DTU_LR_A Instructions

V1.1

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1. Introduction

DTU_LR_A is a wireless information transmission unit based on LoRa, which mainly uses LoRa modulation technology for data transmission. This DTU can run in two modes:

1. General transparent transmission mode, receiving or sending through AT instruction.
2. Master-Slave transparent transmission mode, which can be set as Master or Slave, can interact according to Modbus protocol.

Product features：

- Point-to-point communication protocol
- Support fixed-point sending mode
- Support master-slave mode
- Support data encryption transmission
- AT command configuration, supporting setting tools
- 4000 meters transmission distance(@22dBm)
- -148dBm receiving sensitivity (10.4 kHz, SF 12)
- RS232/RS485 interface
- 12 ~ 36 VDC power supply
- ESD protection (level 4)
- Power surge protection (level 3)
- RS232/RS485 surge protection (Grade 3)
- Hardware watchdog

1.1 Parameter

Type	Specifications	Parameter value
Radio frequency	Working frequency band	Determined by product identification (for example: 470 MHz；; 868 MHz； 915MHz……）
	Transmit power	22dBm / 27dBm
	Receiving sensitivity	- 148dBm@（10.4 kHz, SF 12）
	Transmission distance	4000m @22dBm(test conditions: clear and open, 22dBm transmission power, 2dBi antenna gain, 2m height, BW=3 SF=12).
	Antenna selection	The impedance of SMA antenna pedestal (outer screw inner hole) is 50 ohms.
Electric	Data interface	RS232/RS485 Baud rate: 1200bps-115200bps The default is 9600 bps
	Maximum transmission length	240 bytes
	Operating voltage	12Vdc ~ 36Vdc
	Operational current	Transmission current 40mA @ 12Vin (peak value) Standby current 3mA @ 12Vin
	Working temperature	-40℃ ~ + 85℃
	Storage temperature	-45℃ ~ + 125℃
	Working humidity	5~95%RH(non-condensation)
	Storage humidity	1~95%RH(non-condensation)

1.2 Interface description

Figure 1 Product interface

1. Antenna interface

   SMA antenna (outer screw inner hole) with impedance of 50 Ω.

2. Power interface

   5.5*2. 1 standard DC power interface, input voltage DC12-36V. The product power input has TVS protection.

3. Power interface

   3.81*2P screw terminal is connected to DC power supply, input voltage is DC12-36V.Support anti-connection mechanism of power supply. The product power input has TVS protection.

4. RS232

   This interface is DB9 standard interface (hole) , can be directly connected to the computer serial port, pin sequence and the computer COM interface to maintain consistency, and computer connection with the need to use cross-line (2-3 cross) , three lines are defined, rest lines is suspended.

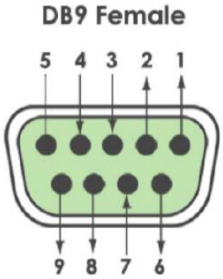

Figure 2 Serial interface

Pin definition:

Pin	Code name	Function
2	RXD	Device data reception
3	TXD	Device data transmission
5	GND	Grounded

5. RS485

3.81 * 3p screw terminal, RS485 has three leads are A, B and GND.

6. RST button

This button is a system reset button. Press it to restart.

7. RTD button

Restore factory settings button, which can be pressed and hold for 10 seconds to restore factory default parameter values.

1.3 Indicator LED

There are five indicator LED in the equipment, from top to bottom:

Indicator LED	Function	Note
POWER	Power indicator (red)	Always on after power on.
LR_TX	LoRa data transmission indication (yellow)	LoRa transmitting signal,LED turn on
LR_RX	LoRa data reception indication (green)	LoRa receiving signal,LED turn on
DTU_TX	DTU data sending indication (green)	DTU transmit data, LED turn on
DTU_RX	DTU data reception indication (yellow)	DTU receives data, LED turn on

