-UART module is connected to D4 and D5 which cannot be directly used for program upload.

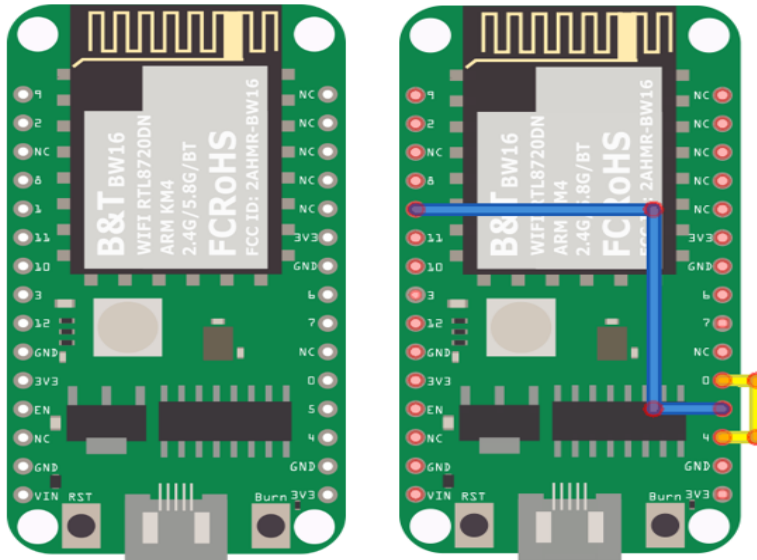
In order to upload firmware to this board, we suggested that you could choose to add in an external USB-to-UART module connecting to D0 and D1 as shown in the pin connection below:



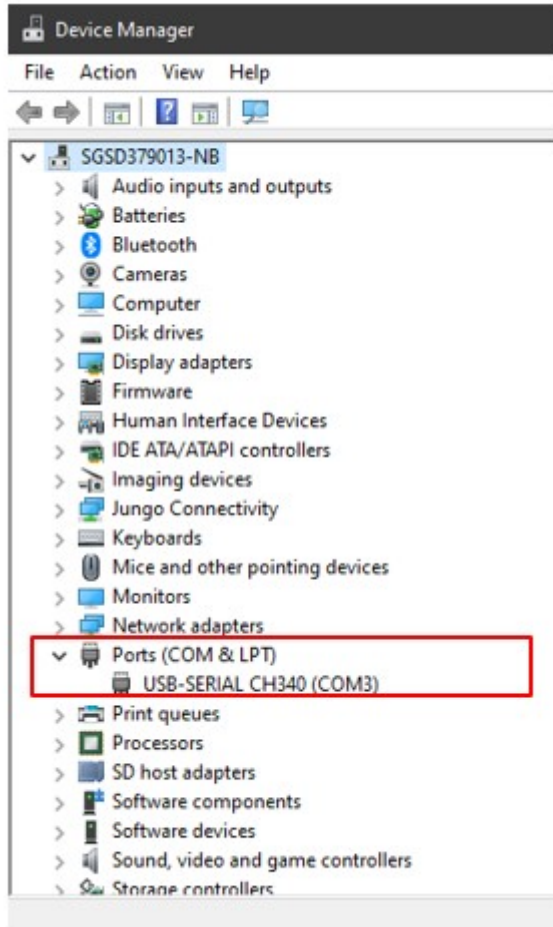
Optionally, you could short the pins indicated below to use the on-board USB:

D1 — D5

D0 — D4



After connecting accordingly, the USB driver for BW16 will be automatically installed. If you have driver issue of connecting board, please go to [http://www.wch-ic.com/downloads/CH341SER\\_ZIP.html](http://www.wch-ic.com/downloads/CH341SER_ZIP.html) for USB driver. You can check the COM Port number in your Device Manager:



## Step 2. Set up Arduino IDE

From version 1.6.5, Arduino IDE supports third-party hardware. Therefore, we can use Arduino IDE to develop applications on BW16, and the basic examples of Arduino can run on BW16 too. Refer to the [Basic Examples](#).

Arduino IDE can be downloaded in the [Arduino website](#).

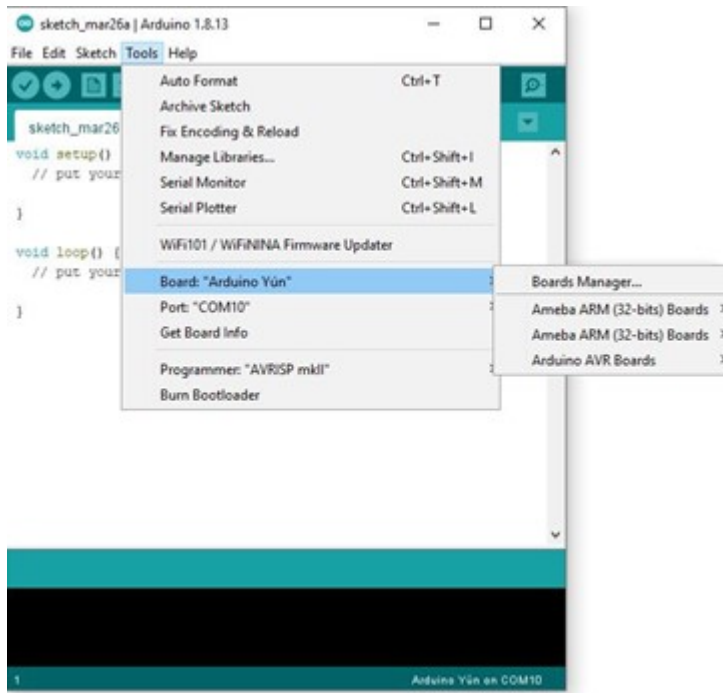
When the installation is finished, open Arduino IDE. To set up BW16 correctly in Arduino IDE, go to “File” -> “Preferences” .

And paste the following URL into “Additional Boards Manager URLs” field:

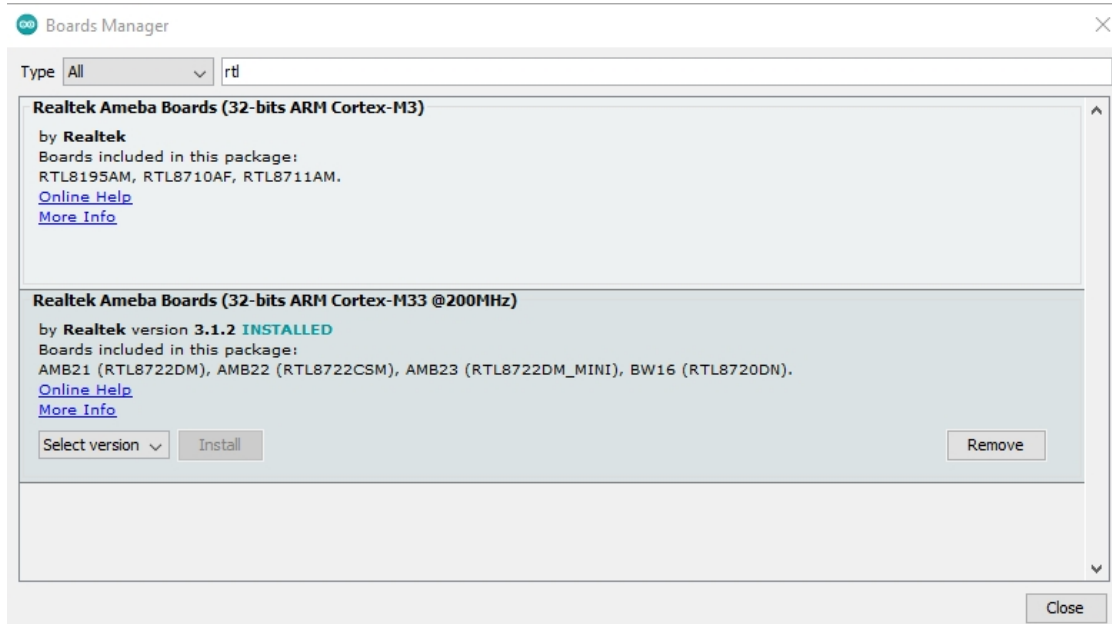
```
https://github.com/ambiot/ambd_arduino/raw/master/Arduino_package/package_realtek.com_amebad_index.json
```

BW16 will be supported from v3.0.8 officially.

Next, go to “Tools” -> “Board” -> “Boards Manager” :



The “*Boards Manager*” requires about 10~20 seconds to refresh all hardware files (if the network is in bad condition, it may take longer). Every time the new hardware is connected, we need to reopen the Board Manager. So, we close the “*Boards Manager*”, and then open it again. Find “*Realtek AmebaD Boards (32-bits ARM Cortex-M33 @200MHz)*” in the list, click “*Install*”, then the Arduino IDE starts to download required files for RTL8722DM.



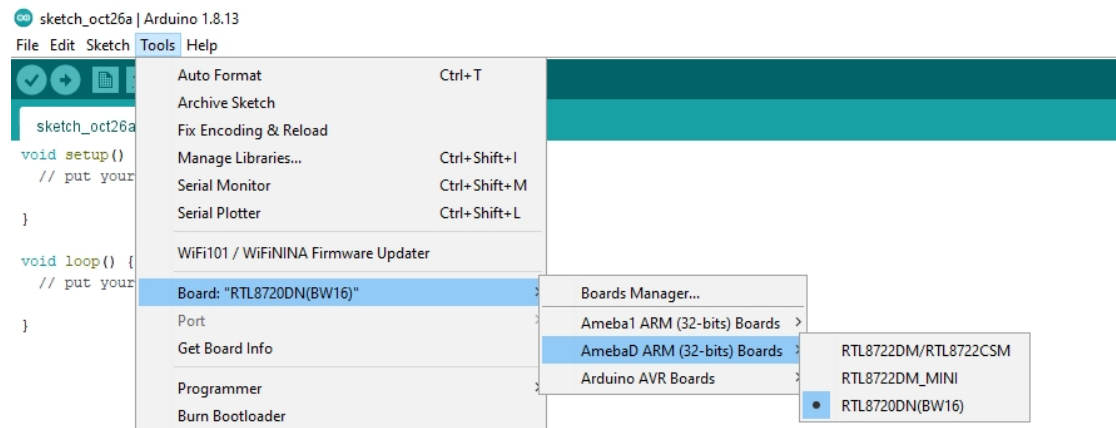
If you are facing GitHub downloading issue, please refer to the following link at [Download/Software Development Kit](#). There are 3 sections:

1. “AmebaD\_Arduino\_patch1\_SDK” , please select at least 1 of the SDKs. There are 5 latest released SDK options.
2. “AmebaD\_Arduino\_patch2\_Tools” , please select according to your operation system. There are Windows, Linux and MacOS.
3. “AmebaD\_Arduino\_Source\_Code” , this section is optional download only wants to refer the latest source code.

Download the files selected, then unzip (patch1 and patch2 are compulsory). There are “Install.doc” / “Install.pdf” for you to refer installation steps. According to your system, please run the installation tool in the “Offline\_SDK\_installation\_tool” folder.

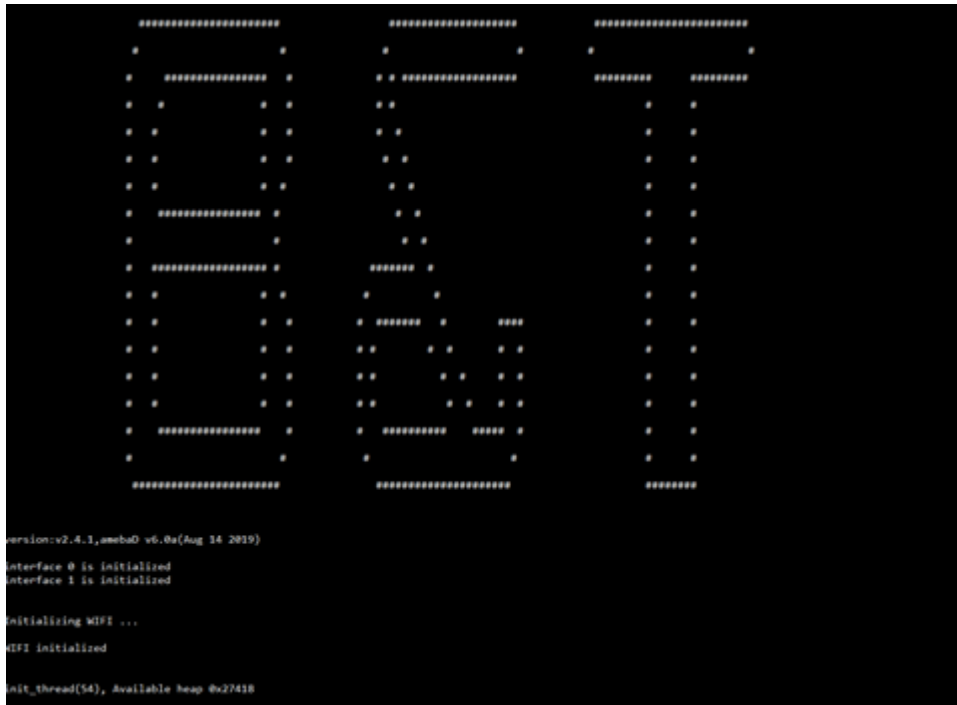
After the installation tool running successfully, you may open Arduino IDE and proceed to “Tools” -> “Board” -> “Boards Manager...”. Try to find “Realtek AmebaD Boards (32-bits ARM Cortex-M33 @200MHz)” in the list, click “Install” , then the Arduino IDE starts to download required files for AmebaD.

Finally, we select RTL8722DM as current connected board in “Tools” -> “Board” -> “Ameba ARM (32-bits) Boards” -> “RTL8722DM”:



## How to upload firmware into BW16

Depending on the batch of manufacturing, some BW16 modules on the development board might have built-in the default B&T firmware, the firmware information is shown in the image below:



This will cause Arduino Image unable to flash into the module. Although information of “All images are sent successfully! Image tool closed! Upload Image did.” is showing in the Image Tool, however, the factory image is unable to be erased. Unfortunately after press the onboard RST button, you will find the factory image still remains in the flash.

Arduino IDE provides many built-in examples, which can be compiled, uploaded and run directly on the boards. Here, we take the “Blink” example as the first try.

Open “File” -> “Examples” -> “01.Basics” -> “Blink” :

## Uploading Solution

### Method 1: Use AmebaD Image Tool to erase flash

The B&T default factory image can be washed using “Erase” function provided by Realtek’ s Image Tool. Using Image Tool to erase the flash image memory starting from memory address: 0x8000\_0000 till the end of 2MB memory location, later on, we need to upload Realtek’ s image back to the module again using Arduino IDE.

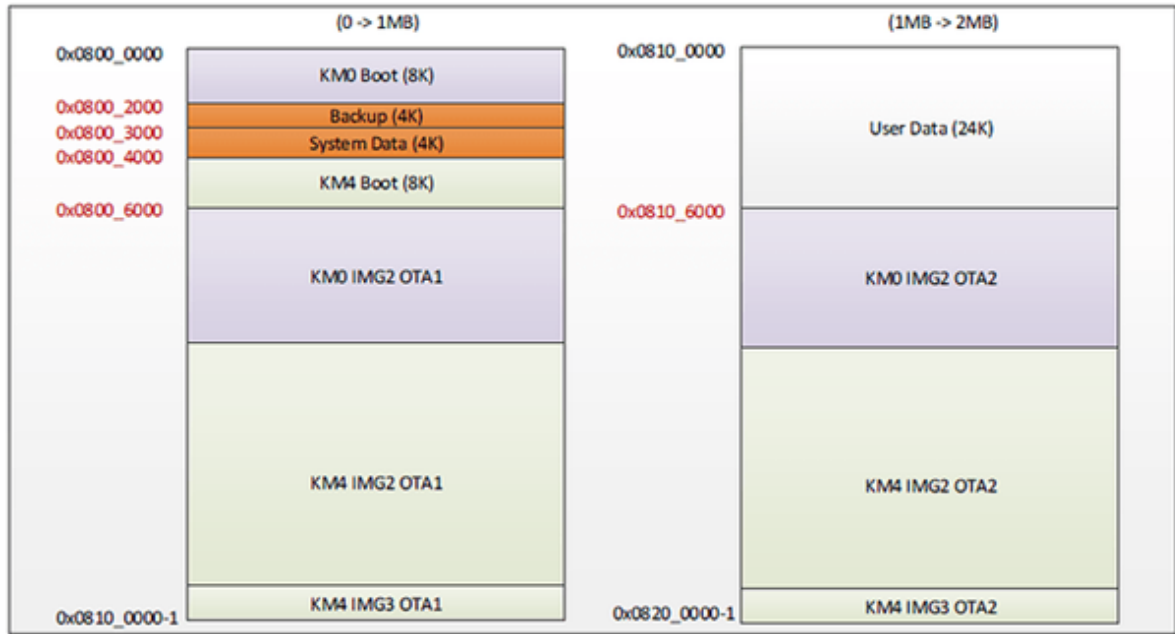


Fig 9-1 1M/2M Flash program layout

### Step 1 –Download and prepare the Image Tool

Download ambd\_sdk from the link ambiot GitHub: [https://github.com/ambiot/ambd\\_sdk](https://github.com/ambiot/ambd_sdk).

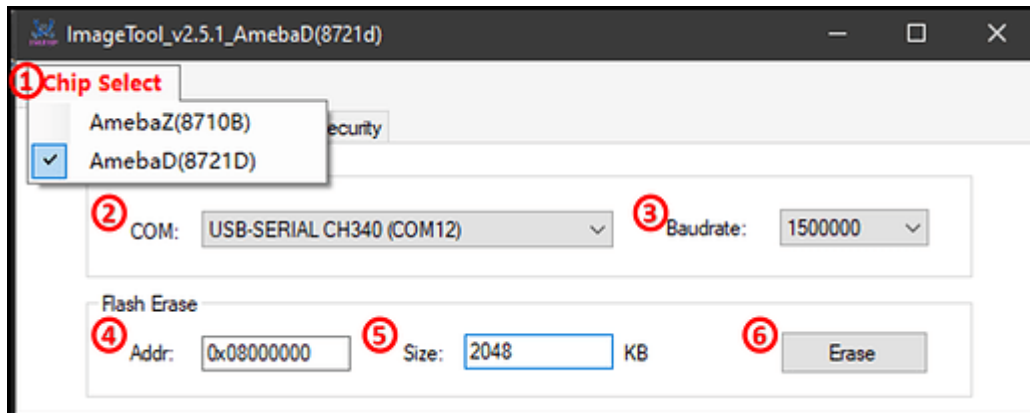
The Realtek' s Image Tool can be found under the following file path:

*“ambd\_sdk\tools\AmebaD\Image\_tool\image\_tool.exe”*

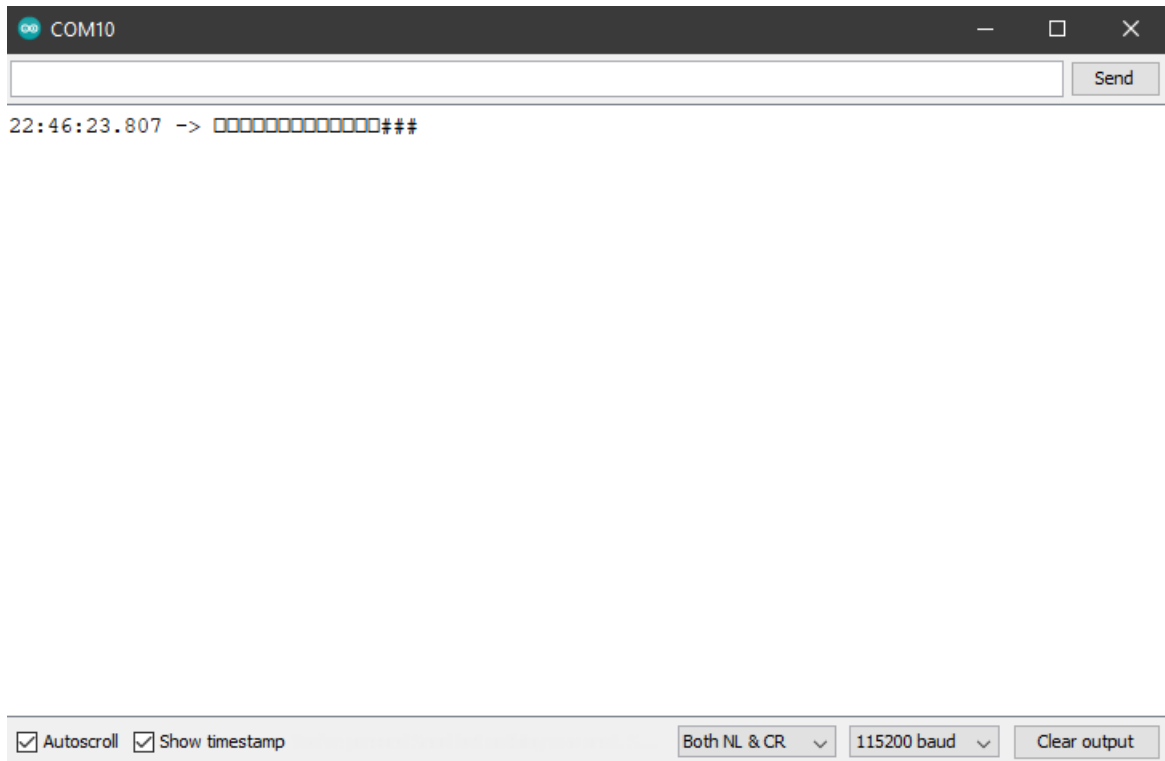
Arduino IDE opens a new window with the complete sample code.

### Step 2 –Setup the Image Tool

1. In the “Chip Select” option, choose “AmebaD(8721D)” which is also suitable for RTL8720DN chip.
2. Select correct COM Port that you are using.
3. Set the Baudrate to “115200” .
4. Then key in the Flash Erase starting position from Memory Address of 0x0800 0000.
5. The size to be 2048 KB.
6. Set the module to “Download mode” first, then click the “Erase” button.



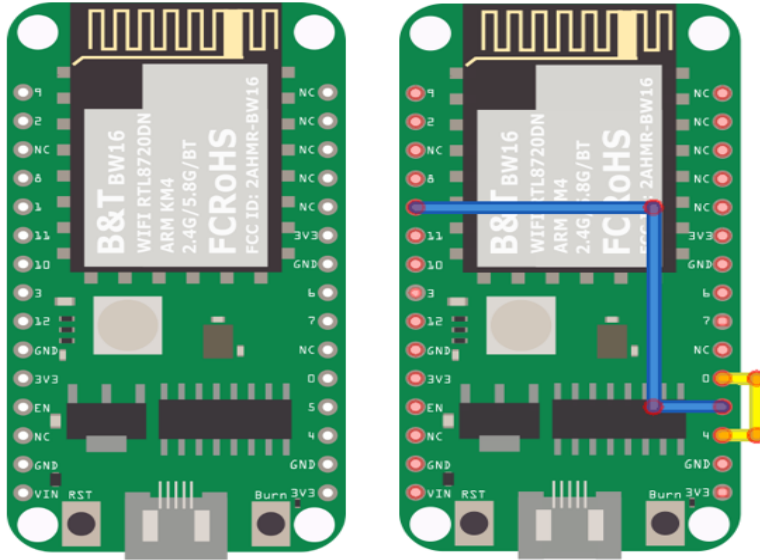
Upon finishing the above image erase and press the reset button, we could find that the "#calibration" will no longer pop out, only "#" will appear in the Serial Monitor.





### Step 3 –Download Image using Arduino IDE

Now you are able to download the program via UART in Arduino IDE. In order to upload the program, you could choose to either use an external USB-to-UART module connecting to D0 and D1, or short the pins indicated below to use the on-board USB:



D1 —D5

D0 —D4

### Optional Uploading Solution

#### OTA (Over The Air)

Ai-Thinker is providing a guide for OTA firmware upload in Section 6.1 of B&T “RTL8720D AT Command User Manual” of which can be retrieved from this [link](#) here.

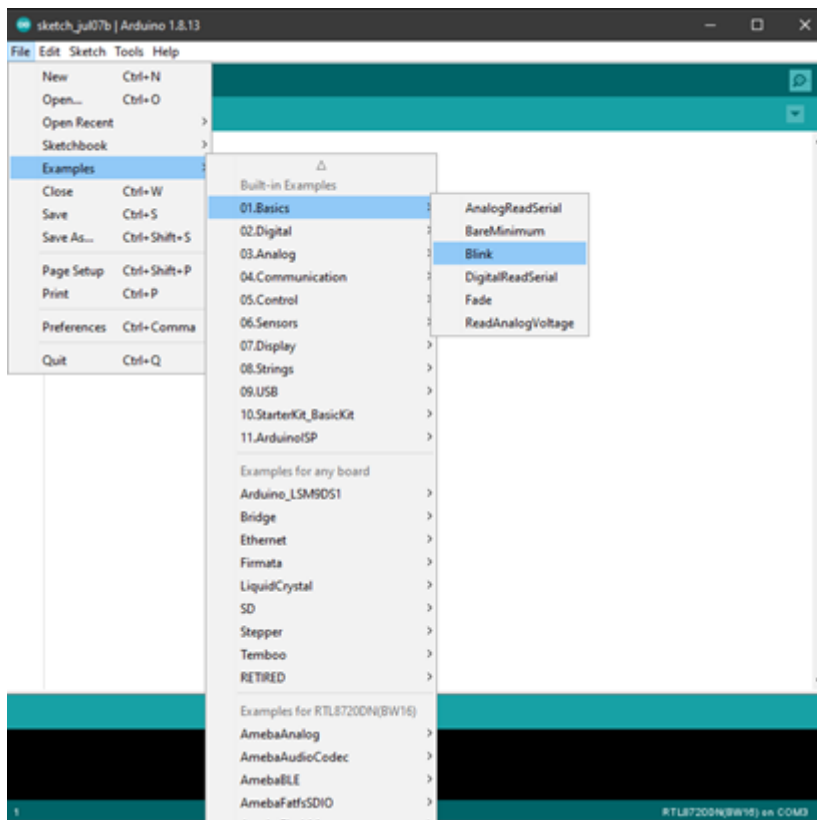
### Try the First Example

#### Step 1. Compile & Upload

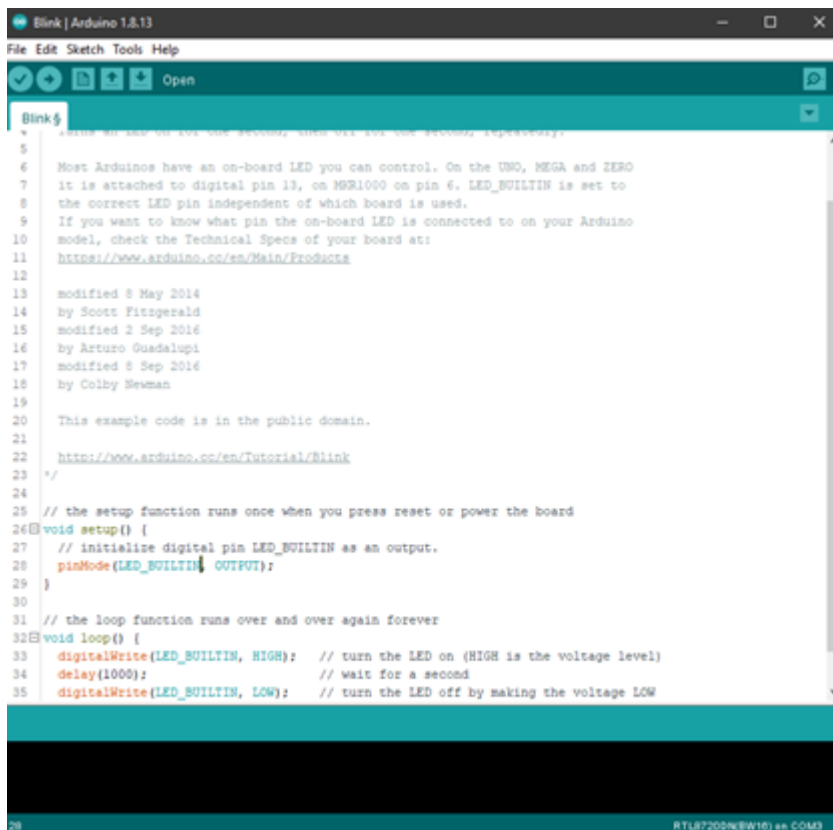
Arduino IDE provides many built-in examples, which can be compiled, uploaded, and run directly on the boards.

Here, we take the “Blink” example as the first try.

Open “File” -> “Examples” -> “01.Basics” -> “Blink” :

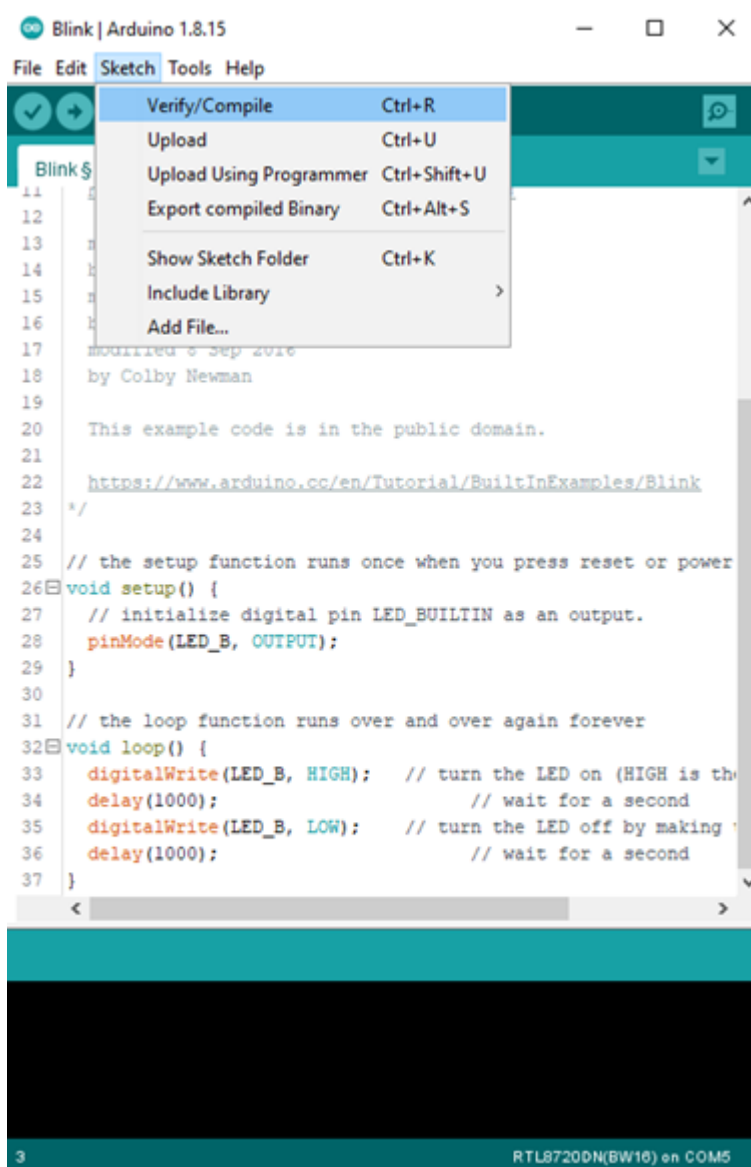


Arduino IDE opens a new window with the complete sample code.



There is an onboard LED of BW16, the default LED\_BUILTIN is a green onboard LED. Change LED\_BUILTIN to LED\_B or LED\_R for different colors such as blue and red. Here we use LED\_B for demonstration purpose.

Next, we compile the sample code directly; click “Sketch” -> “Verify/Compile”



Arduino IDE prints the compiling messages in the bottom area of the IDE window. When the compilation is finished, you will get the message similar to the following figure:

```

Blink | Arduino 1.8.15
File Edit Sketch Tools Help
Blink $
11 // https://www.arduino.cc/en/Tutorial/BuiltInExamples/Blink
12
13 modified 8 May 2014
14 by Scott Fitzgerald
15 modified 2 Sep 2016
16 by Arturo Guadalupi
17 modified 8 Sep 2016
18 by Colby Newman
19
20 This example code is in the public domain.
21
22 https://www.arduino.cc/en/Tutorial/BuiltInExamples/Blink
23 */
24
25 // the setup function runs once when you press reset or power the board
26 void setup() {
27   // initialize digital pin LED_BUILTIN as an output.
28   pinMode(LED_B, OUTPUT);
29 }
30
31 // the loop function runs over and over again forever
32 void loop() {
33   digitalWrite(LED_B, HIGH); // turn the LED on (HIGH is the voltage lev
34   delay(1000); // wait for a second
35   digitalWrite(LED_B, LOW); // turn the LED off by making the voltage L
36   delay(1000); // wait for a second
37 }

```

Done compiling.

```

km0_image2_all.bin
km4_image2_all.bin
1 file(s) copied.
cmd /c copy /y "C:\Users\zhuqi\AppData\Local\Arduino15\packages\realtek\
1 file(s) copied.
"C:\Users\zhuqi\AppData\Local\Arduino15\packages\realtek\tools\ameba_d
Sketch uses 192928 bytes (9%) of program storage space. Maximum is 2097152 byte

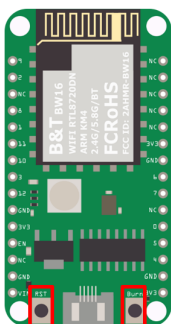
```

RTL8720DN(BW16) on COM5

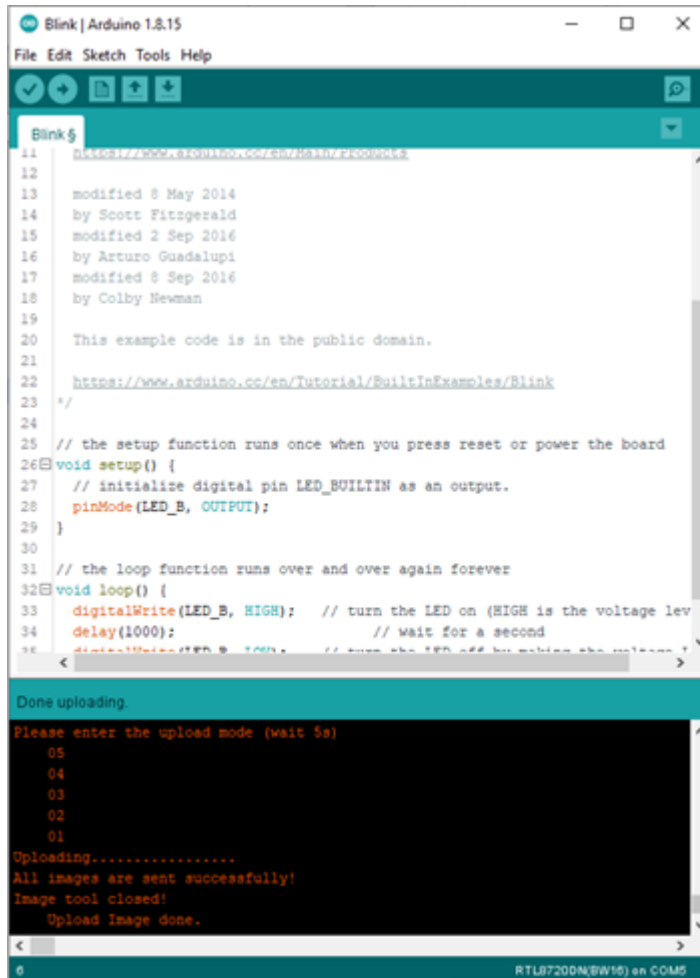
Afterwards, we will upload the compiled code to BW16.

Please make sure BW16 is connected to your computer, then click “Sketch” -> “Upload” .

The Arduino IDE will compile first then upload. During the uploading process, users are required to enter the upload mode of the board. To enter the upload mode, first press and hold the BW16 “Burn” button, press the “RST” button, and then release the “Burn” button.



Press “Upload” button in Arduino IDE to compile and upload the program. Arduino IDE will wait for 5s for the development board to enter the upload mode.



Again, during the uploading procedure the IDE prints messages. Uploading procedure takes considerably longer time (about 30 seconds to 1 minute). When upload completed, the “Done uploading” message is printed.

## Step 2.Run the Blink example

In each example, Arduino not only provides sample code, but also detailed documentation, including wiring diagram, sample code explanation, technical details, ...etc. These examples can be directly used on BW16.

So, we find the detailed information of the [Blink example](#).

In short, for BW16, the example can be run on both the onboard RGB LED or external LED (use any GPIO pins for signal output). Finally, press the “RST” button, and you can see the RGB LED turns into blue and keep blinking.

## References

1. Introduction of BW16 on Instructable: <https://www.instructables.com/RTL8720DN/>
2. Load Arduino image into BW16: [How to load BW16 program with Arduino –#13](#)
3. BW16 IMG2 SIGN Invalid Solution: [RTL8720DN\(BW16\) IMG2 SIGN Invalid Solution](#)
4. FTDI Driver Download from here: [https://ftdichip.com/wp-content/uploads/2021/02/CDM21228\\_Setup.zip](https://ftdichip.com/wp-content/uploads/2021/02/CDM21228_Setup.zip)

(End)

備F: If you face any issue, please refer to the FAQ and Trouble shooting sections on [../support/index](#) page.

## 1.3.2 Peripherals & Examples

### Basic Examples

BW16 (RTL8720DN) Supported ARDUINO built-in example table

There are many built-in examples in Arduino. In the table below, we list all examples that are compatible with Ameba.

Please refer to the following link to set up Ameba for Arduino IDE.

<https://www.amebaiot.com/en/amebad-bw16-arduino-getting-started/>

Please refer to the following link for Arduino built-in example details.

<https://www.arduino.cc/en/Tutorial/BuiltInExamples/>

Category	Name	Comment
01. Basics	Analog ReadSerial	Connect potentiometer to 3.3V. Use ADC pin A2(PB3).
	BareMinimum	
	Blink	Pin LED_BUILTIN sets to LED_G
	Digital ReadSerial	
	Fade	Use PWM pins D7(PA25), D8(PA26), D11(PA13), D12(PA12)
	Read Analog Voltage	Use ADC pin A2(PB3).
02. Digital	BlinkWithout Delay	Pin LED_BUILTIN sets to LED_G
	Button	Replace 「ledPin = 13;」 by available digital pins. e.g. 「ledPin = LED_BUILTIN」

Category	Name	Comment
	Debounce	Replace 「ledPin = 13;」 by available digital pins. e.g. 「ledPin = LED_BUILTIN;」
	Digital InputPullup	Replace 「ledPin = 13;」 by available digital pins. e.g. 「ledPin = LED_BUILTIN;」
	StateChange Detection	Replace 「ledPin = 13;」 by available digital pins. e.g. 「ledPin = LED_BUILTIN;」
	toneKeyboard	Replace 「tone(8, notes[thisSensor], 20);」 by a PWM pin D7(PA25), D8(PA26), D11(PA13), D12(PA12).
	toneMelody	
	tone Multiple	
	tonePitch Follower	
03. Analog	Analog InOutSerial	Replace 「analogOutPin = 9;」 by a PWM pin (D7(PA25), D8(PA26), D11(PA13), D12(PA12)).
	AnalogInput	Replace 「ledPin = 13;」 by available digital pins. e.g. 「ledPin = LED_BUILTIN;」
	Analog Write Mega	Use PWM pins D7(PA25), D8(PA26), D11(PA13), D12(PA12).
	Calibration	Connect another LED to pin D13. Use ADC pin A2(PB3).
	Fading	Use PWM pins D7(PA25), D8(PA26), D11(PA13), D12(PA12).
	Smoothing	Use ADC pin A2(PB3).
04. Communication	ASCIITable	
	Dimmer	
	Graph	Connect potentiometer to 3.3V. Use ADC pin A2(PB3).
	Midi	Use Serial1 and pin D4(PB1).
	MultiSerial	Required external USB-to-UART module.
	Physical Pixel	Replace 「ledPin = 13;」 by available digital pins. e.g. 「ledPin = LED_BUILTIN;」
	Read ASCIIString	Use PWM pins for LED, D7(PA25), D8(PA26), D11(PA13), D12(PA12).
	SerialEvent	
	Serial Passthrough	Required external USB-to-UART module.
05. Control	Arrays	Use pins D9, D2, D8, D1, D11, D10.
	ForLoop Iteration	Use pins D9, D2, D8, D1, D11, D10.
	IfStatement Conditional	Replace 「ledPin = 13;」 by available digital pins. e.g. 「ledPin = LED_BUILTIN;」
	switchCase	Use ADC pin A2(PB3).
	switchCase2	Use pins D9, D2, D8, D1, D11, D10.
	While Statement Conditional	Use ADC pin A2(PB3). Replace 「indicatorLedPin = 13;」 by available digital pins.
06. Display	barGraph	Use ADC pin A2(PB3).
07. Strings	Character Analysis	
	StringAddition Operator	
	StringAppend Operator	
	String CaseChanges	
	String Characters	
	String Comparision Operators	Use ADC pin A2(PB3).
	StringIndexOf	
	StringLength	

Category	Name	Comment
	String LengthTrim	
	String Replace	
	String Starts WithEndsWith	
	String Substring	
	StringToInt	

## Network Examples

### BLE - BLE Battery Service

#### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

#### Example

##### Introduction

BLE connections use a server client model. The server contains the data of interest, while the client connects to the server to read the data. Commonly, a Bluetooth peripheral device acts as a server, while a Bluetooth central device acts as a client. Servers can contain many services, with each service containing a some set of data. Clients can send requests to read or write some data and can also subscribe to notifications so that the server can send data updates to a client.

In this example, a basic battery service is set up on the Ameba Bluetooth stack. A mobile phone is used to connect to the Ameba peripheral device and read the battery data.

##### Procedure

Ensure that the following Bluetooth apps are installed on your mobile phone. These apps will show you the raw data sent by Ameba and allow you to interact with the data.

The recommended application is nRF connect, and is available at the links below:

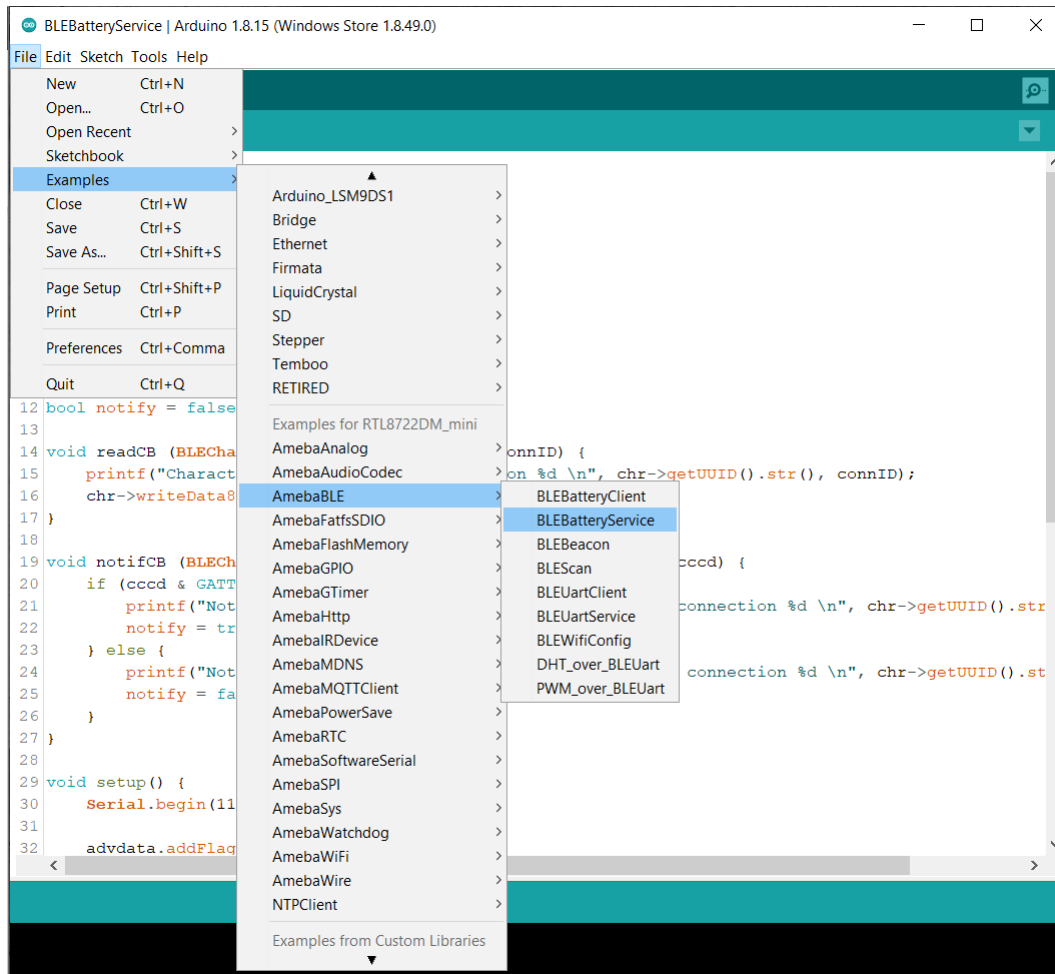
- Android: <https://play.google.com/store/apps/details?id=no.nordicsemi.android.mcp>
- iOS : <https://apps.apple.com/us/app/nrf-connect/id1054362403>

LightBlue is an alternative application that can also be used, but has less features:

- Android: <https://play.google.com/store/apps/details?id=com.punchthrough.lightblueexplorer>
- iOS : <https://apps.apple.com/us/app/lightblue/id557428110>

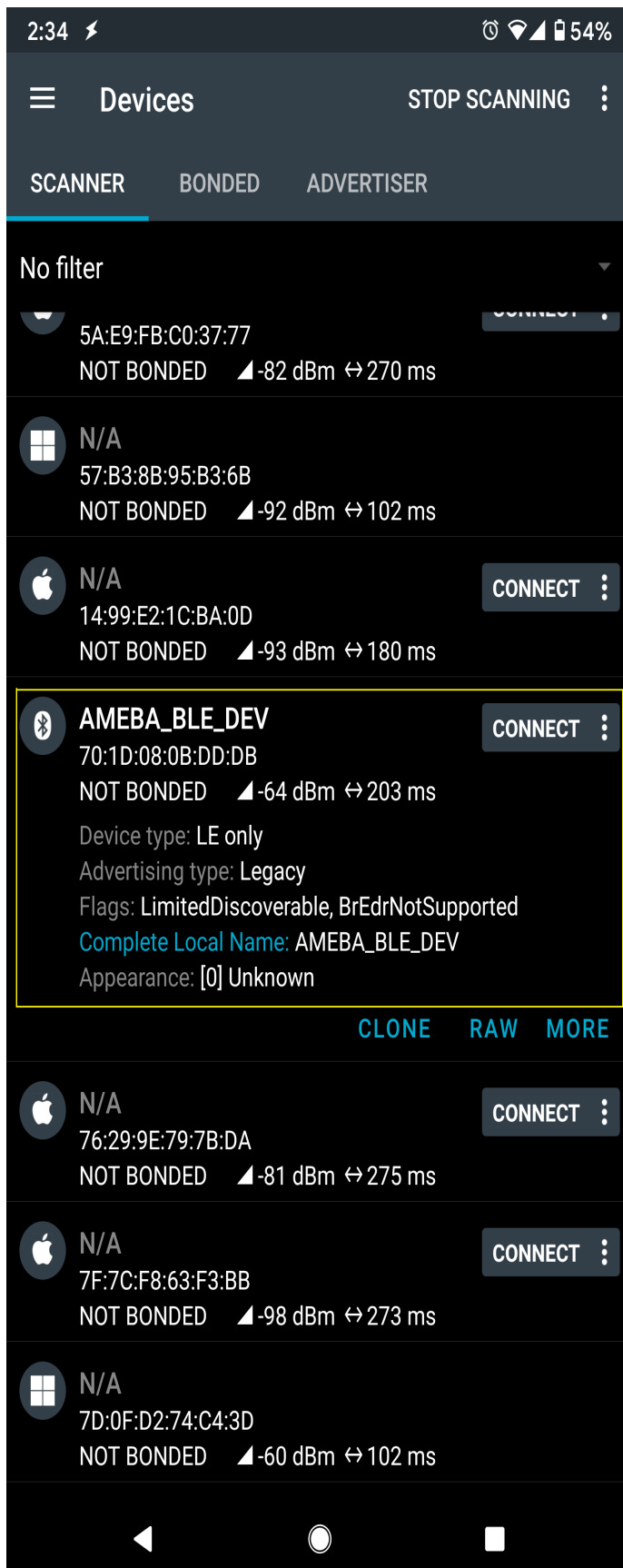


Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEBatteryService”

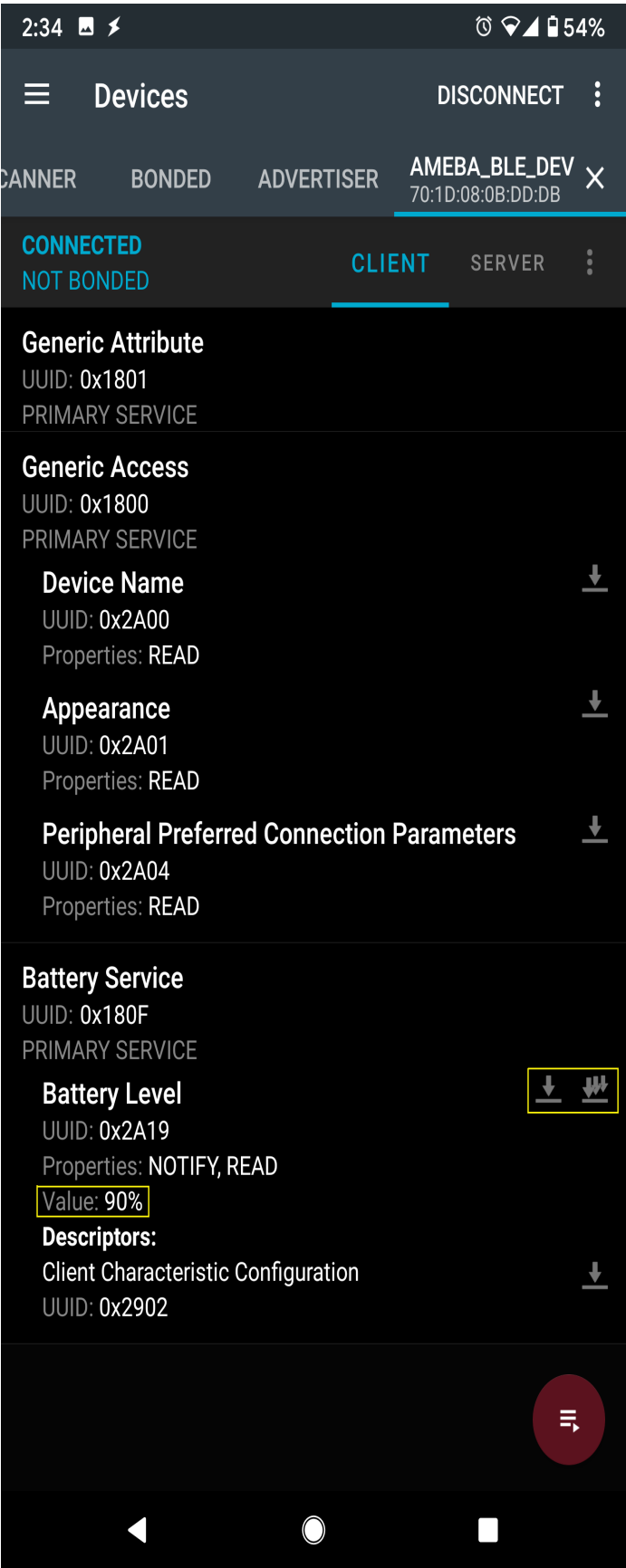


Upload the code and press the reset button on Ameba once the upload is finished.

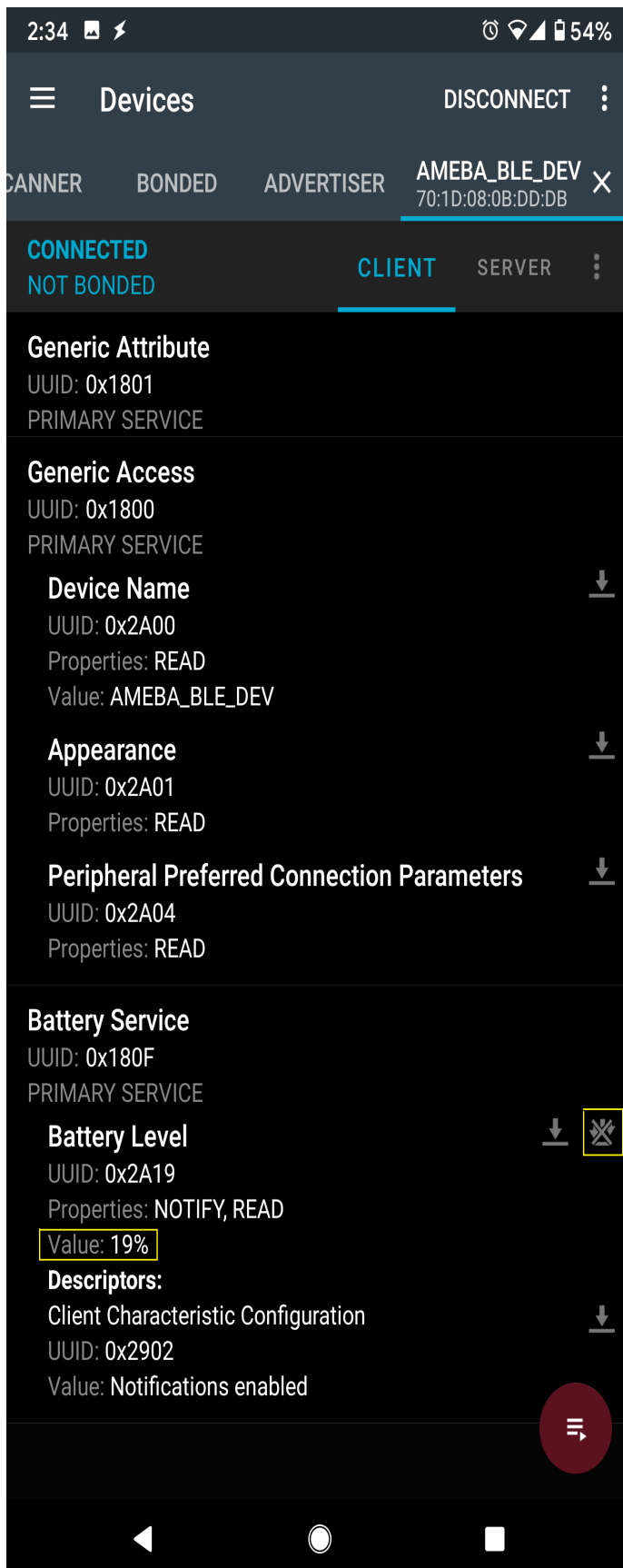
On your mobile phone, open the Bluetooth app and scan for the Bluetooth signal broadcast by Ameba, it should appear as a device named “AMEBA\_BLE\_DEV” .



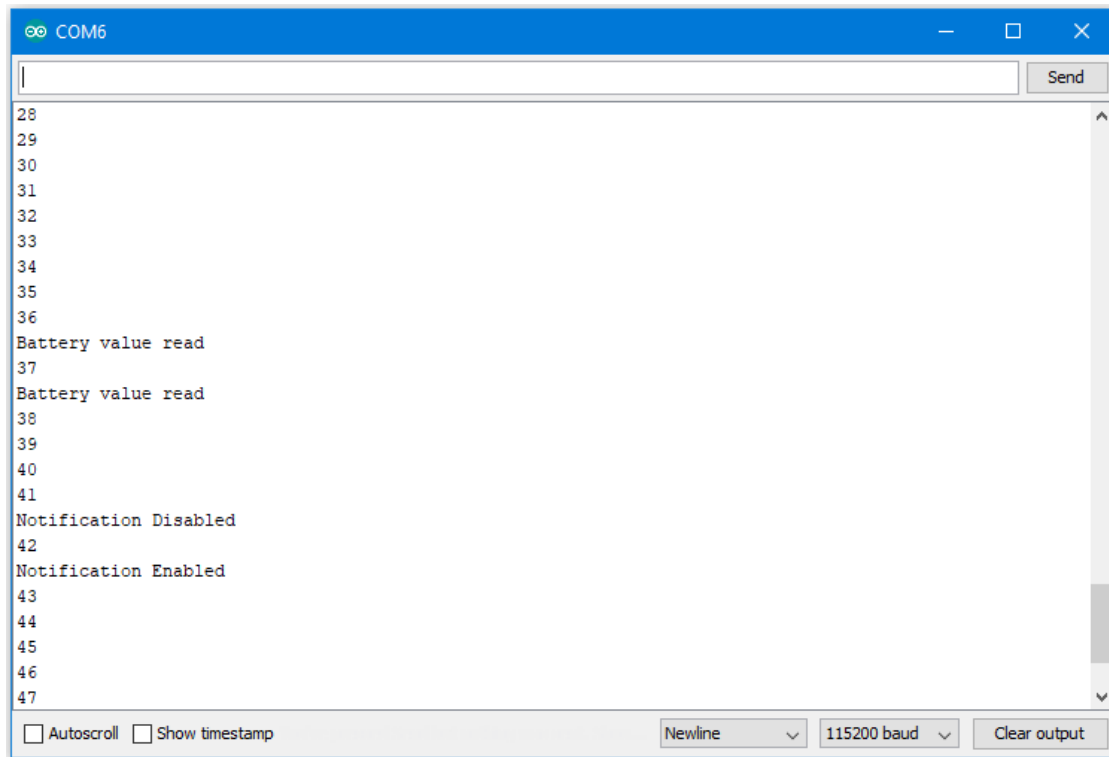
Connect to the Ameba Bluetooth device, and a list of available services should appear. Click on the battery service to expand it, and you can see the battery level data value. The arrows highlighted in the box on the right are used to read data and subscribe to notifications. Click on the single arrow to read the battery level value, and a 90% value will appear.



Click on the triple arrow to subscribe to updates on the battery level value, and the battery value will start updating by itself.



The serial monitor will show the sketch increasing the battery level every second. When you click on either of the arrows, the sketch running on the Ameba will be notified, and will print out the action taken.



## Code Reference

BLEService and BLECharacteristic classes are used to create and define the battery service to run on the Bluetooth device.

`BLE.configAdvert() -> setAdvType(GAP_ADTYPE_ADV_IND)` is used to set the advertisement type to a general undirected advertisement that allows for connections.

`setReadCallback()` and `setCCCDCallback()` is used to register functions that will be called when the battery level data is read, or notification is enabled by the user.

`BLE.configServer(1)` is used to tell the Bluetooth stack that there will be one service running.

`addService()` registers the battery service to the Bluetooth stack.

## BLE –BLE Beacon

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

## Example

### Introduction

A BLE beacon broadcasts its identity to nearby Bluetooth devices, to enable the other devices to determine their location relative to the beacon, and to perform actions based on information broadcasted by the beacon.

Example applications of beacons include indoor positioning system, location-based advertising and more.

From the definition of its purpose as a broadcast device, a BLE beacon thus cannot be connected to, and can only send information in its Bluetooth advertisement packets.

There are several BLE beacon protocols. The Ameba BLEBeacon library supports the iBeacon and AltBeacon protocols.

### Procedure

First, you need to install some Bluetooth apps on your mobile phone. These apps will show you the raw data sent by Ameba and allow you to interact with the data.

The recommended application is nRF connect, and is available at the links below:

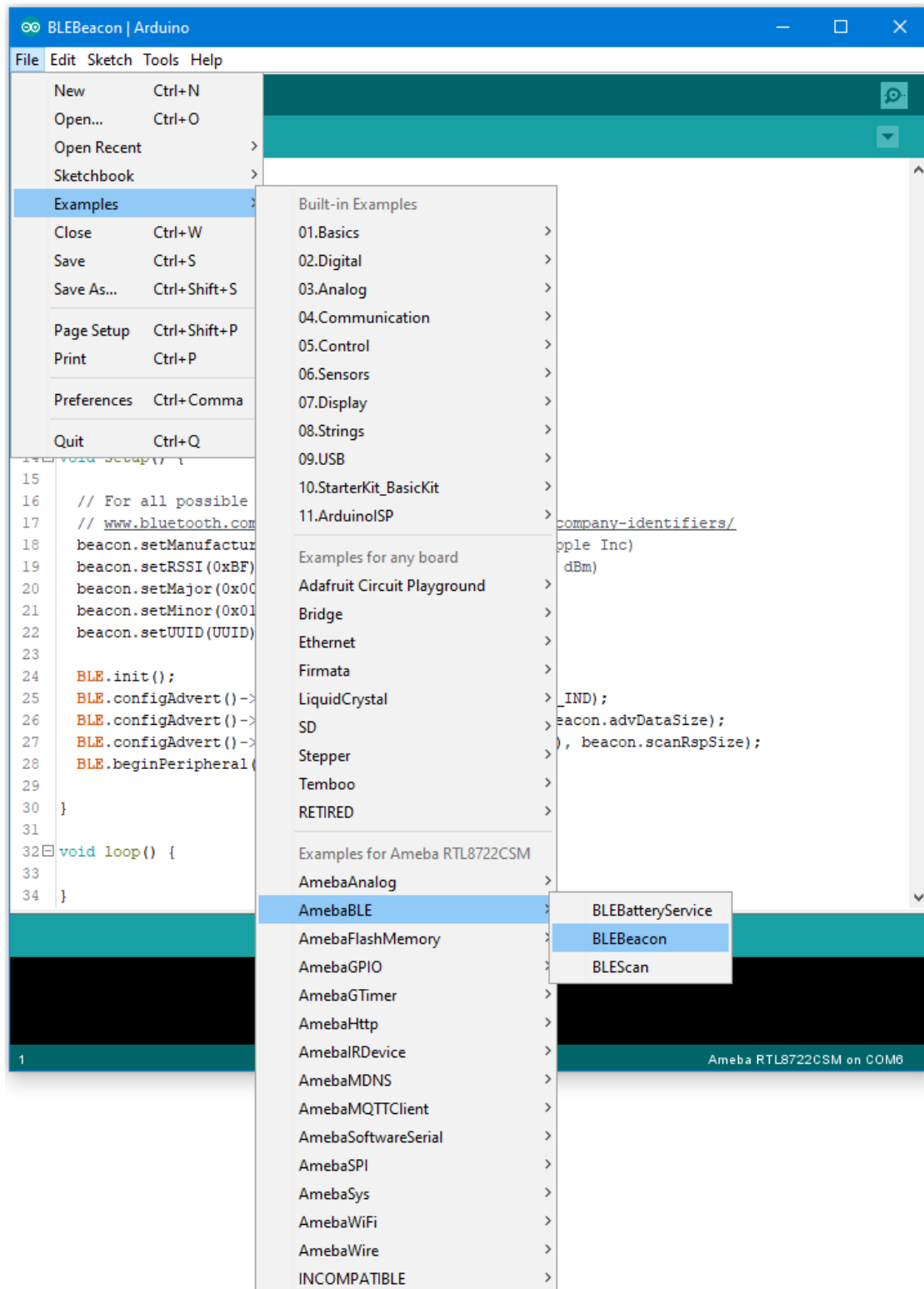
- **Android** : <https://play.google.com/store/apps/details?id=no.nordicsemi.android.mcp>
- **iOS** : <https://apps.apple.com/us/app/nrf-connect/id1054362403>

LightBlue is an alternative application that can also be used, but has less features:

- **Android** : <https://play.google.com/store/apps/details?id=com.punchthrough.lightblueexplorer>
- **iOS** : <https://apps.apple.com/us/app/lightblue/id557428110>

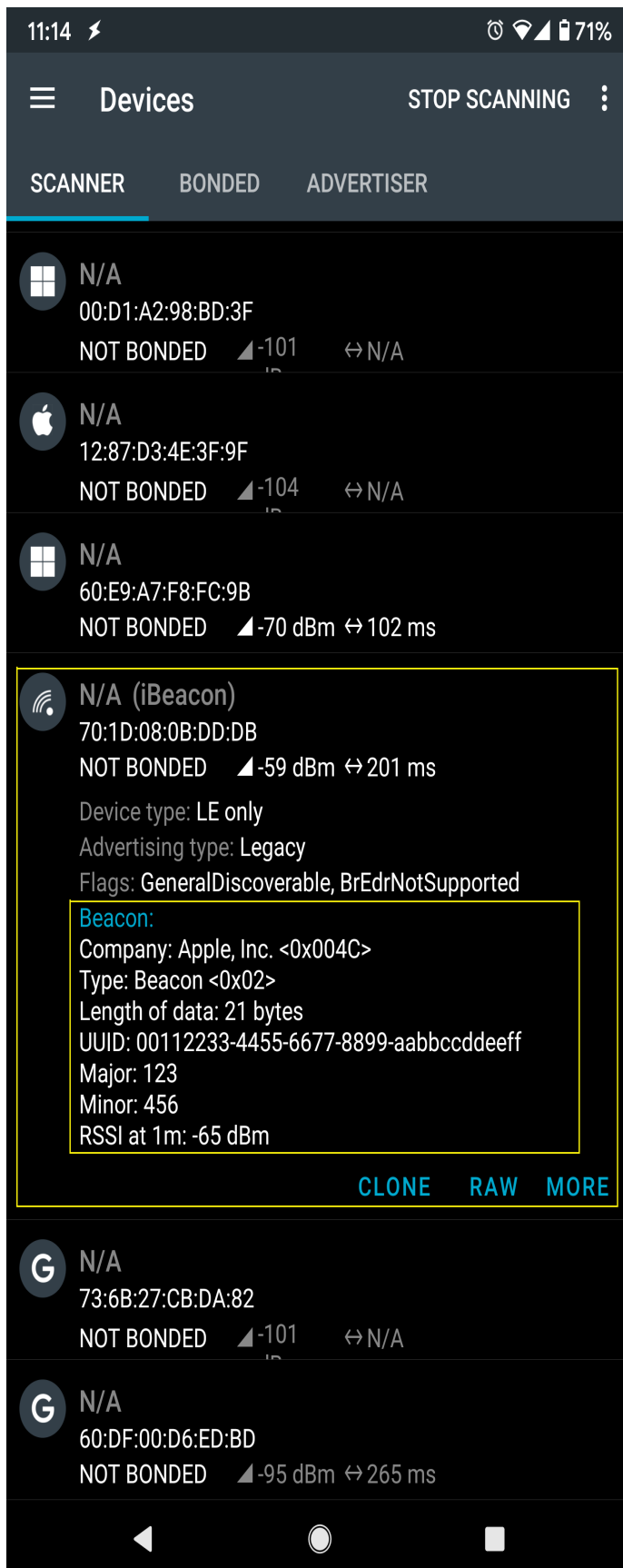
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEBeacon”





Upload the code and press the reset button on Ameba once the upload is finished.

On your mobile phone, open the Bluetooth app and scan for the beacon signal broadcast by Ameba.



If you happen to be in an environment with multiple BLE beacons, you can tap the entries to expand them, and verify that the beacon data is identical to the data in the sketch.

## Code Reference

`setRssi()` is used to set the received signal strength indicator (rssi) data field for a beacon. The specification states that this should be the received signal strength from the beacon at a 1 meter distance. With no method to measure this, it is set to -65dBm as an estimate.

`setMajor()` and `setMinor()` are used to set the two data fields. The purpose of these data are left for the manufacturer of the beacon to define, and can be used in any way.

`setUUID()` is used to give the beacon a universally unique identifier (UUID). This is a 128-bit number usually expressed as a hexadecimal string. It is used to identify each unique beacon, and can be randomly generated for free online.

The BLEBeacon library includes both `iBeacon` and `AltBeacon` classes, replace line 6 `iBeacon` with `altBeacon` to create an `AltBeacon` instead. The data fields are mostly the same, with only minor changes, please look at the header files for more details.

`BLE.init()` is used to allocate memory and prepare Ameba for starting the Bluetooth stack.

`BLE.configAdvert()` is used to configure the Bluetooth advertisement settings, to which we pass the beacon data and set the device as non-connectable.

`BLE.beginPeripheral()` starts Ameba in Bluetooth peripheral mode, after which it will begin to advertise with the beacon data provided.

## BLE –BLE Scan

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone

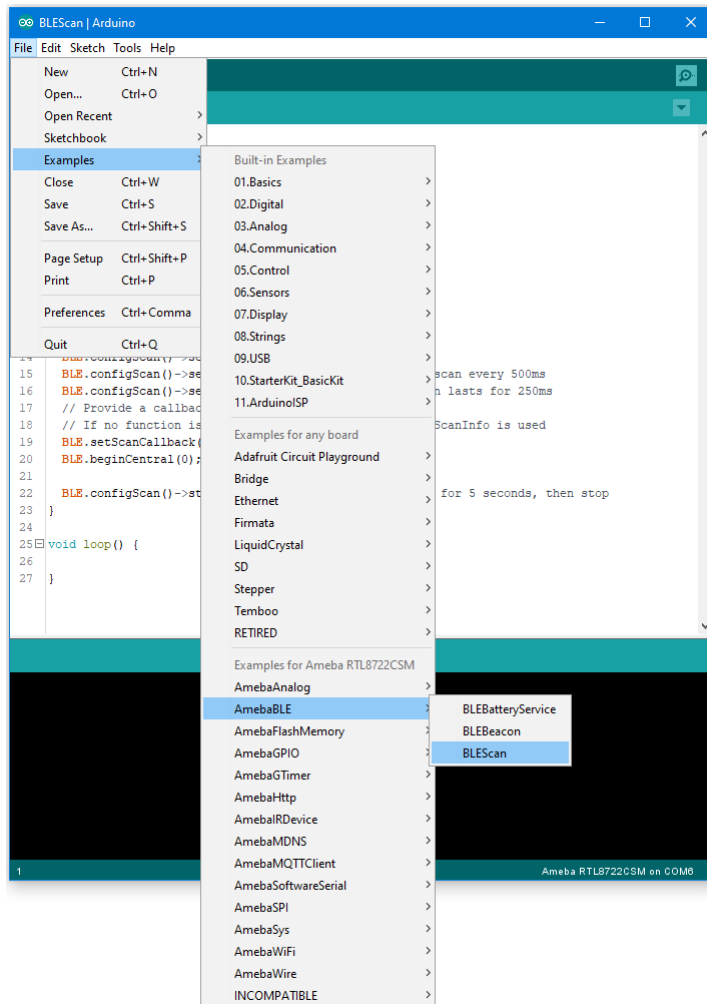
### Example

#### Introduction

This example configures the Ameba as a Bluetooth central device, uses the scan functionality to scan for other Bluetooth devices, and prints out the results to the serial monitor.

#### Procedure

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEScan”



Upload the code and press the reset button on Ameba once the upload is finished.

Open the Arduino serial monitor, and you should see the scan results of nearby Bluetooth devices formatted and printed out.

```

COM6
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
local bd addr: 0x70:1d:08:0b:dd:db
GAP scan start

Scan Data 1
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 79:c1:1f:ed:21:75 | -94
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 2
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 4c:19:13:18:f4:b5 | -98
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 3
ADVType          | AddrType      | BT_Addr        | rssi
NON_CONNECTABLE  | random        | 59:aa:dd:87:da:83 | -62
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x6, len 27

Scan Data 4
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | random        | c7:b9:7f:1e:fb:28 | -96
GAP_ADTYPE_FLAGS: 0x5
GAP_ADTYPE_SERVICE_DATA: UUID 0xfffe, len 4

Scan Data 5
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | random        | 6b:37:ce:55:75:65 | -92
GAP_ADTYPE_FLAGS: 0x1a
GAP_ADTYPE_POWER_LEVEL: 0xc
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0x4c, len 7

Scan Data 6
ADVType          | AddrType      | BT_Addr        | rssi
CON_UNDIRECT     | public        | 68:9e:19:cb:ef:a9 | -78
GAP_ADTYPE_FLAGS: 0x6
GAP_ADTYPE_128BIT_XXX: 0x1bc5ffa0020062abe411f254e005dbd4
GAP_ADTYPE_MANUFACTURER_SPECIFIC: company_id 0xc90, len 2

Scan Data 7
ADVType          | AddrType      | BT_Addr        | rssi
SCAN_RSP         | public        | 68:9e:19:cb:ef:a9 | -78

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

If you have the Bluetooth app nRF Connect installed, you can also use it to send out Bluetooth advertisements for the Ameba to pick up.

## Code Reference

`setScanMode(GAP_SCAN_MODE_ACTIVE)` is used to set the scan mode. Active scanning will request for an additional scan response data packet from a device when it is found. Passive scanning will only look at the advertisement data, and not request for additional data.

`setScanInterval()` and `setScanWindow()` are used to set the frequency and duration of scans in milliseconds. A scan will start every interval duration, and each scan will last for the scan window duration. The scan window duration should be lesser or equal to the scan interval. Set a short interval to discover devices rapidly, set a long interval to conserve power.

`setScanCallback(scanFunction)` is used to register a function to be called when scan results are received. This can be used to set a user function for additional processing of scan data, such as looking for a specific device. If no function is registered, the scan results are formatted and printed to the serial monitor by default.

`beginCentral(0)` is used to start the Bluetooth stack in Central mode. The argument 0 is used to indicate that no clients will be operating in central mode.

`startScan(5000)` is used to start the scanning process for a specified duration of 5000 milliseconds. The scan will repeat according to the set scan interval and scan window values. After 5000 milliseconds, the scan process will stop, and will be ready to be started again.

## BLE –Battery Client

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

#### Introduction

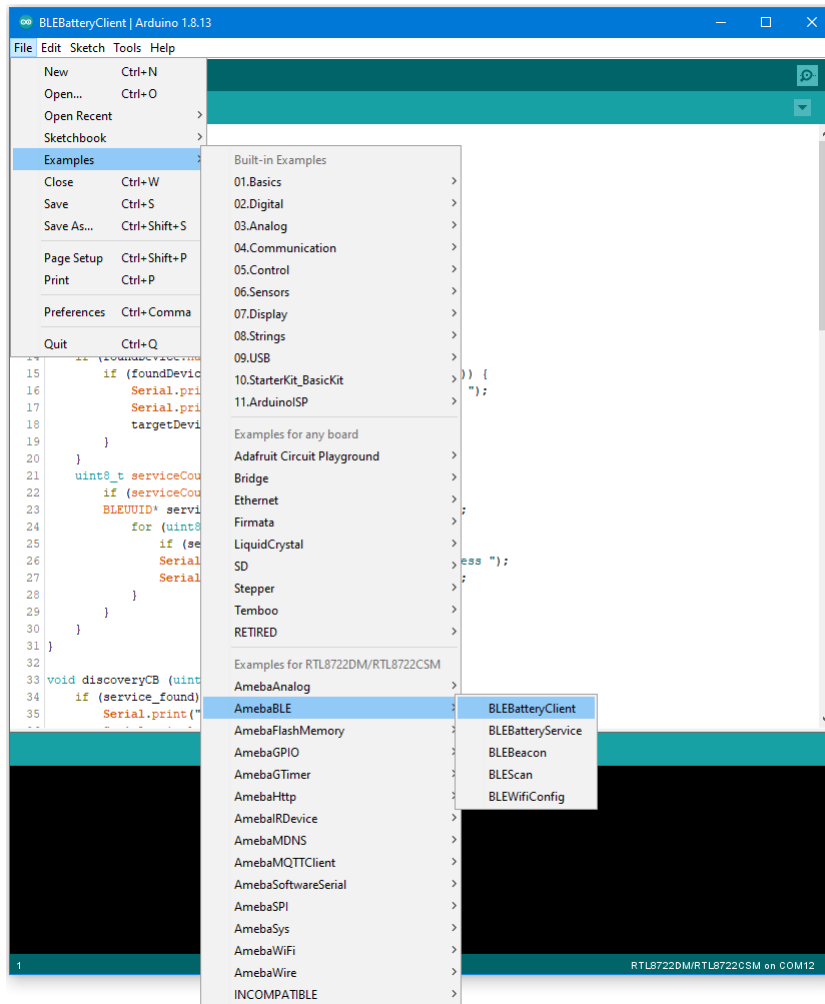
BLE connections use a server client model. The server contains the data of interest, while the client connects to the server to read the data. Commonly, a Bluetooth peripheral device acts as a server, while a Bluetooth central device acts as a client. Servers can contain many services, with each service containing a some set of data. Clients can send requests to read or write some data and can also subscribe to notifications so that the server can send data updates to a client.

In this example, a basic battery client is set up on the Ameba Bluetooth stack. The client connects to another Ameba board running the corresponding BLE battery service to read the battery level data.

#### Procedure

On the first Ameba board, upload the BLEBatteryService example code and let it run.

For the second Ameba board, open the example “Files” -> “Examples” -> “AmebaBLE” -> “BLEBatteryClient” .



Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor and observe the log messages as the Ameba board with the battery client scans, connects, and reads data from the Ameba board with the battery service.

```

COM9
[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:fe:d2
[BLE Device] GAP scan start
Found Ameba BLE Device at address 70:1D:08:0B:DD:DB
Found Battery Service at address 70:1D:08:0B:DD:DB
[BLE Device] GAP scan stop
[BLE Device] Connected conn_id 0
BLE connected to device at 0
Battery service found on connection id: 0
Battery level read callback for connection id: 0 Battery level: 90
Notifications Enabled
Notification received for connection id: 0 Battery level: 9
Notification received for connection id: 0 Battery level: 10
Notification received for connection id: 0 Battery level: 11
Notification received for connection id: 0 Battery level: 12
Notification received for connection id: 0 Battery level: 13
Battery level read callback for connection id: 0 Battery level: 90
Notification received for connection id: 0 Battery level: 14
Notification received for connection id: 0 Battery level: 15
Notification received for connection id: 0 Battery level: 16
Notification received for connection id: 0 Battery level: 17
Notification received for connection id: 0 Battery level: 18
Notifications Disabled
Autoscroll Show timestamp Newline 115200 baud Clear output

```

Highlighted in yellow, the Ameba board with the battery client first scans for advertising BLE devices with the advertised device name “AMEBA\_BLE\_DEV” and the advertised service UUID of 0x180F representing the battery service.

After finding the target device, the Ameba board with the battery client forms a BLE connection and searches for a battery service on the connected device, highlighted in blue.

With the client connected to the service, the battery client begins to read data using both regular data reads and notifications, highlighted in green.

## Code Reference

BLEClient is used to create a client object to discover services and characteristics on the connected device.

- `setNotifyCallback()` is used to register a function that will be called when a battery level notification is received.
- `BLE.configClient()` is used to configure the Bluetooth stack for client operation.
- `addClient(connID)` creates a new BLEClient object that corresponds to the connected device.

## BLE –WiFi Configuration Service

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS mobile phone



## Example

### Introduction

In this example, a WiFi configuration service is set up on the Ameba Bluetooth stack. A mobile phone with the configuration app connects to the Ameba device using BLE and configures the Ameba to connect to the correct WiFi access point.

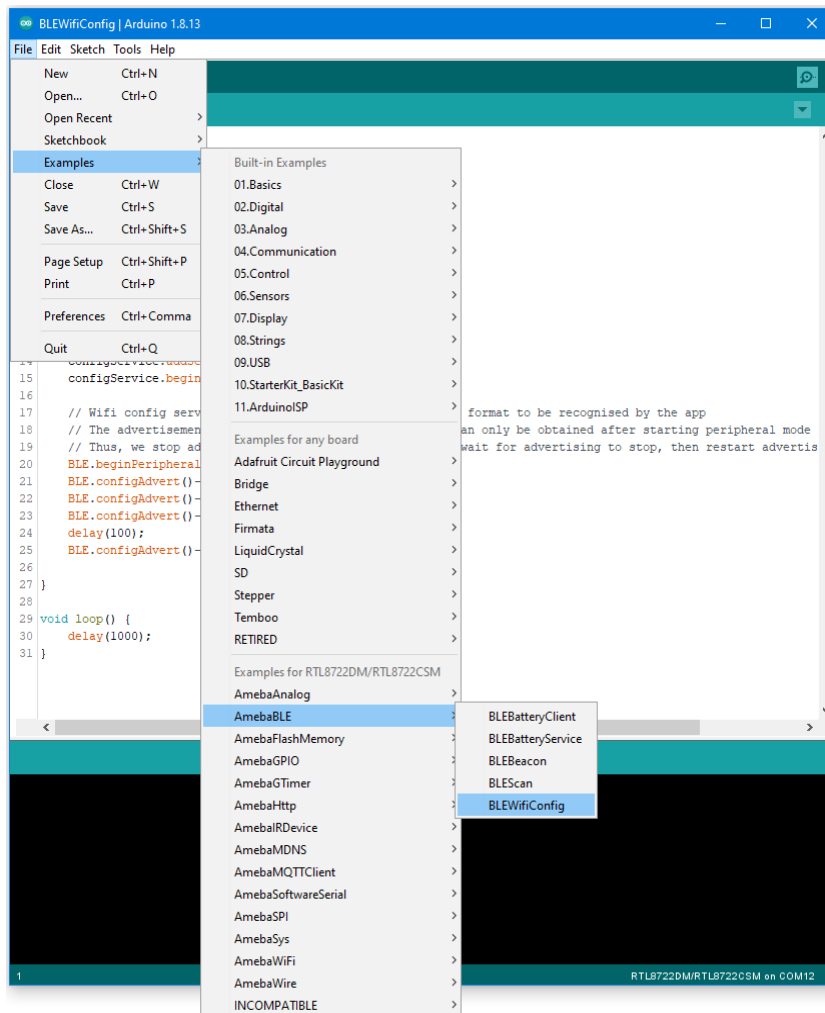
### Procedure

Ensure that the Realtek WiFi configuration app is installed on your mobile phone, it is available at:

–Google Play Store: <https://play.google.com/store/apps/details?id=com.rtk.btconfig>

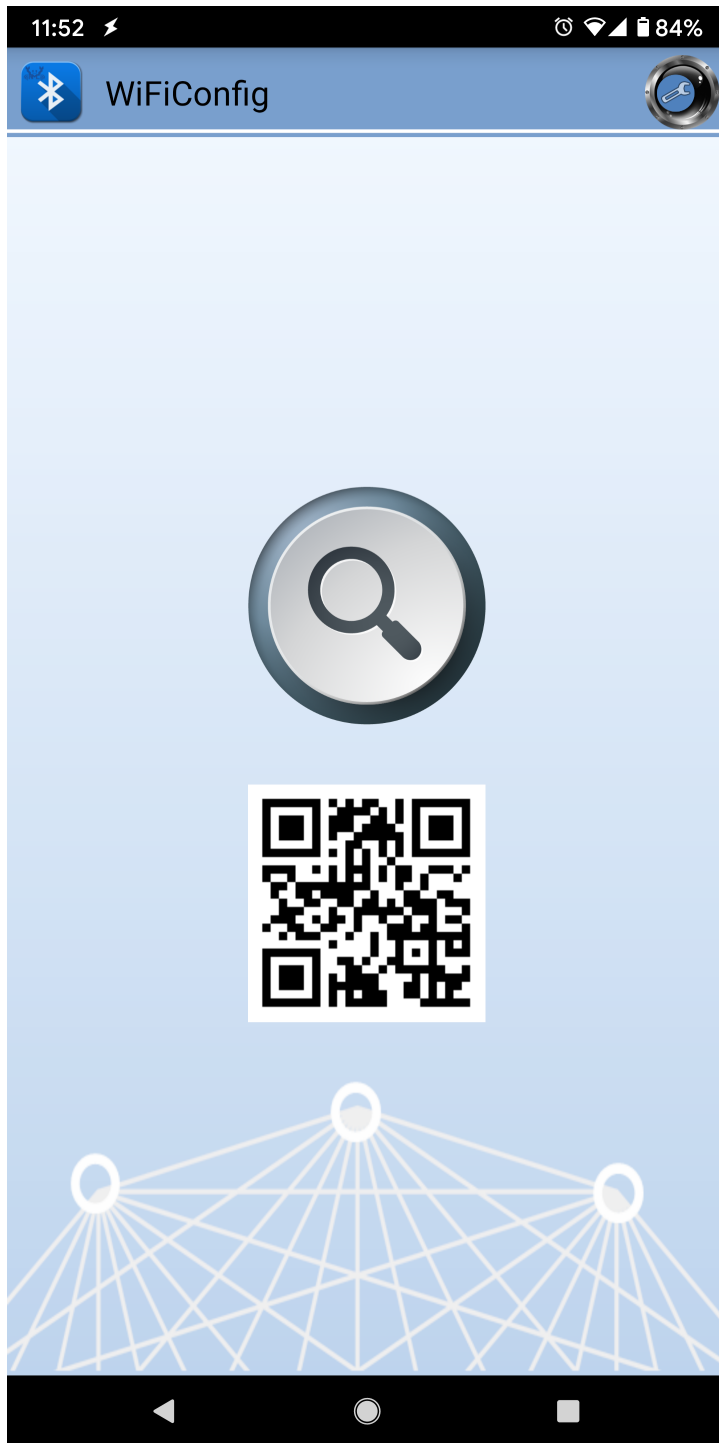
–Apple App Store: <https://apps.apple.com/sg/app/easy-wifi-config/id1194919510>

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEWifiConfigService” .



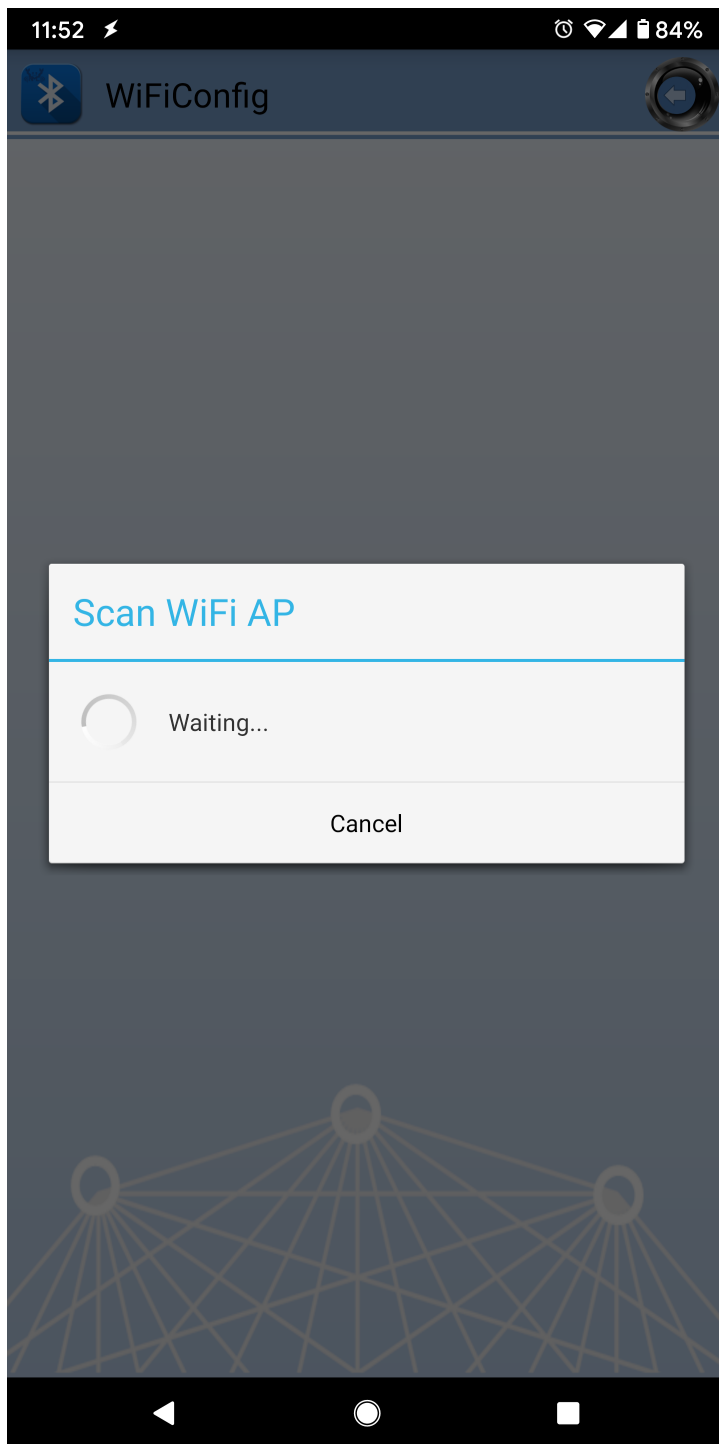
Upload the code and press the reset button on Ameba once the upload is finished.

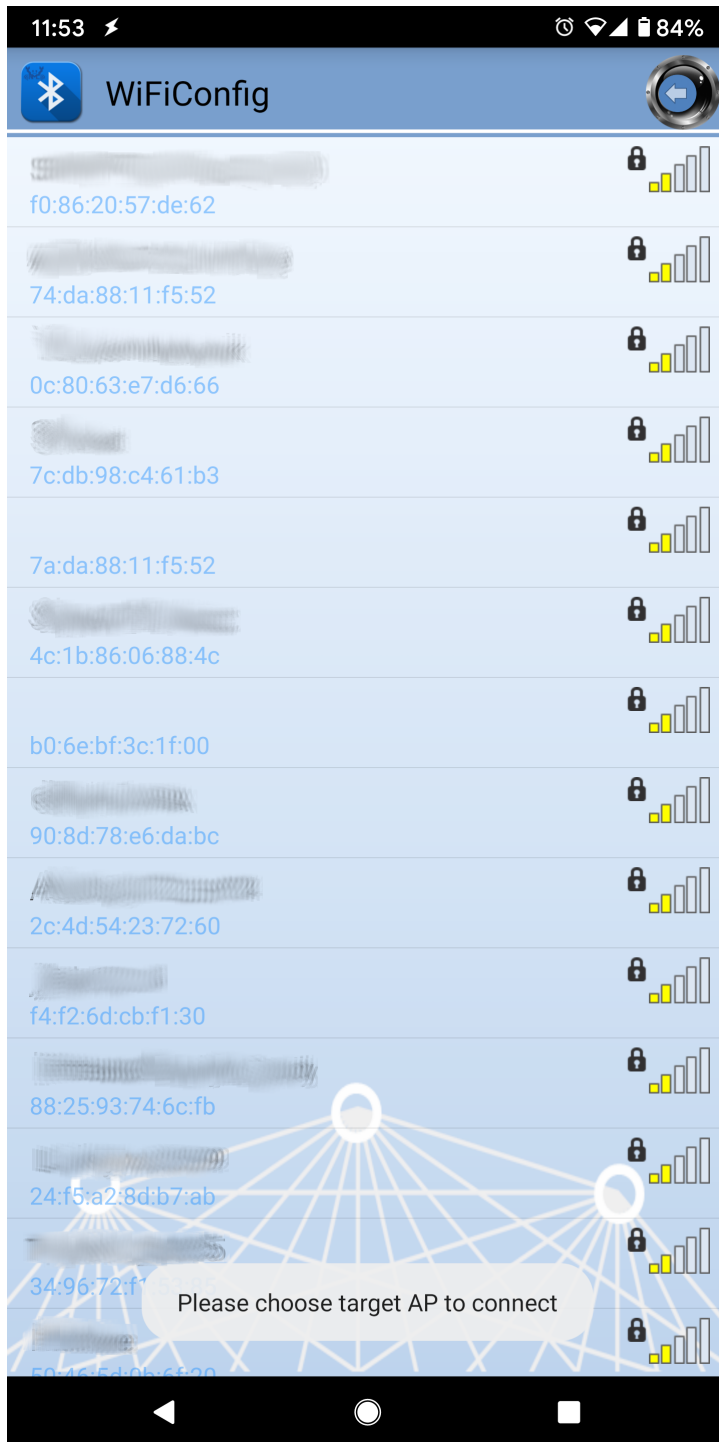
On your mobile phone, open the Realtek WiFiConfig app and tap the round button to scan for Ameba boards.



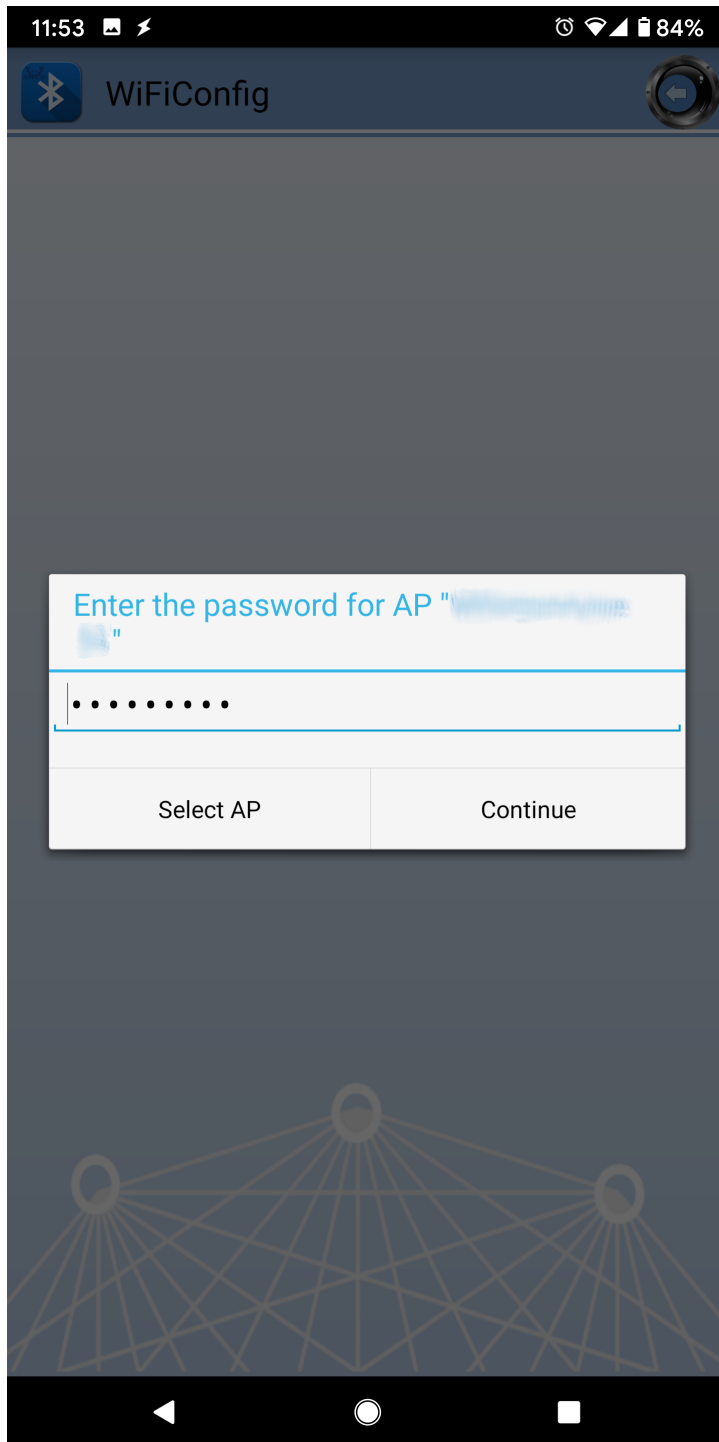
Select the correct Ameba board from the scan results. The app will connect to the Ameba board and ask the board to scan for WiFi networks and send the scan results back to the app using BLE.



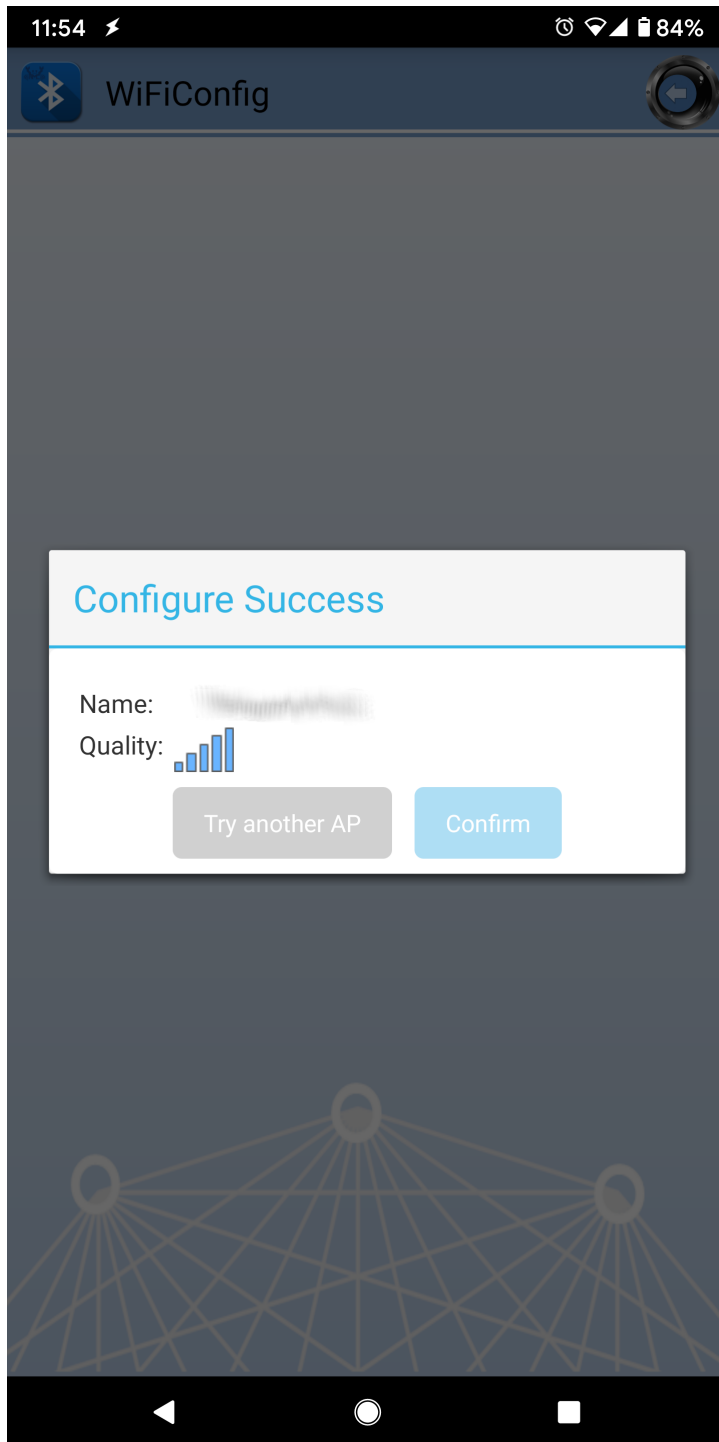




If your phone is currently connected to a WiFi network, the app will ask for the WiFi password to connect the Ameba board to the same WiFi network. Tap “Select AP” to choose another WiFi network, or enter the password and tap continue to connect Ameba to the selected WiFi network.



After the Ameba board connects to the WiFi network, the following message will be shown. Tap “Try another AP” to connect to another WiFi network or tap “Confirm” to keep the current WiFi network and disconnect BLE from the Ameba board.



### Code Reference

BLEWifiConfigService is used to create an instance of the WiFi configuration service to run on the Bluetooth device.

`BLE.configAdvert() -> setAdvType(configService.advData())` is used to set the correct advertisement data necessary for the phone app to find the Ameba Bluetooth device.

## BLE –BLE UART Client

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

### Example

#### Introduction

In this example, two RTL8722 boards are connected using BLE. One board runs a BLE UART service, while the other connects to the service using a client and both boards are able to communicate with text messages over the UART service.

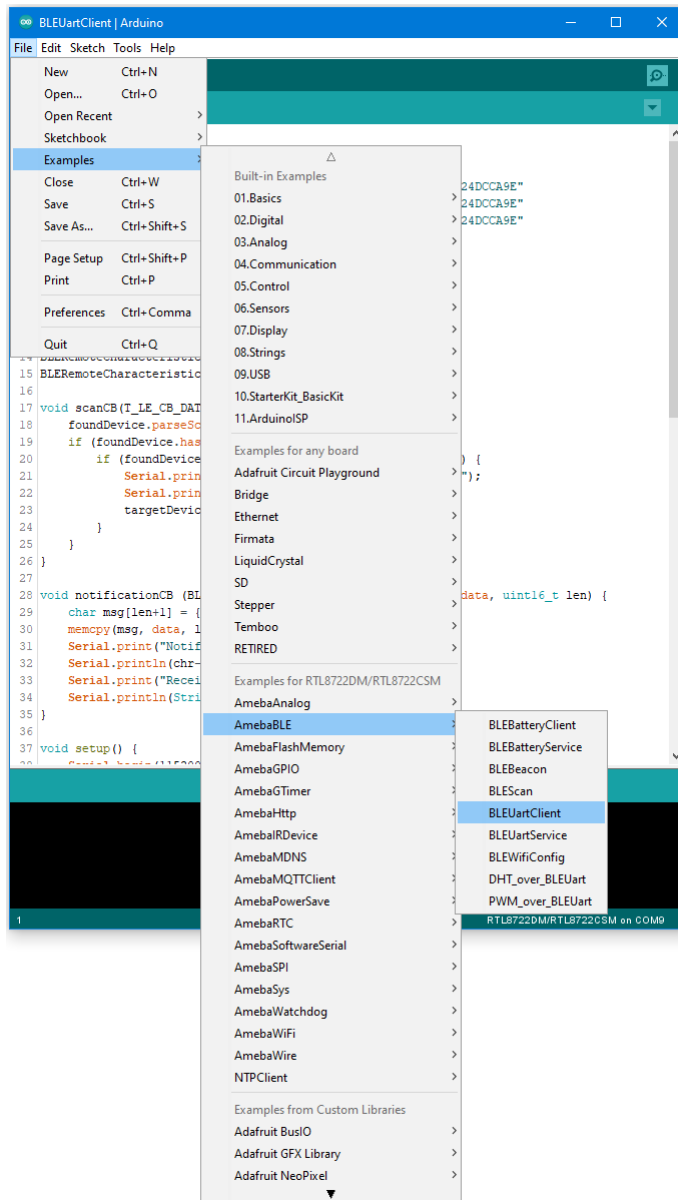
#### Procedure

On the first board, upload the BLE UART service example code. Refer to the example guide for detailed instructions.

For the second board, open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEUartClient”

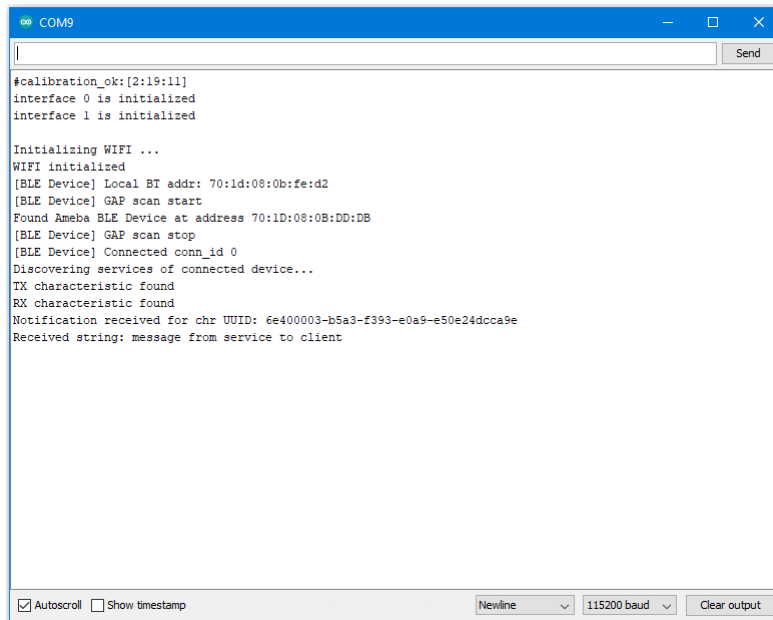
.





Upload the code and press the reset button on Ameba once the upload is finished.

Reset the UART service board first, wait for the BLE advertisement process to begin, and reset the UART client board. The client board should scan, discover, and connect to the service board. After connecting, the client board will verify that the correct UART service exists on the service board, before enabling notifications on the TX characteristic. Any message typed in the serial terminal will be sent to the other board using the UART service.



```
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:fe:d2
[BLE Device] GAP scan start
Found Ameba BLE Device at address 70:1D:08:0B:DD:DB
[BLE Device] GAP scan stop
[BLE Device] Connected conn_id 0
Discovering services of connected device...
TX characteristic found
RX characteristic found
Notification received for chr UUID: 6e400003-b5a3-f393-e0a9-e50e24dcca9e
Received string: message from service to client
```

## Code Reference

The `BLEClient` class is used to discover the services that exist on a connected BLE device. The discovery process will create `BLERemoteService`, `BLERemoteCharacteristic` and `BLERemoteDescriptor` objects corresponding to the services, characteristics and descriptors that exist on the connected device. These objects can then be used to read and write data to the connected device.

## BLE –BLE UART Service

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Android / iOS smartphone

### Example

#### Introduction

With BLE, application data is sent and received using the GATT system. GATT uses services, characteristics, and attributes to organise data and control how the data can be read from and written to. The Bluetooth SIG specification for BLE includes several predefined services for common applications, but users are free to implement custom services and characteristics to best fit their data structure and application needs

In this example, the `BLEService` and `BLECharacteristic` classes are used to implement a custom service for transmitting ASCII characters similar to regular UART. This custom service is the Nordic UART Service, which is supported in several smartphone apps.

## Procedure

Ensure that a compatible BLE UART app is installed on your smartphone, it is available at:

–Google Play Store:

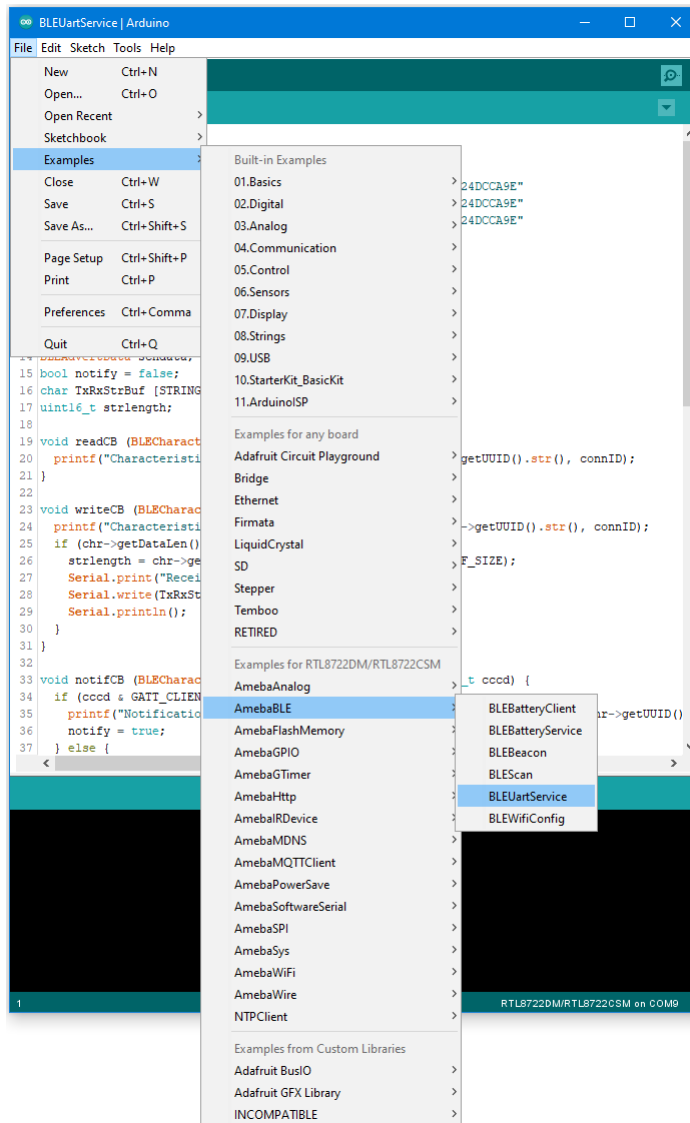
<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connect>

[https://play.google.com/store/apps/details?id=de.kai\\_morich.serial\\_bluetooth\\_terminal](https://play.google.com/store/apps/details?id=de.kai_morich.serial_bluetooth_terminal)

–Apple App Store:

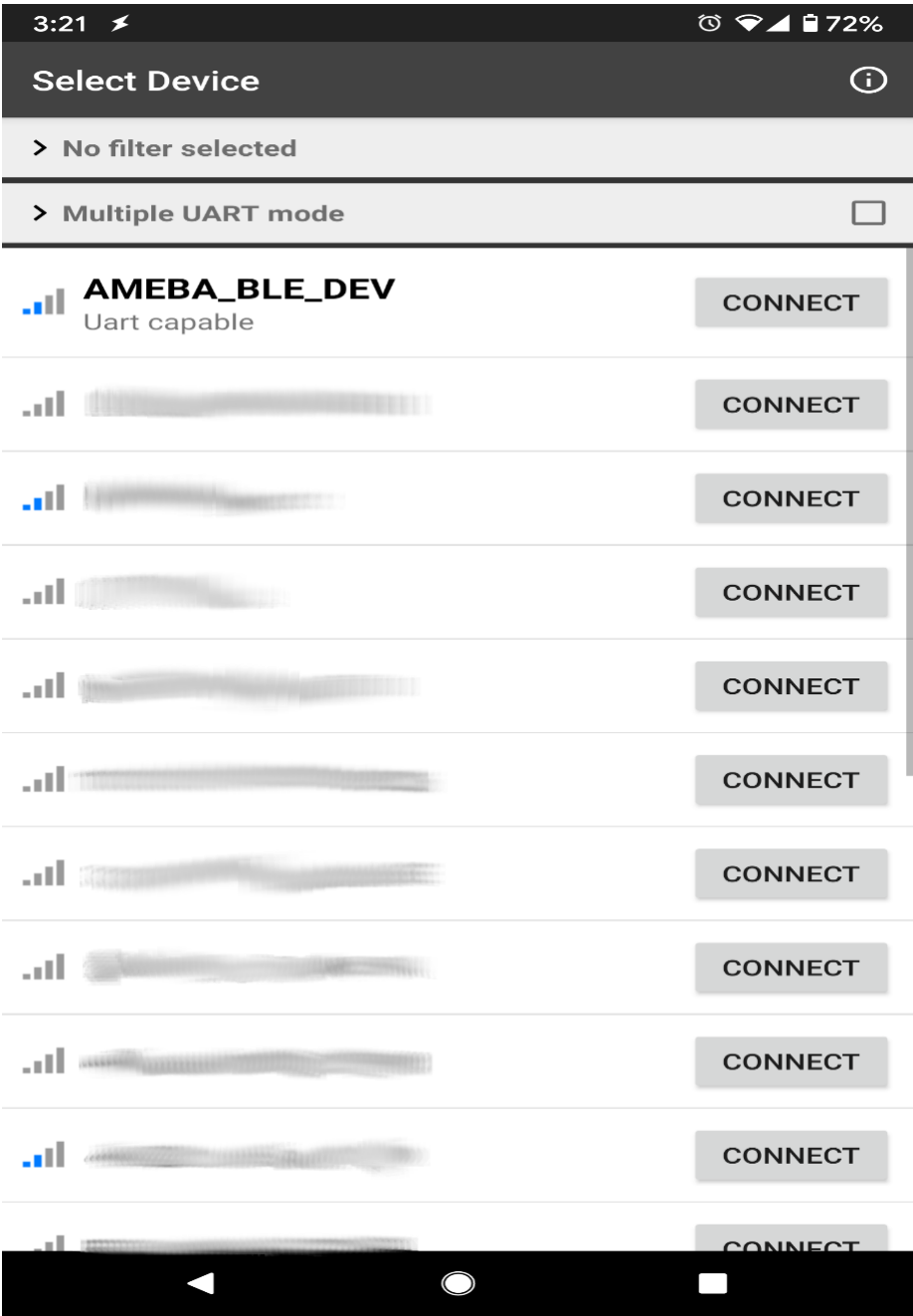
<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

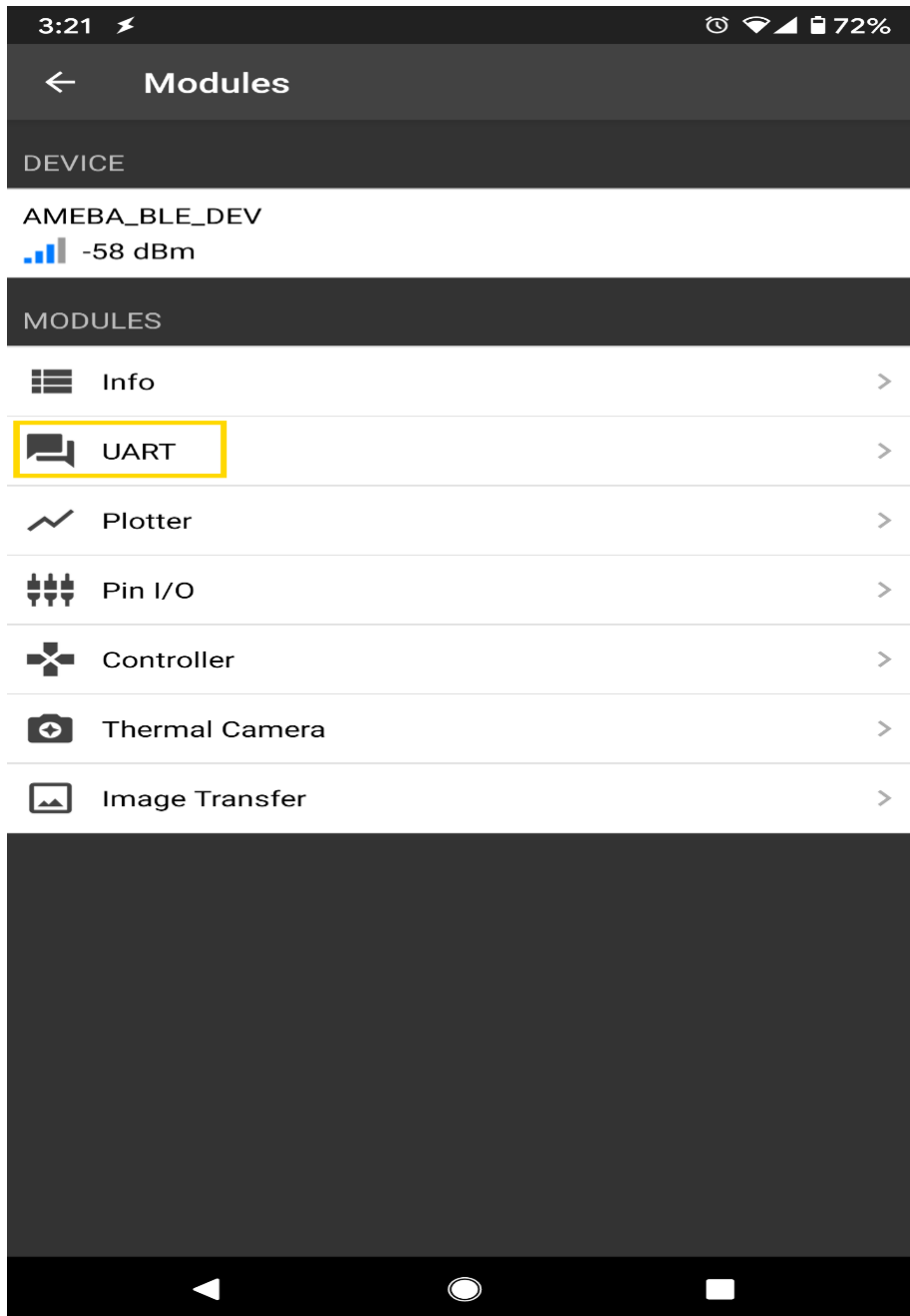
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “BLEUartService” .



Upload the code and press the reset button on Ameba once the upload is finished.

Open the app on your smartphone, scan and connect to the Ameba board shown as “AMEBA\_BLE\_DEV” and choose the UART function in the app. Note that the BLE UART service on the Ameba board will only work with the UART and Plotter functions in the Bluefruit Connect app, other functions (Pin I/O, Image Transfer) require other BLE services that are not included in this example.





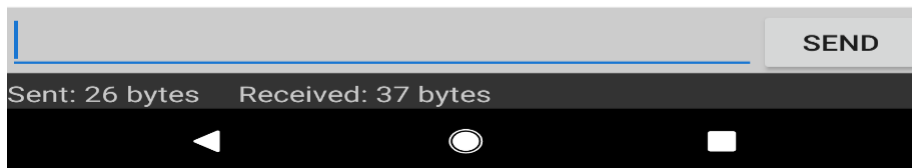
In the UART terminal section of the app, enter a message and click send. You should see the message appear in the Arduino serial monitor.

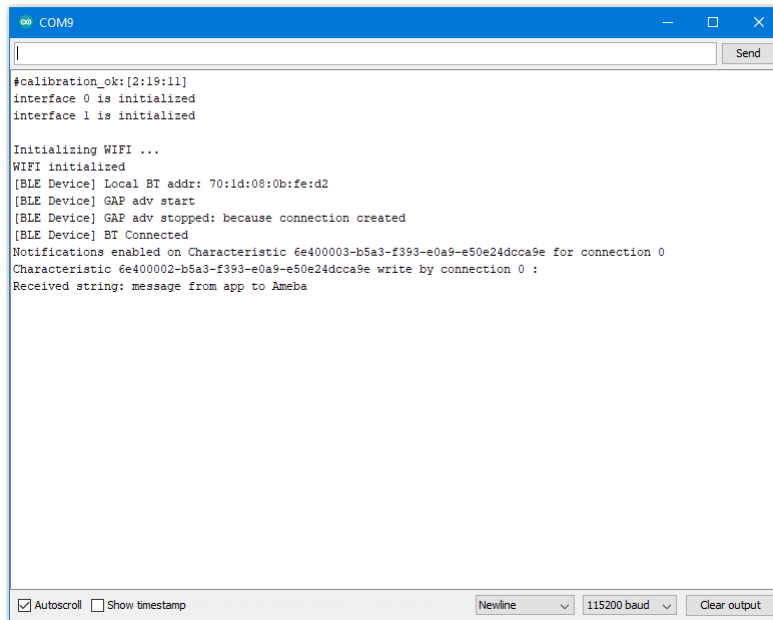
In the Arduino serial monitor, enter a message and click send. The message will appear in the smartphone app.



**message from app to Ameba**

message from Ameba to smartphone app





```
#calibration_ok:[2:19:11]
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
[BLE Device] Local BT addr: 70:1d:08:0b:ferd2
[BLE Device] GAP adv start
[BLE Device] GAP adv stopped: because connection created
[BLE Device] BT Connected
Notifications enabled on Characteristic 6e400003-b5a3-f393-e0a9-e50e24dcca9e for connection 0
Characteristic 6e400002-b5a3-f393-e0a9-e50e24dcca9e write by connection 0 :
Received string: message from app to Ameba
```

## Code Reference

The `BLECharacteristic` class is used to create two characteristics, one for receive (Rx) and one for transmit (Tx), and added to a service created with the `BLEService` class.

The required read/write/notify properties are set for each characteristic using the `set__Property()` methods, and callback functions are registered using the `set__Callback()` methods. The required buffer size is also set for each characteristic so that it has enough memory to store a complete string.

When data is written to the receive characteristic, the registered callback function is called, which prints out the received data as a string to the serial monitor.

When data is received on the serial port, it is copied into the transmit characteristic buffer, and the `notify()` method is used to inform the connected device of the new data.

## BLE –DHT over BLE UART

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21
- Android / iOS smartphone



## Example

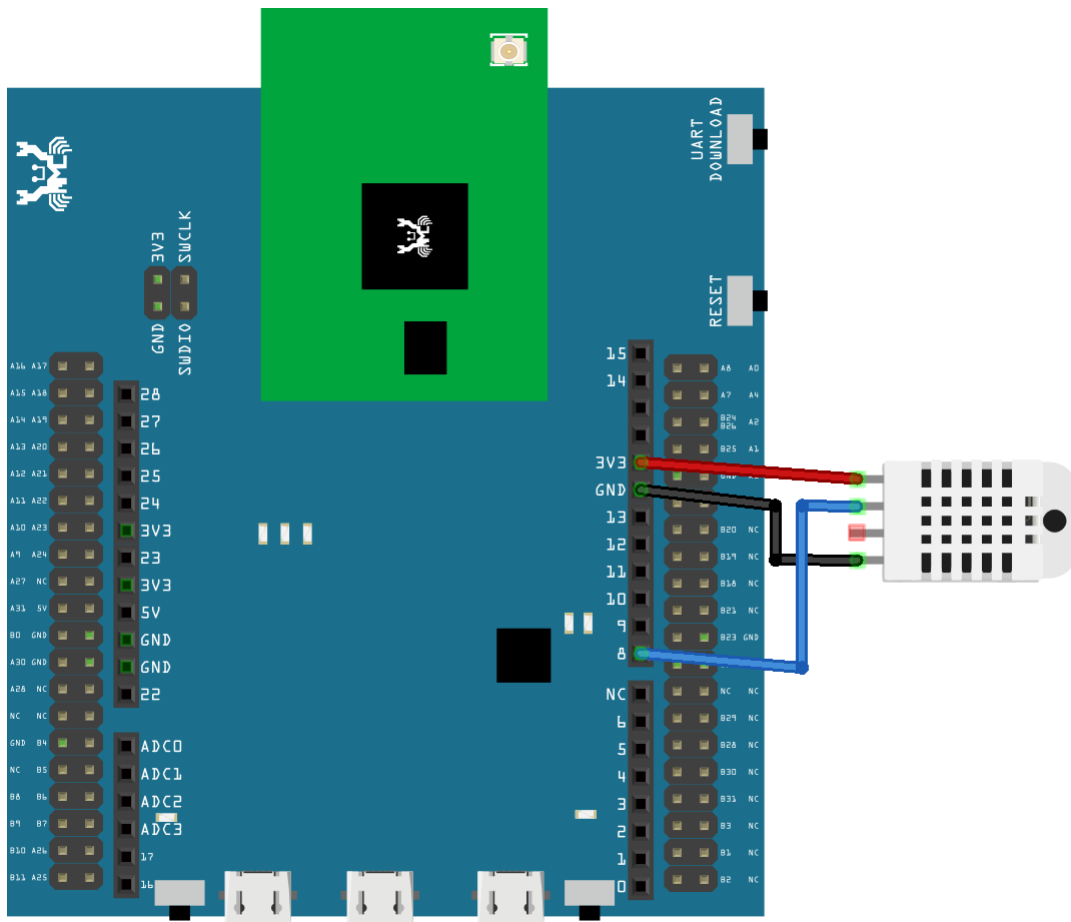
### Introduction

In this example, the data obtained from a DHT temperature and humidity sensor are transmitted over a BLE UART service to a smartphone. Refer to the other examples for detailed explanations of using the DHT sensor and the BLE UART service.

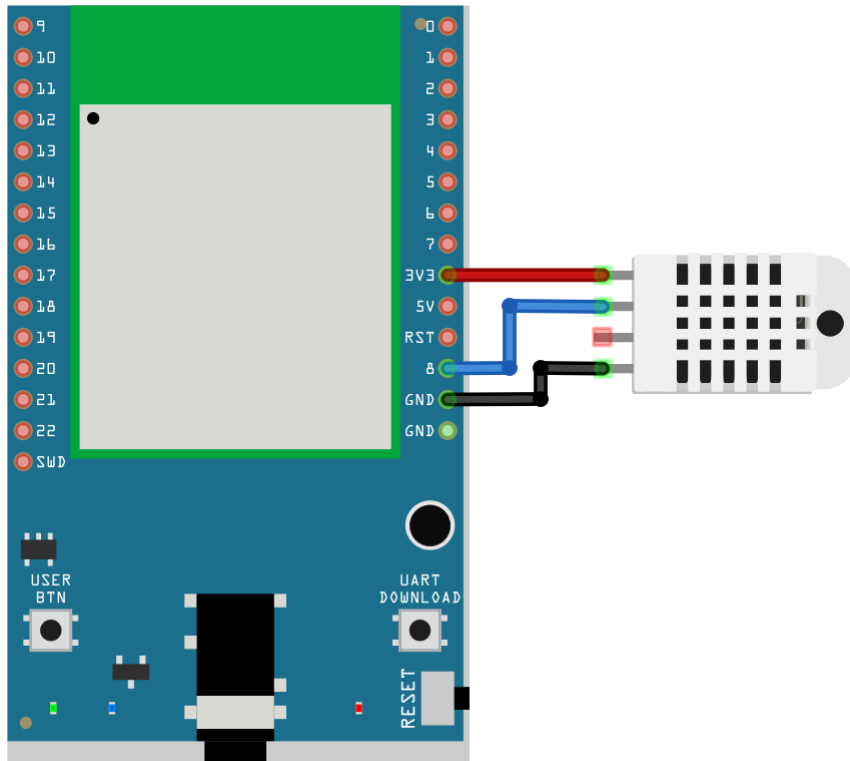
### Procedure

Connect the DHT sensor to the Ameba board following the diagram.

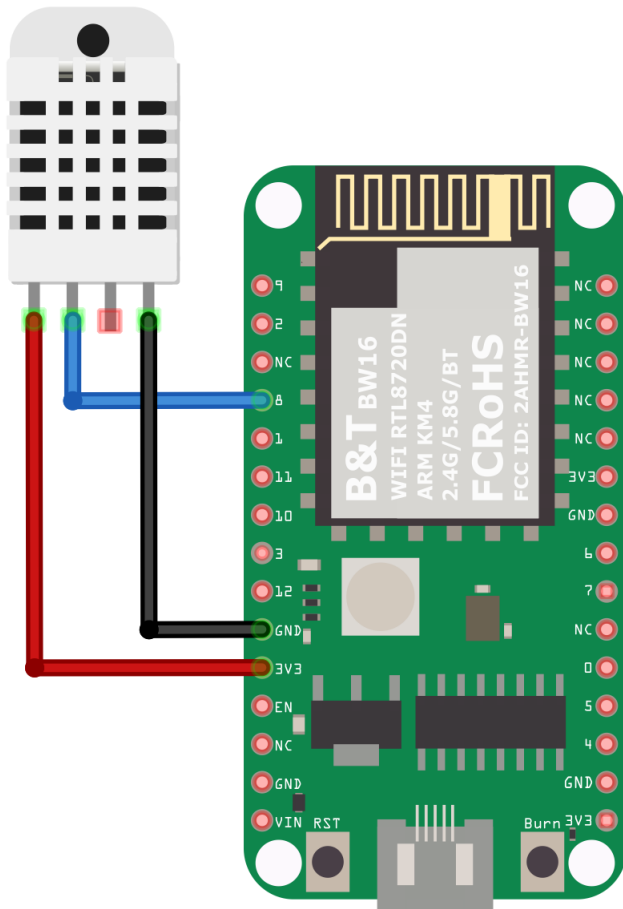
AMB21 / AMB22:



AMB23:



**BW16:**



Ensure that a compatible BLE UART app is installed on your smartphone, it is available at:

- Google Play Store:

<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connecta>  
[https://play.google.com/store/apps/details?id=de.kai\\_morich.serial\\_bluetooth\\_terminal](https://play.google.com/store/apps/details?id=de.kai_morich.serial_bluetooth_terminal)

- Apple App Store:

<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “DHT\_over\_BLEUart” .

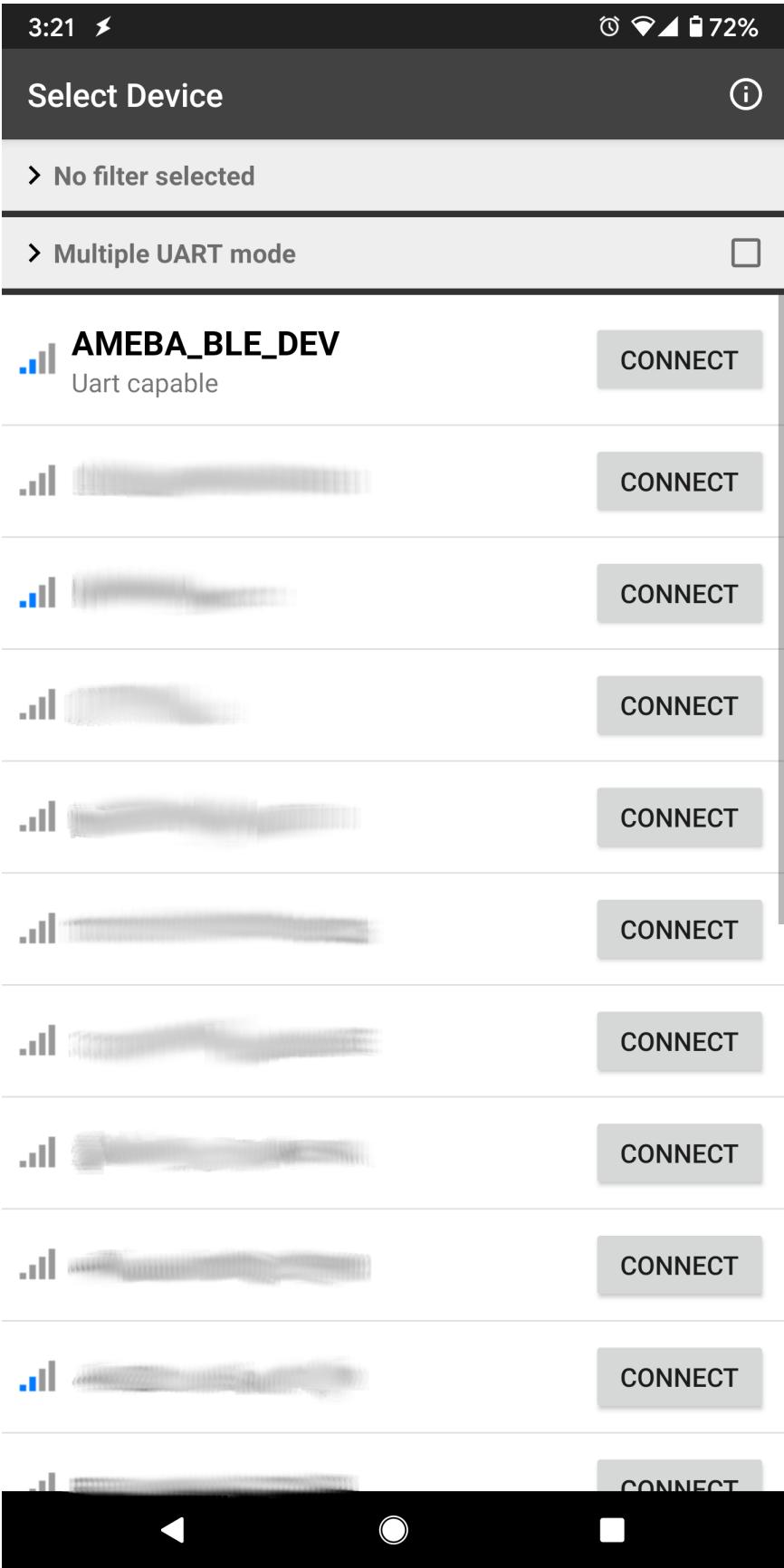
```

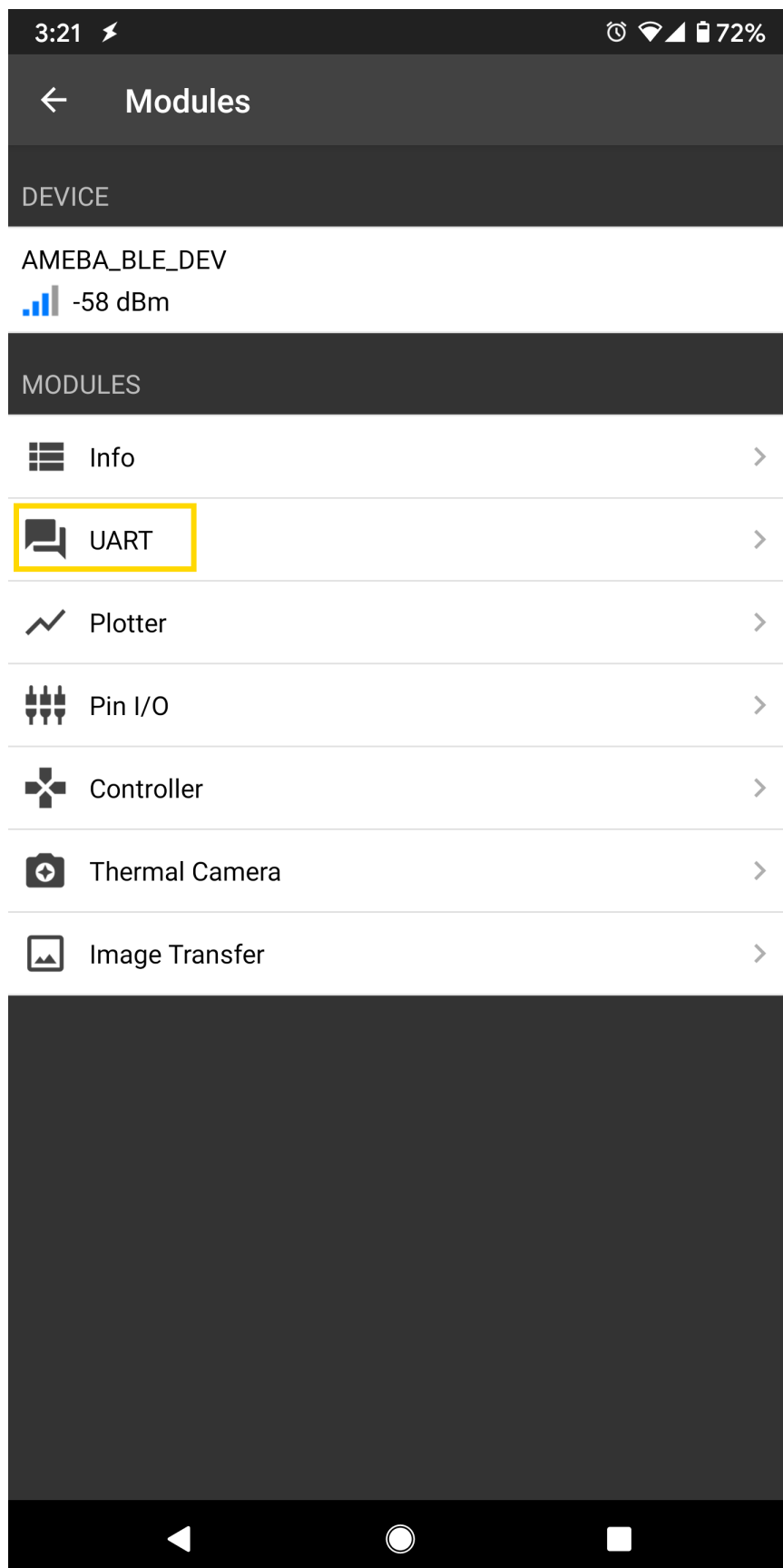
DHT_over_BLEUart
1
2 #include "BLEDevice.h"
3 #include "DHT.h"
4
5 #define UART_SERVICE_UUID    "6E400001-B5A3-F393-E0A9-E50E24DCCA9E"
6 #define CHARACTERISTIC_UUID_RX "6E400002-B5A3-F393-E0A9-E50E24DCCA9E"
7 #define CHARACTERISTIC_UUID_TX "6E400003-B5A3-F393-E0A9-E50E24DCCA9E"
8
9 #define STRING_BUF_SIZE 100
10
11 // The digital pin we're connected to.
12 #define DHTPIN 8
13
14 // Uncomment whatever type you're using!
15 #define DHITYPE DHT11 // DHT 11
16 // #define DHITYPE DHT22 // DHT 22 (AM2302), AM2321
17 // #define DHITYPE DHT21 // DHT 21 (AM2301)
18
19 DHT dht(DHTPIN, DHITYPE);
20
21 BLEService uartService(UART_SERVICE_UUID);
22 BLECharacteristic Rx(CHARACTERISTIC_UUID_RX);
23 BLECharacteristic Tx(CHARACTERISTIC_UUID_TX);
24 BLEAdvertData advdata;
25 BLEAdvertData scndata;
26 bool notify = false;
27 char TxRxStrBuf [STRING_BUF_SIZE] = {0};
28 uint16_t strlength;
29
30 void writeCB (BLECharacteristic* chr, uint8_t connID) {
31     printf("Characteristic %s write by connection %d :\n", chr->getUUID().str(), connID);
32     if (chr->getDataLen() > 0) {
33         strlength = chr->getData((uint8_t*)TxRxStrBuf, STRING_BUF_SIZE);
34         Serial.print("Received string: ");
35         Serial.write(TxRxStrBuf, strlength);
36         Serial.println();
37     }
38 }
39
40 void notifCB (BLECharacteristic* chr, uint8_t connID, uint16_t cccd) {
41     if (cccd & GATT_CLIENT_CHAR_CONFIG_NOTIFY) {
42         printf("Notifications enabled on Characteristic %s for connection %d\n", chr->getUUID().str(), connID);
43     }
44 }

```

Upload the code and press the reset button on Ameba once the upload is finished.

Open the app on your smartphone, scan and connect to the Ameba board shown as “AMEBA\_BLE\_DEV” and choose the UART function in the app.

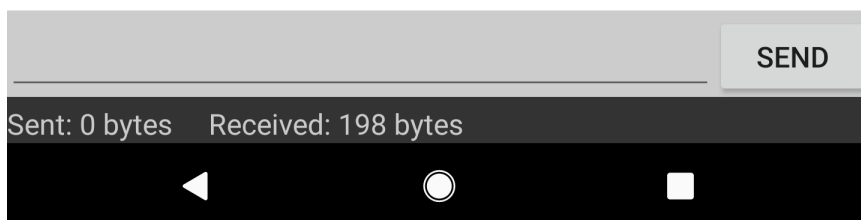




After starting the UART function, notifications should be received every 5 seconds containing the measured temperature and humidity.



Humidity: 59% Temperature: 27°C  
Humidity: 59% Temperature: 27°C  
Humidity: 62% Temperature: 27°C  
Humidity: 67% Temperature: 27°C  
Humidity: 69% Temperature: 27°C  
Humidity: 88% Temperature: 27°C





## BLE –PWM over BLE UART

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- RGB LED
- Android / iOS smartphone

### Example

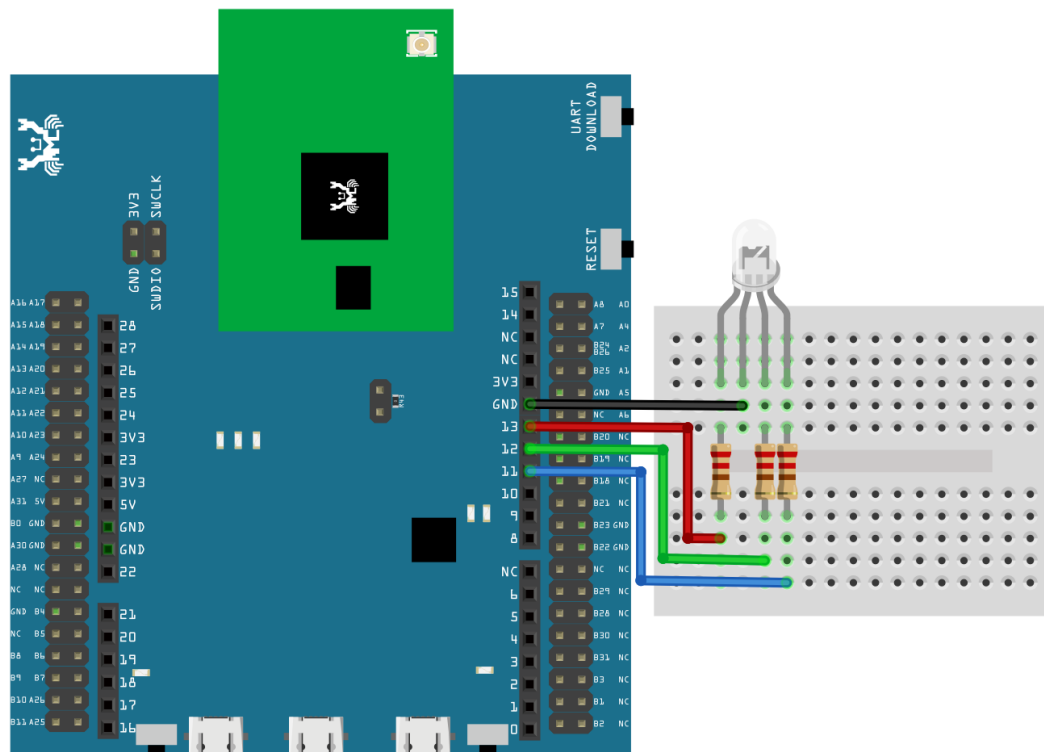
#### Introduction

In this example, a smartphone app is used to transmit commands over BLE UART to control the PWM outputs and change the color of a RGB LED. Refer to the other example guides for detailed explanations of the BLE UART service.

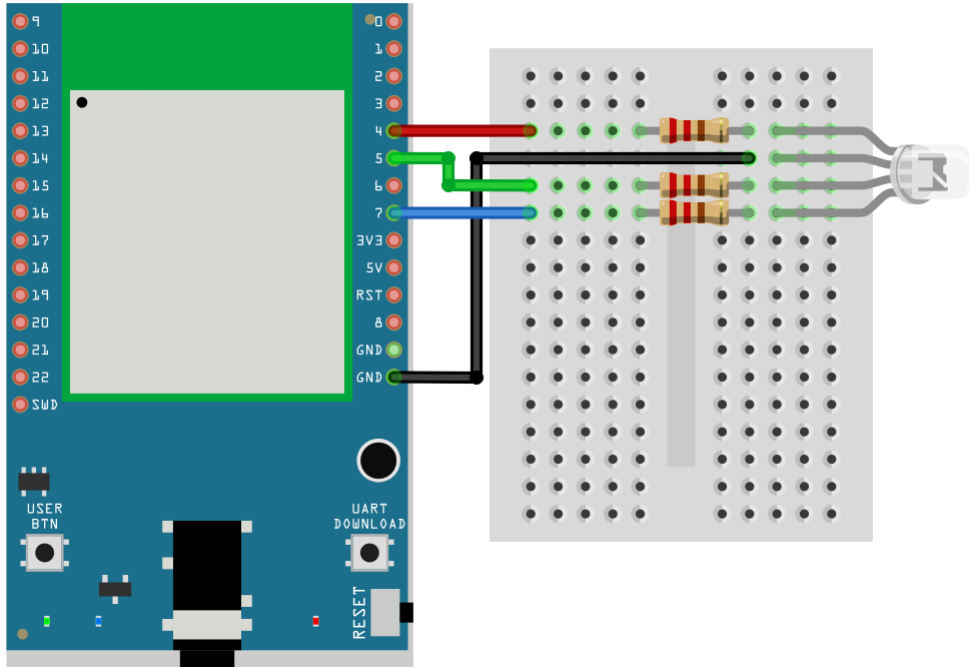
#### Procedure

Connect the RGB LED to the RTL8722 board following the diagram, the common LED pin may need to connect to 3.3V or GND depending on the type of LED (common anode / common cathode).

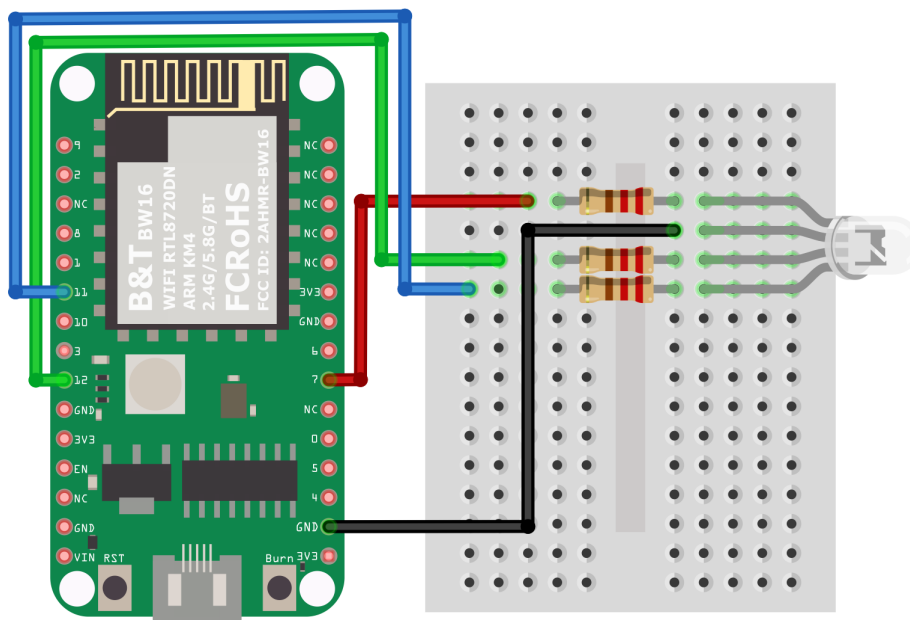
#### AMB21 /AMB22:



## AMB23:



## BW16:



Ensure that the required app is installed on your smartphone, it is available at:

–Google Play Store:

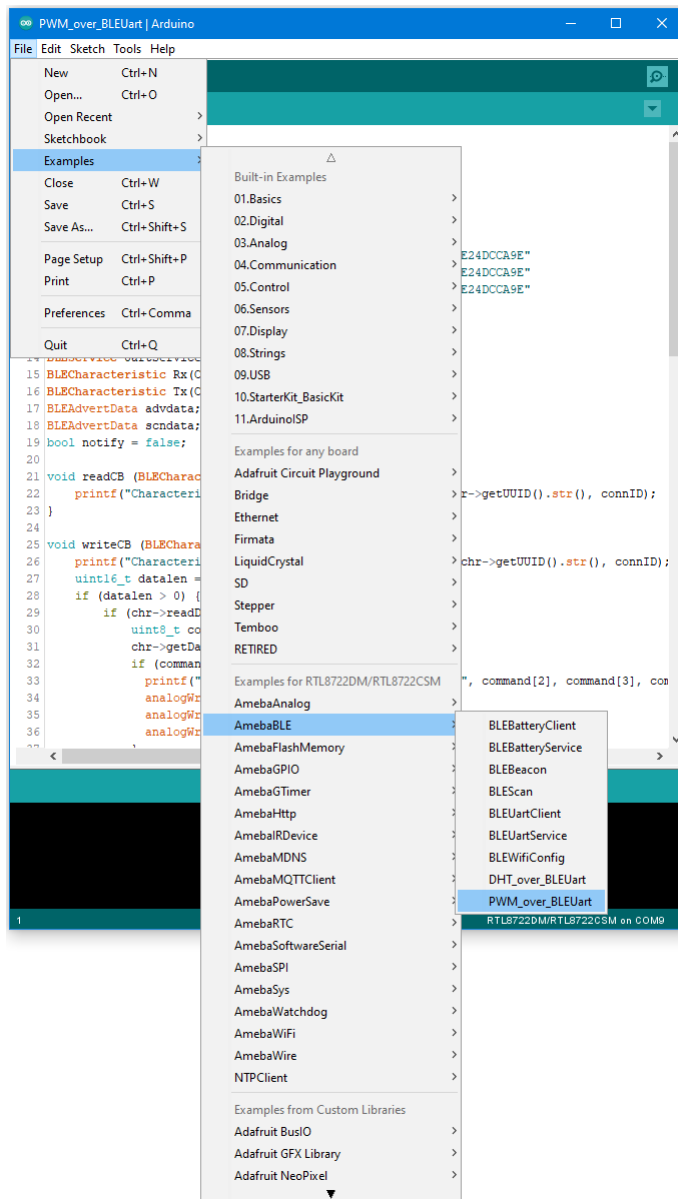
<https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connect>

–Apple App Store:

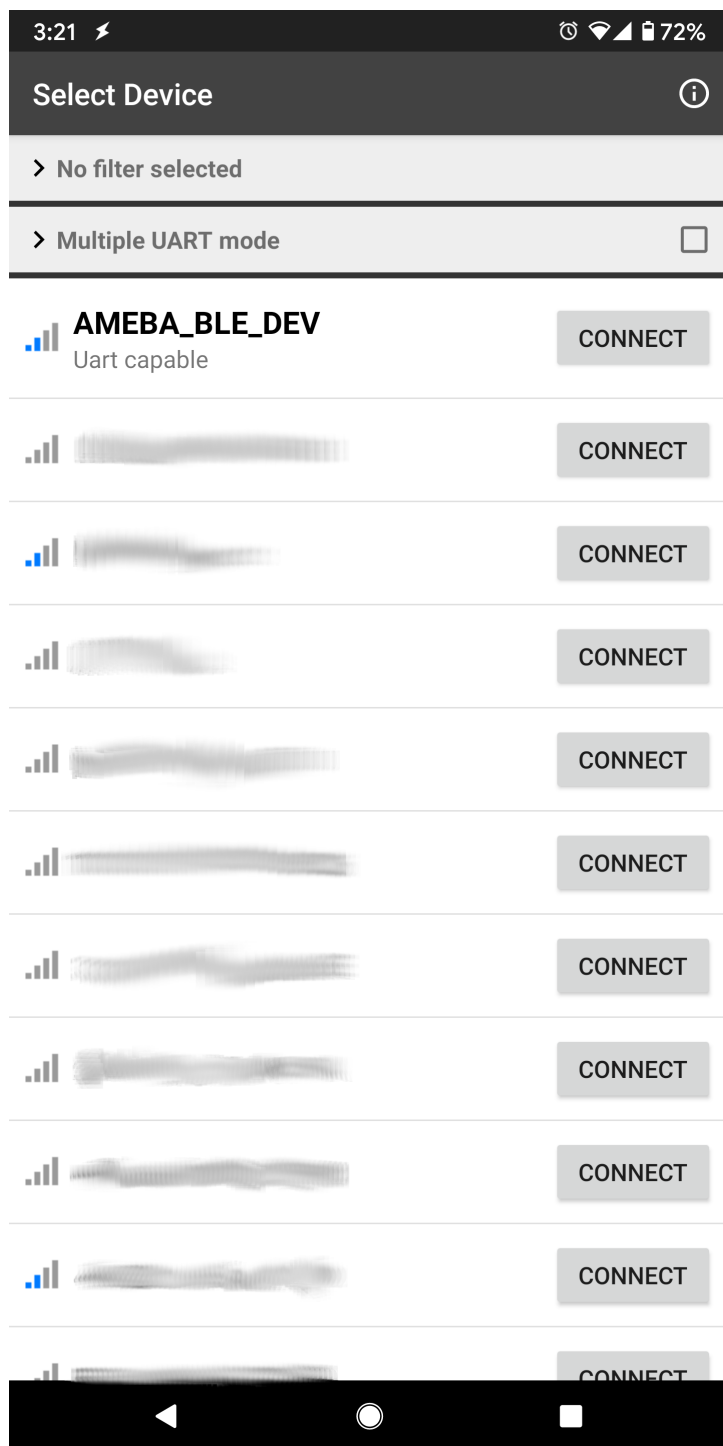
<https://apps.apple.com/us/app/bluefruit-connect/id830125974>

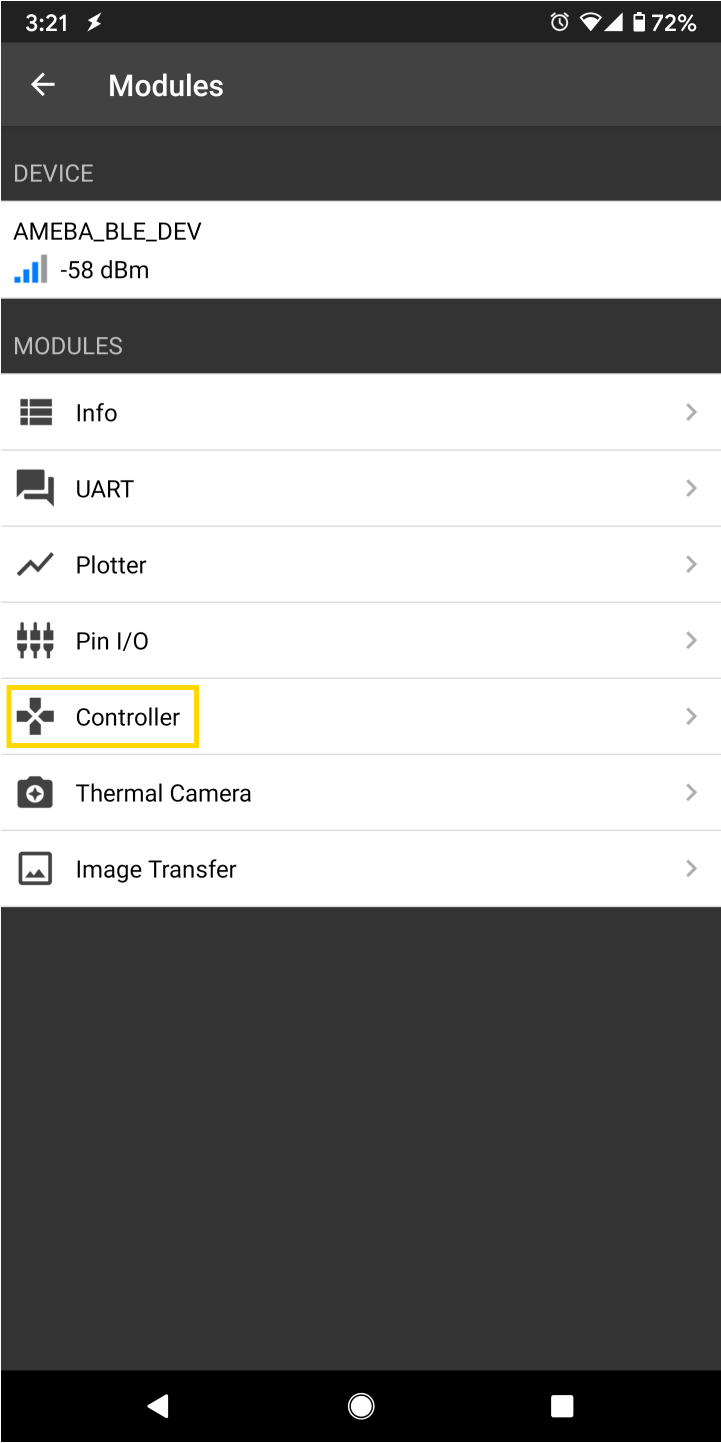
Open the example, “Files” -> “Examples” -> “AmebaBLE” -> “PWM\_over\_BLEUart” .

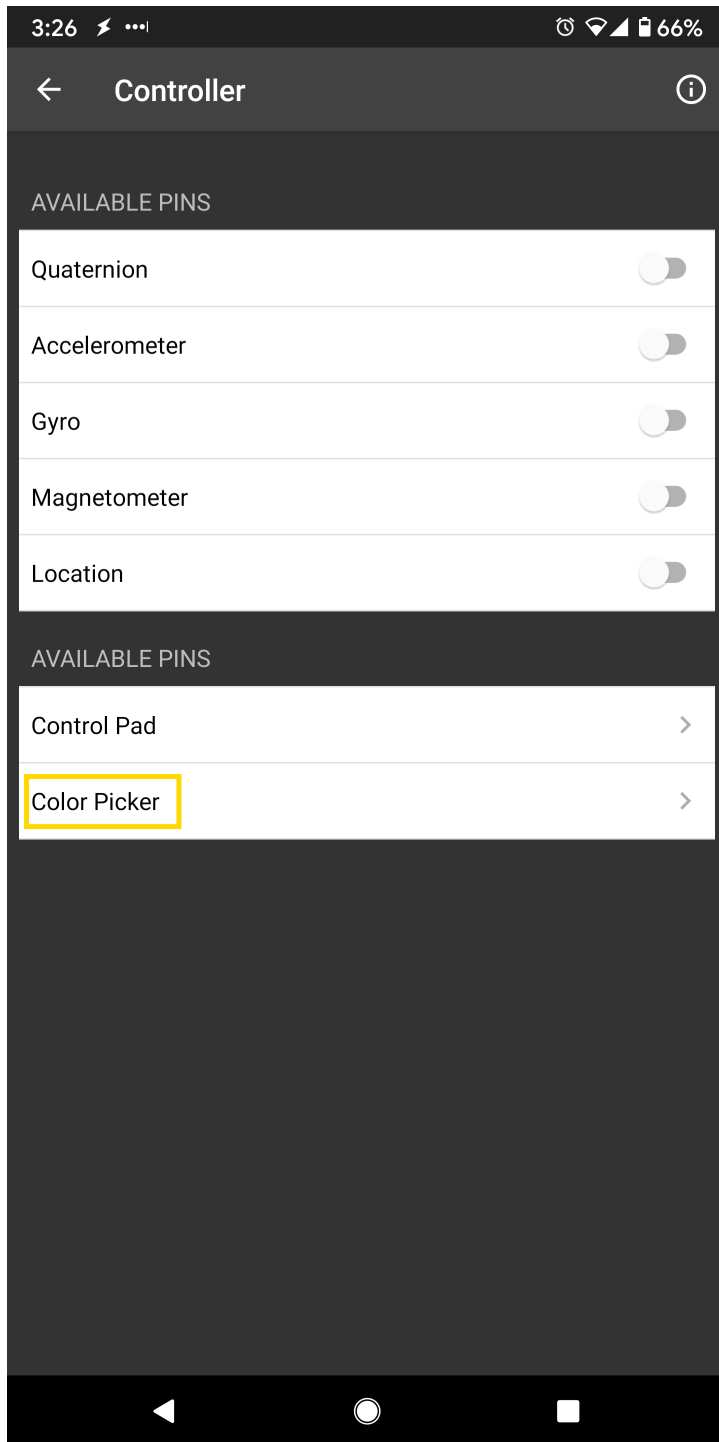
Upload the code and press the reset button on Ameba once the upload is finished.



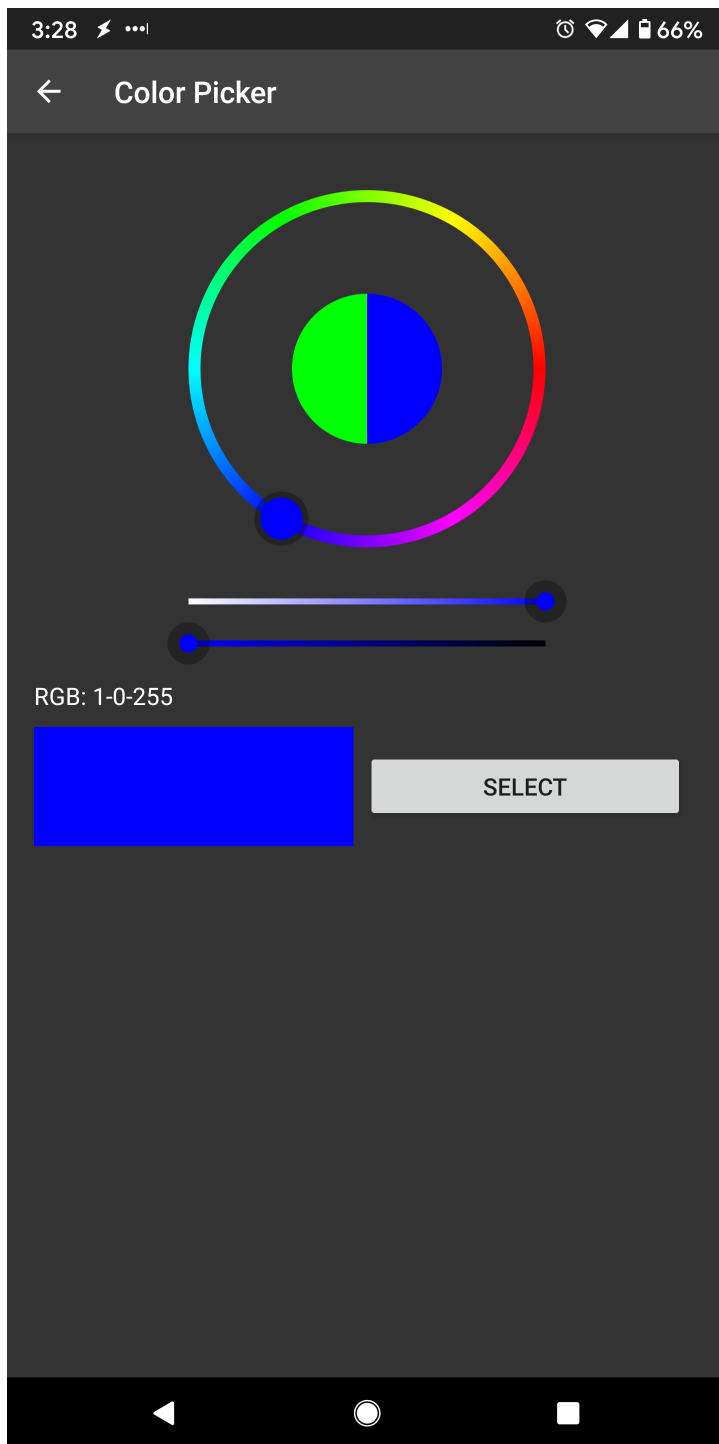
Open the app on your smartphone, scan and connect to the board shown as “AMEBA\_BLE\_DEV” and choose the controller -> color picker function in the app.







Using the color selection wheel, saturation, and brightness sliders, choose a desired color and click select to send the RGB values to the board. You should see the RGB LED change to the matching color.



### Code Reference

The RGB values are sent as three consecutive bytes prefixed by “!C” characters. The “!” exclamation mark is used to indicate that the following data is a command, and the “C” character is used to indicate that the data is RGB values. The received UART message is checked in the callback function for “!C” first, otherwise it is treated as a regular message

and printed to the serial terminal.

## HTTP - Retrieve HTTP websites from the Internet

### Materials

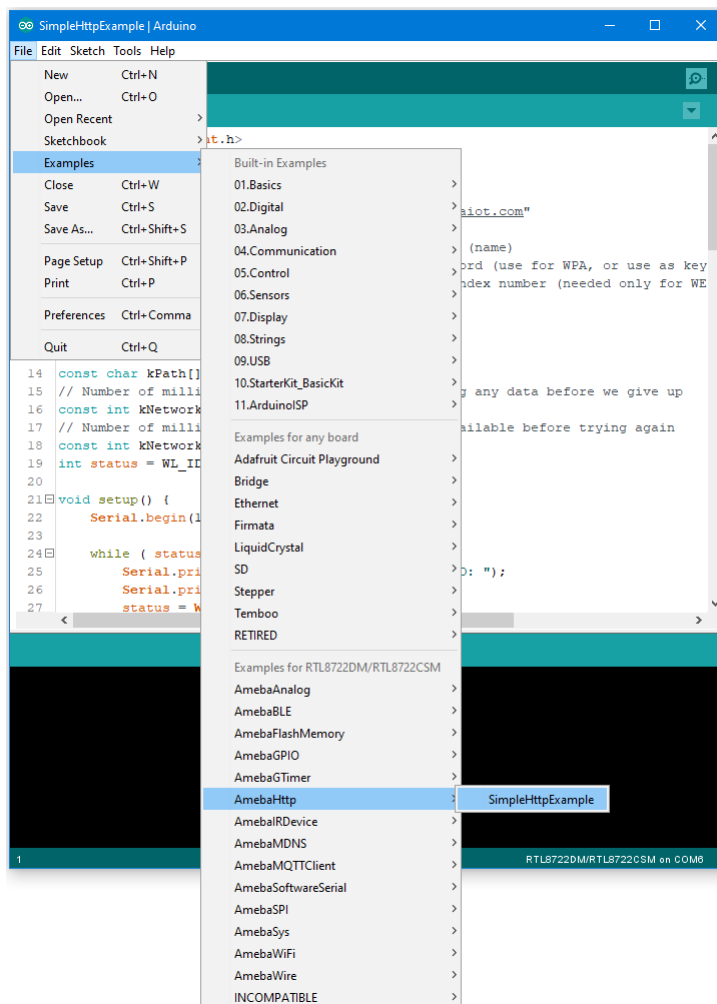
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, the HttpClient library is used to retrieve a webpage using the HTTP protocol.

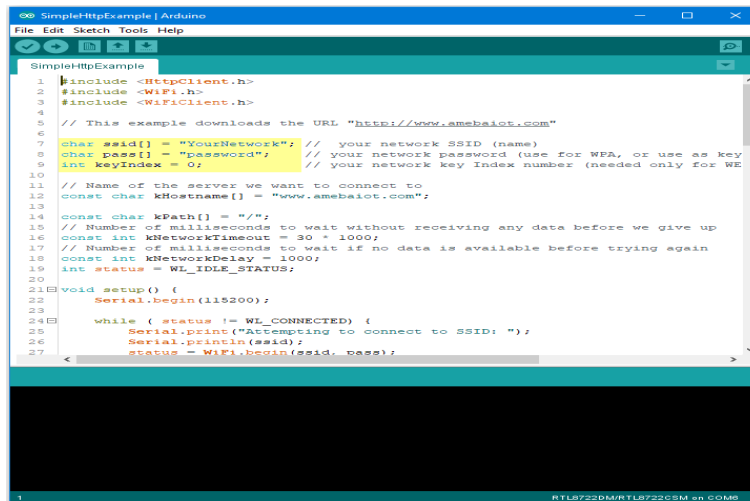
First, make sure that the correct Ameba development board is selected in “Tools” -> “Board”

Then open “File” -> “Examples” -> “AmebaHttp” -> “SimpleHttpExample”





In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.

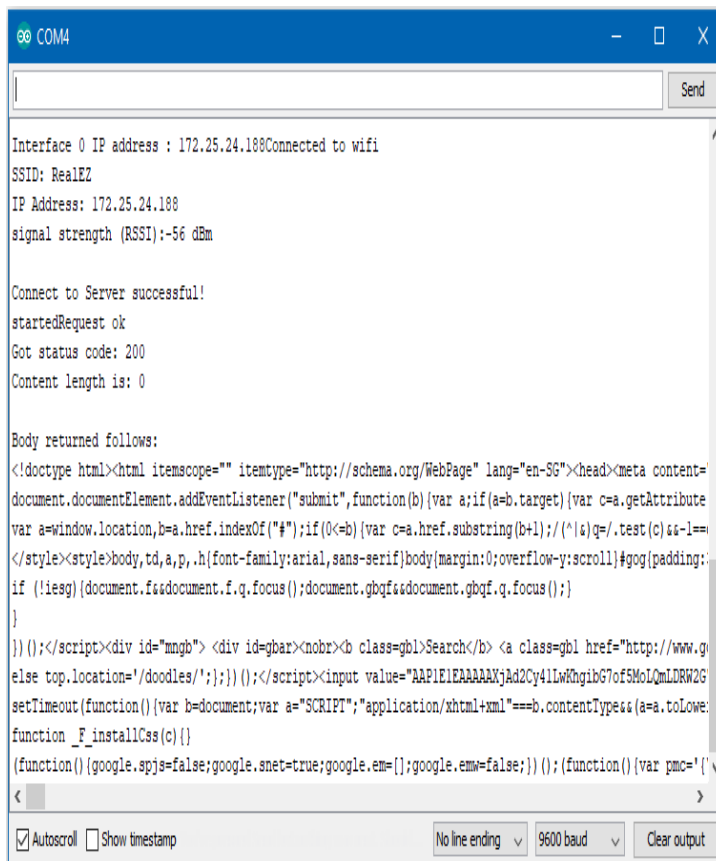


```

SimpleHttpExample
1 #include <HttpClient.h>
2 #include <WiFi.h>
3 #include <WiFiClient.h>
4
5 // This example downloads the URL "http://www.amebacloud.com"
6
7 char ssid[] = "YourNetwork"; // your network SSID (name)
8 char pass[] = "password"; // your network password (use for WPA, or use as key
9 int keyIndex = 0; // your network key Index number (needed only for WE
10
11 // Name of the server we want to connect to
12 const char kHostname[] = "www.amebacloud.com";
13
14 const char kPath[] = "/";
15 // Number of milliseconds to wait without receiving any data before we give up
16 const int kNetworkTimeout = 30 * 1000;
17 // Number of milliseconds to wait if no data is available before trying again
18 const int kNetworkDelay = 1000;
19 int status = WL_IDLE_STATUS;
20
21 void setup() {
22   Serial.begin(115200);
23   while ( status != WL_CONNECTED) {
24     Serial.print("Attempting to connect to SSID: ");
25     Serial.println(ssid);
26     status = WiFi.begin(ssid, pass);
27

```

Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor in the Arduino IDE and you can see the information retrieved from the website.



