

WLR-720

16-Line Mechanical LiDAR

User Manual

VanJee Technology Co., Ltd.

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safety warning

Please read the following safety precautions carefully to avoid damage to this product or other products connected to this product.

- Power cord: Only use the power cord approved by the country;
- Check the product rating: To avoid the impact of excessive current, please check the rating and marking instructions marked on the product, please refer to the manual for detailed information on the rating before connecting the product;
- Overvoltage protection: ensure that no overvoltage is connected to the product;
- Grounding: Ground the power cable ground wire of this product. To avoid electric shock, before connecting any input or output of this product, please ensure that the grounding end of the power cable of this product is reliably connected to the protective grounding end;
- Anti-static protection: Static electricity may cause damage to the instrument, so it should be carried out in an anti-static area or under the premise of good grounding as much as possible;
- Optical cover protection: It is strictly forbidden to use hard objects to scratch the optical cover, otherwise it may cause irreversible damage to the radar; to avoid dust affecting the ranging performance, please keep the optical surface of the product clean;
- Operating environment: In order to ensure the normal operation of the radar, it is strictly forbidden to use or store the instrument in a flammable, explosive and corrosive environment;
- Eye safety: The laser safety level of this product complies with the Class 1 standard, but the device has continuous infrared laser emission during operation. To ensure safety, please do not look directly at the light-emitting surface for a long time.
- Product failure: If you suspect that this product is malfunctioning, please contact the relevant personnel of VanJee Technology for testing. Any maintenance, adjustment or replacement of parts must be performed by VanJee; it is strictly forbidden to disassemble the instrument and open the cover without authorization.

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1. Product introduction

WLR-720 is a 16-line mechanical lidar launched by VanJee Technology, which is used for environmental 3D perception in scenarios such as unmanned driving, robots and industrial automation.

1.1 Main Features

- Highly modular design
- 360° panoramic scan, 30° vertical field of view
- 16-line scanning section, high-precision ranging

1.2 Typical applications

- unmanned
- High-precision mapping
- Obstacle detection

1.3 Product Specifications

Basic parameters	Ranging method	TOF
	Ranging capability	0.5m~50m@10% reflectivity, channel 1-4, 13-16 ; 0.5m~70m@10% reflectivity, channel 5~12
	Ranging accuracy	±3cm (typ.)
	Horizontal scan field of view	360°
	Horizontal scan resolution	0.1°/0.2°/0.4°
	Vertical scan field of view	30° (-16°~14°)
	Vertical scan resolution	2°
	scanning frequency	5Hz/10Hz/20Hz
	echo mode	Single echo/dual echo
Mechanical/Electrical	Laser wavelength	905nm
	Eye safety level	Class1 (eye safety)
	Communication Interface	Ethernet
	Operating Voltage	12 -32V DC (power supply greater than 20W)
	Power consumption	15W
	Protection class	IP67
	size	Φ105.7mm×81.5mm
	net weight	0.91Kg
	Operating temperature	-20°C-60°C
	storage temperature	-40°C-85°C
Data input/output	transfer method	UDP/IP
	Output Data	Distance, horizontal azimuth, reflectivity
	time source	GPS
	GPS synchronization accuracy	≤10ns
	GPS clock drift	≤10ns/s

Table 1 Product Specification Parameters

1.4. Definition of vertical angle

The vertical azimuth angle of WLR-720 is $-16^{\circ}\sim+14^{\circ}$. The 1 to 16 light-emitting channels are evenly distributed from top to bottom at an interval of 2° in the vertical direction. The mapping relationship between the 16 light-emitting channels and the vertical angle is shown in Figure 1.

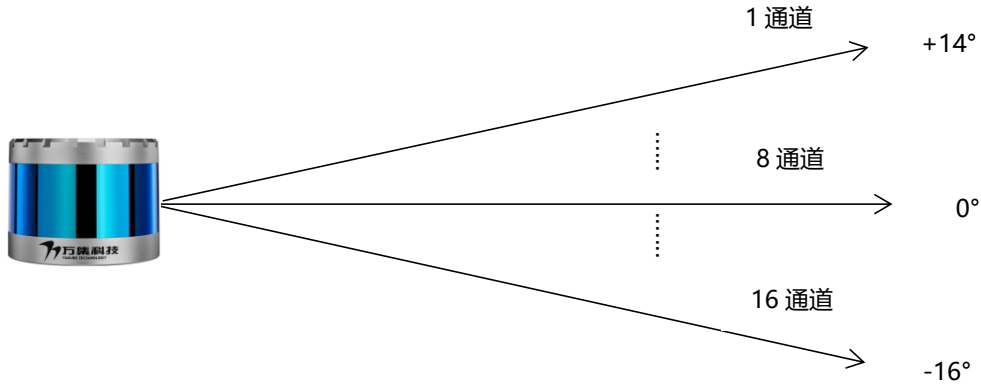


Figure 1 WLR-720 pitch angle definition

Note: The above picture is the vertical angle distribution under ideal conditions. The actual vertical angle distribution of the lidar can be obtained through the VanJeeView point cloud software query, as shown in Table 2 .

channel number	Actual vertical angle value	channel number	Actual vertical angle value
1	14.01°	9	-1.962°
2	12.047°	10	-3.925°
3	10.085°	11	-5.975°
4	8.007°	12	-7.957°
5	6.002°	13	-9.96°
6	4.01°	14	-11.94°
7	2.015°	15	-13.827°
8	0°	16	-15.775°

Table 2 Example description of channel and actual vertical angle value

2. Electrical interface

2.1 Power supply description

WLR-720 integrates the wide voltage function, the working voltage is 12-32V DC, the rated working voltage is 24V DC, the rated working current is 0.55A, and the rated power is 15W . When using, please connect the aerial plug interface to the machine, and then connect the power interface to the 24V DC power supply. Once powered on, the lidar starts working.

Notice! If the power supply voltage is too low or too high, it will affect the performance of the WLR-720 or cause irreversible damage to the laser!

2.2 Electrical interface

The WLR-720 lidar is powered and communicated via an aerial plug-in cable. The network interface is a crystal head, which is connected to the network port of the device receiving data; the GPS interface is a loose wire, which is used to connect the RS232 and PPS signals of the GPS module; the remaining loose wire is the power line. The corresponding structure of the aerial plug-in line is shown in Figure 2, and Table 3 is the interface definition of P1, P2, and P3 in the following figure .

