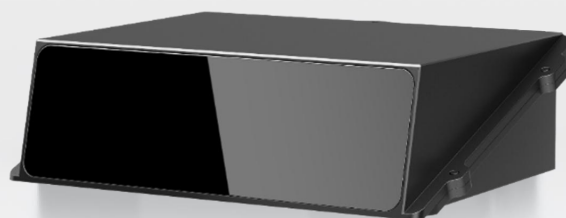




EM4

User Manual



Smart Sensor, Safer World

Manual Version V1.1.0

Change Notes

Version	Revision Date	Changes	edit
1.0.0	2024/12/14	Initial release	PD

Reading Tips

Explanation of symbols

-  Warning: The use process should be strictly followed, otherwise it may cause minor injuries or property losses and other potential dangerous situations;
-  Important: The usage process should be followed, otherwise it may cause potential harmful conditions such as product damage;
-  Tip: Pay enough attention to the usage process to maximize the value of the product efficiently and smoothly.

Resource Download

Please click the following links to download the latest product manuals, RSview and other resources: <https://www.robosense.cn/resources-114>

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1 Safety Tips

1.1 Legal Notice

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 The words and/or logos such as "RoboSense" and "RoboSense", as well as other logos, product and service names, are proprietary to RoboSense. For any use, including publicity and display, you must obtain RoboSense's prior written authorization.

1.2 Usage Guidelines

 Please use this product in accordance with the following requirements:

- 1) Strictly comply with national laser safety laws and regulations;
- 2) Please read this product manual carefully before using the product;
- 3) Use this product within its intended use area;
- 4) Avoid using this product in explosive, highly corrosive environments, or environments exceeding the product's IP rating.

1.3 Illegal operations

 Please use this product in accordance with the specified instructions. Failure to do so may result in product damage, property loss, or personal injury. Any violations of these regulations are at the user's own risk.

- 1) Do not disassemble or modify this product (including its accessories) without authorization.
- 2) Do not use any power supply or accessories other than those specified.
- 3) Avoid any abnormal operation, such as dropping, collision, or burning.

- 4) If you notice any damage to the product, please stop using it immediately and contact RoboSense immediately.
- 5) If you notice any abnormalities in the product's operation, please stop using it immediately and contact RoboSense immediately.

1.4 Operator requirements

 The use of this product requires basic professional knowledge and other relevant qualifications. RoboSense assumes no liability for any damage, injury, or loss to the product, personnel, or property caused by improper operation by untrained and uninformed personnel.

- 1) Please read this manual carefully before using the product.
- 2) Do not operate in violation of regulations.
- 3) Receive training and possess relevant qualifications before starting this operation.
- 4) Have basic knowledge of computer data connections, electrical engineering, and other related topics.

1.5 Work safety and special hazards

 Before using this product, please carefully read and follow the instructions and specifications in this manual to avoid accidents to the user or others, damage to the product, and violation of the warranty.

- 1) Laser Safety: The laser safety level of this product complies with the IEC 60825-1:2014 standard:



- 2) High temperature warning: Pay attention to the overheating mark on the surface to prevent accidents



- 3) Retention Instructions: Please retain all safety and operating instructions for future reference.
- 4) Heed Warnings: Please follow all warnings on the product and in the operating instructions to avoid accidents.
- 5) Product Repair: Do not attempt to open the product for repair without official instructions. If repair is required, please contact RoboSense immediately.

2 Product Description

⚠ The following content describes the status and functions of the EM4-B0 prototype. The product manual will be updated to the latest status when new versions of the prototype are released.

2.1 Product Overview

The EM4 is a high-performance automotive-grade LiDAR with a maximum detection range of 300 meters and a full-area resolution of 0.1° (H) x 0.05° (V).

2.2 Product Structure

The EM4 structure diagram is shown in Figure 1.

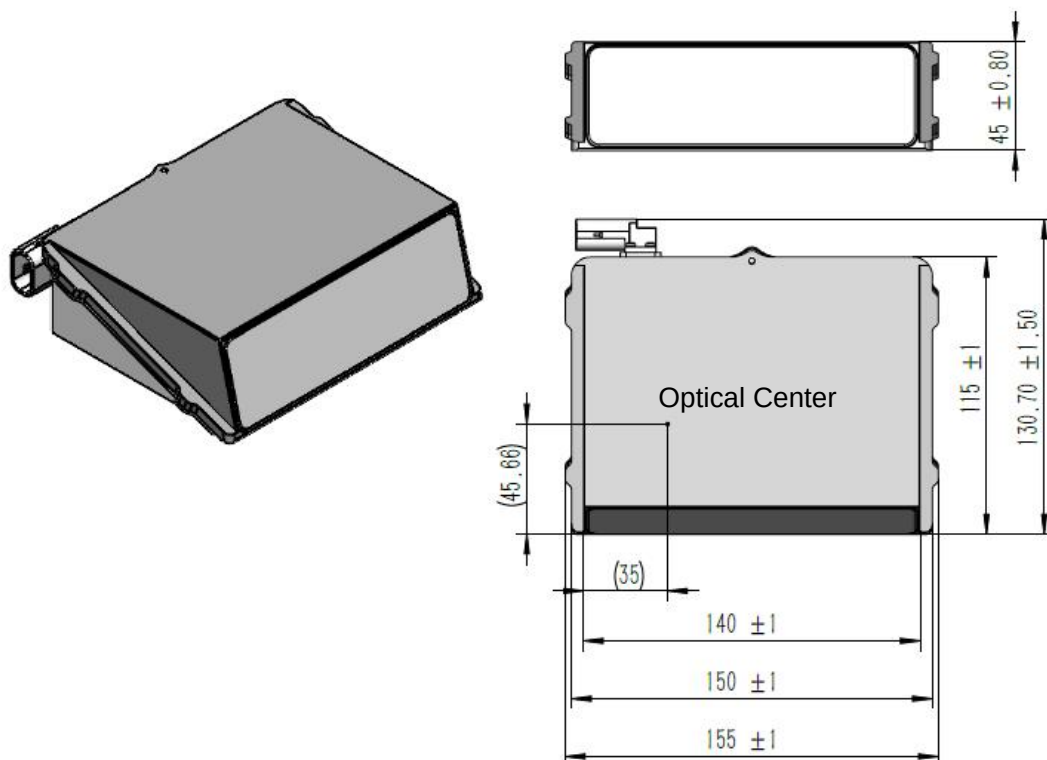


Figure 1 Product structure diagram

2.3 FOV distribution

The FOV distribution of EM4 is shown in Table 1 below.

