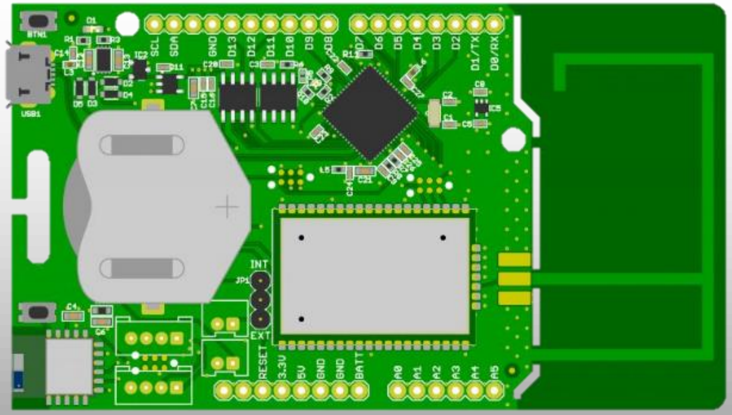
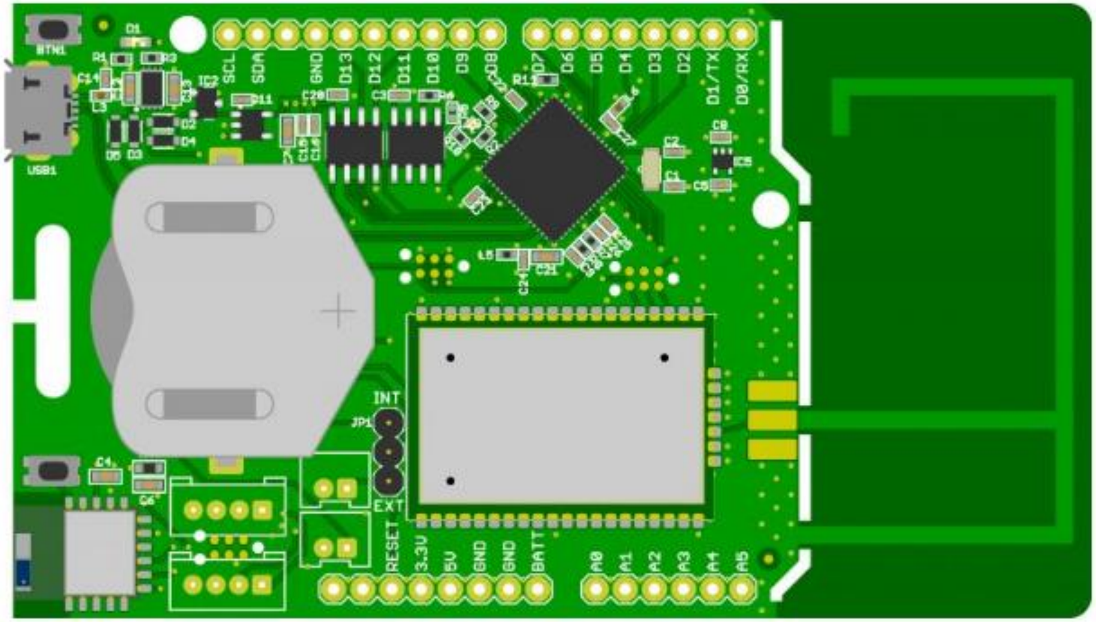
ExpLoRer Starter Kit User Guide



Introducing: ExpLoRer



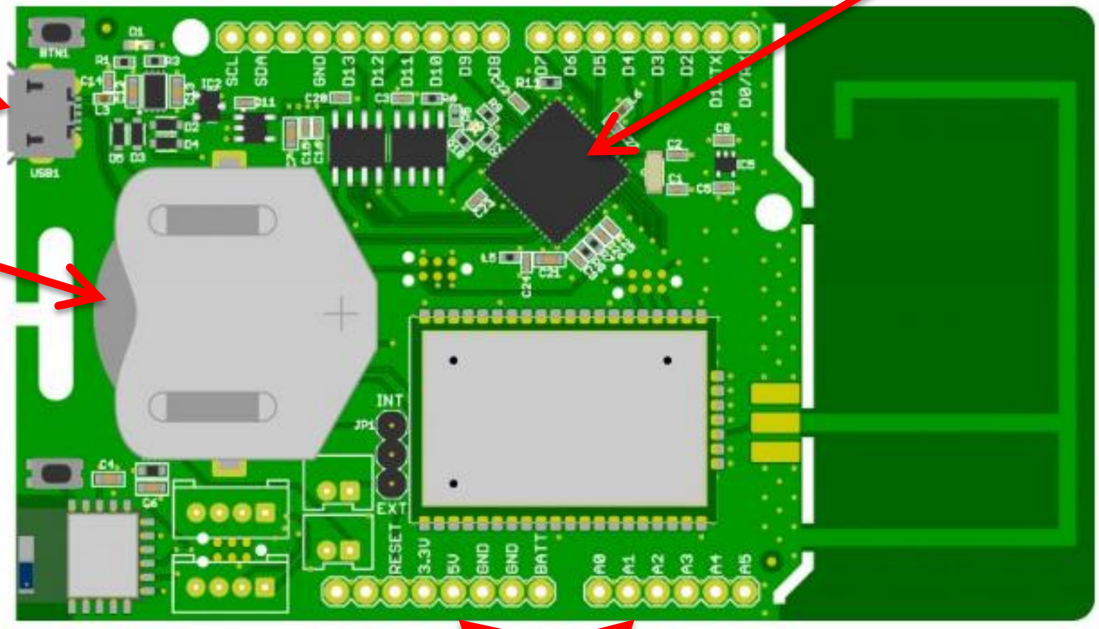
Why Arduino??

- **Open Source**
- **Industry standard**
- **Easily accessible**
  - Free IDEs
  - No flashing tools needed – only a USB cable
  - Simple structure (setup & loop) with examples
- **Excellent HAL**
  - Re-use projects across AVR, PIC, Cortex cores
- **Hugely popular!**

ExpLoRer - Arduino

Micro USB:
Arduino IDE
& charging

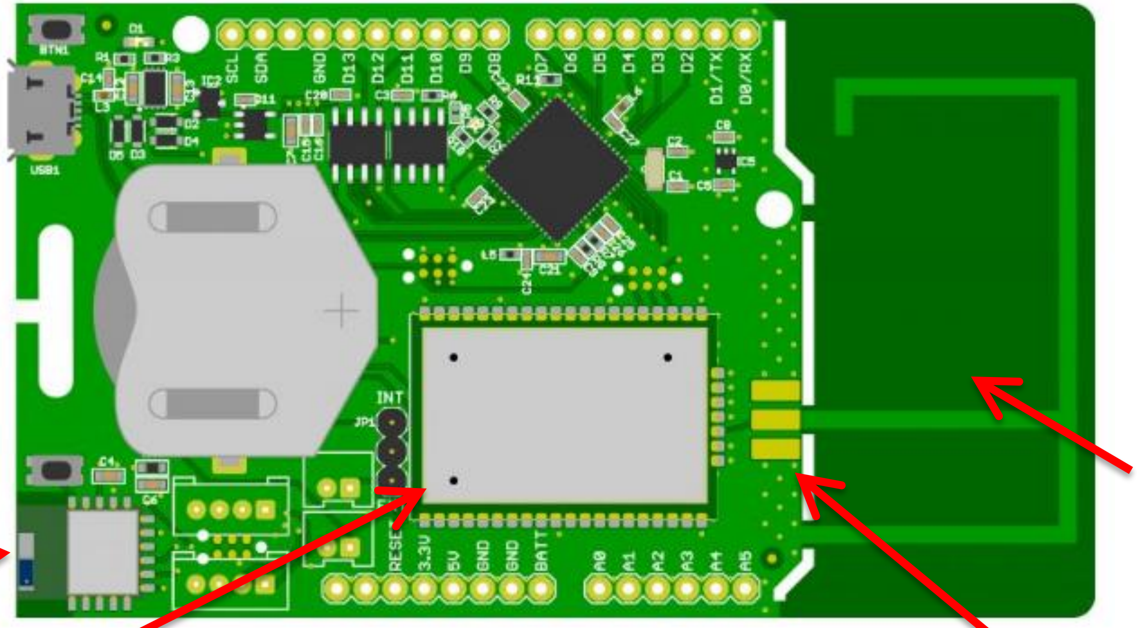
Atmel SAM-D21
Cortex®-M0+ based
microcontroller



LiR2450
rechargeable
battery
120mAh, 3.6V

Standard headers
for feature expansion
(sensors, GPS, solar)

