

MR76S 77GHz millimetre wave radar User Manual



Hunan Nanoradar Science and Technology Co., Ltd.

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Version history

Date	Version	Version description
2020-11-21	1.0	First version of MR76S 77GHz millimetre wave radar user manual

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1 Summary

1.1 Important reminding

This user manual aim to the MR76S 77GHz millimetre wave radar which developed by Nanoradar. Maybe existing individual difference among different radars, this manual not process special description.

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Nanoradar not undertake any responsibilities if human body hurt or property loss caused by that not follow the description in this manual or incorrectly use the equipment, all warranty and claimant terms invalid at the same time. No matter any reasons all not allow to freely change and rebuild the radar sensor, all warranty and claimant terms invalid if occur any danger which caused by above situation.

We keep right to process technical modification or modify the delivery standards. Please contact us if customers need test radar function or maintain radar. Please must keep the product original package, avoid MR76S been forced damage during transporting.

This manual will be syn update according to MR76S 77GHz millimetre wave radar. Revise, correct and strengthen it according to situation of radar, to meet customer's development requirements and precision. This manual unable to list all possible application and use scene of MR76S. The early version manual rejected after new version issued. Please the customers obtain the latest version user manual in time.

1.2 Characteristics summary

MR76S 77GHz millimetre wave radar provide close distance, middle and long distance double beams scan and cover, able to measure the obstacles with farthest distance 300m. The radar support the below functions:

- 1) Able to detect the motion objects with relative speed -200km/h+250km/h at the same time.

- Able to obtain the distance, speed and angle information of objects.
 - Able to discriminate the motion objects such as vehicles and passengers.
 - Able to discriminate the different motion status obstacles, such as coming motion and pass motion, etc.
- 2) Double beams scan and cover, close distance scan position angle up to $50\text{m}@ \pm 45^\circ$, far distance scan distance farthest to $300\text{m}@ 0^\circ$.
 - 3) Able to output max 128 pieces tracing objects through CAN joggle.
 - 4) Need customers self development if need merge radar and other equipment (such as camera).

1.3 Application scene

MR76S 77GHz millimetre wave radar suitable to the application such as traffic flow monitor, crossing detect and boundary safety guard, etc.

- Monitor object distance and alarm: send out distance monitor alarm if found front object at too close distance.
- Industry and carriage application: detect and tracing in industry, building, agriculture and mining, avoid to impact people, vehicles, animals and equipment.
- Traffic monitor: application in the safety respects such as traffic management and discriminate lane objects.
- Crossing alarm: alarm at crossing income vehicles.
- Boundary safety guard: detect the cross obstacles.

The high sensitivity and resolution of radar able to make ensure detected the front objects even though under the situation that unable to judge by visual.

1.4 Principle simple description

MR76S use FMCW (modulate continue wave) modulate method. The basic principle is that launch wave is high frequency continue wave, the frequency change according to delta wave laws and along with time. The same change law of FMCW received return wave frequency and launched frequency, all are delta wave law, just existing one time difference, utilize this tiny time difference then can calculate out the

object distance.

