E22-T Series Product Specifications

AT Command 230/433/868/915MHz LoRa Wireless Module



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1 Introduction

1.1 Brief Introduction

The E22-T series represents a new generation of LoRa wireless data transmission modules. This series of (UART) modules is developed based on SEMTECH's high-performance RF chips, featuring a maximum transmit power of 30dBm. It supports multiple transmission modes and operates across the 230MHz, 400MHz, and 900MHz frequency bands. Utilizing LoRa spread spectrum technology with TTL-level output, it is compatible with 3.3V I/O port voltage.

The E22-T series adopts the latest generation of LoRa spread spectrum technology, delivering faster speeds, lower power consumption, and a more compact form factor. It supports features such as air wake-up, wireless configuration, carrier sense, auto-relay, and communication keys. Custom packet length settings are available, and bespoke development services can be provided.

The 12 modules shown below vary in power, package, and frequency band. Detailed specifications are provided in Section 2.1: E22-T Series Product Selection Comparison.



1.2 Features

- Utilizes the latest generation LoRa spread spectrum modulation technology for extended communication range and enhanced interference resistance;
- Supports multiple frequency bands including 230/433/868/915MHz (customizable);
- Supports serial port firmware upgrades for simplified maintenance;
- Dual command systems (HEX/AT) for flexible user selection;
- Supports relay networking with multi-level relays for ultra-long-range communication, enabling simultaneous

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operation of multiple networks within the same area;

- Allows user-defined communication keys that cannot be read, significantly enhancing data confidentiality;
- Supports LBT (Listen Before Talk) functionality to monitor channel noise before transmission, substantially improving communication success rates in harsh environments;
- Supports RSSI (Received Signal Strength Indication) for signal quality assessment;
- Supports wireless parameter configuration via remote transmission of command packets to configure or read module settings;
- Supports air-to-air wake-up (ultra-low power mode) for battery-powered applications;
- Supports point-to-point transmission, broadcast transmission, and channel monitoring;
- Supports deep sleep mode;
- Multi-level adjustable air-to-air transmission rates;
- Parameters are preserved during power loss; the module resumes operation with preset parameters upon power-up;
- Built-in watchdog automatically resets and restores operation in case of unexpected events.

1.3 Application

- Smart agricultural irrigation and environmental monitoring;
- Photovoltaic power plant monitoring and distributed PV system management;
- Home security alarms and remote keyless entry;
- Smart home devices and industrial sensors;
- Wireless alarm security systems;
- Building automation solutions;
- Wireless industrial-grade remote controllers;
- Healthcare products;
- Advanced Metering Infrastructure (AMI).

2 Specification

2.1 E22-T Series Product Selection Comparison

Category	Product Model	Carrier frequency ①: Hz	Transmit Power②: dBm	Test distance③: km	Package Type	Product Dimensions (mm)	Antenna Configuration ④
230MHz Module	E22-230T22S	220～236M	22	5	SMD	16*26	IPEX-1/Stamp Hole
	E22-230T22D	220～236M	22	5	DIP	21*36	SMA-K
	E22-230T30S	220～236M	30	10	SMD	40.5*25	IPEX-1/Stamp Hole
	E22-230T30D	220～236M	30	10	DIP	43*24	SMA-K

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Category	Product Model	Carrier frequency ①: Hz	Transmit Power②: dBm	Test distance③: km	Package Type	Product Dimensions (mm)	Antenna Configuration ④
433MHz Module	E22-400T22S	410～493M	22	5	SMD	16*26	IPEX-1/Stamp Hole
	E22-400T22D	410～493M	22	5	DIP	21*36	SMA-K
	E22-400T30S	410～493M	30	10	SMD	40.5*25	IPEX-1/Stamp Hole
	E22-400T30D	410～493M	30	10	DIP	43*24	SMA-K
868/915MHz Module	E22-900T22S	850～930M	22	5	SMD	16*26	IPEX-1/Stamp Hole
	E22-900T22D	850～930M	22	5	DIP	21*36	SMA-K
	E22-900T30S	850～930M	30	10	SMD	40.5*25	IPEX-1/Stamp Hole
	E22-900T30D	850～930M	30	10	DIP	43*24	SMA-K

Note:

(1) Carrier Frequency ①: Frequency band range supports user customization;

(2) Transmit Power ②: 22dBm = 158mW / 30dBm = 1000mW, tolerance range ±1dBm, multi-level power adjustable. For detailed power levels, refer to Sections 6 and 7 of this document;

(3) Test Distance③: Clear open space, air speed 2.4kbps, antenna height 2 meters (for reference only; field testing recommended);

(4) Antenna Configuration④: Equivalent impedance approximately 50Ω;

Modules within the same frequency band can communicate with each other.

2.2 Basic Parameters

- E22-T Series 22dBm Low-Power Module Models: E22-230T22D, E22-230T22S, E22-400T22D, E22-400T22S, E22-900T22D, E22-900T22S;
- E22-T Series 30dBm high-power module models: E22-230T30D, E22-230T30S, E22-400T30D, E22-400T30S, E22-900T30D, E22-900T30S;

2.2.1 Basic Parameters

Conditions: Tc=25°C, VCC=5.0V, 230MHz/433MHz/868MHz/915MHz

Parameters	Description
Modulation Scheme	Next-Generation LoRa Modulation Technology
Interface Method	1.27mm pin header / 2.54mm header pins
Communication Interface	Pin header: surface-mount module

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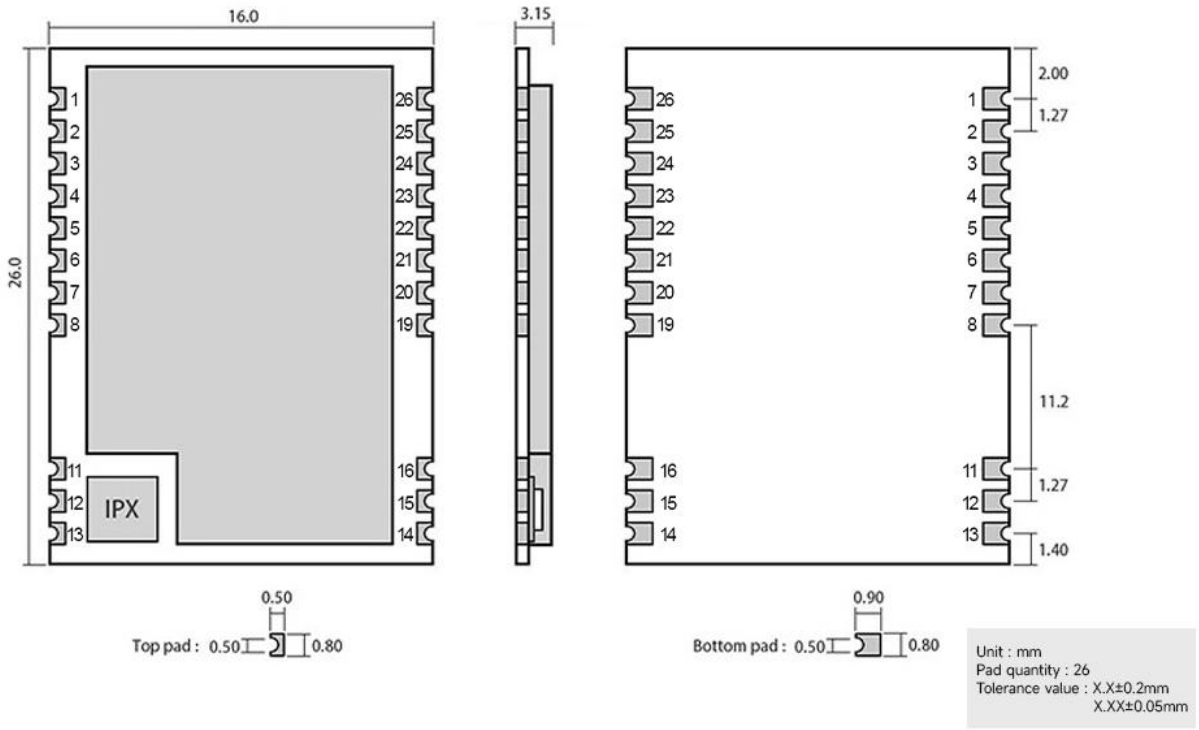
Parameters	Description
Transmission Length	Header pins: through-hole module
Package Type	UART serial port (3.3V)
Buffer Capacity	240 bytes maximum per packet; automatically segments packets exceeding this limit. Adjustable via host computer or commands. Detailed commands are provided in Section 6 of this document.
Cache capacity	1000Byte
Work Environment	
Operating Temperature	-40°C to +85°C, industrial-grade standard
Operating Humidity	10% to 90% RH
Storage Temperature	-40°C to +125°C
Radio Frequency Parameters	
Transmit Power	22dBm = 158mW, multi-level power adjustable. Details in Sections 6 and 7 of this document.
	30dBm = 1000mW, multi-level power adjustable. Details in Sections 6 and 7 of this document.
Operating Frequency Band	220MHz–236MHz, supports custom frequency bands.
	410MHz–493MHz, supports custom frequency bands.
Receiver Sensitivity	850MHz–930MHz, supports band customization
Data Rate	-131dBm, air data rate 2.4kbps@SF11, applicable to E22-T series 22dBm low-power modules
	-134dBm, air data rate 2.4kbps@SF11, applicable to E22-T series 30dBm high-power modules
Blocking Power	2.4–15.5Kbps, multi-level adjustable air data rate, suitable for 230MHz band modules. See Sections 6 and 7 of this document for details
	2.4–62.5Kbps, multi-level adjustable air data rate, suitable for 400MHz and 900MHz band modules. See Sections 6 and 7 of this document for details
Transmit Power	10dBm
Electrical Parameters	
Supply Voltage	2.6–5.5V, 30dBm output module ≥5V, 22dBm output module ≥3.3V ensures output power; exceeding 5.5V will permanently damage the module.
Communication Level	3.3V
Transmit Current	100–140mA, instantaneous power consumption @22dBm, suitable for E22-T series 22dBm low-power modules
	460–620mA, instantaneous power consumption @ 30dBm, suitable for E22-T series 30dBm high-power modules
Receive Current	≈7mA, suitable for E22-T series 22dBm low-power modules
	≈13mA, suitable for E22-T series 30dBm high-power modules
Sleep Current	≈3μA

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3 Mechanical Dimensions and Pin Definitions

3.1 E22-230/400/900T22S Mechanical Dimensions and Pin Definitions



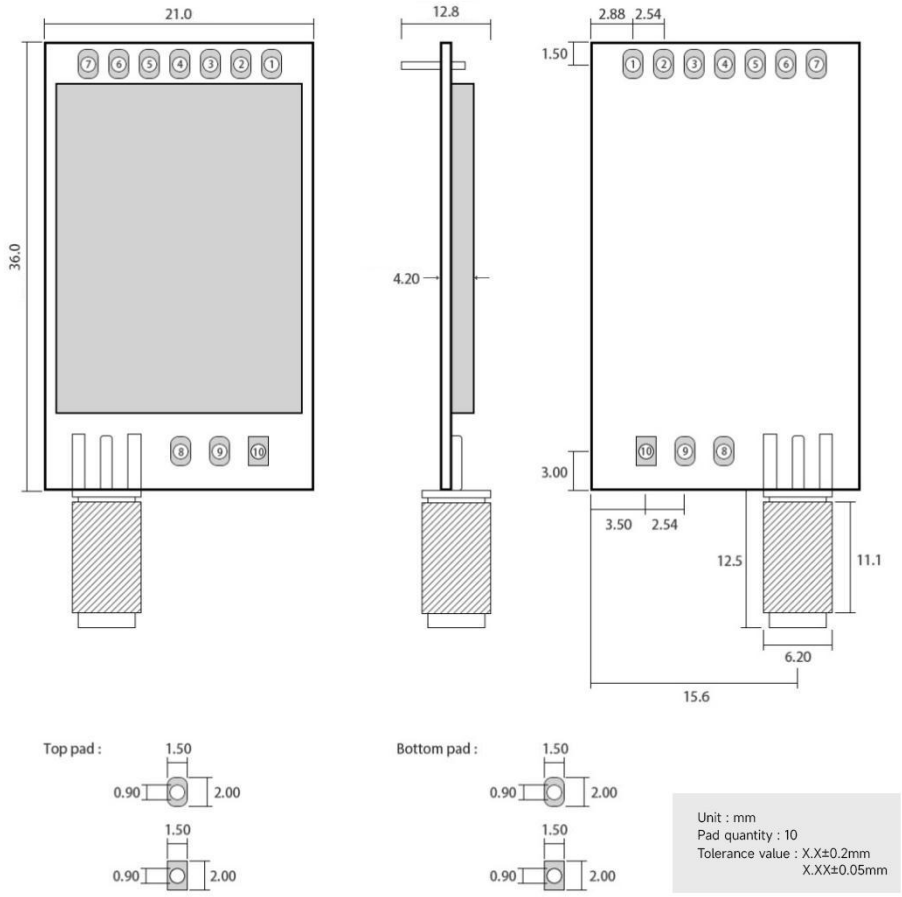
No	Name	Pin orientation	Pin Function
1	RESET	Input	1.Module reset pin. Low-level trigger for reset, requiring a pull-down time exceeding 100μs; 2.Users are strongly advised to connect to a microcontroller for reset and recovery in unexpected situations.
2	GND	-	Module Ground
3	NC	-	Unused Pin (Leave Unconnected)
4	NC	-	Unused Pin (Leave Unconnected)
5	NC	-	Unused Pin (Leave Unconnected)
6	NC	-	Empty pins (programming pins; if possible, bring them out for easier maintenance or firmware customization)
7	NC	-	Empty pins (programming pins; if possible, bring them out for easier maintenance or firmware customization)
8	GND	-	Module Ground
11	GND	-	Module Ground
12	ANT	Output	Antenna Interface (High-Frequency Signal Output, 50 Ohm Characteristic Impedance)
13	GND	-	Module Ground
14	GND	-	Module Ground
15	GND	-	Module Ground

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No	Name	Pin orientation	Pin Function
16	GND	-	Module Ground
19	GND	-	Module Ground
20	M0	Input (Very Weak Pull-Up)	When combined with M1, determines the module's 4 operating modes (cannot be left floating)
21	M1	Input (Very Weak Pull-Up)	When combined with M0, determines the module's 4 operating modes (cannot be left floating)
22	RXD	Input	3.3V serial input, connected to external TXD output pin;
23	TXD	Output	3.3V serial output, connected to external RXD output pin;
24	AUX	Output	1. Indicates module operational status (may be left floating); 2. During normal operation, a low level on this pin indicates busy status, while a high level indicates idle status; 3. It is not recommended to use this pin to drive external devices or pull it low. Otherwise, if the AUX pin is continuously pulled low by an external source during module power-up, the module may forcibly enter upgrade mode and fail to operate normally. For detailed information, please refer to Section 5.
25	VCC	-	Module Power Supply (Refer to the Electrical Parameters section)
26	GND	-	Module Ground

