Single-line Lidar Product Manual Series

XD-TOF-50 Lidar Sensor Operating Instructions

Product specification ■

Product operating instructions ■

Product communication methods and protocols ■

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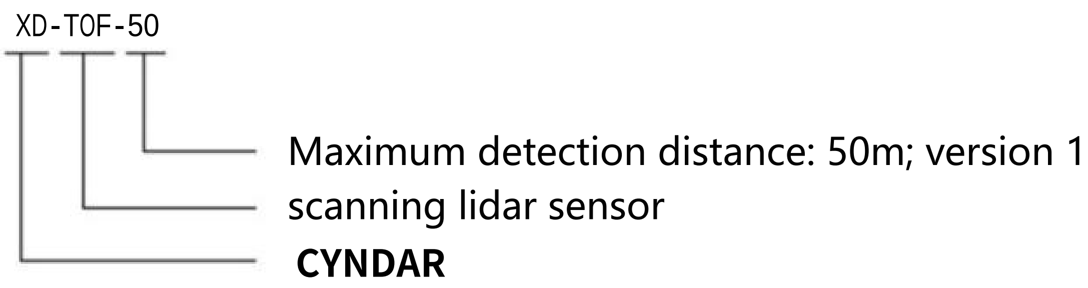
1 About

These operating instructions provide important information about how to handle the laser. First, safe work must meet the following conditions:

- Follow all specified safety instructions and guidelines.
- When using, please observe the local work safety regulations and general safety regulations.

Before starting any operation on the device, please read these instructions carefully to familiarize yourself with the laser measurement sensors and their functions.

These operating instructions are intended to provide technical personnel with guidance on safe installation, electrical installation, commissioning, configuration, and maintenance. They are suitable for the following laser measurement sensors: XD-TOF-30M,XD-TOF-50M. The following uses " XD-TOF " as an example to explain the naming rules for product names.



Please see section 2.1 for more detailed information about these devices. In the following, the XD-TOF series laser measuring sensors will be referred to simply as " ".

These operating instructions contain the following information about XD-TOF-XX:

- product description. First, the basic parameters of XD-TOF-XX are provided, the working principle of the device is given, and the requirements for the space environment under different maximum ranging capabilities are proposed.
- Device profile.
- device installation. The main interfaces of the equipment and their respective functions are listed in detail; a general operation specification for outputting target distance information within the detection range and the communication protocol of XD-TOF-XX are proposed: the network port is connected to the "TCP / IP" protocol The terminal outputs the distance information of the target object in the scanning area. You can convert the distance information of the target into more intuitive information according to actual needs.

2 Product description

2.1 Equipment specifications

Table 2-1 XD-TOF-XXequipment specification list

PARAMETER	XD-TOF-30	XD-TOF-50
Detection distance	0.1-30m	0.1-50m
Light source wavelength	905nm	905nm
Laser class	I	I
Response time	≥ 20ms	≥ 20ms
Angular resolution	0.5°	0.5°
Output resolution	1.0mm	1.0mm
interface	Ethernet	Ethernet
Operating temperature	-30°~50°	-30°~50°
Radar module supply voltage	DC 12-30V	DC 12-30V
Power consumption (heating module off)	< 8.4W	< 8.4W
Heating module supply voltage	24V±20%	24V±20%
Power consumption of heating module	< 50W	< 50W
Programmable alert area	7	7
Support zone shape	quadrilateral	quadrilateral

Table 2-2 fo-sls-xx equipment interface

Interface I	Ethernet port	M12 connector D-code 4 holes
Interface II	Digital I / O	M12 connector type A code 8 holes
Interface III	CAN / Serial	M12 connector A-code 8-pin
Interface IV	power input	M12 connector A-coded 5-pin

Table 2-3 Environmental adaptability parameters

Chassis protection level	IP67	
Laser radiation safety level	Level 1	GB 7247.1-2012
Conduction CE	A grade industrial grade	GBT_9254-2008
Conduction CS	Level 3 10V / M	GBT_17626.6-2008
Power frequency magnetic field	Level 5 100A / M	GBT_17626.8-2006
Voltage drop	0% 、40% 、70%、80% 、120%	GBT_17626.29-2006
Electrostatic discharge	Level 2 4KV	GBT_17626.2-2006
Electrical fast-shift pulse train	Level 4 4KV	GBT_17626.4-2008
surge	Level 2 1000V	GBT_17626.5-2008
Radiation RE	A grade industrial grade	GB_9254-2008
Radiation RS	Level 3 10V / M	GB_17626.3-2006
vibration	10-55Hz double amplitude 1.5mm, 2h each in X, Y, Z axis	GBT_2423.10-2008
Shock	150m / s² for 11ms	GBT_2423.5-1995
Enclosure rating	IP67	GB4208-2008
Hot and humid	Temperature 40℃, humidity 93%	GBT_2423.3-2016
Low temperature	Normal temperature drops to -30 ℃, keep the temperature 2H	GBT_2423.1-2008
high temperature	Raise the temperature to 50 ℃ at low temperature and keep the temperature at 2H	GBT_2423.2-2008

2.2 Working principle

XD-TOF-XX is a scanning photoelectric laser measuring sensor. The emitted laser beam is reflected and deflected by a mirror fixed on a rotating motor and scans the surrounding environment at a fixed frequency. As shown in Figure 2-1, XD-TOF-XX has a two-dimensional sector area with a scanning range of 270 °. The maximum scanning distance is determined by the specific product model. In each specific direction, XD-TOF-XX calculates the distance between the obstacle and the radar at this angle by emitting a laser pulse with a short pulse width and calculating the time between the pulse and the radar to the obstacle. The principle is shown in Figure 2-2.

