

WiMOD Lite Gateway

QuickStartGuide

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Aim of this Document

Aim of this document is to give some quick start instructions how to start working with the WiMOD Lite Gateway (LGW) for LoRa™. This document only applies to LGWs with aluminum case, delivered after January 2018.

Confidentiality Note

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1 Evaluation Kit - Important Notice

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2 Introduction

Purpose of this documentation is to give some useful information how to get started with the Lite Gateway. For further information on hardware and technical specification of Lite Gateway and the integrated iC880A please refer to the corresponding documentation:

- [WiMOD_LiteGateway_Datasheet.pdf](#)
- [iC880A_Datasheet.pdf](#)

This Quick Start Guide is not meant to be a complete instruction guide explaining all steps and configuration options available for LoRa and Linux based systems. The intended reader should (at least) know the basics of the Linux command line and the basics of the LoRa technology in general. This document does not explain the very basic system concepts.

The Lite Gateway is meant to be used as demonstration system for the LoRaWAN network system. It is not designed to be a full featured outdoor gateway.

3 Overview

The Lite Gateway is a device that consists of a Raspberry-Pi B+ and an iC880A LoRa Concentrator. Both parts form a LoRaWAN Gateway which can be connected to a LoRaWAN server.



Figure 3-1: Lite Gateway

3.1 Basic System Concept

Figure 3-2 shows the basic system concept for the LoRaWAN system. The Lite Gateway is the central hardware solution for all LoRa based radio communication. It receives and transmits radio messages. Processing of the radio messages as well as the protocol related tasks is done by the embedded host system (Raspberry Pi). Received and processed radio messages are being sent to a LoRaWAN server. The concrete segmentation of the protocol related tasks is outside the scope of this document.

