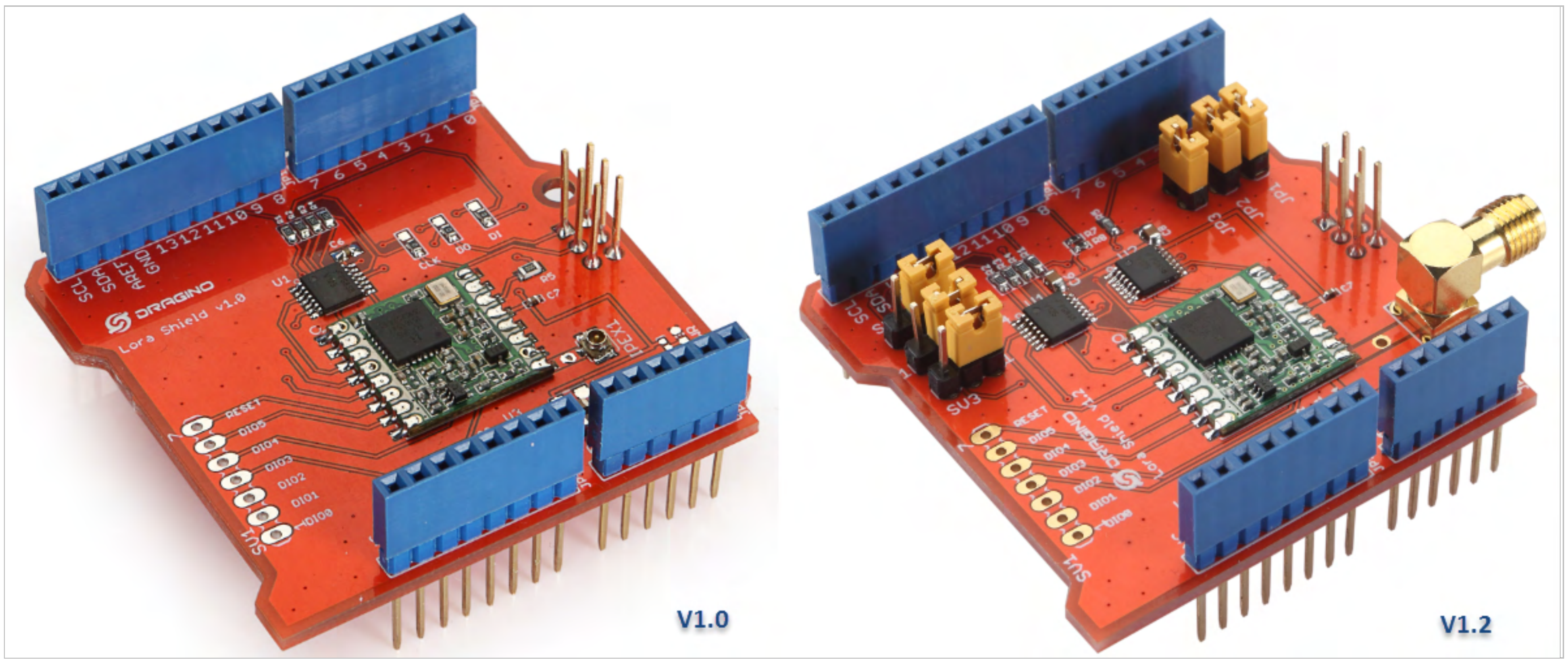
# INTRODUCTION



Dragino LoRa Shield

Dragino LoRa Shield v1.4

## What is the Dragino LoRa Shield

The Dragino LoRa Shield is a long range transceiver on a Arduino shield form factor and based on Open source library.The LoRa Shield allows the user to send data and reach extremely long ranges at low data-rates.It provides ultra-long range spread spectrum communication and high interference immunity whilst minimising current consumption.

The LoRa Shield based on SX1276/SX1278 targets professional wireless sensor network applications such as irrigation systems, smart metering, smart cities, smartphone detection, building automation, and so on.

Using Semtech’s patented LoRa™ modulation technique the LoRa Shield can achieve a sensitivity of over -148dBm using a low cost crystal and bill of materials. The high sensitivity combined with the integrated +20 dBm power amplifier yields industry leading link budget making it optimal for any application requiring range or robustness. LoRa™ also provides significant advantages in both blocking and selectivity over conventional modulation techniques, solving the traditional design compromise between range, interference immunity and energy consumption.

These devices also support high performance (G)FSK modes for systems including WMBus, IEEE802.15.4g. The LoRa Shield deliver exceptional phase noise, selectivity, receiver linearity and IIP3 for significantly lower current consumption than competing devices.

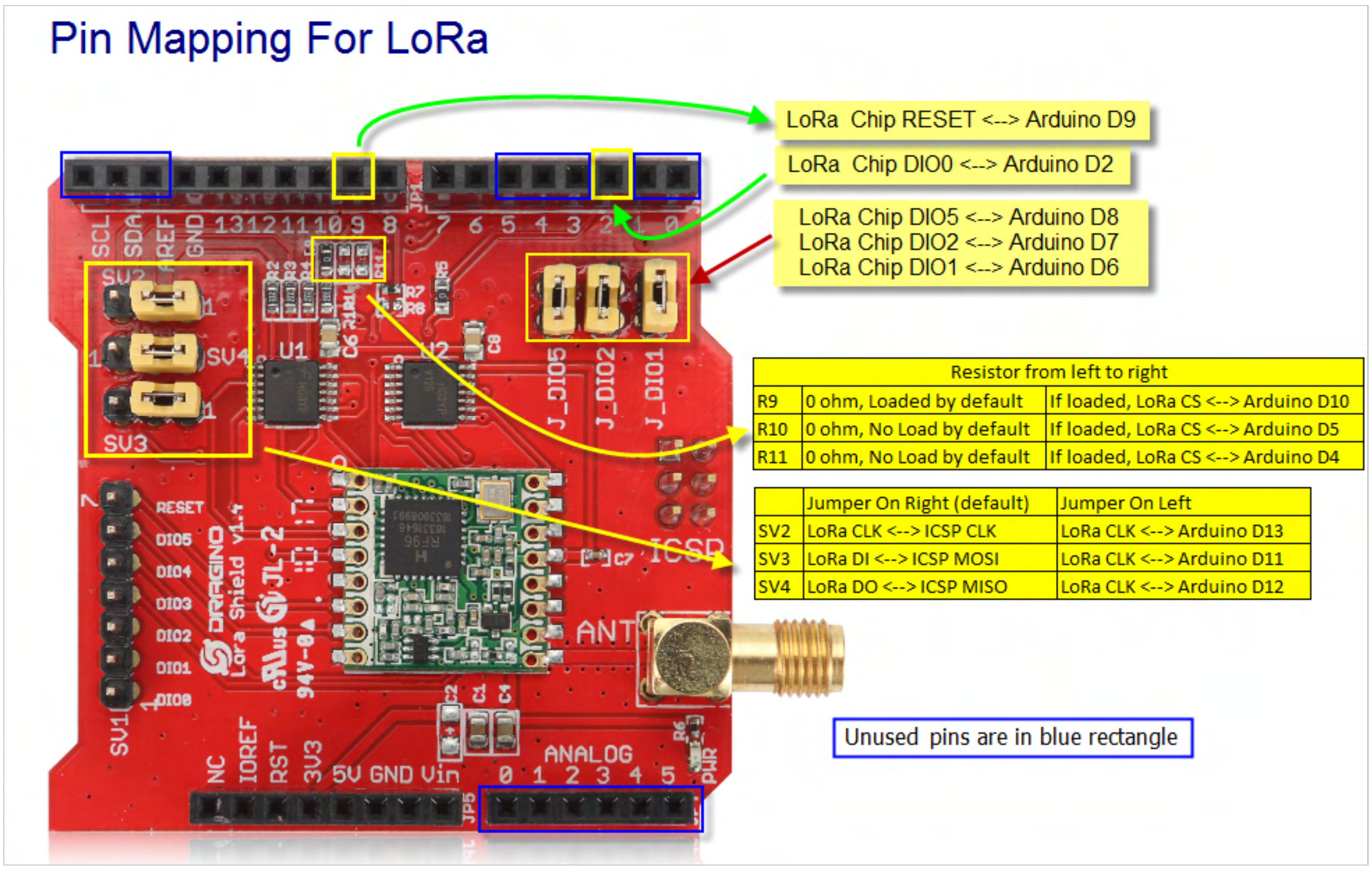
LoRa Shield with Leonado

## Hardware version info

Hardware Source is in: LoRa Shield hardware source (https://github.com/dragino/Lora/tree/master/Lora%20Shield/hardware).