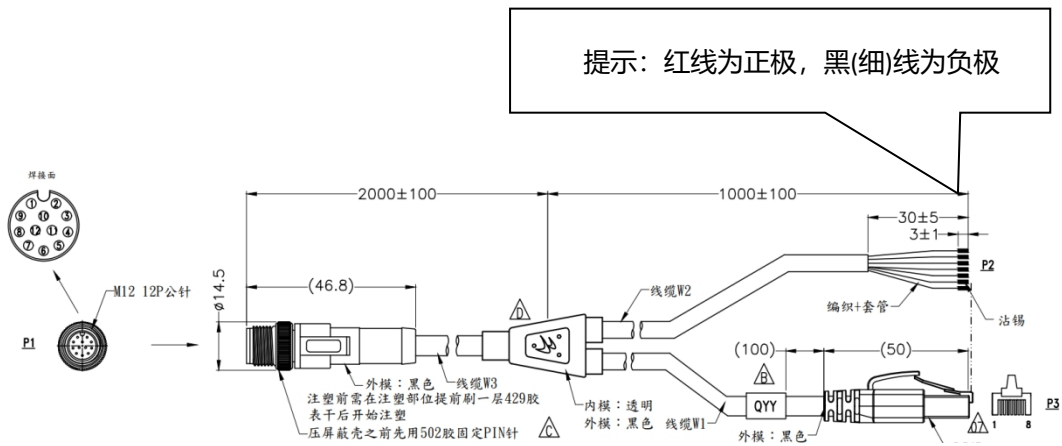


Figure 2 Structure diagram of aerial plug line

P1 (air jack)	P2 (Power)	P3 (network port)	Function
Numbering	color	Numbering	
1		1 white	Ethernet_TX_P
2		2 green	Ethernet_TX_N
3		3 blue	Ethernet_RX_P
4		6 yellow	Ethernet_RX_N
5	White		GPS_PPS
6	green		RS232_RX
7	black (thin)		P24V-
8	red		P24V+
9	blue		IO_OUT _
10	yellow		WGND
11, 12			NC
metal shell	black (coarse)		shield

Table 3 P1, P2, P3 interface definitions

2.3 Electrical connection

Connect the WLR-720's power supply wiring and network wiring correctly according to the interface instructions. The crystal head of the network wiring is connected to a network switching device such as a switch, or directly to a data receiving device. The wiring diagram is shown in Figure 3. Please refer to Table 3 for the interface definition for the connection line sequence .

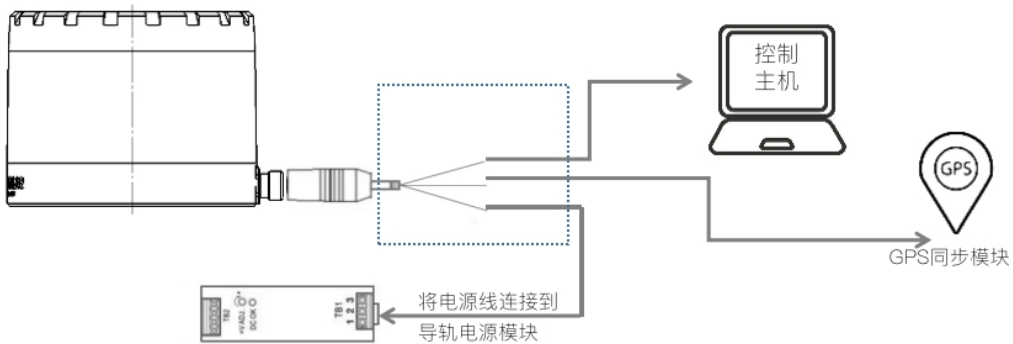


Figure 3 Wiring Diagram

3. Communication Protocol

Data output adopts Fast Ethernet UDP/IP communication protocol, point cloud data and GPS data are in the same UDP packet, and the data format is shown in Figure 4 .

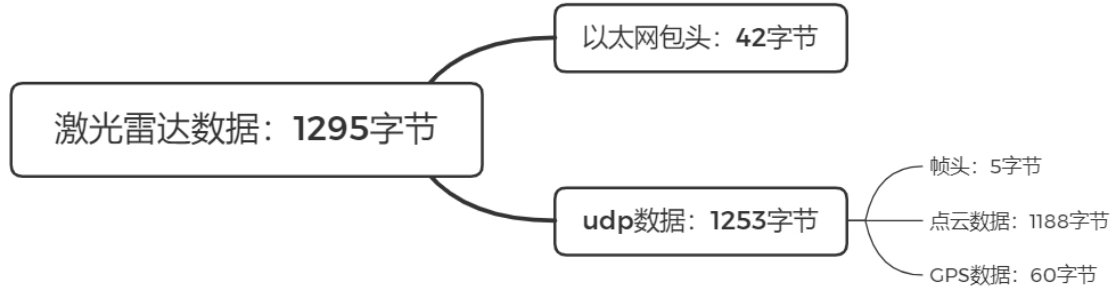


Figure 4 WLR-720 data format

3.1 Ethernet header

Each lidar has a unique MAC address. The default radar IP is 192.168.2.86 and the corresponding port number is 3333. The default computer IP is 192.168.2.88 and the corresponding port number is 3001.

```
Frame 1531: 1295 bytes on wire (10360 bits), 1295 bytes captured (10360 bits) on interface \Device
Ethernet II, Src: BeijingW_89:6d (f8:b5:68:90:89:6d), Dst: LCFChEFeEb:62:ed (8c:8c:aa:eb:62:ed)
Internet Protocol Version 4, Src: 192.168.2.86, Dst: 192.168.2.88
User Datagram Protocol, Src Port: 3333, Dst Port: 3001
```

Figure 5 Ethernet header

Ethernet header: 42 bytes		
parameter name	number of bytes	default data
Radar IP address	4	192.168.2.86
Computer IP address	4	192.168.2.88
Radar port	2	3333
destination port	2	3001

Table 4 Default IP and port number

3.2 UDP data

Multibyte content is in little-endian format.

3.2.1 Frame header

field	number of bytes	
0xFF	1	
0xDD	1	
ChannelNum	1	Number of channels 16
ReturnWaveNum	1	Echo number, 2 is double echo; 1 is single echo;
BlockNum	1	The number of data blocks N; Under 16 channels of single echo, BlockNum is 18; under 16 channels of double echo, BlockNum is 9;

Table 5 Frame header data format

3.2.2 Point cloud data

1188 -byte point cloud data consists of 18 66 -byte data blocks, FFDD is the start bit of each packet of data , ChannelNum is the number of channels, ReturnWaveNum is the echo multiplicity, and BlockNum is the number of data blocks. Since the number of echoes can be set to two types: single echo and double echo , there are two formats corresponding to the point cloud data output.

