E18-2G4Z27SP User Manual

CC2530 2.4GHz 500mW ZigBee Wireless Module

Chengdu Ebyte Electronic Technology Co.,Ltd.

Contents

1. Overview

1.1 Brief Introduction

E18-2G4Z27SP is a small size 2.4GHz ZigBee wireless module designed and produced by Ebyte, SMD, PCB on-board antenna, transmission power 500mW, pin spacing 1.27mm, suitable for a variety of application scenarios (especially smart Home).

E18-2G4Z27SP adopts the original imported CC2530 radio frequency chip from Texas Instruments (TI). The chip integrates 8051 single-chip MCU and wireless transceiver, and built-in PA+LNA, which greatly expands the communication distance and improves communication stability. And suitable for ZigBee design and 2.4GHz IEEE 802.15.4 protocol.

The module leads to all the IO ports of the single-chip MCU, which can be used for multi-directional development.

1.2 Features

- Built-in PA+LNA, maximum transmit power 500mW, realize long-distance ZigBee transmission;
- Under ideal conditions, the communication distance can reach 1600m;
- Built-in ZigBee protocol stack;
- Support direct drive of peripherals such as ADC, PWM and GPIO;
- Built-in 32.768kHz clock crystal oscillator;
- Support the global license-free ISM 2.4GHz frequency band;
- Abundant resources, 256kB FLASH, 8kB RAM;
- High-performance low-power 8051 microcontroller core with code prefetching;
- Support 2.0～3.6V power supply, power supply greater than 3.3V can guarantee the best performance;
- Industrial standard design, supporting long-term use at -40～+85℃;
- The onboard antenna PCB antenna, the built-in antenna does not require an external antenna.

1.3 Applications

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

2. Specification and Parameter

2.1 Limit parameter

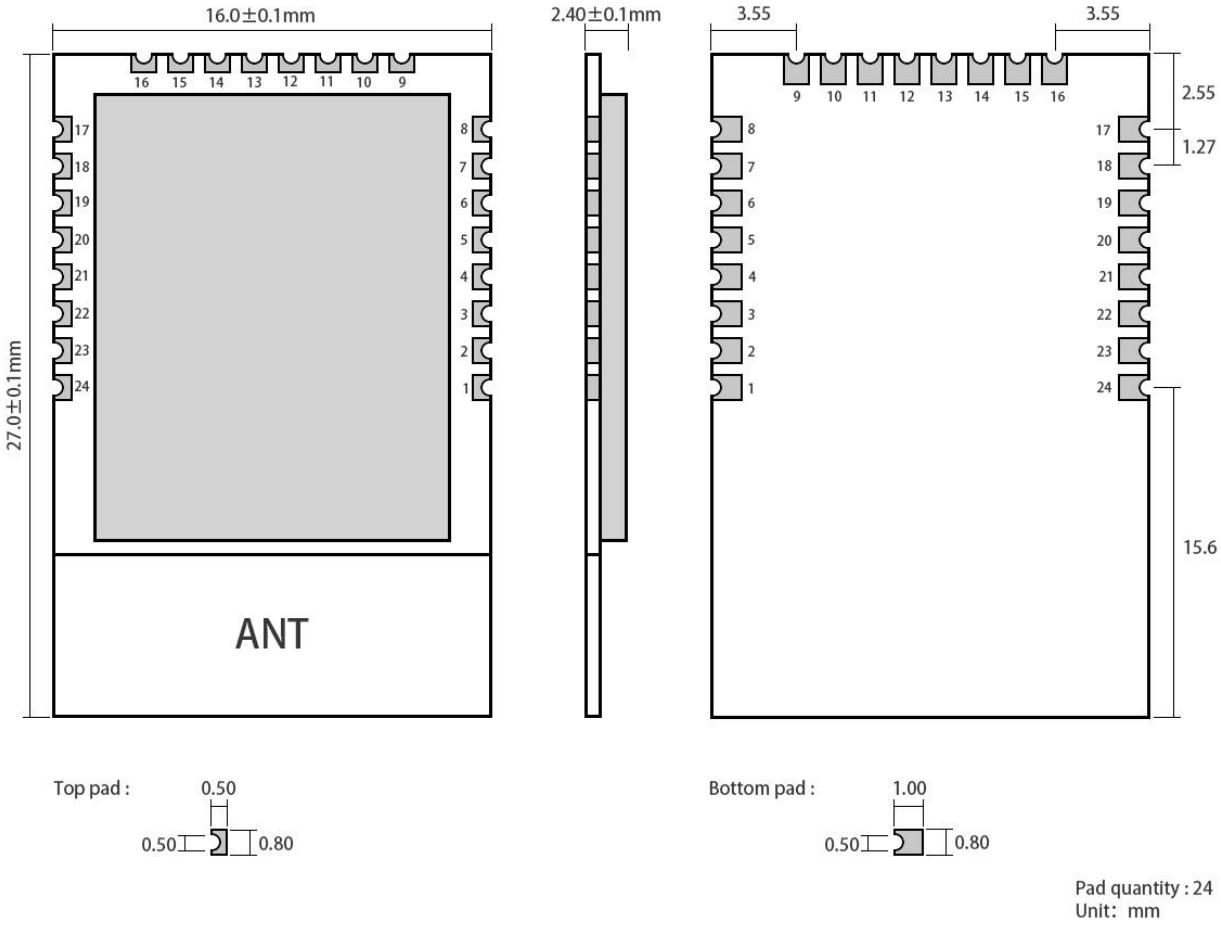
Main parameter	Performance		Remark
	Min.	Max.	
Power supply（V）	0	3.6	Over 3.6V will permanently burn the module
Blocking power（dBm）	-	10	It is less likely to burn when used at close range
Operating temperature（℃）	-40	+85	Industrial grade