- LoRa Shield v1.0: The first hardware release for the LoRa Shield.
- LoRa Shield v1.2: Connect the DIOs to Arduino IO. Change i-pex connector to SMA connector.
- LoRa Shield v1.3: Remove 5v to 3.3v LDO, use 3.3 directly from Arduino +3.3v pin.
- LoRa Shield v1.4: Add 3 resistors R9/R10/R11. Purpose is to provide possibility to change the Arduino pin connect to LoRa CS pin, so Arudino can easier to connect to multi SPI devices. by default, R9 is populated and R10/R11 is not populated. So LoRa CS is connected to Arduino D10.

## Pin Mapping and Unused Pins



Pin Mapping For LoRa

LoRa Chip RESET <--> Arduino D9

LoRa Chip DIO0 <--> Arduino D2

LoRa Chip DIO5 <--> Arduino D8
LoRa Chip DIO2 <--> Arduino D7
LoRa Chip DIO1 <--> Arduino D6

| Resistor from left to right | | |
|---|---|---|
| R9 | 0 ohm, Loaded by default | If loaded, LoRa CS <--> Arduino D10 |
| R10 | 0 ohm, No Load by default | If loaded, LoRa CS <--> Arduino D5 |
| R11 | 0 ohm, No Load by default | If loaded, LoRa CS <--> Arduino D4 |

| | Jumper On Right (default) | Jumper On Left |
|---|---|---|
| SV2 | LoRa CLK <--> ICSP CLK | LoRa CLK <--> Arduino D13 |
| SV3 | LoRa DI <--> ICSP MOSI | LoRa CLK <--> Arduino D11 |
| SV4 | LoRa DO <--> ICSP MISO | LoRa CLK <--> Arduino D12 |

Unused pins are in blue rectangle

LoRa Shield Pin Mapping

## Wireless Specifications of RFM95W

- 168 dB maximum link budget.
- +20 dBm - 100 mW constant RF output vs.
- +14 dBm high efficiency PA.
- Programmable bit rate up to 300 kbps.
- High sensitivity: down to -148 dBm.
- Bullet-proof front end: IIP3 = -12.5 dBm.
- Excellent blocking immunity.
- Low RX current of 10.3 mA, 200 nA register retention.
- Fully integrated synthesizer with a resolution of 61 Hz.
- FSK, GFSK, MSK, GMSK, LoRaTM and OOK modulation.
- Built-in bit synchronizer for clock recovery.
- Preamble detection.
- 127 dB Dynamic Range RSSI.
- Automatic RF Sense and CAD with ultra-fast AFC.
- Packet engine up to 256 bytes with CRC.
- Built-in temperature sensor and low battery indicator.

## Features

- Compatible with 3.3v or 5v I/O Arduino Board.
- Frequency Band: 915 MHZ/868 MHZ/433 MHZ (Pre-configure in factory)
- Low power consumption
- Compatible with Arduino Leonardo, Uno, Mega, DUE
- External Antenna via I-Pex connector

## Power Consumption

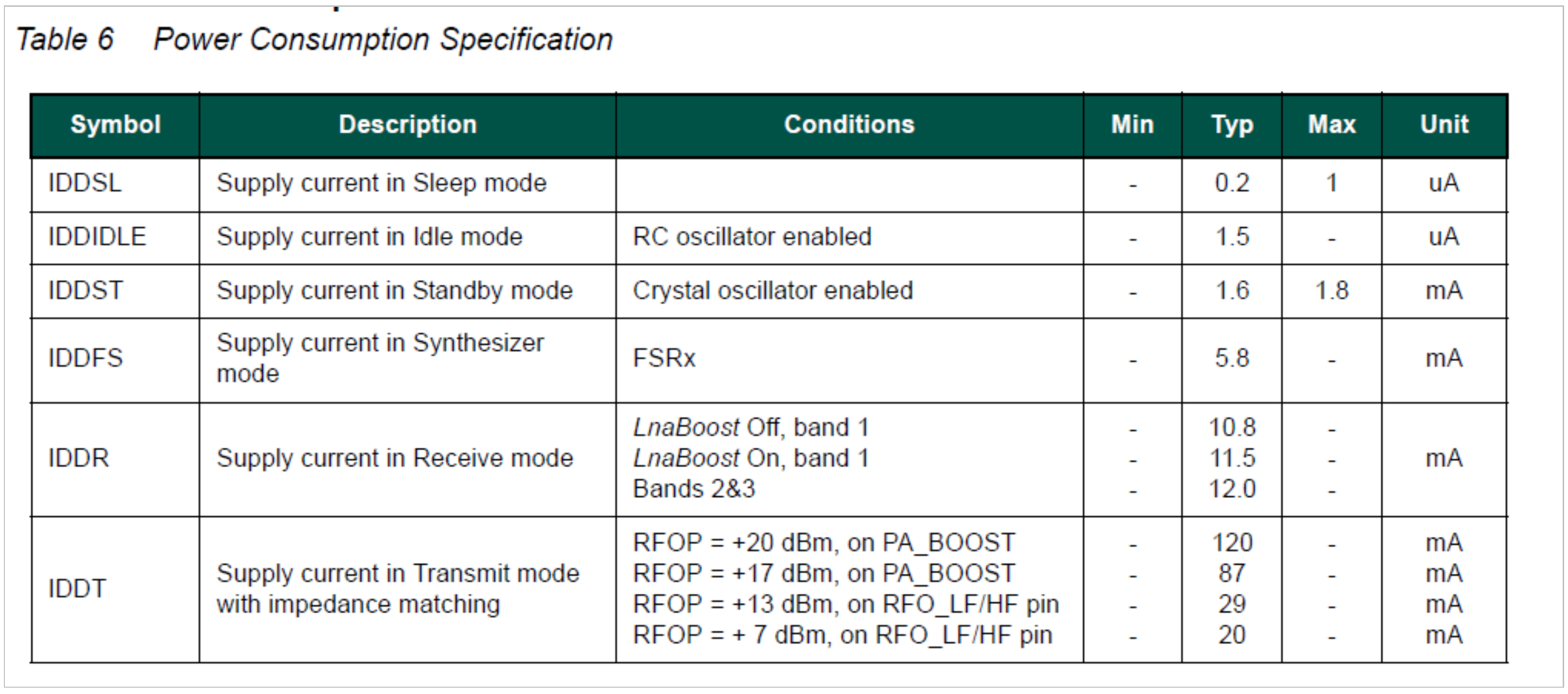


*Table 6 Power Consumption Specification*

| Symbol | Description | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| IDDSL | Supply current in Sleep mode | | - | 0.2 | 1 | uA |
| IDDIDLE | Supply current in Idle mode | RC oscillator enabled | - | 1.5 | - | uA |
| IDDST | Supply current in Standby mode | Crystal oscillator enabled | - | 1.6 | 1.8 | mA |
| IDDFS | Supply current in Synthesizer mode | FSRx | - | 5.8 | - | mA |
| IDDR | Supply current in Receive mode | *LnaBoost* Off, band 1<br>*LnaBoost* On, band 1<br>Bands 2&3 | -<br>-<br>- | 10.8<br>11.5<br>12.0 | -<br>-<br>- | mA |
| IDDT | Supply current in Transmit mode with impedance matching | RFOP = +20 dBm, on PA_BOOST<br>RFOP = +17 dBm, on PA_BOOST<br>RFOP = +13 dBm, on RFO_LF/HF pin<br>RFOP = + 7 dBm, on RFO_LF/HF pin | -<br>-<br>-<br>- | 120<br>87<br>29<br>20 | -<br>-<br>-<br>- | mA<br>mA<br>mA<br>mA |

Power Consumption

## Dimension

- Device Dimension: 62 x 43 x 23 mm
- Device Weight: 22g
- Package Dimension: 111 x 70 x 36 mm
- Package Weight: 53g

# Use Examples

## Example1 -- Use with LMIC library for LoRaWAN compatible

LMIC library is LoRaWAN compatible.

This demo include:

- How to use LoRa Shield to set up single channel gateway for TTN network.
- How to use LoRa Shield to set up a LoRa Node.
- How is the communication between the LoRa Node and LoRa Gateway.

Use the LMIC with **868MHZ** Dragino LoRa boards:

The full instruction is in this link: [1] (http://www.instructables.com/id/Use-Lora-Shield-and-RPi-to-Build-a-LoRaWAN-

Gateway/)

Use the LMIC with **915MHZ** Dragino LoRa boards:

The operations similar to "Use the LMIC with 868MHZ Dragino Lora boards (http://www.instructables.com/id/Use-Lora-Shield-and-RPi-to-Build-a-LoRaWAN-Gateway/)".

