E53-470FMS22S/E53-GW(470FMS22R) Product Specification

Star networking 470~510MHz 22dBm LoRa wireless Module /Gateway



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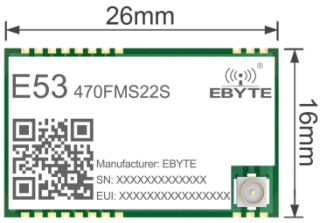
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1. Product introduction

1.1 Product Introduction

E53-470FMS22S and E53-GW(470FMS22R) are Facilities Monitoring System wireless transmission modules and gateways developed based on LoRa spread spectrum technology . Their strong anti-interference capabilities make wireless communications more stable and reliable in industrial sites . At the same time, the equipment monitoring system supports ultra-large network capacity, and the gateway can access up to 1,200 nodes .

The FMS gateway device adopts a multi-channel design of 4RX+1TX to achieve FDD duplex communication. The FMS system has a frequency range of 470-490MHz for RF reception and a frequency range of 500MHz to 510MHz for RF transmission. The wireless transmission module and gateway of the Facilities Monitoring System are suitable for large-scale IoT application scenarios such as smart homes, intelligent buildings, security systems, photovoltaics, logistics, etc..



E53-470FMS22S



E53-GW(470FMS22R)

1.2 Functional features

Gateway features:

- Using the latest LoRa technology, it has a longer distance and more powerful performance than traditional LoRa data transmission radios;
- Adopts military-grade LoRa modulation technology and has data encryption;
- Ultra-large network capacity, the gateway can connect up to 1,200 nodes;
- Self-organizing network, you only need to add the node EUI to the gateway to implement the network, and the node will automatically join the network after being powered on;
- Star networking: The gateway connects multiple node modules to achieve a star network topology;
- Network self-healing: the module automatically joins the network after returning to normal working status;
- Relay networking: The FMS network can expand the communication range by adding slave gateways, thereby realizing relay networking applications;
- Dynamic indication of environmental field strength and dynamic indication of data packet RSSI;
- Configurable gateway type: The gateway can be configured as a master gateway and a slave gateway. The master gateway is the core device of the network. Only one master gateway is allowed to exist in a device monitoring system network. The slave gateway exchanges data with the master gateway through the RS485 bus.
- Supports dynamic allocation of channel frequencies to avoid overlapping of communication channels and digital TV

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signals to ensure signal stability.

- The software has a built-in watchdog to ensure that the device does not crash ;
- Dust-proof and moisture-proof;
- The product is simple and easy to use and can be configured through the host computer ;
- Simple and efficient power supply design, using wire pressing method, supports DC 8 V ~ 28V power supply;
- The transmission power can reach up to 22dBm ;
- The communication distance can reach 3 km;
- Supports CSMA function, the radio automatically waits for transmission according to the current environmental noise intensity , which greatly improves the communication success rate of the module in harsh environments;
- Supports AES128 data encryption to effectively ensure data security ;
- It can realize multi-level relay networking, effectively expand the communication distance, and achieve ultra-long-distance communication;
- Using temperature compensated crystal oscillator , the frequency stability is better than ±1PPM;
- All-aluminum alloy shell, compact in size, easy to install, and good in heat dissipation; perfect shielding design, good electromagnetic compatibility, and strong anti-interference ability;
- Supports wireless parameter configuration, sends command data packets wirelessly, and remotely configures or reads wireless module parameters;

Node features:

- Based on the new LoRa spread spectrum modulation technology, it brings longer communication distance and stronger anti-interference ability;
- Supports users to set their own communication keys, which cannot be read, greatly improving the confidentiality of user data;
- Supports LBT function, which monitors the channel environment noise before sending, which can greatly improve the communication success rate of the module in harsh environments;
- Supports dynamic allocation of channel frequencies to avoid overlapping of communication channels and digital TV signals to ensure signal stability.
- Supports RSSI signal strength indication function for evaluating signal quality, improving communication networks, and ranging;
- Supports ultra-low power consumption functions and is suitable for battery-powered applications;
- Supports AES128 data encryption to effectively ensure data security ;
- The transmission power can reach up to 22dBm ;
- Supports deep sleep, the power consumption of the whole machine in this mode is about 3u A ;
- Using temperature compensated crystal oscillator , the frequency stability is better than ±1PPM;
- Support UART communication interface;
- Support custom data reporting;
- The communication distance can reach 3 km;
- The parameters are saved when power is turned off, and the module will work according to the set parameters after powering on again;
- Efficient watchdog design, once an exception occurs, the module will automatically restart and continue to work according to the previous parameter settings;
- Industrial grade standard design, supports long-term use at -40~+85℃;
- IPEX interface /stamp hole for easy connection of external antennas.

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1.3 Application scenarios

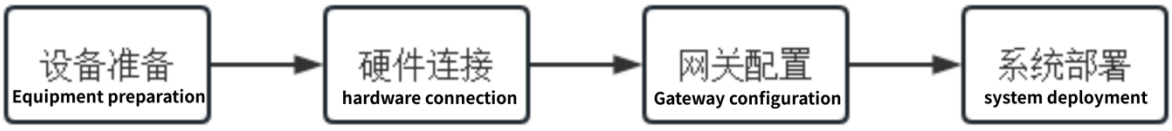
- Smart agricultural greenhouse;
- Smart home and industrial sensors;
- Intelligent building;
- Smoke sensor;
- Intelligent security system;
- Photovoltaic;

2. Quick start

The FMS (Facilities Monitoring System) system consists of three parts: GUI (configuration host computer), gateway and node.

2.1 System construction

In order to complete the system construction, it is necessary to complete the basic material preparation work, and complete the hardware connection, initial configuration and system deployment.



① Equipment preparation:

Equipment	Quantity	Remark
Gateway	≥1 unit	1 master gateway, plus several slave gateways (According to actual demand)
Node	≥1 unit	Node serves as data reporting terminal
Computer	1 set	Configure and monitor gateway and node devices
RS485 cable	1pcs	Connect master and slave gateway (According to actual demand)
USB to RS485 serial port tool	1pcs	TTL or 485 serial port

② Hardware connection:

The master and slave gateways are connected through port ① via RS485 twisted pair. Pay attention to the line sequence when connecting: A1+ is connected to A1+, B1- is connected to B1-, and GND is connected to GND.

Port	Function
1	RS485 communication interface (connected to slave gateway and controller, current configuration is 921600/8/N/1)
2	RS485 configuration interface (connect to PC, configure gateway, current configuration is 921600/8/N/1)
3	DC 5V power supply interface

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4	DC 12V power supply interface
5	Debug UART interface, the physical interface is micro-USB, actually it is TTL serial port. You need to use a USB cable with an internal USB to UART chip to connect. The line sequence is USB_D+ connected to MCU_UART_TX, USB_D- connected to MCU_UART_RX. (Connect to PC, configure gateway, log information, current configuration 921600/8/N/1)
6	Factory reset button
7	RF antenna interface
8	RF antenna interface

③ Gateway and node configuration:

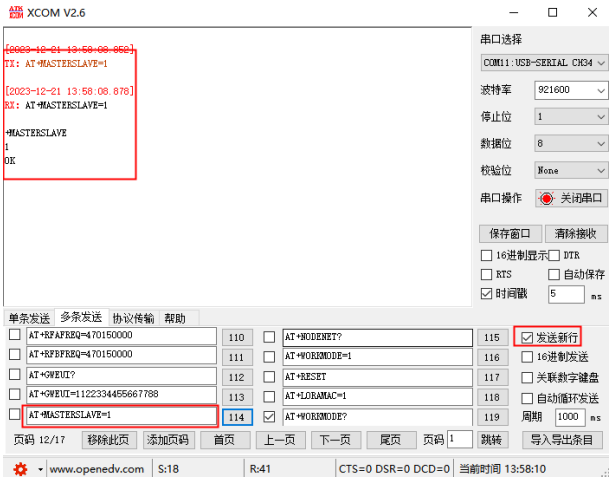
Connect to the PC through port ② and use AT commands to initialize the configuration of the master-slave gateway.

Main gateway configuration: (node and slave gateway EUI are configured according to actual conditions)

Serial number	Parameter	Instruction
1	master-detail attribute	AT+MASTERSLAVE=1 (main gateway)
2	Register the slave gateway	AT+REGISTERGW=0016C001FF18CBF6 (fill in the gateway EUI as needed)
3	Register node	AT+REGISTERNODE=0011223344556672,1122334444332211,00112233445566777766554433221100
4	Slave gateway polling cycle	AT+SLAVEGWHEARTBEAT=1000 (range: [20,10000], unit: ms)
5	Node heartbeat packet	AT+NODEHEARTBEAT=300 (range: [10,2592000], unit: s)

Host computer configuration process:

1、The E53-GW(470FMS22R) gateway defaults to the slave gateway, so first open the serial port debugging assistant to configure the gateway type (AT+MASTERSLAVE=1);

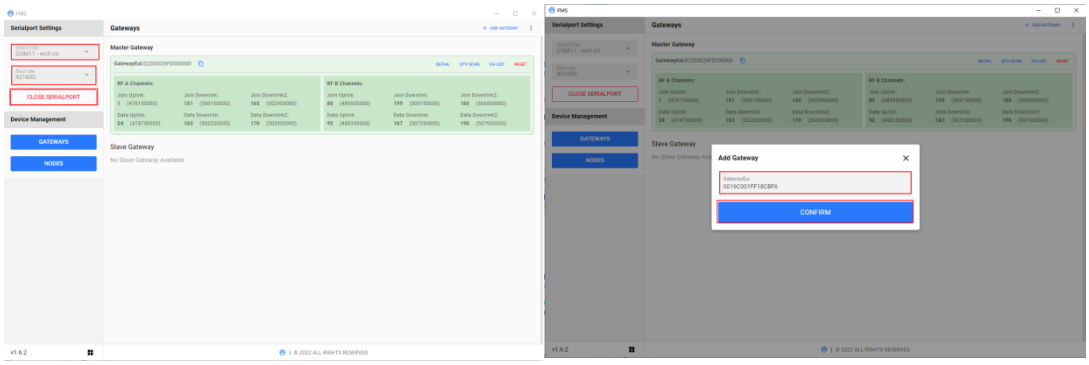


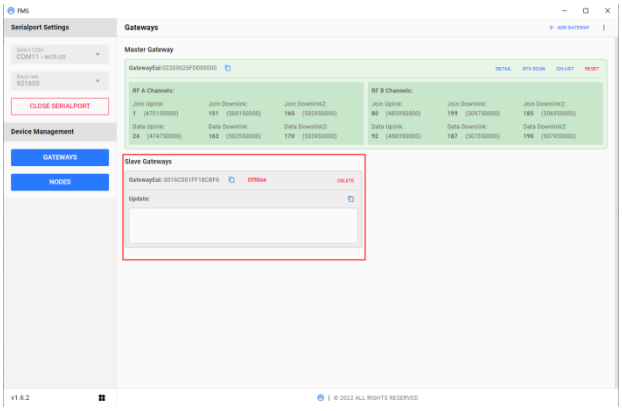
2、Open "FMS.exe" to configure the host computer, select the serial port and open the serial port. The host computer automatically reads the frequency band parameters of the current gateway;

3、Register the slave gateway, click "ADD GATEWAY" in the upper right corner, fill in gatewayEUI, and then click "CONFIRM". You can see that the slave gateway area appears on the main interface of the host computer.

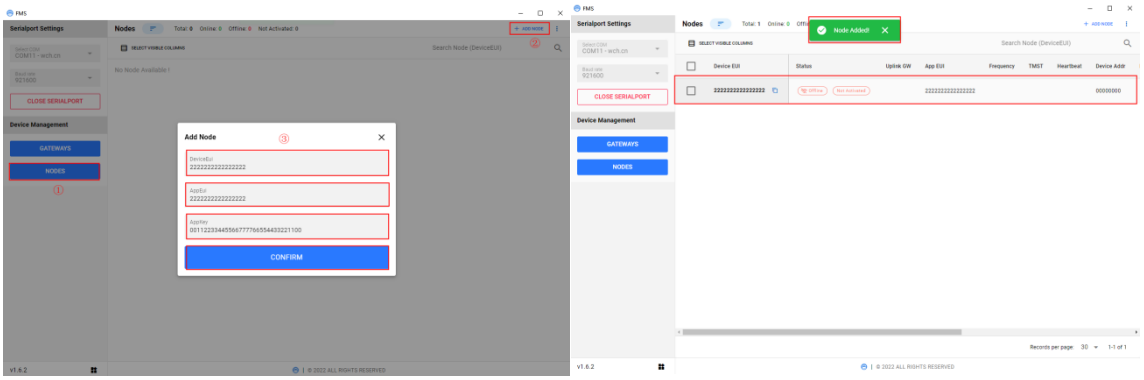
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4、Register the node, click "NODES", then select "ADD NODE" in the upper right corner, fill in DeviceEui, AppEui, AppKey, and then click "CONFIRM". You can see the host computer node addition prompt, and node information appears on the host computer main interface.



The slave gateway configuration:

Serial number	Parameter name	Instruction
1	master-detail properties	AT+MASTERSLAVE=0 (slave gateway)

Node configuration:

Serial number	Parameter name	Instruction
1	Node EUI	AT+EUI=22222222222222222 (restart to take effect)
2	Exit configuration	AT+EXIT (Using this command will automatically reset the node by software)

Note: The default parameter of the gateway is the slave gateway, which does not need to be configured in the initial state. The gateway supports AT command interaction. The command ends with carriage return and line feed, and is not case-sensitive. For specific commands supported, please refer to the "FMS Gateway AT Command Manual".

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Host computer configuration process:

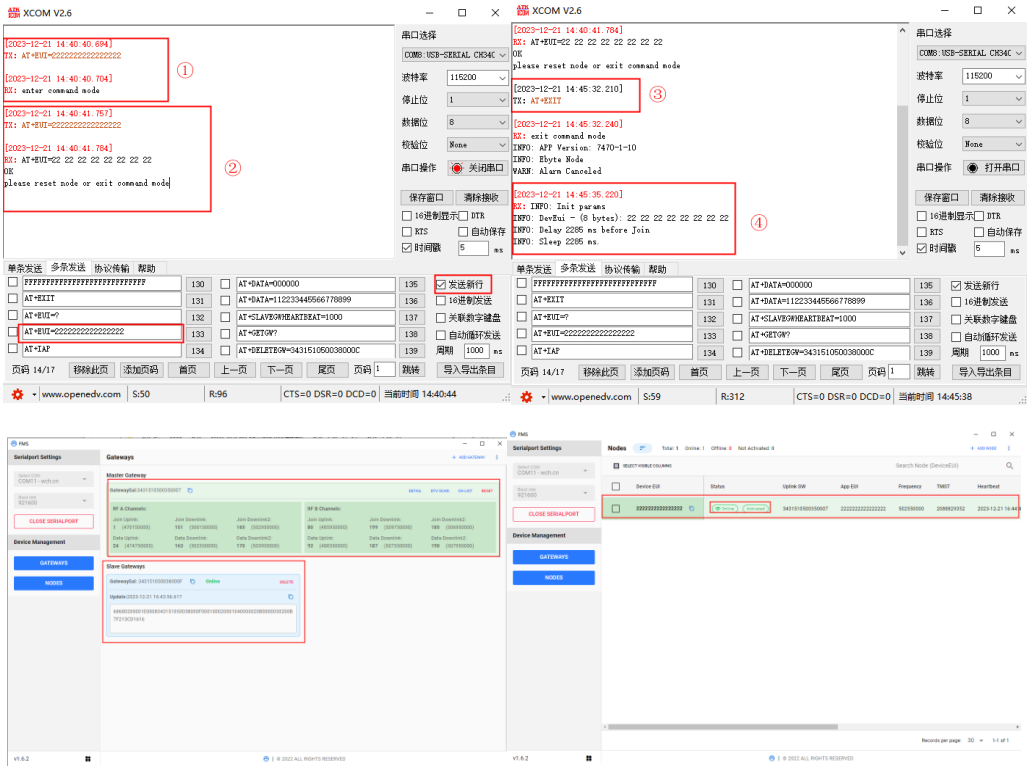
1) Connect the node power supply and serial port, and open the serial port debugging assistant.

① Wake up the node and the node will feedback “enter command mode”;

②Send "AT+EUI=2222222222222222" again to configure the node EUI. After the configuration is successful, you need to restart the module to take effect; (**AT+EXIT or reset pin restart**)

③Use " **AT+EXIT** " to exit the command mode, and the module will automatically restart;

④ Restart to automatically print DeviceEui and software version number;



④System deployment:

For device deployment, you can directly use FMS to configure the host computer. The host computer supports functions such as device management, device status display, command issuance, and data export. The GUI is a security-free version and can be used directly by double-clicking it.

In order to reduce the impact of differences in different actual environments on system evaluation, the following principles need to be met during system deployment:

1) The master-slave gateway is connected through a bus structure matching the RS485 segment;

2) The wires must use national standard shielded twisted pairs, and the recommended wire diameter is not less than 0.5 square meters;

3) The master gateway and a slave gateway are located at both ends of the bus, and the terminal 120R matching resistor is connected in parallel at the line end;

4) Other gateways can be arbitrarily distributed on the bus, and the coverage of gateways can overlap;

5) Nodes are randomly deployed in different locations covered by the gateway. It can be a location covered by a single gateway, or it can be a location where multiple gateways overlap.

