HESAI

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Q01-en-1902A1

PandarQT

64-Channel Short-Range Mechanical LiDAR User Manual

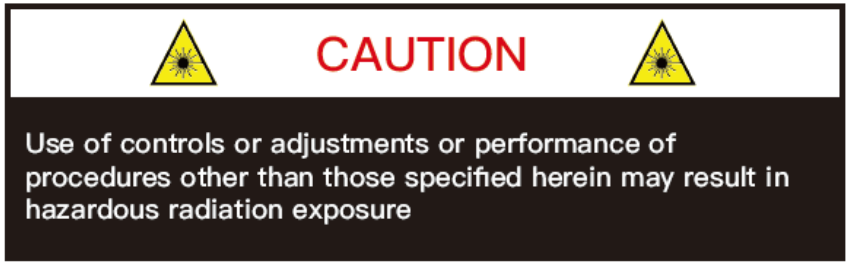
HESAI WeChat

Safety Notice

PLEASE READ AND FOLLOW ALL INSTRUCTIONS CAREFULLY AND CONSULT ALL RELEVANT NATIONAL AND INTERNATIONAL SAFETY REGULATIONS FOR YOUR APPLICATION.

■ Caution

To avoid violating the warranty and to minimize the chances of getting electrically shocked, please do not disassemble the device on your own accord. The device must not be tampered with and must not be changed in any way. There are no user-serviceable parts inside the device. For repairs and maintenance inquiries, please contact an authorized Hesai Technology service provider.



■ Laser Safety Notice – Laser Class 1

This device satisfies the requirements of

- IEC 60825-1:2014
- 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed.3, as described in Laser Notice No.56, dated May 8, 2019

NEVER LOOK INTO THE TRANSMITTING LASER THROUGH A MAGNIFYING DEVICE (MICROSCOPE, EYE LOUPE, MAGNIFYING GLASS, ETC.)

■ Safety Precautions

In all circumstances, if you suspect that the device malfunctions or is damaged, stop using it immediately to avoid potential hazards and injuries. Contact an authorized Hesai Technology service provider for more information on device disposal.

Handling

This device contains metal, glass, plastic, as well as sensitive electronic components. Improper handling such as dropping, burning, piercing, and squeezing may cause damage to the device.

Enclosure

This device contains high-speed rotating parts. To avoid potential injuries, DO NOT operate the device if the enclosure is loose or damaged.

Repair

DO NOT open and repair the device without direct guidance from Hesai Technology. Disassembling the LiDAR may cause degraded performance, failure in water resistance, or potential injuries to the operator.

Power Supply

Use only the cables and power adapters provided by Hesai Technology. Only the power adapters that meet the device's power requirements and the applicable safety standards can be used. Using damaged cables/adapters or supplying power in a humid environment can result in fire, electric shock, personal injuries, product damage, or property loss.

Prolonged Exposure to Hot Surface

Prolonged exposure to the device's hot surface may cause discomfort or injury. If the device has been powered and operating for a long time, avoid skin contact with the device or its power adapter.

Vibration

Strong vibration may cause damage to the device and should be avoided.

Radio Frequency Interference

Please observe the signs and notices on the device that prohibit or restrict the use of electronic devices. Although the device is designed, tested, and manufactured to comply with the regulations on RF radiation, the radiation from the device may still influence other electronic devices.

Medical Device Interference

Some components in the device can emit electromagnetic fields, which may interfere with medical devices such as cochlear implants, heart pacemakers and defibrillators. Consult your physician and medical device manufacturers for specific information regarding your medical device and whether you need to keep a safe distance from the LiDAR. If you suspect that the LiDAR is interfering with your medical device, stop using the LiDAR immediately.

Explosive Atmosphere and Other Air Conditions

Do not use the device in any area where potentially explosive atmospheres are present, such as high concentrations of flammable chemicals, vapors or particulates (including particles, dust, and metal powder) in the air. Exposing the device to high concentrations of industrial chemicals, including liquefied gases that are easily vaporized (such as helium), can damage or weaken the device's function. Please observe all the signs and instructions on the device.

Light Interference

Some precision optical instruments may be interfered by the laser light emitted from the device.

Eye Safety

Although the device meets Class 1 eye safety standards, operators should still avoid looking directly at the LiDAR for maximum self-protection.

Contents

1 Introduction

This manual describes the specifications, installation, and data output format of PandarQT, a 64-channel mechanical LiDAR.

This manual is under constant revision. Please contact Hesai for the latest version.

1.1 Operating Principle

Distance Measurement: Time of Flight (ToF)

1) A laser diode emits a beam of ultrashort laser pulses onto the object.
2) Diffuse reflection of the laser occurs upon contact with the target object. The beams are detected by the optical sensor.
3) Distance to object can be accurately measured by calculating the time between emission and receipt by the sensor.

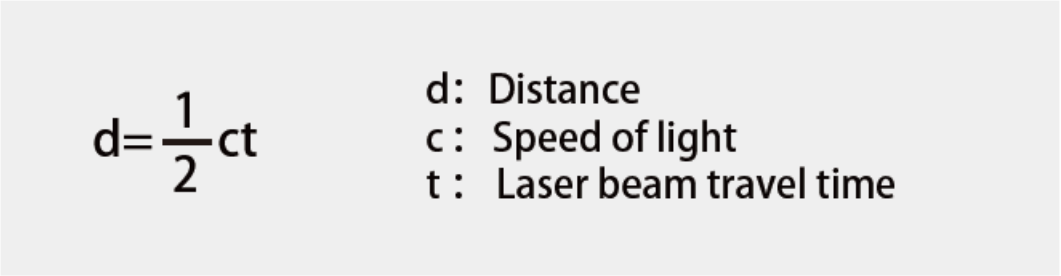


Figure 1.1 ToF Formula

1.2 LiDAR Structure

64 pairs of laser emitters and receivers are attached to a motor that rotates horizontally.

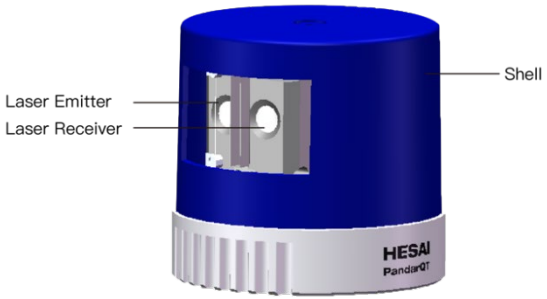


Figure 1.2 Partial Cross-Sectional Diagram

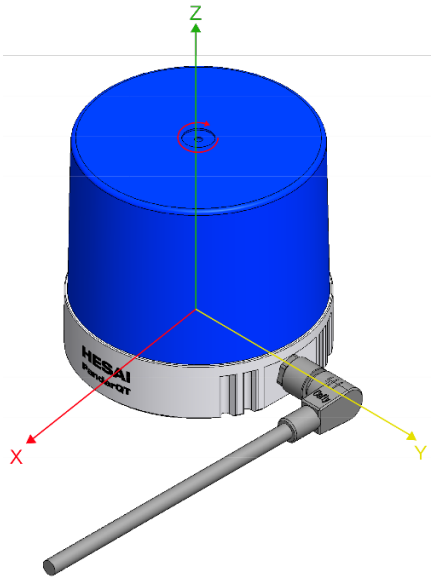


Figure 1.3 Coordinate System (Isometric View)

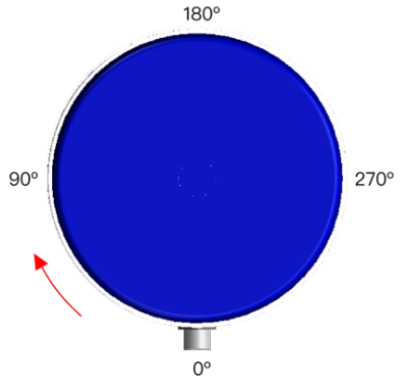


Figure 1.4 Rotation Direction (Top View)

The LiDAR's coordinate system is shown above. The Z-axis is the axis of rotation.
The origin is shown as a red dot in Figure 1.6 on the next page. After geometric transform, all the measurements are relative to the origin.

Each laser channel has an intrinsic horizontal angle offset. When Channel 18 passes the zero degree position illustrated in Figure 1.4, the azimuth data in the corresponding UDP data block will be 0°.

1.3 Channel Distribution

The vertical resolution is unevenly distributed across all channels.

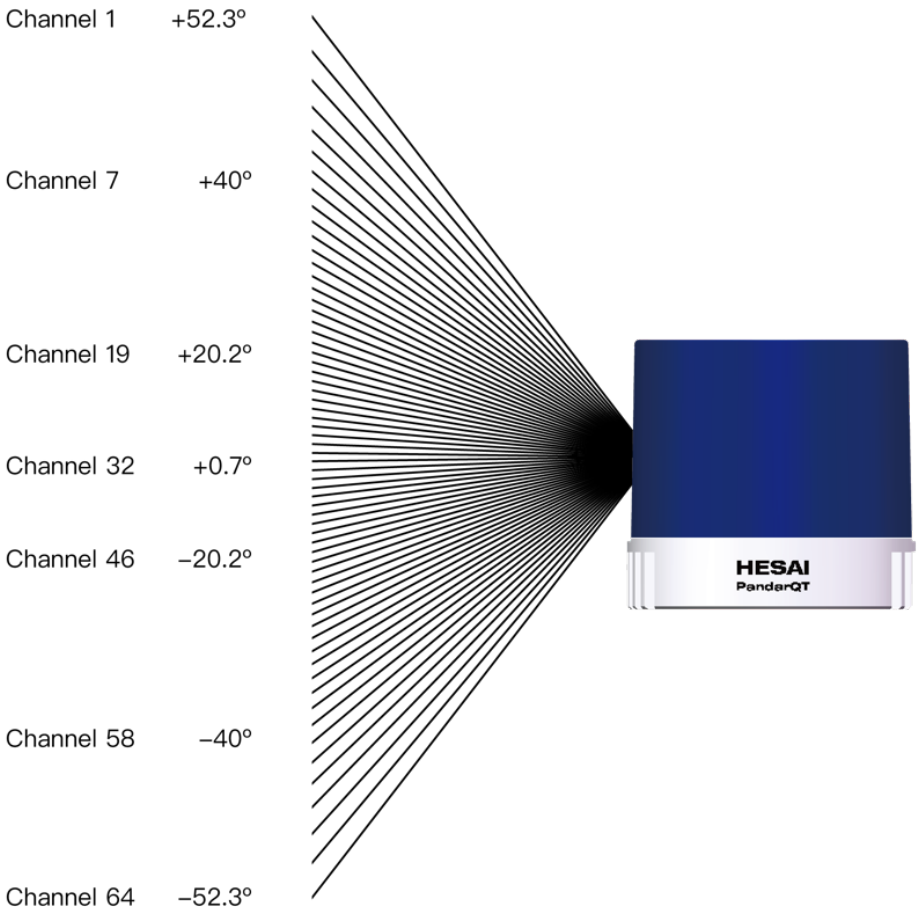


Figure 1.5 Channel Vertical Distribution

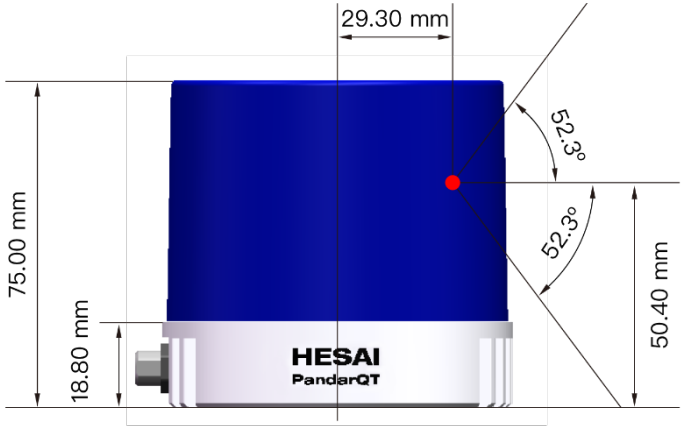


Figure 1.6 Laser Firing Position

1.4 Specifications

SENSOR	
Scanning Method	Mechanical Rotation
Channel	64
Range	0.1 to 20 m (at 10% reflectivity)
Range Accuracy	±5 cm (0.1 to 0.5 m) ±2.5 cm (0.5 to 15 m) ±10 cm (15 to 30 m)
FOV (Horizontal)	360°
Resolution (Horizontal)	0.6°
FOV (Vertical)	104.6° (-52.3° to +52.3°)
Resolution (Vertical)	Finest at 1.4°
Frame Rate	10 Hz
Returns	Single/Dual

