E18-2G4Z27SI

User Manual

CC2530 2.4GHz ZigBee 27dBm SMD Wireless Module

1. General introduction

1.1 Brief introduction

E18-2G4Z27SI is a small-sized 2.4GHz SMD wireless modules, which are designed and produced by Chengdu Ebyte.The space between each pin is 1.27mm. E18 series have been put into stable bulk production, they are applicable for various applications (especially smart home).

E18-2G4Z27SI adopt the original CC2530 RF chip of TI, the chip is integrated with 8051 MCU and wireless transceiver. Built-in PA+LNA，the modules are applicable for ZigBee design and 2.4GHz IEEE 802.15.4 protocol. All IO ports of the MCU have been pinned out for multiple development.

1.2 Features

- Communication distance tested is up to 2.5km;
- Maximum transmission power of 500mW, software multi-level adjustable;
- Built-in ZigBee protocol stack;
- With network firmware;
- Support ADC, PWM, GPIO;
- Support UART transmission, simple and easy to use;
- Built-in 32.768 kHz clock crystal oscillator;
- Support the global license-free ISM 2.4GHz band;
- 256KB FLASH，8KB RAM;
- Built-in PA+LNA, the performance of anti-interference improved;
- High performance and low power 8051 MCU core;
- Support 2.5V~3.6V power supply, power supply over 3.3 V can guarantee the best performance;
- Industrial grade standard design, support -40 ~ 85 °C for working over a long time;
- IPEX and stamp hole optional, good for secondary development and integration.

1.3 Application

- Home security alarm and remote keyless entry;
- Smart home and industrial sensors;
- Wireless alarm security system;
- Wireless industrial-grade remote control;
- Health care products;
- Wireless voice, wireless headphones;
- Automotive industry applications.

2. Technical parameters

2.1 Limit parameter

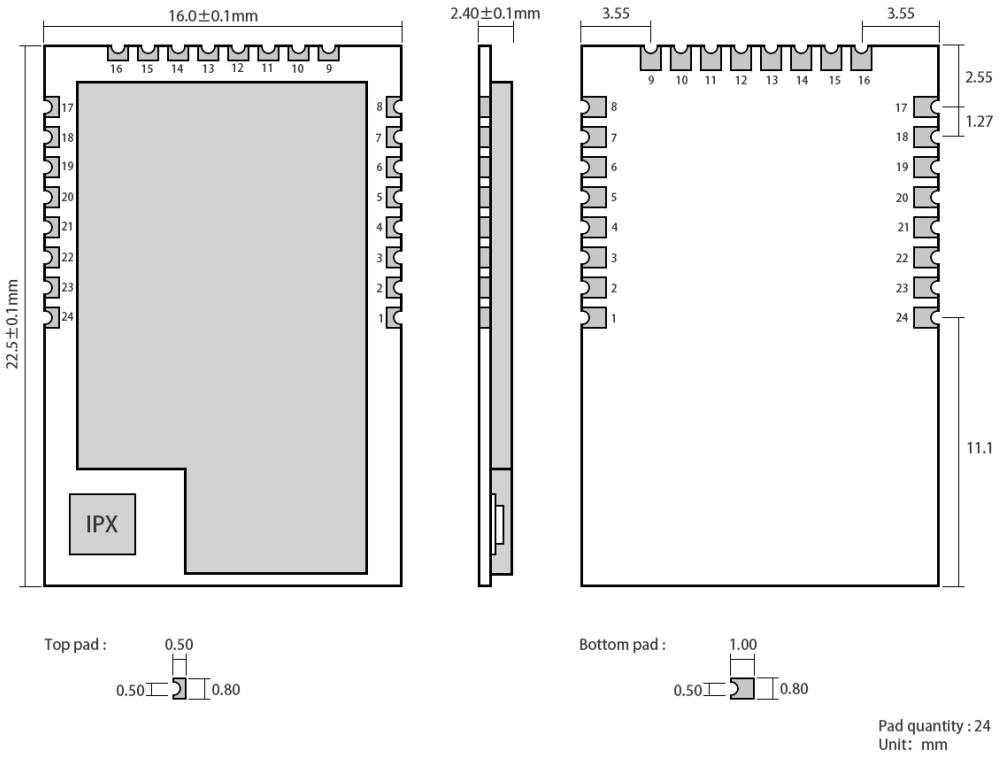
Main parameter	Performance		Remark
	Min	Max	
Voltage supply（V）	0	3.6	Voltage over 3.6V will cause permanent damage to module
Blocking power（dBm）	-	10	Chances of burn is slim when modules are used in short distance
Working temperature（℃）	-40	85	

