FSC-BT6038

DATASHEET V1.3

Revision History

Version	Data	Notes	Writer
1.0	2023/08/10	Initial Version	Marsh
1.1	2024/10/11	Update module size	Xianjian Mo
1.2	2025/4/11	Added electrical parameters in Section 6	Xianjian Mo
1.3	2025/6/5	Update the module thickness to 2.0	Xianjian Mo

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1 INTRODUCTION

Overview

FSC-BT6038 supporting Classic Bluetooth and LE Audio

By default, FSC-BT6038 module is equipped with powerful and easy-to-use Feasycom firmware. It's easyt o use and completely encapsulated. Feasycom firmware enables users to access Bluetooth functionality with simple ASCII commands delivered to the module over serial interface - it's just like a Bluetooth m odem.

Therefore, FSC-BT6038 provides an ideal solution for developers who want to integrate Bluetooth wireless technology into their design.

Features

- Qualified to Bluetooth v5.4 specification
- 240 MHz audio DSP
- High-performance 24-bit stereo audio interface
- Digital and analog microphone interfaces
- Flexible LED controller and LED pins with PWM support
- Serial interfaces: UART, Bit Serializer (I^2C/SPI), USB 2.0
- 1 x unidirectional 24-bit inter-integrated circuit sound (I^2S) interface
- Sony/Philips digital interface (SPDIF): Two instances configurable as inputs
- Quad analog inputs configurable as single ended line inputs or, unbalanced or balanced analog microphone inputs
- Advanced audio algorithms Qualcomm® aptX™ and aptX HD Audio
- aptX Adaptive, enabled using license key
- Class 1 Bluetooth power level supported
- 12*15*2.2mm
- Ceramic Antenna

Application

- USB dongles and source devices

2 General Specification

Table 2-1：General Specifications

Categories	Features	Implementation
Bluetooth		
	Bluetooth Standard	Bluetooth v5.4
	Frequency Band	2402MHz~2480MHz
	Transmit Power	10 dBm
	Receiver	-93dBm
	Interface	UART/I²S/USB
Size		12mm × 15 mm × 2.0mm
Operating temperature		-40°C ~+85°C
Storage temperature		-40°C ~+85°C
Supply Voltage		3.3V
Miscellaneous	Lead Free Warranty	Lead-free and RoHS compliant One Year
Humidity		10% ~ 90% non-condensing
MSL grade		MSL 3
ESD grade		Human Body Model: Pass ±2000 V Charge device model: Pass ±500 V