ExpLoRer - Wireless



Low-cost (removable) PCB IFA antenna

RN4871 BT-Smart

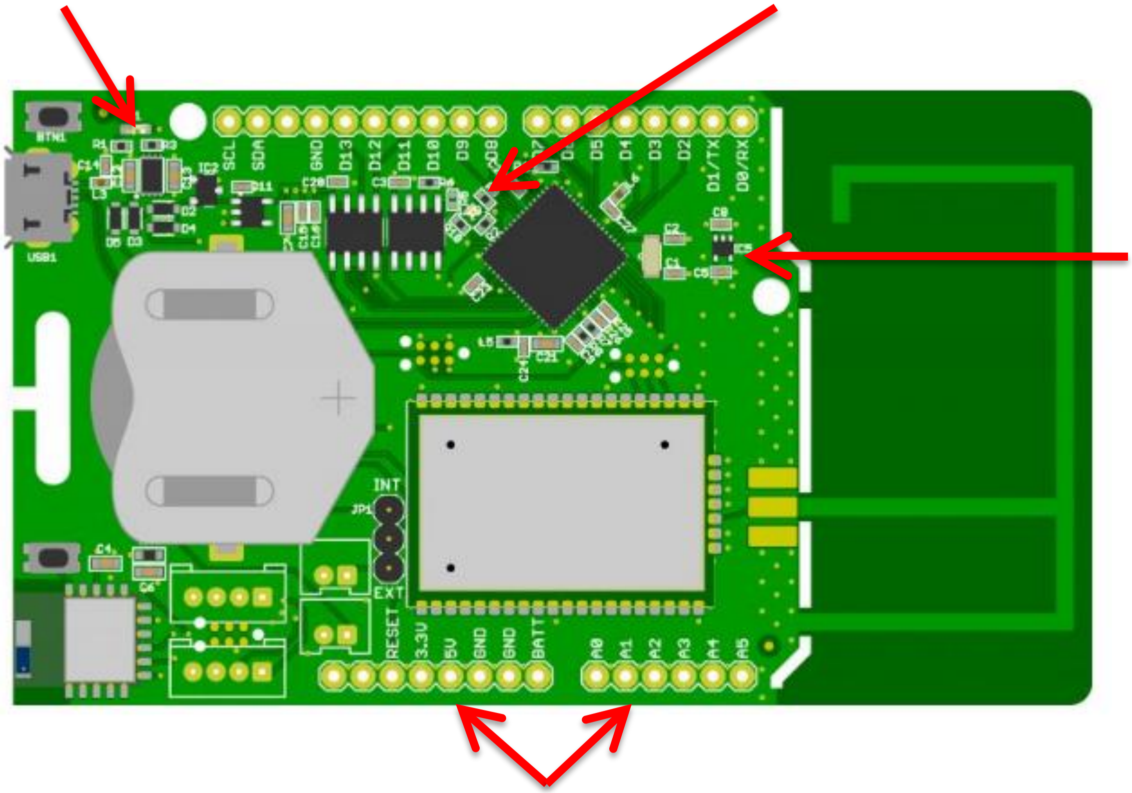
RN2483a LoRaWAN

Footprint for optional SMA

ExpLoRer

Blue LED

RGB LED for status Indication

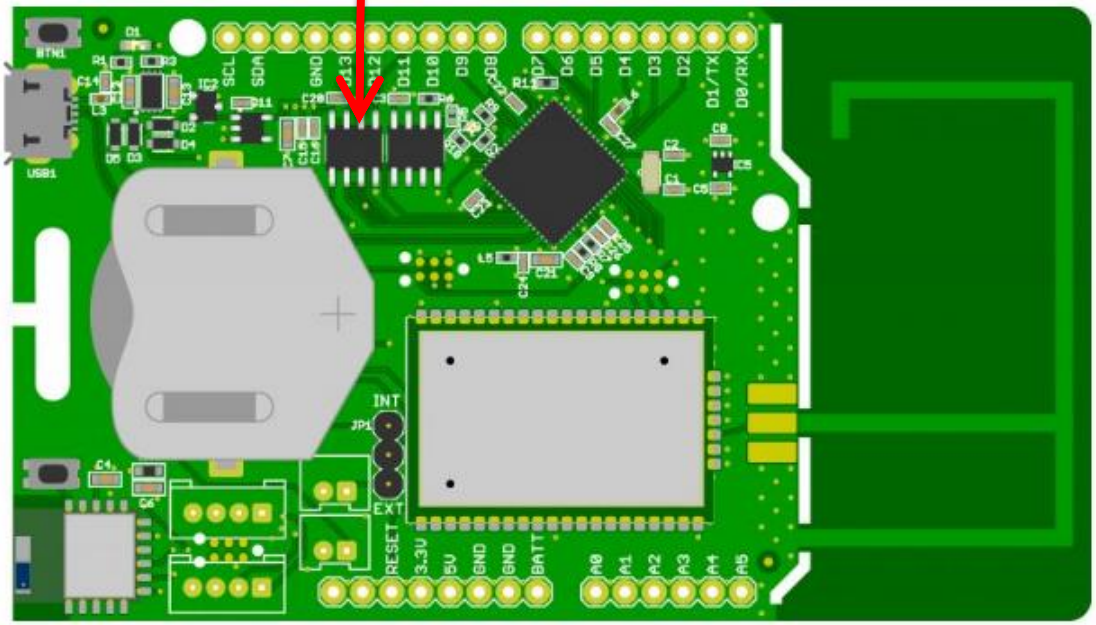


MCP9700AT Temperature Sensor

Standard headers for feature expansion (sensors, GPS, solar)

ExpLoRer - Security

ECC508A
Crypto Device



ExpLoRer

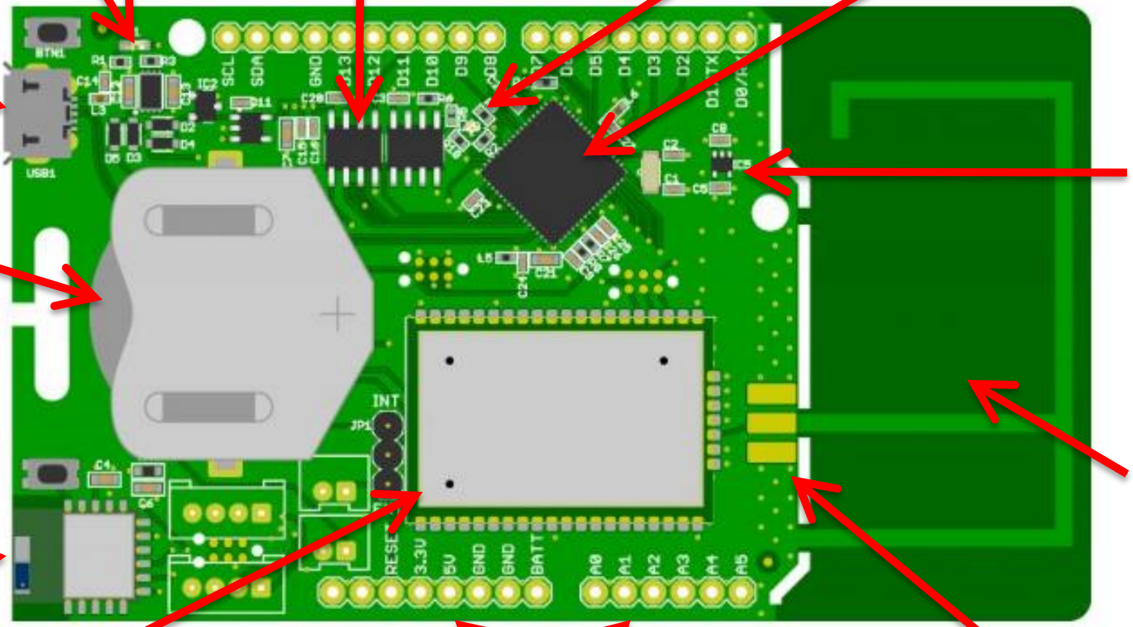
Micro USB:
Arduino IDE
& charging

Blue
LED

ECC508A
Crypto Device

RGB LED for status
Indication

Atmel SAM-D21
Cortex®-M0+ based
microcontroller



LiR2450
rechargeable
battery
120mAh, 3.6V

MCP9700AT
Temperature
Sensor

Low-cost
(removable)
PCB IFA
antenna

RN4871
BT-Smart

RN2xx3
LoRaWAN

Standard headers
for feature expansion
(sensors, GPS, solar)

Footprint for
optional SMA

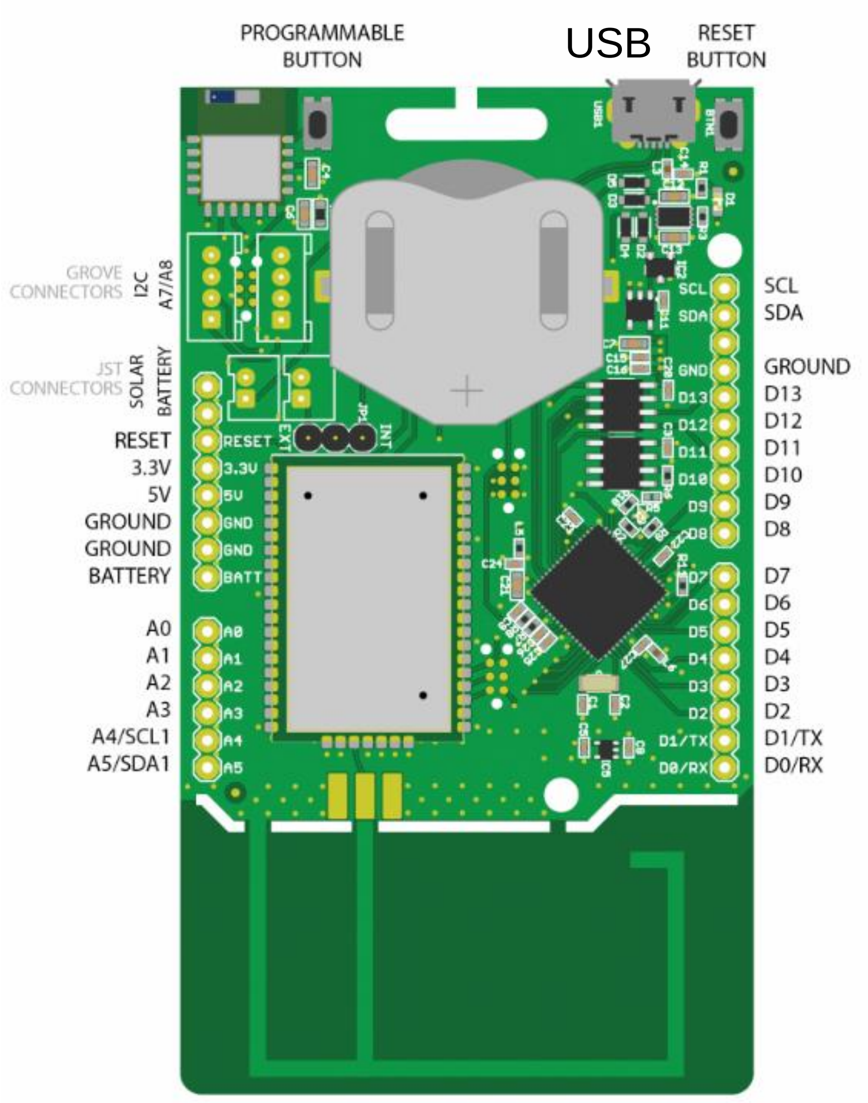
Specifications

Microcontroller	Microchip ATSAMD21J18 32-Bit ARM Cortex M0+
Compatibility	Arduino M0 Compatible
Size	94 x 53 mm
Operating Voltage	3.3V
I/O Pins	20
Analog Output Pin	12-bit ADC
External Interrupts	Available on all pins
DC Current per I/O pin	7 mA
Flash Memory	256 KB (internal) and 4MB (external SST25PF040C flash)
SRAM	32KB
EEPROM	Up to 16KB by emulation

Specifications

Clock Speed	48 MHz
Power	5V USB power and/or 3.7 Lithium battery
Charging	Solar charge controller, up to 500mA charge current
LED	RGB LED, Blue LED
LoRa	Microchip RN2483a Module
Bluetooth	Microchip RN4871 Module
CryptoAuthentication	Microchip ATECC508A
Temperature sensor	Microchip MCP9700AT
USB	Micro USB Port

