CC2530 Wireless Module

E18 Series

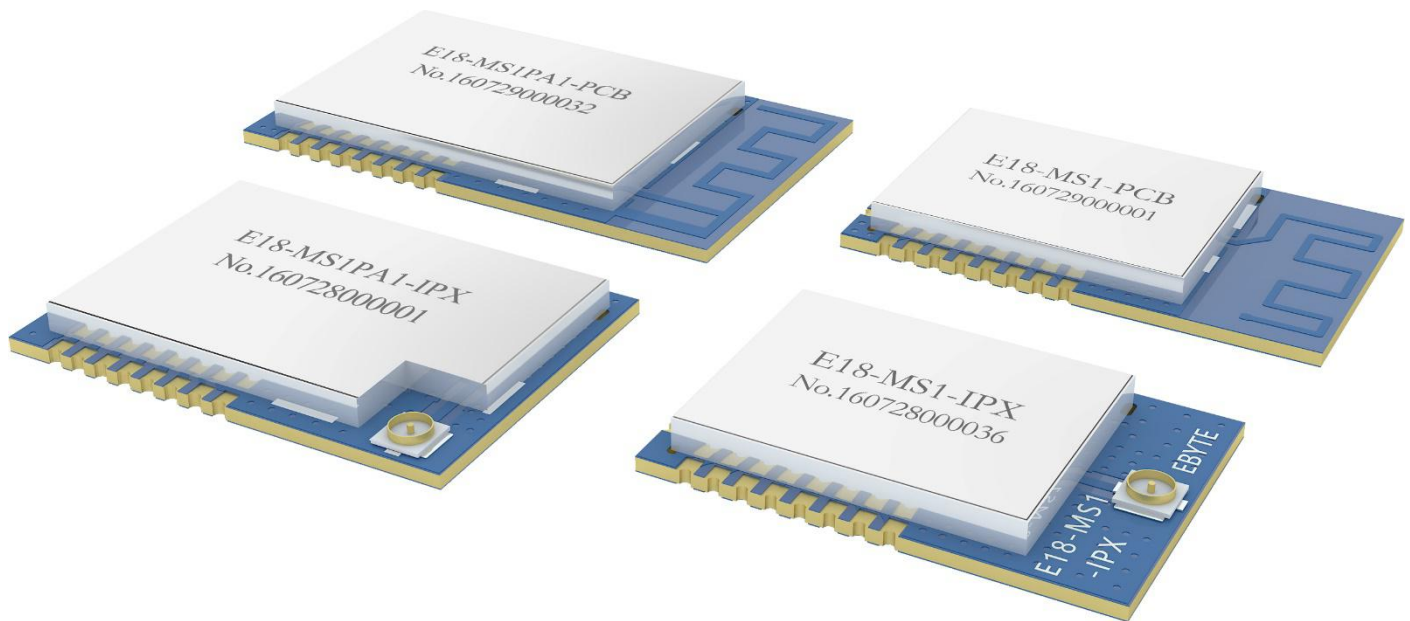## User Manual

Version	Date	Description	Issued by
1.00	2017/11/2	Initial version	huaa

Contents

General introduction

E18 series are 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 series adopt the original CC2530 RF chip of TI, the chip is integrated with 8051 MCU and wireless transceiver. 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.

Model	Antenna connector	PCB packing	Transmitting power	Referential distance
E18-MS1-PCB	PCB antenna	SMD	4dBm	200m
E18-MS1-IPX	IPEX	SMD	4dBm	200m
E18-MS1PA1-PCB	PCB antenna	SMD	20dBm	1000m
E18-MS1PA1-IPX	IPEX	SMD	20dBm	1000m

E18 series are ZigBee modules, which can be used directly and support secondary development.