1.4 Appearance size

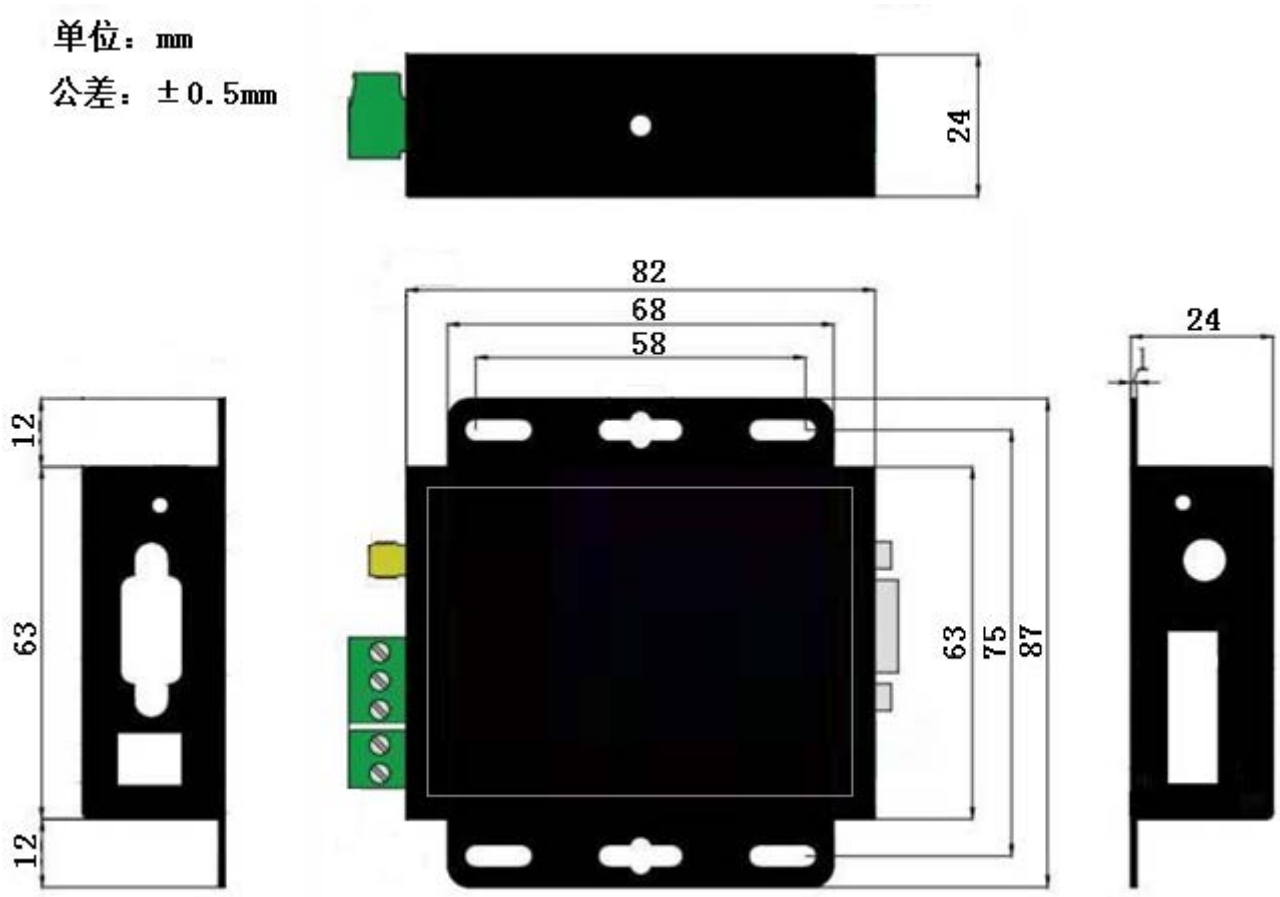

Figure3. Dimension

2. Application

2.1 LoRa DTU Application

The following figure is a schematic diagram of the situation where only LoRa DTU is used, and a LoRa host is connected to the server, which can be connected by RS232 or RS485.

On the server side, the Modbus command can be sent to the LoRa host, and the command will be transmitted by the LoRa host through LoRa. When the LoRa host finds that the command address is its own address, it will parse the command and execute it.

The RS485 interface of DTU slave connects several different Sensors or devices in series. As shown in DTU Slave2 node, the sensor, the ammeter and the remote IO power saving point are connected in series, and the server can communicate to the designated device through Modbus command, and then the device extracts the command, executes the command and returns the result.

In DTU-Slave n, an industrial panel is connected in series. The panel mainly updates the data inside through Modbus commands, and the server will send commands to update the content of the panel according to the collected sensor data.