2.2 Working parameters

Main parameter		Performance			Remark
		Min.	Typ.	Max.	
Operating voltage（V）		2.5	3.3	3.6	≥3.3 V ensures output power
Communication level（V）			3.3		For 5V TTL, it may be at risk of burning down
Working temperature（℃）		-40	-	85	Industrial design
Frequency（GHz）		2.400	-	2.480	Support ISM band
Power consumption	TX current（mA）		500		Instant power consumption
	RX current（mA）		33		
	Sleep current （μA）		2.4		Software is shut down
Max Tx power（dBm）		26.8	27.0	27.4	
Receiving sensitivity（dBm）		-98	-99	-100	Air data rate is 250kbps

Main parameter	Description	Remark
Distance for reference	2500 m	Test condition：clear and open area, antenna gain: 5dBi，antenna height: 2.5m，air data rate: 250kbps
Protocol	ZigBee	
Packing	SMD	
Connector	1.27mm	
IC	CC2530F256RHAT/QFN40	Built-in PA+LNA
FLASH	256 KB	
RAM	8 KB	
Core	8051 MCU	
Size	16.0 * 22.5 mm	
Antenna	IPEX	50 ohm impedance

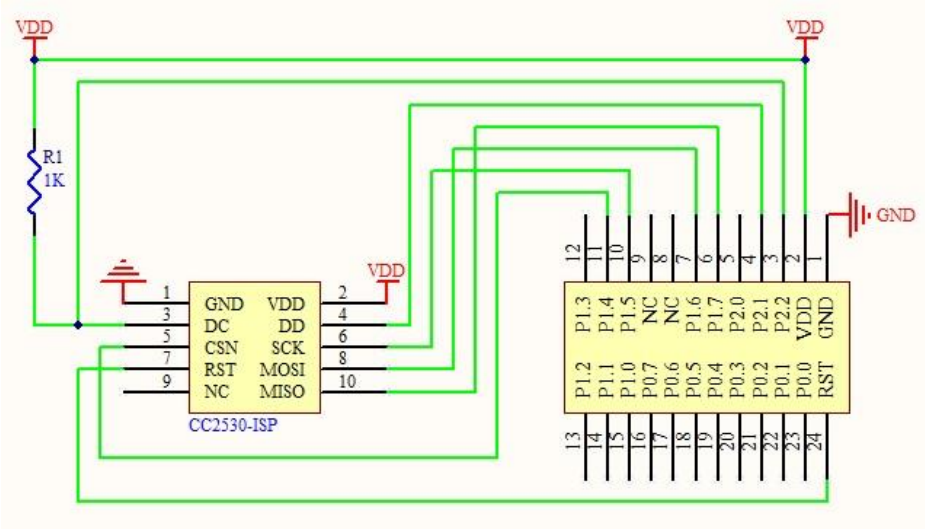
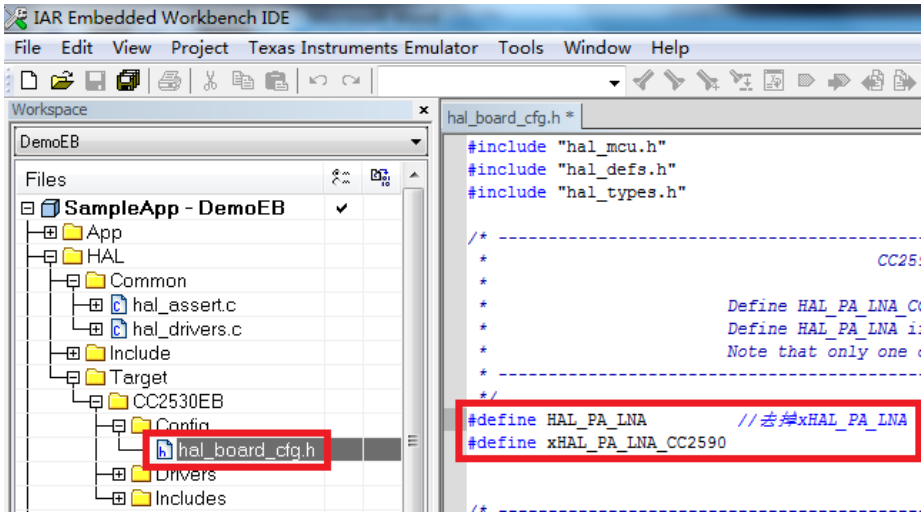
3. Mechanical characteristics