1. Technical parameters

1.1. General parameters

Model	Core IC	Size	Net weight	Operating temperature	Operating humidity	Storage temperature
E18-MS1-PCB	CC2530	14.1*23.0 mm	1.2±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E18-MS1-IPX	CC2530	14.1*20.8 mm	1.2±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E18-MS1PA1-PCB	CC2530	16.0*27.0 mm	1.58±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C
E18-MS1PA1-IPX	CC2530	16.0*22.5 mm	1.46±0.1g	-40 ~ 85°C	10% ~ 90%	-40 ~ 125°C

1.2. Electrical parameters

1.2.1. Transmitting current

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	25.8	28.0	30.8	mA	• When designing current supply circuit, 30% margin is recommended to be remained so as to ensure long-term stable operation of the whole module; • The current at the instant of transmitting may be high, but the total energy consumed may be lower due to very short transmitting time; • When using external antenna, the impedance matching degree at different frequency points between antenna and module may affect the transmitting current value at different levels.
E18-MS1-IPX	25.8	28.0	30.8	mA	
E18-MS1PA1-PCB	128.8	140.0	154	mA	
E18-MS1PA1-IPX	128.8	140.0	154	mA	

1.2.2. Receiving current

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	24.8	27.0	29.7	mA	• The current consumed when the RF chip is only working at receiving mode is called as receiving current, the tested receiving current may be higher for some RF chips with communication protocol or the developers have loaded their own protocol to the whole module. • The current at pure receiving mode will be mA level, the users have to realize µA level receiving current through firmware development.
E18-MS1-IPX	24.8	27.0	29.7	mA	
E18-MS1PA1-PCB	38.6	42.0	46.2	mA	
E18-MS1PA1-IPX	38.6	42.0	46.2	mA	

1.2.3. Turn-off current

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	0.6	1.2	1.8	µA	• The turn-off current means the current consumed when CPU, RAM, Clock and some registers remain operating while SoC is at very low power consumption status. • The turn-off current is always lower than the current consumed when the power supply source of the whole module is at no-load status.
E18-MS1-IPX	0.6	1.2	1.8	µA	
E18-MS1PA1-PCB	0.6	1.2	1.8	µA	
E18-MS1PA1-IPX	0.6	1.2	1.8	µA	

1.2.4. Voltage supply

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	2.0	3.3	3.6	V DC	• If the voltage is at maximum value for long time, the module may be damaged; • The power supply pin has certain surge-resistance ability, but the potential pulse higher than the maximum power supply voltage; • The power supply voltage is recommended to be higher than 3.0V, if the voltage is lower than 3.0V, the RF parameters will be affected at different degrees.
E18-MS1-IPX	2.0	3.3	3.6	V DC	
E18-MS1PA1-PCB	2.0	3.3	3.6	V DC	
E18-MS1PA1-IPX	2.0	3.3	3.6	V DC	

1.2.5.   Communication level

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	2.0	3.3	3.6	V DC	● If the communication level is higher than the allowed maximum value, the module may be damaged; ● Although the communication level can be switched with various methods, the power consumption of the whole module will be affected at great degree.
E18-MS1-IPX	2.0	3.3	3.6	V DC	
E18-MS1PA1-PCB	2.0	3.3	3.6	V DC	
E18-MS1PA1-IPX	2.0	3.3	3.6	V DC	

1.3.   RF parameters

1.3.1.   Transmitting power

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	9.8	4.0	4.6	dBm	● Due to the error of the materials, each LRC component has ±0.1% error, so error accumulation will occur since multiple LRC components are used in the whole RF circuit, and the transmitting currents will be different at different modules; ● The power consumption can be lowered by lowering the transmitting power, but the efficiency of the internal PA will be decreased by lowering transmitting power due to various reasons; ● The transmitting power will be lowered by lowering the power supply voltage.
E18-MS1-IPX	9.8	4.0	4.6	dBm	
E18-MS1PA1-PCB	9.8	20.0	21.2	dBm	
E18-MS1PA1-IPX	9.6	20.0	20.5	dBm	

1.3.2.   Receiving sensitivity

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	-95.8	-96.4	-97.0	dBm	● The sensitivity is tested under the air data rate of 250kbps; ● Due to the error of the materials, each LRC component has ±0.1% error, so error accumulation will occur since multiple LRC components are used in the whole RF circuit, and the transmitting currents will be different at different modules; ● The receiving sensitivity will be reduced and communication range will be shortened while increasing the air data rate.
E18-MS1-IPX	-95.8	-96.4	-97.0	dBm	
E18-MS1PA1-PCB	-97.3	-97.6	-98.0	dBm	
E18-MS1PA1-IPX	-97.3	-97.6	-98.0	dBm	

