E18-MS1-PCB User Manual

CC2530 2.4GHz ZigBee SMD wireless module

Contents

1. General introduction

1.1 Brief introduction

E18-MS1-PCB is small-sized 2.4GHz SMD wireless module, which is designed and produced by Chengdu Ebyte. The space between each pin is 1.27mm. E18-MS1-IPX has been put into stable bulk production, it is applicable for various applications (especially smart home).

E18-MS1-PCB adopts the original CC2530 RF chip of TI. The chip integrates 8051 MCU and wireless transceiver, and built-in CC2592 RF range extender, integrated PA + LNA, greatly expanding communication distance and improving communication stability。Factory-installed self-organizing network firmware based on ZigBee

protocol for serial data transmission. On the basis of serial data wireless inheritance, we also added some special functions, including ADC sampling, remote PWM wave output control, remote GPIO control. Users do not need to understand the complex wireless communication principle, as long as the simple control instructions are sent, data transmission and intelligent control can be realized.

This module supports secondary development, and the user can burn the program。

1.2 Characteristic function

- Role switch：Users can switch freely between the coordinator, router and end device via UART command.

- Automatic networking :Support power-on automatic networking. The coordinator automatically sets up the network, the end device and the router automatically searches and joins the network.

- Network self-healing：Automatically reconnect when losing network. When intermediate node in network is lost, other networks automatically join or maintain the original network. (Isolated nodes automatically join the original network, non-isolated
nodes maintain the original network.) When the coordinator is lost and non-isolated nodes exist in the original network, the coordinator can join the network again or coordinator of the original network PAN_ID set by the same user join the original network.

- Ultra-low power consumption：The device can be set as low power mode in the end state. Sleep time of the device can be changed according to the user's using time. The standby power consumption in the low power mode is less than 2uA. In the father node data storage time, all messages can be received within the time set by users.

- Configuration for data storage time：When device is in the coordinator and router state, the user can set their own data storage time, and work with end device in sleep mode to save data for the end device, and sent data to the end

device when it wakes up.

Data saved is up to 3 data packets, if exceeded, it will automatically clear the first data! After the data is saved, the data heap is automatically cleared.

● Automatic retransmission: In unicast mode, the device will automatically retransmit when failed to send to next node, and the number of retransmission per message is three.

● Automatic routing: The module supports network routing. Router and coordinator have network data routing function, users can conduct multi-hopping networking.

● Support encryption protocol :The module uses AES 128 bit encryption function, can change the network encryption and prevent monitoring. Users can change the network key by themselves. Only devices with the same network key can start normal networking communication.

● Support UART configuration: Module has built-in UART commands, the user can configure (view) the parameters and functions of module via UART command .

● Communication for various types of data: Support broadcasting, multicasting and unicasting in the entire network. In the broadcast and unicast mode, it also supports several transmission methods

● Multi-mode selection: support through mode, semi-through mode, protocol mode, three working modes, user can switch freely

● Change channel: It supports change of 16 channels ranging from 11 to 26（2405~2480MHZ）, different channels have different frequency.

● Change network PAN_ID: Free switch of network PAN_ID. Users can define PAN_ID to join the corresponding network by themselves or automatically select PAN-ID to join the network.

● Change UART baud rate: Users can set baud rate by themselves which can be as high as 1M, it is 8 bits by default without parity bit.

● Search short address: Users can find out corresponding short address according to the (unique and fixed) MAC address of module that already joined network.

● GPIO control:Local/remote gpio control function，there are 10 gpio for users to select.

● Pwm control :Local/remote pwm control function，there are 5 pwm channels for users to select.

● ADC control:Read local/remote adc，there are 7 adc channels for users to select.

● Command format switch: The module supports AT command and HEX command for users' easy configuration and switch.

● Module restore:Users can restore the module via UART commands.

● Onekey recovery of baud rate: The module supports onekey recovery of baud rate when users forget the baud rate. The baud rate is 115200(default).

● Recover factory setting:Users recover the factory setting via UART commands.

1.3 ZigBee introduction

ZigBee technology is a two-way wireless communication technology that features short range, low complexity,low power, low speed and low cost.

There are three types of logical devices in the ZigBee network: Coordinator, Router, and End-Device. The ZigBee network consists of a Coordinator and multiple routers and End-Devices.

These devices own the following functions:

（1）Coordinator

As the first device in the network, the coordinator is responsible for starting the entire network. . The coordinator selects a channel and a network ID (also known as the PAN ID, the Personal Area Network ID), and then starts the entire network.

Coordinators can also be used to help establish bindings between security layer and application layer in the network.

Note that the role of the coordinator mainly involves the network startup and configuration. Once these are done, the coordinator works like a router (or disappears /go away). Due to the distribution characteristics of the ZigBee network itself, the operation of the entire network is not dependent on the existence of the coordinator.

（2）Router

The main functions of the router: to allow other devices to join the network, multi-hop routing and to assist communication of its own battery-powered son node end-devices.

Typically, the router is expected to remain active, so it must use the main power supply. However, when using the tree group network mode, it allows the routing operate once at an interval of a certain cycle, so battery can be used for power supply.

（3）End-Device

The end-device does not have a specific responsibility for maintaining the network structure, it can sleep or wake up, so it can be a battery-powered device.

1.4 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	
Power 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
Operating temperature（℃）	-40	85	-

2.2 Working parameters

Main parameter	Performance			Remark
	Min	Type	Max	
Operating voltage（V）	2.0	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
Operating temperature （℃）	-40	-	85	Industrial grade
Operating frequency（GHz）	2.400	-	2.480	Support ISM band
Power Consum-ption	TX current（mA）	-	28	-	Instant power consumption
	RX current（mA）	-	27	-	-
	Sleep current（μA）	-	1.2	-	Shut down by software
Max TX power（dBm）	3.6	4.0	4.5	-
Receiving sensitivity（dBm）	-95.5	-96.4	-97.5	Air data rate is 250 kbps

Main parameter	Description	Remark
Reference distance	200 m	Test condition：clear and open area, antenna gain: 5dBi，antenna height: 2.5m，air data rate: 250 kbps
Protocol	ZigBee	-
Package	SMD	-
Interface	1.27mm	-
IC	CC2530F256RHAT/QFN40	-
FLASH	256 KB	-
RAM	8 KB	-
Core	8051microcontroller	-
Main parameter	14.1 * 23.0 mm	-
Antenna	PCB	50 ohm impedance