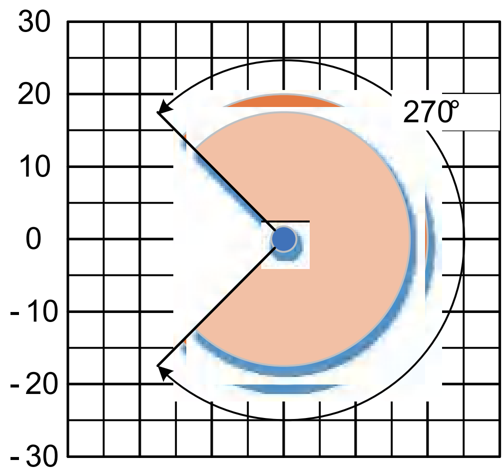


Figure 2-1 Scanning area of FO-SLS-XX laser measuring sensor

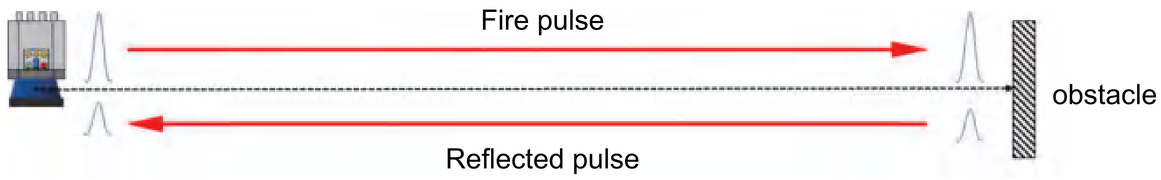


Figure 2-2 XD-TOF-XX laser measuring sensor ranging principle diagram

TheXD-TOF-50 laser measurement sensor emits laser pulses through a laser diode, and after related processing, it becomes a Gaussian distributed circular spot and diverges at a certain emission angle. The beam exit diameter is 8mm. As the detection distance increases, Figure 2-3 visually shows the process of beam divergence. Figure 2-4 shows the curve of the spot size at different distances.

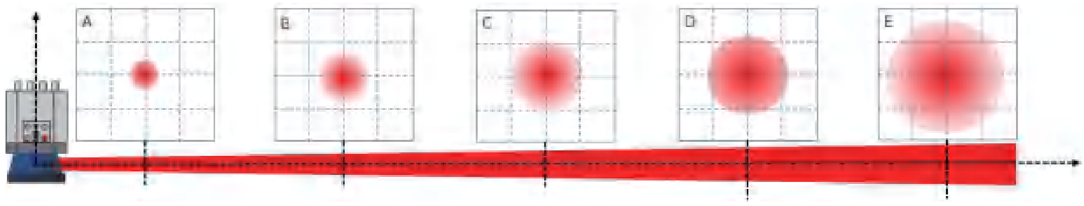


Figure 2-3 The laser pulse gradually diverges

The relationship between the spot diameter D and the detection distance U is:

$$D=8mm+0.013rad \times U(mm)$$

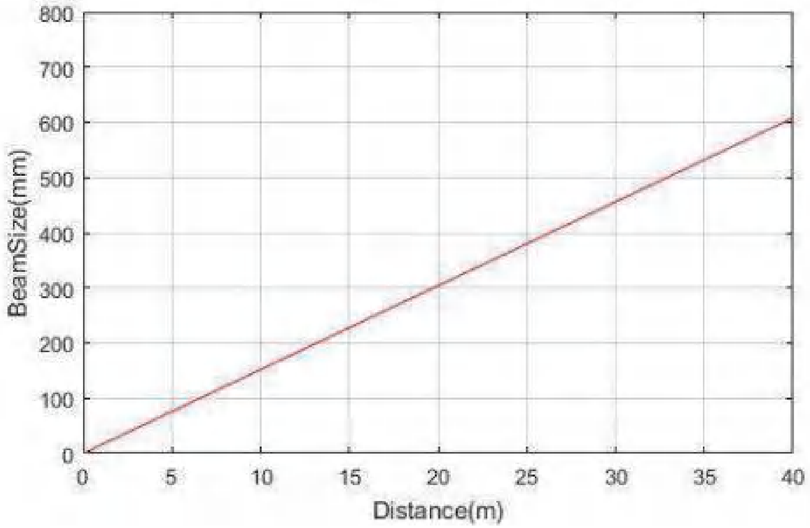


Figure 2-4 Laser beam diameter at different detection distances

As shown in Figure 2-6, when the object under test at a certain distance is larger than the spot size of the laser, the object under test can be stably detected. When the object under test is smaller than the laser spot size at this distance, the smaller the area of the object under test that occupies the area of the laser spot, the easier the object will be missed. Whether it is missed or not depends on the ratio of the measured object to the spot size, the tilt angle of the object itself, and the reflectivity of the object itself. We give the reflectivity requirements for stable detection of objects in Figure 2-8. You can calculate the equivalent reflectivity according to Figure 2-5 and Equation 2-1 according to the inclination of the object, the area of the object and the actual reflectance of the object Compare with the curve shown in Figure 2-8.

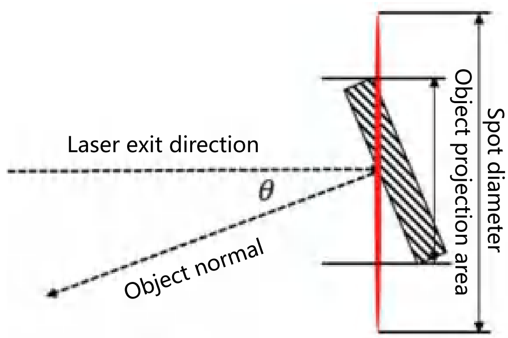
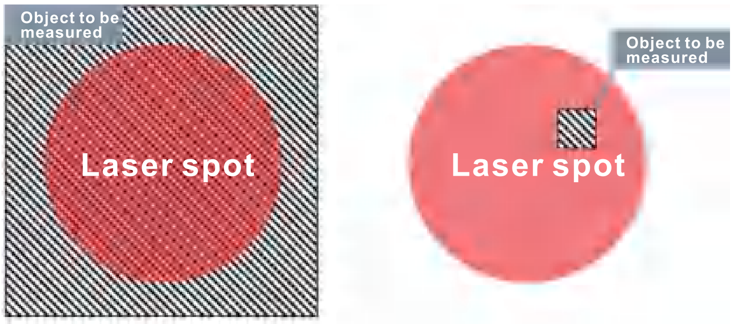


Fig. 2-5 Calculation diagram of equivalent reflectance

Equivalent reflectance calculation: where η_e is the equivalent reflectivity of the object, S_o is the projection of the object in the radar exit direction, S_{beam} is the spot size, θ is the angle between the object surface normal and the radar exit direction, and η_o is the object itself Reflectivity, Determined by the optical properties of the material:

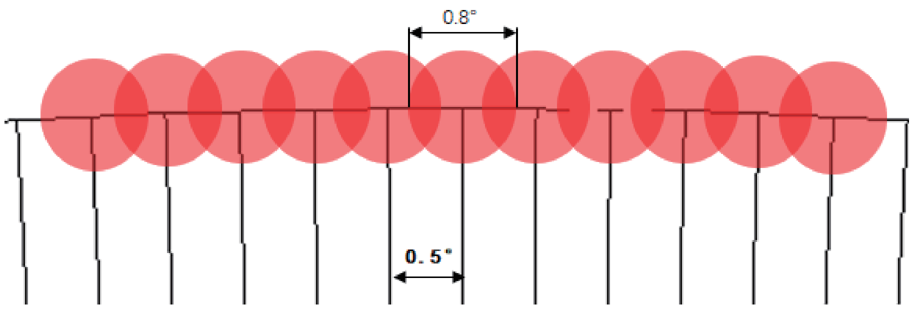
$$\eta_e = \frac{S_o}{S_{beam}} \times \cos\theta \times \eta_o \quad \text{-------------------------} \quad (2\text{-}1)$$



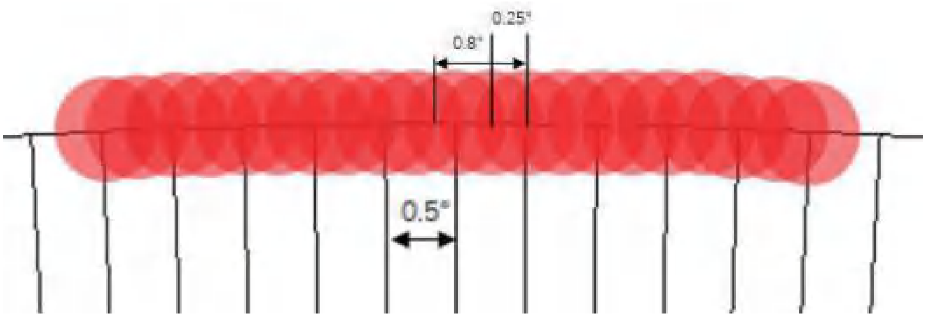
Stable detection of objects   Difficult to detect objects

Figure 2-6 Objects that are easily detected and objects that are not easily detected

With the increase of the laser transmission distance, the farther the distance between adjacent scanning measurement points, in order to ensure that the scanning area does not break, a sufficient number of laser pulses are needed to ensure angular resolution. The XD-TOF-XX series provides two configurable schemes for customers to choose the spatial angular resolution: the laser repetition frequency is 36KHz, if the customer chooses a motor speed of 50Hz, then there are 720 2D plane scans for each pair Laser pulse, the spatial angle of 0.5 ° is resolved If the customer chooses a rotation speed of 25 Hz, then each pair of surroundings completes a two-dimensional plane scan.
There are 1440 laser pulses in the trace, and the spatial angle resolution of 0.25 ° is obtained. As shown in Figure 2-7.



(A) 50Hz working mode



(B) 25Hz working mode

Figure 2-7 Comparison of 0.5 ° and 0.25 ° angle-resolved pulse overlap

2.3 Influence of object surface on measurement

When the laser is incident on most surfaces, it will cause the radar to receive the echo signal in the form of diffuse reflection in all directions. The stronger the reflection capability of the surface, the easier the radar can receive the echo signal. The reflection characteristics of the laser will change with the surface material, structure and color. Compared to surfaces with low reflectivity (black, light absorption), surfaces with high reflectivity (white, light reflected) can be better detected. According to the definition of the standard reflectivity board in the national standard, we select an object with a reflectivity of 3% -1000% (specular reflector) to calibrate the radar test capability. As the detection distance increases, the minimum reflectivity of the surface of the detectable object changes. The minimum detectable reflectance curve of the XD-TOF-XX series products is shown in Figure 2-8: the vertical axis of the curve is the minimum detectable reflection Rate (equivalent reflectance), the abscissa is the corresponding distance.

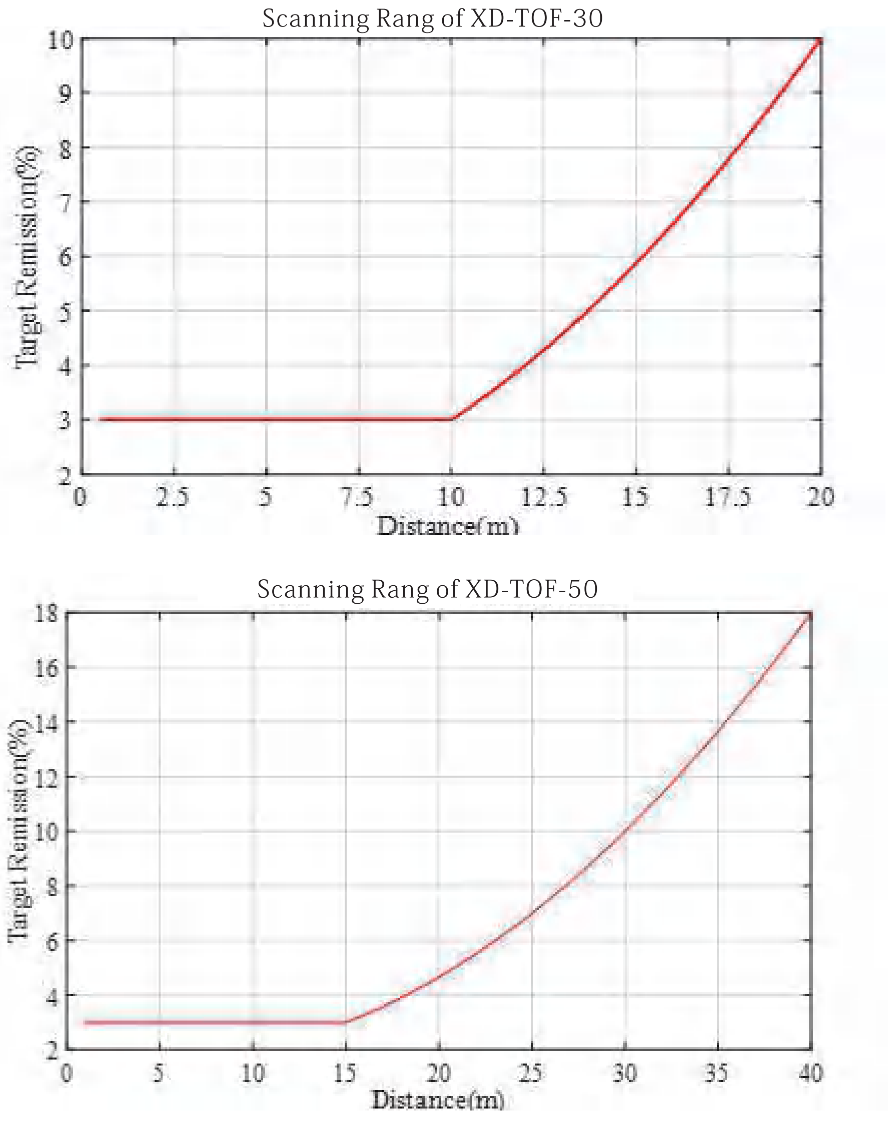


Figure 2-8 Minimum reflectivity at different detection distances

Table 2-4 shows the reflectance characteristics of some common materials for your reference:

Table 2-4 Common materials reflectivity

Material name	Reflectivity
Black cloth	3%
Black rubber	4%
Opaque black plastic	14%
Clean rough board	20%
newspaper	55%
Cardboard box	68%
Human palm	75%
Opaque white plastic	87%
White drawing paper	90%
Unpolished white metal surface	130%
Glossy light metal surface	150%
stainless steel	200%

2.4 Assessment of pollution status

FO-SLS-xxx is equipped with an infrared transparent protective cover for protection. The protective cover uses a new coating material compared to traditional bare infrared transparent acrylic. Or PC material has the characteristics of high hardness and scratch resistance, antistatic adsorption of dust, waterproof beads, anti-condensation and frost. However, this protective cover may still be contaminated by oil stains, foreign objects, rain, etc. The pollution of the protective cover will cause the laser energy emitted and received by the radar to be reduced, which in turn causes the scanned object to be considered to have a lower surface reflectivity than the actual one or even undetectable, which will bring some hidden dangers to the performance of the device. Therefore, it is necessary to continuously measure and evaluate the pollution when the equipment is running: starting from a certain degree of pollution, a pollution alarm is output; if the pollution is more serious, it will output a pollution error and disable the measurement mode. According to actual needs, you can choose different pollution measurement strategies.

We have uninstalled the components of related functions in this version of radar. The main reason is that the pollution alarm requires a calibration process, and under the premise that the user application scenario and application requirements are not clear, the threshold of the pollution alarm cannot be set. At the same time, the protective cover is contaminated The presence of detection components will increase the complexity of system assembly calibration, change the background light level inside the radar, and thus affect the overall performance of the radar system. Therefore, we use the radar shielding pollution detection component as an optional device and equip it when the user has clear requirements. For radar products without pollution detection components, it is recommended that users regularly clean the surface of the protective cover to reduce the risk of false alarms, missing alarms and increased ranging errors caused by radar due to window contamination.

In order to reduce the possibility of contamination of the infrared transparent shield as much as possible, in case of slight pollution, in order to avoid damage to the surface coating, it is recommended that you use an official cleaning cloth (dust-free lens cloth or deerskin cloth) for wiping and cleaning, and it is strictly prohibited to use Screen cleaning sprays, alcohol, acetone and other chemical cleaning agents to avoid damage or contamination of the surface coating; regular cleaning of the optical cover is conducive to the normal work of the device. At the same time, we can also design protective devices adapted to the working environment for your application scenarios. When there is serious pollution, damage or other attachments, you can contact us to replace the new infrared transparent protective cover.

2.5 Ranging and scanning performance

In this section we will introduce the working mode, scanning mode and ranging performance of XD-TOF-XX series in detail.
Within the measurement range, XD-TOF-XX can accurately measure the distance between the object and the specified zero point. The measurement value includes ranging error; in the process of continuous use, the measurement error at the same detection distance presents a normal distribution. The following table gives the measurement error of the statistical results at different detection distances and its standard deviation:

Table 2-5 Ranging error within different detection distances

Ranging range	0.5-10m	10-20m	20-50m
Measurement error	12mm	15mm	30mm
Standard deviation of error distribution	8mm	12mm	24mm

The output range of XD-TOF-XX is 0mm ~ 50000mm (the actual output is hexadecimal ASCII code, 0mm corresponds to 0h, ASCII code 30 30 30 30, 50000mm corresponds to C350h, ASCII code is 43 33 35 30, the specific format and details please (Refer to the section on data communication in Section 4 Device Connection). For the ranging range from 0mm to 50000mm, we have the following divisions:

Table 2-6 Ranging errors within different detection distances

Radar output	Hexadecimal	significance
0mm	0h	No objects can be detected in this observation direction
50mm	32h	The diameter of the radar optics indicates that there is an object in this observation direction, but the radar cannot clearly measure the distance. Appears in extremely special occasions. This option is to avoid some physical conditions that we cannot understand that cause the radar to fail to give accurate ranging values and affect the safety of customers. This option can be turned off. When a similar situation occurs, 0mm Not)

50mm~500mm	32h~1F4h	There is a certain fluctuating distance, with a maximum test relative error of ± 50mm. (Refer to test report)
500mm~50000mm	1F4h~C350h	Stable ranging distance, with a ranging error of not more than 1.5cm for objects with normal reflectivity

The radar does not need to be set by the user, and has its own fog correction function. This function ensures that the radar is not easily triggered by dense fog, water vapor, etc. at close range (within 5m). This function is realized by the internal software and hardware settings of the radar. Except for the slight difference in detection sensitivity within 5m and the range of 5m-10m, there is no difference in ranging error and other performance indicators.

We have also configured secondary echo resources for the XD-TOF-XX series radar, that is, two laser echoes can be received in one direction to deal with the need to detect the rear in the presence of local occlusion, rain, sand, and transparent partitions. The needs of the object. As shown in Figure 2-9:

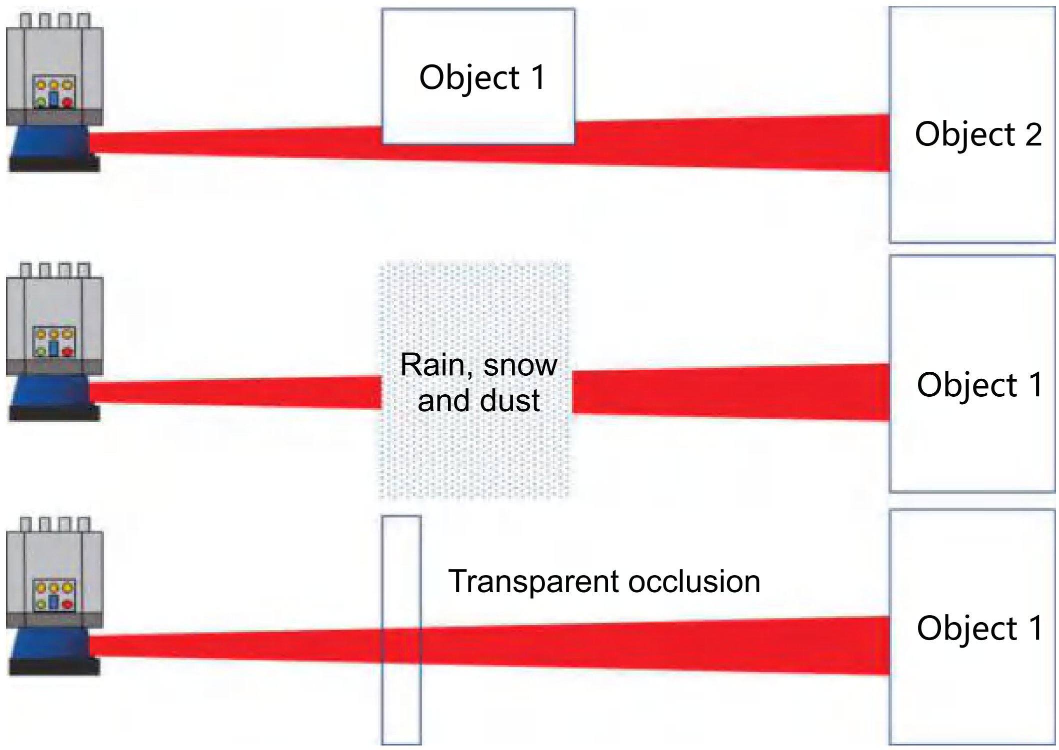


Figure 2-9 Secondary echo function description

The secondary echo and fog correction mode configured by XD-TOF-XX currently does not support customers to modify this part of the configuration through instructions. If you have requirements for the secondary echo function and fog correction function of radar measurement, We will set it at the factory, please contact us in time.

3 Equipment appearance

The overall dimensions and overall installation diagram are as follows. Unmarked units default to millimeters.

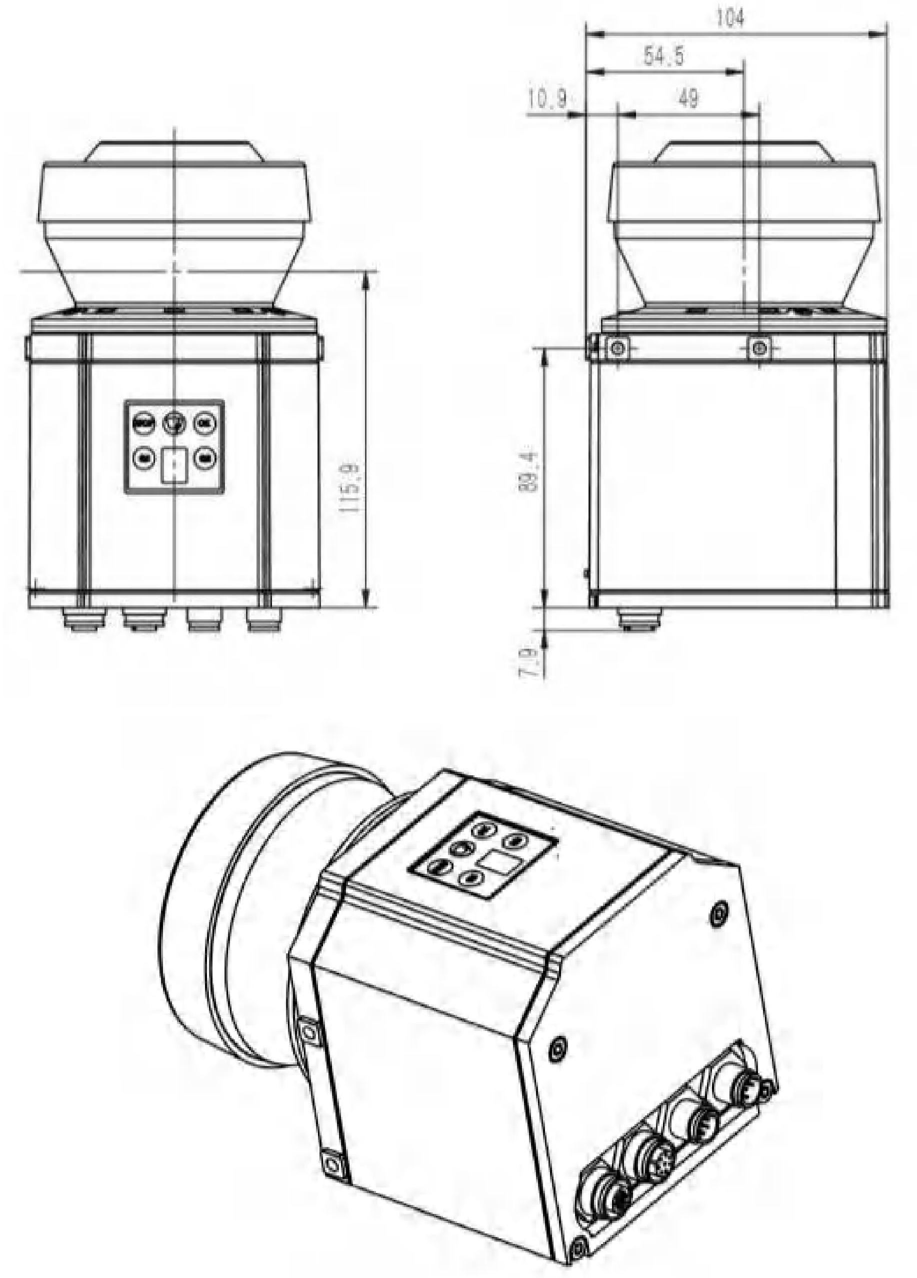


Figure 3-1 Overall installation effect

As shown in the figure above, the front of the device is the status indicator, the horizontal center line is the plane where the laser scanning optical axis is located, and the laser is emitted through the infrared protective cover. Please pay attention to the maintenance of the protective cover during use. Reference 2.4 has established a pollution assessment strategy. Once the infrared shield is heavily polluted and affects the realization of the device function, please consider replacing

Brand new infrared transparent protective cover. Four screw holes are reserved on the side for installation and positioning. You can complete the scanning of the plane you need by fixing in different positions according to actual needs.
There are four interfaces below. The first picture shows the four necessary connection ports. For the sake of safety protection level, we equipped the four interfaces with protective caps.
Of the four interfaces, two are more commonly used. The first one on the left is a power interface, which is connected to a DC power supply of 12-30V (typically 24V); the first one is a network port connection. The initial function is to support direct output of point cloud data of detectable objects in a 270 ° two-dimensional plane The space target distance information output by the device can be converted to the information you need according to actual needs. At the same time, two other interfaces are reserved for your choice. You can see the detailed description of the four interfaces in Section 4 "Device Connection".