```

COM4
Interface 0 IP address : 172.25.24.188Connected to wifi
SSID: RealEZ
IP Address: 172.25.24.188
signal strength (RSSI):-56 dBm

Connect to Server successful!
startedRequest ok
Got status code: 200
Content length is: 0

Body returned follows:
<doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en-SG"><head><meta content=
document.documentElement.addEventListener("submit",function(b){var a;if(a=b.target){var c=a.getAttribute
var a=window.location,b=a.href.indexOf("#");if(0<=b){var c=a.href.substring(b+1);/^(\s)*$/g.test(c)}a=l=
</style><style>body,td,a,p,h{font-family:arial,sans-serif}body{margin:0;overflow-y:scroll}#gog{padding:
if (!ieag){document.f=document.f.q.focus();document.gbqf=document.gbqf.q.focus();}
}
})();</script><div id="mnbg"><div id="gbar"><no><b class="gbl">Search</b><a class="gbl" href="http://www.g
else top.location="/doodles/";})();</script><input value="AAPLEIEAAAAKjAd2Cy4LwKhgibG7of5MoLQmLDRW2G
setTimeout(function(){var b=document;var a="SCRIPT";"application/xhtml+xml"===b.contentType&&(a=a.toLow
function _F_installCss(c){
(function(){google.spjs=false;google.snet=true;google.em=[];google.emw=false;})();(function(){var pnc='
<
Autoscroll Show timestamp No line ending 9600 baud Clear output

```

## Code Reference

Use `WiFi.begin()` to establish WiFi connection:

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiClient` to create a client to handle the WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiClient>

Use `HTTPClient` to create a client to handle the HTTP connection.

Use `http.get()` to send a GET request to the website.

## HTTP - Set up Server to Control LED

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Breadboard x 1
- LED x 1
- 1K $\Omega$  Resistor x 1

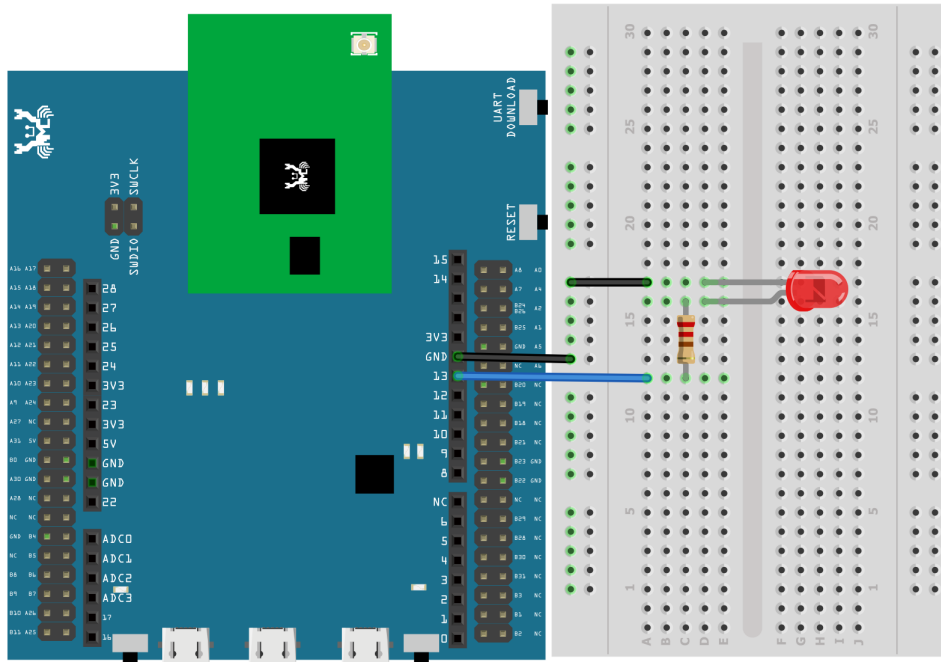
### Procedure

In this example, we connect Ameba to WiFi and use Ameba as server, the user can control the LED on/off through a webpage.

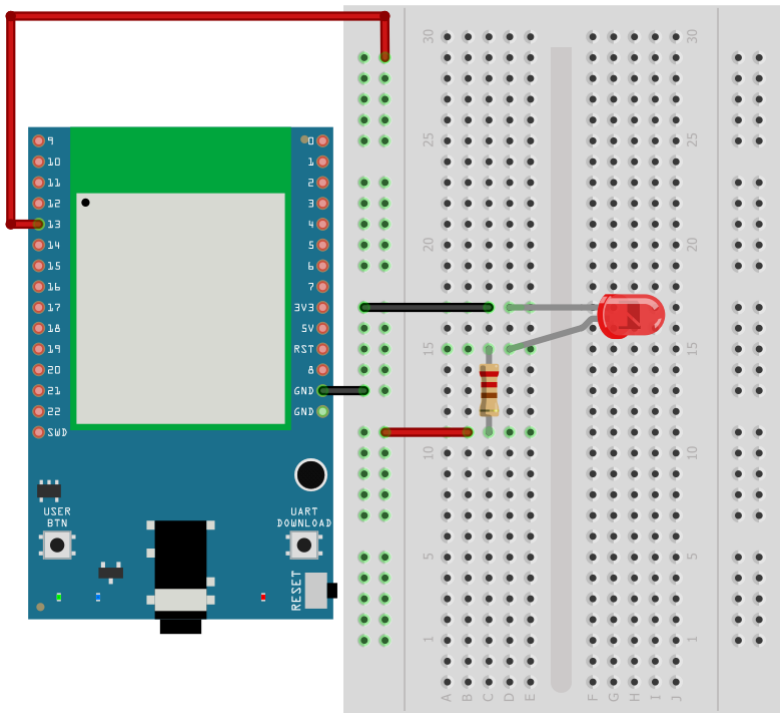
First, connect Ameba with the LED.

In a LED, the longer pin is the positive pole, and the shorter pin is the negative pole. So, we connect the shorter pin to GND and connect the longer pin to D13. Additionally, to avoid the electric current exceeds the tolerance of the LED and causes damage, we connect a resistance on the positive pole.

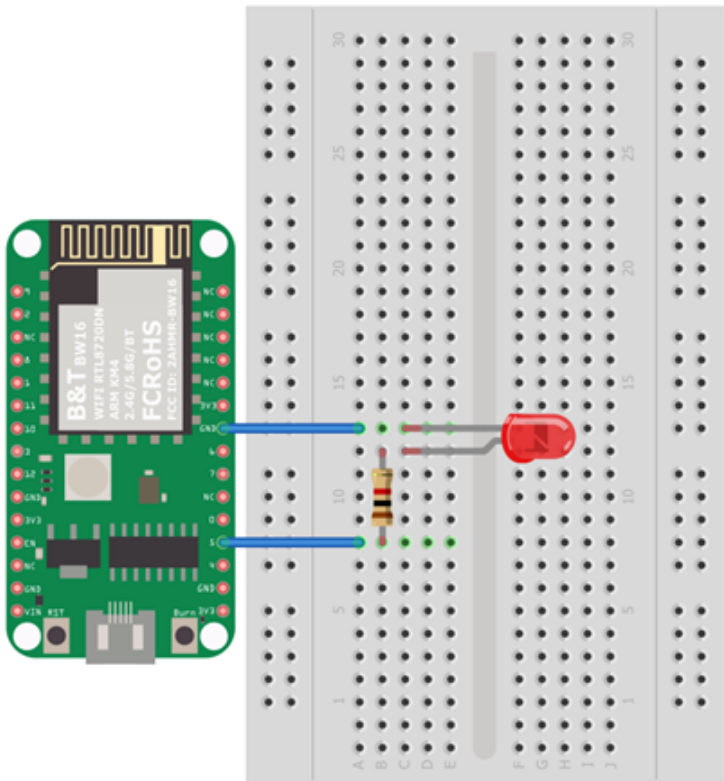
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



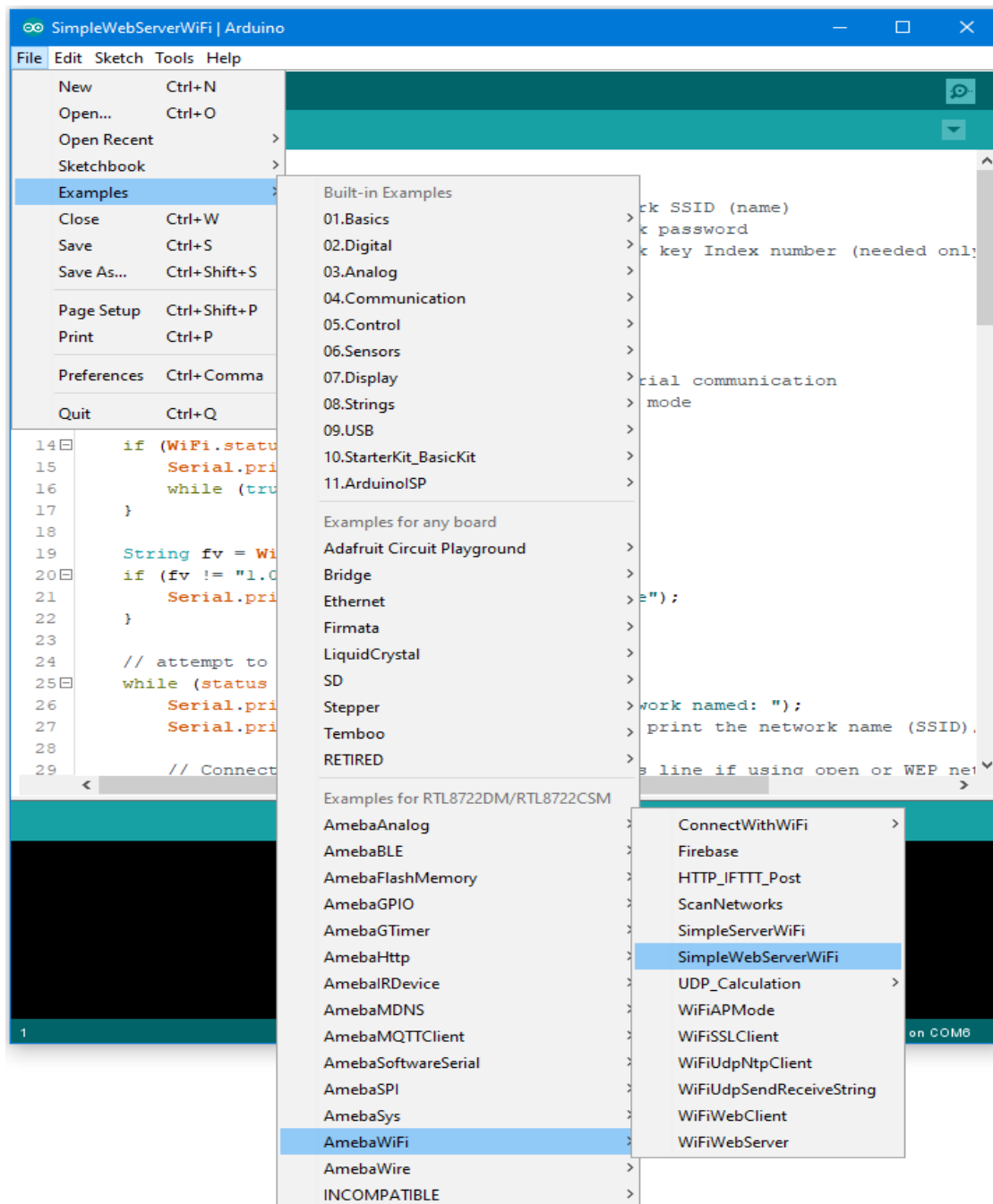
BW16 Wiring Diagram:



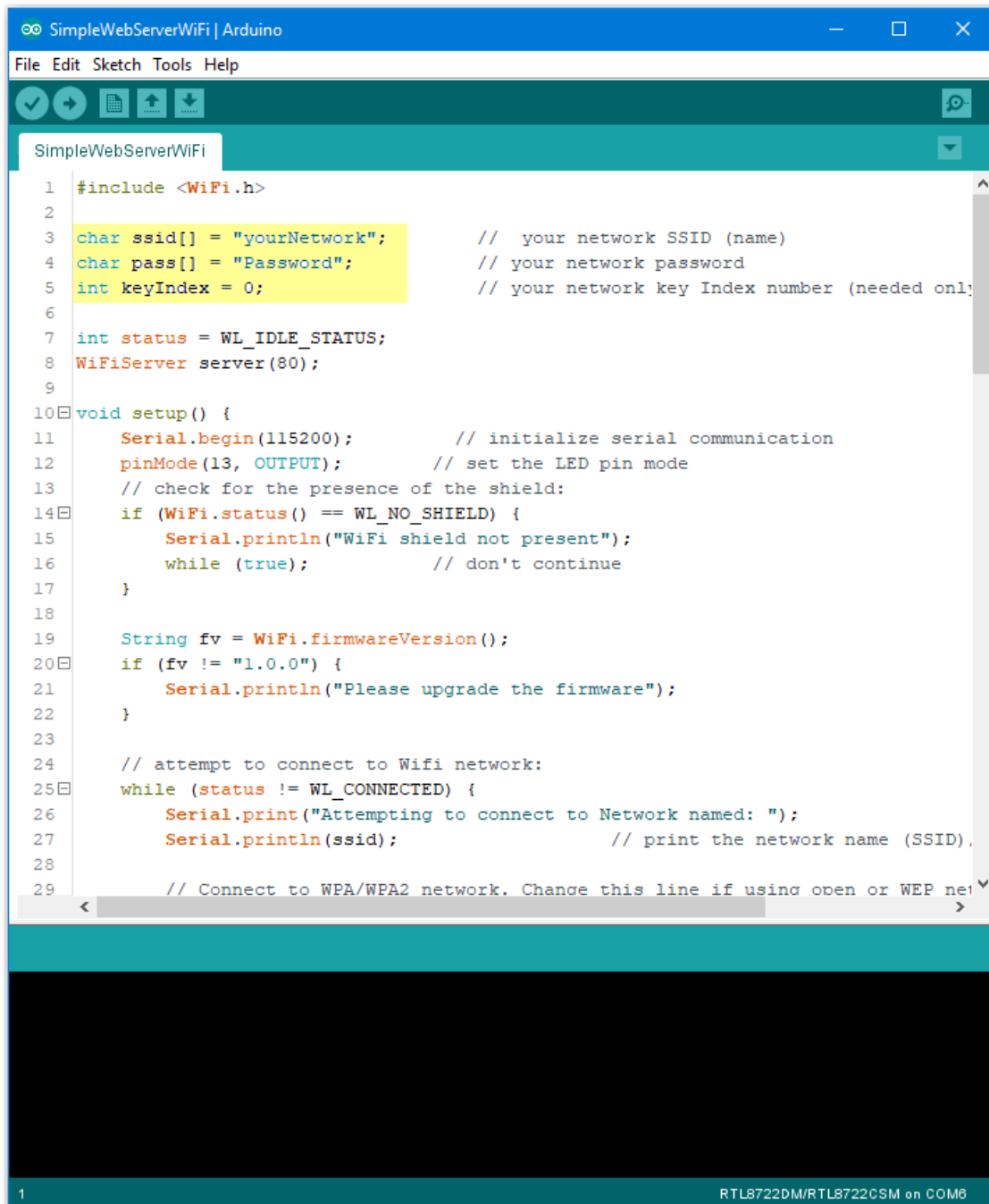
**Note:**

For BW16 board, you may consider to re-define 「LED\_PIN」 macro to **10** for built-in green LED, or **11** for blue built-in LED, or **12** for red built-in LED to avoid using extra components.

Then open “File” -> “Examples” -> “AmebaWiFi” -> “SimpleWebServerWiFi”



In the sample code, modify the highlighted snippet to corresponding information.



```

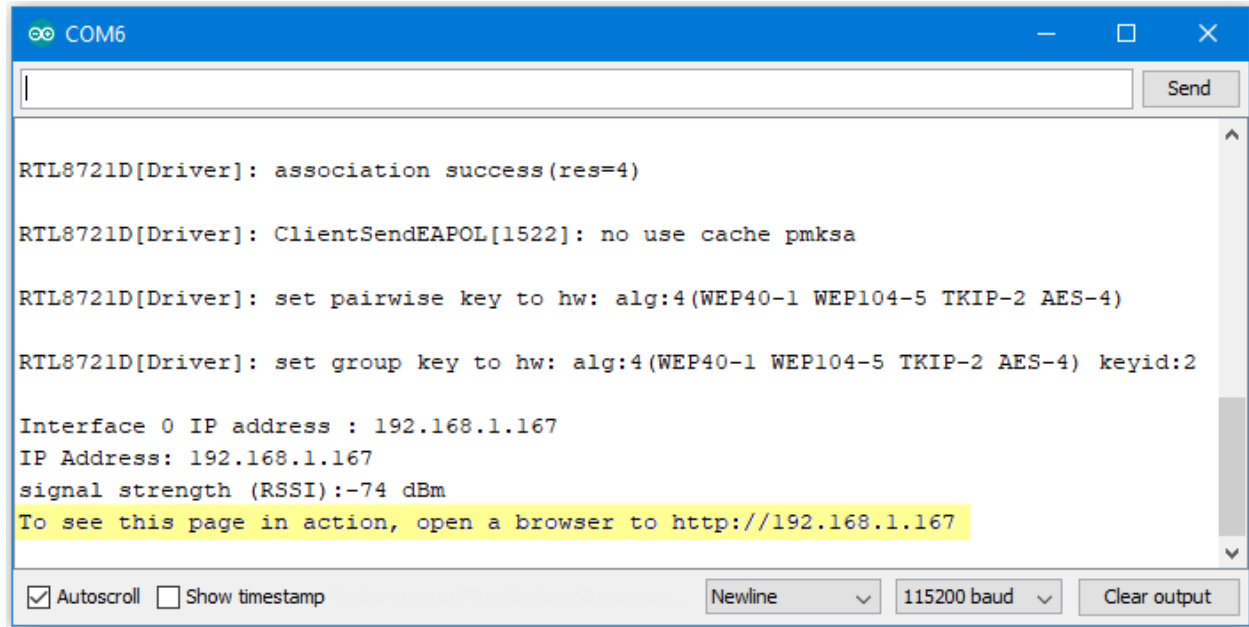
1  #include <WiFi.h>
2
3  char ssid[] = "yourNetwork";      // your network SSID (name)
4  char pass[] = "Password";         // your network password
5  int keyIndex = 0;                 // your network key Index number (needed only)
6
7  int status = WL_IDLE_STATUS;
8  WiFiServer server(80);
9
10 void setup() {
11     Serial.begin(115200);           // initialize serial communication
12     pinMode(13, OUTPUT);           // set the LED pin mode
13     // check for the presence of the shield:
14     if (WiFi.status() == WL_NO_SHIELD) {
15         Serial.println("WiFi shield not present");
16         while (true);              // don't continue
17     }
18
19     String fv = WiFi.firmwareVersion();
20     if (fv != "1.0.0") {
21         Serial.println("Please upgrade the firmware");
22     }
23
24     // attempt to connect to Wifi network:
25     while (status != WL_CONNECTED) {
26         Serial.print("Attempting to connect to Network named: ");
27         Serial.println(ssid);        // print the network name (SSID)
28
29         // Connect to WPA/WPA2 network. Change this line if using open or WEP network

```

Upload the code and press the reset button on Ameba. When the connection is established, you will see the message:

"To see this page in action, open a browser to `http://xxx.xxx.xxx.xxx`"

in the Arduino IDE as shown in the figure:



COM6

Send

```
RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

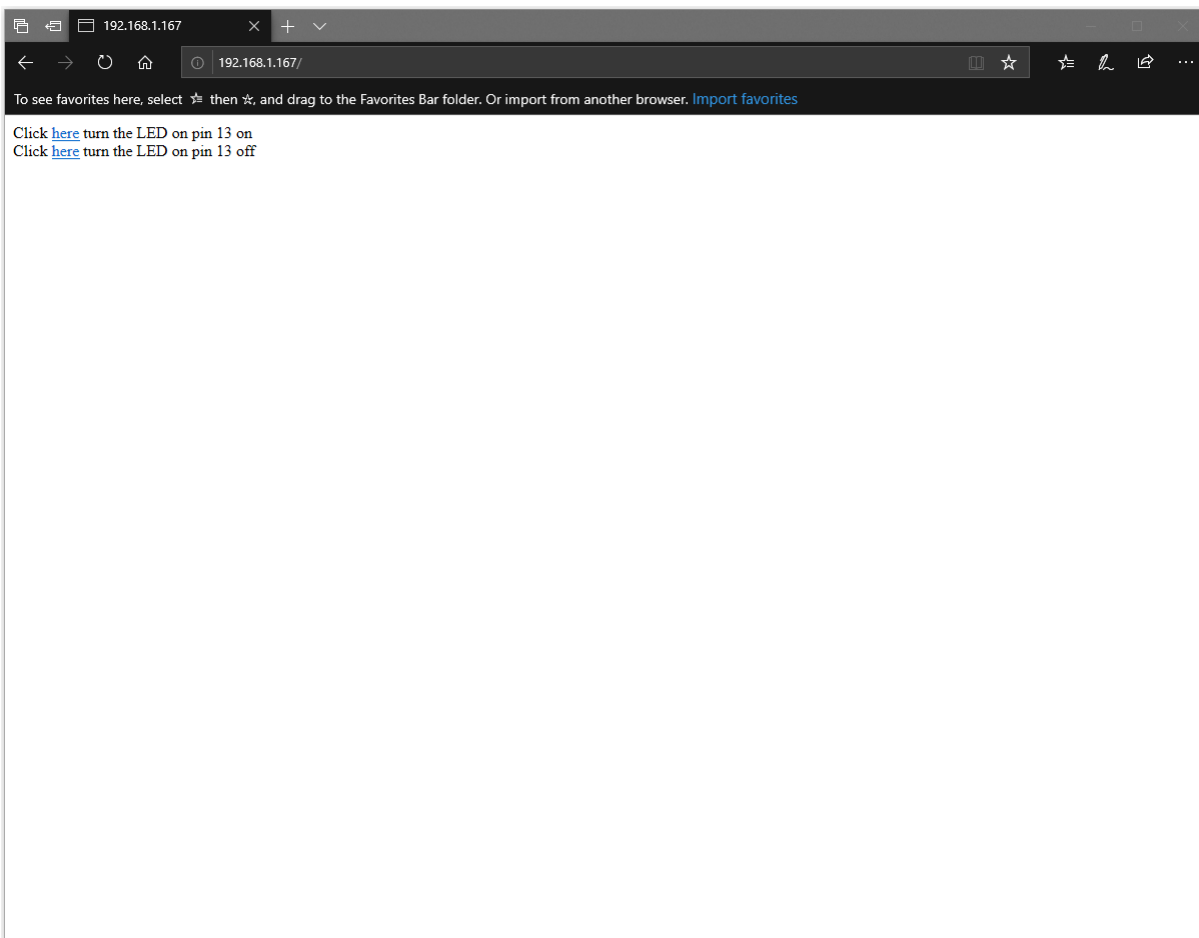
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-74 dBm
To see this page in action, open a browser to http://192.168.1.167
```

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

Next, open the browser of a computer or a cell phone under the same WiFi domain, enter the address in the message.



In the webpage, you can turn on/off the LED.

## Code Reference

Use `WiFi.begin()` to establish WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiServer server()` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.connected()` to get whether or not the client is connected.

<https://www.arduino.cc/en/Reference/WiFiClientConnected>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.print()` to print data to the server that a client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientPrint>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>



## HTTP - Set up Server to Get the Ameba Status

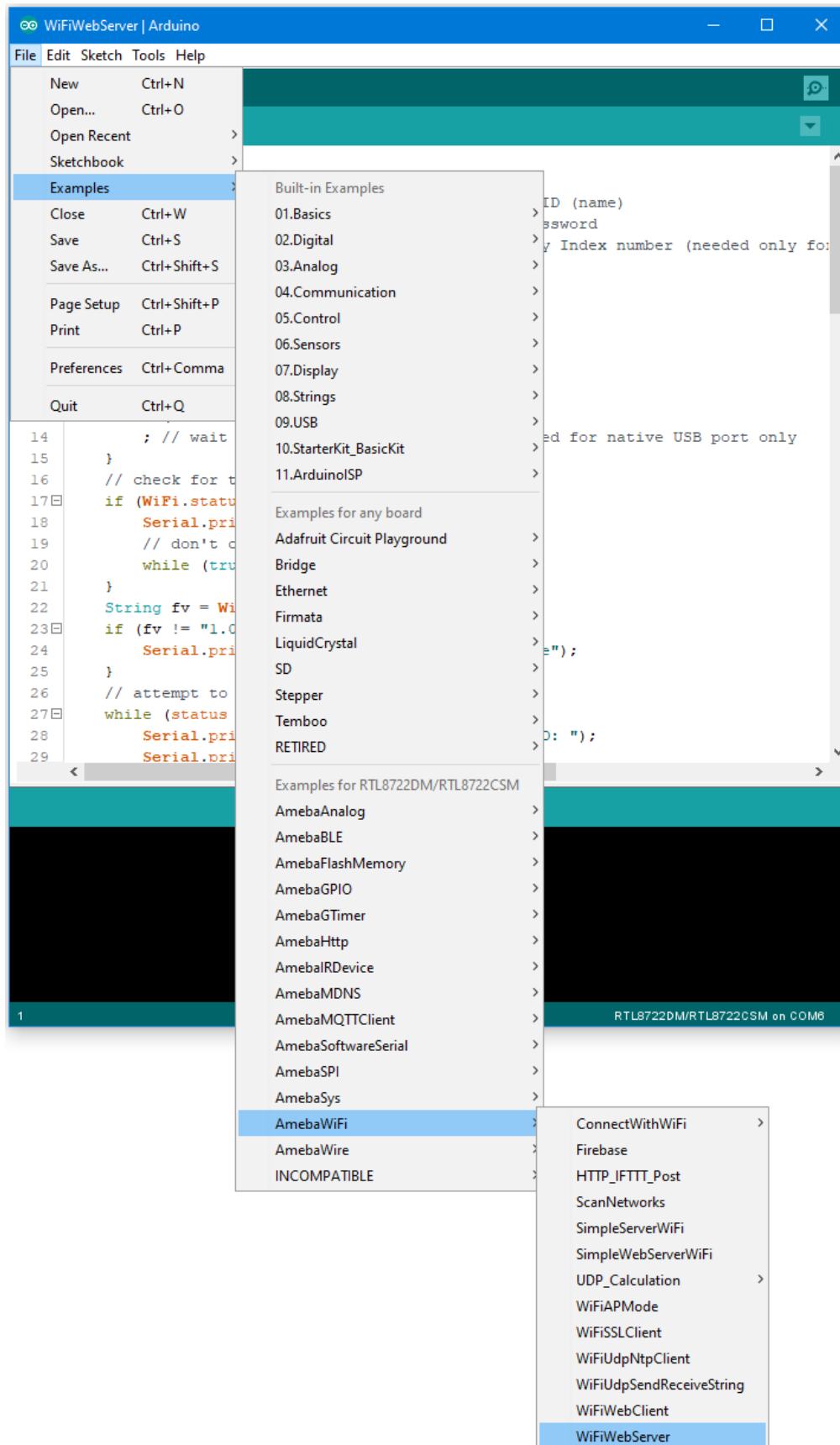
### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

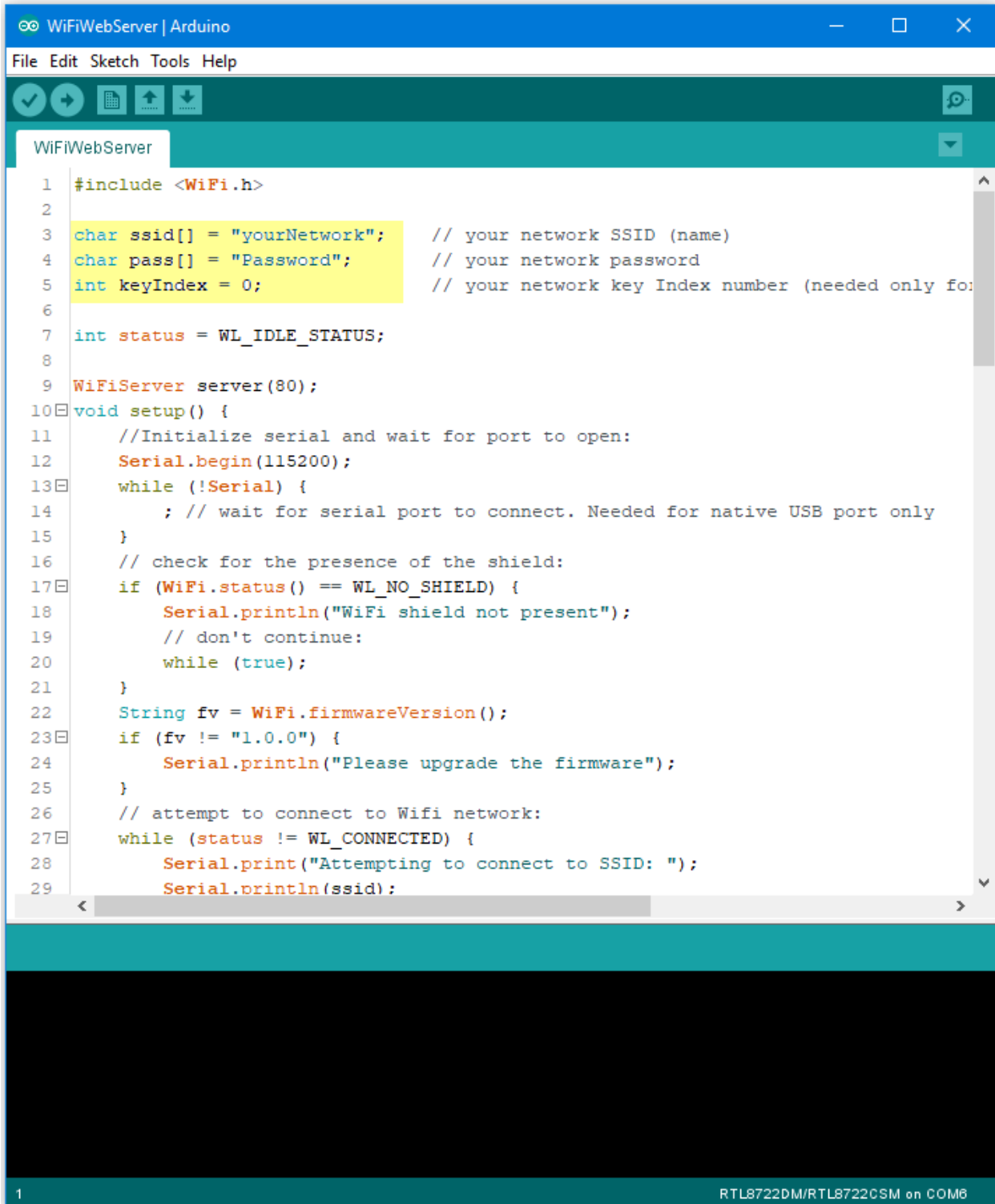
### Example

In this example, we connect Ameba to WiFi and use Ameba as server to send message to connected client.

First, open “File” -> “Examples” -> “AmebaWiFi” -> “WiFiWebServer”



In the sample code, modify the highlighted snippet and enter the required information (ssid, password, key index) required to connect to your WiFi network.

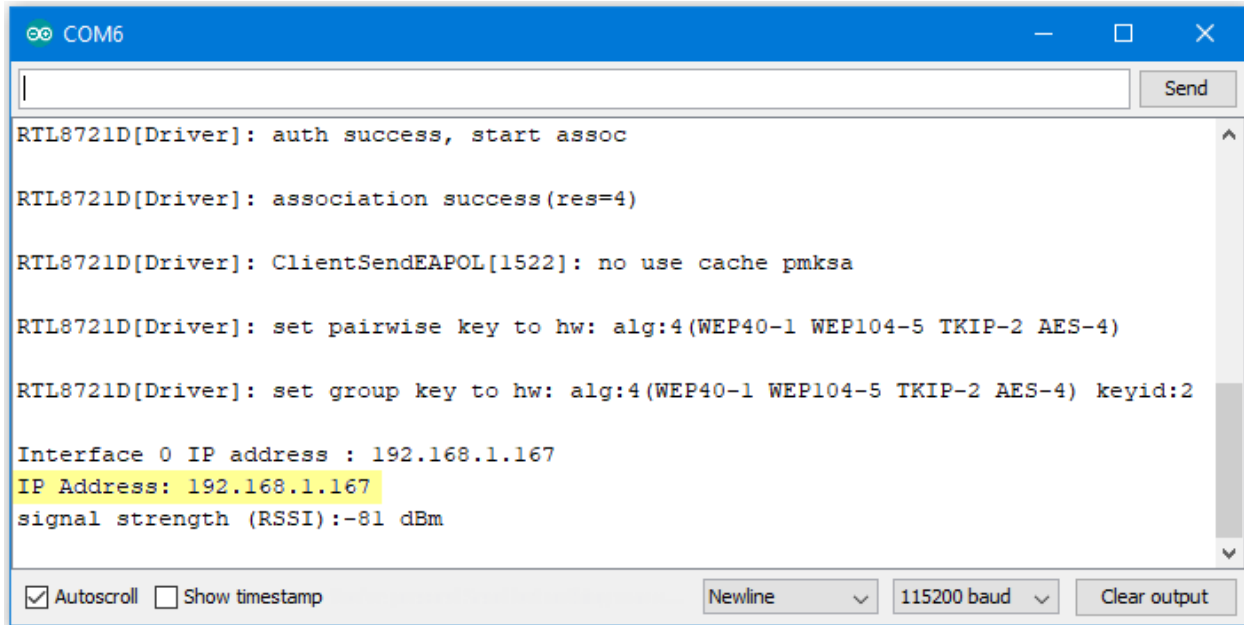


```

1  #include <WiFi.h>
2
3  char ssid[] = "yourNetwork";    // your network SSID (name)
4  char pass[] = "Password";       // your network password
5  int keyIndex = 0;               // your network key Index number (needed only for
6
7  int status = WL_IDLE_STATUS;
8
9  WiFiServer server(80);
10 void setup() {
11     //Initialize serial and wait for port to open:
12     Serial.begin(115200);
13     while (!Serial) {
14         ; // wait for serial port to connect. Needed for native USB port only
15     }
16     // check for the presence of the shield:
17     if (WiFi.status() == WL_NO_SHIELD) {
18         Serial.println("WiFi shield not present");
19         // don't continue:
20         while (true);
21     }
22     String fv = WiFi.firmwareVersion();
23     if (fv != "1.0.0") {
24         Serial.println("Please upgrade the firmware");
25     }
26     // attempt to connect to Wifi network:
27     while (status != WL_CONNECTED) {
28         Serial.print("Attempting to connect to SSID: ");
29         Serial.println(ssid);

```

Upload the code and press the reset button on Ameba. After connecting to WiFi, Ameba starts to run as server. The IP of the server is shown in the serial monitor, and port is 80.



COM6

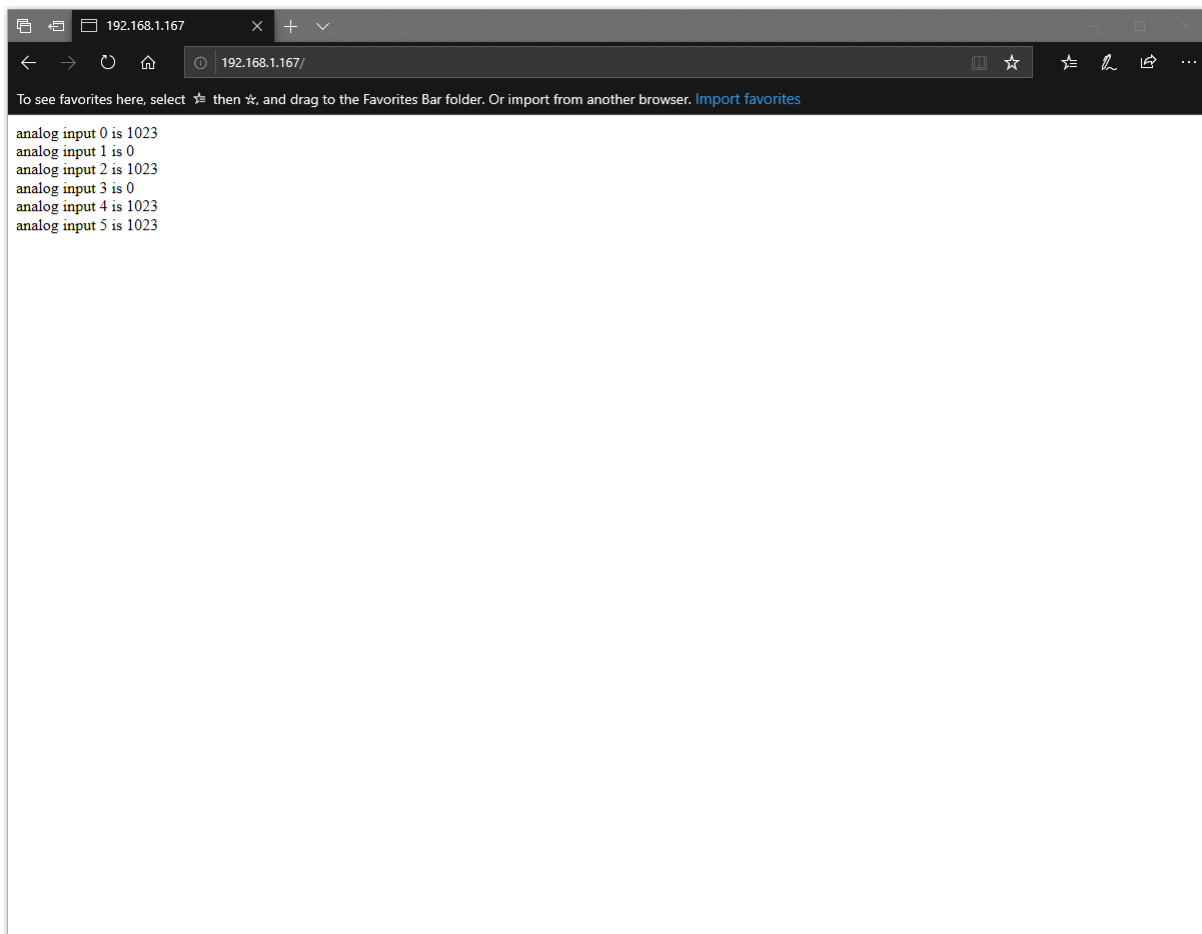
Send

```
RTL8721D[Driver]: auth success, start assoc  
RTL8721D[Driver]: association success(res=4)  
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa  
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)  
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2  
Interface 0 IP address : 192.168.1.167  
IP Address: 192.168.1.167  
signal strength (RSSI):-81 dBm
```

☒ Autoscroll ☐ Show timestamp

Newline ▼ 115200 baud ▼ Clear output

We connect to the server in a browser, and we can see the data sent from the server.



192.168.1.167

192.168.1.167/

To see favorites here, select ☆ then ☆, and drag to the Favorites Bar folder. Or import from another browser. [Import favorites](#)

```
analog input 0 is 1023  
analog input 1 is 0  
analog input 2 is 1023  
analog input 3 is 0  
analog input 4 is 1023  
analog input 5 is 1023
```

## Code Reference

Use `WiFi.begin()` to establish WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiServer server()` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.connected()` to check whether or not the client is connected.

<https://www.arduino.cc/en/Reference/WiFiClientConnected>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.print()` to print data to the server that a client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientPrint>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

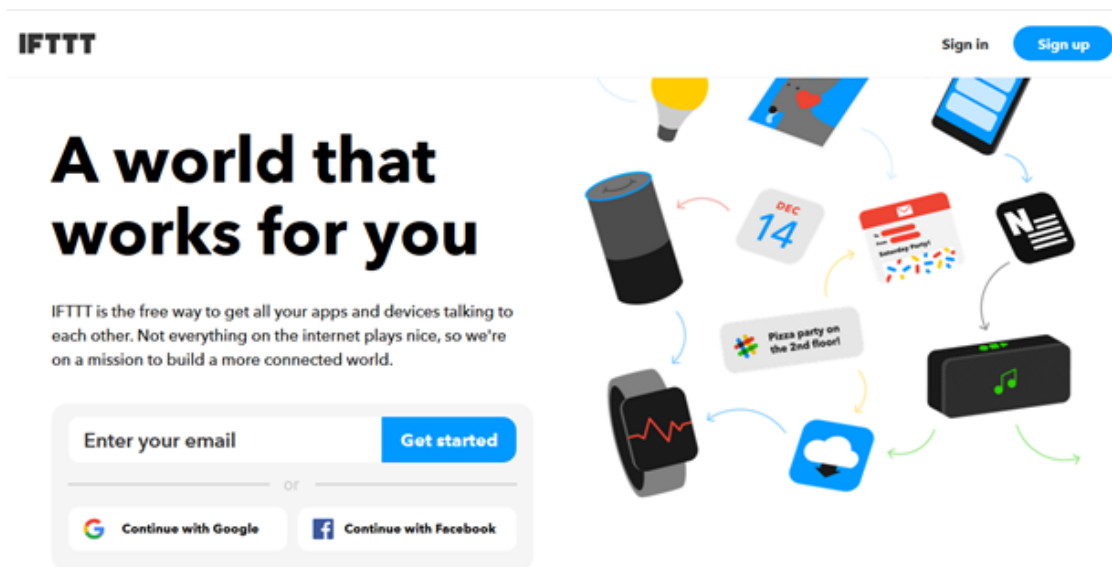
## HTTP - Use IFTTT for Web Service

### Introduction to IFTTT

IFTTT, known as If This Then That, is a website and mobile app and free web-based service to create the applets, or the chains of simple conditional statements. The applet is triggered by changes that occur within other web services such as Gmail, Facebook, Telegram, Instagram, Pinterest etc.

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- An account from <https://ifttt.com/> , in order to access IFTTT service\*



---

備<sup>註</sup>: Upon log in, there are several cloud and online services that are integrated with IFTTT platforms.

---

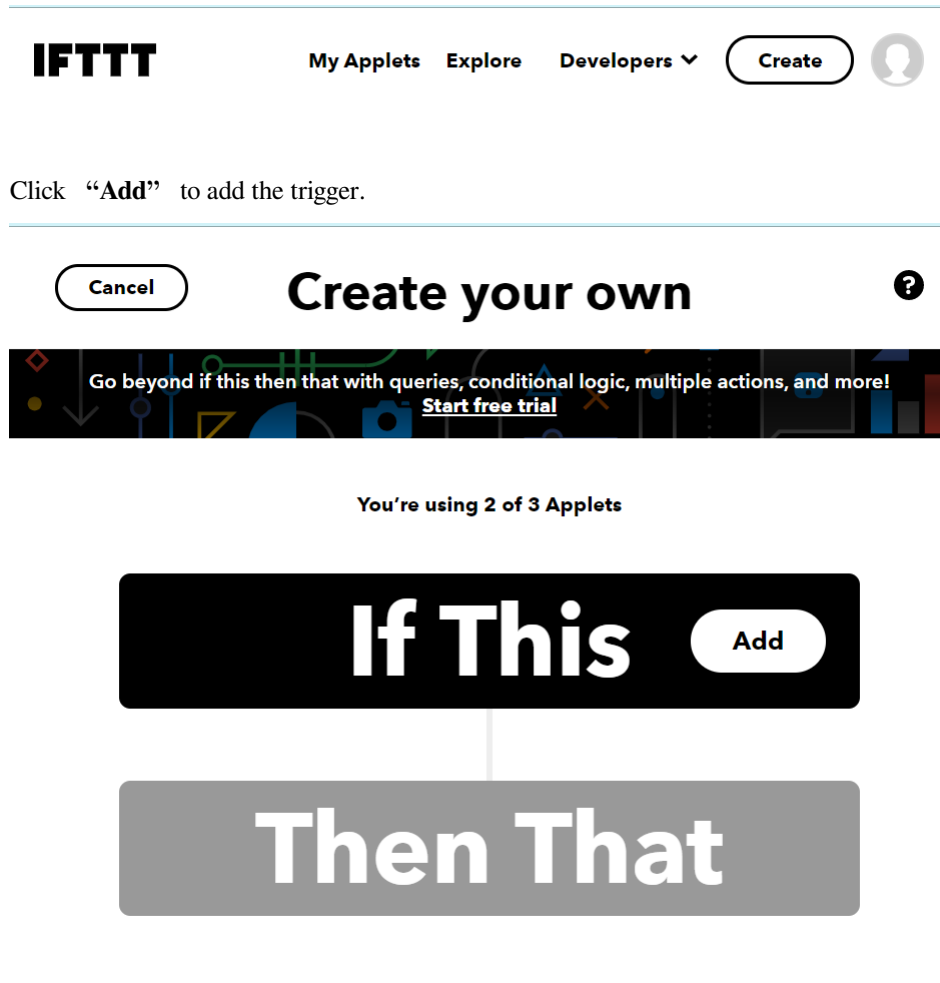
### Example

- Generate Applet from IFTTT

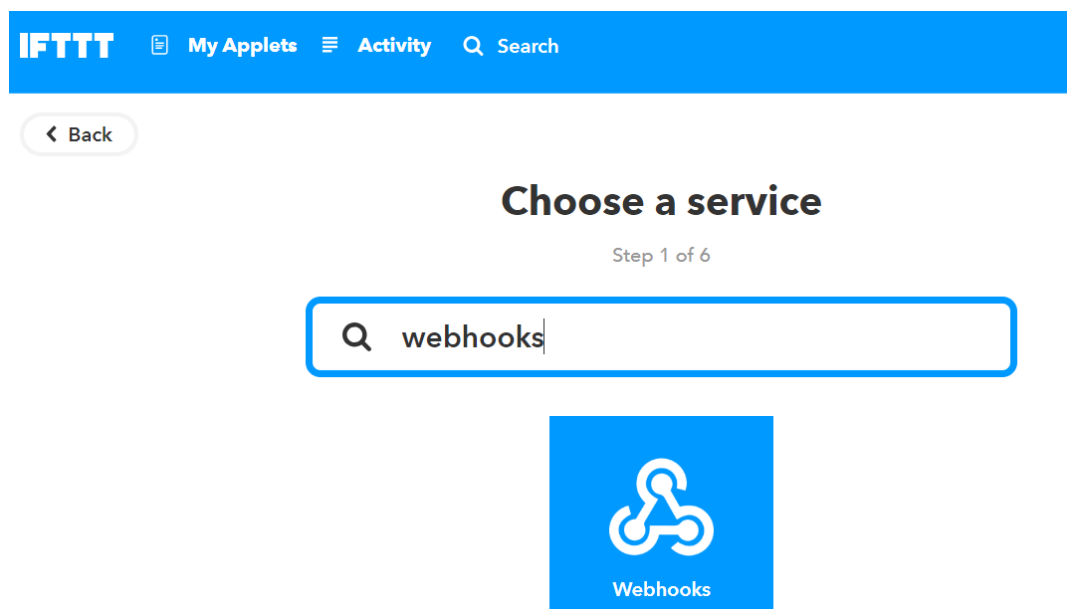
In this example, we obtain an example of IFTTT Applet to send email to specified recipient.

To run the example, HTTP POST feature of the Ameba is used to post a simple webhook service that is received by IFTTT platform and in turn be used to trigger a response (sending an email).

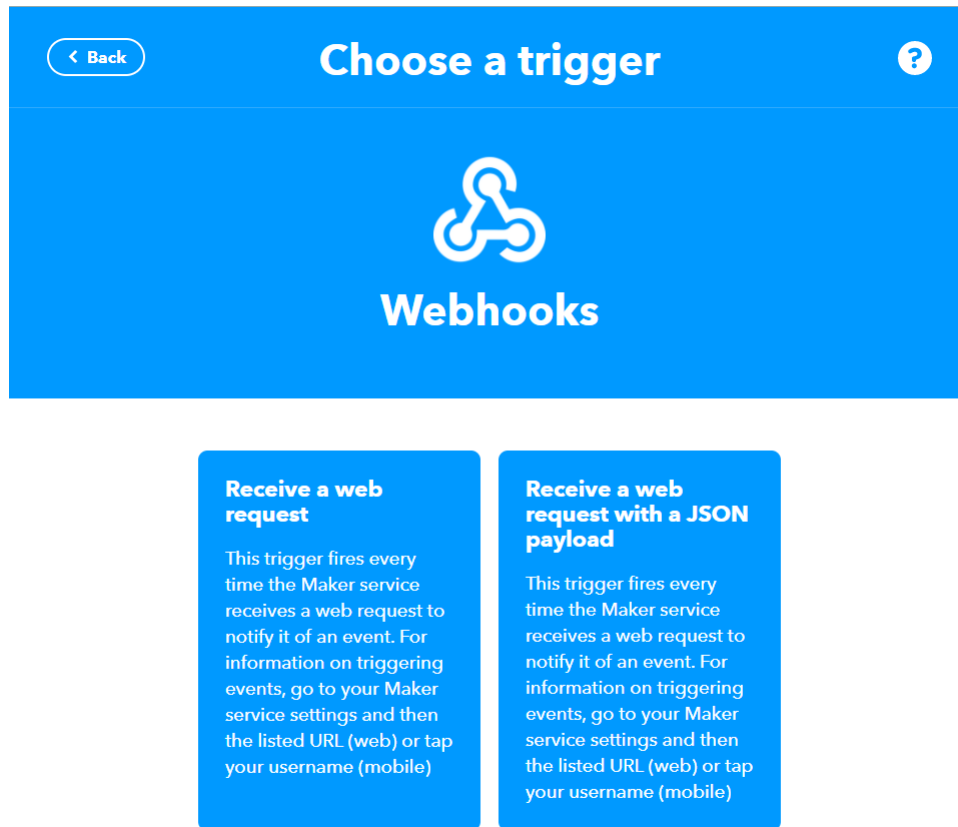
After logging in <https://ifttt.com/>, click **Create** from the top bar.



Choose Webhooks service as shown below. Alternatively, search the service by typing into the search bar.



After that, the available triggers will appear. Choose Receive a Web request.




Next, an Event Name is required to identify the trigger successfully. In this example, set the Event name as “test\_event” .



[< Back](#)

Complete trigger fields

?



Receive a web request

This trigger fires every time the Maker service receives a web request to notify it of an event. For information on triggering events, go to your Maker service settings and then the listed URL (web) or tap your username (mobile)

Event Name

test\_event

The name of the event, like "button\_pressed" or "front\_door\_opened"

Create trigger

Next, click **Add** in Then That field to create the action service taken in response to the last trigger.


[< Cancel](#)

Create your own

?

Go beyond if this then that with queries, conditional logic, multiple actions, and more! [Start free trial](#)

You're using 2 of 3 Applets

IfReceive a web request

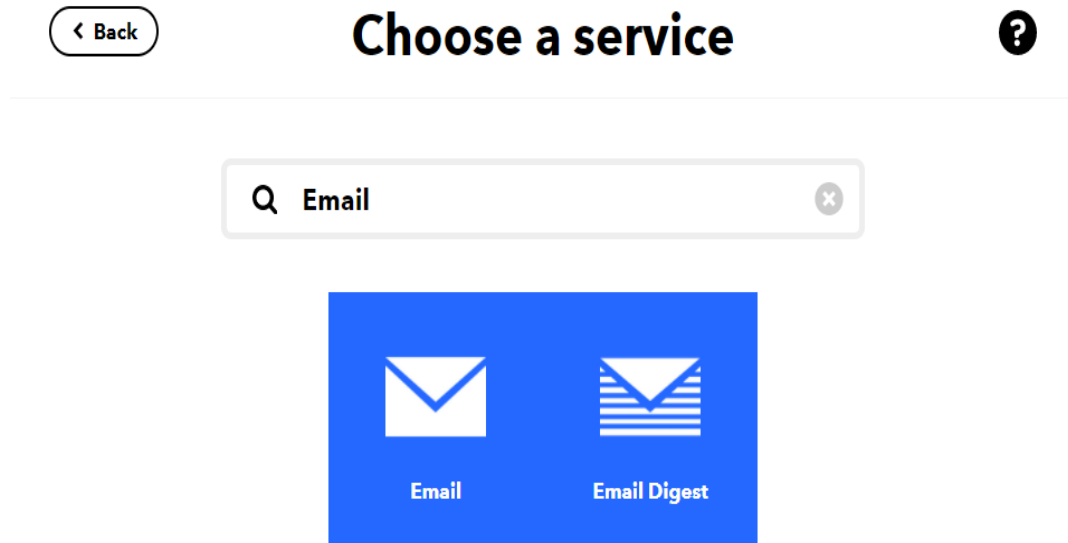
EditDelete

+

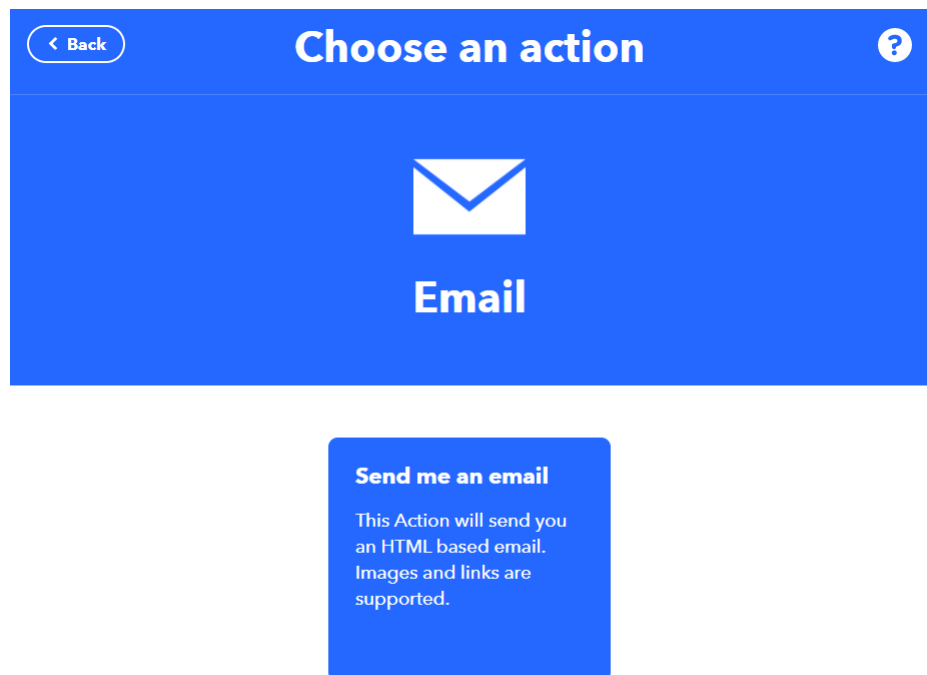
Then That

Add

Choose Email as the action service.



Click on Send me an email.



Under the template of **Send me an Email**, the contents of the email, such as subject and body is editable. Click **Create Action** to complete the action. Take note that **Email service** is offered to the

email address registered under IFTTT account.

The screenshot shows the IFTTT 'Complete action fields' interface for the 'Send me an email' action. The background is blue. At the top left is a '< Back' button, and at the top right is a help icon (?). Below the title 'Send me an email' is a small envelope icon and a note: 'This Action will send you an HTML based email. Images and links are supported.' The 'Subject' field contains the text: 'The event named " **EventName** " occurred on the Maker Webhooks service'. Below the subject field is an 'Add ingredient' button. The 'Body' field contains the text: 'What: **EventName** <br> When: **OccurredAt** <br> Extra Data: **Value1** , **Value2** , **Value3** ,'. Below the body field is another 'Add ingredient' button. At the bottom is a large blue button labeled 'Create action'.

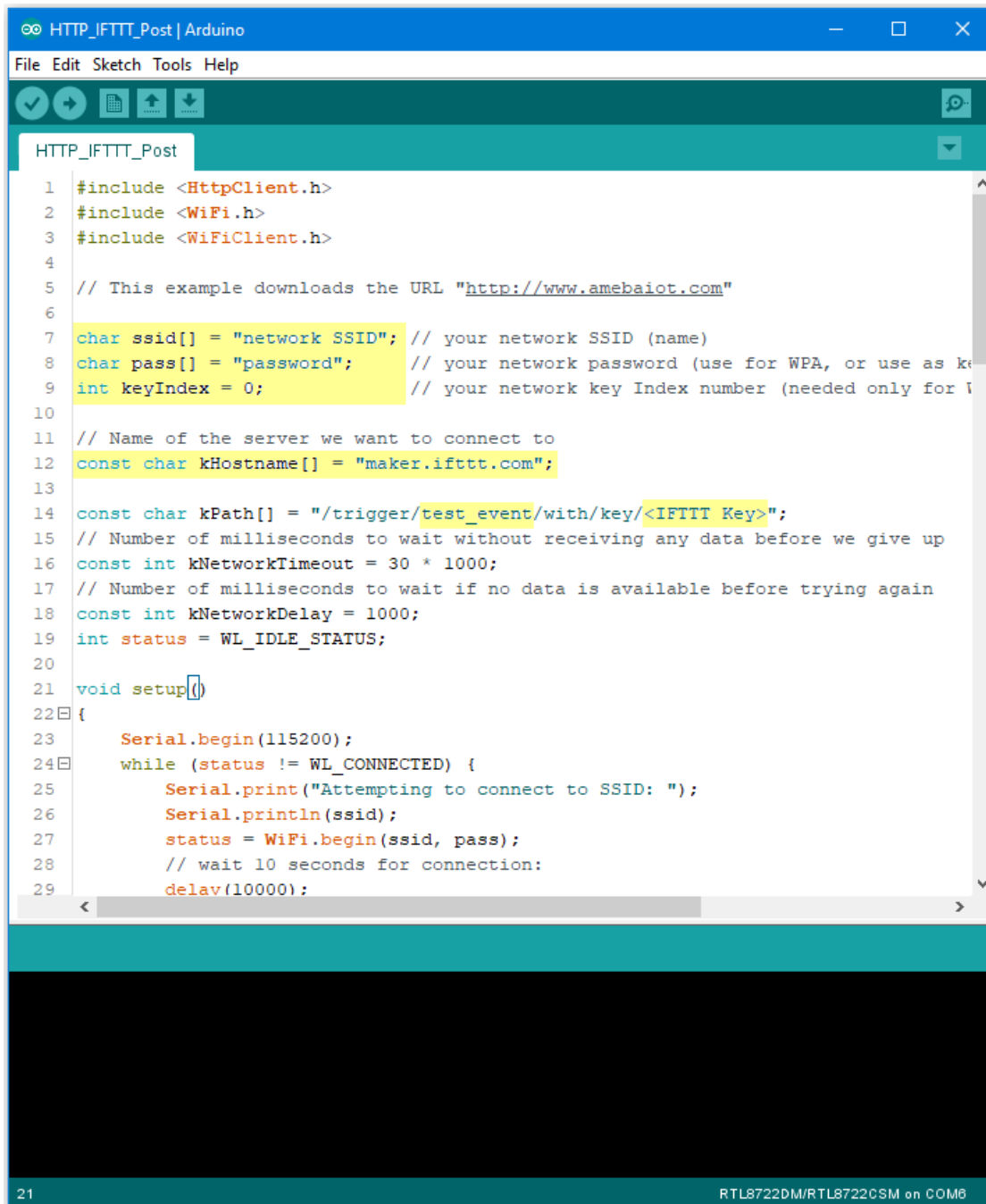
- Post the Trigger via Ameba

Once the Applet is ready in the IFTTT dashboard, the example program can be flashed onto the Ameba board to post the HTTP request.

Open the example code in “File” -> “Examples” -> “AmebaWiFi” -> “HTTP\_IFTTT\_Post”

In the example program, edit the following 3 items inside the code to make the program work.

1. The WiFi credentials to connect to the Wi-Fi hotspot or access point of desirable choice.
2. Under the Host name field, enter the host name of the IFTTT service “maker.ifttt.com” .
3. Under the Path name field, enter the Event name and key field “/trigger/Event name/with/key/Key Field”
  - Event name: The event name should be the same as the one specified in the IFTTT applet. In this example, the event name is “test\_event” .
  - Key Field: Available under webhook service in individual IFTTT account. See the next step for the steps to obtain the Key Field.



```
1 #include <HttpClient.h>
2 #include <WiFi.h>
3 #include <WiFiClient.h>
4
5 // This example downloads the URL "http://www.amebaiot.com"
6
7 char ssid[] = "network SSID"; // your network SSID (name)
8 char pass[] = "password";     // your network password (use for WPA, or use as key for WEP)
9 int keyIndex = 0;              // your network key Index number (needed only for WEP)
10
11 // Name of the server we want to connect to
12 const char kHostname[] = "maker.ifttt.com";
13
14 const char kPath[] = "/trigger/test_event/with/key/<IFTTT Key>";
15 // Number of milliseconds to wait without receiving any data before we give up
16 const int kNetworkTimeout = 30 * 1000;
17 // Number of milliseconds to wait if no data is available before trying again
18 const int kNetworkDelay = 1000;
19 int status = WL_IDLE_STATUS;
20
21 void setup()
22 {
23     Serial.begin(115200);
24     while (status != WL_CONNECTED) {
25         Serial.print("Attempting to connect to SSID: ");
26         Serial.println(ssid);
27         status = WiFi.begin(ssid, pass);
28         // wait 10 seconds for connection:
29         delay(10000);
30     }
31 }
```

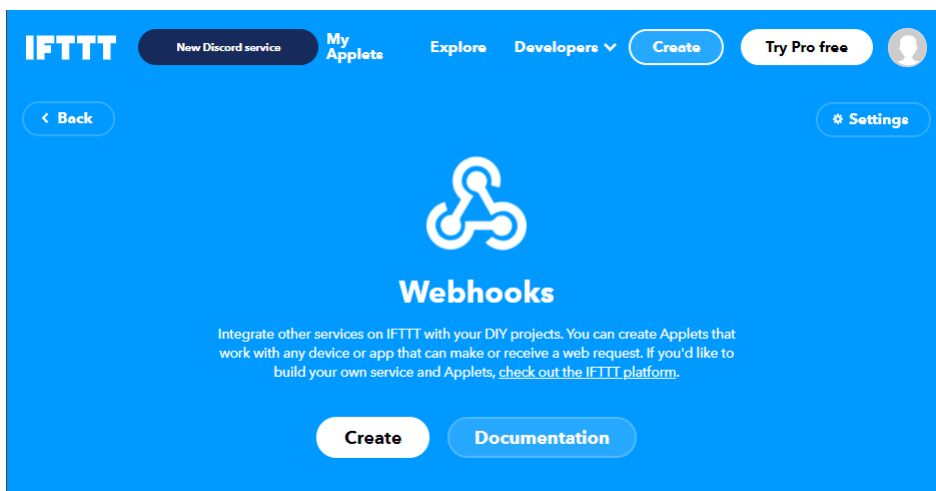
21

RTL8722DM/RTL8722CSM on COM8

To obtain a key from documentation tab of the Webhooks, find the webhook service in the Explore tab.



On the Webhooks service page, click on the Documentation tab.

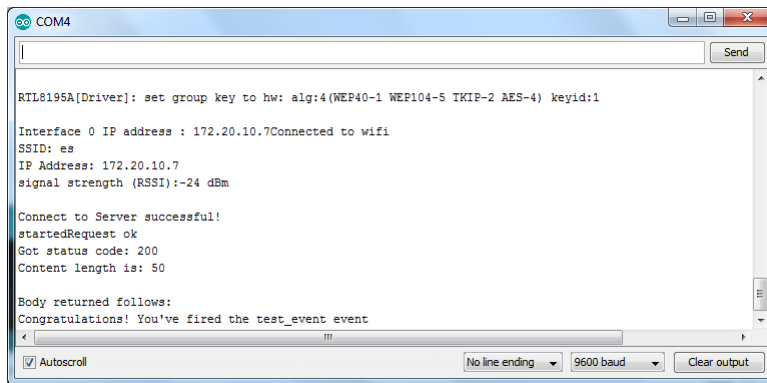


The key can be found in the documentation page. Also, information on how HTTP request can be used.

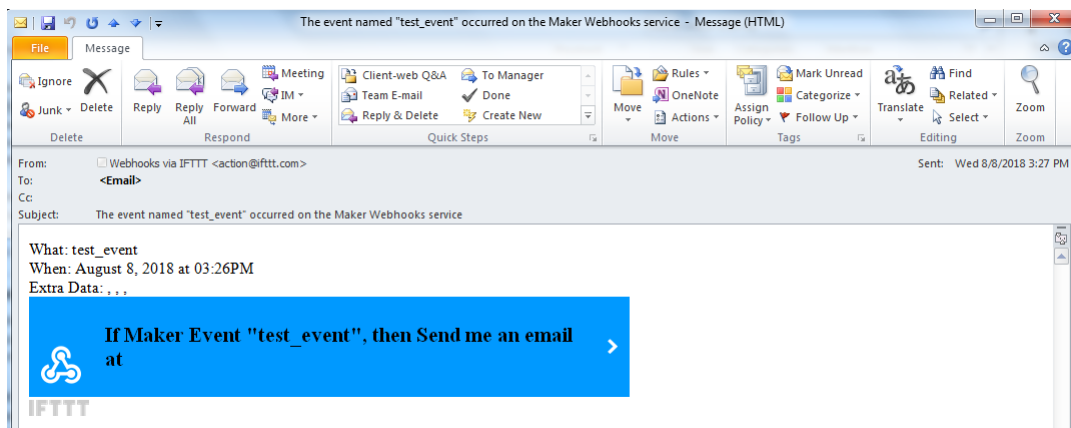


Once the example is ready, connect to Ameba board via USB Cable.

On the Arduino IDE, compile the code and upload the code onto Ameba and press the reset button. After the event has been successfully fired, “Congratulations! You have fired the test\_event event” can be seen on the serial monitor and an email reminder for this event will be delivered.



Thereafter an email is sent to recipient email account registered at IFTTT Applet and email notification will be received.



## IPv6 –Ameba as IPv6 Server/Client over TCP

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

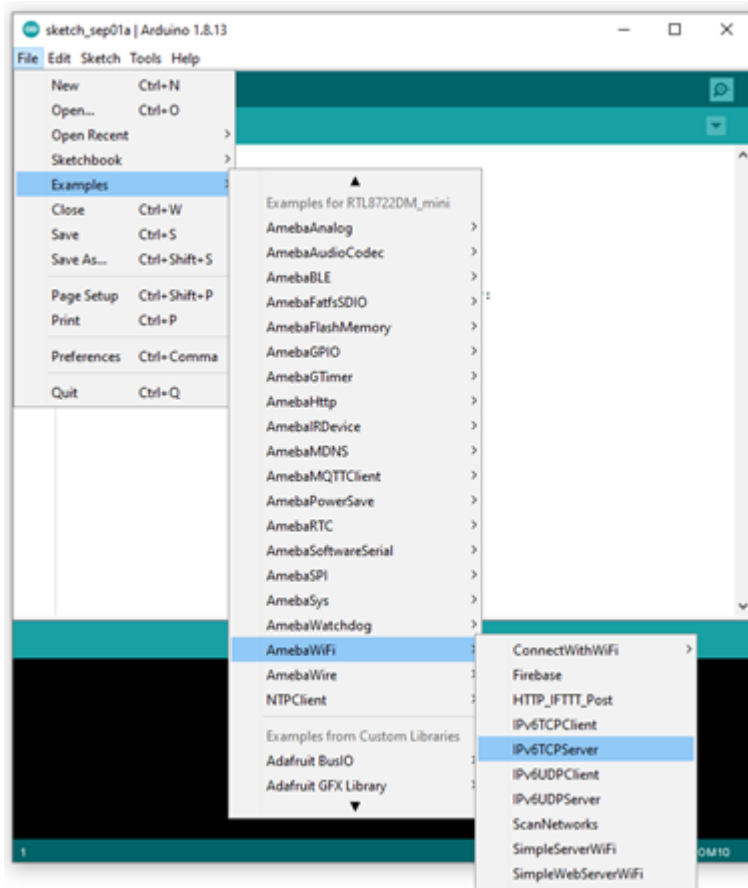
### Example

#### Introduction

This example shows how Ameba can communicate on the local network using Internet Protocol version 6 over TCP. Note that this example only works after you have set up the server and then configure the client accordingly.

#### Procedure

Step 1. IPv6TCPServer Open the example, “Files” -> “Examples” -> “AmebaWiFi” -> “IPv6TCPServer” .



In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.

```

1  #include <WiFi.h>
2
3  #define MAX_SEND_SIZE 256
4  #define MAX_RECV_SIZE 256
5  #define TCP_SERVER_PORT 5003
6
7  char ssid[] = "yourNetwork"; // your network SSID (name)
8  char pass[] = "password"; // your network password (use for WPA, or use
9
10 int status = WL_IDLE_STATUS;
11
12 char data_send[MAX_SEND_SIZE] = "Hi client!!";
13 char data_recv[MAX_RECV_SIZE];
14
15 int server_fd, client_fd;
16 WiFiServer server(TCP_SERVER_PORT);
17
18 void setup() {
19     //Initialize serial and wait for port to open:
20     Serial.begin(115200);

```

Next, upload the code and press the reset button on Ameba once the upload is finished. Open Serial Monitor and copy the IPv6 address of the Server (the highlighted area) for later use,

```

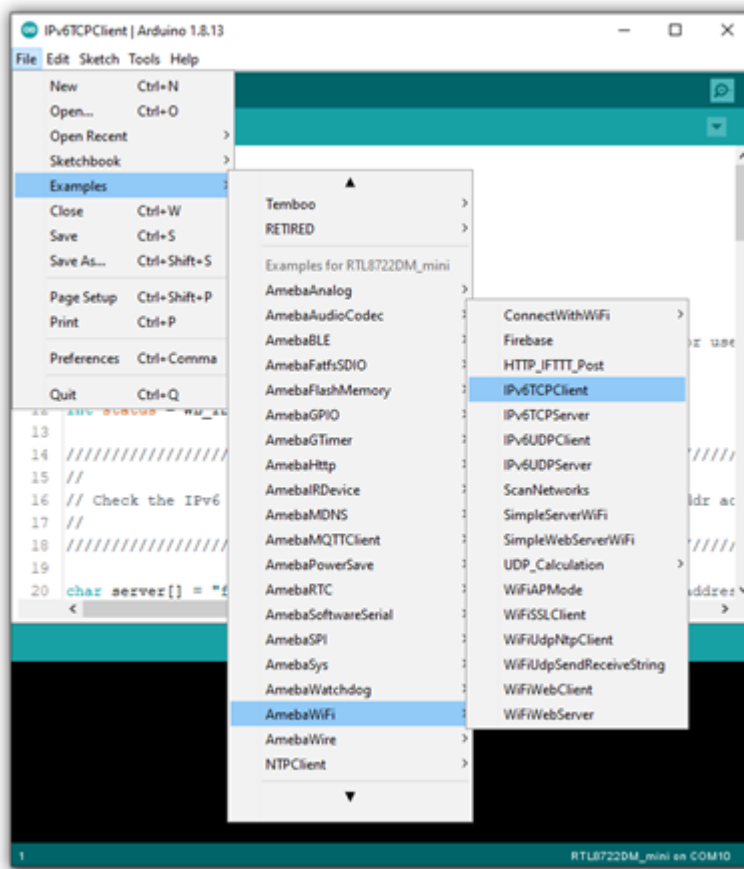
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=2)
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1
Interface 0 IP address : 192.168.197.178
Enable IPv6 functions
SSID: yourNetwork
IP Address: 192.168.197.178
IPv6 link-local address: fe80:0000:0000:0000:02e0:4cff:fe10:0076

```

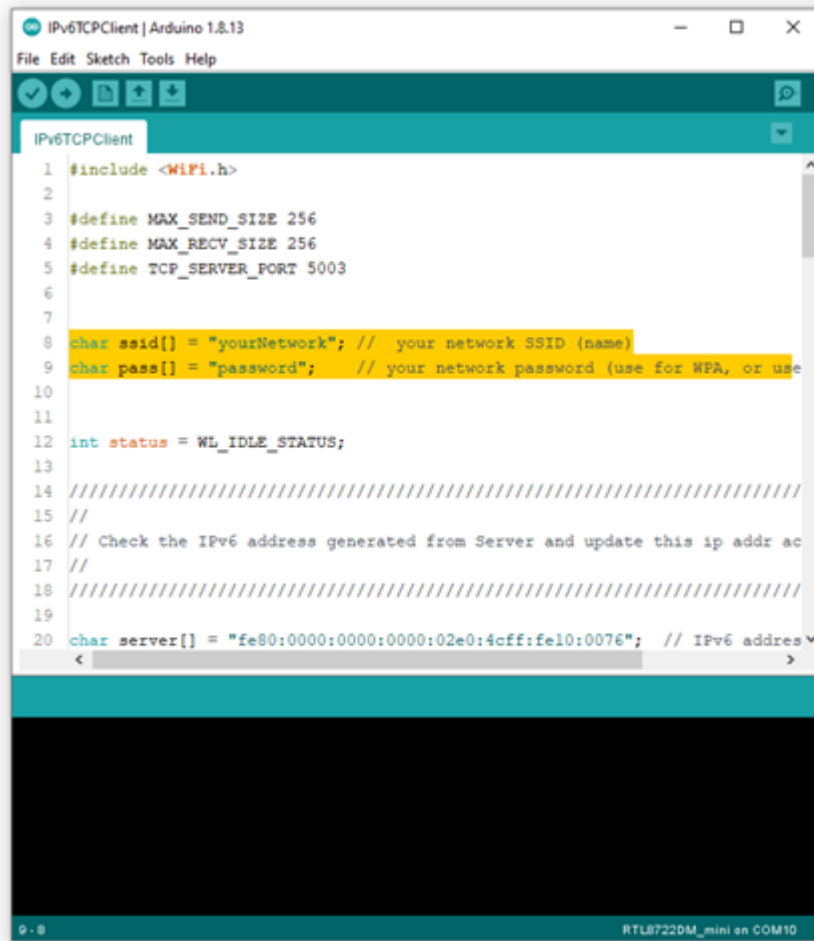
Step 2. IPv6TCPClient Now take the second Ameba D and open another example, “Files” -> “Examples” ->



“AmebaWiFi” -> “IPv6TCPClient”.



In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5 #define TCP_SERVER_PORT 5003
6
7
8 char ssid[] = "yourNetwork"; // your network SSID (name)
9 char pass[] = "password"; // your network password (use for WPA, or use
10
11
12 int status = WL_IDLE_STATUS;
13
14 ///////////////////////////////////////////////////////////////////
15 //
16 // Check the IPv6 address generated from Server and update this ip addr ac
17 //
18 ///////////////////////////////////////////////////////////////////
19
20 char server[] = "fe80:0000:0000:0000:02e0:4cff:fe10:0076"; // IPv6 address
21
```

From the previous step, we have obtained the Server' s IPv6 address, now we copy the server' s IPv6 address to "IPv6TCPCClient" example in the highlighted area below,

```

1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5 #define TCP_SERVER_PORT 5003
6
7
8 char ssid[] = "yourNetwork"; // your network SSID (name)
9 char pass[] = "password";    // your network password (use for WPA, or use as key for WEP)
10
11
12 int status = WL_IDLE_STATUS;
13
14 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
15 //
16 // Check the IPv6 address generated from Server and update this ip addr accordingly !! //
17 //
18 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
19
20 char server[] = "fe80:0000:0000:0000:02e0:4cff:fe10:0074"; // IPv6 address of server board
21 char data_recv[MAX_RECV_SIZE];
22 char data_send[MAX_SEND_SIZE] = "Hi Server!!";
23

```

Image tool closed!  
Upload Image done.

20 RTL8722DN/RTL8722C5M on COM10

Next, upload the code and press the reset button on Ameba once the upload is finished.

Open Serial Monitor on the port to the second Ameba D, you should see server and client are sending text message to each other at the same time.

```

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

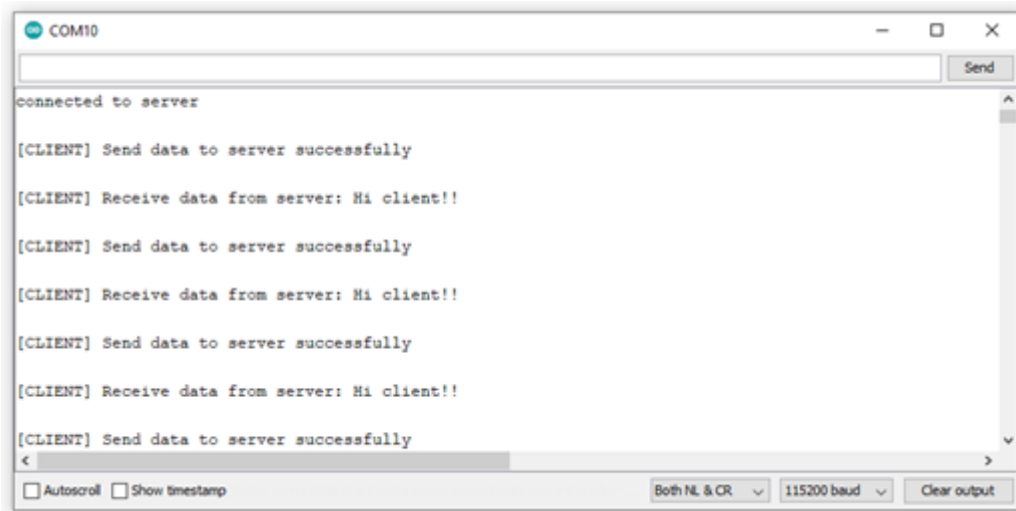
[SERVER] Send data successfully

[SERVER] Receive data: Hi Server!!

[SERVER] Send data successfully

```

☐ Autoscroll ☐ Show timestamp Both NL & CR 115200 baud Clear output



## IPv6 –Ameba as IPv6 Server/Client over UDP

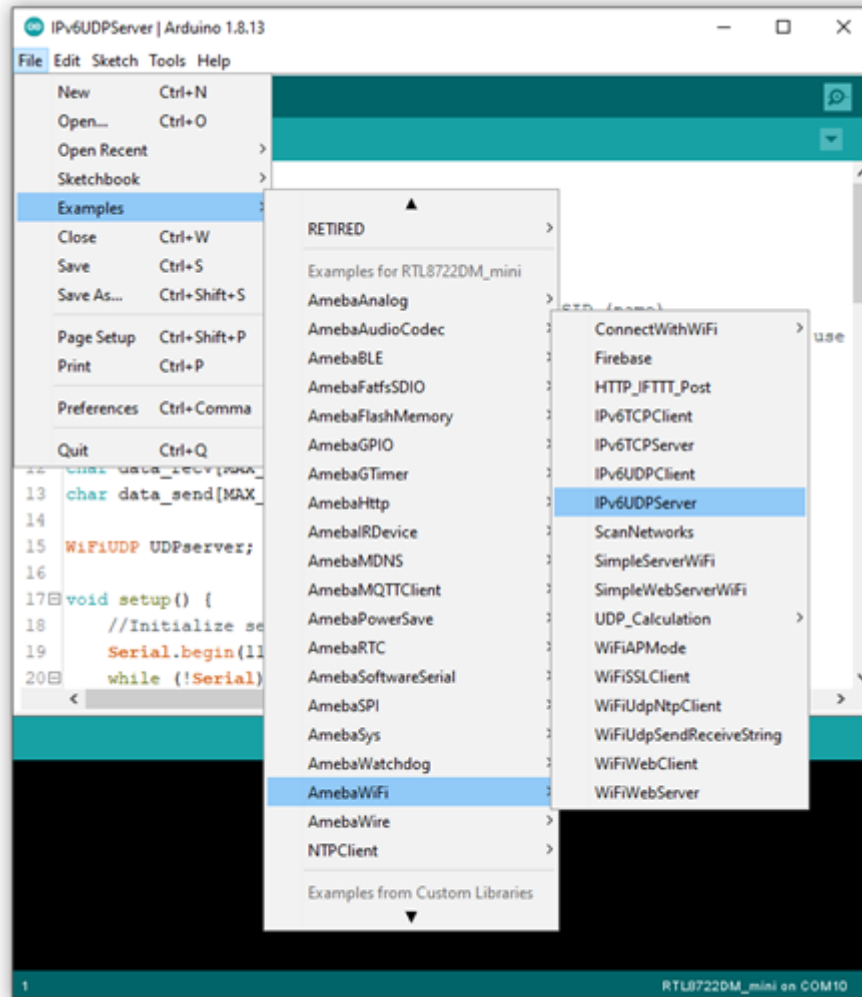
### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 2

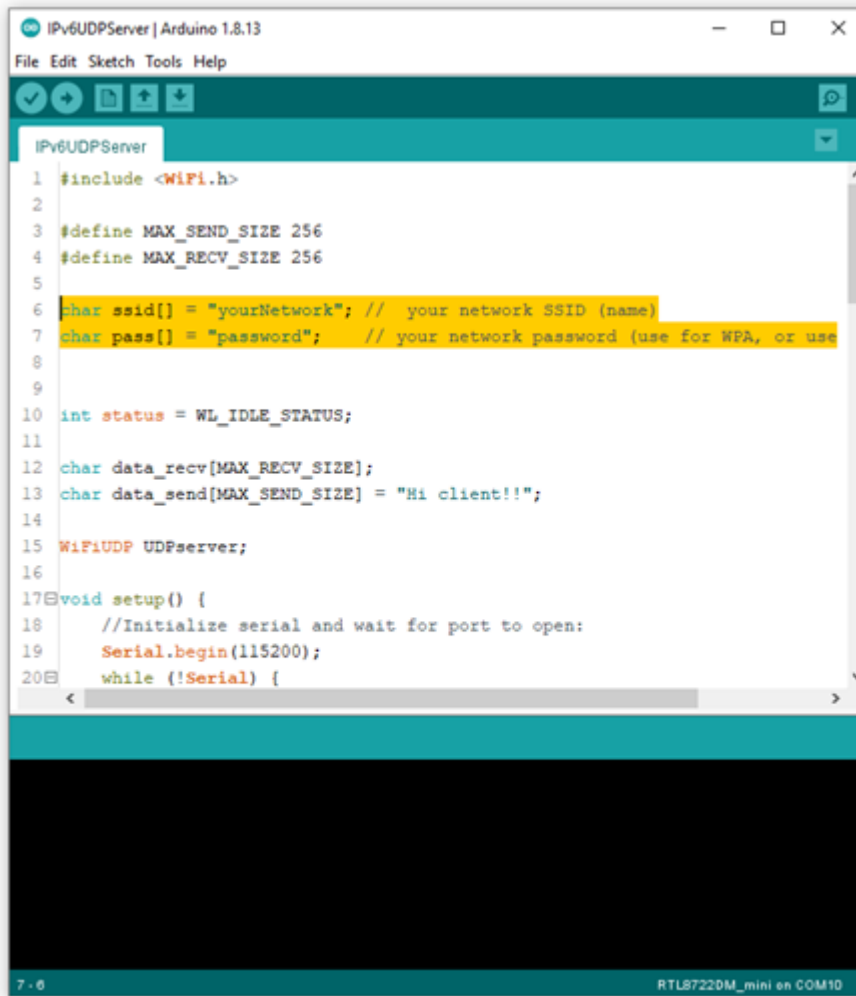
### Example

#### Introduction

This example shows how Ameba can communicate on the local network using Internet Protocol version 6 over UDP. Note that this example only works after you have set up the server and then configure the client accordingly.

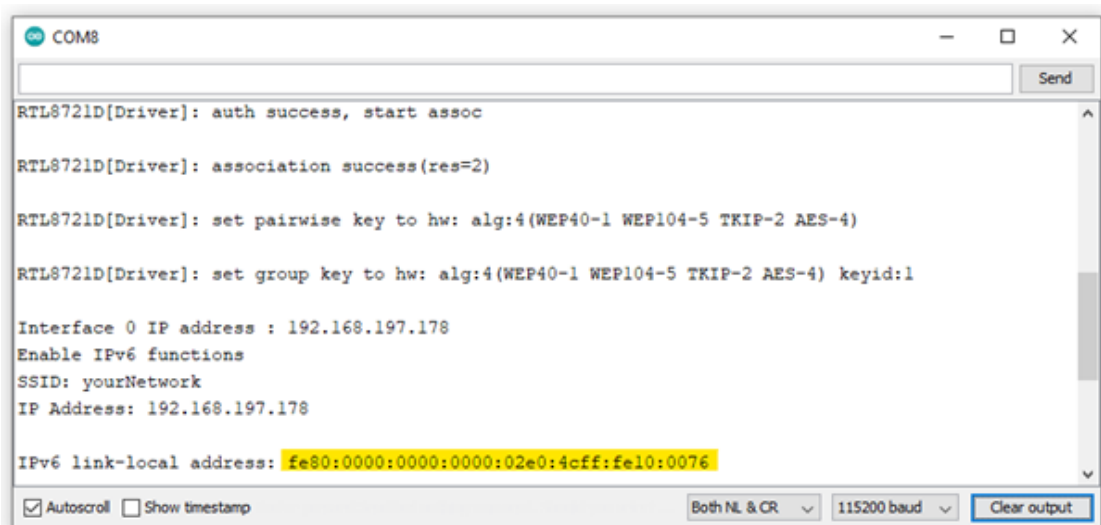


In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #define MAX_SEND_SIZE 256
4 #define MAX_RECV_SIZE 256
5
6 char ssid[] = "yourNetwork"; // your network SSID (name)
7 char pass[] = "password"; // your network password (use for WPA, or use
8
9
10 int status = WL_IDLE_STATUS;
11
12 char data_recv[MAX_RECV_SIZE];
13 char data_send[MAX_SEND_SIZE] = "Hi client!!";
14
15 WiFiUDP UDPServer;
16
17 void setup() {
18   //Initialize serial and wait for port to open:
19   Serial.begin(115200);
20   while (!Serial) {
```

Next, upload the code and press the reset button on Ameba once the upload is finished. Open Serial Monitor and copy the IPv6 address of the Server (the highlighted area) for later use,

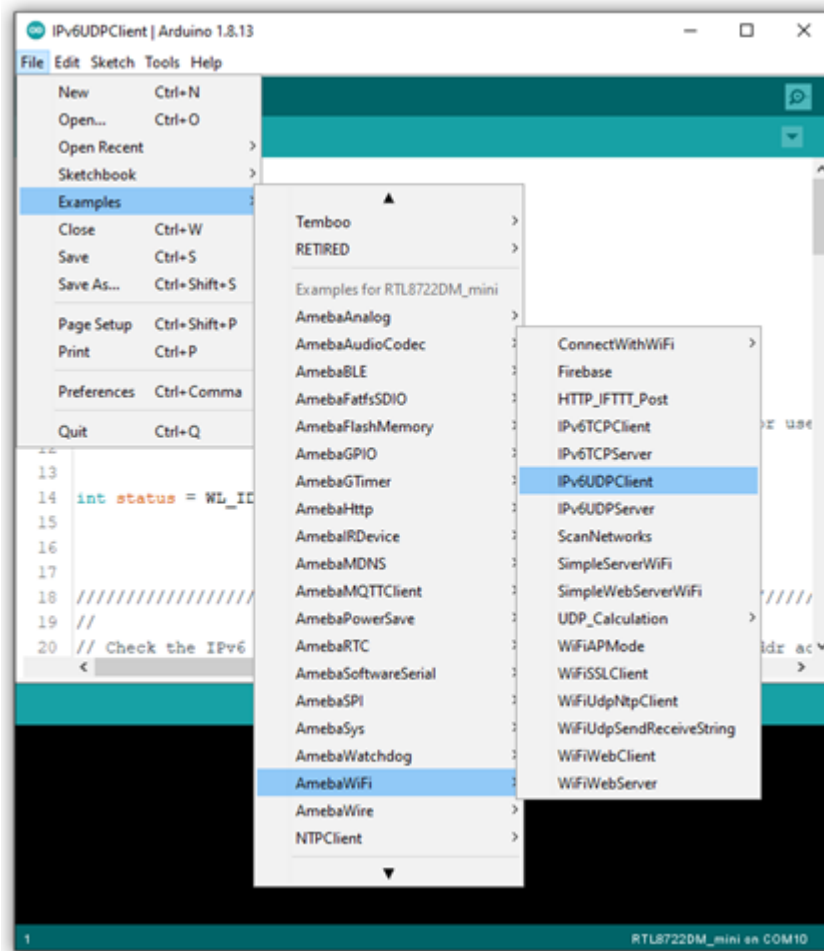


```
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=2)
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

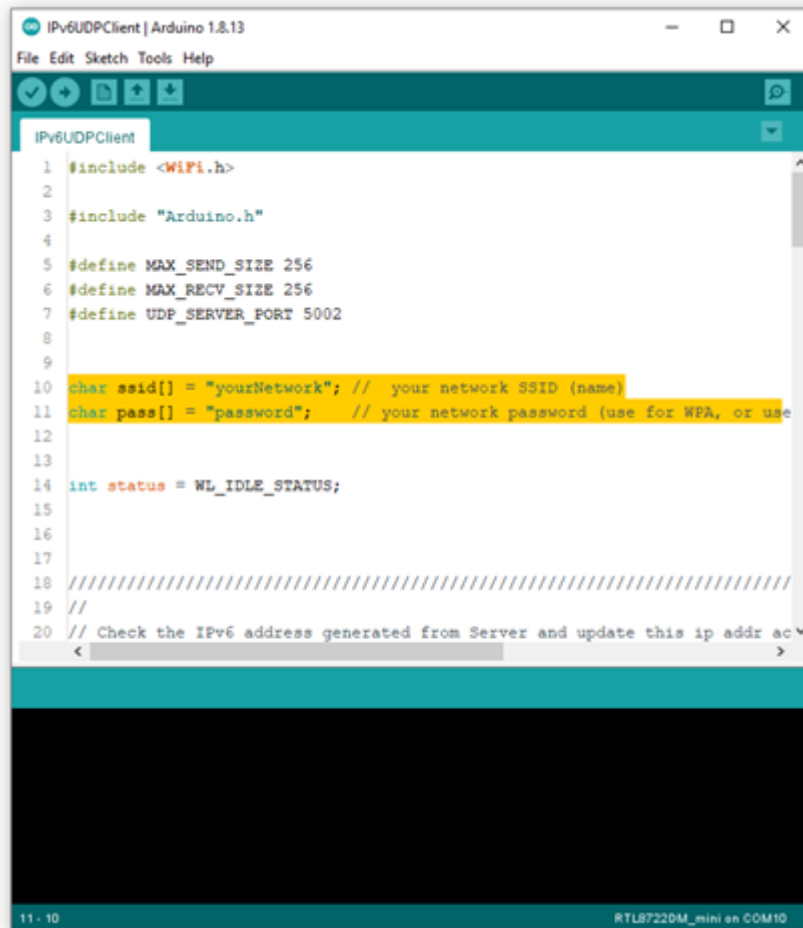
Interface 0 IP address : 192.168.197.178
Enable IPv6 functions
SSID: yourNetwork
IP Address: 192.168.197.178

IPv6 link-local address: fe80:0000:0000:0000:02e0:4c00:fe10:0076
```

Step 2. IPv6UDPCliEnt Now take the second Ameba D and open another example, “Files” -> “Examples” -> “AmebaWiFi” -> “IPv6UDPCliEnt” .



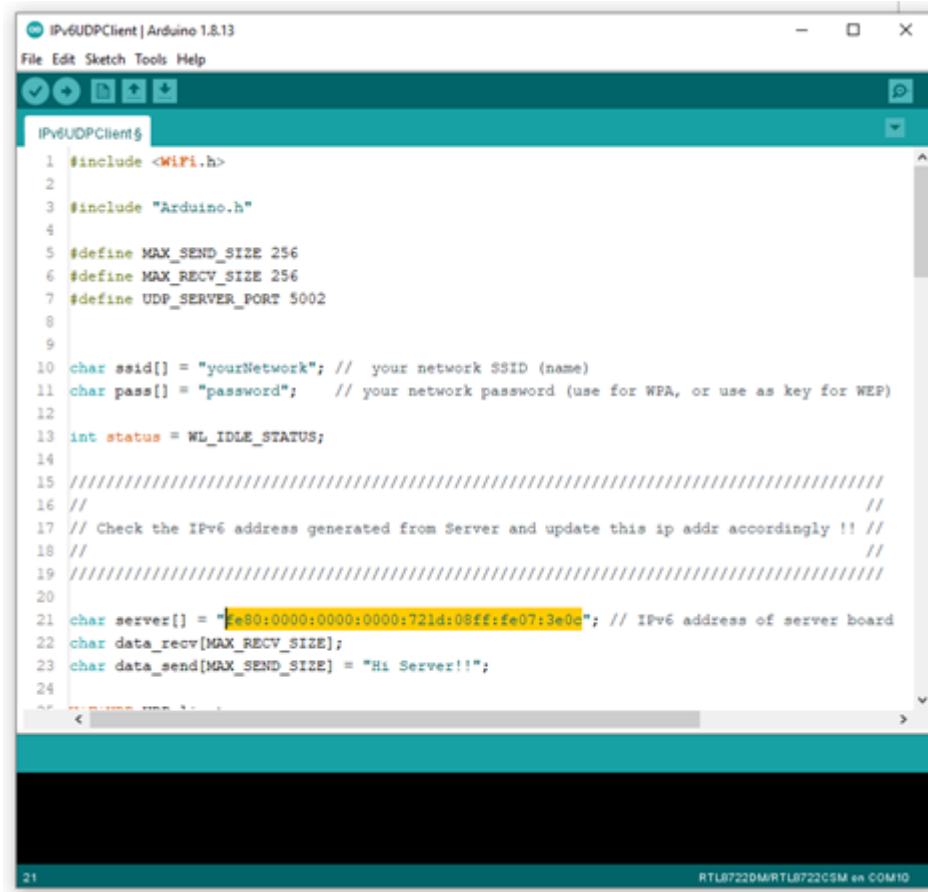
In the sample code, modify the highlighted section to enter the information required (ssid, password) to connect to your WiFi network.



```
1 #include <WiFi.h>
2
3 #include "Arduino.h"
4
5 #define MAX_SEND_SIZE 256
6 #define MAX_RECV_SIZE 256
7 #define UDP_SERVER_PORT 5002
8
9
10 char ssid[] = "yourNetwork"; // your network SSID (name)
11 char pass[] = "password"; // your network password (use for WPA, or use
12
13
14 int status = WL_IDLE_STATUS;
15
16
17
18 ///////////////////////////////////////////////////
19 //
20 // Check the IPv6 address generated from Server and update this ip addr ac
21 < >
```

From the previous step, we have obtained the Server' s IPv6 address, now we copy the server' s IPv6 address to "IPv6UDPClient" example in the highlighted area below,





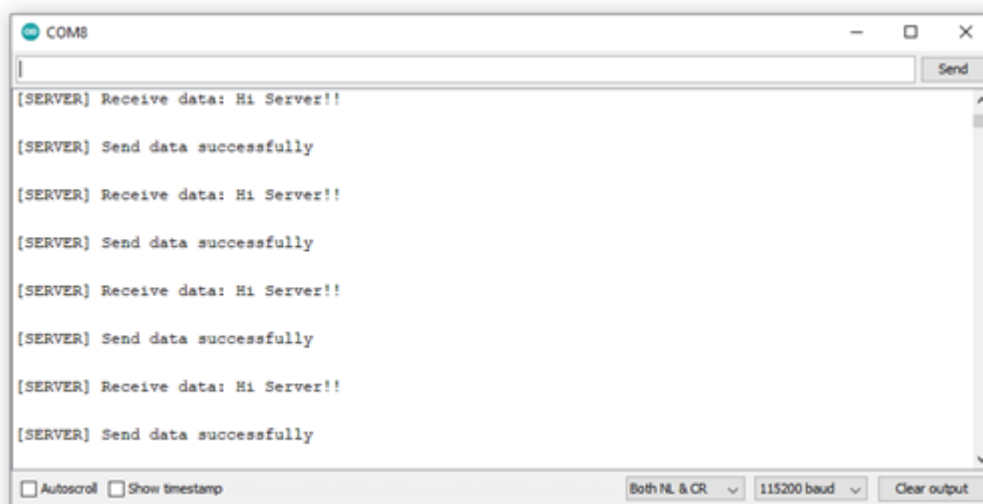
```

1 #include <WiFi.h>
2
3 #include "Arduino.h"
4
5 #define MAX_SEND_SIZE 256
6 #define MAX_RECV_SIZE 256
7 #define UDP_SERVER_PORT 5002
8
9
10 char ssid[] = "yourNetwork"; // your network SSID (name)
11 char pass[] = "password"; // your network password (use for WPA, or use as key for WEP)
12
13 int status = WL_IDLE_STATUS;
14
15 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
16 //
17 // Check the IPv6 address generated from Server and update this ip addr accordingly !! //
18 //
19 ////////////////////////////////////////////////////////////////////////////////////////////////////////////////////
20
21 char server[] = "fe80:0000:0000:0000:721d:08ff:fe07:3e0d"; // IPv6 address of server board
22 char data_recv[MAX_RECV_SIZE];
23 char data_send[MAX_SEND_SIZE] = "Hi Server!!";
24
25

```

Next, upload the code and press the reset button on Ameba once the upload is finished.

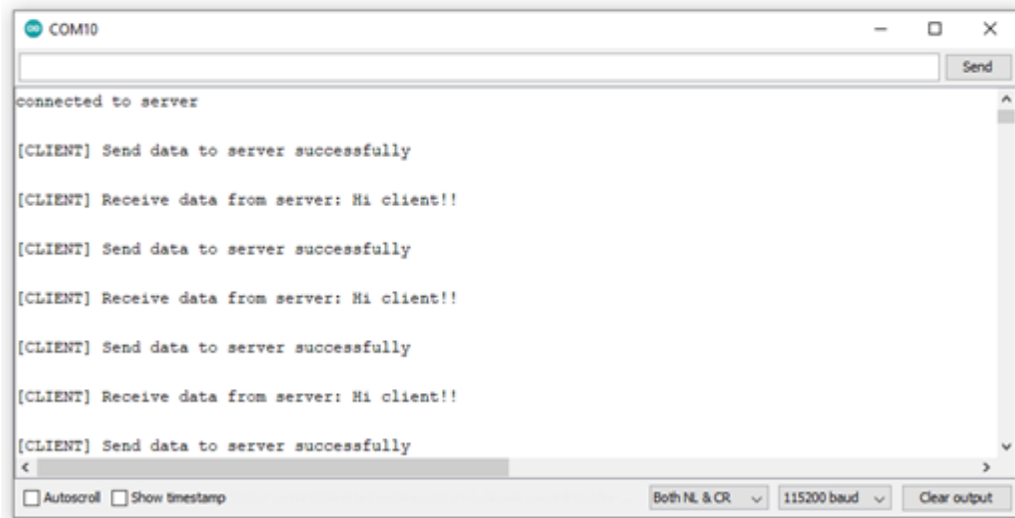
Open Serial Monitor on the port to the second Ameba D, you should see server and client are sending text message to each other at the same time.



```

[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully
[SERVER] Receive data: Hi Server!!
[SERVER] Send data successfully

```



## MDNS - Set up mDNS Client on Arduino IDE

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

mDNS (Multicast DNS) is a protocol used in the local area network. It delivers the network information like IP address and provided services to others. mDNS is based on the UDP protocol, and it sends packets to 224.0.0.251 with port 5353 under IPv4 address. The naming style for the service follows the format: **{Instance Name}.{Protocol Name}.{Domain}**

- Instance Name: used to identify the name of the service
- Protocol Name: Divided into two parts, the front end is in regard to the name of the service, and it adds baseline as a prefix. The rear end is in regard to the transport protocol name it used, and it also adds baseline as a prefix
- Domain: Local area network in normal cases

For example, Arduino IDE adopts the naming for the mDNS service which is used in OTA as following: **MyAmeba.\_arduino.\_tcp.local**

Among the naming example, “MyAmeba” can identify the Ameba device name and the name “MyAmeba” is changeable. “\_arduino.\_tcp” is the protocol that Arduino IDE adopts, and the Domain is set as local in common.

Open the example, “File” -> “Examples” -> “AmebaMDNS” -> “mdns\_on\_arduino\_ide”

You need to input ssid and password of the AP because the example will use WiFi connection.

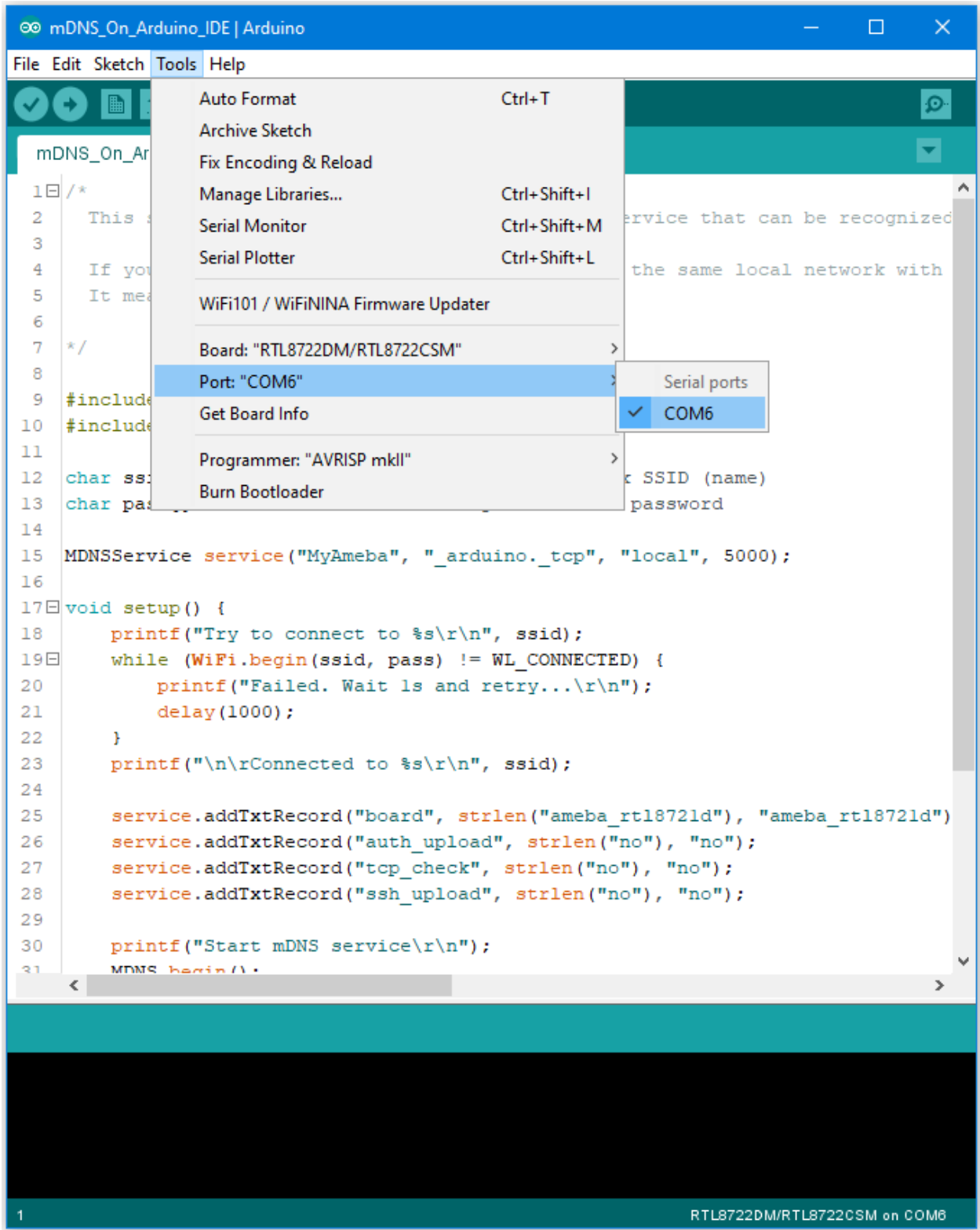
And you can find out the naming of the service at the place where it declares MDNS Service. The example uses the default name “MyAmeba” and the name is changeable.

```

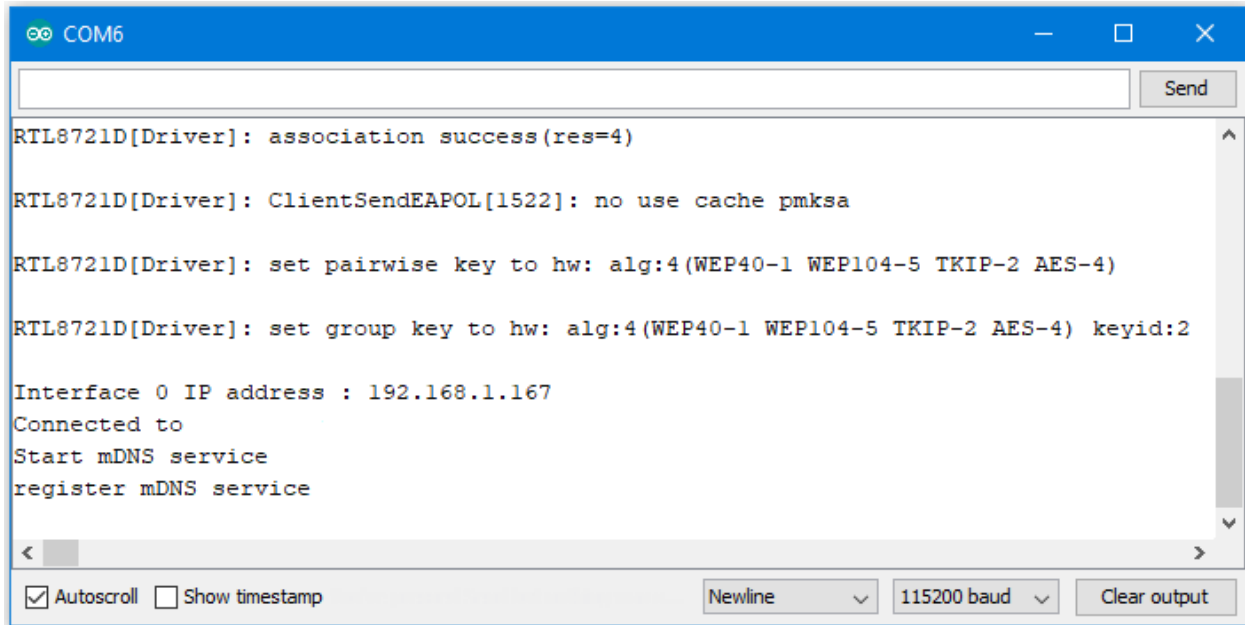
1  /*
2   This sketch shows how to register Ameba as a service that can be recognized
3
4   If your computer that run Arduino IDE stays in the same local network with
5   It means the Arduino IDE find Ameba via mDNS.
6
7   */
8
9   #include <WiFi.h>
10  #include <AmebaMDNS.h>
11
12  char ssid[] = "yourNetwork"; // your network SSID (name)
13  char pass[] = "secretPassword"; // your network password
14
15  MDNSService service("MyAmeba", "_arduino._tcp", "local", 5000);
16
17  void setup() {
18      printf("Trv to connect to %s\r\n", ssid);

```

Next, go to ( “Tools” -> “Port” ), and you can find out at least one Serial Port. This port is simulated by Ameba board via USB. Choose this port and upload the compiled code to



After uploading the code, press the reset button on Ameba and waiting for Ameba to connect with AP and activate the mDNS service after a while. You can see the Log at the bottom of the Serial Monitor.



```
RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

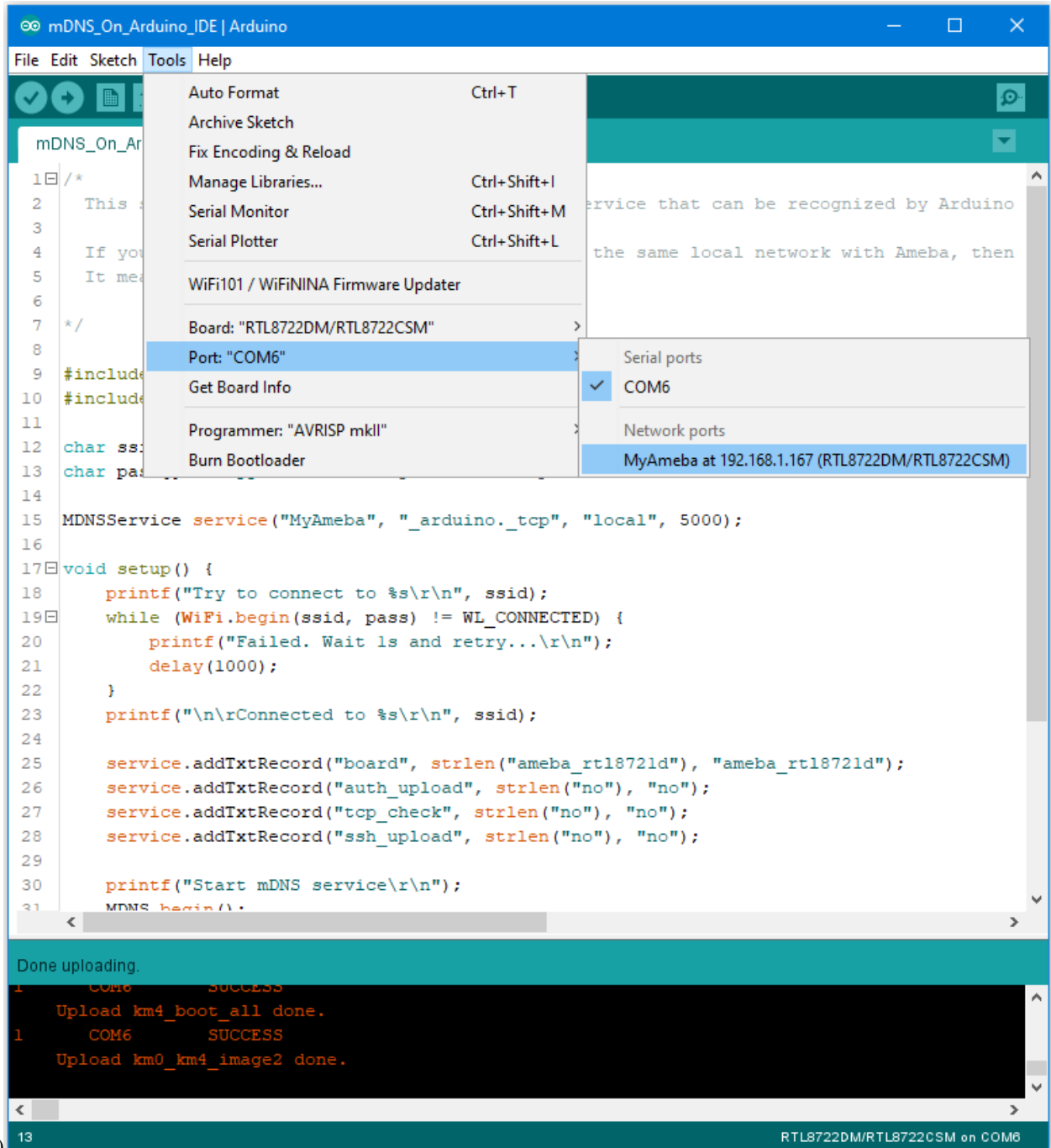
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
Connected to
Start mDNS service
register mDNS service
```

The screenshot shows a serial monitor window with a blue title bar labeled 'COM6'. It contains a text area with several lines of log output from the RTL8721D driver, including association success, EAPOL client send, and key setting messages. It also shows network interface information: 'Interface 0 IP address : 192.168.1.167', 'Connected to', 'Start mDNS service', and 'register mDNS service'. At the bottom, there are controls for 'Autoscroll' (checked), 'Show timestamp' (unchecked), a 'Newline' dropdown, '115200 baud', and a 'Clear output' button.

Then you can find out the added item “Network Ports” “**MyAmeba at 192.168.1.167 (Ameba RTL8722DM/RTL8722CSM)**”, “MyAmeba” is the device name we set up, and “IP” is the IP address that AP assigned to Ameba, the IP address should be the same with the IP shown in the Serial Monitor. Last, “Ameba RTL8722DM/RTL8722CSM” is the type name of the board, and it means that Ameba can let Arduino IDE identify the mDNS service successfully.(We still can not use the Internet to upload the code, and we will explain this part in the OTA exam-



ple.)

If you cannot find the Network ports on your Arduino IDE, please check:

- Does your computer in the same local area network with the Ameba?
- Restart the Arduino IDE, and it will find the mDNS service again
- Check the Log in Serial Monitor if the Ameba connects to the AP and activate mDNS service successfully

## Code Reference

The program set up the mDNS service in the beginning, the first parameter is Instance Name, and it is changeable in this example. The second parameter is the protocol that the service used, and it would be “\_arduino.\_tcp” for Arduino IDE. The third parameter is Domain, and it would be “local” in common. The fourth parameter is the port number for the service, it is 5000 here and we doesn't use it in the example.

```
MDNSService service("MyAmeba", "_arduino._tcp", "local", 5000);
```

After connected to the network, we set up some text fields for the service. For the following example, “board” is the name of the field, “ameba\_rtl8721d” is the value of the field. “board” is used to let Arduino IDE check installed SDK to see if it exists known device or not. We will use the name of the device if there is known device, users can change “ameba\_rtl8721d” to “yun” or other names to find out what's the difference if interested.

```
service.addTxtRecord("board", strlen("ameba_rtl8721d"), "ameba_rtl8721d");
```

Then we add three text fields “auth\_upload”, “tcp\_check”, and “ssh\_upload”, this example does not activate these services.

```
service.addTxtRecord("auth_upload", strlen("no"), "no");
service.addTxtRecord("tcp_check", strlen("no"), "no");
service.addTxtRecord("ssh_upload", strlen("no"), "no");
```

Next we activate MDNS

```
MDNS.begin();
```

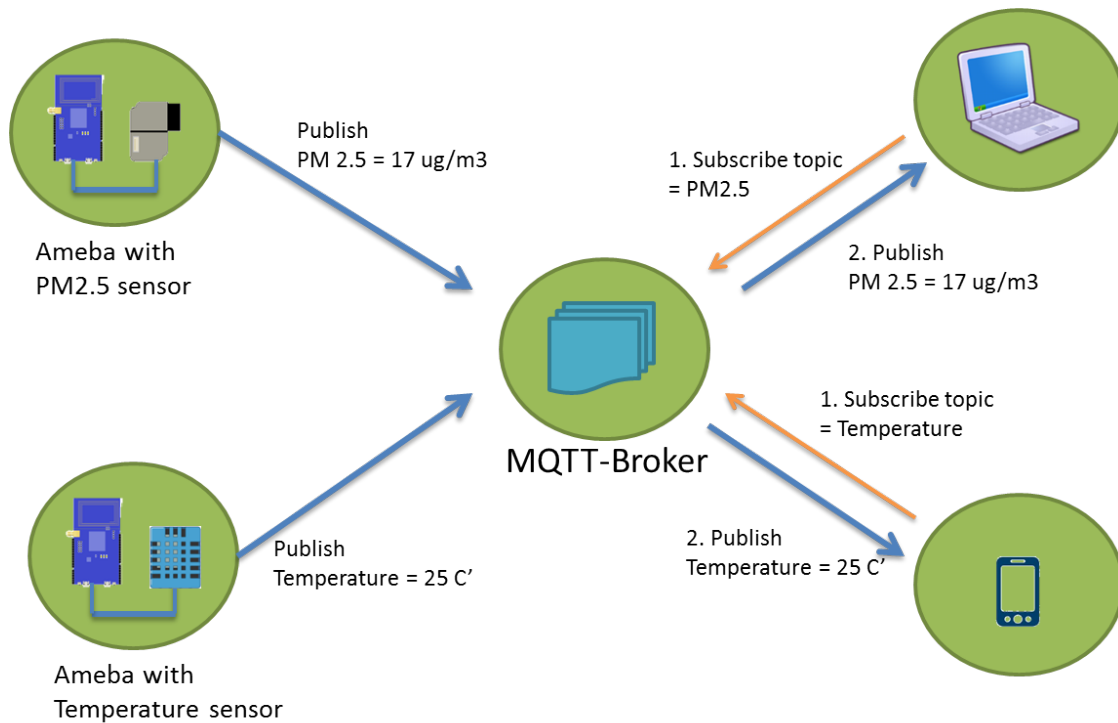
and register to the mDNS service.

```
MDNS.registerService(service);
```

## MQTT - Set up MQTT Client to Communicate with Broker

### Intro to MQTT

MQTT (Message Queuing Telemetry Transport) is a protocol proposed by IBM and Eurotech. The introduction in [MQTT Official Website](#): MQTT is a machine-to-machine (M2M)/“Internet of Things” connectivity protocol. It was designed as an extremely lightweight publish/subscribe messaging transport. We can say MQTT is a protocol designed for IoT. MQTT is based on TCP/IP and transmits/receives data via publish/subscribe. Please refer to the figure below:



In the operation of MQTT, there are several roles:

- **Publisher:** Usually publishers are the devices equipped with sensors (ex. Ameba). Publishers uploads the data of the sensors to MQTT-Broker, which serves as a database with MQTT service.
- **Subscriber:** Subscribers are referred to the devices which receive and observe messages, such as a laptop or a mobile phone.
- **Topic:** Topic is used to categorized the messages, for example the topic of a message can be “PM2.5” or “Temperature” . Subscribers can choose messages of which topics they want to receive.

## Preparation

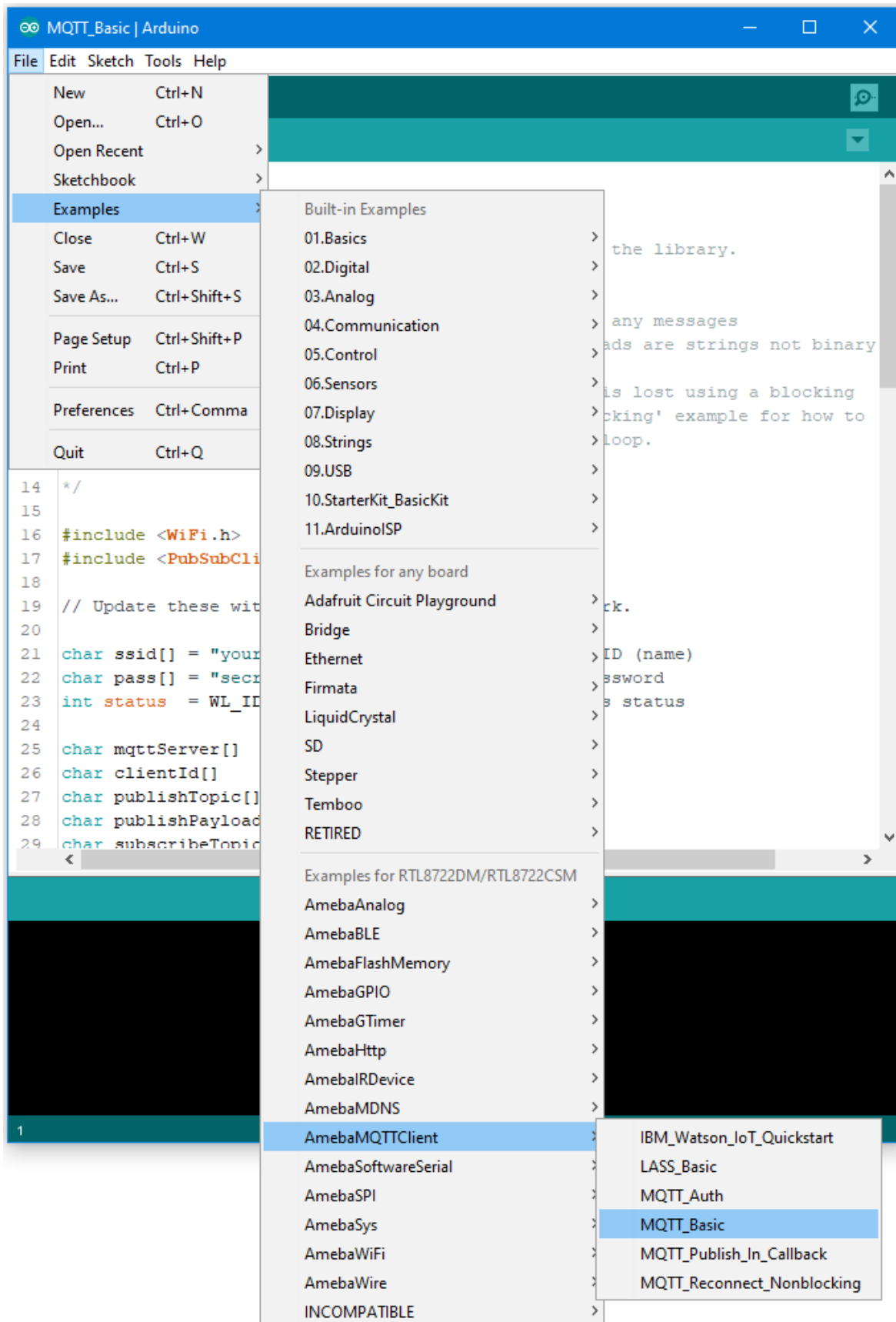
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

## Example

In this example, we connect Ameba to MQTT-Broker. Then send messages as publisher and receive messages from MQTT-Broker as subscriber.

Open the MQTT example “File” -> “Examples” -> “AmebaMQTTClient” -> “MQTT\_Basic”





Please modify some WiFi-related parameters.

And some information related to MQTT:

MQTT\_Basic | Arduino

File Edit Sketch Tools Help

MQTT\_Basic

```
6   - publishes "hello world" to the topic "outTopic"
7   - subscribes to the topic "inTopic", printing out any messages
8     it receives. NB - it assumes the received payloads are strings not binary
9
10  It will reconnect to the server if the connection is lost using a blocking
11  reconnect function. See the 'mqtt_reconnect_nonblocking' example for how to
12  achieve the same result without blocking the main loop.
13
14  */
15
16  #include <WiFi.h>
17  #include <PubSubClient.h>
18
19  // Update these with values suitable for your network.
20
21  char ssid[] = "yourNetwork";    // your network SSID (name)
22  char pass[] = "secretPassword"; // your network password
23  int status  = WL_IDLE_STATUS;   // the Wifi radio's status
24
25  char mqttServer[] = "test.mosquitto.org";
26  char clientId[]   = "amebaClient";
27  char publishTopic[] = "outTopic";
28  char publishPayload[] = "hello world";
29  char subscribeTopic[] = "inTopic";
30
31  void callback(char* topic, byte* payload, unsigned int length) {
32      Serial.print("Message arrived [");
33      Serial.print(topic);
34      Serial.print("] ");
```

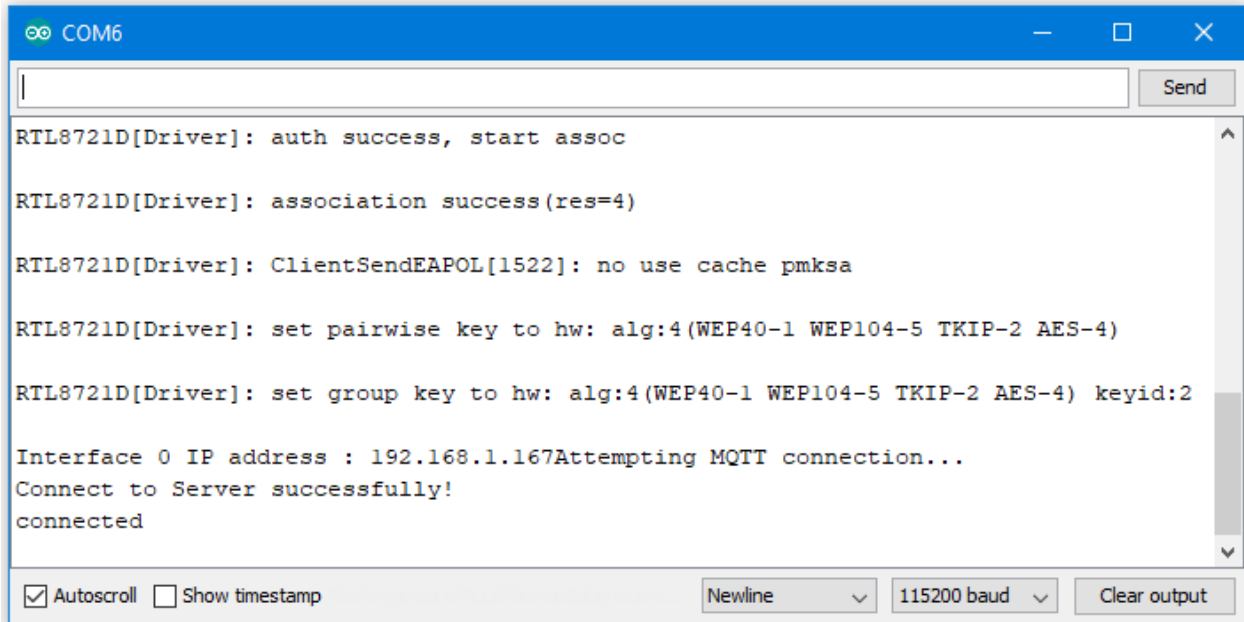
1

RTL8722DM/RTL8722CSM on COM6

The “mqttServer” refers to the MQTT-Broker, we use the free MQTT sandbox “test.mosquitto.org” for testing.

- “clientId” is an identifier for MQTT-Broker to identify the connected device.
- “publishTopic” is the topic of the published message, we use “outTopic” in the example. The devices subscribe to “outTopic” will receive the message.
- “publishPayload” is the content to be published.
- “subscribeTopic” is to tell MQTT-broker which topic we want to subscribe to.

Next, compile the code and upload it to Ameba. Press the reset button, then open the serial monitor



```

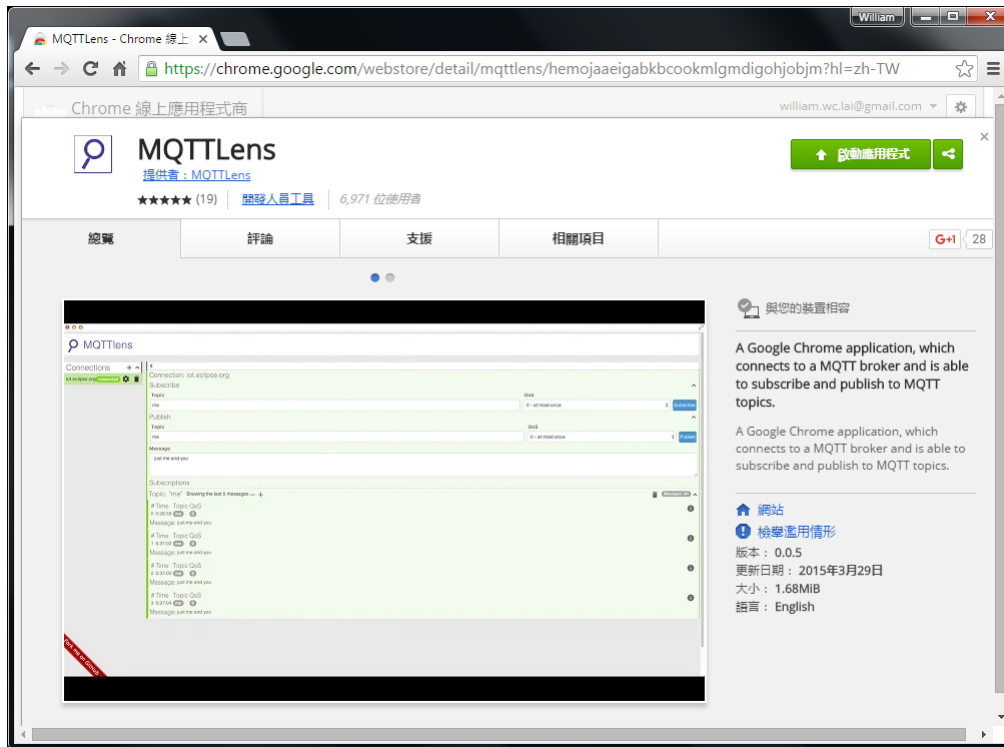
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=4)
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2
Interface 0 IP address : 192.168.1.167Attempting MQTT connection...
Connect to Server successfully!
connected

```

After Ameba is connected to MQTT server, it sends the message “hello world” to “outTopic” .

To see the message, we need another MQTT client.

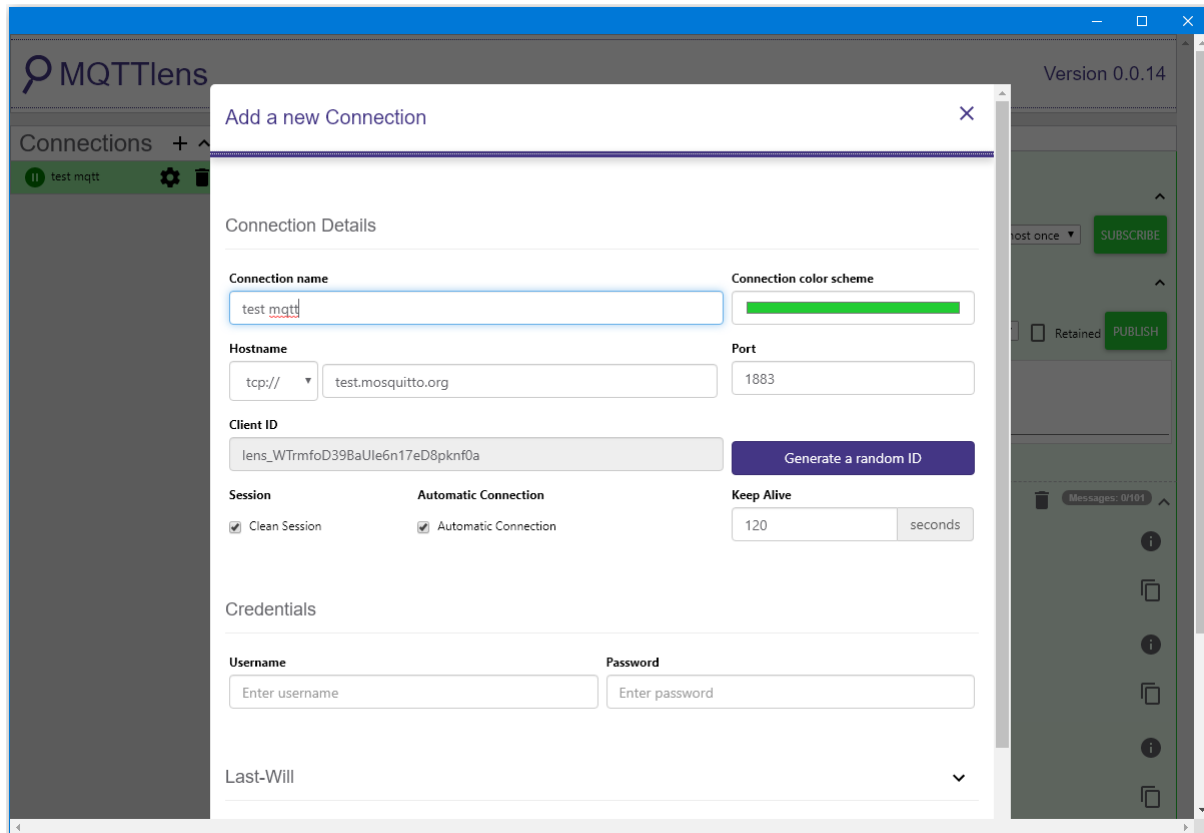
Here we use a chrome plugin “MQTTLens” to be the MQTT client. You can find it in google webstore.



Install and open the MQTTLens, click “+” next to “Connection” on the left, and fill in the required information

- **Connection Name:** Used to identify the connection, you can choose a name you like.
- **Hostname:** The MQTT-Broker server, here we use “iot.eclipse.org”
- **Client ID:** We use the default randomly generated ID.

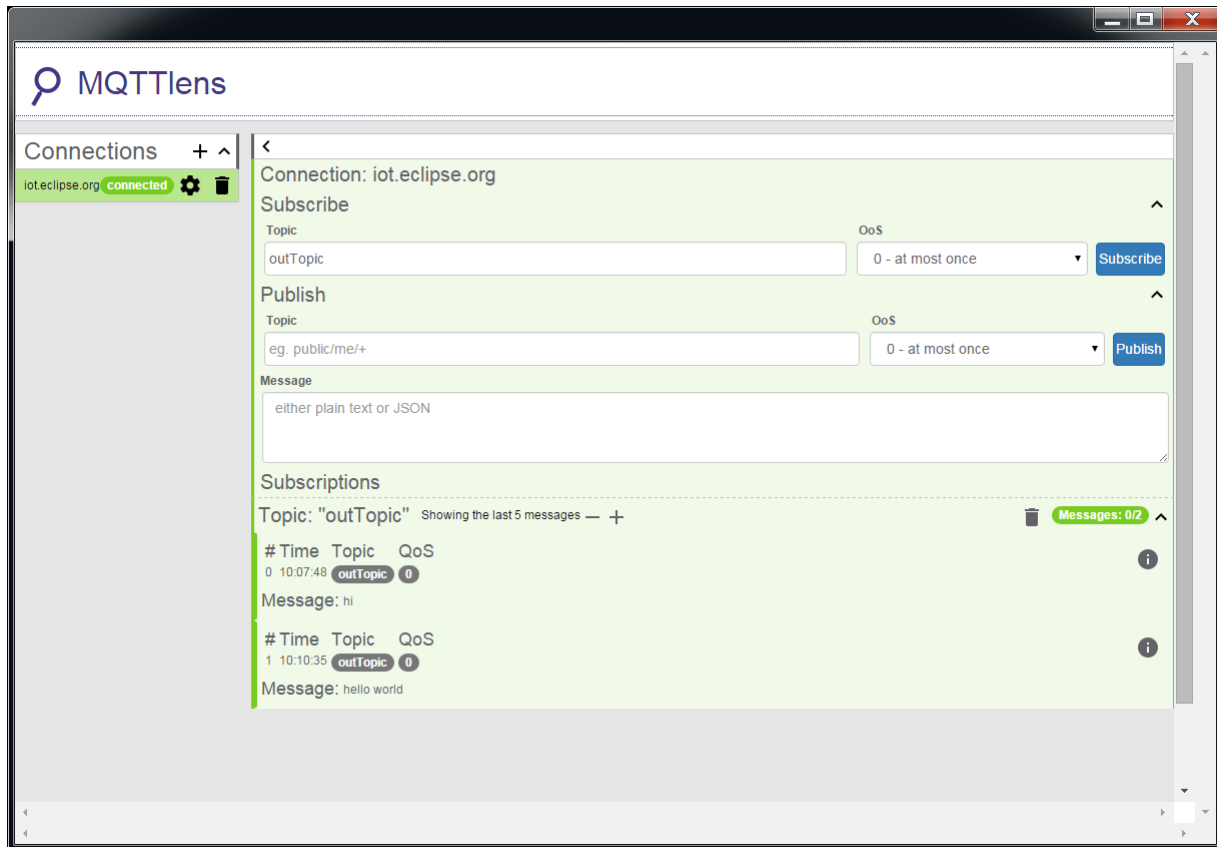
Then click “CREATE CONNECTION” .



Since we have not registered the topic we want to listen to, we would not receive any messages now.

Fill in “outTopic” in the “Topic” field and click “Subscribe” .

Wait for Ameba to send next message (or you can press the reset button). Then you can see the “hello world” message show up.



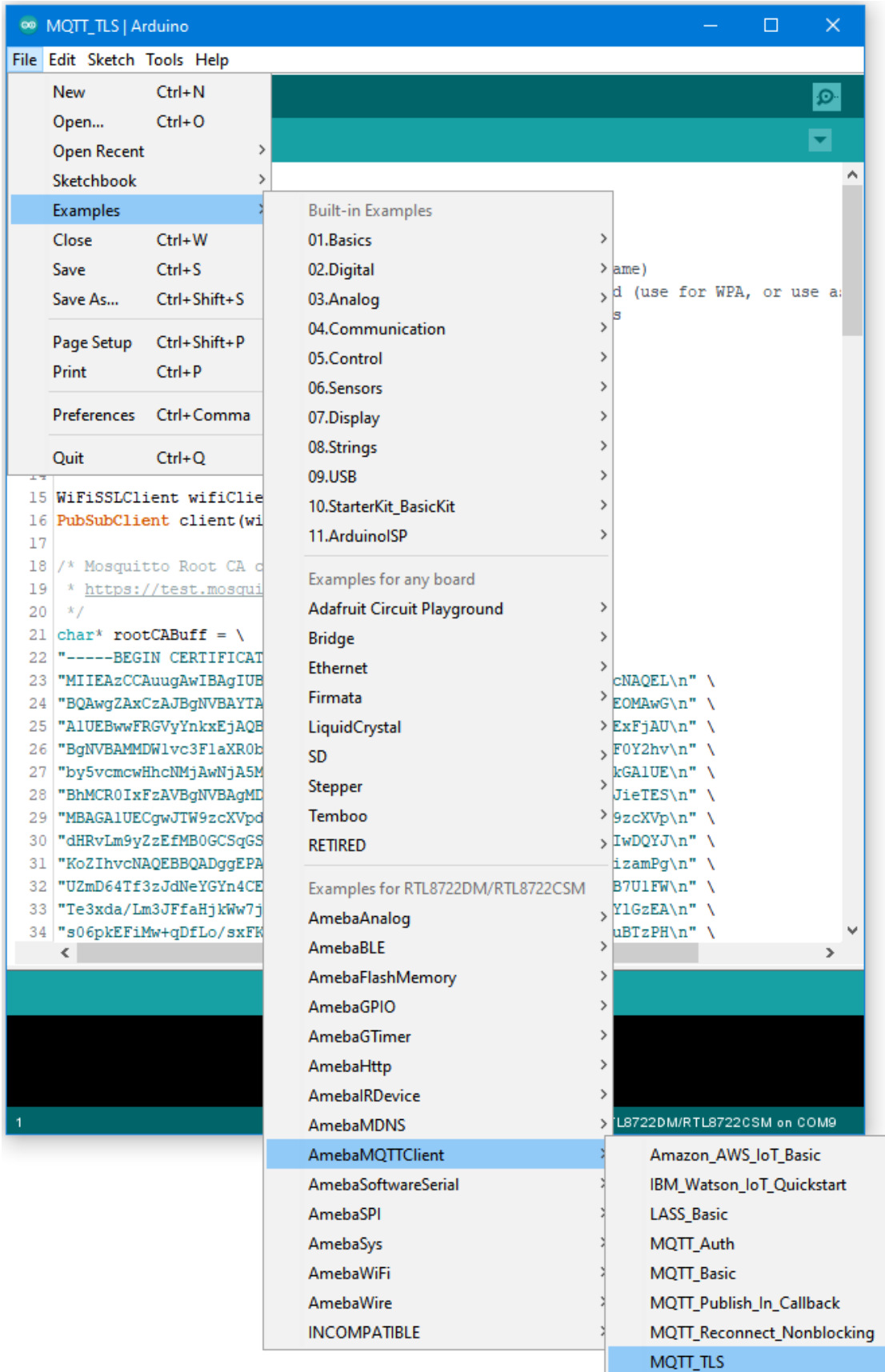
## MQTT - Set up MQTT Client over TLS

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we connect Ameba to a MQTT broker using TLS authentication. Then send messages as a publisher and receive messages from as a subscriber. Open the MQTT example “File” -> “Examples” -> “AmebaMQTTClient” -> “MQTT\_TLS”



Please modify the WiFi-related parameters to connect to your WiFi network.

Modify the MQTT parameters to fit your application:

```
MQTT_TLS | Arduino
File Edit Sketch Tools Help

MQTT_TLS

1 #include <WiFi.h>
2 #include <PubSubClient.h>
3
4 // Update these with values suitable for your network.
5 char ssid[] = "yourNetwork"; // your network SSID (name)
6 char pass[] = "yourPassword"; // your network password (use for WPA, or use a
7 int status = WL_IDLE_STATUS; // the Wifi radio's status
8
9 char mqttServer[] = "test.mosquitto.org";
10 char clientId[] = "amebaClient";
11 char publishTopic[] = "outTopic";
12 char publishPayload[] = "hello world";
13 char subscribeTopic[] = "inTopic";
14
15 WiFiSSLClient wifiClient;
16 PubSubClient client(wifiClient);
17
18 /* Mosquitto Root CA can be download here:
19 * https://test.mosquitto.org/
20 */
21 char* rootCABuff = \
22 "-----BEGIN CERTIFICATE-----\n" \
23 "MIIEAzCCAuugAwIBAgIUBY1hlCGvdj4NhBXkZ/uLUZNI LAwwDQYJKoZIhvcNAQEL\n" \
24 "BQAwGzAxChAJBgNVBAYTAkdCMRcwFQYDVQQIDAA5Vbml0ZWQgS2luZ2RvbTEOMAwG\n" \
25 "A1UEBwwFRGVyYnkvEjAQBgNVBAoMCMU1vc3FlaXR0bzELMAkGA1UECwwCQ0ExFjAU\n" \
26 "BgNVBAMMDWlvc3FlaXR0by5vcmcxHzAdBgqhkiG9w0BCQEWEHJvZ2VyQG0Y2hv\n" \
27 "by5vcmcwHhcNMjAwNjA5MTEwNjM5WheNMzAwNjA3MTEwNjM5WjCBkDELMAkGA1UE\n" \
28 "BhmCR0IxPzAVBgNVBAGMD1VuaXRlZCBLaW5nZG9tMQ4wDAYDVQQHDAVEZXXJieTES\n" \
29 "MBAGA1UECgwJTW9zcXVpdHRvMQswCQYDVQQLDAJDQTEWMBQGA1UEAwNBW9zcXVp\n" \
30 "dHRvLm9yZzEfMB0GCSqGSIb3DQEJARYQcm9nZXJAYXRjaG9vLm9yZzCCASIwDQYJ\n" \
31 "KoZIhvcNAQEBBQADggEPADCCAQoCggEBAME0HKmIzftOwkKLT3THHe+ObdizamPg\n" \
32 "UZmD64Tf3zJdNeYGYn4CEXbyP6fy3tWcS2boW6dZrH8SdFf9uo320GJA9B7U1FW\n" \
33 "Te3xda/Lm3JffaHjKw7jBwcauQZjpGINHapHRlpiCZsquAthOgxW9SgDgY1GzEA\n" \
34 "s06pkEfIMw+qDfLo/sxFKB6vQlFekMeCymjLCbNwPjYqyhFmPwwio/PDMruBTzPH\n" \
```



The “mqttServer” refers to the MQTT-Broker, we use the free MQTT sandbox “test.mosquitto.org” for testing.

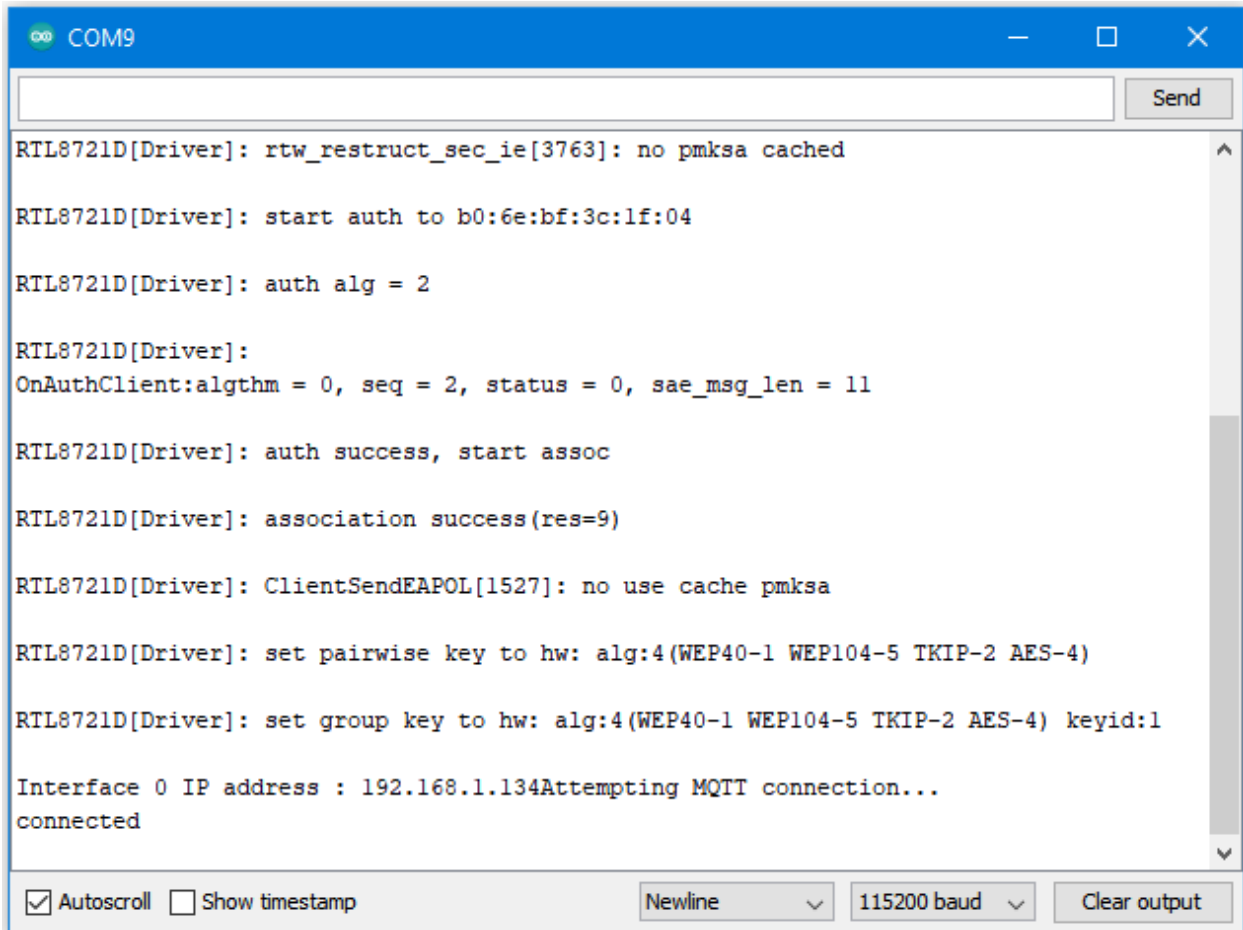
“clientId” is an identifier for MQTT-Broker to identify the connected device.

“publishTopic” is the topic of the published message, we use “outTopic” in the example. The devices subscribe to “outTopic” will receive the message.

“publishPayload” is the content to be published.

“subscribeTopic” is to tell MQTT-broker which topic we want to subscribe to.

Next, compile the code and upload it to Ameba. Press the reset button, then open the serial monitor



```

COM9
Send

RTL8721D[Driver]: rtw_restruct_sec_ie[3763]: no pmksa cached

RTL8721D[Driver]: start auth to b0:6e:bf:3c:1f:04

RTL8721D[Driver]: auth alg = 2

RTL8721D[Driver]:
OnAuthClient:alghm = 0, seq = 2, status = 0, sae_msg_len = 11

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=9)

RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.1.134Attempting MQTT connection...
connected

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

After Ameba is connected to MQTT server, it sends the message “hello world” to “outTopic” . To see the message, use another MQTT client. Refer to the MQTT\_Basic example guide on how to setup a PC-based MQTT client.

If you wish to use TLS client authentication in addition to server authentication, you will need to generate an OpenSSL private key and obtain a signed certificate from the server. For testing purposes, signed certificates can be obtained from test.mosquitto.org by following the guide at <https://test.mosquitto.org/ssl/>.

Replace the character strings “certificateBuff” and “privateKeyBuff” with your signed certificate and OpenSSL private key, ensuring that they are formatted the same way as the shown in the example code. Also uncomment the highlighted code to enable client authentication, and to change the MQTT port number.

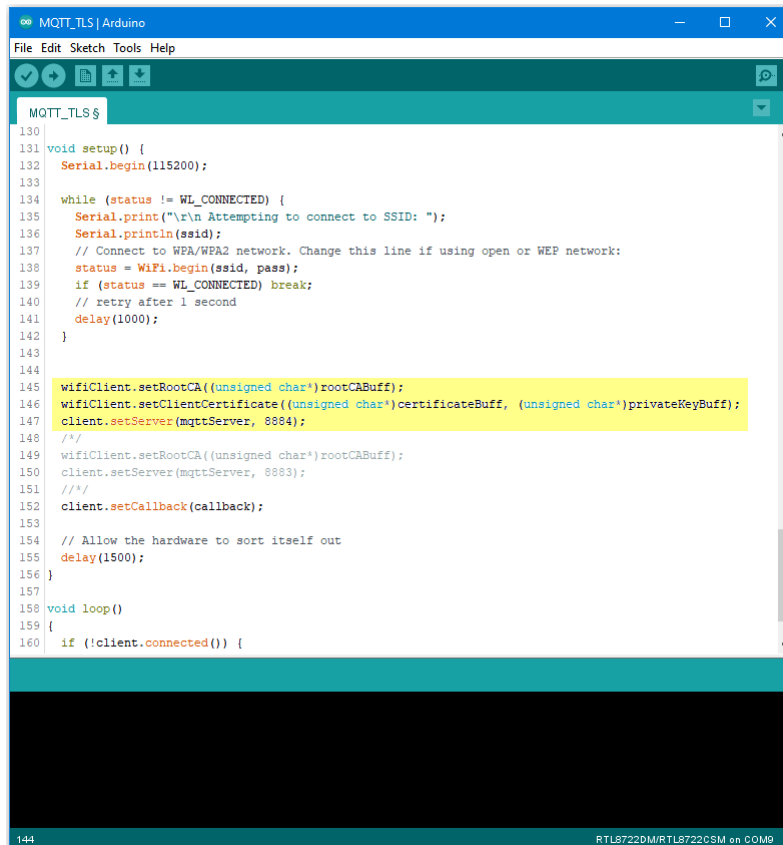
```

MQTT_TLS | Arduino
File Edit Sketch Tools Help

MQTT_TLS
45 "-----END CERTIFICATE-----\n";
46
47 char* certificateBuff = \
48 "-----BEGIN CERTIFICATE-----\n" \
49 "MIIDjTCCAnWgAwIBAgIBADANBgkqhkiG9w0BAQsFADCBkDELMAkGA1UEBhMCR0Ix\n" \
50 "FzAVBgNVBAGMD1VuaXRlZCBLaW5nZG9tMQ4wDAYDVQQHDAVEZXJieTESMBAGAlUE\n" \
51 "CgwJTW9zcXVpdHRvMQswCQYDVQQLDAJQTEWMBQGA1UEAwNBW9zcXVpdHRvLm9y\n" \
52 "ZzEfMB0GCSqGSIb3DQEJARYQcm9nZXJAYXRjaG9vLm9yZzAeFw0yMDA3MTcxMDM0\n" \
53 "MjRaFw0yMDEwMTUxMDM0MjRaMGcxZzAJBgNVBAYTA1NHMRIwEAYDVQQIDAlTaW5n\n" \
54 "YXBvcnUxZjAQBgNVBACMCVnpbmdhcG9yZTEQMA4GA1UECgwHUmVhbHRlZEMMAoG\n" \
55 "AlUECwWDU0QzMRAdDgYDVQDDAdhdXJpY2FsMIIIBIjANBgkqhkiG9w0BAQEFAAO\n" \
56 "AQ8AMIIBCGKCAQEA moglck7TyKdDw/943tfGLvwY/rz6DCZkosOQCYEZhjMSjX4M\n" \
57 "BNcCU/rhwm8EP+luYZfHrdsijalMuSUGUOi9Ylt+SqzYLvvgLi8+h3LIGiGvqghs\n" \
58 "97iyWNulWfWEMqBxjRVAI7/+u3b/lZtkz9UBN7+/y4jGLTsaW4IRQ5qCwt58ov+Q\n" \
59 "QU2PYS8qMlCRTxaokXOiLnBkxsOTq+aKLTdlx8nHjXSNCnOPjz zc4pq7rMjGyzq5\n" \
60 "edrO/pX9yFjD+wTGyssdnhTBgL8xTsx7mfDfpgdT/Bk7wZWQyfLosssdYLGqU6MN\n" \
61 "8wIl3wmqBymHAeFkihMBf4kDlglWLYZuziBWSwIDAQABoxowGDAJBgNVHRMEAjAA\n" \
62 "MAsGAlUdDwQEAwIF4DANBgkqhkiG9w0BAQsFAAOCAQEASqd/fRlpuUgehZMjzRNO\n" \
63 "RADV/gjX/UkWhlu66HbWhPDTuu5Nesms79bR7IbnP0umdt8nYdrW/ersTTFYkEv\n" \
64 "7rV6xlatPjXhuzlbwYeRSglcG+3cjiyFmMr2tlaVHMPXzfHBBEwOvbqIonPQnEe9\n" \
65 "6X0j/10xKMdsVKCb9OpAqlfDd4199M6t1TJiqaZ6OVAGpJ/ga0LNU0MNHPU8s68X\n" \
66 "ODZA8GwI0lkQUxUkrmaYmth3R4A3uIYfs4ff9u71TgT9wtnwQftacHhVAmF+hQpW\n" \
67 "luJqKtHI/Ox0Mya0YlaONZavT3WgtxnRmEdAv6gn9WNfko6qr98AqGijX2VZpjRf\n" \
68 "oQ==\n" \
69 "-----END CERTIFICATE-----\n";
70
71 char* privateKeyBuff = \
72 "-----BEGIN RSA PRIVATE KEY-----\n" \
73 "MIIEpAIBAAKCAQEA moglck7TyKdDw/943tfGLvwY/rz6DCZkosOQCYEZhjMSjX4M\n" \
74 "BNcCU/rhwm8EP+luYZfHrdsijalMuSUGUOi9Ylt+SqzYLvvgLi8+h3LIGiGvqghs\n"

```

1 RTL8722DM/RTL8722CSM on COM9



```

MQTT_TLS $
130
131 void setup() {
132   Serial.begin(115200);
133
134   while (status != WL_CONNECTED) {
135     Serial.print("\r\n Attempting to connect to SSID: ");
136     Serial.println(ssid);
137     // Connect to WPA/WPA2 network. Change this line if using open or WEP network:
138     status = WiFi.begin(ssid, pass);
139     if (status == WL_CONNECTED) break;
140     // retry after 1 second
141     delay(1000);
142   }
143
144
145   wifiClient.setRootCA((unsigned char*)rootCABuff);
146   wifiClient.setClientCertificate((unsigned char*)certificateBuff, (unsigned char*)privateKeyBuff);
147   client.setServer(mqttServer, 8884);
148   /*
149   wifiClient.setRootCA((unsigned char*)rootCABuff);
150   client.setServer(mqttServer, 8883);
151   /*
152   client.setCallback(callback);
153
154   // Allow the hardware to sort itself out
155   delay(1500);
156 }
157
158 void loop()
159 {
160   if (!client.connected()) {

```

## MQTT - Use Amazon AWS IoT Shadow Service

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

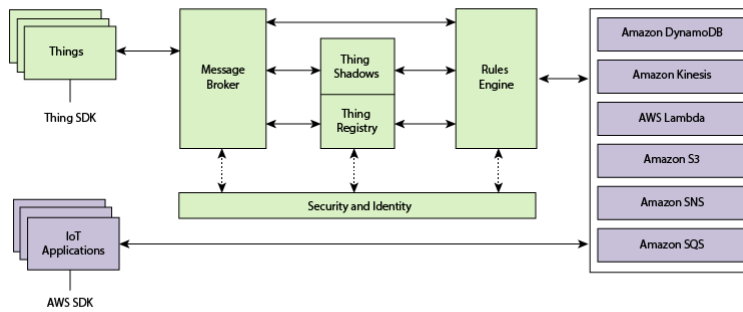
### Example

#### Introduction

Amazon AWS IoT is a cloud IoT service platform:

Amazon AWS IoT is a platform that enables you to connect devices to AWS Services and other devices, secure data and interactions, process and act upon device data, and enable applications to interact with devices even when they are offline. (<https://aws.amazon.com/iot/how-it-works/>)

The service architecture of AWS IoT:



(Picture from <http://docs.aws.amazon.com/iot/latest/developerguide/aws-iot-how-it-works.html> )

In the architecture, Ameba belongs to the upper-left “Things” block. A TLS secure channel will be established between “Things” and the MQTT Message Broker. Afterwards, “Things” and “Message Broker” communicate using MQTT Protocol via this secure channel. Behind the “Message Broker”, the “Thing Shadows” keeps messages temporarily when Ameba is offline, and sends the control message to Ameba next time it is connected. The “Rules Engine” allows you to place restrictions to the behavior of Things or to connect Things to other services of Amazon.

## AWS Management Console

First, create an account and sign up for AWS IoT [service:https://aws.amazon.com/](https://aws.amazon.com/)

Afterwards, log in to the Amazon Management Console and click “IoT Core” found under services -> Internet of Things.

Then you will enter the home page of AWS IoT. To offer the best service quality, Amazon offers servers in different regions for users to choose from.

Click the region dropdown menu at the upper-right:

Ameba Arduino: [RTL819] x AWS IoT x

Secure | https://us-east-2.console.aws.amazon.com/iot/home?region=us-east-2#/home

aws Services Resource Groups testteam Ohio Support

## AWS IoT

AWS IoT is a managed cloud platform that lets connected devices - cars, light bulbs, sensor grids, and more - easily and securely interact with cloud applications and other devices.

[Get started](#)

### Connect and manage your devices

Connect devices to the cloud using the protocol that best fits your requirements - HTTP, MQTT, or WebSocket. Devices can communicate with each other even if they are using different protocols.

[Learn more](#)

### Process and act upon device data

Filter, transform, and act upon data from devices on the fly, based on business rules. AWS IoT can be easily integrated with AWS services like Amazon DynamoDB, Amazon Kinesis, Amazon Machine Learning, and AWS Lambda.

[Learn more](#)

### Read and set device state at any time

AWS IoT stores the latest state of a device so that it can be read or set anytime, even when the device is offline.

[Learn more](#)

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Choose a nearby region.

US East (N. Virginia)  
**US East (Ohio)**  
 US West (N. California)  
 US West (Oregon)  
 Asia Pacific (Mumbai)  
 Asia Pacific (Seoul)  
**Asia Pacific (Singapore)**  
 Asia Pacific (Sydney)  
 Asia Pacific (Tokyo)  
 Canada (Central)  
 EU (Frankfurt)  
 EU (Ireland)  
 EU (London)  
 EU (Paris)  
 South America (São Paulo)

**AWS IoT**

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[Learn more](#)

**Process and act upon device data**

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[Learn more](#)

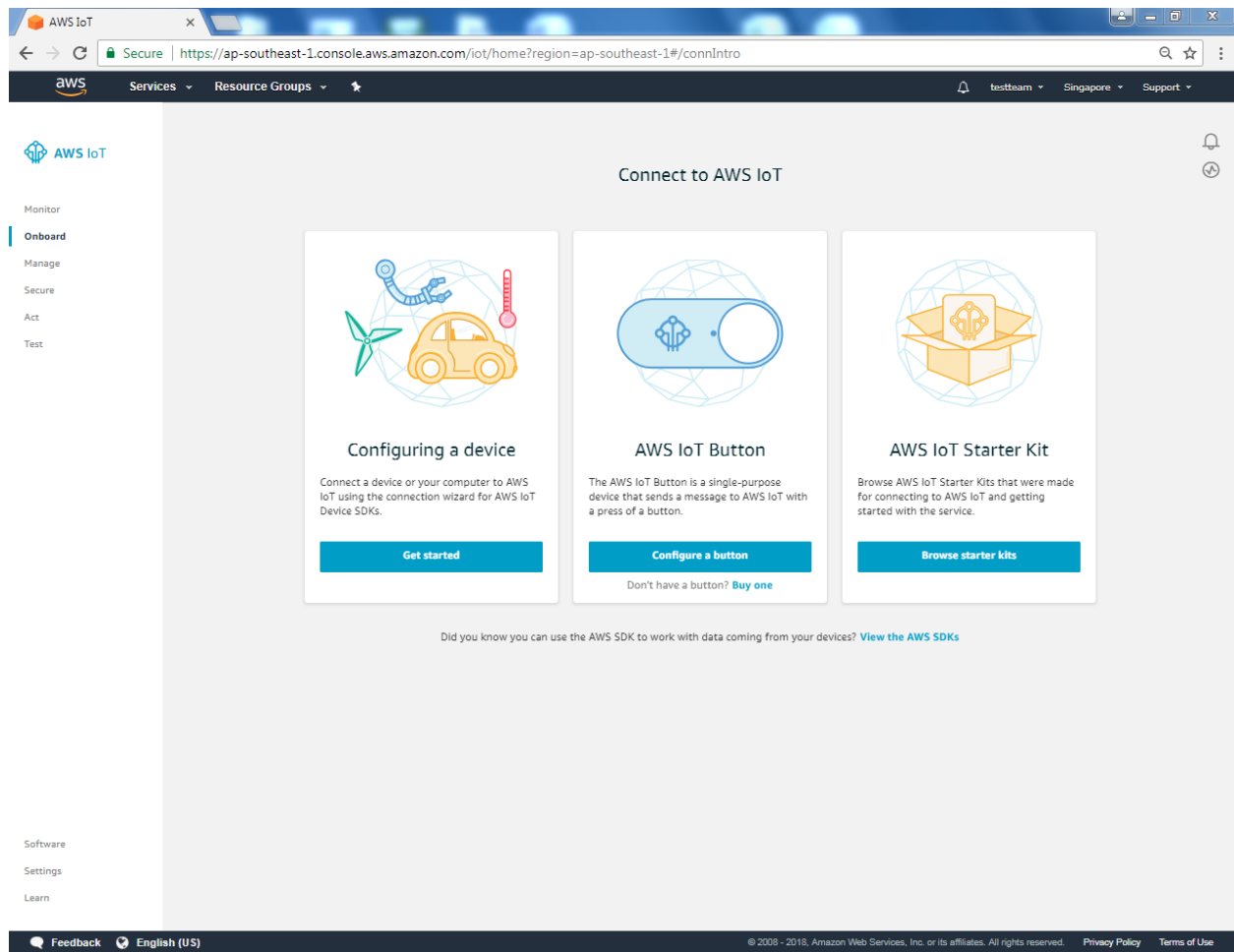
**Read and set device state at any time**

AWS IoT stores the latest state of a device so that it can be read or set anytime, even when the device is offline.

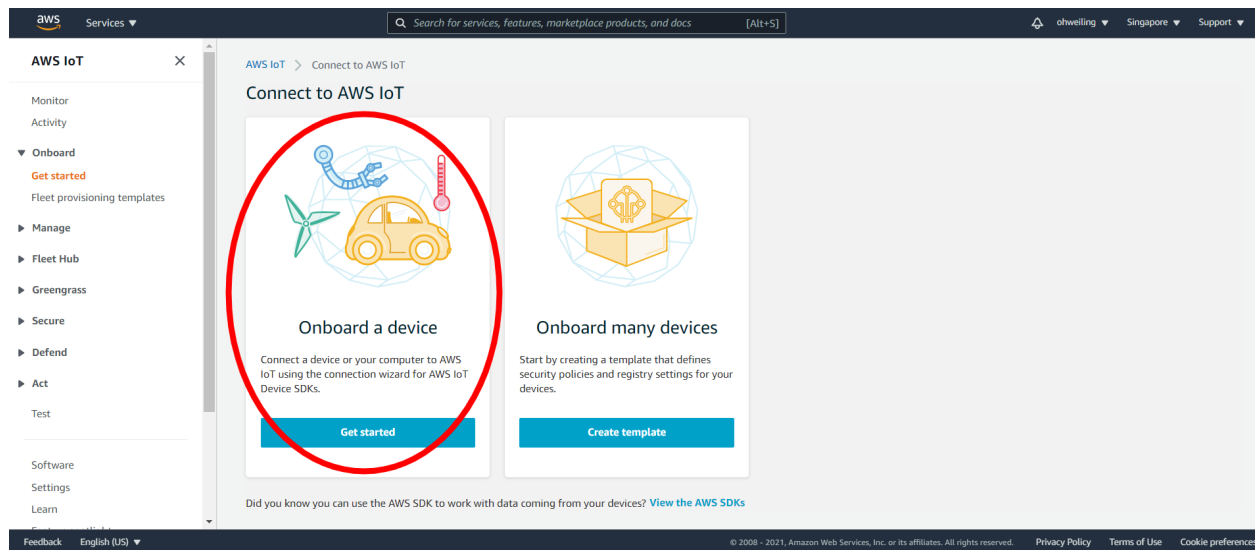
[Learn more](#)

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Then from Services, go to Onboard then Get Started.

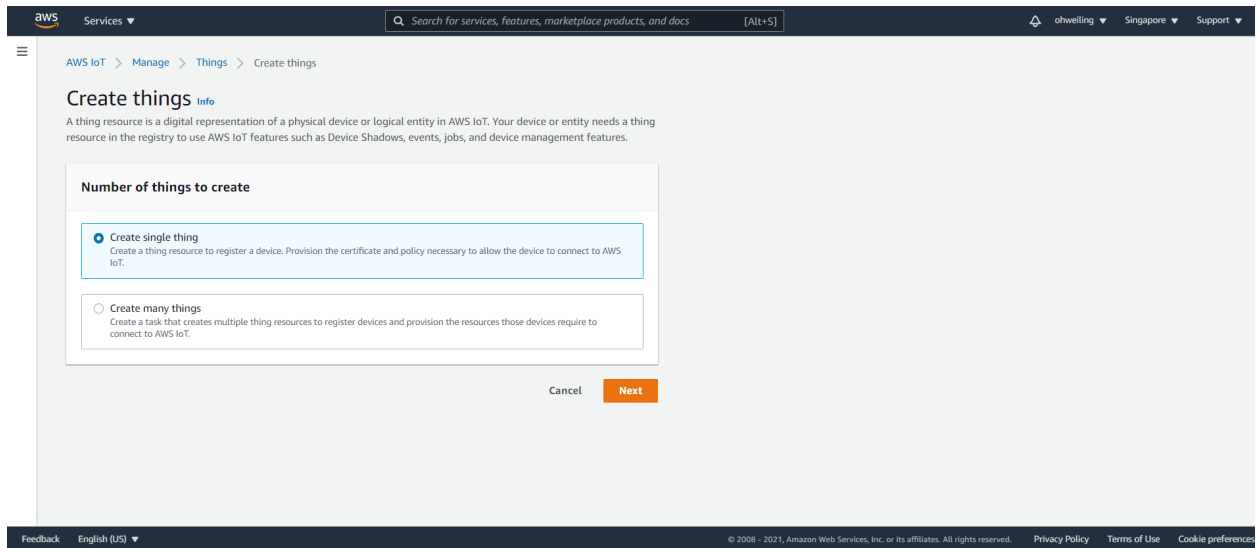


Enter the main page of AWS IoT. Under the Onboard a device, click Get started.





## Click Create single thing



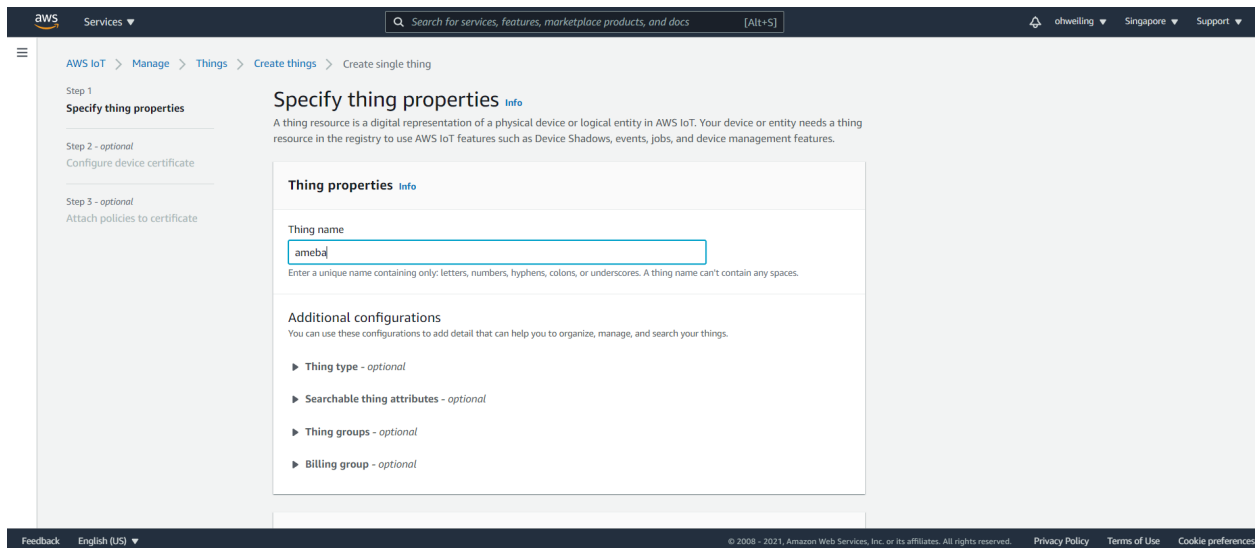
**Number of things to create**

☒ **Create single thing**  
Create a thing resource to register a device. Provision the certificate and policy necessary to allow the device to connect to AWS IoT.

☐ **Create many things**  
Create a task that creates multiple thing resources to register devices and provision the resources those devices require to connect to AWS IoT.

[Cancel](#) [Next](#)

Fill in “ameba” on the name field. Attributes represent the status of Ameba.



**Specify thing properties**

**Thing name**  
ameba  
Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

**Additional configurations**  
You can use these configurations to add detail that can help you to organize, manage, and search your things.

- ▶ **Thing type - optional**
- ▶ **Searchable thing attributes - optional**
- ▶ **Thing groups - optional**
- ▶ **Billing group - optional**

Under the searchable thing attributes. The value of the attributes can be updated directly by Ameba or by the control side and control side can request Ameba to set the attribute to desired value.

Here we add an attribute named “led” with value “0” and click “Next” .

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

**Thing properties** [Info](#)

**Thing name**

ameba

Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

**Additional configurations**

You can use these configurations to add detail that can help you to organize, manage, and search your things.

▶ **Thing type - optional**

▼ **Searchable thing attributes - optional**

Add searchable attributes to allow your thing to be grouped and searched without using fleet indexing.

Searchable attribute	Value - optional	
led	0	Remove

[Add new attribute](#)

You can add up to 2 more attributes.

▶ **Thing groups - optional**

▶ **Billing group - optional**

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Click Skip creating a certificate at this time and then Create thing

**Configure device certificate - optional** [Info](#)

A device requires a certificate to connect to AWS IoT. You can choose how you to register a certificate for your device now, or you can create and register a certificate for your device later. Your device won't be able to connect to AWS IoT until it has an active certificate with an appropriate policy.

**Device certificate**

☐ Auto-generate a new certificate (recommended)  
Generate a certificate, public key, and private key using AWS IoT's certificate authority.

☐ Use my certificate  
Use a certificate signed by your own certificate authority.

☐ Upload CSR  
Register your CA and use your own certificates on one or many devices.

☒ Skip creating a certificate at this time  
You can create a certificate for this thing and attach a policy to the certificate at a later time.

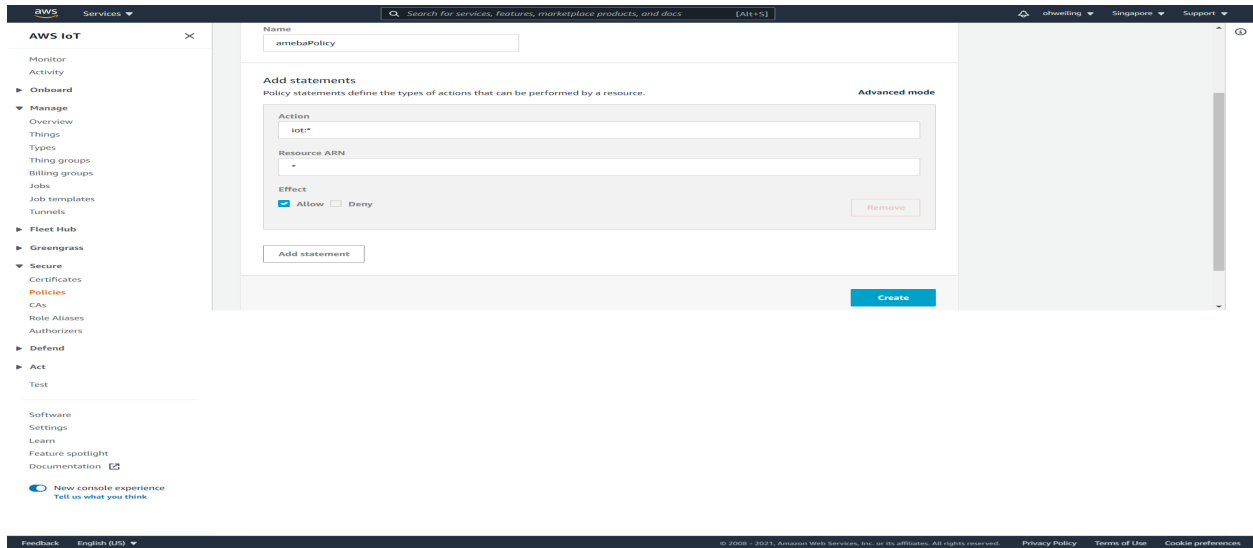
Cancel Previous **Create thing**

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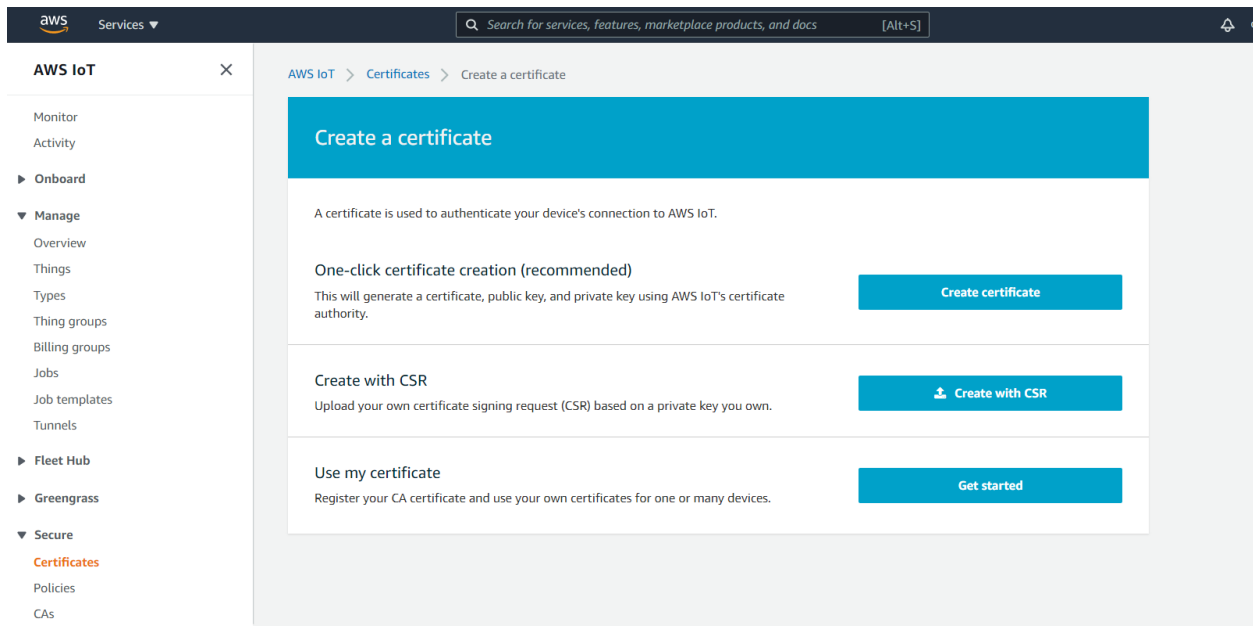
Next, click Policy, and create a policy. Policy is used to restrict the functions that a “thing” can do, it can limit the MQTT actions or specific topic that can be performed. Learn more about policy:

<http://docs.aws.amazon.com/iot/latest/developerguide/authorization.html>

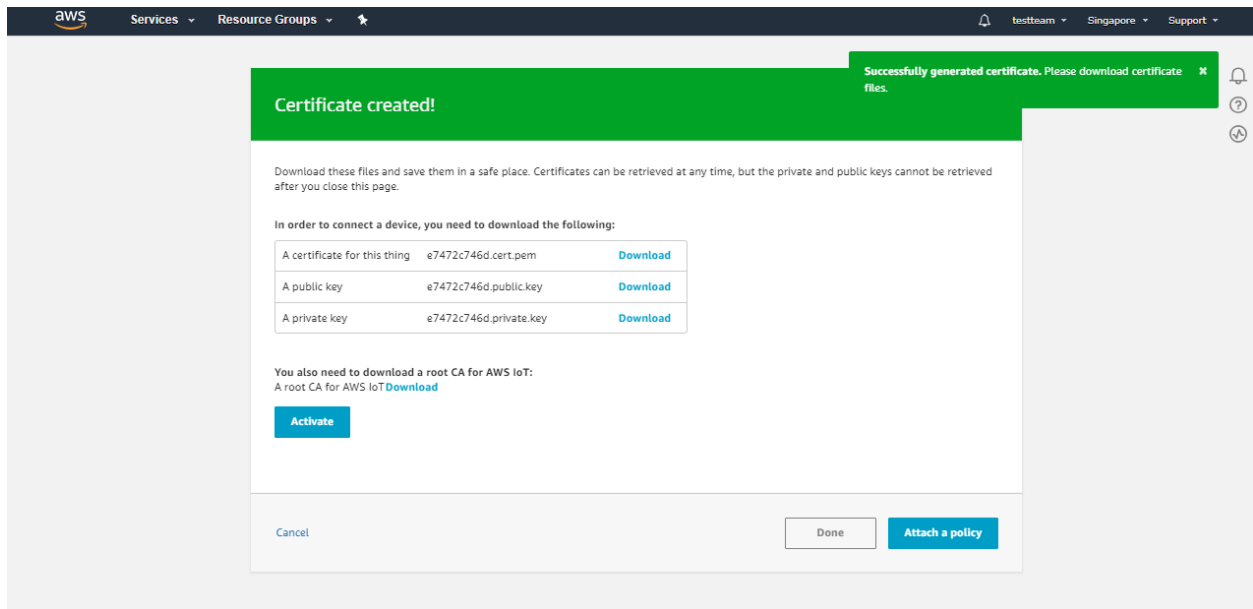
Here we do not place policy on Ameba. Fill in “amebaPolicy” in the Name field, “iot:” in Action field and “\*” in resources field. Then “Allow” . Finally, click “Create” .



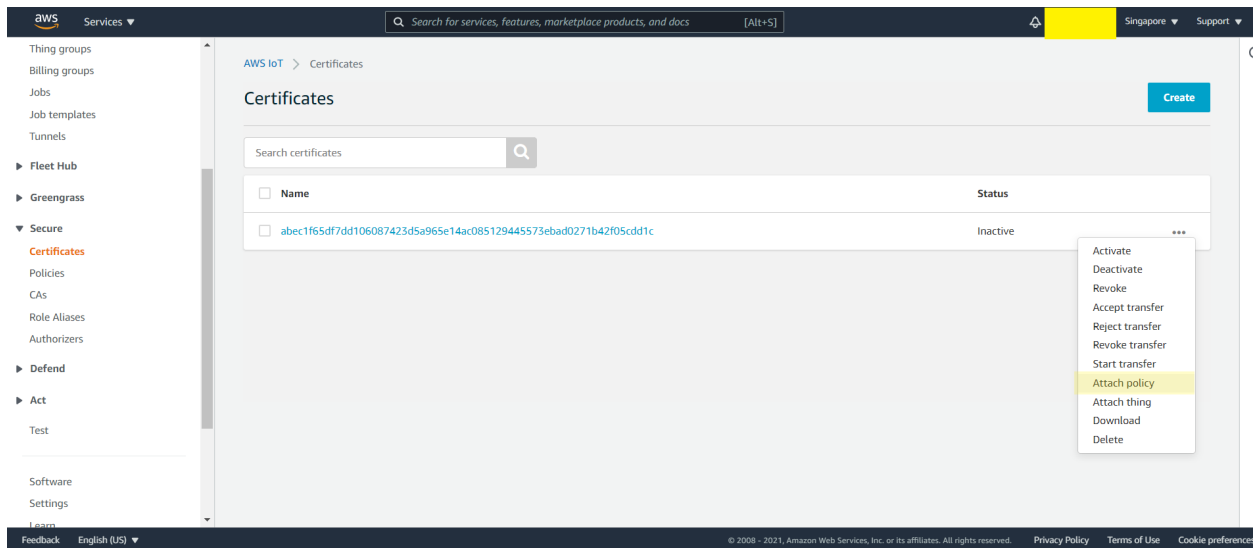
Next, we have to setup the TLS certificate. You can choose to user-defined or generate a certificate by AWS IoT. In this example we click Create Certificate to generate a TLS certificate.



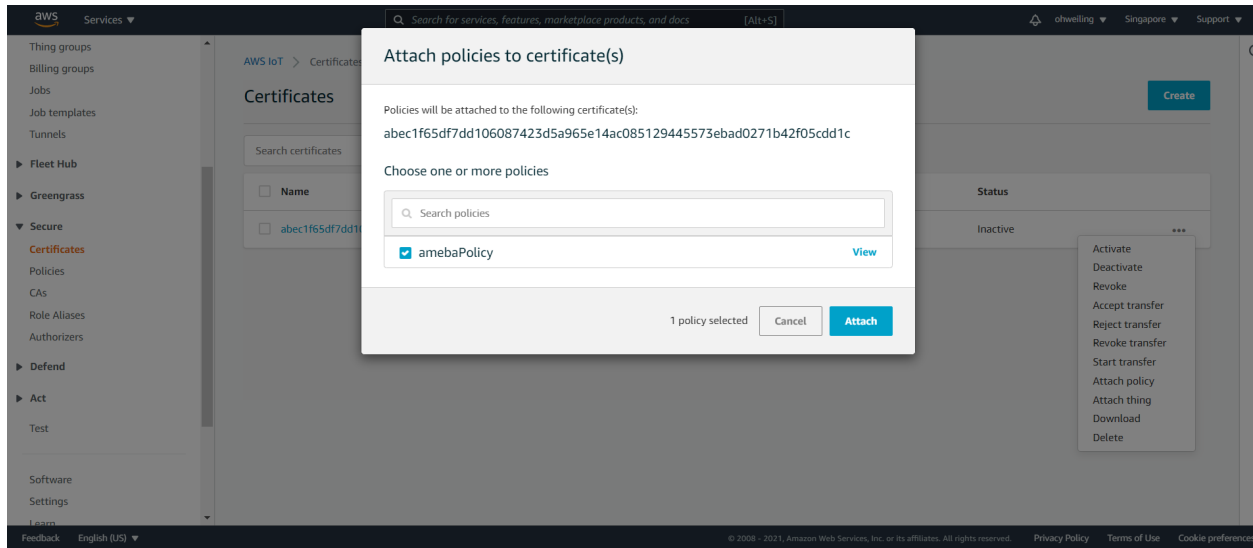
You can see 4 Links. Please download each of the link, “public key” , “private key” , “Certificate” and “rootCA” . After downloading the 4 files, click Done and go back to the certificate main page.



