

# **White paper on SP25 millimeter wave radar**



**Hunan Nanoradar Science and Technology Co.,Ltd.**

## Version history

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2016-08-22	1.0	the 1 <sup>st</sup> version of white paper on SP25

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# White paper on SP25 millimeter wave radar

**Abstract:** SP25 is K-band radar sensor developed by Nanoradar. It has the advantages of being small size, high sensitivity, lightweight, easy to integrate, cost efficient and stable performances. And it has the function of range-measurement and collision avoidance. Now it is widely applied in the UAVs, industrial machinery, intelligent lighting, robots, hydrologic monitoring and railway vehicle safety etc.

**Key words:** SP25, small size, millimeter wave radar, cost efficient

## 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. While Compared with infrared, laser, TV and other optical sensors, millimeter wave sensor can penetrate through the smoke, fog, dust and strong, with all-weather (except for heavy rainy days) and all-day characteristics. Moreover, its capability of anti-jamming and anti-stealth is better than that of other sensors.

### 1.2 The 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

SP25 is a lightweight and compact radar sensor in the same industry, which utilizes radar wave to efficiently measure the distance and velocity of targets.

It has the lowest power consumption(0.5W) in the same industry, the smallest volume(40mm\*31mm\*6mm), a distance-measurement of 30m and the advantages of advanced performances, high cost efficient and integrated peripheral interfaces. And now it has been one of the best 24GHz radar sensors, and has set up a new standard in obstacle avoidance and range measurement.

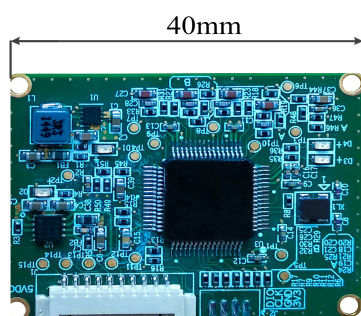


Figure 1 front view of SP25

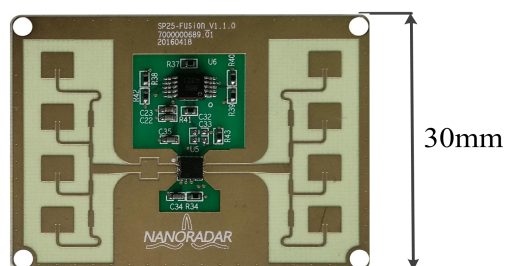


Figure 2 SP25 antenna plane

UART interface default rate of Board-level communications is 115200bit / s, and the target refresh rate of 50Hz. With universal external interface, you can quickly integrate with the host computer or other MCU, which saves the user's configuration time.

## 2.2 Product specifications

SP25 is a K-band millimeter wave radar sensor system, using a higher complexity of the FMCW modulation mode. It can detect the distance and velocity of moving objects, and has a high range and velocity measurement accuracy.

SP25 adopts one-way transmitting antenna and one-way receiving antenna, and the transmitting and receiving antenna is separated. Therefore, the radar transmitting and receiving link higher isolation. Besides, the radio frequency MMIC is coplanar with the antenna, which can reduce the loss of radio frequency link. The low side lobe synthesis of the antenna by using Taylor algorithm has a better suppression ratio than -15dB side lobe, which makes that SP25 is not susceptible to the interference of ground moving targets, and can improve the radar detection performance.

■ Movement	has a
■ Velocity	
■ Distance	
■ Direction	
■ Angle	

pattern  
that of

Product specifications are as the following table 1.

Table 1 SP25 specifications

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
System characteristics					
Transmit frequency		24.00		24.20	GHz
Output power (EIRP)			12		dBm
Modulation type		FMCW			
Update rate			50		Hz
Range-measurement & velocity -measurement					
Range-measurement range	@0 dBsm	0.1		30	m
Velocity-measurement range		-70		70	m/s
Range-measurement accuracy			±0.1		m
Velocity-measurement accuracy			1.2		m/s
Multi-target tracking					
No. of simultaneously tracked targets			1		pcs
Distance resolution			0.75		m
Velocity resolution			2.4		m/s
Antenna performances					
Beam width	Azimuth(-6dB)		100		deg
	Elevation(-6dB)		38		deg
Side lobe level	Azimuth		\		
	Elevation		-15	-16	dB
Other characteristics					
Supply voltage		4	5	6	V DC
Supply current	@5V/25℃	90	100	110	mA
Storage temperature		-60		125	℃
Operating temperature		-40		85	℃
Dimensions			4		g
Size		40x31x6(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
- Intelligent radar lighting-control system
- Range-measurement and anti-collision for machineries
- Range-measurement and anti-collision for hydrological monitoring ships
- Radar and video fusion alarm system

## 3 Typical application examples

### 3.1 Automatic 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 3. 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. SP25 is an ideal choice for the personal aerial photography unmanned aerial vehicles and other consumer-level UAV in low-altitude operation.



