CH256X1

User Manual

V1.1.1 2024.10

Leishen Intelligent System Co., Ltd. http://www.lslidar.com/

Safety Instruction

Before using the product, please read and follow the instructions of this manual carefully, and refer to relevant national and international safety regulations.

ΔAttention

Please do not disassemble or modify the lidar privately. If you need special instructions, please consult our technical support staff.

ΔLaser Safety Level

The laser safety of this product meets the following standards:

● IEC 60825-1:2014

● 21 CFR 1040.10 and 1040.11 standards, except for the deviations (IEC 60825-1, third edition) stated in the Laser Notice No. 56 issued on May 8, 2019.

Please do not look directly at the transmitting laser through magnifying devices (such as microscope, head-mounted magnifying glass, or other forms of magnifying glasses).

Eye Safety

The product design complies with Class 1 human eye safety standards. However, to maximize self-protection, please avoid looking directly at running products.

ΔSafety Warning

In any case, if the product is suspected to have malfunctioned or been damaged, please stop using it immediately to avoid injury or further product damage.

Housing

The product contains high-speed rotating parts, please do not operate unless the housing is fastened. Do not use a product with damaged housing in case of irreparable losses. To avoid product performance degradation, please do not touch the photomask with your hands.

Operation

This product is composed of metal and plastic, which contains precise circuit electronic components and optical devices. Improper operations such as high temperature, drop, puncture or squeeze may cause irreversible damage to the product.

Power Supply

Please use the connecting cable and matching connectors provided with the lidar to supply power. Using cables or adapters that are damaged or do not meet the power supply requirements, or supply power in a humid environment may cause abnormal operation, fire, personal injury, product damage, or other property loss.

Light Interference

Some precise optical equipment may be interfered with by the laser emitted by this product, please pay attention when using it.

Vibration

Please avoid product damage caused by strong vibration. If the product's mechanical shock and vibration performance parameters are needed, please contact us for technical support.

Radio Frequency Interference

The design, manufacture and test of this product comply with relevant regulations on radiofrequency energy radiation, but the radiation from this product may still cause other electronic equipment to malfunction.

Deflagration and Other Air Conditions

Do not use the product in any area with potentially explosive air, such as areas where the air contains high concentrations of flammable chemicals, vapours or particles (like fine grains, dust or metal powder). Do not expose the product to the environment of high-concentration industrial chemicals, including near evaporating liquefied gas (like helium), so as not to impair or damage the product function.

Maintenance

Please do not disassemble the lidar without permission. Disassembly of the product may cause its waterproof performance to fail or personal injury.

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1. Product Profile

1.1 Overview

The CH256X1, a hybrid solid-state LiDAR, is significantly improved in the anti-shock and vibration and point cloud performance, which is suitable for high vibration and high shock scenarios, providing more accurate environment perception. The lidar can operate in environments with continuous small-caliber gun fire, and its ability to maintain structural and functional integrity when subjected to repetitive shock or vibration makes it suitable for use in combat vehicles or fixed emplacements.

1.2 Mechanism

The CH256X1 hybrid solid-state lidar adopts the Time of Flight method. The lidar starts timing (t_1) when the laser pulses are sent out. And when the laser encounters the target object and the light returns to the sensor unit, the receiving end stops timing (t_2).

$$\text{Distance} = \text{Speed of Light} * (t_2 - t_1)/2$$

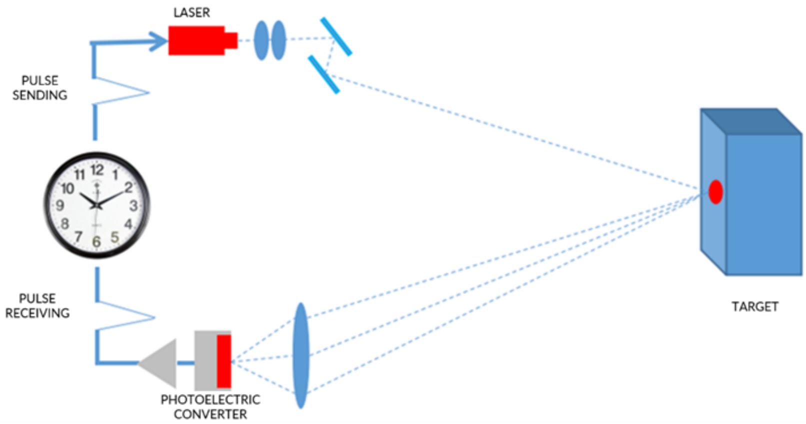

Figure 1.1 Mechanism of the CH256X1

1.3 Specifications

Table 1.1 Specifications of CH256X1

Model	CH256X1-R-1.0-200-A	CH256X1-R-1.0-450-A
Detection Method	ToF	
Wavelength	905 nm	
Laser Class	Class I (eye-safe)	
Channels	256	
Detection Range	200 m (@10% reflectivity)	450 m (@70% reflectivity)

Range Accuracy	±3 cm (1 σ)			
Data Point Generating Rate (Single Echo Mode)	3,070,000 pts/sec		1,237,000 pts/sec	
Vertical FOV	40° (-20°~+20°)			
Horizontal FOV	120°			
Scanning Frequency	10 Hz	20 Hz	10 Hz	20 Hz
Horizontal Angular Resolution	0.1°	0.2°	0.25°	0.5°
Vertical Angular Resolution	0.156°			
Communication Interface	Gigabyte Industrial Ethernet (1000 Base-TX)			
Time Source	gPTP			
Operating Voltage	9 V ~36 VDC			
Operating Temperature	-40℃~ +55℃			
Storage Temperature	-40℃~ +65℃			
Shock Test	500 m/sec^2, lasting for 11 ms			
Vibration Test	5 Hz ~2000 Hz, 3G rms			
IP Grade	IP 67			
Dimensions (L*W*H)	154 *105.8 *100 mm			
Weight	≤2 kg			

1.4 Dimensions

There are 4 mounting holes on the side, 4 spare mounting holes and 2 positioning holes at the bottom of CH256X1 lidar. Four M5*15 (hexagon socket head cap screws) mechanical screws on the side or four M6*12 (hexagon socket head cap screws) mechanical screws at the bottom with spring washers and flat washers needed for locking and fixing the lidar. See the outline dimension drawing shown in Figure 1.2.

Mounting requirements:

(1) Mounting screws: M5*15 (on the side) or M6*12 (on the bottom) hexagon socket head cap screws;

(2) Screws: GB 70;

(3) Spring washers: GB 93;

(4) Flat washers: GB 93.1;

(5) Electric Screwdriver Torque: 7.5 NM.

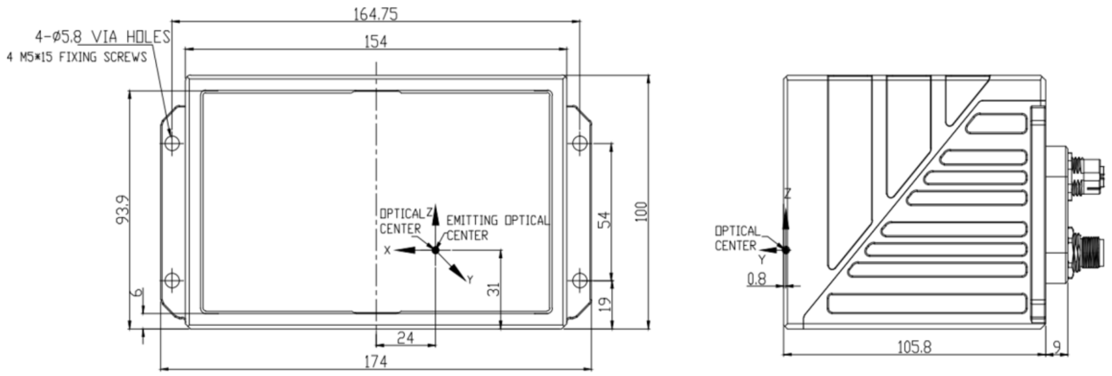

Figure 1.2 CH256X1 Lidar Dimensions (unit: mm)

