

MS200k dToF 2D LiDAR(SR)

User Manual



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ORADAR

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Safety Guidelines

1. Do not disassemble or modify the product without authorization so as to prevent product damage or radiation exposure.
2. Do not fall or hit the product, otherwise, the internal components of the product may be damaged, resulting in abnormal work.
3. Please carefully check the power supply demand of the product, and the excess power supply may cause permanent damage to the product.
4. Do not scrape the optical cover, and keep the optical cover clean, otherwise, the product performance may be affected.
5. The product is classified as class 1 laser product (IEC / EN 60825-1:2014), which is safe under all normal use conditions, but do not look directly at the laser transmitter

through the amplification equipment.

6. The product is not waterproof, do not let the product contact with any liquid or use any liquid with cleaning function to clean it.
7. It is strictly prohibited to use or store products in flammable, explosive or corrosive environments to void product damage.

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1. Product Overview

Product Profile

MS200k is a low-cost, single-line high-precision LiDAR sensor launched by Shenzhen Oradar Technology Co., LTD. The LiDAR adopts precise optical scanning system, combined with high frequency laser pulse generation technology and exquisite structural design, and can achieve fast and accurate distance measurement in the range of 360°/12.0m (@90% reflectivity diffuse reflector surface).

This product can be widely used in, including home sweeping robot, service robot navigation and obstacle avoidance, robot ROS teaching, research, regional security, scanning and 3D reconstruction and many other areas.

Working Principle

The measurement principle is the direct time of flight method (Direct Time of Flight, dToF). The distance measurement formula is:

$$d = \frac{ct}{2}$$

Where d denotes the distance, c denotes the speed of light, and t denotes the time of flight. When the ranging module works, the laser transmitter sends out a laser pulse, which is projected onto the surface of the object and reflected. The SPAD chip receives the reflected light and accurately calculates the distance from the target object to the LiDAR by measuring the flight time of the laser beam in the air. Through the built-in brushless motor, the distance is measured at different angles by rotating the ranging module, thus scanning to obtain the point cloud outline of the surrounding environment.

Product Features

Long range measurement: Integrated with a variety of telemetry optimization algorithms, 90% reflectivity range of up to 12.0m, effectively improve the efficiency of map building.

High accuracy: Compared with the triangulation principle-based LiDAR, MS200k adopts dToF ranging principle to measured distance without accuracy& precision degradation with increasing distance.

Ultra-small size: 54.3*47*35.0mm (L*W*H), which can be built into the robot body to optimize the space utilization inside the robot.

Resistant to dust and dirt: Based on the unique time-correlated single-photon counting ranging technology, it effectively enhances the dust and dirt resistance of the optical cover, and is not afraid of slight dust accumulation.

2. Specifications

Table 2-1 MS200k Specifications

Product model	MS200k		Description
Product name	dToF 2D LiDAR		
Measurement range	0.03m~12.0m		@90% reflectivity
Measurement accuracy	Typical	±10mm [0.03m~2.0m] ±20mm [2.0m~12.0m]	The statistical results of at least 100 data acquisitions by LiDAR at 90% reflectivity conditions. Accuracy is the difference between the mean and true value of the data, and precision is the sample standard deviation of the data (1σ)
	Max	±20mm [0.03m~2.0m] ±30mm [2.0m~12.0m]	
Measurement precision	Typical	4mm [0.03m~2.0m] 15mm [2.0m~12.0m]	
	Max	10mm [0.03m~2.0m] 30mm [2.0m~12.0m]	
Data contents	Distance, angle, intensity, timestamp		-
FOV (horizontal)	360°		-
Measurement frequency	4,500points/s		-
Frame rate	7Hz~15Hz		Default 10Hz
Resolution (horizontal)	0.8°		10Hz rotational speed
Pitch angle of laser emission	0.5°~2°		The bottom surface of the outer frame of the LiDAR base is the reference
Laser emission azimuth	0°±2°		-
Laser wavelength	905nm±10nm		-
Laser Class	Class 1 (IEC60825-1:2014)		-
Ambient	40,000 Lux		-

