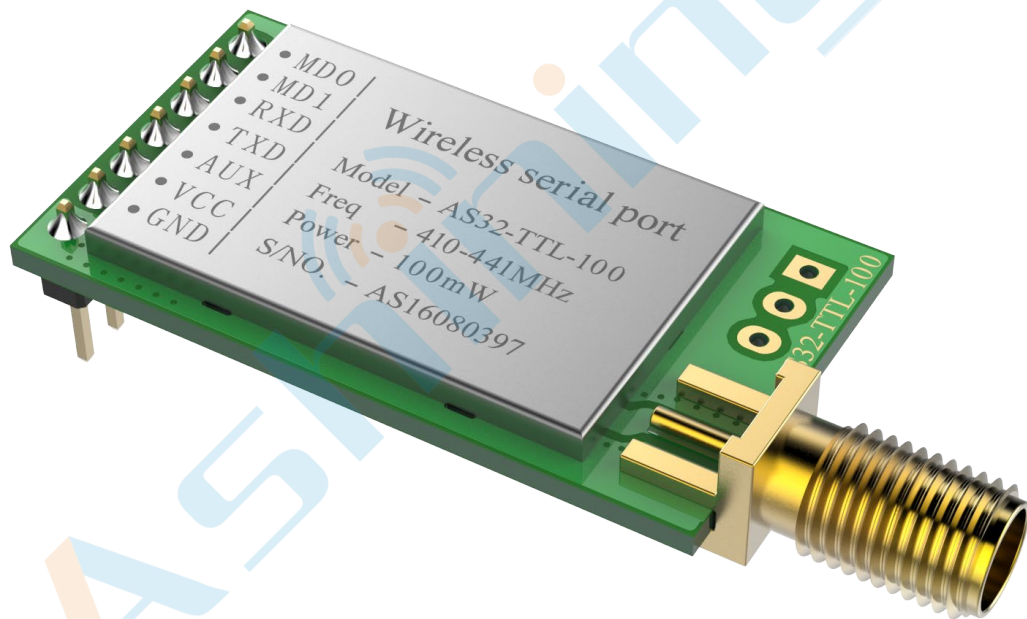# AS32-TTL-100 Data Sheet

433mhz, 100mW, LoRa Spread Spectrum Wireless Serial Port Module

Data Encryption, Point-to-Point Transmission

Table of Content

1. Product Overview

AS32-TTL-100 is a 100mW industrial wireless data transceiver with high stability, operates at 433MHz. The module adopts imported high-performance RF SX1278, Lora spread spectrum modulation, and TTL level output has strong anti-interference ability and high stability. It has four operation modes and can be switched freely in the run time. In power saving mode, the current consumption is extremely low, ideal for applications of ultra-low current consumption.

2. Product Features

- Point-to-point transmission, transparent transmission, wake on radio
- Receiving sensitivity is up to -130dBm, range 3000 meters
- Sleep current is only 1.5uA
- Ultra-low receiving current consumption
- Automatically relay, continuous transmission
- Data encryption
- RSSI and voltage are readable
- Built-in multiple exception handling mechanisms ensure the stable operation for a long time
- Multiple levels of transmitting power
  - ➢ 4 power levels adjustable (0-3), each levels steps 3dBm
  - ➢ Power Range: 11-20dBm, Max 100mW
- Multiple baud rates [1]
  - ➢ 8 commonly used baud rates, default baud rate 9600bps
  - ➢ Baud rate range:1200bps~115200bps
- Multiple air speeds [2]
  - ➢ 6 air speeds adjustable, default air speed 2.4 Kbps
  - ➢ 0.3~19.2kbps（0.3kbps、1.2kbps、2.4kbps、4.8kbps、9.6kbps、19.2kbps）
- 4 operation modes [2]
  - ➢ MD0 = 0 MD1 = 0 general operation mode
  - ➢ MD0 = 0 MD1 =1 Power saving operation mode
  - ➢ MD0 = 1 MD1 = 0 wake up operation mode
  - ➢ MD0 = 1 MD1 = 1 sleep mode
- Frequency 410~441MHz, providing 32 channels [4]
  - ➢ 410M + CHAN * 1MHz

- ➢ CHAN:0* 00~0*1FH (corresponding to 410~441MHz)
- ➢ Default operation frequency 433MHz, application free band
- Supply voltage range
  - ➢ 2.5V-5.5VDC
  - ➢ Built-in LDO ensures stable power supply, meeting variety system requirements
- Data 256 circular FIFO
  - ➢ Transmit FIFO of 256 bytes
  - ➢ Receive FIFO of 256 bytes
  - ➢ Automatic subcontracting transmission
  - ➢ The module can send infinite data packet length with some particular combinations of air rate and baud rate
- Broadcasting data and monitor [5]
  - ➢ Module address set as 0*FFFF, monitor data transmission of all modules in the same channel(monitor). The data sent can be received by all modules of random address and the same channel
- Point-to-Point transmission [5]
  - ➢ The data sent by random module can be received by appointed module. Multiple receivers of the same address and channel all can receive the data
  - ➢ Data can achieve point-to-point transmission across channels
  - ➢ Can realize networking, relay and other applications.
- Wake on Radio [5]
  - ➢ The transmitter in the wake-up mode will automatically increase the wake-up code when sending data, and wake up the target module in the power-saving mode.
  - ➢ Transmit mode is the same as point-to-point transmission

Remarks:

1) For details, see the SPEED register in Chapter 6.2 of module Parameter Configuration.
2) For details, See the pin definition and function in chapter 5
3) For details, see the CHAN register in Chapter 6.2 of module parameter configuration.
4) For details, See the relationship diagram of voltage and power in Chapter 5
5) For details, See the module function table in Chapter 7.

