E91-DTU (xxxSL30) Series Product Specifications

AT Command IP67 433/868/915 MHz LoRa Wireless DTU



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1 Product Overview

1.1 Brief Introduction

E91-DTU(xxxSL30) ① This series represents a new generation of LoRa waterproof wireless data transmission radios. Developed using SEMTECH's high-performance RF chips, these devices feature a maximum transmission power of 30 dBm and support multiple transmission modes. They operate across two frequency bands: 410.125 MHz to 493.125 MHz and 850.125 MHz to 930.125 MHz, and are compatible with our E22 series modules. It is equipped with a 5-pin M12 waterproof connector, a plastic waterproof housing, and a silicone O-ring seal. The interior is potted with resin for waterproofing, achieving an IP67 rating. It supports a wide input voltage range of 8 – 28 V (DC). LoRa spread-spectrum technology provides longer communication ranges and offers strong resistance to interference.

The E91-DTU(xxxSL30)① series adopts the latest generation of LoRa spread-spectrum technology, offering faster speeds, lower power consumption, and a smaller form factor. It supports features such as over-the-air wake-up, wireless configuration, carrier sense, automatic relaying, and communication key management, as well as configurable packet length settings. Custom development services are available.

**E91-DTU(xxxSL30)①: This designation encompasses both the E91-DTU(400SL30) and E91-DTU(900SL30) models. For detailed specifications, refer to Section 2.1, "E91-DTU(xxxSL30) Series Product Comparison."*

1.2 Features

- Features the latest generation of LoRa spread-spectrum modulation technology for longer communication ranges and stronger interference resistance;
- Supports multiple frequency bands including 433/868/915 MHz (customizable);
- Constructed with a waterproof housing made of PC flame-retardant material, internally potted for waterproofing, and sealed with a silicone gasket, achieving IP67 waterproofing;
- Simple and efficient power design supports both power adapters and direct wiring, with a power supply range of 8 – 28 V (DC);
- Maximum transmission power is 30 dBm, with multi-level adjustability, meeting industrial-grade technical specifications;
- Supports data transmission rates from 2.4K to 62.5Kbps;
- Supports Modbus protocol transmission;
- Operating temperature range: -40 ° C to +85 ° C, suitable for various harsh operating environments — a true industrial-grade product;
- Multiple protection features, including reverse polarity protection, overcurrent protection, and antenna surge protection, significantly enhance the radio's reliability;
- Communication ports and power interfaces feature isolation and high-level protection;
- Supports firmware upgrades via serial port for easier maintenance;
- Supports both HEX and AT command systems, allowing users flexible selection;
- Supports relay networking; multi-level relaying is suitable for ultra-long-distance communication, enabling multiple networks to operate simultaneously within the same area;
- Supports user-defined communication keys that cannot be read, greatly enhancing the confidentiality of user data;

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- Supports LBT (Listen Before Talk) functionality, which monitors channel noise before transmission, significantly improving communication success rates in harsh environments;
- Supports RSSI (Received Signal Strength Indication) for assessing signal quality;
- Supports wireless parameter configuration, allowing remote configuration or reading of wireless module parameters via wireless command packets;
- Supports wake-on-air (WOA), an ultra-low-power feature suitable for battery-powered applications;
- Supports point-to-point transmission, broadcast transmission, and channel monitoring;
- Supports deep sleep mode;
- Multi-level adjustable air transmission rates;
- Parameters are retained during power loss; the module resumes operation with the configured settings upon power-up;
- Built-in watchdog timer automatically resets and restores operation in case of unexpected events;

1.3 Application

- Smart irrigation and environmental monitoring for agriculture;
- Monitoring of photovoltaic power plants and management of distributed photovoltaic systems;
- Home security alarms and remote keyless entry;
- Smart home systems and industrial sensors;
- Wireless security alarm systems;
- Building automation solutions;
- Wireless industrial-grade remote controls;
- Healthcare products;
- Advanced Metering Infrastructure (AMI).

2 Specification and parameter

2.1 E91-DTU (xxxSL30) Series Product Comparison Chart

Type	Model	Frequency①Hz	Transmit power②dBm	Test distance③km	Waterproof rating	Size mm	Antenna Type④
433/470MHz	E91-DTU(400SL30)	410～493M	30	8	IP67	90*53*42	SMA-K, External thread, internal bore
868/915MHz	E91-DTU(900SL30)	850～930M	30	8	IP67	90*53*42	SMA-K, External thread, internal bore

Note:

(1) Frequency ①: The frequency band range supports user customization;

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(2) Transmit Power ②: 30 dBm = 1000 mW, with a tolerance of ±1 dBm. Power is adjustable in multiple levels; for details on power levels, please refer to Sections 5 and 6 of this document;

(3) Test distance③: Clear, open area; data rate 2.4 kbps; antenna mounted at a height of 2 meters (for reference only; actual testing is recommended);

(4) Antenna type④: External thread with internal bore, approximately 6 mm in length, equivalent impedance approximately 50 Ω;

2.2 Basic parameter

2.2.1 Basic parameter

Conditions: Tc = 25 °C, VCC = 12 V, 433 MHz/470 MHz/868 MHz/915 MHz

Parameter	Description
Modulation Method	Next-generation LoRa modulation technology
Connection Type	M12, 5-pin waterproof connector
Communication Interface	RS485
Transmission Length	240 bytes (maximum packet size); packets are automatically split if exceeded. This can be adjusted via a host computer or commands; see Section 5 of this document for detailed commands.
Buffer Capacity	1000Btye
Working Environment	
Operating temperature	-40℃～+85℃，industrial grade
Water resistance	IP67
Storage temperature	-40℃～+125℃
RF parameter	
Transmit Power	30 dBm = 1000 mW, multi-level power adjustment; see Sections 5 and 6 of this document for details
Operating Frequency Band	410MHz～493MHz，supports custom frequency bands
	850MHz～930MHz，supports custom frequency bands
Receiver Sensitivity	-132dBm，air rate 2.4kbps@SF11
Air Rate	2.4 to 62.5 kbps, multi-level adjustable air rate; see Sections 5 and 6 of this document for details
Electrical Specifications	
Supply Voltage	8～28V(DC)，12 V or 24 V recommended

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Parameter	Description
Transmit current	260–300 mA, instantaneous power consumption @ 30 dBm, powered by 12 V DC, compatible with E91-DTU (400SL30)
	360–430 mA, instantaneous power consumption @ 30 dBm, powered by 12 V DC, suitable for E91-DTU (900SL30)
Receive current	≈16 mA, powered by 12 V DC, suitable for E91-DTU (900SL30)
	≈15 mA, powered by 12 V DC, suitable for E91-DTU (400SL30)

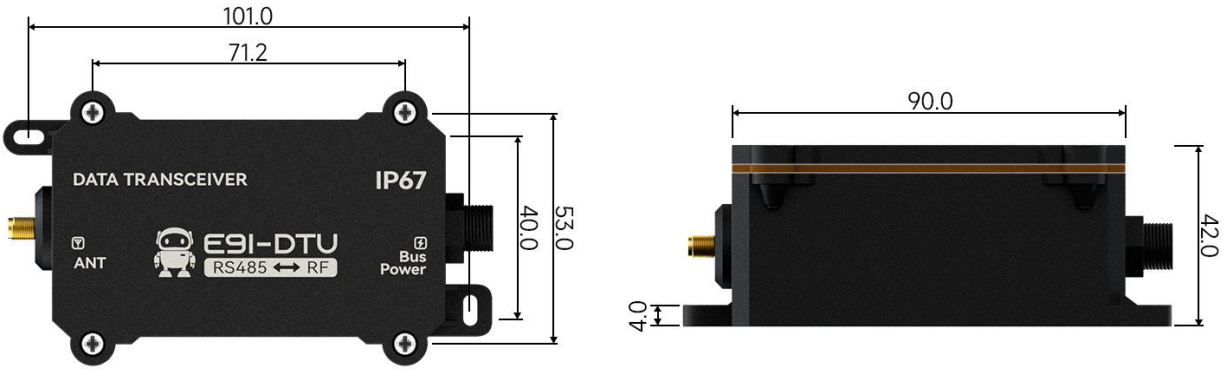
2.2.2 Detailed current specifications

Conditions: Tc = 25° C, 433.125 MHz / 868.125 MHz

Model	Transmit current **mA**			Receive current **mA**		
	8V	**12V**	**2V**	**8V**	**12V**	**28V**
E91-DTU(400SL30)	400～440	250～300	110～140	≈25	≈16	≈8
E91-DTU(900SL30)	550～660	360～430	150～190	≈23	≈15	≈7

3 Mechanical Dimensions and Pin Definitions

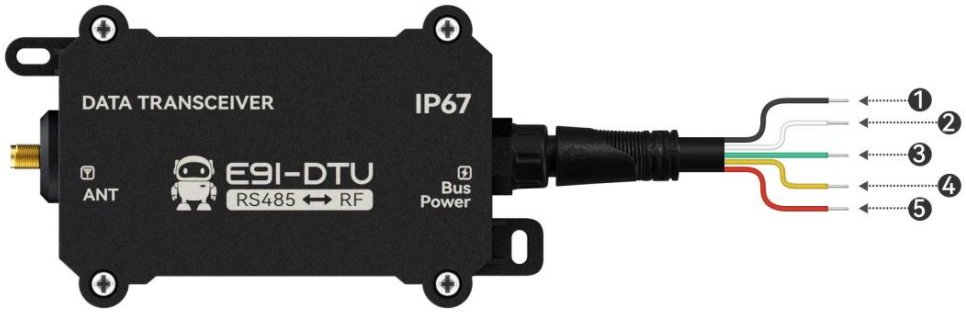
3.1 E91-DTU (xxxSL30) Mechanical Dimensions

