MINEWSEMI

Radio Module
(60G Millimeter Wave Radar) |

MS72SF11

DateSheet

V 1.0.1

Applicable Product Model
MS72SF11

Version Note

Version	Details	Contributor(s)	Date	Notes
1.0.0	First edit	Coral	2023.05.30	
1.0.1	Addition housing layout and welding requirements	Vincle	2023.7.10	

MS72SF11

Low-cost,high-reliability,high-performance,accurate tracking and positioning of multiple people indoors,user motion track detection
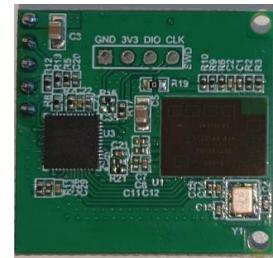
MS72SF11 is a 60G millimetre wave radar module, relative to the traditional visual, infrared, laser and other means of perception, millimetre wave radar is not affected by light, can be achieved around the clock without sensing active indoor personnel perception and monitoring, and has a personal privacy protection function, it is the best sensor for the current application of home scenes. This product adopts the national production chip, independent and controllable, to achieve accurate tracking, and can inhibit curtains, green plants and other interference. This product has the advantages of low cost, high reliability and high performance and so on.

■ Features

➢ Low-cost

➢ High-reliability

➢ High-performance

➢ User motion track detection

➢ accurate tracking and positioning of multiple people indoors

■ Application

Smart home people detection

User motion track detection

Indoor personnel track detection

Industrial control radar sensor

■ Key parameter

Working frequency	57~64GHz	Antenna	Integrated Patch Antenna
Module size	29.36×28mm	Processing Period	≤30ms
Installation method:	top/side installation	Detection Distance	0.5 ~ 8m
Azimuth Coverage	±60°	Pitch angle coverage	±60°
Max Consumption	1.7W	Avg Current	110mA(Processing Period 100ms)
Firmware	top/side firmware		

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1 Module Description

1.1 Module Function Description

| No.	Function	Detailes
1	Multi-target tracking	1) It can realize the target tracking function of up to 10 people, including the target movement trajectory and the real-time position of the target; 2) Strong ability to suppress false targets (curtains, green plants, multipath, etc.); High sensitivity to detect micro-moving targets (stationary, shaking, waving, etc.).
2	Area division	The user can flexibly configure the detection area.

1.2 Module Features

No.	Function	Detailes
1	Installation scene	 Detection distance: 0.5~8m, (the effective projection ground is a circle with a radius of 4meters, and the installation height is 2.7meters) （Note: The detection distance is related to factors such as installation environment, human body volume, relative angle, and movementrange. The above parameters are the test results of our company. Under different test conditions, the actual test results shall prevail）
2	Unaffected by the environment	Unaffected by temperature, humidity, dust, light, noise, etc.
3	Flexible parameter configuration	The detection threshold, function mode, etc. can be configured through the serial port.

2 Electrical Specification

Parameter	Values	Notes
Working Voltage	2.5 ~ 3.3	Standard supply voltage 3.3V
Working Temperature	-40℃~+85℃	Storage temperature is -40℃~+125℃
Transmission Power	-20 ~ +8dBm	
Avg Current	110mA	Processing Period 100ms
Max Consumption	1.7W	
Max Tx Power	-2.25dBm	Actual test value
Module Dimension	29.36*28mm	
Quantity of IO Port	5	

