Chengdu Ebyte Electronic Technology Co.,Ltd

Wireless Modem

User Manual



E90-DTU(900SL33)/E90-DTU(400SL33)

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1. Product Introduction

1.1. Product Overview

The **E90-DTU(xxxSL33)①** is a wireless data transceiver utilizing military-grade LoRa modulation technology. It supports multiple transmission modes and operates in the **433 / 470 / 868 / 915 MHz** frequency bands. The transceiver provides transparent **RS-232** and **RS-485** interfaces and supports an input voltage range of **8–28 V**.

LoRa Direct Sequence Spread Spectrum (DSSS) technology provides longer communication distances while offering concentrated power density and strong anti-interference capability.

The module incorporates a software FEC (Forward Error Correction) algorithm with high coding efficiency and strong error correction capability. Under burst interference conditions, corrupted data packets can be actively corrected, greatly improving communication reliability and transmission distance. Without FEC, such data packets would only be discarded.

The transceiver also supports data encryption. Data transmitted over the air exhibits randomness, and the rigorous encryption/decryption algorithm makes intercepted data meaningless. Packet length configuration is supported, allowing adaptation to different real-time requirements and packet sizes.

As a communication medium, wireless data transceivers, like optical fiber, microwave, and wired communication, have specific application scenarios. They provide real-time and reliable data transmission for monitoring signals in private networks under special conditions. They feature low cost, convenient installation and maintenance, strong diffraction capability, flexible networking structure, and wide coverage, making them suitable for applications with numerous distributed nodes and complex geographical environments. They can be connected to PLCs, RTUs, rain gauges, level meters, and other data terminals.

1.2. Features

★ Utilizes the latest LoRa technology, providing longer communication distance and higher performance than traditional LoRa data transceivers;

★ Supports AT commands for easier operation;

★ Supports firmware upgrade via serial port, making firmware updates more convenient;

★ Communication distance up to **16 km** under ideal conditions;

★ Supports **433 / 470 / 868 / 915 MHz** frequency bands;

★ Supports data encryption and configurable packet length;

★ Supports extra-large packets, with a maximum packet length of **240 bytes**, compatible with the Modbus protocol;

★ Simple and efficient power supply design, supporting either power adapter or terminal block power input, with **8–28 V** supply voltage;

★ Maximum transmit power up to **2 W**, with multiple adjustable power levels. All technical specifications comply with European industrial standards;

★ Supports **LBT (Listen Before Talk)** function. The transceiver automatically delays transmission according to the current environmental noise level, greatly improving communication success rate in harsh environments;

★ Supports wireless transmission of command packets for remote configuration or parameter reading of wireless modules;

★ Supports communication key function to effectively prevent data interception;

★ Supports multi-level relay networking, effectively extending communication distance and enabling ultra-long-distance communication;

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- ★ Uses a temperature compensation circuit with frequency stability better than **±1.5 PPM**;
- ★ Operating temperature range: **-40°C to +85°C**, suitable for various harsh operating environments and truly industrial-grade;
- ★ Full aluminum alloy enclosure with compact size, easy installation, and excellent heat dissipation; optimized shielding design provides excellent EMC performance and strong anti-interference capability;
- ★ Multiple protection functions including reverse power polarity protection, over-voltage protection, and antenna surge protection, greatly improving transceiver reliability;
- ★ Powerful software functions. All parameters can be configured through programming, such as transmit power, frequency, air data rate, address ID, etc.;
- ★ Built-in watchdog with precise timing management. In case of abnormal operation, the module automatically restarts and continues operating with the previously configured parameters.

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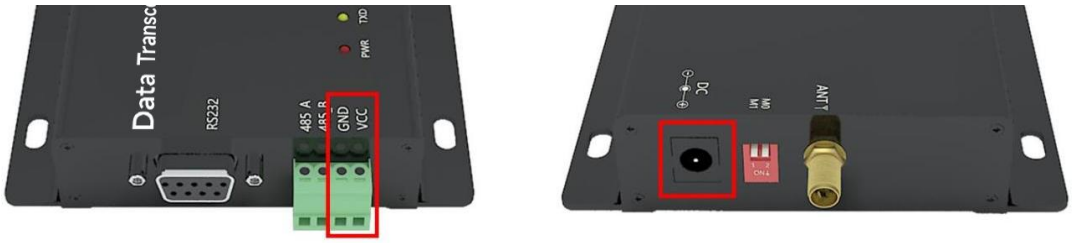
2. Quick Start

Preparation Required

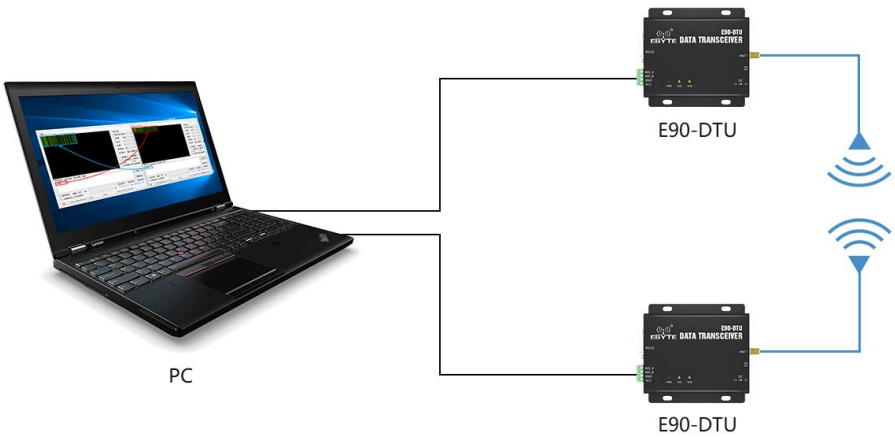


Notes: When using this device, a **50 Ω impedance antenna** must be connected externally. In addition, the two devices and their antennas must be placed at least **6 meters apart**; otherwise, there is a risk of permanent device damage.

1、 First install the antenna on the wireless data transceiver, then connect the power supply, and ensure that the DIP switch is set correctly. Users may choose either the terminal block power input or the power adapter as required. Only one power supply method should be used.



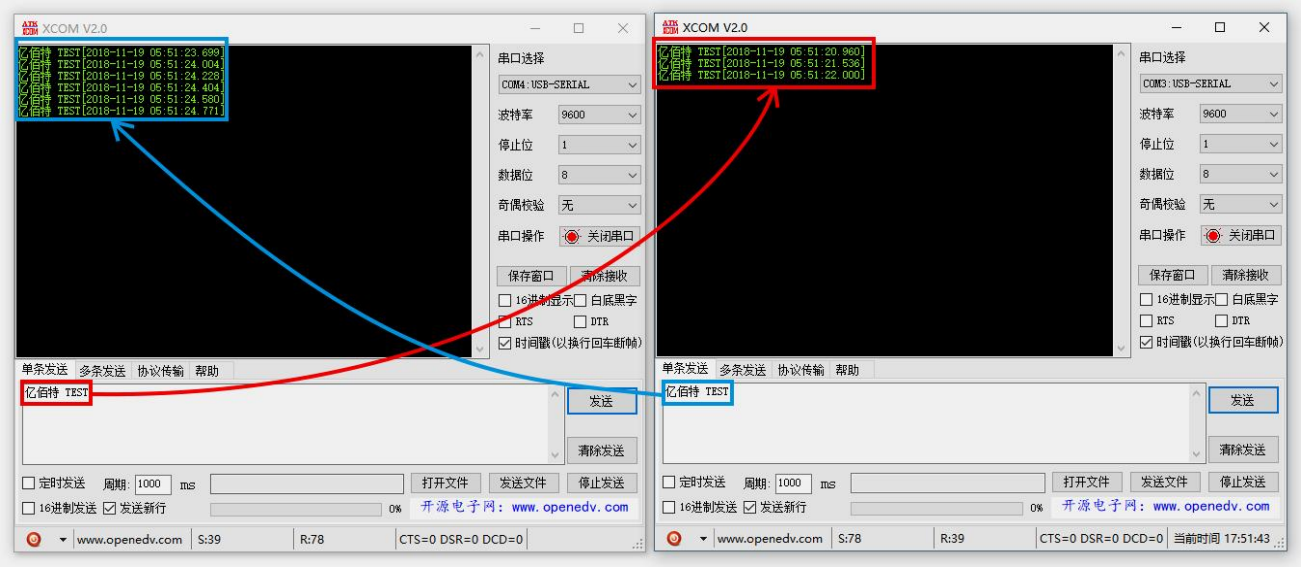
2、 Connect the computer to the wireless data transceiver using a **USB-to-RS232**, **USB-to-RS485**, or another suitable interface.



