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# T90-DTU\_User Manual

## 1. Introduction

### 1.1. Brief introduction

T90-DTU (900SL22) is a data transceiver with military-grade LoRa modulation technology. With multiple transmission modes, it works in the (920-925MHz) frequency band. The transceiver provides transparent RS232/RS485 interface and supports 8~28V voltage input. LoRa direct-sequence spread spectrum technology will bring longer communication distances, and has the advantages of concentrated power density and strong anti-interference ability. It features a software FEC forward error correction algorithm, which has high coding efficiency and strong error correction capability. In the case of sudden interference, it can proactively correct the interfered data packets, greatly improving reliability and transmission distance. In the absence of FEC, such packets can only be discarded. It has data encryption. The data transmitted by the transceiver over the air is random, and the data interception is meaningless through strict encryption and decryption algorithms. Packet length setting is available to support different real-time and data packets.

As a communication medium, wireless data transceiver has the same scope as optical fiber, microwave and bright line: it provides real-time and reliable data transmission of monitoring signals in private networks under certain special conditions, with low cost, installation and maintenance. It is convenient, has strong diffraction ability, flexible networking structure and long coverage. It is suitable for occasions with many points and scattered, complex geographical environment, etc. It can be connected with PLC, RTU, rain gauge, liquid level meter and other data terminals.

### 1.2. Features

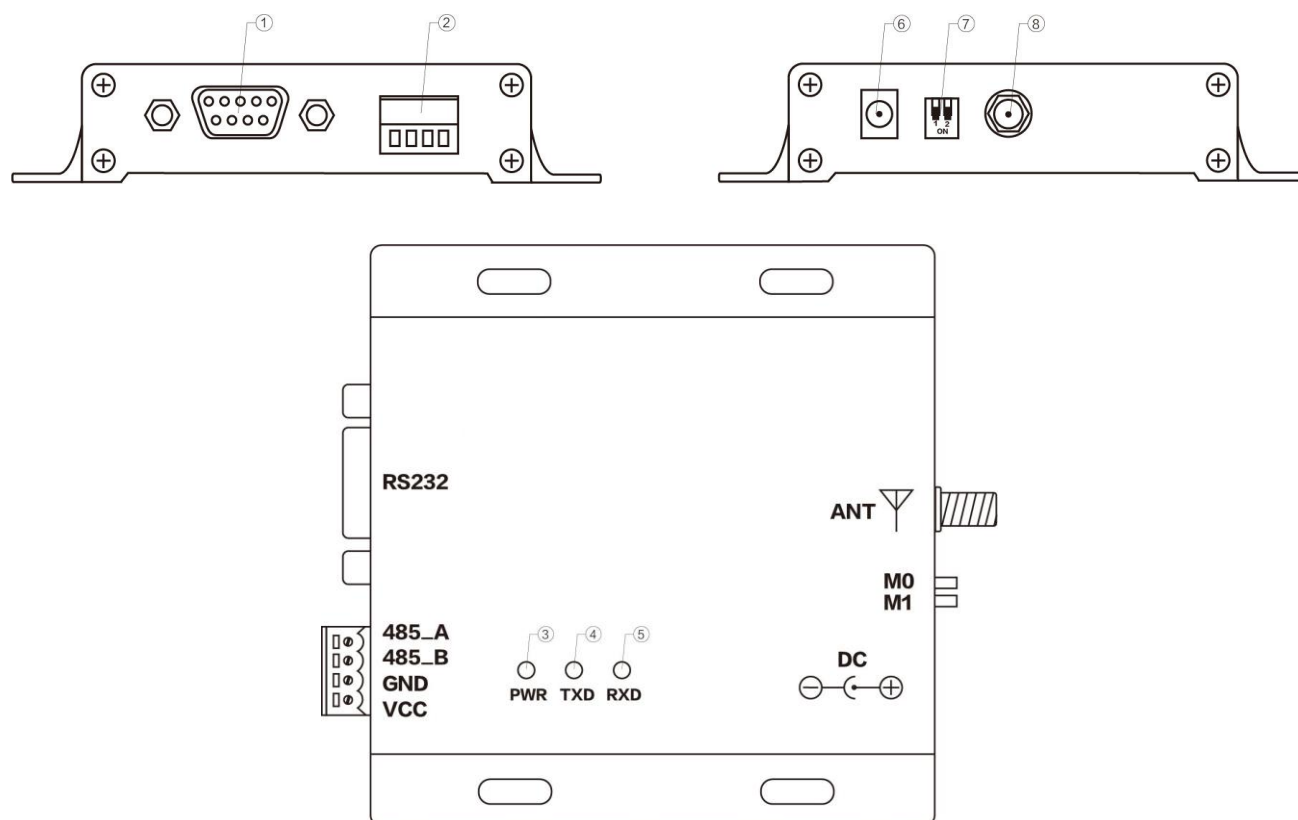
- ★ All core components are imported, featuring the most advanced functions, the smallest volume and the best price.
- ★ Using military-grade LoRa modulation technology, with data encryption, the packet length is available for configuration.
- ★ Large single package, single package is up to 240 bytes, adapt to Modbus.
- ★ Simple and efficient power supply design, support power adapter or crimping mode, support 8~28V power supply.
- ★ Transmit power is up to 1W, multi-level adjustable, with all technical indicators meeting European industrial standards.
- ★ Support LBT function, the transceiver automatically waits to send data according to the current ambient noise intensity. The communication success rate of the module in harsh environments is greatly improved.
- ★ Remotely configure or read wireless module parameters by sending command packets wirelessly.
- ★ Multi-level relay networking can be realized, which effectively extends communication distance for ultra-long-distance communication.
- ★ With temperature compensation circuit, the frequency stability is better than  $\pm 1.5\text{PPM}$ .
- ★ Operating temperature range:  $-40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$ , to adapt to a variety of harsh working environment.
- ★ All-aluminum alloy casing, compact size, easy installation and good heat dissipation; perfect shielding design, with good electromagnetic compatibility and strong anti-interference ability.
- ★ Multiple protection functions such as power reverse connection protection, over-current protection, and antenna surge protection greatly increase the reliability of the device.
- ★ Powerful software functions, all parameters can be programmed: such as power, frequency, air data rate, address ID, etc.