illuminance		
Working life	$\geq 10,000\text{h}$	-
Voltage supply range	DC 5.0V $\pm$ 0.3V	-
Voltage supply ripple	$<100\text{mV}$	Voltage Ripple Corresponding to the Operating Power Supply
Peak Power Consumption	2.5W	For reference only, there may be individual differences in actual use.
Average Power Consumption	1.6W	
Operating temperature	-10°C~50°C	-
Storage temperature	-30°C~70°C	-
Dimensions	54.3*47*35.0	Long*width*height(mm)
Weight	~45g	The overall weight of the unit may vary slightly due to the counterbalance
Certification	RoHS2.0, REACH, CE, FCC	

ⓘ LiDAR is a type of precision optoelectronic sensor, and its performance test results are related to factors such as temperature, humidity, vibration, ambient light, and the method of installation. There is a certain extent of performance degradation in harsh environments. Please pay attention to protection during use and operate according to the guidance provided by technical support personnel.

3. Electrical Interface

Interface Definition

The MS200k uses a standard 4-pin 1.5mm pitch female chassis interface, which is equipped with system power and data communication functions:

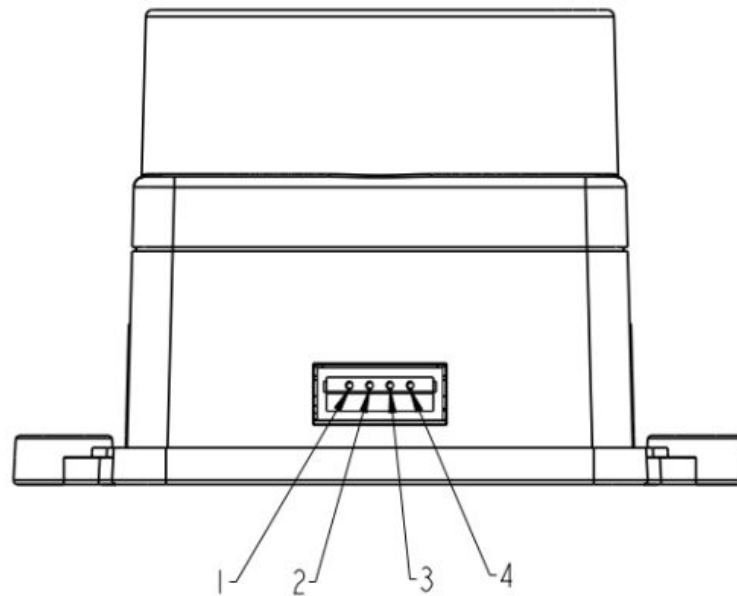


Figure 3-1 Oradar MS200k interface

Table 3-1 Interface wire sequence

Pin	Signal	Properties	Description
1	Tx	Serial data sending	Tx (Local sending, 0V~3.3V)
2	Rx	Serial data receiving	Rx (Local receiving, 0V~3.3V)
3	GND	Input power negative	GND (0V)
4	VCC	Input power positive	DC 5.0V (4.7V~5.3V)

Serial Port Configuration

The MS200K communicates with the outside in both directions through the UART serial port. The serial port configuration parameters are set as shown in the following table:

Table 3-2 Serial port configuration parameters

Baud rate (bps)	Data bit	Stop bit	Check bit	Flow control
230400	8	1	None	None

⚠ When the user leaves pin 2 (RX) floating or sets it to a fixed logic level (0/3.3V), it does not affect the normal operation of the LiDAR. However, the LiDAR will not have bidirectional communication capabilities, and the user will not be able to send down setting/query commands.

