Obstacle avoidance radar

Model: R21-F-1

Application: UAV front Obstacle avoidance

2023-01-31 V1.0

Overview

R21-F-1 obstacle avoidance radar is a lightweight millimeter wave obstacle avoidance radar sensor with high measurement accuracy, small size, high sensitivity, light weight, easy integration, and stable performance. By transmitting 79GHz fan-shaped electromagnetic waves to the front and processing the echo signal, the product judges whether there is an obstacle in front, and feeds back the relative distance, speed and azimuth between the obstacle and the radar, so as to guide the radar carrier such as the UAV to avoid the obstacle and ensure its safe work.

- The transceiver antenna adopts a two-send and four-receive MIMO array, with a azimuth field of view range of 30 degrees, high Angle resolution and Angle measurement accuracy.
- The operating frequency is 77GHz~81GHz. It has the advantages of sensitive moving target and high precision of distance measurement.
- Effective detection range 27m;
- Support CAN protocol output, default baud rate 500K;
- The signal processing and control unit adopts single-chip DSP +ARM dual-core architecture, and runs radar data processing, target detection and target tracking algorithms on the internal high-speed digital signal processor.

Features:

1. Power and antenna board higher integration;

2. power supply range 5-12V;

3. Stronger energy and stronger ability to detect targets;

4. The hardware bottom noise is relatively low, can set a high sensitivity

5. Fewer false positives

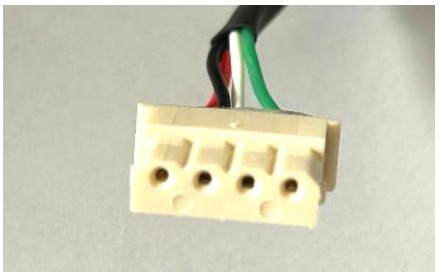
6. Light weight design at 90g.

Specifications:

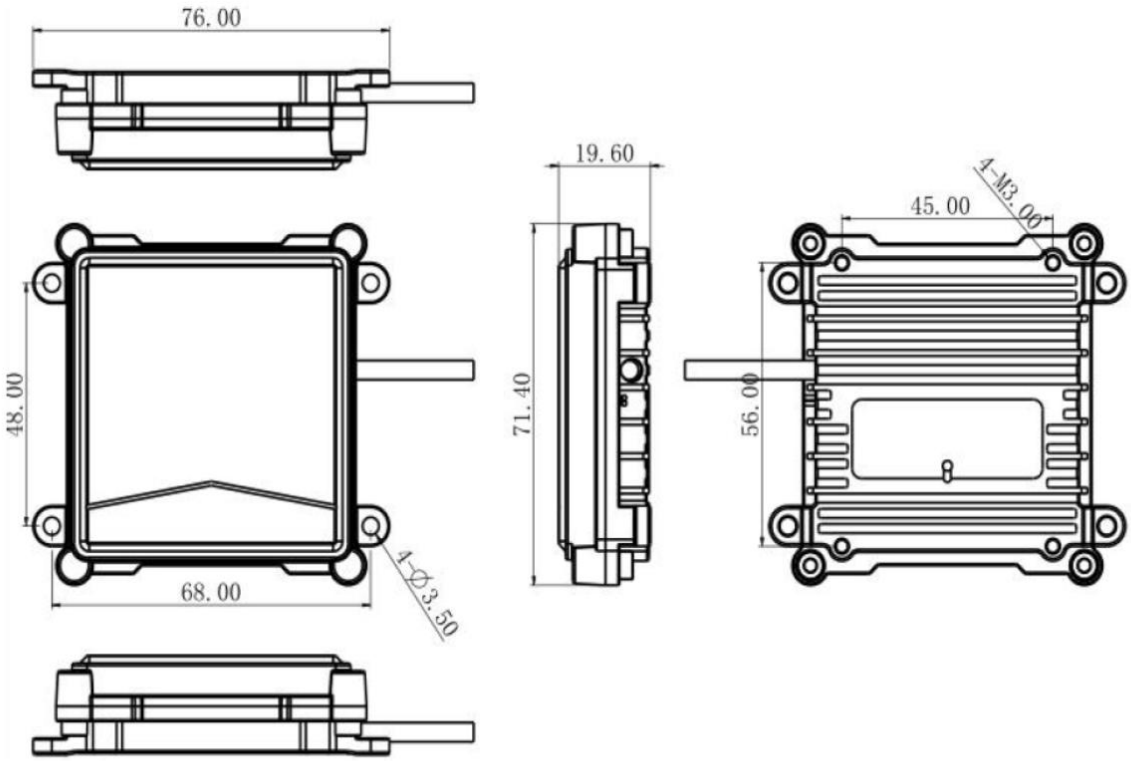
Feature	Parameter	Data
Antenna performance	Azimuth beam （3dB	+/- 15°
	Pitch beam width(3dB)	-7~ +1°
	Max EIRP(dBm)	30
Radar performance	Detect range(m)	1.5-27
	Ranging accuracy(m)	+/-0.1
	Range resolution(m)	0.12
Radar attribute	Transmitting frequency(GHz)	77-81
	Refresh rate(Hz)	20
	Bandwidth(GHz)	1.5
System attribute	Operating voltage(VDC)	5~12VDC
	Operating temperature	-40~ +65°C
	Power consumption(W)	2.7
	Data interface	CAN
	IP rating	IP67
	Size(mm)	76*71.5*19.6
	Weight(g)	90