Pinout

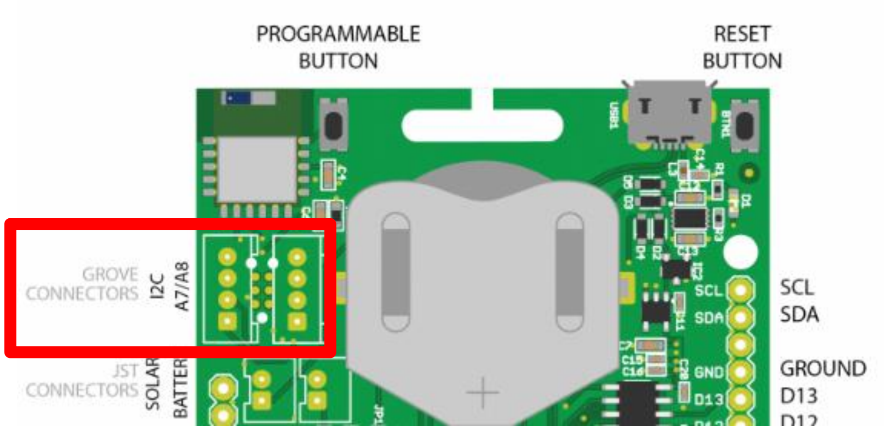

PROGRAMMABLE BUTTON
USB
RESET BUTTON
GROVE CONNECTORS
I2C
A7/A8
JST CONNECTORS
SOLAR
BATTERY
RESET
3.3V
5V
GROUND
GROUND
BATTERY
A0
A1
A2
A3
A4/SCL1
A5/SDA1
SCL
SDA
GROUND
D13
D12
D11
D10
D9
D8
D7
D6
D5
D4
D3
D2
D1/TX
D0/RX

Pins Definition

	Definition	Pin index
Blue LED	LED_BUILTIN	13
RGB Red LED	LED_RED	16
RGB Green LED	LED_GREEN	17
RGB Blue LED	LED_BLUE	18
Bluetooth Wake	BLUETOOTH_WAKE	19
LoRa Reset	LORA_RESET	45
Bluetooth Reset	BT_RESET	46
Programmable Button	BUTTON	47
Temperature Sensor	TEMP_SENSOR	A6
Grove Header	-	14-15
Grove Header I2C	PIN_WIRE_SDA, PIN_WIRE_SCL	33-34

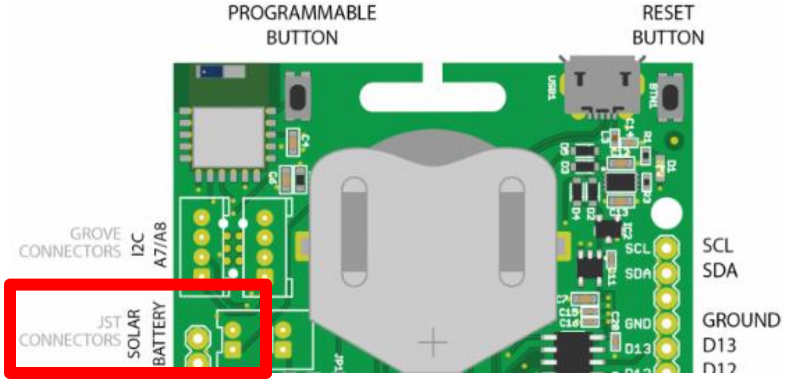
Grove connector

- **The Seeedstudio Grove system is a seamless set of open-source plug-and-play components. It simplifies the study and electronic prototypes by proposing a wide selection of sensors and actuators**
- **You can find two types of grove connectors on the board:**
  - I2C
  - Analogic



Solar power

- **You can plug on the board a solar panel**
- **This input has some limitations**
  - Maximum voltage : 5.5V
  - Maximum current : 500mA
  - Maximum power : 2.5W



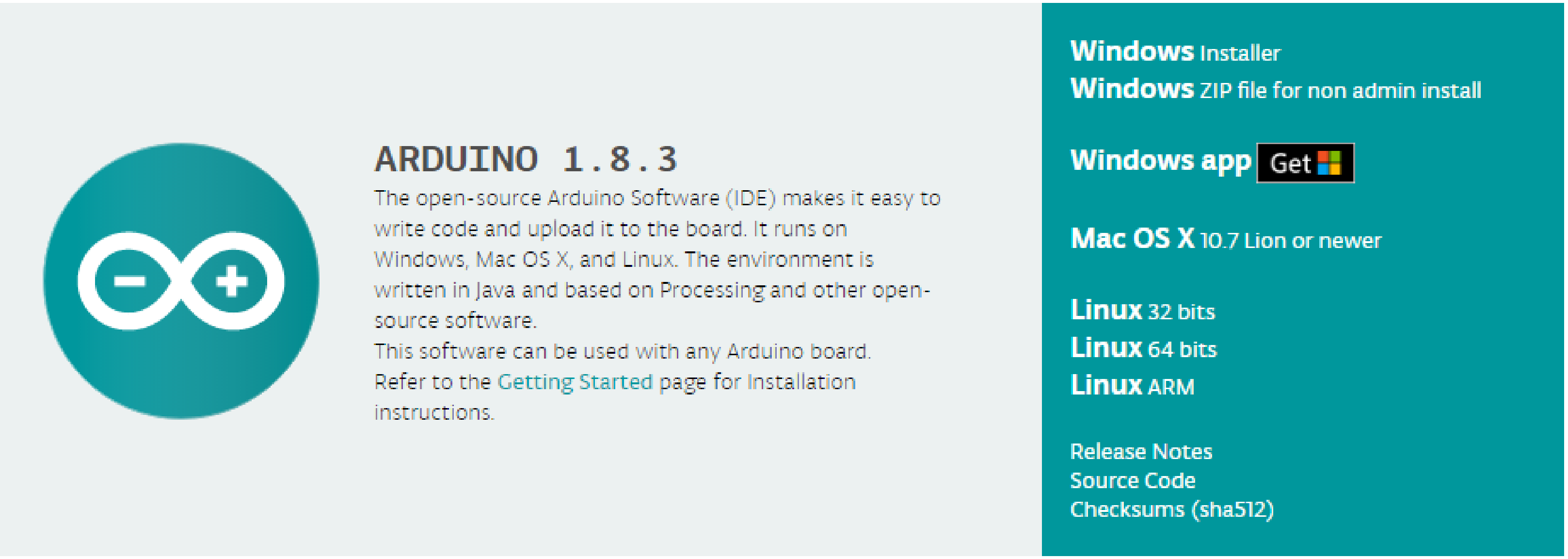
- **You can use a 1.5W Solar Panel for example**

ARDUINO IDE

Setup

Arduino IDE Setup

- **Download and install the latest Arduino IDE: https://www.arduino.cc/en/Main/Software**



ARDUINO 1.8.3

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

This software can be used with any Arduino board.
Refer to the Getting Started page for Installation instructions.

Windows Installer
Windows ZIP file for non admin install

Windows app Get

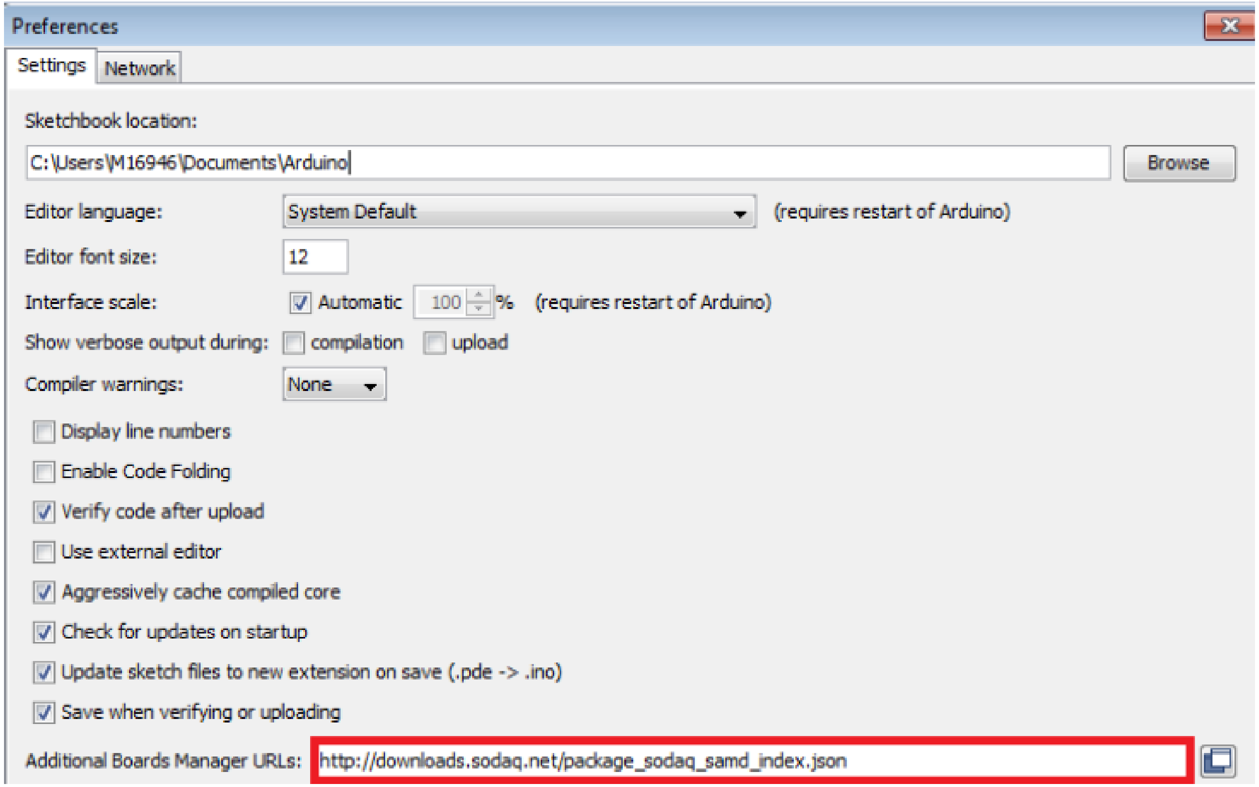
Mac OS X 10.7 Lion or newer

Linux 32 bits
Linux 64 bits
Linux ARM

Release Notes
Source Code
Checksums (sha512)

Board Setup

- **In order to install the board you will need to add the SODAQ board manager URL:** ***http://downloads.sodaq.net/package_sodaq_samd_index.json*** **to File -> Preferences -> Additional Board Manager URLs:**



Preferences

Settings | Network

Sketchbook location:

C:\Users\M16946\Documents\Arduino

Editor language: System Default (requires restart of Arduino)

Editor font size: 12

Interface scale: ☑ Automatic 100 % (requires restart of Arduino)