3.2 E22-230/400/900T22D Mechanical Dimensions and Pin Definitions

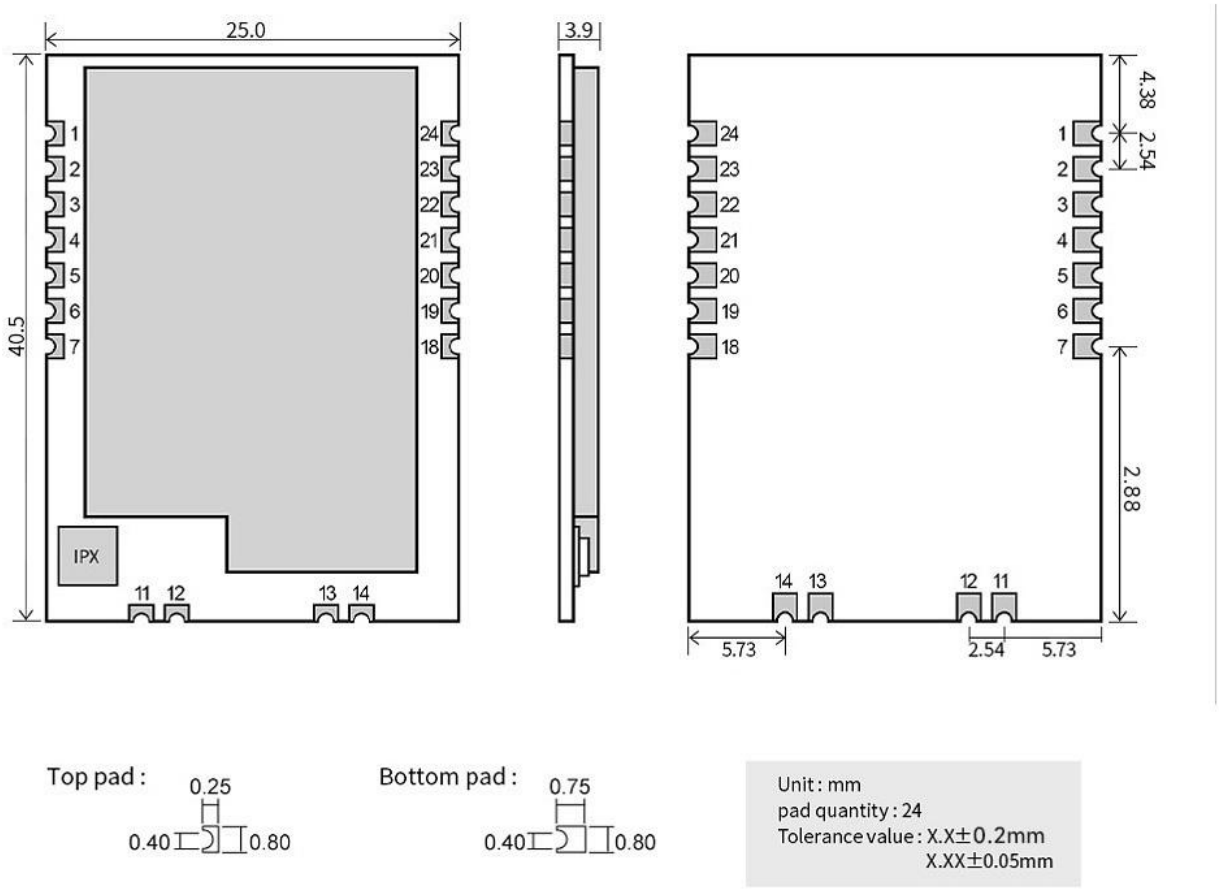


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No	Name	Pin orientation	Pin Function
1	M0	Input (Very Weak Pull-Up)	When paired with M1, it determines the module's four operating modes (cannot be left floating; if not in use, it can be grounded).
2	M1	Input (Very Weak Pull-Up)	When paired with M0, it determines the module's four operating modes (cannot be left floating; if not in use, it can be grounded).
3	RXD	Input	TTL serial input, connected to external TXD output pin;
4	TXD	Output	TTL serial output, connected to external RXD input pin;
5	AUX	Output	1. Indicates module operational status (may be left floating); 2. During normal operation, a low level on this pin indicates busy status, while a high level indicates idle status; 3. It is not recommended to use this pin to drive external devices or pull it low. Otherwise, if the AUX pin is continuously pulled low by an external source during module power-up, the module may forcibly enter upgrade mode and fail to operate normally. For detailed information, refer to Section 5.
6	VCC	Power Supply	Module Power Supply (Refer to the Electrical Parameters section)
7	GND	Power Supply	Module Ground
8	Fixed hole	-	Fixed hole
9	Fixed hole	-	Fixed hole
10	Fixed hole	-	Fixed hole

3.3 E22-230/400/900T30S Mechanical Dimensions and Pin Definitions



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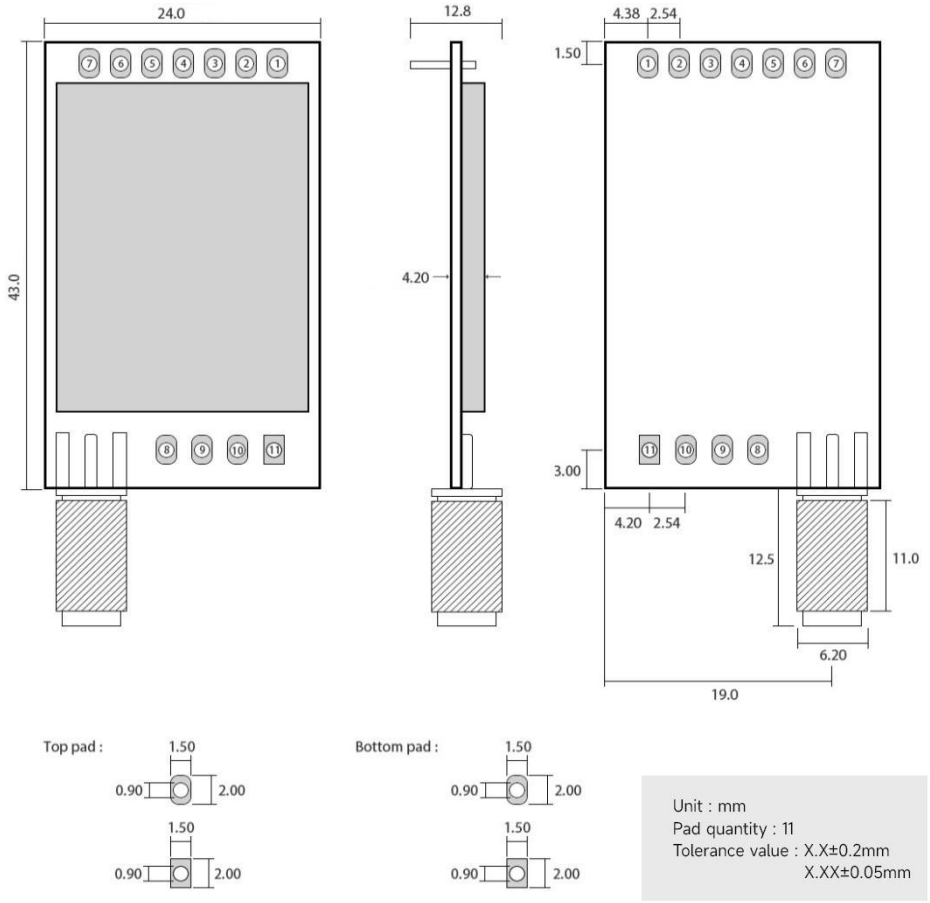
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No	Name	Pin orientation	Pin Function
1	GND	Input	Module Ground
2	VCC	Input	Module Power Supply (Refer to Electrical Parameters Section)
3	AUX	Output	1. Indicates module operational status (may be left floating); 2. During normal operation, a low level on this pin indicates busy status, while a high level indicates idle status; 3. It is not recommended to use this pin to drive external devices or pull it low. Otherwise, if the AUX pin is continuously pulled low by an external source during module power-up, the module may forcibly enter upgrade mode and fail to operate normally. For detailed information, refer to Section 5.
4	TXD	Output	3.3V serial output, connected to the external RXD input pin;
5	RXD	Input	3.3V serial input, connected to the external TXD output pin;
6	M1	Input (Very Weak Pull-Up)	In conjunction with M0, determines the module's four operating modes (cannot be left floating).
7	M0	Input (Very Weak Pull-Up)	In conjunction with M1, determines the module's 4 operating modes (cannot be left floating)
11	ANT	Output	Antenna interface (high-frequency signal output, 50-ohm characteristic impedance)
12	GND	-	Fixed location
13	GND	-	Fixed location
14	GND	-	Fixed location
18	NC		Empty pin (programming pin; if possible, bring it out for easier maintenance or firmware customization)
19	NC		Empty pin (programming pin; if possible, bring it out for easier maintenance or firmware customization)
20	NC		Empty pin (leave it open)
21	NC		Empty pin (leave it open)
22	RESET	Input	1.Module reset pin. Low-level trigger for reset, requiring a pull-down time exceeding 100μs; 2.Users are strongly advised to connect to a microcontroller for reset and recovery in unexpected situations.
23	GND	-	Fixed
24	NC	-	Empty foot (please leave it suspended)

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3.4 E22-230/400/900T30D Mechanical Dimensions and Pin Definitions

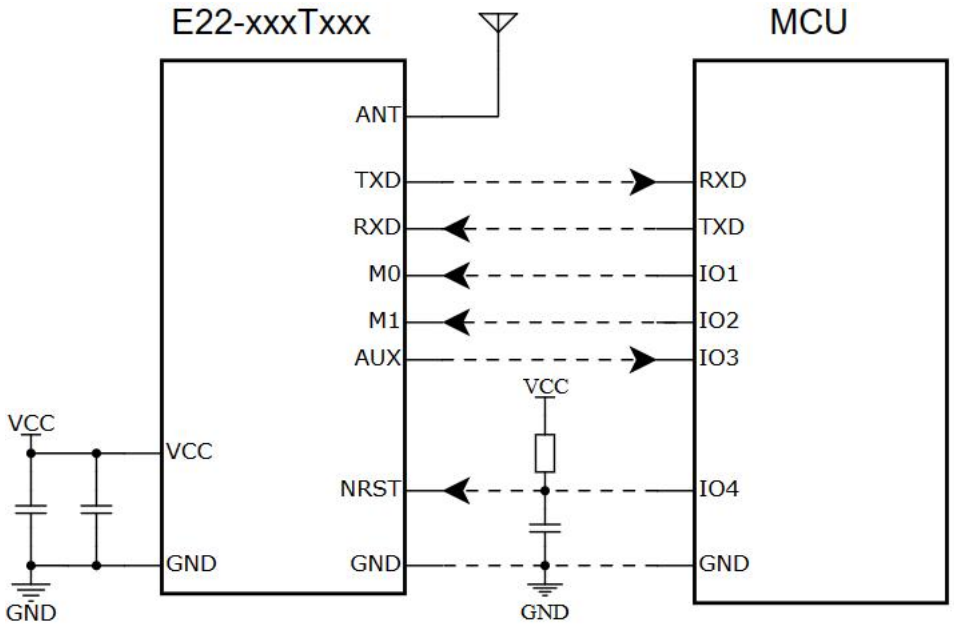


No	Name	Pin orientation	Pin Function
1	M0	Input (Very Weak Pull-Up)	When used with M1, determines the module's four operating modes (cannot be left floating; may be grounded if unused).
2	M1	Input (Very Weak Pull-Up)	When used with M0, determines the module's four operating modes (cannot be left floating; may be grounded if unused).
3	RXD	Input	TTL serial input, connected to external TXD output pin;
4	TXD	Output	TTL serial output, connected to external RXD input pin;
5	AUX	Output	1. Indicates module operational status (may be left floating); 2. During normal operation, a low level on this pin indicates busy status, while a high level indicates idle status; 3. It is not recommended to use this pin to drive external devices or pull it low. Otherwise, if the AUX pin is continuously pulled low by an external source during module power-up, the module may forcibly enter upgrade mode and fail to operate normally. For detailed information, please refer to Section 5.
6	VCC	Input	Module Power Supply (Refer to Electrical Parameters Section)
7	GND	Input	Module Ground Terminal
8	Fixed hole	-	Mounting Hole
9	Fixed hole	-	Mounting Hole
10	Fixed hole	-	Mounting Hole
11	Fixed hole	-	Mounting Hole

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4 Recommended Connection Diagram



No	Important Notes
1	The module features a 3.3V serial port and I/O pins. Users with 5V microcontrollers must consider level conversion.
2	Strongly recommend connecting the RESET pin to prevent unexpected malfunctions.
3	If adding an external switch to the module's VCC, account for leakage current from the external microcontroller's serial port. Failure to do so may prevent module shutdown.
4	Avoid using the AUX pin to drive external components (e.g., LEDs, relays). Continuous external pull-down during power-on will cause malfunction.
5	(Optional) For surface-mount modules, consider exposing the programming pins for future maintenance or firmware customization.
6	(Optional) Consider adding an auxiliary interface to the serial port for future maintenance (enabling online upgrades via PC tools).