MECHANICAL/ELECTRICAL/OPERATIONAL	
Laser Class	Class 1 Eye Safe
Waterproof Grade	IPX7
Weight	0.4 kg
Dimensions	Height: 75.0 mm Diameter: 80.2 mm
Operating Voltage	9~65 VDC
Power Consumption	7 W
Operating Temperature	-20℃ to 65℃

DATA I/O	
Data Transmission	UDP/IP Ethernet (100BASE-T1 Slave Mode)
Data Outputs	Distance, Azimuth Angle, Background Illumination
Data Points Generated	Single Return Mode: 384,000 pts/s Dual Return Mode: 768,000 pts/s
Clock Source	GPS / PTP
PTP Clock Accuracy	⩽1 μs
PTP Clock Drift	⩽1 μs/s

NOTE Specifications are subject to change without notice.
NOTE Range accuracy as the average range error across all channels may vary with range, temperature and target reflectivity.

2 Setup

2.1 Mechanical Installation

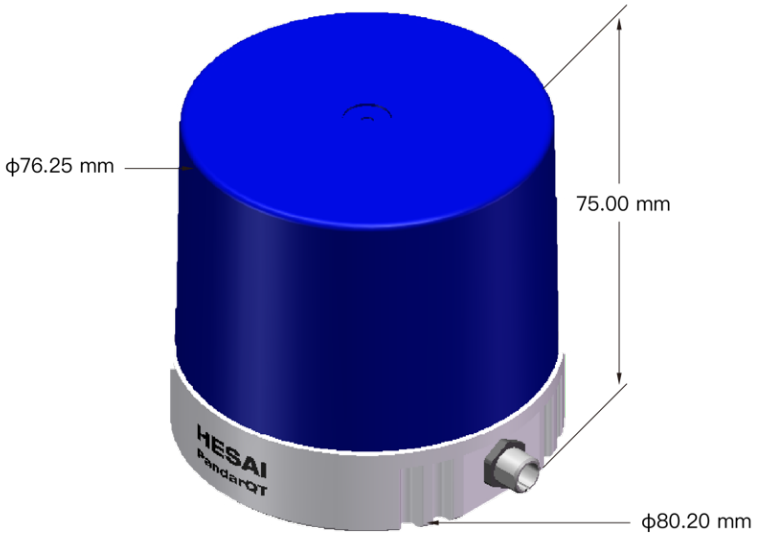


Figure 2.1 Isometric View

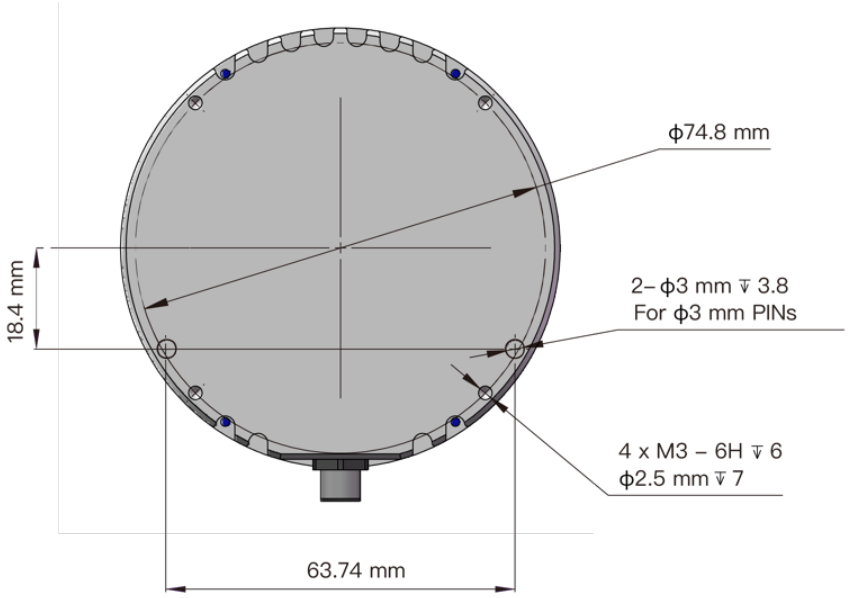


Figure 2.2 Mounting Base

■ Installation

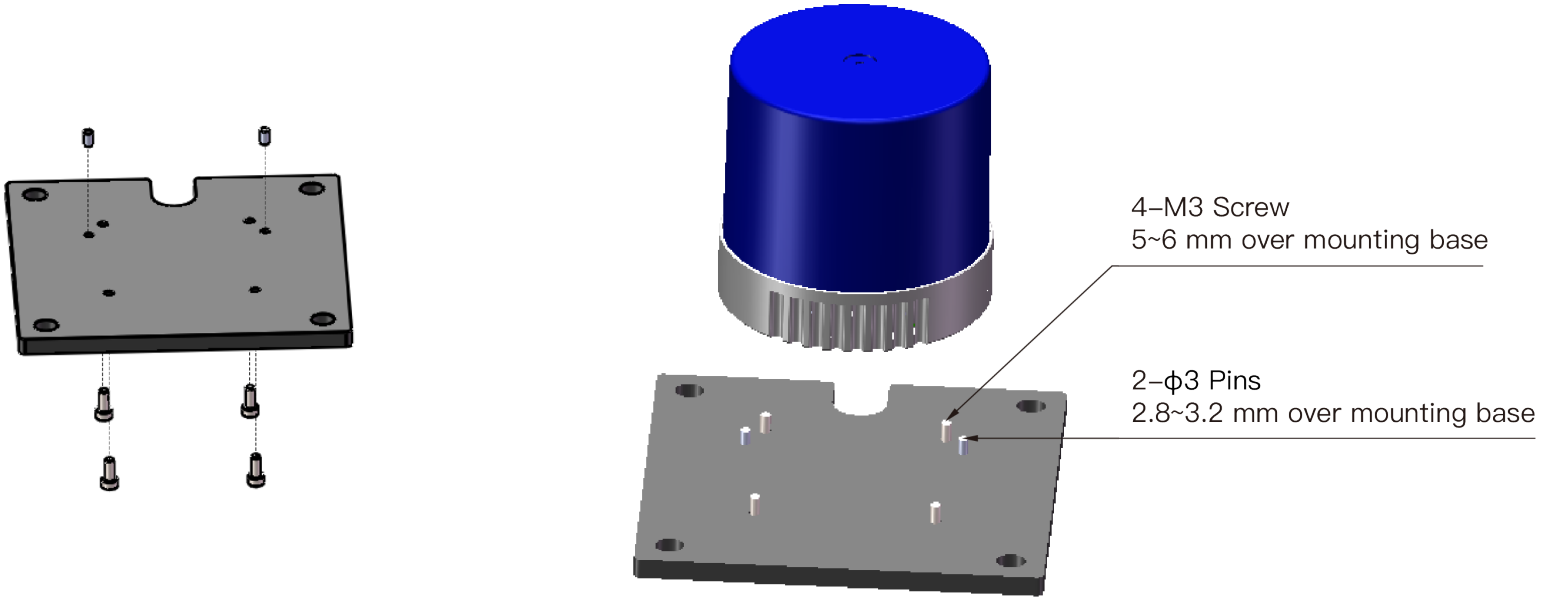


Figure 2.3 Installation Diagram

2.2 Interfaces

PandarQT by default uses a 4-pin M8 male socket (with needles inside), which includes power wires and 100BASE-T1 twist-pairs. Another option is an 8-pin male socket with the same size. The use of 4-pin M8 sockets is strongly recommended.

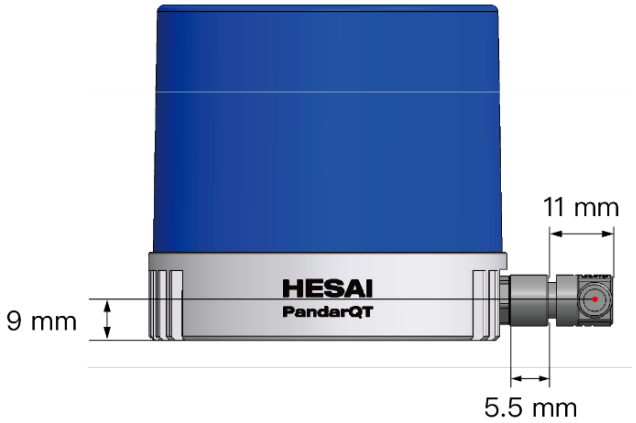
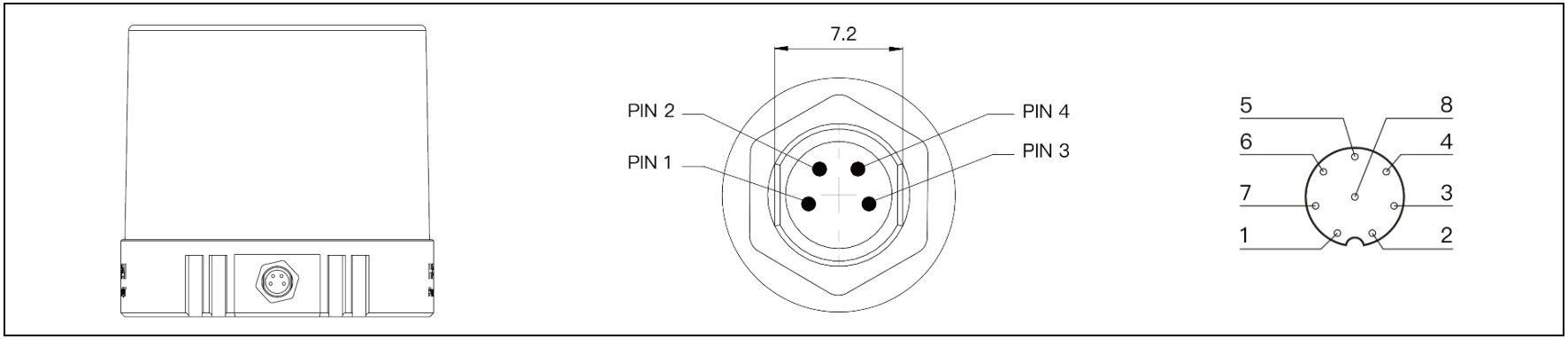


Figure 2.4 Connector Dimensions



Connector 4-pin 8-pin

Figure 2.5 PandarQT Connector Options (Male socket, on the LiDAR)

The 4-pin male socket (recommended):

Pin #	Description
1	VIN
2	GND
3	Ethernet_TRX+
4	Ethernet_TRX-

The 8-pin male socket (optional, not recommended):

Pin #	Description
1	VIN
2	Ethernet_TRX-
3	Ethernet_TRX+
4	GPS_RX
5	GPS_PPS
6	Sync_N
7	Sync_P
8	GND

Cables

The optional cable for connecting QT to the connection box is 2 m in length.