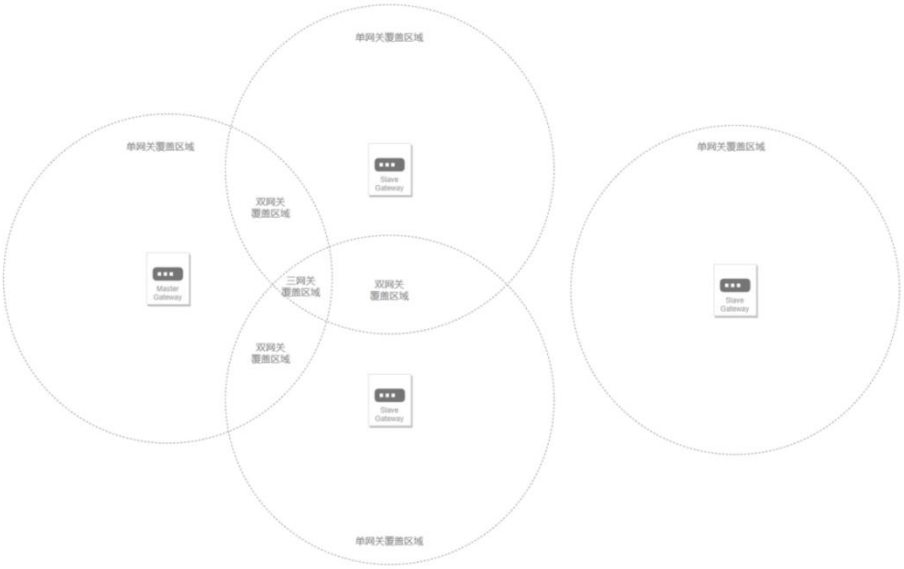
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Gateway device connection diagram:



Network range diagram:



3. Specifications

3.1 Node specification parameters

E53-470FMS22S:

RF parameters	unit	parameter	Remark
Working frequency	MHz	470~510	-
Transmit power	dBm	22.0 ± 0.5	-
Blocking power	dBm	0 ~ 10.0	Less likely to be burned if used at close range
Receive sensitivity	dBm	-1 25 ± 1.0	Air rate 5.4kbps,SF 9,BW 125KHz

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Measured distance	K m	3	Clear and open, antenna gain of 3.5dBi, antenna height of 2.5 meters, aerial speed of 5.4kbps
Air speed	bps	5.4k	-

Electrical parameters	unit	parameter	Remark
Operating Voltage	V	2.3~5.5V	High power module ≥ 5 V can guarantee output power
Communication level	V	3.3	Using 5V TTL risks burning out
Emission current	mA	110	Instantaneous power consumption
receive current	mA	7	-
Sleep current	u A	3	Software shutdown
Operating temperature	℃	-40 ~ +85	Industrial grade

The main parameters	Parameter value	Remark
Dimensions	16*26mm	±0.1 mm
Weight	2.4 g	±0.1 g
Launch length	20 Bytes	Custom data sending, supports up to 20 bytes single packet sending
Modulation	LoRa	New generation LoRa modulation technology
Communication Interface	UART serial port	TTL level
Serial port Baud rate	115200 bps	Fixed value
Packaging method	SMD type	-
Interface mode	1.27mm	-
Antenna form	IPEX/stamp hole	Equivalent impedance is about 50Ω

3.2 Gateway specifications

E53-GW(470FMS22R):

The main parameters	Parameter value	Remark

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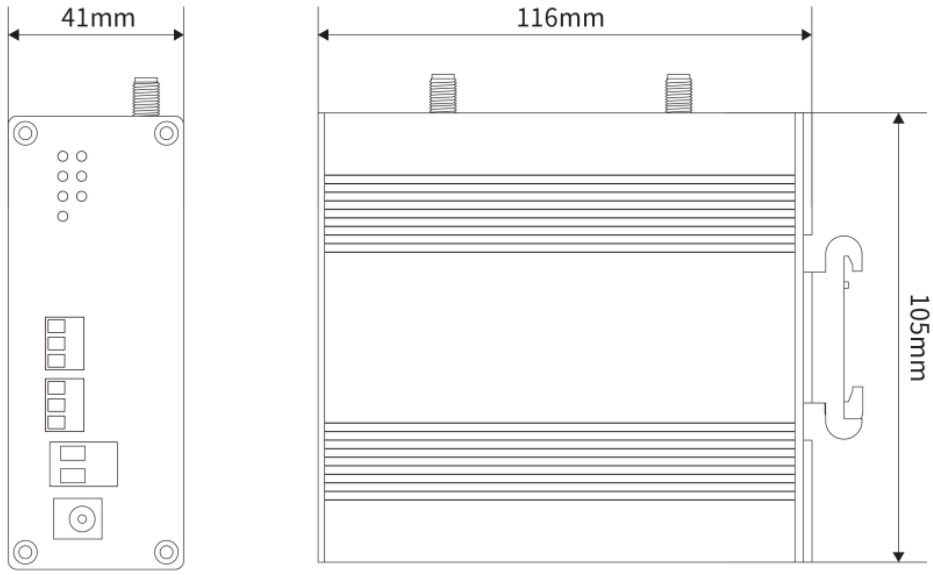
Working frequency	470-510MHz	-
Operating Voltage	DC 8 V~ 28 V	It is recommended to use 12V or 24V DC power supply
Emission current	1 35mA _ @12V (normal temperature)	-
Stand-by current	80mA _ @12V (normal temperature)	-
Air speed	5.4 kbps	-
Antenna interface	SMA-K	SMA -K interface , external thread and internal hole, equivalent impedance about 50Ω
Communication Interface	RS485	-
RS485 baud rate	921600bps	Support 1200~3000000 bps, default 921600bps, software adjustable
Product size (H*W*D)	11 6 *105*41 mm	±0.1mm
Product weight	342g	±5g
Operating temperature	-40℃~+85℃	-
Storage temperature	-40℃~+ 125 ℃	-
Working humidity	5%~95%	-
Storage humidity	1%~95%	-

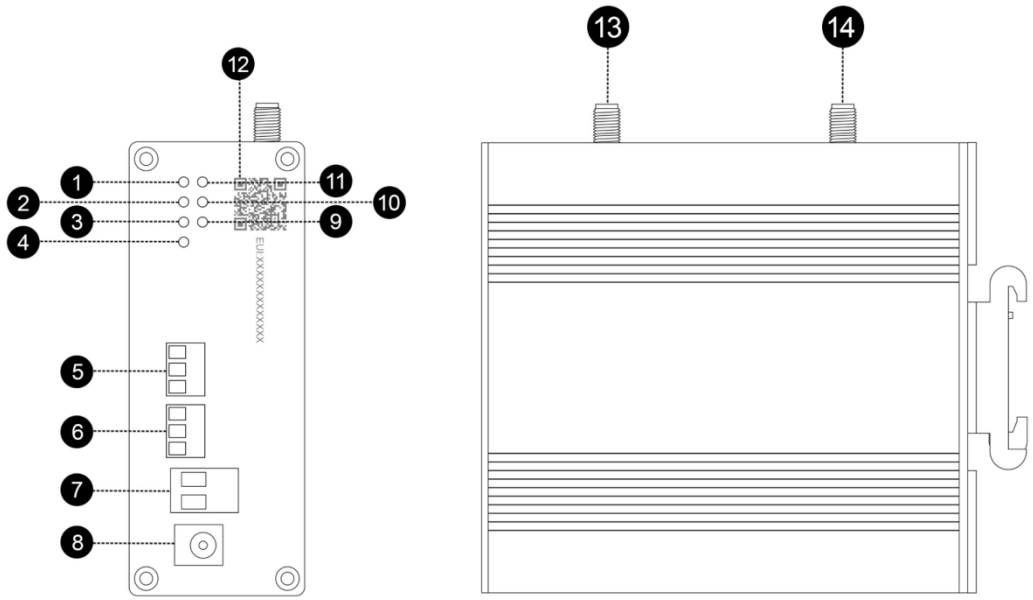
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4. Product size and pin definition

E53-GW(470FMS22R):





Serial number	Name	Function	Illustrate
1	PWR	Power Indicator	
2	INF1	AT command indicator light	Flashes during AT command configuration
3	RF_RX	RF receiving indicator light	Flashes during RF reception

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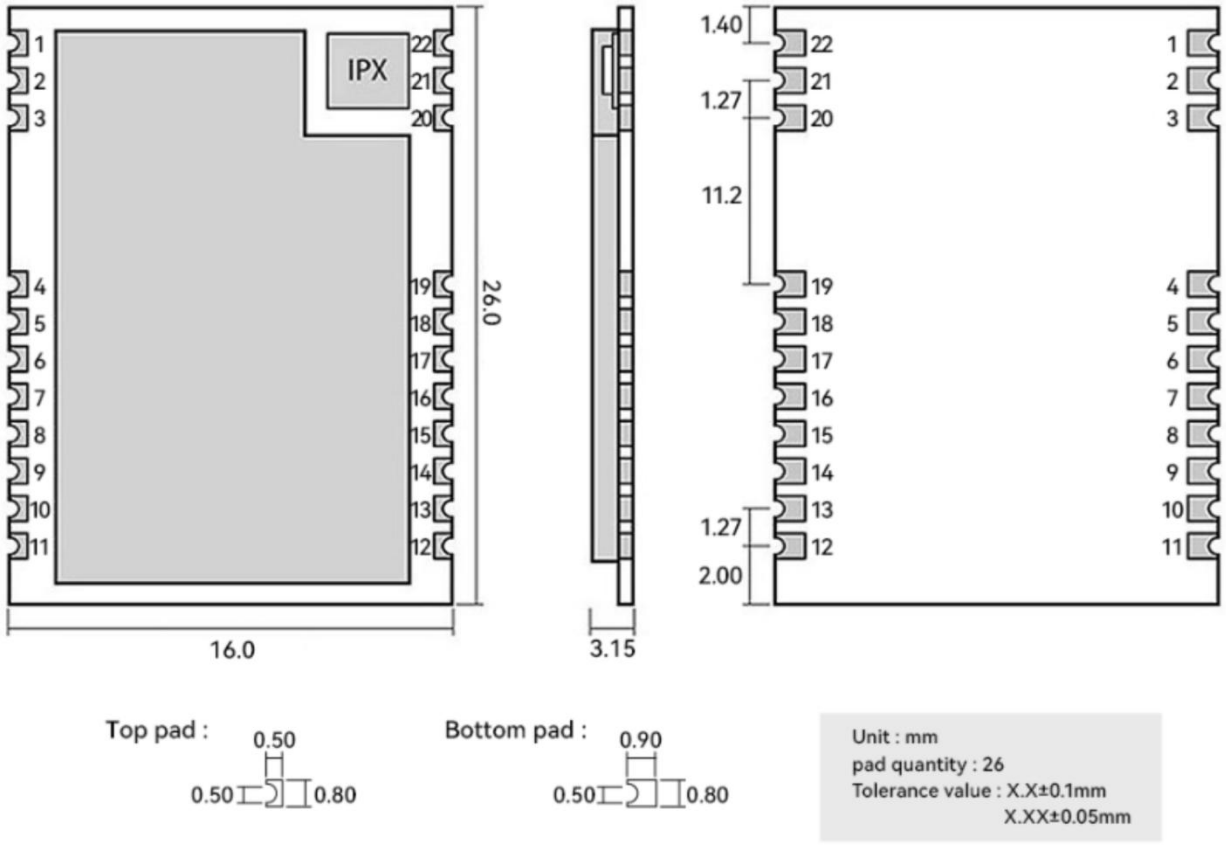
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4	Restore		Factory reset button	Press and hold for more than 5 seconds to restore to factory default parameters	
5	RS485 ①	RS485A	RS485 interface A	RS485 interface A is connected to device A interface	This interface is used to connect to the gateway
		RS485B	RS485 interface B	RS485 interface B is connected to device B interface	
		RS485G	RS485 interface G	RS485 interface G is connected to the device GND interface (recommended connection)	
6	RS485 ②	RS485A	RS485 interface A	RS485 interface A is connected to device A interface	This interface is used for data transmission
		RS485B	RS485 interface B	RS485 interface B is connected to device B interface	
		RS485G	RS485 interfaceG	RS485 interface G is connected to the device GND interface (recommended connection)	
7	GND		Pressed wire power input negative pole	Power reference ground	
	VCC		Pressed line power input positive pole	Power input (DC 8~28V)	
8	DC power interface		Power interface	Power input (DC 8~28V)	
9	RF_TX		RF transmit indicator light	Flashes when radio frequency is transmitting	
10	INF2		Slave gateway>Master gateway data indicator	Flashes when sending data from gateway to main gateway	
11	INF0		Master gateway>Slave gateway data indicator	Flashes when the master gateway sends data to the slave gateway	
12	EUI QR code		Store EUI information	Store factory EUI information	
13	Tx		Antenna interface	SMA -K interface , external thread and internal hole, equivalent impedance about 50Ω	
14	RX				

E53-470FMS22S:

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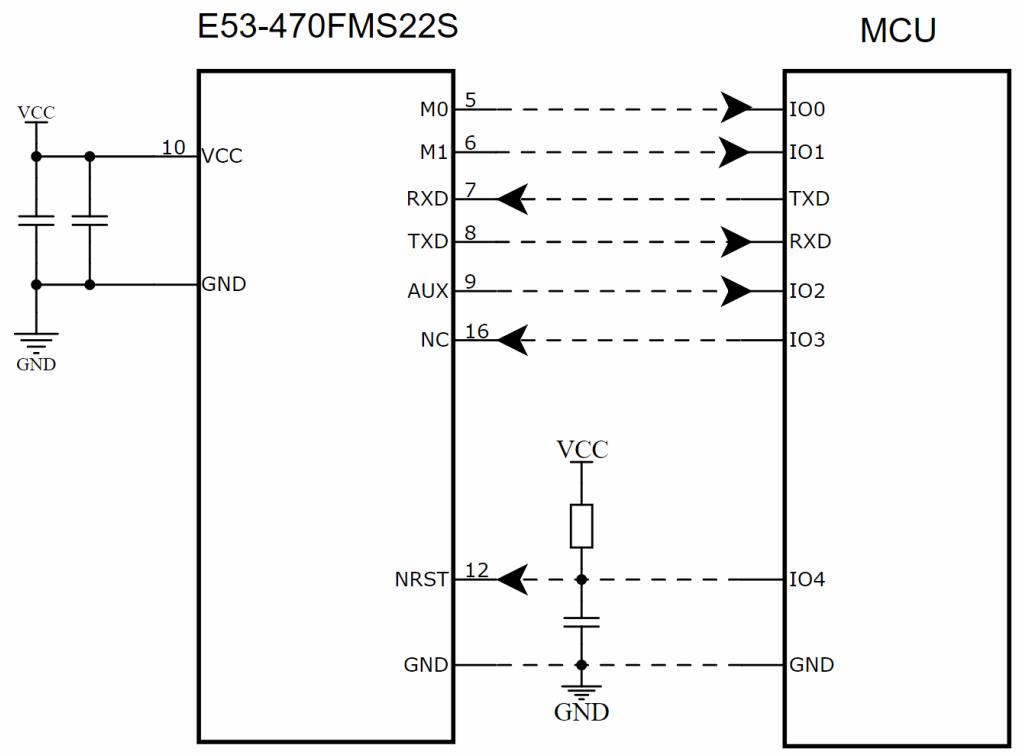
Serial number	Pin definition	Pin direction	Remark
1	GND	-	Module ground wire
2	GND	-	Module ground wire
3	GND	-	Module ground wire
4	GND	-	Module ground wire
5	M0	output	RF output indication pin , active low level
6	M1	output	RF input indication pin , active low level
7	RXD	input	TTL serial port input, connected to the external TXD output pin;
8	TxD	output	TTL serial port output, connected to the external RXD input pin;
9	AUX	output	Used to indicate module network status , low level is active ;
10	VCC	-	Module power supply positive reference, voltage range: 2.3~5.5V DC
11	GND	-	Module ground wire
1 2	NRST	input	Module reset pin, low level reset
13	GND	-	Module ground wire
14	NC	-	Empty feet
15	NC	-	Empty feet
16	NC	input	Alarm trigger pin, active low level
17	NC	-	Empty feet
18	NC	-	Empty feet

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19	GND	-	Module ground wire
20	GND	-	Module ground wire
21	ANT	-	antenna
22	GND	-	Module ground wire

E53-470FMS22S recommended wiring diagram:



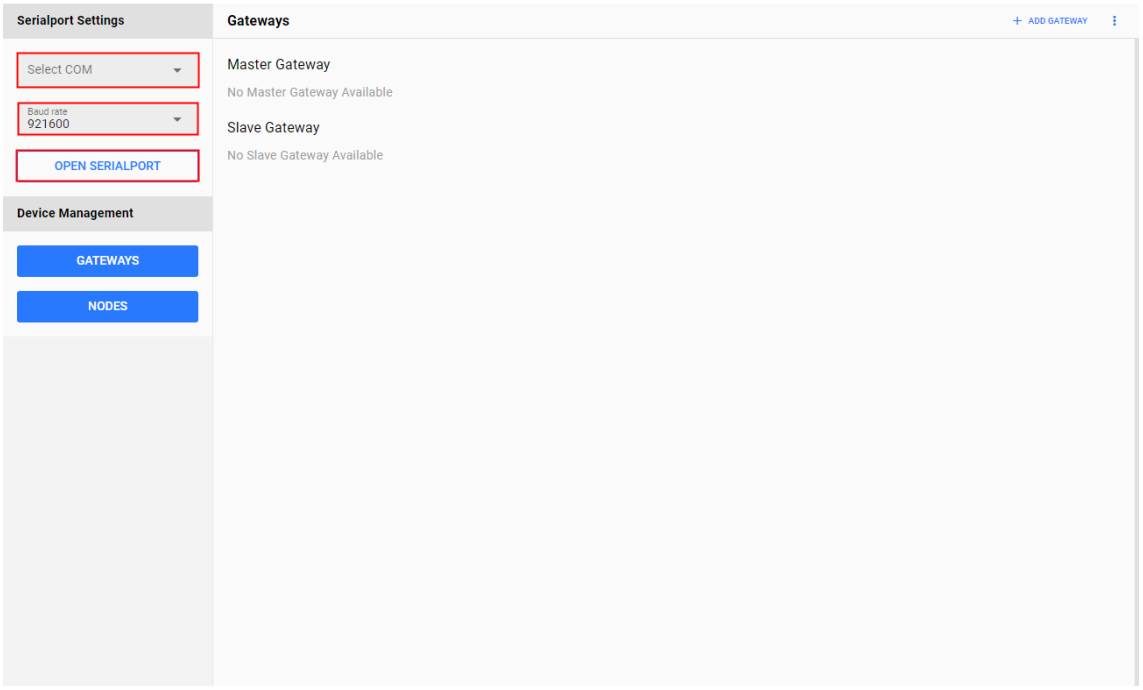
5. System usage

5.1 GUI startup

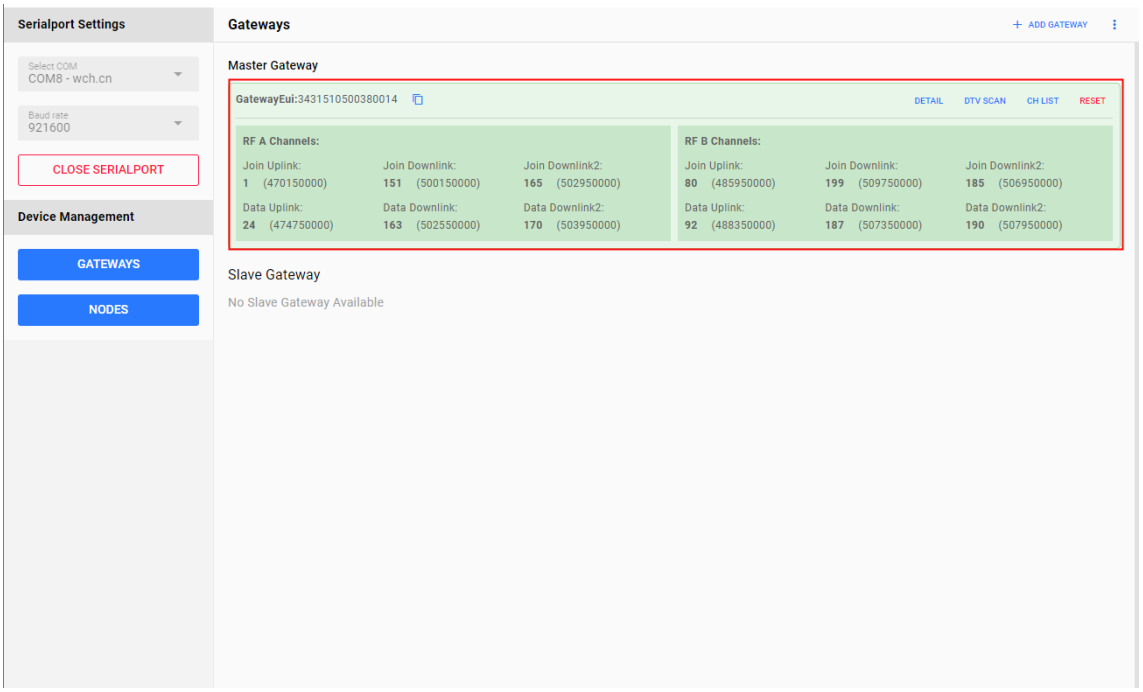
Open the GUI, and the main interface displays node list information. The left side is the serial port connection and device management entrance.

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Select the serial port number of the currently connected main gateway from "Serialport Settings" on the left, and the baud rate is 921600bps. Click "OPEN SERIALPORT" to open the serial port. After the serial port is opened, the GUI will automatically query the current master gateway information, including network spectrum information, mounted slave gateway information, etc.



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5.2 GUI device management

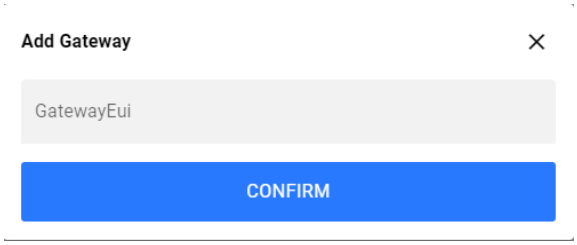
5.2.1 Gateway management

Click the "GATEWAYS" button on the left, and the GUI will switch to the gateway management interface. The gateway management interface is divided into title area, main gateway area and slave gateway area.

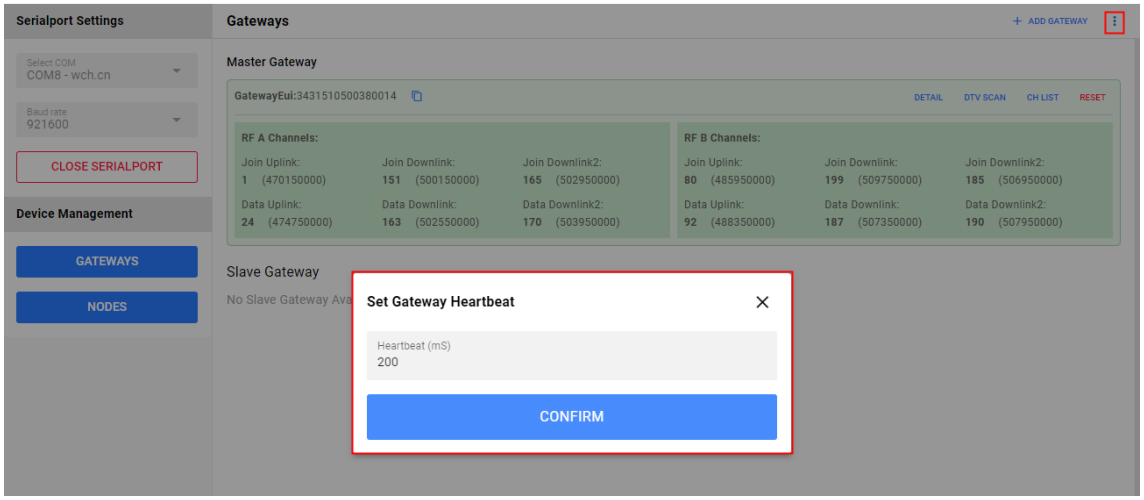


① Title area: The title area mainly provides functions such as adding slave gateways, setting polling heartbeat values, refreshing the gateway list, and importing and exporting gateways.

➢ Add a slave gateway: Click "Add Gateway" on the right, enter the slave gateway GatewayEui in the pop-up window, and you can successfully add a new gateway.



➢ Set the heartbeat value for polling: click "..." on the right, select "Set Heartbeat" in the list, and enter the value in the pop-up window to set the heartbeat value for the master gateway to poll the slave gateway information. Unit: ms, range: 200~10000.



➢ Refresh the gateway list: Click "..." on the right and select "Reset List" in the list to refresh the secondary gateway list immediately.

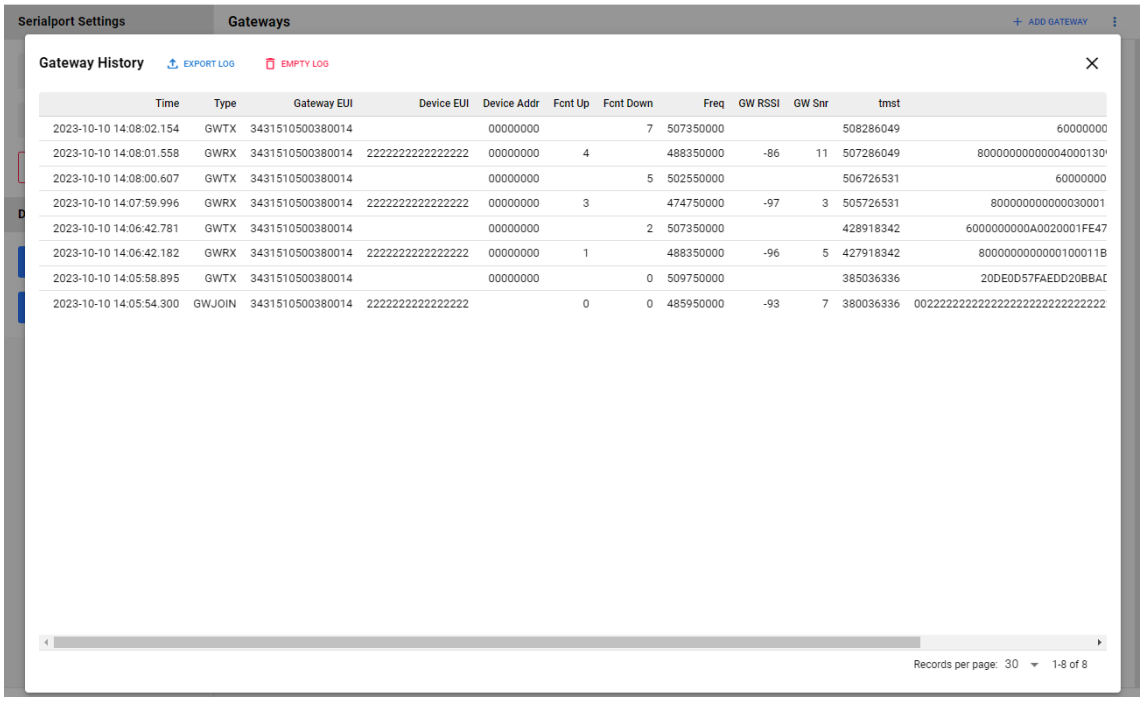
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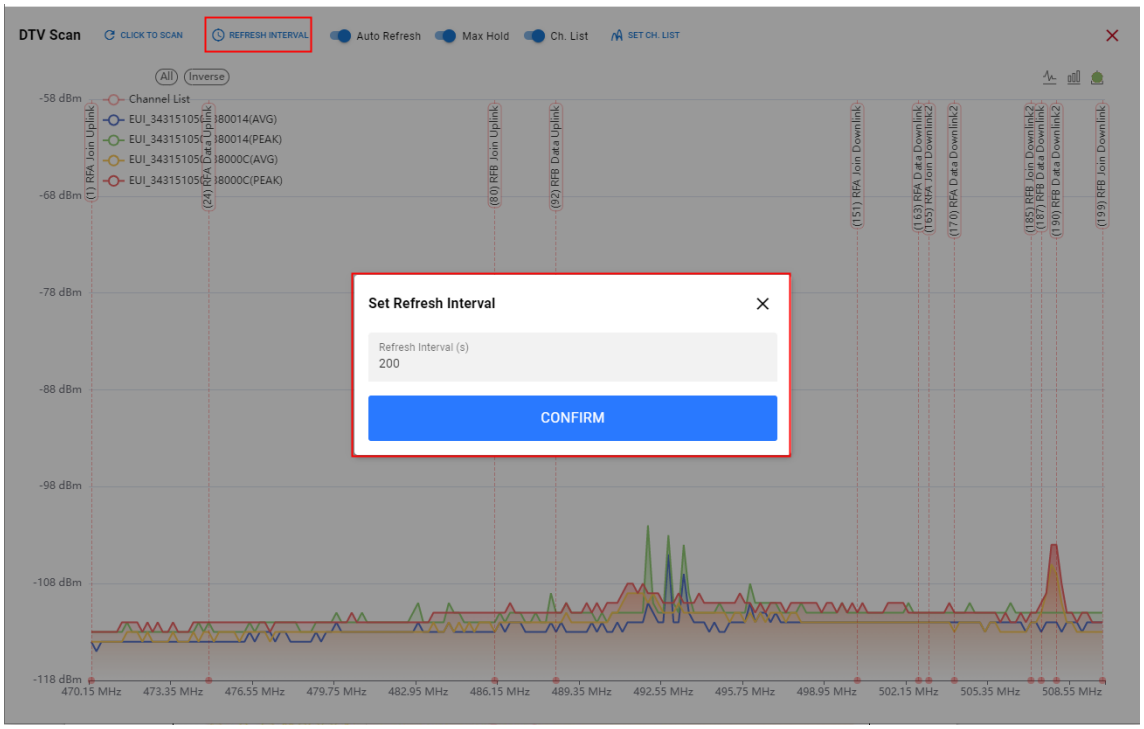
➢ Gateway import and export: Click "..." on the right and select "Export Gateways" or "Import Gateways" from the function list for batch import or export from gateways.

②Main gateway area: The main gateway area mainly provides functions such as displaying gateway historical communication data, DTV Scan configuration, Chlist configuration, and restarting the main gateway.

➢ Gateway historical communication data: Click "Detail" to view the historical communication data of the main gateway. The log includes time, data packet type, gateway GwEui receiving data, device DevEui, etc.

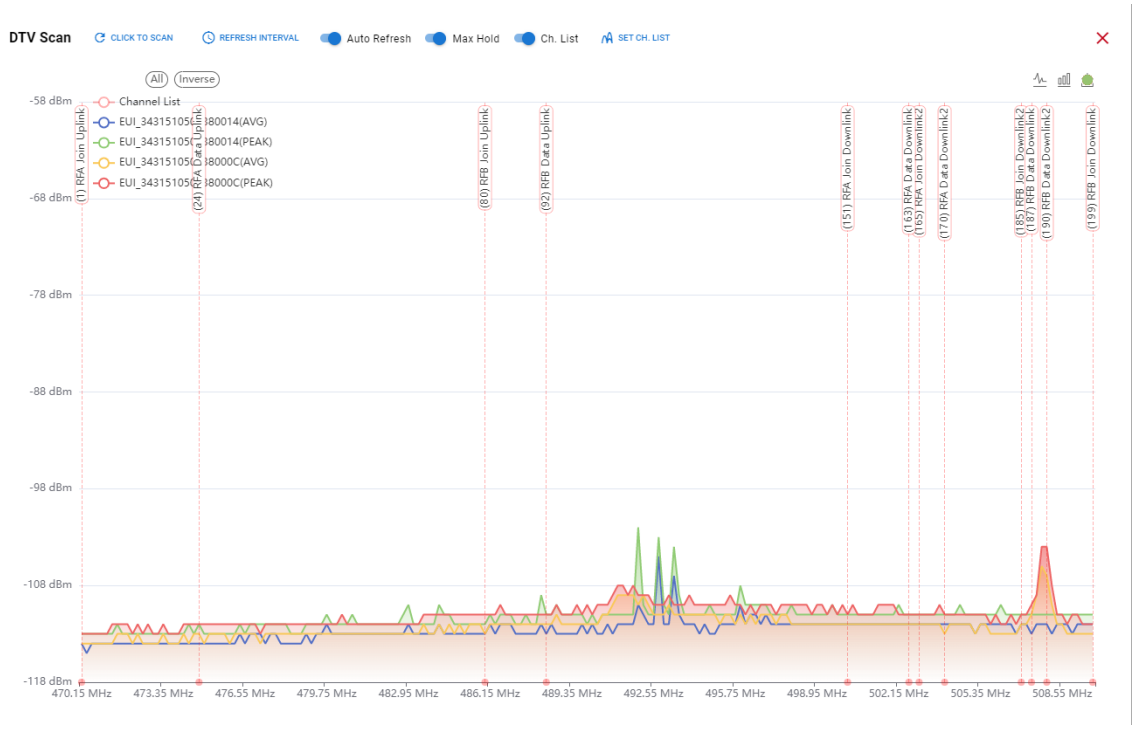


➢ DTV Scan configuration: Click "DTV Scan" and the DTV Scan configuration interface will pop up. The functions of this interface include the following: Configure DTV cycle.



