
0755-86325830
robosense
RS-LiDAR-M1(B2)
User Manual
www.robosense.ai

Revision History

Revision	Content	Date	Edited by
1.0	Initial Release (For B2 Sample)	06.02.2020	PD
1.0.1	Update Dimension Drawing in Appendix D Modify some not precise description	18.02.2020	PD
1.0.2	Add the interpretation of UTC timestamp	10.03.2020	PD

Terminologies

MSOP	Main Data Stream Output Protocol
MEMS	Micro-Electro-Mechanical System
Pitch	The vertical angle
Yaw	The horizontal angle
Timestamp	The marker that records the system time
Header	The starting part of the protocol packet
Tail	The ending part of the protocol packet
Thermolysis	The loss of Heat from the Object

TABLE of CONTENT

Congratulations on your purchase of a RS-LiDAR-M1 (B2 Sample) Real-Time 3D LiDAR Sensor. Please read carefully before operating the product. Wish you a pleasurable product experience with RS-LiDAR-M1 (B2 Sample).

1 Safety Notices

To reduce the risk of device damage and to avoid breach of terms, do not disassemble sensor.

- Laser Safety - The laser safety complies with following standards:

  IEC 60825-1:2004;

  21 CFR 1040.10 and 1040.11, except the terms in Laser Notice No. 50 that was published at 24.06.2007;

  Chinese National Standard GB7247.1-2012.

- Read Instructions - All safety and operating instructions should be read before operating the product.

- Follow Instructions - All operating and use instructions should be followed.

- Retain Instructions - The safety and operating instructions should be retained for future reference.

- Heed Warning - All warnings on the product and in the operating instructions should be obeyed.

- Servicing - The user should not attempt to service the product beyond what is described in the operating instructions. All other servicing should be referred to RoboSense.

2 Introduction

RS-LiDAR-M1 (B2 Sample) is the world leading automotive grade solid-state LiDAR with small size that is particular applied in perception of environment for autonomous driving and ADAS.

RS-LiDAR-M1 (B2 Sample), as a MEMS solid-state LiDAR, the technical details are listed as below:

- Measurement rang up to 180 meters
- Accuracy ± 5 centimeter (within 60 meter)
- Data rate up to 1,125,000 points/second
- Horizontal field of view (FOV): 120°
- Vertical field of view (FOV): -12.5°~12.5°

In comparison to RS-LiDAR-M1 (B1 Sample), not only the dimension but also the specification of B2 Sample has been further optimized.
For RS-LiDAR-M1(B2 Sample), laser beams are emitted and then sent out from sensor by a 2D MEMS Mirror, in order to scan continuously the surrounding environment. Meanwhile, advanced digital signal processing and ranging algorithms calculate point cloud data and reflectivity of objects to enable the machine to “see” the world and to provide reliable data for localization, navigation and obstacle avoidance.

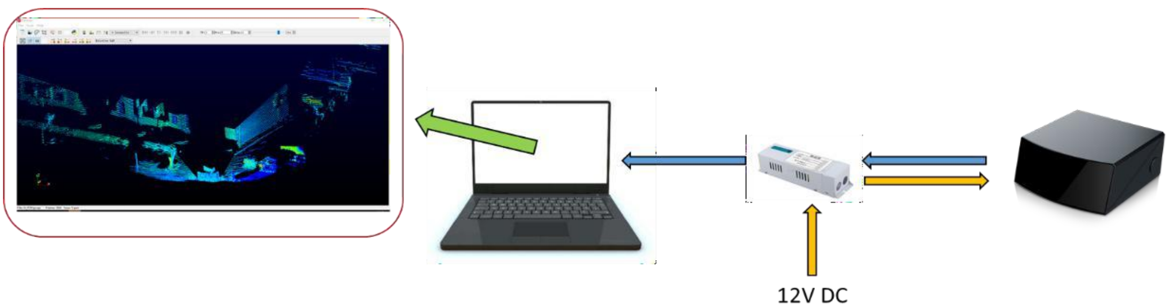


Figure 1: RS-LiDAR-M1(B2 Sample) Imaging System.

Operation of device includes:
- Establish communication with RS-LiDAR-M1;
- Parse the data packets for angle, measured distance, and reported calibrated reflectivity;
- Calculate X, Y, Z coordinates from reported measured distance and angle;
- Store the data as needed;

3 Product Specifications(B2 Sample)[1]

Table 1: Product Parameters.

Sensor	• Time of Flight Distance Measurement • Measurement Range: 1 m to 180 m(120 m@10%)[2] • Accuracy: ±5 cm (within 60 m)[3] • Field of View (Vertical): -12.5°~+12.5° • Angular Resolution (Vertical): 0.2°[4] • Field of View (Horizontal): 120° • Angular Resolution (Horizontal/Azimuth): 0.2°[4] • Frame Rate: 15 Hz
Laser	• Class 1 • Wavelength: 905 nm
Output	• Data Rate: ~1125k points/second • 1000Base-T1 Ethernet • UDP Packet includes: Distance, Angle, Reflectivity
Mechanical/ Electrical/ Operational	• Power Consumption: 28 W (B2 Sample)[5] • Operating Voltage: 9-36 VDC • Weight: ~0.8 kg(without cable) • Dimensions: L:140 mm x H:50 mm x W:110 mm • Environmental Protection: IP67, IP6K9K • Operation Temperature: -40 °C to +65 °C[6], (Convection Cooling is necessary, while device operates for a long time) • Storage Temperature: -40 °C to +105 °C

[1] The following data is only for mass-produced products. Any samples, testing machines and other non-mass-produced versions may not be referred to this specification. If you have any questions, please contact RoboSense sales.
[2] The measurement target of rang 120 m is a 10% NIST Diffuse Reflectance Calibration Targets, the test performance is depending on circumstance factors, not only temperature, range and reflectivity but also including other uncontrollable factors.
[3] The measurement target of accuracy is a 50% NIST Diffuse Reflectance Calibration Targets, the test performance is depending on circumstance factors, not only temperature, range and reflectivity but also including other uncontrollable factors.
[4] Resolution is not always the same in the whole FOV, the mean value of the resolution is 0.2°.
[5] The test performance of power consumption is depending on circumstance factors, not only temperature, range and reflectivity but also including other uncontrollable factors.
[6] Device operating temperature is depending on circumstance, including but not limited to ambient lighting, air flow and pressure etc.

4 Electrical Interface

4.1 Power Supply

The device requires a voltage input range of 9-36 VDC, and 12 VDC is recommended. The power consumption of the device is about 28 W (typical).

4.2 Electrical Configuration

The connectors of RS-LiDAR-M1 (B2 Sample) are shown as below:

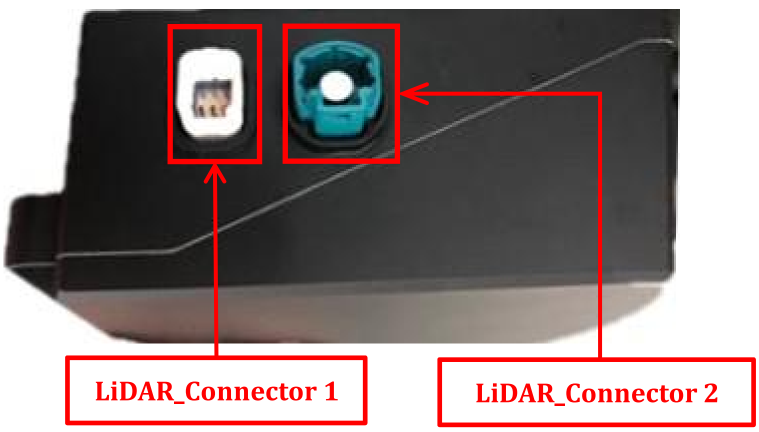
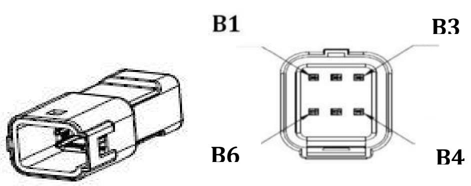


Figure 2: Image of the two connectors on RS-LiDAR-M1(B2 Sample).

The PINs definition of these two connectors are shown as below:

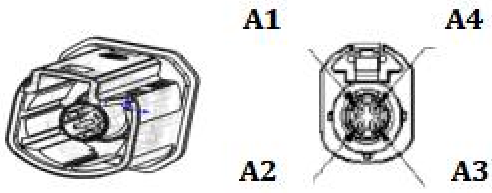
LiDAR_Connector 1:



PIN	Definition
B1	GPS_1PPS
B2	DC Power Input
B3	Ground
B4	CANH (DISABLE)
B5	CANL (DISABLE)
B6	Wake-up Mode Input (DISABLE)

Figure 3: Image of PINs Definition of LiDAR_Connector 1(Power Source).

LiDAR_Connector 2:



PIN	Definition
A1	GMSL_P (DISABLE)
A2	1000Base-T1_P
A3	GMSL_N (DISABLE)
A4	1000Base-T1_N

Figure 4: Image of PINs Definition of Connector 2(Signal).

The connectors on the RS-LiDAR-M1(B2 Sample) can be connected to the Robosense Interface Box, the cable length from the side of LiDAR to the Interface Box is 3 m (standard).

4.3 Interface Box

The interface box is connected to the RS-LiDAR-M1 by default, while the main function of the interface box is to transfer the 1000Base-T1 signal to 1000Base-TX signal.
There are also connectors for power supply and for 1000Base-TX Ethernet with RJ45 interface.
All interfaces on Interface Box are shown in the image as below:

Connection to external device	1PPS
	Wake-up
	DC_INPUT
	RJ45
Connection to LiDAR	Box_Connector 1
	Box_Connector 2

Figure 5: Connector Definition on Interface Box

4.4 Connection Details of Interface Box

The details of all interfaces are shown in following image.

