

## EMW3166 Hardware design guide

### Abstract

This document lists the consideration in each step during designing product with MXCHIP module. In order to achieve rapid mass production, Users should be familiar with the document to pre-consider and avoid problems effectively in designing, producing, programming and testing.

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## Version Record

Date	Version	Details
2016-9-23	0.1	Initial document
2016-9-29	0.2	Add reference circuit Add description of pin function and design consideration Add position figure of PCB
2016-11-17	0.3	Add Module downloading method
2017-05-31	1.0	Update antenna design information

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## 1. Introduction

This document lists the consideration in each step during designing product with MXCHIP module. In order to achieve rapid mass production, Users should be familiar with the document to pre-consider and avoid problems effectively in designing, producing, programming and testing.

### Suitable module type:

EMW3166

### Phase of attention:

- Hardware design;
- Firmware testing;
- SMT;
- Online update.

### Basic Characteristics:

- Each module has a unique MAC address;
- PCB antenna and external antenna;
- Support Bluetooth classic and BLE;
- Maximum instantaneous current 360mA@3.3V;
- Testing mode inside;
- OTA inside;
- Secondary reflow soldering at SMT
- Working temperature: -30°C to +70°C

### EMW3166 Top View



Figure 1.1 Top View of EMW3166-P



Figure 1.2 Top View of EMW3166-E

**EMW3166**

Module type	Antenna Type	Illustration
EMW3166-P	On-board PCB	Default
EMW3166-E	IPEX	Optional

**Hardware Block**

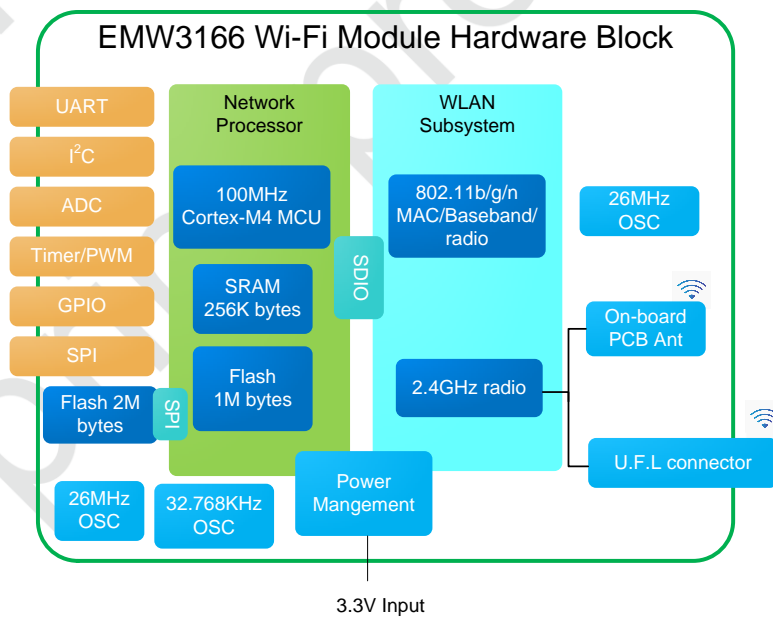


Figure 1.3 Hardware Block

## 2. Considerations in Hardware Design

### 2.1 Mechanical Size

Mechanical size of EMW3166 (Unit: mm)

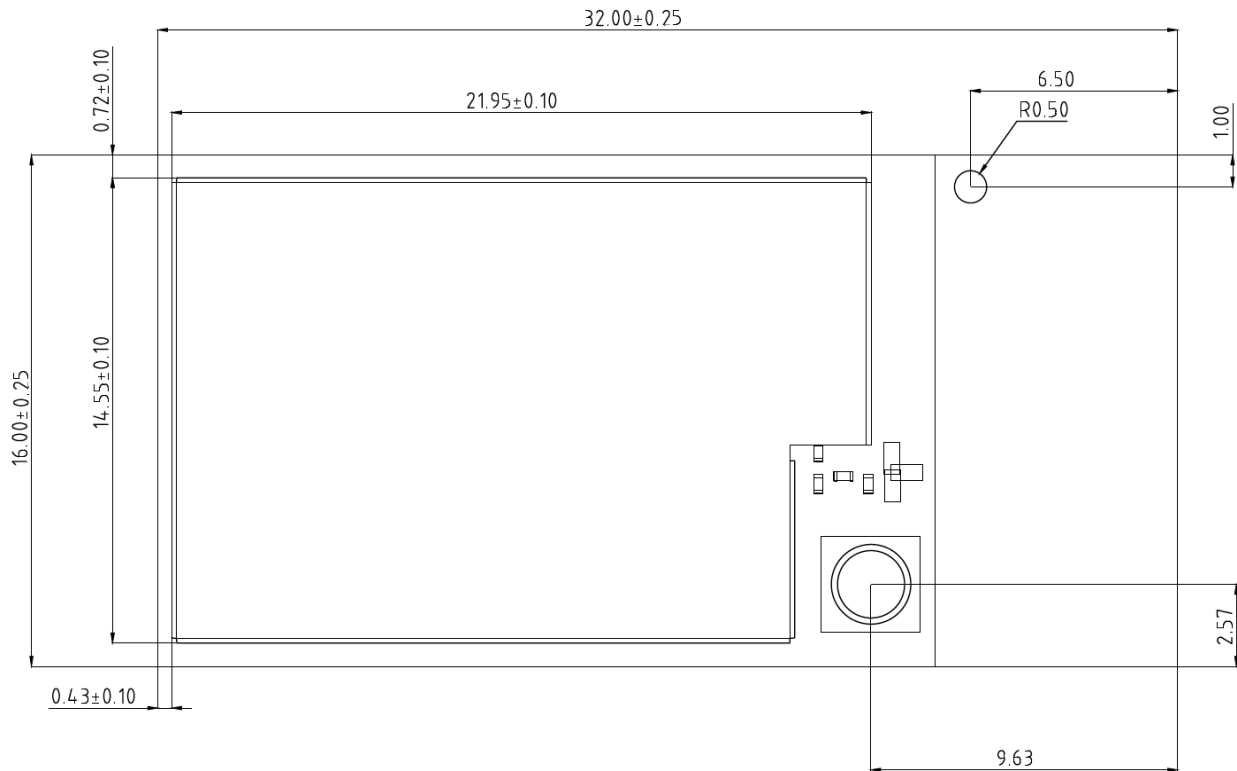


Figure 2.1 Top View of Mechanical Size

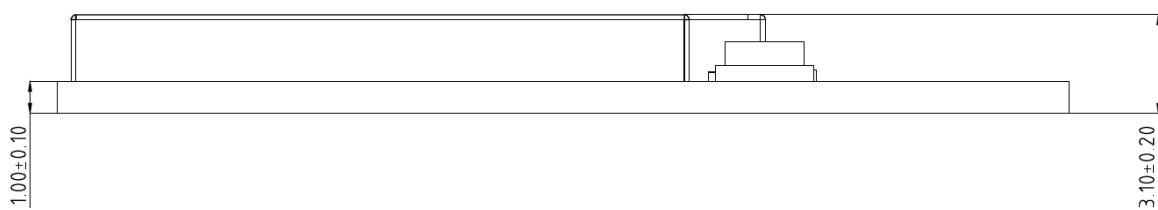


Figure 2.2 Side View of Mechanical Size

### 2.2 Reference Package Design

Solder mask openness has the same size with land, as shown in figure2.3 (Unit: mm)