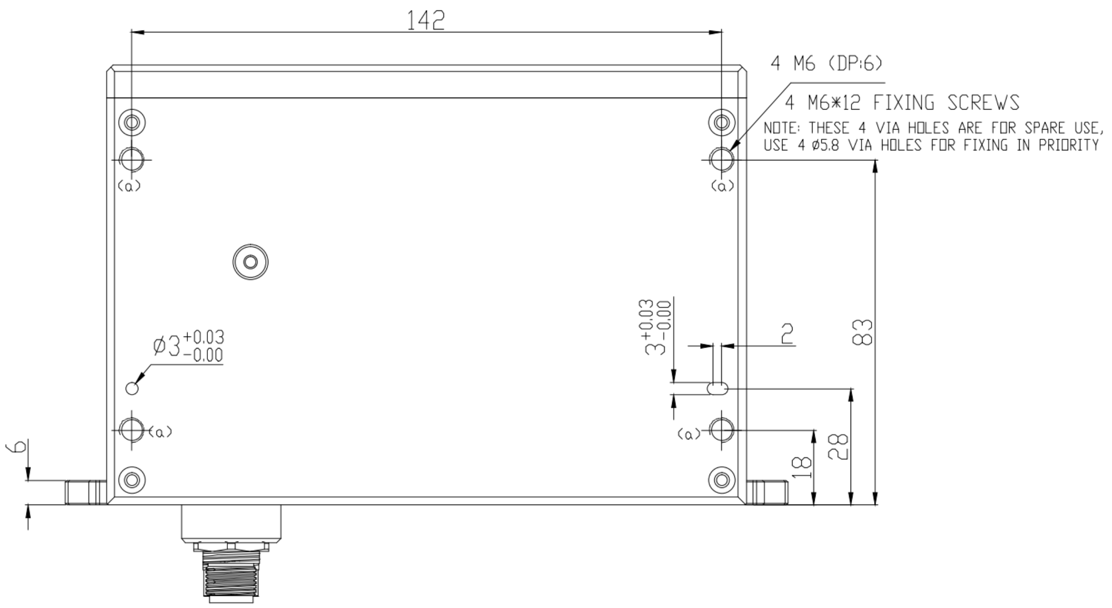

Figure 1.3 CH256X1 Lidar Base Dimensions (unit: mm)

2. Electrical Interface

2.1 Power Supply

The power input range of the CH256X1 lidar is 9 V~ 36 VDC. If other DC power supply is adopted, the recommended output voltage of the power supply is 24 VDC. Please note that DC 12 V and 36 V are short-term power supply in extreme environment, which cannot be used as working voltage. When the voltage output fluctuates, the lidar may not be able to work normally.

The maximum output current should be ≥2 A (@24 V) (the lidar requires a large instantaneous current when starting, and a small starting current may cause its failure to start normally). The output ripple noise should be <120 mVp-p and output voltage accuracy <5%.

The line length of the lidar power supply is 5~10 m, and the power supply voltage needs to be over 24 V but less than 36 V. If the line length is more than 10 m, then it is recommended to use a 220 V AC adapter nearby for power supply (DC long-distance power supply is not recommended).

2.2 Electrical Interface

There are 2 interfaces on the side of the CH256X1 lidar, one is the 8-pin industrial Ethernet interface, model number from supplier: Quan Ma PNA:ZGA.1M.308.XLL. The other 6-pin interface is for power supply, model number from supplier: ZGA.1M.306.XLL. The definition of the interfaces is shown as below.

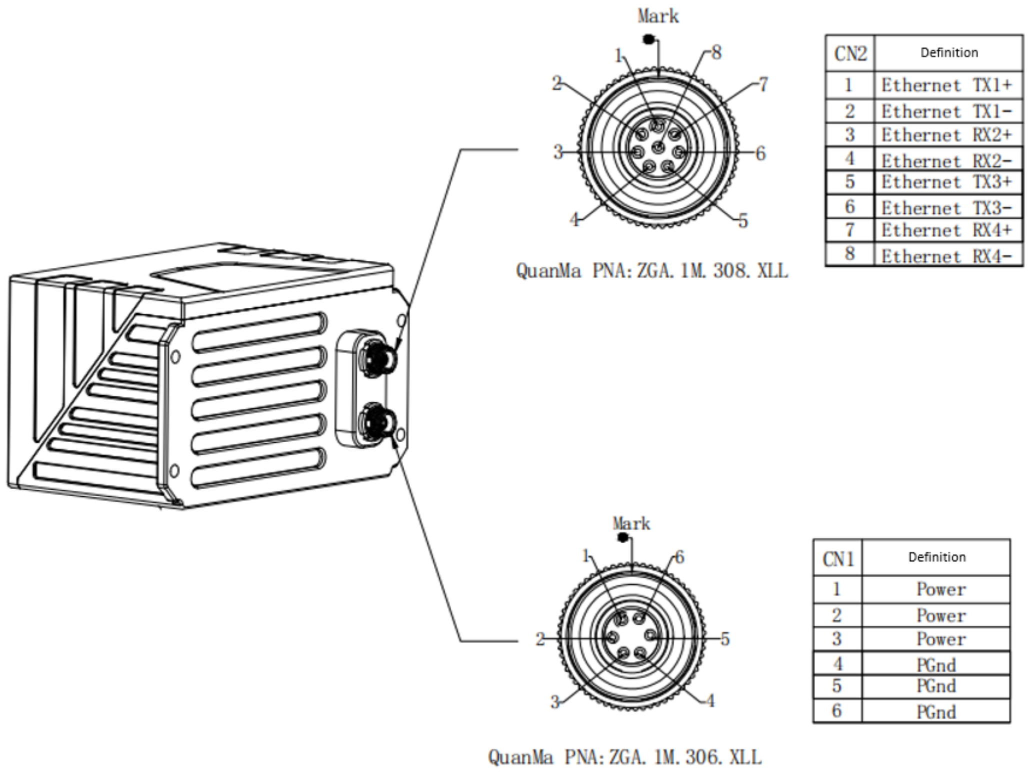

Figure 2.1 The Interfaces of CH256X1

The recommended cables connecting to the CH256X1 lidar interface are one 6-pin power supply and one 8-pin industrial Ethernet cable. As is shown below.

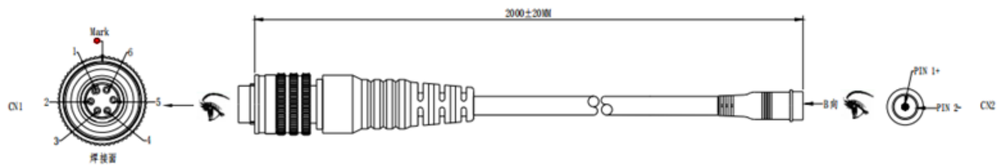

Figure 2.2 6-pin Power Supply Cable

Table 2.1 Wiring Definition of the 6-pin Power Supply Cable

CN1	Definition	Color	CN2	Description
1	Power	Red	1	12-36 V Power+
2	Power	Green		12-36 V Power+
3	Power	Blue		12-36 V Power+
4	Pgnd	Black	2	Power-
5	Pgnd	White		Power-
6	Pgnd	Yellow		Power-
Shell	PE	Braided	/	Shield Shielded
Connectors Specifications: CN 1: Quan Ma PNA: TGA.1M.306.XLA CN 2: DC 5.5*2.5 MM female connector				

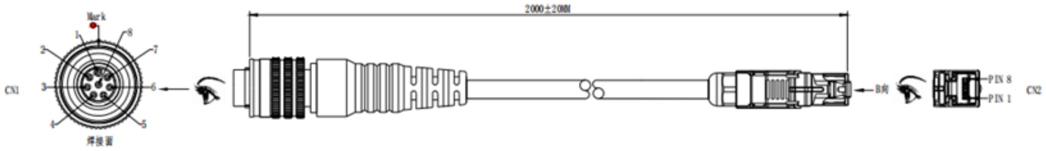

Figure 2.3 8-pin Industrial Ethernet Cable

Table 2.2 Wiring Definition of the 8-pin Industrial Ethernet Cable

CN1	Definition	Color	CN2	Description
1	Ethernet TX1+	Orange/White	1	1000 Base-T; Ethernet TX+
2	Ethernet TX1-	Orange	2	1000 Base-T; Ethernet TX-
3	Ethernet RX2+	Green/White	3	1000 Base-T; Ethernet RX+
4	Ethernet RX2-	Green	6	1000 Base-T; Ethernet RX-
5	Ethernet TX3+	Blue	4	1000 Base-T; Ethernet TX+
6	Ethernet TX3-	Blue/Blue	5	1000 Base-T; Ethernet TX-
7	Ethernet RX4+	Brown/White	7	1000 Base-T; Ethernet RX+
8	Ethernet RX4-	Brown	8	1000 Base-T; Ethernet RX-
Shell	PE	Braided	Shell	Shielded
Connectors Specifications: CN 1: Quan Ma PNA:TGA.1M.308.XLA CN 2: Shielded RJ45 8P8C Cat.6				

3. Get Ready

3.1 Lidar Connection

To get ready for the lidar operation, please connect the lidar, host computer, GPS module and power supply as shown in below.