4 Device connection

4.1 Main interface

The main view of the plane where the four interfaces are located is as follows:

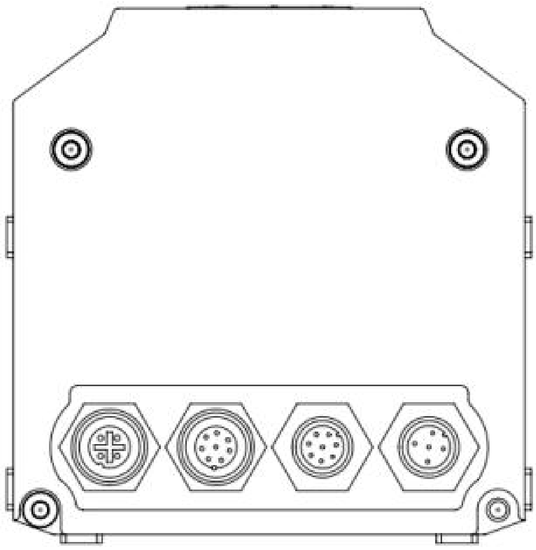
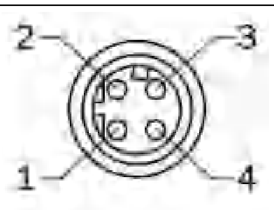
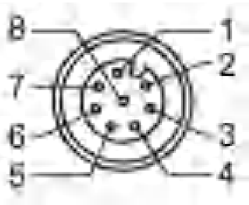
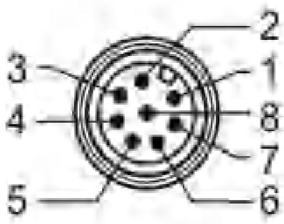
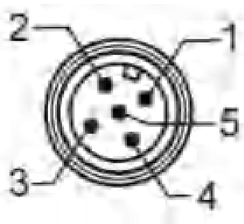


Figure 4-1 Device external interface

The four interfaces from left to right are: network interface, I / O interface, data interface, and power interface. More detailed information is listed in the table below:

Table 4-1 Interface Pin Information Table

interface	Icon	Pin	signal	Features
Network port		1	TX+	Send +
		2	RX+	Receive +
		3	TX －	send-
		4	RX －	receive-
I/O interface		1	INC1 A	Encoder input A
		2	INC1 B	Encoder input B
		3	GND INC1	Encoder input
		4	OUT1 A	Output
		5	OUT2 A	Output
		6	OUT3 A	Output
		7	OUT1_3 B	Switch output
		8	OUT1_3 R	Switch output, resistance monitoring

Data interface		1	RxD HOST	Rs232 receiving
		2	TxD HOST	RS232 send
		3	CAN H	CAN-H line
		4	CAN L	CAN-L line
		5	GND RS/CAN	Ground
		6	IN1	Input
		7	IN2	Input
		8	GND IN1/IN2	Ground
Power interface		1	Vs (brown)	Power supply +
		2	Vs heat (white)	Heating +
		3	GND (blue)	Power supply
		4	Reserved	Set aside
		5	GND heat (green)	Heatedly

4.2 Device connection and communication

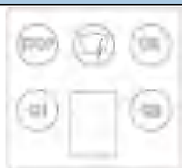
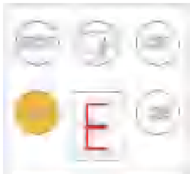
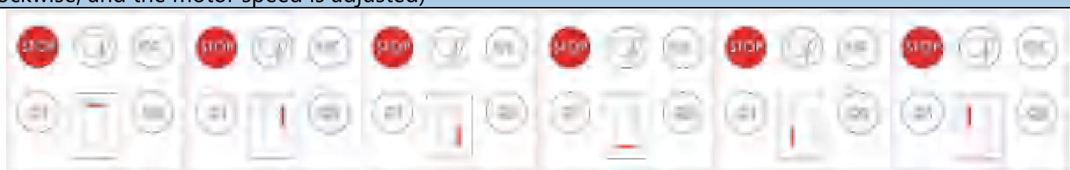
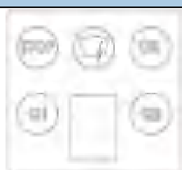
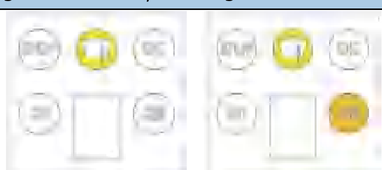
In order to complete the connection of the device and output the distance information of the target object in the scanning area for the subsequent conversion of information, at least the following accessories are required:

- 12-30V DC power supply (typical value is 24V).
- XD-TOF-XX laser measuring sensor.
- Adapted power cord and network cable.
- Terminals equipped with TCP / IP protocol.

The device connection and the output of the target distance information within the detection range will follow the following main steps (we have attached simple routines to help you carry out simple and fast communication development. Definition, clearing and other operations, you need to design according to the actual situation).

STEP1: Place the XD-TOF-XX laser measurement sensor in a suitable position so that it can scan the area you need.
STEP2: The connection of the main interface. Network port connection: Use the appropriate network cable to complete the connection to the TCP terminal of the protocol terminal through TCPclient; use the appropriate power cable to complete the connection between the XD-TOF-XX laser measurement sensor and
STEP3: DC power supply output power supply, the status display on the front of the device lights up (refer to Table 4-2), and the XD-TOF-XX laser measurement sensor starts to scan the defined scanning area when the green OK display light is on.

Table 4-2 Device display and status diagram

Unpowered state (all display lights are off, power is not connected)

Power-on initial self-test state (digital display tube rotates clockwise, power-on initialization and device self-test)
 (1) (2) (3) (4) (5) (6)
Error status (Q1 orange light is on, digital display tube displays "E", failed self-test, failed to complete initialization, or failed to complete speed regulation)
 ※ This state cannot be restored and needs to be returned to the factory for repair
After the self-test is completed, the device is initialized (the STOP red light is on, the digital display tube rotates clockwise, and the motor speed is adjusted)
 (1) (2) (3) (4) (5) (6)
Initialization is complete (all indicator lights 0.6 are off, allowing users to access and request data)
 (1)
After the self-test is completed, the device is initialized (the STOP red light is on, the digital display tube rotates clockwise, and the motor speed is adjusted) Initialization is complete (all indicator lights 0.6 are off, allowing users to access and request data)
 ※In this state, the optical protective cover needs to be cleaned or replaced

STEP4: Connect the network cable and set the relevant parameters of the client, refer to Table 4-3.

