White paper on SP70C millimeter wave radar

Hunan Nanoradar Science and Technology Co.,Ltd.

Version history

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2016-10-09	1.0	The 1st version of white paper on SP70C

Contents

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Abstract： SP70C is K-band radar sensor developed by Nanoradar, which utilizes 24GHz-ISM frequency and the design of double receiving antennas. It has the advantages of being small size, high sensitivity, lightweight, easy to integrate, cost efficient and stable performances. With the advantages of long range measurement, small size, high sensitivity, light weight, easy to integrate and stable performances, it is now widely applied in the industrial measurement and collision avoidance, the personnel positioning and track in security fields , and automotive active safety and auto pilot and other fields. Therefore it is highly recognized by our partners.

Key words： SP70C, double receiving antennas, mmw radar, range measurement and collision avoidance

1 Introduction about mmw radar

1.1 What is mmw radar?

Millimeter-wave radar is an electronic device that senses objects by transmitting and receiving microwaves. The millimeter wave has a wavelength between the centimeter wave and the light wave. Compared with the centimeter wave sensor, the millimeter wave sensor has the characteristics of small volume, light weight and high spatial resolution.

1.2The development history of mmw radar

In 1842, the Austrian physicist Doppler (Doppler, Christian Johann) found the Doppler effect of electromagnetic waves. Nearly two hundred years, people have been adopting Doppler Effect in radar operation. Thanks to the development of electronic science, great progress has been made in radar field. And K-band 24GHz radar is one of the mainstream products in the civil field, which is a global radar operating frequency range specified by ISM. The frequency range of the electromagnetic wave is 24.00-24.25GHz.

In Europe and the United States, the use of 24GHz anti-collision radar products in automotive is already very common. This makes radar be the mainstream detection method in the ACC cruise system, car blind spot detection system and automotive collision avoidance system. Relevant laws and regulations have also been introduced to guide the 24GHz radar for vehicle detection and industrial anti-collision.

Hunan Nanoradar Science and Technology Co., Ltd. set about the R&D of 24GHz millimeter wave radar sensor earlier. Therefore it has mature solutions of millimeter wave radar sensor system.

2 Product overview

2.1 Product features

SP70C is a lightweight and compact radar sensor in the same industry, which utilizes radar wave to efficiently measure the distance, velocity and angle of targets, to guide UAV, electronic motors to avoid the obstacles and work stably.

SP70C utilizes a highly integrated MMIC solution, with extremely low power consumption (1.75W), a small size (71x63x5.2mm), a measuring range of 40m and the lightweight design to meet the requirements of range measurement and collision avoidance in unmanned aerial vehicles, industrial machinery and electric vehicles.

It adopts 1T2R antennas, to accurately measure the angle information of targets.

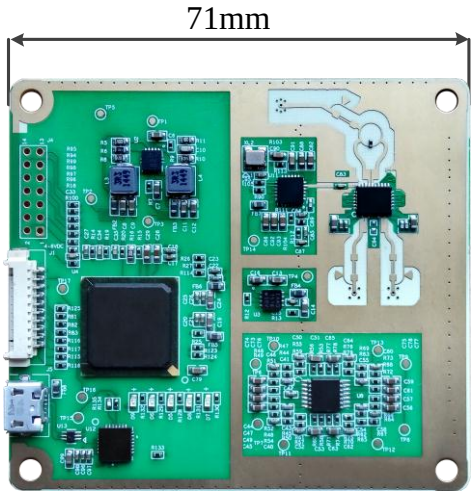

Figure 1 front view of SP70C

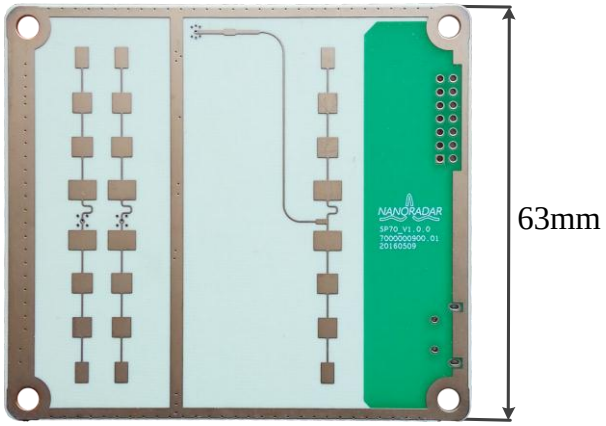

Figure 2 SP70C antenna plane

To facilitate the development and test by customers, SP70C radar provides two communication interfaces: UART and Micro USB.

Using Micro USB interface, and Nanoradar's millimeter-wave radar common management tools, customers can quickly and intuitively view the product test results data. The UART interface default rate of Board-level communications is 115200bit/s, and the target refresh rate of it is 50Hz. With the universal external interface, you can quickly integrate it with the host computer or other MCU, which saves the user's configuration time.

2.2 Product specifications

SP70C is a K-band millimeter-wave radar sensor system, using a higher complexity of the FMCW modulation mode. It can detect the distance, velocity and angle of moving objects, and has a high range and velocity measurement accuracy.

- Movement
- Velocity
- Distance
- Direction
- Angle

SP70C 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.

SP70C uses integrated planar microstrip 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 100 °. Therefore, it can detect the moving targets within 100 °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. The design of wide beam makes SP70C have a wide angle of view. At the same time, the design of low side lobe design makes that SP70C is not susceptible to the interference of ground moving targets, and can improve the radar detection performance.