3 Pin Description
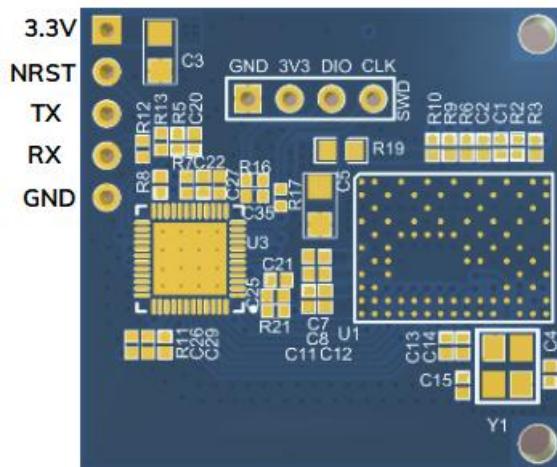
4 Pin Definition

Symbol	Type	Definition
3.3V	Power Supply	Power supply, input voltage 3.3V
NRST	Reset	Module reset pin
TX	UART TX	Used for UART serial transmitter (UART TX)
RX	UART RX	Used for UART serial reception (UART RX)
GND	Power supply ground	Ground

4.1 Mechanical Drawing
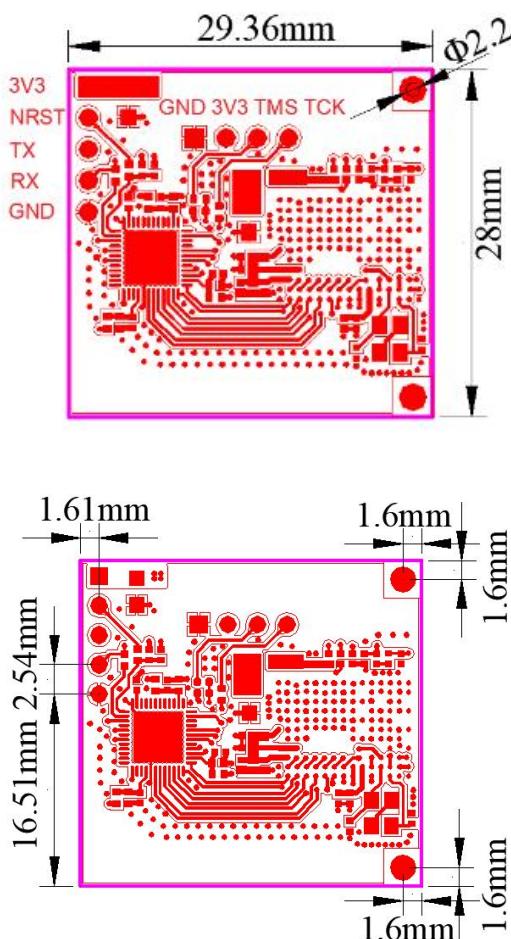
* （Default unit：mm   Default tolerance：±0.1）

5 Electrical Characteristics

5.1 Limit Rated Parameters

Pin	Min	Max	unit
3.3V	-0.5	3.6	v
I/O (TX/RX/VO)	-0.5	3.6	v

5.2 Typical working parameters

Pin	Typical value	unit
3.3V	3.0 ~ 3.3	v
I/O (TX/RX/VO)	-0.5 ~ VDD+0.3	v
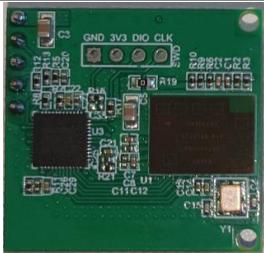
Notice: .VDD in the above table refers to the power supply input.

5.3 Module Consumption

The radar module contains RF devices, the current is about 530mA during the working time of starting RF transceiver, and about 80mA during the working time of shutting down RF transceiver. the average power consumption of the module is related to the frame period of the radar detection and processing, and if the radar works with a frame period of 100ms, then the average current is about 110mA. for the power supply input of the module, the power supply needs to be of high driving capacity, and the output current needs to be not less than 1A.

6 Environmental Build

6.1 Hardware components

NO.	Name	Figure	Description
1	Radar Module		Model NO.：MS72SF1
2	USB to TTL Module		USB to TTL module for serial port command configuration, antenna calibration and other functions.
3	USB Extension Cable		USB extension cable for connecting PC to USB TTL module
4	ST-LINK Down-loader		ST-LINK down-loader for radar module firmware upgrade and secondary development simulation debugging.

