E72-2G4M02S2B User Manual

CC2640 2.4GHz BLE5.1 SMD Wireless Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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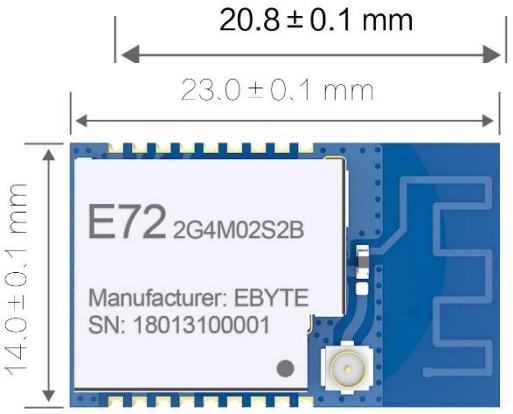
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1 General Introduction

1.1 Brief Introduction



E72-2G4M02S2B is a small-size SMD RF module BLE Bluetooth wireless module independently developed based on CC2640 produced by Texas Instruments (TI)。

CC2640 chip integrates 128KB intra-system programmable flash and 8KB buffer static RAM (SRAM) and different 2.4GHz wireless communication protocols. It also has a rich set of peripherals. Because of its unique ultra-low-power sensor controller, it's ideal for connecting external sensors, and it is also suitable for autonomous collection of analog and digital data while the rest of the system is in sleep mode.Thanks to its built-in dual-core low-power processor, users can build a complete system based on their own supporting modules. We used a 24MHz industrial grade high precision low temperature drift active crystal.

The module also supports secondary development. Users can write their own code to achieve the functions.

1.2 Features

- The measured communication distance can reach150/300 m;
- Maximum transmission power of 1.6mW, software multi-level adjustable;
- Built-in BLE 5.1protocol stack；
- Built-in 32.768kHz clock crystal oscillator;
- Support the global license-free ISM 2.4GHz band;
- Built-in high performance low power Cortex-M3 and Cortex-M0 dual core processor;
- Rich resources，128KB FLASH，28KB RAM;
- Support 1.8V~3.8V power supply，power supply over 3.3Vcan guarantee the best performance;
- Industrial grade standard design, support -40 ~ 85 °C for working over a long time;
- Support PCB antenna and IPEX interface, users can choose according to needs.

1.3 Application

- Smart homes and industrial sensors；
- Security system, positioning system；
- Wireless remote control, drone；
- Wireless game remote control；
- Health care products；
- Wireless voice, wireless headset；
- Automotive industry applications.

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2 Specification and parameter

2.1 limit parameter

Main parameter	Performance		Remark
	Min	Max	
Power supply （V）	0	3.8	Voltage over 3.6V will cause permanent damage to module
Blocking power（dBm）	-	10	Chances of burn is slim when modules are used in short distance
Operating temperature（℃）	-40	85	-

2.2 Operating parameter

Main parameter		Performance			Remark
		Min	Type	Max	
Operating voltage（V）		1.8	3.3	3.8	≥3.3 V ensures output power
Communication level （V）			3.3		For 5V TTL, it may be at risk of burning down
Operating temperature （℃）		-40	-	85	Industrial grade
Operating frequency（GHz）		2.402	-	2.480	Support ISM band
Power Consu m-ption	TX current（mA）		11		Instant power consumption
	RX current（mA）		2.0		
	Sleep current（μA）		0.2		Shut down by software
Max TX power（dBm）		1.6	2.0	2.5	
Receiving sensitivity（dBm）		-96.5	-97	-97.5	Air data rate is 1Mbps
Air data rate（bps）		-	1M	-	User programming to control