3 HARDWARE SPECIFICATION

3.1 Block Diagram and PIN Diagram

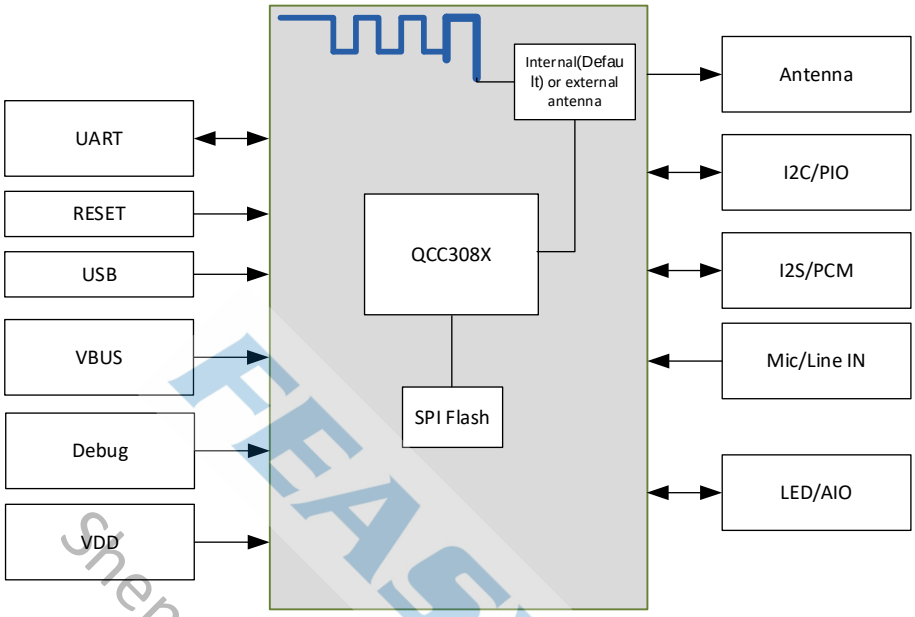

Figure 3-1:Block Diagram

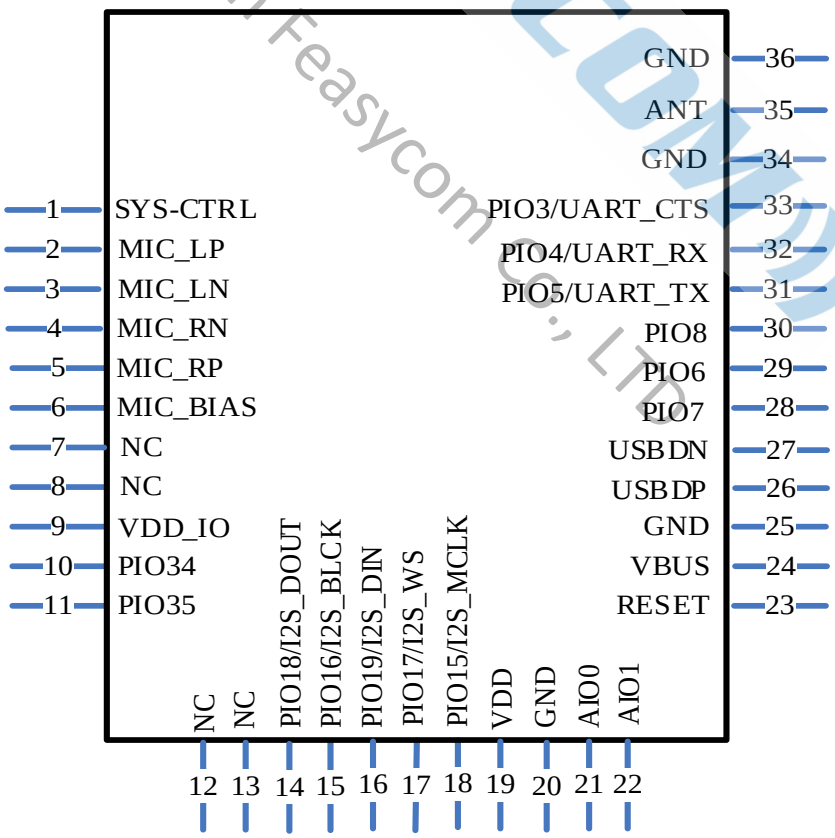

Figure 3-2:FSC-BT6038 PIN Diagram(Top View)

3.2 PIN Definition Descriptions

Table 3-2：Pin definition

Pin	Pin Name	Type	Pin Descriptions	Notes
1	SYS-CTRL	I	Typically connected to an ON/OFF push button. If power is present from the battery and/or charger, and software has placed the device in the OFF or DORMANT state, a button press boots the device. Also usable as a digital input in normal operation. No pull.	
2	MIC_LP	I/O	Microphone differential 1 input, positive/ Differential audio line input 1, positive	
3	MIC_LN	I/O	Microphone differential 1 input, negative./ Differential audio line input 1, negative	
4	MIC_RN	I/O	Microphone differential 2 input, negative./ Differential audio line input 2, negative	
5	MIC_RP	I/O	Microphone differential 2 input, positive./ Differential audio line input 2, positive	
6	MIC_BIAS	I/O	Mic bias output.	
7	NC			
8	NC			
9	VDD_IO	Supply	1.8V/3.3V	
10	PIO34	I/O	Programmable I/O Alternative function: I2C_SDA	
11	PIO35	I/O	Programmable I/O Alternative function: I2C_SCL	
12	NC			
13	NC			
14	PIO18/I2S_DOUT	I/O	Programmable I/O Alternative function: I2S_DOUT	
15	PIO16/I2S_BCLK	I/O	Programmable I/O Alternative function: I2S_BCLK	
16	PIO19/I2S_DIN	I/O	Programmable I/O Alternative function: I2S_DIN	
17	PIO17/I2S_WS	I/O	Programmable I/O Alternative function: I2S_WS	
18	PIO15/I2S_MCLK	I/O	Programmable I/O Alternative function: I2S_MCLK	
19	VDD	VDD	3V3	

20	GND	Vss	Power Ground
21	AIO0	I/O	General-purpose analog/digital input or open drain LED output.
22	AIO1	I/O	General-purpose analog/digital input or open drain LED output.
23	RESET	I	RESET
24	VBUS	I	USB Power(4.75~5.25V)
25	GND	Vss	Power Ground
26	USB_DP		USB Full Speed device D+
27	USB_DN		USB Full Speed device D-
28	PIO7	I/O	Programmable I/O line/ TBR_MISO[0]
29	PIO6	I/O	Programmable I/O line/ TBR_MOSI[0]
30	PIO8	I/O	Programmable I/O line/ TBR_CLK
31	PIO5/UART_TX	I/O	Programmable I/O Alternative function:UART_TX
32	PIO4/UART_RX	I/O	Programmable I/O Alternative function:UART_RX
33	PIO3/UART_CTS	I/O	Programmable I/O Alternative function:UART_CTS
34	GND	Vss	Power Ground
35	ANT	RF	Bluetooth transmit/receive.
36	GND	Vss	Power Ground

