HESAI

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JT128

128-Channel Mechanical Lidar
User Manual

Classification: Confidential

Doc Version: J01-en-241210

Table of Contents

About this manual

Please make sure to read through this user manual before your first use and follow the instructions herein when you operate the product. Failure to comply with the instructions may result in product damage, property loss, personal injuries, and/or a breach of warranty.

Access to this manual

To obtain the latest version, please do one of the following:

- Contact your sales representative of Hesai.
- Contact Hesai technical support: service@hesaitech.com

Technical support

If your question is not addressed in this user manual, please contact us at:

- service@hesaitech.com
- https://www.hesaitech.com/technical-support/
- https://github.com/HesaiTechnology

Legends and format

Warnings: Instructions that must be followed to ensure safe and proper use of the product.

Notes: Additional information that may be helpful.

Monospace font: field names

For example: `Distance` represents the Distance field.

Safety notice

- Please make sure to read through this safety notice and follow all the instructions and warnings. Failure to comply with the instructions and warnings may result in product damage, property loss, and/or personal injuries.
- Please check the certification information on the product's nameplate and read through the corresponding certification warnings. If specific users require not presenting certification information on the nameplate, please follow the agreed-to arrangements.
- If you incorporate this lidar product into your product(s), you are required to provide this user manual (or access to this user manual) to the intended users of your product(s).
- This lidar product is intended as a component of an end product. It is the responsibility of the end-product supplier to assess the risk of use in accordance with applicable standards and inform the intended user of safety-related information.
- Should there be other agreements with specific users, the other agreements shall apply.
- Before using a product, please confirm with Hesai the development maturity of the product in a timely manner. For products still in development, Hesai makes no warranty of non-infringement nor assumes any responsibility for quality assurance.

Special warnings

Hot surface

Hot parts!
Burned fingers when handling the parts.
Wait one-half hour after switching off before handling the parts.

Abnormalities

In any of the circumstances listed below, stop using the product immediately:

- If you suspect malfunctions of or damage to the product, with symptoms such as significant noise or visible vibration.
- If you or people in the nearby environment feel discomfort.
- If any device or equipment in the nearby environment malfunctions.

Meanwhile, contact Hesai or an authorized Hesai service provider for more information on product disposal.

Prohibition of disassembly

Unless expressly agreed to in writing by Hesai, do NOT disassemble the product.

Operating environment

Radio frequency (RF) interference

- Before using the product, make sure to read all the signs and notices on the product enclosure (including the nameplate). If specific users require not presenting certification information on the nameplate, please follow the agreed-to arrangements.

Vibration

- If significant mechanical shocks and vibration exist in the product's operating environment, please contact Hesai's technical support to obtain the shock and vibration limits of your product model. Exposure to over-the-limit shocks or vibration may damage the product.
- Make sure to package the product in shock-proof materials to avoid damage during transport.

Explosive atmosphere and other air conditions

- Do NOT use the product in any area where potentially explosive atmospheres are present, such as environments with high concentrations of flammable chemicals, vapors, or particulates (including particles, dust, and metal powder) in the air.
- Do NOT expose the product to environments having high concentrations of industrial chemicals, including liquefied gases that are easily vaporized (such as helium). Such exposure can damage or impair product functionality.

Chemical environment

Do NOT expose the product to corrosive or strong polar chemical environments (such as liquids or gases), including but not limited to strong acids, strong bases, esters, and ethers. This is to avoid damage to the product (including but not limited to water resistance failure).

Ingress protection (IP)

Please check the product's user manual for its IP rating (refer to Section 1.4 Specifications). Make sure to avoid any ingress beyond that rating.

Operating temperature

Please check the product's user manual for its operating temperature (refer to Section 1.4 Specifications). Make sure not to exceed the operating temperature range.

Recommended storage conditions

Please store the product in a dry and well-ventilated place. The recommended ambient temperature is 23 ± 5°C, and the humidity is between 30% and 70%.

Light interference

Certain precision optical instruments may interfere with the laser light emitted from the product. Please check all the instructions for these instruments and take preventive measures if necessary. For example, protective leather covers are provided for certain product models; when these lidars are temporarily not used for measurement, the leather covers can be applied to block laser light emission.

Personnel

Recommended operator qualifications

The product should be operated by professionals with engineering backgrounds or experience in operating optical, electrical, and mechanical instruments. Please follow the instructions in this manual when operating the product and contact Hesai technical support if needed.

Medical device interference

- Some components in the product can emit electromagnetic fields. If the product operators or people in the nearby environment wear medical devices (such as cochlear implants, implanted pacemakers, and defibrillators), make sure to consult the physicians and medical device manufacturers for medical advice, such as determining whether keeping the product a safe distance away from the medical devices is needed.
- If you suspect that the product is interfering with your medical device, stop using the product immediately.

Installation and operation

Power supply

- Before powering on the product, make sure the electrical interfaces are dry and clean. Do NOT power on the product in humid conditions.
- Do NOT use out-of-spec or damaged cables or adapters.
- You are recommended to use only the cables and power adapters provided by Hesai. If you are to design, configure, or select the power supply system (including cables) for the product, make sure to comply with the electrical specifications in the product's user manual (refer to Section 1.4 Specifications and the Power Supply Requirements section if available); for technical support, please contact Hesai.
- Please check Section 2.2 Electrical interface and strictly follow the instructions on plugging/unplugging the connector. If abnormalities already exist (such as bent pins, broken cables, and loose screws), stop using the product and contact Hesai technical support.

Eye safety

CAUTION

- For maximum self-protection, it is strongly warned that users do NOT look into the transmitting laser through a magnifying product (microscope, eye loupe, magnifying glass, etc.).
- This product does not have a power switch. It starts operating once connected to power. During operation, the entire cover lens can be regarded as the product's laser emitting window; looking at the cover lens can be regarded as looking into transmitting laser.

Product enclosure

- The product contains metal, glass, plastic, as well as sensitive electronic components. If the product is dropped or burnt, stop using it immediately and contact Hesai technical support.
- Do NOT squeeze or pierce the product. If the product enclosure is broken, stop using it immediately and contact Hesai technical support.
- Certain product models contain high-speed rotating parts. To avoid potential injuries, do NOT operate the product if the enclosure is loose.
- If the product enclosure consists of fins or grooves, please wear gloves when handling the product. Applying too much pressure with your bare hands may cause cuts, bruises or other injuries.

Cover lens

The location of the cover lens is illustrated in Section 1 Introduction.

- Do NOT apply protective film, wax or any other substance on the cover lens.
- To keep the product's cover lens from fingerprints and other stains, do NOT touch the cover lens with bare hands. If the cover lens is already stained, please refer to the cleaning method in Section 5 Maintenance.
- To prevent scratches, do NOT touch the product's cover lens with hard or sharp objects. If scratches already exist, stop using the product and contact Hesai technical support. Severe scratches may affect the quality of the product's point cloud data.

Mounting

- Before operating the product, make sure it is properly and securely mounted. The mounting should prevent the product from leaving its mounting position under external forces (such as collisions, high winds, and stone impacts).
- Before installing any exterior part, please ensure that each exterior part and its movable area do not overlap the Field of View (FOV) of the lidar.

The FOV of lidar is the spatial angular range bounded by the horizontal and vertical FOV ranges (see Section 1.4 Specifications); the distance to the origin of the lidar's coordinate system is not limited. For inquiries about the FOV, please contact Hesai technical support.

Hot surface

During operation or the time period after the operation, the product's enclosure can be hot.

- To prevent discomfort or even burns, do NOT touch the product's enclosure with your skin.
- To prevent fires, make sure to keep flammable materials away from the product's enclosure.

Certain product models support active heating of the cover lens to reduce the impact of ice and frost.

- While active heating is ON, please avoid direct skin contact with the cover lens.
- Users can turn off active heating.

Peripherals

The product may be used along with accessories and devices, such as suction cup mounts, extension cables, power supplies, network devices, GPS/PTP devices, CAN transceivers, and cleaning equipment.

When selecting a peripheral, please refer to all relevant specifications in the product's user manual or contact Hesai technical support. Using out-of-spec or unsuitable devices may result in product damage or even personal injuries.

Firmware and software upgrading

Make sure to use only the upgrade files provided by Hesai. Make sure to observe all the instructions provided for that upgrade file.

Customized firmware and software

- Before using a customized version of firmware and software, please fully understand the differences in functions and performance between the customized version and the standard version.
- Make sure to strictly follow all the instructions and safety precautions provided for that customized version. If the product does not function as anticipated, stop using the product immediately and contact Hesai technical support.

Repair

- Unless expressly agreed to in writing by Hesai, do NOT disassemble, repair, modify, or retrofit the product by yourself or entrust any third party to do so. Such a breach:
  - can result in product damage (including but not limited to water resistance failure), property loss, and/or injuries;
  - shall constitute a breach of warranty.
- For more product repair issues, please contact Hesai or an authorized Hesai service provider.

1. Introduction

1.1. Operating principle

Distance measurement: Time of Flight (ToF)

1. A laser diode emits a beam of ultrashort laser pulses onto the target object.
2. The laser pulses are reflected after hitting the target object. The returning beam is detected by an optical sensor.
3. Distance to the object can be accurately measured by calculating the time between laser emission and receipt.

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

d: Distance
c: Speed of light
t: Travel time of the laser beam

1.2. Basic structure

The basic structure is shown in Figure 1.
Multiple pairs of laser emitters and receivers are attached to a motor that rotates 360° horizontally.

