EWM628-T Series Product Specifications

Full-Duplex Frequency-Hopping 2.4 GHz ISM-Band LoRa Wireless Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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1 Product Overview

1.1 Product Introduction

The EWM628-T series comprises next-generation LoRa full-duplex, automatic frequency-hopping data-transmission modules. Based on a high-performance Semtech RF chip, these UART modules provide up to 27 dBm transmit power, multiple transmission modes, operation in the 2.4 GHz ISM band, LoRa spread-spectrum communication, TTL-level output, and compatibility with 3.3 V I/O.

The EWM628-T series uses next-generation LoRa spread-spectrum technology for higher speed, lower power consumption, and a smaller footprint. It supports full-duplex frequency hopping, carrier sensing, automatic relaying, communication keys, and configurable packet length. Custom development is also available.

The EWM628-T series includes three modules with different power levels and packages. For details, see Section 2.1, “EWM628-T Series Model Comparison”.

1.2 Key Features

- Next-generation LoRa spread-spectrum modulation for longer range and greater interference immunity;
- Operation in the 2.4 GHz ISM band;
- Full-duplex and frequency-hopping operation;
- Firmware upgrade over UART for easier maintenance;
- Both HEX and AT command sets;
- Relay networking, including multistage relays for long-range communication and multiple co-located networks;
- User-defined, write-only communication keys for improved data confidentiality;
- Listen before talk (LBT), which measures channel noise before transmission to improve reliability in harsh RF environments;
- RSSI indication for assessing signal quality;
- Fixed-point transmission, broadcast transmission, and channel monitoring;
- Deep-sleep mode;
- Multiple over-the-air data rates;
- Nonvolatile parameter storage, allowing the module to resume operation with the configured settings after power-up;
- Built-in watchdog for automatic recovery after an unexpected fault.

1.3 Applications

- Smart irrigation and environmental monitoring;
- Photovoltaic-plant monitoring and distributed PV-system management;
- Home-security alarms and remote keyless entry;
- Smart-home and industrial-sensor systems;

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- Wireless alarm and security systems;
- Building-automation solutions;
- Wireless industrial remote controls;
- Healthcare products;
- Advanced metering infrastructure (AMI).

2 Specifications

2.1 EWM628-T Series Model Comparison

Product model		EWM628-2G4T12SX	EWM628-2G4T20SX	EWM628-2G4T27SX
Product image				
Modulation		Next-generation LoRa modulation	Next-generation LoRa modulation	Next-generation LoRa modulation
Operating band①		2400–2500 MHz	2400–2500 MHz	2400–2500 MHz
Buffer capacity	Transmit buffer	2048 bytes	2048 bytes	2048 bytes
	Receive buffer	2048 bytes	2048 bytes	2048 bytes
Maximum packet length②		240 bytes	240 bytes	240 bytes
Air data rate③		8.8–203.1 kbps	8.8–203.1 kbps	8.8–203.1 kbps
Blocking power④		10 dBm	10 dBm	10 dBm
Transmit power⑤		12 dBm	20 dBm	27 dBm
Operating voltage⑥		2.3–5.5 V	2.3–5.5 V	2.3–5.5 V
Logic level		3.3 V	3.3 V	3.3 V
Transmit current⑦		35–48 mA, instantaneous current at 12 dBm	120–160 mA, instantaneous current at 20 dBm	260–560 mA, instantaneous current at 27 dBm
Receive current		14–15 mA	20–22 mA	21–23 mA
Average sleep current		5–7 μA	6–8 μA	6–8 μA
Reference range⑧		2.1 km	3.5 km	4 km
Operating temperature		−40 to +85 °C	−40 to +85 °C	−40 to +85 °C
Storage temperature		−40 to +95 °C	−40 to +95 °C	−40 to +95 °C
Antenna interface⑨		IPEX-1/PCB	IPEX-1/stamp-hole	IPEX-1/stamp-hole
Interface		1.27 mm stamp-hole	1.27 mm stamp-hole	2.54 mm stamp-hole
Package		SMD	SMD	SMD
Dimensions		28.7 × 17.5 × 2.8 mm	16 × 26 × 3.15 mm	40.5 × 25 × 4 mm
Weight		≈2.2 g	≈1.38 g	≈4.8 g

Notes:

(1) Operating band①: the frequency range can be customized.

(2) Maximum packet length②: Maximum payload per packet. Longer data are packetized automatically. The length can be configured with the PC tool or commands; see Section 6.

(3) Air data rate③: The air data rate is adjustable in multiple steps; see Sections 6 and 7.

(4) Blocking power④: High-power modules may be damaged if used at very short range.

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(5) Transmit power[⑤]: 12 dBm = 15.8 mW, 20 dBm = 100 mW, and 27 dBm = 500 mW. Accuracy is ±1 dBm. Multiple power levels are available; see Sections 6 and 7.

(6) Operating voltage[⑥]: To ensure rated output power, supply the 20 dBm and 27 dBm modules with at least 5 V and the 12 dBm module with at least 3.3 V. Voltages above 5.5 V will permanently damage the module.

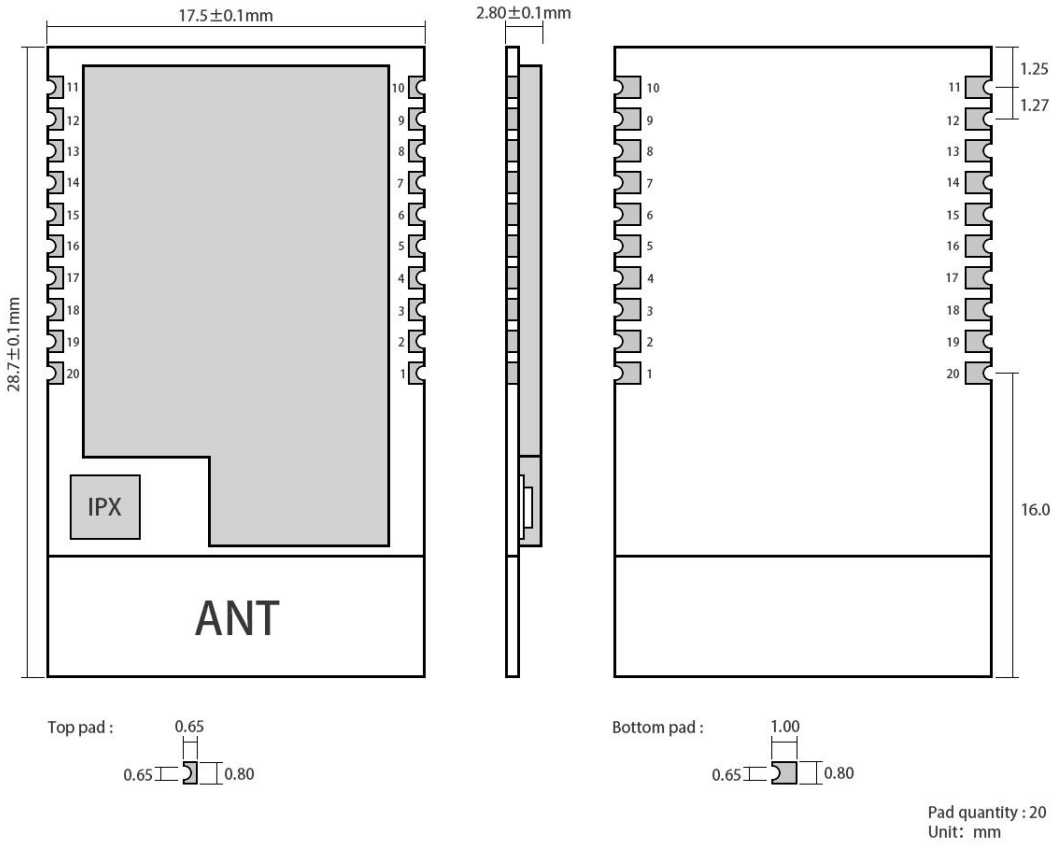
(7) Transmit current[⑦]: Transmit current varies with the supply voltage.

(8) Test range[⑧]: Measured in clear, open conditions at 8.8 kbps with the antenna 2 m above ground. Values are for reference only; verify performance in the intended installation.

(9) Antenna interface[⑨]: nominal impedance approximately 50 Ω.

3 Mechanical Dimensions and Pin Definitions

3.1 EWM628-2G4T12S Dimensions and Pin Definitions



Pin no.	Pin name	Direction	Function
1	GND	Ground reference	Module ground
2	NC	-	NC (leave floating)

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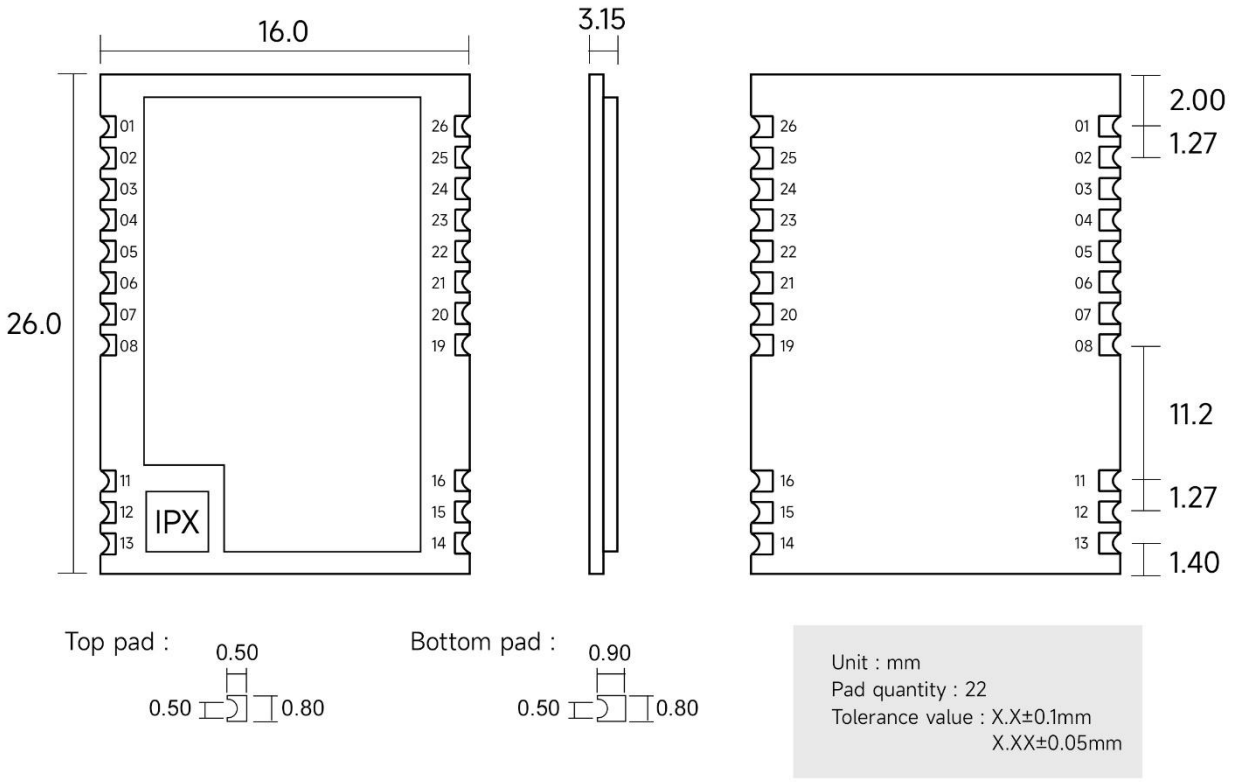
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Pin no.	Pin name	Direction	Function
3	M0	Input	M1 and M0 select one of four operating modes. Do not leave these pins floating; ground them if unused.
4	M1	Input	M1 and M0 select one of four operating modes. Do not leave these pins floating; ground them if unused.
5	WKP	Input	WKP controls sleep: low enters sleep and high keeps the module awake. The pin has a weak internal pull-up.
6	RXD	Input	TTL UART input; connect to the external TXD output.
7	TXD	Output	TTL UART output; connect to the external RXD input.
8	AUX	Output	1. Indicates module status; may be left unconnected. 2. During normal operation, low indicates busy and high indicates idle. 3. Do not use AUX to drive external devices or pull it low. If AUX is held low during power-up, the module may enter upgrade mode and fail to operate normally. See Section 5.
9	VCC	-	Positive supply input; 2.3–5.5 V DC.
10	GND	Ground reference	Module ground
11	GND	Ground reference	Module ground
12	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
13	NRST	Input	1. Module reset input. A low pulse longer than 100 μs resets the module. 2. Connect this pin to the host MCU so that the module can be reset and recovered after an unexpected fault.
14	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
15	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
16	NC	-	NC (leave floating)
17	LOCK	Output	1. Synchronization-status output. Valid in full-duplex frequency-hopping mode; ignore it in half-duplex mode. 2. High indicates that the two communicating modules are synchronized and data can be transferred. 3. Low indicates that the modules are not synchronized; data sent in this state will be lost.
18	NC	-	NC (leave floating)
19	NC		NC (leave floating)
20	GND	Ground reference	Module ground

