WS8452

LoRa Uart Module

Data Sheet

UART Module

- Adopting ultra wide frequency band design at 850-930MHz
- Using LoRa spread spectrum technology, strong anti-interference, long transmission distance
- Self set communication key supported, key cannot be read, greatly improving the confidentiality of user data
- Support the maximum of 158 mW (about 22 dBm) transmitting power
- Support the AT commands
- Support Modbus programmable register read and write, flexibility can customize functions
- Support air wake-up, that is, ultra-low power consumption function, suitable for battery-powered applications
- Support transparent transmission, fixed-point transmission, broadcast transmission, channel monitoring, wireless relay and other functions
- Support deep dormancy, the power consumption of the whole machine is about 1 uA
- Support the data transmission rate of 0.3k ~62.5kbps
- Support 2.3~3.7V power supply, and 3.3V power supply is recommended
- Industrial standard design, support long use at-40~ + 85℃

SILENT SMART
无声讯通科技

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Overview	LoRa Uart Module	
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No.	Version	Revised content	Revised date	Revised
1	v1.0	The initial version	2022.04.26	YT
2	V1.1	Correction to the AT + RSSI instruction description	2023.06.06	CL

1 Overview

1.1 Brief Introduction

WS8452 is a LoRa wireless data transmission module that supports multiple frequency bands designed and produced by Silent Smart.

WS8452 is developed by using the first domestic SoC chip supporting LoRa LPWAN wireless communication protocol launched by ASR. ASR6601 integrates a general-purpose microcontroller and radio frequency unit on a single chip, including radio frequency transceiver, modem and a 48 MHz main frequency, 32-bit MCU with Arm Cortex M4 architecture, Flash capacity 128kB, SRAM capacity 16kB. Its Lora core adopts a new generation of SX1262 design scheme, with longer transmission distance, faster speed, lower power consumption and smaller size.

WS8452 supports fixed-point transmission, transparent transmission, wireless wake-up, wireless relay... functions. Its high-performance MCU has greatly improved its functions and efficiency. Internal data processing adopts 3-level cache, which greatly increases the stability and real-time performance of data.

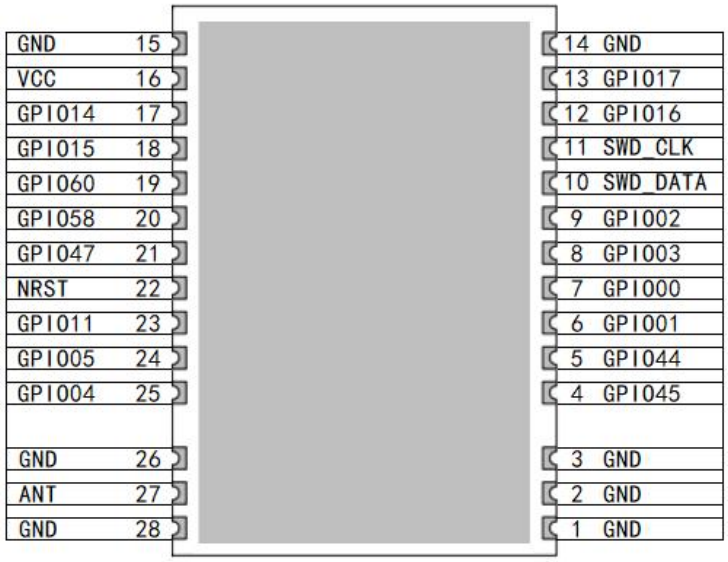
1.2 Features

Features
The measured communication distance is up to 6km (the weather is clear, the antenna height is 2M, and the gain is 5dBi)
Adopting ultra wide frequency band design at 850-930MHz
Using LoRa spread spectrum technology, it has strong anti-interference performance and long communication distance
Support users to set the communication key by themselves, and it cannot be read, which greatly improves the confidentiality of user data
Support AT command configuration module,
Support Modbus programmable register read and write operations, and can flexibly customize product functions
Support air wake-up, that is, ultra-low power consumption function, suitable for battery-powered applications
Support transparent transmission, fixed-point transmission, broadcast transmission, channel monitoring, wireless relay and other functions
Support deep sleep, the power consumption of the whole machine is about 1uA in this mode;
Support data transmission rate of 0.3k～62.5kbps
Adopt wide voltage working range: 2.3V~3.7V to support various battery application scenarios
Industrial-grade standard design, support long-term use at -40～+85℃

1.3 Application

Application
Street light control
Environmental monitoring
Smart Parking Sensors
Smart Agriculture Sensor
Industrial sensor, remote control
Smart home
Wireless Alarm Security System
Building Automation Solutions
Street light control
Environmental monitoring

2 Pin definition



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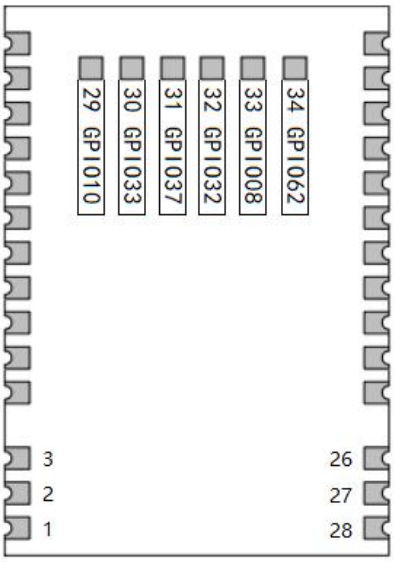


