E104-BT5040U User manual

nRF52840 USB-Type Bluetooth Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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1. Introduction....

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1.1 Introduction



E104-BT5040U is a small Bluetooth wireless module with USB interface designed and produced by Ebyte; the function and pin of the module correspond to the official Nordic nRF52840 USB Dongle module (the relevant schematic diagram can be downloaded on the official website of Nordic). It comes with a high-performance PCB antenna and uses the Bluetooth Low Energy (BLE) SOC solution.

E104-BT5040U uses Nordic imported genuine nRF52840 RF chip which supports Bluetooth 4.2 and Bluetooth 5.0; the chip comes with high-performance ARM CORTEX-M4 core, 32M+32.768kHz industrial-grade crystal oscillator, and has UART, I2C, SPI, ADC, DMA Rich peripheral resources such as, PWM, etc.; nRF52840 leads to most of the I/O ports (please check the pin definitions for details), which is convenient for users to carry out multi-directional development.

E104-BT5040U is a hardware platform with factory program. See below for specific usage.

1.2 Features

- Under ideal conditions, the communication distance can reach 250m;
- The maximum transmit power is 6mW, and the software is multi-level adjustable;
- Support the global license-free ISM 2.4GHz frequency band;
- Equipped with 32.768kHz clock crystal oscillator;
- Built-in high-performance low-power ARM@Cortex-M4 processor;
- Sufficient memory: 1024kB Flash, 256kB RAM;
- USB power supply, USB has ESD protection;
- Industrial-grade standard design, supporting long-term use at -40℃~85℃;
- PCB antenna without external antenna.

1.3 Applications

- Smart home and industrial sensors, etc.;
- Security system, positioning system;
- Wireless remote control, UAV;
- Wireless game remote control;
- Healthcare products;
- Wireless voice
- Automotive industry applications.

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2. Parameters

2.1 Limit Parameters

The main parameters	Value		Notice
	Min	Max	
USB power supply voltage (V)	0	5.5	Over 5.5V will permanently burn the module
VBUS power supply hole (V)	0	5.5	Over 5.5V will permanently burn the module
VDD power supply hole power supply (V)	0	3.6	Over 3.6V will permanently burn the module
Blocking power (dBm)	-	10	It is less likely to burn when used at close range
Working temperature (℃)	-40	+85	Industrial grade

2.2 Working Parameters

Description		Value			Notes
		Min	Typical	Max	
Working voltage (V)		4.35	5	5.5	USB/VBUS power supply
Communication level (V)		0	3.3	3.6	Using 5V level is risky to burn
Working temperature (℃)		-40	-	+85	Industrial design
Working frequency (MHz)		2360	2402	2500	Support ISM frequency band
TX	TX only run current (DCDC, 3V) PRF =+8 dBm（mA）		17.05		
	TX only run current (DCDC, 3V) PRF =+4 dBm（mA）		12.68		
	TX only run current (DCDC, 5V, REG0 out = 3.3 V)PRF = 0dBm（mA）		7.25		
	TX only run current (DCDC, 3V)PRF = 0dBm（mA）		7.63		
	TX current (3V) 1Mbps BLE measured from VBAT with PRF=9dBm（mA）		32		
RX	RX only run current (DCDC, 3V) 1Mbps / 1Mbps BLE（mA）		7.71		
	RX only run current (DCDC, 3V) 2Mbps / 2Mbps BLE（mA）		8.27		
Max TX Power（dBm）		7.5	8	8.5	
Rx Sensitivity（dBm）		-103dBm@BLE 125kbps			Long range mode
		-95dBm@BLE 1Mbps			