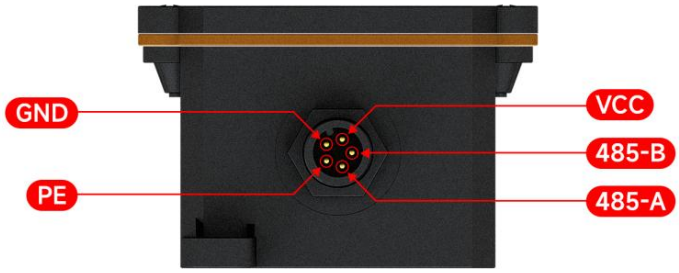


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3.2 Introduction to the Components





No.	Name	Function	Note
1	ANT	RF interface	SMA-K, male connector with an inner bore of approximately 6 mm, with an equivalent impedance of approximately 50 Ω.
2	M12 Waterproof 5-Pin Female Connector	Communication power cable	1. Black wire: Power ground
			2. White wire: RS485 Signal B
			3. Green wire: PE, connect to ground
			4. Yellow wire: RS485 Signal A
			5. Red wire: VCC power supply (DC 8–28 V)
3	M12 Waterproof 5-Pin Male Connector	Connect to the radio: power supply + RS485	VCC：Power supply positive（DC 8～28V）
			RS485-B：RS485 Signal B
			RS485-A：RS485 Signal A
			PE：Grounding: Connecting with the Earth
			GND：Power Negative

★ Note: If communication issues occur when connecting the radio to multiple devices but not when using a single device, try connecting a 120Ω resistor in parallel between the 485_A and 485_B terminals.

★ The E91-DTU(xxxSL30) can be powered by an 8 – 28 V (DC) power supply and uses a 5-pin M12 aviation connector for wiring.

4 Feature Overview

- The E91-DTU(xxxSL30) uses software-based mode switching; please refer to the AT+MODE command in Chapter 6;

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4.1 Operating Mode

The module has four operating modes, set via the AT command. Details are shown in the table below:

Mode（0-3）	Mode Switch Command	Overview of the Model	Notes
0 Transmission mode	AT+MODE=0	Serial port enabled, Wi-Fi enabled, transparent transmission	Can be configured remotely; see Section 5.1.3.2 for details
1 WOR mode	AT+MODE=1	These can be defined as WOR senders and WOR receivers	Supports wake-on-air
2 Configuration Mode	AT+MODE=2	Users can access the registers via the serial port to control the module's operating status.	-
3 Deep sleep	AT+MODE=3	Module enters sleep mode	-

4.1.1 Transmission mode enabled, mode 0 (AT+MODE=0)

4.1.1.1 Quick Start Guide for Transparent Transmission

What you send is what you get; simply use the Serial Port Assistant for communication (the default factory settings are identical for both devices, and the transmission mode is set to transparent). An example is shown below:

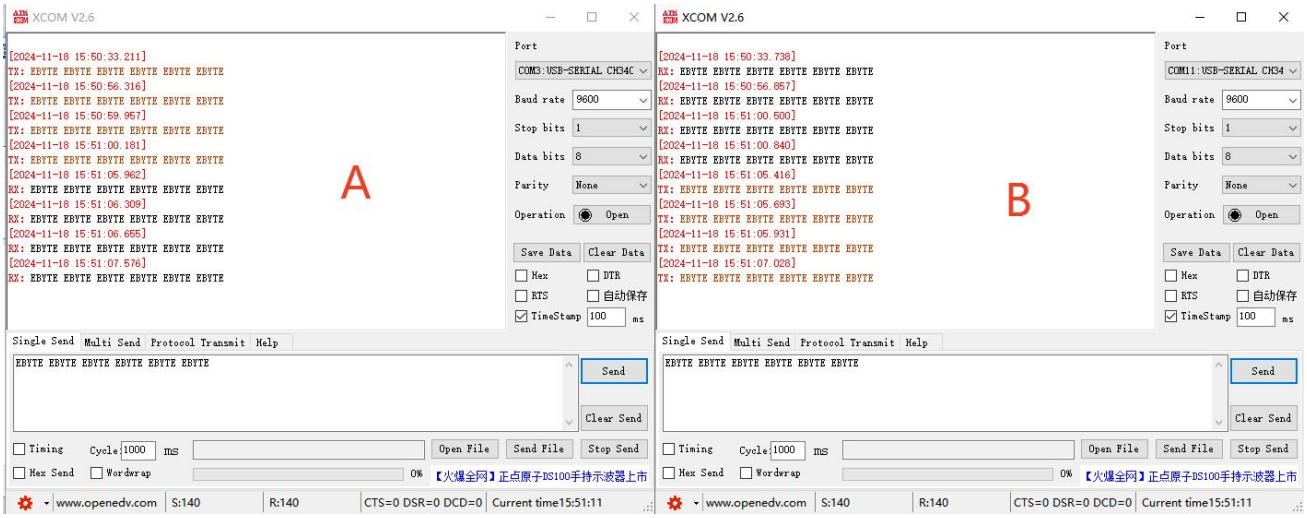


Figure 1: Diagram of bidirectional transmission and reception

4.1.1.2 Quick Start Guide for Point-to-Point Transmission (Specifying Destination Address and Channel)

Data is transmitted and received using a fixed format: destination address + destination channel + data, which effectively prevents certain types of interference.

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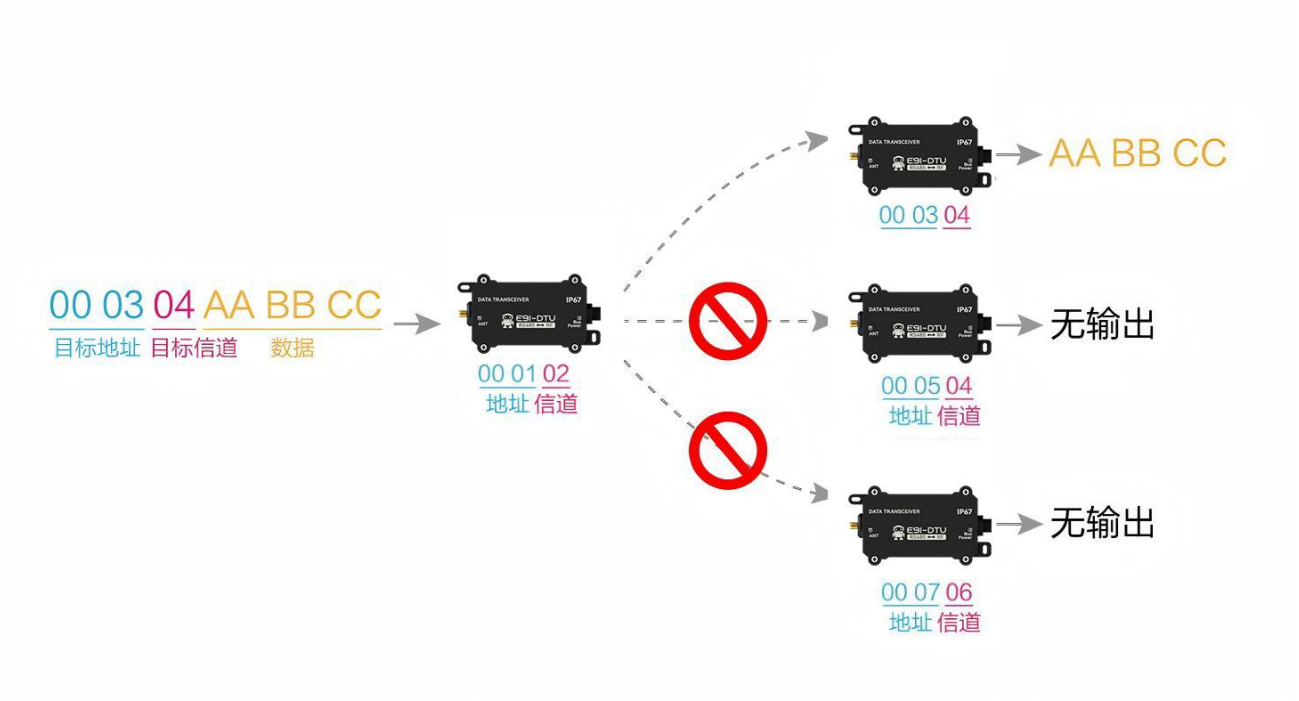


Figure 2: Schematic Diagram of Point-to-Point Transmission

Instructions:

Step 1: Modify the module parameters via the host computer: In configuration mode (AT+MODE=2), change the module address and channel, switch the transmission mode from transparent to fixed-point, and finally save the parameters to complete the modification.