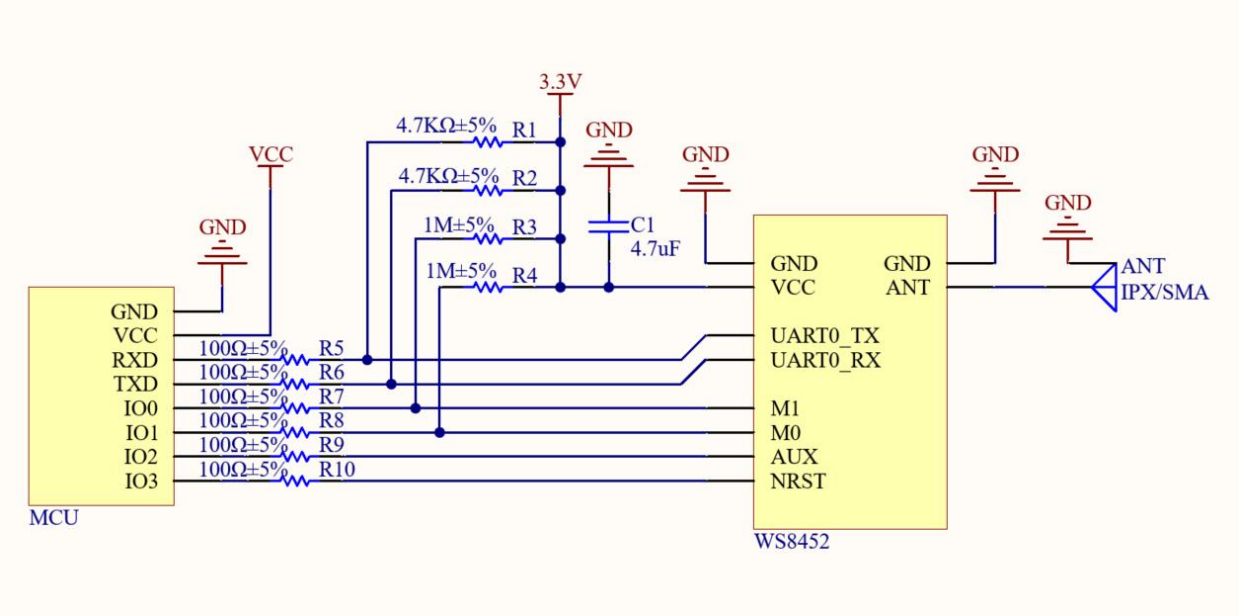
BOT

Pin No.	Item	Type	Description
1	GND	P	Power reference
2	GND	P	Power reference
3	GND	P	Power reference
4	AUX	O	Module state pins
5	M1	I	Mode 1 pin (default suspended, external pull)
6	M0	I	Mode 0 pin (default suspended, external pull)
7	GPIO00	I/O	Single-chip microcomputer GPIO (reserved)
8	GPIO03	I/O	Single-chip microcomputer GPIO (reserved)

9	GPIO02	I/O	Single-chip microcomputer GPIO (reserved)
10	GPIO06	I/O	Single-chip microcomputer GPIO (reserved)
11	GPIO07	I/O	Single-chip microcomputer GPIO (reserved)
12	UART0_RX	I/O	Serial port UART TTL pin RX
13	UART0_TX	I/O	Serial port UART TTL pin TX
14	GND	P	Power reference
15	GND	P	Power reference
16	VCC	P	Power supply, recommended range 2.3V~3.7V (recommended external added ceramic filter capacitor)
17	GPIO14	I/O	Single-chip microcomputer GPIO (reserved)
18	GPIO15	I/O	Single-chip microcomputer GPIO (reserved)
19	GPIO60	I/O	Single-chip microcomputer GPIO (reserved)
20	GPIO58	I/O	Single-chip microcomputer GPIO (reserved)
21	GPIO47	I/O	Single-chip microcomputer GPIO (reserved)
22	NRST	I	Modulreset pin, low level effective
23	GPIO11	I/O	Single-chip microcomputer GPIO (reserved)
24	GPIO05	I/O	Single-chip microcomputer GPIO (reserved)
25	GPIO04	I/O	Single-chip microcomputer GPIO (reserved)
26	GND	P	Power reference
27	ANT	RF_I/O	RF interface, stamp hole (50 ohm characteristic impedance)
28	GND	P	Power reference
29	GPIO10	I/O	Single-chip microcomputer GPIO (reserved)
30	GPIO33	I/O	Single-chip microcomputer GPIO (reserved)
31	GPIO37	I/O	Single-chip microcomputer GPIO (reserved)
32	GPIO32	I/O	Single-chip microcomputer GPIO (reserved)
33	GPIO08	I/O	Single-chip microcomputer GPIO (reserved)
34	GPIO62	I/O	Single-chip microcomputer GPIO (reserved)
During PCB design, all SU GPIO (retain) should be suspended			

Item	Description	Details
M0	Mode 0 pin	The M0 and M1 pins are the module mode pins. Through different level inputs in M0 and M1, the modules will work in different working modes.
M1	Mode 1 pin	
AUX	Pattern state pin	AUX is the module state pin. When the module is undergoing operation processing (internal initialization, serial / wireless data sending and receiving), the AUX pin will be pulled down. When the module is idle, AUX will restore the high level. (Note: AUX pulls down 2ms before the module operation, and restores the high level immediately after processing)

3 Hardware design



- It is recommended to use a DC regulated power supply to power the module. The ripple coefficient of the power supply should be as small as possible, and the module must be reliably grounded;
- The pins RXD and TXD of the MCU are respectively connected with the modules UART0_TXD and UART0_RX to form UART data communication;
- The pins IO0 and IO1 of the MCU determine the working mode of the module, and it is recommended to add an external weak pull-up;
- The pin IO2 of the MCU can get the current working status of the module by reading the level change of the AUX pin;
- MCU pin IO3 control module hardware reset, low level reset;

4 Working mode

M0	M1	Mode	Description	Optional function
0	0	Transmission mode	Digital wireless data transmission can be conducted through this mode	1. Transparent transmission 2. Fixed-point transmission 3. Relay transmission 4.AT configuration mode
0	1	Command mode	The module can configure the internal programmable registers via the modbus protocol	1. modbus Read register type 0x03 2. modbus Write-register type 0x10
1	0	WOR pattern	The module can wake up the data wirelessly	1. WOR sending mode 2. WOR receiving mode 3.AT configuration mode (in WOR sending mode)
1	1	Sleep mode	In the current mode, the module can sleep with low power consumption, reduce the power consumption and extend the service time of the battery supply module	None

5 Function introduction

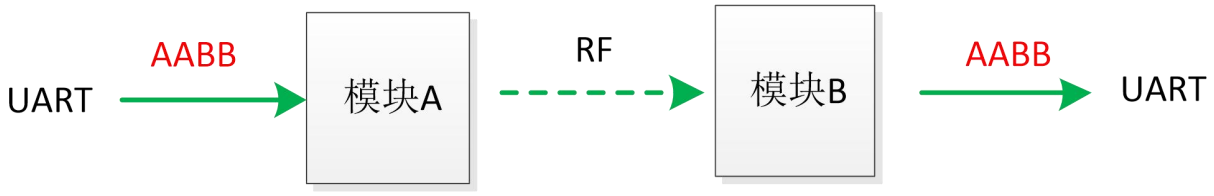
5.1 Transmission mode

In the transmission mode, according to the 0x0008 register value, the module itself selects the module function for transparent transmission function (0x0000), fixed point transmission function (0x0001), and relay transmission function (0x0002).

(Note: In the following example, the wireless address, network number, wireless channel, wireless empty speed, encryption mode, and key must be consistent.)

5.1.1 Transparent transmission function

Example:

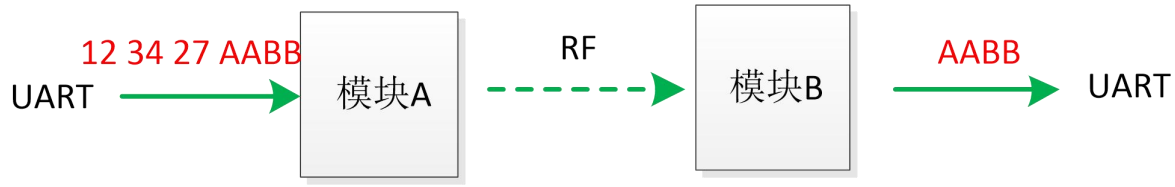


module A	module B
Mode: Transmission mode-transparent transmission	Mode: Transmission mode-transparent transmission
Address: 0x0000 Network number: 0x25 Channel: 0x20	Address: 0x00 Network number: 0x25 Channel: 0x20

Note: In the transparent transmission function, the serial port and the radio frequency are directly transmitted without any format conversion and data packaging.