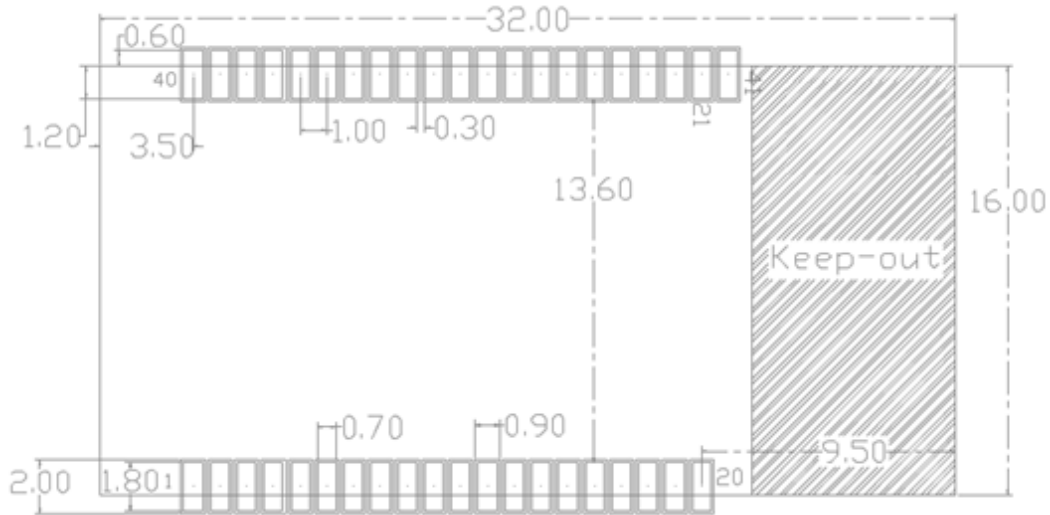


Figure 2.3 SMT Package

### 2.3 DC Power Design

Peak current of the module is approximately 360mA. DC/DC with maximum output current 600mA is suggested as power supply. DC/DC is better than LDO in low power consumption.

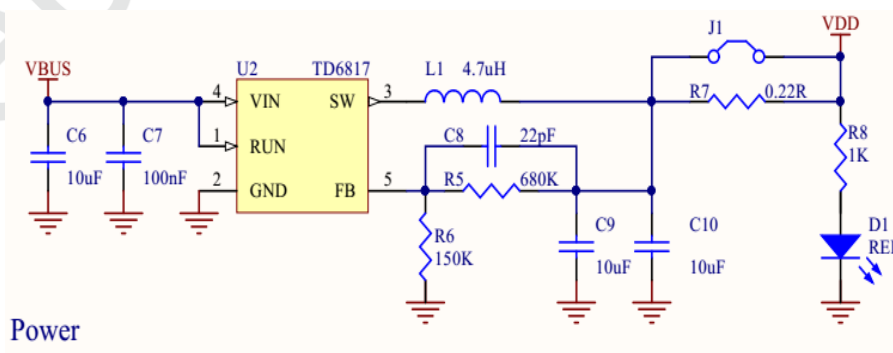
Route should be particularly aware for DC/DC power supply. Compact element, excellent connection between input and output ground, long distance between feedback signal and inductance and Schottky diode are required for route. Details about the requirements should refer to the datasheet of DC/DC device.

Maximum output current and dissipate heat should be aware for the using of LDO. voltage drop is 1.7V when voltage reduce from 5V to 3.3V. If the current is 300mA, power consumption is  $1.7V * 360mA = 612mW$ , PowerDissipation is a parameter on LDO datasheet which should be over 510mW (same methods are used to calculate other input voltage).

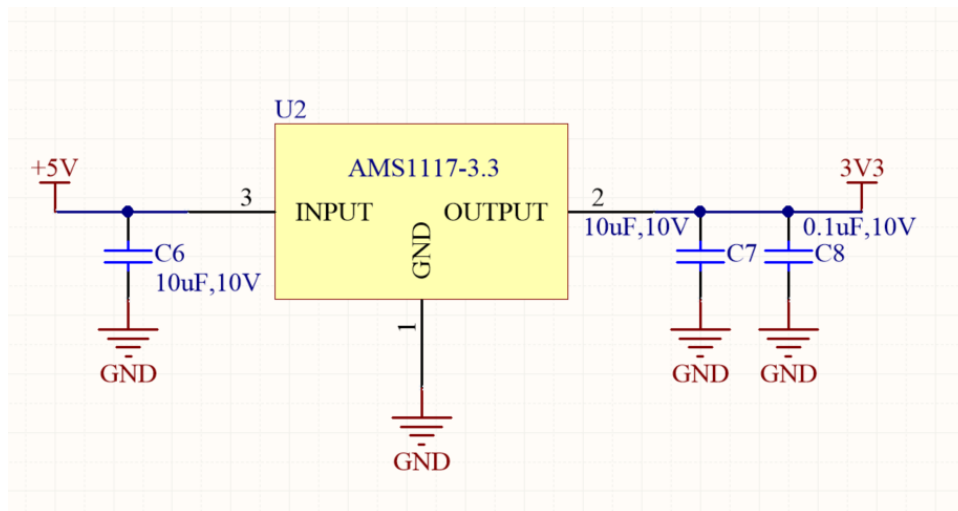
The problem rate about final product would be reduced by fully consideration of power design.

### 2.4 Reference Circuit Design and Illustration

EMW3166 reference circuit is shown below.



