NRA24 millimeter wave radar

Application manual

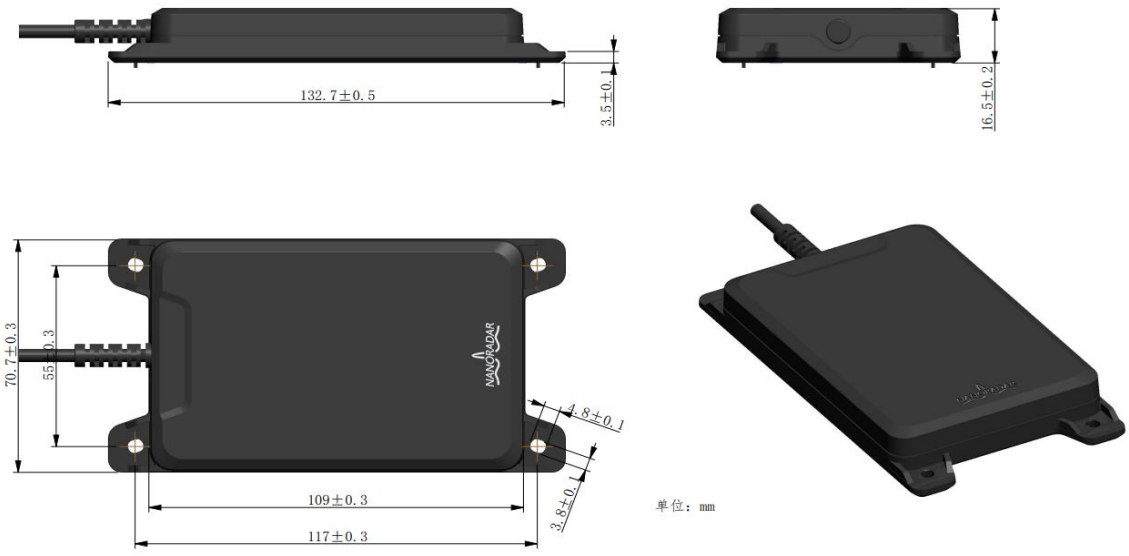
(CAN interface)

Table of content

1 Introduction to NRA24 1
2 Precautions for Product Use 1
3 Shipping List 1
4 Quick Use Steps 2
4.1 Pin Definitions 2
4.2 Test Usage 2
5 CAN Port Data Analysis 4
5.1 NRA24 Configuration (Sensor Configuration) 5
5.2 Radar Feedback (Sensor Feedback) 5
5.3 Radar Status 6
5.4 Target Output Status 7
5.5 Target Output Information (Target Info) 8
6 An Example of Data Parsing 9
7 Electrostatic Protection 10
7.1 Electrostatic Protection Measures 10
7.2 Identify Electrostatic Damage 10
8 Frequently Asked Questions (FAQ) 11
9 References 11

1 Introduction to NRA24

NRA24 is a compact K-band altimeter radar designed for applications such as unmanned aerial systems (UAS), helicopters, and lighter-than-air vehicles.



Size: 130 × 70 × 14.5 (mm)
Weight: 66 G (without connecting wire)

Figure 1 NRA24 contour map

2 Precautions for Product Use

"Precautions" are very important and should be paid attention to.

(1) Connect the power supply pin to an external regulated DC power supply (5 – 16 V);

(2) Secure the NRA24 with four M3 screws.

If you encounter problems that can not be solved in the installation process, please contact the customer service staff of Nanoradar Technology, we will serve you wholeheartedly!

3 Shipping List

Shipping list includes: NRA24 sensor (as shown in Figure 2).

Figure 2 NRA24 physical delivery drawing

4 Quick Use Steps

4.1 Pin Definitions

Interface pin definition of NRA24 sensor, as shown in Table 1:

Table 1 NRA24-pin interface definition

Pin	Definition	Range
1	POWER IN (RED)	5~20V DC
2	-	-
3	GND (black)	-
4	-	-
5	CAN _ L (white)	-
6	CAN _ H (yellow)	-
7	-	-
8	-	-

4.2 Test Usage

The upper computer test software of Millimeter Wave Radar General Management Tool provided by Nanoradar Technology can obtain and analyze the NRA24 sensor data, and display the observation results intuitively. Using this tool is helpful to use the NRA24 sensor.