3. Series Products

Table 3-1 Brief Specification of AS32-TTL-100

| Item model	Carrier frequency (Hz)	IC	Size (mm)	Max transmit power (dBm)	Range (km)	Package	Antenna
AS32-TTL-100	410~441M	SX1278	20*36	21	3.0	In-line package	SMA-K
AS32-TTL-1W	410~441M	SX1278	23*43	30	8.0	In-line package	SMA-K
All models of the AS32 series can communicate with each other							

4. Electrical Parameters

Table 4-1 Electrical Parameters of AS32-TTL-100

Test Condition: Tc=25℃，   VCC=3.3V

Item model	Parameter name	Description	Min	Typical value	Max	Units
AS32-TTL-100	Supply voltage	If the power supply voltage is less than 3.6v, the output power will decline, but it has little influence on the received power	2.0		5.5	V
AS32-TTL-100	Transmitting current	SendPower[1]= 0		110		mA
		SendPower= 1		89		mA
		SendPower= 2		60		mA
		SendPower= 3		47		mA
AS32-TTL-100	Receiving current	General working mode （MD0=0，MD1=0)		18		mA
		Power saving mode （MD0=0，MD1=1)		30		mA
		Wake-up mode （MD0=1，MD1=0)		18		mA
		Sleep mode （MD1=1，MD1=1)				
AS32-TTL-100	Sleep current	current measured in sleep mode （MD0=1，MD1=1)		1.5		uA
AS32-TTL-100	Working frequency	410-441MHz,1MHz stepping, 32Channels, factory default 433MHz	410	433	441	MHz
AS32-TTL-100	Transmit power	SendPower= 0		20		dBm
		SendPower= 1		17		dBm
		SendPower= 2		14		dBm
		SendPower= 3		11		dBm
AS32-TTL-100	Airspeed	6 levels adjustable (0.3kbps、1.2kbps、2.4kbps、4.8kbps、9.6kbps、19.2kbps)	0.3k	2.4k	19.2k	bps
AS32-TTL-100	Receiving sensitivity	The receiving sensitivity has nothing to do with the serial port rate or delay time		-130		dBm

AS32-TTL-100	Operation temperature	AS32-TTL-100 industrial product	-40		+85	℃
AS32-TTL-100	Operation humidity	Relative humidity, no condensation	10%		90%	
AS32-TTL-100	Storage temperature		-40		+125	℃

5. Module Functions

5.1 Recommended Connection Diagram
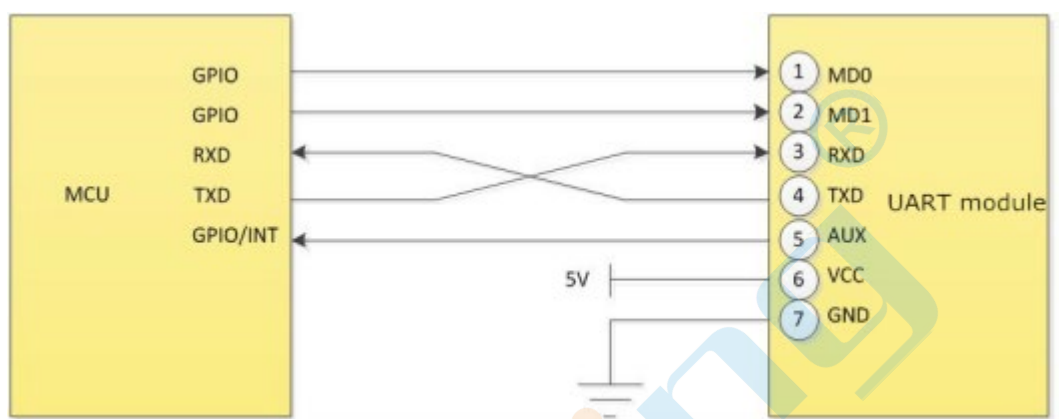

0-1 Recommended Connection Diagram

5.2 Pin Definition

Table 5-1 Pin Definition of AS32-TTL-100

Pin Number	Pin Name	Pin Orientation	Pin Usage
1	MD0	Input (weak pull up)	Cooperates with MD1 of low delay to decide four kinds of operation modes
2	MD1	Input (weak pull up)	Cooperates with MD0 of low delay to decide four kinds of operation modes
3	RXD	Input	TTL UART inputs, connects to external TXD output pin. It can be configured as open-drain or pull-up input, see parameter setting for details
4	TXD	output	TTL UART outputs, connects to external RXD input pin. It can be configured as open-drain or push-pull output, see parameter setting for details
5	AUX	output	Indicates the operation status of the module, and wakes up the external MCU. During the procedure of self-test initialization, the pin outputs low level. Can be configured as open-drain output, or push-pull output. see parameter settings for details
6	VCC		power supply, voltage2.5-5.5V (Note: if it is less than 3.6V, the output power will decline, but the impact on the receiving performance is very small.)
7	GND		Ground line, connected to the power supply reference ground

5.3 Pin Function

5.3.1 Pins Function of MDO and MD1 in Low Latency Mode
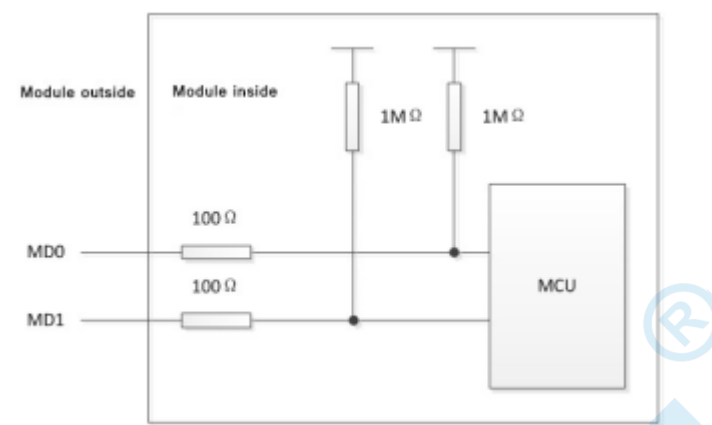
Picture 0-2 Internal structure of the MD0 and MD1 pin

The free combinations of the high and low level of pins MD0 and MD1 in low-latency operation mode can determine the four operating modes of the wireless UART module and these four operating modes can be freely switched.