★ Ultra-low power consumption, the standby current is only 10mA (lower than power consumption in power-saving mode and sleep mode), and the transmitting current is  $\leq 0.1A$ .

★ with built-in watchdog and precise time layout, once an exception occurs, the transceiver will automatically restart, and continue to work according to the previous parameters.

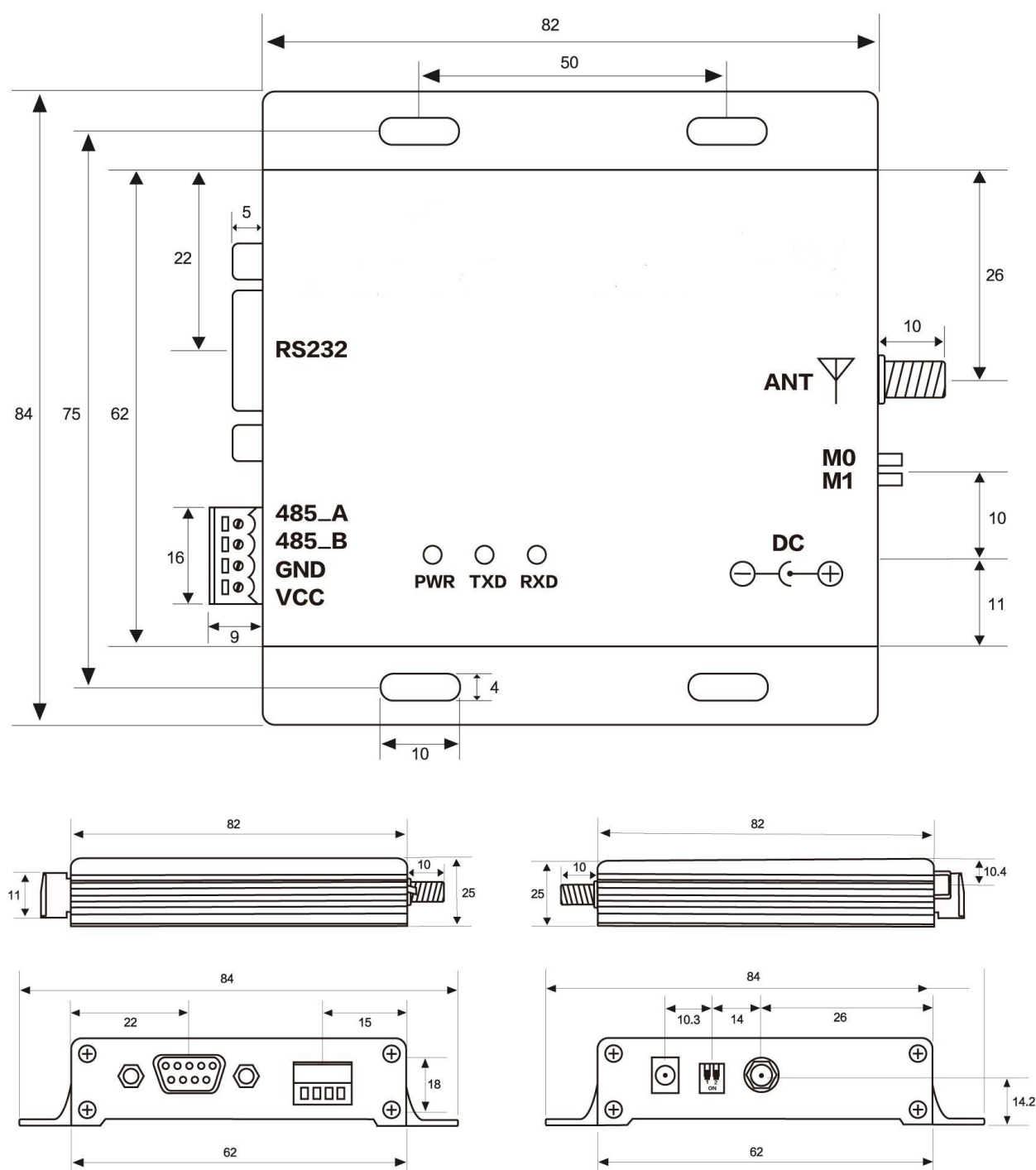
## 2. Dimensions

### 2.1. Parts description



No.	Name	Function	Note
1	DB-9 female socket	RS-232 interface	Standard RS-232 interface
2	3.81 terminal block	RS-485, power interface	Standard RS-485 interface and pressure line power interface
3	PWR-LED	Power LED	Red, lit when the power is on
4	TXD-LED	Transmit LED	Yellow, blinks when sending data
5	RXD-LED	Receive LED	Yellow, blinks when receiving data
6	DC power interface	Power interface	In-line round hole, outer diameter 5.5mm, diameter 2.5mm
7	DIP switch	DIP switch	Controlled by working mode
8	Antenna interface	SMA-K interface	external thread, 10mm, 50Ω characteristic impedance