5 Functions in detail

• The M1 and M0 pins described in this section use 0 to represent a low level and 1 to represent a high level;
• If using software switching mode, refer to the AT+MODE command in Chapter 7;

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5.1 Working Mode

The module has four operating modes, set via pins M1 and M0, as detailed in the table below:

Mode（0-3）	M1	M0	Model Introduction	Remarks
0 Transmission Mode	0	0	Serial port enabled, wireless enabled, transparent transmission	Can be remotely configured; see Section 5.1.3.2 for details.
1 WOR Mode	0	1	Can be defined as WOR sender and WOR receiver	Supports wake-on-air.
2 Configuration Mode	1	0	Users can access registers via the serial port to control the module's operational state	-
3 Deep Sleep	1	1	Module enters sleep mode	-

5.1.1 Transmission mode in use: Mode 0 (M1 and M0 pins set to 0,0)

5.1.1.1 Quick Start Guide for Transparent Transfer

What you see is what you get. Simply use Serial Port Assistant for mutual communication (all factory default parameters are identical, and transmission mode is transparent). An example scenario is as follows:

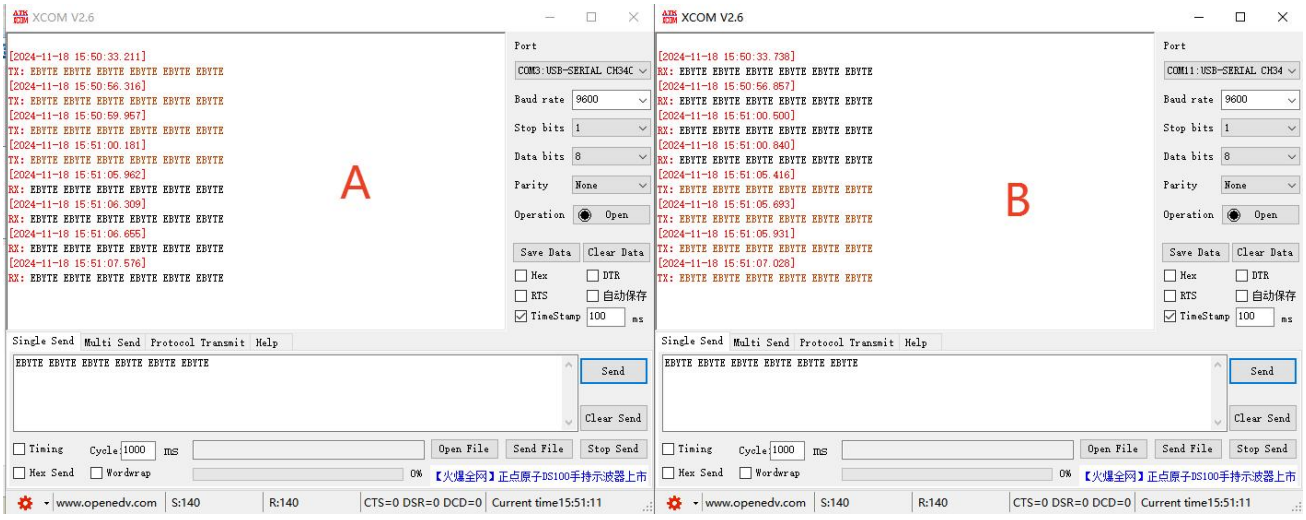


Figure 1: Schematic of Bidirectional Transmission and Reception

5.1.1.2 Quick Point-to-Point Transmission (Specify Destination Address and Channel)

Data transmission and reception follow a fixed format: destination address + destination channel + data. This effectively minimizes interference in certain scenarios.

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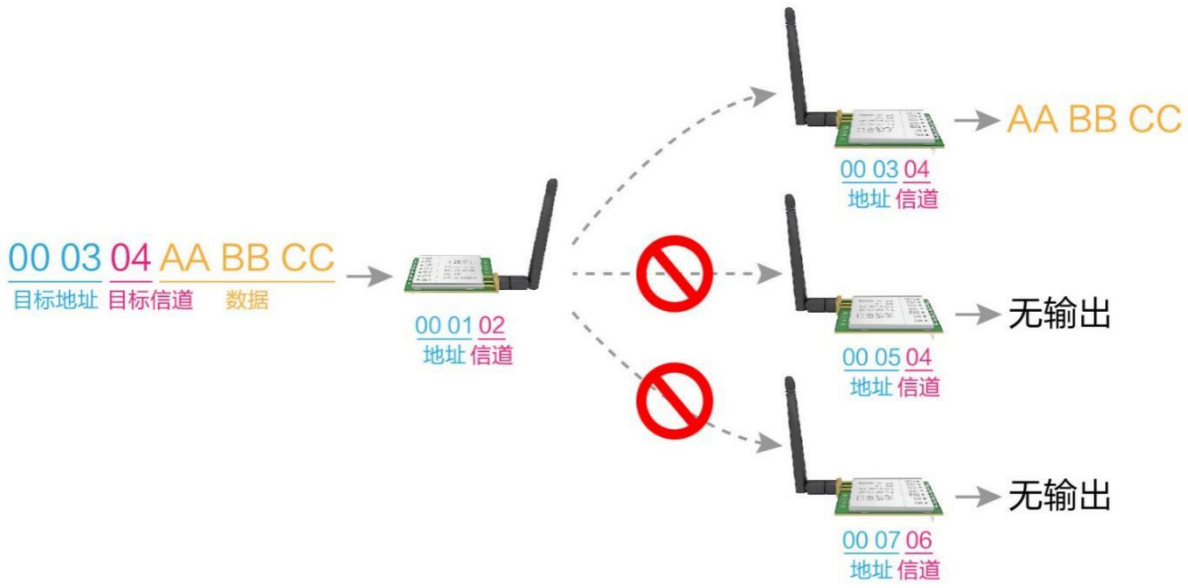


Figure 2 Point-to-Point Transmission Schematic

Operating Procedure:

Step 1: Modify module parameters via the host computer:

In configuration mode (set M1 and M0 pins to 1 and 0 respectively), modify the module address and channel. Change the transmission mode from transparent to fixed-point transmission. Finally, write the parameters to complete the modification.

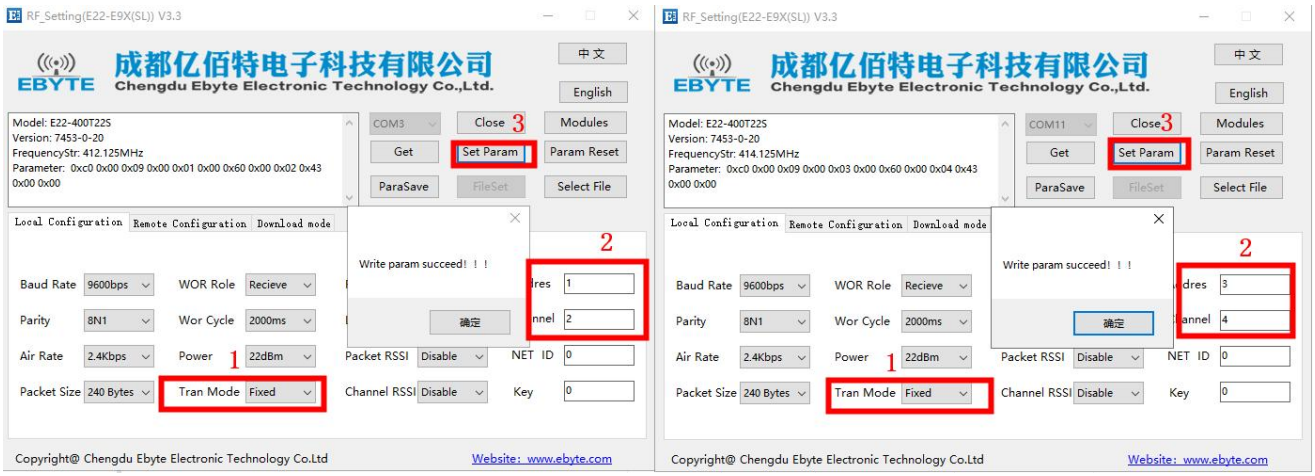


Figure 3: Host Computer Interface

Step 2: Switch the module operating mode to normal mode: Edit Module A parameters to 000304AABBCC and send to Module B. Similarly, Module B sends data as 000102AABBCC. (Data transmission format in fixed-point mode: Destination address + Destination channel + Data)

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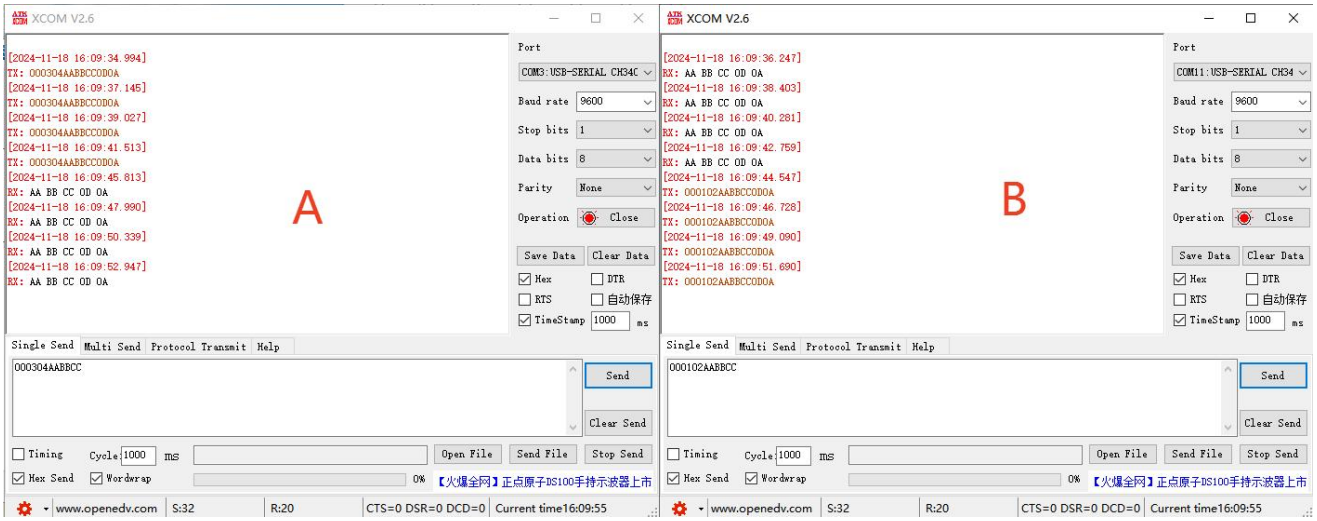


Figure 4 Data Transmission Diagram

5.1.1.3 Quick Guide to Broadcasting

- Set Module A's address to 0xFFFF and channel to 0x04. When Module A transmits (in the same mode, transparent or fixed-point transmission), all receiving modules on channel 0x04 can receive the data, achieving broadcast functionality.
- Set Module A's address to 0xFFFF and channel to 0x04. When Module A operates as a receiver, it can receive all data on channel 0x04, achieving monitoring functionality.

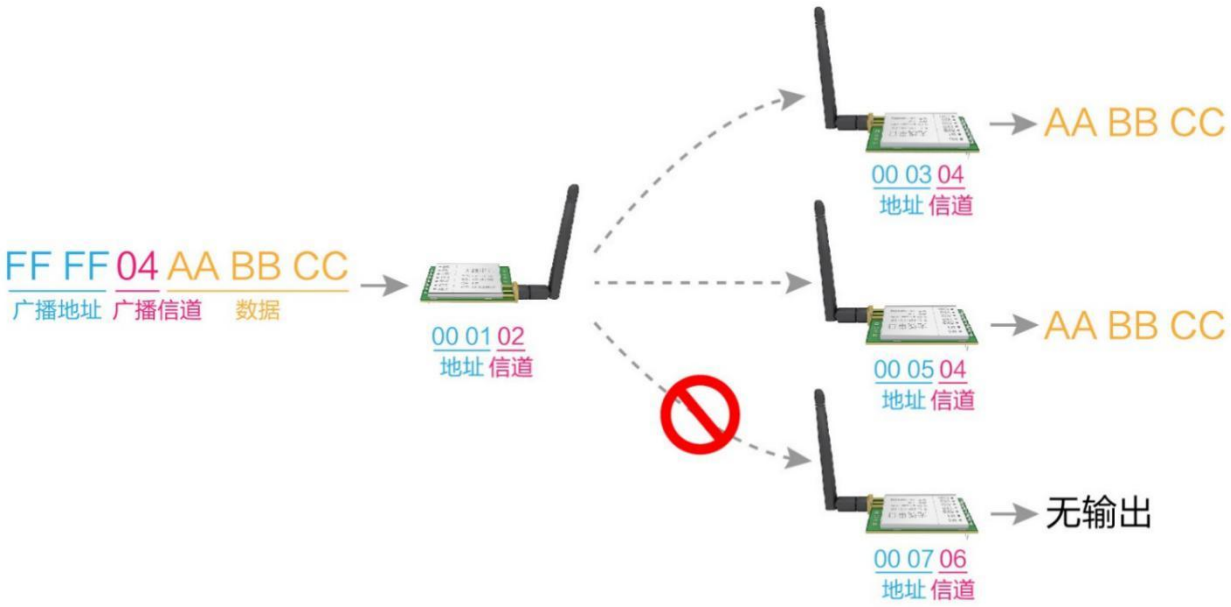


Figure 5 Point-to-Point Broadcast Transmission Diagram

Operating Procedure:

Step 1: Modify module parameters via the host computer:

In configuration mode (set M1 and M0 pins to 1 and 0), modify the module address and channel. Change the transmission mode from transparent to fixed-point transmission. Finally, write the parameters to complete the modification.

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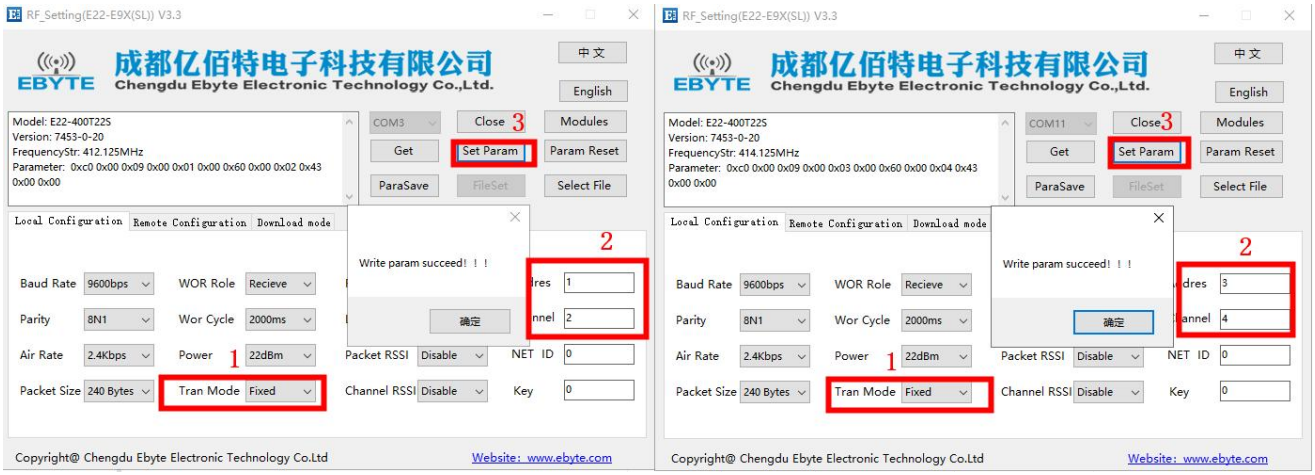


Figure 6: Host Computer Interface Diagram

Step 2: Switch the module operating mode to normal mode: Edit Module A parameters to FFFF04AABBCC and transmit to Module B. Similarly, Module B transmits data as FFFF02AABBCC. (Data transmission format in point-to-point broadcast mode: Broadcast address + Target channel + Data).