Show verbose output during: □ compilation □ upload

Compiler warnings: None

□ Display line numbers

□ Enable Code Folding

☑ Verify code after upload

□ Use external editor

☑ Aggressively cache compiled core

☑ Check for updates on startup

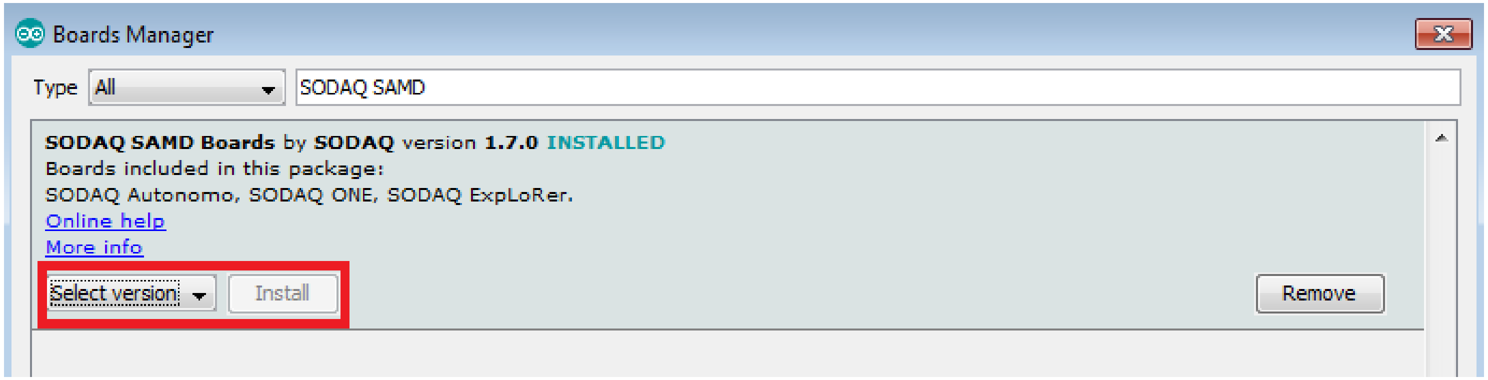
☑ Update sketch files to new extension on save (.pde -> .ino)

☑ Save when verifying or uploading

Additional Boards Manager URLs: http://downloads.sodaq.net/package_sodaq_samd_index.json

Board Setup

- Then, the SODAQ SAMD Boards package will appear in the Tools -> Board -> Board Manager



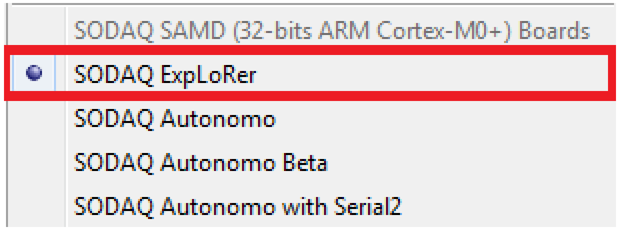
Boards Manager

Type: All | SODAQ SAMD

SODAQ SAMD Boards by **SODAQ** version **1.7.0** INSTALLED
Boards included in this package:
SODAQ Autonomo, SODAQ ONE, SODAQ ExpLoRer.
Online help
More info

- Install the latest SODAQ SAMD Boards package

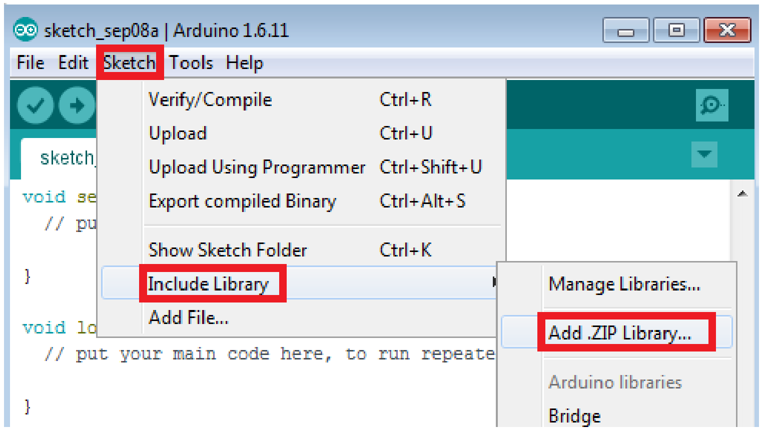
- Select the SODAQ ExpLoRer board from Tools -> Board



SODAQ SAMD (32-bits ARM Cortex-M0+) Boards
● SODAQ ExpLoRer
SODAQ Autonomo
SODAQ Autonomo Beta
SODAQ Autonomo with Serial2

Library Setup

- **Import the libraries provided by using:**
  Sketch -> Include Library -> Add .ZIP Library



sketch_sep08a | Arduino 1.6.11
File Edit Sketch Tools Help
Verify/Compile Ctrl+R
Upload Ctrl+U
Upload Using Programmer Ctrl+Shift+U
Export compiled Binary Ctrl+Alt+S
Show Sketch Folder Ctrl+K
Include Library
Add File...
Manage Libraries...
Add .ZIP Library...
Arduino libraries
Bridge

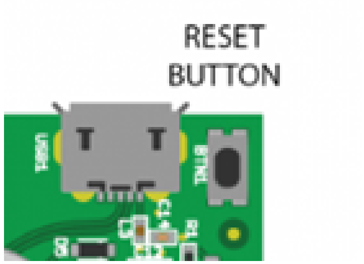
```
void se
  // pu

}

void lo
  // put your main code here, to run repeate

}
```

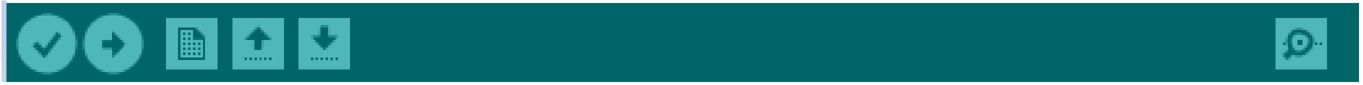
- **Then you search for the file named ‘OrangeRn2483.zip’ that you have previously downloaded on**

  https://github.com/Orange-OpenSource

Arduino IDE Basis

- **Open a sketch example file (.ino)**
  - From menu : File -> Examples -> OrangeRn2483
- **(1) Compile and check if the code has no error**
- **Press the reset button twice within a second to place the board into bootloader mode and is expecting a new sketch**
- **Select the ExpLoRer COM port assigned**
- **(2) Upload the sketch to the board**
- **(3) Open the Serial monitor for debugging**





(1) (2) **(3)**

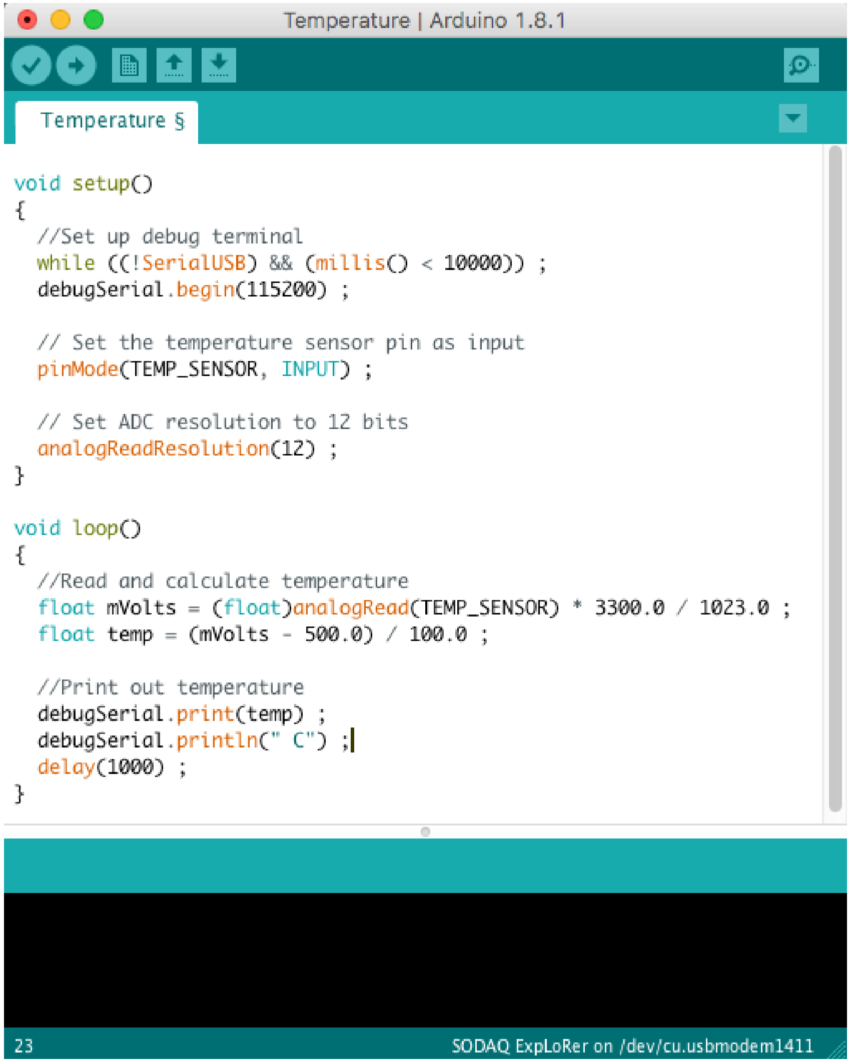
Arduino IDE and Sketch

setup()

Loop that runs only once

loop()

Loop that runs continuously



```
void setup()
{
  //Set up debug terminal
  while ((!SerialUSB) && (millis() < 10000)) ;
  debugSerial.begin(115200) ;

  // Set the temperature sensor pin as input
  pinMode(TEMP_SENSOR, INPUT) ;

  // Set ADC resolution to 12 bits
  analogReadResolution(12) ;
}

void loop()
{
  //Read and calculate temperature
  float mVolts = (float)analogRead(TEMP_SENSOR) * 3300.0 / 1023.0 ;
  float temp = (mVolts - 500.0) / 100.0 ;

  //Print out temperature
  debugSerial.print(temp) ;
  debugSerial.println(" C") ;
  delay(1000) ;
}
```