3. Mechanical characteristics

Top pad : 0.50
0.50 0.80

Bottom pad : 1.00
0.50 0.80
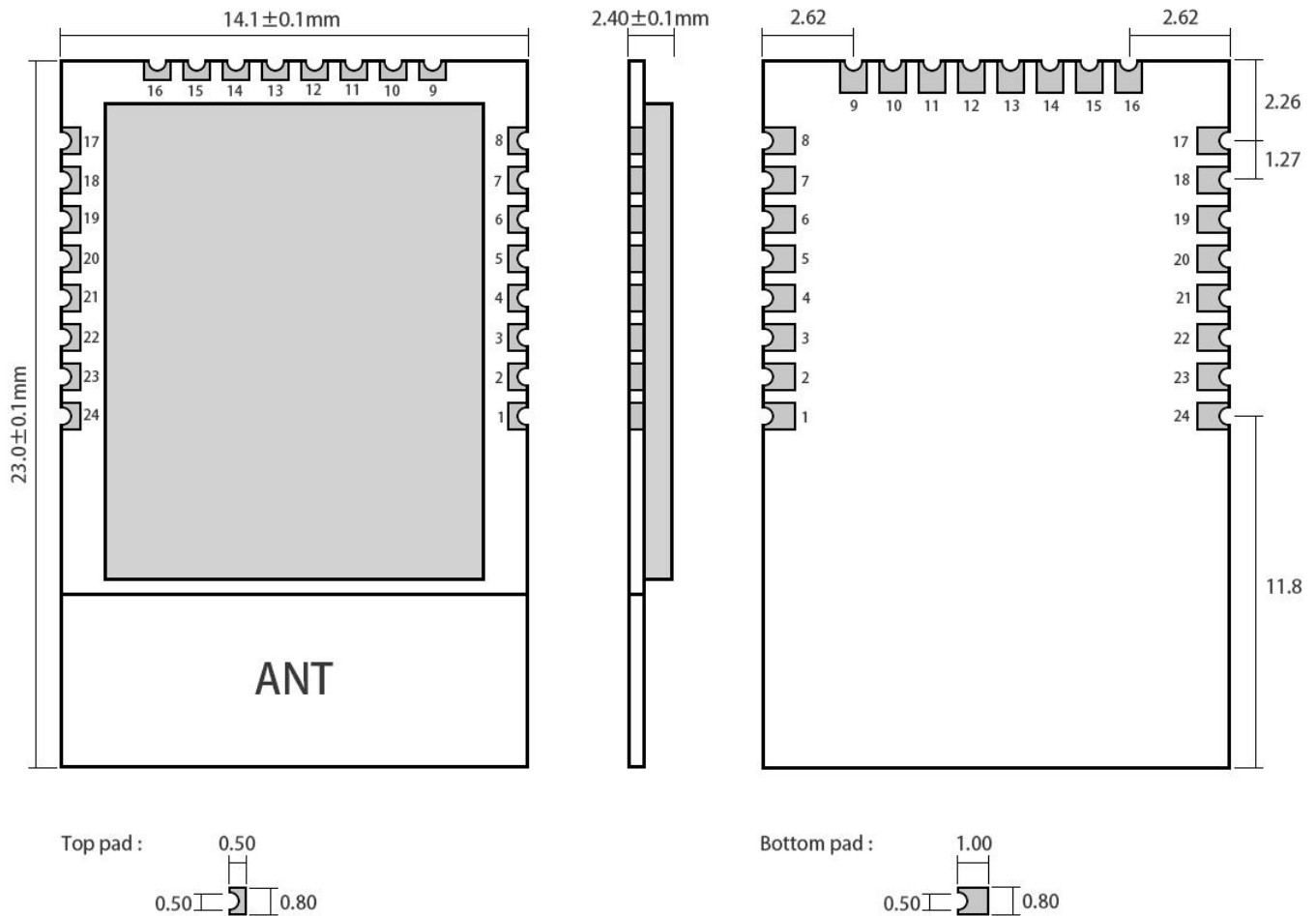
Pad quantity : 24
Unit: mm

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	Output	MCU GPIO
15	P1.0	Output	MCU GPIO
16	P0.7		NC
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

- For the IO function, please go to the official website to download "E18_Software_Datasheet_CN";
- For secondary development, please refer to TI's official "CC2530 Datasheet" for pin definition, software driver and communication protocol.

4. Operation mode

| Mode	Node	Description	Data Communication Display Mode
Mode 1 （Transparent transmission mode）	Coordinator	This type of node is a transmission mode, which transmits serial data to non-sleeping devices in the network through broadcasting.	Data carrier formats can be configured by instructions: 1 Display the sender's MAC address; 2.Display short address of sender; 3 Display the RSSI value of the shortest path of the message; (User can configure the display mode to carry no display and any one or more display modes)）
	Router	This type of node is in the transmission mode, passing serial data to the coordinator through on-demand. (Note: Terminal can't receive the transmitted data of Mode 1 in dormant mode)	
	End device		
Mode 2 （Half transparent transmission mode）	Coordinator	The module transmits data according to fixed format and full protocol. It can carry out unicast, broadcast and multicast. Please see more details in HEX command data communication format	
	Router	This type of node is in the transmission mode, passing serial data to the coordinator through unicast	
	End device		
Mode 3 （Protocol mode）	Coordinator	The module transmits data according to fixed format and full protocol. Can be unicast,broadcast, multicast; for details, please see more details in HEX command data communication format	/
	Router		
	End device		
Note: Only mode 3 can be selected for GPIO function configuration. Any mode can communicate with each other without affecting each other.			

5. Protocol mode

No	Using mode	Description

1	Broadcast	When joining the network, the user can broadcast according to the commands in the whole network (which can be divided into three broadcast modes) 1, Broadcast Mode 1 - The message is broadcasted to all devices in the entire network. 2, broadcast mode 2 - the message is broadcasted only to receiving devices (except sleep mode). 3, broadcast mode 3 - the message is broadcasted to all full-functional devices (router and coordinator).
2	Multicast	When joining the network, the user can multicast all the devices (not in sleep) in the entire network.
3	Unicast	When joining the network, the user can independently communicate with the devices in the network in a short address mode according to the commands (which can be divided into three broadcast modes) 1, transparent transmission mode - (no carrying information) 2, short address mode - (carry information for the short address) 3, MAC address mode - (carry information for the MAC address)

6.Function description

6.1 Pin diagram
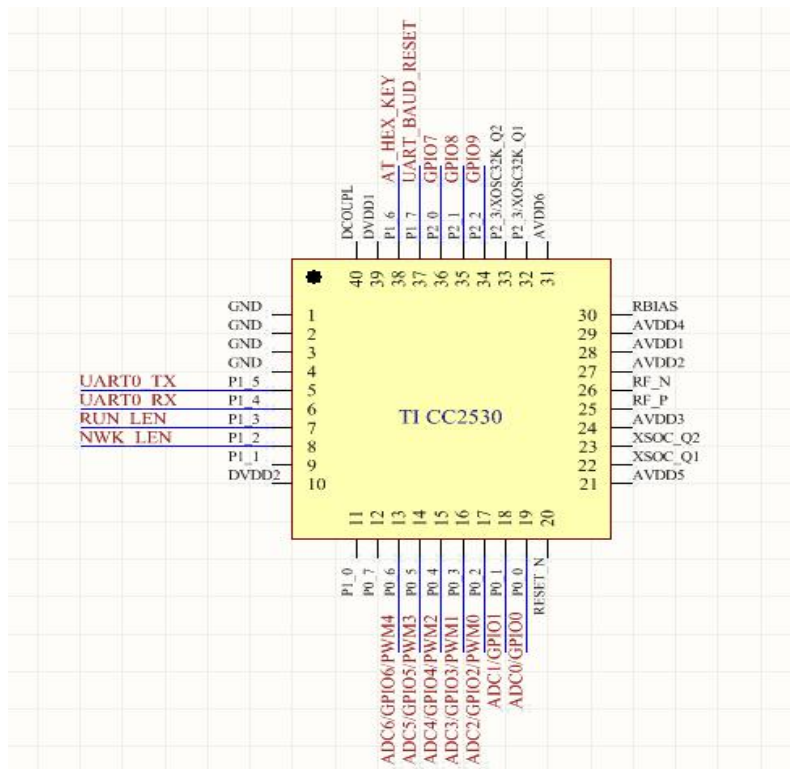
Pin No.	Function indication	Description (reuse function pin can only be defined as the function rectified for the last time)	Input/Output
P0_0	GPIO0/ADC0	User controlled function pin GPIO0/ADC0	I/O
P0_1	GPIO1/ADC1	User controlled function pin GPIO1/ADC1	I/O
P0_2	GPIO2/ADC2/PWM0	User controlled function pin GPIO2/ADC2/PWM0	I/O