You need to make following changes here:

### 1.Copy this code (https://github.com/dragino/Lora/blob/master/Lora%20Shield/Examples/lora_shield_ttn-915-fix-frequency/lora_shield_ttn-915-fix-frequency.ino) to you IDE and upload the sketch to your Arduino board:

There,you can also add below code to your sketch to check the **current emission frequency**:

```
Serial.println(LMIC.freq);
```

### 2.Edit "config.h"

change

```
#define CFG_eu868 1
```

to

```
#define CFG_us915 1
```

**3.Edit "lmic.c"**,about on the line 760,

change

```
void LMIC_disableChannel (u1_t channel) {
    if( channel < 72+MAX_XCHANNELS )
        LMIC.channelMap[channel/4] &= ~(1<<(channel&0xF));
}
```

to

```
void LMIC_disableChannel (u1_t channel) {
    if( channel < 72+MAX_XCHANNELS )
        LMIC.channelMap[channel/16] &= ~(1<<(channel&0xF));
}
```

**4.Edit the "main.cpp"** to "Set center frequency" on your Raspberry Pi.

change

```
uint32_t freq = 868100000; //in Mhz! (868.1)
```

to

```
uint32_t freq = 915000000; //in Mhz! (915.0)
```

The other operations please refer to Use the LMIC with 868MHZ Dragino LoRa boards (http://www.instructables.com/id/Use-Lora-Shield-and-RPi-to-Build-a-LoRaWAN-Gateway/).

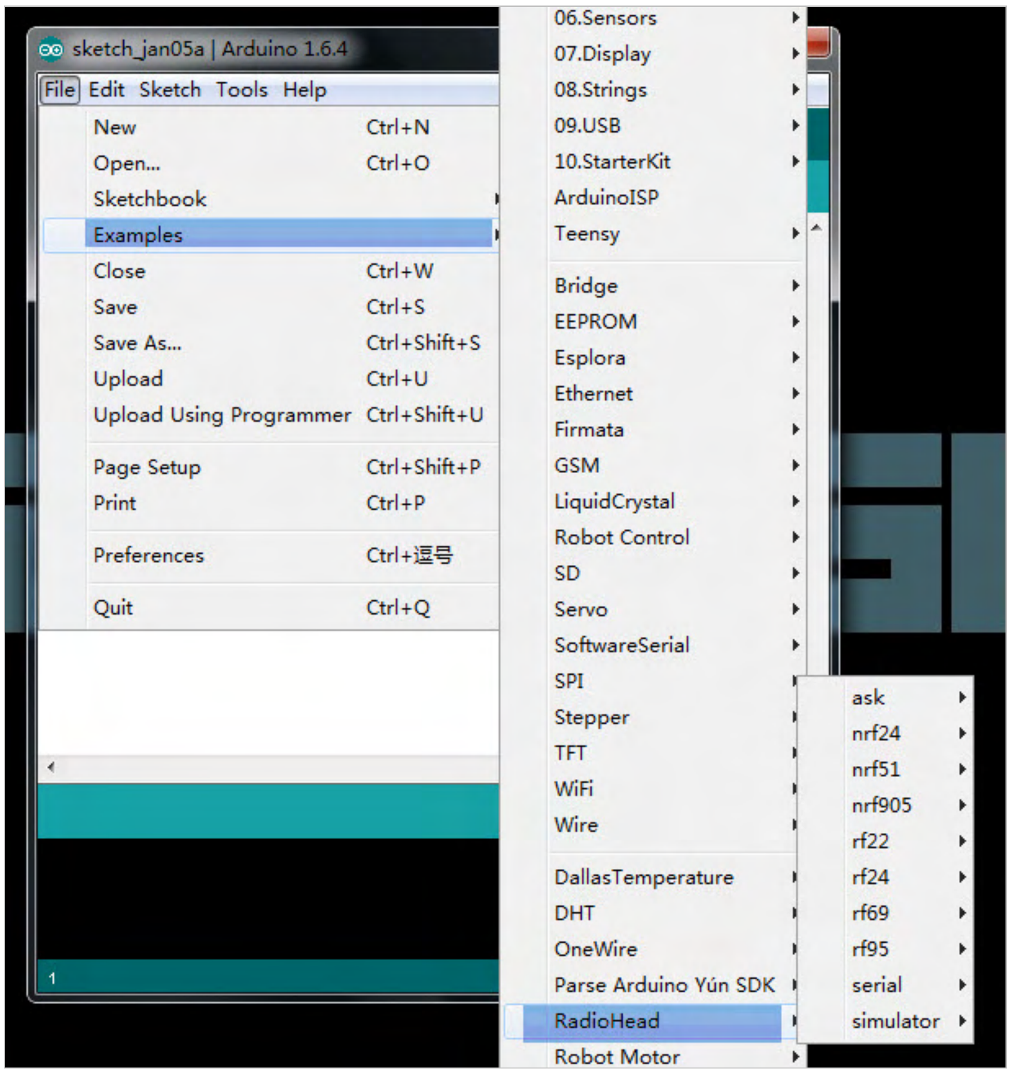
## Example2 -- Use the RadioHead Library With Arduino Boards

The RadioHead Library simplifies communication between the Arduino Board and the LoRa Shield.We can find it here: http://www.airspayce.com/mikem/arduino/RadioHead/ To use it in your project you just have to copy it in your Arduino project folder (next to your main Arduino project file .ino).

Compile Notice:

- Check if you have set the right frequency:After putting the library in the right place, you have to also modify the frequency to the frequency you want to use, the position of this is setFrequency() in the file: arduino-xxx\libraries\RadioHead\RH_RF95.cpp;
- The RF95-server sketch use the led=9 to show the status. please change it to other LED , such 8. because 9 is connected to the LoRa module's RESET pin. you will see 'init fail' in the default server sketch

Then ,we can easily to use it to do some experimentation.

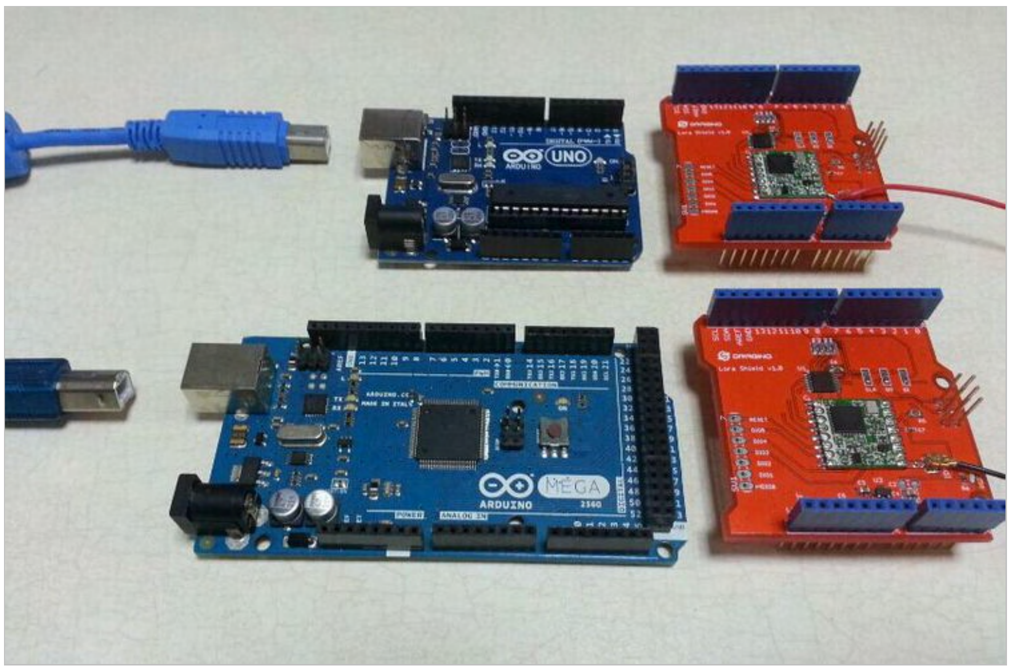


RadioHead Examples

In this example,we use two LoRa Shields to transmit and receive signal,there are some project in the RadioHead Library,the operation is as follows:

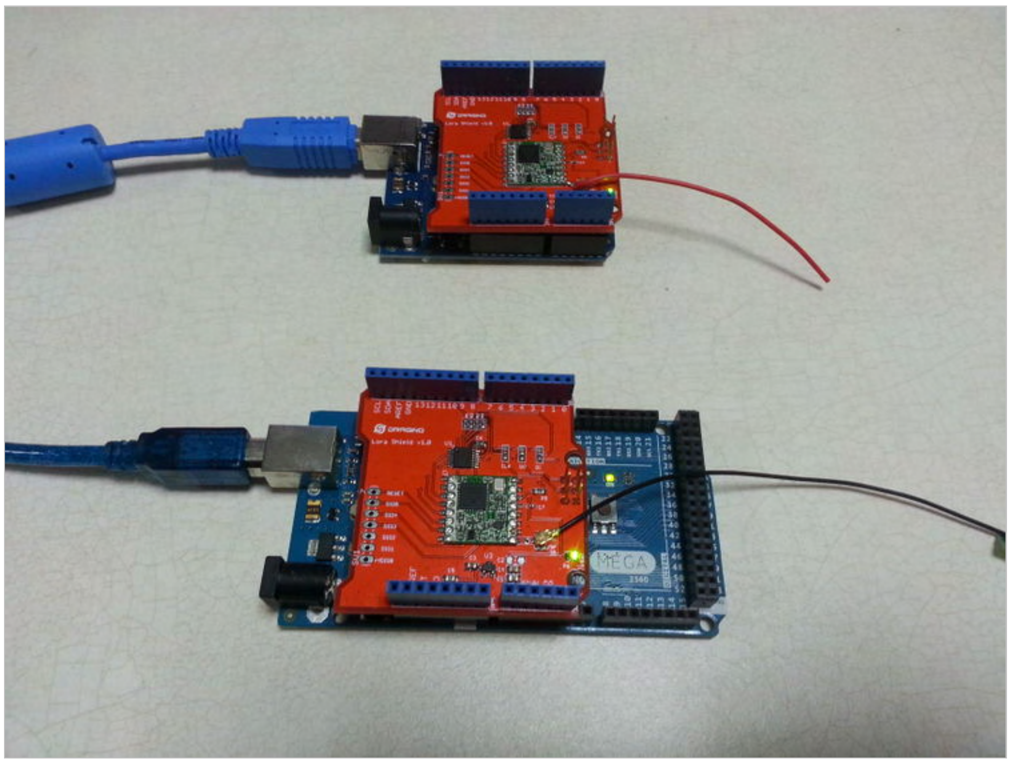
- Connect two LoRa Shields with Arduino board and connect them to computer via the USB cable;

We used the LoRa Shield+Arduino UNO as the server to transmit signal and the LoRa Shield+Aduino MEGA2560 as the client to receive signal here.



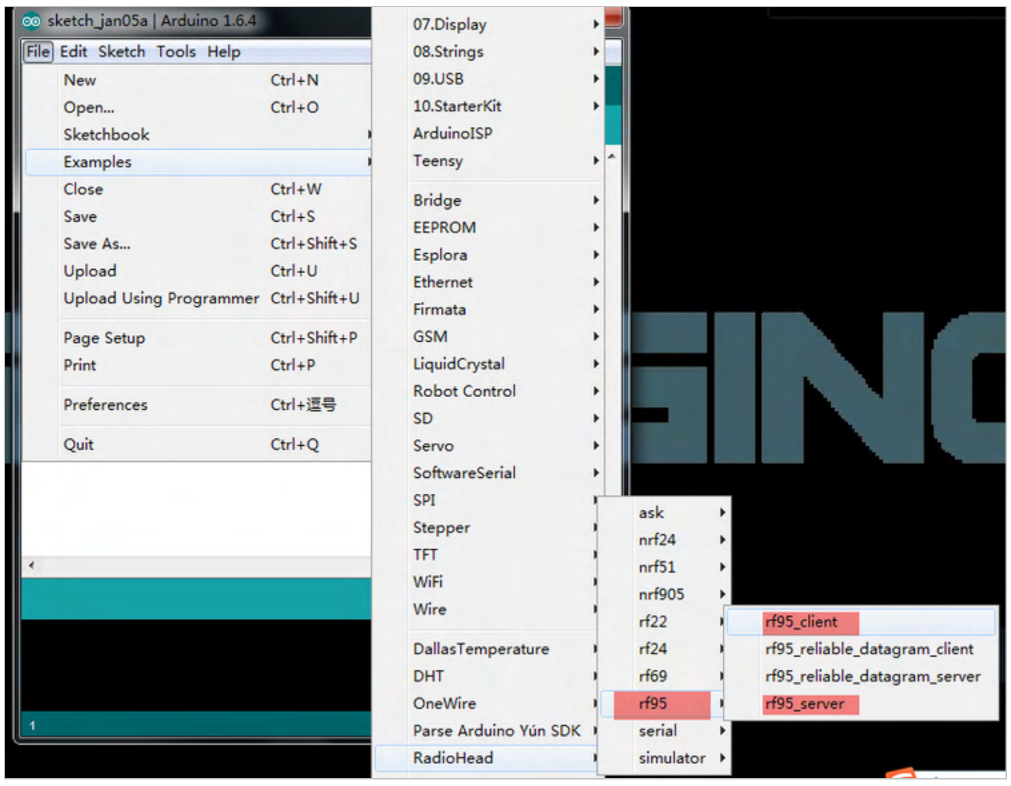
Lora Shields and Arduino boards

Connect the LoRa Shield and Arduino,and connect them to computer.



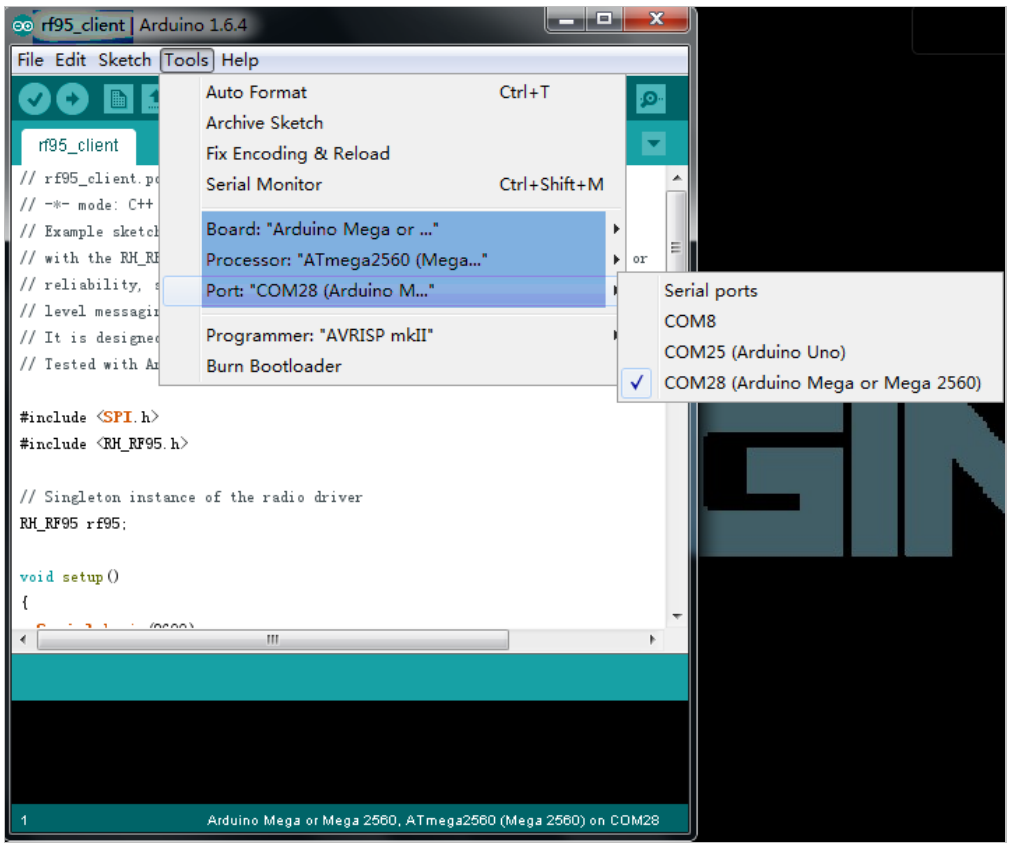
Connection

- Open the IDE and choose the right example;



Choose the example

- Configure the IDE settings and upload the two skteches to Aduino.