## 2.2. Dimensions



单位: mm

### 3. Interface definition

#### 3.1. Power interface



Users can choose ⑥ DC power interface, using the power adapter supply with the interface of the 5.5mm outer diameter, 2.5mm diameter ;

Also users can choose the VCC and GND terminal power supply from ② , both are optional;

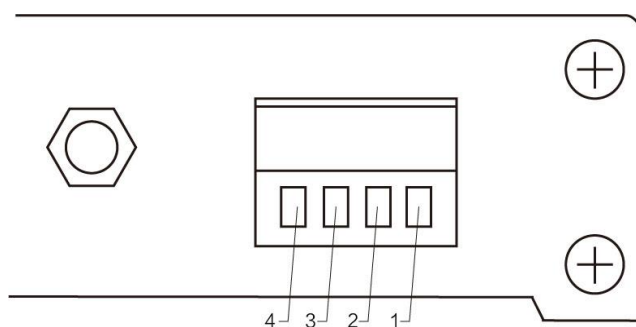
8 ~ 28V DC power supply, it is recommended to use 12V or 24V DC power supply for T90-DTU.

#### 3.2. RS232

The T90-DTU can be connected to the device via RS-232 using the standard DB-9 interface.

#### 3.3. RS485

T90-DTU can be connected to the 485\_A terminal and 485\_B terminal from ② with the RS-485 A terminal and B terminal of other device respectively.



Pin NO.	Definition	Function	Description
1	VCC	Crimping power interface, positive	8 ~ 28V DC, recommended 12V or 24V
2	GND	Crimping power interface, negative	The power supply negative pole is connected to the system ground and the housing
3	485_B	RS-485 interface, interface B	The RS-485 interface B is connected to the device interface B
4	485_A	RS-485 interface, interface A	The RS-485 interface A is connected to the device interface A

- ★ Note: The transceiver will be in poor communication when connected to multiple devices , it is recommended to be connected to a single device, please try to use parallel 120Ω resistor between 485\_A terminal and 485\_B.

## 4. Technical specification

### 4.1. Model specification

Model No.	Frequency	TX power	Distance	Features	Recommended application
	Hz	mW	km		
T90-DTU	920M	7.9	5	LoRa, anti-interference	Suitable for transmission of fast speed in complex environment with data interference over a long distance

Note: Test condition: in clear and open air without shelters, 12V /2A power supply, 5dBi gain sucker antenna over 2 meters height from the ground, with the factory default parameters.

### 4.2. General specification parameter

No.	Item	Value	Note
1	Size	82 * 62 * 25 mm	See more in 3.2. <i>Dimensions</i>
2	Weight	130g	±4.5 g
3	Temperature	-40°C ~ 85°C	Meet industrial request
4	Antenna impedance	50 Ω	Standard 50 Ω characteristic impedance
5	Supply voltage	+8 ~ +28V DC	It is recommended to use 12V or 24V
6	Communication interface	RS232/RS485	Standard DB9 hole / 3.81 terminal block
7	Baud rate	Default 9600	From 1200~115200
8	Address	Default 0	65536 configurable address

### 4.3. Frequency and channel numbers

Model No.	Default Frequency	Frequency Range	Channel Interval	Channel numbers
	Hz	Hz	Hz	
T90-DTU	920M	920~925MHz	1M	81, half duplex

★ Note: In the same area when multiple data transceivers are communicating one to one at the same time , it is recommended to set the channel spacing between each group of data transceivers at 2MHz or more.

### 4.4. Transmitting power

Model No.	22dBm	17dBm	13dBm	9dBm
T90-DTU	-	-	-	√

★ Note: The lower the transmit power, the closer the transmission distance, but the working current won't be declined in exact proportion , it is recommended to use the maximum transmit power.

### 4.5. Air data rate

Model	Default	Levels	Air data rate (bps)
	bps		bps
T90-DTU	2.4k	8	0.3、1.2、2.4、4.8、9.6、19.2、38.4、62.5k

★ Note: The higher the air data rate, the faster the transmission rate, the transmission distance is also closer; when the rate meets the requirements , the lower air data rate, the better quality.

### 4.6. Current

Model	TX current mA		Standby current mA	
	12V	24V	12V	24V
T90-DTU	45	26	10	7

★ Note: It is recommended to retain more than 50% of the current margin when selecting the power supply, which will help the data transceiver to work steadily for a long time.

