

White paper on CAR70 millimeter wave radar



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Version history

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White paper on CAR70 millimeter wave radar

Abstract: CAR70 is a 24GHz medium-range radar sensor developed by Hunan Nanoradar Science and Technology Co., Ltd., aimed at the advanced driver assistant system (ADAS). It adopts reliable solid-state technology, with the advantages of accurate speed-measurement, high sensitivity, easy integration and high performance. It is widely applied in blind spot detection (BSD), lane change assistant (LCA), rear cross traffic alert (RCTA), exit assistance function (EAF) and forward cross traffic alert (FCTA).

Key words: CAR70, accurate velocity-measurement, SRR mmw radar, high cost-efficient

1 Applications of short/medium-range radar in automotive

1.1 The development of advanced driver assistant system

Nowadays, cars are becoming more and more popular, which play a more and more important role in people's travel. The Advanced Driver Assistant System (ADAS) utilizes a wide range of sensors mounted on the vehicle to sense the surrounding environment, collect data, recognize the static and moving objects, detect and track, and carry out the calculation and analysis with the combination of navigation map data, which in advance makes the driver be aware of the possible dangers, and effectively increases the comfort and safety of driving.

ADAS has a rapidly increasing demand in recent years. It gradually enters into the low-end market from the high-end market. And the improved millimeter-wave radar technology is creating new opportunities and strategies for the system deployment.

1.2 Applications of short/medium-range radar

The traditional driver assistance system mainly consists of laser radar, visual system, GPS and other modules. The modules is bad in weather conditions, and cannot accurately detect the surrounding obstacles, which often lead to serious traffic accidents. Besides, visual system is demanding on work environment. Due to the constraints of technology, manufacturing techniques, material costs and physical size, radar is mainly used in high-end cars and forward radar fields.

Short/mid-range millimeter-wave radar can be applied in BSD, LCA, RCTA, EAF, and FCTA. Owing to its performances in all weather and all day, it can accurately detect the short-range targets in front side and rear side of vehicle. And it plays an important role in ADAS system.

2 Product overview of CAR70 medium-range radar

2.1 Product features

CAR70 is a very cost-effective K-band medium-range millimeter wave radar sensor system with a detection range of 50 meters. It adopts LFM + FSK modulation mode, which can detect the distance of a moving object and has a high accuracy for range and velocity Measurement.

■	Movement
■	Velocity
■	Distance
■	Direction
■	Angle

CAR70 can be applied for blind spot detection (BSD), lane change assistant (LCA), rear cross traffic alert (RCTA), exit assistance function (EAF) and forward cross traffic alert (FCTA). The product function diagram is as follows.

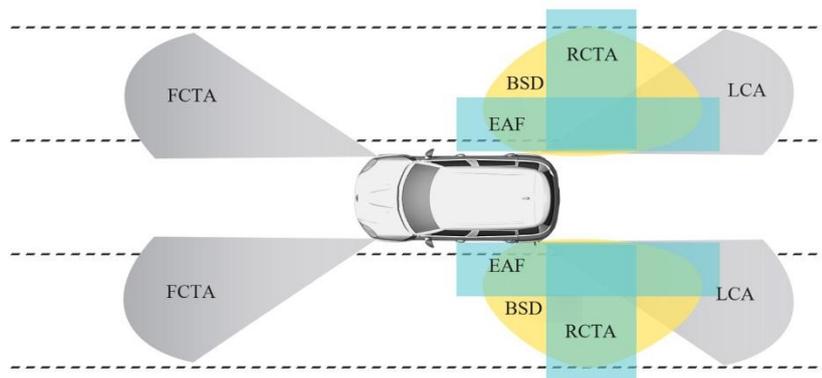


Figure 1 CAR70 functions diagram

The CAN communication network interface of CAR70 sensor follows the specification in ISO11898-2, with a communication speed of 500Kb/s. The universal external communication interface is convenient for the integration with the host computer or other ADAS module.

