LSD series LiDAR
User Manual

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Preface

This user manual contains the introduction, use and maintenance of LSD series LiDAR. Please read this manual carefully before formal use, and strictly follow the steps described in the manual during use to avoid product damage, property loss, personal injury or/and violation of product warranty terms.

If you encounter problems that cannot be solved during use, please contact SentiAcu staff for assistance.

Contact Details

Official website: www.sentiacu.com

For technical questions, please contact: support@sentiacu.com

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Disclaimer

The LSD series product is constantly being improved, and its specifications and parameters will undergo iterative changes. Please refer to the official website for latest version.

1. Safety Notices

ⓘ Make sure to read through this user manual before your first use. The manufacturer shall not be held responsible for any direct or indirect loss caused by abnormal working or damage of the pr oducts due to users' failure to store and use our products in strict accordance with the requirem ents of the latest product manual or to accept guidance or reference from a third party.

- Retain Manual
  - Please keep the user manual properly,and it must be handed over together with product.
- Follow Instructions
  - Please carefully check and follow the working rating of this product before use, operation beyond the rated range will cause permanent damage to this product.
- Flammable and Explosive
  - Do not use the measuring instrument in a potentially explosive environment with flammable liquid, gas or dust. The product may generate sparks which ignite dust and gas.
- Prohibition of Disassembly
  - In order to ensure user safety and avoid equipment damage, do not modify or disassemble the product without permission.
- Do not View Directly
  - When the device is running, infrared laser is emitted continuously. To ensure safety, do not view the optical window for a long time.

Special Warnings

International Electrotechnical Commission (IEC) and Food and Drug Administration (FDA) have classified laser equipment according to the magnitude of the laser output value:

The IEC standard classifies laser equipment into four classes, called Class1, Class2, Class3, Class4.Among which, they can be subdivided into the following classes: Class 1 laser equipment, for example, is a safety device under "foreseeable operating conditions"; The use of Class 4 laser equipment, however, is likely to generate harmful diffuse reflectance, which can cause skin burns and even fire, and should be used with special care.

The FDA standard classifies laser equipment into five classes, from I to V.

I laser products have no biological hazards. Any beam that may be viewed is shielded, and the laser system is interlocked during laser exposure.

II laser products have an output power of 1 mW. It won't burn your skin and won't cause a fire. Because eye reflexes can prevent some eye damage, such lasers are not considered dangerous optical devices.

IIIa laser products have output power from 1 mW to 5 mW. It won't burn the skin. Under certain conditions, such lasers can cause blindness and other damage to the eye.

IIIb laser products have output power ranging from 5 mW to 500 mW. At high power levels, these laser products can scorch skin. This kind of laser product is clearly defined as harmful to eyes, especially when the power is relatively high, it will cause eye damage.

V laser products have an output power greater than 500 mW. Such laser products can certainly cause eye damage. Just as it burns skin and sets clothing on fire, it can also ignite other materials.

This product belongs to Class 1 laser equipment and has no biological hazard.

Laser Safety

2. Product Overview

As a miniaturized lidar for obstacle avoidance designed based on the principle of direct Time of Flight (dToF), This product is mainly used in obstacle avoidance of AGV/AMR, Indus trial automation, Industrial security and other fields.

The product uses a laser diode with a high speed continuously rotating mirror to realize the scanning measurement of the environmental profile within 270 degrees of the horizontal plane. The wavelength of laser is 905nm which is invisible and laser satisfies the Class 1 standard of IEC60825-1 and ensure the safety of the eyes when the product is working. High quality motor and light weight scanning mirror ensures the product can work steadily for a long time and create maximum value for users.

The product provides RS485-MODBUS connection, the DC power supply supports an ultra-wide voltage range of 9~36V, and provides Bluetooth/Wireless confiuration function[1]. After the evaluation field is established through the software , Bluetooth or wireless configur ation, once there is objects in the set field, LiDAR will have the corresponding port output digital signal, and the hardware(like PLC) will make further judgment and processing after obtaining the signal.

1. Bluetooth/wireless configuration function can be turned on by firmware update in the future, please stay tuned.

3. Product Specifications

The following specifications are based on the final product received by the users and are subject to change without notice.