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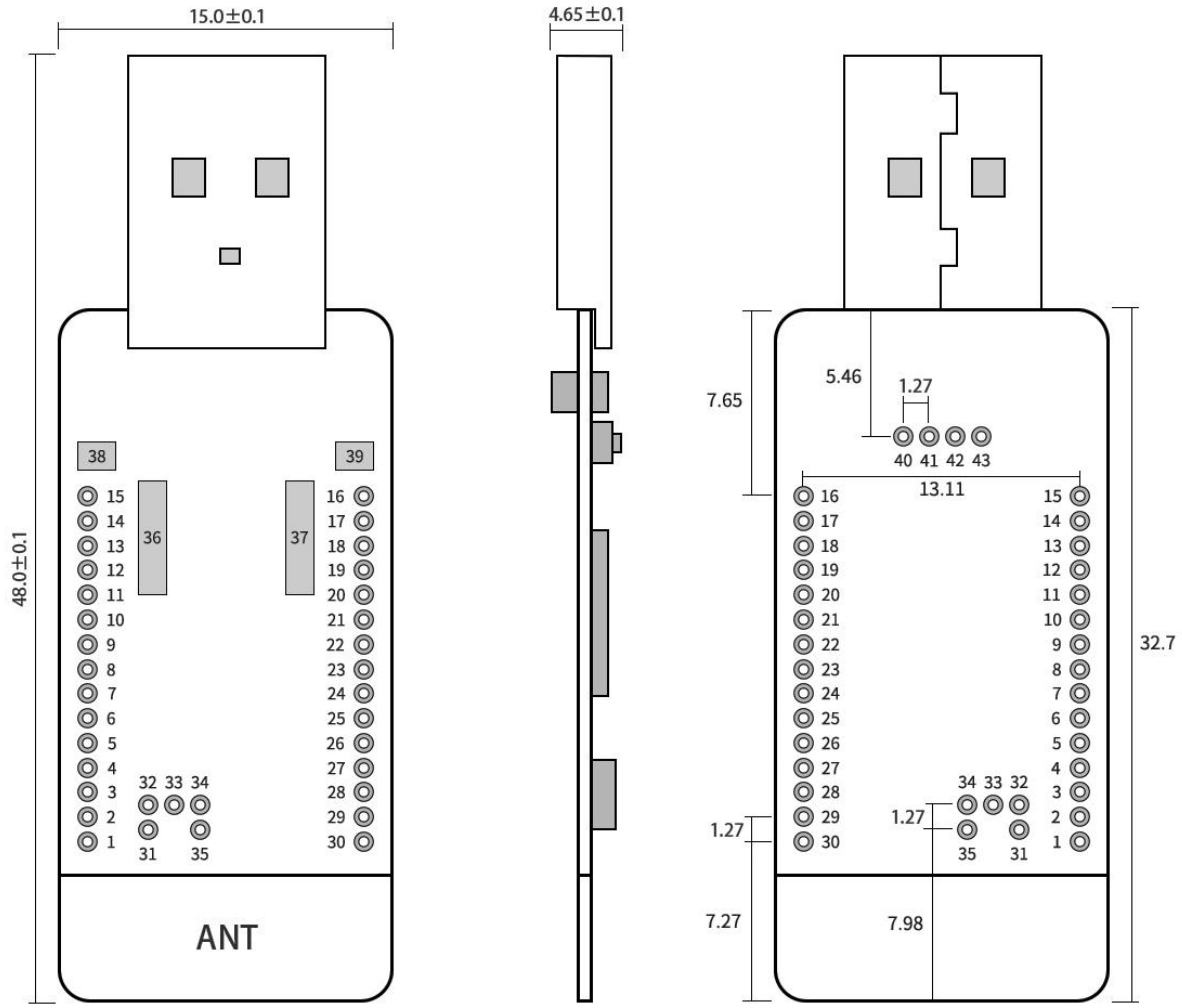
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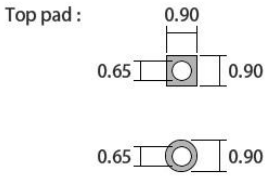
Description	Value	Notes
Reference distance	250m	Clear weather, open location, antenna height 2.5 meters, air rate 1Mbps
Crystal frequency	32MHz/32.768kHz	
supporting agreement	BLE4.2/5.0	
Power supply	USB/1.27mm 孔	
Interface method	USB/1.27mm 孔	
IC full name	nRF52840-QIAAC0/aQFN ™ 73	
FLASH	1024kB	
RAM	256kB	
Kernel	ARM@ Cortex ® -M4	
Dimensions	59*18mm	Housing and ports size counted
Antenna Type	PCB Antenna	