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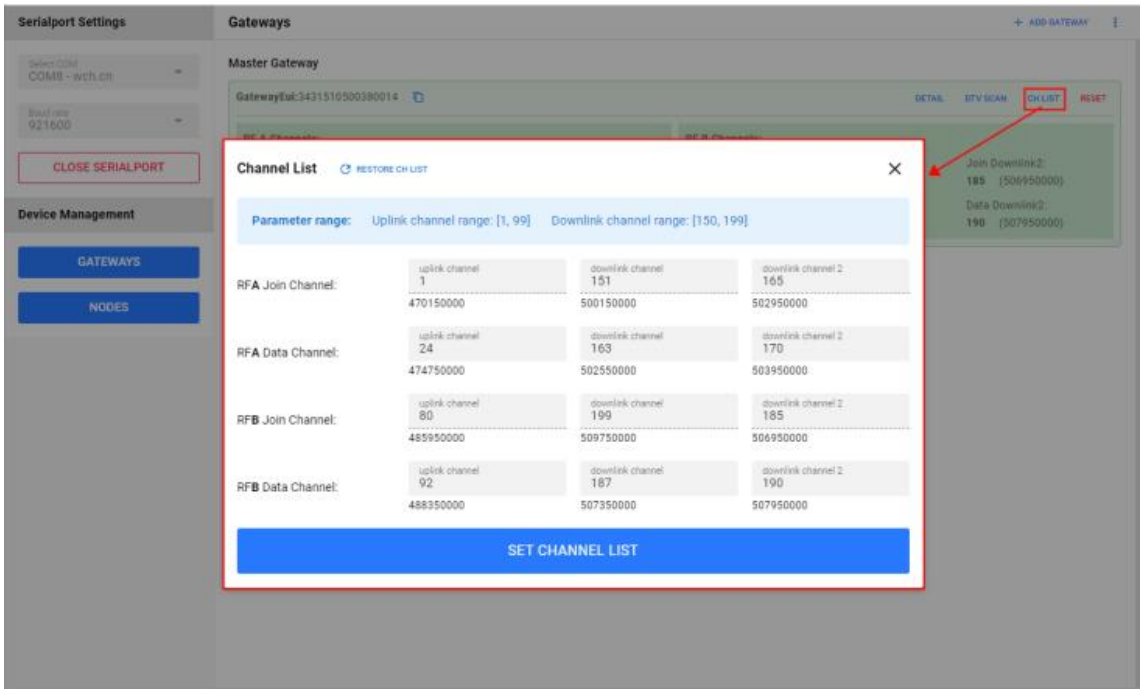


- Manually trigger DTV Scan: Click "CLICK TO SCAN", including manually triggering a DTV Scan. When all gateways complete the DTV scan, the results will be displayed in the form of a legend. The user-configured display mode is a line chart or a bar chart, and screenshots are supported. .
- Periodic DTV Scan: The GUI turns off periodic DTV SCAN by default. If you need to turn it on, check "Auto Refresh", click "REFRESH INTERNAL", and enter the period value in the pop-up window; if you need to turn off this function, turn off and check "Auto Refresh".
- Maximum value hold: Check "Max Hold", then the maximum value of each channel of DTV Scan will always be retained.
- Chlist configuration: By checking "Ch. List", users can clearly see the current gateway JOIN and DATA channels. Combined with the DTV SCAN scanning results, users can quickly determine whether the current gateway channel is interfered with.
- If there is interference on the current channel, the user can drag the starting circle of the channel line to the appropriate channel, and then click "SET CH.LIST" -> "SET CHANNEL LIST" to quickly modify the gateway channel value (JOIN upstream channels do not support modification);
- Or click "SET CH. LIST" to enter the Chlist configuration interface, manually enter the channel value, and then click "SET CHANNEL LIST" to modify it;
- If the user wants to cancel this operation, in the Chlist configuration interface, click "RESTORE CHLIST" to cancel this operation (this operation will be invalid after clicking "SET CHANNEL LIST").

Note: During the modification of the entire network Chlist, it cannot be triggered again.

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➢ Set Chlist: Refer to the instructions of "DTV Scan Configuration-Chlist Configuration".

➢ Restart the main gateway: Click “Reset” to restart the main gateway immediately.

② Slave gateway area: The slave gateway area mainly provides functions such as displaying the network status of the slave gateway, real-time communication logs between the master and slave gateways, and deleting the slave gateway.

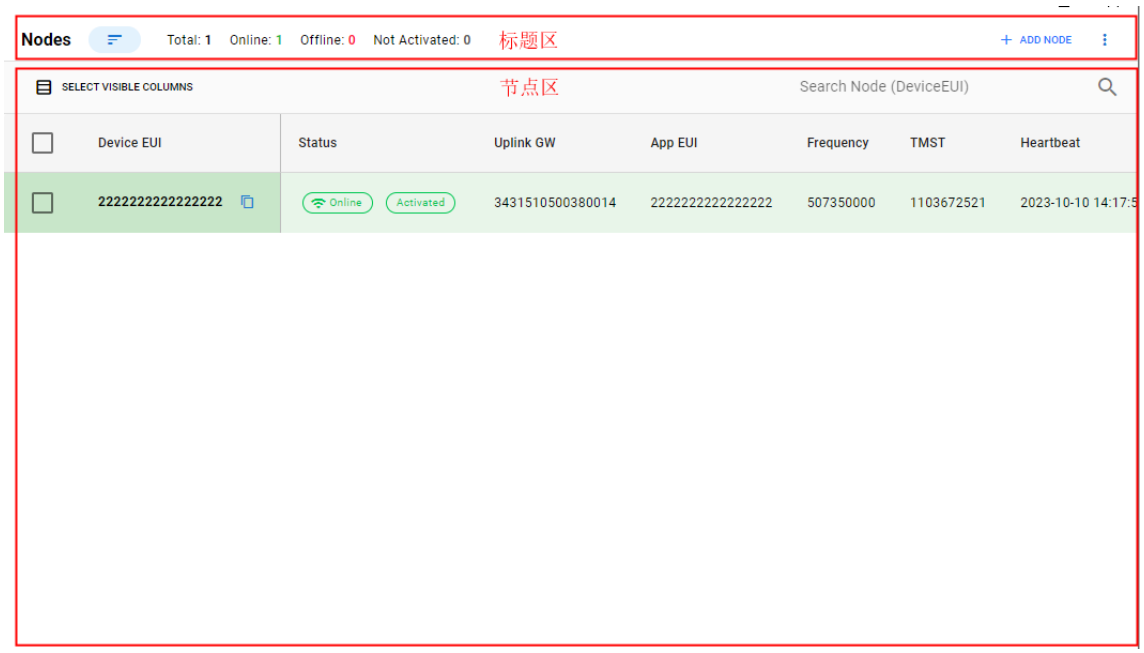


5.3 GUI node status management

Click the "NODES" button on the left, and the GUI will switch to the node management interface and provide the user with an operation interface. The node management interface is divided into title area and node area.

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① Title area: The title area mainly provides functions such as node sorting configuration, node status summary, adding nodes, restoring alarms, closing alarms, data reporting heartbeat value configuration, node list refresh, node import and export, etc.

➢ Node sorting configuration: Click the "Enable Sorting" button to enable the node sorting function, and the GUI will sort according to the node activation status and network status; click the "Disable Sorting" button again to turn off the node sorting function.

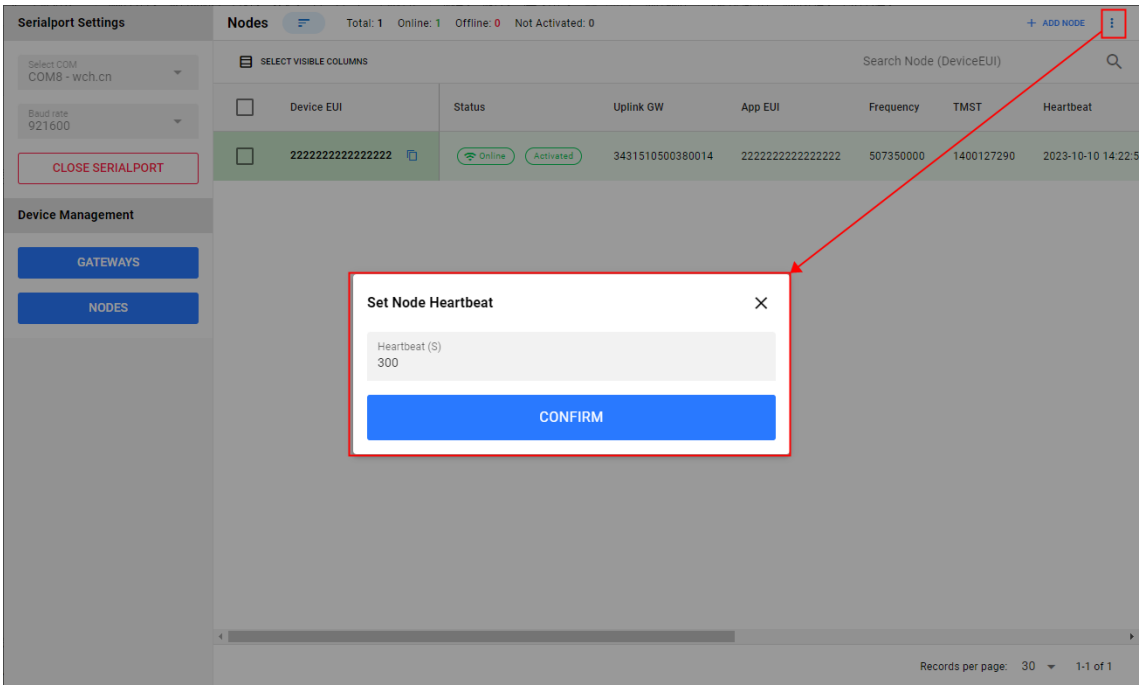
➢ Node status summary: The title area will display the current activation status and network status of all nodes in real time.

➢ Add node: Click "Add Node" on the right and enter the node triplet in the pop-up window to successfully add a new node.

➢ Restore alarm: Click "..." on the right, select "Restore alarm beep" from the function list, and refer to "Node Communication" for details.

➢ Turn off the alarm: click "..." on the right and select "Automatic Shut-off alarm beep" from the function list. For details, refer to "Node Communication".

➢ Data reporting heartbeat value configuration: Click "..." on the right, select "Set Heartbeat" from the function list, and enter the value in the pop-up window to set the node data reporting heartbeat value. Unit: s, range: greater than or equal to 20.



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➢ Refresh the node list: Click "..." on the right, select "Reset List" in the function list, and the slave node list will be refreshed immediately.

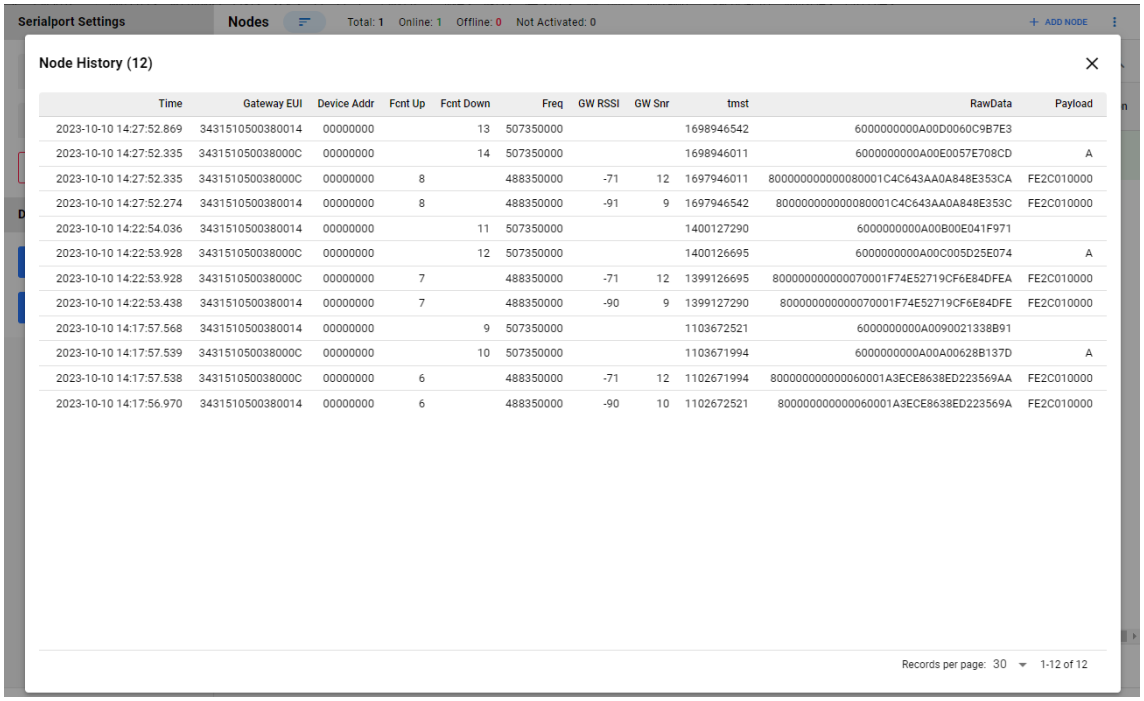
➢ Node import and export: Click "..." on the right and select "Export Nodes" or "Import Nodes" from the function list to import or export nodes in batches.

②Node area: Mainly provides node search, node historical communication data display, node deletion and other functions.

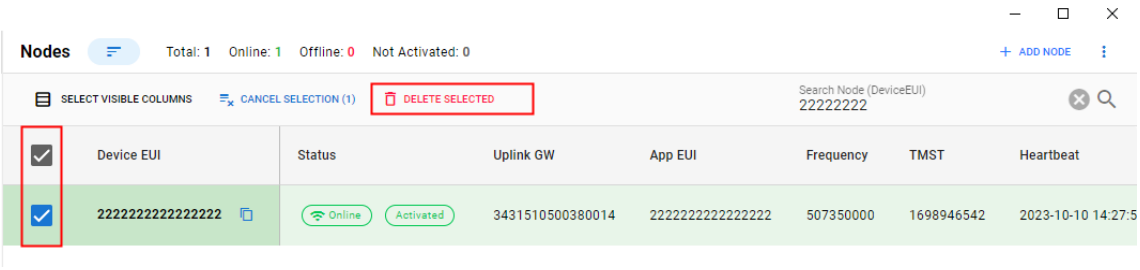
➢ Node search: Enter the partial value or complete value of the node DevEui in the node area to quickly search for matching nodes.



➢ Node historical communication data display: Click "Detail" to view the node's historical communication data. The log includes time, gateway gwEui, node Deveui Addr, Fcnt, etc.



➢ Delete nodes: Click "Delete" to delete nodes individually, or select multiple nodes to delete them in batches.



③Node status: If the gateway is a new gateway and no node information is stored, the list will be empty. Click "Add Node" in the upper right corner to add a new device.

After the GUI starts, all registered nodes are displayed with gray information boxes. The node status of "Not Actived" and "Offline" means that after the system is connected, the node has not yet conducted any communication and the device is in an inactive state.

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When a node sends an incoming network or data frame, the node status is displayed as online, and the status is marked as "Actived" and "Online".

When the device has no uplink data packets for a certain period of time, the status is displayed as offline. Currently, if the device does not receive uplink data for three consecutive heartbeat cycles, it is determined that the device is offline and the node status is refreshed.

5.4. GUI node communication

There are three message types for node upstream messages: Heartbeat, Alarm, and custom data reporting.

5.4.1. Heartbeat message

Heartbeat is a heartbeat message. The node wakes up periodically and sends heartbeat frames according to the heartbeat cycle setting. You can configure it by clicking the "More" button drop-down menu in the upper right corner of the GUI and selecting "Set Heartbeat".

The unit of heartbeat cycle is s, the minimum cycle is 20s (the maximum value of the random range of heartbeat cycle), and the maximum cycle is 2592000S. The calculation formula of the actual heartbeat period of the node:

heartbeat_period = heartbeat_period_baisc + heartbeat_period_random

wherein:

heartbeat_period_random = rand(0, 20)s

Therefore, if the heartbeat period is configured as 60s, that is, the maximum heartbeat period is 60s, and the actual period is:

heartbeat_period = 40s + rand(0, 20)s

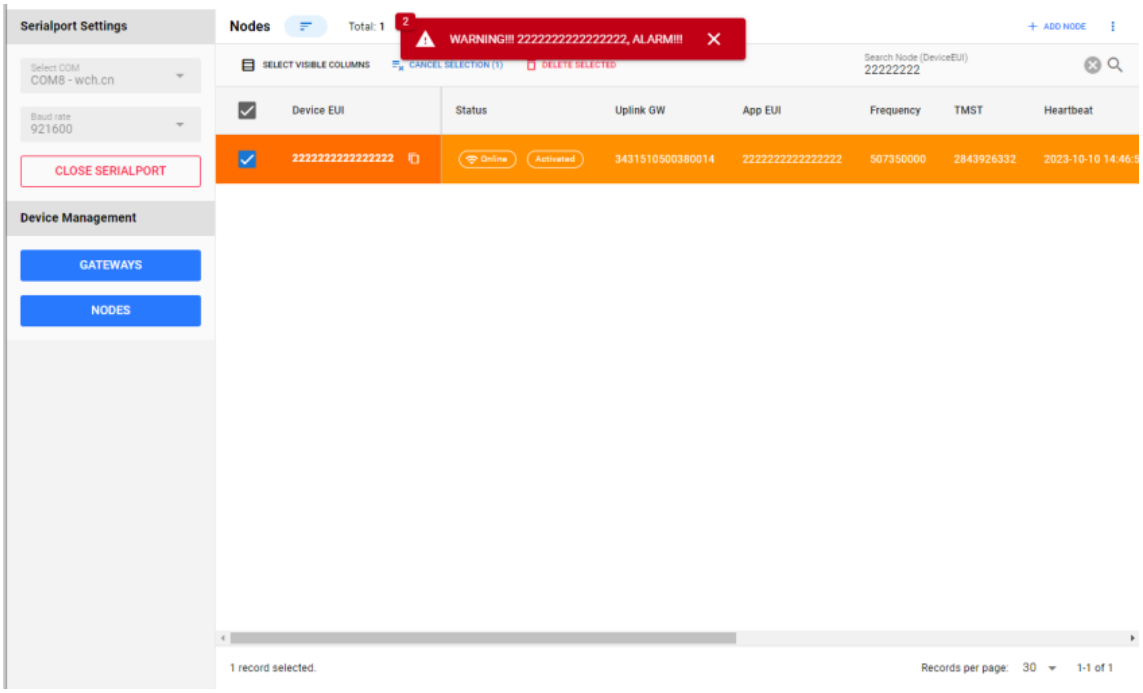
5.4.2. Alarm message

① Alarm signal generation:

By triggering the button on the node, a fire signal is simulated. The node will wake up immediately and report alarm information periodically, and sound the alarm sound through the buzzer. When the GUI receives an alarm signal, the corresponding node will display the alarm information.

