

MR76 White Paper on 77Ghz Millimeter Wave Radar



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Version history

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MR76 77GHz MMW White Paper

Abstract: MR76 is a compact 77GHz front anti-collision radar developed by Hunan Nanoradar Science and Technology Co., Ltd. It can accurately remind drivers of obstacles in front of commercial vehicles by transmitting two-beam fan-shaped microwaves to the front, detecting the reflection of microwaves, judging whether there are obstacles in front, and feedback the relative distance between obstacles and radar. This product adopts double beam design, DBF digital beam synthesis, virtual synthetic aperture, short/long distance dual-mode detection and many other advanced technologies to realize 0.2~170m measurement distance, small size, high sensitivity, stable performance, light weight and easy integration. MR76 performance has been recognized by many partners.

The products are applied to the Mid-long distance anti-collision for passenger car, commercial vehicle, special vehicle, etc.

Key words: MR76, 77GHz mmw, Virtual synthetic aperture, accurate measurement

1 FCW Application Demand

1.1 Challenge on Vehicle FCW

Nowadays, cars have become much more popular and have played vital roles in traveling. ADAS system, integrated by variety of sensors, can sensing the surrounding based on data collection, static and dynamic object identification, detection and tracking, system operation and analysis combined with map navigation data, which assist drivers to sense and avoid the potential dangers and effectively increase the comfort and safety of driving. In recent years, ADAS market, rapidly develop from the high-end market into the low-end market. The improved millimeter-wave radar technology for system deployment will create new opportunities and strategies.

The "Technology Road map for Energy Saving and New Energy Vehicles" released at the 2016 Annual Meeting of the China Society of Automotive Engineers pointed out that in 2020, the market share of China's driver assistance/partially autonomous vehicles will reach 50%, and will reach 80% in 2030. In 2020, an average of 3 millimeter-wave radars

(2 for short distances + 1 for long distance) will be installed per vehicle. It is estimated that the demand for millimeter-wave radars of new vehicles will be nearly 45 million pcs. In 2030, an average of 5 millimeter-wave radars per vehicle will be installed. (4 for short distances + 1 for long distance), the demand is expected to reach 120 million pcs.

For the Many manufacturers are still facing challenges on application of automotive forward anti-collision millimeter wave radar:

1. Binocular vision and laser radar are limited by the influence of light and environment, and it is impossible to achieve all-day and all-weather operation
2. Millimeter wave radars used in applications such as FCW, ACC, AEB, etc. However, the technology and pricing are mainly controlled by European countries. Radar prices remain high, and high customization fees, resulting in only a few high-end car models can be configured.

1.2 The difference between millimeter wave radar and other sensor on obstacle avoidance

The traditional driving assistance system is mainly composed of laser radar, visual system, GPS and other modules, which do not accurately detect the surrounding obstacles under bad weather conditions, it often leads to serious traffic accidents, and the working environment of the visual system is demanding. Due to the constraints of the technology, processing technology, material costs and physical size, radar is mainly used in high-end vehicles and forward radar field.