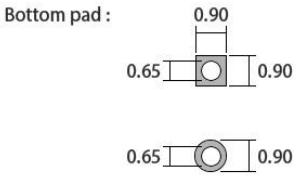
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3. Dimensions and Pin Definition







weight : 7.1±1.0g
Pad quantity : 43
Unit: mm

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Pin No.	Name	Direction	Functions
1	GND	—	Power Ground
2	P0.10	J24	See nRF52840 chipset datasheet
3	P0.09	L24	See nRF52840 chipset datasheet
4	P1.04	U24	See nRF52840 chipset datasheet
5	P1.02	W24	See nRF52840 chipset datasheet
6	P1.00	AD22	See nRF52840 chipset datasheet
7	P1.07	P23	See nRF52840 chipset datasheet
8	P1.01	Y23	See nRF52840 chipset datasheet
9	P0.24	AD20	See nRF52840 chipset datasheet
10	P0.22	AD18	See nRF52840 chipset datasheet
11	P0.20	AD16	See nRF52840 chipset datasheet
12	P0.17	AD12	See nRF52840 chipset datasheet
13	P0.15	AD10	See nRF52840 chipset datasheet
14	P0.13	AD8	See nRF52840 chipset datasheet
15	P0.14	AC9	See nRF52840 chipset datasheet
16	VBUS	USB5V	This interface cannot be powered at the same time as the USB interface, the maximum is 5.5V
17	VDD	—	Chip power supply pin, maximum 3.6V, cannot be supplied with USB power supply at the same time
18	GND	—	Power Ground
19	P0.04	J1	See nRF52840 chipset datasheet
20	P0.26	G1	See nRF52840 chipset datasheet
21	P0.11	B19	See nRF52840 chipset datasheet
22	P0.31	A8	See nRF52840 chipset datasheet
23	P0.29	A10	See nRF52840 chipset datasheet
24	P0.02	A12	See nRF52840 chipset datasheet
25	P1.15	A14	See nRF52840 chipset datasheet
26	P1.13	A16	See nRF52840 chipset datasheet
27	P1.11	B19	See nRF52840 chipset datasheet
28	P1.10	A20	See nRF52840 chipset datasheet
29	GND	—	Power Ground
30	GND	—	Power Ground
31	V	VDD	Download interface, try to avoid USB and VDD supplying power at the same time
32	R	RESET	
33	D	SWDIO	
34	C	SWCLK	
35	G	GND	
36	RST	RESET	Reset button.
37	SW	P1.06	function button
38	LED1	RGB LED	R (red): P0.08; G (green): P1.09; B (blue): P0.12;
39	LED	LED	P0.06
40	G	GND	USB Test Port
41	D+		
42	D-		

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43	V	VBUS	USB Test Port

4. Development

4.1 Development Tool

No.	Item	Notes
1	Burn Firmware	1.The module is embedded with ARM MCU. For program downloading, please use the J-LINK downloader. Any other serial port or JTAG、ISP、ICP are unavailable to download. The burn firmware needs to be completed in two parts. Since the protocol stack provided by NORDIC is not loaded in the program, in the second development, you need to use the official burning tool nRFgo studio to burn the protocol stack, and then use nRFgo studio to burn. The hex of the application code; you can also use the official burning tool nRFgo studio to burn the protocol stack, and then download it with IAR or KEIL. 
2	Testing Board	Testing board is not available.

4.2Factory Default Firmware

The factory firmware of E104-BT5040U is only DFU firmware (device firmware upgrade).

Main features of DFU:

Update application, SoftDevice and bootloader

Certification update

Downgrade prevention

Hardware compatibility verification

Multiple transmission methods: (BLE, UART, USBD)

Support application with or without SoftDevice

Support the replacement of SoftDevice-dependent firmware with SoftDevice-independent firmware

Support the replacement of SoftDevice-independent firmware with SoftDevice-dependent firmware

The factory DFU firmware is compiled with the sample program "nRF5SDK160098a08e2\examples\dfu\open_bootloader" in the SDK16.0 firmware (nRF5SDK160098a08e2.zip).