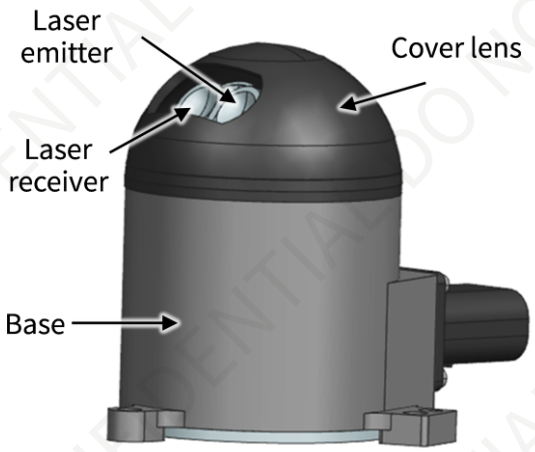


Figure 1. Partial cross-sectional diagram

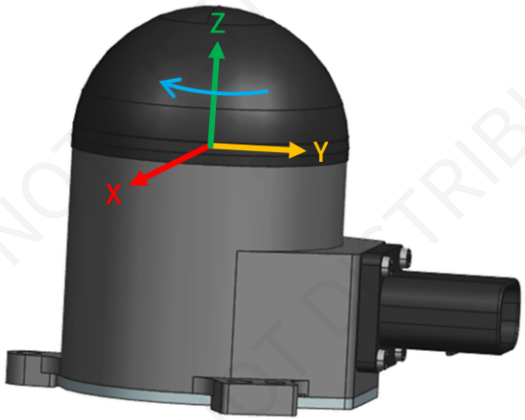


Figure 2. Coordinate system (isometric view)

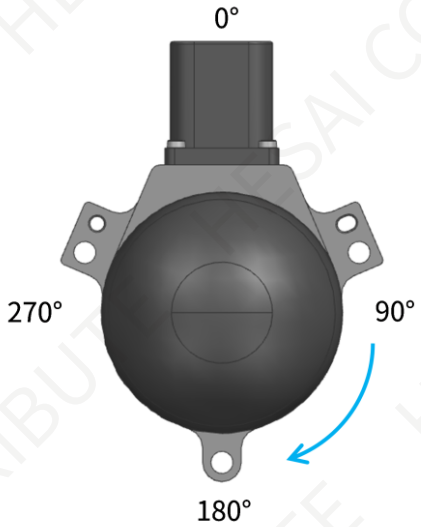


Figure 3. Lidar azimuthal position (top view)

The lidar's coordinate system is illustrated in Figure 2. Z-axis is the axis of rotation.

The lidar's azimuthal position is defined in Figure 3.

- By default, the lidar rotates clockwise in the top view.
- Y-axis corresponds to 0°.
- Each laser channel has an intrinsic azimuth offset. The horizontal center of the emitter-receiver array defines the lidar's azimuthal position.

For example, when the horizontal center passes the 90° position, the lidar is at the 90° position, and the azimuth of the corresponding data block in the Point Cloud Data Packet is 90°.

1.3. Channel distribution

All channels are unevenly distributed, as illustrated in Figure 4.

- Vertical resolution: See Section 1.4 Specifications.
- The design values of each channel's angular position: See Appendix A Channel distribution data.
- Channel number counts from 1, bottom to top.

Only the even-numbered channels are used; the odd-numbered channels do not fire laser pulses.

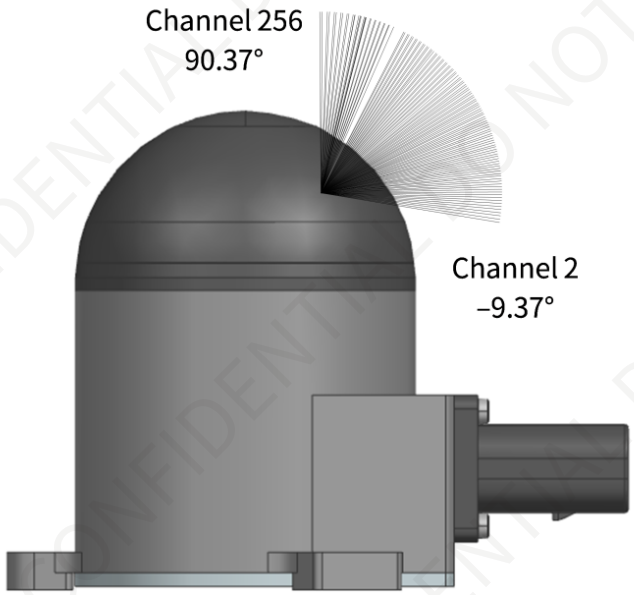


Figure 4. Channel vertical distribution

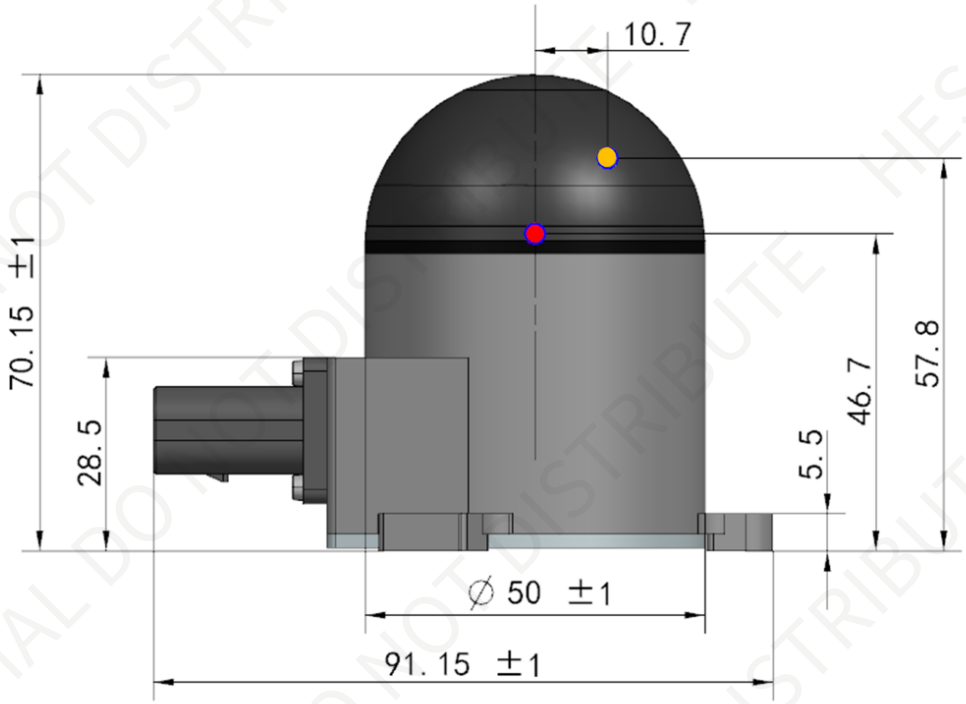


Figure 5. Laser firing position (unit: mm)

In Figure 5:

- The origin of the lidar's coordinate system is marked as a red dot.
- The optical center (the midpoint of the entrance pupil and exit pupil) is marked as a yellow dot. All measurements are relative to the optical center.

Each channel has an intrinsic angle offset, both horizontally and vertically. These angles are recorded in this lidar unit's angle correction file.

Angle correction file

The angle correction file is provided when shipping the unit. If you need the file again, please reach out to a sales representative or Hesai technical support to obtain it.

1.4. Specifications

SENSOR

Scanning method	Mechanical rotation
Number of channels	128
Instrumented range	0 to 25 m
Ranging capability ①	20 m (at 10% reflectivity, for all channels)
Horizontal FOV	360°
Horizontal resolution ②	Approx. 0.45°
Vertical FOV	99° (–9° to 90°)
Vertical resolution	0.8° (average)
Frame rate	20 Hz
Return mode	Single return: Strongest/First

MECHANICAL/ELECTRICAL/OPERATIONAL

Wavelength	905 nm
Ingress protection	IP6K7
Dimensions	Height: 70.15 mm Bottom: Φ50 mm
Rated voltage range ③	DC 12 V
Power consumption ④	7.5 W
Operating temperature	–20°C to 55°C
Storage temperature	–40°C to 85°C

Weight	220 ± 10 g

DATA I/O

Data transmission	Automotive Ethernet, 1000BASE-T1, slave mode
Measurements	Distance, azimuth angle, and reflectivity
Valid point rate	Approx. 1 684 000 pts/sec
Point cloud data rate	115.8 Mbps

Specifications are subject to change. Please refer to the latest version of this manual.

Notes to specifications

① **Ranging capability**	Test conditions: normal incidence, 0 to 100 klux ambient illuminance, and probability of detection (PoD) > 90%
② **Horizontal resolution**	Equivalent horizontal resolution in space.
③ **Rated voltage range**	The input voltage at the lidar's connector shall be within 9 to 16 V DC.
④ **Power consumption**	Typical value • Not including accessories such as the connection box. • Test conditions: 55°C ambient temperature, 20 Hz frame rate. • The external power supply should be able to provide at least 2A, 18 W.

2. Setup

Before operating the lidar, strip away the protective cover on the cover lens.

The information in this section may be different for customized models. The mechanical drawings and data exclusively provided for customized models shall prevail.

2.1. Mechanical installation

2.1.1. Exterior dimensions

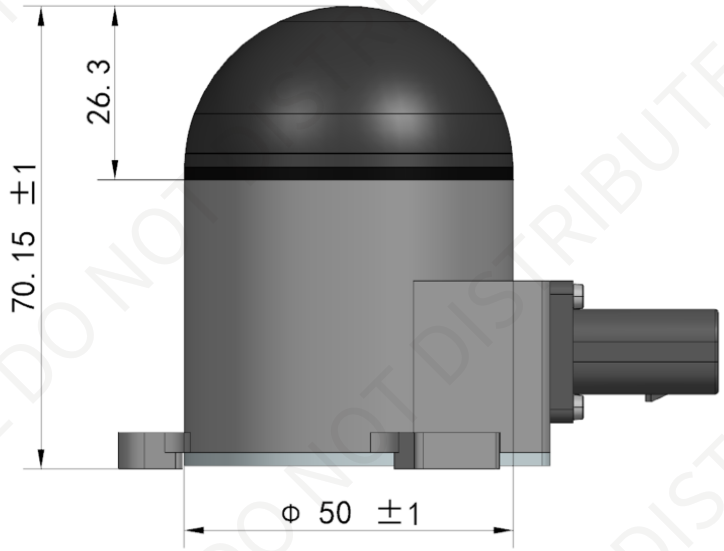


Figure 6. Right side view (unit: mm)