1.4.   Tested parameters

1.4.1.   Tested distance

Model	Min	Typ	Max	Unit	Remarks
E18-MS1-PCB	180	200	230	m	● The external antenna used is of 5dBi gain and vertical polarization; ● The interval between each data packet is 2s, sending 100 packets with 30 bytes in each packet, the range at data lose rate of lower than 5% is valid range; ● In order to obtain meaningful and reproduceable results, we conducted the tests under in clear weather with little electromagnetic interference at suburb areas; ● Distance may be shorter with interference or obstacles.
E18-MS1-IPX	220	240	260	m	
E18-MS1PA1-PCB	960	800	1220	m	
E18-MS1PA1-IPX	540	1000	670	m	

2. Mechanical characteristics

2.1. E18-MS1-PCB

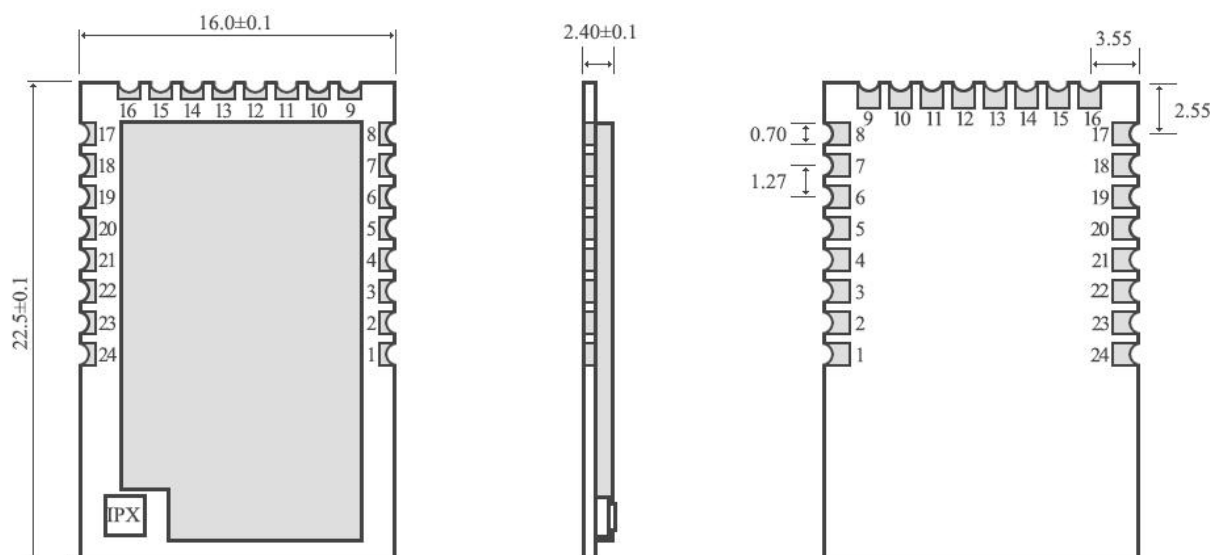| Pin No.	Pin item	Pin direction	Application
1	GND	Input	Ground, connecting to power source referential ground
2	VDD	Input	Power supply, must be 2.0 ~ 3.6V
3	P2.2	Input/Output	MCU GPIO
4	P2.1	Input/Output	MCU GPIO
5	P2.0	Input/Output	MCU GPIO
6	P1.7	Input/Output	MCU GPIO
7	P1.6	Input/Output	MCU GPIO
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	Input/Output	MCU GPIO
15	P1.0	Input/Output	MCU GPIO
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
★ Please refer to TI official CC2530 Datasheet for module pin definitions, software driver and protocol ★			

2.2. E18-MS1-IPX

Pin No.	Pin item	Pin direction	Application
1	GND		Ground, connecting to power source referential ground
2	VDD		Power supply, must be 2.0 ~ 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	Input/Output	MCU GPIO
15	P1.0	Input/Output	MCU GPIO
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
★ Please refer to TI official CC2530 Datasheet for module pin definitions, software driver and protocol ★			