2.2 Product specifications

CAR70 parameters are as followings:

Table 1 Radar parameters

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
System performance					
Transmit frequency		24.00		24.20	GHz
Output power (EIRP)	Output adjustable	13		24	dBm
Update rate			25		Hz
Power consumption	@12V DC 25°C	1.8	2.04	2.2	W
Range-measurement characteristics					
Distance-measuring range	@0 dBsm vehicles	0.1		40	m
Distance-measuring range	@0 dBsm pedestrians	0.1		15	m
Distance-measuring accuracy			±0.1		m
Velocity-measurement characteristics					
Velocity-measuring range		-70		70	m/s
Velocity-measuring accuracy			0.1		m/s
Multi-target checking					
Numbers of simultaneously checking targets			32		pcs
Range resolution			0.75		m
Antenna performance					
Beam width/TX	Azimuth(-6dB)		100		deg
	Elevation(-6dB)		17		deg
Other characteristics					
Supply voltage		9	12	16	V DC
Supply current	@12V/25°C	150	170	190	mA
Storage temperature		-60		125	°C
Operating temperature		-40		85	°C

CAR70 utilizes one transmitting antenna and two receiving antennas. The separation design of transmitting / receiving antennas makes the transmitting / receiving link of the radar have high isolation, and improves the dynamic range of radar detected target. Moreover, the design of multi-receiving antennas makes the radar obtain a fine phase difference of the target echo; therefore it has a precise angle measurement.

CAR70 uses integrated planar micro strip array antenna that contains eight vertically polarized radiating elements. The radar antenna has a wide beam in the azimuth plane and a narrow beam in the elevation plane. The beam width in the azimuth plane (@-6 dB) exceeds 120 °. Therefore, it can detect the moving targets within 140 ° in the azimuth plane. While the beam width in the pitch plane (@-6dB) is 17 °, and the low side lobe synthesis of the antenna pattern by using Taylor algorithm makes it have a better suppression ratio than that of -18dB side lobe.

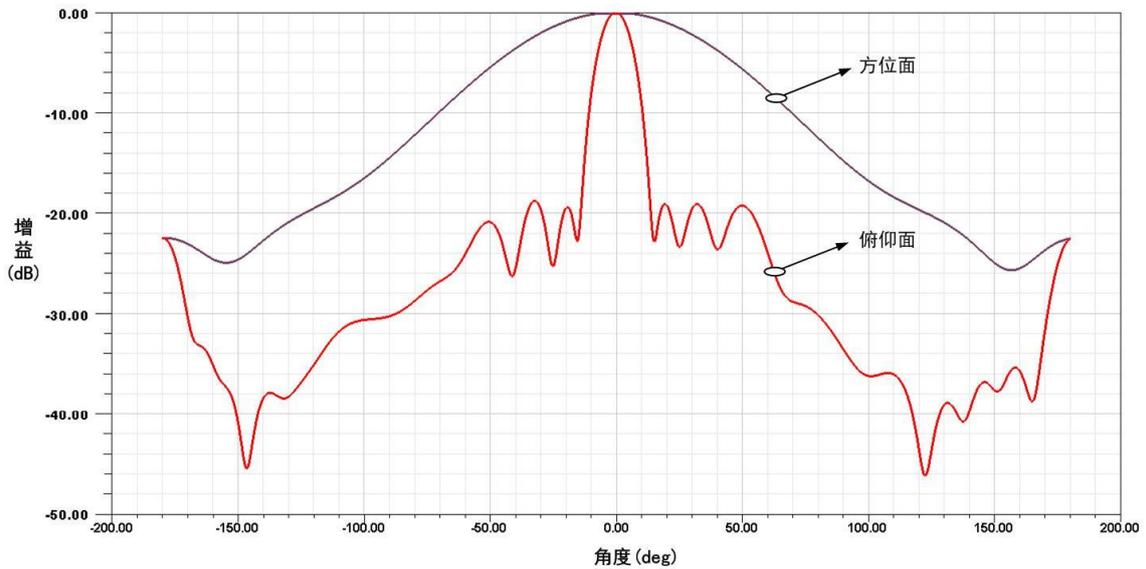


Figure 2 CAR70 antenna pattern

The design of wide beam makes CAR70 have a wide angle of view. At the same time, the design of low side lobe design makes that CAR70 is not susceptible to the interference of ground moving targets, and can improve the radar detection performance.