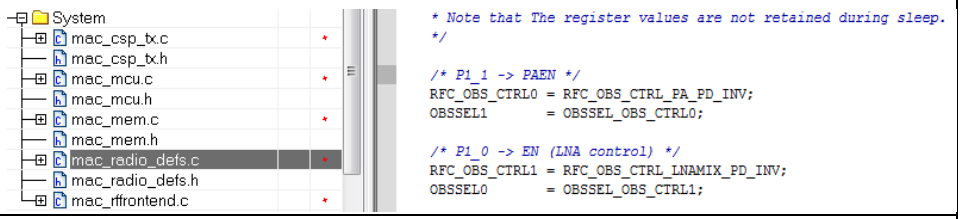
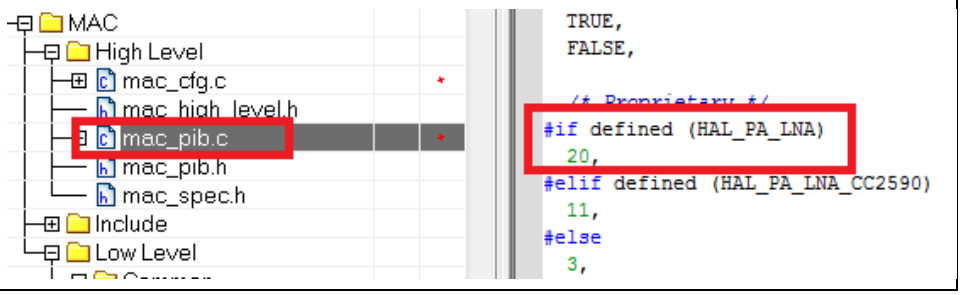


Pin No.	Pin item	Pin direction	Application
1	GND	Input	Ground, connecting to power source referential ground
2	VCC	Input	Power supply, must be 2.5-3.6V
3	P2.2	Input /Output	MCU GPIO
4	P2.1	Input /Output	MCU GPIO
5	P2.0	Input /Output	MCU GPIO
6	P1.7	Input /Output	MCU GPIO
7	P1.6	Input /Output	MCU GPIO
8	NC		Reserved
9	NC		Reserved
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, PA receiving high gain control pin
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
★ Please refer to TI official CC2530 Datasheet for module pin definitions, software driver and protocol ★			

4. Usage

4.1 Development

<table>
<tr><th>No.</th><th>Keyword</th><th>Remark</th></tr>
<tr><td>1</td><td>Burn firmware</td><td>The module is with built-in 8051 MCU.
 
</td></tr>
<tr><td>2</td><td>Initiate PA</td><td>Initiate PA , modify it in file hal_board_cfg.h.
 
</td></tr>
<tr><td>3</td><td>Parameter setting</td><td>This product is compatible with E18-MS1PA1-IPX software, can modify PA settings in zstack in the previous program directly,
In this example, P1.1 and P1.0 of CC2530 are respectively connected with PA_EN and LNA_EN of internal PA. Meanwhile, LNA_EN is in high level,and it is in receiving mode.
<table>
<tr><th>Operation mode</th><th>PA-_EN</th><th>LAN_EN</th></tr>
<tr><td>Transmitting mode</td><td>1</td><td>0</td></tr>
<tr><td>Receivingg mode</td><td>0</td><td>1</td></tr>
<tr><td>Sleep mode</td><td>0</td><td>0</td></tr>
</table></td></tr>
</table>

4	Program modification	Find macRadioTurnOnPower() from mac_radio_defs.c, and modify. 
5	Power modification	Find static CODE const macPib_t macPibDefaults from file mac_pib.c. Modify in the red signed below. 