The length of each data block is 66 bytes, the Azimuth of 2 bytes is the horizontal rotation angle, the Channeldata of 4 bytes is the data of each channel , and $2+4 \times 16$ is equal to 66 . The single-echo data structure and the double-echo data structure are shown in Figure 6 and Figure 7 below:

- Taking the horizontal resolution of 0.2° and the calculation in single echo mode as an example , each packet of point cloud data is a total of 3.6° of data, and a 360° scan generates 100 packets of data to form one frame.
- Taking the horizontal resolution of 0.2° and the double echo mode as an example , each packet of point cloud data is a total of 1.8° of data, and a 360° scan generates 200 packets of data to form one frame.

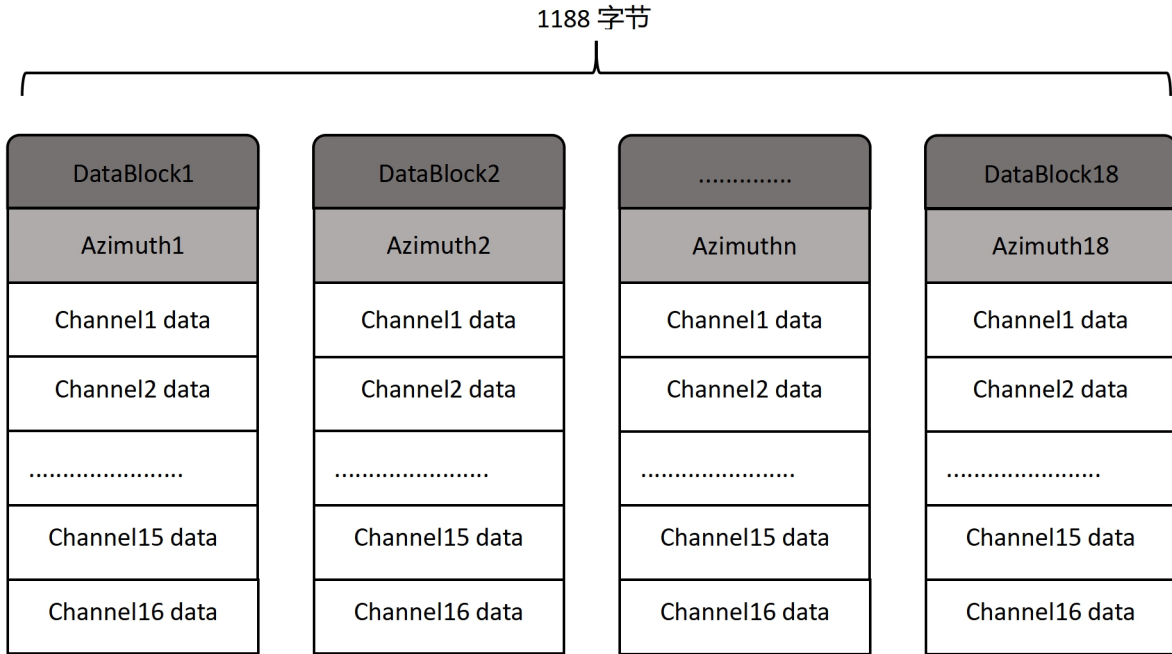


Figure 6 Single echo data structure

	data block	illustrate
single echo (three modes)	first echo	Foremost echo in time
	strongest echo	The strongest echo
	last echo	Last echo in time

Table 6 Description of single echo mode

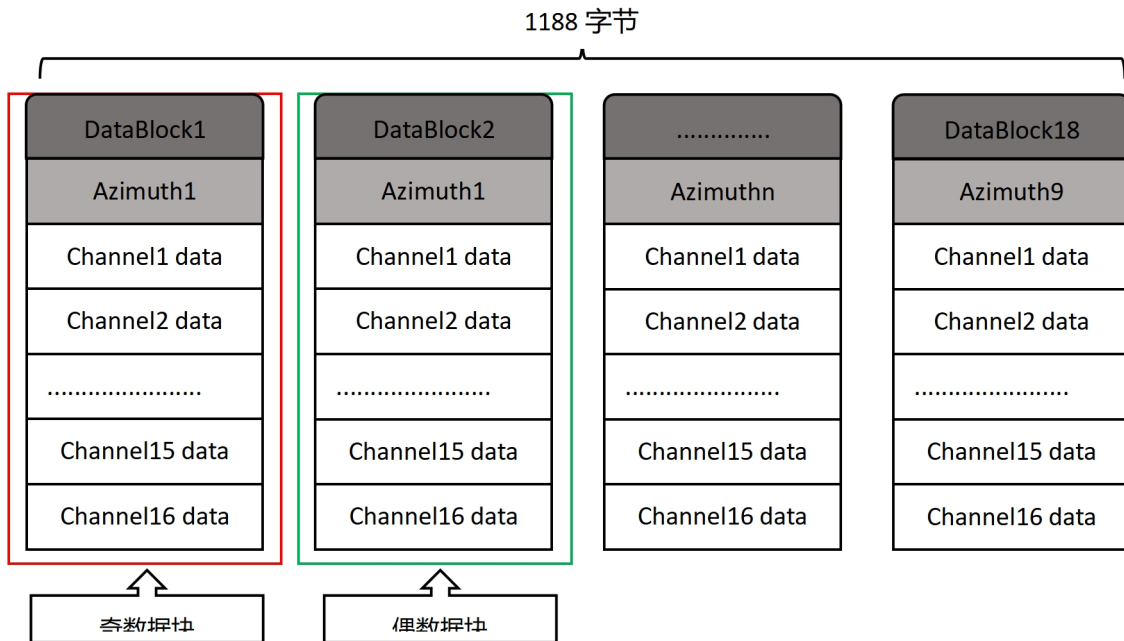


Figure 7 Double echo data structure

Odd and even data blocks alternate, a total of 18 data blocks. The horizontal azimuth angles of each group of odd and even data blocks in sequence are the same, that is, each packet of point cloud data in the dual-echo mode only contains 9 horizontal azimuth data. Echo mode can be set via VanJeeView.

	odd data block	even data block	illustrate
double echo (three modes)	last echo	strongest echo	If the last and strongest echo is the same echo, the even data block saves the next strongest echo
	last echo	first echo	If the last and first are the same echo, the data of the parity data block is the same
	first echo	strongest echo	If the first and strongest echoes are the same echo, the even data block saves the second strongest echo

Table 7 Description of dual echo mode

Each 4-byte channel data contains 2 bytes of distance information, 1 byte of pulse width data, and 1 byte of reflectivity information, as shown in Figure 8 :