Table 1 EM4 FOV

Specification	Horizontal direction	vertical direction
25° FOV	-60° ~ +60°	-12.5° ~ +12.5°

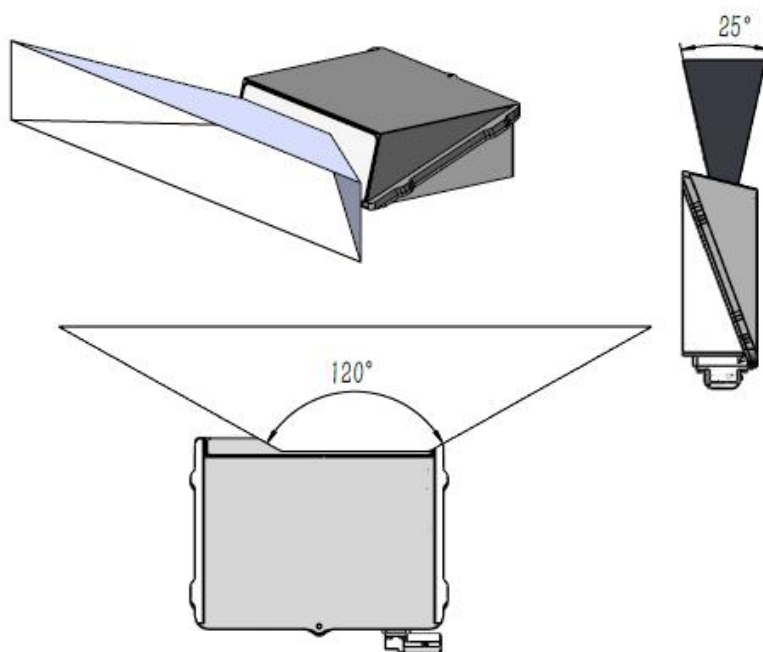


Figure 2 EM4FOV schematic diagram

2.4 Specifications

Table 2 Related parameters and specifications

Sensor			
Ranging capability	300m @10% NIST ¹ , 100klux	Accuracy (Typical values)	$\pm 5 \text{ cm}@1\sigma$
Horizontal field of view	120° (-60° ~ +60°)	Horizontal angular resolution	$\sim 0.1^\circ$
Vertical field of view	25° (-12.5° ~ +12.5°)	Vertical angular resolution	$\sim 0.05^\circ$

1. Ranging capability is based on a 10% NIST diffuse reflectance plate as the target. Test results are affected by environmental factors, including but not limited to ambient temperature and light intensity.

2. Ranging accuracy is based on a 90% NIST diffuse reflectance plate as the target. Test results are affected by environmental factors, including but not limited to ambient temperature and target distance.

Output			
Out of points	6,000,000pts/s(Single echo mode)		
Ethernet output	1000Base-T1		
Output data protocol	UDP		
LiDAR data package contents	3D space coordinates, reflection intensity, timestamp, etc.		
Mechanical/electronic operation			
Operating voltage	12V（9V~16VDC）	Size	D 100mm*W 140mm*H 45mm（B0 prototype）
Product power	16W（Typical values）	Operating temperature	-40℃ ～ +85℃
weight	<1000g	Storage temperature	-40℃ ～ +105℃
Time synchronization	gPTP	Protection level	IP67/IP6K9K
Frame rate	10 Hz	blind spot	1m

Table 2 (Continued)

2.5 Time synchronization method

EM4 currently supports gPTP (IEEE802.1AS protocol) synchronization. If you have special requirements, please contact RoboSense.

2.5.1 gPTP synchronization principle

gPTP(generalPreciseTimeProtocol, IEEE802.1AS protocol) is PTP in time-sensitive network

gPTP is a derivative of Time-Sensitive Networking (PTP). Its synchronization mechanism uses the same peer-to-peer delay mechanism as PTP and utilizes Ethernet Layer 2 communication. Unlike PTP, gPTP requires hardware timestamping, placing strict requirements on switches and master clocks, which must comply with the IEEE 802.1AS protocol.

2.5.2 gPTP wiring method

To use gPTP synchronization, you need the following:

- 1) gPTP Master timing host (plug-and-play, no additional configuration required);

3. Product power consumption test results may be affected by external factors, including but not limited to ambient temperature, target distance, and target reflectivity.

4. Product operating temperature may be affected by external factors, including but not limited to lighting conditions and airflow.

- 2) Ethernet switch;
- 3) Device waiting for timing that supports the gPTP protocol.



Notes

1) The Master timing device is a third-party device and is not included with RoboSense shipments. Users must purchase this accessory.

2) As a slave device, the RoboSense product only obtains the time sent by the master and does not judge the accuracy of the master's clock source. If the time of parsing the lidar point cloud suddenly changes, please check whether the time provided by the master is accurate.

3) After the LiDAR is synchronized, the Master is disconnected and the time in the point cloud data packet is superimposed according to the LiDAR's internal clock. It will not be reset until the LiDAR is powered off and restarted.

3 Product Installation

3.1 LiDAR wiring and interface description

3.1.1 Automotive Ethernet harness interface and definition

The EM4 uses a two-in-one connector for vehicle Ethernet and power, and the supporting wiring harness is shown in Figure 3.

