ERDI LASER®

1535nm Eye-safe Laser Ranging Module

1 PRODUCT DESCRIPTION

The LRF0308C eye-safe laser ranging module adopts a self-developed 1535nm diode-pumped solid-state microchip laser. It has the capability to measure the distance of NATO targets with a size of 2.3m×2.3m, and the measuring range is ≥3000m. Its volume is ≤48×30.5×21 mm, and the weight is ≤32g. It is compact in size yet powerful in function. In addition, it supports serial port program updates and provides various installation options and electrical interfaces (excluding the housing). To further facilitate its integration into handheld portable devices or multi-functional systems, the module is equipped with embedded software. This product is widely applied in laser ranging, Unmanned Aerial System (UAS), optical pods, and border monitoring.

2 TECHNICAL SPECIFICATIONS

PROJECT	PERFORMANCE INDICATORS
Model	LRF0308C
Laser Wavelength	1535±5nm
Eye- safety	Class I
Divergence Angle	≤0.6 mrad
Laser Energy	≥100 μJ
Launch Lens Diameter	Φ8 mm
Receiver Lens Diameter	Φ16 mm
Measuring Range (Reflectance 30%; visibility ≥ 5km.)	NATO objective(2.3m×2.3m) ≥3000m Measuring human target(0.5m×1.7m) ≥1200m
Minimum Range	≤15 m
Ranging Frequency	Single, 1Hz ~10Hz
Number of multi-target detections	Up to 3 targets
Ranging Accuracy	±2 m
Range Resolution	≤20 m

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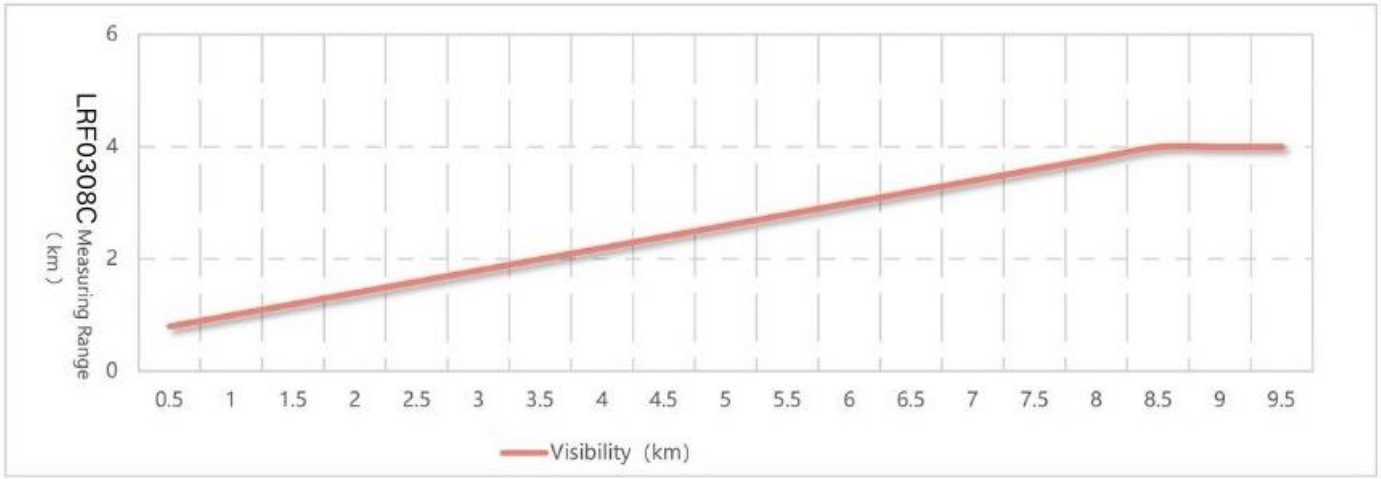
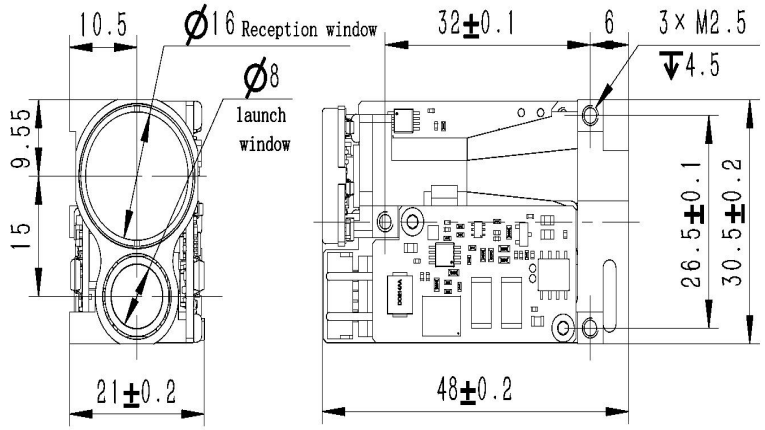
Precision Rate	≥98%
False Alarm Rate	≤1%
Pin-in-lead package model	FWF08002-S06B13W5M
Supply Voltage	DC3 ~ 5 V
Standby power consumption	≤1 mW
Average power consumption	≤2.5 W @10 Hz
Peak Power Consumption	≤7 W @12 V
Weight	≤32±1 g
Dimension (L×W×H)	48mm×30.5mm×21 mm
Operating Temperature	-40 ~ +70 ℃
Storage Temperature	-55 ~ +75 ℃
Impact Resistance	Meet the MIL-STD-810G testing standard
Vibration Resistance	Meet the MIL-STD-810G testing standard