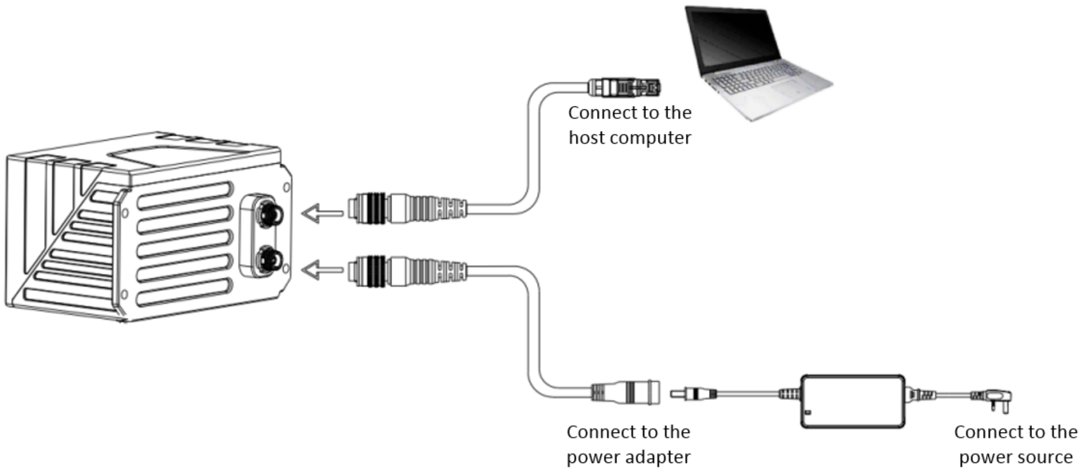

Figure 3.1 Connecting the Lidar and Other Devices

3.2 Software Preparation

The lidar can be operated under both Windows operating system and Linux operating system. Software needed is as follows::

Wireshark: to capture the ARP (Address Resolution Protocol) packets.

Note: Wireshark is a third-party software that you need to download by yourself. Leishen Intelligent bears no responsibility to any copyright and commercial disputes caused by the use of this software.

To view the point cloud data generated by the lidar, you can either use the **Upper Computer Platform** (Windows Client) or the **ROS Driver Program.**

Upper Computer Platform: a host computer software to view point cloud image under Windows operating system, which is also referred to as "point cloud display software".

- Software Acquisition

This Upper Computer Platform has been pre-stored in the Service Pack provided along with the lidar. It can also be obtained from the sales or technical support personnel. .

- Operating Environment

This software can only run under the Windows x64 operating system at present. The computer configuration requirements for installing the software are: CPU: Intel(R) Core(TM) i5 or higher; Graphics Card: NVIDIA GeForce GTX750 or higher achieves the best effect, otherwise the display of the point cloud may be affected. And the computer graphics card must support OpenGL 2 or higher graphics acceleration to display the point cloud normally.

- Supplemental Software

To use the Upper Computer Platform, it is necessary to install the **Npcap** third-party library, which is also included in the Upper Computer Platform installation files package.

ROS Driver Program (optional): to view the point cloud data under Linux operating system. This program has been included in the customer service package which can be obtained from the sales or technical support personnel.

4. Usage Guide

This part states operation instructions of the Upper Computer Platform and ROS driver.

4.1 Operation Under Windows OS

4.1.1 Lidar Configuration

The default IP address and port number of the lidar network are as follows:

Table 4.1 Default Lidar Network Configuration

	IP Address	UDP Device Package Port	UDP Data Package Port
Lidar	192.168.1.200	2368 (Fixed)	2369 (Fixed)
Computer	192.168.1.102	2369	2368

Note:

The lidar IP (local IP) and the computer IP (destination IP) cannot be set to the same, otherwise the lidar will not work normally.

In the multicast mode, no two destination ports should be set to the same port number.

The lidar IP range are forbidden to be set to

1) Class D IP address (multicast address: i.e. 224.0.0.0~ 239.255.255.255)

2) Class E IP address (reserved address: i.e. 240.0.0.0~ 255.255.255.254)

3) Broadcast address (i.e. 255.255.255.255 and x.x.x.255 for each network segment)

4) Special class IP address (0.x.x.x and 127.x.x.x)

The lidar destination IP are forbidden to be set to

1) Class E IP address (i.e. 240.0.0.0 to 255.255.255.254)

2) Special class address (0.x.x.x and 127.x.x.x)

When connecting to the lidar, if the computer IP and the lidar IP are in different network segments, you need to set the gateway; if they are in the same network segment, you only need to set different IPs, for example: 192.168.1.x, and the subnet mask is 255.255.255.0. If you need to find the Ethernet configuration information of the lidar, please connect the lidar to the computer and use “Wireshark” to capture the ARP packet of the device for analysis. For the feature identification of the ARP packet, see the figure below.

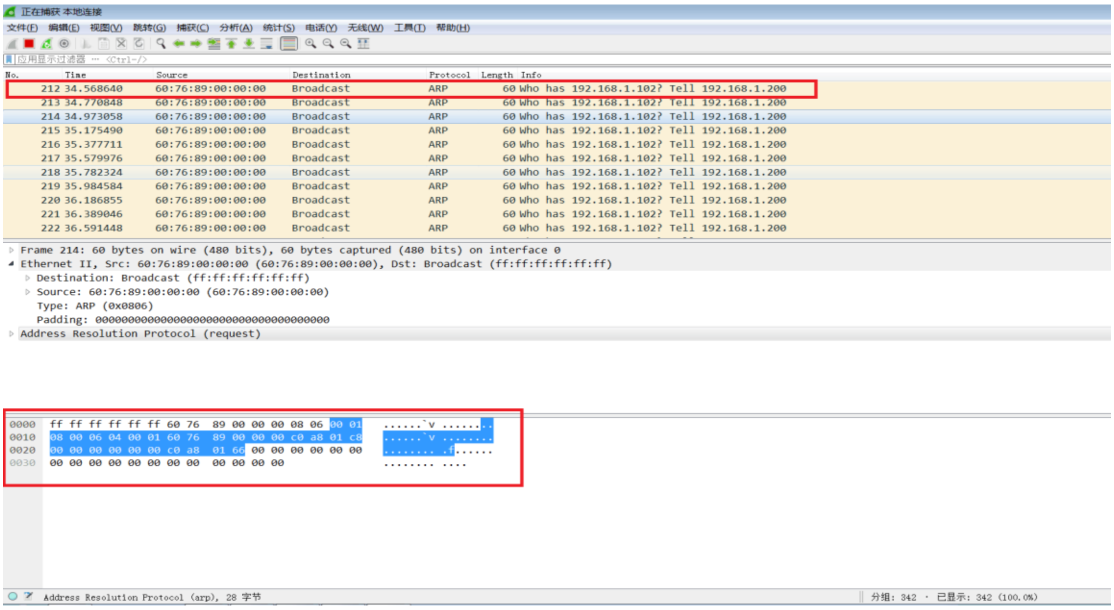

Figure 4.1 Wireshark captures APR packets

4.1.2 Upper Computer Platform

Upper Computer Platform (Windows Client), which is also referred to as "point cloud display software". Simple functions like parameter configuration, lidar test and fault detection can be realized through the software, too.

For more information on how to use the software, please refer to the software operation manual included in the LiDAR service package or click on the icon  in the upper right corner of the software to jump to the software operation.

4.1.3 Point Cloud Data Parsing

If you need to parse lidar data, please follow the steps below:

Step 1. Parse the data package to obtain the relative horizontal angle, ranging information, intensity data and nanosecond timestamp information of each laser;

Step 2. Read the device package to obtain information such as the UTC time (GPS, gPTP time service) and the current configuration of the device;

Step 3. Obtain the vertical angle of each line according to the laser beam distribution;

Step 4. According to the distance measurement value, vertical angle and the calculated horizontal angle of the point cloud data, the XYZ coordinate values are obtained;

Step 5. If necessary, calculate the precise time of the point cloud data through

UTC time, nanosecond timestamp, light-emitting time of each laser, as well as single and dual echo modes;

Step 6. Reconfigure information such as Ethernet, PPS synchronization horizontal angle, motor speed and other information as needed, and pack the configuration package protocol.