4. Mechanical Interface

Mechanical Dimension

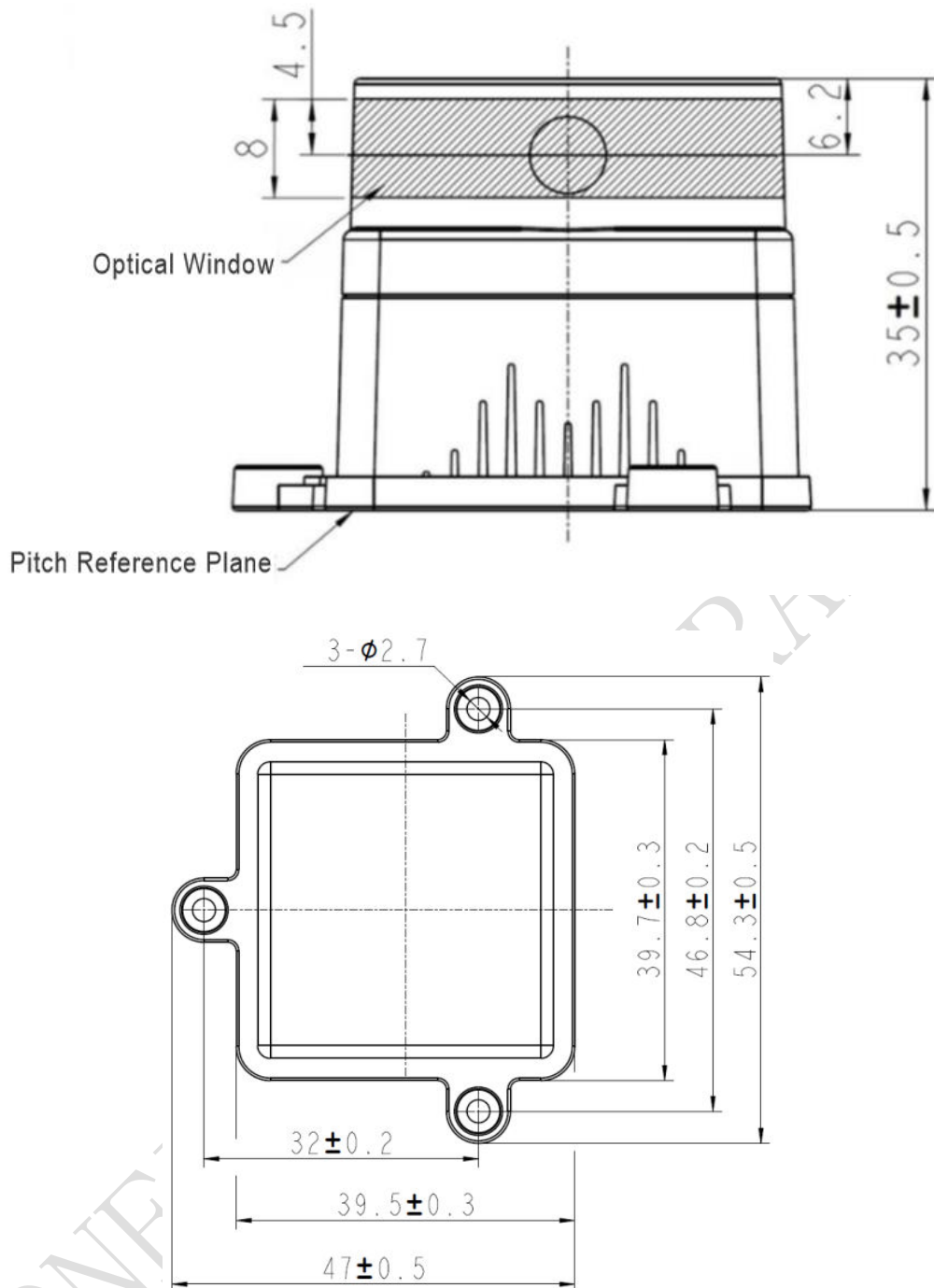


Figure 4-1 Oradar MS200k mechanical structure

⚠ Please do not obstruct the optical window during installation, and consider the pitch angle range of the laser emission for the design to avoid any obstructions, as they may affect the ranging performance. You may contact your technical support personnel to obtain the 3D model of the space range required for the emission of the LiDAR.