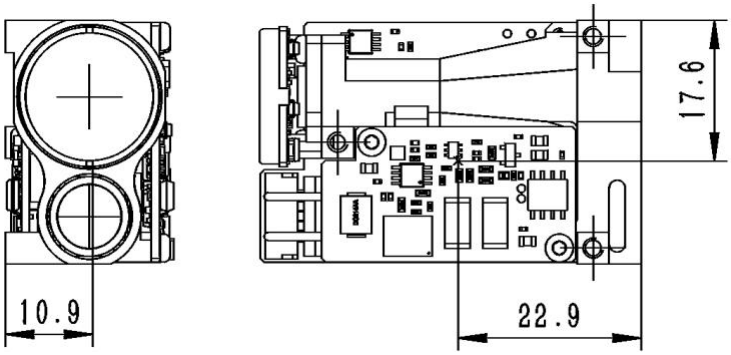
3 OUTLINE DIMENSION(mm)

The overall dimension and user installation interface of the ranging module are shown in the figure below.

The centroid position of the ranging module is shown in the figure below.



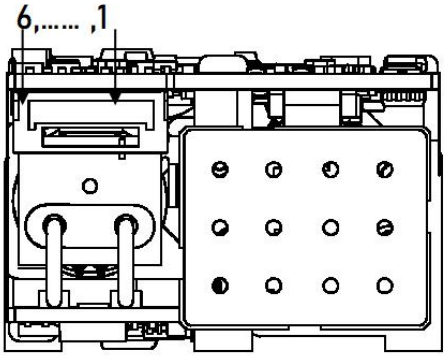
The centroid position of the ranging module is shown in the figure below.



4 PIN INTERFACE

User Electrical interface: UART（TTL_3.3V）

The connector model of electrical interface is A1257WR-S-6P, and the specific wiring definition is shown in the table below.



Pin	Definition	Description	Cable color
1	Positive power supply	Power supply, 4.5 ~ 16V	Red
2	Negative power supply	Power supply, ground	Black
3	POWER_ON	Module power switch, TTL_ 3.3V level; Module on (> 2.7V), module off (< 0.3V);	White
4	UART_TX	Serial port sender, TTL_ 3.3V level	Yellow
5	UART_RX	Serial port receiver, TTL_ 3.3V level	Green

5 EMBEDDED SOFTWARE

1 Protocol description

1.1 Communication rate and format

Format standard	Baud rate: 115200bps (ex factory) / 57600bps / 9600bps Byte data format: 1 start bit, 8 data bits, 1 stop bit, no verification

1.2 Basic packet format

Section description	Section length(number of bytes)	Value range	Remarks
Frame header	2	0xEE 0x16	Fixed value
Data length	1	2~9	The data length is the total number of bytes in the three parts: device code, command code and command parameters
Equipment code	1	0x03	Fixed value, LRF S Series ranging module
Command code	1	0~255	Indicates the control object of the current control command
Command parameters	0~4	0~255	Indicates the control object parameters of the current control command
Checksum	1	0~255	Checksum is the sum of all byte data in the three parts of equipment code, command code and command parameters, with the lower 8 bits

1.3 control command (system → ranging module)

