UM01649

IoT Discovery User Manual

V1.1

Document Information

Item	Content
Keyword	*LoRaWAN，UM，IoT，Wireless communication*
Abstract	This document describes how to use, test and configure RisingHF RHF2S001 IoT Discovery LoRa Kit

Content

1 Introduction

RisingHF IoT Discovery is a LoRa kit which integrates evaluation, development and quick test features which is designed by RisingHF. This document will describe the usage of IoT Discovery (RHF2S001) in details, include how to build up hardware, how to connect to a LoRaWAN network, how to test hardware and so on.

1.1 Product List
- 1 x Raspberry Pi
- 1 x RHF0M301
- 1 x RHF4T002
- 1 x RHF3M076
- 3 x RHF76-052
- 1 x USB to UART adapter
- 1 x 4 pin dual female splittable jumper wire
- 1 x SD Card
- 1 x 5V/2A Adapter
- 3 x USB cables
- 1 x Ethernet cable
- 2 x Antenna: **-2dBi, Omni-directional antenna**

Figure 1 IoT Discovery Product list

2 Get started

Figure 2 RHF2S001 package

Open each box, and take out "RPi + RHF0M301 + RHF4T002", SD card is already burned RisingHF standard image. Please follow below description and pictures to connect the core gateway board.
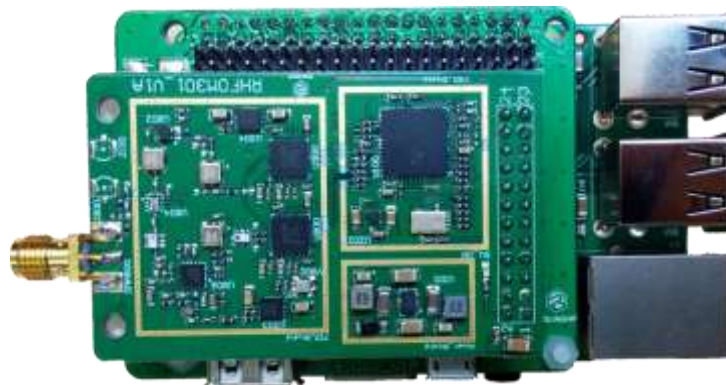

Figure 3 Raspberry Pi + RHF4T002 + RHF0M301 Top View

Definition of 4 connectors in below picture:

> ➢ <mark style="background-color:yellow">Yellow</mark>   Gateway kit main supply connector)
> ➢ <mark style="background-color:red">Red</mark>   USB Host connector, used to supply power for Raspberry Pi
> ➢ <mark style="background-color:lime">Green</mark>   Raspberry Pi power input connector (Micro USB)
> ➢ <mark style="background-color:blue">Blue</mark>   RPi Ethernet port
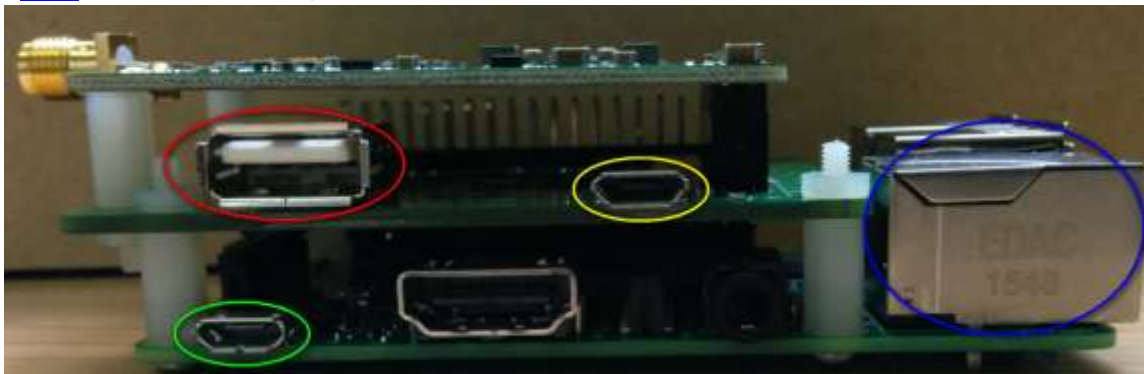

Figure 4 RPi+RHF4T002+RHF0M301 side view

Please follow below picture to connect short USB cable (15cm), long USB cable (1M) and 5V/2A adapter.