Figure 3: Host Computer Interface

Step 2: Switch the module to normal mode (AT+MODE=0): Set Module A’s parameters to 000304AABBCC and send them to Module B. Similarly, when Module B sends data, the format is 000102AABBCC. (In fixed-point mode, the data transmission format is: destination address + destination channel + data)

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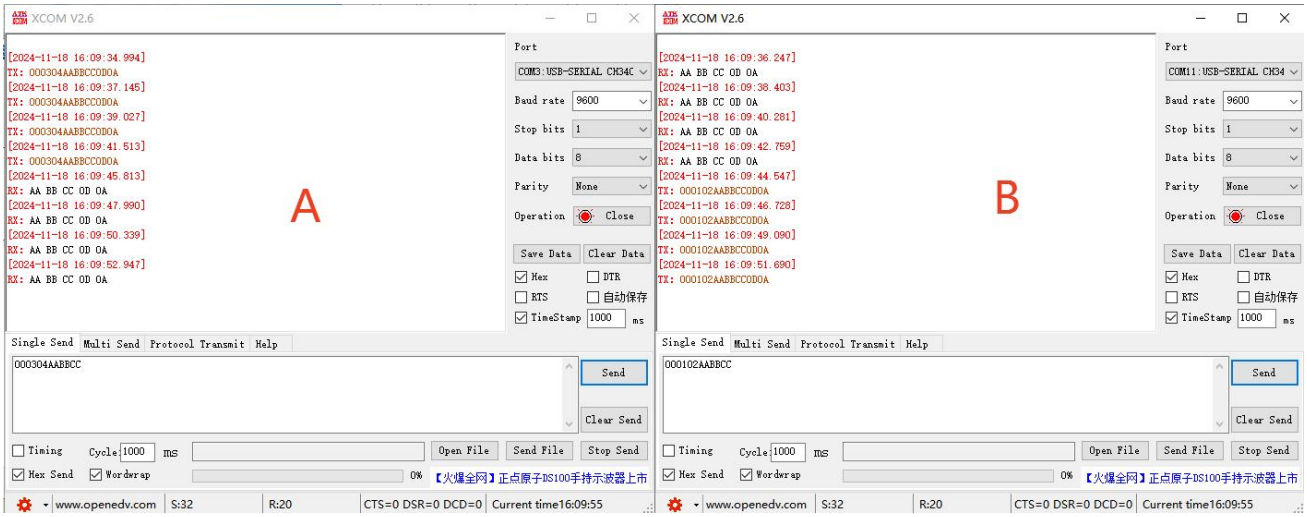


Figure 4: Data Transmission Diagram

4.1.1.3 Quick Start Guide for Broadcasting

- Set Module A's address to 0xFFFF and its channel to 0x04. When Module A is transmitting (in the same mode, transparent transmission, or fixed-point transmission), all receiving modules on channel 0x04 will receive the data, achieving the purpose of broadcasting.
- Set Module A’ s address to 0xFFFF and the channel to 0x04. When Module A is in receive mode, it can receive all data on channel 0x04, thereby achieving the purpose of monitoring.

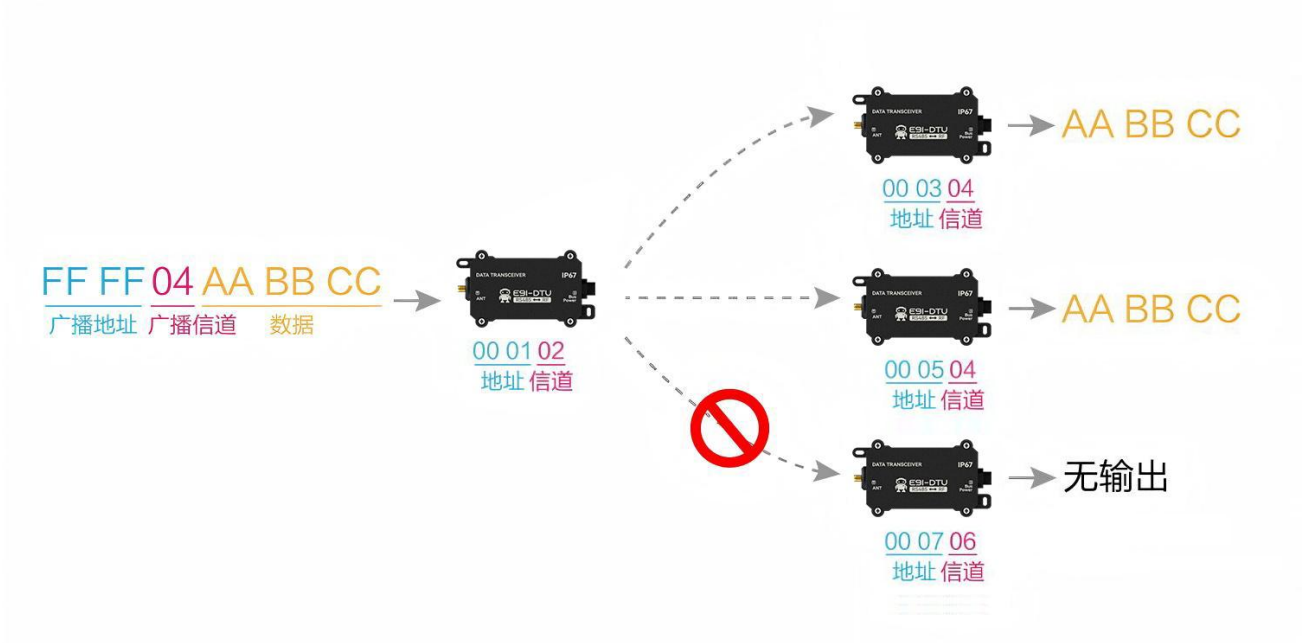


Figure 5: Schematic Diagram of Point-to-Point Broadcast Transmission

Instructions:

Step 1: Modify the module parameters via the host computer: In configuration mode (AT+MODE=2), modify the module address and channel, change the transmission mode from transparent to fixed-point, and finally save the parameters to complete the modification.

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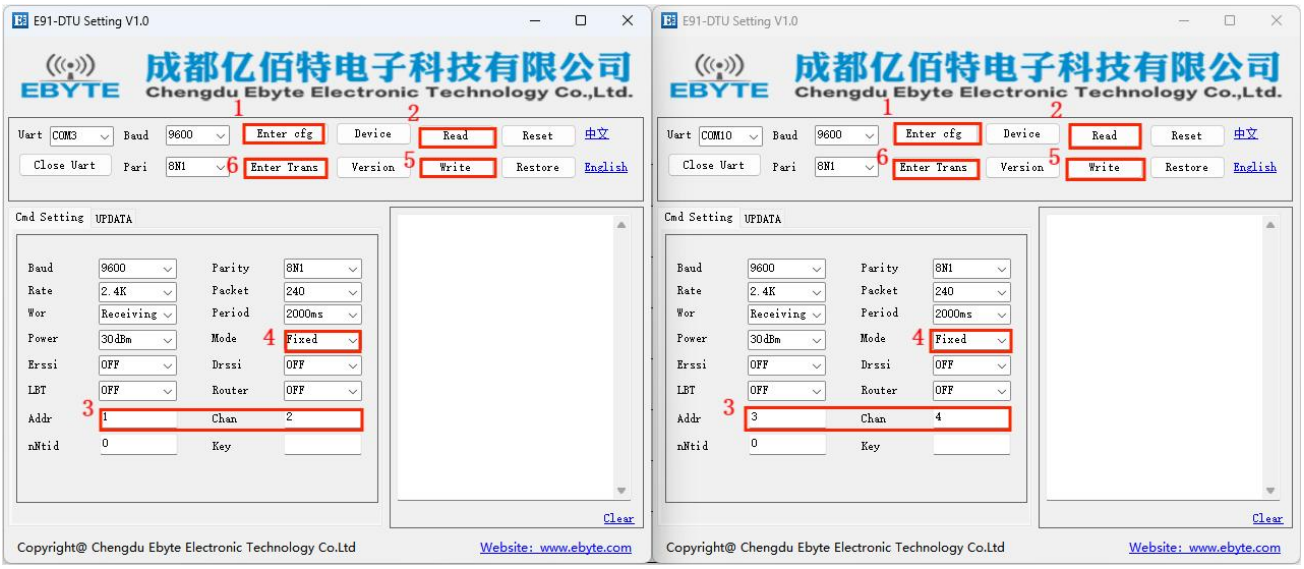


Figure 6: Host Computer Interface

Step 2: Switch the module to normal mode (AT+MODE=0): Set Module A’s parameters to FFFF04AABBCC and send them to Module B. Similarly, when Module B sends data, the format is FFFF02AABBCC. (In fixed-point broadcast mode, the data transmission format is: broadcast address + target channel + data.)