2.2 Operating parameter

Main parameter		Performance			Remark
		Min.	Typ.	Max.	
Operating voltage（V）		2.5	3.3	3.6	≥3.3V ensures output power
Communication level（V）			3.3		For 5V TTL, it may be at risk of burning down
Operating temperature（℃）		-40	-	+85	Industrial design
Operating frequency（MHz）		2.400	-	2.480	Support ISM band
Power consumption	TX current（mA）		500		Instantaneous power consumption @27dBm
	RX current（mA）		36		
	Sleep current（nA）		2.5		Software is shut down
Max TX power（dBm）		26.8	27	27.4	
Receiving sensitivity（dBm）		-98	-99	-100	Air data rate is 250kBps

Main parameter	Performance	Remark
Distance for reference	1600m	PCB on board antenna
Protocol supported	ZigBee	
Communication interface	I/O	All IO ports lead
Packaging	SMD	
Connector	1.27mm	
IC	CC2530F256RHAT/QFN40	Built-in PA+LNA
FLASH	256kB	
RAM	8kB	
Core	8051	
Size	16*27.0mm	
Antenna	PCB on board antenna	Equivalent impedance is about 50Ω

3. Size and Pin Definition

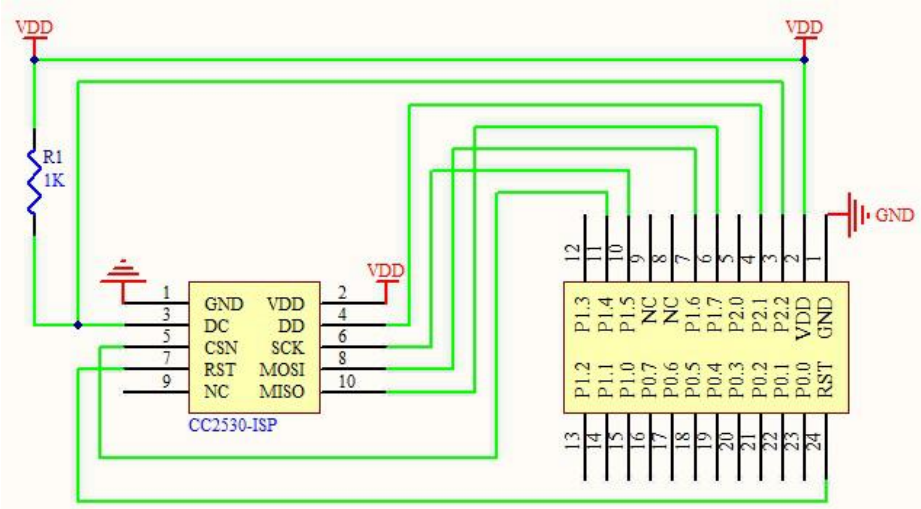


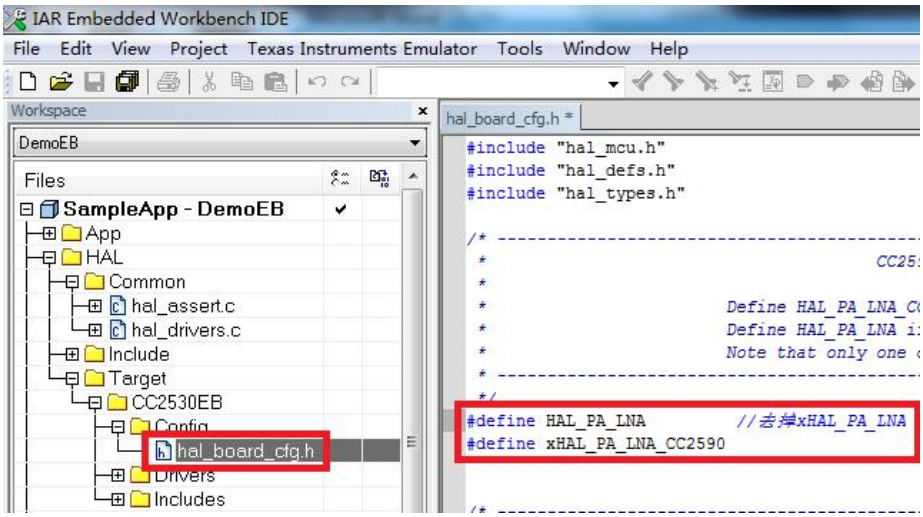
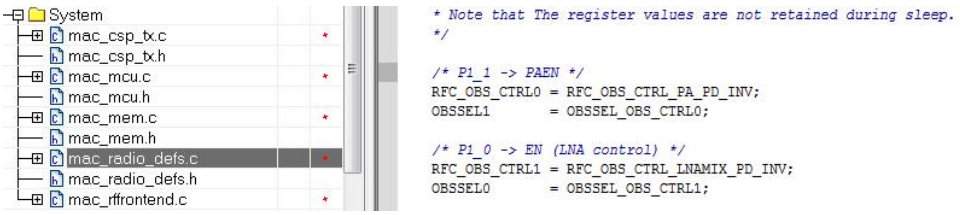
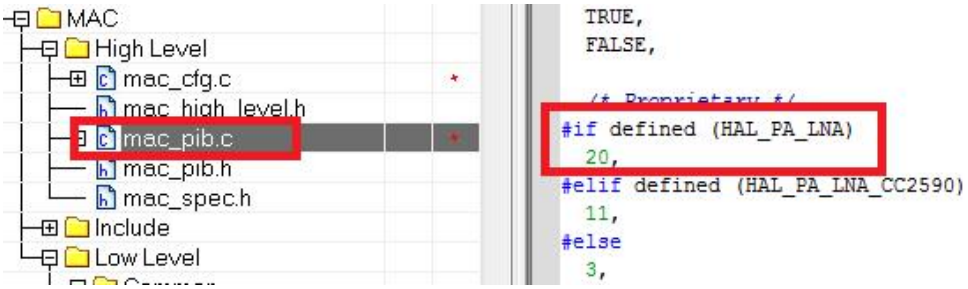