P0_3	GPIO3/ADC3/PWM1	User controlled function pin GPIO3/ADC3/PWM1	I/O
P0_4	GPIO4/ADC4/PWM2	User controlled function pin GPIO4/ADC4/PWM2	I/O
P0_5	GPIO5/ADC5/PWM3	User controlled function pin GPIO5/ADC5/PWM3	I/O
P0_6	GPIO6/ADC6/PWM4	User controlled function pin GPIO6/ADC6/PWM4	I/O
P2_0	GPIO7	User controlled function pin GPIO7	I/O
P2_1	GPIO8	User controlled function pin GPIO8	I/O
P2_2	GPIO9	User controlled function pin GPIO9	I/O
P1_2	NWK_LED	To indicate module network joining state, low level means that module joins network, high level means no network.	O
P1_3	RUN_LED	To indicate module works normally, low level means that module works normally, high level means module does not work.	O
P1_6	AT_HEX_KEY	To switch AT command and HEX command, low level means HEX command mode, high level means AT command mode（default）.	I
P1_7	UART_BAUD_RESET	To reset baud rate, when users forget or do not know the baud rate use this button to restore factory setting （115200）（valid for falling edge）.	I
P1_4	UART0_RX	UART RX pin	I
P1_5	UART0_TX	UART TX pin	O

6.2 Pin connection instructions
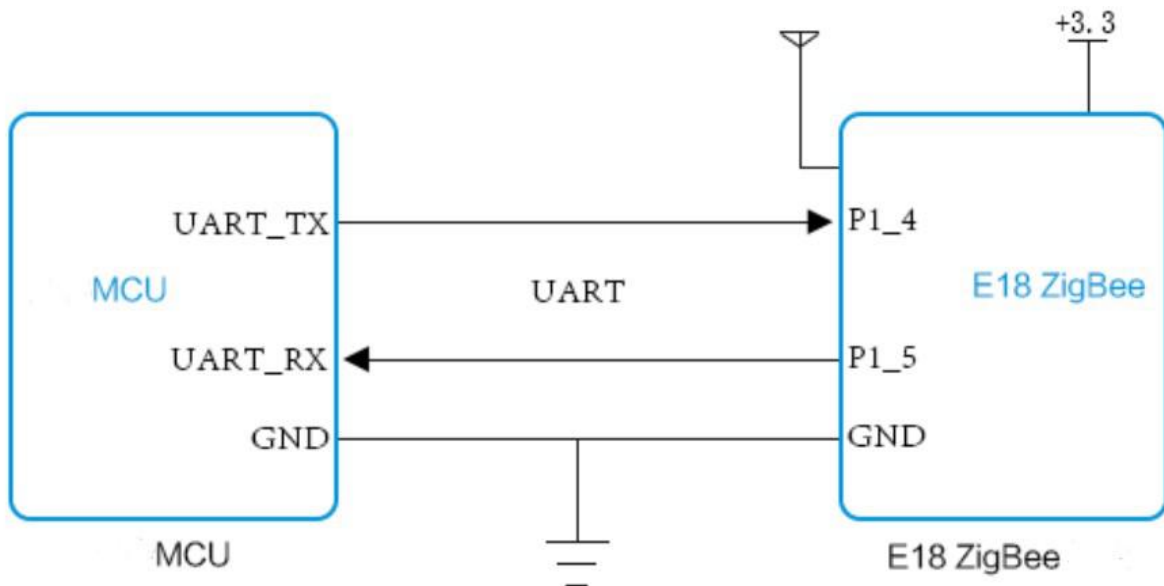
7.Quick start

The ZigBee ad hoc network module is easy to use. In order to allow users to be quickly familiar with modules,this section will guide users to achieve configuration and communication in various modes via a simple configuration. The working mode is mode 3 (protocol mode).

The user can pull down the P1.6 pin and conduct the HEX instruction set. In order to facilitate observation of the host computer , the experiment will use HEX command format, AT command users do not test in this test. (AT command cannot be used for the configuration of host computer.)

In addition, the user can use the external microcontroller (MCU) instead of test board directly to connect with module for UART command communication to achieve secondary development.

7.1 Network construction and communication

No	Notes
1	【Construct network】: ①.Connect Zigbee ad hoc module via USB to UART converter. ② .Open host computer software " Zigbee_Setting_V1.1 " , select Com port and set baud rate as 115200(default), then open port; ③.Click read parameter to read corresponding module parameter.

④.Select node type as coordinator, write in parameter. Wait the coordinator to start constructing network and users can check module parameter.

　　Set network parameter：（when PAN ID is FFFF, it is automatic PAN ID）

Read parameter when network is constructed：

⑤. Select another module, set it as the router or end device following the same steps (module is set as end device when leave factory (default),no need to set again, in this experiment it is end device)。
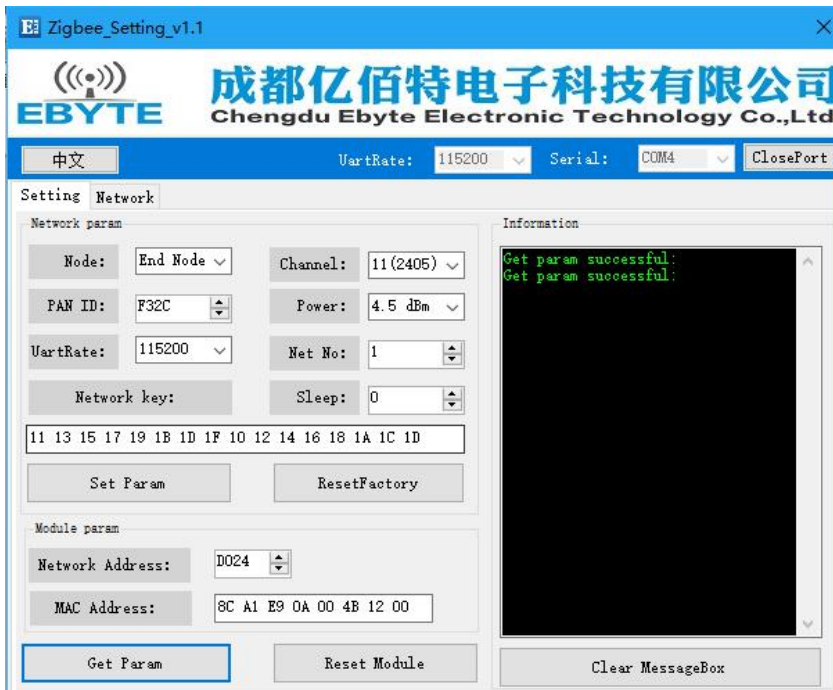
2	【Communication test】:
	①.Click "fixed networking"of the coordinator and end device of the host computer. Corresponding info is available to be viewed.
	Coordinator：

End device：

②. For users' convenience to observe, in this experiment it is HEX transmitting mode.