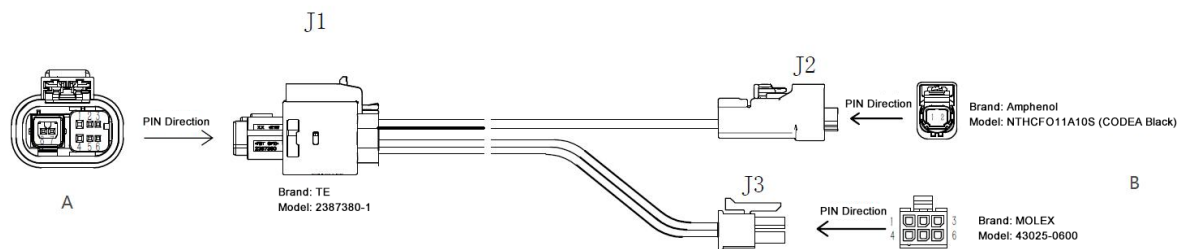


Figure 3 Vehicle Ethernet power harness

Table 3 shows the connector and pin definitions for the EM4 in-vehicle Ethernet power harness.

Table 3 Automotive Ethernet Power Harness Interface Definition

A-side line sequence		Definition	B-side line sequence	
J1 (TE 2387380-1)	1	GND	J3 (Molex 43025-0600)	1
	2	Wakeup		6
	3	/		3
	4	V_BAT (KL15)		2
	5	/		4
	6	/		5
	7	1000BASE-T1 N	J2 (Amphenol)	1

	8	1000BASE-T1 P	NTHCF011A10S)	2
--	---	---------------	---------------	---

3.1.2 Interface box interface

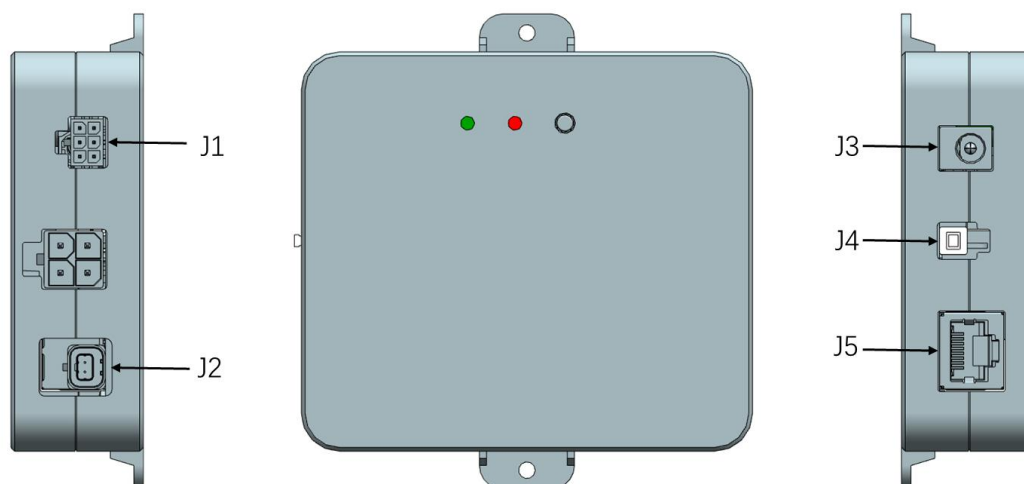


Figure 4 Schematic diagram of the interface box

The EM4 accessory interface box has a power indicator light and various interfaces, as shown in Figure 4, which can be connected to the power input and RJ45 network port.

Table 4 Interface box interface definition

Connectors	Interface	Illustrate
J1	Power wake-up signal	Power the radar and output a wake-up signal
J2	Ethernet	1000BASE-T1 automotive Ethernet interface
J3	DC Power Connectors	Power input
J4	Pushbutton switch	The wake-up signal controls the switch, and the wake-up signal is turned on when the switch is pressed
J5	RJ45	1000BASE-TX Industrial Ethernet

3.1.3 Power interface

The EM4 interface box uses a standard DC5.5-2.1 power connector.

When power is properly input, the green indicator light on the power box will remain on. If the green indicator light goes off, check the power supply.

Check whether the power input is normal. If the power input is normal, the interface box may be damaged. Please contact RoboSense.

3.1.4 RJ45 network port

The interface box only supports Gigabit Ethernet. When using the interface box, the network interface uses a standard RJ45 interface.

3.2 Quick Connect

The EM4 network parameters are configurable. The factory default is fixed IP and port number mode. For details, see Table 5.

Table 5 Factory default network configuration table

equipment	IP address	MSOP packet port number	DIFOP packet port number
EM4	192.168.1.200	6699	7788
computer	192.168.1.102		

When using the product, you need to set your computer's IP address to the same network segment as the product, for example, 192.168.1.x (x ranges from 1 to 254), with a subnet mask of 255.255.255.0. If you don't know the product's network configuration, connect to the product and use Wireshark to capture the output packets for analysis. The IP configuration and connection method are as follows.

1) Connecting the LiDAR: The connection method is shown in Figure 5.

- The LiDAR and interface box are connected via the vehicle's Ethernet power harness.
- The PC and interface box are connected via an RJ45 Ethernet connector using Gigabit Industrial Ethernet.
- After power is applied and the LiDAR interface box is operating normally, the green indicator light on the LiDAR interface box will remain on.

See Figure 5 for details on the indicator light locations.

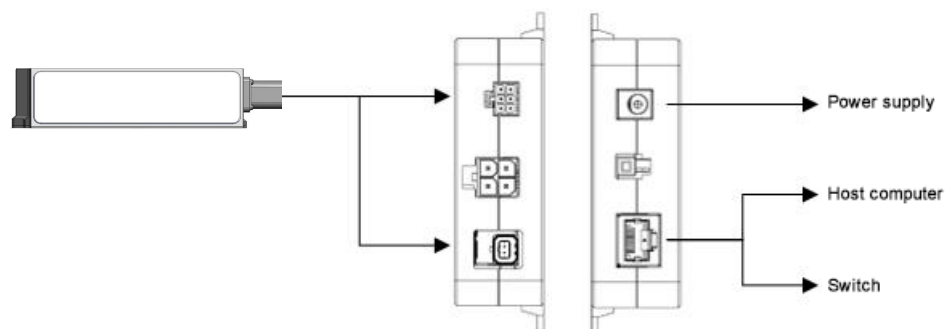
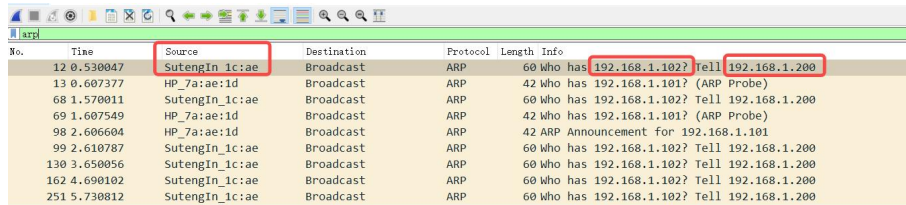


Figure 5 Interface Box Connection Diagram

2) Capture packets using Wireshark and parse ARP packets for local IP configuration.

