泽耀科技
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A39-T900A30D1a Manual

850~931MHz,1W, LORA Spread Spectrum Wireless Serial Module

Data encryption, fixed-point transmission

Version: Spec_A39-T900A30D1a _V3.0

Date: 2023-02-23

Status: Controlled status

Catalog
Content

850~931MHz, 1W, LORA Spread Spectrum Wireless Serial Module

Data encryption, fixed-point transmission

1. Product Overview

A39-T900A30D1a is a 850~931MHz, 1W, high stability, industrial wireless serial port module. Designed and developed with RF chip SX126x, LORA spread spectrum modulation, the measured transmission distance is up to 10km.

The module has more transmission methods, supports data broadcasting, data monitoring, fixed-point transmission, master-slave mode, automatic relay, fixed-point wake-up, automatic response and other transmission methods.

More comprehensive functions, support ultra-low power consumption, IO control, ADC data acquisition, wireless configuration, package configuration, package separator, output address and other functions. Diversified functions and high stability can be widely used in various environments to easily realize low-frequency wireless data transmission.

2. Product Features

- With data broadcast, data listening, fixed-point transmission, master-slave mode, automatic relay, fixed-point wake-up, automatic answer
- Receiving sensitivity up to -140dBm, transmission distance of 10km
- Sleeping current as low as 2uA
- Ultra-low reception power consumption
- AES encryption
- Readable module RSSI
- Built-in multiple exception handling mechanisms to ensure long and stable operation of the module
- Multi-level transmitting power
  - ➢ Four levels of adjustable power (0~3), each step of about 3dBm
  - ➢ Power range: 21~30 dBm, max 1W
- Level Baud Rate [1]
  - ➢ Eight common baud rates, default baud rate is 9600bps
  - ➢ Baud rate range: 1200bps~115200bps
- Multi-level air rate [2]
  - ➢ Eight levels of adjustable air rate, default air rate 4.8kbps
  - ➢ 1.2~62.5kbps
- Working state [3]
  - ➢ MD0 = 0 Enter command configuration mode
  - ➢ MD0 = 1 Exit command configuration mode
  - ➢ MD1 = 0 Normal operating state
  - ➢ MD1 = 1 Dormant operating state

- Frequency 850~931MHz, providing 82 channels [4]
  - ➢ 850MHz + CHAN * 1MHz
  - ➢ CHAN: 0x00~0x50H (corresponding to 850~931MHz)
  - ➢ Operates in the 915MHz application-free band by default
- Supply voltage range [5]
  - ➢ 2.0V~5.5V
  - ➢ Built-in LDO to ensure stable power supply to the module, able to meet a variety of system requirements
- 1K ring FIFO
  - ➢ 1K bytes of transmit-receive FIFO

850~931MHz, LORA Spread Spectrum Wireless Serial Module

Data encryption, fixed-point transmission

  - ➢ Internal automatic subcontracting of transfers
  - ➢ Some combinations of airspeed and baud rate can send infinitely long packets [1]
- Broadcast Data and Listening [6]
  - ➢ The module address is set to 0xFFFF to listen to data transmissions from all modules on the same channel. The transmitted data can be received by any module at any address on the same channel
- Wake up in the air [6]
  - ➢ The sender in the wake-up mode will automatically add a wake-up code when sending data to wake up the target module in the power-saving mode
  - ➢ Same transmission method as fixed point transmission
- Fixed-point transmission [6]
  - ➢ Any module can send data and specify a module to receive it. When multiple receiver modules have the same address channel, they can all receive data.
  - ➢ Data can be transmitted point-to-point across channels
  - ➢ Can achieve a variety of applications such as networking and relaying

Remark.

[1] See the 0x04 register in Chapter 6, Section 6.2 Module Parameter Registers for details

[2] See the 0x06 register in Chapter 6, Section 6.2 Module Parameter Registers for details

[3] See Chapter 5 for pin definition and pin function details

[4] See the 0x06 register in Chapter 6, Section 6.2 Module Parameter Registers for details

[5] See Chapter 5 for details on power vs. voltage

[6] See Chapter 7, Module Functions for details

3. Series Products

Module Model	Carrier frequency (Hz)	Core Chip	Size (mm)	Maximum transmit power (dBm)	Communication distance (km)	Package	Antenna Form
A39-T230A30D1a	210M~241M	SX126x	23*43	30	10	SMD	IPEX
A39-T400A30D1a	410M~490M	SX126x	23*43	30	10	SMD	IPEX

4. Electrical parameters

Conditions: Tc = 25°C, VCC = 3.3V

Module Model	Parameter Name	Description	Minimum value	Typical values	Maximum value	Unit
A39-T900A30D1a	Supply voltage	Supply voltage is less than 3.3V, the output power will be reduced, but the impact on the received power is small	3.3		5.5	V
A39-T900A30D1a	Emission current	SendPower[1] = 0		550		mA
		SendPower = 1		334		mA
		SendPower = 2		260		mA
		SendPower = 3		220		mA
A39-T900A30D1a	Receiving current	Enter configuration mode (MD0=0, MD1=0)		10		mA
		General operating mode (MD0=1, MD1=0)		10		mA
		Enter low-power mode (MD0=1, MD1=1)		3		uA
		Exit low-power mode (MD0=1, MD1=0)		10		mA
A39-T900A30D1a	Dormant current	is the current measured in the dormant operating state (MD0=1, MD1=1)		3		uA
A39-T900A30D1a	Operating Frequency Band	850M~931MHz, 82 channels, 1MHz step, factory default 915 MHz	850	915	931	MHz
A39-T900A30D1a	Transmitting power	SendPower = 0		30		dBm
		SendPower = 1		27		dBm
		SendPower = 2		24		dBm

		SendPower = 3		21		dBm
A39-T900A30D1a	airspeed	8 levels adjustable (1.2kbps, 2.4kbps, 4.8kbps, 9.6kbps, 19.2kbps, 38.4kbps, 50kbps, 62.5kbps)	1.2k	4.8k	62.5k	bps
A39-T900A30D1a	Reception sensitivity	Receiving sensitivity is independent of serial port baud rate and delay time		-140		dBm@ 2.4kbps
A39-T900A30D1a	Operating temperature		-40		+85	℃
A39-T900A30D1a	Working humidity	Relative humidity, non-condensing	10%		90%	
A39-T900A30D1a	Storage temperature		-40		+125	℃

Remark.

