Notes on using the RF transceiver:
The use of wireless receivers and transmitters is restricted by international standards and domestic regulations. Wireless receivers and transmitters must therefore be used in accordance with the applicable laws and regulations of the country in which they are being used.
Contents

- LoRaWAN® Features
- Required Equipment
- Setup LoRaWAN® End Node
- Setup LoRaWAN® Gateway and LoRaWAN® Network Server
- Register End Node to Network Server
- LoRaWAN® Sensor Demo Operation
Outline

This tutorial shows how to setup and operate RA LoRaWAN® Sensor Demo to experience LoRaWAN®-based IoT application

In this demo, sensor data can be sent to cloud service via LoRaWAN® wireless network utilizing the LoRaWAN® end node software for RA2E1 from Renesas and visualized on the cloud service.

You can easily build a wireless network and realize IoT application with the LoRaWAN® ecosystem.
Required Equipment

- Micro USB (USB A-Micro B) Cable
Ordering Reference
Semtech SX1261/SX1262 Shield and Kerlink Wirnet iFemtoCell (LoRaWAN® Gateway)

- Semtech SX1261 Shield or Semtech SX1262 Shield

<table>
<thead>
<tr>
<th>Region</th>
<th>Parts number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>SX1261MB2BAS</td>
<td>SX1261 @868MHZ MBED SHIELD ; +14dBm, XTAL</td>
</tr>
<tr>
<td>US</td>
<td>SX1262MB2CAS</td>
<td>SX1262 @915MHZ MBED SHIELD ; +22dBm, XTAL</td>
</tr>
</tbody>
</table>

- Others region: SX1261 can transmit up to +15 dBm. SX1262 can transmit up to +22 dBm. First, please select by your local transmission power limit. If you are not sure, it is better to select SX1261 for demonstration purposes.

- Kerlink Wirnet iFemtoCell (LoRaWAN® Gateway)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
<th>ISM-Frequencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDTIOT-IFE00</td>
<td>Wirnet iFemtoCell 868 MHz</td>
<td>863-874.4MHz</td>
</tr>
<tr>
<td>PDTIOT-IFE01</td>
<td>Wirnet iFemtoCell 915 MHz</td>
<td>902-928MHz</td>
</tr>
<tr>
<td>PDTIOT-IFE02</td>
<td>Wirnet iFemtoCell 923 MHz</td>
<td>915-928MHz</td>
</tr>
</tbody>
</table>

Information: https://lora-alliance.org/lora_products/kerlink-wirnet-ifemtocell/
Setup for LoRaWAN® End Node
Setup LoRaWAN® End node (1)
Hardware Setup

1) Pattern cut and short. Change of debugger setting

- **STEP1:** Cut E3, E6, E17, and E12. Short E4, E5, E19, and E20.

- **STEP2:** Plug the SX126x shield to the Arduino Uno connector, US082-HS3001EVZ to the PMOD1 connector, and the Pmod USBUART to the PMOD2 connector.

- **STEP3:** Short pin 1 and 2 of CN1 with jumper plug when to download the sample software with the flash programmer. Short pin 2 and 3 of CN1 with jumper plug to make the sample software running after the reset.

2) Connection of boards and cables
Setup LoRaWAN® End node (2)
Write LoRaWAN® Sensor Demo software to flash memory

- Download LoRaWAN(R)-Sensor Demo Package
  - RA2E1 LoRaWAN(R)-Sensor Demo Package
    

- Flash programming to RA2E1 Fast Prototyping Board
  - Download Renesas Flash Programmer (RFP)
    RFP V3.08.3 or higher required.
    
    https://www.renesas.com/rfp

  - Write LoRaWAN® Sensor Demo software to flash memory by RFP

    Write the following file to RA2E1 Fast Prototyping Board (Refer to next slide for more details)
    
    samples\project\e2studio\ra2e1fpb_sx126x\LoRaSensorSample\LoRaSensorSample.hex
Setup LoRaWAN® End node (3)
Write LoRaWAN® Sensor Demo software to flash memory

1. Select **New Project**.
2. Select **RA** in Microcontroller.
3. Enter project name in Project Name.
4. Select **E2 emulator Lite** in Tool.
5. Click **Connect**.

7. Select software file (LoRaSensorSample.hex) in **Program file**.
8. Click **Start**.
Setup for LoRaWAN® Gateway and LoRaWAN® Network Server
Setup LoRaWAN® Gateway
Login to Kerlink LoRaWAN® Gateway by Terminal software (SSH)

- **Necessary information of gateway for setup**

  Individual information of iFemtoCell is as follows.