Figure 5 Connect USB Cables

2.1 USB Serial Tool
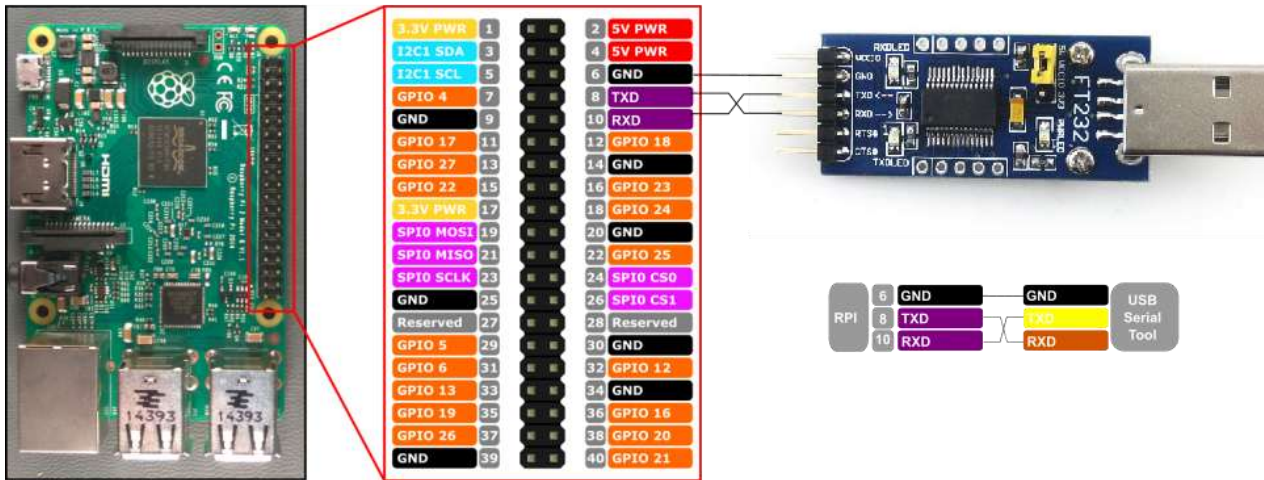
Follow below picture to connect FT232 USB to serial tool

Figure 6 RPi and FT232 connection map

Figure 7 RPi and FT232 real product connections

2.2 Software Tools

In the following chapters, below tools will be needed, please install it to your computer[1]:

➢ SSCOM, portable serial tool, used to control RHF3M076
➢ ExtraPuTTY, terminal tool include both serial and SSH terminal, used to control RPi
➢ Internet browser, used to access RHF2S001 integrated LoRaWAN server (It is recommended to use Chrome or Firefox)

Please access RisingHF Wiki Resources RHF2S001 Section to download related tools. You may have your other favorite serial tools, if you have any trouble to use it, please make comparison test with the proposal tool.

---

[1] This document assumes user use Windows operating system

2.3 Power Up
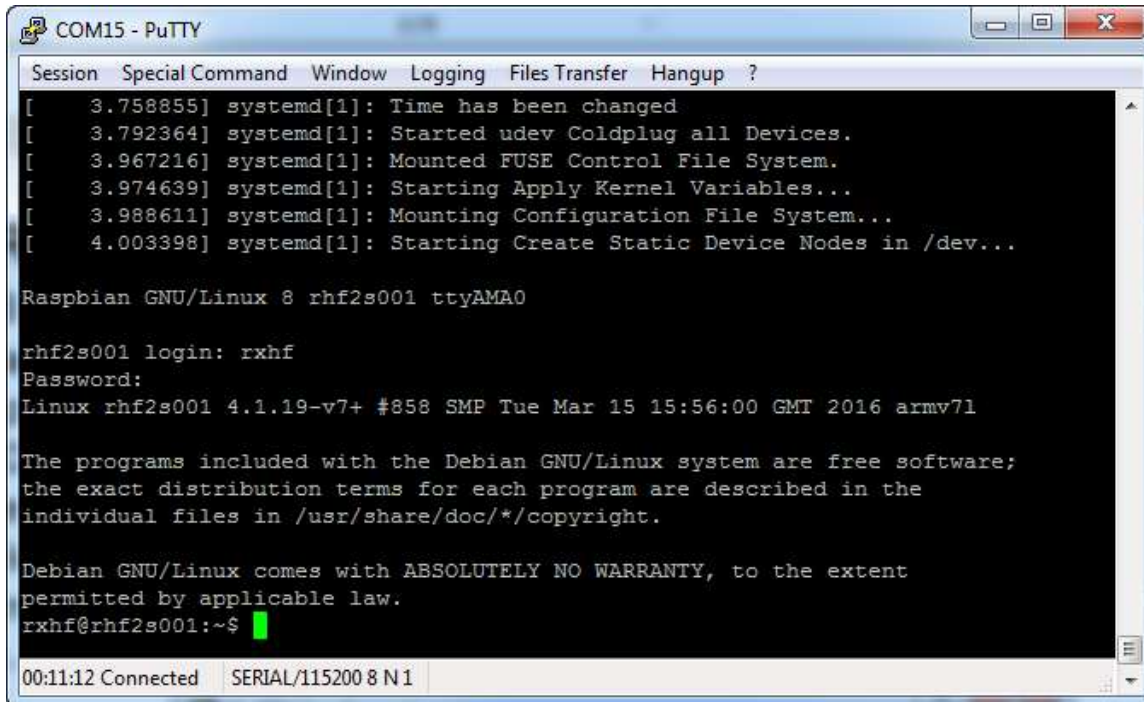
a) First, make sure the serial tool and RPi (RHF4T002 Adapter) are connected correctly.

b) Plug FT232 tool to PC (If COM port is not recognized correctly, please refer below driver installation chapter)