The test method using CAN protocol is as follows:

First, obtain the general management tool (upper computer test software), user manual, CANUSB box and driver of Nanoradar technology millimeter wave radar from Nanoradar customer service or official website. Install the CANTEST driver, then configure the upper computer test software as described in the user manual.

The test tools or software are shown in the following table:

Table 2 Tools for product testing

Serial number	Device name	Quantity
1	NRA24 products	1
2	PC	1
3	USBTOCAN adapter	1
4	5V or 12V power adapter	1
5	Upper computer test software	1

1) Connect the PC to the NRA24 radar sensor through the USBTOCAN serial port adapter, and the connection diagram is as follows:

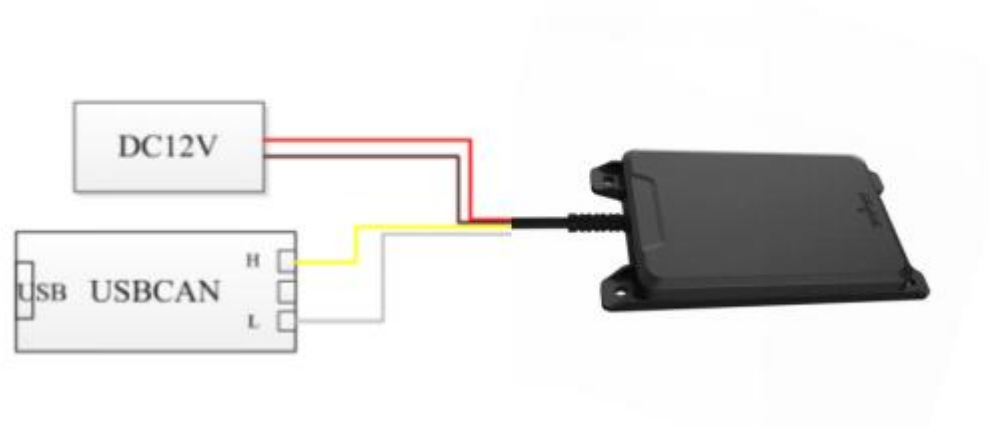


Figure 3 Schematic diagram of CAN connections

Note:

The USB2CAN adapter shown in the figure below shall be used to communicate with the NRA24 during the test. Currently, other types of USB2CAN adapters are not supported. The USB2CAN adapter is not included in the shipping list by default. Customers can obtain the can adapter link address from Nanoradar customer service to purchase by themselves, and Nanoradar can also help customers to purchase on behalf of others.

Figure 4 CAN box for test

2) Connect the USBCAN serial port adapter to the PC, open the upper computer software, first configure the parameters as shown in Figure 5, the red part is the NRA24 test configuration parameters, the default is COM communication, select CAN, and the blue part is the coordinate range adjusted according to the test distance. Then click the Connect Device button on the right.