Hardware Serials

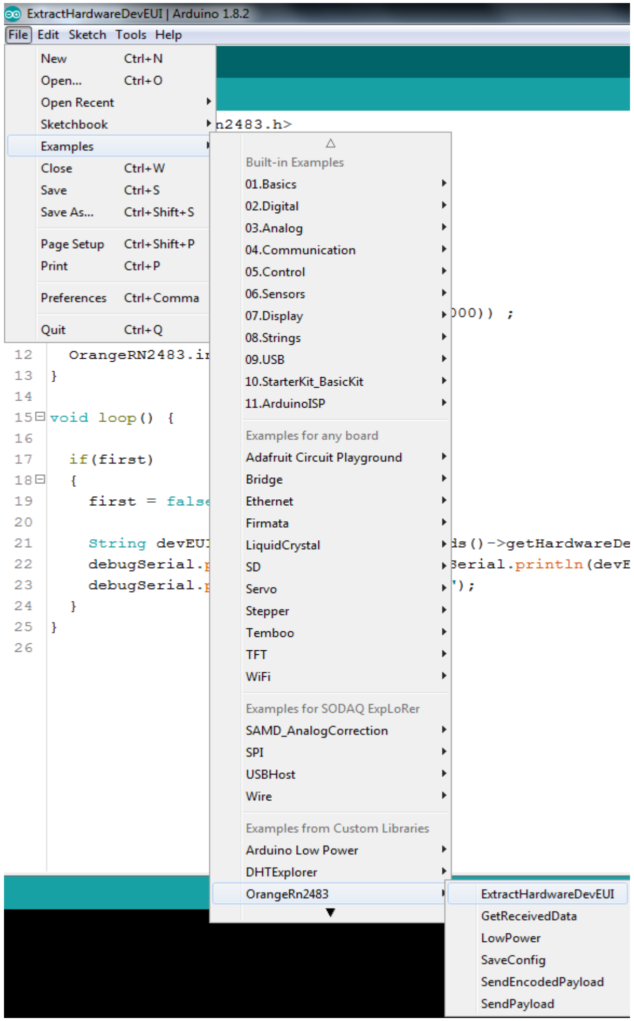
- **The ExpLoRer has 4 hardware serials:**
  - **SerialUSB** this is for debugging over the USB cable
  - **Serial** Serial is attached to pin D1/TX and D0/RX
  - **Serial1** is connected to the RN4871 Bluetooth module
  - **Serial2** is connected to the RN2483 LoRaWAN module
  - **Software Serial** refer to https://www.arduino.cc/en/Reference/SoftwareSerial
- **The sketch starts direct after uploading new code or when connected to a power source. After opening a Serial Monitor the code will not reset, add the following code to your sketch if you want your sketch to wait for a Serial Monitor**

```
void setup()
{
   // put your setup code here, to run once:
   // wait for SerialUSB or start after 10 seconds
   while ((!SerialUSB) && (millis() < 10000)) ;
   SerialUSB.begin(57600) ;
   Serial.begin(57600) ;
   Serial1.begin(115200) ;
   Serial2.begin(57600) ;
}

void loop()
{
   // put your main code here, to run repeatedly:
}
```

Basics sketches

- The Arduino IDE has some examples built in

- Open the ExtractHardwareDevEUI sketch
  File -> Examples -> OrangeRn2483
  -> ExtractHardwareDevEUI



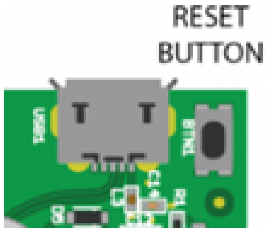
```
n2483.h>
000)) ;
  OrangeRN2483.i
}

void loop() {

  if(first)
  {
    first = false

    String devEU                 ds()->getHardwareDe
    debugSerial.p                Serial.println(devE
    debugSerial.p                ");
  }
}
```

MAIN FEATURES OF THE KIT

Getting Started

Reset Button

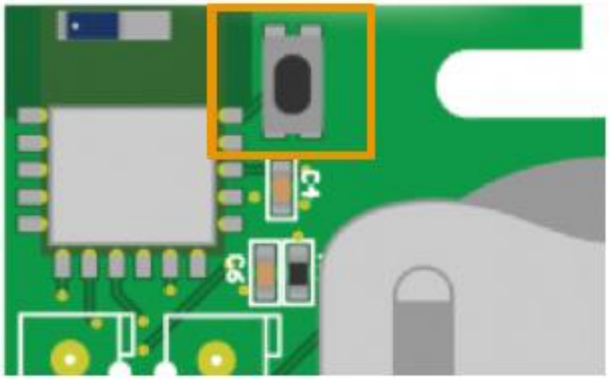
- **On legacy Arduino board the reset button restarts your program from the beginning**



- **On the ExpLoRer board the reset button has two modes:**
  - Mode 1: simple click that acts as legacy Arduino reset
  - Mode 2: double click that starts the board in a bootloader mode. In this mode, Arduino sketch is put on hold and the board awaits the upload of a new sketch.
- **Warning:**
  - When switching between mode 1 and 2 the COM port that you see in Arduino IDE will change (but remains the same for a given mode)

Push Button

- The ExpLoRer Starterkit has a programmable button
- This example will light the built-in Blue LED when the button is pushed



```
void setup()
{
   // Configure the button as an input
   // and enable the internal pull-up resistor
   pinMode(BUTTON, INPUT_PULLUP) ;
   pinMode(LED_BUILTIN, OUTPUT) ;
}
void loop()
{
   // Read the button value into a variable
   int sensorVal = digitalRead(BUTTON) ;
   // Turn on the LED when the Button is pushed
   if (sensorVal == HIGH)
   {
      digitalWrite(LED_BUILTIN, LOW) ;
   }
   else
   {
       digitalWrite(LED_BUILTIN, HIGH) ;
   }
}
```

RGB LED

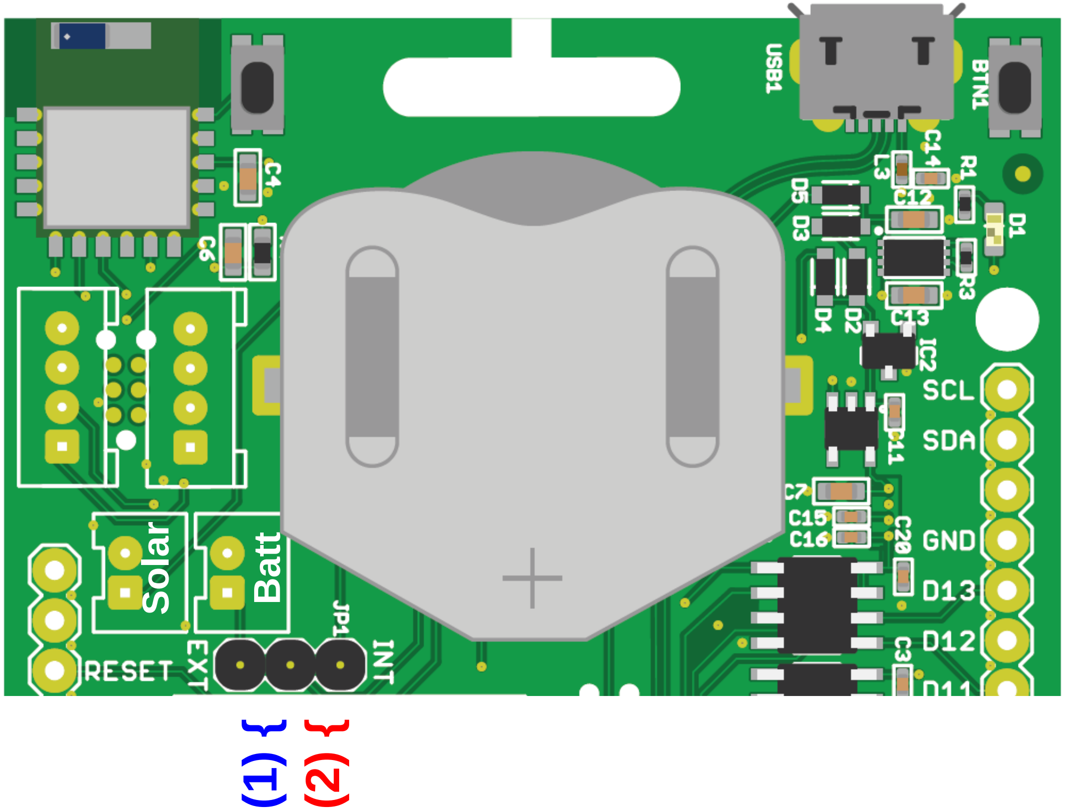
```
int led = LED_RED; // the PWM pin the LED is attached to
int brightness = 0; // how bright the LED is
int fadeAmount = 5; // how many points to fade the LED by

// the setup routine runs once when you press reset:
void setup()
{
   pinMode(led, OUTPUT) ;
}

// the loop routine runs over and over again forever:
void loop()
{
   // set the brightness
   analogWrite(led, brightness) ;

   // change the brightness for next time through the loop:
   brightness = brightness + fadeAmount ;

   // reverse the direction of the fading at the ends of the
fade:
   if (brightness == 0 || brightness == 255)
   {
      fadeAmount = -fadeAmount ;
   }
   // wait for 30 milliseconds to see the dimming effect
   delay(30);
}
```

Temperature Sensor

```
#define debugSerial SerialUSB

void setup()
{
   pinMode(TEMP_SENSOR, INPUT) ;
   // Set ADC resolution to 12 bits
   analogReadResolution(12) ;
}

void loop()
{
   // 10mV per C, 0C is 500mV
   float mVolts = (float)analogRead(TEMP_SENSOR) * 3300.0 / 4096.0 ;
   float temp = (mVolts - 500.0) / 10.0 ;

   debugSerial.print(temp) ;
   debugSerial.println(" C") ;

   delay(1000) ;
}
```

Battery Charging

- USB power and Solar panel sources can be used for charging
- Jumpers JP1 determines which battery is used/charged
- (1) External battery
- (2) Internal battery



BLE Module

Arduino library for using the Microchip RN487x BLE module

```
#include "RN487x_BLE.h"
#define bleSerial Serial1
void setup()
{
  rn487xBle.hwInit() ;
  bleSerial.begin(rn487xBle.getDefaultBaudRate()) ;
  rn487xBle.initBleStream(&bleSerial) ;
  if (rn487xBle.swInit())
  {
    rn487xBle.enterCommandMode() ;
    rn487xBle.stopAdvertising() ;
    rn487xBle.setAdvPower(3) ;
    rn487xBle.setSerializedName("Microchip") ;
    rn487xBle.clearAllServices() ;
    rn487xBle.reboot() ;
  }
}
void loop()
{
}
```

LoRa® Communication

- **Arduino library for using the Microchip RN2483 LoRaWAN module: OrangeRn2483**

```
#include <OrangeRn2483.h>
// The following keys are for structure purpose only. You must define YOUR OWN.
const int8_t appEUI[8] = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 };
const int8_t appKey[16] = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 };

bool joinNetwork()
{
  OrangeRN2483.setDataRate(DATA_RATE_1); // Set DataRate to SF11/125Khz
  return OrangeRN2483.joinNetwork(appEUI, appKey);
}

bool SendLoRaMessage()
{
  const uint8_t size = 5;
  int8_t port = 5;
  int8_t data[size] = { 0x48, 0x65, 0x6C, 0x6C, 0x6F }; // Hello
  return OrangeRN2483.sendMessage(data, size, port); // send unconfirmed message
}
```

- **You can find a complete document on this library and its functions in the library's file**