- After the LiDAR is connected to the PC as described above, start Wireshark (a third-party network analysis tool), select the correct network port, and start packet capture;

b) Enter "ARP" in the search box of Wireshark to search for mutual addressing messages between the LiDAR and the PC, as shown in Figure 6;



No.	Time	Source	Destination	Protocol	Length	Info
12	0.530047	SutengIn_1c:ae	Broadcast	ARP	60	who has 192.168.1.102? Tell 192.168.1.200
13	0.607377	HP_7a:ae:1d	Broadcast	ARP	42	who has 192.168.1.101? (ARP Probe)
68	1.570011	SutengIn_1c:ae	Broadcast	ARP	60	who has 192.168.1.102? Tell 192.168.1.200
69	1.607549	HP_7a:ae:1d	Broadcast	ARP	42	who has 192.168.1.101? (ARP Probe)
98	2.606604	HP_7a:ae:1d	Broadcast	ARP	42	ARP Announcement for 192.168.1.101
99	2.610787	SutengIn_1c:ae	Broadcast	ARP	60	who has 192.168.1.102? Tell 192.168.1.200
130	3.650056	SutengIn_1c:ae	Broadcast	ARP	60	who has 192.168.1.102? Tell 192.168.1.200
162	4.690102	SutengIn_1c:ae	Broadcast	ARP	60	who has 192.168.1.102? Tell 192.168.1.200
251	5.730812	SutengIn_1c:ae	Broadcast	ARP	60	who has 192.168.1.102? Tell 192.168.1.200

Figure 6: Parsing ARP packets

c) As shown in step 6, the "SutengIn" column in the Source column indicates the lidar information source. 192.168.1.200 is the SourceIP, which is the lidar IP address. Then, requesting access to 192.168.1.102 is the PC IP address. If the local IP address is not the requested IP address, configure the PC's local IP address to 192.168.1.102. See step 3 for details. If access is successful, skip to step 4.

3) Configure the local IP of the PC

a) In the Control Panel, go to "Network and Internet" and enter "Network and Sharing Center". In "View active networks", click the corresponding Ethernet connection, enter the corresponding "Ethernet Status", and click "Properties";

b) Double-click Internet Protocol Version 4 (TCP/IPv4), enter the IP information settings, and configure using a static IP address.

c) Set the local IP address to 192.168.1.102 and the subnet mask to 255.255.255.0. Click "Confirm" to complete the static IP setting of the PC.

4) Connection completed



Tips:

- 1) The gPTP time synchronization module is not standard equipment. Please purchase it if you require this feature.
- 2) The above example of configuring a local static IP address is based on Windows. For other operating systems, please refer to the actual configuration.
- 3) The EM4 uses a static ARP table, sending ARP packets only after the radar is powered on and before it connects to the host computer. If the host computer is replaced after the radar and the host computer are communicating normally, the radar needs to be powered on again to communicate with the new host computer.

4 Product Usage

4.1 Product coordinate system

The vehicle coordinate system is shown in Figure 7.

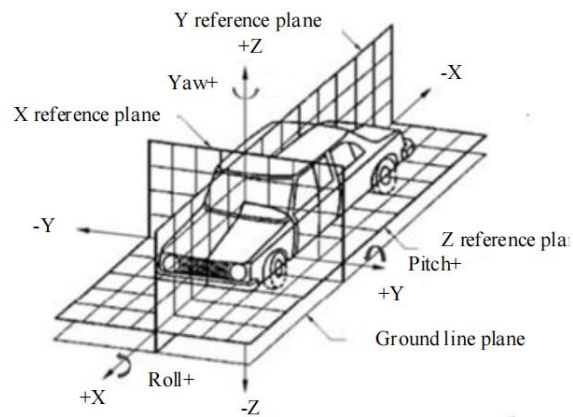


Figure 7 Schematic diagram of vehicle coordinates

The coordinate system of the product is shown in Figure 8.

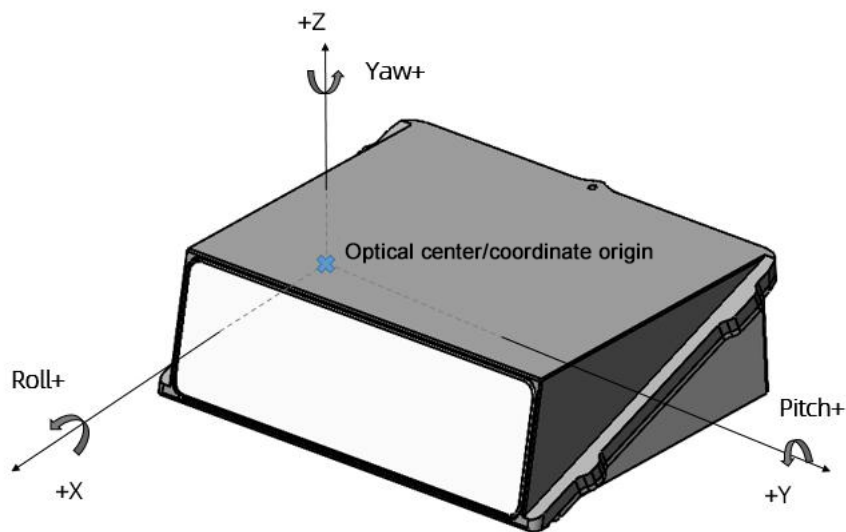


Figure 8 Schematic diagram of laser radar coordinates

4.2 RSView Usage

In terms of data visualization in EM4, free tools such as Wireshark and tcpdump can be used to capture raw data, while RSView can help users visualize raw data more conveniently.