#### 4.7. TX and RX FIFO and sub-packing method

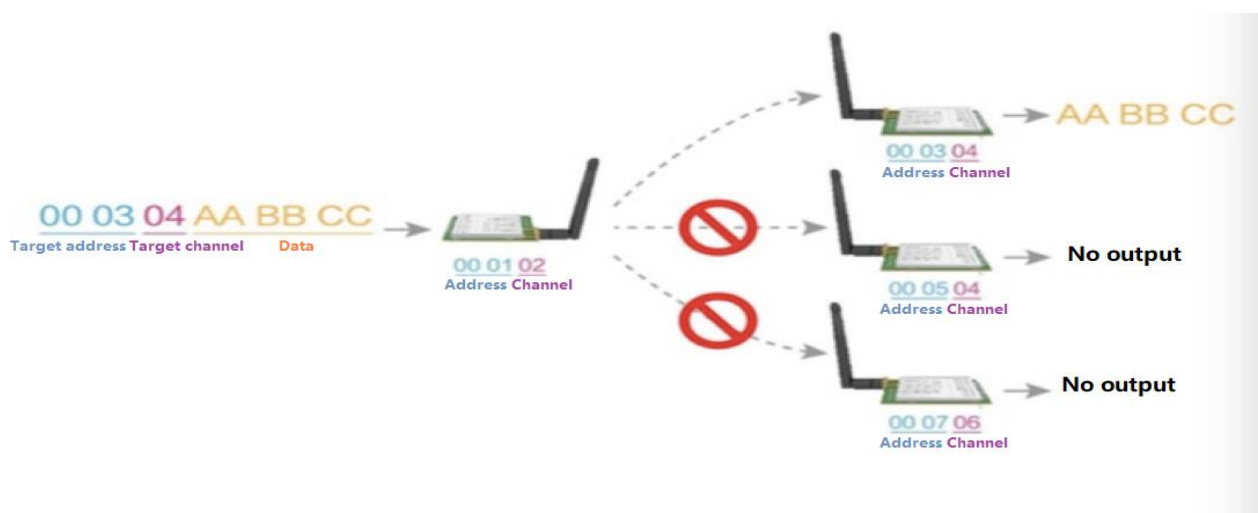
Model No.	Buffer	Sub-packing method
T90-DTU	1000 bytes	Can be sub-packed to 32/64/128/240 byte each time via command

★ Note:1. When the receiving data is more than a single packet capacity, the beyond part will be automatically assigned to the second transmission until it is completed;

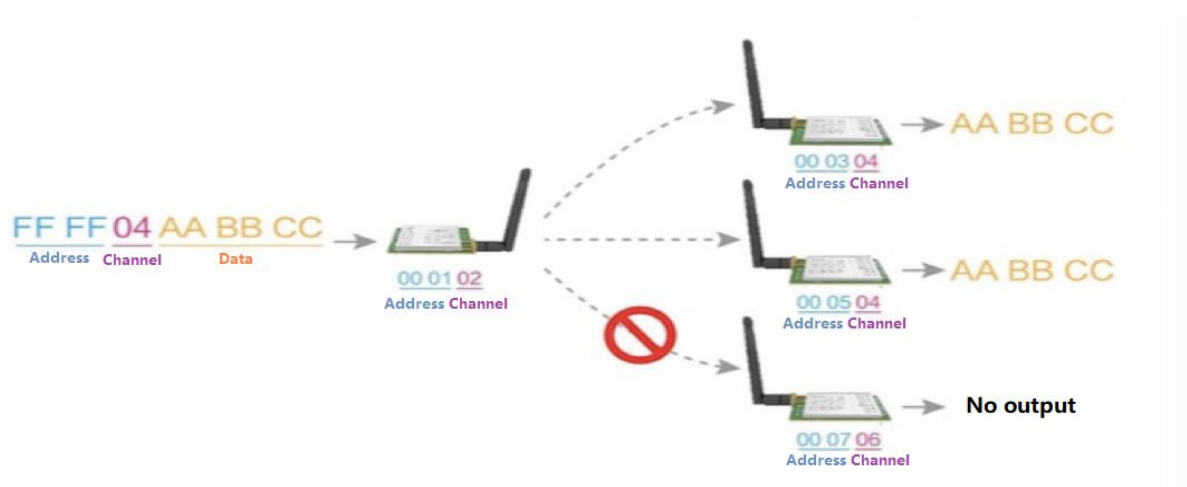
2. The data transceiver can not receive data which is more than the buffer capacity;

## 5. Function Description

### 5.1. Fixed Transmission



## 5.2. Broadcast Transmission



## 5.3. Broadcast Address

- For example: Set the address of module A as 0xFFFF and channel as 0x04;
- When module A is the transmitter (same mode, transparent transmission), all modules under channel 0x04 will receive the data, the purpose of broadcast is realized.

## 5.4. Monitor Address

- For example: Set the address of module A as 0xFFFF and channel as 0x04;
- When module A is the receiver, it can receive the data sent from all modules under channel 0x04. The purpose of monitor is realized.

## 6. Operating mode

There are four operating modes, if low power consumption is not required, for normal communication it is recommended to configure the data transceiver to the normal mode (mode 0);

The factory default is normal mode (mode 0).

	Categories	M1	M0	Notes
Mode 0	Normal Mode	ON	ON	Open UART Comm port and RF, transparent transmission is on, configuration over air via special command is available.
Mode 1	WOR Mode	ON	OFF	Can be defined as WOR transmitter and WOR receiver, WOR is available.
Mode 2	Configuration Mode	OFF	ON	Users access the register through the serial port to control the working state of the device. The DTU can be configured through



				the configuration software on computer.
Mode 3	Sleep Mode	OFF	OFF	DTU is in sleep mode.