Table 3.1: Product Parameters

Model	TE05	TE10
Ranging Principle	dToF	
Wavelength	905nm	
Horizontal Field of View	270°	
Measurement Range	≥10m@70%reflectivity ≥5m@10%reflectivity	≥20m@70%reflectivity ≥10m@10%reflectivity
Scan Frequecy	10Hz; 15Hz; 20Hz; 25Hz; 30Hz	
Data Sample Rate	22.5kHz	
Horizontal Resolution	0.16°(10Hz) 0.24°(15Hz) 0.32°(20Hz) 0.4°(25Hz) 0.48°(30Hz)	
Accuracy(Typical)	±2cm	
Interface		
Data Protocol	RS485-MODBUS	
Digital Channels	4 Digital Inputs , 4 Digital Outputs	
Digital Outputs	4 NPN (or PNP), *Iout* ≤ 100mA	
Response Time	33ms(30Hz)	
Start Time	<15s	
Detection Output Time	0 ~ 1000ms	
Detection Holding Time	0 ~ 1000ms	

Laser and Electrical	
Laser Safety	Class 1 eye safe
Ambient Light Immunity	< 100000 lux
Rated Voltage Range	9 ~ 36V
Power Consumption(Typical)	2.5W
Other Parameters	
Dimension	(D × W × H) 55mm × 55mm × 51mm
Operating Temperature	-25°C ~ 60°C
Storage Temperature	-40°C ~ 75°C
Ingress Protection	IP67

4. Operating Principle

The lidar using direct Time-of-Flight (dToF) methodology, which consists of laser diode, optical detector, optical system and Time-to-Digital converter.

The core ranging principle of product: laser diode emits a beam of by short laser pulses, meanwhile the Time-to-Digital converter starts, object's surface produces a diffuse reflection after the beam hitting the target object and the returning beam is detected by the optical detector, and then Time-to-Digital converter stops. Then we can get the time between laser emission and receipt, which is the travel time of the laser beam. The travel distance of the laser beam can be calculated by multiplying the speed of light and travel time of the laser beam, accordingly distance of sensor to target object can be calculated, as is shown in figure 4.1.

Travel distance of the laser beam: $d = c \times \Delta t$ (4.1)

Distance of sensor to target object: $d = \frac{c \times \Delta t}{2}$ (4.2)

The method above only achieves point-to-point ranging, in order to realize point-to-plane 2 dimensional Scanning, I t has a built-in rotating mirror to realize ranging of different azimuth with rotating mirror by the motor driving. The ranging results obtained by rotation of the mirr or are combined in sequence, which are the set of all the ranging results in a plane.

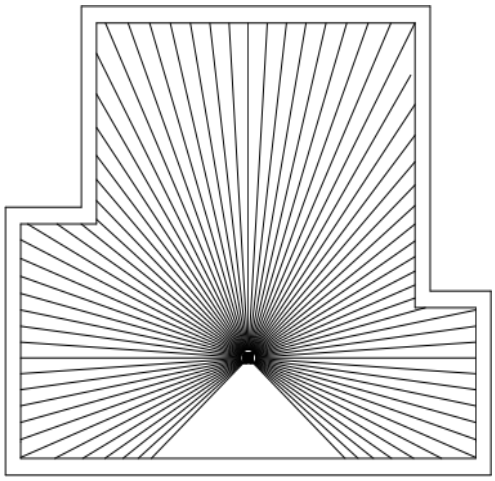

Figure 4.1: 2-Dimensional Scanning Diagram

5. Electrical Interface

ⓘPlease check and follow the working rating of product before use,operation out of the rated range will cause permanent damage to product.

5.1 Mechanical Interface

The cable interface definition is as follows:

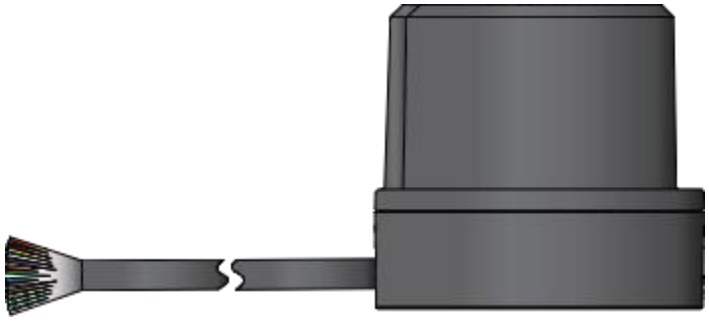

Figure 5.1: LiDAR Cable Diagram

Wire Color	Signal	Function
Red	Sensor Supply Voltage	Supply Voltage(9~36V)
Black	GND	Ground
Yellow	RS485A	RS485A
White	RS485B	RS485B
Purple	Common(NPN)	COM+
Orange	Input	IN1
Green	Input	IN2
Blue	Input	IN3
Brown	Input	IN4
Gray	Common(PNP)	COM-
White and Orange	Output	OUT1
White and Green	Output	OUT2
White and Blue	Output	OUT3
White and Brown	Output	OUT4