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3.2 EWM628-2G4T20SX Dimensions and Pin Definitions



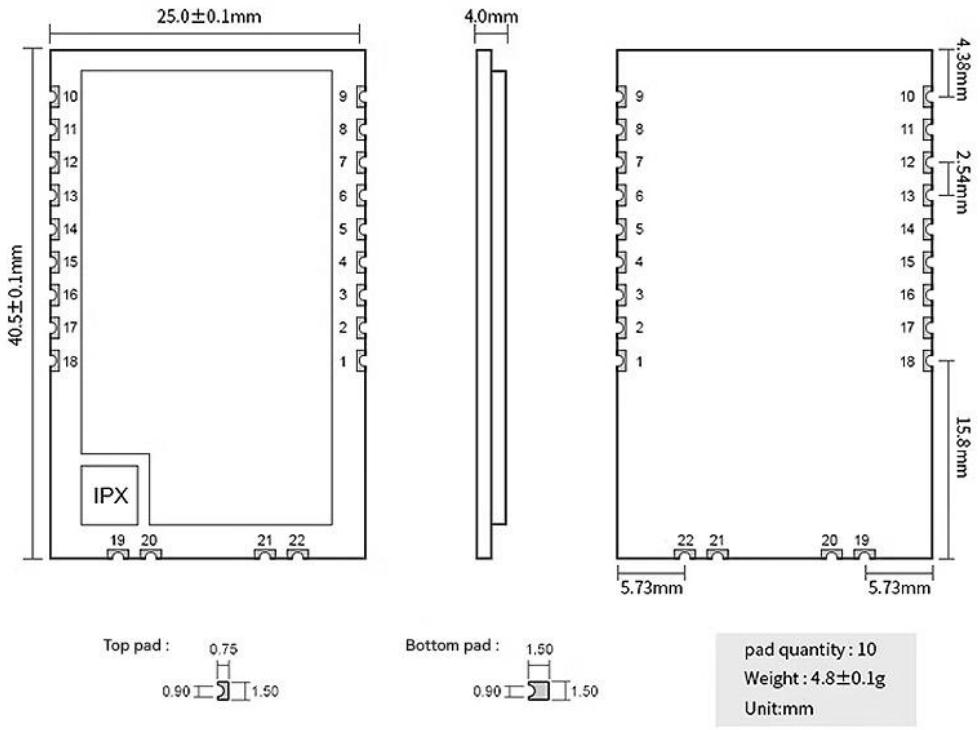
Pin no.	Pin name	Direction	Function
1	NRST	Input	Module reset input, active low.
2	GND	Ground reference	Module ground
3	WKP	Input (very weak pull-up)	WKP controls sleep: low enters sleep and high keeps the module awake. The pin has a weak internal pull-up.
4	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
5	LOCK	Output	1. Synchronization-status output. Valid in full-duplex frequency-hopping mode; ignore it in half-duplex mode. 2. High indicates that the two communicating modules are synchronized and data can be transferred. 3. Low indicates that the modules are not synchronized; data sent in this state will be lost.
6	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
7	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
8	GND	Ground reference	Module ground
11	GND	Ground reference	Module ground
12	ANT	-	Antenna port (50 Ω characteristic impedance)
13	GND	Ground reference	Module ground

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Pin no.	Pin name	Direction	Function
14	GND	Ground reference	Module ground
15	GND	Ground reference	Module ground
16	GND	-	Module ground
19	GND	-	Module ground
20	M0	Input (very weak pull-up)	M1 and M0 select one of four operating modes. Do not leave these pins floating; ground them if unused.
21	M1	Input (very weak pull-up)	M1 and M0 select one of four operating modes. Do not leave these pins floating; ground them if unused.
22	RXD	Input	TTL UART input; connect to the external TXD output.
23	TXD	Output	TTL UART output; connect to the external RXD input.
24	AUX	Output	1. Indicates module status; may be left unconnected. 2. During normal operation, low indicates busy and high indicates idle. 3. Do not use AUX to drive external devices or pull it low. If AUX is held low during power-up, the module may enter upgrade mode and fail to operate normally. See Section 5.
25	VCC	-	Positive supply input; 2.3–5.5 V DC.
26	GND	-	Module ground

3.3 EWM628-2G4T27SX Dimensions and Pin Definitions



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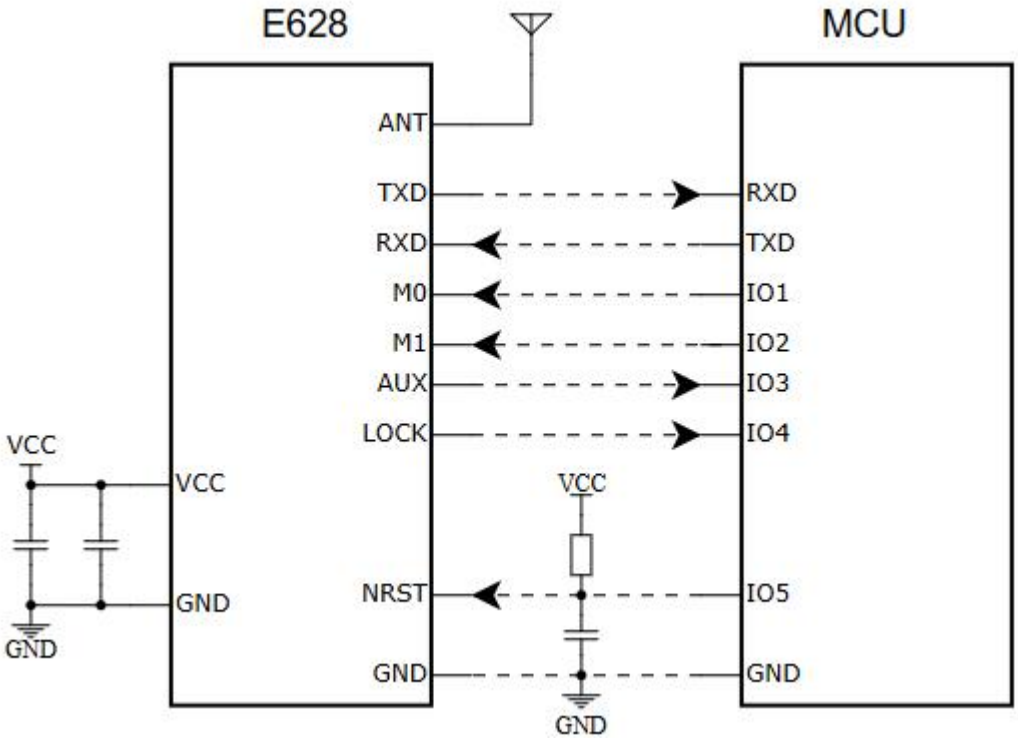
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Pin no.	Pin name	Direction	Function
1	GND	Ground reference	Module ground
2	NC	-	NC (leave floating)
3	NC	-	NC (leave floating)
4	LOCK	Output	1. Synchronization-status output. Valid in full-duplex frequency-hopping mode; ignore it in half-duplex mode. 2. High indicates that the two communicating modules are synchronized and data can be transferred. 3. Low indicates that the modules are not synchronized; data sent in this state will be lost.
5	NRST	Input	Module reset input, active low.
6	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
7	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
8	GND	Ground reference	Module ground
9	NC	-	NC (leave floating). This is a programming pin; if practicable, route it to a test point for maintenance or custom firmware.
10	GND	Ground reference	Module ground
11	VCC	-	Positive supply input; 2.3–5.5 V DC.
12	AUX	Output	1. Indicates module status; may be left unconnected. 2. During normal operation, low indicates busy and high indicates idle. 3. Do not use AUX to drive external devices or pull it low. If AUX is held low during power-up, the module may enter upgrade mode and fail to operate normally. See Section 5.
13	TXD	Output	TTL UART output; connect to the external RXD input.
14	RXD	Output	TTL UART input; connect to the external TXD output.
15	M1	Input	M1 and M0 select one of four operating modes. Do not leave these pins floating; ground them if unused.
16	M0	Input	M1 and M0 select one of four operating modes. Do not leave these pins floating; ground them if unused.
17	WKP	Input (very weak pull-up)	WKP controls sleep: low enters sleep and high keeps the module awake. The pin has a weak internal pull-up.
18	GND	Ground reference	Module ground
19	ANT	-	Antenna port (50 Ω characteristic impedance)
20	GND	Ground reference	Module ground
21	GND	Ground reference	Module ground
22	NC	-	NC (leave floating)

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4 Recommended Wiring



No.	Precaution
1	The module uses 3.3 V UART and I/O levels. Use level translation when connecting it to a 5 V MCU.
2	Connect the RESET pin to the host MCU so the module can be recovered from an unexpected fault.
3	If an external switch is used on VCC, account for leakage current through the host MCU's UART pins; otherwise, the module may not power off completely.
4	Do not use AUX to drive external devices such as LEDs or relays. If external circuitry holds AUX low during power-up, the module may fail to start.
5	Optional: route the programming pins of an SMD module to test points for maintenance or custom firmware.
6	Optional: route the module UART to an additional connector for maintenance and online upgrades with the PC tool.

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5 Functional Description

- In this chapter, 0 and 1 denote low and high levels, respectively, on the M1 and M0 pins.

5.1 Operating Modes

The module provides four operating modes selected by M1 and M0, as shown below.

Mode (0–3)	WKP	M1	M0	Description	Remarks
0 Half-duplex transmission	1	0	0	Half-duplex transmission with fixed-point and relay support	Fixed-frequency transmission
1 Full-duplex frequency hopping	1	0	1	Full-duplex frequency-hopping transmission; wait until LOCK goes high	Fixed-point transmission, relaying, RSSI, LBT, and related functions are unavailable in this mode
2 Reserved mode	1	1	0	Same behavior as configuration mode	-
3 Configuration mode	1	1	1	Registers can be accessed through UART commands	Supports HEX and AT commands
Deep sleep	0	X	X	The module enters deep sleep; drive WKP high to wake it	WKP must remain low during sleep

5.1.1 Half-Duplex Transmission, Mode 0 (M1 = 0, M0 = 0; hold WKP high)

5.1.1.1 Quick Start: Transparent Transmission

Data are delivered exactly as sent. With factory-default parameters and transparent transmission enabled on both modules, communication can be tested directly with a serial-terminal program, as shown below.