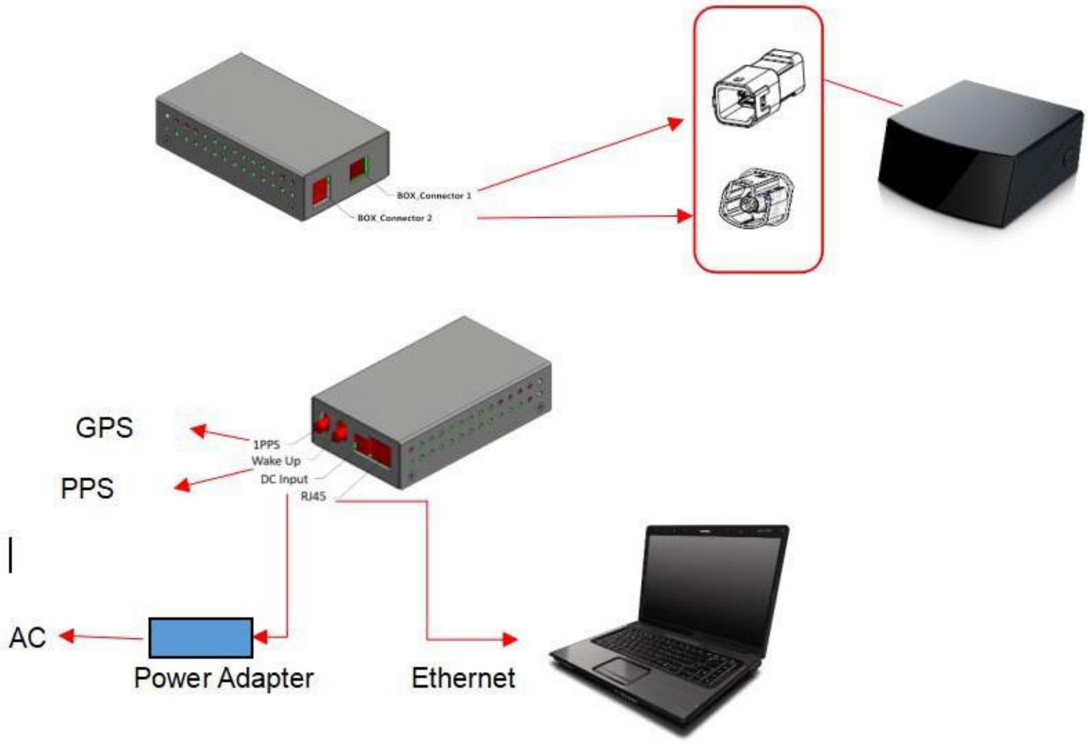


Figure 6: Wiring Diagram of Interface Box.

5 Communications Protocols

RS-LiDAR-M1 (B2 Sample) adopts UDP protocol and communicates with PC through Ethernet. The length of UDP packet in this user manual is fixed at 1400 bytes. The Ethernet parameters of RS-LiDAR-M1 (B2 Sample) can be changed as user wish. The factory Ethernet parameters, IP address and port number, are shown in the following table.

Table 2: The IP Address and Port Number Setting at the Factory.

Device	IP Address	MSOP Packet Port Number
RS-LiDAR-M1(B2 Sample)	192.168.1.200	6699
PC	192.168.1.102	

The default MAC Address of eachRS-LiDAR-M1 (B2 Sample) is set in the factory. The MAC Address is sole.

To establish communication between a sensor and a computer, the IP address of the computer should be set at the same network segment of that of the sensor. By default: 192.168.1.X (X can take any positive integer between 1 and 254), subnet mask: 255.255.255.0. In case of uncertainty about the internet setting of the sensor, please connect the sensor to the computer, and parse packet to get the IP and port through Wireshark.

The content of MSOP protocol is shown as below:

Table 3: Protocols Adopted by RS-LiDAR-M1(B2 Sample).

Protocol	Abbreviation	Function	Type	Size	Cycle
Main data Stream Output Protocol	MSOP	Scan Data Output	UDP	1400byte	~ 75 μs[7]

Note: The following section describes and defines the valid payload (1400 byte) of the UDP protocol packet.

5.1 MSOP

I/O type: device output data, computer parse data. Default port number is 6699.

MSOP outputs data information of the 3D environment in packets. Each MSOP packet is 1400 bytes long and consists of reported distance, calibrated reflectivity values, yaw and pitch values and a time stamp.

Each RS-LiDAR-M1 (B2 Sample) packet payload is 1400 bytes long and consists of a 20-byte header, a 1300-byte data field containing 25 blocks of 52-byte data block and 80 bytes for reservation.

The format of MSOP packet in single return mode is shown as below:

[7] For RS-LiDAR-M1(Sample B2), the complete scan process is realized through MEMS-Mirror reflecting laser beams. Its scanning path is like a zigzag. In one complete frame, that includes 126 lines, each line contains 5 UDP packets, it will cost 75 μs between two packets. In the transition of two lines, the time between the near two UDP packets cost about 80 μs. After finishing the 126-line scan, there is still 17 ms time interval to start the first line scan in a new one frame.

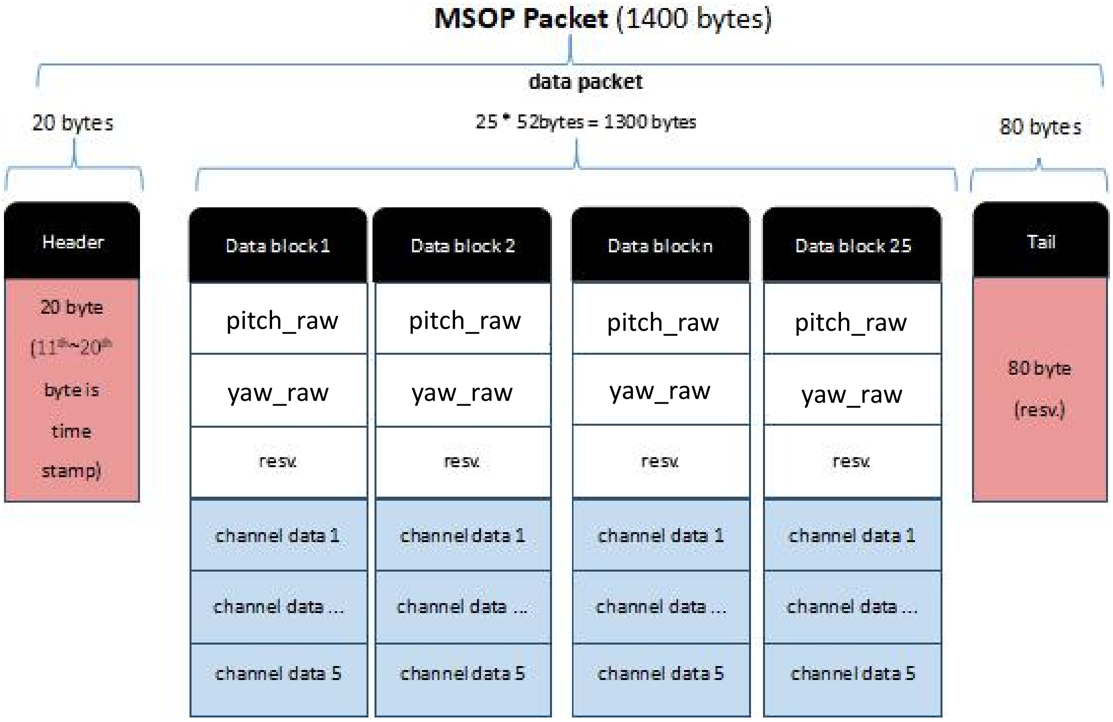


Figure 7: Image of MSOP Packet Format.

5.1.1 Header

The 20-byte Header marks the beginning of data blocks, packet command, reservation bits and time stamp. The details is shown as below:

Table 4: Header of MSOP Packet.

Header(20bytes)			
header	cmd	resv	time
4bytes	4bytes	2bytes	10bytes

header: 0x55,0xAA,0x05,0x5A;

cmd: packet command, fore 16 bits are packet number (cycle count), rear 16 bits are packet length (exclude header and packet command);

time: time stamp, which records system time, resolution 1 us, can refer to time definition in the Appendix A.1;

resv: reservation bits.

5.1.2 Data Field

Data field comprises data blocks that contain valid measurement data, in total 1300 bytes. Each data filed contains 25 blocks. Each block is 52-byte long and is a complete measurement data set. The details are shown in the following table 5.

Table 5: Definition of Data Block in MOSP Packet.

Data block n(52bytes)			
content	offset(byte)	size(bit)	instruction
pitch	0	16	Vertical angle
yaw	2	16	Horizontal angle
resv	4	64	Reservation
ch1_ref_w1	12	16	Channel 1 reflectivity for 1st return
ch1_dist_w1	14	16	Channel 1 distance for 1st return
ch1_ref_w2	16	16	Channel 1 reflectivity for 2nd return
ch1_dist_w2	18	16	Channel 1 distance for 2nd return
ch2_ref_w1	20	16	Channel 2 reflectivity for 1st return
ch2_dist_w1	22	16	Channel 2 distance for 1st return
ch2_ref_w2	24	16	Channel 2 reflectivity for 2nd return
ch2_dist_w2	26	16	Channel 2 distance for 2nd return
ch3_ref_w1	28	16	Channel 3 reflectivity for 1st return
ch3_dist_w1	30	16	Channel 3 distance for 1st return
ch3_ref_w2	32	16	Channel 3 reflectivity for 2nd return
ch3_dist_w2	34	16	Channel 3 distance for 2nd return
ch4_ref_w1	36	16	Channel 4 reflectivity for 1st return
ch4_dist_w1	38	16	Channel 4 distance for 1st return
ch4_ref_w2	40	16	Channel 4 reflectivity for 2nd return
ch4_dist_w2	42	16	Channel 4 distance for 2nd return
ch5_ref_w1	44	16	Channel 5 reflectivity for 1st return
ch5_dist_w1	46	16	Channel 5 distance for 1st return
ch5_ref_w2	48	16	Channel 5 reflectivity for 2nd return
ch5_dist_w2	50	16	Channel 5 distance for 2nd return

Pitch: vertical angle;
Yaw: horizontal angle;
Chn_ref_w1: channel n the reflectivity of first return;
Chn_dist_w1: channel n the measured distance of first return;
Chn_ref_w2: channel n the reflectivity of second return;
Chn_dist_w2: channel n the measured distance of second return;
Here, n = 1, 2, 3, 4, 5.

5.1.1.1 Channel Data

Channel data is 8-byte long, respectively first return and second return. Each block is 4 bytes and include 2 set data, of which the 2 higher bytes contain reflectivity and the lower 2 bytes contain measured distance.