Table 5.1: LiDAR Cable Interface Function

5.2 Wiring of Digital Output

5.2.1 NPN

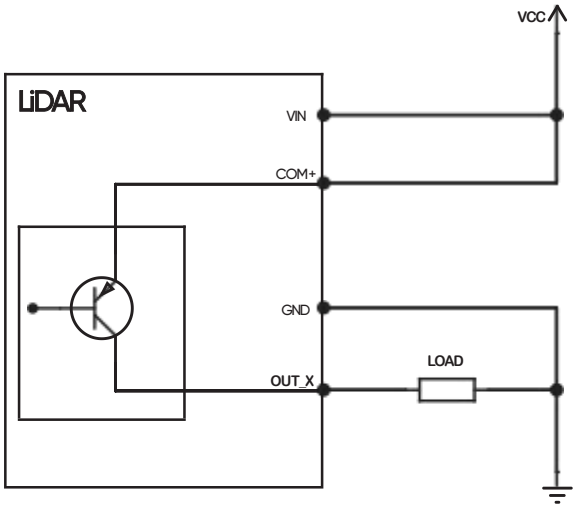

Figure 5.2: Wiring of Digital Output (NPN version)

5.2.2 PNP

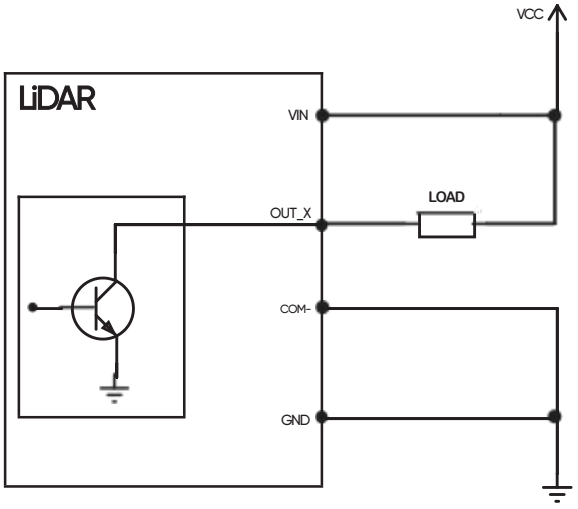

Figure 5.3: Wiring of Digital Output (PNP version)

April 2024

6. Data Interface

This LiDAR is not only capable of outputting Switching Digital Outputs through I/O, but also outputting raw data through RS485 protocol, which is convenient for users to develop the LiDAR's raw data.

6.1 RS485-MODBUS Protocol

Before establishing the communication with the LiDAR, the basic parameters of the serial port should be set, as shown in the Table 6.1.

	Parameter	Default Settings
Communication mode	Single Master Station/Multi Slave Stations	_
Protocol	Modbus RTU	Modbus RTU
T/R Mode	Half Duplex	_
Data Transmission Rate	110 Baud ~ 921.6kBaud	460.8kBaud
Data Bits	8 Bits	8 Bits
Parity	No Parity	_

Table 6.1: RS485-Modbus Communication Parameters

6.2 Register Definition

REG Address	Read-Write Mode	REG Name	Function	Default Value	Notes
0	R/W	Slave ID ID	MODBUS Slave Address Slave Address	1	Setting Range: 1~247 1~247
1	R/W	Sensor Enable	LiDAR work enable setting	1	1: Enable 0: Disable
2	_	_	Reserve	_	_
3	R/W	_	Baudrate Set Low Bytes	2048	Configurable Parameter: 9600,115200, 230400, 460800, 961200
4	R/W	_	Baudrate Set High Bytes	7	
5	R/W	I/O Mode Selection		0	0: Hardware Control 1: Register Control
6	R/W	Group	Current Avoidance Field Set Channel	0	Setting Range: 0~63
7	R/W	Scan Freq	LiDAR Scanning Frequency Settings	30	Configurable Parameter: 10,15,20,25,30Hz
8	R/W	Scan Start	LiDAR Scanning Start Angle Settings	4500	4500=45.00°
9	R/W	Scan Stop	LiDAR Scanning End Angle Settings	31500	31500=315.00°
10~14	_	_	Reserve	_	_
15	R/W	Software Reset	LiDAR Software Reset	0	Writing 0x7372 will immediately trigger a reset