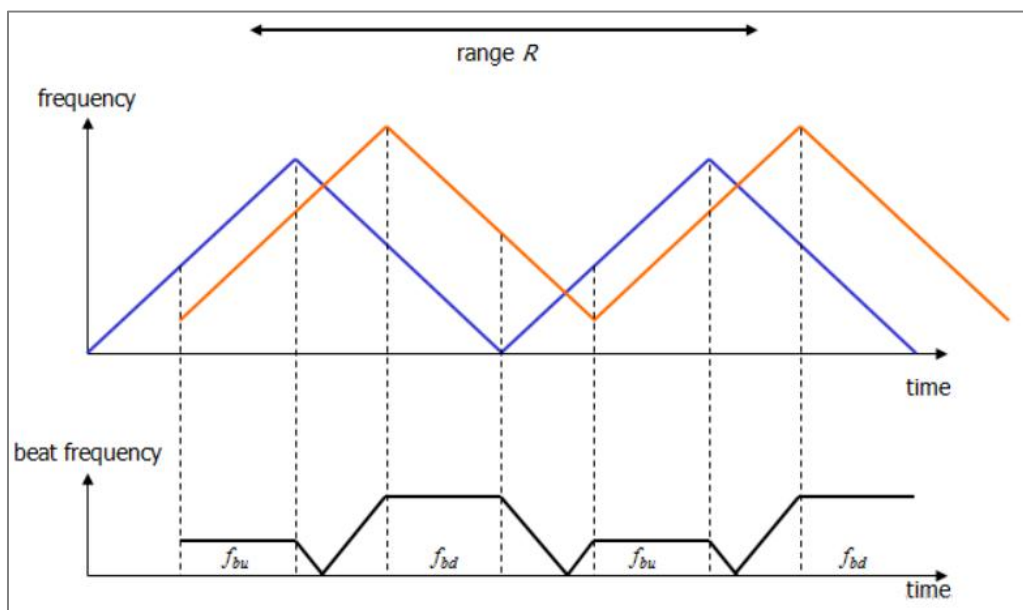


Fig 1 Principle frame figure of continue wave radar

Make delta wave modulate frequency continue wave as sample to simply introduce the distance detect/speed detect principle of radar. Shown as fig 1, blue is launch signal frequency, yellow is retrieve signal frequency, sweep frequency period is T , sweep frequency band width is B , launch signal through object launch, return wave signal will has delay, able to process distance measurement at both rise border and drop border in frequency change of delta wave.

1.5 Radar visual field

MR76S 77GHz millimetre wave radar is one middle distance radar. It able to detect object distance, speed and angle information through retrieve radar reflex wave.

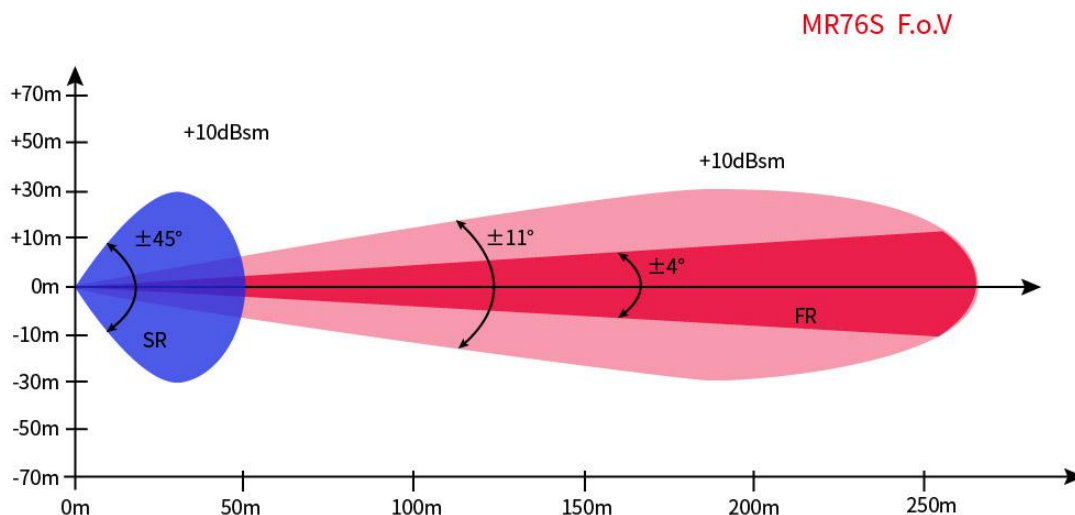


Fig 2 FoV of MR76S

1.6 Technical parameters

Table 1 Specification parameters table of MR76S

Detect performance	Common object (non reflex object)	
Modulate method		FMCW
Distance measure range		1.2~300m@0° & 1.2-200m@±11° for LRR 1.2~50m@±45° for MRR
Distance measure resolution ratio	Point target, non tracing	1.2m (able to discriminate two objects under 1.5 to 2 times resolution condition)
Distance measure precision	Point target, non tracing	±0.6m
Position wave beam	-6dB(F.o.V)	90° for MRR 22° for LRR
Pitch wave beam	-6dB(F.o.V)	14°
Angle precision	Point target, non tracing	0.2°@±11° 1°@±45°
Speed range		-200km/h...+250km/h (+means far away target, - means close to target)
Speed resolution	Point target, non tracing	0.43km/h
Speed precision	Point target, non tracing	±0.36km/h
Circling period		About 80ms

Antenna passageway quantity		3TX/4RX=12 passageways
Operating conditions		
Radar launch frequency	Follow ETSI&FCC	76...77GHz
Transmit capacity	Average/peak value EIRP	29.8dBm
Power supply		+8.0V...32VDC
Power consumption	Under 12V/24V	2.5W
Operating temperature		-40°C...+70°C
Storage temperature		-40°C...+85°C
Protection grade		IP67
Joggle types		
Joggles	The max support 8 pieces ID	1xCAN-high speed 500kbit/s
Shell		
Size	Length*width*height (mm)	137*75*20
Weight	Without harness	124g
Materials	Shell front end/rear cover	PBT front shell+glass fiber, press casting aluminum bottom shell

2 Radar setting

2.1 Joggle connection

MR76S outer joggle only support CAN joggle connection.