[1] See the 0x06 register in Chapter 6, Section 6.2 Module Parameter Registers for details

5. Module Function

5.1 Recommended connection diagram(basic functions)

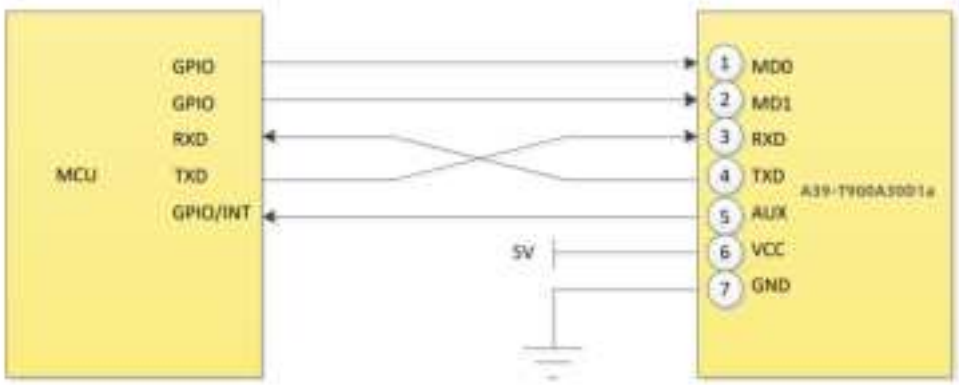


Figure 5-1 Recommended connection diagram

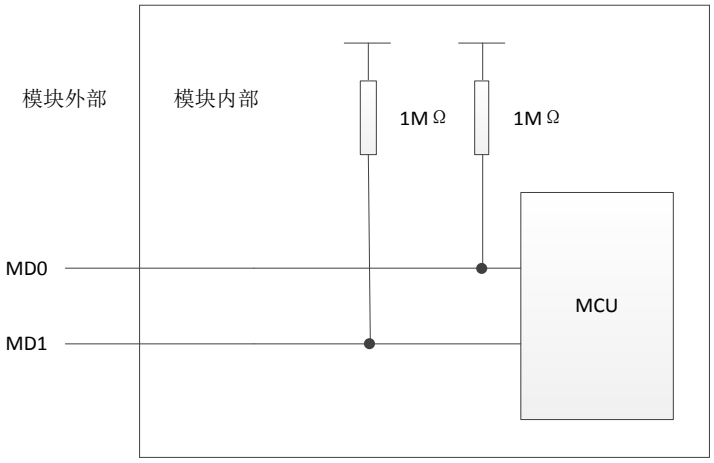
5.2 Pin Definition

Pin Definition Table

Pin Serial Number	Pin Name	Pin Orientation	Pin Usage
1	MD0	Input (very weak pull-up)	Together with the low latency operating state pin MD1, it determines the four operating states of the module
2	MD1	Input (very weak pull-up)	Together with the low latency operating state pin MD0, it determines the four operating states of the module
3	RXD	Input	3.3V, TTL serial input, connected to external TXD output pin, can be configured as open drain or pull-up input, see parameter configuration for details
4	TXD	Output	3.3V, TTL serial output, connected to external RXD input pin, can be configured as open drain or push-pull output, see parameter configuration for details
5	AUX	Output	Used to indicate the working status of the module, the user wakes up the external MCU, output low during power-on self-test initialization, can be configured as open-drain output or push-pull output, see parameter settings for details
6	VCC		Power supply, voltage 2.0 ~ 5.5V (Note: below 3.3V, the output power is reduced, but the impact on reception performance is small)
7	GND		Ground wire, connected to power reference ground

5.3 Pin Function

➢ MD0 and MD1 low latency operating state pin functions



The free combination of high and low levels of the low-latency operating state pins MD0 and MD1 can determine the operating state of the wireless serial module, and these operating states can be freely switched.

The following two special cases need to be noted when switching between working states.

1, the module receives wireless data has not yet been output, then the data output is completed and then enter a new state.

2, the module sends wireless data has not yet been sent, then the data is sent to a new state after completion.

Working status table

Working Status	MD0	MD1	Working state introduction
Enter configuration mode	0	0	The serial port parameters go to 9600, 8, n, 1. The data received will be processed as configuration parameters and the wireless goes into sleep mode and no messages can be received.
Exit configuration mode	1	0	Reconfigure the peripheral with the configured parameters, run with the new configuration, serial port on, wireless on
Enter low power mode	1	1	The serial port is off, the wireless is off, and it is in very low-power mode, and it will wake up periodically on its own to receive the wake-up code, and the module is in a power-saving working state at this time.
Exit low power mode	X	0	The serial port is open, wireless is open, all peripherals are running normally, at this time the module is in general working state, when the sleep time register is configured, then the device will automatically add the wake-up code before sending data, at this time the module is in wake-up working state.

Status Communication Table

Send \ Receiving		Working Status			Data transfer mode		
		General Working Status	Awakening Working Status	Power saving Working Status	Transparent Broadcasting	Broadcast and Monitoring	Fixed-point transmission
Working Status	General working condition	Y	Y		Y	Y	Y
	Wake up working state	Y	Y	Y	Y	Y	Y

- AUX Pin Function

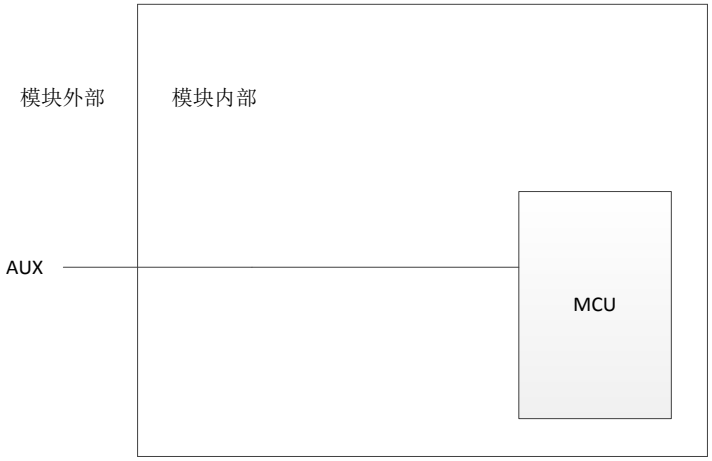


Figure 5-3 AUX pin internal structure diagram

AUX is used for wireless transceiver buffer status indication. It indicates whether the module's internal buffer is currently overflowing.

During power-on initialization, the module pulls down the AUX, which is inoperable until the initialization is completed and the module pulls up the AUX, at which time the module can be operated normally.

In operating mode, AUX will be continuously high. If the internal buffer is full, the module pulls AUX low, the serial port is closed and does not continue to receive serial data until the buffer has enough space to be released and AUX is pulled high.

➢ RXD and TXD pin functions

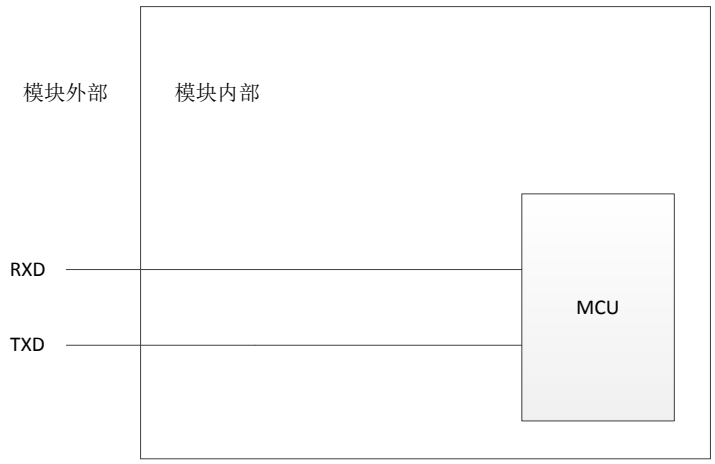


Figure 5-4 Internal structure of RXD and TXD pins

RXD and TXD serial data sending and receiving pins, at the same time, the serial port baud rate can be customized, more convenient for development, the supported baud rate range 1200 ~ 115200 (bps); serial port parity also has odd parity, even parity, no parity to choose from. The format of serial port transmission bytes is as follows.

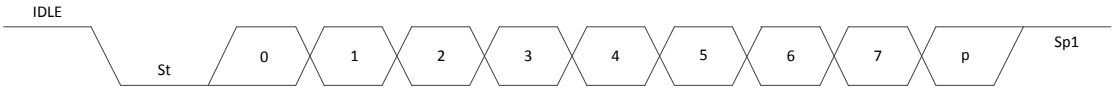


Figure 5-5 Serial port transmission byte format

IDLE: High when idle

St: Starting position

P: Parity bit

Sp1: Stop bit

Remark.