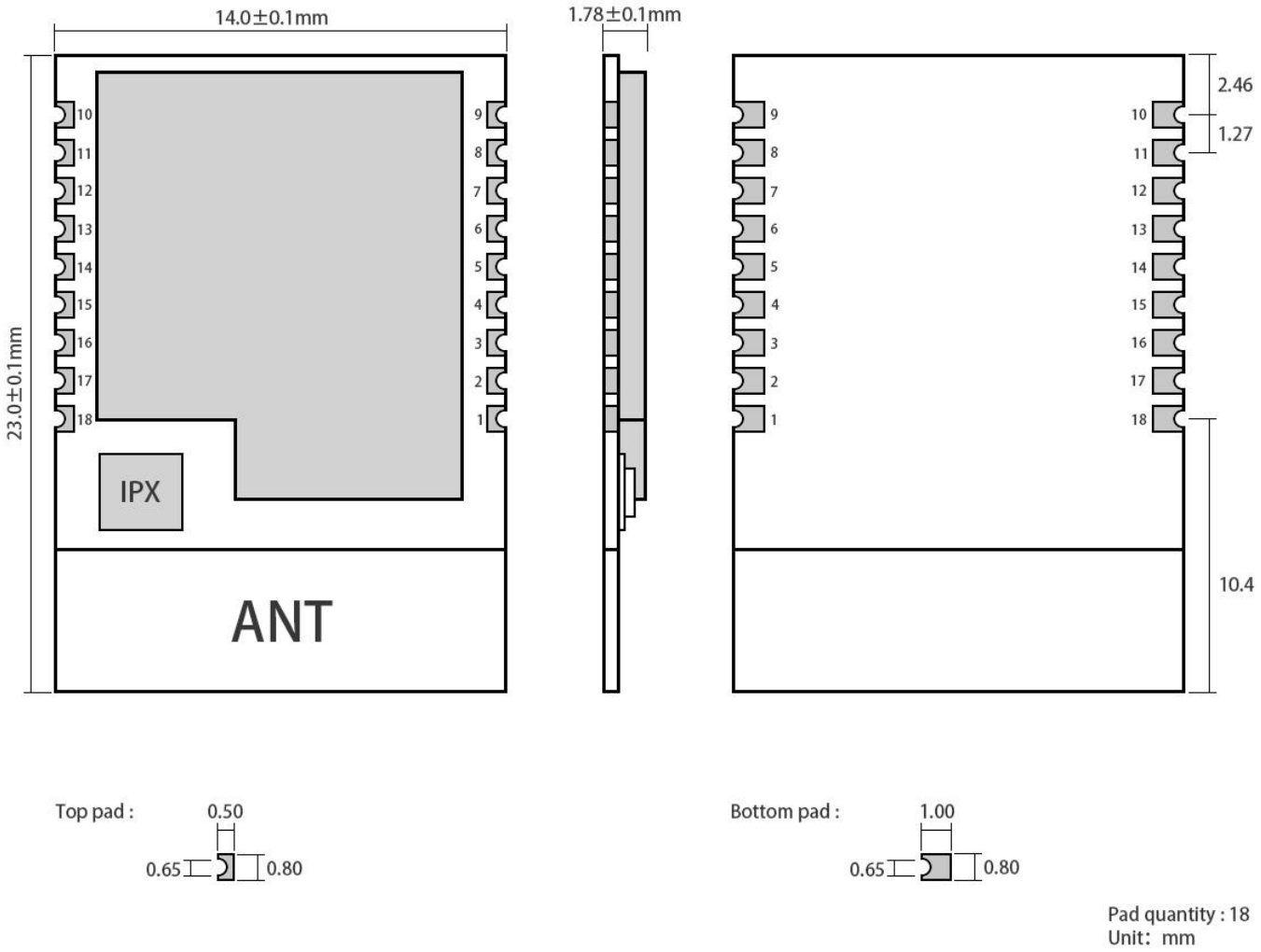
Main parameter	Description	Remark
Reference distance	150/300 m	Test condition：clear and open area, antenna gain: 5dBi，antenna height: 2.5m，air data rate: 250 kbps
Crystal Oscillator	24MHz / 32.768KHz	-
Protocol	BLE 5.1	-
Package	SMD	-
Interface	1.27mm	-
IC	CC2640F128RSMR	-
FLASH	128 KB	-
RAM	28 KB	-

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Core	Cortex-M3 + Cortex-M0	-
Size	14 * 23 mm	-
Antenna	PCB / IPEX	50 ohm impedance

3 Size and pin definition



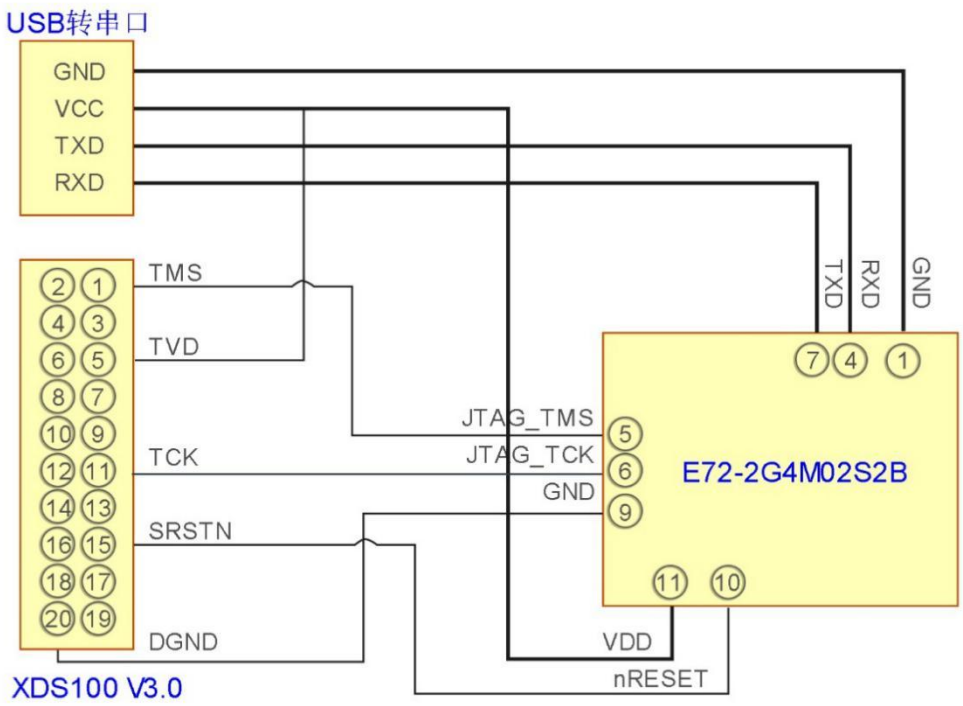
Pin No.	Item	Direction	Description
1	GND	-	Ground, connecting to power source referential ground
2	DIO_0	Input/Output	General IO port, sensor controller (see CC2640 manual for details)
3	DIO_1	Input/Output	General IO port, sensor controller (see CC2640 manual for details)
4	RXD	Input/Output	Serial receive pin
5	JTAG_TMS	Input/Output	JTAG_TMSC（see CC2640 manual for details）
6	JTAG_TCK	Input/Output	JTAG_TCKC（see CC2640 manual for details）
7	TXD	Input/Output	Serial port transmit pin
8	DIO_4	Input/Output	High drive IO, JTAG_TDI（see CC2640 manual for details）