Antenna patterns are as the following figures:

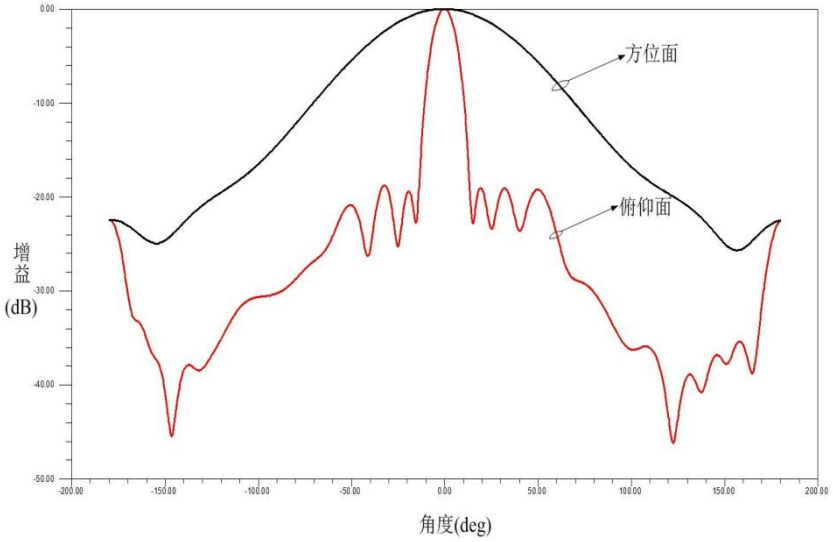

Figure 3 SP70C antenna pattern

Product specifications are as the following table 1.

Table 1 SP70C performance specifications

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
System characteristics					
Transmit frequency		24.00		24.20	GHz
Output power（EIRP）		13	20	24	dBm
Modulation type			FMCW		
Update rate			50		Hz
Range measurement and velocity measurement					
Distance-measurement range	@0 dBsm	0.1		40	m
Velocity-measurement range		-70		70	m/s
Range-measurement accuracy			±0.1		m
Velocity-measurement accuracy			±1.2		m/s
Multi-targets tracking characteristics					
Numbers of tracked targets simultaneously			8		pcs
Range resolution			0.75		m
Velocity resolution			2.4		m/s
Antenna characteristics					
Beam width	Azimuth(-6dB)		100		deg
	Elevation(-6dB)		17		deg
Side lobe level	Azimuth(-6dB)		\		
	Elevation(-6dB)		-18	-20	dB
Other features					
Supply voltage		4	5	6	V DC
Supply current	25℃@5V	340	360	380	mA
Storage temperature		-60		125	℃
Operating temperature		-40		85	℃
Weight			18		g
Dimensions			71x63x5.2(L*W*H)		mm

2.3 Applications

- Range-measurement and anti-collision for railway vehicles
- Range-measurement and anti-collision for robots
- Range-measurement and anti-collision for UAVs
- Range-measurement and anti-collision for machineries
- Intelligent radar lighting-control system
- Range-measurement and anti-collision for hydrological monitoring ships
- Radar and video fusion alarm system

3 Typical application examples

3.1 Range measurement and collision avoidance for UAVs

In recent years, with the increasing demand of UAV market, a large number of unmanned aerial vehicles encountered flying obstacles in the air, resulting in the occurrence of flight difficulties, as shown in Figure 4. Thus collision avoidance has been one of the key challenges in restricting the development of unmanned aerial vehicles. Millimeter-wave radar can detect five times as far as that of ultrasonic. Moreover, due to its high frequency and anti-interference ability, it has become the standard accessories in UAV. Furthermore, millimeter-wave radar has the advantages of being small size, high resolution and low power consumption, which could fully meet UAV's demanding requirements about the size and power consumption. SP70C is an ideal choice for the personal aerial photography unmanned aerial vehicles and other consumer-level UAV in low-altitude operation.

Figure 4 UAV "air crash"

The installation position for SP70C is flexible, which is applicable to various types of UAV platform, and directly connected to unmanned aircraft flight control system through the UART serial port. At the same time, according to the application demands, one or more modules can be installed to extend the flight detection perspective, to transmit low power electromagnetic beam to the surrounding and capture the echo signal to calculate the distance, speed, angle of obstacles. So that it can guide the UAV flight control system to quickly make adjustments to the flight direction.

Figure 5 the application of SP70C in UAV collision avoidance

When the detected target exceeds the safe distance, the collision avoidance system (sensing and avoiding system) can basically replace the operator to complete the relevant calculation, and automatically trigger to avoid the other aircraft.

The advantages of SP70C in UAV collision avoidance:

1) Low cost and low power consumption
2) Accurate measurement of angles
3) Accurate and stable detection of obstacles
4) Long distance measurement and strong anti-interference ability

4 Conclusion

SP70C developed by Nanoradar is a very cost-effective 24GHz millimeter wave radar sensor aimed at mid-range collision avoidance. It has the advantages of accurate angular measurement, velocity measurement and excellent range measurement performance to meet the rapidly growing demand of collision avoidance in UAV, security and related fields. Differing from our well-known short-range infrared sensors, it utilizes a low-power electromagnetic wave that is completely harmless to the human body for the detection of targets. At the same time, we provide excellent after-sales service, detailed manual, to help you solve the difficulties in use.

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