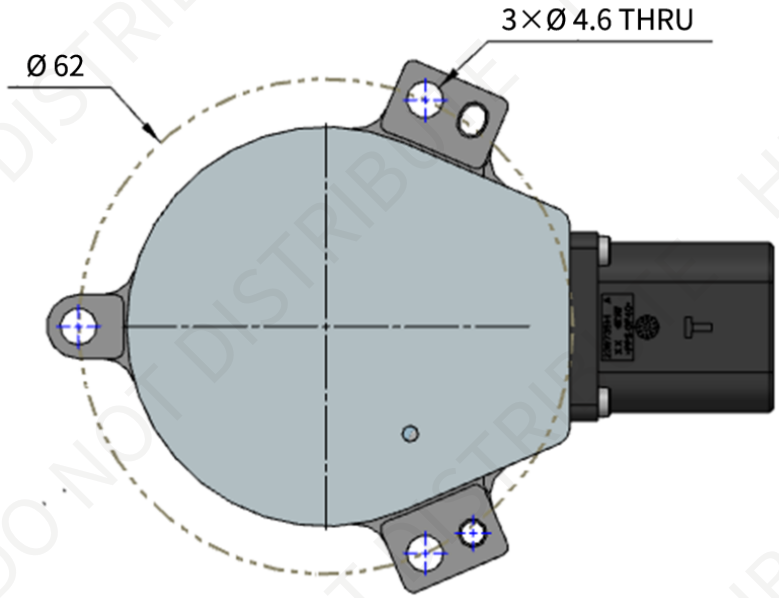


Figure 7. Bottom view (unit: mm)

2.1.2. Recommended installation

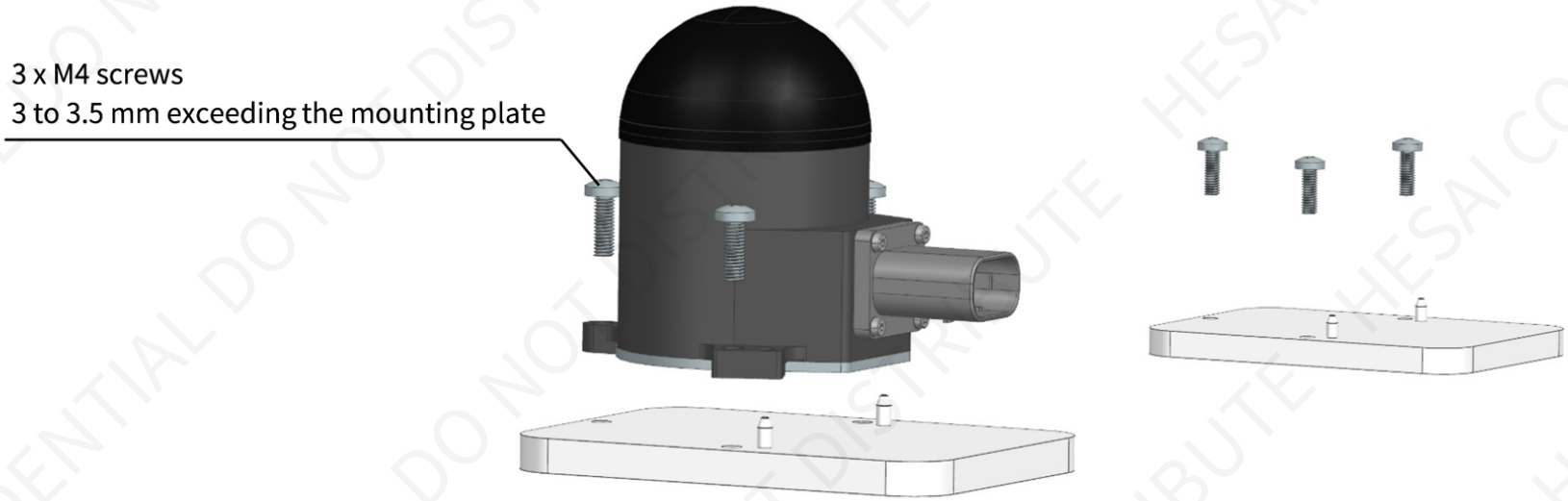


Figure 8. Recommended installation

2.1.3. Notes on screw installation

Screw type

SEMS screws (with pre-attached flat washers and lock washers) are recommended. Property class should be at least 4.8.

Screw torque

The base material of the threaded holes is aluminum alloy instead of steel. Refer to the following table for the appropriate screw torque.

Thread size	Recommended screw torque
M2	0.2 to 0.3 Nm
M3	0.5 to 0.6 Nm
M4	1 to 1.5 Nm
M5	2 to 2.5 Nm
M6	3.5 to 4 Nm

Thread service life

- Ten times. (Each screwing counts as one time, so as each unscrewing.)
- If threadlocker is used, clean the threaded hole before each retightening. Avoid contact between the cover lens and the cleaner.

2.2. Electrical interface

TE Connectivity part number: 2446023-1 (male socket, on the lidar)

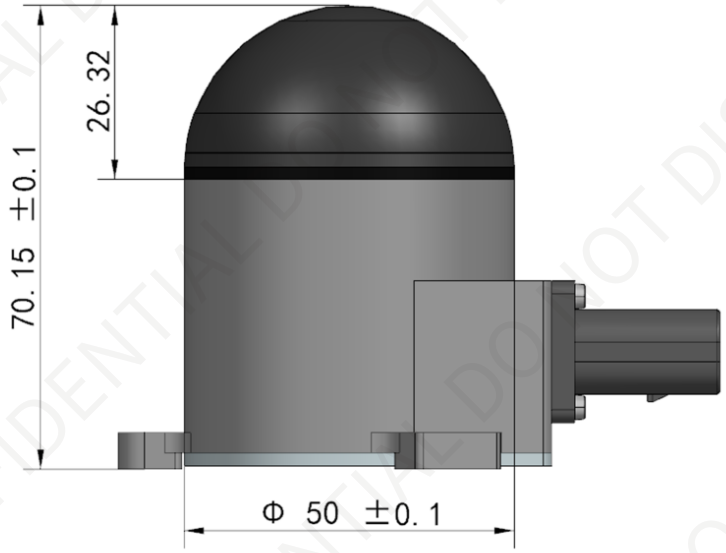


Figure 9. Connector right side view (unit: mm)

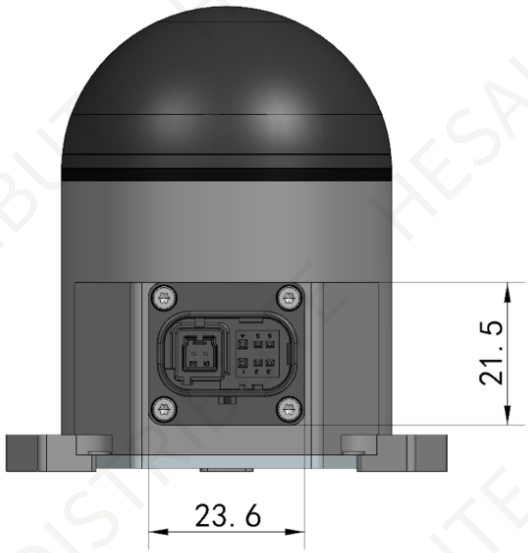


Figure 10. Connector front view (unit: mm)

2.2.1. Pin description

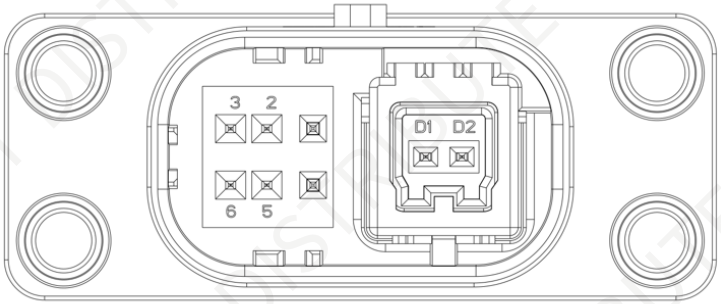


Figure 11. TE connector (male socket)

No.	Signal	Voltage
1	VCC	9 to 16 V
2	Reserved	-
3	Reserved	-
4	GND	0 V
5	Reserved	-
6	Reserved	-
D2	MDI-P	-
D1	MDI-N	-

Avoid touching the reserved wires or ports with bare hands.

2.2.2. Connector use

- Before connection, check the pins on the socket and the holes on the plug. In case of bent pins or damaged holes, stop using the connector and contact technical support.
- To prevent breakdowns, turn off the power source before connection and disconnection.
- Do NOT attempt to force open a connection by pulling on the cables or by twisting the connectors in any way. Doing so can loosen the connectors' shells, or even damage the contacts.
- If the connector's shell is accidentally pulled off, stop using the connector and contact Hesai technical support.
- Do NOT attempt to assemble the connector's shell and cable collet; do NOT connect a connector without its shell. Doing so may damage the lidar's circuits.
- For further troubleshooting, please contact Hesai's technical support or obtain work instructions from the connector manufacturer.
- The connector is designed to withstand at least 20 mating cycles; exceeding this number may increase the risk of connector damage.

Connection	1. Turn off the power source. 2. Make sure the plug's red CPA is on the same side as the socket's locking nose. 3. Push the plug straight into the socket until you feel and hear a click. 4. Push the red CPA towards the socket until you feel and hear a click.
Disconnection	1. Turn off the power source. 2. Pull the red CPA away from the socket until you feel and hear a click. 3. Depress the black locking latch; then pull the plug from the socket.