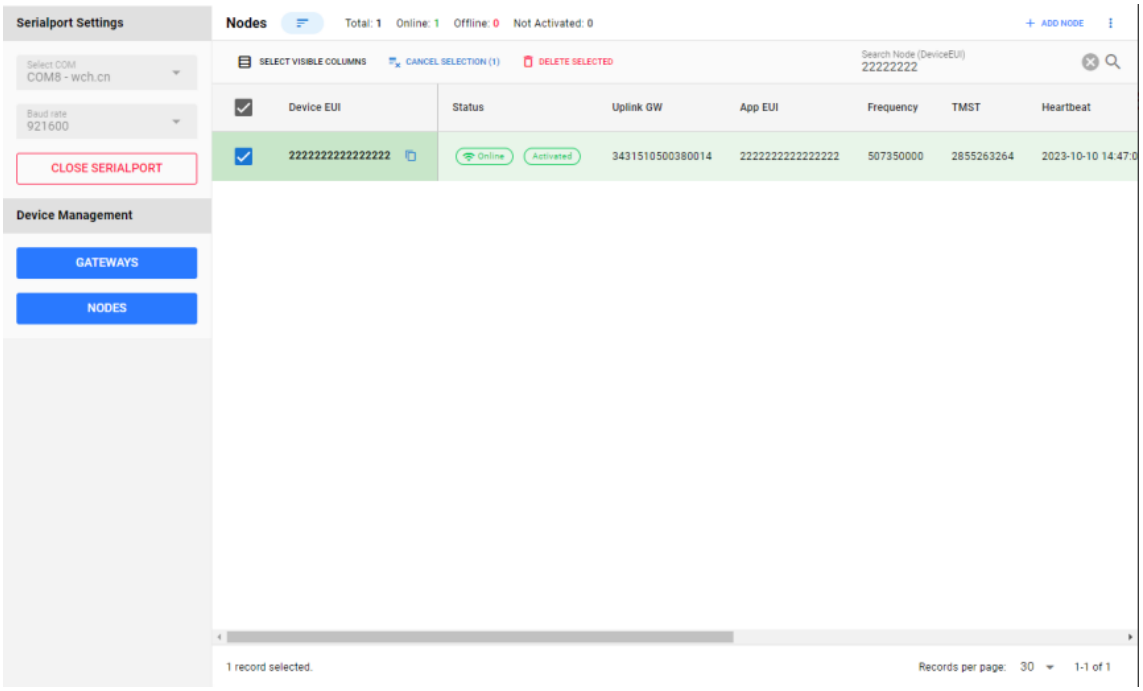
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②Alarm signal elimination:

When the node is in the alarm state, click the button again to simulate the fire signal disappearing, the node turns off the buzzer alarm sound, and returns to the heartbeat state. When the GUI receives the heartbeat data, it considers that the alarm has disappeared and clears the alarm prompt.



③Remote shutdown alarm sound: (Node does not support remote shutdown temporarily)

The GUI has two instructions about alarms, Restore alarm beep and Automatic Shut-off alarm beep.

Automatic Shut-off alarm beep: Remotely turn off the alarm beep function. The command validity period defaults to 300s and can be customized. When the gateway receives this instruction, it will start an N-second alarm-off timer. When an alarm frame is received within this timer range, it will issue a shutdown alarm sound command and remotely turn off the node alarm sound.

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Note: The node only turns off the alarm sound, but the alarm signal still exists and will continue to send alarm frames. Node alarm signals need to be cleared manually by pressing the button.

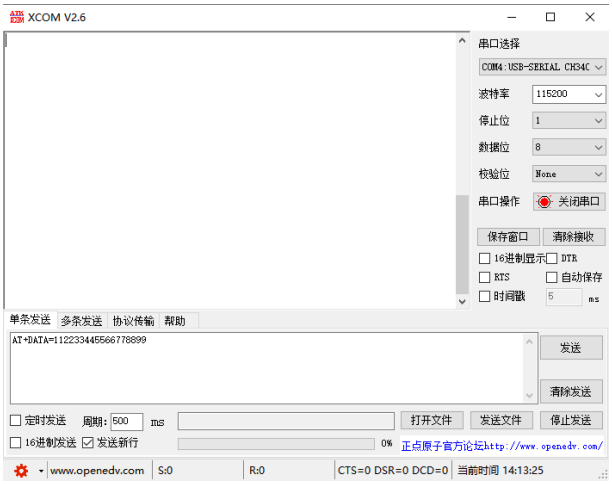
Restore alarm beep: Reset Shutdown Alarm status. In Shutdown Alarm state, the alarm sound of any node will be turned off by the gateway. Restore Alarm is to reset the state. After reset, if a new device generates an alarm, the alarm will sound normally.

5.4.3. Custom data messages

①The node sends a message (please ensure that the node has successfully connected to the network)

Nodes report customized data in the form of instructions. An example of the reported information will be shown below:

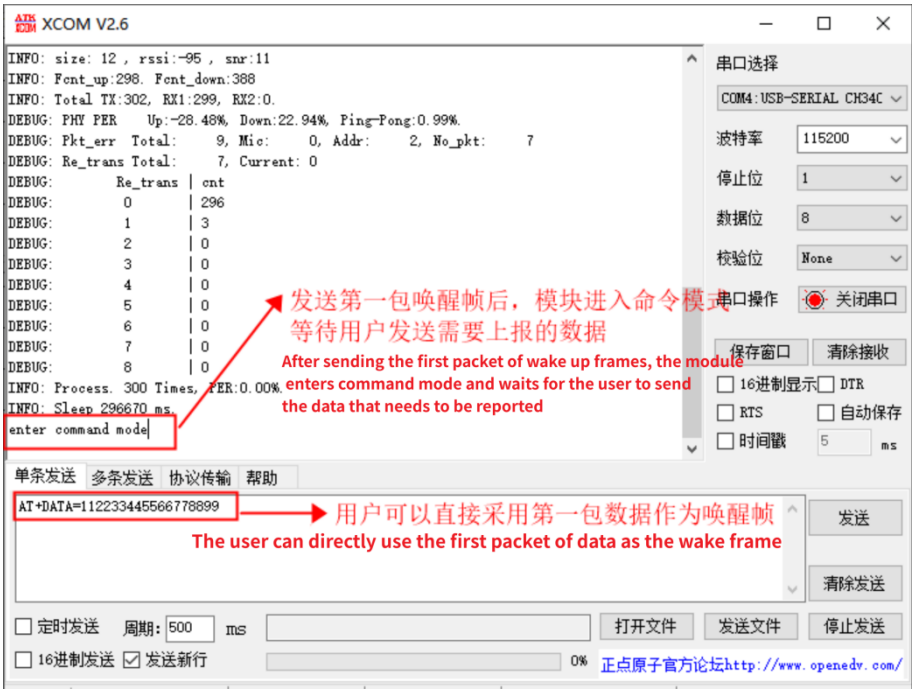
A. Connect the node serial port to the PC through TTL and open the serial port debugging tool;



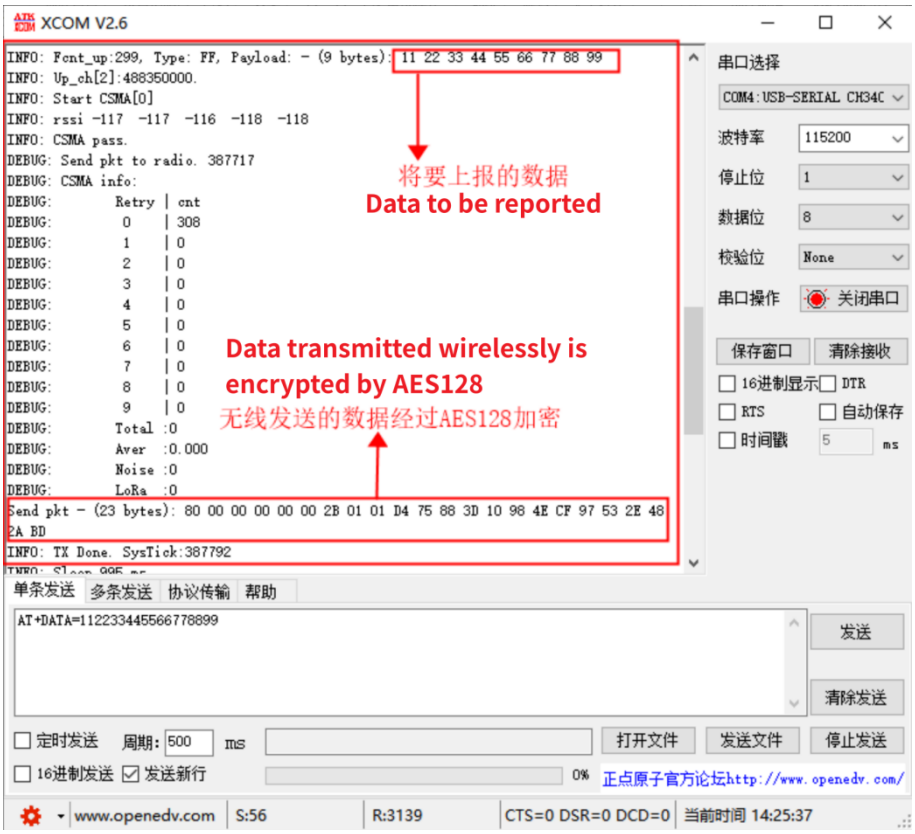
B. Send the command "AT+DATA=112233445566778899". Because the node is in a low power consumption state at other times except for actively reporting information, so we need to send a packet of data through the serial port as a wake-up frame before sending data, and then perform real data transmission. ;

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C. After sending the wake-up frame and the module enters the command mode, the user reports data through the command "AT+DATA=112233445566778899".



Custom data reporting logic:

a. The command needs to end with a carriage return and line feed;

b. After the serial port command is sent, the node will automatically exit the command mode and immediately report the data to the gateway via wireless. Then the node will automatically enter sleep and wait for the response data from the gateway (if no response from the gateway is received, the node will automatically take reset steps. development mechanism);

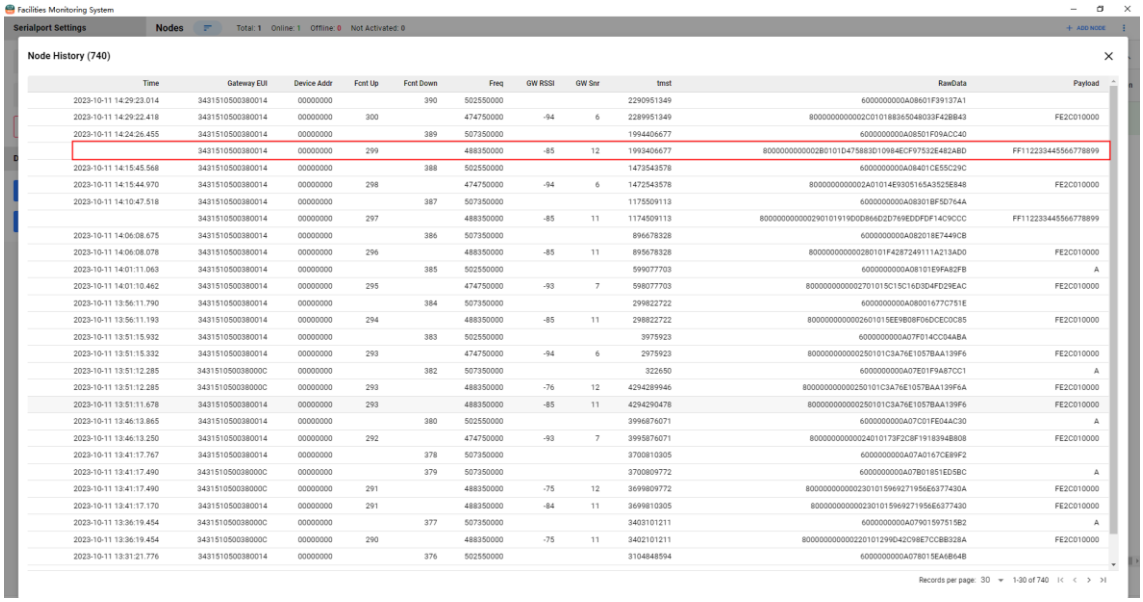
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c. After receiving the data reported by the node, the gateway delays the response to the node;

d. After receiving the response from the gateway, the node re-enters sleep and periodically reports heartbeat packet data according to the set heartbeat cycle.

D. We can see from the historical interaction data of the gateway GUI node that we received the data " **112233445566778899** " reported from the node. The previous **FF** is used as the alarm data protocol header. **Note that the custom data reported by our nodes uses the same protocol header as the alarm, so in theory, the custom data can be used directly to simulate alarm signals. However, it is not recommended for users to use this method, and the overlap of alarm and custom data content should be avoided. The maximum single packet transmission is 20 bytes (see the command description for details).**



Time	Gateway EUI	Device Addr	Fcnt Up	Fcnt Down	Freq	GW RSSI	GW Snr	tmst	RawData	Payload
2023-10-11 14:29:23.014	3431510500380014	00000000		390	502550000			2290951349	6000000000A08601F39137A1	
2023-10-11 14:29:22.418	3431510500380014	00000000	300		474750000	-94	6	2289951349	8000000000002C0101883650480 33F42BB43	FE2C010000
2023-10-11 14:24:26.455	3431510500380014	00000000		389	507350000			1994406677	6000000000A08501F09ACC40	
	3431510500380014	00000000	299		488350000	-85	12	1993406677	8000000000002B0101D475883D10984ECF97532E482ABD	FF112233445566778899
2023-10-11 14:15:45.568	3431510500380014	00000000		388	502550000			1473543578	6000000000A08401CE55C29C	
2023-10-11 14:15:44.970	3431510500380014	00000000	298		474750000	-94	6	1472543578	8000000000002A01014E9305165A3525E848	FE2C010000
2023-10-11 14:10:47.518	3431510500380014	00000000		387	507350000			1175509113	6000000000A08301BF5D764A	
	3431510500380014	00000000	297		488350000	-85	11	1174509113	8000000000002901019190D0D866D2D769EDDFDF14C9CCC	FF112233445566778899
2023-10-11 14:06:08.675	3431510500380014	00000000		386	507350000			896678328	6000000000A0820187E7449CB	
2023-10-11 14:06:08.078	3431510500380014	00000000	296		488350000	-85	11	895678328	8000000000002801011F4287249111A213AD0	FE2C010000
2023-10-11 14:01:11.063	3431510500380014	00000000		385	502550000			599077703	6000000000A08101E9FA82FB	A
2023-10-11 14:01:10.462	3431510500380014	00000000	295		474750000	-93	7	598077703	8000000000002701015C15C16D3D4FD29EAC	FE2C010000
2023-10-11 13:56:11.790	3431510500380014	00000000		384	507350000			299822722	6000000000A08001677C751E	
2023-10-11 13:56:11.193	3431510500380014	00000000	294		488350000	-85	11	298822722	8000000000002601015EE9B08F06DCEC0C85	FE2C010000
2023-10-11 13:51:15.932	3431510500380014	00000000		383	502550000			3975923	6000000000A07F014CC04ABA	
2023-10-11 13:51:15.332	3431510500380014	00000000	293		474750000	-94	6	2975923	8000000000002501013C3A76E1057BAA139F6	FE2C010000
2023-10-11 13:51:12.285	343151050038000C	00000000		382	507350000			322650	6000000000A07E01F9A87CC1	A
2023-10-11 13:51:12.285	343151050038000C	00000000	293		488350000	-76	12	4294289946	8000000000002501013C3A76E1057BAA139F6A	FE2C010000
2023-10-11 13:51:11.678	3431510500380014	00000000	293		488350000	-85	11	4294290478	8000000000002501013C3A76E1057BAA139F6	FE2C010000
2023-10-11 13:46:13.865	3431510500380014	00000000		380	502550000			3996876071	6000000000A07C01FE04AC30	A
2023-10-11 13:46:13.250	3431510500380014	00000000	292		474750000	-93	7	3995876071	8000000000002401017 3F2C8F1918394B808	FE2C010000
2023-10-11 13:41:17.767	3431510500380014	00000000		378	507350000			3700810305	6000000000A07A0167CE89F2	
2023-10-11 13:41:17.490	343151050038000C	00000000		379	507350000			3700809772	6000000000A07B01851ED5BC	A
2023-10-11 13:41:17.490	343151050038000C	00000000	291		488350000	-75	12	3699809772	8000000000002301015969271956E6377430A	FE2C010000
2023-10-11 13:41:17.170	3431510500380014	00000000	291		488350000	-84	11	3699810305	8000000000002301015969271956E6377430	FE2C010000
2023-10-11 13:36:19.454	343151050038000C	00000000		377	507350000			3403101211	6000000000A07901597515B2	A
2023-10-11 13:36:19.454	343151050038000C	00000000	290		488350000	-75	11	3402101211	8000000000002201012990 42C98E7CCBB328A	FE2C010000
2023-10-11 13:31:21.776	3431510500380014	00000000		376	502550000			3104848594	6000000000A078015EA6B64B	