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9	GND	-	Ground, connecting to power source referential ground
10	nRESET	Input	Reset（see CC2640 manual for details）
11	VDD	-	Power supply: 1.8V ~ 3.8V
12	DIO_5	Input/Output	SLEEP pin, trigger and wake up
13	GND	-	Ground, connect to the power reference ground
14	DIO_6	Input/Output	MRDY pin, trigger serial reception
15	DIO_7	Input/Output	SRDY pin, wake up external MCU
16	DIO_8	Input/Output	Connection, output low level
17	DIO_9	Input/Output	General IO, sensor controller, digital analog（see CC2640 manual for details）
18	GND	-	Ground electrode, connect to power reference ground
★ Please refer to “CC2640 Datasheet” of TI for pin definition, software drive and protocol★			

4 Circuit design



- TMS, TCK, reset, and ground need to be connected between the emulator and the module, and an additional 3.3V power supply is required for the emulator;
- Use USB to UART module to connect with module, module serial port and IO port are multiplexed, users can set according to their own needs;
- Please note that good grounding is required. When there is a large area of grounding, the power supply ripple is small. Increase the filter capacitor and try to be close to the VCC and GND pins of the module.

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5 Operation mode

No.	Operation mode	Function Description
1	Low power consumption	The module enters low power mode after it powers on and the module keeps in advertising state. The serial port stops receiving any data while transparent output function of Bluetooth will not be affected, which means serial output function is still valid in this mode, data received by Bluetooth can output via serial ports.
2	Transparent transmission	In the low power consumption mode, the module enters the state of serial port receiving by pulling down DIO_6 pin. When the Bluetooth is not connected, it keeps in command reception status; When the Bluetooth is connected, it's in transparent transmission mode, the data sent by the serial port to the Bluetooth module can be sent out via Bluetooth. By inputting character "+++", the module enters the instruction configuration mode and displays "CMD IN", meaning to enter the command mode; Inputting the character "+++" again, the module returns to command input mode and displays "CMD OUT".
3	Sleep	By giving the DIO_5 pin a low level of at least 300ms, the module goes into sleep mode and again triggers the pin, the module returns to low power mode.

5.1 Multiple roles

This module can be configured as a multi-role mode through the instruction AT+ROLE=1. In this mode, each module can act as master or slave, one device supports three connections, as shown in figure 1.

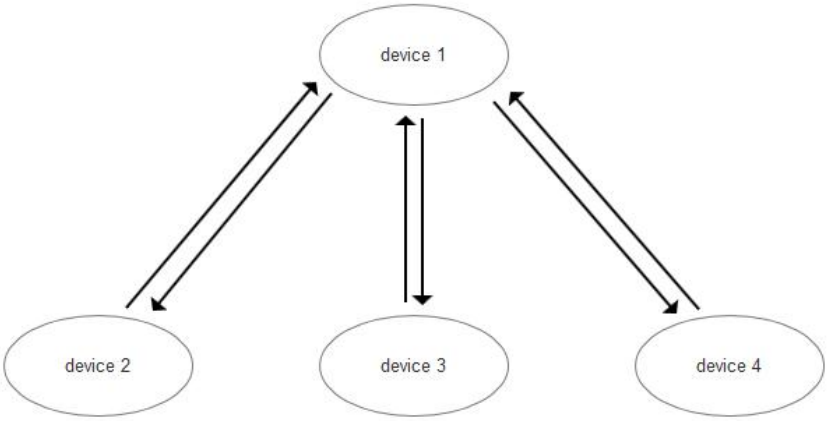


Figure 1

It refers to one master- multi slaves. device 1 can connect device 2, device 3 and device 4 at the same time. The data sent by device 1 can be received by other three devices simultaneously.