4.2 ROS Driver Operation Under Linux OS

4.2.1 Hardware Connection and Test

Step 1. Connect the lidar to the internet and power supply

Step 2. Set the computer wired IP according to the destination IP of the lidar, (whether the computer wired IP is set successfully can be checked by the ifconfig command, as shown in the figure, the destination IP is 192.168.1.102)

```
ls@lidar:~$ ifconfig
enp3s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.1.102  netmask 255.255.255.0  broadcast 192.168.1.255
        inet6 fe80::8f7d:d4f9:2c6a:850d  prefixlen 64  scopeid 0x20<link>
        ether f0:2f:74:a1:99:53  txqueuelen 1000  (以太网)
        RX packets 377598  bytes 78074323 (78.0 MB)
        RX errors 0  dropped 1272  overruns 0  frame 0
        TX packets 958224  bytes 1418001117 (1.4 GB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Figure 4.2 ifconfig Command Feedback

Note: The default destination IP of the lidar is 192.168.1.102, and the computer must be configured according to the actual lidar destination IP. After setting the IP for the first time, please restart the lidar.

Step 3. After the lidar is powered on and restarted, check the wired connection icon of the computer to see whether it is connected properly.

Step 4. Open the terminal: ping the lidar IP, and test whether the hardware is connected normally. If the ping is successful, then the data is received, otherwise check the hardware connection.

Step 5. Use “sudo tcpdump -n -i eth0” (here eth0 is the name of the wired network device, see the device name of ifconfig wired connection display for details) to view the data packets sent by the lidar (as shown in the figure, there are 1212-byte data packets sent by the lidar to the destination, which means that the lidar data is sent normally).

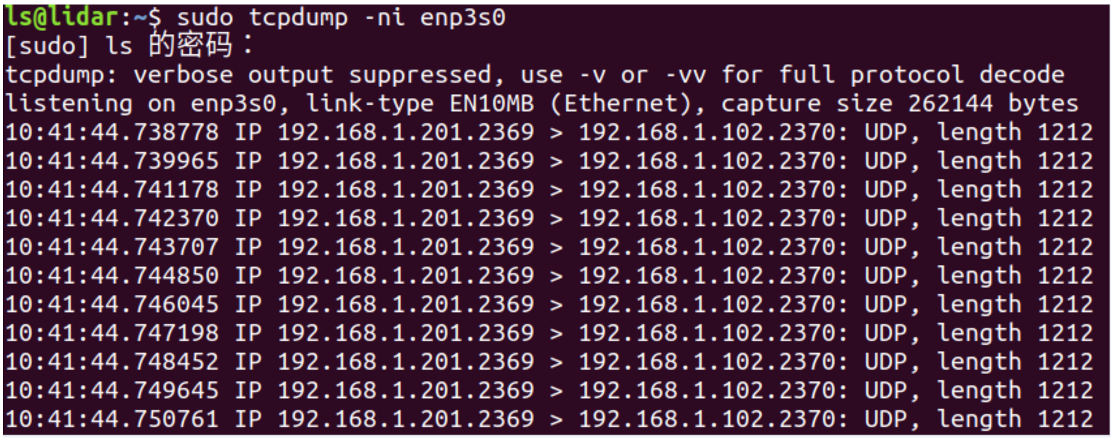

Figure 4.3 sudo tcpdump -n -i eth0 Command Feedback

4.2.2 Software Operation Example

Note: The following instructions are for reference only. Please refer to the README file of the ROS driver bag in the customer service pack for details.

Step 1. Establish a workspace and build a compilation environment

mkdir -p ~/leishen_ws/src

cd ~/leishen_ws

Note: The workspace can be named arbitrarily. For example, “leishen_ws” can be changed to any name.

Step 2. Download the lidar driver and dependency package

The driver and dependency package can also be obtained directly from our website or customer service. Copy the obtained driver file to the newly created workspace “leishen_ws/src”, and use the “tar –xvf” command to decompress it.

Step 3. Compile and package

cd ~/leishen_ws

catkin_make

Step 4. Run the program

source ~/leishen_ws /devel/setup.bash

roslaunch lslidar_ch_decoder lslidar_ch.launch

Reopen a terminal again and execute the following command:

rosrun rviz rviz

Note 1): If the lidar destination port and motor speed are modified, please open "lslidar_ch.launch" to modify the configuration accordingly. The default data packet port is 2368, device packet port is 2369, IP address is 192.168.1.200.

Note 2): If timeout appears, it means that the driver has no data reception. Please check the hardware connection.

Note 3): If steps 1, 2, and 3 have been completed, next time after the "Displays Window" is reopened, start directly from step 4.

Step 5. Display the data detected by the lidar

In the "Displays Window" that pops up, modify the value of "Fixed Frame" to "laser_link". Click the "Add" button at the same time, and click "PointCloud2" under "By topic" to add a multi-line point cloud node.

5. Communication Protocol

Lidar data output and configuration use Gigabit Ethernet UDP/IP communication protocol. There are 3 UDP packet protocols, among which MSOP packet length is 1254 bytes (42 bytes Ethernet header and 1212 bytes payload). DIFOP and UCWP are 1248 bytes (42 bytes Ethernet header and 1206 bytes payload) Lidar supports unicast, broadcast and multicast communication.

The communication protocols of the lidar are:

Main data Stream Output Protocol (MSOP): outputting the distance, angle, intensity and other information measured by the lidar;

Device Information Output Protocol (DIFOP): outputting the current status of lidar and accessory equipment and various configuration information;

User Configuration Write Protocol (UCWP): setting the configuration parameters of the lidar.

Table 5.1 UDP Packet Protocol

Protocol Name	Abbr.	Function	Length	Transmission Interval
Main data Stream Output Protocol	MSOP	Outputting measured data and timestamp	1254 bytes	about 44.5 μs;
Device Information Output Protocol	DIFOP	Outputting parameter configuration and status information	1248 bytes	1s (for 1 packet)
User Configuration Write Protocol	UCWP	Inputting user configured device parameters	1248 bytes	Not Fixed

5.1 MSOP Protocol

The data package outputs measured data such as the angle value, distance value, intensity value, and timestamp of the point cloud. The data of the package adopts Big-Endian mode.

The data package includes a 42-byte Ethernet header and a 1212-byte payload, with a total length of 1254 bytes.

Single echo mode: The payload consists of 1197 bytes of point cloud data and 15 bytes of additional information (including 3 bytes reserved, 6 bytes of UTC time of year, month, day, hour, minute and second, 4 bytes of Timestamp and 2 bytes of Factory).

Dual echo mode: The payload consists of 1199 bytes of point cloud data and 13 bytes of additional information (including 1 byte reserved, 6 bytes of UTC time of year, month, day, hour, minute and second, 4 bytes of Timestamp and 2 bytes of Factory).

5.1.1 Format

The CH256X1 lidar supports single echo mode which measures the most recent echo value and dual echo mode which measures the most recent and second recent echo values.

Single Echo Mode

Each MSOP data packet contains 1212 bytes of data. Each packet of data contains 171 points, that is, 171*7=1197 bytes, and the frame tail is 15 bytes (including 3 bytes reserved, 6 bytes of UTC time of year, month, day, hour, minute and second, 4 bytes of Timestamp and 2 bytes of Factory). See the table below:

Header (42 bytes)		
Measure point 1		
Measure point 2		
Measure point 3		
……		
Measure point 171		
Reserved (3 bytes)		
UTC Time (6 bytes)	Timestamp (4 bytes)	Factory (2 bytes)

Note: The lidar displays the point cloud image by frame. In the MSOP data package, if the data of the first point is FF AA BB CC DD EE 11, then it is the start mark of the point cloud frame (the lidar scans to the far right at this time). The start mark can be anywhere in a packet of data, not necessarily the packet header. This point is not displayed as point cloud data, but is only a judgment mark for the beginning of an image frame.

Dual Echo Mode

Each MSOP data packet contains 1212 bytes of data. Each packet of data contains 109 points, that is, 109*11=1199 bytes, and the frame tail is 13 bytes (including 1 byte reserved, 6 bytes of UTC time of year, month, day, hour, minute and second, 4 bytes of Timestamp and 2 bytes of Factory). See the table below:

Header (42 bytes)
Measure point 1

Measure point 2
Measure point 3
……
Measure point 109
Reserved (1 byte)

UTC Time (6 bytes)	Timestamp (4 bytes)	Factory (2 bytes)

Note: The lidar displays the point cloud image by frame. In the MSOP data package, if the data of the first point is FF AA BB CC DD EE 11 22 33 44 55, then it is the start mark of the point cloud frame (the lidar scans to the far right at this time). The start mark can be anywhere in a packet of data, not necessarily the packet header. This point is not displayed as point cloud data, but is only a judgment mark for the beginning of an image frame.

5.1.2 Data Package Parameter Description

Ethernet Header

The Ethernet header has a total of 42 bytes, as shown in the table below.

Ethernet Header: 42 Bytes				
Name	**S/N**	**Information**	**Offset**	**Length (Byte)**
Ethernet II MAC	0	Destination	0	6
	1	Source	6	6
Ethernet Packet Type	2	Type	12	2