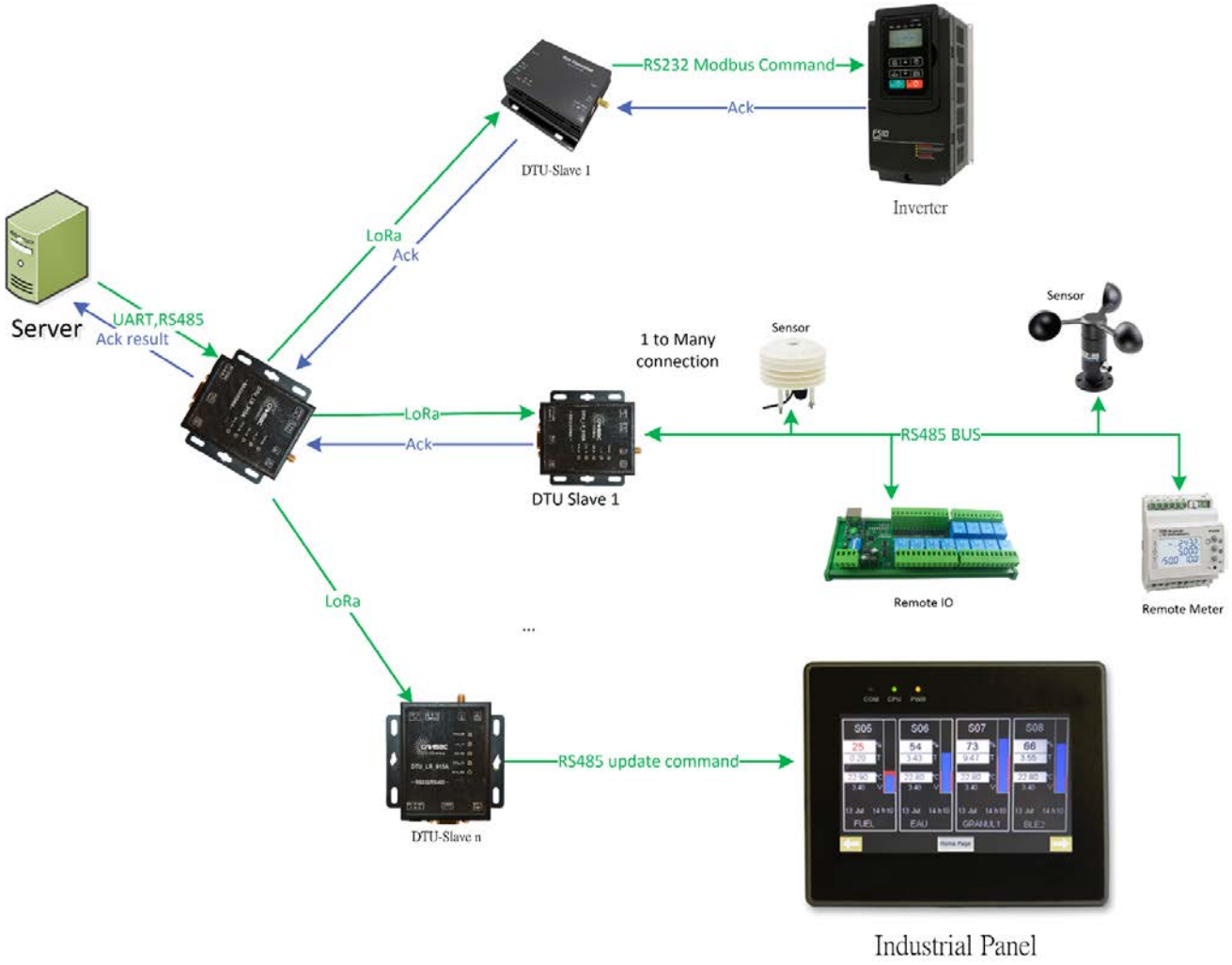

Figure 4 LoRa DTU Application

2.2 LoRa DTU + 4G Application

In the application part, we can divide it into two application. The first one is the application that only needs to send the sensor data back to the server through the Cellular network in outdoor places.