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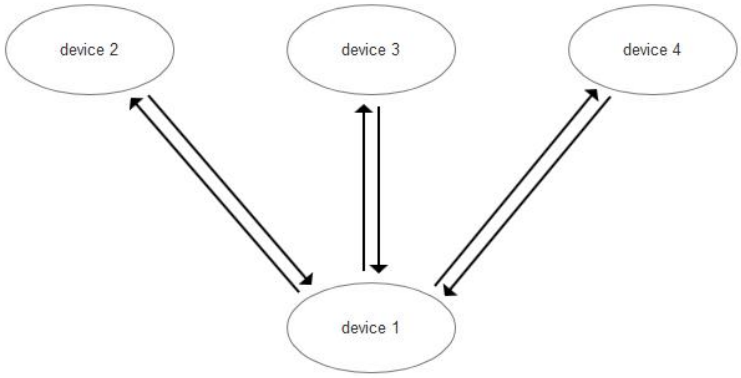


Figure 2

It refers to multi-masters-one slave. Device 1 can connect device 2, device 3 and device 4 at the same time. The data sent by device 1 can be received by other three devices simultaneously, the data sent by device 2, device 3 and device 4 can be received by device 1.

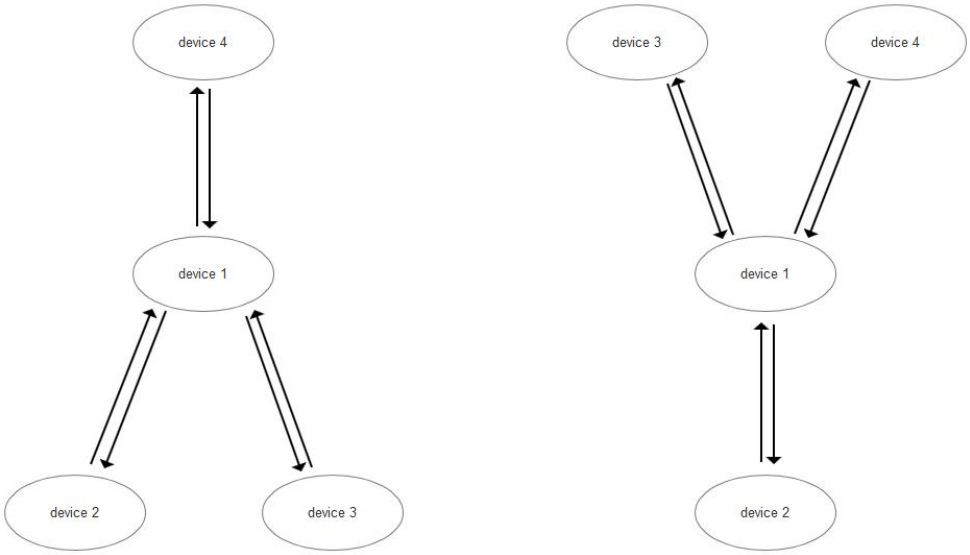


Figure 3

It refers to the topological structure of one master- multi slaves and multi masters- one slave. In the left picture, device 1 can be scanned by device 4 after it connects equipment 2 and equipment 3 at a same time, the connection will be created. The data sent by equipment 1 can be simultaneously received by other three devices, the data sent by equipment 2, equipment 3 and equipment 4 can be received by equipment 1. In the right picture, the device 1 can be scanned by device 3 and device 4 after it connects device 2, the connection will be created. The data sent by device 1 can be simultaneously received by other three devices, the data sent by device 2,device 3 and device 4 can be received by device 1.

5.2 Transparent Continuous Transmission

The module supports transparent continuous transmission, and the baud rate set under continuous transmission can be up to 19200bps. That is to say, the sender's baud rate is not higher than 19200bps, and the receiving side baud rate is not lower than the baud rate set by the receiver, no matter how large or even continuous data is received by the serial port. Flow, there will be no data loss phenomenon, realizing a transparent transmission in the true sense.

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6 Instruction Operation

No	Command	Description
1	Factory parameter configuration	See more details in Factory parameter configuration command
2	AT Instruction set	See more details in 4.11 AT command
3	Instruction format	All operating instruction formats are in the normal string input mode, no newline, no carriage return, non-hexadecimal For example, query baud rate, the format is AT+UART Set the baud rate in the format of AT + UART = 115200, 8, 1, 0

6.1 Command response

Returned value	Description
OK—AT+instruction:	Query response return
PARA SET:	Set response return
CMD ERROR	Command error
RANG ERR	Configuration range error
PARA ERR	Parameter configuration error
PARITY ERR	Serial parity bit error
STOP ERR	Serial stop bit error
DATA ERR	Serial data bit error
BAUD ERR	Serial baud rate error