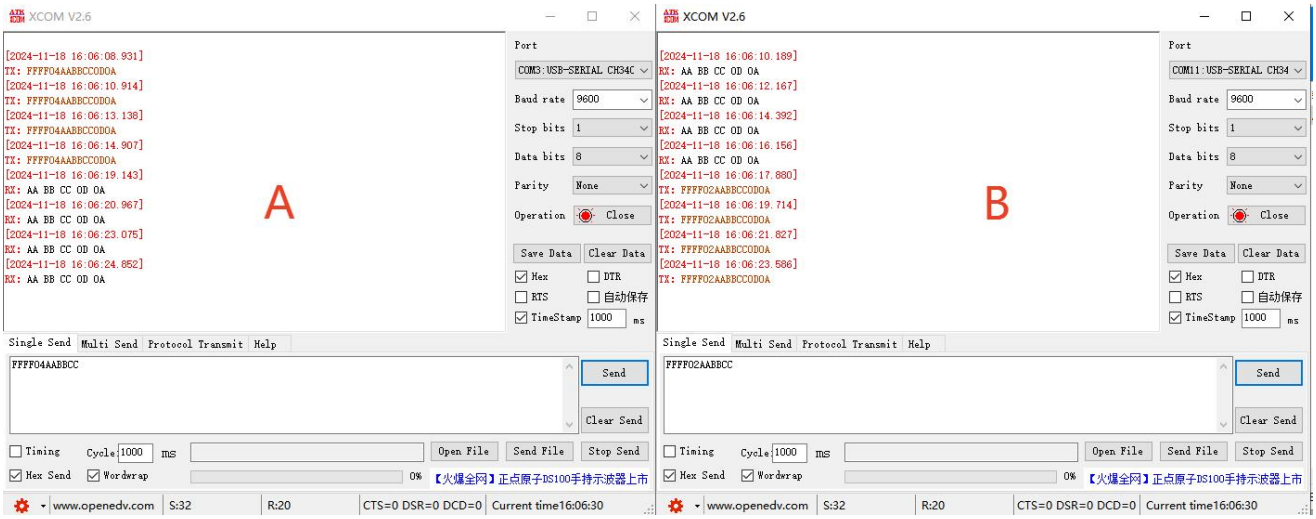


Figure 7 Data Transmission Diagram

5.1.2 Transmission mode in use: Mode 0 (M1 and M0 pins set to 0,0)

5.1.2.1 Quick Start Guide for Transparent Transfer

Operating Procedure:

Step 1: Modify module parameters via the host computer: In configuration mode (with M1 and M0 pins set to 1 and 0 respectively), modify the module's WOR role and write the parameters to complete the modification.

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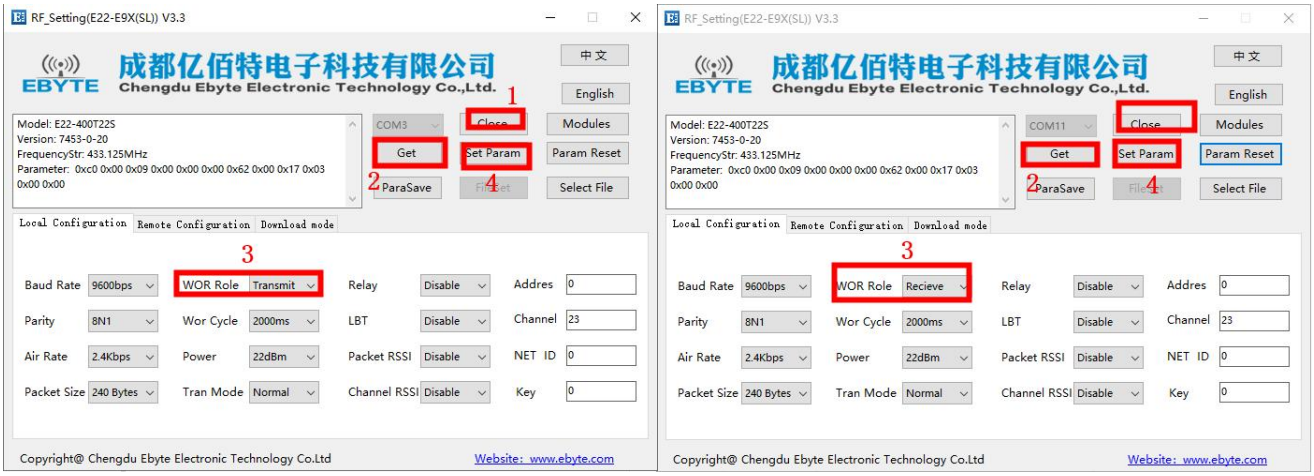


Figure 8: Host Computer Interface Diagram

Step 2: Switch the module operating mode to WOR mode (set M1 and M0 pins to 0,1): The WOR receiving module transmits data to the WOR transmitting module, but the WOR transmitting module cannot send data back to the transmitting module.

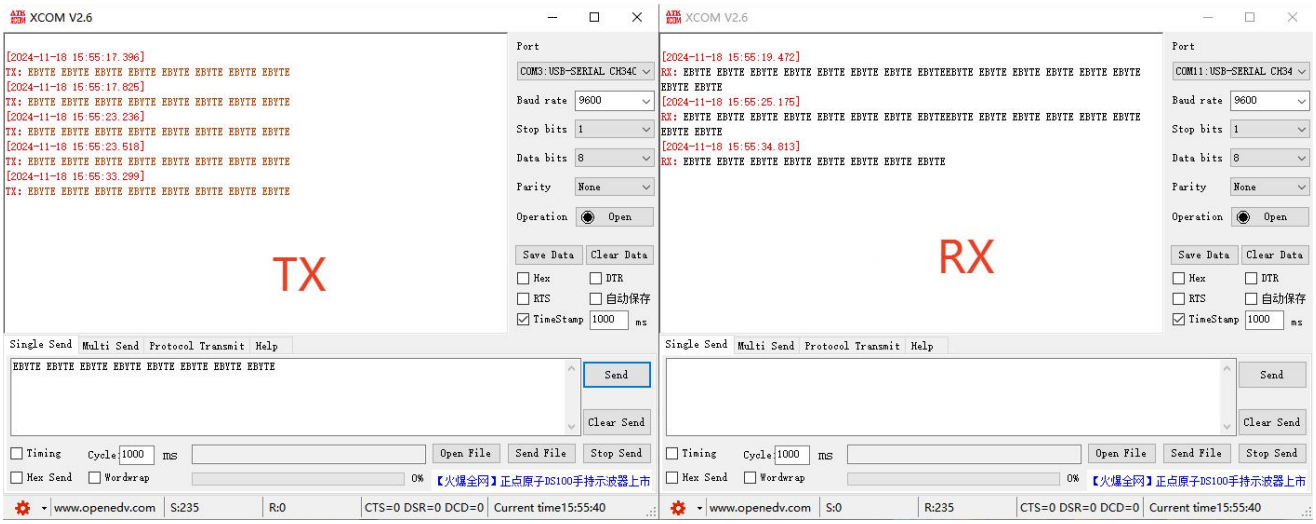


Figure 9 Data Transmission Diagram

5.1.3 Configuration mode usage, Mode 2 (M1, M0 pins set to 1,0)

5.1.3.1 Quick Start Guide for Configuration Tools

The figure below shows the configuration interface for the host computer. Users can switch to command mode using M0 or M1 to quickly configure and read parameters on the host computer.

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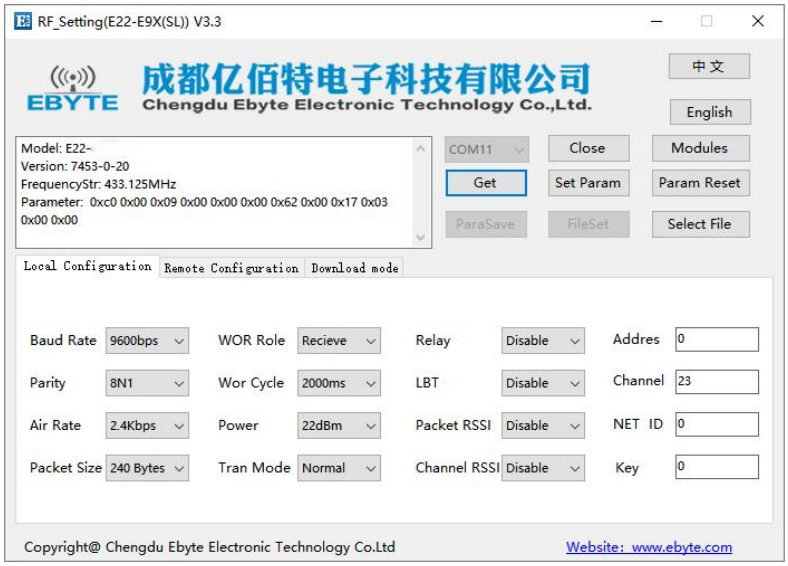


Figure 10: Host Computer Interface Diagram

- In the host computer configuration, module address, frequency channel, network ID, and key are all displayed in decimal mode. For the valid parameter ranges, refer to the specific parameters for different product models in the registers listed in Section 6.3.
- When configuring relay mode via the host computer, users must pay special attention: since all parameters are displayed in decimal mode on the host computer, module address and network ID must be converted to the appropriate base when entered. For example, if the network ID entered at transmitter A is 02 and the network ID entered at receiver B is 10, then when configuring the module address for repeater R, convert the hexadecimal value 0x020A to the decimal value 522. This decimal value 522 should be entered as the module address for repeater R.

5.1.3.2 Quick Start Guide for Remote Configuration

Operating Procedure:
Step 1: Remotely read and modify module parameters via the host computer:
Modules A and B must have identical parameters to enable remote configuration.
Example shown in the right diagram:
Module A is in configuration mode, while Module B is in normal mode.
Simply open remote configuration on Module A via the host computer and read the parameters.

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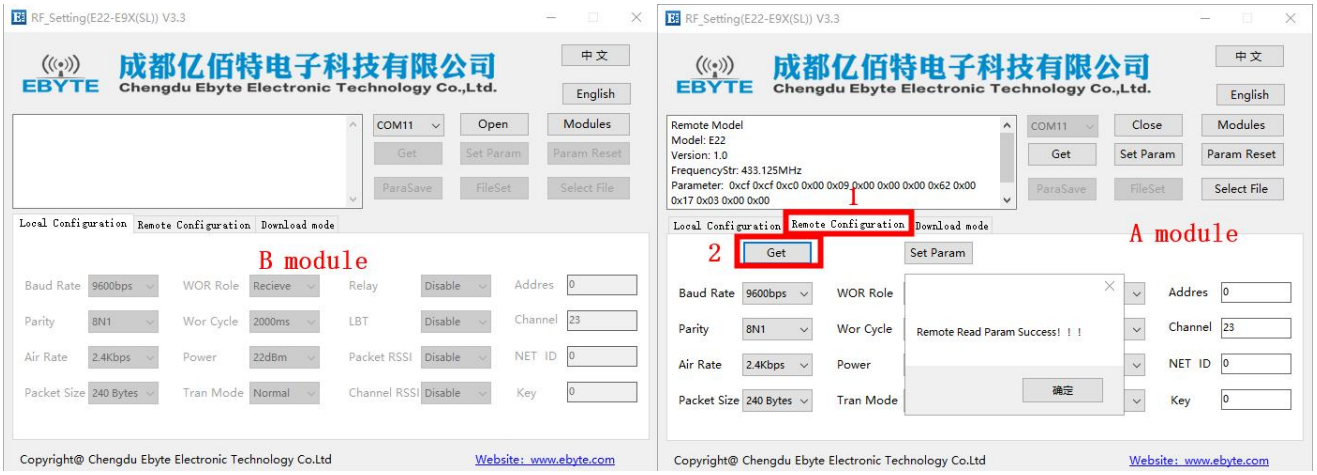


Figure 11: Host Computer Interface Diagram

Step 2: Modify parameters remotely and perform parameter writing.

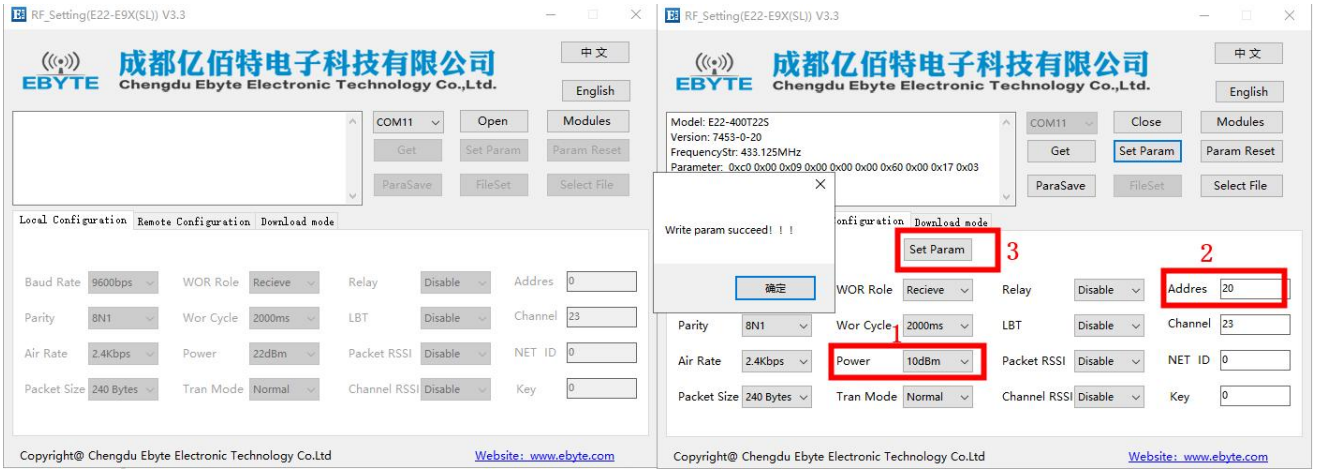


Figure 12: Host Computer Interface Diagram

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



Figure 13: Host Computer Interface Diagram

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5.1.4 Sleep Mode Usage, Mode 3 (M1, M0 pins set to 1,1)

- To activate sleep mode, simply set the M1 and M0 pins to a high level. The module will then enter sleep mode with minimal power consumption.