2.54mm 4P Connector define:

Pins	Define	Parameter
1	DC_In (Red)	5~12VDC
2	GND (Black)	GND
3	TX_CAN_H (Green)	CAN_H
4	RX-CAN_L (White)	CAN-L

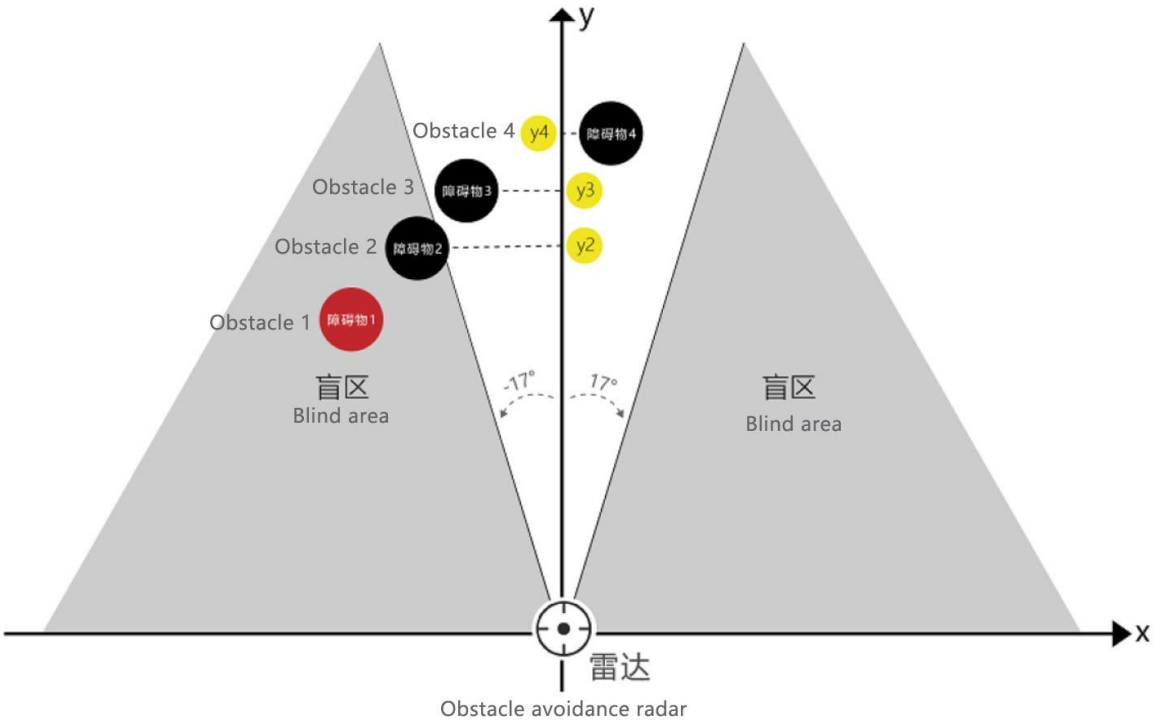


Product Dimisions:



Data Output explain

R21-F-1 Radar sensor directly outputs the Y coordinate of the nearest obstacle, as shown in the figure below. Obstacle 1 is not within the radar beam range and cannot be detected by the radar. Among obstacles 2, 3 and 4, obstacle 2 is closest to the radar Y2, and the final output value of the radar is Y2.