【1】 Need to set the data bits to 7 bits, then set the frame length to 8 bits and the parity bits to ODD or EVEN

【2】If you need to set 8 as data bits with parity bit, you need to set the frame length to 9 bits and then set the parity bit to ODD or EVEN

➢ VCC and GND pin functions

GND indicates the ground wire, VCC indicates the power supply, and the module power itself has with LDO, input voltage range: 2.0~5.5VDC, as follows.

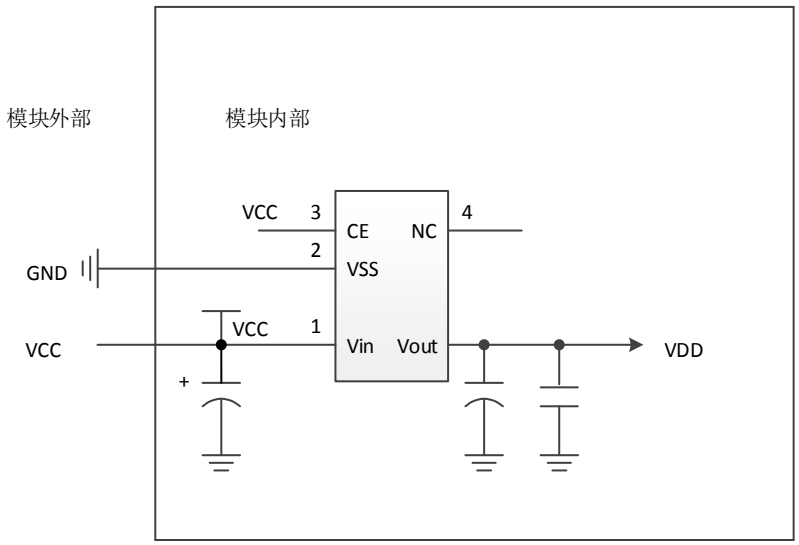


Figure 5-6 Power Supply LDO

Note: The input power supply ripple coefficient should be controlled within 100mV, and can provide instantaneous pulse current of 200mA or more

When the supply voltage is less than the critical value, the output power decreases, but the impact on the reception performance is small. The relationship between power and voltage is shown in Figure 5-7.

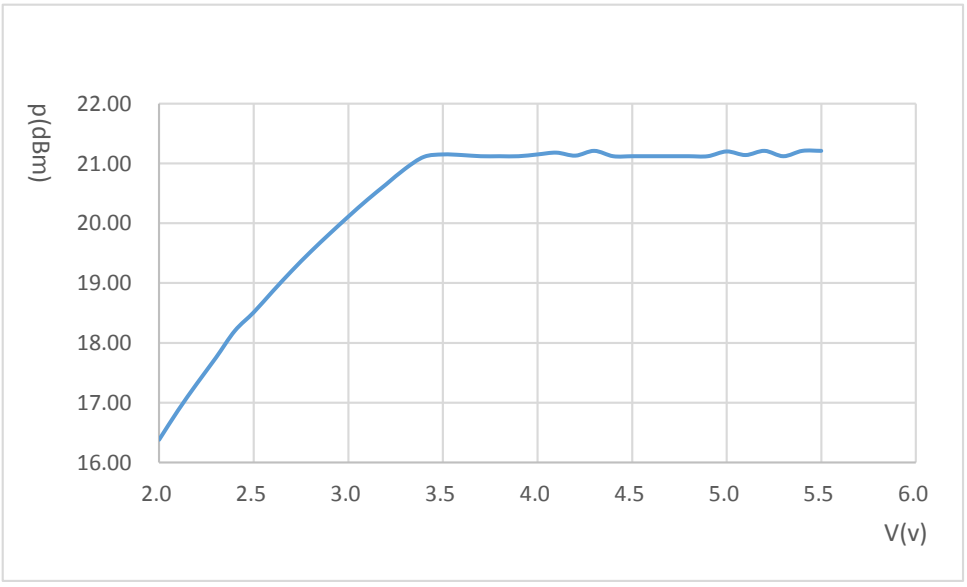


Figure 5-7 Power versus voltage

6. Module commands

6.1 Command Format

The parameter configuration command only supports parameter modification in configuration mode, i.e., when MD0 pin is low (MD0 = 0, MD1 = 0), and the serial port parameters are 9600, 8N1 at this time.

The configuration command is implemented by adding the register address and register length to the command word, which can realize the configuration of multiple configuration items continuously at the same time.

The command format is as follows.

Command word	Register start address	Number of configuration registers	Register Value	Register Value	Register value n
CMD	REG	LEN	DATA0	.....	DATAn
CMD [7] 0 for read, 1 for write	The range of REG in this model is 0x00~0x20	Indicates the number of registers to be operated. When the number of registers to be operated exceeds the number of current operation rights, an error will be returned, for example, if a read-only register is written, an error will be returned.	When reading, you can leave it unfilled, when writing, make sure to correspond to the register length and total length, otherwise it will report an error		
CMD [6] 0 for local command, 1 for remote configuration					
CMD [5]. 0 is return operation success, 1 is return operation error					
CMD[4...0] Reserved					

Note: The register address is a functional distinction, not according to the occupied bytes to be divided

Command functions are detailed in the following table, using the default factory configuration as an example.

Command Format	Module Answer	Description
0x80 ADDR LEN VAL1 VAL2 ... VALn (See parameter configuration register description for details)	0x80 ADDR LEN	Configuration success, configuration parameters power down and save
	0xC0 ADDR LEN	Configuration failed, the original configuration parameters were not changed
0x80 0x0B 0x01 0x77 0x77 0x77 0x2E 0x61 0x73 0x68 0x69 0x6E 0x69 0x6E 0x67 0x2E 0x63 0x6F 0x6D	0x80 0x0B 0x01	Data key success
	0xC0 0x0B 0x01	Data key failure
0x00 0x04 0x1B	0x00 0x00 0x25 0x80 0x00 0x02	The module returns the parameters of all

	0xBD 0x00 0x01 0x05 0x03 0xE8 0x00 0x77 0x77 0x77 0x77 0x2E 0x61 0x73 0x68 0x69 0x6E 0x69 0x6E 0x67 0x2E 0x63 0x6F 0x6D 0x7C 0x7C 0x7C 0x7C 0x7C 0x7C 0x05 0x40 0x00 0x23 0x00 0x00 0x00 0x00 0x3C 0x3C 0x00 0x0A 0x04 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	currently writable registers in hexadecimal format
0x00 0x00 0x01	a39-t868a21s1a-v1.0.1	The module will return the current version number in ASCII format
0x80 0x20 0x01	OK	The module generates a reset, during which the module performs a self-test and the AUX goes low, after the reset the AUX goes high and the module starts to work normally. At this time, you can switch the status or initiate the next command
0x80 0x21 0x01	OK	Restore default parameters configuration successfully
0x00 0x01 0x01	XXXX	Read the current data signal RSSI and environment signal RSSI directly. e.g. the module returns XXXX, the first two XX represent the current environment RSSI, the last two XX represent the current data RSSI, convert them to decimal data, it indicates the current signal strength. This command can be used in all modes