c) Open "Device Manager" to get the right COM port. Like COM15 for example. Configure ExtraPuTTY according to below picture (Speed 115200, others use defaults), click "Open". As the gateway is still not opened, so there is nothing in the terminal.
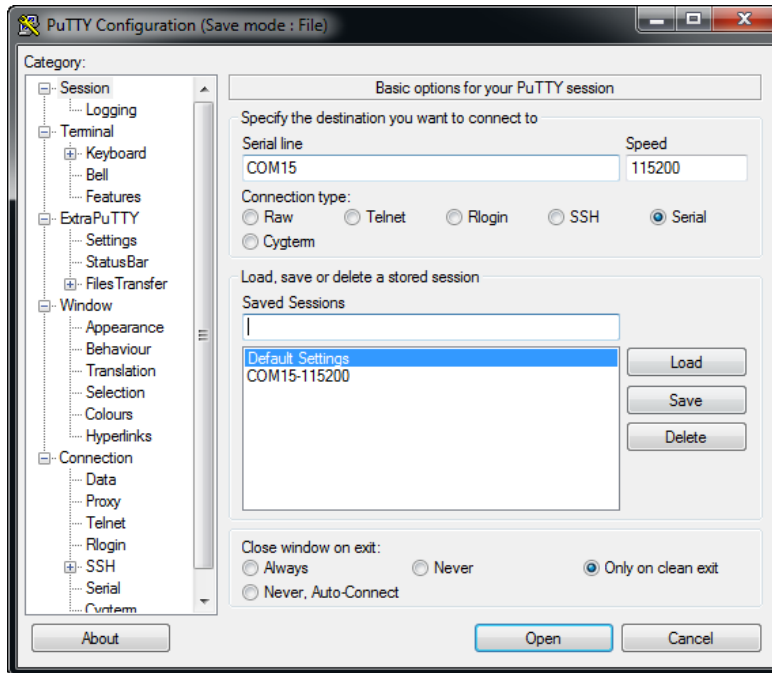
d) Power the gateway up. Booting log will be showed in the ExtraPuTTY terminal, in the end it will prompt you to input your log in name. Please note it takes 1 or 2 minutes to get the prompt information.
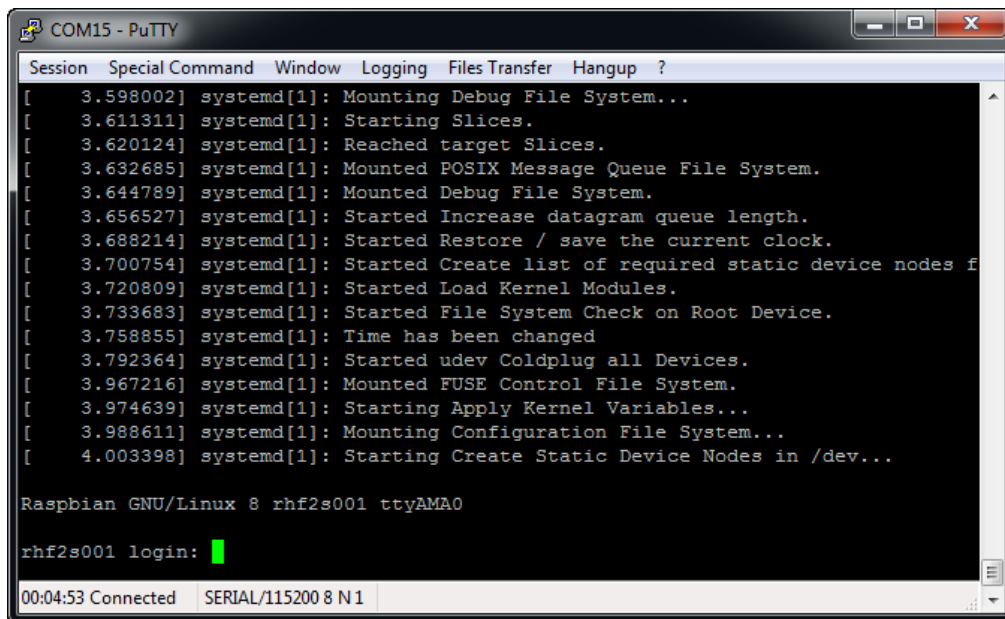
e) Please use RHF2S001 default user name and password to log in. (Username: **rxhf**, Password: **risinghf**). Note, when input the password, there is no any echo

f) Connect RHF2S001 with router through ethernet cable
g) Run ifconfig to check the ip address and mac address. IP is in the red circle, MAC address is in white circle (Format: b8:27:eb:xx:xx:xx)

After you get the IP, it is recommended to login RHF2S001 again through SSH. Because SSH is faster (Ethernet than UART) and stable. We normally use serial tool to get the IP. Reopen ExtraPuTTY input the IP and use default port 22 to connect again.
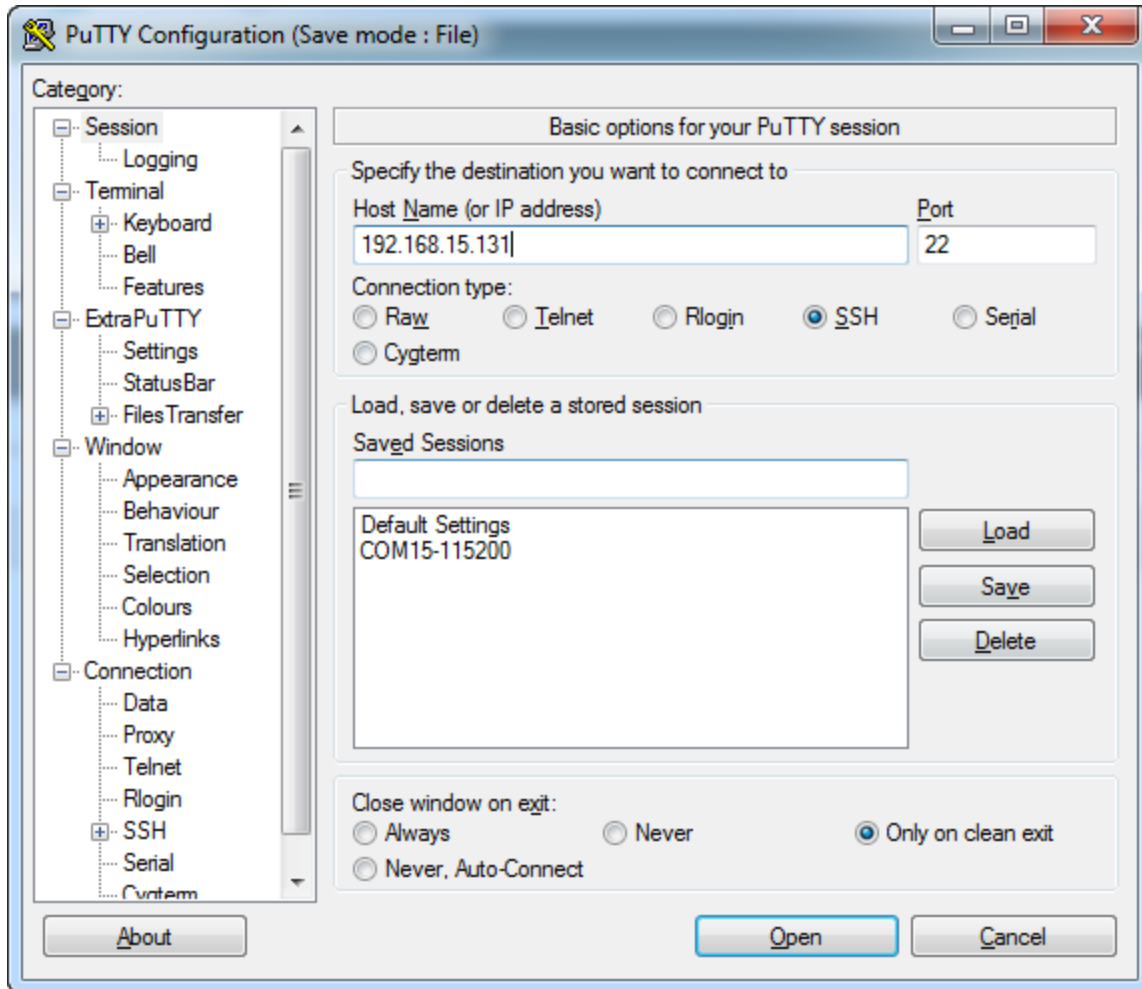
h) Please note, the gateway connects to http://cn1.loriot.io by default, following chapter will introduce how to register gateway to cn1.loriot.io