Product outline is as followings:

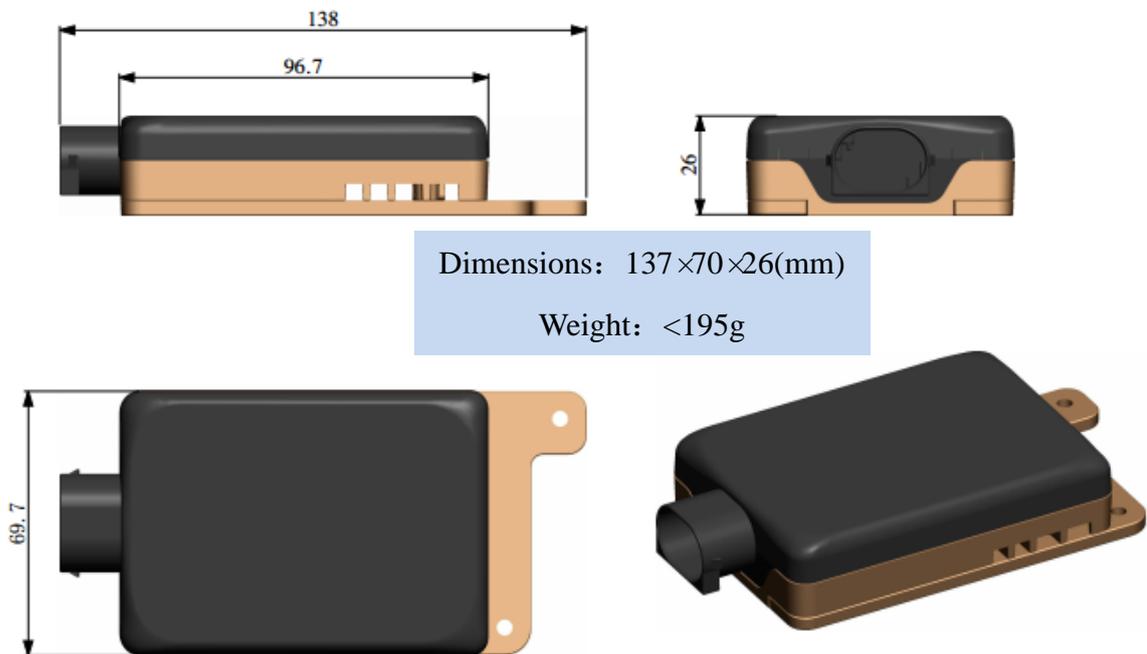


Figure 3 CAR70 outline

2.3 Applications

- Blind Spot Detection
- Lane Change Assistant
- Multisensory fusion
- Rear Cross Traffic Alert
- Forward Cross Traffic Alert
- Exit Assistance Function

3 Typical application examples

3.1 Lane-changing auxiliary system

Lane change decision assist system (LCDAS) includes the two subsystems of blind spot detection (BSD) and the lane change assistant (LCA). By utilizing CAR70 millimeter wave radar sensor, it can monitor the vehicle's rear and sides' environment. CAR70 radar is generally composed of a pair of master radar and slave radar. The slave radar detects only the target's distance, velocity, and angle information and then sends all the information to the master radar. While the main control radar not only have the detection function, but also receive the vehicle's own velocity, steering angular speed and other information, and then send all the detection information to the automotive comprehensive decision-making system to make action decisions, or directly control the brakes.