Pin No.	Pin item	Pin direction	Pin application
1	GND	Input	Ground wire, connected to the power reference ground
2	VCC	Input	The power supply must be between 2.5～3.6V
3	P2.2	Input/Output	MCU GPIO
4	P2.1	Input/Output	MCU GPIO
5	P2.0	Input/Output	MCU GPIO
6	P1.7	Input/Output	MCU GPIO
7	P1.6	Input/Output	MCU GPIO
8	NC		Void
9	NC		Void
10	P1.5	Input/Output	MCU GPIO
11	P1.4	Input/Output	MCU GPIO
12	P1.3	Input/Output	MCU GPIO
13	P1.2	Input/Output	MCU GPIO
14	P1.1	Output	MCU GPIO, PA transmitting control pin
15	P1.0	Output	MCU GPIO, PA receiving control pin
16	P0.7	Input/Output	MCU GPIO

17	P0.6	Input/Output	MCU GPIO
18	P0.5	Input/Output	MCU GPIO
19	P0.4	Input/Output	MCU GPIO
20	P0.3	Input/Output	MCU GPIO
21	P0.2	Input/Output	MCU GPIO
22	P0.1	Input/Output	MCU GPIO
23	P0.0	Input/Output	MCU GPIO
24	RESET	Input	Reset port

- If you need to use the mesh network function, please download "E18_Software_Datasheet_EN" from the official website for reference;
- If secondary development is required, please refer to TI's official "CC2530 Datasheet" for the pin definition, software driver and communication protocol of the module.