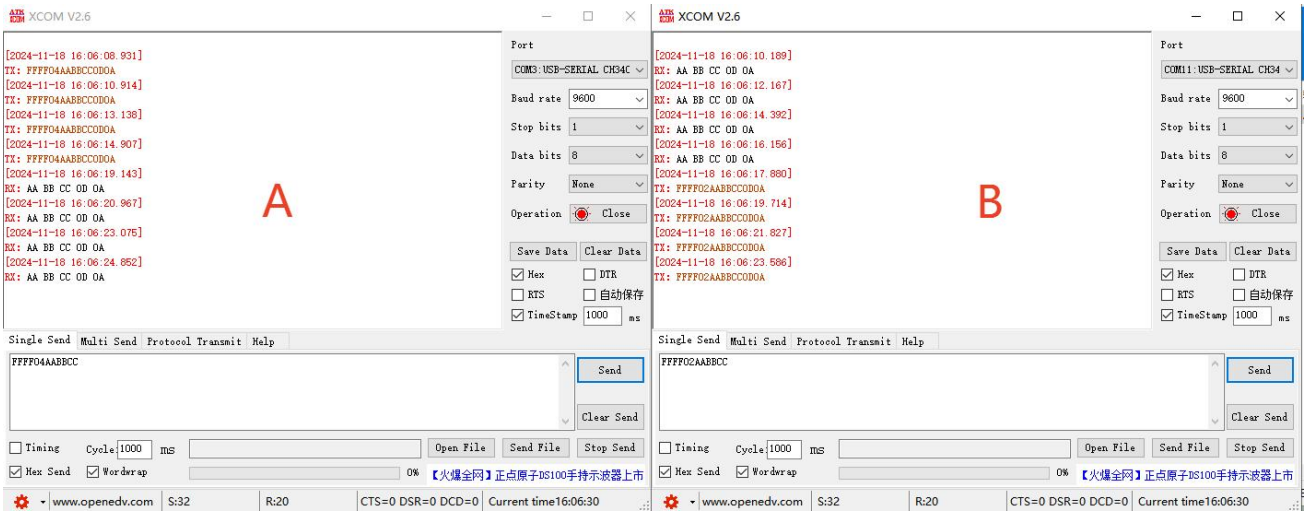


Figure 7: Data Transmission Diagram

4.1.2 Using WOR mode, Mode 1 (AT+MODE=1)

4.1.2.1 Quick Start Guide for Transparent Transmission

Instructions:

Step 1: Modify the module parameters using the host computer: In configuration mode (AT+MODE=2), modify the module’s WOR role, then save the parameters to complete the modification.

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Figure 8: Host Computer Interface

Step 2: Set the module to WOR mode (use the serial port assistant to send: AT+MODE=1). In WOR mode, the sending module transmits data to the receiving module, but the receiving module cannot send data back to the sending module.

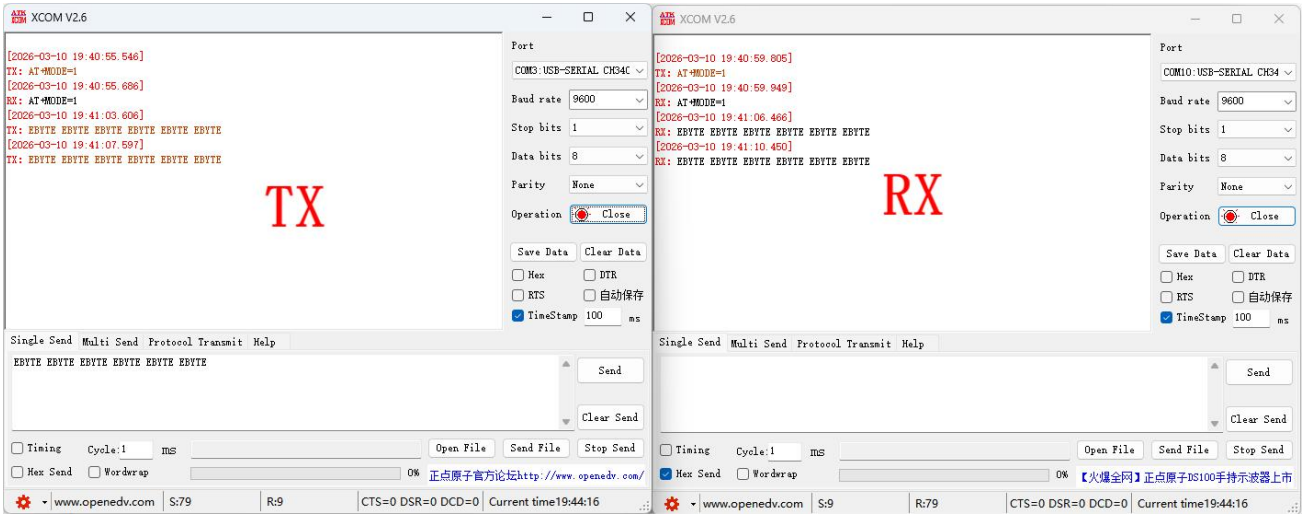


Figure 9: Data Transmission Diagram

4.1.3 Configuration mode: Mode 2 (AT+MODE=2)

4.1.3.1 Quick Start Guide for the Configuration Tool

The figure below shows the configuration interface on the host computer. Users can switch to configuration mode using AT commands or the host computer’ s buttons to quickly configure and read parameters on the host computer.

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Figure 10: Host Computer Interface

- In the host computer configuration, the module address, frequency channel, network ID, and key are all displayed in decimal format. For the valid ranges of each parameter, please refer to the specific parameters for different product models in the registers described in Section 6.3.
- When configuring the relay mode using the host computer, users must pay special attention: since all parameters are displayed in decimal format in the host computer, the module address and network ID must be entered after converting the number system. For example, if the network ID entered for Transmitter A is 02 and the network ID entered for Receiver B is 10, when setting the module address for Relay R, convert the hexadecimal value 0X020A to the decimal value 522 and enter 522 as the module address for Relay R; that is, the module address value to be entered for Relay R in this case is 522.

4.1.3.2 Quick Start Guide for Remote Configuration

Instructions:

Step 1: Remotely read and modify module parameters via the host computer: Modules A and B must have matching parameters to enable remote configuration. As shown in the figure on the right: Module A is in configuration mode, and Module B is in normal mode.



Figure 11: Host Computer Interface

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Step 2: Modify the parameters remotely and save the changes.

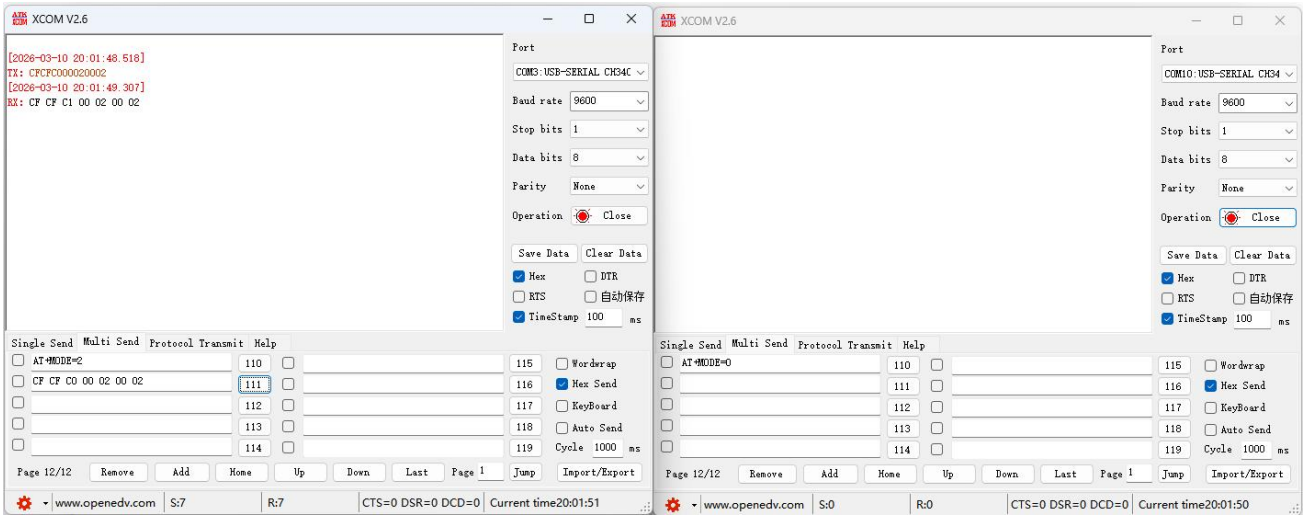


Figure 12: Host Computer Interface

Step 3: Switch Module B to configuration mode to view the modified parameters.



Figure 13: Host Computer Interface

4.1.4 Sleep mode enabled, Mode 3 (AT+MODE=3)

- To enter sleep mode, simply send the mode switch command AT+MODE=3. The module will then enter sleep mode and consume the least amount of power.

4.2 Relay Networking Rules

Relay networking uses relay nodes to forward data between source and destination nodes, thereby expanding network coverage and improving communication reliability.

No.	Relay Mode Description
1	After configuring the relay mode in the settings, switch to normal mode, and the relay will begin operating, enabling bidirectional data forwarding between the two NETIDs.

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No.	Relay Mode Description
2	In relay mode, ADDH and ADDL are no longer used as module addresses; instead, they correspond to NETID forwarding pairs. If a packet is received on one of these networks, it is forwarded to the other network;
3	In relay mode, the relay module cannot send or receive data and cannot operate in low-power mode.
4	The repeater's own network ID is invalid.
5	It is not recommended to use two or more repeaters with identical or swapped ADDH and ADDL addresses, as this may cause a loop between the repeaters.