6.2 Installation position

The module is installed on the ceiling with the antenna facing down, and the installation height is 2.3-2.8m. When installing the module, try to keep it as fixed as possible to avoid shaking of the module. The surrounding environment should be as open as possible, and the USB extension cable should be fixed as much as possible to avoid interference caused by the cable. See e.g. Figure 1.
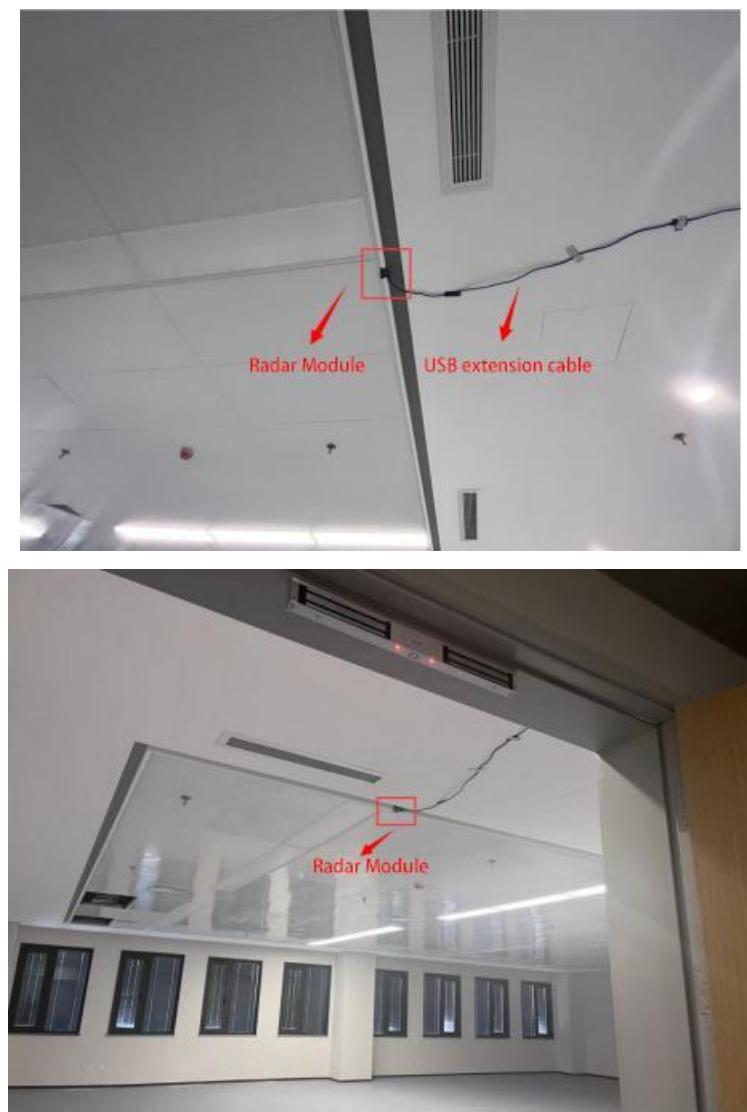
Figure 1 Top Mounting Legend