DC/DC 5V to 3.3V Conversion Circuit



LDO 5V to 3.3V Conversion Circuit

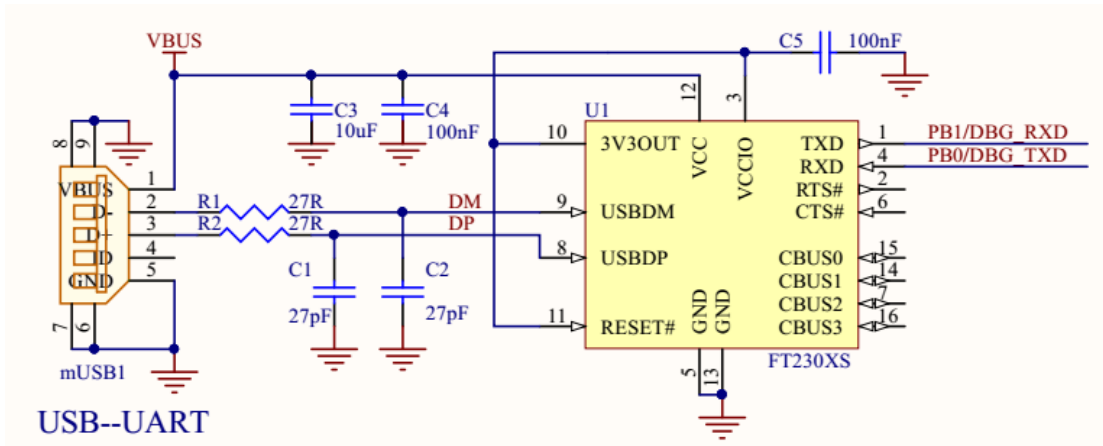


Figure 2.4 Conversion Circuit of USB to Serial Port Debugging

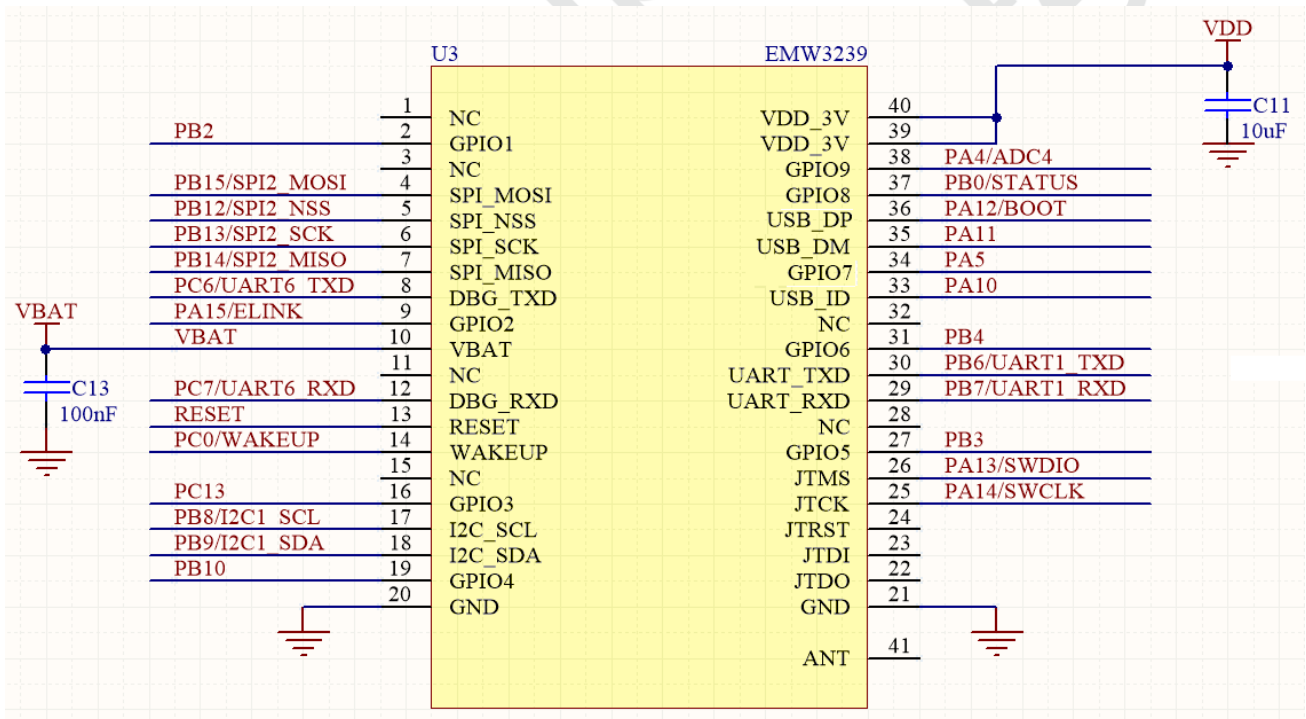


Figure 2.5 Wi-Fi Circuit

Q1 is Conversion transistor, could be chosen as S8050 or MBT2222ADW1, DC-DC is suitable for chip which has rated current over 600mA such as RT8059, TD6817 or LDO. Voltage input should be PTC or TVS in order to avoid input voltage unstable. SMD0805P100TF or SMFJ6.0A are reasonable choices.

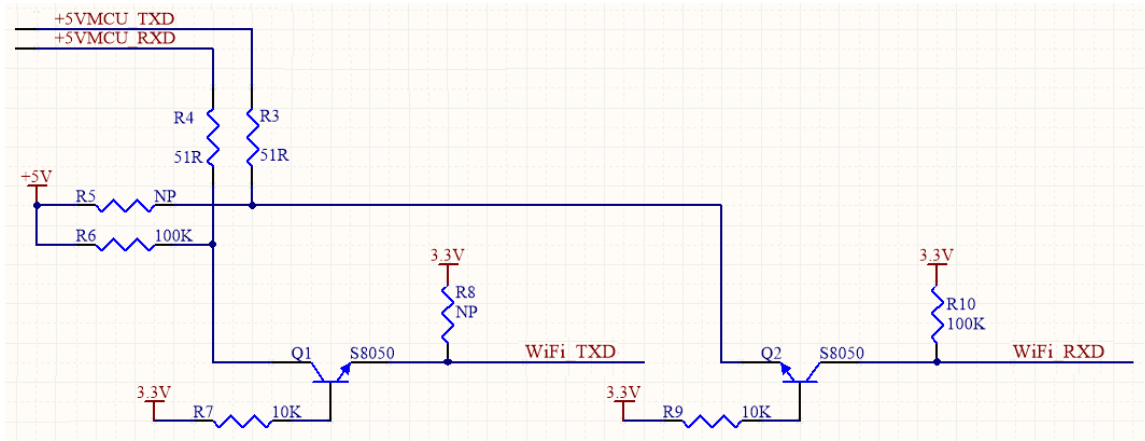


Figure 2.6 3.3V UART-5V UART Conversion Circuit

- Pin Function

Set module in different mode by combo PIN 36 (BOOT) , PIN37 (STATUS) , PIN9(ELINK).

Table 2.1 Switch Mode

BOOT	STATUS	ELINK	FUNCTION
H	/	/	NORMAL WORK
L	H	L	ATE
L	L	H	QC
L	H	H	BOOTLOADER

Relative contents of the module are sent by pin UART2\_TX. Mobile phone could connect to internet and have normal communication with app at NORMAL WORK. Module must in ATE mode when certificate with SRRRC, FCC, CE. MFG mode could be used in product storage test. Module must in BOOTLOADER mode when update firmware by UART.

- Reset pin

Pin 13 is reset pin triggered by low level voltage. Voltage must over 2.9V. Pin should be in dangling state when it is not working. There is weak pull-up resistor inside. Please make sure the pin is in high level voltage when the module is powered on.

- SPI

Pin 4~7 could be used as off-chip SPI port. Maximum transport rate could be 25Mbps with host and slave mode, duplex mode and simplex mode.