If the device address is unknown, please input corresponding mac address and click get network address. The short address of coordinator is 0.

③.Input random content in these 3 modes, click start.

Transparent transmission：

From coordinator to end device：

From end device to coordinator：

【Network address】

From coordinator to end device：

【Network address】

From end device to coordinator

【MAC address】

From coordinator to end device：

【MAC From end device to coordinator】

【Multicast】:

Broadcast ： broadcast only conduct Mode 1, the entire network conduct broadcast mode experiment, other modes test by themselves ）

Data function transmission needs to reflect its own characteristics in the case of multi-node network, the users can test by themselves！

8. User instruction set

In order to facilitate user use, E18 ZigBee module uses two instruction formats, namely AT instruction format and HEX instruction format. The format mode is controlled by default P1_6.

When P1_6 = 0, the module enters HEX instruction mode. In this mode, input +++, enter the temporary AT instruction mode. AT command can be used to configure, input AT + EXIT exit temporary AT command.

When P1_6 = 1, the module enters AT instruction mode. Line break endings cannot be used in AT instructions.

Remarks：

　　1 Serial data format error message

　　　　HEX instruction mode ： 　F7 FF

　　　　　AT instruction mode 　： 　+ERROR<CR><LF>

　　2 Coordinator device network establishment will prompt information:

　　　　HEX instruction mode 　： 　FF FF

　　　　　AT instruction mode 　： 　Builded network<CR><LF>

　　3 Devices joining the network will prompt information

　　　　HEX instruction mode： 　FF AA

　　　　　AT instruction mode： 　Joined network<CR><LF>

　　4 Module device without or lost network will prompt information

HEX   instruction mode :FF 00

AT   instruction mode：No network<CR><LF>

5 <CR>：0x0D

6 <LF>：0x0A

8.1 HEX read command description

Command description	Command format	Command example
Read device type	Send：FE 01 01 FF Return：FB dev_type	Send：FE 01 01 FF Return：FB 02
Read network state	Send：FE 01 02 FF Return：FB nwk_state	Send：FE 01 02 FF Return：FB 01
Read network PAN_ID	Send：FE 01 03 FF Return：FB pan_id	Send：FE 01 03 FF Return：FB 02 F4
Read network key	Send：FE 01 04 FF Return：FB key	Send：FE 01 04 FF Return :FB 11 13 15 17 19 1B 1D 1F 10 12 14 16 18 1A 1C 1D
Read local short address	Send：FE 01 05 FF Return：FB ShortAddr	Send：FE 01 05 FF Return：FB F2 EF
Read local MAC address	Send：FE 01 06 FF Return：FB Mac_Addr	Send：FE 01 06 FF Return :FB 89 6C 50 09 00 4B 12 00
Read short address of father nodes	Send：FE 01 07 FF Return：FB Coor_shortAddr	Send：FE 01 07 FF Return：FB 00 00
Read short MAC address of father nodes	FE 01 08 FF Return：FB Coor _Mac_Addr	Send：FE 01 08 FF Return：FB 20 39 EA 0A 00 4B 12 00
Read network group number	Send：FE 01 09 FF Return：FB group	Send：FE 01 09 FF Return：FB 01
Read communication channel	Send：FE 01 0A FF Return：FB channel	Send：FE 01 0A FF Return：FB 0B
Read Send power	Send：FE 01 0B FF Return：FB txpower	Send：FE 01 0B FF Return：FB 04
Read UART baud rate	Send：FE 01 0C FF Return：FB baud	Send：FE 01 0C FF Return：FB 09
Read sleep state (valid for terminal nodes)	Send：FE 01 0D FF Return：FB sleep_time	Send：FE 01 0D FF Return：FB 05
Read data storage time of the node(valid for router and coordinator)	Send：FE 01 0E FF Return：FB 1E	Send：FE 01 0E FF Return：FB 1E

Command description	Command format	Command example
Read all device data	Send：FE 01 FE FF Return：FB all_info	Send：FE 01 FE FF Return：FB 02 01 02 F4 11 13 15 17 19 1B 1D 1F 10 12 14 16 18 1A 1C 1D F2 EF 89 6C 50 09 00 4B 12 00 00 00 20 39 EA 0A 00 4B 12 00 01 0B 04 09 05
Acquire short address of random MAC address in network	Send：FE 09 10 Mac_Addr FF Return：FB shortAddr	Send：FE 09 10 AF 99 E9 0A 00 4B 12 00 FF Return：FB 08 35
Read remote/local GPIO input and output state	Command：FE 04 20 addr gpiox FF Return：FB 20 addr In/Out	FE 04 20 F9 DE 04 FF
Read remote/local GPIO level	Command：FE 04 21 addr gpiox FF Return：FB 21 addr In/Out level	FE 04 21 FF FF 04 FF
Read remote/local PWM state	Command：FE 04 22 addr 22 FF Return：FB 22 addr period duty1 duty2 duty3 duty4 duty5	FE 04 22 FFFF 22 FF
Read remote/local ADC state	Command：FE 04 23 addr pin FF Return：FB 23 addr adc_value	FE 04 23 FF FF 01 FF

8.2 HEX Parameter description

8.2.1. Device type　dev_type ：00　coordinator

01　router

02　terminal（default）

8.2.2. Network state　nwk_state ：00　no network

01　network exists

8.2.3. Network PAN_ID　pan_id ：0000~FFFE　fixed network PAN_ID

FFFF　　　stochastic network　PAN_ID

8.2.4. Network key　key ：16 bits network key

8.2.5. Network short address　shortAddr ：2 Byte address

8.2.6. MAC address　　Mac_Addr ：8 Byte address

8.2.7 Short address of father nodes　Coor_shortAddr ：2 Byte address

8.2.8. MAC address of father nodes   Coor_Mac_Addr：   : 8 Byte address

8.2.9. Network group number group   : range from 1~99（default 1）

8.2.10. Channel   channel   : range from 11~26（default 11）

8.2.11. Power   txpower table（default 0dBm）：

txpower	power (dBm)
00	-3
01	-1.5
02	0

txpower	power (dBm)
03	2.5
04	4.5
05	

8.2.12. Buad rate   baud table（default 115200）：

baud	Baud rate
00	2400
01	4800
02	9600
03	14400
04	19200
05	38400
06	43000
07	57600

baud	Baud rate
08	76800
09	115200
0A	128000
0B	230400
0C	256000
0D	460800
0E	921600
0F	1000000