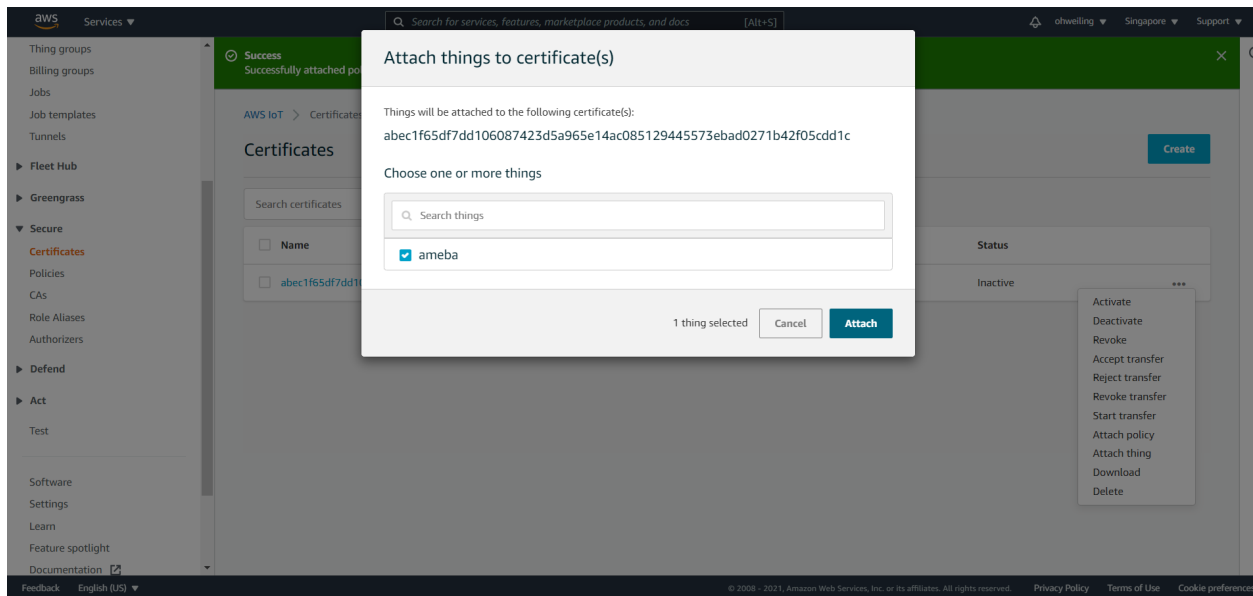
Click Attach a policy in the Actions dropdown menu.



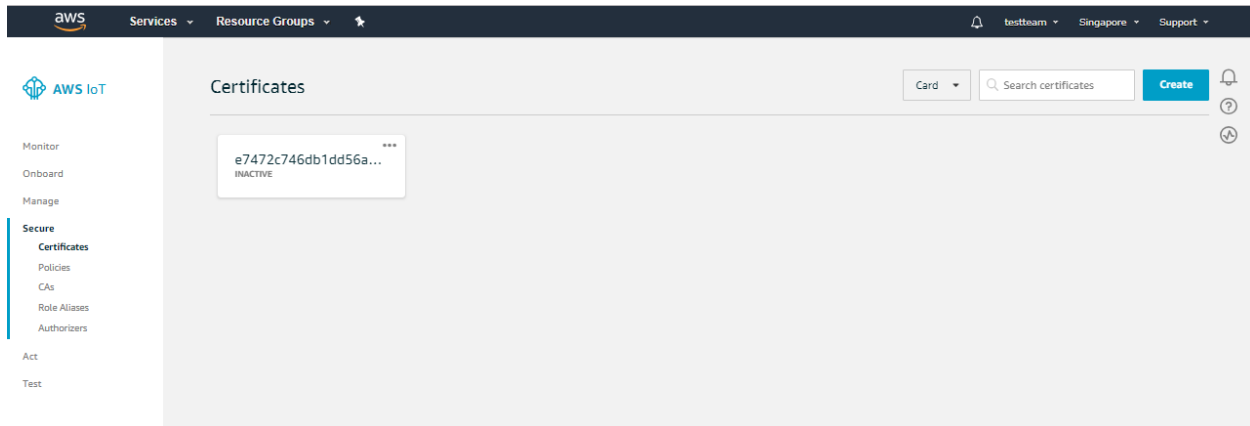
Choose amebaPolicy and click attach.



Then go back to the “Actions” drop-down menu at the top right of the certificates homepage, click on “Attach thing” , select the thing “ameba” you just created when the window below appears, then click on “Attach”

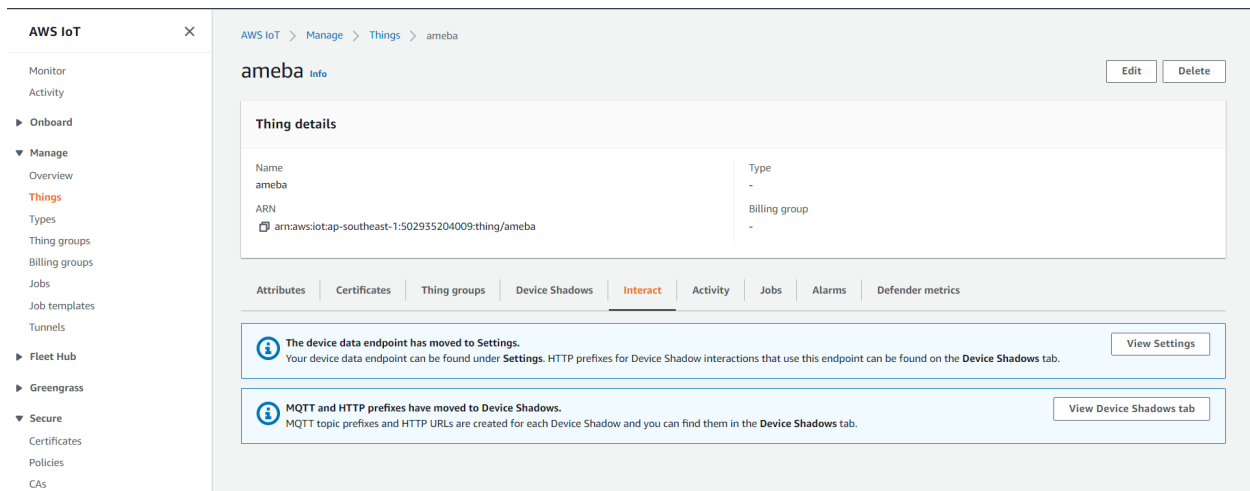


Go back to certificate main page and click Certificate and click Activate in the Actions drop down menu.



Next, click Manage, and click Things, then click “ameba” the thing we created just now.

Click on Interact and View settings.



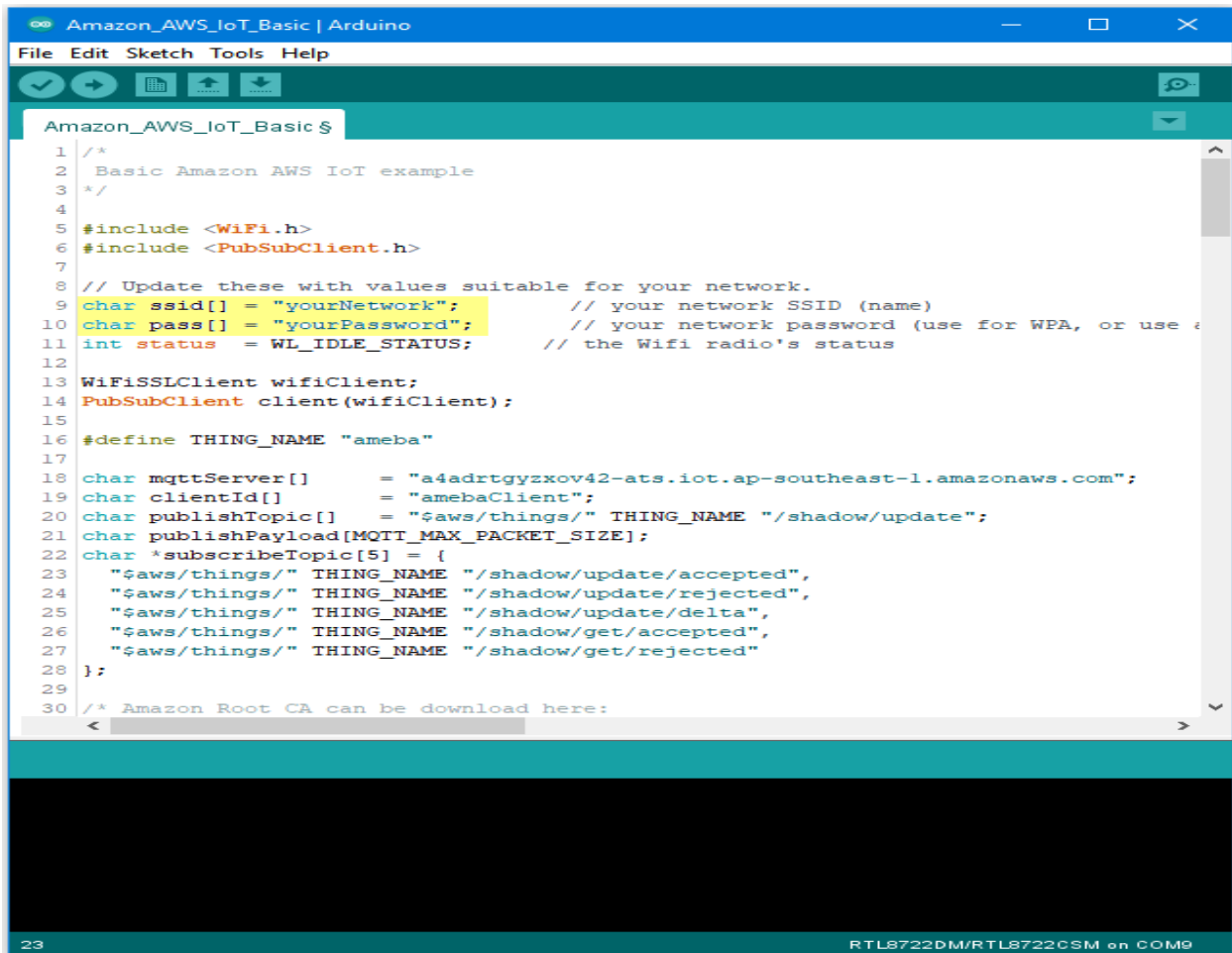
Find out the information of Rest API Endpoint to set Amazon Alexa:

- REST API endpoint: In the value “<https://a1a7004baosggy.iot.us-east-1.amazonaws.com/things/ameba/shadow>”, the part “a1a7004baosggy.iot.us-east-1.amazonaws.com” is the MQTT Broker server address.
- MQTT topic: The value “\$aws/things/ameba/shadow/update” represents the MQTT topic we will use in the AWS IoT Shadow service (if we use MQTT only, without AWS IoT Shadow service, then we can specify other topic name). It is recommended to use “\$aws/things/ameba/shadow/update” here.

## Ameba setting

Open “File” -> “Examples” -> “AmebaMQTTClient” -> “Amazon\_AWS\_IoT\_Basic”

In the sample code, modify the highlighted snippet to reflect your WiFi network settings.

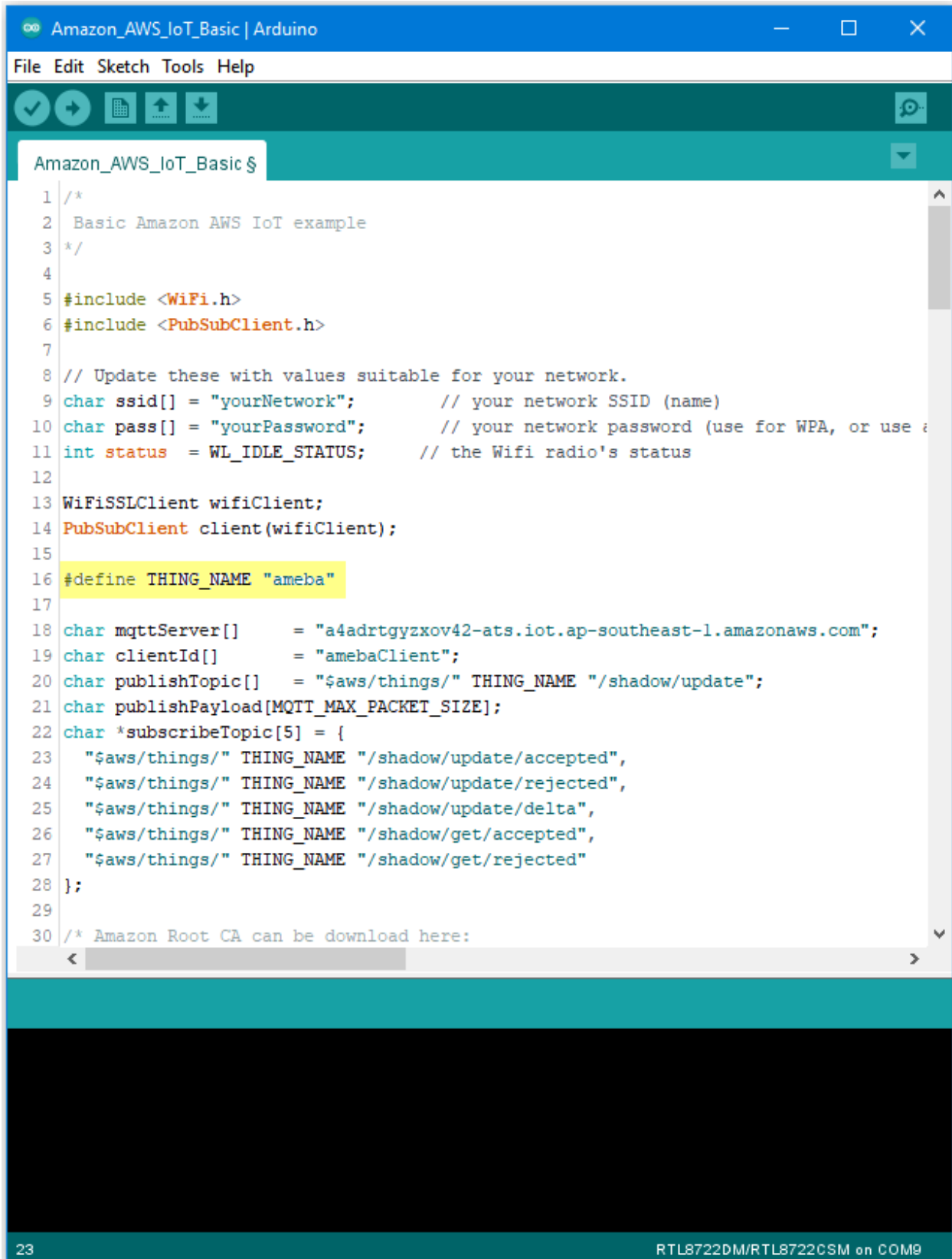


```

1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork"; // your network SSID (name)
10 char pass[] = "yourPassword"; // your network password (use for WPA, or use e
11 int status = WL_IDLE_STATUS; // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

```

Then fill in the “thing” name “ameba” .



```

Amazon_AWS_IoT_Basic $
1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork";      // your network SSID (name)
10 char pass[] = "yourPassword";     // your network password (use for WPA, or use a
11 int status = WL_IDLE_STATUS;      // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

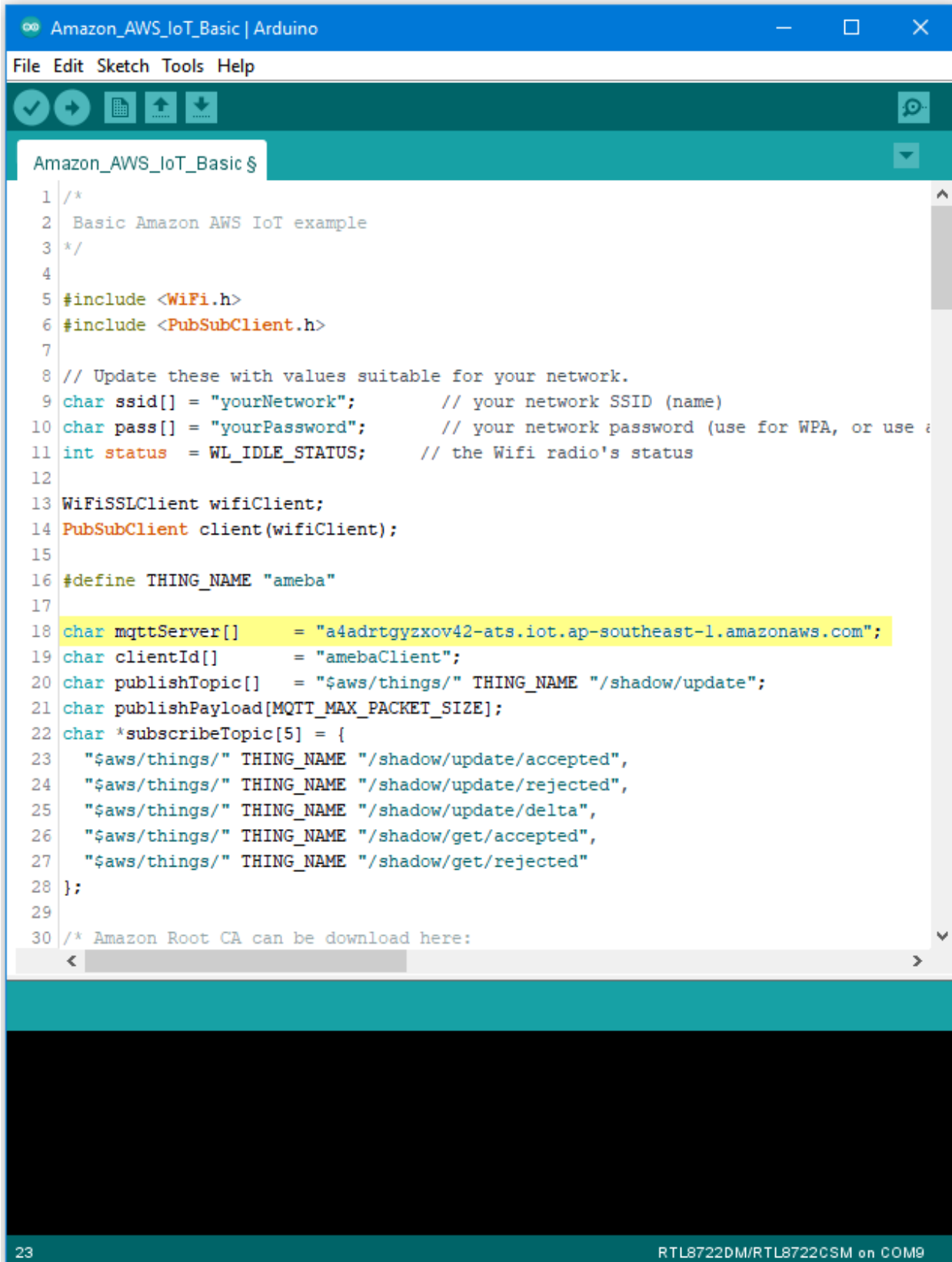
```

23

RTL8722DM/RTL8722CSM on COM9



And the MQTT Broker server address we found earlier in AWS IoT.



```

Amazon_AWS_IoT_Basic | Arduino
File Edit Sketch Tools Help

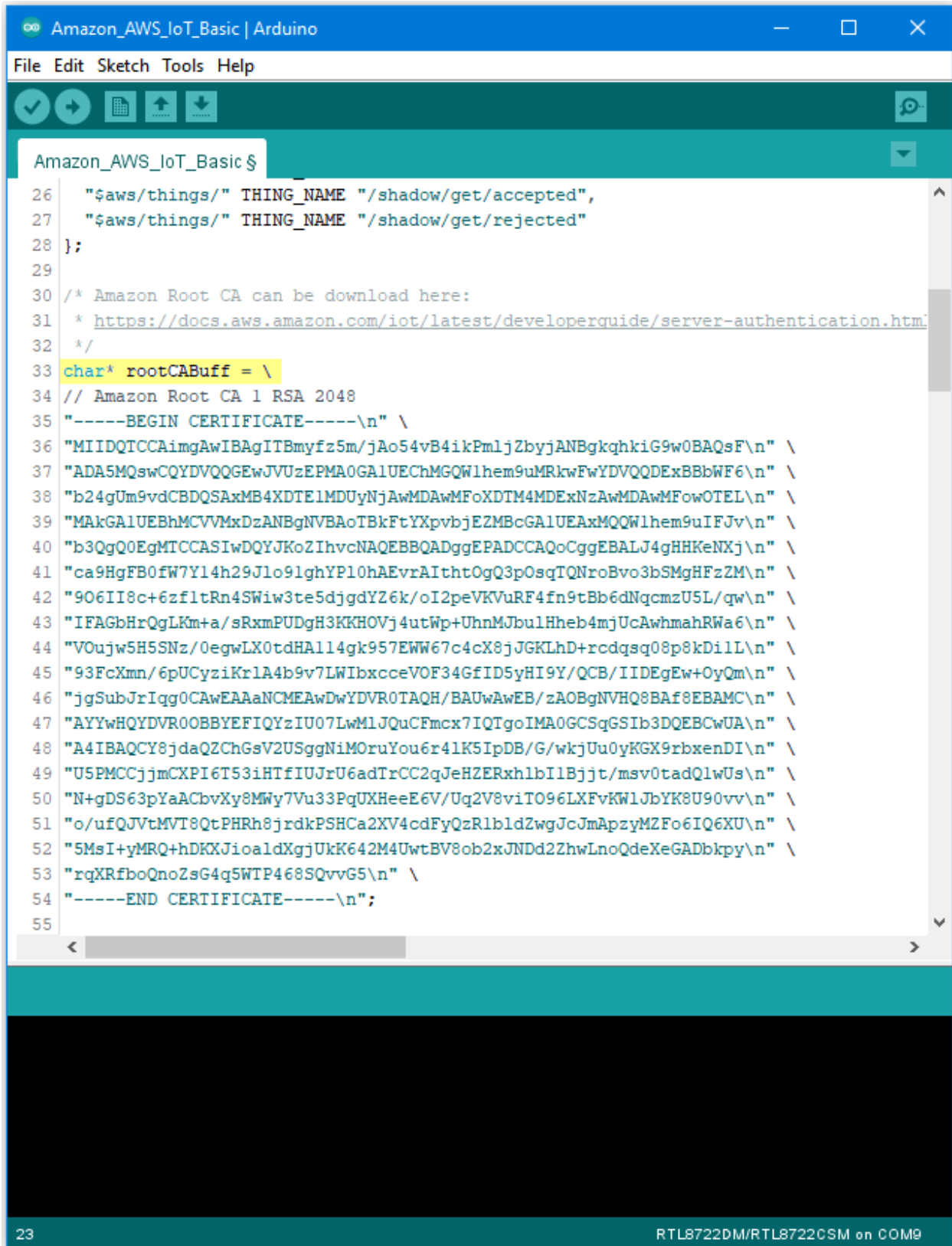
Amazon_AWS_IoT_Basic $
1  /*
2   Basic Amazon AWS IoT example
3  */
4
5  #include <WiFi.h>
6  #include <PubSubClient.h>
7
8  // Update these with values suitable for your network.
9  char ssid[] = "yourNetwork";      // your network SSID (name)
10 char pass[] = "yourPassword";     // your network password (use for WPA, or use a
11 int status = WL_IDLE_STATUS;      // the Wifi radio's status
12
13 WiFiSSLClient wifiClient;
14 PubSubClient client(wifiClient);
15
16 #define THING_NAME "ameba"
17
18 char mqttServer[] = "a4adrtgyzxov42-ats.iot.ap-southeast-1.amazonaws.com";
19 char clientId[] = "amebaClient";
20 char publishTopic[] = "$aws/things/" THING_NAME "/shadow/update";
21 char publishPayload[MQTT_MAX_PACKET_SIZE];
22 char *subscribeTopic[5] = {
23   "$aws/things/" THING_NAME "/shadow/update/accepted",
24   "$aws/things/" THING_NAME "/shadow/update/rejected",
25   "$aws/things/" THING_NAME "/shadow/update/delta",
26   "$aws/things/" THING_NAME "/shadow/get/accepted",
27   "$aws/things/" THING_NAME "/shadow/get/rejected"
28 };
29
30 /* Amazon Root CA can be download here:

```

23

RTL8722DM/RTL8722C5M on COM9

Next, fill in the root CA used in TLS. Download and make sure the downloaded root CA contents conforms to the root CA used in the sketch.



```

Amazon_AWS_IoT_Basic | Arduino
File Edit Sketch Tools Help

Amazon_AWS_IoT_Basic $
26  "$aws/things/" THING_NAME "/shadow/get/accepted",
27  "$aws/things/" THING_NAME "/shadow/get/rejected"
28  };
29
30  /* Amazon Root CA can be download here:
31   * https://docs.aws.amazon.com/iot/latest/developerguide/server-authentication.htm
32   */
33  char* rootCABuff = \
34  // Amazon Root CA 1 RSA 2048
35  "-----BEGIN CERTIFICATE-----\n" \
36  "MIIDQTCCAimgAwIBAgITBmyfz5m/jAo54vB4ikPmljZbyjANBgkqhkiG9w0BAQsF\n" \
37  "ADA5MQswCQYDVQQGEwJVUzEPMA0GA1UEChMGMGQwLhem9uMRkwFwYDVQQDExBBbWF6\n" \
38  "b24gUm9vdCBDQSAxMB4XDTE1MDUyNjAwMDAwMFoXDTE1MDUyNjAwMDAwMFowOTEL\n" \
39  "MAkGA1UEBhMCVVMxMC4ANBgNVBAoTBBkFTYXpvcjEzMDEwGA1UEAxMQQWwLhem9uIFJv\n" \
40  "b3QgQ0EgMTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALJ4gHHKeNXj\n" \
41  "ca9HgFB0fW7Y14h29Jl091ghYP10hAEvrAithtOgQ3pOsqTQNroBvo3bSMgHFzZM\n" \
42  "906II8c+6zfltRn4SWiw3te5djgdYZ6k/oI2peVKVuRF4fn9tBb6dNqcmzU5L/qw\n" \
43  "IFAGbHrQgLKm+a/sRxmPUDgH3KKHOVj4utWp+UhnMJbulHheb4mjUcAwhmahRWa6\n" \
44  "VOUjw5H5SNz/0egwLX0tdHA114gk957EWW67c4cX8jJGKLhD+rcdqsq08p8kDilL\n" \
45  "93FcXmn/6pUCyziKrlA4b9v7LWIbxcceVOF34GfID5yHI9Y/QCB/IIDEgEw+OyQm\n" \
46  "jgSubJrIqq0CAwEAaANCMEAwDwYDVR0TAQH/BAUwAwEB/zAOBgNVHQ8BAf8EBAMC\n" \
47  "AYYwHQYDVRR0OBByEFIQYzIU07LwMlJQuCFmcx7IQTgoIMA0GCSqGSIsb3DQEB\n" \
48  "CwUA\n" \
49  "A4IBAQCjY8jdaQZChGsV2USggNiMOruYou6r4lK5IpDB/G/wkjUu0yKGX9rbxen\n" \
50  "DI\n" \
51  "U5PMCCjjmCXPI6T53iHTfIUJrU6adTrCC2qJeH2ERxhlb1lBjtt/msv0tadQ1wU\n" \
52  "s\n" \
53  "N+gDS63pYaACbvXy8MWy7Vu33PqUXHeeE6V/Uq2V8viT096LXFvKW1JbYK8U90\n" \
54  "vv\n" \
55  "o/ufQJvtMVT8QtPHRh8jrdkPSHCa2XV4cdFyQzR1bldZwgJcJmApzyMZFo6IQ6XU\n" \
56  "n\n" \
57  "5MsI+yMRQ+hDKXJioaldXgjUkK642M4UwtBV8ob2xJNDd2ZhwLnoQdeXeGADbkpy\n" \
58  "n\n" \
59  "rqXRfboQnoZsG4q5WTP468SQvvG5\n" \
60  "-----END CERTIFICATE-----\n";

```

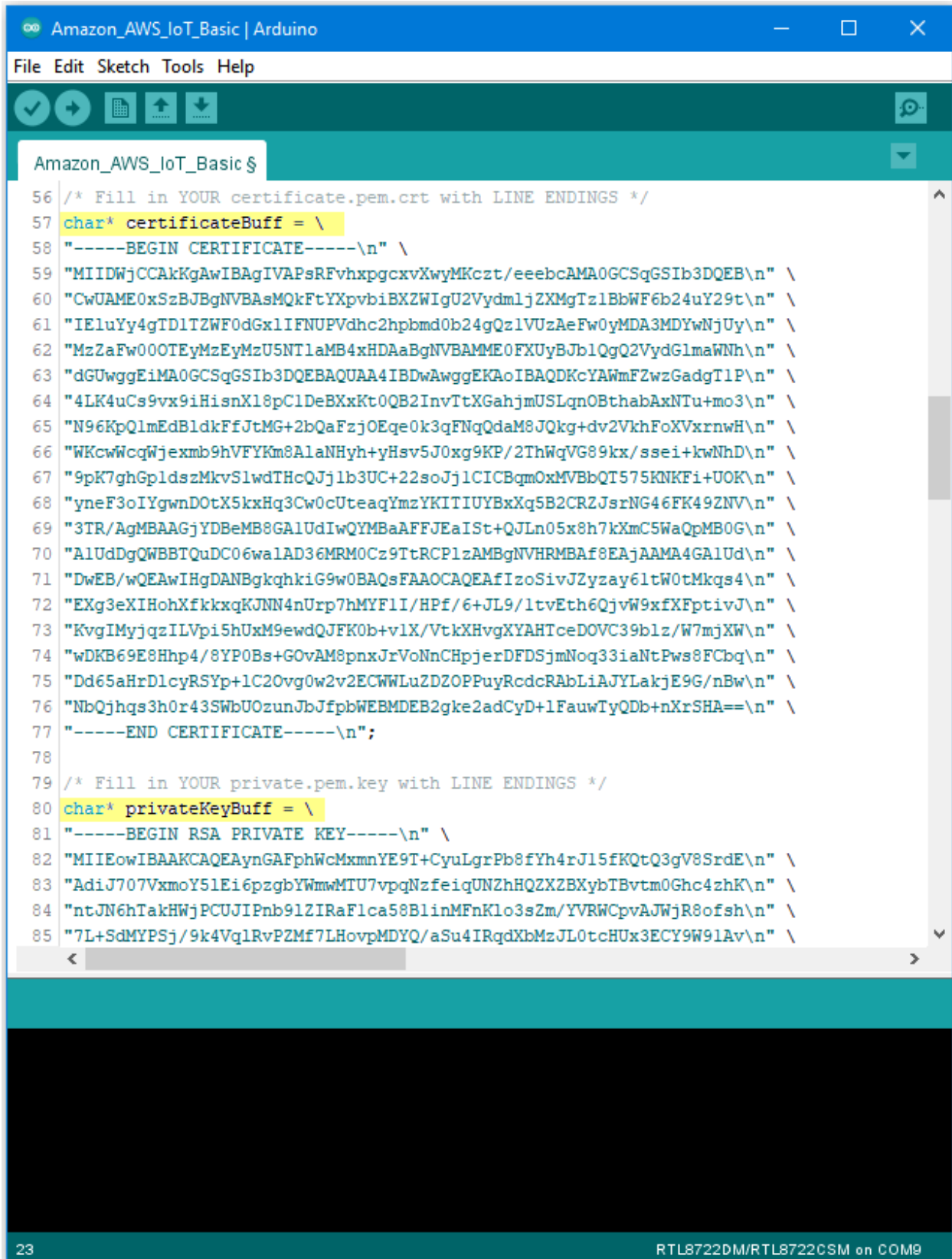
23

RTL8722DM/RTL8722CSM on COM9

Next, fill in the certificate we created in the AWS IoT Console (i.e., client certificate), usually its file name ends with “-certificate.pem.crt” (e.g., “efae24a533-certificate.pem.crt” ). Open the certificate with a text editor, and adjust its format as follows to use in the sketch:

- Add the new line character “\n” at the end of each line.
- Add double-quote at the beginning and the end of each line.
- To concatenate each line as a string, add “” at the end of each line.
- The last line ends with semicolon.

Adjust the format of the private key in the same way and add it to privateKeyBuff.



```

Amazon_AWS_IoT_Basic $
56 /* Fill in YOUR certificate.pem.crt with LINE ENDINGS */
57 char* certificateBuff = \
58 "-----BEGIN CERTIFICATE-----\n" \
59 "MIIDWjCCAKKgAwIBAgIVAPsRFvnxpgcxvXwyMKczt/eeebcAMA0GCSqGSIb3DQEBA\n" \
60 "CwUAME0xSzBjBjBjNVBAsMQkFtYXpviBXZWIGU2VydmljZXMgTz1BbWF6b24uY29t\n" \
61 "IEluYy4gTD1TZWF0dGx1IFNUPVdhc2hpbmd0b24gQz1VUzAeFw0yMDA3MDYwNjUy\n" \
62 "MzZaFw00OTYyMzYyMzU5NT1aMB4xHDAaBgNVBAMME0FXUyBj1QgQ2VydG1maWNh\n" \
63 "dGUwgGsiMA0GCSqGSIb3DQEBAQUAA4IBDwAwggEKAoIBAQDKcYAWmFZwzGadgT1P\n" \
64 "4LK4uCs9vx9iHisnXl8pC1DeBXxKt0QB2InvTtXGahjmUSLqnOBthabAxNTu+mo3\n" \
65 "N96KpQ1mEdBldkFfJtMG+2bQaFzjOEge0k3qFNqQdaM8JQkg+dv2VkhFoXVxr\n" \
66 "WKcWwqWjexmb9hVFYKm8AlaNHyh+yHsv5J0xg9KP/2ThWqVG89kx/ssei+kwN\n" \
67 "9pK7ghGpldszKmvSlwdTHcQJj1b3UC+22soJj1CICBqmOxMVBbQT575KNKFi+U\n" \
68 "yneF3oIYgwnDotX5kxHq3Cw0cUteaYmzYKITIUYBxXq5B2CRZJsrNG46FK492\n" \
69 "3TR/AgMBAAGjYDBeMB8GA1UdIwQYMBaFAFFJEaISt+QJLn05x8h7kXmC5WaQp\n" \
70 "AlUdDgQWBBTQuDC06walAD36MRM0Cz9TtRCPlzAMBgNVHRMBAf8EAjAAMA4GA1\n" \
71 "UdEB/wQEAwIHgDANBgkqhkiG9w0BAQsFAAOCAQEAFIzoSivJZyay6ltW0tMkqs4\n" \
72 "EXg3eXIHohXfkkxqKJNN4nUrp7hMYfII/HPf/6+JL9/ltvEth6QjvW9xfXFpti\n" \
73 "vKvgIMyjqzILVpi5hUxM9ewdQJFK0b+v1X/VtkXHvgXYAHTceDOVC39blz/W7m\n" \
74 "jXW/wDKB69E8Hhp4/8YP0Bs+GOvAM8pnxJrVoNnCHpjerDFDSjmNoq33iaNtPws\n" \
75 "8FCbq/nBw/Dd65aHrDlcyRSYp+lC2Ovg0w2v2ECWWLuZDZOPPuyRdcRABLiAJY\n" \
76 "LakjE9G/nBw/NbQjhqs3h0r43SWbU0zunJbJfpbWEBMDEB2gke2adCyD+lFauwTy\n" \
77 "QDb+nXrSHA==\n";
78
79 /* Fill in YOUR private.pem.key with LINE ENDINGS */
80 char* privateKeyBuff = \
81 "-----BEGIN RSA PRIVATE KEY-----\n" \
82 "MIIEowIBAAKCAQEAynGAFphWcMxmnyE9T+CyuLgrPb8fYh4rJl5fKQtQ3gV8SrdE\n" \
83 "AdiJ707VxmoY51Ei6pzgbYWmwMTU7vpqNzfeiqUNZhHQ2XZBXybTBvtm0Ghc4zh\n" \
84 "K/ntJN6hTakHWjPCUJIPnb9lZIRaFlca58BlinMFnKlo3sZm/YVRWCpvAJWjR8of\n" \
85 "sh/7L+SdMYPSj/9k4VqlRvPZMf7LHovpMDYQ/aSu4IRqdXbMzJL0tcHUx3ECY9W91\n"

```

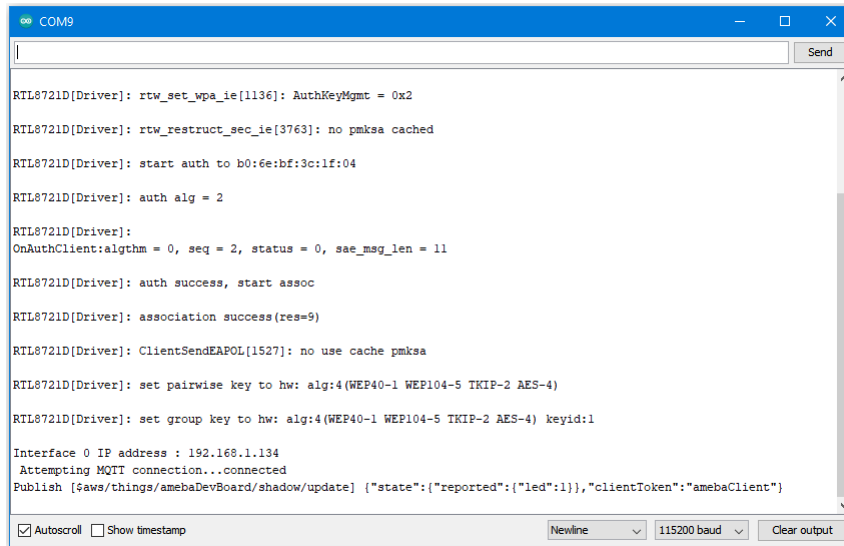
23

RTL8722DM/RTL87220SM on COM9

## Compile and run

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in the Arduino IDE and observe as Ameba connects to the AWS IoT server and sends updates on the LED state variable.



```

RTL8721D[Driver]: rtw_set_wpa_ie[1136]: AuthKeyMgmt = 0x2
RTL8721D[Driver]: rtw_restruct_sec_ie[3763]: no pmksa cached
RTL8721D[Driver]: start auth to b0:6e:bf:3c:1f:04
RTL8721D[Driver]: auth alg = 2
RTL8721D[Driver]:
OnAuthClient:alghth = 0, seq = 2, status = 0, sae_msg_len = 11
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=9)
RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1
Interface 0 IP address : 192.168.1.134
Attempting MQTT connection...connected
Publish [aws/things/amebaDevBoard/shadow/update] {"state":{"reported":{"led":1}}, "clientToken":"amebaClient"}
  
```

## Alternatives

Ameba can also retrieve the current LED status variable from the AWS shadow. This is done by sending a message to the “shadow/get” topic. Refer to the [Amazon\\_AWS\\_IoT\\_with\\_ACK](#) example code for more information.

## Code Reference

Change led state:

In this example, we use GPIO interface to control the led. We set led\_pin to 10 and led\_state to 1 by default in the sample code.

```
pinMode(led_pin, OUTPUT);
digitalWrite(led_pin, led_state);
```

Set up certificate:

Note that we use the WiFiSSLClient type of wifiClient.

```
WiFiSSLClient wifiClient;
```

WiFiSSLClient inherits Client, so it can be passed as the parameter of PubSubClient constructor.

Next, set up TLS certificate required in connection.

```
wifiClient.setRootCA((unsigned char*)rootCABuff);
wifiClient.setClientCertificate((unsigned char*)certificateBuff, (unsigned_
↳char*)privateKeyBuff);
```

Configure MQTT Broker server

Then MQTT PubClient set MQTT Broker server to connect

```
client.setServer(mqttServer, 8883);
client.setCallback(callback);
```

Connect to MQTT Broker server:

In loop(), call reconnect() function and try to connect to MQTT Broker server and do the certificate verification.

```
while (!client.connected()) {
```

Subscribe & Publish

Next, subscribe to topics.

```
for (int i=0; i<5; i++) {
    client.subscribe(subscribeTopic[i]);
}
```

There are some common topics:

“\$aws/things/ameba/shadow/update/accepted” ,

“\$aws/things/ameba/shadow/update/rejected” ,

“\$aws/things/ameba/shadow/update/delta” ,  
“\$aws/things/ameba/shadow/get/accepted” ,  
“\$aws/things/ameba/shadow/get/rejected”

Related documentation:

<http://docs.aws.amazon.com/iot/latest/developerguide/thing-shadow-data-flow.html>

Then publish current status::

```
sprintf(publishPayload,  
"\"state\":{\"reported\":{\"led\":%d}},\"clientToken\": \"%s\"}",  
led_state, clientId);
```

```
client.publish(publishTopic, publishPayload);
```

Listen to topic and make response:

In the callback function, we listen to the 5 subscribed topics and check if there are messages of “/shadow/get/accepted” :

```
if (strstr(topic, "/shadow/get/accepted") != NULL) {
```

If there is, the message is from the control side. If the attribute state in the message is different from current state, publish the new state.

```
updateLedState(desired_led_state);
```

## MQTT - Use Google Cloud IoT

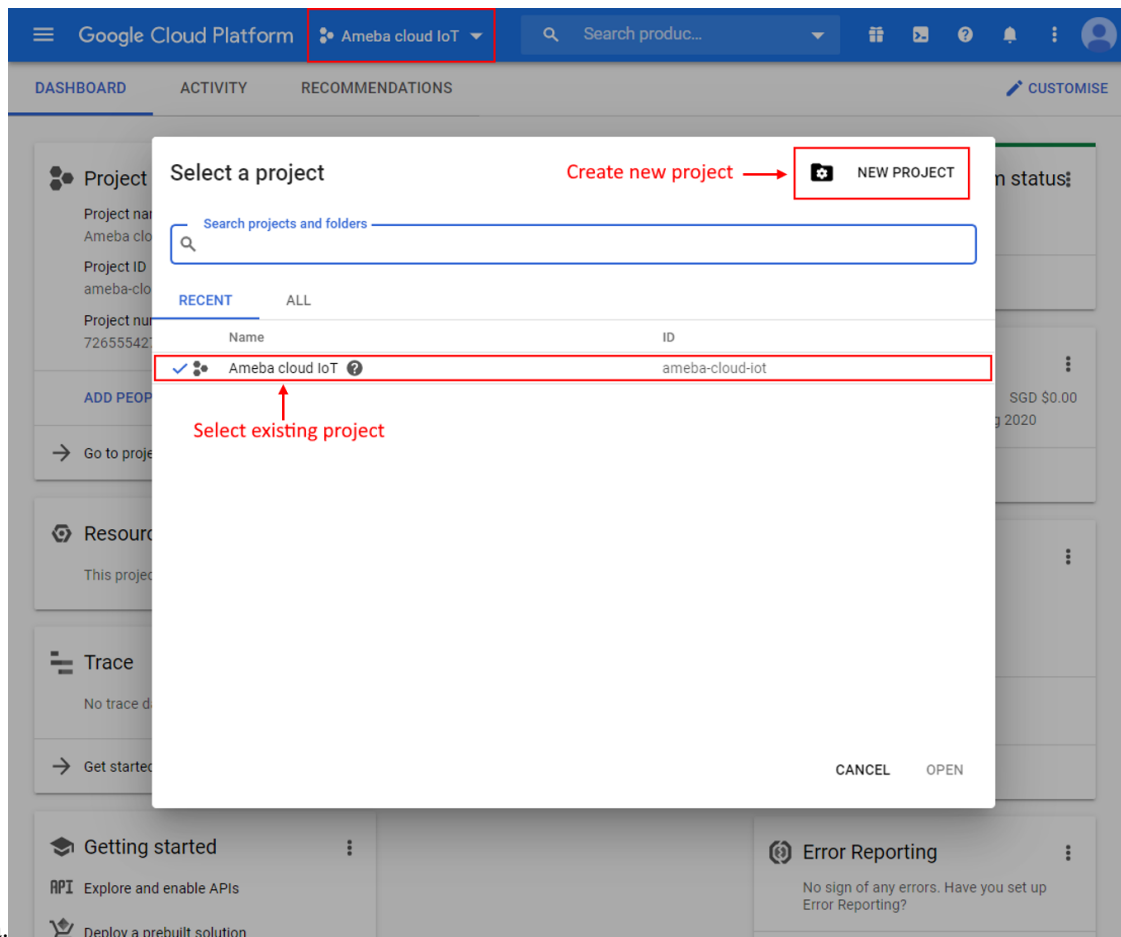
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Google Cloud IoT Configuration

1. Select or create a Cloud Platform project In the Google Cloud Console, select an existing project or create a new project. You will need a **Project ID** to use with





Ameba.

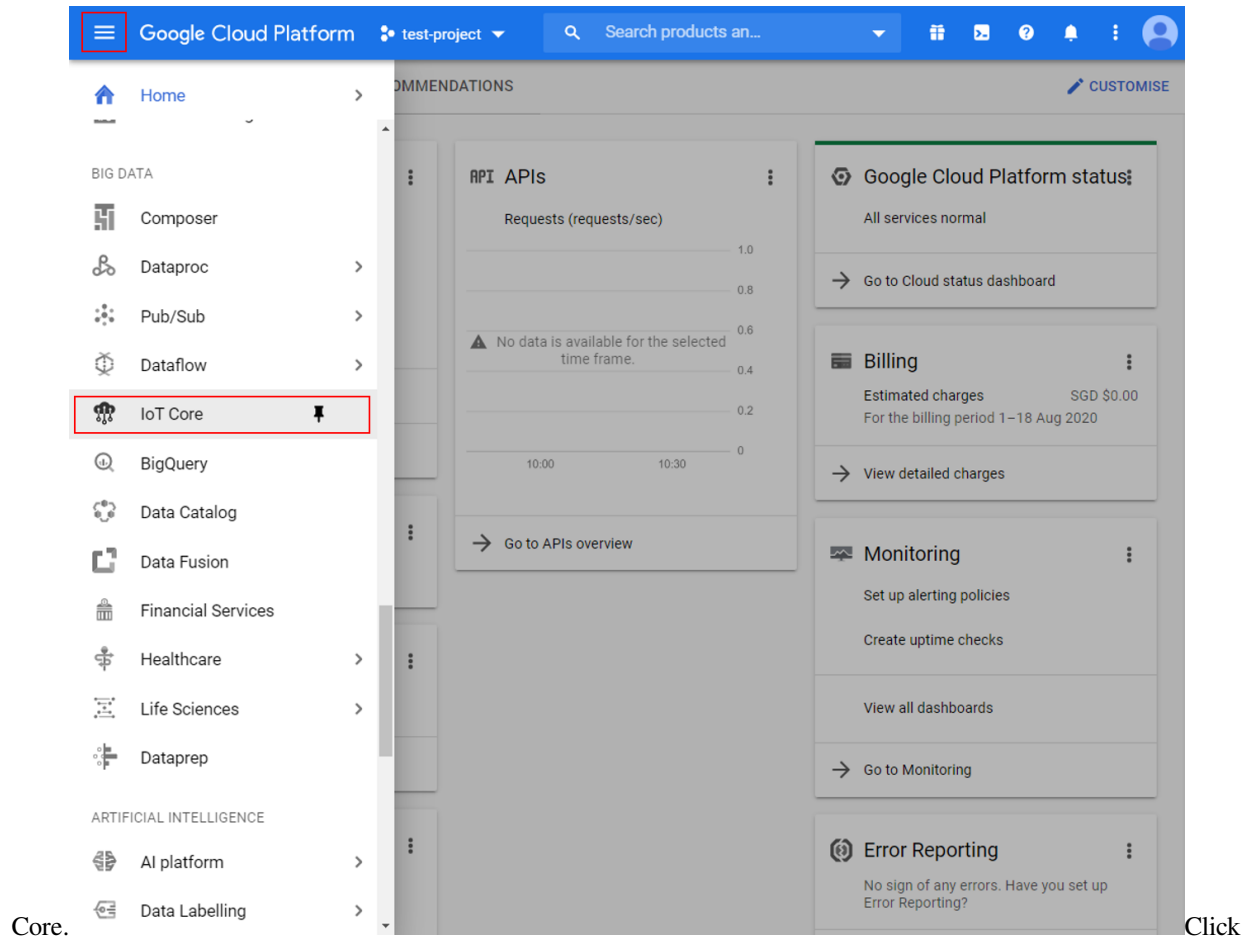
If

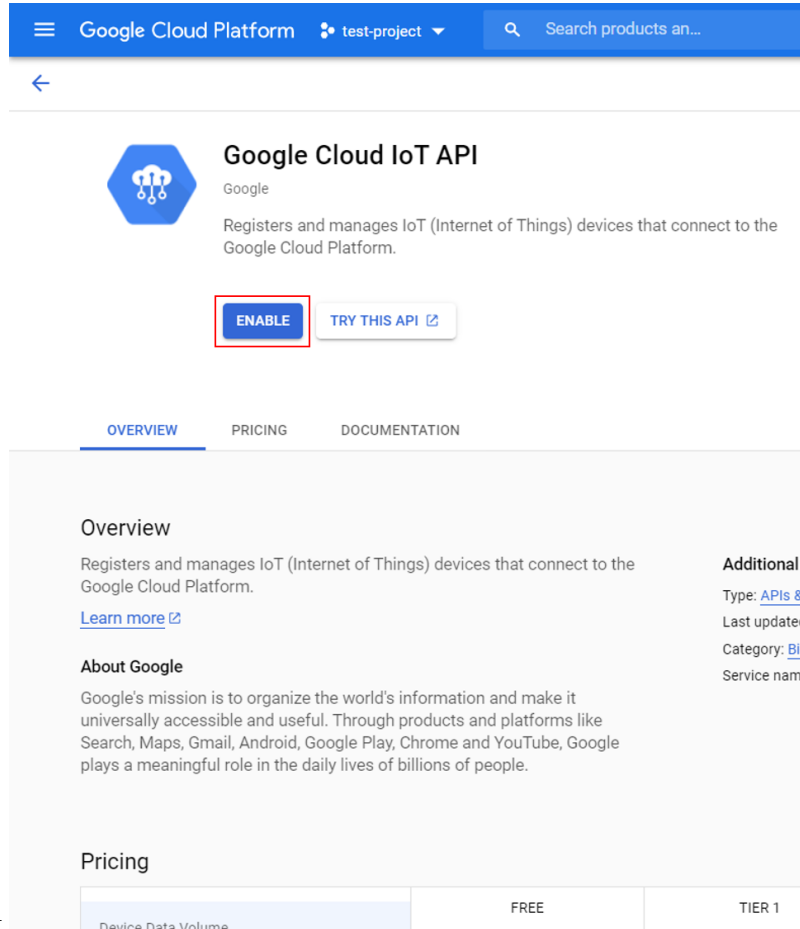
creating a new project, enter a project name, and take note of the **Project ID** generated.

The screenshot shows the 'New Project' form in the Google Cloud Platform console. The 'Project name' field contains 'test-project'. The 'Project ID' field contains 'test-project-286902' and is highlighted with a red box. Below the 'Project ID' field, there is a note: 'it cannot be changed later. EDIT'. The 'Location' field is set to 'No organisation'. At the bottom, there are 'CREATE' and 'CANCEL' buttons.

2.

Enable billing for your project Billing needs to be enabled for your project to use Google Cloud Platform features. Follow the guide in Google cloud documentation to enable billing. <https://cloud.google.com/billing/docs/how-to/modify-project> 3. Enable the Cloud IoT Core API In Google Cloud console, click on the top left menu button and search for IoT





The screenshot shows the Google Cloud IoT API page. At the top, there's a blue header with the Google Cloud Platform logo, a dropdown menu for 'test-project', and a search bar. Below the header, the Google Cloud IoT API is displayed with its logo and a description: 'Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.' A red box highlights the 'ENABLE' button. To the right of the 'ENABLE' button is a 'TRY THIS API' button with an external link icon. Below the main content, there are tabs for 'OVERVIEW', 'PRICING', and 'DOCUMENTATION'. The 'OVERVIEW' tab is selected, showing an 'Overview' section with a description, a 'Learn more' link, and an 'About Google' section. The 'PRICING' tab is also visible, showing a table with columns for 'Device Data Volume', 'FREE', and 'TIER 1'.

Google Cloud IoT API

Google

Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.

**ENABLE** TRY THIS API

OVERVIEW PRICING DOCUMENTATION

**Overview**

Registers and manages IoT (Internet of Things) devices that connect to the Google Cloud Platform.

[Learn more](#)

**About Google**

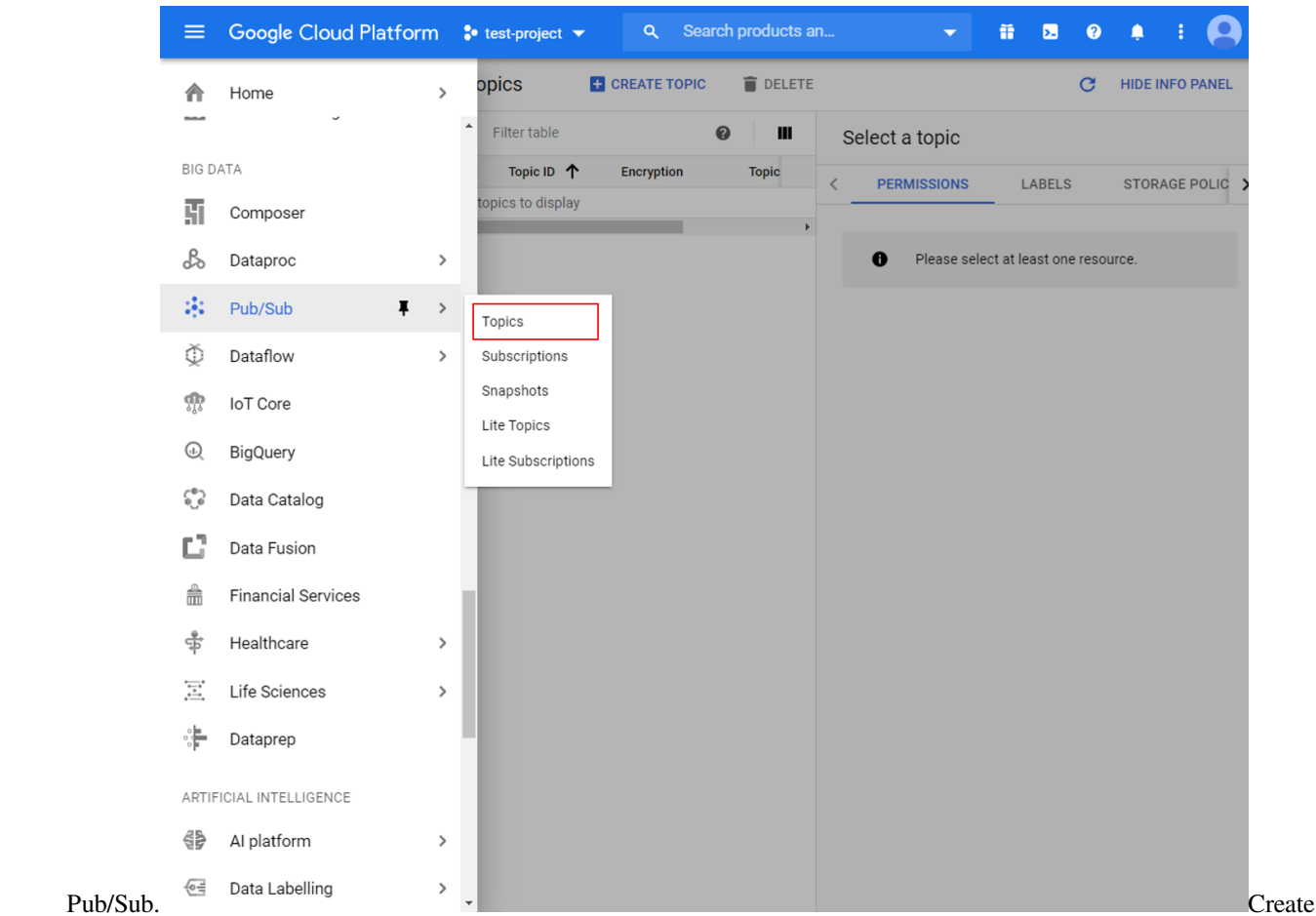
Google's mission is to organize the world's information and make it universally accessible and useful. Through products and platforms like Search, Maps, Gmail, Android, Google Play, Chrome and YouTube, Google plays a meaningful role in the daily lives of billions of people.

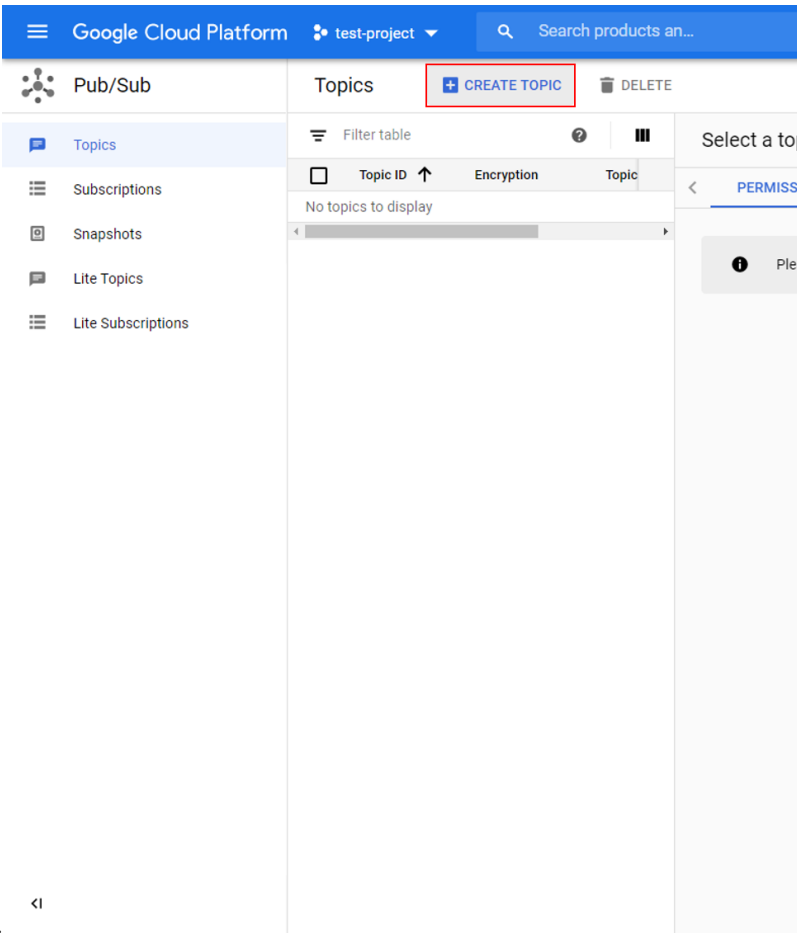
**Pricing**

Device Data Volume	FREE	TIER 1
--------------------	------	--------

enable to activate Google Cloud IoT API for your project.

Create a Cloud Pub/Sub topic In Google Cloud console, click on the top left menu button and search for





a new topic for your project and give it a suitable topic ID.  
the topic is created, go to the permissions tab of the info panel, and add “cloud-iot@system.gserviceaccount.com” with the role of “Pub/Sub Publisher” .

Google Cloud Platform

test-project

Search products and resources

Pub/Sub

Topics

Subscriptions

Snapshots

Lite Topics

Lite Subscriptions

Topics

CREATE TOPIC

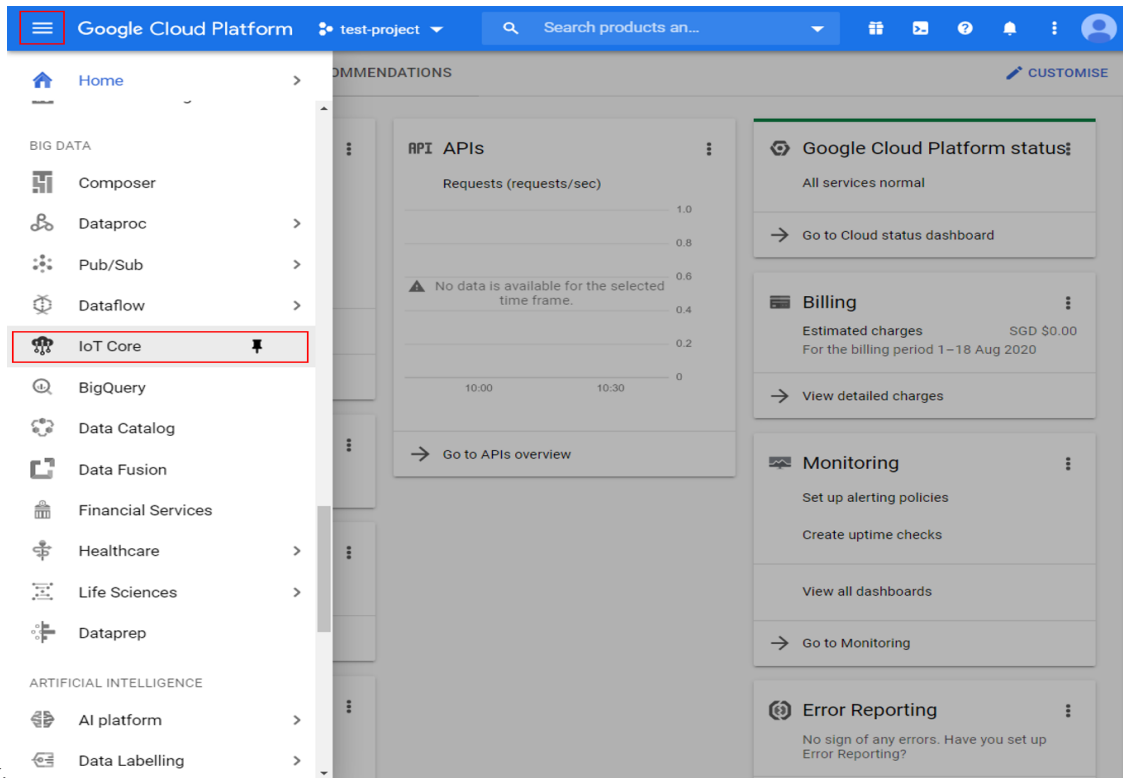
DELETE

SHOW INFO PANEL

Filter table

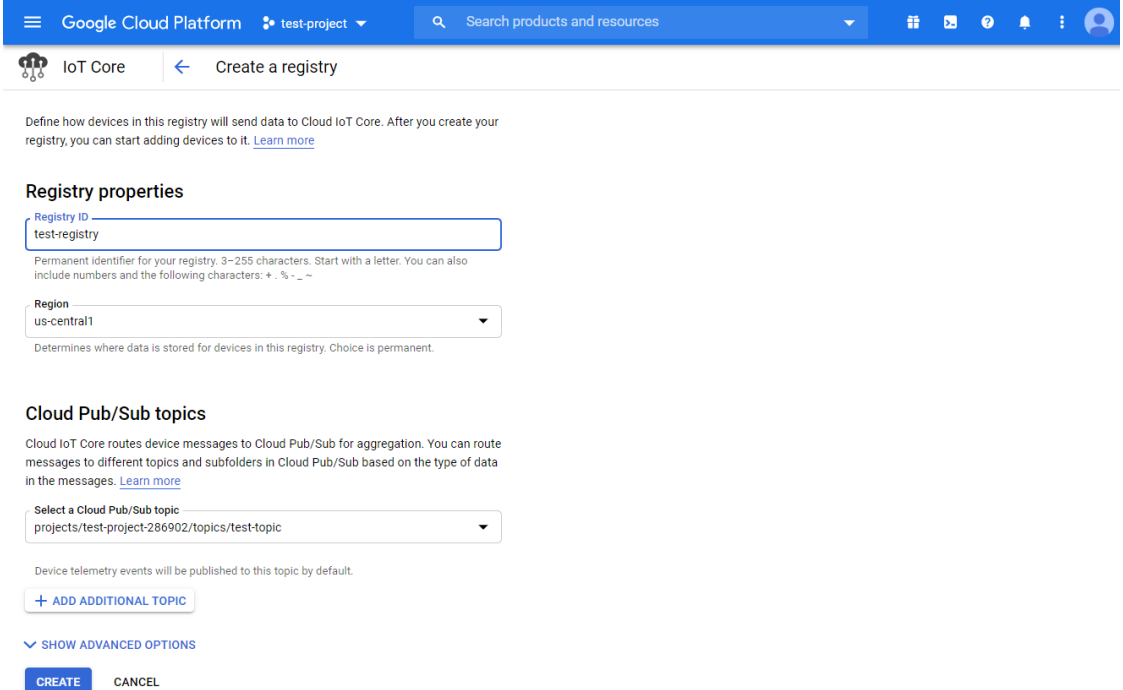
Topic ID	Encryption	Topic name	Labels
<input checked="" type="checkbox"/> test-topic	Google-managed	projects/test-project-286902/topics/test-topic	-

a device registry Go back to the IoT Core settings page and create a new reg-



istry.

a suitable **Registry ID** and in which to store data. Remember the **\*\*Registry ID** and **Region** for use with Ameba later. For the Pub/Sub topic, select the topic created in the previous

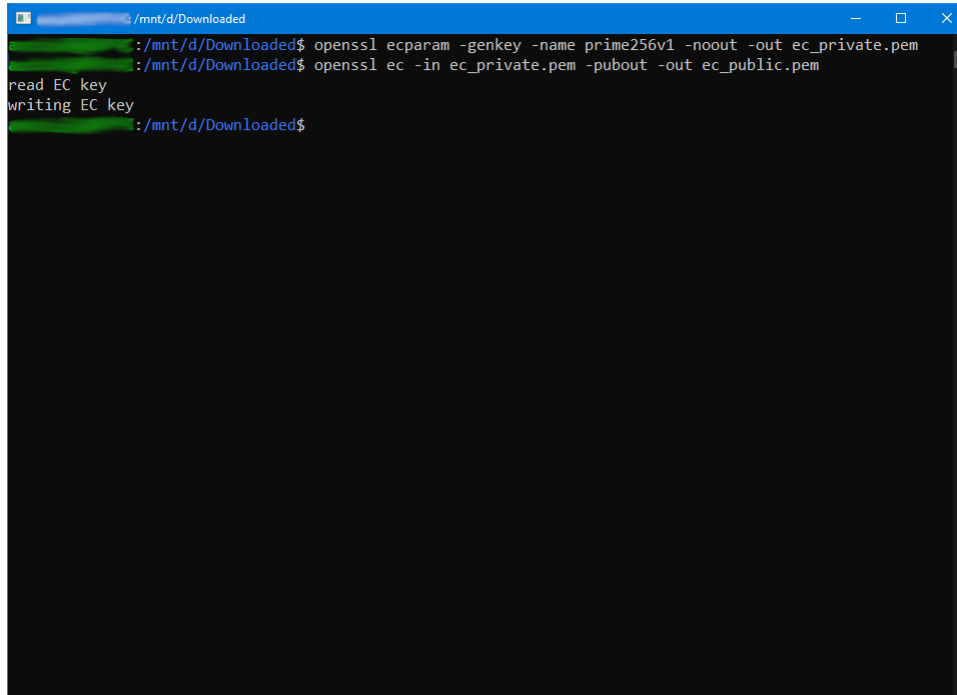


step. 6.

Create a public/private key pair Using Openssl in a terminal in Windows/Linux/MacOs, run the following commands to generate a private and public key pair. Two files will be created by these commands,

“ec\_private.pem” containing the private key, and “ec\_public.pem” containing the public key.

```
$ openssl ecparam -genkey -name prime256v1 -noout -out ec_private.pem
$ openssl ec -in ec_private.pem -pubout -out ec_public.pem
```

A screenshot of a terminal window with a blue title bar. The terminal shows the execution of two OpenSSL commands. The first command generates a private key, and the second command generates a public key from the private key. The output of the second command is highlighted in green. The terminal prompt is `:/mnt/d/Downloaded$`.

```
:/mnt/d/Downloaded$ openssl ecparam -genkey -name prime256v1 -noout -out ec_private.pem
:/mnt/d/Downloaded$ openssl ec -in ec_private.pem -pubout -out ec_public.pem
read EC key
writing EC key
:/mnt/d/Downloaded$
```

Run the next command to extract out the private key, and remember the highlighted string of hexadecimal numbers for use with Ameba later.

```
$ openssl ec -in ec_private.pem -noout -text
```

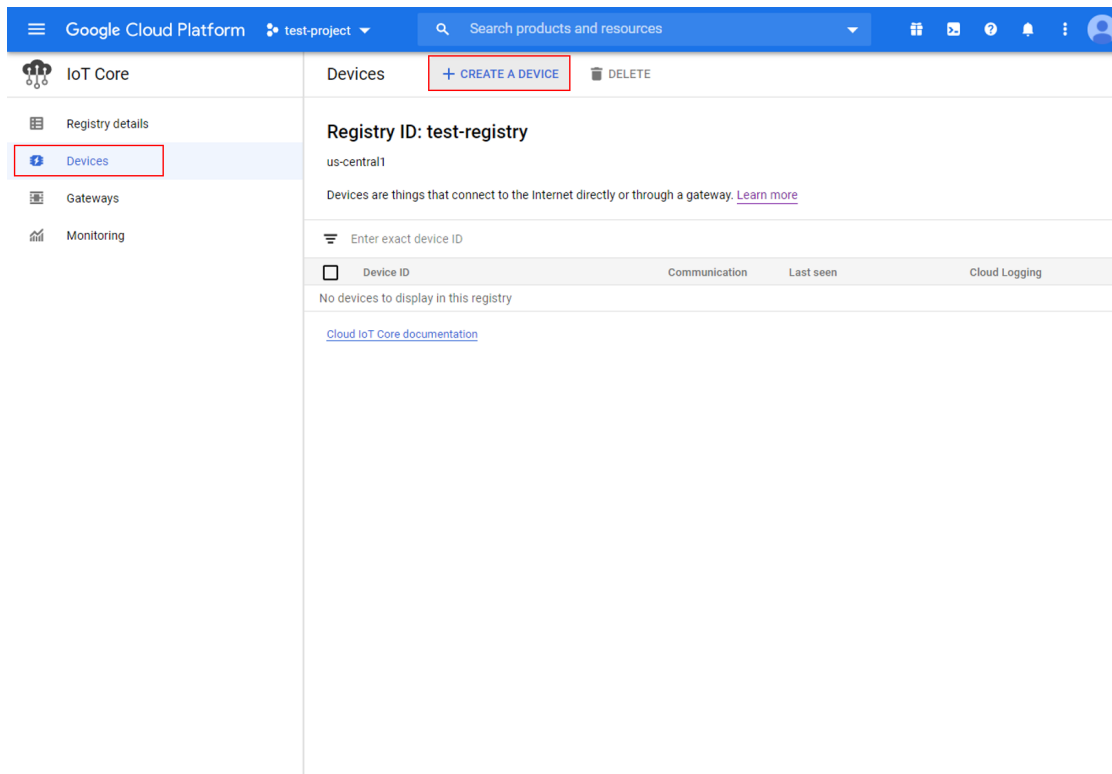


```

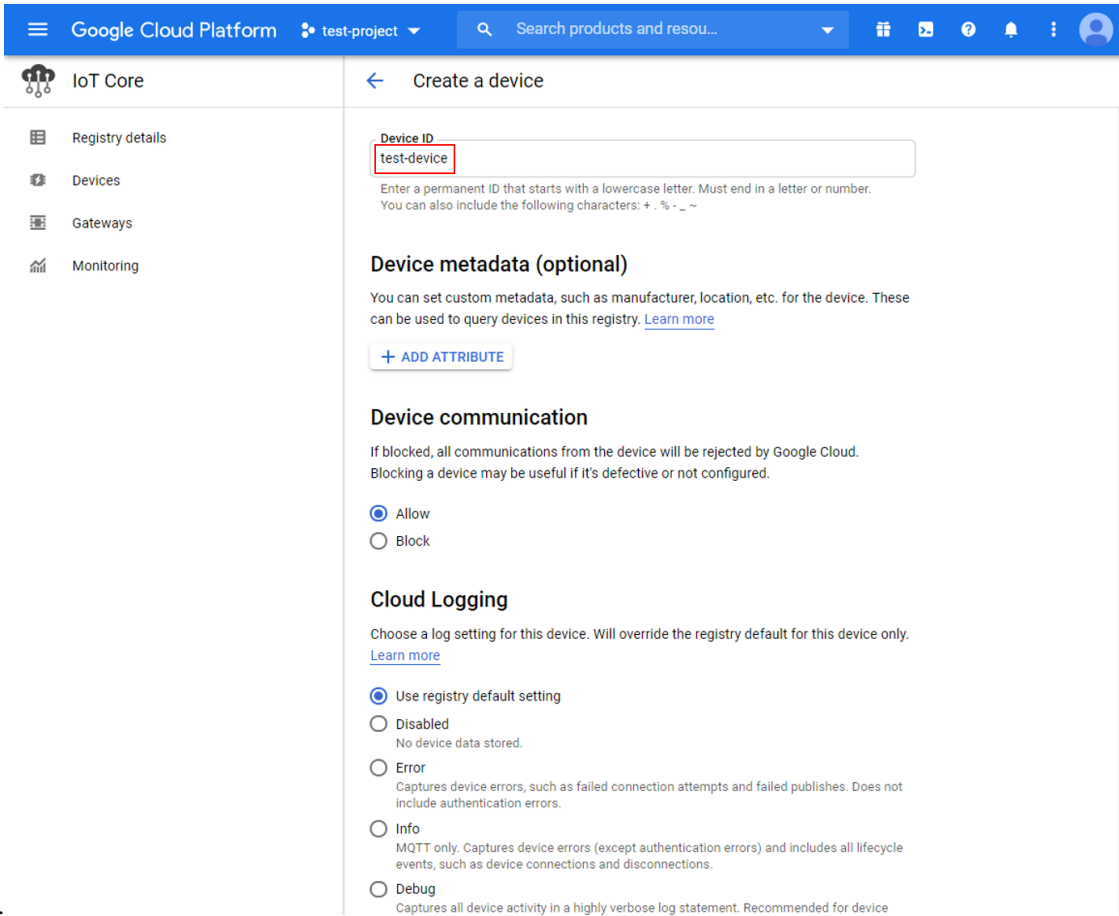
/mnt/d/Downloaded$ openssl ec -in ec_private.pem -noout -text
read EC key
Private-Key: (256 bit)
priv:
    f9:93:86:98:66:b0:f0:34:79:c5:fe:c9:82:50:0d:
    76:f2:ad:c6:2e:23:b9:af:02:c0:1c:d4:11:65:81:
    0a:fb
pub:
    04:29:8f:09:db:9c:d6:e2:b2:05:b8:11:c0:b5:f7:
    90:2a:7c:42:42:3e:db:ec:2d:05:88:b3:8b:14:09:
    9e:de:2d:ec:1b:da:7f:ae:6a:8d:31:55:e1:22:0c:
    d8:94:63:a2:4a:79:09:6f:57:68:76:61:72:9e:e3:
    22:23:93:fd:a6
ASN1 OID: prime256v1
NIST CURVE: P-256
/mnt/d/Downloaded$

```

7. Create a device Go back to the IoT Core settings page and create a new device.



Give the device a suitable **Device ID** and remember it for use with Ameba



later. In the authentication section of the additional options, upload the previously generated “ec\_public.pem” public

Google Cloud Platform

test-project

Search products and resou...

IoT Core

Registry details

Devices

Gateways

Monitoring

Create a device

No device data stored.

Error

Captures device errors, such as failed connection attempts and failed publishes. Does not include authentication errors.

Info

MQTT only. Captures device errors (except authentication errors) and includes all lifecycle events, such as device connections and disconnections.

Debug

Captures all device activity in a highly verbose log statement. Recommended for device troubleshooting.

Authentication (optional)

Specify the public key that will be used to authenticate this device. You can leave the key empty, but devices will not be able to connect to Google Cloud without a key. [Learn more](#)

Input method

Enter manually

Upload

Public key format

ES256

Public key value

ec\_public.pem

X

BROWSE

File content must be in PEM format

Public key expiry date (optional)

Expires on:

Date

HKT

COMMUNICATION, CLOUD LOGGING, AUTHENTICATION

CREATE

CANCEL

key. 8.

Create a Cloud Pub/Sub subscription To observe messages sent by Ameba, create a subscription in

Google Cloud Platform

test-project

Search products and resou...

Pub/Sub

Topics

Subscriptions

Snapshots

Lite Topics

Lite Subscriptions

Subscriptions

CREATE SUBSCRIPTION

DELETE

SHOW INFO PANEL

Filter table

Subscription ID

Delivery type

Topic name

Subscription name

Acknowledge deac

No subscriptions to display

Pub/Sub.

Choose

a suitable subscription ID and select the previously created topic.

## Example

Open the example in “File” -> “Examples” -> “AmebaMQTTClient” -> “Google\_Cloud\_IoT”.

Google Cloud Platform test-project Search products and resou...

Pub/Sub

- Topics
- Subscriptions**
- Snapshots
- Lite Topics
- Lite Subscriptions

Create subscription

A subscription directs messages on a topic to subscribers. Messages are delivered to subscribers immediately, or subscribers can pull messages as needed.

Subscription ID \*  
test-subscription

Subscription name: projects/test-project-286902/subscriptions/test-subscription

Select a Cloud Pub/Sub topic \*

Type to filter

test-project-286902

projects/test-project-286902/topics/test-topic

SWITCH PROJECT CREATE A TOPIC ENTER TOPIC NAME

☒ Expire after this many days of inactivity (up to 365)

31 Days

A subscription is inactive if there is no subscriber activity such as open pulls or successful pushes.

☐ Never expire  
The subscription will never expire, no matter the activity.

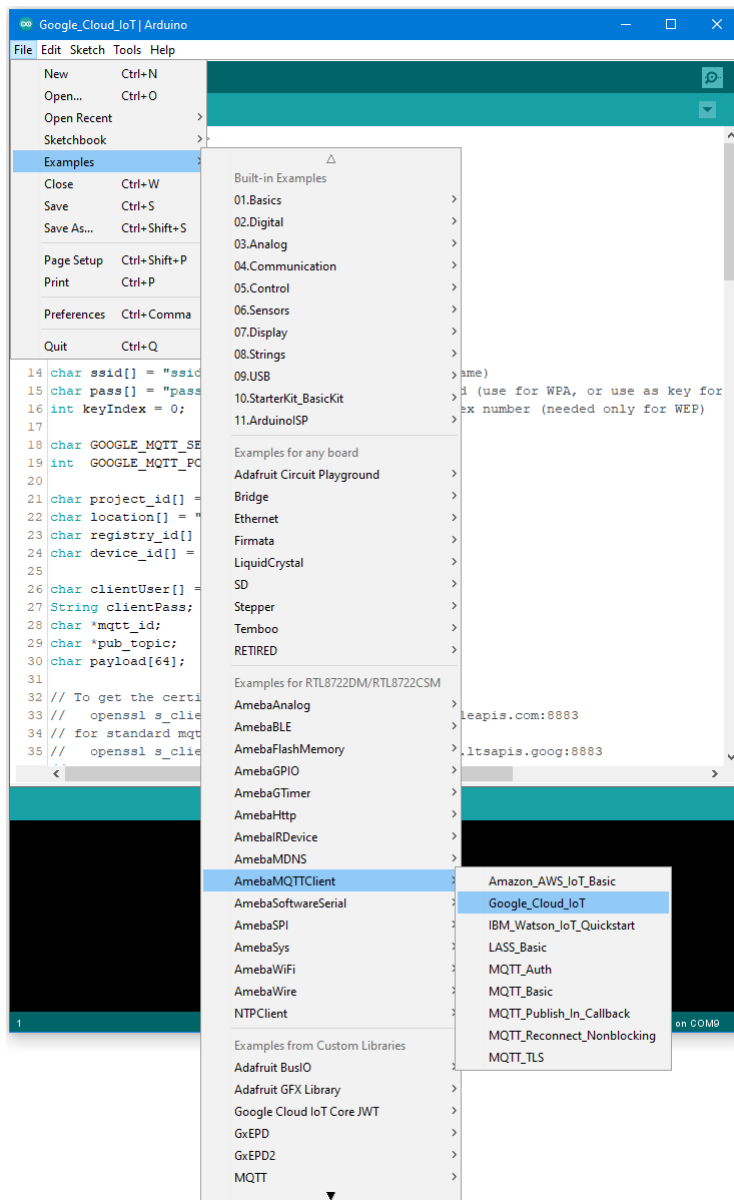
**Acknowledgement deadline** ⓘ

Deadline time is from 10 seconds to 600 seconds

10 Seconds

**Subscription filter** BETA

If a filter syntax is provided, subscribers will only receive messages that match the filter. [Learn more](#)



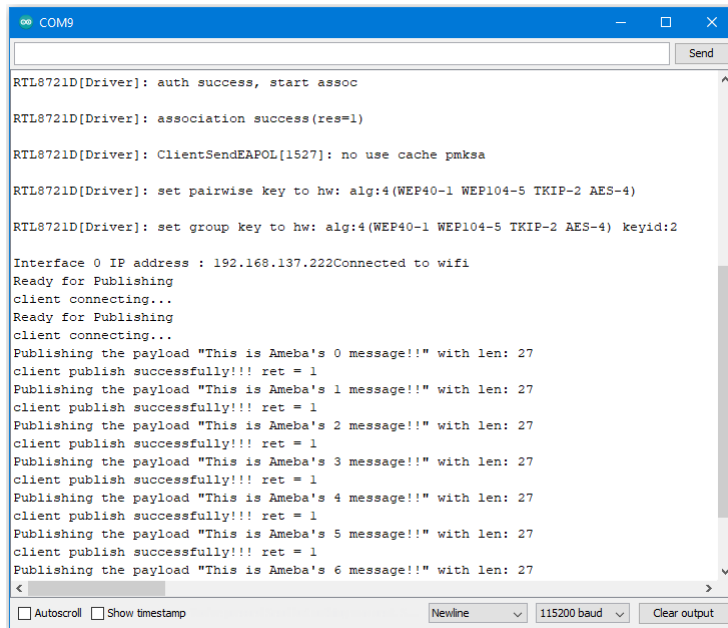
Enter the required information in the highlighted sections below.

```

9  WiFiSSLClient wifiClient;
10 PubSubClient client(wifiClient);
11 WiFiUDP udpClient;
12 NTPClient timeClient(udpClient);
13
14 char ssid[] = "ssid";           // your network SSID (name)
15 char pass[] = "pass";          // your network password (use for WPA, or use as key for
16 int keyIndex = 0;              // your network key Index number (needed only for WEP)
17
18 char GOOGLE_MQTT_SERVER[] = "mqtt.googleapis.com";
19 int  GOOGLE_MQTT_PORT = 8883;
20
21 char project_id[] = "project-id";
22 char location[] = "us-central1";
23 char registry_id[] = "my-registry";
24 char device_id[] = "ameba-device";
25
26 char clientUser[] = "unused";
27 String clientPass;
28 char *mqtt_id;
29 char *pub_topic;
30 char payload[64];
31 NN_DIGIT priv_key[9];
32
33 // To get the private key run (where private-key.pem is the ec private key
34 // used to create the certificate uploaded to google cloud iot):
35 // openssl ec -in <private-key.pem> -noout -text
36 // and copy priv: part.
37 // The key length should be exactly the same as the key length below (32 pairs
38 // of hex digits). If it's bigger and it starts with "00:" delete the "00:". If
39 // it's smaller add "00:" to the start. If it's too big or too small something
40 // is probably wrong with your key.
41 char *private_key_str =
42 "57:e1:c0:3b:e5:cd:2f:42:fb:14:4f:a9:1e:3f:0a:"
43 "65:22:4c:f0:ac:0f:a0:82:e1:73:71:ae:76:70:48:"
44 "68:fe";
45

```

In the yellow section, enter the SSID and password required to connect to your WiFi network. In the green section, enter the Project ID, server Region, Registry ID and Device ID previously configured in Google Cloud console. In the blue section, enter the hexadecimal string previously extracted from the private key. Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor and observe as Ameba connects and sends messages to Google Cloud IoT.



```

COM9
Send

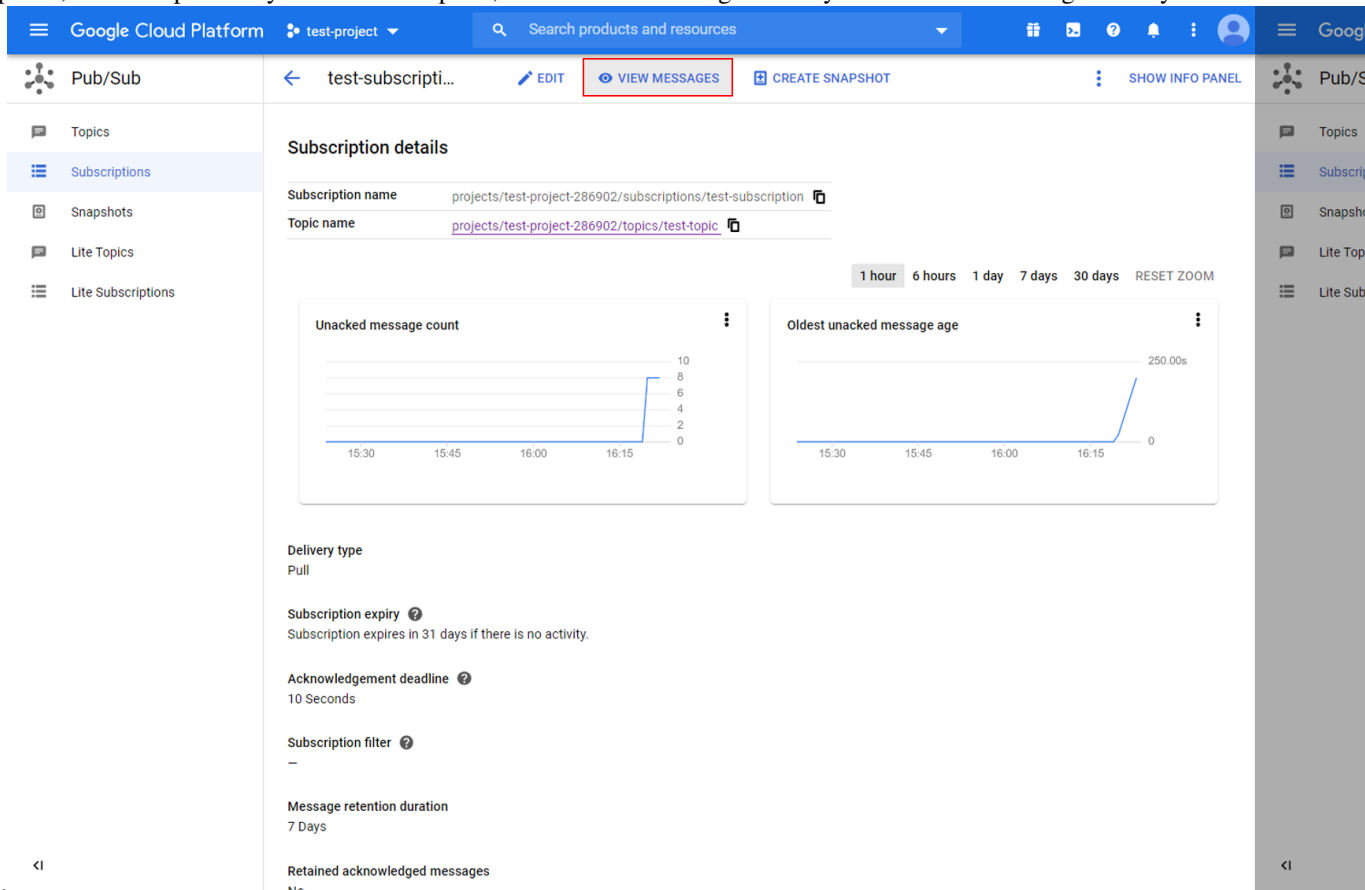
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=1)
RTL8721D[Driver]: ClientSendEAPOL[1527]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.137.222Connected to wifi
Ready for Publishing
client connecting...
Ready for Publishing
client connecting...
Publishing the payload "This is Ameba's 0 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 1 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 2 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 3 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 4 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 5 message!!" with len: 27
client publish successfully!!! ret = 1
Publishing the payload "This is Ameba's 6 message!!" with len: 27
Autoscroll Show timestamp Newline 115200 baud Clear output

```

In Google Cloud console, go to Pub/Sub

subscriptions, select the previously created subscription, and click view messages. Here you can view the messages sent by



Google Cloud Platform test-project Search products and resources

Pub/Sub test-subscripti... EDIT VIEW MESSAGES CREATE SNAPSHOT SHOW INFO PANEL

Topics Subscriptions Snapshots Lite Topics Lite Subscriptions

### Subscription details

Subscription name `projects/test-project-286902/subscriptions/test-subscription`

Topic name `projects/test-project-286902/topics/test-topic`

1 hour 6 hours 1 day 7 days 30 days RESET ZOOM

Unacked message count

Oldest unacked message age

Delivery type: Pull

Subscription expiry: Subscription expires in 31 days if there is no activity.

Acknowledgement deadline: 10 Seconds

Subscription filter: -

Message retention duration: 7 Days

Retained acknowledged messages: No

Ameba.



## Code Reference

In `setup()`, we set up RootCA which is required to form a TLS connection with Google's servers.

```
wifiClient.setRootCA((unsigned char*)rootCABuff);
```

In `loop()`, each loop checks the Internet status and re-connect to it when the environment has a problem.

```
if (WiFi.status() != WL_CONNECTED) {
    while (WiFi.begin(ssid, pass) != WL_CONNECTED)
    {
        delay(1000);
    }
    Serial.println("Connected to wifi");
}
```

To publish messages, `mqtt_id`, `clientPass` and `pub_topic` are required. `mqtt_id` is generated by printing the project ID, server location, registry ID and device ID in the required format:

```
mqtt_id = (char *)malloc(strlen("projects/") + strlen(project_id) + strlen("/locations/us-central1/registries/") + strlen(registry_id) + strlen("/devices/") + strlen(device_id) + 1);
sprintf(mqtt_id, "projects/%s/locations/us-central1/registries/%s/devices/%s", project_id, registry_id, device_id);
```

`clientPass` is generated using a JSON web token (JWT) generator function, which requires the project ID and current time, and signs it with the private key:

```
clientPass = CreateJwt(project_id, timeClient.getEpochTime(), priv_key);
```

`pub_topic` is generated by printing the project ID and topic in the required format:

```
pub_topic = (char *)malloc(strlen("/devices/") + strlen(device_id) + strlen("/events") + 1);
sprintf(pub_topic, "/devices/%s/events", device_id);
```

MQTT Server setting:

```
client.setServer(GOOGLE_MQTT_SERVER, GOOGLE_MQTT_PORT);
client.setPublishQos(MQTTQOS1);
client.waitForAck(true);
```

Connect to google cloud and publish messages:

```
if (client.connect(mqtt_id, clientUser, clientPass.c_str())){
    // ...
}
```

(繼續下一頁)

(繼續上一頁)

```
    for(int i = 0; i < count; i++){
        // ...
        sprintf(payload, "This is Ameba's %d message!!", i);
        ret = client.publish(pub_topic, payload);
        // ...
    }
    // ...
    client.disconnect();
}
free(mqtt_id);
free(pub_topic);
```

## MQTT - Upload PM2.5 Data to LASS System

### Intro to LASS

The LASS stands for “Location Aware Sensor System” . It is an open project and was started only for the interest of public welfare. Find detailed introduction [here](#).

Practically, LASS is based on MQTT protocol to collect all kinds of uploaded data, and for those who need these data can subscribe top as well.

Find more LASS information at their [official hackpad](#).

### Preparation

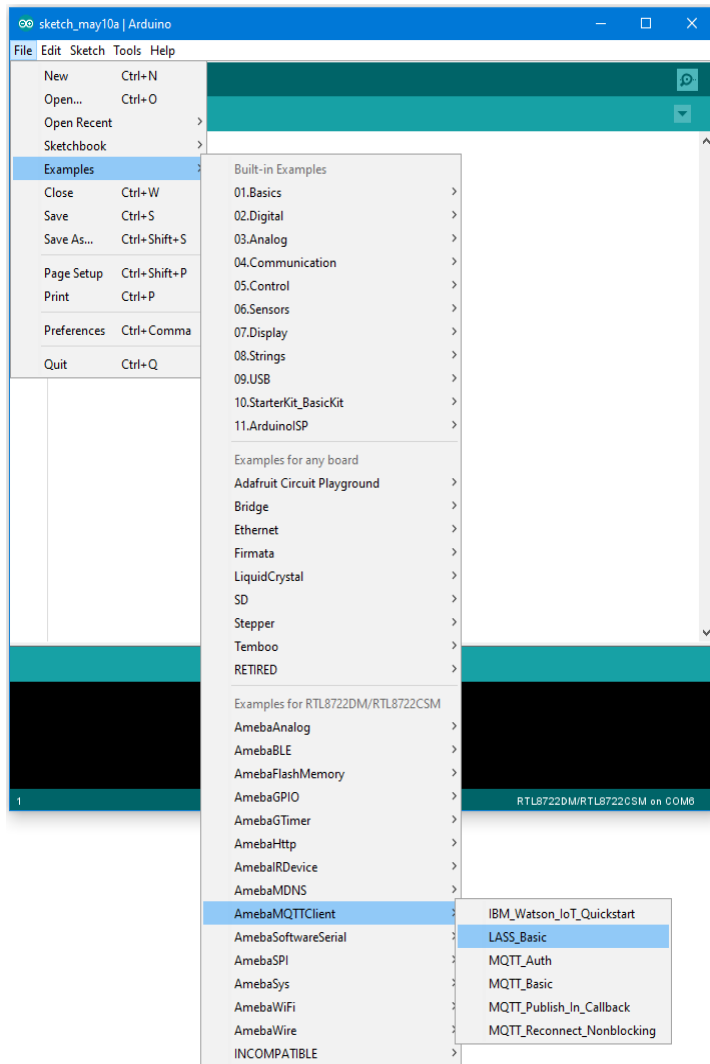
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- PlanTower PMS3003 or PMS5003 x1

### Example

In this example, we use applications mentioned at our website, including:

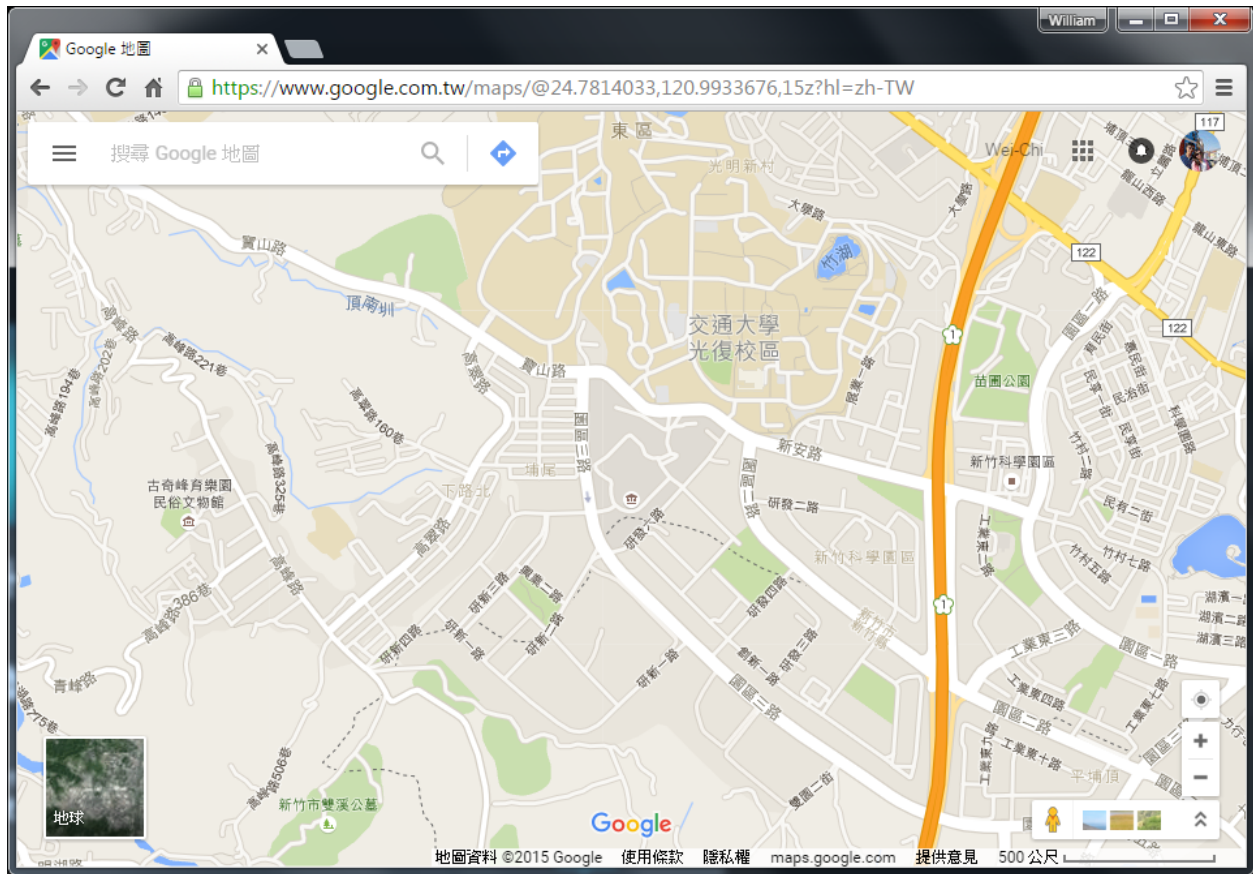
- **MQTT**: a MQTT-Broker to connect to LASS. The Client is “FT1\_0XXXX” , the XXXX are the four last digits of Ameba’ s Wi-Fi MAC, and the outTopic is “LASS/Test/Pm25Ameba/**clientID** “, where clientID is the actual Ameba’ s MQTT client ID.
- **NTP**: uploaded data must have time notation
- **PM2.5**: uploaded data includes PM2.5 information

Open the example. “File” -> “Examples” -> “AmebaMQTTClient” -> “lass\_basic”

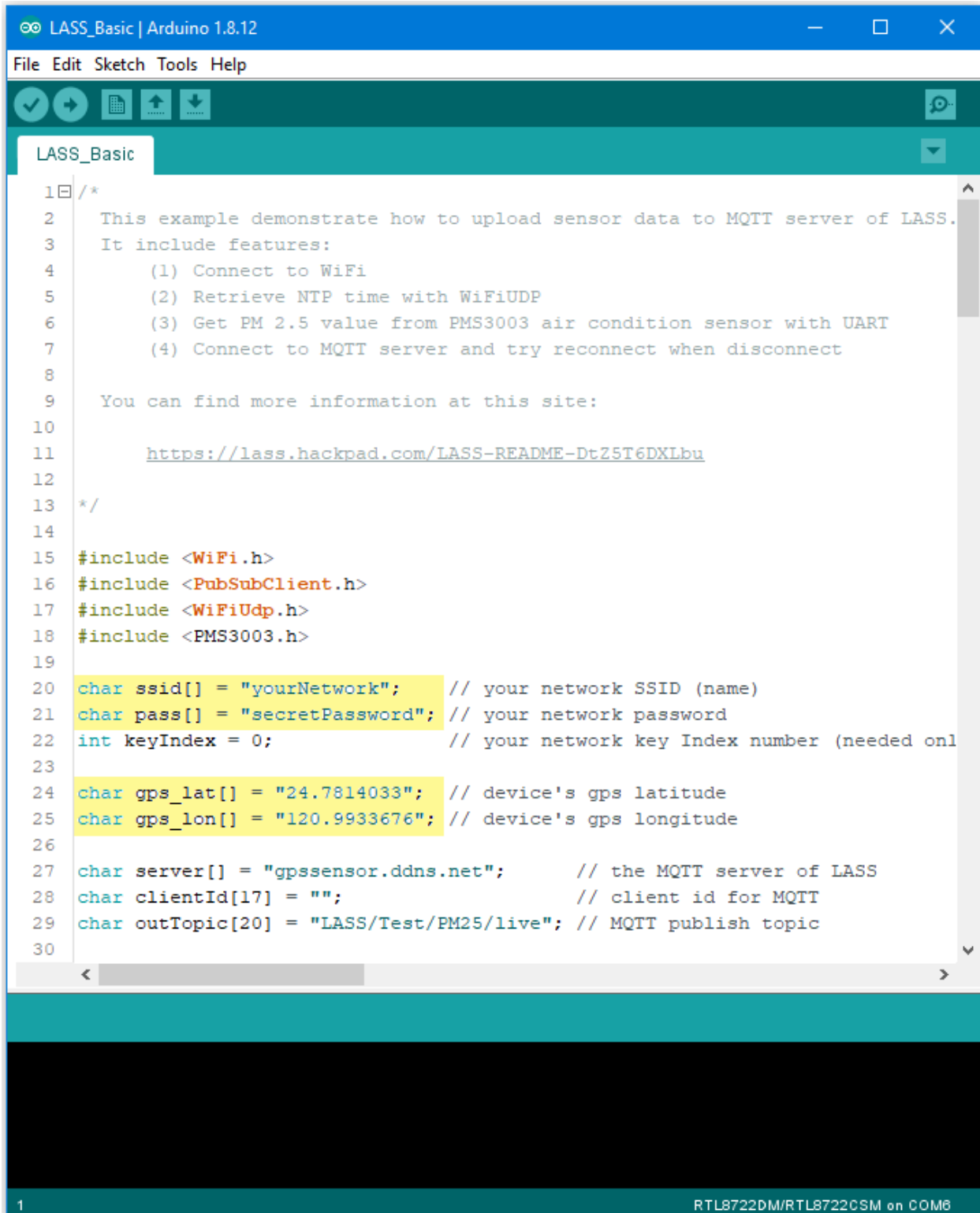


This example requires internet connection, so make sure you fill in SSID and PASS into AP information that you wish to connect.

Also, LASS requires GPS information. There is no GPS sensor included in this example, so you must manually provide GPS information. Use Google Map to find the coordinates you plan to place your Ameba. You can see in this example that the latitude is 24.7814033, and the longitude is 120.9933676



Fill in GPS info at `gps_lat` and `gps_lon`.



```

1  /*
2   This example demonstrate how to upload sensor data to MQTT server of LASS.
3   It include features:
4       (1) Connect to WiFi
5       (2) Retrieve NTP time with WiFiUDP
6       (3) Get PM 2.5 value from PMS3003 air condition sensor with UART
7       (4) Connect to MQTT server and try reconnect when disconnect
8
9   You can find more information at this site:
10
11   https://lass.hackpad.com/LASS-README-DtZ5T6DXLbu
12
13  */
14
15  #include <WiFi.h>
16  #include <PubSubClient.h>
17  #include <WiFiUdp.h>
18  #include <PMS3003.h>
19
20  char ssid[] = "yourNetwork"; // your network SSID (name)
21  char pass[] = "secretPassword"; // your network password
22  int keyIndex = 0; // your network key Index number (needed onl
23
24  char gps_lat[] = "24.7814033"; // device's gps latitude
25  char gps_lon[] = "120.9933676"; // device's gps longitude
26
27  char server[] = "gpssensor.ddns.net"; // the MQTT server of LASS
28  char clientId[17] = ""; // client id for MQTT
29  char outTopic[20] = "LASS/Test/PM25/live"; // MQTT publish topic
30

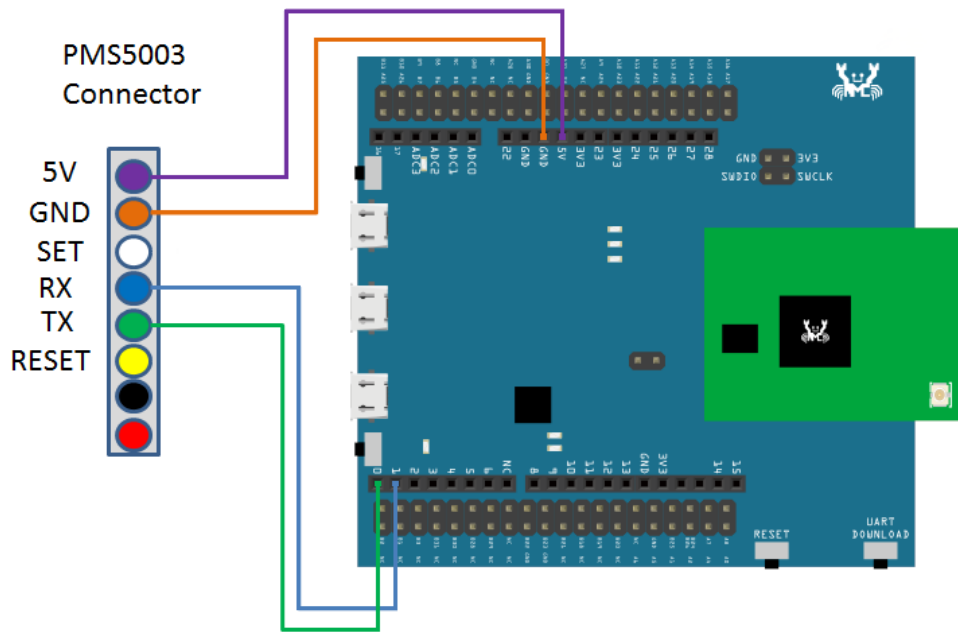
```

1

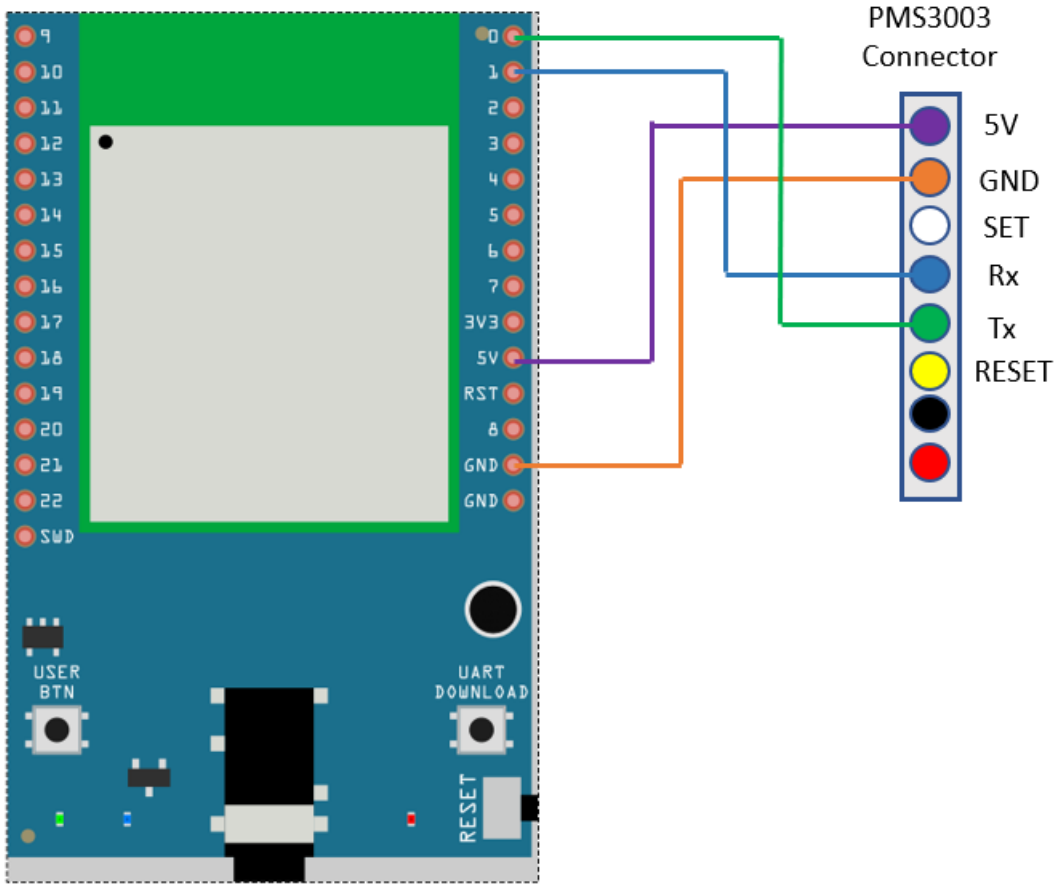
RTL8722DM/RTL8722CSM on COM6

Then connect sensors according to UART-PlanTower PMS3003 wiring example.

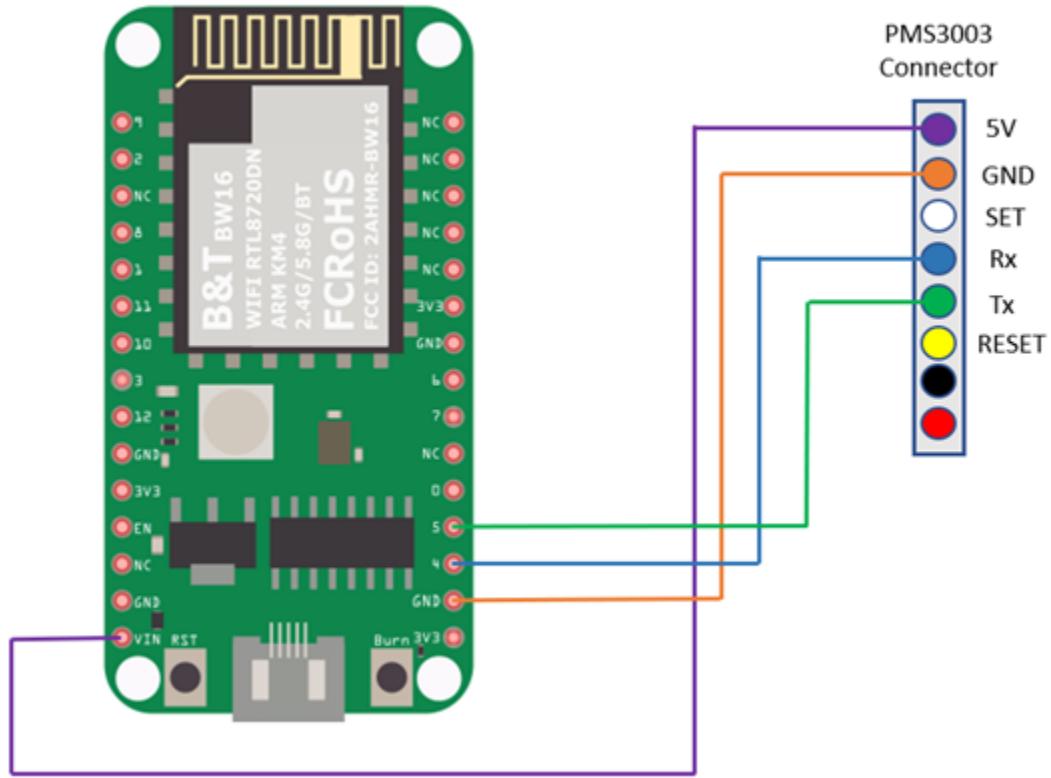
AMB21 / AMB22:



AMB23:

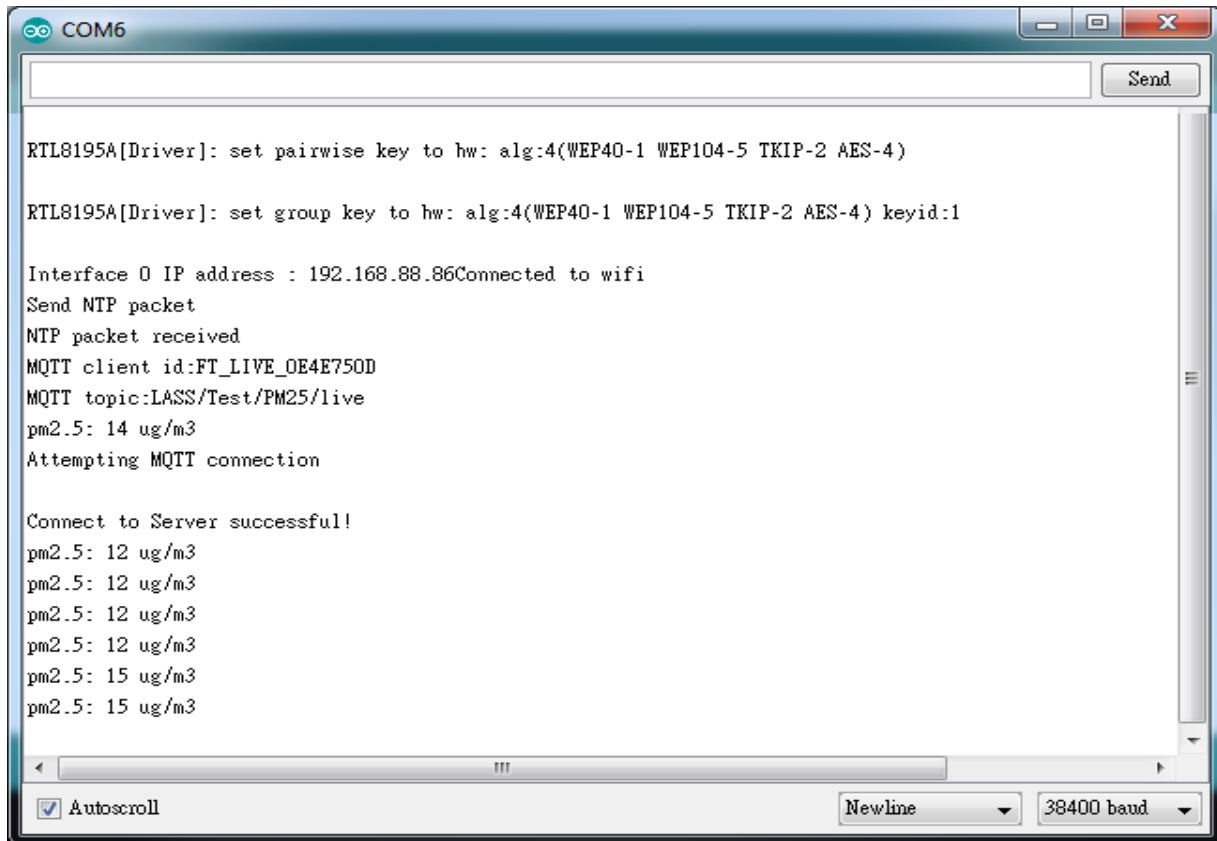


BW16:



Compile the code and upload it to Ameba. After pressing the Reset button, Ameba will attempt to read PM2.5 data every minute and upload it to LASS MQTT-Broker. Open Serial Monitor to see the uploaded data, including client id, topic, and current PM2.5 status.





```
COM6

RTL8195A[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

Interface 0 IP address : 192.168.88.86Connected to wifi
Send NTP packet
NTP packet received
MQTT client id:FT_LIVE_OE4E750D
MQTT topic:LASS/Test/PM25/live
pm2.5: 14 ug/m3
Attempting MQTT connection

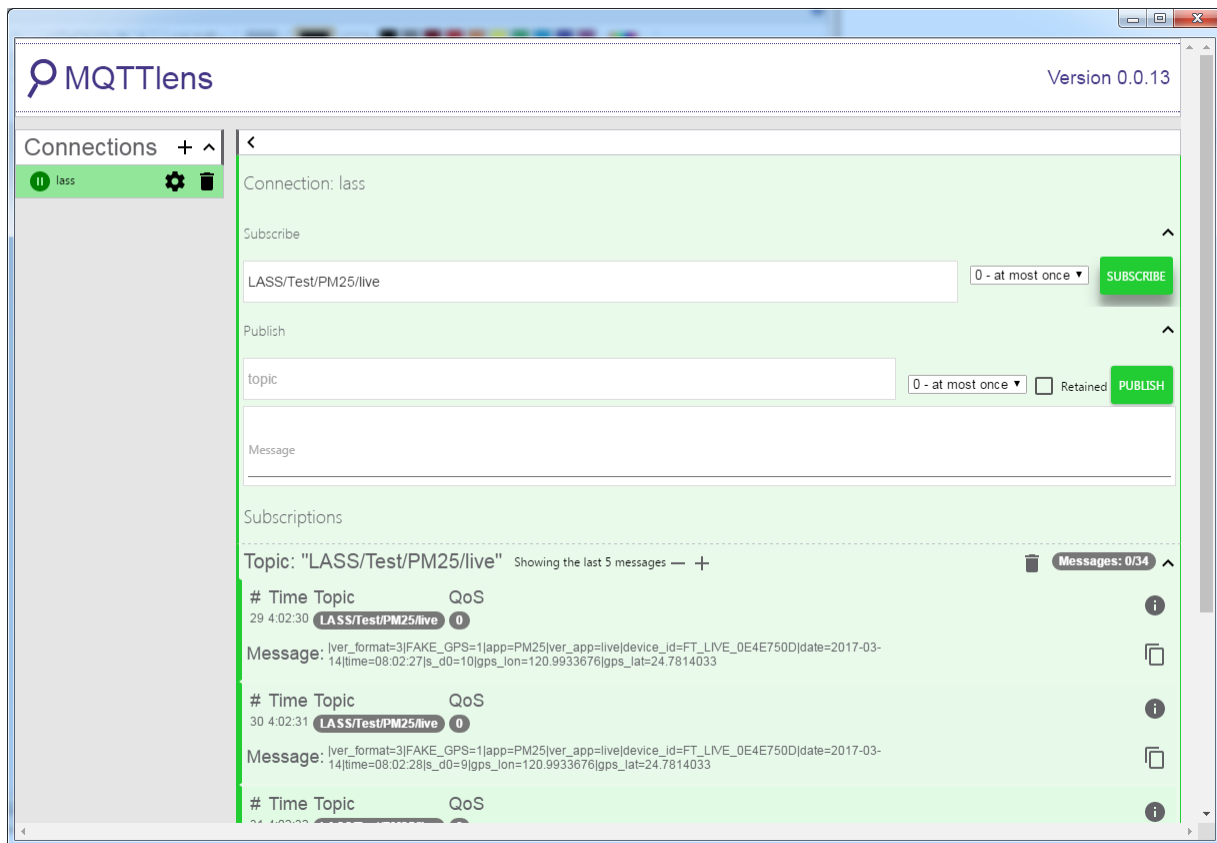
Connect to Server successful!
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 12 ug/m3
pm2.5: 15 ug/m3
pm2.5: 15 ug/m3

Autoscroll Newline 38400 baud
```

We can also use MQTTlens to verify if the data is properly uploaded.

Enter “gpssensor.ddns.net” as the MQTT-Broker server and “LASS/Test/PM25/live” as the subscribe topic to receive data.

The time uses UTC format, and the PM2.5 data stores in s\_d0. In the figure, s\_d0 = 9 represents that the PM2.5 is 9, meaning that the entire publish/subscribe process is working successfully.



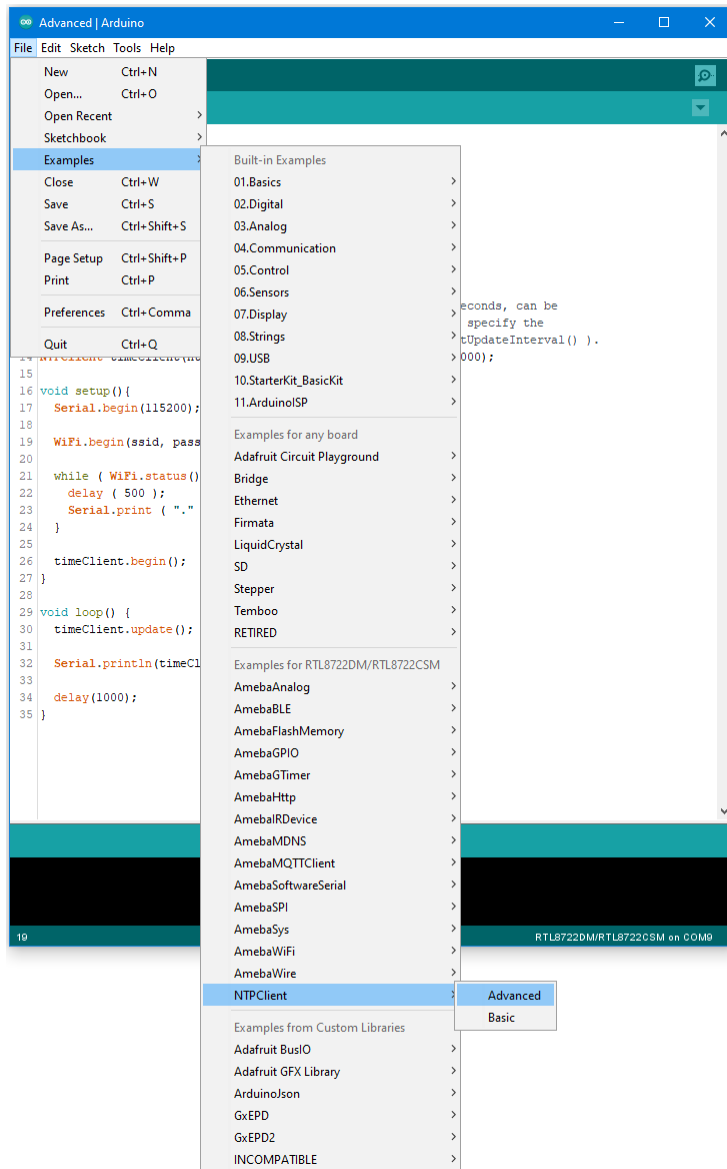
## NTP - Retrieve Universal Time (UTC) by NTPClient library

### Preparation

- AmebaD [RTL8722DM / RTL8722CSM / RTL8722DM MINI] x 1

### Example

In this example, we use an NTP client to sync with NTP servers using UDP and keep track of time locally. Open the example. “File” -> “Examples” -> “NTPClient” -> “Advanced”

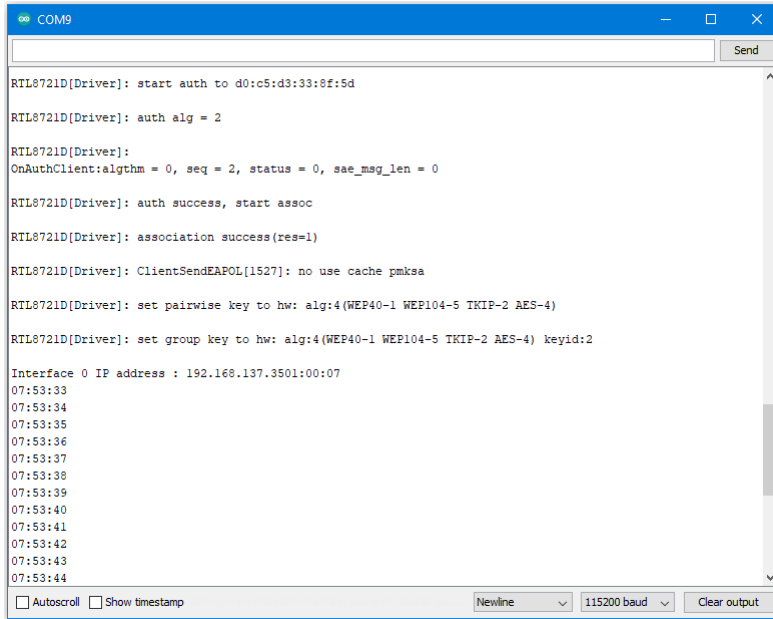


Modify the highlighted code section (ssid, password) to connect to your WiFi network.



```
1 #include <NTPClient.h>
2 #include <WiFi.h>
3 #include <WiFiUDP.h>
4
5 char ssid[] = "<SSID>";
6 char pass[] = "<PASS>";
7
8
9 WiFiUDP ntpUDP;
10
11 // You can specify the time server pool and the offset (in seconds, can be
12 // changed later with setTimeOffset() ). Additionally you can specify the
13 // update interval (in milliseconds, can be changed using setUpdateInterval() ).
14 NTPClient timeClient(ntpUDP, "europe.pool.ntp.org", 3600, 60000);
15
16 void setup() {
17   Serial.begin(115200);
18
19   WiFi.begin(ssid, pass);
20
21   while ( WiFi.status() != WL_CONNECTED ) {
22     delay ( 500 );
23     Serial.print ( "." );
24   }
25
26   timeClient.begin();
27 }
28
29 void loop() {
30   timeClient.update();
31
32   Serial.println(timeClient.getFormattedTime());
33
34   delay(1000);
35 }
```

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi, gets the UTC time from the NTP server, and prints out the current time with time zone offset to the serial monitor.



## Code Reference

Configure NTP client:

The NTPClient needs to use a UDP client for communications. A WiFiUDP client is declared and passed to the NTPClient constructor, along with an NTP server address, time zone offset in seconds, and update interval in milliseconds. If detailed configuration is not needed, just passing in the UDP client is also sufficient, refer to the “NTPClient” -> “Basic” example.

```
WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP, "europe.pool.ntp.org", 3600, 60000);
```

Start NTP client:

After connecting to WiFi, the NTPClient is started using the `begin()` function, which causes the client to sync with the NTP server and get the UTC time.

```
WiFiUDP ntpUDP;
timeClient.begin();
```

Get local time:

`getFormattedTime()` is used to format the received UTC time into the local time zone. `update()` is called every loop so that the `NTPClient` will sync with the NTP server once every update interval.

```
timeClient.update();  
timeClient.getFormattedTime();
```

## WiFi - Approximate UDP Receive Delay

### Materials

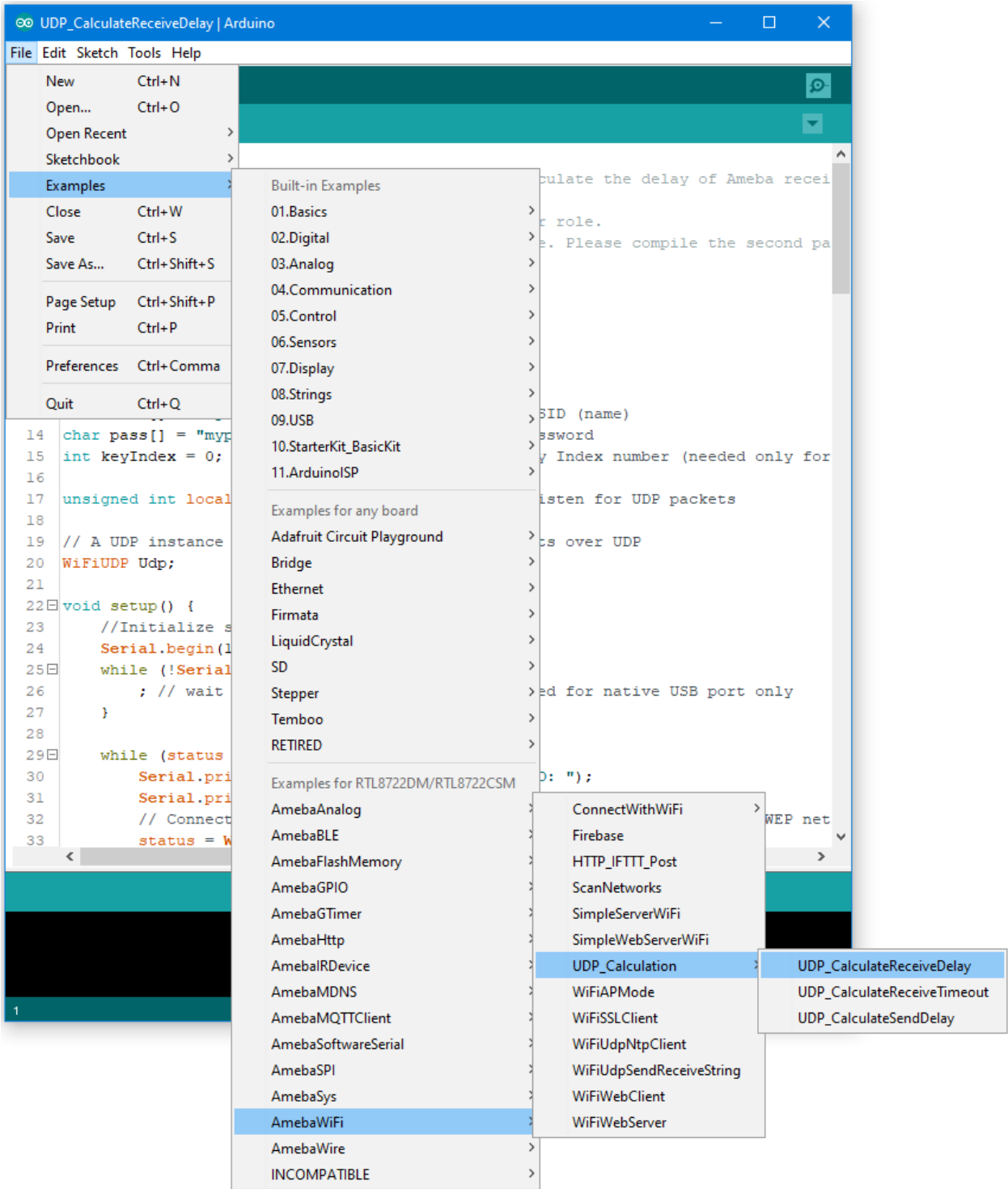
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to receive UDP packets from a computer and calculates the UDP receive delay.

### Ameba Preparation

Open the “CalculateUdpReceiveDelay” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation” -> “CalculateUdpReceiveDelay”.



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.

```

1  /*
2   * This sketch provide a simple way to roughly calculate the delay of Ameba recei
3   * The source code is separate into two parts.
4   * The first part is Ameba code which play receiver role.
5   * The second part is PC code wich play sender role. Please compile the second pa
6   */
7
8  #include <WiFi.h>
9  #include <WiFiUdp.h>
10 #include <stdio.h>
11
12 int status = WL_IDLE_STATUS;
13 char ssid[] = "mynetwork"; // your network SSID (name)
14 char pass[] = "mypassword"; // your network password
15 int keyIndex = 0; // your network key Index number (needed only for
16
17 unsigned int localPort = 5001; // local port to listen for UDP packets
18
19 // A UDP instance to let us send and receive packets over UDP
20 WiFiUDP Udp;
21
22 void setup() {
23     //Initialize serial and wait for port to open:
24     Serial.begin(115200);
25     while (!Serial) {
26         ; // wait for serial port to connect. Needed for native USB port only
27     }
28
29     while (status != WL_CONNECTED) {
30         Serial.print("Attempting to connect to SSID: ");
31         Serial.println(ssid);
32         // Connect to WPA/WPA2 network. Change this line if using open or WEP net
33         status = WiFi.begin(ssid, pass);

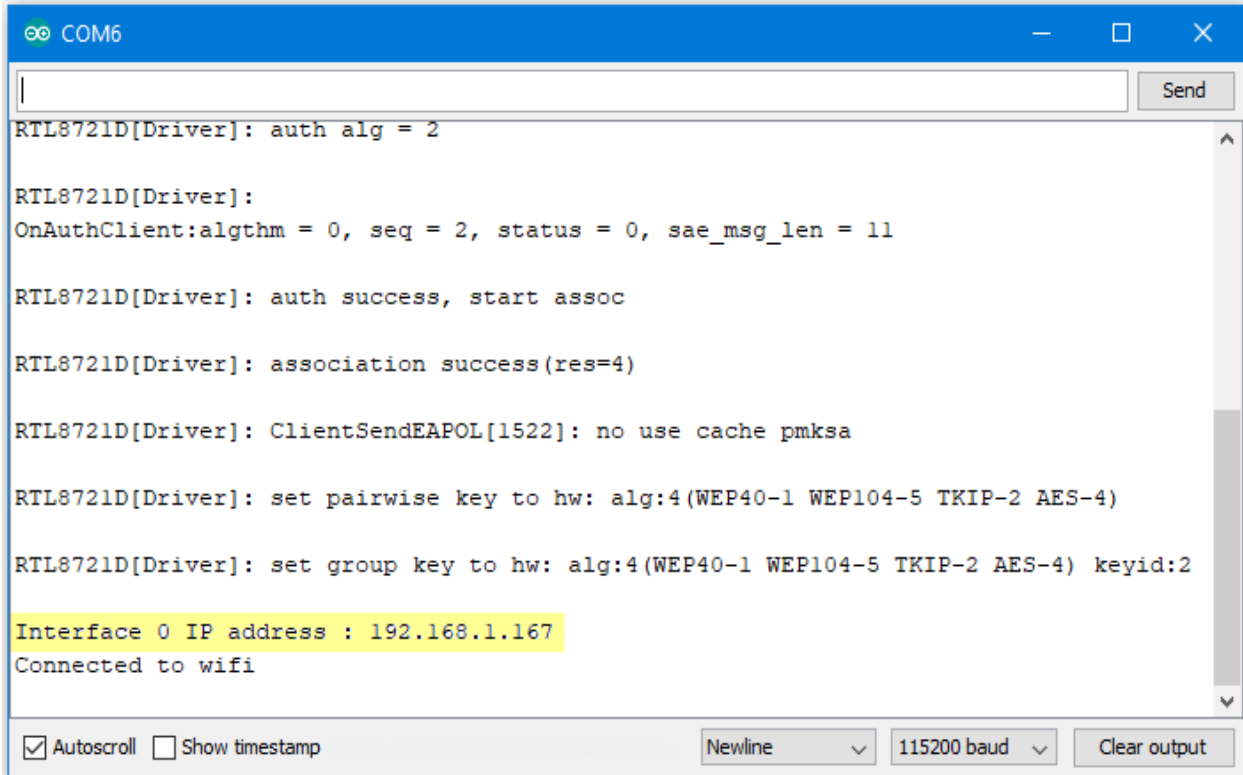
```

1

RTL8722DM/RTL8722CSM on COM8

Upload the code and press the reset button on Ameba once the upload is finished. Open the serial monitor in Arduino IDE and take note of the IP address assigned to Ameba.





```
COM6
| Send
RTL8721D[Driver]: auth alg = 2
RTL8721D[Driver]:
OnAuthClient:alghm = 0, seq = 2, status = 0, sae_msg_len = 11
RTL8721D[Driver]: auth success, start assoc
RTL8721D[Driver]: association success(res=4)
RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa
RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2
Interface 0 IP address : 192.168.1.167
Connected to wifi
☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output
```

### Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpReceiveDelay” Arduino example, copy the code from the bottom between “#if 0” and “#endif” , into a new text file, change the hostname to the IP address assigned to Ameba, and rename the file to “UdpReceiveDelay.cpp” .

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <netinet/in.h>
6  #include <arpa/inet.h>
7  #include <sys/time.h>
8  #include <unistd.h>
9
10 #define BUFSIZE 1024
11
12 char *hostname = "172.25.24.243";
13 int portno = 5001;
14
15 long base_current_time = 0;
16 long get_current_time_with_ms (void)
17 {
18     struct timeval tv;
19
20     gettimeofday(&tv, NULL);
21
22     long millisecondsSinceEpoch =
23         (long)(tv.tv_sec) * 1000 +
24         (long)(tv.tv_usec) / 1000;
25
26     if (base_current_time == 0) {
27         base_current_time = millisecondsSinceEpoch;
28         return 0;
29     } else {
30         return millisecondsSinceEpoch - base_current_time;
31     }
32 }

```

length: 1,666 lines: 67 Ln: 12 Col: 1 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpReceiveDelay.cpp”, and use the command “g++ UdpReceiveDelay.cpp -o UdpDelay” to compile the code. A file named “UdpDelay.exe” will be created in the same directory.

### Running the Example

Reset the Ameba, wait for the WiFi to connect, and check that the IP address remains the same. On the computer, run the UdpDelay.exe file, and the computer will begin to send packets to Ameba. Once 10000 packets have been received, Ameba will calculate the average delay and print out the result to the serial monitor. It may take up to a few minutes for 10000 packets to be sent.

```

COM6
Send

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
Connected to wifi
data count: 10000      average delay: 95.47 ms
data count: 20000      average delay: 198.96 ms
data count: 30000      average delay: 272.98 ms

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

## WiFi - Approximate UDP Sending Delay

### Materials

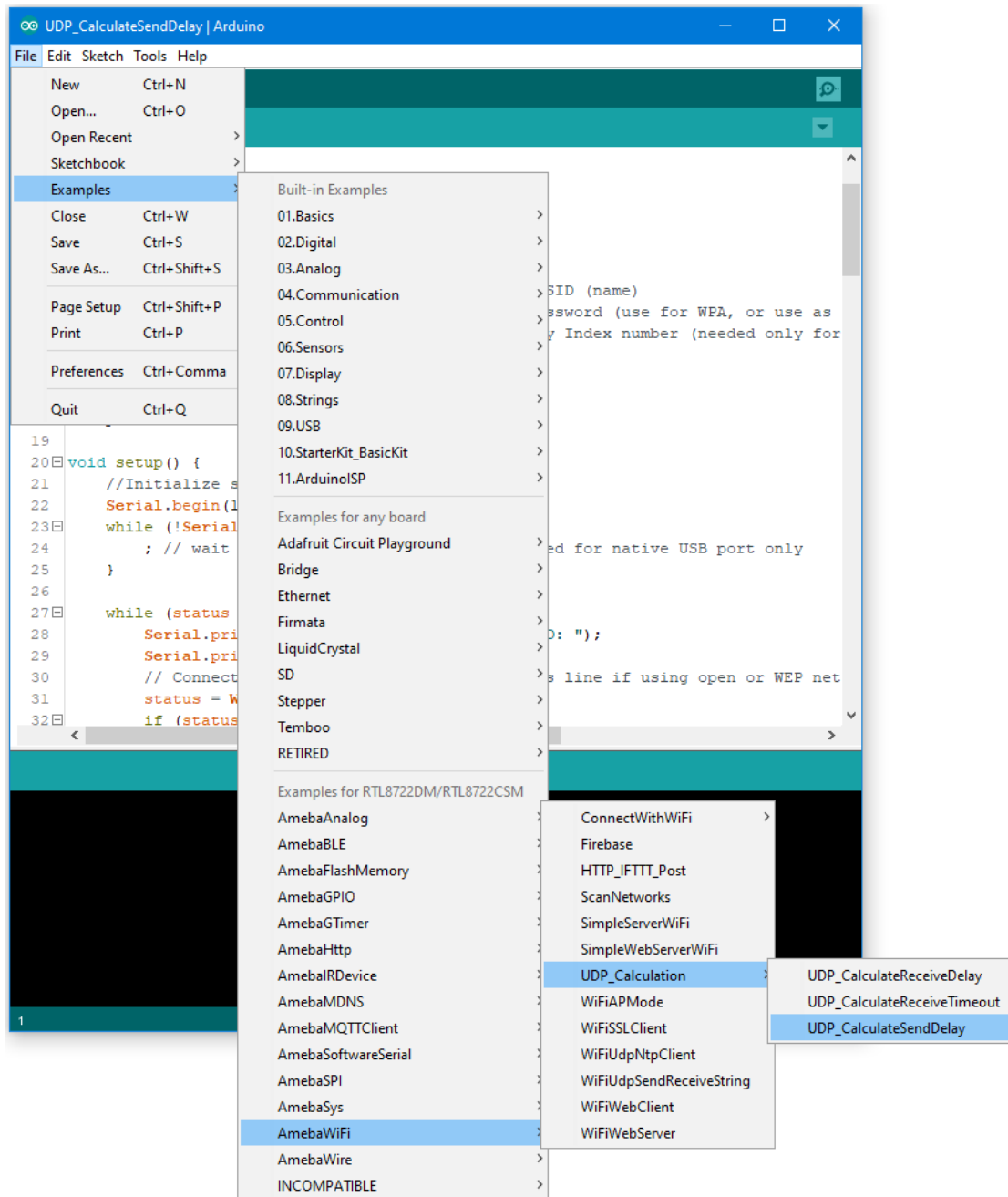
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to send UDP packets to a computer and calculates the UDP sending delay.

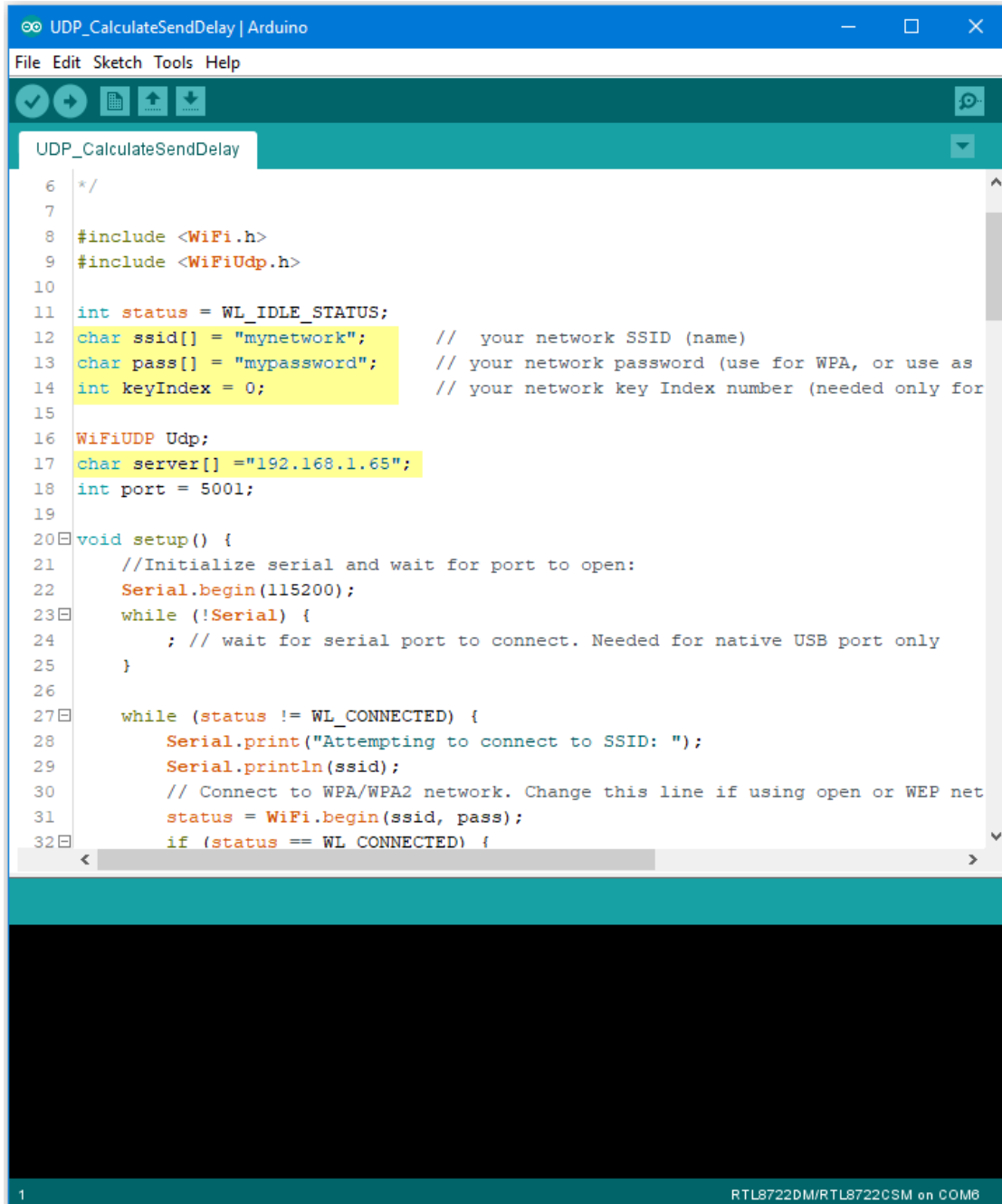
### Ameba Preparation

Open the “CalculateUdpSendDelay” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation ” -> “CalculateUdpSendDelay” .



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.

The server variable also needs to be changed to match the IP address of your computer. You can find the IP address using the “ipconfig” command in a terminal window.



```

6  */
7
8  #include <WiFi.h>
9  #include <WiFiUdp.h>
10
11 int status = WL_IDLE_STATUS;
12 char ssid[] = "mynetwork"; // your network SSID (name)
13 char pass[] = "mypassword"; // your network password (use for WPA, or use as
14 int keyIndex = 0; // your network key Index number (needed only for
15
16 WiFiUDP Udp;
17 char server[] = "192.168.1.65";
18 int port = 5001;
19
20 void setup() {
21     //Initialize serial and wait for port to open:
22     Serial.begin(115200);
23     while (!Serial) {
24         ; // wait for serial port to connect. Needed for native USB port only
25     }
26
27     while (status != WL_CONNECTED) {
28         Serial.print("Attempting to connect to SSID: ");
29         Serial.println(ssid);
30         // Connect to WPA/WPA2 network. Change this line if using open or WEP net
31         status = WiFi.begin(ssid, pass);
32         if (status == WL_CONNECTED) {

```

### Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpSendDelay” Arduino example, copy the code from the bottom between “#if 0” and “#endif”, into a new text file and rename the file to “UdpSendDelay.cpp”.

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <arpa/inet.h>
6  #include <sys/time.h>
7
8  #define BUFSIZE 1024
9  #define PORT 5001
10
11 long get_current_time_with_ms (void)
12 {
13     struct timeval tv;
14
15     gettimeofday(&tv, NULL);
16
17     long millisecondsSinceEpoch =
18         (long) (tv.tv_sec) * 1000 +
19         (long) (tv.tv_usec) / 1000;
20
21     return millisecondsSinceEpoch;
22 }
23
24 long early_diff = 0;
25
26 long ameba_epoch = 0;
27 long sys_epoch = 0;
28
29 long datacount = 0;
30 long total_shift = 0;
31
32 void process_data(char *buf) {

```

length: 2,706 lines: 110 Ln: 110 Col: 2 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpSendDelay.cpp”, and use the command “g++ UdpSendDelay.cpp -o UdpDelay” to compile the code. A file named “UdpDelay.exe” will be created in the same directory.

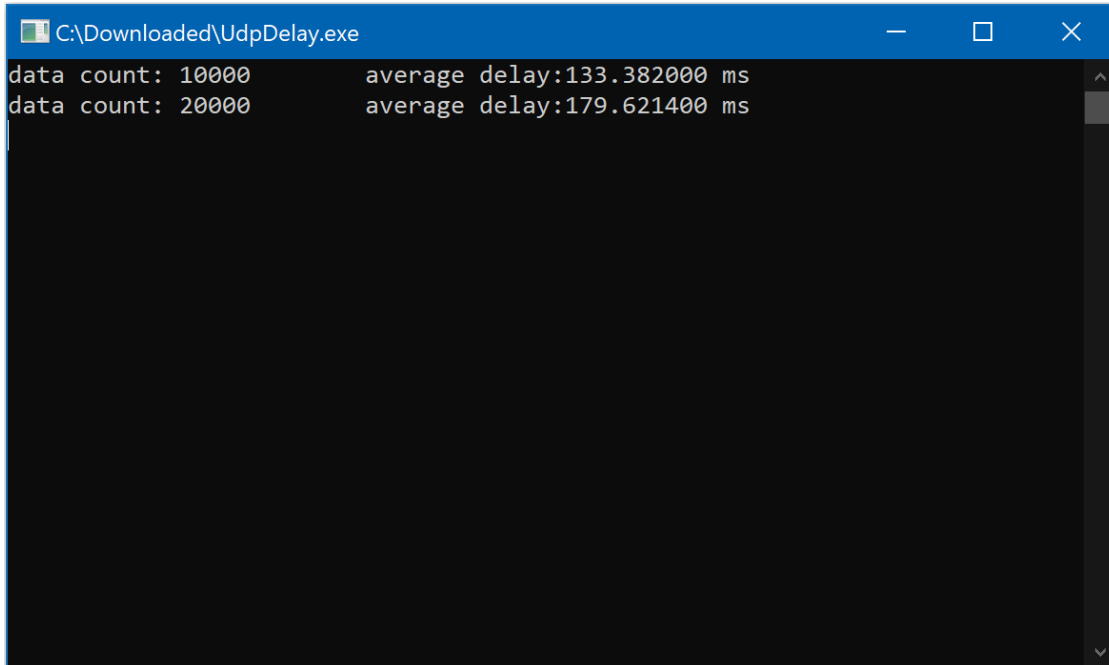
### Running the Example

First, on the computer, run the UdpDelay.exe file, and the computer will begin to listen for packets from Ameba.

Next, compile and upload the code from the Arduino IDE to Ameba and press the reset button when the upload is complete.

The Ameba will begin to send UDP packets to the computer. Once 10000 packets have been received, the computer will calculate the average delay and print out the result.

It will take some time for 10000 packets to be sent.



```
C:\Downloaded\UdpDelay.exe
data count: 10000      average delay:133.382000 ms
data count: 20000      average delay:179.621400 ms
```

## WiFi - Approximate UDP Receive Timeout

### Materials

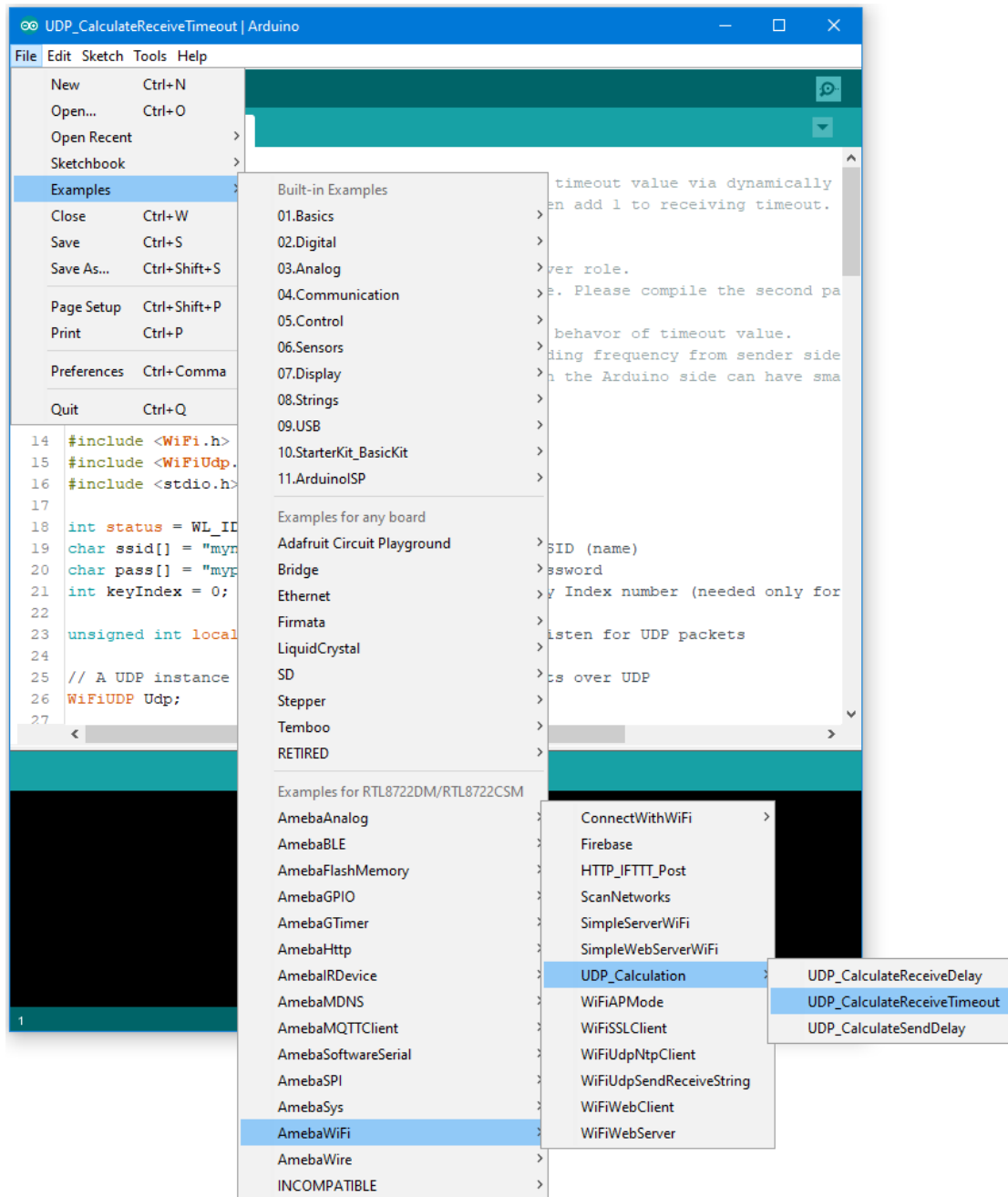
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Windows computer connected to same network

### Example

This example uses Ameba to receive UDP packets from a computer and calculates the allowed UDP receive timeout setting.

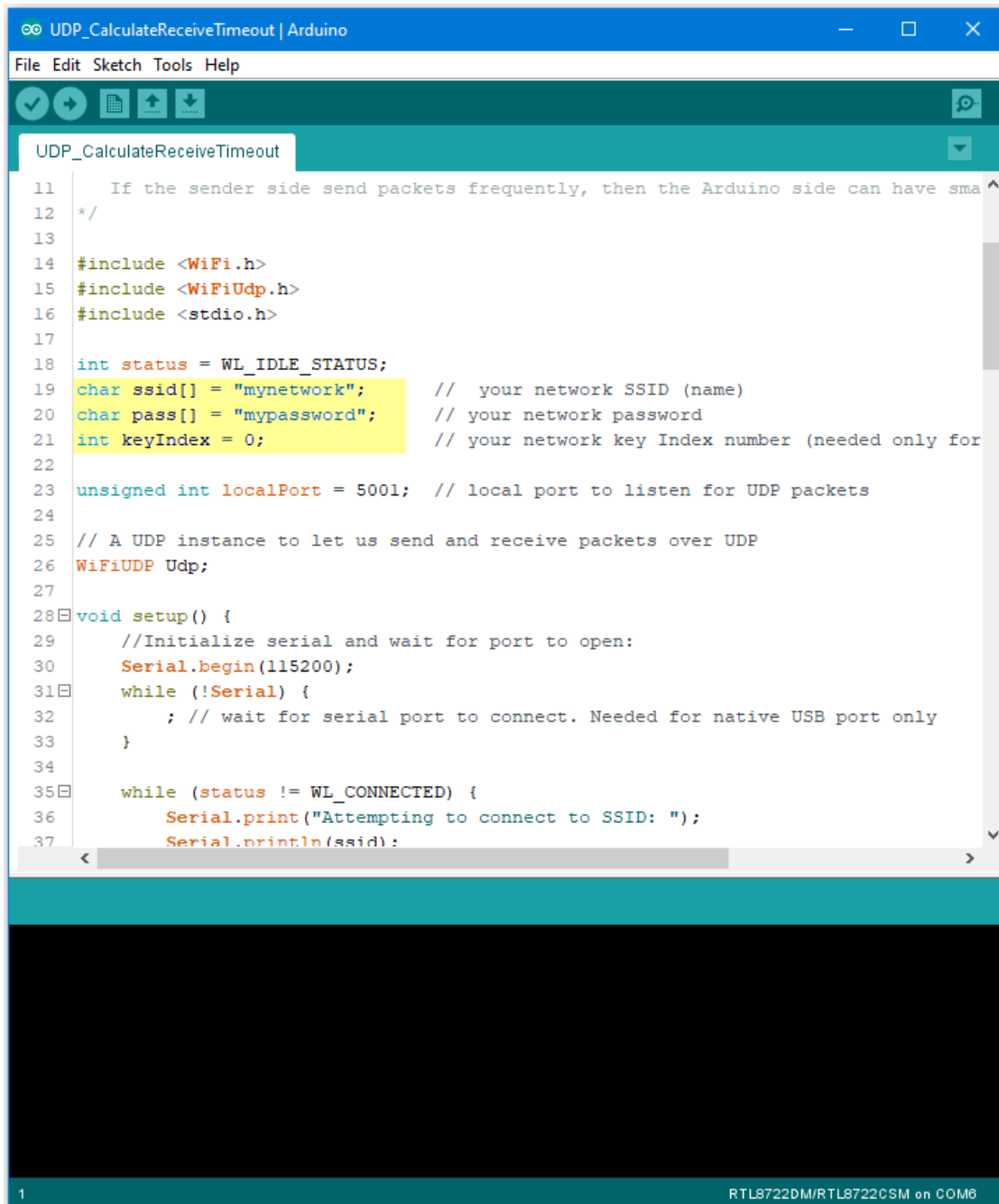
### Ameba Preparation

Open the “CalculateUdpReceiveTimeout” example in “File” -> “Examples” -> “AmebaWiFi” -> “UDP\_Calculation ” -> “CalculateUdpReceiveTimeout” .



In the sample code, modify the highlighted section to enter the information required (ssid, password, key index) to connect to your WiFi network.





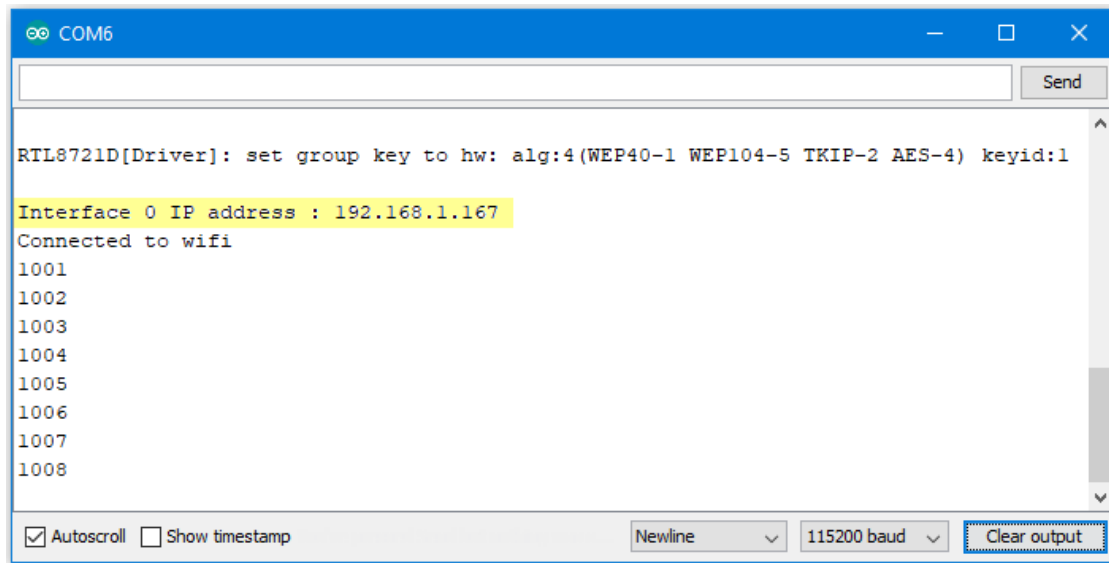
```

11  If the sender side send packets frequently, then the Arduino side can have sma
12  */
13
14  #include <WiFi.h>
15  #include <WiFiUdp.h>
16  #include <stdio.h>
17
18  int status = WL_IDLE_STATUS;
19  char ssid[] = "mynetwork"; // your network SSID (name)
20  char pass[] = "mypassword"; // your network password
21  int keyIndex = 0; // your network key Index number (needed only for
22
23  unsigned int localPort = 5001; // local port to listen for UDP packets
24
25  // A UDP instance to let us send and receive packets over UDP
26  WiFiUDP Udp;
27
28  void setup() {
29      //Initialize serial and wait for port to open:
30      Serial.begin(115200);
31      while (!Serial) {
32          ; // wait for serial port to connect. Needed for native USB port only
33      }
34
35      while (status != WL_CONNECTED) {
36          Serial.print("Attempting to connect to SSID: ");
37          Serial.println(ssid);

```

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in Arduino IDE and take note of the IP address assigned to Ameba.



The screenshot shows a serial terminal window titled "COM6". The output text is as follows:

```
RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1  
Interface 0 IP address : 192.168.1.167  
Connected to wifi  
1001  
1002  
1003  
1004  
1005  
1006  
1007  
1008
```

The line "Interface 0 IP address : 192.168.1.167" is highlighted in yellow. At the bottom of the window, there are controls: a checked "Autoscroll" checkbox, an unchecked "Show timestamp" checkbox, a "Newline" dropdown menu, a "115200 baud" dropdown menu, and a "Clear output" button.

## Computer Preparation

On the computer, Cygwin will be required to compile the code to send the UDP packets. Cygwin can be downloaded from <https://www.cygwin.com/>

Follow the instructions there to install it. Next, from the “CalculateUdpReceiveTimeout” Arduino example, copy the code from the bottom between “#if 0” and “#endif” , into a new text file, change the hostname to the IP address assigned to Ameba, and rename the file to “UdpReceiveTimeout.cpp” .

```

1  #include <stdio.h>
2  #include <stdlib.h>
3  #include <string.h>
4  #include <sys/socket.h>
5  #include <netinet/in.h>
6  #include <arpa/inet.h>
7  #include <unistd.h>
8
9  #define BUFSIZE 16
10
11  char *hostname = "192.168.1.213";
12  int portno = 5001;
13
14  int main(int argc, char **argv) {
15      int sockfd, n;
16      struct sockaddr_in serveraddr;
17      int serverlen = sizeof(serveraddr);
18      char buf[BUFSIZE];
19      int counter = 0;
20
21      /* socket: create the socket */
22      sockfd = socket(AF_INET, SOCK_DGRAM, 0);
23      if (sockfd < 0) {
24          printf("ERROR opening socket\r\n");
25          return -1;
26      }
27
28      /* build the server's Internet address */
29      memset(&serveraddr, 0, sizeof(serveraddr));
30      serveraddr.sin_family = AF_INET;
31      serveraddr.sin_addr.s_addr = inet_addr(hostname);
32      serveraddr.sin_port = htons(portno);

```

length: 1,246 lines: 49 Ln: 11 Col: 5 Sel: 0|0 Windows (CR LF) UTF-8 INS

Next, open a Cygwin terminal, change the working directory to the location of “UdpReceiveTimeout.cpp”, and use the command “g++ UdpReceiveTimeout.cpp -o UdpTimeout” to compile the code. A file named “UdpTimeout.exe” will be created in the same directory.

### Running the Example

Reset the Ameba, wait for the WiFi to connect, and check that the IP address remains the same. On the computer, run the UdpTimeout.exe file, and the computer will begin to send packets continuously to Ameba.

The timeout value is set to 1000ms initially. For each packet received successfully, Ameba decreases the timeout value. The next packet must be received within the timeout period, otherwise Ameba registers a failed packet and increases the timeout value. Open the serial monitor and observe the timeout value converge to a minimum value.

## WiFi - Connect to WiFi networks

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Procedure

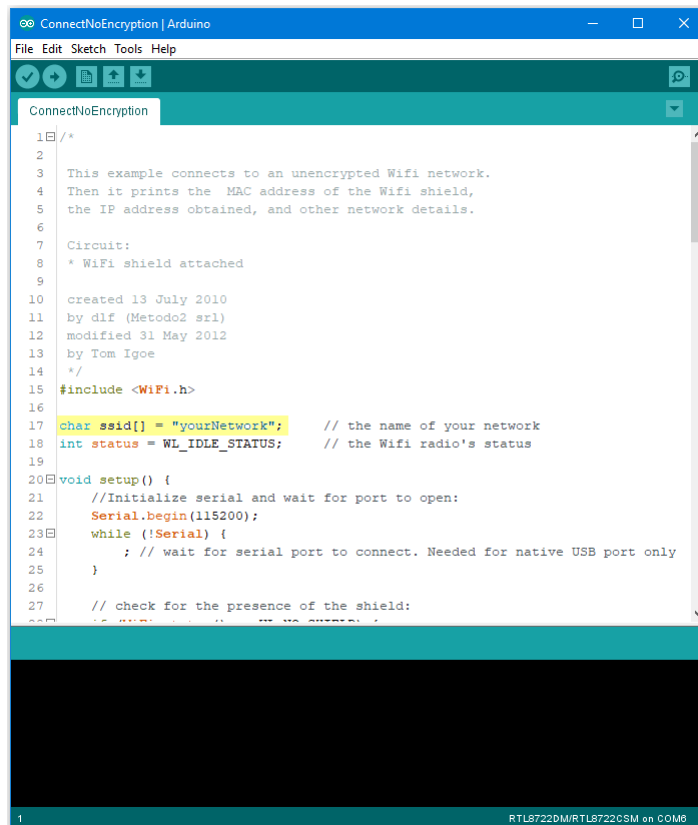
There three common encryption type in WiFi connection. The first one is “OPEN” , which means there is no password needed to connect to this network. The second type of encryption is WPA, which requires the correct password to access. The third type is WEP, which requires a hexadecimal password and a keyindex.

In the following, we will give a brief introduction on how to establish WiFi connection with these three types of encryption on Ameba.

First, make sure the correct Ameba development board is selected in “Tools” -> “Board” .

- Open (WiFi connection without password)

Open the “ConnectNoEncryption” example in “File” -> “Examples” -> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectNoEncryption”



```

1  /*
2
3  This example connects to an unencrypted Wifi network.
4  Then it prints the MAC address of the Wifi shield,
5  the IP address obtained, and other network details.
6
7  Circuit:
8  * Wifi shield attached
9
10 created 13 July 2010
11 by dlf (Metodo2 srl)
12 modified 31 May 2012
13 by Tom Igoe
14 */
15 #include <WiFi.h>
16
17 char ssid[] = "yourNetwork"; // the name of your network
18 int status = WL_IDLE_STATUS; // the Wifi radio's status
19
20 void setup() {
21   //Initialize serial and wait for port to open:
22   Serial.begin(115200);
23   while (!Serial) {
24     ; // wait for serial port to connect. Needed for native USB port only
25   }
26
27   // check for the presence of the shield:

```

In the sample code, modify “ssid” to be the same as the WiFi SSID to be connected to.

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’re connected to the networkSSID: XXXXX”, and the information of this WiFi connection is printed in the serial monitor every 10 seconds.

```

COM6
Interface 0 IP address : 192.168.43.32
You're connected to the networkSSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-55
Encryption Type:0
IP Address: 192.168.43.32
192.168.43.32
MAC address: 70:1D:8:4:55:32
NetMask: 255.255.255.0
Gateway: 192.168.43.235
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-55
Encryption Type:0
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-58
Encryption Type:0
SSID: Test network
BSSID: EE:C0:E7:86:9E:E
signal strength (RSSI):-57
Encryption Type:0
Autoscroll Show timestamp Newline 115200 baud Clear output

```

- WiFi connection with WPA encryption

Open the “ConnectWithWPA” example in “File” -> “Examples”  
 -> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectWithWPA”

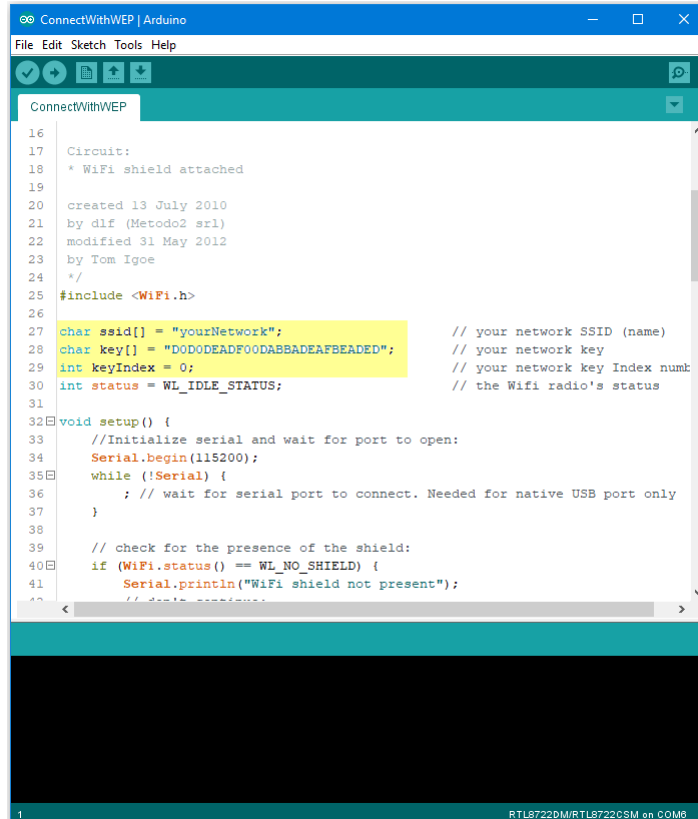
```

ConnectWithWPA
1 /*
2
3  This example connects to an unencrypted Wifi network.
4  Then it prints the  MAC address of the Wifi shield,
5  the IP address obtained, and other network details.
6
7  Circuit:
8  * Wifi shield attached
9
10 created 13 July 2010
11 by dlf (Metodo2 srl)
12 modified 31 May 2012
13 by Tom Igoe
14 */
15 #include <WiFi.h>
16
17 char ssid[] = "yourNetwork"; // your network SSID (name)
18 char pass[] = "secretPassword"; // your network password
19 int status = WL_IDLE_STATUS; // the Wifi radio's status
20
21 void setup() {
22   //Initialize serial and wait for port to open:
23   Serial.begin(115200);
24   while (!Serial) {
25     ; // wait for serial port to connect. Needed for native USB port only
26   }
27
28   // ...
29 }
30
31 // ...
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```

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’ re connected to the networkSSID: XXXXX” , and the information of this WiFi connection is printed in the serial monitor every 10 seconds.

- WiFi connection with WEP encryption

Open the “ConnectWithWEP” example in “File” -> “Examples” -> “AmebaWiFi” -> “ConnectWithWiFi” -> “ConnectWithWEP”



```

16
17 Circuit:
18 * WiFi shield attached
19
20 created 13 July 2010
21 by dlf (Metodo2 srl)
22 modified 31 May 2012
23 by Tom Igoe
24 */
25 #include <WiFi.h>
26
27 char ssid[] = "yourNetwork"; // your network SSID (name)
28 char key[] = "D0D0DEADFO0DABBAD0AFBEAD0"; // your network key
29 int keyIndex = 0; // your network key Index number
30 int status = WL_IDLE_STATUS; // the Wifi radio's status
31
32 void setup() {
33 //Initialize serial and wait for port to open:
34 Serial.begin(115200);
35 while (!Serial) {
36 ; // wait for serial port to connect. Needed for native USB port only
37 }
38
39 // check for the presence of the shield:
40 if (WiFi.status() == WL_NO_SHIELD) {
41 Serial.println("WiFi shield not present");
42 // don't continue
43 }
44
45 }
46
47 void loop() {
48 // print the status of the WiFi connection:
49 Serial.print("WiFi status: ");
50 Serial.println(WiFi.status());
51
52 // print the SSID of the network you're connected to:
53 Serial.print("SSID: ");
54 Serial.println(WiFi.SSID());
55
56 // print the MAC address of the network you're connected to:
57 Serial.print("MAC: ");
58 Serial.println(WiFi.macAddress());
59
60 // print the IP address of the network you're connected to:
61 Serial.print("IP: ");
62 Serial.println(WiFi.localIP());
63
64 // print the gateway IP address of the network you're connected to:
65 Serial.print("Gateway: ");
66 Serial.println(WiFi.gatewayIP());
67
68 // print the DNS server IP address of the network you're connected to:
69 Serial.print("DNS: ");
70 Serial.println(WiFi.dnsServerIP());
71
72 // wait 10 seconds
73 delay(10000);
74 }

```

In the sample code, modify “ssid” to the SSID to be connected, “key” to the hexadecimal password, “keyIndex” to your key index number.

Next, upload the sample code, and press the reset button on Ameba. Then you will see a message “You’ re connected to the networkSSID: XXXXX” , and the information of this WiFi connection is printed in the IDE every 10 seconds.

## Code Reference

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.encryptionType()` to get the encryption type of the WiFi connection.

<https://www.arduino.cc/en/Reference/WiFiEncryptionType>

Use `WiFi.BSSID()` to get the MAC address of the router you are connected to.

<https://www.arduino.cc/en/Reference/WiFiBSSID>

To get the information of Ameba:

Use `WiFi.macAddress()` to get the MAC address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiMACAddress>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFi.subnetMask()` to get the subnet mask.

<https://www.arduino.cc/en/Reference/WiFiSubnetMask>

Use `WiFi.gatewayIP()` to get the WiFi shield's gateway IP address.

<https://www.arduino.cc/en/Reference/WiFiGatewayIP>

## Comparison with Arduino

In the Arduino platform, we need to add an extra WiFi shield to be the WiFi module to realize the WiFi connection.

And we must `#include` to use SPI to communicate with WiFi module.

However, Ameba is already equipped with WiFi module. Therefore, `#include` is not needed.

## WiFi - Retrieve Universal Time (UTC) by UDP

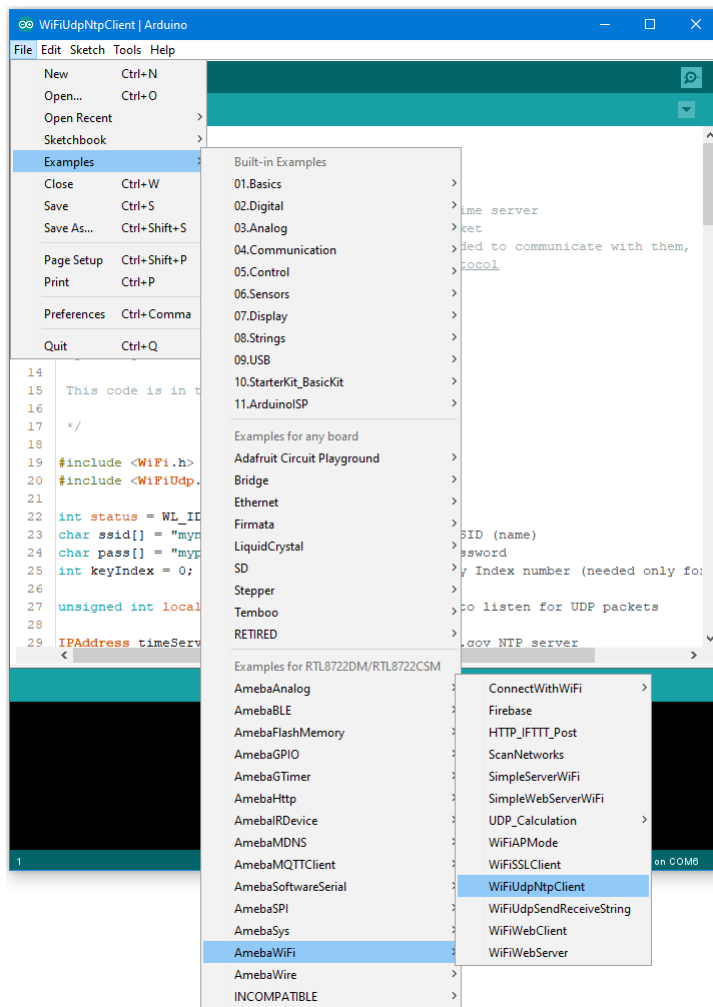
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

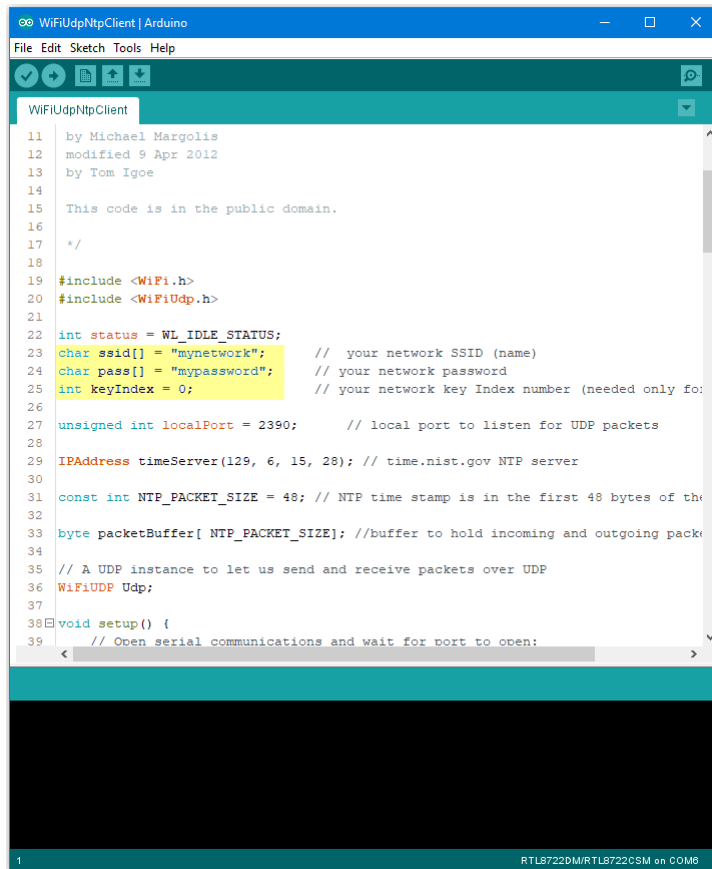
In this example, we connect Ameba to WiFi. Then send NTP (Network Time Protocol, RFC 1305) request to NTP server using UDP. After receiving the NTP request, the NTP server replies current UTC (Coordinated Universal Time) packet. We will parse the UTC packet to show current UTC time in the serial monitor.