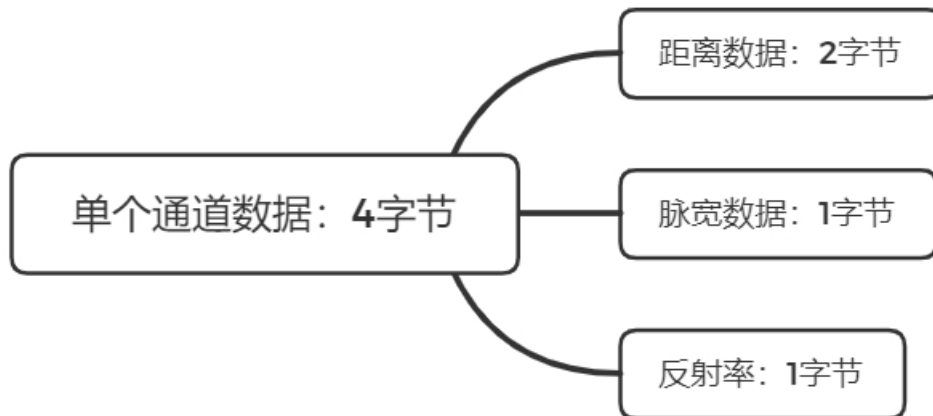


Figure 8 Single-channel data structure

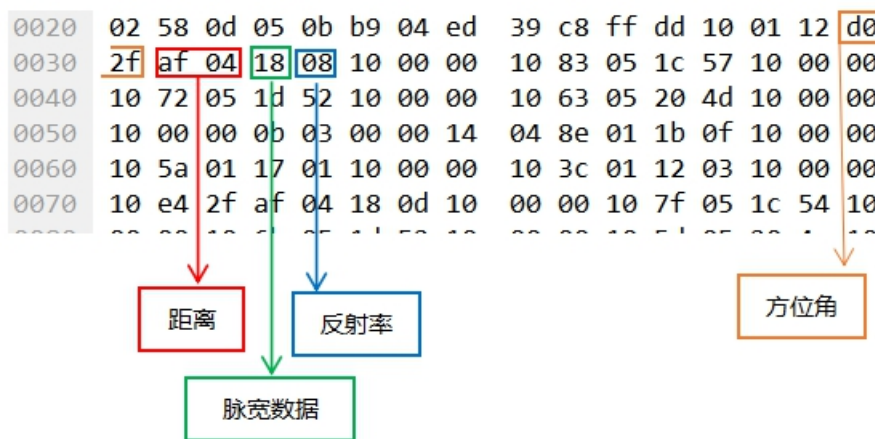


Figure 8 Screenshot of channel data

in Figure 8 above is the horizontal rotation angle. In each data block, there is only one horizontal rotation angle value, which corresponds to the angle value during the laser ranging of the first channel. The angle value comes from the angle encoder. The zero point of the device is the zero point of the angle.

An example of calculating azimuth, distance data, pulse width data, reflectivity is given below.

1) Azimuth

The azimuth data of the data packet captured in the above figure is: 0x d0 0x 2f

Because it is little -endian storage, the composition of 16bit is 0x 2fd0

Converted to decimal is: 12240

Divide by 100 to get 122.4

Therefore, the emission angle of the laser this time is 122.4 0 degrees

2) Ranging data

distance data of the packet captured in the above figure is: 0x af 0x 04

Since it is a little -endian storage, the composition of 16bit is 0x0 4af

Converted to decimal is 1199 * 4 is equal to 4796 , the unit is millimeter, so the distance between the

radar and the point is 4.796 meters

3) Pulse width data

pulse width data in the data block captured in the above figure is: 0x1 8

Converted to decimal: 2 4 , that is, the pulse width information of the object is 2 4

4) Reflectivity (range 0~255)

reflectivity information in the data block captured in the image above is: 0x 08

Converted to decimal: 8 , that is, the reflectivity of the object is 8

◆ Note: Only the first echo has reflectivity information, the second echo does not

3.2.3 GPS data

The udp data contains 60 bytes of GPS data, as shown in Table 8 below.

field	number	byte offset	
MACID	2	1192	MACID[5],MACID[4]
CycleNum	2	1194	circle number
DateTime	6	1196	Seconds: 0-59 Score: 0-59 Hours: 0-23 Days: 1-31 Month: 1-12 year: positive integer, the current year minus 21
timestamp	4	1202	0-27bit: 10ns unit, fractional part after second 28-29bit: GPS module satellite link status 0: disconnect 1: The module output message is normal, no satellite signal 2: Module connection to satellite is unstable, no PPS signal 3: The module is connected to the satellite normally Transmission mode little endian mode
X axis	2	1206	Mdeg/s, multiplied by a factor of 8.75
Y axis	2	1208	Mdeg/s, multiplied by a factor of 8.75
Z axis (course rate)	2	1210	Mdeg/s, multiplied by a factor of 8.75
X-axis acceleration	2	1212	Mg, multiplied by a factor of 0.061, g is the acceleration of gravity

Y axis acceleration	2	1214	Mg, multiplied by a factor of 0.061, g is the acceleration of gravity
Z axis acceleration	2	1216	Mg, multiplied by a factor of 0.061, g is the acceleration of gravity
Gyroscope Status	10	1226	
reserved	20	1246	
number of packages	2	1248	
end of frame	2	1250	

Table 8 GPS data structure

4. GPS synchronization

WLR -720 can be connected to GPS module, and synchronize the time sent by GPS to the system time of the device, and can also synchronize the GPRMC message sent by GPS to the GPS data part of the udp package.

The GPS module continuously sends GPRMC data and PPS synchronization pulse signal to the device. The length of the PPS synchronization pulse is 20ms to 200ms, and the GPRMC data must be completed within 500ms of the rising edge of the synchronization pulse.

The GPS interface level protocol of WLR-720 radar is the RS232 level standard. The pin RS232_RX receives the RS232 level standard serial port data output from the GPS module, and the pin GPS_PPS receives the synchronization pulse signal output from the GPS module. The level requirement is 3.0V~15.0V, the related pins are shown in the figure below.

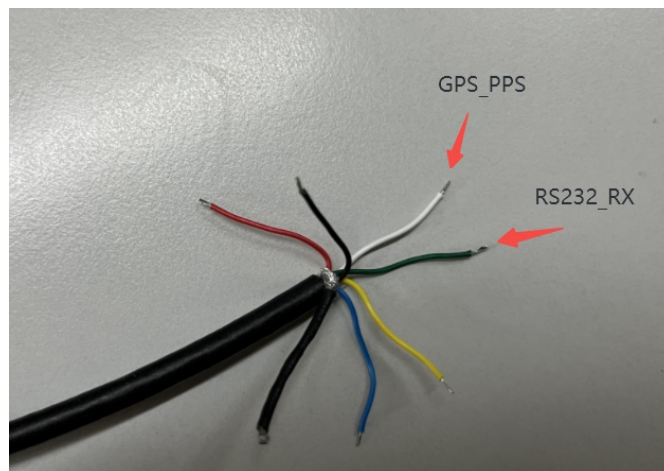


Figure 9 Schematic diagram of GPS pins

WLR-720 only reads the data in GPRMC format sent by GPS module , and its standard format is as follows:

\$GPRMC, <1> , <2> , <3> , <4> , <5> , <6> , <7> , <8> , <9> , <10> , <11> , <12> *hh

*After hh is the XOR sum of all characters from \$ to *

The corresponding meanings of the numbers are shown in Table 9 below.