6.2 AT Command

+++	Mode switching instruction
AT+RESET	Reset instruction
AT+FACTORY	Restore default settings
AT+VER	Query version information
AT+MAC	Query MAC address
AT+NAME	Query /Set device’s name
AT+UART	Query baud rate
AT+ROLE	Query/Set device’s role
AT+ADVIN	Query/Set advertising interval

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AT+CONIN	Query/Set connection interval
AT+ADVON	Open advertising
AT+ADVOFF	Close advertising
AT+TXPWR	Query/Set power
AT+RSSI	Acquire the RSSI of connected device
AT+DISCONN	Disconnection
AT+UUID	Query/Set UUID
AT+ADVDATA	Query/Set advertising data
AT+IBEACON	Query/Set IBEACON data
AT+SCAN	Scan advertising device
AT+CONNECT	Connect to specified device

6.3 Mode switching

Command	Description	Echo
+++	Mode switching	CMD IN，CMD OUT
This command is used to switch to the command mode after the device has been connected, or to enter the transparent transmission from the command mode. The transparent mode enters the command mode to generate the echo CMD IN, and enters the transparent mode from the command mode to generate the echo CMD OUT.		

6.4 Reset

Command	Description	Echo
AT+RESET	System Reset	Null
After executing this instruction, the module generates a reset operation.		

6.5 Restore the default settings

Command	Description	Echo
AT+ FACTORY	Restore the default settings	OK--AT+FACTORY: Factory Mode SUCCESS
After executing this command, the module will be restored to factory settings and will be valid after reset.		

6.6 Query version information

Command	Description	Echo

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AT+ VER	Query version information	OK--AT+VER: HV: V1.0，SV: V1.0
After executing this command, the module will echo the current software and hardware version number.		

6.7 Query MAC address

Command	Description	Echo
AT+ MAC	Query MAC address	如：OK--AT+MAC: 0x98072D8E79DE
After executing this instruction, the module will return to display the MAC address.		

6.8 Query / Set device's name

Command	Description	Echo
AT+ NAME	Query/Set device's name	Example: OK--AT+NAME: CdEbyte_MultiRole
Execute the command AT+NAME=CdEbyte_MultiRole to set the current module name, no more than 20 characters. Return PARA SET: CdEbyte_MultiRole after success.		

6.9 Query/Set UART configuration

Command	Description	Echo
AT+UART	Query/Set UART Configuration	Example: OK--AT+UART: 115200,8,1,0
Execute the command AT+UART=115200,8,1,0 to set the current module name. After success, return PARA SET: 115200,8,1,0. The first data represents the baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 128000, 230400, 256000, 460800, 921600; The second data represents the data bit: 5,6,7,8; The third data represents the stop bit: 0,1; The fourth data represents the check digit: 0(none)，1(even)，2(odd)).		

6.10 Query/Set device's role

Command	Description	Echo
AT+ROLE	Query/Set device's role	Example: OK--AT+ROLE: Normal
Execute the command AT+ROLE=0 to set the current module role to normal mode. After successful, return PARA SET: Normal； Execute the command AT+ROLE=1 to set the current module role to multi-role mode. After successful, return to PARA		

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SET: MultiRole.

6.11 Query/Set advertising interval

Command	Description	Echo
AT+ADVIN	Query/Set advertising interval	Example: OK--AT+ADVIN: 160
After executing the AT+ADVIN=160 command, it returns to PARA SET after successful: AT+ADVIN=160. Among them, the broadcast time = set parameter * 0625ms, if set 160, the broadcast gap is 160 * 0625ms = 100ms. Setting range: 12 ~ 16000.		

6.12 Query/Set connection interval

Command	Description	Echo
AT+CONIN	Query/Set connection interval	Example: OK--AT+CONIN: 200,200,0,1000
Execute the command AT+CONIN=200,200,0,1000 to set the current module name. After success, return PARA SET: 200,200,0,1000. The first data represents the minimum connection gap: 6 ~ 3200, connection gap time = set parameter * 1.25ms, if the setting parameter is 200, the connection gap time = 200 * 1.25ms = 250ms; The second data represents the maximum connection gap: 6 ~ 3200, the same as the minimum connection gap setting; The third data represents a delayed event: 0 ~ 499; The fourth data represents the connection timeout period: 10~3200.		

6.13 Open advertising

Command	Description	Echo
AT+ADVON	Open advertising	Example: OK--AT+ADVON: Advertising...
After executing this command, the module will turn on the broadcast. In Normal mode, if this device is connected, the broadcast will not be executed after executing this command. In MultiRole mode, if the number of connected devices of this device reaches 3, the broadcast will not be executed after this command is executed.		

6.14 Close advertising

Command	Description	Echo
AT+ADVOFF	Close advertising	Example: OK--AT+ADVOFF: Advert closeing...
After executing this command, the module will turn off the broadcast.		