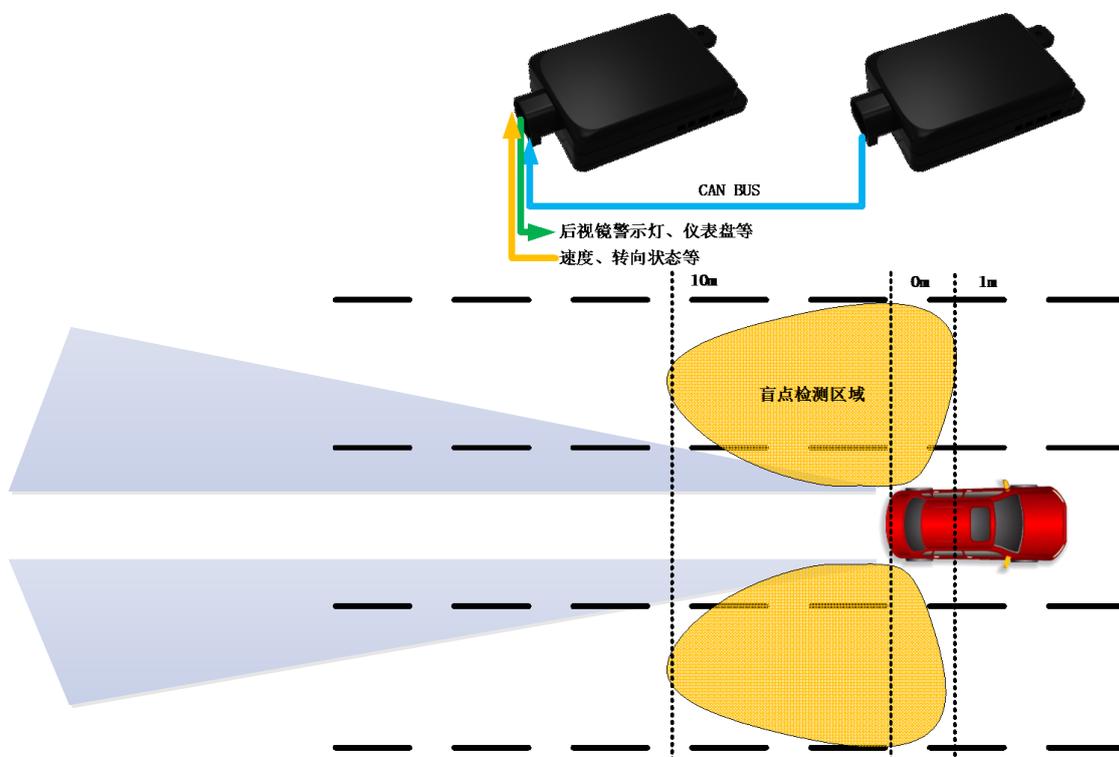


Figure 4 the detection range of the system

The monitoring area of LCDAS includes a driving "vision" blind zone and a 30m (50m effective) area behind the vehicle, and it provides an auxiliary warning function when the driver normally travels through the lane-changing area. When the system recognizes that the lane change may cause a collision risk, the warning lights in the exterior mirrors will light up or blink quickly to alert or warn the driver of potential risks. As an application of the Advanced Driver Assistant System (ADAS), the system significantly reduces the inconvenience for observation by drivers in harsh conditions such as night, fog, heavy rain, etc., and also greatly reduces the collision risks in the adjacent lanes and "view" blind zone in the process of merging.