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4.3The Modified Codes

4.3.Public Key(dfu_public_key.c)

```
#ifdef NRF_DFU_DEBUG_VERSION

    /** @brief Public key used to verify DFU images */
    __ALIGN(4) const uint8_t pk[64] =
    {
        0x1b, 0x0c, 0xae, 0x9f, 0x22, 0x80, 0x60, 0xa1, 0x85, 0xa0, 0xba, 0x18, 0xe7, 0xaf, 0xfc, 0x94, 0x63, 0xfb, 0xd2, 0x58, 0xac,
    0xde, 0x1c, 0xa0, 0x1d, 0x2a, 0xd2, 0x0d, 0x25, 0x72, 0x9f, 0x37,
        0x57, 0x00, 0xc4, 0xf6, 0x0b, 0x92, 0x21, 0x44, 0x85, 0x70, 0x5d, 0xbe, 0x62, 0x0d, 0x9e, 0x09, 0x82, 0x02, 0xf8, 0xec,
    0x3b, 0xcd, 0x06, 0xb5, 0xc9, 0x68, 0xc7, 0xff, 0x2e, 0xe7, 0x95, 0x4a
    };

    #else
/** @brief Public key used to verify DFU images */
__ALIGN(4) const uint8_t pk[64] =
{
    0xc2, 0xdf, 0x7a, 0x7f, 0x4a, 0x64, 0xcd, 0x56, 0x63, 0x77, 0x82, 0x94, 0x49, 0x70, 0xe8, 0x1b, 0x8f, 0x69, 0x31, 0xd7, 0xcb,
0x71, 0x0f, 0x2d, 0xcc, 0x03, 0x7d, 0x6f, 0x26, 0x14, 0x1d, 0x32,
    0x55, 0xa2, 0x2f, 0xea, 0x7e, 0x1d, 0xca, 0x52, 0xa0, 0x86, 0x9f, 0xee, 0x16, 0x43, 0xc8, 0x8e, 0x3f, 0xbc, 0xcc, 0xa3, 0x2b,
0x36, 0xe1, 0x0e, 0xdb, 0xeb, 0x6f, 0x7b, 0x3c, 0x79, 0x67, 0x55
};
#endif
```

4.3.2 Disable Hash value check function

File Routing：“nRF5SDK160098a08e2\components\libraries\bootloader\dfu\nrf_dfu_validation.c”. **Disable below codes.**

```
err_code = nrf_crypto_ecdsa_verify(&m_verify_context,
                                                    &m_public_key,
                                                    m_init_packet_hash,
                                                    hash_len,
                                                    m_signature,
                                                    sizeof(m_signature));
//      if (err_code != NRF_SUCCESS)
//      {
//          NRF_LOG_ERROR("Signature failed (err_code: 0x%x)", err_code);
//          NRF_LOG_DEBUG("Signature:");
//          NRF_LOG_HEXDUMP_DEBUG(m_signature, sizeof(m_signature));
//          NRF_LOG_DEBUG("Hash:");
//          NRF_LOG_HEXDUMP_DEBUG(m_init_packet_hash, hash_len);
```