2.3. E18-MS1PA1-PCB

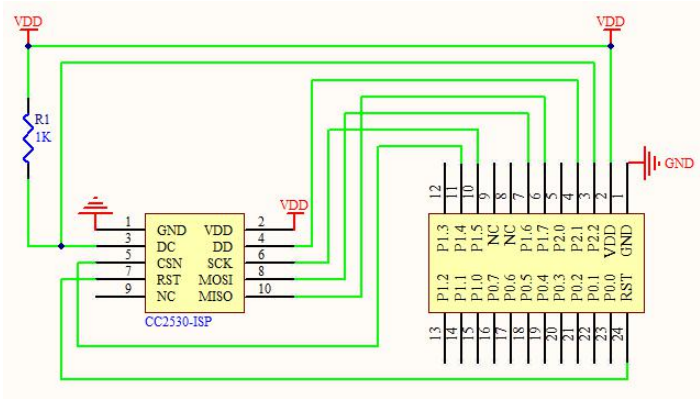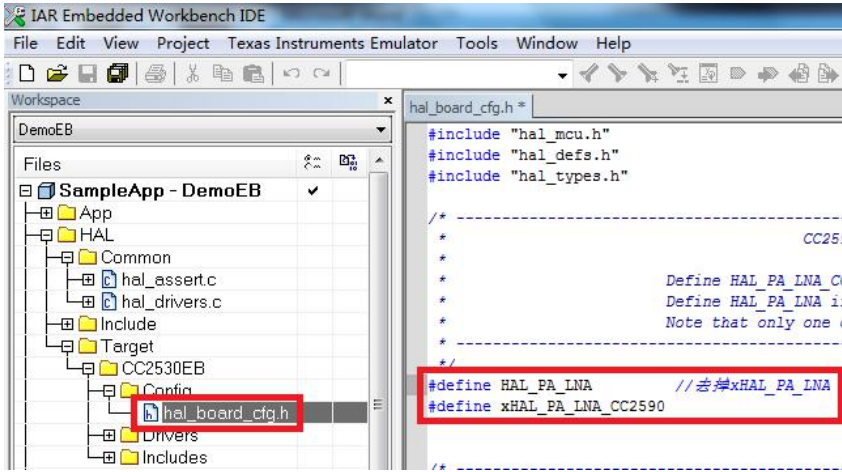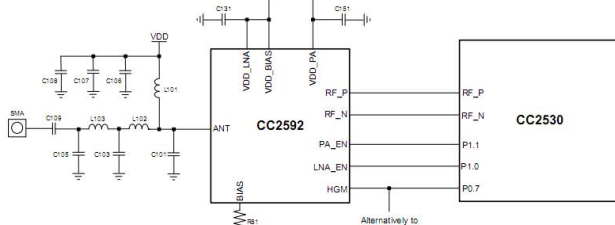| Pin No.	Pin item	Pin direction	Application
1	GND	Input	Ground, connecting to power source referential ground
2	VCC	Input	Power supply, must be 2.0 ~ 3.6V
3	P2.2	Input/Output	MCU GPIO
4	P2.1	Input/Output	MCU GPIO
5	P2.0	Input/Output	MCU GPIO
6	P1.7	Input/Output	MCU GPIO
7	P1.6	Input/Output	MCU GPIO
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	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 ★			

2.4. E18-MS1PAI-IPX

Pin No.	Pin item	Pin direction	Application
1	GND	Input	Ground, connecting to power source referential ground
2	VCC	Input	Power supply, must be 2.0 ~ 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	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 ★		

3. Usage

3.1. Development

No.	Keyword	Remark
1	Programming	Embedded 8051 MCU, Program-download can only use specified downloader CC-DeBugger,, UART or any other tools like JTAG、ISP、ICP cannot be used for download. Demo program can be provided for user as reference. User can download the compiled HEX file directly, or modify on the basis of primary code to achieve their needs.
2	Test board	N/A

Below function available for PA version module		
No.	Keyword	Remark
1	Burn firmware	The module is with built-in 8051 MCU, to download program please use downloader YHT15-A2 （click to open）

2	Initiate PA	Initiate PA , modify it in file hal_board_cfg.h.
3	Parameter setting	The setting of CC2592 in zstack，CC2530 pin: P1.1、P1.0、P0.7 are connected with CC2592 pin :PA_EN、LNA_EN、HGM. Meanwhile, LNA_EN is in high level,and it is in receiving mode.
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.