As shown in the example below:

Level 1 Relay

- “Node 1” has a NETID of 08. “Node 2” has a NETID of 33.
- “Relay 1” has ADDH and ADDL values of 08 and 33, respectively.
- Therefore, signals sent by Node 1 (08) can be forwarded to Node 2 (33).
- Additionally, since Node 1 and Node 2 have the same address, data sent by Node 1 can be received by Node 2.

Second-Level Relay

- “Relay 2” has ADDH and ADDL set to 33 and 05, respectively.
- Therefore, Relay 2 can forward data from Relay 1 to the network with NETID 05.
- Consequently, Node 3 and Node 4 can receive data from Node 1. Node 4 outputs data normally, while Node 3 has a different address from Node 1, so it does not output data.

Two-Way Relay

- As shown in the figure: data sent by Node 1 can be received by Nodes 2 and 4, and data sent by Nodes 2 and 4 can also be received by Node 1.

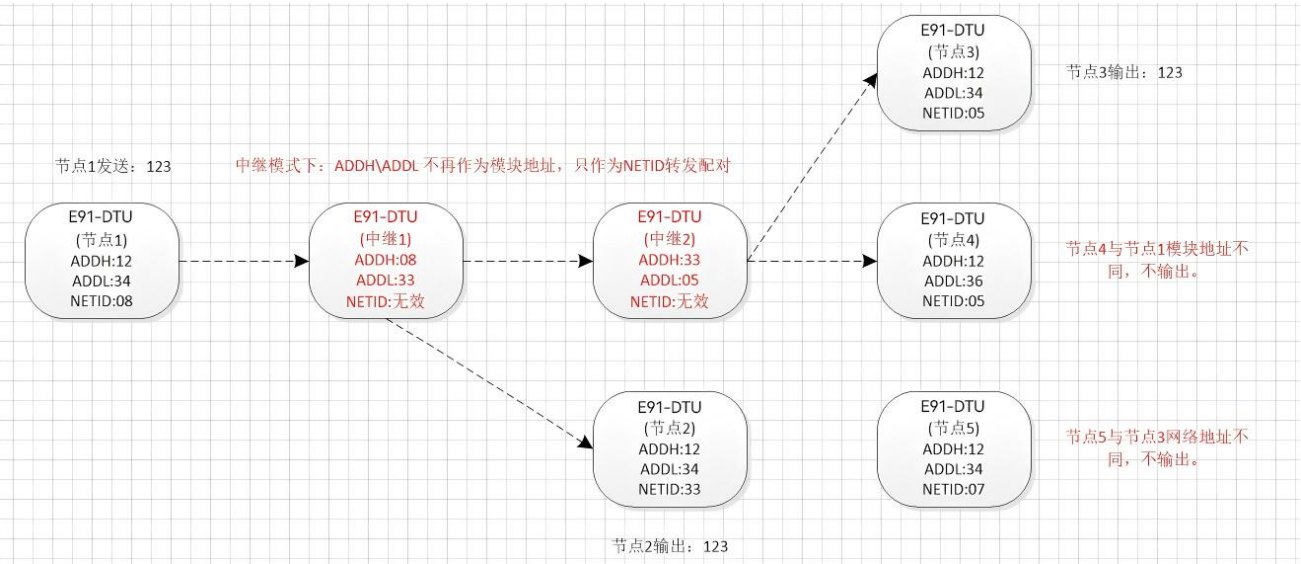


Figure 14: Relay Network Diagram

4.3 Serial Port Firmware Update

① If a customer needs to upgrade the firmware, they must obtain the appropriate upgrade package from their sales representative and then use the PC software provided by EBYTE to perform the upgrade. Generally, users do not need to upgrade the firmware; please do not use the “AT+IAP” command.

② Once upgrade mode is entered, the baud rate will automatically switch to 115200 and remain there until the mode exits automatically. Logs will be output during this process.

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4.3.1 Quick Start Guide for Host Computer Upgrade

Step 1: Use the host computer to put the module into configuration mode (Note: The baud rate is 9600 in configuration mode); open the configuration software and select the Firmware Upgrade tab.
Step 2: Click “Read Parameters” to view the module information in the left pane of the host computer.
Step 3: Open File (select the firmware.bin file) > Click “Start Download.”
Step 4: Click “Start Download” to begin the firmware upgrade. Once complete, a message will appear indicating the download was successful.
Step 5: After the firmware upgrade is complete, reopen the serial port and verify the parameters.



Figure 15: Host Computer Interface

5 Register Read/Write Control

5.1 HEX Command Format

In configuration mode (Mode 2: AT+MODE=2), the list of supported commands is as follows **(when configuring, the serial port only supports 9600 baud, 8N1 format):**

No.	Command Format	Detailed Description
1	Set the register	Command: C0 + Start Address + Length + Parameter Response: C1 + Start Address + Length + Parameter Example 1: Configure channel 0x09 Command Start Address Length Parameter

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No.	Command Format	Detailed Description
		Transmit: C0 05 01 09 Receive: C1 05 01 09 Example 2: Simultaneously configure module address (0x1234), network address (0x00), serial port (9600 8N1), and air rate (1.2K) Transmit: C0 00 04 12 34 00 61 Receive: C1 00 04 12 34 00 61
2	Read register	Command: C1 + Start Address + Length Response: C1 + Start Address + Length + Parameter Example 1: Read Channel Command Start Address Length Parameter Transmit: C1 05 01 Receive: C1 05 01 09 Example 2: Simultaneously reading module address, network address, serial port, and airspeed Transmit: C1 00 04 Receive: C1 00 04 12 34 00 61
3	Set up a temporary register	Command: C2 + Start Address + Length + Parameter Response: C1 + Start Address + Length + Parameter Example 1: Configure channel 0x09 Command Start Address Length Parameter Transmit: C2 05 01 09 Receive: C1 05 01 09 Example 2: Simultaneously configure module address (0x1234), network address (0x00), serial port (9600 8N1), and air rate (1.2K) Transmit: C2 00 04 12 34 00 61 Receive: C1 00 04 12 34 00 61
4	Wireless Configuration	Command: CF CF + standard command Response: CF CF + standard response Example 1: Wireless configuration channel 0x09 Wireless command header Command Start address Length Parameter Transmit: CF CF C0 05 01 09 Receive: CF CF C1 05 01 09 Example 2: Simultaneously configure the module address (0x1234), network address (0x00), serial port (9600 8N1), and air rate (1.2K) Transmit: CF CF C0 00 04 12 34 00 61 Receive: CF CF C1 00 04 12 34 00 61
5	Invalid format	Invalid format response FF FF FF

5.2 Register Function Overview

Address	Name	Bit							
		bit 7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
00h	ADDH	Communication Address [15:8]							
01h	ADDL	Communication Address [7:0]							
02h	NETID	Web address [7:0]							
03h	REG0	Serial baud rate [2:0]			Serial Port Check		Wireless transmission rate		

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				Character Type [1:0]		[2:0]	
04h	REG1	Serial packet length [1:0]	Environment RSSI	Reserve	Reserve	Soft-cut mode	Wireless transmission power [1:0]
05h	REG2	Channel Control [7:0]					
06h	REG3	Data RSSI	Transmission method	Relay Enable	Listen first, then post	Wake-up in the Air	Air Wake Cycle [2:0]
07h	CRYPT_H	Wireless data encryption key [15:8]					
08h	CRYPT_L	Wireless data encryption key [7:0]					
09h	WD_H	The window time during which the recipient can respond (send) after receiving data following an air-based wake-up [15:8]					
0Ah	WD_L	The window time during which the recipient can respond (send) after receiving data following an air-based wake-up [7:0]					

5.3 Detailed Description of Registers

No.	Read /write	Name	Description	Notes
00 H	Read/ Write	ADDH	ADDH（Default 0）	1. The high and low bytes of the module address; 2. When the module address is FFFF, it can be used as a broadcast and listen address; that is, the module will not perform address filtering in this case.
01 H	Read/ Write	ADDL	ADDL（Default 0）	
02 H	Read/ Write	NETID	NETID（Default 0）	1. Network address, used to distinguish networks; 2. When communicating with each other, they should be set to the same value.
03 H	Read/ Write	REG0	7 6 5 UART baud rate (bps) 0 0 0 The serial port baud rate is 1200 0 0 1 The serial port baud rate is 2400 0 1 0 The serial port baud rate is 4800 0 1 1 The serial port baud rate is 9600（Default） 1 0 0 The serial port baud rate is 19200（Not supported） 1 0 1 The serial port baud rate is 38400（Not supported） 1 1 0 The serial port baud rate is 57600（Not supported） 1 1 1 The serial port baud rate is 115200（Not supported） 4 3 Serial port parity bit 0 0 8N1（Default）	1. The two modules communicating with each other may have different baud rates and different parity settings; 2. When transmitting large data packets continuously, users should be aware that identical baud rates may cause data congestion or even data loss; 3. It is generally recommended that both communicating parties use the same baud rate. 4. The maximum supported baud rate is 9600 bps. The serial port modes of the two communicating parties may differ;