Table 4-3 Basic information of device network connection

IP	XD-TOF -3O	192. 168. 1. 121
	XD-TOF -50	192. 168. 1. 121
Subnet mask	255 . 255 . 255 . 0	
Gateway	192 . 168 . 1 . 1	
port	2111	

Before officially starting communication, the communication format of XD-TOF-XX is first introduced. The communication method of FO-SLS-XX is composed of hexadecimal byte ASCII codes. The format includes:

Table 4-3 Communication data packet format

Packet format	Hexadecimal ASCII code
Start header: <STX>	02
Packet content	Refer to specific instruction content or data packet content
End trailer: <ETX>	03

STX	Command name	Signs and status	Data (populated as appropriate)	Signs and status	ETX

(Routine 1) Connect with the device

```
TcpClient tcpClient = new TcpClient();
_ tcpClient = tcpClient;
string ip = 192.169.1.121;                    / / Radar ip
int port = 2111;                              / / Radar port
tcpClient.Connect(ip, port);
```

You can change the basic network information settings of the XD-TOF-XX series through commands. The commands are:
The command to set the IP address is: (set to 192.168.0.2)

instruction	<STX>sWN{SPC}EIIpAddr{SPC} C0 {SPC} A8 {SPC} 00 {SPC} 02 <ETX>	
Actually send instructions (Hex)	02 73 57 4E20 45 49 49 70 41 64 6420 72 43 3020 41 3820 30 30 20 30 3203	
Header	<STX>	02
Data content	sWN	73 57 4E
	Space(SPC)	20
	EIIpAddr	45 4949 70 41 64 64 72

	Space (SPC)	20
	C0h (hexadecimal, corresponding to 192)	43 30
	Space (SPC)	20
	A8h (hexadecimal, corresponding to 168)	41 38
	Space (SPC)	20
	00h (two-byte hexadecimal, corresponding to 0)	30 30
	Space (SPC)	20
	02h (two-byte hexadecimal, corresponding to 2)	30 32
Footer	<ETX>	03

If the command is successfully sent and the modification is successful, you will receive the following feedback from the radar:

ASCII	<STX>sWA{SPC}EIIpAddr<ETX>
Hex	02 73 57 4120 45 49 49 70 41 64 64032

And, you can query the current IP address through the command. The command to query the current IP address is:

ASCII	<STX>sRN{SPC} EIIpAddr <ETX>
Hex	02 73 52 4E20 45 49 49 70 41 64 64032

If the command is successfully sent, the response will be in the same format as the command you set for IP address.

The command to set the gateway is: (set to 192.168.0.1)

instruction	<STX>sWN{SPC}EIgate{SPC}C0{SPC}A8{SPC}00{SPC}01<ETX>	
Actually send instructions (Hex)	02 73 57 4E20 45 49 67 61 74 65 20 43 3020 41 3820 30 3020 30 31 03	
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	EIgate	45 49 67 61 74 65
	Space (SPC)	20
	C0h (hexadecimal, corresponding to 192)	43 30
	Space (SPC)	20
	A8h (hexadecimal, corresponding to 168)	41 38
	Space (SPC)	20

	00h (two byte hexadecimal, corresponding to 0)	30 30
	Space (SPC)	20
	01h (two byte hexadecimal, corresponding to 2)	30 31
Footer	<ETX>	03

If the command is successfully sent and the modification is successful, you will receive the following feedback from the radar:

ASCII	<STX>sWA{SPC}EIgate<ETX>
Hex	02 73 57 41 20 45 49 67 61 74 65 03

And, you can query the current gateway through instructions,
The command to query the current gateway is:

ASCII	<STX>sRN{SPC}EIgate<ETX>
Hex	02 73 52 4E 20 45 49 67 61 74 65 03

If the command is successfully sent, the response will be in the same format as the command you set for the gateway.
The command to set the subnet mask is: (set to 255.255.254.0)

instruction	<STX>sWN{SPC}EImask{SPC}FF {SPC}FF {SPC}FE {SPC}00<ETX>	
Actually send instructions (Hex)	02 73 57 4E 20 45 49 6D 61 73 6B 20 46 46 20 46 46 20 46 45 20 30 30 03	
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	EImask	45 49 6D 61 73 6B
	Space (SPC)	20
	FFh (hexadecimal, corresponding to 255)	46 46
	Space (SPC)	20
	FFh (hexadecimal, corresponding to 255)	46 46
	Space (SPC)	20
	FEh (two-byte hexadecimal, corresponding to 254)	46 45
	Space (SPC)	20
	00h (two-byte hexadecimal, corresponding to 0)	30 30
Footer	<ETX>	03

If the command is successfully sent and the modification is successful, you will receive the following feedback from the radar:

ASCII	<STX>sWA{SPC}EImask<ETX>
Hex	02 73 57 41 20 45 49 6D 61 73 6B 03

In addition, you can query the current subnet mask through the command.

The command to query the current subnet mask is:

ASCII	<STX>sRN{SPC} EImask <ETX>
Hex	02 73 52 4E 20 45 49 6D 61 73 6B 03

If the command is sent successfully, the reply will be in the same format as the command you set for the subnet mask.

The command to set the MAC address is: (set to 01.02.03.04.05.06)

instruction	<STX>sWN{SPC} EIMacAddr{SPC}01{SPC}02{SPC}03{SPC}04{SPC}05{SPC}06<ETX>	
Actual sending instruction (Hex)	02 73 57 4E 20 45 49 4D 61 63 41 64 64 72 20 30 31 20 30 32 20 30 33 20 30 34 20 30 35 20 30 36 03	
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	EIMacAddr	45 49 4D 61 63 41 64 64 72
	Space (SPC)	20
	01h	30 31
	Space (SPC)	20
	02h	30 32
	Space (SPC)	20
	03h	30 33
	Space (SPC)	20
	04h	30 34
	Space (SPC)	20
	05h	30 35
	Space (SPC)	20
	06h	30 36
Footer	<ETX>	03

If the command is successfully sent and the modification is successful, you will receive the following feedback from the radar:

ASCII	<STX>sWA{SPC}EI MacAddr<ETX>
Hex	02 73 57 41 20 45 49 4D 61 63 41 64 64 03

And, you can query the current MAC address by command,
The command to query the current MAC address is:

ASCII	<STX>sRN{SPC} }EI MacAddr <ETX>
Hex	02 73 52 4E 20 45 49 4D 61 63 41 64 64 03

If the command is successfully sent, the response is in the same format as the command you set for MAC address.

