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 Page 03
- REQUIRED EQUIPMENT Page 04
- SETUP LoRaWAN® END NODE Page 07
- SETUP LoRaWAN® GATEWAY AND LoRaWAN® NETWORK SERVER Page 13
- SETUP END NODE IN NETWORK SERVER Page 21
- LoRaWAN® DEMONSTRATION EXECUTION Page 25
- MORE VISUALIZATION (OPTION) Page 31
LoRaWAN® FEATURES

- You can build network with the LoRaWAN ecosystem.
- You can send data to the cloud with AT commands using the LoRaWAN End node Renesas software.
- You can realize IoT devices with LoRaWAN.
REQUIRED EQUIPMENT

- RL78/G14 Fast Prototyping Board (RTK5RLG140C00000BJ) ([https://www.renesas.com/rl78g14-fast-prototyping-board](https://www.renesas.com/rl78g14-fast-prototyping-board))
- Micro USB(USB A-Micro B) Cable. *(When using SX1262, you need two USB cables.)*
- Pin header(2 pins) and Short pin for standalone operation

---

![Diagram of LoRaWAN Network](image)

**LoRaWAN End node**
- Digilent Pmod USBUART
- RF78/G14 Fast Prototyping Board

**LoRaWAN Gateway**
- Kerlink Wirnet iFemtoCell

**Network Server**
- Wired LAN (Ethernet)/Wi-Fi

---
ORDERING REFERENCE
SEMTECH SX1261/SX1262 SHIELD AND LORA GATEWAY'S KERLINK WIRNET IFEMTOCELL

- 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.

- Gateway’s Kerlink Wirnet iFemtoCell

<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>
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</table>

Certification

<table>
<thead>
<tr>
<th>Region</th>
<th>868</th>
<th>915</th>
<th>923</th>
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</thead>
<tbody>
<tr>
<td>EU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Information:
LORIOT NETWORK SERVER
https://loriot.io/index.html#loriot-network-server

LORIOT Network Server has three plans. The tutorial uses a community public network server.

<table>
<thead>
<tr>
<th>COMMUNITY PUBLIC NETWORK SERVER</th>
<th>PROFESSIONAL PUBLIC SERVER</th>
<th>PRIVATE NETWORK SERVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Worldwide Community Public Servers Public LoRaWAN® servers on-demand including <strong>FREE connectivity.</strong></td>
<td>Professional Network Server for production services Professional LoRaWAN® network servers with 99.9% SLA and built-in redundancy. Guaranteed network infrastructure to deploy PoC and commercial services.</td>
<td>Full-featured enterprise-grade Network Server Private cloud or on-premise network server deployment. Carrier-grade solution for network operator and large-scale production services.</td>
</tr>
<tr>
<td>Ideal for Academic/Development/Proof-of-concept/Small-scale/non-critical.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature</th>
<th>Community Public</th>
<th>Professional Public</th>
<th>Private Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlimited User Accounts</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Unlimited Applications</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Unlimited gateways</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Unlimited Messages</td>
<td>Inclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Multitenancy</td>
<td>Exclusive</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Included Gateways</td>
<td>1 Gateway FREE</td>
<td>Unlimited</td>
<td>Unlimited</td>
</tr>
<tr>
<td>Included Devices</td>
<td>10 Devices FREE</td>
<td>Device connectivity packages available</td>
<td>Contact us</td>
</tr>
<tr>
<td>Service Level Agreement</td>
<td>Exclusive</td>
<td>99.9%</td>
<td>Inclusive</td>
</tr>
<tr>
<td>On-Premise Deployment</td>
<td>—</td>
<td>—</td>
<td>—</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>—</td>
<td>—</td>
</tr>
<tr>
<td>Technical support</td>
<td>Basic</td>
<td>Inclusive</td>
<td>Inclusive</td>
</tr>
<tr>
<td>Test Server</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Pricing</td>
<td><strong>FREE</strong></td>
<td><strong>See the plans</strong></td>
<td><strong>Contact us</strong></td>
</tr>
</tbody>
</table>

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SETUP LoRaWAN® END NODE
SETUP LoRaWAN END NODE(1)

• Connect as shown below

• For flash programming (Renesas Flash Programmer) or debugging with IDE (CS+/e2studio), EJ1 pin header should be OPEN. After completion of flash programming, “short EJ1” enables standalone operation without IDE.

• Pmod USBUART (USB-Serial Converter) should be connected to the PMOD1 connector’s upper.

Need to prepare pin header for standalone operation.
SETUP LoRaWAN END NODE(2)

- Download LoRa-based Wireless Software Package
  LoRa®-based Wireless Software Package

- Flash programming to RL78/G14 Fast Prototyping Board
  - For flash programming, EJ1 pin header should be OPEN.
  - Download Renesas Flash Programmer (RFP).
    RFP V3.05 or higher required. RFP site: https://www.renesas.com/rfp
  - Execute flash programming by RFP.
    Write the following file. to RL78/G14 Fast Prototyping Board
    samples\project\e2studio7\rl78g14fpb_sx126x\LoRaSample\DefaultBuild\LoRaSample.mot

- After completion of flash programming, “short EJ1” enables standalone operation.
HOW TO USE RENESAS FLASH PROGRAMMER

• Select New Project.
• Select RL78 in Microcontroller. Enter Project Name. Select E2 emulator Lite in Tool. Click Connect.
• Select file in Program file of Main Window.
• Click Start.
SETUP LoRaWAN END NODE(3)

You can control End node by the AT command from Terminal software of PC.
If you do not have any terminal software on your PC, please install a terminal software.