<table>
<thead>
<tr>
<th>Board ID</th>
<th>xxxxxx012345</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host name</td>
<td>klk-wifc-012345</td>
</tr>
<tr>
<td>Default password</td>
<td>pdmk-012345</td>
</tr>
<tr>
<td>Username</td>
<td>root</td>
</tr>
</tbody>
</table>

- **Login to gateway**

  • Connect the gateway to the LAN environment
  • Execute "arp -a" command from Windows command prompt. Identify the gateway by the MAC address and confirm the IP address of the gateway assigned by the DHCP server.
  • Connect and login to the confirmed IP address (e.g.: 192.168.1.11) via SSH using Tera Term. Login name: “root“, Password: Above default password

- **Similar information**

  • https://www.thethingsnetwork.org/docs/gateways/kerlink/ifemtocell/
Setup LoRaWAN® Gateway (2)
Install LORIOT Software to Kerlink LoRaWAN® Gateway

- Install LORIOT software for iFemtocell to Kerlink gateway
  - Once login to the gateway, enter the following commands to install the software

```bash
cd /tmp
chmod +x loriot-install.sh
./loriot-install.sh -f -s ap2.loriot.io
```

- Enter the following command for reboot

```
reboot
```

Note: By downloading and/or using any software from the list you Agree with the EULA.
[https://loriot.io/terms-of-service.html](https://loriot.io/terms-of-service.html)
LORIOT LoRaWAN® Network Server
https://loriot.io/index.html#loriot-network-server

- LORIOT Network Server has three plans. In this tutorial, COMMUNITY PUBLIC NETWORK SERVER is used.

<table>
<thead>
<tr>
<th>PLAN</th>
<th>COMMUNITY PUBLIC NETWORK SERVER</th>
<th>PROFESSIONAL PUBLIC SERVER</th>
<th>PRIVATE NETWORK SERVER</th>
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</thead>
<tbody>
<tr>
<td>13 Worldwide Community Public Servers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public LoRaWAN® servers on-demand including</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FREE connectivity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ideal for Academic/Development/Proof-of-concept/</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small-scale/non-critical.</td>
<td></td>
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<tr>
<td>Unlimited User Accounts</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
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<tr>
<td>Unlimited Applications</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
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<tr>
<td>Unlimited gateways</td>
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<td>Inclusive</td>
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<td>Unlimited Messages</td>
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<td>Inclusive</td>
<td>Inclusive</td>
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<tr>
<td>Multitenancy</td>
<td>Inclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
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<tr>
<td>Included Gateways</td>
<td>Inclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
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<tr>
<td>Included Devices</td>
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<td>Unlimited</td>
<td>Unlimited</td>
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<tr>
<td>Service Level Agreement</td>
<td>30 Devices FREE</td>
<td>Device connectivity packages available</td>
<td>Contact us</td>
</tr>
<tr>
<td>On-Premise Deployment</td>
<td>Exclusive</td>
<td>99.9%</td>
<td>Inclusive</td>
</tr>
<tr>
<td>LoRaWAN® Network Operator</td>
<td>Exclusive</td>
<td>Exclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>White Label + Custom Domain</td>
<td>—</td>
<td>Exclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Technical support</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Test Server</td>
<td>Basic</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Pricing</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Worldwide - 13 Regional Servers</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Worldwide Professional Servers</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
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<tr>
<td>—</td>
<td>Exclusive</td>
<td>Exclusive</td>
<td>Inclusive</td>
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<td>—</td>
<td>Basic</td>
<td>Inclusive</td>
<td>Inclusive</td>
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<tr>
<td>—</td>
<td>FREE</td>
<td>See the plans</td>
<td>Contact us</td>
</tr>
</tbody>
</table>

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Setup LoRaWAN® Network Server (1)
Web Browser (LORIOT)

- Create LORIOT account
  - Select a SERVER close to your location
  - Click Register a new account

Note: Please use Google Chrome, Firefox or Microsoft Edge for a web browser

[https://www.loriot.io/login.html](https://www.loriot.io/login.html)
Setup LoRaWAN® Network Server (2)

Web Browser (LORIOT)

- Add Gateway
  - Click Dashboard → Networks

- Click Sample network
Setup LoRaWAN® Network Server (3)
Web Browser (LORIOT)

- Register gateway
  - Click “+Add Gateway”
  - Select “Kerlink iFemtocell”
  - Set gateway MAC ADDR to eth0 MAC address
  - Set gateway location in Gateway Location
  - Click “Register Kerlink iFemtocell gateway”
Setup LoRaWAN® Network Server (4)  
Web Browser (LORIOT)

- **Set region**
  - Click Region in Configuration
  - Select Region Code
    
    Example:
    - Europe: EU863-870
    - US: US902-928
    - JAPAN: AS923

Regarding Region Code, see below for other regions

Global Frequency Plans

https://docs.loriot.io/display/LNS/Global+Frequency+Plans
Setup LoRaWAN® Network Server (5)
Web Browser (LORIOT)

- **Set Channel Plans**
  - Click “- Remove Plans”
  - Click “+Add Band”
  - Select Channel Plan
    - Example:
      - Europe: EU868
      - US: US915_CH0_7
      - JAPAN: AS923-1
  - Click “Restart”
    - Note: Restart will not be shown when gateway is not online.