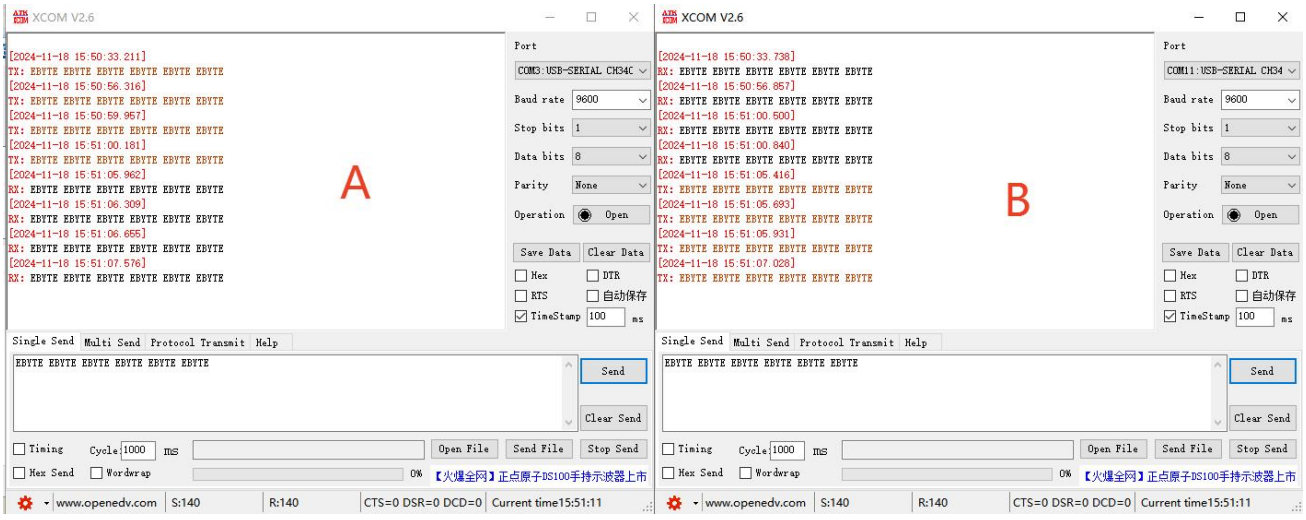


Figure 1. Bidirectional transmission and reception

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5.1.1.2 Quick Start: Fixed-Point Transmission (Specified Address and Channel)

Data are sent in the format target address + target channel + payload. This format allows the receiver to filter unrelated traffic and reduce some forms of interference.

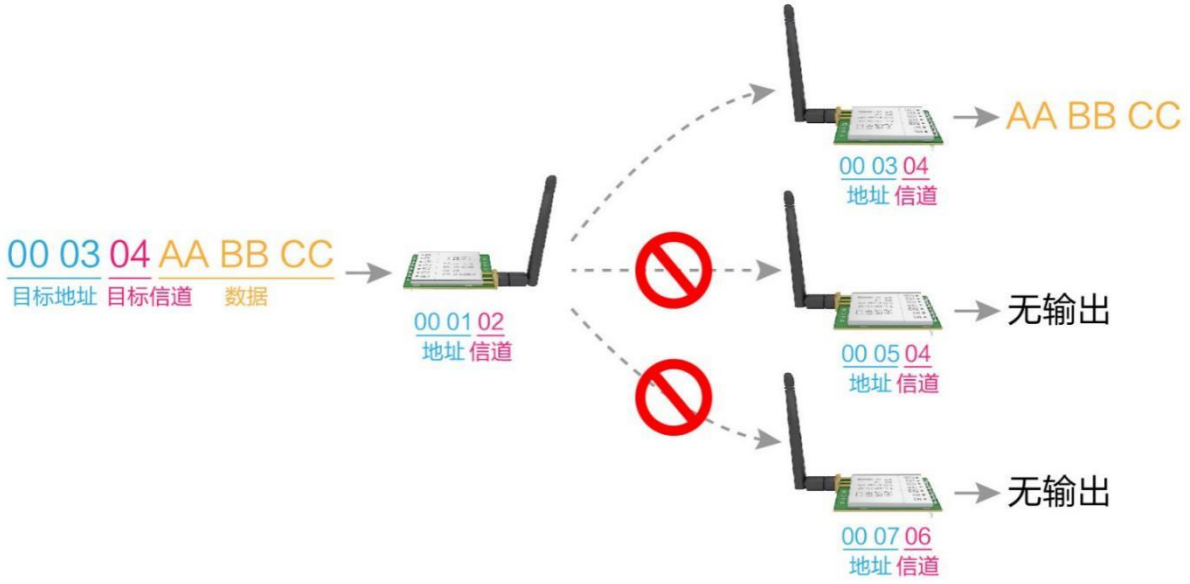


Figure 2. Fixed-point transmission

Procedure:

Step 1. Configure each module with the PC tool. In configuration mode (M1 = 1, M0 = 1), set the module address and channel, change the transmission mode from transparent to fixed-point, and write the parameters.

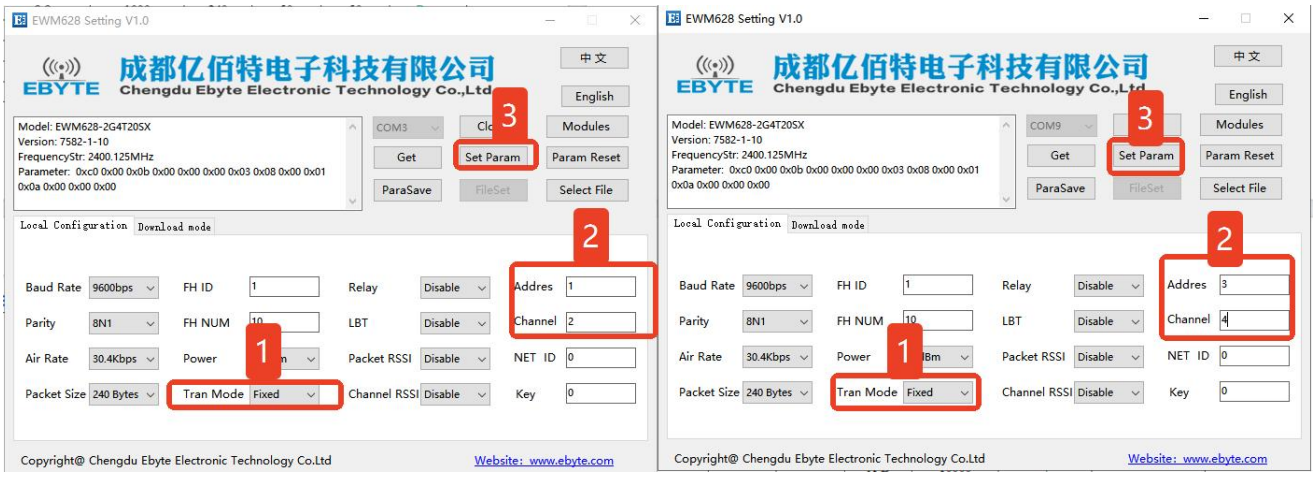


Figure 3. PC-tool interface

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Step 2. Switch the modules to half-duplex transmission mode. To send from module A to module B, enter 000304AABBCC on A. To send from B to A, enter 000102AABBCC on B. In fixed-point mode, the data format is target address + target channel + payload.

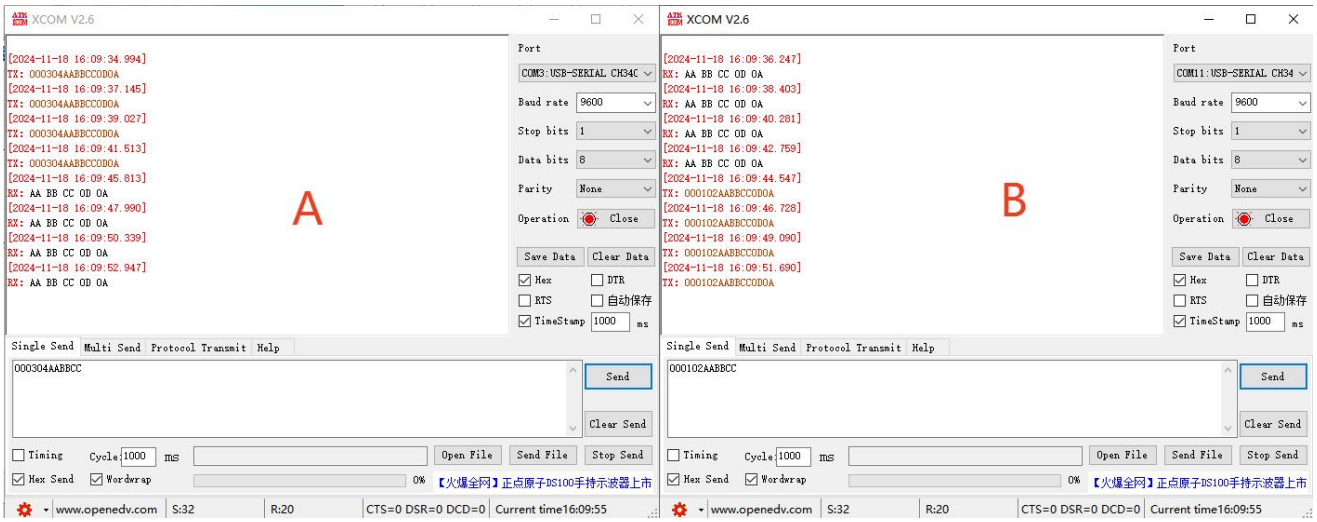


Figure 4. Data transmission

5.1.1.3 Quick Start: Broadcast

- Set module A's address to 0xFFFF and its channel to 0x04. When A transmits, every receiving module on channel 0x04 in the same transmission mode (transparent or fixed-point) can receive the data.
- When module A is configured with address 0xFFFF and channel 0x04 and acts as a receiver, it receives all traffic on channel 0x04, thereby operating as a monitor.

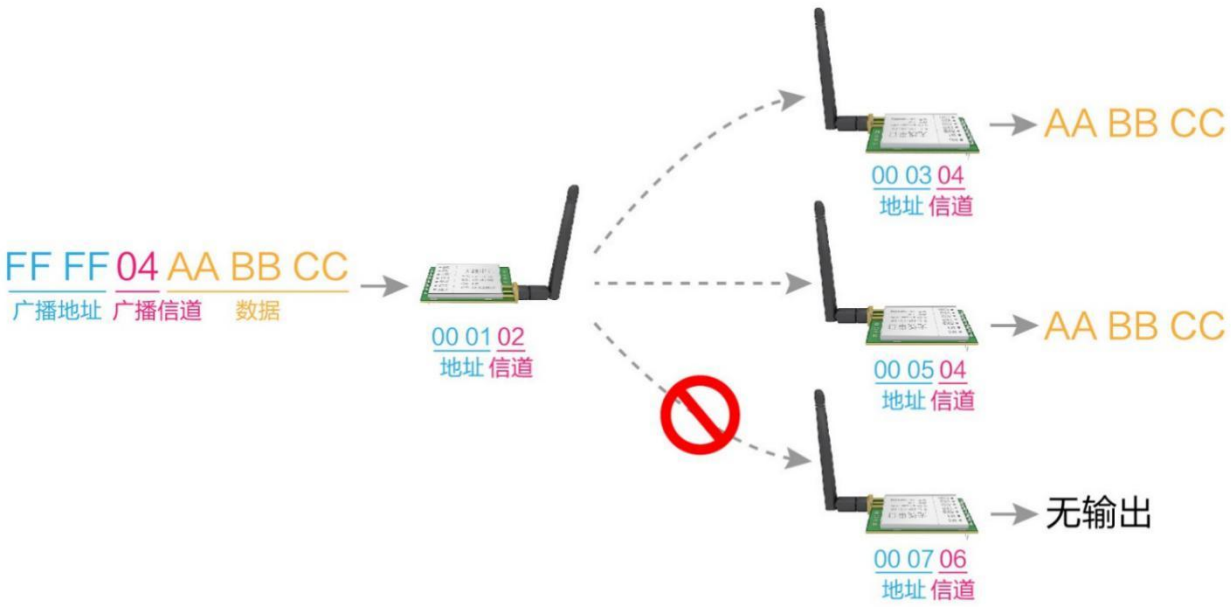


Figure 5. Fixed-point broadcast transmission

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Procedure:

Step 1. Configure each module with the PC tool. In configuration mode (M1 = 1, M0 = 1), set the module address and channel, change transparent transmission to fixed-point transmission, and write the parameters.