5. Programming

5.1 TI ZigBee FAQ

5.1.1 How to select proper protocol stack from different ZigBee protocol stacks of TI?

From the Z-Stack 0.1 to Z-Stack 2.5.1a and the current Z-Stack Home 1.2.1, Z-Stack Lighting 1.0.2, Z-Stack Energy 1.0.1, Z-Stack Mesh 1.0.0, TI mainly upgraded the protocol stack through: 1) adding some new features according to ZigBee Specification of the ZigBee Alliance, for example, ZigBee2007 tree-shape route, adding Mesh route in ZigBee Pro, and raising MTO and Source Routing algorithms so TI added some new functions to the protocol stack, also did some correction of bugs in Spec such as some unclear descriptions; 2) Correction of bugs of TI ZigBee protocol itself. You can find the differences between one protocol stack and the previous version in the Release Note of the installation directory.

After the Z-Stack 2.5.1a, TI did not publish the protocol stack in the form of Z-Stack 2.6.x but in Application Profile form, because TI hopes the developers could select proper protocol stack based on actual applications. The protocol stacks like Z-Stack Home 1.2.1 includes two parts: 1) Core Stack, it is the follow-up versions of Z-Stack 2.5.1a, it can be found from the Z-Stack Core Release Notes.txt, Version 2.6.2. 2) Profile-related part, this part is related to the actual application, Home Automation stack is about the realization of ZigBee Home Automation Profile. Meanwhile, Z-Stack Lighting 1.0.2 and Z-Stack Energy 1.0.1 are Core Stack with Profile for application.

1) Z-Stack Home 1.2.2a is specific for smart home products development.

2) Z-Stack Lighting 1.0.2 is specific for ZLL products development.

3) Z-Stack Energy 1.0.1 is specific for intelligent energy, meter, In Home Display, and so on.

4) Z-Stack Mesh 1.0.0 is specific for private applications, it only utilizes the function of standard ZigBee protocol, Mesh route and so on, the application layer shall be defined by the developer.

After the publish of ZigBee 3.0 protocol, the latest ZigBee protocol stack is Z-Stack 3.0, it supports CC2530 and CC2538.

5.1.2 How to apply for standard ZigBee test certification?

Take standard ZigBee Home Automation products as example, developers must develop according to the description in the ZigBee Home Automation Profile Specification, this document can be found from www.zigbee.or. After developing the product, developers need to learn the ZigBee Home Automation Profile Test Specification, this document described the items to be tested by the Test House, it can be downloaded from www.zigbee.org also, in addition, there is another PICS document, it is specific for describing the functions supported, developers confirm the functions by checking the boxes according to the actual functions and the required

functions in the Specification, as below are the testing procedure:

1) Join the ZigBee alliance, generally assisted by testing labs;

2) Send samples to testing lab, complete the PICS file;

3) First round pre-testing, the testing lab feedback the testing results, developers modify the sample codes.

4) The testing lab verify the modified sample, and starts formal test;

5) The testing lab assists developers to complete the ZigBee alliance online certification application;

6) The testing lab submits the test report to ZigBee alliance. The alliance will review and issue certificate.

Currently, there are two testing labs in China who can complete standard ZigBee test:

1) CESI in Beijing;

2) Element Shenzhen Office (headquartered in England)

Please refer to below wiki link for details:

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

5.1.3 How to select the 64-bit MAC address of the device?

There are two IEEE addresses in CC2530/CC2538/CC2630, one is Primary IEEE address, the other is Secondary address. Primary IEEE address is stored in Information Page of the chip, this address is bought by TI from IEEE, each chip has one unique address. Users could only Read this value and cannot modify or erase it. By reading the address in the protocol stack, users can obtain osal_memcpy(aExtendedAddress, (uint8 *)(P_INFOPAGE+HAL_INFOP_IEEE_OSET), Z_EXTADDR_LEN). Secondary address is stored in the last Page of the Flash of CC2530, users can Read/Write with the function HalFlashRead(HAL_FLASH_IEEE_PAGE, HAL_FLASH_IEEE_OSET, aExtendedAddress, Z_EXTADDR_LEN).