Open the example: “File” -> “Examples” -> “AmebaWiFi” -> “WiFiUdpNtpClient”



Modify the highlighted code section (ssid, password, keyindex) to connect to your WiFi network.





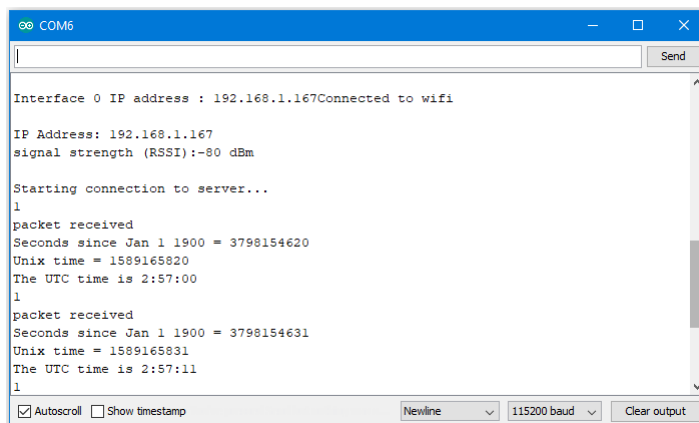
```

11  by Michael Margolis
12  modified 9 Apr 2012
13  by Tom Igoe
14
15  This code is in the public domain.
16
17  */
18
19  #include <WiFi.h>
20  #include <WiFiUdp.h>
21
22  int status = WL_IDLE_STATUS;
23  char ssid[] = "mynetwork"; // your network SSID (name)
24  char pass[] = "mypassword"; // your network password
25  int keyIndex = 0; // your network key Index number (needed only for
26
27  unsigned int localPort = 2390; // local port to listen for UDP packets
28
29  IPAddress timeServer(129, 6, 15, 28); // time.nist.gov NTP server
30
31  const int NTP_PACKET_SIZE = 48; // NTP time stamp is in the first 48 bytes of the
32
33  byte packetBuffer[ NTP_PACKET_SIZE]; //buffer to hold incoming and outgoing packets
34
35  // A UDP instance to let us send and receive packets over UDP
36  WiFiUDP Udp;
37
38  void setup() {
39    // Open serial communications and wait for port to open:

```

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi and sends NTP request packet to NTP server “129.6.15.28” .

We parse the replied packet and show UTC time in serial monitor:



```

Interface 0 IP address : 192.168.1.167Connected to wifi
IP Address: 192.168.1.167
signal strength (RSSI):-80 dBm

Starting connection to server...
1
packet received
Seconds since Jan 1 1900 = 3798154620
Unix time = 1589165820
The UTC time is 2:57:00
1
packet received
Seconds since Jan 1 1900 = 3798154631
Unix time = 1589165831
The UTC time is 2:57:11
1

```

## WiFi - Scan the surrounding WiFi networks

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Antenna x 1
- AmebaD `[raw-html:<p style=」 color:#1A76B4;」 >AMB21(RTL8722DM/CSM)</p>‘ / AMB23(RTL8722DM_MINI) / BW16(RTL8729DN)] x 1`

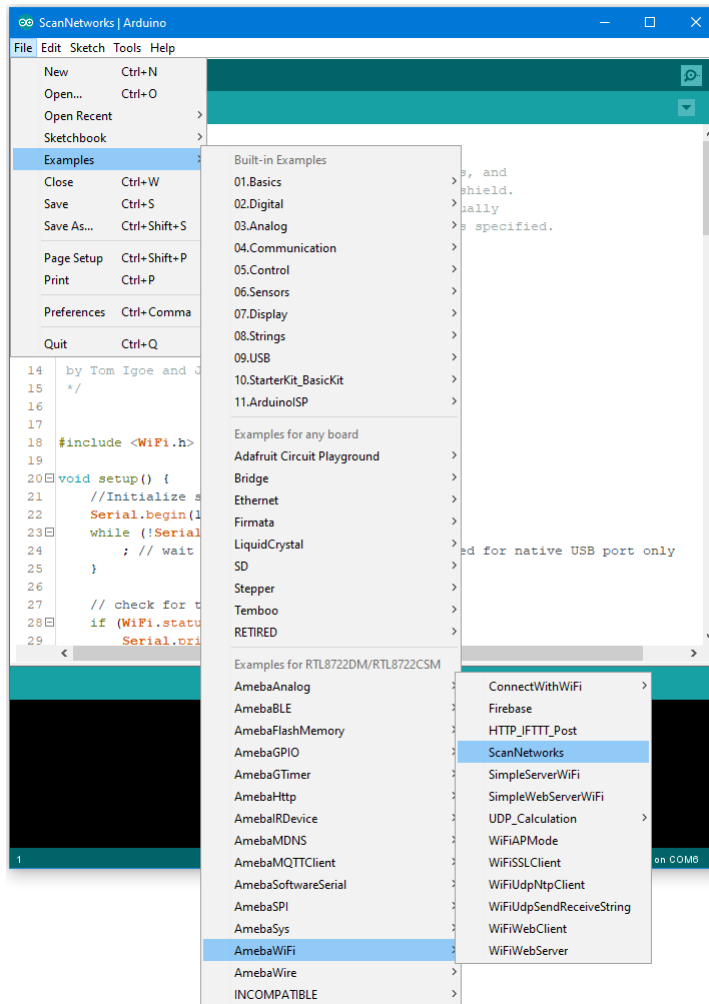
### Example

In this example, we use Ameba to scan available WiFi hotspots in the surroundings, and prints the SSID, encryption type, signal strength information of each detected hotspot.

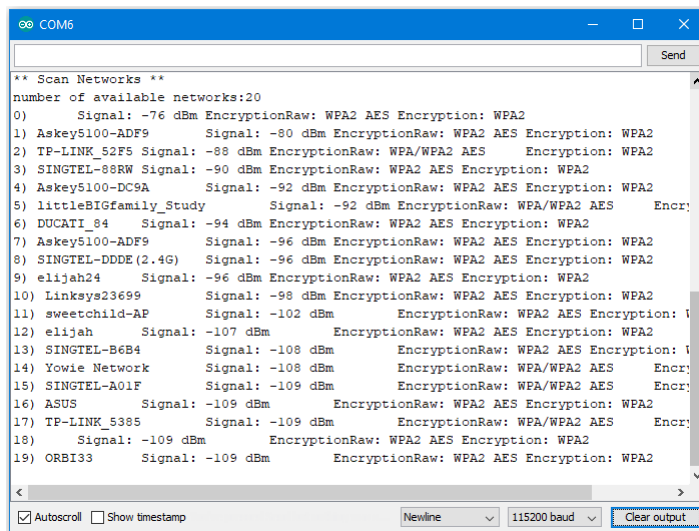
First, make sure the correct Ameba development board is selected in Arduino IDE: “Tools” -> “Board”

Open the “ScanNetworks” example in “File” -> “Examples” -> “AmebaWiFi” ->

“ScanNetworks” :



Then upload the sample code and press the reset button on Ameba. Afterwards, you can see “\*\*Scan Networks\*\*” message appears, with the detected WiFi hotspots and the information of each hotspot.



## Code Reference

- First we use `WiFi.macAddress(mac)` to get the MAC address of Ameba: <https://www.arduino.cc/en/Reference/WiFiMACAddress>
- Then we use `WiFi.scanNetworks()` to detect WiFi hotspots: <https://www.arduino.cc/en/Reference/WiFiScanNetworks>
- To get information of detected WiFi hotspot: We use `WiFi.SSID(thisNet)` to retrieve SSID of a network: <https://www.arduino.cc/en/Reference/WiFiSSID> We use `WiFi.RSSI(thisNet)` to get the signal strength of the connection to the router: <https://www.arduino.cc/en/Reference/WiFiRSSI>
- We use `WiFi.encryptionType(thisNet)` to get the encryption type of the network: <https://www.arduino.cc/en/Reference/WiFiEncryptionType>

## Comparison with Arduino

In the Arduino platform, we need to add an extra WiFi shield to be the WiFi module to realize the WiFi connection. And we must `#include` to use SPI to communicate with WiFi module.

However, Ameba is already equipped with WiFi module. Therefore, `#include` is not needed.

## WiFi - Set up Server to communicate

### Materials

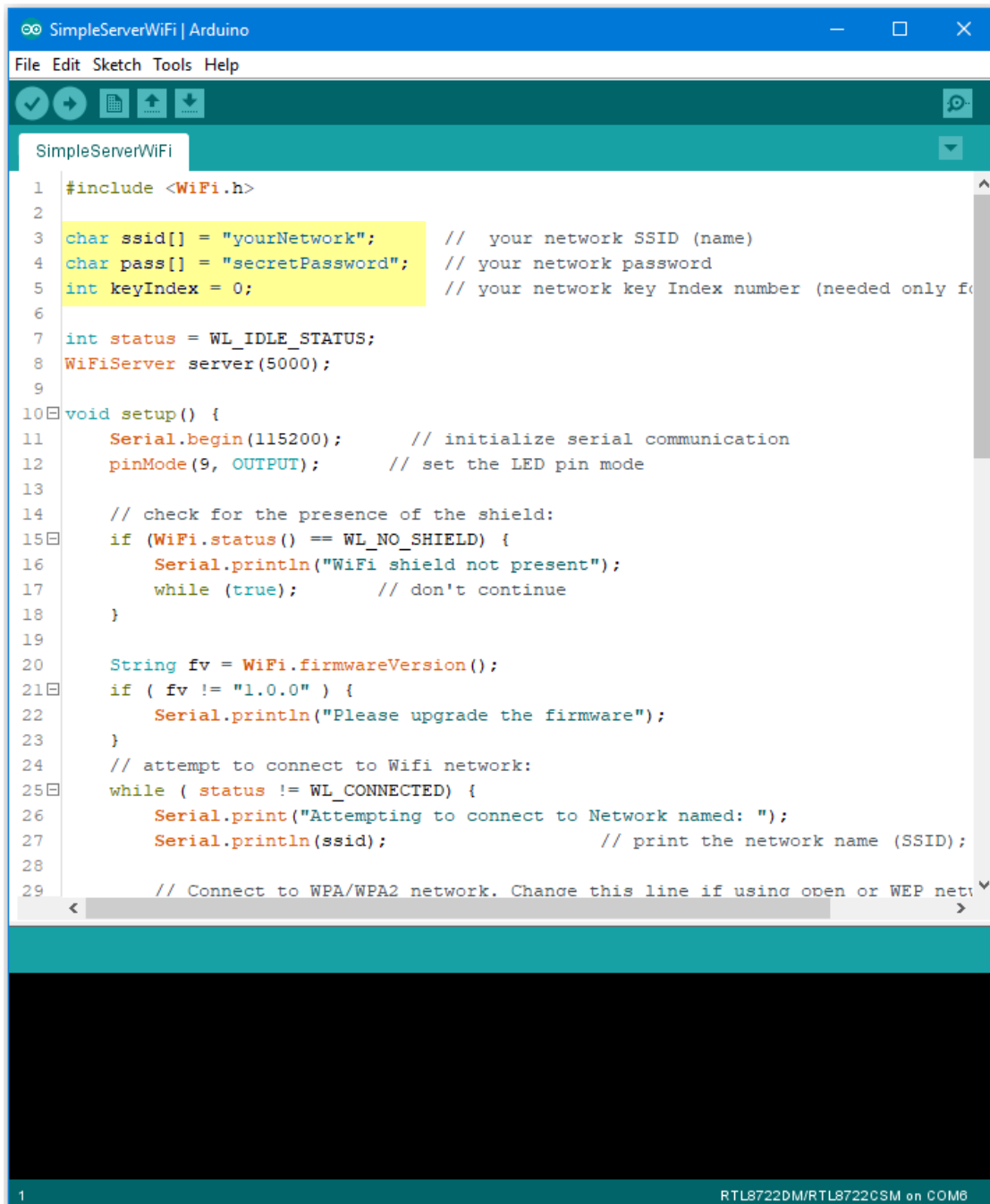
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Laptop (Make sure it is connected to the same network domain as Ameba, and tcp tools are installed.)

### Example

In this example, we first connect Ameba to WiFi, then we use Ameba as server to communicate with client.

First, we make sure the correct Ameba development board is set in “Tools” -> “Board”

Then, open the Simple WiFi Server example in “File” -> “Examples” -> “AmebaWiFi” -> “SimpleServerWiFi”

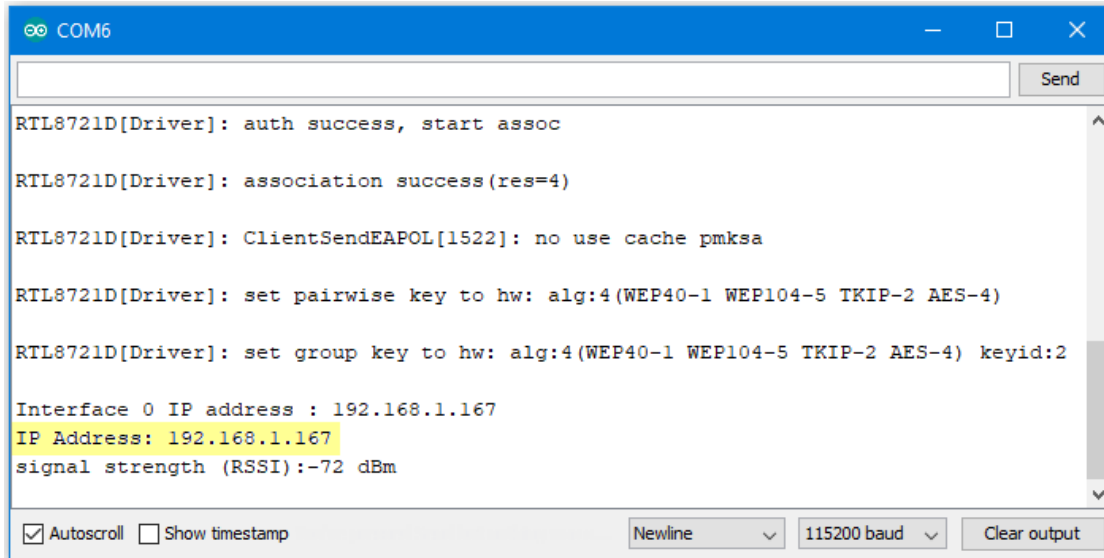


```

1  #include <WiFi.h>
2
3  char ssid[] = "yourNetwork";    // your network SSID (name)
4  char pass[] = "secretPassword"; // your network password
5  int keyIndex = 0;               // your network key Index number (needed only for WEP)
6
7  int status = WL_IDLE_STATUS;
8  WiFiServer server(5000);
9
10 void setup() {
11     Serial.begin(115200);        // initialize serial communication
12     pinMode(9, OUTPUT);         // set the LED pin mode
13
14     // check for the presence of the shield:
15     if (WiFi.status() == WL_NO_SHIELD) {
16         Serial.println("WiFi shield not present");
17         while (true);           // don't continue
18     }
19
20     String fv = WiFi.firmwareVersion();
21     if ( fv != "1.0.0" ) {
22         Serial.println("Please upgrade the firmware");
23     }
24     // attempt to connect to Wifi network:
25     while ( status != WL_CONNECTED) {
26         Serial.print("Attempting to connect to Network named: ");
27         Serial.println(ssid);    // print the network name (SSID);
28
29         // Connect to WPA/WPA2 network. Change this line if using open or WEP network

```

In the sample code, modify the highlighted parameters and enter the ssid and password for your WiFi connection.



```

COM6
Send

RTL8721D[Driver]: auth success, start assoc

RTL8721D[Driver]: association success(res=4)

RTL8721D[Driver]: ClientSendEAPOL[1522]: no use cache pmksa

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

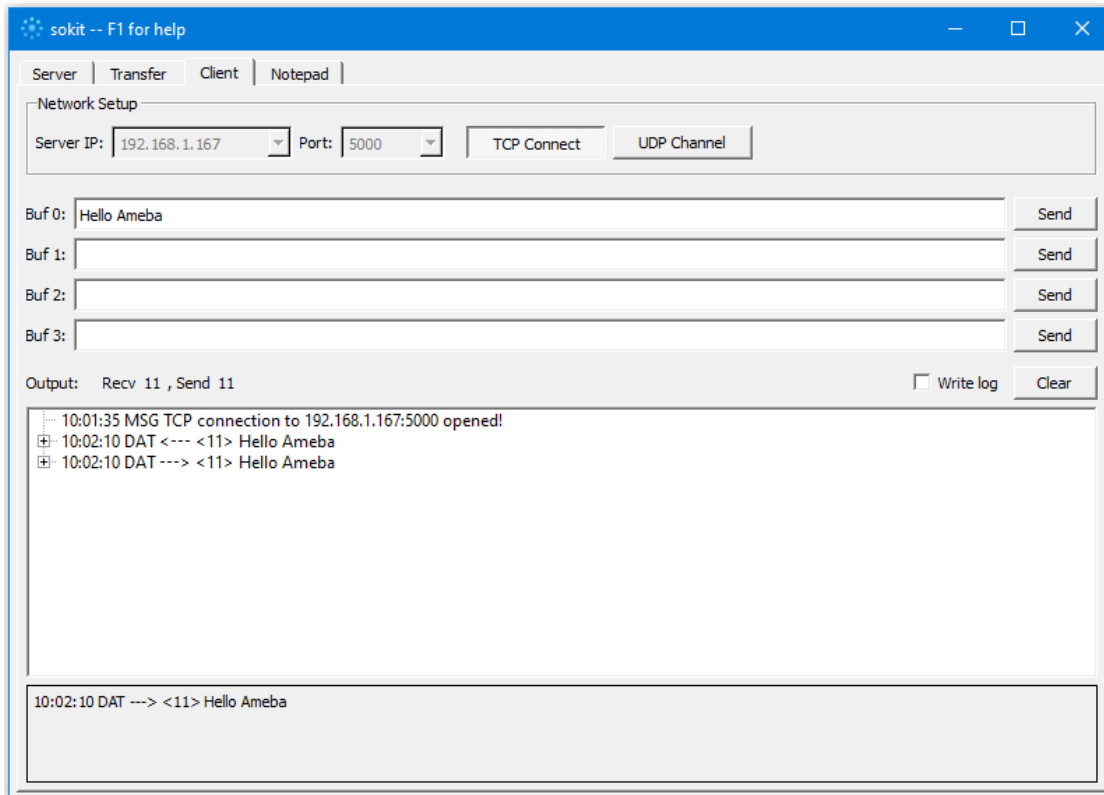
Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-72 dBm

☒ Autoscroll ☐ Show timestamp
Newline 115200 baud Clear output

```

Next, upload the code, then press the reset button on Ameba. At this moment, you will see the connection information is displayed in the console.

Next, we use the socket tool in the laptop to be the client and connect to the IP address of the Ameba board shown in the connection information at port 5000. (Note: The socket tool we used in this example is “sokit” )



```

sokit -- F1 for help
Server | Transfer | Client | Notepad |
Network Setup
Server IP: 192.168.1.167 Port: 5000 TCP Connect UDP Channel
Buf 0: Hello Ameba Send
Buf 1: Send
Buf 2: Send
Buf 3: Send
Output: Recv 11 , Send 11 Write log Clear
10:01:35 MSG TCP connection to 192.168.1.167:5000 opened!
10:02:10 DAT <--- <11> Hello Ameba
10:02:10 DAT ---> <11> Hello Ameba
10:02:10 DAT ---> <11> Hello Ameba

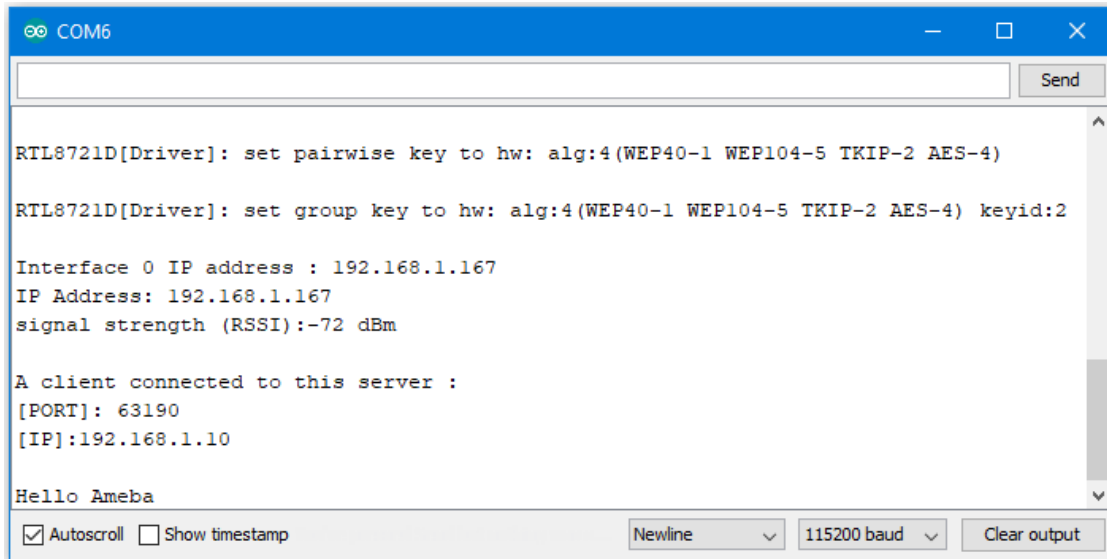
```

Click on the “Client” tab to choose the client mode, specify the IP and port of the server, then click “TCP Connect” .

If the connection is established successfully, the server shows a message: “A client connected to this Server” , and the

IP and port of the connected client.

In this example, when the client and server are connected and the client sends a string to Ameba server, the Ameba server returns the identical string back to the client.



```

COM6

RTL8721D[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4)

RTL8721D[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:2

Interface 0 IP address : 192.168.1.167
IP Address: 192.168.1.167
signal strength (RSSI):-72 dBm

A client connected to this server :
[PORT]: 63190
[IP]:192.168.1.10

Hello Ameba

☒ Autoscroll ☐ Show timestamp
Newline ▼ 115200 baud ▼ Clear output

```

The string sent to server is returned and showed at the client side.

## Code Reference

Use `WiFi.begin()` to establish WiFi connection;

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection:

Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the Ameba WiFi shield's IP address.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Create server and transmitting data:

Use `Server(port)` to create a server that listens on the specified port.

<https://www.arduino.cc/en/Reference/WiFiServer>

Use `server.begin()` to tell the server to begin listening for incoming connections.

<https://www.arduino.cc/en/Reference/WiFiServerBegin>

Use `server.available()` to get a client that is connected to the server and has data available for reading.

<https://www.arduino.cc/en/Reference/WiFiServerAvailable>

Use `client.read()` to read the next byte received from the server.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.write()` to write data to the server.

<https://www.arduino.cc/en/Reference/WiFiClientWrite>

Use `client.stop()` to disconnect from the server.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

## WiFi - Set up Client to Retrieve Google Search Information

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

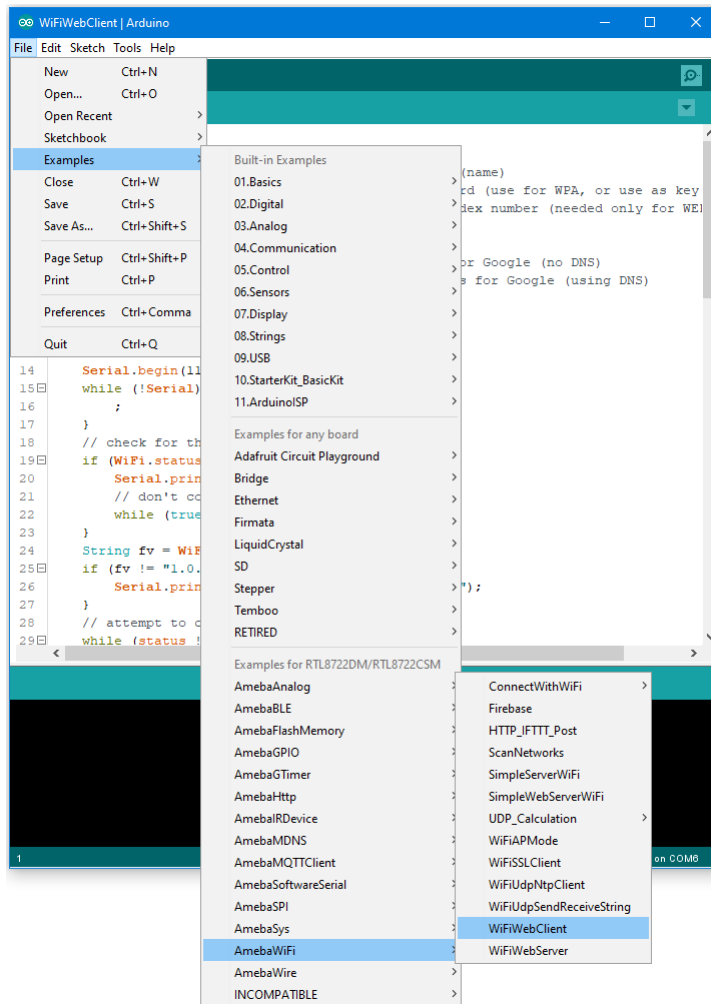
### Example

In this example, we use Ameba to be a web client to retrieve information from the Internet.

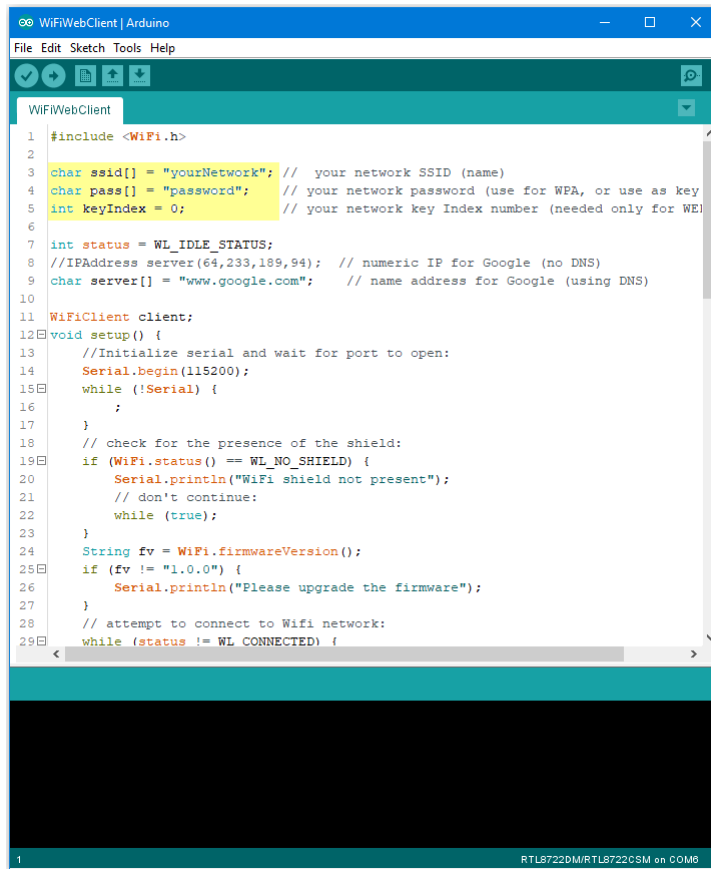
First, make sure the correct Ameba development board is selected in “Tools” -> “Board”

Then open “File” -> “Examples” -> “AmebaWiFi” -> “WiFiWebClient”





In the sample code, modify the highlighted snippet and enter the required information (ssid, password, key index) required to connect to your WiFi network.

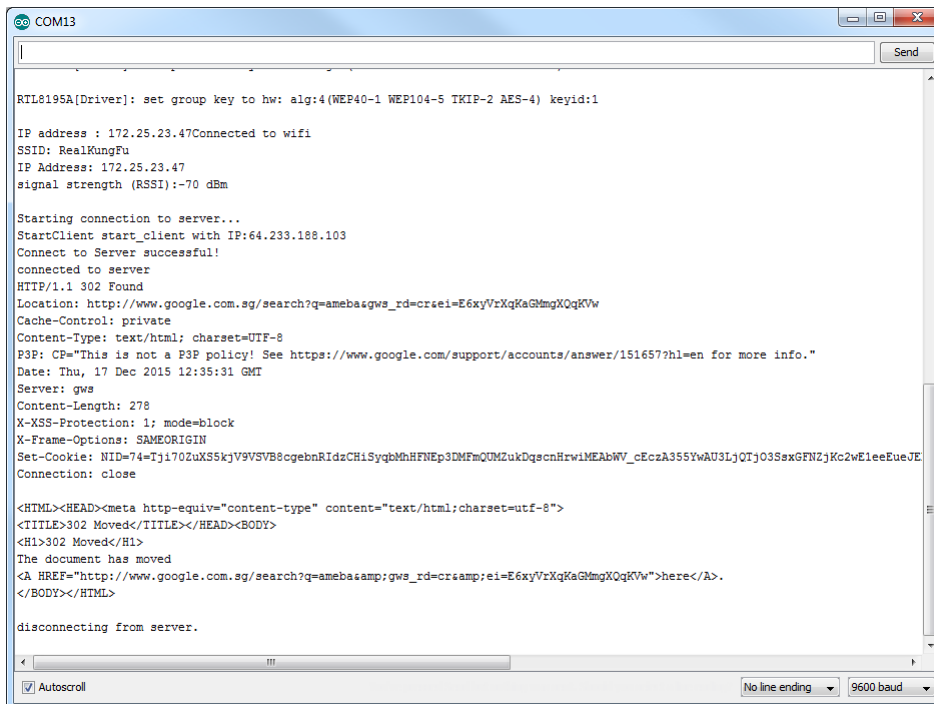


```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; // your network SSID (name)
4 char pass[] = "password"; // your network password (use for WPA, or use as key
5 int keyIndex = 0; // your network key Index number (needed only for WE
6
7 int status = WL_IDLE_STATUS;
8 //IPAddress server(64,233,189,94); // numeric IP for Google (no DNS)
9 char server[] = "www.google.com"; // name address for Google (using DNS)
10
11 WiFiClient client;
12 void setup() {
13     //Initialize serial and wait for port to open:
14     Serial.begin(115200);
15     while (!Serial) {
16         ;
17     }
18     // check for the presence of the shield:
19     if (WiFi.status() == WL_NO_SHIELD) {
20         Serial.println("WiFi shield not present");
21         // don't continue:
22         while (true);
23     }
24     String fv = WiFi.firmwareVersion();
25     if (fv != "1.0.0") {
26         Serial.println("Please upgrade the firmware");
27     }
28     // attempt to connect to Wifi network:
29     while (status != WL_CONNECTED) {

```

Upload the code and press the reset button on Ameba. Then you can see the information retrieved from Google is shown in the Arduino serial monitor.



```

RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1

IP address : 172.25.23.47Connected to wifi
SSID: RealKungFu
IP Address: 172.25.23.47
signal strength (RSSI): -70 dBm

Starting connection to server...
StartClient start_client with IP:64.233.188.103
Connect to Server successful!
connected to server
HTTP/1.1 302 Found
Location: http://www.google.com.sg/search?q=amebas&gws_rd=cr&ei=E6xyVrXqKaGmngXQqKVw
Cache-Control: private
Content-Type: text/html; charset=UTF-8
P3P: CP="This is not a P3P policy! See https://www.google.com/support/accounts/answer/151657?hl=en for more info."
Date: Thu, 17 Dec 2015 12:35:31 GMT
Server: gws
Content-Length: 278
X-XSS-Protection: 1; mode=block
X-Frame-Options: SAMEORIGIN
Set-Cookie: NID=74=Tji70ZuX55kjV9VSVB8cgebnRIdzChISyqkMhHFNep3DMFmQUMZukDqscnHrwiMEAbWV_cEcA355YwAU3LjQTjO3SsxGFNZjKc2wE1eeEueJE
Connection: close

<HTML><HEAD><meta http-equiv="content-type" content="text/html; charset=utf-8">
<TITLE>302 Moved</TITLE></HEAD><BODY>
<H1>302 Moved</H1>
The document has moved
<A HREF="http://www.google.com.sg/search?q=amebas&gws_rd=cr&ei=E6xyVrXqKaGmngXQqKVw">here</A>.
</BODY></HTML>

disconnecting from server.

```

## Code Reference

<https://www.arduino.cc/en/Reference/WiFiBegin>

To get the information of a WiFi connection: Use `WiFi.SSID()` to get SSID of the current connected network.

<https://www.arduino.cc/en/Reference/WiFiSSID>

Use `WiFi.RSSI()` to get the signal strength of the connection.

<https://www.arduino.cc/en/Reference/WiFiRSSI>

Use `WiFi.localIP()` to get the IP address of Ameba.

<https://www.arduino.cc/en/Reference/WiFiLocalIP>

Use `WiFiClient()` to create a client.

<https://www.arduino.cc/en/Reference/WiFiClient>

Use `client.connect()` to connect to the IP address and port specified.

<https://www.arduino.cc/en/Reference/WiFiClientConnect>

Use `client.println()` to print data followed by a carriage return and newline.

<https://www.arduino.cc/en/Reference/WiFiClientPrintln>

Use `client.available()` to return the number of bytes available for reading.

<https://www.arduino.cc/en/Reference/WiFiClientAvailable>

Use `client.read()` to read the next byte received from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientRead>

Use `client.stop()` to disconnect from the server the client is connected to.

<https://www.arduino.cc/en/Reference/WiFiClientStop>

## WiFi - Set up UDP Server to Communicate

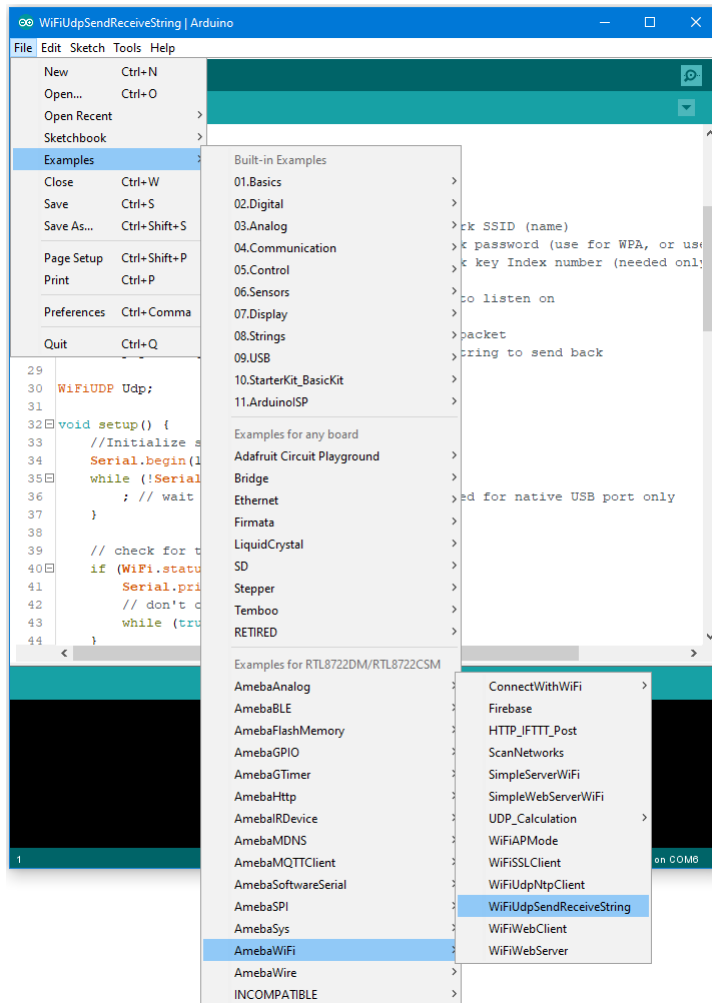
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we connect Ameba to WiFi and use Ameba to be an UDP server. When Ameba receives a message from UDP client, it replies “acknowledged” message to client.

Open the WiFi Web Server example. “File” -> “Examples” -> “AmebaWiFi” -> “WiFiUdpSendReceiveString”



Modify the highlighted code section (ssid, password, keyindex) to connect to your WiFi network.

```

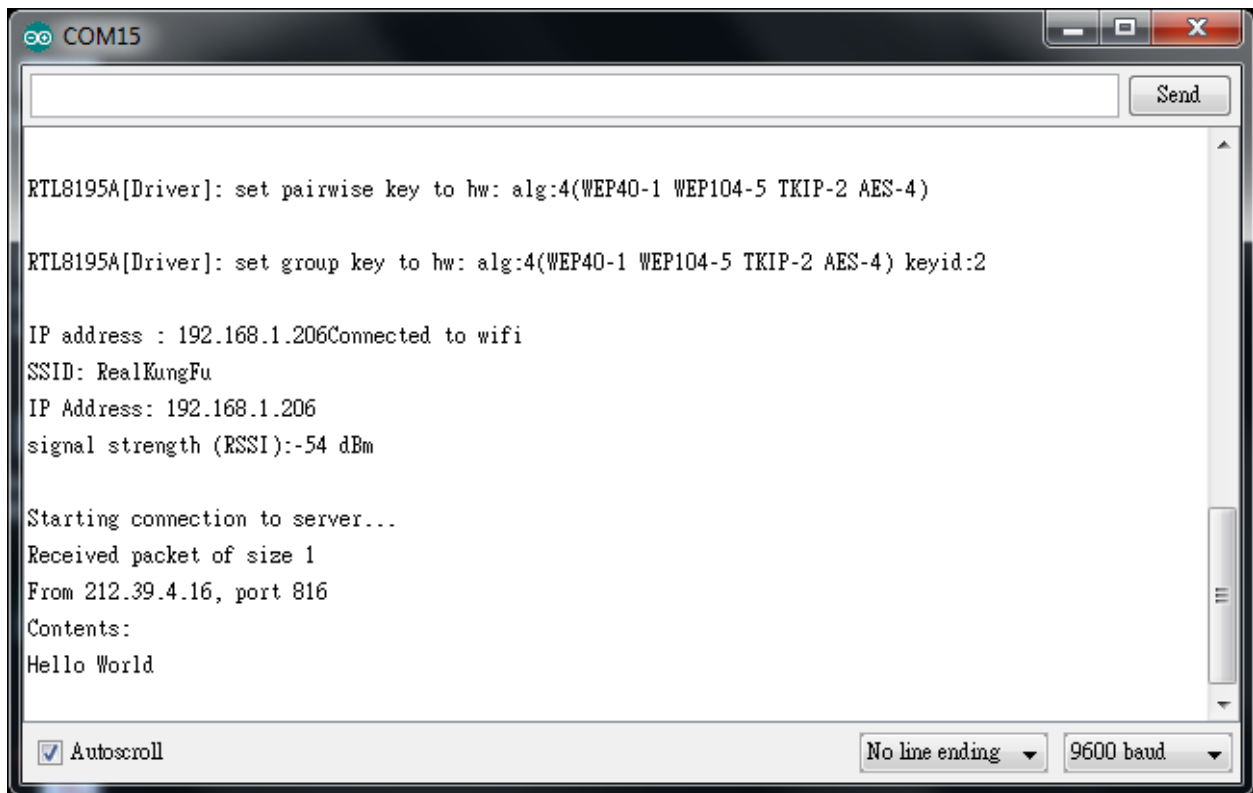
16
17 #include <WiFi.h>
18 #include <WiFiUdp.h>
19
20 int status = WL_IDLE_STATUS;
21 char ssid[] = "yourNetwork"; // your network SSID (name)
22 char pass[] = "secretPassword"; // your network password (use for WPA, or use
23 int keyIndex = 0; // your network key Index number (needed only)
24
25 unsigned int localPort = 2390; // local port to listen on
26
27 char packetBuffer[255]; //buffer to hold incoming packet
28 char ReplyBuffer[] = "acknowledged"; // a string to send back
29
30 WiFiUDP Udp;
31
32 void setup() {
33     //Initialize serial and wait for port to open:
34     Serial.begin(115200);
35     while (!Serial) {
36         ; // wait for serial port to connect. Needed for native USB port only
37     }
38
39     // check for the presence of the shield:
40     if (WiFi.status() == WL_NO_SHIELD) {
41         Serial.println("WiFi shield not present");
42         // don't continue:
43         while (true);
44     }

```

1

RTL8722DM/RTL8722CSM on COM8

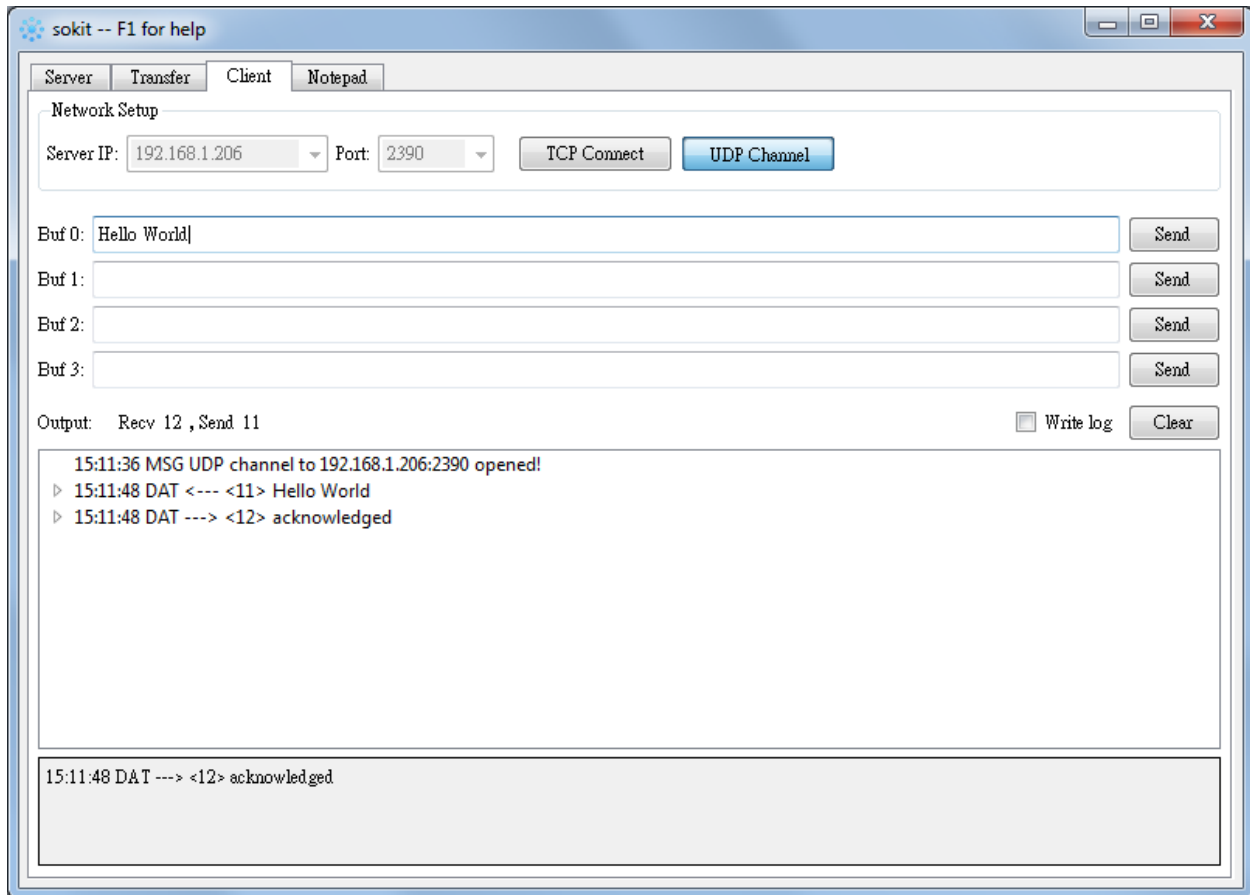
Compile the code and upload it to Ameba. After pressing the Reset button, Ameba connects to WiFi and starts the UDP server with port 2390. After the UDP server starts service, Ameba prints the “Starting connection to server” message and waits for client connection.



As to the UDP client, we use “sokit” program in the computer to connect to UDP server.

Choose client mode and fill in the IP of UDP server (which is the IP of Ameba) and port 2390, then click “UDP Connect” .

After the connection is established, fill in “Hello World” in the Buf 0 field in sokit and click “Send” . Then you can see the Ameba UDP server replies “acknowledged” .



## Code Reference

Refer to the Arduino tutorial for detailed information about this example.

<https://www.arduino.cc/en/Tutorial/WiFiSendReceiveUDPString>

First, use `begin()` to open an UDP port on Ameba.

<https://www.arduino.cc/en/Reference/WiFiUDPPBegin>

Use `parsePacket()` to wait for data from client.

<https://www.arduino.cc/en/Reference/WiFiUDPParsePacket>

When a connection is established, use `remoteIP()` and `remotePort()` to get the IP and port of the client.

<https://www.arduino.cc/en/Reference/WiFiUDPRemoteIP>

Then use `read()` to read the data sent by client.

<https://www.arduino.cc/en/Reference/WiFiUDPRead>

To send reply, use `beginPacket()`, `write()`, `end()`.

<https://www.arduino.cc/en/Reference/WiFiUDPBeginPacket>

<https://www.arduino.cc/en/Reference/WiFiUDPWrite>

<https://www.arduino.cc/en/Reference/WiFiUDPEndPacket>

## WiFi - Set up WiFi AP Mode

In AP mode, Ameba can accept at most 3 station connections, and can be set to open mode or WPA2 mode.

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we turn on the AP mode of Ameba and connect station to Ameba.

Open the WiFi AP example, “File” -> “Examples” -> “AmebaWiFi” -> “WiFiAPMode”



```

1 #include <WiFi.h>
2
3 char ssid[] = "yourNetwork"; //Set the AP's SSID
4 char pass[] = "Password"; //Set the AP's password
5 char channel[] = "1"; //Set the AP's channel
6 int status = WL_IDLE_STATUS; // the Wifi radio's status
7
8 void setup() {
9     //Initialize serial and wait for port to open:
10    Serial.begin(115200);
11    while (!Serial) {
12        ; // wait for serial port to connect. Needed for native USB port only
13    }
14
15    // check for the presence of the shield:
16    if (WiFi.status() == WL_NO_SHIELD) {
17        Serial.println("WiFi shield not present");
18        while (true);
19    }
20    String fw = WiFi.firmwareVersion();
21    if (fw != "1.0.0") {
22        Serial.println("Please upgrade the firmware");
23    }
24
25    // attempt to start AP:
26    while (status != WL_CONNECTED) {
27        Serial.print("Attempting to start AP with SSID: ");
28        Serial.println(ssid);
29        status = WiFi.apbegin(ssid, pass, channel);
30        delay(10000);

```

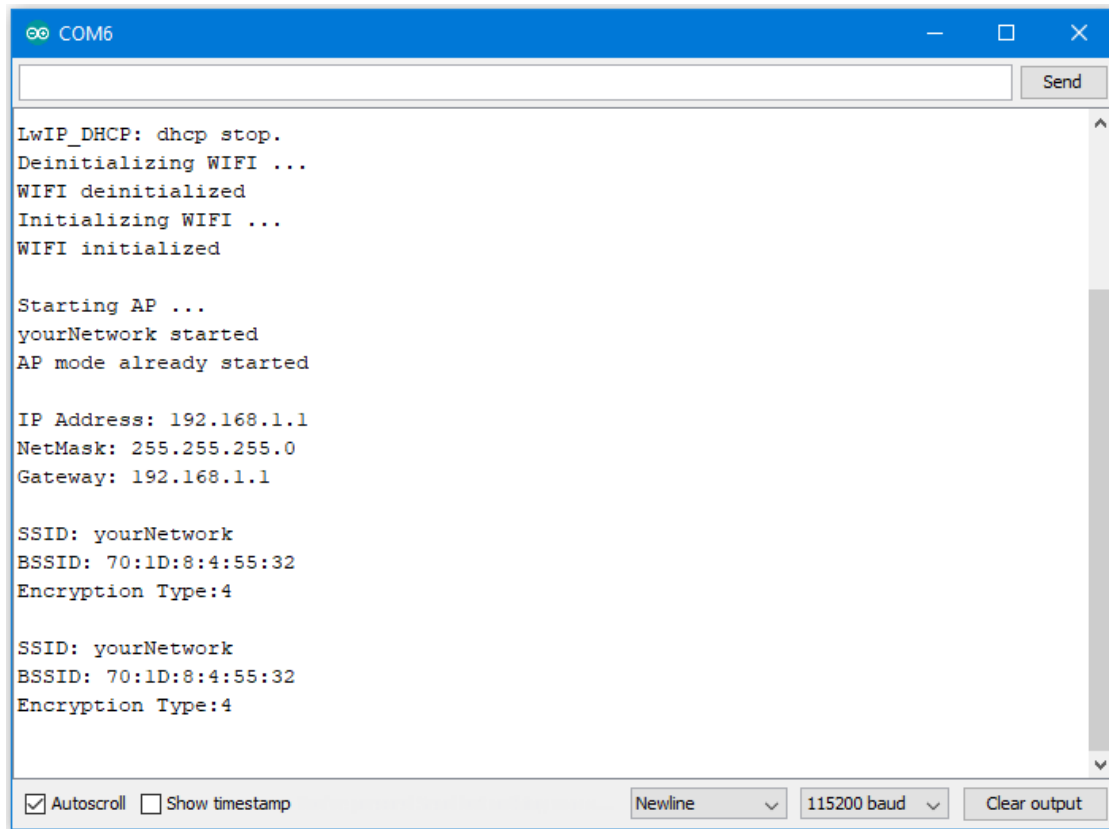
In the highlighted code snippet, fill in your SSID, PASSWORD and CHANNEL.

The code highlighted in green is the API we used to turn on the AP mode in security mode.

If you want to turn on the AP mode in open mode, please modify the code to

```
status = WiFi.apbegin(ssid, channel);
```

Then upload the sample code and press reset, and you can see related information shown in serial monitor.



```
COM6
LwIP_DHCP: dhcp stop.
Deinitializing WIFI ...
WIFI deinitialized
Initializing WIFI ...
WIFI initialized

Starting AP ...
yourNetwork started
AP mode already started

IP Address: 192.168.1.1
NetMask: 255.255.255.0
Gateway: 192.168.1.1

SSID: yourNetwork
BSSID: 70:1D:8:4:55:32
Encryption Type:4

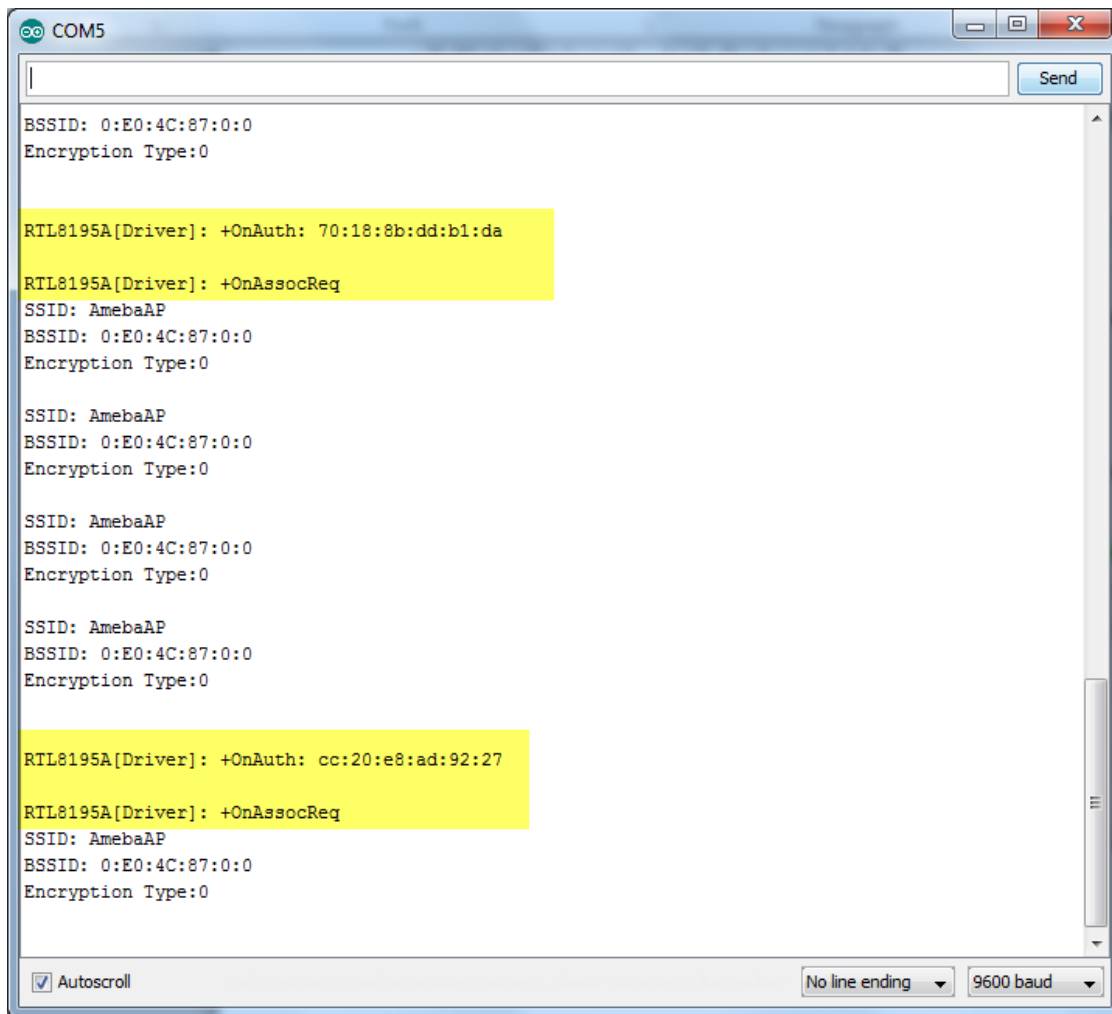
SSID: yourNetwork
BSSID: 70:1D:8:4:55:32
Encryption Type:4
```

Serial monitor window titled "COM6" with a "Send" button. The output shows the following messages:

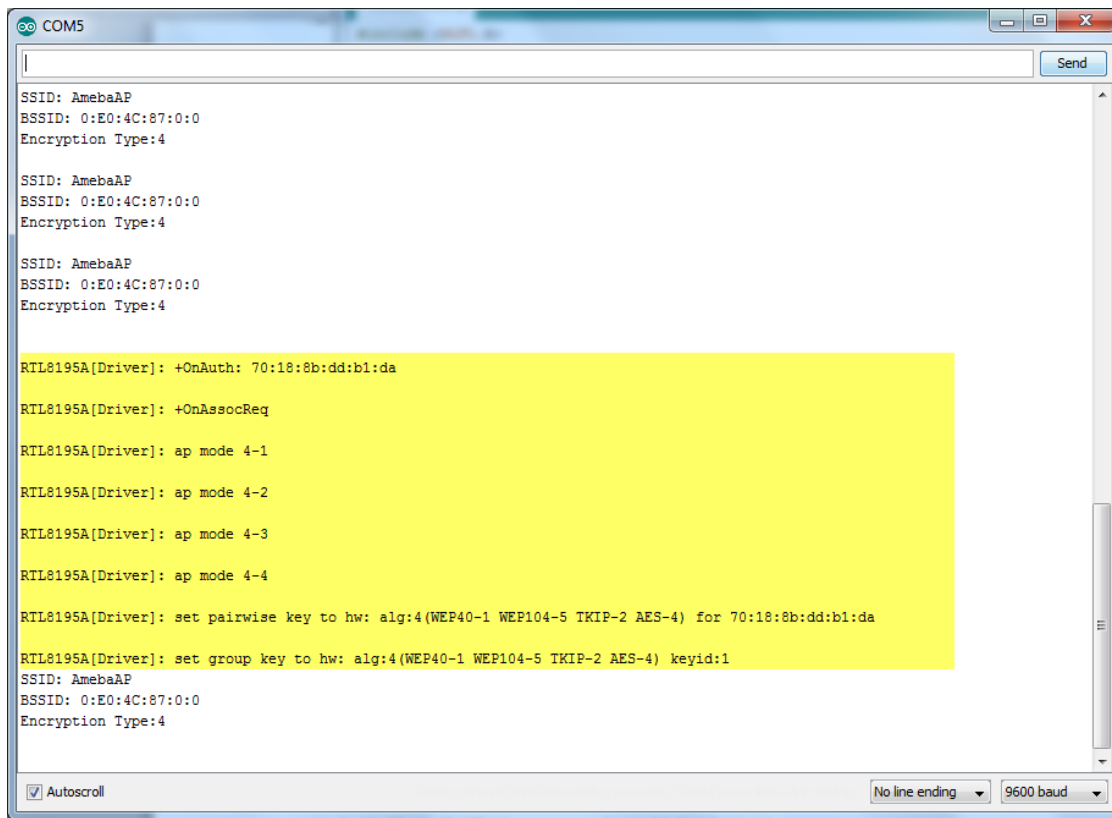
- LwIP\_DHCP: dhcp stop.
- Deinitializing WIFI ...
- WIFI deinitialized
- Initializing WIFI ...
- WIFI initialized
- Starting AP ...
- yourNetwork started
- AP mode already started
- IP Address: 192.168.1.1
- NetMask: 255.255.255.0
- Gateway: 192.168.1.1
- SSID: yourNetwork
- BSSID: 70:1D:8:4:55:32
- Encryption Type:4
- SSID: yourNetwork
- BSSID: 70:1D:8:4:55:32
- Encryption Type:4

At the bottom, there are checkboxes for "Autoscroll" (checked) and "Show timestamp" (unchecked), a "Newline" dropdown menu, a "115200 baud" dropdown menu, and a "Clear output" button.

In the figure below, we show the messages shown in serial monitor when two stations connect to Ameba AP in open mode:



In the figure below, we show the messages shown in serial monitor when a station connects to Ameba AP in security mode:



```
COM5
Send

SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

RTL8195A[Driver]: +OnAuth: 70:18:8b:dd:b1:da
RTL8195A[Driver]: +OnAssocReq
RTL8195A[Driver]: ap mode 4-1
RTL8195A[Driver]: ap mode 4-2
RTL8195A[Driver]: ap mode 4-3
RTL8195A[Driver]: ap mode 4-4

RTL8195A[Driver]: set pairwise key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) for 70:18:8b:dd:b1:da
RTL8195A[Driver]: set group key to hw: alg:4(WEP40-1 WEP104-5 TKIP-2 AES-4) keyid:1
SSID: AmebaAP
BSSID: 0:E0:4C:87:0:0
Encryption Type:4

Autoscroll No line ending 9600 baud
```

## WiFi - Set up SSL Client for HTTPS Communication

### Materials

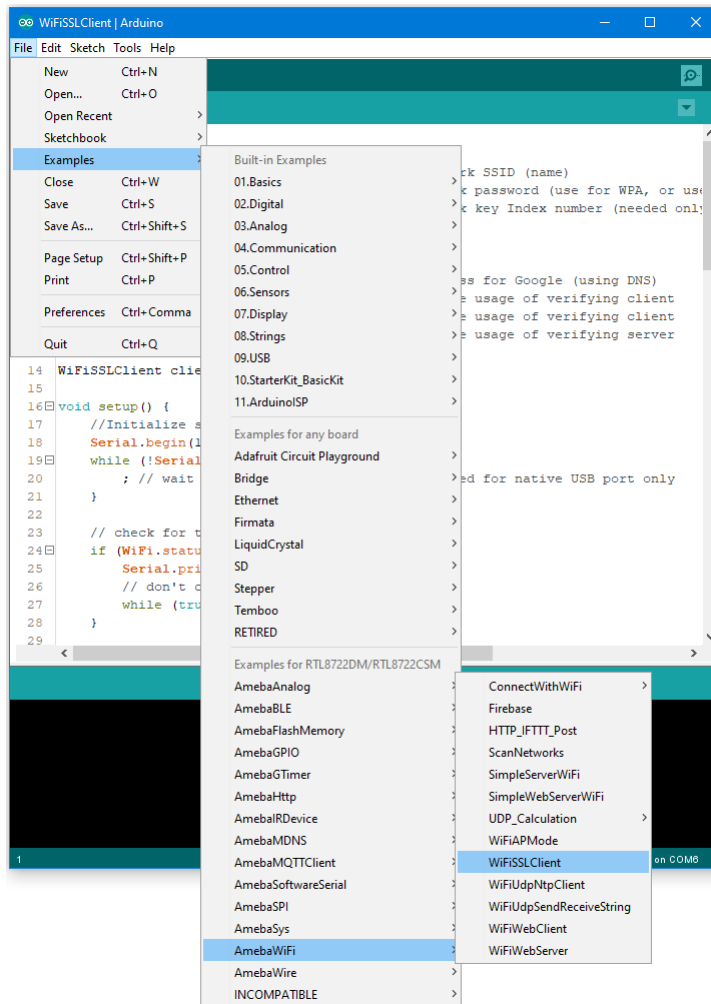
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

This example uses Ameba to securely retrieve information from the internet using SSL. SSL is an acronym for Secure Sockets Layer. It is a cryptographic protocol designed to provide communications security over a computer network, by encrypting the messages passed between server and client.

Open the “WiFiSSLClient” example in “File” -> “Examples” -> “AmebaWiFi” -> “WiFiSSLClient”

.



In the sample code, modify the highlighted snippet to reflect your WiFi network settings.

```

1  #include <WiFi.h>
2
3  char ssid[] = "yourNetwork";    // your network SSID (name)
4  char pass[] = "secretPassword"; // your network password (use for WPA, or use
5  int keyIndex = 0;               // your network key Index number (needed only
6
7  int status = WL_IDLE_STATUS;
8
9  char server[] = "www.google.com"; // name address for Google (using DNS)
10 //unsigned char test_client_key[] = ""; //For the usage of verifying client
11 //unsigned char test_client_cert[] = ""; //For the usage of verifying client
12 //unsigned char test_ca_cert[] = ""; //For the usage of verifying server
13
14 WiFiSSLClient client;
15
16 void setup() {
17     //Initialize serial and wait for port to open:
18     Serial.begin(115200);
19     while (!Serial) {
20         ; // wait for serial port to connect. Needed for native USB port only
21     }
22
23     // check for the presence of the shield:
24     if (WiFi.status() == WL_NO_SHIELD) {
25         Serial.println("WiFi shield not present");
26         // don't continue:
27         while (true);
28     }
29

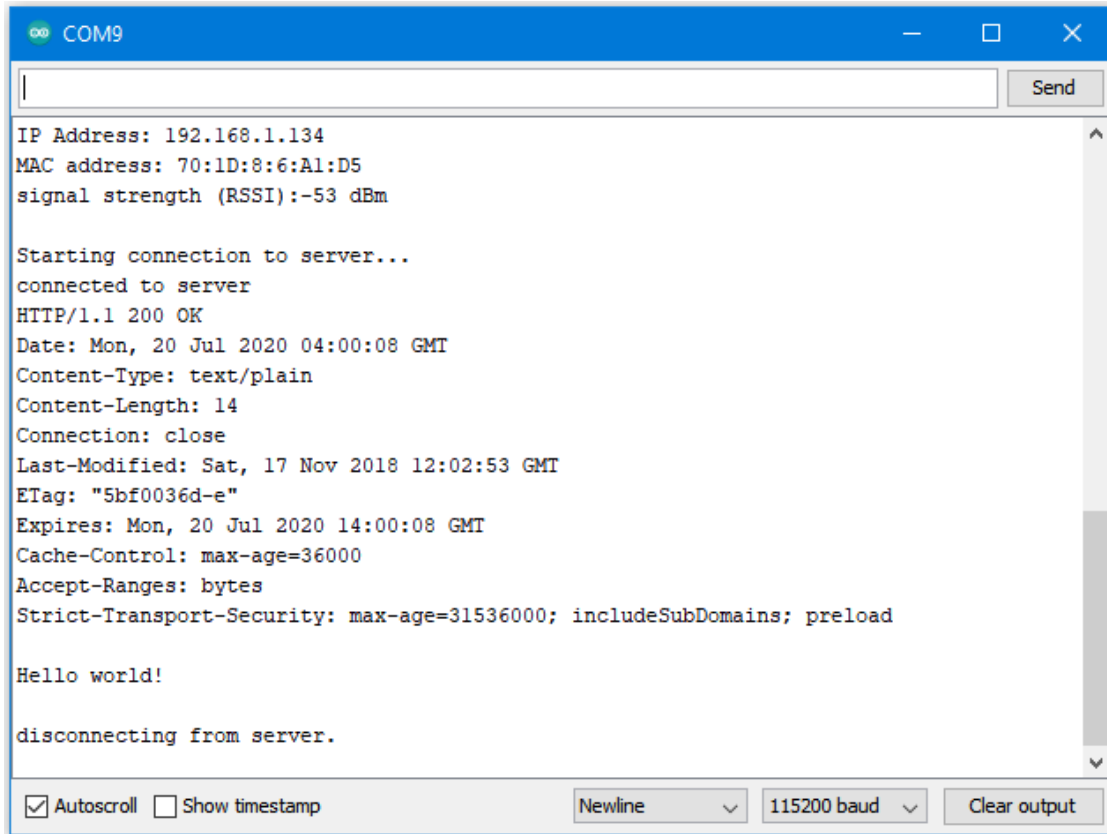
```

1

RTL8722DM/RTL8722CSM on COM8

Upload the code and press the reset button on Ameba once the upload is finished.

Open the serial monitor in the Arduino IDE and observe as Ameba retrieves a text file from [os.mbed.com](https://os.mbed.com).



```
COM9

IP Address: 192.168.1.134
MAC address: 70:1D:8:6:A1:D5
signal strength (RSSI):-53 dBm

Starting connection to server...
connected to server
HTTP/1.1 200 OK
Date: Mon, 20 Jul 2020 04:00:08 GMT
Content-Type: text/plain
Content-Length: 14
Connection: close
Last-Modified: Sat, 17 Nov 2018 12:02:53 GMT
ETag: "5bf0036d-e"
Expires: Mon, 20 Jul 2020 14:00:08 GMT
Cache-Control: max-age=36000
Accept-Ranges: bytes
Strict-Transport-Security: max-age=31536000; includeSubDomains; preload

Hello world!

disconnecting from server.
```

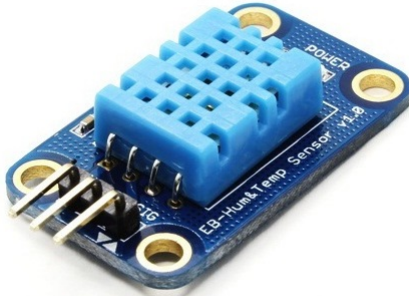

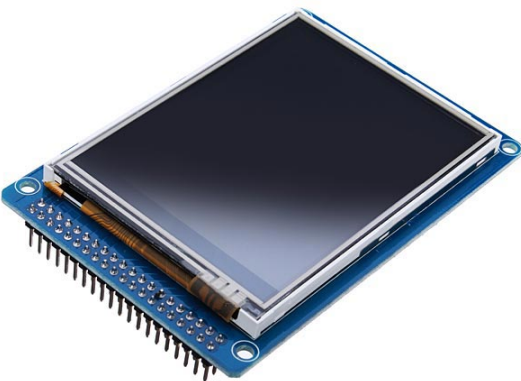


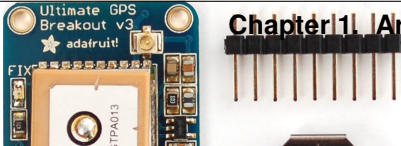
☒ Autoscroll ☐ Show timestamp    Newline    115200 baud    Clear output

## Code Reference

Use “WiFiSSLClient client;” to create a client that uses SSL. After creation, the client can be used in the same way as a regular client.

Components Used

表格 8: Components used in Examples

	
DHT11_DHT22 Humidity & temperature sensor	HC_SR04 Distance measurement function
	
ILI9341 TFT LCD TFT LCD display with SPI interface	PMS3003/5003 Air quality sensor that detects concentration of micro particulate matters
	



## Peripheral Examples

### E-Paper - Display Images

#### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

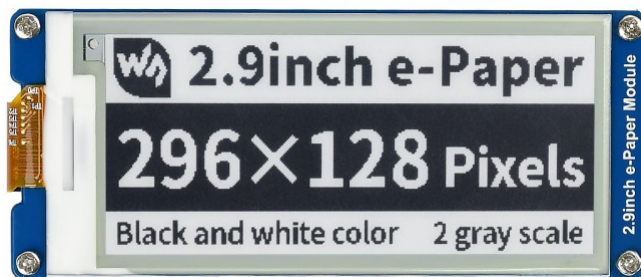
#### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc...are supplied with each panel.

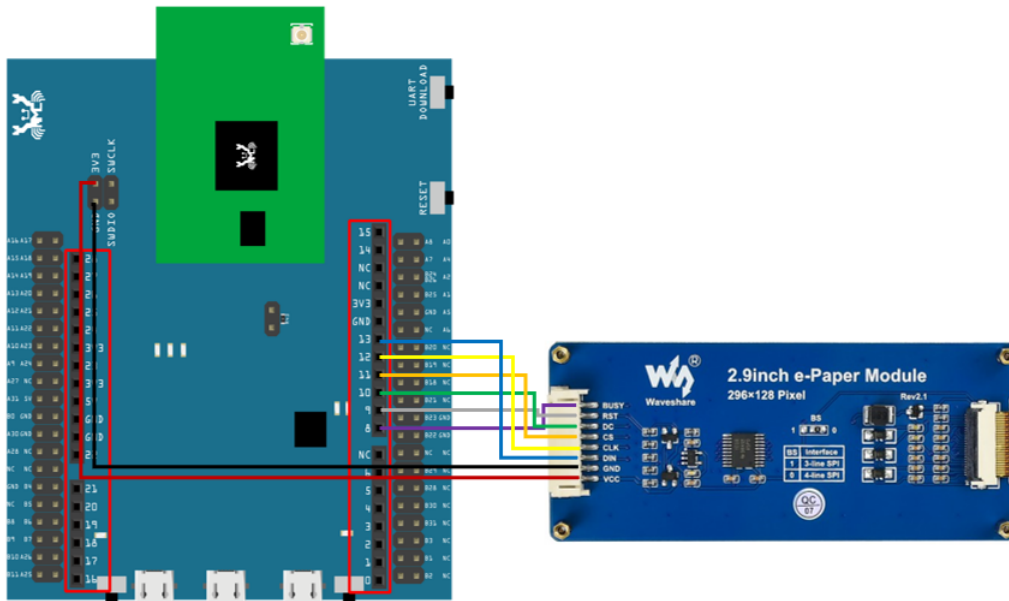
You may refer to the official [2.9inch e-Paper HAT \(D\) datasheet](#) to know more information about this module.

Front view of the e-Paper Module:

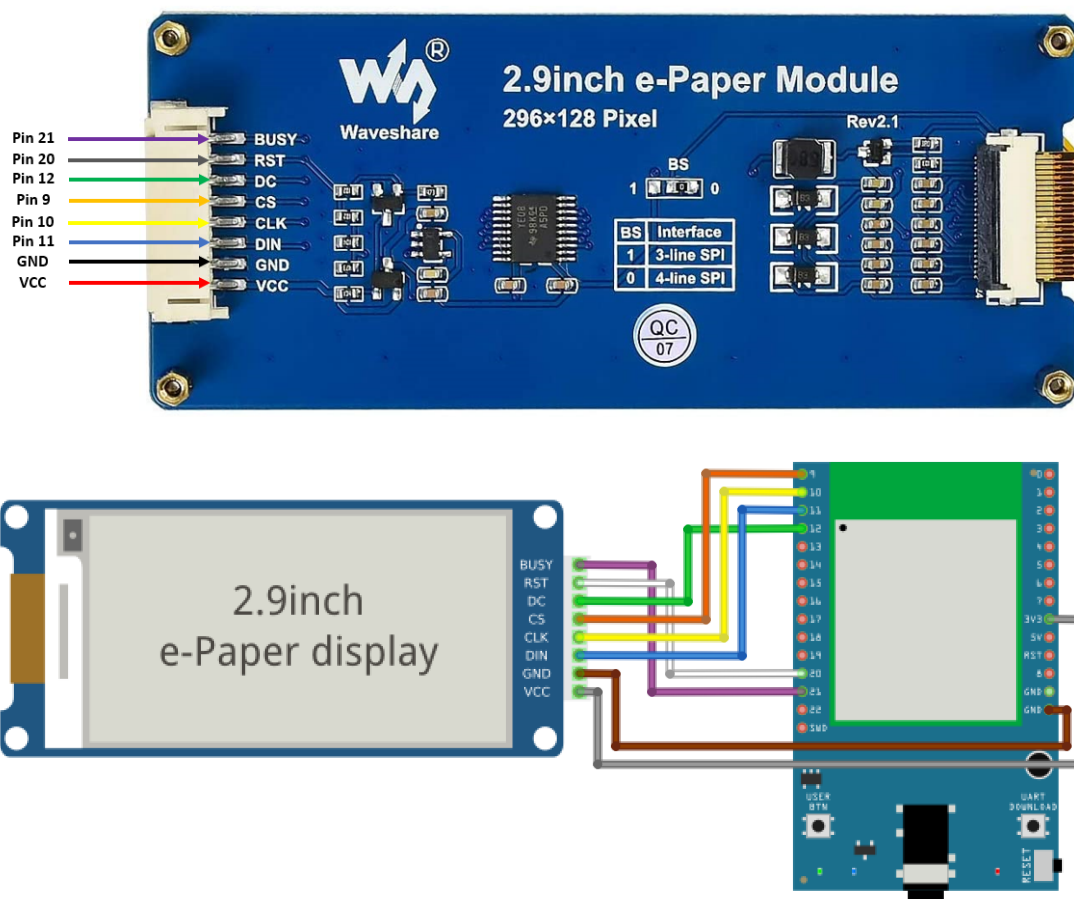


AMB21 / AMB22 Wiring Diagram:

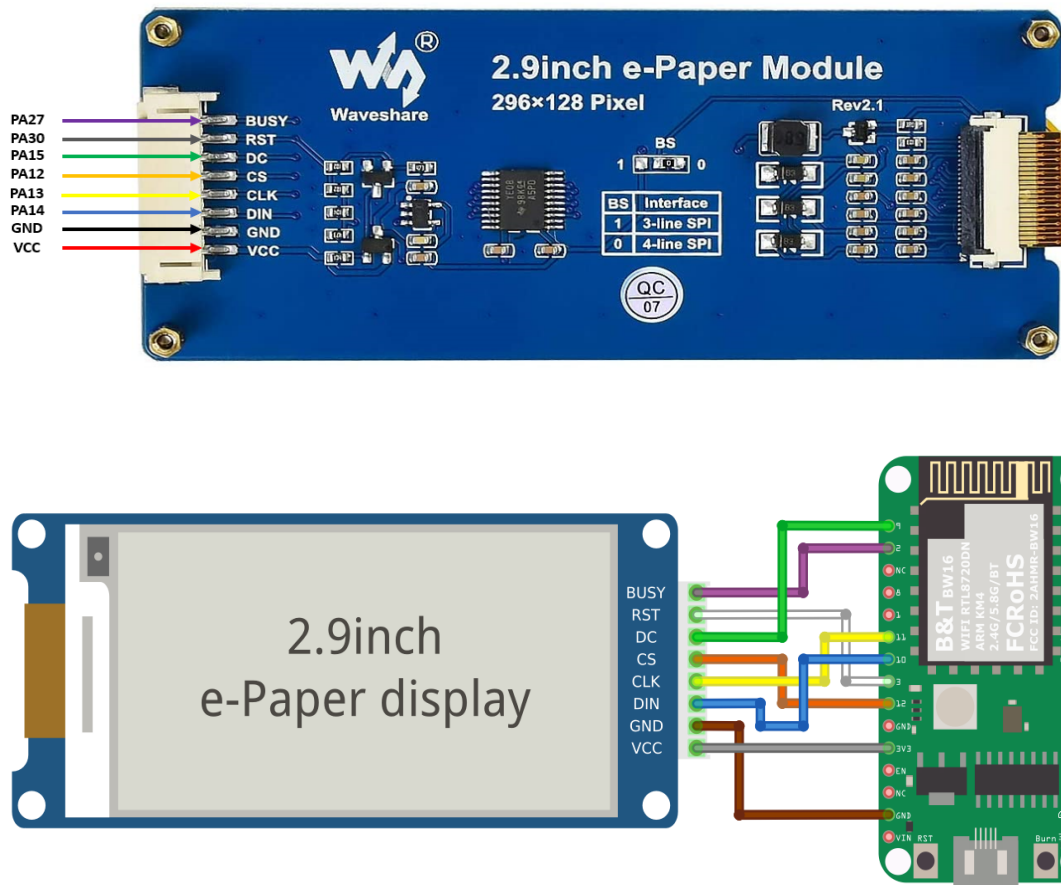




AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Firstly, you need to prepare a picture/photo in the format of 296×128 pixels. We can easily find a photo resizing tool online, for example, the [Online Image Resizer](#).

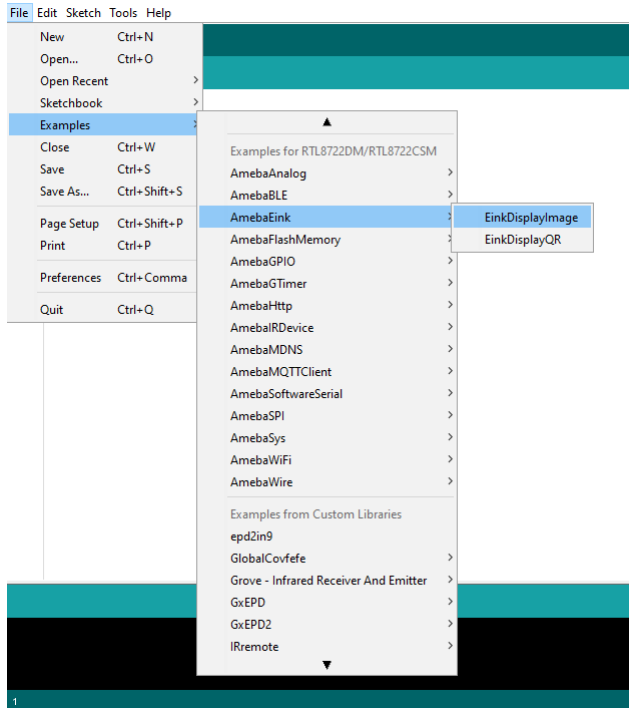
Following the instructions on the website, then download the generated image in JPG format.

Secondly, we use the [Image2LCD](#) tool to transfer the downloaded 296×128 image into hexadecimal codes. You can visit this [YouTube](#) link to get detailed instructions.

Download the Eink zip library, AmebaEink.zip, at

[https://github.com/ambiot/amdb\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/amdb_arduino/tree/master/Arduino_zip_libraries)

Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” → “Examples” → “AmebaEink” → “EinkDisplayImage” :



Press the reset button after uploading the sample code, you will need to wait for around 1-2 seconds for the e-Paper module to fresh its screen. Then the screen will start to display an image for 5 seconds first, then 3 different QR codes will be displayed every 5 seconds (showing in the screenshot below, you may scan the QR codes and find out more information if you wish to). Lastly, a gif which comes in form of 3 frames will be displayed for a few seconds.



### Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

[2] Provide the link to how to generate a QR code on the E-paper module: <https://eugeniopace.org/qrcode/arduino/eink/2019/07/01/qrcode-on-arduino.html>



## E-Paper - Display Text

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

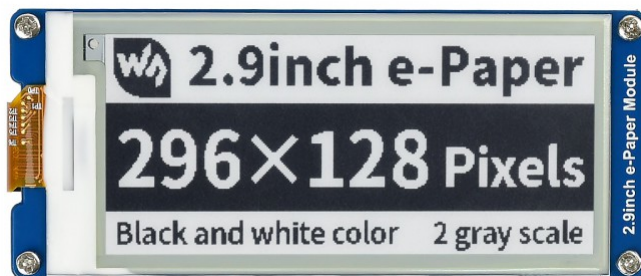
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc... are supplied with each panel.

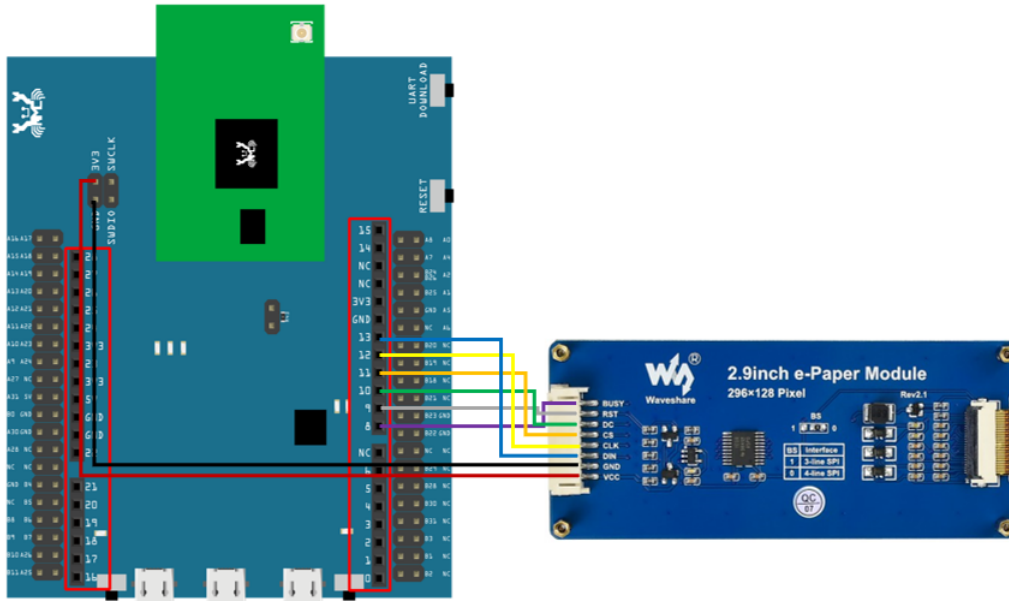
You may refer to the official [2.9inch e-Paper HAT \(D\) datasheet](#) to know more information about this module.

Front view of the e-Paper Module:

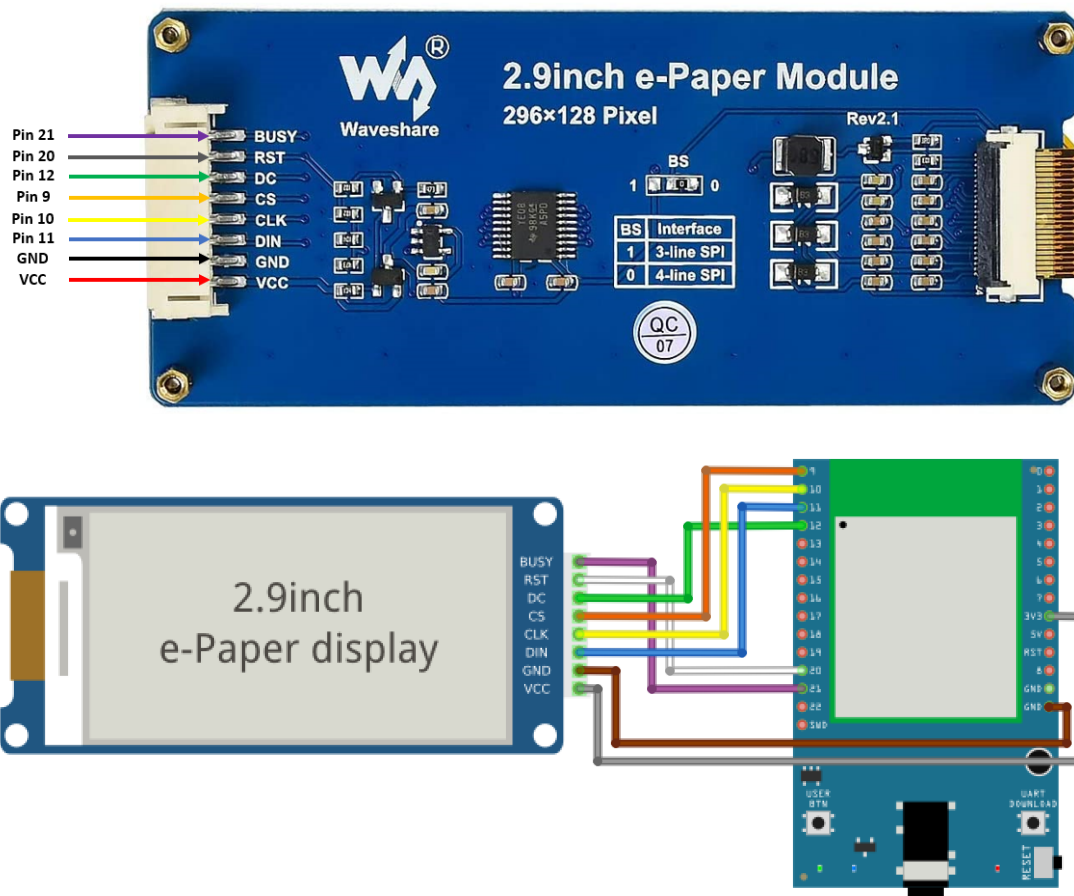


AMB21 / AMB22 Wiring Diagram:

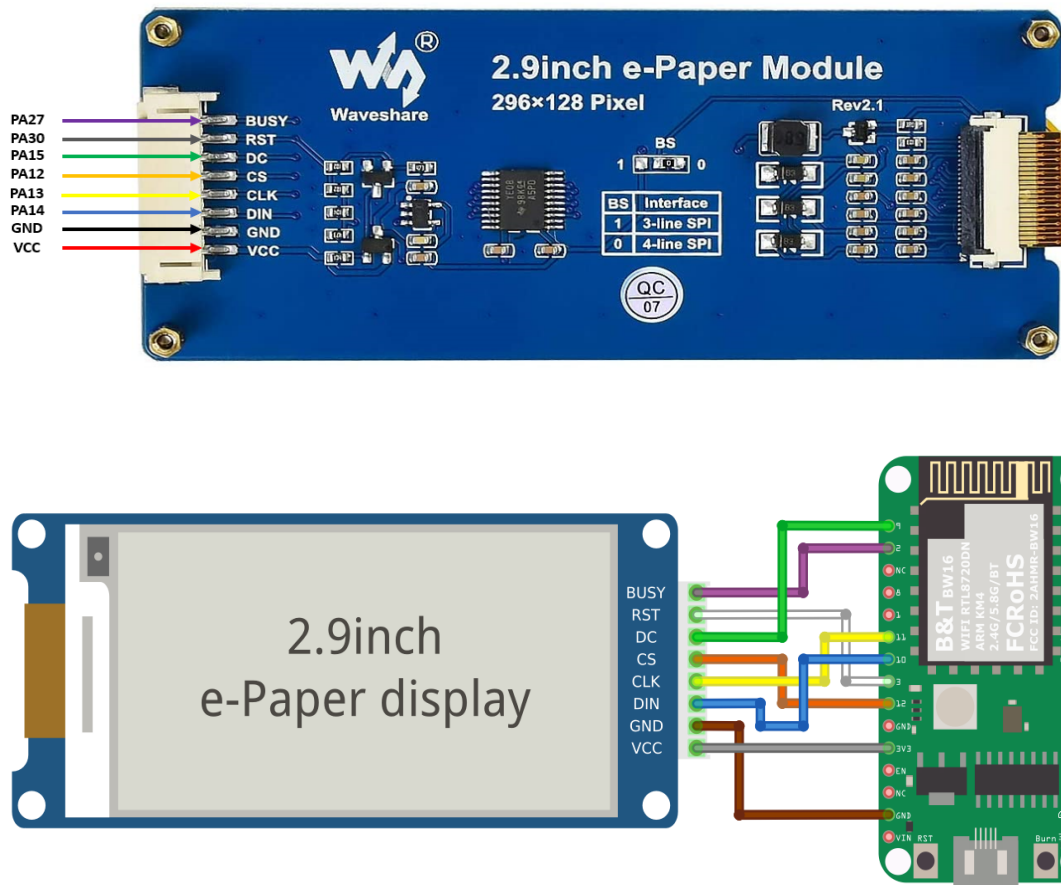




AMB23 Wiring Diagram:



BW16 Wiring Diagram:

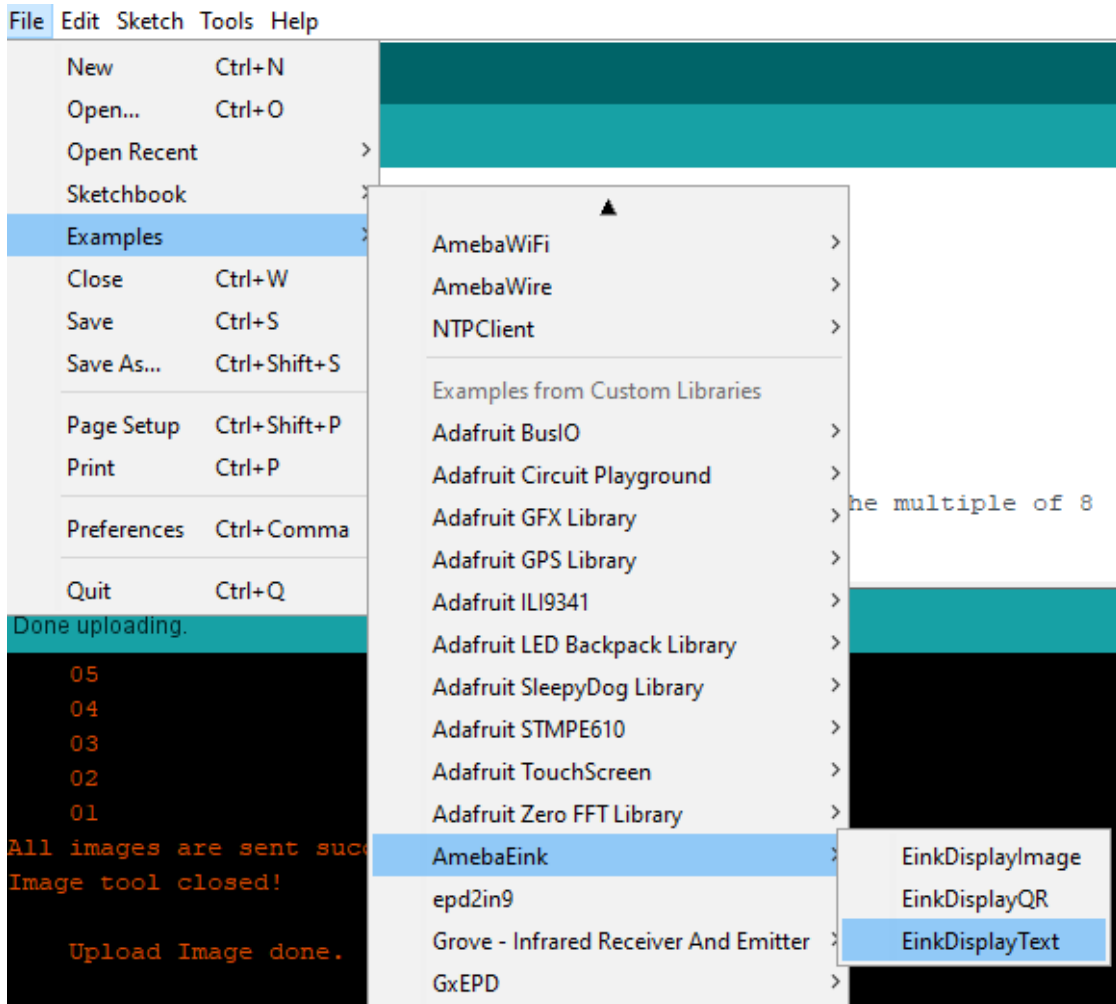


Download the E Ink zip library, AmebaEink.zip, at

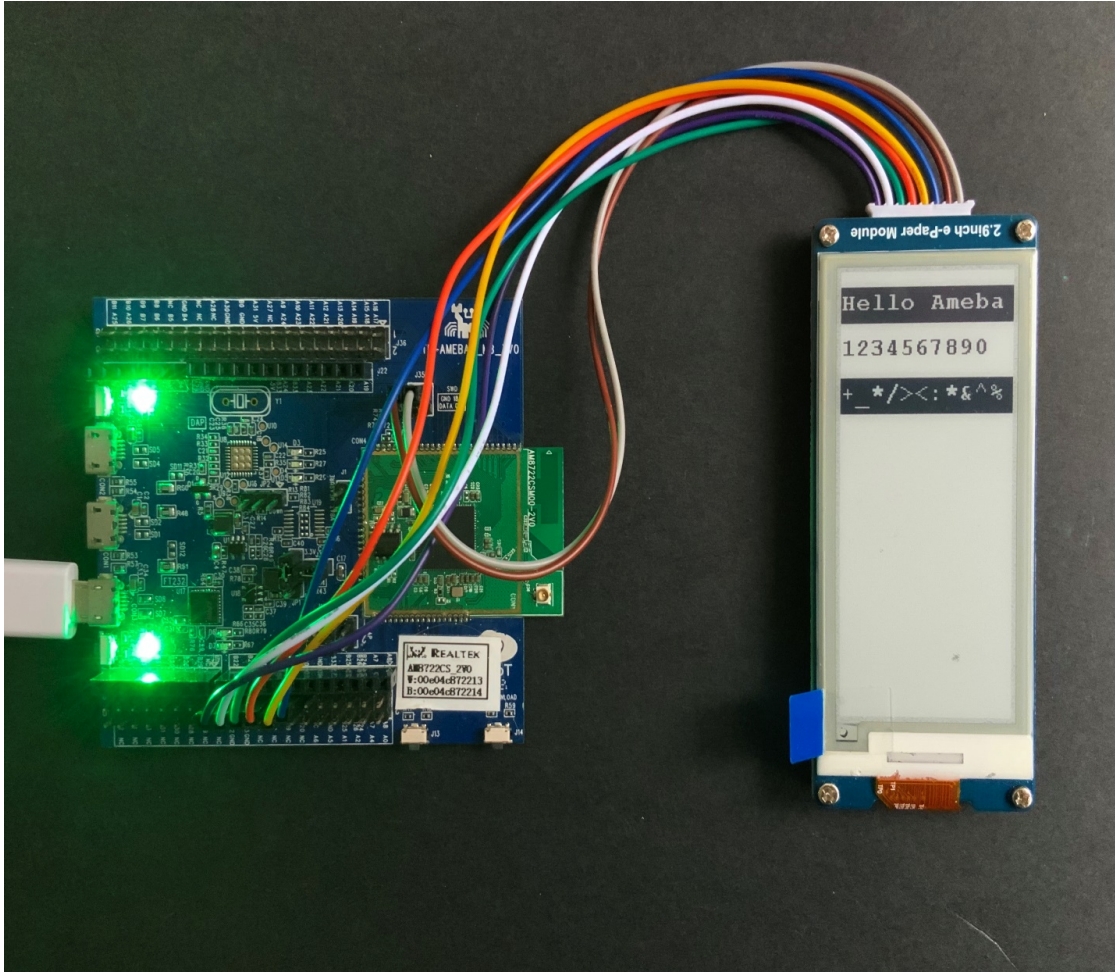
[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries)

Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” -> “Examples” -> “AmebaEink” -> “EinkDisplayText” :





Upload the code to the board and press the Reset button after the uploading is done. You will find these texts displayed on the board:



## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

## E-Paper - Display User-generated QR Code

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Waveshare 2.9inch e-Paper HAT (D) x 1

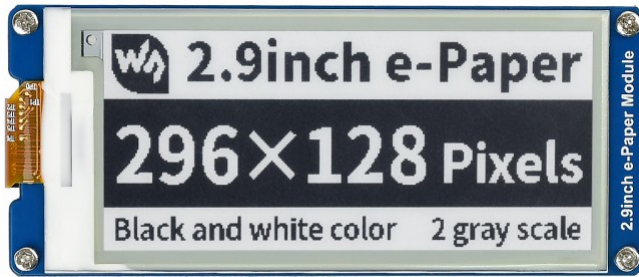
### Example

In this example, we use the Ameba RTL8722 module connects to a Waveshare 2.9inch e-Paper module to display a few QR codes. The display uses the flexible substrate as a base plate, with an interface and a reference system design.

The 2.9" active area contains 296×128 pixels and has 1-bit white/black full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, etc...are supplied with each panel.

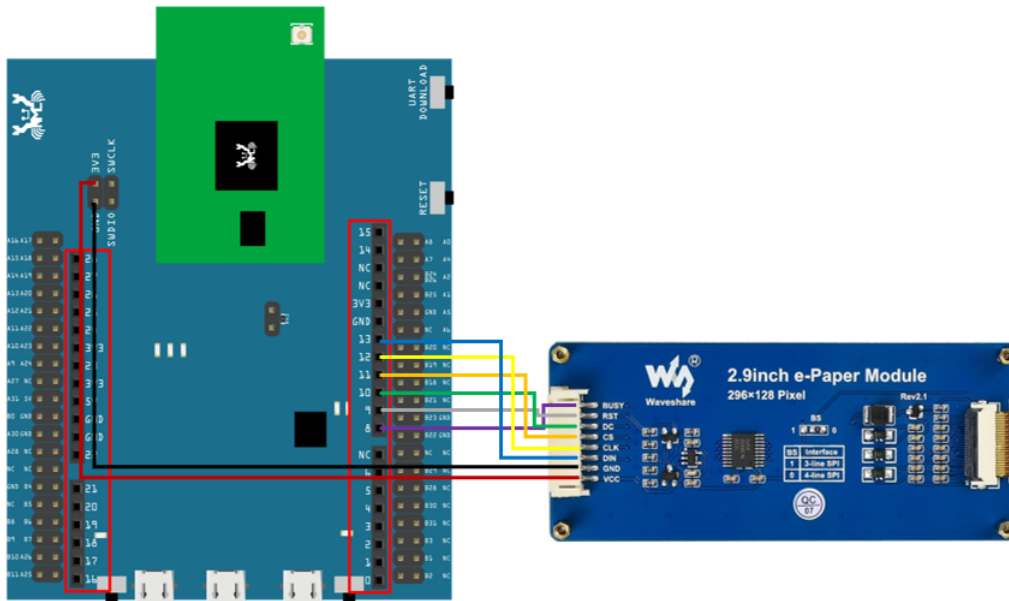
You may refer to the official [2.9inch e-Paper HAT \(D\)](#) datasheet to know more information about this module.

Front view of the e-Paper Module:

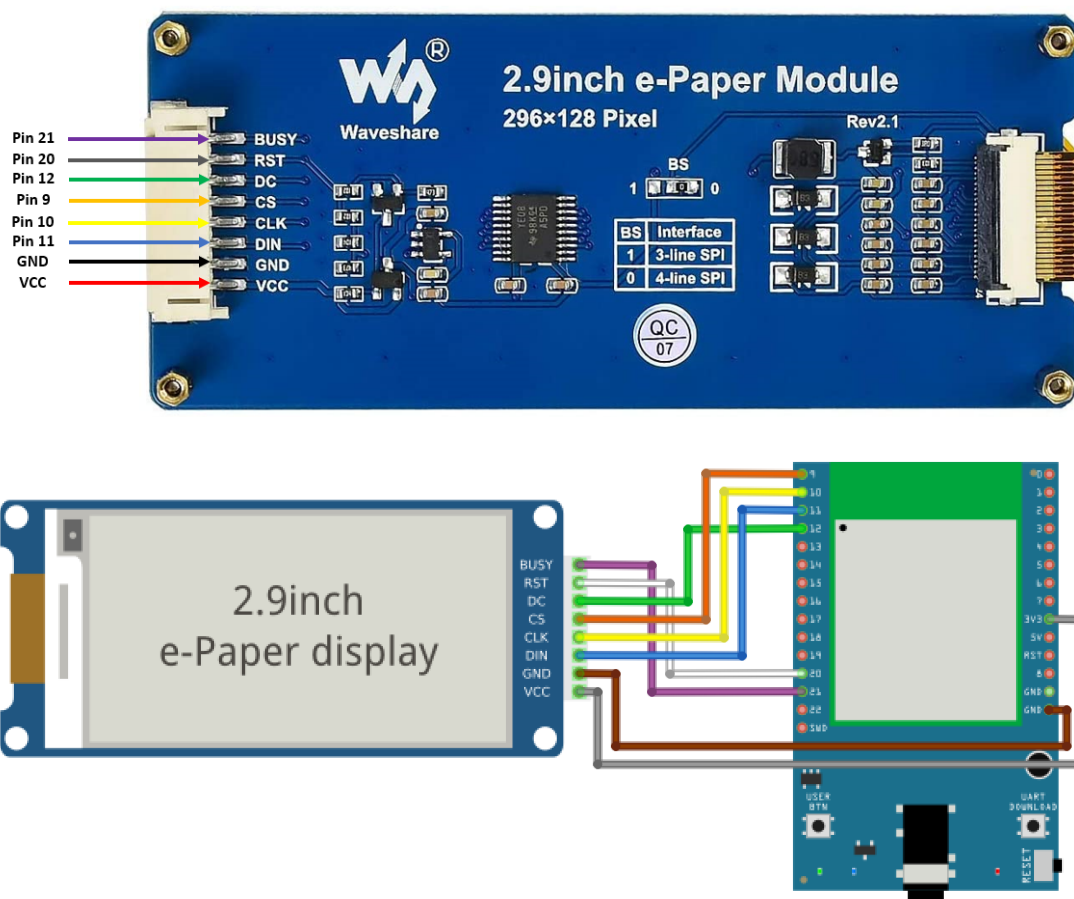


AMB21 / AMB22 Wiring Diagram:

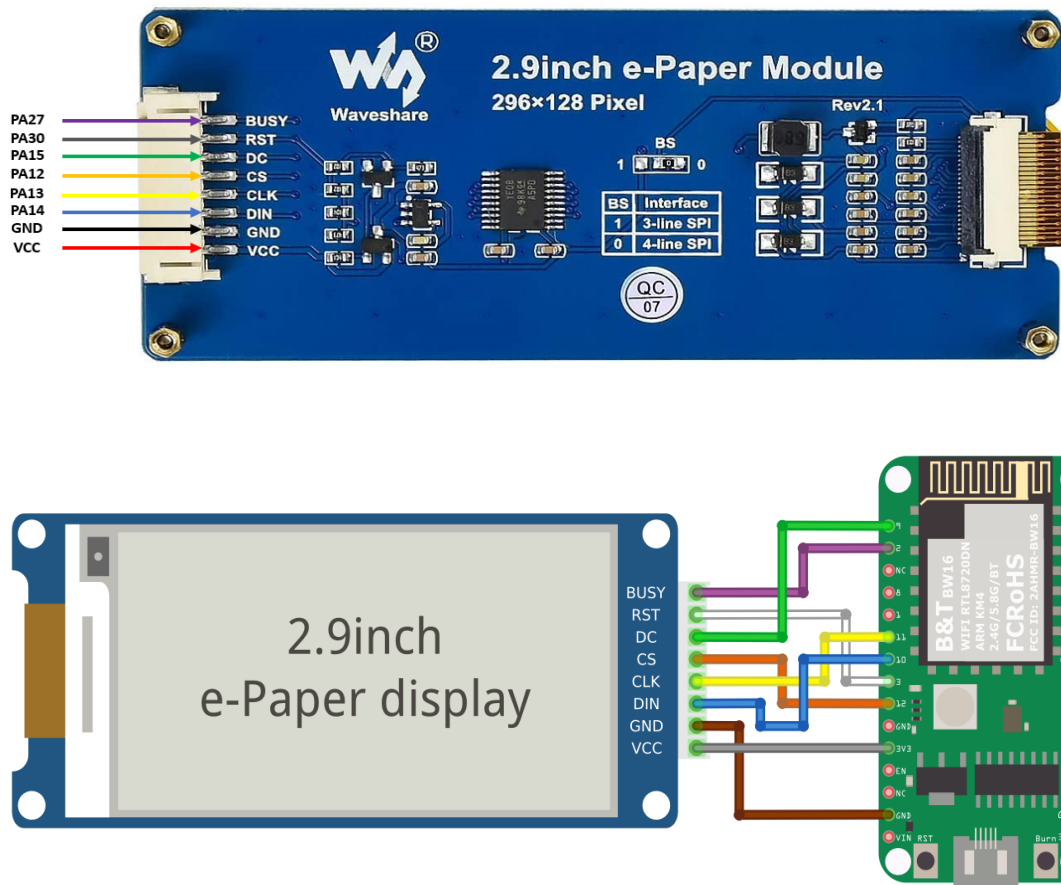




AMB23 Wiring Diagram:



BW16 Wiring Diagram:

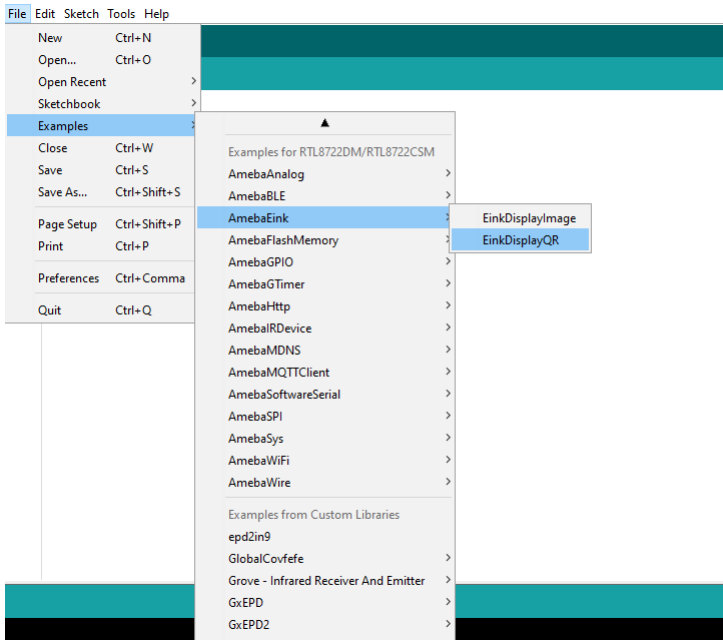


Download the E Ink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries)

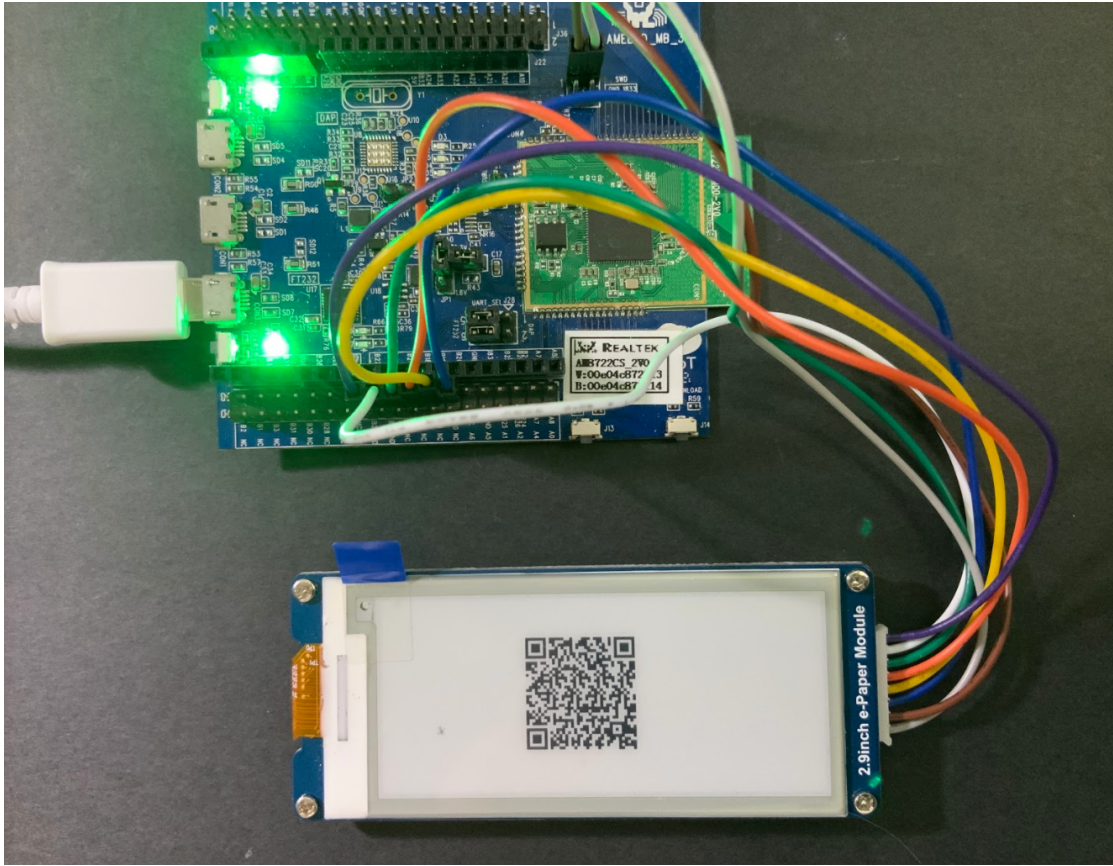
Then install the AmebaEink.zip. Open the “DisplayQR” example in “File” → “Examples” →





"AmebaEink" → "DisplayQR" :

Modify the URL in the loop() section as your wish, after that, verify and upload the code to the Ameba board. Upon successfully upload the sample code and press the reset button, a QR code generated based on the URL of your input will be shown on the E-Paper module. The QR code showing below leads to our Ameba IoT official website: [Ameba ARDUINO](#)



## Code Reference

[1] We use Good Display GDEH029A1 2.9 Inch / 296×128 Resolution / Partial Refresh Arduino Sample Code to get the e-Paper successfully Display: <http://www.good-display.com/product/201.html>

[2] Provide the link to how to generate a QR code on the E-paper module: <https://eugeniopace.org/qrcode/arduino/eink/2019/07/01/qrcode-on-arduino.html>

[3] A simple library for generating QR codes in C, optimized for processing and memory-constrained systems: <https://github.com/ricmoo/QRCode#data-capacities>

## Flash Memory - Store data in FlashEEProm

### Preparation

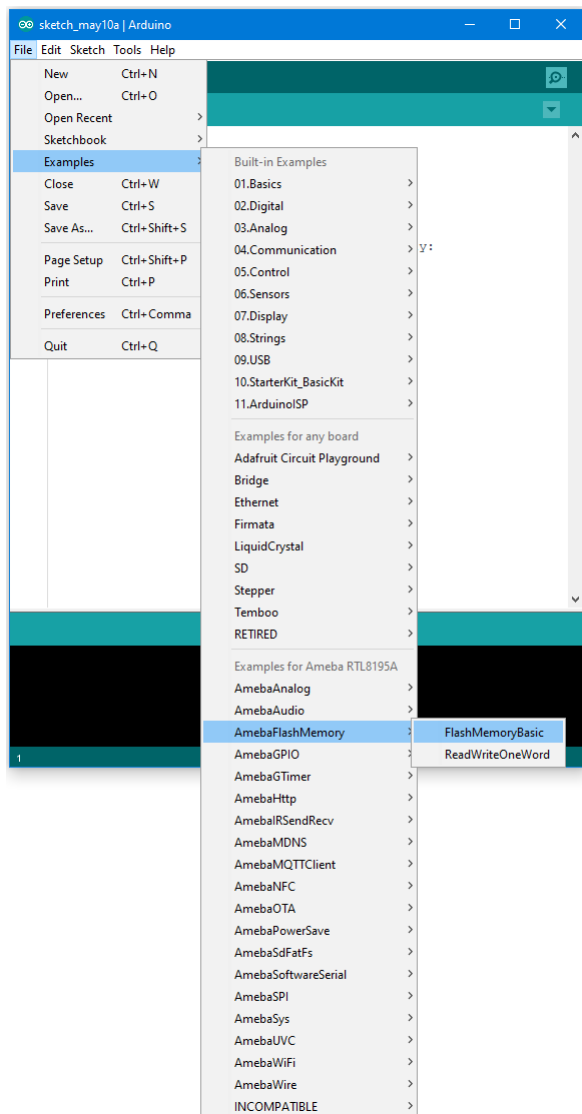
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

## Example

Ameba provides Flash Memory component for data storage and the data can be preserved when the power is off if necessary, e.g., compiled program. To avoid the memory space overlapped with the program on Ameba, the Flash API uses the tail part of the address space, with sector size 4K.

In this example, we store the value of boot times in flash memory. Every time Ameba reboots, it reads the boot times from flash, increases the value by 1, and writes it back to flash memory.

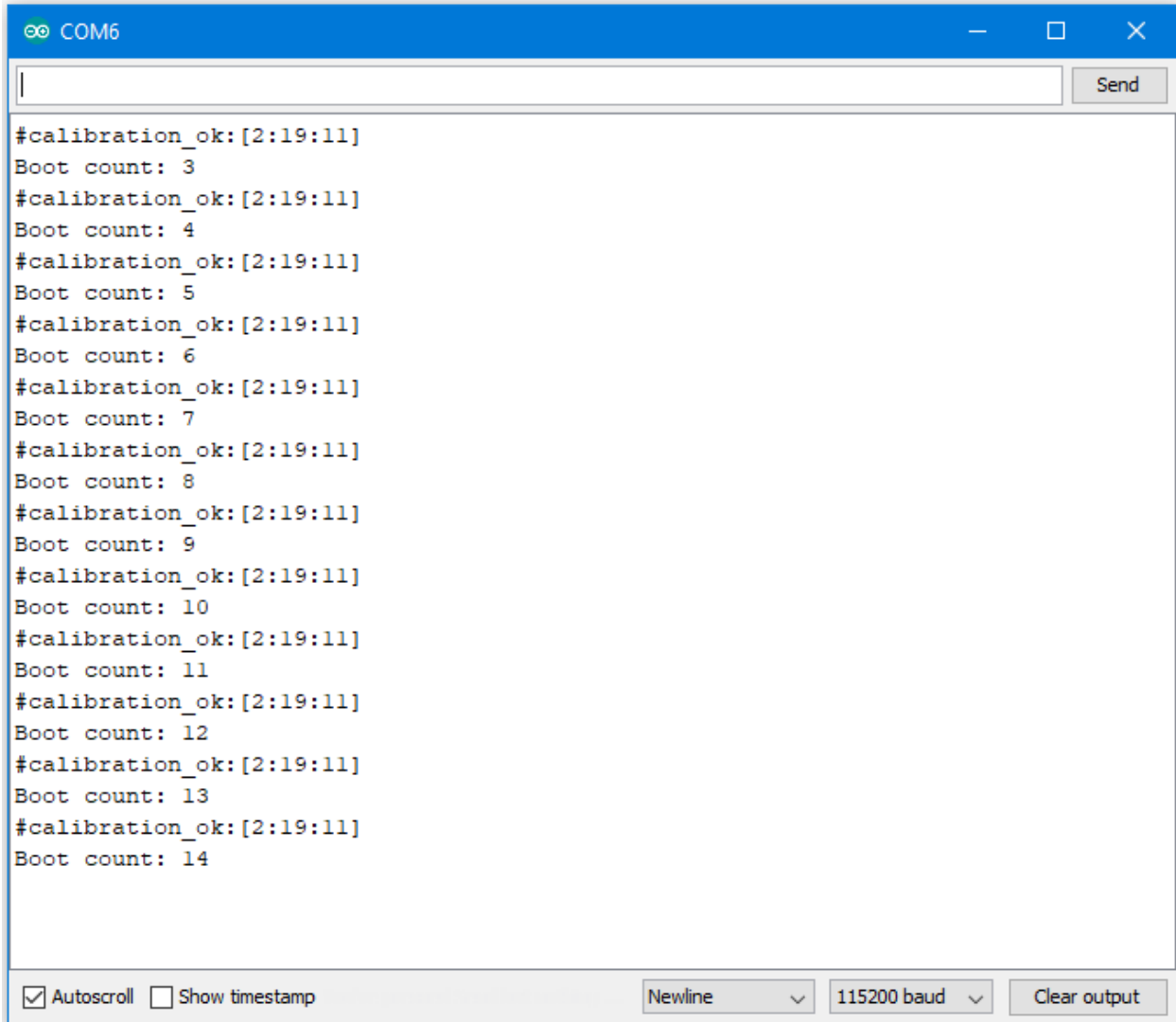
First open the example, “File” -> “Example” -> “AmebaFlashMemory” -> “FlashMemoryBasic”



Compile and upload to Ameba, then press the reset button.

Open the Serial Monitor, press the reset button for a few times. Then you can see the boot times value increases.





```
#calibration_ok:[2:19:11]
Boot count: 3
#calibration_ok:[2:19:11]
Boot count: 4
#calibration_ok:[2:19:11]
Boot count: 5
#calibration_ok:[2:19:11]
Boot count: 6
#calibration_ok:[2:19:11]
Boot count: 7
#calibration_ok:[2:19:11]
Boot count: 8
#calibration_ok:[2:19:11]
Boot count: 9
#calibration_ok:[2:19:11]
Boot count: 10
#calibration_ok:[2:19:11]
Boot count: 11
#calibration_ok:[2:19:11]
Boot count: 12
#calibration_ok:[2:19:11]
Boot count: 13
#calibration_ok:[2:19:11]
Boot count: 14
```

## Code Reference

By default, the Flash Memory API uses address 0xFF000~0xFFFFF to store data.

There is limitation when writing to flash memory. That is, you can not directly write data to the same address you used in last write. To do that correctly, you need erase the sector first. The Flash API of Ameba uses a 4K SRAM to record the user modification and do the erase/write task together.

Use `FlashMemory.read()` to read from Flash memory.

Use `FlashMemory.buf[0] = 0x00;` to manipulate the 4K buf.

Use `FlashMemory.update()` ; to update the data in buf to Flash Memory.

## Flash Memory - Use Flash Memory Larger Than 4K

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

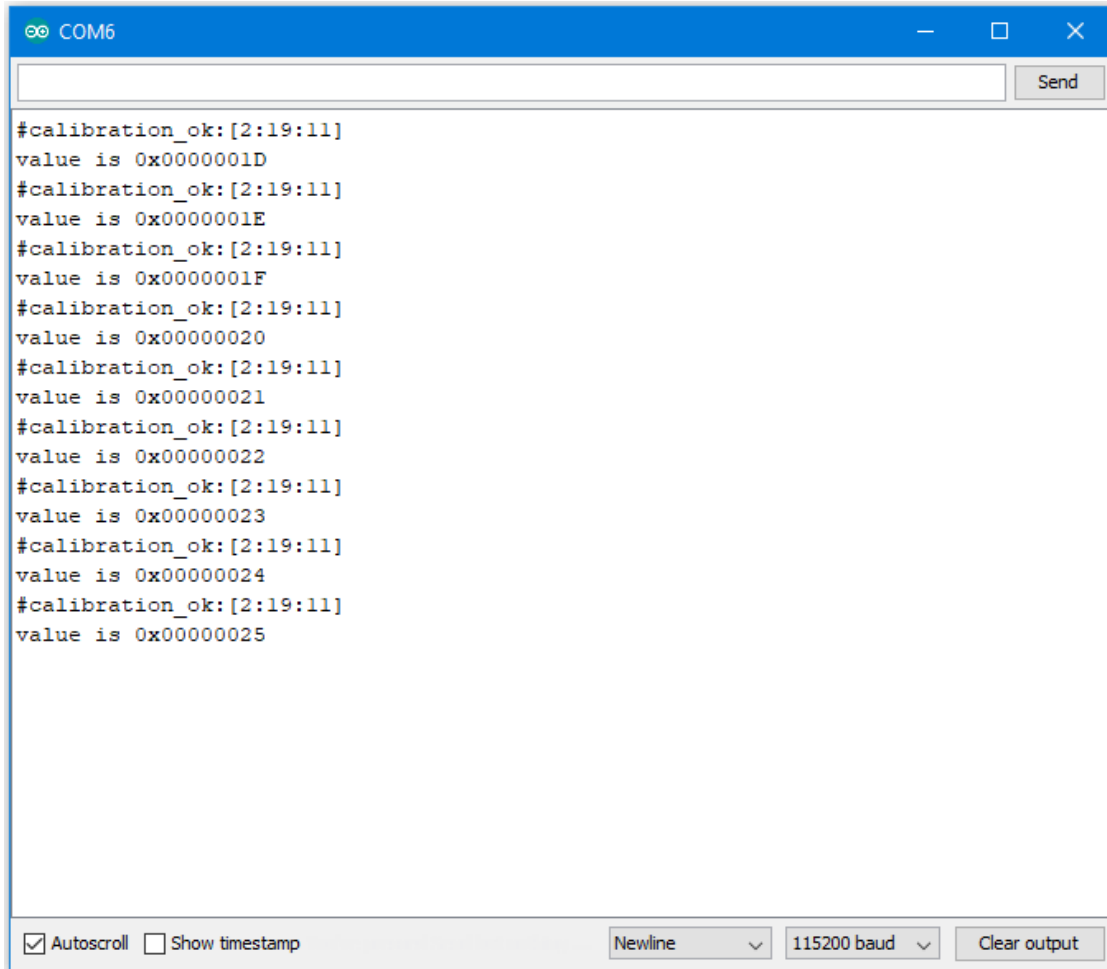
### Example

Flash Memory API uses memory of 4K bytes, which is normally sufficient for most application. However, larger memory can be provided by specifying a specific memory address and required size.

First, open the sample code in “File” -> “Examples” -> “AmebaFlashMemory” -> “ReadWriteOneWord”

In this example, we specify the starting address of flash memory is 0xFC000 and size is 0x4000 (The default starting address is 0xFF000 and size is 0x1000).

Then calculate correct address according to the specified offset and perform read/write operation. In the sample code we use offset 0x3F00, that is,  $0xFC000 + 0x3F00 = 0xFFFF00$  in flash. We set the value to 0 at first, then increase by 1 every time Ameba reboots.



## Code Reference

We can use the flash api we used in previous flash memory example, but we need to use `begin()` function to specify the desired starting address and memory size.

```
FlashMemory.begin(0xFC000, 0x4000);
```

Use `readWord()` to read the value stored in a memory address. In the example, we read the value stored in memory offset `0x3F00`, that is `0xFC000 + 0x3F00 = 0xFFFF00`. `readWord()` function reads a 32-bit value and returns it.

```
value = FlashMemory.readWord(0x3F00);
```

Use `writeWord()` to write to a memory address. The first argument is the memory offset, the second argument is the value to write to memory.

```
FlashMemory.writeWord(0x3F0C, value);
```

## GPIO - Measure Distance By Ultrasound Module

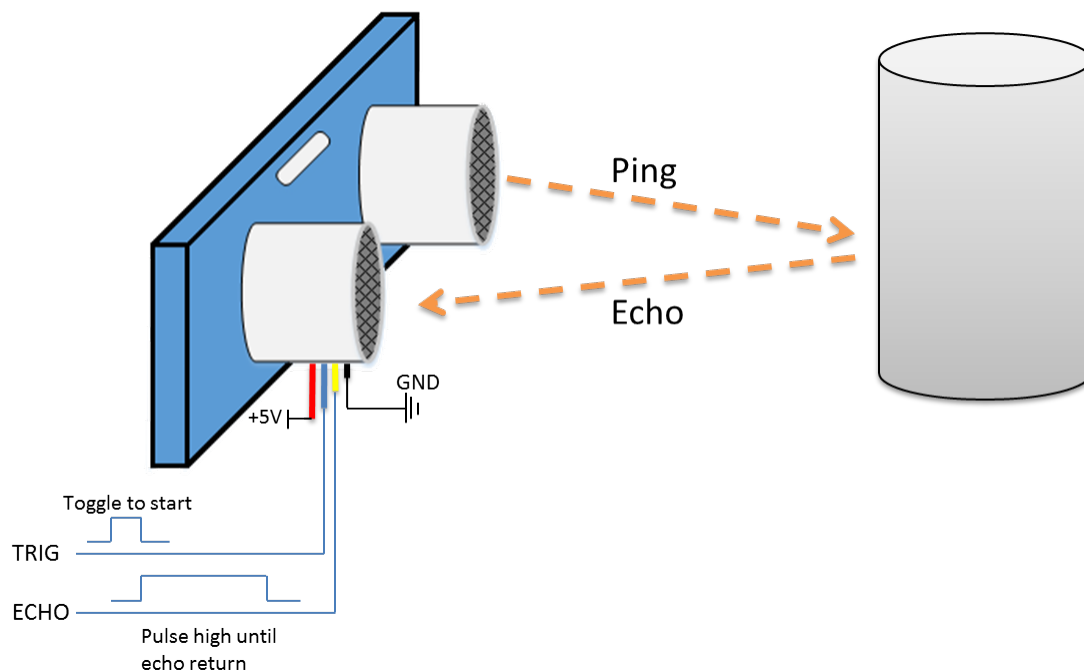
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- HC-SR04 Ultrasonic x 1
- Dropping resistor or Level converter

### Example

HC-SR04 is a module that uses ultrasound to measure the distance. It looks like a pair of eyes in its appearance, therefore it' s often installed onto robot-vehicle or mechanical bugs to be their eyes.

The way it works is that first we “toggle high” the TRIG pin (that is to pull high then pull low). The HC-SR04 would send eight 40kHz sound wave signal and pull high the ECHO pin. When the sound wave returns back, it pull low the ECHO pin.

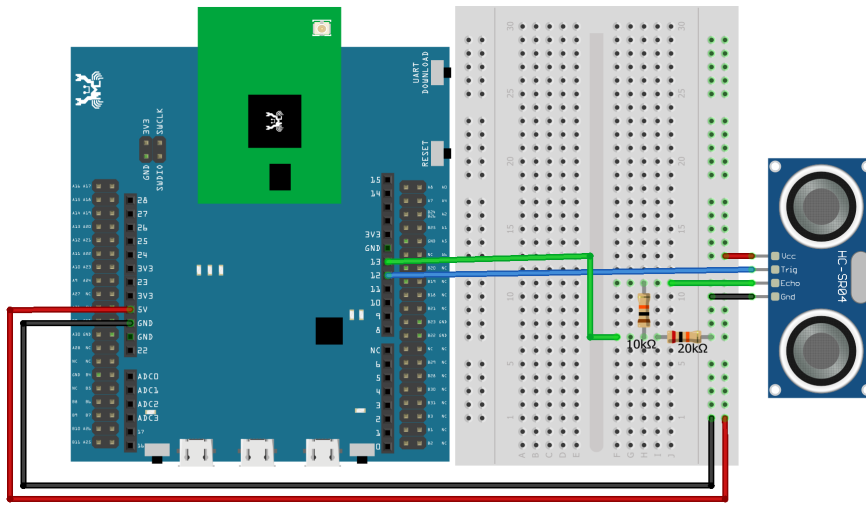


Assume the velocity of sound is 340 m/s, the time it takes for the sound to advance 1 cm in the air is  $340 \times 100 \times 10^{-6} = 29 \mu\text{s}$ .

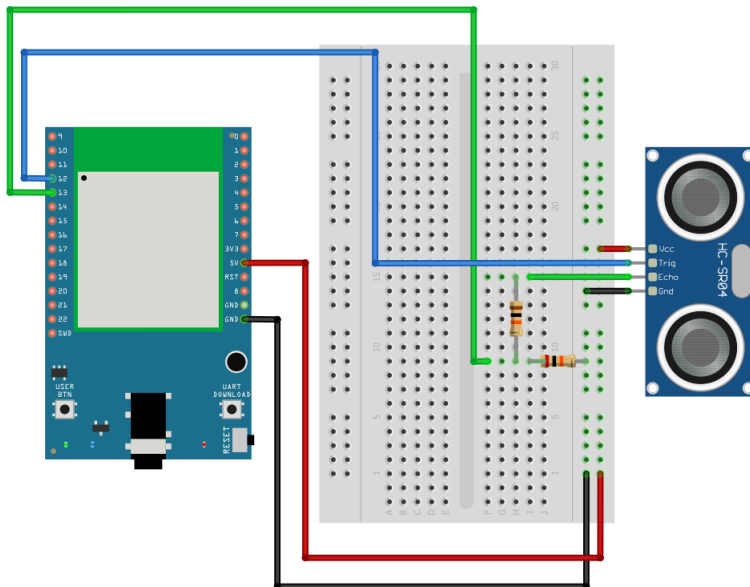
The sound wave actually travels twice the distance between HC-SR04 and the object, therefore the distance can be calculated by  $(\text{time}/29) / 2 = \text{time} / 58$ .

The working voltage of HC-SR04 is 5V. When we pull high the ECHO pin to 5V, the voltage might cause damage to the GPIO pin of Ameba. To avoid this situation, we need to drop the voltage as follows:

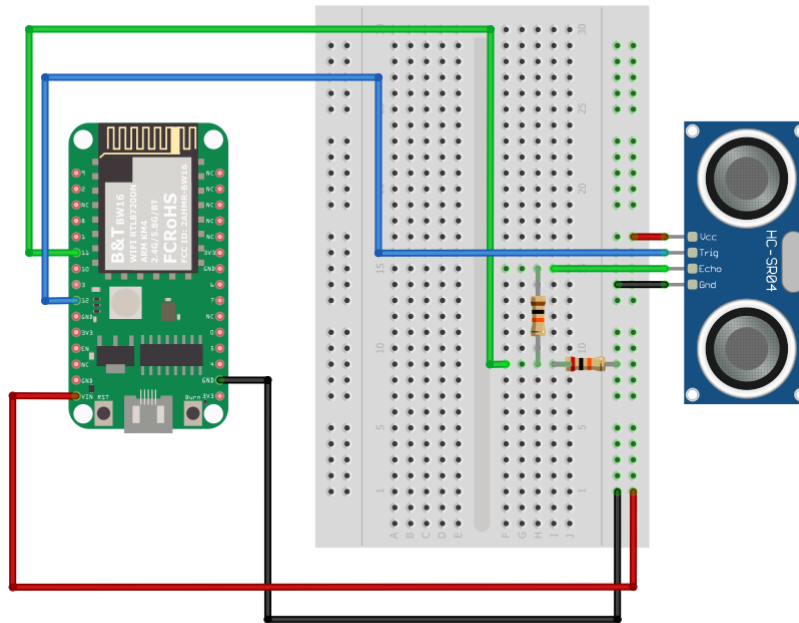
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



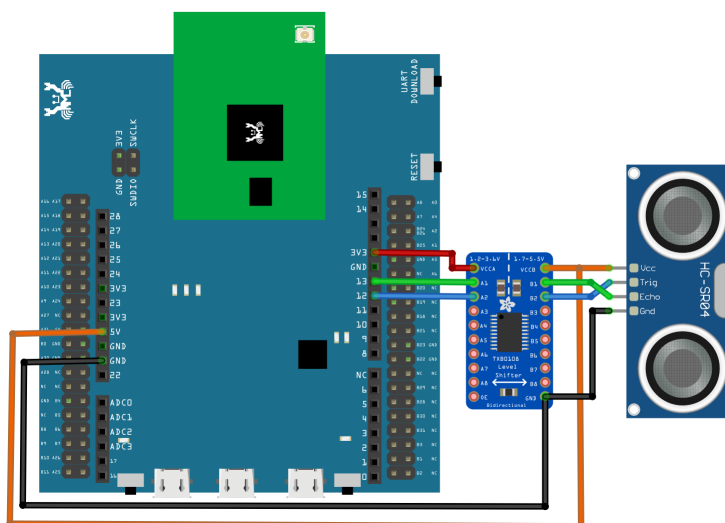
BW16 Wiring Diagram:



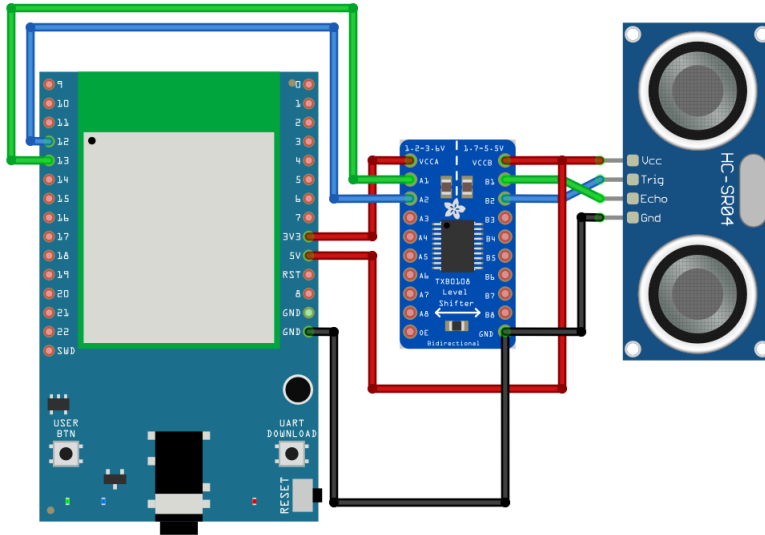
We pick the resistors with resistance 1:2, in the example we use  $10k\Omega$  and  $20k\Omega$ .

If you do not have resistors in hand, you can use level converter instead. The TXB0108 8 channel level converter is a suitable example:

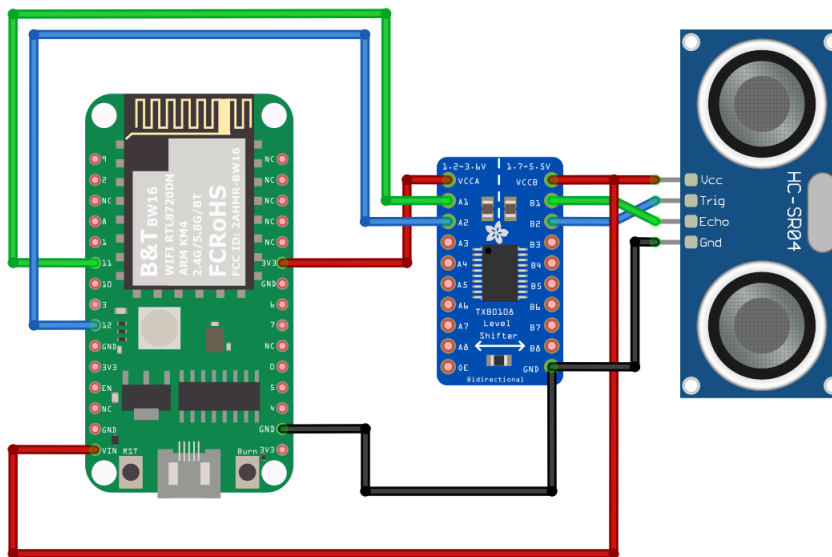
AMB21 / AMB22 Wiring Diagram:



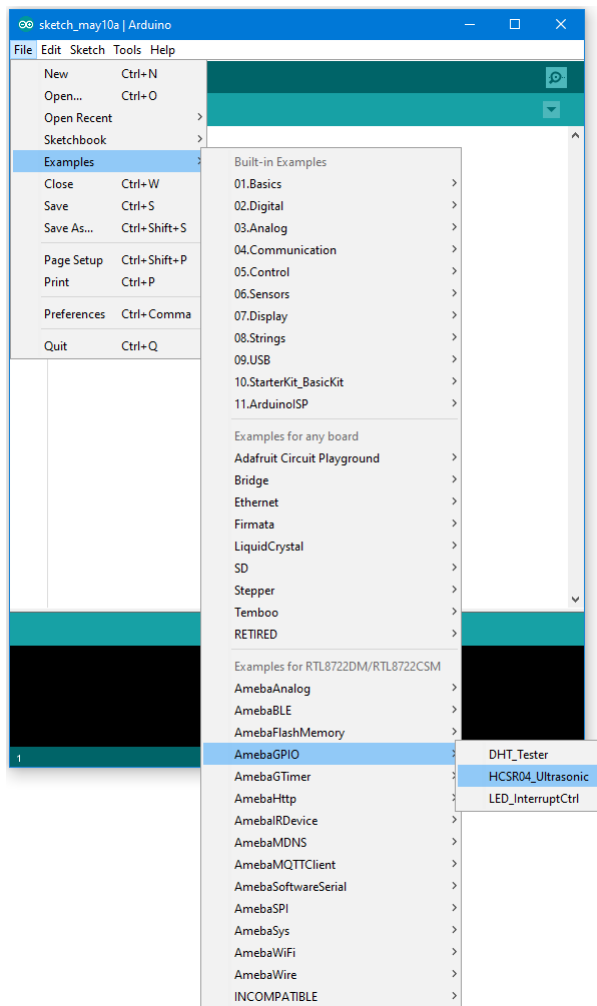
AMB23 Wiring Diagram:



BW16 Wiring Diagram:

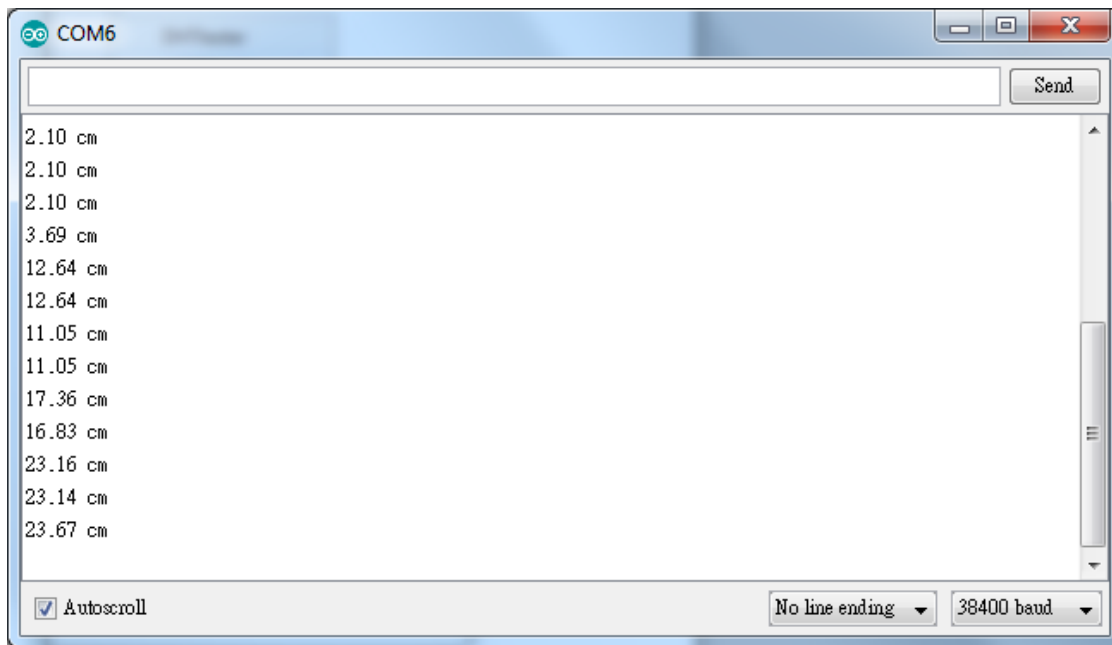


Next, open the sample code in “File” -> “Examples” -> “AmebaGPIO” -> “HCSR04\_Ultrasonic”



Compile and upload to Ameba, then press the reset button. Open the Serial Monitor, the calculated result is output to serial monitor every 2 seconds.





Note that the HCSR04 module uses the reflection of sound wave to calculate the distance, thus the result can be affected by the surface material of the object (e.g., harsh surface tends to cause scattering of sound wave, and soft surface may cause the sound wave to be absorbed).

### Code Reference

Before the measurement starts, we need to pull high the TRIG pin for 10us and then pull low. By doing this, we are telling the HC-SR04 that we are about to start the measurement:

```
digitalWrite(trigger_pin, HIGH);  
delayMicroseconds(10);  
digitalWrite(trigger_pin, LOW);
```

Next, use pulseIn to measure the time when the ECHO pin is pulled high.

```
duration = pulseIn (echo_pin, HIGH);
```

Finally, use the formula to calculate the distance.

```
distance = duration / 58;
```

## GPIO - Measure Temperature and Humidity

### Preparation

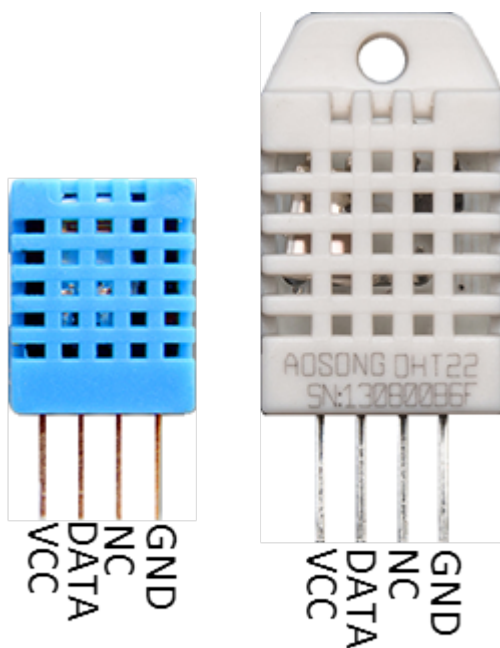
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21

### Example

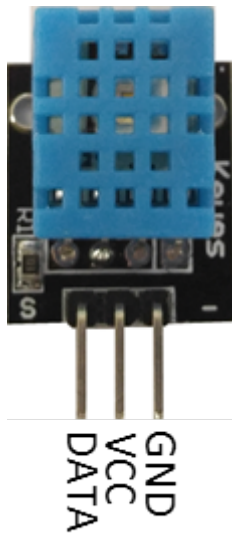
DHT11 is a temperature and humidity sensor which operates at voltage 3.3V~5V. At room temperature, the measurable range of the humidity is 20% ~ 90%RH with  $\pm 5\%$ RH precision, the measurable range of the temperature is 0 ~ 50°C with  $\pm 2^\circ\text{C}$  precision.

Another choice of temperature and humidity sensor is DHT22 sensor, which has better precision. Its measurable range of the humidity is 0%~100%RH with  $\pm 5\%$ RH precision, the measurable range of the temperature is -40~125 °C with  $\pm 0.2^\circ\text{C}$  precision.

There are 4 pins on the sensor:

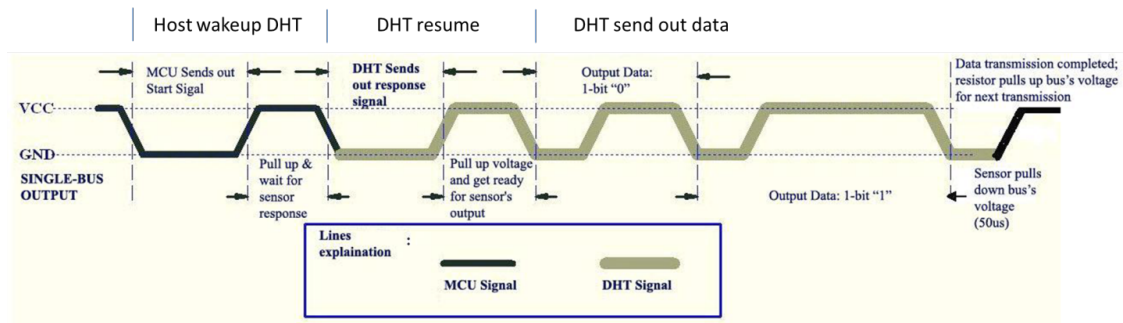


Since one of the 4 pins has no function, there are temperature/humidity sensors with only 3 pins on the market:

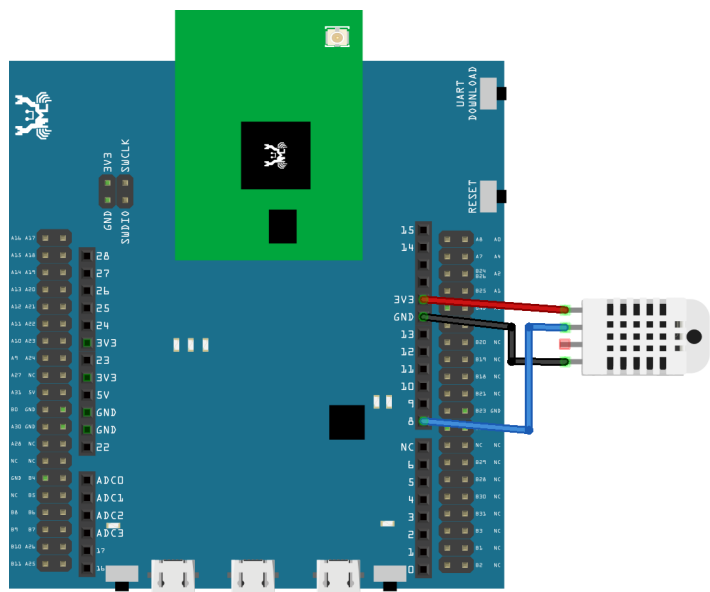


DHT is normally in the sleeping mode. To get the temperature/humidity data, please follow the steps:

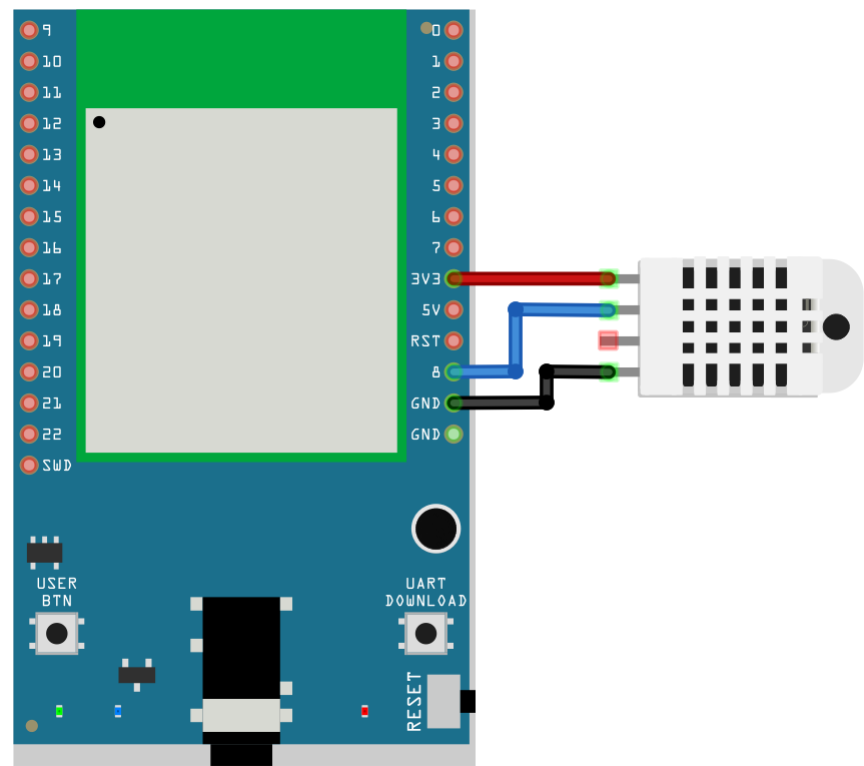
1. Awake DHT: Ameba toggles low its DATA pin of GPIO. Now the DATA pin of GPIO serves as digital out to Ameba.
2. DHT response: DHT also toggle low its DATA pin of GPIO. Now the DATA pin of GPIO serves as digital in for Ameba.
3. DHT sends data: DHT sends out the temperature/humidity data (which has size 5 bytes) in a bit by bit manner. To represent each bit, DHT first pull low the DATA GPIO pin for a while and then pull high. If the duration of high is smaller than low, it stands for bit 0. Otherwise it stands for bit 1.



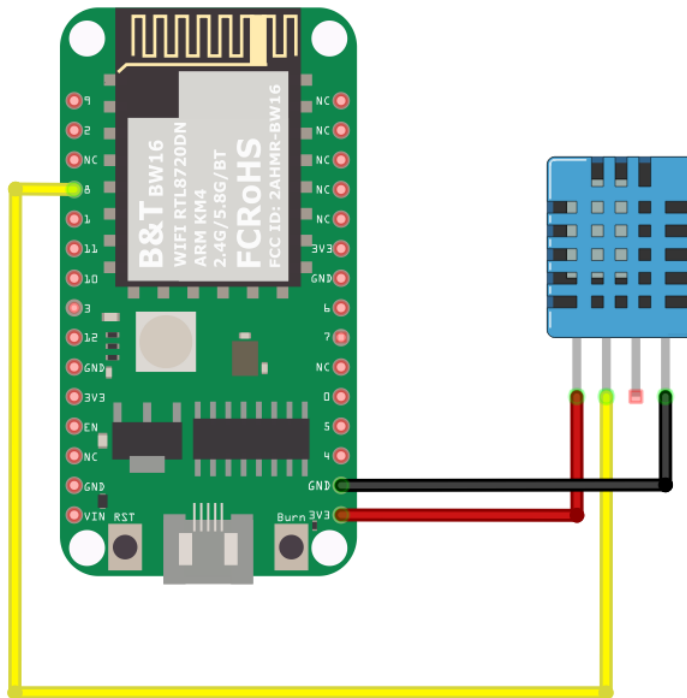
AMB21 / AMB22 Wiring Diagram:



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the sample code in “Files” -> “Examples” -> “AmebaGPIO” -> “DHT\_Tester” . Compile and upload to Ameba, then press the reset button. The result would be shown on the Serial Monitor.

```

COM6
#calibration_ok:[2:19:11]
DHTxx test!
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 61.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.15 *C 77.27 *F
Humidity: 91.00 %      Temperature: 25.00 *C 77.00 *F  Heat index: 25.93 *C 78.68 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 91.00 %      Temperature: 27.00 *C 80.60 *F  Heat index: 31.27 *C 88.28 *F
Humidity: 92.00 %      Temperature: 28.00 *C 82.40 *F  Heat index: 34.46 *C 94.03 *F

```

☒ Autoscroll ☐ Show timestamp    Newline    115200 baud    Clear output

## Code Reference

Use `dht.readHumidity()` read the humidity value, and use `dht.readTemperature()` to read the temperature value.

Every time we read the temperature/humidity data, Ameba uses the buffered temperature/humidity data unless it found the data has expired (i.e., has not been updated for over 2 seconds). If the data is expired, Ameba issues a request to DHT to read the latest data.

## GPIO - Use GPIO Interrupt To Control LED

### Preparation

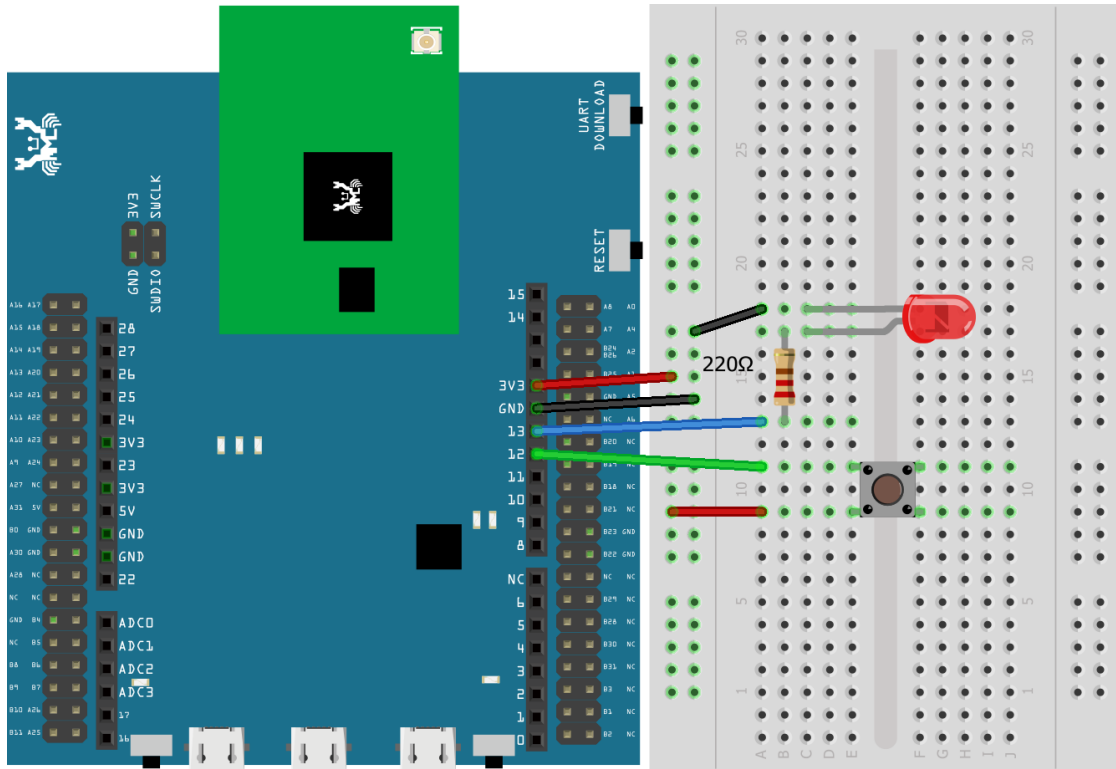
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- LED x 1
- Button x 1

## Example

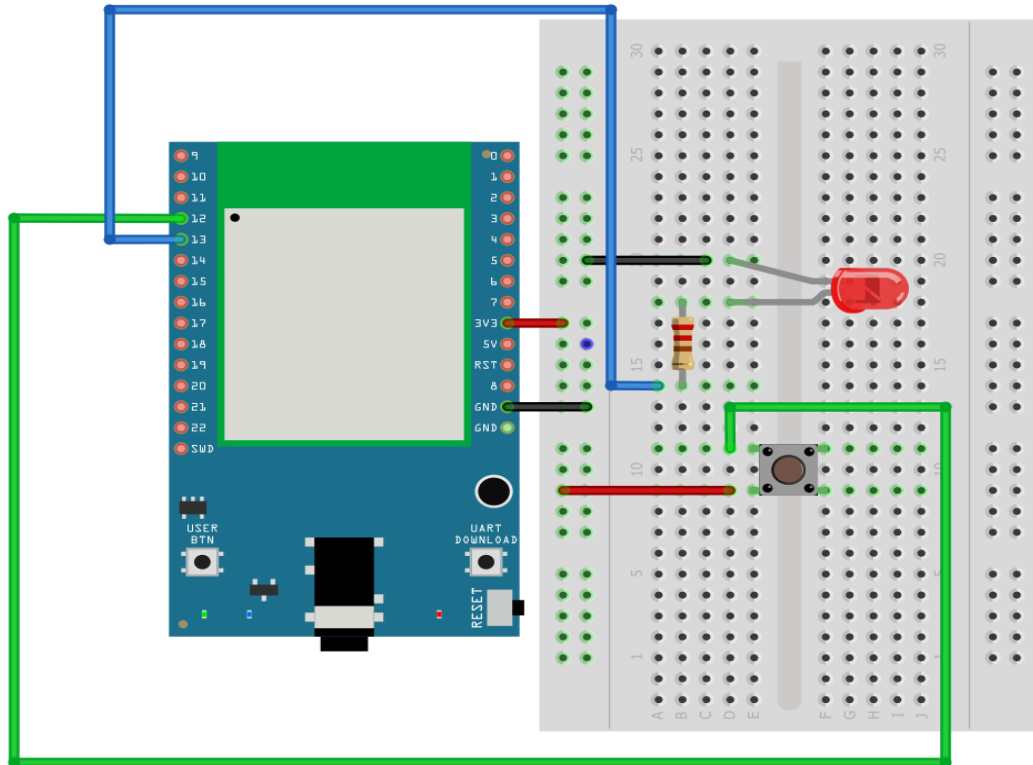
In this example, we use a button to trigger interrupt and control the LED. When we press and release the button, the LED dims, press and release the button again, and the LED lights. Note that in the Arduino example “Button and LED”, LED only lights when the button is pressed and hold, when we release the button, the LED dims.

Open the example, “Files” -> “Examples” -> “AmebaGPIO” -> “LED\_InterruptCtrl”

AMB21 / AMB22 Wiring Diagram:

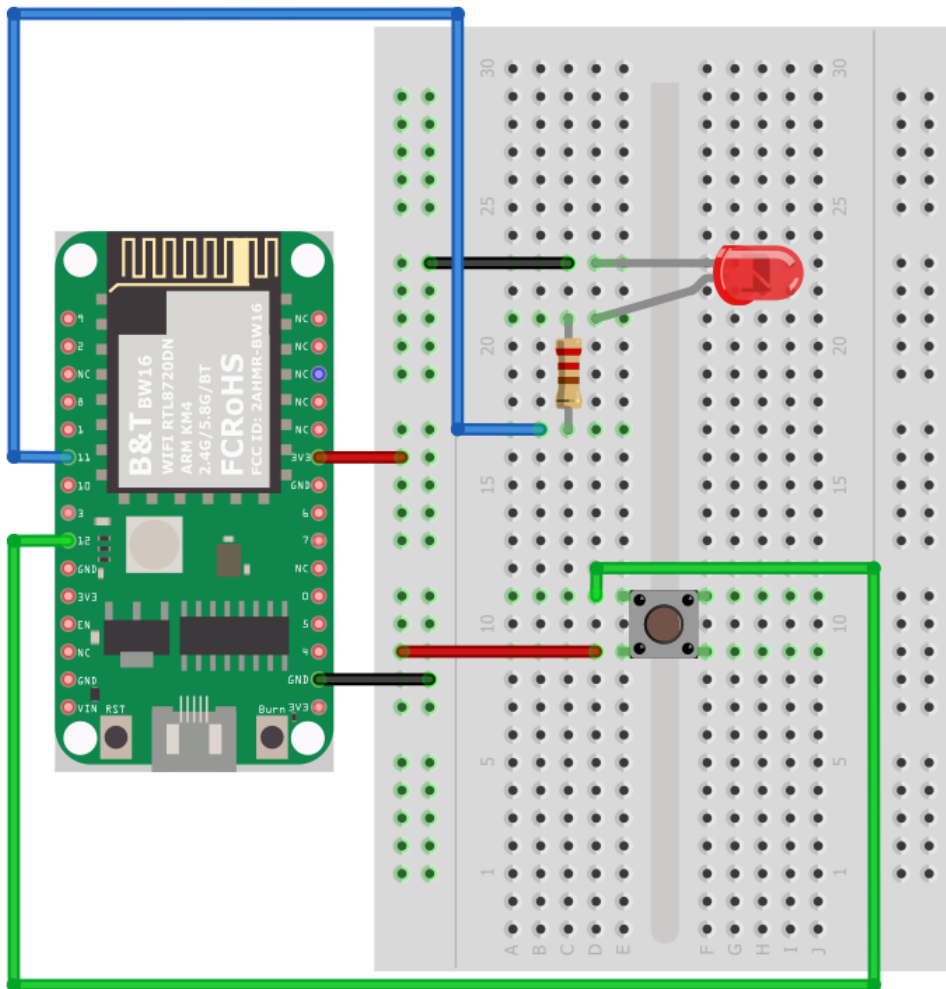


AMB23 Wiring Diagram:



**BW16** Wiring Diagram:





Compile and upload the program, press reset.

The LED lights at first. Press and release the button, then the LED should dim. Press again, then the LED should light.

### Code Reference

In

```
setup()
```

we set Pin 12 to

```
INPUT_IRQ_RISE
```

, this means that an interrupt occurs when the voltage of this pin changes from GND to 3V3. Therefore, we connect the other side of the button to 3V3, so as to trigger interrupt event when the button is pressed.

```
pinMode(button, INPUT_IRQ_RISE);
```

On the other hand, we can set pin 12 to

```
INPUT_IRQ_FALL
```

, this means that an interrupt occurs when the voltage of this pin changes from 3V3 to GND. In this case, the other side of the button is connected to GND. Next, we need to specify the function to be executed to handle the interrupt:

```
digitalSetIrqHandler(button, button_handler);
```

The second parameter is a function pointer, with prototype:

```
void button_handler(uint32_t id, uint32_t event)
```

In this handler, every time we press and release the button, we trigger an interrupt, and change the status of the LED.

## GTimer - Using The Periodic GTimer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

Ameba provides 4 hardware GTimer for users to use. The timers' resolutions are at microseconds scale.

The timer can be set to be periodic or for single use. The periodic timers reset periodically, and the single-use timers do not.

Open the example, "File" -> "Examples" -> "AmebaGTimer" -> "TimerPeriodical".

Compile and upload to Ameba, and press reset.

In the Serial Monitor, you can see the counter value is increased periodically.

## Code Reference

The first argument of `begin()` is the timer id (0~3).

The second argument is the value of the timer (in microseconds). In the example, we fill in  $1000000\text{us} = 1\text{s}$ .

The third argument specifies the function to call when the time is up. In the example, we call the “myhandler” function to increase the counter value by 1 and print the counter value to serial monitor.

```
GTimer.begin(0, 1 * 1000 * 1000, myhandler);
```

The GTimer is periodic by default, therefore “myhandler” function is called every second. When we want to stop the GTimer, use `stop()`:

```
GTimer.stop(0);
```

## GTimer - Using the One-Time Gtimer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

In this example, we will use 4 One-Time GTimer, and pass user data to each timer.

Open the example “File” -> “Examples” -> “AmebaGTimer” -> “TimerOneshot”. Compile and upload to Ameba, and press reset. Then you can see the 4 timer log printed to the serial monitor in series.

## Code Reference

The first argument of `begin()` is the Timer ID (0~3). The second argument is the value of the timer (in microseconds). In the example, we fill in  $1000000\text{us} = 1\text{s}$ . The third argument specifies the function to call when the time is up. The fourth argument is to set whether this timer is a periodic timer, we use “false” here to begin a single-use timer. The fifth argument is the user data, we give 0 here to represent that this is timer 0.

```
GTimer.begin(0, 1 * 1000 * 1000, myhandler, false, 0);
```

Next, we set up the second timer, which has timer value 2 seconds, and user data 1. And other timers are set similarly.

```
GTimer.begin(1, 2 * 1000 * 1000, myhandler, false, 1);
```

In myhandler function, we print the user data to serial monitor. Since the 4 timers are separately set to count for 1, 2, 3, 4 seconds, from 1 second to 4 second, the user data of each timer are printed on the serial monitor in order. After 4 second, no log will be printed.

## I2C - Send Data to Arduino UNO

### Introduction of I2C

There are two roles in the operation of I2C, one is “master” , the other is “slave” . Only one master is allowed and can be connected to many slaves. Each slave has its unique address, which is used in the communication between master and the slave. I2C uses two pins, one is for data transmission (SDA), the other is for the clock (SCL). Master uses the SCL to inform slave of the upcoming data transmission, and the data is transmitted through SDA. The I2C example was named “Wire” in the Arduino example.

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Arduino UNO x 1

### Example

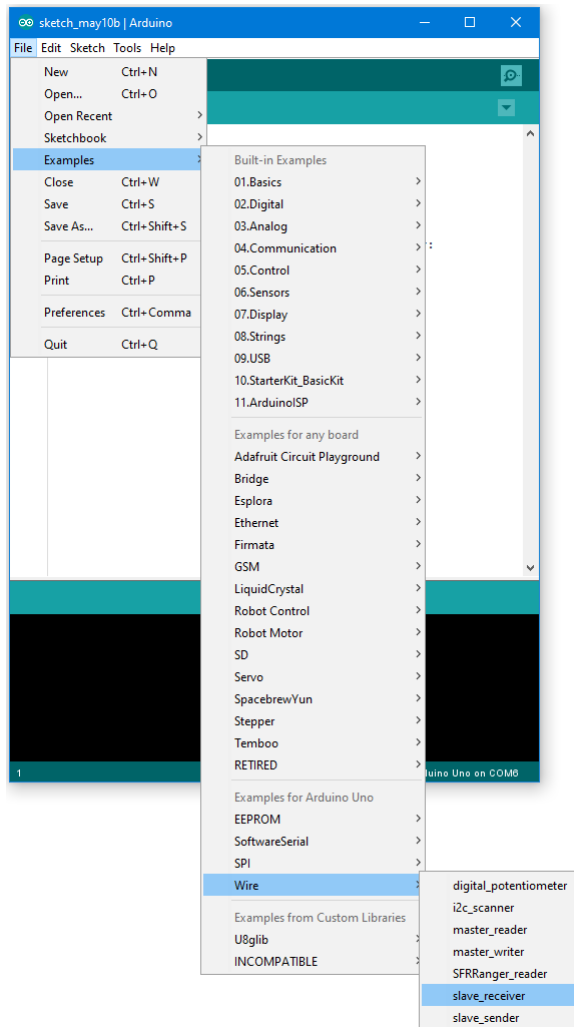
In this example, we use Ameba as the I2C master writer, and use Arduino as the I2C slave receiver.

When the I2C slave receives string sent from I2C master, it prints the received string.

- Setting up Arduino Uno to be I2C Slave

First, select Arduino in the Arduino IDE in “Tools” -> “Board” -> “Arduino Uno”

Open the “Slave Receiver” example in “Examples” -> “Wire” -> “slave\_receiver” :



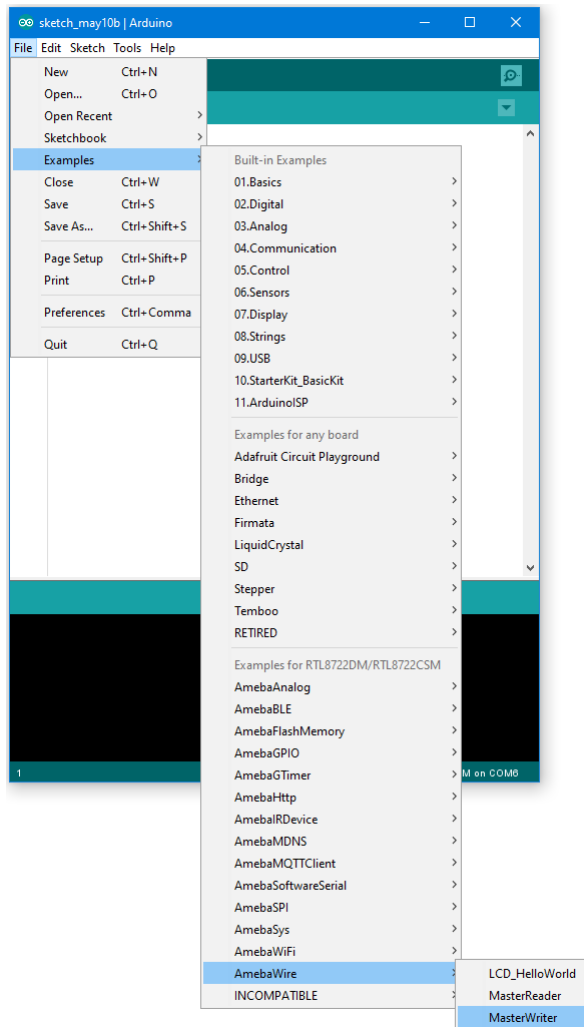
Then click “Sketch” -> “Upload” to compile and upload the example to Arduino Uno.

- Setting up Ameba to be I2C Master

Next, open another window of Arduino IDE, make sure to choose your Ameba development board in the IDE:

“Tools” -> “Board”

Then open the “Master Writer” example in “File” -> “Examples” -> “AmebaWire” -> “MasterWriter”

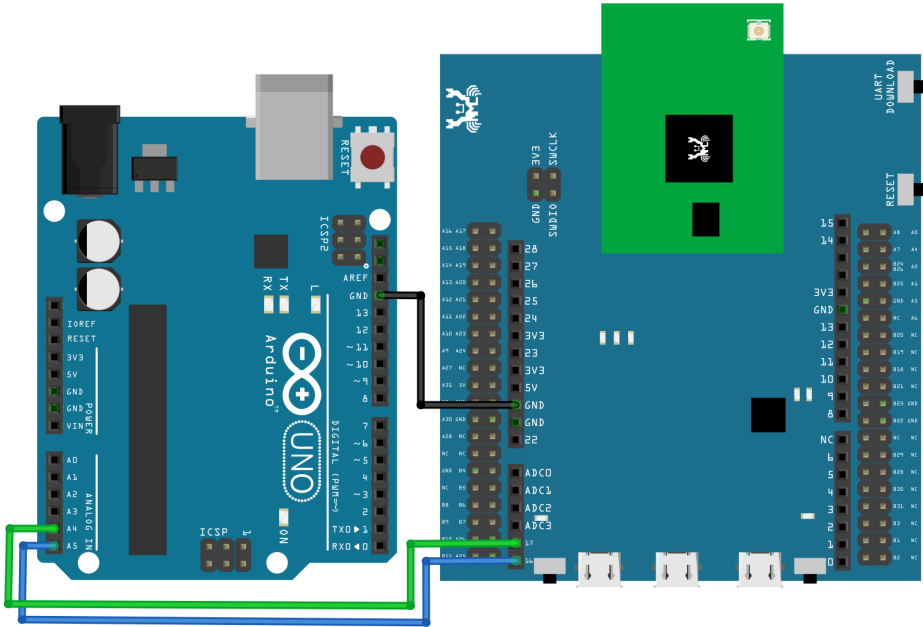


- Wiring

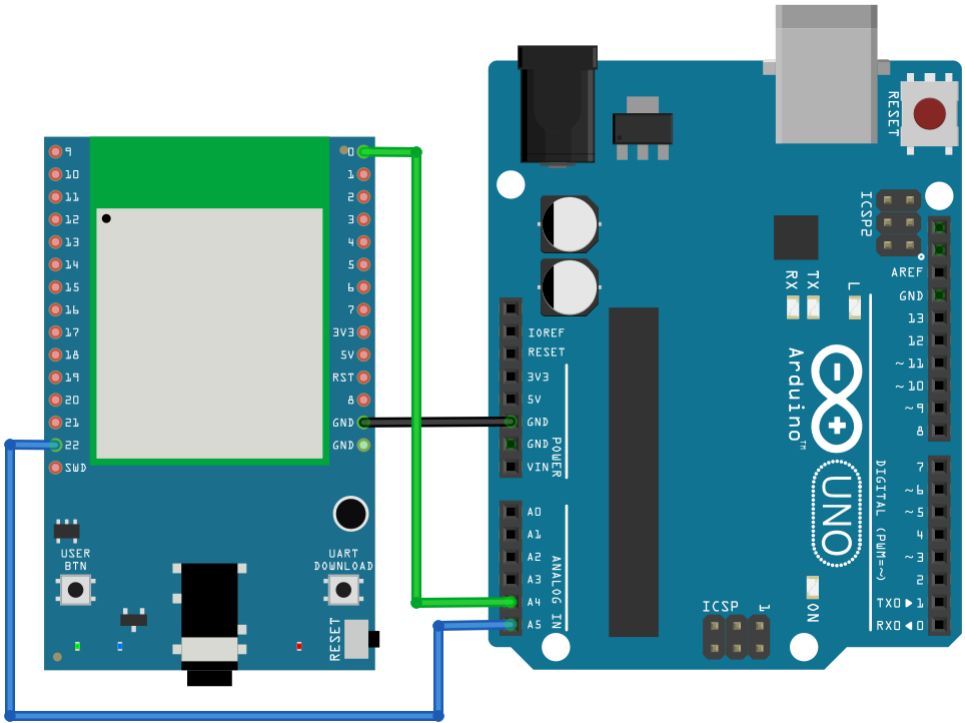
The Arduino example uses A4 as the I2C SDA and A5 as the I2C SCL.

Another important thing is that the GND pins of Arduino and Ameba should be connected to each other.

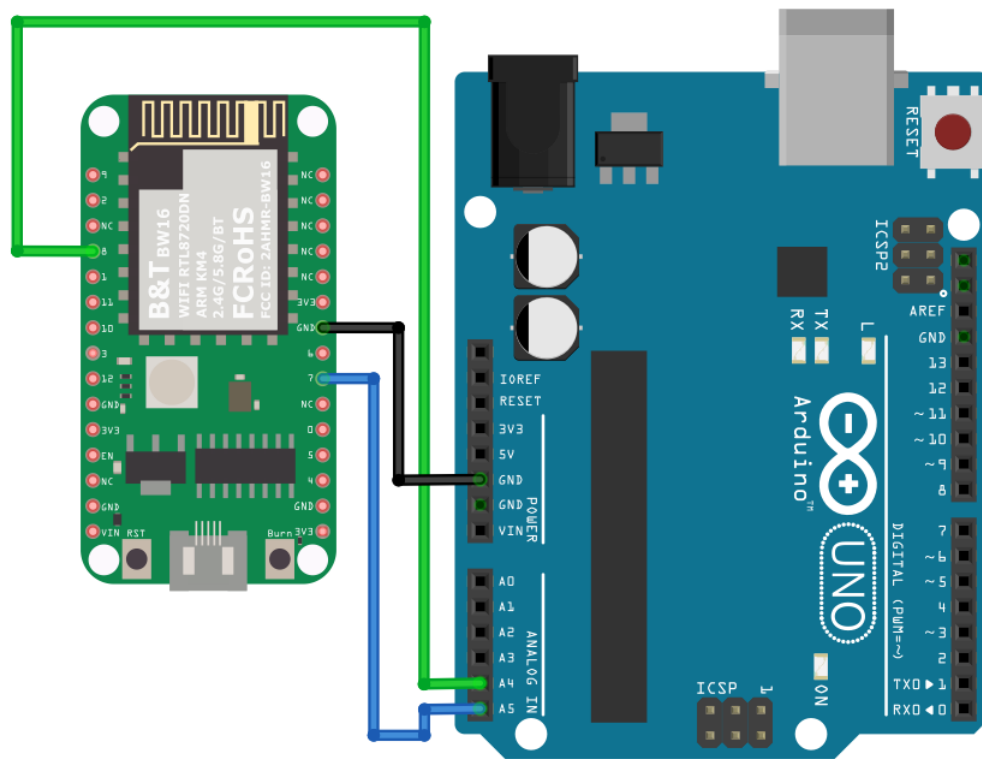
**AMB21/ AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



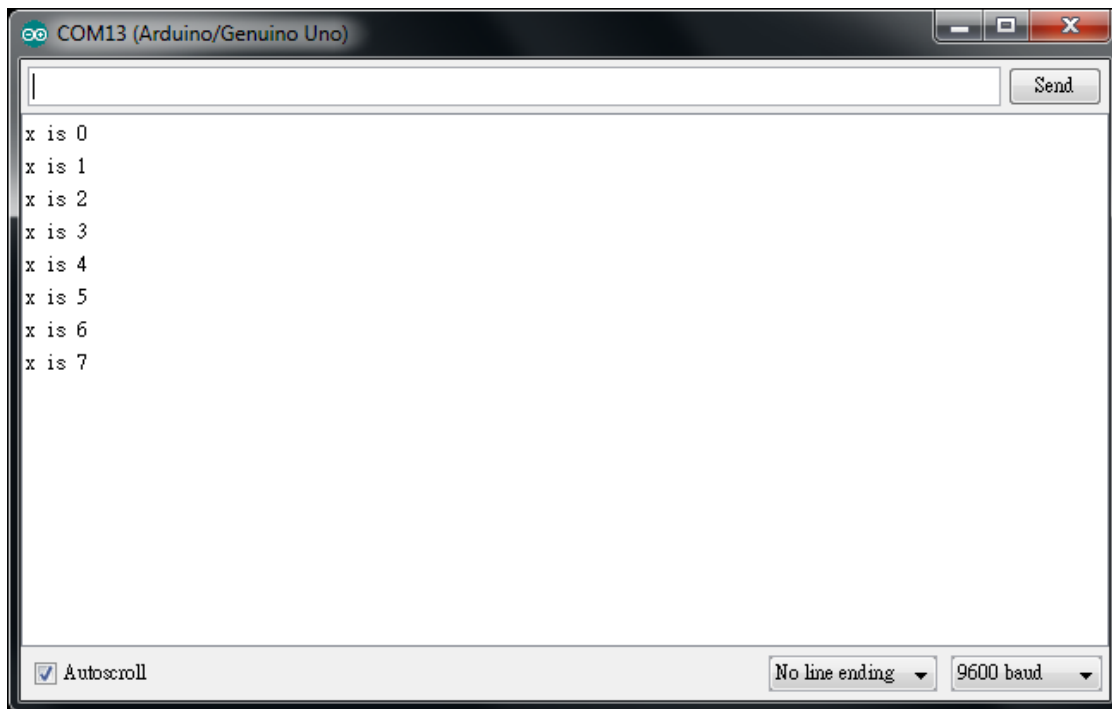
Open the Arduino IDE of the Arduino Uno and open the serial monitor ( “Tools” -> “Serial Monitor” ).