Contact Hesai if you need customized cables for connecting the LiDARs to your control units directly. The maximum allowable diameter of power wires is 0.511 mm, 24 AWG.

When choosing cables, please check their voltage drop and power consumption to ensure a minimum of 9 V DC input to the LiDARs.

TYPE	Diameter (mm)	Resistance/meter (Ohm)	Max Voltage Drop over 1 m cable (V)	Max Voltage Drop over 6 m cable (V)	Average Power Consumption over 1 m cable (W)	Average Power Consumption over 6 m cable (W)
24AWG	0.511	0.0894	0.1788	1.0728	0.064368	0.386208

2.3 Connecting Box (Optional)

This device converts automotive 100BASE-T1 to 100BASE-TX typical Ethernet, as well as providing a power port with 5.5 mm X 2.1 mm socket and a GPS port.
Users may connect the LiDAR directly or use the connecting box.
The cable length from the connector to the connecting box is 2 m by default.

NOTE The GPS port only supports 8-pin cables.

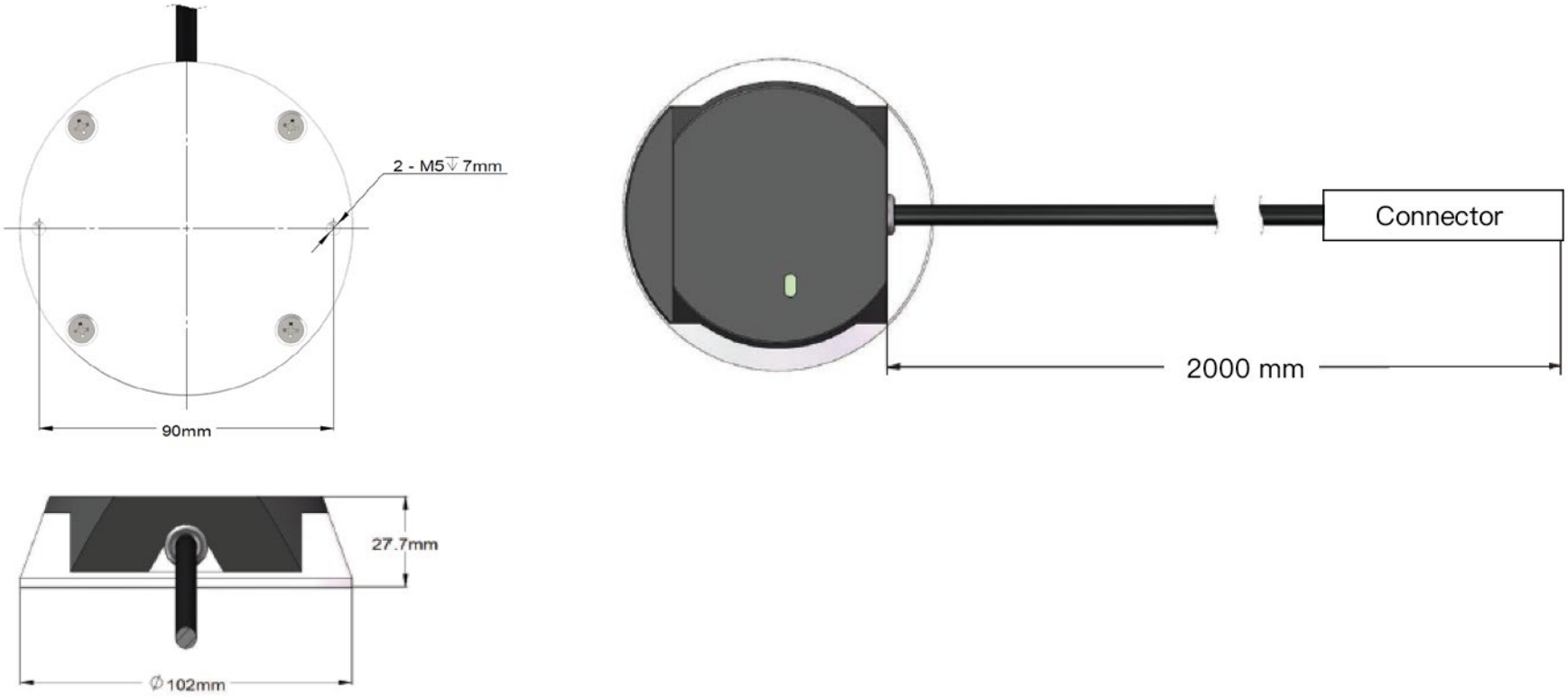


Figure 2.6 Connecting Box

2.3.1 Connecting Box Interfaces

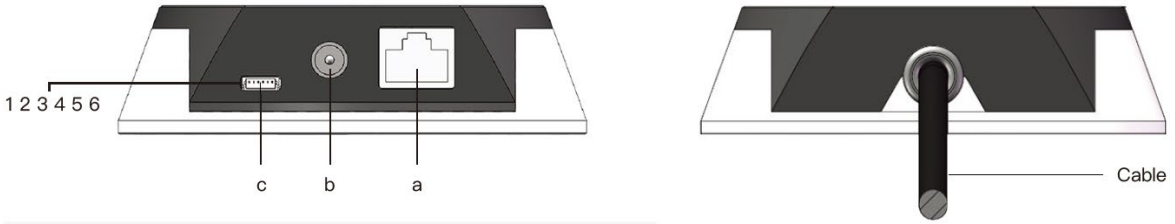


Table 2.2 Connecting Box Interfaces

Port #	Port Name	Description
a	Standard Ethernet Port	RJ45, 100BASE-TX Ethernet
b	Power Port	DC power adapter with voltage ranging from 12 V to 48 VDC and a minimum power output of 18 W is suggested
c	GPS Port	Connector type: JST SM06B-SRSS-TB Recommended connector for the external GPS module: JST SHR-06V-S-B Voltage standard: RS232 Baud rate: 9600 bps

The GPS port pin numbers are 1 to 6 from left to right, defined as follows:

Table 2.3 GPS Pin Description

Pin #	Direction	Pin Description	Requirements
1	Input	PPS (pulse-per-second) signal for synchronization	TTL level 3.3 V/5 V Pulse width: 1 ms or longer is recommended Cycle: 1 s (from rising edge to rising edge)
2	Output	Power for the external GPS module	5 V
3	Output	Ground for the external GPS module	-
4	Input	Receiving serial data from the external GPS module	RS232 level
5	Output	Ground for the external GPS module	-
6	Output	Transmitting serial data to the external GPS module	RS232 level

2.3.2 Connection

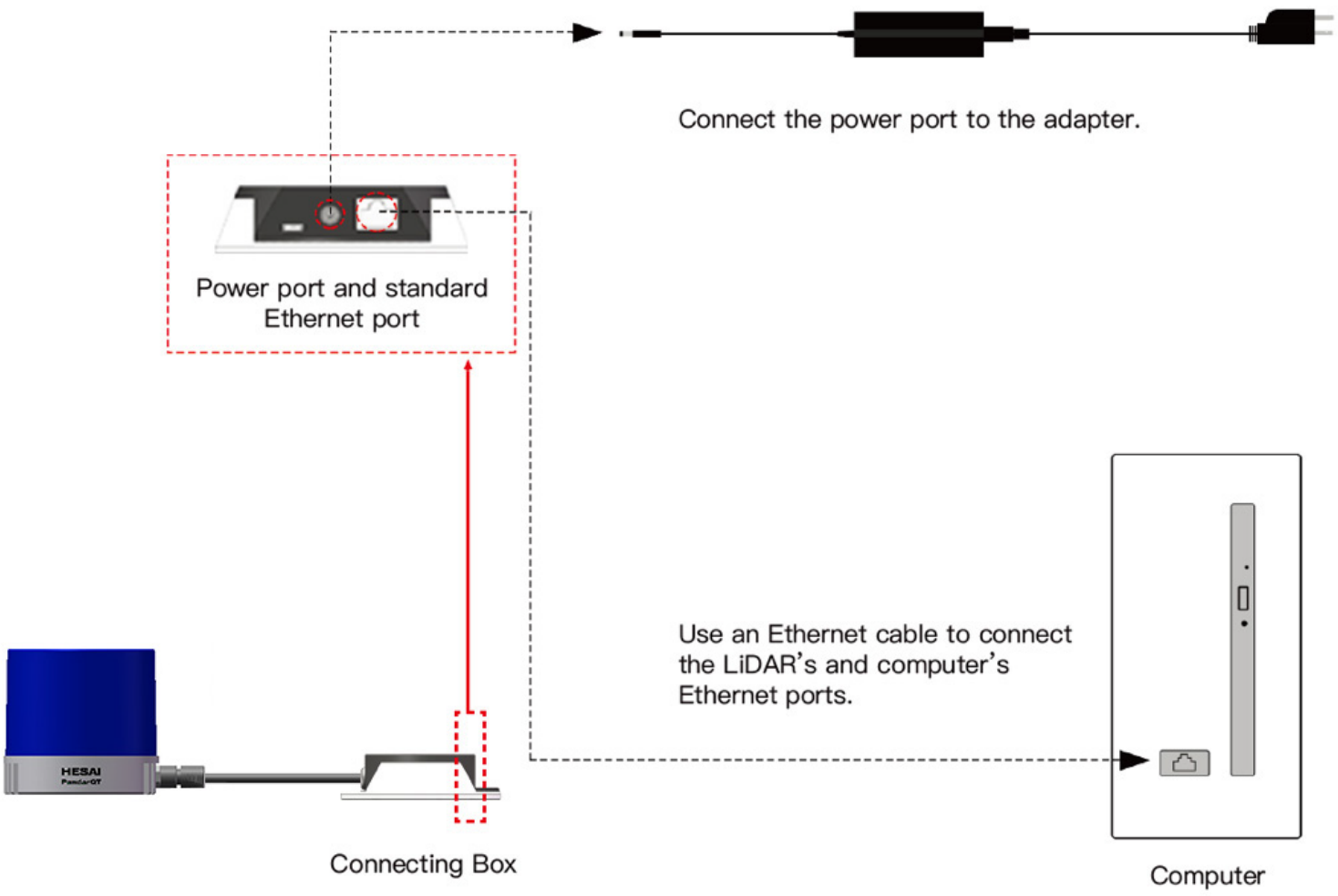


Figure 2.7 LiDAR Connection When Using the Connecting Box

NOTE Refer to Appendix I when PTP protocol is used.

2.4 Use

The Pandar family LiDARs do not have a power switch. They start operating once wired and powered up.