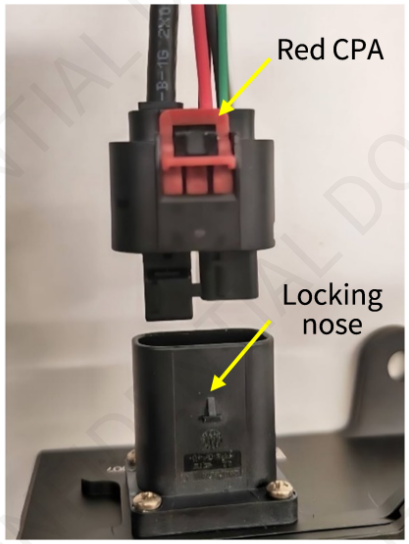


Figure 12. Connection

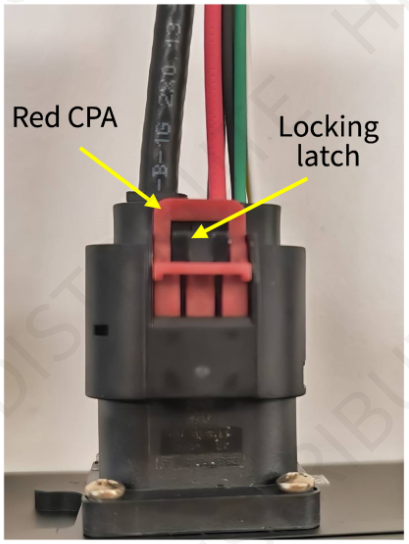


Figure 13. Disconnection

2.2.3. Cables (Ethernet)

Outer diameter (OD) = 4.10 ± 0.20 mm
Minimum bend radius:

- Single: 5 × OD
- Multiple: 15 × OD

2.3. Connection box (optional)

Users may connect the lidar with or without a connection box.
The connection box has a power port and a standard Ethernet port.

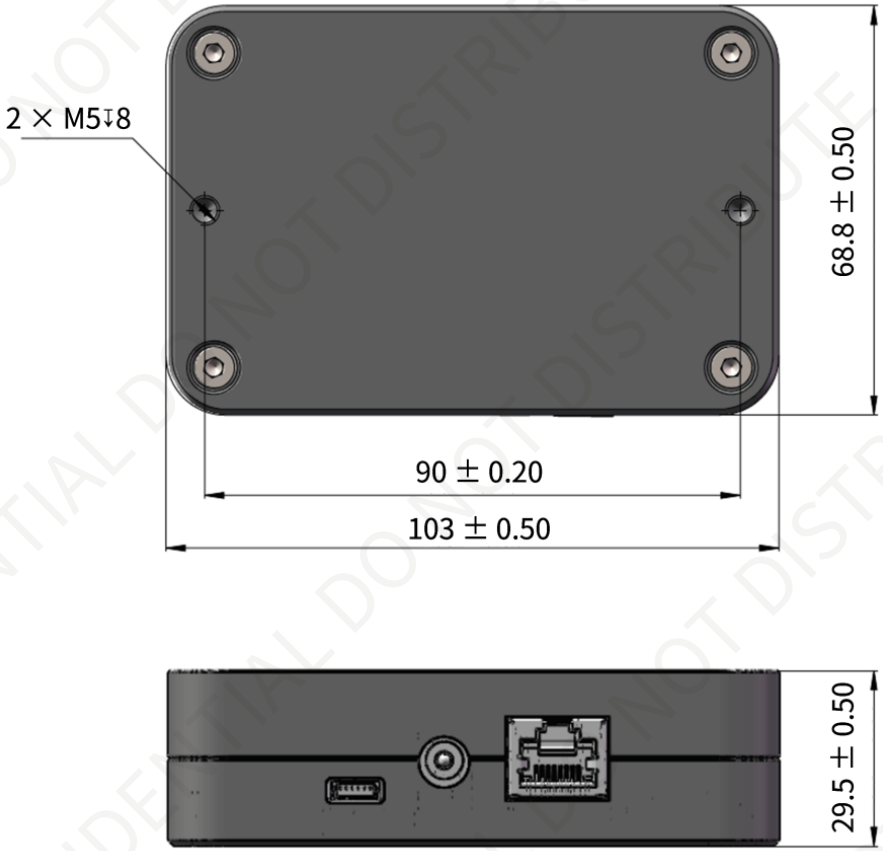


Figure 14. Connection box (unit: mm)

An additional cable assembly is used for connecting the lidar (on the left) and the connection box (on the right), as shown below.

One cable's head cannot connect to another cable's tail, so each lidar can only use one cable.

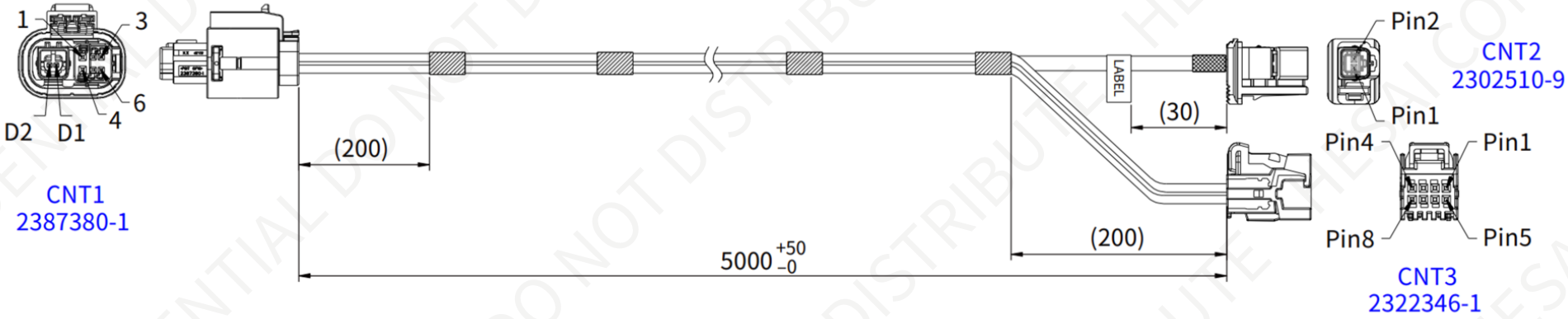


Figure 15. Cable assembly between lidar and connection box (unit: mm)

The wire colors and cross-section areas are listed below.

Pin No. on CNT1	Pin No. on CNT3	Signal	Wire color	Wire cross section
Pin 1	Pin 4	VCC	Red	0.75 mm^2
Pin 4	Pin 8	GND	Black	0.75 mm^2

Pin No. on CNT1	Pin No. on CNT2	Signal	Wire color	Wire cross section
D2	Pin 1	MDI-P	White	-
D1	Pin 2	MDI-N	Green	-

2.3.1. Ports

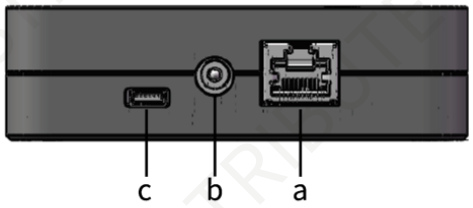


Figure 16. Connection box (front)

Port No.	Port name	Description
a	Standard Ethernet port	RJ45, 1000 Mbps Ethernet
b	Power port	Connects to a DC-005 DC power adapter.
c	Reserved port	Do NOT connect this port to external signals.

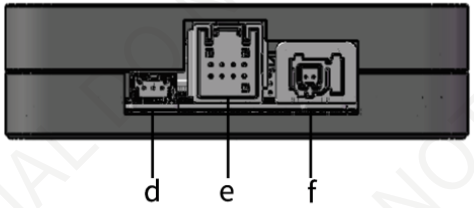


Figure 17. Connection box (back)

Port No.	Port name	Description
d	Reserved port	Do NOT connect this port to external signals.
e	Power Output port	See CNT 3 in Figure 15.
f	Automotive Ethernet port	See CNT2 in Figure 15.

2.3.2. Connection

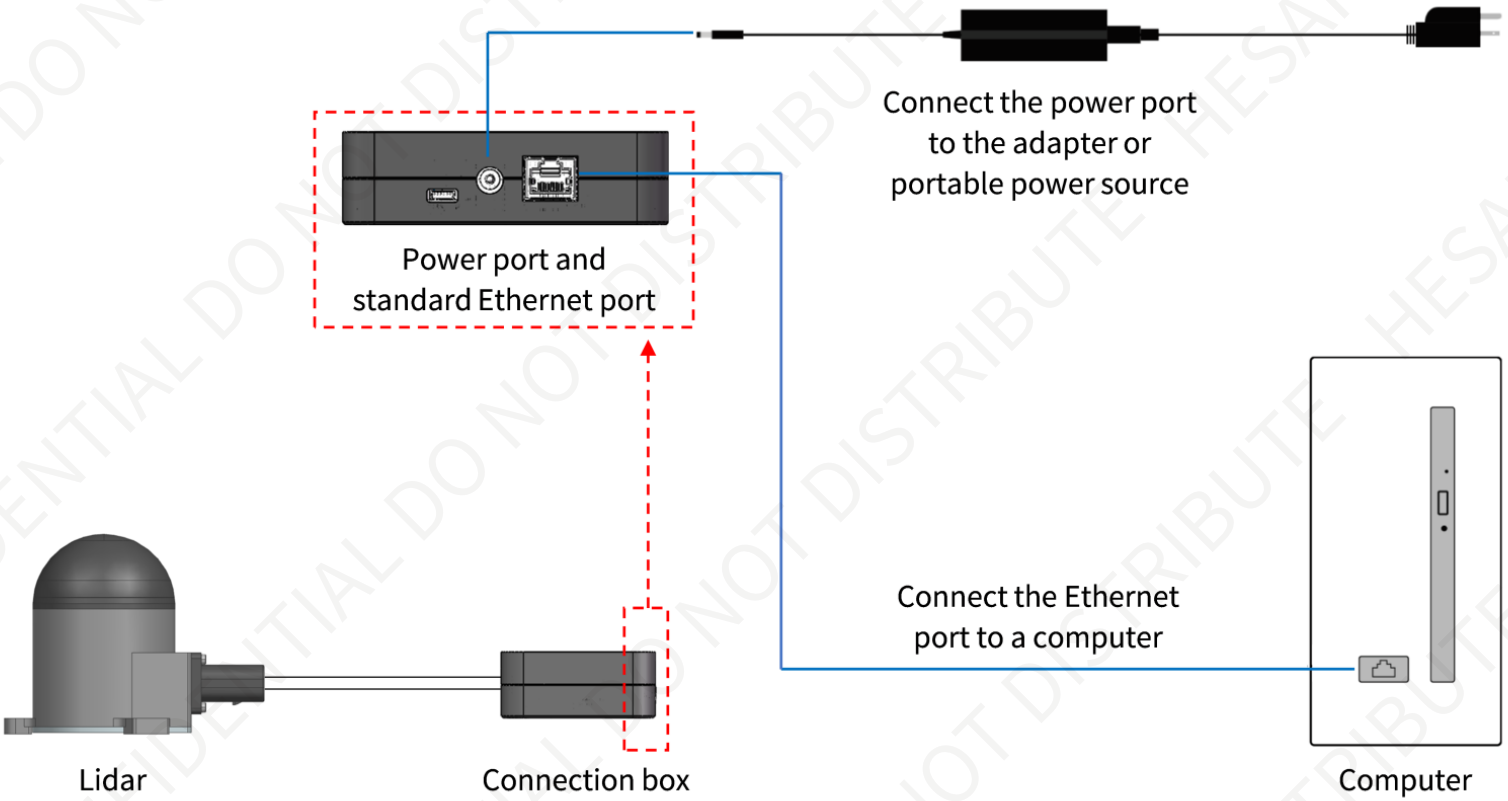


Figure 18. Connection with PTP (software simulation)