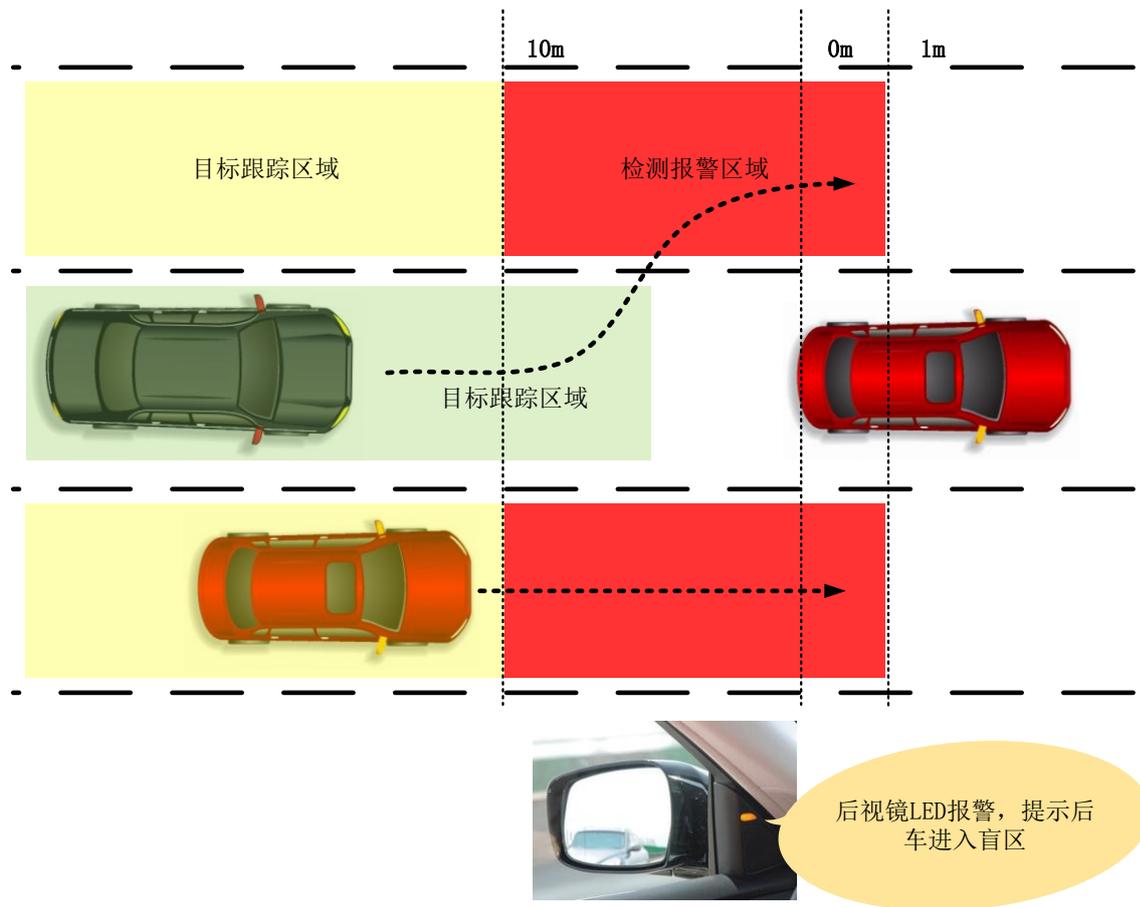


Figure 5 diagram of lane change decision auxiliary system

The workflow for lane change decision auxiliary system:

- When the vehicle moving speed is greater than 20km / h, the system would first start LCA for long-range detection;
- If the LCA detects that the distance of the rear target vehicle is less than 10 meters, the system would start the BSD function. And the detection angle of the microwave sensor becomes larger, and it can detect the target vehicles within 3 meters in sides and 10 meters behind the vehicle.
- If the LCA detects that the target distance is greater than 10 meters, the system will continue to activate the LCA function. The detection angle of the microwave sensor will be smaller and the target will be detected within 50 meters behind the vehicle.
- When the moving speed is less than 20km / h or the driver manually turns off the LCDAS function, the whole system would not work.

CAR70 can detect up to 32 moving targets simultaneously. In the field of view, it has sufficient detection of pedestrian s and vehicles, which greatly reduces the driver's driving burden.

Advantages of CAR70 in LCDAS applications:

- 1) The package is compact, with solid-state technology;
- 2) Cost-effective, with long detection distance;

- 3). High detection accuracy;
- 4) Leading performance and durability.

4 Conclusion

CAR70 is our first self-developed medium-range automotive millimeter-wave radar. It adopts advanced MMIC and signal processing technology, with the advantages of long measuring distance, accurate speed and stable performance. And it is widely applied in automotive blind spot detection(BSD), lane change assistant (LCA), rear cross traffic alert(RCTA), forward cross traffic alert(FCTA), radar video fusion, unmanned pilot, and other fields. It can significantly improve vehicle safety performance and reduce the driver's driving burden.

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