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3、 Start two serial port debugging assistants and set the serial port parameters to **9600 bps** with **8N1** format to enable transparent serial communication.



4、 If parameter modification is required, switch the wireless data transceiver to **Configuration Mode** before connecting it to the computer. Open the **E90-DTU Wireless Data Transceiver Configuration Software** to modify the required parameters. After configuration is completed, be sure to restore the DIP switch to the appropriate operating mode before communication.



Mode 0 (Factory Default Mode)



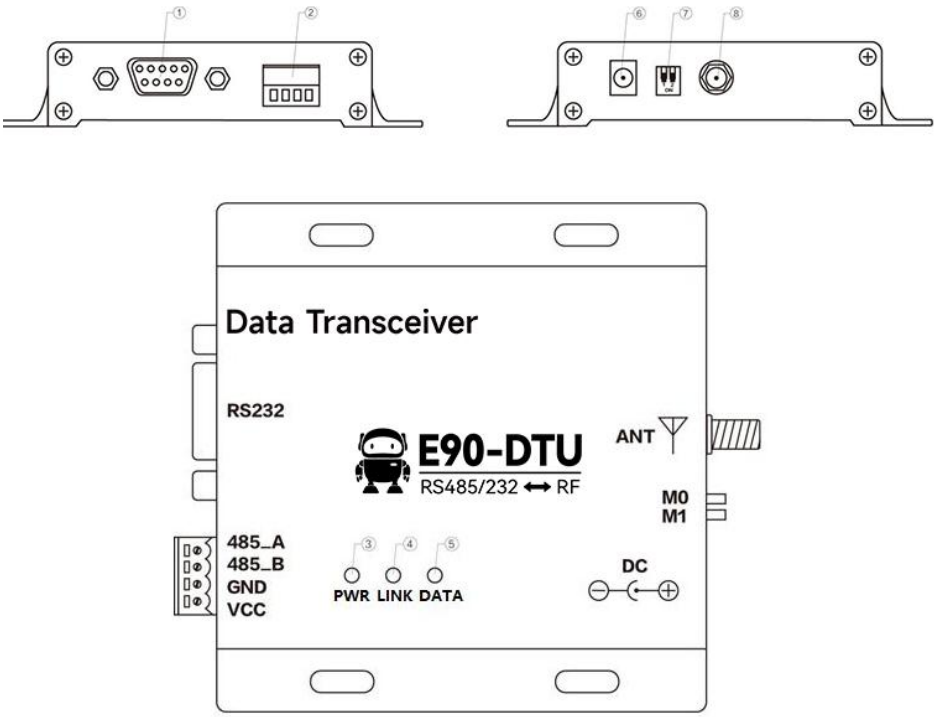
Mode 2 (Parameter Configuration Mode)

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3. Installation Dimensions

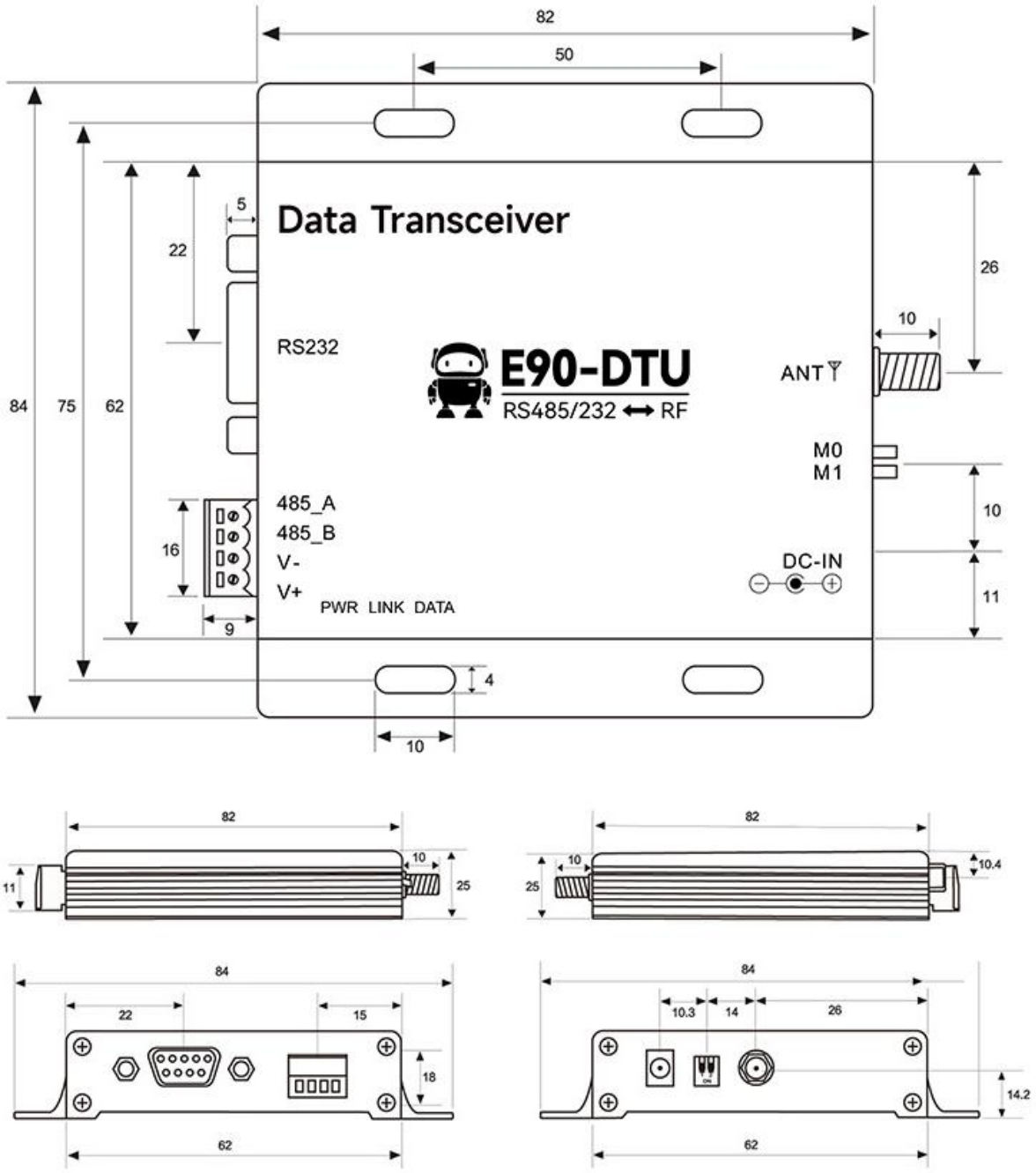
3.1 Component Description



No.	Name	Function	Description
1	DB-9 Female Connector	RS-232 Interface	Standard RS-232 interface
2	3.81 Terminal Block	RS-485 / Power Interface	Standard RS-485 interface and terminal block power input
3	PWR-LED	Power Indicator	Red, lights when power is on
4	TXD-LED	Transmit Indicator	Yellow, flashes during data transmission
5	RXD-LED	Receive Indicator	Yellow, flashes during data reception
6	DC Power Connector	Power Input	DC barrel jack, outer diameter **5.5 mm**, inner diameter **2.5 mm**
7	DIP Switch	DIP Switch	Operating mode selection
8	Antenna Connector	SMA-K Connector	Female center contact with external thread, length **10 mm**, characteristic impedance **50 Ω**

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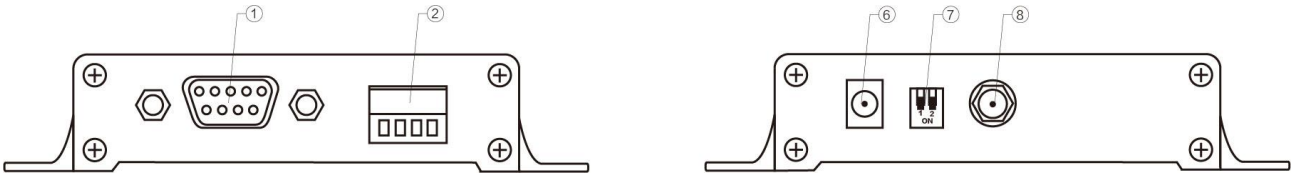
Unit: mm

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4. Interface Definition

4.1 Power Interface Description



Users may choose to power the device through ⑥ **DC Power Connector** using a power adapter with an outer diameter of **5.5 mm** and an inner diameter of **2.5 mm**.

Alternatively, power can be supplied through the **VCC** and **GND** terminals of ②. Only one of these two power supply methods should be used.