5.1.2 Fixed-point transmission function

Example:



module A	module B
Mode: Transmission mode-fixed-point transmission mode	Mode: Transmission mode-fixed-point transmission mode
Address: 0x0000 Network number: 0x25 Channel: 0x20	Address: 0x1234 Network number: 0x25 Channel: 0x27

Note: In the fixed-point transmission function, the module needs to add the channel and address to be sent before sending data.
Transmission format: target address high + target address low + target channel

5.1.3 Relay transmission function

When the module works in the relay transmission mode, the parameter description of the module should be added to the parameter description of the distal module, as shown in the figure below:

A Schematic diagram of the relay module configuration parameters

Example:

module A	module B	module C
Mode: Transmission mode-transparent transmission mode Address: 0x1234 Network number: 0x25	Mode: Transmission mode-relay transmission mode Address: non-0x1234,0x5678, Network number: non-0x25,0 xA1 Relay terminal 1: address 0x1234, network number 0x25 Relay terminal 2: address 0x5678,	Mode: Transmission mode-transparent transmission mode Address: 0x5678 Network number: 0 xA1

network number 0 xA1

Note: In this scenario, module B acts as a relay to forward the data, so that module A and module C can communicate with each other.

5.2 Command mode

5.2.1 MODBUS Introduction

(1) Agreement description

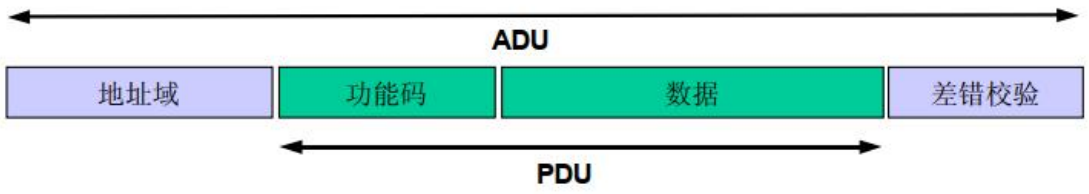
MODBUS The protocol defines a simple protocol data unit (PDU) unrelated to the underlying communication layer. On a specific bus, or on a network

The MODBUS protocol mapping introduces some additional domains into the application data unit (ADU).

This product supports the standard Modbus RTU protocol for access to internal registers. In the access, the function code 0x03 (read register instruction) and the function code 0x10 (write register instruction) are used. Other function codes are invalid, and the detailed instruction format can refer to the modbus protocol standard document.

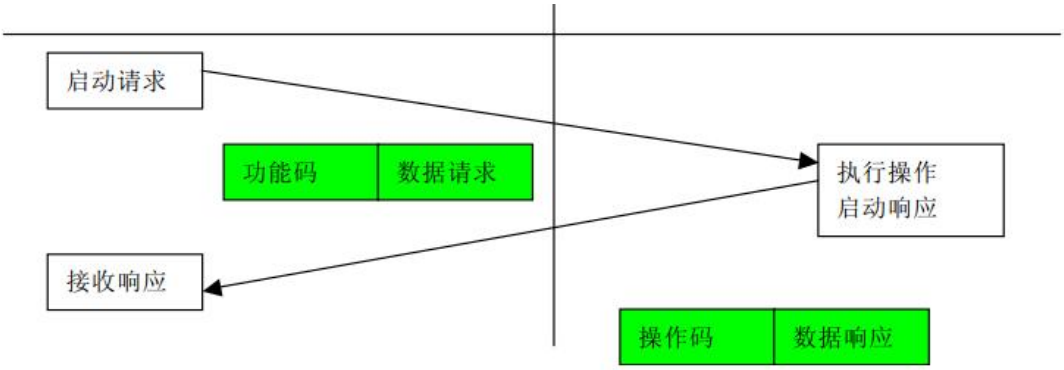
Local address 0x01, serial port parameter fixed to the port rate 9600,8 data bits, no check.

(2) Modbus universal frame

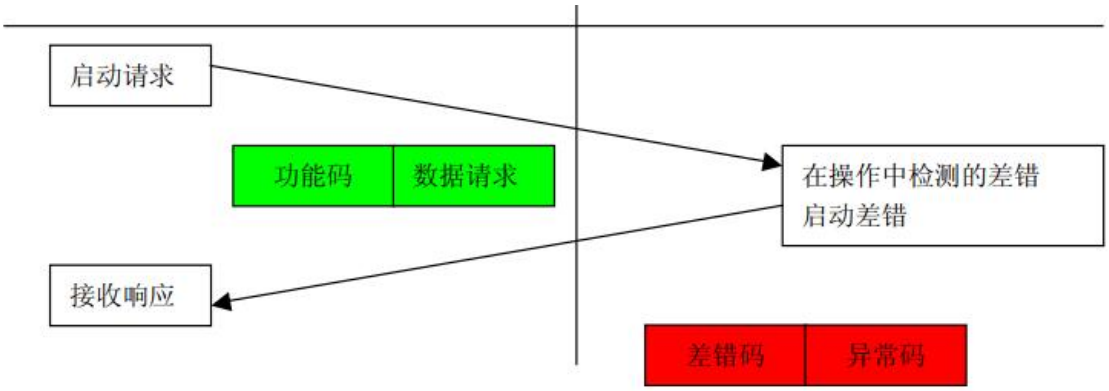


Address field	1 Bytes	Equipment address, this product is fixed at 0x01
Function code	1 Bytes	Operation function code 0x03 Read the multiple registers 0x10 Write in multiple registers
Data	N bytes	PDU data load
Error checking	Two bytes	CRC 16 Check (small mode)

Modbus Transaction processing process
(no error)



(exception response)



(3) modbus PDU

0x03 Read the multiple registers

ask

FC	1 Bytes	0x03
start address	Two bytes	0x0000 to 0xFFFF
Number of registers	Two bytes	0x01 to 0X7D (1-125)

respond

FC	1 Bytes	0x03
Byte number	1 Bytes	2xN
Register value	Nx2 bytes	Actual register contents

wrong

Error code	1 Bytes	0x83
outlier	1 Bytes	0x01: Illegal function 0x02: Illegal data address 0x03: Illegal data value

		0x04: Equipment failure

0x10 Write in multiple registers

ask

FC	1 Bytes	0x10
start address	Two bytes	0x0000 to 0xFFFF
Number of registers	Two bytes	0x0001 to 0X0078
Byte number	1 Bytes	2xN
Register value	Nx2 bytes	The tents of register to be written

respond

FC	1 Bytes	0x10
start address	Two bytes	0x0000 to 0xFFFF
Number of registers	Two bytes	0x0001 to 0X0078

wrong

Error code	1 Bytes	0x90
outlier	1 Bytes	0x01: Illegal function 0x02: Illegal data address 0x03: Illegal data value 0x04: Equipment failure