The second application is mainly changed from 4G DTU version to 4G-to-LoRa gateway application by concatenating LoRa DTU. The related application diagram is as follows:

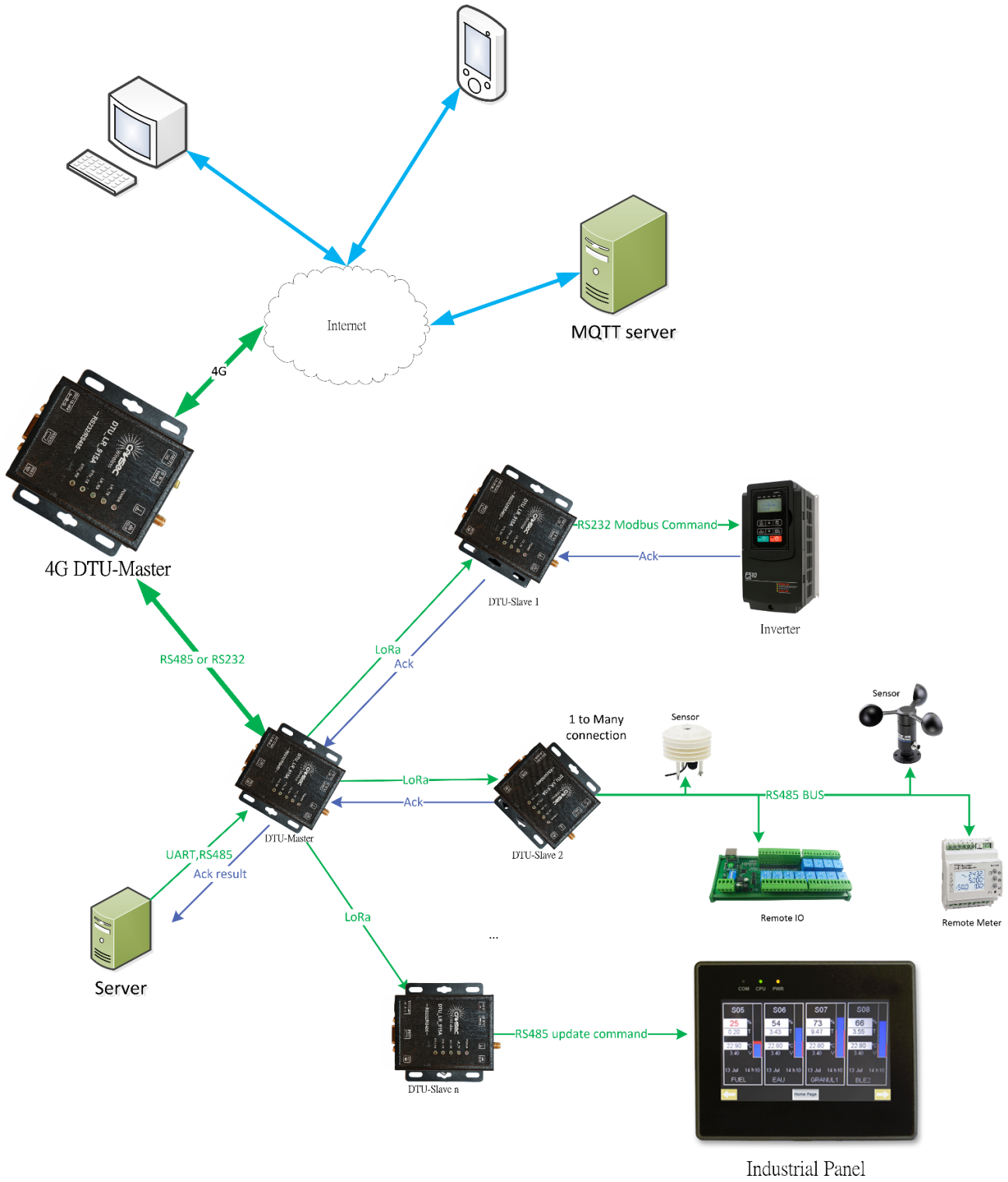

Figure 5 LoRa DTU + 4G DTU Application

3. Working Mode

This DTU mainly has two working modes, namely general transparent transmission mode and master-slave transparent transmission mode.

In the general transparent transmission mode, all actions in DTU use AT command to tell DTU what behavior it wants, such as make DTU enter the receiving state now, or make DTU transmit data. In this whole process, AT command is used to control DTU.