Numbering	meaning	Numbering	meaning
<1>	UTC time	<7>	ground rate
<2>	Positioning status, A=valid positioning, V=invalid positioning	<8>	ground heading
<3>	latitude	<9>	UTC date
<4>	Latitude Hemisphere N (Northern Hemisphere) or S (Southern Hemisphere)	<10>	Magnetic declination
<5>	longitude	<11>	Magnetic Declination Direction, E (East) or W (West)
<6>	Longitude Hemisphere E (East Longitude) or W (West Longitude)	<12>	Mode indication (A=autonomous positioning, D=differential, E=estimated, N=data invalid)

Table 9 GPRMC data format number meaning

5. Phase lock

When multiple WLR-720s are placed at close range, there will be mutual interference between radars, that is, noise will appear in point cloud imaging. Therefore, the WLR-720 provides the function of phase locking. The phase locking function enables the radar to rotate to a specific angle after starting to emit the laser. Therefore, when multiple radars work at close range, the relative rotation angle between them can be kept unchanged, thereby reducing the interfere with each other. At present, the WLR-720 can set the phase locking of four angles through the VanJeeView point cloud software, which are 0° , 90° , 180° , and 270° , as shown in Table 10 .

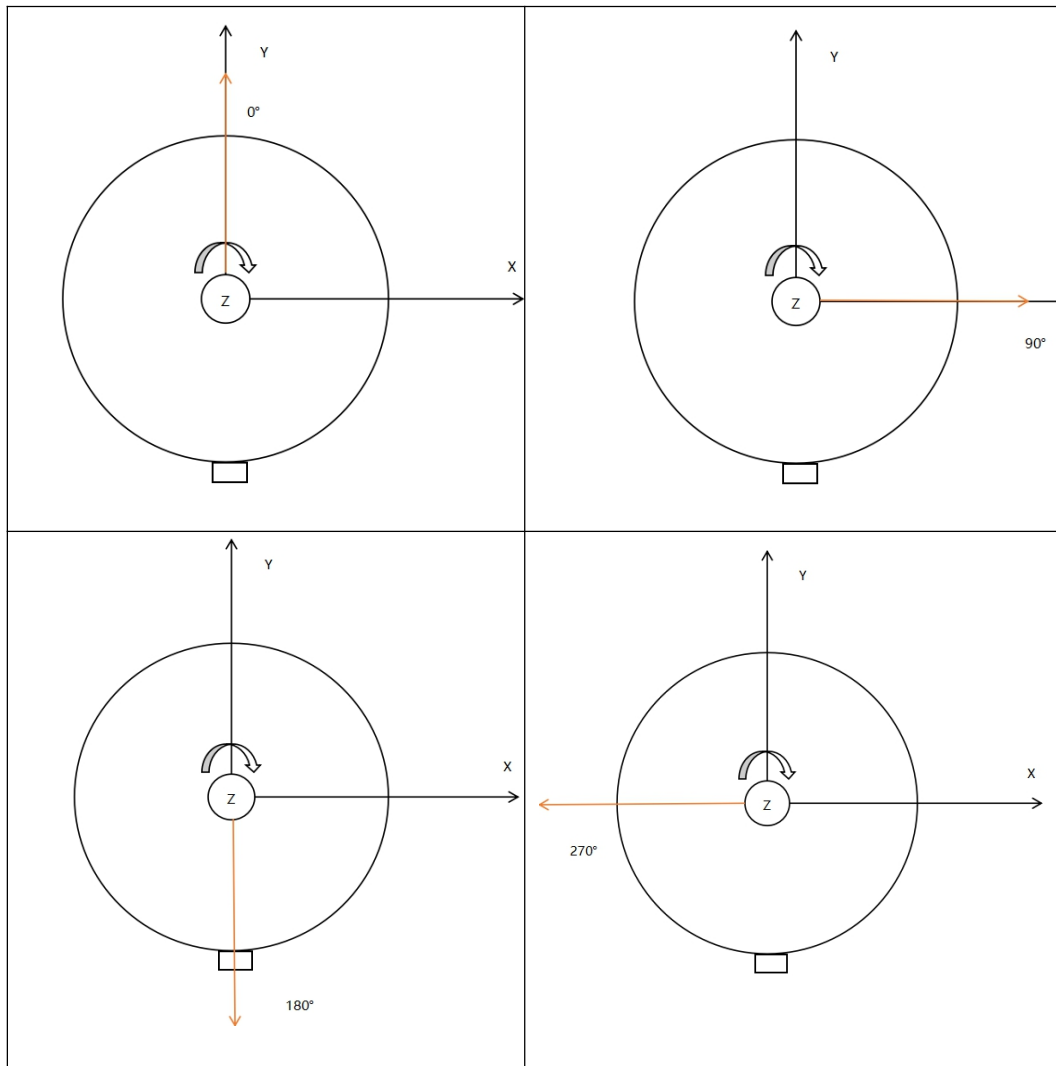


Table 10 Schematic diagram of phase locking

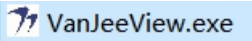
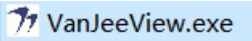
6. VanJeeView

VanJeeView provides the function of visualizing the output data of WLR-720, and can save and play back pcap format files. The version used this time is VanJeeView V 2.0.2 .

6.1 Software Installation

1. Unzip the VanJeeView archive.
2. Install the npcap.exe component (included in the necessary component library folder in the installation package, the recorded point cloud cannot be saved without installation).

6.2 Point cloud display

1. Open the  installation package and click .
2. Before the first  use, you need to ensure that the computer IP is 192.168.2.88, and the software is not prohibited by the firewall or third-party security software, as shown in Figure 10 below, check both the domain network and the private network, and click Allow access to ensure that the software can work normally use.