4.2.1 Software Features

RSView provides real-time visualization of EM4 data. RSView can also play back data saved in .pcap file format, but currently does not support .pcapng format files.

RSView displays distance measurements obtained by the EM4 as a point cloud. It supports a variety of custom colors to display data such as reflection intensity, time, distance, horizontal angle, and laser beam number. Displayed data can be exported and saved in .csv format.

RSView includes the following features:

- 1) Real-time data display via Ethernet;
- 2) Record and save real-time data as PCAP files;
- 3) Play back recorded PCAP files;
- 4) Various visualization modes, such as distance, time, horizontal angle, etc.;
- 5) Display point data in a table;
- 6) Export point cloud data as a CSV file;
- 7) Measure distance tool;
- 8) Simultaneously display multiple frames of playback data;
- 9) Show or hide individual bundles (channels) in EM4;
- 10) Crop the display.

4.2.2 Installing RSView

RSView supports running on Windows 64-bit and Ubuntu 18.04 and above operating systems. Download the latest version of RSView software installation package: <http://www.robosense.cn/resources>

Please do not use Chinese characters in the decompression path of the software. The software does not need to be installed. You can use it normally by running the executable file after decompression.

4.2.3 Using RSView

After opening RSView, you can open the software user guide by pressing the F1 button on the software interface, or by clicking the RS-LiDAR User Guide in the Help option on the software menu bar.

4.3 Communication Protocol

Communication between the EM4 and the computer uses Ethernet, using the UDP protocol.

There are two types of outgoing packets: MSOP packets and DIFOP packets. All MSOP packets mentioned in this document have a fixed length of 1084 bytes, and all DIFOP packets have a fixed length of 1310 bytes. The EM4's network parameters can be configured by contacting technical support. By default, fixed IP and fixed destination port numbers are used.

The communication between EM4 and the computer uses Ethernet media and UDP protocol. The communication protocols between EM4 and the computer are mainly divided into two categories. See Table 6 for details.

Table 6 Product Agreement List

(Protocol/Package) Name	Abbreviation	Function	type	Package size	Number of sends per second
Main data Stream Output Protocol	MSOP	Scan data output	UDP	1084 bytes	24,000 times
Device Information Output Protocol	DIFOP	Product information output	UDP	1310 bytes	100times

 Tips

- 1) The Main Data Stream Output Protocol (MSOP) encapsulates and outputs information such as distance, angle, and reflection intensity from the LiDAR scan.
- 2) The Product Information Output Protocol (DIFOP) outputs various LiDAR configuration information.

4.3.1 Master Stream Output Protocol (MSOP)

Main Data Stream Output Protocol (MSOP). I/O Type: Product output, computer parsing.

The factory default port number is 6699.

The basic structure is shown below:

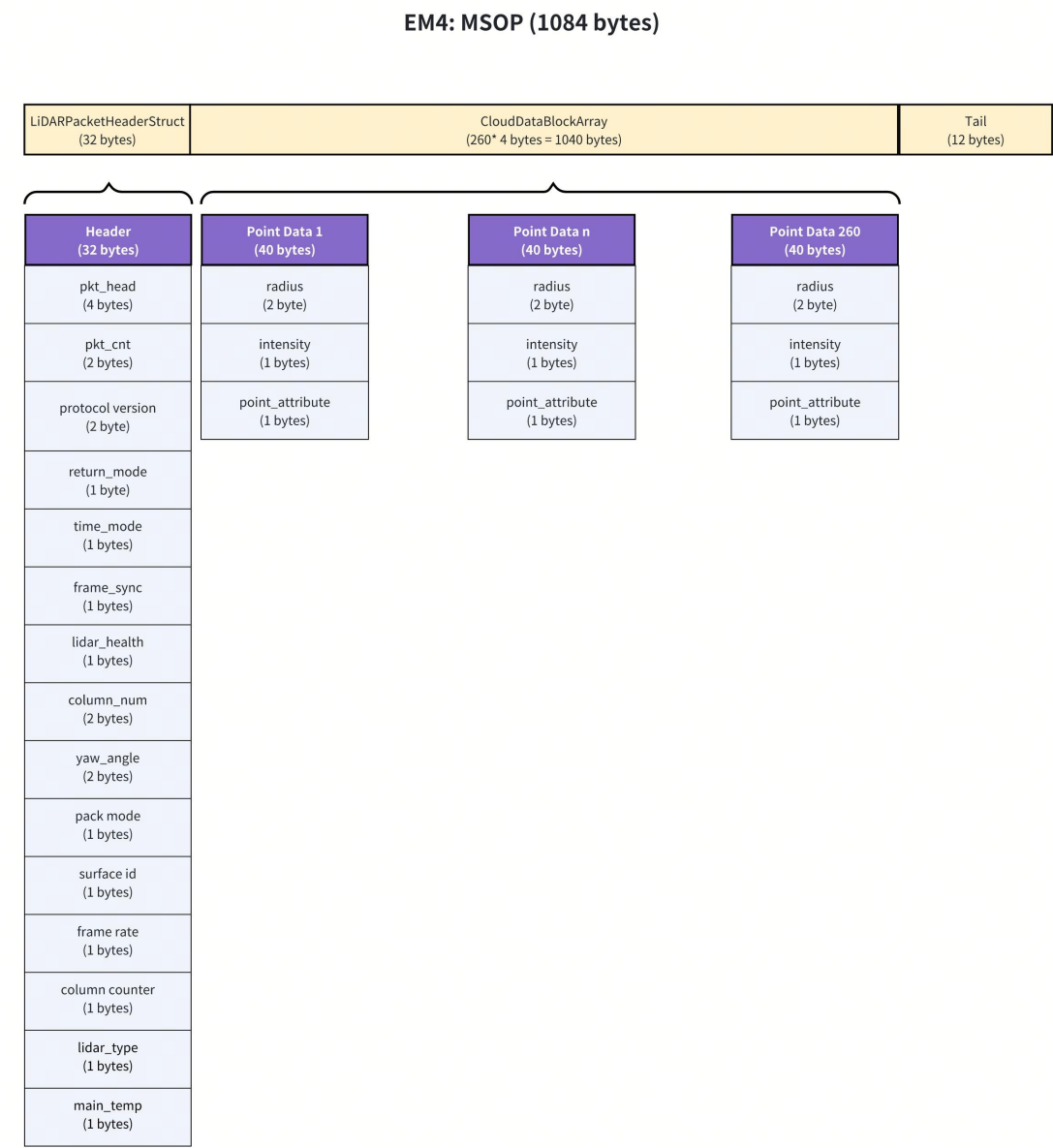


Figure 9 MSOPPacket data packet definition diagram

4.3.1.1 Frame Header

The frame header is 32 bytes long and is used to identify the start position of the data, packet count, UDP communication reservation, and store the timestamp. Detailed definitions are shown in Table 7.

Table 7 MSOP data sheet

Field	Offset	Length (bytes)	Definition
pkt_head	0	4	header: 55aa5aa5
pkt_cnt	4	2	Packetetcnt: Indicates the packet count and loop count, starting from the packet count 0 at the beginning of each frame and ending at the maximum packet count at the end of each frame. Single echo mode: 1 to 2400 Dual echo mode: 1 to 4800
protocol version	6	2	Indicates the version number of the UDP communication protocol
return_mode	8	1	4- Strongest echo 5- Last echo 6- Most recent echo
time_mode	9	1	Time Synchronization Mode: 0x00 indicates the radar's internal time is being used 0x02 indicates the PTP time synchronization mode is being used 0x03 indicates the GPTP time synchronization mode is being used
timestamp	10	10	Timestamp: The first 6 bytes represent seconds, the last 4 bytes represent microseconds
frame_sync	20	1	Frame synchronization 0x00 indicates not synchronized, 0x01 indicates synchronized
lidar_health	21	1	Column number; two consecutive packets have the same column number. Horizontal angle; yaw units are all 0.01 degrees; x100; output in M1P format. Packet mode: 0 for transparent transmission, 1 for uncompressed, 2 for PS test packets, 3 for compressed, 4 for header only. Indicates the current surface being measured: range 1 to 4 surfaces. 0: 10Hz 1: 20Hz
column_num	22	2	Column number: 0~1199
yaw_angle	24	2	Yaw angle: Unit: 0.01deg
pack mode	26	1	Packet Mode 0x01: No compression 0x03: Compression
surface id	27	1	Indicates which surface is currently being measured: range A~D surfaces 0x01: A

			0x02:B 0x03:C 0x04:D
frame rate	28	1	0:10Hz 1:20Hz
reserved	29	1	
lidar_type	30	1	Default value: 0x70
main_temp	31	1	FPGA temperature in °C

4.3.1.2 Data Block Area

The data block section contains the sensor's measurement values within the MSOP packet, totaling 1040 bytes. It consists of 260 datablocks, each 4 bytes long. In single-echo mode, the EM4 has 260 pointdata echoes per MSOP, corresponding to 260 data points. The EM4 has a resolution of 520 x 1200 pixels. Therefore, in single-echo mode, a total of $520 \times 1200 / 260 = 2400$ packets are required to transmit a full image frame via Ethernet.

The detailed definition of each pointdata is shown in Table 8:

Table 8 pointdata data packet definition

point data (4 Bytes)			
Field	Offset	Length (bytes)	Definition
radius	0	2	In polar coordinates, the radial point distance value of channel 1, the distance resolution is 5mm
intensity	2	1	The point reflection intensity value of channel 1, ranging from 0 to 255
point_attribute	3	1	Channel point attributes 0x01: Normal point 0x02: Noise point

4.3.1.3 Frame tail

The frame tail length is 12 bytes and is reserved.

4.3.2 Product Information Output Protocol (DIFOP)

Device Information Output Protocol, DeviceInfoOutputProtocol, abbreviated as DIFOP.

I/O Type: Product output, computer analysis.

The factory default port number is 6699.

DIFOP is an output-only protocol that periodically transmits device serial number (S/N), firmware version information, host computer driver compatibility information, network configuration information, calibration information, motor operation configuration, operating status, and fault diagnosis information to the user. Users can read DIFOP to interpret the various parameters of the current device.

The basic structure of the data packet is shown in Table 9.

Table 9 DIFOP data table

Name	Data Offset	Length	Type	Unit	Value Offset	Range	Description
DifopHdr	0	8	XNbytes			0xa5ff005a11115555	A5 FF 00 5A 11 11 55 55
PsPn	8	4	XNbytes				
AlPn	12	4	XNbytes			0x01000000	
PlPn	16	4	XNbytes			0x01000000	
McuVersion	20	4	XNbytes			0x010000	
HwVersion	24	1	XByte			0xA0	Default:A1
IntSN	25	6	XNbytes			0x000000000000	
SN	31	4	XNbytes			0x21091000	
Res0	35	9	XNbytes			0x000000000000000000000000	
LocalIP	44	4	IP			192.168.1.200	Default:C0 A8 01 C8
NetMask	48	4	IP			255.254.0.0	Default:FF FE 00 00
MacAddress	52	6	MAC			42-2C-76-80-14-C8	Default:42 2C 76 80 14 C8
MsopRemoteIp	58	4	IP			224.0.0.205	Default:E0 00 00 CD
MsopLocalPort	62	2	UnShort			6699	Default:1A 2B
MsopRemotePort	64	2	UnShort			6699	Default:1A 2B
DifopRemoteIp	66	4	IP			224.0.0.205	Default:E0 00 00 CD
DifopLocalPort	70	2	UnShort			7788	Default:1E 6C
DifopRemotePort	72	2	UnShort			7788	Default:1E 6C
DoIPRemoteIp	74	4	IP			192.168.1.102	Default:C0 A8 01 66
DoIPLocalPort	78	2	UnShort			13400	Default:34 58
DoIPRemotePort	80	2	UnShort			0	Default:00 00
LogicalEcuAddress	82	2	XNbytes			0x0001	Default: 00 01
LogicalFuncAddress	84	2	XNbytes			0xE400	Default: E4 00