(4) CRC check reference code (look-up table method)

```
/* modbus CRC, Check the table method, high-level table */
static const uint8_t crc_table_h[] =
{
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
```

```
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01,
0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0,
0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01,
0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81,
0x40,
};

/* modbus CRC, Check the table method, low table */
static const uint8_t crc_table_l[] =
{
0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7, 0x05, 0xC5, 0xC4,
0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E, 0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09,
0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9, 0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD,
0x1D, 0x1C, 0xDC, 0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32, 0x36, 0xF6, 0xF7,
0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D, 0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A,
0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38, 0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE,
0x2E, 0x2F, 0xEF, 0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1, 0x63, 0xA3, 0xA2,
0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4, 0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F,
0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB, 0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB,
0x7B, 0x7A, 0xBA, 0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0, 0x50, 0x90, 0x91,
0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97, 0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C,
0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E, 0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88,
0x48, 0x49, 0x89, 0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83, 0x41, 0x81, 0x80,
0x40,
};

/* modbus crc Data verification * /
uint16_t modbus_crc16(uint8_t *pdata, uint16_t size)
{
/* Judge the legitimacy of the input parameter */
if(pdata    == NULL || size == 0)
  {
  return 0;
  }
```

```
uint8_t crc_h = 0xff;
uint8_t crc_l = 0xff;
uint16_t crc_i = 0;
uint16_t i = 0;
for(i = 0; i < size; i++)
{
crc_i = crc_h ^ pdata[i];
crc_h = crc_l ^ crc_table_h[crc_i];
crc_l = crc_table_l[crc_i];
}
return   ((uint16_t)(( crc_l) & 0x00FF) + (((crc_h) & 0x00FF) << 8)));
}
```

5.2.2 Modbus register description

Register address	Register description	Details
0x1000	Modbus ID	0x01-0 xF 7: Module MODBUS ID address 1-247, default 0x01
0x1001	Module wireless address	0x0000-0xFFFF: Module wireless address, default 0x0000 Note: When the module address is 0XFFFF 1. It can receive the data sent by any address module that meets the relevant parameters (except the address parameters) 2. Data can be sent to any address module that meets the relevant parameters (except for the address parameters)
0x1002	Wireless network number	0x00-0 xFF: Module network number, default 0x00 Note: When the module address is 0 XFF 1. It can receive the data sent by any network number module that meets the relevant parameters (except for the network number parameters) 2. Data can be sent to any network number module that

		meets the relevant parameters (except for the network number parameters)
0x1003	Serial port port rate	0x00: Baud rate of 1200 0x01: Baud rate of 2400 0x02: Baud rate of 4800 0x03: Baud rate 9600 (default) 0x04: Baud rate of 19200 0x05: Baud rate of 38400 0x06: Baud rate of 57600 0x07: Baud rate of 115200 Others: invalid (Note: change the serial port port rate parameter in transmission mode and WOR mode to 9600 in command mode)
0x1004	Serial check bit	0x00: No checked NONE 0x01 odd-check ODD 0x02: Even-check EVEN Others: invalid (Note: only change the serial port check bit parameters in transmission mode and WOR mode, fixed to no check NONE in command mode)
0x1005	Wireless air speed	0x00: Wireless air speed of 0.3 kbps 0x01: Wireless air speed of 1.2 kbps 0x02: Wireless air speed of 2.4 kbps 0x03: Wireless air speed of 4.8 kbps 0x04: Wireless air speed of 9.6 kbps 0x05: Wireless air speed of 19.2kbps 0x06: wireless air speed 38.4kbps

		0x07: wireless air speed 62.5kbps Others: invalid
0x1006	Serial port data packing length	0x0A-0 xF 0: Serial port package length 10-240, default 0 xF 0 (240 bytes) Note: When the serial port data exceeds the serial port packaging length, it will be subcontracted (Note: Change the serial port packing length only in transport mode and WOR mode)
0x1007	Serial port data packaging time	0x0000-0x1388: Serial port packing length 0-1000ms Others: invalid Note: When the serial port packing time is the 20bit time of the + port rate on this basis, it is the actual packing time (Note: Change the serial port packing length only in transport mode and WOR mode)
0x1008	Wireless working mode	0x00: transparent transmission function 0x01: Fixed-point transmission function 0x02: Relay transmission function Others: invalid (Note: valid only in transmission mode)
0x1009	environment RSSI	0x00-0 xFF: Current environment RSSI Others: invalid RSSI of the current register stored when reading the current register (Note: invalid configured current register)
0x100A	Wireless data RSSI follows	0x00: The data does not follow the current package RSSI 0x01: Data is followed by the current packet RSSI Others: invalid

0x100B	Wireless emission power	0x00: Wireless transmission power: 22 dBm (default) 0x01: Wireless transmission power is 17 dBm 0x02: Wireless transmission power is 13 dBm 0x03: Wireless transmission power is 10 dBm Others: invalid
0x100C	Wireless channel	0x00-0x53: the current wireless channel 0-80 Others: invalid Description: Support frequency band 850-930 MHz, calculation method: 850 + 1 * channel Default channel: 18 (868 MHz)
0x100D	WOR period	0x00: a WOR cycle of 500ms 0x01: WOR cycle of 1000ms 0x02: WOR cycle of 1500ms 0x03: WOR cycle of 2000ms 0x04: WOR cycle of 2500ms 0x05: WOR cycle of 3000ms 0x06 WOR cycle of 3500ms 0x07: WOR cycle of 4000ms Others: invalid
0x100E	WOR type	0x00: the WOR emission mode 0x01: the WOR receiving mode Others: invalid explain: WOR transmission, before the wireless data transmission, first transmit the corresponding cycle of Lora wake-up code, and then conduct effective data transmission WOR receives and performs weekly dormancy according to the WOR time cycle. After receiving the Lora wake-up code,

		the module is awakened and receives the correct data. After receiving the data, it enters periodic dormancy, ensuring the low power consumption of the module communication. Advantages: WOR receiving nodes, reduce power consumption Disadvantages: the receiving delay increases and the transmitting time increases, thus increasing the transmitting power consumption
0x100F	Relay terminal 1 address	Address: 0x0000-0 xFFFE, default 0x00 Network number: 0x00-0 xFE, with the default of 0x00 Note: In the relay mode, Case 1: If the data aimed at the receiver 1 is received, the repeater will forward the received data to the receiver 1; Situation 2: If the data aimed at the receiving terminal 2 is received, the repeater will forward the received data to the receiving terminal 2; (Note: If you receive your own data and output it directly from the serial port, you will not forward it.)
0x1010	1 network number of relay terminal	
0x1011	Relay terminal 2 address	
0x1012	Relay receiving terminal 2 network number	
0x1013	way of encryption	0x00: Encryption mode: 1 0x01: Encryption mode: 2 0x02: Encryption mode: 3 Others: invalid
0x1014	Secret key	0x0000 0xFFFF: Product secret key Configure only, when read, the return value is 0x0000
0x1015	AT instruction back switch	0x00: display off 0x01: open back