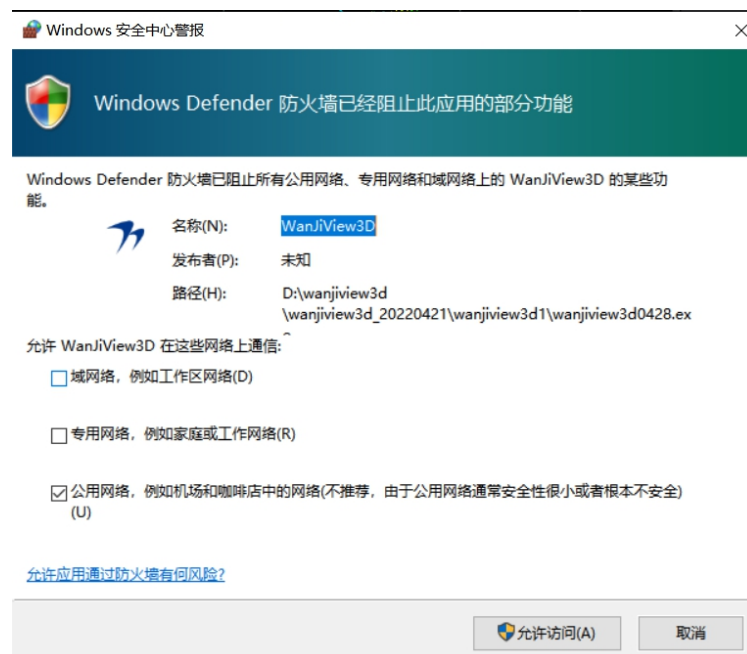


Figure 10 Firewall Warning


3.  Click to pop up the network connection pop-up window as shown in Figure 11, click the connection, you can see the real-time point cloud, when you do not know the device IP, you can click the broadcast to find the device in the local area network



Figure 11 Network connection

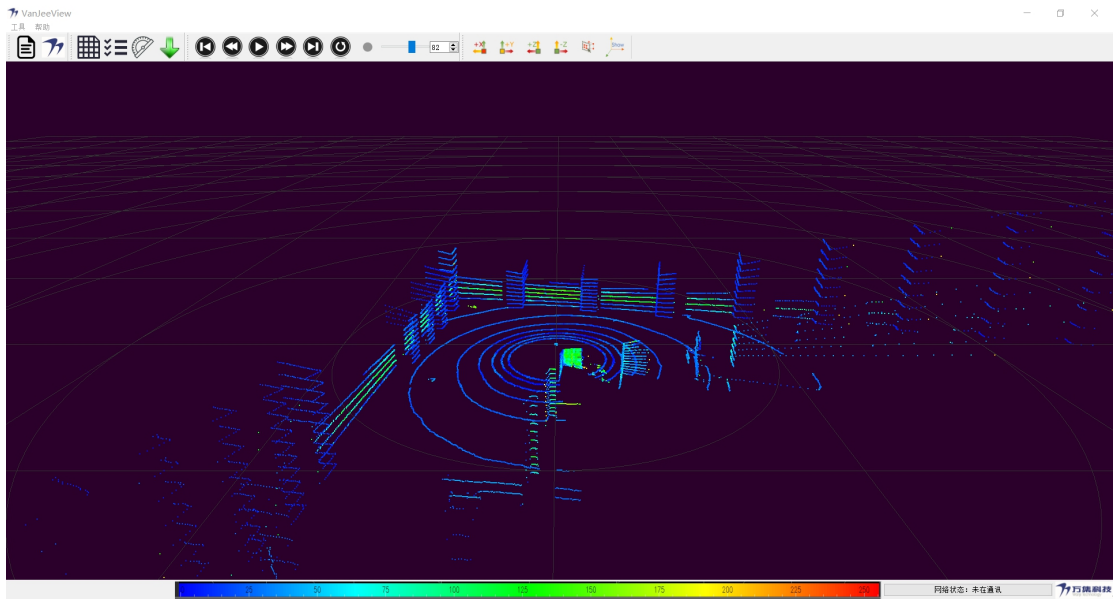

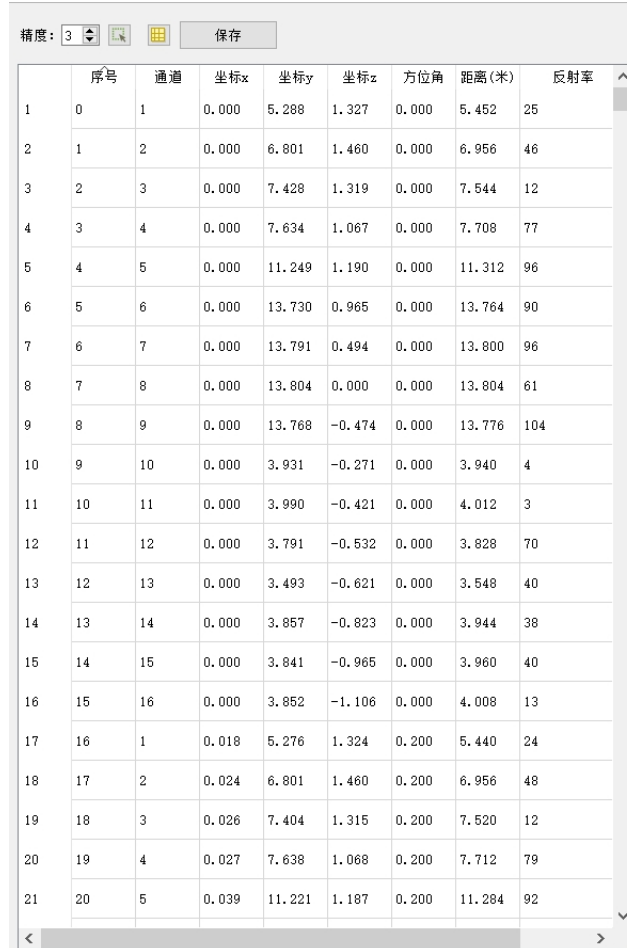


Figure 12 Real-time point cloud

6.3 Data tables

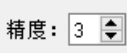





click , the pop-up data table pop-up window is shown in Figure 13, the default display is the complete data of one frame.