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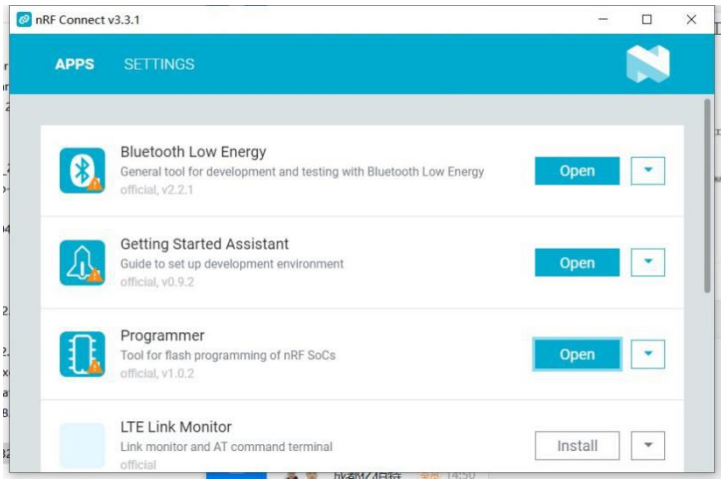
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```
//              NRF_LOG_DEBUG("Public Key:");
//              NRF_LOG_HEXDUMP_DEBUG(pk, sizeof(pk));
//              NRF_LOG_FLUSH();
//
//              return NRF_DFU_RES_CODE_INVALID_OBJECT;
//      }
```

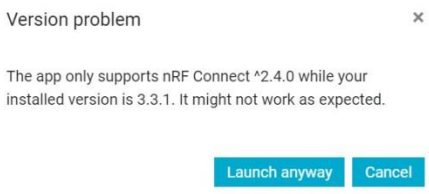
4.4 DFU Guide

There are many ways to use DFU, such as upgrading through APP, UART upgrading, etc. Here we only introduce how to use E104-BT5040U and nrf connect.

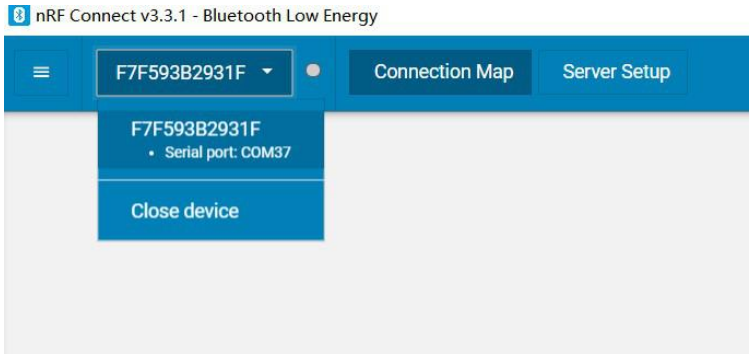
The version of nrf connect in the document is V3.3.1. Start the nrf connect software, as shown in the figure below:



Take the first item as an example (Bluetooth Low Energy). Select "Open" to display the interface as shown in the figure below, and select "Launch anyway". Start the Bluetooth Low Energy APP.



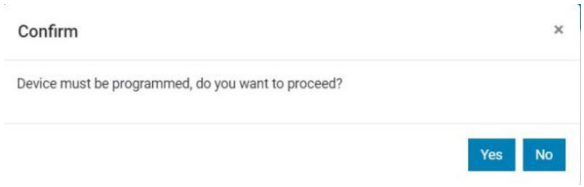
Select the virtual serial port corresponding to E104-BT5040U.



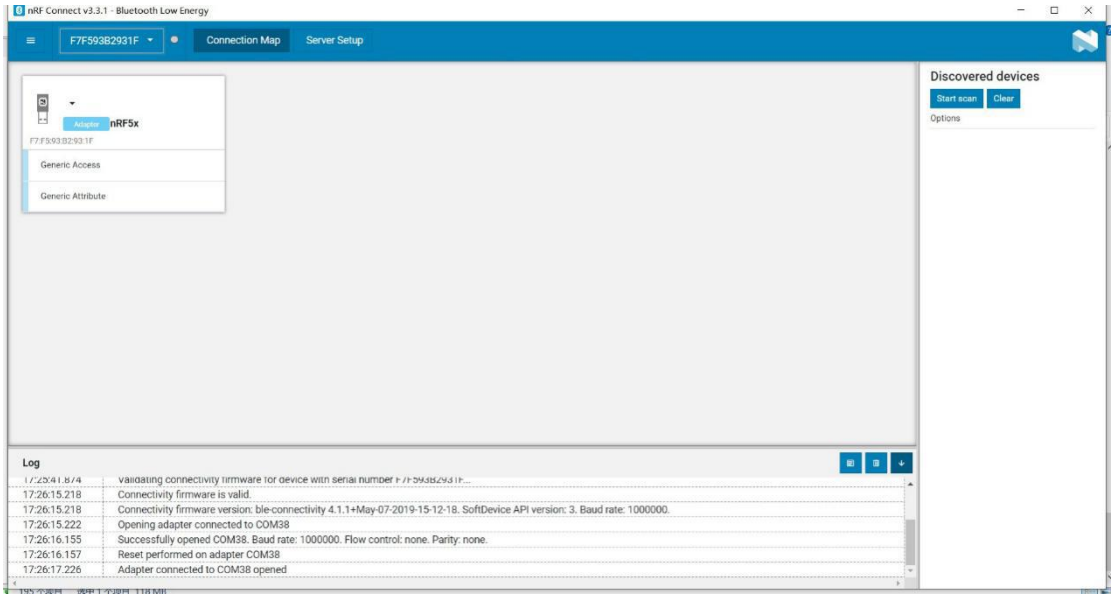
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E104-BT5040U has no application firmware when it is powered on for the first time. The app will prompt the user to program the module, select "Yes" and wait for the firmware update to complete.



After the firmware update is complete, the following page appears. At this time, you can use the bluetooth low energy function normally.



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5. Hardware Notice

5.1 Hardware Notice

- It is recommended to use a DC stabilized power supply to supply power to the module, and the power ripple coefficient is as small as possible, and the module needs to be grounded reliably;
- 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 it is within the recommended supply voltage. If it exceeds Max, it will cause permanent damage to the module;
- Please check the stability of the power supply, the voltage should 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, and the whole machine is conducive to long-term stable operation;
- The module should be as far away as possible from the power supply, transformer, high-frequency wiring and other parts with large electromagnetic interference;
- High-frequency digital wiring, high-frequency analog wiring, and power wiring must avoid the bottom of the module. If it is necessary to pass under the module, assume that the module is soldered to the Top Layer, and the top layer of the contact part of the module is covered with copper (all copper And well grounded), it must be close to the digital part of the module and routed in the Bottom Layer;