7 Parameter Configuration
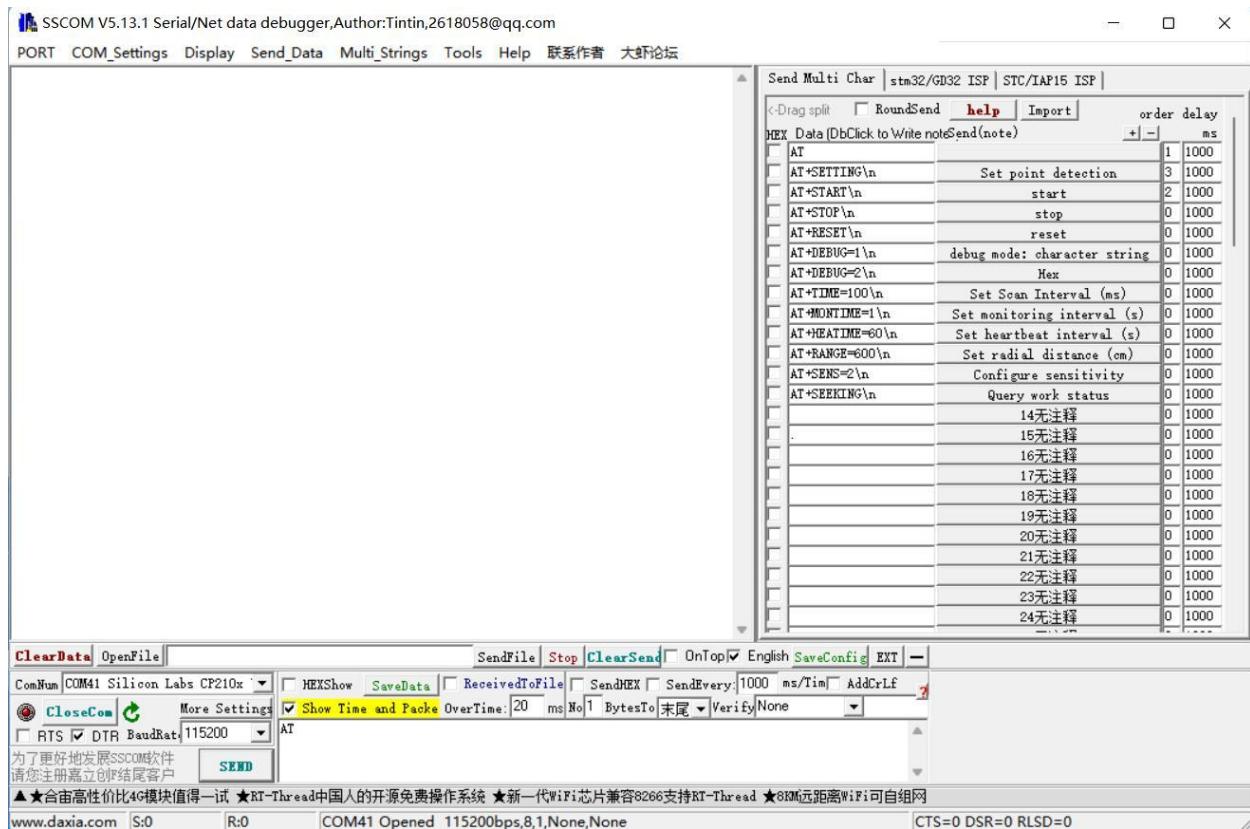
Adjust the corresponding parameters as needed. Note: After modifying the parameters, click the button behind the parameters to complete the parameter modification.

Common parameters are as follows:

Command	interpretations
AT+START\n	Start Operation
AT+STOP\n	Stop Operation
AT+RESET\n	Module reset
AT+TIME=XX\n	Configure scan interval (unit:ms, range:100-10000, default value 100）
AT+MONTIME=XX\n	Configure monitoring interval(units:s, range 1-99, default value 1)
AT+HEATIME=XX\n	Configure heartbeat interval (unit s, range 10-999, default value 60)
AT+RANGE=XX\n	Configure radial distance (in cm, range 10-1000, default 600)
AT+SENS=XX\n	Configure sensitivity (range 1-19, default is 2)

AT+SETTING\n	Fixed-point detection mode
AT+SEEKING\n	Check operation status
AT+WINARANGE=XXXXXXXXXXXX\n	Gate 1 configuration
AT+WINBRANGE=XXXXXXXXXXXX\n	Gate 2 configuration
AT+WINCRANGE=XXXXXXXXXXXX\n	Gate 3 configuration
AT+WINDRANGE=XXXXXXXXXXXX\n	Curtain 1 configuration
AT+WINERANGE=XXXXXXXXXXXX\n	Curtain 2 configuration
AT+WINFRANGE=XXXXXXXXXXXX\n	Curtain 3 configuration

Typical example：

If the configuration is successful, it will return AT+OK, if the configuration fails, it will return Save Para Fail, and you need to resend the command.