Command code	explain	Command parameter bytes
0x01	Equipment self inspection	0
0x02	Single ranging	0
0x03	Set first / last / multiple targets	1
0x04	Continuous ranging	0
0x05	Stop ranging	0
0xA0	Set baud rate of laser ranging module	4
0xA1	Set continuous ranging frequency	2
0xA2	Set minimum gating distance	2
0xA3	Query minimum gating distance	0
0xA4	Maximum gating distance	2
0xA5	Query the maximum gating distance	0
0xA6	Query FPGA software version number	0
0xA7	Query MCU software version number	0
0xA8	Query hardware version number	0
0xA9	Query Sn number	0
0x90	Total times of light output	0
0x91	Query the power on and light out times this time	0

1.4 Response data (ranging module → system)

Command code	explain	Command parameter bytes
0x01	Equipment self inspection	4
0x02	Single ranging	7
0x03	Set first / last / multiple targets	0
0x04	Continuous ranging	4
0x05	Stop ranging	0
0x06	Ranging abnormality (only when the state in the ranging abnormality command is abnormal, the command is returned	4

	after the response command of single ranging or continuous ranging is returned)	
0xA0	Set baud rate of laser ranging module	4
0xA1	Set continuous ranging frequency	2
0xA2	Set minimum gating distance	2
0xA3	Query minimum gating distance	2
0xA4	Maximum gating distance	2
0xA5	Query the maximum gating distance	2
0xA6	Query FPGA software version number	4
0xA7	Query MCU software version number	4
0xA8	Query hardware version number	4
0xA9	Query Sn number	3
0x90	Total times of light output	3
0x91	Query the power on and light out times this time	3

1.5 Operation process

fter the ranging module is powered on, it is in the standby mode by default. It needs to enable the module power switch (power_on is pulled up) for about 0.5 s (the driving capacitor completes charging), and then all the command operations in 6.2 below can be carried out.

2 Specific agreement

2.1 Equipment self inspection

2.1.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x01	0x04

2.1.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0x01	Status3	Status2	Status1	Status0	Check_sum

Status3: reserved

Status2: echo intensity 0x00~0xFF

Status1: bit0 -- FPGA system status; 1 Normal 0 Exception

bit1 -- laser light output state; 1 light output 0 no light

bit2 -- main wave detection status; 1 main wave 0 no main wave

bit3 -- echo detection status; 1 echo 0 no echo

bit4 -- bias switch status; 1 bias on 0 bias off

bit5 -- bias output state; 1 the bias voltage is normal 0 bias abnormal

bit6 -- temperature state; 1 the temperature is normal 0 temperature abnormal

bit7 -- light output off state; 1 valid 0 invalid

Status0: bit0 -- 5v6 power status; 1 normal 0 exception

2.2 Single ranging

2.2.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x02	0x05

2.2.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9

Describe	0xEE	0x16	0x06	0x03	0x02	Status	Ranging value integer high 8 bits	Ranging value integer lower 8 bits	Ranging value decimal places	Check_sum

When ranging the first / last target:
Status: 0x00 indicates that the ranging result is a single target;
0x01 indicates that there is a front target in the ranging result;
0x02 indicates that there is a rear target in the ranging result;
0x03 reserved;
0x04 indicates that the ranging result is out of range;
0x05 reserved;
In case of multi-target ranging:
Status_ bit3~0：
0x0 indicates that the ranging result is a single target;
0x1 indicates that there is a front target in the ranging result;
0x2 indicates that there is a rear target in the ranging result;
0x3 indicates that the ranging result has front target and rear target;
0x4 indicates that the ranging result is out of range;
0x5 reserved;
Status_ bit7~4：
0x0 ~ 0xf indicates the current distance result number; Value range [0, N-1], number of targets 1 ≤ N ≤ 16;
Range value = range value integer high 8 bits × 256 + range value integer low 8 bits + range value decimal bits × 0.1, unit m

2.3 Set first / last / multiple targets

2.3.1 Send to laser ranging module:

Byte	0	1	2	3	4	5	6
Describe	0xEE	0x16	0x03(data length)	0x03	0x03	Target	Check_sum

Target：0x01 Set the first target ranging;
0x02 set terminal target ranging;
0x03 set multi-target ranging;

2.3.2 Laser ranging module return:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x03	0x06

2.4 Continuous ranging

2.4.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x04	0x07

2.4.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0x04	Status	Ranging value integer high 8 bits	Ranging value integer lower 8 bits	Ranging value decimal places	Check_sum