Polar Coordinate System

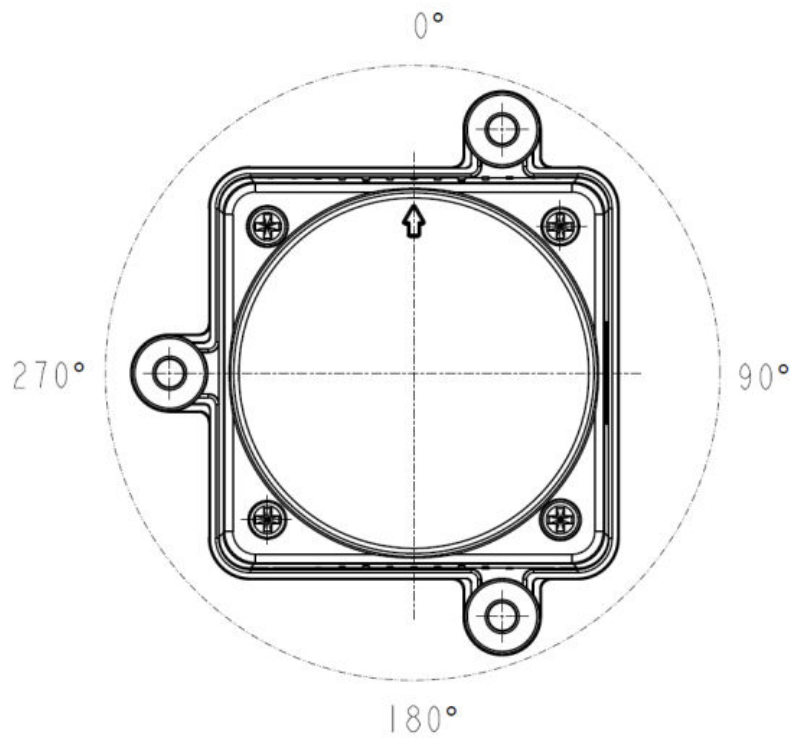


Figure 4-2 Oradar MS200k polar coordinate system

The angular information output within the MS200k product protocol is defined by the polar coordinate system within the LiDAR.

As shown in the mechanical structure diagram, the top of the LiDAR optical housing is marked in the zero-degree angle direction and the angle rotation direction is clockwise.

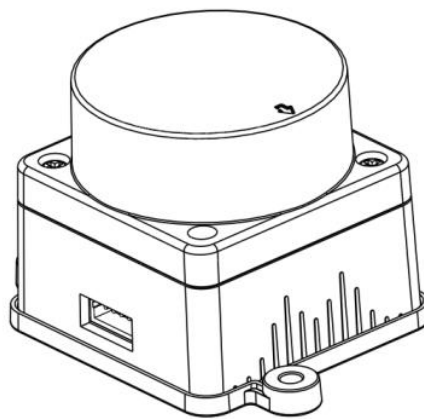


Figure 4-3 Oradar MS200k zero angle identification

The overall orientation diagram is shown above. According to the definition of the polar coordinate system, the zero-degree angle is the $\uparrow$ marking direction of the top of the outer cover, and the LiDAR external interface socket is located at 90°

⚠ Due to production assembly tolerances, there is a tolerance of $\pm 2^\circ$ in the azimuth of the laser's zero-degree exit

5. Working Mode

Oradar MS200k system is set up with 2 working modes: ranging mode and standby mode.

Ranging mode: The LiDAR is successfully initialized and enters into normal ranging operation.

Standby mode: The LiDAR is successfully initialized, but no laser beam is emitted, and the system enters a low-power state. In other words, the system stops ranging and the serial port stops data transmission.

System Workflow

After the LiDAR is powered on and initialized, it defaults to the ranging mode. At the same time, the LiDAR can be controlled to switch between standby mode and ranging mode by sending control commands to it.

Data Format

The Oradar MS200k data protocol is divided into three categories: point cloud data protocol, LiDAR information protocol, and set/get command protocol. All data protocols are transmitted in little-endian hexadecimal format, and the data types are all unsigned integers. For specific details of the data protocols, please refer to the following description.