In the Serial Monitor, you can see the messages printed from Arduino Uno.

Next, press the reset button on Arduino Uno. Now the Arduino Uno is waiting for the connection from I2C Master.

We press the reset button on Ameba to start to send messages. Then observe the serial monitor, you can see the messages show up every half second.





## Code Reference

You can find detailed information of this example in the documentation of Arduino:

<https://www.arduino.cc/en/Tutorial/MasterWriter>

First use `Wire.begin()/Wire.begin(address)` to join the I2C bus as a master or slave, in the Master case the address is not required.

<https://www.arduino.cc/en/Reference/WireBegin>

Next, the Master uses `Wire.beginTransmission(address)` to begin a transmission to the I2C slave with the given address:

<https://www.arduino.cc/en/Reference/WireBeginTransmission>

Uses `Wire.write()` to send data, and finally use `Wire.endTransmission()` to end a transmission to a Slave and transmits the bytes that were queued:

<https://www.arduino.cc/en/Reference/WireEndTransmission>

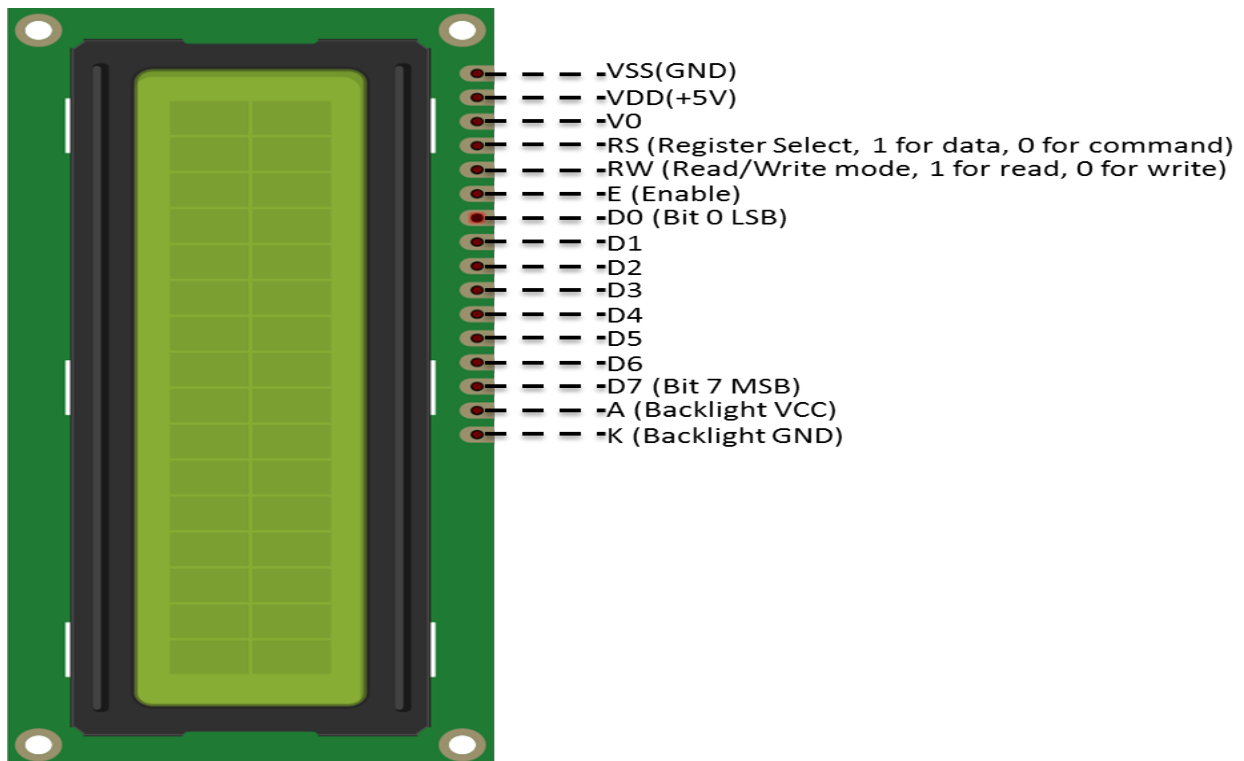
## I2C - Display Data On LCD Screen

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- I2C 2×16 LCD

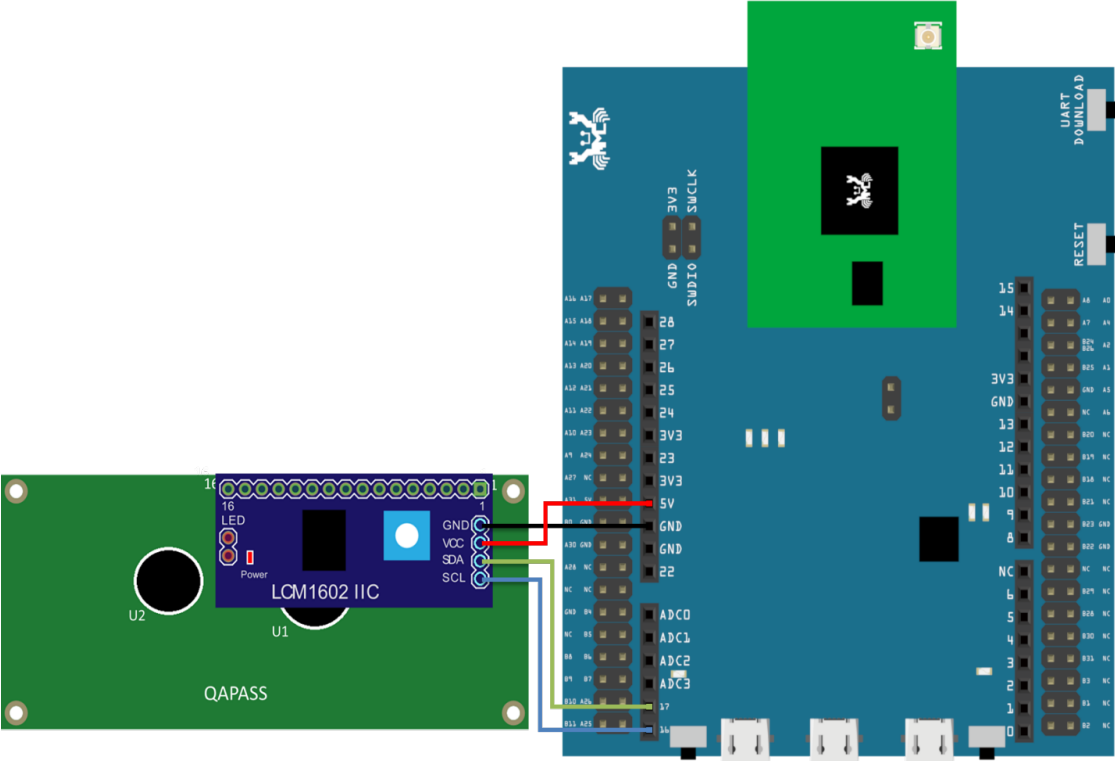
### Example

Normally there are many pins on an LCD display, as shown in below figure.

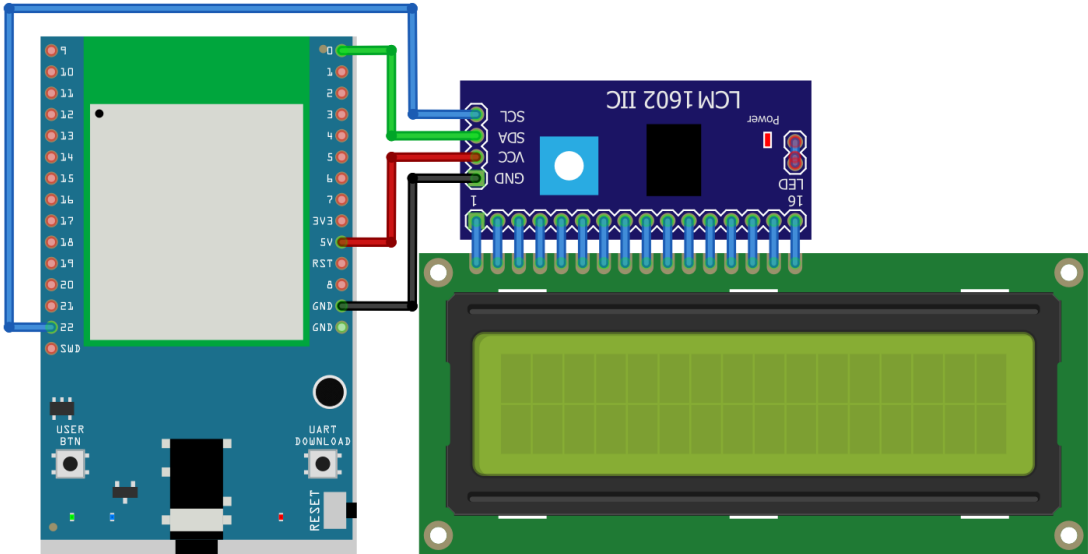


An LCD display can be equipped with an additional processing chip to process the data. The processing chip can connect to a microcontroller using the I2C interface.

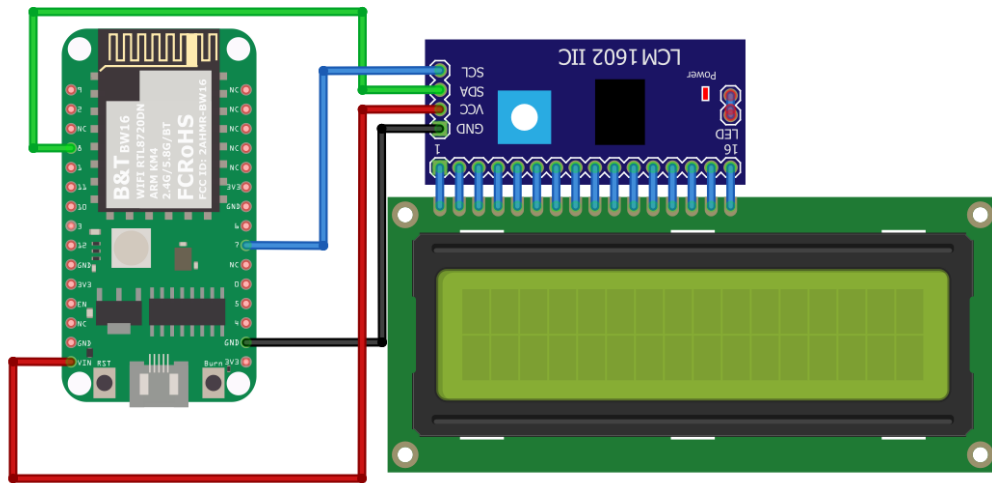
**AMB21 / AMB22 Wiring Diagram:**



AMB23 Wiring Diagram:



BW16 Wiring Diagram:



Open the example in “File” -> “Examples” -> “AmebaWire” -> “LCD\_HelloWorld” .

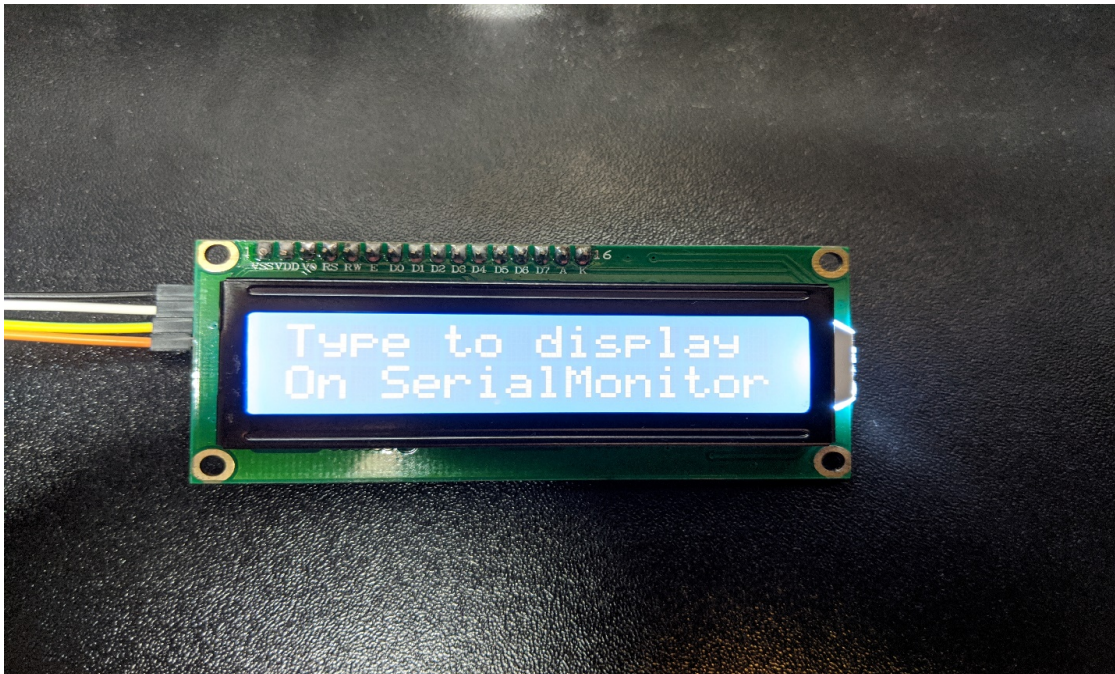
Compile and upload to Ameba, then press the reset button.

Then you can see “Hello World” in the first line, and “Ameba” in the second line displayed on the LCD screen.



After 8 seconds, you can input to the Serial Monitor the string you would like to display on the LCD.





For example, we enter “123456789” and press “Send” :



### Code Reference

The required settings of each model of LCD might be different, the constructor we use in this example is:

```
LiquidCrystal_I2C(uint8_t lcd_Addr, uint8_t En, uint8_t Rw, uint8_t Rs,  
                  uint8_t d4, uint8_t d5, uint8_t d6, uint8_t d7,
```

(繼續下一頁)

(繼續上一頁)

```
uint8_t backlighPin, t_backlighPol pol);
```

And the setting parameters are as follows:

```
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE); // Set the LCD I2C  
↪address
```

The first parameter 0x27 is the address of I2C. Each of the following 8 parameters represents the meaning of each bit in a byte, i.e., En is bit 2, Rw is bit 1, Rs is bit 0, d4 is bit 4, and so forth.

Call `backlight()` to light the screen,

Call `setCursor(0, 0)` to set the position of the cursor.

LCD inherits the `Print` class, so we can use `lcd.print()` to output string on the screen.

## I2C - Receive Data from Arduino UNO

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Arduino UNO x 1

### Example

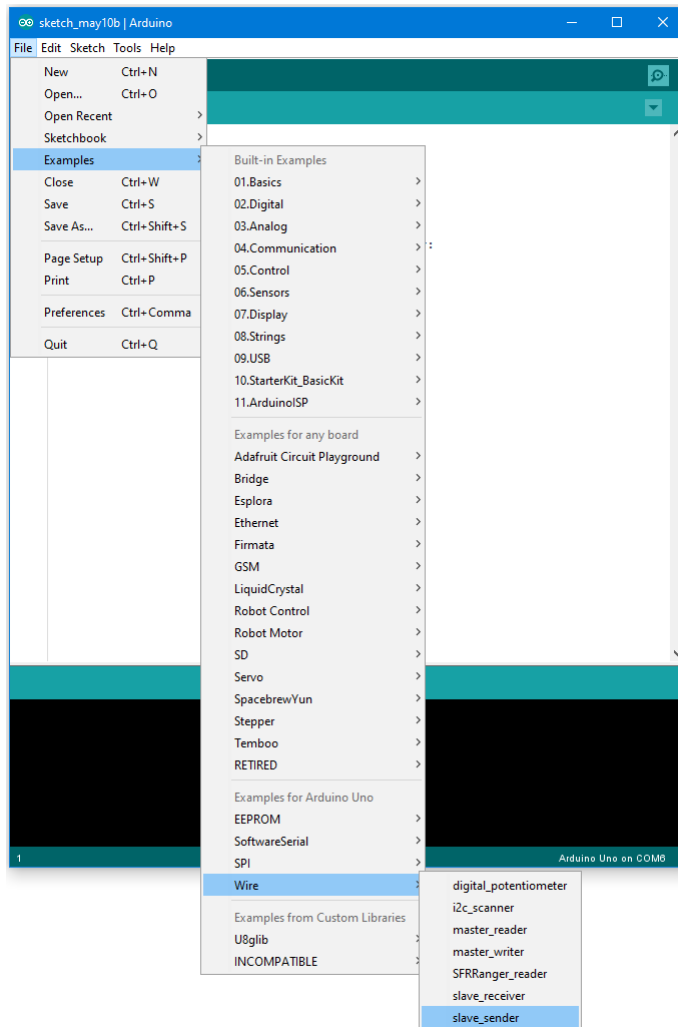
In the previous example “[I2C –Communicate with Arduino UNO via I2C](#)”, Ameba, the I2C master, transmits data to the Arduino UNO, the I2C slave.

As to this example, Ameba is the I2C master, and receives data from the Arduino UNO, which is the I2C slave.

- **Setting up Arduino Uno to be I2C Slave**

First, select Arduino in the Arduino IDE in “Tools” -> “Board” -> “Arduino Uno” :

Open “Examples” -> “Wire” -> “slave\_sender”

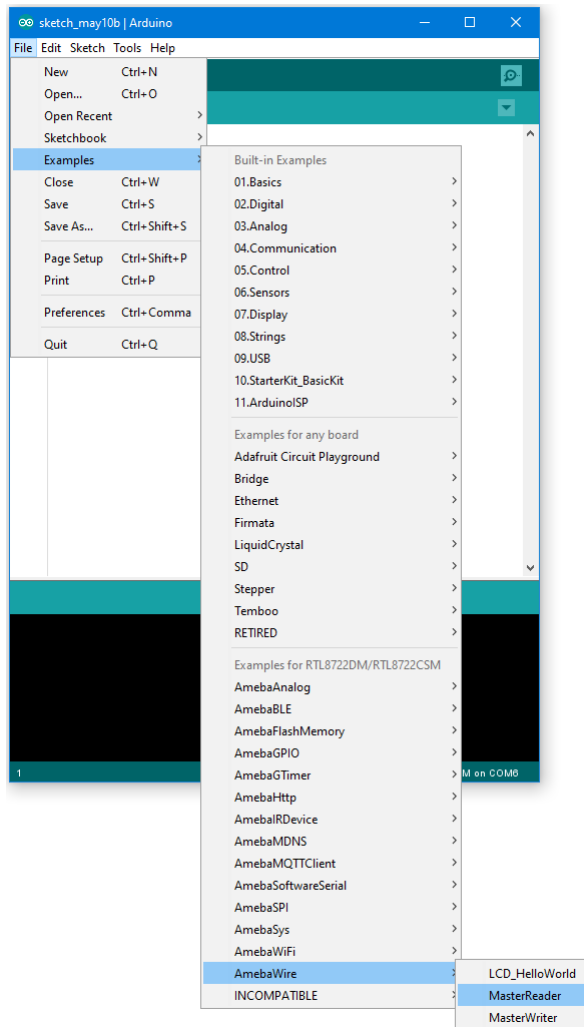


Then click “Sketch” -> “Upload” to compile and upload the example to Arduino Uno.

- **Setting up Ameba to be I2C Master**

Next, open another window of Arduino IDE, make sure to choose your Ameba development board in the IDE: “Tools” -> “Board”

Open “File” -> “Examples” -> “AmebaWire” -> “MasterReader”



Click “Sketch” -> “Upload” to compile and upload the example to Ameba.

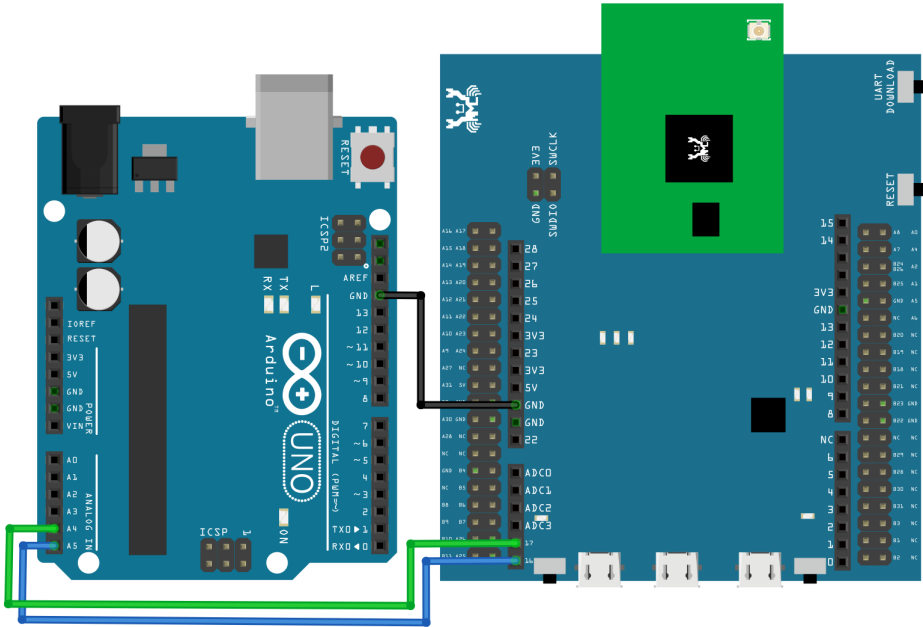
- **Wiring**

The Arduino example uses A4 as the I2C SDA and A5 as the I2C SCL.

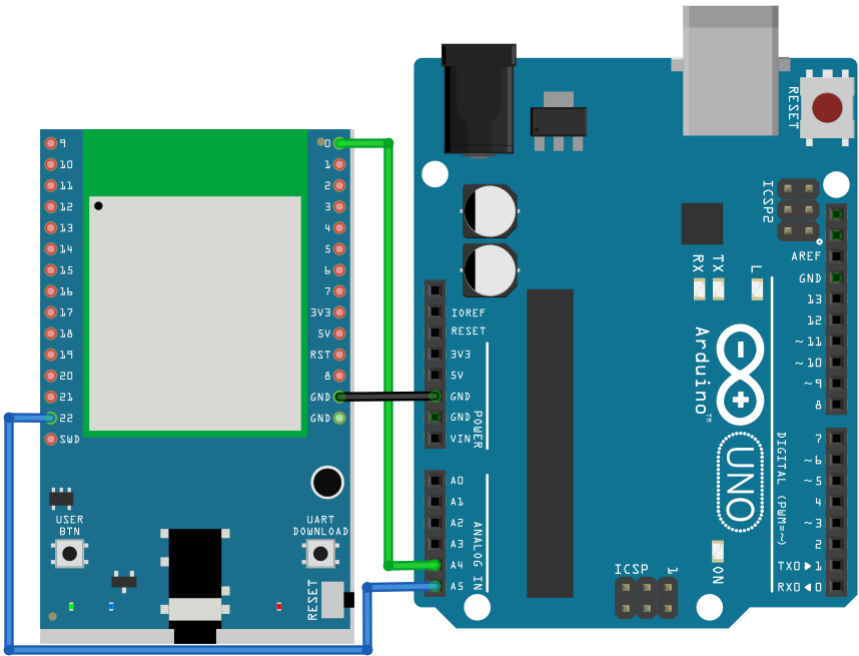
Another important thing is that the GND pins of Arduino and Ameba should be connected to each other.

**AMB21 / AMB22 Wiring Diagram:**

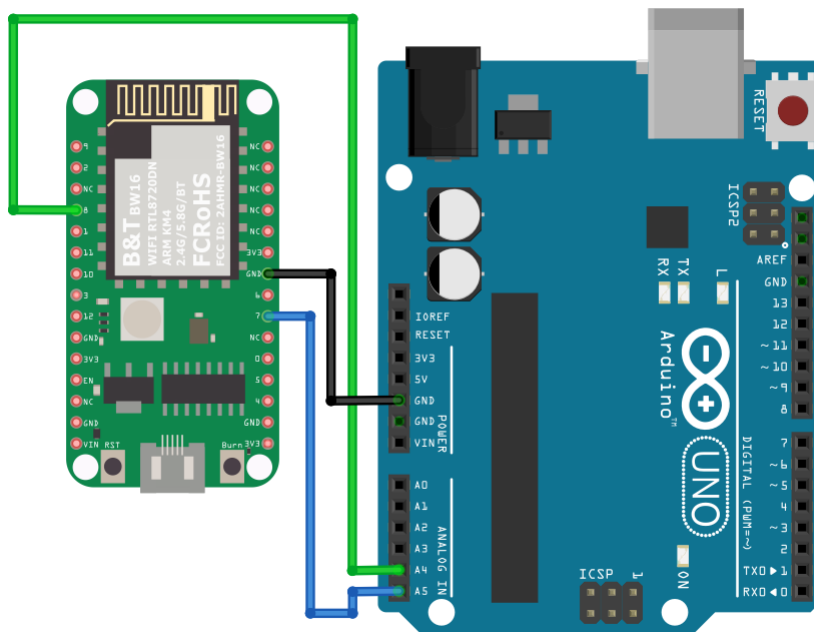




AMB23 Wiring Diagram:

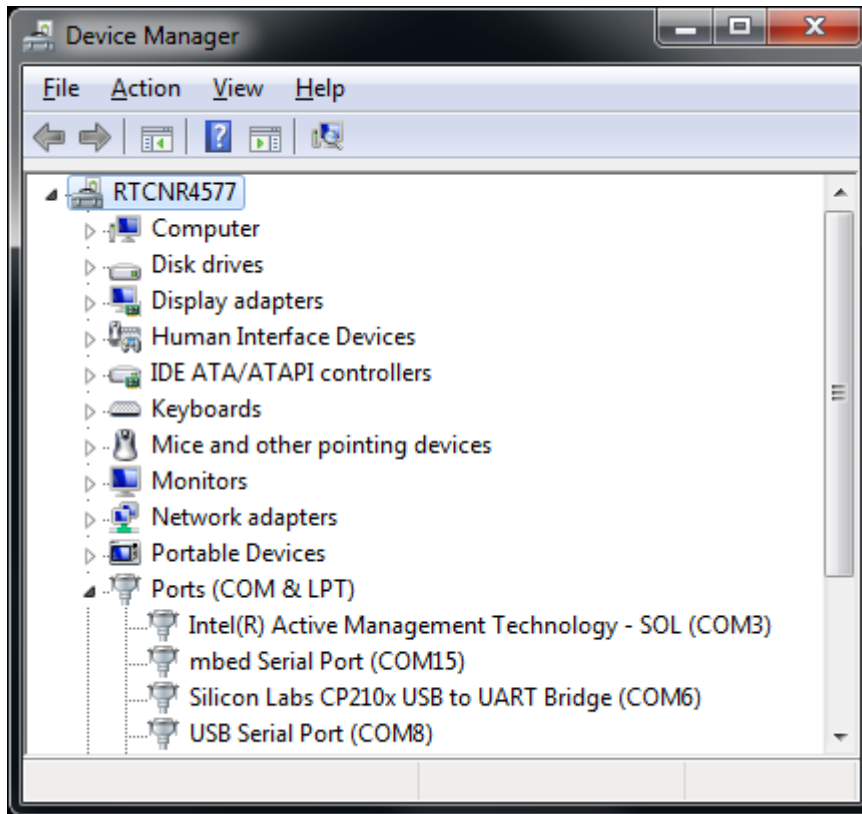


BW16 Wiring Diagram:



Next, we will observe the data receive by Ameba in the Serial Monitor.

(Note: If you do not know which port the Ameba development board is connected to, please find it in the Device Manager of Windows first. Ameba is connected as “mbed Serial Port” . For example, if you find mbed Serial Port (COM15) means Ameba is connected to port COM15.)



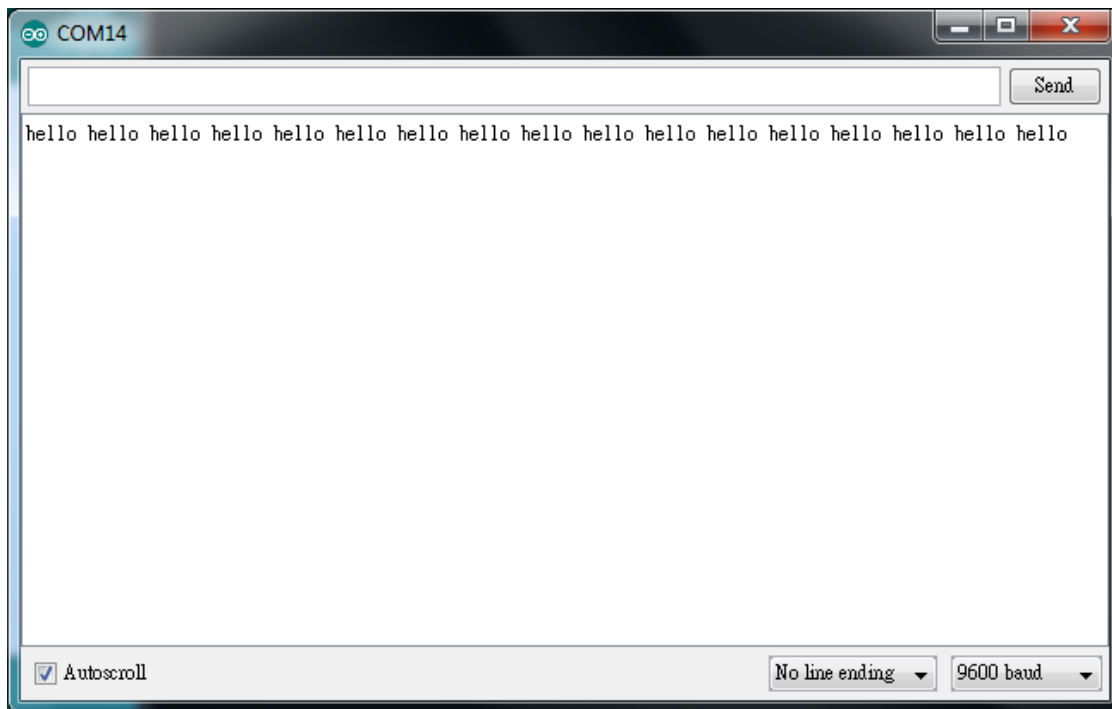
We select the port in “Tools” -> “Port” -> “COM15” (the port connected to Ameba)

Open the Arduino IDE window of the Ameba, go to “Tools” -> “Serial Monitor” to display the messages printed by Ameba.

Press the reset button on Arduino Uno, Arduino Uno now waits for connection from I2C master.

Then press the reset button on Ameba, Ameba will start to receive messages from Arduino Uno. And you can see the “hello ” message printed every half second in serial monitor.

(NOTE: If the message does not show in the Serial Monitor of Ameba, please close and open the serial monitor again.)



## Code Reference

You can find detailed information of this example in the documentation of Arduino:

<https://www.arduino.cc/en/Tutorial/MasterReader>

First use `Wire.begin()` / `Wire.begin(address)` to join the I2C bus as a master or slave, in the Master case the address is not required.

<https://www.arduino.cc/en/Reference/WireBegin>

Next, the Master uses `Wire.requestFrom()` to specify from which Slave to request data.

<https://www.arduino.cc/en/Reference/WireRequestFrom>

## IR - Transmit IR NEC Raw Data And Decode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16 ] x 2
- Grove –Infrared Emitter x1 (Figure 1)
- Grove –Infrared Receiver x1 (Figure 2)

### Example

In this example, we use two Ameba RTL8722 modules that connecting with an infrared (IR) Emitter and an IR Receiver separately to transmit and receive IR NEC Raw data.



Figure 1: Grove –Infrared Receiver

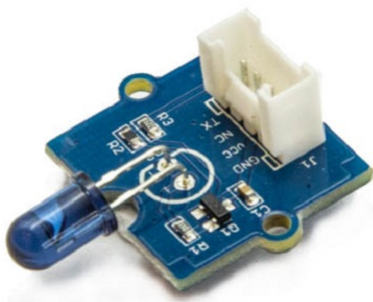


Figure 2: Grove –Infrared Emitter

On the transmission side, the transmitter will send IR NEC raw data. The raw data can be seen as consecutive durations of “marks” and “spaces” (Figure 3) in microseconds (us).

- Mark: a specific period of sending pulses
- Space: a specific period of sending nothing

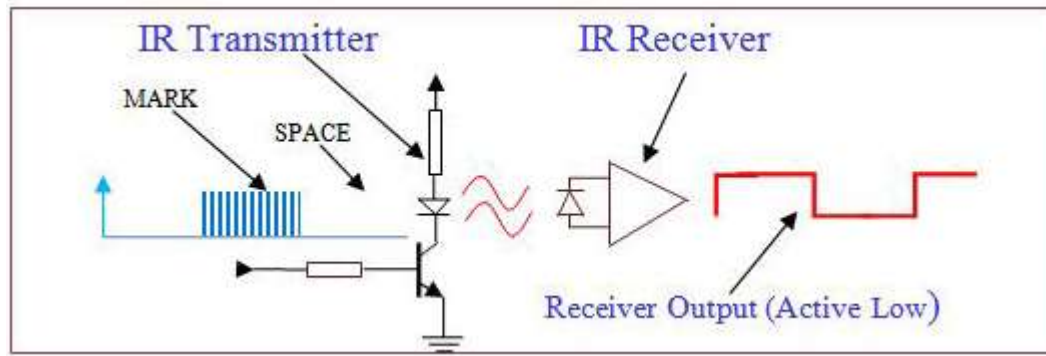


Figure 3: A typical IR transmission and reception setup implementation

For more details, please refer to SB-Projects' topic of [IR Remote Control Theory](#) to learn the theory of IR remote controls operation and a collection of IR protocol descriptions. In this example, we are going to use NEC (Now Renesas, also known as Japanese Format) as the transmission protocol.

### NEC Features

- 8-bit address and 8-bit command length.
- Extended mode available, doubling the address size.
- Address and command are transmitted twice for reliability.
- Pulse distance modulation.
- The carrier frequency of 38kHz.
- Bit time of 1.125ms or 2.25ms.

### Modulation

NEC protocol uses Pulse Distance Encoding of the bits for data communication (Figure 4). A logical "1" is represented by total duration of 2250us, with 560us of "marks" and (2250-560) us of "spaces". While logical "0" is represented by total duration of 1120us, with 560us "marks" and (1120-560) us of "spaces".

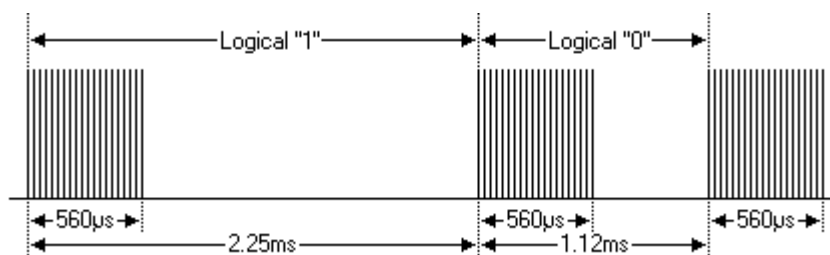


Figure 4: Modulation of NEC

Since a total number of 32-bit data together with the header and the end-bit will be transferred (Figure 5). If we separate the data in the time-frame (in us), there will be  $(2 + 32) \times 2 + 1 = 69$  “marks” / “spaces” to be transmitted (Figure 6), which forms the raw NEC data we would like to transmit in our Arduino “\*.ino” file. This part of the code can be modified by users. Details of how to obtain raw data code for your remote devices, you may refer to [Ken Shirriff’s blog](#), where it provides multiple libraries provided online.

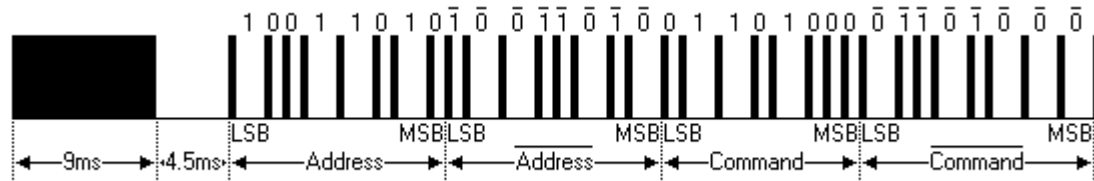


Figure 5: Sample of a Full NEC Data (in logic1 or 0)

```

9000, 4500, // starting bit
560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, 560, // address
560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, // ~address
560, 560, 560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, // data
560, 1690, 560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, //~data
560 // stoping bit

```

Figure 6: Sample of a Full NEC RAW Data (in us)

Figure 7 and 8 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8722 board.

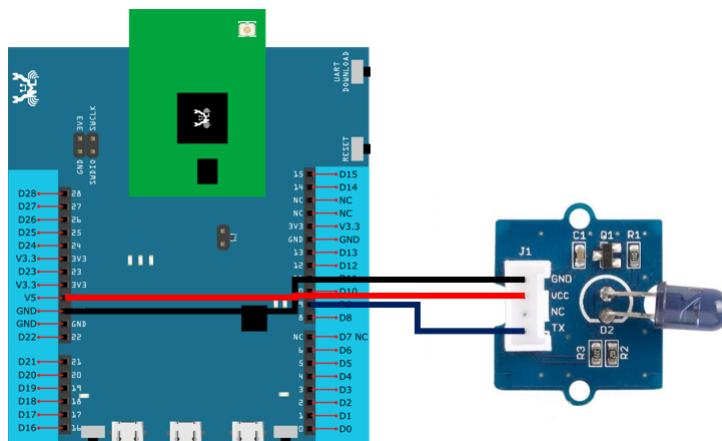


Figure 7: Pin configuration of IR Emitter and AMB21/AMB22

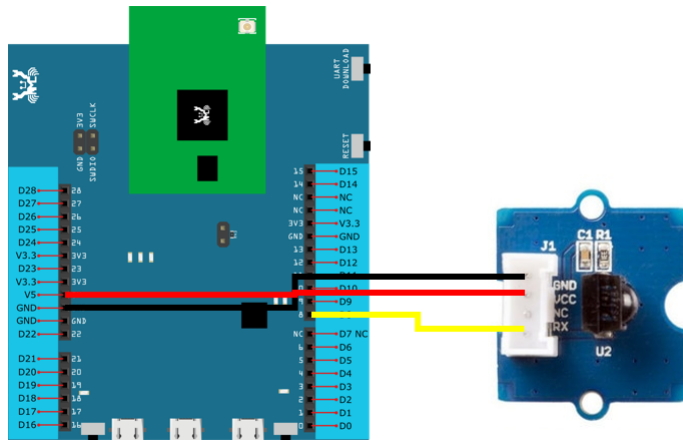


Figure 8: Pin configuration of the IR Receiver and Ameba RTL8722

Figure 9 and Figure 10 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8722DM MINI.

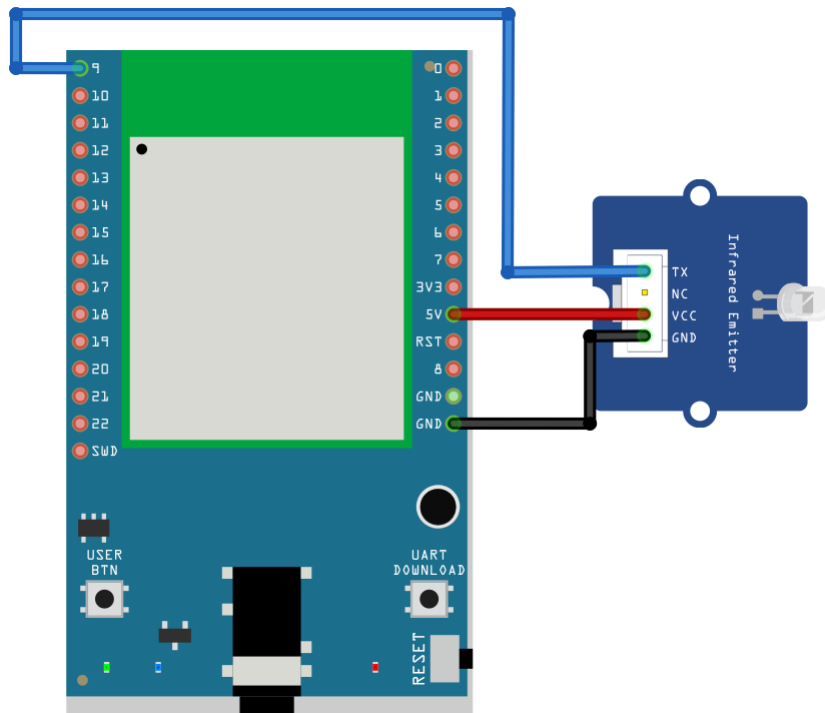


Figure 9: Pin configuration of IR Emitter and AMB23



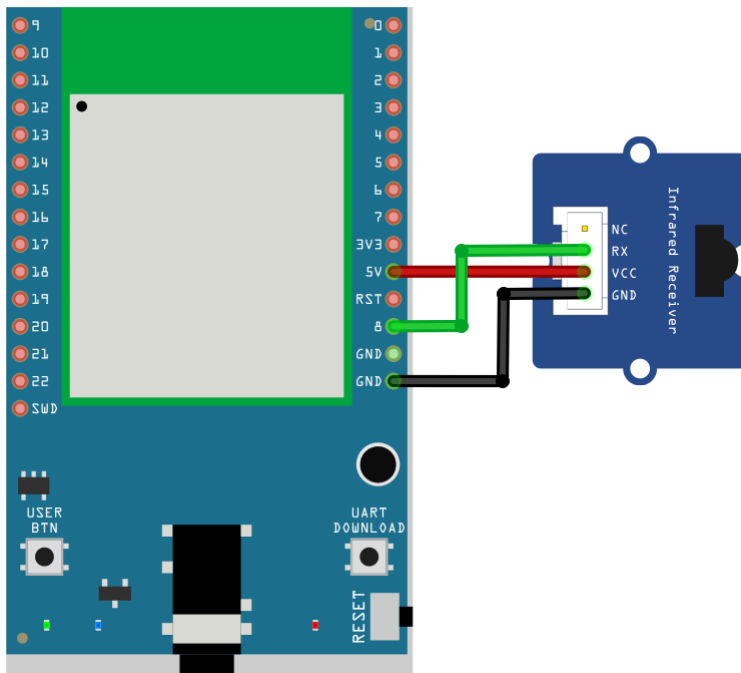


Figure 10: Pin configuration of the IR Receiver and AMB23

Figure 11 and Figure 12 shows the pin configuration of IR Emitter and Receiver with Ameba RTL8720DN (BW16).

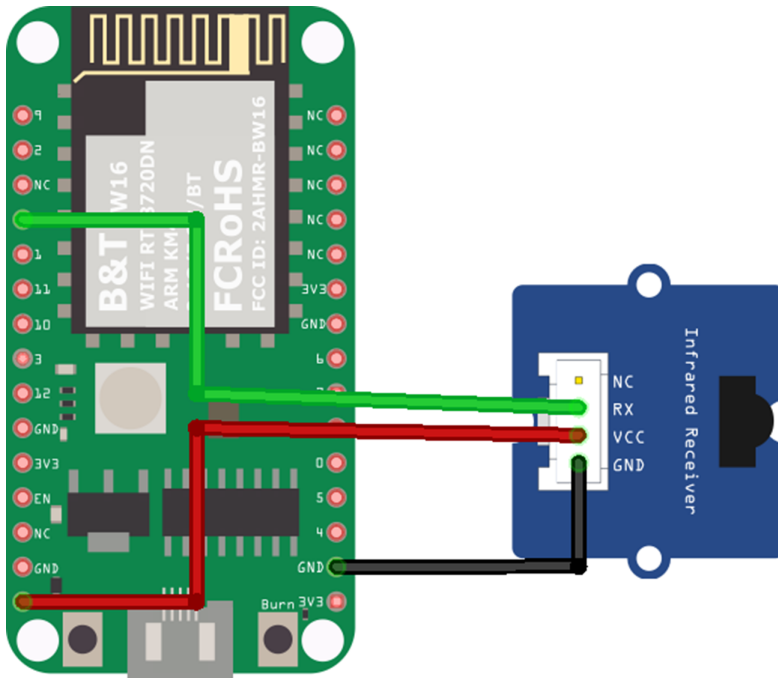


Figure 11: Pin configuration of IR Emitter and BW16

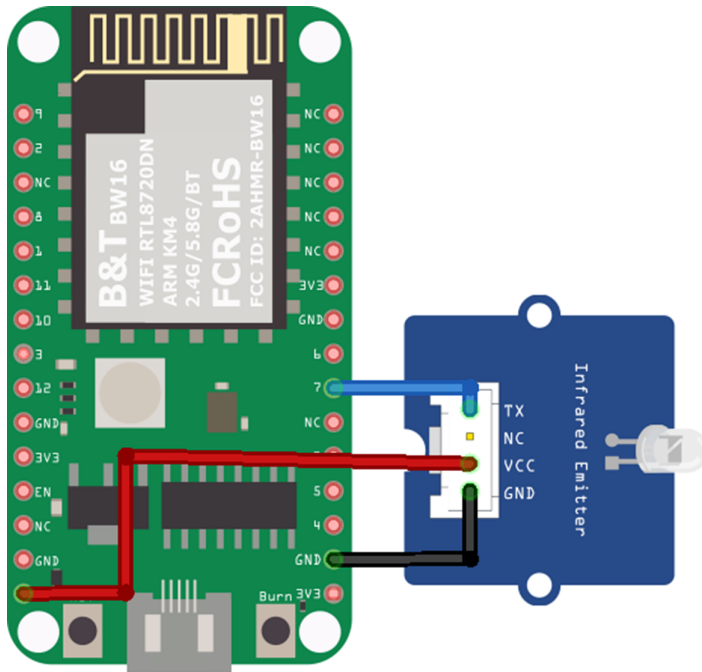


Figure 12: Pin configuration of IR Receiver and BW16

After the connection is being set up correctly, we will move to the coding part for this example. First, make sure the correct Ameba development board is selected in Arduino IDE: “Tools” -> “Board” .

Open the “IRSendRAW” example in “File” -> “Examples” -> “AmebaIRDevice” -> “IRSendRAW” (Figure 11) and upload to 1st board connected with IR Emitter:

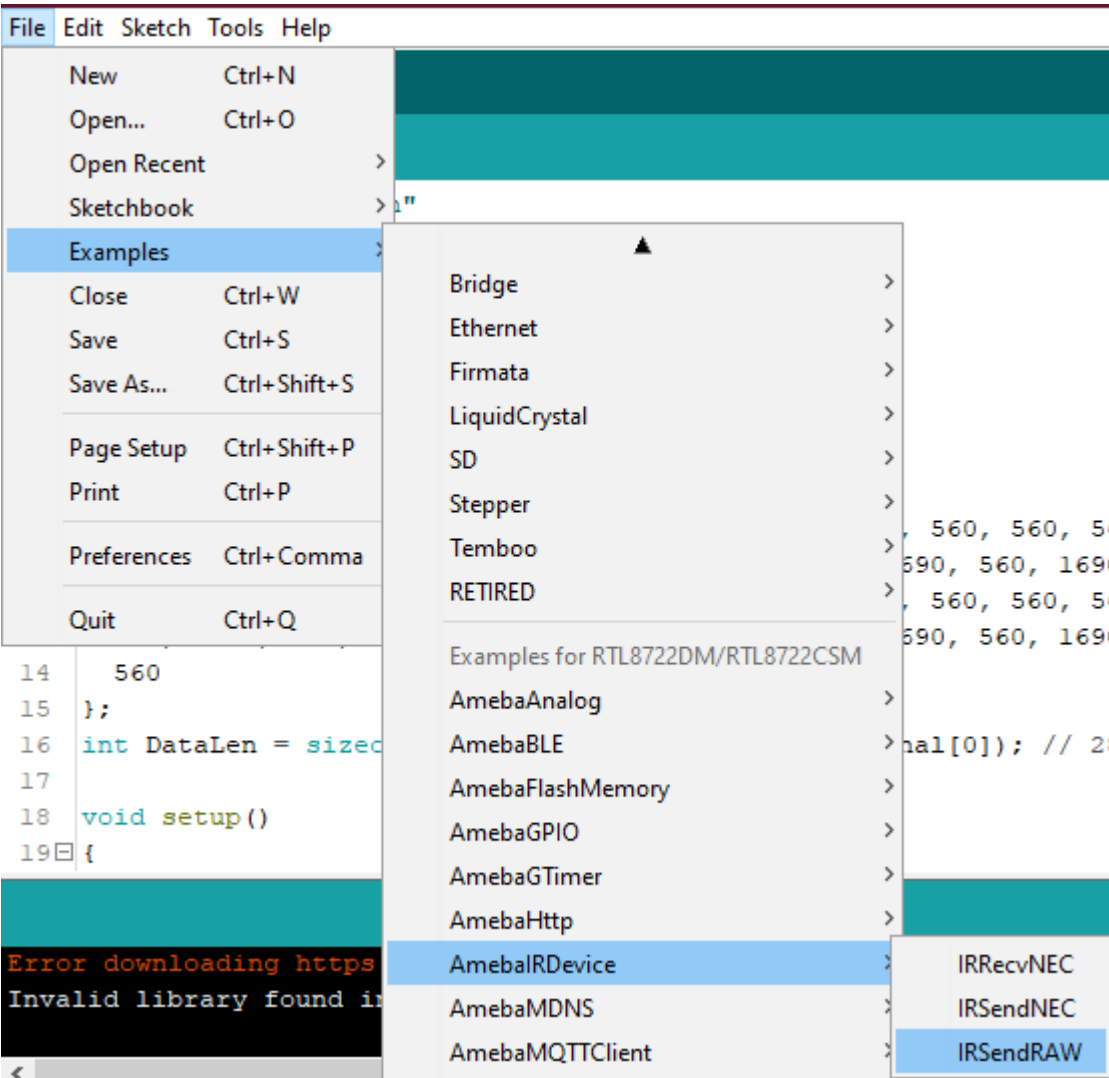


Figure 13: Example Location of IRSendRaw and IRRecvNEC

After successfully upload the sample code for IRSendRaw, you might need to upload the IRRecvNEC example for the 2nd board connected with IR Receiver from “File” -> “Examples” -> “AmebaIRDevice” -> “IRRecvNEC” .

After opening the serial monitor on the IR Receiver side and press the reset buttons on two boards, the data “48” will be received every 3 seconds (due to the delays () function, not compulsory to wait). After decoding the signal from the receiving Pin D8 and transmitting Pin D9 with Logic Analyser and Pulse View (Figure 10), the result is also shown as “48” after decoding the receiving data with IR NEC Protocol.

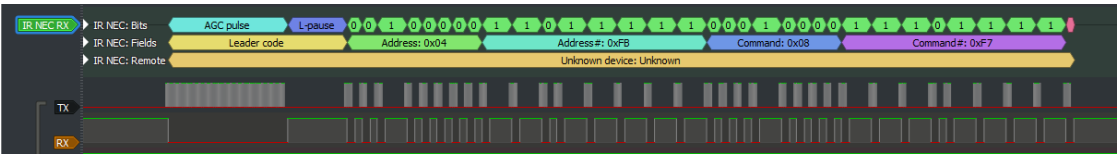


Figure 14: Pulse View results from sending and receiving pin

## Code Reference

[1] Seeed Official website for Grove –Infrared Receiver

[https://wiki.seeedstudio.com/Grove-Infrared\\_Receiver/](https://wiki.seeedstudio.com/Grove-Infrared_Receiver/)

[2] Seed Official website for Grove –Infrared Emitter

[https://wiki.seeedstudio.com/Grove-Infrared\\_Emitter/](https://wiki.seeedstudio.com/Grove-Infrared_Emitter/)

[3] Ken SHirriff’ s blog on A Multi-Protocol Infrared Remote Library for the Arduino

<http://www.rightho.com/2009/08/multi-protocol-infrared-remote-library.html>

[4] SB-Projects: IR Remote Control Project

<https://www.sbprojects.net/knowledge/ir/index.php>

## Power Save - Deep Sleep Mode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

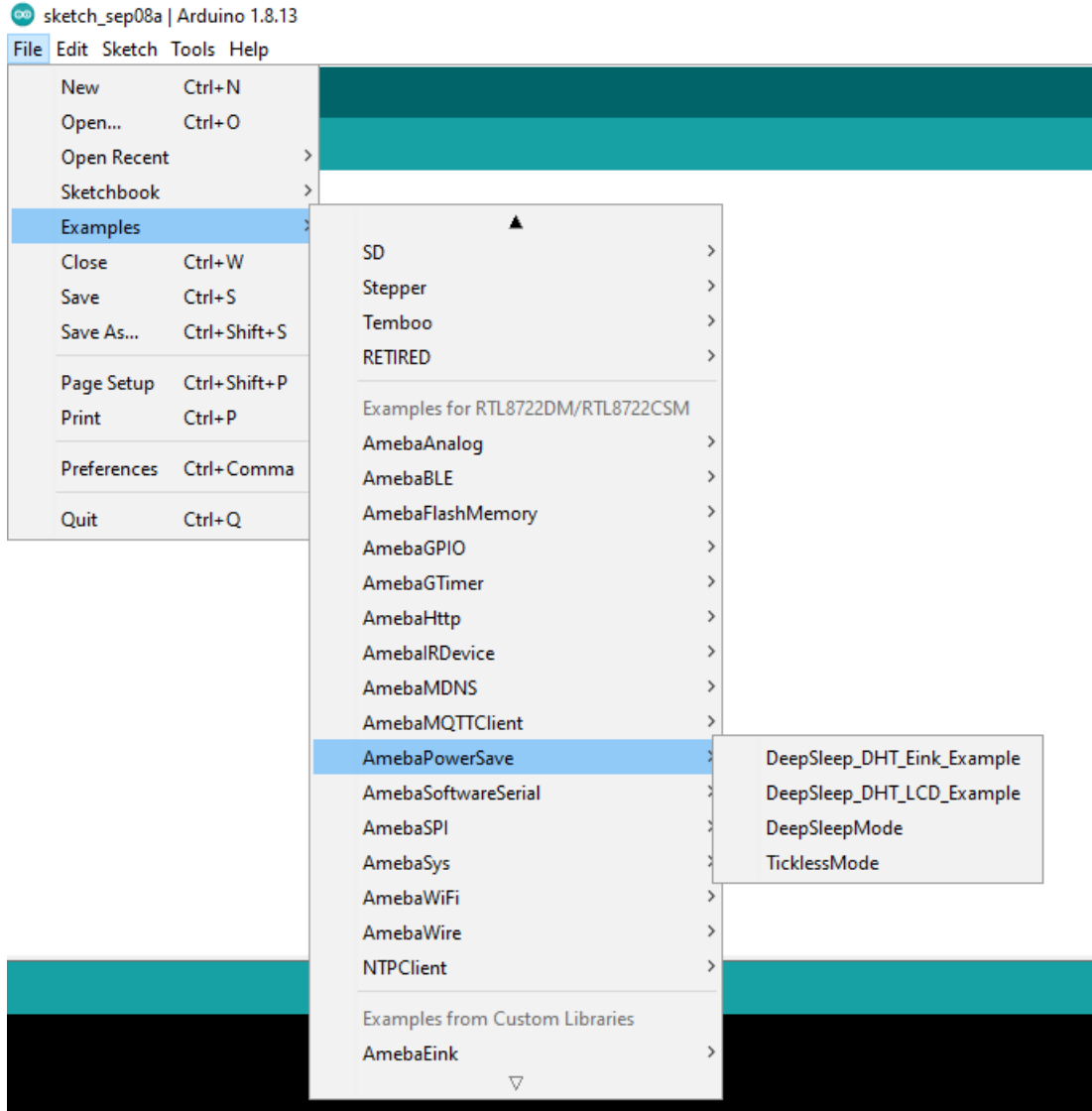
### Example

#### Introduction

Ameba-D supports 2 low power modes which are deepsleep mode and sleep mode. Deep Sleep mode turns off more power domain than sleep mode. The power consumption of Deep Sleep mode is around 7 $\mu$ A to 8 $\mu$ A as compared to normal state which is around 22mA. This example describes how to enter Deep Sleep mode and configure the wakeup source

#### Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleepMode”



Set condition values as picture below.

“DS\_WAKEUP\_SOURCE” is used to set the wake-up source, user can chose 3 wake up sources now,

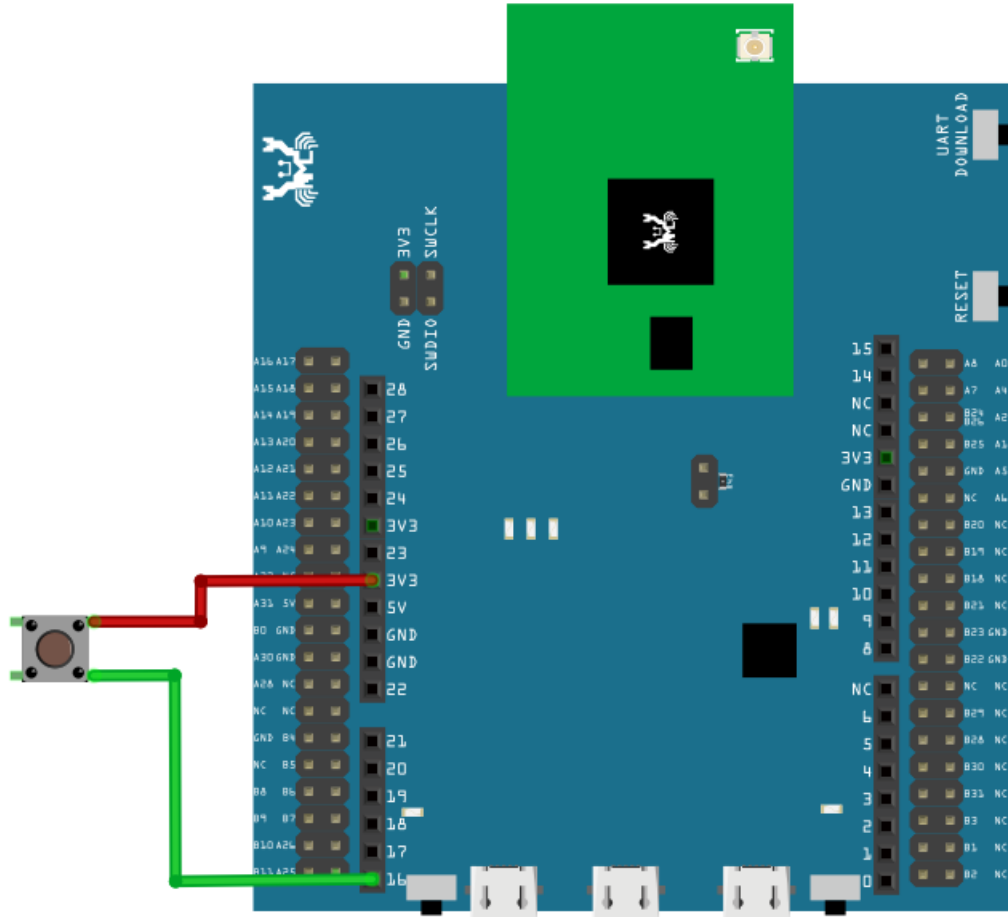
```
AON Timer (SET_DS_AON_TIMER_WAKEUP);
AON GPIO pins (SET_AONWAKEPIN_WAKEUP);
RTC Timer (SET_DS_RTC_WAKEUP);
```

### Using AON Timer as wakeup source

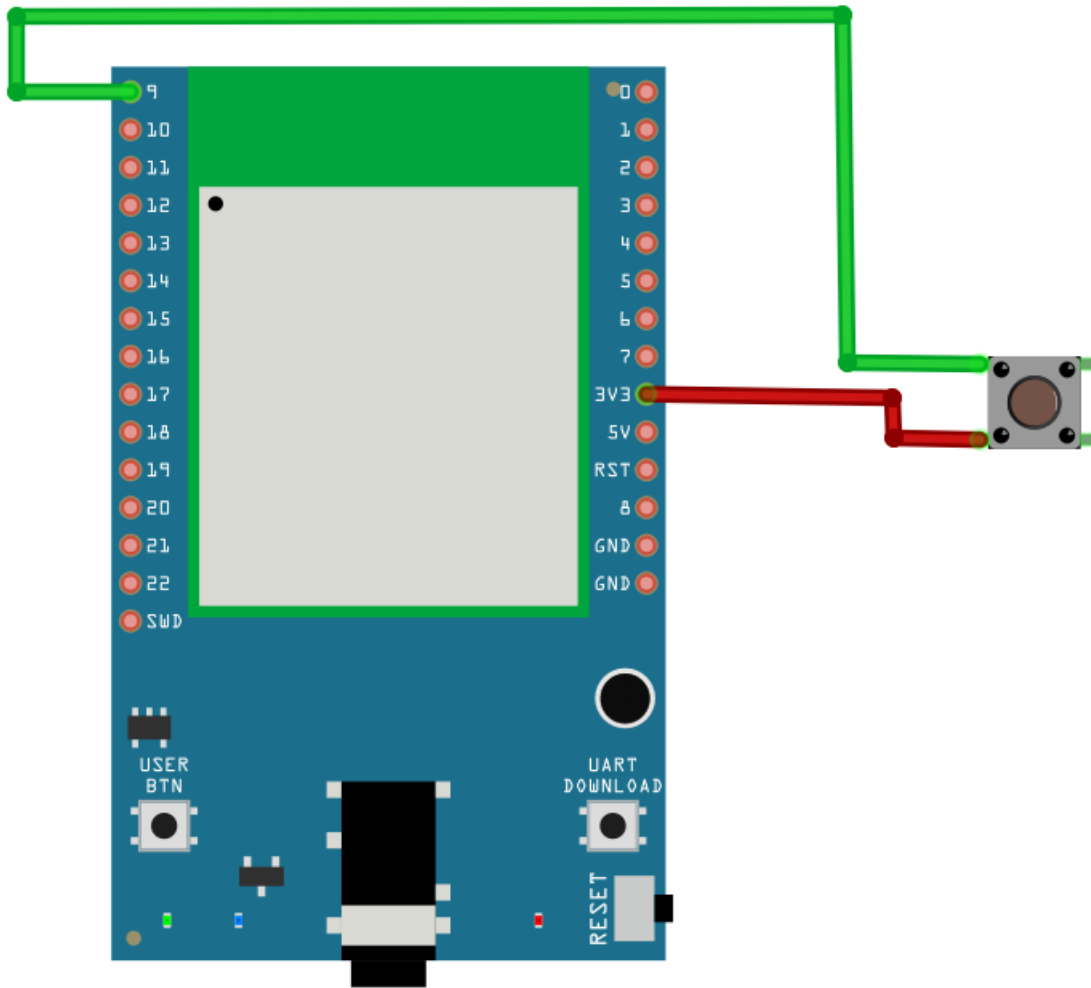
AON Timer can be set from 0 to 32760000ms range by AON\_TIMER\_SLEEP\_DURATION

### Using AON GPIO pins as wakeup source

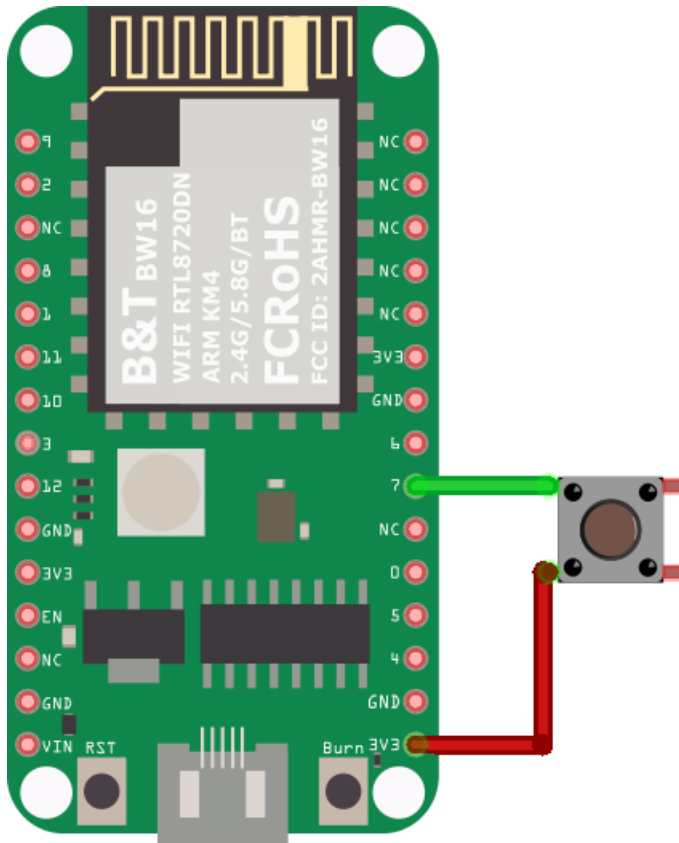
For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).



For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).



For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).



These AON pins can be set by using `SET_AON_GPIO_WAKEUP_GPIOA25` or the pin that you want to use as shown in the picture below



DeepSleepMode | Arduino 1.8.16 (Windows Store 1.8.51.0)

File Edit Sketch Tools Help

```

8
9 //For RTL8722DM only the AON GPIO pins listed below should be selected
10 //SET_AON_GPIO_WAKEUP_GPIOA25 // D16
11 //SET_AON_GPIO_WAKEUP_GPIOA26 // D17
12 //SET_AON_GPIO_WAKEUP_GPIOA21 // D26
13 //SET_AON_GPIO_WAKEUP_GPIOA20 // D27
14 //SET_AON_GPIO_WAKEUP_GPIOA19 // D28
15 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
16 //SET_AON_GPIO_WAKEUP_GPIOA12 // D9
17 //SET_AON_GPIO_WAKEUP_GPIOA13 // D10
18 //SET_AON_GPIO_WAKEUP_GPIOA14 // D11
19 //SET_AON_GPIO_WAKEUP_GPIOA15 // D12
20 //SET_AON_GPIO_WAKEUP_GPIOA16 // D13
21 //SET_AON_GPIO_WAKEUP_GPIOA18 // D15
22 //SET_AON_GPIO_WAKEUP_GPIOA19 // D16
23 //SET_AON_GPIO_WAKEUP_GPIOA21 // D18
24 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA25 // D7
26 //SET_AON_GPIO_WAKEUP_GPIOA26 // D8
27 //SET_AON_GPIO_WAKEUP_GPIOA15 // D9
28 //SET_AON_GPIO_WAKEUP_GPIOA14 // D10
29 //SET_AON_GPIO_WAKEUP_GPIOA13 // D11
30 //SET_AON_GPIO_WAKEUP_GPIOA12 // D12

```

### Using RTC Timer as wakeup source

RTC Timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC

DeepSleepMode | Arduino 1.8.16 (Windows Store 1.8.51.0)

File Edit Sketch Tools Help

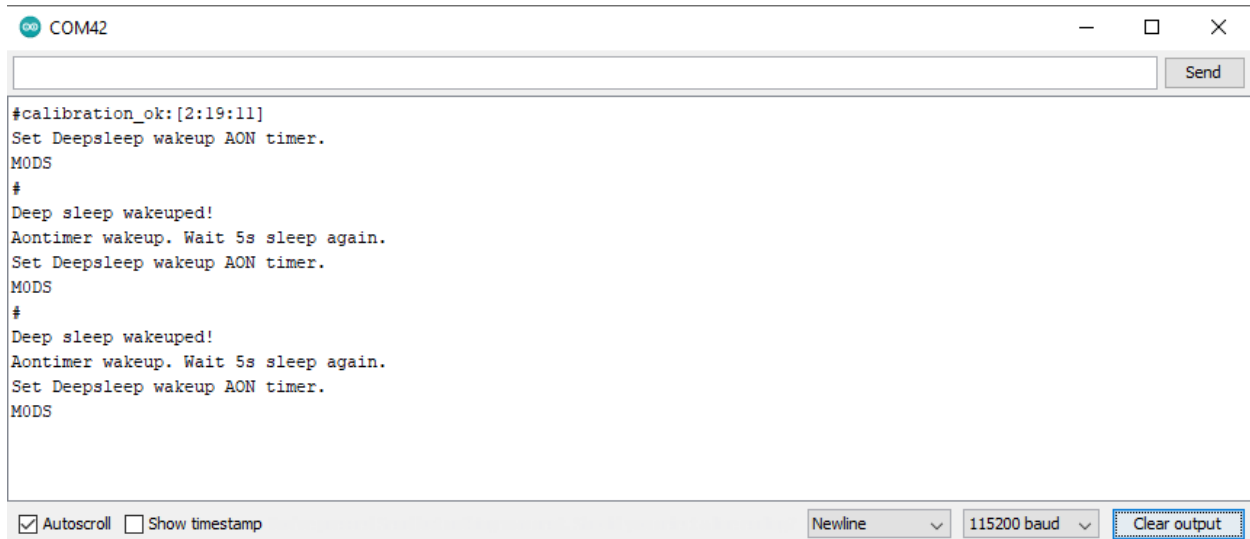
```

33
34 #define AON_TIMER_SLEEP_DURATION 5000
35 #define DS_RTC_ALARM_DAY 0
36 #define DS_RTC_ALARM_HOUR 0
37 #define DS_RTC_ALARM_MIN 0
38 #define DS_RTC_ALARM_SEC 10

```

When all the condition values are set, the system will run and switch between normal and deep sleep mode which is controlled by the wakeup source. The serial monitor will display the switching log as shown below.

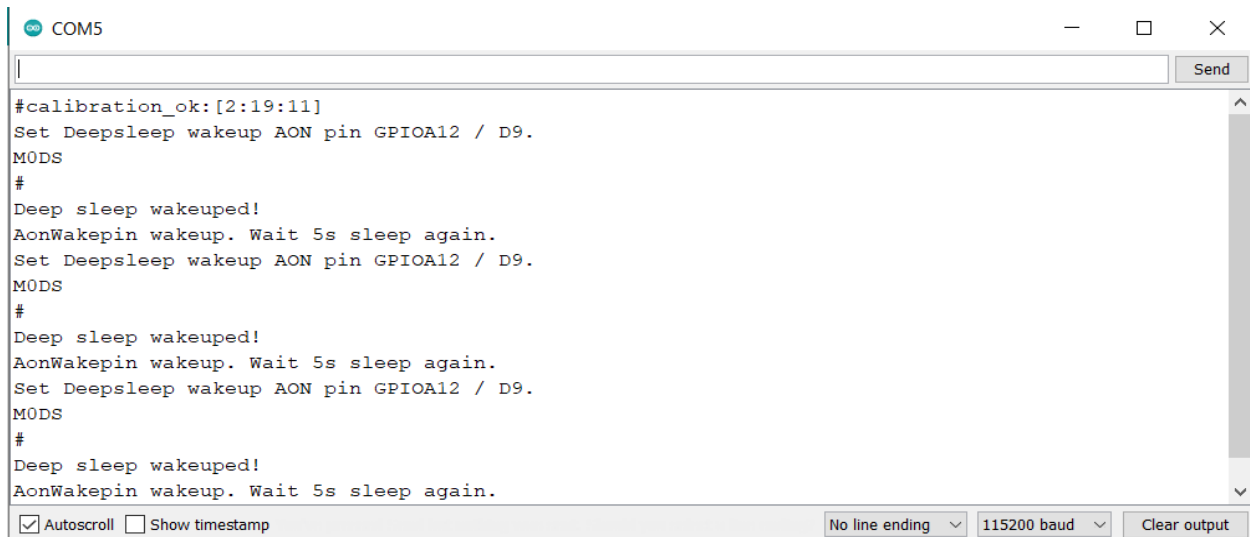
## AON Timer



```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON timer.
MODS
#
Deep sleep wakeupid!
Aontimer wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON timer.
MODS
#
Deep sleep wakeupid!
Aontimer wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON timer.
MODS
```

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

## AON GPIO Pin



```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupid!
AonWakepin wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupid!
AonWakepin wakeup. Wait 5s sleep again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.
MODS
#
Deep sleep wakeupid!
AonWakepin wakeup. Wait 5s sleep again.
```

☒ Autoscroll ☐ Show timestamp No line ending 115200 baud Clear output

## RTC Timer

```

COM42
#calibration_ok:[2:19:11]
Set Deepsleep wakeup RTC.
MODS
#
Deep sleep wakeuped!
RTC wakeup. Wait 5s sleep again.
Set Deepsleep wakeup RTC.
MODS
#
Deep sleep wakeuped!
RTC wakeup. Wait 5s sleep again.
Set Deepsleep wakeup RTC.
MODS

```

☒ Autoscroll ☐ Show timestamp Newline 115200 baud Clear output

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Deep Sleep for DHT and E-paper

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21 x 1
- LCD I2C screen x 1

### Example

#### Introduction

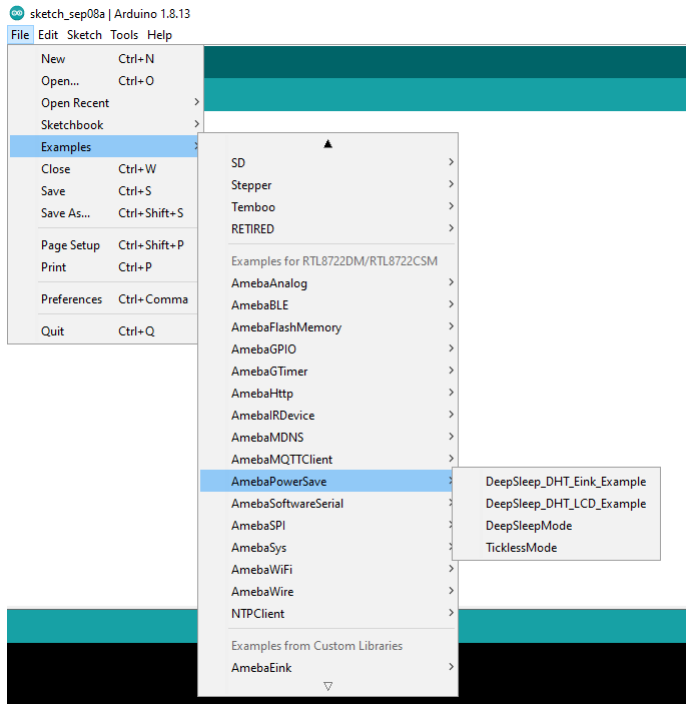
Ameba-D supports low power modes which are deepsleep mode. Deepsleep mode turns off most of the system power domain. The power consumptions of core module in DeepSleep Mode is around 7uA to 8uA compare to normal state around 22mA. This example gives demo of system switch between “working” and “sleep” (power save). Using DHT sensor to read data and display on E-ink screen when system is awake. After 5 seconds system auto enter DeepSleep Mode for power save. System will wake up by wakeup source. (Aon timer, Aon Pins or RTC timer).

#### Procedure

Download the Eink zip library, AmebaEink.zip, at

[https://github.com/ambiot/ambd\\_arduino/tree/master/Arduino\\_zip\\_libraries](https://github.com/ambiot/ambd_arduino/tree/master/Arduino_zip_libraries). Then install the AmebaEink.zip.

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleep\_DHT\_Eink\_Example”



Set condition values as picture below.

DS\_WAKEUP\_SOURCE is used to set the wake-up source, user can chose 3 wake up sources now,

```
AON timer (SET_DS_AON_TIMER_WAKEUP);
AON pins (SET_AON_WAKEPIN_WAKEUP);
RTC timer (SET_DS_RTC_WAKEUP);
```

### Using AON Timer as wakeup source

AON timer can be set from 0 to 32760000 range (unit ms) by AON\_TIMER\_SLEEP\_DURATION

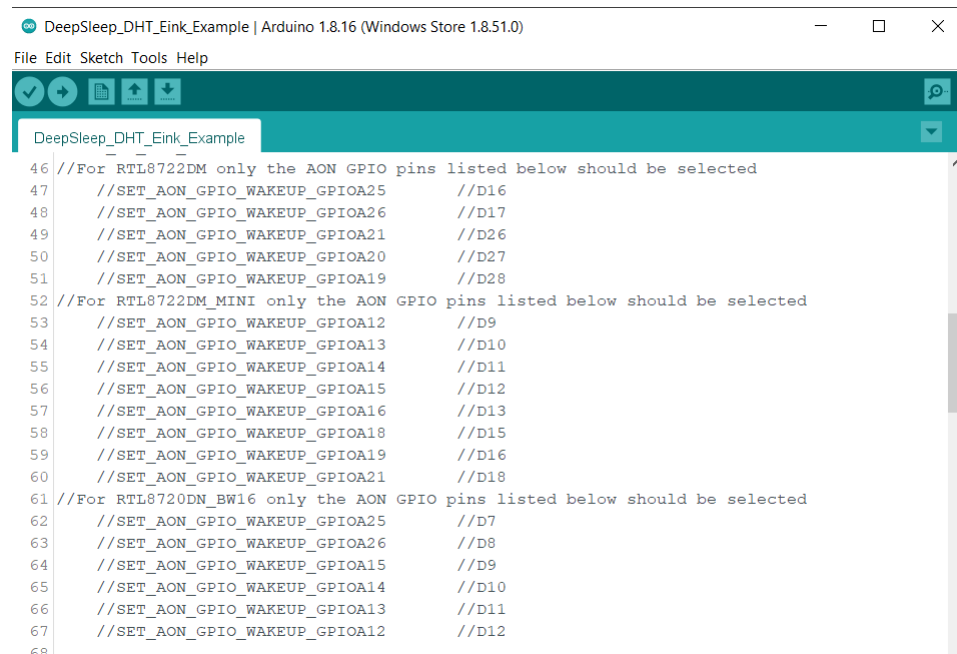
### Using AON GPIO pins as wakeup source

For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).

For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).

These AON pins can be set by using SET\_AON\_GPIO\_WAKEUP\_GPIOA25 or the pin that you want to use as shown in the picture below.



```

46 //For RTL8722DM only the AON GPIO pins listed below should be selected
47 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
48 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
49 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
50 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
51 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
52 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
53 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
54 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
55 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
56 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
57 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
58 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
59 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
60 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
61 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
62 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
63 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
64 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
65 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
66 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
67 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12

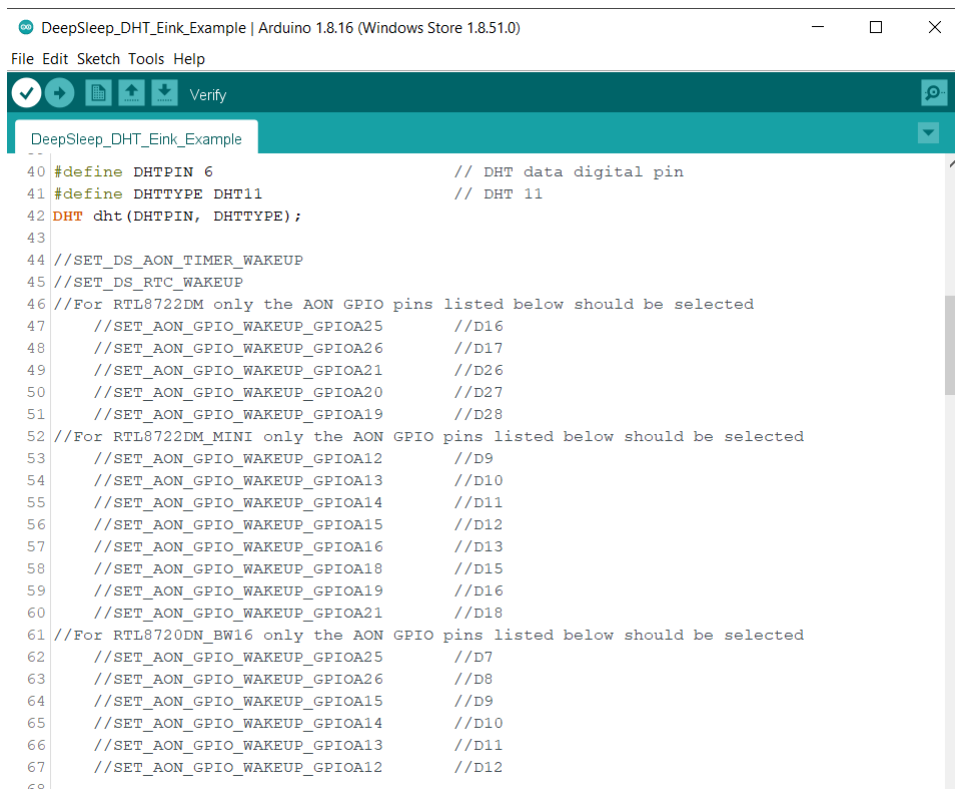
```

### Using RTC Timer as wakeup source

RTC timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC

DHTPIN is used to set DHT sensor data pin. User can choose any GPIO pins.

DHTTYPE is used to set DHT sensor type. (DHT11, DHT22 and DHT33)



```

DeepSleep_DHT_Eink_Example | Arduino 1.8.16 (Windows Store 1.8.51.0)
File Edit Sketch Tools Help
Verify
DeepSleep_DHT_Eink_Example
40 #define DHTPIN 6 // DHT data digital pin
41 #define DHTTYPE DHT11 // DHT 11
42 DHT dht(DHTPIN, DHTTYPE);
43
44 //SET_DS_AON_TIMER_WAKEUP
45 //SET_DS_RTC_WAKEUP
46 //For RTL8722DM only the AON GPIO pins listed below should be selected
47 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
48 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
49 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
50 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
51 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
52 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
53 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
54 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
55 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
56 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
57 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
58 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
59 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
60 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
61 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
62 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
63 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
64 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
65 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
66 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
67 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
68

```

When finished the condition values setting, system will run and switch between normal working mode and deepsleep mode controlled by wakeup source. Eink screen will display the temperature and humidity data measured from DHT sensor when system is awake.

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Deep Sleep for DHT and LCD

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- DHT11 or DHT22 or DHT21 x 1
- LCD I2C screen x 1

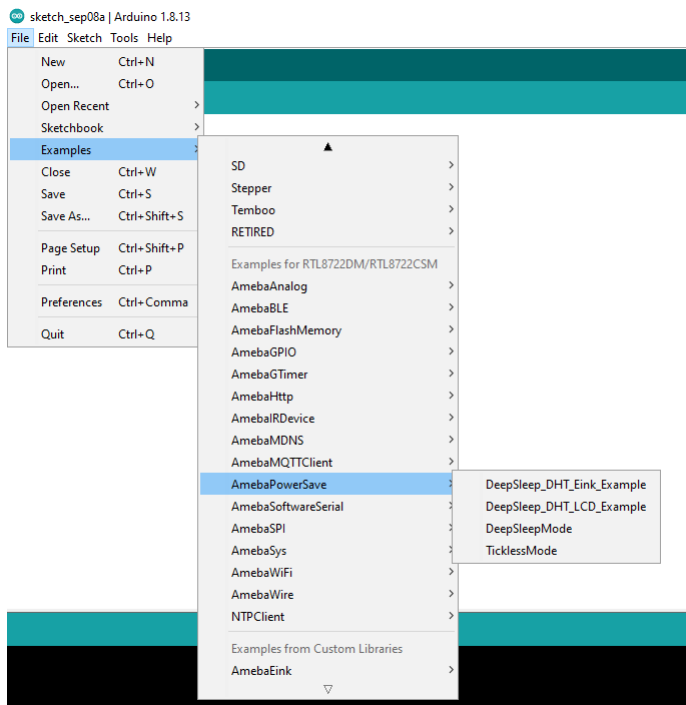
### Example

### Introduction

Ameba-D supports low power modes which are deepsleep mode. Deepsleep mode turns off most of the system power domain. The power consumptions of core module in DeepSleep Mode is around 7uA to 8uA compare to normal state around 22mA. This example gives demo of system switch between “working” and “sleep” (power save). Using DHT sensor to read data and display on LCD screen when system is awake. After 5 seconds system auto enter DeepSleep Mode for power save. System will wake up by wakeup source.( Aon timer, Aon Pins or RTC timer).

## Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “DeepSleep\_DHT\_LCD\_Example”



Set condition values as picture below.

DS\_WAKEUP\_SOURCE is used to set the wake-up source, user can chose 3 wake up sources now,

```
AON timer (SET_DS_AON_TIMER_WAKEUP);
AON pins (SET_AON_WAKEPIN_WAKEUP);
RTC timer (SET_DS_RTC_WAKEUP);
```

## Using AON Timer as wakeup source

AON timer can be set from 0 to 32760000 range (unit ms) by AON\_TIMER\_SLEEP\_DURATION

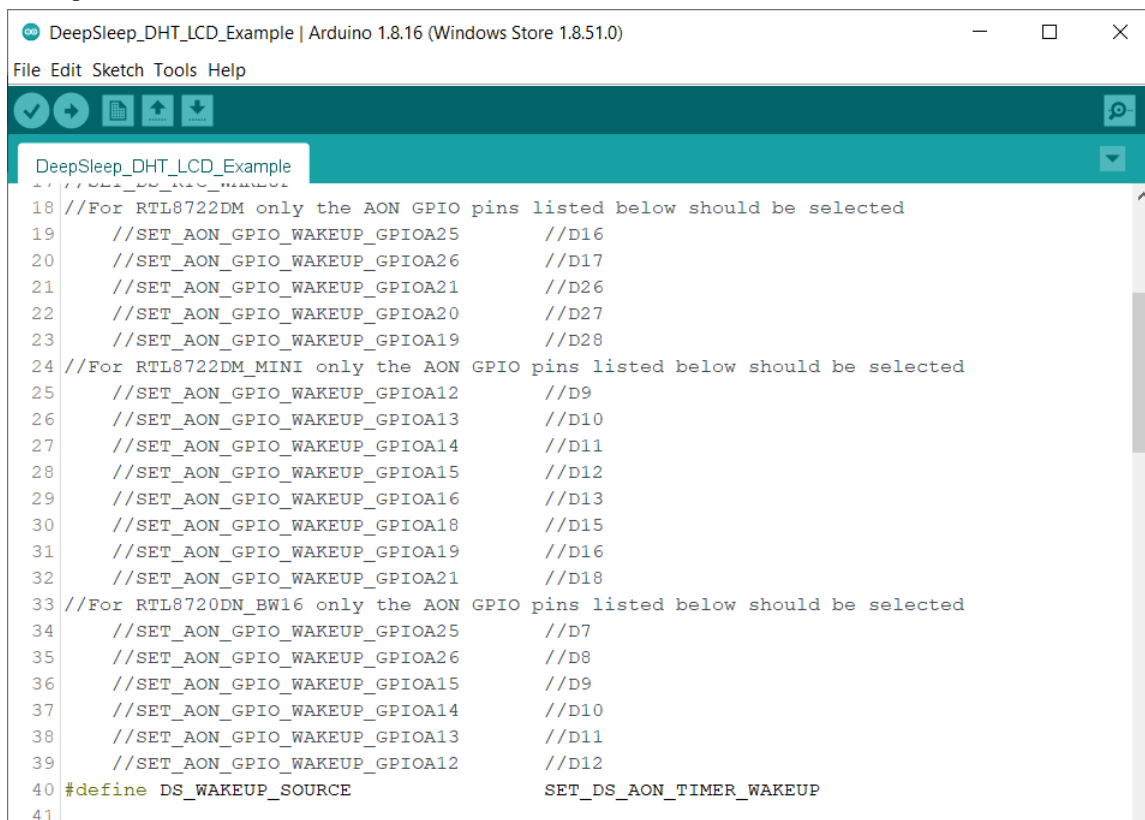
### Using AON GPIO pins as wakeup source

For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).

For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).

These AON pins can be set by using SET\_AON\_GPIO\_WAKEUP\_GPIOA25 or the pin that you want to use as shown in the picture below.



```

DeepSleep_DHT_LCD_Example | Arduino 1.8.16 (Windows Store 1.8.51.0)
File Edit Sketch Tools Help
DeepSleep_DHT_LCD_Example
18 //For RTL8722DM only the AON GPIO pins listed below should be selected
19 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
20 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
21 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
22 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
23 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
24 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
26 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
27 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
28 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
29 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
30 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
31 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
32 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
33 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
34 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
35 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
36 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
37 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
38 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
39 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
40 #define DS_WAKEUP_SOURCE SET_DS_AON_TIMER_WAKEUP
41

```

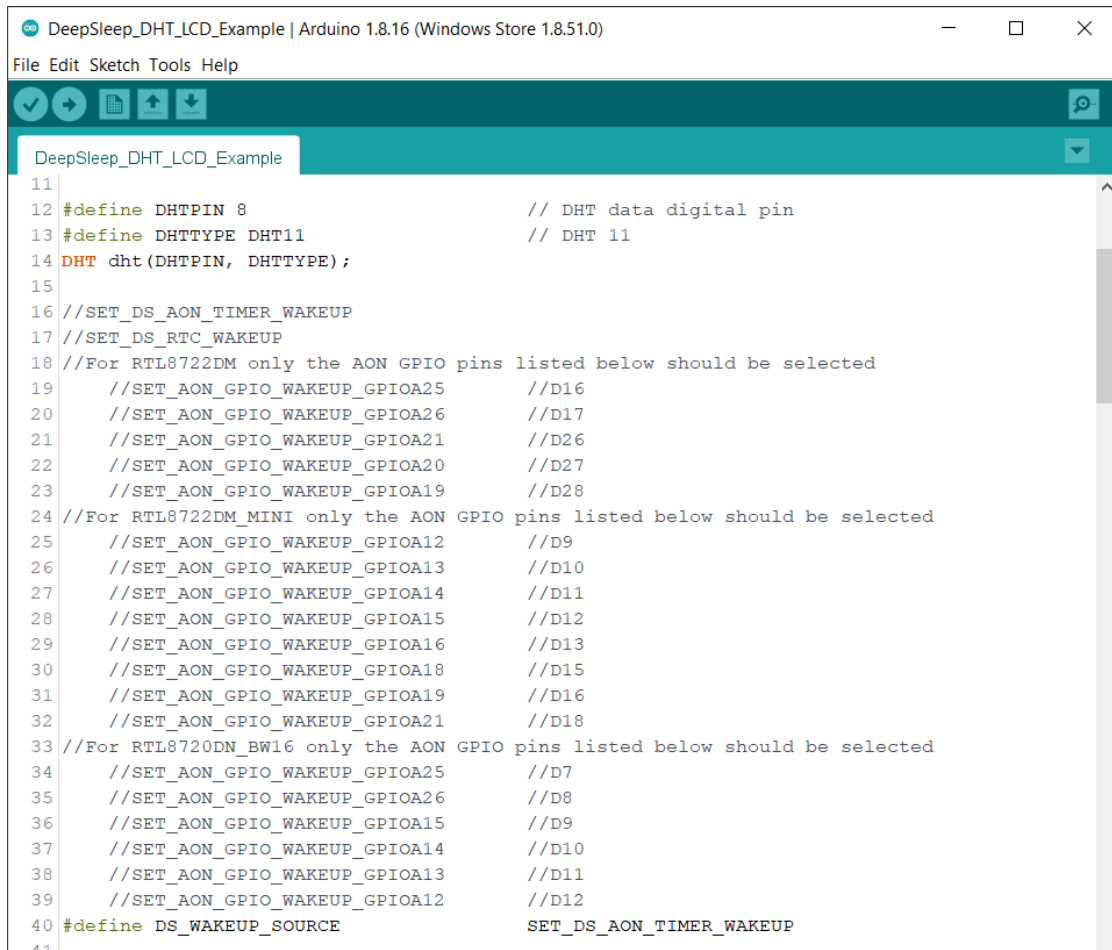
### Using RTC Timer as wakeup source

RTC timer wakeup system is by setting alarm. The alarm has 4 values, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC



DHTPIN is used to set DHT sensor data pin. User can choose any GPIO pins.

DHTTYPE is used to set DHT sensor type. (DHT11, DHT22 and DHT33)



```

11
12 #define DHTPIN 8 // DHT data digital pin
13 #define DHTTYPE DHT11 // DHT 11
14 DHT dht(DHTPIN, DHTTYPE);
15
16 //SET_DS_AON_TIMER_WAKEUP
17 //SET_DS_RTC_WAKEUP
18 //For RTL8722DM only the AON GPIO pins listed below should be selected
19 //SET_AON_GPIO_WAKEUP_GPIOA25 //D16
20 //SET_AON_GPIO_WAKEUP_GPIOA26 //D17
21 //SET_AON_GPIO_WAKEUP_GPIOA21 //D26
22 //SET_AON_GPIO_WAKEUP_GPIOA20 //D27
23 //SET_AON_GPIO_WAKEUP_GPIOA19 //D28
24 //For RTL8722DM_MINI only the AON GPIO pins listed below should be selected
25 //SET_AON_GPIO_WAKEUP_GPIOA12 //D9
26 //SET_AON_GPIO_WAKEUP_GPIOA13 //D10
27 //SET_AON_GPIO_WAKEUP_GPIOA14 //D11
28 //SET_AON_GPIO_WAKEUP_GPIOA15 //D12
29 //SET_AON_GPIO_WAKEUP_GPIOA16 //D13
30 //SET_AON_GPIO_WAKEUP_GPIOA18 //D15
31 //SET_AON_GPIO_WAKEUP_GPIOA19 //D16
32 //SET_AON_GPIO_WAKEUP_GPIOA21 //D18
33 //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
34 //SET_AON_GPIO_WAKEUP_GPIOA25 //D7
35 //SET_AON_GPIO_WAKEUP_GPIOA26 //D8
36 //SET_AON_GPIO_WAKEUP_GPIOA15 //D9
37 //SET_AON_GPIO_WAKEUP_GPIOA14 //D10
38 //SET_AON_GPIO_WAKEUP_GPIOA13 //D11
39 //SET_AON_GPIO_WAKEUP_GPIOA12 //D12
40 #define DS_WAKEUP_SOURCE SET_DS_AON_TIMER_WAKEUP
41

```

When finished the condition values setting, system will run and switch between normal working mode and deepsleep mode controlled by wakeup source. LCD screen will display the temperature and humidity data measured from DHT sensor when system is awake.

### Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## Power Save - Tickless Mode

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

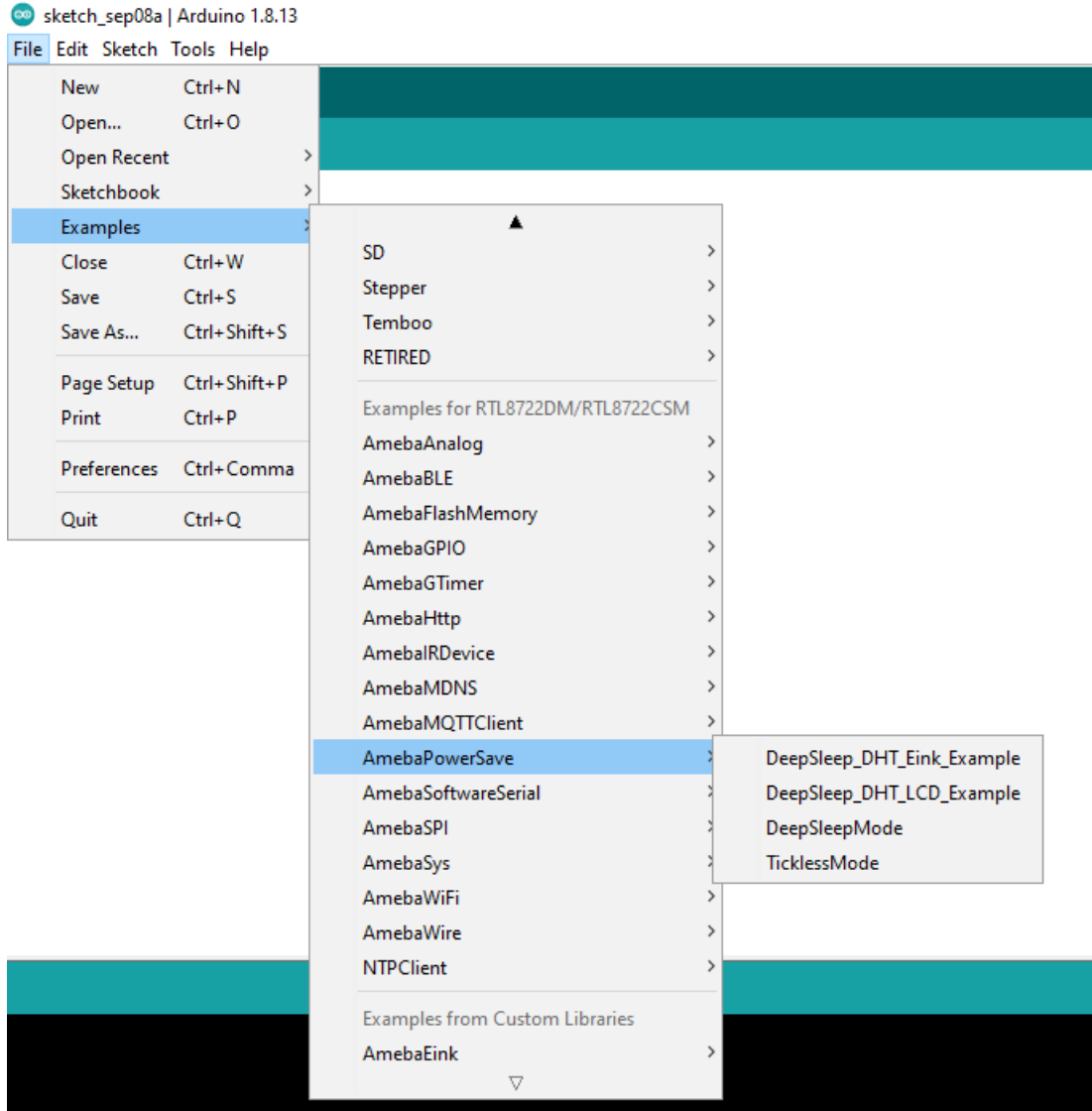
### Example

#### Introduction

Ameba-D supports two low power modes which are deepsleep mode and sleep mode. The power consumptions of Tickless Sleep Mode is around 28uA to 30uA compare to normal state around 15mA. This example describes how to use freertos tickless with uart interruptable interface.

#### Procedure

Open “File” -> “Examples” -> “AmebaPowerSave” -> “TicklessMode”



Set condition values as picture below.

“TL\_WAKEUP\_SOURCE” is used to set the wake-up source, user can chose 3 wake up sources now,

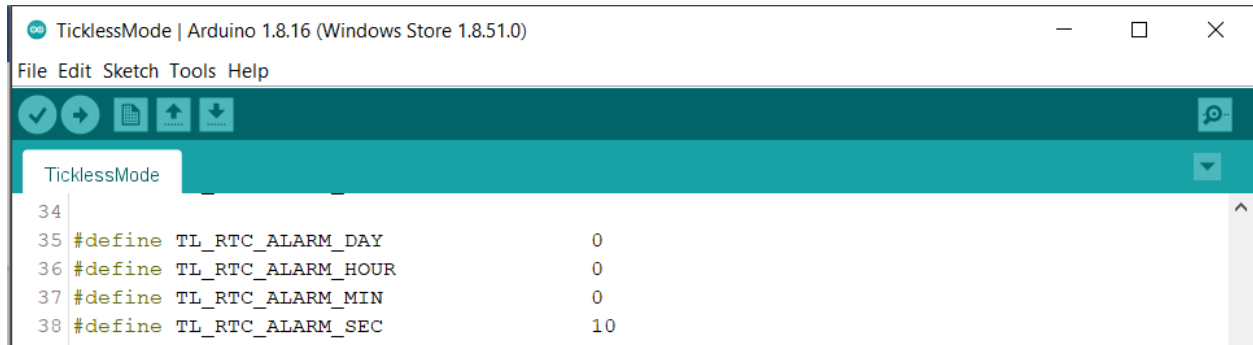
```
LOGUART (SET_TL_UART_WAKEUP) ;
RTC Timer (SET_TL_RTC_WAKEUP) ;
AON pins (SET_AON_WAKEPIN_WAKEUP) ;
```

### Using LOGUART as wakeup source

When the LOGUART is selected as the wakeup source, the “TL\_Suspend\_function” will enter sleep mode. And then it is kept alive for 13s then enter sleep mode. To wakeup, press enter.

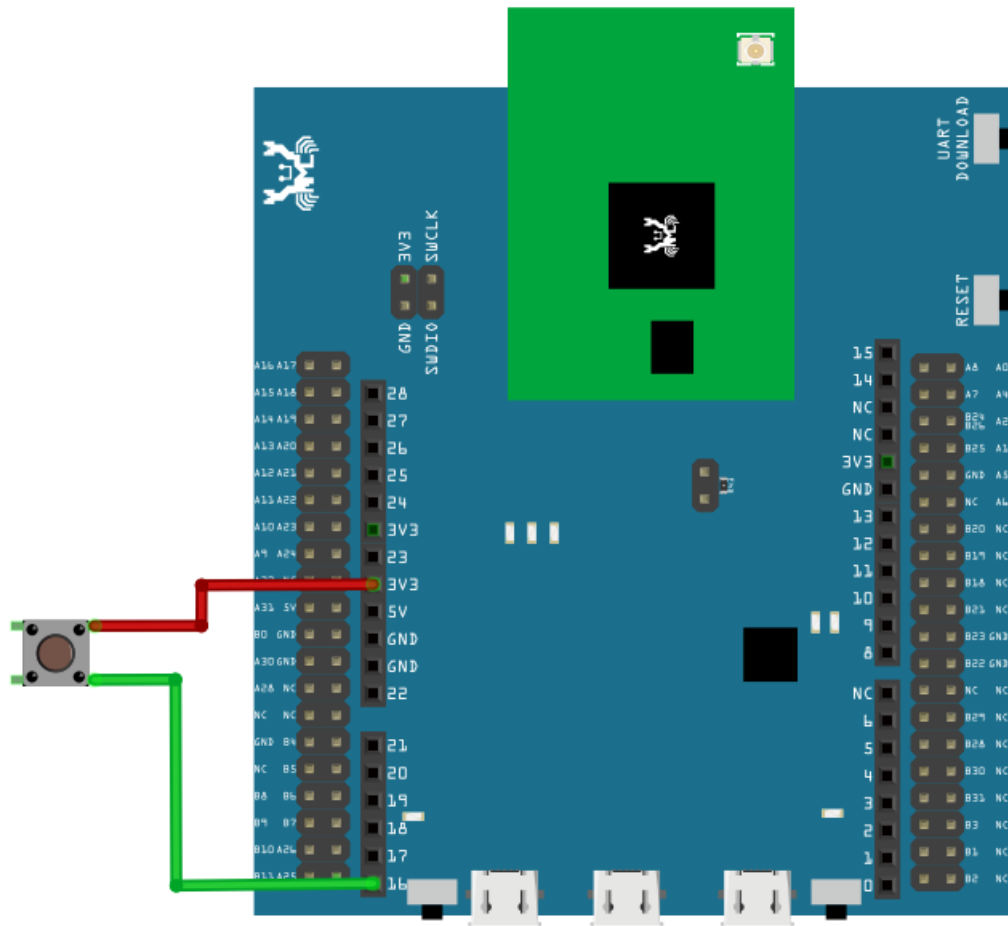
### Using RTC Timer as wakeup source

RTC Timer wakeup system is by setting alarm. The alarm has 4 values to be set, day, hour, min and sec. All 4 values can be set by DS\_RTC\_ALARM\_DAY, DS\_RTC\_ALARM\_HOUR, DS\_RTC\_ALARM\_MIN, and DS\_RTC\_ALARM\_SEC.

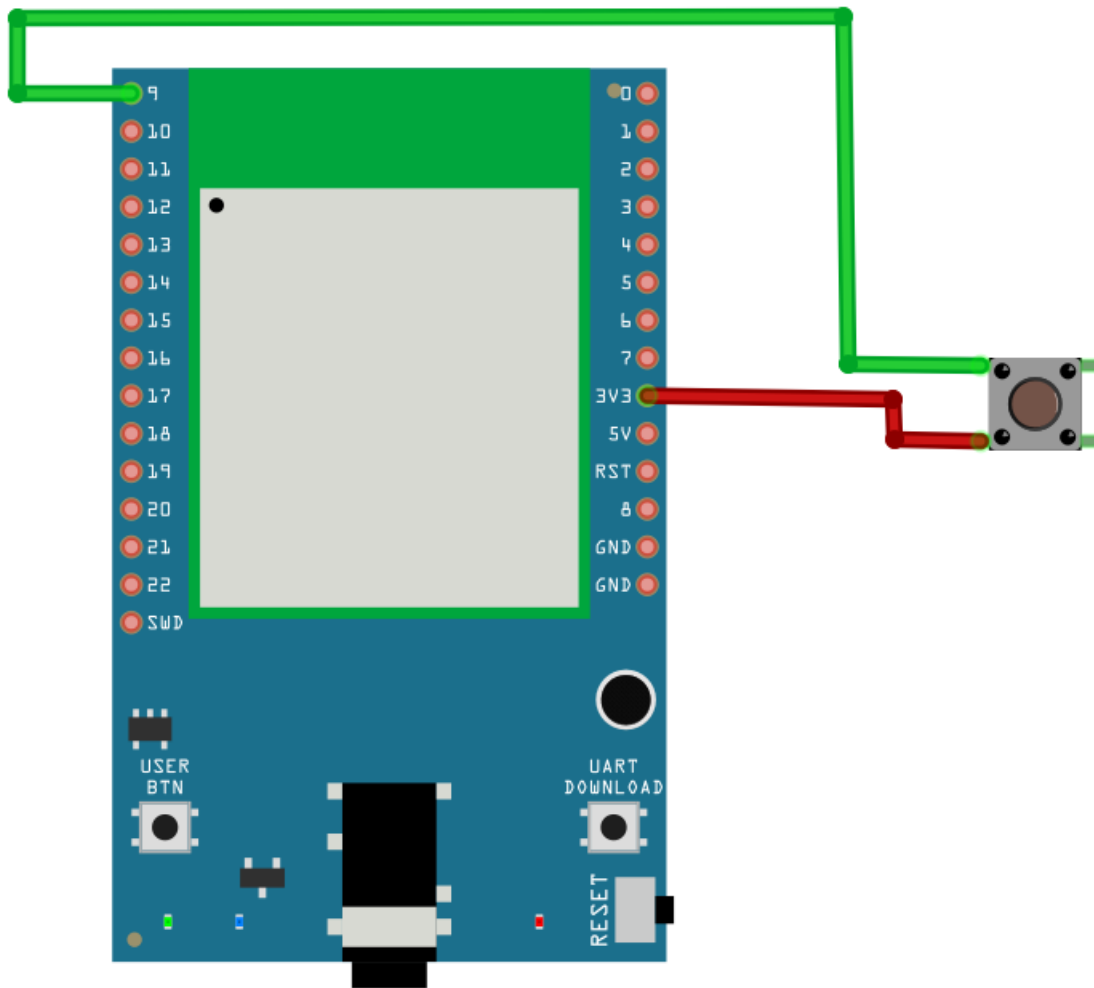


### Using AON GPIO pins as wakeup source

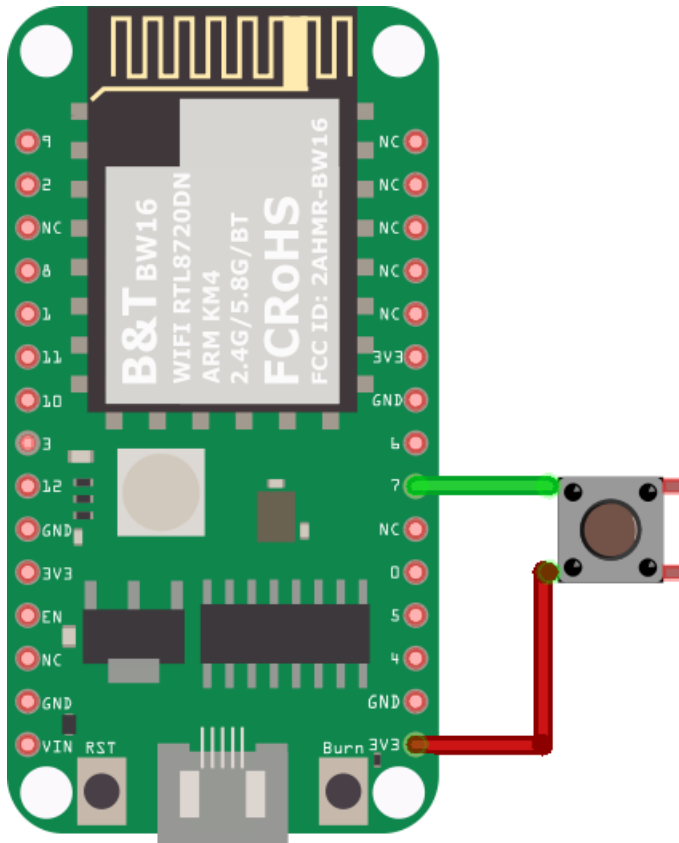
For AMB21, there are 5 pins that can be set as AON pins and active high for wakeup, GPIOA25(D16), GPIOA26(D17), GPIOA21(D26), GPIOA20(D27), GPIOA(D28).

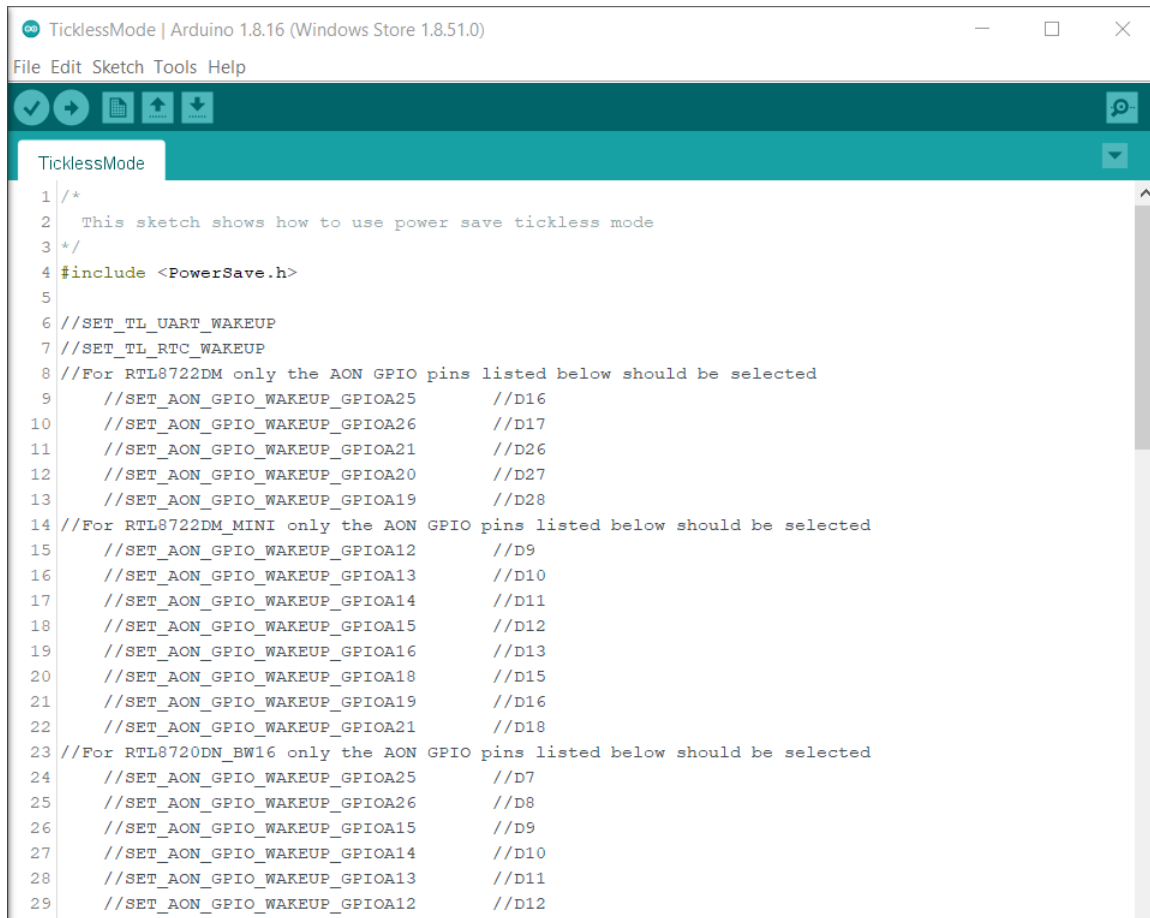


For AMB23, there are 8 pins that can be set as AON pins and active high for wakeup, GPIOA12(D9), GPIOA13(D10), GPIOA14(D11), GPIOA15(D12), GPIOA16(D13), GPIOA18(D15), GPIOA19(D16), GPIOA21(D18).



For BW16, there is only 6 pins that can be set as AON pin and active high for wakeup, GPIOA\_25 (D7), GPIOA\_26 (D8), GPIOA\_15 (D9), GPIOA\_14 (D10), GPIOA\_13 (D11), GPIOA\_12 (D12).





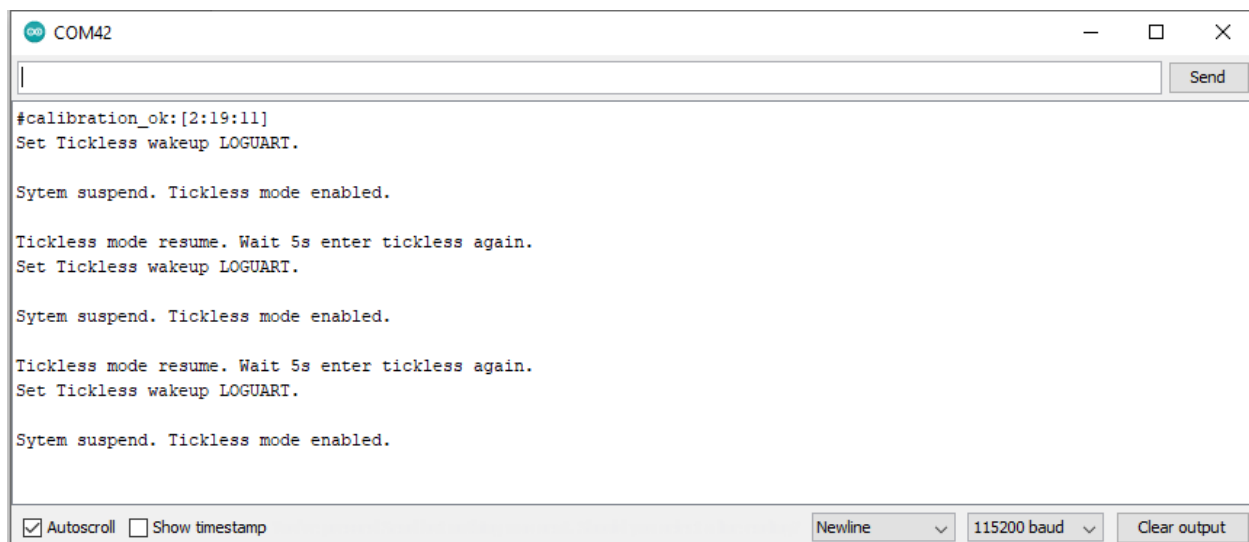
```

1 /*
2  This sketch shows how to use power save tickless mode
3  */
4  #include <PowerSave.h>
5
6  //SET_TL_UART_WAKEUP
7  //SET_TL_RTC_WAKEUP
8  //For RTL8722DM only the AON GPIO pins listed below should be selected
9      //SET_AON_GPIO_WAKEUP_GPIOA25      //D16
10     //SET_AON_GPIO_WAKEUP_GPIOA26      //D17
11     //SET_AON_GPIO_WAKEUP_GPIOA21      //D26
12     //SET_AON_GPIO_WAKEUP_GPIOA20      //D27
13     //SET_AON_GPIO_WAKEUP_GPIOA19      //D28
14  //For RTL8722DM MINI only the AON GPIO pins listed below should be selected
15     //SET_AON_GPIO_WAKEUP_GPIOA12      //D9
16     //SET_AON_GPIO_WAKEUP_GPIOA13      //D10
17     //SET_AON_GPIO_WAKEUP_GPIOA14      //D11
18     //SET_AON_GPIO_WAKEUP_GPIOA15      //D12
19     //SET_AON_GPIO_WAKEUP_GPIOA16      //D13
20     //SET_AON_GPIO_WAKEUP_GPIOA18      //D15
21     //SET_AON_GPIO_WAKEUP_GPIOA19      //D16
22     //SET_AON_GPIO_WAKEUP_GPIOA21      //D18
23  //For RTL8720DN_BW16 only the AON GPIO pins listed below should be selected
24     //SET_AON_GPIO_WAKEUP_GPIOA25      //D7
25     //SET_AON_GPIO_WAKEUP_GPIOA26      //D8
26     //SET_AON_GPIO_WAKEUP_GPIOA15      //D9
27     //SET_AON_GPIO_WAKEUP_GPIOA14      //D10
28     //SET_AON_GPIO_WAKEUP_GPIOA13      //D11
29     //SET_AON_GPIO_WAKEUP_GPIOA12      //D12

```

TL\_SYSACTIVE\_TIME is for setting time duration of the system to keep alive. (Unit ms)

## LOGUART



```

#calibration_ok:[2:19:11]
Set Tickless wakeup LOGUART.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup LOGUART.

System suspend. Tickless mode enabled.

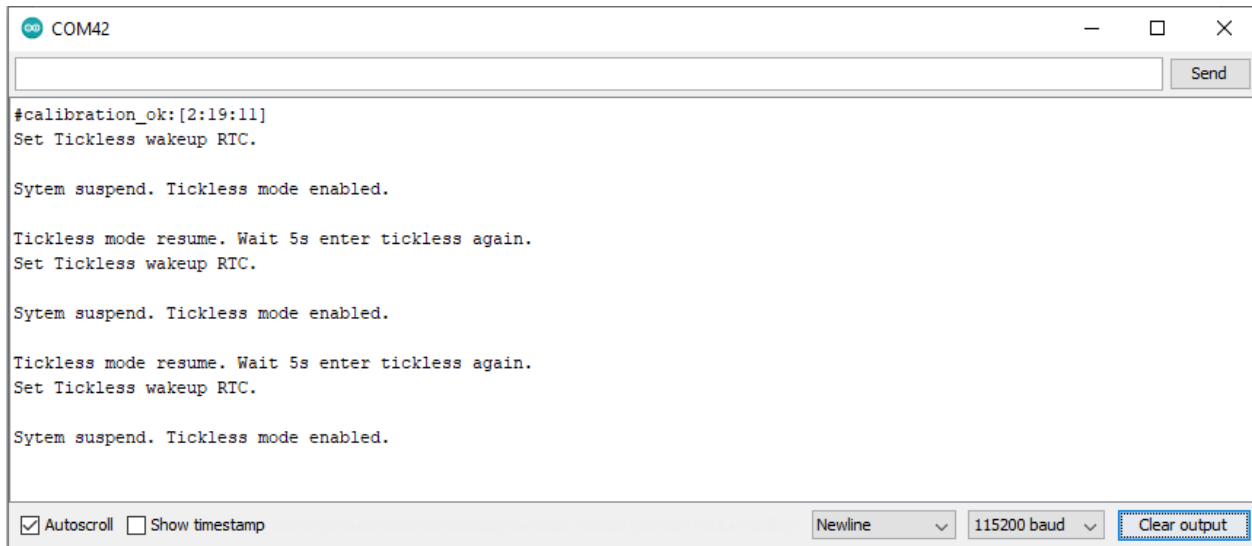
Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup LOGUART.

System suspend. Tickless mode enabled.

```

## RTC Timer





```
#calibration_ok:[2:19:11]
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.

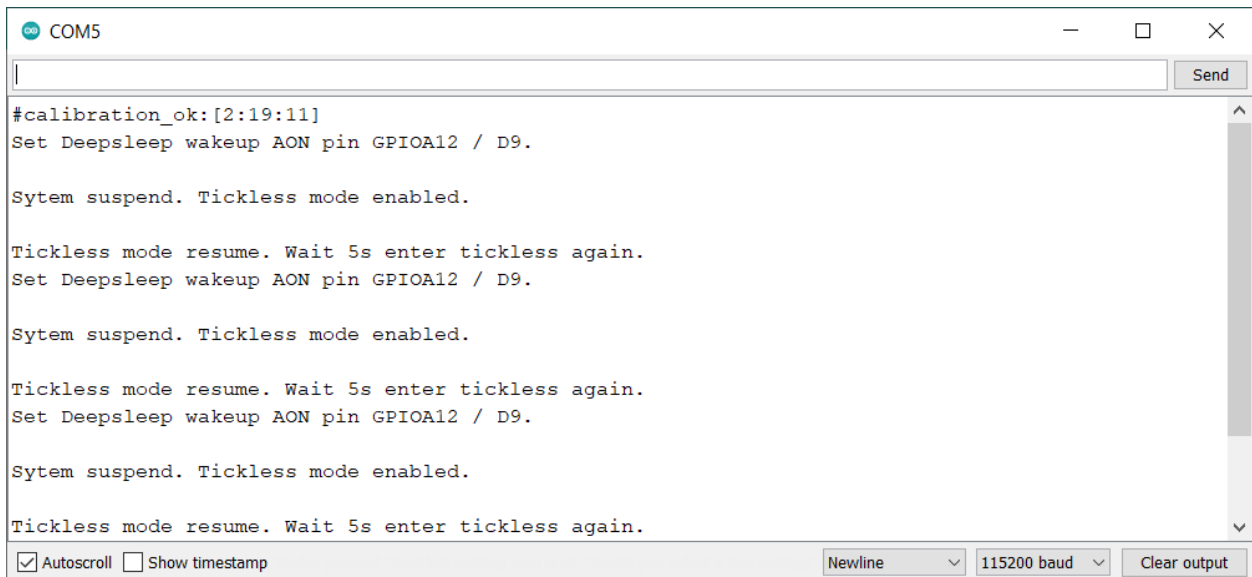
Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Tickless wakeup RTC.

System suspend. Tickless mode enabled.
```

## AON GPIO Pins



```
#calibration_ok:[2:19:11]
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
Set Deepsleep wakeup AON pin GPIOA12 / D9.

System suspend. Tickless mode enabled.

Tickless mode resume. Wait 5s enter tickless again.
```

## Code Reference

Please refer to the [API Documents](#) PowerSave section for detail description of all API.

## PWM - Play Music by Buzzer

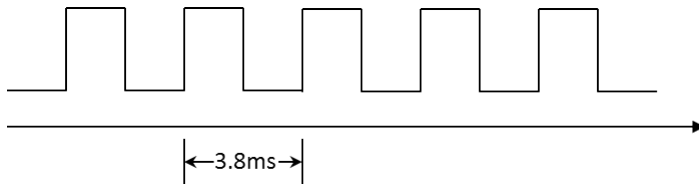
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Buzzer x 1

### Example

A sound is composed of volume, tone and timbre. Volume is determined by the amplitude of the sound wave. Tone is determined by the frequency of the sound wave. Timbre is determined by the waveform of the sound wave.

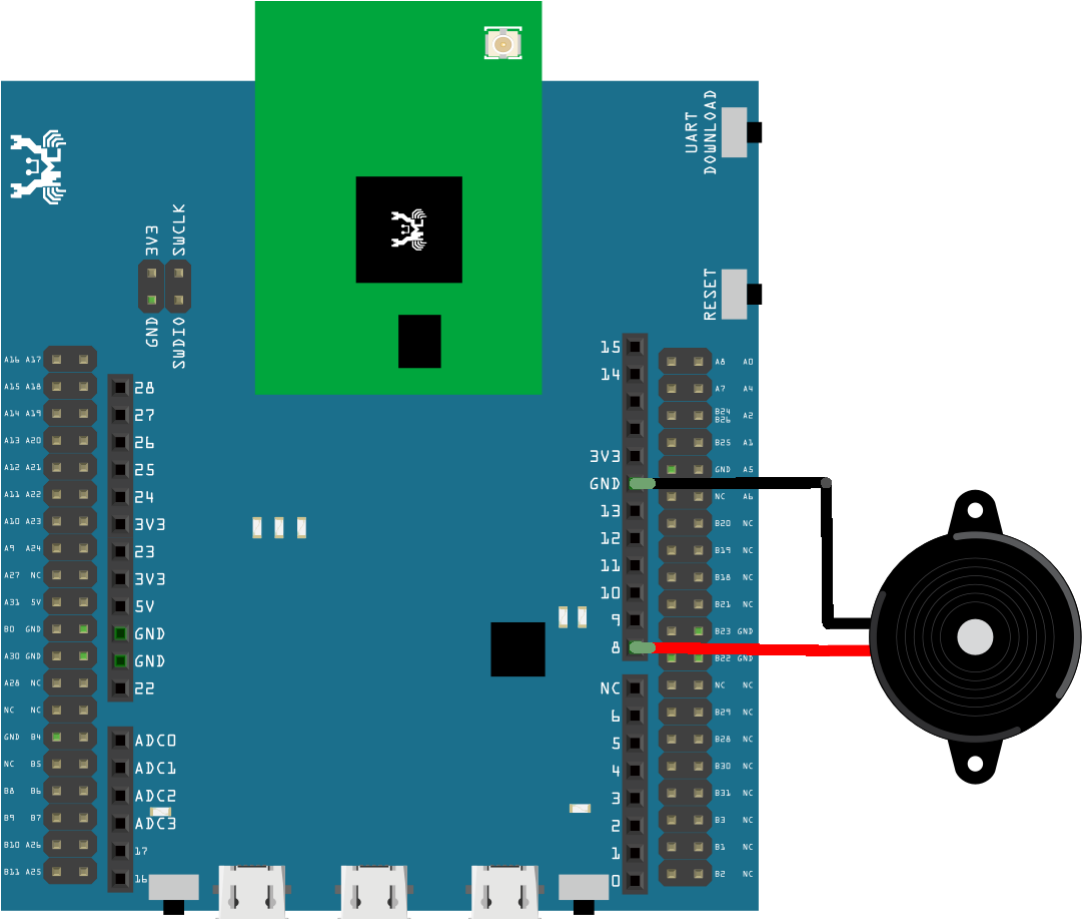
In this example, we use PWM to control the buzzer to emit sound with desired tone. As PWM outputs square wave, if we wish to emit tone C4 (frequency=262Hz), we have to make PWM to output square wave with wavelength  $1/262 = 3.8\text{ms}$ :



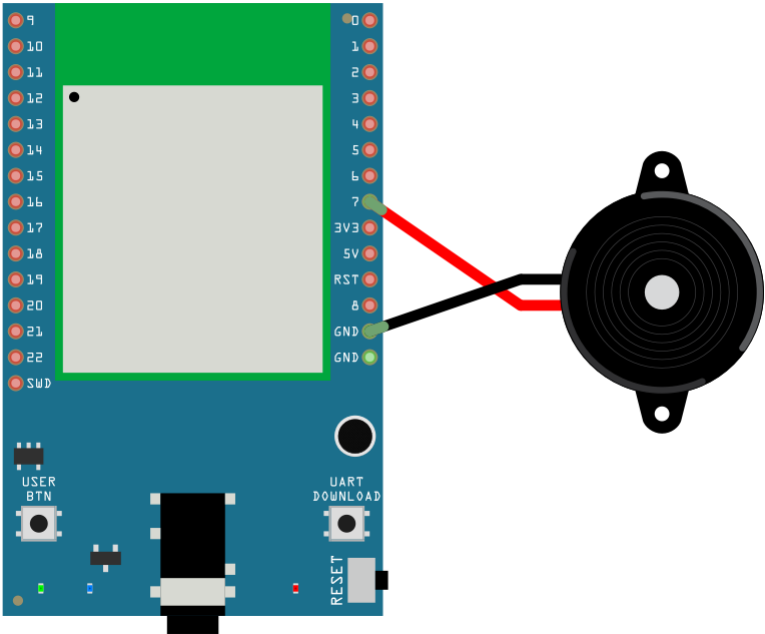
We use PWM to output sound wave with different frequency, so as to play music by the buzzer.

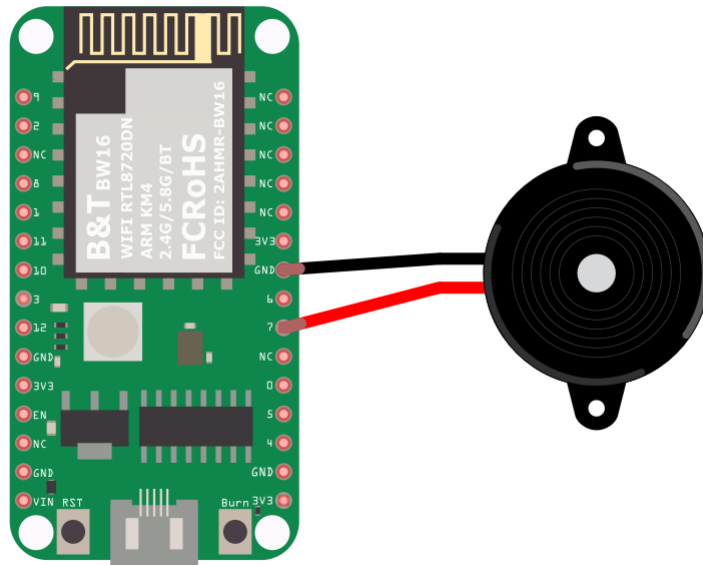
Connect the buzzer to the PWM output pin shown in the following diagrams.

**AMB21 / AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



**BW16 Wiring Diagram:**

Open the example code in “Examples” -> “AmebaAnalog” -> “TonePlayMelody”  
Compile and upload to Ameba, press the reset button. Then you can hear the buzzer playing music.

**Code Reference**

Ameba implement the `tone()` and `noTone()` API of Arduino:

<https://www.arduino.cc/en/Reference/Tone>

<https://www.arduino.cc/en/Reference/NoTone>

In the sample code, we initiate a melody array, which stores the tones to make. Another array, `noteDurations`, contains the length of each tone, 4 represents quarter note (equals to  $3000\text{ms}/4 = 750\text{ms}$ , and plus an extra 30% time pause), 8 represents eighth note.

## PWM - Servo Control

### Preparation

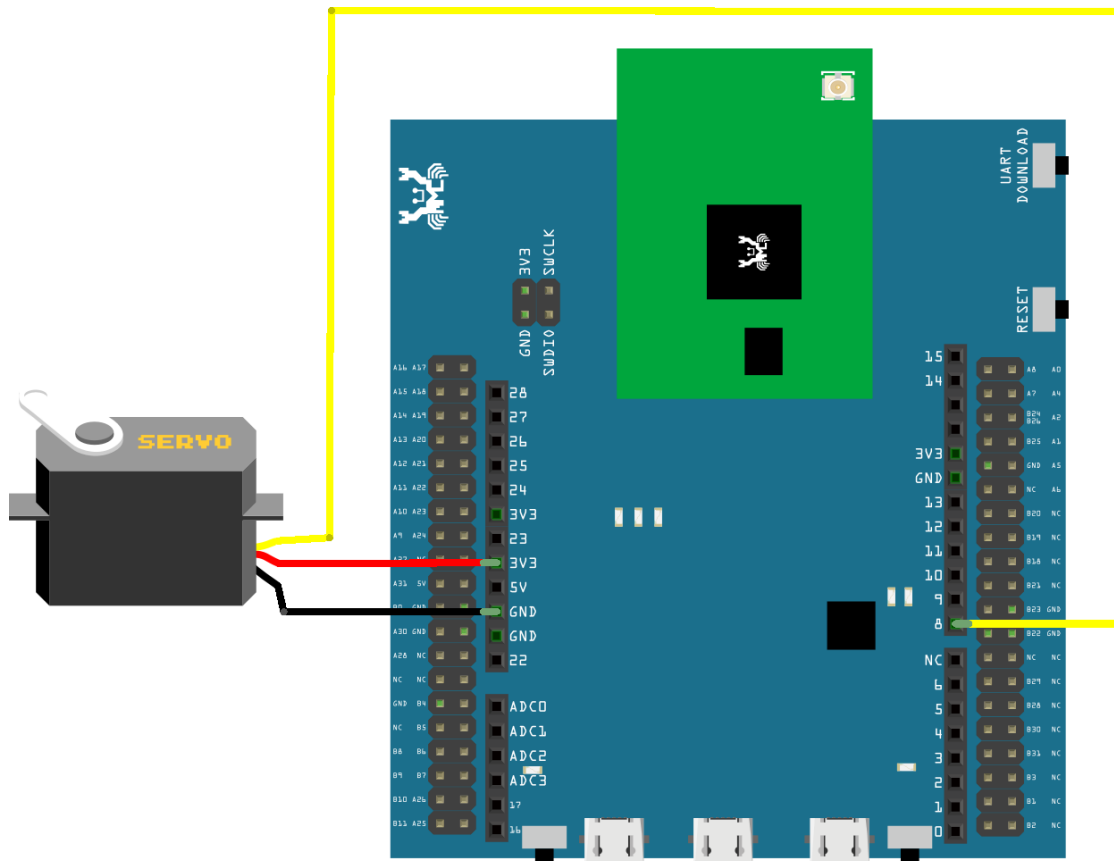
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Servo x 1 (Ex. Tower Pro SG90)

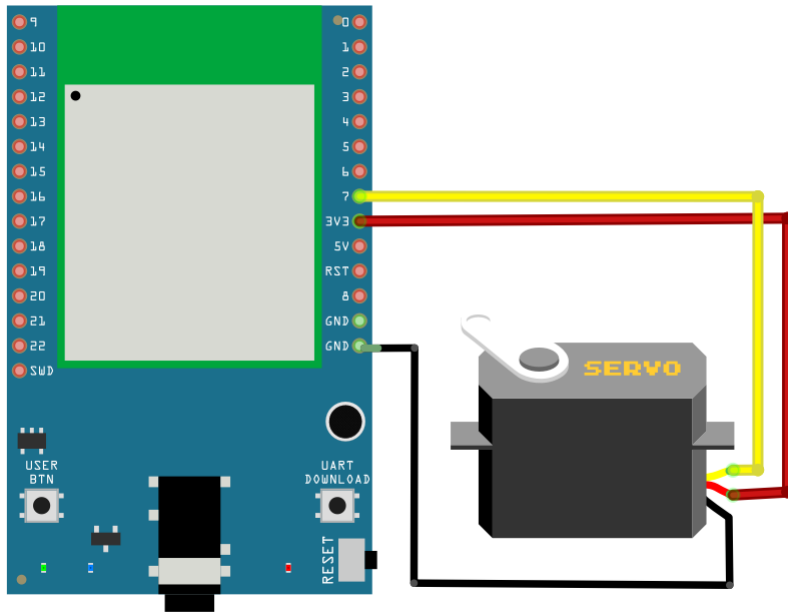
### Example

A typical servo has 3 wires, the red wire is for power, black or brown one should be connected to GND, and the other one is for signal data. We use PWM signal to control the rotation angle of the axis of the servo. The frequency of the signal is 50Hz, that is length 20ms. Each servo defines its pulse bandwidth, which is usually 1ms~2ms.

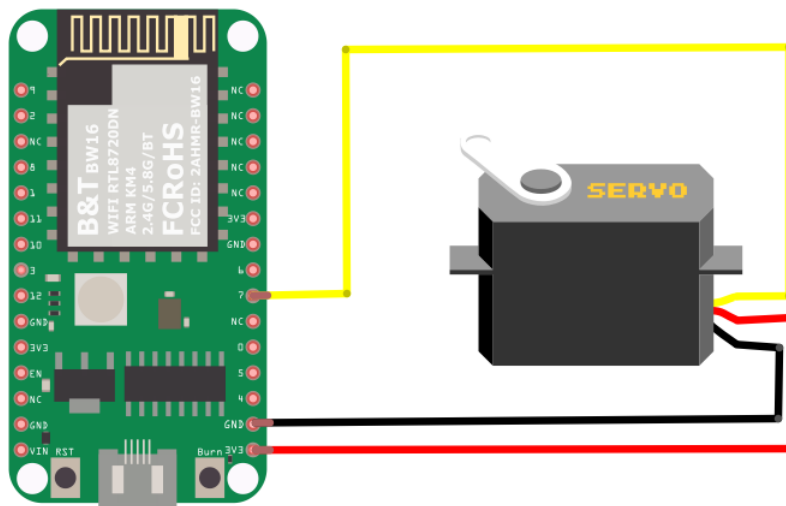
To control the rotation angle, for example if 1ms-length pulse rotates the axis to degree 0, then 1.5 ms pulse rotates the axis to 90 degrees, and 2 ms pulse rotates the axis to 180 degrees. Furthermore, a servo defines the “dead bandwidth”, which stands for the required minimum difference of the length of two consecutive pulse for the servo to work.

AMB21 / AMB22 Wiring Diagram:





BW16 Wiring Diagram:



Open the example, “File” -> “Examples” -> “AmebaAnalog” -> “ServoSweep”

This example makes the servo to rotate from degree 0 to 180, and then rotate back to degree 0.

## Code Reference

The Servo API of Ameba is similar to the API of Arduino. To distinguish from the original API of Arduino, we name the header file “AmebaServo.h” and the Class “AmebaServo” , the usage is identical to the Arduino API.

The default pulse bandwidth of Arduino Servo is 0.5ms~2.4ms, which is the same as Tower Pro SG90. Therefore, we set the attached pin directly:

```
myservo.attach(9);
```

Next, rotate the axis to desired position:

```
myservo.write(pos);
```

## RTC - Simple RTC

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

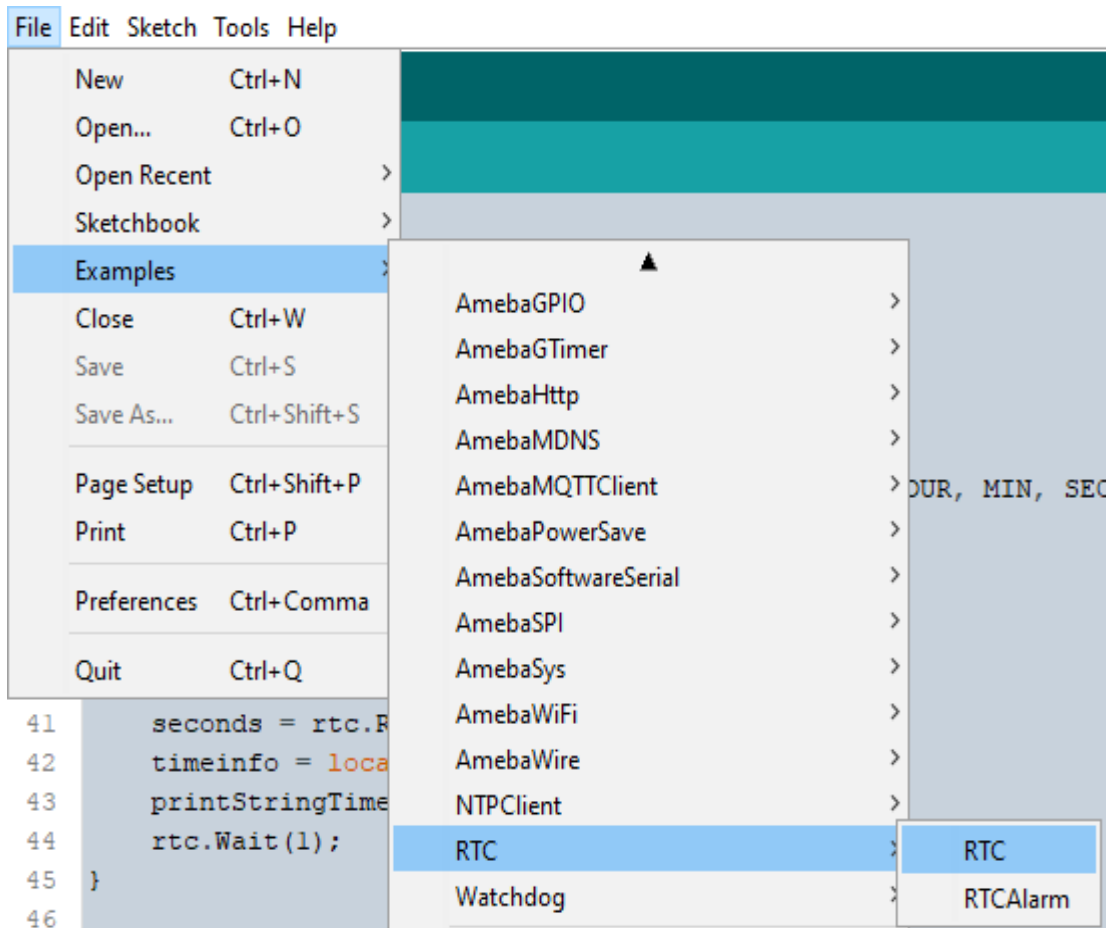
### Example

This example demonstrates how to use the RTC library methods. This function describes how to use the RTC API. The RTC function is implemented by an independent BCD timer/counter.

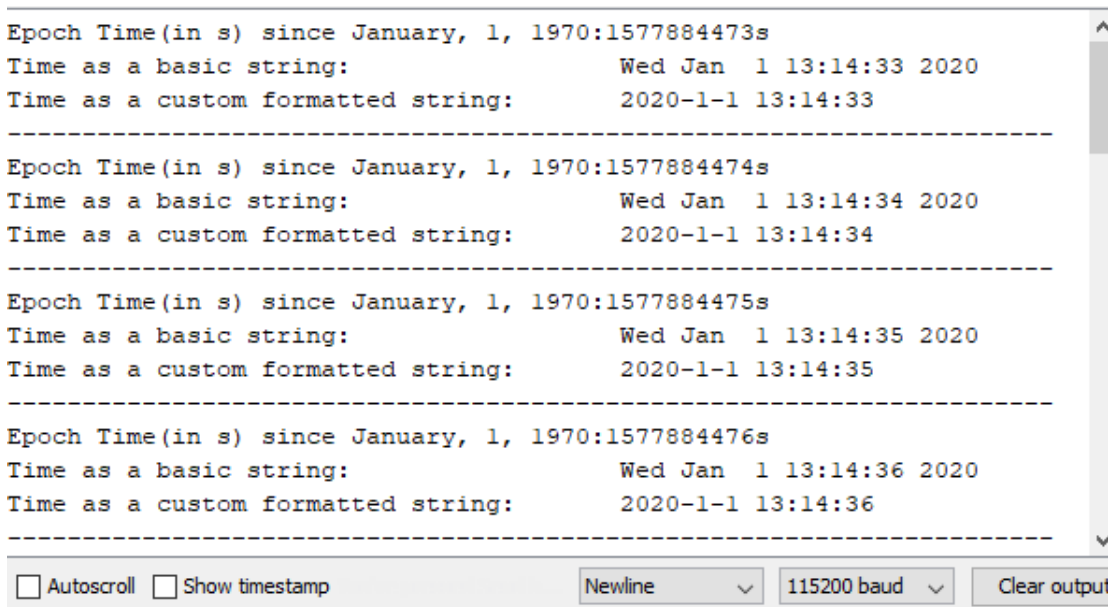
Select the correct Ameba development board from the Arduino IDE: 「Tools」 -> 「Board」 .

Then open the “RTC” example from:

"File" -> "Examples" -> "AmebaRTC" -> "RTC":



Upon successfully upload the sample code and press the reset button, this example will print out time information since the user initialized time every second in the Serial Monitor.





## Code Reference

[1] Simple RTC example from Arduino Tutorials:

<https://www.arduino.cc/en/Tutorial/SimpleRTC>

## RTC - Simple RTC Alarm

### Materials

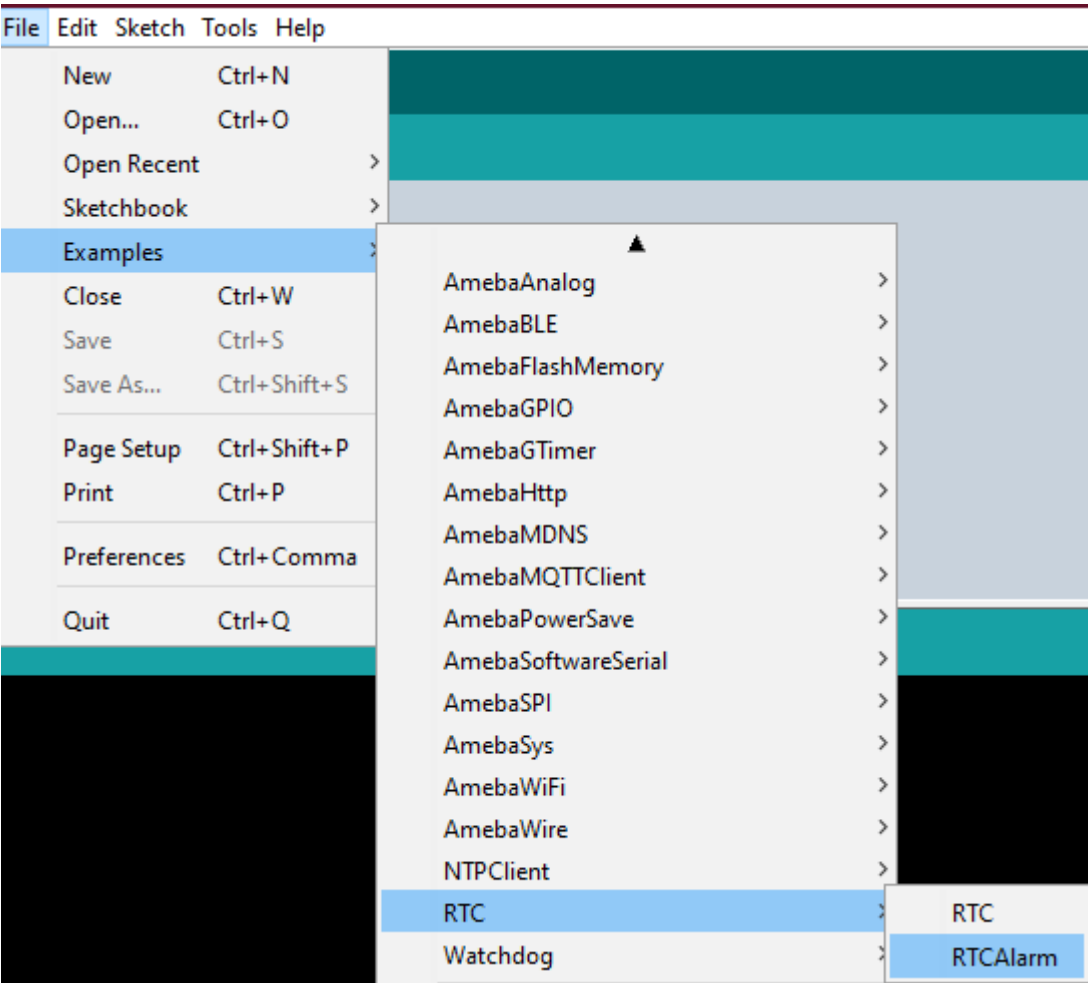
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

### Example

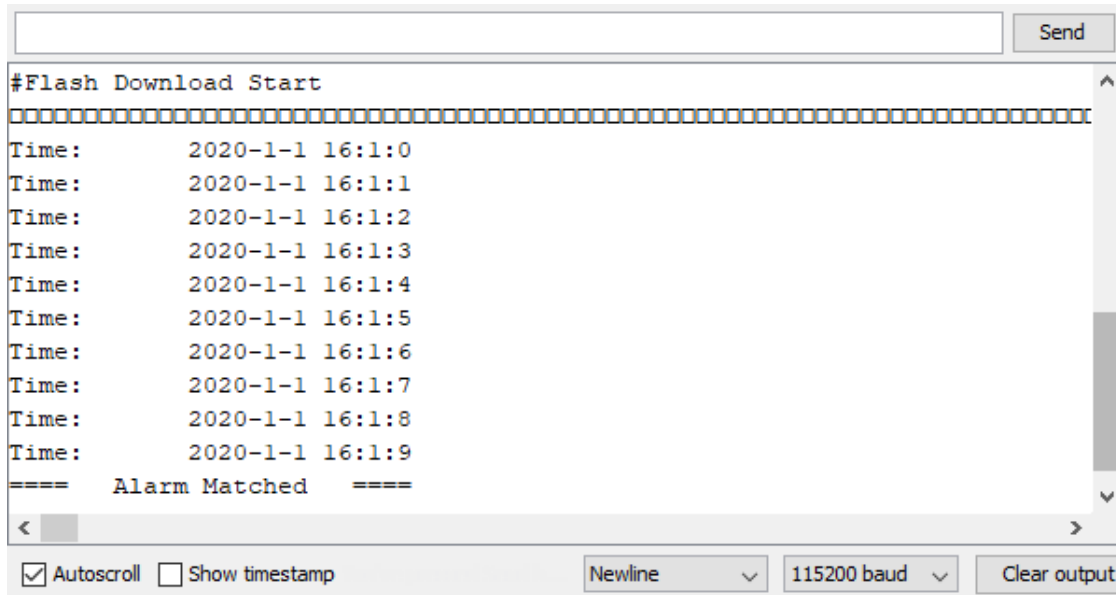
This example demonstrates how to use the RTC library methods to create a RTC Alarm, so that to do some tasks when an alarm is matched. In particular, the RTC time is set at 16:00:00 and an alarm at 16:00:10. When the time matches, “Alarm Match” information will be printed on the serial monitor.

First, select the correct Ameba development board from the Arduino IDE: “Tools” -> “Board” .

Then open the 「RTCArm」 example from: “File” -> “Examples” -> “RTC” -> “RTCArm” :



In the example, the RTC time is set at 16:00:00 and an alarm is set at 16:00:10. Upon successfully upload the sample code and press the reset button. When the alarm time (10 seconds) is reached the attached interrupt function will print the following information: “Alarm Matched!” showing in this figure below.



## SPI –Print Image And Text On LCD Screen

If you are not familiar with SPI, please read [Introduction to SPI](#) first.

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- ILI9341 TFT LCD with SPI interface x 1

### Example

We have tested the following two models of ILI9341 TFT LCD with SPI interface:

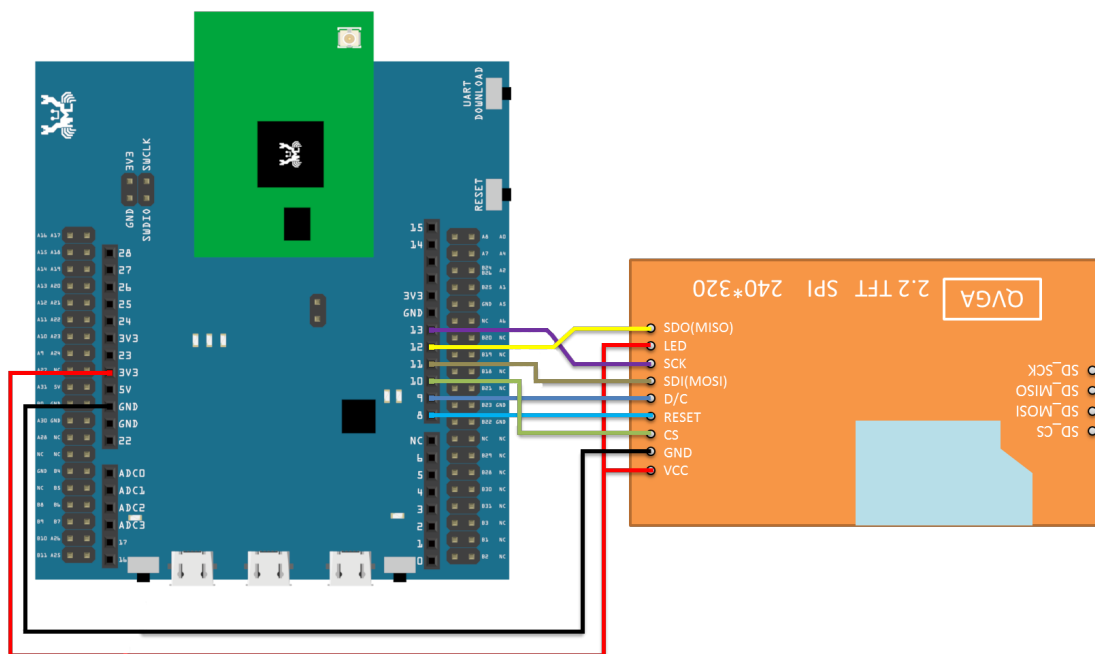
- Adafruit 2.8" TFT LCD (with touch screen)
  - <https://www.adafruit.com/products/1651>
  - <https://learn.adafruit.com/adafruit-2-8-tft-touch-shield-v2?view=all>
- QVGA 2.2" TFT LCD
  - [http://www.lcdwiki.com/2.2inch\\_SPI\\_Module\\_ILI9341\\_SKU:MSP2202](http://www.lcdwiki.com/2.2inch_SPI_Module_ILI9341_SKU:MSP2202)

Common pins in ILI9341 TFT LCD with SPI interface:

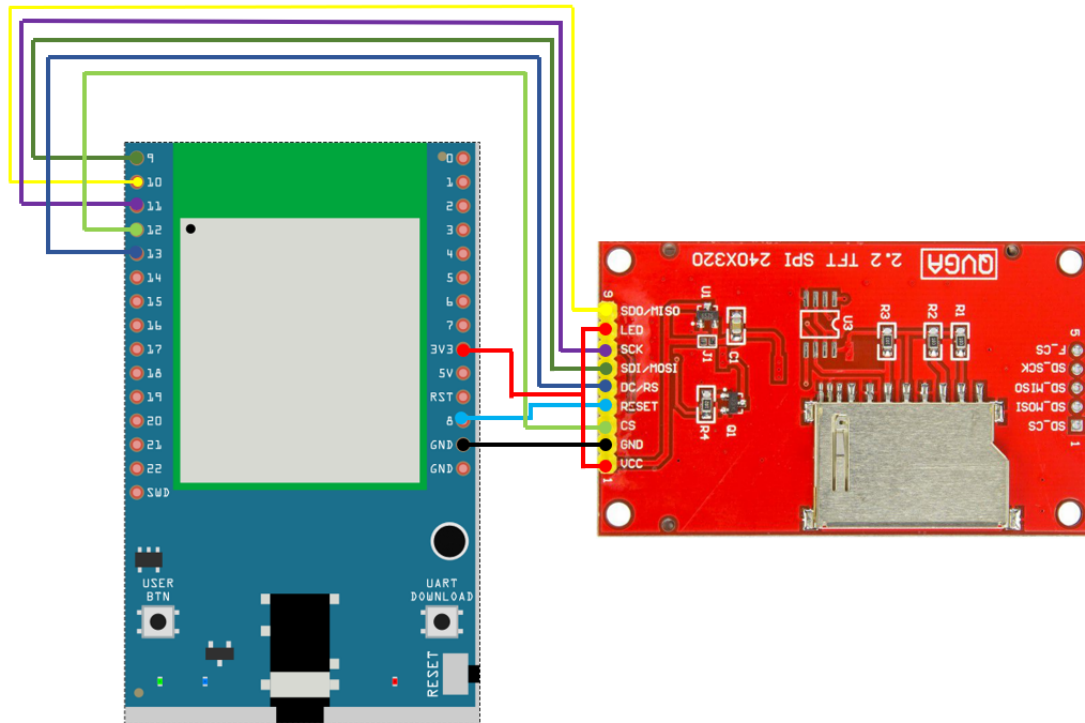
- MOSI: Standard SPI Pin
- MISO: Standard SPI Pin
- SLK: Standard SPI Pin

- CS: Standard SPI Pin
- RESET: Used to reboot LCD.
- D/C: Data/Command. When it is at Low, the signal transmitted are commands, otherwise the data transmitted are data.
- LED (or BL): Adapt the screen backlight. Can be controlled by PWM or connected to VCC for 100% backlight.
- VCC: Connected to 3V or 5V, depends on its spec.
- GND: Connected to GND.

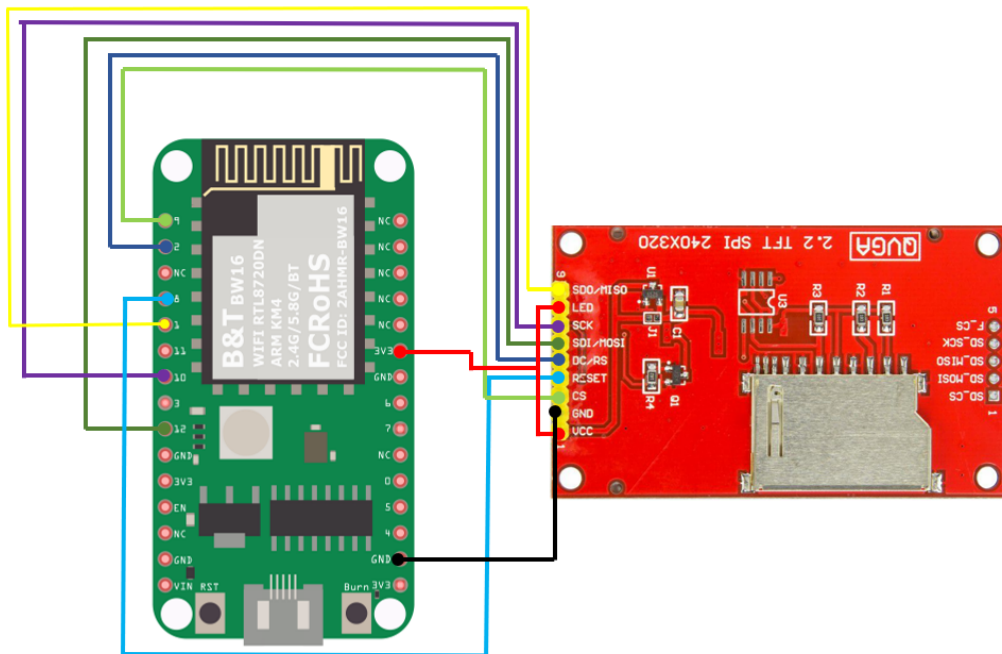
#### AMB21/ AMB22 and QVGA TFT LCD Wiring Diagram:



#### AMB23 and QVGA TFT LCD Wiring Diagram:



**BW16 and QVGA TFT LCD Wiring Diagram:**

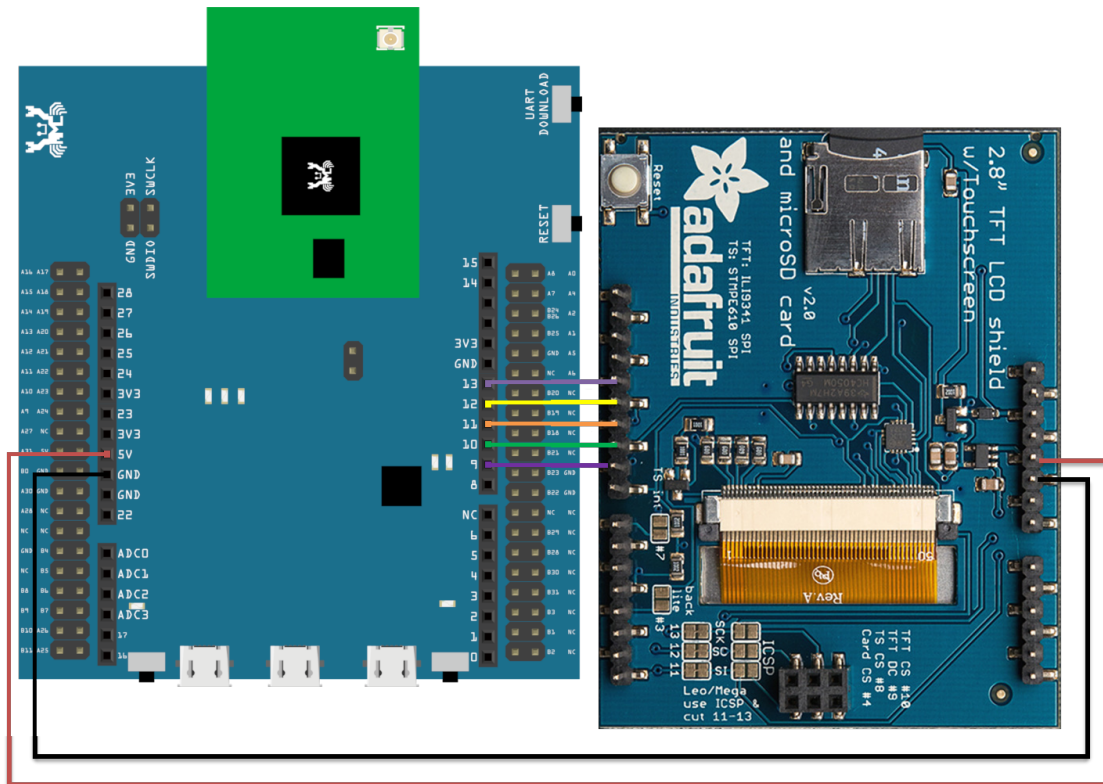


Wiring example of Adafruit 2.8" TFT LCD touch shield:

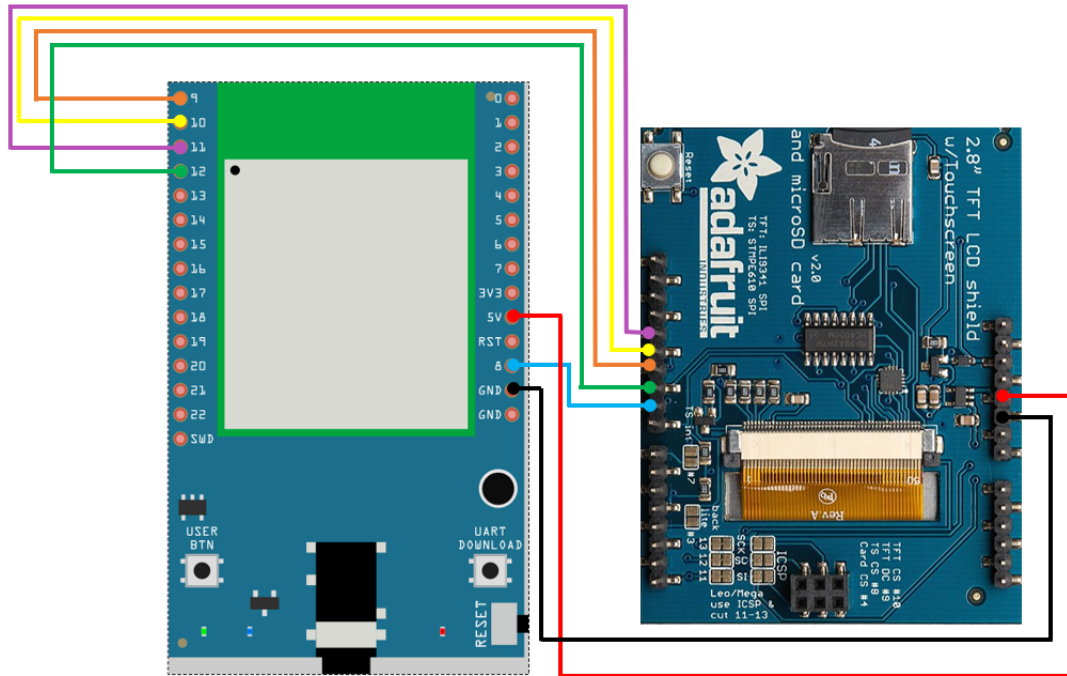
Please note that this shield model enables the backlight by default and pin 8 is not for backlight, and the VCC should be connected to 5V.

## AMB21 / AMB22 and Adafruit 2.8" TFT LCD touch shield Wiring Diagram:

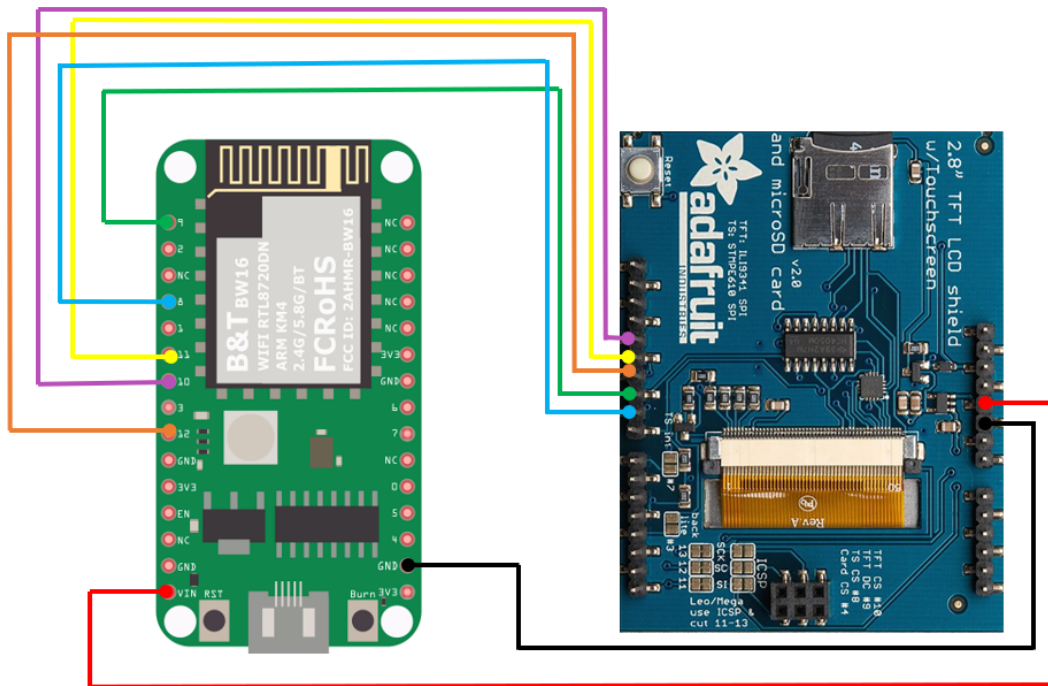
Please note that this shield model enables the backlight by default and pin 8 is not for backlight, and the VCC should be connected to 5V.



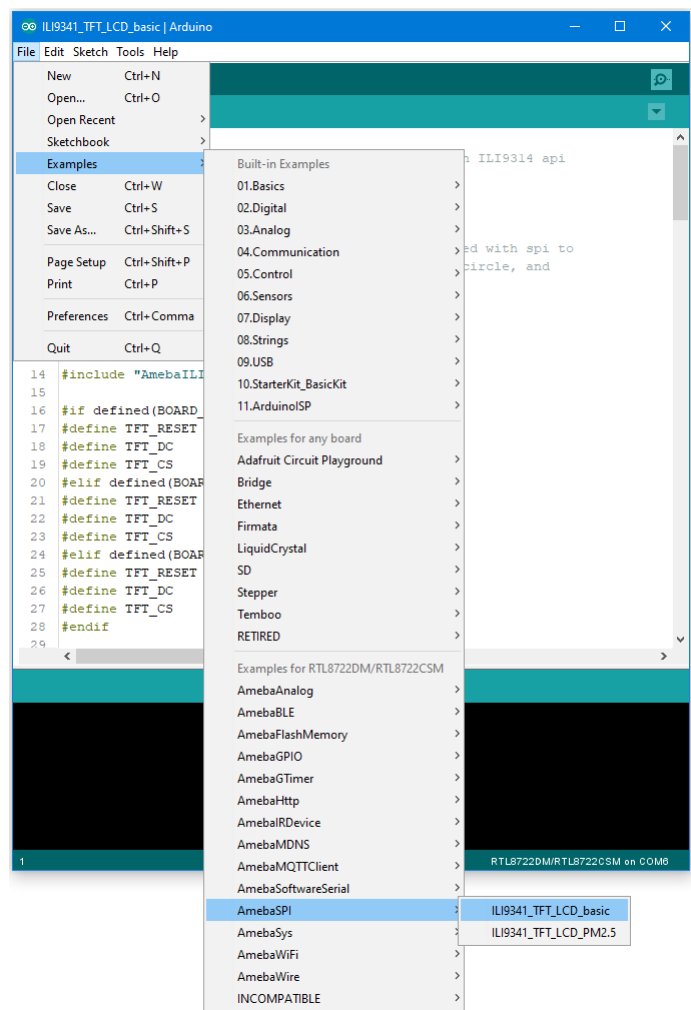
## AMB23 and Adafruit 2.8" TFT LCD touch shield Wiring Diagram:



BW16 and Adafruit 2.8 inch TFT LCD touch shield Wiring Diagram:

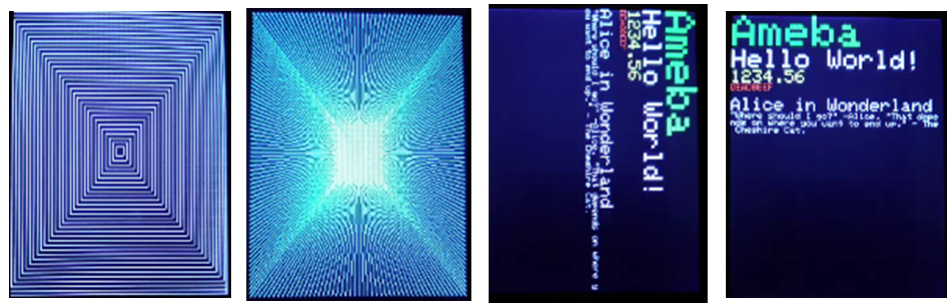


Open the example, “Files” -> “Examples” -> “AmebaSPI” -> “ILI9341\_TFT\_LCD\_basic”



Compile and upload to Ameba, then press the reset button.

Then you can see some display tests appear on the LCD screen, such as displaying different colors, drawing vertical and horizontal lines, drawing circles, etc. ...



Code Reference



- **RGB 16-bit**

ILI9341 uses RGB 16-bit to display colors. Different from RGB 24-bit, it uses 5 bits for red, 6 bits for green, 5 bits for blue. For example, the RGB 24-bit representation of sky blue is 0x87CEFF, that is in binary:

- Red: 0x87 = B10000111
- Green: 0xCE = B11001110
- Blue: 0xFF = B11111111

and converted to RGB 16-bit:

- Red: B10000
- Green: B110011
- Blue: B11111

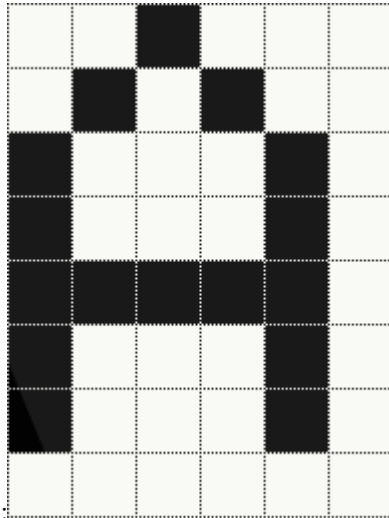
Then concatenate them, which forms B1000011001111111 = 0x867F

- **Drawing of ILI9341**

- First you must specify the range of the rectangle to draw, then pass the 2-byte RGB 16-bit color to ILI9341 corresponding to each pixel one by one, in this way ILI9341 fills each color to each pixel.
- You still must specify the drawing range even though the range covers only one pixel.
- From the rules we mentioned above, we can conclude that drawing vertical or horizontal lines are faster than diagonal lines.

- **Printing text on ILI9341**

- In our API, each character is 5×7 but each character is printed to size 6×8 (its right side and below are left blank), so as to separate from next character. For example, the character “A”



- The font size represents the dot size. For example, if the font size is 2, each dot in the character is a 2×2 rectangle

- **Screen rotation**

- ILI9341 provides 0, 90, 180, 270 degrees screen rotation.
- If the original width is 240 and original height is 320, when the screen rotates 90 degrees, the width becomes 320 and the height becomes 240.

## **SPI –Show PM2.5 Concentration On ILI9341 TFT LCD**

If you are not familiar with SPI, please read [Introduction to SPI](#) first.

### **Preparation**

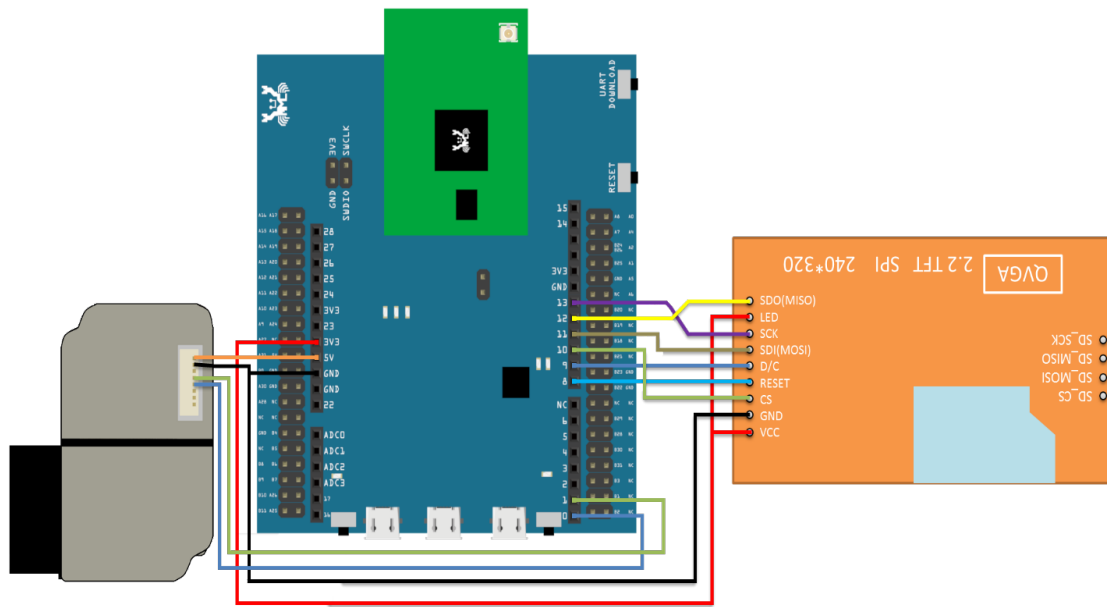
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- ILI9341 TFT LCD with SPI interface x 1
- Plantower PMS3003 or PMS5003 x 1

### **Example**

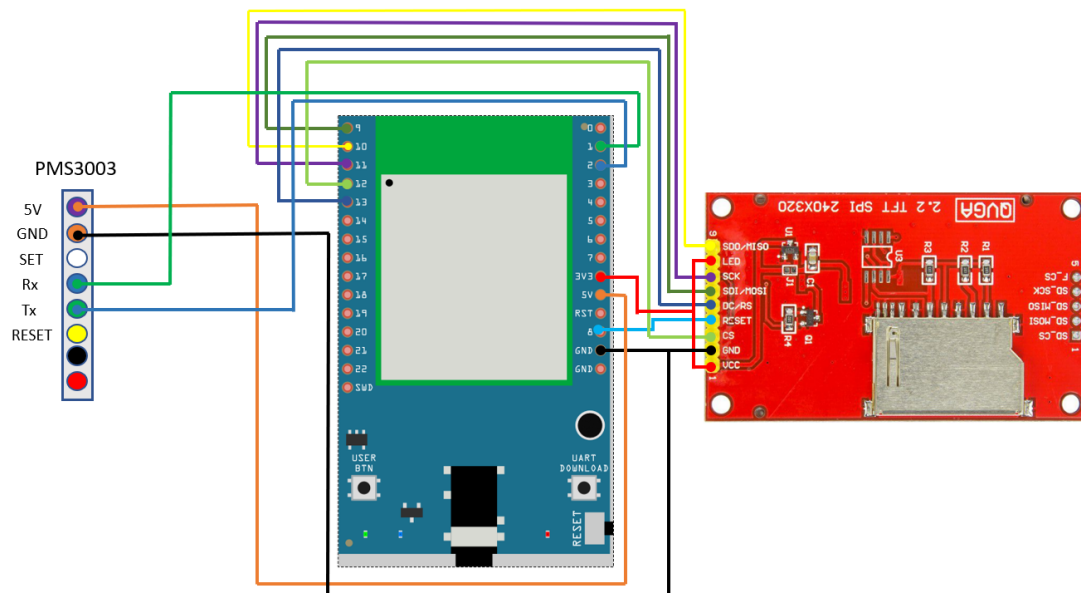
This example extends previous PM2.5 example to show the PM2.5 concentration on the LCD.