0x1016	transmission mode WOR send enables	0x00: Normal transmission 0x01: Send the wake-up code of the WOR cycle before transmitting the data
0x8000 – 0x8013	on-product information	Each address is valid, the content is ascii code of product model + version number For example: this product is called WS8452, and the version number is V1.0 [0x8000] = 'W', [0x8001] = 'S', [0x8002] = '8' [0x8003] = '4', [0x8004] = '5', [0x8005] = '2' [0x8006] = 'F', [0x8007] = 'L', [0x8008] = 'S' [0x8009] = 0x20, [0x800A] = 'V', [0x800B] = '1' [0x800C] = '.', [0x800D] = '0', [0x800E] = 0x00 [0x800F] = 0x00, [0x8010] = 0x00, [0x8011] = 0x00 [0x8012] = 0x00, [0x8013] = 0x00,

5.3 Sleep mode

In the current mode, the module will enter low power consumption, when the module current is about 1 uA. If the module detects a mode change, it will awaken from low power consumption to enter the corresponding mode of M0 M1.

5.4 Introduction to AT commands

In the transmission mode, the module enters characters "+ + +", then enters the AT instruction mode. After entering the AT instruction, the module will output characters "+ OK <CR> <LF>". If there is no correct AT instruction operation in 10S, it will automatically exit to the transmission mode. Upon exit to transport mode, characters are exported to the serial port "+ EXIT <CR> <LF>".

Note: In AT refers to

All the parameters modified under the order will take effect after withdrawing the AT instruction or sending the reset instruction (AT + RST). If the module is powered off without withdrawing the AT instruction, all the

parameters set in the secondary AT instruction mode will not be saved.

Symbol description

symbol	explain
<CR>	Return car, hex system 0x0D
<LF>	Change change, hex 0x0A

5.4.1 List of AT commands

Commands	Description
AT	test instruction
AT+RST	system reset
AT+RESTORE	factory data reset
AT+EXIT	Exit AT Directive
AT+GMR	Query module information
ATE	Set / query instruction back switch
AT+UART	Set / query the serial port parameters
AT+CH	Set up / query the wireless channel
AT+SPD	Set / query the wireless air rate
AT+PWR	Set up / query the wireless transmission power
AT+ADDR	Set up / query the module address
AT+NETID	Set up / query the module network number
AT+WMODE	Set up / query the wireless working mode
AT+WORT	Set up / query the module WOR time
AT+WORM	Set up / query the WOR working mode
AT+PKRSSI	Set up / query the wireless data RSSI follow enable
AT+RSSI	Read the current channel environment RSSI

AT+TXWOR	Transport mode WOR send is enabled
AT+RTP_ADDR1	Set up / query the node 1 address in relay mode
AT+RTP_NETID1	Set up / query the node 1 network number in relay mode
AT+RTP_ADDR2	Set up / query the node 2 address in relay mode
AT+RTP_NETID2	Set up / query the node 2 network number in relay mode
AT+KEY	Set up the wireless communication secret key
AT+ENC	Set up / query the wireless communication encryption mode
AT+PKTS	Set up / query the data package length
AT+PKTT	Set up / query the data packing time
AT+MODBUS_ID	Set up / query the MODBUS address

5.4.2 Test Instruction AT

Execute command	AT<CR><LF>
Response	+OK<CR><LF>
Parameter Description	Non

5.4.3 Reset instruction AT + RST

Execute command	AT+RST<CR><LF>
Response	+OK<CR><LF>
Parameter Description	Non

5.4.4 Recovery of the factory setting instruction AT + RESTORE

Execute command	AT+RESTORE<CR><LF>
Response	+OK<CR><LF>
Parameter Description	Non

5.4.5 Exit the AT directive AT + EXIT

Execute command	AT+EXIT<CR><LF>
Response	+OK<CR><LF>
Parameter Description	Non

5.4.6 View the version information instruction AT + GMR

Execute command	AT+GMR<CR><LF>
Response	+GMR=Module <name> Version <version><CR><LF> +OK<CR><LF>
Parameter Description	Non

5.4.7 Return display control instruction ATE

Execute command	ATE<CR><LF>
Response	+OK<CR><LF>
Parameter Description	ATE 0: Off display ATE 1: open back

5.4.8 Serial port operation instruction AT + UART

Execute command	query AT+UART?<CR><LF>	configure AT+UART=<baud>,<databits>,<stopbits>, <parity>,<fow cntrol><CR><LF>
Response	+UART=<baud>,<databits>,<stopbits>,<parity>,<flow cntrol><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <baudrate>: UART rate (following only) ➢ 1200 ➢ 2400 ➢ 4800 ➢ 9600 (by default) ➢ 19200 ➢ 38400 ➢ 57600 ➢ 115200 ● <databits>: Data bit ➢ 8:8 bit, data bit ● <stopbits>: Stop bits ➢ 1:1 bit, stop bits ● <parity>: Check bit ➢ 0: None None Check (default) ➢ 1: Odd, odd check ➢ 2: Even Even check	

	● <flow control>: Stream control ➢ 0: Do not enable flow control
Sample	AT+UART=115200,8,1,0,0<CR><LF>

5.4.9 Wireless channel operation instruction AT + CH

Execute command	query AT+CH?<CR><LF>	configure AT+UART=<channel><CR><LF>
Response	+CH=<channel><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <channel>: Wireless channel ➢ 0~80 Channel Description: Support frequency band 850-930 MHz, calculation method: 850 + 1 * channel Default channel: 18 (868 Mhz) Note: The module can only receive data from the current channel and cannot communicate between different channels	
Sample	AT+CH=10<CR><LF>	

5.4.10 Wireless aerial rate operation instruction AT + SPD

Execute command	query AT+SPD?<CR><LF>	configure AT+SPD=<speed><CR><LF>
Response	+SPD=<speed><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter	● <Speed>: Wireless channel	

Description	➢ 0: Air speed of 0.3 kbps ➢ 1: Air speed of 1.2 kbps ➢ 2: Empty speed 2.4 kbps (default) ➢ 3: Air speed of 4.8 kbps ➢ 4: Air speed of 9.6 kbps ➢ 5: Air speed of 19.2kbps ➢ 6: Air speed of 38.4kbps ➢ 7: Air speed of 62.5kbps
Sample	AT+SPD=2<CR><LF>

5.4.11 Wireless transmit power operation instruction AT + PWR

Execute command	query AT+PWR?<CR><LF>	configure AT+PWR=<power><CR><LF>
Response	+PWR=<power><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <Power>: Wireless transmission power ➢ 0: transmit power 22 dBm: (default) ➢ 1: Transmitting power of 17 dBm: ➢ 2: Transmitting power of 13 dBm: ➢ 3: Transmitting power of 10 dBm:	
Sample	AT+PWR=2<CR><LF>	