Internet Protocol	3	Version, Header Length, Differentiated Services, Field, Total Length, Identification, Flags, Fragment Offset, Time to Live, Protocol, Header, Checksum, Source IP Address, Destination IP Address	14	20
UDP Port Number	4	Lidar Port (0x0941, represent 2369)	34	2
	5	Computer Port (0x0940, represent 2368)	36	2
UDP Length & Sum Check	6	Length (0x04BE, represent 1214 bytes)	38	2
	7	Sum Check	40	2

Subframe (Single Echo Mode)

The subframe is the effective data area of the data packet, which contains a total of 1197 bytes, including 171 points, that is, 171*7=1197 bytes. Take the first measure point as an example:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Line_num	Horizontal angle[15:8]	Horizontal angle[7:0]	Distance[23:16]	Distance[15:8]	Distance[7:0]	strength

Byte 1 represents the line number, whose value range from 0 to 255, a total of 256 lines. The 256 lines respectively corresponds to the lowermost ray to the uppermost ray in the entire vertical field of view. For example, line No. 0 represents a vertical angle of -20°, line No. 1 represents a vertical angle of -19.84°, and the angle difference between adjacent lines is 0.16°.

Byte 2 and **Byte 3** represent the horizontal angle, whose data are stored in Big-Endian mode. The unit is 0.01 degrees. For example, 0x11AD=4525, that is 45.25°.

Byte 4, **Byte 5**, and **Byte 6** represent the distance value. Their data are stored in Big-Endian mode. The two high bytes are the integer part, whose unit is “cm”; and the last byte is the decimal part, whose unit is 1/256 cm. To analyze the distance value, for example: the distance value in the obtained data packet is represented by the hexadecimal number 0x02, 0x18, 0x32, and the first two bytes are composed of 16-bit unsigned data, that is: 0x0218, which is converted to decimal distance value: 536 cm. The last byte is the decimal part, 0x32 equals 50 in decimal, that is, 50*1/256 cm=0.1953125 cm. Then the two parts add up to 536. 1953125 cm.

Byte 7 represents echo strength, and the value range is 0-255 (Echo strength can reflect the energy reflection characteristics of the measured object in the actual measurement environment. Therefore, the echo strength can be used to distinguish objects with different reflection characteristics).

Subframe (Dual Echo Mode)

The subframe is the effective data area of the data packet, which contains a total of 1199 bytes, including 109 points, that is, 109*11=1199 bytes. Take the first measure point as an example:

FIRST ECHO (Byte 4 – Byte 7)

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Line_num	Horizontal angle[15:8]	Horizontal angle[7:0]	Distance[23:16]	Distance[15:8]	Distance[7:0]	strength

Byte 8	Byte 9	Byte 10	Byte 11
Distance_2[23:16]	Distance_2[15:8]	Distance_2[7:0]	Strength_2

SECOND ECHO (Byte 8 – Byte 11)

Byte 1 represents the line number, which is 0x00 by default.

Byte 2 and **Byte 3** represent the horizontal angle, whose data are stored in Big-Endian mode. The unit is 0.01 degrees. For example, 0x11AD=4525, that is

45.25°.

Byte 4, **Byte 5**, and **Byte 6** represent the the first echo distance value. Their data are stored in Big-Endian mode. The two high bytes are the integer part, whose unit is “cm”; and the last byte is the decimal part, whose unit is 1/256 cm. To analyze the distance value, for example: the distance value in the obtained data packet is represented by the hexadecimal number 0x02,0x18,0x32, and the first two bytes are composed of 16-bit unsigned data, that is: 0x0218, which is converted to decimal distance value: 536 cm. The last byte is the decimal part, 0x32 equals 50 in decimal, that is, 50*1/256 cm=0.1953125 cm. Then the two parts add up to 536. 1953125 cm.

Byte 7 represents the first echo strength, and the value range is 0-255. (Echo strength can reflect the energy reflection characteristics of the measured object in the actual measurement environment. Therefore, the echo strength can be used to distinguish objects with different reflection characteristics) .

Byte 8, Byte 9 and Byte 10 represent the second echo distance value. Their data are stored in Big-Endian mode. The two high bytes are the integer part, whose unit is “cm”; and the last byte is the decimal part, whose unit is 1/256 cm. The distance value analysis method is the same as the first echo.

Byte 11 represents the second echo strength, and the value range is 0-255. (Echo strength can reflect the energy reflection characteristics of the measured object in the actual measurement environment. Therefore, the echo strength can be used to distinguish objects with different reflection characteristics) .

Azimuth

The resolution of the horizontal angle value is determined according to the motor speed. The horizontal angle defines the right side of the lidar as 0°, the left side as 180°, and the vertical direction as 90°. The range of the lidar’s horizontal direction is 30° to 150°, as shown in the figure below.

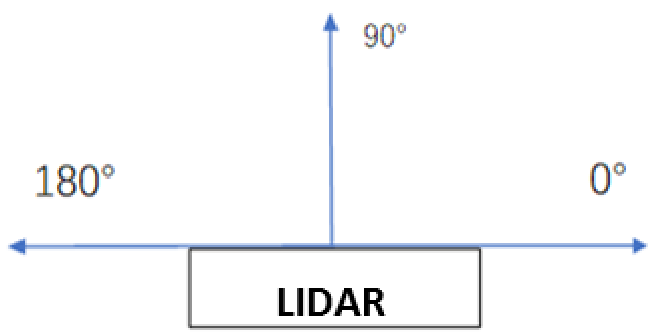

Figure 5.1 The Azimuth of the Lidar

Additional Information

The additional information of the single echo mode is 15 bytes in length, including 3 bytes reserved, 6 bytes of UTC time of year, month, day, hour, minute and second, 4 bytes of Timestamp and 2 bytes of Factory.

<table>
<tr><th colspan="4">Additional Information (single echo mode): 15 bytes</th></tr>
<tr><th colspan="2">Name</th><th>Length (byte)</th><th>Function</th></tr>
<tr><td colspan="2">Reserved</td><td>3</td><td>Reserved</td></tr>
<tr><td colspan="2">UTC time</td><td>6</td><td>Timestamp (unit: second)</td></tr>
<tr><td colspan="2">Timestamp</td><td>4</td><td>Timestamp (unit: nanosecond)</td></tr>
<tr><td rowspan="2">Factory</td><td>Vendor Information</td><td>1</td><td>0xff represents the CH256X1 lidar</td></tr>
<tr><td>Echo Information</td><td>1</td><td>0x1 represents single echo lidar
0x2 represents dual echo lidar</td></tr>
</table>

The additional information of the dual echo mode is 13 bytes in length, including 1 byte reserved, 6 bytes of UTC time of year, month, day, hour, minute and second, 4 bytes of Timestamp and 2 bytes of Factory.

<table>
<tr><th colspan="4">Additional Information (dual echo mode): 13 bytes</th></tr>
<tr><th colspan="2">Name</th><th>Length (byte)</th><th>Function</th></tr>
<tr><td colspan="2">Reserved</td><td>1</td><td>Reserved</td></tr>
<tr><td colspan="2">UTC time</td><td>6</td><td>Timestamp (unit: second)</td></tr>
<tr><td colspan="2">Timestamp</td><td>4</td><td>Timestamp (unit: nanosecond)</td></tr>
<tr><td rowspan="2">Factory</td><td>Vendor Information</td><td>1</td><td>0xff represents the CH256X1 lidar</td></tr>
<tr><td>Echo Information</td><td>1</td><td>0x1 represents single echo lidar
0x2 represents dual echo lidar</td></tr>
</table>

When there is no synchronization device inputting PPS signal, the lidar generates timestamp with a period of 1 second. The range of the timestamp is 0-999,999,999 (ns).

5.2 DIFOP Protocol

The device package outputs read-only parameters and status information such as version number, Ethernet configuration, motor speed and operating status, and fault diagnosis. The data of the device package adopts Big-Endian mode.

The device package includes a 42-byte Ethernet header and a 1206-byte payload, with a length of 1248 bytes. The payload is composed of an 8-byte frame header, 1196-byte data and a 2-byte frame tail.

Table 5.2 Data Format of the Device Package

<table>
<tr><th colspan="6">Ethernet Header: 42 bytes</th></tr>
<tr><th>Name</th><th>S/N</th><th>Information</th><th>Offset</th><th>Length (byte)</th><th>Note</th></tr>
<tr><td rowspan="2">Ethernet II MAC</td><td>0</td><td>Destination</td><td>0</td><td>6</td><td>/</td></tr>
<tr><td>1</td><td>Source</td><td>6</td><td>6</td><td>/</td></tr>
<tr><td>Ethernet Packet Type</td><td>2</td><td>Type</td><td>12</td><td>2</td><td>/</td></tr>
</table>

Internet Protocol	3	Version, Header Length, Differentiated Services, Field, Total Length, Identification, Flags, Fragment Offset, Time to Live, Protocol, Header, Checksum, Source IP Address, Destination IP Address	14	20	/