Table 6: Details of each Channel Data.

Channel data n(8 byte)							
First Reflectivity(2 byte)		First Distance(2 byte)		Second Reflectivity(2 byte)		Second Distance(2 byte)	
Reflectivity1 [15:8]	Reflectivity 2[7:0]	Distance [15:8]	Distance [7:0]	Reflectivity1 [15:8]	Reflectivity2 [7:0]	Distance [15:8]	Distance [7:0]

Distance is 2-byte, unit: cm, resolution: 0.5 cm. The following shows how to parse channel data.

In the case of Figure 8, the distance information is calculated by:

Get distance values: higher bits is 0x03 , lower bits is 0xfc; Convert to decimal: 3, 252;

*Formula: Distance = (higher bits * 256 + lower bits) * resolution = (3 * 256 + 252) * 0.005*

= 5.10 m

Result: 5.10 m

Hence, the measured distance is 5.10 m

Reflectivity data records relative reflectivity (more definition on reflectivity, please refer to description on calibrated reflectivity in Section 9 of this manual). Reflectivity data reveals the reflectivity performance of the system in real measurement environments, it can be used in distinguishing different materials.

5.1.2.2 Demonstration of MSOP Packet

The following image shows the content of MSOP packet and the parsing process:

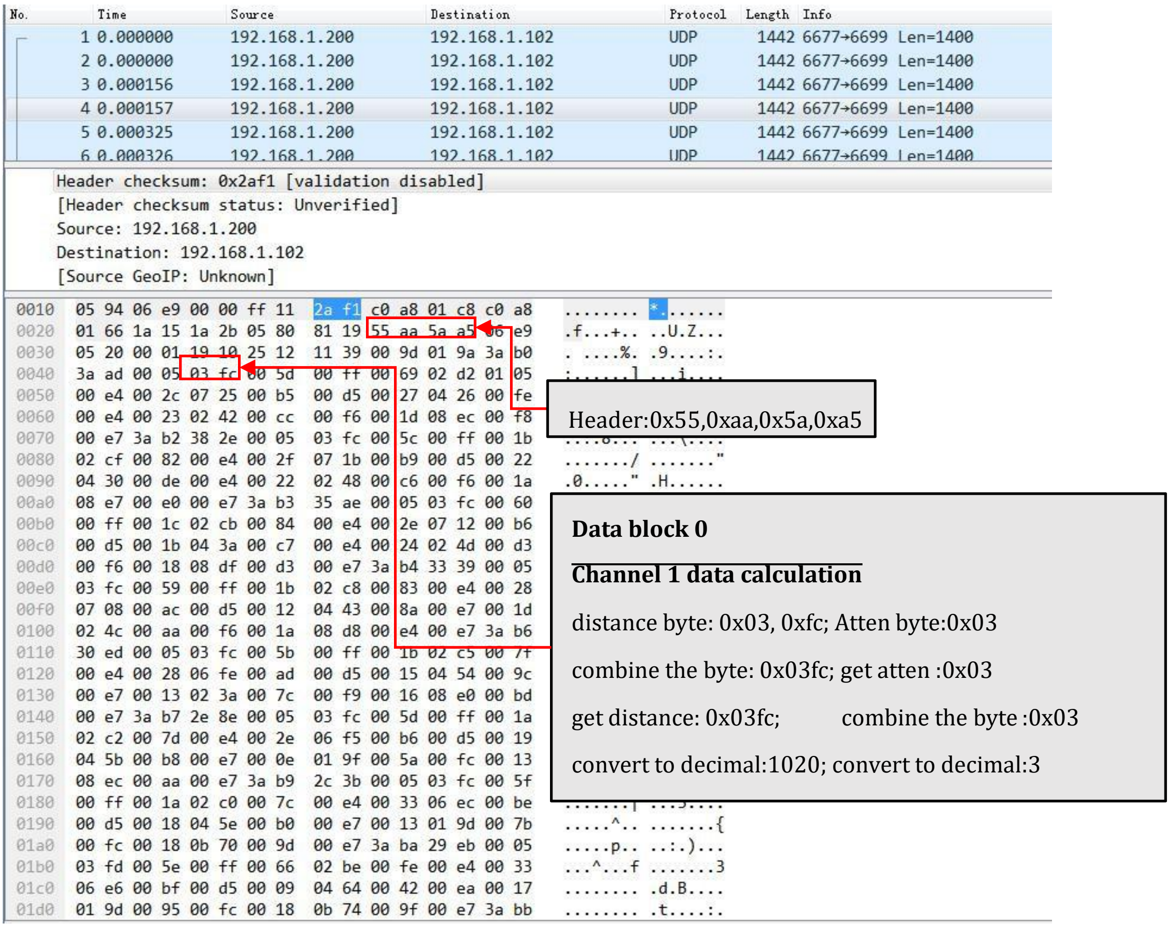


Figure 8: Example for showing Data Block in Wireshark.

6 GPS Synchronization (not support now)

TBD

7 Key characteristics

7.1 Return Mode

7.1.1 Return Mode Principle

RS-LiDAR-M1(B2 Sample) supports multiple return modes: Strongest return, Last return, and Dual return modes. When set to dual return mode, the details of the target will be enhanced, and the number of point is twice than that of a single return.

Due to the divergence of the beam, it is possible to generate multiple laser returns with one laser emission. When the laser pulse is emitted, its light spot gradually becomes larger. Suppose a light spot is large enough to shot multiple targets and produce multiple returns. Generally, the farther away the target is, the weaker it will be at the receiver, while the high reflective surface may be the opposite.

RS-LiDAR-M1(B2 Sample) analyzes the received multiple return values and outputs the strongest, last or simultaneous output of these two return values depending on the setting. If set to the strongest return mode, only the strongest reflected return value is output. Similarly, if the setting is the last return mode, only the last return value is output; if set to double return mode, the strongest and last return information is output simultaneously.

Note: Only when the distance between two objects is greater than 1 meter, the LiDAR could distinguish these two returns.

7.1.2 The Strongest Return

When the LiDAR beam hits only one object, there is only the strongest return at this time.

7.1.3 Strongest, Last and Dual Returns

When the laser pulse hit two objects at different distances, there will be two return wave, then it will lead two situations:

(1) When the strongest return is not the last return, return the strongest and last return;

(2) When the strongest return is also the last return, return the strongest return and the second strongest return;

Note: For RS-LiDAR-M1 (B2 Sample), it is only support Strongest Return mode.

8 Point Cloud

8.1 Coordinating Mapping

Please refer to the ROS source code to get the coordinating mapping and point calculation method. The exact source code is located in the unpack function of rawdata.cc file.
More details will be replenished in later version.

9 Reflectivity

For RS-LiDAR-M1(B2 Sample), the reflectivity is included in the data field of MSOP packet. Reflectivity is a scale to evaluate the ability of the reflection of light from object. This value is highly related to the material of measured object. Hence, the character can be used to distinguish the different materials.

RS-LiDAR-M1(B2 Sample) reports reflectivity values from 0 to 255 with 255 being the reported reflectivity for an ideal reflector. Diffuse reflection reports values from 0 to 100, with the weakest reflectivity reported from black objects and strongest reflectivity reported from white object. Retro-reflector reports values from 101 to 255.

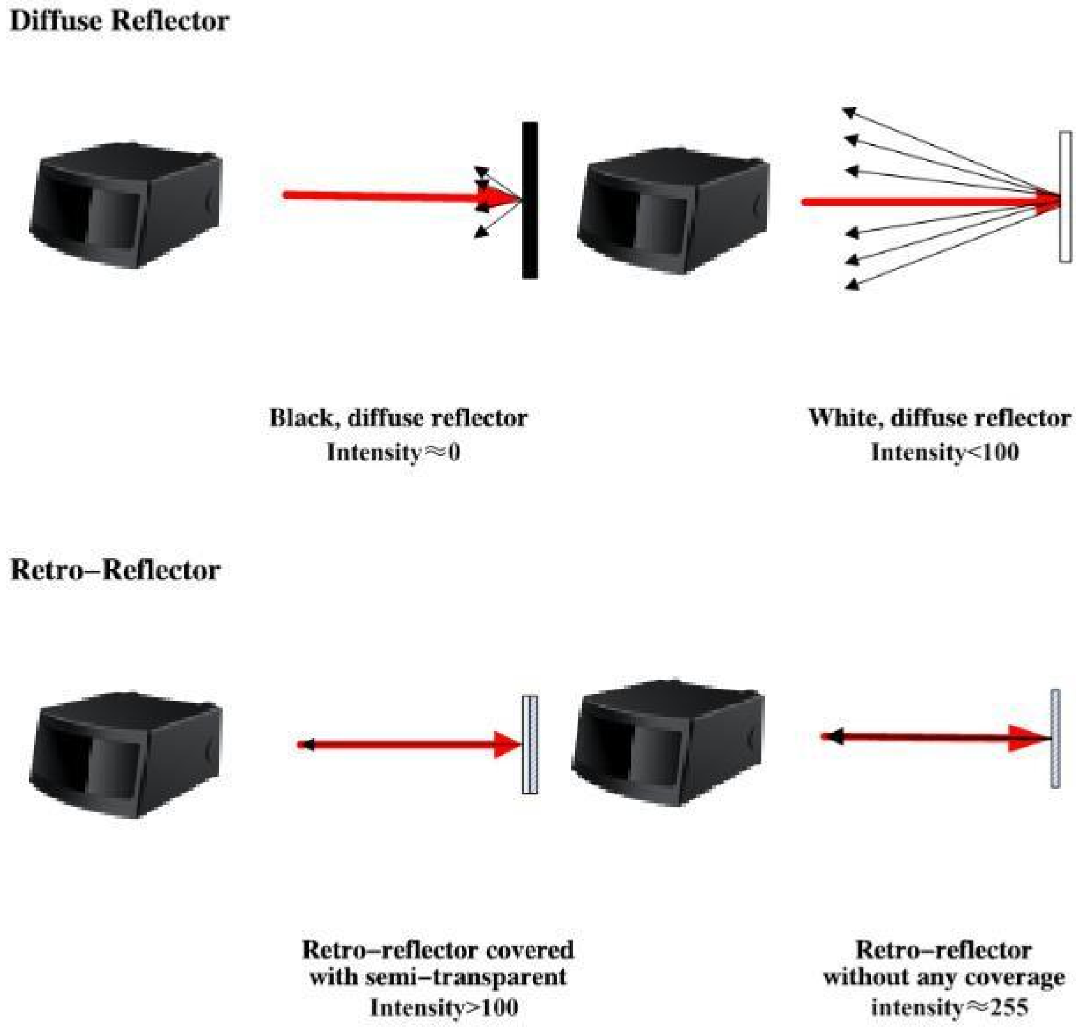


Figure 9: Calibration of Reflectivity.