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6.15 Query/Set power

Command	Description	Echo
AT+TXPWR	Query/Set power	Example: OK--AT+TXPWR: 0dBm
Execute the command AT+TXPWR=2dbm to set the transmit power of the current module. After successful, return to PARA SET: AT+TXPWR=2dbm. Power range: 2dbm, 1dbm, 0dbm, -3dbm, -6dbm, -9dbm, -12dbm, -15dbm, -18dbm, -21dbm.		

6.16 Acquire the RSSI of connected devices

Command	Description	Echo
AT+RSSI	Acquire the RSSI of connected devices	Example: OK--AT+RSSI: -64dBm
After executing this instruction, the module will return the connected device RSSI. This command is valid only after the device has been connected.		

6.17 Disconnection

Command	Description	Echo
AT+DISCONN	Disconnection	Example: PARA SET: Connected to: 0 Disconnected!
After executing this command, the module will disconnect the device.		

6.18 Query/Set UUID

Command	Description	Echo
AT+UUID	Query/Set UUID	Example: OK--AT+UUID: 0,0xFFF0 1,0xFFF1 2,0xFFF2 3,0xFFF3
Execute the command AT+UUID=0, FFF0 sets the current module name, and returns PARA SET after success: AT+UUID=0, FFF0. The first parameter sets the first UUID, which ranges from 0 to 3; The second parameter is the set UUID number. Please refer to the Bluetooth specification protocol to set the corresponding UUID.		

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6.19 Query/Set advertising data

Command	Description	Echo
AT+ADVDATA	Query/Set advertising data	Example: OK--AT+ADVDATA: 0x0A00010203040506070809
After executing AT+ADVDATA=0A00010203040506070809, the module will return PARA SET: 0x0A00010203040506070809. The above parameter 0A represents the length of the data to be input, and 00010203040506070809 represents the data to be input. The input data is entered in hexadecimal format. For example, 00 stands for 0x00, 01 stands for 0x01, and 02 stands for 0x02. The data length does not exceed 23 bytes.		

6.20 Query/Set IBEACON data

Command	Description	Echo
AT+IBEACON	Query/Set IBEACON data	Example: OK--AT+ADVOFF: Advert closeing...
After executing AT+IBEACON=, the module will return PARA SET: 0x020106061AFF4C000215B9407F30F5F8466EAFF925556B57FE6D0049000AC5. The character length does not exceed 31 bytes. The parameters under this command should be in accordance with the format specified by Apple's official IBEACON protocol.		

6.21 Scan advertising device

Command	Description	Echo
AT+SCAN	Scan advertising device	Example: OK--AT+SCAN: Discovering with AT_SCAN... Device 1: 0xDE798E2D0798 • • • Device n: 0xxxxxxxxxxx
If a device is broadcasting, a scan to the device's MAC address will be printed. The broadcast scanned by this instruction must be the same type of broadcast as the device service. If the service number of the module is FFF0, only the device with the service number FFF0 can be scanned, and other service numbers cannot be scanned.		

6.22 Connect to specified device

Command	Description	Echo
AT+CONNECT=<Value>	Connect to specified device. <Value> specifies the serial number of the device	CONNECT OK

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After executing this command, the module will return to display the connection success message CONNECT OK. When the connection is successfully established, the IOID_8 pin will be pulled low and when disconnected, DIO_8 will be set high.

7 Basic operation

7.1 Hardware design

- It is recommended to use a DC stabilized power supply. The power supply ripple factor is as small as possible and the module needs to be reliably grounded.
- Please pay attention to the correct connection of the positive and negative poles of the power supply, reverse connection may cause permanent damage to the module.
- Please check the power supply to ensure that between the recommended supply voltage, if exceeding the maximum, the module will be permanently damaged;
- Please check the stability of the power supply. Voltage can not fluctuate greatly and frequently;
- When designing the power supply circuit for the module, it is often recommended to reserve more than 30% of the margin, so the whole machine is beneficial for long-term stable operation;
- The module should be as far away as possible from the power supply, transformers, high-frequency wiring and other parts with large electromagnetic interference;
- Bottom Layer High-frequency digital routing, high-frequency analog routing, and power routing must be avoided under the module. If it is necessary to pass through the module, assume that the module is soldered to the Top Layer, and the copper is spread on the Top Layer of the module contact part(well grounded), it must be close to the digital part of the module and routed in the Bottom Layer;
- Assuming the module is soldered or placed over the Top Layer, it is wrong to randomly route over the Bottom Layer or other layers, which will affect the module's spurs and receiving sensitivity to varying degrees;
- It is assumed that there are devices with large electromagnetic interference around the module that will greatly affect the performance. It is recommended to keep them away from the module according to the strength of the interference. If necessary, appropriate isolation and shielding can be done;
- Assume that there are traces with large electromagnetic interference (high-frequency digital, high-frequency analog, power traces) around the module that will greatly affect the performance of the module. It is recommended to stay away from the module according to the strength of the interference.If necessary, appropriate isolation and shielding can be done;
- If the communication line uses a 5V level, a 1k-5.1k resistor must be connected in series (not recommended, there is still a risk of damage);
- Try to stay away from some physical layers such as TTL protocol at 2.4GHz , for example: USB3.0;
- The mounting structure of antenna has a great influence on the performance of the module. It is necessary to ensure that the antenna is exposed, preferably vertically upward. When the module is mounted inside the case, use a good antenna extension cable to extend the antenna to the outside;
- The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.