4. Operation Methods

No.	Keywords	Precautions
1	Burning program	The module has a built-in 8051 MCU, CC Debugger can be used when download program; 
2	Enable the amplifier	Enable the power amplifier and modify the macro definition in the file hal_board_cfg.h;

<table>
<tr><td></td><td></td><td> 
</td></tr>
<tr><td>3</td><td>Parameter settings</td><td>This product can directly modify the PA settings in zstack of the previous program;
In the example, the pins P1.1 and P1.0 of CC2530 are respectively connected to the PA_EN and LNA_EN of the internal PA;
At the same time, it can be seen that LNA_EN has been in the high level, and it has been in the receiving mode.
<table>
<tr><td>Working mode</td><td>PA_EN</td><td>LAN_EN</td></tr>
<tr><td>TX mode</td><td>1</td><td>0</td></tr>
<tr><td>RX mode</td><td>0</td><td>1</td></tr>
<tr><td>Sleep mode</td><td>0</td><td>0</td></tr>
</table></td></tr>
<tr><td>4</td><td>Program modification</td><td>Find the macRadioTurnOnPower() function in the file mac_radio_defs.c and modify it.
 
</td></tr>
<tr><td>5</td><td>Modify power</td><td>Find the array static CODE const macPib_t macPibDefaults in the file mac_pib.c, and modify it in the red box.
 
</td></tr>
</table>

5. Software Programming

5.1 TI ZigBee FAQ

① The difference between the different versions of TI's ZigBee protocol stack, how to choose a suitable protocol stack for product development?

TI's ZigBee protocol stack Z-Stack has started from Z-Stack 0.1 to the familiar Z-Stack 2.5.1a, and now Z-Stack Home 1.2.1, Z-Stack Lghting 1.0.2, Z-Stack Energy 1.0 .1, Z-Stack Mesh 1.0.0. In the protocol stack upgrade process, TI has mainly done two aspects of the protocol stack. 1) According to the ZigBee Specification of the ZigBee Alliance, some new features are added. For example, ZigBee2007 is a tree. For routing, there is Mesh routing in ZigBee Pro, and routing algorithms such as MTO and Source Routing have been proposed, so TI has added corresponding new functions to the protocol stack. Of course, part of it is the correction of related bugs in the Spec, for example, some descriptions are ambiguous; 2) TI ZigBee protocol stack itself software bug fixes. The difference between a version of the protocol stack and the previous version of the protocol stack can be found in the Release Note under the protocol stack installation directory.

After Z-Stack 2.5.1a, TI's protocol stack did not continue to be released directly in the form of Z-Stack 2.6.x, but was released in the form of Application Profile. The reason is that TI hopes that developers choose based on actual applications A more targeted protocol stack is developed. Protocol stacks like Z-Stack Home 1.2.1 mainly include two parts, 1) Core Stack Core Stack, this part starts with the continuation of the previous Z-Stack 2.5.1a and can be installed in the protocol stack Found in the Z-Stack Core Release Notes.txt file under the directory, Version 2.6.2. 2) Application protocol stack Profile is related, this part is mainly related to actual application, Home Automation protocol stack is all related to ZigBee Home Automation Profile implementation. Similarly, Z-Stack Lghting 1.0.2 and Z-Stack Energy 1.0.1 are also a Core Stack plus an application profile.

1) Z-Stack Home 1.2.2a is aimed at the development of smart home related products

2) Z-Stack Lighting 1.0.2 is aimed at the development of ZLL related products

3) Z-Stack Energy 1.0.1 is aimed at the development of smart energy, Meter, In Home Display, and other related products

4) Z-Stack Mesh 1.0.0 is aimed at the development of related private application products, only using standard ZigBee protocol related functions, Mesh routing, etc. The application layer is defined by the developer.

After the ZigBee Alliance released the ZigBee 3.0 protocol, the latest ZigBee protocol stack is Z-Stack 3.0, and currently supported devices are CC2530 and CC2538.