2.4 Loriot Server Gateway Registration

a) New user need register an account first, registration address https://cn1.loriot.io/register.html. Fill in UserName, Password and email address to register, after registration an email will be sent to you, please follow the instruction in the email to activate.

b) After successful activation, acess https://cn1.loriot.io/home/login.html to log in. Default tier is "Community Network", it supports 1 Gateway (RHF2S001) and 10 nodes.

c) Enter Dashboard -> Gateway, click "Add Gateway" start to add Gateway

d) Select "Raspberry Pi"

e) Raspberry Pi model -> Raspberry Pi 2

Concentrator model -> SX1301/SX1255 Reference (for RHF2S001-434, RHF2S001-470)

SX1301 Reference (for RHF2S001-868, RHF2S001-920, RHF2S001-780)

Connected over -> SPI
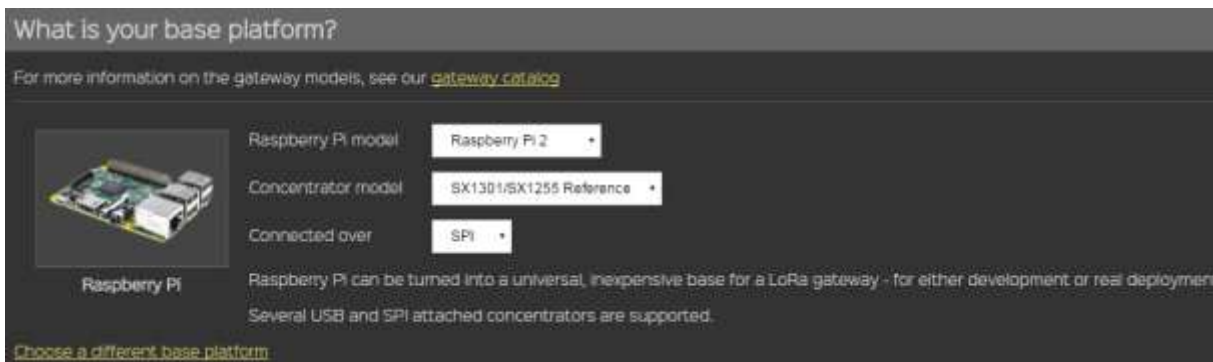
f) Fill in the MAC address of your RHF2S001, should be in format of b8:27:eb:xx:xx:xx. And also input Gateway Location information.

g) Click "Register Raspberry Pi gateway" to finish the registration.

h) Click the registered gateway to enter configuration page, switch "Frquency Plan" manually, your plan here is decided by the type of your RHF2S001 type, available plan are CN470，CN473，CN434，CN780，EU868, after selected please refresh the page to get the exact channel.

i)   Run command "**sudo /etc/init.d/loriot-gw restart**" to restart loriot gateway service (reboot is also OK to force loriot service reconnect). Status is showed as below after the gateway is connected:
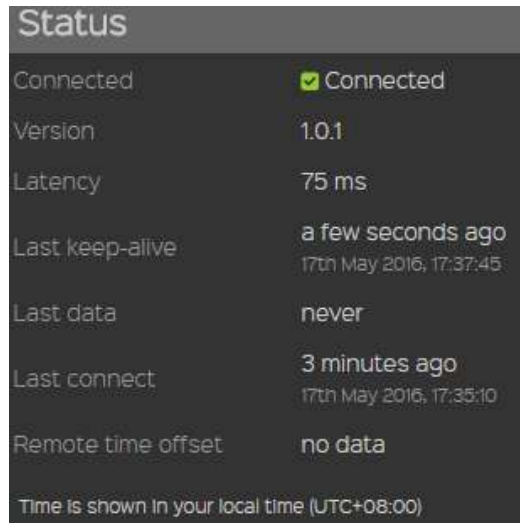
j)   Finish gateway registration. Next is to register node.