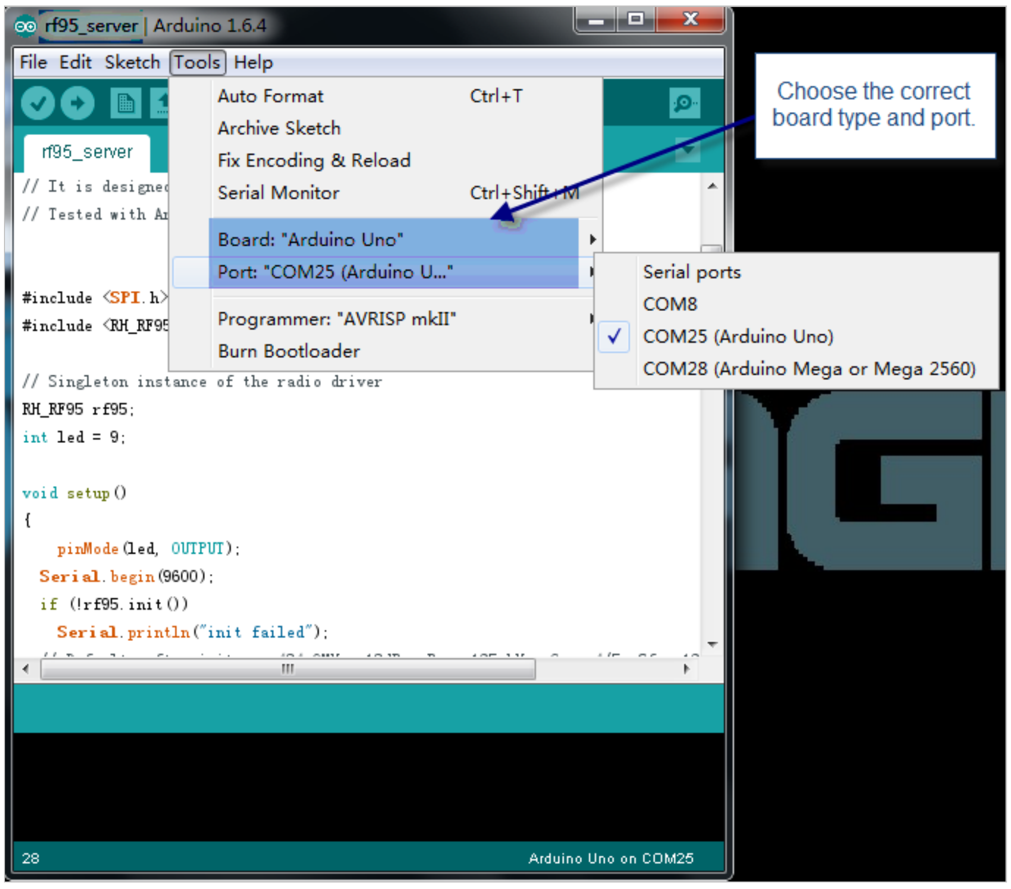


Board: "Arduino Mega or ..."
Processor: "ATmega2560 (Mega..."
Port: "COM28 (Arduino M..."
✓ COM28 (Arduino Mega or Mega 2560)

```
// rf95_client.pc
// -*- mode: C++
// Example sketch
// with the RH_RF
// reliability, s
// level messagin
// It is designed
// Tested with Ar

#include <SPI.h>
#include <RH_RF95.h>

// Singleton instance of the radio driver
RH_RF95 rf95;

void setup()
{
```

1 Arduino Mega or Mega 2560, ATmega2560 (Mega 2560) on COM28

Configure the IDE settings of MEGA

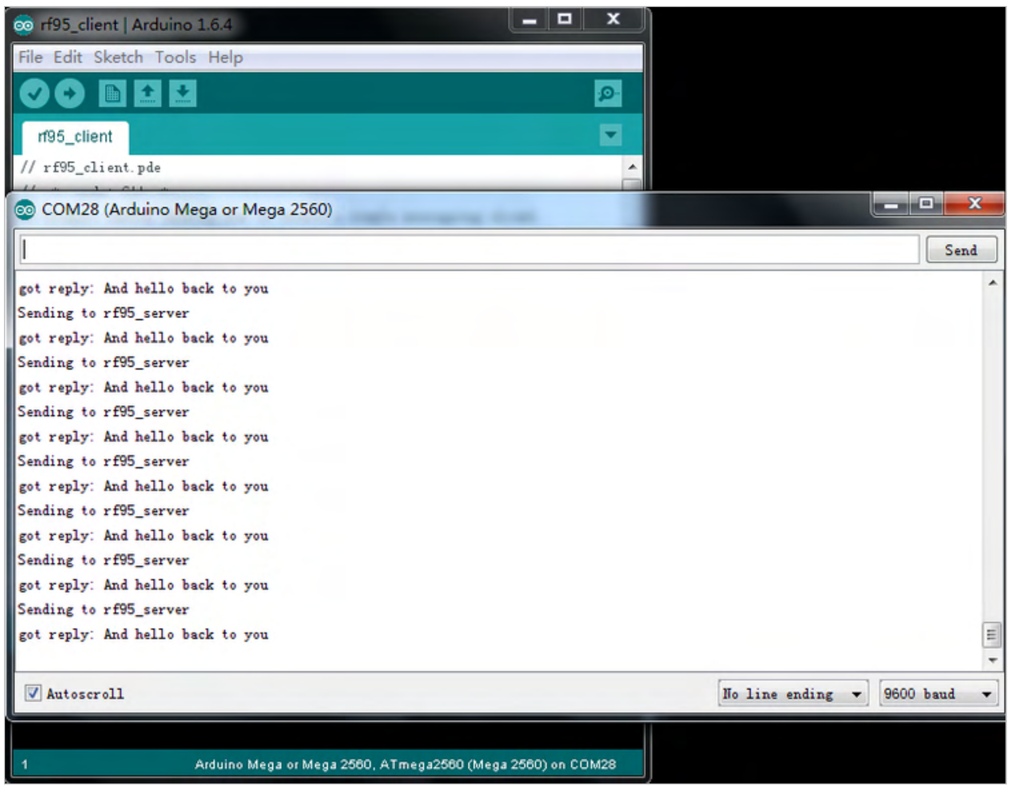

rf95_server | Arduino 1.6.4
File Edit Sketch Tools Help
Auto Format Ctrl+T
Archive Sketch
Fix Encoding & Reload
Serial Monitor Ctrl+Shift+M
Board: "Arduino Uno"
Port: "COM25 (Arduino U..."
Programmer: "AVRISP mkII"
Burn Bootloader
Serial ports
COM8
✓ COM25 (Arduino Uno)
COM28 (Arduino Mega or Mega 2560)
rf95_server
28
Arduino Uno on COM25

Choose the correct board type and port.

```
// It is designe
// Tested with Ar


#include <SPI.h>
#include <RH_RF95

// Singleton instance of the radio driver
RH_RF95 rf95;
int led = 9;

void setup()
{
    pinMode(led, OUTPUT);
  Serial.begin(9600);
  if (!rf95.init())
    Serial.println("init failed");
```

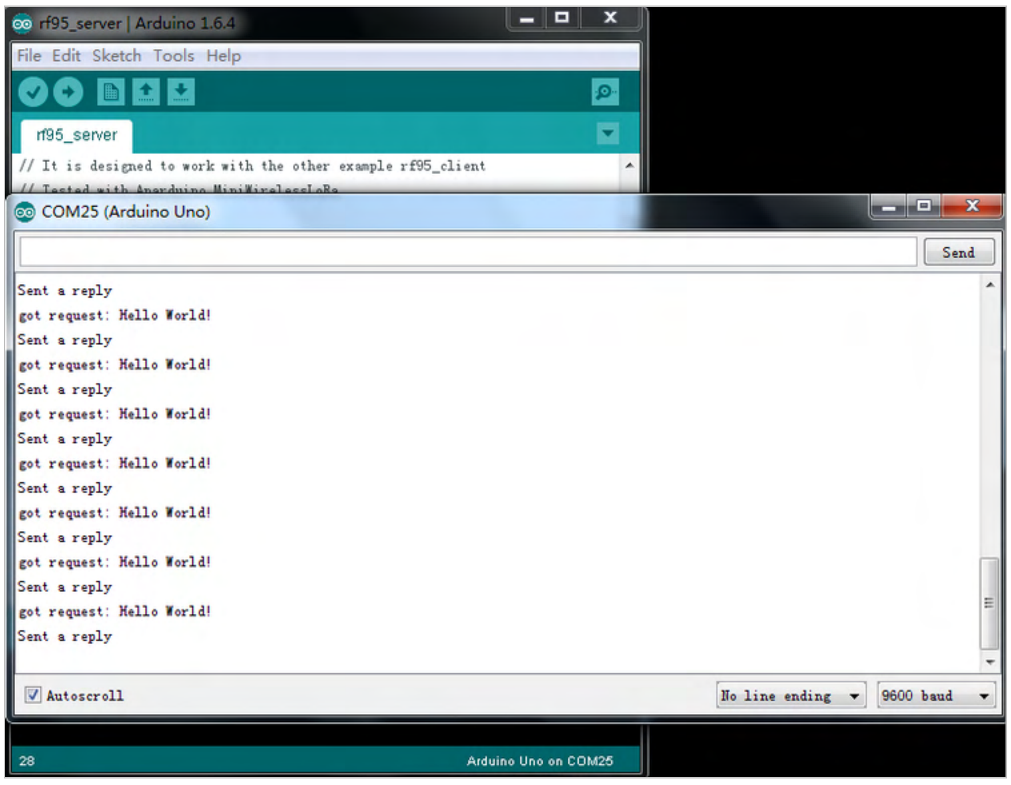
Configure the IDE settings of UNO

After configure the IDE settings,upload the skteche to Aduino.Check the Serial Moniter and we can view the running result of the two boards.