4 PHYSICAL INTERFACE

4.1 UART Interface

FSC-BT6038 UART interface is a standard 4-wire interface with RX, TX, CTS, and RTS. Supports H4 HCI interface

or raw UART to application. The default baud rate is 115.2 kbaud. In order to support high and low speed baud rate, FSC-BT6038 provides multiple UART clocks.

The UART signal level ranges from 1.8V to 3.3V. The host provides the power source with the targeted power level to the UART interface via the VIO_HOST pin .

Table 4-1： Possible UART Settings

Parameter	Possible Values
Baudrate	Minimum 1200 baud (≤0%Error)
	Standard 115200bps(≤0.08%Error)
	Maximum 4Mbps(≤0%Error)
Flow control	Supports Automatic Flow Control (CTS and RTS lines)
Parity	None, Odd or Even
Number of stop bits	1
Bits per channel	8

5 MSL & ESD

Table 5-1: MSL and ESD

Parameter	Value
MSL grade:	MSL 3
ESD grade	Electrostatic discharge
ESD – Human-body model (HBM) rating, JESD22-A114-F (Total samples from one wafer lot)	Pass ±2000 V, all pins
ESD – Charge-device model (CDM) rating, JESD22-C101-D (Total samples from one wafer lot)	Pass ±400 V, all pins

6 ELECTRICAL CHARACTERISTICS

6.1 Absolute maximum ratings

Table 6-1： Absolute maximum ratings

Parameter	Pin	Min	Max	Unit
Storage Temperature	-	-40	85	℃
Supply voltage				
VCHG	VBUS	-0.4	6	V
Battery	VDD	-0.4	4.8	V
VDD IO	VDD_IO	-0.4	3.8	V
1.8 V	MIC_LN/ LINEIN_1_N MIC_LP/ LINEIN_1_P MIC_RN/ LINEIN_2_N MIC_RP/ LINEIN_2_P	-0.4	2.1	V
Digital I/O	PIO,RESET	-0.3	3.6	V
	VDD_IO	-0.3	3.6	V
	AIO/LED[1:0] (Disabled / Digital Input / Open Drain Output Modes)	0	4.8	V
	AIO/LED[1:0] (AIO Mode)	0	1.95	V
	SYS_CTRL	-0.4	4.8	V
All ground / VSS pads	-	-0.4	0.4	V
DC Voltage	BT_RF	0	0	V
Radio Receive	BT_RF	-0.4	0.4	V
Radio Transmit (3:1 VSWR)	BT_RF	-1.6	1.6	V

CAUTION: Stressing the device beyond the Absolute Maximum Ratings may cause instantaneous and permanent damage. Device performance is not guaranteed beyond the Recommended Operating Conditions. Prolonged exposure beyond the Recommended Operating Conditions may permanently affect device reliability and/or performance.

6.2 Recommended operating conditions

Table 6-2： Power Supply Characteristics

Parameter	Pin	Min	Typ	Max	Unit
Operating temperature range	-	-40	25	85	℃
Charger operating temperature range	-	-10	25	85	℃
Supply voltage					
5 V (USB VBUS)	VBUS	4.75	5.00	5.5	V

Battery	VDD	3.0 / 2.8(b)	3.7	4.6	V
	MIC_BIAS	0	-	2.3	V
	USB_DN	0	-	3.6	V
	USB_DP	0	-	3.6	V
1.8 V	MIC_LN / LINEIN_1_N MIC_LP/ LINEIN_1_P MIC_RN/ LINEIN_2_N MIC_RP / LINEIN_2_P	1.65	1.80	1.95	V
Digital I/O	VDD_IO	1.7	1.8	3.6	V
	PIO	0	-	VDD_IO	V
	RESET	0	-	3.5	V
	AIO/LED[1:0] (Disabled / Digital Input / Open Drain Output Modes)	0	-	5	V
	AIO/LED[1:0] (AIO Mode)	0	-	1.95	V
	SYS_CTRL	0	-	4.6	V
All ground / VSS pads	-	0	-	0	V

a：Minimum input voltage of 4.75 V is required for full specification.

b：Recommended software power-off threshold at 3.0 V. Device operates down to 2.8 V.