Pay attention to the following two special cases when switching working modes:

1. The module received wireless data and has not finished outputting, and then enters a new mode after the data output is completed.
2. The module sends wireless data has not been sent yet, and then enters the new mode after the data is sent.

Table 5-2 Operation Mode Form

Operation Mode	MD1	MD0	Mode Introduction
General Mode	0	0	UART open, wireless channel open
Power-Saving Mode	0	1	UART receiving is off, the wireless is in the wake-up mode, after receiving wireless data, open the UART to send data.
Wake-Up Mode	1	0	UART open, wireless channel open, and the only difference between general mode is: Before the packet is transmitted, the wake code is automatically increased so that it can wake up the receiver in power saving mode
Sleep Mode	1	1	Module entering into sleep can receive the parameter configuration Command

Table 5-3 Communication Mode Form

| Transmit \ Receive		Operation Mode			Data Transmission Mode		
		General Mode	Wake-Up Operation Mode	Power Saving Operation Mode	Transparent Broadcasting	Broadcasting and Monitor	Point-To-Point Transmission
Operation Mode	General operation mode	Y	Y	-	Y	Y	Y
	Wake-up operation mode	Y	Y	Y	Y	Y	Y

5.3.2 Function of AUX Pin
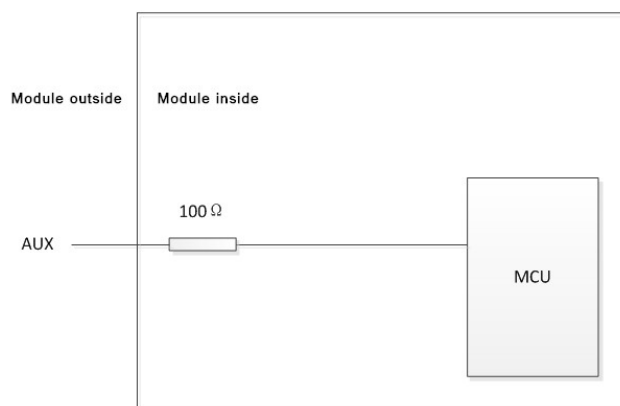
Picture 0-3 Schematic Diagram of The Internal Structure of The AUX Pin

AUX is used as indication for wireless send and receive buffer and self-test. It indicates whether the module has data not sent by wireless, or whether the received data has been sent through the UART, or the module is initializing the self-test.

Mode of AUX pin should be checked before switching operation mode. When the AUX output is low, it indicates that the module is busy. After the AUX output is high for 2ms, it indicates the module is idle and ready to change operation mode. MDO, MD1 in low latency mode start to jump and after that AUX keeps outputting high level for 3ms, the module changes the mode. When AUX outputs high level and maintains for about 2ms, the mode change is done.

In the process of reset, the module will reinitialize the parameters, during which the AUX keep low level.

5.3.3 Function of RXD And TXD Pins
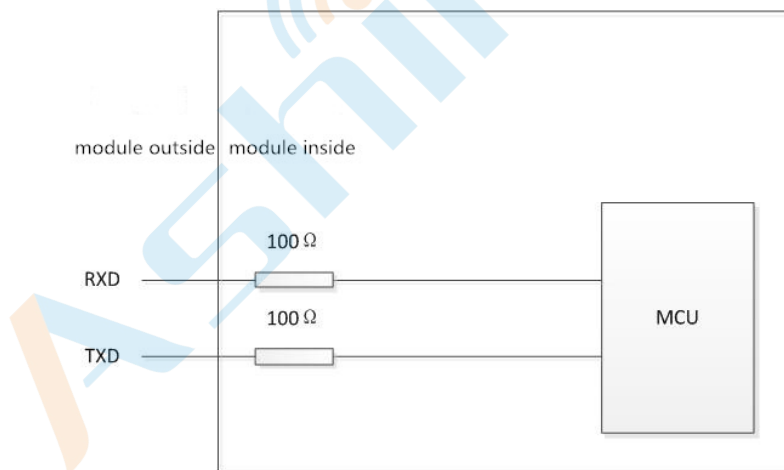
Picture 0-4 Internal Structure of the RXD and TXD Pin

RXD and TXD are serial data transmission and reception pins, at the same time, the UART has 8 common baud rates to choose from, the supported baud rate range is 1200~115200 (bps); the UART parity mode also has odd parity, even parity and No parity. The byte transmission format of UART is shown in Picture:
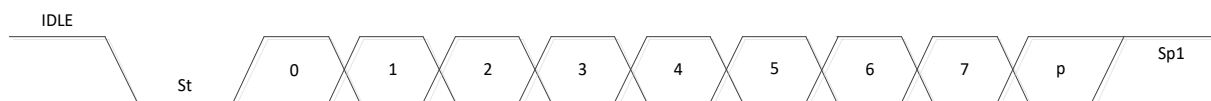
Picture 0-5 Format of UART Byte Transmission
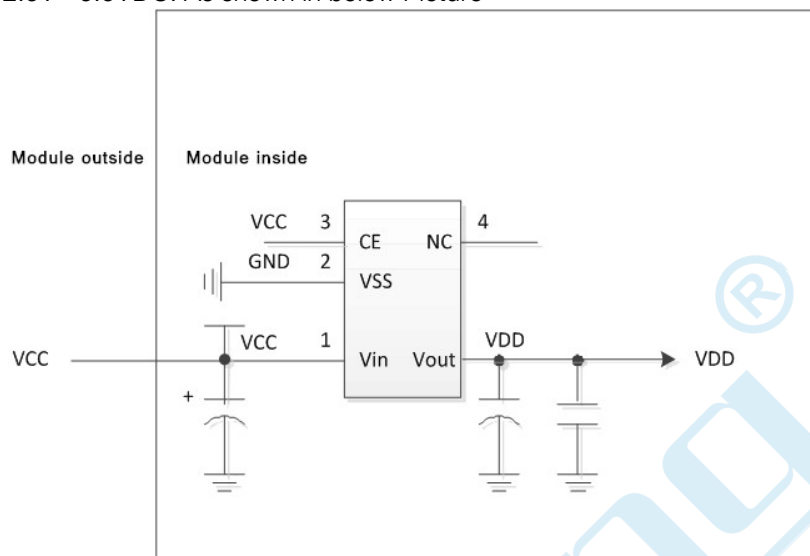
IDLE: High level when idle
St: start bit
P: parity bit