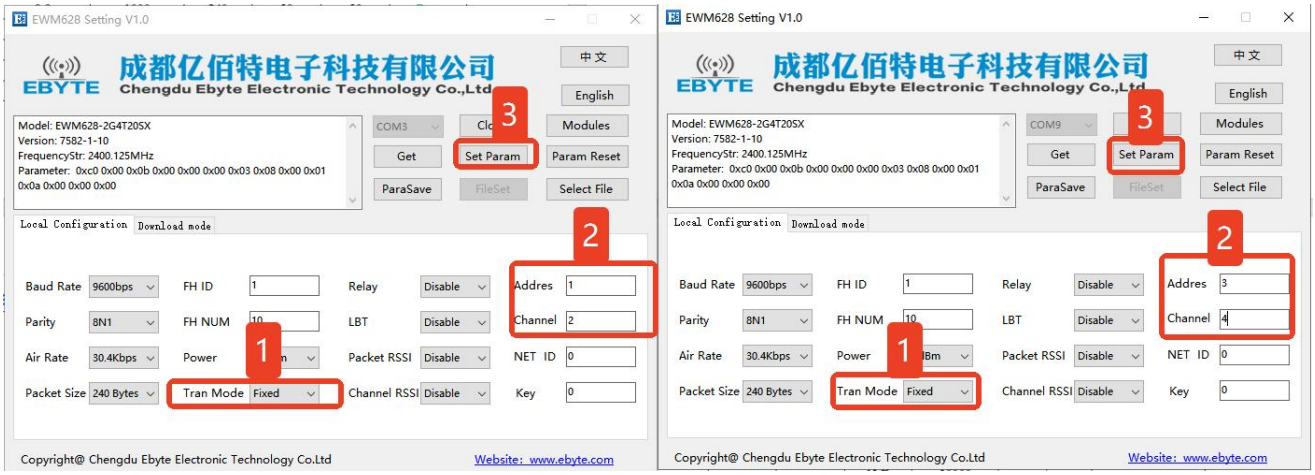


Figure 6. PC-tool interface

Step 2. Switch the modules to half-duplex transmission mode. To send from module A to B, enter FFFF04AABBCC on A. To send from B to A, enter FFFF02AABBCC on B. In fixed-point broadcast mode, the data format is broadcast address + target channel + payload.

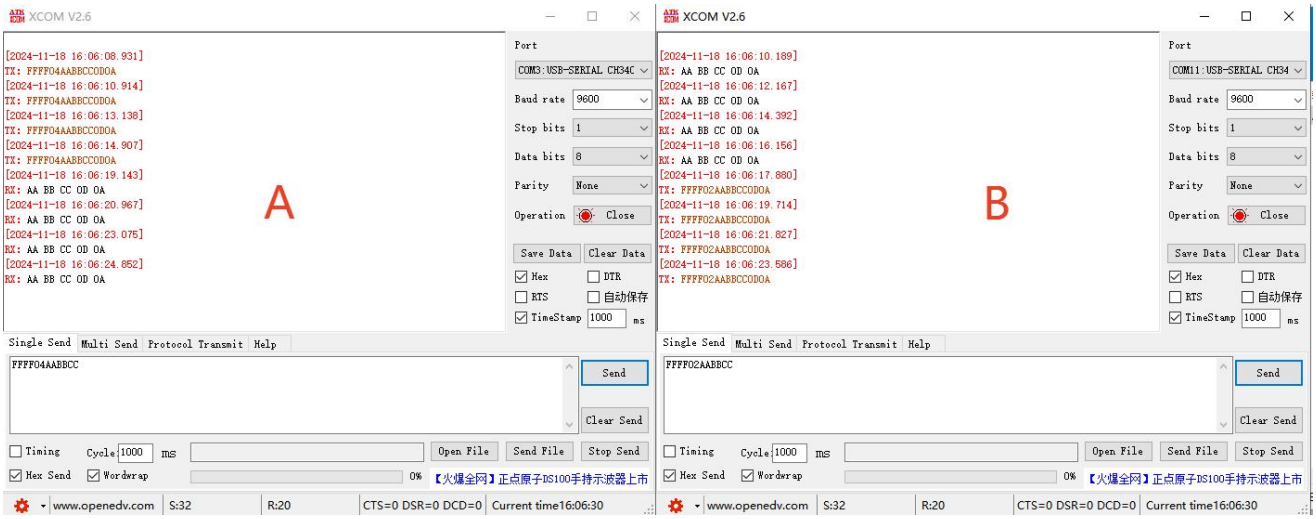


Figure 7. Data transmission

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5.1.2 Full-Duplex Frequency-Hopping Transmission, Mode 1 (M1 = 0, M0 = 1; hold WKP high)

5.1.2.1 Quick Start: Transparent Transmission

Procedure:

Step 1. Configure the hopping parameters with the PC tool. In configuration mode, set both modules to the same hopping-channel count and hopping ID, then write the parameters. FHID determines the hopping sequence, and FHNUM determines the number of hopping channels.

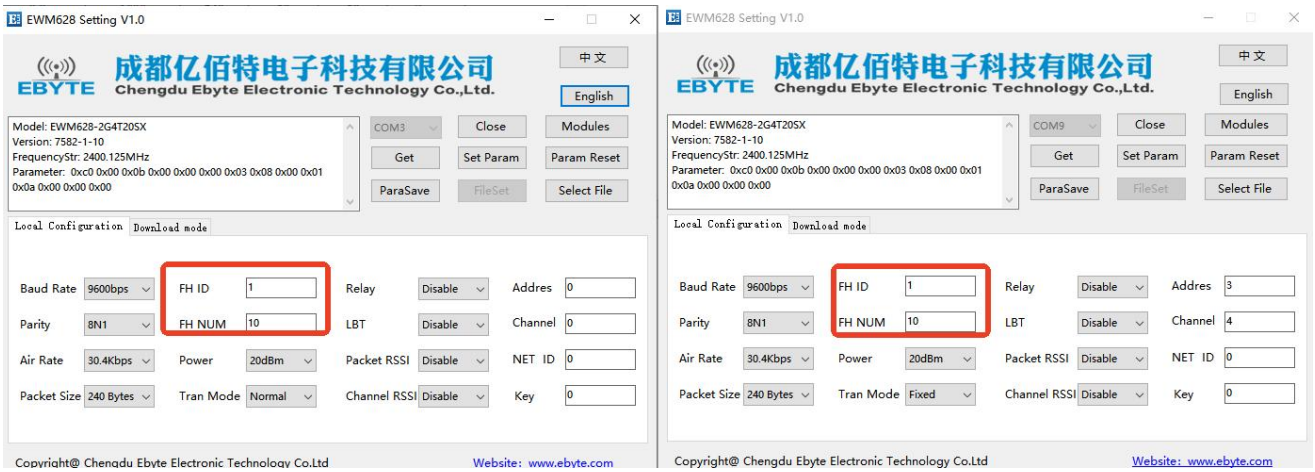


Figure 8. PC-tool interface

Step 2. Switch both modules to full-duplex frequency-hopping mode (M1 = 0, M0 = 1). When the LOCK pins go high, the modules are synchronized and can exchange data.

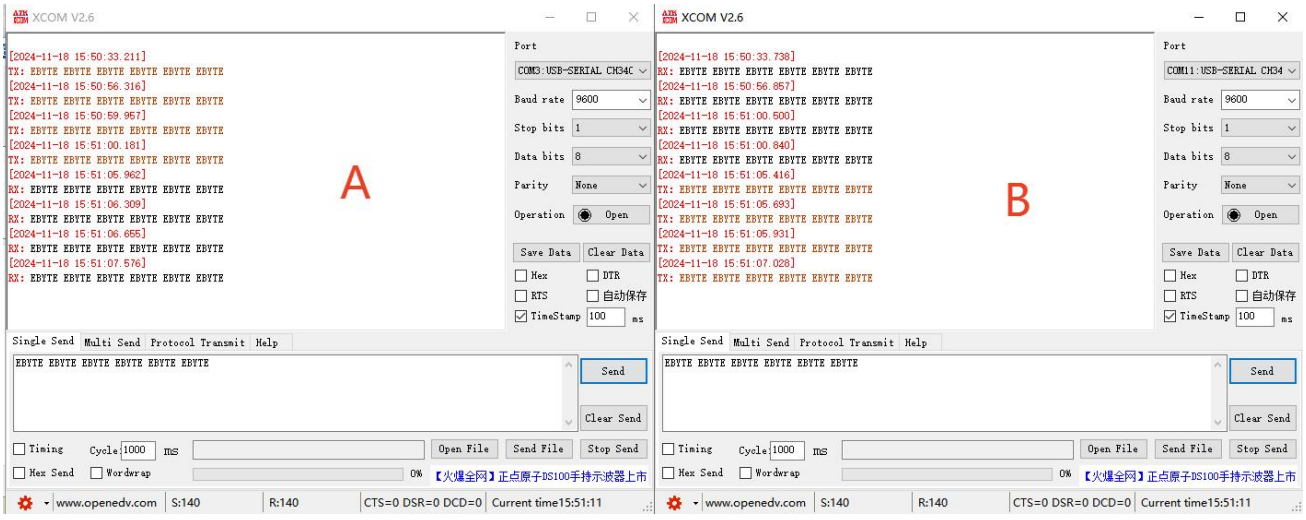


Figure 9. Data transmission

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5.1.2.2 Continuous-Transmission Considerations in Full-Duplex Frequency-Hopping Mode

In full-duplex frequency-hopping transparent mode, communication performance depends on the UART baud rate and air data rate. Configure the parameters according to the following table.