6.3 Digital terminals

Table 6-3：Digital terminals

Digital terminals	Min	Typ	Max	Unit
VDD_IO supply	1.7	1.8	3.6	V
VIL input logic level low	-	-	0.25 x VDD_IO	V
VIH input logic level high	0.625 x VDD_IO	-	-	V
Drive current (configurable)	2,4,8,12	4	-	mA
VOL output logic level low, at configured drive current	-	-	0.22 x VDD_IO	V
VOH output logic level high, at configured drive current	0.75 x VDD_IO	-	-	V
Strong pull (up and down)	50	70	125	kΩ
Weak pull (up and down)	729	1050	1350	kΩ

6.4 LED driver pins

Table 6-4：LED driver pads

Digital terminals		Min	Typ	Max	Unit
Open drain current	High impedance state	-	-	5	μA
	Current sink state	-	-	50	mA

LED pad resistance	V < 0.5 V	-	-	12	Ω
VIL input logic level low		-	-	0.4	V
VIH input logic level high		0.8	-	-	V

7 RECOMMENDED TEMPERATURE REFLOW PROFILE

Prior to any reflow, it is important to ensure the modules were packaged to prevent moisture absorption. New packages contain desiccate (to absorb moisture) and a humidity indicator card to display the level maintained during storage and shipment. If directed to bake units on the card, please check the below and follow instructions specified by IPC/JEDEC J-STD-033.

Note: The shipping tray cannot be heated above 65°C. If baking is required at the higher temperatures displayed in the below , the modules must be removed from the shipping tray.

Any modules not manufactured before exceeding their floor life should be re-packaged with fresh desiccate and a new humidity indicator card. Floor life for MSL (Moisture Sensitivity Level) 3 devices is 168 hours in ambient environment 30°C/60%RH.

Notice (注意) :

The Feasycom's module must be used with a Step-Stencil. It is suggested to use a stencil thickness of approximately 0.16-0.2mm, which can be modified according to the product.

Table 7-1: Recommended baking times and temperatures

MSL	125°C Baking Temp.		90°C/≤ 5%RH Baking Temp.		40°C/ ≤ 5%RH Baking Temp.	
	Saturated @ 30°C/85%	Floor Life Limit + 72 hours @ 30°C/60%	Saturated @ 30°C/85%	Floor Life Limit + 72 hours @ 30°C/60%	Saturated @ 30°C/85%	Floor Life Limit + 72 hours @ 30°C/60%
3	9 hours	7 hours	33 hours	23 hours	13 days	9 days

Feasycom surface mount modules are designed to be easily manufactured, including reflow soldering to a PCB. Ultimately it is the responsibility of the customer to choose the appropriate solder paste and to ensure oven temperatures during reflow meet the requirements of the solder paste. Feasycom surface mount modules conform to J-STD-020D1 standards for reflow temperatures.

The soldering profile depends on various parameters necessitating a set up for each application. The data here is given only for guidance on solder reflow.