Sp1: stop bit

5.3.4 Function of VCC and GND Pins

GND indicates the ground line, VCC indicates the power supply, and the module power supply has its own LDO. Input voltage range: 2.5V - 5.5VDC. As shown in below Picture

Picture 0-6 Power LDO

Remarks:

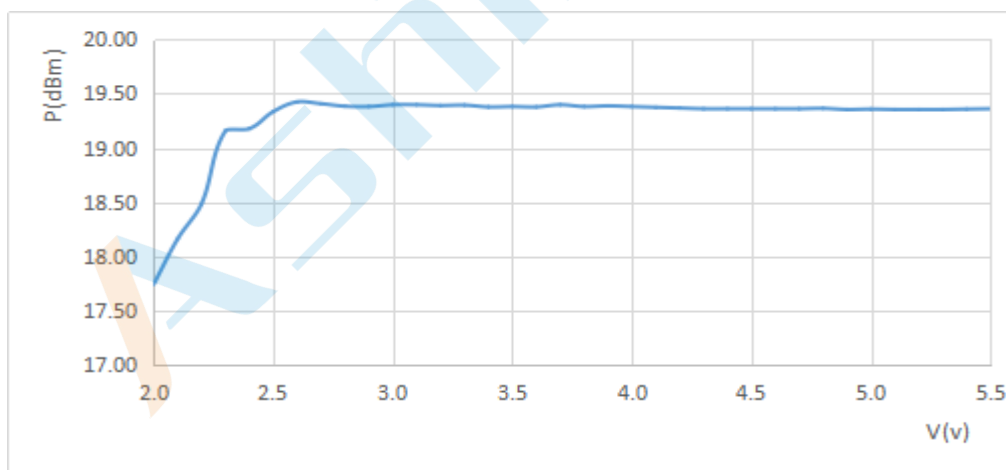The input power ripple coefficient should be controlled within 100mV, and the instantaneous pulse current should be more than 200mA.

When the power supply voltage is less than critical value, the output power declines, but the reception performance is less affected. The relationship between voltage and power is shown in below Picture

Picture 0-7 Relationship diagram of voltage and power

6. Module Command

6.1 Command Format

The parameter configuration Command is supported in the sleep operation mode, which means that the pins in low latency operation mode are set to high level (MD0 = 1, MD1 = 1).

Table 6-1 Command Overview Form

No.	Command	Command Function
1	0xC0	Set the module parameters. The parameters set by this Command can be saved after power off.
2	0xC2	Set the module parameters. The parameters set by this Command are not saved after power off.
3	0xC6	Configure data encryption key of the module
4	0xC1 + 0xC1 + 0xC1	Read module parameters
5	0xC3 + 0xC3 + 0xC3	Read the hardware version of the module
6	0xC4 + 0xC4 + 0xC4	Reset module Command
7	0xC5 + 0xC5 + 0xC5	Read the actual voltage of the module
8	0xC9 + 0xC9 + 0xC9	Restore default parameters
9	0xE1 + 0xE1 + 0xE1	Handshake command
10	0xF3 + 0xF3 + 0xF3	Read the software version of the module
11	0xAF + 0xAF + 0x73 + 0x00 + 0xAF +0xF3	Read RSSI of the current data signal directly
12	0xAF + 0xAF + 0x74 + 0x00 + 0xAF +0xF4	Read RSSI of the environmental signal directly

Detailed explanation of the command function, taking the default factory configuration as an example. See the following form for details:

Table 6-2

Command Format	Module Response	Description
0xC0 ADDH ADDL SPEED CHAN OPTION （See the register description of parameter configuration for details）	OK	The configuration succeeds and the ASCII string is returned. The parameters configured can be saved after power-off.
	ERROR	The configuration failed and the ASCII string is returned. The original configuration parameters are not changed.
0xC2 ADDH ADDL SPEED CHAN OPTION (See the register description of parameter configuration for details）	OK	The configuration succeeds and the ASCII string is returned. The parameters configured cannot be saved after power-off.
	ERROR	The configuration failed and the ASCII string is returned. The original configuration parameters are not changed.
0xC6 + 16byte Configure key	OK	Data encryption succeeded
0xC1 0xC1 0xC1	C0 00 00 1A 17 40	The module returns the present configuration parameters in hexadecimal format.
0xC3 0xC3 0xC3	AS32-TTL-100-V3.0	The module returns the present hardware version in ASCII format.
0xC4 0xC4 0xC4	OK	The module generates a reset. During the reset process, the module performs a self-test and the AUX outputs a low level. After the reset, the AUX output is high, and the module starts to work normally. At this time, you can switch mode or initiate next Command.
0xC5 0xC5 0xC5	C5 VH VL	VH and VL are voltage data. For example, the module returns C5 0C 1C, converts 0C 1C to decimal to get 3100, indicating that the current voltage of the module is 3.1V.
0xC9 0xC9 0xC9	OK	Restore default parameter configuration successfully

0xE1 0xE1 0xE1	OK	When the user forgets the baud rate, it can be used to query by baud rate until 'OK' is received.
0xF3 0xF3 0xF3		The module will return the current software version in ASCII format.
0xAF 0xAF 0x73 0x00 0xAF 0xF3	XX	Read RSSI of the current data signal directly. For example, if the module returns XX and converts it to decimal data, it indicates the current signal strength.
0xAF 0xAF 0x74 0x00 0xAF 0xF4	XX	Read RSSI of the environmental signal directly. For example, if the module returns XX and converts it to decimal data, it indicates the current signal strength.

6.2 Module Parameter Register

The module parameters can be modified in the sleep mode (i.e. MD0 = 1, MD1 = 1).