The value of reflectivity can be gotten from MSOP packet.

10 Troubleshooting

This section provides detail on how to troubleshoot your sensor.

Problem	Solution
Interface BOX green LED doesn't light or blink.	● Verify the power connection and polarity ● Verify the power supply satisfy the requirement(at least 4A @19V)
Unit operates but no data	● Verify network wiring is functional. ● Verify receiving computer's network settings. ● Verify packet output using another application (e.g. Wireshark) ● Verify no security software is installed which may block Ethernet broadcasts. ● Verify input voltage and current draw are in proper ranges
Can see data in Wireshark but not RSVIEW	● Check no firewall is active on receiving computer. ● Check the receiving computer's IP address is the same as LiDAR destination IP address. ● Check the RSVIEW Data Port setting. ● Check if the wireshark receive the MSOP packets.
Data dropouts	● This is nearly always an issue with the network and/or user computer. ● Check the following: Is there excessive traffic and/or collisions on network? Are excessive broadcast packets from another service being received by the sensor? This can slow the sensor down. Is the computer fast enough to keep up with the packet flow coming from the sensor? ● Remove all network devices and test with a computer directly connected to the sensor.
No data via router	● Close the DHCP function in router or set the Sensor IP in router configuration
Point cloud data to be a radial	● If the computer is windows 10 OS, then run the RSVIEW with windows 7 OS compatible mode.

Appendix A Registers Definition

A.1 MSOP cmd

Cmd (4 bytes)			
Packet Number(2bytes)		Packet Length(2bytes)	
Number1 [15:8]	Number2 [7:0]	Length1 [15:8]	Length1 [7:0]

A.2 UTC_TIME

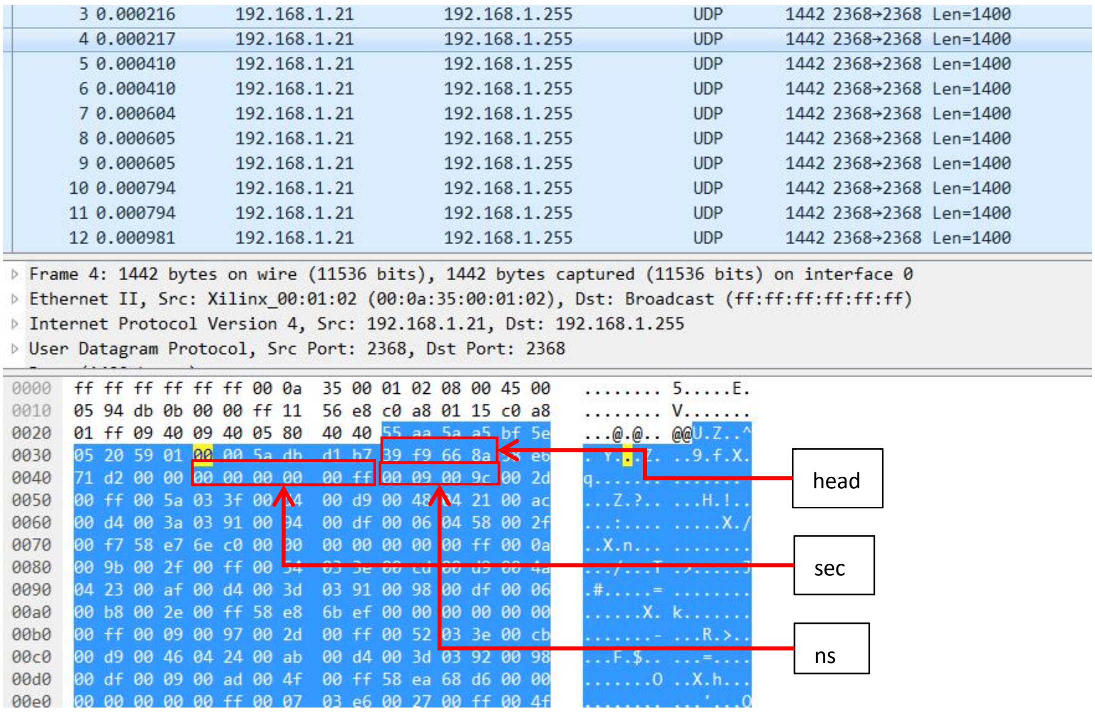


Figure A - 1: UTC Data Block.

(1) The timestamps are divided into second part and nanosecond part. The second part shown in Figure A-1 is 0x005adbd1b7 (1524355511); the nanosecond part is 0x39f9668a (972646026);

(2) The second part is UTC timestamp, which indicates the incremental count of seconds from 0:00 (London time) on January 1, 1970 to the current time. Figure A-1 shows the identification of London time 2018 / 4 / 22 00:05:11;

(3) The maximum value of the nanosecond part is 0x3b9ac9ff (99999999), after the maximum value is increased by 1, the nanosecond returns to zero and the second will be added to 1, as shown in Figure A-1 is 972646026 nanosecond;

(4) Most PC development environments have time conversion functions, such as including system library < time.h >, time.gmtime (&t) function can convert timestamp to London time.

UTC Time (10bytes)								
Byte No.	byte1	byte2	byte3	byte4	byte5	byte6	byte7	byte8
Function	Sec						ns	
Byte No.	byte9	byte10						
Function	ns							

Note: ns[7:0]: 0~999999999;

Appendix B RSView

This appendix gets you started with RSView. It shows you how to use the application to acquire, visualize, save, and replay sensor data.You can examine sensor data with other free tools, such as Wireshark or tcp-dump. But to visualize the 3D data, use RSView. It's free and relatively easy to use.The version of RSView is RSView2.0.

B.1 Features

RSView provides real-time visualization of 3D LiDAR data from RoboSense LiDAR sensors. RSView can also playback pre-recorded data stored in "PCAP" (Packet Capture) files, but RSView still does not support .PCAPNG files.
In RSView, each measurement from RS-LiDAR- M1 (B2 Sample) can be recognized as a point cloud data. A cloud point data could include different information such as distance, reflectivity, pitch and yaw value. According to these values, software can display the measured points in terms of different colors as user wish.
The function of RSView:

- Visualize live streaming sensor data over Ethernet.
- Record real-time measured data in PCAP files.
- Replay the data from recorded PCAP files.
- Different vitalization mode, according to distance, pitch and yaw etc..
- Tabular inspection of point cloud data.
- Tools for distance measuring.

B.2 RSView Installation

Installer for RSView is provided for Windows 64-bit system and it doesn't need other dependencies packet. The executable installer **RSView_2.0.0_Setup.exe** can be found in the U disk in the RS-LiDAR-M1 (B2 Sample) box.

B.3 Set up Network

The default IP address of the computer from factory should be set as 192.168.1.102, sub-net mask should be 255.255.255.0. And the RSView should not be shielded by operating firewall in the computer.

B.4 Visualization of Sensor Data

1. Connect RS-LiDAR- M1(B2 Sample) to power source and through crossover cable to PC.
2. Right Click the symbol of RSView, to start it with **Run as administrator**(Fig. B-1).

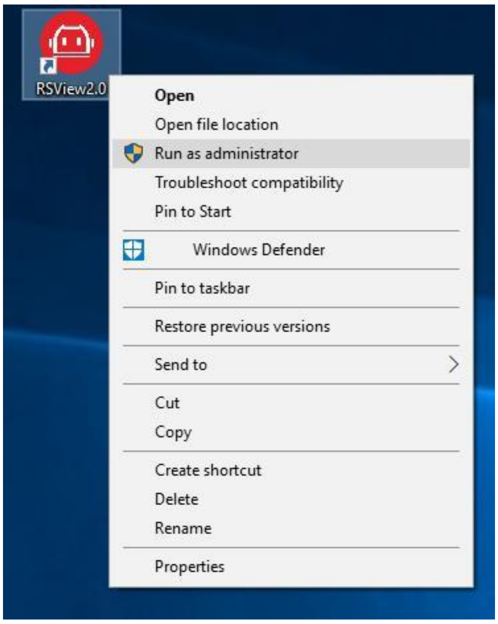


Figure B - 1: Open RSView with Run as administrator.

3. Click **File** > **Open** then select **Sensor Stream** (Fig. B-2).

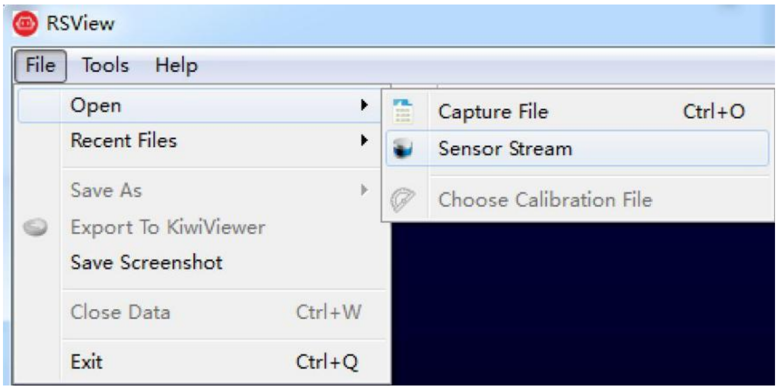


Figure B - 2: Open Sensor Stream for displaying real-time Data.

4. The Sensor Configuration dialog will appear. A default configuration folder of RS-LiDAR-M1 called “RSlidarM1CorrectionFile” for reference, but please add the right configuration files folder of the RS-LiDAR-M1 in USB stick, which should include all three csv files (angle.csv, ChannelNum.csv, curves.csv). That can be found in the configuration files folder named “configuration_data”, otherwise point cloud display will be chaos with the default configuration files. Select the configuration files folder of corresponding LiDAR and then click **OK**.