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6. Detailed explanation of gateway function

6.1. Function list

Serial number	Function
1	Configure system parameters (master-slave gateway parameters, network parameters)
2	Node management (registration, query, deletion)
3	Manage the slave gateway (registration, query, delete)
4	Node communication (heartbeat , alarm , custom data, modify heartbeat cycle, modify frequency)
5	Master-slave gateway communication (heartbeat, RF data sending and receiving, DTV scanning, frequency switching)
6	Main gateway communicates with GUI
7	DTV signal scan
8	Whole network frequency switching
9	Alarm application (demo function)
10	Data storage
11	Communication encryption
12	Serial port data sending and receiving
13	RF driver and frequency switching

6.2. Function module

Parameter	Attributes	Remark
GwEui	Configurable	Gateway EUI
MasterSlave	Configurable	Gateway master-slave attributes
Chlist	Configurable	Network spectrum list (supports DATA UP/DOWN)
LoRaMAC	Configurable	Sync word configuration
Workmode	Configurable	Operating mode

6.3. Node management

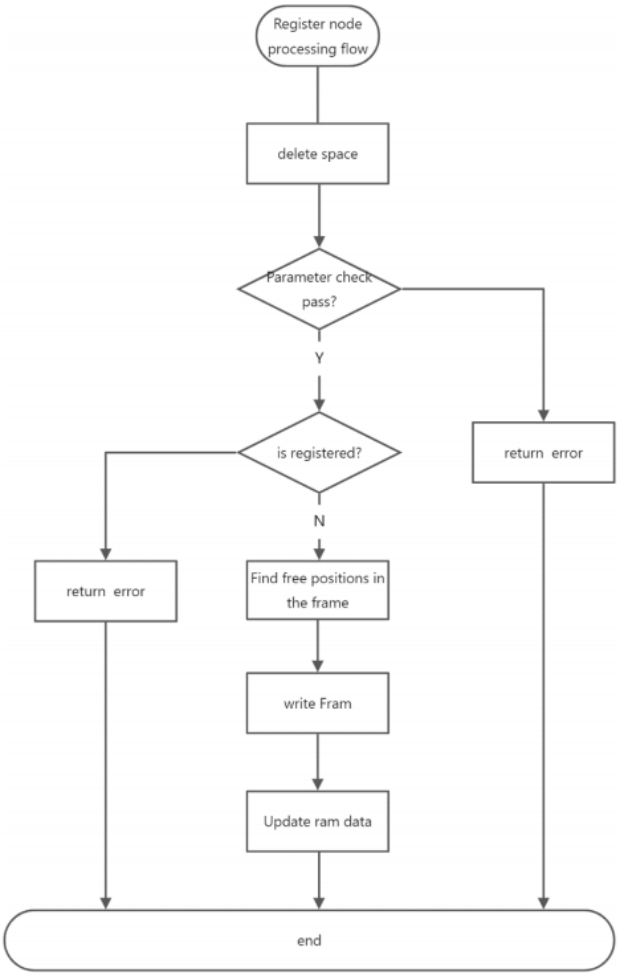
6.3.1. Register node

The parameters when registering a node include DevEui, AppEui, and AppKey. When registering a node, the gateway will determine whether the node DevEui is duplicated. Duplicate nodes cannot be registered again. The gateway writes the verified node information into external memory and updates the node information in RAM at the same time.

Node management functions include: registering nodes, deleting nodes, and querying nodes.

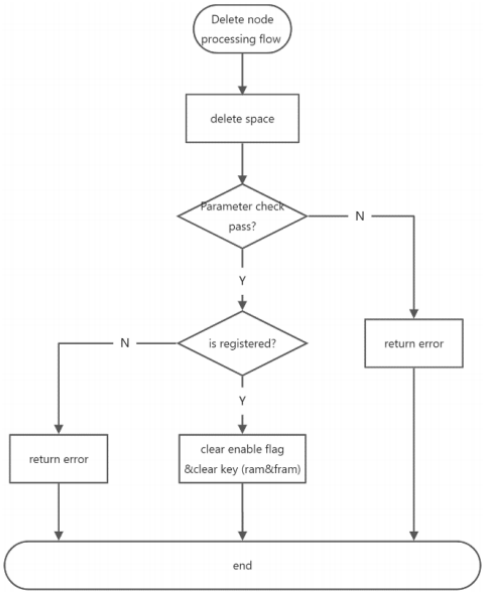
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6.3.2. Delete node

The gateway deletes a node by changing the enable attribute in the node's attributes. The gateway retrieves whether the DevEui of the node to be deleted exists. If the node does not exist, it directly returns ERROR.

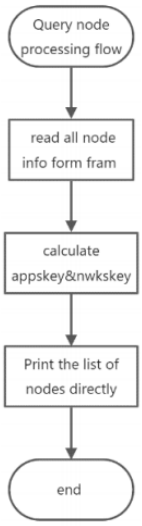


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6.3.3. Query nodes

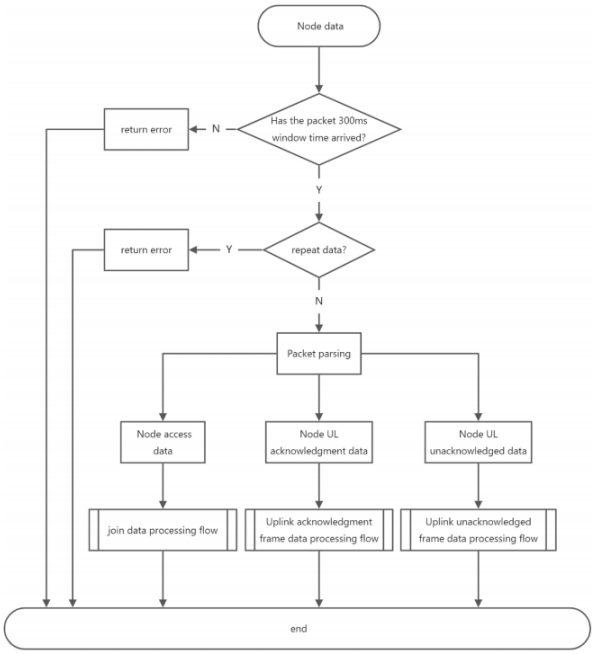
Querying a node is to output the registered node attribute information. The gateway reads the node information in the external memory and outputs the read data through the serial port.



6.4. Management the slave gateway

Slave gateway management includes: registering slave gateway, deleting slave gateway, and querying slave gateway. The operation process is similar to that of the node and will not be repeated.

The node's uplink data includes: network incoming data, acknowledgment frame uplink data, and non-acknowledgement frame uplink data. In order to deduplicate data packets and optimize downlink paths, MAC opens a 300ms time window for each piece of data from the node, and processes it only after the 300ms time is up. The data communication process is as follows:

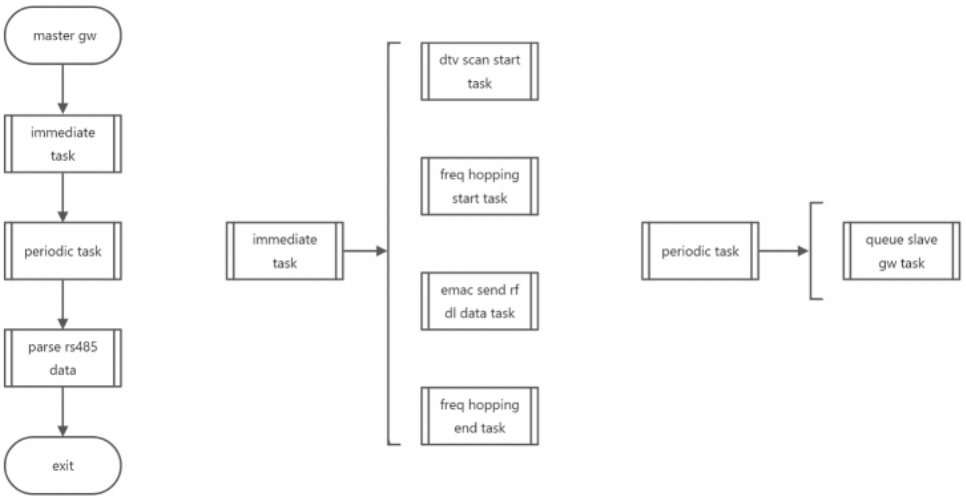


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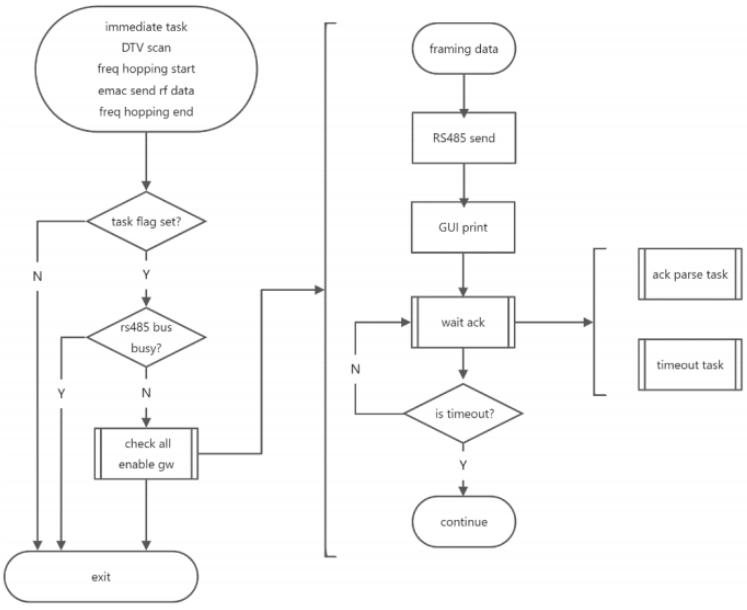
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6.5. Master-slave gateway communication

RS485 master-slave gateway communication includes immediate execution tasks, periodic execution tasks, and data analysis tasks. The overall block diagram is as follows:



DTV scanning, frequency switching start, EMAC sending RF data, frequency switching end tasks need to be executed immediately, these tasks are collectively called immediate tasks. It can be sent when the RS485 bus is idle. The master gateway needs to send all task data to all slave gateways until a response is received or times out.

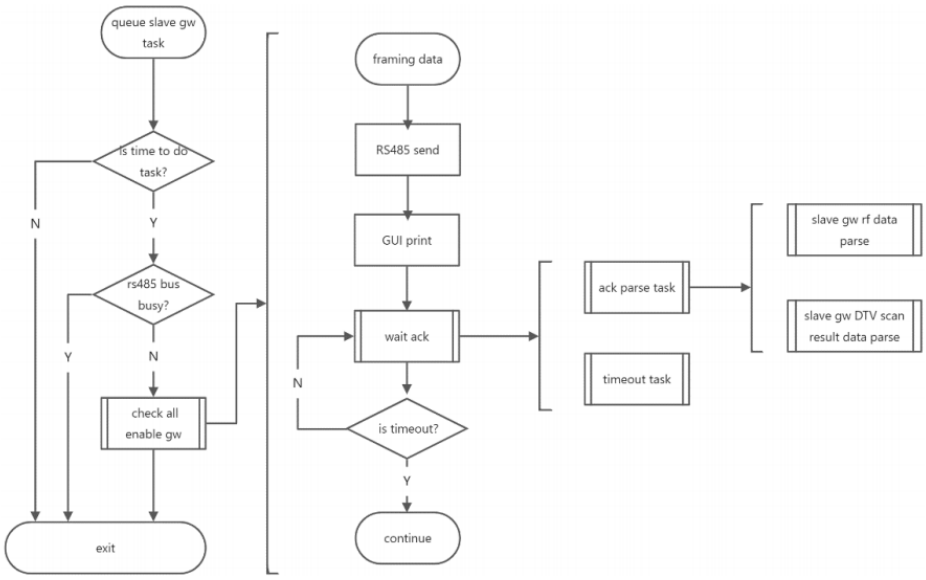


The master gateway periodically polls the slave gateway, and the polling data includes the time synchronization function. The slave gateway replies to the master gateway based on the cached polling response task. After the polling data is sent, the main gateway

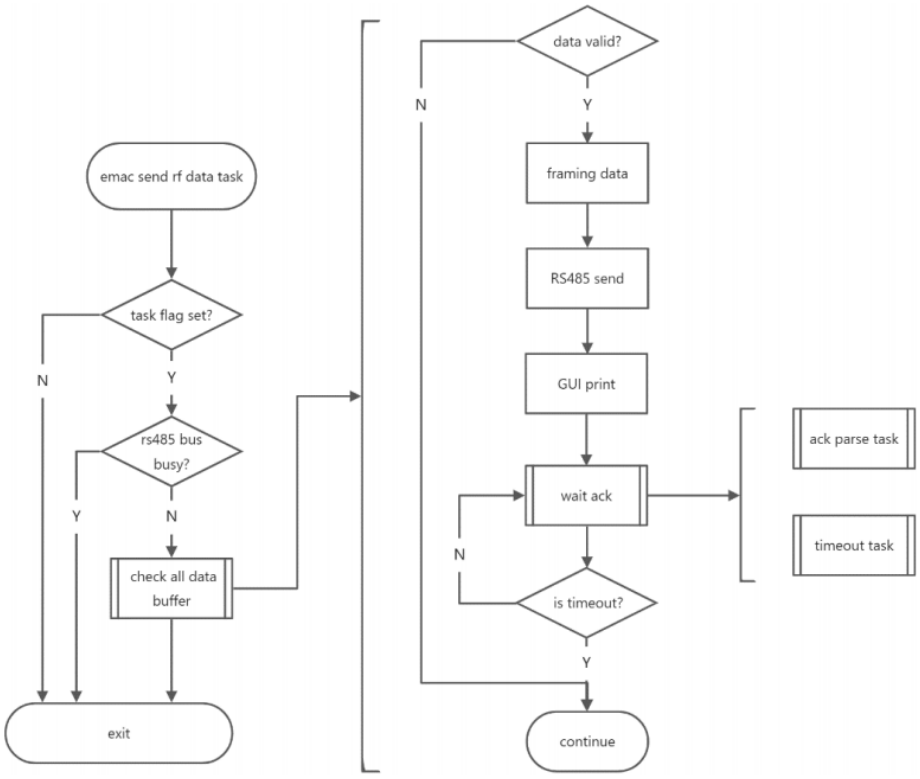
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starts a timer. If the response data is received before the timeout, the task is marked as completed. If the response data is not received after the timeout, the task fails.



The main gateway will select a gateway with a better radio frequency signal to transmit downlink data, and all data sent from the slave gateway will be stored in a data cache pool. When obtaining the right to use RS485, the main gateway sends the downstream data in the EMAC downstream data cache to each target gateway in turn. The main gateway will start a timeout timer when sending EMAC downlink radio frequency data.



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6.6. Gateway communication protocol

6.6.1. Master-slave gateway communication protocol

The main gateway communicates with the GUI through the RS485 interface or the debugging serial port. Communication is in ASCII format. The communication data starts with "AT" and is compatible with the gateway AT command protocol.