5.2 AUX Timing

5.2.1 Power-On Start Indicator

Tc = 25°C, VCC = 5 V

Parameters	Description	Typical value	Unit
T1	The entire startup process after powering on the module's VCC takes time (entering operational mode, user-accessible state).	16	ms
T2	After the module's VCC power supply is applied, the AUX pin begins its initial pull-down delay period. It does not immediately indicate a busy state (low level) because the internal microcontroller also requires a certain startup time. Note: During the initial phase of T2, the AUX pin operates in internal pull-up input mode. If it detects an externally applied low signal lasting over 1 second (e.g., due to an external pull-down resistor or shorting to GND), it will force an upgrade state. This prevents normal wireless data transmission/reception and configuration command processing. For further details, refer to the firmware upgrade section.	5	ms

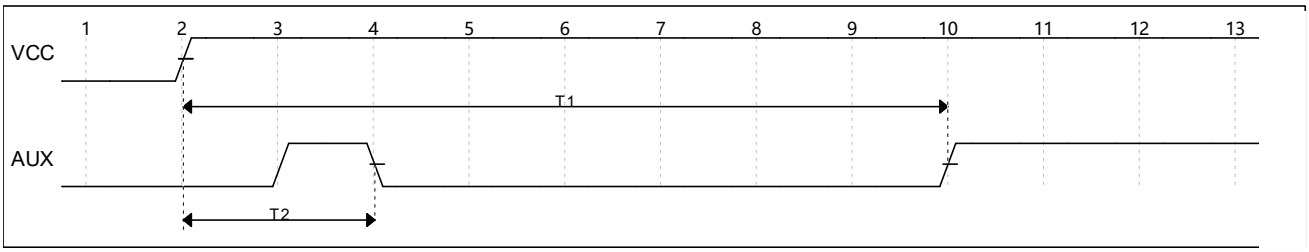


Figure 14 Power-Up Sequence Diagram

5.2.2 Serial Port Data Output Indicator

Conditions：Tc = 25°C, VCC = 5 V

Parameters	Description	Typical value	Unit
T1	After the module completes receiving air data packets, the AUX pin pulls low to indicate to external users that the microcontroller is ready. It can also serve as a	3	ms

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Parameters	Description	Typical value	Unit
	wake-up signal, suitable for certain low-power battery applications.		
T2	The module outputs the time interval between two consecutive packets of air data. Scenario 1: When the transmitter is transmitting data in an oversized packet loop and the air rate significantly exceeds the receiver's serial port rate, the serial output data from the receiver module will exhibit packet sticking (T2=0). The length of a single serial output may exceed the user-defined packet size. This is suitable for applications where Modbus reads multiple registers from a slave device and acknowledges responses. Scenario 2: When the sender is transmitting oversized packets in a loop, but both the air interface rate and serial baud rate are slow (e.g., default air interface 2.4 Mbps, serial 9600 baud). In this case, air transmission is time-consuming, so the receiver outputs packets at the packet interval.	0 or Tx (single packet airtime)	ms

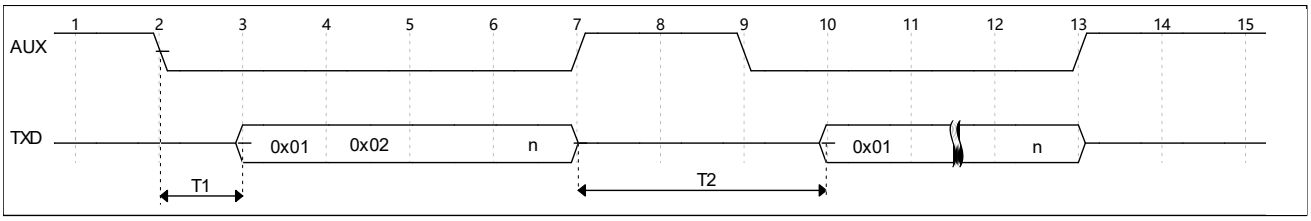


Figure 15 Serial Port Data Output Timing Diagram

5.2.3 Wireless Transmission Indicator

Tc = 25°C, VCC = 5 V

Parameters	Description	Typical value	Unit
n	Internal buffer capacity of the module serial port (maximum single-transmission data length). When the buffer contains data exceeding the user-defined packet size (default 240 bytes), it will automatically segment the data for wireless transmission processing.	1000	Byte
T1	AUX indicator delay time when the module receives serial data. The busy state (pulled low) is only indicated after the module identifies and receives the first byte of the serial data packet. Therefore, the delay time is related to the serial baud rate (default 9600 bps).	1	ms
T2	Module Cache Idle State AUX Indicator Delay (Pull-High) Time Scenario 1: When the data length transmitted to the module is shorter than the packet length (default 240 bytes), At this point, T2 represents the serial port reception frame break delay, with a default frame break time of 3 bytes (dependent on the serial port baud rate, default 9600). Once the frame break countdown ends, the AUX pin is immediately pulled high to indicate cache idle,	3 Or Tx (Transmission time)	ms

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Parameters	Description	Typical value	Unit
	simultaneously triggering the air transmission process (under default conditions, AUX does not indicate wireless transmission busy; refer to the AT+UAUX command for additional settings). Scenario 2: When the data length transmitted to the module exceeds the packet size, T2 represents the total airtime consumption (dependent on air interface rate). During serial reception, once the packet size is reached, the air transmission process is triggered immediately (LoRa air transmission is relatively time-consuming). Subsequent cycles involve multiple packet transmissions (based on the incoming data length) until all data in the receive buffer is fully transmitted. Only then is the AUX pin pulled high to indicate buffer availability.		

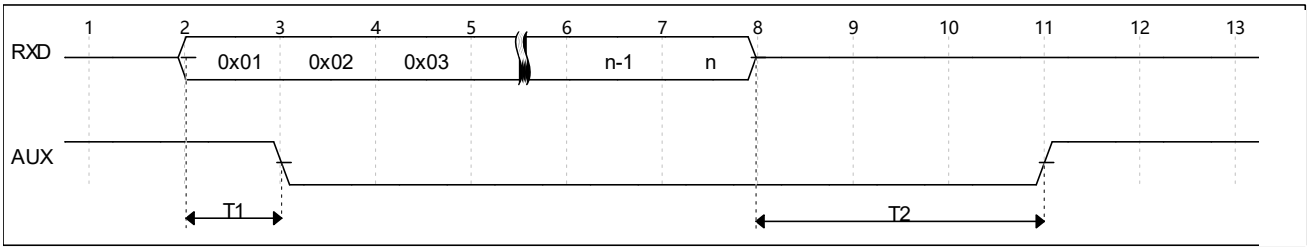


Figure 16 Wireless Transmission Timing Diagram

5.2.4 Switch Mode

When switching between all modes, the AUX will indicate a busy state for the duration specified in the table below:

Original working mode	Switch Mode	T1 Switching Time (ms)
Sleep Mode	Transparent Mode	9～11
	WOR Mode	9～11
	Configuration Mode	9～11
Transparent Mode	Sleep Mode	9～11
	WOR Mode	9～11
	Configuration Mode	9～11
Configuration Mode	Sleep Mode	9～11
	Transparent Mode	9～11
	WOR Mode	9～11
WOR Mode	Sleep Mode	9～11
	Transparent Mode	9～11
	Configuration Mode	9～11

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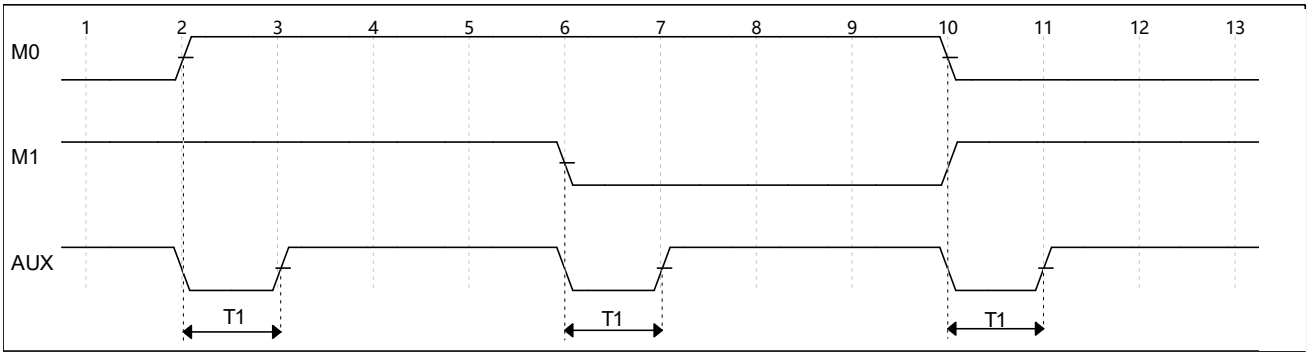


Figure 17 Mode Switching Sequence Diagram

5.2.5 Important Notes

No	AUX Notes
1	When the AUX output is low, it indicates the module is busy and will not perform mode detection.
2	If AUX remains high, mode switching will take effect immediately.
3	When transitioning from Mode 2 (Configuration Mode) to other modes or during reset, the module will reset user parameters, during which the AUX output will be low.

5.3 Relay Networking Rules

Relay networking achieves expanded network coverage and enhanced communication reliability by forwarding data between source and destination nodes via relay nodes.

No	Relay Mode Description
1	After configuring relay mode in the configuration pattern, switching to normal mode enables the relay to operate, facilitating bidirectional data forwarding between two NETIDs.
2	In relay mode, ADDH and ADDL no longer function as module addresses but correspond to NETID forwarding pairs. If data is received from one network, it is forwarded to the other network.
3	In relay mode, the relay module cannot send or receive data and cannot perform low-power operations.
4	The relay's own network ID becomes invalid.
5	Using two or more relays with identical or swapped ADDH and ADDL addresses is not recommended, as it may cause circular forwarding between relays.

As shown in the example diagram below:

Tier 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).
- Since Node 1 and Node 2 share the same address, data sent by Node 1 can be received by Node 2.

Secondary Relay

- Relay 2's ADDH and ADDL are 33 and 05, respectively.

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- Therefore, Relay 2 can forward Relay 1's data to network NETID: 05.
- Consequently, Node 3 and Node 4 can receive Node 1's data. Node 4 outputs data normally, while Node 3 does not output data because its address differs from Node 1's.
- Bidirectional Relay
- As configured in the diagram: Data sent by Node 1 can be received by Nodes 2 and 4. Data sent by Nodes 2 and 4 can also be received by Node 1.

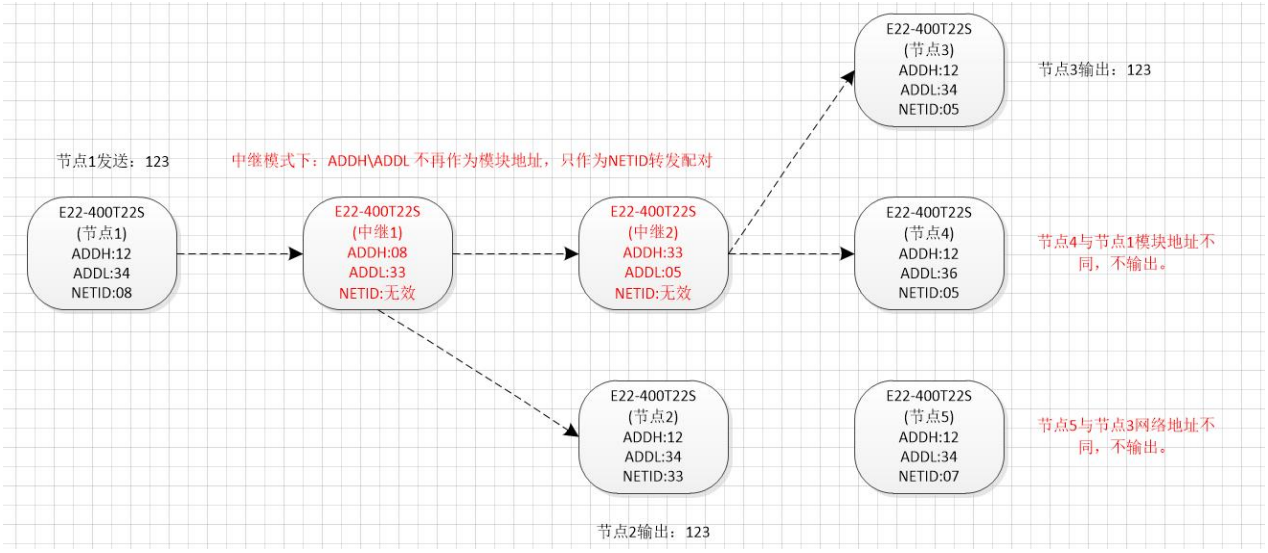


Figure 18: Relay Network Diagram

5.4 Serial Port Firmware Upgrade

① If customers require firmware upgrades, they must obtain the corresponding upgrade package through their sales channel contact. Use the host computer provided by Yibait to perform the firmware upgrade. Under normal circumstances, users do not need to upgrade the firmware. Do not use the “AT+IAP” command.

② The pins required for the upgrade must be brought out (M1, M0, AUX, TXD, RXD, VCC, GND). Then, send the “AT+IAP” command in configuration mode to enter upgrade mode.

③ After entering upgrade mode, the baud rate will automatically switch to 115200 until it exits automatically. Log output will be displayed during this process.

5.4.1 Quick Guide to Host Computer Upgrade

Step 1: Enter configuration mode by changing M0 and M1 (Note: Baud rate is 9600 in configuration mode). Open the configuration host computer and select the Firmware Upgrade tab.

Step 2: Click Read Parameters to view module information in the left window 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. A success message will appear upon completion.

Step 5: After the firmware upgrade finishes, reopen the serial port and verify the parameters by clicking Read Parameters.