Example:
Tera Term  https://ttssh2.osdn.jp/index.html.en

<table>
<thead>
<tr>
<th>Terminal setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration Items</td>
<td>Value</td>
</tr>
<tr>
<td>Baud rate</td>
<td>115,200 bps</td>
</tr>
<tr>
<td>Data bit</td>
<td>8 bits</td>
</tr>
<tr>
<td>Parity bit</td>
<td>None</td>
</tr>
<tr>
<td>Stop bit</td>
<td>1 bit</td>
</tr>
<tr>
<td>Flow control</td>
<td>None</td>
</tr>
<tr>
<td>Local echo back</td>
<td>No</td>
</tr>
<tr>
<td>Line terminator</td>
<td>Transmission: CR+LF</td>
</tr>
<tr>
<td></td>
<td>Reception: CR+LF</td>
</tr>
</tbody>
</table>
WHEN USING SX1262

If you use SX1262, power supply capability of Digilent Pmod USBUART is not enough. Please supply power from the USB port of the RL78/G14 Fast Prototyping Board.

You need two USB cables.

In this case, please change the jumper pin on Digilent Pmod USBUART as the right pictures.
SETUP LoRaWAN® GATEWAY AND LoRaWAN® NETWORK SERVER
SETUP LoRaWAN GATEWAY
KERLINK GATEWAY BY TERMINAL SOFTWARE (SSH)

You need Gateway information for setup.
Individual information of iFemtoCell is as follows.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Board ID</strong></td>
<td>75xxxx012345</td>
</tr>
<tr>
<td><strong>Host name</strong></td>
<td>klk-wifc-012345</td>
</tr>
<tr>
<td><strong>MAC ADDR</strong></td>
<td>70:76:FF:xx:xx:xx</td>
</tr>
<tr>
<td><strong>Default password</strong></td>
<td>pdmk-012345 (Last 6 digits of Board ID)</td>
</tr>
<tr>
<td><strong>Username</strong></td>
<td>root</td>
</tr>
</tbody>
</table>

Gateway must be connected to the network to connect to the Network Server.
- Connect iFemtoCell to the LAN environment
- It is necessary to know the IP address assigned by the DHCP server in order to set up with SSH. Please Execute “arp -a” command from Windows command prompt. You identify iFemtoCell from the MAC address. Then check the IP address.
- Next, login via SSH to the confirmed IP address (Example: 192.168.1.11) using Tera Term.
- Use “root” to login with the default password.

Similar information
- https://www.thethingsnetwork.org/docs/gateways/kerlink/ifemtocell/
SETUP LoRaWAN NETWORK SERVER (1)
WEB BROWSER (LORIOT)

Please use Google Chrome, Firefox or Microsoft Edge

Create LORIOT account

- [https://www.loriot.io/login.html](https://www.loriot.io/login.html)
- Select SERVER close to your location
- Click Register a new account
SETUP LoRaWAN NETWORK SERVER(2)
WEB BROWSER(LORIOT)

- Add Gateway
  - Click Dashboard → Networks

- Click Dashboard → Networks → Sample network
SETUP LoRaWAN NETWORK SERVER(3)
WEB BROWSER(LORIOT)

- Click “+Add Gateway”
- **Gateway Registration**
  - Select “Kerlink iFemotoCell”
  - Set Gateway MAC ADDR to MAC address of eth0 interface
  - Set Gateway Location Form
  - Click “Register Kerlink iFemotoCell Gateway”
SETUP LoRaWAN NETWORK SERVER (4)
WEB BROWSER (LORIOT)

• Click Region of Configure

• 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_CH8_15
    • JAPAN:AS923
  • Click “Restart”

Regarding Channel Plan, see below for other regions.
Supported Frequency Plans
https://docs.loriot.io/display/LNS/Supported+Frequency+Plans
SETUP LoRaWAN GATEWAY FOR NETWORK SERVER (LORIOT)
KERLINK GATEWAY BY TERMINAL SOFTWARE (SSH)

• Execute LORIOT Gateway self-extracting installer

Once connected on the gateway with an SSH console.

Run the following commands:
  • cd /tmp
  • chmod +x loriot-install.sh
  • ./loriot-install.sh –f

Run the following command for reboot
  • reboot

By downloading and/or using any software from the list you Agree with the EULA.
  • https://ap2.loriot.io/assets/statics/eula.html
SETUP END NODE IN NETWORK
SERVER
SETUP END NODE IN NETWORK SERVER(1)
WEB BROWSER(LORIOT)

• Add Device
  • Click Dashboard→ Applications

• Click Dashboard→ Applications SampleApp
SETUP END NODE IN NETWORK SERVER(2)
WEB BROWSER(LORIOT)

- Click Dashboard→Application→SampleApp→ Enroll Device
About Device EUI
Please prepare 58-bit MAC address. Put FF: FE in the middle of the 48-bit MAC address and use it as a 64-bit Device EUI.