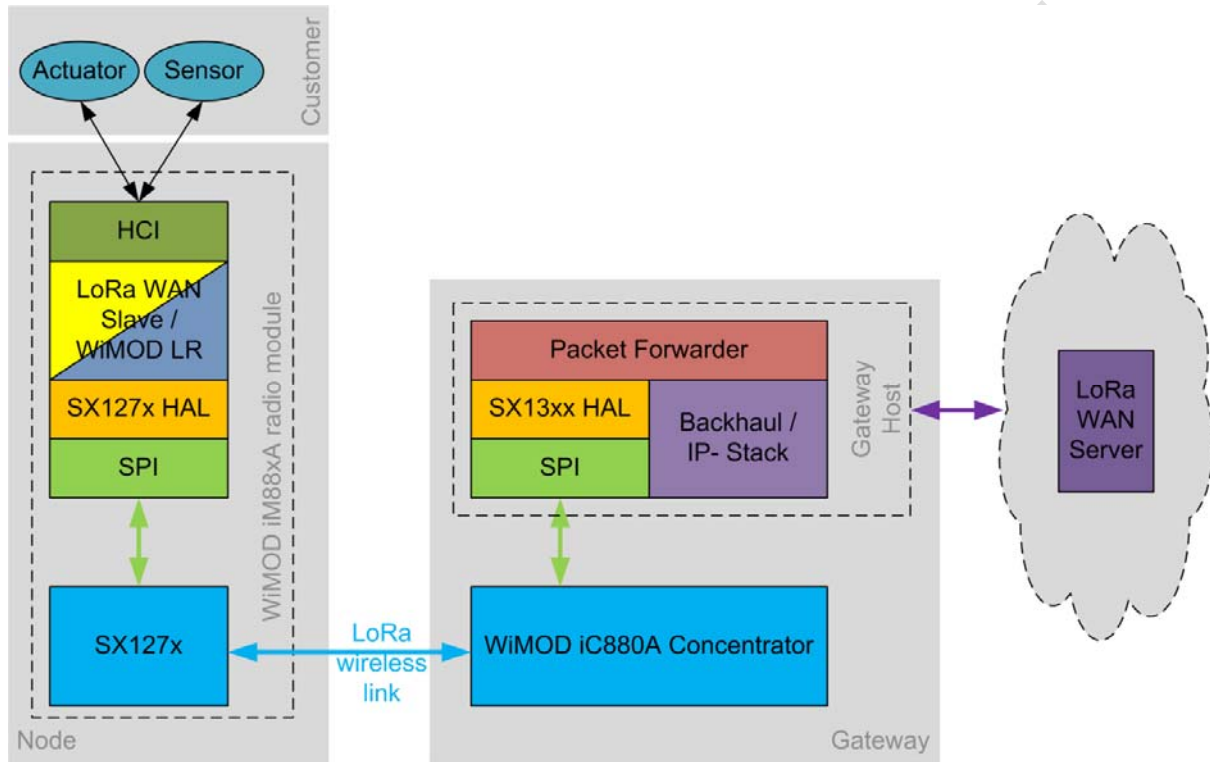


Figure 3-2: Basic System Concept

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4 Getting Started

4.1 General Information

The SD-Card image has been prepared in a way that the root file system is mounted in ReadOnly (RO) mode. That means that the user has to enable write access to the SD card before accomplishing (permanent) modifications to the system.

Note:

Please note that the declaration of conformity (regarding RED, 2014/53/EC) for the Lite Gateway becomes invalid after changing any part of the delivered pre-installed LoRa software image or hardware

In order to enable write access to the file system a script called “**enableWriteAccess.sh**” has been placed in the user’s home folder. If this script is executed the system is in ReadWrite (RW) mode. Modifications can now be permanently stored on the SD card.

After all modifications are done the user can switch back to ReadOnly (RO) mode by executing the “**disableWriteAccess.sh**” script that is placed in the home folder, too.

Hint: The following chapters will not mention the additional step of activating the RW mode before modifying the system. This knowledge is implied.

4.2 Basic Setup

Before connecting the power cord to the Lite Gateway, the antenna must be connected to the 50 Ohm SMA connector and an Ethernet cable must be connected to the box.

- After powering up, the Lite Gateway tries to obtain an IP-address by using a DHCP discovery procedure.
- If the network does not support DHCP, the Lite Gateway will use a fallback address of **169.254.125.124**.
- The box tries to register the name “**LoRaGateway.local**” for its current (IP) address via zeroconf protocol, so PCs running a zeroconf / bonjour client¹ are able to access the Lite Gateway via the convenient name.

For restricted DHCP servers the MAC address of the box must be added to the DHCP server service. For detailed instructions the local network administrator / the handbook of the DHCP server / router should be consulted.

¹ MacOS and most Linux distributions offer an appropriate service as part of the standard installation. Windows needs an additional client in order to support this.

4.2.1.1 (Optional) Setting Up a Customized IP Configuration

An easy way to change the IP related settings of the Lite Gateway is to use a cross link Ethernet cable to establish a direct one to one connection between the Lite Gateway and a PC. If the PC is setup to use the DHCP service, it will also use fallback IP within the 169.254.x.x range. A SSH session can be opened via the default fallback address. By editing the file `/etc/dhcpd.conf` a customized IP configuration can be setup. A customized setup may look like this:

```
# Custom static IP address for eth0.  
interface eth0  
static ip_address=192.168.0.200/24  
static routers=192.168.0.1  
static domain_name_servers=192.168.0.1
```

Note: Any change will require a reboot in order to activate the new settings. Using the command

```
sudo reboot
```

is highly recommended. (See also chapter 5)

4.2.2 Firewall Settings:

If a firewall is involved the following connections / ports must be allowed since the Lite Gateway needs to have internet access for working with external LoRaWAN server services:

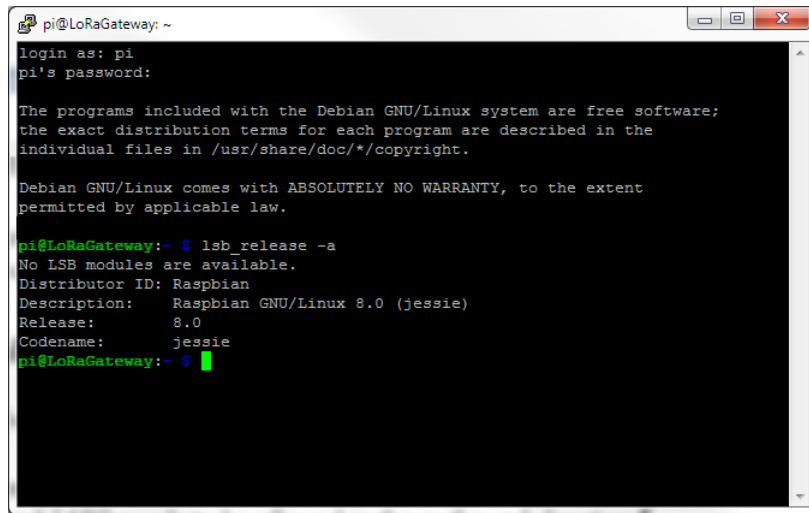
- Ports 123, 443, 1680 and 1780 needs to be allowed in the outbound direction.
- Optional: For SSH access from outside of the local LAN port 22 needs to be accessible.

4.2.3 Obtaining Access to the Lite Gateway

Since this system is headless, the main interface to the box is the Ethernet interface. (This documents assumes that the user as already got a SSH client (e.g. PuTTY) installed.)

In order to login to the box the following credentials for a SSH based console can be used:

- User: `pi`
- Password: `raspberry`

A screenshot of an SSH terminal window. The window title is 'pi@LoRaGateway: ~'. The terminal shows a login prompt for 'pi' with the password field masked. After login, it displays the Debian GNU/Linux copyright notice. The user then enters the command 'lsb_release -a', which outputs: 'No LSB modules are available. Distributor ID: Raspbian Description: Raspbian GNU/Linux 8.0 (jessie) Release: 8.0 Codename: jessie'.

```
pi@LoRaGateway: ~  
login as: pi  
pi's password:  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
  
pi@LoRaGateway:~$ lsb_release -a  
No LSB modules are available.  
Distributor ID: Raspbian  
Description:  Raspbian GNU/Linux 8.0 (jessie)  
Release:      8.0  
Codename:    jessie  
pi@LoRaGateway:~$
```

Figure 4-1: SSH terminal window

Hint: It is recommended to change these default credentials.

4.2.3.1 (Optional) Expanding the file system

By default a generic image has been copied to the SD card that is not configured to use the full space of the SD card.

In order to expand the file system to the full size of the SD card, the tool “**raspi-config**” can be used.

4.2.3.2 Getting the MAC-Address of the Box

The LoRaWAN network server services use the unique MAC-address of the box to identify it in the list of gateways. In order to find out the MAC address of the hardware the following command can be executed on the command line:

```
ifconfig | grep HWaddr
```

The box will output an address in the form of “**HWaddr: aa:bb:cc:dd:ee:ff**”². This is the 48 bit unique MAC address of the concrete hardware. Since the LoRaWAN servers use a 64 bit unique address the 48bit address must be extended by adding a “**:FF:FE:**” in the middle of the address.

For example a 48 bit address of **aa:bb:cc:dd:ee:ff** will be transformed into the 64 bit address of **aa:bb:cc:FF:FE:dd:ee:ff**.

This address will be used as identification address for the Lite Gateway within the LoRaWAN server.

² Note: The string “aa:bb:cc:dd:ee:ff” is only a place holder for individual hexadecimal numbers.

The Lite Gateway needs to be configured before it can be used.