② How do products undergo standard ZigBee testing and certification, what do I need to know, and what process do I need to follow?

Take the development of standard ZigBee Home Automation related products as an example. First, when developers develop products, they must develop products according to the products described in the ZigBee Home Automation Profile Specification. This document can be downloaded at www.zigbee.org. After completing the product development, the developer needs to understand the ZigBee Home Automation Profile Test Specification. This document describes the relevant test items that a specific product needs to be tested in the Test House. The document can also be downloaded at www.zigbee.org, in addition to the above In addition to the two documents, there is a PICS document. This document is specifically used to describe the functions supported by the products that need to be certified and tested. Developers check the actual functions of the developed products and the functions required in the Specification. The following is the test process,

1) Join the ZigBee Alliance first, usually with the help of a test laboratory.

2) Send samples to the testing laboratory and complete the PICS file.

3) In the first round of pre-testing, the test laboratory feedbacks the test results, and the developer modifies the sample code.

4) The test laboratory verifies the modified sample and then starts the formal test.

5) The testing laboratory assists developers to complete the preparation and submission of ZigBee Alliance online certification application materials.

6) The test laboratory submits a formal test report to the ZigBee Alliance. The alliance will complete the review and issue a certificate

At present, there are two test laboratories that can complete standard ZigBee testing in China

1) CESI Beijing Standardization Electronics Institute.

2) Element Shenzhen office (headquartered in the UK)

For details, please refer to the following wiki address,

http://processors.wiki.ti.com/index.php/ZigBee_Product_Certification_Guide

③ How is the 64-bit MAC address of the device being selected?

There are two IEEE addresses in CC2530, one is called Primary IEEE address, and the other is called Secondary address. The Primary IEEE address is stored in the Information Page of the chip. This address was purchased by TI from the IEEE Association. The address of each chip is unique. And the user can only Read this value, there is no way to erase/modify it. You can get osal_memcpy(aExtendedAddress, (uint8 *)(P_INFOPAGE+HAL_INFOP_IEEE_OSET), Z_EXTADDR_LEN) directly by reading the address in the protocol stack. The secondary address is stored in the last page of Flash in CC2530, and users can read/write. Through the function HalFlashRead(HAL_FLASH_IEEE_PAGE, HAL_FLASH_IEEE_OSET, aExtendedAddress, Z_EXTADDR_LEN);.

The operation of the protocol stack is how to select the Primary IEEE address or the Secondary address as the MAC address of the device, specifically in the function zmain_ext_addr(void) operation.

1) Read the IEEE address from NV, if it already exists (neither 0xFF), use this address as the MAC address.

2) If not in 1), read from the secondary IEEE address storage location, if there is (not 0xFF), write the address to NV, and use the address as the MAC address in the future.

3) If not in 2), read from the storage location of the Primary IEEE address, if there is (not 0xFF), write the address to NV, and use the address as the MAC address in the future

4) If not in 3), a 64-bit variable is randomly generated and written into NV as the MAC address.

④ How can I prevent nodes from continuously searching the network, or increase the interval between sending Beacon Requests?

End Device is a low-power device with battery power supply. After the node is disconnected from the network, how can the node continue to search the network or increase the interval between sending Beacon Requests

1) Start the search network uint8 ZDApp_StartJoiningCycle(void)

Stop searching the network uint8 ZDApp_StopJoiningCycle(void)

2) Change the period of sending Beacon Request

Modify the variable zgDefaultStartingScanDuration

```
// Beacon Order Values
#define BEACON_ORDER_NO_BEACONS        15
#define BEACON_ORDER_4_MINUTES         14   // 245760 milliseconds
#define BEACON_ORDER_2_MINUTES         13   // 122880 milliseconds
#define BEACON_ORDER_1_MINUTE          12   //  61440 milliseconds
#define BEACON_ORDER_31_SECONDS        11   //  30720 milliseconds
#define BEACON_ORDER_15_SECONDS        10   //  15360 MSecs
#define BEACON_ORDER_7_5_SECONDS        9   //   7680 MSecs
#define BEACON_ORDER_4_SECONDS          8   //   3840 MSecs
#define BEACON_ORDER_2_SECONDS          7   //   1920 MSecs
#define BEACON_ORDER_1_SECOND           6   //    960 MSecs
#define BEACON_ORDER_480_MSEC           5
```

```
#define BEACON_ORDER_240_MSEC     4
#define BEACON_ORDER_120_MSEC     3
#define BEACON_ORDER_60_MSEC      2
#define BEACON_ORDER_30_MSEC      1
#define BEACON_ORDER_15_MSEC      0
```

⑤ How to make End Device enter a low power consumption state and how to set the sleep time?