AT+SETTING\n

Before performing fixed-point detection, please first ensure that the detection environment has no other interference and let people stand still at the place where the fixed point is required, and then send AT+SETTING\n to configure. At this time, the module will upload the location information of the person as follows.

In this way, the coordinates of each point are recorded

AT+WINARANGE=XXXXXXXXXXXX\n

AT+WINARANGE followed by 12 digits, e.g.AT+WINARANGE=123211128217\n

It means that the doors and windows are on the straight line between point x1=-2.3, y1=1.1 and point x2=-2.8, y2=1.7, and the radar module will discard detection targets outside the straight line.

AT+WINARANGE=999999999999\n means to delete the restriction（the 1st, 4th, 7th,

and 10th digits indicate that the sign bit can only be 1 or 2, and 1 means negative, 2 means positive,AT+WINBRANGE=, AT+WINCRANGE=, AT+WINDRANGE=,

AT+WINERANGE=, AT+WINFRANGE= the same reason）

As shown in Figure 2, the radar detection area is diagrammed.
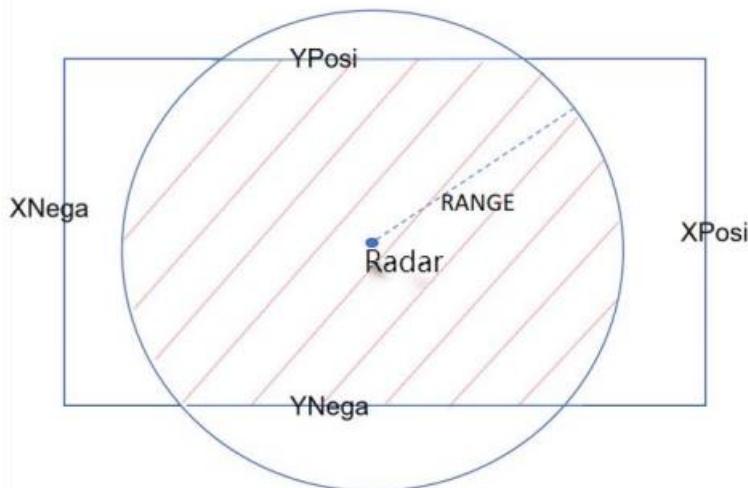

Figure 2   Radar detection area diagrammed.

8 Radar Module Serial Data Communication Protocol Description

8.1 Communication parameters

Baud Rate	115200
Data bits	8
Stop bits	1
Parity	NONE
Flow control	None

Notice: .Existing firmware module can update the firmware by serial port burning

8.2 Message Output Protocol Format

Field		Number of bytes	Description
HEAD		8	Frame header, fixed\x01\x02\x03\x04\x05\x06\x07\x08
LENGTH		4	Whole frame data length (uint32)
FRAME		4	Frame number (uint32)
TLVs		4	TLVs=1 followed by point cloud information (uint32)
POINTLENTH		4	Point cloud data length (points = POINTLENTH/25) (uint32)
Point 1	x	4	Coordinates x/y/z and energy signal-to-noise ratio information (v is int8, all others are float)
	y	4	
	z	4	
	v	1	
	SNR	4	
	POW	4	
	DPK	4	
......			
Point n	x	4	Coordinates x/y/z and energy signal-to-noise ratio information (v is int8, all others are float)
	y	4	
	z	4	
	v	1	
	SNR	4	
	POW	4	
	DPK	4	
TLVs		4	TLVs=2 followed by person information (uint32)
TRACKLENTH		4	Length of person data (number of persons = TRACKLENTH/32) (uint32)