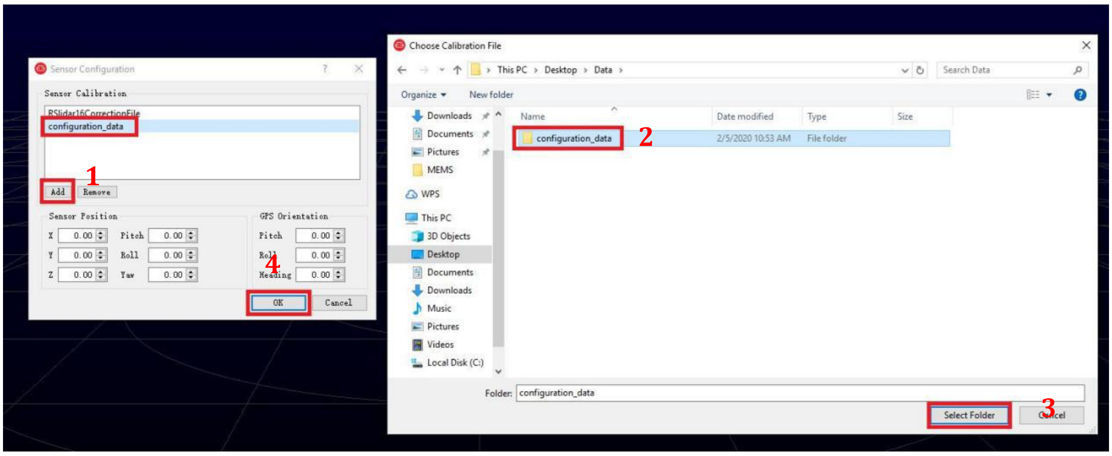


Figure B - 3: Import Configuration_data of RS-LiDAR-M1(B2 Sample).

5. RSView begins displaying the real-time sensor data stream. The stream can be paused by pressing the **Play/Pause** button. Press it again to resume stream play.

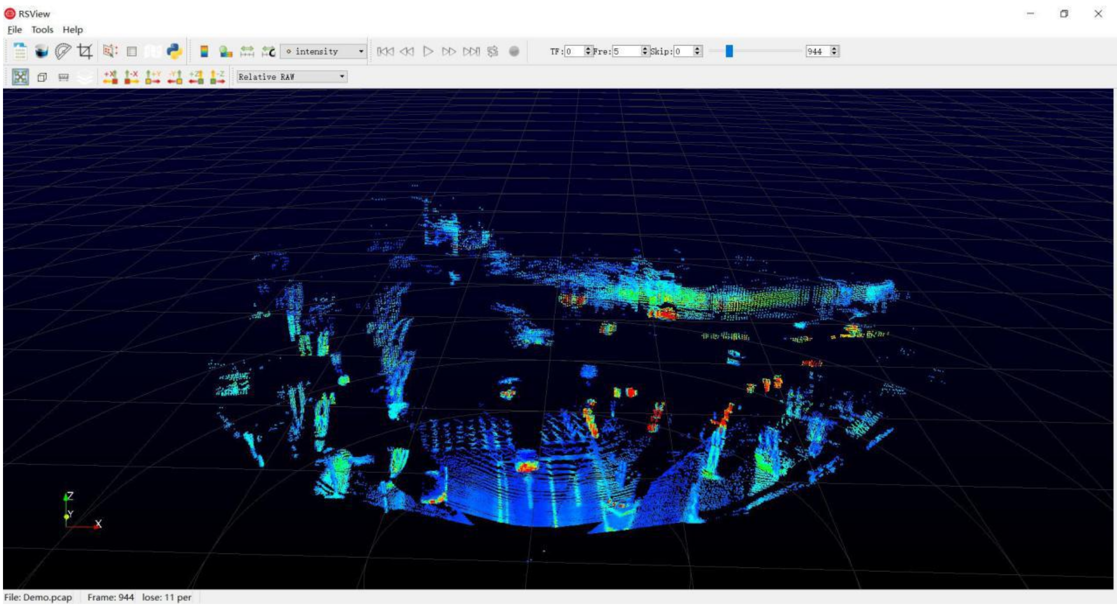


Figure B - 4: Point Cloud Image of R-LiDAR-M1(B2 Sample).

B.5 Capture Streaming Sensor Data to PCAP File

RSView as packet capture tool (the RSView for RS-LiDAR-M1 doesn't support this function):

1. Display real-time stream data, and then click **Record** button (Fig. B-5).

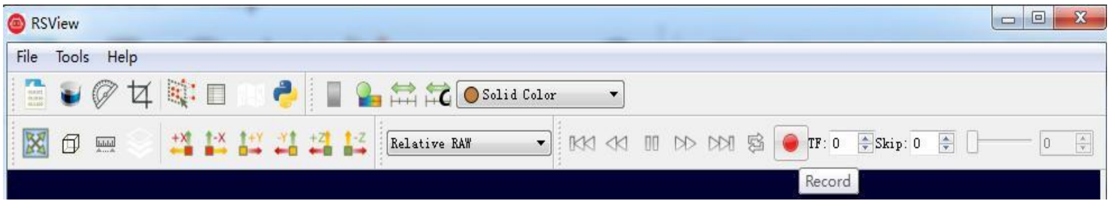


Figure B - 5: The Record Button in RSView

2. A Choose Output File dialog will pop up. Navigate to where you want the file to be saved and click the **Save** button (Fig. B-6). RSView begins writing packets to your pcap file. (Note: RS-LiDAR-32 sensors generate a lot of data. The pcap file can become quite large if the recording duration is lengthy. Also, it is best to record to a fast, local HDD or SSD, not to a slow subsystem such as a USB storage device or network drive.).

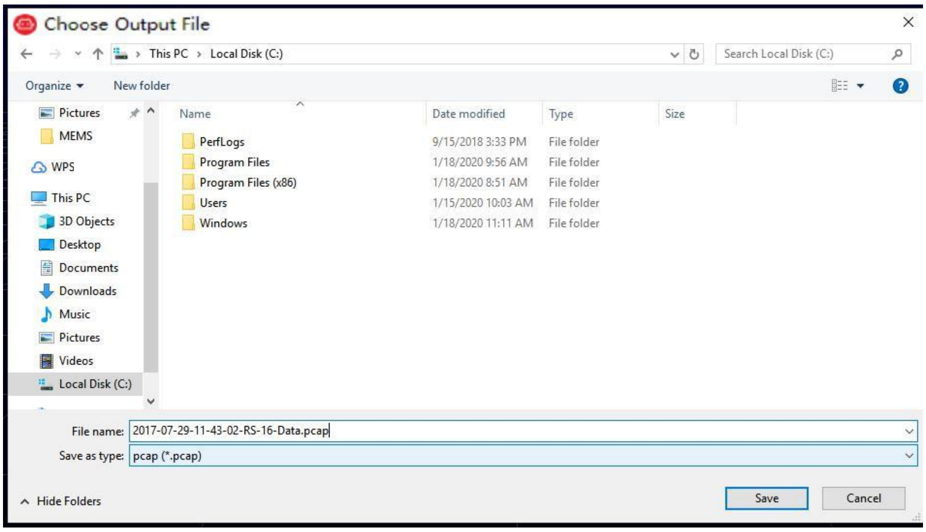


Figure B - 6: Dialogue after clicking Record Button.

3. Recording will continue until the **Record** button is clicked again, which stops the recording and closes the .pcap file.

Wireshark as packet capture tool:

1. Download software Wireshark (Fig. B-7).

Figure B - 7: Icon of Wireshark.

2. Double left click Wireshark, then select the LiDAR corresponding Network.

Figure B - 8: Start Software Wireshark.

3. When the data is shown like following image, it means that LiDAR operates normally. “LiDAR IP”, “PC IP”, “MSOP Port Number”, ”DIFO Port Number” can be checked in the red box.

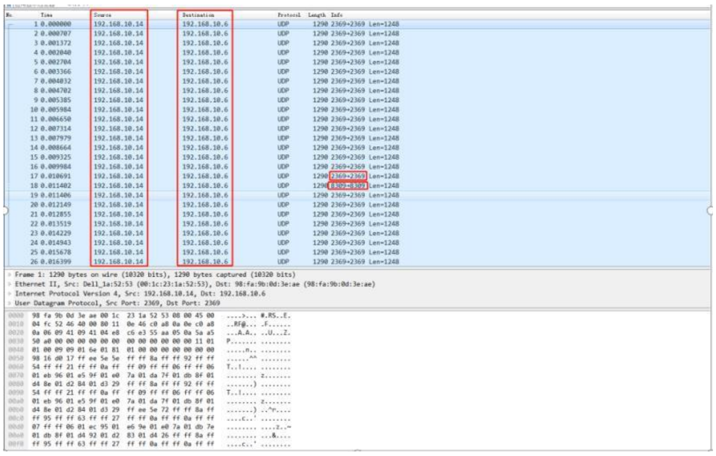


Figure B - 9: The Information Display of Ethernet Packet.

4. Click **Files > Save** (Fig. B-10).

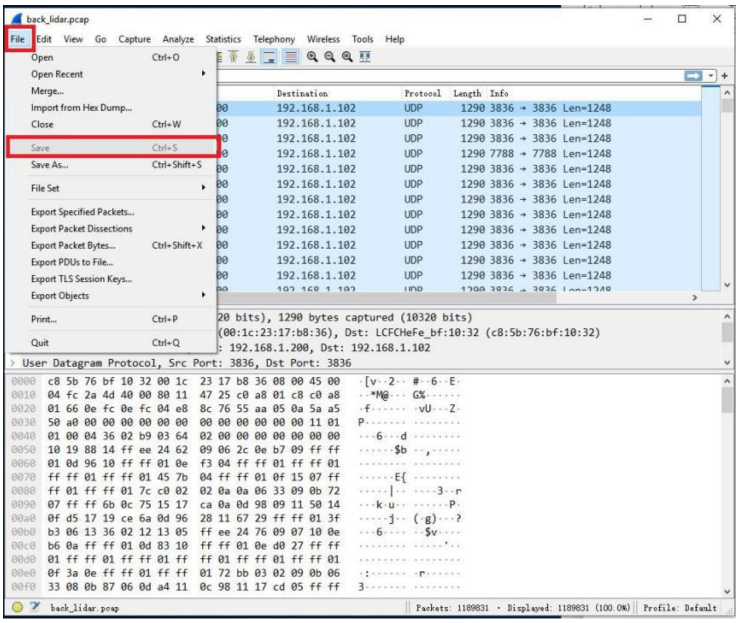


Figure B - 10: Save Data of Capturing Packet.