16~27	_	_	Reserve	_	_
28	Read Only	Output State	Output Status Register	0	Indicates that the current output control state is 8 bits, with the lowest 4 bits corresponding one-to-one with the hardware output ports.
29	_	_	Retain	_	_

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REG Address	Read-Write Mode	REG Name	Function	Default Value	Notes
30	Read Only	APD Temp	APD Sensor Temperature	_	REG Value: Temperature × 100
31	Read Only	APD bias Voltage	APD bias Voltage	_	REG Value: Voltage × 100
32	Read Only	Motor RPM	Motor RPM	_	Unit: rpm
33~35	_	_	Reserve	_	_
36	Read Only	Scan Range Start	Scan Range Start	4500	LIDAR Minimum Scanning Start Angle
37	Read Only	Scan Range Stop	Scan Range Stop	31500	LIDAR Maximum Scanning End Angle
38	Read Only	Range Limit	Maximum Allowed Scanning Distance	_	Maximum Distance Limit of LIDAR Returns
39	Read Only	Input Voltage	Input Voltage	_	The value of this memory is voltage × 100
40~44	_	_	Reserve	_	_
45~49	Read Only	Device Model	Device Model	_	A total of 10 bytes need to be converted from raw data to characters according to the ASCII code.
50~54	Read Only	Serial Number	Serial Number	_	A total of 10 bytes need to be converted from raw data to characters according to the ASCII code.
55~59	Read Only	Hardware Version	Hardware Version	_	A total of 10 bytes need to be converted from raw data to characters according to the ASCII code.
60~63	Read Only	Software Version	Software Version	_	A total of 8 bytes need to be converted from raw data to characters according to the ASCII code.

Table 6.2: RS485-MODBUS Register Structure

7. Zone Divisions

7.1 Inputs and Zones

This series products allow for the selection of the desired zone group by adjusting the input connections. The correspondence between the zone groups and the input port switch signals is shown in Table 7.1:

Field Set Channel Sequence	In1	In2	In3	In4
Field Set Channel 1	0	0	0	0
Field Set Channel 2	0	0	0	1
Field Set Channel 3	0	0	1	0
Field Set Channel 4	0	0	1	1
Field Set Channel 5	0	1	0	0
Field Set Channel 6	0	1	0	1
Field Set Channel 7	0	1	1	0
Field Set Channel 8	0	1	1	1
Field Set Channel 9	1	0	0	0
Field Set Channel 10	1	0	0	1
Field Set Channel 11	1	0	1	0
Field Set Channel 12	1	0	1	1
Field Set Channel 13	1	1	0	0
Field Set Channel 14	1	1	0	1
Field Set Channel 15	1	1	1	0
Field Set Channel 16	1	1	1	1

Table 7.1: Correspondence Between Zone Group and Input Port Switch Signals

7.2 Relationship Between Zone Intrusion and Signal Output

This series products have four switchable digital outputs. Outputs OUT1 to OUT4 send signals in a combined form based on the intrusion status of each zone in the zone group. The relationship between the output signals and zone intrusion is shown in Table 7.2:

Infringed Fields				Digital Outputs			
Field 1	Field 2	Field 3	Field 4	OUT1	OUT2	OUT3	OUT4
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	0
0	0	1	1	0	0	1	1
0	1	0	0	0	1	0	0
0	1	0	1	0	1	0	1
0	1	1	0	0	1	1	0
0	1	1	1	0	1	1	1
1	0	0	0	1	0	0	0
1	0	0	1	1	0	0	1
1	0	1	0	1	0	1	0
1	0	1	1	1	0	1	1
1	1	0	0	1	1	0	0
1	1	0	1	1	1	0	1
1	1	1	0	1	1	1	0
1	1	1	1	1	1	1	1

Table 7.2: Digital Outputs

1. If the intrusion status of a zone is "1", it indicates that there is an object intruding into that zone; if the status is "0", it means there is no object intruding into that zone.
2. If the signal output is "1", it indicates that the output signal indicates the presence of an object intrusion; if the signal output is "0", it indicates the absence of object intrusion.