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Figure 18: Host Computer Interface Diagram

6 Register Read/Write Control

6.1 HEX Instruction Format

In configuration mode (Mode 2: M1=1, M0=0), the supported command list is as follows (when setting, the serial port only supports 9600 baud, 8N1 format):

No	Command Format	Detailed Description
1	Set the register	Command: C0 + Start Address + Length + Parameters Response: C1 + Start Address + Length + Parameters Example 1: Configure channel to 0x09 Command Start Address Length Parameters Send: C0 05 01 09 Return: C1 05 01 09 Example 2: Simultaneously configure module address (0x1234), network address (0x00), serial port (9600 8N1), baud rate (2.4K) Send: C0 00 04 12 34 00 61 Return: C1 00 04 12 34 00 61
2	Read register	Command: C1 + Start Address + Length Response: C1 + Start Address + Length + Parameters Example 1: Read Channel Command Start Address Length Parameter

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No	Command Format	Detailed Description
		Send: C1 05 01 Return: C1 05 01 09 Example 2: Simultaneously Read Module Address, Network Address, Serial Port, Airspeed Send: C1 00 04 Return: C1 00 04 12 34 00 62/63
3	Set temporary registers	Command: C2 + Start Address + Length + Parameters Response: C1 + Start Address + Length + Parameters Example 1: Configure channel to 0x09 Command Start Address Length Parameters Send: C2 05 01 09 Return: C1 05 01 09 Example 2: Simultaneously configure module address (0x1234), network address (0x00), serial port (9600 8N1), baud rate (2.4K) Send: C2 00 04 12 34 00 61 Return: C1 00 04 12 34 00 62/63
4	Wireless Configuration	Command: CF CF + Standard Command Response: CF CF + Standard Response Example 1: Wireless configuration channel set to 0x09 Wireless Command Header Command Start Address Length Parameters Send: CF CF C0 05 01 09 Return: CF CF C1 05 01 09 Example 2: Simultaneously configure module address (0x1234), network address (0x00), serial port (9600 8N1), baud rate (2.4K) Send: CF CF C0 00 04 12 34 00 62/63 Return: CF CF C1 00 04 12 34 00 62/63
5	Format error	Format Error Response FF FF FF

6.2 Register Function Reference Table

Address	Name	Bit							
		bit 7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
00h	ADDH	Mailing Address [15:8]							
01h	ADDL	Mailing Address [7:0]							
02h	NETID	Network Address [7:0]							
03h	REG0	Serial Port Baud Rate [2:0]			Serial Port Parity Type [1:0]		Wireless Transmission Rate [2:0]		
04h	REG1	Serial Port Packet Length [1:0]		Environmental 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 speak.	Air Wake-Up	Air Wake Cycle [2:0]		
07h	CRYPT_H	Wireless Data Encryption Key [15:8]							
08h	CRYPT_L	Wireless Data Encryption Key [7:0]							

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09h	WD_H	Air-to-Air Wake-Up Recipient, Window Time for Acknowledgment (Transmission) After Data Receipt [15:8]
0Ah	WD_L	Air-to-Air Wake-Up Recipient, Window Time for Acknowledgment (Transmission) After Data Receipt [7:0]

Note: For reference on register software structure design, consult the E22-xxxTBL-SC series sample code (available in the relevant download section of this page). See e22_demo.h for details.

6.3 Register Specificationsj

No	Read and Write	Name	Description	Note
00 H	Read and Write	ADDH	ADDH（Default 0）	1. High byte and low byte of the module address; 2. When the module address equals FFFF, it can serve as a broadcast and listening address, meaning: the module will not perform address filtering at this time.
01 H	Read and Write	ADDL	ADDL（Default 0）	
02 H	Read and Write	NETID	NETID（Default 0）	1. Network address, used to distinguish networks; 2. Must be set to the same value for mutual communication.
03 H	Read and Write	REG0	7 6 5 UART Serial Port Speed (bps) 0 0 0 Serial port baud rate: 1200 0 0 1 Serial port baud rate: 2400 0 1 0 Serial port baud rate: 4800 0 1 1 Serial port baud rate: 9600 (Default) 1 0 0 Serial port baud rate: 19200 1 0 1 Serial port baud rate: 38400 1 1 0 Serial port baud rate: 57600 1 1 1 Serial port baud rate: 115200	1. Two modules communicating with each other may have different serial port baud rates and parity settings; 2. When transmitting large data packets consecutively, users should consider potential data blocking or even loss caused by differing baud rates; 3. It is generally recommended that both communicating parties use the same baud rate.
			4 3 Serial Port Parity Bit 0 0 8N1（Default） 0 1 8O1 1 0 8E1 1 1 8N1（equivalent 00）	The serial port modes of the communicating parties may differ;
			2 1 0 Wireless Air Interface Rate（bps） E22-400Txxx① E22-900Txxx② / E22-230Txxx③	1. E22-400Txxx①：E22-400T22D、E22-400T22S、E22-400T30D、E22-400T30S 2. E22-900Txxx②：E22-900T22D、E22-900T22S、E22-900T30D、E22-900T30S 3. E22-230Txxx③：E22-230T22D、E22-230T22S、E22-230T30D、E22-230T30S
			0 0 0 Air Rate 2.4k / Air Speed 2.4k 0 0 1 Air Rate 2.4k / Air Speed 2.4k	Note: Both communication parties must share the same air interface rate; a higher air

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<table>
<tr><td></td><td></td><td></td><td>0</td><td>1</td><td>0</td><td>Air Rate 2.4k (Default)</td><td>Air Speed 2.4k</td><td>interface rate results in lower latency but shorter transmission distance.</td></tr>
<tr><td></td><td></td><td></td><td>0</td><td>1</td><td>1</td><td>Air Rate 4.8k</td><td>Air Speed 2.4k (Default)</td><td></td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>0</td><td>0</td><td>Air Rate 9.6k</td><td>Air Speed 4.8k</td><td></td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>0</td><td>1</td><td>Air Rate 19.2k</td><td>Air Speed 9.6k</td><td></td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>0</td><td>Air Rate 38.4k</td><td>Air Speed 15.6k</td><td></td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>1</td><td>Air Rate 62.5k</td><td>Air Speed 15.6k</td><td></td></tr>
<tr><td rowspan="15">04 H</td><td rowspan="15">Read and Write</td><td rowspan="15">REG1</td><td>7</td><td>6</td><td colspan="3">Subcontract Settings</td><td rowspan="6">Note:
1. If the user sends data shorter than the packet length, the receiving serial port will output it as a continuous stream without interruption.
2. If the user sends data longer than the packet length, the receiving serial port will output it in separate packets.</td></tr>
<tr><td>0</td><td>0</td><td colspan="3">240 bytes (default)</td></tr>
<tr><td>0</td><td>1</td><td colspan="3">128 bytes</td></tr>
<tr><td>1</td><td>0</td><td colspan="3">64 bytes</td></tr>
<tr><td>1</td><td>1</td><td colspan="3">32 bytes</td></tr>
<tr><td>5</td><td colspan="4">RSSI Environmental Noise Enable</td><td rowspan="3">1. After enabling, the C0 C1 C2 C3 command can be sent in transmission mode or WOR send mode to read the register;
2. Register 0x00: Current environmental noise RSSI;
3. Register 0x01: RSSI at the time of last data reception (current environmental noise: 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 (addresses must start from 00)</td></tr>
<tr><td>0</td><td colspan="4">Disabled (default)</td></tr>
<tr><td>1</td><td colspan="4">Enable</td></tr>
<tr><td>4</td><td>3</td><td colspan="3">reserve</td><td></td></tr>
<tr><td>2</td><td colspan="4">Software Mode Switching</td><td rowspan="3">1. If using our company's host computer configuration parameters, this pin will be automatically disabled. To avoid using the M0 and M1 pins for switching operating modes, you can enable this feature and use specific serial port commands to switch modes.
2. Format: C0 C1 C2 C3 02 + Operating Mode:
●Send C0 C1 C2 C3 02 00 to switch to transparent mode;
●Send C0 C1 C2 C3 02 01 to switch to WOR mode;</td></tr>
<tr><td>0</td><td colspan="4">Disabled (Default)</td></tr>
<tr><td>1</td><td colspan="4">Enable</td></tr>
</table>

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<table>
<tr><td rowspan="11"></td><td rowspan="11"></td><td rowspan="11"></td><td colspan="2"></td><td></td><td>●Send C0 C1 C2 C3 02 02 to switch to configuration mode;
● Send C0 C1 C2 C3 02 03 to switch to sleep mode;
● Return: C1 C2 C3 02 + operating mode;
Note: After enabling this feature, configuration mode still only supports 9600 baud rate.</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">0</td><td colspan="2">Transmit Power</td><td rowspan="6">1. Power and current exhibit a nonlinear relationship; power supply efficiency peaks at maximum power output.
2. Current does not decrease proportionally with reduced power.</td></tr>
<tr><td>Suitable for 30dBm modules</td><td>Suitable for 22dBm modules</td></tr>
<tr><td>0</td><td>0</td><td>30dBm
（Default）</td><td>22dBm
（Default）</td></tr>
<tr><td>0</td><td>1</td><td>27dBm</td><td>17dBm</td></tr>
<tr><td>1</td><td>0</td><td>24dBm</td><td>14dBm</td></tr>
<tr><td>1</td><td>1</td><td>21dBm</td><td>10dBm</td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td colspan="5"></td></tr>
<tr><td>05 H</td><td>Read and Write</td><td>REG2</td><td colspan="2">Channel Control (CH)
0-64 represents a total of 65 channels (applicable to the 230 band)
0-83 represents a total of 84 channels (applicable to the 400 band)
0-80 represents a total of 81 channels (applicable to the 900 band)）</td><td>1.230 band actual frequency = 220.125 + CH × 0.25 MHz
2.400 band actual frequency = 410.125 + CH × 1 MHz
3.900 band actual frequency = 850.125 + CH × 1 MHz</td></tr>
<tr><td rowspan="12">06 H</td><td rowspan="12">Read and Write</td><td rowspan="12">REG3</td><td>7</td><td>Enable RSSI bytes (packet RSSI)</td><td rowspan="3">1. After activation, when the module receives wireless data, it outputs via the serial port TXD followed by an RSSI strength byte.
2. The current packet RSSI is: dBm = -(256 - RSSI)</td></tr>
<tr><td>0</td><td>Disabled (default)</td></tr>
<tr><td>1</td><td>Enable</td></tr>
<tr><td>6</td><td>Transmission Mode</td><td rowspan="3">During fixed-point transmission, the module identifies the first three bytes of serial data as: address high byte + address low byte + channel, and uses this as the wireless transmission target.</td></tr>
<tr><td>0</td><td>Transparent Transmission (Default)</td></tr>
<tr><td>1</td><td>Point-to-Point Transmission</td></tr>
<tr><td>5</td><td>Relay Function</td><td rowspan="3">1. When relay functionality is enabled, if the destination address is not the module itself, the module will initiate a single forwarding operation.
2. To prevent data backhaul, it is recommended to use this feature in conjunction with fixed-point mode; that is, the destination address must differ from the source address.</td></tr>
<tr><td>0</td><td>Disable Relay Function (Default)</td></tr>
<tr><td>1</td><td>Enable Relay Function</td></tr>
<tr><td>4</td><td>LBT Enable</td><td rowspan="3">1. When enabled, wireless data transmission will perform listening before transmission, which can help avoid interference to some extent but may cause data delays.
2. The maximum LBT dwell time is 2 seconds; transmission will be forced once this duration is reached.</td></tr>
<tr><td>0</td><td>Disable (Default)</td></tr>
<tr><td>1</td><td>Enable</td></tr>
<tr><td>3</td><td>WOR Mode Transmit/Receive Control</td><td rowspan="2">Applicable only to Mode 1;
1. In WOR receive mode, the module can</td></tr>
<tr><td>0</td><td>WOR Receiver (Default)</td></tr>
</table>

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				Operates in WOR listening mode with a listening cycle as described below (WOR cycle), enabling significant power savings.			modify the wake-up delay time, with the default time set to 0; 2. The receiver must send the command C0 09 02 03 E8 in configuration mode (C0 is the write command, 09 is the starting address of the register, 02 is the length, 03 E8 is the set delay time, with a maximum of FFFF corresponding to 65535ms; setting it to 0 disables the wake-up delay). 3. Data can be transmitted within the delay period.
			1	WOR Transmitter The module's transceiver is activated, and a wake-up code of a specified duration is inserted during data transmission.			
			2	1	0	WOR Cycle	**Applicable only to Mode 1;** 1. Cycle T = (1 + WOR) × 500 ms, maximum 4000 ms, minimum 500 ms; 2. Longer WOR monitoring interval cycles result in lower average power consumption but increased data latency; 3.Transmitter and receiver must be synchronized (critical).
			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	Key High Byte (Default 0)				1.Write only; reads return 0; 2.Used for encryption to prevent interception of wireless data by similar modules; 3.Internally, the module will use these two bytes as computational factors to transform and encrypt wireless signals.
08 H	Write	CRYPT_L	Key Low Byte (Default 0)				
80 H ～ 86 H	Read	PID	Product Information 7 bytes				Product Information 7 bytes Note: Refer to Section 7.1 for the AT+DEVTYPE=? query command, which is more convenient.

6.4 Register Parameter Factory Default Values

Model	**Factory default parameter values for 230MHz module: C0 00 09 00 00 00 63 00 28 03 00 00 Factory default parameter values for 400MHz module: C0 00 09 00 00 00 62 00 17 03 00 00 Factory default parameter values for 900MHz module:: C0 00 09 00 00 00 62 00 12 03 00 00**						
SKU	Frequency	Address	Channel	Air Rate	Baud rate	Serial Port Format	Transmit Power
E22-230T22S E22-230T22D	230.125MHz	0x0000	0x28	2.4kbps	9600	8N1	22dbm
E22-230T30S E22-230T30D	230.125MHz	0x0000	0x28	2.4kbps	9600	8N1	30dbm
E22-400T22S E22-400T22D	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	22dbm

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E22-400T30S E22-400T30D	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	30dbm
E22-900T22S E22-900T22D	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	22dbm
E22-900T30S E22-900T30D	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	30dbm

7 AT Commands

- Parameter configuration or queries using AT commands must be performed in configuration mode (configuration mode serial port is fixed at 9600 8N1);
- For software version (7453-0-20) and earlier, no carriage return/line feed is required at the end of user-entered AT commands;
- Starting with software version (7453-0-21), the system automatically recognizes the carriage return/line feed at the end of user AT commands and will still recognize them even without the return/feed;
- If AT command recognition or execution encounters an error, the response “=ERR” will be returned;
- Input parameters exceeding the specified range will be restricted. Do not allow parameters to exceed the range to avoid unexpected situations.

7.1 General Command

7.1.1 AT+RESET Software Reset

Command Format	AT+RESET
Execution Example	Send: AT+RESET Response: =OK
Feature Description	● Software versions (7453-0-20) and earlier will not respond with “=OK”. ● Software versions (7453-0-21) and later will respond with “=OK”. ● The actual reset process will only begin after the “=OK” response. Users should wait approximately 30ms before proceeding with the next operation.

7.1.2 AT+DEFAULT Restore factory settings

Command Format	AT+DEFAULT
Execution Example	Send: AT+DEFAULT Response: =OK
Feature Description	After acknowledging (=OK), the system will perform parameter restoration and initiate a restart process. Please wait approximately 30 milliseconds before proceeding with the next operation.