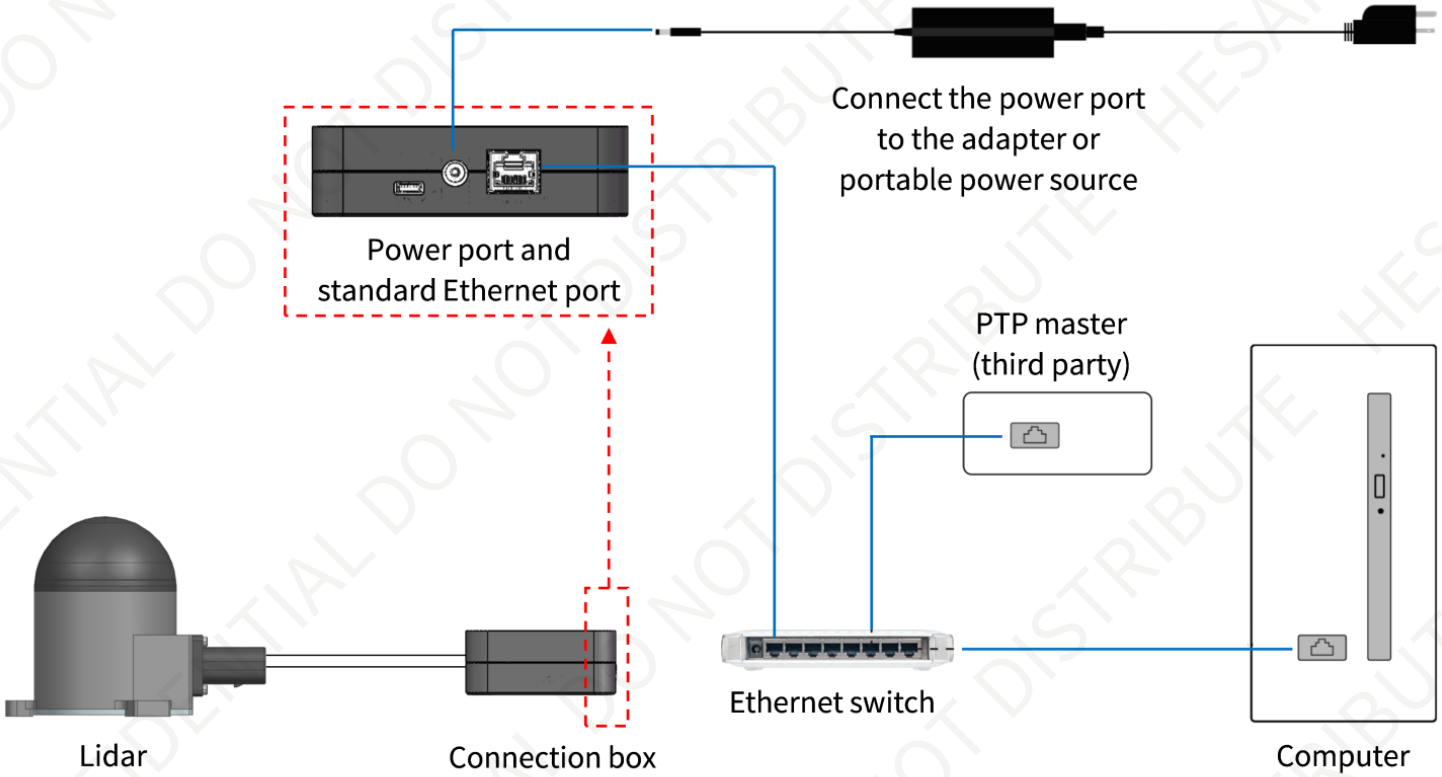


Figure 19. Connection with PTP (hardware device)

2.4. Network settings on the receiving host

The lidar does not have a power switch. It starts transmitting data when both of these conditions are met:

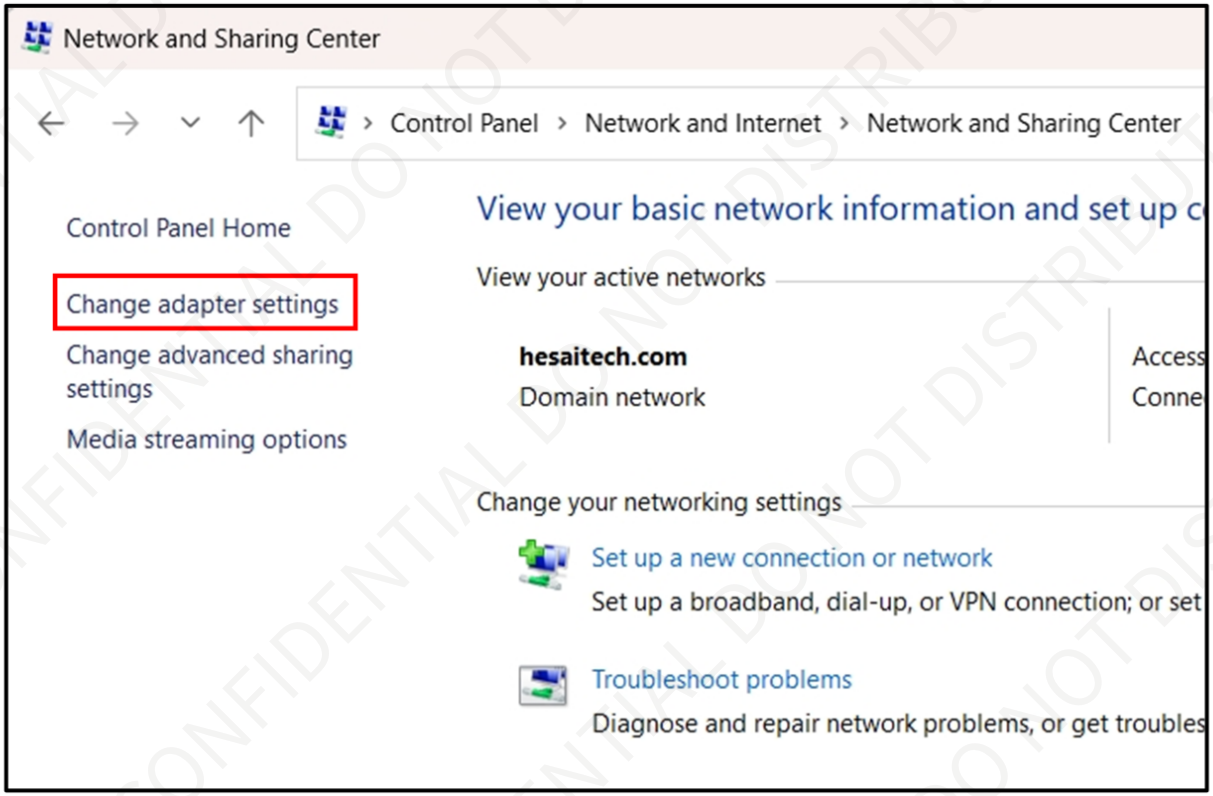
- The lidar is connected to power.
- The lidar is connected to a host computer via Ethernet.

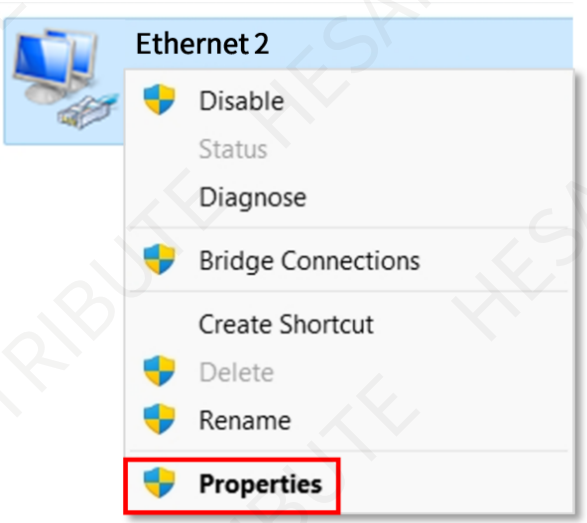
Configure the network parameters of the host computer before receiving point cloud data

Network parameters	Value	Description
IP address	192.168.1.100	-
Subnet mask	255.255.255.0	-