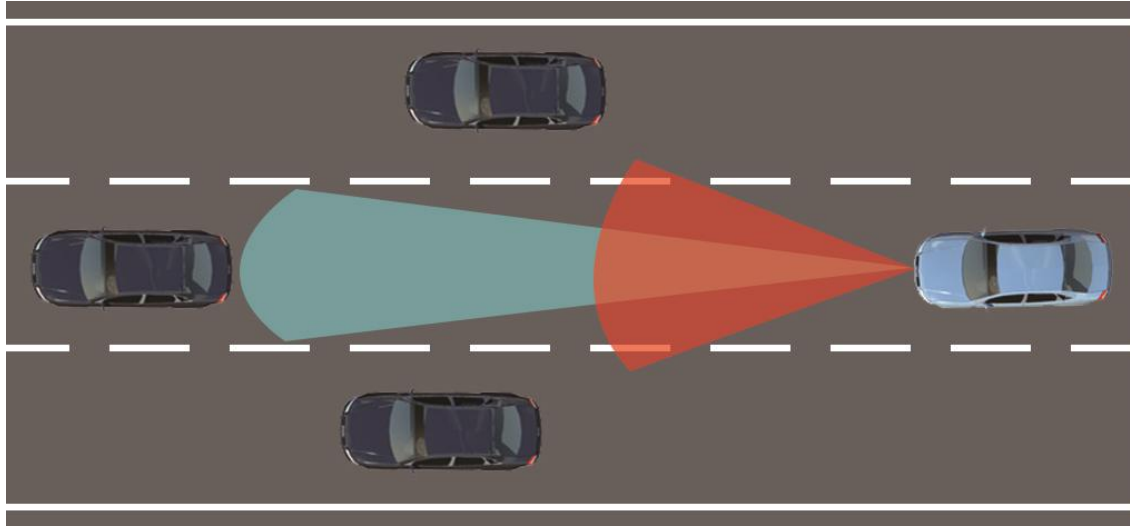


Figure 1 MR76 77GHz obstacle detection illustration

Table 1 comparison of vehicle obstacle avoidance technology

Obstacle avoidance method	Realize principle	Distance	Accuracy	Advantages	Disadvantages
Visual	Visual positioning	0.3~10M	$\pm 0.1\text{m}$	High accuracy Relatively low cost	High power consumption, Complex algorithm Poor effect under haze condition
Ultrasonic	TOF	0.3~6M	$\pm 0.1\text{m}$	Low cost	Short detection range, unable to work under the high wind
Lidar	TOF	Less than 200M	$\pm 0.02\text{m}$	High accuracy under a good measurement condition	Expensive, big size, high power consumption
Millimeter wave radar	FMCW	0-40M	$\pm 0.18\text{m}$	High accuracy, full day, all weather	Medium cost

Distance measurement is an important part of FCW system. Ultrasonic wave, millimeter wave, lidar and visual camera all can realize the function. Ultrasonic ranging principle is simple, the cost is the lowest, but its ranging accuracy is greatly influenced by outdoor temperature, and it's attenuation rapidly, so it's currently only suitable for short distance ranging, mainly used in car reversing application. In practical application, millimeter-wave radar and vision ranging are commonly used. Compared with millimeter-wave radar, the

algorithm required for visual ranging is complex, and the error of visual ranging will increase along with the increasing distance.

The short-range millimeter-wave radar can support functions of ACC, FCW, etc. It has the characteristics of working day and night in all weather conditions, and can accurately detect the mid-long range target on the front and rear sides of the vehicle and play an important role in the ADAS system.

2 MR76 77GHz millimeter wave radar introduction

2.1 Features

MR76 is a compact 77GHz front anti-collision radar. It can accurately guide the drivers to avoid obstacles in front of the vehicles by transmitting two-beam fan-shaped microwaves to the front, detecting the reflection of microwaves, judging whether there are obstacles in front, and feedback the relative distance and angle between obstacles and radar.



Figure 2 MR72-CAR 77GHz millimeter wave radar appearance

The MR76 77GHz millimeter wave radar uses a highly integrated MMIC solution with extremely low power consumption (2.5W), small size, dual beam design, up to 170m detection range, and lightweight design to meet ranging demand on good performance and environmental adaptability of passenger cars, commercial vehicles and special vehicles. The outstanding performance of the MR76 77GHz millimeter wave radar is highly recognized by many partners.

The MR76 77GHz millimeter wave radar is provided with a CAN communication interface. The board-level communication CAN interface has a default rate of 500kbit/s and refresh rate of 17Hz. The universal external interface can be quickly integrated with the host computer or

other MCUs, saving users' configuration time.

2.2 Parameter

The MR76 77GHz millimeter-wave radar uses a high-complexity FMCW modulation mode to accurately measure the obstacle distance within its detection range.