When ranging the first and last targets:
Status: 0x00 indicates that the ranging result is a single target;
0x01 indicates that there is a front target in the ranging result;
0x02 indicates that there is a rear target in the ranging result;
0x03 reserved;

0x04 indicates that the ranging result is out of range;
0x05 reserved;
In case of multi-target ranging:
Status_ bit3~0：
0x0 indicates that the ranging result is a single target;
0x1 indicates that there is a front target in the ranging result;
0x2 indicates that there is a rear target in the ranging result;
0x3 indicates that the ranging result has front target and rear target;
0x4 indicates that the ranging result is out of range;
0x5 reserved;
Status_ bit7~4：
0x0 ~ 0xf indicates the current distance result number; Value range [0, N-1], number of targets 1 ≤ N ≤ 16;

2.5 Stop ranging

2.5.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x05	0x08

2.5.2 Laser ranging module return:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0x05	0x08

2.6 Ranging anomaly

Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0x06	reserve	reserve	reserve	Status1	Check_sum

Status1: bit0 -- FPGA system status;	1 normal	0 exception
Bit1 -- laser light output state;	1 light output	0 no light
Bit2 -- main wave detection status;	1 main wave	0 no main wave
Bit3 -- echo detection status;	1 echo	0 no echo
Bit4 -- bias switch status;	1 bias on	0 bias off
Bit5 -- bias output state;	1 The bias voltage is normal	0 bias abnormal
Bit6 -- temperature state;	1 The temperature is normal	0 abnormal temperature
Bit7 -- light output off state;	1 valid	0 is invalid

This instruction is returned only when bit0~7 in status1 is abnormal.

2.7 Set baud rate of laser ranging module

2.7.1 Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0xA0	BaudHigh24	BaudHigh16	BaudLow8	BaudLow0	Check_sum

2.7.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
Describe	0xEE	0x16	0x06	0x03	0xA0	BaudHigh24	BaudHigh16	BaudLow8	BaudLow0	Check_sum

2.8 Set continuous ranging frequency

2.8.1 Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0x0A1	Freq	Num	Check_sum

Freq： 0x01~0x0A Single / continuous ranging frequency

Num：0x00	reserve

2.8.2 Laser ranging module return:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0xA1	0xA4

2.9 Set minimum gating distance

2.9.1 Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0xA2	DIS_H	DIS_L	Check_sum

DIS_H： Distance high 8 bits
DIS_L： Distance lower 8 bits
DIS： 10~20000 Minimum gating distance range, in M

2.9.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0xA2	DIS_H	DIS_L	Check_sum

DIS_H： Distance high 8 bits
DIS_L： Distance lower 8 bits
DIS： 10~20000 Minimum gating distance range, in M

2.10 Query minimum gating distance

2.10.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
Describe	0xEE	0x16	0x02	0x03	0xA3	0xA6

2.10.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
Describe	0xEE	0x16	0x04(data length)	0x03	0xA3	DIS_H	DIS_L	Check_sum

DIS_H： Distance high 8 bits
DIS_L： Distance lower 8 bits
DIS： 10~20000 Minimum gating distance range, in M

2.11 Set maximum gating distance

2.11.1 Send to laser ranging module:

Byte	0	1	2	3	4	5	6	7
describe	0xEE	0x16	0x04(data length)	0x03	0xA4	DIS_H	DIS_L	Check_sum

DIS_H： Distance high 8 bits
DIS_L： Distance lower 8 bits
DIS： 10~20000 Minimum gating distance range, in M

2.11.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
describe	0xEE	0x16	0x04(data length)	0x03	0xA4	DIS_H	DIS_L	Check_sum

DIS_H： Distance high 8 bits
DIS_L： Distance lower 8 bits
DIS： 10~20000 Minimum gating distance range, in M

2.12 Query maximum gating distance

2.12.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA5	0xA8

2.12.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7
describe	0xEE	0x16	0x04(data length)	0x03	0xA5	DIS_H	DIS_L	Check_sum

DIS_H： Distance high 8 bits
DIS_L： Distance lower 8 bits
DIS： 10~20000 Minimum gating distance range, in M

2.13 Query FPGA software version number

2.13.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA6	0xA9

2.13.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
describe	0xEE	0x16	0x06	0x03	0xA6	Version	Date	MonYear	Author	Check_sum