UART baud rate	Air data rate (kbps)	Communication status
4800	8.8	Continuous transmission unavailable
	15.2	Normal
	30.4	Normal
	50.7	Normal
	60.8	Normal
	101.5	Normal
	121.8	Normal
	203.1	Normal
9600	8.8	Continuous transmission unavailable
	15.2	Continuous transmission unavailable
	30.4	Normal
	50.7	Normal
	60.8	Normal
	101.5	Normal
	121.8	Normal
	203.1	Normal
19200	8.8	Continuous transmission unavailable
	15.2	Continuous transmission unavailable
	30.4	Continuous transmission unavailable
	50.7	Normal
	60.8	Normal
	101.5	Normal
	121.8	Normal
	203.1	Normal
38400	8.8	Continuous transmission unavailable
	15.2	Continuous transmission unavailable
	30.4	Continuous transmission unavailable
	50.7	Continuous transmission unavailable
	60.8	Continuous transmission unavailable
	101.5	Normal
	121.8	Normal
	203.1	Normal
57600	8.8	Continuous transmission unavailable
	15.2	Continuous transmission unavailable
	30.4	Continuous transmission unavailable
	50.7	Continuous transmission unavailable
	60.8	Continuous transmission unavailable
	101.5	Continuous transmission unavailable
	121.8	Continuous transmission unavailable
	203.1	Continuous transmission unavailable
115200	8.8	Continuous transmission unavailable
	15.2	Continuous transmission unavailable
	30.4	Continuous transmission unavailable
	50.7	Continuous transmission unavailable
	60.8	Continuous transmission unavailable
	101.5	Continuous transmission unavailable
	121.8	Continuous transmission unavailable
	203.1	Continuous transmission unavailable

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5.1.2.3 Half-Duplex Transparent-Transmission Latency

*** Laboratory results may vary slightly. Verify performance with the physical product. ***

UART baud rate	Air data rate (kbps)	Data latency (ms)			
		1 bytes	50 bytes	100 bytes	240 bytes
4800	8.8	44.6	292.7	545.7	1254.2
	15.2	30.3	259.6	494.8	1151.7
	30.4	22.5	238.9	460.2	1080.8
	50.7	18.9	230.2	446.6	1051.3
	60.8	18.4	228.2	444.0	1044.9
	101.5	16.1	224.4	436.7	1030.3
	121.8	16.5	223.3	434.6	1027.1
	203.1	15.4	221.3	431.3	1020.4
9600	8.8	39.3	185.6	33.4	753.5
	15.2	24.4	152.6	283.4	649.8
	30.4	17.3	131.7	249.6	579.0
	50.7	13.7	122.6	235.2	550.2
	60.8	13.0	121.5	232.9	543.1
	101.5	11.1	117.4	225.6	528.7
	121.8	10.9	116.0	223.9	525.3
	203.1	9.9	114.4	220.7	518.9
19200	8.8	36.9	132.5	229.7	502.8
	15.2	22.4	99.1	178.5	399.6
	30.4	14.1	77.9	144.6	328.6
	50.7	10.6	69.5	130.0	298.8
	60.8	10.1	68.2	127.0	293.1
	101.5	8.4	63.9	119.9	277.9
	121.8	7.7	63.2	118.6	275.2
	203.1	7.1	60.1	115.4	267.3
38400	8.8	35.6	106.2	176.3	377.1
	15.2	20.5	72.5	125.6	274.1
	30.4	13.0	51.8	91.5	203.3
	50.7	8.9	42.7	77.7	174.2
	60.8	8.7	41.5	74.9	167.1
	101.5	7.2	37.3	67.6	152.6
	121.8	6.4	35.6	65.5	150.1
	203.1	5.7	34.1	62.2	142.2
57600	8.8	35.1	96.9	158.8	335.5
	15.2	20.5	62.9	107.5	232.0
	30.4	12.5	42.2	74.2	160.9
	50.7	8.4	33.6	59.5	131.7
	60.8	8.0	32.7	56.8	126.1
	101.5	6.2	27.6	49.8	111.1
	121.8	6.0	26.8	48.3	107.9
	203.1	5.8	24.8	44.6	100.6
115200	8.8	34.6	87.5	141.3	293.7
	15.2	20.3	54.3	90.1	190.4
	30.4	11.6	33.9	56.3	119.6
	50.7	8.7	24.8	42.5	89.7
	60.8	8.2	23.4	38.9	83.9
	101.5	6.6	18.8	31.9	69.1
	121.8	5.9	18.1	30.6	65.9
	203.1	5.0	15.6	26.9	58.4

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5.1.3 Configuration Mode (M1 = 1, M0 = 1; hold WKP high)

5.1.3.1 Quick Start: Configuration Tool

The PC-tool interface is shown below. Set M0 and M1 for configuration mode, then use the tool to read and configure the module parameters.



Figure 10. PC-tool interface

- In the PC tool, the module address, hopping ID, hopping-channel count, frequency channel, network ID, and key are displayed in decimal. See the model-specific register limits in Section 6.3.
- When configuring relay mode with the PC tool, note that all parameters are displayed in decimal and the module address and network IDs may require base conversion. For example, if transmitter A uses network ID 02 and receiver B uses network ID 10, combine them as hexadecimal 0x020A and convert this value to decimal 522. Enter 522 as relay R's module address.

5.1.4 Sleep Mode (M1 and M0 can be at any level; pull WKP low and hold)

- To enter sleep mode, drive WKP low. Do not change the M0 or M1 input level while the module is asleep.

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5.2 AUX Timing

5.2.1 UART Data-Output Indication

Conditions: Tc = 25 °C, VCC = 5 V

Parameter	Description	Typical value	Unit
T1	After receiving an over-the-air packet, the module drives AUX low to allow the host MCU time to prepare. AUX can also serve as a wake-up signal in low-power battery applications.	3	ms
T2	Interval between two consecutive over-the-air packets output by the module. Case 1: The transmitter is sending data in a continuous sequence of packets, and the air data rate is much higher than the receiver's UART rate. The receiver therefore outputs the data as a continuous stream (T2 = 0). A single UART output can exceed the user-configured packet length. This behavior is suitable, for example, when a Modbus master reads and receives replies from many slave registers. Case 2: The transmitter is sending a continuous sequence of packets, but both the air data rate and UART baud rate are relatively low (for example, the defaults of 30.4 kbps over the air and 9600 bps over UART). Because over-the-air transmission takes longer, the receiver outputs each packet separately.	0 or Tx (single-packet airtime)	ms

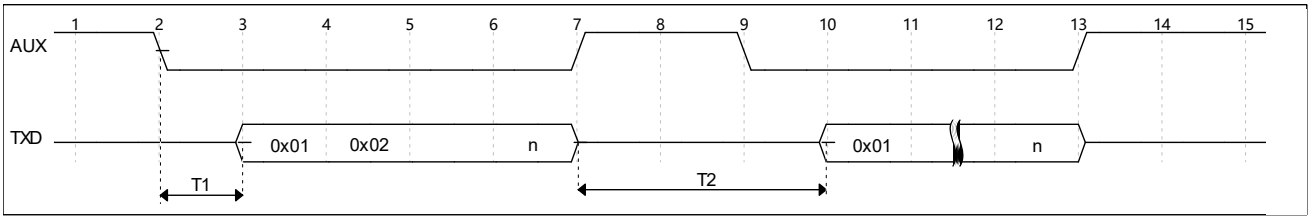


Figure 14. UART data-output timing

5.2.2 Wireless-Transmission Indication

Tc = 25 °C, VCC = 5 V

Parameter	Description	Typical value	Unit
n	Module UART buffer capacity (maximum amount of data accepted at one time). If buffered data exceed the configured packet length (240 bytes by default), the module automatically divides them into packets for wireless transmission.	1000	Bytes
T1	AUX indication delay while the module receives UART data. AUX is driven low only after the module recognizes and receives the first byte, so the delay depends on the UART baud rate (9600 bps by default).	1	ms
T2	AUX delay before indicating that the module buffer is idle (high). Case 1: If the input is shorter than the packet length (240 bytes by default), T2 is the UART frame-timeout delay. The default is three byte times and therefore	3 or	ms

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Parameter	Description	Typical value	Unit
	depends on the UART baud rate (9600 bps by default). When the timeout expires, AUX immediately goes high to indicate an idle buffer and wireless transmission starts. Under default settings, AUX does not indicate the wireless-transmission busy period; see the AT+UAUX command for additional options. Case 2: If the input exceeds the packet length, T2 is the total over-the-air transmission time, which depends on the air data rate. As soon as the UART input reaches one packet length, wireless transmission begins. Because LoRa transmission takes time, the module sends successive packets until all data in the receive buffer have been transmitted; AUX then goes high to indicate an idle buffer.	Tx (over-the-air transmission time)	

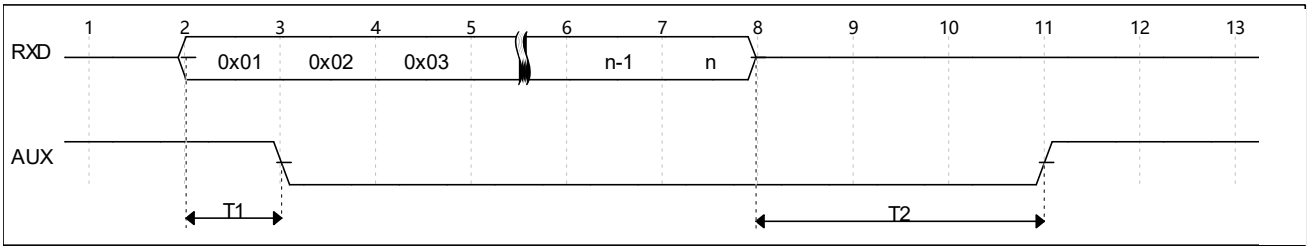


Figure 15. Wireless-transmission timing

5.2.3 Notes

No.	AUX notes
1	When AUX is low, the module is busy and does not detect changes in operating mode.
2	If AUX remains high, a mode change takes effect immediately.
3	When switching from configuration mode to another mode, or during reset, the module reloads the user parameters and drives AUX low.

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5.3 Relay-Network Rules

A relay node forwards data between source and destination nodes, extending network coverage and improving communication reliability.

No.	Relay-mode notes
1	Relay operation is available only in half-duplex mode.
2	Enable relay mode in configuration mode, then switch to half-duplex mode. The relay forwards data bidirectionally between the two specified NETIDs.
3	In relay mode, ADDH and ADDL no longer form the module address; instead, each corresponds to one NETID in the forwarding pair. Data received from either network are forwarded to the other.
4	In relay mode, the relay module cannot transmit or receive data.
5	The relay's own network ID is ignored.
6	Do not use two or more relays with identical or reversed ADDH/ADDL pairs; doing so may create a forwarding loop.

The following diagram gives an example.

Single-stage relay

- Node 1 has NETID 08, and Node 2 has NETID 33.
- Relay 1 has ADDH = 08 and ADDL = 33.
- Relay 1 can therefore forward a signal from Node 1 (08) to Node 2 (33).
- Nodes 1 and 2 also have the same address, so Node 2 accepts and outputs the data sent by Node 1.

Two-stage relay

- Relay 2 has ADDH = 33 and ADDL = 05.
- Relay 2 can therefore forward data from Relay 1 to NETID 05.
- Nodes 3 and 4 can then receive data from Node 1. Node 4 outputs the data; Node 3 does not because its address differs from Node 1's.

Bidirectional relay

- With the configuration shown, data from Node 1 can be received by Nodes 2 and 4, and data from Nodes 2 and 4 can be received by Node 1.