Figure 3 UAV "air crash"

The installation location for SP25 is flexible, which is applicable to various types of UAV platform, directly connecting to the unmanned aircraft flight control system through the UART serial port. At the same time, according to the application needs, by installing one or more modules, it can extend the flight detection perspective, radiate low-power electromagnetic beam to the surrounding, and capture the echo signal to calculate the obstacle distance. Therefore it can guide the UAV flight control system to quickly make adjustments to the direction of flight. When the distance is beyond safety, the collision avoidance system (sensing-avoidance system) can basically replace the operator to complete the relevant calculations, and automatically trigger to avoid other aircraft movements.



Figure 4 SP25 application in UAV collision avoidance

The advantages of SP25 in UAV collision avoidance:

1. Low cost and low power consumption;
2. Small size and light weight;
3. Accurate and stable detection of obstacles;
4. Long distance measurement and strong anti-interference ability.

### 3.2 Intelligent radar lighting control system

Intelligent lighting system can be used as the core subsystem of the smart city, utilizing wireless Zigbee, GPRS and other Internet of Things and IT technology, millimeter-wave radar sensor technology. It can be used for remote single lamp switch, dimming, detection and other control functions, and can percept the road traffic flow information in real time, which has opened up a new chapter for the city lighting "management of energy saves". But at the same time energy-saving is also an imminent problem. In various cities energy-saving requirements have been put forward, looking forward to make adjustments in lighting control.

There exist the following problems in the market's existing intelligent lighting control system:

1. The control stratagem of setting different brightness in different time has poor adaptability to the environment, and therefore the energy-saving degree is limited;
2. High cost and difficult to maintain in the using the traditional way of power line carrier communication.



In order to solve the problem of street lamp control system, SP25 millimeter wave radar is used as the intelligent sensing module, and the radar sensor detects whether there are pedestrians and vehicles passing through the road to give the lighting strategy to realize the intelligent control of the street lamp.

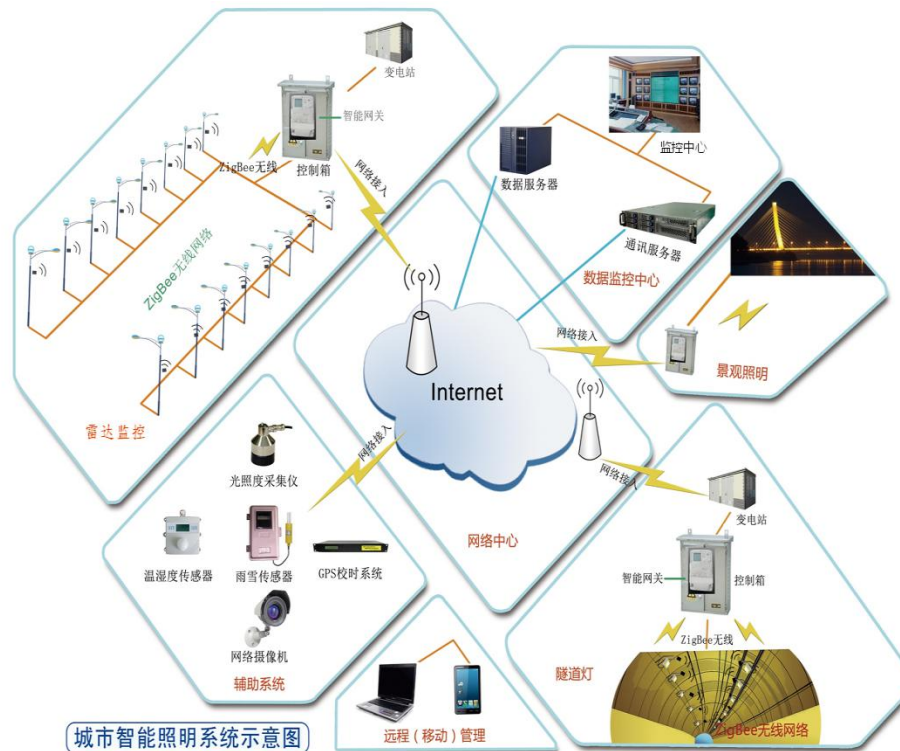


Figure 5 Urban intelligent lighting system

A radar sensor could provide the distance and velocity of targets for 3 to 5 lights. And the detection data is transmitted through the light control system.

Energy saving ways:

19:00-1:00, with more vehicles and people, the average power is 70%;

1:00-5:00, with less vehicles and people, the average power is 20%.

For the 120W LED street lighting system using nanoradar's intelligent lighting control sensor, the average power could be reduced 50% (in accordance with 1 RMB / KWh), and therefore 100,000 lights per year can save the cost of about 18.25 million RMB yuan. It can make great contributions to the intelligent city construction and reasonable energy savings.

The advantages of SP25 in intelligent lighting:

1. Easy to maintain;
2. Good in energy saving;
3. Low cost and easy to integrate.



Figure 6 The application of SP25 in intelligent lighting field

## 4 Conclusion

SP25 is a cost-effective millimeter-wave radar sensor aiming at collision avoidance in short range. It can meet the rapidly growing demands of industrial control, unmanned aerial vehicles, smart lighting, security, sports and related fields. Different from our well-known short-range infrared sensors, it utilized a low-power electromagnetic wave for the detection of targets; therefore it is completely harmless to the human body. At the same time, we provide excellent after-sales service, detailed manual, to help you solve the difficulties in use.

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