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			0	1	8O1		
			1	0	8E1		
			1	1	8N1（Equivalent to 00）		
			2	1	0	Wireless air rate（bps）	Note: Both communicating parties must use the same air rate; the higher the air rate, the lower the latency and the shorter the transmission distance.
			0	0	0	Air rate 2.4k	
			0	0	1	Air rate 2.4k	
			0	1	0	Air rate 2.4k（Default）	
			0	1	1	Air rate 4.8k	
			1	0	0	Air rate 9.6k	
			1	0	1	Air rate 19.2k	
			1	1	0	Air rate 38.4k	
			1	1	1	Air rate 62.5k	
04 H	Read/ Write	REG1	7	6	Subcontracting Settings		Note: 1. If the data sent by the user is shorter than the packet length, the receiving end's serial port will output the data as a continuous stream; 2. If the data sent by the user is longer than the packet length, the receiving end's serial port will output the data in separate packets.
			0	0	240 bytes(Default）		
			0	1	128 bytes		
			1	0	64 bytes		
			1	1	32 bytes		
			5	RSSI Enable ambient noise			1. Once enabled, the C0 C1 C2 C3 command can be sent in transmission mode or WOR send mode to read registers; 2. Register 0x00: Current ambient noise RSSI; 3. Register 0x01: RSSI at the time of the last data reception (current ambient noise is: dBm = -(256 - RSSI)); 4. Command format: C0 C1 C2 C3 + start address + read length; ●Return: C1 + address + read length + valid read value; ■ Example: Send C0 C1 C2 C3 00 01 ■ Return: C1 00 01 RSSI (address must start from 00)
			0	Disable（Default）			
			1	Enable			
			4	3	Reserve		
			2	Software Mode Switch			**Enabled by default; disabling it has no effect.** 1. Use specific serial HEX commands or AT commands to switch modes. 2. Format for switching modes using HEX commands: C0 C1 C2 C3 02 + operating mode: ●Send C0 C1 C2 C3 02 00 to switch to pass-through mode; ●Send C0 C1 C2 C3 02 01 to switch to WOR mode; ●Send C0 C1 C2 C3 02 02 to switch to configuration mode; ●Send C0 C1 C2 C3 02 03 to switch to sleep
			0	Disable（Default）			
			1	Enable			

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					mode; ●Return: C1 C2 C3 02 + operating mode; Note: After enabling this feature, configuration mode only supports a baud rate of 9600.
			1	0	Transmit power
			0	0	30dBm（Default）
			0	1	27dBm
			1	0	24dBm
			1	1	21dBm
					1. There is a nonlinear relationship between power and current; power supply efficiency is highest at maximum power; 2. Current does not decrease proportionally as power decreases.
05 H	Read/ Write	REG2	Channel Control（CH） 0–83 represents a total of 84 channels (for the 400 MHz band) 0–80 represents a total of 81 channels (for the 900 MHz band)		1. Actual frequency in the 400 MHz band = 410.125 + CH * 1 M 2. Actual frequency in the 900 MHz band = 850.125 + CH * 1 M
			7	Enable RSSI bytes (packet RSSI)	1. Once enabled, when the module receives wireless data and outputs it via the serial port (TXD), an RSSI strength byte will follow. 2. The RSSI value for the current data packet is: dBm = -(256 - RSSI)
			0	Disable（Default）	
			1	Enable	
			6	Transmission method	During point-to-point transmission, the module identifies the first three bytes of the serial data as: high-order address + low-order address + channel, and uses this as the wireless transmission destination.
			0	Transparent transmission(Default）	
			1	Point-to-point transmission	
			5	Relay function	1. Once the relay function is enabled, if the destination address is not the module itself, the module will initiate a single forwarding operation; 2. To prevent data from being sent back, it is recommended to use this in conjunction with fixed-point mode; that is, the destination address should be different from the source address.
			0	Disable the relay function（Default）	
			1	Enable relay functionality	
06 H	Read/ Write	REG3	4	LBT Enabled	1. Once enabled, the system will listen for existing traffic before transmitting wireless data, which can help avoid interference to some extent, but may cause data delays; 2. The maximum LBT timeout is 2 seconds; once this limit is reached, transmission will be forced.
			0	Disable（Default）	
			1	Enable	
			3	WOR Mode Transmit/Receive Control	**Applies only to Mode 1;** 1. In WOR receive mode, the module can modify the delay time after wake-up; the default value is 0; 2. The receiving end must send the command C0 09 02 03 E8 in configuration mode (where C0 is the write command, 09 is the starting register address, 02 is the length, and 03 E8 is the delay value; the maximum value of FFFF corresponds to 65,535 ms; setting it to 0 disables the wake-up delay); 3. Data can be transmitted during the delay period.
			0	WOR Receiver (Default) Operates in WOR listening mode; the listening interval is described below (WOR Interval), which can significantly reduce power consumption.	
			1	WOR Transmitter The module's transceiver is enabled, and a wake-up code of a certain duration is included when transmitting data.	

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			2	1	0	WOR Cycle	**Applies only to Mode 1;** 1. Cycle T = (1 + WOR) × 500 ms, with a maximum of 4000 ms and a minimum of 500 ms; 2. The longer the WOR polling interval, the lower the average power consumption, but the greater the data latency; 3. The sender and receiver must be synchronized (very important)
			0	0	0	500ms	
			0	0	1	1000ms	
			0	1	0	1500ms	
			0	1	1	2000ms（Default）	
			1	0	0	2500ms	
			1	0	1	3000ms	
			1	1	0	3500ms	
			1	1	1	4000ms	
07 H	Write	CRYPT_H	Upper bytes of the key（Default 0）				1. Write-only; a read operation returns 0; 2. Used for encryption to prevent wireless data from being intercepted by other modules of the same type; 3. The module will use these two bytes as calculation factors to perform transformational encryption on the wireless signal.
08 H	Write	CRYPT_L	Low byte of the key（Default 0）				
80 H ～ 86 H	Write	PID	Product information (7 bytes)				Product information: 7 bytes Note: For greater convenience, please refer to the AT+DEVTYPE=? query command in Section 6.1.

5.4 Factory default values for register parameters

Model	Factory default parameter values for the 400 MHz module: C0 00 09 00 00 00 62 00 17 03 00 00 Factory default parameter values for the 900 MHz module: C0 00 09 00 00 00 62 00 12 03 00 00						
Model	Frequency	Address	channel	Air rate	Baud rate	Serial Port Format	Transmit power
E91-DTU(400SL30)	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	30dbm
E91-DTU(900SL30)	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	30dbm

6 AT Command

- Configuration or querying using AT commands must be performed in configuration mode (the serial port in configuration mode is fixed at 9600 baud, 8 bits, no parity, 1 stop bit);
- For software versions 7453-0-20 and earlier, users do not need to enter a carriage return or line feed at the end of AT commands;
- For software version 7453-0-21 and later, the system automatically recognizes the carriage return/line feed at the end of AT commands; commands are recognized even without it;
- If an AT command is not recognized or execution fails, the response will be “=ERR”;
- If the input parameter exceeds the valid range, it will be restricted. Please ensure parameters remain within the valid range to avoid unexpected issues.

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6.1 General Instructions

6.1.1 AT+RESET Soft reboot

Command Format	AT+RESET
Example of execution	Send: AT+RESET Response: =OK
Feature Description	● Software versions (7453-0-20) and earlier do not respond with “OK.” ● The “OK” response was added starting with software version (7453-0-21) and later. ● The actual reset process begins only after the “OK” response is received. Please wait approximately 30 ms before proceeding to the next step.

6.1.2 AT+DEFAULT Restore factory settings

Command Format	AT+DEFAULT
Example of execution	Send: AT+DEFAULT Response: =OK
Feature Description	● After the response (=OK), in addition to restoring the parameters, a restart process will be executed. Please wait approximately 30 ms before proceeding to the next step.

6.1.3 AT+DEVTYPE Search by product model

Command Format	AT+DEVTYPE=?
Example of execution	Send: AT+DEVTYPE=? Response: DEVTYPE=E91-DTU(400SL30)
Feature Description	● Product Series: E91 ● Operating Band: 400 (170/230/400/900) ● Maximum Power: 30 (22/30/33)

6.1.4 AT+FWCODE Check Software Version

Command Format	AT+FWCODE=?
Example of execution	Send: AT+FWCODE=? Response: FWCODE=7453-0-23
Feature Description	● Major version: 7453 ● Branch number: 0 ● Minor version: 23 (incrementing from 10)

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6.1.5 AT+SWITCH Enable software mode switching

Command Format	AT+SWITCH=<on_off>
Configuration Example	Send: AT+SWITCH=0 Response: =OK
Query Example	Send: AT+SWITCH=? Response: AT+SWITCH=0
Parameter Description	**<on_off>: Toggle** **0 Off (default)** **1 On**
Feature Description	● It is enabled by default upon factory shipment, and disabling it is ineffective.

6.1.6 AT+MODE Software switches operating modes

Command Format	AT+MODE=<mode>
Configuration Example	Send: AT+MODE=0 Response: =OK
Query Example	Send: AT+MODE=? Response: AT+MODE=0
Parameter Description	**<mode>:** Operating mode number 0 Transmission mode 1 Wake-on-Radio (WOR) mode 2 Configuration mode 3 Sleep mode
Feature Description	● This feature must be enabled via AT+SWITCH before it can be used. ● It can be used in any operating mode. ● The actual mode switch will not begin until a response (OK) is received; please wait approximately 15 ms before proceeding to the next step. ● Please read the AT+SWITCH feature description. ● For details on switching times, please refer to Chapter 5.