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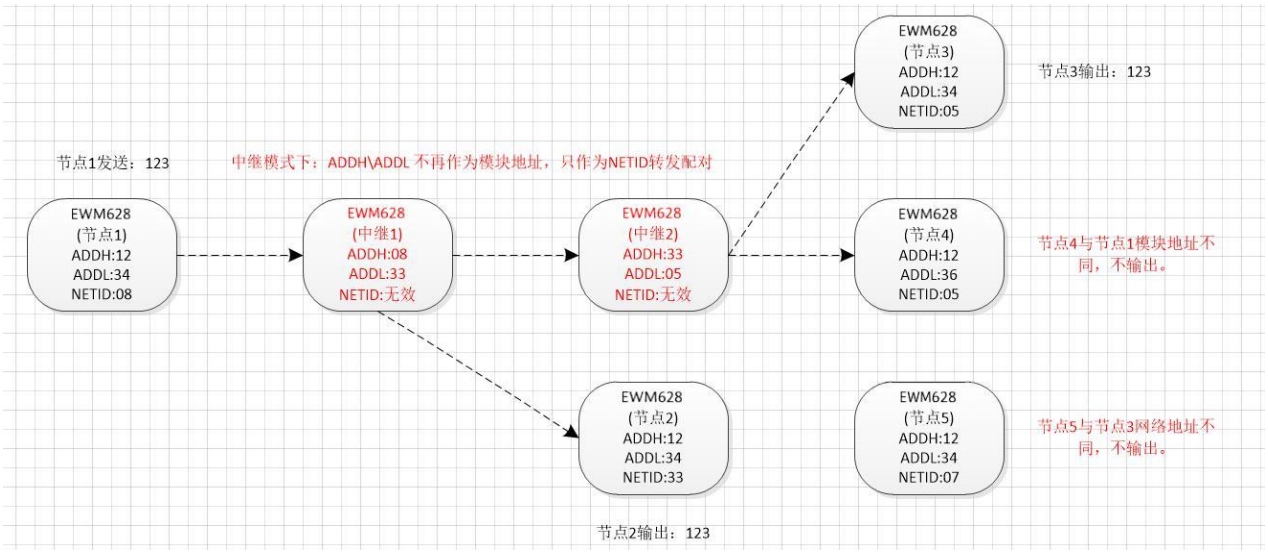


Figure 17. Relay network

5.4 Firmware Upgrade over UART

① If a firmware upgrade is required, obtain the correct upgrade package through your EBYTE sales contact and use the EBYTE PC tool. Firmware upgrades are not normally required; do not issue AT+IAP unless instructed to do so.

② Route the required pins (M1, M0, AUX, TXD, RXD, VCC, and GND) to accessible points. In configuration mode, issue AT+IAP to enter upgrade mode.

③ In upgrade mode, the baud rate automatically changes to 115200 bps and remains there until the mode exits automatically. Upgrade logs are output during this period.

5.4.1 Quick Upgrade with the Configuration Tool

Step 1. Set M0 and M1 to enter configuration mode. The baud rate is fixed at 9600 bps in this mode. Open the configuration tool and select the firmware-upgrade tab.

Step 2. Click Read Parameters. Module information appears in the left pane.

Step 3. Click Open File, select the firmware .bin file, and then click Start Download.

Step 4. The firmware upgrade begins. Wait for the download-success message.

Step 5. When the upgrade is complete, reopen the serial port and read the parameters to verify operation.

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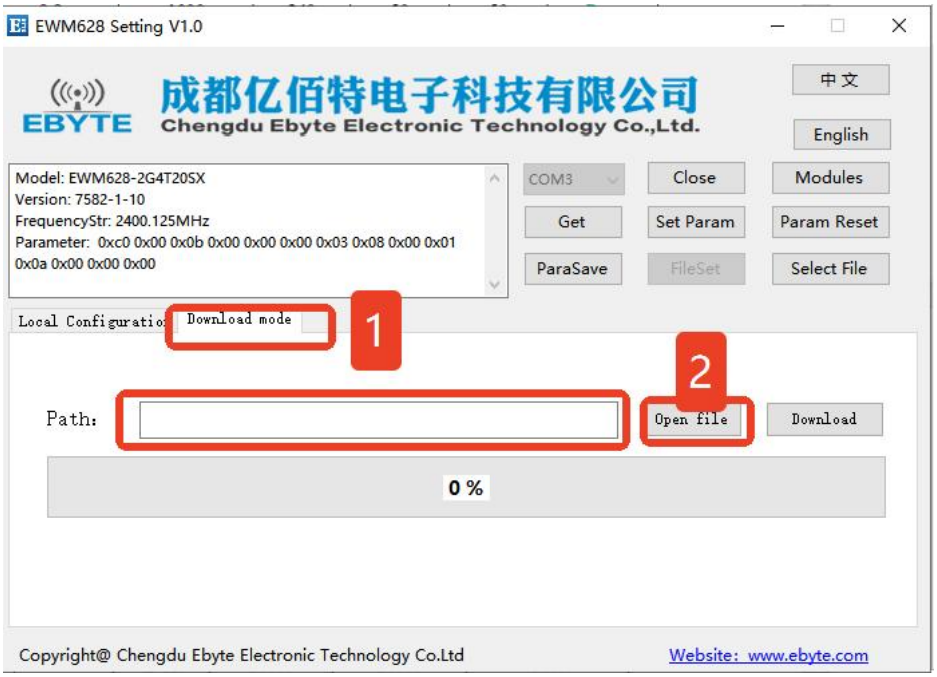


Figure 18. PC-tool interface

6 Register Read/Write Control

6.1 HEX Command Format

In configuration mode (Mode 3: M1 = 1, M0 = 1, WKP = 1), the following commands are supported. The UART is fixed at 9600 bps, 8N1 when setting parameters.

No.	Command format	Description
1	Write registers	Command: C0 + start address + length + parameters Response: C1 + start address + length + parameters Example 1: Set the channel to 0x09 Command Start address Length Parameter Send: C0 05 01 09 Return: C1 05 01 09 Example 2: Set the module address (0x1234), network address (0x00), and UART (9600 bps, 8N1) together Send: C0 00 04 12 34 00 03

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No.	Command format	Description
		Return: C1 00 04 12 34 00 03
2	Read registers	Command: C1 + start address + length Response: C1 + start address + length + parameters Example 1: Read the channel Command Start address Length Parameter Send: C1 05 01 Return: C1 05 01 09 Example 2: Read the module address, network address, UART settings, and air data rate together Send: C1 00 04 Return: C1 00 04 12 34 00 03
3	Write temporary registers	Command: C2 + start address + length + parameters Response: C1 + start address + length + parameters Example 1: Set the channel to 0x09 Command Start address Length Parameter Send: C2 05 01 09 Return: C1 05 01 09 Example 2: Set the module address (0x1234), network address (0x00), and UART (9600 bps, 8N1) together Send: C2 00 04 12 34 00 03 Return: C1 00 04 12 34 00 03
4	Invalid format	Invalid-format response FF FF FF

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6.2 Register Overview

Address	Name	Bits							
		bit 7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
00H	ADDH	Communication address [15:8]							
01H	ADDL	Communication address [7:0]							
02H	NETID	Network address [7:0]							
03H	REG0	Reserved [7:5]			UART parity [4:3]		UART baud rate [2:0]		
04H	REG1	Reserved [7:5]			Air data rate [4:2]			Transmit power [1:0]	
05H	REG2	Channel control [7:0]							
06H	REG3	Frequency-hopping sequence [7:0]							
07H	REG4	Number of hopping channels							
08H	REG5	Reserved	Packet length [6:5]		Ambient RSSI	Packet RSSI	LBT	Relay	Fixed-point transmission
09H	CRYPT_H	Wireless encryption key [15:8]							
0AH	CRYPT_L	Wireless encryption key [7:0]							

6.3 Detailed Register Descriptions

No.	Access	Name	Description				Remarks
00H	Read/write	ADDH	ADDH (default: 0)				1. High and low bytes of the module address. 2. When the module address is FFFF, it acts as a broadcast/monitoring address and address filtering is disabled.
01H	Read/write	ADDL	ADDL (default: 0)				
02H	Read/write	NETID	NETID (default: 0)				1. Network address used to distinguish networks. 2. Set the same value on modules that communicate with each other.
03H	Read/write	UART	7	6	5	Reserved	
			4	3	UART parity		The communicating modules may use different UART settings.
			0	0	8N1 (default)		
			0	1	8O1		
			1	0	8E1		
			1	1	8N1 (same as 00)		
			2	1	0	UART baud rate (bps)	1. The two communicating modules may use different UART baud rates and parity settings. 2. When transmitting large data streams continuously, consider the congestion and possible data loss caused by equal UART rates. See Section 5.1.2.2 for continuous-transmission parameter combinations. 3. Using the same baud rate at both ends is generally recommended.
			0	0	0	UART baud rate: 1200	
			0	0	1	UART baud rate: 2400	
			0	1	0	UART baud rate: 4800	
			0	1	1	UART baud rate: 9600 (default)	
			1	0	0	UART baud rate: 19200	
			1	0	1	UART baud rate: 38400	
			1	1	0	UART baud rate: 57600	
			1	1	1	UART baud rate: 115200	
04H	Read/write	RADIO	7	6	5	Reserved	Note: The communicating modules must use the same air data rate. A higher rate reduces latency but also reduces range.
			4	3	2	Air data rate (bps)	
			0	0	0	8.8 kbps (default)	
			0	0	1	15.2 kbps	

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<table>
<tr><th>No.</th><th>Access</th><th>Name</th><th>Description</th><th>Remarks</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><td>0</td><td>1</td><td>0</td><td>30.4 kbps</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>50.7 kbps</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>60.9 kbps</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>101.5 kbps</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>121.8 kbps</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>203.1 kbps</td></tr>
</table>
</td><td></td></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><td rowspan="2">1</td><td rowspan="2">0</td><td colspan="3">Transmit power (model-dependent)</td></tr>
<tr><td>12S</td><td>20SX</td><td>27SX</td></tr>
<tr><td>0</td><td>0</td><td>12 dBm</td><td>20 dBm</td><td>27 dBm</td></tr>
<tr><td>0</td><td>1</td><td>10 dBm</td><td>17 dBm</td><td>23 dBm</td></tr>
<tr><td>1</td><td>0</td><td>7 dBm</td><td>14 dBm</td><td>20 dBm</td></tr>
<tr><td>1</td><td>1</td><td>4 dBm</td><td>10 dBm</td><td>17 dBm</td></tr>
</table>
</td><td>1. Power and current are nonlinear; power-supply efficiency is highest at maximum output power.
2. Current does not decrease in direct proportion to the power setting.
3. The default setting is maximum output power.</td></tr>
<tr><td>05H</td><td>Read/write</td><td>CHANNEL</td><td>Channel control (CH)
Range: 0 – 100; default: 0x02. Both communicating modules must use the same value.</td><td>1. Half-duplex transmission: 2400 + CHANNEL MHz
2. Full-duplex transmission: 2400 + CHANNEL + (0 to FHOP_NUM) MHz</td></tr>
<tr><td>06H</td><td>Read/write</td><td>FHOP_ID</td><td>Frequency-hopping sequence; default: 0x01</td><td>1. Valid only in full-duplex mode. Both communicating modules must use the same value.</td></tr>
<tr><td>07H</td><td>Read/write</td><td>FHOP_NUM</td><td>Number of hopping channels; default: 0x0A</td><td>1. Valid only in full-duplex mode. Minimum: 1; range: 1–20; default: 10.</td></tr>
<tr><td>08H</td><td>Read/write</td><td>REG5</td><td>
<table>
<tr><td>7</td><td colspan="2">Reserved</td></tr>
<tr><td>6</td><td>5</td><td>Packet length (bytes)</td></tr>
<tr><td>0</td><td>0</td><td>240 (default)</td></tr>
<tr><td>0</td><td>1</td><td>128</td></tr>
<tr><td>1</td><td>0</td><td>64</td></tr>
<tr><td>1</td><td>1</td><td>32</td></tr>
<tr><td>4</td><td colspan="2">Ambient RSSI enable</td></tr>
<tr><td>0</td><td colspan="2">Disabled (default)</td></tr>
<tr><td>1</td><td colspan="2">Enabled</td></tr>
</table>
</td><td>1. Valid only in half-duplex mode; the communicating modules may use different values.
2. In full-duplex mode, packets are divided internally with a variable length.
3. If the user data are shorter than the packet length, the receiver outputs them over UART as a continuous stream.
4. If the user data exceed the packet length, the receiver outputs them over UART in separate packets.
1. Valid only in half-duplex mode.
2. When enabled, the C0 C1 C2 C3 register-read command can be issued in transmission mode or WOR transmit mode.
3. Register 0x00: current ambient-noise RSSI.
4. Register 0x01: RSSI of the most recently received data.
5. RSSI is returned as a hexadecimal two's-complement value.
6. Command: C0 C1 C2 C3 + start address + read length.
●Response: C1 + address + read length + valid data.</td></tr>
</table>