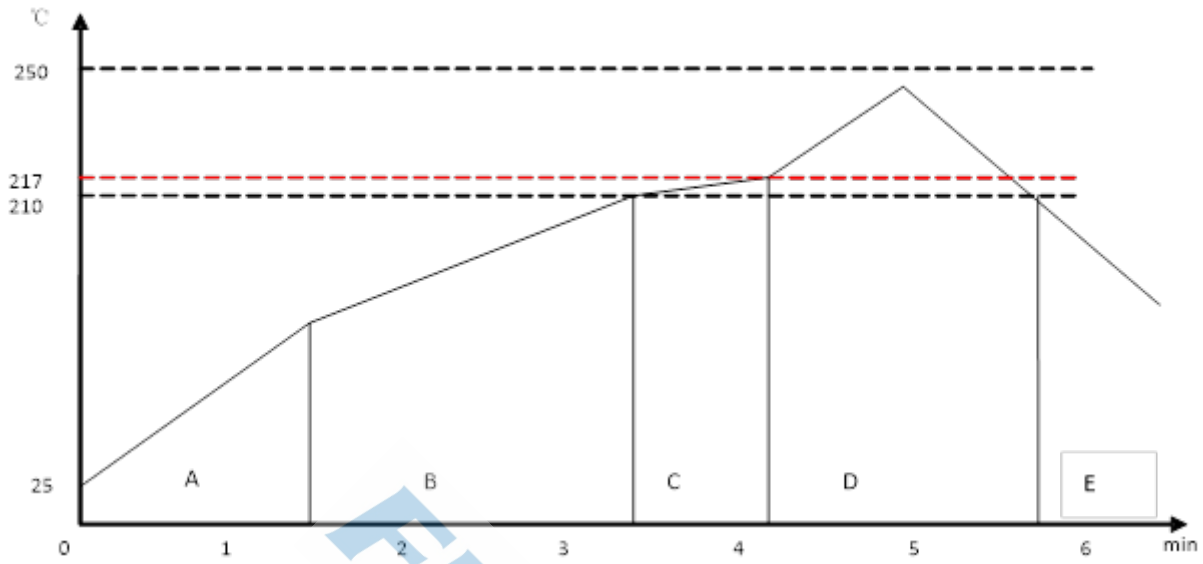

Figure 7-1：Typical Lead-free Re-flow

Pre-heat zone (A) — This zone raises the temperature at a controlled rate, **typically 0.5 – 2 °C/s**. The purpose of this zone is to preheat the PCB board and components to 120 ~ 150 °C. This stage is required to distribute the heat uniformly to the PCB board and completely remove solvent to reduce the heat shock to components.

Equilibrium Zone 1 (B) — In this stage the flux becomes soft and uniformly encapsulates solder particles and spread over PCB board, preventing them from being re-oxidized. Also with elevation of temperature and liquefaction of flux, each activator and rosin get activated and start eliminating oxide film formed on the surface of each solder particle and PCB board. **The temperature is recommended to be 150° to 210° for 60 to 120 second for this zone.**

Equilibrium Zone 2 (C) (optional) — In order to resolve the upright component issue, it is recommended to keep the temperature in 210 – 217 ° for about 20 to 30 second.

Reflow Zone (D) — The profile in the figure is designed for Sn/Ag3.0/Cu0.5. It can be a reference for other lead-free solder. The peak temperature should be high enough to achieve good wetting but not so high as to cause component discoloration or damage. Excessive soldering time can lead to intermetallic growth which can result in a brittle joint. The recommended peak temperature (Tp) is 230 ~ 250 °C. The soldering time should be 30 to 90 second when the temperature is above 217 °C.

Cooling Zone (E) — The cooling ate should be fast, to keep the solder grains small which will give a longer-lasting joint. **Typical cooling rate should be 4 °C.**

8 MECHANICAL DETAILS

8.1 Mechanical Details

- Dimension: 12mm(W) x 15mm(L) x 2.0mm(H) Tolerance: ±0.2mm
- Module size: 12mm X 15mm Tolerance: ±0.2mm
- Pad size: 1.7mmX0.5mm Tolerance: ±0.2mm
- Pad pitch: 0.9mm Tolerance: ±0.1mm
- **(Residual plate edge error: < 0.5mm)**

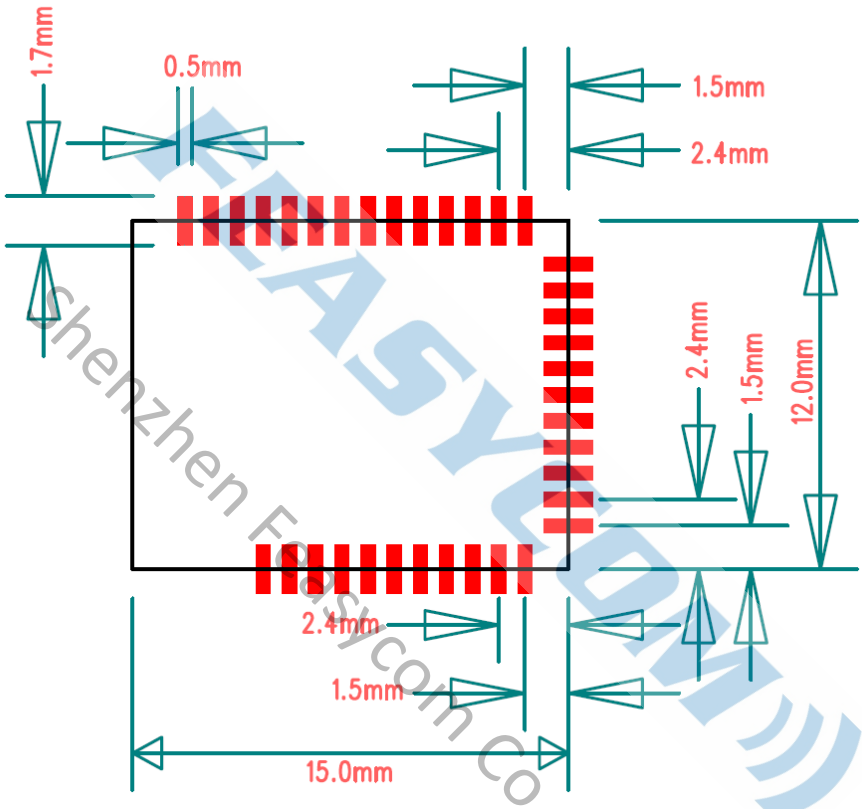

Figure 8-1：FSC-BT6038 footprint Layout Guide (Top View)

9 HARDWARE INTEGRATION SUGGESTIONS

9.1 Soldering Recommendations

FSC-BT6038 is compatible with industrial standard reflow profile for Pb-free solders. The reflow profile used is dependent on the thermal mass of the entire populated PCB, heat transfer efficiency of the oven and particular type of solder paste used. Consult the datasheet of particular solder paste for profile configurations.