- To receive data on your PC, set the PC's IP address to 192.168.1.100 and subnet mask to 255.255.255.0

For Ubuntu-16.04:	For Windows:
Use the ifconfig command in the terminal: ~$ sudo ifconfig enp0s20f0u2 192.168.1.100 (replace enp0s20f0u2 with the local network port name)	1) Open the Network Sharing Center, click on "Ethernet" 2) In the "Ethernet Status" interface, click on "Properties" 3) Double-click on "Internet Protocol Version 4 (TCP/IPv4)" 4) Configure the IP address to 192.168.1.100 and subnet mask to 255.255.255.0

- To record and display point cloud data, see Chapter 5 PandarView
- To set parameters, check device info, and upgrade firmware, see Chapter 4 Web Control
- The SDK (Software Development Kits) download links can be found at www.hesaitech.com/en/download

3 Data Structure

Fast Ethernet UDP/IP is used for data output. The output data includes Point Cloud Data Packets and GPS Data Packets. Each data packet consists of an Ethernet header and UDP data.

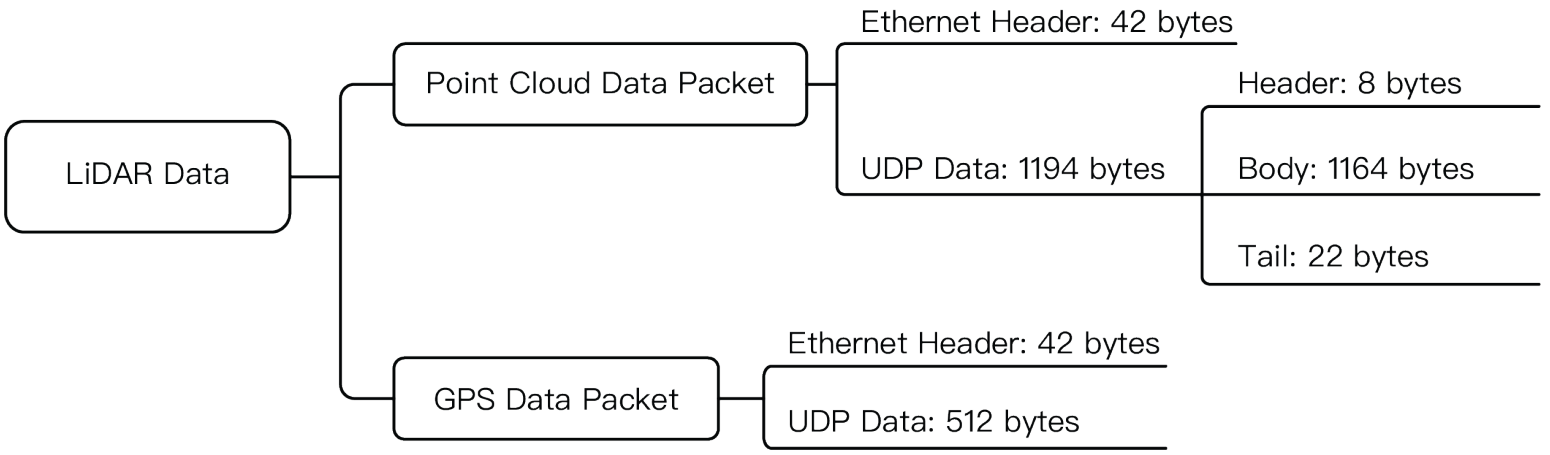


Figure 3.1 Data Structure with UDP Sequence OFF

The UDP sequence feature is OFF by default. When UDP sequence is ON, the Tail in the UDP data changes from 22 bytes to 26 bytes.

3.1 Point Cloud Data Packet

3.1.1 Ethernet Header

Each LiDAR has a unique MAC address.
The source IP is 192.168.1.201 by default. The destination IP address is 0xFF FF FF FF and in broadcast form.

Ethernet Header: 42 bytes		
Ethernet II MAC	12 bytes	Destination: broadcast (0xFF: 0xFF: 0xFF: 0xFF: 0xFF: 0xFF) Source: (xx:xx:xx:xx:xx:xx)
Ethernet Data Packet Type	2 bytes	0x08, 0x00
Internet Protocol	20 bytes	Shown in Figure 3.2
UDP Port Number	4 bytes	UDP source port (0x2710, representing 10000) Destination port (0x0940, representing 2368)
UDP Length	2 bytes	0x04b2 when UDP sequence is OFF, representing 1202 bytes (8 bytes more than the size of the Point Cloud UDP Data, shown in Figure 3.1) 0x04b6 when UDP sequence is ON, representing 1206 bytes
UDP Checksum	2 bytes	-

Table 3.1 Point Cloud Data Packet – Ethernet Header

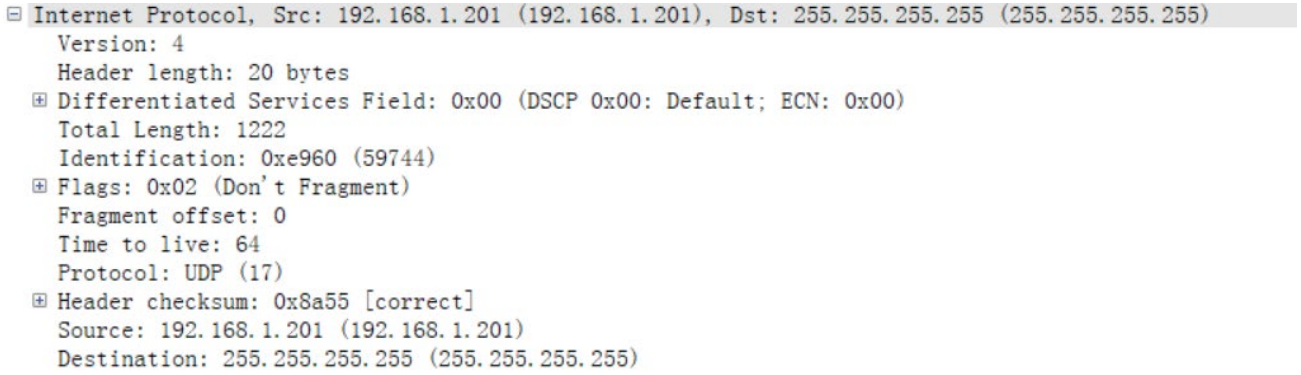


Figure 3.2 Point Cloud Ethernet Header – Internet Protocol

3.1.2 UDP Data

All the multi-byte values are unsigned and in little endian format.

Header

Header: 8 bytes		
0xEEFF	2 bytes	SOP (start of packet), 0xEE first
Laser N	1 byte	0x40 (64 channels)
Block N	1 byte	0x6 (6 blocks per packet)
Reserved	1 byte	-
Dis Unit	1 byte	4 mm
Reserved	1 byte	-
Reserved	1 byte	-

Table 3.4 Point Could UDP Data – Header

Body

Body: 1164 bytes (6 blocks)				
Block 1	**Block 2**	**Block 3**	**…**	**Block 6**
Azimuth 1	Azimuth 2	Azimuth 3	…	Azimuth 6
Channel 1	Channel 1	Channel 1	…	Channel 1
Channel 2	Channel 2	Channel 2	…	Channel 1
…	…	…	…	…
Channel 64	Channel 64	Channel 64	…	Channel 64

Table 3.5 Point Could UDP Data – Body

Block size = 64 * Size of Channel XX + Size of Azimuth

NOTE Under the Dual Return mode, the ranging data from each firing is stored in two adjacent blocks: the odd number block is the last return, and the even number block is the strongest return. If the last and strongest returns coincide, the second strongest return will be placed in the even number block. The azimuth changes every two blocks.

Each Block in the Body: 194 bytes			
Azimuth	2 bytes	Current reference angle of the rotor Azimuth[15:0]: lower byte Azimuth_L[7:0], upper byte Azimuth_H[15:8]. Azimuth Angle = [Azimuth_H, Azimuth_L] / 100° = Azimuth / 100°	
Channel XX	3 bytes	2-byte distance data	Distance[15:0]: lower byte Distance_L[7:0], upper byte Distance_H[15:8] Distance Value = [Distance_H, Distance_L] * 4 mm = Distance * 4 Maximum Distance Value = (2 ^ 16 – 1) * 4 mm = 262.14 m
		1-byte background illumination data	Relative brightness of the receiving FOV Synchronized to the point cloud, but not related to the emitting laser pulse or distance

Table 3.6 Point Cloud UDP Data – Block Definition

Tail

Tail: 22 (+4) bytes		
Reserved	5 bytes	-
High Temperature Shutdown Flag	1 byte	0x01 for high temperature; 0x00 for normal operation When high temperature is detected, the shutdown flag will be set to 0x01, and the system will shut down after 60 s. The flag remains 0x01 during the 60 s and the shutdown period When the system is no longer in high temperature status, the shutdown flag will be reset to 0x00 and the system will automatically return to normal operation
Reserved	2 bytes	-
Motor Speed	2 bytes	speed_2_bytes [15:0] = speed (RPM)
GPS Timestamp	4 bytes	Packing time of this data packet, in units of 1 μs Range: 0 to 1000000 μs (1 s)
Return Mode Information	1 byte	0x37 for Strongest Return mode, 0x38 for Last Return mode, and 0x39 for Dual Return mode
Factory Information	1 byte	0x42 (or 0x43)
UTC	6 bytes	Year, month, date, hour, minute, second, decimal digit
UDP Sequence	4 bytes	Added only when UDP sequence is ON Label the sequence number of Point Cloud UDP packets, 1 to 0xFF FF FF FF in little endian format

Table 3.7 Point Cloud Data UDP Data – Tail

Example of UDP Data Analysis

Take PandarQT's Channel 5 in Block 3 of the UDP Data as an example:

1) Vertical angle of Channel 5 is 43.877°, according to the calibration file included with each LiDAR.
1. Horizontal angle is the current reference angle of the rotor (Azimuth of Block 3) plus the horizontal angle offset (7.388°, according to the calibration file included with each LiDAR). Define clockwise in the top view as the horizontal angles' positive direction
2. The 2-byte distance data in the UDP Data Packet, multiplied by 4 mm, is the actual distance in real world millimeters.

After determining the horizontal angle, vertical angle, and distance of a data point, this point can be drawn in a polar or rectangular coordinate system. The real-time point cloud data is drawn by analyzing every point in the UDP data.

3.2 GPS Data Packet

GPS Data Packets are triggered every second. All the multi-byte values are unsigned and in little endian format.

Before $GPRMC messages are available from the external GPS module
Each rising edge of the LiDAR's internal 1 Hz signal triggers a GPS Data Packet.
The time and date in the GPS Data Packets are unreal, starting from 00 01 01 00 00 00 (year, month, day, hour, minute, second) and increasing with the internal 1 Hz signal.

Once the LiDAR receives the PPS (pulse-per-second) signal and $GPRMC messages
The internal 1 Hz signal will be locked to the PPS. Each rising edge still triggers a GPS Data Packet.
Meanwhile, the LiDAR will extract the actual UTC time and date from $GPRMC messages, and stamp them into both Point Cloud Data Packets and GPS Data Packets.

- Point Cloud Data Packets: 6-byte UTC Time (year, month, day, hour, minute, second) in decimal
- GPS Data Packets: 6-byte Date (year, month, day) and 6-byte Time (second, minute, hour) in ASCII

The GPS module sends first the PPS signal and then the $GPRMC message. At the rising edge of the PPS pulse, the corresponding $GPRMC message is not yet available. Therefore, the LiDAR extracts UTC information from the previous $GPRMC message and automatically adds 1 full second. Users need not worry.