The default baud rate of CAN communication is 500K (if it needs to be output at other baud rates, the customer needs to inform in advance). The message ID adopts 29bit extended frame, the forward radar ID is 0x71C, and the backward radar ID is 0x72C. The sending data: obstacle X and Y coordinates, each frame data is fixed as 4 bytes, and the sending data is hexadecimal. X and Y are both types uint16_t, which each comprises two bytes, the high byte beginning.

For example:

0x80 0x23 0x00 0xf8

x = ((0x80*256)+0x23) -32768 (cm)

Y = (0x00*256)+0xf8 (cm)

Output data definition:

Name	Length(Byte)	Value	Explain
DATA[0] DATA[1]	2	0xXX 0xXX	Obstacle X coordinate (Negative numbers are invalid, the high byte comes first, in centimeters)
DATA[2] DATA[3]	2	0xXX 0xXX	Obstacle Y coordinate (Negative numbers are invalid, the high byte comes first, in centimeters)

Installation guide：

Steps for R21-F-1 radar installation:

- Installation position: radar horizontal beam ±17°, vertical beam -7°~ +1° beam range should not have any occlusion;
- Installation direction: The radar transceiver antenna is located at the arrow on the back of the radar. During installation, the arrow on the back of the radar faces downward, the radar wiring harness faces left, and the radar front faces the flight direction of the UAV.
- Installation Angle: When the radar is installed, the antenna surface (radar front) points to the front of the UAV. According to the maximum downward inclination Angle of the UAV's flight attitude, the radar is installed at an upward tilt. The optimal installation inclination Angle is related to the maximum inclination Angle and the altitude off the ground during the flight of the aircraft, and the installation inclination Angle is generally 12°.

It is assumed that the inclination Angle of the UAV during flight is θ and the working height of the UAV is H. The maximum warning distance is R_max; Then we have the following expression:

$$\frac{H}{Sin(\theta+3)} > R_max$$

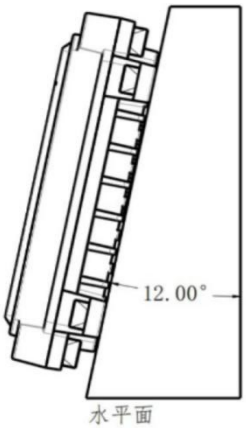
After derivation, it can be obtained:

$$\theta < \arcsin\left\{\frac{H}{R_max}\right\} - 3$$

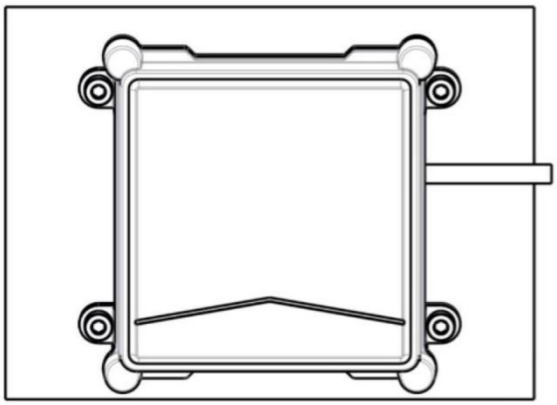
To make $\Theta_{0=}\ \arcsin\left\{\frac{H}{R_max}\right\}$

That is, when the radar is mounted horizontally, the UAV acceptable maximum Angle, If the dip Angle of the UAV is greater than Θ_0, it needs to be corrected, that is, the radar should be installed at an upward tilt and the installation Angle is $\Theta_{comp,}$ That is, $\theta-\Theta_{comp}<\Theta_0$, Then install angle is: $\Theta_{comp}>\theta-\Theta_0$

It should be pointed out that the better the stability of the platform, the smaller the fluctuation of the radar beam in pitch direction, the smaller the installation Angle $\Theta_{comp,}$ and the more stable the radar detection of obstacles ahead.



Horizontal plane



Reference Install photo Pic.1