2.5 Loriot Server Connect Node device

2.5.1 RHF3M076 Configuration

Connect RHF3M076 with your PC befores configuration, like below picture:

图 **8 RHF3M076**

a)   RHF3M076 will be recognized as a USB CDC (COM Port) device. Please refer to UM01516 about how to install driver. The driver file could be downloaded from RisingHF Wiki or contact support@risinghf.com

b)   Open SSCOM tool, please note SSCOM only scan com port when it is opened, if the device is connected after SSCOM is opened, please reopen SSCOM to refresh device list.

c)   Make sure "SendNew" option is checked this will make SSCOM append Windows newline "\r\n" for every command. So that RHF3M076 could recognize the command.

d) Send "AT+CH" to get channel lis. RHF3M076 work at 868MHz by default.
   at+ch
   +CH: 3; 0,868100000,DR0,DR5; 1,868300000,DR0,DR5; 2,868500000,DR0,DR5;

e) Configure RHF3M076 channels according to the selected frequency plan. Current gateway channels could be got from "Dashboard -> Gateway -> Your Gateway" Use below command to reconfigure the channels:
   (For exmpale: CN470)
   at+ch=0,471.5
   at+ch=1,471.7
   at+ch=2,471.9

   At lease set 3 channels to overwrite all default channels, when finished execute "at+ch" to check channel list:
   at+ch
   +CH: 3; 0,471500000,DR0,DR5; 1,471700000,DR0,DR5; 2,471900000,DR0,DR5;

f) Send "AT+ID" to check device DEVADDR, DEVEUI, APPEUI
   at+id
   +ID: DevAddr, 00:82:2c:96
   +ID: DevEui, 47:97:c5:34:90:1d:00:48
   +ID: AppEui, 52:69:73:69:6e:67:48:46
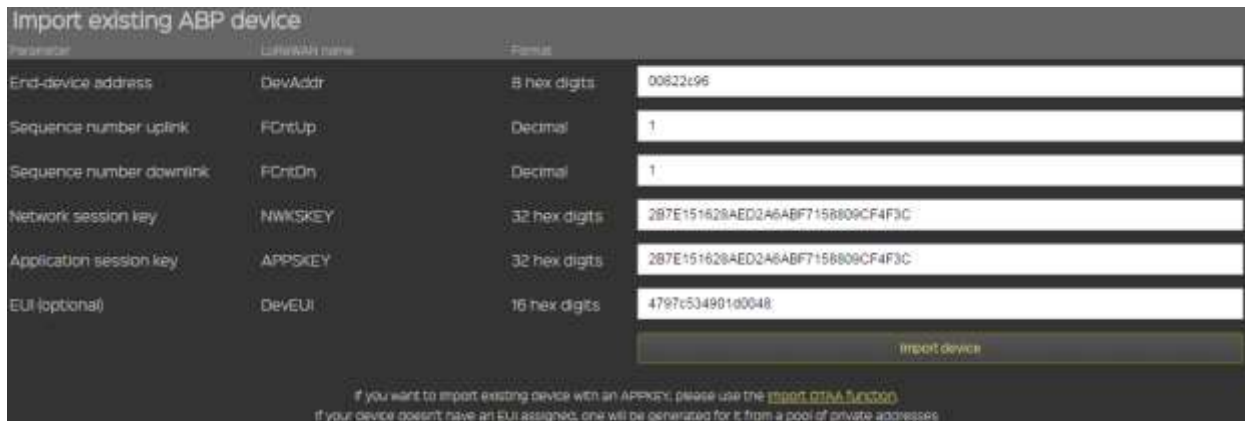
g) After get DEVADDR, DEVEUI, APPEUI, go back Loriot server to add node

2.5.2 ABP Mode

a) Log in Loriot server , Click "Dash Board" -> "Applications" -> "SimpleApp"

b) Click "Import ABP" ，input below items：

DevAddr: RHF3M076 get through "AT+ID" command (Note: Loriot doesn't support colon connector, need remove manually)

FCntUp：Set to 1

FCntDn：Set to 1

NWKSKEY：Default value 2B7E151628AED2A6ABF7158809CF4F3C

APPSKEY：Default value 2B7E151628AED2A6ABF7158809CF4F3C

EUI：DEVEUI, RHF3M076 get through "AT+ID" command

c) Click "Import Device" finish device import

d) "Dashboard -> Applications -> SampleApp", click "Devices" in the left side, continue click DevAddr to add the device

e) Set "Seqno checking" to "Relaxed" (Relaxed mode will allow device sequence number reset)

f) Back to SSCOM, send command:

```
AT+CMSGHEX"0a 0b 0c 0d 0e"
+CMSGHEX: Start LoRaWAN transaction
+CMSGHEX: TX "0A 0B 0C 0D 0E "
+CMSGHEX: Wait ACK
+CMSGHEX: ACK Received
+CMSGHEX: RXWIN1, RSSI -47, SNR 3.25
+CMSGHEX: Done
```


2.5.3 OTAA Mode

Note: OTAA mode is unavailable for free Loriot account

a) Delete already joined ABP mode device to avoid DEVEUI collision

b) Log in Loriot server, click "Dash Board" -> "Applications" -> "SimpleApp"

Click "Import ABP" ，input below items:

DevEui: RHF3M076 get through "AT+ID" command
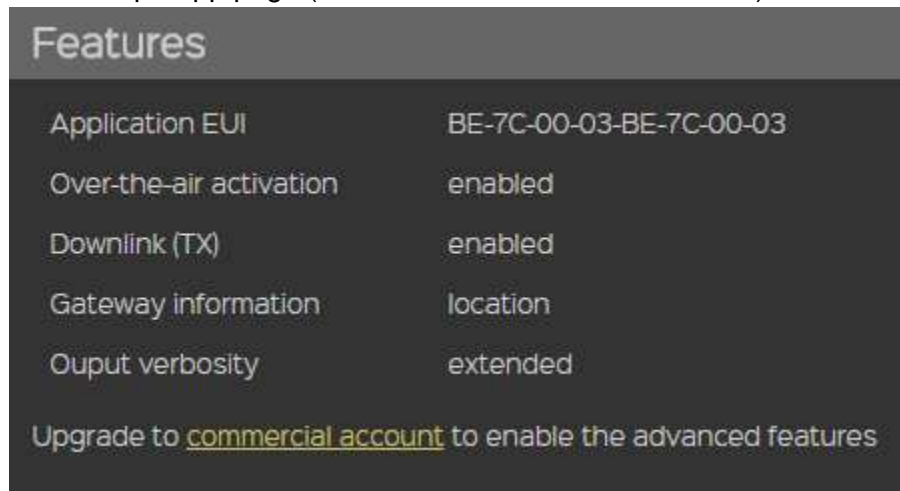
APPKEY：Default value 2B7E151628AED2A6ABF7158809CF4F3C

