ERDILRF

1535nm Eye-safe Laser Ranging Module

Model: LRF0405C

1. PRODUCT DESCRIPTION

The LRF0405C is a 4km 1535nm Class I eye-safe laser rangefinder module delivering ≥200μJ pulses, ≤0.6mrad divergence and NATO-range performance of ≥4000m with ±2m accuracy and up to three simultaneous targets at 1–10Hz. Powered from a 3–5V supply with ≤2.5W average power in a 48×30.5×21mm, ≤32g housing and controlled via TTL UART, it is ideal for UAV gimbals, vehicle EO/IR turrets, handheld optics and fixed security or border-surveillance sensors.



2. TECHNICAL SPECIFICATIONS

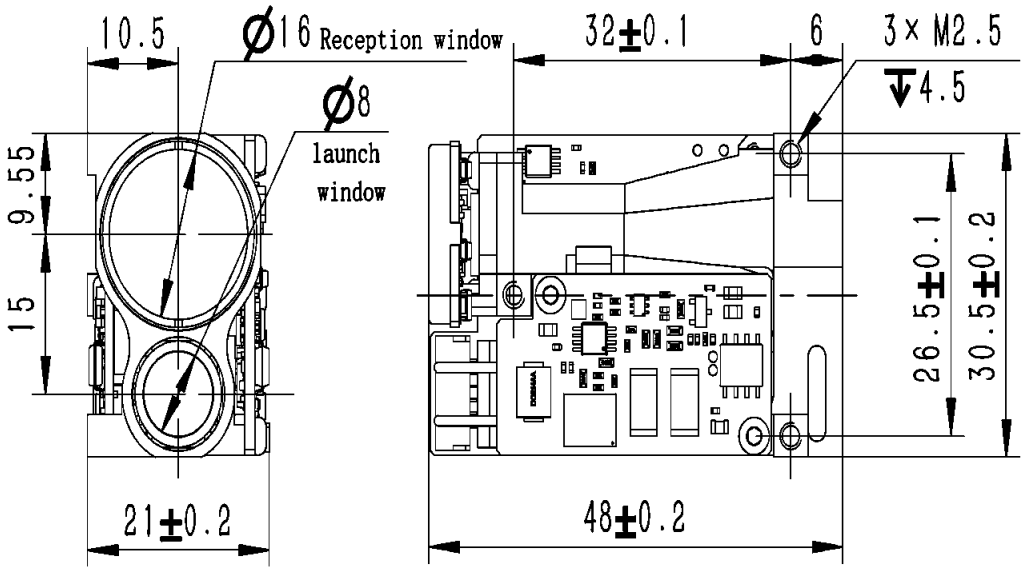
PROJECT	PERFORMANCE INDICATORS
Model	LRF0405C
Laser Wavelength	1535±5nm
Eye- safety	Class I
Divergence Angle	≤0.6 mrad
Laser Energy	≥200 μJ
Launch Lens Diameter	Φ8 mm
Receiver Lens Diameter	Φ16 mm
Measuring Range (Reflectance 30%; visibility ≥ 6km.)	NATO objective(2.3m×2.3m) ≥4000m Measuring human target(0.5m×1.7m) ≥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	≤0.1 m
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. MECHANICAL DIMENSIONS

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.

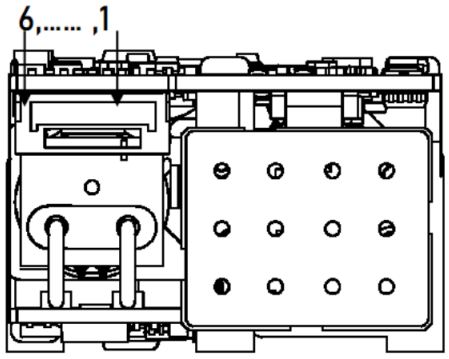


The centroid position of the ranging module is shown in the figure below.

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. COMMUNICATION PROTOCOL

5.1 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

5.1.1 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

5.1.2 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

5..1.3 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 after the response command of single ranging or continuous ranging is returned)	4
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

5..1.4 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.

5.2 Specific agreement

5.2.1 Equipment self inspection

5.2.1.1 Send to laser ranging module:

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

5.2.1.2 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

5.2.2 Single ranging

5.2.2.1 Send to laser ranging module:

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

5.2.2.2 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

5.2.3 Set first / last / multiple targets

5.2.3.1 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;

5.2.3.2 Laser ranging module return:

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

5.2.4 Continuous ranging

5.2.4.1 Send to laser ranging module:

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

5.2.4.2 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;

5.2.5 Stop ranging

5.2.5.1 Send to laser ranging module:

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

5.2.5.2 Laser ranging module return:

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

5.2.6 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.

5.2.7 Set baud rate of laser ranging module

5.2.7.1 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

5.2.7.2 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

5.2.8 Set continuous ranging frequency

5.2.8.1 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

5.2.8.2 Laser ranging module return:

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

5.2.9 Set minimum gating distance

5.2.9.1 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

5.2.9.2 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

5.2.10 Query minimum gating distance

5.2.10.1 Send to laser ranging module:

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

5.2.10.2 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

5.2.11 Set maximum gating distance

5.2.11.1 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

5.2.11.2 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

5.2.12 Query maximum gating distance

5.2.12.1 Send to laser ranging module:

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

5.2.12.2 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

5.2.13 Query FPGA software version number

5.2.13.1 Send to laser ranging module:

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

5.2.13.2 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

5.2.14 Query MCU software version number

5.2.14.1 Send to laser ranging module:

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

5.2.14.2 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

5.2.15 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

5.2.15.2 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

5.2.16 Query Sn number

5.2.16.1 Send to laser ranging module:

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

5.2.16.2 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

5.2.17 Total times of light output

5.2.17.1 Send to laser ranging module:

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

5.2.17.2 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									

5.2.18 Query the power on and light out times this time

5.2.18.1 Send to laser ranging module:

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

5.2.18.2 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									

5.3 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	3.7 Set multiple targets