6.1.7 AT+ADDR Communication Address (Match Filter)

Command Format	AT+ADDR=<address>
Configuration Example	Send: AT+ADDR=0 Response: =OK
Query Example	Send: AT+ADDR=? Response: AT+ADDR=0
Parameter Description	**<address>:** Communication address 0–65535
Feature Description	● Default address 0 ● An address is not a radio frequency characteristic; it is merely an identifier carried within a data packet to help the receiving software determine whether to apply filtering. ● Broadcast address 65535. When acting as a receiver, it can receive data sent from any address on the same channel (without filtering). When acting as a sender, the transmitted data packet carries the broadcast address, so the recipient will not filter it (broadcast data).

6.1.8 AT+NETID Communication Network Code (Match Filtering)

Command Format	AT+NETID=<net>
Configuration Example	Send: AT+NETID=0 Response: =OK
Query Example	Send: AT+NETID=? Response: AT+NETID=0
Parameter Description	**<net> ：** Communication network code 0–255

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Feature Description	● Default Network 0 ● The network code is not a radio frequency characteristic; it is merely an identifier carried within data packets that helps the receiving software determine whether to relay, forward, or filter the data. ● The filtering priority of the network code is lower than that of broadcast addresses. Even if the network codes differ, broadcast data can still be received.

6.1.9 AT+CHANNEL Communication channel (carrier frequency)

Command Format	**AT+CHANNEL=<ch>**	
Configuration Example	Send: AT+CHANNEL=0 Response: =OK	
Query Example	Send: AT+CHANNEL=? Response: AT+CHANNEL=0	
Parameter Description	**<ch>** ： Communication Channels 0–83 E91-DTU (400SL30)	**<ch>** ： Communication Channels 0–80 E91-DTU (900SL30)
Feature Description	● The channel ranges vary by frequency band; please be sure to distinguish between them. ● For the 400 MHz band, the actual carrier frequency corresponds to: 410.125 MHz + ch * 1 MHz ● For the 900 MHz band, the actual carrier frequency corresponds to: 850.125 MHz + ch * 1 MHz	

6.1.10 AT+KEY Communication Encryption (Data Encryption)

Command Format	**AT+KEY=<key>**
Configuration Example	Send: AT+KEY=0 Response: =OK
Parameter Description	**<key>** ： Encryption/decryption password: 0–65535
Feature Description	● Default 0 ● Cannot query (unable to read password) ● Modules with mismatched passwords cannot communicate (unable to decode the correct data packet; fails validation and is discarded)

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6.1.11 AT+UART Serial Port Baud Rate and Parity

Command Format	AT+UART=<baud>,<parity>
Configuration Example	Send: AT+UART=3,0 Response: =OK
Query Example	Send: AT+UART=? Response: AT+UART=3,0
Parameter Description	**<baud>**: Serial port baud rate 0 1200 bps 1 2400 bps 2 4800 bps 3 9600 bps (default) 4 19200 bps (Not supported) 5 38400 bps (Not supported) 6 57600 bps (Not supported) 7 115200 bps (Not supported) **<parity>**: Serial port parity type 0 None (Default) 1 Odd 2 Even
Feature Description	● In configuration mode (AT+MODE=2, Mode 2), the baud rate is fixed at 9600 with 8N1. ● This setting takes effect after switching operating modes.

6.1.12 AT+PACKET Serial port packet length

Command Format	AT+PACKET=<len>
Configuration Example	Send: AT+PACKET=0 Response: =OK
Query Example	Send: AT+PACKET=? Response: AT+PACKET=0
Parameter Description	**<len>**: Serial data packet length 0 240 bytes (default) 1 128 bytes 2 64 bytes 3 32 bytes
Feature Description	● During serial reception, if the data received from the user is shorter than the specified length, it is treated as a timeout and the frame is split; the data is then repackaged for wireless transmission. ● During serial reception, when the data received from the user reaches the specified length, it is immediately repackaged for wireless transmission. ● Any portion of the data received from the user that exceeds the specified length continues to accumulate in the serial buffer. Once wireless transmission is complete, the data is split according to the specified length and transmitted in single packets on a cyclical basis.

6.1.13 AT+URXT Conditions for a lost frame on the serial port

Command Format	AT+URXT=<byte>
Configuration Example	Send: AT+URXT=3 Response: =OK
Query Example	Send: AT+URXT=? Response: AT+URXT=3
Parameter Description	**<byte>** ： Byte Time 1–255
Feature Description	● By default, serial port timeout and frame truncation are handled based on a 3-byte time window. ● The time varies depending on the baud rate (byte time). At 9600 baud, it is approximately 1 millisecond per byte; at 115200 baud, it is approximately 100 microseconds per byte. ● For some customers, data input from an external microcontroller to the module via the serial port

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	is intermittent (e.g., due to RTOS task interrupts). When this exceeds the module's configured byte time window, it triggers frame truncation, resulting in fragmented data packets at the receiving end.

6.1.14 AT+RATE Wireless transmission rate

Command Format	AT+RATE=<rate>
Configuration Example	Send: AT+RATE=2 Response: =OK
Query Example	Send: AT+RATE=? Response: AT+RATE=2
Parameter Description	**<rate>** : air rate E91-DTU(400SL30) E91-DTU(900SL30) 0 2.4Kbps 1 2.4Kbps 2 2.4Kbps (default) 3 4.8Kbps 4 9.6Kbps 5 19.2Kbps 6 38.4Kbps 7 62.5Kbps
Feature Description	● The air rate ranges vary by frequency band; please be sure to distinguish between them. ● The higher the airspeed, the lower the communication latency (shorter transmission time), but the lower the reception sensitivity (shorter communication range).

6.1.15 AT+TRANS Wireless transmission mode (transparent/fixed-point)

Command Format	AT+TRANS=<mode>
Configuration Example	Send: AT+TRANS=0 Response: =OK
Query Example	Send: AT+TRANS=? Response: AT+TRANS=0
Parameter Description	**<mode>** : Transmission Mode 0 Transparent Transmission (Default) 1 Fixed-Point Transmission
Feature Description	● Point-to-point transmission applies special processing to the first three bytes of user-input data. The first and second bytes are identified as the destination address, and the third byte is identified as the destination channel (for automatic channel switching). ● After completing data transmission, point-to-point transmission automatically switches back to the original channel.

6.1.16 AT+LBT Listen Before Posting Enabled (Yield)

Command Format	AT+LBT=<on_off>
Configuration Example	Send: AT+LBT=0 Response: =OK
Query Example	Send: AT+LBT=? Response: AT+LBT=0
Parameter Description	**<on_off>** : Switch 0 Off (default) 1 On
Feature Description	● When the LBT (Listen Before Talk) feature is enabled, the system checks whether the ambient signal strength is below the set threshold before each wireless data transmission. If the condition is met within the timeout period, the wireless transmission is initiated. If the condition is not met by the maximum timeout period, the wireless transmission is forced to start.

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	● For specific LBT configuration settings, please refer to the AT+LBR command.

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6.1.17 AT+LBR Conditions for "Listen First, Post Later"

Command Format	AT+LBR=<rssi>,<timeout>
Configuration Example	Send: AT+LBR=-55,2000 Response: =OK
Query Example	Send: AT+LBR=? Response: AT+LBR=-55,2000
Parameter Description	**<rssi>:** Signal strength threshold (dBm) 0 - (-128) **<timeout>:** Maximum timeout (milliseconds) 0 - 65535
Feature Description	● This command is not supported in software version 7453-0-20 and earlier, but the default parameters remain the same: -55 dBm and 2000 ms.

6.1.18 AT+ROUTER Relay forwarding

Command Format	AT+ROUTER=<on_off>
Configuration Example	Send: AT+ROUTER=0 Response: =OK
Query Example	Send: AT+ROUTER=? Response: AT+ROUTER=0
Parameter Description	**<on_off>** ： Switch 0 Off (default) 1 On
Feature Description	● Once enabled, please refer to the explanation of the relay networking mode in Chapter 5. ● Relaying essentially involves forwarding the received wireless data once more, which doubles the airtime (latency). ● Relaying operates in half-duplex mode; please ensure sufficient time is allowed for the relay to complete the forwarding process. If a user sends data to the relay while it is in the process of forwarding, packet loss may occur.

6.1.19 AT+WOR Wake-up Calls (Send/Receive)

Command Format	AT+WOR=<role>
Configuration Example	Send: AT+WOR=0 Response: =OK
Query Example	Send: AT+WOR=? Response: AT+WOR=0
Parameter Description	**<role>** ： Role 0 Recipient (default) 1 Sender
Feature Description	● The receiver operates in a low-power mode, while the transmitter remains in normal power consumption mode. ● The receiver enters sleep mode according to a set over-the-air wake-up cycle to reduce power consumption and cannot receive wireless signals during sleep. When the sleep timer expires, the RF unit briefly wakes up and enters a receive state. If a wake-up signal is detected during this window, it enters a normal continuous receive state and waits for subsequent wireless data. If no signal is detected, it enters the next sleep-wake-up cycle. ● The transmitter inserts a wake-up code before the user data according to the configured air wake-up cycle, meaning it wakes up the receiver first and then transmits the data. Consequently, this results in a longer transmission time (latency).