Feasycom will give following recommendations for soldering the module to ensure reliable solder joint and operation of the module after soldering. Since the profile used is process and layout dependent, the optimum profile should be studied case by case. Thus following recommendation should be taken as a starting point guide.

9.2 Layout Guidelines(Internal Antenna)

It is strongly recommended to use good layout practices to ensure proper operation of the module. Placing copper or any metal near antenna deteriorates its operation by having effect on the matching properties. Metal shield around the antenna will prevent the radiation and thus metal case should not be used with the module. Use grounding vias separated max 3 mm apart at the edge of grounding areas to prevent RF penetrating inside the PCB and causing an unintentional resonator. Use GND vias all around the PCB edges.

The mother board should have no bare conductors or vias in this restricted area, because it is not covered by stop mask print. Also no copper (planes, traces or vias) are allowed in this area, because of mismatching the on-board antenna.

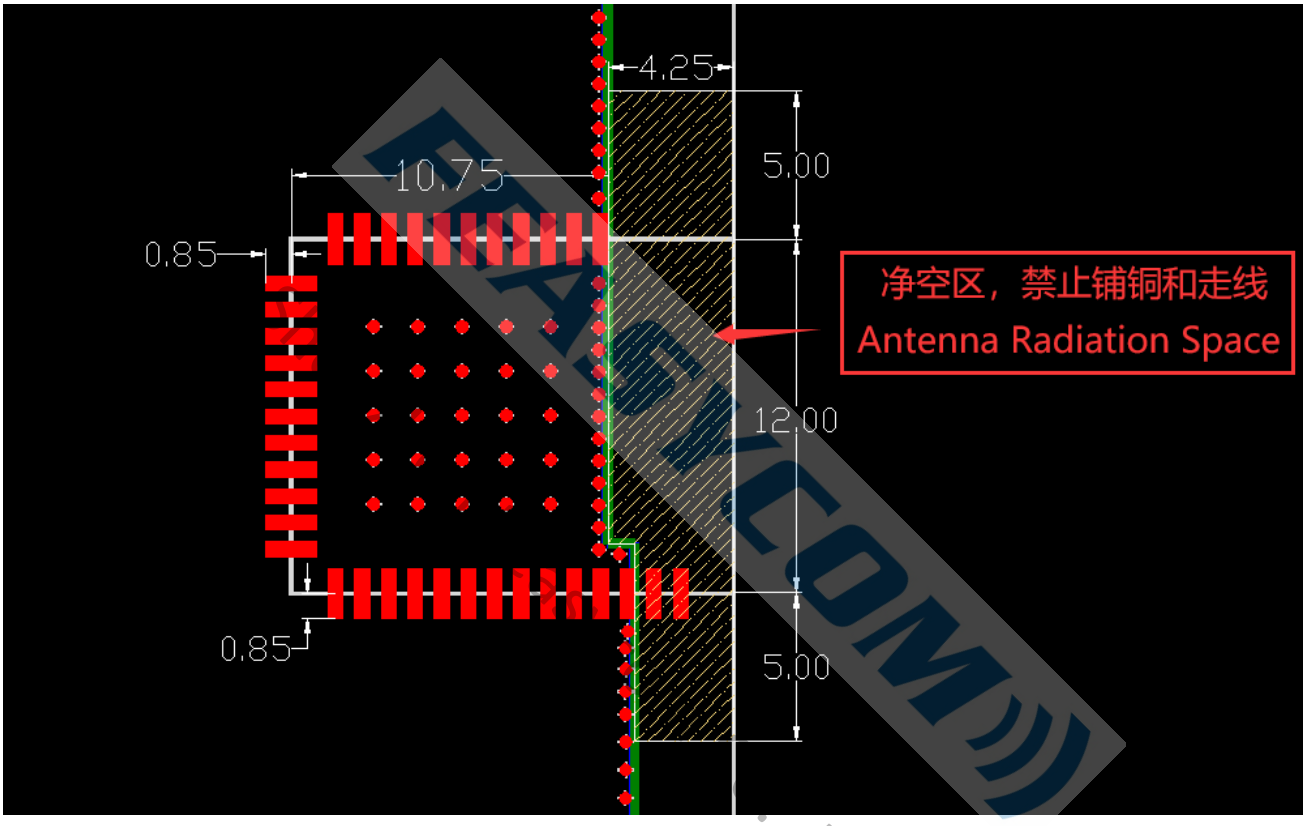

Figure 9-2-0： Restricted Area (Design schematic, for reference only. Unit: mm)