c) Check AppEui from SampleApp page (Note: unavailable for free account)

d) Use at+id=appeui,"BE-7C-00-03-BE-7C-00-03" command to set RHF3M076 APPEUI。

```
at+id=appeui,"BE-7C-00-03-BE-7C-00-03"
```

e) Run below commands in sequence to set OTAA mode work as OTAA mode
```
at+mode=lwotaa
+MODE: LWOTAA

at+join
+JOIN: Starting
+JOIN: NORMAL, count 1, 0s, 0s
+JOIN: Network joined
+JOIN: NetID 4C5254 DevAddr a9:4b:5c:0a
+JOIN: Done

AT+CMSGHEX"0a 0b 0c 0d 0e"
+CMSGHEX: Start LoRaWAN transaction
+CMSGHEX: TX "0A 0B 0C 0D 0E "
+CMSGHEX: Wait ACK
+CMSGHEX: ACK Received
+CMSGHEX: RXWIN1, RSSI -47, SNR 3.25
+CMSGHEX: Done
```

3 Advanced Usage

3.1 Use RHF2S001 integrated LoRaWAN server

3.1.1 Connect Gateway with internal server

Run below commands: (Please note, these commands will disable loriot service permanently until you re-enable it.

```
sudo /etc/init.d/loriot-gw stop
sudo update-rc.d loriot-gw remove
sudo update-rc.d lrgateway defaults
```

3.1.2 Change Frequency Plan

```
cd ~/semtech/gateway/packet_forwarder/gps_pkt_fwd/
```

Run either of below four commands to select needed frequency plan:

CN470

```
ln -sf global_conf_cn470.json global_conf.json
```

CN433

```
ln -sf global_conf_cn433.json global_conf.json
```

AS920

```
ln -sf global_conf_as920.json global_conf.json
```

EU868

```
ln -sf global_conf_eu868.json global_conf.json
```

Detailed channel definition:

	CN433	CN470	AS920	EU868
CH0	433.3	471.5	921.5	867.1
CH1	433.5	471.7	921.7	867.3
CH2	433.7	471.9	921.9	867.5
CH3	433.9	472.1	922.1	867.7
CH4	434.1	472.3	922.3	867.9
CH5	434.3	472.5	922.5	868.1
CH6	434.5	472.7	922.7	868.3
CH7	434.7	472.9	922.9	868.5

Restart gateway service to make new updated configuration valid:

```
sudo /etc/init.d/lrgateway restart
```

3.1.3 Access Internal Server Console

Access ip of your gateway to get the web server console, which is showed as below:
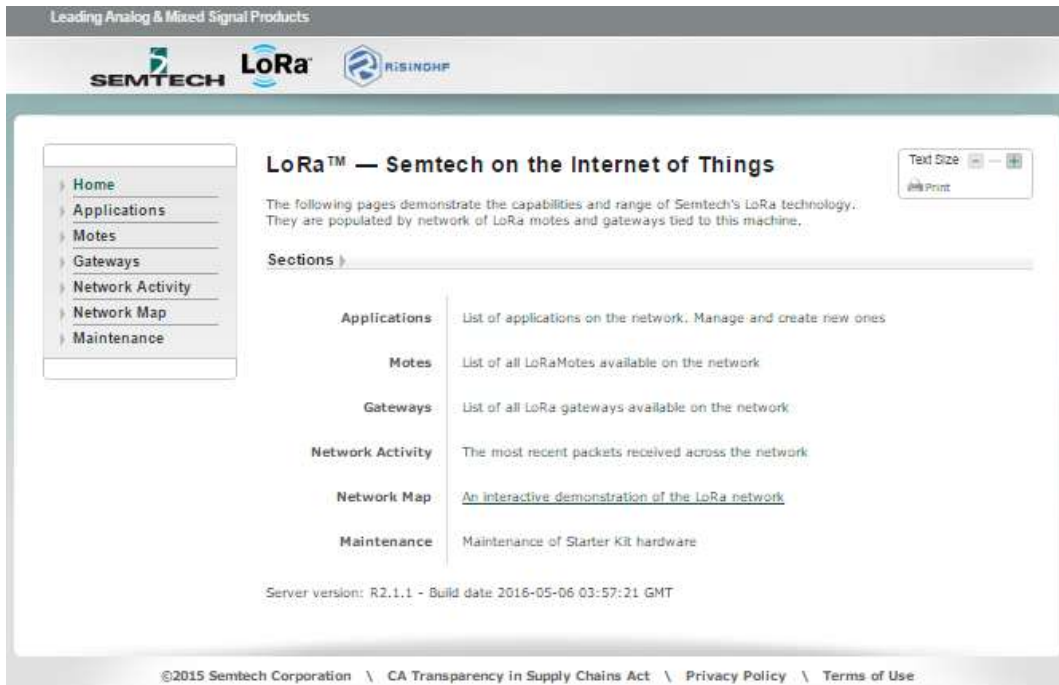
3.1.4 ABP Mode