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6.1.20 AT+WTIME Air Wake Cycle

Command Format	AT+WTIME=<timeout>
Configuration Example	Send: AT+WTIME=3 Response: =OK
Query Example	Send: AT+WTIME=? Response: AT+WTIME=3
Parameter Description	**<timeout>** ： Sleep time 0 500ms 1 1000ms 2 1500ms 3 2000ms (default) 4 2500ms 5 3000ms 6 3500ms 7 4000ms
Feature Description	● The longer the sleep time before the receiver is woken up via air, the lower the average power consumption, but the greater the communication latency. ● Software versions 7453-0-16 and earlier do not support this command; please use the HEX command to configure the register instead.

6.1.21 AT+DELAY Air Wake-up Recipient Response Time

Command Format	AT+DELAY=<timeout>
Configuration Example	Send: AT+DELAY=0 Response: OK
Query Example	Send: AT+DELAY=? Response: AT+DELAY=0
Parameter Description	**<timeout>** ： Response window time (milliseconds) 0–65535
Feature Description	● The default value is 0, meaning that after the air-wake receiver receives wireless data and outputs it via the serial port, it immediately enters sleep mode. ● If a time is set (e.g., 1000 milliseconds), the air-wake receiver will remain in the normal wake state for the specified duration after receiving wireless data and outputting it via the serial port. During this window, the user can send response data to the module and transmit it.

6.1.22 AT+ERSSI Environmental signal strength

Command Format	AT+ERSSI=<on_off>
Configuration Example	Send：AT+ERSSI=0 Response：=OK
Query Example	Send：AT+ERSSI=? Response：AT+ERSSI=0
Parameter Description	**<on_off>** ： Switch 0 Off (default) 1 On
Feature Description	● Once enabled, please refer to the “RSSI Environmental Noise Enable” section in the register description and use a hexadecimal command to read the data.

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6.1.23 AT+DRSSI Received packet signal strength

Command Format	AT+DRSSI=<on_off>
Configuration Example	Send: AT+DRSSI=0 Response: =OK
Query Example	Send: AT+DRSSI=? Response: AT+DRSSI=0
Parameter Description	**<on_off> ：** Switch 0 Off (default) 1 On
Feature Description	● When enabled, signal strength data (1 byte, hexadecimal representation, signed number) will be appended to the end of received data packets. ● Conversion example: Suppose the appended signal strength data is 0xC4 (-60 dBm). Converting the hexadecimal value 0xC4 to decimal yields 196. The conversion formula is: RSSI = -(256 - 196) = -60 ● When the distance between the sender and receiver is too short or the sender's power is too high, the received signal strength may be 0 (the upper limit); in this case, convert it directly to 0 dBm.

6.1.24 AT+POWER Power settings

Command Format	AT+POWER=<Power>
Configuration Example	Send：AT+POWER=0 Response：AT+POWER=0
Query Example	Send：AT+POWER=? Response：AT+POWER=0
Parameter Description	**<Power> ：** Power 0 30dBm （default） 1 27dBm 2 24dBm 3 21dBm
Feature Description	-

6.2 Signaling Testing (Authentication)

6.2.1 Test Command Declaration

The section on testing AT commands is intended solely to assist users in obtaining product certifications (e.g., CE, FCC, etc.) and should not be used for any other purpose.

EBYTE assumes no liability for any damages resulting from failure to comply with relevant operating or design specifications. EBYTE makes every effort to ensure the completeness, accuracy, and timeliness of the features under development; however, the possibility of errors or omissions in such features cannot be ruled out. Unless otherwise specified in a separate agreement, no implied or statutory warranties are provided regarding the use of the features under development. To the fullest extent permitted by applicable law, EBYTE shall not be liable for any damages arising from the use of the features under development, regardless of whether such damages were foreseeable.

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6.2.2 List of Test Instructions

For detailed documentation on command operations, please contact your EBYTE sales representative.

AT Command	Overview of Features
AT+FPOWER	Transmit Power Fine-Tuning
AT+XCAP	Crystal Oscillator Calibration
AT+ULORAM	LoRa Modulation Parameter Adjustment (SF Spreading Factor, BW Transmit Bandwidth, CR Coding Rate)
AT+OPTIMIZE	Low-Rate Optimization Options
AT+UFREQ	Carrier Frequency Adjustment (Start Frequency, Channel Spacing)
AT+SWAVE	Fixed-Frequency Continuous Single-Carrier Transmission
AT+MWAVE	Fixed-Frequency Continuous Modulated Wave Transmission
AT+TFHSS	Frequency-Hopping Modulated Wave Transmission
AT+DUTYTX	Fixed-Frequency Continuous Single-Carrier/Modulated Wave Duty Cycle Transmission

7 Frequently Asked Questions

7.1 The transmission distance is not ideal

- When there are obstacles in the line of sight, the communication range will decrease accordingly;
- Temperature, humidity, and co-channel interference can lead to an increase in packet loss;
- The ground absorbs and reflects radio waves, so testing results are poor when close to the ground;
- Seawater strongly absorbs radio waves, so testing results are poor near the coast;
- Signal attenuation is severe if there are metal objects near the antenna or if the antenna is housed in a metal enclosure;
- Incorrect power register settings or excessively high air-to-air data rates (higher data rates result in shorter communication distances);
- At room temperature, if the power supply voltage is lower than the recommended value, the lower the voltage, the lower the transmitted power;
- Poor matching between the antenna and the module, or issues with the antenna’s quality.

7.2 The module is prone to damage

- Please check the power supply to ensure it falls within the recommended voltage range; exceeding the maximum voltage may cause permanent damage to the module.
- Please check the stability of the power supply; the voltage must not fluctuate significantly or frequently.
- Please ensure that anti-static precautions are followed during installation and use, as high-frequency components are sensitive to static electricity.
- Please ensure that humidity levels do not become too high during installation and use, as some components are humidity-sensitive.
- Unless otherwise specified, we do not recommend using the module in environments with extremely high or low temperatures.

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7.3 The bit error rate is too high

- There is interference from a signal on the same frequency nearby; move away from the source of interference or change the frequency or channel to avoid interference;
- A poor power supply can also cause garbled data; ensure that the power supply is reliable;
- Extension cords or feedlines that are of poor quality or too long can also result in a high bit error rate.

8 Antenna recommendation

8.1 Recommendation

Antennas play a crucial role in communication. Poor-quality antennas can often have a significant negative impact on communication systems. Therefore, we recommend a selection of antennas that are compatible with our wireless modules and offer excellent performance at a reasonable price.

Model	Type	Frequency band (Hz)	Interface	Gain (dBi)	Height (mm)	Feeder (cm)	Features
TX433-JZG-6	Rubber rod antenna	433M	SMA-J	2.5	62	-	Ultra-short, straight-type, omnidirectional antenna
TX433-JW-5	Rubber rod antenna	433M	SMA-J	2.0	50	-	Flexible antenna rod, omnidirectional antenna
TX433-JWG-7	Rubber rod antenna	433M	SMA-J	2.5	75	-	Flexible antenna rod, omnidirectional antenna
TX433-JK-11	Rubber rod antenna	433M	SMA-J	2.5	110	-	Flexible rubber rod, omnidirectional antenna
TX433-XPL-100	Suction-cup antenna	433M	SMA-J	3.5	185	100	Compact suction cup antenna, cost-effective
TX433-XP-200	Suction-cup antenna	433M	SMA-J	4.0	190	200	Neutral suction cup antenna, low loss
TX433-XPH-300	Suction-cup antenna	433M	SMA-J	6.0	965	300	Large suction cup antenna, high gain
TX490-JZ-5	Rubber rod antenna	470/490M	SMA-J	2.0	50	-	Ultra-short, straight-type, omnidirectional antenna
TX490-XPL-100	Suction-cup antenna	470/490M	SMA-J	3.5	120	100	Compact suction cup antenna, cost-effective
TX868-JKS-IPX20	Rubber rod antenna	868M	IPEX-1	3.0	197	200	Flexible rubber rod, omnidirectional antenna

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Model	Type	Frequency band (Hz)	Interface	Gain (dBi)	Height (mm)	Feeder (cm)	Features
TX868-JZLW-15	Rubber rod antenna	868M	IPEX-1	3.0	165	150	Flexible rubber rod, omnidirectional antenna
TX868-XPL-100	Suction-cup antenna	868M	SMA-J	3.5	290	100	Compact suction cup antenna, great value for money
TX868-JKD-20	Rubber rod antenna	868M	SMA-J	3.0	170	-	Flexible rubber rod, omnidirectional antenna
TX915-JKS-IPX20	Rubber rod antenna	915M	IPEX-1	3.0	197	200	Flexible rubber rod, omnidirectional antenna
TX915-JZLW-15	Rubber rod antenna	915M	IPEX-1	3.0	155	150	Flexible rubber rod, omnidirectional antenna
TX915-JKD-20	Rubber rod antenna	915M	SMA-J	3.5	200	-	Flexible rubber rod, omnidirectional antenna
TX915-XPL-100	Suction-cup antenna	915M	SMA-J	3.5	260	100	Compact suction cup antenna, great value for money

Revision history

Version	Revision Date	Revision Notes	Maintainer
1.0	2026-3-20	Initial version	Hao

About us

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