If DTU is in Master, Slave transparent transmission mode, DTU will have two roles: master and slave. As soon as DTU is powered on, it will enter the receiving state, and always listen to whether there is any data to receive. When there is any data received, it will be transmitted to RS232 and RS485. At this time, when RS232 or RS485 has data to ACK, it will be transmitted DTU, the DTU through RS232 or RS485, and DTU will then transmit the data to the Master through LoRa.

3.1 General transparent transmission mode

The following figure shows the sequence diagram of the general transparent transmission mode. We use two LoRa nodes for illustration, namely LoRa1 Node and LoRa2 Node, and these two nodes are controlled by two users, namely Side 1 User and Side 2 User.

First of all, Side 1 User used LoRa1 node to issue the AT command, which made LoRa1 Node enter the receiving mode with a duration of 5 seconds, as shown in No.1 and No.2 of the label.

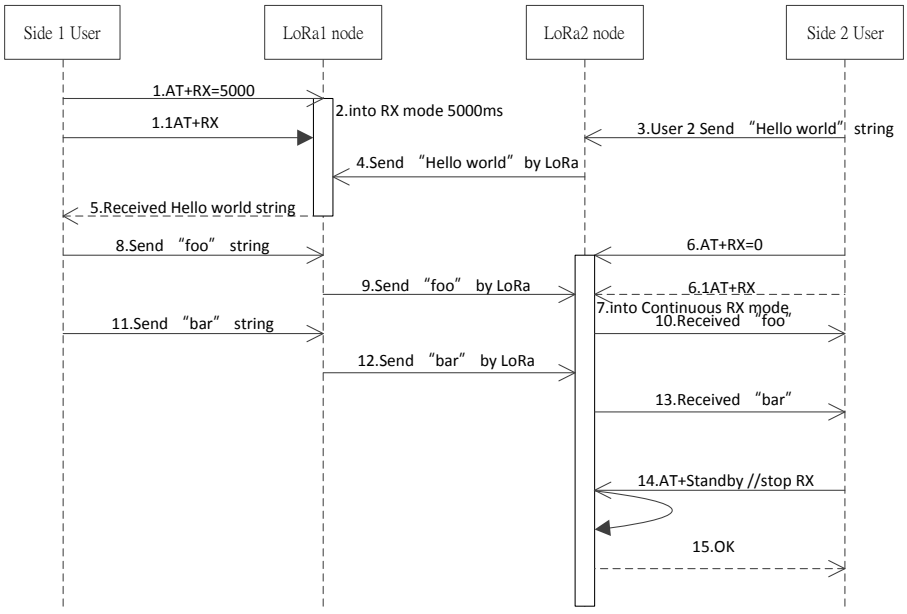

Figure 6 sequence chart

At this time, Side 2 User sends a string of Hello world to LoRa2 Node. After LoRa2 node receives this string, it will send it out wirelessly through LoRa modulation technology, as shown in numbers 3 and 4.

While in LoRa1 node, because it is still in the RX state, it will receive the Hello world string and transmit it to Side 1 User via RS485/RS232, as shown in No.5.

Next, change side 2 user to make LoRa 2 enter the continuous receiving mode, because side 2 user sends AT+RX=0 and then sends AT+RX to make it enter the continuous receiving state, as shown in numbers 6-7. On the side 1, the user sends the foo string and the bar string through the Node1, as shown by the reference numerals 8, 9, 11 and 12, and since the Node2 is currently in a continuous receiving state, it will receive the foo and bar strings, as shown by the reference numerals 10 and 13.

Finally, side 2 user used AT+Standby to make LoRa 2 node stop receiving.

The above is a description of the general mode. As can be seen from the above figure, in the general mode, the LoRa node is mainly one command one action, and any operation must be driven by the at command of the host controller to drive LoRa DTU into any working state.

3.2 Master-slave transparent transmission mode

After entering the master-slave mode, it means that there is a master with the concept of slave. When the host is idle, it will wait for RS485 or RS232 to see if there is any data coming in, and if there is any data come in, it will transmit it to the slave. Suppose the following settings are made in LoRa DTU.

```
AT+Freq=920000000
AT+SF=7
AT+BW=2
AT+CR=1
AT+Mode=1 //Set DTU as the master mode.
//Press the reset key to reset and make it start working.
```

After the above settings are completed, the internal process of LoRa DTU runs as follows:

After pressing the reset key, DTU will enter the continuous receiving mode after initialization, and it will wait for RS485 or RS232 to see if there is any data come in. If there is any data come in, it will send the data through LoRa TX, and after the launch is successful, it will wait for receiving.