5.4.12 Wireless module address operation instruction AT + ADDR

Execute command	query AT+ADDR?<CR><LF>	configure AT+ADDR<address><CR><LF>
Response	+ADDR=<address><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <address>: Module address (ASCII type) ➢ 0000~FFFF: Module address (default 0) Note: When the module address is 0XFFFF 1. It can receive the data sent by any address module that meets the relevant parameters (except the address parameters) 2. Data can be sent to any address module that meets the relevant parameters (except for the address parameters)	
Sample	AT+ADDR=FA02<CR><LF>	

5.4.13 Wireless network number operation instruction AT + NETID

Execute command	query AT+NETID?<CR><LF>	configure AT+NETID<netid><CR><LF>
Response	+NETID=<netid><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <netid>: Module network number (ASCII type in hexadecimal) ➢ 00 to FF: module address (default 0) Note: When the module address is 0 XFF 1. It can receive the data sent by any network number module that meets the relevant parameters (except for the network number parameters) 2. Data can be sent to any network number module that meets the relevant parameters (except for the network number parameters)	

Sample	AT+NETID=B2<CR><LF>

5.4.14 Wireless working mode operation instruction AT + WMODE

Execute command	query AT+WMODE?<CR><LF>	configure AT+WMODE<mode><CR><LF>
Response	+WMODE=<mode><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <Mode>: wireless working mode ➢ 0: Wireless transtransmission mode (default) ➢ 1: Wireless fixed-point transmission mode ➢ 2: Wireless relay mode	
Sample	AT+WMODE=1<CR><LF>	

5.4.15 WOR Cycle operation instruction AT + WORT

Execute command	query AT+WORT?<CR><LF>	configure AT+WORT=<wor time><CR><LF>
Response	+WORT=<wor time><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <wor time>: Wor time ➢ 0: WOR time of 500ms (default 0) ➢ 1: WOR time of 1000ms ➢ 2: WOR time of 1,500 ms ➢ 3: WOR time of 2000ms ➢ 4: for a WOR time of 2,500 ms ➢ 5: WOR time of 3,000 ms	

	➢ 6: WOR time of 3,500 ms ➢ 7: WOR time of 4000ms
Sample	AT+WORT=1<CR><LF>

5.4.16 WOR type operation instruction AT + WORM

Execute command	query AT+WORM?<CR><LF>	configure AT+WORM<mode><CR><LF>
Response	+WORM=<mode><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <mode>:WOR pattern ➢ 0: WOR sending mode ➢ 1: WOR receiving mode Note: When the WOR is in sending mode, the module will automatically increase the wake up code of WOR time before sending wireless data, and then send the data after the wake up code is completed	
Sample	AT+WORM=0<CR><LF>	

5.4.17 Wireless data RSSI follows the operation instruction AT + PKRSSI

Execute command	query AT+PKRSSI?<CR><LF>	configure AT+PKRSSI<rssi en><CR><LF>
Response	+PKRSSI=<rssi en><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <rssi en>: Wireless data RSSI ➢ 0: Wireless data is not followed by data RSSI (default) ➢ 1: Wireless data follows the data RSSI	

Sample	AT+PKRSSI=1<CR><LF>

5.4.18 Read the current ambient noise instruction AT + RSSI

Execute command	query AT+RSSI?<CR><LF>
Response	+RSSI=<rssi><CR><LF> +OK<CR><LF>
Parameter Description	● <rssi>: Read value range is from 00 to FF ➢ Signal intensity of current ambient noise: -rssi / 2 (dBm)
Sample	AT+RSSI ? <CR><LF>

5.3.19 Transmission mode WOR sends the enable command AT + TXWOR

Execute command	query AT+TXWOR?<CR><LF>	configure AT+TXWOR<txwor><CR><LF>
Response	+TXWOR=<txwor><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <txwer>: WOR transport mode sends enabled ➢ 0: Normal transmission ➢ 1: Send the wake-up code of the WOR cycle before transmitting the data	
Sample	AT+TXWOR=1<CR><LF>	

5.4.20 relay receiver 1 address operation instruction AT + RPT _ ADDR 1

Execute command	query AT+RPT_ADDR1?<CR><LF>	configure AT+RPT_ADDR1<address><CR><LF>
Response	+RPT_ADDR1=<address><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <address>: Module address (ASCII type) ➢ 0000~FFFF: Module address (default 0)	
Sample	AT+RPT_ADDR1=FA02<CR><LF>	

5.4.21 AT + RPT _ NETID 1

Execute command	query AT+RPT_NETID1?<CR><LF>	configure AT+RPT_NETID1<netid><CR><LF>
Response	+RPT_NETID1=<netid><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <netid>: Module network number (ASCII type in hexadecimal) ➢ 00 to FF: module address (default 0)	
Sample	AT+RPT_NETID1=B2<CR><LF>	

5.4.22 Address operation instruction AT + RPT _ ADDR 2

Execute command	query AT+RPT_ADDR2?<CR><LF>	configure AT+RPT_ADDR2<address><CR><LF>
Response	+RPT_ADDR2=<address><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter	● <address>: Module address (ASCII type)	

Description	➢ 0000~FFFF: Module address (default 0)
Sample	AT+RPT_ADDR1=FA02<CR><LF>

5.4.23 AT + RPT _ NETID 2

Execute command	query AT+RPT_NETID2?<CR><LF>	configure AT+RPT_NETID2<netid><CR><LF>
Response	+RPT_NETID2=<netid><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <netid>: Module network number (ASCII type in hexadecimal) ➢ 00 to FF: module address (default 0)	
Sample	AT+RPT_NETID2=B2<CR><LF>	

5.4.24 Wireless communication secret key configuration instruction AT + KEY

Execute command	configure AT+KEY<key><CR><LF>
Response	+OK<CR><LF>
Parameter Description	● <key>: Communication key (ASCII type in hex) ➢ 0000~FFFF: Module address (default 0)
Sample	AT+KEY=A1C8<CR><LF>

5.4.25 Wireless communication encryption type operation instruction AT + ENC

Execute command	query AT+ENC?<CR><LF>	configure AT+ENC<type><CR><LF>
Response	+ENC=<type><CR><LF>	+OK<CR><LF>

	+OK<CR><LF>
Parameter Description	● <Type>: wireless communication encryption mode ➢ 0: Encryption mode 0 (default 0) ➢ 1: Encryption mode 1 ➢ 2: Encryption mode 2
Sample	AT+ENC=0<CR><LF>

5.4.26 AT + PKTS

Execute command	query AT+PKTS?<CR><LF>	configure AT+ENC<length><CR><LF>
Response	+PKTS=<length><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <length>: Data package length, per unit byte ➢ 10~240: Data package length (default 240) Description: When the module serial port receives more than the data package length, the subcontracting of <length> length will occur automatically Effective for wireless transmission only	
Sample	AT+PKTS=10<CR><LF>	