Point Cloud Data Format

When the LiDAR is in ranging mode, it does not need to interact with the host computer and continuously outputs the measured point cloud data, which includes distance, angle, target reflectivity, rotation speed information, and timestamp. The format of the point cloud data protocol is as follows:

Table 5-11 Oradar MS200k data format

Offset (Byte)	Length (Byte)	Field	Description
0	1	Frame header identification	Takes the value 0x54 to mark the starting position of the data frame
1	1	The number of	Length 1 Byte, the high three bits are

		points in a data packet.	reserved, the low five bits indicate the number of measurement points of a packet, currently fixed at 12
2	2	Speed	Current rotation speed in °/s
4	2	Start angle	Point cloud starting angle in 0.01 °
6	3*N	Point cloud info	Point cloud information data block
6+3*N	2	End angle	Point cloud end angle in 0.01 °
8+3*N	2	Time stamp	0~29999ms, and then resets to 0 and starts counting again after reaching 29999. The timestamp corresponds to the first point of each data packet
10+3*N	1	Check bit	The CRC-8 checksum of all previous bytes

The point cloud information contains the distance and intensity information from the first point of the starting angle measurement to the nth point of the ending angle measurement in sequence. Currently, N is fixed to 12. Each point information is represented by 3 bytes and the nth point data format is shown as follows:

Table 5-2 Point cloud data format

Offset (Byte)	Length (Byte)	Field	Description
6+3*(n-1)	2	Distance	Unit is 1mm
8+3*(n-1)	1	Intensity	Rang is 0~255

The intensity indicates the intensity of the laser pulse echo, and the larger the value, the higher the confidence of the range measurement, and the smaller the value, the lower the confidence. The intensity values from 0 to 15 are reserved and indicate invalid ranging values, with the ranging value set to 0mm in these cases.

The angle value of each point in the point cloud information can be obtained by linear interpolation of the starting and ending angles. The calculation method is:

```

1 step = (theta_end - theta_start) / (N - 1)
2 theta_n = theta_start + n * step;
```

LiDAR Information Format

LiDAR automatically reports relevant information through the serial port, as follows:

The SN Code Data Format

After MS200k is powered on or transitions from standby mode to ranging mode, it automatically reports its Serial Number (SN) once, The data format is as follows:

Table 5-2 MS200k SN code data format

Offset (Byte)	Length (Byte)	Field	Description
0	2	Frame header identification	Takes the value 0x55AA to mark the starting position of the data frame
2	1	Flag bit	Fixed to 0x01, indicating that the current message is a SN code
3	1	Data length	Thereafter, the length of the data excluding the check and the end of the frame, N
4	N	SN code info	The SN code corresponds to an array of ASCII characters, such as: CF3P525002F
4+N	1	Check Bit	The CRC-8 checksum of all previous bytes
5+N	2	Frame tail	Takes the value 0xF231 to mark the end of the data frame

Note: The SN information character array does not end with a null character '\0'.

Set/Get Command Format

By sending Set/Get commands to the LiDAR through the serial port, you can set and query the operational status of the LiDAR. The Set/Query commands are part of the LiDAR's interactive command protocol, which is initiated by the host computer actively sending commands to the LiDAR. Upon receiving the commands, the LiDAR responds. The format for the interactive commands of the Oradar MS200k is as follows:

Table 5-3 Interactive Command Format Description

Offset (Byte)	Length (Byte)	Field	Description
0	2	Frame header identification	Takes the value 0xF5A5 to mark the starting position of the data frame
2	1	Command Code	Each command code represents an

			interactive command.		
3	1	Operation Code		Host Computer Issues	LiDAR Responds
			Set	0xC1	0xC2
			Get	0xC3	0xC4
4	1	Command Length N	The length of the command parameters		
5	N	Command Parameters	Interactive Parameters	Command	Corresponding
5+N	1	Check Bit	Single-Byte XOR (BCC) Check of All Previous Bytes		
6+N	1	Frame End	Takes the value 0xF231, Indicates the End Position of the Command Data Frame		

Set Working Mode Command

The command code for setting the working mode is '0xA2', with the operation code type corresponding to 'Set'. The host computer sends a command to the LiDAR, where the command parameter '0x80' indicates setting the LiDAR to standby mode, and '0x81' indicates setting it to ranging mode. An example of a command is: 'A5 F5 A2 C1 01 80 B2 31 F2', which signifies setting the LiDAR to standby mode.