When GPS signal is lost
The LiDAR will still trigger GPS Data Packets by the rising edge of the internal 1 Hz signal. However, the GPS time in the packets will be counted by the internal 1 Hz signal and will drift from the actual GPS time.

3.2.1 Ethernet Header

The source IP is 192.168.1.201 by default. The destination IP address is 0xFF FF FF FF and in broadcast form.

Table 3.5 GPS Data Packet – Ethernet Header

Ethernet Header: 42 bytes		
Ethernet II MAC	12 bytes	Destination: broadcast (0xFF: 0xFF: 0xFF: 0xFF: 0xFF: 0xFF) Source: (xx:xx:xx:xx:xx:xx)
Ethernet Data Packet Type	2 bytes	0x08, 0x00
Internet Protocol	20 bytes	Shown in the figure below
UDP Port Number	4 bytes	UDP source port (0x2710, represents 10000) Destination port (0x277E, represents 10110)
UDP Length	2 bytes	0x208, representing 520 bytes (8 bytes more than the size of the GPS UDP Data, shown in Figure 3.1)
UDP Checksum	2 bytes	-

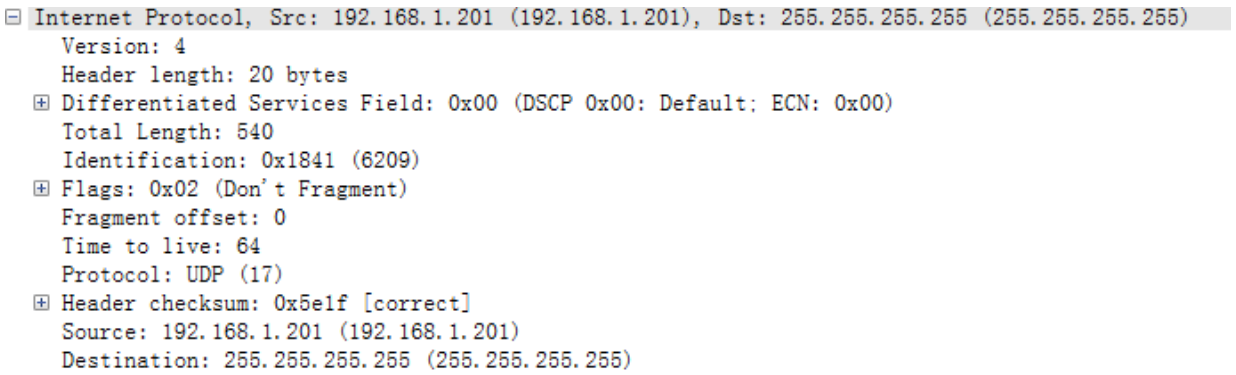


Figure 3.3 GPS Ethernet Header – Internet Protocol

3.2.2 UDP Data

Table 3.6 GPS Data Packet – UDP Data

GPS UDP data: 512 bytes				
GPS time data	18 bytes	Header	2 bytes	0xFFEE, 0xFF first
		Date	6 bytes	Year, month, and day (2 bytes each, lower byte first) in ASCII
		Time	6 bytes	Second, minute, and hour (2 bytes each, lower byte first) in ASCII
		µs Time	4 bytes	In units of µs (lower byte first)
GPRMC data	77 bytes	ASCII code, valid till 2 bytes after '*'		
reserved	411 bytes	411 bytes of 0xDF		
validity of location	1 byte	ASCII code, obtained from $GPRMC A (hex = 41) for Valid Position, V (hex = 56) for Invalid Position, and NUL (hex = 0) for GPS being unlocked		
flag of PPS lock	1 byte	1 – locked 0 – unlocked		
reserved	4 bytes	-		

Example of UDP Data Analysis in GPS Data Packets

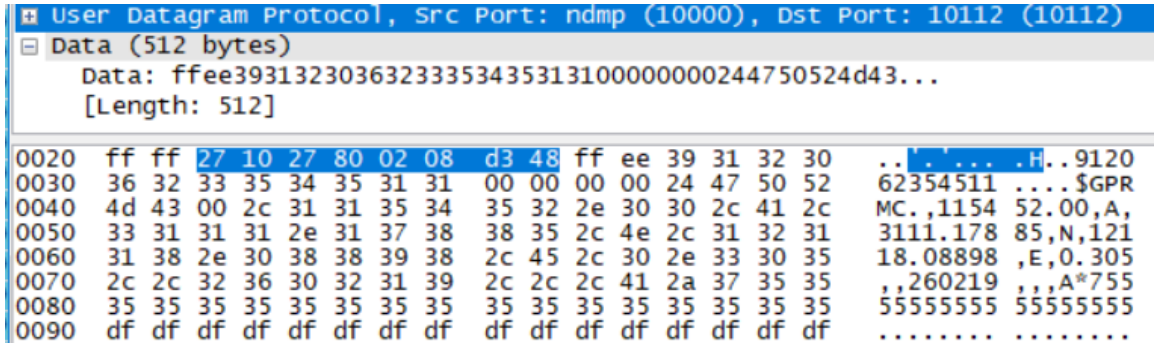


Figure 3.4 GPS Data Packet – UDP Data (Example)

Date

Field	Data (ASCII Code)	Characters	Meaning
Year	0x39 0x31	'9', '1'	19
Month	0x32 0x30	'2', '0'	02
Day	0x36 0x32	'6', '2'	26

(UTC) Time

Field	Data (ASCII Code)	Characters	Meaning
Second	0x33 0x35	'3', '5'	53
Minute	0x34 0x35	'4', '5'	54
Hour	0x31 0x31	'1', '1'	11

µs Time

4 bytes, in units of µs, using the same clock source as the GPS Timestamp in Point Cloud Data Packets
Reset to 0 at the rising edge of each PPS signal

GPRMC Data Format

The standard $GPRMC data format:

$GPRMC, <01>, <02>, <03>, <04>, <05>, <06>, <07>, <08>, <09>, <10>, <11>, <12>*hh

<01> UTC Time, hhmmss (hour, minute, second) format
<02> Location Status, A (hex = 41) for Valid Position, V (hex = 56) for Invalid Position, and NUL (hex = 0) for GPS being unlocked
<03> Latitude, ddmm.mmmm (degree, minute) format
<04> Latitude, Northern (N) or Southern (S) Hemisphere
<05> Longitude, dddmm.mmmm (degree, minute) format
<06> Longitude, Eastern (E) or Western (W) Hemisphere
<07> Ground Rate (000.0 to 999.9 knots)
<08> Ground Direction (000.0 ~ 359.9 degrees, referencing true north)
<09> UTC Date, ddmmyy (day, month, year) format

<10> Declination (000.0 to 180.0 degrees)
<11> Declination Direction, E (east) or W (west)
<12> Mode (only on version NMEA0183 3.00, A = Automatic Positioning, D = Differential, E = Estimation, N = Invalid Data)

The LiDAR's GPS data interface is compatible with a variety of formats. as long as:
<01> is the hour, minute, and second information
<09> is the date information.

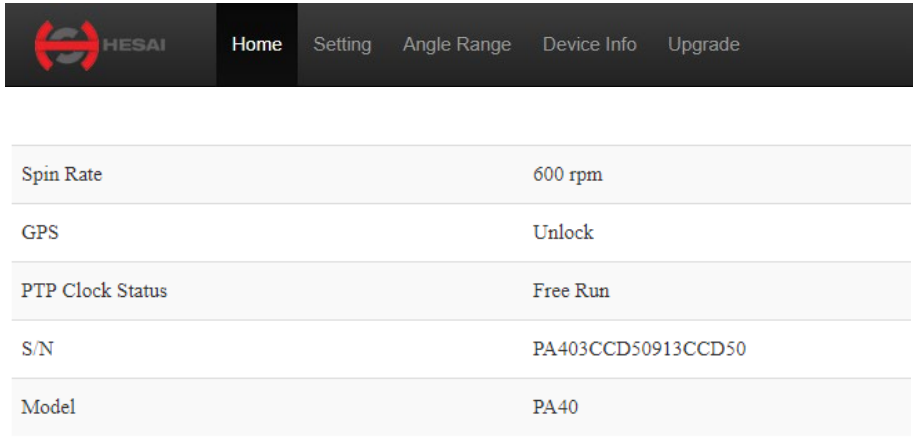
For example, the following two formats are both acceptable:
$GPRMC,072242,A,3027.3680,N,11423.6975,E,000.0,316.7,160617,004.1,W*67
$GPRMC,065829.00,A,3121.86377,N,12114.68322,E,0.027,,160617,,,A*74

4 Web Control

Web control is used for setting parameters, checking device info, and upgrading.
To access web control
1) Connect the LiDAR to your PC using an Ethernet cable
Set the IP address according to Section 2.4 Use
Enter this URL into your web browser: 192.168.1.201/index.html

NOTE Use Google Chrome or Firefox instead of IE. Turn off VPN.

4.1 Homepage



GPS

Lock	LiDAR's internal clock is in sync with the GPS
Unlock	Not in sync

PTP Clock Status

Free Run	No PTP master is selected; only the LiDAR's clock is used
Tracking	Slave is trying to sync with the selected PTP Master, but the offset is more than 1 μs
Locked	Offset between the Slave and the Master is below 1 μs
Frozen (Holdover)	LiDAR has lost connection to the PTP master and is attempting to recover it. Meanwhile, the LiDAR starts drifting from the previous clock; if drifting out of specifications, it goes back to the Free Run mode.

Figure 4.1 Home Page of Web Control

4.2 Settings

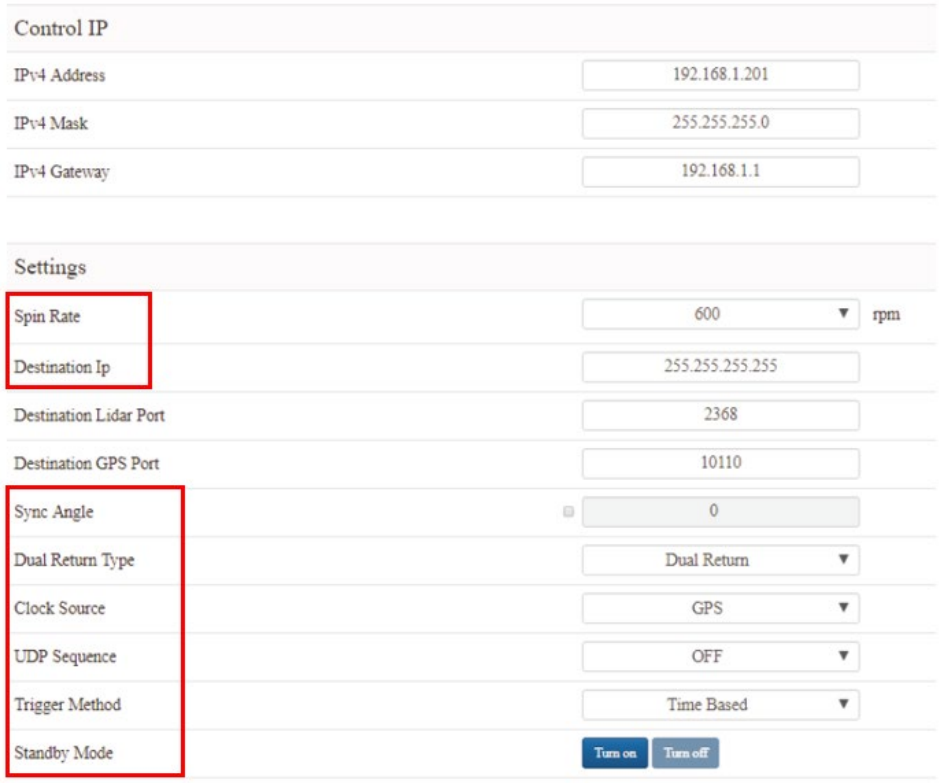


Figure 4.2 Setting Page of Web Control

1. Control IP

Mode	Destination IP
Broadcast (default)	255.255.255.255
Multicast	239.0.0.0~239.255.255.255
Unicast	Same as the PC's IP address