2.2 Configuration, start, close and failure

The relate agreement please refer to MR76S millimetre wave radar agreement manual when MR76S connect to bus line or PC through CAN agreement.

MR76S not support working plug in or plug out. If system internal test and found error then maybe caused abnormal radar function, even though caused radar restart.

3 Installation standards

3.1 Install radar

MR76S installation need height 3~6m distant to ground (recommend) in traffic

flow detect and the related application, radar antenna face to front, able to downward incline $0^{\circ} \sim 15^{\circ}$ according to customer application requirements at detect distance and blind area. Installation standards shown as fig 3 and fig 4:

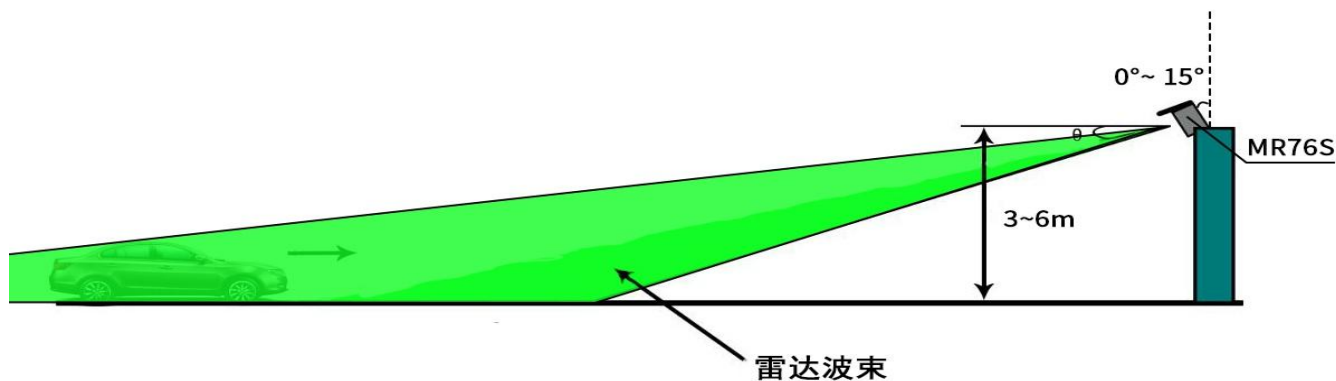


Fig 3 MR76S radar vertical installation diagram

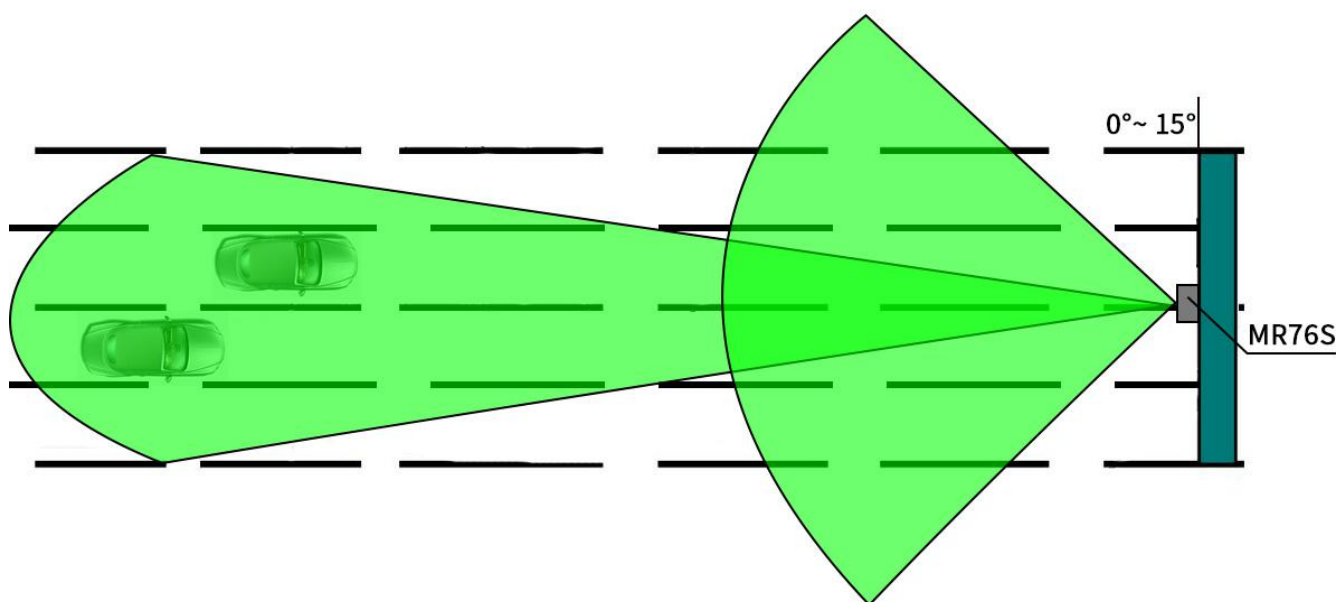


Fig 4 MR76S radar horizontal installation diagram

Table 2 Different installation height/angle detect blind area data table of MR76S

<p>Different installation height/angle detect blind area data table of MR76S</p>

Installation angle	Installation height				
		3m	4m	5m	6m
	0°	19\1	21\3	21\10	22\12
	5°	12\1	17\2	18\2	21\3
	10°	8\1	12\1	14\2	16\3

Remark:

*Tested object is WULING HONGGUANG MPV vehicle, the data are empty road actually tested data, will has difference of actually tested data under different environment;