Orange Live Objects

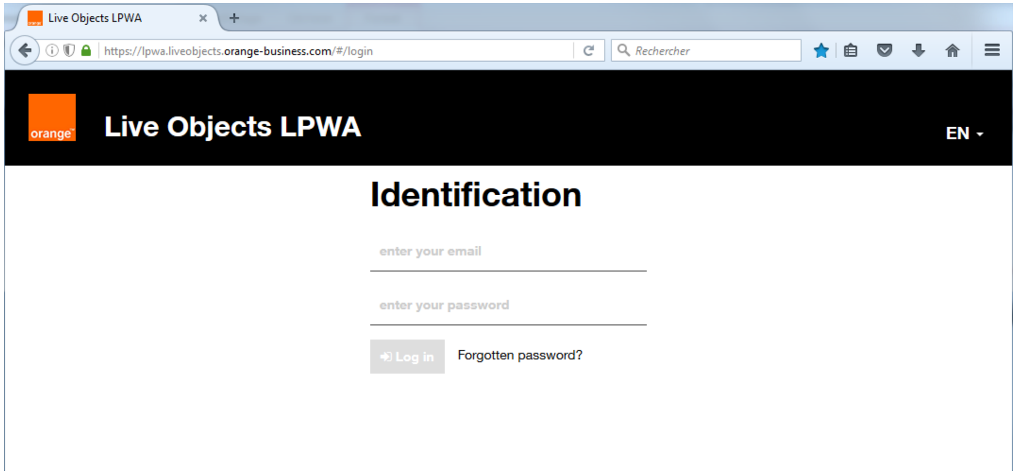
Getting Started

Let’s get started

- **Provision your LoRa end device to join the network**
  - The **devEUI** is provided by the ExpLoRer board
    Get and note the hardware devEUI of the board by using the ExtractHardwareDevEUI sketch
  - The application identifier (**appEUI**) is 8 bytes long (16 hexadecimal characters).
    - You can use this one **4578704C6F526572**
    - Or create your own
  - The application session key (**appKey**) is specific for the end-device. It is 16 bytes long (32 hexadecimal characters).
    - It is **safer** to create your own appKey
    - Or you can create one using {FFEEDDCCBBAA9988} as the 8 first bytes and the device’s devEUI for the 8 last bytes. This option presents a security risk.
  - Write down your keys here for safe keeping :
    - devEUI =
    - appEUI =
    - appKEY =

Orange Live Objects

- **Go to the following URL to access Live Objects :** https://lpwa.liveobjects.orange-business.com/#/login



Identification

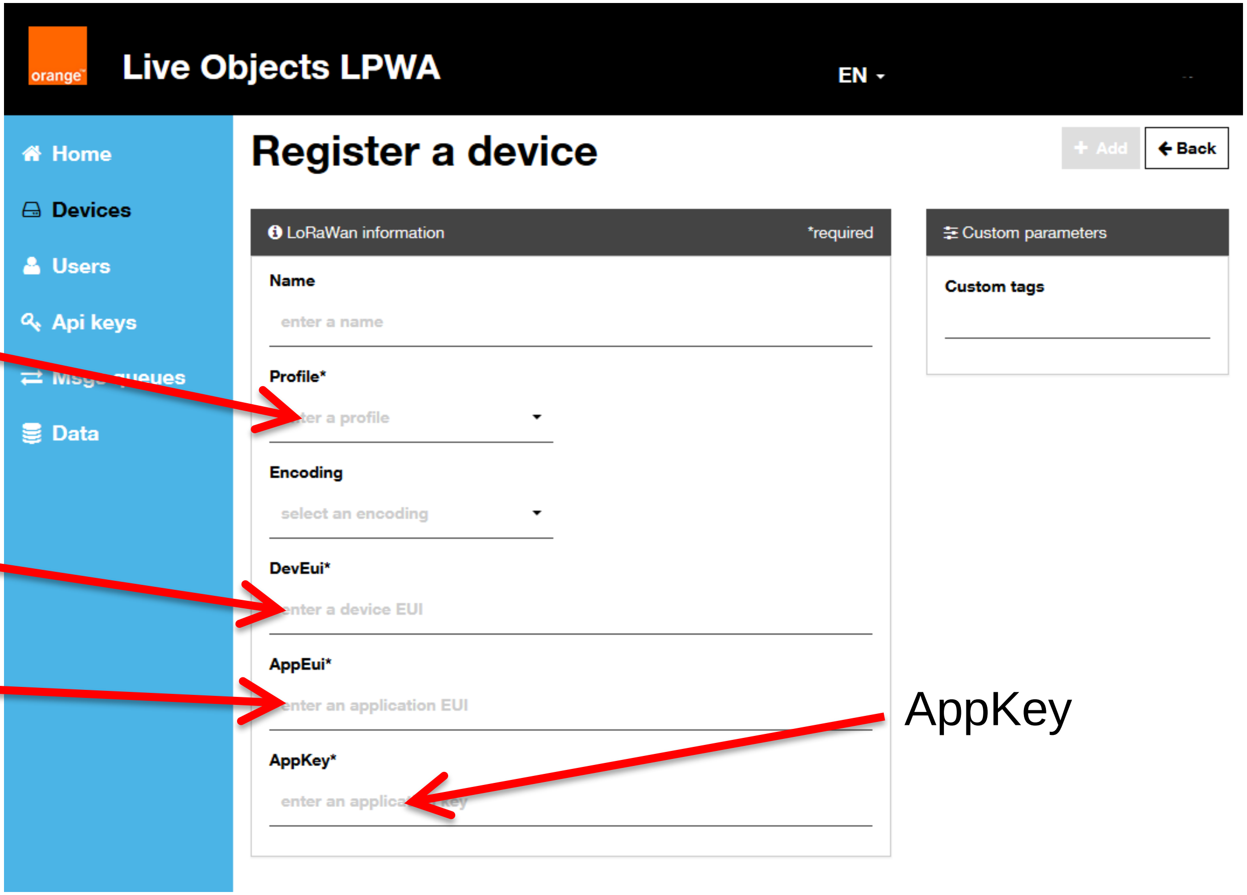
enter your email

enter your password

- **You can find some useful videos about Live Objects on this website :** https://www.youtube.com/channel/UCqiOhIRIpjRvR3Bw0hMLciw

Provisioning a device

- **Create your device within Orange Live Objects by adding the activation keys and the right profile**



Live Objects LPWA

EN ▾

Register a device

+ Add | ← Back

LoRaWan information *required

Name
enter a name

Profile*
enter a profile

Encoding
select an encoding

DevEui*
enter a device EUI

AppEui*
enter an application EUI

AppKey*
enter an application key

Custom parameters

Custom tags

Choose the profile
Michrochip RN2483

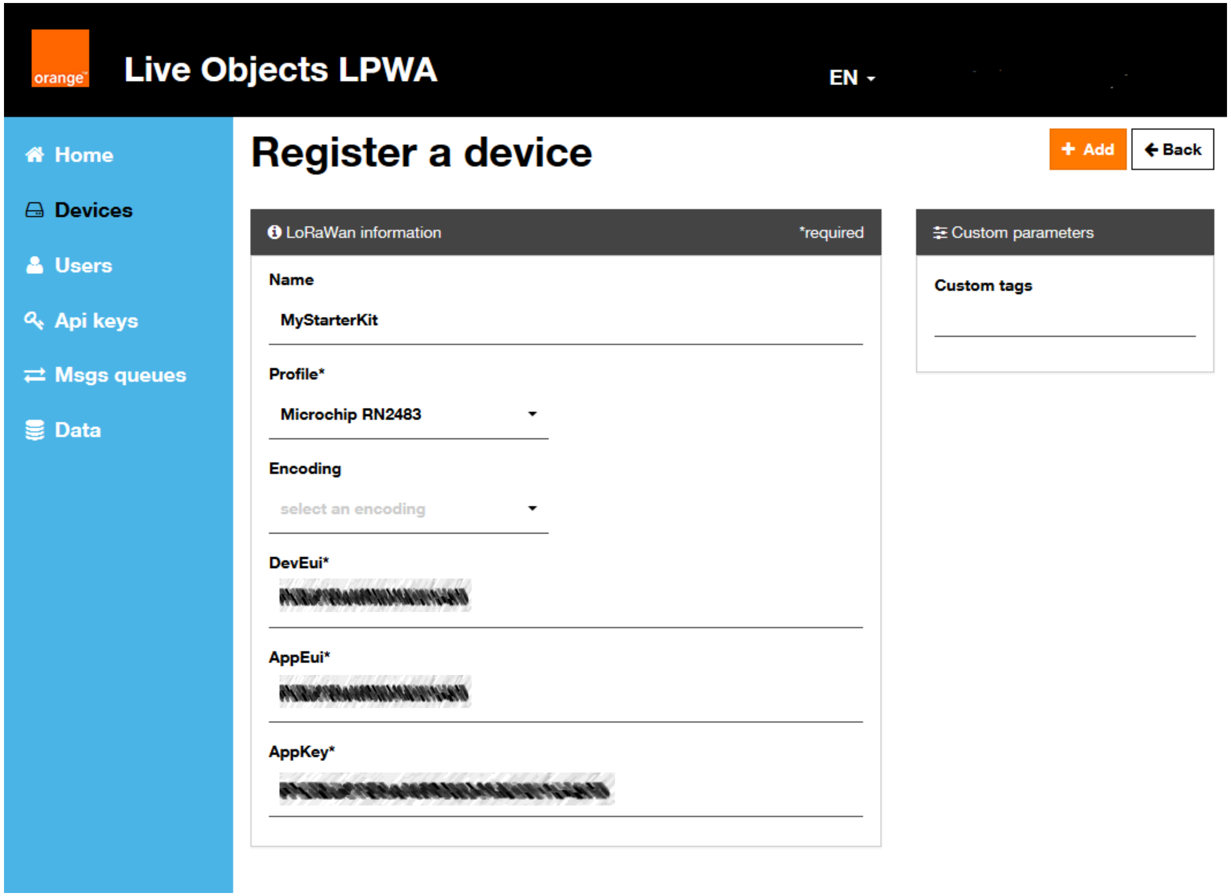
DevEui

AppEui

AppKey

Provisioning a device

- **In addition to the activation keys you have to choose the profil Microchip RN2483**



Register a device

LoRaWan information *required

Name
MyStarterKit

Profile*
Microchip RN2483

Encoding
select an encoding

DevEui*
[redacted]