Personnel 1	ID	4	Personnel markers (uint32)
	Q	4	(uint32)
	X	4	X/Y/Z coordinates of the person and the speed (float)
	Z	4	
	Y	4	
	Vx	4	
	Vz	4	
	Vy	4	
......			
Personnel n	ID	4	Personnel markers (uint32)
	Q	4	(uint32)
	X	4	X/Y/Z coordinates of the person and the velocity (float), in units: coordinates in m and velocity in m/s, to two decimal places. Single precision floating point type according to the standard for binary floating point arithmetic (IEEE 754),with the small endunwrappedbefore. https://www.binaryconvert.com/convert_float.html https://www.cnblogs.com/guanshan/articles/guan022.html
	Z	4	
	Y	4	
	Vx	4	
	Vz	4	
	Vy	4	

Provide example

01 02 03 04 05 06 07 08 BE 01 00 00 6E 6F 09 00 01 00 00 00 00 00 5E 01 00 00 01 CC 34 BF 01 A0 CE 3D 08 5A B9 3F 00 BE B3 07 40 00 06 8B 3F EA 86 87 41 01 B6 41 BF 01 08 3B 3E 6E 1B BD 3F FF B4 93 79 41 00 E4 8F 3F 63 32 50 41 01 B6 41 BF 01 50 20 3E 7C 7D BD 3F 00 36 A9 01 40 00 C2 11 40 03 A3 78 41 01 08 3B BF 01 98 05 3E 2D 7B BF 3F 01 68 19 99 41 00 E5 92 3F 33 6E 77 41 01 2B 48 BF 01 A8 25 3E 77 CE C3 3F FF DD 6C 72 41 00 7F 8F 3F 54 F6 4C 41 01 2B 48 BF 01 0C 0A 3E 0A 24 C4 3F 00 59 D0 02 40 00 D4 0D 40 DF C7 5F 41 01 2B 48 BF 01 E0 5C 3E FB F3 C2 3F 01 0D 4B C8 41 00 C7 8A 3F E4 19 68 41 01 C0 55 BF 01 80 0E 3E 37 9C C8 3F 00 15 00 0A 40 00 1D 9A 3F 7B 9B 22 41 01 5B 36 BF 01 F0 0A 3E 23 F5 02 40 00 97 6C 09 40 00 DF B7 3F 56 B1 06 41 01 F0 43 BF 01 20 32 3E 33 5A 05 40 00 D0 1C 0F 40 00 1D D0 3F 7B B2 DF 40 01 E9 35 BF 01 C3 22 3F 0C 82 0C 40 00 C0 A6 09 40 00 42 BE 3F 5B 9B C6 40 01 58 30 BF 01 8C 26 3F A1 8B 10 40 FF 22 FD 2E 43 00 9C D5 3F 15 5C 01 41 01 8C 26 BF 01 8C 26 3F 16 45 11 40 00 B6 B3 05 40 00 20 5F 40 7D 2C 00 41 01 8C 26 BF 01 8C 26 3F 16 45 11 40 01 45 00 78 41 00 AF E7 3F 5E B5 08 41 02 00 00 00 00 40 00 00 00 00 01 00 00 00 08 00 00 00 26 C2 2C BF 98 C1 B1 3E 6D 86 E7 3F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03 09 00 00 00 3E 4F 81 BF B1 3D 38 BF 45 06 2B 40 00 00 00 00 00 00 00 00 00 00 00 00 00

01 02 03 04 05 06 07 08 : Frame header

BE 01 00 00 : frame length 446 bytes

6E 6F 09 00 : frame number 618350

01 00 00 00 : TLVs=1 followed by point cloud information

5E 01 00 00 : Length of point cloud 350, number of points = 350/25 = 14

01 CC 34 BF 01 A0 CE 3D 08 5A B9 3F 00 BE B3 07 40 00 06 8B 3F EA 86 87 41:
Point information, X=-0.7,Y=0.1,Z=1.44,V=0,SNR=2.12,POW=1.08,DPK=16.94