2. Settings

Spin Rate	600 rpm / 1200 rpm
Destination IP	See "Control IP" above
(GPS) Sync Angle	If set as 0, the LiDAR's zero-degree position is in sync with PPS
Dual Return Type	Last / Strongest / Dual Return
Clock Source	GPS / PTP (In the PTP mode, LiDARs will not output GPS UDP Packets but only Point Cloud UDP Packets. See Appendix I PTP Protocol for more details.)
UDP Sequence	ON / OFF (With the UDP sequence ON, UPD packets are labeled with a sequence number. See Appendix II for changes in data structure.)
Trigger Method	Angle-Based / Time-Based (In the angle-based trigger mode, lasers fire every 0.2 deg at 10 Hz or 0.4 deg at 20 Hz. In the time-based Mode, lasers fire every 55.56 us.)
Standby Mode	Enter / Exit (In the Standby mode, the motor will stop running and lasers stop firing. This screen shows that LiDAR is in operation, i.e. Standby mode is turned off.)

4.3 Angle Range

Users can set azimuth angle range in the **“Angle Range”** tab. There are two methods to set angle range: LiDAR based angle range method and laser based angle range method.

Figure 4.3 Angle Range Page

■ **LiDAR Based**

If LiDAR based angle range method is selected, the start and end angles that users enter will be applied to all 64 channels. In other words, all 64 channels will have the same angle range. There will be no laser firing or data generated outside the specified angle range. After setting, click “Save”.

NOTE Please do not forget to click “Save” after finishing setting. Otherwise, angle range will not be applied.

■ **Laser Based**

If laser based angle range method is selected, users will see the table as in Figure 4.4. The start and end angles of each laser can be configured individually.

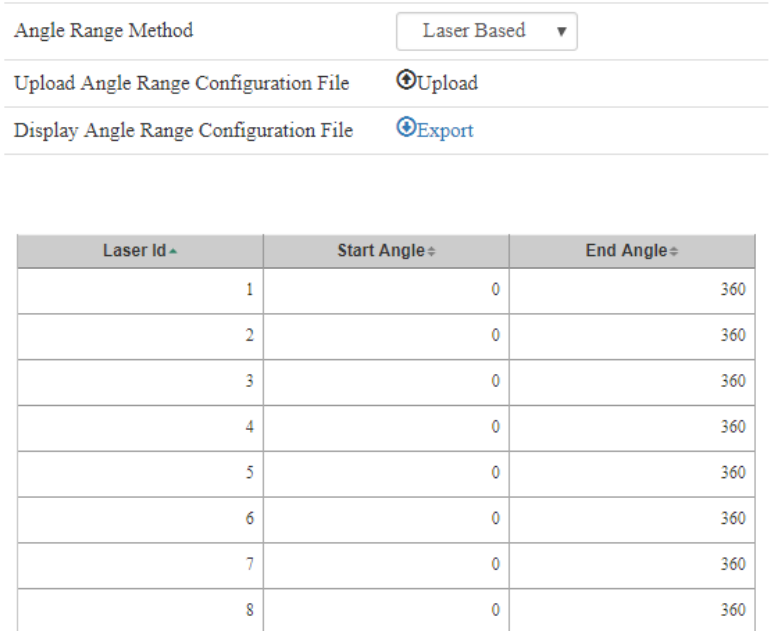


Figure 4.4 Angle Range Page-Laser Based

Users can edit the start and end angles by first exporting the angle range configuration file and then upload the edited configuration file. Please click "Save" to apply your settings.

NOTE

1) Use LiDAR Based Method if the same angle range is expected on all 64 channels. Outside the specified range, no laser will be firing and no data will be generated.

2) If Laser Based Method is chosen and the angle range varies channel by channel, there will be no data generated only outside the union of all specified angle ranges.

4.4 Device Info

Software version, hardware version, and firmware version are shown in the **“Device Info”** tab.

Software Version	2.6.0
Hardware Version	1.0.0
Firmware Version	5.2
Mac Address	EC:9F:0D:00:2A:FC
S/N	PA6437CC519A37CC50
Model	PA64

Figure 4.5 Device Info Page of Web Control

4.5 Time Statistics

The LiDAR's operation time in aggregate and in different temperature ranges are listed in the **“Time Statistics”** tab.

Start-up Times	3
Current Working Temperature	40.00℃
Total Working Time	0 hs 27 mins

Working Time Statistics	
< -40 ℃	0 hs 0 mins
-40 ~ -20 ℃	0 hs 0 mins
-20 ~ 0 ℃	0 hs 0 mins
0 ~ 20 ℃	0 hs 0 mins
20 ~ 40 ℃	0 hs 19 mins
40 ~ 60 ℃	0 hs 5 mins
60 ~ 80 ℃	0 hs 0 mins
80 ~ 100 ℃	0 hs 0 mins
100 ~ 120 ℃	0 hs 0 mins
>120 ℃	0 hs 3 mins

Figure 4.6 Time Statistics Page of Web Control

4.6 Firmware Upgrade

Please ask Hesai for the latest upgrade file if needed.
Click the **“Upload”** tab and select the upgrade file. Reboot the LiDAR when the upgrade is complete.

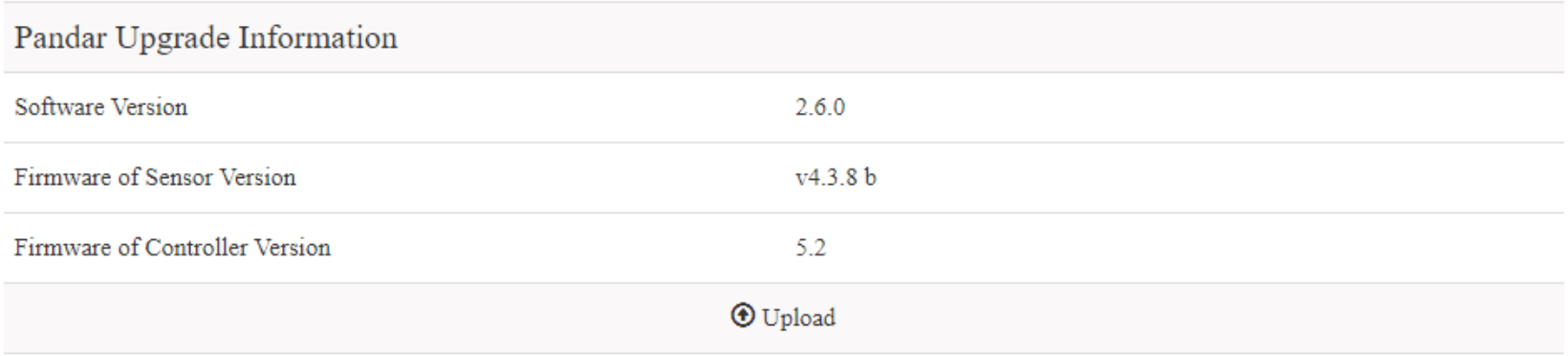


Figure 4.7 Upgrade Page of Web Control

5 PandarView

PandarView is a software that records and displays the point cloud data from Hesai LiDARs, available in **64-bit Windows 7/8/10** and **Ubuntu-16.04**.

5.1 Installation

Copy the installation files from the USB disk included in the LiDAR's explosion-proof box, or download these files from Hesai's official website: www.hesaitech.com/en/download

NOTE Separate Python installation is required only for older PandarView versions.

Table 5.1 PandarView Installation

System	Installation Files	Installation Steps
Windows	PandarView_Windows_V1.6.9.msi python-2.7.13.msi	Uninstall PandarView before installing a new version
		Double click and install python Use the default settings in the setup wizard, including "install for all users"
		Double click and install PandarView_Windows using the default settings
Ubuntu-16.04	PandarView_Installer_V1.6.9.tar.gz	Enter the following command in the terminal: sudo apt-get install qt4-default libboost-all-dev
		Unzip PandarView_Installer.tar.gz and run PandarView_Installer.bin

This manual describes PandarView 1.6.9. Users can check the software version from "About" in the menu bar.

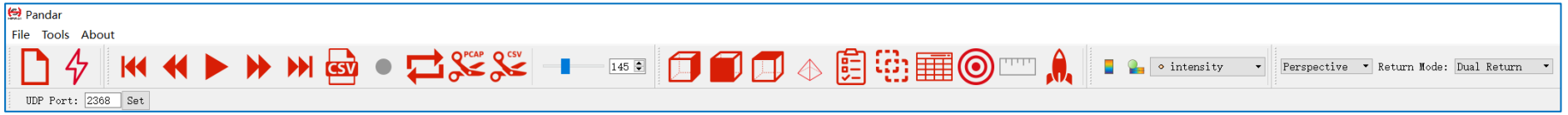


Figure 5.1 Menu and Buttons (PandarView 1.6.9)

5.2 Use

Set the PC's IP address according to Section 2.4 Use.

■ Check Live Data

Click on and select your LiDAR model to begin receiving data over Ethernet.

■ Record a PCAP File

Click on to pop up the "Choose Output File" window.
Click on "Save" to begin recording a PCAP file.
Click on again to stop recording.

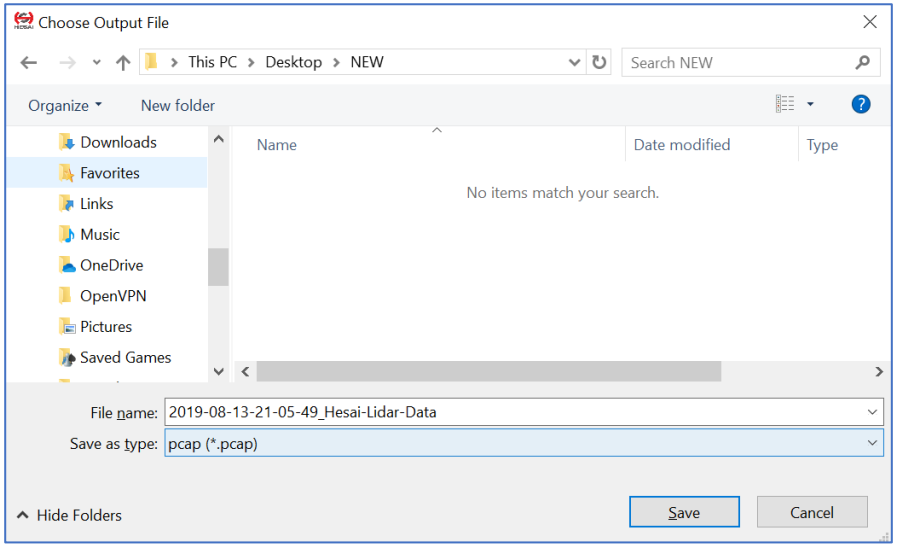


Figure 5.2 Choose Output File

■ Open a PCAP File

Click on to pop up the "Choose Open File" window. Select a PCAP file to open.