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7.1.3 AT+DEVTYPE Query product model

Command Format	AT+DEVTYPE=?
Execution Example	Send: AT+DEVTYPE=? Response: DEVTYPE=E22-400T30S
Feature Description	● Product Series: E22 ● Operating Frequency Bands: 400 (170/230/400/900) ● Maximum Power: 30 (22/30/33)

7.1.4 AT+FWCODE Query Software Version

Command Format	AT+FWCODE=?
Execution Example	Send: AT+FWCODE=? Response: FWCODE=7453-0-23
Feature Description	● Major Version: 7453 ● Branch Number: 0 ● Minor Version: 23 (increments starting from 10)

7.1.5The AT+SWITCH software switching mode is enabled

Command Format	AT+SWITCH=<on_off>
Configuration Examples	Send: AT+SWITCH=0 Response: =OK
Query Examples	Send: AT+SWITCH=? Response: AT+SWITCH=0
Parameter Descriptions	**<on_off>: Switch** 0 Off (default) 1 On
Feature Descriptions	● Factory default is disabled. Use the M0M1 pin to switch operating modes (hard switch). ● When enabled, the M0M1 pin remains functional. The last triggered switch (hard or soft) takes precedence. ● After enabling, restart the system for it to take effect. ● When enabled, AT+MODE can be used to specify the operating mode (soft switch), and each soft switch immediately saves the operating mode number ● When enabled, for software versions (7453-0-20) and earlier, the initial operating mode after power-off restart is determined by the M0/M1 hardware mode ● When enabled, for software versions (7453-0-21) and later, the last saved soft-switch mode number becomes the initial operating mode after power-off reset. ● When disabled, the M0/M1 hardware mode becomes the initial operating mode after power-off reset.

7.1.6 AT+MODE Software Mode Switching

Command Format	AT+MODE=<mode>
Configuration Example	Send: AT+MODE=0 Response: AT+MODE=0

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Query Example	Send: AT+MODE=? Response: AT+MODE=0
Parameter Description	**<mode>: Operating Mode Number** 0 Transmission Mode 1 Wake-on-Radio Mode (WOR) 2 Configuration Mode 3 Sleep Mode
Feature Description	● Must be enabled via AT+SWITCH before use ● Operates in any working mode ● Actual mode switching begins only after acknowledgment (=OK); users should wait approximately 15ms before proceeding ● Refer to AT+SWITCH feature documentation ● See Chapter 5 for detailed switching time specifications

7.1.7 AT+UAUX Wireless AUX Indicator Enable

Command Format	**AT+UAUX=<on_off>**
Configuration Example	Send: AT+UAUX=0 Response: =OK
Query Example	Send: AT+UAUX=? Response: AT+UAUX=0
Parameter Description	**<on_off>: Switch** **0 Off (default)** **1 On**
Feature Description	● Software version (7453-0-20) and earlier do not support this command. By default, AUX indicates the wireless transmission process (pulls low during transmission). For upgrades, please contact Yibait staff. ● Software version (7453-0-21) and later versions are disabled by default. AUX does not indicate the wireless transmission process (enabling faster packet transmission for some users). Enable this feature if compatibility with previous AUX timing is required. ● For detailed AUX timing output specifications, refer to Chapter 5.

7.1.8 AT+ADDR Communication Address (Matching 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>: Postal Address 0 - 65535**
Feature Description	● Default address 0 ● The address is not an RF characteristic but merely an identifier carried within the packet, assisting the receiving software logic in determining whether to perform matching and filtering. ● Broadcast address 65535. As a receiver, it can receive data sent from any address on the same channel (unfiltered). As a sender, the transmitted packet carries the broadcast address, so the recipient will not filter it either (broadcast data).

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7.1.9 AT+NETID Communication Network Code (Matching Filter)

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>: Network code 0 - 255**
Feature Description	● Default network 0 ● Network codes are not RF characteristics but merely identifiers carried within packets, assisting receiving-end software logic in determining whether to relay forwarding or filtering. ● Network code filtering has lower priority than broadcast addresses. Even with differing network codes, broadcast data can still be received.

7.1.10 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	**Communication Channel 0 - 83 E22-400T22D, E22-400T22S, E22-400T30D, E22-400T30S**	**Communication Channels 0 - 80 E22-900T22D, E22-900T22S, E22-900T30D, E22-900T30S**	**Communication Channels 0 - 63 E22-230T22D, E22-230T22S, E22-230T30D, E22-230T30S**
Feature Description	● Channel ranges differ across frequency bands; please note the distinctions. ● For the 230 MHz band, the actual carrier frequency corresponds to:= 220.125 MHz + channel * 0.25 MHz ● For the 400 MHz band, the actual carrier frequency corresponds to:= 410.125 MHz + channel frequency × 1 MHz ● For the 900 MHz band, the actual carrier frequency corresponds to:= 850.125 MHz + channel frequency × 1 MHz		

7.1.11 AT+KEY Communication Password (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 ● Unable to query (cannot read password) ● Modules with mismatched passwords cannot communicate (unable to decode correct data packets, fail verification checks and are discarded)

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7.1.12 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 1200bps 1 2400bps 2 4800bps 3 9600bps (default) 4 19200bps 5 38400bps 6 57600bps 7 115200bps <parity>: Serial port parity type 0 None (default) 1 Odd parity 2 Even parity
Feature Description	● In configuration mode (M0M1 Mode 2), force fixed 9600 8N1 ● Takes effect after switching operating modes

7.1.13 AT+PACKET Serial 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 port reception, if user-transmitted data falls short of the set length, it is processed as a timeout frame break and repackaged for wireless transmission. ● During serial port reception, when user-transmitted data reaches the set length, it is immediately packaged for wireless transmission. ● Data exceeding the set length continues to accumulate in the serial port buffer. After wireless transmission completes, it is resplit according to the set length and sent in single packets cyclically.

7.1.14 AT+URXT Serial Port Frame Disconnection Condition

Command Format	**AT+URXT=<byte>**
Configuration	Send: AT+URXT=3

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Example	Response: =OK
Query Example	Send: AT+URXT=? Response: AT+URXT=3
Parameter Description	**<byte>: Byte time 1 - 255**
Feature Description	● Default serial port frame break processing uses a 3-byte timeout. ● Timeout duration varies by baud rate (per-byte time). At 9600 baud, approximately 1 millisecond per byte; at 115200 baud, approximately 100 microseconds per byte. ● Some customers experience discontinuous data transmission from external microcontroller serial ports to the module (e.g., due to RTOS task interruptions). When data exceeds the module's configured byte time window, it is treated as a frame break and manifests as packet fragmentation at the receiving end.

7.1.15 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	**Air Speed** **E22-400T22S, E22-400T22D, E22-400T30S, E22-400T30D, E22-900T22S, E22-900T22D, E22-400T30D, E22-900T30S** 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	**<rate>: Air Data Rate** **E22-230T30D, E22-230T30S, E22-230T30D, E22-230T30S** 0 2.4Kbps 1 2.4Kbps 2 2.4Kbps 3 2.4Kbps (Default) 4 4.8Kbps 5 9.6Kbps 6 15.6Kbps 7 15.6Kbps
Feature Description	● Airspeed ranges vary across different frequency bands; please note the distinctions. ● Higher airspeeds result in lower communication latency (shorter transmission times), but also reduced reception sensitivity (shorter communication distances).	

7.1.16 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 Point-to-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 target communication address, while the third byte identifies the target communication channel (automatic channel switching).

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	● After completing data transmission, point-to-point transmission automatically switches back to the original channel.

7.1.17 AT+LBT Listen Before Talk Enable (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 LBT (Listen Before Talk) is enabled, the system will check whether the ambient signal strength is below the set threshold before each wireless transmission. If the condition is met within the timeout period, the wireless transmission will proceed normally. If the condition remains unmet after the maximum timeout period, the wireless transmission will be forced to initiate. ● For specific LBT condition settings, refer to the AT+LBR command.

7.1.18 AT+LBR Listen-Before-Transmit Determination Condition

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 duration (milliseconds) 0 - 65535**
Feature Description	● Software version (7453-0-20) and earlier versions do not support this command, but the default parameters remain the same: fixed at -55dBm and 2000ms.

7.1.19 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	● After enabling, refer to Chapter 5 for details on the relay networking mode. ● A relay essentially retransmits received wireless data, doubling the airtime transmission duration (latency). ● Relays operate in half-duplex mode. Ensure sufficient time is allocated for the relay to complete its forwarding task. If a user sends data to the relay during its forwarding process, packet loss may occur.

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7.1.20 AT+WOR Wake-on-Radio Role (Transmit/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 maintains normal power consumption. ● The receiver enters sleep mode according to a predefined air wake-up cycle to reduce power consumption and cannot receive wireless signals during sleep. After the sleep period countdown ends, the RF unit briefly wakes up and enters a receiving state. If a wake-up signal is detected during this window, it enters a normal continuous receiving state, awaiting subsequent wireless data. If no signal is detected, it enters the next sleep-wake cycle. ● The transmitter inserts a wake-up code before user data according to the configured air wake-up cycle, meaning it first wakes up the receiver before transmitting data. This results in longer transmission time (delay).

7.1.21 AT+WTIME Wake-on-Air Period

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 duration** 0 500ms 1 1000ms 2 1500ms 3 2000ms (default) 4 2500ms 5 3000ms 6 3500ms 7 4000ms
Feature Description	● The longer the air wake-up receiver sleep time, the lower the average power consumption, but the greater the communication delay. ● Software version (7453-0-16) and earlier do not support this command. Please use the HEX command to set the register instead.

7.1.22 AT+DELAY Air Wake-up Receiver Response Time

Command Format	**AT+DELAY=<timeout>**
Configuration Example	Send: AT+DELAY=0 Response: =OK
Query	Send: AT+DELAY=?

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Example	Response: AT+DELAY=0
Parameter Description	**<timeout>** ： Response Window Time (milliseconds) 0 - 65535
Feature Description	● Default value is 0, meaning the air-wake receiver immediately enters sleep mode after receiving wireless data and outputting it via the serial port. ● After setting a time (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. Users can transmit response data to the module and send it out within this window.

7.1.23 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	● After enabling, refer to the “RSSI Environmental Noise Enable” section in the detailed register description and use the hexadecimal command to read the data.

7.1.24 AT+DRSSI Receive Data Packet Signal Strength

Command Format	**AT+DRSSI=<on_off>**
Configuration Example	Send: AT+DRSSI=0 Response: =OK
Query Example	Send: AT+ERSSI=? Response: AT+ERSSI=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: Assuming the received RSSI data is 0xC4 (-60dBm), hexadecimal 0xC4 converts to decimal 196. The conversion formula is: RSSI = -(256 - 196) = -60 ● When the distance between transmitter and receiver is too short or transmitter power is excessively high, the received signal strength may reach 0 (upper limit). In such cases, directly convert to 0dBm.

7.1.25 AT+POWER Power Tiering

Command Format	AT+POWER=**<Power>**
Configuration Example	Send: AT+POWER=0 Response: AT+POWER=0
Query	Send: AT+POWER=?

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Example	Response: AT+POWER=0	
Parameter Description	**<Power>: Power** **E22-400T30S, E22-400T30D, E22-900T30D, E22-900T30S, E22-230T30D, E22-230T30S,** 0 30dBm (Default) 1 27dBm 2 24dBm 3 21dBm	**<Power>: Power** **E22-400T22S, E22-400T22D, E22-900T22D, E22-900T22S, E22-230T22D, E22-230T22S,** 0 22dBm (Default) 1 17dBm 2 14dBm 3 10dBm
Feature Description	-	

7.2 Signaling Testing (Certification)

7.2.1 Test Command Declaration

The AT command testing section is intended solely for auxiliary use during product certification processes (e.g., CE, FCC certification, etc.). Do not use it for any other purposes.

EBYTE assumes no liability for damages resulting from failure to comply with relevant operational or design specifications. Yibait strives to ensure the completeness, accuracy, and timeliness of features under development, but does not exclude the possibility of errors or omissions in such features. Unless otherwise agreed upon, no implied or statutory warranties are provided for the use of features under development. To the maximum extent permitted by applicable law, Yibait shall not be liable for any damages incurred from using features under development, regardless of whether such damages were foreseeable.

7.2.2 Test Command Reference

- Detailed documentation for instruction operations is available through EBYTE sales channels.

AT command	Function Overview
AT+FPOWER	Fine-tuning of transmit power
AT+XCAP	Crystal oscillator calibration
AT+ULORAM	Modification of LoRa modulation parameters (SF spread factor, BW transmit bandwidth, CR coding rate)
AT+OPTIMIZE	Low-rate optimization options
AT+UFREQ	Carrier frequency adjustment (starting frequency point, 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

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8 Hardware Design

- It is recommended to power this module using a DC regulated power supply with minimal ripple coefficient. Ensure the module is reliably grounded.
- Pay attention to correct polarity connection of the power supply terminals. Reverse polarity may cause permanent damage to the module.
- Verify the power supply voltage falls within the recommended range. Exceeding the maximum voltage may cause permanent damage to the module.
- Verify power supply stability; voltage must not fluctuate significantly or frequently.
- When designing the power circuit for the module, it is generally recommended to maintain a margin of at least 30% to ensure long-term stable operation of the entire system.
- Keep the module as far as possible from power supplies, transformers, high-frequency traces, and other sources of significant electromagnetic interference;
- High-frequency digital traces, high-frequency analog traces, and power traces must avoid routing beneath the module. If routing beneath the module is unavoidable (assuming the module is soldered to the Top Layer), place a ground plane (full copper grounding) on the Top Layer where the module contacts the board. Routing must be positioned close to the module's digital section and placed on the Bottom Layer;
- If the module is soldered or placed on the Top Layer, routing traces arbitrarily on the Bottom Layer or other layers is incorrect and will adversely affect the module's spurious emissions and reception sensitivity to varying degrees;
- Components emitting significant electromagnetic interference near the module will severely degrade its performance. Depending on the interference strength, position them appropriately away from the module. Where feasible, implement suitable isolation and shielding;
- If high-interference traces (high-frequency digital, high-frequency analog, power lines) exist near the module, performance will be severely degraded. Depending on interference intensity, maintain adequate distance from the module. Where feasible, implement appropriate isolation and shielding.
- Antenna mounting structure significantly impacts module performance. Ensure the antenna is exposed and ideally oriented vertically upward.
- When installing the module inside an enclosure, use a high-quality antenna extension cable to route the antenna externally.
- Never install the antenna inside a metal enclosure, as this will drastically reduce transmission range.

9 Common problems

9.1 Unsatisfactory transmission distance

- When there are linear communication barriers, the communication distance will decay accordingly;
- Temperature, humidity, and co-channel interference, which will lead to higher communication packet loss rate;
- The ground absorbs and reflects radio waves, and the test results are poorer near the ground;
- Seawater has a strong ability to absorb radio waves, so the effect of the seaside test is poor;
- Metal objects near the antenna, or placed in a metal shell, the signal attenuation will be very serious;

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- Wrong power register setting, air rate setting is too high (the higher the air rate, the closer the distance);
- Low voltage of power supply at room temperature is lower than the recommended value, the lower the voltage the lower the hair power;
- The use of antenna and module matching degree is poor or the antenna itself quality problems.