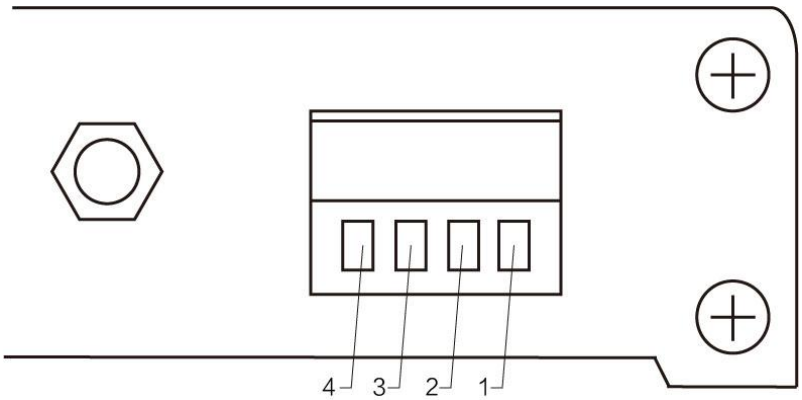
The **E90-DTU** supports a **8–28 V DC** power supply. A **12 V** or **24 V DC** power supply is recommended.

4.2 RS232 Interface Definition

The **E90-DTU** can be connected to external equipment through the standard **DB-9** connector using the **RS-232** interface.

4.3 RS485 Interface Definition

The **E90-DTU** can be connected to the device by connecting the **485_A** and **485_B** terminals in ② to the corresponding **A** and **B** terminals of the device's **RS-485** interface.



Pin No.	Standard Definition	Function	Description
1	VCC	Terminal Block Power Input, Positive	8–28 V DC, 12 V or 24 V recommended
2	GND	Terminal Block Power Input, Negative	Connect to power negative, system ground, and chassis
3	485_B	RS-485 Interface, B	Connect to the B terminal of the RS-485 device

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4	485_A	RS-485 Interface, A	Connect to the A terminal of the RS-485 device

★ Note: If communication becomes unstable when the transceiver is connected to multiple devices, while communication with a single device is normal, try connecting a **120 Ω resistor** in parallel between the **485_A** and **485_B** terminals.

5. Specifications

5.1 Model Specifications

Model	Operating Frequency	Transmit Power	Reference Distance	Features	Recommended Application
	Hz	W	km		
E90-DTU(900SL33)	868.125M	2	16	LoRa Spread Spectrum, High Interference Immunity	Suitable for long-distance and interference-prone environments
E90-DTU(400SL33)	433.125M	2	16	LoRa Spread Spectrum, High Interference Immunity	Suitable for long-distance and interference-prone environments

★ Note: Measured under clear weather, open environment without obstructions, powered by a **12 V / 2 A** supply, using a **5 dBi magnetic-mount antenna** installed **2 meters** above ground, with factory default parameters.

5.2 General Specifications

No.	Item	Specification	Description
1	Product Dimensions	82 × 62 × 25 mm	Refer to Installation Dimensions
2	Product Weight	150g	Weight tolerance: 4.5 g
3	Operating Temperature	-40℃～+85℃	Meets industrial-grade requirements
4	Antenna Impedance	50Ω	Standard 50 Ω characteristic impedance
5	Supply Voltage	8～28V DC	12 V/2 A or 24 V/1 A recommended
6	Communication Interface	RS232/RS485	Standard DB9 female connector / 3.81 terminal block
7	Baud Rate	Factory default: 9600	Adjustable from 1200 to 115200
8	Address Code	Factory default: 0	Up to 65,536 configurable addresses

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5.3 Frequency Range and Channel Count

Model	Default Frequency	Frequency Range	Channel Spacing	Number of Channels
	Hz	Hz	Hz	
E90-DTU(900SL33)	868.125M	850.125–930.125M	1M	81, Half-duplex
E90-DTU(400SL33)	433.125M	410.125–493.125M	1M	84, Half-duplex

★ Note: When multiple pairs of transceivers are used simultaneously within the same area, it is recommended that adjacent channels be separated by at least **2 MHz**.

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5.4 Transmit Power Levels

Model	2W	1W	500mW	250mW
E90-DTU(900SL33)	Factory Default	√	√	√
E90-DTU(400SL33)	Factory Default	√	√	√

★ Note: Lower transmit power results in shorter communication distance, but the operating current is not reduced proportionally. It is recommended to use the maximum transmit power whenever possible.

5.5 Air Data Rate Levels

Model	Default Air Data Rate	Number of Levels	Air Data Rate Levels
	bps		bps
E90-DTU(900SL33)	2.4k	6	2.4、4.8、9.6、19.2、38.4、62.5k
E90-DTU(400SL33)			

★ Note: Higher air data rates provide faster transmission speed but shorter communication distance. Therefore, use the lowest air data rate that satisfies application requirements.

5.6 Current Consumption

Model	Transmit Current (mA)		Standby Current (mA)	
	12V	24V	12V	24V
E90-DTU(900SL33)	650	330	10	6
E90-DTU(400SL33)				

★ **Note:** It is recommended that the selected power supply reserve at least **50%** additional current capacity to ensure long-term stable operation.

5.7 Receive/Transmit Length and Packet Segmentation

Model	Buffer Size	Packet Segmentation
E90-DTU(900SL33)	1000 Bytes	Configurable via commands: 32 / 64 / 128 / 240 bytes per packet
E90-DTU(400SL33)		

★ Note: 1、If the amount of data received by the transceiver exceeds the maximum packet size, the remaining data will be automatically transmitted in subsequent packets until all data has been sent.

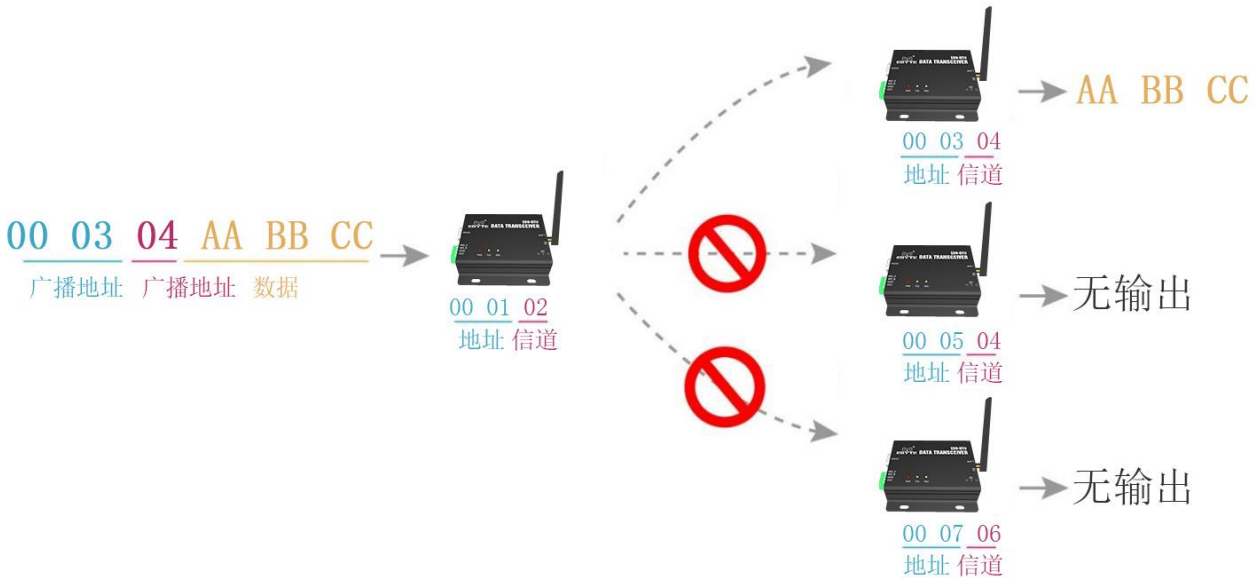
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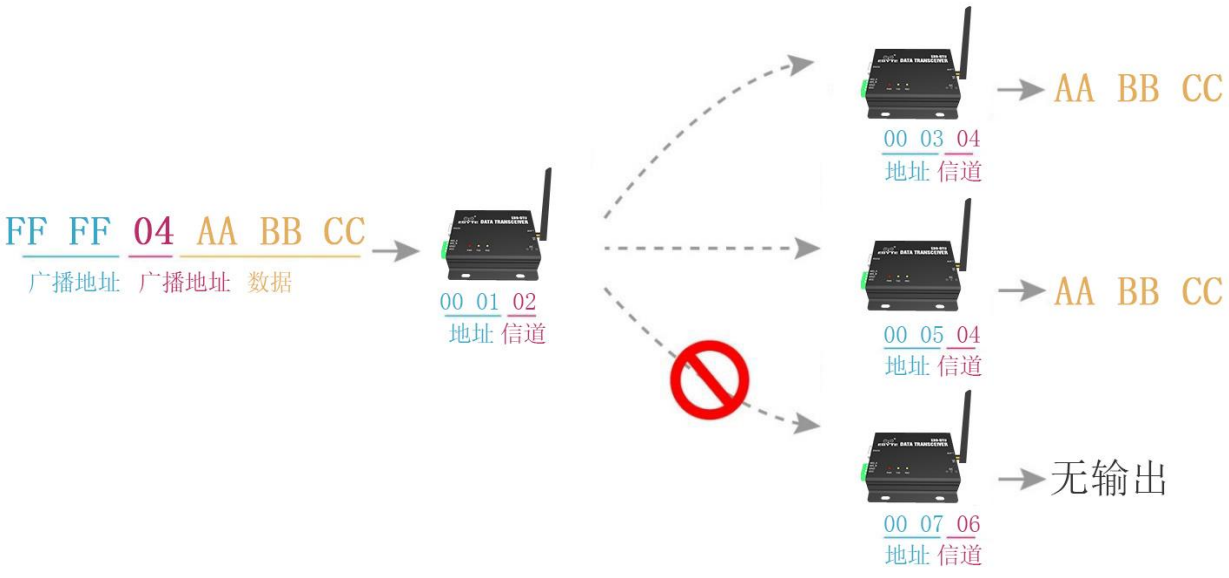
2、The total amount of data received in a single transmission must not exceed the buffer capacity.