UDP Port Number	4	Lidar Port (0x0940, represents 2368)	34	2	/
	5	Computer Port (0x0941, represents 2369)	36	2	/
UDP Length & Sum Check	6	Length (0x04BE, represents 1214 bytes)	38	2	/
	7	Sum Check	40	2	/
Payload: 1206 Bytes					
Name	**S/N**	**Information**	**Offset**	**Length (byte)**	**Note**
Header	0	DIFOP Identification Header	0	8	/
Data	1	Motor Speed	8	2	/
	2	Ethernet (IP, MAC, Port, NTP)	10	22	/
	3	Ethernet (Gateway, Subnet Mask)	32	8	/
	4	Scanning Status	40	2	
	5	Device Flow Packet Interval	42	2	/
	6	Clock Source Selection	44	1	/
	7	Reserved	45	1	/
	8	Phase Lock Enable	46	1	/
	9	Phase Lock Angle Value Settings	47	2	/
	10	Line Number Switching	49	1	"0" represents 256 lines, "1" represents 128 lines, "2" represents 64 lines
	11	Fault Code	50	2	The 50th byte is reserved, the 51st byte is used to represent fault; "0" represents "normal", "1" represents fault.

	12	UTC Time	52	6	/
	13	Longitude and Latitude	58	22	/
	14	Left APD Board Temperature	80	2	temp=(data /4096) *2.5*100-50
	15	Left LD Board Temperature	82	2	/
	16	Left APD High Voltage	84	2	HV=281-0.0692142* data
	17	Right APD Board Temperature	86	2	/
	18	Right LD Board Temperature	88	2	/
	19	Right APD High Voltage	90	2	/
	20	GPS Status	92	1	/
	21	PPS Status	93	1	/
	22	High Temperature Pause	94	1	/
	23	Device Temperature after Stopped Working	95	2	/
	24	Cover Dirty Alarm Message	97	1	/
	25	Cover Dirty Count	98	2	/
	26	Reserved	100	1	/
	27	Reserved	101	1	/
	28	Phase Lock Angle Offset	102	2	temp=(data /4096) *2.5*100-50
	29	Main Control Board FPGA Temperature	104	2	temp= (data* 503.975)/4 096-273.15
	30	Input Voltage	106	2	/
	31	12 V Voltage	108	2	/
	32	5 V Voltage	110	2	/
	33	Input Current	112	2	/
	34	Reserved	114	2	/
	35	Left Emitting Voltage	116	2	/
	36	Right Emitting Voltage	118	2	/
	37	Threshold Value Adjustable Value 1	120	1	/
	38	Threshold Value Adjustable Value 2	121	1	/
	39	Threshold Value Adjustable Value 3	122	1	/
	40	Threshold Value Adjustable Value 4	123	1	/
	41	Threshold Value Adjustable Value 5	124	1	/
	42	Threshold Value Adjustable Value 6	125	1	/
	43	Threshold Value	126	1	/

		Adjustable Value 7			
	44	Threshold Value Adjustable Value 8	127	1	/
	45	Lidar's Total Operating time	128	4	/
	46	Operating Time Below -40°C	132	3	/
	47	Operating Time Below -10°C	135	3	/
	48	Operating Time Below 30°C	138	3	/
	49	Operating Time Below 70°C	141	3	/
	50	Operating Time Below 100°C	144	3	/
	51	Reserved	147	13	/
	52	Reserved	160	864	/
Tail	120	Tail	1204	2	0f, f0

Header is the device packet identification header, which is fixed as 0xA5,0xFF, 0x00,0x5A,0x11,0x11,0x55,0x55, and the first 4 bytes can be used as the packet inspection sequence. The tail is fixed as 0x0F,0xF0.

Table 5.3 Fault Code Table

No.	Fault Code	Fault Type	Description
1	0x00000000	No fault	/
2	0x00000001	Overvoltage (>36 V)	The 1st digit of fault code. 1: overvoltage; 0: input voltage not exceed 36 V
3	0x00000010	Undervoltage (<12 V)	The 2nd digit of fault code. 1: undervoltage; 0: input voltage not below 12 V
4	0x00000100	High power consumption (>25 W)	The 3rd digit of fault code. 1: high power consumption; 0: normal power consumption
5	0x00001000	High FPGA temperature (>135°)	The 4th digit of fault code. 1: high FPGA temperature; 0: normal FPGA temperature
6	0x00010000	High emitting board temperature (>105°)	The 5th digit of fault code. 1: high emitting board temperature; 0: normal emitting board temperature
7	0x00100000	High receiving board temperature (>105°)	The 6th digit of fault code. 1: high receiving board temperature; 0: normal receiving board temperature
8	0x01000000	Big motor speed error (>10 RPM)	The 7th digit of fault code. 1: big motor speed error; 0: normal motor speed
9	0x10000000	Over-high APD high voltage (> standard 10 V)	The 8th digit of fault code. 1: over-high APD high voltage; 0: normal APD high voltage

Note: This fault code can report the faults listed in the table above at the same time, e.g. 0x01000001, which indicates that a motor speed error fault and an overvoltage fault are reported at the same time.

5.3 UCWP Protocol

The UCWP configures the lidar's Ethernet, motor speed and other parameters, and the data of the configuration package adopts the Big-Endian mode.

The configuration packet includes a 42-byte Ethernet header and a 1206-byte payload, with a length of 1248 bytes. The payload is composed of an 8-byte Header, 1196-byte Data, and a 2-byte Tail.

Note: It is recommended that you configure the lidar through the Windows point cloud display software. Please do not pack and configure the lidar parameters by yourself.

Table 5.4 Data Format of the Configuration Package

Ethernet Header: 42 bytes				
Name	**S/N**	**Information**	**Offset**	**Length (byte)**
Ethernet II MAC	0	Destination	0	6
	1	Source	6	6
Ethernet Packet Type	2	Type	12	2
Internet Protocol	3	Version, Header Length, Differentiated Services, Field, Total Length, Identification, Flags, Fragment Offset, Time to Live, Protocol, Header, Checksum, Source IP Address, Destination IP Address	14	20
UDP Port Number	4	Lidar Port (0x0941, represent 2369)	34	2
	5	Computer Port (0x0940, represent 2368)	36	2
UDP Length & Sum Check	6	Length (0x04BE, represent 1214 bytes)	38	2
	7	Sum Check	40	2
Payload: 1206 bytes-				
Name	**S/N**	**Information**	**Offset**	**Length (byte)**
Header	0	UCWP Header	0	8
Data	1	Motor Speed	8	2
	2	Ethernet (IP, MAC, Port, NTP)	10	22
	3	Ethernet (Gateway, Subnet Mask)	32	8
	4	Scanning Status	40	2
	5	Device Flow Packet Interval	42	2
	6	Clock Source Selection	44	1
	7	Reserved	45	1
	8	Phase Lock Enable	46	1
	9	Phase Lock Angle Setting	47	2

	10	Line Number Switching	49	1
	11	Fault Code	50	2
	12	Reserved	52	2
Tail	13	Frame Tail	1204	2

Header is the configuration packet identification header, which is fixed as 0xAA, 0x00, 0xFF, 0x11, 0x22, 0x22, 0xAA, 0xAA, and the first 4 bytes are used as the packet inspection sequence. The Tail of the frame is fixed as 0x0F, 0xF0.

5.3.1 Configuration Parameters and Status Description

Here below are the configuration parameters and status description of specific lidar information.

Motor Speed

Motor Speed (2 bytes)		
S/N	Byte 1	Byte 2
Function	Speed: 10 Hz/20 Hz	

The motor rotates clockwise. two speeds can be set: when it is set to 0x04B0, the speed is 1200 RPM; when it is set to 0x0258, the speed is 600 RPM. Other setting data is not supported.

Ethernet Configuration

The length of the source IP address "IP_SRC" is 4 bytes and the length of the destination IP address "IP_DEST" is also 4 bytes. Each lidar has a fixed MAC address "MAC_ADDR" (6 bytes in length), which cannot be configured. Port 1 is the UDP data port number and port 2 is the UDP device port number.

Ethernet Configuration (22 bytes)								
S/N	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Function	IP_SRC				IP_DEST			
S/N	Byte 9	Byte 10	Byte 11	Byte 12	Byte 13	Byte 14	Byte 15	Byte 16
Function	MAC_ADDR (Read Only)						Data Port: Port 1	
S/N	Byte 17	Byte 18	Byte 19	Byte 20	Byte 21	Byte 22		
Function	Device Port: Port 2		Reserved					

Lidar Rotation & Stationary

Lidar Rotation & Stationary (2 bytes)		
S/N	Byte 1	Byte 2

Function	0: Rotation； 1: Stationary

0x0000 indicates that the lidar is rotating, and 0x0001 indicates that the lidar is stationary, and the default value of the lidar is rotating scan.

Device Flow Packet Interval

Device Flow Packet Interval (2 bytes)		
S/N	Byte 0	Byte 1
Function	0: send 1 device packet every time 4 data packets are sent; other values: 1 packet per second.	

The configuration 0x0000 means to send 1 device packet every time 4 packets are sent, and other values mean 1 packet per second. The default value is 1.

Clock Source Selection

Clock Source Selection (2 bytes)	
S/N	Byte 0
Function	0: GPS; 1: gPTP, the unit of GPS timestamp is µs and of PTP timestamp is ns

Configure 0x00 to indicate GPS timing, for which the lidar should be connected to a GPS clock source. Configure 0x01 to indicate gPTP timing, for which the lidar should be connected to a gPTP clock source.

Phase Lock Enable

Phase Lock Enable (2 Bytes)	
S/N	Byte 0