- I2C

Standard mode (100kbps), fast mode (400 kbps), high speed mode (1Mbps) is supported in I2C.

- SWDIO/SWCLK

Module supports with one standard SED port without external pull-up or pull-down resistance. Pin 25 and Pin 26 supports with online debugging and upgrading with J-FLASH or used as GPIO.

- **GPIO**

EMW3166 has 25group of GPIO that could be reused as other pins.

- **UART**

Module has one current control UART communications and one normal UART communication. Pin 29 and Pin 30 are used as serial port of users (Test information, download and communication). Pin 8 and Pin 12 is debugging ports (running log print). Please make sure Wi-Fi RX and TX is connected to host RX and TX.

- **VBAT**

VBAT supports for RTC, PIN10 is clock source which requires power supply 3.3V. External output compensation calibration in 512HZ could be used in RTC. RTC has programmable alarm and programmable period interruption wake-up from stop mode to standby mode.

Power supply of EMW3166 is from 2.6V to 3.6V. Low voltage working mode is from 2.6V to 3.0V with battery. Common working mode is from 3.0V to 3.6V. Rated power is only used as pressure test parameter. Permanent damage would be caused if the device works in this condition.

- **Others**

Pins that not be used should be set NC(Not Connected). Pin39 and pin 40 is power supply input that could be added a 10uF ceramic capacitors closing to two pins. Power supply is 2.6V to 3.6V. Module could be breakdown if the voltage is over 3.6V.

Typical PCB design is shown in figure 2.6.

In order to make sure the antenna performance, sufficient clearance zone should be designed in the antenna part. PCB part below antenna could be hollowed up. Copper, route, closing to metal element is not allowed if the structure needed. The circuit for P1~P8 should be surrounded with ground and holes, to avoid interference signal.

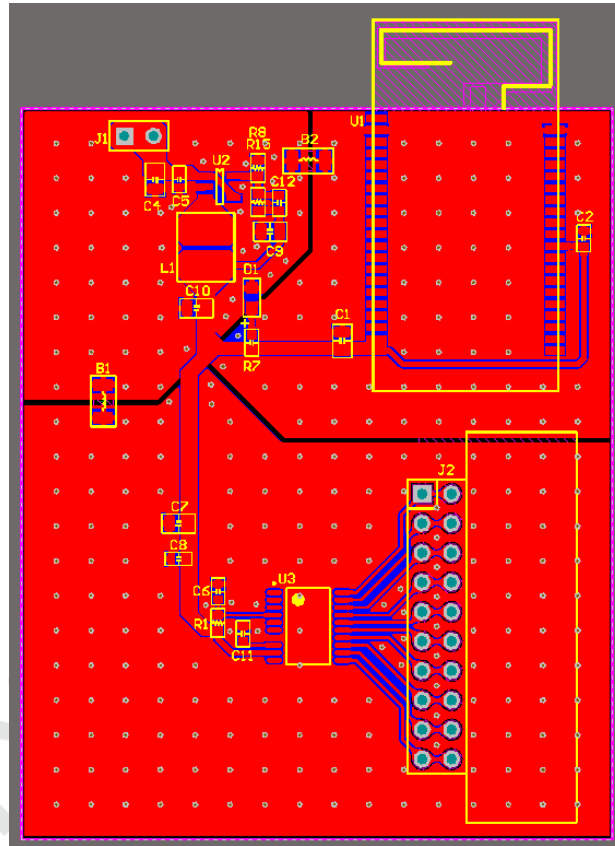


Figure 2.7 PCB Design

## 2.5 RF Design

### 2.5.1 On-board PCB Antenna Design

The main board PCB should be over 16mm far away from other metal components. Copper, route, closing to metal element is not allowed if the structure needed. P1 to P8 should connect to ground with copper. PCB part below antenna could be hollowed up.

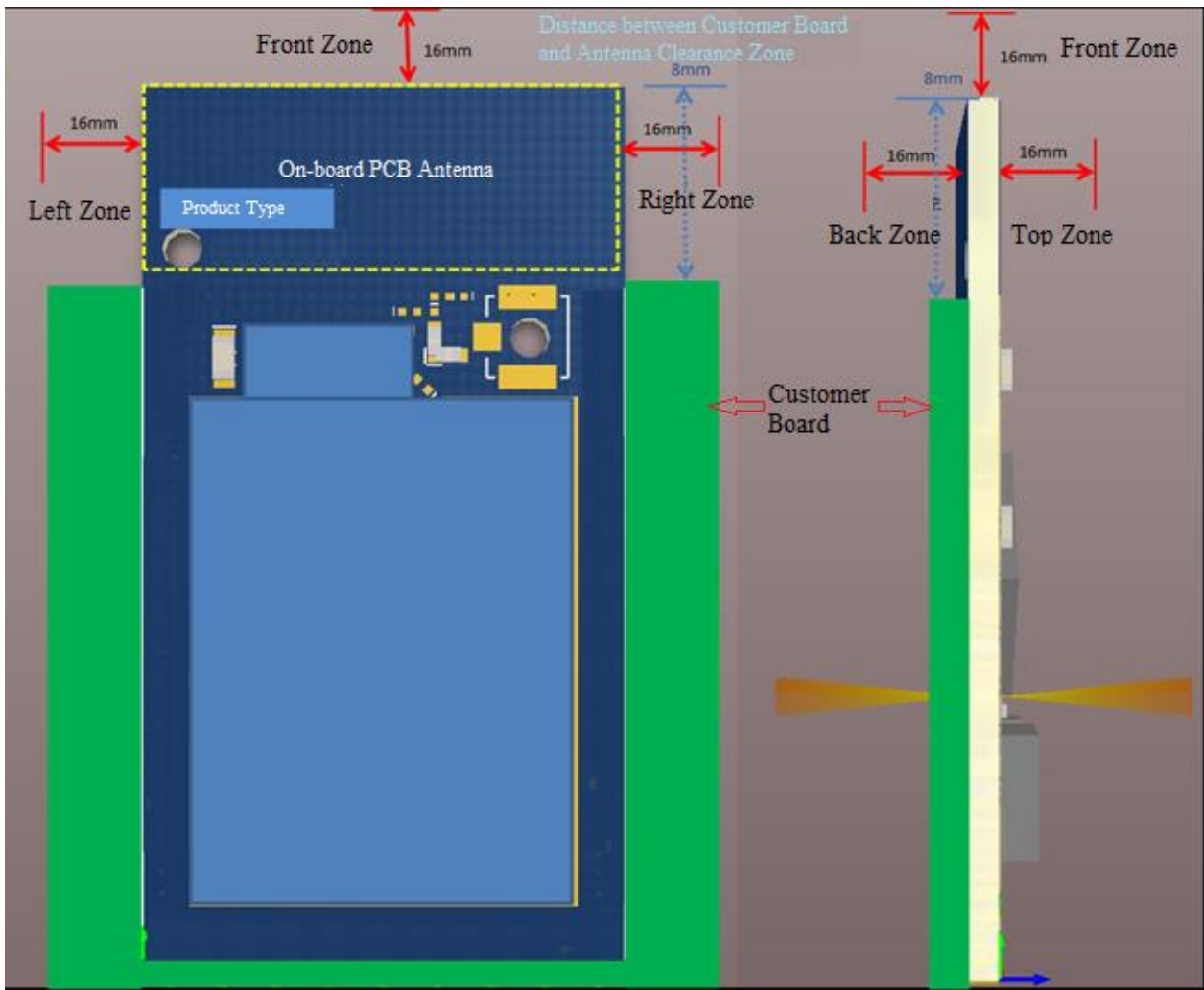


Figure 2.8 Minimum PCB Clearance Area

In order to reduce the influence from metal components to PCB antenna and wireless signal, it is better to mount EMW3166 on four parts.