6. Function Description

6.1 Fixed-Point Transmission (Hexadecimal)



6.2 Broadcast Transmission (Hexadecimal)



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6.3 Broadcast Address

- Example: Set the address of Module A to **0xFFFF**, and set the channel to **0x04**.
- When Module A operates as the transmitter (same operating mode, transparent transmission), all receiving modules on **Channel 0x04** can receive the transmitted data, thereby achieving broadcast communication.

6.4 Monitor Address

- Example: Set the address of Module A to **0xFFFF**, and set the channel to **0x04**.
- When Module A operates as the receiver, it can receive all data transmitted on **Channel 0x04**, thereby achieving the monitoring function.

6.5 Configuration Software Instructions

- The figure below shows the configuration software interface of the **E90-DTU(900SL33)**. Users can switch the module to **Command Mode** using **M0** and **M1**, allowing quick parameter configuration and reading through the configuration software.



- In the configuration software, the **Module Address**, **Frequency Channel**, **Network ID**, and **Key** are displayed in **decimal format**. The valid ranges are:
  - Network Address: 0～65535
  - Frequency Channel: 0～80
  - Network ID: 0～255
  - Key: 0～65535
- When configuring **Relay Mode**, special attention should be paid because all parameters in the configuration software are displayed in decimal format. Therefore, the module address and Network ID must be converted accordingly.

  For example, if the **Network ID** of transmitter **A** is **02**, and the **Network ID** of receiver **B** is **10**, then the relay **R** should use the hexadecimal value **0x020A**, which converts to the decimal value **522**. Therefore, the module address configured for relay **R** should be **522**.

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6.6 Quick Guide for Firmware Upgrade via Configuration Software

Step 1. Set **M0** and **M1** to switch the module into **Configuration Mode** (Note: The baud rate in Configuration Mode is **9600**). Open the configuration software and select the **Firmware Upgrade** tab.

Step 2. Click **Read Parameters** to display the module information in the left window.

Step 3. Open the firmware file (select the **.bin** firmware file), then click **Start Download**.

Step 4. Click **Start Download**. The firmware upgrade begins, and a successful download message will be displayed upon completion.

Step 5. After the firmware upgrade is completed, reopen the serial port and verify the parameters by reading them again.



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6.7 Quick Guide for Relay Networking

Relay networking expands network coverage and improves communication reliability by forwarding data between the source node and the destination node through relay nodes.

No.	Relay Mode Description
1	After enabling Relay Mode in Configuration Mode and switching back to Normal Mode, the relay starts operating and can forward data bidirectionally between two NETIDs.
2	In Relay Mode, **ADDH** and **ADDL** no longer represent the module address. Instead, they correspond to the paired NETIDs for forwarding. Data received from one network is forwarded to the other network.
3	In Relay Mode, the relay module itself cannot transmit or receive user data and does not support low-power operation.
4	The relay module's own Network ID is ignored.
5	It is not recommended to use two or more relays with identical or swapped ADDH/ADDL values, as this may cause endless forwarding loops between relays.

As shown in the example below:

Single-Level Relay

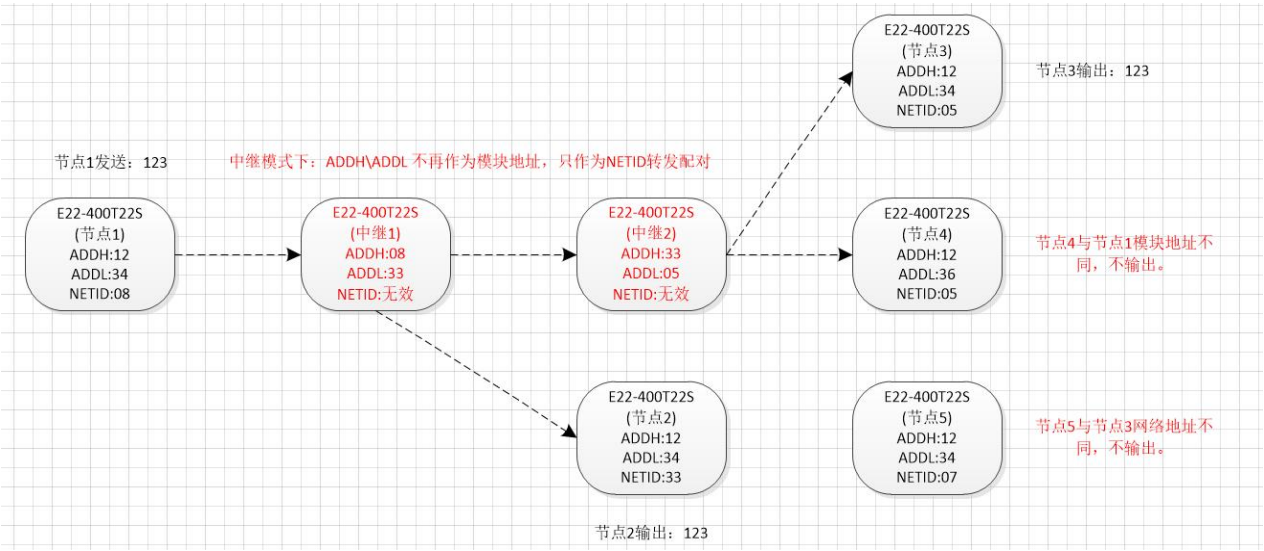
- "Node 1" has NETID **08**. "Node 2" has NETID **33**.
- "Relay 1" has **ADDH = 08** and **ADDL = 33**.
- Therefore, data transmitted from Node 1 (08) can be forwarded to Node 2 (33).
- At the same time, Node 1 and Node 2 have the same address, so data transmitted from Node 1 can be received by Node 2.

Two-Level Relay

- "Relay 2" has **ADDH = 33** and **ADDL = 05**.
- Relay 2 forwards data from Relay 1 to **NETID 05**.
- As a result, Node 3 and Node 4 can receive data from Node 1. Node 4 outputs the data normally, while Node 3 does not output data because its address differs from Node 1.

Bidirectional Relay

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



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7. Operating Modes

The **E90-DTU** provides four operating modes. If ultra-low power consumption is not required, **Normal Mode (Mode 0)** is recommended for standard communication.

The factory default operating mode is **Normal Mode (Mode 0)**.

	Mode	M1	M0	Description
Mode 0	Normal Mode	ON	ON	Serial port enabled, wireless enabled, transparent transmission (factory default). Supports over-the-air configuration using special commands.
Mode 1	WOR Mode	ON	OFF	Can be configured as a WOR transmitter or WOR receiver, supporting wireless wake-up.
Mode 2	Configuration Mode	OFF	ON	Users can access registers through the serial port to configure the operating status of the transceiver using the configuration software.
Mode 3	Deep Sleep Mode	OFF	OFF	The transceiver enters sleep mode.



模式0



模式1



模式2



模式3

★ Note: If low-power operation is not required, **WOR Mode (Mode 1)** can be ignored.

7.1 Normal Mode (Mode 0)

Type	When M0 = ON and M1 = ON, the module operates in Mode 0
Transmit	Users can input data through the serial port, and the module will transmit it wirelessly.
Receive	The wireless receiver is enabled. Received wireless data is output through the serial **TXD** pin.