6.2 Module parameter register

Serial number	Address	Register Permissions	Register Length	Register Description
1	0x00	R	20	Module Current Version Number
2	0x01	R	4	The first two bytes indicate the current environment RSSI, and the last two bytes indicate the current packet RSSI
3	0x02	R	2	Reserved
4	0x03	R	2	Reserved
5	0x04	R/W	4	Serial port baud rate of the module, the range: 1200~115200bps
6	0x05	R/W	1	Serial port parameters of the module Bit4 is the frame length (data bits + parity bits) 0 for 8 bits 1 for 9 bits Bit5 is the stop bit 0 is 1 bit 1 is 2 bits Bit2 | Bit1 is the parity bit 00 is no parity 10 is even parity 11 is odd

				parity
7	0x06	R/W	2	Bit11 |Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 is the channel coding, the default is 100001 (65) Bit4 | Bit3 for power 11 : 30dBm 10 : 27dBm 01 : 24dBm 00 : 21dBm Default is 11, power is 30dBm Bit2 | Bit1 | Bit0 is air speed [1] 111 : 62.5K 110 : 50K 101 : 38.4K 100 : 19.2K 011 : 9.6K 010 : 4.8K 001 : 2.4K 000 : 1.2K Default is 010 with an airspeed of 4.8K [2]
8	0x07	R/W	2	Working mode 0x0001, Transparent 0x0002, fixed point 0x0004, Master-Slave 0x0021, Relay 0x0100. Passing
9	0x08	R/W	1	Auto-answer settings Bit7 is 0 for off, 1 for enable Bit6~Bit0 indicates the number of re-transmission
10	0x09	R/W	2	Auto-answer re-transmission interval, in ms
11	0x0A	R/W	1	Device as master or slave Bit0 Master (0) or slave (1) of master-slave mode
12	0x0B	R/W	16	AES Key
13	0x0C	R/W	5	Package-to-package separator content
14	0x0D	R/W	1	Use the length of the separator in bytes
15	0x0E	R/W	1	Serial packet length in bytes
16	0x0F	R/W	2	Serial port packing cycle in 0.1ms
17	0x10	R/W	2	Reserved
18	0x11	R/W	1	Reserved
19	0x12	R/W	1	Reserved
20	0x13	R/W	1	Reserved
21	0x14	R/W	1	Low power consumption level in 100ms units
22	0x15	R/W	1	Reserved
23	0x16	R/W	1	Data window length in polling mode and active reporting mode, in 200ms
24	0x17	R/W	2	Job Options

				Bit9 turns on data sending before scanning for new to idle Bit8 opens data sending with random delay before sending Bit6 opens the group number output to request lost packets after the reception is complete Bit5 opens the function of group packet output Bit4 turns remote configuration on or off Bit3 When configured over the air, whether to reply to ACK, only available in one-to-one configuration Bit2When configured over the air, whether to output the result from the serial port Whether to output packet and packet separator on Bit1 serial output Bit0 output address
25	0x18	R/W	1	Local Group Number
26	0x19	R/W	1	Local Address
27	0x1A	R/W	1	Target group number
28	0x1B	R/W	1	Target Address
29	0x1C	R/W	1	In relay mode, the path A group number
30	0x1D	R/W	1	Relay mode, path A address
31	0x1E	R/W	1	In relay mode, the path B group number
32	0x1F	R/W	1	Relay mode, path B address
31	0x20	X	1	Module reboot
32	0x21	X	1	Module restores factory settings

[1] The air rate of both sides of the communication must be consistent

[2] Some combinations of airspeed and baud rate can send infinitely long packets, as detailed in the following table

Baud rate (bps) / Airspeed (bps)	1200	2400	4800	9600	19200	38400	57600	115200
1.2k								
2.4k	√							
4.8k	√	√						
9.6k	√	√	√					
19.2k	√	√	√	√				
38.4k	√	√	√	√	√			
50k	√	√	√	√	√			
62.5k	√	√	√	√	√			
√ means unlimited packet transmission is supported								

6.3 Module factory settings

Register factory configuration table.

Serial number	Address	Register Permissions	Register Length	Default Parameters
1	0x00	R	20	Module current version. Like A39-T900A30D1a-V1.0.1,
2	0x01	R	4	0x0000 (default), which means that the current environment RSSI is 0x00 and the current package RSSI is 0x00
3	0x02	R	2	Reserved
4	0x03	R	2	Reserved
5	0x04	R/W	4	0x00002580 (9600bps, default) serial port baud rate of the module, range 1200~115200
6	0x05	R/W	1	0x00 (default) Bit4 is 0. data bits are 8 bits Bit5 is 0. stop bit is 1 bit Bit2 | Bit1 is 00 means no checksum Serial port parameters are 8-bit data bit 1-bit stop bit No parity bit
7	0x06	R/W	2	0x83 (default) Bit11|Bit10 | Bit9 | Bit8 | Bit7 | Bit6 | Bit5 is the channel number, the default is 1000001 (65) Bit4 | Bit3 is the power number, the default is 11, the power is 30dBm Bit2 | Bit1 | Bit0 is the null speed number, default is 010, the air speed is 4.8K
8	0x07	R/W	2	0x0001 (default) Operating mode is transparent transmission
9	0x08	R/W	1	0x05 (default) Bit7 is 0 to turn off stable transmission by default Bit6~Bit0 is 5, which means the default number of re-transmission is 5 times
10	0x09	R/W	2	1000 in ms, stable transmission re-transmission interval is 1S by default
11	0x0A	R/W	1	0x00 (default) Bit0=0 means that when in master-slave mode, as the host Bit1=0 means that when in polling mode, as a slave Bit2=0 means that when it is in the timed-up report, it acts as a slave
12	0x0B	R/W	16	0x77 0x77 0x77 0x2E 0x61 0x73 0x68 0x69 0x6E 0x69 0x6E 0x67 0x2E 0x63 0x6F 0x6D (default) Indicates that the packet is encrypted using the above AES key
13	0x0C	R/W	5	||||| (default) When the separator output is turned on, the above separator is output between packages
14	0x0D	R/W	1	0x05 (default) Indicates that the maximum valid length for using separators is 5
15	0x0E	R/W	1	64 (default) When the serial input is more than 64 bytes, then every 64 bytes will be treated as 1 packet
16	0x0F	R/W	2	35 (default)

				When the serial port data idle time exceeds 3.5ms, then the currently received data is treated as a packet
17	0x10	R/W	2	Reserved
18	0x11	R/W	1	Reserved
19	0x12	R/W	1	Reserved
20	0x13	R/W	1	Reserved
21	0x14	R/W	1	0 (default) No wake-up code and no sleep will be sent by default
22	0x15	R/W	1	Reserved
23	0x16	R/W	1	Reserved
24	0x17	R/W	1	0x80 (default) Turn on wake-up code
25	0x18	R/W	1	0x00, the local group number is 0x00
26	0x19	R/W	1	0x00 with a local address of 0x00
27	0x1A	R/W	1	0x00, the target group number is 0x00
28	0x1B	R/W	1	0x00, the destination address is 0x00
29	0x1C	R/W	1	0x00, in relay mode, the path A group number is 0x00
30	0x1D	R/W	1	0x00, in relay mode, the path A address is 0x00
31	0x1E	R/W	1	0x00, in relay mode, the path B group number is 0x00
32	0x1F	R/W	1	0x00, in relay mode, the path B address is 0x00