rf95_client | Arduino 1.6.4
File Edit Sketch Tools Help
rf95_client
// rf95_client.pde
COM28 (Arduino Mega or Mega 2560)
Send
☑ Autoscroll
No line ending
9600 baud
1
Arduino Mega or Mega 2560, ATmega2560 (Mega 2560) on COM28

```
got reply: And hello back to you
Sending to rf95_server
got reply: And hello back to you
Sending to rf95_server
got reply: And hello back to you
Sending to rf95_server
got reply: And hello back to you
Sending to rf95_server
got reply: And hello back to you
Sending to rf95_server
got reply: And hello back to you
Sending to rf95_server
got reply: And hello back to you
Sending to rf95_server
got reply: And hello back to you
```

Running result of MEGA

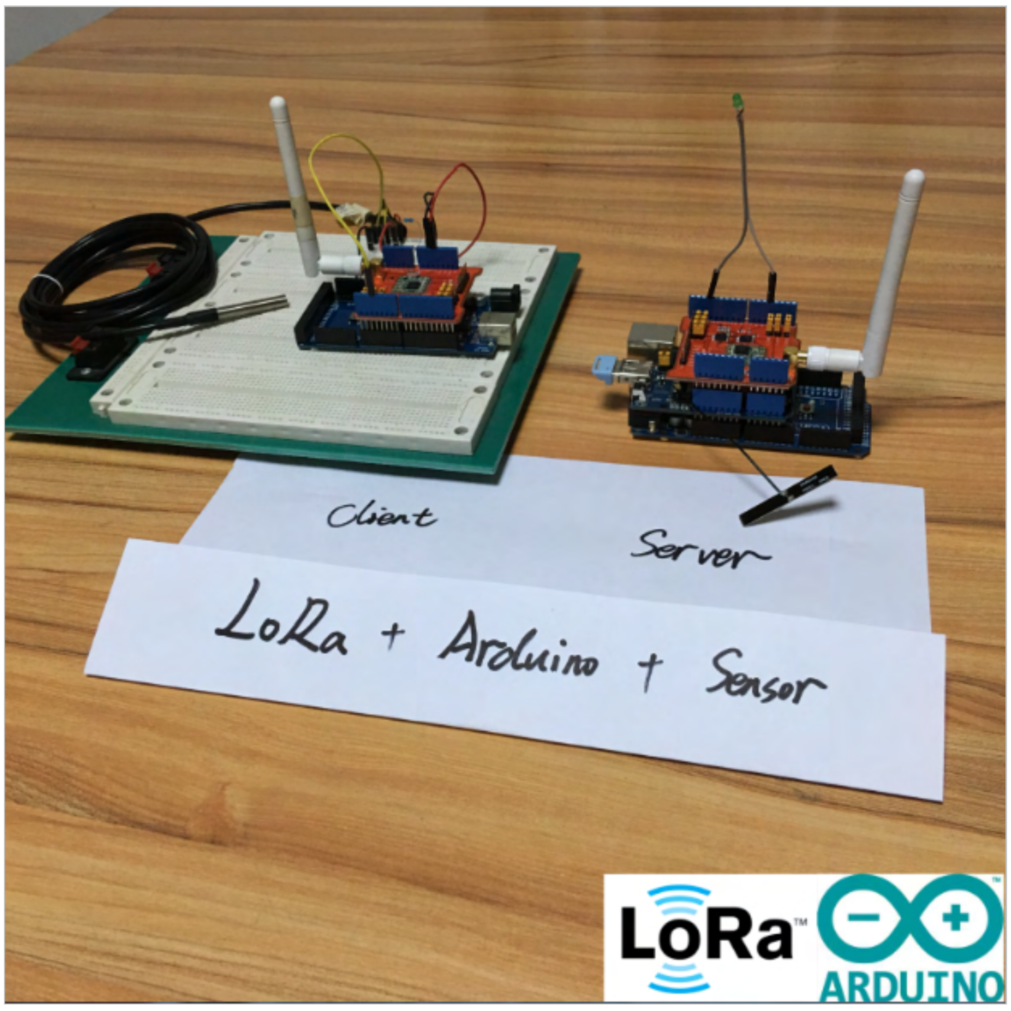


```
// It is designed to work with the other example rf95_client
```

```
Sent a reply
got request: Hello World!
Sent a reply
got request: Hello World!
Sent a reply
got request: Hello World!
Sent a reply
got request: Hello World!
Sent a reply
got request: Hello World!
Sent a reply
got request: Hello World!
Sent a reply
got request: Hello World!
Sent a reply
```

Running result of UNO

## Example3 -- How to get sensor data from a remote Arduino via Wireless LoRa Protocol



LoRa Temperature Project

This is an example to show how to get sensor data from a remote Arduino via Wireless LoRa Protocol. The exampels requries below hardwares:

1) Client Side: Arduino + LoRa Shield (868Mhz) + DS18B20 (Temperature Sensor).

2) Server Side: Arduino + LoRa Shield (868Mhz) + Yun Shield + USB flash.

make sure the USB flash has this file datalog.csv in the data directory of root.

Requrie below software: Radiohead library from: http://www.airspayce.com/mikem/arduino/RadioHead/...

Client side will get the temperature and keep sending out to the server via LoRa wireless. Server side will listin on the LoRa wireless frequency, once it get the data from Client side, it will turn on the LED and log the sensor data to a USB flash.

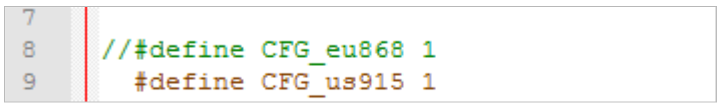
The full instruction is in this link: http://www.instructables.com/id/How-to-Get-Sensor-Data-From-a-Remote-Arduino-Via-W/

## Example4 -- LMIC-RAW-915

This example is for the **LoRa Shield 915** users.We use the library "arduino-lmic" in this project.Over here,we use the things below to complete this project.

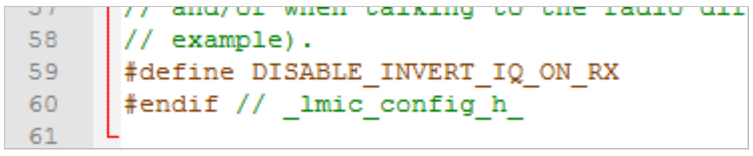
- Dragino LoRa Shield(915) x 2
- Arduino board x 2
- Antenna (915MHZ) x 2
- USB cable
- Power supply

Connected the hardware,edit the "config.h" of LMIC library,change the "#define CFG_eu868 1" to "#define CFG_us915 1".This example requires DISABLE_INVERT_IQ_ON_RX to be set.**Uncomment** "#define DISABLE_INVERT_IQ_ON_RX" (line 59 of config.h),save settings.



```
7
8   //#define CFG_eu868 1
9     #define CFG_us915 1
```

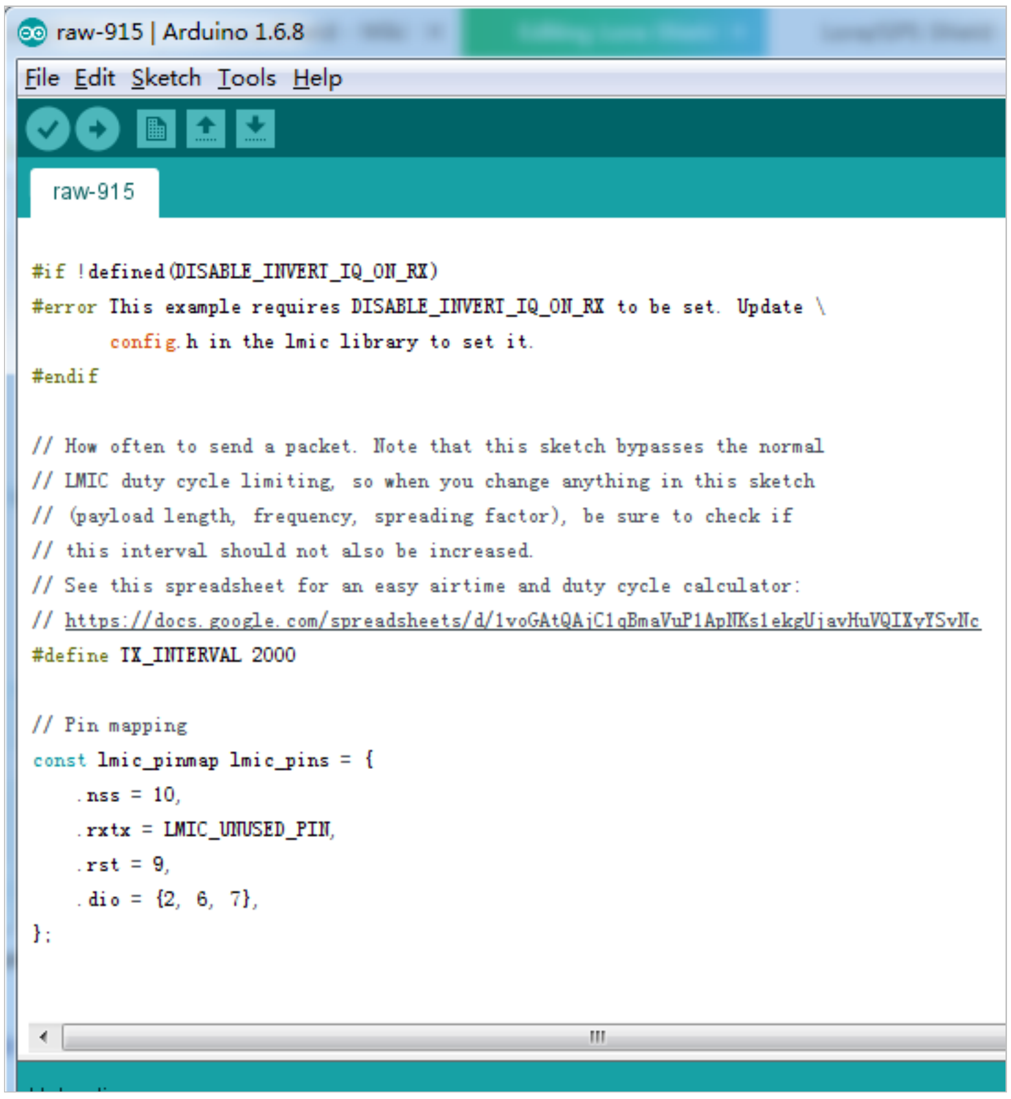
LMIC config 1



```
57   // and/or when talking to the radio dir
58   // example).
59   #define DISABLE_INVERT_IQ_ON_RX
60   #endif // _lmic_config_h_
61
```