8.2.13. Sleep time   sleep_time : 0   sleep mode closed（default）

               Otherwise   sleep mode open , sleep time is sleep_time, unit S

8.2.14. Storage time of father nodes   time：range from 0~120（default 30）, unit S

8.2.15. Gpio parameter

（1）gpio portal table

GPIO	P0_0	P0_1	P0_2	P0_3	P0_4	P0_5	P0_6	P2_0	P2_1	P2_2
HEX	00	01	02	03	04	05	06	07	08	09

（2）gpio input/output state

In/Out： 　　　1　　 input state

　　　　　　　　　0　　　 output state

（3）gpio state value（ invalid for input state configuration）

　　　　level　　　　0　　 low level

　　　　　　　　　　1　　 high level

　　　　　　　　　　2　　 switch

8.2.16. pwm parameter

（1）pwm portal table

pwmx	duty1	duty2	duty3	duty4	duty5
GPIO	P0_2	P0_3	P0_4	P0_5	P0_6

（2）period： 　　period　　 unit 62.5ns　　 0~0xffff

（3）dutyx： 　　　　　duty cycleunit 62.5ns　　 0~0xffff

8.2.17. adc parameter：

（1）adc state value

　　　　adc_state　　0　　　　ADC enabled

　　　　　　　　　　1　　　　ADC closed

（2）adc sample value

　　　　adc_value 0~0XFFFF

8.2.18. Peripheral addr parameter description

　　　　Addr value

　　　　　　　　　　FFFF　　　　 check/configure local information

　　　　　　　　　　0~FFF8　 check/configure information with network address addr

　　　　　　　　　　FFFE FFFD FFFC　 check/configure information for all devices receiving broadcast

　　　　　　　　　　（FFFE：broadcast to all devices in network

　　　　　　　　　　 FFFD：broadcast to devices receiving when free (except devices in sleep）

　　　　　　　　　　 FFFC：broadcast to coordinator and router）

8.2.19. All information   all_info

dev_type   (1 Byte (0)   )   device type

nwk_state   (1   Byte (1)   )   network state

pan_id   (2   Byte (2~3)   )   PAN_ID

key   (16   Byte (4~20)   )   network key

shortAddr   (2   Byte (21~22)) network short address

Mac_Addr   (8   Byte (23~30)) MAC address

Coor_shortAddr   (2   Byte (31~32)) Short address of father nodes

Coor_Mac_Addr   (8   Byte (33~40)) MAC address of father nodes

group   (1   Byte (41)   )   network group number

channel   (1   Byte (42)   )   communication channel

txpower   (1   Byte (43)   )   transmit power

baud   (1   Byte (44)   )   UART baud rate

sleep_time   (1   Byte (45)   )   sleep state

Detailed parameter for example：

all_info：02 01 02 F4 11 13 15 17 19 1B 1D 1F 10 12 14 16 18 1A 1C 1D F2 EF 89 6C 50 09 00 4B 12 00 00 00 20 39 EA 0A 00 4B 12 00 01 0B 04 09 05

Device type：   02 （Terminal）

Network state：   01 （Network exists）

Network PANID：   02 F4 （PAN_ID=0X02F4）

Network key：   11 13 15 17 19 1B 1D 1F 10 12 14 16 18 1A 1C 1D

Short address of local network：   F2 EF （Short Address=0XF2EF）

Local MAC address：   89 6C 50 09 00 4B 12 00

Short address of father nodes：   00 00（Short Address=0X0000）

MAC address of father nodes：   20 39 EA 0A 00 4B 12 00

Network group number：   01

Network channel：   0B（channel 11）

Transmit power：   04（transmit power 4.5dBm）

Baud rate：   09（baud rate 115200）

Sleep time：   05（sleep mode starts，sleep time is 5s）

(Notes：Father node reserve time is not listed here, please use corresponding command for configuration and examination.)

8.3. HEX command data communication format

8.3.1. Command format description

Command（COM） 1Byte	Data length（LEN） 1Byte	Data content（DATA）
FC	LEN	DATA

8.3.2. DATA parameter description（data is content awaiting to send）

1）Broadcast data

     Command：01+type+data

     Parameter description：type

       01：broadcast mode1 ——broadcast the message to all devices in network

       02：broadcast mode2 ——broadcast the message to receiving devices(except ones in sleep mode)

       03：broadcast mode3 ——broadcast the message to all functional devices （router and coordinator）

Example：FC 05 01 02 31 32 33

Example explanation：Transmit HEX data to network broadcast in broadcast mode 2: 0X310X320X33

2）Multicast data

     Command：02+ group+data

     Parameter description：group

          0~99：number for the multicasted message

Example：FC 05 02 01 31 32 33

Example explanation：Send HEX data to Network Group 1：0X31 0X32 0X33

3）Unicast data

     Command：03+ type +addr+data

    Parameter description： type

        01：transparent transmission mode（no carry message）

        02：short address mode（carry message is short address）

        03：MAC address mode（carry message is MAC address）

    Parameter description：addr: network short address   valid unicast address 0x0000—0xFFF8）

Example：FC 07 03 01 AB CD 31 32 33

8.4 AT Command

8.4.1 AT+DEV

Function：Inquire/Configure device type

Format：

　　Inquire

　　Send：AT+DEV= type

　　Return：+OK<CR><LF>

　　Configure

　　　　Send：AT+DEV=?

　　Return：DEV= type<CR><LF>

Parameter：type

　　　　C　Coordinator

　　　　R　Router

　　　　E　End device

Example：AT+DEV=C

Default：DEV=E

8.4.2 AT+EXIT

Function: Exit the temporary AT instruction. (P1_6 pin is valid when it is pulled down into AT command.)

Format: Configure

　　Send：AT+EXIT

　　Return：+OK<CR><LF>

Example：AT+EXIT

8.4.3 AT+MODE

Function：Inquire/Configure operation mode

Format：Inquire

　　Send：AT+MODE=?

　　Return：MODE=type<CR><LF>

　　Configure

　　Send：AT+MODE=mode

　　Return：+OK<CR><LF>

Parameters：mode

　　　　1　mode 1　（transparent mode）

　　　　2　mode 2　（half transparent mode）

　　　　3　mode 3　（protocol mode）

Example：AT+MODE=3

Default：MODE=3

8.4.4 AT+RMODE

Function：Inquire/Configure communication display mode

Format：Inquire

Send：AT+RMODE=?

Return：RMODE=type<CR><LF>

Configure

Send：AT+RMODE=type

Return：+OK<CR><LF>

Parameter： rmode（1:on, 0:off ；Range：0-7 ）

0bit ： MAC address

1bit ： Short address

2bit ： RSSI value of message shortest path

Example：AT+RMODE=0

Default：RMODE=0

8.4.5 AT+NWK

Function： Inquire network state

Format：Inquire

Send：AT+NWK=?

Return：NWK=nwk_state<CR><LF>

Parameter：nwk_state

0   No network

1   Existing network

Example：AT+NWK=?

8.4.6 AT+PANID

Function：Inquire/Configure PANID

Format：Inquire

Send：AT+PANID=?

Return：PANID=panid<CR><LF>

Configure

Send：AT+PANID=mode

Return：+OK<CR><LF>

Parameter：panid

0000-FFFE   Fixed PANID

FFFF   Random PANID

Example：AT+ PANID=0XA1B2

8.4.7 AT+KEY

Function：Inquire/ Configure network key

Format：Inquire

Send：AT+KEY=?