**AMB21 / AMB22 and QVGA TFT LCD Wiring Diagram:**

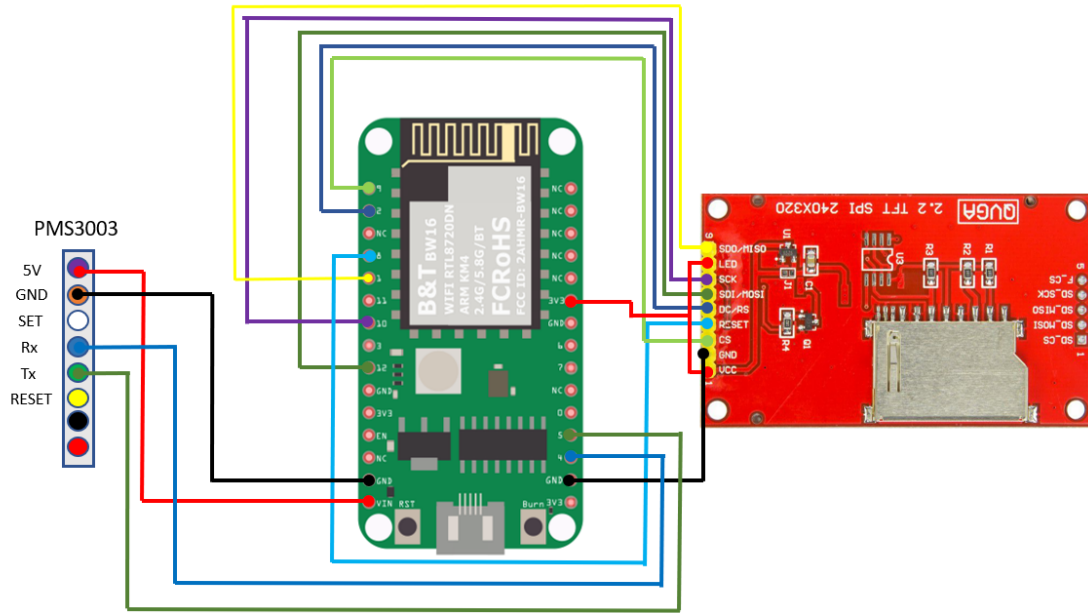
(Note: PMS3003/PMS5003 sensor requires 5V voltage)



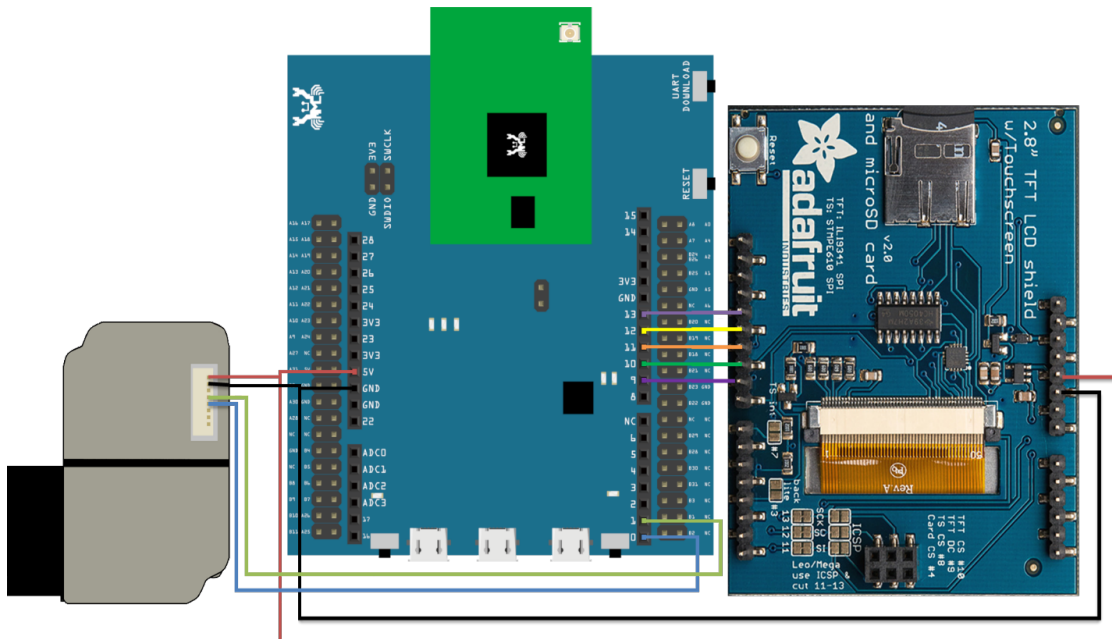
AMB23 and QVGA TFT LCD Wiring Diagram:



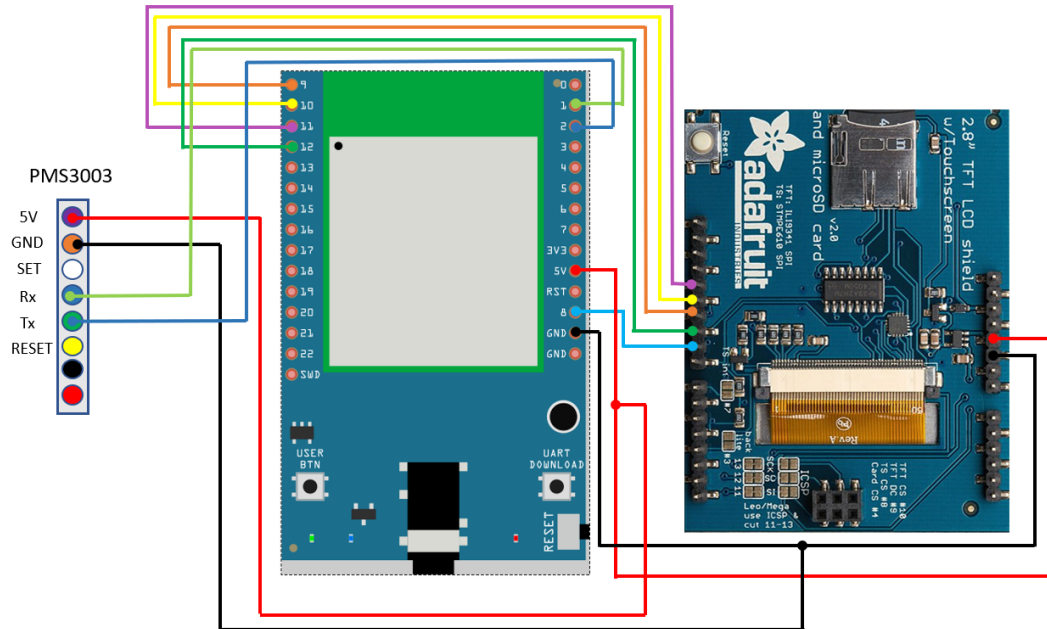
BW16 and QVGA TFT LCD Wiring Diagram:



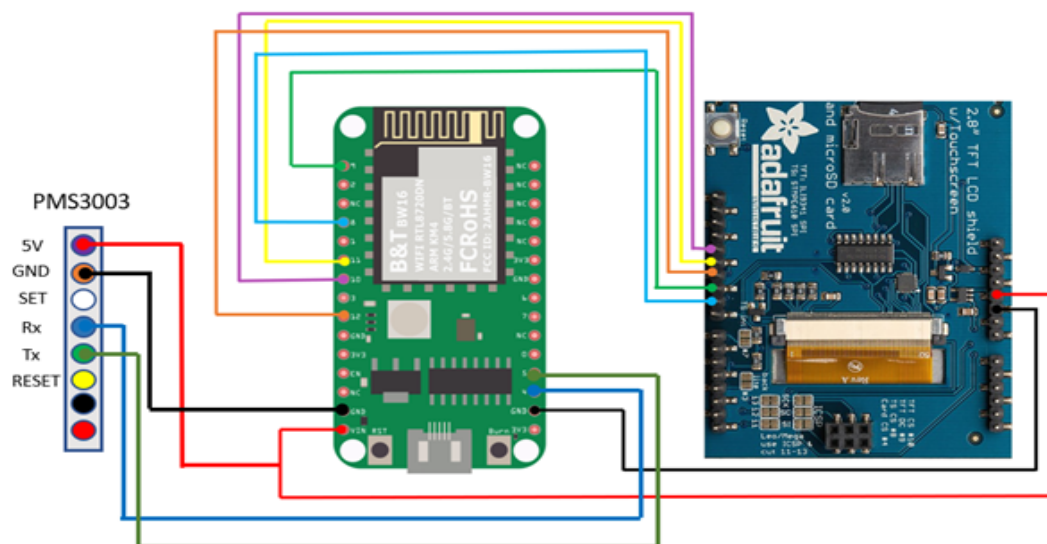
AMB21 / AMB22 and Adafruit 2.8" TFT LCD Wiring Diagram:



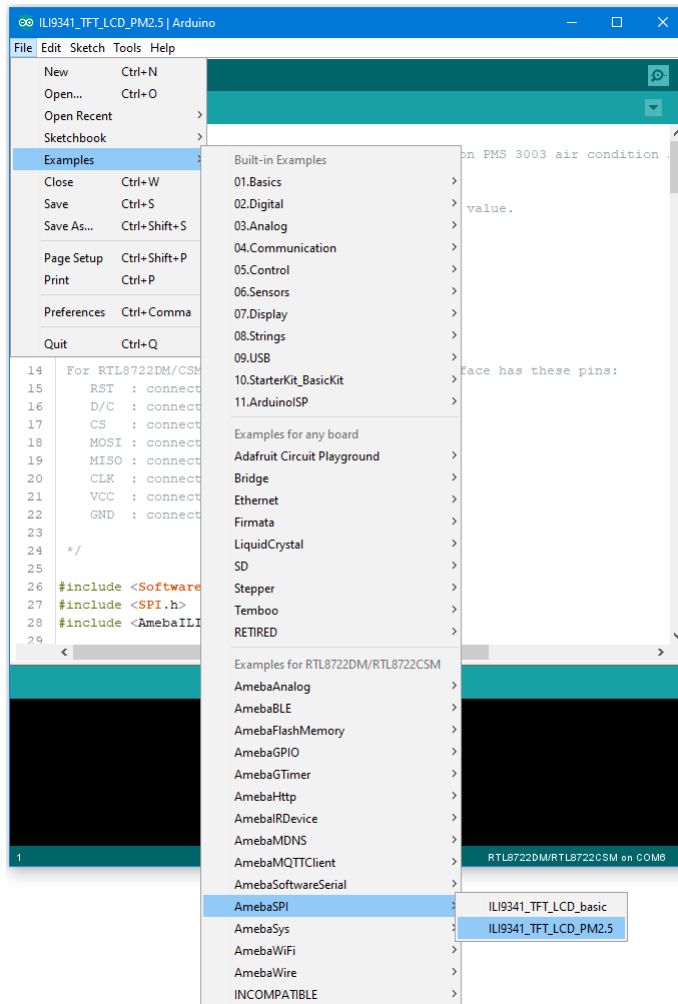
AMB23 and and Adafruit 2.8" TFT LCD Wiring Diagram:



**BW16 and Adafruit 2.8" TFT LCD Wiring Diagram:**

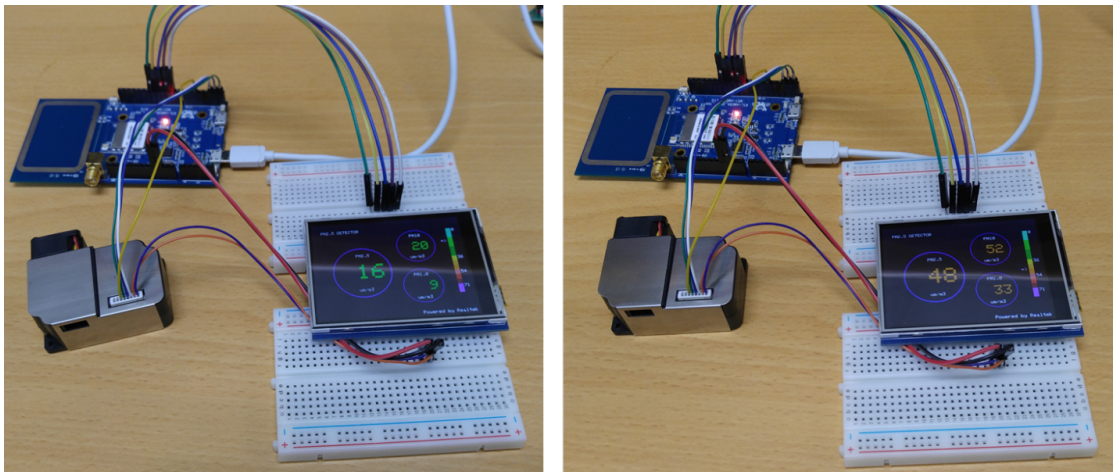


Open the example, “Files” -> “Examples” -> “AmebaSPI” -> “PM25\_on\_ILI9341\_TFT\_LCD”



Compile and upload to Ameba, then press the reset button.

Then you can see the concentration value of PM1.0, PM2.5 and PM10 on the LCD.



## Code Reference

In this example, first rotate the screen by 90 degrees, and draw the static components such as the circles, the measuring scale, and the title text. After the concentration value is detected, it is printed inside the circle.

## UART - Communicate with PC over USB to Serial Module

### Introduction of UART

UART uses two wire, one for transmitting and the other one for receiving, so the data transmission is bidirectional. The communication uses a predefined frequency (baud rate) to transmit data. In Arduino, UART is called “Serial” . There is only one hardware UART on Arduino Uno and it is primarily used to read the log and messages printed by Arduino (so it is also called “Log UART” ). If we use the hardware UART for other purposes, the Log UART does not have resources to function. To provide more UART connections, it is possible to use a GPIO pin to simulate the behavior of UART with a software approach, this is called Software Serial. Ameba is equipped with several hardware UART ports, but it is also compatible with the Software Serial library.

### Materials

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- USB to TTL Adapter x 1

### Example

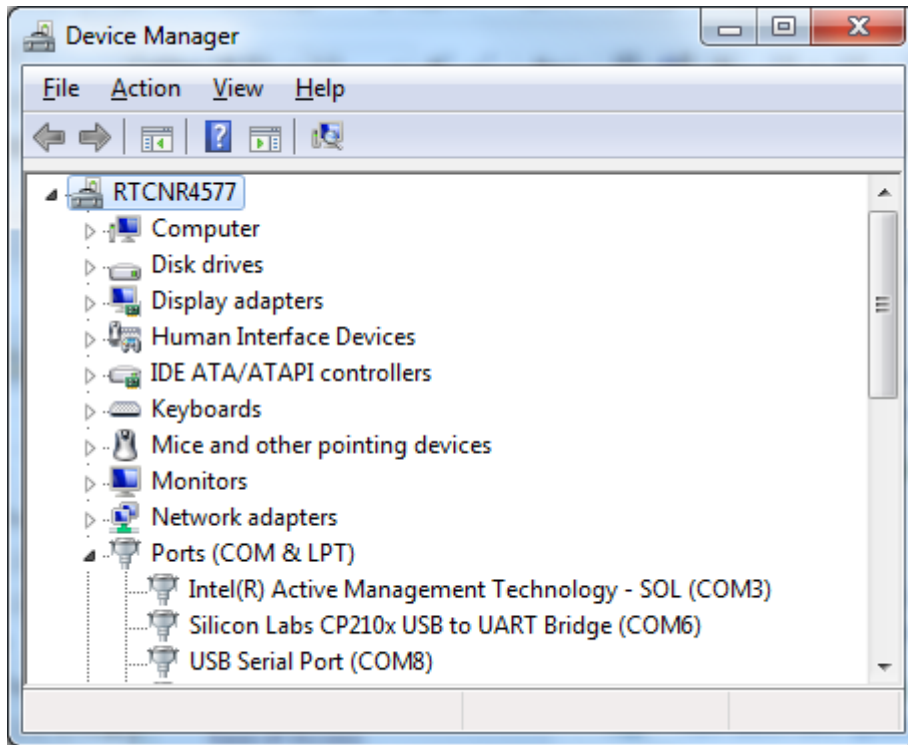
In this example, we use UART to connect USB to TTL adapter to Ameba.

USB to TTL adapter sends data to Ameba, the data would be returned by Ameba, and showed on the screen.

- **Install USB to TTL Adapter**

USB to TTL adapter converts USB to serial interface. Normally, there are at least 4 pins on the adapter, that is 3V3 (or 5V), GND, TX and RX. Generally, installing the driver for the USB to TTL adapter would be required before using it. If the adapter uses the chip of FTDI, Windows will search and install the driver automatically, otherwise, you may need to install corresponding driver yourself.

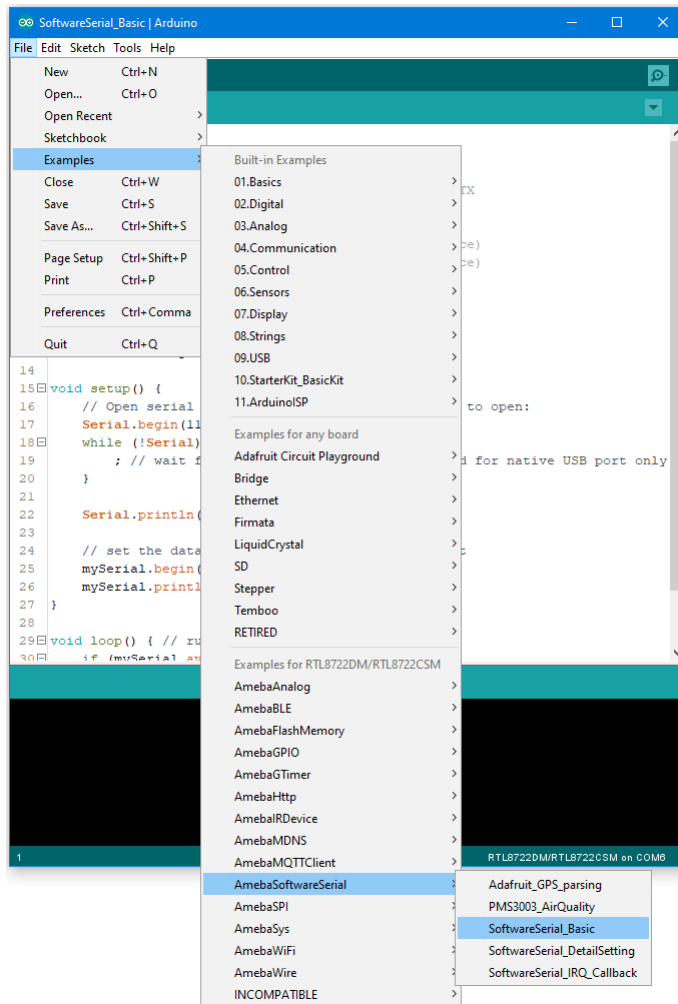
Afterwards, open device manager. You can find corresponding serial port number of the USB to TTL adapter:



- Executing the Example

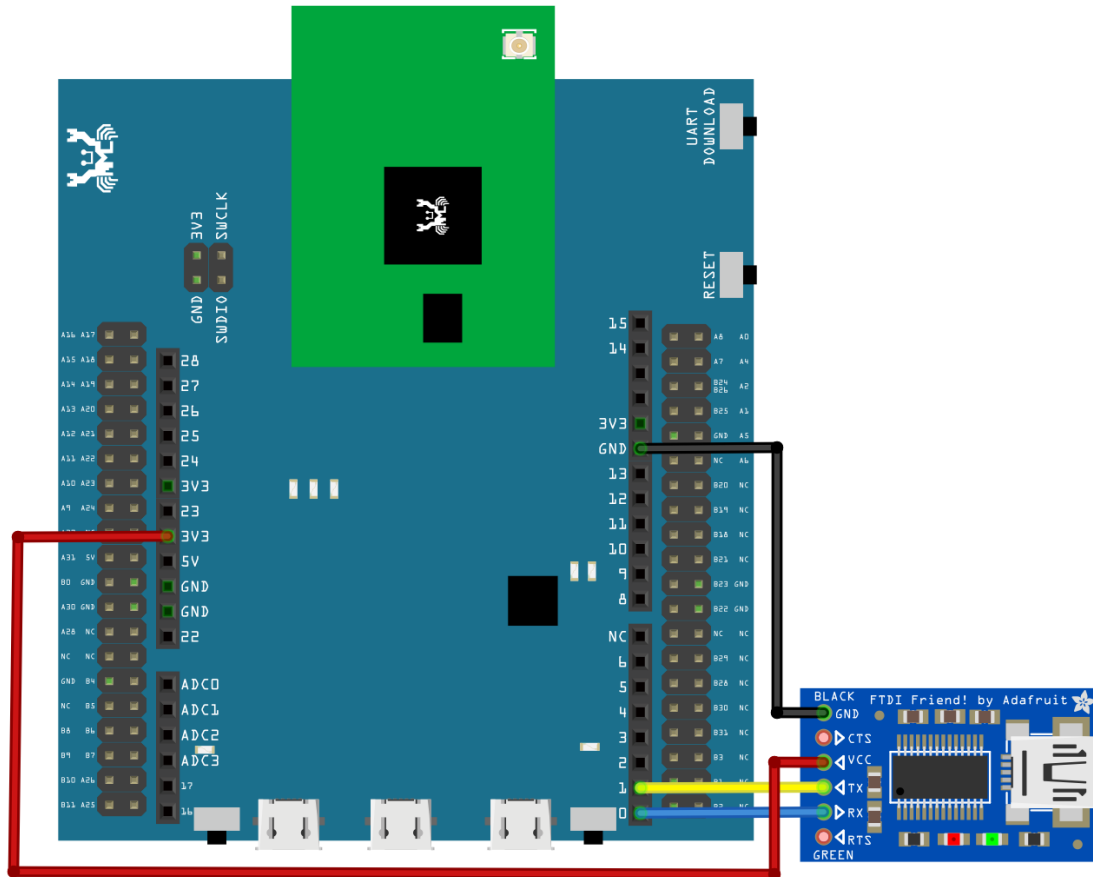
Open the “SoftwareSerialExample” example in “File” -> “Examples” -> “AmebaSoftwareSerial”  
-> “SoftwareSerial\_Basic” :

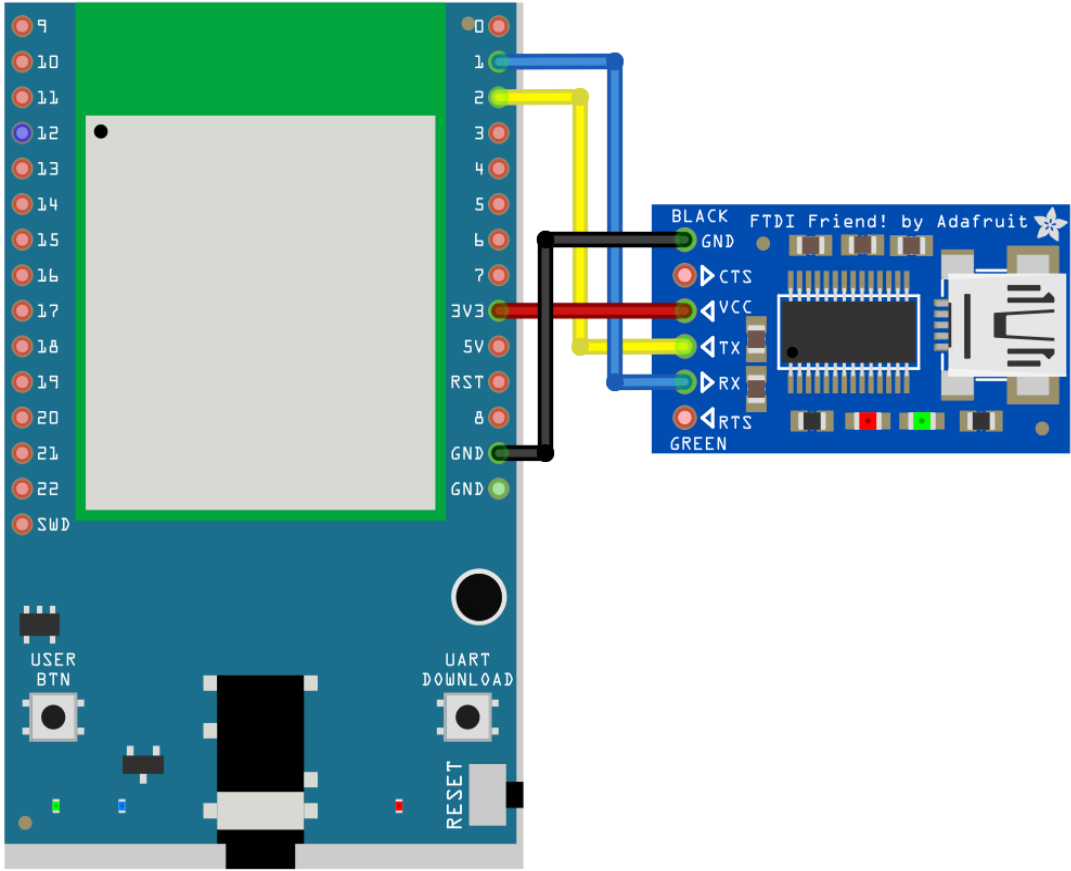




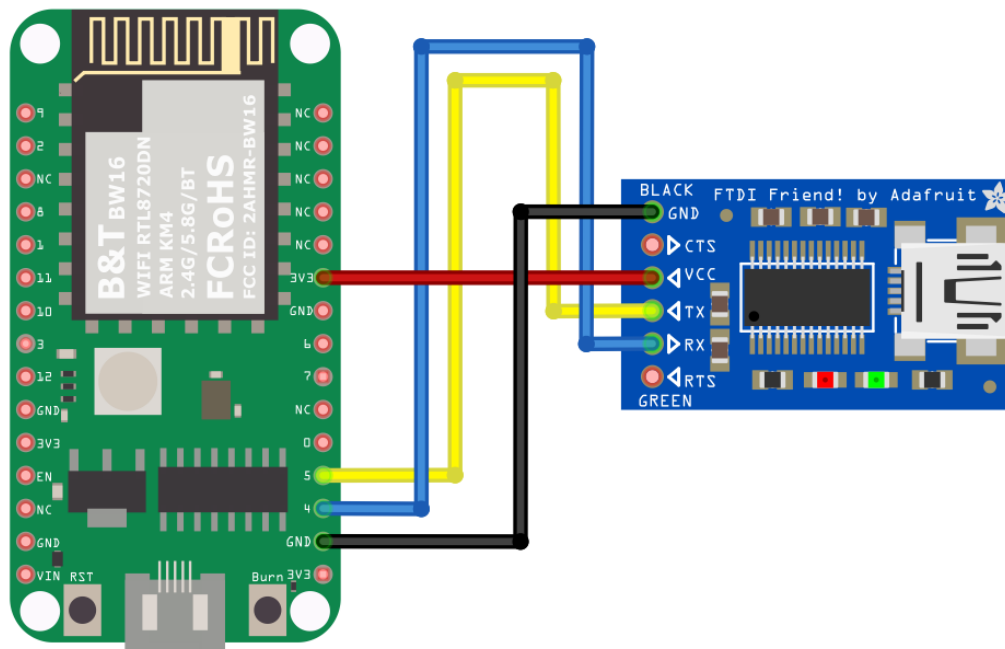
Connect the wire as the following diagrams show. The TX pin of USB to TTL adapter is connected to the RX of Ameba, and the RX pin of USB to TTL adapter is connected to the TX of Ameba.

**AMB21 / AMB22 Wiring Diagram:**

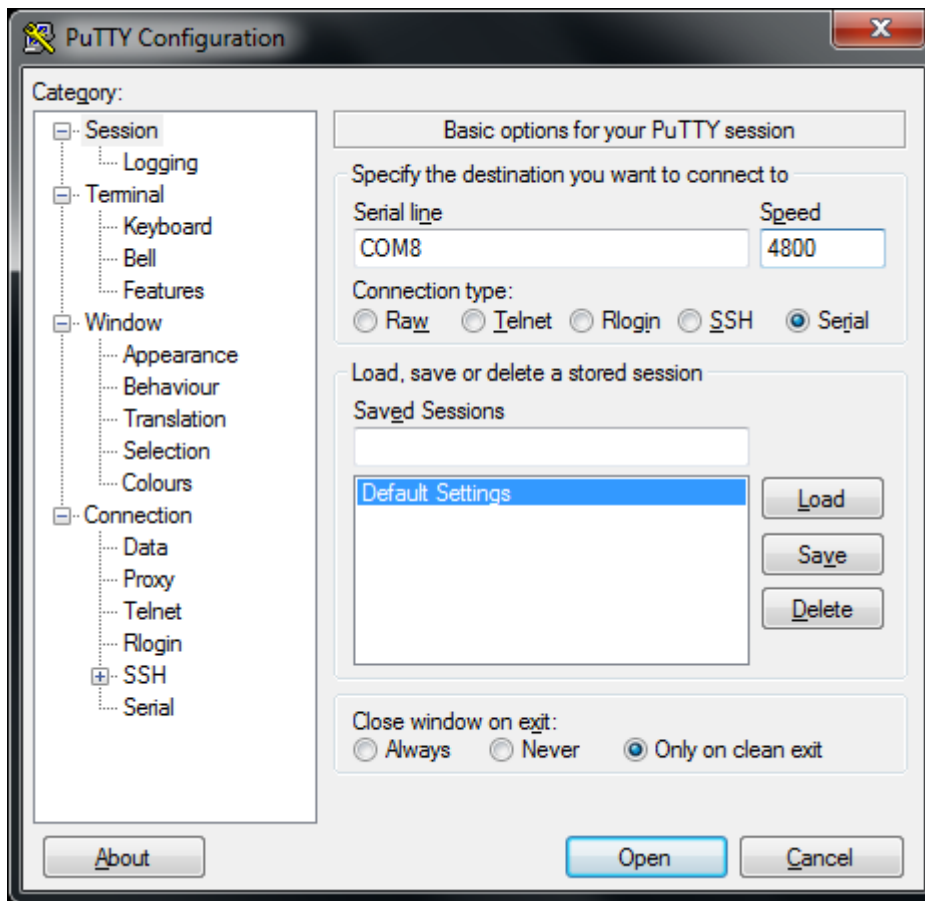




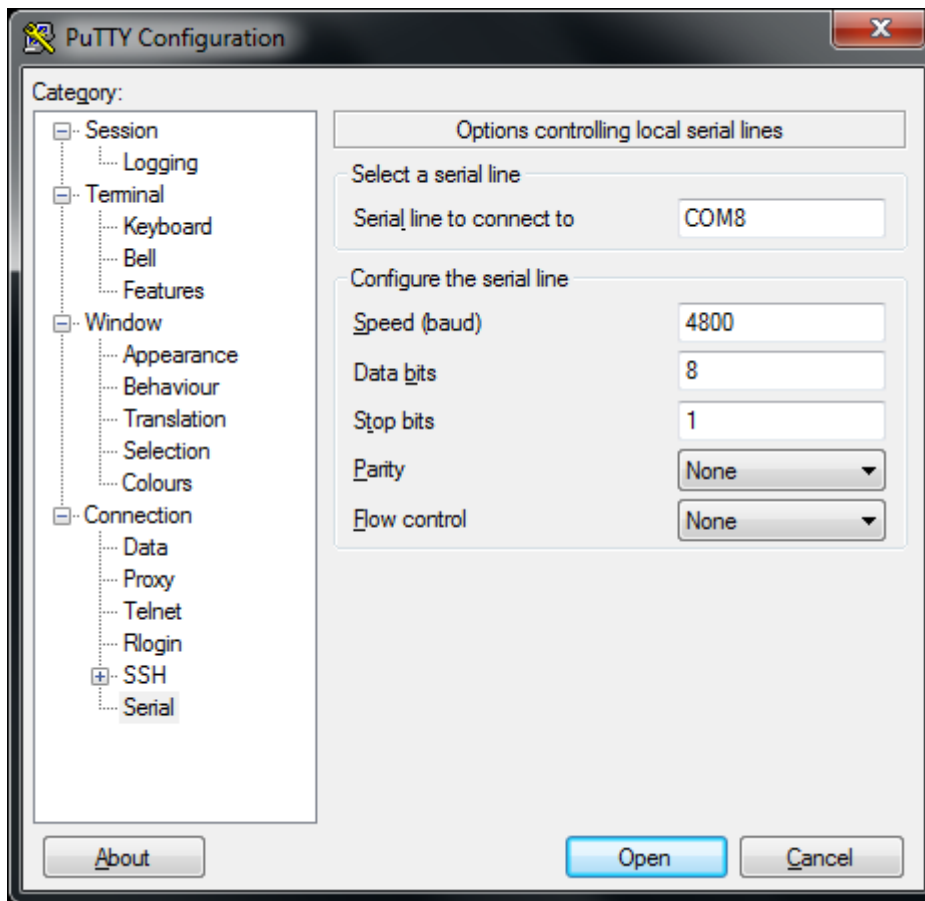
### BW16 Wiring Diagram:



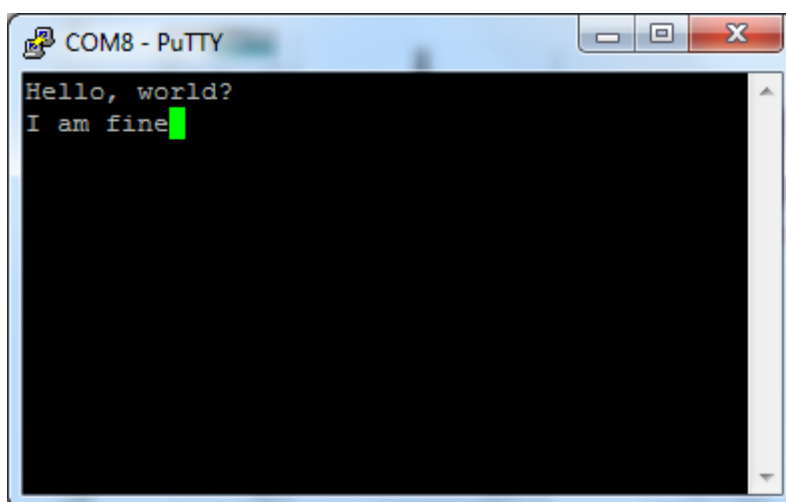
Next, open a serial port terminal, such as Putty or Tera Term. (Putty is used in this example). Open the Putty window, choose “Serial” in connection type, and specify the port number of the USB to TTL adapter (e.g. COM8). In the speed field, fill in the baud rate of this connection. Note that both sides of the connection should use the same baud rate. In this example we set baud rate 4800.



Next, select “Serial” on the left side. Set data bits to 8, stop bits to 1, parity to none, and flow control to none.



Then click Open and press the reset button on Ameba. You can see the “Hello, world?” message appears in Putty. If characters are typed into Putty, the input characters would be sent to Serial RX of Ameba by TX of USB to TTL Adapter, and returned by Serial TX of Ameba. Finally, RX of USB to TTL Adapter receives the returned characters and prints them in Putty. Therefore, if you insert “I am fine” , you will get something like this:



## Code Reference

First, use `SoftwareSerial::begin(speed)` to set the baud rate for the serial communication:

<https://www.arduino.cc/en/Reference/SoftwareSerialBegin>

Use `write()` to send data, and use `SoftwareSerial::available()` to get the number of bytes available for reading from a software serial port:

<https://www.arduino.cc/en/Reference/SoftwareSerialAvailable>

If there are data available to read, use `read()` to read from serial port.

## UART - Retrieve GPS Position

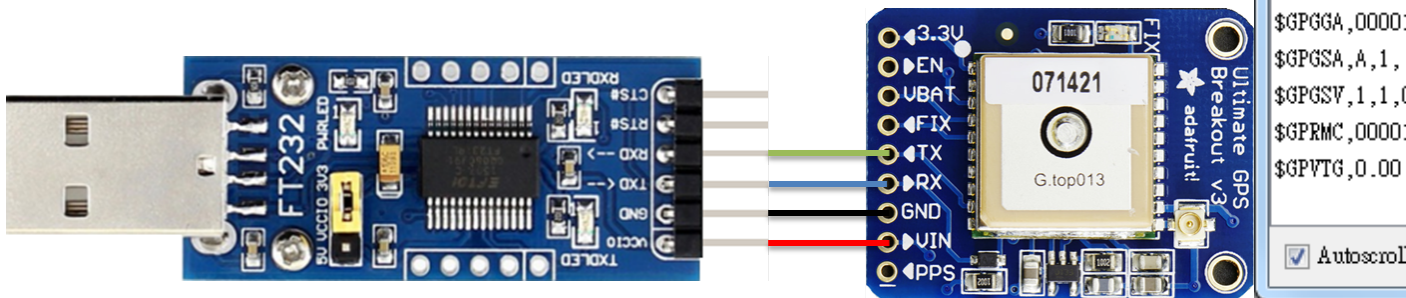
### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- Adafruit Ultimate GPS Breakout x 1 (Refer to official document)

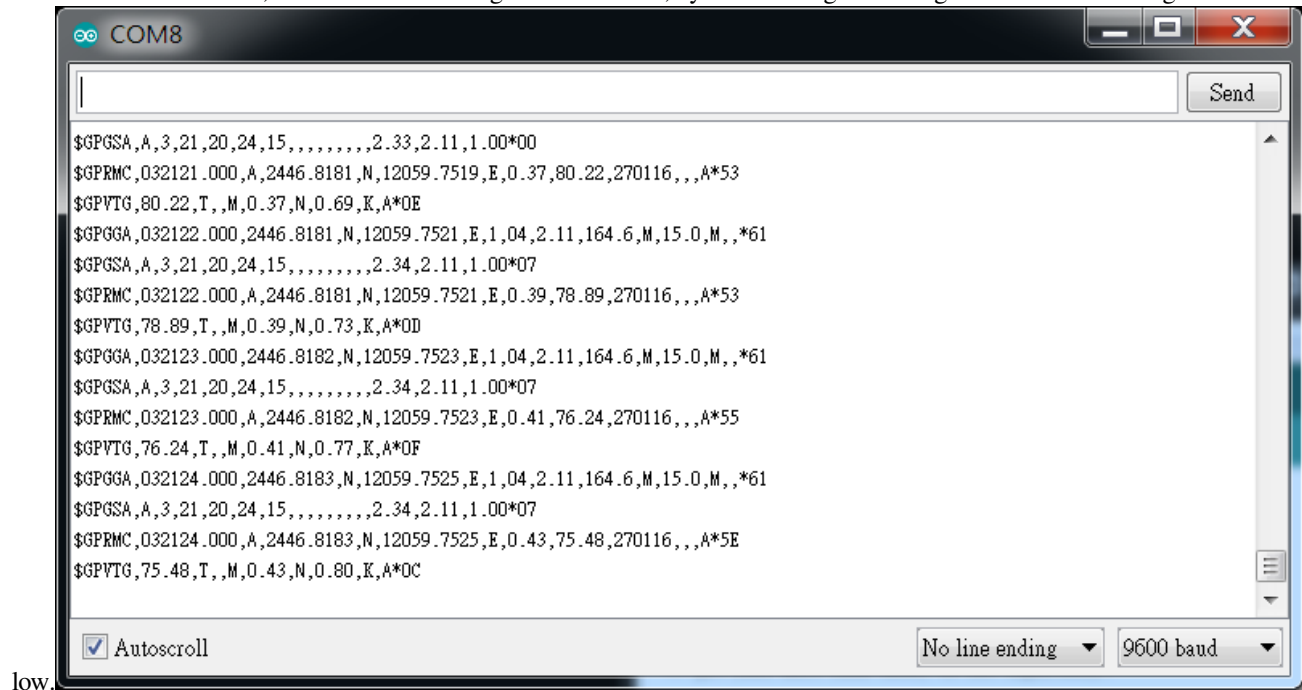
### Example

In this example, we use Adafruit Ultimate GPS Breakout. Its data format is pure text, so we can connect it to USB to TTL Adapter and observe the out-

put.



It follows the NMEA sentence format (refer to <http://aprs.gids.nl/nmea/>) The GPS signal is weak in indoor environment. The status that the GPS signal is not received is called “not fix”. Bring the GPS module outdoors, when the GPS signal is “fix”, you would get message similar to the figure below.



In this example we are only interested in the “\$GPRMC (Global Positioning Recommended Minimum Coordinates)” :  
**\$GPRMC,032122.000,A,2446.8181,N,12059.7251,E,0.39,78.89,270116,,,A\*53**

Each field is separated by a comma.

- First field is the GMT time (Greenwich Mean Time), that is 032122.000 in this example. The time format is HH:MM:SS.SSS, i.e., 03:21:22.000. Note that the time zone and the daylight-saving time adjustment should be handled on your own.
- Second field represents the status code
  - V: Void (Invalid)
  - A: Active, meaning the GPS signal is fix.
- The third to sixth fields represent the geolocation

In this example, 2446.8181,N represents 24 degrees 46.8181 minutes north latitude, and 12059.7251,E represents 120 degrees 59.7251 minutes east longitude.

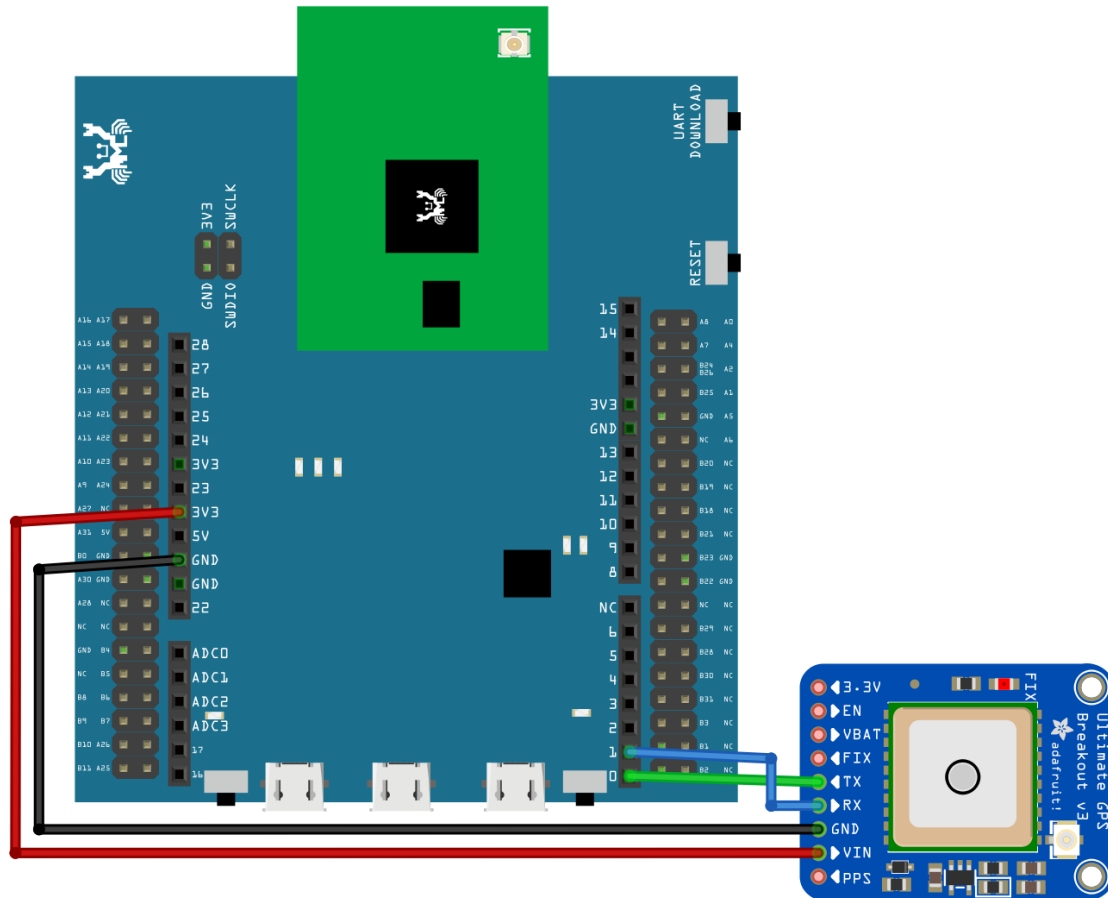
We can search **+24 46.8181'** , **+120 59.7251'** in Google map to check whether the position is cor-



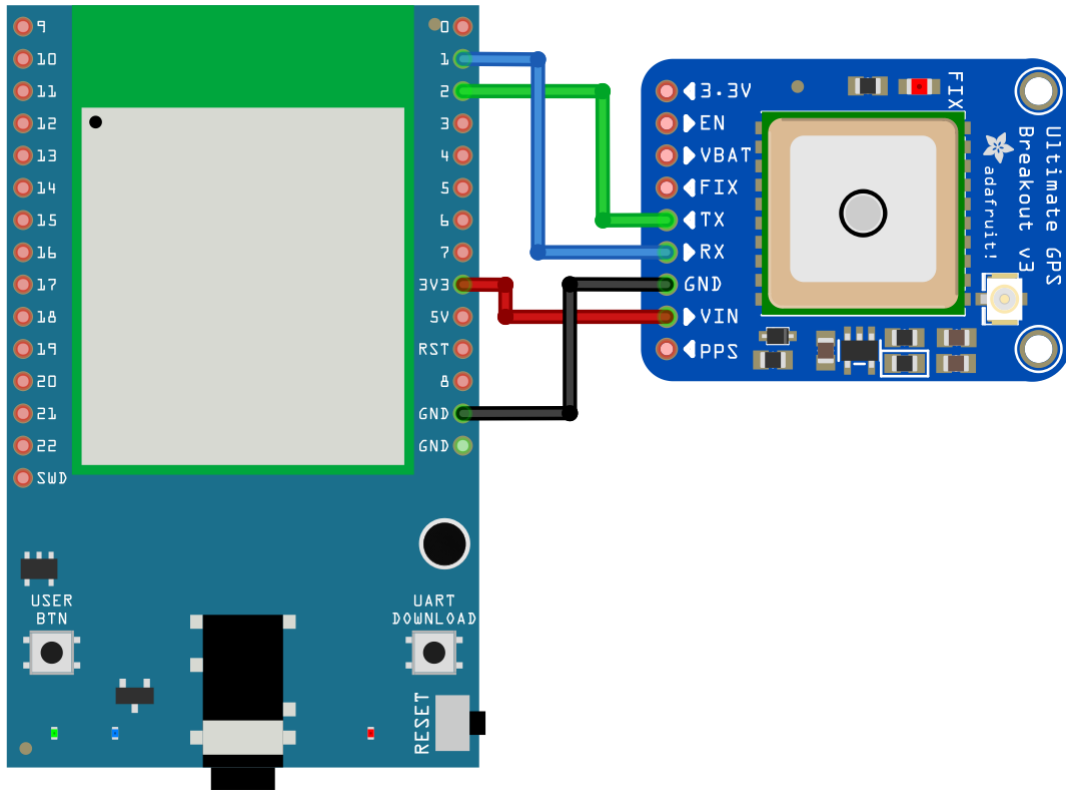


- The seventh field is relative speed(knot). 1 knot = 1.852km/hr, in this example the relative speed is 0.39 knot.
- The eighth field is the moving angle, which is calculated by its moving orbit.
- The ninth field is the date with format ddMMyy. In this example, “270116” stands for day 27, January, year 2016.
- The last field is checksum. In the example we have \*53 as checksum.

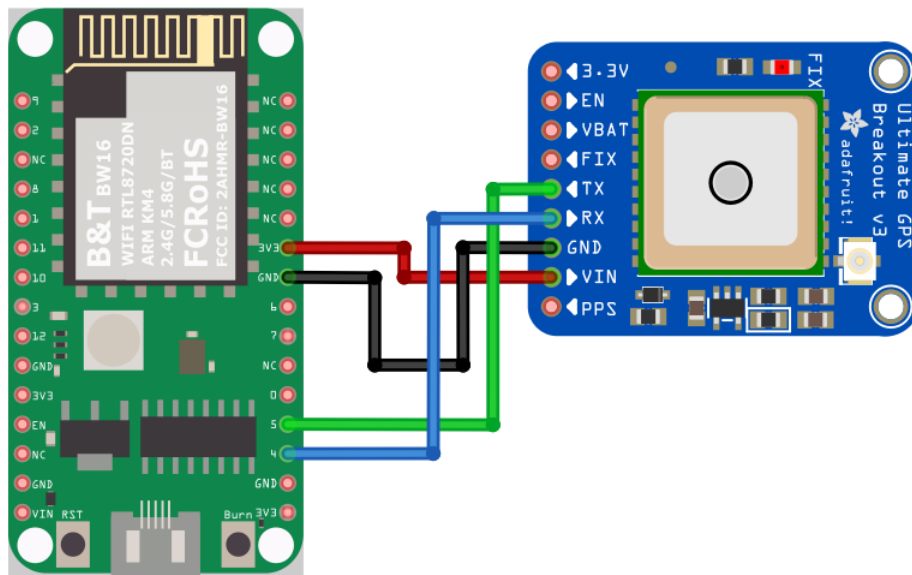
**AMB21 / AMB22** Wiring Diagram:



AMB23 Wiring Diagram:



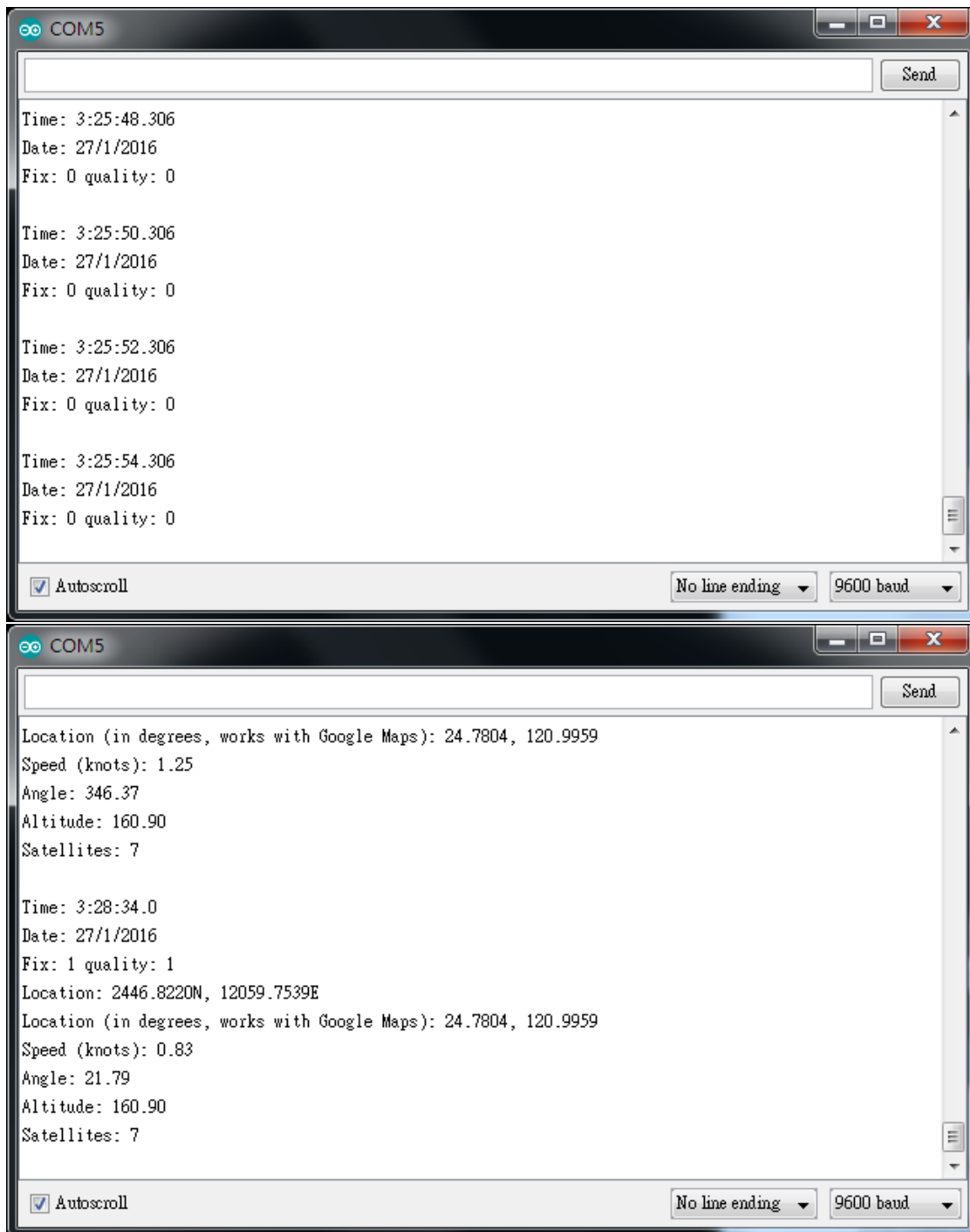
AMB23 Wiring Diagram:



Open the example in “Files” -> “Examples” -> “AmebaSoftwareSerial” -> “Adafruit\_GPS\_parsing” .

Compile and upload to Ameba, then press the reset button.

The result will be output to Serial Monitor:



## UART –Set Callback Function For UART Communications

### Materials

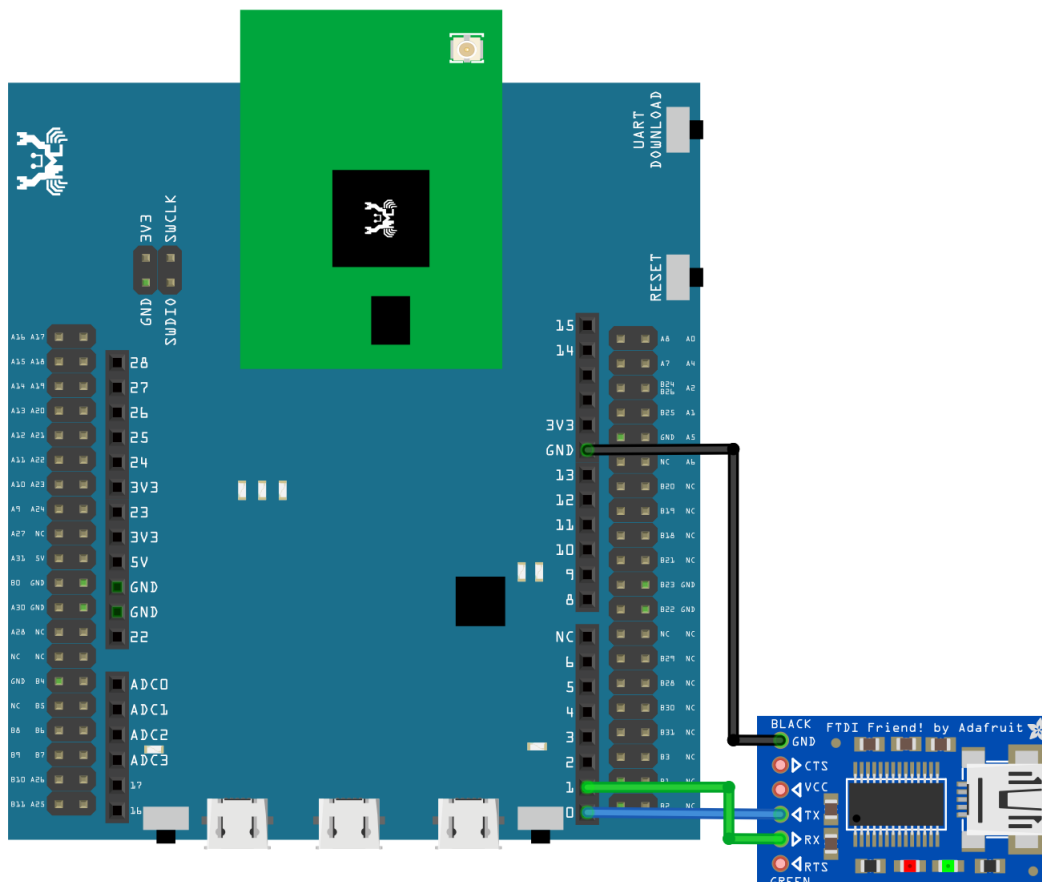
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- USB to TTL Adapter x 1

### Example

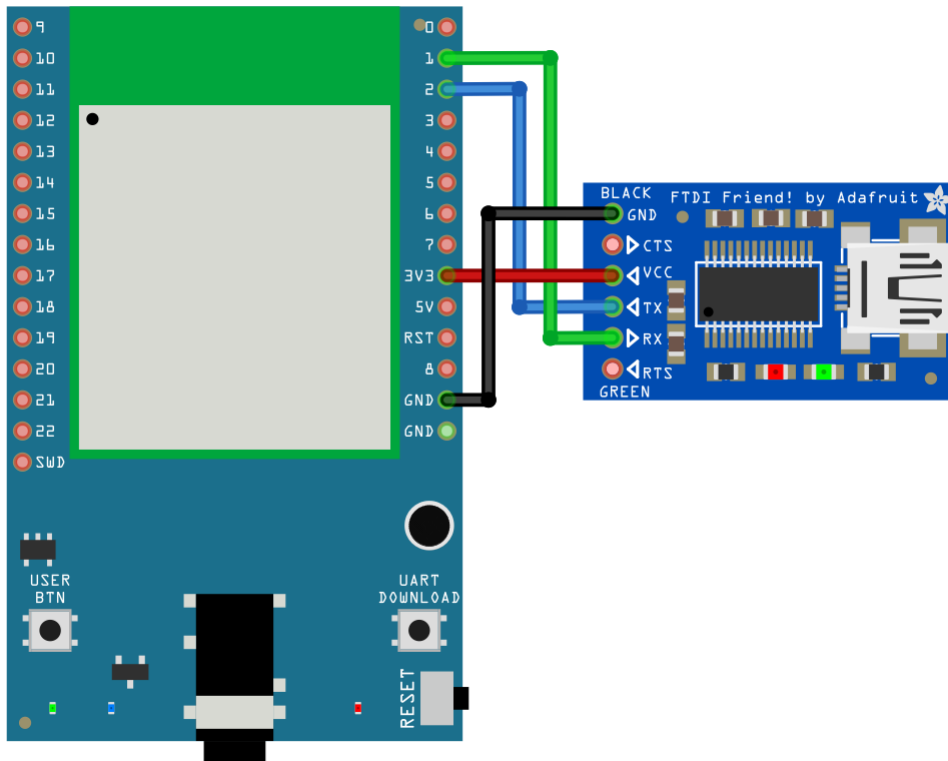
This example shows how to set a callback function for UART communication to process the UART data.

A USB to TTL adapter is required for this example. Ensure that you have the driver installed and connect it to the Ameba board as shown.

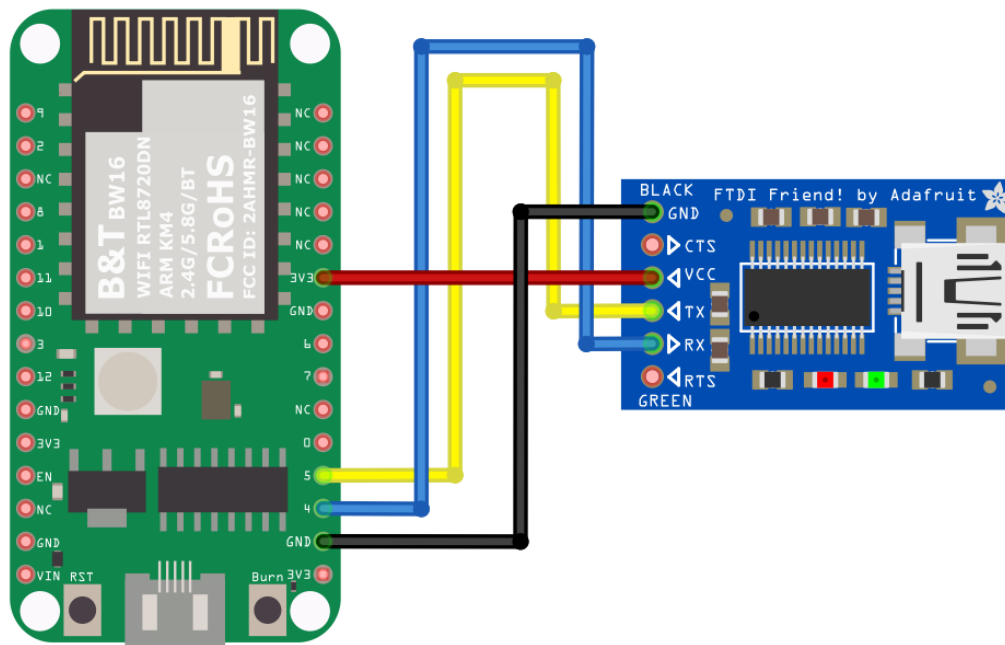
AMB21 / AMB22 Wiring Diagram:



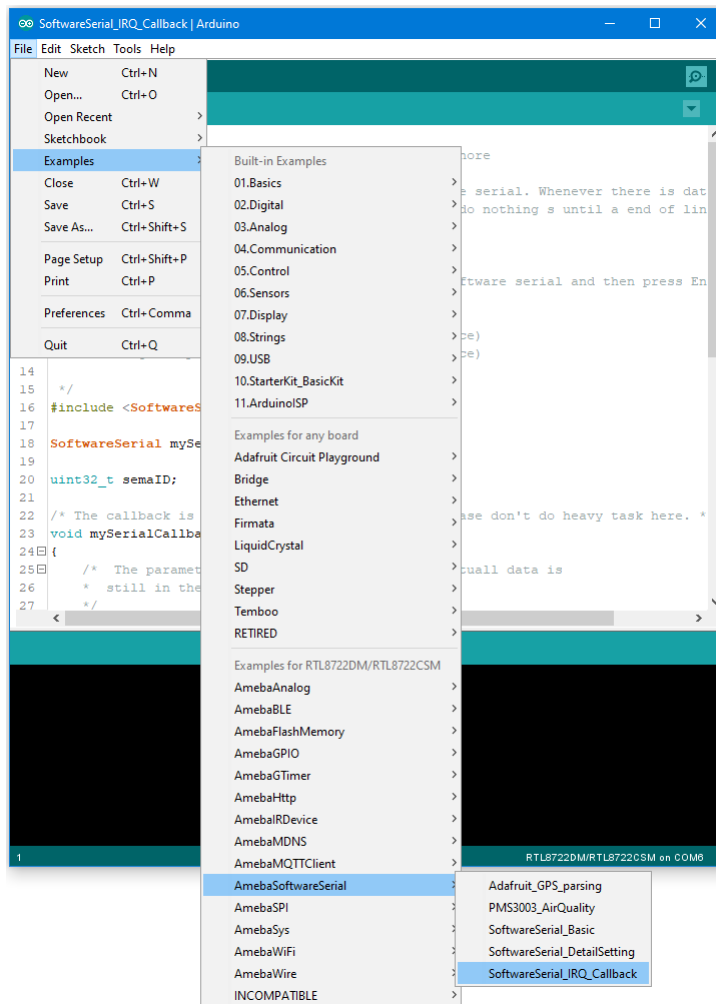
AMB23 Wiring Diagram:



BW16 Wiring Diagram:



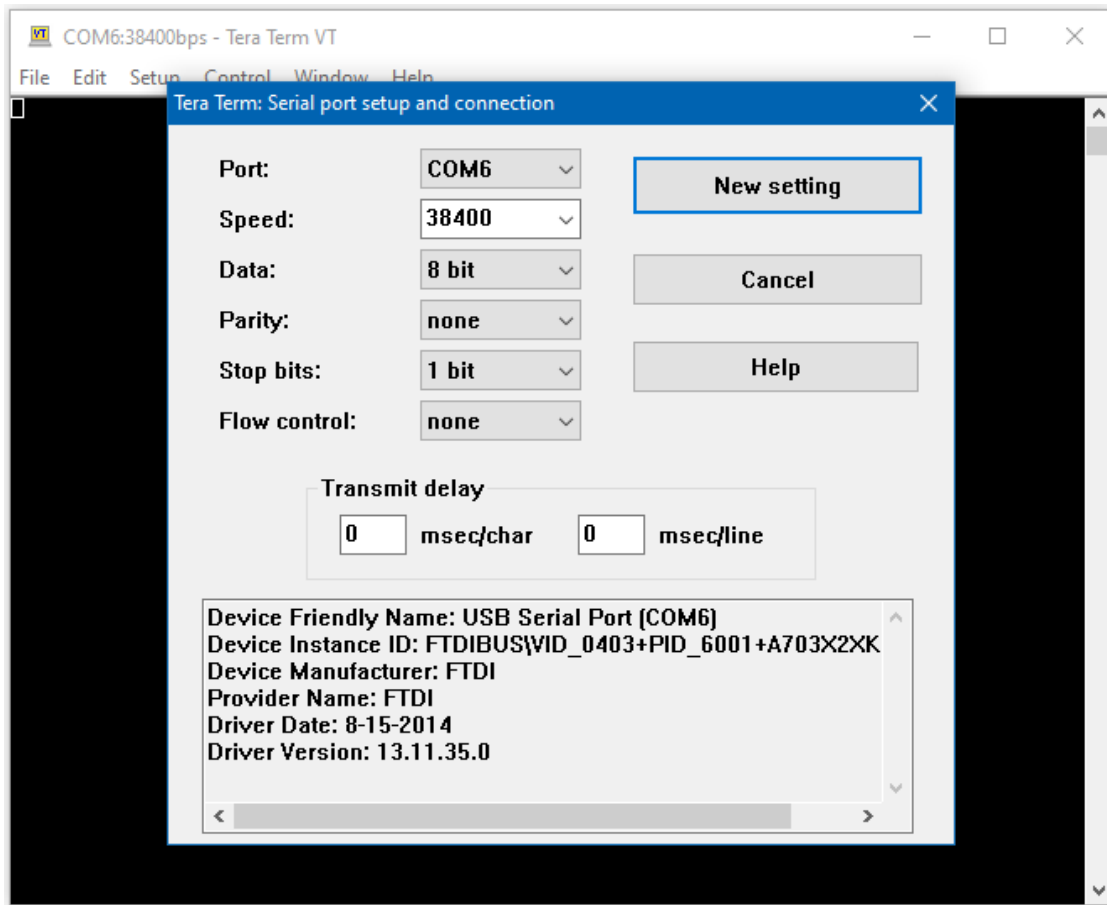
Open the example in “File” -> “Examples” -> “AmebaSoftwareSerial” -> “SoftwareSerial\_Irq\_Callback”



Upload the code and press the reset button on Ameba once the upload is finished.

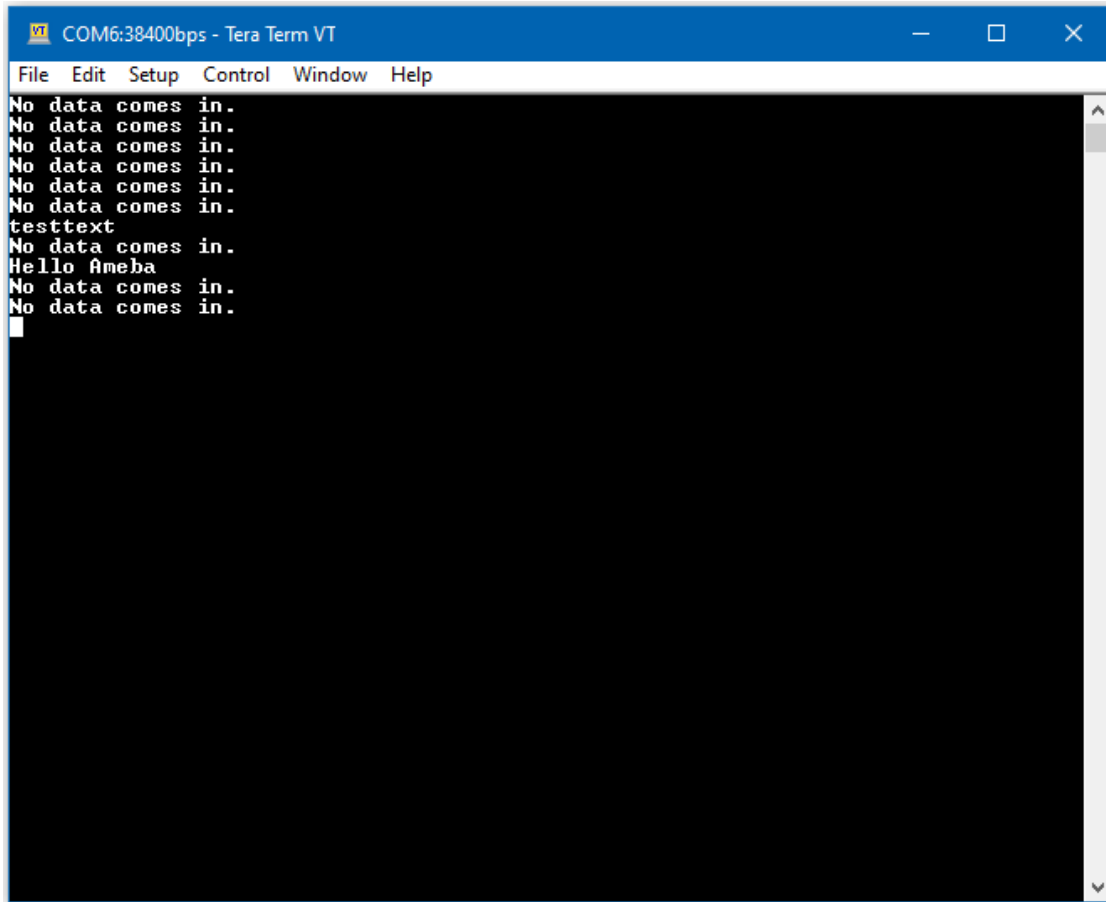
Next, using a terminal program, such as TeraTerm or PuTTY, open a serial port and configure it according to the settings. Make sure the serial port number corresponds to the USB to TTL adapter.

- Speed: 38400
- Data: 8 bit
- Parity: none
- Stop bits: 1 bit
- Flow control: none



Once the serial port is open, type in the terminal and press the enter key, and you will see the corresponding output.



A screenshot of a Tera Term VT window titled 'COM6:38400bps - Tera Term VT'. The window has a menu bar with 'File', 'Edit', 'Setup', 'Control', 'Window', and 'Help'. The main area is a black terminal with white text. The text shows a sequence of 'No data comes in.' messages, followed by 'testtext', and then 'Hello Ameba'. The window has standard Windows-style window controls (minimize, maximize, close) in the top right corner and a vertical scrollbar on the right side.

```
COM6:38400bps - Tera Term VT
File Edit Setup Control Window Help
No data comes in.
No data comes in.
No data comes in.
No data comes in.
No data comes in.
No data comes in.
testtext
No data comes in.
Hello Ameba
No data comes in.
No data comes in.
```

### Code Reference

`mySerial.setAvailableCallback(mySerialCallback)` ; is used to set the function `mySerialCallback` as a callback function for software serial. When a new character is received, the callback function checks if the character corresponds to the enter key, and releases the semaphore if it is true, which in turn allows the main loop to print out all the previously received characters.

## UART - PM2.5 Concentration in The Air

### Preparation

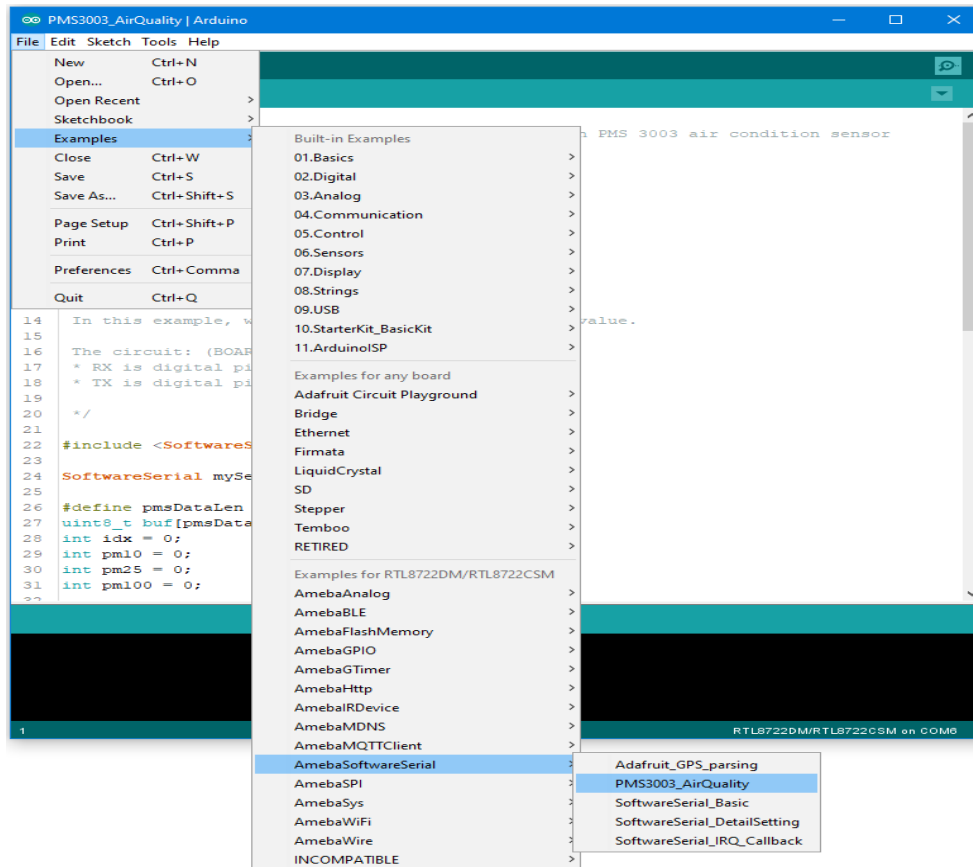
- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1
- PlanTower PMS3003 or PMS5003 x 1

### Example

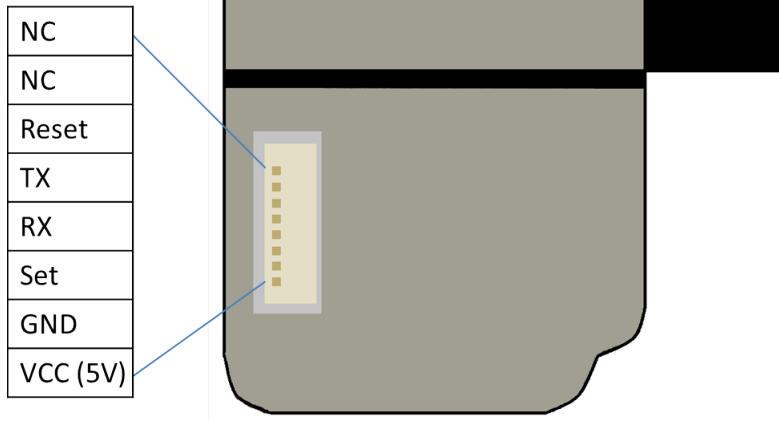
PMS3003 (or PMS5003) is a sensor of air quality, it can detect the concentration of those 0.3 to 10 micrometer particulate matters in the air. The sensor output its data via UART.

The PMS3003 (or PMS5003) sensor detects the concentration value of PM 1.0, PM 2.5, PM 10. Take PM 2.5 for example, it stands for the fine particles with a diameter of 2.5 micrometers or less.

Open the example in “File”-> “Examples”-> “AmebaSoftwareSerial”-> “PMS3003\_AirQuality”



There are 8 pins in PMS3003:

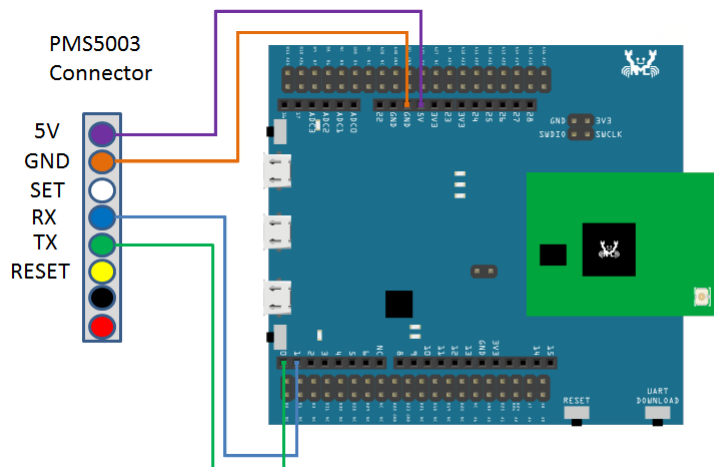


PMS3003 requires 5V power, but the working voltage of its IC is 3.3V. Therefore, the working voltage of Reset, TX, RX, Set are 3.3V as well. If the “Set” pin is pulled to high, the PMS3003 is put to operating mode. If the “Set” pin is pulled low, the PMS3003 is put to standby mode.

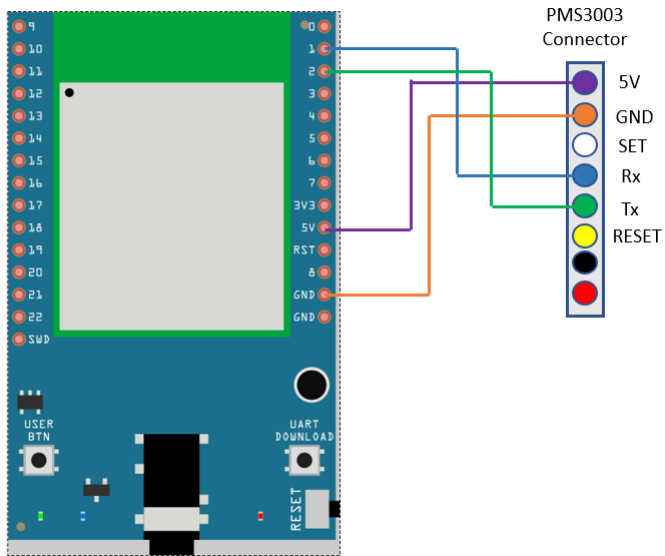
TX/RX pins are for UART connection. Under operating mode, PMS3003 outputs the data it reads continuously. Each data is of 32 bytes, please refer to the following article for detailed data format information:

[https://www.dfrobot.com/wiki/index.php?title=PM2.5\\_laser\\_dust\\_sensor\\_SKU:SEN0177\\_RTL8722](https://www.dfrobot.com/wiki/index.php?title=PM2.5_laser_dust_sensor_SKU:SEN0177_RTL8722)

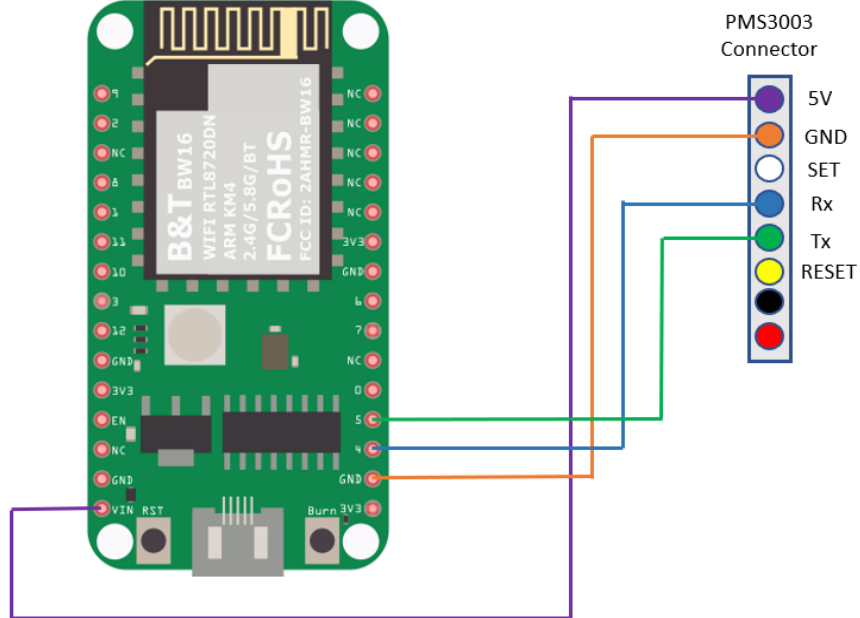
**AMB21 / AMB22 Wiring Diagram:**



**AMB23 Wiring Diagram:**

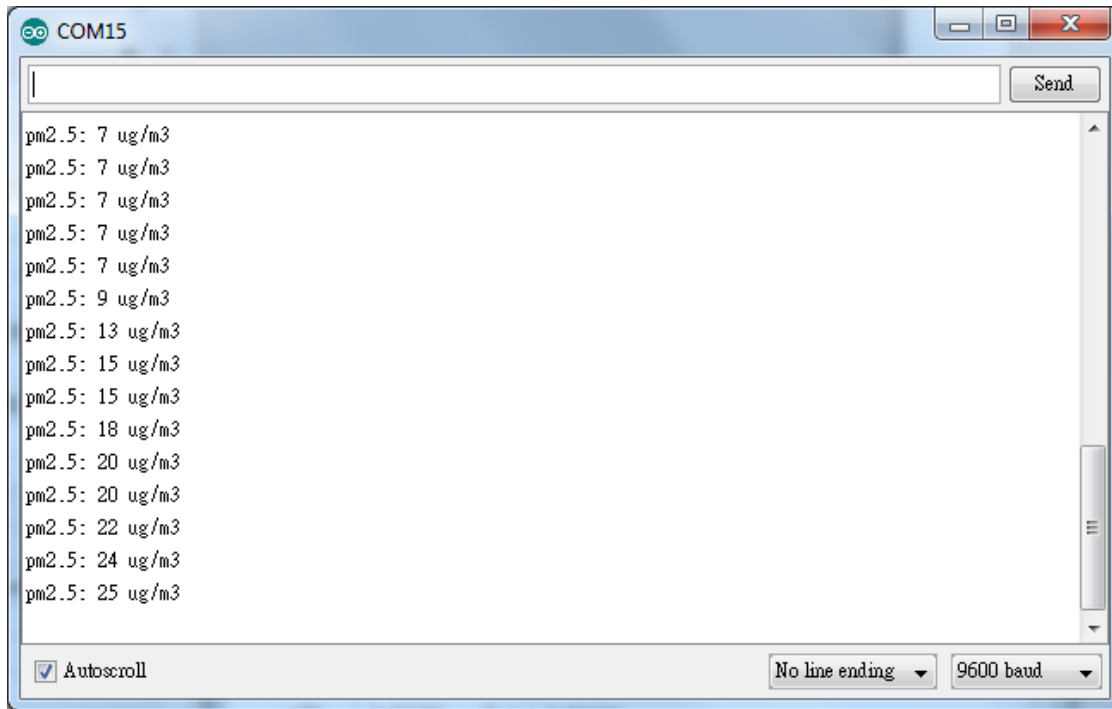


**BW16** Wiring Diagram:



In this example, we do not use the “Set” and “Reset” pins.

Compile the code and upload it to Ameba. After pressing the Reset button, Ameba starts to output the PM 2.5 data to serial monitor.



## Watchdog - Simple WDG Timer

### Preparation

- AmebaD [AMB21 / AMB22 / AMB23 / BW16] x 1

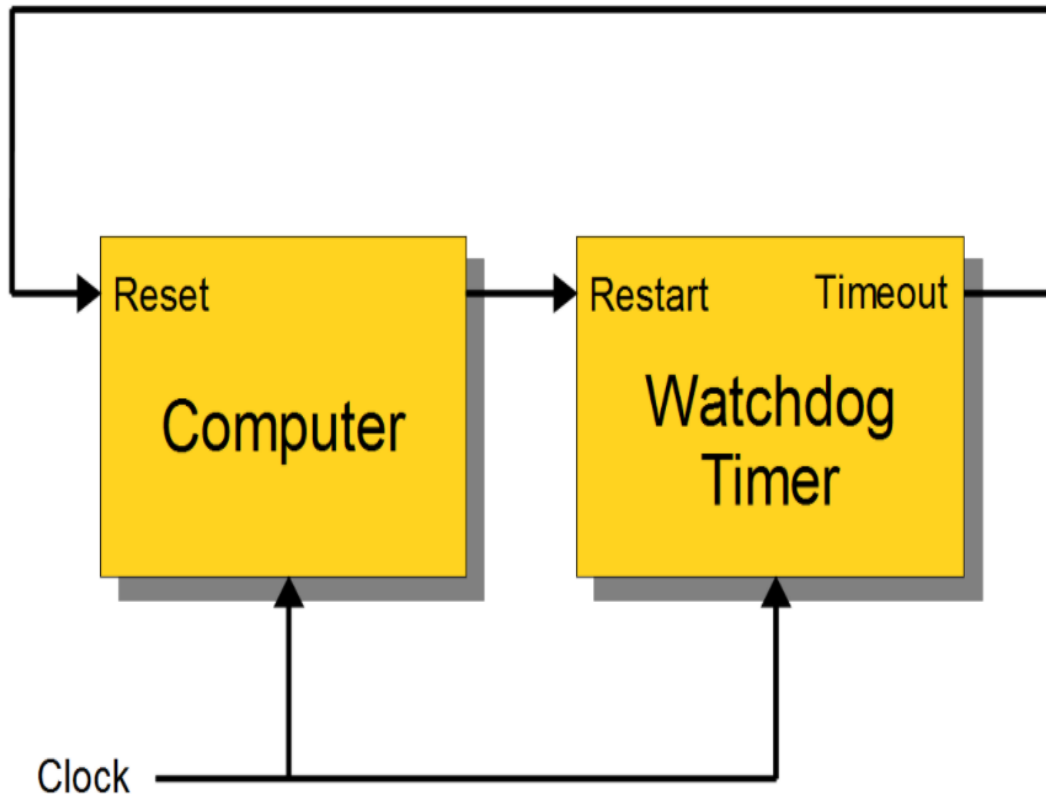
### Example

In this example, we will use this simple watchdog timer example runs on the Ameba RTL8722 module to illustrate how to use the watchdog API. Before we get into the details of the example, let's briefly go through the definition of Watchdog as well as its working principles.

### Watchdog

Watchdog Timer (WDT) is a hardware timer that is used to detect the occurrence of a software fault, then automatically generates a system reset or a watchdog interrupt on the expiry of a programmed period.

In layman terms, imagine in the situation while your micro-controller is confused in an infinity loop, or any case like the micro-controller hang while performing some tasks. The normal troubleshooting method would be to press the reset button and jump out of the infinity loop. However, is it practically impossible to do press on the button all time, therefore, the watchdog timer that embedded inside the micro-controller would help with this situation.



### Feed the Dog

If you have a dog in your home. You need to feed that dog at a regular interval. if you can't feed one day, it will bite you! And likewise, this is the working logic behind the watchdog timer.

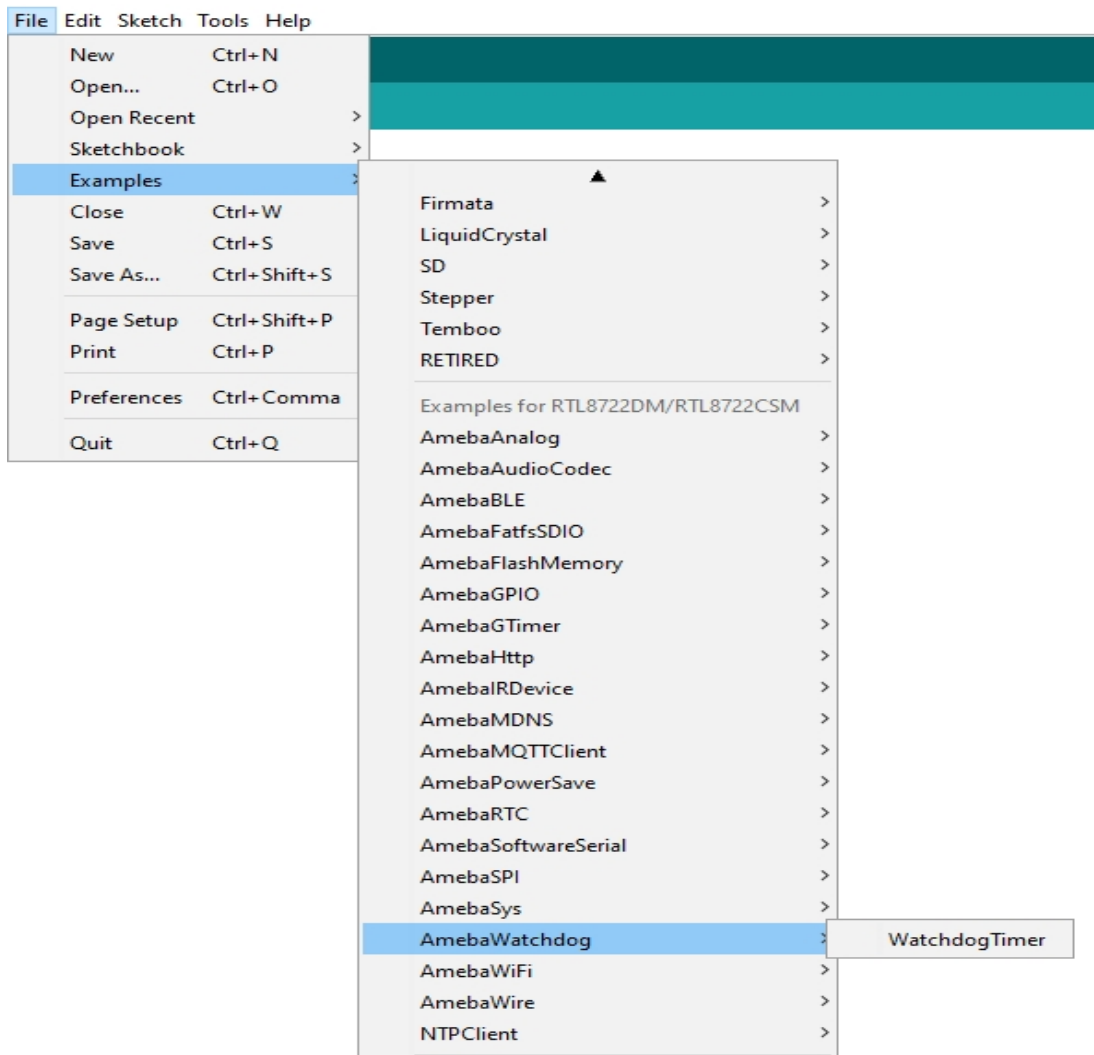
In our example, we created 2 tasks that contain some loop that runs repeatedly, one is called "Small\_Task" and the other is called "Big\_Task". We are enabling the watchdog timer is loaded with an initial value (5 seconds) greater than the total delay in the "Small\_Task", but shorter than the "Big\_Task".

For the successful case, the watchdog is being refreshed/feed within 5 seconds, however, for the failed case, the loop is under processing and the watchdog is not being fresh after 5 seconds, which triggers the watchdog (dog barks), an interrupt is generated to reset the processor. Likewise, the watchdog timer protects the micro-controller from the hanging case.


Then we move to the coding part for this example, for this example, you will only need the RTL8722CSM/RTL8722DM/RTL8722DM MINI Board itself.

Firstly, make sure the correct Ameba development board is selected in Arduino IDE: "Tools" -> "Board" ->

“RTL8722CSM/RTL8722DM” (or “RTL8722DM MINI” ). Then open the “Watchdog Timer” example in “File” -> “Examples” -> “AmebaWatchdog” -> “Watchdog Timer” :



Upon successfully upload the sample code, open the serial monitor, and press the reset button. You will find that the “Small\_Task” can refresh the watchdog within the 5 seconds (initialized in the watchdog timer). However, the “Big\_Task” will not be able to refresh the watchdog within 5 seconds, which the watchdog “barks” then the microcontroller reset.

 COM10

```
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
```



COM10

```
#calibration_ok:[2:19:11]
.....doing small task.....
Small_Task finished refresh watchdog.
.....doing big task, up to 10.....
doing dummy task #1
doing dummy task #2
doing dummy task #3
doing dummy task #4
doing dummy task #5
watchdog barks!!!
doing dummy task #6
doing dummy task #7
doing dummy task #8
doing dummy task #9
doing dummy task #10
Big_Task finished refresh watchdog.
```

## Community Examples

Welcome to share your examples under the **Community Examples** section if you have completed a project using the Ameba boards.

To make contributions, please visit our official [GitHub Wiki](#) page.



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**小訣竅:** Welcome to share your examples under the **Community Examples** section if you have completed a project using the Ameba boards

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### 1.3.3 API Documents

#### RTL8722DM ARDUINO Online API Documents

#### Analog

#### Class AmebaServo

#### AmebaServo Class

##### Description

Defines a class of manipulating servo motors connected to Arduino pins.

##### Syntax

```
class AmebaServo
```

##### Members

Public Constructors	
AmebaServo::AmebaServo	Constructs an AmebaServo object.
Public Methods	
AmebaServo::attach	Attach the given pin to the next free channel.
AmebaServo::detach	Detach the servo.
AmebaServo::write	Write value, if the value is < 200 it's treated as an angle, otherwise as pulse-width in microseconds.
AmebaServo::writeMicroseconds	Write pulse width in microseconds.
AmebaServo::read	Output current pulse width as an angle between 0 and 180 degrees.
AmebaServo::readMicroseconds	Output current pulse width in microseconds for this servo.
AmebaServo::attached	Check if the servo is attached.

#### AmebaServo::attach

##### Description

Attach the given pin to the next free channel, sets pinMode (including minimum and maximum values for writes), returns channel number, or 0 if failure.

##### Syntax

```
uint8_t attach(int pin);

uint8_t attach(int pin, int min, int max);
```

### Parameters

pin: The Arduino pin number to be attached.

min: Minimum values for writes.

max: Maximum values for writes.

### Returns

The function returns channel number or 0

### Example Code

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree.

列表 3: ServoSweep.ino

```
1  /* Sweep
2  by BARRAGAN < http://barraganstudio.com >
3  This example code is in the public domain.
4  modified 8 Nov 2013
5  by Scott Fitzgerald
6  http://www.arduino.cc/en/Tutorial/Sweep
7  refined 2016/03/18 by Realtek
8  */
9
10 #include "AmebaServo.h"
11
12 // create servo object to control a servo
13 // 4 servo objects can be created correspond to PWM pins
14
15 AmebaServo myservo;
16
17 // variable to store the servo position
18 int pos = 0;
19
20 void setup() {
21   #if defined(BOARD_RTL8195A)
22     // attaches the servo on pin 9 to the servo object
23     myservo.attach(9);
```

(繼續下一頁)

```
24 #elif defined(BOARD_RTL8710)
25     // attaches the servo on pin 13 to the servo object
26     myservo.attach(13);
27 #elif defined(BOARD_RTL8721D)
28     // attaches the servo on pin 8 to the servo object
29     myservo.attach(8);
30 #else
31     // attaches the servo on pin 9 to the servo object
32     myservo.attach(9);
33 #endif
34 }
35
36 void loop() {
37     // goes from 0 degrees to 180 degrees in steps of 1 degree
38     for (pos = 0; pos <= 180; pos += 1) {
39         // tell servo to go to position in variable 'pos'
40         myservo.write(pos);
41         // waits 15ms for the servo to reach the position
42         delay(15);
43     }
44     // goes from 180 degrees to 0 degrees
45     for (pos = 180; pos >= 0; pos -= 1) {
46         // tell servo to go to position in variable 'pos'
47         myservo.write(pos);
48         // waits 15ms for the servo to reach the position
49         delay(15);
50     }
51 }
```

## Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

## AmebaServo::detach

### Description

Detach the servo.

### Syntax

```
void AmebaServo::detach(void);
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::write****Description**

Write an integer value to the function, if the value is < 200, it’ s being treated as an angle, otherwise as pulse-width in microseconds.

**Syntax**

```
void AmebaServo::write(int value);
```

**Parameters**

value: The value < 200 its treated as an angle; otherwise as pulse width in microseconds.

**Returns**

The function returns nothing.

**Example Code**

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree. Please refer to code in “AmebaServo:: attach” section.

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::writeMicroseconds****Description**

Write pulse width to the servo in microseconds.

**Syntax**

```
void AmebaServo::writeMicroseconds(int value);
```

**Parameters**

value: Write value the pulse width in microseconds.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::read****Description**

The function reads current pulse width and returns as an angle between 0 and 180 degrees.

**Syntax**

```
int AmebaServo::read(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The pulse width as an angle between 0 ~ 180 degrees.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

**AmebaServo::readMicroseconds****Description**

The function returns a Boolean value “true” if this servo is attached, otherwise returns “false” .

**Syntax**

```
int AmebaServo::readMicroseconds(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns current servo pulse width in microseconds.

**Example Code**

NA

**Notes and Warnings**

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

## AmebaServo::attached

### Description

It returns true if this servo is attached, otherwise false.

### Syntax

```
bool AmebaServo::attached(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a Boolean value as true or false.

### Example Code

Example: ServoSweep

The code demos servo motor sweeping from 0 degrees to 180 degrees then sweep back to 0 degrees in the step of 1 degree. Please refer to code in “AmebaServo:: attach” section.

### Notes and Warnings

Every time must include the header file “AmebaServo.h” in front of the project to use the class function.

---

## AudioCodec

### Class AudioCodec

#### Description

A class used for general control and management of the hardware audio codec functions.

#### Syntax

```
class AudioCodec
```

#### Members

#### Public Constructors

The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named Codec.

#### Public Methods

AudioCodec::begin	Configure and start the audio codec for transmit and receive operation
AudioCodec::end	Stop all audio codec operation
Au- dioCodec::getBufferSize	Get the byte size of a single page of the audio codec buffer
AudioCodec::setSampleRate	Configure the audio codec transmit and receive sampling rate
AudioCodec::setBitDepth	Configure the audio codec transmit and receive bit depth (bits per sample)
Au- dioCodec::setChannelCount	Configure the audio codec transmit and receive channel count
Au- dioCodec::setInputMicType	Configure for analog or digital input microphone type
Au- dioCodec::setInputLRMux	Configure input left right channel multiplexing
AudioCodec::setDMicBoost	Configure boost gain for digital microphone input
AudioCodec::setAMicBoost	Configure boost gain for analog microphone input
AudioCodec::setADCGain	Configure gain of ADC used to acquire analog input
AudioCodec::muteInput	Mute input audio data stream
Au- dioCodec::setOutputVolume	Configure output audio volume
AudioCodec::muteOutput	Mute output audio
AudioCodec::writeAvaliable	Check for free buffer page available for data write
AudioCodec::writeDataPage	Write audio data to an available buffer page
AudioCodec::readAvaliable	Check for buffer page with new data available for read
AudioCodec::readDataPage	Read audio data from a ready buffer page
Au- dioCodec::setWriteCallback	Set a callback function to be notified when a free buffer page is available for write
Au- dioCodec::setReadCallback	Set a callback function to be notified when a buffer page with new data is available for read

**AudioCodec::begin****Description**

Configure and start the audio codec for transmit and receive operation.

**Syntax**

```
void begin(bool input, bool output);
```

**Parameters**

input: enable audio codec data input

output: enable audio codec data output

**Returns**



The function returns nothing.

#### **Example Code**

Example: BasicInputOutput

#### **Notes and Warnings**

##### **AudioCodec::end**

#### **Description**

Stop all audio codec operation.

#### **Syntax**

```
void end();
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

##### **AudioCodec::getBufferPageSize**

#### **Description**

Get the byte size of a single page of the audio codec buffer.

#### **Syntax**

```
uint32_t getBufferPageSize();
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The size of a audio codec buffer page, in number of bytes.

#### **Example Code**

NA

#### **Notes and Warnings**

The AudioCodec class includes a transmit and receive buffer to store audio sample data while transferring to and from the DAC output and ADC input. The buffer is divided into pages of fixed size, and audio data can be read and written

one page at a time. Depending on the configured bit depth (bits per audio sample) and channel count, a buffer page may contain a different number of audio samples.

### **AudioCodec::setSampleRate**

#### **Description**

Configure the audio codec transmit and receive sampling rate.

#### **Syntax**

```
void setSampleRate(uint32_t sampleRate);
```

#### **Parameters**

sampleRate: desired audio codec sampling rate in Hz. Default value of 48000. Supported values: 8000, 16000, 32000, 44100, 48000, 88200, 96000.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: BasicInputOutput

#### **Notes and Warnings**

High sample rates above 48000Hz will require frequent buffer reads and writes to keep up with the large amount of data input and output. If there is insufficient processing time dedicated to this task, audio quality will be degraded.

### **AudioCodec::setBitDepth**

#### **Description**

Configure the audio codec transmit and receive bit depth (bits per sample).

#### **Syntax**

```
void setBitDepth(uint8_t bitDepth);
```

#### **Parameters**

bitDepth: desired number of bits per sample. Default value of 16. Supported values: 8, 16, 24.

#### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

Setting a bit depth of 24 bits per sample will require 32 bits (4 bytes) of buffer space for storing each sample, with the most significant byte ignored.

**AudioCodec::setChannelCount****Description**

Configure the audio codec transmit and receive channel count.

**Syntax**

```
void setChannelCount(uint8_t monoStereo);
```

**Parameters**

monoStereo: number of channels. Default value of 1. Supported values: 1, 2.

**Returns**

The function returns nothing.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::setInputMicType****Description**

Configure for analog or digital input microphone type.

**Syntax**

```
Void setInputMicType(Mic_Type micType);
```

**Parameters**

micType: Input microphone type. Default value ANALOGMIC. Valid values:

- ANALOGMIC –microphone with an analog output
- PDMMIC –digital microphone with a PDM output

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

For analog single-ended output, connect to PA\_4 for the left channel and PA\_2 for the right channel.

For digital PDM output, connect the PDM clock to PB\_1 and PDM data to PB\_2.

**AudioCodec::setInputLRMux****Description**

Configure input left right channel multiplexing.

**Syntax**

```
void setInputLRMux(uint32_t mux);
```

**Parameters**

mux: desired left right audio channel multiplexing setting. Default value RX\_CH\_LR. Valid values:

- RX\_CH\_LR
- RX\_CH\_RL
- RX\_CH\_LL
- RX\_CH\_RR

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

In mono channel mode, both RX\_CH\_LR and RX\_CH\_LL will result in the audio codec sampling input data from the left channel microphone. Similarly, both RX\_CH\_RL and RX\_CH\_RR will result in the audio codec sampling input data from the right channel microphone.

In stereo channel mode, RX\_CH\_RL will switch the positions of input data sampled from the microphones. RX\_CH\_RR and RX\_CH\_LL will result in duplicated samples from the right and left microphones respectively.\*\* \*\*

**AudioCodec::setDMicBoost****Description**

Configure boost gain for digital microphone input.

**Syntax**

```
void setDMicBoost(uint32_t leftBoost, uint32_t rightBoost);
```

**Parameters**

leftBoost: boost gain for left channel digital microphone input

rightBoost: boost gain for right channel digital microphone input

Valid boost gain values:

- 0 : 0dB
- 1 : 12dB
- 2 : 24dB

- 3 : 36dB

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::setAMicBoost****Description**

Configure boost gain for analog microphone input.

**Syntax**

```
void setAMicBoost(uint32_t leftBoost, uint32_t rightBoost);
```

**Parameters**

leftBoost: boost gain for left channel analog microphone input

rightBoost: boost gain for right channel analog microphone input

Valid boost gain values:

- 0 : 0dB
- 1 : 20dB
- 2 : 30dB
- 3 : 40dB

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Only use this function if additional gain is required after using setADCGain function.

**AudioCodec::setADCGain****Description**

Configure gain of ADC used to acquire analog input.

**Syntax**

```
void setADCGain(uint32_t leftGain, uint32_t rightGain);
```

**Parameters**

leftGain: Gain for left channel ADC

rightGain: Gain for right channel ADC

Valid value range is from 0x00 to 0x7f. Gain increases by 0.375dB for every increment in value:

- 0x00 : -17.625dB
- 0x01 : -17.25dB
- 0x2f : 0dB
- 0x30 : 0.375dB
- 0x7f : 30dB

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::muteInput****Description**

Mute input audio data stream.

**Syntax**

```
void muteInput(uint8_t leftMute, uint8_t rightMute);
```

**Parameters**

leftMute: 1 to mute left channel input, 0 to unmute

rightMute: 1 to mute right channel input, 0 to unmute

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::setOutputVolume****Description**

Configure output audio volume.

**Syntax**

```
void setOutputVolume(uint8_t leftVol, uint8_t rightVol);
```

**Parameters**

leftVol: left channel output volume

rightVol: right channel output volume

Valid value ranges from 0 to 100, corresponding to a volume of -65.625dB to 0dB.

**Returns**

The function returns nothing.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::muteOutput****Description**

Mute output audio.

**Syntax**

```
void muteOutput(uint8_t leftMute, uint8_t rightMute);
```

**Parameters**

leftMute: 1 to mute left channel output, 0 to unmute

rightMute: 1 to mute right channel output, 0 to unmute

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****AudioCodec::writeAvaliable****Description**

Check for free buffer page available for data write.

**Syntax**

```
bool writeAvaliable();
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns true if there is a buffer page that is available for writing data into. Returns false if all buffer pages are full.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::writeDataPage****Description**

Write audio data to an available buffer page.

**Syntax**

```
uint32_t writeDataPage(int8_t* src, uint32_t len);  
uint32_t writeDataPage(int16_t* src, uint32_t len);
```

**Parameters**

src: pointer to array containing audio samples to write to audio codec.

len: number of audio samples in array.

**Returns**

The function returns the number of audio samples written to the audio codec.

**Example Code**

Example: BasicInputOutput

**Notes and Warnings****AudioCodec::readAvaliable****Description**

Check for buffer page with new data available for read.

**Syntax**

```
bool readAvaliable();
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns true if there is a buffer page with new data that is ready for reading data from. Returns false if all buffer pages are empty.



### Example Code

Example: BasicInputOutput

### Notes and Warnings

#### AudioCodec::readDataPage

##### Description

Read audio data from a ready buffer page.

##### Syntax

```
uint32_t readDataPage(int8_t* dst, uint32_t len);  
uint32_t readDataPage(int16_t* dst, uint32_t len);
```

##### Parameters

dst: pointer to array to contain audio samples read from audio codec.

len: number of audio samples to read.

##### Returns

The function returns the number of audio samples read from the audio codec.

### Example Code

Example: BasicInputOutput

### Notes and Warnings

#### AudioCodec::setWriteCallback

##### Description

Set a callback function to be notified when a free buffer page is available for write.

##### Syntax

```
void setWriteCallback(void (writeCB)(**void*));
```

##### Parameters

writeCB: function to be called when a buffer page becomes available for data write. Takes no arguments and returns nothing

##### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

After starting the audio codec with `AudioCodec::begin()`, the callback function will be called each time the audio codec finishes outputting the data in a buffer page.

### **AudioCodec::setReadCallback**

#### **Description**

Set a callback function to be notified when a buffer page with new data is available for read.

#### **Syntax**

```
void setReadCallback(void (readCB)(**void*));
```

#### **Parameters**

`readCB`: function to be called when a buffer page with new data becomes available for data read. Takes no arguments and returns nothing

#### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

After starting the audio codec with `AudioCodec::begin()`, the callback function will be called each time the audio codec fills up a buffer page with newly acquired audio samples.

## **Class FFT**

#### **Description**

A class used for performing FFT calculations with real-number inputs and outputs.

#### **Syntax**

```
class FFT
```

#### **Members**

#### **Public Constructors**

FFT::FFT	Create an instance of the FFT class
----------	-------------------------------------

#### **Public Methods**

FFT::setWindow	Configure the window function used in FFT calculations
FFT::calculate	Calculate FFT for an input array of values
FFT::getFrequencyBins	Get the FFT output frequency bins
FFT::getFFTSIZE	Get the size of FFT output for a given input size

**FFT::FFT****Description**

Create a FFT class object.

**Syntax**

```
void FFT();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: FFT

**Notes and Warnings****FFT::setWindow****Description**

Configure the window function used in FFT calculations.

**Syntax**

```
void setWindow(FFTWindow_t window, uint16_t sampleCount);
```

**Parameters**

window: The window function to be used in FFT calculations. Valid values: None, Hann, Hamming.

sampleCount: Number of sample datapoints in the input.

**Returns**

The function returns nothing.

**Example Code**

Example: FFT

**Notes and Warnings**

The window function is used to reduce the effects of discontinuities that occur when the input signal has frequencies that do not fit an integer number of periods in the sample datapoints.

More information on FFTs and window functions can be seen at:

<https://download.ni.com/evaluation/pxi/Understanding%20FFTs%20and%20Windowing.pdf>

[https://en.wikipedia.org/wiki/Window\\_function](https://en.wikipedia.org/wiki/Window_function)

## **FFT::Calculate**

### **Description**

Calculate FFT for an input array of values.

### **Syntax**

```
void calculate(float* inputBuf, float* outputBuf, uint16_t sampleCount);
```

```
void calculate(int16_t* inputBuf, float* outputBuf, uint16_t sampleCount);
```

### **Parameters**

inputBuf: pointer to an array of sampleCount size, containing input sample datapoints, in float or uint16\_t format.

outputBuf: pointer to a float array of sampleCount/2 size, for containing FFT output.

sampleCount: number of sample datapoints in the input array, valid values: 16, 32, 64, 128, 256, 512, 1024, 2048.

### **Returns**

The function returns nothing.

### **Example Code**

Example:FFT

### **Notes and Warnings**

Large sample counts will require a longer time for FFT calculations, but will also return a result with higher frequency resolution.

## **FFT::getFrequencyBins**

### **Description**

Get the FFT output frequency bins.

### **Syntax**

```
void getFrequencyBins(uint16_t* outputBuf, uint16_t sampleCount, uint32_t sampleRate);
```

### **Parameters**

outputBuf: pointer to a uint16\_t array of sampleCount/2 size, for containing the calculated center frequency of each FFT output element.

### **Returns**

The function returns nothing.

### Example Code

Example: FFT

Notes and Warnings NA

---

### FFT::getFFTSIZE

#### Description

Get the size of FFT output for a given input size.

#### Syntax

```
uint16_t getFFTSIZE(uint16_t sampleCount);
```

#### Parameters

sampleCount: number of input sample datapoints.

#### Returns

The function returns the FFT output size for the given sampleCount, which is sampleCount/2.

### Example Code

NA

Notes and Warnings NA

## Class PlaybackWav

#### Description

A class used for control and playback of .wav file format audio data.

#### Syntax

```
class PlaybackWav
```

#### Members

#### Public Constructors

PlaybackWav::PlaybackWav	Create an instance of the PlaybackWav class
--------------------------	---

#### Public Methods

PlaybackWav::openFile	Open a .wav file for playback
PlaybackWav::closeFile	Close a previously opened file
PlaybackWav::fileOpened	Check if a .wav file is already opened
PlaybackWav::getSampleRate	Get the sample rate of the .wav file
PlaybackWav::getChannelCount	Get the number of audio channels in the .wav file
PlaybackWav::getBitDepth	Get the bit depth of each sample in the .wav file
PlaybackWav::getLengthMillis	Get the playback length of the .wav file in milliseconds
PlaybackWav::getPositionMillis	Get the current playback position in milliseconds
PlaybackWav::setPositionMillis	Set the current playback position in milliseconds
PlaybackWav::millisToBytes	Convert a playback duration to equivalent number of bytes
PlaybackWav::bytesToMillis	Convert number of bytes to an equivalent playback duration
PlaybackWav::readAudioData	Read audio data from the .wav file

---

## **PlaybackWav::PlaybackWav**

### **Description**

Create a PlaybackWav class object.

### **Syntax**

```
void PlaybackWav(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

NA

---

## **PlaybackWav::fileOpened**

### **Description**

Check if a .wav file is already opened.

### **Syntax**

```
bool fileOpened(void);
```

### **Parameters**

The function requires no input parameter.

**Returns**

The function returns true if a .wav file is already open, false otherwise.

**Example Code**

Example: RecordPlaybackWav

**Notes and Warnings**

NA

---

**PlaybackWav::getSampleRate****Description**

Get the sample rate of the .wav file.

**Syntax**

```
uint32_t getSampleRate(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns sampling rate encoded in the .wav file header.

**Example Code**

Example: PlaybackWavFile

**Notes and Warnings**

NA

---

**PlaybackWav::getChannelCount****Description**

Get the number of audio channels in the .wav file.

**Syntax**

```
uint16_t getChannelCount(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns channel count encoded in the .wav file header.

### Example Code

Example: PlaybackWavFile

### Notes and Warnings

NA

---

## PlaybackWav::getBitDepth

### Description

Get the bit depth of each sample in the .wav file.

### Syntax

```
uint16_t getBitDepth(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns bit depth encoded in the .wav file header.

### Example Code

Example: PlaybackWavFile

### Notes and Warnings

NA

---

## PlaybackWav::getLengthMillis

### Description

Get the playback length of the .wav file in milliseconds.

### Syntax

```
uint32_t getLengthMillis(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the total playback length of the currently open .wav file in milliseconds.

### Example Code

Example: PlaybackWavFile

### Notes and Warnings



NA

---

### **PlaybackWav::getPositionMillis**

#### **Description**

Get the current playback position in milliseconds.

#### **Syntax**

```
uint32_t getPositionMillis(void);
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns the current playback position of the currently open .wav file in milliseconds.

#### **Example Code**

Example: PlaybackWavFile

#### **Notes and Warnings**

NA

---

### **PlaybackWav::setPositionMillis**

#### **Description**

Set the current playback position in milliseconds.

#### **Syntax**

```
void setPositionMillis(uint32_t pos);
```

#### **Parameters**

pos: The desired playback position expressed in milliseconds.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PlaybackWavFile

#### **Notes and Warnings**

Any changes to playback position will only take effect on the next call to PlaybackWav::readAudioData. If the desired playback position is beyond the total playback length of the file, the playback position will be set to the end of file, and no audio data will be output on subsequent data reads.

---

### **PlaybackWav::millisToBytes**

#### **Description**

Convert a playback duration to equivalent number of bytes.

#### **Syntax**

```
uint32_t millisToBytes(uint32_t ms);
```

#### **Parameters**

ms: playback duration in milliseconds.

#### **Returns**

The function returns the number of bytes that is equivalent to the input playback duration, converted using the current sample rate, number of channels and bit depth.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

---

### **PlaybackWav::bytesToMillis**

#### **Description**

Convert number of bytes to an equivalent playback duration.

#### **Syntax**

```
uint32_t bytesToMillis(uint32_t bytes);
```

#### **Parameters**

bytes: playback duration in number of bytes.

#### **Returns**

The function returns the time duration in milliseconds that is equivalent to the input number of bytes, converted using the current sample rate, number of channels and bit depth.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

---

### **PlaybackWav::readAudioData**

**Description**

Read audio data from the .wav file.

**Syntax**

- `uint32_t readAudioData(int8_t* dst, uint32_t len);`
- `uint32_t readAudioData(int16_t* dst, uint32_t len);`

**Parameters**

- `dst`: pointer to array to store data read from .wav file.
- `len`: number of audio samples to read from .wav file.

**Returns**

The function returns number of audio samples read.

**Example Code**

Example: PlaybackWavFile

**Notes and Warnings**

NA

**Class RecordWav****Description**

A class used for control and recording of .wav file format audio data.

**Syntax**

`class RecordWav`

**Members****Public Constructors**

RecordWav:: RecordWav	Create an instance of the RecordWav class
-----------------------	---

**Public Methods**

RecordWav::openFile	Open a .wav file for playback
RecordWav::closeFile	Close a previously opened file
RecordWav::fileOpened	Check if a .wav file is already opened
RecordWav::setSampleRate	Get the sample rate of the .wav file
RecordWav::setChannelCount	Set the number of audio channels in the .wav file
RecordWav::setBitDepth	Set the bit depth of each sample in the .wav file
RecordWav::getLengthMillis	Get the current record length of the .wav file in milliseconds
RecordWav::millisToBytes	Convert a playback duration to equivalent number of bytes
RecordWav::bytesToMillis	Convert number of bytes to an equivalent playback duration
RecordWav::writeAudioData	Write audio data to the .wav file

---

## **RecordWav::RecordWav**

### **Description**

Create a RecordWav class object.

### **Syntax**

```
void RecordWav(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

Example: RecordWavFile

### **Notes and Warnings**

NA

---

## **RecordWav::openFile**

### **Description**

Open a .wav file for recording.

### **Syntax**

```
void openFile(const char* absFilepath);
```

### **Parameters**

absFilepath: the filepath of the .wav file to open.

**Returns**

The function returns nothing.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

NA

---

**RecordWav::closeFile****Description**

Close a previously opened file.

**Syntax**

```
void closeFile(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

Any open .wav files should be closed after recording is complete, otherwise, loss of recorded audio data may occur.

---

**RecordWav::fileOpened****Description**

Check if a .wav file is already opened.

**Syntax**

```
bool fileOpened(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns true if a .wav file is already open, false otherwise.

**Example Code**

Example: RecordWavFile

### Notes and Warnings

NA

---

## RecordWav::setSampleRate

### Description

Set the recording sample rate of the .wav file.

### Syntax

```
void setSampleRate(uint32_t sampleRate);
```

### Parameters

sampleRate: The desired recording sample rate.

### Returns

The function returns nothing.

### Example Code

Example: RecordWavFile

### Notes and Warnings

NA

---

## RecordWav::setChannelCount

### Description

Set the number of recording audio channels in the .wav file.

### Syntax

```
void setChannelCount(uint16_t channelCount);
```

### Parameters

channelCount: number of recording audio channels.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

---

**RecordWav::setBitDepth****Description**

Set the recording bit depth of each sample in the .wav file.

**Syntax**

```
void setBitDepth(uint16_t bitDepth);
```

**Parameters**

bitDepth: number of bits per sample.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::getLengthMillis****Description**

Get the current recorded length of the .wav file in milliseconds.

**Syntax**

```
uint32_t getLengthMillis(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the current recorded length of the currently open .wav file in milliseconds.

**Example Code**

NA

**Notes and Warnings**

NA

---

**RecordWav::millisToBytes****Description**

Convert a playback duration to equivalent number of bytes.

#### **Syntax**

```
uint32_t millisToBytes(uint32_t ms);
```

#### **Parameters**

ms: playback duration in milliseconds.

#### **Returns**

The function returns the number of bytes that is equivalent to the input playback duration, converted using the current sample rate, number of channels and bit depth.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

---

### **RecordWav::bytesToMillis**

#### **Description**

Convert number of bytes to an equivalent playback duration.

#### **Syntax**

```
uint32_t bytesToMillis(uint32_t bytes);
```

#### **Parameters**

bytes: playback duration in number of bytes.

#### **Returns**

The function returns the time duration in milliseconds that is equivalent to the input number of bytes, converted using the current sample rate, number of channels and bit depth.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

---

### **RecordWav::writeAudioData**

#### **Description**

Write audio data to the .wav file.



**Syntax**

```
uint32_t writeAudioData(int8_t* src, uint32_t len); uint32_t writeAudioData(int16_t* src, uint32_t len);
```

**Parameters**

src: pointer to array containing data to write to .wav file. len: number of audio samples to write to .wav file.

**Returns**

The function returns number of audio samples written.

**Example Code**

Example: RecordWavFile

**Notes and Warnings**

NA

**BLE****Class BLEAddr****BLEAddr Class****Description**

A class used for managing Bluetooth addresses.

**Syntax**

```
class BLEAddr
```

**Members**

<b>Public Constructors</b>	
BLEAddr::BLEAddr	Constructs a BLEAddr object
<b>Public Methods</b>	
BLEAddr::str	Get the Bluetooth address represented as a formatted string
BLEAddr::data	Get the Bluetooth address represented as an integer array

**BLEAddr::BLEAddr****Description**

Constructs a BLEAddr object.

### Syntax

```
BLEAddr::BLEAddr(void);  
BLEAddr::BLEAddr(uint8_t (&addr)[6]);  
BLEAddr::BLEAddr(const char* str);
```

### Parameters

addr: An array of 6 bytes containing the desired Bluetooth address.

str: A character string representing the desired Bluetooth address.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

When expressed as a string, the Bluetooth address should be written as 6 bytes in hexadecimal format, using a colon “:” to separate the bytes is acceptable (example –00:11:22:33:EE:FF).

### BLEAddr::str

### Description

Get the Bluetooth address represented as a formatted string.

### Syntax

```
const char* str(void);
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns a pointer to a character string containing the hexadecimal representation of the Bluetooth address.

**Example Code**

Example: BLEScan

**Notes and Warnings**

The Bluetooth address expressed as a string will be written as 6 bytes in hexadecimal format, with a colon “:” separating the bytes (example –00:11:22:33:EE:FF).

**BLEAddr::data****Description**

Get the Bluetooth address represented as an integer array.

**Syntax**

```
uint8_t* data(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a pointer to a 6 byte array containing the Bluetooth address.

**Example Code**

NA

**Notes and Warnings**

The Bluetooth address is stored with MSB at array index [5].

## Class BLEAdvert

### BLEAdvert Class

#### Description

A class used for managing BLE advertising settings.

#### Syntax

```
class BLEAdvert
```

#### Members

Public Constructors
No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using BLEDevice::configAdvert().

Public Methods	
BLEAdvert::updateAdvertParams	Update the current BLE advertisement settings to the lower Bluetooth stack
BLEAdvert::startAdv	Start BLE advertising
BLEAdvert::stopAdv	Stop BLE advertising
BLEAdvert::setAdvType	Set the BLE advertising type
BLEAdvert::setMinInterval	Set the BLE advertising minimum interval
BLEAdvert::setMaxInterval	Set the BLE advertising maximum interval
BLEAdvert::setAdvData	Set BLE advertising data
BLEAdvert::setScanRspData	Set BLE scan response data

### BLEAdvert::updateAdvertParams

#### Description

Update the lower Bluetooth stack with the current advertising settings.

#### Syntax

```
void updateAdvertParams(void);
```

#### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Please use the other class member functions to set the BLE advertising parameters first before using this function.

**BLEAdvert::startAdv****Description**

Start BLE advertising.

**Syntax**

```
void startAdv(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

This function is provided for flexibility in controlling and updating BLE advertising parameters. You should avoid using this function to directly start the BLE advertising process without first registering the necessary callback and handler functions. Call `BLEDevice::beginPeripheral()` to register the necessary functions and start advertising for the first time.

## **BLEAdvert::stopAdv**

### **Description**

Stop BLE advertising.

### **Syntax**

```
void stopAdv(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

This function is provided for flexibility in controlling and updating BLE advertising parameters. You should avoid using this function to directly stop the BLE advertising process. Call `BLEDevice::end()` to stop advertising and free up used resources.

## **BLEAdvert::setAdvType**

### **Description**

Set the BLE advertising type.

**Syntax**

```
void setAdvType(uint8_t advType);
```

**Parameters**

advType: the desired advertisement type. Valid values:

- 0 = GAP\_ADTYPE\_ADV\_IND : connectable undirected advertisement
- 1 = GAP\_ADTYPE\_ADV\_HDC\_DIRECT\_IND : connectable high duty cycle directed
- 2 = GAP\_ADTYPE\_ADV\_SCAN\_IND : scannable undirected advertisement
- 3 = GAP\_ADTYPE\_ADV\_NONCONN\_IND : Non-connectable undirected advertisement
- 4 = GAP\_ADTYPE\_ADV\_LDC\_DIRECT\_IND : connectable low duty cycle directed advertisement

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

Call this function with the GAP\_ADTYPE\_ADV\_IND argument if connection requests should be allowed, and GAP\_ADTYPE\_ADV\_NONCONN\_IND if all connection requests should be rejected.

**BLEAdvert::setMinInterval****Description**

Set the minimum BLE advertising interval.

**Syntax**

```
void setMinInterval(uint16_t minInt_ms);
```

**Parameters**

minInt\_ms: the desired advertisement minimum interval, expressed in milliseconds. The valid values for the interval are from 20ms to 10240ms.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

BLE advertisements will repeat with an interval between the set minimum and maximum intervals. Set a shorter interval for the BLE device to be discovered rapidly and set a longer interval to conserve power.

**BLEAdvert::setMaxInterval****Description**

Set the maximum BLE advertising interval.

**Syntax**

```
void setMaxInterval(uint16_t minInt_ms);
```

**Parameters**

minInt\_ms: the desired advertisement maximum interval, expressed in milliseconds. The valid values for the interval are from 20ms to 10240ms.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

BLE advertisements will repeat with an interval between the set minimum and maximum intervals. Set a shorter interval for the BLE device to be discovered rapidly and set a longer interval to conserve power.



## BLEAdvert::setAdvData

### Description

Set BLE advertising data.

### Syntax

```
void setAdvData(BLEAdvertData adData);  
void setAdvData(uint8_t* pData, uint8_t size);
```

### Parameters

adData: scan response data formatted in a BLEAdvertData class object  
pData: pointer to a byte array containing the required scan response data.  
size: number of bytes the scan response data contains, maximum of 31 bytes.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

N/A

## BLEAdvert::setScanRspData

### Description

Set BLE scan response data.

### Syntax

```
void setScanRspData(BLEAdvertData adData);  
void setScanRspData(uint8_t* pData, uint8_t size);
```

**Parameters**

adData: scan response data formatted in a BLEAdvertData class object

pData: pointer to a byte array containing the required scan response data.

size: number of bytes the scan response data contains, maximum of 31 bytes.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

N/A

**Class BLEAdvertData****BLEAdvertData Class****Description**

A class used for managing BLE advertising data.

**Syntax**

```
class BLEAdvertData
```

**Members**

Public Constructors	
BLEAdvertData::BLEAdvertData	Constructs a BLEAdvertData object

Public Methods	
BLEAdvertData::clear	Clear all advertising data
BLEAdvertData::addData	Add binary advertising data
BLEAdvertData::addFlags	Add flags to advertising data
BLEAdvertData::addPartialServices	Add partial services to advertising data
BLEAdvertData::addCompleteServices	Add complete services to advertising data
BLEAdvertData::addAppearance	Add device appearance to advertising data
BLEAdvertData::addShortName	Add short device name to advertising data
BLEAdvertData::addCompleteName	Add complete device name to advertising data
BLEAdvertData::parseScanInfo	Parse advertising data received from a scan
BLEAdvertData::hasFlags	Check if received data includes advertising flags
BLEAdvertData::hasUUID	Check if received data includes UUIDs
BLEAdvertData::hasName	Check if received data includes device name
BLEAdvertData::hasManufacturer	Check if received data includes manufacturer data
BLEAdvertData::getAdvType	Get advertising type of received data
BLEAdvertData::getAddrType	Get Bluetooth address type of received data
BLEAdvertData::getAddr	Get Bluetooth address of received data
BLEAdvertData::getRSSI	Get RSSI of received data
BLEAdvertData::getFlags	Get advertising flags of received data
BLEAdvertData::getServiceCount	Get number of advertised services in received data
BLEAdvertData::getServiceList	Get array of advertised services in received data
BLEAdvertData::getName	Get advertised device name in received data
BLEAdvertData::getTxPower	Get advertised transmission power in received data
BLEAdvertData::getAppearance	Get advertised device appearance in received data
BLEAdvertData::getManufacturer	Get advertised manufacturer in received data
BLEAdvertData::getManufacturerDataLength	Get length of manufacturer data in received data
BLEAdvertData::getManufacturerData	Get advertised manufacturer data in received data

## BLEAdvertData::BLEAdvertData

### Description

Constructs a BLEAdvertData object.

### Syntax

```
BLEAdvertData::BLEAdvertData(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This class is used for managing BLE advertising data for two primary uses. First is to assemble advertising data for broadcasting as advertising packets. Second is to process and split up the advertising data received from a scan into separate types.

### BLEAdvertData::clear

### Description

Clear all advertising data currently saved in class object.

### Syntax

```
void clear(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### **BLEAdvertData::addData**

#### **Description**

Add binary advertising data.

#### **Syntax**

```
void addData(const uint8_t* data, uint8_t size);
```

#### **Parameters**

data: pointer to array containing desired advertising data.

size: number of bytes in array.

#### **Returns**

The function returns nothing.

#### **Example Code**

NA

#### **Notes and Warnings**

This function is provided for flexibility in adding BLE advertising data. Other functions should be used for adding advertising data if possible, as this function does not perform any checks on the validity of the data.

### **BLEAdvertData::addFlags**

#### **Description**

Add flags to advertising data.

#### **Syntax**

```
uint8_t addFlags(uint8_t flags);
```

### Parameters

flags: desired flags to add to advertising data. Valid values:

- GAP\_ADTYPE\_FLAGS\_LIMITED
- GAP\_ADTYPE\_FLAGS\_GENERAL
- GAP\_ADTYPE\_FLAGS\_BREDR\_NOT\_SUPPORTED
- GAP\_ADTYPE\_FLAGS\_SIMULTANEOUS\_LE\_BREDR\_CONTROLLER
- GAP\_ADTYPE\_FLAGS\_SIMULTANEOUS\_LE\_BREDR\_HOST

### Returns

Current total size of advertising data.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

NA

## BLEAdvertData::addPartialServices

### Description

Add partial list of service UUIDs to advertising data.

### Syntax

```
uint8_t addPartialServices(BLEUUID uuid);
```

### Parameters

uuid: the desired UUID contained in BLEUUID class object.

### Returns

Current total size of advertising data.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::addCompleteServices****Description**

Add complete list of service UUIDs to advertising data.

**Syntax**

```
uint8_t addCompleteServices(BLEUUID uuid);  
uint8_t addCompleteServices(uint8_t uuidBitLength);
```

**Parameters**

uuid: the desired UUID contained in BLEUUID class object.

uuidBitLength: UUID bit length for which a blank entry is to be added. Valid values: 16, 32, 128.

**Returns**

Current total size of advertising data.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

uuidBitLength is used when it is desired to add a blank entry to the advertisement data, used to indicate that no services with UUIDs of a certain length are available.

**BLEAdvertData::addAppearance**

### Description

Add device appearance to advertising data.

### Syntax

```
uint8_t addAppearance(uint16_t appearance);
```

### Parameters

appearance: the desired device appearance.

### Returns

Current total size of advertising data.

### Example Code

NA

### Notes and Warnings

Refer to Bluetooth specifications for a full list of device appearance values.

## BLEAdvertData::addShortName

### Description

Add shortened device name to advertising data.

### Syntax

```
uint8_t addShortName(const char* str);
```

### Parameters

str: character string containing desired device name.

### Returns

Current total size of advertising data.



**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::addCompleteName****Description**

Add complete device name to advertising data.

**Syntax**

```
uint8_t addCompleteName(const char* str);
```

**Parameters**

str: character string containing desired device name.

**Returns**

Current total size of advertising data.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLEAdvertData::parseScanInfo****Description**

Parse advertising data received from a scan.

### Syntax

```
void parseScanInfo(T_LE_CB_DATA *p_data);
```

### Parameters

p\_data: pointer to advertising data received from a Bluetooth scan.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

Advertising data fields of parsed receive data can be access using member functions starting with “has” and “get” .

### BLEAdvertData::hasFlags

### Description

Check if received data includes advertising flags.

### Syntax

```
bool hasFlags(void);
```

### Parameters

The function requires no input parameter.

### Returns

True if flags are present in received advertising data.

### Example Code

NA

**Notes and Warnings**

NA

**BLEAdvertData::hasUUID****Description**

Check if received data includes service UUIDs.

**Syntax**

```
bool hasUUID(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

True if service UUIDs are present in received advertising data.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::hasName****Description**

Check if received data includes device name.

**Syntax**

```
bool hasName(void);
```

### Parameters

The function requires no input parameter.

### Returns

True if device name is present in received advertising data.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

NA

## BLEAdvertData::hasManufacturer

### Description

Check if received data includes manufacturer specific data.

### Syntax

```
bool hasManufacturer(void);
```

### Parameters

The function requires no input parameter.

### Returns

True if manufacturer specific data is present in received advertising data.

### Example Code

NA

### Notes and Warnings

NA

**BLEAdvertData::getAdvType****Description**

Get advertising type of received data.

**Syntax**

```
T_GAP_ADV_EVT_TYPE getAdvType(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertising type of received advertising data.

**Example Code**

NA

**Notes and Warnings**

Possible types:

- GAP\_ADV\_EVT\_TYPE\_UNDIRECTED
- GAP\_ADV\_EVT\_TYPE\_DIRECTED
- GAP\_ADV\_EVT\_TYPE\_SCANNABLE
- GAP\_ADV\_EVT\_TYPE\_NON\_CONNECTABLE
- GAP\_ADV\_EVT\_TYPE\_SCAN\_RSP

**BLEAdvertData::getAddrType****Description**

Get Bluetooth address type of received data.

### Syntax

```
T_GAP_REMOTE_ADDR_TYPE getAddrType(void);
```

### Parameters

The function requires no input parameter.

### Returns

Bluetooth address type of received data.

### Example Code

NA

### Notes and Warnings

Possible types:

- GAP\_REMOTE\_ADDR\_LE\_PUBLIC
- GAP\_REMOTE\_ADDR\_LE\_RANDOM

### BLEAdvertData::getRSSI

### Description

Get received signal strength indicator (RSSI) of received data.

### Syntax

```
Int8_t getRSSI(void);
```

### Parameters

The function requires no input parameter.

### Returns

Received signal strength.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::getFlags****Description**

Get advertising flags of received data.

**Syntax**

```
uint8_t getFlags(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertising flags present in received advertising data, expressed as a single byte.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEAdvertData::getServiceCount****Description**

Get number of advertised services in received data.

### Syntax

```
uint8_t getServiceCount(void);
```

### Parameters

The function requires no input parameter.

### Returns

Number of advertised service UUIDs in received data.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

NA

## BLEAdvertData::getServiceList

### Description

Get list of advertised service UUIDs in received data.

### Syntax

```
BLEUUID* getServiceList(void);
```

### Parameters

The function requires no input parameter.

### Returns

Pointer to a BLEUUID array containing all advertised service UUIDs.

### Example Code

Example: BLEBatteryClient



**Notes and Warnings**

NA

**BLEAdvertData::getName****Description**

Get advertised device name in received data.

**Syntax**

```
String getName(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertised device name contained in a String class object.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

NA

**BLEAdvertData::getTxPower****Description**

Get advertised transmission power in received data.

**Syntax**

```
int8_t getTxPower(void);
```

### Parameters

The function requires no input parameter.

### Returns

Advertised transmission power.

### Example Code

NA

### Notes and Warnings

NA

## BLEAdvertData::getAppearance

### Description

Get advertised device appearance in received data.

### Syntax

```
uint16_t getAppearance(void);
```

### Parameters

The function requires no input parameter.

### Returns

Advertised device appearance.

### Example Code

NA

### Notes and Warnings

Refer to Bluetooth specifications for full list of device appearance values.

**BLEAdvertData::getManufacturer****Description**

Get advertised manufacturer in received data.

**Syntax**

```
uint16_t getManufacturer(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Advertised manufacturer.

**Example Code**

NA

**Notes and Warnings**

Refer to Bluetooth specifications for full list of manufacturer codes.

**BLEAdvertData::getManufacturerDataLength****Description**

Get length of manufacturer data in received data.

**Syntax**

```
uint8_t getManufacturerDataLength(void);
```

**Parameters**

The function requires no input parameter.

### Returns

Number of bytes of manufacturer data present in received advertising data.

### Example Code

NA

### Notes and Warnings

NA

## BLEAdvertData::getManufacturerData

### Description

Get manufacturer data in received data.

### Syntax

```
uint8_t* getManufacturerData(void);
```

### Parameters

The function requires no input parameter.

### Returns

Pointer to array containing manufacturer data.

### Example Code

NA

### Notes and Warnings

NA

## Class BLEBeacon

### iBeacon Class

#### Description

A class used for managing iBeacon BLE advertising data.

#### Syntax

```
class iBeacon
```

#### Members

Public Constructors	
iBeacon::iBeacon	Create an instance of iBeacon advertising data
Public Methods	
iBeacon::getManufacturerId	Get current manufacturer ID value
iBeacon::getUUID	Get current UUID value
iBeacon::getMajor	Get current Major value
iBeacon::getMinor	Get current Minor value
iBeacon::getRSSI	Get current RSSI value
iBeacon::setManufacturerId	Set manufacturer ID value
iBeacon::setUUID	Set UUID value
iBeacon::setMajor	Set Major value
iBeacon::setMinor	Set Minor value
iBeacon::setRSSI	Set RSSI value
iBeacon::getAdvData	Get current advertising data
iBeacon::getScanRsp	Get current scan response data

### altBeacon Class

#### Description

A class used for managing altBeacon BLE advertising data.

#### Syntax

```
class altBeacon
```

## Members

Public Constructors	
altBeacon::altBeacon	Create an instance of altBeacon advertising data
Public Methods	
altBeacon::getManufacturerId	Get current manufacturer ID value
altBeacon::getUUID	Get current UUID value
altBeacon::getMajor	Get current Major value
altBeacon::getMinor	Get current Minor value
altBeacon::getRSSI	Get current RSSI value
altBeacon::getRSVD	Get current Reserved value
altBeacon::setManufacturerId	Set manufacturer ID value
altBeacon::setUUID	Set UUID value
altBeacon::setMajor	Set Major value
altBeacon::setMinor	Set Minor value
altBeacon::setRSSI	Set RSSI value
altBeacon::setRSVD	Set Reserved value
altBeacon::getAdvData	Get current advertising data
altBeacon::getScanRsp	Get current scan response data

## iBeacon::iBeacon

### Description

Create an iBeacon object.

### Syntax

```
void iBeacon(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “BLEBeacon.h” to use this class function.

## **altBeacon::altBeacon**

### Description

Create an altBeacon object.

### Syntax

```
void altBeacon(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “BLEBeacon.h” to use this class function.

## **iBeacon::getManufacturerId**

## **altBeacon::getManufacturerId**

### Description

Get current Manufacturer ID value.

### Syntax

```
uint16_t getManufacturerId(void);
```

### Parameters

The function requires no input parameter.

### Returns

A 16-bit unsigned integer containing the current Company ID.

### Example Code

NA

### Notes and Warnings

Refer to <https://www.bluetooth.com/specifications/assigned-numbers/company-identifiers/> for the full list of assigned Bluetooth company identifiers.

### iBeacon::getUUID

### altBeacon::getUUID

### Description

Get the current UUID value.

### Syntax

```
void getUUID(uint8_t* UUID);
```

### Parameters

UUID: pointer to a 16 element uint8\_t array, current UUID will be copied into the array.

### Returns

The function returns nothing.

### Example Code



NA

### Notes and Warnings

UUID is a 128-bit number used to uniquely identify a beacon. It is commonly expressed as a 32-character hexadecimal string. UUIDs can be generated at <https://www.uuidgenerator.net/>.

### **iBeacon::getMajor**

### **altBeacon::getMajor**

### Description

Get current Major value.

### Syntax

```
uint16_t getMajor(void);
```

### Parameters

The function requires no input parameter.

### Returns

A 16-bit unsigned integer containing the current Major value.

### Example Code

NA

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### **iBeacon::getMinor**

### **altBeacon::getMinor**

### Description

Get current Minor value.

### Syntax

```
uint16_t getMinor(void);
```

### Parameters

The function requires no input parameter.

### Returns

A 16-bit unsigned integer containing the current Minor value.

### Example Code

NA

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

## iBeacon::getRSSI

## altBeacon::getRSSI

### Description

Get the current RSSI value.

### Syntax

```
int8_t getRSSI(void);
```

### Parameters

The function requires no input parameter.

**Returns**

An 8-bit signed integer containing the currently set RSSI value.

**Example Code**

NA

**Notes and Warnings**

The beacon RSSI value is the received signal strength at 1 meter. This can be used to estimate the distance to the beacon. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

**iBeacon::setManufacturerId****altBeacon::setManufacturerId****Description**

Set Manufacturer ID value.

**Syntax**

```
void setManufacturerId(uint16_t id);
```

**Parameters**

id: desired Manufacturer ID

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

**Notes and Warnings**

Refer to <https://www.bluetooth.com/specifications/assigned-numbers/company-identifiers/> for the full list of assigned Bluetooth company identifiers.

## **iBeacon::setUUID**

## **altBeacon::setUUID**

### **Description**

Set UUID value.

### **Syntax**

```
void setUUID(uint8_t* UUID);
```

```
void setUUID(const char* UUID);
```

### **Parameters**

uint8\_t\* UUID: pointer to a 16 element uint8\_t array containing the desired UUID

const char\* UUID: desired UUID expressed as a character string

### **Returns**

The function returns nothing.

### **Example Code**

Example: BLEBeacon

### **Notes and Warnings**

UUID is a 128-bit number used to uniquely identify a beacon. It is commonly expressed as a 32-character hexadecimal string. UUIDs can be generated at <https://www.uuidgenerator.net/>.

## **iBeacon::setMajor**

## **altBeacon::setMajor**

### **Description**

Set Major value.

### **Syntax**

```
void setMajor(uint16_t major);
```

**Parameters**

major: desired Major value

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

**Notes and Warnings**

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

**iBeacon::setMinor****altBeacon::setMinor****Description**

Set Minor value.

**Syntax**

```
void setMinor(uint16_t minor);
```

**Parameters**

minor: desired Minor value

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBeacon

### Notes and Warnings

Major and Minor are values used for customizing beacons. These can be set to any value. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::setRSSI

### altBeacon::setRSSI

### Description

Set RSSI value.

### Syntax

```
void setRSSI(int8_t RSSI);
```

### Parameters

RSSI: desired RSSI value

### Returns

The function returns nothing.

### Example Code

Example: BLEBeacon

### Notes and Warnings

The beacon RSSI value is the received signal strength at 1 meter. This can be used to estimate the distance to the beacon. Refer to <https://developer.apple.com/ibeacon/> or <https://altbeacon.org/> for more information.

### iBeacon::getAdvData

### altBeacon::getAdvData

**Description**

Get current beacon advertising data.

**Syntax**

```
uint8_t* getAdvData(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

A uint8\_t pointer to the structure containing beacon advertising data.

**Example Code**

NA

**Notes and Warnings**

Avoid changing the beacon data through the returned pointer, use the member functions instead.

**iBeacon::getScanRsp****altBeacon::getScanRsp****Description**

Get current beacon advertising scan response data.

**Syntax**

```
uint8_t* getScanRsp(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

A uint8\_t pointer to the structure containing beacon advertising scan response data.

### Example Code

NA

### Notes and Warnings

Avoid changing the beacon data through the returned pointer, use the member functions instead.

### altBeacon::getRSVD

#### Description

Get current Reserved value.

#### Syntax

```
uint8_t getRSVD(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

An 8-bit unsigned integer containing the current Reserved value.

### Example Code

NA

### Notes and Warnings

Reserved for use by the manufacturer to implement special features. The interpretation of this value is to be defined by the manufacturer and is to be evaluated based on the MFG ID value. Refer to <https://altbeacon.org/> for more information.



## **altBeacon::setRSVD**

### **Description**

Set Reserved value.

### **Syntax**

```
void setRSVD(uint8_t rsvd);
```

### **Parameters**

rsvd: desired Reserved value

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Reserved for use by the manufacturer to implement special features. The interpretation of this value is to be defined by the manufacturer and is to be evaluated based on the MFG ID value. Refer to <https://altbeacon.org/> for more information.

## **Class BLECharacteristic**

### **BLECharacteristic Class**

#### **Description**

A class used for creating and managing BLE GATT characteristics.

#### **Syntax**

```
class BLECharacteristic
```

#### **Members**

<b>Public Constructors</b>	
BLEC haracteristic::BLECharacteristic	Constructs a BLECharacteristic object
<b>Public Methods</b>	
BLECharacteristic::setUUID	Set the characteristic UUID
BLECharacteristic::getUUID	Get the characteristic UUID
BLECharacteristic::setBufferLen	Set the size of the internal data buffer
BLECharacteristic::getBufferLen	Get the current size of the internal data buffer
BLECharacteristic::setReadProperty	Get the current size of the internal data bufferSet the characteristic r
BLECharacteristic::setWriteProperty	Set the characteristic write property
BLEC haracteristic::setNotifyProperty	Set the characteristic notify property
BLECha racteristic::setIndicateProperty	Set the characteristic indicate property
BLECharacteristic::setProperties	Set the characteristic properties
BLECharacteristic::getProperties	Get the characteristic properties
BLECharacteristic::readString	Read the characteristic data buffer as a String object
BLECharacteristic::readData8	Read the characteristic data buffer as an unsigned 8-bit integer
BLECharacteristic::readData16	Read the characteristic data buffer as an unsigned 16-bit integer
BLECharacteristic::readData32	Read the characteristic data buffer as an unsigned 32-bit integer
BLECharacteristic::writeString	Write data to the characteristic data buffer as a String object or char
BLECharacteristic::writeData8	Write data to the characteristic data buffer as an unsigned 8-bit integer
BLECharacteristic::writeData16	Write data to the characteristic data buffer as an unsigned 16-bit integer
BLECharacteristic::writeData32	Write data to the characteristic data buffer as an unsigned 16-bit integer
BLECharacteristic::setData	Write data to the characteristic data buffer
BLECharacteristic::getData	Read data from the characteristic data buffer
BLECharacteristic::getDataBuff	Get a pointer to the characteristic data buffer
BLECharacteristic::getDataLen	Get the number of bytes of data in the characteristic data buffer
BLECharacteristic::notify	Send a notification to a connected device
BLECharacteristic::indicate	Send an indication to a connected device
BLEC haracteristic::setUserDescriptor	Add a user description descriptor to characteristic
BLECha racteristic::setFormatDescriptor	Add a data format descriptor to characteristic
BLECharacteristic::Add a data format descriptor to characteristic	Set a user function as a read callback
BLECharacteristic::setWriteCallback	Set a user function as a write callback
BLECharacteristic::setCCCDCallback	Set a user function as a CCCD write callback

**BLECharacteristic::BLECharacteristic****Description**

Constructs a BLECharacteristic object.

**Syntax**

```
BLECharacteristic::BLECharacteristic(BLEUUID uuid);  
BLECharacteristic::BLECharacteristic(const char* uuid);
```

**Parameters**

uuid: characteristic UUID, expressed as a BLEUUID class object or a character array

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::setUUID****Description**

Set the characteristic UUID.

**Syntax**

```
void setUUID(BLEUUID uuid);
```

**Parameters**

uuid: the new characteristic UUID, expressed with a BLEUUID class object

**Returns**

The function returns nothing.

**Example Code**

NA

## Notes and Warnings

NA

## BLECharacteristic::getUUID

### Description

Get the characteristic UUID.

### Syntax

```
BLEUUID getUUID();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the characteristic UUID in a BLEUUID class object.

### Example Code

NA

## Notes and Warnings

NA

## BLECharacteristic::setBufferLen

### Description

Set the size of the internal data buffer of the characteristic.

### Syntax

```
void setBufferLen(uint16_t max_len);
```

### Parameters

max\_len: number of bytes to resize the internal buffer to

### Returns

The function returns nothing.

### Example Code

Example: BLEUartService

### Notes and Warnings

Characteristic data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

## BLECharacteristic::getBufferLen

### Description

Get the size of the characteristic internal buffer.

### Syntax

```
uint16_t getBufferLen();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the currently set internal buffer size.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::setReadProperty

### Description

Set the characteristic read property.

### Syntax

```
void setReadProperty(bool value);
```

### Parameters

value: TRUE to allow connected devices to read characteristic data

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

NA

## BLECharacteristic::setWriteProperty

### Description

Set the characteristic write property.

### Syntax

```
void setWriteProperty(bool value);
```

### Parameters

value: TRUE to allow connected devices to write characteristic data

### Returns

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::setNotifyProperty****Description**

Set the characteristic notify property.

**Syntax**

```
void setNotifyProperty(bool value);
```

**Parameters**

value: TRUE to allow connected devices to enable receiving characteristic data notifications.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

Enabling this property will add a CCCD descriptor to the characteristic.

**BLECharacteristic::setIndicateProperty****Description**

Set the characteristic indicate property.

**Syntax**

```
void setIndicateProperty(bool value);
```

### Parameters

value: TRUE to allow connected devices to enable receiving characteristic data indications.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Enabling this property will add a CCCD descriptor to the characteristic.

## BLECharacteristic::setProperties

### Description

Set the characteristic properties.

### Syntax

```
void setProperties(uint8_t value);
```

### Parameters

value: desired characteristic properties

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings



NA

### **BLECharacteristic::getProperties**

#### **Description**

Get the currently set characteristic properties.

#### **Syntax**

```
uint8_t getProperties();
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns the currently set characteristic properties expressed as an unsigned 8-bit integer.

#### **Example Code**

NA

#### **Notes and Warnings**

NA

### **BLECharacteristic::readString**

#### **Description**

Read the data in the characteristic internal buffer, expressed as a String class object.

#### **Syntax**

```
String readString();
```

#### **Parameters**

The function requires no input parameter.

### Returns

The function returns the data in the characteristic internal buffer expressed as a String class object.

### Example Code

Example: BLEUartService

### Notes and Warnings

Non-ASCII data may result in unexpected characters in the string.

## BLECharacteristic::readData8

### Description

Read the data in the characteristic internal buffer, expressed as an unsigned 8-bit integer.

### Syntax

```
uint8_t readData8();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic internal buffer expressed as a uint8\_t value.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::readData16

### Description

Read the data in the characteristic internal buffer, expressed as an unsigned 16-bit integer.

**Syntax**

```
uint16_t readData16();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic internal buffer expressed as a uint16\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::readData32****Description**

Read the data in the characteristic internal buffer, expressed as an unsigned 32-bit integer.

**Syntax**

```
uint32_t readData32();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic internal buffer expressed as a uint32\_t value.

**Example Code**

NA

### Notes and Warnings

NA

## BLECharacteristic::readData32

### Description

Write data to the characteristic data buffer as a String object or character array.

### Syntax

```
bool writeString(String str);  
bool writeString(const char* str);
```

### Parameters

str: the data to write to the characteristic buffer, expressed as a String class object or a char array.

### Returns

The function returns TRUE if write data is successful.

### Example Code

Example: BLEUartService

### Notes and Warnings

NA

## BLECharacteristic::writeData8

### Description

Write data to the characteristic data buffer as an unsigned 8-bit integer.

### Syntax

```
bool writeData8(uint8_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 8-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLECharacteristic::writeData16****Description**

Write data to the characteristic data buffer as an unsigned 16-bit integer.

**Syntax**

```
bool writeData16(uint16_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 16-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

## **BLECharacteristic::writeData32**

### **Description**

Write data to the characteristic data buffer as a 32-bit integer.

### **Syntax**

```
bool writeData32(uint32_t num);
```

```
bool writeData32(int num);
```

### **Parameters**

num: the data to write to the characteristic buffer expressed as a 32-bit integer.

### **Returns**

The function returns TRUE if write data is successful.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **BLECharacteristic::setData**

### **Description**

Write data to the characteristic data buffer.

### **Syntax**

```
bool setData(uint8_t* data, uint16_t datalen);
```

### **Parameters**

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::getData

### Description

Read data from the characteristic data buffer.

### Syntax

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

### Parameters

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

### Returns

The function returns the number of bytes read.

### Example Code

NA

### Notes and Warnings

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

**BLECharacteristic::getDataBuff****Description**

Get a pointer to the characteristic data buffer.

**Syntax**

```
uint8_t* getDataBuff();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns a pointer to the uint8\_t array used as the characteristic internal buffer.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::getDataLen****Description**

Get the number of bytes of data in the characteristic data buffer.

**Syntax**

```
uint16_t getDataLen
```

**Parameters**

The function requires no input parameter.

**Returns**



The function returns the number of bytes of data in the internal buffer.

**Example Code**

NA

**Notes and Warnings**

NA

**BLECharacteristic::notify****Description**

Send a notification to a connected device.

**Syntax**

```
void notify(uint8_t conn_id);
```

**Parameters**

conn\_id: the connection ID for the device to send a notification to.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::indicate****Description**

Send an indication to a connected device.

### Syntax

```
void indicate(uint8_t conn_id);
```

### Parameters

conn\_id: the connection ID for the device to send an indication to.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLECharacteristic::setUserDescriptor

### Description

Add a user description descriptor attribute (UUID 0x2901) to the characteristic.

### Syntax

```
void setUserDescriptor(const char* description);
```

### Parameters

description: the desired user description string expressed in a char array.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## BLECharacteristic::setFormatDescriptor

### Description

Add a data format descriptor attribute (UUID 0x2904) to the characteristic.

### Syntax

```
void setFormatDescriptor(uint8_t format, uint8_t exponent, uint16_t unit, uint16_t description);
```

### Parameters

format: refer to <https://www.bluetooth.com/specifications/assigned-numbers/format-types/> for the valid values and associated format types.

exponent: base-10 exponent to be applied to characteristic data value.

unit: refer to <https://btprodspecificationrefs.blob.core.windows.net/assigned-values/16-bit%20UUID%20Numbers%20Document.pdf> for the valid values and associated units.

descriptor: refer to <https://www.bluetooth.com/specifications/assigned-numbers/gatt-namespaces-descriptors/> for the valid values and associated descriptors.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## BLECharacteristic::setReadCallback

### Description

Set a user function to be called when the characteristic data is read by a connected device.

**Syntax**

```
void setReadCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing data read

conn\_id: connection ID of connected device that read characteristic data

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

**Notes and Warnings**

NA

**BLECharacteristic::setWriteCallback****Description**

Set a user function to be called when the characteristic data is written by a connected device.

**Syntax**

```
void setWriteCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing written data.

conn\_id: connection ID of connected device that wrote characteristic data.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLECharacteristic::setCCCDCallback****Description**

Set a user function to be called when a connected device modifies the characteristic CCCD to enable or disable notifications or indications.

**Syntax**

```
void setCCCDCallback(void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id, uint16_t ccc_bits));
```

**Parameters**

fCallback: A user callback function that returns void and takes two arguments.

chr: pointer to BLECharacteristic object containing written data.

conn\_id: connection ID of connected device that wrote characteristic data.

ccc\_bits: the new CCCD data bits after modification by the connected device

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

## Class BLEClient

### BLEClient Class

#### Description

A class used for discovering and accessing BLE GATT services on a connected remote device.

#### Syntax

```
class BLEClient
```

#### Members

Public Constructors
No public constructor is available for this class. You can get a pointer to an instance of this class using BLEDevice::addClient().

Public Methods	
BLEClient::connected	Check if the corresponding remote device for the client is connected
BLEClient::discoverServices	Start service discovery process for connected device
BLEClient::discoveryDone	Determine if service discovery process has been completed
BLEClient::printServices	Format and print discovered services to serial port
BLEClient::getService	Get a specific service on the remote device
BLEClient::getConnId	
BLEClient::getClientId	Get corresponding client ID
BLEClient::setDisconnectCallback	Set a user function to be called when the remote device is disconnected

### BLEClient::connected

#### Description

Check if the remote device associated with the client is still connected.

#### Syntax

```
bool connected();
```

#### Parameters

The function requires no input parameter.

**Returns**

The function returns TRUE if the remote device is connected.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEClient::discoverServices****Description**

Start the service discovery process for the connected remote device.

**Syntax**

```
void discoverServices();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

## **BLEClient::discoveryDone**

### **Description**

Check if the service discovery process has been completed.

### **Syntax**

```
bool discoveryDone();
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns TRUE if the service discovery process has been completed successfully, FALSE if the service discovery process failed, is still in progress, or has yet to start.

### **Example Code**

Example: BLEUartClient

### **Notes and Warnings**

NA

## **BLEClient::printServices**

### **Description**

Print out a formatted list of discovered services to the serial port.

### **Syntax**

```
void printServices();
```

### **Parameters**

The function requires no input parameter.



**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEClient::getService****Description**

Get a service with the specified UUID on the remote device.

**Syntax**

```
BLERemoteService* getService(const char* uuid);
```

```
BLERemoteService* getService(BLEUUID uuid);
```

**Parameters**

uuid: the desired service UUID, expressed as a character array or a BLEUUID object.

**Returns**

The function returns the found service as a BLERemoteService object pointer, otherwise nullptr is returned if a service with the UUID is not found.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

## **BLEClient::getConnId**

### **Description**

Get the connection ID associated with the remote device.

### **Syntax**

```
uint8_t getConnId;
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns the connection ID for the connected remote device.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **BLEClient::getClientId**

### **Description**

Get the client ID for the BLEClient object.

### **Syntax**

```
T_CLIENT_ID getClientId();
```

### **Parameters**

The function requires no input parameter.

**Returns**

The function returns the BLEClient object's client ID.

**Example Code**

NA

**Notes and Warnings**

The client ID is used when calling internal GATT client API.

**BLEClient::setDisconnectCallback****Description**

Set a user function as a callback function when the remote device is disconnected.

**Syntax**

```
void setDisconnectCallback(void (*fCallback) (BLEClient* client));
```

**Parameters**

fCallback: A user callback function that returns void and takes one argument.

client: A pointer to the BLEClient object corresponding to the disconnected remote device

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The user callback function will be called after the remote device has disconnected, before the characteristics, services and client associated with the remote device are deleted.

## Class BLEConnect

### BLEConnect Class

#### Description

A class used for managing BLE connection settings.

#### Syntax

```
class BLEConnect
```

#### Members

Public Constructors
No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using BLEDevice::configConnection.

Public Methods	
BLEConnect::connect	Connect to a target BLE device
BLEConnect::disconnect	Disconnect from a target BLE device
BLEConnect::setScanInterval	Set the BLE scanning interval when connecting
BLEConnect::setScanWindow	Set the BLE scanning window when connecting
BLEConnect::setConnInterval	Set the BLE connection interval duration
BLEConnect::setConnLatency	Set the BLE connection slave latency
BLEConnect::setConnTimeout	Set the BLE connection timeout value
BLEConnect::updateConnParams	Send new BLE connection parameters to a connected device
BLEConnect::getConnInfo	Get connection information
BLEConnect::getConnAddr	Get the Bluetooth address for a certain connection
BLEConnect::getConnId	Get the connection ID for a certain device

### BLEConnect::connect

#### Description

Connect to a target BLE device.

#### Syntax

```
bool connect(char* btAddr, T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);
```

```
bool connect(uint8_t (&btAddr)[6], T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);  
bool connect(BLEAdvertData targetDevice, uint16_t scanTimeout);  
bool connect(BLEAddr destAddr, T_GAP_REMOTE_ADDR_TYPE destAddrType, uint16_t scanTimeout);
```

### Parameters

char\* btAddr: target device Bluetooth address expressed as a character string.

uint8\_t (&btAddr): target device Bluetooth address contained in a 6 byte array.

destAddr: target device Bluetooth address contained in BLEAddr class object.

targetDevice: advertising data packet scanned from target device.

destAddrType: Bluetooth address type of target device. Valid values:

–GAP\_REMOTE\_ADDR\_LE\_PUBLIC

–GAP\_REMOTE\_ADDR\_LE\_RANDOM

scan timeout: duration in milliseconds for which to look for target device before giving up.

### Returns

True if connection successful, false if connection failed.

### Example Code

Example: BLEBatteryClient

### Notes and Warnings

NA

## BLEConnect::disconnect

### Description

Disconnect from a target BLE device.

### Syntax

```
bool disconnect(uint8_t connId);
```

### Parameters

connId: connection ID for target device.

### Returns

True if operation successful, false if otherwise.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::setScanInterval

### Description

Set the BLE scan interval when searching for a target device to connect to.

### Syntax

```
void setScanInterval(uint16_t scanInt_ms);
```

### Parameters

scanInt\_ms: scan interval in milliseconds. Value range of 3 to 10240.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::setScanWindow

### Description

Set the BLE scan window when searching for a target device to connect to.

### Syntax

```
void setScanWindow(uint16_t scanWindow_ms);
```

### Parameters

scanWindow\_ms: scan window in milliseconds. Value range of 3 to 10240.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEConnect::setConnInterval

### Description

Set the BLE connection interval value.

### Syntax

```
void setConnInterval(uint16_t min_ms, uint16_t max_ms);
```

### Parameters

min\_ms: minimum acceptable connection interval in milliseconds. Value range of 8 to 4000.

max\_ms: maximum acceptable connection interval in milliseconds. Value range of 8 to 4000.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The BLE connection interval defines the period between successive connection events between a connected central and peripheral device. Even if there is no data to exchange, a connection event is required to maintain the connection. max\_ms should be larger than or equal to min\_ms.

### BLEConnect::setConnLatency

### Description

Set the BLE connection slave latency value.

### Syntax

```
void setConnLatency(uint16_t latency);
```

### Parameters

latency: Connection slave latency value. Value range of 0 to 499.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The BLE connection slave latency defines the number of successive connection events a connected peripheral device can ignore without being considered as disconnected by the central device.



**BLEConnect::setConnTimeout****Description**

Set the BLE connection timeout value.

**Syntax**

```
void setConnTimeout(uint16_t timeout_ms);
```

**Parameters**

timeout\_ms: connection timeout in milliseconds. Value range of 100 to 32000.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The BLE connection timeout defines the duration after a failed connection events before a peripheral or central device considers the connection broken.

**BLEConnect::updateConnParams****Description**

Update a connected device with new connection parameters.

**Syntax**

```
void updateConnParams(uint8_t conn_id);
```

**Parameters**

conn\_id: connection ID of target device to update connection parameters.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Update a connected device with previously set connection interval, slave latency and timeout values. The connected device may reject the new values if it is unable to conform to them.

**BLEConnect::getConnInfo****Description**

Get connection information.

**Syntax**

```
bool getConnInfo(uint8_t connId, T_GAP_CONN_INFO *pConnInfo);
```

**Parameters**

connId: connection ID to get connection information from.

pConnInfo: pointer to T\_GAP\_CONN\_INFO structure to store obtained connection information.

**Returns**

True if operation success, false if operation failed.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEConnect::getConnAddr****Description**

Get the Bluetooth address for a certain connection.

**Syntax**

```
bool getConnAddr(uint8_t connId, uint8_t* addr, uint8_t* addrType);
```

**Parameters**

connId: connection ID to get address information for

addr: pointer to 6 byte array to store retrieved Bluetooth address

addrType: pointer to uint8\_t variable to store retrieved Bluetooth address type

**Returns**

True if operation success, false if operation failed.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEConnect::getConnId****Description**

Get the connection ID for a certain device.

**Syntax**

```
int8_t getConnId(char* btAddr, uint8_t addrType);
```

```
int8_t getConnId(uint8_t* btAddr, uint8_t addrType);
```

```
int8_t getConnId(BLEAdvertData targetDevice);
```

**Parameters**

char\* btAddr: target device Bluetooth address expressed as a character string.

uint8\_t\* btAddr: pointer to a 6 byte array containing target device Bluetooth address.

targetDevice: advertising data packet scanned from target device.

addrType: Bluetooth address type of target device. Valid values:

–GAP\_REMOTE\_ADDR\_LE\_PUBLIC

–GAP\_REMOTE\_ADDR\_LE\_RANDOM

**Returns**

The function returns the requested connection ID. Returns -1 if failed to obtain connection ID.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

NA

**Class BLEDevice****BLEDevice Class****Description**

A class used for general control and management of BLE functions.

**Syntax**

class BLEDevice

**Members**

Public Constructors
The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named BLE.

Public Methods	
BLEDevice::init	Allocate resources required for BLE functionality
BLEDevice::deinit	Free resources used by BLE functionality
BLEDevice::connected	Check if a BLE device is connected
BLEDevice::setDeviceName	Set BLE GAP device name
BLEDevice::setDeviceAppearance	Set BLE GAP device appearance
BLEDevice::configAdvert	Configure BLE advertising parameters
BLEDevice::configScan	Configure BLE scan parameters
BLEDevice::setScanCallback	Set callback function for BLE scans
BLEDevice::beginCentral	Start BLE stack in central mode
BLEDevice::beginPeripheral	Start BLE stack in peripheral mode
BLEDevice::end	Stop BLE stack
BLEDevice::configServer	Configure BLE stack for services
BLEDevice::addService	Add a service to the BLE stack
BLEDevice::configClient	Configure BLE stack for clients
BLEDevice::addClient	Add a client to the BLE stack
BLEDevice::getLocalAddr	Get local device Bluetooth address

**BLEDevice::init****Description**

Allocate resources required for BLE functionality.

**Syntax**

```
void init(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

## Notes and Warnings

Call this member function first before using any other member functions in the BLEDevice class.

## BLEDevice::deinit

### Description

Free up resources used for BLE functionality.

### Syntax

```
void deinit(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

Call this member function last after all other BLE operations are stopped.

## BLEDevice::connected

### Description

Check if a BLE device is connected.

### Syntax

```
bool connected(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

TRUE if another BLE device is connected, FALSE if no BLE device is connected.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEDevice::setDeviceName****Description**

Set the BLE GAP device name.

**Syntax**

```
void setDeviceName(String devName);
```

**Parameters**

devName: desired device name contained in an Arduino String object

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The GAP device name has a maximum length of 39 characters. Other devices can see this name after a BLE connection is established. This name is separate and different from the device name sent in a BLE advertisement, the names should be the same but are not required.

## **BLEDevice::setDeviceAppearance**

### **Description**

Set the BLE GAP device appearance.

### **Syntax**

```
void setDeviceAppearance(uint16_t devAppearance);
```

### **Parameters**

devAppearance: desired device appearance expressed as a 16-bit unsigned integer.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Refer to Bluetooth SIG assigned device appearances at <https://www.bluetooth.com/specifications/gatt/characteristics/>.

## **BLEDevice::configAdvert**

### **Description**

Configure BLE advertising parameters.

### **Syntax**



```
BLEAdvert* configAdvert(void);
```

### Parameters

The function requires no input parameter.

### Returns

A pointer to a BLEAdvert class instance for configuring BLE advertising parameters.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

Use this member function instead of creating a BLEAdvert class instance manually.

## BLEDevice::configScan

### Description

Configure BLE scanning parameters.

### Syntax

```
BLEScan* configScan(void);
```

### Parameters

The function requires no input parameter.

### Returns

A pointer to a BLEScan class instance for configuring BLE scanning parameters.

### Example Code

Example: BLEScan

```
#include 「BLEDevice.h」

#include 「BLEScan.h」

int dataCount = 0;

void scanFunction(T_LE_CB_DATA* p_data) {
    printf(「 rnScan Data %drn」 , ++dataCount);
    BLE.configScan()->printScanInfo(p_data);
}

void setup() {
    BLE.init();
    BLE.configScan()->setScanMode(GAP_SCAN_MODE_ACTIVE);
    BLE.configScan()->setScanInterval(500); // Start a scan every 500ms
    BLE.configScan()->setScanWindow(250); // Each scan lasts for 250ms
    // Provide a callback function to process scan data.
    // If no function is provided, default BLEScan::printScanInfo is used
    BLE.setScanCallback(scanFunction);
    BLE.beginCentral(0);
    BLE.configScan()->startScan(5000); // Repeat scans for 5 seconds, then stop
}

void loop() {
}
```

### Notes and Warnings

Use this member function instead of creating a BLEScan class instance manually.

### BLEDevice::setScanCallback

#### Description

Set a callback function for processing BLE scan results.

#### Syntax

```
void setScanCallback(void (scanCB)(T_LE_CB_DATA));
```

### Parameters

scanCB: a function that returns nothing and takes in a scan data pointer of type T\_LE\_CB\_DATA\*

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

### Notes and Warnings

Use this member function to set a callback function that will be called for each BLE device scan result found.

## BLEDevice::beginCentral

### Description

Start the BLE stack in central mode.

### Syntax

```
void beginCentral(uint8_t connCount);
```

### Parameters

connCount: maximum number of allowed connected devices. If no argument is provided, default to maximum allowed connected devices for specific board.

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

The function returns nothing.

### Notes and Warnings

Use this member function to start the device in BLE central mode, after other BLE parameters are set correctly.

## BLEDevice::beginPeripheral

### Description

Start the BLE stack in peripheral mode.

### Syntax

```
void beginPeripheral(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

### Notes and Warnings

Use this member function to start the device in BLE peripheral mode, after other BLE parameters are set correctly.

## BLEDevice::end

### Description

Stop the BLE stack.

**Syntax**

```
void end(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Use this member function to stop the device operating in either BLE peripheral mode or BLE central mode.

**BLEDevice::configServer****Description**

Configure the BLE stack for services.

**Syntax**

```
void configServer(uint8_t maxServiceCount);
```

**Parameters**

maxServiceCount: Maximum number of services that will run on the device

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryService

## Notes and Warnings

Use this member function before adding any service to the BLE stack.

## BLEDevice::addService

### Description

Add a new service to the BLE stack.

### Syntax

```
void addService(BLEService& newService);
```

### Parameters

newService: the service to be added, defined using a BLEService class object.

### Returns

The function returns nothing.

### Example Code

Example: BLEBatteryService

## Notes and Warnings

N/A

## BLEDevice::configClient

### Description

Configure the BLE stack for clients.

### Syntax

```
void configClient();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

Use this member function before adding any client to the BLE stack.

**BLEDevice::addClient****Description**

Add a new client to the BLE stack.

**Syntax**

```
BLEClient* addClient(uint8_t connId);
```

**Parameters**

connId: the connection ID of the connected device to create a client for.

**Returns**

The function returns a pointer to a BLEClient class object, corresponding to the device with the specified connection ID, which can be used to access the services and characteristics on the connected device.

**Example Code**

Example: BLEBatteryClient

**Notes and Warnings**

Only one client should be added per connected device.

The BLEClient object and any service, characteristic, descriptor associated with the connected device will be deleted when the device is disconnected.

## **BLEDevice::getLocalAddr**

### **Description**

Get local device Bluetooth address.

### **Syntax**

```
void getLocalAddr(uint8_t (&addr)[GAP_BD_ADDR_LEN]);
```

### **Parameters**

addr: 6 byte array to store local device Bluetooth address.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Local device address is only available after starting in central or peripheral mode. This function will return all zeros for the address if central or peripheral mode is not in operation.

## **Class BLEHIDDevice**

### **BLEHIDDevice Class**

#### **Description**

A class used for creating and managing HID over GATT Profile (HOGP) services.

#### **Syntax**



```
class BLEHIDDevice
```

## Members

### Public Constructors

The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named BLEHIDDev.

Public Methods	
BLEHIDDevice::init	Initialize the HID Device Profile by creating the required services
BLEHIDDevice::setNumOutputReport	Configure the number of HID output reports
BLEHIDDevice::setNumInputReport	Configure the number of HID input reports
BLEHIDDevice::setReportMap	Configure the HID report map
BLEHIDDevice::inputReport	Send a HID input report
BLEHIDDevice::setOutputReportCallback	Set a user callback function for receiving HID output reports
BLEHIDDevice::bootKeyboardReport	Send a HID boot keyboard input report
BLEHIDDevice::setHidInfo	Set HID info of the HID service
BLEHIDDevice::setBattLevel	Set battery level info of the Battery service
BLEHIDDevice::setPNPInfo	Set PNP information of the Device Information service
BLEHIDDevice::setManufacturerString	Set manufacturer information of the Device Information service
BLEHIDDevice::setModelString	Set model information of the Device Information service
BLEHIDDevice::hidService	Get reference to HID service
BLEHIDDevice::devInfoService	Get reference to Device Information service
BLEHIDDevice::battService	Get reference to Battery service

### BLEHIDDevice::init

### Description

Initialize the HID Device profile by creating the required services.

### Syntax

```
void init(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

The HID Device object should be initialized before any HID reports can be sent.

### BLEHIDDevice::setNumOutputReport

#### Description

Configure the number of HID output reports.

#### Syntax

```
void setNumOutputReport (uint8_t numOutputReports);
```

#### Parameters

numOutputReports: number of output reports

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

The number of output reports should be configured before BLEHIDDevice init() function is called.

### BLEHIDDevice::setNumInputReport

#### Description

Configure the number of HID input reports.

**Syntax**

```
void setNumInputReport (uint8_t numInputReports);
```

**Parameters**

numInputReports: number of input reports

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

The number of input reports should be configured before BLEHIDDevice init() function is called.

**BLEHIDDevice::setReportMap****Description**

Configure the HID report map characteristic with a HID report descriptor.

**Syntax**

```
void setReportMap (uint8_t* report_map, uint16_t len);
```

**Parameters**

report\_map: pointer to HID report descriptor

len: HID report descriptor length in bytes

**Returns**

The function returns nothing.

## Example Code

Example: BLEHIDGamepad

## Notes and Warnings

The HID report map characteristic can only be configured after BLEHIDDevice init() function is called.

## BLEHIDDevice::inputReport

### Description

Send a HID input report.

### Syntax

```
void inputReport (uint8_t reportID, uint8_t* data, uint16_t len, uint8_t conn_id);
```

### Parameters

reportID: HID report ID of input report

data: pointer to HID input report data to send

len: length of HID input report data in bytes

conn\_id: connection ID of device to send HID report to

### Returns

The function returns nothing.

## Example Code

NA

## Notes and Warnings

HID input reports can only be sent after BLEHIDDevice init() function has been called.

## BLEHIDDevice::setOutputReportCallback

### Description

Set a user callback function for receiving HID output report data.

### Syntax

```
void setOutputReportCallback (uint8_t reportID, void (*fCallback) (BLECharacteristic* chr, uint8_t conn_id));
```

### Parameters

reportID: HID report ID of output report to link callback function with

chr: BLECharacteristic class object containing received HID output report data

conn\_id: connection ID of device which sent HID report data

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Setting a user callback function for output reports can only occur after BLEHIDDevice init() function has been called.

## BLEHIDDevice::bootKeyboardReport

### Description

Send a HID boot keyboard input report.

### Syntax

```
void bootKeyboardReport (uint8_t* data, uint16_t len, uint8_t conn_id);
```

### Parameters

data: pointer to HID input report data to send

len: length of HID input report data in bytes

conn\_id: connection ID of device to send HID report to

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

By default, the HID service Protocol Mode characteristic has boot mode disabled. To send boot keyboard input reports, the Protocol Mode characteristic needs to have boot mode enabled.

**BLEHIDDevice::setHidInfo****Description**

Set data of the HID Info characteristic of the HID service.

**Syntax**

```
void setHidInfo (uint16_t bcd, uint8_t country, uint8_t flags);
```

**Parameters**

bcd: 16-bit unsigned integer representing version number of base USB HID Specification implemented by HID Device

country: 8-bit integer identifying country HID Device hardware is localized for. Most hardware is not localized (value 0x00).

flags: Bit flags indicating remote-wake capability and advertising when bonded but not connected.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

For detailed information on the characteristic, refer to Bluetooth SIG HID Service specifications.

## **BLEHIDDevice::setBattLevel**

### **Description**

Set battery level data of the Battery service.

### **Syntax**

```
void setBattLevel (uint8_t level);
```

### **Parameters**

level: battery level expressed as % of full charge

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Battery level is set to 100% by default. For detailed information refer to Bluetooth SIG Battery service specifications.

## **BLEHIDDevice::setPNPInfo**

### **Description**

Set PNP data of the Device Information service.