■ Import a Correction File

Each LiDAR comes with a correction file (.CSV) in the provided USB disk.

When a PCAP file is open, click on "File" in the menu bar and "Import Correction File".

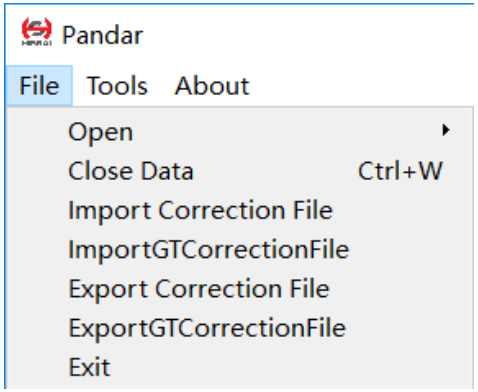
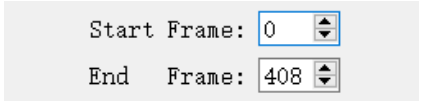
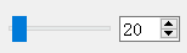


Figure 5.3 File Menu

■ Play a PCAP File

Table 5.2 Play Buttons

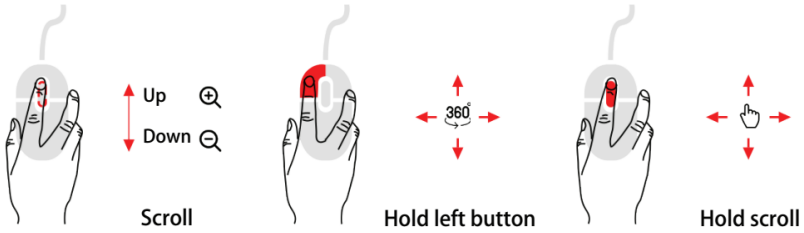
Button	Description	
	Jump to the beginning of the file	
	While paused, jump to the previous frame While playing, rewind. May click again to adjust the rewind speed (2x, 3x, 1/2x, 1/4x, and 1x)	
	After loading a point cloud file, click to play the file While playing, click to pause	
	While paused, jump to the next frame. While playing, forward. May click again to adjust the forward speed (2x, 3x, 1/2x, 1/4x, and 1x)	
	Jump to the end of the file	
	Save a single frame to .CSV (the XYZ coordinates as the first three columns)	
	While playing, this Record button will be gray and unclickable	
	While playing, click to loop playback. Otherwise the player will stop at the end of the file	
	Save multiple frames to .PCAP	 Specify the start and end frames
	Save multiple frames to .CSV (the XYZ coordinates as the last three columns)	
	Drag this progress bar or enter a frame number to jump to a specific frame	

5.3 Features

■ Viewpoint Selection

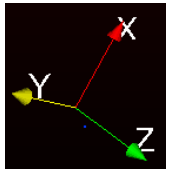
Users can select from the right view, front view, and top view.

■ Mouse Shortcuts



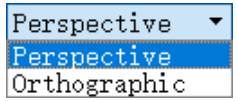
- Slide the scroll wheel up/down to magnify/minimize
- Drag while holding the left button to adjust the point of view
- Drag while holding the scroll wheel to pan

NOTE The bottom-left coordinate axes shows the current point of view



■ 3D Projection and Distance Measurement

Both perspective projection (default) and orthographic projection are supported.

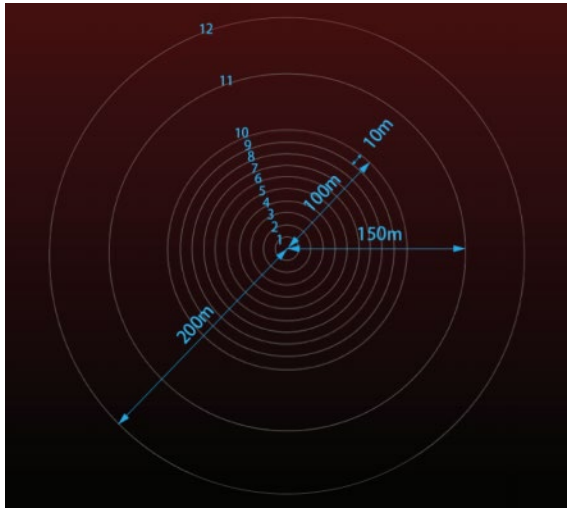


The distance measurement ruler is available only under orthographic projection. After clicking on , drag your mouse while holding the Ctrl key to make a measurement in units of meters. Click on again to quit.

■ Distance Reference Circles

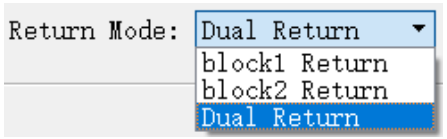
Click on to show/hide the 12 distance reference circles in gray. The actual distances are marked below.

To change the color and line width of these circles, and click on “Tools” in the menu bar and open “Grid Properties”.



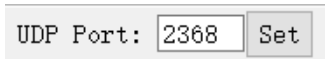
■ Return Mode

Users can select from Block 1 Return (i.e. Last Return), Block 2 Return (i.e. Strongest Return), and Dual Return.



■ UDP Port

Enter the UDP Port, and click “Set” to apply it.

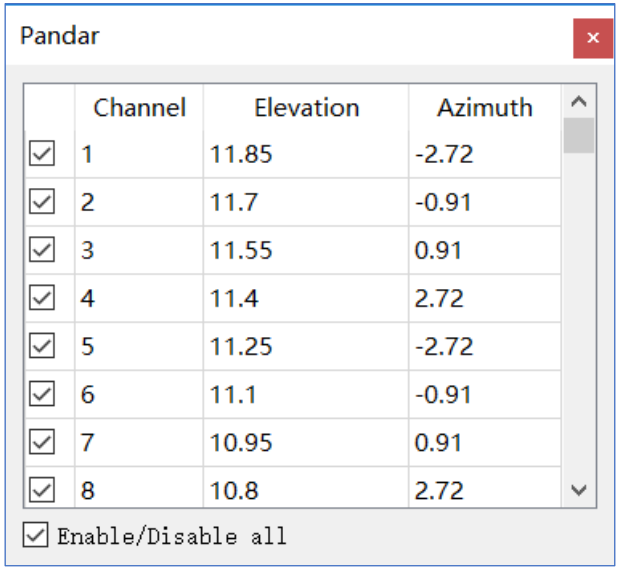


■ Channel Selection

Click on  to show/hide point cloud data from selected laser channels.

Check/Uncheck the boxes on the left to show/hide each channel.

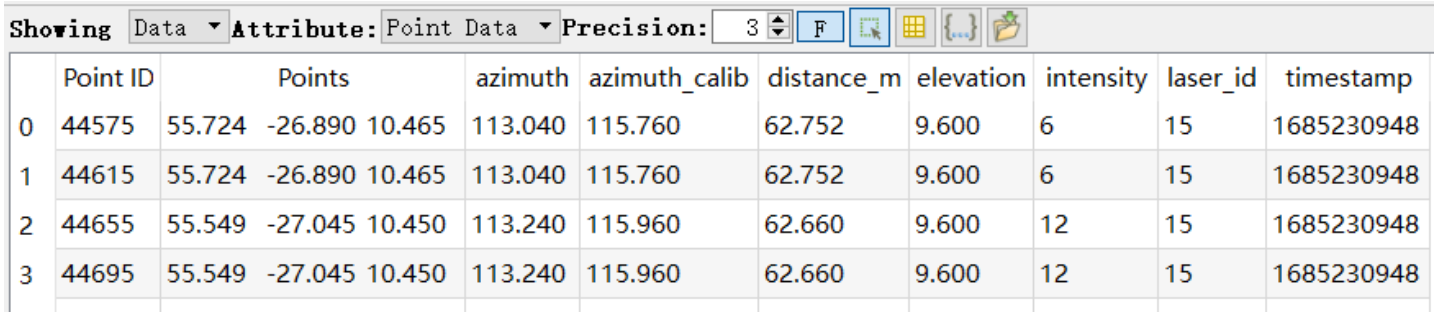
Check the “Enable/Disable all” option at the bottom of the table to show/hide all channels.



■ Point Selection and Data Table

Click on  and drag the mouse over the point cloud to highlight an area of points.

Click on  to the view the data of the highlighted points, as shown below.



	Point ID	Points	azimuth	azimuth_calib	distance_m	elevation	intensity	laser_id	timestamp
0	44575	55.724 -26.890 10.465	113.040	115.760	62.752	9.600	6	15	1685230948
1	44615	55.724 -26.890 10.465	113.040	115.760	62.752	9.600	6	15	1685230948
2	44655	55.549 -27.045 10.450	113.240	115.960	62.660	9.600	12	15	1685230948
3	44695	55.549 -27.045 10.450	113.240	115.960	62.660	9.600	12	15	1685230948

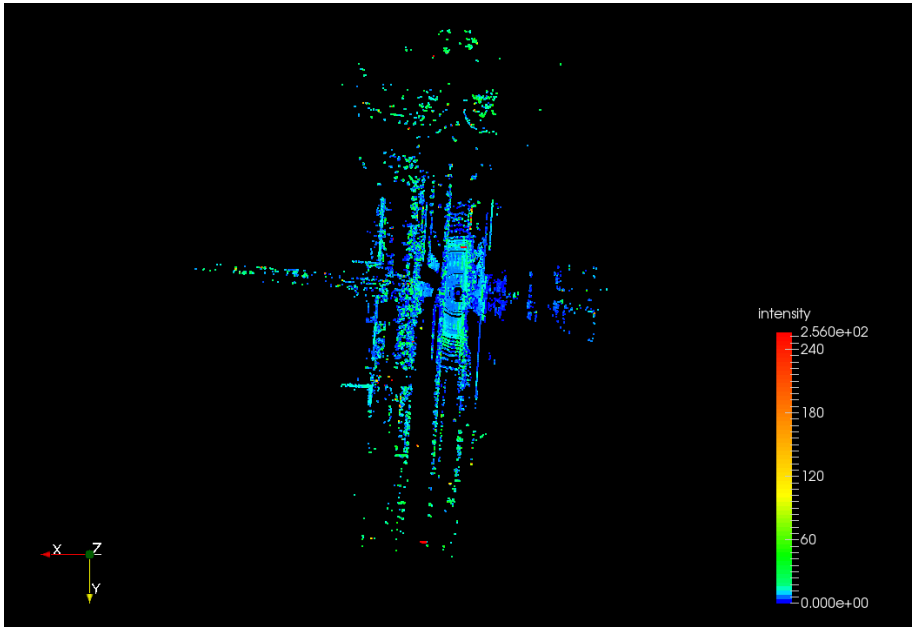
Some of the data fields are defined below:

Field	Description
points	The XYZ coordinates of each point
azimuth	Rotor's current reference angle
azimuth_calib	Azimuth + horizontal angle offset

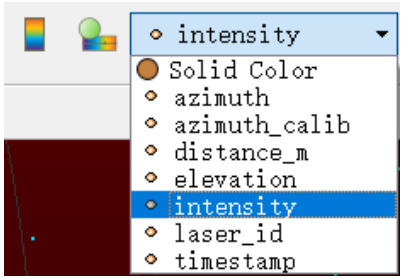
To cancel the selection, click on  again and click on any place outside the selected area.