Top bottom

Figure 9-2-1： Imitated diagram

Following recommendations helps to avoid EMC problems arising in the design. Note that each design is unique and the following list do not consider all basic design rules such as avoiding capacitive coupling between signal lines. Following list is aimed to avoid EMC problems caused by RF part of the module. Use good consideration to avoid problems arising from digital signals in the design.

Ensure that signal lines have return paths as short as possible. For example if a signal goes to an inner layer through a via, always use ground vias around it. Locate them tightly and symmetrically around the signal vias. Routing of any sensitive signals should be done in the inner layers of the PCB. Sensitive traces should have a ground area above and under the line. If this is not possible, make sure that the return path is short by other means (for example using a ground line next to the signal line).

9.3 Layout Guidelines(External Antenna)

Placement and PCB layout are critical to optimize the performances of a module without on-board antenna designs. The trace from the antenna port of the module to an external antenna should be 50Ω and must be as short as possible to avoid any interference into the transceiver of the module. The location of the external antenna and RF-IN port of the module should be kept away from any noise sources and digital traces. A matching network might be needed in between the external antenna and RF-IN port to better match the impedance to minimize the return loss.

As indicated in below, RF critical circuits of the module should be clearly separated from any digital circuits on the system board. All RF circuits in the module are close to the antenna port. The module, then, should be placed in this way that module digital part towards your digital section of the system PCB.

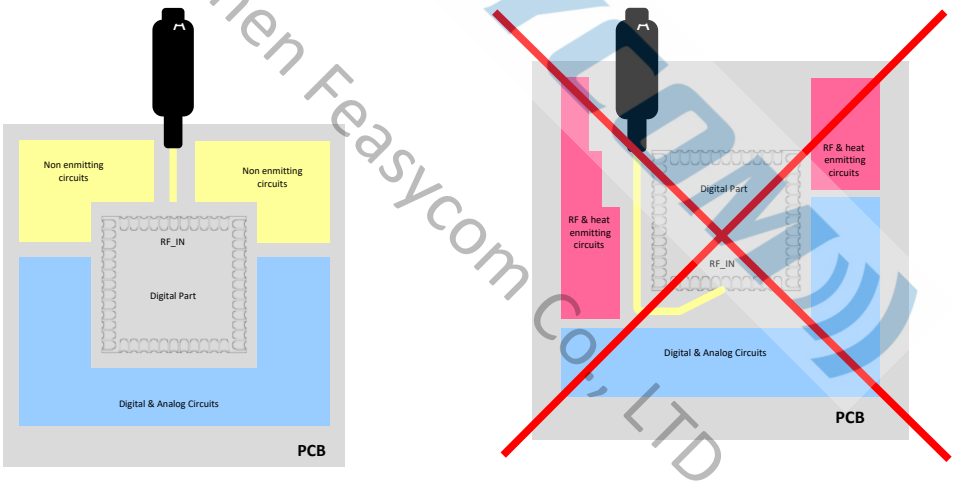

Figure 9-3: Placement the Module on a System Board

9.3.1 Antenna Connection and Grounding Plane Design

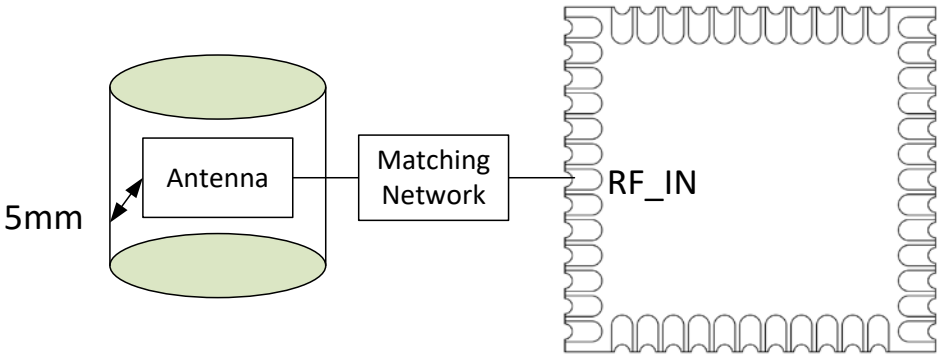

Figure 9-3-0: Leave 5mm Clearance Space from the Antenna

General design recommendations are:

- The length of the trace or connection line should be kept as short as possible.
- Distance between connection and ground area on the top layer should at least be as large as the dielectric thickness.
- Routing the RF close to digital sections of the system board should be avoided.
- To reduce signal reflections, sharp angles in the routing of the micro strip line should be avoided. Chamfers or fillets are preferred for rectangular routing; 45-degree routing is preferred over Manhattan style 90-degree routing.