Function	0: not enabled; 1: enabled

Configure 0x00 to indicate that phase lock is not enabled; configure 0x01 to indicate that phase lock is enabled and the phase lock function is activated.

Phase Lock Angle Setting

Phase Lock Angle Setting (2 Bytes)		
S/N	Byte 0	Byte 1
Function	Set phase lock angle	

Multiply the angular accuracy of 0.01° by 100 and then write it to the lidar. If the phase lock is at 100, then configure 10000, i.e. 0x2710 in hex. The lidar locks the motor around 100° when the phase lock is enabled.

5.3.2 Configuration Package Example

If you want to reset the lidar IP as 192.168.1.105, computer IP as 192.168.1.225, data port number as 6688, device port number as 8899, motor speed as 1200 rpm, according to the definition of the UCWP Packet and each register, it can be reconfigured as follows:

Table 5.5 Configuration Package Example

Info	Content	Config	Length (Byte)
Header		0xAA,0x00,0xFF,0x11,0x22,0x22,0xAA,0xAA	8
Motor Speed	1200 rpm	0x04,0xB0	2
Lidar IP (IP_SRC)	192.168.1.105	0xC0,0xA8,0x01,0x69	4
Computer IP (IP_DEST)	192.168.1.225	0xC0,0xA8,0x01,0xE1	4
Data Port (port 1)	6688	0x1A20	2
Device Port (port 2）	8899	0x22C3	2
Lidar Rotation / Stationary	Rotation	0x0000	2
Reserved	Reserved	0x00	1180
Tail		0x0F,0xF0	2

When using this protocol to configure the device, byte-level or section-level addressing and writing are not allowed, and the entire list must be written completely. After the list is written, the corresponding function will be updated and take effect immediately.

6. Time Synchronization

The synchronization mode adopted by the lidar to synchronize with external equipment is gPTP synchronization. If there is no external synchronization input, the lidar internally generates timing information.

Single echo mode: The absolute accurate time of the point cloud data is obtained by adding the 6-byte timestamp (accurate to seconds) and the 4-byte timestamp (accurate to nanoseconds) of the data packet.

Dual echo mode: The absolute accurate time of the point cloud data is obtained by adding the 6-byte timestamp (accurate to seconds) and the 4-byte timestamp (accurate to nanoseconds) of the data packet.

6.1 Lidar Internal Timing

When there is no other equipment to synchronize, the lidar uses 1 second ($1*10^9$ ns) as the cycle. With the nanosecond as the timing unit, the timing value is output as the time stamp of the data packet. At this time, there is no UTC time reference

6.2 gPTP Synchronization

Generalized Precise Time Protocol (gPTP) is derived from Precise Time Protocol (PTP) and is used to synchronize the time of individual devices within a local area network with high precision.

This series of lidar supports gPTP timing synchronization. Before synchronizing the lidar via gPTP, the time source needs to be set to “PTP” in the lidar's point cloud display software. And the lidar should be connected to a gPTP master.

The settings steps on the point cloud display software are as follows: run the software, click on “” to bring up the parameter modification window, change “Source Selection” to “PTP”.

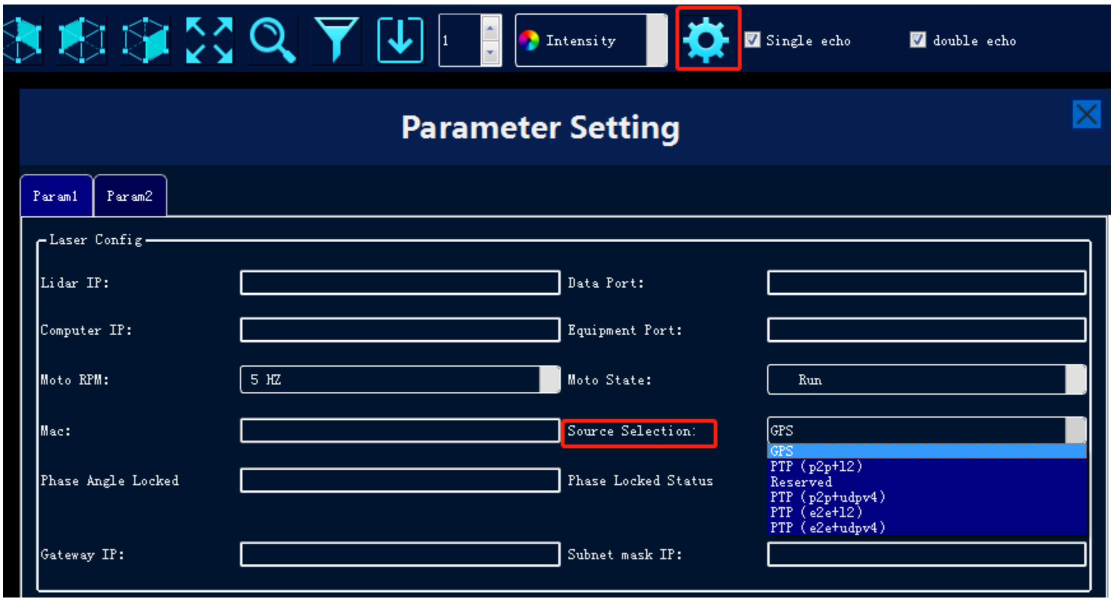

Figure 6.1 Clock Source Selection

Note:

The Timestamp and Date & Time in the point cloud packets will be synchronized strictly according to the time signal provided by the gPTP master clock. The time output from some master clocks may have a fixed offset from the Lidar's Date & Time, make sure the master clock is set up correctly and calibrated.

If "PTP" has been selected as the time source and no gPTP master clock is currently available, the lidar will start timing from the internal default start time; if a gPTP time source is provided and then interrupted, the lidar will continue timing from the time of the interruption.

7. Angle and Coordinate Calculation

7.1 Vertical Angle

Take **single echo mode** as an example: The vertical angle is obtained from the data packet, whose effective data area contains a total of 1197 bytes, including 171 points, that is, 171*7=1197 bytes. Take the first measure point as an example:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Line_num	Horizontal angle[15:8]	Horizontal angle[7:0]	Distance[23:16]	Distance[15:8]	Distance[7:0]	strength

Byte 1 represents the line number, whose value range from 0 to 255, a total of 256 lines. The 256 lines respectively corresponds to the lowermost ray to the uppermost ray in the entire vertical field of view. For example, line No. 0 represents a vertical angle of -20°, line No. 1 represents a vertical angle of -19.84°, and the angle difference between adjacent lines is 0.16°.

7.2 Horizontal Angle

Byte 2 and **Byte 3** represent the horizontal angle, whose data are stored in Big-Endian mode. The unit is 0.01 degrees. For example, 0x11AD=4525, that is 45.25°.

7.3 Distance Value and Intensity

Byte 4, **Byte 5**, and **Byte 6** represent the first echo distance value. Their data are stored in Big-Endian mode. The two high bytes are the integer part, whose unit is “cm”; and the last byte is the decimal part, whose unit is 1/256 cm. To analyze the distance value, for example: the distance value in the obtained data packet is represented by the hexadecimal number 0x02,0x18,0x32, and the first two bytes are composed of 16-bit unsigned data, that is: 0x0218, which is converted to decimal distance value: 536 cm. The last byte is the decimal part, 0x32 equals 50 in decimal, that is, 50*1/256 cm=0.1953125 cm. Then the two parts add up to 536. 1953125 cm.

Byte 7 represents the first echo strength, and the value range is 0-255 (Echo strength can reflect the energy reflection characteristics of the measured object in the actual measurement environment. Therefore, the echo strength can be used to distinguish objects with different reflection characteristics).

Note: There are 4 more bytes of distance value and intensity information in dual echo mode than in single echo mode. (for more information, see 5.1.2 subframe)

Byte 8, Byte 9 and Byte 10 represent the secondary echo distance value. Their data are stored in Big-Endian mode. The two high bytes are the integer part, whose unit is "cm"; and the last byte is the decimal part, whose unit is 1/256 cm. The distance value analysis method is the same as the first echo.

Byte 11 represents the second echo strength, and the value range is 0-255. (Echo strength can reflect the energy reflection characteristics of the measured object in the actual measurement environment. Therefore, the echo strength can be used to distinguish objects with different reflection characteristics.)

7.4 Cartesian Coordinate Representation

In order to obtain the vertical angle, horizontal angle and distance parameters of the lidar, the angle and distance information in polar coordinates can be converted to the x, y, z coordinates in the right-hand Cartesian coordinate system. The conversion relationship is shown in the following formula:

$$\begin{cases} x = r\cos\alpha\cos\theta; \\ y = r\cos\alpha\sin\theta; \\ z = r\sin\alpha \end{cases}$$

In the above formula, r is the distance, α is the vertical angle, θ is the horizontal rotation angle. And x, y, and z are the coordinates of the polar coordinates projected onto the x, y, and z axes.

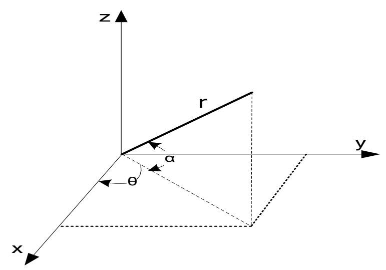

Figure 7.1 Coordinate Mapping

8. Accurate Time Calculation

To accurately calculate the time of the point cloud data, it is necessary to obtain the timestamp of the data packet and the UTC time of the device package output by the lidar. The timestamp and UTC time come from the same synchronization source, such as a GPS.

The laser emission interval of the CH256X1 lidar is about 0.434 μs, and the measurement interval of adjacent points is 0.434 μs.

8.1 Single Echo Mode

In the single echo mode, a data packet has a total of 171 measurement data. The packaging time of the data packet is about 0.434 μs*171~=74 .214 μs, and the data rate is about 1s/74 .214 μs ~=13474 data packets/second.

8.1.1 Calculation of Data Packet End Time