Version： bit7~bit4 Major version number（1~15）
bit3~bit0 Minor version number（0~15）
eg： 0x10——V1.0
Data： Date（1~31）
MonYear： bit7~bit4 month（1~12）
bit3~bit0 particular year（0~15）， Corresponding to 2020-2035
Author： 0x6c cliu；
0x5d dwu
0xcc cycheng

2.14 Query MCU software version number

2.14.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA7	0xAA

2.14.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
describe	0xEE	0x16	0x06	0x03	0xA7	Version	Date	MonYear	Author	Check_sum

Version： bit7~bit4 Major version number（1~15）
bit3~bit0 Minor version number（0~15）
eg： 0x10——V1.0
Data： Date（1~31）
MonYear： bit7~bit4 month（1~12）
bit3~bit0 particular year（0~15A）,Corresponding to 2020-2035
Author： 0x00 jyang
0xf1 llfu
0x01 zqxiong

2.15 Query hardware version number2.15.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA8	0xAB

2.15.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8	9
describe	0xEE	0x16	0x06	0x03	0xA8	MBVS	CTVS	APDVS	LDVS	Check_sum

MBVS: Motherboard hardware version number
CTVS: Control board hardware version number
Apdvs: detection board hardware version number
LDVS: Driver board hardware version number
Bit7 ~ bit4 major version number (1 ~ 15)
bit3 ~ bit0 minor version number (0 ~ 15)
eg: 0x10——V1. 0

2.16 Query Sn number

2.16.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0xA9	0xAC

2.16.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8
describe	0xEE	0x16	0x05	0x03	0xA9	MonYear	Num_H	Num_L	Check_sum

Monyear: bit7 ~ bit4 months (1 ~ 12)
Bit3 ~ bit0 years (0 ~ 15), corresponding to 2020 ~ 2035
Num_ H: The number is 8 digits high
Num_ 50: Lower 8 digits of No
Num: 1 ~ 999 No

2.17 Total times of light output

2.17.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0x90	0x93

2.17.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8
describe	0xEE	0x16	0x05	0x03	0x90	PNUM3	PNUM2	PNUM1	Check_sum

PNUM3: total light output times, bit23 ~ bit16
PNUM2: total light output times, bit15 ~ bit8
PNUM1: total light output times, bit7 ~ bit0

2.18 Query the power on and light out times this time

2.18.1 Send to laser ranging module:

Byte	0	1	2	3	4	5
describe	0xEE	0x16	0x02	0x03	0x91	0x94

2.18.2 Laser ranging module return:

Byte	0	1	2	3	4	5	6	7	8
describe	0xEE	0x16	0x05	0x03	0x91	PNUM3	PNUM2	PNUM1	Check_sum

PNUM3: total light output times, bit23 ~ bit16
PNUM2: total light output times, bit15 ~ bit8
PNUM1: total light output times, bit7 ~ bit0

3 Instruction example

3.1 Equipment self inspection SEND: ee 16 02 03 01 04 RECV: ee 16 06 03 01 ff 00 f7 ff f9	3.5 Set first target SEND: ee 16 03 03 03 01 07 RECV: ee 16 02 03 03 06
3.2 Single ranging SEND: ee 16 02 03 02 05 RECV: ee 16 06 03 02 04 00 00 00 09	3.6 Set end goal SEND: ee 16 03 03 03 02 08 RECV: ee 16 02 03 03 06
3.3 Continuous ranging SEND: ee 16 02 03 04 07 RECV: ee 16 06 03 04 04 00 00 00 0b RECV: ee 16 06 03 04 04 00 00 00 0b RECV: ……	3.7 Set multiple targets SEND: ee 16 03 03 03 03 09 RECV: ee 16 02 03 03 06
3.4 Stop ranging SEND: ee 16 02 03 05 08 RECV: ee 16 02 03 05 08	3.8 Set continuous ranging frequency 1Hz SEND: ee 16 04 03 a1 01 00 a5 RECV: ee 16 02 03 a1 a4
	3.9 Set continuous ranging frequency 5Hz SEND: ee 16 04 03 a1 05 00 a9 RECV: ee 16 02 03 a1 a4

6 INSTRUCTIONS FOR USE

1. In order to enable the operators to safely and correctly use various functions of the LRF0105C miniature laser rangefinder product, this operation and maintenance manual provides instructions on its operation and maintenance. It is applicable to the operators and maintenance personnel of this product.