Regarding Channel Plan, see below for other regions.
Supported Frequency Plans
https://docs.loriot.io/display/LNS/Supported+Frequency+Plans
Registration of End Node to LoRaWAN® Network Server
Registration of End Node to LoRaWAN® Network Server (1)

Web Browser (LORIOT)

- Add Device
  - Click Dashboard → Applications
  - Click Dashboard → Applications SampleApp
Registration of End Node to LoRaWAN® Network Server (2)
Web Browser (LORIOT)

- Click Enroll Device
Registration of End Node to LoRaWAN® Network Server (3)

Web Browser (LORIOT)

- **Ender Title, Device EUI, Join EUI, and Application Key**
  
  Example:
  - Title=demo
  - Device EUI=xxxxxxFFFFxxxxxx
    - x is the following MAC address
  - Join EUI (Application EUI)=0123456701234567
  - Application Key=5555555555555555AAAAAAAAAAAAAAAA
    (5:16 digits and A:16 digits)

- **Click Enroll**

Please prepare 48-bit MAC address. Put FF:FE in the middle of the 48-bit MAC address and use it as a 64-bit Device EUI.

MAC address: Companies that do not have a MAC address can purchase it from IEEE or alternatively purchase an EEPROM with a MAC address written.
LoRaWAN® Sensor Demo Operation Method
Operation method of LoRaWAN® End Node (1)

Terminal Software used to connect to End Node

- **Confirmation of UART connection**
  - Connect with PC by Terminal Software
  - Setup Serial and Terminal of right figure
    COM Port number in Port needs to be changed for the one you use
  - Enter ‘AT’ for control confirmation and confirm ‘OK’
Operation method of LoRaWAN® End Node (2)
Configuration of end node

Example of configuration

Enter the following commands in Terminal Software

1. Set LoRaWAN® specific parameters with AT-commands

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+REGION=X</td>
<td>X: 0, 1, 6, 6</td>
</tr>
<tr>
<td>AT+CLASS=0</td>
<td></td>
</tr>
<tr>
<td>AT+ACTMODE=1</td>
<td></td>
</tr>
<tr>
<td>AT+DEV EUI=XXXXX...</td>
<td></td>
</tr>
<tr>
<td>AT+APPEUI=012345...</td>
<td></td>
</tr>
<tr>
<td>AT+APPKEY=555555...</td>
<td></td>
</tr>
<tr>
<td>AT+SAVE</td>
<td></td>
</tr>
</tbody>
</table>

// Region: 0:EU868, 1:US915(*Note1), 6:AS923-Group1
// Class A
// Activation: OTAA
// DevEUI
// AppEUI
// AppKey
// Save settings

Note1: Enter the following command before AT+SAVE in case US915_CH8_15 is used for channel plan
AT+CHDEFMASK=FF00,0000,0000,0000,0002

2. Set sensor demo specific parameters with AT-command

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT+SENSOR=60,60,1</td>
<td>Set parameters (*Note2)</td>
</tr>
<tr>
<td>AT+SAVE</td>
<td>Save settings to data flash</td>
</tr>
<tr>
<td>AT+RESET=1</td>
<td>Auto start after reset</td>
</tr>
</tbody>
</table>

Note2: AT+SENSOR=REJOIN,MEASURE,MODE
REJOIN: Join retry interval after join failure [sec], MEASURE: Next measurement after Tx [sec], MODE: 1: Auto start mode
Example of execution screen of end node

- Example of execution screen of end node
Data Visualization
Cayenne for LoRa®

- Sensor data such as temperature and humidity can be displayed on Cayenne dashboard via LORIOT network server.

Cayenne for LoRa®
https://developers.mydevices.com/cayenne/lora/

Network Server

![Cayenne for LoRa®](https://developers.mydevices.com/cayenne/lora/)
Data Visualization
Network Server Setting for Output (Cayenne)

- Set output of network server
  - Click Dashboard → Application → SampleApp → Output
  - Click Cayenne
  - Click Add Output
Data Visualization
Get Network Server Information (1)

- Remember Application ID for setting of Cayenne later
Data Visualization
Get Network Server Information (2)

- Remember Token for setting of Cayenne later
Data Visualization
Create Account of Cayenne for LoRa®

- Access to Cayenne for LoRa®
  https://developers.mydevices.com/cayenne/lora

- Crate Account
Data Visualization
Setting Cayenne for LoRa® (1)

- Login to Cayenne
- Click “LoRa®”

- Click “Loriot”
Data Visualization
Setting Cayenne for LoRa® (2)

- Click “Cayenne LPP”
Data Visualization
Setting Cayenne for LoRa® (3)

- **Set Information of device and network server**
  - Device EUI
  - Loriot information (Loriot App ID, Loriot Token)
  - Others

- **Click Add Device**
  - This button will be enabled once you enter the correct information.

---

DevEUI is the EUI-64 address of the end node

Select server you use

App ID and Token are values from Loriot Network Server

---
Data Visualization
Display at Cayenne for LoRa®

- Values of temperature and humidity sensor will be displayed once the data is sent from the end node.
- Icons for temperature and humidity sensor can be customized by menu shown when to left-click on chart and the gear wheel on the icons.
- You can also check it on your smart phone.
Related Videos

- RA LoRaWAN® Sensor Demo Tutorial

- RA LoRa® Solution