**A/B in the table means that measure far distance/close radar detected blind area, because the tracing algorithm reasons, distance of far distance/close radar blind area has a certain difference;

***Adjust the radar installation height and installation angle not only will affect the blind area, but also will affect the farthest detect distance to radar, more close detect distance more installation angle;

****Please contact technology support staffs of Nanoradar for help if exiting bigger difference of data in this table when install radar.

3.2 Radar direction instruction

MR76S antenna beam width is position plane 90°(-6dB), pitch surface 14°(-6dB), direction instruction in Decare coordinate shown as fig 5:

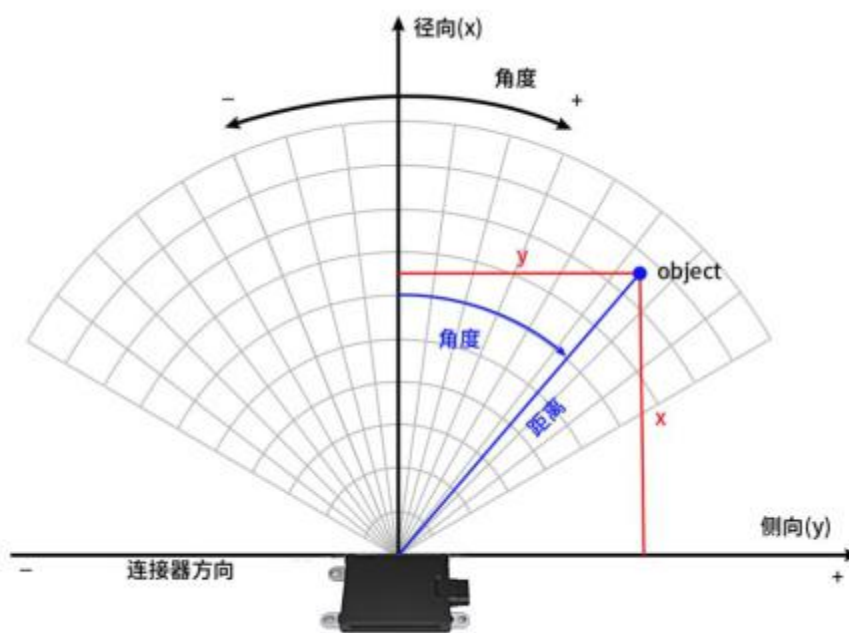


Fig 5: Radar direction instruction diagram

3.3 Installation notices

Radar sensor installation principle:

- Do best to far away other signal antenna when installing;
- Far away the bigger power equipment frequently starting position when

installing;

Additionally, still should pay attention at the below items when install MR76S 77GHz millimetre wave radar:

- Make ensure no ice pellets or water fog on surface of antenna cover when install sensor.
- Can't welding nearby the radar sensor position.
- Only can use damp and non fibre cotton cloth to wipe dust on surface of radar sensor, can't shave, scratch and damage sensor surface.
- Equipment need process daily inspection before put into use.
- Make ensure it will not caused deformation at fix position, tightly lock torque of radar sensor can't exceed 7Nm.