When the protocol stack is operating, how to select Primary IEEE address or Secondary address as MAC address? Please operate in the function zmain_ext_addr(void).

1) Read IEEE address from NV, if it already exists (not 0xFF), use this address as MAC address;

2) If not in 1), read from the Secondary IEEE address storage place, if it exists (not 0xFF), write the address into NV, and use this address as MAC address;

3) If not in 2), read from the Primary IEEE address storage place, if it exists (not 0xFF), write the address into NV, and use this address as MAC address;

4) If not in 3), generate one 64-bit variable randomly, write it into NV, use it as MAC address.

5.1.3 How to forbid node from searching network, or extend the interval for sending Beacon Request?

End Device is low power consumption device powered by battery, after cutting from network, how to forbid the node from searching network, or how to extend the interval for sending Beacon Request.

1) Start searching network uint8 ZDApp_StartJoiningCycle(void)

   Stop searching network uint8 ZDApp_StopJoiningCycle(void)

2) Change the Beacon Request sending period

   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
```

5.1.4 How to put End Device into low power consumption mode, how to set up sleep time?

After the POWER_SAVING is enabled in the protocol stack macro definition, put DRFD_RCVC_ALWAYS_ON=FALSE in f8wConfig.cfg file, then the End Device will enter sleep mode.

The sleep time is decided by the OSAL operating system, the latest Event Timeout to occur will be set as sleep time. There is

description in the protocol stack hal_sleep function.

There are two kinds of timeout: one is the timeout of application layer event, the other is the timeout of MAC layer event.

1) Timeout of application layer, can be obtained through osal_next_timeout() of osal_pwrmgr_powerconserve(void) function;

2) Timeout of MAC layer, can be obtained through MAC_PwrNextTimeout() of halSleep(uint16 osal_timeout) function.

5.1.5 What new features does ZigBee 3.0 stack have?

Please refer to below link, it describes the new features of the ZigBee 3.0 stack as compared with the previous ZigBee Home Automation/ZigBee Light Link.