a) Use SSCOM to get device ID

```
at+id
+ID: DevAddr, 00:82:2c:96
+ID: DevEui, 47:97:c5:34:90:1d:00:48
+ID: AppEui, 52:69:73:69:6e:67:48:46
```
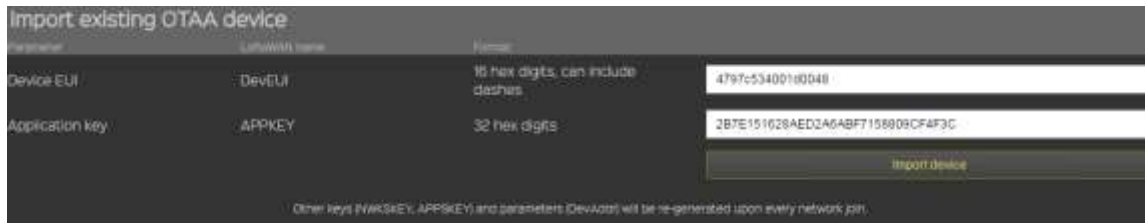
b) Create a new application at Applications page, fill into Name, Owner and EUI, among them EUI is 8 bytes hexadecimal number

c) When finished, click button behind application to configure device.

d) Fill ABP mode related information, DevEui/DevAddr/NwkSKey/AppSKey.

   DevEui：RHF3M076 get through AT+ID command

   DevAddr: RHF3M076 get through AT+ID command

   NWKSKEY：Default value 2B7E151628AED2A6ABF7158809CF4F3C

   APPSKEY：Default value 2B7E151628AED2A6ABF7158809CF4F3C

Personalised Motes

Personalised motes are configured with the network address, application session key and network session key already present, so they are ready to communicate on the network. Enter these same details below to prepare the server.

Mote (DevEUI)	Network Address (DevAddr)	Application Session Key (AppSKey)	Network Session Key (NwkSKey)	
New: 47:97:c5:34:00:1d:00:48	00:82:2c:96	2B7E151628AED2A6ABF7158809CF4F3C	2B7E151628AED2A6ABF7158809CF4F3C	Add

e) Test through below commands:

```
at+mode=lwabp
+MODE: LWABP

AT+CMSGHEX"0a 0b 0c 0d 0e"
+CMSGHEX: Start LoRaWAN transaction
+CMSGHEX: TX "0A 0B 0C 0D 0E "
+CMSGHEX: Wait ACK
+CMSGHEX: ACK Received
+CMSGHEX: RXWIN1, RSSI -47, SNR 3.25
+CMSGHEX: Done
```

3.1.5 OTAA Mode

a) Delete device which is just added, avoid DevEui collision

b) Check AppEui from Application page

Applications

Below is a list of LoRa applications on the network. Use the fields at the top to set up a new one on the server.

Name ▲	Owner	EUI (AppEUI)		Configured Motes
New:			Add	
defaultApp	[Unknown]	00-00-00-00-00-00-00-00	Delete	0
null	[Unknown]	FF-FF-FF-FF-FF-FF-FF-FE	Delete	0
rhf3m076	rxhf	00-00-00-00-00-00-00-01	Delete	0

c) Use at+id=appeui, " 00-00-00-00-00-00-00-01" command to set RHF3M076 APPEUI

```
at+id=appeui," 00-00-00-00-00-00-00-01"
```

d) Fill in DevEui and AppKey

Over-the-Air Motes

Motes ordinarily join the network by negotiating with the server using an application key. Enter this key below to prepare the server.

Mote (DevEUI)	Application Key (AppKey)	
New: 47:97:c5:34:00:1d:00:48	2B7E151628AED2A6ABF7158809CF4F3C	Add

```
at+mode=lwotaa
+MODE: LWOTAA
```

```
at+join
```
+JOIN: Starting
+JOIN: NORMAL, count 1, 0s, 0s
+JOIN: Network joined
+JOIN: NetID 000000 DevAddr 00:82:2c:96
+JOIN: Done

```
AT+CMSGHEX"0a 0b 0c 0d 0e"
```
+CMSGHEX: Start LoRaWAN transaction
+CMSGHEX: TX "0A 0B 0C 0D 0E "
+CMSGHEX: Wait ACK
+CMSGHEX: ACK Received
+CMSGHEX: RXWIN1, RSSI -47, SNR 3.25
+CMSGHEX: Done

3.2 Hardware Performance Test

This chapter is just for hardware developer who wants to integrate RHF0M301 to their own design.
Test command list:

a) Enter test directory
```
cd ~/risinghf/test
```
b) Hardware reset
```
sudo gwrst
```
c) Hardware connection validation
```
./test_loragw_reg
```
d) RX test
```
// Different frequency use different configuration file, syncword34 directory
   contains LoRaWAN format data packet receiving configuration file
./util_rx_test -c ./cfg/freq_conf_470.josn
```
e) TX test
```
Use util_tx_test and util_tx_continuous, refer to the help information (-h parameter
```
could be used to get help information)
f) Channel scan to use util_rssi_histogram (Note: SX1301 RSSI value precision is very limited).
Detailed usage:
```
rxhf@rhf2s001:~/risinghf/test$ ./util_rssi_histogram -h
Available options:
 -h print this help
 --file log file name
 --fmin start frequency in Hz, default is 863 MHz
 --fmax stop frequency in Hz, default is 870 MHz
 --fstep frequency resolution in Hz, default is 50 kHz
 -n number of RSSI captures, each capture is 4096 samples long, default is 90 (3s for 125Khz capture rate)
 -p div ratio of capture rate (32 MHz/p), default is 256 (125 kHz)
```
Eg:
```
./util_rssi_histogram --fmin 470000000 --fmax 471000000 --file a.csv
```