LMIC config 2

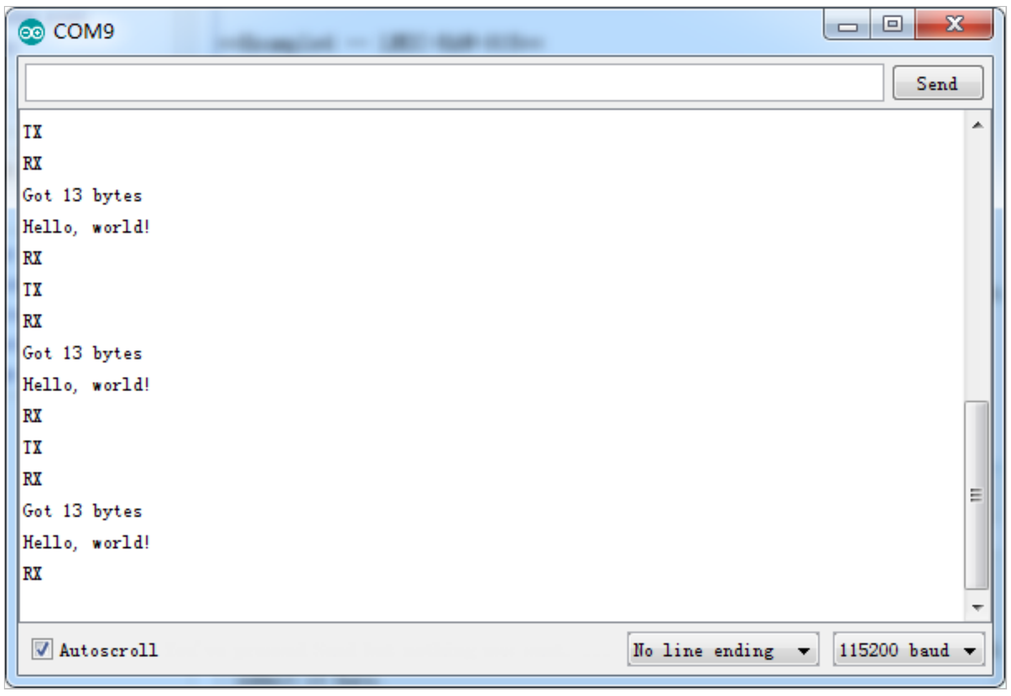
Open the IDE(1.6.8 here),choose the correct board and correct port,then upload the sktech "lmic-raw-915 (https://github.com/dragino/Lora/blob/master/Lora%20Shield/Examples/lmic-raw-915/lmic-raw-915.ino)" to the two arduino boards.



```
#if !defined(DISABLE_INVERT_IQ_ON_RX)
#error This example requires DISABLE_INVERT_IQ_ON_RX to be set. Update \
       config.h in the lmic library to set it.
#endif

// How often to send a packet. Note that this sketch bypasses the normal
// LMIC duty cycle limiting, so when you change anything in this sketch
// (payload length, frequency, spreading factor), be sure to check if
// this interval should not also be increased.
// See this spreadsheet for an easy airtime and duty cycle calculator:
// https://docs.google.com/spreadsheets/d/1voGAtQAjC1qBmaVuP1ApNKs1ekgUjavHuVQIXyYSvNc
#define TX_INTERVAL 2000

// Pin mapping
const lmic_pinmap lmic_pins = {
    .nss = 10,
    .rxtx = LMIC_UNUSED_PIN,
    .rst = 9,
    .dio = {2, 6, 7},
};
```

LMIC_RAW_915

Open the Serial Monitor and you can see the running result as below:



```
TX
RX
Got 13 bytes
Hello, world!
RX
TX
RX
Got 13 bytes
Hello, world!
RX
TX
RX
Got 13 bytes
Hello, world!
RX
```

Running result of raw-915

# Example5 -- Set up as a LoRa Gateway using the LowCostLoRaGw library

The LowCostLoraGw source code (https://github.com/CongducPham/LowCostLoRaGw) provides good examples to shows how to use RPi to set data to the IoT provider and Dropbox. The LoRa Shield and LoRa and LoRa/GPS Hat can work with these examples, by doing some modifications as below:

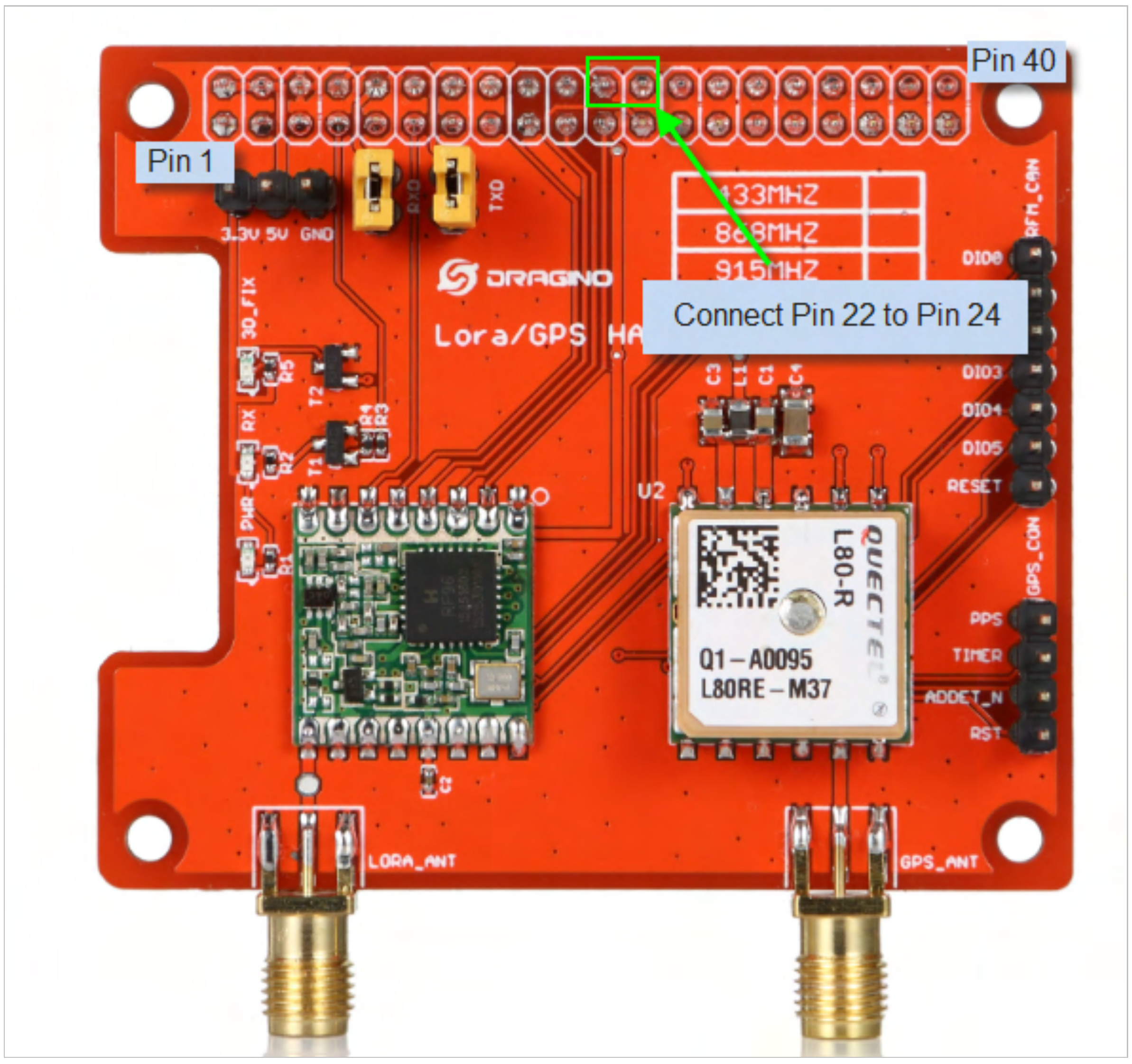
When use LoRa Shield with Arduino, what need to modify is:

```
In the sketch:
// uncomment if your radio is an HopeRF RFM92W or RFM95W
#define RADIO_RFM92_95
```

```
In the code: SX1272.h
change #define SX1272_RST  3 to #define SX1272_RST  9
change #define SX1272_SS 2 to #define SX1272_SS 10
```