02 00 00 00 : TLVs=2 followed by person information

40 00 00 00 : Length of person 64, number of points = 64/32 = 2

9 Use of the upper computer

1) Use USB to TTL to power the radar with 3.3V voltage, then open "Radar_DemoSideMount.exe" (Check that it has been adjusted to HEX data mode (AT+DEBUG=3););

2) Select the serial port number as shown in Figure 3, the default baud rate is 115200, click "Open Serial Port";

3) Select "Top or Side Fit";

4) Click on "Start" and the radar starts to operate;

5) Selecting "R&D Mode" displays the point cloud, while selecting "Demo Mode" does not display the point cloud data;

6) As in Figure 3, the left side is 2D coordinates display, the right side is 3D display；

7) Click on the " Stop " button and the radar stops working.
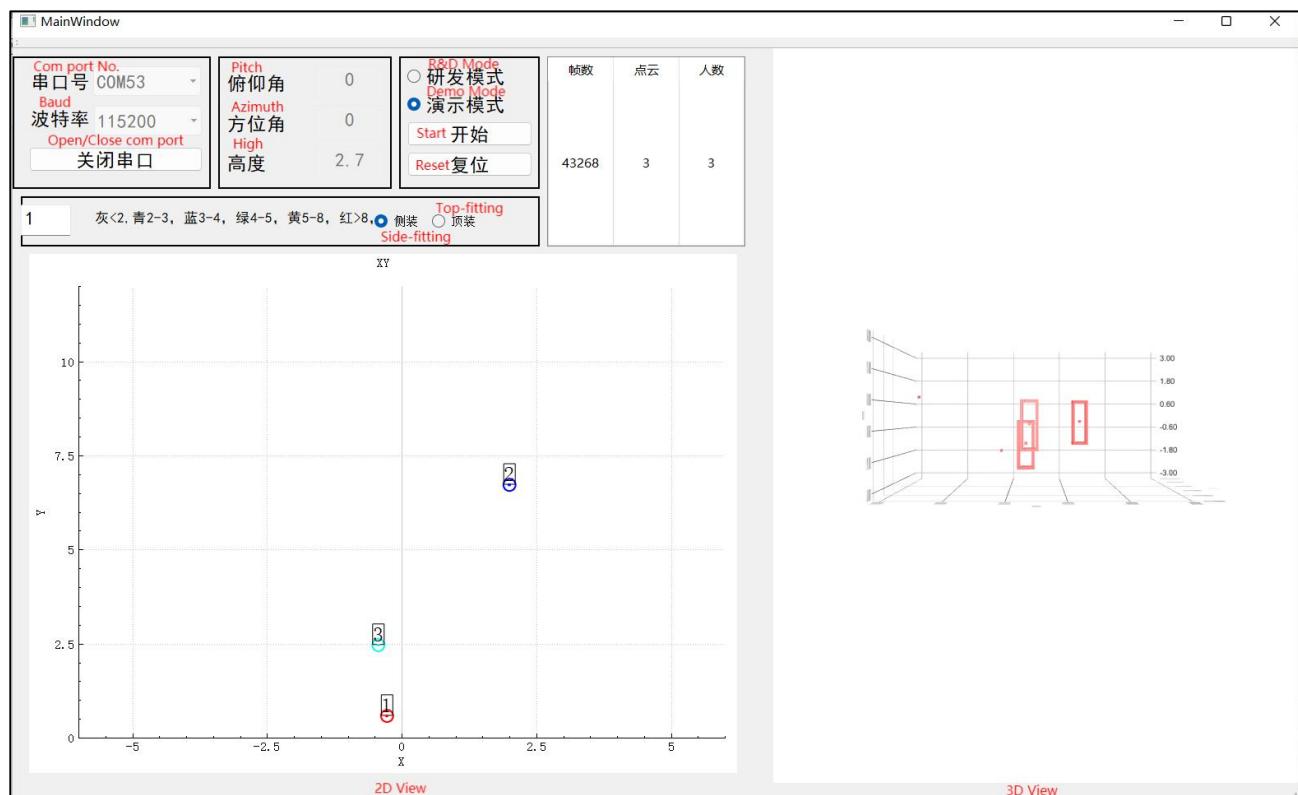
Figure3 Upper computer diagram