Identifier	Function	Remark	Subfunction
AT+GWRXJOIN	EMAC successfully received node join data	Node network access data	none
AT+GWRX	EMAC receives RF data	RF data received from master gateway and slave gateway	heartbeat
			Request frequency list
			Call the police
AT+GWTX	EMAC sends radio frequency data	RF data sent from master gateway and slave gateway	heartbeat response
			Modify heartbeat cycle
			Send frequency list
			Reset alarm
AT+GW485TX	The master gateway sends data to the slave gateway through RS485	Data sent from the master gateway to the slave gateway	Periodic polling (time synchronization)
			Download radio frequency data
			Send DTV scan
			Delivery starts frequency switching
			Frequency switching after delivery ends
AT+GW485RX	The main gateway receives the data replied by the slave gateway through RS485	The master gateway receives passive response data from the slave gateway, and the slave gateway will not actively send data.	Polling response (time synchronization)
			Transmit frequency data in response from the gateway
			Reply to DTV scan command from gateway
			Answer DTV scan results from gateway
			Frequency switching starts from gateway reply
			Frequency switching ends from gateway reply
AT+GWDTV	Gateway completes DTV scan data	DTV scan data of master-slave gateway	none

A. Gateway RF transmission frequency range: **500-510MHz** ;

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B. Gateway RF receiving frequency range: **470-490MHz** ;

C. The gateway hardware does not support reception of the channel between **490M-500MHz , so you should avoid setting reception in this frequency range;**

D. **Support user modification. Except for the JOIN receiving channel fixed in the specification, all other channels support modification.**

The function codes in the gateway communication protocol are as follows:

Main gateway				**Slave gateway**		
CID	**Function**	**Remark**		**CID**	**Function**	**Remark**
0x81	The master gateway polls the slave gateway			**0x01**	Reply from gateway	
0x93	The main gateway sends radio frequency data to the slave gateway.			**0x03**	The slave gateway responds to the radio frequency data command issued by the master gateway	
0x94	The main gateway issues a DTV scanning command			**0x04**	The slave gateway responds to the DTV scanning command issued by the main gateway	
0x95	The main gateway issues the start frequency switching command			**0x05**	The slave gateway responds to the start frequency switching command issued by the master gateway.	
0x96	The main gateway issues the frequency switching end command			**0x06**	The slave gateway responds to the end frequency switching command issued by the master gateway.	

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7. Detailed explanation of node functions

7.1. Function overview

The software design of nodes in the FMS (Facilities Monitoring System) system includes the overall system design and the detailed design of key subsystems. User messages can be realized in three message types: alarm, heartbeat and service messages.

Module application: This product is mainly used to detect various alarm signals. The working logic is that when an external alarm signal is detected, the user actively inputs a low-level signal to the module alarm pin. Because most of the modules are in a low-power sleep state, when the external input level is to the module alarm detection pin, the module will wake up and send alarm data immediately. If the input level of the alarm detection pin is always low, the module will continue to send alarm data at irregular intervals. Until the pin inputs a high level, the module immediately sends a heartbeat packet data frame to the gateway, indicating that the alarm signal is cancelled.

7.2 User message frame

<table>
<tr><th colspan="3">MsgType</th><th colspan="15">MsgPayload</th></tr>
<tr><th>Type</th><th>Value</th><th>Len</th><th colspan="14">Value</th><th>Len</th></tr>
<tr><td rowspan="2">Alarm</td><td rowspan="2">0xFF</td><td rowspan="2">1</td><td colspan="5">1</td><td colspan="5">2</td><td colspan="4">3</td><td rowspan="2">3</td></tr>
<tr><td colspan="5">0x00</td><td colspan="5">0x00</td><td colspan="4">0x00</td></tr>
<tr><td rowspan="2">Heartbeat</td><td rowspan="2">0xFE</td><td rowspan="2">1</td><td colspan="4">1</td><td colspan="4">2</td><td colspan="3">3</td><td colspan="3">4</td><td rowspan="2">3</td></tr>
<tr><td colspan="14">Current period in second, Little-Endian</td></tr>
<tr><td rowspan="6">Service message</td><td rowspan="6">0xFD</td><td rowspan="6">1</td><td>Type</td><td colspan="13">payload</td><td rowspan="6">2-13</td></tr>
<tr><td rowspan="4">Frequency change</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>0x00</td><td>Join1_UL</td><td>Join1_DL1</td><td>Join1_DL2</td><td>Data1_UL</td><td>Data1_DL1</td><td>Data1_DL2</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>Join2_UL</td><td>Join2_DL1</td><td>Join2_DL2</td><td>Data2_UL</td><td>Data2_DL1</td><td>Data2_DL2</td></tr>
<tr><td rowspan="2">Heartbeat period</td><td>0</td><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td><td colspan="2">4</td></tr>
<tr><td>0x01</td><td colspan="11">Period in second, Little-Endian</td></tr>
<tr><td>Alarm</td><td colspan="6">0</td><td colspan="6">1</td></tr>
</table>

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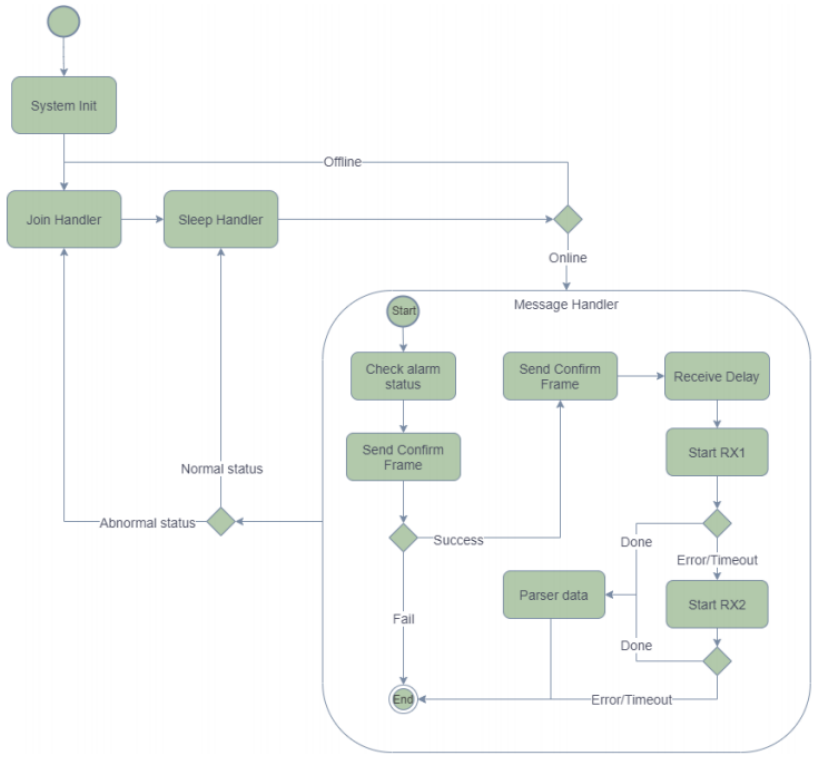
			control	0x02	0x00: **Alarm off** 0x01: **Alarm on**	

Note: The node uses AES128 for data encryption during wireless data air transmission.

7.3. Node system block diagram

After the device is powered on, it will automatically complete initialization and connect to the network, and then start a heartbeat or alarm. The node system block diagram is as follows.

Note: During the System Init process when the node is powered on, Device Eui will be read. This parameter is stored starting at the Flash address 0xFC00, totaling 8 bytes. If the Device EUI is read as 8 0xFF, the module will automatically obtain the 8 bytes in the unique UID of the chip as the Device EUI.



Node network access mechanism:

A. After the node is powered on and initialized, it automatically initiates a network access request frame with a random delay;

B. The gateway receives the network access request frame data and confirms whether the node has been registered to the gateway. The gateway will only allow registered nodes to join the network;

C. The node receives the gateway's response to the network access request and begins to synchronize the clock, frequency information, and network access status;

D. Finally, the heartbeat packet time synchronization is entered, the network access process is completed, and the node automatically wakes up according to the heartbeat packet cycle to report the heartbeat packet data .

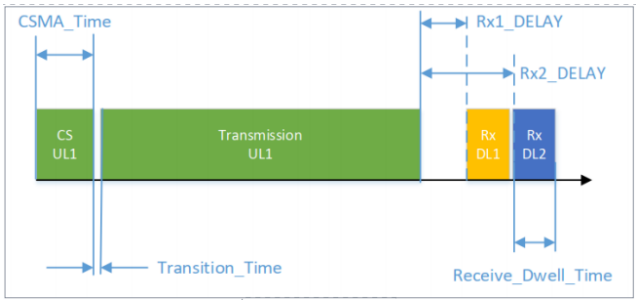
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7.4. Message timing and functions

CSMA_Time is to perform carrier sensing of the channel, back off as needed when the channel is occupied, and retry after a delay until the maximum number of attempts is reached.

The service message types supported by the node include frequency list, heartbeat cycle, alarm switch, etc. It should be noted that the alarm switch only operates the alarm sound and will not affect the node reporting alarm information. The unit of heartbeat period is seconds, and the minimum configurable value is 20s (random value range of heartbeat period: configured through the gateway).



7.5. Node default frequency point

Group	Name	Frequency
JOIN GROUP 1 (not configurable)	JOIN_1_TX1_FREQ	470150000
	JOIN_1_RX1_FREQ	500150000
	JOIN_1_RX2_FREQ	502950000
JOIN GROUP 2 (not configurable)	JOIN_2_TX1_FREQ	485950000
	JOIN_2_RX1_FREQ	509750000
	JOIN_2_RX2_FREQ	506950000
DATA GROUP 1	DATA_1_TX1_FREQ	474750000
	DATA_1_RX1_FREQ	502550000
	DATA_1_RX2_FREQ	503950000
DATA GROUP 2	DATA_2_TX1_FREQ	488350000
	DATA_2_RX1_FREQ	507350000
	DATA_2_RX2_FREQ	507950000

The normal working frequency range of the node is: 470~510MHz. Users can adjust the overall frequency offset of nodes through the gateway (with the DTV SCAN function) to avoid channels with large environmental noise and effectively improve the stability of the entire network system.

7.5. Node firmware upgrade

IAP (In Application Programming) refers to online application programming . This module uses this method to perform serial port online upgrade of firmware. At the same time, this series of modules supports two ways to enter the online upgrade mode: host computer instructions and NETWORK level input.

- **Host computer instruction upgrade**

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A. Open the serial port debugging assistant "XCOM V2.6.exe"

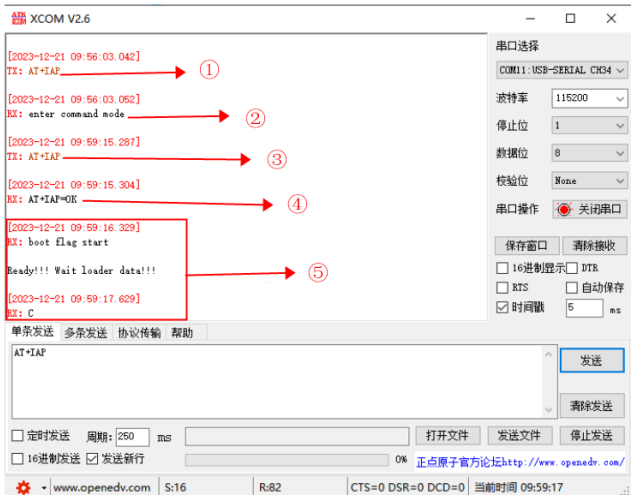
① Send "AT+IAP" to wake up the node first;

②Module feedback enters command mode;

③Send “AT+IAP” again;

④Module feedback “AT+IAP=OK”;

⑤The module enters upgrade mode and waits for firmware transmission.



B. Open the official website to configure the host computer "RF_Setting(E22-E9X(SL)) V3.1.exe";

①Select the serial port number and open the serial port;

②Select "Open File" and select the firmware path;

③Click "Start Download";

④Click "OK" to start the online firmware upgrade.



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8. AT command

Note: Each AT command ends with a carriage return and line feed (\r\n) .

8.1. Detailed explanation of gateway instructions

Serial number	Function	Instruction	Response	Describe
1	Gateway reset	AT+RESET	+RESET OK	Reset command. After the gateway is reset, the gateway software version information and other attribute information will be output.
2	Set RFA center frequency	AT+RFAFREQ=470150000	+RFAFREQ 470150000	Set the receiving frequency of RFA in debugging mode, parameter unit is Hz, range [470,510 MHz]
3	Query RFA center frequency	AT+RFAFREQ?	+RFAFREQ 470150000 OK	Query the RFA center frequency, the return value unit is Hz
4	Set RFB center frequency	AT+RFBFREQ=470150000	+RFBFREQ 470150000	Set the receiving frequency of RFB in debugging mode, parameter unit is Hz, range [470,510 MHz]
5	Query RFB center frequency	AT+RFBFREQ?	+RFBFREQ 470150000 OK	Query the RFB center frequency, the return value unit is Hz
6	Set RFC center frequency	AT+RFCFREQ=470150000	+RFCFREQ 470150000	C in debugging mode , parameter unit is Hz, range [470,510 MHz]
7	Query RFC center frequency	AT+RFCFREQ?	+RFCFREQ 470150000 OK	Query the RFC center frequency, the return value unit is Hz
8	Query software version	AT+VER?	+VER: App of smoke alarm gateway_v0.0.14_May 5 2022 09:11:39 OK	Get software version
9	Set up gateway EUI	AT+GWEUI=0016C001FF18CBF9	+GWEUI 00 16 C0 01 FF 18 CB F9	Set the gateway EUI. The gateway EUI is 16 bits and the

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			OK	data format is HEX. If it is set to all 0s, the gateway MCU chip serial number will be used as the gateway ID.
10	Query gateway EUI	AT+GWEUI?	+GWEUI 00 16 C0 01 FF 18 CB F9 OK	Get the gateway EUI, the gateway EUI is 16 bits, and the data format is HEX. If it is set to all 0s, the gateway MCU chip serial number is used as the gateway ID.
11	Configure gateway master-slave parameters	AT+MASTERSLAVE=0	+MASTERSLAVE 0 OK	Set the gateway master and slave, 0=slave gateway, 1=master gateway
12	Query gateway master-slave parameters	AT+MASTERSLAVE?	+MASTERSLAVE 0 OK	Query the gateway master and slave, 0=slave gateway, 1=master gateway
13	Configure gateway LORAMAC parameters	AT+LORAMAC=1	+LORAMAC 1 OK	Set the LORAMAC of the gateway, 0=LORAMAC is turned off, 1=LORAMAC is turned on
14	Query gateway LORAMAC parameters	AT+LORAMAC?	+LORAMAC 1 OK	Query the LORAMAC of the gateway, 0=LORAMAC is turned off, 1=LORAMAC is turned on
15	Configure gateway receive mode	AT+RXMODE=0	+RXMODE 0 OK	Set the receiving mode, 0=normal reception, 1=sensitivity test
16	Query gateway receiving mode	AT+RXMODE?	+RXMODE 0 OK	Query the reception mode, 0=normal reception, 1=sensitivity test
17	Query the TMST of the gateway	AT+TMST?	+TMST 439349342 OK	Query the TMST of the gateway, the gateway's internal 32-bit timestamp, unit us
18	Register from the gateway	AT+REGISTERGW=0016C001FF18CBF6	Normal return: +REGISTERGW 00 16 C0 01 FF 18 CB F6 OK Exception return: AT+REGISTERGW=0016C001FF18CBF6 +REGISTERGW ERROR EXIST	Register from the gateway Parameters: EUI from the gateway (Gateway EUI only)
19	Query registered slave gateways	AT+DELETEGW=0016C001FF18CBF	Normal return: +DELETEGW	Delete a gateway, parameter EUI of the gateway to be deleted

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		6	GWEui:00 16 C0 01 FF 18 CB F6 OK Exception return: +DELETEGW ERROR NOT EXIST	Returns an error if it does not exist
20	Register node	AT+REGISTERNODE=001122334455 6672, 1122334444332211, 0011223344556677 7766554433221100	Normal return: +REGISTERNODE DevEui:00 11 22 33 44 55 66 72 AppEui:11 22 33 44 44 33 22 11 AppKey:00 11 22 33 44 55 66 77 77 66 55 44 33 22 11 00 OK Exception return: +REGISTERNODE ERROR EXIST	Gateway registration node, parameter 1=DEVEUI, parameter 2=APPEUI, parameter 3=APPKEY DEVEUI data length is 16 bits, must be unique, data format is HEX APPEUI data length is 16 bits, data format is HEX APPKEY data length is 32 bits, data format is HEX
21	Query registered nodes	AT+GETNODE?	+GETNODE Network Have 1 EndNodes DevEui:36 35 37 36 64 30 98 0A AppEui:36 35 37 36 64 30 98 0A AppKey:00 11 22 33 44 55 66 77 77 66 55 44 33 22 11 00 DevAddr:00 00 00 00 OK	Query registered nodes Return the total number of value nodes DEVEUI, APPEUI, APPKEY, DEVADDR of each node DEVEUI, APPEUI, and APPKEY are registration parameters DEVADDR is the address assigned after the node joins the network. The address of the node that has not been connected to the network is all 0s.
22	Delete a registered node	AT+DELETENODE=36353736623092 0A	Normal return: +DELETENODE DevEui:36 35 37 36 62 30 92 0A OK Exception return: +DELETENODE ERROR NOT EXIST	Returns the DEVEUI of the node whose parameter has been deleted You can verify whether the deletion is successful through the GETNODE command. If no node is found, ERROR is returned.
23	Configure device heartbeat cycle	AT+NODEHEARTBEAT=300	Normal return: +NODEHEARTBEAT 300 OK Exception return: +NODEHEARTBEAT 5	Set node heartbeat period Unit: S Default value: 300 Range:[10,2592000]

