LPS8 LoRaWAN Gateway User Manual

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Firmware Version: LG02_LG08--build-v5.4.1590459021-20200526-1012

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1 Introduction

1.1 What is the LPS8

The LPS8 is an open source LoRaWAN Gateway. It lets you bridge LoRa wireless network to an IP network via WiFi, Ethernet. The LoRa wireless allows users to send data and reach extremely long ranges at low data-rates.

The LPS8 uses Semtech packet forwarder and fully compatible with LoRaWAN protocol. It includes a SX1308 LoRa concentrator, which provides 10 programmable parallel demodulation paths.

LPS8 has pre-configured standard LoRaWAN frequency bands to use for different countries. User can also customized the frequency bands to use in their own LoRa network.
1.2 Specifications

**Hardware System:**

Linux Part:
- 400Mhz ar9331 processor
- 64MB RAM
- 16MB Flash

**Interface:**
- 10M/100M RJ45 Ports x 1
- WiFi : 802.11 b/g/n
- LoRaWAN Wireless
- Power Input: 5V DC, 2A, Type C
- USB 2.0 host connector x 1

**WiFi Spec:**
- IEEE 802.11 b/g/n
- Frequency Band: 2.4 ~ 2.462GHz
- Tx power:
  - 11n tx power : mcs7/15: 11db     mcs0 : 17db
  - 11b tx power: 18db
  - 11g 54M tx power: 12db
  - 11g 6M tx power: 18db
- Wifi Sensitivity
  - 11g 54M : -71dbm
  - 11n 20M : -67dbm

**LoRa Spec:**
- Up to -140 dBm sensitivity with SX1257 Tx/Rx front-end
- 70 dB CW interferer rejection at 1 MHz offset
- Able to operate with negative SNR, CCR up to 9dB
- Emulates 49 x LoRa demodulators and 1 x (G)FSK demodulator
- Dual digital TX & RX radio front-end interfaces
- 10 programmable parallel demodulation paths
- Dynamic data-rate (DDR) adaptation
- True antenna diversity or simultaneous dual-band operation

1.3 Features

- Open Source OpenWrt system
- Managed by Web GUI, SSH via WAN or WiFi
- Remote access with Reverse-SSH
- Emulates 49x LoRa demodulators
- LoRaWAN Gateway
- 10 programmable parallel demodulation paths
- Pre-configure to support different LoRaWAN regional settings.
- Allow to customize LoRaWAN regional parameters.
- Support Local decode ABP end node info and transfer to MQTT server
- Support different level log in.

1.4 Hardware System Structure

LPS8 System Overview:
1.5 LPS8 Applications

1.6 LED Indicators

LPS8 has totally four LEDs, They are:

- **Power LED** : This RED LED will be solid on if the device is properly powered.

- **LoRa LED** : This RGB LED will blink GREEN when LoRaWAN module starts or transmit a packet.

- **SYS LED** : This RGB LED will shows different colors on different state:
  - **SOLID BLUE** : Device is alive with LoRaWAN server connection.
  - **BLINKING BLUE** : a) Device has internet connection but no LoRaWAN Connection. or b) Device is in booting stage, in this stage, it will BLINKING BLUE for several seconds and then with SOLID RED and BLINKING BLUE together
  - **SOLID RED** : Device doesn’t have Internet connection.

- **ETH LED** : This LED shows the ETH interface connection status.
2 Access and Configure LPS8

The LPS8 is configured as a WiFi Access Point by factory default. You can access and configure the LPS8 after connecting to its WiFi network, or via its WAN Ethernet port.

2.1 Find IP address of LPS8

2.1.1 Connect via WiFi

At the first boot of LPS8, it will auto generate a WiFi network called *dragino-xxxxxx* with password:

```
dragino+dragino
```

You can use a PC to connect to this WiFi network. The PC will get an IP address 10.130.1.xxx and the LPS8 has the default IP 10.130.1.1

2.1.2 Connect via Ethernet with DHCP IP from router
Alternatively, connect the LPS8 Ethernet port to your router and LPS8 can obtain an IP address from your router. In the router’s management portal, you should be able to find what IP address the router has assigned to the LPS8. You can also use this IP to connect.

### 2.1.3 Connect via WiFi with DHCP IP from router

If the LPS8 already connect to the router via WiFi, use can use the WiFi IP to connect to LPS8.