5. Select type of files as **“Wireshark/tapdump/ pcap”**.

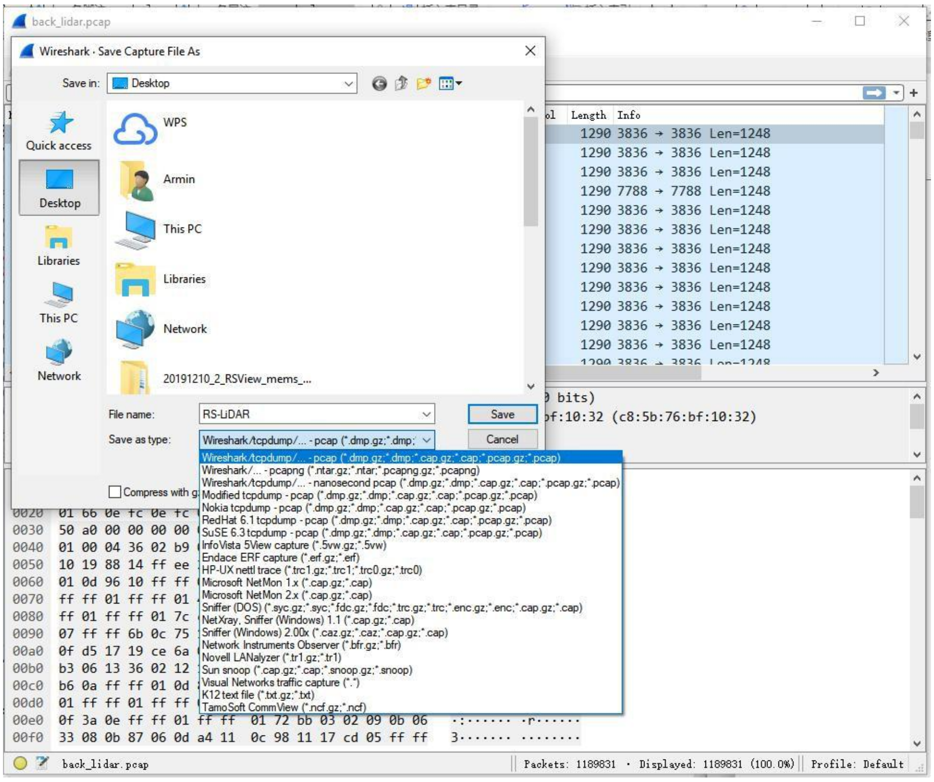


Figure B - 11: Save Data as PCAP Packet using Wireshark.

6. The saved PCAP data will appear in corresponding save path, the data can be visualized in RSView or ROS driver (the instruction of RSView can be referred in this Appendix of above section).

Figure B - 12: Data saved in selected Document.

B.6 Replay Captured Sensor Data from PCAP File

To replay (or examine) a pcap file, open it with RSView. You can press **Play** to let it run, or scrub through the data frames with the Scrub slider. Select a set of 3D rendered data points with your mouse and examine the numbers with a Spreadsheet sidebar.

1. Click on **File** > **Open** and select **Capture File** (Fig. B-13).

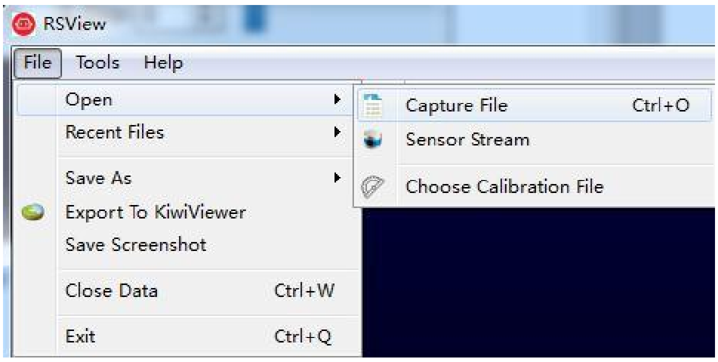


Figure B - 13: Open recorded PCAP File.

2. An Open File dialog will pop up. Navigate to a PCAP file, select it, and click the **Open** button.

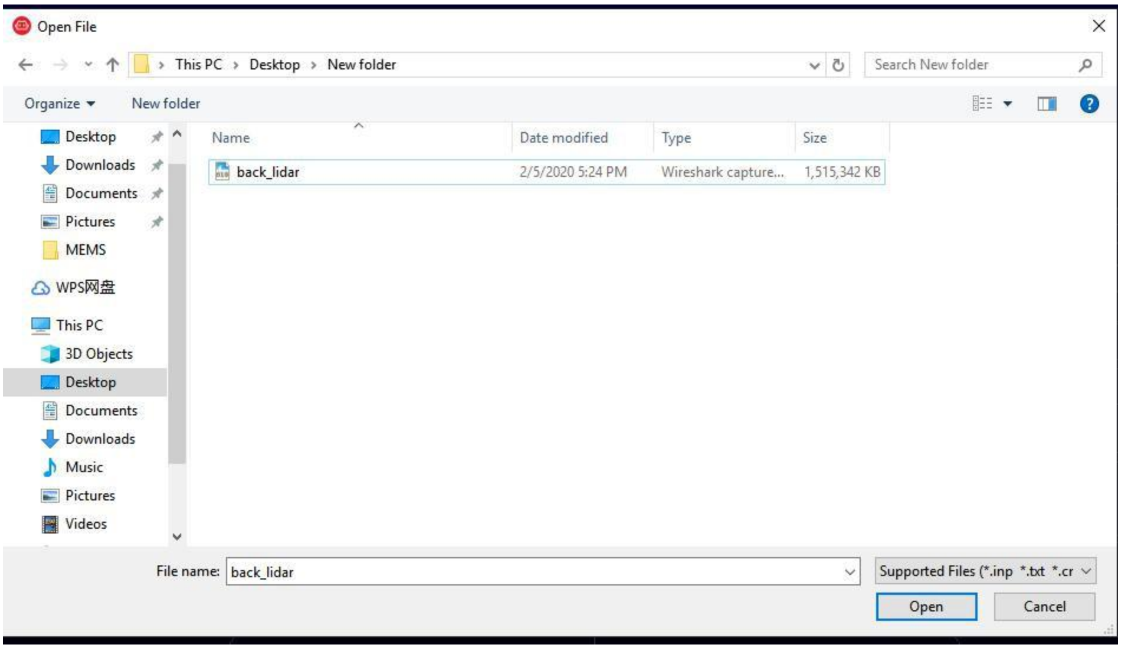


Figure B - 14: Select and open PCAP File.

3. The Sensor Configuration dialog will pop-up. Select your sensor configuration folder and click **OK.**
4. Press **Play** to replay/pause the data stream. Use the Scrub slider tool (it looks like an old-fashioned volume slider) to move back and forth through the data frames. Both controls are in the same toolbar as the **Record** button.

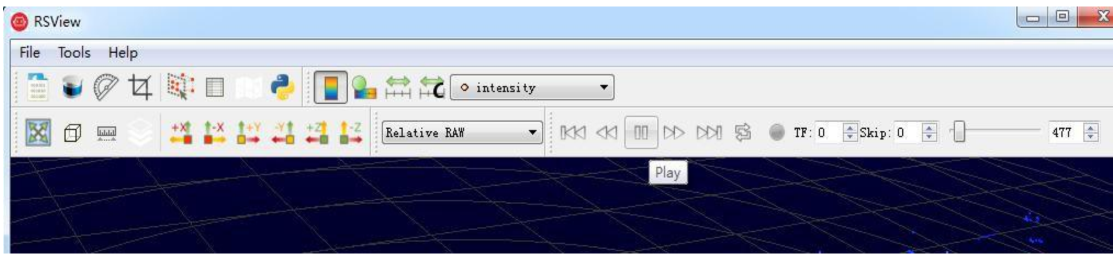


Figure B - 15: The Position of Play Button and Scrub Tool.

5. To get more detailed data, scrub to an interesting frame and click the **Spreadsheet** button (Fig. B-16). A sidebar of tabular data is displayed to the right of the rendered frame, containing all data points in this frame.

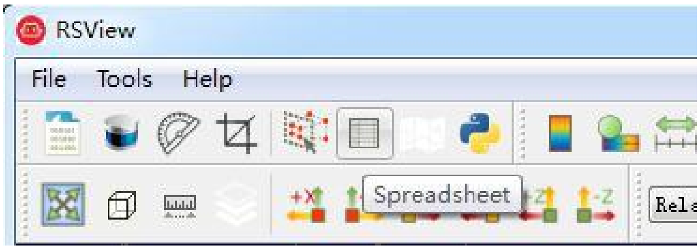


Figure B - 16: Spreadsheet Tools in RSView.

6. Adjust the width of columns or sort the parameter per different physical quantity can get a much better view of those data.

Showing: Data Attribute: Point Data Precision: 3

	Point ID	Points_m_XYZ	adjustedtime	azimuth	distance_m	intensity	laser_id	timestamp
0	0	0.003...	12320919.000	3	6.170	1	0	12320919
1	1	0.005...	12320922.000	4	7.600	3	1	12320922
2	2	0.008...	12320925.000	5	9.210	2	2	12320925
3	3	0.012...	12320928.000	6	11.520	1	3	12320928
4	4	0.108...	12320958.000	17	36.690	1	13	12320958
5	5	0.022...	12320969.000	21	6.160	1	0	12320969
6	6	0.029...	12320972.000	22	7.660	3	1	12320972
7	7	0.036...	12320975.000	23	9.230	3	2	12320975
8	8	0.048...	12320978.000	24	11.520	1	3	12320978
9	9	0.222...	12321008.000	35	36.540	2	13	12321008
10	10	0.041...	12321019.000	39	6.170	1	0	12321019
11	11	0.052...	12321022.000	40	7.650	2	1	12321022

Figure B - 17: Tabular Info Display of all selected Point Cloud.