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

About the status switch in the TI ZigBee protocol stack

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

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

OAD is short for Over the Air Download, OTA is short for Over the Air. The functions of these two are the same, they can be called the software upgrade on air. In the earlier ZigBee protocol standard, there was no standard for node software upgrading on air, but many customers have such requirements, thus TI developed their own protocol stack for software upgrading on air, and named it as OAD. After that, ZigBee alliance noticed the more and more requirements for upgrading on air, so they developed the upgrading on air standard and named it as OTA, this standard has taken the TI OAD method as reference and has made some modification. The upgrading on air in TI's earlier protocol stack, it is called OAD, and in the later stack, it is called OTA as following the ZigBee alliance stack.

5.1.7 Which protocol stack shall be selected for developing private application based on ZigBee Mesh?

Many customers only need to apply the function of ZigBee Mesh network in their system or products, and do not need to do according to the application layer as defined by the ZigBee, especially for some industrial applications, as for such requirements, how to select proper TI protocol stack for developing products?

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. 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 it is within the recommended voltage otherwise when it exceeds the maximum value the module will be permanently damaged;
- Please check the stability of the power supply, the voltage cannot be fluctuated 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
- 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.

7. FAQ

7.1 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 2.5V, the lower the voltage, the lower the transmitting power.
- Due to antenna quality or poor matching between antenna and module.

7.2 Module is easy to damage

- Please check the power supply source, ensure it is 2.0V~3.6V, voltage higher than 3.6V 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.