The customers able to design the radar antenna cover and other structure according to requirements, the antenna cover materials will generate more bigger affection at radar performance, accurately, the radar antenna cover will affect the radar performance at three respects, first, radar wave can't completely pass through antenna cover, this caused radar valid radiation power reduced, include reflex consumption and agent consumption; second, radar antenna beam aberration caused radar performance area happen change, this maybe caused radar disturbed by backward objects; third, antenna cover make radar standing wave come to be bad. The detail design of antenna able to refer Nanoradar 77GHz radar antenna cover design guidance. This design data comes from theory value, actual requirements need customers process further more test according to actual antenna cover.

(1) Conduct coefficient of materials:

Table 3 Conduct coefficient of antenna cover materials

Material	Conduct coefficient (under 77GHz)
Polypropylene	2.35
Polyamide	2.75
Polycarbonate	2.8
PC-PBT	2.9

ABS	3.12
ASA	~3.8
PMMA	~3-4TBC

(2) Thickness:

Table 4 The affection of different material thickness to radar

Material	The best thickness 1(mm)	The best thickness 2(mm)	The best thickness 3(mm)	The best thickness 4(mm)	Decay (77GHz)	Usability
PP	1.28	2.55	3.38	5.10	0.10	Best
ABS	1.19	2.39	3.58	4.77	0.30	Good
PA	1.18	2.36	3.54	4.72	0.30	Good
PC	1.16	2.33	3.49	4.66	0.17	Good
SMC	0.88	1.77	2.65	3.54	1.10	Bad

Need select the thickness of antenna cover carefully to guarantee radar achieved the higher conduct ratio. The bumper thickness in above materials should be integer times of half of 77GHz millimetre wave radar wave length. Such as that thickness of ABS material antenna cover should be $n \times 1.2\text{mm}$ (in 77GHz range, $n=1, 2, \dots$). The decay will increasing along with antenna cover thickness.

The antenna cover should do best to keep level to prevent radar beam generate aberration, and maintain even thickness, any tiny bending all will generate bigger affection at radar beams.

(3) Plating

The antenna able to be plated in theory, but should process detail analyse and test, avoid the radar sensor performance occur notably reduce.

(4) Heat radiation and electromagnetism shield

If customer self design the radar antenna cover and other structure, then still need consider radar heat radiation and affection of electromagnetism shield, able to refer the design drawing which provided by Nanoradar.

4 Electric characteristics

4.1 Harness connection

MR76S standard connect harness is the cable with length 3m, include positive and negative pole of power supply, CAN_H and CAN_L.

MR76S radar need be supplied power by battery or other equipment. The power supply wire need use 10A wire. The grounding wire should do best to be short to guarantee the radar freely electromagnetism disturb.

4.2 Test and use

The millimetre wave radar common management tools host computer test software provided by Nanoradar able to obtain and analyse MR76S sensor data, visually display the observe result, utilize this tool favour to use MR76S sensor.

Utilize CAN agreement test method as below: firstly, obtain the Nanoradar millimetre wave radar common management tool (host computer test software), operating manual and CAN2USB box and drive from Nanoradar customer service or official website. Customer install CAN Monitor drive, install and configure host computer test software according to operating manual.

Test used tool or software shown as the below table:

Table 5 Product test used tools

S/N	Equipment name	Qty
1	MR76S 77GHz millimetre wave radar	1
2	PC computer/laptop	1
3	USB2CAN adapter	1
4	12V power supply adapter	1
5	Host computer test software	1

Connect PC and MR76S radar sensor through USB2CAN adapter, the connect diagram shown as fig 6:

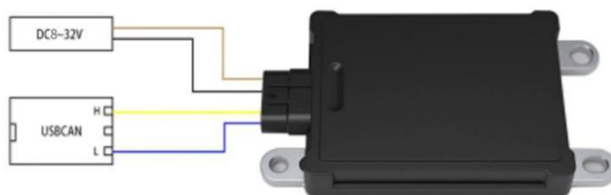


Fig 6 Harness connect diagram

Note:

The test need use the USB2CAN adapter and MR76S communication shown as the below picture, currently not support other types USB2CAN adapter, the delivery list default not contain USB2CAN adapter. The customer able to obtain the CAN adapter link address from Nanoradar customer service and self purchase it, Nanoradar also can help customers to purchase it.



Fig 7 Test used CAN box

- 1) USB2CAN adapter connect PC computer and open host computer software, firstly configure parameter shown as fig 8. red parts are MR76S test configured parameters, blue part is the adjusted coordinate range according to test distance. Then click the right side connect equipment button.