4.3 Pre Installed LoRa Software

4.3.1 General Information

The pre-installed LoRa clients need write access to the file system in order to make changes to the default configuration files. Since the file system is mounted in ReadOnly (RO) mode, the folders containing the tools will be copied to the `/tmp` folder of the system. The `/tmp` folder is mounted as a RAM file system and allows full Read/Write (RW) access. Please note that all changes to the `/tmp` folder are volatile and lost after a power cycle / re-boot.

On delivery there is the LoRa HAL software pre-installed on the SD card:

4.3.2 Github Repositories

The pre-installed github repositories are:

- "lora_gateway" (V5.0.1) (https://github.com/Lora-net/lora_gateway)
- "packet_forwarder" (V4.0.1) (https://github.com/Lora-net/packet_forwarder)

Both repositories have been installed on the folder `/home/pi/github`.

In general the code base has been untouched, expect some files that mainly cover hardware specific adoptions. In detail the following files have been modified:

- `reset_lgw.sh`: Adaptations to the concrete hardware connections used on the PCBs.
- The PA settings within the `global_config.json` files; see Appendix 7.

Additionally a `systemd3.service` file has been installed in order to simplify to start of the lora packet forwarder. The file is named "IoTSemtech.service".

Note: In order to use "vanilla" github code as client to connect to a LoRaWAN server service the user has to setup a connection to the LoRaWAN server according to the guidelines of the chosen LoRaWAN server. This is outside of the scope of this document.

4.3.3 Loriot.io Client

Additionally to the gitub code base a loriot.io client binary has been installed on the SD card. It has been installed on the folder `/home/pi/loriot`.

³ systemd is an init system used in several Linux distributions to manage bootstrapping user space processes.

Note: In order to use the loriot client an account on the <http://loriot.io> website has to be created.

Note 2: The loriot client uses an encrypted communication path to the loriot.io servers. This requires that the local system time setup correctly. Since the used Raspberry-Pi has no build-in RTC, an update of the system time has to be done at boot-up. Please make sure that the system has access to public time servers.

4.3.4 Other LoRa clients

Other LoRa clients are currently not installed on the SD card but can be installed by the user. It is recommended to follow the installation instructions of the favorite client software.

4.3.5 Automatic Software Start

On delivery the system will boot-up **without** starting any of the pre-installed LoRa (client) packages. The user has to choose one and activate it manually.

4.3.5.1 Packet_forwarder (github)

For demonstration purposes the system can be configured to start the LoRa client software "packet_forwarder" which is part of the github repository.

This client software can be used to connect to e.g. the iot.semtech.com server. In order to use this LoRaWAN server the user has to register an account and follow the instructions given by the network operator. It is recommended to check the pre-set server address and port numbers given in the `global_conf.json` file.

The usage of the iot.semtech.com service is out of the scope of this document.

In order to start the `packet_forwarder` application on start-up, the following instructions have to be executed in the ssh command shell:

- Disable the loriot client:
 - `sudo systemctl stop loriot`
 - `sudo systemctl disable loriot`
- Enable the `packet_forwarder`:
 - `sudo systemctl enable IoTSemtech`
 - `sudo systemctl start IoTSemtech`

The first two commands try to stop a running loriot application and try to remove this service from the list of services that should be started automatically during the boot process. The next two commands try to activate the automatic start of the IoTSemtech service at (next) boot time and try to start the service for the current session. If no change of the automatic start procedure is intended, commands two and three can be left out.

Note: It is important to note that only one program can access the hardware at a given time. If several programs try to access the hardware, undefined behavior may occur. (see also chapter 6.1)

4.3.5.2 Local Tests (github)

Next to the “packet_forwarder” there are other tools included within the github repositories that allow local tests with the hardware (e.g. logging each received LoRa packet in a .csv file).

In order to use these tools the “packet_forwarder” needs to be stopped via the command:

```
sudo systemctl stop IoTSemtech
```

4.3.5.3 Loriot Client:

Additionally there is a loriot.io client installed on the system. In order to use this service following instructions must be executed in the ssh command shell:

- Disable the packet_forwarder:
 - `sudo systemctl stop IoTSemtech`
 - `sudo systemctl disable IoTSemtech`
- Enable the loriot.io client
 - `sudo systemctl enable loriot`
 - `sudo systemctl start loriot`

Next the Lite Gateway has to be registered at the loriot.io service following the instructions given on the website.