7. Module Function

7.1 Module Function Overview

Module Menu

Module Function	Data format of the sender	Receiver data format	Function Introduction
Transparent Broadcasting	User Data	User Data	Any module that sends data can be received by modules with the same address and the same channel. Sending data is transparent, and what is sent is received.
Master-Slave Mode	Host: Receiver address + user data Slave: User data	User Data	The host can set to send data to a single slave, or send data to multiple slaves at the same time, and any slave sending data can be received by the host.
Fixed-point transmission	Receiver address + receiver channel + user data	User Data	Any module can send data and specify a module to receive it, and multiple receiving modules can receive data when they have the same address channel. Data can be transmitted point-to-point across channels.
Broadcast and Monitoring (under fixed-point	0xFF+0xFF+receiver channel+user data	User Data	Broadcast: any module sends data, and all modules under the same channel can receive data at the same time. Listening: modules with 0xFFFF address can receive data sent by modules with any address under the same channel.

transmission)			
Wake Up in the Air	1. In transparent transmission mode. The wake-up code will be sent automatically before sending the data packet, and when the wake-up code is sent, the data will be sent immediately afterwards, and the user does not need to care about the internal operation, but only needs to send the user data 2. In fixed transmission mode. The module will first switch to the target channel and then automatically send a wake-up code to wake up the target module to send the packet immediately afterwards, the user needs to add the target address and channel in the header of the packet first in this mode. Target module group number + target module address + target module channel + user data	User Data	1、 The sender module in the wake-up state can wake up the receiver module in the power-saving state over the air 2、 Modules in wake-up mode automatically send a wake-up code first when sending data 3、 The number of wake-up codes sent can be set by setting the wireless wake-up time
Low power consumption		User Data	Configure the module's receive response delay time to adjust the module's overall power consumption, the module can be configured to receive the maximum response delay register 0x14 is 255, in this configuration the module's average current is extremely low
Relay	User Data	User Data	Relay can be used in case of insufficient transmission distance. After receiving the data, the relay node will transmit the data to the next level as it is until the destination address is the same as the address of the module, then it will output the data.

7.2 Module Function Details

7.2.1 The concept of group number and address

➢ Function Description

Each function has the concept of group number and address in it, and with the concept of group number, it is more flexible than the traditional serial module in the way of using.

If the module's local group number and local address are both set to 0xFF, the module will listen to all data on the current channel

If the module's target group number is set to 0xFF, the module sends data that is broadcast to all groups of the target address module

If the module's destination address is set to 0xFF, the module sends data that is broadcast to all addresses in the current destination group

7.2.2 Transparent Broadcasting

➢ Function Description

Any module sends data, and all modules with the same address and the same channel can receive data at the same time. Data is sent and received in a transparent manner, and what is sent is received.

➢ Module Settings

1. MD0 = 0, MD1 = 0
2. Need to configure 0x07 special function register to 0x0001, transparent transmission mode
3. The destination address of the sending module and the local address of the receiving module are set to the same value
4. The channels of the transmitter and receiver modules are set to the same value
5. MD0 = 1, MD1 = 0

➢ Examples

Sender		Receiver	
Target group number address	0x00 0x01	Local group number address	0x00 0x01
Module channel airspeed	0x17 (default)	Module channel airspeed	0x17 (default)
Sending data	0123456789	Receiving data	0123456789

7.2.3 Master-Slave Mode

➢ Function Description

The master can send data to the specified slaves, and all slaves can receive the data sent by the master.

➢ Module Settings

1. MD0 = 0, MD1 = 0
2. Need to configure 0x07 special function register to 0x0004, master-slave mode
3. The addresses of the transmitter and receiver modules can be set differently
4. The channels of the transmitter and receiver modules are set to the same
5. MD0 = 1, MD1 = 0

➢ Examples

Sender		Receiver	
Target group number address	0xXXXX	Local group number address	0x5678
Modular	0x18	Modular	0x18

channels Master-Slave	Mainframe	channels Master-Slave	From the machine
Sending data	Receive address high + receive address low + data	Output Data	User Data
	0x56 0x78 0x11 0x22 0x33		0x11 0x22 0x33

7.2.4 Fixed-point transmission

➢ Function Description

Any module can send data and specify a module to receive it. When multiple receiver modules have the same address channel, they can all receive data.

➢ Module Settings

1. MD0 = 0, MD1 = 0
2. Need to configure 0x07 special function register to 0x0002, fixed point transfer mode
3. The addresses of the transmitter and receiver modules can be set differently
4. The channels of the transmitter and receiver modules can be set differently
5. MD0 = 1, MD1 = 0

➢ Examples

Sender		Receiver	
Target group number address	0xXXXX	Local group number address	0x5678
Modular channels	0xXXXX	Modular channels	0x18
Sending data	Receive address high + receive address low + receive channel + data	Output Data	User Data
	0x56 0x78 0x18 0x11 0x22 0x33		0x11 0x22 0x33

7.2.5 Broadcast under fixed point transmission

➢ Function Description

Any module sends data, and the modules under the same channel can receive data.

➢ Module Settings

1. MD0 = 0, MD1 = 0
2. Need to configure 0x07 special function register to 0x0002, fixed point transfer mode
3. The addresses of the transmitter and receiver modules can be set differently
4. The channels of the transmitter and receiver modules can be set differently
6. The first 3 bytes of the sender's data must be 0xFF+0xFF+receiver channel
7. MD0 = 1, MD1 = 0

➢ Examples

Sender		Receiver	
Target group number address	0xXXXX	Local group number address	0xXXXX
Modular channels	0xXXXX	Modular channels	0x17 (factory default)
Sending data	0xFF+0xFF+receive channel+user data	Output Data	User Data
	0xFF 0xFF 0x17 0x11 0x22 0x33		0x11 0x22 0x33

7.2.6 Listening under fixed-point transmission

➢ Function Description

Any module sends data, and the modules under the same channel can receive data.

➢ Module Settings

1. MD0 = 0, MD1 = 0
2. Need to configure 0x07 special function register to 0x0002, fixed point transfer mode
3. The address of the listener module must be set to 0xFFFF
4. The channels of the listener and transmitter modules must be set to the same
5. The first 3 bytes of the sender's data must be 0xXX+0xXX+receiver channel
6. MD0 = 1, MD1 = 0

➢ Examples

Sender		Receiver	
Destination group number address	0x0000 (factory default)	Local group number address	0xFFFF
Modular channels	0x17 (factory default)	Modular channels	0x17 (factory default)
Sending data	arbitrary address high + arbitrary address low + receive channel + user data	Output Data	User Data
	0xXX 0xXX 0xXX 0x17 0x11 0x22 0x33		0x11 0x22 0x33

7.2.7 Wake Up in the Air

➢ Function Description

The transmitter module in the wake-up state can wake up the receiver module in the power-saving state over the air. If a valid wake-up code is received during the "listening" process, the module will calculate the time of the arrival of the valid data. If the time of valid data arrival is longer than the time of three wake-up codes, the device will continue to enter the sleep state and wait until the data arrives to wake up and receive the data automatically. If it is less than the time of three wake-up codes, the module will keep waiting for the valid data packets. After receiving, the serial port will be opened and the received wireless data will be sent through TXD, after sending, the module will continue to enter the "sleep-listening" working state.