Mode 0



Mode 1



Mode 2



Mode 3

Note: WOR(mode 1) and sleep mode(mode 3) are for low power consumption. If users do not require low power, then it is OK to use mode 0 and mode2 only.

### 6.1. Normal mode ( mode 0)

	<b>M0 = ON, M1 = ON, device works in Mode 0</b>
Transmitting	Users send data via UART. The device will start wireless transmission.
Receiving	Wireless receiving is enabled, data received will be output via pin TXD.

### 6.2. WOR mode (mode 1)

	<b>M0 = OFF, M1 = ON, device works in Mode 1</b>
Transmitting	As a transmitter, a certain preamble code will be added before each transmission.
Receiving	Wireless receiving is enabled, its function is same as Mode 0.

### 6.3. Configuration mode (mode 2)

	<b>M0 = ON, M1 = OFF, device works in Mode 2</b>
Transmitting	Wireless transmission is off.

Receiving	Wireless receiving is off.
Configuration	Users can visit register to configure the working status.

#### 6.4. Sleep mode (mode 3)

	<b>M0 = OFF, M1 = OFF, device works in Mode 3</b>
Transmitting	Wireless transmission is unavailable.
Receiving	Wireless receiving is unavailable.
Note	When entering other modes from the sleep mode, the parameters will be reconfigured. During the configuration process, AUX remains low level; After the configuration, it outputs high level, it is recommended that users detect the rising edge T_BUSY.

## 7. Register read and write control

### 7.1. Command format

In configuration mode (mode 2: M1=OFF, M0=ON) , supported commands are as follows (only **9600**, **8N1** are available) :

NO	Command format	Description
1	Configure register	command: C0+start address+length+parameter Reply: C1+start address+length+parameter  Example 1: set channel as 0x09 command  start address  length  parameter Transmit: C0  05        01      09 Return:  C1  05        01      09 Example 2: set module address (0x1234),network address (0x00),UART(9600 8N1),air data rate(1.2K) Transmit: C0 00 04 12 34 00 61 Return:  C1 00 04 12 34 00 61
2	Read register	Command: C1+start address+length Reply: C1+start address+length+parameter  Example 1: read channel command  start address  length  parameter Transmit: C1  05        01 Return:  C1  05        01      09  Example 2: read module address, network address, UART and air data rate Transmit: C1 00 04 Return:  C1 00 04 12 34 00 61
3	Configure temporary register	Command: C2 +start address+length+parameter Reply: C1 +start address+length+parameter

		<p>Example 1: Set channel as 0x09</p> <table><tr><td>command</td><td>start address</td><td>length</td><td>parameter</td></tr><tr><td>Transmit: C2</td><td>05</td><td>01</td><td>09</td></tr><tr><td>Return: C1</td><td>05</td><td>01</td><td>09</td></tr></table> <p>Example 2: set module address (0x1234) , network address (0x00), UART (9600 8N1), air data rate (1.2K)</p> <p>Transmit: C2 00 04 12 34 00 61</p> <p>Return: C1 00 04 12 34 00 61</p>	command	start address	length	parameter	Transmit: C2	05	01	09	Return: C1	05	01	09			
command	start address	length	parameter														
Transmit: C2	05	01	09														
Return: C1	05	01	09														
5	Wireless configuration	<p>Command: CF CF + general command</p> <p>Reply: CF CF + general response</p> <p>Example 1: set channel as 0x09</p> <table><tr><td>wireless command head</td><td>command</td><td>start address</td><td>length</td><td>parameter</td></tr><tr><td>Transmit: CF CF</td><td>C0</td><td>05</td><td>01</td><td>09</td></tr><tr><td>Return: CF CF</td><td>C1</td><td>05</td><td>01</td><td>09</td></tr></table> <p>Example 2: set module address (0x1234) , network address(0x00), UART(9600 8N1), air data rate(1.2K)</p> <p>Transmit: CF CF C0 00 04 12 34 00 61</p> <p>Return: CF CF C1 00 04 12 34 00 61</p>	wireless command head	command	start address	length	parameter	Transmit: CF CF	C0	05	01	09	Return: CF CF	C1	05	01	09
wireless command head	command	start address	length	parameter													
Transmit: CF CF	C0	05	01	09													
Return: CF CF	C1	05	01	09													
6	Format error	Reply: FF FF FF															