### 2.1.4 Connect via Ethernet with fall back ip

The WAN port also has a fall back ip address for access if user doesn’t connect to uplink router. Click [here](#) to see how to configure.
2.2 Access Configure Web UI

Web Interface

Open a browser on the PC and type in the LPS8 ip address (depends on your connect method)

http://10.130.1.1/  (Access via WiFi AP network)

or

http://IP_ADDRESS or http://IP_ADDRESS:8000  (The web port has been changed to 8000 in WAN interface (WAN port or WiFi Client Mode) since firmware 5.3.xxx firmware)

You will see the login interface of LPS8 as shown below.
The account details for Web Login are:

User Name: root
Password: dragino
3 Typical Network Setup

3.1 Overview

The LPS8 supports flexible network set up for different environments. This section describes the typical network topology can be set in LPS8. The network set up includes:

- WAN Port Internet Mode
- WiFi Client Mode
- WiFi AP Mode

3.2 Use WAN port to access Internet

By default, the LPS8 is set to use the WAN port to connect to an upstream network. When you connect the LPS8’s WAN port to an upstream router, LPS8 will get an IP address from the router and have Internet access via the upstream router. The network status can be checked as below:
3.3 **Access the Internet as a WiFi Client.**

In the WiFi Client Mode, LPS8 acts as a WiFi client and gets DHCP from an upstream router via WiFi.

The settings for WiFi Client is under page *System → WiFi → WiFi WAN Client Settings*

In the WiFi Survey Choose the WiFi AP, and input the Passphrase then click Save & Apply to connect.

3.4 **Check Internet connection**

In the *Home* page, we can check the Internet connection.

- GREEN Tick 🟢: This interface has Internet connection.
- Yellow Tick 🟠: This interface has IP address but don’t use it for internet connection.
- RED Cross 🟥: This interface doesn’t connected.
4 Example: Configure as a LoRaWAN gateway

LPS8 is fully compatible with LoRaWAN protocol. It uses the legacy Semtech Packet forwarder to forward the LoRaWAN packets to server. The structure is as below.

This chapter describes how to use the LPS8 to work with

TheThingsNetwork (TTN) LoRaWAN Server (www.thethingsnetwork.org)
4.1 Create a gateway in TTN Server

Step 1: Get a Unique gateway ID.
Every LPS8 has a unique gateway id. The ID can be found at LoRaWAN page:

The example gateway id is: a840411b8268ffff

Step 2: Sign up a user account in TTN server

![TTN Server Configuration](image)
Step 3: Create a Gateway

Click on the Gateways icon to open the page below:

Notice: The TTN router should match the Frequency Plan you choose, otherwise you will have problem for End Node to join the network. If you don’t which router you need to select, please check: https://www.thethingsnetwork.org/docs/gateways/packet-forwarder/semtech-udp.html#connect-a-gateway_server-addresses

After creating the gateway, you can see the gateway info, as below.
4.2 Configure LPS8 to connect to TTN

You can now configure the LPS8 to let it connect to TTN network. Make sure your LPS8 has a working Internet Connection first.

Choose the right server provider and click **Save&Apply**

**Note:** The server address must match the router you choose in TTN.

In the home page, we can see the LoRaWAN connection is ready now.
In TTN portal, we can also see the gateway is connected.
4.3 Configure frequency

We also need to set the frequency plan in LPS8 to match the end node we use, so to receive the LoRaWAN packets from the LoRaWAN sensor.

In logread page, user can check the frequency actually used.
4.4 Add a LoRaWAN End Device

This section shows how to add a LoRaWAN End device to a LoRaWAN network and see the data from TTN web site.

We use LT-22222-L IO Controller as a reference device - the setup for other LoRaWAN devices will be similar.

**Step 1:** Create a Device definition in TTN with the OTAA keys from the example LT-33222-L IO Controller device.

Three codes are required to define the device in TTN:

- **DEV EUI** - Unique ID code for a particular device.
- **APP EUI** - ID code for an Application defined in TTN.
- **APP Key** - Unique key to secure communications with a particular device.

A set of these codes are stored in each device by the manufacturer as the default codes for that particular device. Each device is shipped with a sticker with the default Device EUI as shown below.

Note: You may be able to change these codes in a device by using a configuration facility on the device e.g. the LT-22222 uses a serial port access and a series of AT commands. Changing the codes may be necessary in the case where you have to use codes assigned by a LoRa WAN server.

For the TTN server, you can use the codes set in the device as in the following example.
Select **Add Application** to open the screen below.