➢ Module Settings

1. The sender module must be operating in the wake-up working state (MD0 = 1, MD1 = 0)
2. The sender sets the length of the wake-up time by setting the wireless wake-up time register 0x14. The wireless wake-up time of the sender module is greater than or equal to the listening interval of the receiver module to ensure that the receiver module can listen to the wake-up code when it is in the power-saving working state. After receiving the wake-up code, the receiver module calculates whether it needs to enter the sleep state again. If the time of valid data arrival is greater than the time of three wake-up codes, the module will enter the sleep state again and wake up before the arrival of valid data to complete the data reception.
3. Receiver module must be in power-saving operation (MD0 = 1, MD1 = 1)
4. Set the listen interval time register 0x14 of the receiver module to ensure that the receiver module can receive a valid wake-up code within the listen interval time.
5. In general application cases, it is sufficient for both the sender and receiver modules to set the wake-up time register 0x14 to the same value.

7.2.8 Low power consumption

➢ Function Description

The wake-up module is in the power-saving state, and the module will listen to the wake-up code or not at regular intervals. If no wake-up code is received, the module will always be in the "sleep-listening" state. If a wake-up code is received during the wake-up listening process, the receiving module calculates whether it needs to enter the sleep state again. If the time of valid data arrival is longer than the time of three wake-up codes, the module will enter the sleep state again and wake up before the arrival of valid data to complete the data reception.

By setting different listening interval times, the module has different receive response latency and average power consumption. Users need to strike a balance between the communication delay time and the average power consumption time.

➢ Module Settings

1. Set the operating state of the module to power-saving operation (MD0 = 1, MD1 = 1)
2. Set the module's wireless wake-up time register 0x14

7.2.9 Relay

➢ Function Description

The device in relay mode will forward the received data backward according to the set path until the target device for the purpose of extending the transmission distance.

➢ Module Settings

1. MD0 = 0, MD1 = 0
2. Need to configure 0x07 special function register to 0x0020, relay mode
3. Set the previous group number address and the next group number address in relay mode (0x1B~0x1E registers)
4. The channels of the relay module and the transmitter module must be set to the same

5. MD0 = 1, MD1 = 0

7.2.10 Remote Configuration

➢ Function Description

You can configure the working parameters of another module or modules through wireless by one module, the sender module is required to enable the function of remote configuration, the remote configuration command needs to add two keywords before the configuration command, and the command word or on 0x40, which means the remote configuration command, if the command is wrong the sender will send the data as ordinary user data.

➢ Module Settings

1. The 0x17 special function register needs to be turned on for remote configuration
2. The channels of the transmitter and receiver modules must be set to the same

➢ Examples

Sender		Receiver	
Destination group number address	0x0000 (factory default)	Local group number address	0x0000 (factory default)
Modular channels	0x17 (factory default)	Modular channels	0x17 (factory default)
Sending data	Special word+0x40|Command word+start address of register+length+parameter	Output Data	
	0x41 0x53 0xC0 0x07 0x01 0x00 0x02		Module is configured in fixed point mode

7.2.11 Output Address

➢ Function Description

When the output address function is turned on, it precedes the user data with the address information of the sender so that the receiver can distinguish the source of the data.

➢ Module Settings

1. Need to turn on the 0x17 special function register to output address function

➢ Examples

Sender		Receiver	
Destination group number address	0x0000 (factory default)	Local group number address	0x0001 (factory default)
Modular channels	0x17 (factory default)	Modular channels	0x17 (factory default)
Sending data	User Data	Output Data	User Data
	0x11 0x22 0x33		0x00 0x00 0x11 0x22 0x33

7.2.12Output separator

➢ Function Description

When the output delimiter function is turned on, it precedes the user data with a user-set delimiter so that the recipient can distinguish the boundaries of the data.

➢ Module Settings

1. Need to turn on the 0x17 special function register for output separator
2. Set the 0x0C special function register to the content of the separator you want to send
3. Set the 0x0D special function register to the length of the desired separator

➢ Examples

Sender		Receiver	
Destination group number address	0x0000 (factory default)	Local group number address	0x0001 (factory default)
Modular channels	0x17 (factory default)	Modular channels	0x17 (factory default)
Sending data	User Data	Output Data	User Data
	123456789		|||||123456789

7.2.13Auto-Answer

➢ Function Description

After the sender sends the data, it will wait for the answer packet from the receiver. When the packet is received, it means that the current packet is sent successfully, if the timeout is not received, then the sender radio will automatically resend this packet data until the answer packet is received or until the maximum number of packets is sent.

➢ Module Settings

1. Bit 7 of the 0x08 special function register needs to be configured to 1 to turn on the stable transfer function, which is off by default.
2. It is necessary to configure bits 6~0 of the 0x08 special function register to the number of times retransmission is required, maximum 127 times, default 5 times
3. The 0x09 special function register needs to be configured to require a retransmission interval in ms, the default is 1000ms

➢ Examples

Sender		Receiver	
Radio Address	0x1234 (factory default)	Radio Address	0x1234 (factory default)
Radio Channels	0x17 (factory default)	Radio Channels	0x17 (factory default)
Sending data	User Data	Output Data	User Data
	First send 0x11 0x22 0x33		

	No ACK received		
	nth send 0x11 0x22 0x33		0x11 0x22 0x33
	Receive ACK		

7.2.14 Packages available with

➢ Function Description

The data received from the serial port will not be sent out immediately, it will wait until a group packet boundary set by the user before passing the data out. The maximum group packet can be matched with 230 bytes, and if the packet splitting time is less than the transmission time of three bytes at the current baud rate, the module will automatically correct to the transmission time of three bytes.

➢ Module Settings

1. The 0x0E special function register needs to be configured with the desired number of bytes of sub-packet length, 64 bytes by default.
2. The 0x0F special function register needs to be configured for the desired packet splitting interval, which defaults to three bytes of transmission delay.

7.2.15 Passing mode

➢ Function Description

The device in pass-through mode will automatically transmit the data in the up and down directions, knowing that the final node will only output the data. If you need to output data at every node, just set the destination address to 0xFF.

➢ Module Settings

1. The 0x07 special function register needs to be configured to pass the mode 0x0100.
2. Set the address of the module at each level, and the address increases in sequence.

7.2.16 Send after random delay

➢ Function Description

A device that sends with random delay turned on will delay the data for a random period of time before sending it out each time, in order to reduce the chance of data collisions, and the maximum delay time will be less than the transmission time of a full packet.

➢ Module Settings

1. Need to turn on the 0x17 special function register for random delay

7.2.17Send after scanning channel

➢ Function Description

The device that sends after opening the scanning channel will scan whether the current channel is occupied before sending data each time, and if it is occupied will wait for a period of time and then scan again until the channel is clean before sending the data out, in order to reduce the chance of data collision.

➢ Module Settings

1. It is necessary to turn on the 0x17 special function register to scan the channel and then send

7.2.18Timed reporting

➢ Function Description

The devices in the timed-up mode will automatically form a star network with one host and multiple slaves. The slave devices will be assigned network numbers by the master device after they join the network and send cached data in their own time slice, and will not send data at other times. The hosts need to send data when they need to send data also need to send data in the host's time slice, and are in the receiving state at other times.

➢ Module Settings

1. 0x07 special function register needs to be configured for timed reporting mode 0x0400
2. It is necessary to set the 0x0A special function register whether the host or slave for timing up.
3. Set the address of the host and slave.

7.2.19Active polling

➢ Function Description

Devices in polling mode automatically form a star network. When a slave device sends data, it does not send it to the master device immediately, but waits for a request from the master device and sends the data out only when it receives the request. The master device sends data and needs to wait for the send send window of the master device before sending the data out.