After enabling POWER_SAVING in the protocol stack macro definition, and setting -DRFD_RCVC_ALWAYS_ON=FALSE in the f8wConfig.cfg file, the End Device can enter the sleep state.

The sleep time is determined by the scheduling of the OSAL operating system. Each sleep time is based on the latest Event Timeout that will occur as the sleep time. The details are explained in the protocol stack hal_sleep function.

This timeout is mainly divided into two categories, one is the timeout of application layer events, and the other is the timeout of MAC layer events,

1) The timeout of the application layer is obtained through osal_next_timeout(); in the osal_pwrmgr_powerconserve(void) function.

2) The timeout time of the MAC layer is obtained by MAC_PwrNextTimeout(); in the halSleep(uint16 osal_timeout) function.

⑥ What's new in the ZigBee 3.0 protocol stack?

Please refer to the link below to introduce the additions of the ZigBee 3.0 protocol stack compared to the previous ZigBee Home Automation/ZigBee Light Link.

http://processors.wiki.ti.com/index.php/What%27s_New_in_ZigBee_3.0

State machine switching of terminal equipment in TI ZigBee protocol stack

http://www.deyisupport.com/question_answer/wireless_connectivity/zigbee/f/104/t/104629.aspx

⑦ About the difference between OAD and OTA in the TI protocol stack?

The full name of OAD is Over the Air Download, and the full name of OTA is Over the Air. The functions of these two implementations are the same, and both can be called an over-the-air upgrade of the program. In the early ZigBee protocol standards, there was no standard for over-the-air upgrade of node programs, but many customers have requirements for over-the-air upgrades, so TI developed a set of protocol stacks for over-the-air upgrade of programs and named it OAD. Later, the ZigBee Alliance saw the increasing demand for over-the-air upgrades of products, and randomly specified a standard for over-the-air upgrades, named OTA. The standard also referred to TI's OAD implementation and made relevant modifications. Therefore, in TI's early protocol stack, the over-the-air upgrade was called OAD, and later in the protocol stack that followed the ZigBee Alliance's over-the-air upgrade protocol, it was called OTA.

⑧ If you develop private applications based on the ZigBee Mesh network, which protocol stack should you choose?

Many users only want to use the functions of the zigbee mesh network in their own systems or products, and do not need to follow the application layer specifications defined by zigbee, especially for some industrial applications. For such application requirements, how should TI choose the appropriate protocol stack for product development?

http://www.deyisupport.com/question_answer/wireless_connectivity/zigbee/f/104/t/132197.aspx

6. Basic Operation

6.1 Hardware design

- It is recommended to use a DC stabilized power supply to supply power to the module. The power ripple coefficient should be as small as possible, and the module must 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 it is within the recommended power supply voltage. If it exceeds the maximum value, the module will be permanently damaged;
- 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 devices with large electromagnetic interference around the module, it will greatly affect the performance 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 large electromagnetic interference traces (high-frequency digital, high-frequency analog, power traces) around the module, it will greatly affect the performance 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, such as: USB3.0;
- The antenna installation structure has a great impact on the performance of the module. Make sure that the antenna is exposed and preferably vertically upward; when the module is installed inside the case, you can use a high-quality antenna extension cable 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.

7. FAQ

7.1 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.

7.2 Module is easy to damage

- Please check the power supply to ensure that it is within the recommended power supply voltage. If it exceeds the maximum value, 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.
- If there is no special requirement, it is not recommended to use it at too high or too low temperature.