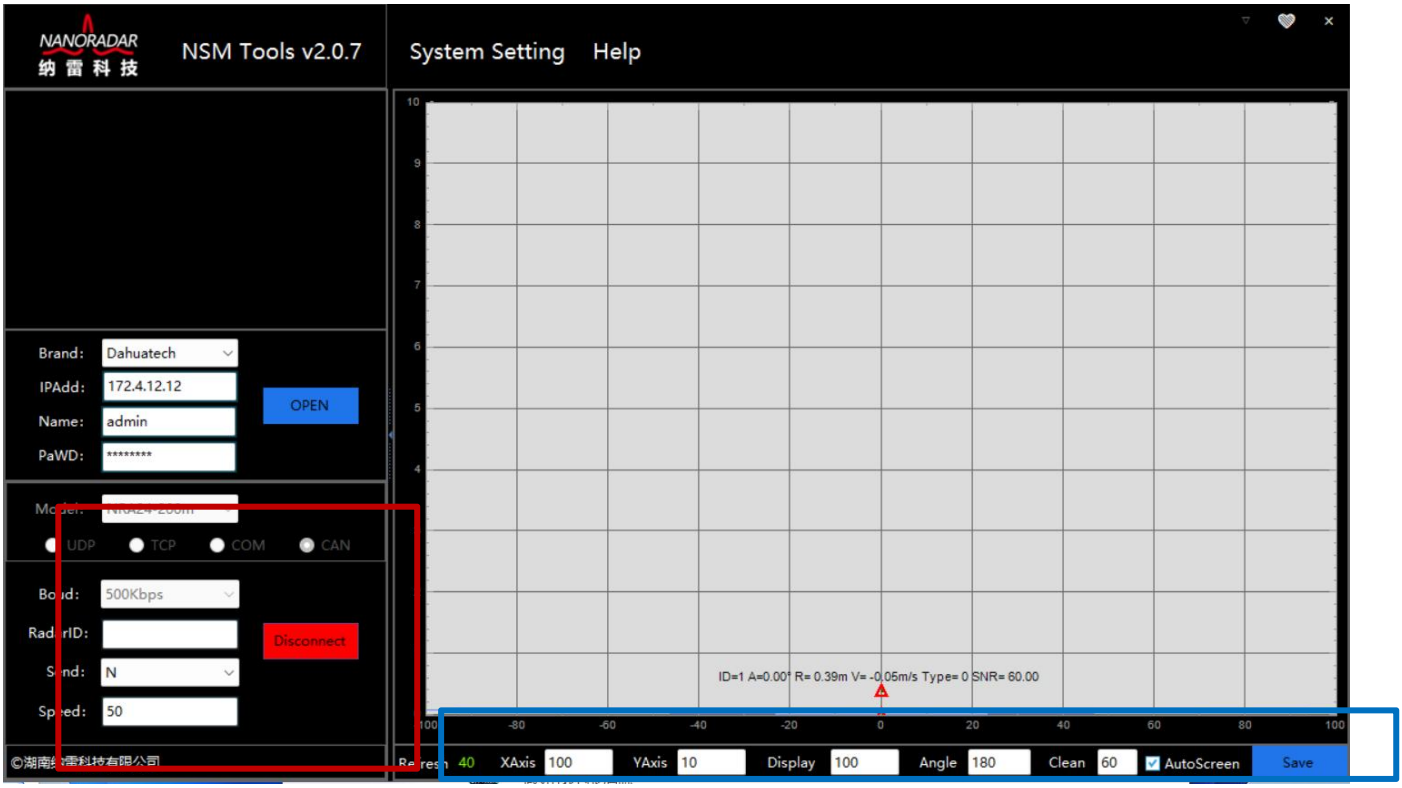


Figure 5 Test interface of radar upper computer

3) Start the test. If the antenna surface of the NRA24 radar is facing the moving target, or there is a small relative movement between the sensor and the target, the red triangle indicating the target will appear on the UI interface, and the target distance R will be displayed. Figure 5. The radial distance between the target and the radar is 2.35 m (NRA24 can detect the target within 50/200 meters from the ground). If there is no red triangle indication, it means that there is no target in the detectable distance and field of view.

5 CAN Port Data Analysis

The NRA24 radar supports the CAN interface, and the CAN bus communication network conforms to the ISO11898-2 standard, with a transmission rate of 500 Kbit/s. The NRA24 emits a radar signal, and the received signal is processed through multiple stages to extract target distance information. The distance information of the target information is transmitted via CAN interface.