The LRF0105C miniature laser rangefinder (hereinafter referred to as the laser rangefinder) is a precision optoelectronic product that emits laser towards the measured target and calculates the distance information based on the laser flight time. This laser rangefinder achieves communication through the Uart (TTL_3.3V) communication interface, and is characterized by outstanding performance and simple operation. The laser of this rangefinder is prohibited from direct exposure to human eyes.

2. Recommendations for Optical Window Selection and Coating

2.1 Material Recommendations

The optical glass H-K9L is recommended as the material for the optical window. H-K9L is the most common colorless optical glass, suitable for the laser range of 300nm to 2100nm. It has a high cost-performance ratio and superior physical properties.

2.2 Processing Recommendations

The wedge angle tolerance of the optical window should be as small as possible. It is recommended that the wedge angle tolerance ≤ 3' (tolerance grade ≤ level 7);

The optical surface of the optical window should be as smooth as possible. It is recommended that the arithmetic average deviation of the profile (Ra) is 0.012.

2.3 Coating Recommendations

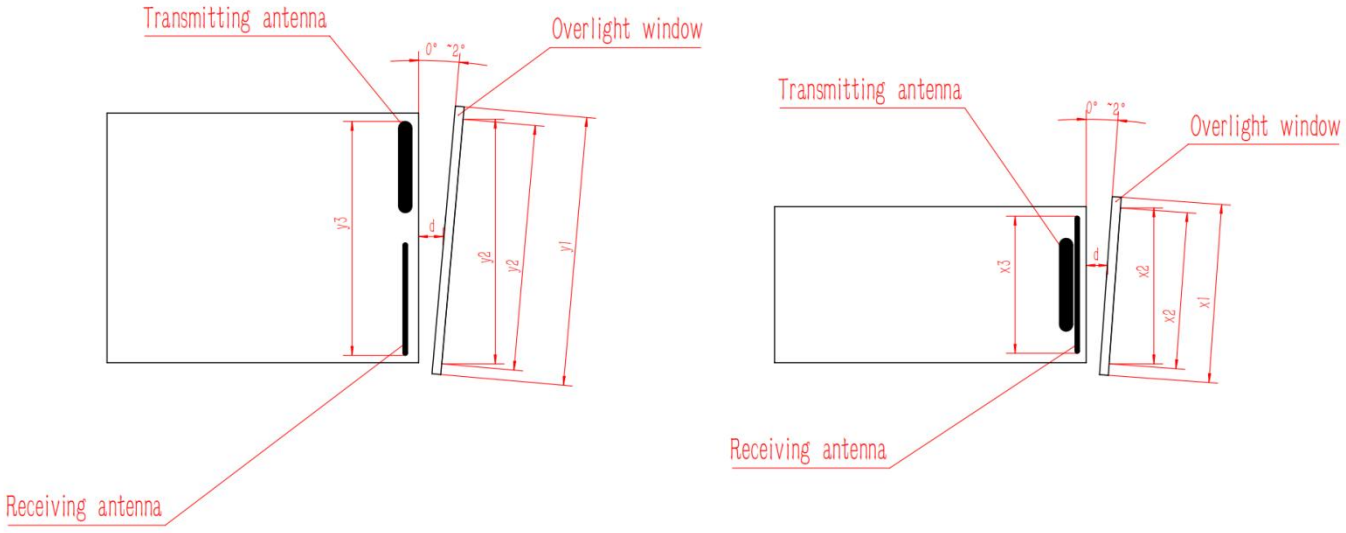
For the optical window of the 1535nm laser rangefinder, it is recommended to coat an anti-reflective film in the range of 1525nm to 1545nm, with a transmittance of ≥ 99%.

According to the specific usage environment of the product, other protective films such as a hydrophobic film or a hard film can be additionally selected for coating on the outer surface of the optical window. For the remaining indicators, refer to MIL-STD-810G, and the transmittance should be ≥ 97%.

2.4 Recommendations for the Shape and Use of the Optical Window

The effective aperture of the optical window depends on different products. Its external dimension should ensure that the effective aperture of the optical window - the outer diameter of the optical window ≥ 2mm, and the outer diameter of the rangefinder antenna - the projected dimension of the effective aperture of the optical window ≥ 1.5mm. The schematic diagram is shown as follows. Since the optical window has a certain absorption of the laser, it is recommended that the thickness of the optical window itself be controlled within 2 to 4mm according to the external dimension.