7.3 BER (Bit Error Rate) is high

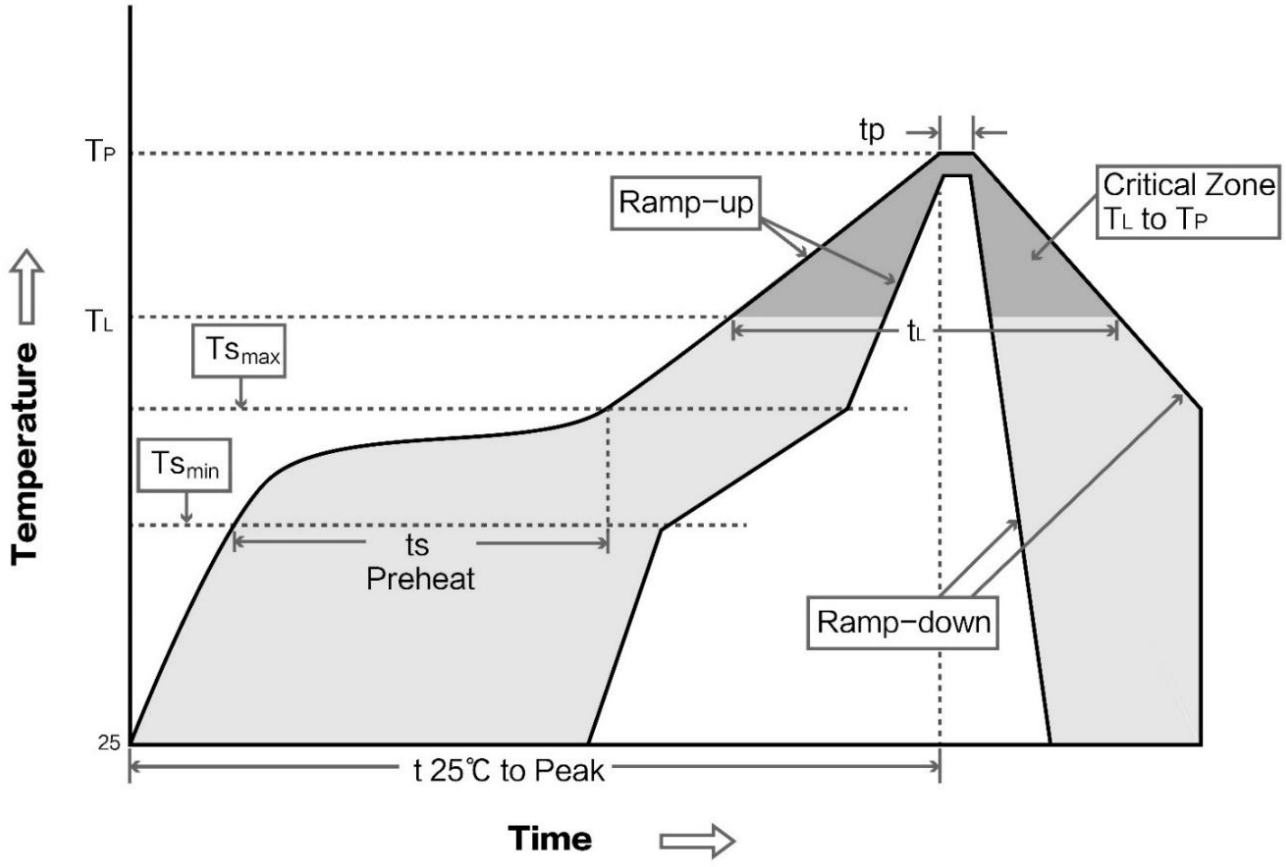
- There is co-frequency signal interference nearby, stay away from the interference source or modify the frequency and channel to avoid interference;
- Unsatisfactory power supply may also cause garbled codes. Be sure to ensure the reliability of the power supply;
- Poor or too long extension cables and feeders will also cause high bit error rates.

8. Soldering Guidance

8.1 Reflow soldering temperature

Profile Feature	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min （Tsmin）	100℃	150℃
Preheat temperature max (Tsmax)	150℃	200℃
Preheat Time (Tsmin to Tsmax)(ts)	60-120 sec	60-120 sec
Average ramp-up rate(Tsmax to Tp)	3℃/second max	3℃/second max
Liquidous Temperature (TL)	183℃	217℃
Time（tL）Maintained Above（TL）	60-90 sec	30-90 sec
Peak temperature（Tp）	220-235℃	230-250℃
Aveage ramp-down rate（Tp to Tsmax）	6℃/second max	6℃/second max
Time 25℃ to peak temperature	6 minutes max	8 minutes max