NRA24 bus messages are defined in the following table:

Table 3 Definition of radar frame message

CAN	Frame format	Base message ID	Message name	Content	Message source
1	CAN2.0A(11Bit)	0x200	RadarConfiguration	Radar configuration	NRA24
1	CAN2.0A(11Bit)	0x400	RadarFeedback	Radar reply	NRA24
1	CAN2.0A(11Bit)	0x60A	RadarStatus	Radar status output	NRA24
1	CAN2.0A(11Bit)	0x70B	TargetStatus	Radar target status	NRA24
1	CAN2.0A(11Bit)	0x70C	TargerInformation	Radar target information	NRA24

Note:

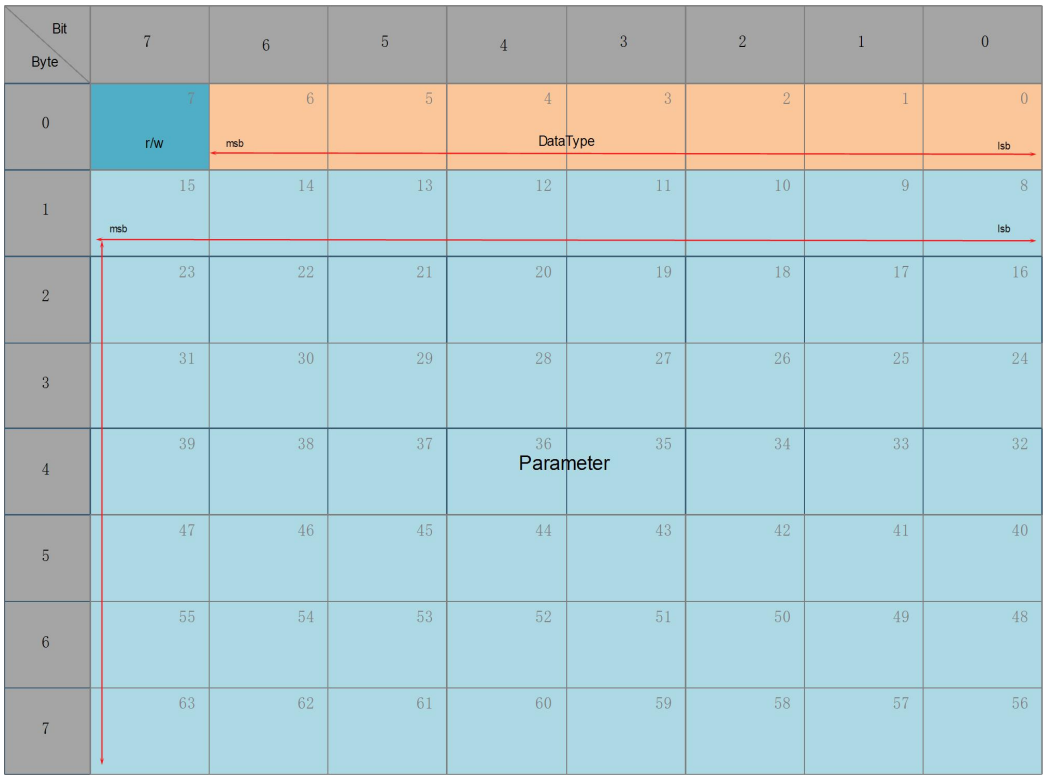
Specific ID calculation formula: each radar message ID = radar ID * 0x10 + basic message ID. Since the CAN bus can mount multiple devices, each device has its own ID. In the above table, the radar ID is 0 by default, and the basic message ID is 0x200, 0x400, 0x60A, 0x70B and 0x70C. If the radar ID

is configured as 1, its Message ID is 0 x210, 0 x410, 0 x61A, 0 x71B, 0 x71C, and so on.

5.1 NRA24 Configuration (Sensor Configuration)

The NRA24 radar configures the radar sensor through Message ID0x200, and the radar configuration message structure is shown in the following table:

Table 4 Structure of Radar Configuration Message



Each field of radar configuration message structure is described as follows:

Table 5 Structure Description of Radar Configuration Message

Parameter	Start position	Length	Definition
DataType	0	7	1: Sensor ID 2: Sensor Version 3: Start/stop target information output 4: Distance filtering 7 e: Internal test use 7 f: Save parameters
R/W	7	1	0: Read parameters; 1: Write parameter
Parameter	8	56	As defined by the DataType