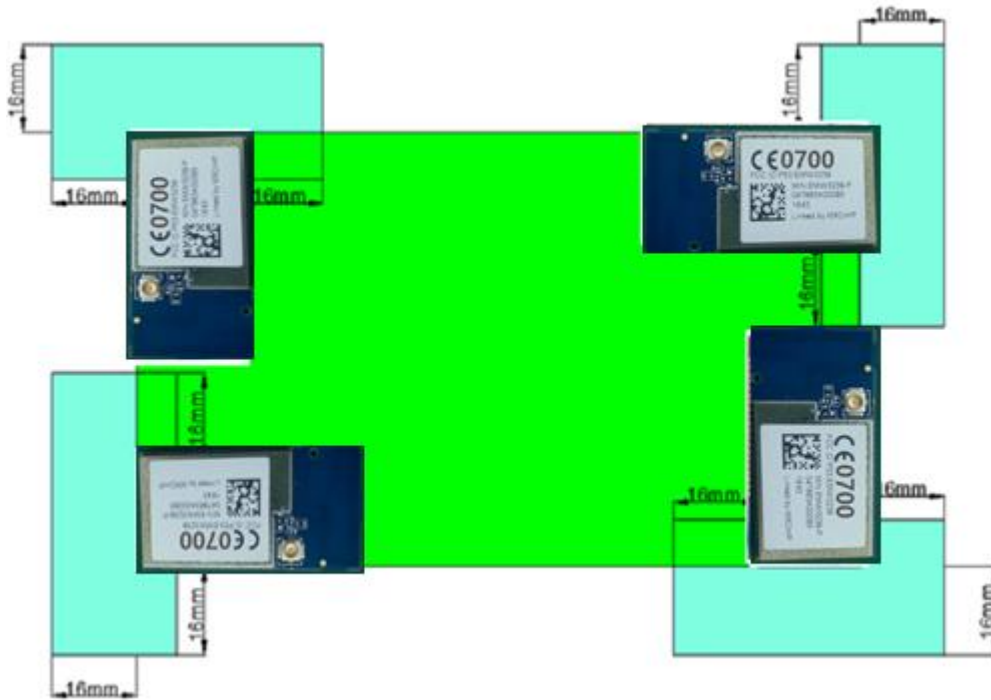


Figure 2.9 Position of the Module

## 2.5.2 External Antenna

Size of external antenna is shown in figure 2.10. Make sure the correct size with suppliers before buying the connectors of antenna.



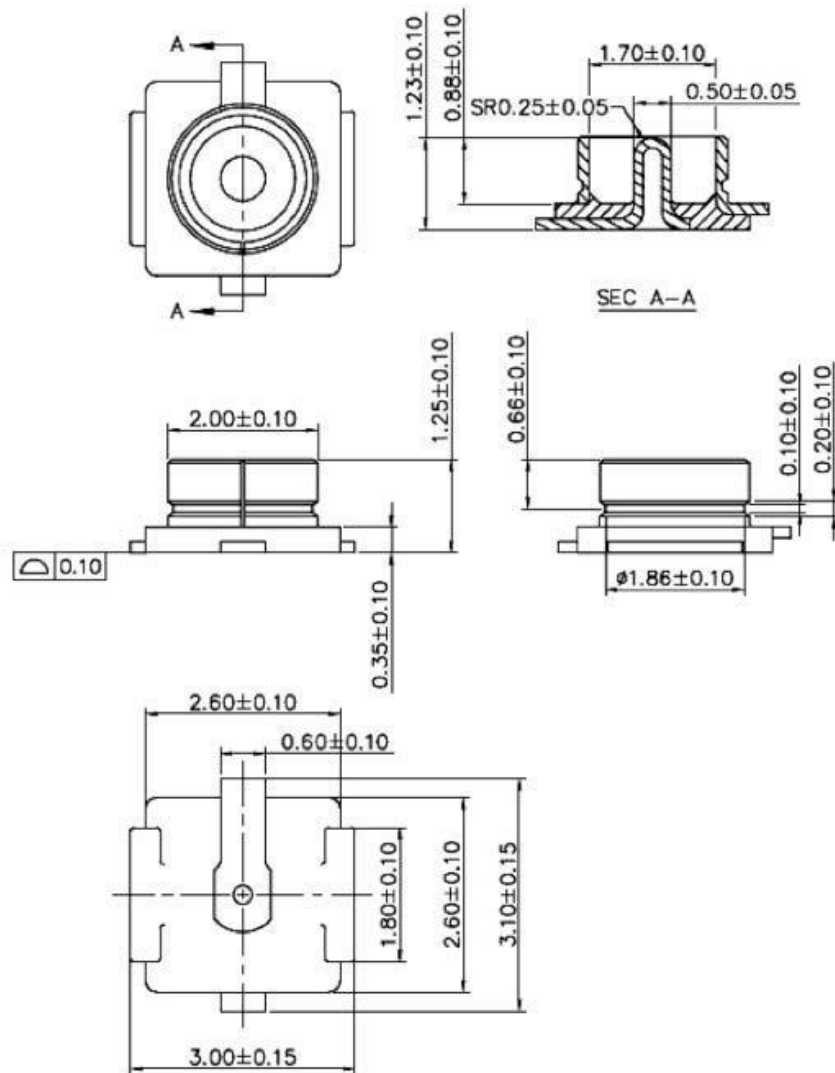


Figure 2.10 Size of External Antenna

## 2.6 ESD Design

ESD level of the module: Human body model (HBM) is 2000V, charged device model (CDM) is 500V. Position of ESD protected components should be reserved if the products require higher ESD requirement such as pins connect to USB and SD-card.

EMI should be aware when the module operated by connecting external wire. Using shielding wire or reserving common mode choke could avoid EMI.

### 3. Downloading Firmware and Storage Test Method

#### 3.1 Preparations

Table 3.1 Device List

Device	Quantity
PC	1
Tools of downloading firmware	1
EMW3166	1
Micro USB	1
Downloading Software	1
Testing Software	1

Download website is shown in table 3.2.