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			ERROR	
24	Analysis of node heartbeat configuration instructions	AT+NODEHEARTBEAT=?	+NODEHEARTBEAT AT+NODEHEARTBEAT=21 AT+NODEHEARTBEAT=,Set the node heartbeat period 21,Node heartbeat period, unit (seconds), range [10,2592000] OK	Analysis of node heartbeat setting instructions Range [10,2592000], unit seconds
25	Query node heartbeat period	AT+NODEHEARTBEAT?	+NODEHEARTBEAT 300 OK	Parameter, unit S
26	Query alarm configuration parameters	AT+SLAVEGWHEARTBEAT=1000	Normal return: +SLAVEGWHEARTBEAT 10000 OK Exception return: +SLAVEGWHEARTBEAT 10 ERROR	Set the slave gateway heartbeat period Parameter unit: ms Default value: 10000 Range: [20,10000] The period at which the master gateway polls the slave gateway
27	Query the heartbeat period of the slave gateway	AT+SLAVEGWHEARTBEAT?	+SLAVEGWHEARTBEAT 10000 OK	Parameter unit ms
28	Format memory	AT+FRAMFORMAT	+FRAMFORMAT OK	Format FRAM and delete all parameters. After formatting, you need to restart the gateway.
29	Working mode command analysis	AT+WORKMODE=?	+WORKMODE AT+WORKMODE=0 AT+WORKMODE=,Set the gateway working mode 0,0=normal mode,1=test mode OK	Working mode parameter analysis, Set the gateway working mode, 0 is normal working mode 1 is test mode
30	Configure gateway working mode	AT+WORKMODE=0	+WORKMODE 0 OK	Set the gateway working mode, 0 is normal working mode 1 is test mode
31	Query the working mode of the gateway	AT+WORKMODE?	+WORKMODE 0 OK	Query the gateway working mode, 0 is normal working mode 1 is test mode

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32	Send data command analysis	AT+RFXSEND=?	+RFXSEND AT+RFXSEND=505300000,22,0,10,0011 2233445566778899 AT+RFXSEND=,Gateway RF sending instructions 505300000,Gateway RF transmit frequency (Hz) 22,Gateway RF transmit power (dBm) 0,Gateway RF transmit modulation mode (0=LORA, 1=CW) 10.Gateway RF transmit data length 00112233445566778899,Gateway RF sends data OK	Send parameter parsing Transmission frequency, unit Hz Transmit power, unit dBm Send mode Send data length, unit byte Send data content
33	RFA sent	AT+RFASEND=505300000,22,0,10,00 1122334455667788 99	+RFASEND OK	RFA sends data Parameter analysis is the same as above
34	RFC sent	AT+RFCSEND=505300000,22,0,10,00 1122334455667788 99	+RFCSEND OK	RFA sends data Parameter analysis is the same as above
35	DTV scan command analysis	AT+DTVSCAN=?	+DTVSCAN AT+DTVSCAN=0 AT+DTVSCAN=,Set DTV scan parameters 0,dtv mode(0=immediately,1=cycle) OK	DTV scan parameter analysis Scan mode[0,1] 0: Scan immediately 1: Periodic scan 18+rand(0,6), unit: hour
36	Configure DTV scanning parameters	AT+DTVSCAN=0	+DTVSCAN 0 OK	Set DTV scanning parameters Parameter 1: Scan mode [0,1], 0=Scan now, 1. Periodic scan, 18+rand(0,6), unit: hour
37	Query DTV scanning parameters	AT+DTVSCAN?	+DTVSCAN 0 OK	Query DTV scanning parameters Parameter 1: Scan mode [0,1], 0=immediate scan, 1, periodic scan Parameter 2: Scanning range (0,744), unit hour
38	Channel list configuration command analysis	AT+CHLIST=?	+CHLIST AT+CHLIST=1,150,164,22,162,169,79,1 98,184,56,186,189 AT+SETCHLIST=,Set ch num list 1,radio a join ul ch num,rang[0,99]	Channel list command analysis Parameter 1: rf a join uplink channel Parameter 2: rf a join downlink channel 1

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			150,radio a join dl 1 data ch num,rang[150,199] 164,radio a join dl 2 data ch num,rang[150,199] 22,radio aul data ch num,rang[0,99] 162,radio a dl 1 data ch num,rang[150,199] 169,radio a dl 2 data ch num,rang[150,199] 79,radio b join ul ch num,rang[0,99] 198,radio b join dl 1 data ch num,rang[150,199] 184,radio b join dl 2 data ch num,rang[150,199] 56,radio b ul data ch num,rang[0,99] 186,radio b dl 1 data ch num,rang[150,199] 189,radio b dl 2 data ch num,rang[150,199] OK	Parameter 3: rf a join downlink channel 2 Parameter 4: rf a data channel uplink Parameter 5: rf a data channel downlink1 Parameter 6: rf a data channel downlink2 Parameter 7: rf b join uplink channel Parameter 8: rf b join downlink channel 1 Parameter 9: rf b join downlink channel 2 Parameter 10: rf b data channel uplink Parameter 11: rf b data channel downlink1 Parameter 12: rf b data channel downlink2 uplink range[0,99] downlink range[150,199]
39	Channel list configuration command analysis	AT+CHLIST=?	+CHLIST AT+CHLIST=1,150,164,22,162,169,79,198,184,56,186,189 AT+SETCHLIST=,Set ch num list 1,radio a join ul ch num,rang[0,99] 150,radio a join dl 1 data ch num,rang[150,199] 164,radio a join dl 2 data ch num,rang[150,199] 22,radio aul data ch num,rang[0,99] 162,radio a dl 1 data ch num,rang[150,199] 169,radio a dl 2 data ch num,rang[150,199] 79,radio b join ul ch num,rang[0,99] 198,radio b join dl 1 data ch num,rang[150,199] 184,radio b join dl 2 data ch num,rang[150,199] 56,radio b ul data ch num,rang[0,99] 186,radio b dl 1 data ch num,rang[150,199]	Channel list command analysis Parameter 1: rf a join uplink channel Parameter 2: rf a join downlink channel 1 Parameter 3: rf a join downlink channel 2 Parameter 4: rf a data channel uplink Parameter 5: rf a data channel downlink1 Parameter 6: rf a data channel downlink2 Parameter 7: rf b join uplink channel Parameter 8: rf b join downlink channel 1 Parameter 9: rf b join downlink channel 2 Parameter 10: rf b data channel uplink Parameter 11: rf b data channel

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			189,radio b dl 2 data ch num,rang[150,199] OK	downlink1 Parameter 12: rf b data channel downlink2 uplink range[0,99] downlink range[150,199]
40	Configure channel list	AT+CHLIST=1,150,164,22,162,169,79,198,184,56,186,189	+CHLIST 1,151,165,24,163,170,80,199,185,92,187,190 OK	Set the network channel list, parameter analysis is the same as above
41	Query channel list	AT+CHLIST?	+CHLIST: 1,151,165,24,163,170,80,199,185,92,187,190 OK	+CHLIST: 1,151,165,24,163,170,80,199,185,92,187,190 OK
42	Set the baud rate of RS485 data interface	AT+BAUDRATE=921600	+BAUDRATE 921600 OK	Set the baud rate of the RS485 data interface Range[1200,3000000]
43	Query the baud rate of RS485 data interface	AT+BAUDRATE?	+BAUDRATE 921600 OK	Query the baud rate of the RS485 data interface
44	Query node frequency switching status	AT+NODENET?	Return 1: +GETNODENET: Frequency changing is not start. OK 返回 2: +GETNODENET: Frequency changing is finished. Fail Eui list: RF CHLIST: 1,151,165,27,163,170,80,199,185,92,187,190 OK 返回 3: +GETNODENET: Frequency changing is running. Running Eui list: 38 33 35 31 70 31 86 16 , 00 00 00 00 38 38 33 33 71 31 7d 05 , 00 00 00 01 38 33 35 31 5a 31 70 17 , 00 00 00 02 Freq-chg get eui time: 2134 RF_NEW CHLIST: 1,151,165,27,163,170,80,199,185,92,187,190	Query node frequency switching status Return 1: No frequency switching command has been run yet Return 2: The execution frequency switching of all nodes is completed Return 3: Partial node switching completed

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			RF CHLIST: 1,151,165,27,163,170,80,199,185,92,187, 190 OK	
45	Query the number of registered nodes	AT+GETNODENUM?	+GETNODENUM 1 OK	Query the number of registered nodes
46	Query N node attributes	AT+GETNODEN= 0,10	+GETNODEN total:1,current:0,num:1 DevEui:38 33 35 31 50 31 91 17 AppEui:38 33 35 31 50 31 91 17 AppKey:00 11 22 33 44 55 66 77 77 66 55 44 33 22 11 00 DevAddr:00 00 00 00 DevNonce:F7 E2 AppNonce:D2 E0 43 OK	Query N registered node information Parameter 1: Starting index, range [0,N-1] Parameter 2: Number of query nodes, range [0, N] returned messages: total summary points currentCurrent node index num is the number of nodes queried by this command. DevEui, AppEui, AppKey, DevAddr, DevNonce, AppNonce, node attribute information, data format hex

8.2. Detailed explanation of node instructions

Instruction	Response	Remark
AT+EUI=?	AT+EUI=FFFFFFFFFFFFFFFF OK	Read Device EUI
AT+EUI=1122334455667788	AT+EUI=1122334455667788 OK	Configure Device EUI (Take effect after restart)
AT+IAP	AT+IAP=OK	Enter firmware upgrade mode If the firmware is not upgraded within 60S, the module will automatically exit the firmware upgrade mode and run the firmware normally.
AT+EXIT	exit config succeed	Exit configuration (automatic restart) Can be used as a software reset
AT+DATA=112233445566	none	You still need to wake up the node device before use. After sending this

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		command, the node will convert the data after AT+DATA= into HEX format (**note that the ASCII code needs to be input in HEX format, two characters are one byte HEX code**), and then Immediately wirelessly sent to the gateway.

9. Related products

Product number	Interface Type	Working frequency Hz	Transmitting power W	Communication distancekm	Features
E90-DTU(230L22)	RS232 RS485	230M	0.16	5	LoRa spread spectrum, wireless configuration, network transmission, suitable for complex environments
E90-DTU(230SL30)	RS232 RS485	230M	1	10	LoRa spread spectrum, wireless configuration, network transmission, suitable for complex environments
E90-DTU(400SL22)	RS232 RS485	433\470M	0.16	5	LoRa spread spectrum, wireless configuration, network transmission, long-distance anti-interference
E90-DTU(400SL30)	RS232 RS485	433\470M	1	10	LoRa spread spectrum, wireless configuration, network transmission, long-distance anti-interference
E90-DTU(900SL22)	RS232 RS485	868\915M	0.16	5	LoRa spread spectrum, wireless configuration, network transmission, long-distance anti-interference
E90-DTU(900SL30)	RS232 RS485	868\915M	1	10	LoRa spread spectrum, wireless configuration, network transmission, long-distance anti-interference
E90-DTU(170L30)	RS232 RS485	170M	1	8	LoRa spread spectrum, super penetration and diffraction
E90-DTU(433L30)	RS232 RS485	433M	1	8	LoRa spread spectrum, long-distance anti-interference
E90-DTU(433L37)	RS232 RS485	433M	5	20	LoRa spread spectrum, 20km ultra-long distance, anti-interference
E90-DTU(433C30)	RS232 RS485	433M	1	3	High-speed continuous transmission, supporting ModBus protocol
E90-DTU(433C33)	RS232 RS485	433M	2	4	High-speed continuous transmission, supporting ModBus protocol

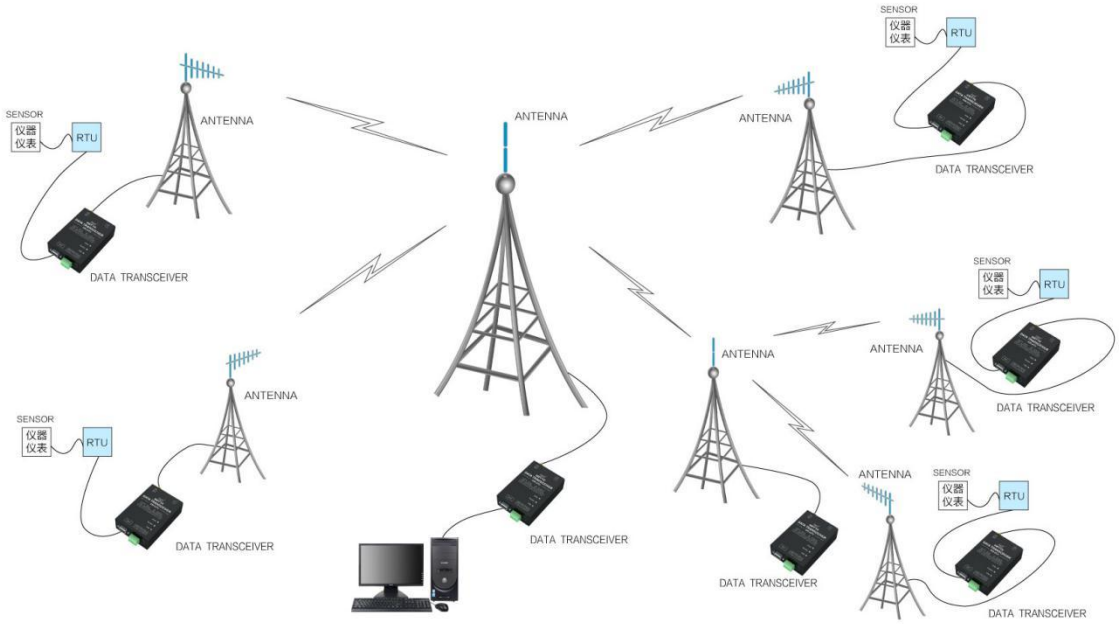
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E90-DTU(433C37)	RS232 RS485	433M	5	10	High-speed continuous transmission, supports ModBus protocol, long distance
E90-DTU(230N27)	RS232 RS485	230M	0.5	5	Low frequency narrowband, suitable for complex environments
E90-DTU(230N33)	RS232 RS485	230M	2	8	Low frequency narrowband, suitable for complex environments
E90-DTU(230N37)	RS232 RS485	230M	5	15	Low frequency narrow band, suitable for complex environments, super diffraction

10. Practical application areas

Ebyte digital radio is suitable for various point-to-point and point-to-multipoint wireless data transmission systems, such as smart homes, Internet of Things transformation, power load monitoring, distribution network automation, hydrology and water situation forecasting, water pipe network monitoring, and urban street lights. Monitoring, air defense alarm control, railway signal monitoring, railway water supply centralized control, oil and gas pipeline network monitoring, GPS positioning system, remote meter reading, electronic crane scale, automatic target reporting, earthquake forecasting, fire prevention and theft prevention, environmental monitoring and other industrial automation system, as shown below:



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11. Precautions for use

- Please keep the warranty card of this device properly. The warranty card contains the factory number (and important technical parameters) of the device, which is of great reference value for future maintenance and new equipment.
- During the warranty period, if the radio is damaged due to the quality of the product itself rather than man-made damage or natural disasters such as lightning strikes, it enjoys free warranty; please do not repair it yourself. If there is a problem, please contact our company immediately. Yibyte provides first-class service After-sales service.
- Do not operate this radio in some flammable places (such as coal mines) or near explosive and dangerous objects (such as detonators).
- A suitable DC regulated power supply should be selected, which requires strong resistance to high-frequency interference, small ripple, and sufficient load capacity; it is best to have over-current, over-voltage protection and lightning protection functions to ensure the normal operation of the data transmission station. Work.
- Do not use it in a working environment that exceeds the environmental characteristics of the digital radio, such as high temperature, humidity, low temperature, strong electromagnetic field or dusty environment.
- Do not let the digital radio station be in full-load transmitting state continuously, otherwise the transmitter may be burned out.
- The ground wire of the digital transmission radio should be well connected with the ground wire of external equipment (such as PC, PLC, etc.) and the ground wire of the power supply, otherwise it is easy to burn out the communication interface, etc.; do not plug or unplug the serial port while the power is on.
- When testing the digital radio station, a matching antenna or 50Ω dummy load must be connected, otherwise the transmitter will be easily damaged; if the antenna is connected, the distance between the human body and the antenna should be more than 2 meters to avoid injury. Do not Touch the antenna while transmitting.
- Wireless data transmission stations often have different communication distances in different environments. The communication distance is often affected by temperature, humidity, obstacle density, obstacle volume, and electromagnetic environment. In order to ensure stable communication, it is recommended to reserve more than 50% communication distance margin.
- If the measured communication distance is not ideal, it is recommended to improve the communication distance by analyzing the antenna quality and antenna installation method. You can also contact support@cdebyte.com for help .
- When selecting a power supply, in addition to retaining a 50% current margin as recommended, you should also pay attention to the fact that its ripple must not exceed 100mV.
- Wireless communication products need to be connected to impedance-matching antennas to work properly. Even short-term testing cannot be omitted. If the product is damaged due to this reason, it will not be covered by the warranty.

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Important statement

- Ebyte reserves the right of final interpretation and modification of all contents in this manual.
- Due to the continuous improvement of product hardware and software, this manual may be changed without prior notice. The latest version of the manual shall prevail.

Revise history

Version	Revision date	Revision Notes	Maintenance man
1.0	2023-12-27	Initial version	Bin
1.1	2024-04-08	Content revision	Bin
1.2	2024-10-21	Supplementary Baud rate description	Bin
1.3	2024-12-05	Modify the system build description	Bin
1.4	2025-03-17	Modify the system build description	Bin

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