■ Color Schemes.

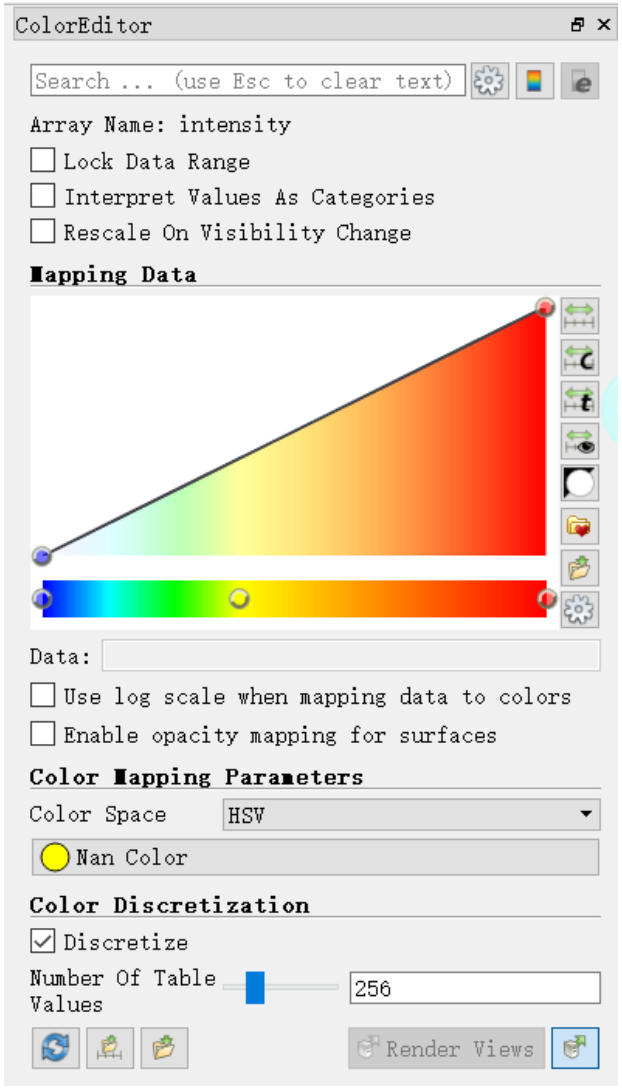
Click on to show the color legend at the lower right corner.



The default color scheme is intensity based. Users can choose from other colors schemes based on azimuth, azimuth_calib, distance, elevation, laser_id, or timestamp.



Click on  to open or close the Color Editor.



6 Sensor Maintenance

Storage

Store the device in a dry, well ventilated environment. The ambient temperature should be between -40°C and +85°C, and the humidity below 85%. Please check the specifications in the device's user manual for the product IP rating, and avoid any ingress beyond that rating.

Transport

Package the device in shock-proof materials to avoid damage during transport.

Cleaning

If the device's enclosure is stained with dirt, fingerprints, or oil, perform the follow cleaning steps.

1) Spray the LiDAR enclosure with warm, neutral solvent using a spray bottle

Solvent type	99% isopropyl alcohol (IPA) or 99% ethanol (absolute alcohol)
Solvent temperature	40 to 60 ℃

2) After the stains on the LiDAR enclosure loosen, gently wipe the enclosure along its curved surface with a piece of soft microfiber cloth

3) Should another cleaning agent be applied to remove certain stains, repeat Step 1 afterwards

4) Spray the enclosure with clean water, and gently wipe off the remaining liquid with another piece of soft microfiber cloth

7 Troubleshooting

Table 8.1 Troubleshooting (To Be Continued)

Symptoms	Points to Check
Indicator light is off on the connection box	1) Make sure the power adapter is properly connected and in good condition 2) Make sure the connection box is intact
Motor is not running	Same as above
Motor is running but no output data received, neither on Wireshark nor PandarView	1) Make sure the Ethernet cable is properly connected 2) Check the IP configuration: use Wireshark to get the LiDAR's IP and make sure it's in the same subnet with the PC's 3) Check the angle range of laser firing and data generation on the Angle Range page of web control 4) Check the firmware version of the sensor on the Firmware Upgrade page of web control. If the version is not shown properly but as "xxxx", contact Hesai for further diagnostics
Can receive data on Wireshark but not on PandarView	1) Make sure the Destination IP and the Destination LiDAR Port are set correctly on the Settings page of web control 2) Make sure the PC's firewall is disabled
Cannot open web control	1) Make sure the Ethernet cable is properly connected. 2) Make sure the LiDAR's and the PC's IP addresses are correct, possibly using Wireshark 3) Restart the PC, or connect the LiDAR to another PC
Abnormal packet size (missing packets)	1) Check if the FOV (field of view) has been changed on the Angle Range page of web control 2) Check if the Ethernet is overloaded 3) Check if a switch is connected into the network. The data transmitted from other devices may cause network congestion and packet loss 4) Connect the PC only to the LiDAR and check for packet loss

Table 8.1 Troubleshooting (Continued)

Symptoms	Points to Check
Abnormal point cloud (misaligned points, flashing points, or incomplete FOV)	1) Make sure the LiDAR's enclosure is clean. If not, refer to Chapter 7 Sensor Maintenance for the cleaning method 2) Make sure the LiDAR's calibration file is imported. (Pandar40P automatically imports the calibration file, while Pandar40 requires manual importing) 3) Check for packet loss. If no packet is missing while the point cloud flashes, please update PandarView to the latest version and restart the PC. If problem persists, try connecting the LiDAR to another PC
GPS cannot be locked	1) Make sure the GPS receiver is properly connected 2) Make sure the PPS signal is connected to the LiDAR 3) Make sure the Destination GPS Port is correct on the Settings page of web control 4) Make sure the input GPS signals satisfy the electrical requirements in Section 2.2 Interface and Section 2.3.1 Connecting Box Interfaces in the user manual

Appendix I PTP Protocol

The Precision Time Protocol (PTP), also known as the IEEE 1588 standard, is used to synchronize clocks across a computer network. It can achieve sub-microsecond clock accuracy and is suitable for measurement and control systems.

■ LiDAR Connection When Using PTP

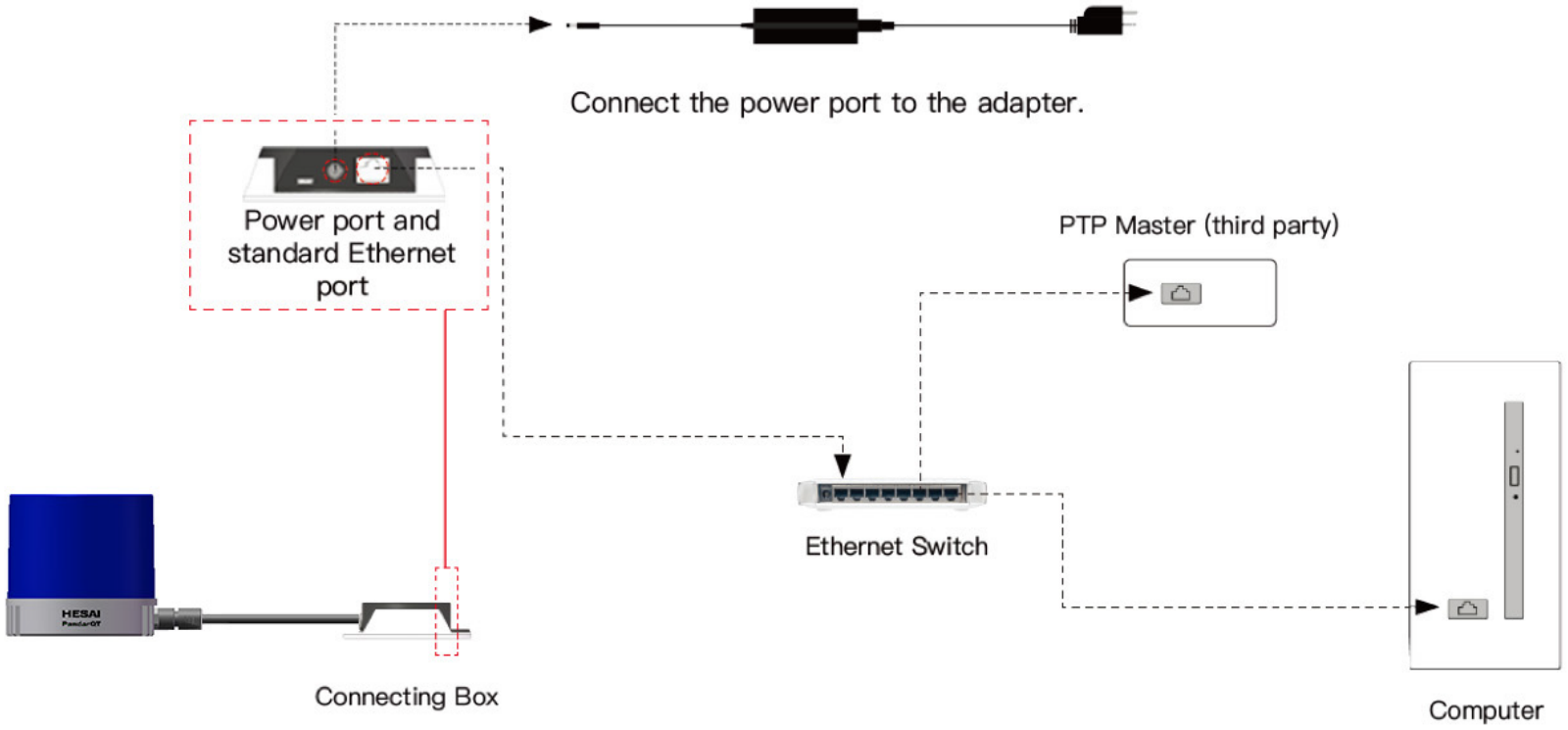


Figure III.1 LiDAR Connection When Using PTP

■ Absolute Packing Time When Using PTP

To use PTP as the clock source, users need to connect a PTP master device to get the absolute time.

If a PTP clock source is selected, the LiDAR will not transmit GPS Data Packets, but only Point Cloud Data Packets with 4-byte μs timestamps and 6-byte UTC time. The sum of the μs timestamp and the UTC time is the absolute packing time of this data packet.

NOTE

- The PTP master device is a third-party product and is not included with the LiDAR.
- The LiDAR's clock follows the PTP master device according to the PTP protocol.
- The timestamps and UTC time in Point Cloud Data Packets strictly follow the PTP time from the PTP master device. There may be offset with UTC time for certain PTP master devices. Please verify the configuration and calibration of your PTP master device in order to get precise time information.
- The LiDAR works as a PTP slave device and the PTP protocol is Plug&Play. No additional setup is required.
- If a PTP clock source is selected but no PTP master device is available, the LiDAR will count the time from an invalid past time. If a PTP clock source is supplied and later stopped, the LiDAR will continue to count the time with an internal clock.

Appendix II FCC Statement

FCC ID: 2ASO2PANDARQT

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

NOTE Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the equipment.

Appendix III Support and Contact

■ Technical Support

For any question not addressed in this manual, please contact us at:

service@hesaitech.com
www.hesaitech.com
https://github.com/HesaiTechnology

NOTE Please leave your questions under the corresponding GitHub projects.

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