Configuring parameter register (Configuring parameter register cannot be used alone, it must be used according to the command format of the configuration parameter, see Chapter 6, Section 6.1 for details)

Table 6-3 ADDH Module Address High 8-Bit Register

	ADDH [7:0]							
Read and Write Properties	rw	rw	rw	rw	rw	rw	rw	rw
Default Value	0	0	0	0	0	0	0	0

ADDH [7:0]: indicates the module address high byte, factory default 0x00

Table 6-4 ADDL Module Address Low 8-Bit Register

	ADDL [7:0]							
Read and Write Properties	rw	rw	rw	rw	rw	rw	rw	rw
Default Value	0	0	0	0	0	0	0	0

ADDL [7:0]: module address low byte, factory default 0x00

Table 6-5 SPEED Communication Configuration Register

	UART CS [1: 0]		UART BAUD [2: 0]			AIR SPEED [2: 0]		
Read and Write Properties	rw	rw	rw	rw	rw	rw	rw	rw
Default Value	0	0	0	1	1	0	1	0

SPEED [7: 6]
UART CS [1: 0]: UART parity bit
00: 8N1 (default)
01: 8O1
10: 8E1
11: Same as 8N1

SPEED [5: 3]
UART BAUD [2: 0]: UART baud rate
000: UART baud rate is 1200 bps
001: UART baud rate is 2400 bps
010: UART baud rate is 4800 bps
011: UART baud rate is 9600 bps (default)
100: UART baud rate is 19200 bps
101: UART baud rate is 38400 bps
110: UART baud rate is 57600 bps
111: UART baud rate is 115200 bps

SPEED [2: 0]
AIR SPEED [2: 0]: airspeed
000: Air speed is 0.3k
001: Air speed is 1.2k
010: Air speed is 2.4k (default)
011: Air speed is 4.8k
100: Air speed is 9.6k
101: Air speed is 19.2k

<u>Remarks:</u>

1) The air speeds of receiver and transmitter should be the same.
2) Some combinations of air speed and baud rate can send infinite data packet, please see below form for details.

Table 6-6

Baud Rate（bps） Air Speed（bps）	1200	2400	4800	9600	19200	38400	57600	115200
0.3K								
1.2K	√	√						
2.4K	√	√	√					
4.8K	√	√	√					
9.6K	√	√	√					
19.2K	√	√	√	√				
√means supporting transmission of infinite data packet								

Table 6-7 CHAN Channel Register

	CHAN [7: 0]							
Read and Write Properties	rw	rw	rw	rw	rw	rw	rw	rw
Default Value	0	0	0	1	0	1	1	1

CHAN [7: 0] ： frequency（410 + CHAN*1M）
Factory Default: 0x17 (433MHz)
00000000：0x00（Min：410MHz）
00011111：0x1F（Max：441MHz）

Table 6-8 OPTION Special Function Register

	FixedTransmitEn	IOType	WakeTime [2: 0]			Reserved	SendPower [1: 0]	
Read and Write Properties	rw	rw	rw	rw	rw	rw	rw	rw
Default Value	0	1	0	0	0	0	0	0

OPTION [7] FixedTransmitEn: Point-to-Point transmission enable
0: Transparent transmission (default)
1: Point-to-Point transmission

OPTION [6] IOType: IO port drive mode
0: TXD, AUX open output, RXD open input
1: TXD, AUX push-pull output, RXD pull-up input (default)

OPTION [5：3]

WakeTime [2：0]: Wireless wake-up time (it is the monitoring interval time for the receiver, for the transmitter it is the time of continuous transmission of the wake-up code)
000:250ms (default)
001:500ms
010:750ms
011: 1000ms
100:1250ms

101:1500ms
110:1750ms
111:2000ms

Remarks:

wireless wake-up time is typical value

OPTION [2]: Reserved

OPTION [1:0] Send Power [1:0]: Transmitting power
00:20dBm (default)
01:17dBm
10:14dBm
11:11dBm

Remarks:

power is the typical value

6.3 Module Factory Setting

Table 6-9 Factory Configuration Form of Register:

Register Name	ADDH	ADDL	SPEED	CHAN	OPTION
Register Parameter	00	00	1A	17	40

Table 6-10 Module Factory Parameter:

Item Model	Operation Frequency (MHZ)	ID Address (HEX)	Factory Channel	Air Speed (Kbps)	Baud Rate (bps)	UART Format	Transmit Power (mW)
AS32-TTL-100	433.0	0x0000	23	2.4	9600	8N1	100

7. Module Functions

7.1 Overview of Module Functions

Table 7-1 Module Function Form

Module Function	Data Format of Transmitter	Data Format of Receiver	Function Introduction
Transparent broadcasting	User data	User data	The data sent by random module can be received by the modules with the same address and channel. The data transmission is transparent. What is sent is what is received.
Point-to-Point transmission	Receiver address + receiver channel + user data	User data	Random module can be the transmitter. When it sends data to random module in point-to-point communication, the data can be transmitted across the channel.
Broadcast and monitor（in Point-to-Point transmission）	0xFF+0xFF+receiver's channel + user data	User data	Broadcast: the data sent by random module can be received by modules in the same channel at the same time; Monitor: A module with a 0xFFFF address can receive data sent by random address module on the same channel.
Wake on radio	1.In transparent transmission mode： (Auto add wake-up code 010101010······) + user data 2.In Point-to-Point transmission mode ： (Auto add wake-up code 010101010······) +receiver's address + receiver's channel + user data	User data	1. The transmitter in the wake-up mode can wake up the receiver module in the power-saving mode in the air. 2. The module in the wake-up mode will automatically add the wake-up code when sending data. 3. The length of the wake-up code can be set by setting the wireless wake-up time.
Low power consumption		User data	The configuration of the receiving response delay time can adjust the overall power consumption of the module. The maximum configurable response delay of the module is WakeTime=7. In this configuration, the average current of the module is extremely low

7.2 Detailed Module Functions

7.2.1. Transparent Broadcasting

i. Function Description

The data sent by random module can be received by the modules with the same address and channel. The data transmission is transparent. What is sent is what is received.

ii. Module Setting

1. MD0 = 0, MD1 = 0
2. The 7th bit of the OPTION Special Function Register needs to be configured to 0, transparent transmission mode.
3. The addresses of the transmitter and the receiver are set to the same value.
4. The channels of the transmitter and the receiver are set to the same value.