7.2 WOR Mode (Mode 1)

Type	When M0 = OFF and M1 = ON, the module operates in Mode 1

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Transmit	When configured as the transmitter, a wake-up preamble is automatically added before transmission.
Receive	Data can be received normally. The receive function is the same as in Mode 0.

7.3 Configuration Mode (Mode 2)

Type	**When M0 = ON and M1 = OFF, the module operates in Mode 2**
Transmit	Wireless transmission is disabled.
Receive	Wireless reception is disabled.
Configuration	Users can access registers to configure the module operating parameters.

7.4 Deep Sleep Mode (Mode 3)

Type	**When M0 = OFF and M1 = OFF, the module operates in Mode 3**
Transmit	Wireless transmission is unavailable.
Receive	Wireless reception is unavailable.
Note	When switching from Deep Sleep Mode to another operating mode, the module reinitializes its parameters. During this process, **AUX** remains at a low level. After initialization is complete, **AUX** outputs a high level. Therefore, it is recommended that users detect the rising edge of **T_BUSY**.

8. Register Read/Write Control

8. 1 Command Format

In **Configuration Mode (Mode 2: M1 = OFF, M0 = ON)**, the following commands are supported (only **9600, 8N1** format is supported during configuration):

No.	**Command Format**	**Description**
1	Write Register	**Command:** C0 + Start Address + Length + Parameters **Response:** C1 + Start Address + Length + Parameters **Example 1:** Configure Channel to **0x09** Command Start Address Length Parameter Send: **C0 05 01 09** Return: **C1 05 01 09** **Example 2:** Configure Module Address (**0x1234**), Network Address (**0x00**), UART (**9600 8N1**), Air Data Rate (**2.4K**) simultaneously Send: **C0 00 04 12 34 00 60**

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		Return: **C1 00 04 12 34 00 60**
2	Read Register	**Command: C1 + Start Address + Length** **Response: C1 + Start Address + Length + Parameters** **Example 1: Read Channel** **Command Start Address Length Parameter** **Send: C1 05 01** **Return: C1 05 01 09** **Example 2: Read Module Address, Network Address, UART, and Air Data Rate simultaneously** **Send: C1 00 04** **Return: C1 00 04 12 34 00 60**
3	Write Temporary Register	**Command: C2 + Start Address + Length + Parameters** **Response: C1 + Start Address + Length + Parameters** **Example 1:** Configure Channel to **0x09** Command Start Address Length Parameter Send: **C2 05 01 09** Return: **C1 05 01 09** **Example 2:** Configure Module Address (**0x1234**), Network Address (**0x00**), UART (**9600 8N1**), Air Data Rate (**2.4K**) simultaneously Send: **C2 00 04 12 34 00 60** Return: **C1 00 04 12 34 00 60**
4	Wireless Configuration	**Command:** CF CF + Standard Command **Response:** CF CF + Standard Response **Example 1:** Configure Channel to **0x09** wirelessly Wireless Header Command Start Address Length Parameter Send: **CF CF C0 05 01 09** Return: **CF CF C1 05 01 09** **Example 2:** Wirelessly configure Module Address (**0x1234**), Network Address (**0x00**), UART (**9600 8N1**), Air Data Rate (**2.4K**) simultaneously Send: **CF CF C0 00 04 12 34 00 60** Return: **CF CF C1 00 04 12 34 00 60**
5	Invalid Format	Invalid format response **FF FF FF / "=ERR"**

8.2 Register Description

<table>
<tr><th>Address</th><th>R/W</th><th>Name</th><th colspan="4">Description</th><th>Remarks</th></tr>
<tr><td>00H</td><td>R/W</td><td>ADDH</td><td colspan="4">ADDH (Default: 0)</td><td rowspan="2">High byte and low byte of the module address.
Note: When the module address is FFFF, it functions as a broadcast/monitor address. In this case, the module does not perform address filtering.</td></tr>
<tr><td>01H</td><td>R/W</td><td>ADDL</td><td colspan="4">ADDL (Default: 0)</td></tr>
<tr><td>02H</td><td>R/W</td><td>NETID</td><td colspan="4">NETID (Default: 0)</td><td>Network ID used to distinguish different networks.
Modules must be configured with the same Network ID to communicate with each other.</td></tr>
<tr><td rowspan="2">03H</td><td rowspan="2">R/W</td><td rowspan="2">REG0</td><td>7</td><td>6</td><td>5</td><td>UART Baud Rate (bps)</td><td rowspan="2">Two communicating modules may use different UART baud rates and parity settings.</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>UART Baud Rate = 1200</td></tr>
</table>

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			0	0	1	UART Baud Rate = **2400**	When continuously transmitting large packets, different baud rates may cause data congestion or even packet loss. It is generally recommended that both communicating modules use the same baud rate.
			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**	
			4	3	UART Parity		Communicating modules may use different UART modes.
			0	0	8N1 (Default)		
			0	1	8O1		
			1	0	8E1		
			1	1	8N1 (Equivalent to 00)		
			2	1	0	Air Data Rate (bps)	Both communicating modules must use the same air data rate. Higher air data rates provide lower latency but shorter transmission distance.
			0	0	0	Air Data Rate = **2.4k (Default)**	
			0	0	1	Air Data Rate = **4.8k**	
			0	1	0	Air Data Rate = **9.6k**	
			0	1	1	Air Data Rate = **19.2k**	
			1	0	0	Air Data Rate = **38.4k**	
			1	0	1	Air Data Rate = **62.5k**	
04H	R/W	REG1	7	6	Packet Length Setting		If the transmitted data is shorter than the packet length, the receiver outputs the serial data continuously without interruption. If the transmitted data exceeds the packet length, the receiver outputs the data in multiple packets.
			0	0	240 Bytes (Default)		
			0	1	128 Bytes		
			1	0	64 Bytes		
			1	1	32 Bytes		
			5	RSSI Ambient Noise Enable			After enabling, register reading commands (**C0 C1 C2 C3**) can be executed in Transmission Mode or WOR Transmit Mode. Register **0x00**: Current ambient noise RSSI Register **0x01**: RSSI of the last received packet (Current channel noise: **dBm = -(256 - RSSI)**) Command: **C0 C1 C2 C3 + Start Address + Read Length** Response: **C1 + Address + Read Length + Value** Example: Send: **C0 C1 C2 C3 00 01** Return: **C1 00 01 RSSI** (Reading must start from address 00.)
			0	Disabled (Default)			
			1	Enabled			
			4	3	Reserved		**When configuring with the Ebyte configuration software, this option is automatically disabled.** **If M0/M1 hardware switching is not desired, software mode switching can be enabled.** **Format:** **C0 C1 C2 C3 02 + Operating Mode** **Send C0 C1 C2 C3 02 00 → Transparent Mode** **Send C0 C1 C2 C3 02 01 → WOR Mode** **Send C0 C1 C2 C3 02 02 → Configuration**
			2	Software Mode Switching			
			0	Disabled (Default)			
			1	Enabled			