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No.	Access	Name	Description		Remarks
					■ Example - send: C0 C1 C2 C3 00 01 Response: C1 00 01 RSSI (the start address must be 00)
			3	Append RSSI byte (packet RSSI)	1. Valid only in half-duplex mode. 2. When enabled, the module appends one RSSI byte after the wireless payload output through TXD. 3. RSSI is returned as a hexadecimal two's-complement value.
			0	Disabled (default)	
			1	Enabled	
			2	LBT enable	1. Valid only in half-duplex mode. 2. When enabled, the module listens before transmitting. This can reduce interference but may increase latency. The maximum LBT wait is 2 s; transmission is forced when this timeout expires.
			0	Disabled (default)	
			1	Enabled	
			1	Relay function	1. Valid only in half-duplex mode. 2. When relaying is enabled and the destination address is not the module's own address, the module forwards the packet once. 3. To prevent data from being sent back to the source, use relaying with fixed-point transmission so that source and destination addresses differ.
			0	Relay disabled (default)	
			1	Relay enabled	
			0	Transmission mode	1. Valid only in half-duplex mode. 2. In fixed-point mode, the module interprets the first three UART bytes as address high byte + address low byte + channel and uses them as the wireless destination.
			0	Transparent transmission (default)	
			1	Fixed-point transmission	
09H	Write	CRYPT_H	Key high byte (default: 0)		1. Valid only in half-duplex mode. Both communicating modules must use the same value. 2. Write-only; reads return 0. 3. Encrypts wireless data to prevent interception by similar modules. 4. The module uses these two bytes as factors in its over-the-air signal-transformation and encryption process.
0AH	Write	CRYPT_L	Key low byte (default: 0)		

6.4 Factory-Default Register Values

Model	Factory-default module parameters: C0 00 00 00 00 03 00 02 01 0A 00 00 00						
Module model	Frequency	Address	Channel	Air data rate	Baud rate	UART format	Transmit power
EWM628-2G4T12S	2400 MHz	0x0000	0x00	8.8 kbps	9600	8N1	12dbm
EWM628-2G4T20SX	2400 MHz	0x0000	0x00	8.8 kbps	9600	8N1	20dbm
EWM628-2G4T27SX	2400 MHz	0x0000	0x00	8.8 kbps	9600	8N1	27dbm

7 AT Commands

- AT commands for parameter setting and queries must be issued in configuration mode, in which the UART is fixed

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at 9600 bps, 8N1.

- A trailing carriage return and line feed are optional; the module recognizes commands with or without them.
- If a command cannot be recognized or executed, the module returns "=ERR". Responses end with carriage return and line feed (\r\n).
- Out-of-range parameters are constrained. Keep every parameter within its documented range to avoid undefined behavior.
- Parameters set with AT commands are not saved automatically. Issue AT+SAVE=1 to store them.

7.1 General Commands

7.1.1 AT+HELP: List Supported AT Commands

Command format	AT+HELP
Example	Send: AT+HELP Response: supported AT commands
Notes	● Outputs every supported AT command, separated by carriage return and line feed (\r\n).

7.1.2 AT+FWCODE: Query Firmware Version

Command format	AT+FWCODE=?
Example	Send: AT+FWCODE=? Response: FWCODE=7582-1-10
Notes	● Major version: 7xxx ● Branch number: 1 ● Minor version: 10 (increments from 10)

7.1.3 AT+DEVTYPE: Query Product Model

Command format	AT+DEVTYPE=?
Example	Send: AT+DEVTYPE=? Response: DEVTYPE=EWM628-2G4T12S
Notes	● Product series: EWM628 ● Operating band: 2.4 GHz ● Maximum power: 12 (12/20/27)

7.1.4 AT+RESET: Software Reset

Command format	AT+RESET
Example	Send: AT+RESET Response: =OK
Notes	● The reset begins only after "=OK" is returned. Wait approximately 100 ms before the next operation.

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7.1.5 AT+IAP: Enter Upgrade Mode

Command format	AT+IAP
Example	Send: AT+IAP Response: =OK
Notes	● After the response, the module enters IAP upgrade mode and exits automatically if the upgrade times out. ● Firmware upgrades are not normally required. Do not issue AT+IAP unless instructed to do so.

7.1.6 AT+DEFAULT: Restore Factory Defaults

Command format	AT+DEFAULT
Example	Send: AT+DEFAULT Response: =OK
Notes	● After "=OK" is returned, the factory-default parameters have been restored and saved.

7.1.7 AT+SAVE: Save Parameters

Command format	AT+SAVE
Example	Send: AT+SAVE=1 Response: =OK
Notes	● After "=OK" is returned, the parameters have been saved and are retained after power-off. ● To retain parameters configured with AT commands, issue this command after completing the configuration.

7.1.8 AT+ADDR: Communication Address (Match Filtering)

Command format	AT+ADDR=<address>
Set example	Send: AT+ADDR=0 Response: =OK
Query example	Send: AT+ADDR=? Response: AT+ADDR=0
Parameters	**<address>: communication address, 0–65535**
Notes	● Default address: 0 ● The address is not an RF parameter. It is an identifier carried in the packet and used by the receiver's software to decide whether the packet passes match filtering. ● Broadcast address: 65535. As a receiver, the module accepts data from any address on the same channel without filtering. As a transmitter, it marks outgoing packets with the broadcast address, so receivers do not filter them.

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7.1.10 AT+NETID: Network ID (Match Filtering)

Command format	AT+NETID=<net>
Set example	Send: AT+NETID=0 Response: =OK
Query example	Send: AT+NETID=? Response: AT+NETID=0
Parameters	**<net>: communication network ID, 0–255**
Notes	● Default network ID: 0 ● The network ID is not an RF parameter. It is an identifier carried in the packet and used by the receiver's software for relay forwarding and filtering. ● Broadcast-address matching takes priority over network-ID filtering. A module can therefore receive broadcast data even when the network IDs differ. ● Valid only in half-duplex transmission mode.

7.1.11 AT+CHANNEL: Communication Channel (Carrier Frequency)

Command format	AT+CHANNEL=<ch>
Set example	Send: AT+CHANNEL=0 Response: =OK
Query example	Send: AT+CHANNEL=? Response: AT+CHANNEL=0
Parameters	**<ch>: communication channel, 0–100**
Notes	● The channel-frequency calculation depends on the operating mode. ● Half-duplex transmission: 2400 + ch MHz ● Full-duplex frequency hopping: 2400 + ch + (0 to number of hopping channels) MHz ● See Section 6.3 for the number of hopping channels.

7.1.12 AT+KEY: Communication Key (Data Encryption)

Command format	AT+KEY=<key>
Set example	Send: AT+KEY=0 Response: =OK
Parameters	**<key>: encryption/decryption key, 0–65535**
Notes	● Default: 0 ● Cannot be queried; the key is write-only and a query returns 0. ● Modules with different keys cannot communicate because the packet cannot be decrypted, fails validation, and is discarded.

7.1.13 AT+UART: UART Baud Rate and Parity

Command format	AT+UART=<baud>,<parity>
Set example	Send: AT+UART=3,0 Response: =OK
Query example	Send: AT+UART=? Response: AT+UART=3,0
Parameters	**<baud>: UART baud rate** 0 1200bps 1 2400bps 2 4800bps 3 9600 bps (default)

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Command format	AT+UART=<baud>,<parity>
	4 19200bps 5 38400bps 6 57600bps 7 115200bps **<parity>: UART parity** 0 None (default) 1 Odd 2 Even
Notes	● In configuration mode, the UART is fixed at 9600 bps, 8N1. ● The setting takes effect after the operating mode is changed.

7.1.14 AT+FHSS: Hopping Sequence and Number of Hopping Channels

Command format	AT+FHSS=<id>,<num>
Set example	Send: AT+FHSS=3,10 Response: =OK
Query example	Send: AT+FHSS=? Response: AT+FHSS=3,10
Parameters	**<id>: frequency-hopping sequence ID** Range: 0–255. The two communicating modules must use the same <id>. **<num>: number of hopping channels** Range: 0 – 100. This parameter determines the number of hopping channels; the two communicating modules must use the same value.
Notes	● More hopping channels improve interference immunity but increase synchronization time. ● Fewer hopping channels reduce interference immunity but shorten synchronization time.

7.1.15 AT+PACKET: Packet Length

Command format	AT+PACKET=<len>
Set example	Send: AT+PACKET=0 Response: =OK
Query example	Send: AT+PACKET=? Response: AT+PACKET=0
Parameters	**<len>: UART packet length** 0 240 bytes (default) 1 128 bytes 2 64 bytes 3 32 bytes
Notes	● If the UART input is shorter than the configured length, the frame ends on timeout and the data are then packetized for wireless transmission. ● When the UART input reaches the configured length, it is packetized and transmitted immediately. ● Data beyond the configured length remain in the UART buffer. After each wireless transmission, the module continues splitting the buffered data into packets of the configured length and sends them sequentially. ● Valid only in half-duplex transmission mode.

7.1.16 AT+RATE: Wireless Data Rate

Command format	AT+RATE=<rate>

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Command format	AT+RATE=<rate>
Set example	Send: AT+RATE=0 Response: =OK
Query example	Send: AT+RATE=? Response: AT+RATE=0
Parameters	**<rate>: air data rate** 0 8.8 kbps (default) 1 15.2 kbps 2 30.4 kbps 3 50.7 kbps 4 60.9 kbps 5 101.5 kbps 6 121.8 kbps 7 203.1 kbps
Notes	● A higher air data rate reduces latency by shortening transmission time, but also reduces receiver sensitivity and communication range.

7.1.17 AT+TRANS: Transmission Mode (Transparent/Fixed-Point)

Command format	AT+TRANS=<mode>
Set example	Send: AT+TRANS=0 Response: =OK
Query example	Send: AT+TRANS=? Response: AT+TRANS=0
Parameters	**<mode>: transmission mode** 0 Transparent transmission (default) 1 Fixed-point transmission
Notes	● In fixed-point mode, the first three input bytes are handled specially: bytes 1 and 2 are the destination address, and byte 3 is the destination channel. The module switches channels automatically. ● After sending in fixed-point mode, the module automatically returns to its original channel. ● Valid only in half-duplex transmission mode.

7.1.18 AT+LBT: Listen-Before-Talk Enable

Command format	AT+LBT=<on_off>
Set example	Send: AT+LBT=0 Response: =OK
Query example	Send: AT+LBT=? Response: AT+LBT=0
Parameters	**<on_off>: switch** 0 Disabled (default) 1 Enabled
Notes	● When LBT (listen before talk) is enabled, the module checks whether the ambient signal strength is below the configured threshold before each wireless transmission. If the condition is met before timeout, transmission begins. If the maximum wait expires first, transmission is forced. ● Valid only in half-duplex transmission mode.