7.2.1 Four Overlapping Rectangular Zones

When the zones are set as four overlapping rectangular areas, the relationship between the output signal triggers and the intrusion status of different zones is shown in Table 7.3:

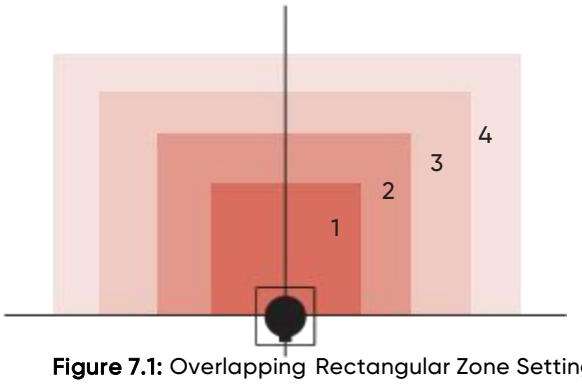

Figure 7.1: Overlapping Rectangular Zone Settings

Infringed Fields	Digital Outputs			
	OUT1	OUT2	OUT3	OUT4
1	1	0	0	0
2	1	1	0	0
3	1	1	1	0
4	1	1	1	1

Table 7.3: Infringed Fields and Digital Outputs

1. If the signal output is "1", it indicates that the output signal shows the presence of object intrusion; if the signal output is "0", it indicates the absence of object intrusion.

7.2.2 Four Nested Rectangular Zones

When the zones are set as four nested overlapping rectangular areas, the relationship between the output signal triggers and the intrusion status of different zones is shown in Table 7.4:

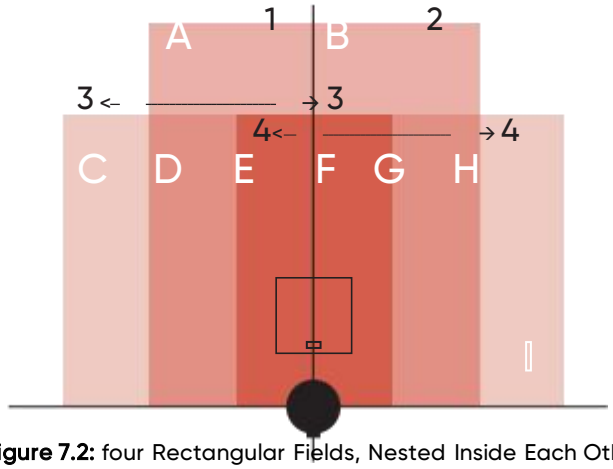

Figure 7.2: four Rectangular Fields, Nested Inside Each Other

	Digital Outputs			
Infringed Fields	**OUT1**	**OUT2**	**OUT3**	**OUT4**
A	1	0	0	0
B	0	1	0	0
C	0	0	1	0
D	1	0	1	0
E	1	0	1	1
F	0	1	1	1
G	0	1	0	1
H	0	0	0	1

Table 7.4: Infringed Fields and Digital Outputs

1. If the signal output is "1", it indicates that the output signal shows the presence of object intrusion; if the signal output is "0", it indicates the absence of object intrusion.

8 Assembly Guide

8.1 Mechanical Interface

The following mechanical dimensions are in mm unless specified.