Since the optical window has a high transmittance, it is recommended that the axial deviation between the emitting optical axis and the normal of the optical window be controlled within 0° to 2°. The schematic diagram of the position of the optical window and the two lens barrels is shown as follows. At the same time, the air gap between the optical window and the rangefinder should be as small as possible. Figure 4 shows the schematic diagrams of the placement of the optical window in two ways.



The effective aperture of the optical window y_2 - the outer diameter of the optical window y_1>2mm

The outer diameter of the rangefinder antennay$_3$-the projection size of the effective aperture of the optical window y_2，>1.5mm

The air gap d between the optical window and the rangefinder should be as small as possible

The effective aperture of the optical window x_2 - the outer diameter of the optical window x_1>2mm

The outer diameter of the rangefinder antenna x_3-the projection size of the effective aperture of the optical window x_2，>1.5mm

The air gap d between the optical window and the rangefinder should be as small as possible

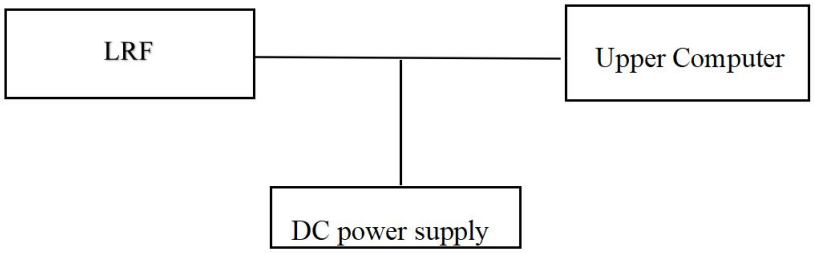
Schematic diagrams of two ways of the external dimensions and placement of the optical window

3. Operation In order for you to fully understand all the functions of this system and correctly master the installation, operation and maintenance methods, please read the content of this chapter carefully before installing and using this system.

3.1 Power-on Operation

3.1.1 Before Power-on

Connect the laser rangefinder, the debugging cable, the DC power supply and the host computer as shown in the figure.



Schematic Diagram of the Connection

3.1.2 Power-on

Power-on operation: Connect the power supply.

3.2 Power-off Operation

3.2.1 Before Power-off

Before powering off, it should be confirmed that the working processes and tasks of each product are in the ended state, and the program is exited.

3.2.2 Power-off

Power-off steps: Disconnect the power supply.

3.3 Operation

3.3.1 Ranging Mode

Operation method of the ranging mode:

a) Send the "Single Ranging" command to the laser rangefinder. The laser rangefinder will perform single ranging and report the ranging status and the distance value.

b) Send the "1Hz Ranging" command to the laser rangefinder. The laser rangefinder will perform ranging once per second and report the ranging status and the distance value.

c) Send the "Stop Ranging" command to stop ranging.

d) Send the "5Hz Ranging" command to the laser rangefinder. The laser rangefinder will perform ranging five times per second and report the ranging status and the distance value.

e) Send the "Stop Ranging" command to stop ranging.

f) Send the "10Hz Ranging" command to the laser rangefinder. The laser rangefinder will perform ranging ten times per second and report the ranging status and the distance value.

g) Send the "Stop Ranging" command to stop ranging.

3.3.2 Distance Gating Setting

Distance gating means setting a section of gating distance (represented in hexadecimal) within the ranging capability range. The target distance information lower than the gating value will not be sent back, and the ranging value higher than the gating value within the measurement range is the effective ranging value.
If setting is required, the operation method is as follows:
a) Send the "Gating Value Setting" command to the laser rangefinder.
Send the "Ranging" command to the laser rangefinder. The laser rangefinder will perform ranging, determine whether the sent-back distance value is greater than the distance gating value, and then report the ranging result.
c) Send the "Stop Ranging" command to stop the ranging operation. If the distance gating function is not needed, the initial settings need to be manually restored (set the gating value to 0).

3.3.3 Self-check Mode
The operation method of the self-check:
a) Send the "Self-check Inquiry" instruction to the laser rangefinder. The laser rangefinder starts to conduct a self-check and sends back information such as the current ambient temperature and working status.

4. Inspection and Maintenance

4.1 General Inspection
Visual inspection and power-on inspection should be carried out when the product is used for the first time and after the resource module is replaced. For products in normal use, only power-on inspection is required before use.