Table2 MR76 77GHz MMW Parameter radar

Measuring performance		to natural targets (non-reflector targets)
Modulation		FMCW
Distance Range		0.20~170m@±4°, 0.20~120m@±9°(Mid range mode) 0.20~70m@±9°, 0.20 - 40m@45° (short range mode)
Distance Resolution	spot target, none tracking	0.82m, ability to separate targets and objects 1.5...2 x resolution
Distance Accuracy	spot target, none tracking	±0.30m
FOV		±45°@-16dB
Angle Resolution	spot target, none tracking	±0.1°(middle mode), ±0.3°@0°, ±1°@±45°(short mode)
Velocity Range		-200km/h...+300km/h (-leaving object, +approximation)
Velocity Resolution	spot target, none tracking	±1km/h
Velocity Accuracy	spot target, none tracking	±0.5km/h
Antenna Channels		2TX/4RX=8 channels
Cycle Time		60ms
Elevation beam	-6dB	14°
Azimuth beam	-6dB	90°
MR76 Dual beams (mid-range and short-range) work simultaneously and can not be switched. The detected targets are output in order of distance or RCS. By default, they are output by distance from near to far.		
Operation Condition		
Transmit frequency	ETSI&FCC	76...77GHz
Transmit capacity	average/peak EIRP	29.8dBm
Power		+6.0V~32VDC
Consumption		2.5W
Weight		124g
Working Temp		-40°C...+85°C
Storage Temp		-40°C...+90°C
Protection class		IP67
Interface		
Interface		1xCAN- High speed 500kbit/s
Cover		
Dimension	W*L*H	140*70*35mm
Weight		200g
Material	front/back	PBT+GF30 for front shell, Die-cast aluminum sump for back shell.

The MR76 77 GHz millimeter wave radar uses an advanced two-transmitter four-receiver planar microstrip array antenna. The receiving antenna contains 40 polarized radiating elements, and the transmitting antenna contains 120 polarized radiating elements. The transceiver antenna uses the Taylor algorithm to perform low sidelobe synthesis on the antenna pattern. The low sidelobe design of the antenna makes the radar less susceptible to interference from ground clutter and targets outside the main beam, which can significantly improve the signal-to-noise ratio of the radar detection target.

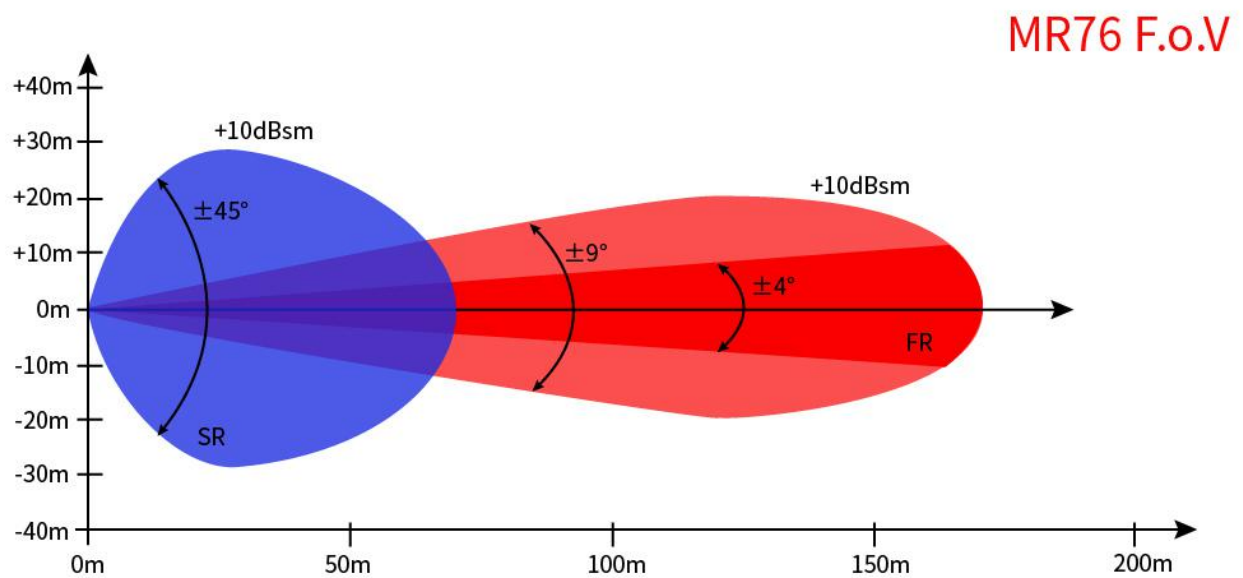


Figure 3 MR76 77GHz mmw radar FoV

Product Dimension is as below:

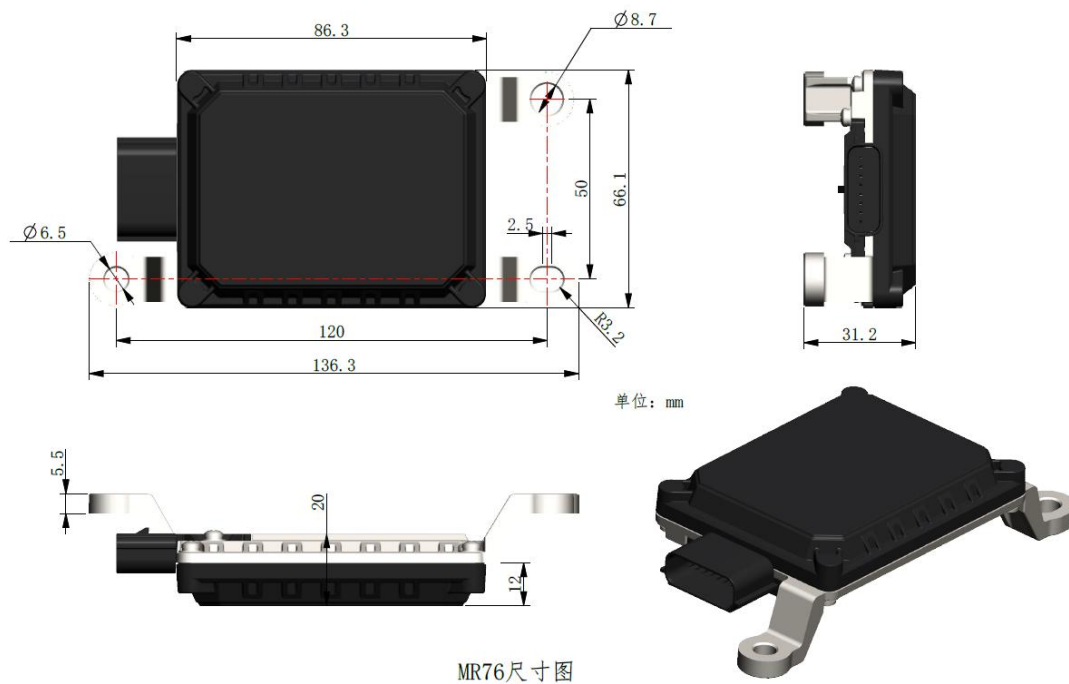


Figure 4 MR76 77GHz MMW radar dimension

2.3 Application

- Passenger car FCW
- Commercial vehicle FCW
- Special vehicle FCW

3 Application cases

3.1 Front Collision Warning(FCW)

On March 7, 2017, the ministry of transport organized and formulated the transportation industry standard "safety technical conditions for passenger cars", which was formally implemented on April 1, 2017. It requires passenger cars over 9 meters in operation to have lane departure warning and forward collision warning system (FCW), and gives a 13-month transition period. The mandatory requirement of the ministry of communications is the first case of mandatory installation of ADAS in China. Therefore, FCW is an essential basic function of ADAS.



Figure 5 MR76 77GHz MMW Radar Application Illustration

Relevant statistical data show that the driver's subjective factors account for the highest proportion of traffic accidents. If an early warning is given to the driver 1.5 seconds before the occurrence of traffic accidents, 90% of collision accidents can be avoided and the injuries caused by traffic accidents can be greatly reduced. The vehicle anti-collision safety control system is through a variety of sensors, such as cameras, radar, real-time detection of objects around the vehicle, and detect the distance between the target vehicle and the vehicle. When the safe distance is less than the threshold value, an alarm will be issued to alert the driver, effectively reducing the occurrence of traffic accidents.