Return：KEY=key<CR><LF>

Configure

Send：AT+PANID=mode

Return：+OK<CR><LF>

Parameter：key

16　Byte network key

Example：AT+ KEY=01030507090B0D0F00020406080A0C0D

Default：KEY=01030507090B0D0F00020406080A0C0D

8.4.8　AT+SHORT_ADDR

Function：Inquire local network address

Format：Inquire

Send：AT+SHORT_ADDR =?

Return：SHORT_ADDR=shortaddr<CR><LF>

Parameter：shortaddr

0000-FFFF Network short address

Example：AT+SHORT_ADDR=?

8.4.9　AT+MAC_ADDR

Function：Inquire/Configure network PANID

Format：Inquire

Send：AT+MAC_ADDR=?

Return：MAC_ADDR=macaddr<CR><LF>

Parameter：macaddr

8 Byte MAC long address（unique IEEE ID）

Example：AT+MAC_ADDR=?

8.4.10　AT+COOR_SHORT_ADDR

Function：Inquire father node network short address

Format：Inquire

Send：AT+COOR_SHORT_ADDR=?

Return：COOR_SHORT_ADDR=macaddr<CR><LF>

Parameter ：macaddr

8 Byte MAC long address（unique IEEE ID）

Example：AT+COOR_SHORT_ADDR=?

8.4.11　AT+COOR_MAC_ADDR

Function：Inquire father node MAC address

Format：Inquire

Send：AT+COOR_MAC_ADDR=?

Return：COOR_MAC_ADDR=macaddr<CR><LF>

Parameter：macaddr

8 Byte MAC short address（unique IEEE ID）

Example：AT+COOR_MAC_ADDR=?

8.4.12　AT+GET_SHORT_ADDR

Function：Inquire the network short addresses of any MAC device

Format：Inquire

    Send：AT+GET_SHORT_ADDR=macaddr

    Return：GET_SHORT_ADDR=shoraddr<CR><LF>

Parameter：macaddr

      8 Byte MAC Length address（Unique IEEE ID）

   shoraddrt

     Short address of inquired device

Example：AT+GET_SHORT_ADDR=4B805A3D25741200

8.4.13　AT+GROUP

Function：Inquire/Set network group number

Format：Inquire

     Send：AT+GROUP=?

    Return：GROUP=group<CR><LF>

Set

    Send：AT+GROUP=group

    Return：+OK<CR><LF>

Parameter：group（0~99）

     Local group number

Example：AT+GROUP=group

Default：GROUP=1

8.4.14　AT+CH

Function：Inquire/Configure wireless channel

Format：Inquire

     Send：AT+CH=?

    Return：CH=ch<CR><LF>

Configure

    Send：AT+CH=ch

    Return：+OK<CR><LF>

Parameter：ch（11~26）

     Wireless channel

Example：AT+CH=11　　**Default**：CH=11

8.4.15　AT+TXPOWER

Function：Inquire/Configure wireless transmitting power

Format：Inquire

     Send：AT+TXPOWER=?

    Return：CH=txpower<CR><LF>

Configure

    Send：AT+TXPOWER=txpower

    Return：+OK<CR><LF>

Parameter：txpower（0~4）

     Transmitting power

Example：AT+TXPOWER=4

Default：TXPOWER=4

8.4.16   AT+UART

Function：Inquire/Configure serial port baud rate

Format：Inquire

        Send：AT+UART=?

     Return：UART=baud\<CR>\<LF>

  Configure

     Send：AT+UART=baud

     Return：+OK\<CR>\<LF>

Parameter：baud（0~15）

     Serial Port Baud Rate

Example：AT+UART=9

Default：UART=9

8.4.17   AT+SLEEP

Function：Inquire/Configure device sleep mode (End device valid)

Format：Inquire

        Send：AT+SLEEP=?

     Return：SLEEP=sleep\<CR>\<LF>

  Configure

     Send：AT+SLEEP=sleep

     Return：+OK\<CR>\<LF>

Parameter：sleep

       0 close sleep mode

       1~250 Sleep mode is turned on, sleeping time is 1-250 seconds

Example：AT+SLEEP=0

Default：SLEEP=0

8.4.18   AT+DATA_TIME

Function：Inquire/Configure data reserved time

Format：Inquire

        Send：AT+DATA_TIME=?

     Return：DATA_TIME=data_time\<CR>\<LF>

  Configure

     Send：AT+SLEEP=data_time

     Return：+OK\<CR>\<LF>

Parameter：data_time

       0~120 Data retention time,Unit:S

Example：AT+DATA_TIME=30

Default：DATA_TIME=30

8.4.19   AT+SOFT_ID

Function：Inquire software version number

Format：Inquire

        Send：AT+SOFT_ID=?

      Return：SOFT_ID=soft_id<CR><LF>

Parameter：soft_id

        software version number

Example：AT+SOFT_ID=?

8.4.20 AT+RESET

Function：Device reset

Format：Configure

        Send：AT+RESET

      Return：+OK<CR><LF>

Example：AT+ RESET=?

8.4.21 AT+RESTORE

Function：Restore factory settings

Format：Configure

        Send：AT+RESTORE

      Return：+OK<CR><LF>

Example：AT+RESTORE=?

8.3.22 AT+GPIO_PUT

Function：Configure remote/local GPIO input/output mode

Format：Configure

        Send：AT+GPIO_PUT=addr,gpiox,inout

       Return：+OK<CR><LF>

Parameter：addr

    0000~FFF8 remote short address device

    FFFF local device

gpiox   (0~9)

    GPIO port number

    input

    0 Output state

    1 Input state

Example：AT+GPIO_PUT=1AC0,5,0

8.4.23 AT+RGPIO_PUT

Function：Read remote/local GPIO input/output mode

Format：Configure

        Send：AT+RGPIO_PUT=addr,gpiox

       Return：RGPIO_PUT=addr,input<CR><LF>

Parameter：addr

    0000~FFF8 Remote short address device

    FFFF local device

gpiox   (0~9)

GPIO Port number

input

0 Output state

1 Input state

Example：AT+RGPIO_PUT=1AC0,5

8.4.24   AT+GPIO_LEVEL

Function：Read remote/local GPIO input/output mode

Format：Configure

Send：AT+GPIO_LEVEL=addr,gpiox,level

Return：+OK<CR><LF>

Parameter：addr

0000~FFF8 Remote short address device

FFFF Local device

gpiox   (0~9)

GPIO port number

level

0 high level

1 low level

2 overturn

Example：AT+GPIO_LEVEL=1AC0,5,2

8.4.25   AT+RGPIO_LEVEL

Function：Read remote/local GPIO input/output mod

Format：Read

Send：AT+RGPIO_LEVEL=addr,gpiox

Return：RGPIO_LEVEL=addr,input,level<CR><LF>

Parameter：addr

0000~FFF8 Remote short address device

FFFF Local device

gpiox   (0~9)

GPIO Port number

input

0 Output state

1 Input mode

level

0 High level

1 Low level

Example：AT+RGPIO_LEVEL=1AC0,5

8.4.26   AT+PWM

Function：Configure remote/local PWM input/output mode

Format：Configure

Send：AT+PWM= addr,period,duty1, duty2,duty3,duty4,duty5

Return：+OK<CR><LF>

Parameter：addr

    0000~FFF8 Remote short address device

    FFFF Local device

period　(1 = 62.5ns)

    0~65535　周期

  duty1

      0　　　Close

    Other　channel 1 is square wave with duty cycle of 50%.

duty2~ duty5　（0~65535 1 = 62.5ns）

    The PWM of the channel is closed when the pulse width time of the corresponding channel number is 0 or greater than the period.