- Assuming that the module is soldered or placed on the Top Layer, it is also wrong to randomly route the wires on the Bottom Layer or other layers, which will affect the stray and receiving sensitivity of the module to varying degrees;
- Assuming that there are components with large electromagnetic interference around the module, it will greatly affect the value of the module. According to the intensity of the interference, it is recommended to stay away from the module. If the situation permits, proper isolation and shielding can be done;
- Assuming that there are traces with large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power wiring), it will greatly affect the value of the module. According to the intensity of the interference, it is recommended to stay away from the module. Isolation and shielding;
- If the communication line uses 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 part of the physical layer that is also 2.4GHz TTL protocol, for example: USB3.0;
- The antenna installation structure has a great influence on the value of the module. Make sure that the antenna is exposed, preferably vertically upward. When the module is installed inside the case, a high-quality antenna extension cable can be used to extend the antenna to the outside of the case;
- The antenna must not be installed inside the metal shell, which will greatly reduce the transmission distance.
- It is recommended to add a 200R protection resistor to the RXD/TXD of the external MCU.

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6. FAQ

6.1 Communication range is too short

- When there is a straight line communication obstacle, the communication distance will be attenuated accordingly;
- Temperature, humidity, and co-frequency interference will increase the communication packet loss rate;
- The ground absorbs and reflects radio waves, and the test results near the ground are poor;
- Sea water has a strong ability to absorb radio waves, so the seaside test results are poor;
- If there is a metal object near the antenna or placed in a metal shell, the signal attenuation will be very serious;
- The power register setting is wrong, the air speed setting is too high (the higher the air speed, the closer the distance);