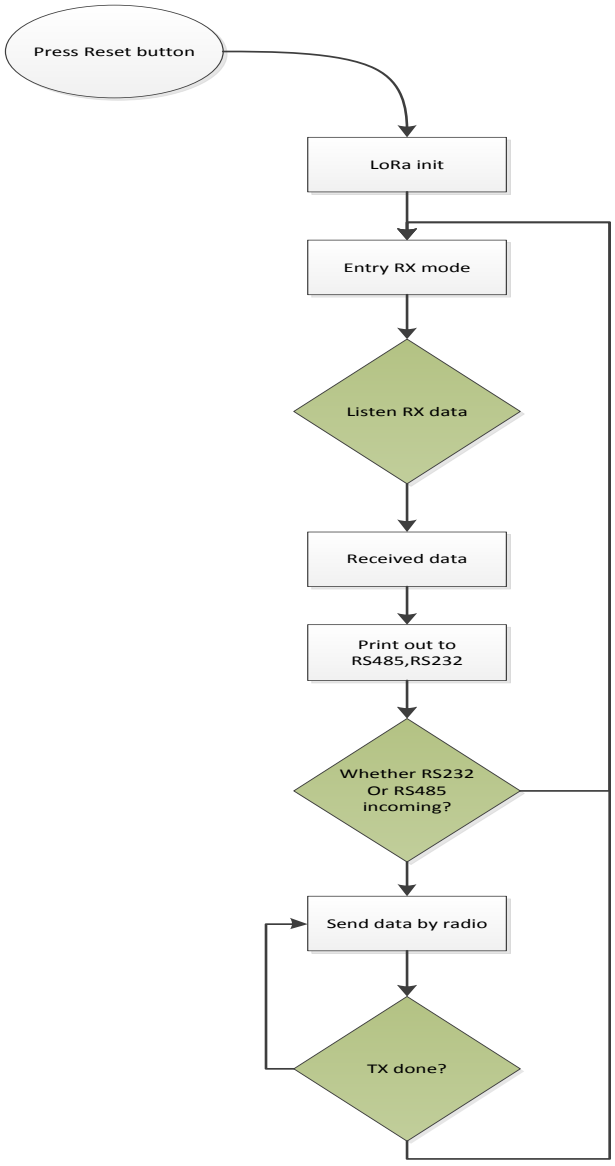

Figure 7 Host transparent transmission flow chart

If DTU sets the slave state in master-slave mode, when DTU is idle, it will turn on LoRa receiving mode, and it will wait for whether there is any data come in the radio frequency. If there is any data come in, it will send the data to the host controller via RS232 and RS485.

Suppose the following settings are made in LoRa DTU.

```
AT+Freq=920000000
AT+SF=7
AT+BW=2
AT+CR=1
AT+Mode=2 //Set DTU as the slave mode of master-slave mode.
//Press the reset key to reset and make it start working.
```

After the above settings are completed, the internal process of LoRa DTU runs as follows:

After pressing the reset key, DTU will enter the receiving state after initialization. When receiving data from the radio frequency, it will transmit the data to the host controller through RS485/RS232. When the host controller receives the data, if it needs to send back the data, At this time, the host controller will send the data to the LoRa slave through RS485/RS232, and after LoRa receives the data from the slave, it will send the data to the LoRa host through radio frequency, and then LoRa will continue to return to the RX continuous receiving mode from the slave, waiting for whether there is any data come in. The flow chart is shown below.