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<table>
<tr><td></td><td></td><td></td><td colspan="4"></td><td>Mode
Send C0 C1 C2 C3 02 03 → Sleep Mode
Response:
C1 C2 C3 02 + Operating Mode
Note: After enabling this function, WOR Mode and Sleep Mode only support 9600 baud.</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>0</td><td colspan="2">Transmit Power</td><td rowspan="5">Power and current are non-linear. Maximum power provides the highest power efficiency. Current consumption does not decrease proportionally with lower transmit power.</td></tr>
<tr><td></td><td></td><td></td><td>0</td><td>0</td><td colspan="2">33 dBm (Default)</td></tr>
<tr><td></td><td></td><td></td><td>0</td><td>1</td><td colspan="2">30 dBm</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>0</td><td colspan="2">27 dBm</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td colspan="2">24 dBm</td></tr>
<tr><td>05H</td><td>R/W</td><td>REG2</td><td colspan="5">Channel Control (CH)
CH values 0–80 correspond to 81 channels (900 MHz version)</td><td>Actual Frequency = 850.125 + CH × 1 MHz</td></tr>
<tr><td rowspan="20">06H</td><td rowspan="20">R/W</td><td rowspan="20">REG3</td><td>7</td><td colspan="4">RSSI Byte Enable</td><td rowspan="3">After enabling, when wireless data is received and output through TXD, an additional RSSI byte is appended.</td></tr>
<tr><td>0</td><td colspan="4">Disabled (Default)</td></tr>
<tr><td>1</td><td colspan="4">Enabled</td></tr>
<tr><td>6</td><td colspan="4">Transmission Mode</td><td rowspan="3">In Fixed Transmission Mode, the first three bytes of serial data are interpreted as Destination Address High + Destination Address Low + Channel, and used as the wireless destination.</td></tr>
<tr><td>0</td><td colspan="4">Transparent Transmission (Default)</td></tr>
<tr><td>1</td><td colspan="4">Fixed Transmission</td></tr>
<tr><td>5</td><td colspan="4">Relay Function</td><td rowspan="3">When enabled, if the destination address is not the module's own address, the module forwards the packet once.
To avoid packet looping, it is recommended to use this together with Fixed Transmission Mode, so that the destination address differs from the source address.</td></tr>
<tr><td>0</td><td colspan="4">Relay Disabled (Default)</td></tr>
<tr><td>1</td><td colspan="4">Relay Enabled</td></tr>
<tr><td>4</td><td colspan="4">LBT Enable</td><td rowspan="3">When enabled, the module performs channel listening before transmission to reduce interference, though this may introduce transmission delay.
The maximum LBT waiting time is 2 seconds. After 2 seconds, transmission is forced.</td></tr>
<tr><td>0</td><td colspan="4">Disabled (Default)</td></tr>
<tr><td>1</td><td colspan="4">Enabled</td></tr>
<tr><td>3</td><td colspan="4">WOR Transmit/Receive Control</td><td rowspan="3">Valid only in Mode 1.
1. In WOR Receive Mode, the wake-up delay after activation can be configured. Default = 0.
2. In Configuration Mode, send:
C0 09 02 03 E8
(C0 = Write Command, 09 = Register Address, 02 = Length, 03E8 = Delay Value. Maximum = FFFF (65535 ms). Setting 0 disables the wake-up delay.)
3. Data can be transmitted during the configured delay period.</td></tr>
<tr><td>0</td><td colspan="4">WOR Receiver (Default)
Operates in WOR Listening Mode. See WOR Period below. Significantly reduces power consumption.</td></tr>
<tr><td>1</td><td colspan="4">WOR Transmitter
Wireless transmission/reception remains enabled. A wake-up preamble is added before data transmission.</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td colspan="2">WOR Period</td><td rowspan="6">Valid only in Mode 1.

Period T = (1 + WOR) × 500 ms
Minimum = 500 ms
Maximum = 4000 ms

A longer listening interval results in lower average power consumption but higher communication latency.</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td colspan="2">500ms</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td colspan="2">1000ms</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td colspan="2">1500ms</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td colspan="2">2000ms</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td colspan="2">2500ms</td></tr>
</table>

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			1	0	1	3000ms	The transmitter and receiver **must use the same WOR period (very important)**.
			1	1	0	3500ms	
			1	1	1	4000ms	
07H	Write	CRYPT_H	Encryption Key High Byte (Default: 0)				Write only. Reading always returns **0**. Used for data encryption to prevent wireless data from being intercepted by similar modules. The module internally uses these two bytes as encryption factors for over-the-air signal encryption.
08H	Write	CRYPT_L	Encryption Key Low Byte (Default: 0)				
80H～86H	Read	PID	Product Information (7 Bytes)				Deprecated and reserved only. Please refer to Section **9.1** for the **AT+DEVTYPE** and **AT+FWCODE** commands.

8.3 Factory Default Parameters

Module Model	Frequency	Address	Channel	Air Data Rate	Baud Rate	UART Format	Transmit Power
E90-DTU(900SL33)	868.125MHz	0x0000	0x23	2.4kbps	9600	8N1	2W
E90-DTU(400SL33)	433.125MHz	0x0000	0x23	2.4kbps	9600	8N1	2W

9. AT Commands

- AT commands for parameter configuration or query can only be used in **Configuration Mode** (the serial port is fixed at **9600, 8N1** in Configuration Mode);
- For firmware version **7453-0-20** and earlier, users do **not** need to append a carriage return and line feed (CR/LF) after AT commands;
- For firmware version **7453-0-21** and later, the module automatically detects the CR/LF at the end of AT commands. Commands without CR/LF are also recognized;
- If an AT command is invalid or execution fails, the module responds with **"=ERR"**;
- If an input parameter exceeds the valid range, it will be limited automatically. Do not exceed the specified parameter range to avoid unexpected behavior.

9.1 General Commands

9.1.1 AT+RESET Software Reset

Command Format	AT+RESET
Example	Send: AT+RESET Response: =OK
Description	● Firmware version **7453-0-20** and earlier does **not** respond with **=OK**.

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Command Format	AT+RESET
	● Firmware version **7453-0-21** and later adds the **=OK** response. ● The actual reset process starts **after** the **=OK** response. Please wait approximately **30 ms** before performing the next operation.

9.1.2 AT+DEFAULT Restore Factory Settings

Command Format	AT+DEFAULT
Example	Send: AT+DEFAULT Response: =OK
Description	● After responding with **=OK**, the module restores factory settings and then automatically restarts. Please wait approximately **30 ms** before performing the next operation.

9.1.3 AT+DEVTYPE Query Product Model

Command Format	AT+DEVTYPE=?
Example	Send: AT+DEVTYPE=? Response: DEVTYPE=E90-DTU(400SL30)
Description	● Product Series: **E90-DTU** ● Operating Band: **400 / 900** ● Maximum Output Power: **33**

9.1.4 AT+FWCODE Query Firmware Version

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

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9.1.5 AT+SWITCH Enable Software Mode Switching

Command Format	AT+SWITCH=<on_off>
Setting Example	Send: AT+SWITCH=0 Response: =OK
Query Example	Send: AT+SWITCH=? Response: AT+SWITCH=0
Parameter	**<on_off>: Switch** 0 Disable (Default) 1 Enable
Description	● Disabled by default. The operating mode is switched using the **M0/M1** pins (hardware switching). ● After being enabled, the **M0/M1** pins remain functional. The most recently triggered hardware or software switch takes effect. ● A restart is required for this setting to take effect. ● After being enabled, **AT+MODE** can be used to switch operating modes (software switching). Each software switch immediately saves the selected operating mode. ● When enabled, firmware version **7453-0-20** and earlier uses the **M0/M1 hardware mode** as the initial operating mode after power-up. ● When enabled, firmware version **7453-0-21** and later uses the **last software-saved mode** as the initial operating mode after power-up. ● When disabled, the module always uses the **M0/M1 hardware mode** as the initial operating mode after power-up.

9.1.6 AT+MODE Software Mode Switching

Command Format	AT+MODE=<mode>
Setting Example	Send: AT+MODE=0 Response: AT+MODE=0
Query Example	Send: AT+MODE=? Response: AT+MODE=0
Parameter	**<mode>** ： Operating Mode 0 Transmission Mode 1 Wake-on-Radio (WOR) Mode 2 Configuration Mode 3 Sleep Mode
Description	● This command is available only after enabling **AT+SWITCH**. ● It can be used in any operating mode. ● The actual mode switching starts **after** the **=OK** response. Please wait approximately **15 ms** before performing the next operation. ● Please refer to the description of **AT+SWITCH**.

9.1.7 AT+UAUX Enable AUX Indication During Wireless Transmission

Command Format	AT+UAUX=<on_off>
Setting Example	Send: AT+UAUX=0 Response: AT+MODE=0
Query Example	Send: AT+UAUX=? Response: AT+UAUX=0
Parameter	**<on_off>: Switch** 0 Disable (Default) 1 Enable
Description	● Firmware version **7453-0-20** and earlier does not support this command. In those versions, the **AUX** pin indicates the wireless transmission process by remaining low during transmission. To upgrade, please contact Ebyte. ● Firmware version **7453-0-21** and later disables this indication by default, allowing users to feed data packets more efficiently. To maintain compatibility with the AUX timing of previous versions, enable this function.

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9.1.8 AT+ADDR Communication Address (Address Filtering)

Command Format	AT+ADDR=<address>
Setting Example	Send: AT+ADDR=0 Response: =OK
Query Example	Send: AT+ADDR=? Response: AT+ADDR=0
Parameter	**<address>** ： Communication Address (0–65535)
Description	● Default address: **0** ● The address is **not** an RF parameter. It is only an identifier carried within the data packet to assist the receiver in determining whether address filtering should be applied. ● Broadcast address: **65535**. As a receiver, the module can receive data from any address on the same channel (no filtering). As a transmitter, transmitted packets carry the broadcast address, so receivers will not filter them (broadcast transmission).

9.1.9 AT+NETID Communication Network ID (Network Filtering)

Command Format	AT+NETID=<net>
Setting Example	Send: AT+NETID=0 Response: =OK
Query Example	Send: AT+NETID=? Response: AT+NETID=0
Parameter	**<net>: Network ID (0–255)**
Description	● Default Network ID: **0** ● The Network ID is **not** an RF parameter. It is only an identifier carried within the data packet to assist the receiver in determining relay forwarding and filtering. ● Network ID filtering has lower priority than the broadcast address. Broadcast packets can still be received even if the Network IDs are different.