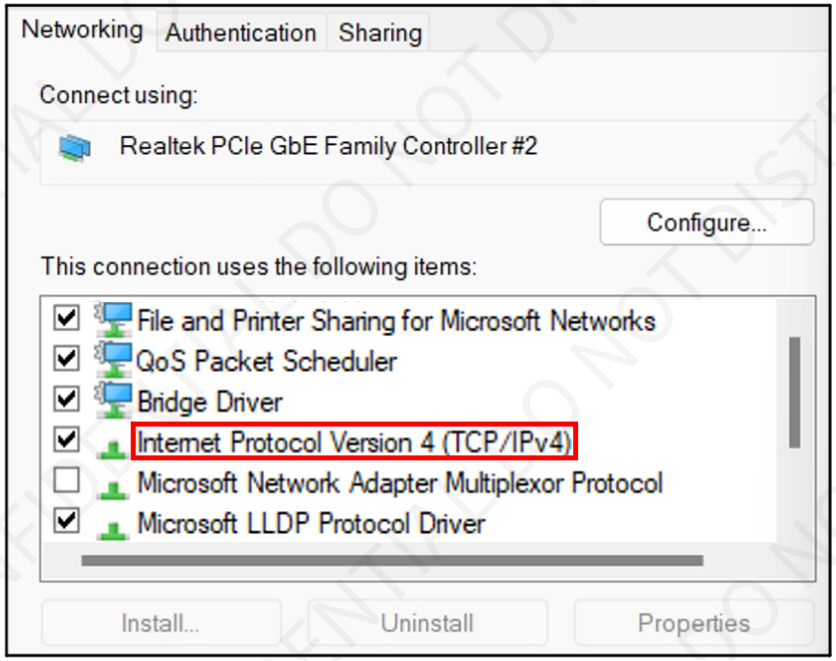
2.4.1. In Windows

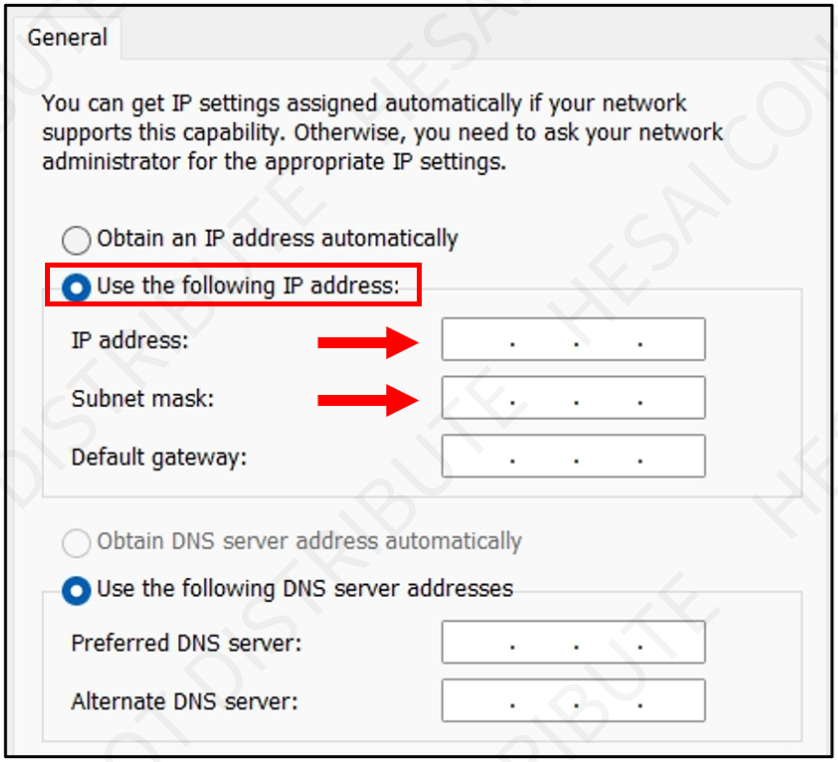
1. [**Control Panel**] > [**Network and Internet**] > [**Network and Sharing Center**] > [**Change adapter settings**].
2. Right-click [**Ethernet**] or [**Ethernet X**] which shows Ethernet connection (with no red cross at the bottom left of the icon) > Select [**Properties**].





3. Double-click [**Internet Protocol Version 4 (TCP/IPv4)**].
4. Select [**Use the following IP addresses**] > Input the host computers's IP address and subnet mask.





Ping command can be used to check the connection:

1. Press Win + R to open the Run dialog box.
2. Enter "cmd" and click [**OK**] to open the Command Prompt.
3. Enter "ping 192.168.1.2" and check the output.

2.4.2. In Ubuntu

Run this command in the terminal:

```
sudo ifconfig ${interface_name} ${ip_addr}
```

- Replace `${interface_name}` with the host computer's network interface name.
- Replace `${ip_addr}` with the host computer's IP address.

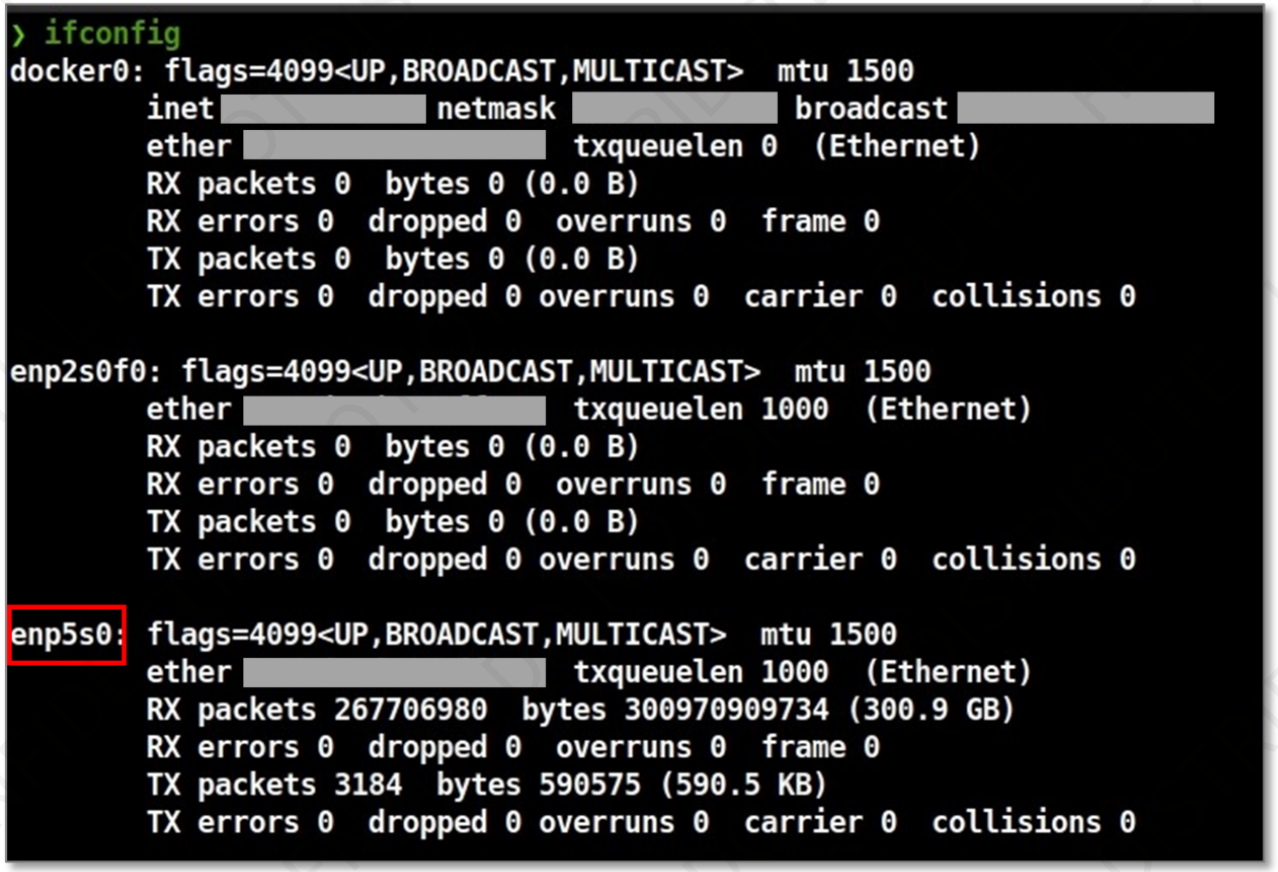
To find the host computer's network interface name:

Method 1

In the Settings — Network page, the content in brackets after **[Ethernet]** is the network interface name.

Method 2

Enter "ifconfig" in the terminal.

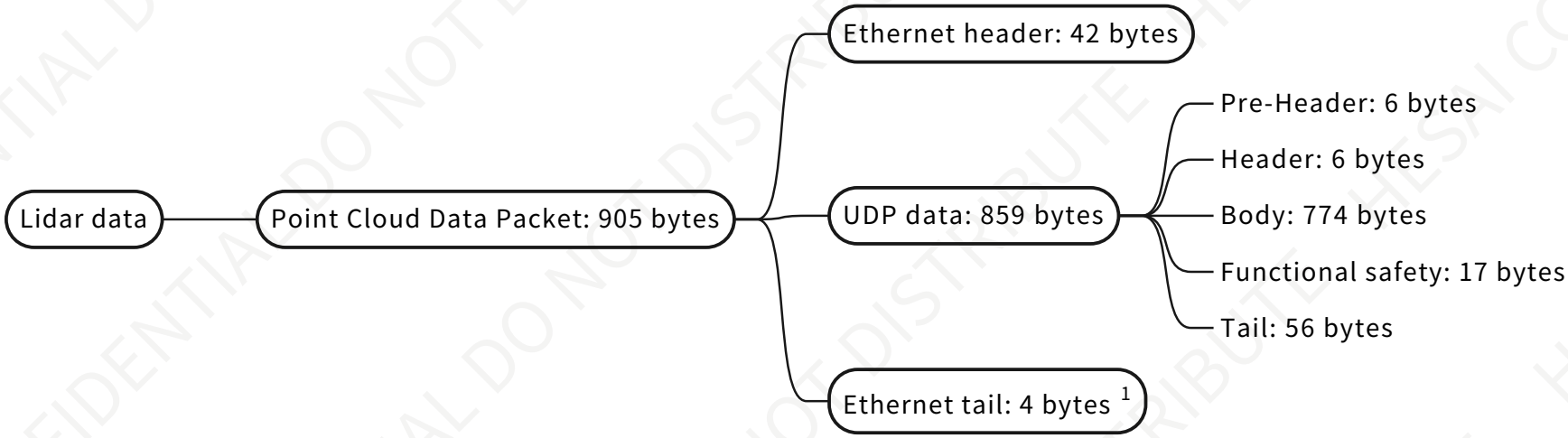


2.5. Tools

Tool	Purpose	Where to find it
PandarView 2	Point cloud visualization software: To record and display point cloud data.	Please contact Hesai technical support.
Pandar TCP Commands (PTC) API	To set parameters, check device info, or upgrade firmware and software. Network parameters: • Default Source IPv4 address: 192.168.1.2 • Default PTC port: 9347	Please contact Hesai technical support.