The usage of the loriot.io service is out of the scope of this document.

Note: It is highly recommended to use the optimized settings for the power level configuration in the pre-installed global_config.json (see Appendix 7). Furthermore you have to inform the network operator about this adaptation, may be you have to clarify it via out of band communication.

5 Important Information / Shutdown Instructions

Since the system is mounted in ReadOnly (RO) mode, the user is not required to issue a shutdown command to prevent data loss. However it is still recommended to shutdown the system in an ordered way via the command:

```
sudo halt
```

After issuing the command it is recommended to wait 20 sec before unplugging the power supply.

6 Troubleshooting

If the (automatic) start of the LoRa clients does not work as expected a manual investigation on the problem can be started.

6.1 Only one Software at a Time

Only one piece of software can access the RF-hardware (iC880A) at the same time. Unfortunately there is no low level lock mechanism implemented that manages access trials. In case of unpredictable behavior it is a good practice to check if there is already another LoRa software running.

6.2 Gateway does not show up on the LoRa server website

This situation may have several reasons. The remote server may be down, or the gateway has not been registered correctly.

In order to check the local setting some status information can be checked via the command:

```
sudo systemctl status IoTSemtech
```

or:

```
sudo systemctl status loriot
```

If there is a network related problem shown the user should check the network connection / setup. In some constellations the network service has not been setup completely before the automatic start of the LoRa client software is being triggered during the boot process. The user should consult the network administrator to solve the reason for the delayed setup.

6.3 No automatic Start at Boot Time

1. On delivery there is no automatic start of any pre-installed LoRaWAN client software enabled. Please choose your favorite one and follow the instructions given above.
2. Some LoRaWAN clients need to have the correct time in order to start. Please check that the system has acquired a valid time from public time servers.

6.4 Disk Space

In default mode the system starts in ReadOnly (RO) mode. That means that there will be no write operations to the SD card. Therefore there is no storage of various log information that persist a power cycle.

7 Appendix

7.1 Global_conf.json

The pre-installed github software has been adapted regarding the power level configuration in the global_conf.json File to optimize the output power of the Lite Gateway.

Because the output power of the Lite Gateway is limited to +20 dBm, the power level above this limit have to be avoided. Therefore the TX gain parameters (Indices 12, 13, 14, 15 with settings for "rf_power" 23, 25, 26, 27) above this limit are duplicates of index 11 (with "rf_power" 20). Please note that these different values have to be clarified with the network operator, maybe via out of band communication.

The following code-snippet of this global_conf.json shows the necessary TX gain parameters (pa_gain, mix_gain and dig_gain) and recommended values for the optimized power level configuration of the Lite Gateway. It is highly recommended to use these optimized settings for the power level configuration. Please note that you have to adapt these settings accordingly after an update of the github software.