Upon receiving the command, the LiDAR sends a corresponding response to the host computer. The command parameter '0xE1' indicates that the working mode has been set successfully, while '0xE2' indicates that the received command parameter is illegal and the switch has failed. An example of a response command is: 'A5 F5 A2 C2 01 E1 D0 31 F2', which confirms that the LiDAR's working mode has been set successfully.

Get Working Mode Command

The command code for the 'Get Working Mode Command' is '0xA2', with the operation code type corresponding to 'Get'. The host computer sends a command to the LiDAR with no command parameters, as in the example: 'A5 F5 A2 C3 00 31 31 F2'.

Upon receiving the command, the LiDAR responds to the host computer with a corresponding response command. The command parameter '0x80' indicates that the LiDAR is in standby mode, while '0x81' indicates that it is in ranging mode. An example of a response command is: 'A5 F5 A2 C4 01 80 B7 31 F2', which signifies that the LiDAR is

currently in standby mode.

Set Rotation Speed Command

The command code for the 'Set Rotation Speed Command' is '0xA1', with the operation code type corresponding to 'Set'.

The host computer sends a command to the LiDAR with a command length of 2 bytes. The first byte (Byte0) of the command parameters is the target rotation speed value in Hz, and the second byte (Byte1) is a reserved value set to 0. An example of a command is: 'A5 F5 A1 C1 02 0A 00 38 31 F2', which indicates setting the LiDAR's rotation speed to 10Hz.

After receiving the command, the LiDAR sends a corresponding response command to the host computer. The command parameter '0xE1' signifies that the rotation speed setting was successful, while '0xE2' indicates that the parameter is invalid. An example of a response command is: 'A5 F5 A2 C4 01 80 B7 31 F2', indicating that the setting was successful.

Get Rotation Speed Command

The command code for the 'Get Rotation Speed Command' is '0xA1', with the operation code type corresponding to 'Get'.

The host computer sends a command to the LiDAR with no command parameters, as in the example: 'A5 F5 A1 C3 00 32 31 F2'.

After receiving the command, the LiDAR sends a corresponding response command to the host computer. The first byte (Byte0) of the command parameters is the current set rotation speed value in Hz, and the second byte (Byte1) is a reserved value set to 0. An example of a response command is: 'A5 F5 A1 C4 02 0A 00 3D 31 F2', indicating that the LiDAR's current set rotation speed is 10Hz.

⚠ The Set/Get command protocol requires the LiDAR to have bidirectional communication capabilities, which means that pin 2 (RX) of the LiDAR must be correctly connected. Do not continuously issue commands; it is recommended that there be an interval of greater than 100 ms between commands.

6. Quick Start Guide

If you are a first-time user of the MS200k and wish to quickly evaluate the performance of the product, or wish to do secondary development based on the product, you can use the adapter board, Oradar Viewer software, SDK and ROS package provided by Oradar to quickly get started evaluating the performance of the MS200k and early development.

Device Connection

It is recommended to use the Oradar adapter board with a USB Type-C cable to connect the device to the PC.

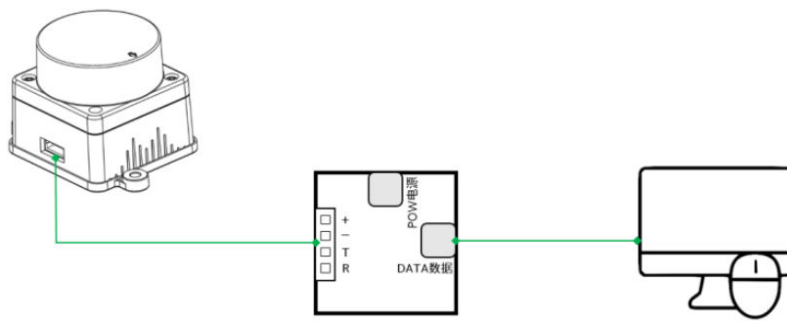


Figure 6-1 Device connection method

Connection steps:

- Connect the LiDAR to the adapter board using the 4pin power/signal cable;
- Use a USB Type-C cable to plug into the Data port of the adapter board and connect to a personal computer;
- Open Oradar Viewer on your personal PC to view LiDAR real-time point cloud data.