3. Data structure

Unless otherwise specified, all the multi-byte fields are unsigned values in little-endian format.



1. Network monitoring software (such as WireShark) usually does not display the **Ethernet tail** (4 bytes).

Figure 20. Data structure

3.1. Point Cloud Data Packet

Before receiving Point Cloud Data Packets, please perform Section 2.4 Network settings on the receiving host.

3.1.1. Ethernet header

Point Cloud Data Packet: Ethernet header

Field	Byte(s)	Description
Ethernet II MAC	12	Destination MAC: xx:xx:xx:xx:xx:xx (FF:FF:FF:FF:FF:FF for broadcast) Source MAC: xx:xx:xx:xx:xx:xx
Ethernet Data Packet Type	2	0x08, 0x00
Internet Protocol	20	Protocol parameters
UDP Port Number	4	Source port (default: 10000) Destination port (default: 2368)
UDP Length	2	Eight bytes more than point cloud UDP data (see Figure 20. Data structure).
UDP Checksum	2	Checksum of the Ethernet header

3.1.2. Point cloud UDP data

3.1.2.1. Pre-Header

Field	Byte(s)	Description
Start of Packet	1	0xEE
Start of Packet	1	0xFF
Protocol Version Major	1	Main class of the point cloud UDP packet structure Current value: 0x01
Protocol Version Minor	1	Subclass of the point cloud UDP packet structure Current value: 0x04
Reserved	2	-

3.1.2.2. Header

Field	Byte(s)	Description
Channel Num	1	Fixed: 0x80 (128)
Block Num	1	Fixed: 0x01 (1)
First Block Return	1	Indicating the return in the first block of this packet. Fixed: 0x00 — Single Return Mode
Dis Unit	1	Fixed: 0x04 (4 mm)
Return Num	1	Number of returns that each channel generates Fixed: 0x01 (1)

<table>
<tr><th>Field</th><th>Byte(s)</th><th>Description</th></tr>
<tr><td>Flags</td><td>1</td><td>Each bit indicates whether this data packet contains certain information.
1 — YES
0 — NO
<table><tr><th>Bit</th><th>Value</th></tr><tr><td>[7:4] Reserved</td><td>-</td></tr><tr><td>[3] Digital Signature</td><td>0</td></tr><tr><td>[2:1] Reserved</td><td>-</td></tr><tr><td>[0] UDP Sequence</td><td>1</td></tr></table></td></tr>
</table>

3.1.2.3. Body

Field	Byte(s)	Description
Azimuth 1	2	For Block 1: Current reference angle of the azimuth Unit: 0.01°
Block 1	768	Measurements made by each channel (starting from Channel 1) Refer to Each channel in the block.
CRC 1	4	CRC-32/MPEG-2 checksum of the Body For more on the CRC-32/MPEG-2 computation algorithm, refer to: https://www.mathworks.com/matlabcentral/fileexchange/72226-crc-32-mpeg-2-computation-algorithm

Each channel in the block

Field	Byte(s)	Description
Channel 1	3	Fixed: 0x000000
Channel 2	3	Measurements of Channel 2 Distance, 2 bytes: Object distance = **`Distance`** × **`Dis Unit`** **`Dis Unit`** is specified in Section 3.1.2.2 Header. Reflectivity, 1 byte: Range: 0 to 255 0 to 255 linearly represents target reflectivity 0 to 255%. Reflectivity = **`Reflectivity`** field value × 1%
Channel 3	3	Fixed: 0x000000
Channel 4	3	Measurements of Channel 4
…	…	…
Channel 255	3	Fixed: 0x000000
Channel 256	3	Measurements of Channel 256

The unused (odd-numbered) channels are filled with zeros.

3.1.2.4. Functional safety

Field	Byte(s)	Description
Reserved	17	-

3.1.2.5. Tail

<table>
<tr><th>Field</th><th>Byte(s)</th><th>Description</th></tr>
<tr><td>Reserved</td><td>12</td><td>-</td></tr>
<tr><td>Return Mode</td><td>1</td><td>0x33 — First
0x37 — Strongest (default)</td></tr>
<tr><td>Motor Speed</td><td>2</td><td>Unit: 0.1 RPM
Spin rate of the motor (RPM) = frame rate (Hz) × 60</td></tr>
<tr><td>Date & Time</td><td>6</td><td>The whole second part of the Coordinated Universal Time (UTC) of this data packet.
<table>
<tr><th>Each byte</th><th>Range (decimal)</th></tr>
<tr><td>Year (current year minus 1900)</td><td>⩾70</td></tr>
<tr><td>Month</td><td>1 to 12</td></tr>
<tr><td>Day</td><td>1 to 31</td></tr>
<tr><td>Hour</td><td>0 to 23</td></tr>
<tr><td>Minute</td><td>0 to 59</td></tr>
<tr><td>Second</td><td>0 to 59</td></tr>
</table></td></tr>
<tr><td>Timestamp</td><td>4</td><td>The microsecond part of the Coordinated Universal Time (UTC) of this data packet.
Unit: µs
Range: 0 to 999 999 µs (1 s)</td></tr>
<tr><td>Factory Information</td><td>1</td><td>Fixed: 0x42</td></tr>
<tr><td>UDP Sequence</td><td>4</td><td>Sequence number of this data packet
Range: 0 to 0xFF FF FF FF</td></tr>
<tr><td>Reserved</td><td>22</td><td>-</td></tr>
</table>

Field	Byte(s)	Description
CRC 3	4	CRC-32/MPEG-2 checksum of the Tail

3.1.3. Ethernet tail

Field	Byte(s)	Description
FCS	4	Frame check sequence

3.1.4. Point cloud data analysis method

Take **Channel 6** in **Block 1** as an example.

3.1.4.1. Analyze the vertical angle of a data point

The designed vertical angle of **Channel 6** is –7.21°, according to Appendix A Channel distribution data.

- The accurate vertical angles are recorded in the angle correction file of this lidar; see Angle correction file.
- 0° is the horizontal direction. The upward direction is defined as positive; see Figure 4. Channel vertical distribution.

3.1.4.2. Analyze the horizontal angle of a data point

Y-axis is the 0° position. The clockwise direction (in the top view) is defined as positive; see Figure 3. Lidar azimuthal position (top view).

Horizontal angle = ① + ②

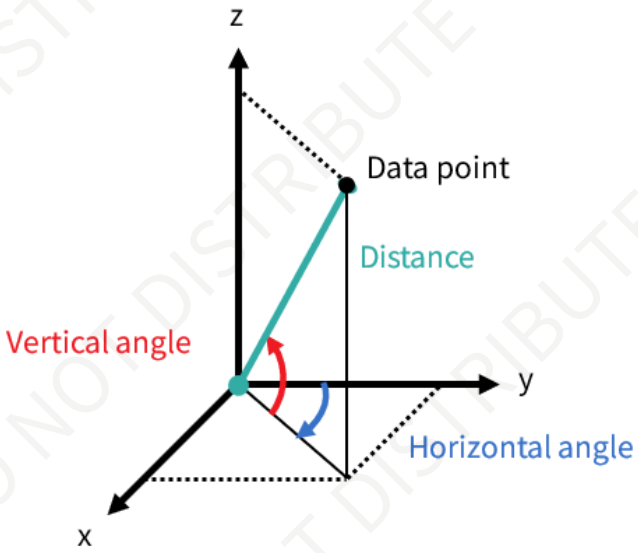
① Azimuth of the current block (see the `Azimuth 1` field in Section 3.1.2.3 Body)
② Azimuth offset of the current firing channel (6.18° for **Channel 6**, according to Appendix A Channel distribution data)

The accurate azimuth offset is recorded in this lidar unit's angle correction file; see Angle correction file.

3.1.4.3. Analyze the distance of a data point

See the `Distance` field of **Block 1: Channel 6** in Section 3.1.2.3 Body.

3.1.4.4. Draw the data point in a spherical or rectangular coordinate system



3.1.4.5. Obtain the real-time point cloud data by analyzing and drawing every data point in each frame

4. Parameter interfaces

Users cannot read or write the parameters in this section.

4.1. Network connection

4.1.1. Source

Source IPv4 Address

Option(s)	Description
Default: 192.168.1.2	UDP
Default: 192.168.1.201	PTC API

Source IPv4 Subnet Mask

Option(s)	Description
Default: 255.255.255.0	Applies to both UDP and PTC ports.

Source IPv4 Gateway

Option(s)	Description
Default: 192.168.1.1	Applies to both UDP and PTC ports.

Ethernet Communication Mode

Option(s)	Description
Slave	Role of the lidar in automotive Ethernet communication. Because the lidar is in **Slave** mode, connection is possible only when the receiving host is in **Master** mode.

4.1.2. Destination

Destination IPv4 Address

Option(s)	Description
192.168.1.100	Destination address for Point Cloud Data Packets

Destination Point Cloud UDP Port

Option(s)	Description
Default: 2368	Destination port for Point Cloud Data Packets

4.2. Functional settings

Return Mode

Option(s)	Description
Single Return: • Strongest (default) • First	The current return mode is shown in Point Cloud Data Packets; see the `Return Mode` field in Section 3.1.2.5 Tail.

Rotation Direction

Option(s)	Description
Clockwise	Direction of motor rotation (in the lidar's top view)

Spin Rate

Option(s)	Description
1200 RPM	Spin rate of the motor The current spin rate is shown in Point Cloud Data Packets; see the **`Motor Speed`** field in Section 3.1.2.5 Tail.

Trigger Method

Option(s)	Description
Angle-Based	The way laser firings are triggered In Angle-Based mode, lasers fire every 0.2° at 20 Hz.

4.3. State settings

Restart

Option(s)	Description
Restart	-

4.4. Upgrade

Upgrade

Option(s)	Description
Upgrade	Upgrade the lidar's firmware and software. (Not yet supported)

5. Maintenance

The lidar's cover lens is made of plastic (polycarbonate, PC), similar to the material used for car lamps.