### **Syntax**

```
void setPNPInfo (uint8_t sig, uint16_t vid, uint16_t pid, uint16_t version);
```

### **Parameters**

sig: The Vendor ID Source field designates which organization assigned the value used in the Vendor ID field value.

vid: The Vendor ID field is intended to uniquely identify the vendor of the device.

pid: The Product ID field is intended to distinguish between different products made by the vendor.

version: The Product Version field is a numeric expression identifying the device release number in Binary-Coded Decimal.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

By default, sig and vid are configured to indicate Realtek as the vendor. For detailed information refer to Bluetooth SIG Device Information service specifications.

## BLEHIDDevice::setManufacturerString

### Description

Set manufacturer information of the Device Information service.

### Syntax

```
void setManufacturerString (const char* manufacturer);
```

### Parameters

manufacturer: pointer to character string containing manufacturer name info.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Manufacturer is set to “Realtek” by default. For detailed information refer to Bluetooth SIG Device Information service specifications.



## **BLEHIDDevice::setModelString**

### **Description**

Set model information of the Device Information service.

### **Syntax**

```
void setModelString (const char* model);
```

### **Parameters**

model: pointer to character string containing device model info.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

Model is set to “Ameba\_BLE\_HID” by default. For detailed information refer to Bluetooth SIG Device Information service specifications.

## **BLEHIDDevice::hidService**

### **Description**

Get reference to HID service

### **Syntax**

```
BLEService& hidService ();
```

### **Parameters**

The function requires no input parameter.

### Returns

The function returns a reference to the BLEService class object for the HID service.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDDevice::devInfoService

### Description

Get reference to Device Information service

### Syntax

```
BLEService& devInfoService ();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a reference to the BLEService class object for the Device Information service.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDDevice::battService

### Description

Get reference to Battery service

### Syntax

```
BLEService& battService ();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a reference to the BLEService class object for the Battery service.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## Class BLEHIDGamepad

### BLEHIDGamepad Class

#### Description

A class used for creating and managing a BLE HID Gamepad.

#### Syntax

```
class BLEHIDGamepad
```

#### Members

Public Constructors	
BLEHIDGame pad::BLEHIDGamepad	Constructs a BLEHIDGamepad object
Public Methods	
BLEHIDGamepad::setReportID	Set HID report ID for the HID Gamepad
BLEHIDGame pad::gamepadReport	Send a HID Gamepad report
BLEHIDGamepad::buttonPress	Send a HID Gamepad report indicating buttons pressed
BLEHIDGame pad::buttonRelease	Send a HID Gamepad report indicating buttons released
BLEHIDGamepad::buttonReleaseAll	Send a HID Gamepad report indicating no buttons pressed
BLEHIDGamepad::setHat	Send a HID Gamepad report indicating hat switch position
BLEHIDGamepad::setAxes	Send a HID Gamepad report indicating position of all axes
BLEHIDGamepad::setLeftStick	Send a HID Gamepad report indicating position of axes corresponding to left analog stick
BLEHIDGamepad::setRightStick	Send a HID Gamepad report indicating position of axes corresponding to right analog stick
BLEHIDGamepad::setTriggers	Send a HID Gamepad report indicating position of axes corresponding to triggers

## BLEHIDGamepad::BLEHIDGamepad

### Description

Constructs a BLE object

### Syntax

```
BLEHIDGamepad::BLEHIDGamepad();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

By default, the BLEHIDGamepad class assumes the HID report descriptor implements a gamepad device with 16 buttons, 6 16-bit axes and an 8-direction hat switch. This class will not work if a different gamepad report descriptor is implemented.

## BLEHIDGamepad::setReportID

### Description

Set HID report ID for the HID Gamepad.

### Syntax

```
void setReportID (uint8_t reportID);
```

### Parameters

reportID: The report ID for the gamepad device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

HID report ID should start at 1. Some systems may consider a report ID of 0 as invalid.

## BLEHIDGamepad::gamepadReport

### Description

Send a HID Gamepad report.

### Syntax

```
void gamepadReport (hid_gamepad_report_t* report);  
void gamepadReport (uint16_t buttons, uint8_t hat, int16_t x, int16_t y, int16_t z, int16_t Rz, int16_t Rx, int16_t Ry);
```

### Parameters

report: pointer to gamepad report structure containing data on all inputs

buttons: bitmap indicating state of each button. 1 = pressed, 0 = released.

hat: position of hat switch. Valid values:

–GAMEPAD\_HAT\_CENTERED = 0

–GAMEPAD\_HAT\_UP = 1

–GAMEPAD\_HAT\_UP\_RIGHT = 2

–GAMEPAD\_HAT\_RIGHT = 3

–GAMEPAD\_HAT\_DOWN\_RIGHT = 4

–GAMEPAD\_HAT\_DOWN = 5

–GAMEPAD\_HAT\_DOWN\_LEFT = 6

–GAMEPAD\_HAT\_LEFT = 7

–GAMEPAD\_HAT\_UP\_LEFT = 8

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

**Notes and Warnings**

NA

**BLEHIDGamepad::buttonPress****Description**

Send a HID Gamepad report indicating buttons pressed.

**Syntax**

```
void buttonPress (uint16_t buttons);
```

**Parameters**

buttons: bitmap indicating buttons pressed. 1 = pressed.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDGamepad::buttonRelease****Description**

Send a HID Gamepad report indicating buttons released.

**Syntax**

```
void buttonRelease (uint16_t buttons);
```

**Parameters**

buttons: bitmap indicating buttons released. 1 = released.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDGamepad::buttonReleaseAll

### Description

Send a HID Gamepad report indicating no buttons pressed.

### Syntax

```
void buttonReleaseAll (void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

NA



## BLEHIDGamepad::setHat

### Description

Send a HID Gamepad report indicating hat switch position.

### Syntax

```
void setHat (uint8_t hat);
```

### Parameters

hat: position of hat switch. Valid values:

- GAMEPAD\_HAT\_CENTERED = 0
- GAMEPAD\_HAT\_UP = 1
- GAMEPAD\_HAT\_UP\_RIGHT = 2
- GAMEPAD\_HAT\_RIGHT = 3
- GAMEPAD\_HAT\_DOWN\_RIGHT = 4
- GAMEPAD\_HAT\_DOWN = 5
- GAMEPAD\_HAT\_DOWN\_LEFT = 6
- GAMEPAD\_HAT\_LEFT = 7
- GAMEPAD\_HAT\_UP\_LEFT = 8

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDGamepad::setAxes

### Description

Send a HID Gamepad report indicating position of all axes.

### Syntax

```
void setAxes (int16_t x, int16_t y, int16_t z, int16_t Rz, int16_t Rx, int16_t Ry);
```

### Parameters

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDGamepad

### Notes and Warnings

NA

## BLEHIDGamepad::setLeftStick

### Description

Send a HID Gamepad report indicating position of axes corresponding to left analog stick.

### Syntax

```
void setLeftStick (int16_t x, int16_t y);
```

**Parameters**

x: position of x axis. Integer value from -32767 to 32767.

y: position of y axis. Integer value from -32767 to 32767.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDGamepad::setRightStick****Description**

Send a HID Gamepad report indicating position of axes corresponding to right analog stick.

**Syntax**

```
void setLeftStick (int16_t z, int16_t Rz);
```

**Parameters**

z: position of z axis. Integer value from -32767 to 32767.

Rz: position of Rz axis. Integer value from -32767 to 32767.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## BLEHIDGamepad::setTriggers

### Description

Send a HID Gamepad report indicating position of axes corresponding to triggers.

### Syntax

```
void setTriggers (int16_t Rx, int16_t Ry);
```

### Parameters

Rx: position of Rx axis. Integer value from -32767 to 32767.

Ry: position of Ry axis. Integer value from -32767 to 32767.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Class BLEHIDKeyboard

### BLEHIDKeyboard Class

#### Description

A class used for creating and managing a BLE HID Keyboard.

#### Syntax

```
class BLEHIDKeyboard
```

#### Members

<b>Public Constructors</b>	
BLEHIDKeyboard ard::BLEHIDKeyboard	Constructs a BLEHIDKeyboard object
<b>Public Methods</b>	
BLEHIDKeyboard::setReportID	Set HID report ID for the HID Keyboard and HID consumer control
BLEHIDKeyboard::consumerReport	Send a HID Consumer report
BLEHIDKeyboard::keyboardReport	Send a HID Keyboard report
BLEHIDKeyboard::consumerPress	Send a HID Consumer report indicating button pressed
BLEHIDKeyboard::consumerRelease	Send a HID Consumer report indicating button released
BLEHIDKeyboard::keypress	Send a HID Keyboard report indicating keys pressed
BLEHIDKeyboard::keyRelease	Send a HID Keyboard report indicating keys released
BLEHIDKeyboard::keyReleaseAll	Send a HID Keyboard report indicating no keys pressed
BLEHIDKeyboard::keyCharPress	Send a HID Keyboard report indicating keys pressed to output an ASCII character
BLEHIDKeyboard::keySequence	Send a HID Keyboard report indicating keys pressed to output an ASCII string

## BLEHIDKeyboard::BLEHIDKeyboard

### Description

Constructs a BLEHIDKeyboard object.

### Syntax

```
BLEHIDKeyboard::BLEHIDKeyboard();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDKeyboard

## Notes and Warnings

NA

## BLEHIDKeyboard::setReportID

### Description

Set HID report ID for the HID Keyboard and HID consumer control.

### Syntax

```
void setReportID (uint8_t reportIDKeyboard, uint8_t reportIDConsumer);
```

### Parameters

reportIDKeyboard: The report ID for the HID keyboard device, corresponding to the HID report descriptor.

reportIDConsumer: The report ID for the HID consumer control device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

NA

## Notes and Warnings

NA

## BLEHIDKeyboard::consumerReport

### Description

Send a HID Consumer report.

### Syntax

```
void consumerReport (uint16_t usage_code);
```

### Parameters

usage\_code: HID consumer control usage code for the button pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keyboardReport

### Description

Send a HID Keyboard report.

### Syntax

```
void keyboardReport (void);  
void keyboardReport (uint8_t modifiers, uint8_t keycode[6]);
```

### Parameters

modifiers: bitmap indicating key modifiers pressed (CTRL, ALT, SHIFT).  
keycode: byte array indicating keys pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::consumerPress

### Description

Send a HID Consumer report indicating button pressed.

### Syntax

```
void consumerPress (uint16_t usage_code);
```

### Parameters

usage\_code: HID consumer control usage code for the button pressed.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::consumerRelease

### Description

Send a HID Consumer report indicating button released.

### Syntax

```
void consumerRelease (void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.



**Example Code**

NA

**Notes and Warnings**

NA

**BLEHIDKeyboard::keypress****Description**

Send a HID Keyboard report indicating keys pressed.

**Syntax**

```
void keyPress (uint16_t key);
```

**Parameters**

key: HID keycode for key pressed, value ranges from 0x00 to 0xE7.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDKeyboard

**Notes and Warnings**

NA

**BLEHIDKeyboard::keyRelease****Description**

Send a HID Keyboard report indicating keys released.

**Syntax**

```
void keyRelease (uint16_t key);
```

### Parameters

key: HID keycode for key pressed, value ranges from 0x00 to 0xE7.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keyReleaseAll

### Description

Send a HID Keyboard report indicating no keys pressed.

### Syntax

```
void keyReleaseAll(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDKeyboard

### Notes and Warnings

NA

## BLEHIDKeyboard::keyCharPress

### Description

Send a HID Keyboard report indicating keys pressed to output an ASCII character.

### Syntax

```
void keyCharPress (char ch);
```

### Parameters

ch: ASCII character to output.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDKeyboard::keySequence

### Description

Send a HID Keyboard report indicating keys pressed to output an ASCII string.

### Syntax

```
void keySequence (const char* str, uint16_t delayTime);  
void keySequence (String str, uint16_t delayTime);
```

### Parameters

str: pointer to character string to output

str: String object containing character string to output

delayTime: time delay between key press and release, in milliseconds. Default value of 5.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDKeyboard

**Notes and Warnings**

NA

**Class BLEHIDMouse****BLEHIDMouse Class****Description**

A class used for creating and managing a BLE HID Mouse.

**Syntax**

```
class BLEHIDMouse
```

**Members**

Public Constructors	
BLE HIDMouse::BLEHIDMouse	Constructs a BLEHIDMouse object
Public Methods	
BLE HIDMouse::setReportID	Set HID report ID for the HID Mouse
BLE HIDMouse::mouseReport	Send a HID Mouse report
BL EHIDMouse::mousePress	Send a HID Mouse report indicating buttons pressed
BLEH IDMouse::mouseRelease	Send a HID Mouse report indicating buttons released
BLEHIDM ouse::mouseReleaseAll	Send a HID Mouse report indicating no buttons pressed
B LEHIDMouse::mouseMove	Send a HID Mouse report indicating mouse movement
BLE HIDMouse::mouseScroll	Send a HID Mouse report indicating mouse scroll wheel movement

## BLEHIDMouse::BLEHIDMouse

### Description

Constructs a BLEHIDMouse object.

### Syntax

```
BLEHIDMouse::BLEHIDMouse();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::setReportID

### Description

Set HID report ID for the HID Mouse.

### Syntax

```
void setReportID (uint8_t reportID);
```

### Parameters

reportID: The report ID for the HID mouse device, corresponding to the HID report descriptor.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDMouse::mouseReport

### Description

Send a HID Mouse report.

### Syntax

```
void mouseReport (hid_mouse_report_t* report);  
void mouseReport (uint8_t buttons, int8_t x, int8_t y, int8_t scroll);
```

### Parameters

report: pointer to mouse report structure containing data on mouse inputs

buttons: bitmap indicating state of each button. 1 = pressed, 0 = released.

x: mouse x-axis movement. Integer value from -127 to 127.

y: mouse y-axis movement. Integer value from -127 to 127.

scroll: mouse scroll wheel movement. Integer value from -127 to 127.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDMouse::mousePress

### Description

Send a HID Mouse report indicating buttons pressed.

### Syntax

```
void mousePress (uint8_t buttons);
```

### Parameters

buttons: bitmap indicating buttons pressed. 1 = pressed.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::mouseRelease

### Description

Send a HID Mouse report indicating buttons released.

### Syntax

```
void mouseRelease (uint8_t buttons);
```

### Parameters

buttons: bitmap indicating buttons released. 1 = released.

### Returns

The function returns nothing.

### Example Code

Example: BLEHIDMouse

### Notes and Warnings

NA

## BLEHIDMouse::mouseReleaseAll

### Description

Send a HID Mouse report indicating no buttons pressed.

### Syntax

```
void mouseReleaseAll(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEHIDMouse::mouseMove

### Description

Send a HID Mouse report indicating mouse movement.

### Syntax

```
void mouseMove (int8_t x, int8_t y);
```



**Parameters**

x: mouse x-axis movement. Integer value from -127 to 127.

y: mouse y-axis movement. Integer value from -127 to 127.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDMouse

**Notes and Warnings**

NA

**BLEHIDMouse::mouseScroll****Description**

Send a HID Mouse report indicating mouse scroll wheel movement.

**Syntax**

```
void mouseScroll (int8_t scroll);
```

**Parameters**

scroll: mouse scroll wheel movement. Integer value from -127 to 127.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEHIDMouse

**Notes and Warnings**

NA

## Class BLERemoteCharacteristic

### BLERemoteCharacteristic Class

#### Description

A class used for managing BLE GATT characteristics on connected remote devices.

#### Syntax

```
class BLERemoteCharacteristic
```

#### Members

Public Constructors
No public constructor is available for this class. You can get a pointer to an instance of this class using BLERemoteService::getCharacteristic().

Public Methods	
BLERemoteCharacteristic::getDescriptor	Get a specific descriptor on the remote device
BLERemoteCharacteristic::getUUID	Get the characteristic UUID
BLERemoteCharacteristic::setBufferLen	Set the size of the internal data buffer
BLERemoteCharacteristic::getBufferLen	Get the current size of the internal data buffer
BLERemoteCharacteristic::canRead	Determine if characteristic has read property enabled
BLERemoteCharacteristic::canWrite	Determine if characteristic has write property enabled
BLERemoteCharacteristic::canNotify	Determine if characteristic has notify property enabled
BLERemoteCharacteristic::canIndicate	Determine if characteristic has indicate property enabled
BLERemoteCharacteristic::getProperties	Get the characteristic properties
BLERemoteCharacteristic::readString	Read the characteristic data buffer as a String object
BLERemoteCharacteristic::readData8	Read the characteristic data buffer as an unsigned 8-bit integer
BLERemoteCharacteristic::readData16	Read the characteristic data buffer as an unsigned 16-bit integer
BLERemoteCharacteristic::readData32	Read the characteristic data buffer as an unsigned 32-bit integer
BLERemoteCharacteristic::writeString	Write data to the characteristic as a String object or character array
BLERemoteCharacteristic::writeData8	Write data to the characteristic as an unsigned 8-bit integer
BLERemoteCharacteristic::writeData16	Write data to the characteristic as an unsigned 16-bit integer
BLERemoteCharacteristic::writeData32	Write data to the characteristic as an unsigned 16-bit integer
BLERemoteCharacteristic::setData	Write data to the characteristic
BLERemoteCharacteristic::getData	Read data from the characteristic
BLERemoteCharacteristic::enableNotifyIndicate	Enable notification or indication for the characteristic
BLERemoteCharacteristic::disableNotifyIndicate	Disable notification and indication for the characteristic
BLERemoteCharacteristic::setNotifyCallback	Set a user function as a notification callback

### BLERemoteCharacteristic::getDescriptor

#### Description

Get a descriptor with the specified UUID on the remote device.

#### Syntax

```
BLERemoteDescriptor* getDescriptor(const char* uuid);
BLERemoteDescriptor* getDescriptor(BLEUUID uuid);
```

#### Parameters

uuid: the desired descriptor UUID, expressed as a character array or a BLEUUID object

### Returns

The function returns the found descriptor as a BLERemoteDescriptor object pointer, otherwise nullptr is returned if a descriptor with the UUID is not found.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::getUUID

### Description

Get the characteristic UUID.

### Syntax

```
BLEUUID getUUID();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the characteristic UUID as a BLEUUID class object.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::setBufferLen

### Description

Set the size of the internal data buffer of the characteristic.

### Syntax

```
void setBufferLen(uint16_t max_len);
```

### Parameters

max\_len: number of bytes to resize the internal buffer to.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartClient

### Notes and Warnings

Characteristic data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

## BLERemoteCharacteristic::getBufferLen

### Description

Get the size of the characteristic internal buffer.

### Syntax

```
uint16_t getBufferLen();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the currently set internal buffer size.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::canRead

### Description

Determine if characteristic has read property enabled.

### Syntax

```
bool canRead();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns TRUE if the read property for the characteristic is enabled.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::canWrite

**Description**

Determine if characteristic has write property enabled.

**Syntax**

```
bool canWrite();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns TRUE if the write property for the characteristic is enabled.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::canNotify****Description**

Determine if characteristic has notify property enabled.

**Syntax**

```
bool canNotify();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns TRUE if the notify property for the characteristic is enabled.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::canIndicate

### Description

Determine if characteristic has indicate property enabled.

### Syntax

```
bool canIndicate();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns TRUE if the indicate property for the characteristic is enabled.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteCharacteristic::getProperties

### Description

Get the characteristic properties.



**Syntax**

```
uint16_t getProperties();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the characteristic properties.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::readString****Description**

Request for characteristic data from the remote device and read the data in the buffer, expressed as a String class object.

**Syntax**

```
String readString();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic buffer expressed as a String class object.

**Example Code**

Example: BLEUartClient

## Notes and Warnings

NA

## BLERemoteCharacteristic::readData8

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 8-bit integer.

### Syntax

```
uint8_t readData8();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the data in the characteristic buffer expressed as a uint8\_t value.

### Example Code

Example: BLEBatteryClient

## Notes and Warnings

NA

## BLERemoteCharacteristic::readData16

### Description

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 16-bit integer.

**Syntax**

```
uint16_t readData16();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic buffer expressed as a uint16\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::readData32****Description**

Request for characteristic data from the remote device and read the data in the buffer, expressed as an unsigned 32-bit integer.

**Syntax**

```
uint32_t readData32();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the characteristic buffer expressed as a uint32\_t value.

**Example Code**

NA

#### Notes and Warnings

NA

### BLERemoteCharacteristic::writeString

#### Description

Write data to the remote device characteristic as a String object or character array.

#### Syntax

```
bool writeString(String str);  
bool writeString(const char* str);
```

#### Parameters

str: the data to write to the remote characteristic, expressed as a String class object or a char array.

#### Returns

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteCharacteristic::writeData8

#### Description

Write data to the remote device characteristic as an unsigned 8-bit integer.

**Syntax**

```
bool writeData8(uint8_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 8-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::writeData16****Description**

Write data to the remote device characteristic as an unsigned 16-bit integer.

**Syntax**

```
bool writeData16(uint16_t num);
```

**Parameters**

num: the data to write to the characteristic buffer expressed as an unsigned 16-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

## Notes and Warnings

NA

## BLERemoteCharacteristic::writeData32

### Description

Write data to the remote device characteristic as a 32-bit integer.

### Syntax

```
bool writeData32(uint32_t num);
```

```
bool writeData32(int num);
```

### Parameters

num: the data to write to the characteristic buffer expressed as a 32-bit integer.

### Returns

The function returns TRUE if write data is successful.

## Example Code

NA

## Notes and Warnings

NA

## BLERemoteCharacteristic::setData

### Description

Write data to the remote device characteristic.

### Syntax

```
bool setData(uint8_t* data, uint16_t datalen);
```

**Parameters**

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::getData****Description**

Request for characteristic data from the remote device and read the data in the buffer.

**Syntax**

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

**Parameters**

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

**Returns**

The function returns the number of bytes read.

**Example Code**

NA

### Notes and Warnings

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

## BLERemoteCharacteristic::enableNotifyIndicate

### Description

Enable the remote device to send notifications or indications for the characteristic.

### Syntax

```
void enableNotifyIndicate(bool notify = 1);
```

### Parameters

notify: TRUE to enable notifications, FALSE to enable indications.

### Returns

The function returns nothing.

### Example Code

Example: BLEUartClient

### Notes and Warnings

NA

## BLERemoteCharacteristic::disableNotifyIndicate

### Description

Disable receiving notifications and indications for the characteristic from the remote device.



**Syntax**

```
void disableNotifyIndicate();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteCharacteristic::setNotifyCallback****Description**

Set a user function to be called when the characteristic receives a notification from the remote device.

**Syntax**

```
void setNotifyCallback(void (*fCallback) (BLERemoteCharacteristic* chr, uint8_t* data, uint16_t length));
```

**Parameters**

fCallback: A user callback function that returns void and takes three arguments.

chr: pointer to BLERemoteCharacteristic object associated with notification.

data: pointer to byte array containing notification data.

length: number of bytes of notification data in array.

**Returns**

The function returns nothing.

## Example Code

Example: BLEUartClient

## Notes and Warnings

NA

## Class BLERemoteDescriptor

### BLERemoteDescriptor Class

#### Description

A class used for managing BLE GATT descriptors on connected remote devices.

#### Syntax

```
class BLERemoteDescriptor
```

#### Members

Public Constructors
No public constructor is available for this class. You can get a pointer to an instance of this class using BLERemoteCharacteristic::getDescriptor().

Public Methods	
BLERemoteDescriptor::getUUID	Get the descriptor UUID
BLERemoteDescriptor::setBufferLen	Set the size of the internal data buffer
BLERemoteDescriptor::getBufferLen	Get the current size of the internal data buffer
BLERemoteDescriptor::readString	Read the descriptor data buffer as a String object
BLERemoteDescriptor::readData8	Read the descriptor data buffer as an unsigned 8-bit integer
BLERemoteDescriptor::readData16	Read the descriptor data buffer as an unsigned 16-bit integer
BLERemoteDescriptor::readData32	Read the descriptor data buffer as an unsigned 32-bit integer
BLERemoteDescriptor::writeString	Write data to the descriptor as a String object or character array
BLERemoteDescriptor::writeData8	Write data to the descriptor as an unsigned 8-bit integer
BLERemoteDescriptor::writeData16	Write data to the descriptor as an unsigned 16-bit integer
BLERemoteDescriptor::writeData32	Write data to the descriptor as an unsigned 16-bit integer
BLERemoteDescriptor::setData	Write data to the descriptor
BLERemoteDescriptor::getData	Read data from the descriptor

**BLERemoteDescriptor::getUUID****Description**

Get the descriptor UUID.

**Syntax**

```
BLEUUID getUUID();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the descriptor UUID as a BLEUUID class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::setBufferLen****Description**

Set the size of the internal data buffer of the descriptor.

**Syntax**

```
void setBufferLen(uint16_t max_len);
```

**Parameters**

max\_len: number of bytes to resize the internal buffer to.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Descriptor data buffer has a default size of 20 bytes and can be increased up to 230 bytes.

## BLERemoteDescriptor::getBufferLen

### Description

Get the size of the descriptor internal buffer.

### Syntax

```
uint16_t getBufferLen();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the currently set internal buffer size.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::readString

**Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as a String class object.

**Syntax**

```
String readString();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a String class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::readData8****Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 8-bit integer.

**Syntax**

```
uint8_t readData8();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a uint8\_t value.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::readData16

#### Description

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 16-bit integer.

#### Syntax

```
uint16_t readData16();
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the data in the descriptor buffer expressed as a uint16\_t value.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::readData32

**Description**

Request for descriptor data from the remote device and read the data in the buffer, expressed as an unsigned 32-bit integer.

**Syntax**

```
uint32_t readData32();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the data in the descriptor buffer expressed as a uint32\_t value.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::writeString****Description**

Write data to the remote device descriptor as a String object or character array.

**Syntax**

```
bool writeString(String str);  
bool writeString(const char* str);
```

**Parameters**

str: the data to write to the remote descriptor, expressed as a String class object or a char array.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::writeData8

### Description

Write data to the remote device descriptor as an unsigned 8-bit integer.

### Syntax

```
bool writeData8(uint8_t num);
```

### Parameters

num: the data to write to the descriptor buffer expressed as an unsigned 8-bit integer.

### Returns

The function returns TRUE if write data is successful.

### Example Code

NA

### Notes and Warnings

NA

## BLERemoteDescriptor::writeData16



**Description**

Write data to the remote device descriptor as an unsigned 16-bit integer.

**Syntax**

```
bool writeData16(uint16_t num);
```

**Parameters**

num: the data to write to the descriptor buffer expressed as an unsigned 16-bit integer.

**Returns**

The function returns TRUE if write data is successful.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteDescriptor::writeData32****Description**

Write data to the remote device descriptor as a 32-bit integer.

**Syntax**

```
bool writeData32(uint32_t num);  
bool writeData32(int num);
```

**Parameters**

num: the data to write to the descriptor buffer expressed as a 32-bit integer.

**Returns**

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::setData

#### Description

Write data to the remote device descriptor.

#### Syntax

```
bool setData(uint8_t* data, uint16_t datalen);
```

#### Parameters

data: pointer to byte array containing desired data

datalen: number of bytes of data to write

#### Returns

The function returns TRUE if write data is successful.

#### Example Code

NA

#### Notes and Warnings

NA

### BLERemoteDescriptor::getData

### Description

Request for descriptor data from the remote device and read the data in the buffer.

### Syntax

```
uint16_t getData(uint8_t* data, uint16_t datalen);
```

### Parameters

data: pointer to byte array to save data read from buffer

datalen: number of bytes of data to read

### Returns

The function returns the number of bytes read.

### Example Code

NA

### Notes and Warnings

If the data buffer contains less data than requested, it will only read the available number of bytes of data.

## Class BLERemoteService

### BLERemoteService Class

#### Description

A class used for managing BLE GATT services on connected remote devices.

#### Syntax

```
class BLERemoteService
```

#### Members

**Public Constructors**

No public constructor is available for this class. You can get a pointer to an instance of this class using BLE-Client::getService().

Public Methods	
BLERemoteService::getUUID	Get the service UUID
BLE RemoteService::getCharacteristic	Get a specific characteristic on the remote device

**BLERemoteService::getUUID****Description**

Get the service UUID.

**Syntax**

```
BLEUUID getUUID();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the service UUID as a BLEUUID class object.

**Example Code**

NA

**Notes and Warnings**

NA

**BLERemoteService::getCharacteristic****Description**

Get a characteristic with the specified UUID on the remote device.

**Syntax**

BLERemoteCharacteristic\* getCharacteristic (const char\* uuid);  
BLERemoteCharacteristic\* getCharacteristic (BLEUUID uuid);

**Parameters**

uuid: the desired characteristic UUID, expressed as a character array or a BLEUUID object.

**Returns**

The function returns the found characteristic as a BLERemoteCharacteristic object pointer, otherwise nullptr is returned if a characteristic with the UUID is not found.

**Example Code**

Example: BLEUartClient

**Notes and Warnings**

NA

**Class BLEScan**

**BLEScan Class**

**Description**

A class used for managing BLE scanning settings.

**Syntax**

class BLEScan

**Members**

Public Constructors
No public constructor is available as this class is intended to be a singleton class. You can get a pointer to this class using BLEDevice::configScan

Public Methods	
BLEScan::updateScanParams	Update the current BLE advertisement settings to the lower Bluetooth stack
BLEScan::startScan	Start a BLE scan
BLEScan::stopScan	Stop a BLE scan
BLEScan::setScanMode	Set the BLE scanning mode
BLEScan::setScanInterval	Set the BLE scanning interval
BLEScan::setScanWindow	Set the BLE scanning window
BLEScan::setScanDuplicateFilter	Set the BLE scan duplicate filter
BLEScan::scanInProgress	Check if a scan is currently in progress
BLEScan::printScanInfo	Print out scanned information

### **BLEScan::updateScanParams**

#### **Description**

Update the lower Bluetooth stack with the current scan settings.

#### **Syntax**

```
void updateScanParams(void);
```

#### **Parameters**

The function requires no input parameter.

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: BLEScan

#### **Notes and Warnings**

Stop any scans in progress first before using this function.

### **BLEScan::startScan**

**Description**

Start BLE scanning.

**Syntax**

```
void startScan();  
void startScan(uint32_t scanDuration_ms);
```

**Parameters**

scanDuration: BLE scan will stop after scanDuration milliseconds.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

Set the scan parameters first before starting a scan. BLE scans will occur continuously for the duration set with BLEDevice::setScanWindow() and will repeat with a time interval set with BLEDevice::setScanInterval(). Call this member function without an argument to start scanning until BLEDevice::stopScan() is called.

**BLEScan::stopScan****Description**

Stop BLE scanning.

**Syntax**

```
void stopScan(void);
```

**Parameters**

The function requires no input paramter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## BLEScan::setScanMode

### Description

Set the BLE scan mode.

### Syntax

```
void setScanMode(uint8_t scanMode);
```

### Parameters

scanMode: GAP\_SCAN\_MODE\_PASSIVE for passive scanning, GAP\_SCAN\_MODE\_ACTIVE for active scanning

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

### Notes and Warnings

Active scanning will request for scan response packets after discovering an advertising device. Passive scanning will only capture advertising data packets.



## **BLEScan::setScanInterval**

### **Description**

Set the BLE scan interval.

### **Syntax**

```
void setScanInterval(uint16_t scanInt_ms);
```

### **Parameters**

scanInt\_ms: scan interval in milliseconds. Value range of 3 to 10240.

### **Returns**

The function returns nothing.

### **Example Code**

Example: BLEScan

### **Notes and Warnings**

A BLE scan will repeat with a time interval set with this member function.

## **BLEScan::setScanWindow**

### **Description**

Set the BLE scan window.

### **Syntax**

```
void setScanWindow(uint16_t scanWindow_ms);
```

### **Parameters**

scanWindow\_ms: scan window in milliseconds. Value range of 3 to 10240.

### Returns

The function returns nothing.

### Example Code

Example: BLEScan

### Notes and Warnings

A BLE scan will scan continuously for a window duration set with this member function. The scan window should be less than or equal to the scan interval.

### BLEScan::setScanDuplicateFilter

### Description

Set the scan duplicate filter.

### Syntax

```
void setScanDuplicateFilter(bool dupeFilter);
```

### Parameters

dupeFilter: TRUE to enable duplicate filtering.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Enabling duplicate filters will ignore scan results for devices already discovered previously.

**BLEScan::scanInProgress****Description**

Set the scan duplicate filter.

**Syntax**

```
bool scanInProgress(void);
```

**Parameters**

The function requires no input paramter.

**Returns**

TRUE if BLE scanning is in progress.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEScan::printScanInfo****Description**

Parse and print out scanned information.

**Syntax**

```
void printScanInfo(T_LE_CB_DATA* p_data);
```

**Parameters**

p\_data: pointer to scan data of type T\_LE\_CB\_DATA\*

**Returns**

The function returns nothing.

**Example Code**

Example: BLEScan

**Notes and Warnings**

Use this member function to parse the various fields of received advertisement data packets and print the results out to the serial monitor.

**Class BLEService****BLEService Class****Description**

A class used for creating and managing BLE GATT services.

**Syntax**

```
class BLEService
```

**Members**

Public Constructors	
BLEService::BLEService	Constructs a BLEService object
Public Methods	
BLEService::setUUID	Set service UUID
BLEService::getUUID	Get service UUID
BLEService::addCharacteristic	Add a characteristic to service
BLEService::getCharacteristic	Get a previously added characteristic

**BLEService::BLEService****Description**

Constructs a BLEService object.

**Syntax**

```
BLEService::BLEService(BLEUUID uuid);  
BLEService::BLEService(const char* uuid);
```

**Parameters**

uuid: service UUID, expressed as a BLEUUID class object or a character array

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLEService::setUUID****Description**

Set the service UUID.

**Syntax**

```
void setUUID(BLEUUID uuid);
```

**Parameters**

uuid: service UUID, expressed as a BLEUUID class object.

**Returns**

The function returns nothing.

**Example Code**

NA

#### Notes and Warnings

NA

### BLEService::getUUID

#### Description

Get the service UUID.

#### Syntax

```
BLEUUID getUUID();
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the service UUID in a BLEUUID class object.

#### Example Code

NA

#### Notes and Warnings

NA

### BLEService::addCharacteristic

#### Description

Add a characteristic to the service.

**Syntax**

```
void addCharacteristic(BLECharacteristic& newChar);
```

**Parameters**

newChar: the BLECharacteristic to add to the service.

**Returns**

The function returns nothing.

**Example Code**

Example: BLEUartService

**Notes and Warnings**

NA

**BLEService::getCharacteristic****Description**

Get a previously added characteristic.

**Syntax**

```
BLECharacteristic* getCharacteristic(uint8_t charIndex);
```

**Parameters**

charIndex: position index of characteristic.

**Returns**

The function returns a pointer to the BLECharacteristic at the requested position index.

**Example Code**

NA

## Notes and Warnings

NA

## Class BLEUUID

### BLEUUID Class

#### Description

A class used for creating and managing UUIDs.

#### Syntax

```
class BLEUUID
```

#### Members

Public Constructors	
BLEUUID::BLEUUID	Create a UUID object
Public Methods	
BLEUUID::str	Get the character string representation of UUID
BLEUUID::data	Get the binary representation of UUID
BLEUUID::length	Get the length of UUID

### BLEUUID::BLEUUID

#### Description

Create a UUID object from a UUID character string

#### Syntax

```
BLEUUID();  
BLEUUID(const char* str);  
BLEUUID(uint8_t* data, uint8_t length);
```

#### Parameters

str: UUID character string used to created object

data: pointer to byte array containing the desired UUID



length: number of bytes in array containing the desired UUID. Valid values of 2, 4 or 16

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings****BLEUUID::str****Description**

Get the character string representation of UUID

**Syntax**

```
const char* str(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Pointer to a character string representation of the UUID

**Example Code**

NA

**Notes and Warnings****BLEUUID::data**

### Description

Get the binary representation of UUID

### Syntax

```
const uint8_t* data(void);
```

### Parameters

The function requires no input parameter.

### Returns

Pointer to an unsigned 8-bit integer array containing the UUID expressed in binary form

### Example Code

NA

### Notes and Warnings

Returned pointer is of const uint8\_t\* type and will not allow changing of the data.

## BLEUUID::length

### Description

Get the length of UUID

### Syntax

```
uint8_t length(void);
```

### Parameters

The function requires no input parameter.

### Returns

Length of the UUID, in terms of bytes

**Example Code**

NA

**Notes and Warnings**

A 4-character UUID will be 16 bits / 2 bytes long.

A 32-character UUID will be 128 bits / 16 bytes long.

**Class BLEWifiConfigService****BLEWifiConfigService Class****Description**

A class used for managing a BLE WiFi configuration service running on the device.

**Syntax**

```
class BLEWifiConfigService
```

**Members**

Public Constructors	
BLEWifiCon figService::BLEWifiConfigService	Only one instance of this class should be created

Public Methods	
BLEWifiConfigService::begin	Start background thread to process WiFi configuration commands
BLEWifiConfigService::end	Stop background thread processing WiFi configuration commands
BLEWifiConfigService::addService	Add the service to the BLE stack
BLEWifiConfigService::advData	Get advertising data correctly formatted for WiFi configuration service

**BLEWifiConfigService::BLEWifiConfigService****Description**

Create an instance of the BLEWifiConfigService object.

**Syntax**

```
void BLEWifiConfigService ();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEWifiConfig

### Notes and Warnings

Only one instance of this class / service should be created.

### BLEWifiConfigService::begin

### Description

Start background thread to process WiFi configuration commands.

### Syntax

```
void begin();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEWifiConfig

**Notes and Warnings**

NA

**BLEWifiConfigService::end****Description**

Stop background thread processing WiFi configuration commands.

**Syntax**

```
void end();
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**BLEWifiConfigService::addService****Description**

Add the WiFi configuration service to the BLE stack.

**Syntax**

```
void addService();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: BLEWifiConfig

### Notes and Warnings

NA

## BLEWifiConfigService::advData

### Description

Get advertising data correctly formatted for WiFi configuration service.

### Syntax

```
BLEAdvertData advData();
```

### Parameters

The function requires no input parameter.

### Returns

The function returns a BLEAdvertData object that contains the required advertising data fields for the WiFi configuration service to work.

### Example Code

Example: BLEWifiConfig

### Notes and Warnings

The advertisement data needs to be correctly formatted for the corresponding smartphone app to recognise the device. WiFi configuration service advertisement data requires the local BT address, and should be called only after peripheral mode is started and may also require stopping and restarting the advertising process.

## EPDIF

### Class EpdIf

#### EpdIf Class

#### Description

A class used to control the electronic paper display internal functions.

#### Syntax

```
class EpdIf
```

#### Members

##### Public Constructors

A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named EpdIf.

##### Public Methods

EpdIf::EPD_Dis_Part	Put an image buffer to the frame memory, but not updating the display
EpdIf::EPD_SetFrame	Put display data to the frame memory, usually used for setup text display functions
EpdIf::EPD_SetRAMValue_BaseMap	To read image data stored in the RAM, but not display on the screen
EpdIf::EPD_SetFrameMemory	To read image data stored in the buffer, but not display on the screen
EpdIf::EPD_UpdateDisplay	Update the display
EpdIf::EPD_ClearScreen_White	Clear the frame memory with the White color, but not updating the display
EpdIf::EPD_ClearScreen_Black	Clear the frame memory with the Black color, but not updating the display
EpdIf::EPD_Busy	Wait until the Busy pin goes to low, which is the idle state
EpdIf::EPD_Reset	Used for the Epaper module reset. Often used to awaken the module in deep sleep
EpdIf::EPD_Sleep	After this command is transmitted, the chip would enter the deep-sleep mode to save power

## **EpdIf:: EPD\_Dis\_Part**

### **Description**

Put an image buffer to the frame memory, but not updating the display.

### **Syntax**

```
void EPD_Dis_Part(unsigned int x_start, unsigned int y_start, const unsigned char* datas, unsigned int PART_COLUMN, unsigned int PART_LINE);
```

### **Parameters**

x\_start: starting position of the x-axis

y\_start: starting position of the y-axis

datas: data to be displayed on the e-paper module

PART\_COLUMN: height of the display area

PART\_LINE: width of the display area

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

NA

## **EpdIf:: EPD\_SetFrame**

### **Description**

Put display data to the frame memory, usually used for setup text display functions.

### **Syntax**

```
void EPD_SetFrame(const unsigned char* image_buffer, int x, int y, int image_width, int image_height);
```



**Parameters**

image\_buffer: the buffer which stores the data to be displayed on the e-paper module, usually used to display texts.

x: starting position of the x-axis

y: starting position of the y-axis

image\_width: width of the display area

image\_height: height of the display area

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**EpdIf:: EPD\_SetRAMValue\_BaseMap****Description**

To read image data stored in the RAM, but not display on the screen.

**Syntax**

```
void EPD_SetRAMValue_BaseMap(const unsigned char* datas);
```

**Parameters**

datas: contains the black and white information that forms the image stored in RAM

**Returns**

The function returns nothing.

**Example Code**

NA

## Notes and Warnings

NA

## EpdIf:: EPD\_SetFrameMemory

### Description

To read image data stored in the buffer but not display on the screen.

### Syntax

```
void EPD_SetFrameMemory(const unsigned char* image_buffer);
```

### Parameters

image\_buffer: the buffer where stores the image data in hexadecimal numbers

### Returns

The function returns nothing.

## Example Code

NA

## Notes and Warnings

NA

## EpdIf:: EPD\_UpdateDisplay

### Description

Update the ePaper display module. Always combined used with functions set the frames.

### Syntax

```
void EPD_UpdateDisplay(void);
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

There are 2 memory areas embedded in the e-paper display but once this function is called, then the next action of SetFrameMemory or ClearScreen will set the other memory area.

**EpdIf:: EPD\_ClearScreen\_White****Description**

Clear the frame memory with the White color.

**Syntax**

```
void EpdIf::EPD_ClearScreen_White(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

## **EpdIf:: EPD\_ClearScreen\_Black**

### **Description**

Clear the frame memory with the Black color.

### **Syntax**

```
void EpdIf::EPD_ClearScreen_Black(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

NA

### **Notes and Warnings**

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

## **EpdIf:: EPD\_Busy**

### **Description**

Wait until the busy\_pin goes to low, which is the idle state.

### **Syntax**

```
void EpdIf::EPD_Busy(void);
```

### **Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

If the users want to see the actual display on the e-paper screen, the function EPD\_UpdateDisplay() is required to be added behind this code.

**EpdIf:: EPD\_Reset****Description**

This command will let the E-paper module reset, it is often used to awaken the module in while it' s in the deep sleep mode, you will find more details in the function EpdIf:: EPD\_Sleep().

**Syntax**

```
void EpdIf::EPD_Reset(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**EpdIf::EPD\_Sleep**

### Description

After this command is transmitted, the chip would enter the deep-sleep mode to save power. The deep sleep mode would return to standby by hardware reset. You can use EPD:: Init() to awaken the E-paper module.

### Syntax

```
void EpdIf::EPD_Sleep(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

---

## FatfsSDCard

### Class SdFatFs

#### Description

Defines a class of SD FAT File system.

#### Syntax

```
class SdFatFs
```

#### Members

##### Public Constructors

SdFatFs::SdFatFs Constructs a SdFatFs object

SdFatFs::~~SdFatFs Destructs a SdFatFs object

**Public Methods**

SdFatFs::begin	Initialize SD FAT File System
SdFatFs::end	Deinitialize SD FAT File System
SdFatFs::*getRootPath	Get the root path of the SD FAT File System
SdFatFs::readDir	List items under a specific folder
SdFatFs::mkdir	Create folder
SdFatFs::rm	Remove folder or file
SdFatFs::isDir	Check if a specific path is a directory
SdFatFs::isFile	Check if a specific path is a file
SdFatFs::getLastModTime	Get the last modified time for a file or directory
SdFatFs::setLastModTime	Set the last modified time for a file or directory
SdFatFs::status	Return the current status of SD
SdFatFs::open	Open a file

**SdFatFs::begin****Description**

Initialize SD FAT File System.

**Syntax**

```
int SdFatFs::begin(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## **SdFatFs::end**

### **Description**

De-initialize SD FAT File System.

### **Syntax**

```
int SdFatFs::end(void);
```

### **Parameters**

The function requires no input parameter.

### **Returns**

Returns “0” if success, else returns a negative value.

### **Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

### **Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## **SdFatFs::\*getRootPath**

### **Description**

Get the root path of the SD FAT File System. The logical volume character is starting from ‘0’, so the root path would like “0:” .

### **Syntax**

```
char *SdFatFs::getRootPath(void);
```

### **Parameters**

The function requires no input parameter.



**Returns**

The function returns the root path.

**Example Code**

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::readDir****Description**

List items under a specific folder. List items under a specific folder and store the result in the buffer that user specified. Each item is separated by ‘0’ .

**Syntax**

```
int SdFatFs::readDir(char *path, char *result_buf, unsigned int bufsize);
```

**Parameters**

path: The absolute directory path to be listed.

result\_buf: The buffer to be stored results.

bufsize: The size of result\_buf. If results exceed this size, then the results larger than this size would be discarded.

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

Example: get\_file\_attribute; list\_root\_files

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

## SdFatFs::mkdir

### Description

Create folder.

### Syntax

```
int SdFatFs::mkdir(char *absolute_path);
```

### Parameters

absolute\_path: The absolute directory path to be created

### Returns

Returns “0” if success, else returns a negative value.

### Example Code

Example: create\_folder

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::rm

### Description

Remove folder or file.

### Syntax

```
int SdFatFs::rm(char *absolute_path);
```

### Parameters

absolute\_path: The absolute directory or file path to be deleted

**Returns**

Returns “0” if success, else returns a negative value.

**Example Code**

NA

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::isDir****Description**

Check if a specific path is a directory.

**Syntax**

```
unsigned char SdFatFs::isDir(char *absolute_path);
```

**Parameters**

absolute\_path: The absolute path to be queried

**Returns**

The function returns “1” if it is a directory, else returns “0” .

**Example Code**

Example: get\_file\_attribute

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**SdFatFs::isFile**

### Description

Check if a specific path is a file.

### Syntax

```
unsigned char SdFatFs::isFile(char *absolute_path);
```

### Parameters

absolute\_path: The absolute path to be queried

### Returns

The function returns “1” if it is a directory, else returns “0” .

### Example Code

Example: get\_file\_attribute

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::getLastModTime

### Description

Get the last modified time for a file or directory.

### Syntax

```
int SdFatFs::getLastModTime(char *absolute_path, uint16_t *year, uint16_t *month, uint16_t *date, uint16_t *hour, uint16_t *minute, uint16_t *second);
```

### Parameters

absolute\_path: The absolute path to be queried.

year: The value of the year.

month: The value of the month.

date: The value of the date.

hour: The value of an hour.

minute: The value of a minute.

second: field “second” contains no valid information in the current version.

### Returns

The function returns “0” if success, otherwise returns a negative value for failure.

### Example Code

Example: last\_modified\_time

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::setLastModTime

### Description

Set the last modified time for a file or directory. Ameba doesn't have built-in RTC. So we manually change file/directory last modified time.

### Syntax

```
int SdFatFs::setLastModTime(char *absolute_path, uint16_t year, uint16_t month, uint16_t date, uint16_t hour,
uint16_t minute, uint16_t second);
```

### Parameters

absolute\_path: The absolute path to be queried.

year: The value of the year.

month: The value of the month.

date: The value of the date.

hour: The value of an hour.

minute: The value of a minute.

second: field “second” contains no valid information in the current version.

### Returns

The function returns “0” if success, otherwise returns a negative value for failure.

### Example Code

Example: last\_modified\_time

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::open

### Description

Open a file.

### Syntax

```
SdFatFile SdFatFs::open(char *absolute_path);
```

### Parameters

absolute\_path: The path to a file.

### Returns

The file object is an instance of SdFatFile.

### Example Code

Example: create\_folder; file\_read\_write; get\_file\_attribute; last\_modified\_time; list\_root\_files.

### Notes and Warnings

Include “SdFatFs.h” to use the class function.

## SdFatFs::status

**Description**

Return the current status of SD.

**Syntax**

```
int SdFatFs::status(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Function returns “1” if ready to use, else return “0” if the status is inactivating or abnormal.

**Example Code**

NA.

**Notes and Warnings**

Include “SdFatFs.h” to use the class function.

**Class SdFatFile****Description**

Defines a class of SD FAT File.

**Syntax**

```
class SdFatFile
```

**Members**

Public Constructors	
SdFatFile::SdFatFile	Constructs a SdFatFile object
SdFatFile::~SdFatFile	Destructs a SdFatFile object
Public Methods	
SdFatFile::write	Write 1 byte/bytes to file
SdFatFile::read	Read 1 byte/bytes from the file
SdFatFile::peek	Read 1 byte from file without move curser
SdFatFile::available	Check if the cursor is at EOF (End-Of-File)
SdFatFile::bool	Check if file is opened
SdFatFile::seek	Change cursor to a specific position
SdFatFile::close	Close file

### SdFatFile::write

#### Description

Write 1 byte or bytes to the file.

#### Syntax

```
size_t SdFatFile::write(uint8_t c);
```

```
size_t SdFatFile::write(const uint8_t *buf, size_t size);
```

#### Parameters

c: The character to be written.

buf: The buffer to be written.

size: The length of buffer to be written.

#### Returns

The function returns the number of byte count that has been successfully written to the file.

#### Example Code

NA.

#### Notes and Warnings

Include “SdFatFile.h” to use the class function.



**SdFatFile:: read****Description**

Read 1 byte or bytes from the file.

**Syntax**

```
int SdFatFile::read(void);
```

```
int SdFatFile::read(void *buf, uint16_t nbyte);
```

**Parameters**

buf: The buffer to store the content.

nbyte: The buffer size. (Or can be regarded as the desired length to read).

**Returns**

The function returns a read character or the read size of the buffer.

**Example Code**

```
1. #include 「FatFs_SD.h」
2.
3. char dirname[] = 「testdir」 ;
4. char filename[] = 「test.txt」 ;
5. char write_content[] = 「hello world!」 ;
6.
7. FatFsSD fs;
8.
9. void setup() {
10. char buf[128];
11. char absolute_filename[128];
12.
13. fs.begin();
14.
```

```
15. sprintf(absolute_filename, 「%s%s」 , fs.getRootPath(), dirname);
16. fs.mkdir(absolute_filename);
17. printf(「create dir at \」 %s”rn」 , absolute_filename);
18.
19. sprintf(absolute_filename, 「%s%s/%s」 , fs.getRootPath(), dirname, filename);
20. SdFatFile file = fs.open(absolute_filename);
21. file.println(write_content);
22. file.close();
23. printf(「create file at \」 %s”rn」 , absolute_filename);
24.
25. printf(「read back from \」 %s”rn」 , absolute_filename);
26. file = fs.open(absolute_filename);
27.
28. memset(buf, 0, sizeof(buf));
29. file.read(buf, sizeof(buf));
30.
31. file.close();
32. printf(「==== content ====rn」 );
33. printf(「%s」 , buf);
34. printf(「==== end ====rn」 );
35.
36. fs.end();
37. }
38.
39. void loop() {
40. delay(1000);
41. }
42.
```

Example: create\_folder;

This example shows how to create a folder and open a file under it.

```
1. #include 「FatFs_SD.h」
2.
3. char filename[] = 「test.txt」 ;
4. char write_content[] = 「hello world!」 ;
5.
6. FatFsSD fs;
7.
8. void setup() {
9.   char buf[128];
10.  char absolute_filename[128];
11.
12.  fs.begin();
13.
14.  printf(「write something to \」 %s\rn」 , filename);
15.  sprintf(absolute_filename, 「%s%s」 , fs.getRootPath(), filename);
16.  SdFatFile file = fs.open(absolute_filename);
17.
18.  file.println(write_content);
19.
20.  file.close();
21.  printf(「write finish\rn」 );
22.
23.  printf(「read back from \」 %s\rn」 , filename);
24.  file = fs.open(absolute_filename);
25.
26.  memset(buf, 0, sizeof(buf));
27.  file.read(buf, sizeof(buf));
28.
```

```
29. file.close();
30. printf(「==== content ====rn」);
31. printf(「%s」, buf);
32. printf(「==== end ====rn」);
33.
34. fs.end();
35. }
36.
37. void loop() {
38.   delay(1000);
39. }
40.
```

Example: file\_read\_write;

This example shows how to open/close files and perform read/write to it.

## Notes and Warnings

Include “SdFatFile.h” to use the class function.

## SdFatFile:: peek

### Description

Read one byte from the file without moving the cursor.

### Syntax

```
int SdFatFile::peek(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the read character as an integer number.

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: available

### Description

Check if the cursor is at EOF.

### Syntax

```
int SdFatFile::available(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “0” if the cursor is at EOF, else returns “1” .

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: flush

### Description

It is a nop. This is an inherited function from class Stream. And it does not affect SD File.

### Syntax

```
void SdFatFile::flush(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “SdFatFile.h” to use the class function.

### SdFatFile:: seek

### Description

Change cursor to a specific position.

### Syntax

```
int SdFatFile::seek(uint32_t pos);
```

### Parameters

pos: The desired position.

### Returns

The function returns 0 if success otherwise returns a negative value.

### Example Code

NA

## Notes and Warnings

Include “SdFatFile.h” in order to use the class function.

## SdFatFile:: close

### Description

Close file.

### Syntax

```
int SdFatFile::close(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns 0 if runs successfully otherwise it returns a negative value.

### Example Code

Example: last\_modified\_time;

The example shows how to get and set last modified time of a file.

Example: create\_folder;

This example shows how to create a folder and open a file under it. The details of the code can be found in the section of SdFatFile:: read.

Example: file\_read\_write;

This example shows how to open/close files and perform read/write to it. The details of the code can be found in the section of SdFatFile:: read.

1. #include <FatFs\_SD.h>
- 2.
3. FatFsSD fs;
- 4.
5. char filename[] = 「test.txt」 ;

```
6.
7. void setup() {
8.   char absolute_filename[128];
9.
10.  uint16_t year = 2021;
11.  uint16_t month = 4;
12.  uint16_t date = 4;
13.  uint16_t hour = 12;
14.  uint16_t minute = 12;
15.  uint16_t second = 12;
16.
17.  fs.begin();
18.
19.  sprintf(absolute_filename, "[%s%s]", fs.getRootPath(), filename);
20.  SdFatFile file = fs.open(absolute_filename);
21.  file.close();
22.
23.  fs.setLastModTime(absolute_filename, year, month, date, hour, minute, second);
24.
25.  fs.getLastModTime(absolute_filename, &year, &month, &date, &hour, &minute, &second);
26.  printf("filename: \"%s\" \r\n", absolute_filename);
27.  printf("time mod: %04d/%02d/%02d %02d:%02d:%02drn", year, month, date, hour, minute, second);
28.
29.  fs.end();
30. }
31.
32. void loop() {
33.   delay(1000);
34. }
35.
```



## Notes and Warnings

Include “SdFatFile.h” in order to use the class function.

## FlashMemory

### Class EpdIF

#### FlashMemoryClass Class

#### Description

Defines a class of Flash memory API

#### Syntax

```
class FlashMemoryClass
```

#### Members

Public Constructors	
FlashMemoryClass::FlashMemoryClass	Constructs a FlashMemoryClass object
FlashMemoryClass::~~FlashMemoryClass	Deconstructs a FlashMemoryClass object
Public Methods	
FlashMemoryClass::begin	Initialize/Re-initialize the base address and size
FlashMemoryClass::read	Read the content to buf
FlashMemoryClass::update	Write buf back to flash memory
FlashMemoryClass::readWord	Read 4 bytes from flash memory
FlashMemoryClass::writeWord	Write 4 bytes into flash memory
FlashMemoryClass::buf_size	The buf size
FlashMemoryClass::*buf	The buf to be operated

#### FlashMemoryClass::FlashMemoryClass

#### Description

Constructs a FlashMemoryClass object.

## Syntax

FlashMemoryClass(unsigned int \_base\_address, unsigned int \_buf\_size);

## Parameters

\_base\_address: The base address to operate.

\_buf\_size: The buf size for mirror a copy to reduce flash memory operation

## Returns

The function returns nothing.

## Example Code

Example: FleshMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Direct read from flash memory is allowed. To write data into flash memory, each bit on flash memory can only change from '1' to '0' and it cannot change from '0' to '1'. To make sure the data are correctly written we do erase the flash memory sector before write data on it.

```
#include <FlashMemory.h>
```

```
void setup() {  
  FlashMemory.read();  
  if (FlashMemory.buf[0] == 0xFF) {  
    FlashMemory.buf[0] = 0x00;  
    FlashMemory.update();  
    Serial.println(「write count to 0」);  
  } else {  
    FlashMemory.buf[0]++;  
    FlashMemory.update();  
    Serial.print(「Boot count: 」);  
    Serial.println(FlashMemory.buf[0]);  
  }  
}
```

```
}  
  
void loop() {  
  delay(1000);  
}
```

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

```
#include <FlashMemory.h>  
  
void setup() {  
  unsigned int value;  
  
  /* request flash size 0x4000 from 0xFC000 */  
  FlashMemory.begin(0xFC000, 0x4000);  
  
  /* read one word (32-bit) from 0xFC000 plus offset 0x3F00 */  
  value = FlashMemory.readWord(0x3F00);  
  printf(「value is 0x%08Xrn」, value);  
  
  if (value == 0xFFFFFFFF) {  
    value = 0;  
  } else {  
    value++;  
  }  
  
  /* write one word (32-bit) to 0xFC000 plus offset 0x3F00 */  
  FlashMemory.writeWord(0x3F00, value);  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
}
```

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::begin

### Description

Initialize/Re-initialize the base address and size. The base address shell aligns with the size of 0x1000. And the size shell is multiple of 0x1000.

### Syntax

```
void begin(unsigned int _base_address, unsigned int _buf_size);
```

### Parameters

\_base\_address: The base address

\_buf\_size: The desired work size

### Returns

The function returns nothing.

### Example Code

Example: FleshMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit). Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::read

### Description

Read the content to buf. Read flash memory into the buf. The size would be 0x1000.

**Syntax**

```
void read(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: FleshMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

**Notes and Warnings**

Include “FlashMemory.h” to use the class function.

**FlashMemoryClass::update****Description**

Write buf back to flash memory. Write flash memory with the content of the buffer. The size is 0x1000.

**Syntax**

```
void update(bool erase = true);
```

**Parameters**

erase: By default, it is true and erases flash memory before writing to it

**Returns**

The function returns nothing.

**Example Code**

Example: `FleshMemory_Basic`

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of `"FlashMemoryClass:: FlashMemoryClass"` .

**Notes and Warnings**

Include `"FlashMemory.h"` to use the class function.

**FlashMemoryClass::readWord****Description**

Read 4 bytes from flash memory. Read 4 byte from specific offset based on base address.

**Syntax**

```
unsigned int readWord(unsigned int offset);
```

**Parameters**

offset: The offset according to the base address

**Returns**

The read data with a size of 4 bytes

**Example Code**

Example: `ReadWriteOneWord`

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

Details of the example codes can be found in the previous section of `"FlashMemoryClass:: FlashMemoryClass"` .

**Notes and Warnings**

Include `"FlashMemory.h"` to use the class function.

## FlashMemoryClass::writeWord

### Description

Write 4 bytes into flash memory. It will try to write 4 bytes first. If the read data differ from the write data, then we buffer the sector of flash memory, erase it, and write correct data back to it.

### Syntax

```
void writeWord(unsigned int offset, unsigned int data);
```

### Parameters

offset: The offset according to the base address

data: The data to be written

### Returns

The function returns nothing.

### Example Code

Example: ReadWriteOneWord

This example shows how to request flash memory larger than default 0x4000, and read/write one specific word (32-bit).

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

## FlashMemoryClass::buf\_size

### Description

The buf size (It can be regarded as work size).

### Syntax

```
unsigned int buf_size;
```

### Example Code

Example: FlashMemory\_Basic

This example demonstrates the basic use of flash memory. Since boot count is stored in flash, each time upon device boot up, the boot count will be read from the flash, add one, then write back to the flash. Ameba's flash memory can be edit in a unit of a sector which has the size of 4K bytes.

Details of the example codes can be found in the previous section of “FlashMemoryClass:: FlashMemoryClass” .

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

### FlashMemoryClass::\*buf

### Description

The buf to be operated. Modify buf won't change the content of the buf. It needs an update to write back to flash memory.

### Syntax

```
unsigned char *buf;
```

### Example Code

NA

### Notes and Warnings

Include “FlashMemory.h” to use the class function.

---



## GPIO

### Class DHT

#### DHT Class

##### Description

Defines a class of using DHT temperature & humidity sensors

##### Syntax

```
class DHT
```

##### Members

Public Constructors	
DHT::DHT	Constructs a DHT object
Public Methods	
DHT::begin	Initialize the DHT sensor
DHT::readTemperature	Read temperature(Fahrenheit or Celcius) from the DHT sensor
DHT::convertCtoF	Convert a value from Celcius to Fahrenheit
DHT::convertFtoC	Convert a value from Fahrenheit to Celcius
DHT::readHumidity	Read humidity(%) from the DHT sensor
DHT::computeHeatIndex	Compute the HeatIndex from the readings (Using both Rothfusz and Steadman' s equations)
DHT::read	Check if the sensor is readable

#### DHT::DHT

##### Description

Constructs a DHT object.

##### Syntax

```
DHT::DHT(uint8_t pin, uint8_t type, uint8_t count)
```

##### Parameters

pin: The Arduino digital PIN connected

type: The DHT sensor type(DHT11, DHT22, or DHT21)

count: The count is now ignored as the DHT reading algorithm adjusts itself based on the speed of the processor

### Returns

The function returns nothing.

### Example Code

Example:DHTTester

The code demos basic testing for various DHT humidity & temperature sensors.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

```
// Example testing sketch for various DHT humidity/temperature sensors
// Written by ladyada, public domain

#include 「DHT.h」

// The digital pin we' re connected to.

#define DHTPIN 8

// Uncomment whatever type you' re using!

#define DHTTYPE DHT11 // DHT 11

// #define DHTTYPE DHT22 // DHT 22 (AM2302), AM2321

// #define DHTTYPE DHT21 // DHT 21 (AM2301)

// Connect pin 1 (on the left) of the sensor to +5V

// NOTE: If using a board with 3.3V logic like an Arduino Due connect pin 1
// to 3.3V instead of 5V!

// Connect pin 2 of the sensor to whatever your DHTPIN is

// Connect pin 4 (on the right) of the sensor to GROUND

// Connect a 10K resistor from pin 2 (data) to pin 1 (power) of the sensor

// Initialize DHT sensor.

// Note that older versions of this library took an optional third parameter to
// tweak the timings for faster processors. This parameter is no longer needed
```

```

// as the current DHT reading algorithm adjusts itself to work on faster procs.
DHT dht(DHTPIN, DHTTYPE);

void setup() {
  Serial.begin(115200);
  Serial.println(「DHTxx test!」);
  dht.begin();
}

void loop() {
  // Wait a few seconds between measurements.
  delay(2000);

  // Reading temperature or humidity takes about 250 milliseconds!
  // Sensor readings may also be up to 2 seconds 『old』 (its a very slow sensor)

  float h = dht.readHumidity();

  // Read temperature as Celsius (the default)
  float t = dht.readTemperature();

  // Read temperature as Fahrenheit (isFahrenheit = true)
  float f = dht.readTemperature(true);

  // Check if any reads failed and exit early (to try again).
  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println(「Failed to read from DHT sensor!」);
    return;
  }

  // Compute heat index in Fahrenheit (the default)
  float hif = dht.computeHeatIndex(f, h);

  // Compute heat index in Celsius (isFahreheit = false)
  float hic = dht.computeHeatIndex(t, h, false);

  Serial.print(「Humidity: 」);
  Serial.print(h);
  Serial.print(「 %t」);

  Serial.print(「Temperature: 」);

```

```
Serial.print(t);  
Serial.print(「 *C 」);  
Serial.print(f);  
Serial.print(「 *Ft 」);  
Serial.print(「 Heat index: 」);  
Serial.print(hic);  
Serial.print(「 *C 」);  
Serial.print(hif);  
Serial.println(「 *F 」);  
}
```

**DHT::begin****Description**

Initialize the DHT sensor.

**Syntax**

```
void DHT::begin(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

**Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

## DHT::readTemperature

### Description

Read temperature(Fahrenheit or Celcius) from the DHT sensor.

### Syntax

```
float DHT::readTemperature(bool S, bool force);
```

### Parameters

S: Temperature scale, True is Fahrenheit and False is Celcius

force: Index of checking sensor readability, default is False

### Returns

The function returns the current temperature as a float value.

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

## DHT::convertCtoF

### Description

Convert a value from Celcius to Fahrenheit.

### Syntax

```
float DHT::convertCtoF(float c);
```

### Parameters

c: The value in Celcius

### Returns

The function returns the temperature in Fahrenheit as a float number.

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

### DHT::convertFtoC

### Description

Convert a value from Fahrenheit to Celcius.

### Syntax

```
float DHT::convertFtoC(float f);
```

### Parameters

f: The value in Fahrenheit

### Returns

The function returns the temperature in Celcius as a float number.

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

## Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

## DHT::computeHeatIndex

### Description

Compute the HeatIndex from the readings (Using both Rothfusz and Steadman’ s equations). More details refer to [http://www.wpc.ncep.noaa.gov/html/heatindex\\_equation.shtml](http://www.wpc.ncep.noaa.gov/html/heatindex_equation.shtml) .

### Syntax

float DHT::computeHeatIndex(float temperature, float percentHumidity, bool isFahrenheit);

### Parameters

temperature: The temperature value

percentHumidity: The humidity percent value

isFahrenheit: True, temperature value in Fahrenheit (Default); False, temperature value in Celcius

### Returns

The function returns the heat index in Fahrenheit or Celsius as a float value.

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

## Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function.

## DHT::readHumidity

### Description

Reading temperature or humidity from the DHT sensor and return as a float value(%).

### Syntax

```
float DHT::readHumidity(bool force);
```

### Parameters

force: Ignored.

### Returns

The function returns current humidity in a float number (in %).

### Example Code

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

### Notes and Warnings

Every time must include the header file “DHT.h” in front of the project to use the class function. Reading temperature or humidity takes about 250 milliseconds! Sensor readings may also be up to 2 seconds.

### DHT::read

### Description

Check if the sensor is readable.

### Syntax

```
boolean DHT::read(bool force);
```

### Parameters

force: Index of whether checking the sensor was read less than two seconds ago or not. False, checking; True, not checking.



**Returns**

Return the last correct measurement of the sensor. False, low means not readable; True, high means readable.

**Example Code**

Example: DHTTester

The code demos basic testing for various DHT humidity & temperature sensors. Please refer to code in the “DHT: DHT” section.

**Notes and Warnings**

Every time must include the header file “DHT.h” in front of the project to use the class function.

**Class HttpClient****InterruptLock Class****Description**

Defines a class of turning off/on interrupts temporarily

**Syntax**

class InterruptLock

**Members**

Public Constructors	
InterruptLock::InterruptLock	Constructs a InterruptLock object
InterruptLock::~~ InterruptLock	Deconstructs a InterruptLock object

## GTimer

### Class EpdIF

#### GTimerClass Class

##### Description

GTimer is a hardware timer and this class is to operate it. The GTimer occupy same resource as PWM. Please make sure the timer is not conflict with you PWM index.

##### Syntax

```
class GTimerClass
```

##### Members

Public Constructors	
GTimerClass::GTimerClass	Constructs a GTimerClass object
Public Methods	
GTimerClass::begin	Initialize a timer and start it immediately
GTimerClass::stop	Stop a specific timer
GTimerClass::reload	Reload a specific timer
GTimerClass::read_us	Read current countdown value

#### GTimerClass::begin

##### Description

Initialize a timer and start it immediately.

##### Syntax

```
void GTimerClass::begin(uint32_t timerid, uint32_t duration_us, void (*handler)(uint32_t), bool periodical, uint32_t userdata);
```

##### Parameters

timerid: There are 5 valid GTimer with timer id 0~4.

duration\_us: The duration of the timer. The time unit is microsecond and the precision is 32768Hz.

periodical: By default, the timer would keep periodically countdown and reload which means the handler would periodically be invoked.

userdata: The user data brings to the handler.

### Returns

The function returns nothing.

### Example Code

Example: TimerOneshot

```
/*
This sketch shows how to use several hardware timers in invoke handler only once for each timer.
*/
#include <GTimer.h>

void myhandler(uint32_t data) {
  Serial.print(「I am timer!」);
  Serial.println(data);
}

void setup() {
  // Open serial communications and wait for port to open:
  Serial.begin(115200);

  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }

  // timerid 0, period 1s, invoke myhandler, invoke only once, user data is 0
  GTimer.begin(0, 1 * 1000 * 1000, myhandler, false, 0);

  // timerid 1, period 2s, invoke myhandler, invoke only once, user data is 1
  GTimer.begin(1, 2 * 1000 * 1000, myhandler, false, 1);

  GTimer.begin(2, 3 * 1000 * 1000, myhandler, false, 2);

  GTimer.begin(3, 4 * 1000 * 1000, myhandler, false, 3);
}
```

```
void loop() {  
  delay(1000);  
}
```

Example: TimerPeriodical

/\*

This sketch shows how to use hardware timer and invoke interrupt handler periodically

\*/

```
#include <GTimer.h>
```

```
int counter = 0;
```

```
void myhandler(uint32_t data) {
```

```
  counter++;
```

```
  Serial.print(「counter:  」);
```

```
  Serial.println(counter);
```

```
  if (counter >= 10) {
```

```
    Serial.println(「stop timer」 );
```

```
    GTimer.stop(0);
```

```
  }
```

```
}
```

```
void setup() {
```

```
  // Open serial communications and wait for port to open:
```

```
  Serial.begin(115200);
```

```
  while (!Serial) {
```

```
    ; // wait for serial port to connect. Needed for native USB port only
```

```
  }
```

```
  // timerid 0, period 1s, invoke myhandler
```

```
  GTimer.begin(0, (1 * 1000 * 1000), myhandler);
```

```
}
```

```
void loop() {
```

```
  delay(1000);
```

```
}
```

### Notes and Warnings

Include “GTimer.h” to use the class function.

### GTimerClass::stop

#### Description

Stop a specific timer

#### Syntax

```
void GTimerClass::stop(uint32_t timerid);
```

#### Parameters

timerid: Stop the timer with this timer id

#### Returns

The function returns nothing.

#### Example Code

Example: TimerPeriodical, please refer to GTimerClass:: begin for more details.

### Notes and Warnings

Include “GTimer.h” to use the class function.

### GTimerClass::reload

#### Description

Reload a specific timer. The GTimer is a countdown timer. Reload it would make it discard the current countdown value and restart countdown based on the duration.

#### Syntax

```
void GTimerClass::reload(uint32_t timerid, uint32_t duration_us);
```

### Parameters

timerid: The timer to be modified

duration\_us: The updated duration in unit of microseconds

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Include “GTimer.h” to use the class function.

## GTimerClass::read\_us

### Description

Read the current countdown value

### Syntax

```
uint64_t GTimerClass::read_us(uint32_t timerid);
```

### Parameters

timerid: The timer to be read

### Returns

The function returns the current countdown value.

### Example Code

NA

## Notes and Warnings

Include “GTimer.h” to use the class function.

## Http

### Class HttpClient

#### HttpClient Class

#### Description

Defines a class of using HttpClient

#### Syntax

```
class HttpClient
```

#### Members

Public Constructors	
HttpClient::HttpClient	Constructs a HttpClient object
Public Methods	
HttpClient::beginRequest	Start a more complex request
HttpClient::endRequest	End a more complex request
HttpClient::get	Connect to the server and start to send a GET request
HttpClient::post	Connect to the server and start to send a POST request
HttpClient::put	Connect to the server and start to send a PUT request
HttpClient::startRequest	Connect to the server and start to send the request
HttpClient::sendHeader	Send an additional header line
HttpClient::sendBasicAuth	Send a basic authentication header
HttpClient::finishRequest	Finish sending the HTTP request
HttpClient::responseStatusCode	Get the HTTP status code contained in the response
HttpClient::readHeader	Read the next character of the response headers
HttpClient::skipResponseHeaders	Skip any response headers to get to the body
HttpClient::endOfHeadersReached	Test whether all of the response headers have been consumed
HttpClient::endOfBodyReached	Test whether the end of the body has been reached
HttpClient::contentLength	Return the length of the body

## HttpClient::HttpClient

### Description

Constructs a HttpClient object. If Macro “PROXY\_ENABLED” is defined, currently disabled as introduces a dependency on DNS.h in Ethernet.

### Syntax

```
HttpClient::HttpClient(Client& aClient, const char* aProxy = NULL, uint16_t aProxyPort = 0);
```

```
HttpClient::HttpClient(Client& aClient);
```

### Parameters

aClient: The object of class WiFiClient.

aProxy: The proxy name. The default proxy name is “NULL” .

aProxyPort: The proxy port. The default value for the proxy port is 0.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrate how to download the content from URL indicated in kHostname[].

```
#include <HttpClient.h>
```

```
#include <WiFi.h>
```

```
#include <WiFiClient.h>
```

```
char ssid[] = 「YourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「password」 ; // your network password (use for WPA, or use as key for WEP)
```

```
int keyIndex = 0; // your network key Index number (needed only for WEP)
```

```
// Name of the server we want to connect to
```

```
const char kHostname[] = 「www.google.com」 ;
```

```
const char kPath[] = 「/」 ;
```

```
// Number of milliseconds to wait without receiving any data before we give up
```



```

const int kNetworkTimeout = 30*1000;

// Number of milliseconds to wait if no data is available before trying again
const int kNetworkDelay = 1000;

int status = WL_IDLE_STATUS;

void setup() {
  Serial.begin(9600);

  while ( status != WL_CONNECTED) {
    Serial.print( 「 Attempting to connect to SSID: 」);
    Serial.println(ssid);
    status = WiFi.begin(ssid, pass);
    // wait 10 seconds for connection:
    delay(10000);
  }
  Serial.println( 「 Connected to wifi 」 );
  printWifiStatus();
}

void loop() {
  int err =0;
  WiFiClient c;
  HttpClient http(c);
  err = http.get(kHostname, kPath);
  if (err == 0)
  {
    Serial.println( 「 startedRequest ok 」 );
    err = http.responseStatusCode();
    if (err >= 0)
    {
      Serial.print( 「 Got status code: 」);
      Serial.println(err);
      // Usually you'd check that the response code is 200 or a

```

```
// similar 「success」 code (200-299) before carrying on,

// but we' ll print out whatever response we get

err = http.skipResponseHeaders();

if (err >= 0)

{

int bodyLen = http.contentLength();

Serial.print( 「Content length is: 」);

Serial.println(bodyLen);

Serial.println();

Serial.println( 「Body returned follows:」 );

// Now we' ve got to the body, so we can print it out

unsigned long timeoutStart = millis();

char c;

// Whilst we haven' t timed out & haven' t reached the end of the body

while ( (http.connected() || http.available()) &&

((millis() - timeoutStart) < kNetworkTimeout) )

{

if (http.available())

{

c = http.read();

// Print out this character

Serial.print(c);

bodyLen--;

// We read something, reset the timeout counter

timeoutStart = millis();

}

else

{

// We haven' t got any data, so let' s pause to allow some to arrive

delay(kNetworkDelay);
```

```
}  
}  
}  
else  
{  
  Serial.print(「Failed to skip response headers:  」);  
  Serial.println(err);  
}  
}  
else  
{  
  Serial.print(「Getting response failed:  」);  
  Serial.println(err);  
}  
}  
else  
{  
  Serial.print(「Connect failed:  」);  
  Serial.println(err);  
}  
  
http.stop();  
  
// And just stop, now that we' ve tried a download  
while(1);  
}  
  
void printWifiStatus() {  
  // print the SSID of the network you' re attached to:  
  Serial.print(「SSID:  」);  
  Serial.println(WiFi.SSID());  
  
  // print your WiFi shield' s IP address:  
  IPAddress ip = WiFi.localIP();
```

```
Serial.print(「IP Address: 」);  
Serial.println(ip);  
  
// print the received signal strength:  
  
long rssi = WiFi.RSSI();  
Serial.print(「signal strength (RSSI):」 );  
Serial.print(rssi);  
Serial.println(「 dBm」 );  
  
}
```

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::beginRequest

#### Description

Start a more complex request. Use this when you need to send additional headers in the request, but you will also need to call endRequest() when you are finished.

#### Syntax

```
void HttpClient::beginRequest(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

## Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::endRequest

### Description

End a more complex request. Use this when you need to have sent additional headers in the request, but you will also need to call beginRequest() at the start.

### Syntax

```
void HttpClient::endRequest(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

## Notes and Warnings

Include “HttpClient.h” to use the class function.

## HttpClient::get

### Description

Connect to the server and start to send a “GET” request. If the input parameter contains “aServerAddress” , the connection will not perform a DNS lookup and just purely connect to the given IP address.

### Syntax

```
int HttpClient::get(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::get(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::get(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::get(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
```

### Parameters

aServerName: The name of the server being connected to. If aServerName is “NULL” , the “Host” header line will not be sent.

aServerPort: The port on which server connected.

aURLPath: The URL to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

### Returns

Return 0 if successful, otherwise indicates an error occurs.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::post

#### Description

Connect to the server and start to send a “POST” request. If the input parameter has “aServerAddress” , connects doesn’t perform a DNS lookup and just connects to the given IP address.

**Syntax**

```
int HttpClient::post(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
  
int HttpClient::post(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);  
  
int HttpClient::post(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
  
int HttpClient::post(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
```

**Parameters**

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’ t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

**Returns**

Return 0 if successful, otherwise indicates an error occurs.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::put****Description**

Connect to the server and start to send a PUT request. If the input parameter has “aServerAddress” , connects doesn’ t perform a DNS lookup and just connects to the given IP address.

**Syntax**

```
int HttpClient::put(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::put(const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::put(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char* aUserAgent = NULL);  
int HttpClient::put(const IPAddress& aServerAddress, const char* aServerName, const char* aURLPath, const char* aUserAgent = NULL);
```

**Parameters**

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aUserAgent: User-Agent string to be sent. If aUserAgent indicated as “NULL” , the default user-agent kUserAgent will be sent.

aServerAddress: IP address of the server to connect to.

**Returns**

Return 0 if successful, otherwise indicates an error occurs.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::startRequest****Description**

Connect to the server and start to send the request.

**Syntax**



```
int HttpClient::startRequest(const char* aServerName, uint16_t aServerPort, const char* aURLPath, const char*
aHttpMethod, const char* aUserAgent);
```

```
int HttpClient::startRequest(const IPAddress& aServerAddress, const char* aServerName, uint16_t aServerPort, const
char* aURLPath, const char* aHttpMethod, const char* aUserAgent);
```

### Parameters

aServerAddress: IP address of the server to connect to.

aServerName: Name of the server being connected to. If NULL, the “Host” header line won’t be sent.

aServerPort: Port to connect to on the server.

aURLPath: Url to request.

aHttpMethod: Type of HTTP request to make, e.g. “GET” , “POST” , etc.

aUserAgent: User-Agent string to send. If NULL the default user-agent kUserAgent will be sent.

### Returns

Return 0 if successful, else error.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::sendHeader

#### Description

The function sends an additional header line.

The function void HttpClient:: sendHeader(const char\* aHeader);can only be called in between the calls to startRequest and finishRequest.

The other 2 functions void HttpClient::sendHeader(const char\* aHeaderName, const char\* aHeaderValue); and void HttpClient::sendHeader(const char\* aHeaderName, const int aHeaderValue); are alternate form the previous one, which takes the header name and content as separately (as strings or integer). For example, to send an XXXXXX header, user might call sendHeader( “XXXXXX” , “Something” ) or sendHeader( “XXXXXX” , 123).And the call will add the “: ” in the log to separate different header in the case of multiple headers.

### Syntax

```
void HttpClient::sendHeader(const char* aHeader);  
void HttpClient::sendHeader(const char* aHeaderName, const char* aHeaderValue);  
void HttpClient::sendHeader(const char* aHeaderName, const int aHeaderValue);
```

### Parameters

aHeader: Header line to send, in its entirety (but without the trailing CRLF. E.g. “Authorization: Basic YQDDCAIGES” .

aHeaderName: Type of header being sent.

aHeaderValue: Value for that header.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::sendBasicAuth

#### Description

The function sends a basic authentication header which will encode the given username and password, and send them in a suitable header line for doing Basic Authentication.

#### Syntax

```
void HttpClient::sendBasicAuth(const char* aUser, const char* aPassword);
```

#### Parameters

aUser: Username for the authorization.

aPassword: Password for the user aUser.

### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::finishRequest

#### Description

Finish sending the HTTP request. The function sends a blank line to signify the end of the request.

#### Syntax

```
void HttpClient::finishRequest(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::responseStatusCode****Description**

Get the HTTP status code contained in the response. For example, “200” for successful requests, “404” for file not found, etc.

**Syntax**

```
int HttpClient::responseStatusCode(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return 0 if successful, else error.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::readHeader****Description**

The function reads the next character of the response headers. This functions the same as read() but to be used when reading through the headers which are slightly less efficient. The user might check whether the end of the headers has been reached by calling endOfHeadersReached(), although after that point this will still return data as read() would.

**Syntax**

```
int HttpClient::readHeader(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return the next character of the response headers.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::skipResponseHeaders****Description**

Skip any response headers to get to the body. Use this if you don't want to do any special processing of the headers returned in the response. You can also use it after you've found all of the headers you're interested in, and just want to get on with processing the body.

**Syntax**

```
int HttpClient::skipResponseHeaders(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return 0 if successful, else error.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::endOfHeadersReached

#### Description

Test whether all of the response headers have been consumed.

#### Syntax

```
bool HttpClient::endOfHeadersReached(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

Return true if we are now processing the response body, else false.

### Example Code

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

### Notes and Warnings

Include “HttpClient.h” to use the class function.

### HttpClient::endOfBodyReached

**Description**

Test whether the end of the body has been reached. It only works if the Content-Length header was returned by the server.

**Syntax**

```
bool HttpClient::endOfBodyReached(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return true if we are now at the end of the body, else false.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

**HttpClient::contentLength****Description**

The function returns the length of the body.

**Syntax**

```
int HttpClient::contentLength(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Return Length of the body, in bytes, or kNoContentLengthHeader if no Content-Length header was returned by the server.

**Example Code**

Example: SimpleHttpExample

The example demonstrates how to download the content from the URL indicated in kHostname[]. Details of the code can be found in the previous section of HttpClient:: HttpClient.

**Notes and Warnings**

Include “HttpClient.h” to use the class function.

---

**IRDevice****Class HttpClient****IRDevice Class****Description**

A class used for managing, sending, and receiving data using IR.

**Syntax**

class IRDevice

**Members**

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named IR.	



Public Methods	
IRDevice::getFreq	Get the current IR modulation frequency
IRDevice::begin	Allocate resources and start the IR device with a custom frequency
IRDevice::end	Stop the IR device operations and free up resources
IRDevice::send	Send IR raw data
IRDevice::beginNEC	Allocate resources and start the IR device with a frequency suitable for the NEC protocol
IRDevice::sendNEC	Send data using the NEC protocol
IRDevice::recvNEC	Receive data using the NEC protocol

**IRDevice::getFreq****Description**

Get the current IR modulation frequency.

**Syntax**

```
uint32_t getFreq(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

Currently set IR modulation frequency in Hertz.

**Example Code**

NA

**Notes and Warnings**

NA

**IRDevice::begin****Description**

Allocate resources and start the IR device with a custom frequency.

### Syntax

```
void begin(uint8_t receivePin, uint8_t transmitPin, uint32_t irMode, uint32_t freq);
```

### Parameters

receivePin: pin on which IR sensor is connected. Hardware IR receiver is available at pins 3, 8, 17.

transmitPin: pin on which IR LED is connected. Hardware IR transmitter is available at pins 6, 9, 16.

irMode: transmit or receive mode. Valid values: IR\_MODE\_TX, IR\_MODE\_RX

freq: IR modulation frequency in Hertz

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

IR device can only operate in either transmit or receive mode.

### IRDevice::end

### Description

Stop the IR device operations and free up resources.

### Syntax

```
void end(void);
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**IRDevice::send****Description**

Send IR raw data.

**Syntax**

```
void send(const unsigned int buf[ ], uint16_t len);
```

**Parameters**

buf[ ] : IR raw signals (in us) in an array form.

len: total length of the IR raw signal array.

**Returns**

The function returns nothing.

**Example Code**

```
#include 「IRDevice.h」

// User defined txPin, rxPin and carrier frequency

#define IR_RX_PIN 8

#define IR_TX_PIN 9

#define CARRIER_FREQ 38000

unsigned int irRawSignal[] = {
```

```
9000, 4500, // starting bit

560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, 560, // address 00100000 : 4

560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, 560, 1690, // ~ address 11011111

560, 560, 560, 560, 560, 560, 560, 1690, 560, 560, 560, 560, 560, 560, 560, 560, // data 00010000 : 8

560, 1690, 560, 1690, 560, 1690, 560, 560, 560, 1690, 560, 1690, 560, 1690, 560, 1690, //~ data 11101111

560 // stoping bit

};

int DataLen = sizeof(irRawSignal) / sizeof(irRawSignal[0]); // 284/ 4 = 71

void setup()
{
  Serial.begin(115200);

  IR.begin(IR_RX_PIN, IR_TX_PIN, IR_MODE_TX, CARRIER_FREQ);
}

void loop()
{
  IR.send(irRawSignal, DataLen);

  Serial.println(「 Finished Sending NEC Raw Data…」 );

  delay(3000);
}
```

## Notes and Warnings

IR Raw Data array contains information in the form of consecutive microseconds (us). For more details, please refer to:  
<http://www.righ.to.com/2009/08/multi-protocol-infrared-remote-library.html>.

## IRDevice::beginNEC

### Description

Allocate resources and start the IR device with a frequency suitable for the NEC protocol.

### Syntax

```
void beginNEC(uint8_t receivePin, uint8_t transmitPin, uint32_t irMode);
```

### Parameters

receivePin: pin on which IR sensor is connected. Hardware IR receiver is available at pins 3, 8, 17.

transmitPin: pin on which IR LED is connected. Hardware IR transmitter is available at pins 6, 9, 16.

irMode: transmit or receive mode. Valid values: IR\_MODE\_TX, IR\_MODE\_RX

### Returns

The function returns nothing.

### Example Code

Example: IRRecvNEC

```
#include 「IRDevice.h」

uint8_t adr = 0;
uint8_t cmd = 0;
void setup() {
  //Initialize serial and wait for port to open:
  Serial.begin(115200);
  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }
  IR.beginNEC(8, 9, IR_MODE_RX); // configure for NEC IR protocol
}
void loop() {
  if (IR.recvNEC(adr, cmd, 1000)) {
    Serial.print(「Received 」);
    Serial.print(adr);
    Serial.print(cmd);
    Serial.println();
  } else {
```

```
Serial.println(「Received nothing, timed out」);  
  
}  
  
//IR.end();  
  
}
```

### Notes and Warnings

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

### IRDevice::sendNEC

#### Description

Send data using the NEC protocol.

#### Syntax

```
void sendNEC(uint8_t adr, uint8_t cmd);
```

#### Parameters

adr: 8-bit address to transmit

cmd: 8-bit command to transmit

#### Returns

The function returns nothing.

#### Example Code

Example: IRSendNEC

```
#include 「IRDevice.h」  
  
uint8_t adr = 0;  
  
uint8_t cmd = 0;  
  
void setup() {
```

```

//Initialize serial and wait for port to open:
Serial.begin(115200);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

IR.beginNEC(8, 9, IR_MODE_TX); // configure for NEC IR protocol

}

void loop() {

if (cmd++ >=255) {

adr++;

}

IR.sendNEC(adr, cmd);

Serial.print(「Sent  」);

Serial.print(adr);

Serial.print(cmd);

Serial.println();

//IR.end(); // Call this method to stop IR device and free up the pins for other uses

}

```

### Notes and Warnings

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

### IRDevice::recvNEC

#### Description

Receive data using the NEC protocol.

#### Syntax

```
void recvNEC(uint8_t& adr, uint8_t& cmd uint32_t timeout);
```

**Parameters**

adr: variable to store received NEC address

cmd: variable to store received NEC command

timeout: time duration to wait for an incoming transmission

**Returns**

The function returns “1” if data has been received, returns “0” if no data has been received.

**Example Code**

Example: IRRecvNEC

Details of the code can be found in the previous section of IRDevice::beginNEC.

**Notes and Warnings**

IR device can only operate in either transmit or receive mode. Refer to <https://techdocs.altium.com/display/FPGA/NEC+Infrared+Transmission+Protocol> for the NEC protocol.

---

**MDNS****Class HttpClient****MDNSClass Class****Description**

A class used for registering and removing MDNS service records.

**Syntax**

```
class MDNSClass
```

**Members**

Public Constructors	
The public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named MDNS.	



Public Methods	
MDNSClass::begin	Start MDNS operations
MDNSClass::end	Stop MDNS operations
MDNSClass::registerService	Add a service record
MDNSClass::deregisterService	Remove service record
MDNSClass::updateService	Update service record

## MDNSClass::begin

### Description

Start MDNS operations to begin responding to MDNS queries.

### Syntax

```
void begin(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

This example shows how to register Ameba as a service that can be recognized by Arduino IDE. If both of the PC runs Arduino IDE and the Ameba board are connecting to the same local network. Then you can find Ameba in “Tools” -> “Port” -> “Arduino at 192.168.1.238 (Ameba RTL8195A), which means the Arduino IDE find Ameba via mDNS.

```
#include <WiFi.h>
```

```
#include <AmebaMDNS.h>
```

```
char ssid[] = 「yourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「secretPassword」 ; // your network password
```

```
MDNSService service( 「MyAmeba」 , 「_arduino._tcp」 , 「local」 , 5000);
```

```
void setup() {
```

```
printf(「Try to connect to %srn」, ssid);

while (WiFi.begin(ssid, pass) != WL_CONNECTED) {

printf(「Failed. Wait 1s and retry…rn」);

delay(1000);

}

printf(「Connected to %srn」, ssid);

service.addTxtRecord(「board」, strlen(「ameba_rtl8195a」), 「ameba_rtl8195a」);

service.addTxtRecord(「auth_upload」, strlen(「no」), 「no」);

service.addTxtRecord(「tcp_check」, strlen(「no」), 「no」);

service.addTxtRecord(「ssh_upload」, strlen(「no」), 「no」);

printf(「Start mDNS servicern」);

MDNS.begin();

printf(「register mDNS servicern」);

MDNS.registerService(service);

}

void loop() {

// put your main code here, to run repeatedly:

delay(1000);

}
```

## Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::end

### Description

Stop MDNS operations and stop responding to MDNS queries.

### Syntax

```
void end(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

**MDNSClass::registerService****Description**

Add a service record to be included in MDNS responses.

**Syntax**

```
void register service(MDNSService service);
```

**Parameters**

service: MDNSService class object with required MDNS service data

**Returns**

The function returns nothing.

**Example Code**

Example: mDNS\_On\_Arduino\_IDE

Details of the code can be found in the previous section of MDNSClass:: begin.

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::deregisterService

### Description

Remove a service record from MDNS responses.

### Syntax

```
void deregisterService(MDNSService service);
```

### Parameters

service: MDNSService class object to be removed

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

Details of the code can be found in the previous section of MDNSClass:: begin.

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSClass::updateService

### Description

Update a service record.

### Syntax

```
void updateService(MDNSService service, unsigned int ttl);
```

### Parameters

service: MDNSService class object to be updated

ttl: time-to-live(TTL) for service

Returns

The function returns nothing.

Example Code

NA

Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

Class HttpClient

MDNSService Class

Description

A class used for creating MDNS service records.

Syntax

class MDNSService

Members

Public Constructors	
MDNSService::MDNSService	Create a MDNS service record
Public Methods	
MDNSService::addTxtRecord	Add text to MDNS service record

MDNSService::MDNSService

Description

Create a MDNS service record.

Syntax

MDNSService(char\* name, char\* service\_type, char\* domain, unsigned short port, int bufsize);

### Parameters

name: device name

service\_type: MDNS service type

domain: host domain

port: network port

bufsize: size of buffer for MDNS text record

### Returns

The function returns nothing.

### Example Code

Example: mDNS\_On\_Arduino\_IDE

### Notes and Warnings

Include “AmebaMDNS.h” to use the class function.

## MDNSService::addTxtRecord

### Description

Add text to MDNS service record.

### Syntax

```
int addTextRecord(char* key, int value_len, char* value);
```

### Parameters

key: record type expressed as character string

value\_len: length of value string

value: record value expressed as character string

### Returns

0 if add record successful

**Example Code**

Example: mDNS\_On\_Arduino\_IDE

**Notes and Warnings**

Include “AmebaMDNS.h” to use the class function.

---

**MQTTClient****Class PMUClass****PubSubClient Class****Description**

Defines a class of MQTT implementation for Ameba.

**Syntax**

```
class PubSubClient
```

**Members**

Public Constructors	
PubSubClient::PubSubClient	Constructs a PubSubClient object
Public Methods	
PubSubClient::setServer	Set MQTT server address and port
PubSubClient::setCallback	Set callback function
PubSubClient::setClient	Set WiFi client
PubSubClient::setStream	Set data stream
PubSubClient::connect	Attempt to connect to server
PubSubClient::disconnect	Disconnect from current session
PubSubClient::publish	Publish a message to server
PubSubClient::publish_P	Same as above
PubSubClient::subscribe	Subscribe to a topic
PubSubClient::unsubscribe	Unsubscribe to a topic
PubSubClient::loop	Keep MQTT session alive and process any queuing tasks
PubSubClient::connected	Check if client still connected
PubSubClient::state	Return connection state

## PubSubClient::PubSubClient

### Description

Constructs a PubSubClient object and, if applicable, sets server address, port, callback function, data stream and wifi client.

### Syntax

```
PubSubClient::PubSubClient();
PubSubClient::PubSubClient(Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(IPAddress, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
PubSubClient::PubSubClient(IPAddress, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
PubSubClient::PubSubClient(uint8_t *, uint16_t, Client& client);
PubSubClient::PubSubClient(uint8_t *, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(uint8_t *, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
PubSubClient::PubSubClient(uint8_t *, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
PubSubClient::PubSubClient(const char*, uint16_t, Client& client);
PubSubClient::PubSubClient(const char*, uint16_t, Client& client, Stream&);
PubSubClient::PubSubClient(const char*, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client);
```



```
PubSubClient::PubSubClient(const char*, uint16_t, MQTT_CALLBACK_SIGNATURE, Client& client, Stream&);
```

### Parameters

client: the network client to use, for example WiFiClient

IPAddress: MQTT server address

port: port for MQTT, usually 1883 for unencrypted connection

MQTT\_CALLBACK\_SIGNATURE: callback function for MQTT

Stream: a stream to write received messages to

### Returns

The function returns nothing.

### Example Code

Example: MQTT\_Basic

```
#include <WiFi.h>

#include <PubSubClient.h>

// Update these with values suitable for your network.

char ssid[] = 「yourNetwork」 ; // your network SSID (name)
char pass[] = 「secretPassword」 ; // your network password
int status = WL_IDLE_STATUS; // the Wifi radio's status

char mqttServer[] = 「test.mosquitto.org」 ;
char clientId[] = 「amebaClient」 ;
char publishTopic[] = 「outTopic」 ;
char publishPayload[] = 「hello world」 ;
char subscribeTopic[] = 「inTopic」 ;

void callback(char* topic, byte* payload, unsigned int length) {
  Serial.print(「Message arrived [」);
  Serial.print(topic);
  Serial.print(「]」);

  for (int i=0;i<length;i++) {
```

```
Serial.print((char)payload[i]);
}
Serial.println();
}

WiFiClient wifiClient;
PubSubClient client(wifiClient);

void reconnect() {
// Loop until we're reconnected
while (!client.connected()) {
Serial.print(「 Attempting MQTT connection…」 );
// Attempt to connect
if (client.connect(clientId)) {
Serial.println(「 connected」 );
// Once connected, publish an announcement...
client.publish(publishTopic, publishPayload);
// ...and resubscribe
client.subscribe(subscribeTopic);
} else {
Serial.print(「 failed, rc=」 );
Serial.print(client.state());
Serial.println(「 try again in 5 seconds」 );
// Wait 5 seconds before retrying
delay(5000);
}
}
}

void setup()
{
Serial.begin(38400);

while (status != WL_CONNECTED) {
```

```

Serial.print( " Attempting to connect to SSID:  ");
Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:
status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:
delay(10000);

}

client.setServer(mqttServer, 1883);

client.setCallback(callback);

// Allow the hardware to sort itself out
delay(1500);

}

void loop()
{
  if (!client.connected()) {
    reconnect();
  }
  client.loop();
}

```

## Notes and Warnings

PubSubClient::PubSubClient(Client& client) would suffice for normal MQTT connection

## PubSubClient::setServer

### Description

Sets the server details.

### Syntax

PubSubClient& PubSubClient::setServer(uint8\_t \* ip, uint16\_t port)

PubSubClient& PubSubClient::setServer(IPAddress ip, uint16\_t port)

PubSubClient& PubSubClient::setServer(const char \* domain, uint16\_t port)

### Parameters

ip: the address of the server

port: the port to connect to, default 1883

domain: the address of the server

### Returns

The client instance, allowing the function to be chained

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::setCallback

### Description

Sets the message callback function.

### Syntax

PubSubClient& PubSubClient::setCallback(MQTT\_CALLBACK\_SIGNATURE)

### Parameters

MQTT\_CALLBACK\_SIGNATURE: a pointer to a message callback function called when a message arrives for a subscription created by this client.

### Returns

The client instance, allowing the function to be chained.

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::setClient

#### Description

Sets the network client instance to use.

#### Syntax

PubSubClient& PubSubClient::setClient(Client& client)

#### Parameters

client: the network client to use, for example WiFiClient

#### Returns

The client instance, allowing the function to be chained

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::setStream

#### Description

Sets the stream to write received messages to.

#### Syntax

PubSubClient& PubSubClient::setStream(Stream& stream)

### Parameters

stream: a stream to write received messages to

### Returns

The client instance, allowing the function to be chained.

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::connect

### Description

Connects the client to the server.

### Syntax

```
boolean PubSubClient::connect(const char *id)
```

```
boolean PubSubClient::connect(const char *id, const char *user, const char *pass)
```

```
boolean PubSubClient::connect(const char *id, const char* willTopic, uint8_t willQos, boolean willRetain, const char* willMessage)
```

```
boolean PubSubClient::connect(const char *id, const char *user, const char *pass, const char* willTopic, uint8_t willQos, boolean willRetain, const char* willMessage)
```

### Parameters

id: Client ID, a unique string identifier

user: Username for authentication, default NULL

pass: Password for authentication, default NULL

willTopic: the topic to be used by the will message

willQoS: the quality of service to be used by the will message

willRetain: whether the will should be published with the retain flag

willMessage: the payload of the will message

**Returns**

True –connection succeeded

False –connection failed

**Example Code**

Example: MQTT\_Basic

**Notes and Warnings**

Client ID is required and should always be unique else connection might be rejected by the server.

**PubSubClient::disconnect****Description**

Disconnect the client

**Syntax**

```
void PubSubClient::disconnect(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PubSubClient::publish**

**Description**

Publishes a message to the specified topic.

**Syntax**

`boolean PubSubClient::publish(const char* topic, const char* payload)`

`boolean PubSubClient::publish(const char* topic, const char* payload, boolean retained)`

`boolean PubSubClient::publish(const char* topic, const uint8_t* payload, unsigned int plength)`

`boolean PubSubClient::publish(const char* topic, const uint8_t* payload, unsigned int plength, boolean retained)`

**Parameters**

topic: the topic to publish to

payload: the message to publish

plength: the length of the payload. Required if payload is a byte[]

retained: whether the message should be retained

–false –not retained

–true –retained

**Returns**

False –publish failed, either connection lost or message too large

True –publish succeeded

**Example Code**

Example: MQTT\_Basic

**Notes and Warnings**

Default max packet size is 128 bytes.

**PubSubClient::publish\_P****Description**

Publishes a message stored in PROGMEM to the specified topic.

**Syntax**



boolean PubSubClient::publish\_P(const char\* topic, const uint8\_t\* payload, unsigned int plength, boolean retained)

### Parameters

topic: the topic to publish to

payload: the message to publish

plength: the length of the payload. Required if payload is a byte[]

retained: whether the message should be retained

–false –not retained

–true –retained

### Returns

False –publish failed, either connection lost or message too large

True –publish succeeded

### Example Code

NA

### Notes and Warnings

NA

## PubSubClient::subscribe

### Description

Subscribes to messages published to the specified topic.

### Syntax

boolean PubSubClient::subscribe(const char\* topic)

boolean PubSubClient::subscribe(const char\* topic, uint8\_t qos)

### Parameters

topic: the topic to subscribe to

qos: the qos to subscribe at

### Returns

False –sending the subscribe failed, either connection lost or message too large

True –sending the subscribe succeeded

### Example Code

Example: MQTT\_Basic

### Notes and Warnings

NA

### PubSubClient::unsubscribe

### Description

Unsubscribes from the specified topic.

### Syntax

boolean PubSubClient::unsubscribe(const char\* topic)

### Parameters

topic: the topic to unsubscribe to

### Returns

False –sending the unsubscribe failed, either connection lost or message too large

True –sending the unsubscribe succeeded

### Example Code

NA

### Notes and Warnings

NA

### PubSubClient::loop

**Description**

A must method called regularly to allow the client to process incoming messages and maintain its connection to the server.

**Syntax**

```
boolean PubSubClient::loop(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

False –the client is no longer connected

True –the client is still connected

**Example Code**

Example: MQTT\_Basic

**Notes and Warnings**

A required method that should not be blocked for too long.

**PubSubClient::connected****Description**

Checks whether the client is connected to the server.

**Syntax**

```
boolean PubSubClient::connected(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

False –the client is not connected

True –the client is connected

### **Example Code**

Example: MQTT\_Basic

### **Notes and Warnings**

NA

### **PubSubClient::state**

#### **Description**

Returns the current state of the client. If a connection attempt fails, this can be used to get more information about the failure.

All of the values have corresponding constants defined in PubSubClient.h.

#### **Syntax**

int PubSubClient::state(void)

#### **Parameters**

The function requires no input parameter.

#### **Returns**

-4 : MQTT\_CONNECTION\_TIMEOUT –the server didn’ t respond within the keepalive time

-3 : MQTT\_CONNECTION\_LOST –the network connection was broken

-2 : MQTT\_CONNECT\_FAILED –the network connection failed

-1 : MQTT\_DISCONNECTED –the client is disconnected cleanly

0 : MQTT\_CONNECTED –the client is connected

1 : MQTT\_CONNECT\_BAD\_PROTOCOL –the server doesn’ t support the requested version of MQTT

2 : MQTT\_CONNECT\_BAD\_CLIENT\_ID –the server rejected the client identifier

3 : MQTT\_CONNECT\_UNAVAILABLE –the server was unable to accept the connection

4 : MQTT\_CONNECT\_BAD\_CREDENTIALS –the username/password were rejected

5 : MQTT\_CONNECT\_UNAUTHORIZED –the client was not authorized to connect

## Example Code

Example: MQTT\_Basic

## Notes and Warnings

NA

## Readme

The Ameba MQTT related APIs and examples are works based on the [PubSubClient libraries](#) written by Nicholas O'Leary

These include,

- `PubSubClient.cpp`
- `PubSubClient.h`

These libraries are under MIT License.

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## NTPClient

### Readme

The NTPClient library is based on the NTPClient library written by Fabrice Weinberg, which can be found at <https://github.com/arduino-libraries/NTPClient>.

These include,

- `NTPClient.cpp`
- `NTPClient.h`

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---

## PowerSave

### Class PMUClass

#### PMUClass Class

#### Description

Defines a class of using Power Save API

#### Syntax

```
class PMUClass
```

#### Members

<b>Public Constructors</b>	
PMUClass::PMUClass	Constructs a PMUClass object
<b>Public Methods</b>	
PMUCLASS::begin	Initialize the PMUCLASS and select sleep mode
PMUCLASS::AONTimerDuration	Set the duration of AON Timer
PMUCLASS::AONTimerCmd	Disable the AON Timer for power save usage
PMUCLASS::RTCWakeSetup	Set up RTC Timer for power save usage
PMUCLASS::enable	Enable power save deep sleep mode
PMUCLASS::AONWakeReason	Check AON wakeup source
PMUCLASS::WakePinCheck	Check AON GPIO pin wakeup source
PMUCLASS::AONWakeClear	Clear all the AON wakeup source
PMUCLASS::DsleepWakeStatusGet	Check if deepsleep mode is set
PMUCLASS::TL_sysactive_time	Tickless mode system active time
PMUCLASS::TL_wakelock	Tickless mode wake lock, select acquire of release
PMUCLASS::DS_AON_TIMER_WAKEUP	Return the Wakeup source
PMUCLASS::DS_RTC_WAKEUP	Return the Wakeup source
PMUCLASS::TL_UART_WAKEUP	Return the Wakeup source
PMUCLASS::TL_RTC_WAKEUP	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA12	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA13	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA14	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA15	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA16	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA17	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA18	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA19	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA20	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA21	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA25	Return the Wakeup source
PMUCLASS::AON_WAKEPIN_WAKEUP_GPIOA26	Return the Wakeup source

## PMUCLASS::PMUCLASS

### Description

Constructs a PMUCLASS object.

### Syntax

```
PMUCLASS::PMUCLASS(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::begin

### Description

Initialize the PMUCLASS and select sleep mode.

### Syntax

```
void PMUClass::begin(uint32_t sleep_mode);
```

### Parameters

sleep\_mode: Selection value, “11” enters the DeepSleep Mode, “22” enters the Tickless Mode

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.



## PMUCLASS::AONTimerDuration

### Description

Set the duration of AON Timer

### Syntax

```
void PMUClass::AONTimerDuration(uint32_t duration_ms);
```

### Parameters

duration\_ms: Timer duration between 0 to 32760000ms.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONTimerCmd

### Description

Disable the AON timer for power save usage.

### Syntax

```
void PMUClass::AONTimerCmd(void);
```

### Parameters

c: The value in Celcius.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::RTCWakeSetup

### Description

Set up the RTC timer for power save usage.

### Syntax

```
void PMUClass::RTCWakeSetu(uint32_t duration_d, uint32_t duration_h, uint32_t duration_m, uint32_t duration_s);
```

### Parameters

duration\_d: Set alarm for number of days from 0.

duration\_h: Set alarm for number of hours from 0.

duration\_m: Set alarm for number of minutes from 0.

duration\_s: Set alarm for number of seconds from 0.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::enable

### Description

Enable power save deep sleep mode

### Syntax

```
void PMUClass::enable(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONWakeReason

### Description

Check the AON wakeup source

### Syntax

```
uint32_t PMUClass::AONWakeReason(void);
```

### Parameters

The function requires no input parameter.

### Returns

Returns the value of wakeup deepsleep source. “11” for AON pin, “22” for AON timer, “33” for RTC timer and “0” for none.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::WakePinCheck

### Description

Check which AON GPIO pins are the wakeup source

### Syntax

```
int PMUClass::WakePinCheck(void);
```

### Parameters

The function requires no input parameter.

### Returns

Return the pin number for indicating Arduino pin names.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AONWakeClear

### Description

Clear all AON Wakeup source.

### Syntax

```
void PMUClass::AONWakeClear(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::DsleepWakeStatusGet

### Description

Check if deepsleep mode is set.

### Syntax

```
bool PMUClass::DsleepWakeStatusGet(void);
```

### Parameters

The function requires no input parameter.

### Returns

Return TRUE when enter DeepSleep Mode or FALSE for negative.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_sysactive\_time

### Description

Tickless mode system active time.

### Syntax

```
void PMUClass::TL_sysactive_time(uint32_t duration_ms);
```

### Parameters

duration\_ms: Set the duration of system active time. The unit is in milliseconds.

### Returns

The function returns nothing.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_wakelock

### Description

Tickless mode wake lock, select acquire or release.

### Syntax

```
void PMUClass::TL_wakelock(uint32_t select_lock);
```

**Parameters**

select\_lock: Wake lock selection value, “1” for acquire or “0” for release.

**Returns**

The function returns nothing.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::DS\_AON\_TIMER\_WAKEUP****Description**

Return the Wakeup source for DeepSleep Mode.

**Syntax**

```
void PMUClass::DS_AON_TIMER_WAKEUP(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON Timer as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::DS\_RTC\_WAKEUP

### Description

Return the Wakeup source for DeepSleep Mode.

### Syntax

```
void PMUClass::DS_RTC_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns RTC as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::TL\_UART\_WAKEUP

### Description

Return the Wakeup source for Tickless Mode.

### Syntax

```
void PMUClass::TL_UART_WAKEUP(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns LOGUART as the wakeup source and output it on the Serial monitor.



**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::TL\_RTC\_WAKEUP****Description**

Return the Wakeup source for Tickless Mode.

**Syntax**

```
void PMUClass::TL_RTC_WAKEUP(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns RTC as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA12****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA12(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA12 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA13

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA13(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA13 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA14

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA14(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA14 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA15

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA15(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA15 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA16

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA16(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA16 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA17

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA17(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA17 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA18****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA18(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA18 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA19

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA19(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA19 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA20

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA20(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA20 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA21****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA21(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

This function returns AON GPIOA21 pin as the wakeup source and output it on the Serial monitor.

**Example Code**

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

**Notes and Warnings**

Include “PMUCLASS.h” in order to use the class function.

**PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA25****Description**

Return the Wakeup source.

**Syntax**

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA25(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA25 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.

## PMUCLASS::AON\_WAKEPIN\_WAKEUP\_GPIOA26

### Description

Return the Wakeup source.

### Syntax

```
void PMUClass::AON_WAKEPIN_WAKEUP_GPIOA26(void);
```

### Parameters

The function requires no input parameter.

### Returns

This function returns AON GPIOA26 pin as the wakeup source and output it on the Serial monitor.

### Example Code

Example: DeepSleep\_DHT\_Eink\_Example; DeepSleep\_DHT\_LCD\_Example; DeepSleepMode; TicklessMode;

### Notes and Warnings

Include “PMUCLASS.h” in order to use the class function.



## RTC

### Class RTC

#### RTC Class

#### Description

A class used for displaying date and time and alarm configuration using RTC, the independent BCD (Binary-Coded-Decimal) timer.

#### Syntax

```
class RTC
```

#### Members

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named RTC.	

Public Methods	
RTC:: Init	Initializes the RTC device, including the Clock, the RTC registers, and other functions
RTC:: DeInit	Deinitialize the RTC device
RTC:: Write	Set the specified timestamp in seconds to RTC
RTC:: Read	Get the current timestamp in seconds from RTC
RTC:: Wait	Wait for 1 second
RTC:: SetEpoch	Convert human-readable time to epoch time

#### RTC::Init

#### Description

Initializes the RTC device, including the Clock, the RTC registers, and other functions.

#### Syntax

```
void RTC::Init(void);
```

#### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: RTC

```
/*
 * This function describes how to use the RTC API.
 * The RTC function is implemented by an independent BCD timer/counter.
 * This example will print out the time information every second.
 */

#include <stdio.h>
#include <time.h>
#include 「rtc.h」
#define YEAR 2020
#define MONTH 9
#define DAY 10
#define HOUR 20
#define MIN 30
#define SEC 40

/* Create an rtc object */
RTC rtc;

int32_t seconds;

struct tm *timeinfo;

void setup() {
  Serial.begin(115200);
  rtc.Init(); // initialize RTC
}
```

```

void loop() {
// step 1: convert user time to epoch
int epochTime = humanReadableToEpoch(YEAR, MONTH, DAY, HOUR, MIN, SEC);

// step 2: write epoch time to rtc
rtc.Write(epochTime);

while (1) {
seconds = rtc.Read();

printf(「Epoch Time (in s) since January 1, 1970 = %dsn」, seconds);

printf(「Time as a basic string = %s」, ctime(&seconds));

timeinfo = localtime(&seconds);

printf(「Time as a custom formatted string = %d-%d-%d %d:%d:%dn」,
(timeinfo->tm_year + 1900), (timeinfo->tm_mon + 1), timeinfo->tm_mday, timeinfo->tm_hour,
timeinfo->tm_min, timeinfo->tm_sec);

Serial.println();

rtc.wait(1);
}
}

// convert human readable time to epoch time
int humanReadableToEpoch(int year, int month, int day, int hour, int min, int sec) {
struct tm t;
time_t t_of_day;

t.tm_year = year - 1900; // Year - 1970
t.tm_mon = month - 1; // Month, where 0 = jan
t.tm_mday = day; // Day of the month
t.tm_hour = hour;
t.tm_min = min;
t.tm_sec = sec;

t.tm_isdst = -1; // Is DST on? 1 = yes, 0 = no, -1 = unknown
t_of_day = mktime(&t);

// printf(「seconds since the Epoch: %dn」, (long)t_of_day);

```

```
return t_of_day;  
}
```

### Notes and Warnings

NA

### RTC::DeInit

#### Description

Deinitializes the RTC device.

#### Syntax

```
void RTC::DeInit(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC:: Write

#### Description

Set the specified timestamp in seconds to RTC. Seconds from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS) to specified date and time which is to be set.

**Syntax**

```
void RTC::Write(int t);
```

**Parameters**

Parameters

t: Seconds from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS) to specified date and time which is to be set.

**Returns**

The function returns nothing.

**Example Code**

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

**Notes and Warnings**

NA

**RTC::Read****Description**

Get the current timestamp in seconds from RTC. The current timestamp in seconds which is calculated from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS).

**Syntax**

```
int32_t RTC::Read(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the current timestamp in seconds which is calculated from 1970.1.1 00:00:00 (YEAR.MONTH.DAY, HOUR: MIN: SECONDS).

### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC:: Wait

#### Description

Send IR raw data.

#### Syntax

```
void RTC::wait(float s);
```

#### Parameters

s: unit microseconds (1 us)

#### Returns

The function returns nothing.

### Example Code

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

### Notes and Warnings

NA

### RTC:: SetEpoch

#### Description

Convert human-readable time to epoch time

**Syntax**

```
int RTC:: SetEpoch(int year, int month, int day, int hour, int min, int sec);
```

**Parameters**

year: user input year

month: user input month

day: user input day

hour: user input hour

min: user input minutes

sec: user input seconds

**Returns**

The function returns epoch time in seconds for RTC use.

**Example Code**

Example: RTC

Details of the code can be found in the previous section of RTC:: Init.

**Notes and Warnings**

NA

---

**SoftwareSerial****Class Adafruit\_GPS****Adafruit\_GPS Class****Description**

Defines a class to use GPS module on Ameba.

**Syntax**

```
class Adafruit_GPS
```

## Members

<b>Public Constructors</b>	
Adafruit_GPS::Adafruit_GPS	Constructs an Adafruit_GPS object
<b>Public Methods</b>	
Adafruit_GPS::begin	Initialize serial communication
*Adafruit_GPS:: lastNMEA	Returns the last NMEA line received and unsets the received flag
Adafruit_GPS:: newNMEAreceived	Check to see if a new NMEA line has been received
Adafruit_GPS:: common_init	Initialization code used by all constructor types
Adafruit_GPS:: sendCommand	Send a command to the GPS device
Adafruit_GPS:: pause	Pause/unpause receiving new data
Adafruit_GPS:: parseHex	Read a Hex value and return the decimal equivalent
Adafruit_GPS:: read	Read one character from the GPS device
Adafruit_GPS:: parse	Parse an NMEA string
Adafruit_GPS:: wakeup	Wake the sensor up
Adafruit_GPS:: standby	Standby Mode Switches
Adafruit_GPS::waitForSentence	Wait for a specified sentence from the device
Adafruit_GPS::LOCUS_StartLogger	Start the LOCUS logger
Adafruit_GPS::LOCUS_StopLogger	Stop the LOCUS logger
Adafruit_GPS::LOCUS_ReadStatus	Read the logger status

## Adafruit\_GPS::Adafruit\_GPS

### Description

Constructs an Adafruit\_GPS object and initialize serial using a SoftSerial object.

### Syntax

```
Adafruit_GPS::Adafruit_GPS(SoftwareSerial *ser)
```

```
Adafruit_GPS::Adafruit_GPS(HardwareSerial *ser)
```

### Parameters

ser: a Serial instance

### Returns

The function returns nothing.



**Example Code**

Example: Adafruit\_GPS\_parsing

This example code from Adafruit demonstrates GPS modules using MTK3329/MTK3339 driver. This code shows how to listen to the GPS module in an interrupt which allows the program to have more ‘freedom’ –just parse when a new NMEA sentence is available! Then access data when desired.

```
#include <Adafruit_GPS.h>

#include <SoftwareSerial.h>

// If you're using a GPS module:

// Connect the GPS Power pin to 3.3V

// Connect the GPS Ground pin to ground

// Connect the GPS TX (transmit) pin to Digital 0

// Connect the GPS RX (receive) pin to Digital 1

#if defined(BOARD_RTL8195A)

SoftwareSerial mySerial(0, 1);

#elif defined(BOARD_RTL8710)

SoftwareSerial mySerial(17, 5); // RTL8710 need change GPS TX/RX to pin 17 and 5

#else

SoftwareSerial mySerial(0, 1);

#endif

Adafruit_GPS GPS(&mySerial);

// Set GPSECHO to 『false』 to turn off echoing the GPS data to the Serial console

// Set to 『true』 if you want to debug and listen to the raw GPS sentences.

#define GPSECHO false

void setup()

{

  Serial.begin(38400);

  Serial.println( 「 Adafruit GPS library basic test! 」 );

  // 9600 NMEA is the default baud rate for Adafruit MTK GPS's- some use 4800

  GPS.begin(9600);

  // uncomment this line to turn on RMC (recommended minimum) and GGA (fix data) including altitude
```

```
GPS.sendCommand(PMTK_SET_NMEA_OUTPUT_RMCGGA);

// uncomment this line to turn on only the 「minimum recommended」 data
//GPS.sendCommand(PMTK_SET_NMEA_OUTPUT_RMONLY);

// For parsing data, we don't suggest using anything but either RMC only or RMC+GGA since
// the parser doesn't care about other sentences at this time
// Set the update rate

GPS.sendCommand(PMTK_SET_NMEA_UPDATE_1HZ); // 1 Hz update rate

// For the parsing code to work nicely and have time to sort thru the data, and
// print it out we don't suggest using anything higher than 1 Hz

// Request updates on antenna status, comment out to keep quiet
GPS.sendCommand(PGCMD_ANTENNA);

delay(1000);

// Ask for firmware version

mySerial.println(PMTK_Q_RELEASE);

}

uint32_t timer = millis();

void loop() // run over and over again
{
    // in case you are not using the interrupt above, you'll
    // need to 「hand query」 the GPS, not suggested :(
    // read data from the GPS in the 「main loop」

    char c = GPS.read();

    // if you want to debug, this is a good time to do it!

    if (GPSECHO)

    if (c) Serial.print(c);

    // if a sentence is received, we can check the checksum, parse it...

    if (GPS.newNMEAreceived()) {

        // a tricky thing here is if we print the NMEA sentence, or data
        // we end up not listening and catching other sentences!

        // so be very wary if using OUTPUT_ALLDATA and trying to print out data
```

```

//Serial.println(GPS.lastNMEA()); // this also sets the newNMEAreceived() flag to false
if (!GPS.parse(GPS.lastNMEA())) // this also sets the newNMEAreceived() flag to false
return; // we can fail to parse a sentence in which case we should just wait for another
}

// if millis() or timer wraps around, we'll just reset it
if (timer > millis()) timer = millis();

// approximately every 2 seconds or so, print out the current stats
if (millis() - timer > 2000) {
timer = millis(); // reset the timer

Serial.print("Time: ");
Serial.print(GPS.hour, DEC); Serial.print(" ");
Serial.print(GPS.minute, DEC); Serial.print(" ");
Serial.print(GPS.seconds, DEC); Serial.print(" ");
Serial.println(GPS.milliseconds);

Serial.print("Date: ");
Serial.print(GPS.day, DEC); Serial.print("/");
Serial.print(GPS.month, DEC); Serial.print("/20");
Serial.println(GPS.year, DEC);

Serial.print("Fix: "); Serial.print((int)GPS.fix);
Serial.print(" quality: "); Serial.println((int)GPS.fixquality);
if (GPS.fix) {
Serial.print("Location: ");
Serial.print(GPS.latitude, 4); Serial.print(GPS.lat);
Serial.print(", ");
Serial.print(GPS.longitude, 4); Serial.println(GPS.lon);
Serial.print("Location (in degrees, works with Google Maps): ");
Serial.print(GPS.latitudeDegrees, 4);
Serial.print(", ");
Serial.println(GPS.longitudeDegrees, 4);
Serial.print("Speed (knots): "); Serial.println(GPS.speed);
}
}

```

```
Serial.print(「Angle:  」); Serial.println(GPS.angle);  
Serial.print(「Altitude:  」); Serial.println(GPS.altitude);  
Serial.print(「Satellites:  」); Serial.println((int)GPS.satellites);  
}  
}  
}
```

### Notes and Warnings

IMPORTANT: SoftSerial is using hardware serial so pin mapping cannot be altered.

### Adafruit\_GPS::begin

#### Description

Initialize serial communication

#### Syntax

```
void Adafruit_GPS::begin(uint16_t baud)
```

#### Parameters

baud: serial baud rate

#### Returns

The function returns nothing.

#### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

**\*Adafruit\_GPS::lastNMEA****Description**

Returns the last NMEA line received and unsets the received flag

**Syntax**

```
char *Adafruit_GPS::lastNMEA(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

Pointer to the last line string

**Example Code**

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

**Notes and Warnings**

NA

**Adafruit\_GPS::newNMEAreceived****Description**

Check to see if a new NMEA line has been received

**Syntax**

```
boolean Adafruit_GPS::newNMEAreceived(void)
```

**Parameters**

The function requires no input parameter.

### Returns

True if received, false if not

### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

### Adafruit\_GPS::common\_init

### Description

Initialization code used by all constructor types

### Syntax

```
void Adafruit_GPS::common_init(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::sendCommand

### Description

Send a command to the GPS device

### Syntax

```
void Adafruit_GPS::sendCommand(const char *str)
```

### Parameters

str: Pointer to a string holding the command to send

### Returns

The function returns nothing.

### Example Code

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

### Notes and Warnings

NA

## Adafruit\_GPS::pause

### Description

Pause/unpause receiving new data

### Syntax

```
void Adafruit_GPS::pause(boolean p)
```

### Parameters

p: True = pause, false = unpause

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::parseHex

### Description

Read a Hex value and return the decimal equivalent

### Syntax

```
uint8_t Adafruit_GPS::parseHex(char c)
```

### Parameters

c: Hex value

### Returns

The decimal equivalent of the Hex value

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::read



**Description**

Read one character from the GPS device

**Syntax**

```
char Adafruit_GPS::read(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The character that we received, or 0 if nothing was available

**Example Code**

Example: Adafruit\_GPS\_parsing

The details of the code can be found in the previous section of Adafruit\_GPS:: Adafruit\_GPS.

**Notes and Warnings**

NA

**Adafruit\_GPS::parse****Description**

Parse an NMEA string

**Syntax**

```
boolean Adafruit_GPS::parse(char *nmea)
```

**Parameters**

nmea: an NMEA string

**Returns**

True if we parsed it, false if it has invalid data

### Example Code

Example: Adafruit\_GPS\_parsing

### Notes and Warnings

NA

## Adafruit\_GPS::wakeup

### Description

Wake the sensor up

### Syntax

boolean Adafruit\_GPS::wakeup(void)

### Parameters

The function requires no input parameter.

### Returns

True if woken up, false if not in standby or failed to wake

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::standby

**Description**

Standby Mode Switches

**Syntax**

```
boolean Adafruit_GPS::standby(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

False if already in standby, true if it entered standby

**Example Code**

NA

**Notes and Warnings**

NA

**Adafruit\_GPS::waitForSentence****Description**

Wait for a specified sentence from the device

**Syntax**

```
boolean Adafruit_GPS::waitForSentence(const char *wait4me, uint8_t max)
```

**Parameters**

wait4me: Pointer to a string holding the desired response

max: How long to wait, default is MAXWAITSENTENCE

**Returns**

True if we got what we wanted, false otherwise

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::LOCUS\_StartLogger

### Description

Start the LOCUS logger

### Syntax

boolean Adafruit\_GPS::LOCUS\_StartLogger(void)

### Parameters

The function requires no input parameter.

### Returns

True on success, false if it failed

### Example Code

NA

### Notes and Warnings

NA

## Adafruit\_GPS::LOCUS\_StopLogger

**Description**

Stop the LOCUS logger

**Syntax**

```
boolean Adafruit_GPS::LOCUS_StopLogger(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

True on success, false if it failed

**Example Code**

NA

**Notes and Warnings**

NA

**Adafruit\_GPS::LOCUS\_ReadStatus****Description**

Read the logger status

**Syntax**

```
boolean Adafruit_GPS::LOCUS_ReadStatus(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

True if we read the data, false if there was no response

**Example Code**

NA

**Notes and Warnings**

NA

**Class HttpClient****PMS3003 Class****Description**

Defines a class to work with PMS3003 air quality sensor on Ameba.

**Syntax**

```
class PMS3003
```

**Members**

Public Constructors	
PMS3003::PMS3003	Constructs a PMS3003 object
Public Methods	
PMS3003::begin	Initialize hardware UART
PMS3003::end	Free allocated space thus stopping UART
PMS3003::get_pm1p0_cf1	Get PM1.0 under correction factor = 1
PMS3003:: get_pm2p5_cf1	Get PM2.5 under correction factor = 1
PMS3003:: get_pm10_cf1	Get PM10 under correction factor = 1
PMS3003:: get_pm1p0_air	Get PM1.0 air quality
PMS3003:: get_pm2p5_air	Get PM2.5 air quality
PMS3003:: get_pm10_air	Get PM10 air quality
PMS3003:update_cache	Updates the cache memory
PMS3003::pms3003_handle_interrupt	Set up the serial event handler

**PMS3003::PMS3003****Description**

Constructs a PMS3003 object and initialize the pin mapping.

**Syntax**

```
PMS3003::PMS3003(int _rx, int _tx, int _set, int _reset)
```

**Parameters**

\_rx: RX pin of UART

\_tx: TX pin of UART

\_set: Set pin

\_reset: Reset pin

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::begin****Description**

Initialize hardware UART and allocate space for serial buffer

**Syntax**

```
void PMS3003::begin(void)
```

**Parameters**

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### PMS3003::end

### Description

Free serial buffer space and stop UART

### Syntax

```
void PMS3003::end(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### PMS3003::get\_pm1p0\_cf1



**Description**

Get PM1.0 under correction factor = 1

**Syntax**

```
int PMS3003::get_pm1p0_cf1(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value “pm1p0\_cf1” as an integer.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm2p5\_cf1****Description**

Get PM2.5 under correction factor = 1

**Syntax**

```
int PMS3003::get_pm2p5_cf1(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm2p5\_cf1” as an integer.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::get\_pm10\_cf1

### Description

Get PM10 under correction factor = 1

### Syntax

```
int PMS3003::get_pm10_cf1(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value of “pm10\_cf1” as an integer.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::get\_pm1p0\_air

### Description

Get PM1.0 air quality

**Syntax**

```
int PMS3003::get_pm1p0_air(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm1p0\_air” as an integer.

**Example Code**

NA

**Notes and Warnings**

NA

**PMS3003::get\_pm2p5\_air****Description**

Get PM2.5 air quality

**Syntax**

```
int PMS3003::get_pm2p5_air(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the value of “pm2p5\_air” as an integer.

**Example Code**

NA

## Notes and Warnings

NA

## PMS3003::get\_pm10\_air

### Description

Get PM10 air quality

### Syntax

```
int PMS3003::get_pm10_air(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the value of “pm10\_air” as an integer.

### Example Code

NA

## Notes and Warnings

NA

## PMS3003::pms3003\_handle\_interrupt

### Description

Set up the serial event handler

### Syntax

```
void pms3003_handle_interrupt(uint32_t id, uint32_t event)
```

### Parameters

id: device identifier

event: Serial event for handling incoming data

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## PMS3003::update\_cache

### Description

Serves the function of updating cache memory. One package has 32 bytes. Illustrate the formate by using below raw data: 42 4d 00 1c 00 1b 00 21 00 29 00 1a 00 21 00 29 2b fb 04 be 00 6b 00 10 00 04 00 04 67 00 04 46

42 4d : header signature

00 1c : frame length, 0x001c = 28 bytes (not include header and this field)

00 1b : PM1.0 under CF=1

00 21 : PM2.5 under CF=1

00 29 : PM10 under CF=1

00 1a : PM1.0 under air

00 21 : PM2.5 under air

00 29 : PM10 under air

2b fb : number of pariticle, diameter size 0.3 um in 0.1 liter air

04 be : number of pariticle, diameter size 0.5 um in 0.1 liter air

00 6b : number of pariticle, diameter size 1.0 um in 0.1 liter air

00 10 : number of pariticle, diameter size 2.5 um in 0.1 liter air

00 04 : number of pariticle, diameter size 5.0 um in 0.1 liter air

00 04 : number of pariticle, diameter size 10 um in 0.1 liter air

67 : serial number

00 : error code

04 46 :

checksum,0x42+0x4d+0x00+0x1c+0x00+0x1b+0x00+0x21+0x00+0x29+0x00+0x1a+0x00+0x21+0x00+0x29+  
0x2b+0xfb+0x04+0xbe+0x00+0x6b+0x00+0x10+0x00+0x04+0x00+0x04+0x67+0x00 = 0x0446

### Syntax

void PMS3003::update\_cache(void)

### Parameters

The function requires no input parameters.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Class SoftwareSerial

### SoftwareSerial Class

#### Description

Defines a class of software serial implementation for Ameba.

#### Syntax

class SoftwareSerial

#### Members

<b>Public Constructors</b>	
SoftwareSerial::SoftwareSerial	Constructs a SoftwareSerial object
<b>Public Methods</b>	
SoftwareSerial::begin	Sets the speed (baud rate) for the serial communication
SoftwareSerial::listen	Enables the selected software serial port to listen
SoftwareSerial::end	Same as stopListening
SoftwareSerial::stopListening	Stop listening on the port
SoftwareSerial::peek	Return a character that was received on the RX pin of the software serial port
SoftwareSerial::write	Prints data to the transmit pin of the software serial port as raw bytes
SoftwareSerial::read	Return a character that was received on the RX pin of the software serial port
SoftwareSerial::available	Get the number of bytes (characters) available for reading from a software serial port
SoftwareSerial::flush	Flush the received buffer
SoftwareSerial::setBufferSize	Set buffer size
SoftwareSerial::setAvailableCallback	Set available callback
SoftwareSerial::handle_interrupt	Private methods handles interrupt

## SoftwareSerial::SoftwareSerial

### Description

Constructs a SoftwareSerial object and sets RX and TX pin, and inverse logic.

### Syntax

```
SoftwareSerial::SoftwareSerial(uint8_t receivePin, uint8_t transmitPin, bool inverse_logic /* = false */)

```

### Parameters

receivePin: the pin on which to receive serial data

transmitPin: the pin on which to transmit serial data

inverse\_logic: is used to invert the sense of incoming bits

### Returns

The function returns nothing.

### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX.

```
/*  
  
The circuit: (BOARD RTL8195A)  
  
* RX is digital pin 0 (connect to TX of other devices)  
* TX is digital pin 1 (connect to RX of other devices)  
  
*/  
  
#include <SoftwareSerial.h>  
  
#if defined(BOARD_RTL8195A)  
  
SoftwareSerial mySerial(0, 1); // RX, TX  
  
#elif defined(BOARD_RTL8710)  
  
SoftwareSerial mySerial(17, 5); // RX, TX  
  
#else  
  
SoftwareSerial mySerial(0, 1); // RX, TX  
  
#endif  
  
void setup() {  
  
  // Open serial communications and wait for port to open:  
  Serial.begin(57600);  
  
  while (!Serial) {  
  
    ; // wait for serial port to connect. Needed for native USB port only  
  
  }  
  
  Serial.println(「Goodnight moon!」);  
  
  // set the data rate for the SoftwareSerial port  
  mySerial.begin(4800);  
  
  mySerial.println(「Hello, world?」);  
  
}  
  
void loop() { // run over and over  
  
  if (mySerial.available()) {  
  
    mySerial.write(mySerial.read());  
  
  }  
  
}
```



```
}
```

### Notes and Warnings

Software Serial is using hardware serial thus DO NOT change the default pins

### SoftwareSerial::begin

#### Description

Sets the speed (baud rate) for the serial communication

#### Syntax

```
void SoftwareSerial::begin(long speed)
```

```
void SoftwareSerial::begin(long speed, int data_bits, int parity, int stop_bits)
```

```
void SoftwareSerial::begin(long speed, int data_bits, int parity, int stop_bits, int flowctrl, int rtsPin, int ctsPin)
```

#### Parameters

speed: the baud rate

data\_bits: number of data bits, 8 bits(default) or 7 bits

stop\_bits: number of stop bits, 1 bit(default), 1.5 bits or 2 bits

flowctrl: flow control pin

rtsPin: request to send pin

ctsPin: clear to send pin

#### Returns

The function returns nothing.

#### Example Code

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial\_Basic:: SoftwareSerial.

### Notes and Warnings

NA

## **SoftwareSerial::listen**

### **Description**

Enables the selected software serial port to listen

### **Syntax**

```
bool SoftwareSerial::listen(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

Returns true if it replaces another

### **Example Code**

NA

### **Notes and Warnings**

NA

## **SoftwareSerial::end**

### **Description**

Same as stopListening

### **Syntax**

```
void SoftwareSerial::end(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**SoftwareSerial::isListening****Description**

Tests to see if requested software serial port is actively listening

**Syntax**

```
bool SoftwareSerial::isListening(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns “True” if the port is listening.

**Example Code**

NA

**Notes and Warnings**

NA

## SoftwareSerial::stopListening

### Description

Stop listening on the port

### Syntax

```
bool SoftwareSerial::stopListening(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “True” if listening on the port is stopped.

### Example Code

NA

### Notes and Warnings

NA

## SoftwareSerial::peek

### Description

Return a character that was received on the RX pin of the software serial port

### Syntax

```
int SoftwareSerial::peek(void)
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns the character read, or returns “-1” if none is available.

**Example Code**

NA

**Notes and Warnings**

NA

**SoftwareSerial::write****Description**

Prints data to the transmit pin of the software serial port as raw bytes

**Syntax**

```
size_t SoftwareSerial::write(uint8_t b)
```

**Parameters**

b: byte to be written

**Returns**

The function returns the number of bytes written.

**Example Code**

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial:: SoftwareSerial.

**Notes and Warnings**

NA

## **SoftwareSerial::read**

### **Description**

Return a character that was received on the RX pin of the software serial port

### **Syntax**

```
int SoftwareSerial::read(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns the character read, or -1 if none is available.

### **Example Code**

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial: SoftwareSerial.

### **Notes and Warnings**

NA

## **SoftwareSerial::available**

### **Description**

Get the number of bytes available for reading from a software serial port

### **Syntax**

```
int SoftwareSerial::available(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the number of bytes available to read.

**Example Code**

Example: SoftwareSerialExample

The example demonstrates a software serial test, it receives from serial RX and sends it to serial TX. Details of the code can be found in the previous section of SoftwareSerial:: SoftwareSerial.

**Notes and Warnings**

NA

**SoftwareSerial::flush****Description**

Flush the received buffer

**Syntax**

```
void SoftwareSerial::flush(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

#### Notes and Warnings

NA

### SoftwareSerial::setBufferSize

#### Description

Set buffer size

#### Syntax

```
void SoftwareSerial::setBufferSize(uint32_t buffer_size)
```

#### Parameters

buffer\_size: the size of the serial buffer

#### Returns

The function returns nothing.

#### Example Code

NA

#### Notes and Warnings

NA

### SoftwareSerial::setAvailableCallback

#### Description

Set available callback



## Syntax

```
void SoftwareSerial::setAvailableCallback(void (*callback)(char c))
```

## Parameters

\*callback: user-defined serial callback function

## Returns

The function returns nothing.

## Example Code

Example: SoftwareSerialIrqCallback

This example demonstrates the software serial testing using IRQ callback and semaphore. Set callback function “mySerialCallback” to software serial. Whenever there is data comes in, “mySerialCallback” is invoked. In this sketch, it does nothing until the end of the line. And then it sends a semaphore. The loop() uses a non-busy loop to wait for the semaphore. To test this sketch, you need to type something on software serial and then press Enter.

```

/*
The circuit: (BOARD RTL8195A)
RX is digital pin 0 (connect to TX of other devices)
TX is digital pin 1 (connect to RX of other devices)
*/

#include <SoftwareSerial.h>

#if defined(BOARD_RTL8195A)
SoftwareSerial mySerial(0, 1); // RX, TX
#elif defined(BOARD_RTL8710)
SoftwareSerial mySerial(17, 5); // RX, TX
#else
SoftwareSerial mySerial(0, 1); // RX, TX
#endif

uint32_t semaID;

// The callback is hooking at UART IRQ handler and please don't do heavy task here.

void mySerialCallback(char c)

```

```
{  
/* The parameter c is only for peeking. The actual data is  
* still in the buffer of SoftwareSerial.  
*/  
  
if (c == 『r』 || c == 『n』 ) {  
  os_semaphore_release(semaID);  
}  
}  
  
void setup() {  
  // use 1 count for binary semaphore  
  semaID = os_semaphore_create(1);  
  
  // There is a token in the semaphore, clear it.  
  os_semaphore_wait(semaID, 0xFFFFFFFF);  
  
  // set the data rate for the SoftwareSerial port  
  mySerial.begin(38400);  
  mySerial.setAvailableCallback(mySerialCallback);  
}  
  
void loop() { // run over and over  
  // wait semaphore for 5s timeout  
  if (os_semaphore_wait(semaID, 5 * 1000)) {  
    // we got data before timeout  
    while(mySerial.available()) {  
      mySerial.print((char)mySerial.read());  
    }  
    mySerial.println();  
  } else {  
    mySerial.println( 「No data comes in.」 );  
  }  
}
```

## Notes and Warnings

NA

## SoftwareSerial::handle\_interrupt

### Description

A private method handles the interrupt

### Syntax

```
void handle_interrupt(uint32_t id, uint32_t event)
```

### Parameters

id: the interrupt id

event: interrupt event

### Returns

The function returns nothing.

## Example Code

NA

## Notes and Warnings

NA

## Readme

The Ameba Software Serial related APIs and examples are works based on libraries formerly known as `NewSoftSerial.h` by Mikal Hart (<http://arduiniiana.org/libraries/newsoftserial>).

These include,

- `SoftwareSerial.cpp`
- `SoftwareSerial.h`

These libraries are under GNU Lesser General Public License.

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The Ameba GPS related APIs and examples are works based on Adafruit GPS library written by Limor Fried/Ladyada for Adafruit Industries (<http://www.adafruit.com/products/746>).

These include,

- Adafruit\_GPS.cpp
- Adafruit\_GPS.h

These libraries are under BSD License.

---

## SPI

### Class AmebaILI9341

#### AmebaILI9341 Class

##### Description

Defines a class to use ILI9341 TFT SPI display for Ameba.

##### Syntax

```
class AmebaILI9341
```

##### Members

<b>Public Constructors</b>	
AmebaILI9341::AmebaILI9341	Constructs an AmebaILI9341 object
<b>Public Methods</b>	
AmebaILI9341::begin	Initialize SPI, pin mapping and screen configuration
AmebaILI9341::setAddress	Initialize image size and position
AmebaILI9341::writecommand	SPI transfer a command
AmebaILI9341::writedata	SPI transfer a piece of data
AmebaILI9341::setRotation	Set screen orientation
AmebaILI9341::fillScreen	Fill the screen with a color
AmebaILI9341::clr	Clear screen
AmebaILI9341::fillRectangle	Fill a rectangular space with a color
AmebaILI9341::drawPixel	Turn on a pixel on the screen
AmebaILI9341::drawChar	To print a character on the screen
AmebaILI9341::drawLine	Draw line on the screen
AmebaILI9341::drawRectangle	Draw a rectangle on the screen
AmebaILI9341::drawCircle	Draw a circle on the screen
AmebaILI9341::write	Same as drawChar
AmebaILI9341::getWidth	Return the width 240
AmebaILI9341::getHeight	Return the height 320
AmebaILI9341::setCursor	Set cursor to the desired position
AmebaILI9341::setForeground	Set foreground color
AmebaILI9341::setBackground	Set background color
AmebaILI9341::setFontSize	Set character font size
AmebaILI9341::reset	Reset pin to High or Low

## AmebaILI9341::AmebaILI9341

### Description

Constructs an AmebaILI9341 object and set CS, DC and RESET pins .

### Syntax

```
AmebaILI9341::AmebaILI9341(int csPin, int dcPin, int resetPin)
```

### Parameters

csPin: pin for Chip Select dcPin: pin for Data/Command resetPin: pin for Reset

### Returns

The function returns nothing.

### Example Code

Example: : PM25\_ON\_ILI9341\_TFT\_LCD

This example demonstrates how to read pm2.5 value on PMS 3003 air-condition sensor and display it on ILI9341 TFT LCD.

/\*

PMS 3003 pin map is as follow:

PIN1 :VCC, connect to 5V

PIN2 :GND

PIN3 :SET, 0:Standby mode, 1:operating mode

PIN4 :RXD :Serial RX

PIN5 :TXD :Serial TX

PIN6 :RESET

PIN7 :NC

PIN8 :NC

In this example, we only use Serial to get PM 2.5 value.

The circuit:

\* RX is digital pin 0 (connect to TX of PMS 3003)

\* TX is digital pin 1 (connect to RX of PMS 3003)

For RTL8195A ILI9341 TFT LCD with SPI interface has these pins:

D/C : connect to pin 9

CS : connect to pin 10

MOSI : connect to pin 11

MISO : connect to pin 12

CLK : connect to pin 13

VCC : connect to 3V3

GND : connect to GND

\*/

**#include** 「SoftwareSerial.h」

**#include** 「SPI.h」

**#include** 「AmebaILI9341.h」

**#if defined**(BOARD\_RTL8195A)

SoftwareSerial mySerial(0, 1); // RX, TX

```

#define TFT_RESET 8

#define TFT_DC 9

#define TFT_CS 10

#elif defined(BOARD_RTL8710)

SoftwareSerial mySerial(17, 5); // RX, TX

// IMPORTANT: Due to limit pin, we do not connect TFT_RESET pin.

#define TFT_RESET 0xFFFFFFFF

#define TFT_DC 2

#define TFT_CS 10

#endif

AmebaILI9341 tft = AmebaILI9341(TFT_CS, TFT_DC, TFT_RESET);

#define ILI9341_SPI_FREQUENCY 20000000

#define pmsDataLen 32

uint8_t buf[pmsDataLen];

int idx = 0;

int pm10 = 0;

int last_pm25 = 0;

int pm25 = 0;

int pm100 = 0;

uint16_t pm25color[] = {

0x9FF3,

0x37E0,

0x3660,

0xFFE0,

0xFE60,

0xFCC0,

0xFB2C,

0xF800,

0x9800,

0xC99F

```

```
};

void setup() {
  Serial.begin(57600);

  mySerial.begin(9600); // PMS 3003 UART has baud rate 9600

  SPI.setDefaultFrequency(ILI9341_SPI_FREQUENCY);

  tft.begin();

  drawPictureFrames();
}

void loop() { // run over and over
  uint8_t c;

  idx = 0;

  memset(buf, 0, pmsDataLen);

  while (true) {
    while (c != 0x42) {
      while (!mySerial.available());

      c = mySerial.read();
    }

    while (!mySerial.available());

    c = mySerial.read();

    if (c == 0x4d) {
      // now we got a correct header

      buf[idx++] = 0x42;

      buf[idx++] = 0x4d;

      break;
    }
  }

  while (idx != pmsDataLen) {
    while(!mySerial.available());

    buf[idx++] = mySerial.read();
  }
}
```



```
pm10 = ( buf[10] << 8 ) | buf[11];
last_pm25 = pm25;
pm25 = ( buf[12] << 8 ) | buf[13];
pm100 = ( buf[14] << 8 ) | buf[15];
updateValueToTftScreen();
}

void drawPictureFrames() {
tft.setRotation(1);

tft.clr();

tft.setFontSize(1);
// Upper title
tft.setFontSize(1);
tft.setCursor(20,20);
tft.print( 「PM2.5 DETECTOR」 );
// PM 2.5 Circle Frame
tft.drawCircle(100,130,60, ILI9341_BLUE);
tft.drawCircle(100,130,61, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(90,85);
tft.print( 「PM2.5」 );
tft.setFontSize(1);
tft.setCursor(90,170);
tft.print( 「um/m3」 );
// PM 10 Circle Frame
tft.drawCircle(220,70,40, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(210,40);
tft.print( 「PM10」 );
tft.setFontSize(1);
tft.setCursor(205,95);
```

```
tft.print(「um/m3」);
// PM 1.0 Circle Frame
tft.drawCircle(220,170,40, ILI9341_BLUE);
tft.setFontSize(1);
tft.setCursor(205,140);
tft.print(「PM1.0」);
tft.setFontSize(1);
tft.setCursor(205,195);
tft.print(「um/m3」);
// right side bar, referenced from: http://taqm.epa.gov.tw/taqm/tw/
tft.fillRect(290, 30+ 0*2, 10, 12*2, pm25color[0]); // 0~11
tft.fillRect(290, 30+12*2, 10, 12*2, pm25color[1]); // 12-23
tft.fillRect(290, 30+24*2, 10, 12*2, pm25color[2]); // 24-35
tft.fillRect(290, 30+36*2, 10, 6*2, pm25color[3]); // 36-41
tft.fillRect(290, 30+42*2, 10, 6*2, pm25color[4]); // 42-47
tft.fillRect(290, 30+48*2, 10, 6*2, pm25color[5]); // 48-53
tft.fillRect(290, 30+54*2, 10, 6*2, pm25color[6]); // 54-58
tft.fillRect(290, 30+59*2, 10, 6*2, pm25color[7]); // 59-64
tft.fillRect(290, 30+65*2, 10, 6*2, pm25color[8]); // 65-70
tft.fillRect(290, 30+71*2, 10, 10*2, pm25color[9]); // >=71
tft.setCursor(302, 30);
tft.setFontSize(1);
tft.print(「0」);
tft.setCursor(302, 30+36*2);
tft.print(「36」);
tft.setCursor(302, 30+54*2);
tft.print(「54」);
tft.setCursor(302, 30+71*2);
tft.print(「71」);
// bottom right text
```

```
tft.setCursor(210,230);
tft.setFontSize(1);
tft.print(「Powered by Realtek」);
updateValueToTftScreen();
}

void updateValueToTftScreen() {
tft.setCursor(60, 111);
tft.setFontSize(5);
tft.setForeground( getPm25Color(pm25) );
if (pm25 < 10) {
tft.print(「」);
} else if (pm25 < 100) {
tft.print(「」);
}
tft.print(pm25);
tft.setCursor(195,60);
tft.setFontSize(3);
if (pm100 < 10) {
tft.print(「」);
} else if (pm100 < 100) {
tft.print(「」);
}
tft.print(pm100);
tft.setCursor(198,160);
if (pm10 < 10) {
tft.print(「」);
} else if (pm10 < 100) {
tft.print(「」);
}
tft.print(pm10);
```

```
tft.setFontSize(1);

tft.setForeground(ILI9341_WHITE);

if (last_pm25 > 80) {
tft.fillRect(275, 80*2+30-3, 12, 8, ILI9341_BLACK);
} else {
tft.fillRect(275, last_pm25*2+30-3, 12, 8, ILI9341_BLACK);
}

if (pm25 > 80) {
tft.setCursor(275, 80*2+30-3);
} else {
tft.setCursor(275, pm25*2+30-3);
}

tft.print(「=>」);
}

uint16_t getPm25Color(int v) {
if (v < 12) {
return pm25color[0];
} else if (v < 24) {
return pm25color[1];
} else if (v < 36) {
return pm25color[2];
} else if (v < 42) {
return pm25color[3];
} else if (v < 48) {
return pm25color[4];
} else if (v < 54) {
return pm25color[5];
} else if (v < 59) {
return pm25color[6];
} else if (v < 65) {
```

```

return pm25color[7];
} else if (v < 71) {
return pm25color[8];
} else {
return pm25color[9];
}
}

```

### Notes and Warnings

NA

## AmebaILI9341::begin

### Description

Initialize hardware SPI, pin mapping and screen configuration

### Syntax

```
void AmebaILI9341::begin(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

This method is required to run first before other operations on the display.

## AmebaILI9341::setAddress

### Description

Initialize image size and positioning on the display

### Syntax

```
void AmebaILI9341::setAddress(uint16_t x0, uint16_t y0, uint16_t x1, uint16_t y1)
```

### Parameters

x0: leftmost coordinate of the image y0: top coordinate of the image x1: rightmost coordinate of the image y1: bottom coordinate of the image

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Do not use this to set the cursor, use the “setCursor” method instead.

### AmebaILI9341::writecommand

#### Description

Write a single-byte command to display

#### Syntax

```
void AmebaILI9341::writecommand(uint8_t command)
```

#### Parameters

command: a single byte command

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### AmebaILI9341::writedata

#### Description

Write 1 byte of data to display

#### Syntax

```
void AmebaILI9341::writedata(uint8_t data)
```

#### Parameters

data: 1 byte data

#### Returns

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Only use this method to write 1 byte at a time.

**AmebaILI9341::setRotation****Description**

Setting screen orientation, “0” for no rotation, “1” for 90 degrees rotation and so on so forth.

**Syntax**

void AmebaILI9341::setRotation(uint8\_t m)/span> **Parameters**

m: one of the 4 rotation modes -> “0” for no rotation, “1” for 90<sup>0</sup>, “2” for 180<sup>0</sup>, “3” for 270<sup>0</sup>

**Returns**

The function returns nothing.

**Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

**Notes and Warnings**

if m=4, it’ s equivalent to mode 0, and m=5 for mode 1, m=6 for mode 2 so on so forth.

**AmebaILI9341::fillScreen****Description**

Fill the entire screen with one color

**Syntax**

void AmebaILI9341::fillScreen(uint16\_t color)

**Parameters**

color: a 16-bit color reference defined in AmebaILI9341.h

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Refer to AmebaILI9341.h for available colors.

## **AmebaILI9341::clr**

### **Description**

Fill the entire screen with a certain background-color

### **Syntax**

```
void AmebaILI9341::clr(void)
```

### **Parameters**

The function requires no input parameter.

### **Returns**

The function returns nothing.

### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341

### **Notes and Warnings**

background-color can be set by calling setBackground method.

## **AmebaILI9341::fillRectangle**

### **Description**

Fill a rectangular space with a color on the screen

### **Syntax**

```
void AmebaILI9341::fillRectangle(int16_t x, int16_t y, int16_t w, int16_t h, uint16_t color)
```

### **Parameters**

x: leftmost coordinate of the image y: top coordinate of the image w: width of the image h: height of the image color: the color of the image

### **Returns**

The function returns nothing.

### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### **Notes and Warnings**

NA

## **AmebaILI9341::drawPixel**



**Description**

Turn on a pixel on the screen

**Syntax**

```
void AmebaILI9341::drawPixel(int16_t x, int16_t y, uint16_t color)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::drawChar****Description**

Draw character on the screen

**Syntax**

```
void AmebaILI9341::drawChar(unsigned char c) void AmebaILI9341::drawChar(int16_t x, int16_t y, unsigned char c, uint16_t _fontcolor, uint16_t _background, uint8_t _fontsize)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image c: a character \_fontcolor: font color \_background: background color \_fontsize: font size

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

In the actual example, the Print method is used to print a string of character on the screen instead of using this method.

**AmebaILI9341::drawLine****Description**

Draw a straight line on the screen

**Syntax**

```
void AmebaILI9341::drawLine(int16_t x0, int16_t y0, int16_t x1, int16_t y1) void AmebaILI9341::drawLine(int16_t x0, int16_t y0, int16_t x1, int16_t y1, uint16_t color)
```

**Parameters**

x0: leftmost coordinate of the image y0: top coordinate of the image x1: leftmost coordinate of the image y1: top coordinate of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::drawRectangle****Description**

Draw a rectangular shape on the screen

**Syntax**

```
void AmebaILI9341::drawRectangle(int16_t x, int16_t y, int16_t w, int16_t h) void AmebaILI9341::drawRectangle(int16_t x, int16_t y, int16_t w, int16_t h, uint16_t color)
```

**Parameters**

x: leftmost coordinate of the image y: top coordinate of the image w: width of the image h: height of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**AmebaILI9341::drawCircle****Description**

Draw a circular shape on the screen

**Syntax**

```
void AmebaILI9341::drawCircle(int16_t x0, int16_t y0, int16_t r) void AmebaILI9341::drawCircle(int16_t x0, int16_t y0, int16_t r, uint16_t color)
```

**Parameters**

x0: leftmost coordinate of the image y0: top coordinate of the image r: radius of the image color: the color of the image

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Include “AmebaServo.h” to use the class function.

**AmebaILI9341::write****Description**

Same as drawChar, write a character on the screen

**Syntax**

```
size_t AmebaILI9341::write(uint8_t c)
```

**Parameters**

c: a character to be written on the screen

**Returns**

Number of bytes written

**Example Code**

NA

**Notes and Warnings**

This an inherited method from Print class and is seldom used.

**AmebaILI9341::getWidth****Description**

Get the width of the image

**Syntax**

```
int16_t AmebaILI9341::getWidth(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

Width of the image

### Example Code

NA

### Notes and Warnings

NA

### AmebaILI9341::getHeight

#### Description

Get the height of the image

#### Syntax

```
int16_t AmebaILI9341::getHeight(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

Height of the image

### Example Code

NA

### Notes and Warnings

NA

### AmebaILI9341::setCursor

#### Description

Set the cursor to a specific position on the screen

#### Syntax

```
void AmebaILI9341::setCursor(int16_t x, int16_t y)
```

#### Parameters

x: coordinate on the x-axis y: coordinate on the y-axis

#### Returns

The function returns nothing.

### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

NA

### **AmebaILI9341::setForeground**

#### **Description**

Set foreground color

#### **Syntax**

```
void AmebaILI9341::setForeground(uint16_t color)
```

#### **Parameters**

color: one of the colors available in AmebaILI9341.h

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

#### **Notes and Warnings**

NA

### **AmebaILI9341::setBackground**

#### **Description**

Set background color

#### **Syntax**

```
void AmebaILI9341::setBackground(uint16_t _background)
```

#### **Parameters**

\_background: one of the colors available in AmebaILI9341.h

#### **Returns**

The function returns nothing.

#### **Example Code**

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

#### **Notes and Warnings**

NA

### **AmebaILI9341::setFontSize**

### Description

Set the font size of the characters printed on the screen.

### Syntax

```
void AmebaILI9341::setFontSize(uint8_t size)
```

### Parameters

size: font size, default 1 for smallest, 5 for largest font size

### Returns

The function returns nothing.

### Example Code

Example: PM25\_ON\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### Notes and Warnings

NA

### AmebaILI9341::reset

#### Description

Reset the pin to High or Low

#### Syntax

```
void AmebaILI9341::reset(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

#### Example Code

NA

#### Notes and Warnings

NA

## Class SPISettings\_SPIClass

### SPISettings Class

#### Description

Defines a class to set SPI parameters.

#### Syntax

```
class SPISettings
```

#### Members

Public Constructors	
SPISettings::SPISettings	Create a SPISettings object and set SPI clock speed, bit order and data mode

### SPISettings::SPISettings

#### Description

Construct an object and configure SPI parameters —clock speed, bit order and data model to the preferred default value.

#### Syntax

```
SPISettings YourObject(uint32_t clock, BitOrder bitOrder, uint8_t dataMode);
```

#### Parameters

clock: SPI clock speed, default is 4000000

bitOrder: order of bit stream, MSB first or LSB first, default is MSBFIRST

dataMode: There are 4 modes -> SPI\_MODE0~3, default is SPI\_MODE0

#### Returns

The function returns nothing.

#### Example Code

NA

## Notes and Warnings

This class seldom used alone, it is always used with `beginTransaction()` as a parameter in `SPIClass`.

## SPIClass Class

### Description

Defines a class of SPI implementation for Ameba.

### Syntax

```
class SPIClass
```

### Members

Public Constructors	
<code>SPIClass::SPIClass</code>	Constructs an SPI object
Public Methods	
<code>SPIClass::transfer</code>	Transfer data through SPI
<code>SPIClass::transfer16</code>	Transfer a 16-bits data through SPI
<code>SPIClass::beginTransaction</code>	Set slave select pin and SPI initial settings
<code>SPIClass::endTransaction</code>	Stop SPI transaction
<code>SPIClass::begin</code>	Associate each SPI pin to Ameba pin using ameba HAL APIs
<code>SPIClass::end</code>	Stop SPI master mode
<code>SPIClass::setBitOrder</code>	Set MSB first or LSB first
<code>SPIClass::setDataMode</code>	Set to one of the four data modes
<code>SPIClass::setClockDivider</code>	Set to correct clock speed (no effect on Ameba)
<code>SPIClass::setDefaultFrequency</code>	Set default SPI frequency

## SPIClass::SPIClass

### Description

Construct an SPI object, create a pointer to the object, and attach “MOSI, MISO, CLK, and SS” to each pin on Ameba.

### Syntax

```
SPIClass(void *pSpiObj, int mosi, int miso, int clk, int ss);
```



**Parameters**

pSpiObj: SPI pointer to the object

mosi: master out slave in

miso: master in slave out

clk: clock

ss: slave select

**Returns**

The function returns nothing.

**Example Code**

```
SPIClass SPI((void *)&spi_obj0), 11, 12, 13, 10);
```

**Notes and Warnings**

2 SPI objects are created in the library for 2 different hardware SPI on Ameba (if applicable), use “SPI” for first hardware SPI and “SPI1” for the second.

**SPIClass::transfer****Description**

Calling HAL API to send data in the buffer to the slave

**Syntax**

```
byte SPIClass::transfer (byte _pin, uint8_t _data, SPITransferMode _mode);
```

```
byte SPIClass::transfer (uint8_t _data, SPITransferMode _mode);
```

```
void SPIClass::transfer (byte _pin, void *_buf, size_t _count, SPITransferMode _mode);
```

```
void SPIClass::transfer (void *_buf, size_t _count, SPITransferMode _mode);
```

**Parameters**

\_pin: Slave select pin

\_data: Actual data being sent over

\_mode: SPI transfer mode

\_count: number of bytes of data

\_buf: data buffer

### Returns

Void or “0” in case of error, “d” in case success

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::transfer16

### Description

Same as “transfer” method above except data being of 16-bits.

### Syntax

```
uint16_t SPIClass::transfer16(byte _pin, uint16_t _data, SPITransferMode _mode)
```

```
uint16_t SPIClass::transfer16(uint16_t _data, SPITransferMode _mode)
```

### Parameters

\_pin: Slave select pin

\_data: Actual data being sent over

\_mode: SPI transfer mode

### Returns

The data being transferred

### Example Code

NA

**Notes and Warnings**

NA

**SPIClass::beginTransaction****Description**

Set slave select pin and initialize SPI with default settings using SPISettings class.

**Syntax**

```
void SPIClass::beginTransaction(uint8_t pin, SPISettings settings)
```

```
void SPIClass::beginTransaction(SPISettings settings)
```

**Parameters**

pin: slave select pin

settings: an object of SPISettings class

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

Refer to SPISettings class for details of the initial settings.

**SPIClass::endTransaction****Description**

Set slave select pin to 1 and stop SPI transaction.

### Syntax

```
void SPIClass::endTransaction(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::begin

### Description

Calling HAL APIs to initialize SPI pins to physical Ameba pins and set SPI format and frequency

### Syntax

```
void SPIClass::begin(void)
```

```
void SPIClass::begin(int ss)
```

### Parameters

void or ss: slave select

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This is a required method to use SPI on Ameba.

### SPIClass::end

#### Description

Free hardware SPI from any activity.

#### Syntax

```
void SPIClass::end(void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

### SPIClass::setBitOrder

#### Description

A specific method to set bit order to either MSB first or LSB first and set slave select pin.

### Syntax

```
void SPIClass::setBitOrder(uint8_t _pin, BitOrder _bitOrder)
void SPIClass::setBitOrder(BitOrder _order)
```

### Parameters

\_pin: slave select  
\_bitOrder: bit order -> either MSB first or LSB first  
\_order: same as above

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## SPIClass::setDataMode

### Description

A specific method to set data mode to one of the 4 modes (default: SPI\_MODE0) and set slave select pin.

### Syntax

```
void SPIClass::setDataMode(uint8_t _pin, uint8_t _mode)
void SPIClass::setDataMode(uint8_t _mode)
```

### Parameters

\_pin: slave select  
\_mode: one of the 4 modes (default: SPI\_MODE0)

### Returns

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**SPIClass::setClockDivider****Description**

A specific method to set to divider in order to get correct clock speed

**Syntax**

```
void SPIClass::setClockDivider(uint8_t _pin, uint8_t _divider)
```

```
void SPIClass::setClockDivider(uint8_t _div)
```

**Parameters**

\_pin: slave select

\_divider: clock divider

\_div: same as above

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

This function does not affect the Ameba board.

## **SPIClass::setDefaultFrequency**

### **Description**

A specific method to set default SPI frequency

### **Syntax**

```
void SPIClass::setDefaultFrequency(int _frequency)
```

### **Parameters**

\_frequency: the default SPI frequency

### **Returns**

The function returns nothing.

### **Example Code**

Example: PM25\_on\_ILI9341\_TFT\_LCD

Details of the code are given in the previous section of AmebaILI9341:: AmebaILI9341.

### **Notes and Warnings**

Take note that defaultFrequency = \_frequency.

### **Readme**

The Ameba SPI related APIs and examples are works based on SPI Master library for arduino written by Cristian Maglie <c.maglie@arduino.cc> and Paul Stoffregen <paul@pjrc.com> (Transaction API).

These include,

SPI.cpp

SPI.h

These libraries are under GNU Lesser General Public License, version 2.1.

---



## Sys

### Wiring\_OS\_API

#### Wiring OS API

##### Description

A wrapper to CMSIS (Cortex Microcontroller Software Interface Standard) OS API which serve as a RTOS to create multi-threaded application with real-time behaviour.

##### Syntax

NA

##### Members

Public Methods	
os_thread_create_arduino	Create a thread and add it to Active Threads and set it to state READY
os_thread_get_id_arduino	Return the thread ID of the current running thread
os_thread_terminate_arduino	Terminate execution of a thread and remove it from Active Threads
os_thread_yield_arduino	Pass control to next thread that is in state READY
os_thread_set_priority_arduino	Change priority of an active thread
os_thread_get_priority_arduino	Get current priority of an active thread
os_signal_set_arduino	Set the specified Signal Flags of an active thread
os_signal_clear_arduino	Clear the specified Signal Flags of an active thread
os_signal_wait_arduino	Wait for one or more Signal Flags to become signaled for the current RUNNING thread
os_timer_create_arduino	Create a timer
os_timer_start_arduino	Start or restart a timer
os_timer_stop_arduino	Stop the timer
os_timer_delete_arduino	Delete a timer that was created by os_timer_create
os_semaphore_create_arduino	Create and Initialize a Semaphore object used for managing resources
os_semaphore_wait_arduino	Wait until a Semaphore token becomes available
os_semaphore_release_arduino	Release a Semaphore token
os_semaphore_delete_arduino	Delete a Semaphore that was created by os_semaphore_create
os_get_free_heap_size_arduino	Return the available heap memory space when called

##### os\_thread\_create\_arduino

## Description

Create a thread and add it to Active Threads and set it to state READY.

## Syntax

```
uint32_t os_thread_create_arduino (void (*task)(const void *argument), void *argument, int priority, uint32_t stack_size);
```

## Parameters

task: task Function pointer which is the thread body. It should not run into the end of function unless os\_thread\_terminate is invoked

argument: the data pointer which brings to task

priority: The underlying os is FreeRTOS. It executes tasks with highest priority which are not in idle state.

stack\_size: The stack\_size is used as memory heap only for this task.

## Returns

The thread id which is used in thread operation and signalling.

## Example Code

NA

## Notes and Warnings

NA

## os\_thread\_get\_id\_arduino

## Description

Return the thread ID of the current running thread

## Syntax

```
uint32_t os_thread_get_id_arduino (void);
```

## Parameters

The function requires no input parameter.

**Returns**

Current thread id which calls `os_thread_get_id`.

**Example Code**

NA

**Notes and Warnings**

NA

**`os_thread_terminate_arduino`****Description**

Terminate execution of a thread and remove it from Active Threads

**Syntax**

```
uint32_t os_thread_terminate_arduino (uint32_t thread_id);
```

**Parameters**

`thread_id`: Terminate the thread with specific `thread_id`

**Returns**

`os_status` code

**Example Code**

NA

**Notes and Warnings**

Thread should not ended without terminate first.

## os\_thread\_yield\_arduino

### Description

Pass control to next thread that is in state READY

### Syntax

```
uint32_t os_thread_yield_arduino (void);
```

### Parameters

The function requires no input parameter.

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

By default, the minimal execution unit is 1 millisecond. In a scenario that if a thread with smaller want to handout execution right to a thread with higher priority immediately without waiting for the ending of current 1 millisecond, then invoke os\_thread\_yield can transfer exection right to OS' s idle task and check which is the next execution thread.

## os\_thread\_set\_priority\_arduino

### Description

Change priority of an active thread

### Syntax

```
uint32_t os_thread_set_priority_arduino (uint32_t thread_id, int priority);
```

### Parameters

thread\_id: The target thread with the thread id to be changed

priority: The updated priority

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## os\_thread\_get\_priority\_arduino

### Description

Get current priority of an active thread

### Syntax

```
uint32_t os_thread_get_priority_arduino (uint32_t thread_id);
```

### Parameters

thread\_id: The target thread with the thread id to be searched

### Returns

os\_priority

### Example Code

NA

### Notes and Warnings

NA

## **os\_signal\_set\_arduino**

### **Description**

Set the specified Signal Flags of an active thread

### **Syntax**

```
int32_t os_signal_set_arduino (uint32_t thread_id, int32_t signals);
```

### **Parameters**

thread\_id: Send signal to a thread with the thread id

signals: the signals to be send

### **Returns**

os\_status code

### **Example Code**

NA

### **Notes and Warnings**

NA

## **os\_signal\_clear\_arduino**

### **Description**

Clear the specified Signal Flags of an active thread

### **Syntax**

```
int32_t os_signal_clear_arduino (uint32_t thread_id, int32_t signals);
```

**Parameters**

thread\_id: Clear signal to a thread with the thread id

signals: The signals to be clear

**Returns**

os\_status code

**Example Code**

NA

**Notes and Warnings**

NA

**os\_signal\_wait\_arduino****Description**

Wait for one or more Signal Flags to become signaled for the current RUNNING thread

**Syntax**

```
os_event_t os_signal_wait_arduino (int32_t signals, uint32_t millisec);
```

**Parameters**

signals: the signals to be wait

millisec: the timeout value if no signal comes in. Fill in 0xFFFFFFFF for infinite wait

**Returns**

os\_status code

**Example Code**

NA

## Notes and Warnings

NA

## os\_timer\_create\_arduino

### Description

Create a timer

### Syntax

```
uint32_t os_timer_create_arduino (void (*callback)(void const *argument), uint8_t isPeriodic, void *argument);
```

### Parameters

callback: The function to be invoke when timer timeout

isPeriodic: OS\_TIMER\_ONCE or OS\_TIMER\_PERIODIC

argument: The argument that is bring into callback function

### Returns

timer id

### Example Code

NA

## Notes and Warnings

NA

## os\_timer\_start\_arduino

### Description

Start or restart a timer



**Syntax**

```
uint32_t os_timer_start_arduino (uint32_t timer_id, uint32_t millisec);
```

**Parameters**

timer\_id: The timer id obtained from by os\_timer\_create

millisec: The delays after timer starts

**Returns**

os\_status code

**Example Code**

NA

**Notes and Warnings**

NA

**os\_timer\_stop\_arduino****Description**

Stop the timer

**Syntax**

```
uint32_t os_timer_stop_arduino (uint32_t timer_id);
```

**Parameters**

timer\_id: The timer id obtained from by os\_timer\_create

**Returns**

os\_status code

**Example Code**

NA

### Notes and Warnings

NA

## os\_timer\_delete\_arduino

### Description

Delete a timer that was created by os\_timer\_create

### Syntax

```
uint32_t os_timer_delete_arduino (uint32_t timer_id);
```

### Parameters

timer\_id: The timer id obtained from by os\_timer\_create

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_semaphore\_create\_arduino

### Description

Create and Initialize a Semaphore object used for managing resources

**Syntax**

```
uint32_t os_semaphore_create_arduino (int32_t count);
```

**Parameters**

count: The number of available resources

**Returns**

semaphore ID

**Example Code**

NA

**Notes and Warnings**

NA

**os\_semaphore\_wait\_arduino****Description**

Wait until a Semaphore token becomes available

**Syntax**

```
int32_t os_semaphore_wait_arduino (uint32_t semaphore_id, uint32_t millisec);
```

**Parameters**

semaphore\_id: semaphore id obtained from os\_semaphore\_create

millisec: timeout value

**Returns**

os\_status code

**Example Code**

NA

### Notes and Warnings

NA

## os\_semaphore\_release\_arduino

### Description

Release a Semaphore token

### Syntax

```
uint32_t os_semaphore_release_arduino (uint32_t semaphore_id);
```

### Parameters

semaphore\_id: semaphore id obtained from os\_semaphore\_create

### Returns

os\_status code

### Example Code

NA

### Notes and Warnings

NA

## os\_semaphore\_delete\_arduino

### Description

Delete a Semaphore that was created by os\_semaphore\_create

**Syntax**

```
uint32_t os_semaphore_delete_arduino (uint32_t semaphore_id);
```

**Parameters**

semaphore\_id: semaphore id obtained from os\_semaphore\_create

**Returns**

os\_status code

**Example Code**

NA

**Notes and Warnings**

NA

**os\_get\_free\_heap\_size\_arduino****Description**

Return the available heap memory space when called

**Syntax**

```
size_t os_get_free_heap_size_arduino(void);
```

**Parameters**

The function requires no input parameter.

**Returns**

current free heap size

**Example Code**

Example: MemInfo

## Notes and Warnings

NA

---

## WDT

### Class WDT

#### WDT Class

#### Description

A class used for initializing, starting, stopping watchdog timer.

#### Syntax

```
class WDT
```

#### Members

Public Constructors	
A public constructor should not be used as this class is intended to be a singleton class. Access member functions using the object instance named WDT.	

Public Methods	
WDT:: InitWatchdog	Initializes the watchdog, include time setting, and mode register
WDT:: StartWatchdog	Start the watchdog counting
WDT:: StopWatchdog	Stop the watchdog counting
WDT:: RefreshWatchdog	Refresh the watchdog counting to prevent WDT timeout
WDT:: InitWatchdogIRQ	Switch the watchdog timer to interrupt mode and register a watchdog timer timeout interrupt handler

#### WDT:: InitWatchdog

#### Description

Initializes the watchdog, include time setting, and mode register.

**Syntax**

```
void InitWatchdog(uint32_t timeout_ms);
```

**Parameters**

timeout\_ms: the watch-dog timer timeout value in millisecond (ms). The default action after watchdog timer timeout is to reset the whole system.

**Returns**

The function returns nothing.

**Example Code**

Example: WatchdogTimer

```
/*
 * This example describes how to use watchdog api.
 * In this example, watchdog is setup to 5s timeout.
 * Watchdog won't bark if we refresh it before timeout in smallTask.
 * The timer is also reloaded after refresh.
 * Otherwise, while running bigTask, watchdog will restart system in default or call callback function if registered.
 */
#include 「wdt.h」

#define RUN_CALLBACK_IF_WATCHDOG_BARKS (0)

WDT wdt;

void setup() {
  Serial.begin(115200);

  wdt.InitWatchdog(5000); // setup 5s watchdog

  #if RUN_CALLBACK_IF_WATCHDOG_BARKS

  wdt.InitWatchdogIRQ(my_watchdog_irq_handler, 0);

  #else

  // system would restart in default when watchdog barks

  #endif
```

```
wdt.StartWatchdog(); // enable watchdog timer

successfulTask();

failedTask();

while (1)

;

}

void loop() {

}

void successfulTask(void) {

Serial.println(「 ……doing small task……」 );

for (int i = 0; i < 50000000; i++) // dummy task

asm(「 nop」 );

Serial.println(「 refresh watchdogn」 );

wdt.RefreshWatchdog();

}

/*

* Doing this task will lead to failed refresh the

* watchdog timer within the time limits of 5 seconds

*/

void failedTask(void) {

Serial.println(「 ……doing big task……」 );

for (int i = 0; i < 10; i++) {

Serial.print(「 doing dummy task #」 );

Serial.println(i, DEC);

for (int j = 0; j < 50000000; j++) // dummy task

asm(「 nop」 );

}

Serial.println(「 refresh watchdogn」 );

wdt.RefreshWatchdog();

}
```



```
void my_watchdog_irq_handler(uint32_t id) {  
    printf(「 watchdog barks!!!rn」 );  
    WDG_Cmd(DISABLE);  
}
```

### Notes and Warnings

NA

## WDT:: StartWatchdog

### Description

Start the watchdog counting.

### Syntax

```
void StartWatchdog(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

### Notes and Warnings

NA

## WDT:: StopWatchdog

### Description

Stop the watchdog counting.

### Syntax

```
void StopWatchdog(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

### Notes and Warnings

NA

## WDT:: RefreshWatchdog

### Description

Refresh the watchdog counting to prevent WDT timeout.

### Syntax

```
void RefreshWatchdog(void);
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

**Example Code**

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

**Notes and Warnings**

NA

**WDT:: InitWatchdogIRQ****Description**

Switch the watchdog timer to interrupt mode and register a watchdog timer timeout interrupt handler. The interrupt handler will be called when the watchdog timer is timeout.

**Syntax**

```
void WDT::InitWatchdogIRQ(wdt_irq_handler handler, uint32_t id)
```

**Parameters**

handler: the callback function for WDT timeout interrupt.

id: the parameter for the callback function

**Returns**

The function returns nothing.

**Example Code**

Example: WatchdogTimer

You may refer to the code in previous section of WDT::InitWatchdog.

**Notes and Warnings**

NA

## WiFi

### Class WiFi

#### WiFiClass Class

#### Description

Defines a class of WiFi and network implementation for Ameba.

#### Syntax

```
class WiFiClass
```

#### Members

<b>Public Constructors</b>	
WiFiClass::WiFiClass	Constructs a WiFiClass object and initializes the WiFi libraries and network settings
<b>Public Methods</b>	
WiFi- Class::firmwareVersion	Get firmware version
WiFiClass:: begin	Start Wifi connection for OPEN networks
WiFiClass:: config	Configure network IP settings
WiFiClass:: setDNS	Set the DNS server IP address to use
WiFiClass:: disconnect	Disconnect from the network
WiFiClass:: macAddress	Get the interface MAC address
WiFiClass:: localIP	Get the interface IP address
WiFiClass:: subnetMask	Get the interface subnet mask address
WiFiClass:: gatewayIP	Get the gateway IP address
WiFiClass:: SSID	Return the current SSID associated with the network
WiFiClass:: BSSID	Return the current BSSID associated with the network
WiFiClass:: RSSI	Return the current RSSI (Received Signal Strength in dBm) associated with the network
WiFiClass:: encryption- Type	Return the Encryption Type associated with the network
WiFiClass:: scanNetworks	Start scan WiFi networks available
WiFiClass:: SSID	Return the SSID discovered during the network scan
WiFiClass:: encryption- Type	Return the encryption type of the networks discovered during the scanNetworks
WiFiClass:: encryption- TypeEx	Return the security type and encryption type of the networks discovered during the scanNetworks
WiFiClass:: RSSI	Return the RSSI of the networks discovered during the scanNetworks
WiFiClass:: status	Return Connection status
WiFiClass:: hostByName	Resolve the given hostname to an IP address
WiFiClass:: apbegin	Start AP mode
WiFiClass:: disablePower- Save	Disable power-saving mode

**WiFiClass::WiFiClass****Description**

Constructs a WiFiClass object and initializes the WiFi libraries and network settings.

**Syntax**

```
WiFiClass::WiFiClass()
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

An instance of WiFiClass is created as WiFi inside WiFi.h and is extern for direct use.