10 Housing Layout and Welding Requirements

- The module recommends a clearance of 2.5mm from the antenna surface to the inner surface of the housing, and a housing (PC/ABS material) thickness of 1.44mm or an integral multiple of 1.44mm.
- The PCBA in SMT, do not contaminate the chip, the chip must be pasted flat, not warped.
- Housing detection surface: non-metallic, need to be flat to avoid bending surface, affecting the performance of the entire swept area.
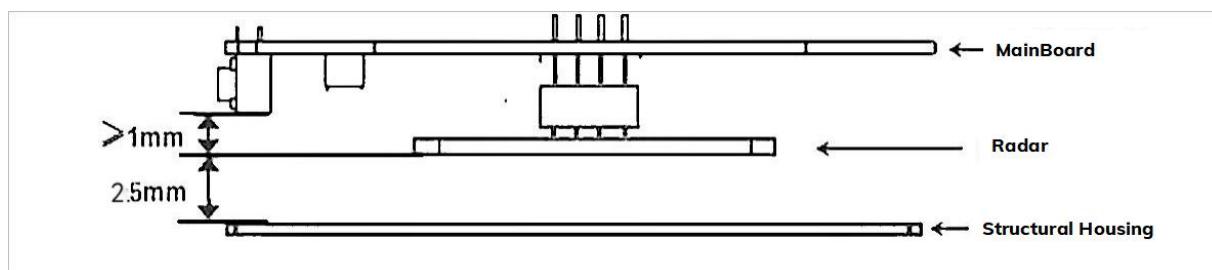

Figure2 Layout diagram of antenna and housing

FCC regulatory compliance statement

§15.19 Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

§15.21 Information to user

Warning: changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

List of applicable FCC rules:

47 CFR Part 15.255

Summarize the specific operational use conditions

This module can be used in IOT devices, the input voltage to the module is nominally 4V.

Limited module procedures

This module is a limited module.

Trace antenna designs

The antenna is not a trace antenna.

RF exposure considerations

This Module complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Antennas

If you desire to increase antenna gain and either change antenna type or use same antenna type certified, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

Label and compliance information

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC ID:2BDJ6-MS72SF11" any similar wording that expresses the same meaning may be used.

§ 15.19 Labelling requirements shall be complied on end user device.

Labelling rules for special device, please refer to §2.925, § 15.19 (a)(5) and relevant KDB publications. For E-label, please refer to §2.935.

Information on test modes and additional testing requirements

The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

The module is limited to installation in mobile application, a separate approval is required for all other operating configurations, including portable configurations with respect to §2.1093 and difference antenna configurations.

FCC other Parts, Part 15B Compliance Requirements for Host product manufacturer

This modular transmitter is only FCC authorized for the specific rule parts listed on our grant, host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

Host manufacturer in any case shall ensure host product which is installed and operating with the module is in compliant with Part 15B requirements.

Please note that For a Class B or Class A digital device or peripheral, the instructions furnished the user manual of the end-user product shall include statement set out in §15.105 Information to the user or such similar statement and place it in a prominent location in the text of host product manual. Original texts as following:

For Class B

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

For Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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Cognizant of our commitment to quality, we operate our own factory equipped with state-of-the-art production facilities and a meticulous quality management system. We hold certifications for ISO9001, ISO14001, ISO27001, OHSA18001, BSCI.

Every product undergoes stringent testing, including transmit power, sensitivity, power consumption, stability, and aging tests. Our fully automated module production line is now in full operation, boasting a production capacity in the millions, capable of meeting high-volume production demands.

● Contact Us

Shenzhen Minewsemi Co., Ltd. is committed to swiftly delivering top-quality connectivity modules to our customers. For assistance and support, please feel free to contact our relevant personnel, or contact us as follows:

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