Table 3.2 Download Websites

Name	Function	Websites
FWUpdate	Download	<a href="http://pan.baidu.com/s/1kVEwnNh">http://pan.baidu.com/s/1kVEwnNh</a>
MicoQcAutoCheck4.0	Test	<a href="http://pan.baidu.com/s/1kVEwnNh">http://pan.baidu.com/s/1kVEwnNh</a>
CP210x_VCP_Windows	USB Drever	<a href="http://www.silabs.com/products/mcu/Pages/SoftwareDownloads.aspx">http://www.silabs.com/products/mcu/Pages/SoftwareDownloads.aspx</a>

Firmware program is sent by FAE of MXCHIP or client which is 600K (application code). 'Test.bin' is shown in this note.

#### 3.2 Switch set up in Downloading Mode

3 switches on develop board of EMW3166 are shown in figure 3.1. Set Easylink as high, STATUS as high and BOOT as L.

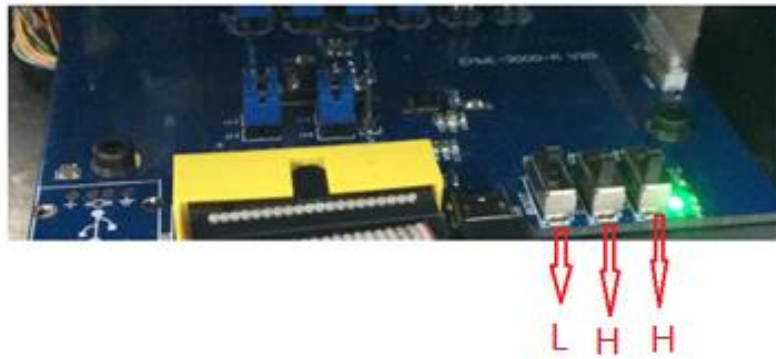


Figure 3.1 Switch Set Up

Decompress file 'CP210X\_VCP\_WINDOWS.ZIP'. 32 or 64 is based on the computer operating system. It could be checked from device manager after installing.

### 3.3 System Connection

Module connects to develop board of EMW3031 with USB. Green light D1 on the develop board enable when connecting.



Figure 3.2 Power Light

### 3.4 Serial Port Selection

Find COM number of develop board connect to PC, such as COM4 in figure 3.3. (Note: Enhanced COM Port must be used in serial number).

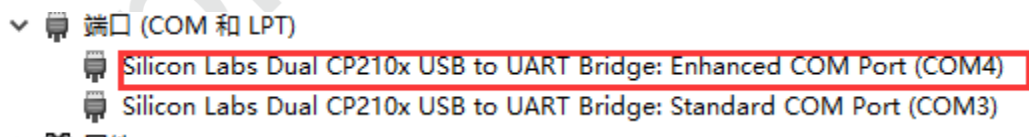


Figure 3.3 Name in Device Manager

### 3.5 J-Flash

Install 'Setup\_JLink\_V600i.exe'.

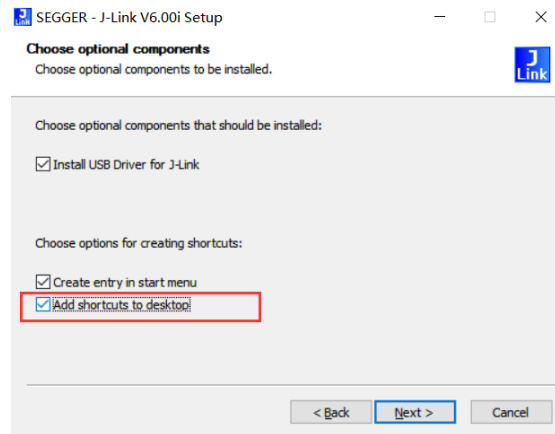


Figure 3.4 Install J-Flash

'JFlash V6.00' would be found after installing.



Figure 3.5 J-Flash signature

### 3.6 J-Flash Set Up

Use 'ALT+F7' or open 'Options' then click 'project settings'. Select 'SWD' in Target Interface, 'ST STM32F412RG' in MCU, 'Start application' in Production.