7.1.19 AT+RELAY: Relay Forwarding

Command format	AT+RELAY=<on_off>
Set	Send: AT+RELAY=0

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Command format	AT+RELAY=<on_off>
example	Response: =OK
Query example	Send: AT+RELAY=? Response: AT+RELAY=0
Parameters	**<on_off>: switch** 0 Disabled (default) 1 Enabled
Notes	● When enabled, see the relay-network description in Section 5. ● A relay retransmits each received wireless packet once, doubling the over-the-air transmission time and associated latency. ● Relaying is half-duplex. Allow enough time for forwarding to complete. Data sent to the relay while it is forwarding may be lost. ● Valid only in half-duplex transmission mode.

7.1.23 AT+ERSSI: Ambient Signal Strength

Command format	AT+ERSSI=<on_off>
Set example	Send: AT+ERSSI=0 Response: =OK
Query example	Send: AT+ERSSI=? Response: AT+ERSSI=0
Parameters	**<on_off>: switch** 0 Disabled (default) 1 Enabled
Notes	● When enabled, see "Ambient RSSI Enable" in the detailed register descriptions and use the HEX command to read the value. ● Valid only in half-duplex transmission mode.

7.1.24 AT+DRSSI: Received-Packet Signal Strength

Command format	AT+DRSSI=<on_off>
Set example	Send: AT+DRSSI=0 Response: =OK
Query example	Send: AT+ERSSI=? Response: AT+ERSSI=0
Parameters	**<on_off>: switch** 0 Disabled (default) 1 Enabled
Notes	● When enabled, the module appends one signal-strength byte to each received packet. The byte is a signed hexadecimal two's-complement value. ● Conversion example: in signed 8-bit two's-complement form, 0xA2 corresponds to −94 dBm. ● Valid only in half-duplex transmission mode.

7.1.25 AT+POWER: Output-Power Level

Command format	AT+POWER=<Power>
Set example	Send: AT+POWER=0 Response: AT+POWER=0
Query	Send: AT+POWER=?

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Command format	AT+POWER=**<Power>**		
example	Response: AT+POWER=0		
Parameters	**<Power>: output power** EWM628-2G4T12S 0 12 dBm (default) 1 10Bm 2 7 dBm 3 4 dBm	**<Power>: output power** EWM628-2G4T20SX 0 20 dBm (default) 1 17 dBm 2 14 dBm 3 10 dBm	**<Power>: output power** EWM628-2G4T27SX 0 27 dBm (default) 1 23 dBm 2 20 dBm 3 17 dBm
Notes	-		

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8 Hardware Design

- Use a regulated DC supply with low ripple, and ensure that the module is reliably grounded.
- Observe the correct supply polarity. Reverse polarity may permanently damage the module.
- Verify that the supply voltage is within the recommended range. Exceeding the maximum will permanently damage the module.
- Ensure a stable supply; the voltage must not fluctuate sharply or frequently.
- When designing the power circuit, provide at least 30% current headroom to support reliable long-term operation of the complete product.
- Keep the module away from power supplies, transformers, high-frequency traces, and other strong sources of electromagnetic interference.
- Do not route high-frequency digital, high-frequency analog, or power traces beneath the module. If routing beneath the module is unavoidable and the module is mounted on the top layer, place a solid, well-grounded copper plane on the top layer under the module. Keep bottom-layer traces close to the module's digital side.
- If the module is mounted on the top layer, arbitrary routing on the bottom or other layers is also unsuitable and can degrade spurious-emission performance and receiver sensitivity.
- Strong nearby sources of electromagnetic interference can substantially degrade performance. Increase separation according to the interference level and use isolation or shielding where practicable.
- Nearby high-frequency digital, high-frequency analog, or power traces can also substantially degrade performance. Increase separation according to the interference level and use isolation or shielding where practicable.
- Antenna placement strongly affects performance. Keep the antenna exposed and, preferably, vertical.
- If the module is installed inside an enclosure, use a high-quality extension cable to place the antenna outside.
- Never install the antenna inside a metal enclosure; doing so will severely reduce transmission range.

9 Troubleshooting

9.1 Insufficient Communication Range

- Line-of-sight obstructions reduce communication range.
- Temperature, humidity, and co-channel interference can increase packet loss.
- The ground absorbs and reflects radio waves, so tests close to the ground generally perform poorly.
- Seawater strongly absorbs radio waves, so coastal tests generally perform poorly.
- Metal near the antenna, or a metal enclosure around it, causes severe attenuation.
- Incorrect power-register settings or an air data rate that is too high will reduce range; higher rates give shorter range.
- A supply voltage below the recommended value at room temperature reduces transmit power.
- A poorly matched or low-quality antenna will reduce performance.

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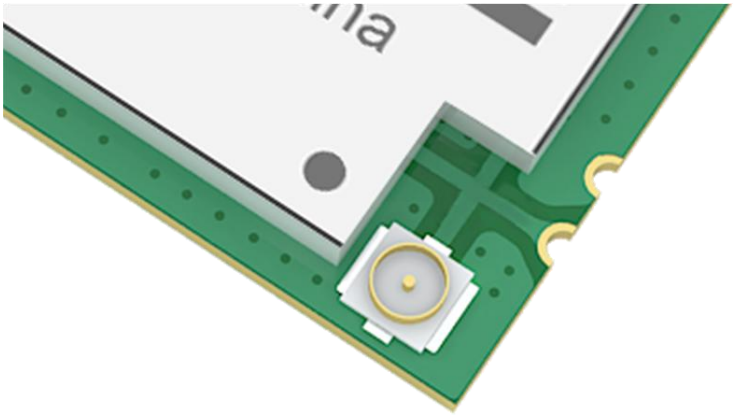
9.2 Module Damage

- Verify that the supply voltage is within the recommended range. Exceeding the maximum will permanently damage the module.
- Ensure a stable supply; the voltage must not fluctuate sharply or frequently.
- Use ESD-safe handling and installation procedures; RF devices are sensitive to static electricity.
- Avoid excessive humidity during installation and operation; some components are moisture-sensitive.
- Unless required by the application, avoid operation at extremely high or low temperatures.

9.3 High Bit-Error Rate

- Co-channel interference may be present. Move away from the source or change frequency/channel.
- An unstable or inadequate supply can corrupt data. Ensure that the power source is reliable.
- Long or low-quality extension cables and feed lines can increase the bit-error rate.

9.4 Antenna Selection



The IPEX and stamp-hole antenna interfaces are enabled simultaneously; either interface may be used.

10 Soldering Guidelines

10.1 Reflow-Soldering Temperature

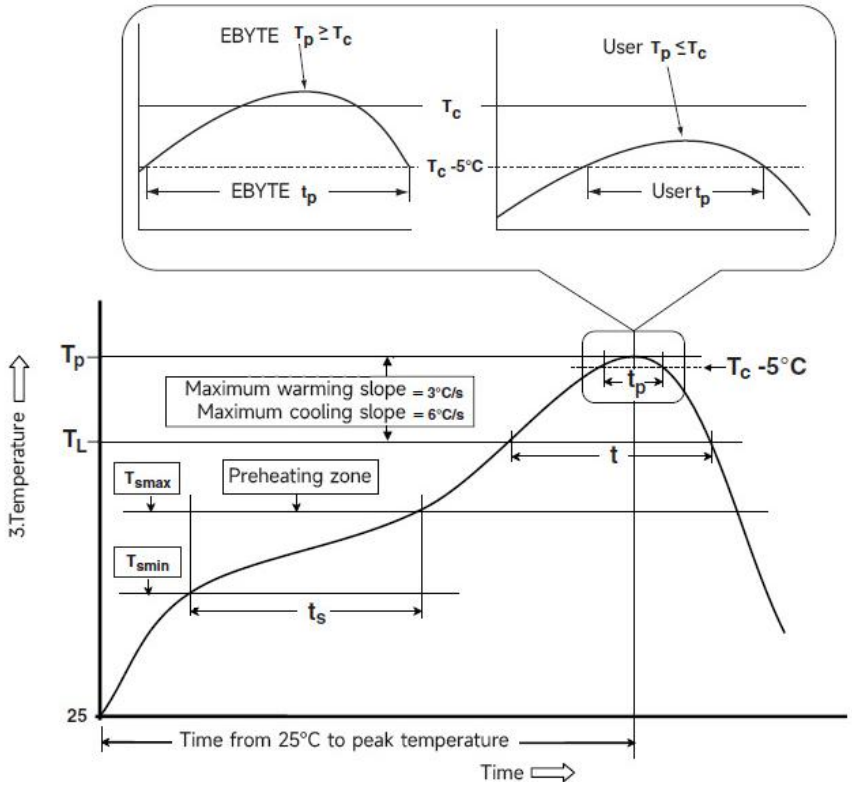
Reflow-profile characteristic		Leaded assembly	Lead-free assembly
Preheat/soak	Minimum temperature (Tsmin)	100 °C	150 °C
	Maximum temperature (Tsmax)	150 °C	200 °C
	Time from Tsmin to Tsmax	60–120 s	60–120 s
Ramp-up rate (TL to Tp)		3 °C/s maximum	3 °C/s maximum
Liquidus temperature (TL)		183 °C	217 °C
Time above TL		60–90 s	60–90 s

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Reflow-profile characteristic	Leaded assembly	Lead-free assembly
Package peak temperature, Tp	Do not exceed the temperature stated on the product's moisture-sensitivity label.	Do not exceed the temperature stated on the product's moisture-sensitivity label.
Time within 5 °C of the specified classification temperature (Tc), Tp; see the figure below.	20 s	30 s
Ramp-down rate (Tp to TL)	6 °C/s maximum	6 °C/s maximum
Time from room temperature to peak temperature	6 min maximum	8 min maximum
※ The peak-temperature tolerance (Tp) of the profile defines the user's upper limit.		

10.2 Reflow Profile



11 Antenna Guide

11.1 Recommended Antennas

The antenna is a critical part of the communication system, and a poor antenna can severely degrade performance. EBYTE therefore recommends the following well-performing, reasonably priced antennas for use with its wireless modules.

Product model	Type	Frequency band	Gain	Dimensions	Feed line	Connector	Features
		Hz	dBi	mm	cm		

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Product model	Type	Frequency band	Gain	Dimensions	Feed line	Connector	Features
		Hz	dBi	mm	cm		
TX2400-NP-5010	Flexible antenna	2.4G	2.0	10x50	-	IPEX	Flexible FPC antenna
TX2400-JZ-3	Rubber-duck antenna	2.4G	2.0	30	-	SMA-J	Ultra-short straight omnidirectional antenna
TX2400-JZ-5	Rubber-duck antenna	2.4G	2.0	50	-	SMA-J	Ultra-short straight omnidirectional antenna
TX2400-JW-5	Rubber-duck antenna	2.4G	2.0	50	-	SMA-J	Fixed-angle omnidirectional antenna
TX2400-JK-11	Rubber-duck antenna	2.4G	2.5	110	-	SMA-J	Flexible rubber-duck omnidirectional antenna
TX2400-JKD-20	Rubber-duck antenna	2.4G	5.0	200	-	SMA-J	Flexible rubber-duck omnidirectional antenna
TX2400-XPL-150	Magnetic-base antenna	2.4G	5	150	150	SMA-J	Compact, cost-effective magnetic-base antenna

Revision History

Version	Revision date	Description	Owner
1.0	2026-7-16	Initial release	Hao

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Web: https://www.cdebyte.com

Address: B5 Mould Industrial Park, 199# Xiqu Ave, High tech Zone, Chengdu, Sichuan, China

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