- Ender Title, Device EUI, Application EUI, and Application EUI
  - Title=demo5
  - Device EUI=xxxxxxxxFFExxxxxx  xxxxxx is the following
  - Application EUI= 0123456701234567
  - Application Key= 5555555555555555AAAAAAAAAAAAAAAA (5:16 digits and A:16 digits)
  - Click Enroll

MAC address: Companies that do not have a MAC address are purchased from IEEE. Alternatively, purchase an EEPROM with the MAC address written.
LoRaWAN® DEMONSTRATION EXECUTION
LoRaWAN END NODE(1)
TERMINAL SOFTWARE TO END NODE

Confirmation of UART connection
• Connect with PC by Terminal Software
• Setup Serial and Terminal of right figure (Port is connection port)
• Enter AT for control confirmation
• Confirm OK
LoRaWAN END NODE(2) TERMINAL SOFTWARE TO END NODE

Parameter setting
Execute command of the following by Terminal Software

Setup:

AT+REGION=X
AT+CLASS=0
AT+ACTMODE=1
AT+DEVEUI=XXXXFFFEXXXXXX
AT+APPEUI=0123456701234567
AT+APPKEY=5555555555555555AAAAAAAAAAAAAAAA
AT+SAVE

<region>
Operation region
0: EU868
1: US915
6: AS923

<class>
Device class
0: Class A (default)
2: Class C

<mode>
Activation mode
0: ABP
1: OTAA (default)

<deveui>
Address (EUI-64) of End node

In case of US region:
Before AT+SAVE, set the following
AT+CHDEFMASK=FF00,0000,0000,0000,0002
LoRaWAN END NODE(3)
TERMINAL SOFTWARE TO END NODE

Network join and sending data
Execute the following commands by Terminal Software.

AT+JOIN
AT+SENDHEX=00112233

If the response is “ERROR” or “JOIN: JOIN_FAILED”, re-enter “AT+JOIN” for retry.
Enter sending message.

Actual execution display

```
AT+JOIN
OK
+JOIN: JOIN_ACCEPTED
AT+SENDHEX=00112233
OK
+SENDHEX: OK
```
CONFIRMATION AT THE NETWORK SERVER (1)
WEB BROWSER (LORIOT)

- Click Dashboard → Application → SampleApp → WebsocketApplications
- Click Websocket sample
CONFIRMATION AT THE NETWORK SERVER(2)
WEB BROWSER(LORIOT)

You can check the data sent from the end node with SampleApp WebSocket of the web browser.
MORE VISUALIZATION(OPTION)
MORE VISUALIZATION

Shows how to display data information as temperature on Cayenne dashboard via LORIOT

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

Network Server
NETWORK SERVER SETTING FOR CAYENNE

• Click Dashboard→Application→SampleApp→Output
• Click Cayenne
• Click Add Output
GET NETWORK SERVER INFORMATION(1)

- Remember Application ID for setting Cayenne
GET NETWORK SERVER INFORMATION (2)

- Remember **Token** for setting Cayenne
CREATE ACCOUNT CAYENNE FOR LoRa®

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

Create Account
SETTING CAYENNE FOR LoRa(1)

- Login
- Click “LoRa”
- Click “Loriot”
SETTIGN CAYENNE FOR LoRa(2)

Click “Cayenne LPP”
SETTING CAYENNE FOR LoRa(3)

Set Information

- Device information
- Loriot information (Loriot App ID, Loriot Token)
- Others

Click Add Device

- If you do not enter the correct information, this button will not be enabled.

DeviceEUI is the address (EUI-64) of the end node

AppID and Token are Network Server values.
DATA TRANSMISSION FROM LoRaWAN END NODE

How to send temperature information from LoRaWAN end node in LPP format by AT command

- First enable Cayenne sensor channels (64 pieces)
  - AT+FPORT=14  ➤ Use LoRaWAN port 14 for initialization
  - AT+SENDHEX=FFFFFFFFFFFFFFFF ➤ Sensor channel bitmap (0:disable,1:enable)

- The temperature information can be transmitted in the following format.
  - AT+FPORT=1  ➤ Use LoRaWAN port 1 for dynamic sensor information
  - AT+SENDHEX=Channel Number(1 byte) Temperature Tag (0x67) Temperature (2 bytes) Repeat after

  - Example: AT+SENDHEX=01670110 ➤ Temperature Sensor:01, 0x0110=272=27.2 degree

When transmitting multiple channels simultaneously
- Example: AT+SENDHEX=0167011002670111 ➤ Temperature Sensor:01 is 27.2 degree, Temperature Sensor:02 is 27.3 degree

Please refer to the following for Data Types when you want to send data other than temperature.
https://community.mydevices.com/t/cayenne-lpp-2-0/7510
DISPLAY AT CAYENNE FOR LoRa

PC example

You can also check it on your smartphone.