Example：AT+ PWM=1AC0,1000,1,500,500,0,500

8.4.27　AT+RPWM

Function：Read remote/local PWM input/output mode

Format：Read

      Send：AT+RPWM=addr

      Return：RPWM=addr,period,duty1,duty2,duty3,duty4,duty5<CR><LF>

Parameter：addr

    0000~FFF8　Remote short address device

    FFFF　Local device

period　(1 = 62.5ns)

    0~65535 cycle

    duty1

      0　　　Close

    Other channel 1 is square wave with duty cycle of 50%

duty2~ duty5　（0~65535 1 = 62.5ns）

    The PWM of the channel is closed when the pulse width time of the corresponding channel number is 0 or greater than the period.

Example：AT+RPWM=1AC0

8.4.28　AT+ADC

Function：Read remote/local ADC input

Format：Read

      Send：AT+ADC=addr,adcx

      Return：ADC=addr,val<CR><LF>

Parameter：addr

    0000~FFF8 Remote short address device

    FFFF Local device

adcx　（0~6）

    ADC Channel

val　（0~3300）

    Current acquisition voltage, unit mV (millivolt)

**Example**：AT+ADC=1AC0,5

9.User instruction

9.1 ZigBee networking role and notice

No.	Description
1	Module uses Zigbee ad hoc networking, consisting of one coordinator and random other devices(routers and end-devices)
2	It has self-organization, self-routing and network multi-hopping function (By default the network depth is 5, there are 20 son nodes and 6 son router nodes in total).
3	The father node device (coordinator and router) can save data for the end-devices in sleep. The save time can be set by the user (by default it is 30 seconds, ranging from 0 to 120 seconds).
4	Only the end device has the sleep function, sleeping within 120S, the user can set by themselves, the default 0 (with sleep mode off). Note: The recommended sleep time must be less than the data storage time of father node , otherwise it will affect the data reception.
5	In network communication Short Address communication is used. Note: The short address is randomly distributed when the device joins the network, the long address of MacAddress is the only fixed one, if the short address is unknown, the network Short Address can be found via corresponding commands according to the MacAddress , and point to point communication is conducted.
6	Coordinator is unique in the network, the short address is 0000.
7	If unicast address is FFFF，FFFD，FFFC，then it corresponds to three broadcast mode.
8	When PANID is FFFF, it means automatic distribution. Networking cannot be realized if PANID is different.
9	When network keys are not the same the network cannot be joined. The module network key of the module remains open, the user cannot get the correct air data via software packet capture .
10	All devices in the network have opened broadcast function. Multiple devices broadcasting at the same time or a single device broadcasting at a higher frequency will lead to a serious network congestion. Please try to avoid this situation.
11	When multicasting module does not need to join the group,but be directly multicasted to any group according to communication usage guidance. After the multicast, the local group number will not change due to different multicast number.
12	PWM function and sleep mode cannot be used at the same time in network, please turn off the sleep mode before turn on PWM function .
13	After sleep mode, it can be waked up via the serial port(UART). Note: In the sleep state, the first frame of data waked up via UART is invalid.
14	In ZigBee network communication, the transmission cycle of single packet data should not be too fast (generally recommended in more than 1 second), too fast may cause data loss. (Pay special attention to the fact that there are too many nodes in the network and the broadcast cycle is too fast, which may cause network instability.)

9.2 Network structure

The network structure of module is MESH network

MESH network topology network has a powerful function, the network can   communicate via "multi-level hopping"; the topology can also form a very complex network; network also has self-organization, self-healing function.

Network structure diagram
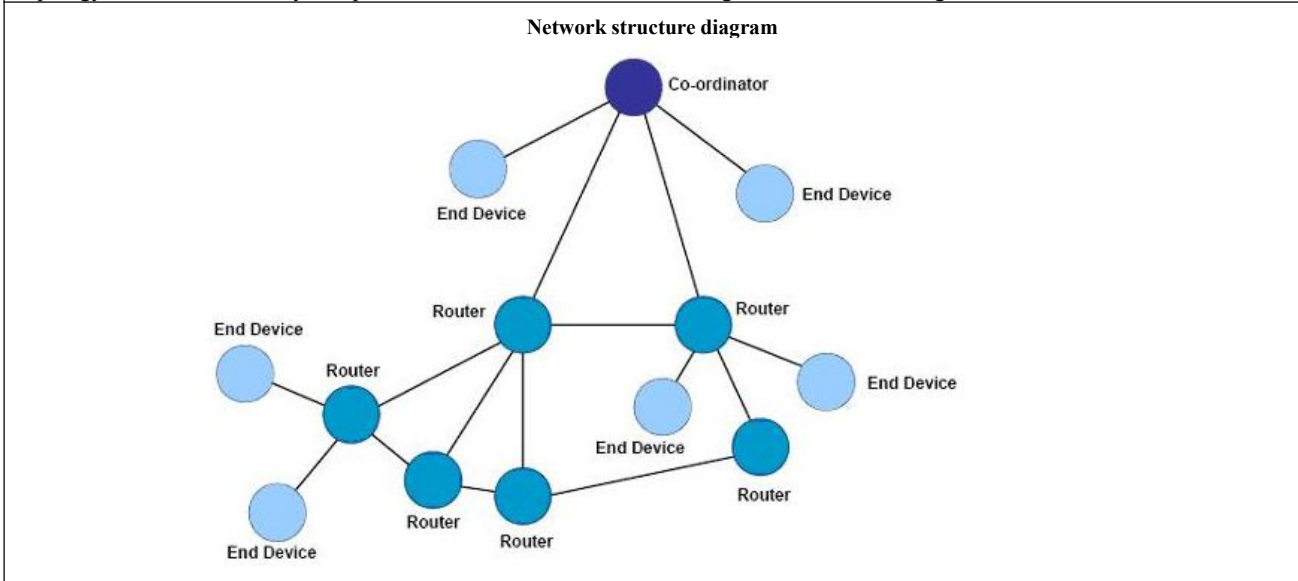
10. Hardware design

- 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.

11. FAQ

11.1 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.

11.2 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.