➢ Module Settings

1. Need to configure the special function register 0x07 polling mode 0x0800
2. You need to set the 0x0A special function register to polling mode host or slave.

3. Set the address of the host and slave.

7.2.20 Packet Output

➢ Function Description

This function requires both the sender and the receiver to turn on the packet grouping function. When the receiver receives the data, it will group the data into a large packet, up to 800 bytes, and output a large packet all at once, which is more widely applicable.

➢ Module Settings

1. The 0x17 special function register needs to be turned on for packet output function for both transmit and receive
2. If you need to ensure the reliability of the data, you can choose to turn on the option to request lost packets after reception is complete under the 0x17 special function register.

7.2.21 IO Control

➢ Function Description

This function requires the sender to be under IO control mode, the sender can control the receiver's restricted IO by adding two bytes of IO control command word before the user data sent, the format of the control word is every two bits of the byte control an IO, valid when 1, the low bit controls the IO output high, the high bit controls the IO output low, 0 means no operation.

➢ Module Settings

1. 0x07 special function register needs to be configured to IO control mode
2. Configure the sender and receiver to be on the same channel and at the same airspeed.
3. The sender module prefixes the user data with a two-byte control word

7.2.22 ADC data acquisition

➢ Function Description

This function can be enabled in any mode, ADC data acquisition is only available for idle IO1 and idle IO2 (see pin definition table), ADC data acquisition is an option to turn on a single channel or both channels, and you can choose whether to send the acquired data at regular intervals, or if not to report it, to get it through wireless configuration commands.

➢ Module Settings

1. To send and receive, you need to turn on the ADC acquisition function in the 0x17 special function register and select whether to send acquisition results at regular intervals.
2. Configure the sender and receiver to be on the same channel and at the same airspeed.
3. Configure the collection period and reporting period

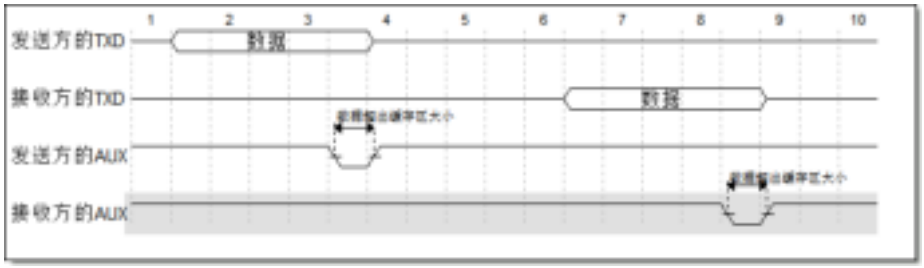
Remark.

The setting of [1] 0x14 is described in the OPTION register in Chapter 6.2 Module parameter configuration commands.

[2] The average power consumption is determined by the duty cycle of the highest power consumption and the lowest power consumption. The power consumption of the module is influenced by the airspeed, baud rate, wake-up time and the number of bytes sent.

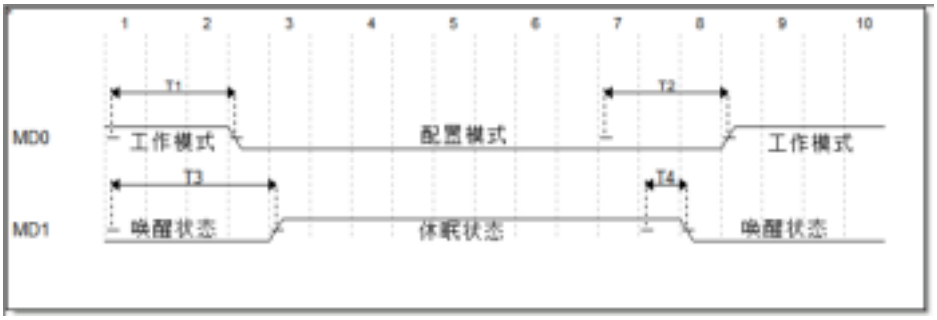
8. Timing Chart

8.1 Data Transfer Timing Diagram



8.2 State Switching Timing Diagram

The module will have a switching delay T_sc to switch from any working state to the next working state. After switching to the next working state, if the module does not perform other working state switching operations, then the module will keep working in the switched working state. The working state switching has nothing to do with the previous working state of the module, the user only needs to perform the state switching delay during the switching process, and then select the low delay working state pins MD0 and MD1 for high and low level operation to switch to the desired working state.



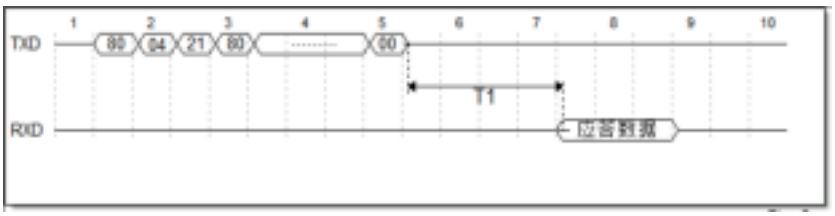
Symbols	Description	Minimum value	Typical values	Maximum value	Unit
T1	De-jitter and wait for the last packet of data to be sent to ensure the module is idle		10		ms
T2	Configure the write and execute the new configuration		50		ms
T3	De-jitter and wait for the last packet of data to be sent to ensure the module is idle		10		ms
T4	Module Wakeup		50		ms

Note: The working state switching can only be switched when AUX is high and the module is idle at this time; if AUX is low, it means that the module is busy at this time, the transmitting (receiving) is not empty and the data is not yet sent (received), so the user needs to add a delay and wait for the data to be sent and received before the working state switching can start.

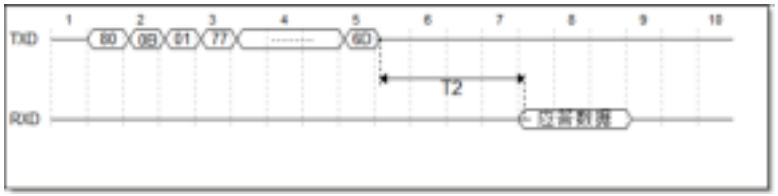
8.3 Module Command Timing Diagram

The command timing diagram is as follows.

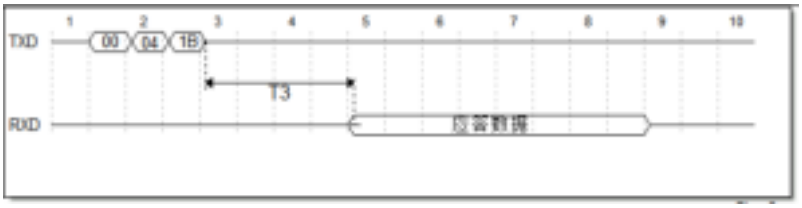
1. Module parameter configuration commands



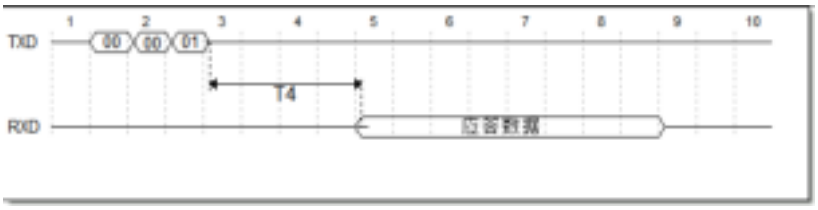
2. Module encryption key setting command