7.3 Bit error rate is too high

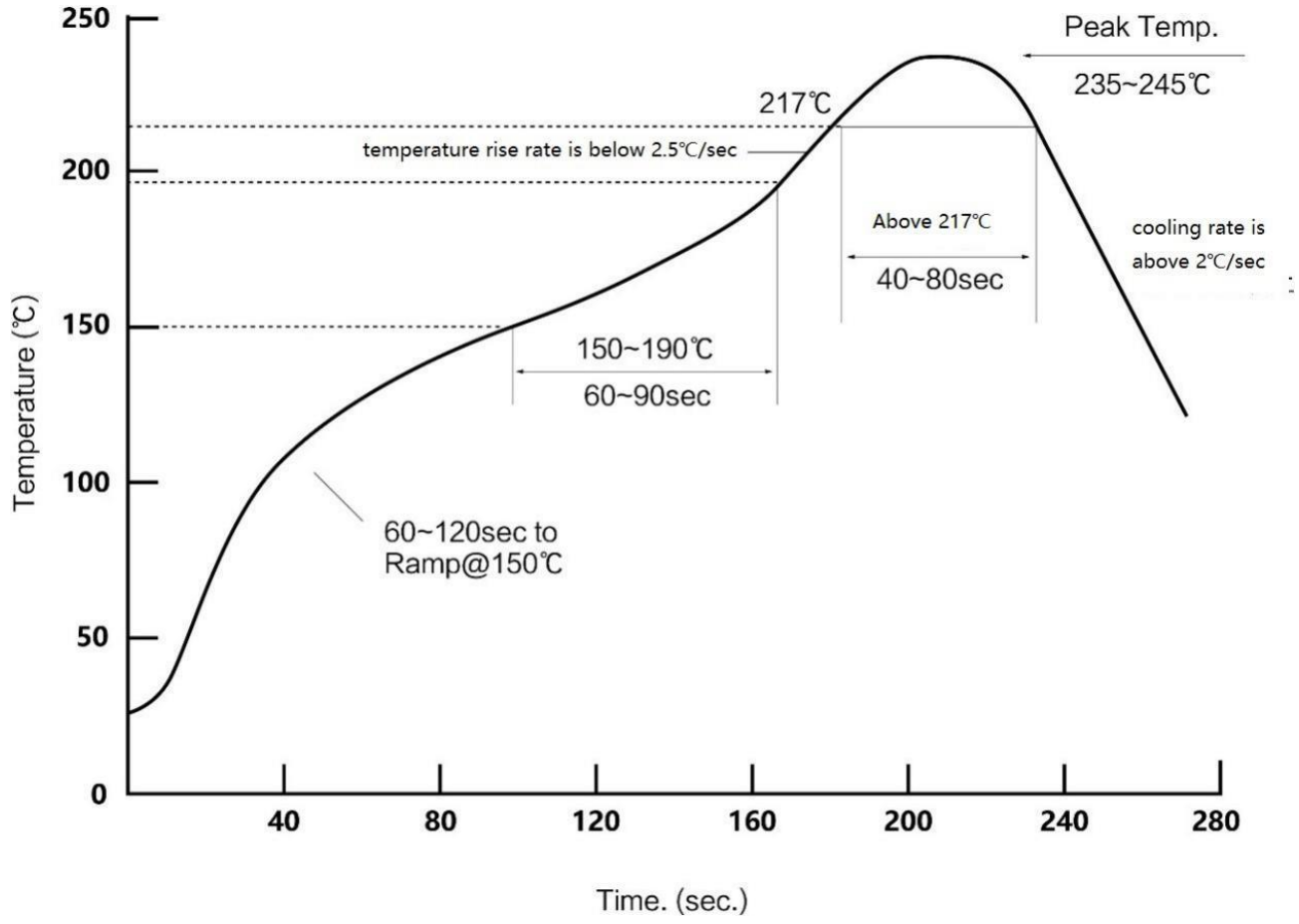
- There are co-channel signal interference nearby, please be away from interference sources or modify frequency and channel to avoid interference;
- Poor power supply may cause messy code. Make sure that the power supply is reliable.
- The extension line and feeder quality are poor or too long, so the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

8.Production guidance

8.1 Reflow soldering temperature

- Pre-heating area: maximum temperature rise is 2.5℃/s;
- Thermal insulation area: temperature is 150~190℃, time is 60~90s， maximum temperature rise is 2.5℃/s;
- Reflowing area: maximum temperature is 235~245℃, time for above 217℃ is 40~80s;
- Cooling area: maximum temperature drop is 4℃/s.

8.2 Reflow soldering curve



9. Related product

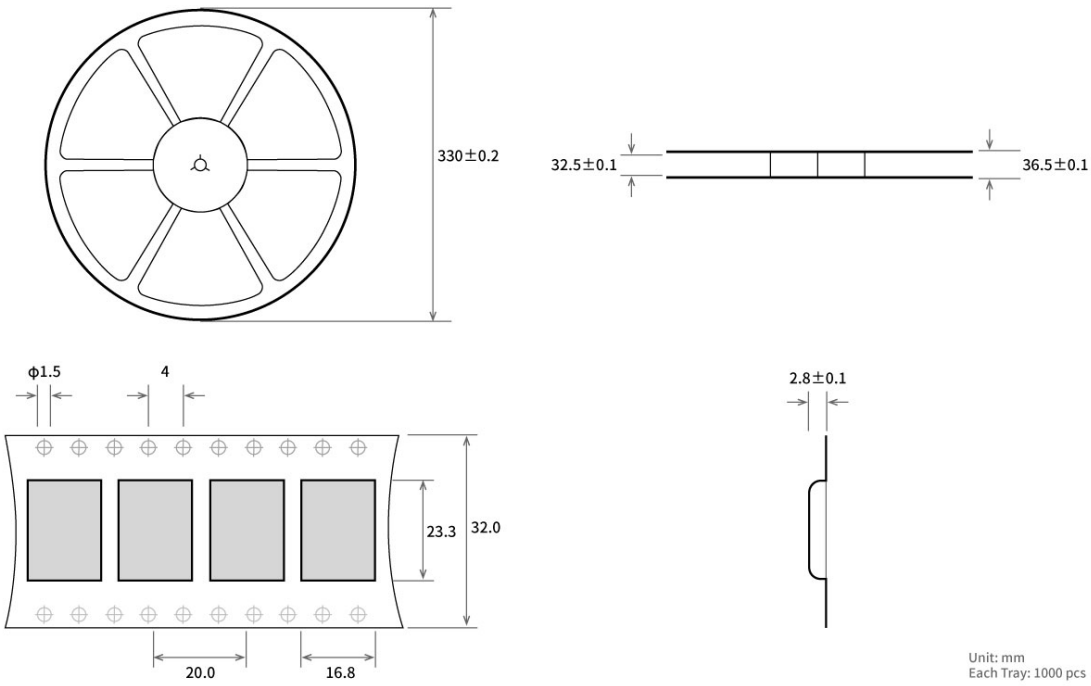
Model	IC	Frequency Hz	Power dBm	Range m	Air data rate bps	Packing	Dimension mm	Antenna Interface
E18-2G4Z27SI	CC2530	2.4G	27	2500	250k	SMD	16 * 22.5	IPEX
E18-MS1PA1-IPX	CC2530	2.4G	20	1000	250k	SMD	16 * 22.5	IPEX
E18-MS1PA1-PCB	CC2530	2.4G	20	800	250k	SMD	16 * 27	PCB
E18-MS1-IPX	CC2530	2.4G	4	240	250k	SMD	14.1 * 20.8	IPEX
E18-MS1-PCB	CC2530	2.4G	4	200	250k	SMD	14.1 * 23	PCB

10. Antenna guidance

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 number	Type	Frequency Hz	Interface	Gain dBi	Dimension	Feature
TX2400-NP-5010	Flexible antenna	2.4G	IPEX	2.0	50*10mm	Flexible FPC antenna
TX2400-JZ-3	Rubber antenna	2.4G	SMA-J	2.0	30mm	Short antenna omnidirectional antenna
TX2400-JK-11	Rubber antenna	2.4G	SMA-J	2.5	110mm	rubber antenna, omnidirectional antenna
TX2400-JK-20	Rubber antenna	2.4G	SMA-J	3.0	200mm	rubber antenna, omnidirectional antenna
TX2400-XPL-150	Sucker antenna	2.4G	SMA-J	3.5	15cm	Sucker antenna high gain

11. Product packaging figure



11.Important Notes

- All rights to interpret and modify this manual belong to Ebyte.
- This manual will be updated based on the upgrade of firmware and hardware, please refer to the latest version.
- Please refer to our website for new product information.

12.About us

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Revision history

Version	Date	Description	Issued by
1.00	2018/12/10	Initial version	huaa