- **LiDAR**

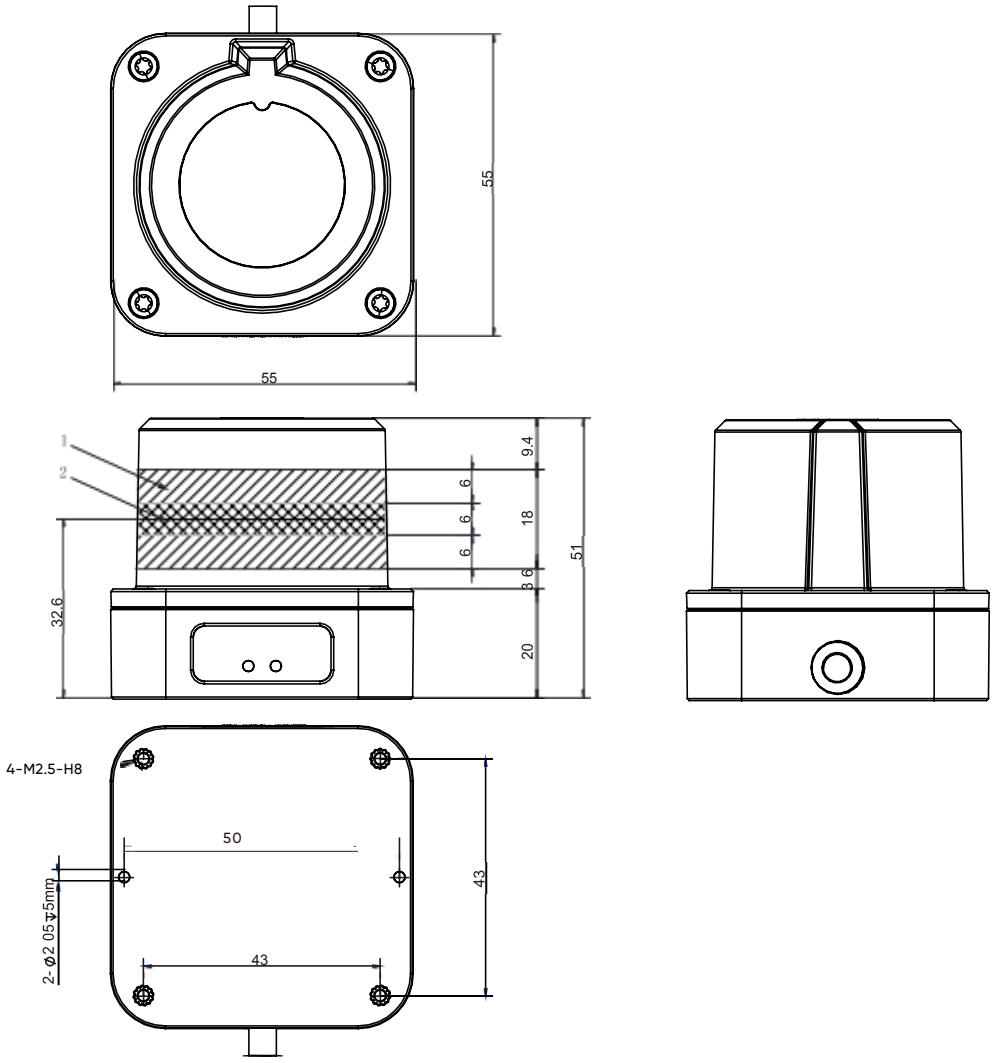

Figure 8.1: LiDAR Dimension Drawing

1.Laser receiving range. 2.Laser transmission range.

A Fault Diagnosis

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B Sensor Maintenance Guide

Stains on the lidar's black cover lens, such as dirt, fingerprints,mud and oil,can negatively affect point cloud data quality after the lidar scans objects,the lidar should be cleaned specifically at this time. Please perform the following steps to remove the stains:

Never use sharp or rough objects to wipe the cover lens as this may cause damage to the device.

Please use recommended cleaning agents and tools to clean.

Please do not reuse cleaning tools, replace cleaning tools when cleaning the lidar several times or when they are contaminated. If the cleaning tool is contaminated, replace it promptly to ensure effective cleaning.

1) If the cover lens of lidar is just covered by dust or dirt, users only need to wear a pair of powder-free PVC gloves and gently wipe the cover lens with a piece of lint-free wipe or optical cleaning paper/mirror wipe paper.

2) If the cover lens of lidar is covered by stains such as fingerprints and oil, users need to wear a pair of powder-free PVC gloves, clean with a piece of lint-free wipe or optical cleaning paper/mirror wipe paper dipped in a little isopropyl alcohol and anhydrous ethanol solvent, wipe gently until to remove stains, and take a new clean piece of lint-free wipe or optical clean paper/mirror wipe paper wipe until the cover lens is completely no other stains.

3) If the cover lens of lidar is caked with mud or bugs, users need to wear a pair of powder-free PVC gloves, loose any debris with clean, warm water in a spray bottle, then clean with a piece of lint-free wipe or optical cleaning paper/mirror wipe paper dipped in a little isopropyl alcohol and anhydrous ethanol solvent, wipe gently until to remove stains, and take a new clean piece of lint-free wipe or optical clean paper/mirror wipe paper wipe until the cover lens is completely no other stains.