For Example

Table 7-2

Transmitter		Receiver	
Module Address	0x0000 (factory default)	Module Address	0x0000 (factory default)
Module Channel	0x17 (factory default)	Module Channel	0x17 (factory default)
Sending Data	User data	Output Data	User data

| | 0x11 0x22 0x33 | | 0x11 0x22 0x33 |

7.2.2 Point-to-Point Transmission

i. Function Description

The data sent by random module can be received by appointed module. Multiple receivers of the same address and channel all can receive the data

ii. Module Setting

1. MD0 = 0, MD1 = 0; MD0 =1, MD1 = 0
2. The 7th bit of the OPTION Special Function Register needs to be configured to 1, Point-to-Point transmission mode.
3. The addresses of the transmitter and the receiver can be different.
4. The channels of the transmitter and the receiver can be different

iii. For Example

Table 7-3

Transmitter		Receiver	
Module Address	0xXXXX	Module Address	0x5678
Module Channel	0xXXXX	Module Channel	0x18
Sending Data	Receiver address high + receiver address low + receiver channel + data	Output Data	User data
	0x56 0x78 0x18 0x11 0x22 0x33		0x11 0x22 0x33

7.2.3 Broadcast in Point-to-point Transmission

i. Function Description

The data sent by random module can be received by all modules of the same channel

ii. Module Setting

1. MD0 = 0, MD1 = 0; MD0 =1, MD1 = 0
2. The 7th bit of the OPTION Special Function Register needs to be configured to 1, Point-to-Point transmission mode.
3. The addresses of the transmitter and the receiver can be different.
4. The channels of the transmitter and the receiver can be the different.
5. The first 3 bytes of the transmitter's data must be 0xFF + 0xFF + receiver channel.

iii. For Example

Table 7-4

Transmitter		Receiver	
Module Address	0xXXXX	Module Address	0xXXXX
Module Channel	0xXXXX	Module Channel	0x17 (factory default)
Sending Data	0xFF+0xFF+receiver channel + User data	Output Data	user data
	0xFF 0xFF 0x17 0x11 0x22 0x33		0x11 0x22 0x33

7.2.4 Monitor in Point-to-point Transmission

i. Function Description

Any module can send data, and any module in the same channel can receive data.

ii. Module Setting

1. MD0 = 0, MD1 = 0; MD0 = 1, MD1 = 0
2. The 7th bit of the OPTION Special Function Register needs to be configured to 1, Point-to-Point transmission mode.
3. The address of the monitor module must be set to 0xFFFF
4. The channel of the monitor module and the transmitter must be the same.
5. The first 3 bytes of the sending data must be 0xXX+0xXX+ monitor channel

iii. For Example

Table 7-5

Transmitter		Receiver	
Module Address	0x0000 (factory default)	Module Address	0xFFFF
Module Channel	0x17 (factory default)	Module Channel	0x17 (factory default)
Sending Data	Random address high + Random address low + receiver channel + User data	Output Data	user data
	0xXX 0xXX 0x17 0x11 0x22 0x33		0x11 0x22 0x33

7.2.5 Wake on Radio

i. Function Description

The sender module in the wake-up working mode can wake up the receiver module in the power-saving working mode in the air, and the module in the power saving working mode is always in the "sleep-monitoring" mode. If a valid wake-up code is received during the "monitoring" process, the module will continue to be in the wake-up [2] receiving mode and wait for the valid data packet to be received. Then AUX output low level, and after about 2ms delay, open the UART, send the received wireless data through TXD, after completion, AUX output high level. The module continues to enter the "sleep-monitor" working mode.

ii. Module Setting

1. Transmitter module: let the module be in the wake-up working mode（MD0 = 1，MD1 = 0）
2. The transmitter sets the wake-up code length by setting the wireless WakeTime [1]. Generally, the wireless wakes up time of the transmitter module is greater than or equal to the monitoring interval of the receiver module, ensuring that the receiver module can monitor to the wake-up code and receive it. When the air wakes up successfully, the receiver module will continue to be awake until the data reception is completed. If the wake-up code is not monitored, the air wakes up fails.
3. Transmitter module: let the module be in the power saving working mode（MD0 = 0，MD1 = 1）
4. Set the monitoring interval WakeTime [1] of the receiver module to ensure that the receiving module can receive a valid wake-up code within the monitoring interval.

7.2.6 Low Power Consumption

i. Function Description

The wireless module is in a command mode, and it periodically monitors whether the wake-up code is received. If the wake-up code is not received, the module will remain in the "sleep-monitor" mode. If the wake-up code is received during the process of the monitor and wake-up, the module will continue to be in wake-up mode until the data is received, and it opens the UART and sends the data. By setting different monitoring intervals, the module has different receive response delays (up to 2s) and average power consumption. Users need to balance the communication latency and average power consumption time.

ii. Module Setting

1. Set the operation mode of the module to power saving mode（MD0 = 0，MD1 = 1）
2. set the module's wireless WakeTime [1]。

Remarks:

1) For the setting of WakeTime, see OPTION register of module Parameter Configuration Command in Chapter 6.2.
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 affected by the space velocity, baud rate, wake-up time, and number of transmitted bytes.