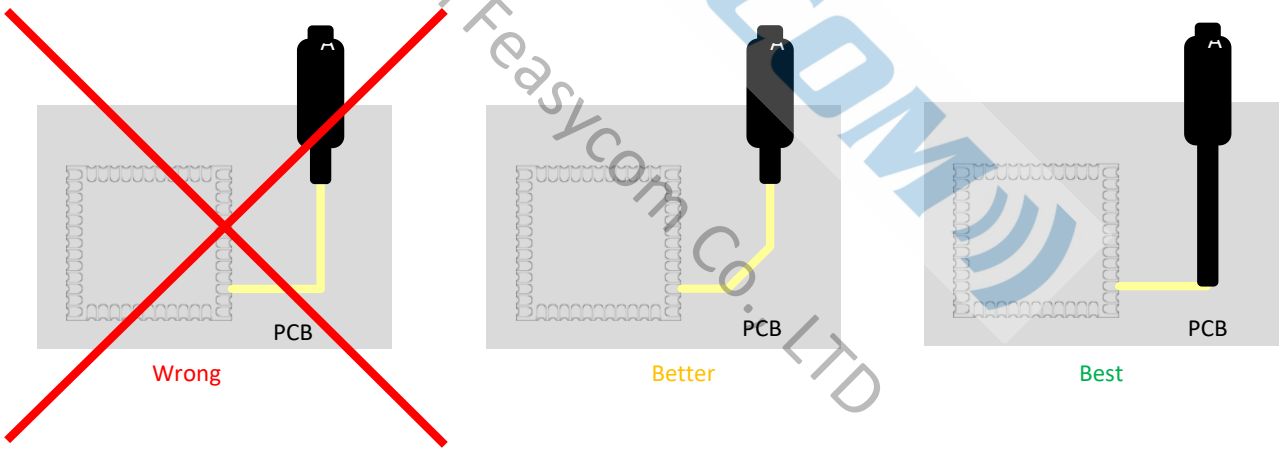

Figure 9-3-1: Recommended Trace Connects Antenna and the Module

- Routing of the RF-connection underneath the module should be avoided. The distance of the micro strip line to the ground plane on the bottom side of the receiver is very small and has huge tolerances. Therefore, the impedance of this part of the trace cannot be controlled.
- Use as many vias as possible to connect the ground planes.

10 PRODUCT PACKAGING INFORMATION

10.1 Default Packing

Figure 10-1: Tray Dimension: 140mm * 265mm Tray vacuum

10.2 Packing box(Optional)

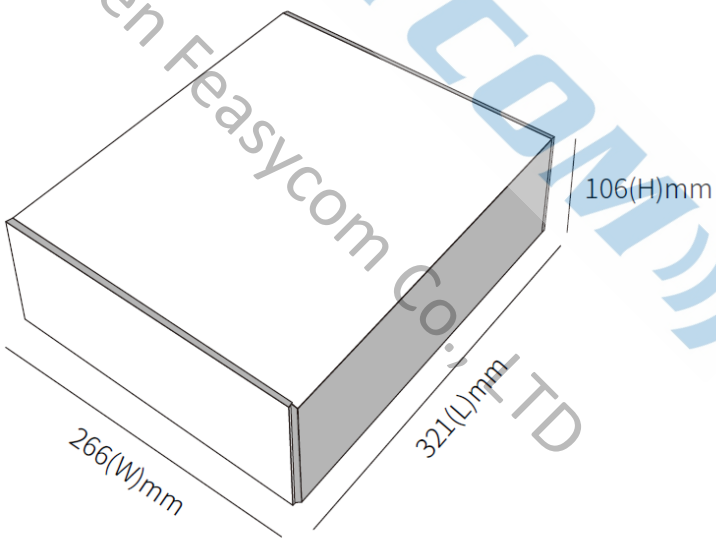

Figure 10-2: Packing box(Optional)

** If any packaging other than the package mentioned above is required, please confirm the packaging size again..*

** Packing: 1000pcs per carton (Minimum packing quantity).*

** The outer packing size provided above is for reference purposes only. For the actual dimensions of the product's packaging, please refer to the packaging of the actual goods.*

11 APPLICATION SCHEMATIC