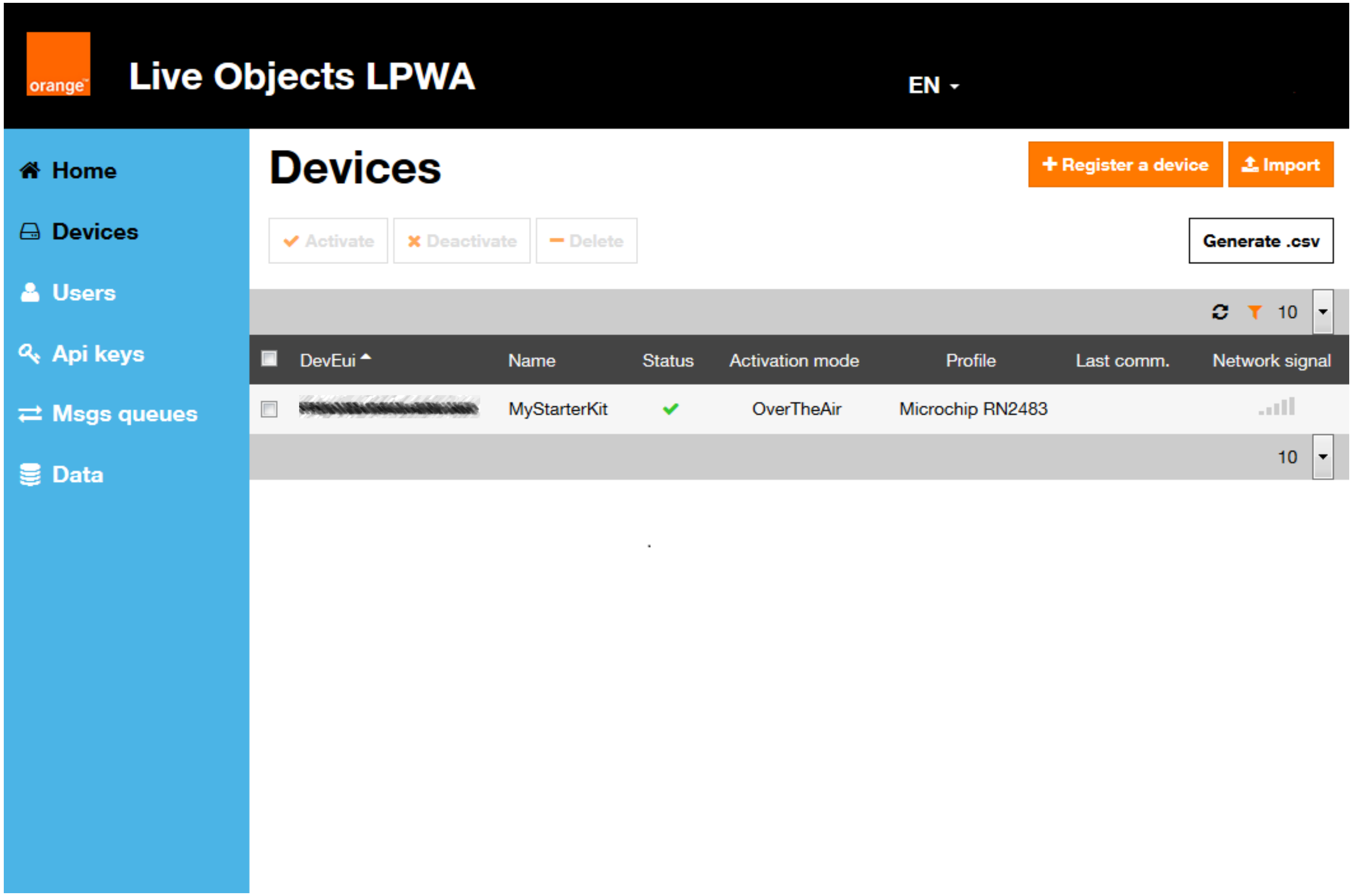
AppEui*
[redacted]

AppKey*
[redacted]

Custom tags

Provisioning a device

- You device is now registered



Devices

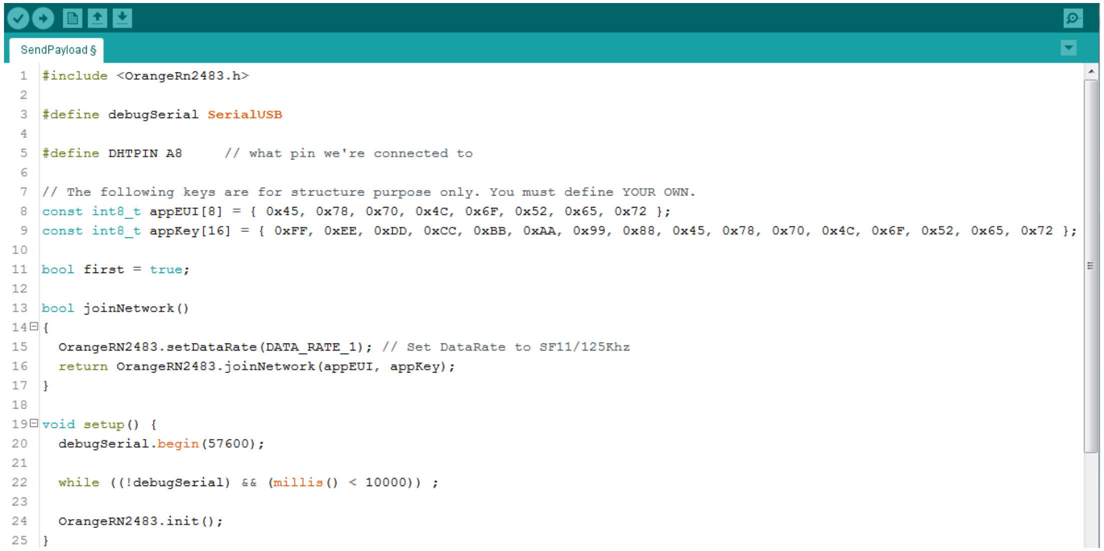
□	DevEui	Name	Status	Activation mode	Profile	Last comm.	Network signal
□	[redacted]	MyStarterKit	✓	OverTheAir	Microchip RN2483		

Testing the network

- **Open the SendPayload sketch to test your device**
  - File -> Examples -> OrangeRn2483 -> SendPayload
- **This sketch will send 3 payloads**
- **Modify the file with your own keys in HEX format (0x)**

```
// The following keys are for structure purpose only. You must define YOUR OWN.
const int8_t appEUI[8] = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 };
const int8_t appKey[16] = { 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,
0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00 };
```

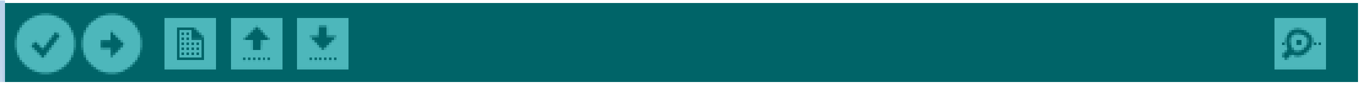
- **Here is what your code should look like :**



```
#include <OrangeRn2483.h>

#define debugSerial SerialUSB

#define DHTPIN A8     // what pin we're connected to

// The following keys are for structure purpose only. You must define YOUR OWN.
const int8_t appEUI[8] = { 0x45, 0x78, 0x70, 0x4C, 0x6F, 0x52, 0x65, 0x72 };
const int8_t appKey[16] = { 0xFF, 0xEE, 0xDD, 0xCC, 0xBB, 0xAA, 0x99, 0x88, 0x45, 0x78, 0x70, 0x4C, 0x6F, 0x52, 0x65, 0x72 };

bool first = true;

bool joinNetwork()
{
  OrangeRN2483.setDataRate(DATA_RATE_1); // Set DataRate to SF11/125Khz
  return OrangeRN2483.joinNetwork(appEUI, appKey);
}

void setup() {
  debugSerial.begin(57600);

  while ((!debugSerial) && (millis() < 10000)) ;

  OrangeRN2483.init();
}
```

Testing the network

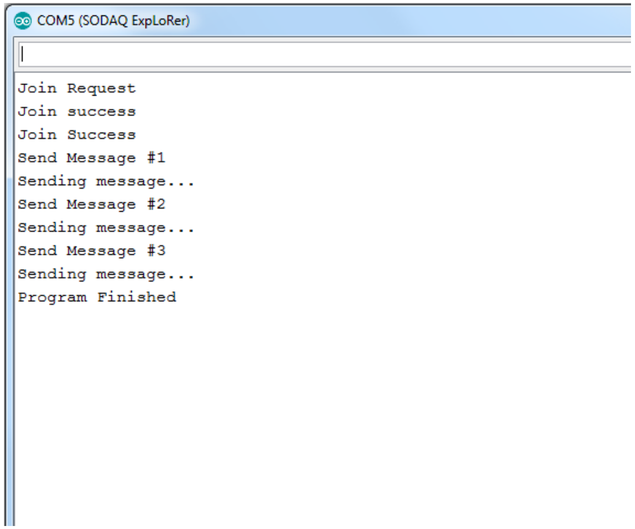
- **(1) Upload the sketch to the board**
- **(2) Open the Serial monitor for debugging**



(1)

(2)

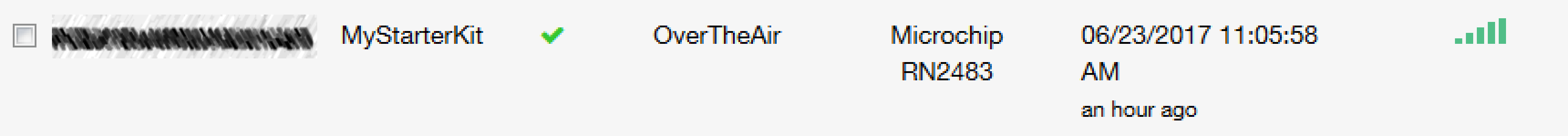
- You should see the following monitor :



```
Join Request
Join success
Join Success
Send Message #1
Sending message...
Send Message #2
Sending message...
Send Message #3
Sending message...
Program Finished
```

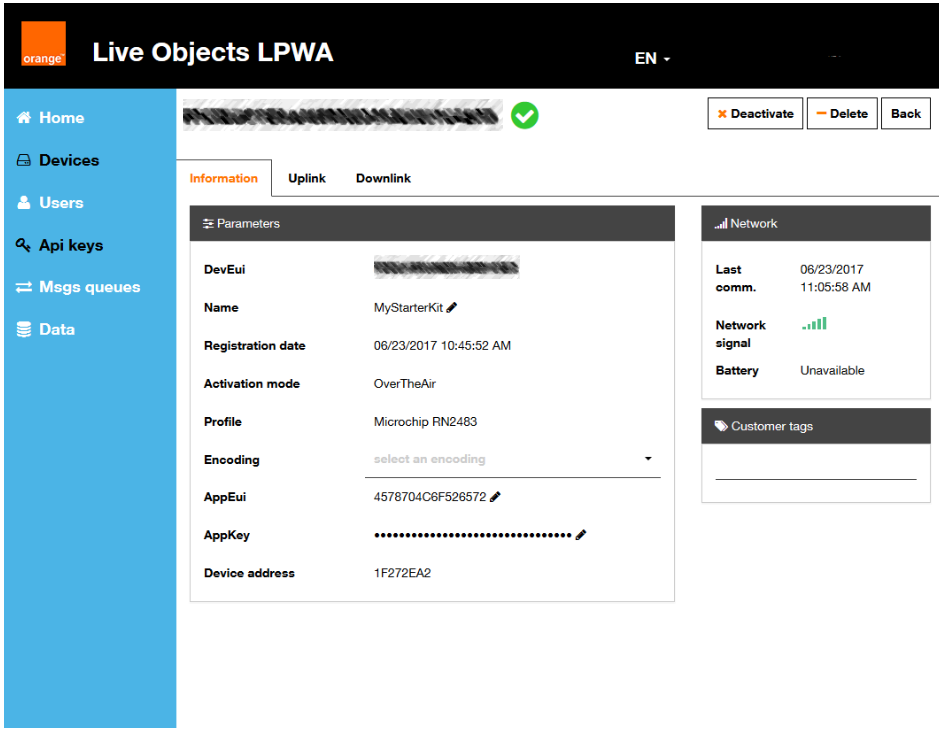
Visualizing Lora Messages

- **To see the 3 payloads that have been sent :**
  - On Live Object select your device