8. Sequence Diagram

8.1 Sequence Diagram of Data Transmission
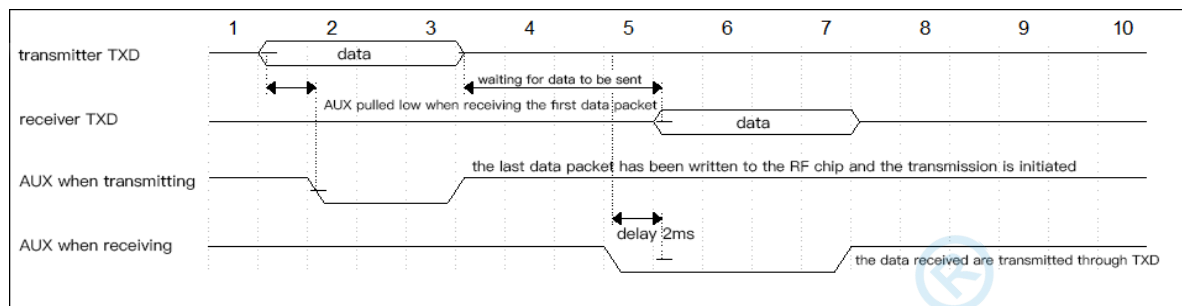
8.2 Sequence Diagram of Module Switch

When the module switches from any operation mode to the next operation mode, there will be a switching delay T_sc. After switching to the next operation mode, the module will always work in the operation mode after the switching, if the module does not perform other operation mode switching. The operation mode switching has nothing to do with the previous operation mode of the module. The programmer only needs to perform the mode switching delay during the switching process, then selects MD0 and MD1 pins of low latency operation mode for the high- and low-level operations. And you can switch to the desired operation mode.
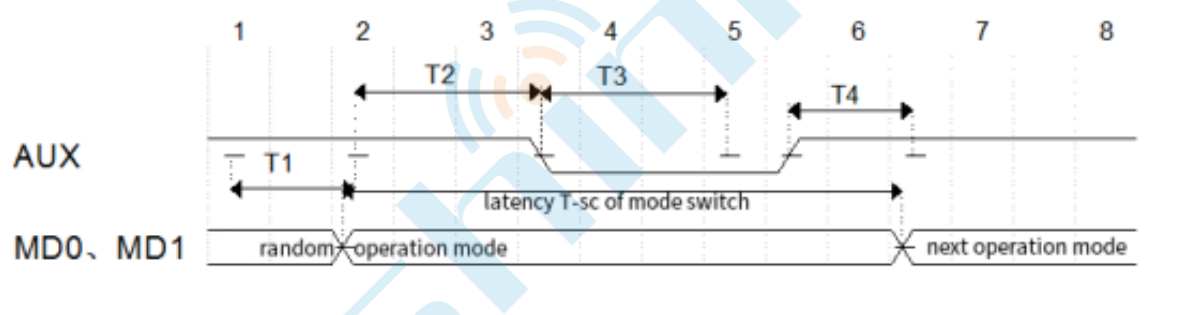
Table 8-1

Symbol	Explanation	Min Value	Typical Value	Max Value	Unit
T1	Wait till the last data packet is transmitted to make sure the module is idle		2		ms
T2	Debounce delay		3		ms
T3	Start modes switch		3		ms
T4	To tell if the mode switch is done		2		ms
T_sc	Mode switch delay				ms

Remarks:

Modes can be switched when AUX is high level, at this time, the module is ideal; If AUX is low level, it means the module is busy. The sending (receiving) is not empty, the data has not been sent (received), and the user needs to add a delay. After waiting for the data to be sent and received, the working mode can be switched.
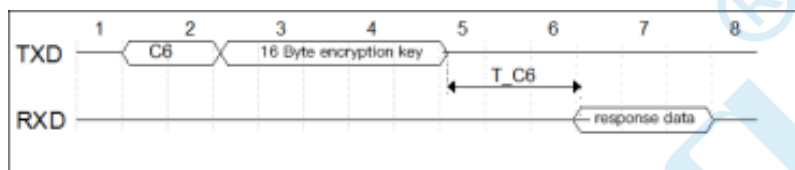
8.3 Sequence Diagram of Module Command
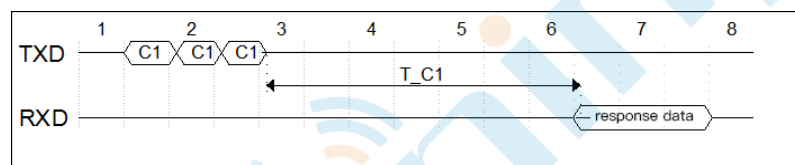
Sequence Diagram of Command as Below:

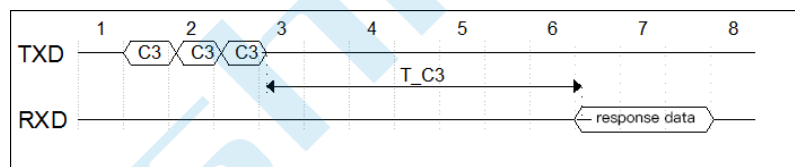### 8.3.1 Command of Parameter Configuration
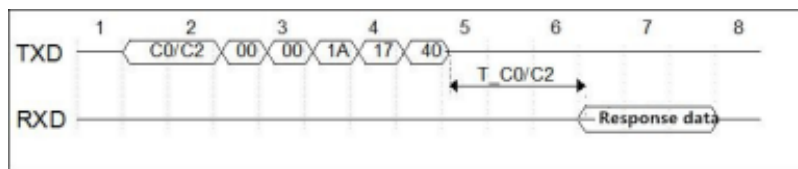
8.3.2 Command of encryption key configuration
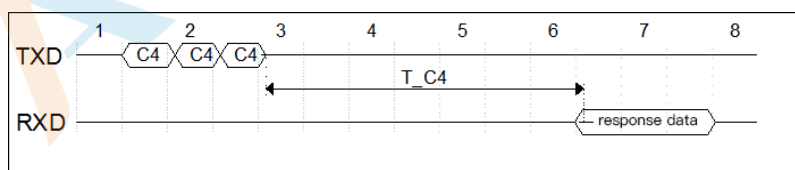