	序号	通道	坐标x	坐标y	坐标z	方位角	距离(米)	反射率
1	0	1	0.000	5.288	1.327	0.000	5.452	25
2	1	2	0.000	6.801	1.460	0.000	6.956	46
3	2	3	0.000	7.428	1.319	0.000	7.544	12
4	3	4	0.000	7.634	1.067	0.000	7.708	77
5	4	5	0.000	11.249	1.190	0.000	11.312	96
6	5	6	0.000	13.730	0.965	0.000	13.764	90
7	6	7	0.000	13.791	0.494	0.000	13.800	96
8	7	8	0.000	13.804	0.000	0.000	13.804	61
9	8	9	0.000	13.768	-0.474	0.000	13.776	104
10	9	10	0.000	3.931	-0.271	0.000	3.940	4
11	10	11	0.000	3.990	-0.421	0.000	4.012	3
12	11	12	0.000	3.791	-0.532	0.000	3.828	70
13	12	13	0.000	3.493	-0.621	0.000	3.548	40
14	13	14	0.000	3.857	-0.823	0.000	3.944	38
15	14	15	0.000	3.841	-0.965	0.000	3.960	40
16	15	16	0.000	3.852	-1.106	0.000	4.008	13
17	16	1	0.018	5.276	1.324	0.200	5.440	24
18	17	2	0.024	6.801	1.460	0.200	6.956	48
19	18	3	0.026	7.404	1.315	0.200	7.520	12
20	19	4	0.027	7.638	1.068	0.200	7.712	79
21	20	5	0.039	11.221	1.187	0.200	11.284	92

Figure 13 Data table


button	illustrate
	Adjust the number of decimal places in the data in the table, the default is 3
	Only display the data of the selected point, it needs to be used together with the point selection button
	Controls the displayed parameter items
	Save the displayed data as a CSV table
parameter	illustrate
aisle	Indicates which channel the point is emitted from

Azimuth	Indicates the horizontal azimuth of this point
distance	Indicates the polar coordinate distance of this point with the radar as the center
Reflectivity	Indicates the reflectivity information of this point

Table 11 Data table buttons and parameter meanings

6.4 Channel selection



Click  to pop up the channel option pop-up window, as shown in Figure 14, you can select the number of channels to be displayed by clicking the option box on the left.

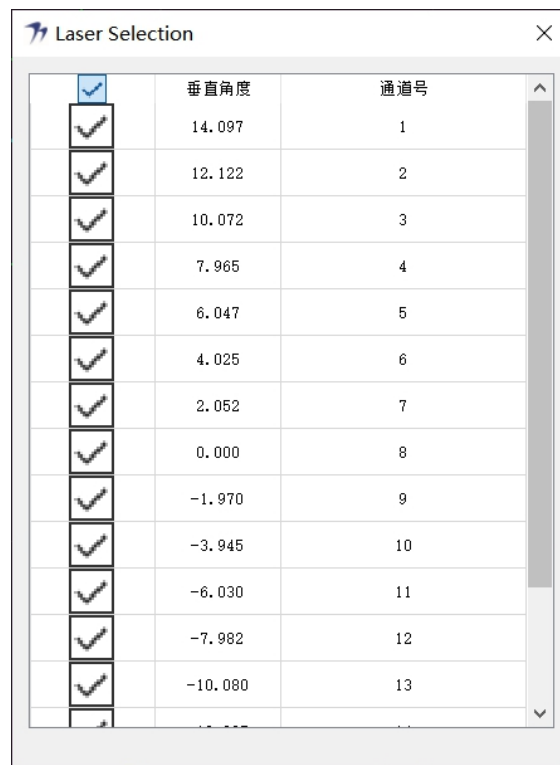


Figure 14 Channel Options

6.5 Parameter configuration



	通道	垂直角度
1	0	14.097
2	1	12.122
3	2	10.072
4	3	7.965
5	4	6.047
6	5	4.025
7	6	2.052
8	7	0.000
9	8	-1.970
10	9	-3.945
11	10	-6.030
12	11	-7.982
13	12	-10.080

Figure 15 Parameter configuration

1. "Network parameters", to query and set the network parameters of the laser, it should be noted that the device IP and the local IP must be in the same network segment, otherwise the setting will be unsuccessful.
2. "Resolution Configuration", to query and set the resolution of the laser.
3. "Phase Lock", query and set the phase of the laser.
4. " Scan Start Angle Setting ", query and set the start angle of the laser point cloud output .
5. " Echo Mode ", query and set the echo mode of the laser , currently supports 6 modes .
6. actual pitch angle of each channel of the laser .
7. "Filter Configuration ", to query and set whether bilateral filtering is enabled.



6.6 Firmware update





Figure 17 Program update

1. Before updating the program, make sure that the value of the advanced property "Speed and Duplex" of the network card connected to the radar is: 100Mbps full duplex. The specific steps are: ①Click to change adapter options; ②Right-click Ethernet and click Properties; ③Click Configure, select "Advanced", find "Speed and Duplex" in the property list on the left, and select the value on the right to "100Mbps" full duplex".
2. Click the file selection to find the location where the corresponding program is placed.
3. Click Program Update and wait for the program to update.

6.7 Point Cloud Recording

Click the point cloud recording button . When  the button shape changes , it means start recording. When recording is not needed, click the button again to end the point cloud recording. The recorded point cloud is saved in the record folder of the installation package.

6.8 Point cloud playback

1. Click  to select the recorded point cloud file. After the data is loaded, click  to play the point cloud normally .
2. Point cloud play button and description







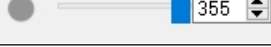

button	illustrate
	Jump to the beginning of the file
	When paused, view the previous frame
	After the point cloud file is loaded, click to start playing, and click to pause during playback
	When paused, look at the next frame
	Jump to end of file
	Loop a point cloud file
	Drag the progress bar or enter the frame number to jump to the specified position

Table 12 Point cloud play buttons and descriptions

6.9 Point selection function

After clicking the selection button , hold down the left button to select the target area, then click the data table, click the button of "only display selected elements" in the data table, you can see the data of the selected area .

Appendix A Mechanical Installation

Mounting holes are reserved at the rear of the WLR-720. Please use 4×M4 screws 4-5mm beyond the mounting surface to fix the lidar. An optional mounting base is available to complete the installation of the WLR-720. Figure 18 is the external dimension drawing and installation hole map of WLR-720:

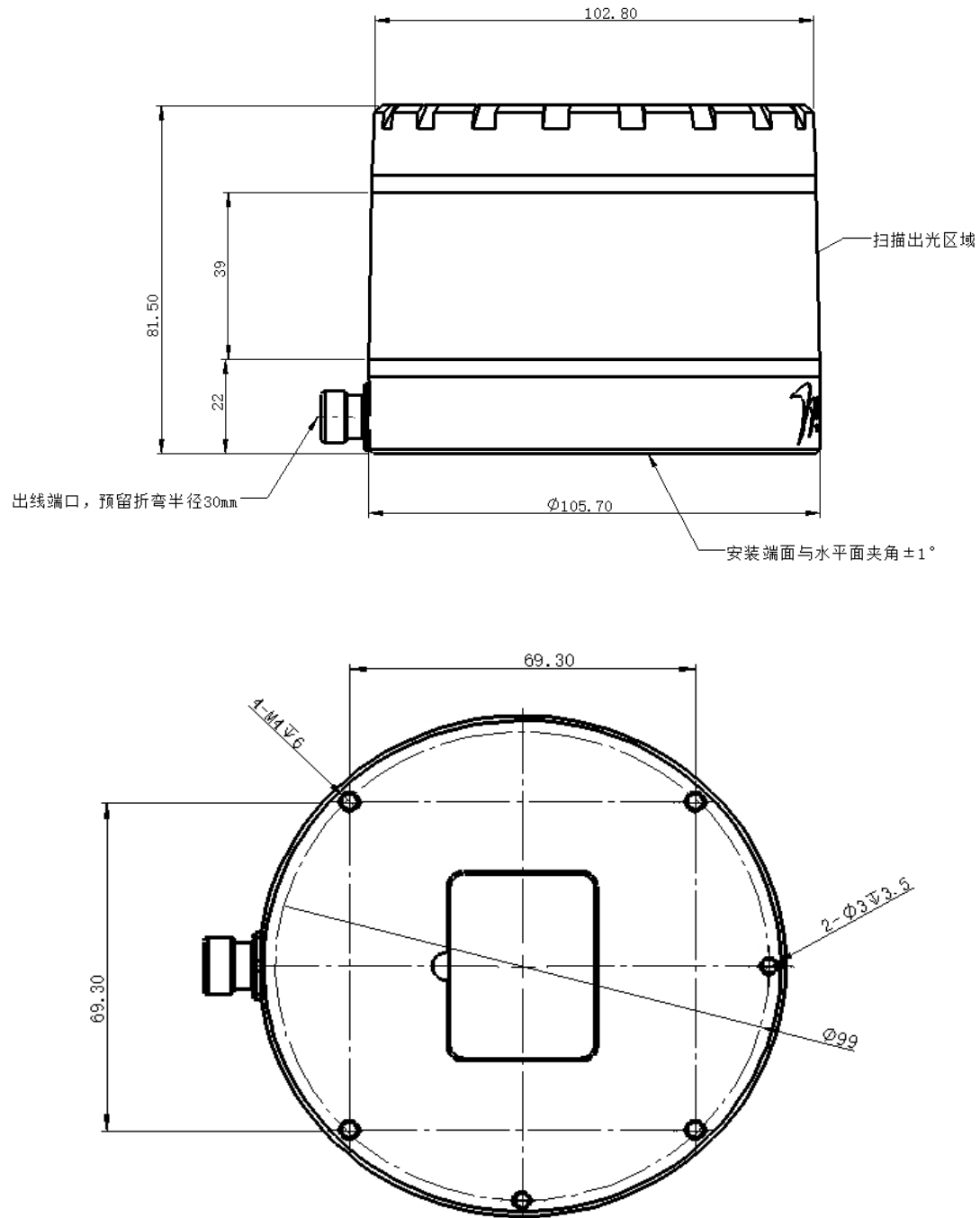
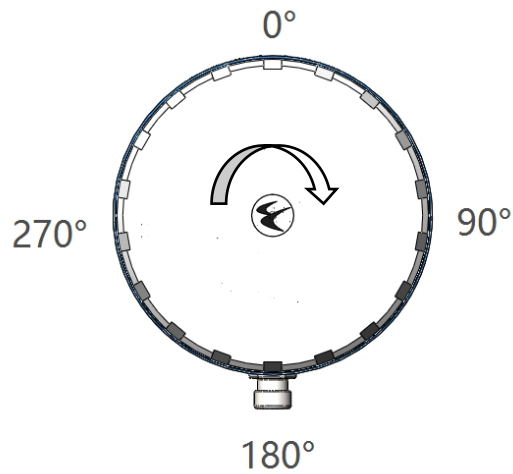
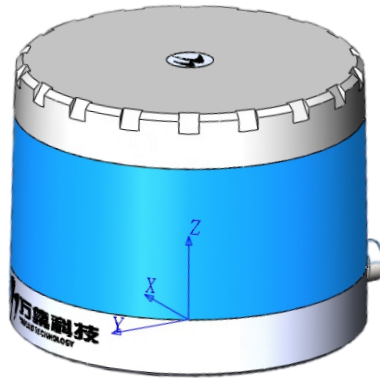
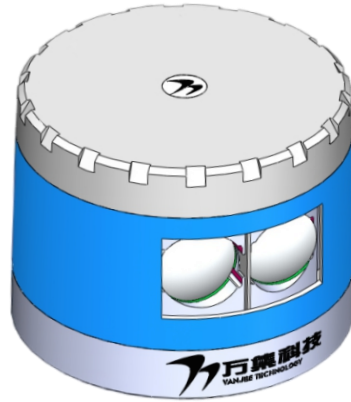


Figure 18 Appearance size and installation hole map

Notes :

1. The angle between the installation end face and the horizontal is $\pm 1^\circ$
2. The reserved bending radius of the outlet port is 30mm
3. Please do not block the scanning light area when the lidar is working

Appendix B Structure Description



Appendix C Troubleshooting

If the following steps cannot be implemented, or the problem is not resolved after implementation, please contact VanJee Technology for technical support .

fault phenomenon	analyze	measure
radar not working	1) power supply problem 2) Internal fault	1) Check the power supply wiring to ensure that the input voltage and current meet the requirements of " 2.3 Electrical Connection" 2) Please contact VanJee after-sales service in time
Radar works but no point cloud display	network failure	1) Make sure the network cable is connected properly; Make sure the IP address is the same as the machine; 2) Turn off the network firewall, or add VanjeeView to the whitelist;
abnormal packet size	1) Packet loss during data transfer 2) Radar internal parameters are abnormal	1) Check the network cable, connect the computer to only one lidar 2) Please contact VanJee after-sales service in time
missing point cloud	1) Packet loss during data transfer 2) Insufficient data processing performance 3) The motor code disc is abnormal	1) Check the network cable and connect the computer to only one lidar 2) Replace the computer with the required performance 3) Please contact VanJee after-sales service in time

Appendix D After Sales Service

■ After-sales service

This product enjoys the stipulated free warranty service within 12 months or the date agreed in the contract from the date of purchase. If the product is damaged or unusable due to non-human factors or product quality problems during the warranty period, please contact VanJee Technology in time and provide the purchase receipt, and the relevant service personnel will repair your product for free; disassembled by the user ;

After the expiration of the warranty period, the relevant service personnel of VanJee Technology are also responsible for the maintenance of product failure, damage and other problems, but the material cost of maintenance and replacement of components shall be charged;

After the warranty period expires, the relevant service personnel of VanJee Technology will still provide users with free service to answer questions, including consulting services such as purchase guidance , usage methods, and product installation.

If you encounter problems that cannot be solved by the instructions, please contact the sales staff or through the following methods:

sales email : wanliyun@vanjee.net

Head Office Service Hotline: +86 (010) 59766766