□	[redacted]	MyStarterKit	✓	OverTheAir	Microchip RN2483	06/23/2017 11:05:58 AM an hour ago	.ıl

  - You are redirected to this page :



[redacted] ✓

Parameters

DevEui	[redacted]
Name	MyStarterKit
Registration date	06/23/2017 10:45:52 AM
Activation mode	OverTheAir
Profile	Microchip RN2483
Encoding	select an encoding
AppEui	4578704C6F526572
AppKey	••••••••••••••••••••••••••••••••
Device address	1F272EA2

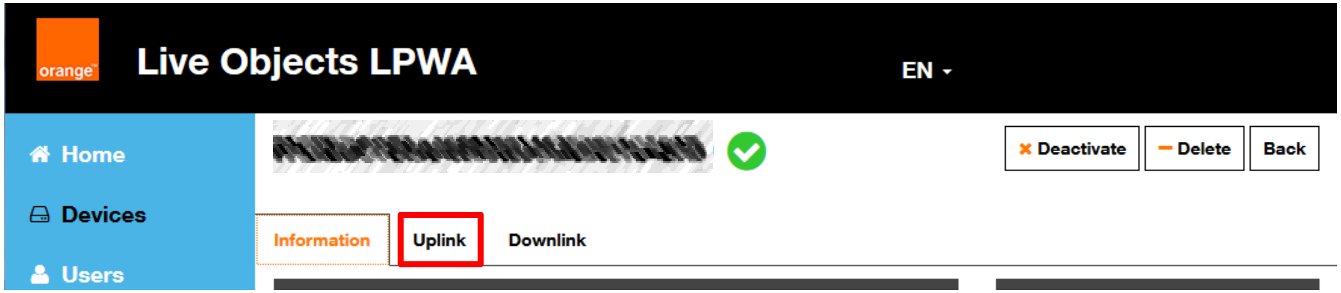
Network

Last comm.	06/23/2017 11:05:58 AM
Network signal	.ıl
Battery	Unavailable

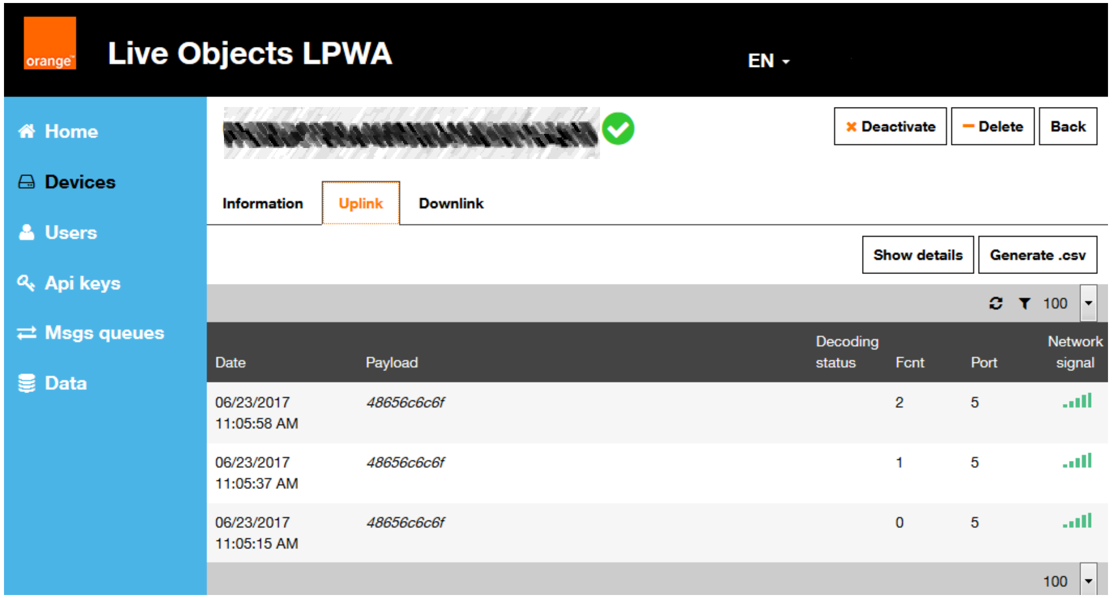
Customer tags

Visualizing uplinks

- Click on the uplink tab



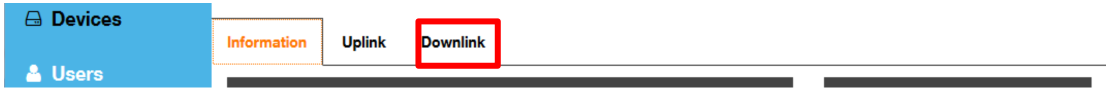
- You can now see the 3 payloads you just sent



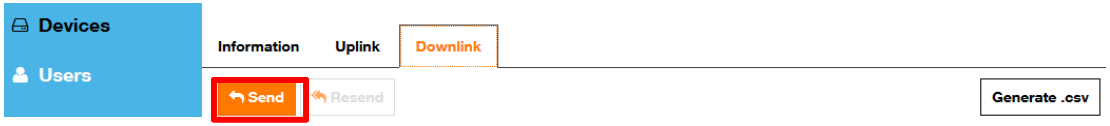
Date	Payload	Decoding status	Fcnt	Port	Network signal
06/23/2017 11:05:58 AM	*48656c6c6f*		2	5	.ıll
06/23/2017 11:05:37 AM	*48656c6c6f*		1	5	.ıll
06/23/2017 11:05:15 AM	*48656c6c6f*		0	5	.ıll

Downlinks

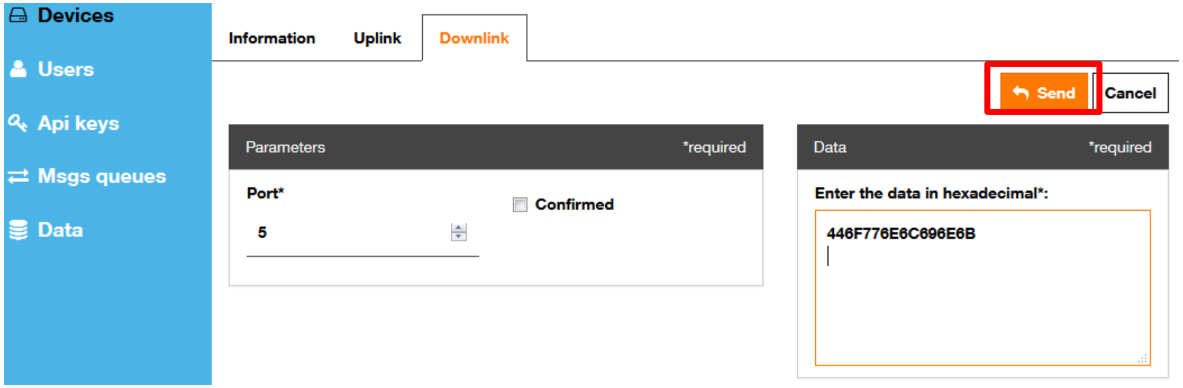
- **Downlink is about sending payloads from Live Object to the device**
  - Click on the downlink tab after selecting your device



  - Then you select the send button



  - Then you fill in the port number and the data to send in hexadecimal form and click on send



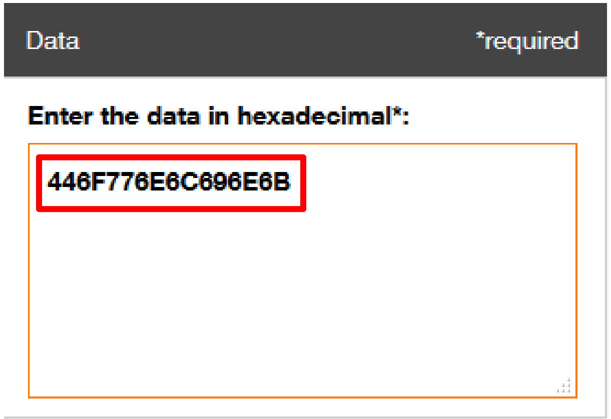
Port*: 5

□ Confirmed

Enter the data in hexadecimal*: 446F776E6C696E6B

Receiving downlinks

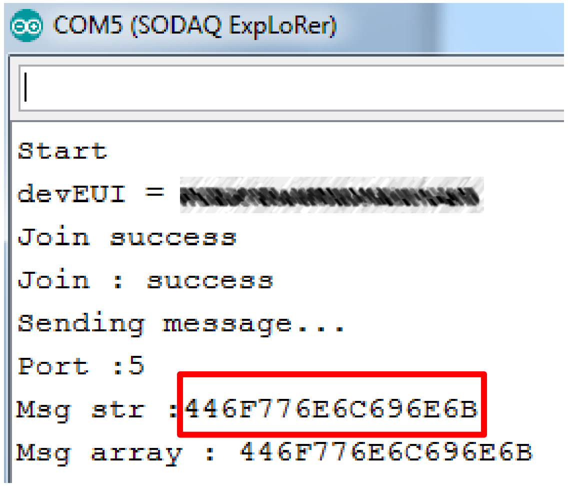
- **To visualize your downlink use the GetReceivedData sketch**
  - File -> Examples -> OrangeRn2483 -> GetReceivedData
- **Then send the payload from Live Object**
- **Finally open the Serial Monitor**
  - You should see the data you sent



Data *required

Enter the data in hexadecimal*:

446F776E6C696E6B



COM5 (SODAQ ExpLoRer)

```
Start
devEUI = [redacted]
Join success
Join : success
Sending message...
Port :5
Msg str :446F776E6C696E6B
Msg array : 446F776E6C696E6B
```

Thank You

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