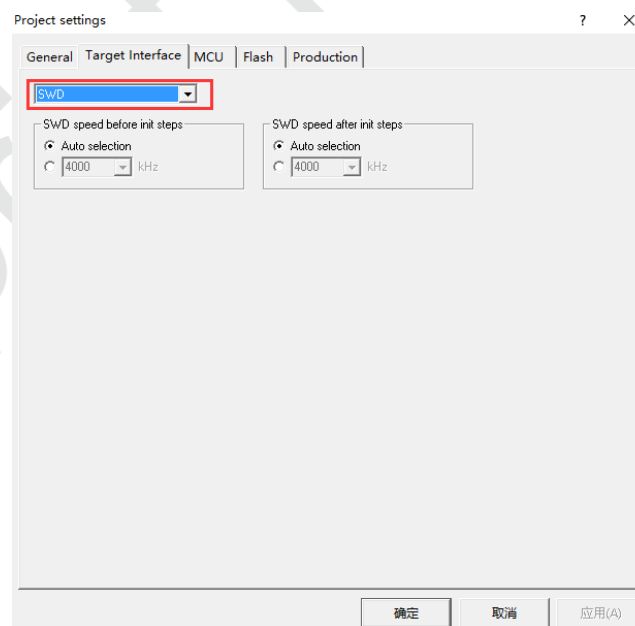


Figure 3.6 Target Interface Set Up

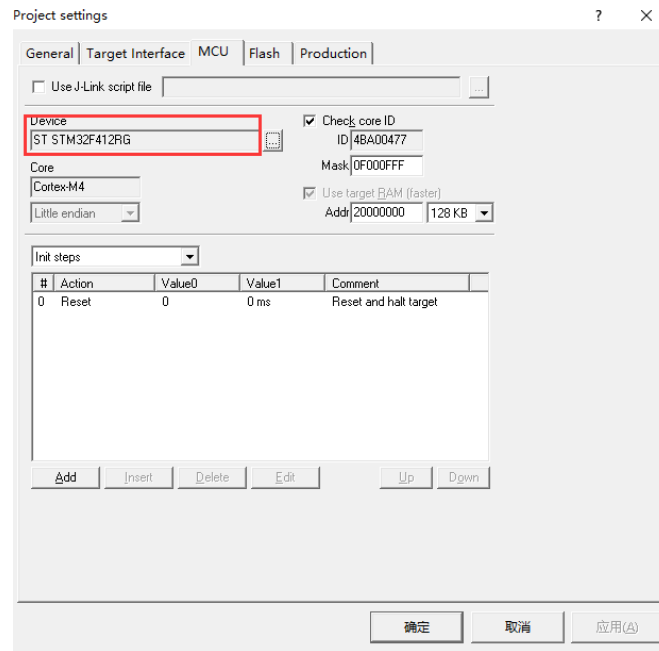


Figure 3.7 MCU Set Up

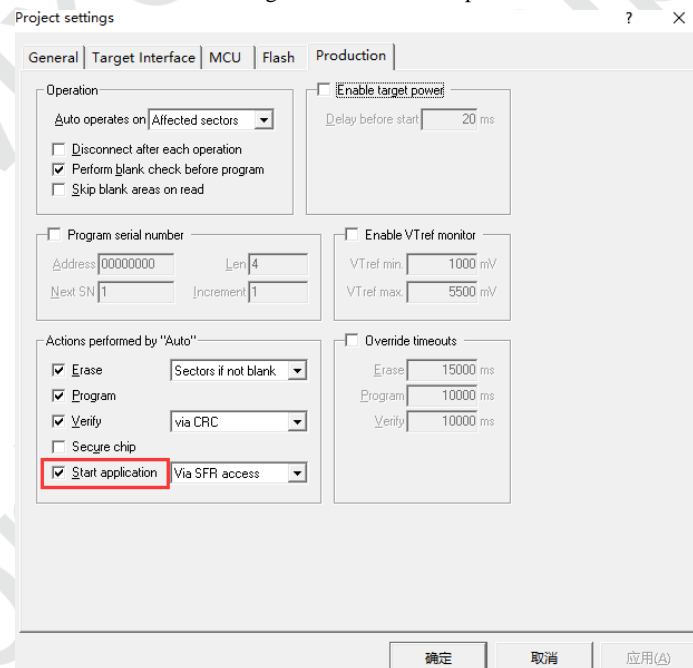


Figure 3.8 Production Set Up

Click 'OK' after set up. There would be no more set up in following downloading if save the set up.

### 3.7 FWUpdate Set Up

Find file 'FWUpdate V2.4.exe' in 'FWUpdate-3239' and set as below:



### 3.8 Downloading

Put 'Test.bin' into J-Flash and type start address '8000000'.

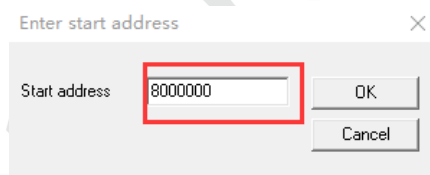


Figure 3.9 Address Input

J-Flash: Use 'F7', or click 'AUTO' in Target to start downloading.

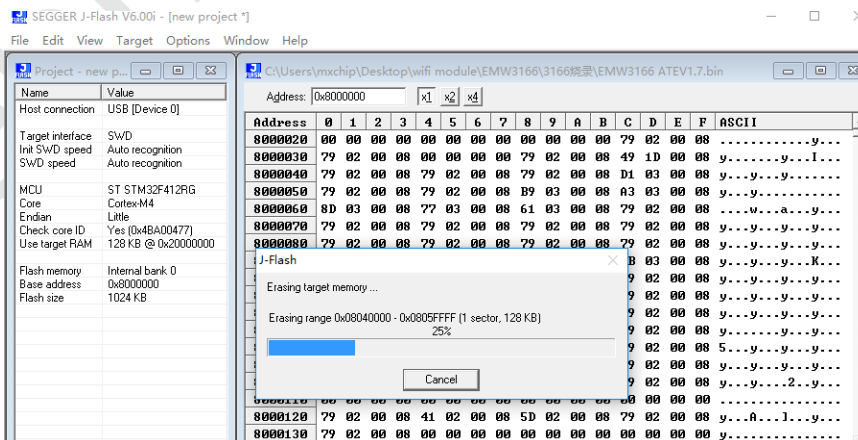


Figure 3.10 J-Flash

'Wait for start' is shown in FWUpdate.



Figure 3.11 FWUpdate

FWUpdate v2.4 would start downloading after J-Flash completing, as shown below.



Figure 3.12 FWUpdate V2.4 Downloading

Timer would count after successfully downloading firmware.



Figure 3.13 Complete

## 3.9 Testing

### 3.9.1 Environment Set Up

Turn on 5 routers that randomly located around test module in a range of 2 to 5 meters.

### WiFi Testing Environment

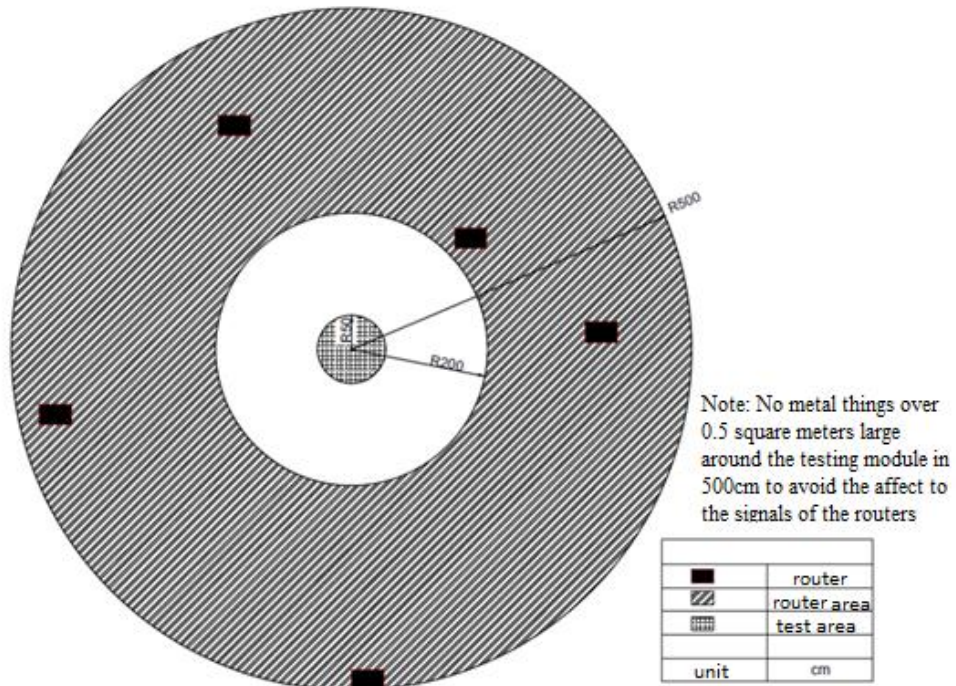


Figure 3.14 Position of Routers

### 3.9.2 Switch Set Up

Set BOOT and STATUS as L, ELINK as H.

Serial number could be found in Device Manager with Enhanced COMPort.

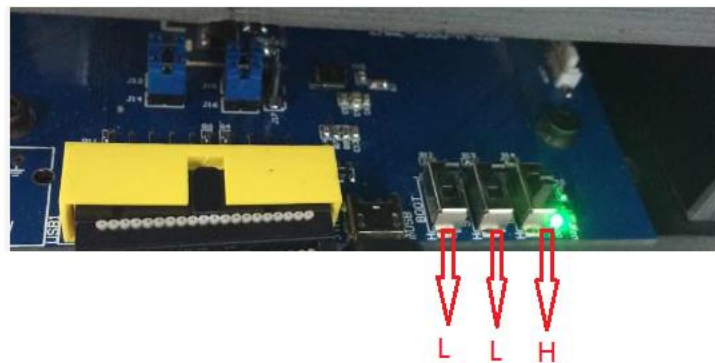


Figure 3.15 Switch Set Up in Testing Mode

### 3.9.3 QC Set Up

Open QC and set up with the product test package information. Set baud band as 921600.