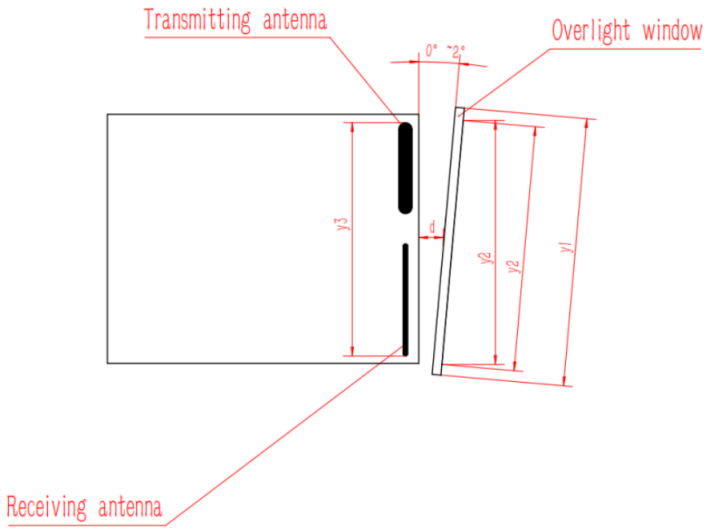
SEND: ee 16 02 03 04 07 RECV: ee 16 06 03 04 04 00 00 00 0b RECV: ee 16 06 03 04 04 00 00 00 0b RECV: ……	SEND: ee 16 03 03 03 03 09 RECV: ee 16 02 03 03 06
3.4 Stop ranging SEND: ee 16 02 03 05 08 RECV: ee 16 02 03 05 08	3.8 Set continuous ranging frequency 1Hz SEND: ee 16 04 03 a1 01 00 a5 RECV: ee 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

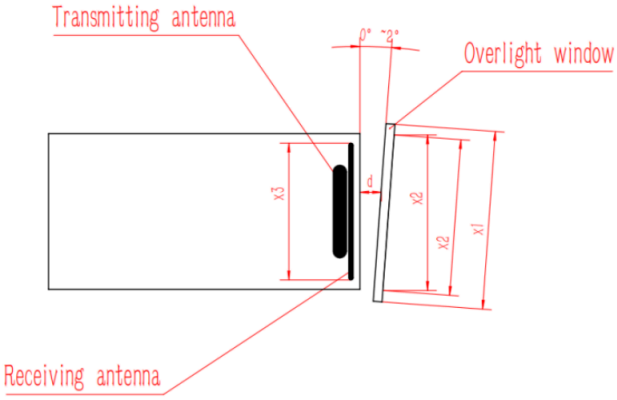
6. OPTICAL COATING RECOMMENDATION

For 1535 nm laser rangefinders, it is recommended that the optical window be coated with an **anti-reflective (AR) coating** optimized for 1525 nm–1545 nm, with transmittance ≥ 99%.
Depending on the actual application environment, additional protective coatings such as **hydrophobic** or **hard coatings** can be applied to the external surface. Other performance criteria should comply with **MIL-STD-810G**, with overall transmittance ≥ 97%.

Optical Window Geometry and Installation Recommendations

- The **effective aperture** of the optical window should be determined according to the specific product design.
- The **outer diameter** of the window should ensure:
  - (Effective aperture – outer diameter) ≥ 2 mm
  - (Antenna outer diameter – projection of effective aperture) ≥ 1.5 mm
    (See schematic illustration below.)
- Since the optical window introduces some laser absorption, its **thickness** should be controlled within **2 – 4 mm**, depending on overall dimensions.
- Due to the high transmittance of the window, the **emission optical axis** should be aligned with the **window normal** within **2°–4°**.
  (See the schematic diagram showing the relative positions of the window and optical barrels.)
- The **air gap** between the optical window and the rangefinder should be minimized. Figure 3 illustrates two recommended configurations for optical window placement.





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

7. DAILY MAINTENANCE AND TROUBLESHOOTING

7.1 Measured distance result does not match the actual distance

- If tests are carried out in conditions such as heavy smog or water-mist weather with high humidity, it is easy to measure back water droplets or particles in the air. It is recommended to choose a good test environment.
- Under extreme low-temperature conditions, within 20 m there is a risk that the ranging accuracy exceeds the tolerance.

7.2 Ranging performance is reduced, target at theoretical range cannot be measured

- Very low target reflectivity will affect the returned laser energy and thus affect the ranging performance. When the ranging target is a low-reflectivity object such as a lake surface, wet road surface in rainy weather, or glass, the actual performance of the product cannot reach the theoretical range.
- The ranging module does not irradiate the target point vertically but forms a certain angle. In an oblique-measurement state, the returned laser energy will attenuate, resulting in reduced ranging performance.
- Under extreme low-temperature conditions, the ranging performance may decrease slightly.

7.3 Using our complete communication cable to communicate with the PC, no command response

Check whether the communication cable is broken (the 6-pin communication cable is thin and easy to break).

7.4 Using self-prepared cable for communication, no command response

Check whether the external wiring sequence of the module is correct, whether the communication cable is short-circuited, open-circuited or has poor contact, and check whether the serial-port TX and RX wire order is reversed.