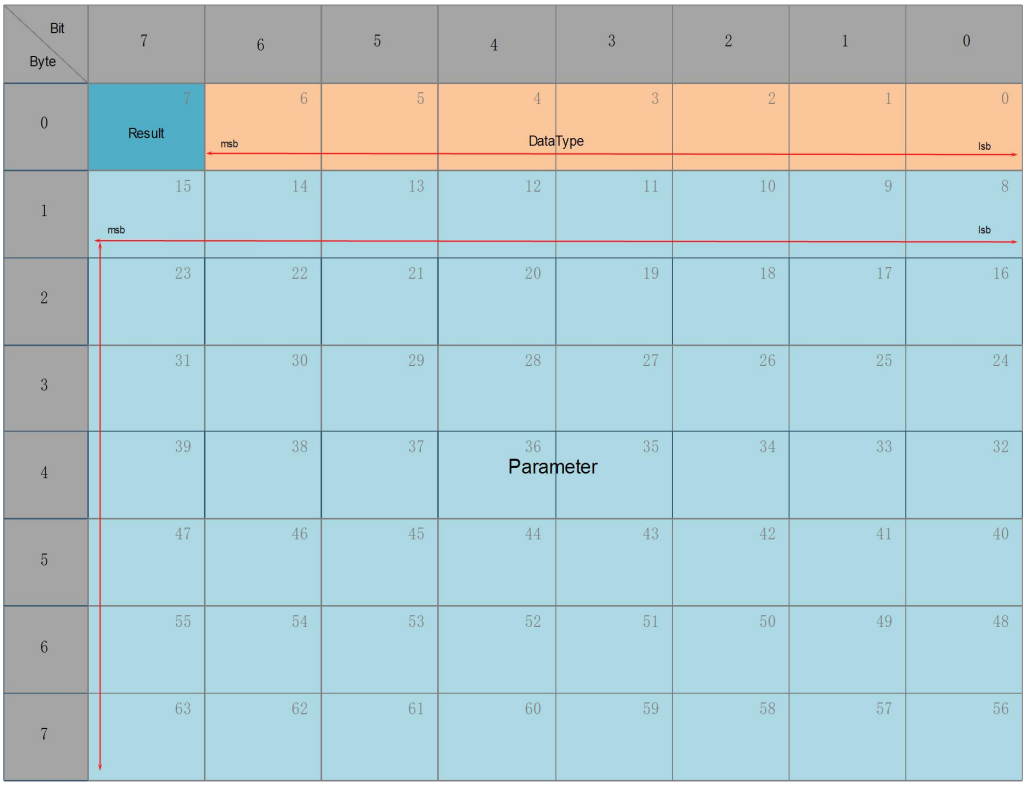
Regardless of whether the parameter is read or written, NRA24 replies with a message that contains the result of writing the parameter or returns the parameter to be read. RadarFeedback defines the format of the reply message. When configuring NRA24, the definitions of Parameter are different for different DataTypes, and the specific definitions are as follows:

5.2 Radar Feedback (Sensor Feedback)

Every time the upper computer or other MCU sends a configuration signal to the NRA24, the NRA24 will immediately return the execution result. The format of the radar reply is shown in the

following table. Radar configuration DataType with R/W and radar feedback are only different from Bit7. In RadarConfiguration, Bit7 is defined as R/W and Radar Feedback is defined as the result of configuration execution. The Parameter field RadarConfiguration is used to write a parameter, and RadarFeedback is used to return the current value of the parameter.

Table 6 Structure of Radar Return Message



Description and definition of each field of radar reply are shown in the following table:

Table 7 Description of each field of radar reply

Parameter	Start position	Length	Definition
DataType	0	7	1: Sensor ID 2: Sensor Version 3: Start/stop target information output 4: Distance filtering 7 e: Internal test use 7 f: Save parameters
Result	7	1	0: Configuration failed; 1: Configuration succeeded
Parameter	8	56	As defined by the DataType

Note:

At present, NRA24 will only return version information, and other functions are not yet available. DataType indicates the configuration item, Result indicates the configuration result, and Parameter is the value of DataType after configuration.