7. Click **Show only selected elements** in the Spreadsheet. Since no points are selected, the table will be empty.

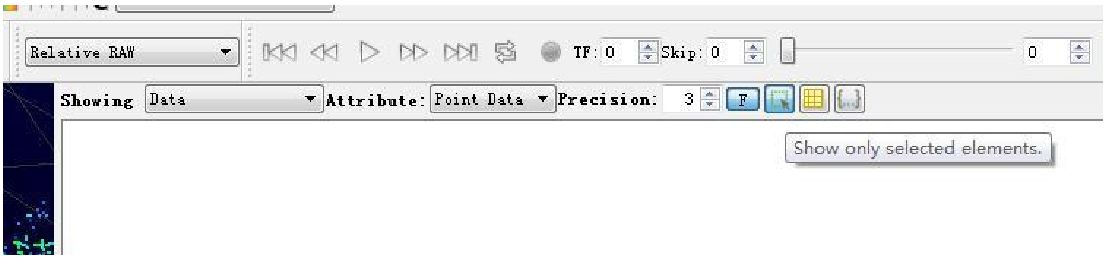


Figure B - 18: RSView show-olny-elements Tool.

8. Click the **Select All Points** tool. This will turn your mouse into a point selection mode (Fig. 19).

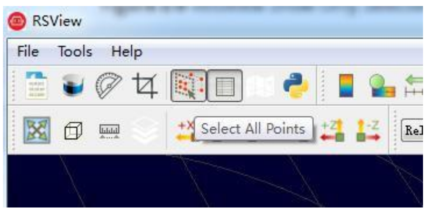


Figure B - 19: RSView Select-All-Points Tool.

9. In the 3D rendered data pane, press left mouse to draw a rectangle around amount of points. The additional information of box selected points will immediately show the data table (Fig. B-20).

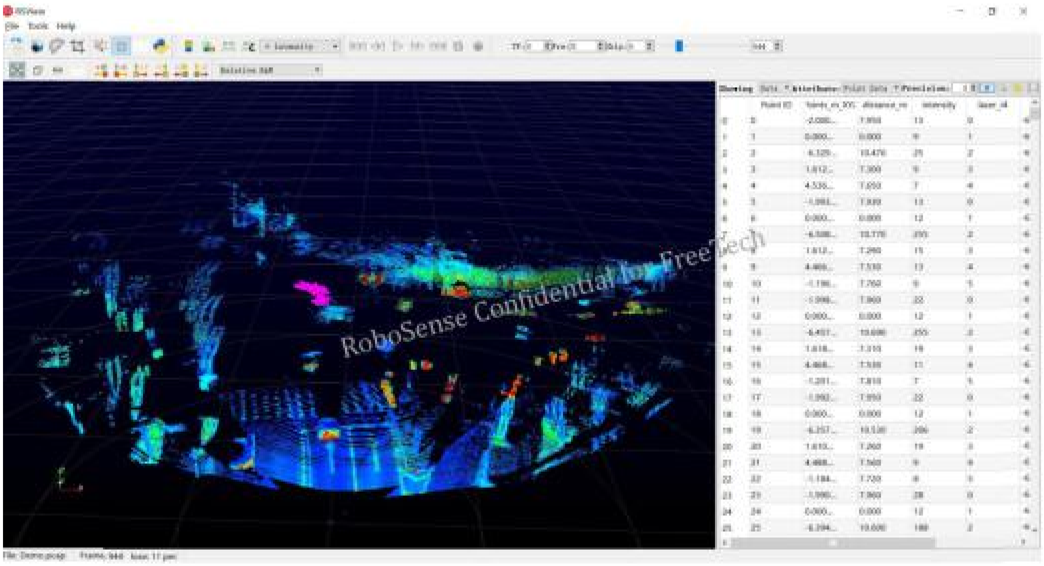


Figure B - 20: RSView can list all of selected Points.

10. At any point you can save a subset of data frames by doing **File > Save As > Select Frames.**

Appendix C RS-LiDAR- M1(B2 Sample) ROS Package

This appendix will describe how to use Ubuntu 16.04 + ROS Kinetic to view the measured data from RS-LiDAR-M1(B2 Sample).

C.1 Prerequisite

1. Please download and install the Ubuntu 16.04.
2. Please refer the link (http://wiki.ros.org/kinetic/Installation/Ubuntu) to install ROS Kinetic.
3. Download and install libpcap-dev.

C.2 compile ROS Package for RS-LiDAR- M1(B2 Sample)

1. Create the work space for ros:

```
cd ~
mkdir -p catkin_ws/src
```

2. Copy the ros_rslidar_package into the work space ~/catkin_ws/src. The latest version of the ros_rslidar driver can be downloaded from

https://github.com/RoboSense-LiDAR/ros_rslidar.

If any problem appears, please ask Robosense for help to get these files.

3. Build:

```
cd ~/catkin_ws
catkin_make
```

C.3 Configuration of PC IP

For factorial default firmware of RS-LiDAR- M1(B2 Sample), the static IP of PC is “192.168.1.102”, subnet mask: “255.255.255.0”, gate way doesn’t need to set.

After configuring, the command “ifconfig” in command prompt can check, whether the static PC IP is worked.

C.4 Display the real-time data with ros_rslidar packet

1. Connect the RS-LiDAR-M1 to your PC via RJ45 cable, and power on it.
2. In ros_rslidar packet, the launch files, e.g. “rs_lidar_m6.launch”, can start the “rslidar_pointcloud” node to visualize the real-time point cloud data. Open a terminal and run the following code:

```
cd ~/catkin_ws
source devel/setup.bash
roslaunch rslidar_pointcloud rs_lidar_m6.launch
```

Figure C - 1: Point Could Display of RS-LiDAR-M1(B2 Sample) using rivz.

3. Set the Fixed Frame to “rslidar”. Add a pointcloud2 type and set the topic to “rslidar_points”.

C.5 View the recorded pcap file offline

The ros_rslidar ROS package can also visualize the recorded .PCAP data.

1. Modify the "rs_lidar_m6.launch" file like below (please pay attention to the red line):

```
<launch>


  <node name="rslidar_node" pkg="rslidar_driver" type="rslidar_node" output="screen" >

    <param name="model" value="MEMS"/>

    <param name="pcap" value="the absolute path to your .pcap file"/>

    <param name="device_ip" value="192.168.1.200"/>

    <!-- Set the Lidar data port on the PC side, default is 6699 -->

    <param name="port" value="6699"/>

    <param name="start_from_edge" value="true"/>

  </node>


  <node name="cloud_node" pkg="rslidar_pointcloud" type="cloud_node" output="screen" >
    <param name="model" value="MEMS"/>

    <param name="angleT_path" value="$(find rslidar_pointcloud)/data/rs_lidar_m6/angleT.csv" />

    <param name="slow_path" value="$(find rslidar_pointcloud)/data/rs_lidar_m6/real_slow_axis.csv"

/>

    <param name="channel_path" value="$(find rslidar_pointcloud)/data/rs_lidar_m6/ChannelNum.csv"

/>

    </node>
```

2. Open a new terminal and run the following codes:

```
cd ~/catkin_ws
source devel/setup.bash
roslaunch rslidar_pointcloud rs_lidar_m6.launch
```

Appendix D Dimension Image

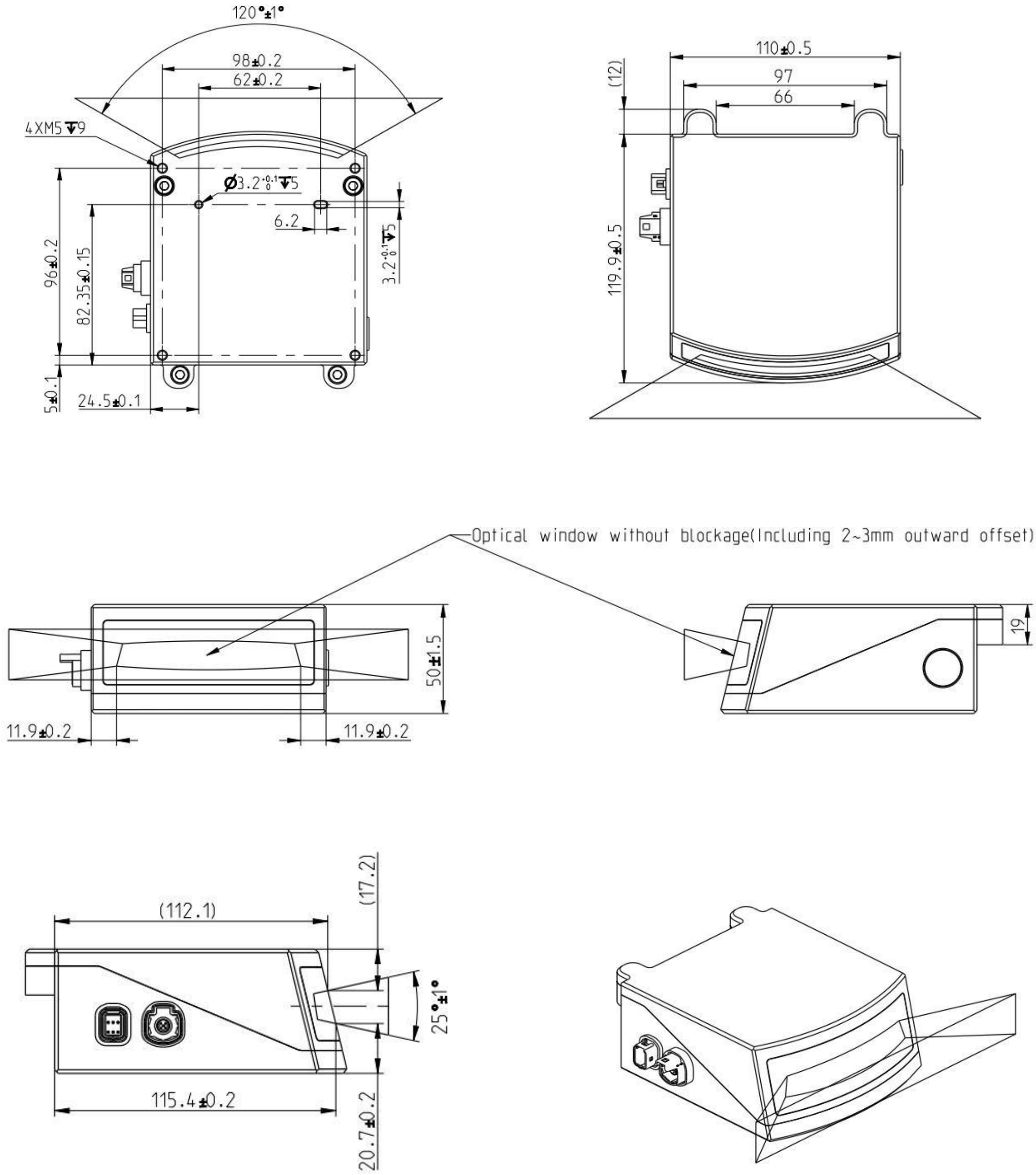


Figure D - 1: Dimension Drawing of RS-LiDAR-M1(B2 Sample).