- The low voltage of the power supply at room temperature is lower than the recommended value, the lower the voltage, the lower the power output;
- The matching degree of the antenna and the module is poor or the quality of the antenna itself is problematic.

6.2 Module is easy to damage

- Please check the power supply to ensure that it is within the recommended power supply voltage. If it exceeds Max, the module will be permanently damaged;
- Please check the stability of the power supply, the voltage should not fluctuate greatly and frequently;
- Please ensure anti-static operation during installation and use, and high-frequency components are electrostatically sensitive;
- Please ensure that the humidity during installation and use should not be too high, and some components are humidity sensitive devices;
- If there is no special requirement, it is not recommended to use it at too high or too low temperature.

6.3 Error Rate is High

- There is co-frequency signal interference nearby, stay away from the interference source or modify the frequency and channel to avoid interference;
- The clock waveform on SPI is not standard, check whether there is interference on the SPI line, and the SPI bus line should not be too long;
- Unsatisfactory power supply may also cause garbled codes. Ensure the reliability of the power supply;
- Poor or too long extension cables and feeders can also cause high bit error rates.

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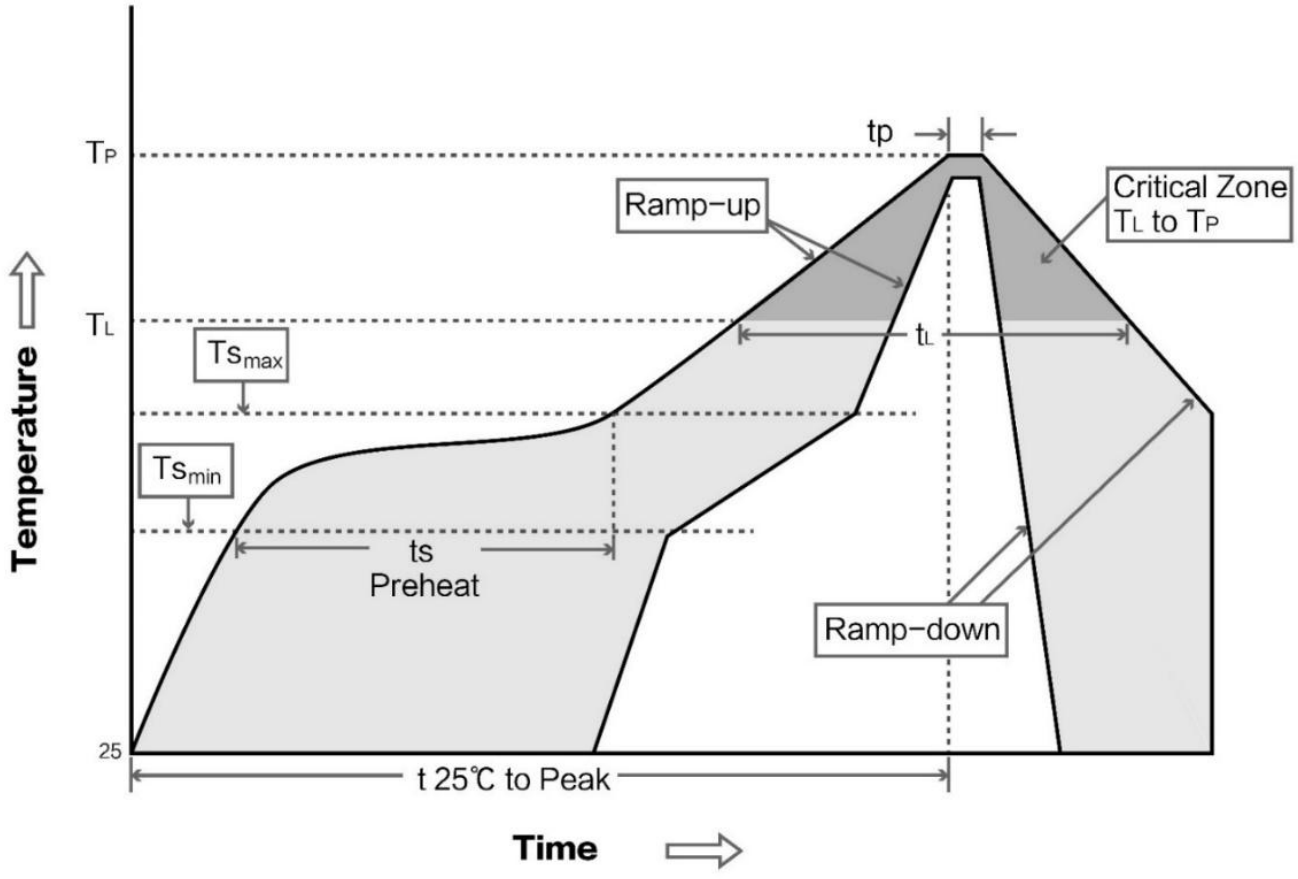
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7. Welding Guide

7.1 Reflow Temperature

Profile Feature	曲线特征	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	锡膏	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min （Tsmin）	最小预热温度	100℃	150℃
Preheat temperature max (Tsmax)	最大预热温度	150℃	200℃
Preheat Time (Tsmin to Tsmax)(ts)	预热时间	60-120 sec	60-120 sec
Average ramp-up rate(Tsmax to Tp)	平均上升速率	3℃/second max	3℃/second max
Liquidous Temperature (TL)	液相温度	183℃	217℃
Time（tL）Maintained Above（TL）	液相线以上的时间	60-90 sec	30-90 sec
Peak temperature（Tp）	峰值温度	220-235℃	230-250℃
Aveage ramp-down rate（Tp to Tsmax）	平均下降速率	6℃/second max	6℃/second max
Time 25℃ to peak temperature	25℃到峰值温度的时间	6 minutes max	8 minutes max

7.2 Reflow Curve



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8. Revision history

Version	Date	Description	Issued by
1.0	2020-11-20	Initial Version	Ren

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