LogicalTesterAddress	86	2	XNbytes			0x0E00	Default: 0E 80
NetAddr	88	2	XNbytes			0x0000	Default: 00 00
Res1	90	7	XNbytes			0x0	
WorkMode	97	1	XByte			0x0a	0x05: Stabdbby 0x0A: Normal
FrameRate	98	1	XByte			0x00	0x00: 10Hz 0x01: 20Hz 0x02: 30Hz other: 10Hz
WaveMode	99	1	XByte			0x04	0x00:NearestFarthestWave 0x04:StrongestWave 0x05:FarthestWave 0x06:NearestWave 0x0A:Hist 0x0B:Gray
TimesyncMode	100	1	XByte			0x03	0x00: Internal 0x01: PPS 0x02: E2E L2 0x03: gptp
TimesyncStatus	101	1	XByte			0x00	0x00: failed 0x01: Success 0x02: Timeout
TimeStatus	102	10	XNbytes			0x0000000002083a66d47b	0-5 bytes: Second 6-9 bytes: MicroSecond
PhyMasterSlaveMode	112	1	XByte			0x00	0x00: auto-negotiation 0x01: master 0x02: slave other: same as 0x00
SurfaceId	113	1	XByte			0x00	0x00:A 0x01:B 0x02:C 0x03:D
YawOffset	114	26	XByte	deg		0x000000000000000000000000	factor:0.01 1 vcsel:20 pixel 1 column:520 pixel: 26 vcsel
pitch 1	140	2	XByte				channel 1 pitch: factor 0.01 deg
pitch 2	142	2	XByte				channel 2 pitch: factor 0.01 deg
pitch 3	144	2	XByte				channel 3 pitch: factor 0.01 deg

...	...	...	XByte				...
pitch 519	1176	2	XByte				channel 519 pitch: factor 0.01 deg
pitch 520	1178	2	XByte				channel 520 pitch: factor 0.01 deg
RollOffset	1180	2	XByte				factor:0.01
Voltage&Temp	1182	66	XByte	deg			
Res2	1248	5	XByte				
IntPowerSupplyFault	1253	3	XNbytes			0x000000	0:No error 1:Fault
IntTempFault	1256	3	XNbytes			0x000000	0:No error 1:Fault
IntSoftwareFault	1259	3	XNbytes			0x000000	0:No error 1:Fault
PerformanceFault	1262	6	XNbytes			0x000000000000	0:No error 1:Fault
FaultStatus	1268	1	XByte			0x00	Byte0 bit[0] Internal_Error bit[1-7] Reserve 0:No error 1:Fault
FaultLevel	1269	1	XNbytes			0x00	0x00: No fault 0x01: FL1 0x02: FL2 0x03: FL3
Res3	1270	28	XNbytes				
DataLength	1298	2	UnShort			256	01 00
Counter	1300	2	XNbytes				00 00~FF FF
DataId	1302	4	XNbytes			0x00000e5c	00 00 0E 5C
Crc32	1306	4	XNbytes				

5 Troubleshooting

This chapter lists some common problems encountered when using the product and the corresponding troubleshooting methods. For details, see Table 10.

Table 10 Common troubleshooting methods

Fault phenomenon	Workaround
The red/green indicator light on the interface box is off/flashing	Check whether the connection wire between the interface box and the power supply is loose; check whether the wiring harness is damaged.
The product keeps restarting at startup	Check the input power connection and polarity for proper operation. Check that the input power voltage and current meet the requirements (12V input, input current $\geq 2A$).
Wireshark can receive data but RSView does not display the point cloud	Disable the computer firewall and run RSView through it. Confirm that the computer's IP configuration matches the destination address set for the product. Confirm that the SensorNetworkConfiguration setting in RSView is correct. Confirm that the RSView installation directory or the directory storing the configuration file does not contain any Chinese characters. Confirm that the data packets received in Wireshark are MSOP packets.
The product has frequent data loss	Check whether there are a large number of other network packets or network conflicts on the network. Check whether other network devices are broadcasting large amounts of data, blocking sensor data. Check whether the computer's performance and interface performance meet requirements. Remove all other network devices and connect directly to the computer to check for packet loss.
Unable to synchronize gPTP time	Verify that the radar firmware matches the required synchronization mode. In gPTP time synchronization mode: Confirm that the gPTPMaster synchronization protocol complies with the current gPTP protocol; and confirm that the gPTPMaster is functioning properly.
The product has no data output after passing through the router	Disable the DHCP function of the router or set the sensor's IP address to the correct one in the router.

 **Tips:** If the above troubleshooting fails to resolve the issue, please contact us.

6 Product Maintenance

6.1 Transportation and Logistics

 Important

Improper transportation can result in product damage!

- 1) Products should be packaged in shock-proof and moisture-proof packaging to prevent damage during transportation. Original packaging is recommended.
- 2) Handle the product with care during transportation, avoiding bumps, drops, and other dangerous behaviors.
- 3) Upon receiving each shipment, carefully inspect the delivery list and check for damage (including the product and packaging).
- 4) If there is any damage during transportation, please refuse to accept the goods and contact us immediately.

6.2 storage

 Important

- 1) Store the product indoors at room temperature in a dry environment.
- 2) Handle the product with care to avoid bumps, drops, etc.
- 3) Store the product in a safe environment, avoiding corrosion, mechanical shock, and exposure to environments exceeding the product's rated load.
- 4) Regularly inspect the condition of all components and packaging. The recommended inspection interval is every three months.