## 7.2. Register description

Address	Read/W rite	Name	Description	Remark
00H	Read/W rite	ADDH	ADDH (Default 0)	<ul style="list-style-type: none"> <li>High and low byte of the module address. Note: When the module address is FFFF, it can be used as the broadcast and monitor address, that is the module will not perform address filtering.</li> </ul>
01H	Read/W rite	ADDL	ADDL (Default 0)	
02H	Read/W rite	NETID	NETID (Default 0)	<ul style="list-style-type: none"> <li>Network address, used to distinguish the network. When communicating with each other, they should be set to the same.</li> </ul>
03H	Read/W rite	REG0	<p>7, 6, 5    UART baud rate (bps)</p> <p>000: baud rate is 1200</p> <p>001: baud rate is 2900</p> <p>010: baud rate is 4800</p> <p>011: baud rate is 9600 (Default)</p> <p>100: baud rate is 19200</p> <p>101: baud rate is 38900</p> <p>110: baud rate is 57600</p> <p>111: baud rate is 115200</p> <p>-----</p> <p>4, 3:      UART parity bit</p> <p>00: 8N1 (Default)</p> <p>01: 8O1</p> <p>10: 8E1</p> <p>11: 8N1 (same as 00)</p> <p>-----</p> <p>2, 1, 0,    air data rate</p> <p>000: air data rate is 0.3k</p> <p>001: air data rate is 1.2k</p> <p>010: air data rate is 2.4k (Default)</p> <p>011: air data rate is 4.8k</p> <p>100: air data rate is 9.6k</p> <p>101: air data rate is 19.2k</p> <p>110: air data rate is 38.4k</p> <p>111: air data rate is 62.5k</p>	<ul style="list-style-type: none"> <li>For the two modules that communicate with each other, the serial port baud rate can be different, and the verification method can also be different.</li> <li>When transmitting large packets continuously, users need to consider the data blocking caused by the same baud rate, and data may even be lost. It is generally recommended that both parties have the same baud rate.</li> </ul> <p>-----</p> <ul style="list-style-type: none"> <li>It should be the same for both communication parities .</li> <li>The higher the rate, the shorter the distance.</li> </ul>

04H	Read/W rite	REG1	<p>7, 6: sub-packing setting 00: 240byte (Default) 01: 128byte 10: 64byte 11: 32byte</p> <hr/> <p>5 : enable RSSI environmental noise 1: on 0: off (Default)</p> <hr/> <p>4, 3, 2 remain</p> <hr/> <p>1, 0: TX power 00: 22dbm (Default) 01: 17dbm 10: 13dbm 11: 10dbm</p>	<ul style="list-style-type: none"> <li>When the data is smaller than the sub packet length, the serial output of the receiving end is an uninterrupted continuous output. When the data is larger than the sub packet length, the receiving end serial port will output the sub packet.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>When enabled, the C0 C1 C2 C3 command can be sent in the transmitting mode or WOR transmitting mode to read the register. Register 0x00: Current ambient noise rssi Register 0x01: rssi when the data was received last time. (Current channel noise is: dBm =-RSSI/2)</li> </ul> <p>Command format: C0 C1 C2 C3 + starting address + read length Returns: C1 + address address + read length + read valid value E.g: send C0 C1 C2 C3 00 01 Return C1 00 01 rssi</p> <hr/> <ul style="list-style-type: none"> <li>Power and current are nonlinear, and power efficiency is highest at maximum power.</li> <li>The current does not decrease in proportion to the decrease in power.</li> </ul>
05H	Read/W rite	REG2	<p>Channel (CH) 0-80 stands for 81 channel respectively</p>	<ul style="list-style-type: none"> <li>Actual frequency= 920+ CH *1M</li> </ul>
06H	Read/W rite	REG3	<p>7 enable RSSI byte 1: on 0: off (Default)</p> <hr/> <p>6, fixed transmission 1: fixed transmission 0: transparent transmission (Default)</p> <hr/> <p>5 enable repeater 1: on 0: off</p> <hr/> <p>4 enable LBT (listen before transmit) 1: on 0: off (Default)</p> <hr/> <p>3 WOR TX and RX control 1: WOR transmitter TX and RX are enabled, certain preamble code is added when transmitting date. Data receiving is on. 0: WOR receiver (Default) Transmission is unavailable. Module works in WOR monitoring, (see details about WOR time below) to save power.</p>	<ul style="list-style-type: none"> <li>When enabled, the module receives wireless data and it will follow an RSSI strength byte after output via the serial port TXD</li> </ul> <hr/> <ul style="list-style-type: none"> <li>The module recognizes the first three bytes of the serial data as: address high + address low + channel and takes it as the wireless transmitting target.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>After the reply function is enabled, if the target address is not the module itself, the module will forward it once.</li> <li>In order to prevent data return-back, it is recommended to use it in conjunction with the fixed point mode. That is: the target address is different from the source address.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>When enabled, wireless data will be monitored before it is transmitted, which can avoid interference to a certain extent, but may cause data delay.</li> </ul> <hr/> <ul style="list-style-type: none"> <li>Only valid in Mode 1.</li> <li>After the WOR receiver receives the wireless data and outputs it through the serial port, it will wait for 1000ms before entering the WOR again. Users can input the serial port data and return it via the wireless during this period. Each serial byte will be refreshed for 1000ms.</li> </ul>

			<p>-----</p> <p>2, 1, 0, WOR time</p> <p>000: 500ms</p> <p>001: 1000ms</p> <p>010: 1500ms</p> <p>011: 2000ms (Default)</p> <p>100: 2500ms</p> <p>101: 3000ms</p> <p>110: 3500ms</p> <p>111: 9000ms</p>	<p>Users must transmit the first byte within 1000ms. -----</p> <ul style="list-style-type: none"> <li>● Only valid in Mode 1.</li> <li>● Time T= (1+WOR) *500ms, Max 9000ms, Min 500ms</li> <li>● The longer the WOR monitoring interval period, the lower the average power consumption, but the greater the data delay</li> </ul> <hr/> <ul style="list-style-type: none"> <li>● Both the transmitter and the receiver must be the same (very important).</li> </ul>
07H	Write	CRYPT_H	key high byte (Default 0)	<ul style="list-style-type: none"> <li>● Write only, read and return 0.</li> <li>● Used for user encryption to avoid intercepting airborne wireless data by similar modules.</li> </ul>
08H	Write	CRYPT_L	key low byte (Default 0)	
80H~86H	Read only	PID	7 bytes of product information	<ul style="list-style-type: none"> <li>● product information: 7 bytes</li> </ul>