5.4.27 Serial port packing time operation command AT + PKTT

Execute command	query AT+PKTT?<CR><LF>	configure AT+PKTT<time><CR><LF>
Response	+PKTT=<time><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter	● <Time>: Data package length unit ms	

Description	➢ 0~1000: Data packaging time (default 0) Description: The actual data packaging time of the module is time + serial port port rate timeout time
Sample	AT+PKTT=0<CR><LF>

5.4.28 MODBUS Device ID operation instruction AT + MODBUS_ID

Execute command	query AT+MODBUS_ID?<CR><LF>	configure AT+MODBUS_ID <id><CR><LF>
Response	+MODBUS_ID=<id><CR><LF> +OK<CR><LF>	+OK<CR><LF>
Parameter Description	● <id>: modbus Device ID ➢ 1~247: Data packaging time (default 1)	
Sample	AT+MODBUS_ID=1<CR><LF>	

6. Electrical and other parameters

6.1 Limit parameters

Parameter	Symbol	Min	Max	Unit
supply voltage	VCC	-0.3	3.9	V
interface voltage	VIN	-0.3	3.9	V
RF input power	RFIN	-	+10	dBm
Storage temperature	TSTG	-40	125	℃

6.2 Working parameters

Parameter	Symbol	Min	Type	Max	Unit
supply voltage	VCC	2.3	3.3	3.7	V
Communication	V_{IN}	2.3	3.3	3.7	V

level					
working temperature	T_{OP}	-40	-	85	℃

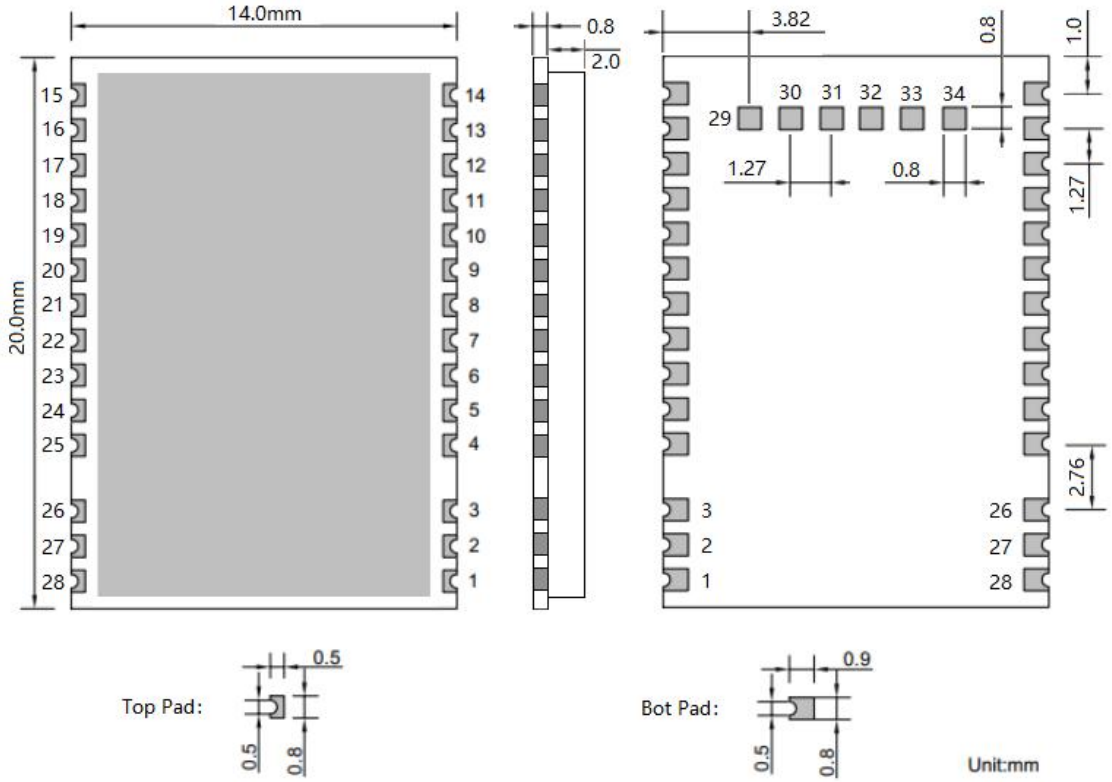
6.3 RF performance parameters

Parameter	Min	Type	Max	Unit	Remarks
Work frequency band	850	868\915	930	MHz	
modulation mode	LoRa				
Aerial Rate @ LoRa	0.3	-	62.5	Kbps	
Maximum emission power	20.6	20.8	21	dBm	
Receiving Sensitivity @ LoRa	-	-148	-	dBm	BW = 10.4 kHz, SF = 12
On-board external crystal vibration		32MHz/10ppm/12pF		MHz	If the recommended internal load capacitor of the secondary development is: 0x13H
emission current	105	108	110	mA	Maximum emission power is instantaneous power consumption
receive current	8.5	8.7	9	m A	
The dormant current	0.8	1	1	uA	

6.4 Other parameters

Parameter	Description
CI	UART
radio frequency interface	Stamp hole, equivalent impedance of about 50 Ω
Packaging method	Patch type
Interface mode	1.27mm spaced stamp hole
outline dimension	20*14*2.8mm (Including the shield cover)
weight	10g