5.3 Radar Status

The message 0x60A contains the status information of the radar. The structure of the radar configuration message is shown in the following table:

Table 8 Message Structure of Radar Status Information (0 x60A)

Byte \ Bit	7	6	5	4	3	2	1	0
0	7 msb	6 Radar_Mode	5	4 lsb	3 msb	2 Radar_ID	1	0 lsb
1	15	14	13	12	11	10	9 msb	8 Radar_RollCount lsb
2	23	22	21	20	19	18	17	16
3	31	30	29	28	27	26	25	24
4	39	38	37	36	35	34	33	32
5	47	46	45	44	43	42	41	40
6	55	54	53	52	51	50	49	48
7	63	62	61	60	59	58	57 Mount_Dir	56 Output_Type

The description of each field of radar status message is shown in the following table:

Table 9 Radar Status Message Description (0 x60A)

Parameter	Start position	Length	Value range
Radar_ID	0	4	0~15
Radar_Mode	4	4	-
Radar_RollCount	8	2	0~3
Radar_Output_Type	56	1	0:Processed;1:Origin
Radar_Mount_Dir	57	1	0: forward direction; 1: Reverse

5.4 Target Output Status

The format of NRA24 system target output status data message is shown in the following table, where NoOfCluster represents the number of detected targets, and the value of RollCount circulates continuously between 0-1-2-3-0-1-2-3. When the upper computer or the external MCU cannot process the output data of the NRA24 sensor in time, the received RollCount value will be discontinuous. At this time, we should find a faster moving method to solve this problem.

Table 10 Target Status (0x70B)

Byte \ Bit	7	6	5	4	3	2	1	0
0	7 msb	6	5	4 NoOfCluster	3	2	1	0 lsb
1	15	14	13	12	11	10	9 msb ClusterSt_RollCount	8 lsb
2	23	22	21	20	19	18	17	16
3	31	30	29	28	27	26	25	24
4	39	38	37	36	35	34	33	32
5	47	46	45	44	43	42	41	40
6	55	54	53	52	51	50	49	48
7	63	62	61	60	59	58	57	56

Description of each field of target status is shown in the following table:

Table 11 Target Status Description (0 x70B)

Parameter	Start position	Length	Value range
NoOfCluster	0	8	0~255
ClusterSt_RollCount	8	3	0~3

5.5 Target Output Information (Target Info)

Format of NRA24 target output information message is shown in the following table:

Table 12 Target Message Structure

Byte \ Bit	7	6	5	4	3	2	1	0
0	7 msb	6	5	4 Cluster_Index	3	2	1	0 lsb
1	15 msb	14	13	12 Cluster_RCSValue	11	10	9	8 lsb
2	23 msb	22	21	20 Cluster_Range[15:8]	19	18	17	16
3	31	30	29	28 Cluster_Range[7:0]	27	26	25	24 lsb
4	39	38 msb	37	36 Cluster_Azimuth	35	34	33	32 lsb
5	47 Cluster1_RollCount msb	46 lsb	45	44	43	42 msb	41 Cluster_Vrel[10:8]	40
6	55	54	53	52 Cluster_Vrel[7:0]	51	50	49	48 lsb
7	63	62	61	60	59	58	57	56

Message 0x70C contains distance information for the target. When the radar sensor works normally, the target output status message will appear after the NRA24 system status message in each cycle, and

the target output information message will appear at last; The number of target output information messages is determined by the value of NoOfCluster in the target output status message. If there is no target, NoOfCluster is 0, and there is no target output information message behind.

The description of each field of target message is shown in the following table:

Table 13 Target Message Description (0x70C)

Parameter	Start position	Length	Calculation method	Value range
Cluster_Index	0	8	-	0~127
Cluster_RCSValue	8	8	Val*0.5-50	-50~30
Cluster_Range	16	16	Val*0.01	0~655
Cluster_Azimuth	32	7	-	-
Cluster_VrelH	40	3	-	-
Cluster1_RollCount	46	2	-	0~3
Cluster_VrelL	48	8	-	-

Note:

The actual values of the target information are derived from the following formulas:

- Index = Index Value//Target ID, obtained from Track information
- Rcs = RcsValue * 0.5 – 50//Retain the value in the factory test and do not output it
- Range = (RangeHValue * 256 + RangeLValue) * 0.01//The original data output by the radar is in cm, and the converted target distance is in meter
- RollCount = RollCountValue//count bit
- SNR = Value-127//Retain the value in the factory test and do not output it

Through these calculations, we can get the target reflection cross section Rcs, the target range Range, and the signal to noise ratio SNR, so as to accurately detect the target range.