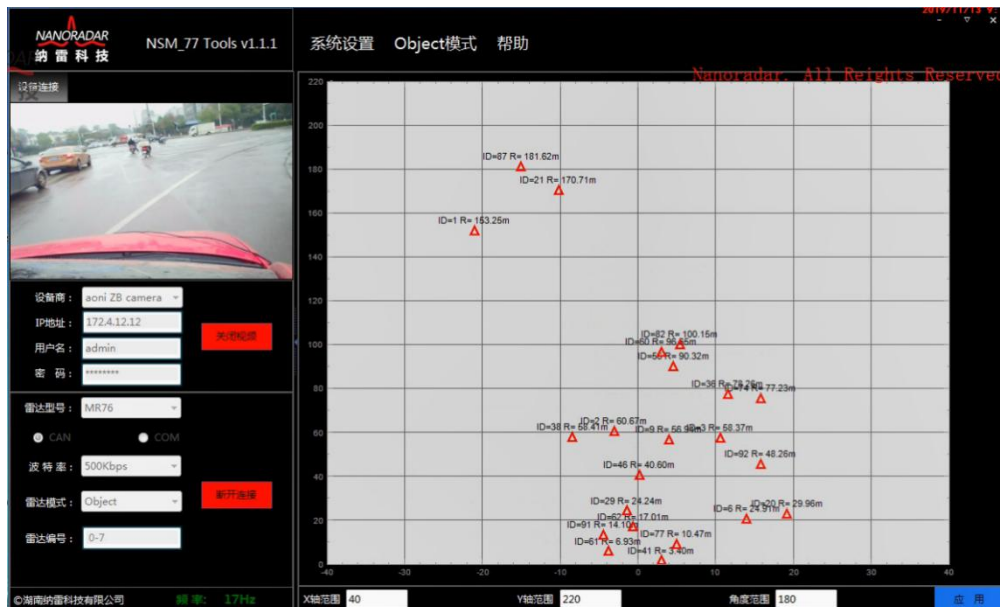


Fig 8 Radar host computer test interface

- 2) Start test. MR76S radar antenna surface face to motion target, or sensor and object existing relative tiny motion, able to check UI interface will occur target indicated red delta, and indicate the target distance R. Shown as fig 8, if not occur red delta indication then means not occur target in detect distance and visual field.

5 Healthy and protection

MR76S 77GHz millimetre wave radar accordance with national law and regulations requirements, so harmless to human healthy. Additionally, the relate research proof that, vehicle radar no negative effect to people.

5.1 Static electric protect actions

Need completely done well at static electric protection works during transporting, storage, pick and place radar. The users must pay more attention when process the non integrated independent module: need start to done well at anti static electric protection works when pick out the module from the sealed anti static electric package; never touch or seize radar antenna surface and connector pin, only can touch the edge and boundary part.

Advise: please do best to wear anti static electric gloves when operating all radar sensor.

◆ Error operating methods:

- Use metal foil or partial metal parts wrap the antenna;
- Use multimeter directly measure pin and caused damages;
- Spraying antenna structure by any types paint or varnish;
- Use CFK thin file (electric conduct) wrap antenna;
- Plastic materials directly contact corroded antenna structure (it will has more higher dielectric constant affection at resonate frequency of paste).

5.2 Discriminate static electric damages

Under common situation, the below two situations proof the radar sensor already damaged by static electric:

- Radar continue output irregular objects when no target object in radar detect range;
- Unable to get the output signal when power supply voltage, power supply current and other parameters be at normal range value.

5.3 Power supply protection

Radar input voltage range 8~32V DC, veins wave less than 20mV. Big veins wave power supply will caused radar continue output error target information and affect the radar normally use.

5.4 Space electromagnetic disturb protection

The product already adopt shield actions and do best to avoid the bad influence which caused by electromagnetism disturb. But radar need far away strong electromagnetism disturb source such as motor and isolated metal shell.

6 Harness connection

6.1 Connect configuration

The harness in connect cable distributed as the below description. The default

install direction should make radar harness toward left side.

Install direction will affect the position of TX and RX antenna. Because different TX and RX antenna hole diameter, so they will be different affection from sub level surface structure. Should estimate the harness direction according to customer test estimation and install position to obtain the best performance.