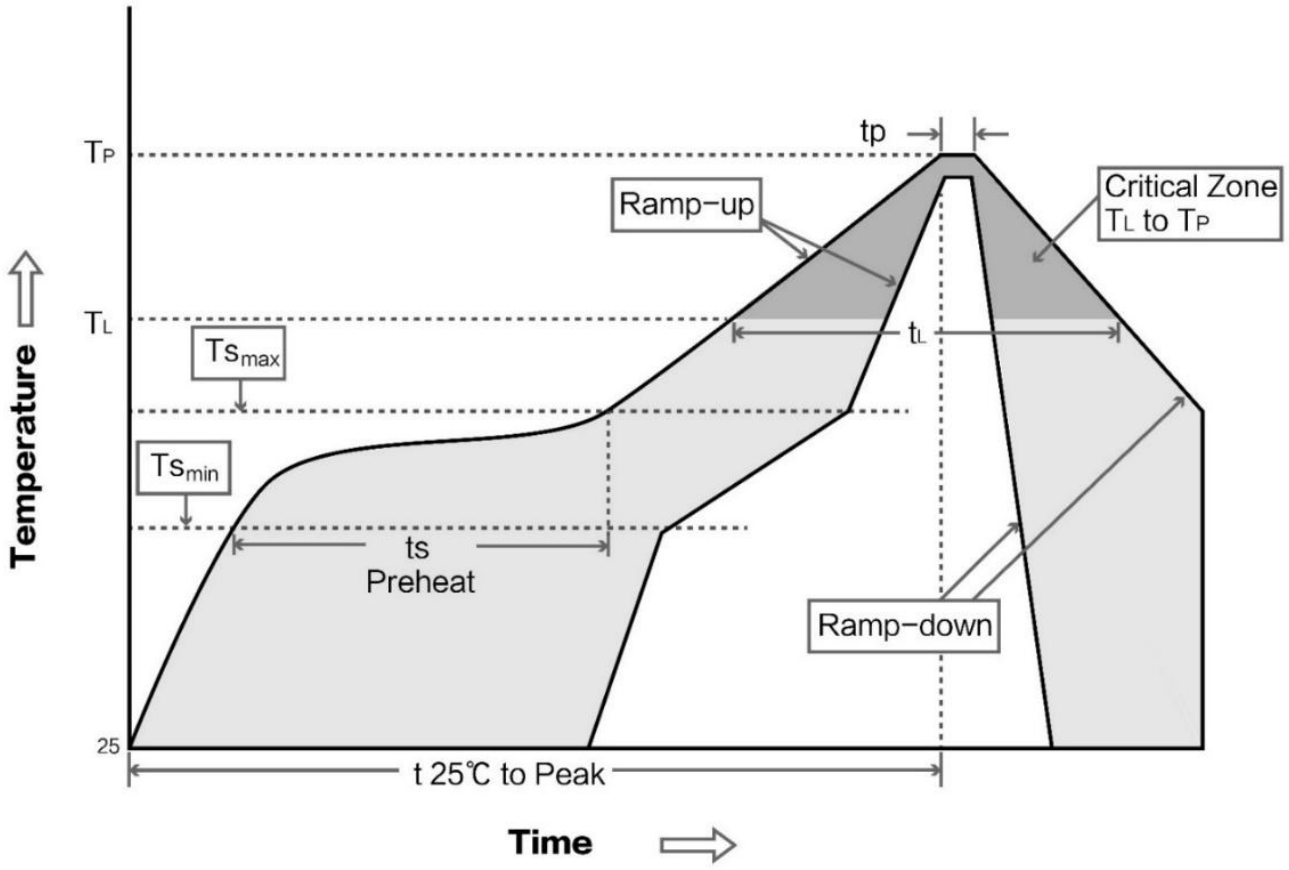
7 Package size



- Recommended pad design: length 2*0.9mm = 1.8mm and width 0.8mm.

8 Production guidance

8.1 Reflow welding curve graph



8.2 Reflow welding temperature and time

Profile Feature	Curve characteristics	Sn-Pb Assembly	Pb-Free Assembly
solder paste	Solder Paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Minimum preheating temperature	Preheat Temperature min (Tsmin)	100℃	150℃
Maximum preheating temperature	Preheat temperature max (Tsmax)	150℃	200℃
preheating time	Preheat Time (Tsmin to Tsmax)(ts)	60-120 sec	60-120 sec
Average rise rate	Average ramp-up rate(Tsmax to Tp)	3℃/second max	3℃/second max
Fluid phase	Liquidous Temperature (TL)	183℃	217℃

temperature			
Time above the liquid-phase line	Time（tL）Maintained Above（TL）	60-90 sec	30-90 sec
Peak temperature	Peak temperature（Tp）	220-235℃	230-250℃
Average decrease rate	Aveage ramp-down rate（Tp to Tsmax）	6℃/second max	6℃/second max
25℃ to peak temperature	Time 25℃ to peak temperature	6 minutes max	8 minutes max

9 Contact information

Contacts	Cell	Email
Manager Chen	15000319232	chenliang@silent-smart.com

Tel.: 028-64823553

Address: 3-307, Floor 3, Building 12, No.38, South Jinke Road, Jinniu Hi-tech Industrial Park, Chengdu

FCC WARNING

FCC Caution: Any changes or modifications not expressly
approved by the party responsible for compliance could void the user's authority to
operate this 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.

This device and its antenna(s) must not be co-located or operating in conjunction with any other
antenna or transmitter.

15.105 Information to the user.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include
the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply
with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are
designed to provide reasonable protection against harmful interference in a residential installation.
This equipment generates, uses and can radiate radio frequency energy and, if not installed and used
in
accordance with the instructions, may cause harmful interference to radio communications.
However, there is no guarantee that interference will not occur in a particular installation. If this
equipment does cause harmful interference to radio or television reception, which can be
determined by turning the equipment off and on, the user is encouraged to try to correct the
interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is
connected.

—Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncon- trolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled
environment.

This transmitter must not be co-located or operating in conjunction with any other

antenna or transmitter.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination. The firmware setting is not accessible by the end user.

The final end product must be labelled in a visible area with the following: "Contains Transmitter Module "FCC ID: 2BB8U-WS8452"

Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power,spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section
2.10 below concerning the need to notify host manufacturers that further testing is required.3

Explanation: This module meets the requirements of FCC part 15C (15.247).it Specifically identified AC Power Line Conducted Emission, Radiated Spurious emissions, Band edge and RF Conducted Spurious Emissions, Conducted Peak Output Power, Bandwidth, Power Spectral Density, Antenna Requirement.

2.3 Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to- point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer' s instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

Explanation: The product antenna uses an irreplaceable antenna with a gain of 0.17dBi

2.4 Single Modular

If a modular transmitter is approved as a "Single Modular ," then the module manufacturer is responsible for approving the host environment that the Single Modular is used with. The manufacturer of a Single Modular must describe, both in the filing and in the installation instructions, the alternative means that the Single Modular manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.

A Single Modular manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited

module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.

This Single Modular procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module. **Explanation:** The module is a single module.

2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects: layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.

a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna); b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered); c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout; d) Appropriate parts by manufacturer and specifications; e) Test procedures for design verification; and f) Production test procedures for ensuring compliance

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application

2.6 **RF exposure considerations**

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person' s body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

Explanation: The module complies with FCC radiofrequency radiation exposure limits for uncontrolled environments. The device is installed and operated with a distance of more than 20 cm between the radiator and your body." This module follows FCC statement design, FCC ID：2BB8U-WS8452

2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an “omni-directional antenna” is not considered to be a specific “antenna type”).

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product.

The module manufacturers shall provide a list of acceptable unique connectors.

Explanation: The product antenna uses an irreplaceable antenna with a gain of 0.17dBi

2.8 **Label and compliance information**

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating "Contains FCC ID" with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

Explanation: The host system using this module, should have label in a visible area indicated the following texts: "Contains FCC ID: 2BB8U-WS8452

2.9 **Information on test modes and additional testing requirements5** Additional guidance for testing host products is given in KDBPublication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer's determination that a module as installed in a host complies with FCC requirements.

Explanation: Chengdu Silent Smart Technology Co., Ltd. can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

2.10 **Additional testing, Part 15 Subpart B disclaimer**

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product

as being Part 15

Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Explanation: The module without unintentional-radiator digital circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host shoule be evaluated by the FCC Subpart B.