Note that there is an APP EUI already created by TTN, but this is not the one set in the device. To add the APP EUI for the LT-22222-L device, select **Manage EUIs** and **Add EUI**, then enter the required code.

Select **Devices** and **Register Device** to open the screen below.

Enter the **Device EUI** and **APP KEY** codes, then select the App EUI from the list. Check that all three codes match those shown on the device label before saving the configuration.

**Step 2**: Power on LT-22222-L device and it will automatically join the TTN network. After joining successfully, it will start to upload messages to the TTN. Select the Data tab and you will see the data appearing in the panel.

Note that it may take some time for the device data to appear in the TTN display.
5 More features

5.1 Packet Filtering

Drop unwanted packets:

5.2 Remote Access

Remote Access Devices for management:
Instruction

5.3 How to decode ABP LoRaWAN node

Decode ABP

5.4 How to set data to MQTT broker

Only support ABP LoRaWAN End Node
Instruction:

5.5 More instructions

http://wiki.dragino.com/index.php?title=Main_Page#LoRa/LoRaWAN_Gateway_Instruction
6 Linux System

The LPS8 is based on the OpenWrt Linux system. It is open source, and users are free to configure and modify the Linux settings.

6.1 SSH Access for Linux console

User can access the Linux console via the SSH protocol. Make sure your PC and the LPS8 are connected to the same network, then use a SSH tool (such as putty in Windows) to access it.

IP address: IP address of LPS8
Port: 22 or 2222 (SSH port in WAN interface has been change to 2222 since firmware 5.3.xx, for security reason)
User Name: root
Password: dragino (default)

After logging in, you will be in the Linux console and can enter commands as shown below.

The “logread -f” command can be used to debug how system runs.
6.2 Edit and Transfer files

The LPS8 supports the SCP protocol and has a built-in SFTP server. There are many ways to edit and transfer files using these protocols.

In Windows, one of the easiest methods is using the WinSCP utility. After establishing access via WinSCP to the device, you can use an FTP style window to drag / drop files to the LPS8, or edit the files directly in the windows.

Screenshot is as below:

![Screenshot of WinSCP interface](image)

6.3 File System

The LPS8 has a 16MB flash and a 64MB RAM. The /var and /tmp directories are in the RAM, so contents stored in /tmp and /var will be erased after rebooting the device. Other directories are in the flash and will remain after reboot.

The Linux system uses around 8MB ~ 10MB flash size which means there is not much room for user to store data in the LPS8 flash.

You can use an external USB flash memory device to extend the size of flash memory for storage.
6.4 Package maintenance system

LPS8 uses the OpenWrt OPKG package maintenance system. There are more than 3000+ packages available in our package server for users to install for their applications. For example, if you want to add the `iperf` tool, you can install the related packages and configure LPS8 to use `iperf`.

Below are some example `opkg` commands. For more information please refer to the OPKG package maintain system (https://wiki.openwrt.org/doc/techref/opkg)

In Linux Console run:

```
root@dragino-169d30:~# opkg update  // to get the latest packages list
root@dragino-169d30:~# opkg list      //shows the available packages
root@dragino-169d30:~# opkg install iperf // install iperf
```

The system will automatically install the required packages as shown below.

```
root@dragino-169d30:/etc/opkg# opkg install iperf
    installing iperf (2.0.12-1) to root...
    Downloading http://downloads.openwrt.org/snapshots/packages/mips_24kc/base/iperf_2.0.12-1_mips_24kc.ipk
    Installing uclibcxx (0.2.4-3) to root...
    Downloading http://downloads.openwrt.org/snapshots/packages/mips_24kc/base/uclibcxx_0.2.4-3_mips_24kc.ipk
    Configuring uclibcxx.
    Configuring iperf.
```
7 Upgrade Linux Firmware

We keep improving the LPS8 Linux side firmware for new features and bug fixes. Below are the links for reference.

- **Latest firmware**: LoRa Gateway Firmware,
  (http://www.dragino.com/downloads/index.php?dir=LoRa_Gateway/LG02-OLG02/Firmware)
- **Change Log**: Firmware Change Log,
  (http://www.dragino.com/downloads/downloads/LoRa_Gateway/LG02-OLG02/Firmware/ChangeLog)

The file named as xxxx–xxxx-squashfs-sysupgrade.bin is the upgrade Image. There are different methods to upgrade, as below.

7.1 Upgrade via Web UI

Go to the page: Web → System → Firmware Upgrade
Select the required image and click Flash Image. The image will be uploaded to the device, and then click Process Update to upgrade.