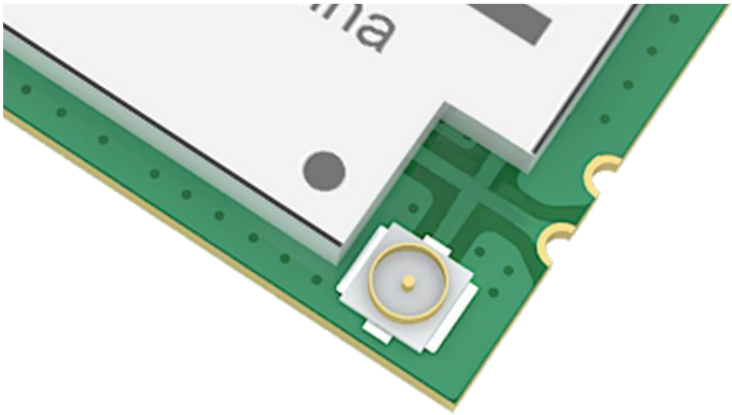
9.2 Modules are fragile

- Please check the power supply to ensure that it is between the recommended supply voltages, if it exceeds the maximum value it will cause permanent damage to the module;
- Please check the power supply stability, the voltage can not be substantial frequent fluctuations;
- Please ensure that the installation and use process anti-static operation, high-frequency device electrostatic sensitivity;
- Please ensure that the installation and use of the process of humidity should not be too high, part of the components for humidity-sensitive devices;
- If there is no special demand is not recommended to be used at too high or too low a temperature.

9.3 BER is too high

- Near the same frequency signal interference, away from the source of interference or modify the frequency and channel to avoid interference;
- Poor power supply may also cause garbled code, be sure to ensure the reliability of the power supply;
- Extension cords, feeder cords of poor quality or too long, can also cause high BER.

9.4 Antenna Selection



Enable both the IPEX interface and the stamp hole interface simultaneously. Either the IPEX interface or the stamp hole interface may be selected as needed.

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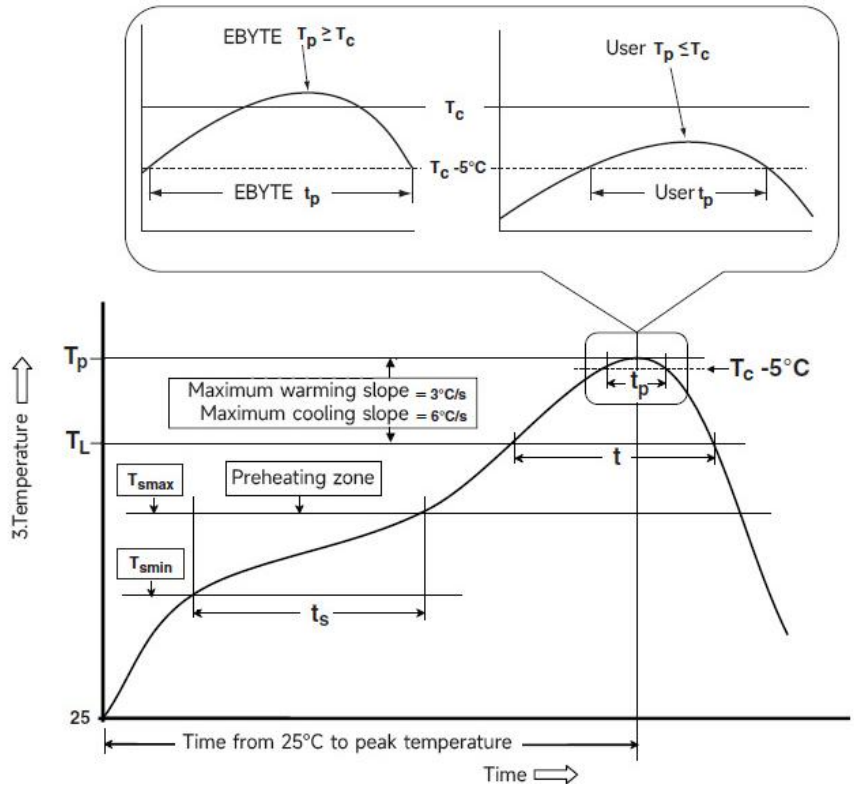
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10 Welding instructions

10.1 Reflow temperature

Reflow Soldering Profile Characteristics		Lead-based assembly process	Lead-Free Assembly Process
Preheat/Keep Warm	Minimum Temperature (Tsmin)	100℃	150℃
	Maximum Temperature (Tsmax)	150℃	200℃
	Time (Tsmin~Tsmin)	60-120S	60-120S
Temperature Rise Rate (TL~Tp)		3°C/s, maximum value	3°C/s, maximum value
Liquid Phase Temperature (TL)		183℃	217℃
Hold Time Above TL		60~90S	60~90S
Peak Package Temperature Tp		Users must not exceed the temperature indicated on the product's "Moisture Sensitivity" label.	Users must not exceed the temperature indicated on the product's "Moisture Sensitivity" label.
Within the specified temperature range (Tc) of 5°C, the time (Tp) required to reach the target temperature is shown in the figure below.		20s	30s
Temperature drop slope (Tp to TL)		6°C/s, maximum value	6°C/s, maximum value
Time from room temperature to peak temperature		6 minutes, maximum	8 minutes, maximum
※The tolerance for the peak temperature (Tp) of the temperature curve is defined as the user's upper limit.			

10.2 Reflow temperature



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11 Related Models

Model No.	Carrier frequency Hz	Transmit Power dBm	Test Distance km	Package Type	Product Dimensions (mm)	Communication Interface
E22-400M22S	433/470M	22	7	SMD	14*20	SPI
E22-400M30S	433/470M	30	12	SMD	24*38.5	SPI
E22-900M22S	868/915M	22	7	SMD	14*20	SPI
E22-900M30S	868/915M	30	12	SMD	24*38.5	SPI

12 Antenna Guide

12.1 Antenna Recommendations

Antennas play a crucial role in communication processes, and substandard antennas can significantly impact communication systems. Therefore, our company recommends certain antennas that are compatible with our wireless modules, offering superior performance at a reasonable price.

Model No.	Type	Frequency Band (Hz)	Interface	Gain (dBi)	Height (mm)	Feed line (cm)	Features
TX433-JZG-6	Rubber Rod Antenna	433M	SMA-J	2.5	62	-	Ultra-short straight, omnidirectional antenna
TX433-JW-5	Rubber Rod Antenna	433M	SMA-J	2.0	50	-	Bendable plastic rod, omnidirectional antenna
TX433-JWG-7	Rubber Rod Antenna	433M	SMA-J	2.5	75	-	Bendable plastic rod, omnidirectional antenna
TX433-JK-11	Rubber Rod Antenna	433M	SMA-J	2.5	110	-	Bendable plastic 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	470/490M	SMA-J	2.0	50	-	Ultra-short straight, omnidirectional antenna

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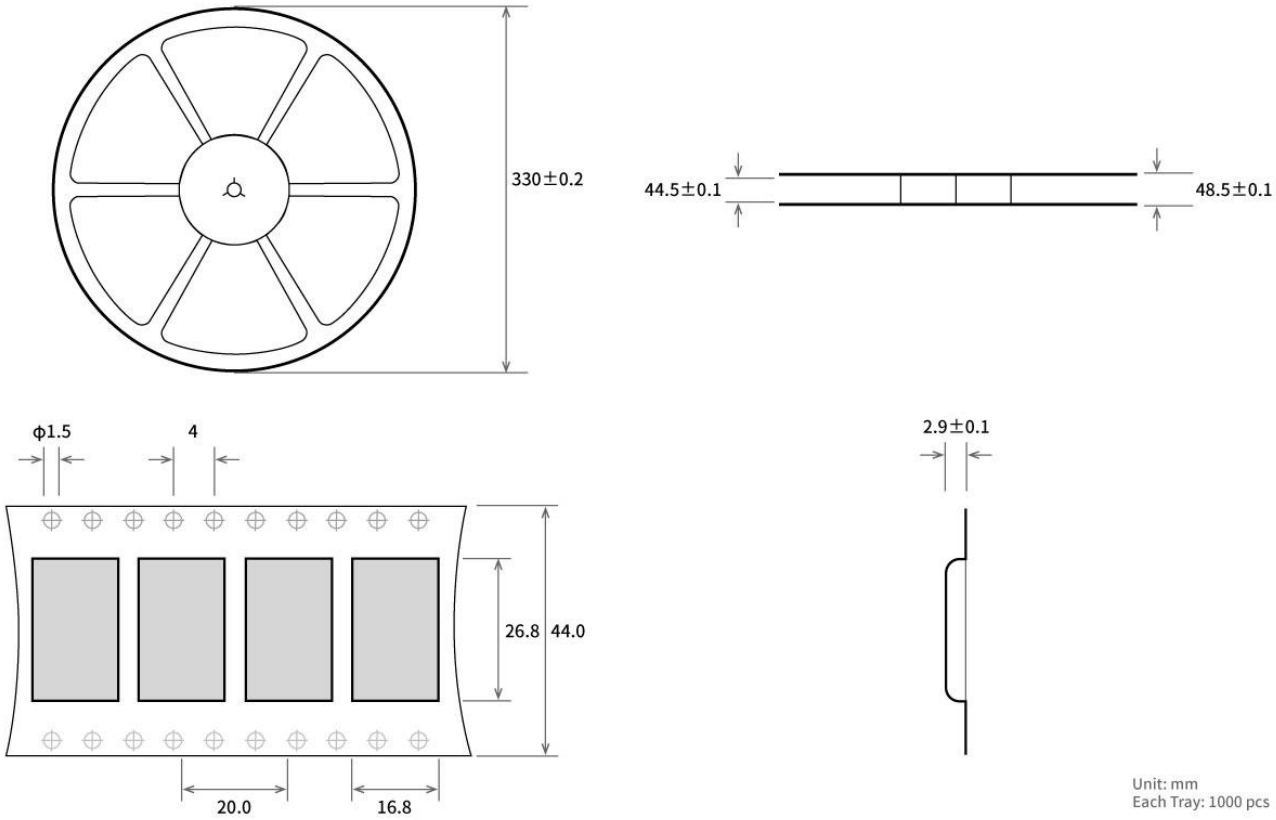
Model No.	Type	Frequency Band (Hz)	Interface	Gain (dBi)	Height (mm)	Feed line (cm)	Features
TX490-XPL-100	Suction Cup Antenna	470/490M	SMA-J	3.5	120	100	Compact suction cup antenna, cost-effective
TX868-JKS-IPX20	Rubber Rod Antenna	868M	IPEX-1	3.0	197	200	Flexible rod antenna, omnidirectional
TX868-JZLW-15	Rubber Rod Antenna	868M	IPEX-1	3.0	165	150	Flexible rod antenna, omnidirectional
TX868-XPL-100	Suction Cup Antenna	868M	SMA-J	3.5	290	100	Compact suction cup antenna, cost-effective
TX868-JKD-20	Rubber Rod Antenna	868M	SMA-J	3.0	170	-	Flexible rod antenna, omnidirectional
TX915-JKS-IPX20	Rubber Rod Antenna	915M	IPEX-1	3.0	197	200	Flexible rod antenna, omnidirectional
TX915-JZLW-15	Rubber Rod Antenna	915M	IPEX-1	3.0	155	150	Flexible rod antenna, omnidirectional
TX915-JKD-20	Rubber Rod Antenna	915M	SMA-J	3.5	200	-	Flexible rod antenna, omnidirectional
TX915-XPL-100	Suction Cup Antenna	915M	SMA-J	3.5	260	100	Compact suction cup antenna, cost-effective

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13 Bulk packaging method

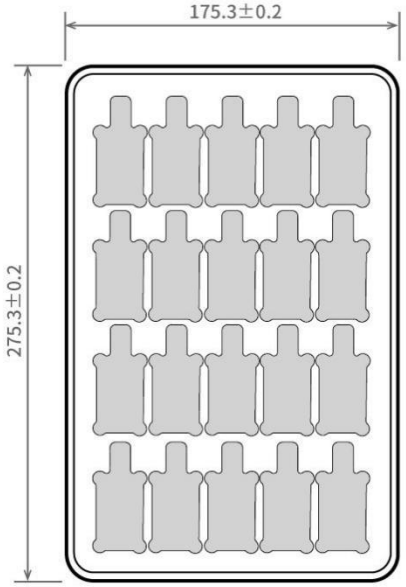
13.1 E22-230/400/900T22S Bulk Packaging Method



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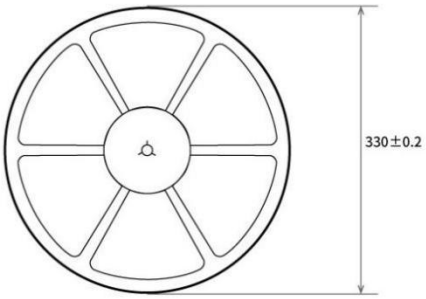
13.2 E22-230/400/900T22D(30D) Bulk Packaging Method

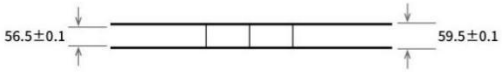


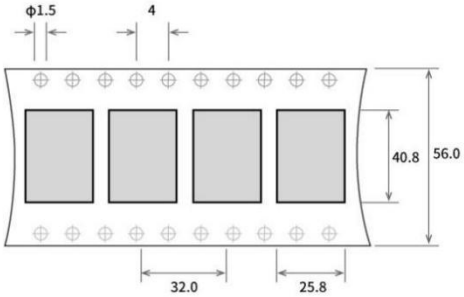


Unit: mm
Each Layer: 20 pcs
Each Package: 5 layers

13.3 E22-230/400/900T30S Bulk Packaging Method









Unit: mm
Each Tray: 400 pcs

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Revision history

Version	Revision Date	Revision Notes	Maintainer
1.0	2023-10-25	Initial Version	Hao
1.1	2024-3-20	Content Corrections	Hao
1.2	2024-3-29	Content Corrections	Hao
1.3	2024-6-21	Content Format Updates	Hao
1.4	2025-2-13	Updated Surface Mount Component Dimension Drawings	Hao
1.5	2025-10-27	Model Consolidation and Content Integration	Hao
1.6	2026-2-5	WOR instruction description modification	Hao
1.7	2026-3-16	Airspeed Command Modification Description	Hao
1.8	2026-5-29	Content Corrections	Hao
1.9	2026-9-2	Content Corrections	Hao

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