Figure 3.16 QC Set Up

Select 'Enhanced COM Port', and click 'Start'.

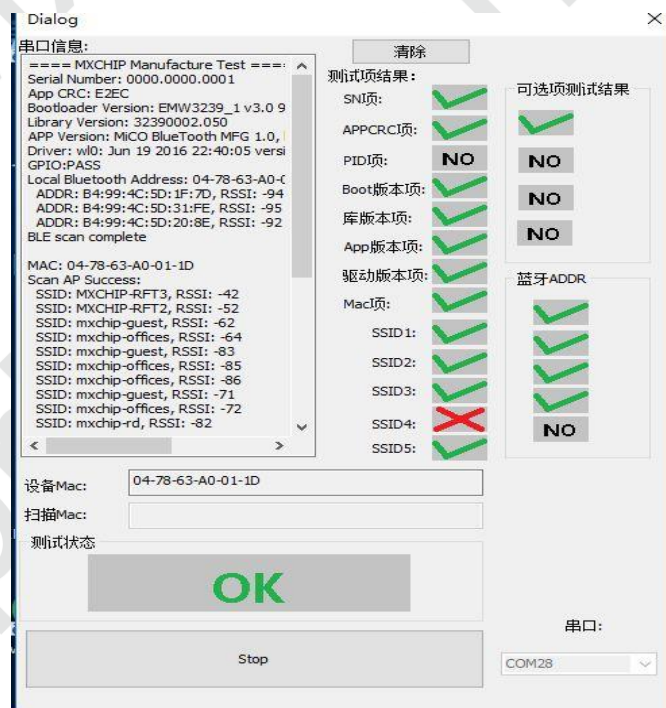


Figure 3.17 Test OK

QC would proofread MAC address automatically in repeated testing. 'X' would show in MAC with 'FAIL' on interface if test failed. Results are saved in file 'log'. Results of inferior module are not shown in the results.



Figure 3.18 Test Fail

Common power of hotspot in 2 to 5 meters is 0 to 80.

### 3.10 Important Statement

MXCHIP has a duty to make sure there is no quality problem when sell the module to customers.

Customers have the rights to ask MXCHIP to exchange goods if the product has quality problem.

If the customer find the problem after welding the module on board without testing at the beginning, MXCHIP is only responsible for the compensation of the module part.

MXCHIP would help customers solve technical problem in developing firmware without save any MVA/bin file. Customers should save different development vision and download relative vision in module before producing.

## 4. SMT

### 4.1 Stencils

Stencils thickness is suggested as 0.12mm (0.1~0.15mm) with Laser grinding. Recommended solder paste: No lead SAC305.

Stencils size is shown in figure 4.1, pad holes extend 0.15mm in order to improving solder wicking. If there is no AOI testing, check module by eye is available to reduce the Pseudo Soldering.

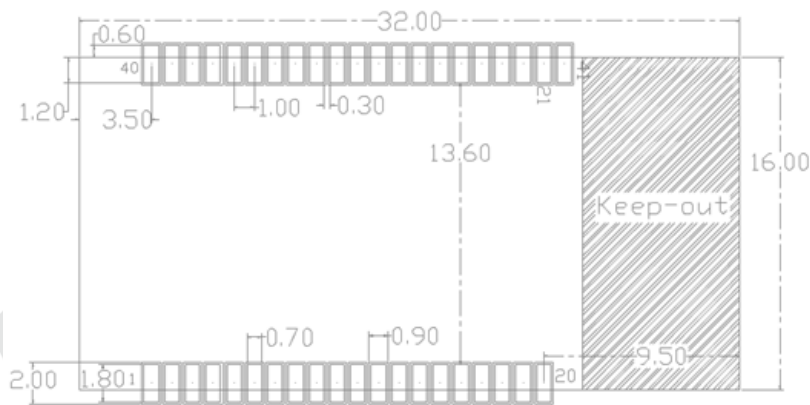


Figure 4.1 Stencils size

### 4.2 Temperature Curve of Secondary Reflow

Pseudo soldering could be reduced by control the furnace with temperature curve of secondary reflow, as shown in figure 4.2.

Secondary reflow times less than 2

Peak temperature: 250°C

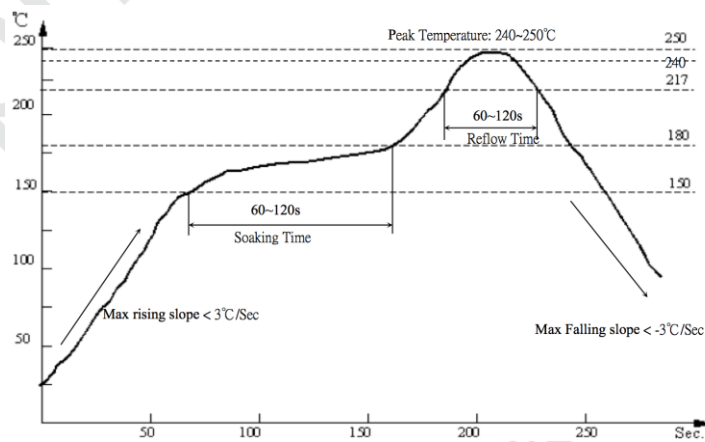


Figure 4.2 Temperature Curve of Secondary Reflow

## 5. Mass Production Test and Product Update

Customers should consider not only the function of product but also the testing method in mass production and update firmware on the product.

### 5.1 Module Test

In order to avoid inferior module and make sure the correct of downloading firmware, MXCHIP strongly suggests product testing before produce. Fully test is required after producing.

#### 5.1.1 Half Secondary Development of Firmware

Module connects the MCU from customer through serial port. In secondary development, test command could be added into firmware. For example, module could scan hotspot around itself and return the results from serial port by sending testing command through serial port.

#### 5.1.2 Complete Secondary Development of Firmware

Application of customer is based on secondary development of module.

Testing method is variable in complete secondary development mode. Test mode could be set to detect the performance of the module. The default set up could be used as router for testing. Router is connected when the module powers on. Details about the test are decided by the application of customers.

### 5.2 Product Update

OTA is suggested in upgrading the product. OTA is a method to update by wireless.

If the product has bug or inferior, OTA is a better way to update the product.

Send the latest firmware to Cloud. Module would download the firmware into itself when connects to internet. Latest firmware would be updated after restart automatically.

## 6. Technical Support

For consultation or purchase the product, please contact Mxchip during working hours:

From Monday to Friday, morning 9:00~12:00, afternoon 13:00~18:00

Telephone: +86-21-52655026

Contact address: 9<sup>th</sup> Floor, No.5, Lane2145 JinshaJiang Road Putuo District, ShangHai.

Postcode: 200333

Email: sales@mxchip.com

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