Oradar adapter board provides USB to UART function, integrated UART@500000/230400/115200, USB data and USB power interface. Some development platforms or personal computers with weak drive current can use the power interface of the adapter board to access DC 5V auxiliary power supply.



Figure 6-2 Oradar MS200k power adapter board

💡 The adapter board is not included as a standard accessory with the product. If needed, please purchase a matching kit. Before use, please install the corresponding adapter board driver provided by the technical support engineer.

Convenient Oradar Viewer

Oradar Viewer is a software that can display, record and analyze point clouds in real time. It is convenient for users to evaluate the performance, and with the development kit to observe the point cloud data scanned in the environment on the PC.

Oradar Viewer currently supports Windows 10 (64-bit) operating system. Unzip the file and open the program with the file name MS200Viewer in the extracted file to use it. Connect the device as Figure 6-1.

Software Development Kit: Oradar SDK

In addition to the above-mentioned Oradar Viewer for viewing real-time point cloud data, users can also apply the LiDAR acquired point cloud data to various custom scenarios through the software development kit. The Oradar SDK supports development in Windows/Linux environments and is available as a ROS/ROS2 package.

💡 Please contact your technical support engineer for Oradar SDK and related usage.

Special scenario usage descriptions.

MS200k is designed based on a home usage environment, which means the space is not too large and relatively mild. If there are the following scenarios, there may be potential risks. Please assess according to the actual situation or consult with Oradar personnel:

1. **Narrow installation space:** To avoid the laser from irradiating the ground when installed at a low position, the LiDAR has a Pitch angle of $0.5^{\circ} \sim 2^{\circ}$. If the installation space is narrow, it may cause the laser to irradiate external structures, forming noise points, which can affect actual use and judgment. It is recommended to design the external structure according to the 3D drawings with light path range.
2. **Spacious spaces with high reflectivity materials:** Due to chip design limitations, the maximum effective distance supported by the LiDAR is about 30 meters. When there are too many glass and high-reflectivity targets beyond this distance, it will interfere with the LiDAR's distance measurement judgment, forming point clouds across periods at close range.

3. **Excessive ambient light:** When the ambient light exceeds 40,000 lux, it will interfere with the accuracy of the LiDAR's distance measurement to varying degrees and produce noise points. If excessive light shines directly on the optical cover, it can even interfere with the encoder, disrupting angle data.
4. **Other high-power laser sources:** Due to the inherent characteristics of SPAD chips, when the operating site contains other high-power laser sources with wavelengths close to that of the MS200k, and the laser directly irradiates the SPAD chip of the MS200k, it can cause damage to the chip. If there is a need to use the MS200k in conjunction with other high-power laser equipment, it should be ensured that the use scenarios do not involve direct line-of-sight exposure between the MS200k and the other lasers, or that a certain height difference is maintained between them.

Please consider these factors when deploying the MS200k in various environments and seek advice from Oradar personnel if necessary to ensure the safety and reliability of the device

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7. Change History

Version	Edited by	Approved by	Date	Description
A1	Bulaien	Ziliu	2024-04-26	First release
A2	Bulaien	Weide	2024-06-27	Add descriptions for some risk scenarios

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Relying on orbbec technology group's strong technical backing and advanced manufacturing platform, the company provides LiDAR sensor service solutions for consumer robots, commercial robots, industrial robots, warehousing and logistics, surveying and mapping, and many other industry scenarios. With the mission of "making autonomous mobile terminals smarter and safer", Oradar is committed to building the world's leading LiDAR sensor solutions and promoting the development of robot intelligence.

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