**NOTE**: You normally need to **uncheck** the Preserve Settings checkbox when doing an upgrade to ensure that there is no conflict between the old settings and the new firmware. The new firmware will start up with its default settings.

The system will automatically boot into the new firmware after upgrade.
7.2 Upgrade via Linux console

SCP the firmware to the system /var directory and then run

```
root@OpenWrt:~# /sbin/sysupgrade -n /var/Your_Image
```

**NOTE**: it is important to transfer the image in the /var directory, otherwise it may exceed the available flash size.
8 FAQ

8.1 How can I configure for a customized frequency band?

See below link for how to customize frequency band:

8.2 Can I make my own firmware for the gateway, Where can I find the source code?

Yes, You can make your own firmware for the LPS8 for branding purposes or to add customized applications.

The source code and compile instructions can be found at:
https://github.com/dragino/openwrt_lede-18.06

8.3 Can I use 868Mhz version for 915Mhz bands?

It is possible but the distance will be very short, you can select US915 frequency band in 868Mhz version hardware. It will work but you will see the performance is greatly decreased because the 868Mhz version has an RF filter for band 863~870Mhz, all other frequencies will have high attenuation.
9 Trouble Shooting

9.1 I get kernel error when install new package, how to fix?

In some cases, when installing a package with `opkg`, it will generate a kernel error such as below due to a mismatch in the kernel ID:

```
root@dragino-16c538:~# opkg install kmod-dragino2-si3217x_3.10.49+0.2-1_ar71xx.ipk
Installing kmod-dragino2-si3217x (3.10.49+0.2-1) to root...
Collected errors:
* satisfy_dependencies_for: Cannot satisfy the following dependencies for kmod-dragino2-si3217x:
  * kernel (= 3.10.49-1-4917516478a753314254643facdf360a) *
  * opkg_install_cmd: Cannot install package kmod-dragino2-si3217x.
```

In this case, you can use the `–force-depends` option to install such package as long as the actual kernel version is the same.

```
opkg install kmod-dragino2-si3217x_3.10.49+0.2-1_ar71xx.ipk –force-depends
```

9.2 How to recover the LPS8 if the firmware crashes

Please follow this instruction to recover your gateway:

9.3 I configured LPS8 for WiFi access and lost its IP. What to do now?

The LPS8 has a fall-back IP address on its WAN port. This IP is always enabled so you can use the fall-back IP to access LPS8 no matter what the WiFi IP is. The fall back IP is useful for connecting and debug the unit.

(Note: fallback IP can be disabled in the WAN and DHCP page)

Steps to connect via fall back IP:
1. Connect PC’s Ethernet port to LG01’s WAN port
2. Configure PC’s Ethernet port has
   IP: 172.31.255.253 and
   Netmask: 255.255.255.252

As below photo:

3. In the PC, use IP address 172.31.255.254 to access the LPS8 via Web or Console.
   Please note the latest firmware uses port 8000 for http and 2222 for ssh access.
9.4 I connect to the LPS8’s SSID but LPS8 didn’t assign DHCP IP to my laptop?

This is a known bug for the firmware version before 2019-09-23 for LPS, the issue was fixed since version: LG02_LG08--build-v5.2.1569218466-20190923-1402.

In the old version, user can use the **fall back ip method** to access and configure the device.
10 Order Info

**PART: LPS8-XXX-YYY:**

**XXX: Frequency Band**

- **868**: valid frequency: 863Mhz ~ 870Mhz. for bands EU868, RU864, IN865 or KZ865.
- **915**: valid frequency: 902Mhz ~ 928Mhz. for bands US915, AU915, AS923 or KR920
11 Packing Info

**Package Includes:**
- LPS8 LoRaWAN Gateway x 1
- Stick Antenna for LoRa RF part. Frequency is one of 470 or 868 or 915Mhz depends the model ordered
- Packaging with environmental protection paper box

**Dimension and weight:**
- Device Size: 12 x 12 x 3 cm
- Weight: 187g
- Package Size: 14.5 x 13.5 x 6 cm
- Weight: 300g

12 Support

- Try to see if your questions already answered in the [wiki](#).
- Support is provided Monday to Friday, from 09:00 to 18:00 GMT+8.
  Due to different timezones we cannot offer live support. However, your questions will be answered as soon as possible in the before mentioned schedule.
- Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc) and send a mail to:

  **support@dragino.com**

13 FCC Warning

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) this device must accept any interference received, including interference that may cause undesired operation