Dimension	Measurement (mm)
Length(along X direction, main body)	119.6
Length(along X direction, include fastener)	131.6
Width(along Y direction)	110.0
Height(along Z direction)	50.0

Appendix E Suggestion of Mounting

E.1 Suggestion of Mounting Position

Recommend mounting position on the vehicle:

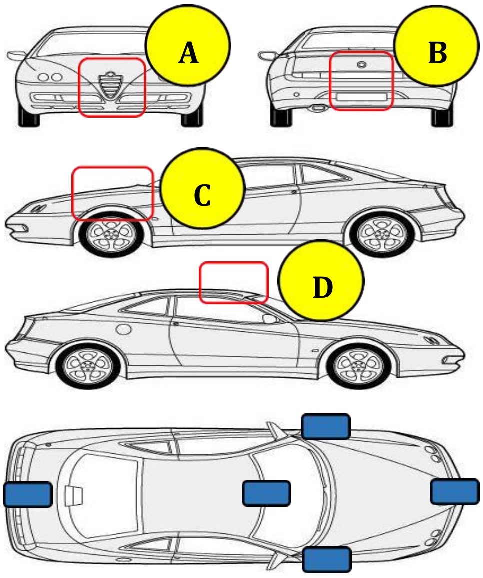


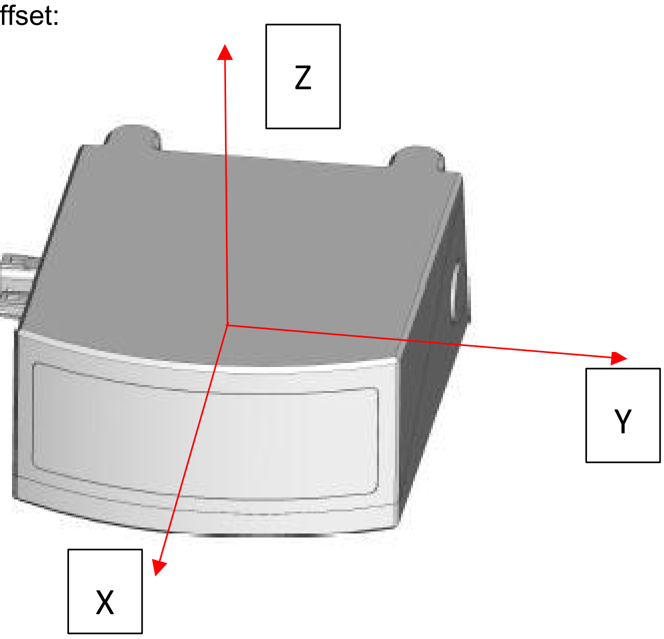
Figure E - 1: Image of Mounting Position of RS-LiDAR-M1 (B2 Sample).

Recommend positions are shown in the following table:

Table E - 1: The recommend Mounting Position on the Vehicle.

Position	Mount	Height	Requirements
A	Air Grille	600mm-1000mm	1. Reserve space for clean from outside. 2. The thermolysis and heating device should be outside of 100mm around sensor. 3. Not recommend offset mount. If needed, the offset should be inside of 100mm. 4. Angle offset with X-Y-Z axis should be smaller 1°.
B	Rear Bumper	600mm-1000mm	1. Reserve space for clean from outside. 2. The thermolysis and heating device should be outside of 100mm around sensor. 3. Not recommend offset mount. The offset should be inside of 100mm. 4. Angle offset with X-Y-Z axis should be smaller 1°.
C	Fender	600mm-1000mm	1. Reserve space for clean from outside. 2. The thermolysis and heating device should be outside of 100mm around sensor. 3. Do not cover FOV. 4. Angle offset with X-Y-Z axis should be smaller 1°.
D	Front Vehicle Roof	--	1. Reserve space for clean from outside. 2. Needs to do some heat Insulation and ventilation, to ensure operating temperature inside of 85 ℃. 3. Angle offset with X-Y-Z axis should be smaller 1°.

Explanation of Mount offset:



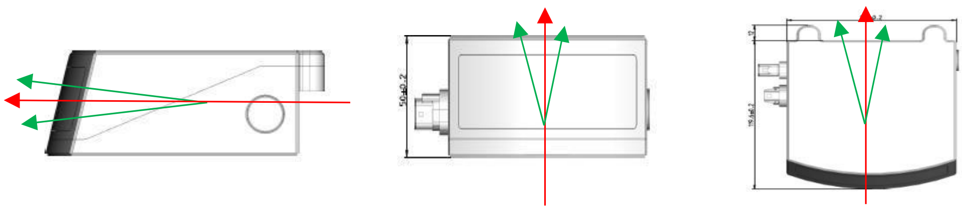


Figure E - 2: Interpretation of Mounting Deviation.

In the above image, the red arrows are X-Y-Z axis in the Cartesian coordinate system. The green arrows are the offset direction. The angle offset between corresponding red and green arrow should be inside of 1°.
Besides, the RS-LiDAR should not be mounted behind windshield. It will cause the descent of LiDAR performance and the increase of LiDAR temperature.

E.2 Product Fixing Requirements

At present, RS-LiDAR-M1(B2 Sample) should be fixed on the bracket with binder bolt, the relative position of fixed hole is shown in the following image.

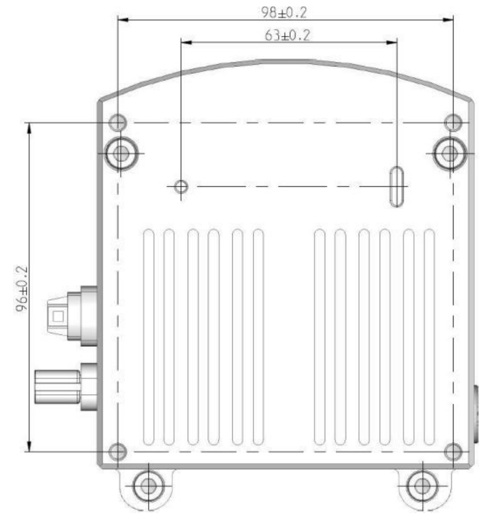
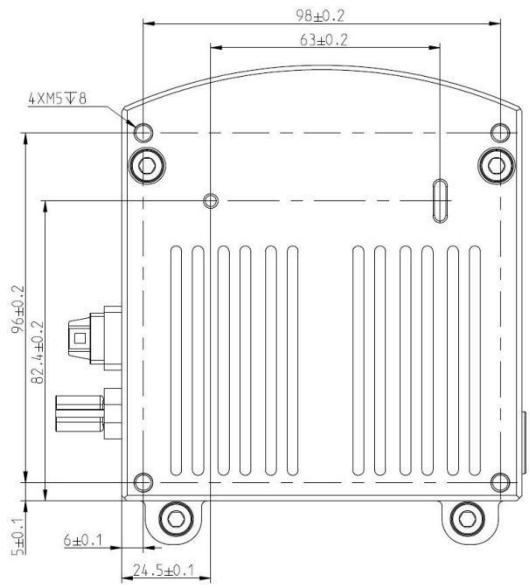


Figure E - 3: Image of Mounting Holes of RS-LiDAR-M1 (B2 Sample).

The current fixed holes are symmetrically distributed threaded holes (those with counterbore structure on the side are housing fastening and non-structural element), which are connected by M5 bolts. The depth of the bolts into the housing is 8mm, and the actual length is compared and confirmed according to the thickness of the bracket.
The current installation method of B2 sample requires that it must be placed in the positive direction, i.e. the fixed hole should be placed downward. It is not allowed to place the B2 sample sideways or upside down. The specific arrangement can be assisted by RoboSense to ensure the stability of LiDAR.

E.3 Product Dimension Tolerance

The following image shows the dimension tolerance of B2 Sample:



The requirements of accessories suiting for bracket should be considered according to the actual installation position. In this manual, it won't be normalization.

E.4 Request of Thermolysis

At present, B2 Sample is a primer product. Thermolysis must be considered as an important variable while estimation of mount position.
For Thermolysis, we recommend as below:

1. Avoid heating source inside of 100 mm around B2 Sample.
2. Provide insulation measures for B2 Sample if possible.
3. Provide air circulation (forced convection) of at least 6m/s under long operating.
4. The bracket should cover the bottom radiator as much as possible to improve the heat transfer efficiency.

Appendix F Sensor Clean

In order to exactly perceiving environment, RS-LiDAR needs to keep clean, specially fore filter part.

F.1 Attention

Please read through this entire Appendix E content before clean the RS-LiDAR. Improper handling can permanently damage it.

F.2 Require Materials

1. Clean microfiber cloths;
2. Mild, liquid dish-washing soap;
3. Spray bottle with warm, clean water;
4. Spray bottle with warm, mildly soapy water;
5. Isotropy alcohol;

F.3 Clean Method

If the sensor is just covered by dust, use a clean microfiber cloth with a little Isotropy alcohol to clean the sensor directly, then dry with another clean microfiber cloths.

If the sensor is caked with mud or bugs, use a spray bottle with clean, warm water to loosen any debris from it. Do not wipe dirt directly off the sensor. Doing so may abrade the surface. Then use warm, mildly-soapy water and gently wipe the sensor with a clean microfiber cloth. Wipe the ring lens gently along the curve of the sensor, not top-to-bottom. To finish, spray the sensor with clean water to rinse off any remaining soap (if necessary, use Isotropy alcohol and a clean microfiber cloth to clean any remaining dirt from the sensor), then dry with another clean microfiber cloth.

0755-86325830

Smart Sensor, Safer World

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