8.2 Reflow soldering curve



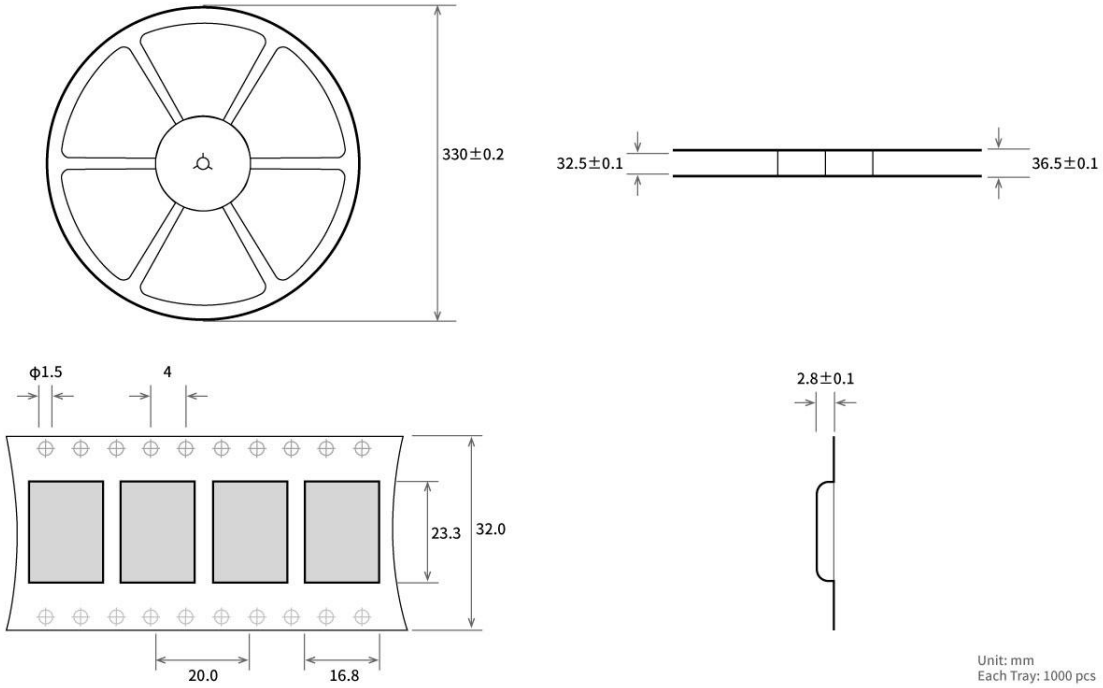
9. Related Products

Model No.	IC	Frequency	Power	Distance	Size	Packaging	Antenna
		Hz	dBm	m	mm		
E18-MS1-PCB	CC2530	2.4G	4	200	14.1*23	SMD	Onboard Antenna
E18-MS1-IPX	CC2530	2.4G	4	240	14.1*20.8	SMD	IPEX
E18-MS1PA1-PCB	CC2530	2.4G	20	800	16*27	SMD	Onboard Antenna
E18-MS1PA2-IPX	CC2530	2.4G	20	1800	16*22.5	SMD	IPEX
E18-MS1PA2-PCB	CC2530	2.4G	20	800	16*27	SMD	Onboard Antenna
E18-2G4U04B	CC2531	2.4G	4	200	18*59	USB	Onboard Antenna

10. Antenna Recommendation

Model No.	Type	Frequency	Gain	Size	Feeder	Interface	Features
		Hz	dBi	mm	cm		
TX2400-NP-5010	Flexible Antenna	2.4G	2.0	10x50	-	PCB	flexible FPC soft antenna
TX2400-JZ-3	Rubber antenna	2.4G	2.0	30	-	SMA-J	Ultra-short straight, omnidirectional antenna
TX2400-JZ-5	Rubber antenna	2.4G	2.0	50	-	SMA-J	Ultra-short straight, omnidirectional antenna
TX2400-JW-5	Rubber antenna	2.4G	2.0	50	-	SMA-J	Fixed bending, omnidirectional antenna
TX2400-JK-11	Rubber antenna	2.4G	2.5	110	-	SMA-J	Bendable rubber. omnidirectional antenna
TX2400-JK-20	Rubber antenna	2.4G	3.0	200	-	SMA-J	Bendable rubber. omnidirectional antenna
TX2400-XPL-150	Suction antenna	2.4G	3.5	150	150	SMA-J	Small suction antenna, cost-effective

11. Packaging



Revision History

Version	Date	Description	Issued by
v1.0	2020-04-22	Original version	Ken

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