6.3 Product cleaning

In order to accurately perceive the surrounding environment, RS-LiDAR needs to keep the annular protective cover clean.

6.3.1 Precautions

 Please read this section carefully and completely before cleaning the RS-LiDAR. Otherwise, improper operation may damage the product.

 When using the LiDAR in a harsh environment, it is necessary to clean the dirt on the surface in time to keep the LiDAR clean, otherwise it will affect the normal use of the LiDAR.

6.3.2 Required Materials

- 1) A clean, dust-free cloth;
- 2) A neutral solution at a moderate temperature (such as soapy water, distilled water, 99% ethanol, etc.).

6.3.3 Cleaning methods

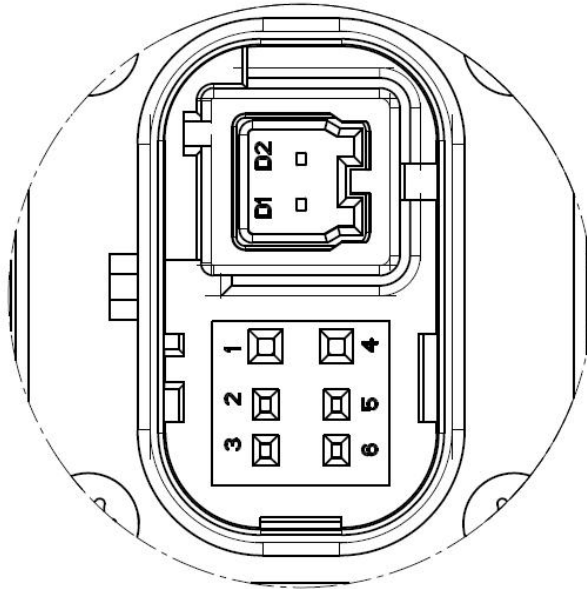
- 1) If the surface of the LiDAR is just covered with dust/powder:
 - a) First, use a clean, dust-free cloth to apply a small amount of neutral solution.
 - b) Next, gently wipe the LiDAR surface clean.
 - c) Finally, wipe it dry with a clean, dry cloth.
- 2) If the LiDAR surface is contaminated with mud or other lumps:
 - d) First, use clean water to spray the dirty surface of the lidar to remove mud and other foreign matter.

(Note: Do not wipe off the mud directly with a dust-free cloth, as this may scratch the surface, especially the protective cover surface);
 - e) Next, spray the dirty area with warm soapy water. The lubricating effect of the soapy water can accelerate the removal of foreign matter. Gently wipe the surface of the LiDAR with a fiber cloth again, but be careful not to scratch the surface.
 - f) Finally, use clean water to clean the soap residue on the surface of the lidar (if there is still residue on the surface, clean it again with 99% ethanol), and wipe it dry with a dry dust-free cloth.

Appendix A ROS&ROS2Package

rslidarsdk is the driver SDK for the ROS platform. If you need it, please contact RoboSense.

Appendix B TE Connector Pin Definition



Connector pinout		
Pin number	Pin definition	Connector model
1	GND	TE 2387351-1
2	Wakeup(KL15)	
3	/	
4	Battery+	
5	/	
6	/	
D1	TRX_N(1000Base-T1)	
D2	TRX_P(1000Base-T1)	

Appendix C Structural Drawings

The EM4B0 prototype radar structure drawing and optical center position are as follows:

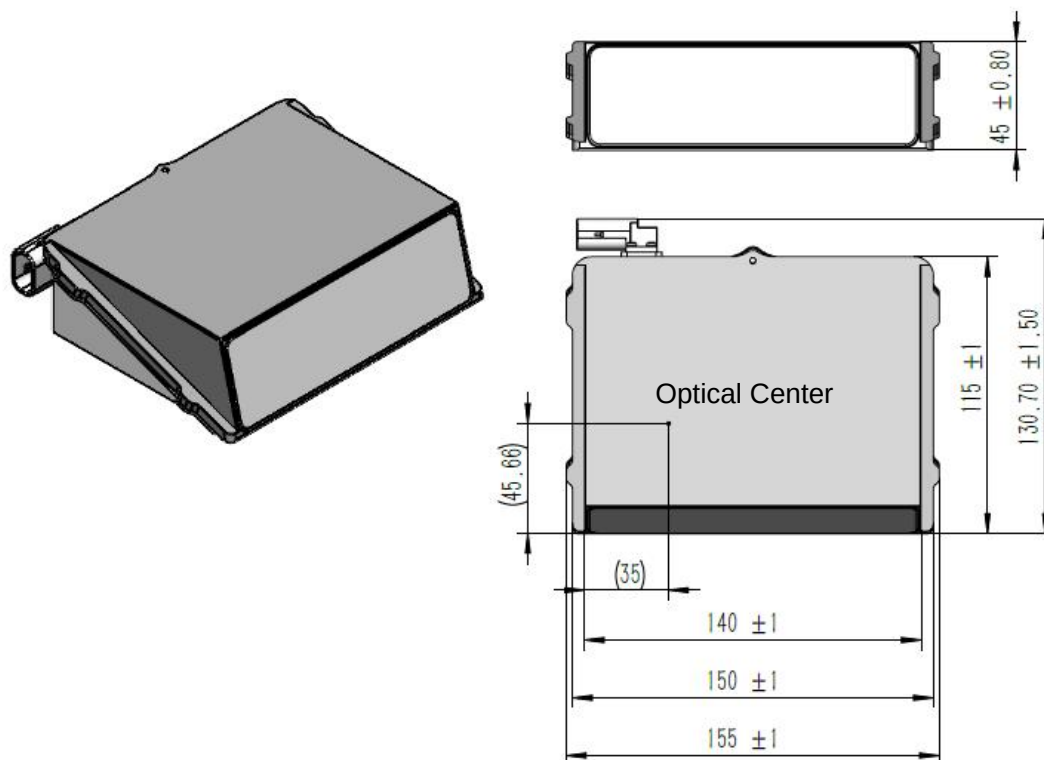


Figure 10B0 prototype structure and optical center position