When use LoRa/GPS HAT with RPi 2/3, what need to modify is:

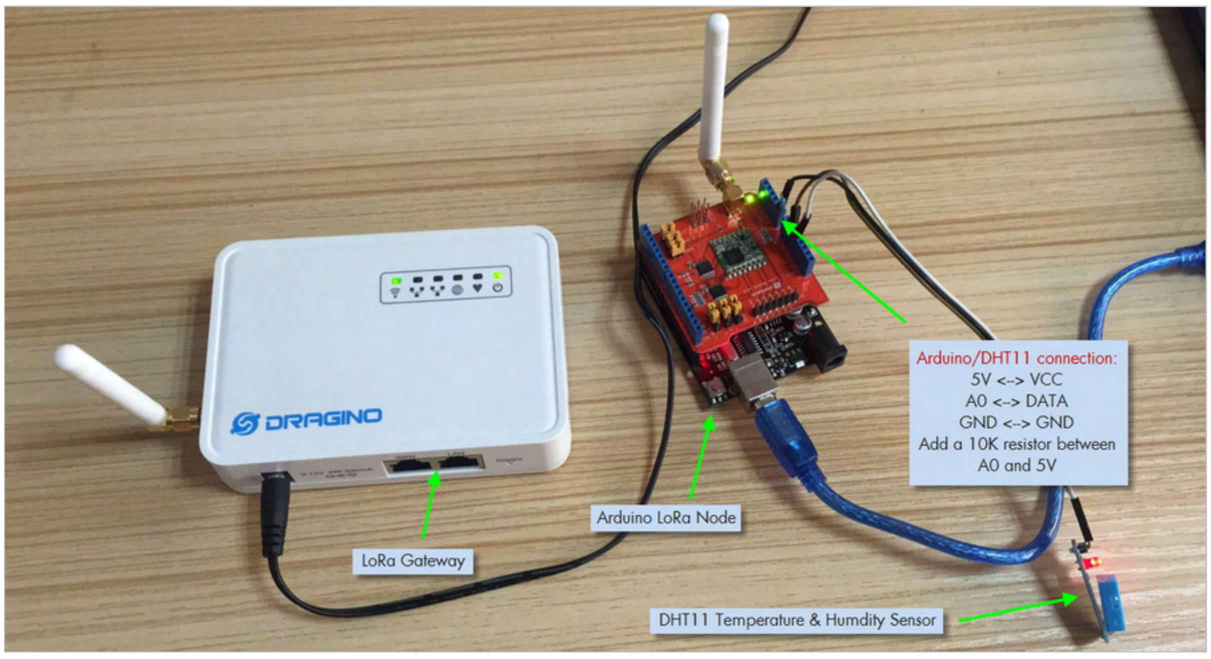
```
Solder the pin22 and pin24. for CS pin use in this library.
otherwise you will see below error:
pi@raspberrypi:~/lora_gateway$ sudo ./lora_gateway
Unrecognized transceiver.
...
```



Use LoRa /GPS HAT with LowCostLoraGw source code

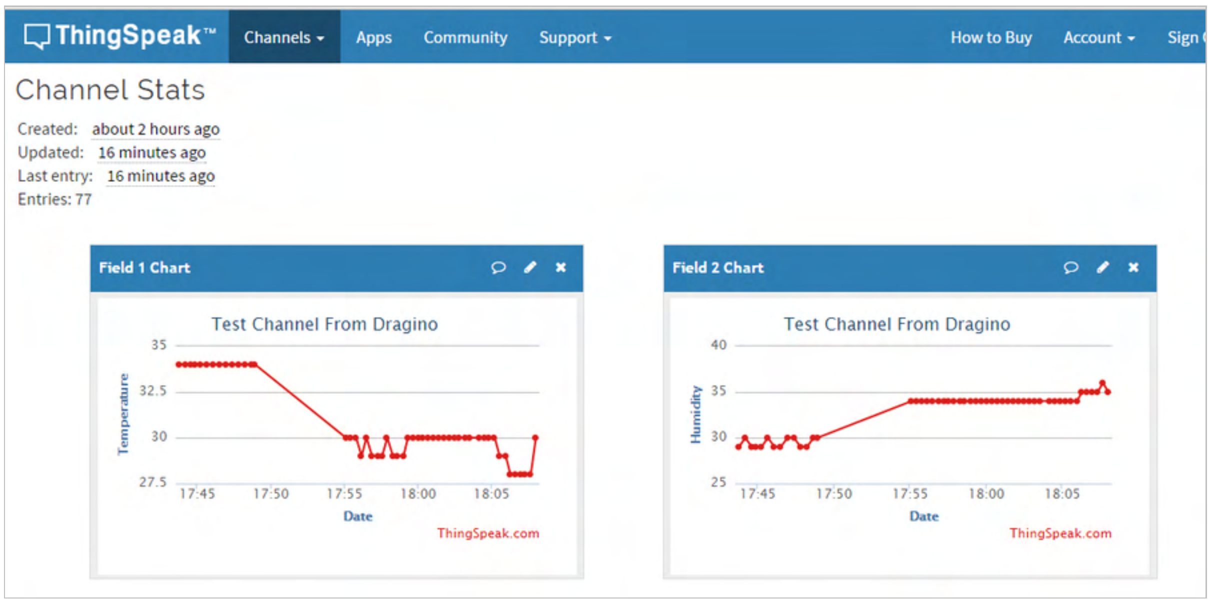
## Example6 -- Upstream/Downstream to ThingSpeak IoT Server

Examples for ThingSpeak are in the LG01 user manual. Please click here (http://www.dragino.com/downloads/index.php?dir=UserManual/&file=LG01_LoRa_Gateway_User_Manual.pdf) for details.



Arduino/DHT11 connection:
5V <--> VCC
A0 <--> DATA
GND <--> GND
Add a 10K resistor between
A0 and 5V

ThingSpeak SetUp



Channel Stats

Created: about 2 hours ago
Updated: 16 minutes ago
Last entry: 16 minutes ago
Entries: 77

ThingSpeak Test Result

The Examples (Source Code (https://github.com/dragino/Arduino-Profile-Examples/tree/master/libraries/Dragino/examples/IoTServer/ThingSpeak)) Include:

- How to upload get data from remote LoRa wireless node and upload it to ThingSpeak
- How to get commands in ThingSpeak and control a remote LoRa wireless node's relay

## Example7 -- use the Dragino LoRa shield with Arduino MKR 1010

Example provided by:Robin Kluth

See the link from: use the Dragino LoRa shield with Arduino MKR 1010 (http://www.dragino.com/downloads/index.php?dir=LoraShield/&file=How%20to%20use%20the%20Dragino%20LoRa%20shield%20with%20Arduino%20MKR%201010.docx)

## Usage Notice

You have to be aware that Radio link quality and performances are highly dependent of environment.

Better performances can be reached with:

- Outdoor environment.
- No obstacles.
- No high level radio interferer in the ISM 868MHz band.
- At least 1 meter above the ground.

Radio performances are degraded with:

- Obstacles: buildings, trees...
- Inner buildings environments.
- High ISM 868MHz band usage by other technologies.

Radio communication are usually killed with bad topographic conditions. It is usually not possible to communicate through a hill, even very small.

# Order Infomation

- LoRa Shield 868: support 868M frenquency
- LoRa Shield 915: support 915M frenquency
- LoRa Shield 433: support 433M frenquency