9.1.10 Communication Channel (Carrier Frequency)

Command Format	AT+CHANNEL=<ch>		
Setting Example	Send: AT+CHANNEL=0 Response: =OK		
Query Example	Send: AT+CHANNEL=? Response: AT+CHANNEL=0		
Parameter	**<ch>** ： channel 0 - 83 **E90-DTU(400SL33)**	**<ch>** ： channel 0 - 80 **E90-DTU(900SL33)**	
Description	● The available channel range varies by frequency band. Please select the correct range accordingly. ● For the **400 MHz** version, the actual carrier frequency = **410.125 MHz + ch × 1 MHz** ● For the **900 MHz** version, the actual carrier frequency = **850.125 MHz + ch × 1 MHz**		

9.1.11 AT+KEY Communication Key (Data Encryption)

Command Format	AT+KEY=<key>
Setting Example	Send: AT+KEY=0 Response: =OK
Parameter	**<key>** ： Encryption/Decryption Key (0–65535)
Description	● Default value: **0** ● This parameter cannot be queried (the key cannot be read back). ● Modules with different keys cannot communicate because the received packet cannot be decrypted correctly, resulting in checksum failure and packet discard.

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9.1.12 AT+UART UART Baud Rate and Parity

Command Format	AT+UART=<baud>,<parity>
Setting Example	Send: AT+UART=3,0 Response: =OK
Query Example	Send: AT+UART=? Response: =OK
Parameter	**<baud>** ： UART Baud Rate 0 1200bps 1 2400bps 2 4800bps 3 9600bps (Default) 4 19200bps 5 38400bps 6 57600bps 7 115200bps **<parity>** ： UART Parity 0 None (Default) 1 Odd 2 Even
Description	● In Configuration Mode (**M0/M1 Mode 2**), the UART is fixed at **9600, 8N1**. ● The new setting takes effect after switching the operating mode.

9.1.13 AT+PACKET UART Packet Length

Command Format	AT+PACKET=<len>
Setting Example	Send: AT+PACKET=0 Response: =OK
Query Example	Send: AT+PACKET=? Response: AT+PACKET=0
Parameter	**<len>** ： UART Packet Length 0 240 Bytes (Default) 1 128 Bytes 2 64 Bytes 3 32 Bytes
Description	● During UART reception, if the received data length is less than the configured packet length, the module performs timeout-based frame segmentation before packaging and transmitting the data wirelessly. ● During UART reception, once the received data reaches the configured packet length, the module immediately packages and transmits it wirelessly. ● Any data exceeding the configured packet length remains buffered in the UART receive buffer. After the current wireless transmission is completed, the remaining data is continuously split into packets of the configured length and transmitted one packet at a time until all data has been sent.

9.1.14 AT+URXT UART Frame Timeout Condition

Command Format	AT+URXT=<byte>
Setting Example	Send: AT+URXT=3 Response: =OK
Query Example	Send: AT+URXT=? Response: AT+URXT=3
Parameter	**<byte>: Byte Time (1–255)**
Description	● By default, the UART timeout frame separation is performed after **3 byte times**. ● The byte time varies with the baud rate. At **9600 bps**, one byte time is approximately **1 ms**; at **115200 bps**, one byte time is approximately **100 µs**. ● For some users, the external MCU may send UART data to the module discontinuously (for example, interrupted by an RTOS task). If the interval exceeds the configured byte-time window, the module performs

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	frame separation, causing the received data to appear as segmented packets.

9.1.15 AT+RATE Wireless Data Rate

Command Format	AT+RATE=<rate>
Setting Example	Send: AT+RATE=2 Response: =OK
Query Example	Send: AT+RATE=? Response: AT+RATE=2
Parameter	**<rate> ：** Air Data Rate **E90-DTU(400SL33)、E90-DTU(900SL33)** 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
Description	● The supported air data rate range differs between products of different frequency bands. Please select accordingly. ● A higher air data rate results in lower communication latency (shorter transmission time), but lower receiver sensitivity (shorter communication distance).

9.1.16 AT+TRANS Wireless Transmission Mode (Transparent / Fixed Transmission)

Command Format	AT+TRANS=<mode>
Setting Example	Send: AT+TRANS=0 Response: =OK
Query Example	Send: AT+TRANS=? Response: AT+TRANS=0
Parameter	**<mode> ：** Transmission Mode 0 Transparent Transmission (Default) 1 Fixed Transmission
Description	● In Fixed Transmission mode, the first **3 bytes** of user data are processed specially. The **1st and 2nd bytes** are interpreted as the destination communication address, and the **3rd byte** is interpreted as the destination communication channel (the module switches to the target channel automatically). ● After the fixed transmission is completed, the module automatically switches back to the original channel.

9.1.17 AT+LBT Enable Listen Before Talk (LBT)

Command Format	AT+LBT=<on_off>
Setting Example	Send: AT+LBT=0 Response: =OK
Query Example	Send: AT+LBT=? Response: AT+LBT=0
Parameter	**<on_off> ：** Switch 0 Disable (Default) 1 Enable
Description	● When the **LBT (Listen Before Talk)** function is enabled, the module checks whether the environmental signal strength is below the configured threshold before every wireless transmission. If the condition is met within the timeout period, wireless transmission starts. If the maximum timeout is reached without meeting the condition, transmission is forced to start. ● For detailed LBT conditions, please refer to the **AT+LBR** command.

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9.1.18 AT+LBR LBT Decision Conditions

Command Format	**AT+LBR=<rssi>,<timeout>**
Setting Example	Send: AT+LBR=-55,2000 Response: =OK
Query Example	Send: AT+LBR=? Response: AT+LBR=-55,2000
Parameter	**<rssi>** ： Signal Strength Threshold (dBm), **0 – (-128)** **<timeout>**：Maximum Timeout (ms), **0–65535**
Description	● Firmware version **7453-0-20** and earlier does not support this command. However, the default parameters are identical: **-55 dBm** and **2000 ms**.

9.1.19 AT+ROUTER Relay Forwarding

Command Format	**AT+ROUTER=<on_off>**
Setting Example	Send: AT+ROUTER=0 Response: =OK
Query Example	Send: AT+ROUTER=? Response: AT+ROUTER=0
Parameter	**<on_off>** ： Switch 0 Disable (Default) 1 Enable
Description	● After enabling, please refer to **Chapter 6** for the relay networking mode description. ● Relay forwarding essentially retransmits every received wireless packet once, so the over-the-air transmission time (latency) is doubled. ● The relay operates in **half-duplex** mode. Please reserve sufficient time for the relay to complete forwarding. If new data is sent to the relay while it is forwarding, packet loss may occur.

9.1.20 AT+WOR Wake-on-Radio Role (Transmitter / Receiver)

Command Format	**AT+WOR=<role>**
Setting Example	Send: AT+WOR=0 Response: =OK
Query Example	Send: AT+WOR=? Response: AT+WOR=0
Parameter	**<role>** ： Role 0 Receiver (Default) 1 Transmitter
Description	● The receiver operates in a low-power mode, while the transmitter remains at normal power consumption. ● The receiver periodically enters sleep according to the configured WOR cycle to reduce power consumption. During sleep, it cannot receive wireless signals. When the sleep timer expires, the RF unit wakes briefly and enters receive mode. If a wake-up signal is detected during the receive window, the module remains awake to receive subsequent wireless data. Otherwise, it enters the next sleep–wake cycle. ● The transmitter inserts a wake-up preamble before the user data according to the configured WOR cycle, waking the receiver before transmitting the actual data. Therefore, the total transmission time (latency) is longer.

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9.1.21 AT+WTIME Wake-on-Radio Cycle

Command Format	AT+WTIME=<timeout>
Setting Example	Send: AT+WTIME=3 Response: =OK
Query Example	Send: AT+WTIME=? Response: AT+WTIME=3
Parameter	**<timeout>** ： Sleep Time 0 500ms 1 1000ms 2 1500ms 3 2000ms (Default) 4 2500ms 5 3000ms 6 3500ms 7 4000ms
Description	● A longer sleep interval for the WOR receiver results in lower average power consumption, but higher communication latency. ● Firmware version **7453-0-16** and earlier does not support this command. Please use the **HEX register command** instead.