4. Programming

You are recommended to use the Code Composer Studio (CCS) integrated development environment (IDE) applicable for wireless.
Code Composer Studio is a kind of IDE, it supports TI MCU and embedded processor series products. Code Composer Studio covers a whole set of tools for development and embedded application. It covers the C/C++ compiler for optimizing, source code editor, project building environment, debugger, descriptor and many other functions. The IDE provides individual user interface, it can help you complete every step in developing. Familiar tool and interface enables users to start more quickly. Code Composer Studio integrates the advantages of Eclipse software frame and the embedded debugging function of TI and provides a knockout and functionable development environment.

4.1. TI ZigBee FAQ

4.1.1. 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.

4.1.2. 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

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.

4.1.3.　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
```

4.1.4.　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.

4.1.5.　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

4.1.6.   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.

4.1.7.   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?
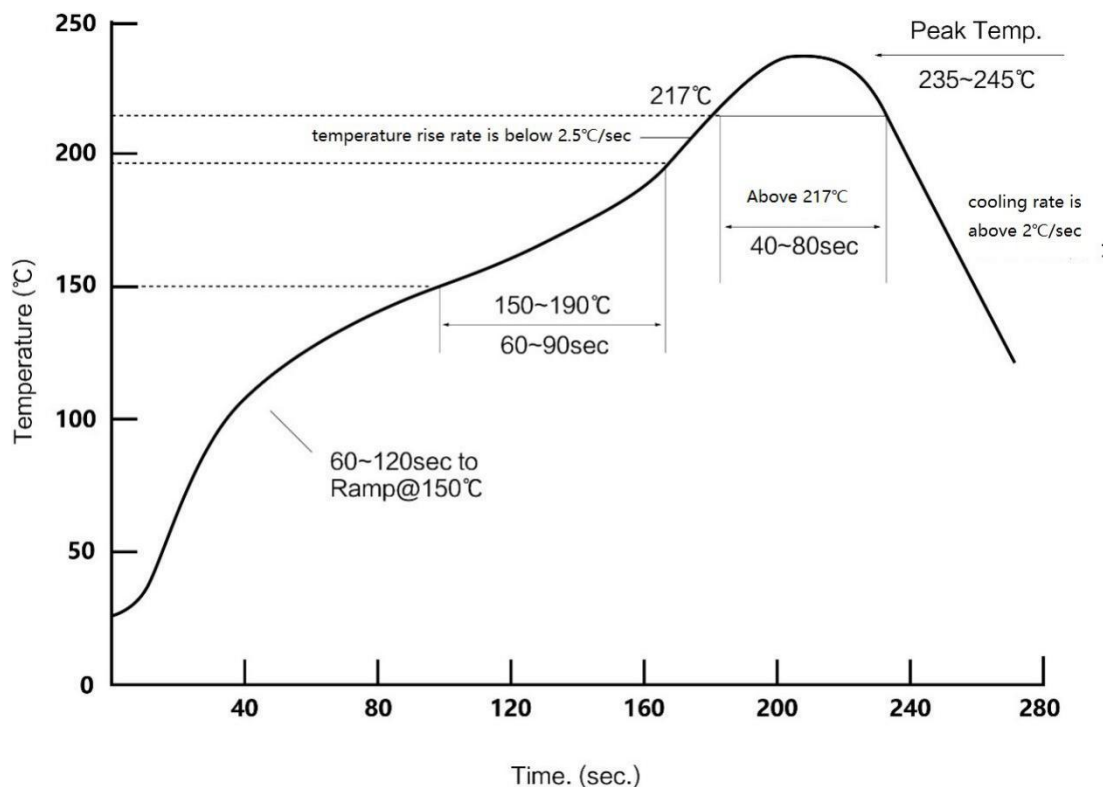
http://www.deyisupport.com/question_answer/wireless_connectivity/zigbee/f/104/t/132197.aspx

5.   Production guidance

5.1.   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.

5.2.   Reflow soldering curve

6. FAQ

6.1. 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.

6.2. 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. 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.

8. About us

Technical support: support@cdebyte.com

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