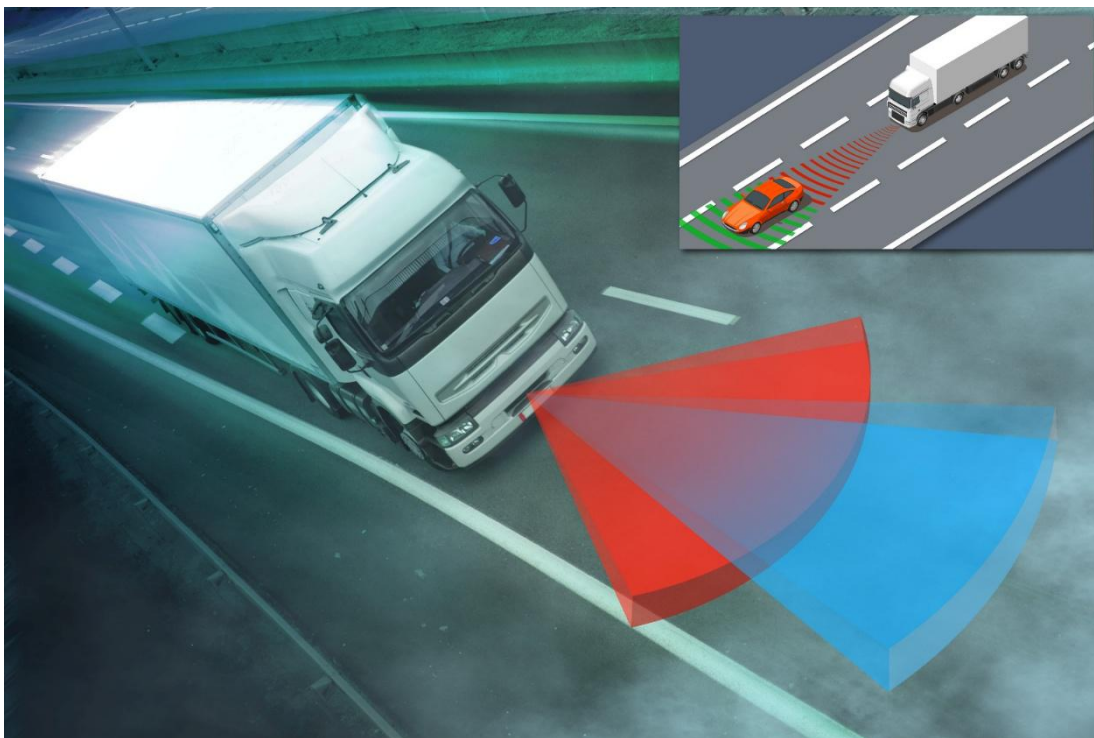


Figure 6 MR76 77GHz MMW Radar Detection Illustration

FCW can monitor the vehicle in front at any time through the radar system, detect the distance, azimuth and relative speed between the vehicle in front, and warn the driver when there is potential collision danger. The FCW system itself does not take any braking measures to avoid collisions or control the vehicle.

Generally speaking, the following scenarios are likely to lead to rear-end collision:

1. Intersection in green light condition, if there is vehicle suddenly slowed down, the rear vehicle can hardly stop since its speed is very fast.
2. When driving, a safe distance between car is not maintained.
3. The car ahead slowed down suddenly and turned without a turn signal.
4. The car in front slowed down suddenly to give way to pedestrians, but car follow back did not notice its brakes.

Advantages of the MR76 77GHz millimeter wave radar:

1. Ranging accuracy;
2. Small size and low power consumption;
3. Strong anti-interference ability and easy integration.

4 Conclusion

The MR76 77GHz millimeter-wave radar is the most cost-effective product for forward collision warning in China. It can ensure the safety of drivers, pedestrians, vehicles and other property under the complicated working environment, and realize the Forward anti-collision function for passenger cars, commercial vehicles and special vehicles with accurate distance measurement. The performance of this product has been verified by many manufacturers and can quickly replace the international forward collision avoidance radar.

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