9.1.22 AT+DELAY WOR Receiver Response Window

Command Format	AT+DELAY=<timeout>
Setting Example	Send: AT+DELAY=0 Response: =OK
Query Example	Send: AT+DELAY=? Response: AT+DELAY=0
Parameter	**<timeout>** ： Response Window Time (ms), **0–65535**
Description	● Default value is **0**, meaning that after the WOR receiver receives wireless data and outputs it through the UART, it immediately returns to sleep. ● After a delay is configured (for example, **1000 ms**), the WOR receiver remains awake for the specified duration after outputting the received data via UART. During this response window, the user can send response data to the module for wireless transmission.

9.1.23 AT+ERSSI Environmental Signal Strength

Command Format	AT+ERSSI=<on_off>
Setting Example	Send: AT+ERSSI=0 Response: =OK
Query Example	Send: AT+ERSSI=? Response: AT+ERSSI=0
Parameter	**<on_off>** ： Switch 0 Disable (Default) 1 Enable
Description	● After enabling, please refer to **"RSSI Environmental Noise Enable"** in the register description section and use hexadecimal commands to read the data.

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9.1.24 AT+DRSSI Received Packet Signal Strength

Command Format	**AT+DRSSI=<on_off>**
Setting Example	Send: AT+DRSSI=0 Response: =OK
Query Example	Send: AT+ERSSI=? Response: AT+ERSSI=0
Parameter	**<on_off>** ： Switch 0 Disable (Default) 1 Enable
Description	● After enabling, an additional **1-byte RSSI value** (signed hexadecimal value) is appended to the end of each received data packet. ● Conversion example: If the appended RSSI value is **0xC4 (-60 dBm)**, hexadecimal **0xC4** equals decimal **196**. The conversion formula is: RSSI = -(256 − 196) = -60 dBm ● If the transmitter and receiver are too close together, or the transmitter power is too high, the received RSSI may reach the upper limit of **0**. In this case, interpret it directly as **0 dBm**.

9.1.25 AT+POWER Power Level

Command Format	AT+POWER=**<Power>**
Setting Example	Send: AT+POWER=0 Response: AT+POWER=0
Query Example	Send: AT+POWER=? Response: AT+POWER=0
Parameter	**<Power>** ： Power Level **E90-DTU(400SL33)、E90-DTU(900SL33)** 0 33dBm (Default) 1 30dBm 2 27dBm 3 24dBm
Description	-

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10. Programming the Radio

10.1. Diagram



Operating Mode	M1	M0	Remarks
Configuration Mode	OFF	ON	The radio can only be programmed using the configuration software in this mode.



1、Programming can only be performed in the specified operating mode (see the table above). If programming fails, please verify that the radio is operating in the correct mode.

2、If advanced programming is not required, simply open the **E90-DTU SL Data Radio Configuration Software** to modify the relevant parameters.

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11. Connection Diagrams for Testing and Practical Applications

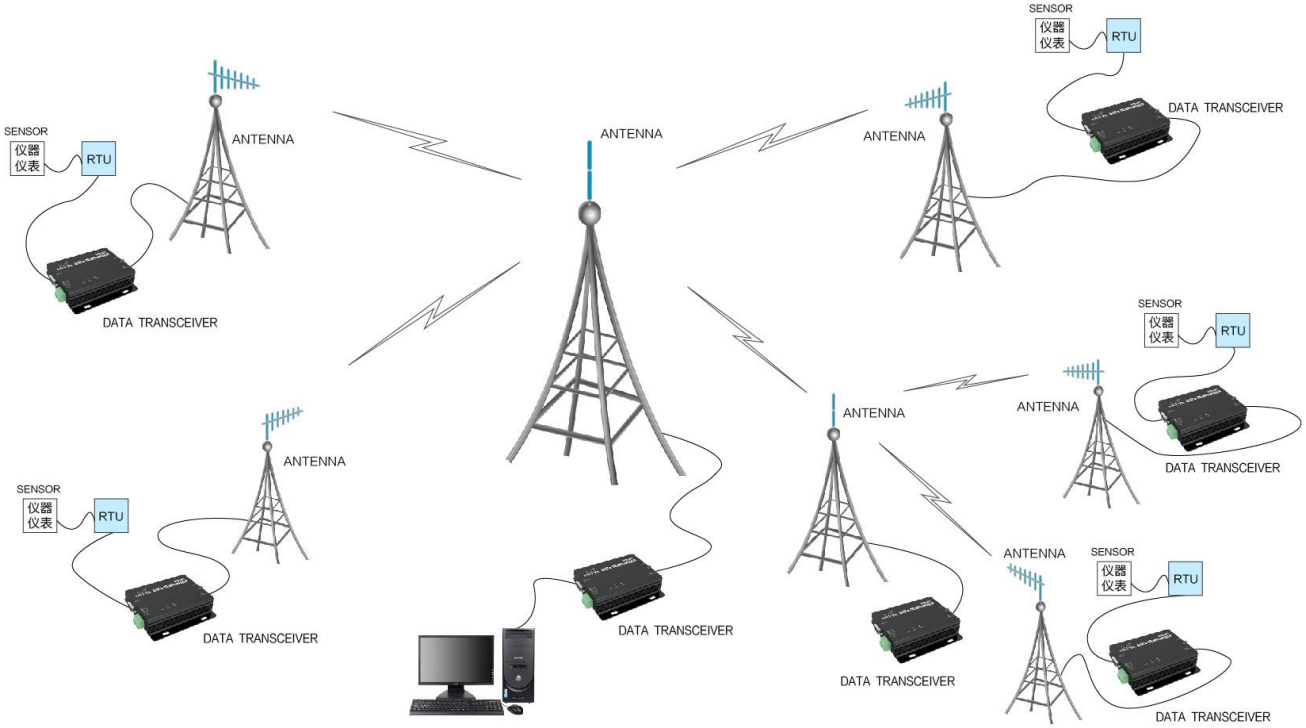


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12. Practical Application Fields

Ebyte data radios are suitable for various point-to-point and point-to-multipoint wireless data transmission systems, such as smart homes, IoT retrofitting, power load monitoring, distribution network automation, hydrological and water condition monitoring, municipal water pipeline monitoring, urban street lighting monitoring, air defense alarm control, railway signal monitoring, centralized railway water supply control, oil and gas pipeline monitoring, GPS positioning systems, remote meter reading, electronic weighing systems, automatic target reporting, earthquake monitoring, fire and burglary prevention, environmental monitoring, and other industrial automation systems, as shown below:



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13. Precautions

1. Please keep the warranty card in a safe place. It contains the factory serial number (and important technical parameters) of the device, which will be valuable for future maintenance and additional equipment purchases.
2. During the warranty period, if the radio is damaged due to product quality issues rather than human causes or natural disasters such as lightning, it is eligible for free warranty service. Do not attempt to repair the device yourself. If any problem occurs, please contact Ebyte. Ebyte provides first-class after-sales service.
3. Do not operate this radio in flammable locations (such as coal mines) or near explosive materials (such as blasting detonators).
4. Use a suitable regulated DC power supply with strong resistance to high-frequency interference, low ripple, and sufficient current capacity. It is recommended that the power supply also provide overcurrent protection, overvoltage protection, and lightning protection to ensure reliable operation of the radio.
5. Do not use the radio outside its specified environmental conditions, such as in environments with high temperature, high humidity, extremely low temperature, strong electromagnetic fields, or excessive dust.
6. Do not keep the radio transmitting continuously at full load for extended periods, as this may damage the transmitter.
7. The radio ground must be properly connected to the ground of external equipment (such as a PC or PLC) and the power supply ground. Otherwise, communication interfaces and other circuits may be damaged. Never plug or unplug the serial port while the device is powered on.
8. During testing, always connect a matched antenna or a 50 Ω dummy load. Otherwise, the transmitter may be damaged. If an antenna is connected, keep at least 2 meters away from it during transmission to avoid injury, and never touch the antenna while transmitting.
9. The communication distance of a wireless data radio varies depending on the operating environment. Factors such as temperature, humidity, obstacle density, obstacle size, and electromagnetic interference all affect communication range. To ensure stable communication, it is recommended to reserve at least 50% communication margin.
10. If the measured communication distance is unsatisfactory, it is recommended to improve communication performance by optimizing the antenna quality and installation method. You may also contact **support@cdebyte.com** for technical assistance.
11. When selecting a power supply, in addition to reserving at least 50% current margin as recommended, ensure that the output ripple voltage does not exceed **100 mV**.
12. Wireless communication products must be connected to an impedance-matched antenna for proper operation. Even during short-term testing, the antenna must not be omitted. Damage caused by operating the product without a matched antenna is not covered by the warranty.

Revision History

Version	Revision Date	Description	Maintainer
1.0	2023-8-18	Initial release	Hao
1.1	2026-7-3	Model consolidation	Hao

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