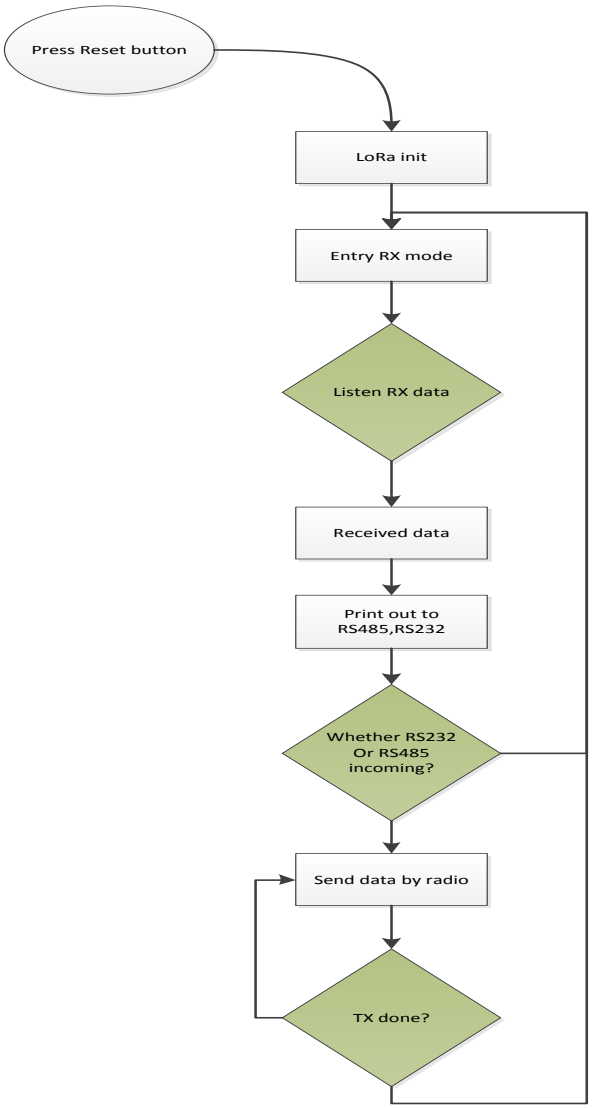

Figure 8 Host transparent transmission flow chart

3.2.1 Same-frequency transmission mode

In the same frequency transmission mode, DTU is in the master-slave mode, and the uplink frequency and downlink frequency will use the same frequency to send and receive. Suppose we prepare two DTUs as the master and slave respectively, and make the following settings in the master and slave.

Host side setting
AT+Freq=920000000 AT+SF=7 AT+BW=2 AT+CR=1 AT+Mode=**1** //Set DTU as the master mode. **AT+ModBusFDDMode=0 //Set to the same frequency transmission.** //Press the reset key to reset and make it start working.

Slave end setting
AT+Freq=920000000 AT+SF=7 AT+BW=2 AT+CR=1 AT+Mode=**2** //Set DTU as the slave mode of master-slave mode. **AT+ModBusFDDMode=0 //Set to the same frequency transmission.** //Press the reset key to reset and make it start working.

After that, when DTU master and slave transmit data, we will find that their uplink frequency and downlink frequency will use 920Mhz for transmission. As shown in Figure 9:

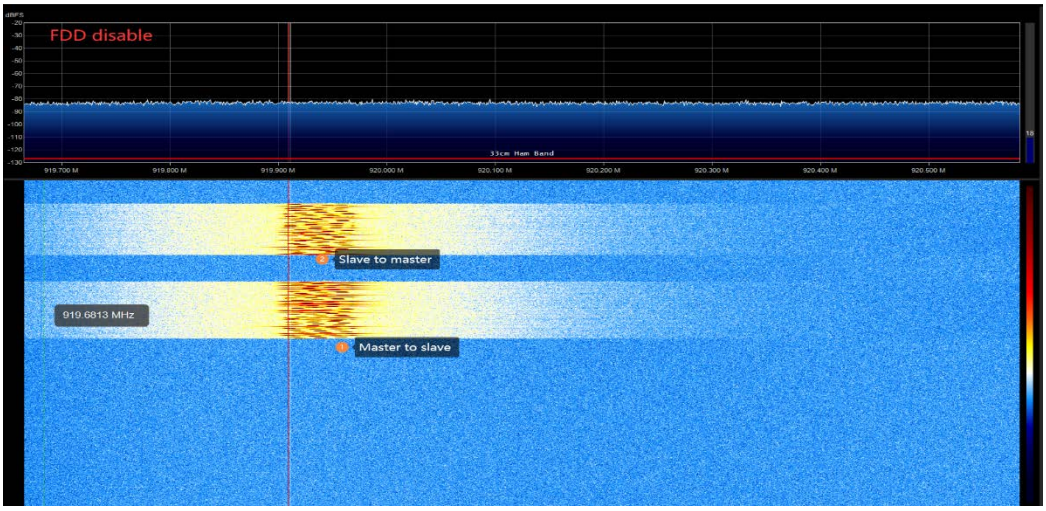

Figure 9 Waterfall diagram of same frequency transmission

3.2.2 Different frequency transmission mode

In the different frequency transmission mode, DTU is in the master-slave mode, and the uplink frequency and downlink frequency will be sent and received separately. Suppose we prepare two DTUs as the master and slave respectively, and make the following settings in the master and slave.

Host side setting
AT+Freq=920000000 AT+SF=7 AT+BW=2 AT+CR=1 AT+Mode=**1** //Set DTU as the master mode. **AT+ModBusFDDMode=1** **//Set to different frequency transmission.** **AT+UNKFreq=920500000****//Set the uplink frequency to 920.5Mhz** //Press the reset key to reset and make it start working.

Slave end setting
AT+Freq=920000000 AT+SF=7 AT+BW=2 AT+CR=1 AT+DTURxWindow=50 //Set the time to open the RX window after sending the data as follows //50*100ms=5Seconds AT+Mode=**2** //Set DTU as the slave mode of master-slave mode. **AT+ModBusFDDMode=1** **//Set to different frequency transmission.** **AT+UNKFreq=920500000** **//Set the uplink frequency to 920.5Mhz** //Press the reset key to reset and make it start working.

After the above settings, we set the two DTUs into different frequency transmission mode. After that, when DTU Master and Slave transmit data, we will find that 920Mhz is used to send instructions to Slave in Master, while 920.5Mhz is used to send instructions to master in slave. As shown in Figure 10:

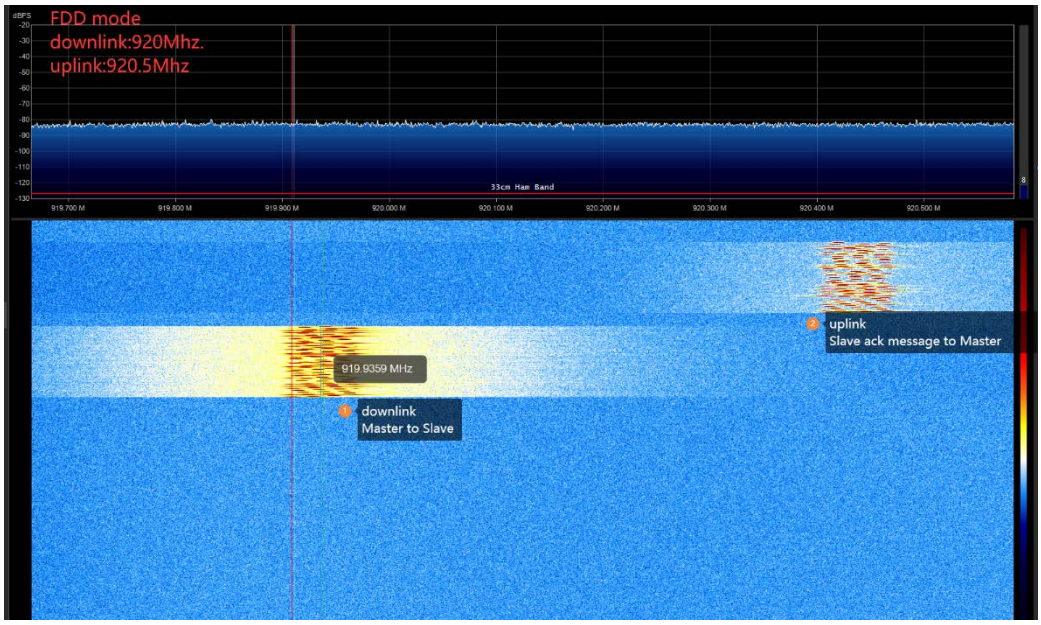

Figure 10 Waterfall diagram of different frequency transmission

4. Contact information

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5. Update history

Data	Version	Describe	Write	Approve
2023-2-14	V1.0	First draft	Weili Wang	Jessy
2024-3-27	V1.1	Add 27dBm	Weili Wang	Jessy