The timestamp in the data packet is a relative time in nanoseconds, which is defined as the packing time of the laser measurement data of the last channel in the data packet (packet end time), and its duration is less than 1 second. Therefore, to calculate the absolute end time of the data packet, it is necessary to obtain the 6-byte year, month, day, hour, minute and second information and the 4-byte nanosecond timestamp from the data packet first, and then combine the two to get the exact time when the data packet ends.

8.1.2 Accurate Time Calculation of Channel Data

The precise measurement time of each data can be calculated with the exact time of the end of the data packet and the light-emitting time interval of the 171 data.

Each data packet block of the CH256X1 lidar contains 171 measurement data. Therefore, the end time interval of each data packet is the time of the last point. Assuming that the absolute time of the data packet end is T_{Packet_end}, and the end time of the previous packet is $T_{Packet\_end\_last}$, then the end time interval of each data packet is:

$T_{Interval} = (T_{Packet\_end} - T_{Packet\_end\_last}) / 171;$

The steps for calculating the end time of each data block $T_{Point\_end(N)}$ are as follows:

$T_{Point\_end(N)} = (T_{Packet\_end} - T_{Interval}*(171-N))$. (N = 1, 2, ..., 171), where $T_{Point\_end(N)}$

indicates the end time of the N^{th} data point.

8.2 Dual Echo Mode

In the dual echo mode, a data packet has a total of 109 measurement data. The packaging time of the data packet is about 0.434 μs*109~=47.306 μs, and the data rate is about 1s/47.306 μs ~=21138 data packets/second.

8.2.1 Calculation of Data Packet End Time

The timestamp in the data packet is a relative time in nanoseconds, which is defined as the packing time of the laser measurement data of the last channel in the data packet (packet end time), and its duration is less than 1 second. Therefore, to calculate the absolute end time of the data packet, it is necessary to obtain the 6-byte year, month, day, hour, minute and second information and the 4-byte nanosecond timestamp from the data packet first, and then combine the two to get the exact time when the data packet ends.

8.2.2 Accurate Time Calculation of Channel Data

The precise measurement time of each data can be calculated with the exact time of the end of the data packet and the light-emitting time interval of the 109 data.

Each data packet block of the CH256X1 lidar contains 109 measurement data. Therefore, the end time interval of each data packet is the time of the last point. Assuming that the absolute time of the data packet end is T_{Packet_end}, and the end time of the previous packet is $T_{Packet\_end\_last}$, then the end time interval of each data packet is:

$T_{Interval} = (T_{Packet\_end} - T_{Packet\_end\_last}) / 109;$

The steps for calculating the end time of each data block $T_{Point\_end(N)}$ are as follows:

$T_{Point\_end(N)} = (T_{Packet\_end} - T_{Interval}*(109-N)).$ (N = 1, 2, ..., 109),

$T_{Point\_end(N)}$ indicates the end time of the N^{th} data point.

Appendix A. Maintenance

Shipping Requirements

This series of lidars are packed with the packaging materials specially customized by our company, which can resist certain vibrations and impacts. For long-distance transportation, special packaging materials must be used to avoid irreversible damage during transportation.

Installation

Use screws that meet the specifications to fix the lidar base, and make sure the base has good heat dissipation. Wear powder-free clean gloves during installation to avoid optical cover contamination and mechanical damage.

Storage Conditions

It is recommended to store the products in a ventilated and dry place where the temperature is 23 ±5 °C, and the relative humidity is 30% ~ 70%. Do not store in environments where humidity, pH, etc. exceed the protection level.

Dirt Treatment

If the mask is dirty during use, such as with fingerprints, muddy water, dry leaves or insect corpses, etc., the lidar's ranging effect will be directly affected. Please clean it according to the following steps:

Tools: PVC gloves, clean cloth, absolute ethanol (99%)

Environment: ventilated and dry, away from fire

(1) Put on PVC gloves and fix the lidar base with your fingers; if it is not stubborn stains, use a dust-free cloth or dry air to gently remove the stains;

(2) For stubborn stains, evenly spray the ethanol in the spray bottle on the location to be cleaned and wait for the stain to be dissolved. Then use a dustless cloth dipped in ethanol solvent, and gently wipe the mask. If the cloth is contaminated, please replace it in time. After cleaning the stain, use a new dustless cloth to remove any remaining liquid.

Appendix B. Troubleshooting

For any of the following problems during the use of the lidar, please refer to the corresponding solutions for troubleshooting. If you are unable to implement the following steps, or if you are still unable to solve the problem after implementing the steps, please contact our technical support.

Problem	Solution
The indicator light on the interface box is not working	Confirm: ● power supply meets electrical requirements ● interface box is in good condition with no damage ● power cord contact is good and undamaged; power adapter is working properly ● re-power the lidar to see if the fault disappears
Motor is not running	Confirm: ● power supply meets electrical requirements ● good contact between interface box and the lidar ● re-power the lidar to see if the fault disappears
Motor running but no data output on the host PC or Wireshark	Confirm: ● power supply meets electrical requirements ● the network cable is well connected ● the IP address of the computer matches the destination IP address of the lidar ● your computer's firewall and other security software that may affect Ethernet broadcasts is turned off ● if the lidar emits laser beam with an IR camera or IR card ● re-power the lidar to see if the fault disappears
Wireshark has data but the host PC has no data	Confirm: ● your computer's firewall is turned off ● the IP address of the computer matches the destination IP address of the lidar ● data port and device port in the host computer are set correctly ● lidar port is not occupied by another process ● Npcap plugin is installed ● re-power the lidar to see if the fault disappears
Point cloud missing	Confirm: ● lidar housing is clean and free of stains ● horizontal FOV setting in the host computer ● the number of packets received by the lidar is normal ● whether the lidar emits laser beams, this can be checked with an IR camera or an IR card ● whether there are network conflicts ● whether there is a network blockage caused by other devices transmitting large amounts of data ● connect the PC to the lidar only and observe if the point cloud is missing ● re-power the lidar to see if the fault disappears
Abnormal point cloud image on the host PC (flickering point cloud;	Confirm: ● the lidar housing is clean and free of stains ● lidar surroundings are not complex

irregular point cloud alignment)	● horizontal FOV setting in the host computer ● whether the network is blocked by other devices transmitting data
Error occurs when running the Windows Client, no interface display	Confirm: ● the graphics card is used correctly, discrete graphics card is recommended ● the graphics card meets the minimum configuration requirements ● the driver for the graphics card is correctly installed
Crash or no response of the Windows Client when modifying lidar parameters	Confirm: ● Npcap plugin is installed ● the device package port number is correctly filled in ● the computer memory is not full

Revision History

Rev.	Release Date	Revised Content	Issued/Revised By
V1.0.0	2024-01-11	Initial Version	LSLiDAR
V1.1.0	2024-09-09	Specifications updated; dimensions updated	LS1499
V1.1.1	2024-10-08	Specifications updated; time synchronization updated	LS1499

*This product information is subject to change without notice.

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