### 7.3. Factory default parameter

Default parameter: 62 00 00 00 00 00							
Model NO.	Frequency	Address	Channel	Air data rate	Baud rate	Parity bit	TX power
T90-DTU	920MHz	0x0000	0x12	2.4kbps	9600	8N1	9dbm

## 8. Repeater networking mode

No.	Description
1	After setting the repeater mode by configuration, switch to the normal mode and the repeater starts working.
2	In the repeater mode, ADDH, ADDL are no longer used as the module address, but is correspondingly paired with the NETID. If the data of one of the networks is received, it is forwarded to another network. The network ID of the repeater itself is invalid.
3	In repeater mode, the repeater module cannot transmit and receive data, and cannot perform low-power operation.
4	The user enters the other mode from mode 3 (sleep mode) or during the reset process, the module resets the user parameters during which the AUX outputs low level.

Repeater networking rules:

1. Forwarding rules, the repeater can forward data in both directions between two NETIDs.
2. In repeater mode, ADDH\ADDL is no longer used as the module address, and it is used as a NETID forwarding pairing flag.

Figure:

- ① Primary repeater

“Node 1” NETID is 08.

“Node 2” NETID is 33.

Primary repeater 1’s ADDH\ADDL are 08, 33.

So the signal sent by node 1 (08) can be forwarded to node 2 (33)

At the same time, node 1 and node 2 have the same address, so the data transmitted by node 1 can be received by node 2.

## ② Secondary repeater

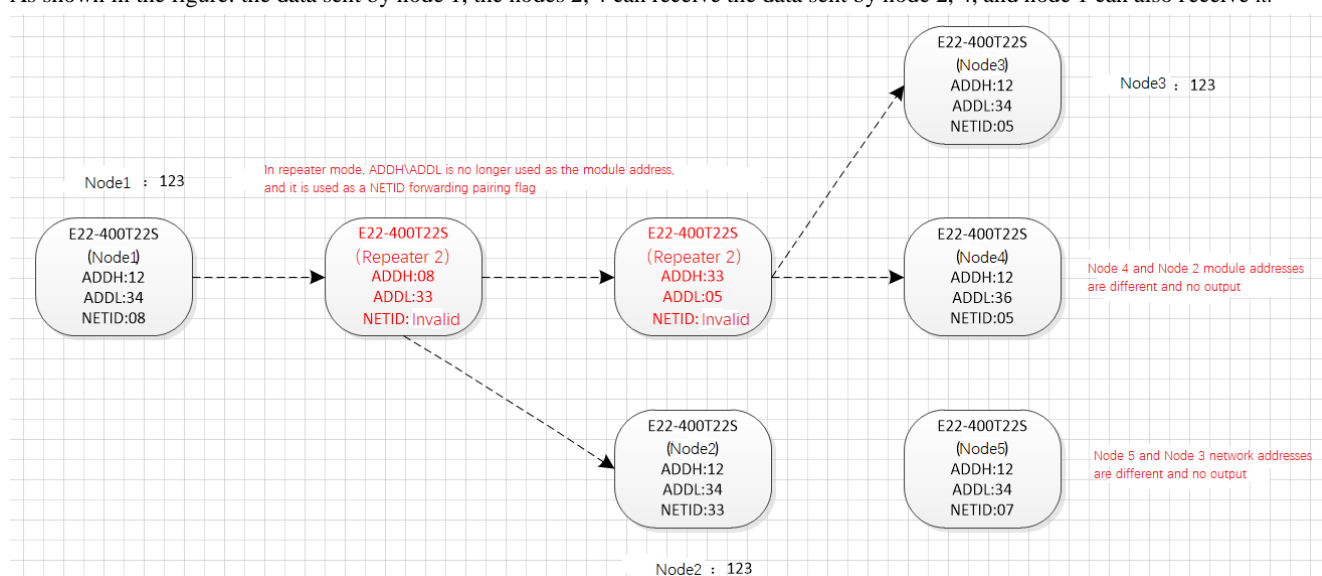
Secondary repeater’s ADDH\ADDL are 33, 05.

Therefore, Repeater 2 can forward the data of Repeater 1 to the network NETID: 05.

Thus node 3 and node 4 can receive node 1 data. Node 4 outputs data normally, and node 3 has a different address than node 1, so no data is output.