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7.2 Programming

- The core of this module is CC2630, its driving method is completely equivalent to CC2630, the user can operate according to the CC2630 chip manual (see CC2630 manual for details);
- It is recommended to use the Code Composer Studio (CCS) Integrated Development Environment (IDE).

8 FAQ

8.1 Communication range is too short

- The communication distance will be affected when obstacle exists;
- Data lose rate will be affected by temperature, humidity and co-channel interference;
- The ground will absorb and reflect wireless radio wave, so the performance will be poor when testing near ground;
- Sea water has great ability in absorbing wireless radio wave, so performance will be poor when testing near the sea;
- The signal will be affected when the antenna is near metal object or put in a metal case;
- Power register was set incorrectly, air data rate is set as too high (the higher the air data rate, the shorter the distance);
- The power supply low voltage under room temperature is lower than recommended value, the lower the voltage, the lower the transmitting power;
- Due to antenna quality or poor matching between antenna and module.

8.2 Module is easy to damage

- Please check the power supply source, ensure it is between the recommended supply voltage, voltage higher than the maximum will damage the module.
- Please check the stability of power source, the voltage cannot fluctuate too much.
- Please make sure antistatic measure are taken when installing and using, high frequency devices have electrostatic susceptibility.
- Please ensure the humidity is within limited range, some parts are sensitive to humidity.
- Please avoid using modules under too high or too low temperature.

8.3 BER(Bit Error Rate) is high

- here are co-channel signal interference nearby, please be away from interference sources or modify frequency and channel to avoid interference;
- Poor power supply may cause messy code. Make sure that the power supply is reliable;
- The extension line and feeder quality are poor or too long, so the bit error rate is high.

9 Production guidance

9.1 Reflow soldering temperature

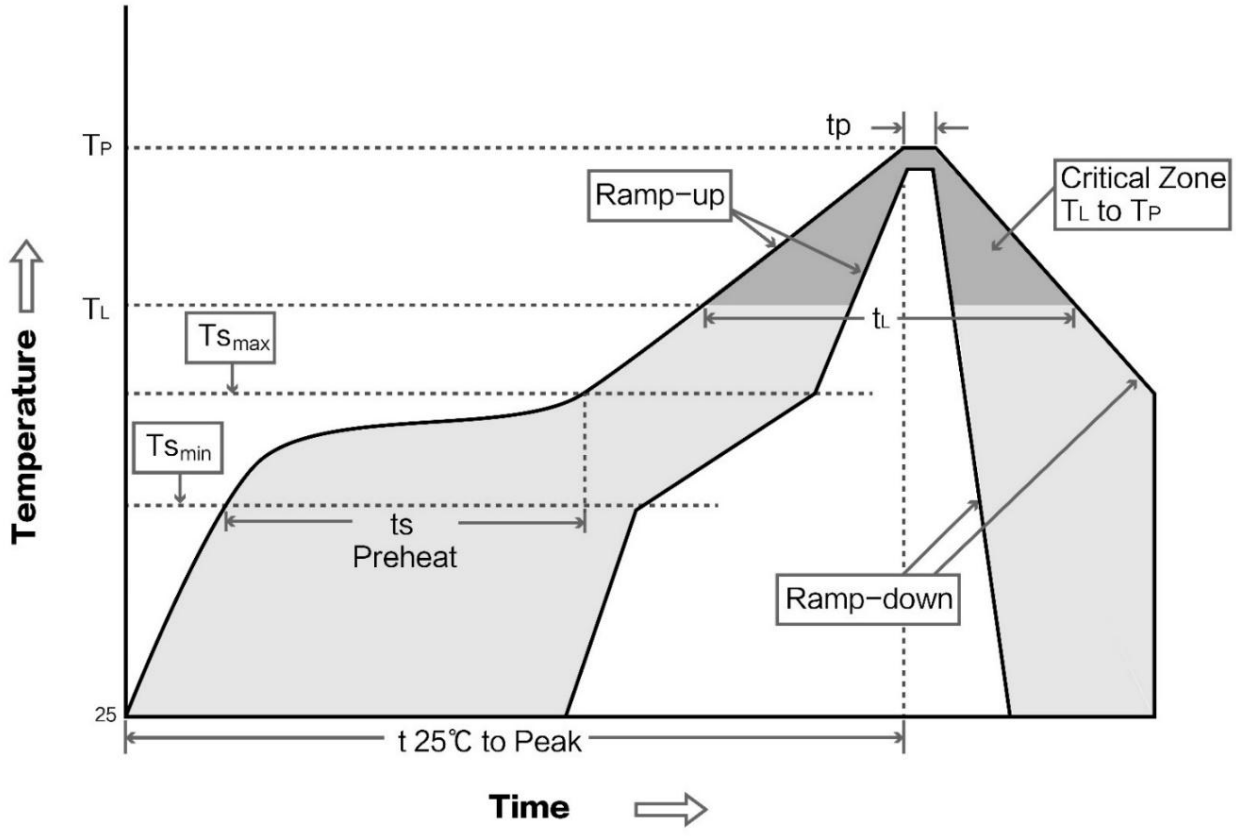
Profile Feature	Curve characteristics	Sn-Pb Assembly	Pb-Free Assembly