### WiFiClass::firmwareVersion

### Description

Get firmware version

### Syntax

```
char* WiFiClass::firmwareVersion()
```

### Parameters

The function requires no input parameter.

### Returns

WiFi firmware version

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details.

```
#include <WiFi.h>
```

```

// char ssid[] = 「yourNetwork」 ; // your network SSID (name)
// char pass[] = 「secretPassword」 ; // your network password
char ssid[] = 「SINGTEL-D45F」 ; // your network SSID (name)
char pass[] = 「mooxuteeth」 ; // your network key
int status = WL_IDLE_STATUS; // the Wifi radio's status

void setup() {

//Initialize serial and wait for port to open:
Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:
if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don't continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to WPA SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network:

status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:

delay(10000);

}

```

```
// you' re connected now, so print out the data:
Serial.print( 「You' re connected to the network」 );
printCurrentNet();
printWifiData();
}

void loop() {

// check the network connection once every 10 seconds:
delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield' s IP address:
IPAddress ip = WiFi.localIP();
Serial.print( 「IP Address: 」);
Serial.println(ip);
Serial.println(ip);

// print your MAC address:
byte mac[6];
WiFi.macAddress(mac);
Serial.print( 「MAC address: 」);
Serial.print(mac[0], HEX);
Serial.print( 「:」 );
Serial.print(mac[1], HEX);
Serial.print( 「:」 );
Serial.print(mac[2], HEX);
Serial.print( 「:」 );
Serial.print(mac[3], HEX);
Serial.print( 「:」 );
Serial.print(mac[4], HEX);
Serial.print( 「:」 );
```



```
Serial.println(mac[5], HEX);
}

void printCurrentNet() {
// print the SSID of the network you're attached to:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());

// print the MAC address of the router you're attached to:
byte bssid[6];
WiFi.BSSID(bssid);
Serial.print(「BSSID: 」);
Serial.print(bssid[5], HEX);
Serial.print(「:」);
Serial.print(bssid[4], HEX);
Serial.print(「:」);
Serial.print(bssid[3], HEX);
Serial.print(「:」);
Serial.print(bssid[2], HEX);
Serial.print(「:」);
Serial.print(bssid[1], HEX);
Serial.print(「:」);
Serial.println(bssid[0], HEX);

// print the received signal strength:
long rssi = WiFi.RSSI();
Serial.print(「signal strength (RSSI):」);
Serial.println(rssi);

// print the encryption type:
byte encryption = WiFi.encryptionType();
Serial.print(「Encryption Type:」);
Serial.println(encryption, HEX);
Serial.println();
```

```
}
```

## Notes and Warnings

NA

## WiFiClass::begin

### Description

Start Wifi connection for OPEN networks

### Syntax

```
int WiFiClass::begin(char* ssid)
int WiFiClass::begin(char* ssid, uint8_t key_idx, const char *key)
int WiFiClass::begin(char* ssid, const char *passphrase)
```

### Parameters

ssid: Pointer to the SSID string

key\_idx: The key index to set. Valid values are 0-3.

key: Key input buffer.

passphrase: Passphrase. Valid characters in a passphrase must be between ASCII 32-126 (decimal).

### Returns

WiFi status

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

## Notes and Warnings

NA

## WiFiClass::config

### Description

Configure network settings for the WiFi network

### Syntax

```
void WiFiClass::config(IPAddress local_ip)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server, IPAddress gateway)
void WiFiClass::config(IPAddress local_ip, IPAddress dns_server, IPAddress gateway, IPAddress subnet)
```

### Parameters

local\_ip: Local device IP address to use on the network  
dns\_server: IP address of the DNS server to use  
gateway: IP address of the gateway device on the network  
subnet: Subnet mask for the network, expressed as a IP address

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

This will disable the DHCP client when connecting to a network, and will require the network accepts a static IP. The configured IP addresses will also apply to AP mode, but the DHCP server will not be disabled in AP mode.

## WiFiClass::setDNS

### Description

Configure the IP address of the DNS server to use

### Syntax

```
void WiFiClass::setDNS(IPAddress dns_server1)
void WiFiClass::setDNS(IPAddress dns_server1, IPAddress dns_server2)
```

### Parameters

dns\_server1: IP address of DNS server to use

dns\_server2: IP address of DNS server to use

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiClass::disconnect

### Description

Disconnect from the network

### Syntax

```
int WiFiClass::disconnect()
```

### Parameters

The function requires no input parameter.

### Returns

The function returns one value of wl\_status\_t enum as an integer.

### Example Code

NA

**Notes and Warnings**

NA

**WiFiClass::macAddress****Description**

Get the interface MAC address

**Syntax**

```
uint8_t* WiFiClass::macAddress(uint8_t* mac)
```

**Parameters**

mac: an array to store MAC address

**Returns**

The function returns a pointer to uint8\_t array with length WL\_MAC\_ADDR\_LENGTH.

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

**Notes and Warnings**

NA

**WiFiClass::localIP****Description**

Get the interface IP address

**Syntax**

IPAddress WiFiClass::localIP()

### Parameters

The function requires no input parameter.

### Returns

Ip address value

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of WiFiClass:: firmwareVersion.

### Notes and Warnings

NA

## WiFiClass::subnetMask

### Description

Get the interface subnet mask address

### Syntax

IPAddress WiFiClass::subnetMask()

### Parameters

The function requires no input parameter.

### Returns

subnet mask address value

### Example Code

Example: ConnectNoEncryption

This example demonstrates how to connect to an unencrypted WiFi network and prints the MAC address of the WiFi shield, the IP address obtained, and other network details.

```
#include <WiFi.h>

char ssid[] = 「SINGTEL-D45F_5G」 ; // the name of your network
int status = WL_IDLE_STATUS; // the Wifi radio' s status

void setup() {
  //Initialize serial and wait for port to open:
  Serial.begin(9600);

  while (!Serial) {
    ; // wait for serial port to connect. Needed for native USB port only
  }

  // check for the presence of the shield:
  if (WiFi.status() == WL_NO_SHIELD) {
    Serial.println(「WiFi shield not present」 );
    // don' t continue:
    while (true);
  }

  String fv = WiFi.firmwareVersion();
  if (fv != 「1.1.0」 ) {
    Serial.println(「Please upgrade the firmware」 );
  }

  // attempt to connect to Wifi network:

  while (status != WL_CONNECTED) {
    Serial.print(「Attempting to connect to open SSID: 」);
    Serial.println(ssid);
    status = WiFi.begin(ssid);

    // wait 10 seconds for connection:
    delay(10000);
  }
```

```
// you' re connected now, so print out the data:
Serial.print( 「You' re connected to the network」 );
printCurrentNet();
printWifiData();
}

void loop() {

// check the network connection once every 10 seconds:
delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield' s IP address:
IPAddress ip = WiFi.localIP();
Serial.print( 「IP Address: 」);
Serial.println(ip);
Serial.println(ip);

// print your MAC address:
byte mac[6];
WiFi.macAddress(mac);
Serial.print( 「MAC address: 」);
Serial.print(mac[0], HEX);
Serial.print( 「:」 );
Serial.print(mac[1], HEX);
Serial.print( 「:」 );
Serial.print(mac[2], HEX);
Serial.print( 「:」 );
Serial.print(mac[3], HEX);
Serial.print( 「:」 );
Serial.print(mac[4], HEX);
Serial.print( 「:」 );
```



```
Serial.println(mac[5], HEX);

// print your subnet mask:
IPAddress subnet = WiFi.subnetMask();

Serial.print(「NetMask: 」);

Serial.println(subnet);

// print your gateway address:
IPAddress gateway = WiFi.gatewayIP();

Serial.print(「Gateway: 」);

Serial.println(gateway);

}

void printCurrentNet() {

// print the SSID of the network you' re attached to:
Serial.print(「SSID: 」);

Serial.println(WiFi.SSID());

// print the MAC address of the router you' re attached to:
byte bssid[6];

WiFi.BSSID(bssid);

Serial.print(「BSSID: 」);

Serial.print(bssid[5], HEX);

Serial.print(「:」 );

Serial.print(bssid[4], HEX);

Serial.print(「:」 );

Serial.print(bssid[3], HEX);

Serial.print(「:」 );

Serial.print(bssid[2], HEX);

Serial.print(「:」 );

Serial.print(bssid[1], HEX);

Serial.print(「:」 );

Serial.println(bssid[0], HEX);

// print the received signal strength:
```

```
long rssi = WiFi.RSSI();  
Serial.print(「signal strength (RSSI):」 );  
Serial.println(rssi);  
  
// print the encryption type:  
byte encryption = WiFi.encryptionType();  
Serial.print(「Encryption Type:」 );  
Serial.println(encryption, HEX);  
}
```

### Notes and Warnings

NA

### WiFiClass::gatewayIP

#### Description

Get the gateway IP address

#### Syntax

```
IPAddress WiFiClass::gatewayIP()
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns the value of the gateway IP address.

#### Example Code

Example: ConnectNoEncryption

This example demonstrates how to connect to an unencrypted WiFi network and prints the MAC address of the WiFi shield, the IP address obtained, and other network details. Details of the code can be found in the section of `WiFiClass::subnetMask`.

**Notes and Warnings**

NA

**WiFiClass::SSID****Description**

Return the current SSID associated with the network

**Syntax**

```
char* WiFiClass::SSID()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns current SSID associate with the network.

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

**Notes and Warnings**

NA

**WiFiClass::BSSID****Description**

Return the current BSSID associated with the network

**Syntax**

uint8\_t\* WiFiClass::BSSID(uint8\_t\* bssid)

### Parameters

bssid: an array to store bssid

### Returns

pointer to uint8\_t array with length WL\_MAC\_ADDR\_LENGTH

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of WiFiClass:: firmwareVersion.

### Notes and Warnings

NA

## WiFiClass::RSSI

### Description

Return the current RSSI (Received Signal Strength in dBm) associated with the network

### Syntax

int32\_t WiFiClass::RSSI()

### Parameters

The function requires no input parameter.

### Returns

The function returns a signed-value signal strength

### Example Code

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

### Notes and Warnings

NA

### WiFiClass::encryptionType

#### Description

Return the Encryption Type associated with the network

#### Syntax

```
uint8_t WiFiClass::encryptionType()
```

#### Parameters

The function requires no input parameter.

#### Returns

The function returns one unsigned integer value of `wl_enc_type` enum.

### Example Code

Example: ConnectWithWPA

### Notes and Warnings

NA

### WiFiClass::scanNetworks

#### Description

Start scan WiFi networks available

**Syntax**

```
int8_t WiFiClass::scanNetworks()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns the number of discovered networks as an integer.

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified.

```
#include <WiFi.h>
```

```
void setup() {
```

```
//Initialize serial and wait for port to open:
```

```
Serial.begin(9600);
```

```
while (!Serial) {
```

```
; // wait for serial port to connect. Needed for native USB port only
```

```
}
```

```
// check for the presence of the shield:
```

```
if (WiFi.status() == WL_NO_SHIELD) {
```

```
Serial.println(「WiFi shield not present」);
```

```
// don't continue:
```

```
while (true);
```

```
}
```

```
String fv = WiFi.firmwareVersion();
```

```
if (fv != 「1.1.0」) {
```

```
Serial.println(「Please upgrade the firmware」);
```

```
}
```

```
// Print WiFi MAC address:

printMacAddress();

}

void loop() {
// scan for existing networks:
Serial.println(「Scanning available networks…」);
listNetworks();
delay(10000);
}

void printMacAddress() {
// the MAC address of your Wifi shield
byte mac[6];
// print your MAC address:
WiFi.macAddress(mac);
Serial.print(「MAC: 」);
Serial.print(mac[0], HEX);
Serial.print(「:」);
Serial.print(mac[1], HEX);
Serial.print(「:」);
Serial.print(mac[2], HEX);
Serial.print(「:」);
Serial.print(mac[3], HEX);
Serial.print(「:」);
Serial.print(mac[4], HEX);
Serial.print(「:」);
Serial.println(mac[5], HEX);
}

void listNetworks() {
// scan for nearby networks:
Serial.println(「 * Scan Networks *」);
```

```
int numSsid = WiFi.scanNetworks();

if (numSsid == -1) {
  Serial.println(「Couldn't get a wifi connection」);
  while (true);
}

// print the list of networks seen:
Serial.print(「number of available networks:」);
Serial.println(numSsid);

// print the network number and name for each network found:
for (int thisNet = 0; thisNet < numSsid; thisNet++) {
  Serial.print(thisNet);
  Serial.print(「」);
  Serial.print(WiFi.SSID(thisNet));
  Serial.print(「SSID: 」);
  Serial.print(WiFi.RSSI(thisNet));
  Serial.print(「RSSI dBm」);
  Serial.print(「EncryptionRaw: 」);
  printEncryptionTypeEx(WiFi.encryptionTypeEx(thisNet));
  Serial.print(「Encryption: 」);
  printEncryptionType(WiFi.encryptionType(thisNet));
}
}

void printEncryptionTypeEx(uint32_t thisType) {
  /* Arduino wifi api use encryption type to mapping to security type.
  * This function demonstrate how to get more richful information of security type.
  */

  switch (thisType) {
  case SECURITY_OPEN:
    Serial.print(「Open」);
    break;
```



```
case SECURITY_WEP_PSK:
Serial.print( 「WEP」 );
break;
case SECURITY_WPA_TKIP_PSK:
Serial.print( 「WPA TKIP」 );
break;
case SECURITY_WPA_AES_PSK:
Serial.print( 「WPA AES」 );
break;
case SECURITY_WPA2_AES_PSK:
Serial.print( 「WPA2 AES」 );
break;
case SECURITY_WPA2_TKIP_PSK:
Serial.print( 「WPA2 TKIP」 );
break;
case SECURITY_WPA2_MIXED_PSK:
Serial.print( 「WPA2 Mixed」 );
break;
case SECURITY_WPA_WPA2_MIXED:
Serial.print( 「WPA/WPA2 AES」 );
break;
}
}
void printEncryptionType(int thisType) {
// read the encryption type and print out the name:
switch (thisType) {
case ENC_TYPE_WEP:
Serial.println( 「WEP」 );
break;
case ENC_TYPE_TKIP:
```

```
Serial.println( 「WPA」 );  
break;  
case ENC_TYPE_CCMP:  
Serial.println( 「WPA2」 );  
break;  
case ENC_TYPE_NONE:  
Serial.println( 「None」 );  
break;  
case ENC_TYPE_AUTO:  
Serial.println( 「Auto」 );  
break;  
}  
}
```

### **Notes and Warnings**

NA

### **WiFiClass::SSID**

#### **Description**

Return the SSID discovered during the network scan

#### **Syntax**

```
char* WiFiClass::SSID(uint8_t networkItem)
```

#### **Parameters**

networkItem: specify from which network item want to get the information

#### **Returns**

The function returns ssid string of the specified item on the networks scanned a list.

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::encryptionType****Description**

Return the encryption type of the networks discovered during the `scanNetworks`

**Syntax**

```
uint8_t WiFiClass::encryptionType(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

encryption type (enum `wl_enc_type`) of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::encryptionTypeEx**

**Description**

Return the security type and encryption type of the networks discovered during the scanNetworks

**Syntax**

```
uint32_t WiFiClass::encryptionTypeEx(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

security and encryption type of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of WiFiClass:: scanNetworks.

**Notes and Warnings**

NA

**WiFiClass::RSSI****Description**

Return the RSSI of the networks discovered during the scanNetworks

**Syntax**

```
int32_t WiFiClass::RSSI(uint8_t networkItem)
```

**Parameters**

networkItem: specify from which network item want to get the information

**Returns**

signed value of RSSI of the specified item on the networks scanned a list

**Example Code**

Example: ScanNetworks

This example prints the Wifi shield's MAC address, and scans for available Wifi networks using the Wifi shield. Every ten seconds, it scans again. It doesn't connect to any network, so no encryption scheme is specified. The details of the code can be found in the previous section of `WiFiClass::scanNetworks`.

**Notes and Warnings**

NA

**WiFiClass::status****Description**

Return Connection status

**Syntax**

```
uint8_t WiFiClass::status()
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns one of the values defined in `wl_status_t` as an unsigned integer.

**Example Code**

Example: ConnectWithWPA

This example demos how to connect to an unencrypted WiFi network, and prints the MAC address of the Wifi shield, the IP address obtained, and other network details. The details of the code can be found in the previous section of `WiFiClass::firmwareVersion`.

**Notes and Warnings**

NA

## WiFiClass::hostByName

### Description

Resolve the given hostname to an IP address

### Syntax

```
int WiFiClass::hostByName(const char* aHostname, IPAddress& aResult)
```

### Parameters

aHostname: Name to be resolved

aResult: IPAddress structure to store the returned IP address

### Returns

The function returns “1” if aIPAddrString was successfully converted to an IP address,else otherwise, it will return as an error code.

### Example Code

NA

### Notes and Warnings

NA

## WiFiClass::apbegin

### Description

Start AP mode

### Syntax

```
int WiFiClass::apbegin(char* ssid, char* channel)
```

```
int WiFiClass::apbegin(char* ssid, char* password, char* channel)
```

**Parameters**

ssid: SSID of the AP network

channel: AP' s channel, default 1

password: AP' s password

**Returns**

The function will return the WiFi status.

**Example Code**

Example: WiFiAPMode

**#include**

```

char ssid[] = 「yourNetwork」 ; //Set the AP' s SSID

char pass[] = 「Password」 ; //Set the AP' s password

char channel[] = 「1」 ; //Set the AP' s channel

int status = WL_IDLE_STATUS; // the Wifi radio' s status

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

```

```
// attempt to start AP:

while (status != WL_CONNECTED) {

Serial.print(「 Attempting to start AP with SSID: 」);

Serial.println(ssid);

status = WiFi.apbegin(ssid, pass, channel);

delay(10000);

}

//AP MODE already started:

Serial.println(「 AP mode already started」 );

Serial.println();

printWifiData();

printCurrentNet();

}

void loop() {

// check the network connection once every 10 seconds:

delay(10000);

printCurrentNet();

}

void printWifiData() {

// print your WiFi shield's IP address:

IPAddress ip = WiFi.localIP();

Serial.print(「 IP Address: 」);

Serial.println(ip);

// print your subnet mask:

IPAddress subnet = WiFi.subnetMask();

Serial.print(「 NetMask: 」);

Serial.println(subnet);

// print your gateway address:

IPAddress gateway = WiFi.gatewayIP();

Serial.print(「 Gateway: 」);
```



```
Serial.println(gateway);

Serial.println();

}

void printCurrentNet() {
// print the SSID of the AP:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());
// print the MAC address of AP:
byte bssid[6];
WiFi.BSSID(bssid);
Serial.print(「BSSID: 」);
Serial.print(bssid[0], HEX);
Serial.print(「:」 );
Serial.print(bssid[1], HEX);
Serial.print(「:」 );
Serial.print(bssid[2], HEX);
Serial.print(「:」 );
Serial.print(bssid[3], HEX);
Serial.print(「:」 );
Serial.print(bssid[4], HEX);
Serial.print(「:」 );
Serial.println(bssid[5], HEX);
// print the encryption type:
byte encryption = WiFi.encryptionType();
Serial.print(「Encryption Type:」 );
Serial.println(encryption, HEX);
Serial.println();
}
```

## Notes and Warnings

NA

## WiFiClass::disablePowerSave

### Description

Disable power-saving mode

### Syntax

```
int WiFiClass::disablePowerSave()
```

### Parameters

The function requires no input parameter.

### Returns

1 if disable success, 0 if failed

### Example Code

NA

### Notes and Warnings

NA

## Class WiFiClient

### WiFiClient Class

### Description

Defines a class of WiFi Client implementation for Ameba.

### Syntax

```
class WiFiClient
```

## Members

Public Constructors	
WiFiClient::WiFiClient	Constructs a WiFiClient instance that connects to the specified IP address and port.
Public Methods	
WiFiClient::connect	Connect to the IP address and port
WiFiClient::write	Write a single byte into the packet
WiFiClient::available	Number of bytes remaining in the current packet
WiFiClient::read	Read a single byte from the current packet
WiFiClient:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiClient:: flush	Finish reading the current packet
WiFiClient::stop	Stop client connection
WiFiClient::connected	Check if client is connected, return 1 if connected, 0 if not
WiFiClient::setRecvTimeout	Set receiving timeout

## WiFiClient::WiFiClient

### Description

Constructs a WiFiClient instance that connects to the specified IP address and port.

### Syntax

```
WiFiClient::WiFiClient()
```

```
WiFiClient::WiFiClient(uint8_t sock)
```

### Parameters

sock: socket state, default -1.

### Returns

The function returns nothing.

### Example Code

Example: WiFiWebClient

```
#include <WiFi.h>
```

```
char ssid[] = 「yourNetwork」 ; // your network SSID (name)
```

```
char pass[] = 「password」 ; // your network password (use for WPA, or use as key for WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

//IPAddress server(64,233,189,94); // numeric IP for Google (no DNS)

char server[] = 「www.google.com」 ; // name address for Google (using DNS)

WiFiClient client;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

;

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don' t continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid, pass);

// wait 10 seconds for connection:

delay(10000);
```

```
}  
  
Serial.println(「Connected to wifi」);  
  
printWifiStatus();  
  
Serial.println(「nStarting connection to server...」);  
  
// if you get a connection, report back via serial:  
  
if (client.connect(server, 80)) {  
  
    Serial.println(「connected to server」);  
  
    // Make a HTTP request:  
  
    client.println(「GET /search?q=ameba HTTP/1.1」);  
    client.println(「Host: www.google.com」);  
    client.println(「Connection: close」);  
  
    client.println();  
  
}  
  
void loop() {  
  
    // if there are incoming bytes available  
  
    // from the server, read them and print them:  
  
    while (client.available()) {  
  
        char c = client.read();  
  
        Serial.write(c);  
  
    }  
  
    // if the server' s disconnected, stop the client:  
  
    if (!client.connected()) {  
  
        Serial.println();  
  
        Serial.println(「disconnecting from server.」);  
  
        client.stop();  
  
        // do nothing forevermore:  
  
        while (true);  
  
    }  
  
}
```

```
void printWifiStatus() {  
  // print the SSID of the network you're attached to:  
  Serial.print( "SSID: ");  
  Serial.println(WiFi.SSID());  
  // print your WiFi shield's IP address:  
  IPAddress ip = WiFi.localIP();  
  Serial.print( "IP Address: ");  
  Serial.println(ip);  
  // print the received signal strength:  
  long rssi = WiFi.RSSI();  
  Serial.print( "signal strength (RSSI):" );  
  Serial.print(rssi);  
  Serial.println( " dBm" );  
}
```

## Notes and Warnings

NA

## WiFiClient::connect

### Description

Connect to the IP address and port

### Syntax

```
int WiFiClient::connect(IPAddress ip, uint16_t port)  
int WiFiClient::connect(const char *host, uint16_t port)
```

### Parameters

ip: IP address

host: Host name

port: the port to listen on

**Returns**

Returns “1” : if successful

Returns “0” : if failed

**Example Code**

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

**Notes and Warnings**

NA

**WiFiClient::write****Description**

Write a single byte into the packet

**Syntax**

size\_t WiFiClient::write(uint8\_t byte)

size\_t WiFiClient::write(const uint8\_t \*buf, size\_t size)

**Parameters**

byte: the outgoing byte

buf: the outgoing message

size: the size of the buffer

**Returns**

The function returns single byte into the packet or returns bytes size from buffer into the packet.

**Example Code**

NA

**Notes and Warnings**

NA

## WiFiClient::available

### Description

Number of bytes remaining in the current packet

### Syntax

```
int WiFiClient::available(void)
```

### Parameters

The function requires no input parameter.

### Returns

- Function returns the number of bytes available in the current packet

Function returns 0: if no data available

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::read

### Description

Read a single byte from the current packet

### Syntax



```
int WiFiClient::read()
int WiFiClient::read(unsigned char* buf, size_t size)
int WiFiClient::read(char *buf, size_t size)
```

**Parameters**

buf: buffer to hold incoming packets (char\*)  
size: maximum size of the buffer (int)

**Returns**

size: the size of the buffer  
-1: if no buffer is available

**Example Code**

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

**Notes and Warnings**

NA

**WiFiClient::peek****Description**

Return the next byte from the current packet without moving on to the next byte

**Syntax**

```
int WiFiClient::peek(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

b: the next byte or character

-1: if none is available

### Example Code

NA

### Notes and Warnings

NA

## WiFiClient::flush

### Description

Finish reading the current packet

### Syntax

```
void WiFiClient::flush(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## WiFiClient::stop

**Description**

Disconnect from the server. Stop client connection

**Syntax**

```
void WiFiClient::stop(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

**Notes and Warnings**

NA

**WiFiClient::connected****Description**

Check if client is connected, return 1 if connected, 0 if not.

**Syntax**

```
uint8_t WiFiClient::connected(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns “1” if connected, returns “0” if not connected.

### Example Code

Example: WiFiWebClient

The details of the example are explained in the previous section of WiFiClient:: WiFiClient.

### Notes and Warnings

NA

## WiFiClient::setRecvTimeout

### Description

Set receiving timeout

### Syntax

```
int WiFiClient::setRecvTimeout(int timeout)
```

### Parameters

timeout: timeout in seconds

### Returns

0

### Example Code

NA

### Notes and Warnings

NA

## Class WiFiServer

### WiFiServer Class

#### Description

Defines a class of WiFi server implementation for Ameba.

#### Syntax

```
class WiFiServer
```

#### Members

Public Constructors	
WiFiServer::WiFiServer(uint16_t port)	Constructs a WiFiServer object and creates a server that listens for incoming connections on the specified port
Public Methods	
WiFiServer::available()	Gets a client that is connected to the server and has data available for reading. The connection persists when the returned client object goes out of scope; you can close it by calling the client.stop()
WiFiServer::begin()	Tells the server to begin listening for incoming connections
WiFiServer::write(const uint8_t* data, size_t len)	Write data to all the clients connected to a server

### WiFiServer::WiFiServer

#### Description

Constructs a WiFiServer object and creates a server that listens for incoming connections on the specified port.

#### Syntax

```
WiFiServer::WiFiServer(uint16_t port)
```

#### Parameters

port: The port number being connected to.

## Returns

The function returns nothing.

## Example Code

Example: SimpleServerWiFi

```
#include <WiFi.h>

char ssid[] = 「yourNetwork」 ; // your network SSID (name)

char pass[] = 「secretPassword」 ; // your network password

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

WiFiServer server(5000);

void setup() {

  Serial.begin(9600); // initialize serial communication

  pinMode(9, OUTPUT); // set the LED pin mode

  // check for the presence of the shield:

  if (WiFi.status() == WL_NO_SHIELD) {

    Serial.println( 「WiFi shield not present」 );

    while (true); // don't continue

  }

  String fv = WiFi.firmwareVersion();

  if ( fv != 「1.1.0」 )

    Serial.println( 「Please upgrade the firmware」 );

  // attempt to connect to Wifi network:

  while ( status != WL_CONNECTED) {

    Serial.print( 「Attempting to connect to Network named: 」);

    Serial.println(ssid); // print the network name (SSID);

    // Connect to WPA/WPA2 network. Change this line if using open or WEP network:

    status = WiFi.begin(ssid, pass);

    // wait 10 seconds for connection:
```

```
delay(10000);
}

server.begin(); // start the tcp server on port 5000

printWifiStatus(); // you're connected now, so print out the status
}

char buffer[256];

void loop() {
  WiFiClient client = server.available();

  while (client.connected()) {
    memset(buffer, 0, 256);

    int n = client.read((uint8_t*)&buffer[0], sizeof(buffer));

    if (n > 0) {
      for (int i=0; i<n; i++) {
        Serial.print(buffer[i]);
      }

      n = client.write(buffer, n);

      if (n <= 0) break;
    }
  }

  client.stop();
}

void printWifiStatus() {
  // print the SSID of the network you're attached to:
  Serial.print( "SSID: ");
  Serial.println(WiFi.SSID());

  // print your WiFi shield's IP address:
  IPAddress ip = WiFi.localIP();
  Serial.print( "IP Address: ");
  Serial.println(ip);

  // print the received signal strength:
```

```
long rssi = WiFi.RSSI();  
Serial.print(「 signal strength (RSSI):」 );  
Serial.print(rssi);  
Serial.println(「 dBm」 );  
}
```

### Notes and Warnings

NA

## WiFiServer::available

### Description

Gets a client that is connected to the server and has data available for reading. The connection persists when the returned client object goes out of scope; you can close it by calling the client.stop().

### Syntax

WiFiClient WiFiServer::available(uint8\_t\* status)

### Parameters

status: WiFi availability status

### Returns

A Client object; if no Client has data available for reading, this object will evaluate to false in an if-statement

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA



## WiFiServer::begin

### Description

Tells the server to begin listening for incoming connections

### Syntax

```
void WiFiServer::begin(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## WiFiServer::write

### Description

Write data to all the clients connected to a server

### Syntax

```
size_t WiFiServer::write(uint8_t b)
size_t WiFiServer::write(const uint8_t *buf, size_t size)
```

### Parameters

b: byte to be written

buf: data buffer

size: Size of the data in the buffer

### Returns

The function returns the number of bytes written. It is not necessary to read this.

### Example Code

Example: SimpleServerWiFi

Details of the code can be found in the previous section of WiFiServer:: WiFiServer.

### Notes and Warnings

NA

## Class WiFiSSLClient

### WiFiSSLClient Class

### Description

Defines a class of WiFi Secure Socket Layer Client implementation for Ameba.

### Syntax

```
class WiFiSSLClient
```

### Members

<b>Public Constructors</b>	
WiFiSSLClient::WiFiSSLClient	Constructs a WiFiSSLClient instance that always connects in SSL to the specified IP address and port
<b>Public Methods</b>	
WiFiSSLClient::connect	Connect to the IP address and port
WiFiSSLClient::write	Write a single byte into the packet
WiFiSSLClient::available	Number of bytes remaining in the current packet
WiFiSSLClient::read	Read a single byte from the current packet
WiFiSSLClient:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiSSLClient:: flush	Finish reading the current packet
WiFiSSLClient::stop	Stop SSL client connection
WiFiSSLClient::connected	Check if SSL client is connected, return 1 if connected, 0 if not
WiFiSSLClient:: setRootCA	Set Root CA for authentication
WiFiSSLClient:: set-ClientCertificate	Set certificate of the client
WiFiSSLClient::setRecvTimeout	Set receiving timeout
WiFiSSLClient::setPreSharedKey	Set the pre shared key (PSK) to use for authentication

**WiFiSSLClient::WiFiSSLClient****Description**

Constructs a WiFiSSLClient instance that always connects in SSL to the specified IP address and port.

**Syntax**

```
WiFiSSLClient::WiFiSSLClient(void)
```

```
WiFiSSLClient::WiFiSSLClient(uint8_t sock)
```

**Parameters**

sock: socket state, default -1

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiSSLClient

**#include**

```
char ssid[] = 「yourNetwork」 ;// your network SSID (name)

char pass[] = 「secretPassword」 ;// your network password (use for WPA, or WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

int status = WL_IDLE_STATUS;

char server[] = 「www.google.com」 ;// name address for Google (using DNS)

//unsigned char test_client_key[] = 「」 ;//For the usage of verifying client
//unsigned char test_client_cert[] = 「」 ;//For the usage of verifying client
//unsigned char test_ca_cert[] = 「」 ;//For the usage of verifying server

WiFiSSLClient client;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don' t continue:

while (true);

}

// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print( 「Attempting to connect to SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid,pass);

// wait 10 seconds for connection:

delay(10000);
```

```

}

Serial.println(「Connected to wifi」);

printWifiStatus();

Serial.println(「nStarting connection to server...」);

// if you get a connection, report back via serial:

if (client.connect(server, 443)) { //client.connect(server, 443, test_ca_cert, test_client_cert, test_client_key)

Serial.println(「connected to server」);

// Make a HTTP request:

client.println(「GET /search?q=realtek HTTP/1.0」);

client.println(「Host: www.google.com」);

client.println(「Connection: close」);

client.println();

}

else

Serial.println(「connected to server failed」);

}

void loop() {

// if there are incoming bytes available

// from the server, read them and print them:

while (client.available()) {

char c = client.read();

Serial.write(c);

}

// if the server's disconnected, stop the client:

if (!client.connected()) {

Serial.println();

Serial.println(「disconnecting from server.」);

client.stop();

// do nothing forevermore:

while (true);

```

```
}  
}  
  
void printWifiStatus() {  
  // print the SSID of the network you're attached to:  
  Serial.print( "SSID: ");  
  Serial.println(WiFi.SSID());  
  
  // print your WiFi shield's IP address:  
  IPAddress ip = WiFi.localIP();  
  Serial.print( "IP Address: ");  
  Serial.println(ip);  
  
  // print your MAC address:  
  byte mac[6];  
  WiFi.macAddress(mac);  
  Serial.print( "MAC address: ");  
  Serial.print(mac[0], HEX);  
  Serial.print( ":");  
  Serial.print(mac[1], HEX);  
  Serial.print( ":");  
  Serial.print(mac[2], HEX);  
  Serial.print( ":");  
  Serial.print(mac[3], HEX);  
  Serial.print( ":");  
  Serial.print(mac[4], HEX);  
  Serial.print( ":");  
  Serial.println(mac[5], HEX);  
  
  // print the received signal strength:  
  long rssi = WiFi.RSSI();  
  Serial.print( "signal strength (RSSI):");  
  Serial.print(rssi);  
  Serial.println(" dBm");  
}
```

```
}
```

## Notes and Warnings

NA

## WiFiSSLClient::connect

### Description

Connect to the IP address and port.

### Syntax

```
int WiFiSSLClient::connect(IPAddress ip, uint16_t port)
```

```
int WiFiSSLClient::connect(const char *host, uint16_t port)
```

```
int WiFiSSLClient::connect(const char* host, uint16_t port, unsigned char* rootCABuff, unsigned char* cli_cert, unsigned char* cli_key)
```

```
int WiFiSSLClient::connect(IPAddress ip, uint16_t port, unsigned char* rootCABuff, unsigned char* cli_cert, unsigned char* cli_key)
```

### Parameters

ip: IP address

host: Host name

port: the port to listen on

rootCABuff: buffer that store root CA

cli\_cert: buffer that store client certificate

cli\_key buffer that store client key pair

### Returns

1: if successful

0: if failed

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::write

### Description

Write a single byte into the packet

### Syntax

```
size_t WiFiSSLClient::write(uint8_t byte)
```

```
size_t WiFiSSLClient::write(const uint8_t *buf, size_t size)
```

### Parameters

byte: the outgoing byte

buf: the outgoing message

size: the size of the buffer

### Returns

The function returns single -byte into the packet or turns bytes size from the buffer into the packet.

### Example Code

NA

## Notes and Warnings

NA

## WiFiSSLClient::available

### Description

Number of bytes remaining in the current packet

### Syntax



```
int WiFiSSLClient::available(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the number of bytes available in the current packet; else return “0:” if no data available.

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

### Notes and Warnings

NA

## WiFiSSLClient::read

### Description

Read a single byte from the current packet

### Syntax

```
int WiFiSSLClient::read()
```

```
int WiFiSSLClient::read(unsigned char* buf, size_t size)
```

### Parameters

buf: buffer to hold incoming packets (char\*)

size: maximum size of the buffer (int)

### Returns

size: the size of the buffer

-1: if no buffer is available

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

### Notes and Warnings

NA

### WiFiSSLClient::peek

#### Description

Return the next byte from the current packet without moving on to the next byte.

#### Syntax

```
int WiFiSSLClient::peek(void)
```

#### Parameters

The function requires no input parameter.

#### Returns

b: the next byte or character

-1: if none is available

### Example Code

NA

### Notes and Warnings

NA

### WiFiSSLClient::flush

#### Description

Finish reading the current packet

**Syntax**

```
void WiFiSSLClient::flush(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiSSLClient::stop****Description**

Disconnect from the server. Stop SSL client connection

**Syntax**

```
void WiFiSSLClient::stop(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::connected

### Description

Check if SSL client is connected, return 1 if connected, 0 if not.

### Syntax

```
uint8_t WiFiSSLClient::connected(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns “1” if connected, returns “0” if not connected.

### Example Code

Example: WiFiSSLClient

Details of the code can be found in the previous section of WiFiSSLClient:: WiFiSSLClient.

## Notes and Warnings

NA

## WiFiSSLClient::setRootCA

### Description

Set Root CA for authentication

### Syntax

```
void WiFiSSLClient::setRootCA(unsigned char *rootCA)
```

**Parameters**

rootCA: a string of rootCA

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiSSLClient::setClientCertificate****Description**

Set certificate of client

**Syntax**

```
void WiFiSSLClient::setClientCertificate(unsigned char *client_ca, unsigned char *private_key)
```

**Parameters**

client\_ca: Client certificate

private\_key: client's private key pair

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

## WiFiSSLClient::setRecvTimeout

### Description

Set receiving timeout

### Syntax

```
int WiFiSSLClient::setRecvTimeout(int timeout)
```

### Parameters

timeout: timeout in seconds

### Returns

The function returns “0” .

### Example Code

NA

### Notes and Warnings

NA

## WiFiSSLClient::setPreSharedKey

### Description

Set the pre shared key (PSK) to use for authentication

### Syntax

```
void WiFiSSLClient::setPreSharedKey(unsigned char *pskIdent, unsigned char *psKey)
```

### Parameters

pskIdent: identity for PSK

psKey: Pre shared key

### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

Do not set a root CA and client certificate if PSK should be used for authentication. If root CA, client certificate and PSK are all set, certificate based authentication will be used.

## Class WiFiUdp

### WiFiUDP Class

#### Description

Defines a class of WiFi UDP implementation for Ameba.

#### Syntax

```
class WiFiUDP
```

#### Members

Public Constructors	
WiFiUDP::WiFiUDP	Constructs a WiFiUDP instance of the WiFi UDP class that can send and receive UDP messages
Public Methods	
WiFiUDP:: begin	initialize, start listening on the specified port. Returns 1 if successful, 0 if there are no sockets available to use
WiFiUDP:: stop	Finish with the UDP socket
WiFiUDP:: begin-Packet	Start building up a packet to send to the remote host-specific in IP and port
WiFiUDP:: endPacket	Finish off this packet and send it
WiFiUDP:: write	Write a single byte into the packet
WiFiUDP:: writeImmediately	Send packet immediately from the buffer
WiFiUDP:: parsePacket	Start processing the next available incoming packet
WiFiUDP::available	Number of bytes remaining in the current packet
WiFiUDP::read	Read a single byte from the current packet
WiFiUDP:: peek	Return the next byte from the current packet without moving on to the next byte
WiFiUDP:: flush	Finish reading the current packet
WiFiUDP:: remoteIP	Return the IP address of the host who sent the current incoming packet
WiFiUDP:: remotePort	Return the port of the host who sent the current incoming packet
WiFiUDP:: setRecv-Timeout	Set receiving timeout

## WiFiUDP::WiFiUDP

### Description

Constructs a WiFiUDP instance of the WiFi UDP class that can send and receive UDP messages.

### Syntax

```
WiFiUDP::WiFiUDP(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.



**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort.

```
#include <WiFi.h>

#include <WiFiUdp.h>

int status = WL_IDLE_STATUS;

char ssid[] = 「yourNetwork」 ; // your network SSID (name)

char pass[] = 「secretPassword」 ; // your network password (use for WPA, or use as key for WEP)

int keyIndex = 0; // your network key Index number (needed only for WEP)

unsigned int localPort = 2390; // local port to listen on

char packetBuffer[255]; //buffer to hold incoming packet

char ReplyBuffer[] = 「acknowledged」 ; // a string to send back

WiFiUDP Udp;

void setup() {

//Initialize serial and wait for port to open:

Serial.begin(9600);

while (!Serial) {

; // wait for serial port to connect. Needed for native USB port only

}

// check for the presence of the shield:

if (WiFi.status() == WL_NO_SHIELD) {

Serial.println( 「WiFi shield not present」 );

// don't continue:

while (true);

}

String fv = WiFi.firmwareVersion();

if (fv != 「1.1.0」 ) {

Serial.println( 「Please upgrade the firmware」 );

}
```

```
// attempt to connect to Wifi network:

while (status != WL_CONNECTED) {

Serial.print(「Attempting to connect to SSID: 」);

Serial.println(ssid);

// Connect to WPA/WPA2 network. Change this line if using open or WEP network:

status = WiFi.begin(ssid,pass);

// wait 10 seconds for connection:

delay(10000);

}

Serial.println(「Connected to wifi」);

printWifiStatus();

Serial.println(「Starting connection to server...」);

// if you get a connection, report back via serial:

Udp.begin(localPort);

}

void loop() {

// if there's data available, read a packet

int packetSize = Udp.parsePacket();

if (packetSize) {

Serial.print(「Received packet of size 」);

Serial.println(packetSize);

Serial.print(「From 」);

IPAddress remoteIp = Udp.remoteIP();

Serial.print(remoteIp);

Serial.print(「, port 」);

Serial.println(Udp.remotePort());

// read the packet into packetBuffer

int len = Udp.read(packetBuffer, 255);

if (len > 0) {

packetBuffer[len] = 0;
```

```

}

Serial.println(「Contents:」);

Serial.println(packetBuffer);

// send a reply, to the IP address and port that sent us the packet we received
Udp.beginPacket(Udp.remoteIP(), Udp.remotePort());

Udp.write(ReplyBuffer);

Udp.endPacket();

}

}

void printWifiStatus() {
// print the SSID of the network you're attached to:
Serial.print(「SSID: 」);
Serial.println(WiFi.SSID());

// print your WiFi shield's IP address:
IPAddress ip = WiFi.localIP();
Serial.print(「IP Address: 」);
Serial.println(ip);

// print the received signal strength:
long rssi = WiFi.RSSI();
Serial.print(「signal strength (RSSI):」);
Serial.print(rssi);
Serial.println(「 dBm」);
}

```

### Notes and Warnings

This constructor does not take in any parameter, thus use another method to set up the IP address and port number.

### WiFiUDP::begin

### Description

Initialize, start listening on the specified port. Returns 1 if successful, 0 if there are no sockets available to use.

### Syntax

```
uint8_t WiFiUDP::begin(uint16_t port)
```

### Parameters

port: the local port to listen on

### Returns

1: if successful

0: if there are no sockets available to use

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

## WiFiUDP::stop

### Description

Disconnect from the server. Release any resource being used during the UDP session.

### Syntax

```
void WiFiUDP::stop(void)
```

### Parameters

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::beginPacket****Description**

Start building up a packet to send to the remote host-specific in IP and port.

**Syntax**

```
int WiFiUDP::beginPacket(const char *host, uint16_t port)
```

```
int WiFiUDP::beginPacket(IPAddress ip, uint16_t port)
```

**Parameters**

host: hostname

port: port number

ip: IP address

**Returns**

1: if successful

0: if there was a problem with the supplied IP address or port

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

## Notes and Warnings

NA

## WiFiUDP::endPacket

### Description

Finish off this packet and send it

### Syntax

```
int WiFiUDP::endPacket(void)
```

### Parameters

The function requires no input parameter.

### Returns

1: if the packet was sent successfully

0: if there was an error

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

## Notes and Warnings

NA

## WiFiUDP::write

### Description

Write a single byte into the packet.

**Syntax**

size\_t WiFiUDP::write(uint8\_t byte)

size\_t WiFiUDP::write(const uint8\_t \*buffer, size\_t size)

**Parameters**

byte: the outgoing byte

buffer: the outgoing message

size: the size of the buffer

**Returns**

single-byte into the packet

bytes size from the buffer into the packet

**Example Code**

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

**Notes and Warnings**

NA

**WiFiUDP::writeImmediately****Description**

Send packet immediately from the buffer

**Syntax**

size\_t WiFiUDP::writeImmediately(const uint8\_t \*buffer, size\_t size)

**Parameters**

buffer: the outgoing message

size: the size of the buffer

### Returns

single-byte into the packet

bytes size from the buffer into the packet

### Example Code

NA

### Notes and Warnings

NA

## WiFiUDP::parsePacket

### Description

Start processing the next available incoming packet

### Syntax

```
int WiFiUDP::parsePacket(void)
```

### Parameters

The function requires no input parameter.

### Returns

The function returns the size of the packet in bytes or returns “0:” if no packets are available.

### Example Code

Example: `WiFiUdpSendReceiveString`

### Notes and Warnings

NA



**WiFiUDP::available****Description**

Number of bytes remaining in the current packet.

**Syntax**

```
int WiFiUDP::available(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

the number of bytes available in the current packet

0: if parsePacket hasn't been called yet

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::read****Description**

Read a single byte from the current packet

**Syntax**

```
int WiFiUDP::read()
```

```
int WiFiUDP::read(unsigned char* buffer, size_t len)
```

### Parameters

buffer: buffer to hold incoming packets (char\*)

len: maximum size of the buffer (int)

### Returns

size: the size of the buffer

-1: if no buffer is available

### Example Code

Example: WiFiUdpSendReceiveString

his example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

## WiFiUDP::peek

### Description

Return the next byte from the current packet without moving on to the next byte

### Syntax

```
int WiFiUDP::peek(void)
```

### Parameters

The function requires no input parameter.

### Returns

b: the next byte or character

-1: if none is available

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::flush****Description**

Finish reading the current packet

**Syntax**

```
void WiFiUDP::flush(void)
```

**Parameters**

The function requires no input parameter.

**Returns**

The function returns nothing.

**Example Code**

NA

**Notes and Warnings**

NA

**WiFiUDP::remoteIP****Description**

Return the IP address of the host who sent the current incoming packet

### Syntax

IPAddress WiFiUDP::remoteIP(void)

### Parameters

The function requires no input parameter.

### Returns

IP address connecting to

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

## WiFiUDP::remotePort

### Description

Return the port of the host who sent the current incoming packet

### Syntax

uint16\_t WiFiUDP::remotePort(void)

### Parameters

The function requires no input parameter.

### Returns

The remote port connecting to

### Example Code

Example: WiFiUdpSendReceiveString

This example demonstrates WiFi UDP send and receive string. This sketch waits for a UDP packet on a local port using a WiFi shield. When a packet is received an Acknowledge packet is sent to the client on port remotePort. The detail of the code can be found in WiFiUDP:: WiFiUDP.

### Notes and Warnings

NA

### WiFiUDP::setRecvTimeout

#### Description

Set receiving timeout

#### Syntax

```
void WiFiUDP::setRecvTimeout(int timeout)
```

#### Parameters

timeout in seconds

#### Returns

The function returns nothing.

### Example Code

NA

### Notes and Warnings

NA

## Readme

The Ameba WiFi related APIs and examples are works based on Arduino WiFi shield libraries (<https://www.arduino.cc/en/Reference/WiFi>).

These include,

- `WiFi.cpp`
- `WiFi.h`
- `WiFiServer.cpp`
- `WiFiServer.h`
- `WiFiUdp.cpp`
- `WiFiUdp.h`

These libraries are under GNU Lesser General Public License, either version 2.1 of the License, or (at your option) any later version.

---

## Wire

### Class TwoWire

#### TwoWire Class

#### Description

Defines a class of I2C API

#### Syntax

```
class TwoWire
```

#### Members

<b>Public Constructors</b>	
TwoWire::TwoWire	Constructs a TwoWire object
<b>Public Methods</b>	
TwoWire::begin	Initialize I2C master/slave
TwoWire::setClock	Set I2C frequency
TwoWire::beginTransaction	Begin I2C transmission
TwoWire::endTransmission	End I2C transmission
TwoWire::requestFrom	Set I2C requestFrom
TwoWire::write	Write data to I2C
TwoWire::available	Check if I2C is available
TwoWire::read	Read data from I2C
TwoWire::peek	Read peek from I2C
TwoWire::flush	Do nothing, use, and transmission(..) to force data transfer
TwoWire::onReceive	Callback function when I2C on receive
TwoWire::onRequest	Callback function when I2C on request

**TwoWire::TwoWire****Description**

Constructs a TwoWire object.

**Syntax**

```
TwoWire::TwoWire (uint32_t dwSDAPin, uint32_t dwSCLPin);
```

**Parameters**

dwSDAPin: The Arduino PIN to be set as an SDA pin.

dwSCLPin: The Arduino PIN to be set as an SCL pin.

**Returns**

The function returns nothing.

**Example Code**

Example: MasterWriter

This example demonstrates the use of the wire library writes to an I2C/TWI slave device.

```
#include <Wire.h>

void setup() {
  Wire.begin(); // join i2c bus (address optional for master)
}

byte x = 0;

void loop() {
  Wire.beginTransmission(8); // transmit to device #8
  Wire.write(「 x is 」); // sends five bytes
  Wire.write(x); // sends one byte
  Wire.endTransmission(); // stop transmitting
  x++;
  delay(500);
}
```

Example: MasterReader

```
#include <Wire.h>

void setup() {
  Wire.begin(); // join i2c bus (address optional for master)
  Serial.begin(9600); // start serial for output
}

void loop() {
  Wire.requestFrom(8, 6); // request 6 bytes from slave device #8
  while (Wire.available()) { // slave may send less than requested
    char c = Wire.read(); // receive a byte as character
    Serial.print(c); // print the character
  }
  delay(500);
}
```

This example demonstrates the use of the wire library reads data from an I2C/TWI slave device.

## Notes and Warnings



Include “Wire.h” to use the class function.

## **TwoWire::begin**

### **Description**

Initialize I2C master/slave.

### **Syntax**

```
void TwoWire::begin (void);  
void TwoWire::begin (uint8_t address = 0);  
void TwoWire::begin (int address);
```

### **Parameters**

void: Set the I2C master mode.

address: Set the I2C master mode with slave address value.

### **Returns**

The function returns nothing.

### **Example Code**

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### **Notes and Warnings**

Include “Wire.h” to use the class function.

## **TwoWire::setClock**

### **Description**

Set I2C frequency.

### Syntax

```
void TwoWire::setClock(uint32_t frequency);
```

### Parameters

frequency: The frequency values.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::beginTransmission

### Description

Begin I2C transmission.

### Syntax

```
void TwoWire::beginTransmission (uint8_t address);
```

```
void TwoWire::beginTransmission (int address);
```

### Parameters

address: The transmission address.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::endTransmission

### Description

End I2C transmission. Originally, ‘endTransmission’ was an f(void) function. It has been modified to take one parameter indicating whether or not a STOP should be performed on the bus. Calling endTransmission(false) allows a sketch to perform a repeated start.

WARNING: Nothing in the library keeps track of whether the bus tenure has been properly ended with a STOP. It is very possible to leave the bus in a hung state if no call to endTransmission(true) is made. Some I2C devices will behave oddly if they do not see a STOP.

If the input parameter is void, this provides backward compatibility with the original definition, and expected behavior, of endTransmission.

### Syntax

```
uint8_t TwoWire::endTransmission (uint8_t sendStop);
```

```
uint8_t TwoWire::endTransmission (void);
```

### Parameters

sendStop: True to end the transmission

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::requestFrom

### Description

Set I2C requestFrom.

### Syntax

```
uint8_t TwoWire::requestFrom (uint8_t address, uint8_t quantity, uint8_t sendStop);  
uint8_t TwoWire::requestFrom (uint8_t address, uint8_t quantity);  
uint8_t TwoWire::requestFrom(int address, int quantity);  
uint8_t TwoWire::requestFrom (int address, int quantity, int sendStop);
```

### Parameters

address: I2C read address.

quantity: I2C read quantity.

sendStop: True to end the transmission.

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::write

### Description

Write data to I2C.

### Syntax

```
size_t TwoWire::write (uint8_t data);  
size_t TwoWire::write (const uint8_t *data, size_t quantity);
```

### Parameters

data: The data to be transmitted.

quantity: The quantity of data.

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::available

### Description

Check if I2C is available.

### Syntax

```
int TwoWire::available (void);
```

### Parameters

The function requires no input parameter.

### Returns

Return 0 if successful, else error.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

## TwoWire::read

### Description

Read data from I2C

### Syntax

```
int TwoWire::read (void);
```

### Parameters

The function requires no input parameter.

### Returns

The read data from the receive buffer.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::peek

#### Description

Read peek from I2C.

#### Syntax

```
int TwoWire::peek (void);
```

#### Parameters

The function requires no input parameter.

#### Returns

The peek data read from the receive buffer.

#### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::flush

#### Description

Do nothing, use endTransmission(..) to force data transfer.

#### Syntax

`void TwoWire::flush (void);`

### Parameters

The function requires no input parameter.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

### Notes and Warnings

Include “Wire.h” in order to use the class function.

## TwoWire::onReceive

### Description

Callback function when I2C on receive.

### Syntax

`void TwoWire::onReceive (void(*function)(int));`

### Parameters

function: The callback function.

### Returns

The function returns nothing.

### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.



### Notes and Warnings

Include “Wire.h” to use the class function.

### TwoWire::onRequest

#### Description

Callback function when I2C on request.

#### Syntax

```
void TwoWire::onRequest (void(*function)(void));
```

#### Parameters

function: The callback function

#### Returns

The function returns nothing.

#### Example Code

Example: MasterReader; MasterWriter

The details of the code can be found in the previous section of TwoWire:: TwoWire.

### Notes and Warnings

Include “Wire.h” to use the class function.

### Wire\_Readme

The Ameba LCD related api and example are works based on “New LiquidCrystal library” (<https://bitbucket.org/fmalpartida/new-liquidcrystal/>).

These include,

LCD.h

LCD.cpp

I2CIO.h

I2CIO.cpp

LiquidCrystal\_I2C.h

LiquidCrystal\_I2C.cpp

examples/LcdHelloWorld/LcdHelloWorld.ino

These files inherit the licence of “New LiquidCrystal Library” which are under a Creative Commons Attribution-ShareAlike 3.0 Unported License. CC BY-SA 3.0.

### 1.3.4 Resources

#### Links

- [AmebaD Arduino Github](#)
- [Arduino Website](#)

### 1.3.5 Support

#### FAQ

---

##### Where to buy Ameba RTL8722DM Board?

Refer to [Purchase link](#).

---

---

##### Which Bluetooth standards are supported by RTL8722CSM/RTL8722DM?

Both boards support BLE 5.0. Classic Bluetooth (BR/EDR) is not supported.

---

---

##### Which BLE roles are supported?

RTL8722CSM/RTL8722DM can operate as either a BLE Central or BLE Peripheral device.

---

---

##### Are all pins on RTL8722CSM/RTL8722DM usable?

No, those marked NC are not connected to any pin and thus unusable.

---

---

**Is XIP (execute in place) supported on RTL8722CSM/RTL8722DM?**

Yes, it is supported.

---

---

**Does RTL8722CSM support 5G WiFi?**

No. Only RTL8722DM supports dual band 2.4G + 5G WiFi. RTL8722CSM only supports single band 2.4G WiFi.

---

---

**How to enter the download mode?**

Press and hold the UART DOWNLOAD button. Then Press the RESET button and release both UART DOWNLOAD and RESET buttons.

---

---

**Trouble shooting**

---

**RTL8722CSM/RTL8722DM cannot be found as a Bluetooth device.**

Please make sure the antenna is connected properly. Check your code for the correct Bluetooth configurations.

---

---

**My code is not behaving as I expected.**

Try to debug your program using `printf()` and `Serial.print()` statements. If the issue persists, you can ask for help at [Forums](#)

---

---

**Why is there no output on my serial terminal after connecting to RTL8722CSM/RTL8722DM UART?**

RTL8722CSM/RTL8722DM is by default configured at 115200 baudrate, please check if your serial terminal is configured to 115200.

---

---

**My program is not being downloaded into RTL8722CSM/RTL8722DM?**

**Please follow the procedure for the correct downloading:**

1. Enter the download mode. The on-board Green LED will blink when entered download mode.
  2. When downloading the image into board the on-board Red LED will blink
  3. After a successful download, you will see log like this “All images sent successfully” .
- 

---

**Sometimes WiFi signal is weak?**

The default antenna for RTL8722CSM/RTL8722DM uses the I-Pex Connector. Please change/connect the I-Pex Connector antenna.

---

---

**Why is my board not powering up?**

Please make sure the connector J38 beside resistor R43 is connected. The connector is used to link the power to IC.

---

---

**If you have driver issue to connect board to your computer?**

Please go to <https://ftdichip.com/drivers/> for USB driver.

---

## CHAPTER 2

---

### MicroPython SDK

---

歡迎來到 Ameba MicroPython 線上文檔



## 2.1 快速入門手 F

### 2.1.1 Ameba MicroPython: 適用於 RTL8722DM 的快速入門手 F

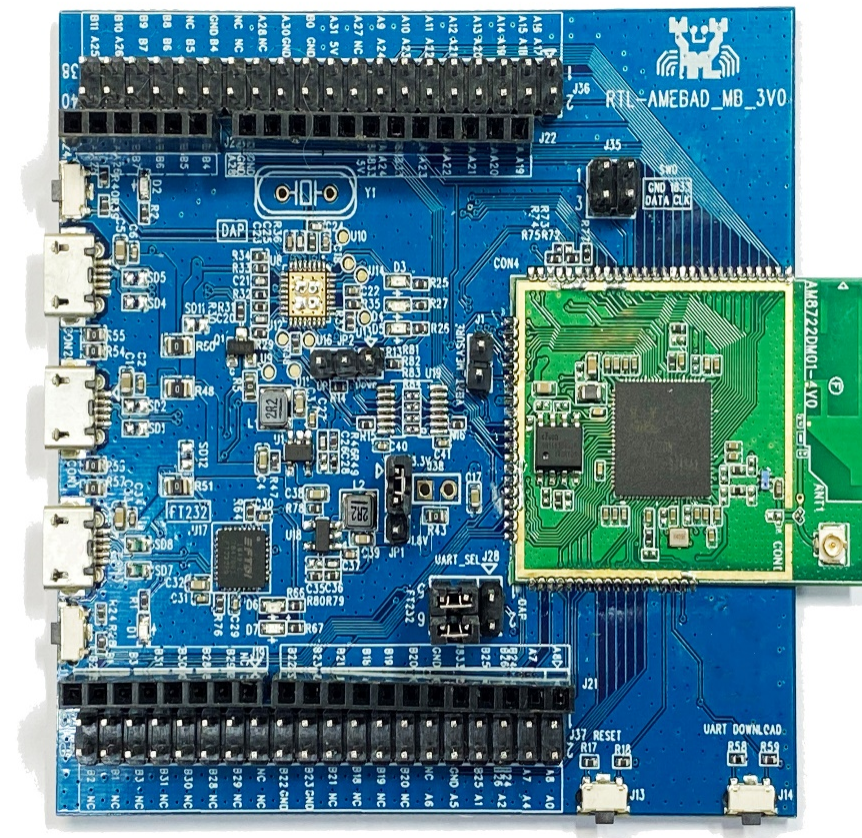
#### 環境配置

AmebaD RTL8722CSM/RTL8722DM MicroPython SDK 目前支持 Windows 10 和 Linux 操作系統。

#### AmebaD RTL8722CSM/RTL8722DM 介紹

Ameba 是一個易於編程的微控制器平台，可用於開發各種物聯網應用程序。AmebaD 有各種外圍接口，包括 WiFi, BLE, GPIO, I2C, UART, SPI, PWM, ADC。通過這些接口，AmebaD 可以連接 LED、開關、壓力計、濕度計、PM2.5 粉塵傳感器等電子元件。

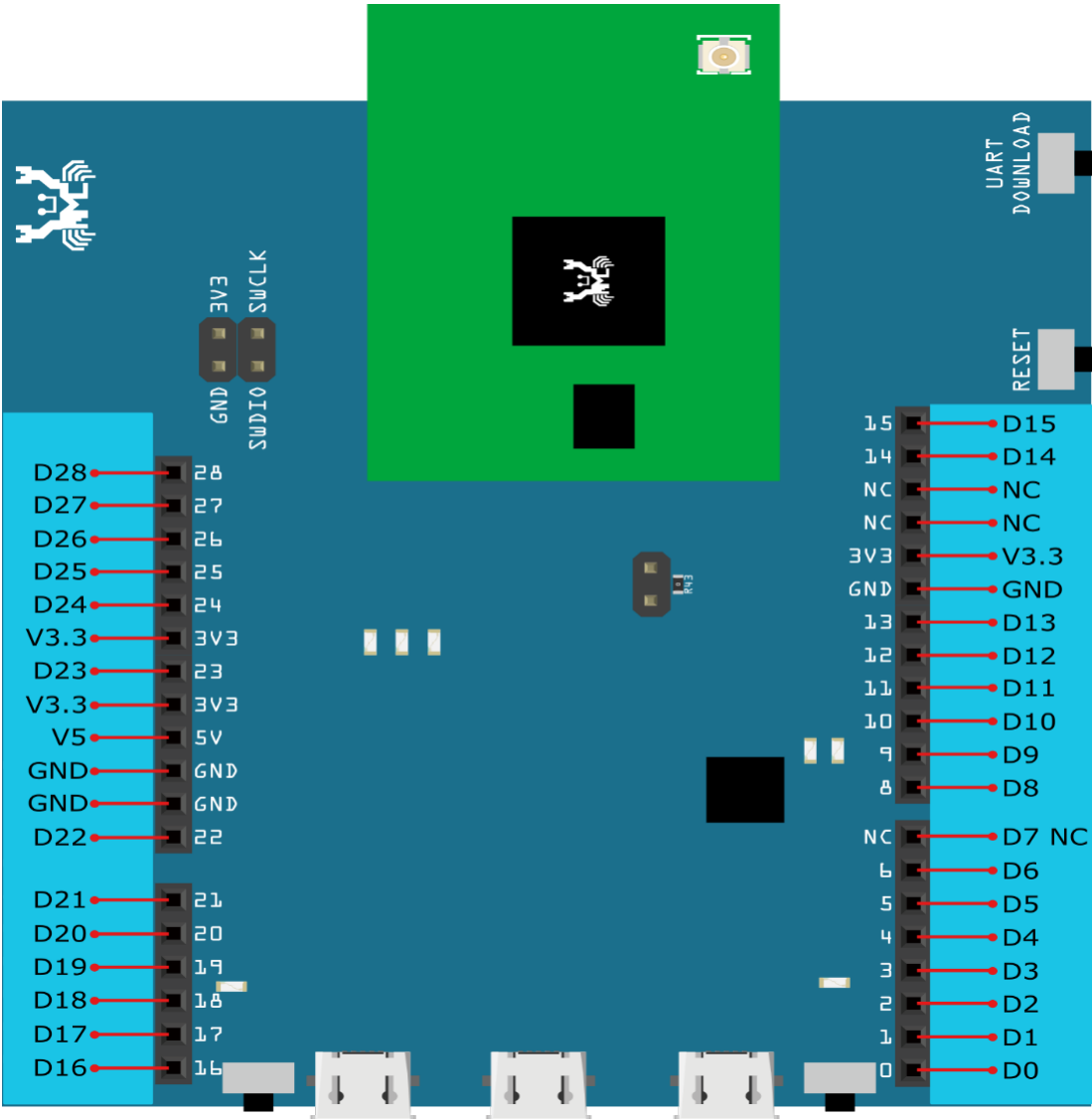
Ameba 所收集的數據可以通過 WiFi 無 F 上傳，F 被智能設備上的應用程序使用，實現物聯網的應用。



AmebaD 和 Arduino Uno 的尺寸類似，如上圖所示，F 且 AmebaD 上的引 F 與 Arduino Uno 兼容。

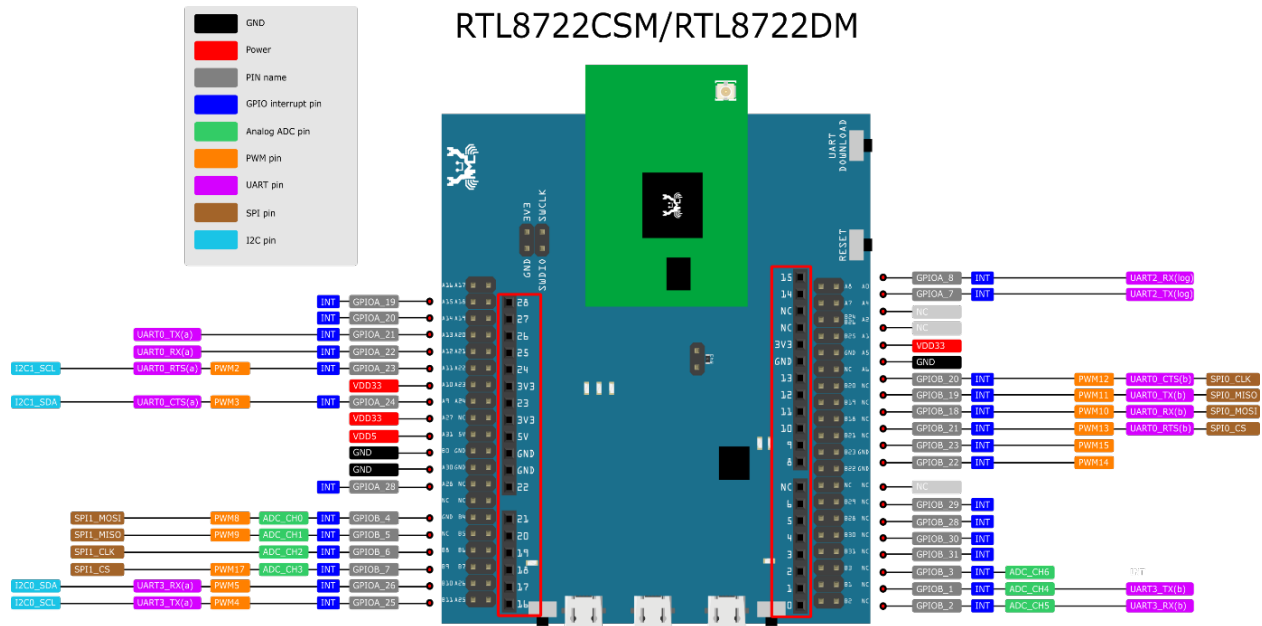
AmebaD 使用 Micro USB 來供電，這在許多智能設備中很常見。

AmebaD 的引腳圖和功能請參考下圖和表格。



	引脚名	GPIO	ADC	PWM	UART	SPI	I2C
D00	GPIOB_2	✓	ADC5		UART3_RX(b)		
D01	GPIOB_1	✓	ADC4		UART3_TX(b)		
D02	GPIOB_3	✓	ADC6				
D03	GPIOB_31	✓					
D04	GPIOB_30	✓					
D05	GPIOB_28	✓					
D06	GPIOB_29	✓					
D07	NC						
D08	GPIOB_22	✓		PWM14			
D09	GPIOB_23	✓		PWM15			
D10	GPIOB_21	✓		PWM13	UART0_RTS(b)	SPI0_CS	
D11	GPIOB_18	✓		PWM10	UART0_RX(b)	SPI0_MOSI	
D12	GPIOB_19	✓		PWM11	UART0_TX(b)	SPI0_MISO	
D13	GPIOB_20	✓		PWM12	UART0_CTS(b)	SPI0_CLK	
D14	GPIOA_7	✓			UART2_TX(log)		
D15	GPIOA_8	✓			UART2_RX(log)		
D16	GPIOA_25	✓		PWM4	UART3_RX(a)		I2C0_SCL
D17	GPIOA_26	✓		PWM5	UART3_TX(a)		I2C0_SDA
D18	GPIOB_7	✓	ADC3	PWM17		SPI1_CS	
D19	GPIOB_6	✓	ADC2			SPI1_CLK	
D20	GPIOB_5	✓	ADC1	PWM9		SPI1_MISO	
D21	GPIOB_4	✓	ADC0	PWM8		SPI1_MOSI	
D22	GPIOA_28	✓					
D23	GPIOA_24	✓		PWM3	UART0_CTS(a)		I2C1_SDA
D24	GPIOA_23	✓		PWM2	UART0_RTS(a)		I2C1_SCL
D25	GPIOA_22	✓			UART0_RX(a)		
D26	GPIOA_21	✓			UART0_TX(a)		
D27	GPIOA_20	✓					
D28	GPIOA_19	✓					





備：

上圖/表中顯示的 非所有外圍設備都可以在 MicroPython 上使用，  
請參 “API 文档” 部分以獲取更多資訊。

## RTL8722 MicroPython 移植簡介

### 基本背景

REPL 代表 Read-Evaluation-Print-Loop，它是一個交互式提示，可用於存取和控制微控制器。

REPL 具有其他 大的特色，例如 tab 處理，行編輯，自動縮排，輸入歷史記 等。它的基本功能類似於標準的 Python IDLE，但是運行在微控制器上。

要使用 REPL，只需在 PC 上打開任何串行終端軟件（最常用的工具是 **TeraTerm**, **Putty** 等），然後連接到微控制器的串行端口，然後將波特率設置 115200，然後手動重置開發板，即可看到 >>> MicroPython 提示符出現在終端畫面上。您就可以在 REPL 上輸入任何 Python 本。

建議多嘗試使用 “help()” 函數以獲得更多資訊。例如，微控制器上電 顯示 REPL 後，只需鍵入

```
>>> help()
```

You will see a help page giving you more details about this port; also if you type

```
>>> help(modules)
```

它將列出所有可用的 建模塊供您使用。

## 2.1. 快速入門

此外，如果您想了解有關模塊的更多資訊，例如可用的 API 和 CONSTANT，只需鍵入以下代碼來獲取該模塊的詳細信息。

```
>>> help(the module of your interest)
```

讓我們以 Pin 模塊（GPIO）為例：

```
>>> help(Pin)

object <class 'Pin'> is of type type
id -- <function>
init -- <function>
value -- <function>
off -- <function>
on -- <function>
toggle -- <function>
board -- <class 'board'>
IN -- 0
OUT -- 1
PULL_NONE -- 0
PULL_UP -- 1
PULL_DOWN -- 2
```

## REPL 快捷鍵

- Ctrl + d

MicroPython 將執行軟件重啟，這在您的微控制器表現時非常有用。並且將再次執行“boot.py”中的代碼。請注意，這只會重置 MicroPython interpreter 而不重置硬件，所有先前配置的硬件將保持原樣，直到您手動重置開發板為止。

- Ctrl + e

此快捷鍵會將 REPL 設置粘貼模式，在粘貼模式下，可以一次將一大部分的代碼粘貼到 REPL 中，而無需一行一行地執行代碼。適合當您找到 MicroPython 庫希望通過複製和貼上立即對其進行測試時。

- Ctrl + b

此快捷鍵會將 REPL 重置為普通模式，您可以利用該指令解除某些模式下的卡死。

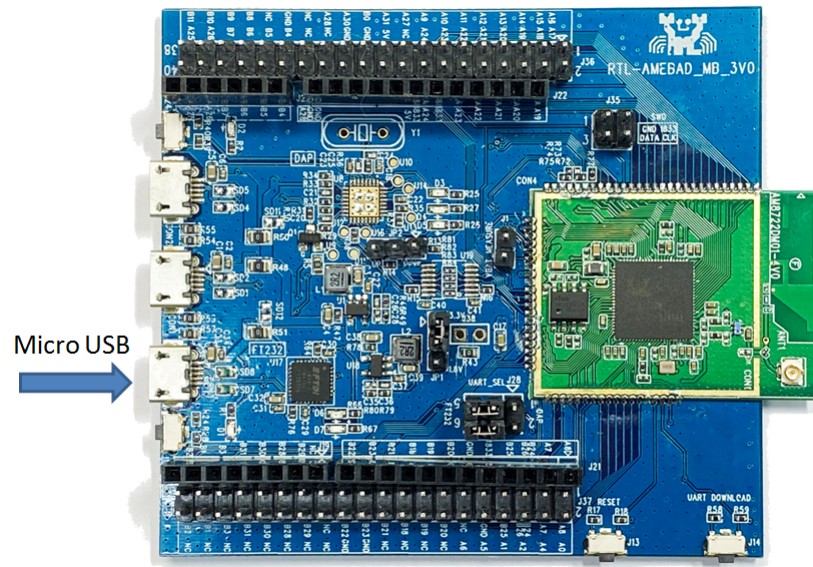
- Ctrl + c

此熱鍵可幫助您快速取消任何輸入並另起一行

## 設置開發環境

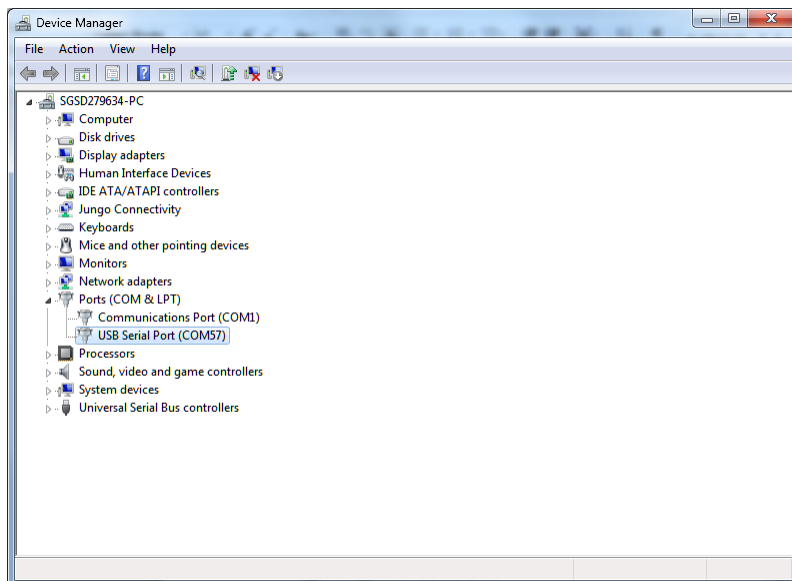
### 步驟 1: 安裝驅動程序

首先，通過 Micro USB 將 AmebaD 連接到電腦：



如果這是您第一次將 AmebaD 連接到您的電腦，那 F AmebaD 的 USB 驅動程序將自動安裝。

如果遇到開發板連接到電腦的驅動程序問題，請參考下列 USB 驅動安裝程序 <https://ftdichip.com/drivers/>  
你可以在你的電腦的裝置管理員中檢查 COM 端口號：



## 步驟 2: 安裝相關工具

### Windows 環境

對於 Windows 用 F，請安裝串行終端軟件。最常見的串行終端是 Tera Term 和 Putty，在這 F 我們建議使用 Tera Term，可以從網路下載。

對於希望從頭開始編譯 MicroPython 的用 F，請確保安裝 Cygwin，這是在 Windows 系統上運行的類似 Linux 的環境。選擇 Cygwin 安裝程序時，我們建議使用 Cygwin 32 位元版本。在 Cygwin 安裝期間，安裝程序將提示用 F 是否安裝其他軟件，請確保從 “Devel ” 類 F 中選擇 make 的 GNU 版本（請參見下圖），然後選擇最新版本。

Cygwin Setup - Select Packages

Select Packages Select packages to install							
View	Category	Search	make	Clear			
Package	Current	New	Src?	Categories	Size	Description	
<input type="checkbox"/> All		Default	<input type="checkbox"/>				
<input type="checkbox"/> Archive (1)		Default	<input type="checkbox"/>				
<input type="checkbox"/> Debug (6)		Default	<input type="checkbox"/>				
<input type="checkbox"/> Devel (27)		Default	<input type="checkbox"/>				
automake		Skip	<input type="checkbox"/>	Devel	3k	Wrapper for multiple versions of Automake	
automake1.10		Skip	<input type="checkbox"/>	Devel	689k	(1.10) a tool for generating GNU-compliant Makefiles	
automake1.11		Skip	<input type="checkbox"/>	Devel	836k	(1.11) a tool for generating GNU-compliant Makefiles	
automake1.12		Skip	<input type="checkbox"/>	Devel	706k	(1.12) a tool for generating GNU-compliant Makefiles	
automake1.13		Skip	<input type="checkbox"/>	Devel	749k	(1.13) a tool for generating GNU-compliant Makefiles	
automake1.14		Skip	<input type="checkbox"/>	Devel	773k	(1.14) a tool for generating GNU-compliant Makefiles	
automake1.15		Skip	<input type="checkbox"/>	Devel	598k	(1.15) a tool for generating GNU-compliant Makefiles	
automake1.16		Skip	<input type="checkbox"/>	Devel	812k	(1.16) a tool for generating GNU-compliant Makefiles	
automake1.4		Skip	<input type="checkbox"/>	Devel	248k	(1.4) a tool for generating GNU-compliant Makefiles	
automake1.5		Skip	<input type="checkbox"/>	Devel	332k	(1.5) a tool for generating GNU-compliant Makefiles	
automake1.6		Skip	<input type="checkbox"/>	Devel	365k	(1.6) a tool for generating GNU-compliant Makefiles	
automake1.7		Skip	<input type="checkbox"/>	Devel	426k	(1.7) a tool for generating GNU-compliant Makefiles	
automake1.8		Skip	<input type="checkbox"/>	Devel	499k	(1.8) a tool for generating GNU-compliant Makefiles	
automake1.9		Skip	<input type="checkbox"/>	Devel	557k	(1.9) a tool for generating GNU-compliant Makefiles	
cmake		Skip	<input type="checkbox"/>	Devel	6,111k	Cross-platform makefile generation system	
cmake-doc		Skip	<input type="checkbox"/>	Devel	1,723k	Cross-platform makefile generation system (documentation)	
cmake-gui		Skip	<input type="checkbox"/>	Devel	1,753k	Cross-platform makefile generation system (GUI)	
extra-cmake-modules		Skip	<input type="checkbox"/>	Devel	281k	Extra CMake Modules for KDE	
gcc-tools-epoch1-automake		Skip	<input type="checkbox"/>	Devel	420k	(gcc-special) a tool for generating GNU-compliant Makefiles	
gcc-tools-epoch2-automake		Skip	<input type="checkbox"/>	Devel	589k	(gcc-special) a tool for generating GNU-compliant Makefiles	
gccmakedep		Skip	<input type="checkbox"/>	Devel	6k	X Makefile dependency tool for GCC	
imake		Skip	<input type="checkbox"/>	Devel	35k	X Imake legacy build system	
make	4.3-1	Keep	<input type="checkbox"/>	Devel	502k	The GNU version of the 'make' utility	
makedepend		Skip	<input type="checkbox"/>	Devel	29k	X Makefile dependency tool	
mingw64-i686-q4-qmake		Skip	<input type="checkbox"/>	Devel	7,292k	Q4 development tools for Win32 toolchain	
mingw64-x86_64-q4-qmake		Skip	<input type="checkbox"/>	Devel	7,290k	Q4 development tools for Win64 toolchain	
psl-make-dafsa		Skip	<input type="checkbox"/>	Devel	8k	Generates optimized DAFSA from Public Suffix List	

另外，在固件編譯過程中需要 Python3，因此請確保從其官方網站下載最新的 Python3，F 在安裝過程中要求時將其添加 F 環境變量。

### Linux 環境

對於 Linux 用 F，請使用 apt-get 安裝命令安裝您選擇的串行終端軟件。在這 F，我們建議使用 picocom。

對於有興趣在 C 語言中開發 MicroPython 模塊的用 F，請確保安裝了至少 3.82 或更高版本的 GNU make 軟件以及 Python3。

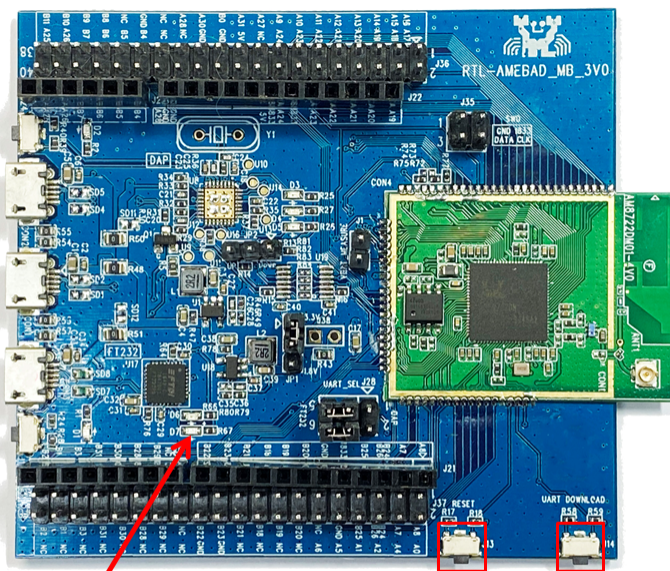
## 2.1.2 將固件上傳到 Ameba

### 步驟 1: 找到 “Release” 文件夾

從 [GitHub](#) 下載 MicroPython repository 後，會在根目錄中看到一個 “Release” 文件夾，並且在該路徑下找到一個名為 “Double-Click-Me-to-Upload” 的工具。

### 步驟 2: 進入 UART 下載模式

請先按住 UART\_DOWNLOAD 按鈕，然後按 RESET 按鈕。如果成功，您應該在 Ameba 上看到綠色的 LED 閃爍。



Green LED

RESET button

UART\_DOWNLOAD button

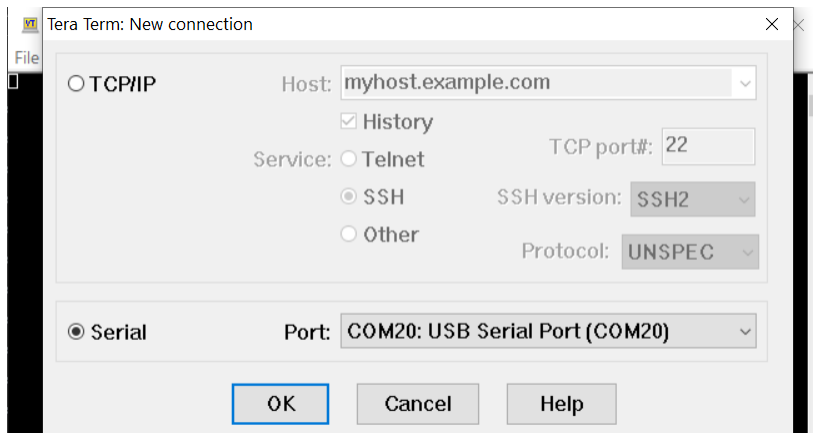
### 步驟 3: 運行 “Double-Click-Me-to-Upload”

顧名思義，雙擊該文件以運行它，然後按照屏幕上顯示的說明更新 Ameba 的串行 COM 端口，這樣上傳就可以成功進行。上傳成功後，您將在屏幕上看到一行日誌 — “All images are sent successfully”。

### 2.1.3 嘗試第一個范例

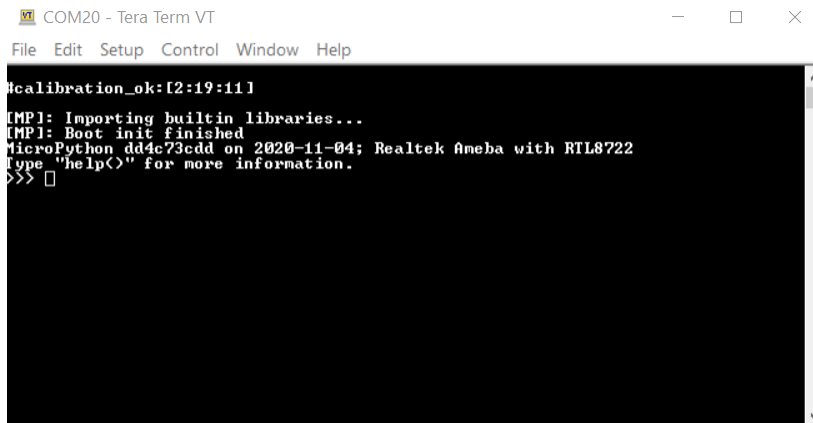
#### 步驟 1: 打開 REPL

REPL 代表讀取 (Read)，評估 (Evaluation)，打印 (Print) 和循環 (Loop)，它是 MicroPython 的終端，供用控制微控制器 REPL 在 LOG UART 上運行，因此我們需要打開串行終端軟件，在本例中 Tera Term，用以查看 REPL。



打開 Tera Term 後，如上圖所示選擇 “Serial”，然後使用下拉列表選擇 Ameba 的串行端口，然後單擊 “OK”。如果您的串行終端未配置 115200 波特率，建議將 115200 設定為默認設置。

現在已經連接了串行端口，在 Ameba 上按一下 RESET 按鈕，如下所示會看到 MicroPython 的歡迎頁面。



過程 Ameba 首先檢查其校準數據，然後啟動 MicroPython 的固件，接著再運行 `boot.py` Python 本和導入的建 python 庫。

現在試著輸入

```
>>> help()
```

查看更多信息，然後輸入



```
>>> help(modules)
```

檢查所有現成可用的 python 庫。

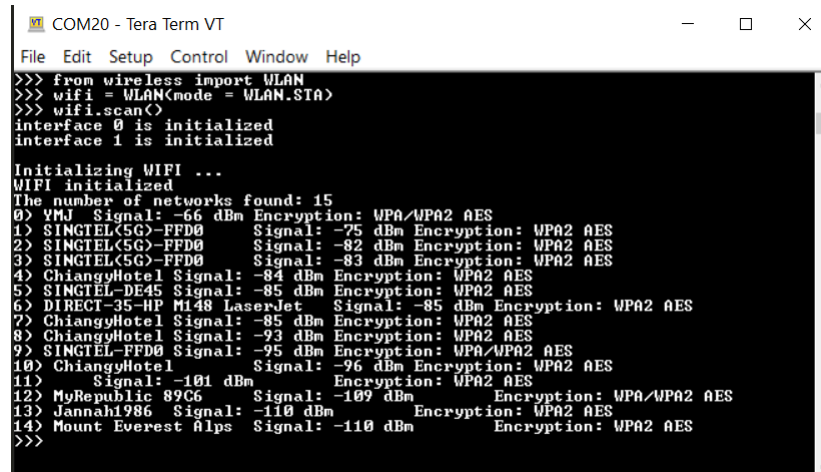
## 步驟 2: 執行 WiFi 掃描範例

由於大多數外圍設備的範例都需要額外的硬件才能顯示該範例是否正常運行，因此我們將僅以 WiFi 掃描範例，來了解使用 MicroPython 控制 WiFi 是十分容易的。

現在，請貼上以下代碼，或手動將其輸入 Tera Term，然後按 “Enter”。

```
from wireless import WLAN
wifi = WLAN(mode = WLAN.STA)
wifi.scan()
```

您應該能看到返回周圍無線網絡的結果



```
COM20 - Tera Term VT
File Edit Setup Control Window Help
>>> from wireless import WLAN
>>> wifi = WLAN(mode = WLAN.STA)
>>> wifi.scan()
interface 0 is initialized
interface 1 is initialized

Initializing WIFI ...
WIFI initialized
The number of networks found: 15
0> YMJ Signal: -66 dBm Encryption: WPA/WPA2 AES
1> SINGTEL(SC)-FFD0 Signal: -75 dBm Encryption: WPA2 AES
2> SINGTEL(SC)-FFD0 Signal: -82 dBm Encryption: WPA2 AES
3> SINGTEL(SC)-FFD0 Signal: -83 dBm Encryption: WPA2 AES
4> ChiangyHotel Signal: -84 dBm Encryption: WPA2 AES
5> SINGTEL-DE45 Signal: -85 dBm Encryption: WPA2 AES
6> DIRECT-35-HP M148 LaserJet Signal: -85 dBm Encryption: WPA2 AES
7> ChiangyHotel Signal: -85 dBm Encryption: WPA2 AES
8> ChiangyHotel Signal: -93 dBm Encryption: WPA2 AES
9> SINGTEL-FFD0 Signal: -95 dBm Encryption: WPA/WPA2 AES
10> ChiangyHotel Signal: -96 dBm Encryption: WPA2 AES
11> Signal: -101 dBm Encryption: WPA2 AES
12> MyRepublic 89C6 Signal: -109 dBm Encryption: WPA/WPA2 AES
13> Jannah1986 Signal: -110 dBm Encryption: WPA2 AES
14> Mount Everest Alps Signal: -110 dBm Encryption: WPA2 AES
>>>
```

(完結)

備註：如果遇到任何問題請參考常見問題 和故障排除 頁面。

## 2.2 Release History

Version 1.0.2 release - 2021/10/14

- Feature:
  - Add MacOS toolchain to support building on MacOS
  - Pre-test passed for RTL8722DM MINI

- API Updates:
    - Update PWM module with new API
    - Re-structure SDFS module and remove warning when no SD card
  - Misc
    - Update WLAN and other libraries
    - Update readme documentation
- 

#### Version 1.0.1 release - 2021/06/07

- Feature:
    - Added MacOS Support for firmware uploading (not compilation)
    - Fixed PWM API issue with loop
    - Implemented SDFS (SD FileSystem) module [Currently only support RTL8722DM\_mini]
    - Update welcome message and help message
    - Update Ameba SDK and libraries
    - Fixed network and WLAN security issues
    - Fix bugs related to WiFi
    - Update Readme
    - Provide examples for new module
- 

#### Version 1.0.0 release - 2020/11/11

- Feature:
    - OS Support Windows and Linux
    - WiFi
    - Socket
    - ADC
    - builtin help
    - Example and online API
- 

#### Version 0.0.1 alpha release - 2020/09/29

- Feature:
    - Ported basic MicroPython functions
-



- Implemented REPL and basic terminal functions
- Added Pin Mapping for RTL8722
- Added peripheral helper modules:
  - GPIO
  - RTC
  - Time and Delay
  - PWM
  - Timer
  - UART
  - I2C
  - SPI

## 2.3 范例演示

### 2.3.1 F 邊硬體相關范例

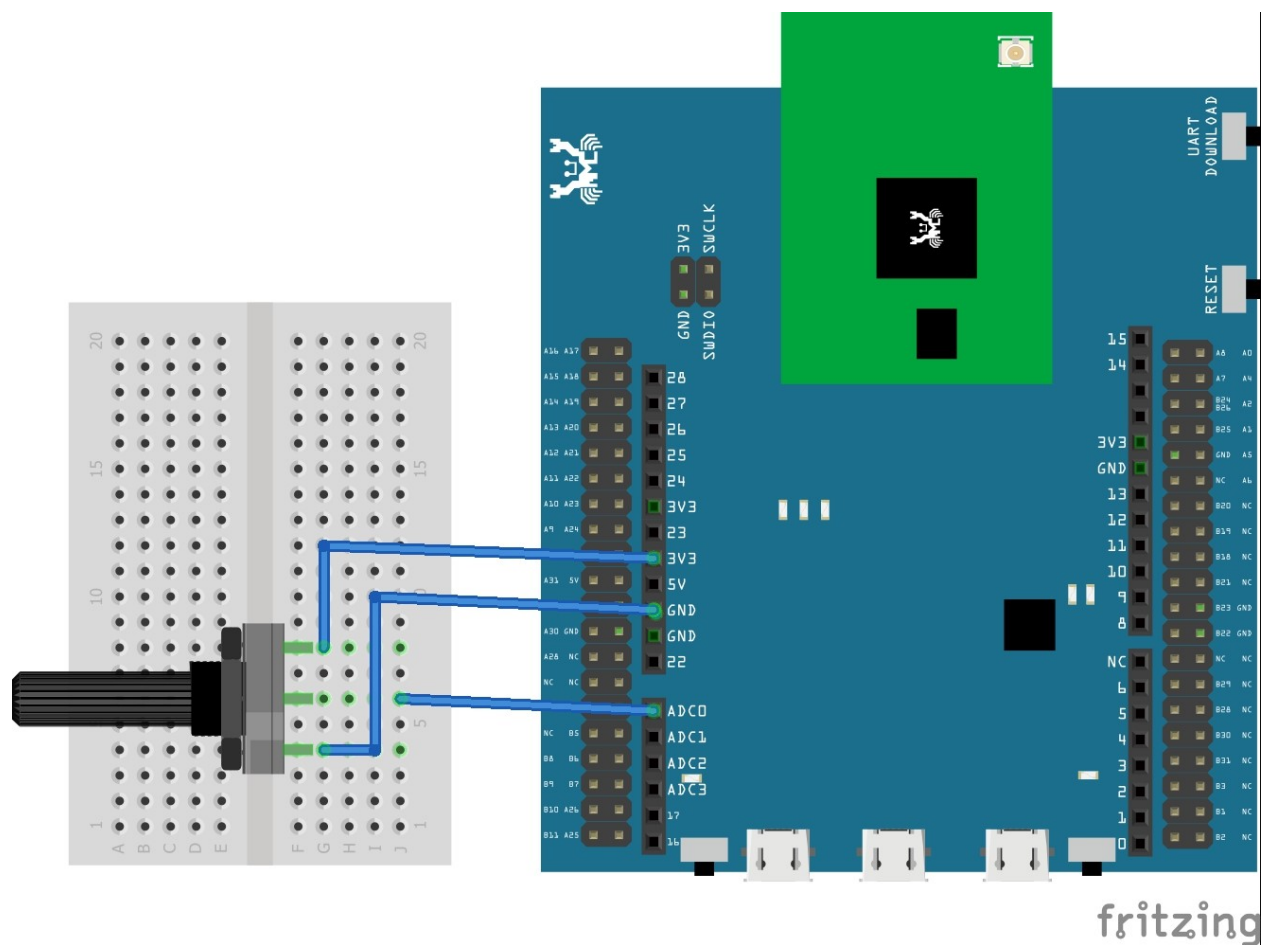
#### [RTL8722CSM] [RTL8722DM] ADC - 讀取電位器數值

##### 材料準備

- Ameba x 1
- 電位器 x 1

##### 範例 F 明

這裏我們把 ameba 連接到一個電位器上來讀取它的數值，連接方式如下：



將以下代碼貼到 REPL 上

```
1 import socket
2 a = ADC(0)
3 a.read()
```

## [RTL8722CSM] [RTL8722DM] GPIO - 閃爍 LED

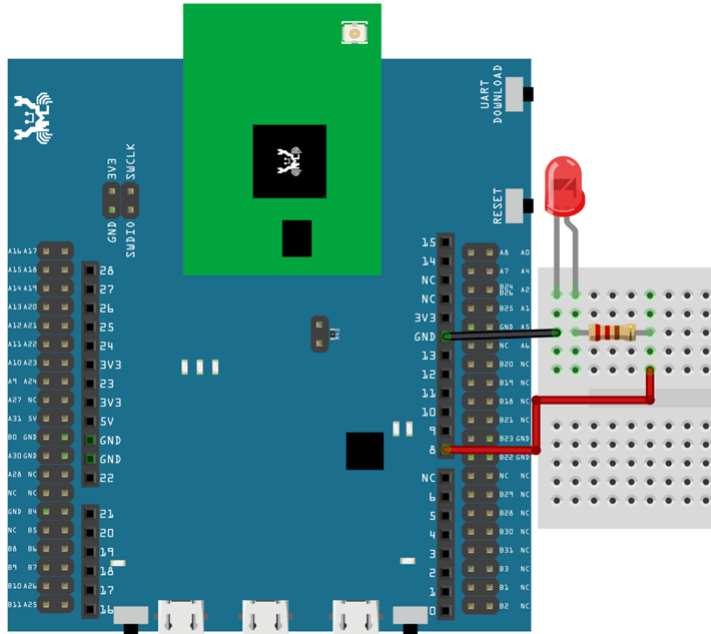
### 材料準備

- Ameba x 1
- LED x 1
- 電阻（阻值 200 歐姆）x 1

### 範例說明

閃爍 LED 是開始解使用 MicroPython 最好示例。

首先，如下圖所示將 PB\_22 引腳連接到與限流電阻串聯的 LED 的陽極引腳，再將 GND 連接到 LED 的陰極引腳：



Then, copy the following code and press `Ctrl + e` in REPL to enter the paste mode (for more information about REPL and paste mode, check “Getting Started” page). If you are using Tera Term, simply right click on any blank space of the terminal and paste the code into REPL, then press `Ctrl + d` to execute the code. If everything is order, you should be able to see the LED blink for 3 times in 3 seconds.

```
from machine import Pin
a = Pin("PB_22", Pin.OUT)
a.value(1)
time.sleep_ms(500)
a.value(0)
time.sleep_ms(500)
a.on()
time.sleep_ms(500)
a.off()
time.sleep_ms(500)
a.toggle()
time.sleep_ms(500)
a.toggle()
```

## [RTL8722CSM] [RTL8722DM] I2C - 發送與接收

## 材料準備

- Ameba x 1
- Arduino UNO x 1

## 範例 F 明

I2C 是一個微控制器上非常常見的模塊，它只需要兩根線就可以實現最大 3.4Mbps 的傳輸速度。它使用主從模式，一個主機可以同時連接最多 128 個從機，因此經常用在微控制器與感應器之間的數據傳輸。

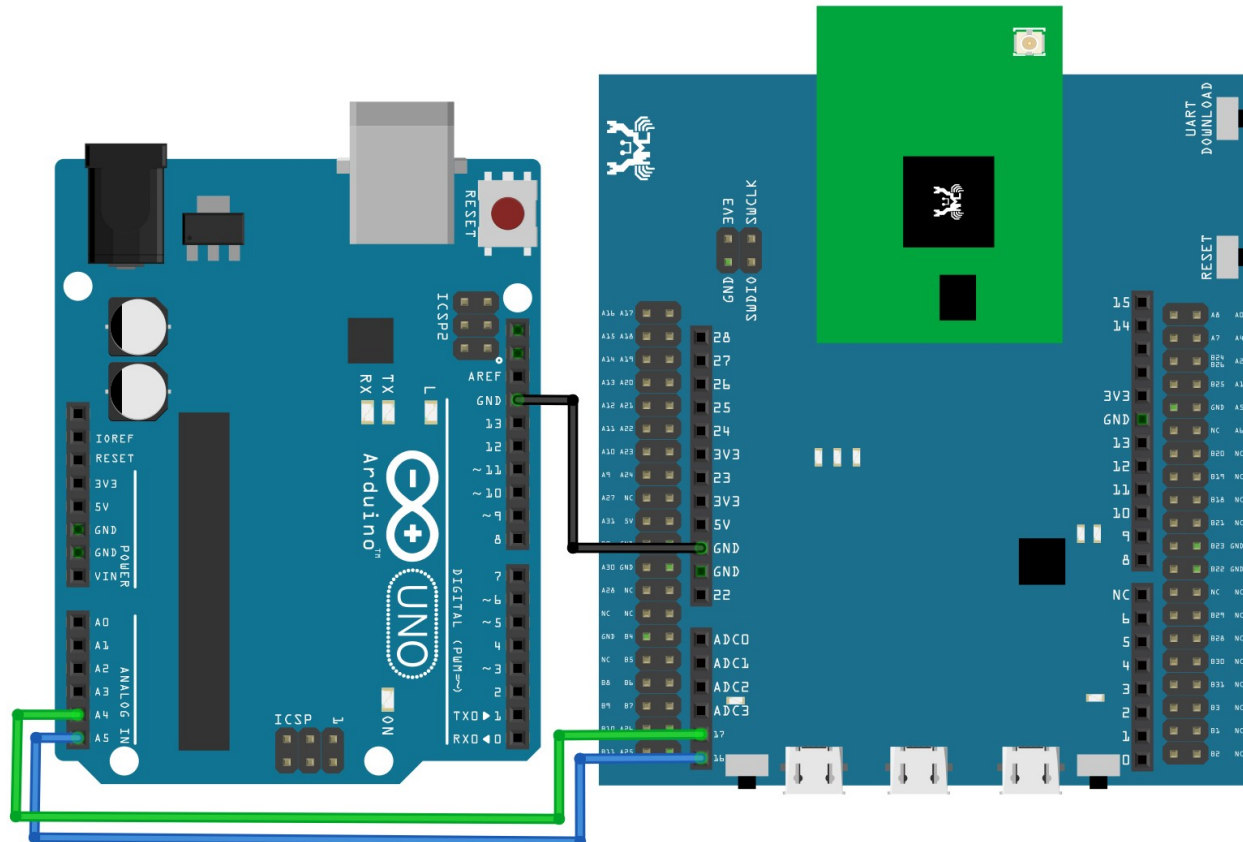
這裏我們使用 ameba 作為主機來連接從機 Arduino UNO，來驗證 I2C 的發送和接受。

在連接之前，請先將以下代碼上傳到 Arduino UNO 中 “Examples -> Wire -> Slave\_receiver”

接下來，請按以下所示來連接，此處我們選擇 PA\_26 作為 SDA 引腳，PA\_25 作為 SCL。

備 F：目前僅支持一組 I2C 在 MicroPython 上使用，引腳如下

编号	SDA	SCL
0	PA_26	PA_25



請一行接一行地 F F 粘貼以下代碼到 REPL 上，來觀察代碼效果。

```
1 from machine import Pin, I2C
2 i2c = I2C(scl = "PA_25", sda = "PA_26", freq=100000) # configure I2C with pins and
   ↳freq. of 100KHz
3 i2c.scan()
4 i2c.writeto(8, 123) # send 1 byte to slave with address 8
5 i2c.readfrom(8, 6) # receive 6 bytes from slave
```

## [RTL8722CSM] [RTL8722DM] PWM - LED 漸變

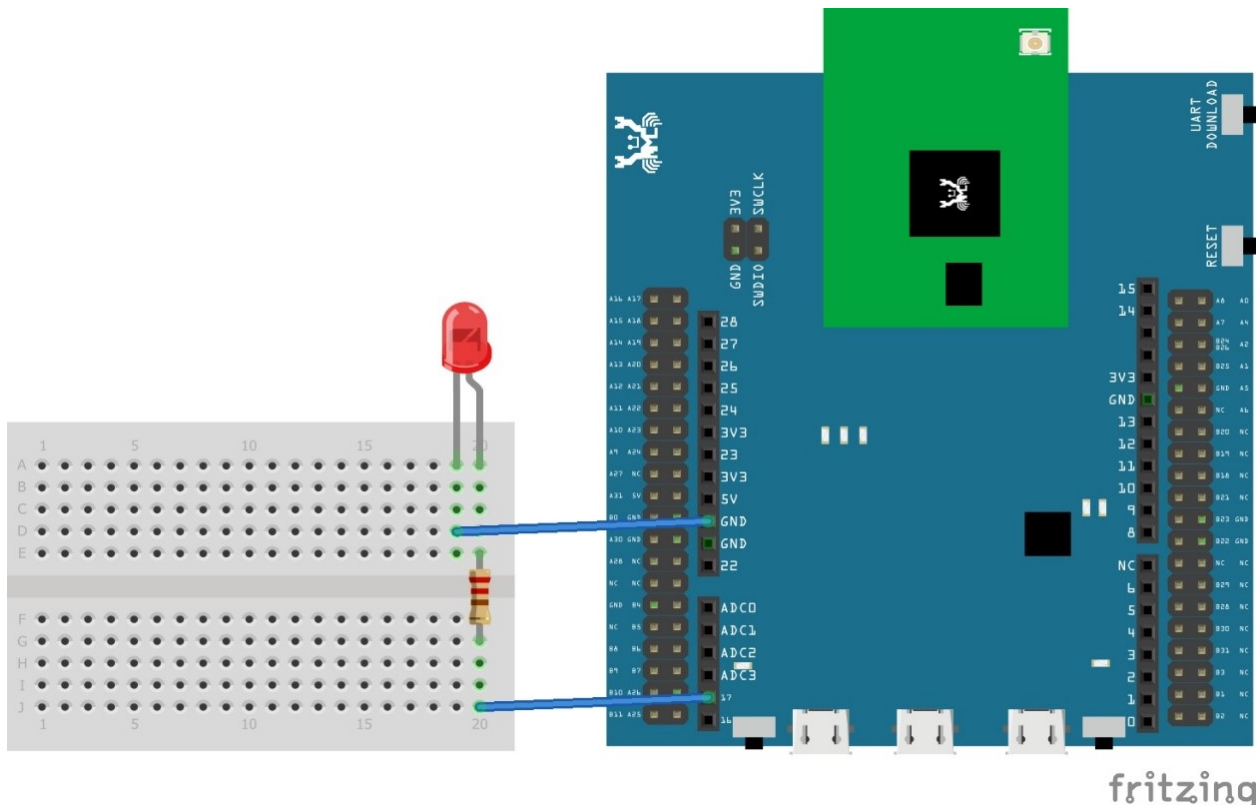
### 材料準備

- Ameba x 1
- LED x 1
- 電阻 (220 歐姆) x 1

### 範例 F 明

PWM F 寬調變控制輸出 F 波 F 期來實現對 LED 亮度和馬達的控制。下面是我們用 LED 來展示 PWM 是如何來實做的。

連接 PA\_26 至 LED 的正極和電阻串聯在一起，然後 GND 接至 LED 負極。如圖所示



然後, 逐行執行下面的代碼去 REPL 觀察結果, LED 會慢慢的漸變明亮。

```

1 from machine import Pin, PWM
2 import time
3 p = PWM(pin = "PA_26")
4 # 0 duty cycle thus output 0
5 p.write(0.0)
6 # 10% duty cycle
7 p.write(0.1)
8 # 50% duty cycle
9 p.write(0.5)
10 # 100% duty cycle
11 p.write(1.0)

```

## [RTL8722CSM] [RTL8722DM] RTC -時間顯示

### 材料準備

- Ameba x 1

### 範例說明

RTC 模組會幫助微控制器來追蹤時間, 是時間模組必須的一部分。我們在這裏有一個示例, 來展示如何來得到本地時間和上傳時間。

執行下面的代碼貼至 REPL, 觀察結果。

```

1 rtc = RTC()
2 rtc.datetime() # get date and time
3 rtc.datetime((2020, 12, 31, 4, 23, 58, 59, 0)) # set a specific date and time (year, ↵
↵month, day, weekday(0 for Monday), hour, minute, second, total seconds)
4 rtc.datetime() # check the updated date and time

```

## [RTL8722CSM] [RTL8722DM] Socket - Echo 服務器與客戶端

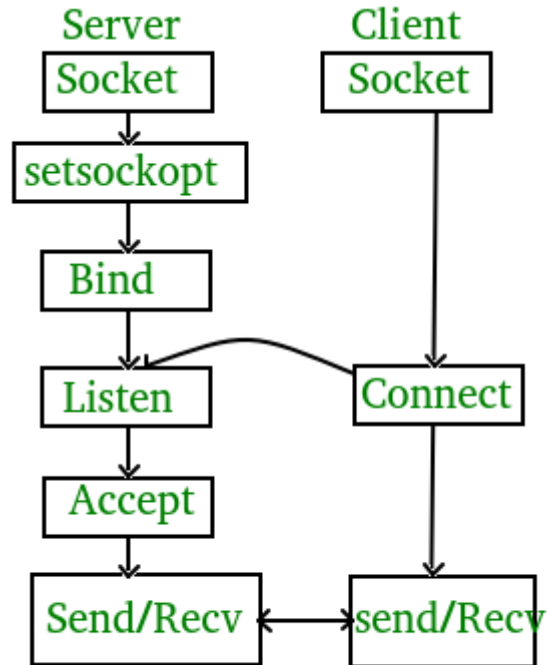
### 材料準備

- Ameba x 2

### 範例說明

WiFi 連接完成後即可使用 Socket 來使用網路。Socket 就像一個假想的乙太網路介面, 你可以用它把你的 PC 連接到互聯網上的服務器上, 比如 Google 或 Github。

即使是像 HTTP 這樣的應用層協議也是建立在 socket 之上的。一旦給定了 IP 地址和端口號, 就可以自由地連接到遠程設備與其進行通信。連接流程如下圖所示。



下面是一個使用服務器 socket 和客戶端 socket 互相傳送消息的範例，要使用這個範例，您需要兩個 ameba RTL8722 來運行 MicroPython，在 REPL 的 paste 模式下分別將下面的代碼粘貼到兩個 Ameba 設備中。

以下是 服務器代碼

```

1  import socket
2  from wireless import WLAN
3  wifi = WLAN(mode = WLAN.STA)
4  wifi.connect(ssid = "YourWiFiSSID", pswd = "YourWiFiPassword") # change the ssid and
   ↪pswd to yours
5  s = socket.SOCK()
6  port = 5000
7  s.bind(port)
8  s.listen()
9  conn, addr = s.accept()
10 while True:
11     data = conn.recv(1024)
12     conn.send(data+"from server")

```

以下是 客戶端代碼

```

1  import socket
2  from wireless import WLAN
3  wifi = WLAN(mode = WLAN.STA)
4  wifi.connect(ssid = "YourWiFiSSID", pswd = "YourWiFiPassword") # change the ssid and
   ↪pswd to yours

```

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(繼續上一頁)

```

5 c = socket.SOCK()
6 # make sure to check the server IP address and update in the next line of code
7 c.connect("your server IP address", 5000)
8 c.send("hello world")
9 data = c.recv(1024)
10 print(data)

```

## [RTL8722CSM] [RTL8722DM] Socket - 從 HTTP 網站獲取信息

### 材料準備

- Ameba x 1

### 範例說明

創建 socket 後，我們可以訪問 HTTP 網站從中獲取信息。

在粘貼模式下，將以下代碼粘貼到 REPL 中。

```

1 import socket
2 from wireless import WLAN
3 wifi = WLAN(mode = WLAN.STA)
4 wifi.connect(ssid = "YourWiFiSSID", pswd = "YourPassword") # change the ssid and pswd
  ↳ to yours
5 def http_get(url):
6     _, _, host, path = url.split('/', 3)
7     c = socket.SOCK()
8     # We are visiting MicroPython official website's test page
9     c.connect(host, 80)
10    c.send(bytes('GET /%s HTTP/1.0\r\nHost: %s\r\n\r\n' % (path, host), 'utf8'))
11    while True:
12        data = c.recv(100)
13        if data:
14            print(str(data, 'utf8'), end='')
15        else:
16            break
17 http_get('http://micropython.org/ks/test.html')

```



## [RTL8722CSM] [RTL8722DM] SPI - 作為從設備接收消息

### 材料準備

- Ameba x 1
- Arduino UNO x 1

### 範例說明

SPI 是一種快速且強大的通訊協議，[\[1\]](#)通常在微處理器中被用來接受傳感器的數據或輸出圖像訊號。在這個示例中將示範 ameba 如何透過 MicroPython 以從屬模式接收數據。

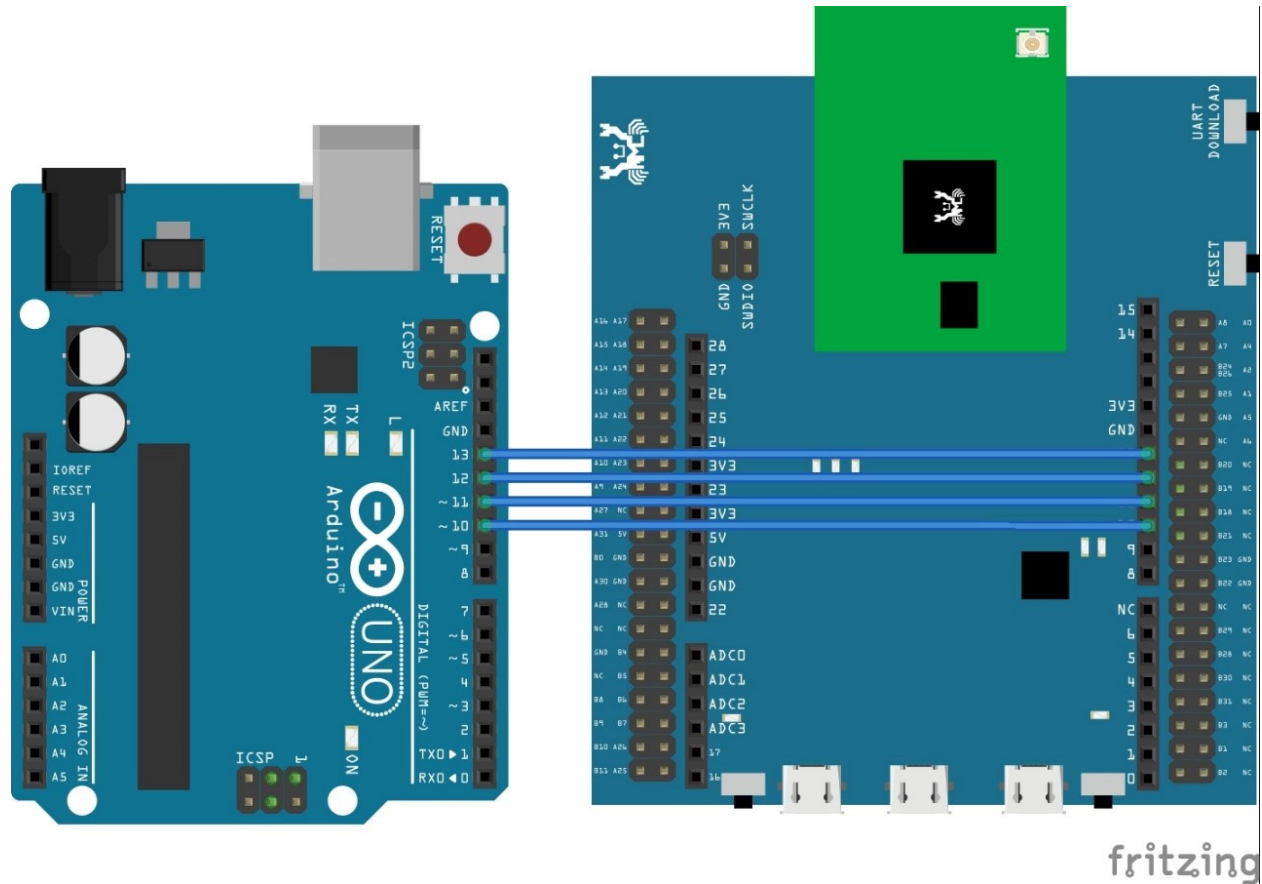
在通訊連接建立之前，需要將以下代碼燒錄到 Arduino UNO。

```

1  //////////////////////////////////////////////////
2  // SPI Master Write //
3  //////////////////////////////////////////////////
4  #include <SPI.h>
5  void setup (void) {
6      Serial.begin(115200); //set baud rate to 115200 for usart
7      digitalWrite(SS, HIGH); // disable Slave Select
8      SPI.begin ();
9  }
10 void loop (void) {
11     char c;
12     digitalWrite(SS, LOW); // enable Slave Select
13     // send test string
14     for (const char * p = "Hello, world!\r" ; c = *p; p++) {
15         SPI.transfer(c);
16         Serial.print(c);
17     }
18     Serial.println();
19     digitalWrite(SS, HIGH); // disable Slave Select
20     delay(2000);
21 }

```

Arduino UNO 將以如下圖所示的連接方式和 Ameba 連接，我們使用第“0”組 SPI 作為從機，[\[1\]](#)將 Arduino UNO 當作 SPI 的主機。



然後將以下代碼粘貼到 REPL 的粘貼模式窗口，等待代碼生效。

```
1 from machine import SPI
2 s1= SPI(0 , mode = SPI.SLAVE)
3 for i in range(14):
4     chr(s1.read())
```

## [RTL8722CSM] [RTL8722DM] Time - 延遲和計時

### 材料準備

- Ameba x 1

### 範例說明

MicroPython 提供了很多函數來處理延遲和計時，以下是一些示例。

下面的代碼至 REP 來觀察結果。

```
1 import time
2 time.sleep(1) # sleep for 1 second
3 time.sleep_ms(500) # sleep for 500 milliseconds
```

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(繼續上一頁)

```

4 time.sleep_us(10) # sleep for 10 microseconds
5 start = time.ticks_ms() # get millisecond counter

```

## [RTL8722CSM] [RTL8722DM] Timer - 周期性定時器

### 材料準備

- Ameba x 1

### 範例說明

這裏有 3 個定時器可以使用, 全部是 32kHz, 分 1/2/3。我們使用定時器 1 來示範一個周期性定時器是怎樣工作的。

下面最初的 3 行代碼至 REPL 來查看結果。

```

1 from machine import Timer
2 t = Timer(1) # Use Timer 1/2/3 only
3 t.start(2000000, t.PERIODICAL) # Set GTimer fired periodically at duration of 2_
  ↳seconds, printing text on the terminal
4 # To stop the periodical timer, type
5 t.stop()

```

一段顯示信息 `timer triggered. to stop: type t.stop()` 的 log 將在終端中每隔 2 秒顯示一次

請使用 “t.stop()” 指令停止定時器計時。

## [RTL8722CSM] [RTL8722DM] UART - 發送和接收

### 材料準備

- Ameba x 1
- USB 轉 TTL 串行模塊 x 1

### 範例說明

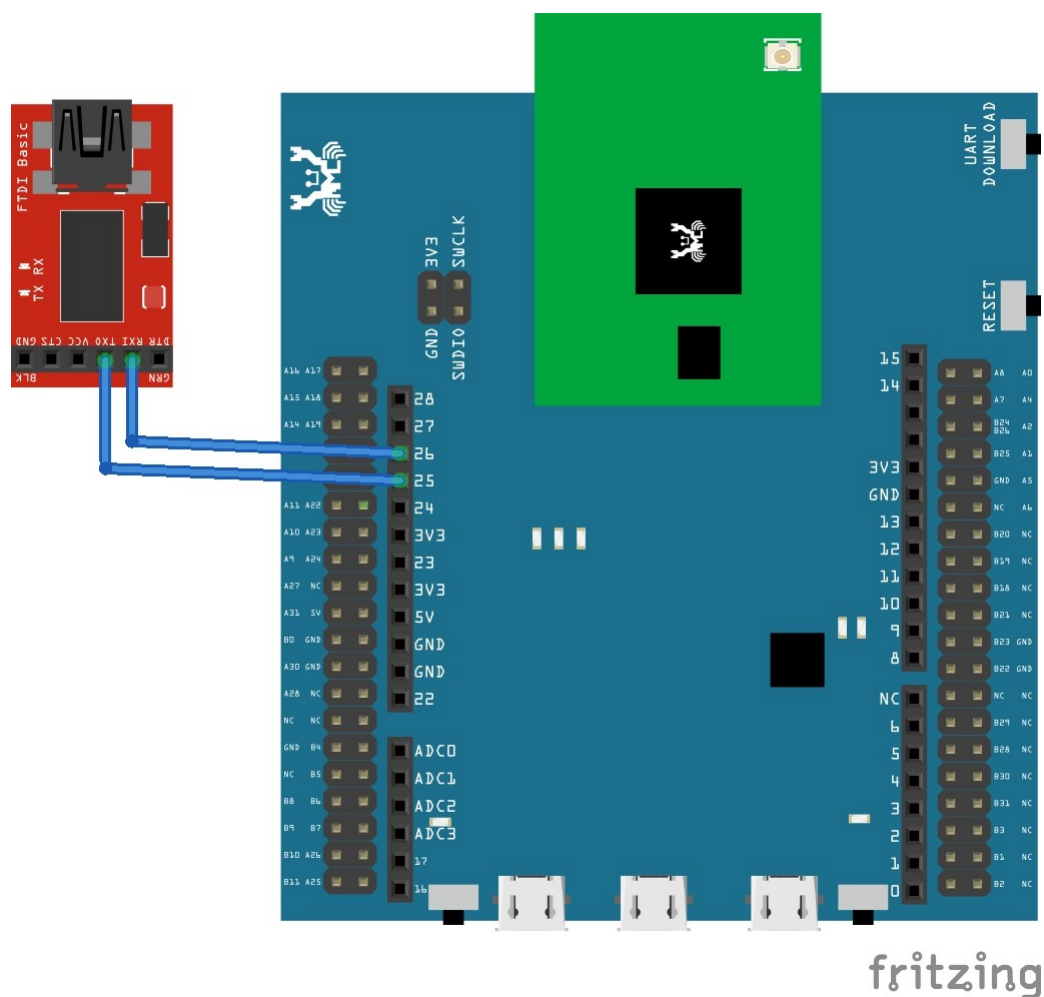
UART 是一種非常通用的通信協議, 是微控制器的一個重要組成部分。USB 轉 TTL 串行傳輸模塊是一種可以將 UART 信號轉 USB 信號的集成電路, 以便我們可以在 PC 上看到 UART 日誌。該模塊經常用於包括 Ameba 在內的許多開發板上。但是, 該模塊在 Ameba 上的功能被保留用於 LOG UART 和固件上傳, 所以我們需要其他獨立模塊在 Ameba 和 PC 之間進行通信。

當前有 2 組 UART 引腳供 MicroPython 使用, 它們分別是

Unit	傳輸引脚	接收引脚
0	PA_21	PA_22
3	PA_26	PA_25

在此示例中，我們使用第“0”組 UART 引脚來示範 UART 在 Ameba 上的工作方式。

如下圖所示，將 USB 轉 TTL 串行傳輸模塊連接到引脚 PA\_21 和 PA\_22



然後，將以下代碼逐行制 F 粘貼到 REPL 中，以查看其效果。

```

1 from machine import UART
2 uart = UART(tx="PA_21", rx= "PA_22")
3 uart.init()
4 uart.write('hello')
5 uart.read(5) # read up to 5 bytes

```

## [RTL8722DM\_MINI] SDFS 資料編輯

### 材料準備

- Ameba RTL8722DM\_MINI x 1
- MicroSD 卡 x 1 (SD 卡必須 < 32GB, 格式設置 fatfs)

### 範例說明

SD 文件系統模塊支持 SD 卡數據操作。可以隨時控制和查看文件，將它們保存在非揮發性記憶體中。

將以下代碼逐行制粘貼到 REPL 中來使用。

```

1 from machine import SDFS
2 s=SDFS()           # create a short form
3 s.create("ameba.txt") # create a file named "ameba.txt"
4 s.write("ameba.txt", "ameba supports sd card file system!") # write a string to the
  ↳file just created
5 s.read("ameba.txt") # read the content from the same file
6 s.rm("ameba.txt")   # delete the file

```

備註：不需要打開或關閉文件，API 會自動為您完成。

## [RTL8722DM\_MINI] SDFS - 目錄操作

### 材料準備

- Ameba RTL8722DM\_MINI x 1
- MicroSD 卡 x 1 (SD 卡必須 < 32GB, 格式設置 fatfs)

### 範例說明

MicroPython RTL8722 通過從 machine 導入 SDFS 模塊來支持 SD 文件系統。該模塊是一個簡化的文件系統，主要著重於 SD 卡操作，因此它不支持擬文件系統。

將以下代碼逐行制粘貼到 REPL 中來使用。

```

1 from machine import SDFS
2 s=SDFS()           # create an instance and mount on file system on SD card
3 s.listdir()        # listing the files and folders under current path
4 s.mkdir("test")     # create a folder named "test" under current path
5 s.chdir("test")     # change directory to test folder
6 s.pwd()             # print out present working directory(current path)
7 s.chdir("/")        # change directory back to root directory
8 s.rm("test")        # delete the test folder

```

---

備註：不需要打開或關閉文件，API 會自動為您完成。

---

## 2.3.2 網路相關范例

### [RTL8722CSM] [RTL8722DM] WiFi - WiFi 連接

#### 材料準備

- Ameba x 1

#### 範例說明

Ameba 可以使用開放安全性或 WPA2 安全類型連接到 WiFi 接入點，WPA2 安全類型是家用無線路由器中最常用的安全類型。

在這我們將使用下面的代碼連接到 WiFi 接入點，將以下代碼逐行複製粘貼到 REPL 中，以查看其作用。

```
1 from wireless import WLAN
2 wifi = WLAN(mode = WLAN.STA)
3 wifi.connect(ssid = "YourWiFiName", pswd = "YourWiFiPassword")
```

### [RTL8722CSM] [RTL8722DM] WiFi - WiFi 掃描

#### 材料準備

- Ameba x 1

#### 範例說明

WiFi 掃描功能可以幫助我們快速發現周圍有哪些 WiFi 網絡。

該範例不需要任何其他硬件，因此只需將以下代碼將其粘貼到 REPL 中即可查看其作用。

```
1 from wireless import WLAN
2 wifi = WLAN(mode = WLAN.STA)
3 wifi.scan()
```

## 2.4 開發板 HDK

### 2.4.1 開發板

- **HDK-AMEBAD\_MB\_4V2**
    - Layout
    - Schematic
- 

- **HDK-AMEBAD\_MB\_4V0**
    - Layout
    - Schematic
- 

### 2.4.2 RTL8722DM 模組

- **HDK-AM8722DM01\_6V2\_WI LPF**
    - Layout
    - Schematic
- 

- **HDK-AM8722DM01\_6V1\_WI LPF**
    - Layout
    - Schematic
- 

- **HDK-AM8722DM01\_4V1**
  - Layout
  - Schematic

## 2.5 API 文档

RTL8722DM MicroPython 线上 API 文档

## 2.5.1 ADC

### API 文檔

#### 構造函數

**ADC**(*unit* [必填])

以所給的組號來創建一個 ADC 對象，這樣就可以從所對應的引腳上讀取數值。

- *unit*: 組號，每個組號對應一個引腳。請查圖表來解更多。

Unit	Pin
0	PB_4
1	PB_5
2	PB_6
3	PB_7
4	PB_1
5	PB_2
6	PB_3

#### 方法

**ADC.read()**

從引腳讀取數值並返還該數值

## 2.5.2 I2C

### API 文档

#### 构造函数

**I2C**(*unit\_id* [选填], 「*sda\_pin*」 [必填], 「*scl\_pin*」 [必填], *frequency* [选填])

创建一个 I2C 对象并关联其到所给的引腳上，使用别的参数来配置该对象。  
如此便可在 I2C 上发送以及接收数据。

- *unit\_id*: 硬件 I2C 的组号, 如不填则使用默认值
- "sda\_pin": SDA 引腳名



- "scl\_pin": SCL 引脚名
- frequency: I2C 的运行频率, 如不填则使用默认值

備註: 所有选填参数的默认值如下

参数	Default
默认值	0
Frequency	100000 (Hz)

方法

I2C.reset()

该方法取消 I2C 设备的初始化.

I2C.scan()

该方法扫描并返回可用 I2C 地址.

I2C.readinto( buf[必填], flag[选填])

该方法读取 I2C 缓存器中的数据并存入用户定义的缓存器中

- buf: 一个 string / array /byte array 类型的缓存器
- flag: 一个布尔标记, 如果是 True 则在数据末尾发送 NACK, 反则反之

I2C.write(buf[必填])

该方法发送已存在 buf 中的数据

- buf: 一个 string / array /byte array 类型的缓存器

I2C.readfrom(addr[必填], len[必填], stop[选填])

该方法从所给的地址上读取 len 长度的数据。如果 stop 值为真，则在传输结尾发送 STOP 字节。

- addr: 读取的地址
- len: 要读取的数据长度

- **stop**: 布尔标记, 若 True 则在传输结束发送 STOP 字节

**I2C.readfrom\_into**(*addr*[必填], *buf*[必填], *stop*[选填])

该方法从所给的地址上读取 *len* 长度的数据。如果 *stop* 值为真, 则在传输结尾发送 STOP 字节。

- **addr**: 读取的地址
- **buf**: 一个 string / array / byte array 类型的缓存器
- **stop**: 布尔标记, 若 True 则在传输结束发送 STOP 字节

**I2C.writeto**(*addr*[必填], *value*[必填], *stop*[选填])

该方法发送一个整数数据到所给的地址上。如果 *stop* 值为真, 则在传输结尾发送 STOP 字节。

- **addr**: 写入的地址
- **value**: 要发送的整数数值
- **stop**: 布尔标记, 若 True 则在传输结束发送 STOP 字节

## 2.5.3 Pin

### API 文档

#### 构造函数

**Pin**(「*pin\_name*」[必填], *direction*[必填], *pull\_mode*[选填], *value*[选填])

创建与给定的 GPIO 引脚名称关联的 Pin 对象, 并使用其他参数进行配置。然后, 您可以在引脚上读/写数值。

- 「*pin\_name*」: 引脚名称, 必须为字符串格式, 可使用 `help(Pin.board)` 查看所有引脚的名称
- 方向
  - `Pin.IN` - 输入引脚
  - `Pin.OUT` - 输出引脚
- 模式
  - `Pin.PULL_NONE` - 没有上拉电阻或下拉电阻
  - `Pin.PULL_UP` - 启用上拉电阻
  - `Pin.PULL_DOWN` - 启用下拉电阻

- 默认值-Pin.PULL\_NONE

- value: 初始值, 并且仅适用于输出, 例如 value = 1。默认值 value = 0.

## 方法

### Pin.id()

声明 Pin 对象后, 使用此 method 将会返回所对应的 GPIO 引脚名称

**Pin.init()** (「pin\_name」[必填], direction[必填], pull\_mode[选填], value[选填])

此方法与构造函数作用相同, 使用键入的参数创建和初始化 Pin 对象。

**Pin.value(number[选填])**

此方法有以下两种用途,

1. 输出 number 数值

number 的数值可以是 0 或者 1, 用来表示逻辑状态的 0 或 1

2. 检查当前引脚状态

当没有数值输入时, 无论引脚配置方向, 此方法都会查看当前引脚的逻辑状态 (0/1)

### Pin.on()

此方法会向相应的引脚发送逻辑信号 1

### Pin.off()

此方法会向相应的引脚发送逻辑信号 0

### Pin.toggle()

该方法会切换相应引脚的逻辑信号

## 2.5.4 PWM

### API 文档

#### 构造函数

**PWM**(*unit*[选填], 「*pin\_name*」[必填])

使用预设的 *pin* 名字来创建一个 PWM 对象。可以向默认的 *pin* 来编写 PWM 信号

- *unit*: PWM 的号码, 如果没有填写预设是 0
- "*pin\_name*": *pin* 的名字, 此名字必须是 string 格式. 参考下列 PWM 支持的 pins

---

#### 備註:

目前只有下列的引脚支持 PWM:

PA\_23 , PA\_24 , PA\_25 , PA\_26

---

#### 方法

**PWM.write**(*dutycycle\_float*[必填])

声明 Pin 对象后, 此方法将返回关联的 GPIO 引脚名称。

- *dutycycle\_float*: 浮点 duty cycle, 可以从 0.0 (0%) 到 1.0 (100%)

## 2.5.5 RTC

### API 文档

#### 构造函数

**RTC()**

创建一个 RTC 对象

#### 方法

**RTC.datetime**(*array\_8*[选填])

以下是该方法的两种使用方法

- 如果没有输入任何参数，会返还本地时间。

格式如下：

(年, 月, 日, 时, 分, 秒, 周 [0-6 表示周一到周日], 年 [1-366])。

- 如果是输入一个 8 位数组的参数，会更新本地时间。格式和上面一致。

## 2.5.6 SDFS

### API 文档

#### 构造函数

#### SDFS()

Create a `sdfs` object and configure it to the given mode. This then allows you to navigate through the SD card and read/write files as you see.

---

備 F: No parameter is required

---

#### Methods

#### `sdfs.listdir()`

This method listing the files and folders under current path.

#### `sdfs.mkdir(「folder name」 [required])`

This method attempts to create a folder under current path.

- **folder name:** the name of the new folder/directory you wish to create, it must be a string less than 128 characters

#### `sdfs.chdir(「folder name」 [required])`

This method change directory to the one given in the parameter.

- **folder name:** the name of the folder/directory you wish to navigate to, it must be a string less than 128 characters

---

備F: Key in “/” as the parameter to this API would navigate back to the root directory.

---

### **sdfs.pwd()**

This method is to print out present working directory (current path).

### **sdfs.rm( [ *folder name or file name*[required] ] )**

This method is to delete a file or a folder. Note that, the folder to be deleted has to be empty before it can be deleted successfully.

- **folder name or file name:** the name of the folder or file you wish to delete, it must be a string less than 128 characters

### **sdfs.create( [ *file name*[required] ] )**

This method is to create a file.

- **file name:** The name of the file you wish to create.

### **sdfs.write( [ *file name*[required] ] , [ *string*[required] ] )**

This method is to write your input as a string to a file specified.

- **file name:** The name of the file you wish to read.
- **string:** The data you wish to write.

### **sdfs.read( [ *file name*[required] ] )**

This method is to read the content from a file.

- **file name:** The name of the file you wish to read.

## 2.5.7 Socket

### API 文档

#### 构造函数

**socket.SOCK(domain[选填], type[选填])**

创建一个 SOCK 对象，并根据其他所给的参数来进行配置。SOCK 类是 socket 类的子集，我们主要使用 SOCK 类来完成 socket 相关的通讯连接。

- **domain:** 地址域类型. 默认为 AF\_INET
  - AF\_INET: IPv4, 常见的 IP 地址, 以点为分隔符, 正在渐渐被 IPv6 取代
  - AF\_INET6: IPv6, 以冒号为分隔符的 IP 地址
- **type:** 类型, 默认为 SOCK\_STREAM
  - SOCK\_STREAM: TCP 类型
  - SOCK\_DGRAM: UDP 类型

#### 方法

**socket.SOCK.connect(host[必填], port[必填])**

该方法连接一个远程的服务器

- **host:** 字符串格式的服务器地址
- **port:** 整数格式的端口号

**socket.SOCK.bind(port[必填])**

这个方法创建一个服务器 socket，并绑定到所指定的端口上

- **port:** 整数格式的端口号

**socket.SOCK.listen()**

这个方法将服务器 socket 设为 listen 模式，等待客户端的连接

**socket.SOCK.accept()**

这个方法接受一个客户端的连接要求，生成并返回一个新的 socket 对象来进行之后的通信

**socket.SOCK.recv(*length*[必填])**

这个方法等待并接收 *length* 长度的数据

- **length**: 预期接收的数据长度

**socket.SOCK.send(*buffer*[必填])**

这个方法将储存在缓存器中的数据发送出去

- **buffer**: 一个 array/bytearray/string 类型的缓存器

**socket.SOCK.settimeout(*seconds*[必填])**

这个方法将 socket 的 timeout 时间设为 *seconds* 秒

- **seconds**: timeout 时间（秒）

**socket.SOCK.close()**

这个方法关闭 socket

## 2.5.8 SPI

### API 文档

#### 构造函数

**SPI(*unit\_id*[必填], *baudrate*[选填], *polarity*[选填], *phase*[选填], *databits*[选填], *firstbit*[选填], *miso*[选填], *mosi*[选填], *sck*[选填], *mode*[选填])**

创建 SPI 对象并使用参数进行配置后，可以在 SPI bus 上读写数据。

- **unit\_id**: 表示 SPI 硬件的 ID，如果保留空白，则采用默认值
- **baudrate**: SPI 传输速度
- **polarity**: 决定 SPI 工作模式的变量 (不推荐使用)
- **phase**: 决定 SPI 工作模式的变量 (不推荐使用)
- **databits**: 数据字节数量
- **Firstbit**: 决定首字节是最高有效位 (MSB) 或最低有效位 (LSB)



- `miso``: miso 引脚 (不推荐使用)
- `mosi`: mosi 引脚 (不推荐使用)
- `sck`: clock 引脚 (不推荐使用)
- `mode`: 决定 MASTER 模式或是 SLAVE 模式

備註: 所有选填参数的初始值设定如下表所示:

参数	默认值
Baudrate	2000000 Hz
Polarity	Inactive_low
Phase	Toggle_middle
Databits	8
Firstbit	MSB
Miso	N.A.
Mosi	N.A.
Sck	N.A.
Mode	MASTER

目前 Ameba D 支持并提供 2 对 SPI 供使用:

unit	MOSI	MISO	SCK	CS
0	PB_18	PB_19	PB_20	PB_21
1	PB_4	PB_5	PB_6	PB_7

備註: 上述所有 SPI 组号都支持主机模式 (Master), 但是仅有 第 0 组适用于从机模式.

## 方法

### **SPI.read()**

此方法将等待并返还从 SPI 缓存区读取的数据, 方法适用于主设备和从设备使用。

### **SPI.write(value[必填])**

该方法将输入一个整数数值, 并写入 SPI bus, 方法适用于主设备和从设备使用。

- **value**: 将写入 SPI bus 的一个整数数值

## 2.5.9 Time

API 文档

构造函数

N.A.

方法

**time.sleep(*seconds*[必填])**

此方法将会用既定的时间，延迟正在工作的微控制器。

- **seconds**: 秒数，必须是整数

**time.sleep\_ms(*milliseconds*[必填])**

此方法将会用既定的时间，延迟正在工作的微控制器。

- **milliseconds**: 毫秒数，必须是整数

**time.sleep\_us(*microseconds*[必填])**

此方法将会用既定的时间，延迟正在工作的微控制器。

- **microseconds**: 微秒数，必须是整数

**time.time()**

此方法将会返回一个秒数，此秒数是从 (1970-01-01) 开始计算。

**time.localtime()**

此方法将会返回 RTC 的本地时间。

(年, 月, 日, 时, 分, 秒, 周 [0-6] 周一到周日, 年 [1-366])。

**time.mktime(*tuple*[必填])**

此方法的功能相反于 `time.localtime()`。它的参数是一个按照 `time.localtime()` 来表达的完整 8 项元组。它会返回一个整数，此整数是从 2000 年一月一日到现在的秒数。

- **tuple:** 一个来表达的完整 8 项元组

### **time.ticks\_ms()**

此方法将会返回一个递增的毫秒数，参考点可以任意时间。通常和 `ticks_add()`, `ticks_diff()` 一起使用。

### **time.ticks\_add(starting\_ticks[必填], ticks\_added[必填])**

This method add given number of ticks to the starting\_ticks.

- **starting\_ticks:** 从 `ticks_ms()` 拿到的毫秒数时间
- **ticks\_added:** 要增加的 ticks

### **time.ticks\_diff(end\_ticks[必填], starting\_ticks[必填])**

此方法将会返回 `end_ticks` 时间和 `starting_ticks` 时间的差值。

- **end\_ticks:** 从 `ticks_ms()` 拿到的毫秒数时间
- **starting\_ticks:** 从 `ticks_ms()` 拿到的毫秒数时间

## 2.5.10 Timer

### API 文档

#### 构造函数

### **Timer(unit[选填])**

用特定 ID 创建一个定时器对象

- **unit:** 可以是 1/2/3，对应定时器 1/2/3

#### 方法

### **Timer.start(microseconds[必填], type[必填])**

此方法将在给定的微秒时间内启动给定类型的定时器，无论是单次还是周期性的。

- **microseconds:** 微秒数间隔，必须是整数。

- **type**: 单次，或周期性定时器。

#### **Timer.deinit()**

此方法将解除创建的定时器对象并停止定时器。

#### **Timer.stop()**

此方法将停止定时器时钟和其中断 handler。

#### **Timer.us ()**

此方法将返还定时器的当前微秒 (us)。

#### **Timer.tick ()**

此方法将返还定时器的当前 ticks (0~32768)。

#### **Timer.reload (duration\_us[必填])**

此方法将用时间长度 (us) 来重新设定定时器。

- **duration\_us**: 时间长度，计量单位是微秒 us。

## 2.5.11 UART

### API 文档

#### 构造函数

**UART**(unit[选填], baudrate[选填], databits[选填], stopbit[选填], paritybit[选填], timeout[选填], tx\_pin[必填], rx\_pin[必填])

创建一个与给定的 TX 和 RX 引脚相关联的 UART 对象，并通过使用其他相关参数进行配置后，便可以在引脚上做读写。

- **unit**: 代表可使用 UART 引脚组的 ID，可输入 0 或 3
- **baudrate**: 在 Ameba 上使用 115200
- **databits**: 数据字节的数量，通常为 7 到 8 个字节
- **stopbits**: 停止位的字节数量，通常为 1 字节，1.5 字节或 2 字节

- `paritybit`: 用于奇偶校验, 数值通常为 `none` (无), `odd` (奇) 或 `even`(偶)
- `timeout`: 计算 UART 在超时 (`timeout`) 之前等待的时间 (以毫秒为单位)
- `tx_pin`: 发送端引脚, 通常与接受器的 RX 引脚连接
- `rx_pin`: 接收端引脚, 通常与发送器的 TX 引脚连接

**備註:** 并非所有参数都是必需的, 因此如果不填, MicroPython 将采用其默认值, 下表为所有选填参数的默认值

参数	默认值
Unit	0
Baudrate	115200
Databits	8
Stopbits	1
Paritybit	0
Timeout	10 (ms)

## 方法

### UART.init()

使用此方法初始化 UART 配置

### UART.read(*length*[选填])

此方法用于从 UART 缓存中读取数据

- **length**: 接收数据的长度

### UART.readline()

此方法功能类似于 `read()` 但每次会读出一行内容

### UART.write(*buffer*[require])

该方法将字节缓冲区发送到总线, 并返回写入的字节数。

- **buffer**: 字节缓存区, 可以存放的数据类型有字符串类型, 整型等其他类型。

**UART.irq\_enable(*bool*[选填])**

此方法有两种使用方式:

1. 当没有传入任何参数, 该方法检查 UART 中断请求 (IRQ) 的状态, 如果启用了 IRQ, 它将返回 `True`; 如果禁用 IRQ, 则返回 `False`
2. 通过传入 `True/False` 来启用/禁用 UART IRQ 处理程序

**UART.irq\_handler(*function*[必填])**

将 Python 处理函数传递给 UART 中断请求, 以便在发生 UART 事件时将其触发。

- **function:** 在 Python 中定义的函数或 lambda 函数

## 2.5.12 WiFi

### API 文档

#### Constructors

**WLAN(*mode*[required])**

创建一个 WLAN 对象, 然后设定对应的模式, 之后可以对 WiFi 进行控制和查看状态。

- **mode:** `WLAN.STA` 是 station 模式

#### 方法

**WLAN.scan()**

搜索和列出周围所有的 WiFi 网络

**WLAN.connect(*ssid*[required], *pswd*[optional], *security*[optional])**

建立连接至 WiFi 网络

- **ssid:** WiFi 网络的名称
- **pswd:** WiFi 网络的密码
- **security:** WiFi 网络的安全协议

---

**備註：** 如果没有填写选填的参数，会使用下面的预设数值。

---

参数	默认值
pswd	NULL
security	WPA2_AES_PSK

---

**備註：**

如果连接 **OPEN** 的网络，可以忽视参数 pswd，  
然后在 ssid 后面输入 security = WLAN.OPEN。

---

### **WLAN.get\_ip()**

成功连接至 AP 后返还当前 WLAN 接口的 IP 地址。

### **WLAN.disconnect()**

从当前连接的网络断开连接，但是 WiFi 模块还在运行

### **WLAN.on()**

This method turns on the WiFi device.

### **WLAN.off()**

关闭 WiFi 并且断开所有连接

### **WLAN.wifi\_is\_running()**

返还 WiFi 的状态，WiFi 启动后返还 True，WiFi 关闭返还 False

### **WLAN.is\_connect\_to\_ap()**

返还连接状态，连接到 AP 后返还 True，如果没有任何连接返还 False

## 2.6 相關資源

## 2.7 支援

### 2.7.1 常見問題

---

什麼是 MicroPython 以及如何使用它？

有關更多資訊，請參考 [MicroPython 官方網站](#)。

---

---

可以使用所有的 Python 標準函式庫嗎？

不可以，MicroPython 僅支持 Python 標準函式庫的一小部分。但是可以通過將標準的 python 庫移植到 MicroPython 來使用。

---

---

RTL8722CSM / RTL8722DM 上的所有引腳都可用嗎？

不可以，那些標有“NC”的因未連接到任何引腳，因此無法使用。

---

---

RTL8722CSM 是否支持 5G WiFi？

否。僅 RTL8722DM 支持雙頻 2.4G + 5G WiFi。RTL8722CSM 僅支持單頻段 2.4G WiFi。

---

---

如何進入下載模式？

按住 UART DOWNLOAD 按鈕。然後按下 RESET 按鈕釋放 UART DOWNLOAD 和 RESET 按鈕。

---

### 2.7.2 故障排除

---

MicroPython 韌體編譯失敗

在構建過程中，某些用項可能會遇到導致過程暫停的錯誤，這是由於缺少系統環境設置而導致的，可以通過以下方法進行修復。



## 1. 與 python 相關的錯誤

預設下，MicroPython 使用 *Python3* 運行 MicroPython kernel 的構建，如果遇到與 python 相關的錯誤，可能是因 *Python3* 檔案相關路徑未添加到系統環境變量中。

但是，如果已經添加了環境變量，但是構建依舊無法完成，則可以嘗試

- 1) 重新啟動電腦
- 2) 在終端上輸入 “python”，如果顯示的 python 是 *Python3*，則請添加  
**‘PYTHON = python’**  
 到 “port/rtl8722” 文件夾路徑下 “Makefile” 的第二行

## 2. 與 MPY-CROSS 相關的錯誤

如果構建過程停止顯示錯誤 mpy-cross，則需要執行以下步驟

- 1) 到 “MicroPython\_RTL8722/mpy-cross” 文件夾下
- 2) 打開您的 Cygwin/Linux 終端，然後輸入  
**‘make’**  
 等待 MicroPython Cross Compiler 的構建完成，然後應該可以修復錯誤

---

## 程式碼未按預期運行

嘗試使用 **print()** 函數調試程序，在 API 頁面詳細了解每個 API。

---



---

## 為什麼不斷從 REPL 收到 “syntax error”？

請注意 MicroPython 僅支持 **Python3** 語法

---



---

## 如何將 Python 上傳到 Ameba 開發板？

有 3 種方式將 Python 代碼上傳到 Ameba 開發板

### 1. 通過 REPL normal 模式

在一般的 REPL 模式下，您可以逐行粘貼代碼到 REPL 上按順序執行它們，但是請注意，在使用條件檢查或循環時（例如 “if” 或 “while”），代碼將被自動縮排，不正確的縮排將導致本錯誤。

### 2. 通過 REPL paste 模式

在一般的 REPL 模式下，按 “Ctrl” + “e” 可以進入 paste 模式，paste 模式僅允許粘貼完整的程式碼，粘貼不完整的程式碼或編輯會導致語法錯誤。

### 3. 通過 mp\_frozenmodules

將 python 本放入“rtl8722”路徑下的“mp\_frozenmodules”文件夾中，您的程式碼將被嵌入到 MicroPython 固件中上傳到 Ameba，接著您只需導入 python 本的名稱即可使用它。

---

---

連接到 RTL8722CSM / RTL8722DM UART 後，什串行終端上有輸出結果？

RTL8722CSM / RTL8722DM 默認配置 115200` baudrate, 請檢查串行終端是否配置 115200。

---

---

程序有被下載到 RTL8722CSM / RTL8722DM 中？

請按照以下步驟正確下載：

1. 進入下載模式。進入下載模式時，開發板上的色 LED 會閃爍
  2. 下載固件時，開發板上的紅色 LED 將閃爍
  3. 成功下載後，您將看到類似 “All images sent successfully” 的訊息
- 

---

為什麼有時 WiFi 信號較弱？

RTL8722CSM / RTL8722DM 的天預設是使用 I-Pex 接口。請更/連接 I-Pex 接口的天。

---

---

什我的開發板無法上電？

請確保已連接電阻 R43 旁的 connector J38。該連接器用於將電源鏈接到 IC。

---

---

遇到開發板連接到電腦的驅動程式問題？

請參考下列 USB 驅動程式 <https://ftdichip.com/drivers/>。

---

## CHAPTER 3

---

### 瑞昱標準 SDK

---

歡迎來到瑞昱標準 SDK 線上文檔

Ameba RTL8722DM (AMB 21)



### 3.1 入門指南

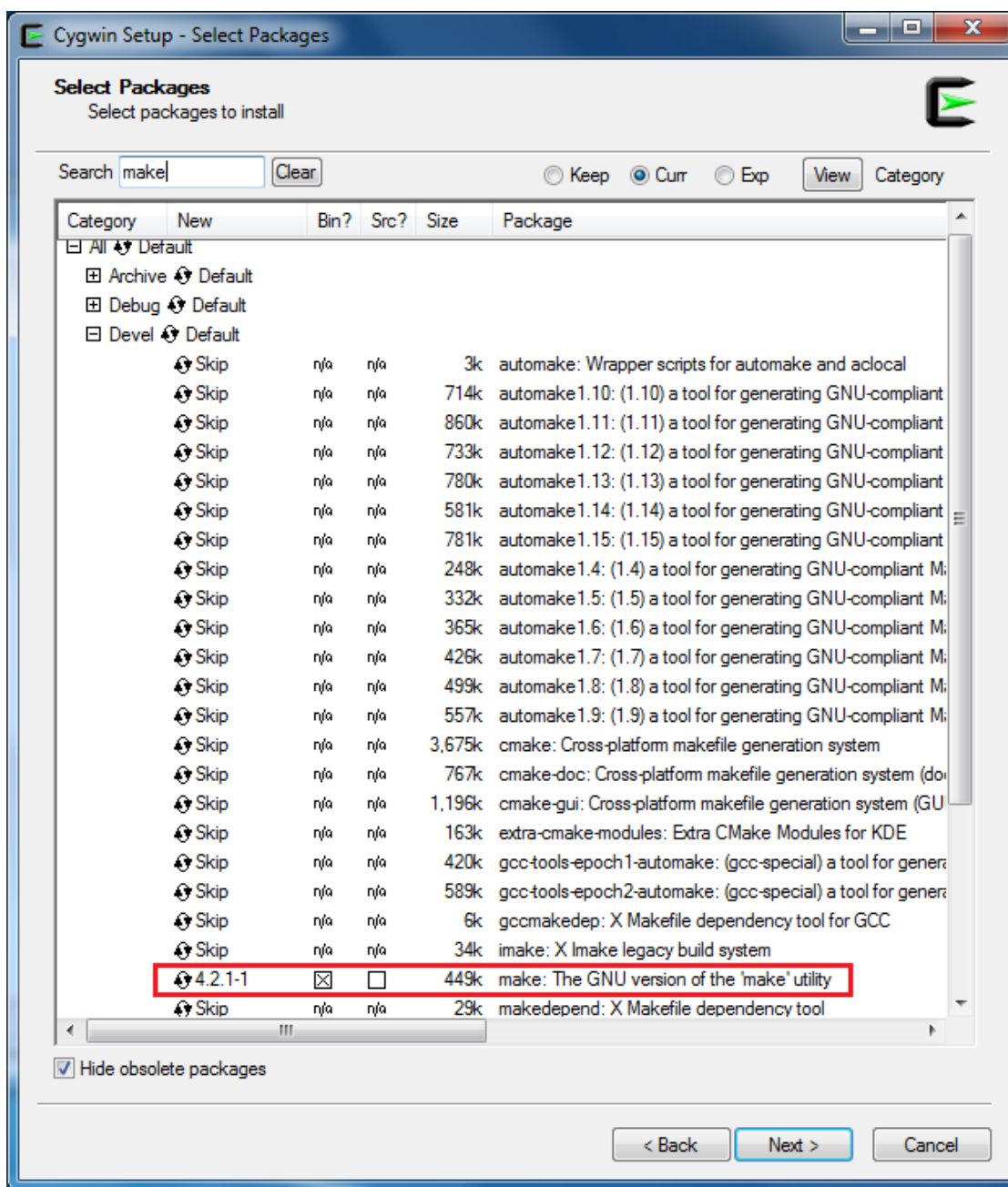
#### 3.1.1 GCC 開發環境的設置

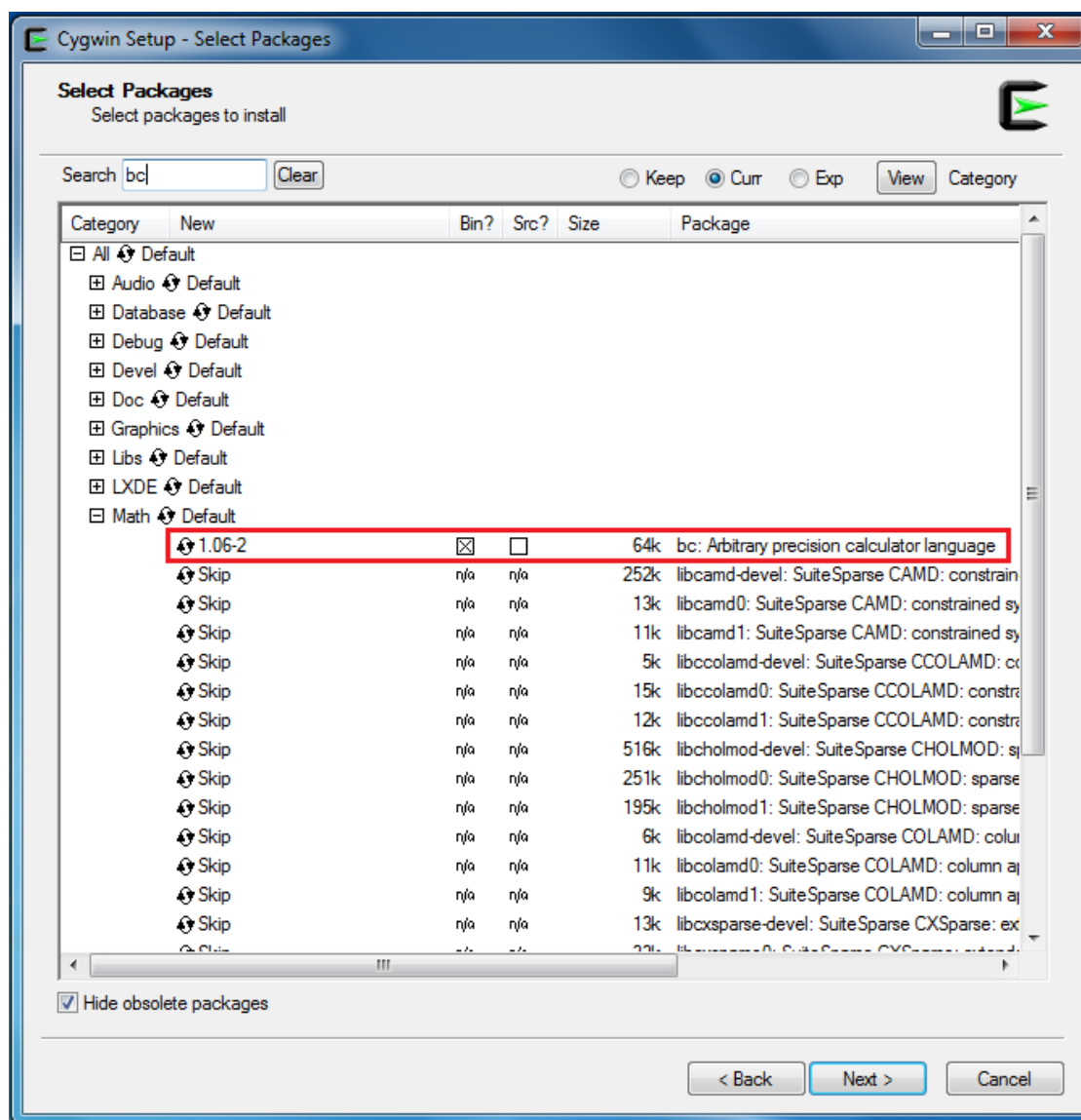
在 Windows 上，可以將 Cygwin 用作 GCC 開發環境。Cygwin 是 GNU 和開源工具的集合，類似於提供 Linux 相關的功能在 Windows 平台上使用。

點選 <http://cygwin.com/> 且依照自己的 Windows 平台來下載 <http://cygwin.com/> 。

1. 32 位元 Windows 和 64 位元 Windows 均支持 32 位元 Cygwin。

2. 安裝 Cygwin package 過程中，如下圖所示在 Select Packages 頁面中選擇 **Devel -> make** 與 **Math -> bc** 功能。





備註：對於 Linux，請參考 [AN0400 Ameba-D Application Note v12.pdf](#) 來建立 GCC 開發環境。

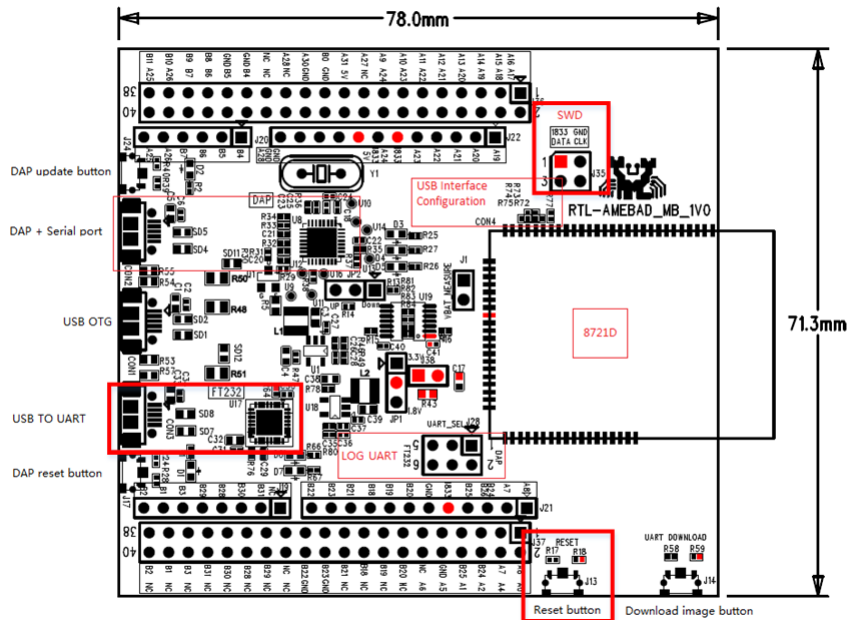
### 3.1.2 Ameba-D 開發板的相關介紹

對於 Ameba-D，有許多類型的芯片組可用，例如 RTL8720CS，RTL8721CSM，RTL8722CSM，RTL8720DN，RTL8720DM，RTL8721DM 和 RTL8722DM。

此外，芯片組可以嵌入在 Ameba-D DEV 開發板上且擴展各種 I/O 接口。我們提供了相應的 HDK（硬件開發套件）文檔，請聯閱 [RTK](#) 了解更多詳細信息。

Ameba-D 開發板的硬件圖如下所示：

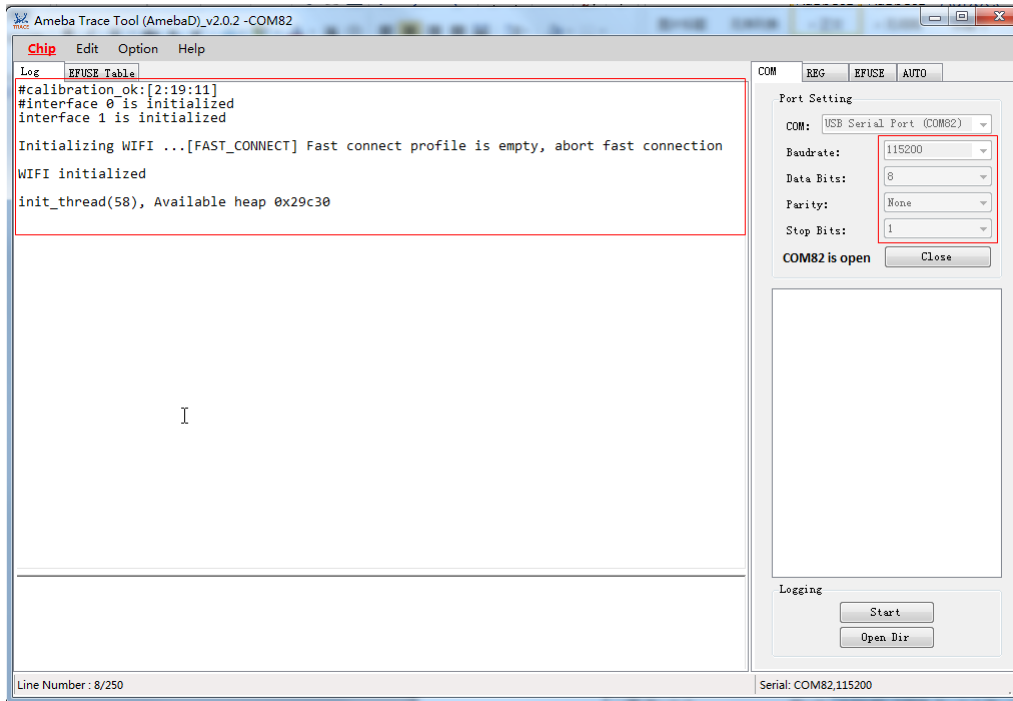
- USB TO UART: 供電和日 F 打印
- 波特率: F 115200bps
- SWD: SWD 介面，用於下載圖像和使用 IAR 進行調試
- Reset Button: IAR 完成下載後，重置 Ameba-D 以運行固件



### 3.1.3 連接串口

在 Ameba-D 板上，FTDI 芯片和 FT232 可用於串口和除錯器。可以使用 SecureCRT、Teraterm 與 Putty 等終端工具查看串口訊息。

- 1) 選擇相對應的 uart 參數且打開連接端口。
- 2) 然後按 Ameba 上的重置按鈕，在終端中可以找到一些訊息。



### 3.1.4 在 Ameba-D 上建立第一個 GCC 項目

以下步驟供首次開發人員在現有 RTK SDK 下構建 GCC 項目。

代碼編譯本節說明如何構建 SDK。

首先，您需要切換到 GCC 目錄。對於 Windows，打開 Cygwin 終端，使用 `$ cd` 命令將目錄更改為 Ameba-D SDK 的 KM0 或 KM4 項目目錄。

**備註：**需要將 {path} 替換成自己的 SDK 位置，在 SDK 位置前面添加前綴 “cygdrive”，以便 Cygwin 可以訪問您的文件系統。

- `$ cd /cygdrive/{path}/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp`
- `$ cd /cygdrive/{path}/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp`

對於 Linux，請打開自己的終端，然後使用 `$ cd` 命令將目錄更改為 Ameba-D SDK 的 KM0 或 KM4 項目目錄。

- `$ cd /{path}/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp`
- `$ cd /{path}/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp`

要構建一般固件的 SDK，只需在 Cygwin（Windows）或終端（Linux）上相應目下使用命令。KM0 project 對於 KM0，如果終端輸出訊息包含 “km0\_image2\_all.bin” 和 “Image manipulating end”，則表示固件已成功構建，如下所示。

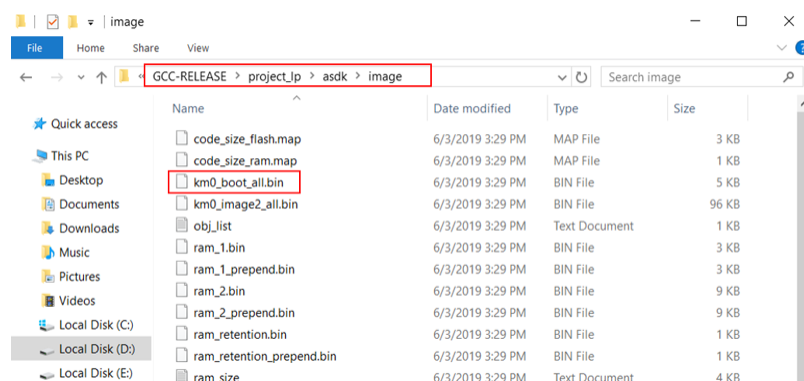
```

/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp
./project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/xip_image2.bin
flash_text_start /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/target_img2.map
/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/gnu_utility/prepend_header.sh /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/ram_retention.bin
retention_entry_func /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/target_img2.map
cat /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/xip_image2_prepend.bin /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/ram_2_prepend.bin > /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/km0_image2_all.bin
/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/gnu_utility/pad.sh /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk/image/km0_image2_all.bin
===== Image manipulating end =====
make[1]: Leaving directory '/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp/asdk'
/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_lp
$

```

如果構建失敗，請輸入 \$ make clean 然後重新執行 make。

成功構建後，固件檔案位於 “project/realtek\_amebaD\_va0\_example/GCC-RELEASE/project\_lp/asdk/image” 下，如下圖所示。



KM4 專案對於 KM4，如果終端輸出訊息包含 “km0\_image2\_all.bin” 和 “Image manipulating end”，則表示固件已成功構建，如下所示。



```

/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp
.ARM.attributes          54          0
.debug_frame            10024        0
.stabstr                 117          0
Total                   847521

/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/./toolchain/cygwin/as
dk-6.4.1/cygwin/newlib/bin/arm-none-eabi-size -t --radix=10 /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va
0_example/GCC-RELEASE/project_hp/asdk/image/target_img2.axf
text data bss dec hex filename
32592 262416 1936 296944 487f0 /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEAS
E/project_hp/asdk/image/target_img2.axf
32592 262416 1936 296944 487f0 (TOTALS)
===== Image Info DEC =====
rm -f -f ./build/ram/*.o
===== linker img2_ns end =====
===== Image manipulating start =====
/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/gnu_utility/prepend_he
ader.sh /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/image/ram_2.bi
n __ram_image2_text_start__ /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_
hp/asdk/image/target_img2.map
/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/gnu_utility/prepend_he
ader.sh /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/image/xip_imag
e2.bin __flash_text_start__ /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_
hp/asdk/image/target_img2.map
cat /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/image/xip_image2_p
repend.bin /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/image/ram_2
prepend.bin > /cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/image/k
m4_image2_all.bin
/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/gnu_utility/pad.sh /cy
qdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/image/km4_image2_all.bin
===== Image manipulating end =====
make[1]: Leaving directory '/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp
/asdk'

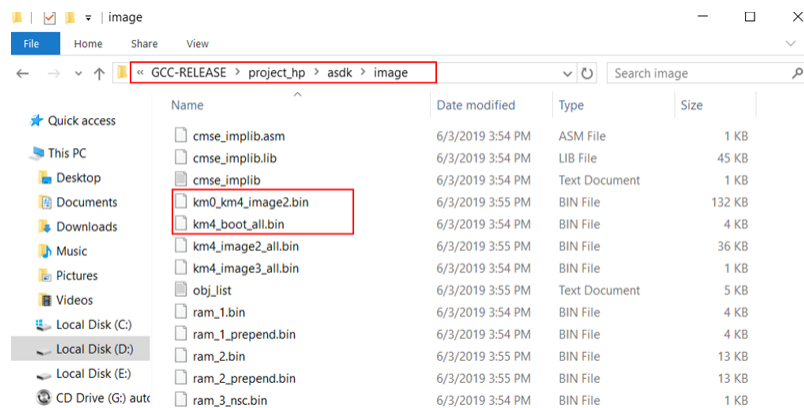
/cygdrive/d/sdk-amebad-beta_v6.0/project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp
$

```

如果構建失敗，請輸入 `$ make clean` 然後重新執行 `make`。

成功構建後，固件檔案位於














`project/realtek_amebaD_va0_example/GCC-RELEASE/project_hp/asdk/image` 下，如下圖所  
示。



### 3.1.5 下載固件至 Ameba-D

瑞昱提供了 Image Tool 在 Windows 中可以方便下載固件

- 環境需求: WinXP, Win 7 以上, Microsoft .NET Framework 3.5
- ImageTool.exe 位置: SDK\tools\AmebaD\Image\_Tool\ImageTool.exe

Name	Date modified	Type	Size
 ChangeLog.txt	7/29/2019 11:52 AM	Text Document	4 KB
 Download.ini	11/4/2019 5:44 PM	Configuration sett...	2 KB
 Encrypt.ini	11/4/2019 5:44 PM	Configuration sett...	1 KB
 ImageTool.exe	7/29/2019 11:52 AM	Application	282 KB
 ImageTool.pdb	7/29/2019 11:52 AM	VisualStudio.pdb....	178 KB
 ImageTool.vshost.exe	8/20/2018 1:41 PM	Application	14 KB
 ImageTool.vshost.exe.manifest	8/20/2018 1:41 PM	MANIFEST File	1 KB
 imgtool_flashloader_amebad.bin	6/6/2019 3:15 PM	BIN File	5 KB
 imgtool_flashloader_amebaz.bin	6/6/2019 3:15 PM	BIN File	6 KB
 SB.exe	8/20/2018 1:41 PM	Application	189 KB
 system.bin	8/6/2019 9:53 AM	BIN File	4 KB
 TestListView.dll	8/20/2018 1:41 PM	Application extens...	5 KB
 TestListView.pdb	8/20/2018 1:41 PM	VisualStudio.pdb....	14 KB

假設 PC 上的 Image Tool 是服務器，它將通過 UART 將固件檔案發送到 Ameba（客端）。要將檔案從服務器下載到客端，客端必須首先進入 UART download 模式。

#### 1) 進入 UART\_DOWNLOAD 模式

- 按下 UART DOWNLOAD 按鈕保持按下狀態
- 重新打開電源，或按重置按鈕
- 放開 UART DOWNLOAD 按鈕

現在 Ameba 板進入 UART\_DOWNLOAD 模式準備接收數據。

#### 2) 點選 UI 上的 Chip Select（紅色），然後選擇芯片（AmebaD 或 AmebaZ）

#### 3) 選擇相應的串行端口和傳輸波特率，默認波特率是 1.5Mbps（推薦）

#### 4) 點選 覽按鈕以選擇要編程的固件（km0\_boot\_all.bin / km4\_boot\_all.bin / km0\_km4\_image2.bin）與其位址

- 固件位址

```
{path}\project\realtek_amebaD_va0_example\GCC-RELEASE\project_lp\asdk\image
```

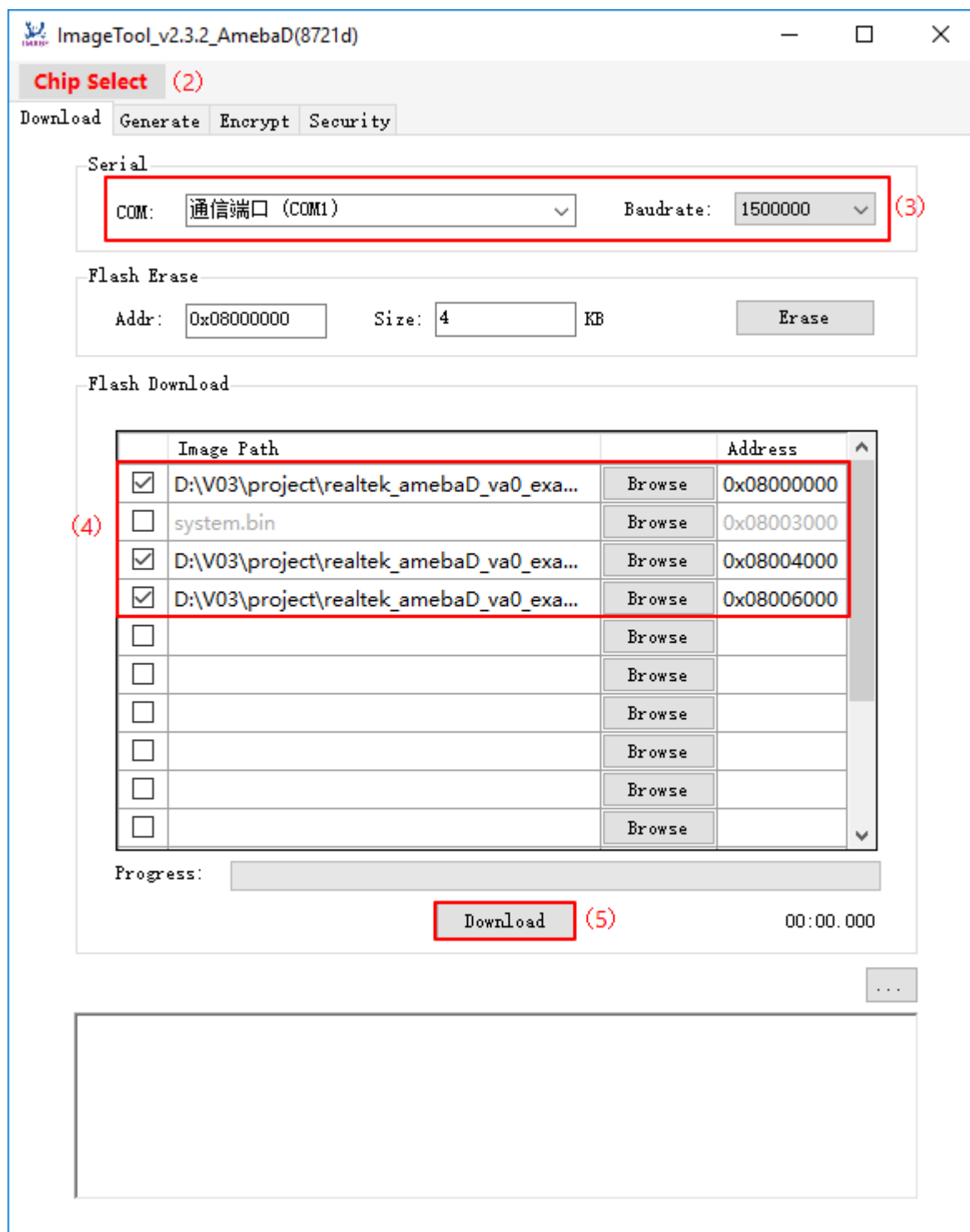
與

```
{path}\project\realtek_amebaD_va0_example\GCC-RELEASE\project_hp\asdk\image,
```

自己電腦上項目的位址。

- 默認目標地址是 SDK 默認固件地址，您可以直接使用它。

5) 點選下載按鈕進度條將顯示每個固件的傳輸進度且可以從日窗口獲取操作成功消息或錯誤消息。



## 3.2 Release History

### Version 1.0.0 –2021/10/12

- Hardware information:
  - CPU. 32-bit KM4 (Arm Cortex-M33 compatible) and 32-bit KM0 (Arm Cortex-M23 compatible)
  - MEMORY. 512KB SRAM + 4MB PSRAM
- Feature:
  - Integrated 802.11a/n Wi-Fi SoC
  - USB Host/Device
  - SD Host
  - BLE5.0
  - Codec
  - LCDC
  - Key Matrix
  - 1 PCM interface
  - 4 UART interface
  - 1 I2S Interface
  - 2 I2C interface
  - 7 ADC
  - 17 PWM
  - Max 54 GPIO

## 3.3 開發板 HDK

AmebaD HDK 資源下載

### 3.3.1 開發板

- **HDK-AMEBAD\_MB\_4V2**

- PCB 線圖
  - 原理圖
- 

- **HDK-AMEBAD\_MB\_4V0**

- PCB 線圖
- 原理圖

### 3.3.2 RTL8722DM 模組

- **HDK-AM8722DM01\_6V2\_WI LPF**

- PCB 線圖
  - 原理圖
- 

- **HDK-AM8722DM01\_6V1\_WI LPF**

- PCB 線圖
  - 原理圖
- 

- **HDK-AM8722DM01\_4V1**

- PCB 線圖
- 原理圖

## 3.4 支援

### 3.4.1 常見問題

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#### 如何購買 Ameba RTL8722DM Board?

請參考 [購買連結](#)。

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### 3.4.2 故障排除

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遇到開發板連接到電腦的驅動程式問題？



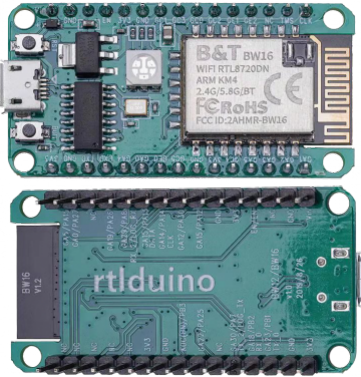
請參考下列 USB 驅動程式 <https://ftdichip.com/drivers/>。

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資源下載

- 4.1 AMB21/AMB22 (RTL8722DM)
- 4.2 AMB23 (RTL8722DM MINI)
- 4.3 BW16 (RTL8720DN) 由安信可提供

表格 1: 開發板列表

		
<i>AMB21(RTL8722DM)</i>	<i>AMB23(RTL8722DM MINI)</i>	<i>BW16(RTL8720DN) by Ai-Thinker</i>

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**小訣竅：**

歡迎貢獻者們對 SDK 相關文檔內容的更改或貢獻

進行文檔貢獻或修改前請先閱讀下面的 [GitHub Wiki](#) 以瞭解更多細節。

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