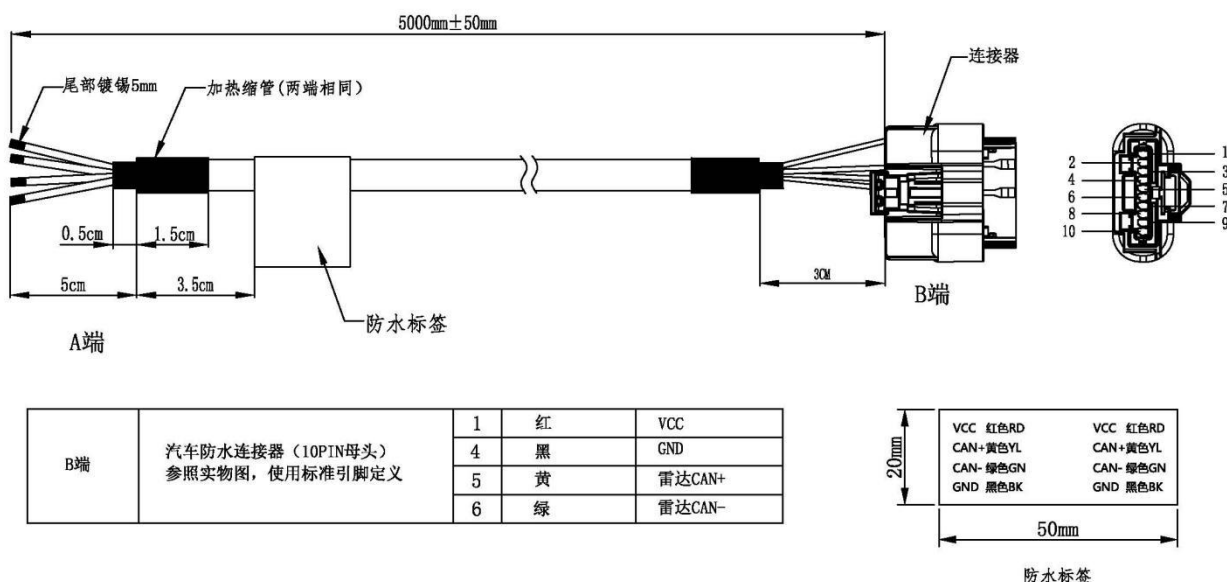


Fig 9 CAN joggle harness connect diagram

MR76S harness configuration and definition as the below table:

Table 6 Harness joggle definition

Harness color	Definition
Yellow	CAN+
Green	CAN-
Red	Power supply positive pole
Black	GND

Current harness max support current is 2A. MR76S power supply mainly provided by red harness and black harness (GND).

MR76S not support power supply polarity reversely connect, the customers self duty for any result which caused by reversely connect. MR76S design accordance with test requirement in ISO16750-2.

6.2 Pin definition

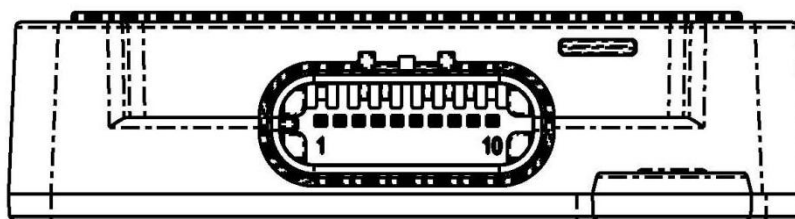


Fig 10 MR76S pin diagram

Table 7 MR76S pin definition table

Pin No.	Name	Description	Outer connected harness color
1	VCC	8-32V DC power supply	Red
2	NC	Not connected	NA
3	NC	Not connected	NA
4	GND	Ground	Black
5	CAN+	500Kbit/s	Yellow
6	CAN-	500Kbit/s	Green
7	NC	Not connected	NA
8	NC	Not connected	NA
9	NC	Not connected	NA
10	NC	Not connected	NA

7 Joggle

7.1 CAN joggle

CAN is abbreviation of controller area network, developed by German BOSCH company which famous at research, develop and produce vehicle electric products, finally it come to be international standard (ISO11898), this is one international most widely applied field joggle. In north American and west Europe, CAN joggle agreement already been the standard joggle in vehicle computer control system and inlay type industry control LAN, and it has J1939 agreement which make CAN as bottom agreement and specially designed for large scale truck and heavy industry mechanical vehicles.

CAN joggle characteristics:

(1) Data communication no difference at main and sub, any one pitch able to start data communication to any other (one piece or several pieces) pitch, decide the communication sequence based on priority sequence of prior level of each one pitch information, high prior level pitch information communication at 134 μ s.