11.3 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;
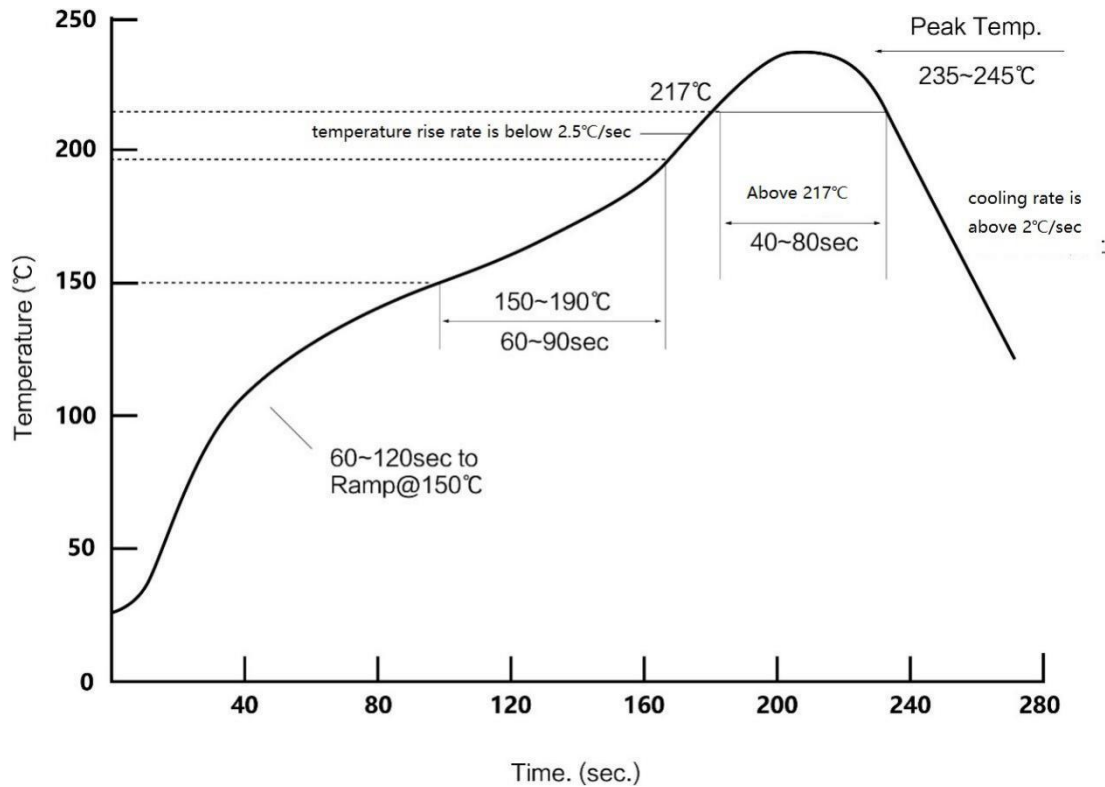
12.Production guidance

12.1 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.

12.2 Reflow soldering curve

13. Related product

| Model	IC	Frequency Hz	Power dBm	Range km	Air data rate bps	Packing	Dimension mm	Antenna Interface
E18-MS1-PCB	CC2530	2.4G	27	2	250K	SMD	16 * 22.5	IPEX
E18-2G4U04B	CC2531	2.4G	4	0.2	250K	USB	59 * 18 mm	PCB
E18-MS1PA1-IPX	CC2530	2.4G	20	1	250K	SMD	16 * 22.5	IPEX
E18-MS1PA1-PCB	CC2530	2.4G	20	0.8	250K	SMD	16 * 27	PCB
E18-MS1-IPX	CC2530	2.4G	4	0.24	250K	SMD	14.1 * 20.8	IPEX
E18-MS1-PCB	CC2530	2.4G	4	0.2	250K	SMD	14.1 * 23	PCB

14. Antenna guidance

14.1 Antenna 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 number	Type	Frequency Hz	Interface	Gain dBi	Dimension	Feature
TX2400-NP-5010	Flexible antenna	2.4G	IPEX	2	50*10mm	Flexible FPC antenna
TX2400-XP-150	Sucker antenna	2.4G	SMA-J	3.5	15cm	Sucker antenna,high gain
TX2400-JK-20	Rubber antenna	2.4G	SMA-J	3	200mm	rubber antenna, omnidirectional antenna
TX2400-JK-11	Rubber antenna	2.4G	SMA-J	2.5	110mm	rubber antenna, omnidirectional antenna
TX2400-JW-5	Rubber antenna	2.4	SMA-J	2.0	50mm	Fixed Bend Omnidirectional Antenna
TX2400-JZ-5	Rubber antenna	2.4G	SMA-J	2.0	50mm	Short antenna，omnidirectional antenna
TX2400-JZ-3	Rubber antenna	2.4G	SMA-J	2	30mm	Short antenna，omnidirectional antenna

15. Product packaging figure
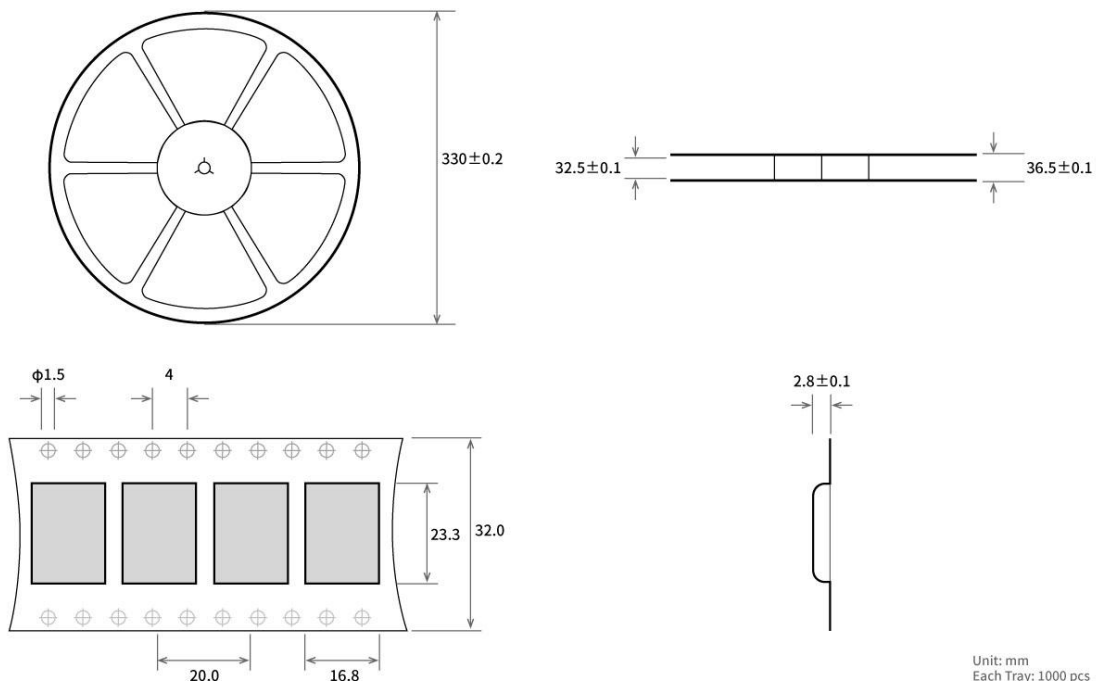
Important Notes

- 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.

Revision history

Version	Date	Description	Issued by
1.0	2018-12-10	Initial version	huaa
1.1	2019-03-08	Content updating	Ray
1.2	2019-04-11	Error correction	Ray

About us

Technical support: support@cdebyte.com

Documents and RF Setting download link: www.cdebyte.com/en/

Tel：+86-28-61399028

Fax：028-64146160

Web：www.cdebyte.com/en/

Address：Innovation Center D347, 4# XI-XIN Road,Chengdu, Sichuan, China

Chengdu Ebyte Electronic Technology Co.,Ltd.