- Do NOT wipe the cover lens when it is dry, nor use abrasive cleaners. Doing so can damage the optical coating.
- Do NOT use organic cleaners, which can damage the cover lens and even cause cracking.
  - Organic cleaners include but are not limited to tar removers, self-cleaning agents, adhesive removers, coating removers, foam cleaners, iron powder removers for car paint, glass cleaners, thinning agents, de-icers, paint surface treatment agents, alcohol, and vinegar.
  - If organic cleaners may be present when cleaning the equipment or performing related operations, please protect the cover lens to prevent any contact with organic cleaners.
- Do NOT apply excessive force to the lidar, as this can damage the cover lens.
  - If a pressure washer is used to clean the cover lens, make sure the distance between the nozzle and the cover lens remains at least 60 cm.
  - Using automatic cleaning devices that are not specifically designed for lidars may pose risks. Please contact Hesai technical support for assessment.
- After prolonged exposure to strong sunlight and high temperatures, the cover lens should NOT be cleaned immediately.
- If snow or ice accumulates on the cover lens, do NOT use a pressure washer or ice scraper.
  - A small broom is recommended to remove snow.
  - A solvent-free (i.e., free of organic solvents) ice removal spray is recommended to remove ice; alternatively, wait for the ice to melt by itself.
- Do NOT wax the cover lens.

Please regularly check on the cover lens, considering your use frequency, storage environment, and climate conditions.

- If foreign objects (such as dust, fingerprints, or oil stains) are found on the cover lens, make sure to clean them.
- If corrosive foreign objects (such as insect remains, bird droppings, tree resin, road dust, industrial dust, asphalt, soot particles, and road salt) are found on the cover lens, make sure to clean them immediately.

Cleaning procedure

1. Make sure the lidar is powered OFF.

2. Choose an appropriate cleaning agent:
   - For light stains, use room temperature water.
   - For heavier stains, use a mild soap solution (no more than two tablespoons of soap per quart or liter of water).
   - For stubborn stains, use a solvent-free (i.e., free of organic solvents), pH-neutral detergent at room temperature, such as car shampoo.
3. Take a clean soft sponge or anti-static microfiber cloth, dampen it with the chosen cleaning agent, and gently wipe the dirty area on the cover lens back and forth.
4. For stubborn stains, cover the dirty area with the dampened sponge or cloth to soften the stains before wiping.
5. Immediately after removing the stains, rinse the cover lens with clean water. Then, use a clean soft sponge or microfiber cloth to gently wipe away any remaining liquid (which may contain residual cleaning agents or contaminants).

6. Troubleshooting

If the following procedures cannot solve your problem, please contact Hesai technical support.

Symptoms	Points to check
Indicator light is off on the connection box.	Make sure that the following conditions are met: • The power adapter is properly connected and in good condition. • The connection box is intact. • The input voltage and input current satisfy the requirements in Section 2.3 Connection box (optional). Afterward, power on the lidar again and check if the symptom persists
Motor is not running.	Make sure that the following conditions are met: • The power adapter is properly connected and in good condition. • The input voltage and input current satisfy the requirements in Section 1.4 Specifications. • The lidar is not in standby mode; this can be confirmed using PTC commands. • If a connection box is used, the connection box is intact. Afterward, power on the lidar again and check if the symptom persists.
Motor is running, but no output data is received, neither by Wireshark nor by PandarView 2.	Make sure that the following conditions are met: • The Ethernet cable is properly connected (by unplugging and plugging again). • Destination IP is correctly set; this can be confirmed using PTC commands. • Firmware version is correct; this can be confirmed using PTC commands. • The lidar is emitting laser light; this can be confirmed using an infrared camera, an infrared sensor card, or a phone camera without an infrared filter. • If a connection box is used, replace the current Ethernet cable with another cable of at least Cat 6; Cat 7 or higher is recommended. Afterward, power on the lidar again and check if the symptom persists.

Symptoms	Points to check
Output data can be received by Wireshark but not by PandarView 2.	Make sure that the following conditions are met: • Lidar Destination Port is correctly set; this can be confirmed using PTC commands. • The PC's firewall for public networks is turned off, or PandarView 2 is added to the firewall exceptions. • The latest PandarView 2 is installed (please contact Hesai technical support to obtain it). Afterward, power on the lidar again and check if the symptom persists.
The point cloud is abnormal, showing obviously misaligned points, flashing points, or incomplete FOV.	Make sure that the following conditions are met: • The lidar's cover lens is clean. If not, refer to Section 5 Maintenance for the cleaning method. • The lidar's angle correction file is imported (refer to *PandarView 2 User Manual*). • Spin Rate is steady; this can be confirmed either by checking the **`Motor Speed`** field (if available) in Point Cloud Data Packets, or by using PandarView 2 or PTC commands. • The lidar's internal temperature is between –20°C and 110°C; this can be confirmed using PandarView 2 or PTC commands. Afterward, check for packet loss. If no packet is lost yet the point cloud flashes, please follow these steps: 1. Update PandarView 2 to the latest version (please contact Hesai technical support to obtain it). 2. Restart the PC. If the point cloud is still abnormal, try these steps: 1. Connect the lidar to another PC and another network. 2. Power on again and check if the symptom persists.

Symptoms	Points to check
The number of data packets received is abnormal, indicating missing packets.	Make sure that the following conditions are met: • Spin Rate is steady; this can be confirmed either by checking the **`Motor Speed`** field (if available) in Point Cloud Data Packets, or by using PandarView 2 or PTC commands. • The lidar's internal temperature is between –20°C and 110°C; this can be confirmed using PandarView 2 or PTC commands. • Ethernet is not overloaded. • No switch is connected to the network (the data transmitted from other devices may cause network congestion and packet loss). Afterward, follow these steps: 1. Connect the PC to no other devices but the lidar and check for packet loss. 2. Power on the lidar again and check if the symptom persists.

Appendix A: Channel distribution data

Notes to the table

Channel number	Counts from 1, bottom to top (only the even-numbered channels fire laser pulses).
Angular position	Design values of each channel's horizontal (azimuth) angle offset and vertical (elevation) angle. • The accurate values are recorded in this lidar unit's angle correction file. • Refer to Section 3.1.4 Point cloud data analysis method for data analysis method.

Channel No.	Angular position	
	Horiz. offset (°)	Vertical (°)
2	6.36	–9.31
4	8.27	–8.28
6	6.18	–7.21
8	8.08	–6.23
10	6.02	–5.21
12	7.92	–4.27
14	5.88	–3.30
16	7.78	–2.39
18	5.75	–1.46
20	7.65	–0.58
22	5.63	0.32
24	7.53	1.18
26	5.51	2.04
28	7.42	2.89
30	5.41	3.73
32	7.32	4.56
34	–6.02	5.39
36	–4.03	6.18
38	–5.97	7.00
40	–3.97	7.78

Channel No.	Angular position	
	Horiz. offset (°)	Vertical (°)
42	–5.92	8.59
44	–3.92	9.35
46	–5.87	10.15
48	–3.86	10.90
50	–5.83	11.69
52	–3.81	12.42
54	–5.79	13.21
56	–3.75	13.93
58	–5.75	14.71
60	–3.70	15.43
62	–5.71	16.19
64	–3.65	16.91
66	6.30	17.62
68	8.34	18.34
70	6.25	19.09
72	8.31	19.80
74	6.19	20.54
76	8.28	21.24
78	6.15	21.98
80	8.26	22.68

Channel No.	Angular position	
	Horiz. offset (°)	Vertical (°)
82	6.10	23.42
84	8.24	24.12
86	6.06	24.84
88	8.23	25.54
90	6.02	26.26
92	8.22	26.96
94	5.99	27.68
96	8.21	28.37
98	–7.15	29.09
100	–4.88	29.78
102	–7.14	30.49
104	–4.84	31.18
106	–7.14	31.89
108	–4.80	32.58
110	–7.14	33.29
112	–4.76	33.98
114	–7.14	34.69
116	–4.73	35.38
118	–7.14	36.09
120	–4.69	36.77

Channel No.	Angular position	
	Horiz. offset (°)	Vertical (°)
122	–7.15	37.48
124	–4.66	38.17
126	–7.17	38.88
128	–4.62	39.56
130	8.34	40.27
132	10.96	40.97
134	8.33	41.67
136	11.00	42.37
138	8.31	43.07
140	11.05	43.77
142	8.30	44.47
144	11.11	45.17
146	8.30	45.88
148	11.18	46.58
150	8.30	47.29
152	11.26	47.99
154	8.31	48.70
156	11.36	49.41
158	8.33	50.12
160	11.47	50.83

Channel No.	Angular position	
	Horiz. offset (°)	Vertical (°)
162	–10.66	51.56
164	–7.48	52.27
166	–10.75	52.99
168	–7.48	53.70
170	–10.87	54.43
172	–7.48	55.15
174	–11.00	55.88
176	–7.49	56.60
178	–11.15	57.34
180	–7.51	58.07
182	–11.32	58.81
184	–7.54	59.55
186	–11.53	60.29
188	–7.57	61.04
190	–11.76	61.79
192	–7.62	62.55
194	29.06	63.34
196	34.18	64.00
198	29.60	64.83
200	35.07	65.48

Channel No.	Angular position	
	Horiz. offset (°)	Vertical (°)
202	30.26	66.34
204	36.12	66.98
206	31.05	67.87
208	37.38	68.48
210	32.03	69.41
212	38.91	69.99
214	33.23	70.97
216	40.78	71.51
218	34.73	72.55
220	43.10	73.04
222	36.64	74.14
224	46.03	74.56
226	–10.59	75.42
228	–2.59	76.12
230	–11.11	77.19
232	–2.00	77.91
234	–11.88	79.01
236	–1.22	79.75
238	–13.04	80.89
240	–0.10	81.67

Channel No.	Angular position	
	Horiz. offset (°)	Vertical (°)
242	–14.99	82.84
244	1.71	83.65
246	–18.74	84.87
248	5.28	85.73
250	–28.37	86.96
252	16.42	87.89
254	–74.62	88.71
256	115.05	89.12

Appendix B: Legal notice

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