(2) Lower prior level avoid higher prior level when multiply pitches start communication at the same time, never caused congestion at communication lines.

(3) The farthest communication distance up to 10KM (speed ratio lower than 5Kbps) speed ratio up to 1Mbps (communication distance less than 40M);

(4) CAN joggle transmit agent able to be double twist wire, coax cable. CAN joggle suitable to big data volume short distance communication or long distance small data volume, more higher real time requirements, used in multiply main, multiply sub or equal each pitch field.

Table 8 Cable parameters table

Cable length	The max transmit speed ratio	Impedance	Intersection area
0-40m	1Mbit/s	70m Ω /m	0.25-0.34mm ²
40-300m	200Kbit/s	<60m Ω /m	0.34-0.60mm ²
300-600m	100Kbit/s	<40m Ω /m	0.50-0.75mm ²
600-1000m	50Kbit/s	<26m Ω /m	0.75-0.80mm ²

7.2 Equipment size

Radar install position refer chapter III, able to installed on vertical pole or longitudinal rod.

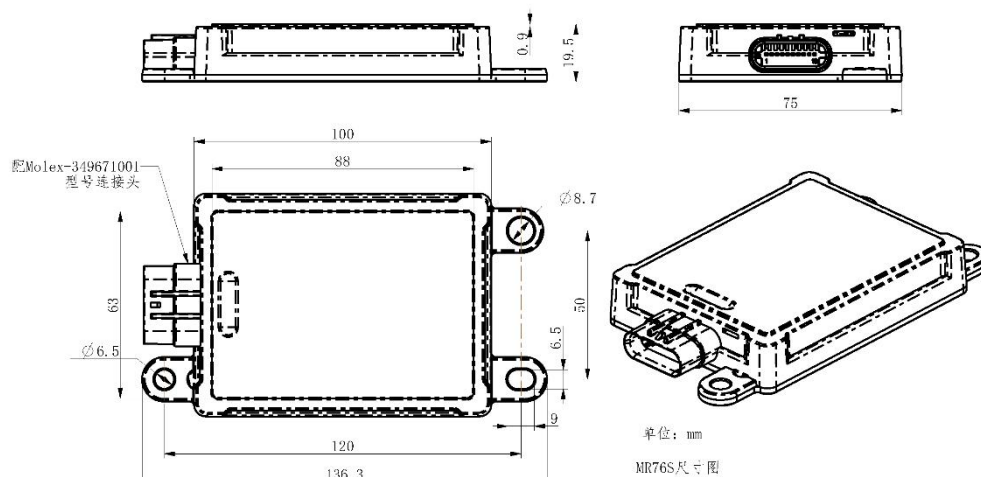


Fig 11 Size diagram of MR76S with shell

8 Safety and risk

This chapter proposed to make MR76S customers and users able to correctly discriminate all possible risk in time.

MR76S developed for the application such as traffic flow statistic and boundary edge guard. The customers must grasp the basic technical knowledge. The radar need be operated by trained professionals. The people charge for this equipment or owners must make ensure all operators understand and follow these safety notices. If MR76S is one part of the whole system then the system manufacturer charge for guarantee the respects relate to safety, such as operating manual, label and specification. The responsibilities divided as below:

(1) The responsible range of manufacturer to equipment

Nanoradar responsible to provide this equipment under the condition that safe and reliable technology, include the white letter, agreement manual and user manual.

(2) The responsible range of the third party manufacturer

The third party accessories manufacturer responsible to develop, carry out with MR76S millimetre wave radar of Nanoradar, guarantee the safety and effect of their products.

(3) The responsible range of customers, final customers and final users.

The customers, final customers and final users responsible to guarantee the equipment used in schedule purpose, used in the employee's action and send order to employees, and used in operating safety of equipment.

(4) The customers, final customers and final users have the below duties:

- Must know well about the safety information and instruction in operating manual on radar.
- Must know well about the local suitable accident prevent regulations.
- Must inform Nanoradar once equipment or equipment occur any safety defects.

The customers must confirm the final customers and final users already join relief statement and information responsible copies, include the qualified statement in their product document responsible manual.

MR76S millimetre wave radar able to be applied in the research, develop and test purposes.

9 Reference files

- [1] MR76S millimetre wave radar white paper
- [2] MR76S millimetre wave radar color page
- [3] MR76S millimetre wave radar communication agreement
- [4] Nanoradar 77GHz radar antenna cover design guidance

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