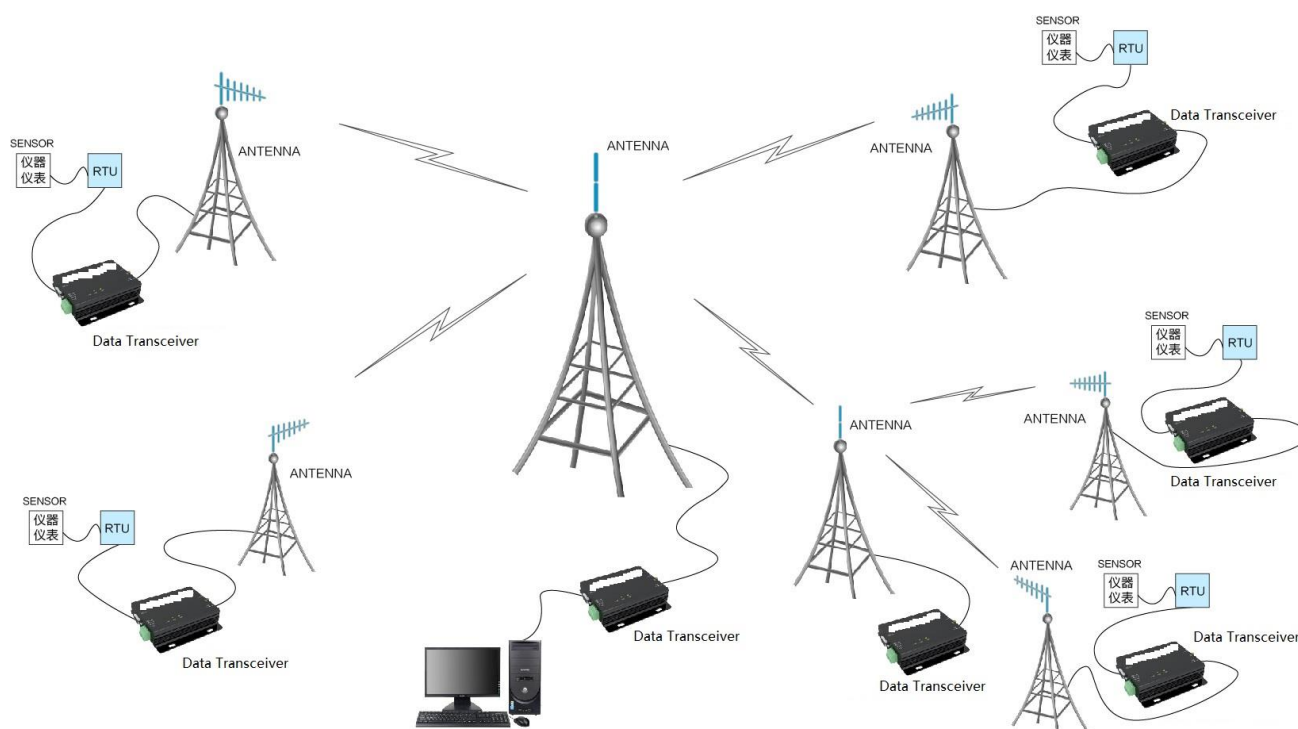
## ③ Two-way repeater

As shown in the figure: the data sent by node 1, the nodes 2, 4 can receive the data sent by node 2, 4, and node 1 can also receive it.



## 9. Application field

The data transceiver of TIE SMART SOLUTIONS CO., LTD. is applied for all kinds of point to point, one point to multiple points wireless data transmission system, such as smart home, Internet of things transformation, power load monitoring, distribution network automation, hydrological and hydrological forecasting, water pipe network monitoring, urban street lamps Monitoring, air defense alarm control, railway signal monitoring, centralized control of railway water supply, oil supply pipe network monitoring, GPS system, remote meter reading, electronic crane, automatic reporting, seismic forecasting, fire prevention, environmental monitoring and other industrial automation system, as shown below:



## 10. Operation notes

1. The device may not be operated in the vicinity of some flammable places (such as coal mines) or explosive dangerous objects (such as detonators for detonators).
2. Appropriate DC stabilized power supply should be selected, which requires strong anti-high frequency interference, small ripple, and sufficient load capacity; it also has functions such as overcurrent, overvoltage protection and lightning protection to ensure data transmission.
3. Do not use it in a working environment that exceeds the environmental characteristics of data transceiver, such as high temperature, humidity, low temperature, strong electromagnetic field or dusty environment.
4. Do not let the data transceiver continuously be in full-load transmission state, otherwise the transmitter may be burned out.
5. The ground wire of the data transceiver should be well connected with that of the external equipment (such as PC, PLC, etc.) and of the power supply. Otherwise, it is easy to burn the communication interface; do not plug or unplug the serial port when electrified.
6. When testing the data transceiver, it must be connected with a matching antenna or a  $50\Omega$  dummy load, otherwise it will easily damage the transmitter; if the antenna is connected, the distance of the human body from the antenna should preferably exceed 2 meters to avoid injury and cut. Do not touch the antenna while launching.
7. Wireless modem often have different communication distances in different environments. The communication distance is often affected by temperature, humidity, obstacle density, obstacle volume, and electromagnetic environment. In order to ensure stable communication, it is recommended to reserve 50. Communication distance margin above %.
8. If the measured communication distance is not ideal, it is recommended to check the antenna quality and the installation method of the antenna.
9. Power supply is required to remain 50% of current, it should be noted that the ripple should not exceed 100mV.
10. Wireless communication products need to be connected with an impedance matching antenna to work properly, even for short-term testing.

**FCC Caution:**

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**FCC RF Radiation Exposure Statement:**

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. This equipment complies with RF radiation exposure limits set forth for an uncontrolled environment.

The device has been evaluated to meet general RF exposure requirement. The device can be used in portable exposure condition without restriction.