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Solder Paste	Solder paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min （Tsmin）	Min preheating temp.	100℃	150℃
Preheat temperature max (Tsmax)	Max preheating temp.	150℃	200℃
Preheat Time (Tsmin to Tsmax)(ts)	Preheating time	60-120 sec	60-120 sec
Average ramp-up rate(Tsmax to Tp)	Average ramp-up rate	3℃/second max	3℃/second max
Liquidous Temperature (TL)	Liquid phase temp	183℃	217℃
Time（tL）Maintained Above（TL）	Time below liquid phase line	60-90 sec	30-90 sec
Peak temperature（Tp）	Peak temp	220-235℃	230-250℃
Aveage ramp-down rate（Tp to Tsmax）	Average ramp-down rate	6℃/second max	6℃/second max
Time 25℃ to peak temperature	Time to peak temperature for 25℃	6 minutes max	8 minutes max

9.2 Reflow soldering curve



10 E72 series

Model	IC	Frequency Hz	Tx power dBm	Distance km	Air data rate bps	Package form	Size mm	Antenna

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E72-2G4M23S1A	CC2630	2.4G	23	1.5	-	SMD	17.5 * 33.5	PCB/IPEX
E72-2G4M05S1A	CC2630	2.4G	5	0.5	-	SMD	17.5 * 28.7	PCB/IPEX
E72-2G4M02S2B	CC2640	2.4G	2	0.3	BLE 5.1	SMD	14 * 23	PCB/IPEX
E72-2G4M05S1B	CC2640	2.4G	5	0.5	BLE 4.2	SMD	17.5 * 28.7	PCB/IPEX

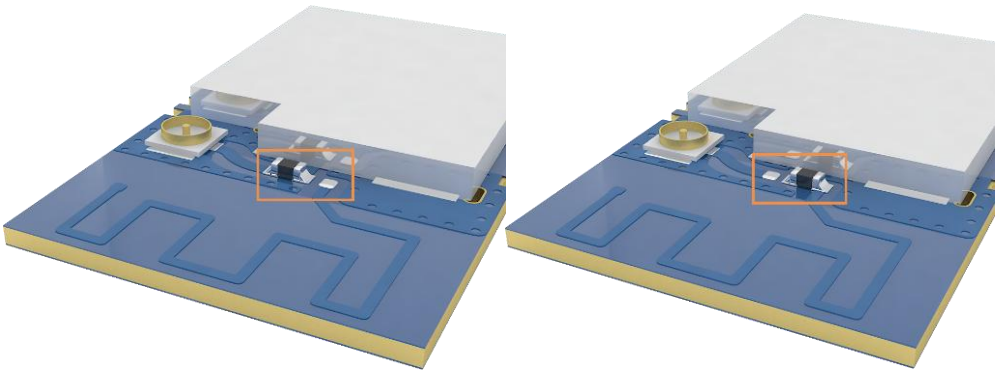
11 Antenna recommendation

11.1 Recommendation

The antenna is an important role in the communication process. A good antenna can largely improve the communication system. Therefore, we recommend some antennas for wireless modules with excellent performance and reasonable price.

Model No.	Type	Frequency Hz	Interface	Gain dBi	Height	Cable	Function feature
TX2400-NP-5010	Flexible Antenna	2.4G	IPEX	2	50*10mm	-	FPC soft antenna
TX2400-XP-150	Sucker antenna	2.4G	SMA-J	3.5	15cm	150cm	High Gain
TX2400-JK-20	Rubber antenna	2.4G	SMA-J	3	200mm	-	Flexible&ommidirectional
TX2400-JK-11	Rubber antenna	2.4G	SMA-J	2.5	110mm	-	Flexible&ommidirectional
TX2400-JZ-3	Rubber antenna	2.4G	SMA-J	2	30mm	-	Short straight &omnidirectional

11.2 Antenna selection



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The onboard PCB antenna is enabled by default at the factory, If users enable the IPEX antenna, change the 0R resistor to the above figure (right).and the 0R resistor is shown in the figure above (left).

Revision history

Version	Date	Description	Issued by
1.00	2018/8/30	Initial version	huaa
1.10	2018/11/08	Model No. split	huaa
1.20	2021-2-20	The image processing	Linson
1.3	2023-03-30	Error corrected	Bin
1.4	2023-11-27	Error corrected	Bin

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