3.3 Switch Loriot Server Region

By default, Loriot CN1 server is selected, below procedures could be used to switch to other region like AP1, EU1 or AU1. Below commands can be used to switch from CN1 to AP1.
Use eu1/au1 replace ap1 to switch to specified server

```
sudo su
sudo ln -sf /opt/loriot/bin/eu1 /opt/loriot/bin/lrt
```

3.3.1 Re-enable Loriot Service

If you need enable loriot service again after you disable it, use below commands: (Note: local lrgateway service will be disabled permanently)

```
sudo /etc/init.d/lrgateway stop
sudo update-rc.d lrgateway remove
sudo update-rc.d loriot-gw defaults
```

4 Others

4.1 RHF3M076 Driver Installation

Reference：
http://wiki.risinghf.com/lib/exe/fetch.php?media=extranet:rhf-um01516_lorawan_modem_driver_installation_guide.pdf

4.2 FT232 Driver Installation

Refer to FTDI Official document:
FTDI:
http://www.ftdichip.com/Support/Documents/AppNotes/AN_119_FTDI_Drivers_Installation_Guide_for_Windows7.pdf

RisingHF mirror
http://wiki.risinghf.com/lib/exe/fetch.php?media=extranet:an_119_ftdi_drivers_installation_guide_for_windows7.pdf

4.3 Recover SD Card

Contact support@risinghf.com to get image address and extract password. And refer to below document to burn SD card.
https://www.raspberrypi.org/documentation/installation/installing-images/windows.md

4.4 Raspberry Pi Raspbian Version

RisingHF Image is based on 2016-03-18-raspbian-jessie-lite.img

4.5 Configure Static IP Address

a) Backup files which will be modified

```
cp /etc/dhcpcd.conf  /etc/dhcpcd.conf.bak
```

b) Configure new IP address. Please replace below ip_address, routers, domain_name_servers
    withc the one you need. Take effect after reboot

```
sudo su
cp /etc/dhcpcd.conf.bak  /etc/dhcpcd.conf
echo "interface eth0" >> /etc/dhcpcd.conf
echo "static ip_address=172.0.41.196/16" >> /etc/dhcpcd.conf
echo "static routers=172.0.0.254" >> /etc/dhcpcd.conf
echo "static domain_name_servers=223.5.5.5" >> /etc/dhcpcd.conf
```

If configuration has something wrong, please use below command to rescue

```
cp /etc/dhcpcd.conf.bak  /etc/dhcpcd.conf
```

4.6 Internal MySQL Database

RHF2S001 internally integrated LoRaWAN server depends on MySQL, because of Raspberry Pi data
is saved at SD card, and MySQL will erase and write data to SD card frequently, this will lead to
potential risk to damage SD card. So please be warned, during your testing and development, please
backup your data in time in case of any lost.

```
Usernmae: root
Passwrod: root
```

Command to log in mysql:

```
mysql -u root –p
```

For users who need use phpMyAdmin, please install through apt-get command

4.7 Expand SD Card File System

Please refer to Raspberry Pi raspi-config tool instruction.
https://www.raspberrypi.org/documentation/configuration/raspi-config.md

Run below command to start raspi-config,

```
sudo raspi-config
```

Choose "Expand Filesystem", when finished reboot to make it effect. Run command "`df -h`" to know to
SD card capacity and usage.

Revision

V1.1 2016-11-09
 + Update with antenna type
V1.0 2016-05-17
 + Draft

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The lora Gateway Mo dule complies with Part 15 of the United States of America FCC rules and regulations. The Original Equipment Manufacturer (OEM) must comply with the FCC certification requirements.

15.21 Any changes or modifications made to the module without the manufacturer's approval could void the user's authority to operate the module.

15.105(b) This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

PLEASE NOTE THE MODULE OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS:

1. This device may not cause harmful interferences.
2. This device must accept any interference received, including interference that may cause undesired operation.

RADIATION EXPOSURE STATEMENT

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter, and the end product must have a separation distance of at least 20cm from all   persons. With the documented max output power the module meets the FCC SAR Exemption to comply with any applicable RF exposure requirements in its final configuration.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) NOTES

- The OEM must certify the final end product to comply with unintentional radiators (FCC Sections 15.107 and 15.109) before declaring compliance of the final product to Part 15 of the FCC rules and regulations. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.

- The OEM must comply with the FCC labeling requirements. If the module's label is not visible when installed, then an additional permanent label must be applied on the outside of the finished product which states: "Contains transmitter module FCC ID: 2AJUZ0M301". Additionally,the following statement should be included on the label and in the final product's user manual: "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 interferences, and (2) this device must accept any interference received, including interference that may cause undesired operation."

- The module is limited to installation in mobile or fixed applications. Separate approval is required for all other operating configurations, including portable configuration with respect to Part 2.1093 and different antenna configurations.

- A module or modules can only be used without additional authorizations if they have been tested and granted under the same intended end-use operational conditions, including simultaneous transmission operations. When they have not been tested and granted in this manner, additional testing and/or FCC application filing may be required. The most straightforward approach to address additional testing conditions is to have the grantee responsible for the certification of at least one of the modules submit a permissive change application. When having a module grantee file a permissive change is not practical or feasible, the following guidance provides some additional options for host manufacturers. Integrations using modules where additional testing and/or FCC application filing(s) may be required are: (A) a module used in devices requiring additional RF exposure compliance information (e.g., MPE evaluation or SAR testing); (B) limited and/or split modules not meeting all of the module requirements; and (C) simultaneous transmissions for independent collocated transmitters not previously granted together.

This Module is Limited modular approval, it is limited to OEM installation ONLY.
Change another host devices or Integration into different devices must add with Class II Permissive Change.

Additional measurements (15B) and/or equipment authorizations (e.g Verification) may need to be addressed depending on co-location or simultaneous transmission issues if applicable.
(OEM) Integrator is reminded to assure that these installation instructions will not be made available to the end user of the final host device.