6 An Example of Data Parsing

Take Message ID as the target output information (Target Info) as an example, there is a Target Info data message as follows:

Message ID:

0x70C

Data Payload:

0x01 0xC8 0x07 0xD0 0x32 0x02 0xEE 0x96

Interpretation：

Message ID = 0x70C

Data Payload = 0x01 0xC8 0x07 0xD0 0x32 0x02 0xEE 0x96

Data Payload fields are parsed as follows:

Index = 1

Rcs	=	0xC8*0.5 – 50 = 50
Range	=	(0x07 * 0 x100 + 0xD0) * 0.01 = 20//units, m
Rsvd1	=	0
RollCount	=	(0x0 & 0xE0) >> 5 = 0
SNR	=	0x96 – 127 = 23

Note:

The user needs to program and interpret the sensor output data (hexadecimal).

Data is transmitted in hexadecimal format and must be converted to decimal for interpretation. 0x2AF5l hexadecimal to base 10:10997 = 5 * 16 ^ 0 + F * 16 ^ 1 + A * 16 ^ 2 + 2 * 16 ^ 3.

7 Electrostatic Protection

7.1 Electrostatic Protection Measures

Adequate electrostatic protection is required during radar transportation, storage, operation, and handling. When dealing with unintegrated independent modules, users must pay attention to: when the module is taken out of the sealed anti-static package, it is necessary to start to do a good job of electrostatic protection; Avoid touching the radar antenna surface or connector pins; handle the module only by its corners.

Recommendation: Always wear anti-static gloves when working on all radar sensors.

Error mode:

- Wrapping the antenna with metal foil or partial metal parts;
- Use a multimeter to directly measure the pin, causing damage;
- Any kind of paint or varnish spray antenna structure;
- Wrap the antenna with CFK foil (conductive);
- The plastic material is in direct contact with the corroded antenna structure (which has a higher dielectric constant effect on the resonant frequency of the patch).

7.2 Identify Electrostatic Damage

In general, the following conditions indicate that the module has been damaged by static electricity:

- When there is no target object in the radar detection coverage, the radar continuously outputs irregular targets;
- When the DC parameter values such as the power supply voltage and the source current are in the normal range, the output signal cannot be obtained.

8 Frequently Asked Questions (FAQ)

1) Angular accuracy of our NRA24?

NRA24 is a 24GHz millimeter wave altimeter radar sensor developed by our company. The antenna is a transmitter and receiver, which cannot measure the angle of the target. However, only radar with more than two receiving antennas has the ability of angular resolution, and the more antennas, the higher the accuracy of angular resolution.

2) What is the altitude accuracy of our NRA24 within 30 m?

NRA24 adopts one transmitting antenna and one receiving antenna, and the separate design of transmitting and receiving antennas makes the radar transmitting and receiving links have high isolation, which improves the dynamic range of radar target detection. At the same time, NRA24 adopts an advanced integrated planar microstrip array antenna, each of which contains 40 vertically polarized radiating elements. Therefore, the height accuracy of ± 0.1 m can be achieved in the effective measurement range of 0.1-30 m.

3) When NRA24 is measuring height, which target will be taken as the standard when it encounters vegetation and the ground? When there is water on the ground, is it the ground or the water?

The NRA24 is a high-precision millimeter-wave radar developed by our company. In actual use, the height should be divided. If the height is less than 3m, the air flow under the aircraft is strong, and the vegetation is likely to be blown away, then the reference point is the ground or water. If the aircraft reaches 5m, the airflow has not affected the vegetation below, and if the vegetation density is high, the reference point becomes vegetation at this time.