4.1.1 Visual Inspection
The steps of visual inspection are as follows:
a) Check whether the appearance of the product is normal;
b) Check if there is any error in the cable connection, and the connection should be firm.

4.1.2 Power-on Inspection
The steps of power-on inspection are as follows:
a) Complete the power-on operation according to the steps in 3.1;
b) Start the self-test module;
c) After the inspection is completed, complete the power-off operation according to the steps in 3.2.

4.2 Regular Maintenance
The laser rangefinder does not need maintenance under normal working conditions. Maintenance is required if it is stored in a dust-free environment for more than one year. The maintenance content includes:

4.2.1 General Inspection
Conduct a general inspection of the product when it is not energized. The steps are as follows:
a) All marks and numbers on the product and the test cable plug (socket) should be correct and clear;
b) All kinds of screws on the panel should be tightened;
c) It should be ensured that there are no attachments such as light spots, pockmarks, water stains, mold, fingerprints, dust particles, etc. and cracks that hinder normal observation on the optical glass of the product as seen visually.

4.2.2 Power-on Inspection

Conduct a comprehensive inspection and maintenance of the laser rangefinder when it is powered on. The content includes:

a) Turn on the power of the product in sequence;

b) Complete the power-on operation according to the steps in 3.1;

c) Start the product self-test module and complete the product self-test;

d) Complete the power-off operation according to the steps in 3.2.

5. Analysis of Fault Symptoms and Troubleshooting Methods

The laser rangefinder is a precision product. When a fault occurs, the entire device needs to be returned to the factory for fault analysis, location, and repair. Self-repair is not allowed.

Common fault symptoms and troubleshooting methods are shown in the following table.

Common Fault Symptoms and Troubleshooting Methods

Fault Symptoms	Possible Reasons	Inspection Method	Measures for Troubleshooting
The product cannot be powered on normally.	a) Faults in the power supply and connection cables. b) Circuit faults.	Check the power supply and the connection cable.	a) Replace the power supply or the connection cable. b) b) In case of a circuit fault, contact the manufacturer for assistance in solving the problem.
Cannot return communication information.	a) Fault of the connection cable b) Abnormal power supply c) c) Communication fault of the laser rangefinder	a) Check whether the connection cable is normal. b) Check whether the power supply is normal.	a) Replace the connection cable and the power supply. b) For communication problems, contact the manufacturer for assistance in solving them.

6. Requirements for Packaging, Transportation and Storage

6.1 Packaging

For the products that have been unsealed and need to be restocked, they should be packaged according to the original packaging. When the products need to be returned to the factory, the original packaging should be used as much as possible. When other forms of packaging are used, it should not cause a decrease in product performance or damage to the products.

6.2 Transportation

The products that have been repacked can be transported by means of automobiles, trains, airplanes, ships, etc. During transportation, the packaged items should be fixed on the means of transportation to avoid phenomena such as impact, rough handling, and being exposed to rain and snow. For the road transportation and railway transportation environments, refer to MIL-STD-810G.

6.3 Storage

The repacked products shall not be stored in the open air in the wild. They should be stored in a warehouse with a storage temperature of 0℃ to +30℃, a relative humidity not exceeding 80%, free from the erosion of corrosive substances, strong mechanical vibration and impact, and strong magnetic fields.

7 SAFETY PRECAUTIONS

In order to use this product safely, please read this instruction manual carefully before operating the product.

- This laser rangefinder is a precision optical and mechanical product. Operating it in violation of the regulations may lead to dangerous laser injury. Do not open or adjust any part of the laser rangefinder, and do not attempt to repair or adjust the performance of the laser rangefinder by yourself.
- Pay attention to electrostatic protection: The electronic components of the laser rangefinder are sensitive to electrostatic discharge. Do not touch any electronic devices without protective measures.
- Only turn on the power of the laser rangefinder for operation within the specified voltage and power range.
- It is prohibited to touch the optical lenses with fingers or hard objects (to prevent oil contamination or scratching of the lenses).
- It is prohibited to measure high-reflectivity targets at too close a distance (to prevent damage to core components of the detector, etc.).
- It is prohibited to store the laser rangefinder under non-specified conditions (such as a highly polluted environment, exceeding the storage temperature range, etc.).
- It is prohibited for the laser rangefinder to be subjected to strong mechanical impacts (vibration, impact, dropping, etc.).