8.3.3 Command of Reading Configured Parameter
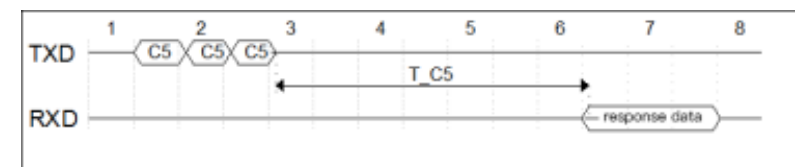

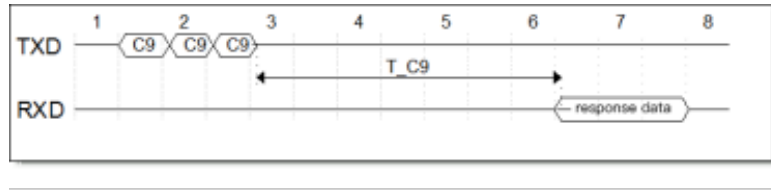### 8.2.4   Command of Reading Module Hardware Version
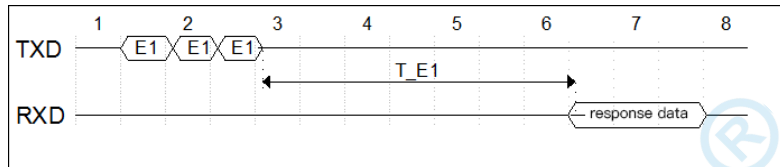

8.2.5   Command of Module Reset

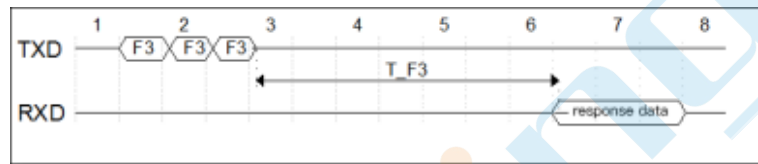### 8.3.6 Command of reading module actual voltage

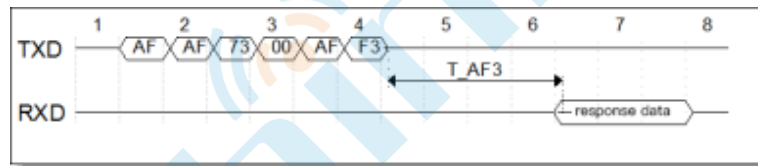### 8.3.7command of restoring default parameters

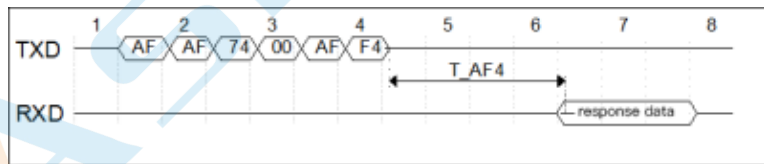
8.3.8 Handshake Command

8.3.9. Command of reading module software version

8.3.10. Reading RSSI of current data signal Command

8.3.11. Reading RSSI of environmental signal Command

Remarks:

Table 8-1

Parameter name	T_answer	Description	Minimum value	Typical value	Maximum value	Unit
Command response delay	T_C0/C2	Parameter configuration delay		139.67		ms
	T_C1	Reading module configured parameter delay		2.80		ms
	T_C3	Reading module hardware version delay		2.80		ms
	T_C4	Waiting module reset delay		2.87		ms
	T_C5	Reading module voltage delay		2.80		ms
	T_C6	Configuring module encryption key delay		140		ms
	T_C9	Restoring default parameter delay		49.07		ms

	T_E1	Handshake response delay				ms
	T_F3	Reading module software version delay		3.00		ms
	T_AF3/AF4	Reading RSSI delay				ms
Delay of waiting for data transmission completion	T_Packet	Delay of one data packet transmission				ms

9. Package Information

9.1 Machine Size (unit: mm)

9.2 Reference Pad Design (unit: mm)

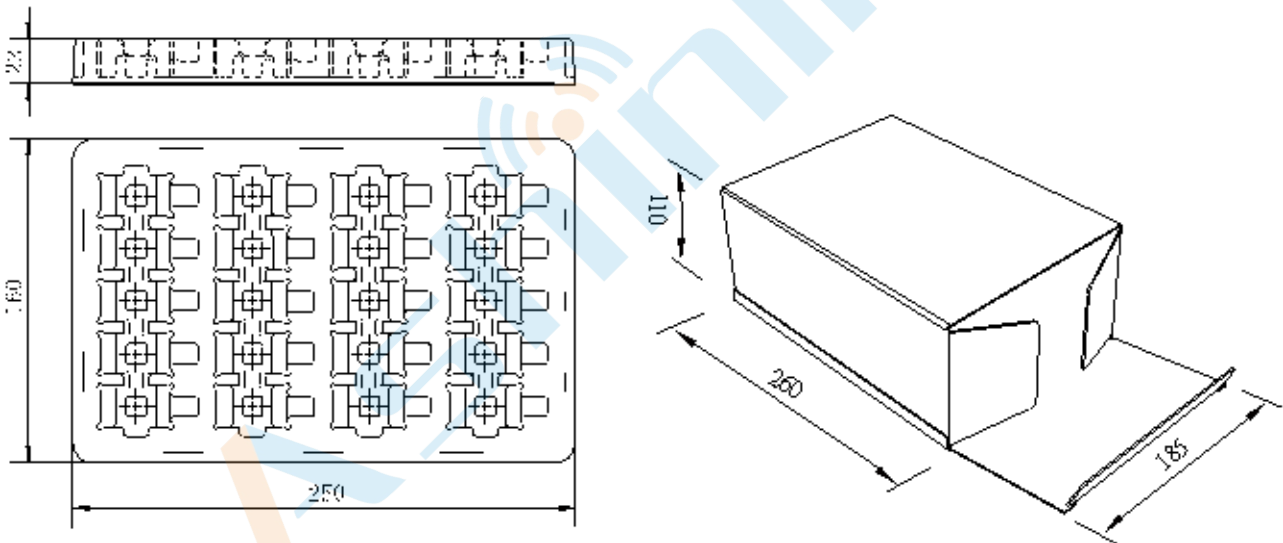# 10. Package Manner

10.1 Electrostatic Bag Package

10.2 Pallet Package (unit: mm)

Important Remarks and Disclaimers

As the hardware and software of the product continue to improve, this manual may be subject to change, and the final version of the manual shall prevail.

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

The pictures and diagrams used in this manual to explain the functions of this product are for reference only.

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

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