Code-snippet from global_conf.json of the adopted, pre-installed github software based on HAL version 5.0.1.

```
=====
"tx_lut_0": {
  /* TX gain table, index 0 */
  "pa_gain": 0,
  "mix_gain": 8,
  "rf_power": -6,
  "dig_gain": 2
},
"tx_lut_1": {
  /* TX gain table, index 1 */
  "pa_gain": 0,
  "mix_gain": 11,
  "rf_power": -3,
  "dig_gain": 3
},
"tx_lut_2": {
  /* TX gain table, index 2 */
  "pa_gain": 0,
  "mix_gain": 10,
  "rf_power": 0,
  "dig_gain": 0
},
"tx_lut_3": {
  /* TX gain table, index 3 */
  "pa_gain": 0,
  "mix_gain": 14,
```

```
"rf_power": 3,  
"dig_gain": 1  
},  
"tx_lut_4": {  
/* TX gain table, index 4 */  
"pa_gain": 2,  
"mix_gain": 8,  
"rf_power": 6,  
"dig_gain": 3  
},  
"tx_lut_5": {  
/* TX gain table, index 5 */  
"pa_gain": 2,  
"mix_gain": 8,  
"rf_power": 10,  
"dig_gain": 2  
},  
"tx_lut_6": {  
/* TX gain table, index 6 */  
"pa_gain": 2,  
"mix_gain": 8,  
"rf_power": 11,  
"dig_gain": 1  
},  
"tx_lut_7": {  
/* TX gain table, index 7 */  
"pa_gain": 2,  
"mix_gain": 9,  
"rf_power": 12,  
"dig_gain": 2  
},  
"tx_lut_8": {  
/* TX gain table, index 8 */  
"pa_gain": 2,  
"mix_gain": 11,  
"rf_power": 13,  
"dig_gain": 3  
},  
"tx_lut_9": {  
/* TX gain table, index 9 */  
"pa_gain": 2,  
"mix_gain": 10,  
"rf_power": 14,  
"dig_gain": 2  
},  
"tx_lut_10": {  
/* TX gain table, index 10 */  
"pa_gain": 2,  
"mix_gain": 11,
```



```
"rf_power": 16,  
"dig_gain": 2  
},  
"tx_lut_11": {  
/* TX gain table, index 11 */  
"pa_gain": 2,  
"mix_gain": 12,  
"rf_power": 20,  
"dig_gain": 0  
},  
"tx_lut_12": {  
/* TX gain table, index 12; this is a duplicate of index 11 due to hardware limitations,  
see datasheet */  
"pa_gain": 2,  
"mix_gain": 12,  
"rf_power": 23,  
"dig_gain": 0  
},  
"tx_lut_13": {  
/* TX gain table, index 13; this is a duplicate of index 11 due to hardware limitations,  
see datasheet */  
"pa_gain": 2,  
"mix_gain": 12,  
"rf_power": 25,  
"dig_gain": 0  
},  
"tx_lut_14": {  
/* TX gain table, index 14; this is a duplicate of index 11 due to hardware limitations,  
see datasheet */  
"pa_gain": 2,  
"mix_gain": 12,  
"rf_power": 26,  
"dig_gain": 0  
},  
"tx_lut_15": {  
/* TX gain table, index 15; this is a duplicate of index 11 due to hardware limitations,  
see datasheet */  
"pa_gain": 2,  
"mix_gain": 12,  
"rf_power": 27,  
"dig_gain": 0  
}
```

=====

7.2 List of Abbreviations

LGW	Lite Gateway

7.3 List of Figures

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8 Restrictions and Limitations

8.1 Hardware Restrictions and Limitations

The characteristic values given by the present document are typically obtained by measurements based on evaluation kits of the entitled module. Using other carrier boards or connected equipment might lead to different characteristics. Subject to given measurement results the characteristic values might show the best performance of the entitled device, independent from any compliancy restriction of final operation purposes.

8.2 Software Restrictions and Limitations

The present document is a datasheet of the entitled device which intentional use is to provide information about basic characteristics related to the device hardware. Typically all described characteristic values require software for obtaining them accordingly. All features of the available software are subject to changes without claim to be complete at any time. Characteristically values might also be provided based on datasheets of the appropriate key components unless there are test results available based on the available software. For more information regarding current supported features of the available software refer to www.wireless-solutions.de.

8.3 Compliancy Restrictions and Limitations

The entitled device has been designed to comply with the standards namely given in the present document. The intentional operation shall be in so called ISM bands, which can be used free of charge within the European Union and typically licences free all over the world. Nevertheless, restrictions such as maximum allowed radiated RF power or duty cycle may apply which might result in a reduction of these parameters accordingly.

In addition, the use of radio frequencies might be limited by national regulations which requirements also need to be met.

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9 Important Notice

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