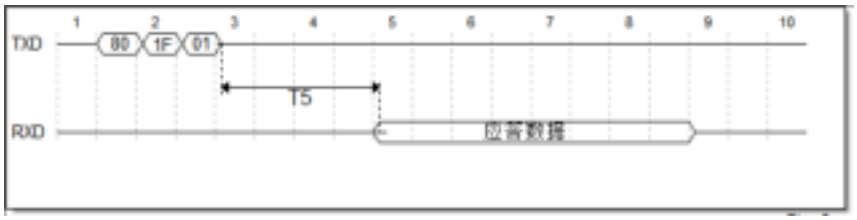
3. Read module configuration parameters command



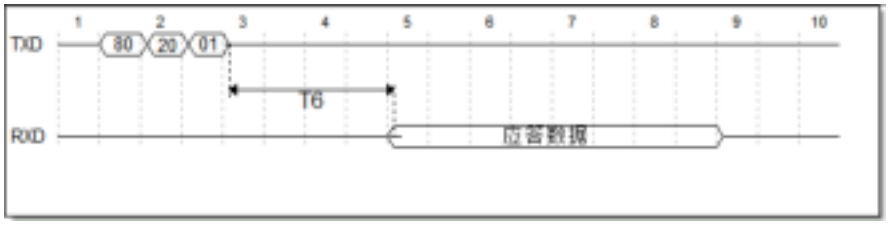
4. Read module hardware version number command



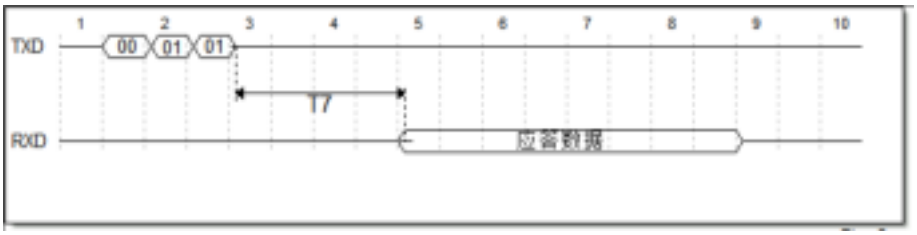
5. Module reset command



6. Restore module default parameter command



7. Read current data signal RSSI and environment RSSI commands directly

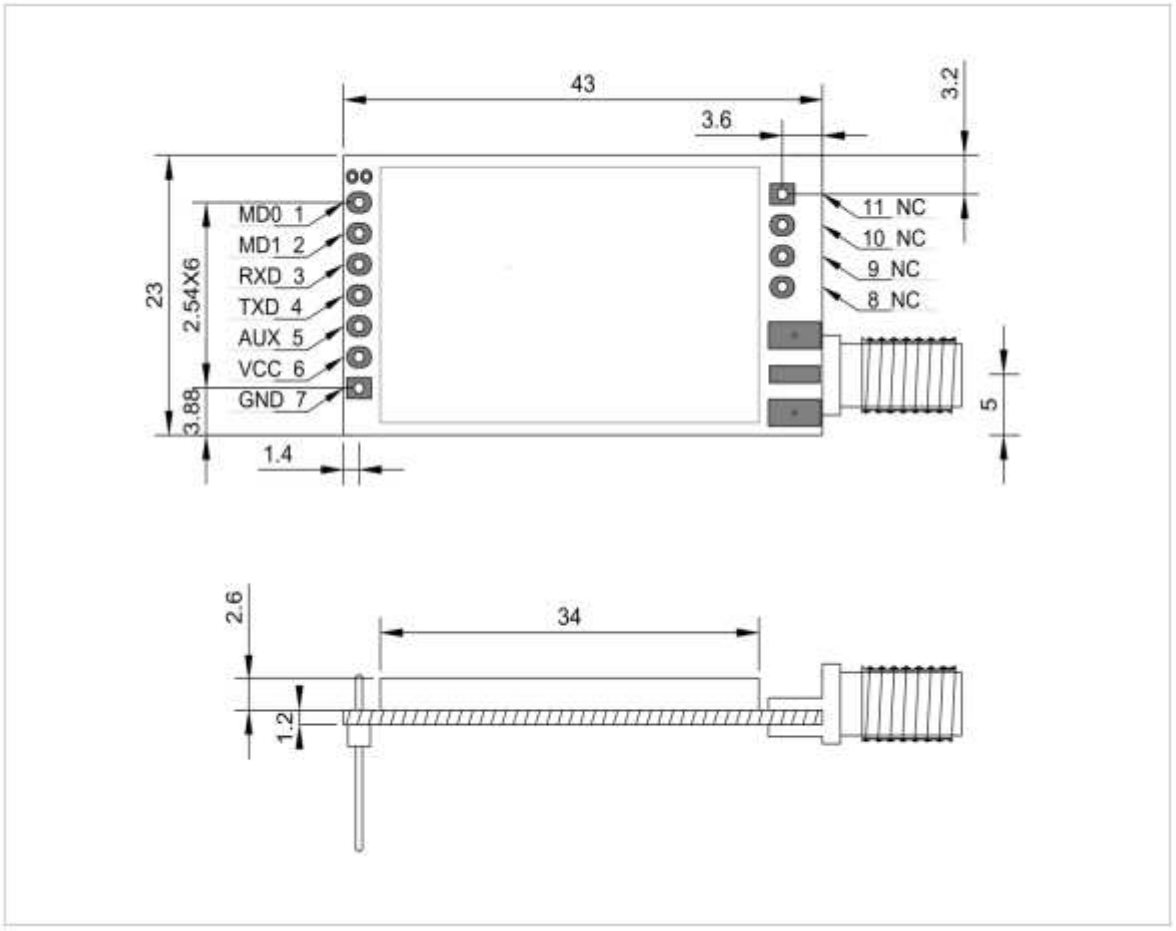


Parameter Name	T_answer	Description	Minimum value	Typical values	Maximum value	Unit
Module Command Answer Delay	T1	Parameter configuration delay		140		ms
	T2	Read module configuration parameters delay		3		ms
	T3	Read module hardware version number delay		3		ms

	T4	Waiting for module reset delay		3		ms
	T5	Read module voltage delay		3		ms
	T6	Configure module encryption key delay		140		ms
	T7	Recovery module default parameter delay		50		ms
Waiting for data transmission completion delay	T_Packet	Delay time required to finish sending a packet of data				ms

9.Package Information

9.1 Mechanical size(unit:mm)



Important Notes and Disclaimers

Due to the continuous improvement of hardware and software of the product, this specification is subject to change, and the latest version of the specification shall prevail in the end.

Users who use this product need to pay attention to the product dynamics at the official website so that users can get the latest information of this product in time.

The pictures and diagrams used in this specification are for illustrating the functions of this product and are for reference only.

The measurement data in this specification are measured by our company at room temperature for reference only, please refer to the actual measurement.

Chengdu Zeyao Technology Co., Ltd. reserves the right of final interpretation and modification of all contents in this specification.

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 uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm 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 “2BFD7-A39”

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 alsoSection 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 special connector External antenna with gain of 3.82dBi Max.

2.4 Single Modular

If a modular transmitter is approved as a "Single Modular ," then the module manufacturer isresponsible 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 :2BFD7-A39

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 special connector external antenna with a gain of 3.82dBi max.

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: 2BFD7-A39

2.9 Information on test modes and additional testing requirements5

Additional guidance for testing host products is given in KDB Publication 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: Ningde lingyang Electronic 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.