It is worth noting that before configuring the basic network information settings, you need to send STEP5 (login device) to obtain the modification authority. After configuring the basic network information settings, you need to send a save command to solidify the current parameters to the radar to ensure Use the basic network information settings you currently set when powering on. See STEP11 for details on saving instructions.

STEP5 5: Log in to the device as a client by sending commands.

The application requests to log in to the client to access the radar communication (if this process is not performed, the radar only receives the request data command by default, and the commands related to the modification configuration have a reply but cannot take effect),
The command to log in to the device is:

instruction	<STX>sMN(SPC) SetAccessMode (SPC) 03 (SPC)F4724744<ETX>	
Actually send instructions (Hex)	02 73 4D 4E 20 53 65 74 41 63 63 65 73 73 4D 6F 64 65 20 30 33 20 46 34 37 32 34 37 34 34 03	
Header	<STX>	02
Data content	sMN	73 4D 4E
	Space (SPC)	20
	SetAccessMode	53 65 74 41 63 63 65 73 73 4D 6F 64 65
	Space (SPC)	20
	03 (Client login status bit)	30 33
	Space (SPC)	20
	F4724744 (Client login password can be modified according to the instruction to modify the login password)	46 34 37 32 34 37 34 34

Footer	<ETX>	03

If the command is successfully sent and the password is correctly logged in, you will receive the following feedback from the radar:

ASCII	<STX>sAN(SPC)SetAccessMode(SPC)1<ETX>
Hex	02 73 41 4E 20 53 65 74 41 63 63 65 73 73 4D 6F 64 65 20 31 03

If the login command fails to be sent successfully, you will receive the following feedback:

ASCII	<STX>sAN(SPC)SetAccessMode(SPC)0<ETX>
Hex	02 73 41 4E 20 53 65 74 41 63 63 65 73 73 4D 6F 64 65 20 30 03

It is worth noting that if you do not perform the login process, you will not have the authority to modify the radar-related configuration. By default, the radar only receives the request data command, and its modification configuration-related commands (including network information, scanning parameters, angle range, time stamp) Synchronization, alarm zone settings, etc.) have a reply but cannot take effect.

(Routine 2) Log in to the device

```
byte[]   loginlidar   ={ 0x02, 0x73, 0x4D, 0x4E, 0x20, 0x53, 0x65, 0x74, 0x41, 0x63,
0x63, 0x65, 0x73, 0x73, 0x4D, 0x6F, 0x64, 0x65, 0x20, 0x30, 0x33, 0x20, 0x46, 0x34,
0x37, 0x32, 0x34, 0x37, 0x34, 0x34, 0x03 };
// Radar login instruction
clientStream.Write(   loginlidar   , 0,   loginlidar   .Length)  ; // Send login instructions to radar
if (clientStream.CanRead)
{
  byte[]   loginanswer  = new byte[1024];                        // Open up cache
  StringBuilder myCompleteMessage = new StringBuilder();  // Receive result variable
  int   numberOfBytesRead = 0;
  do
  {
   numberofBytesRead = clientStream.Read(loginanswer , 0,   loginanswer .Length);
   // Read TCPIP communication receive buffer
   myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(myReadBuffer,
   0,  numberOfBytesRead));
   // Write all the information stack read by the network port to the receiving result variable
  }
   while (clientStream.DataAvailable);  // If the data does not arrive, the loop is received
You can continue to operate the acceptance information in myCompleteMessage to determine
further operations. The following continues to extract key instruction information,
which may contain ETX, STX, you need to further elaborate processing
   string result = myCompleteMessage.ToString();
```

```
    string[] split = result.Split(new char[] { ' ' });//    Divide the received character string into N character string arrays with spaces.
    loginresult    .Text=split[3];//   The third part is the device login result information +ETX, the first byte is the login result information.
```

STEP6: Read the device name (can be omitted).

The application can ask for the name of the radar device,

The command to query the device name is:

Instruction	<STX>sRN{SPC}LocationName<ETX>	
Actually send instructions (Hex)	02 73 52 4E20 4C 6F 63 61 74 69 6F 6E 4E 61 6D 65 03	
Header	<STX>	02
Data content	sRN	73 52 4E
	Space (SPC)	20
	LocationName	4C 6F 63 61 74 69 6F 6E 4E 61 6D 65
Footer	<ETX>	03

If the command is successfully sent, you will receive the following feedback from the radar (the initial name of the radar is named FocusRayLidar):

ASCII	<STX>sRA{SPC}LocationName{SPC}D{SPC}FocusRayLidar<ETX>
Hex	02 73 52 4120 4C 6F 63 61 74 69 6F 6E 4E 61 6D 65 20 44 20 46 6F 63 7573 72 61 79 4C 69 64 61032

(Routine 3) Read the device name

```
byte[]   devicename= { 0x02, 0x73, 0x52, 0x4E, 0x20, 0x4C, 0x6F, 0x63, 0x61, 0x74, 0x69, 0x6F, 0x6E, 0x4E, 0x61, 0x6D, 0x65, 0x03 };  / / Radar interrogation equipment name
clientStream.Write(   devicename, 0,  devicename .Length)  ;  / / Send login instructions to radar
if (clientStream.CanRead)
{
   byte[]   nameanswer= new byte[1024];                              / / Open up cache
   StringBuilder myCompleteMessage = new StringBuilder();      / / Receive result variable
   int numberOfBytesRead = 0;
   do
   {
   numberof BytesRead = clientStream.Read(  nameanswer, 0,  nameanswer.Length);
    / / Read TCPIP communication receive buffer
```

```
    myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(nameanswer, 0,
    numberOfBytesRead));
    / / Write all the information stack read by the network port to the receiving result variable
}
    while (clientStream.DataAvailable);  / / If the data does not arrive, the loop is received
    / / You can continue to operate the acceptance information in myCompleteMessage to
       determine further operations. The following continues to extract key instruction
       information, which may contain ETX, STX, you need to further elaborate processing
    string result = myCompleteMessage.ToString();
    string[] split = result.Split(new char[] { ' ' });// Divide the received character string into N
  character string arrays with spaces.

    lidarname.Text = split[4];//  Part 4 is the device name +ETX, you can remove the last byte.
```

STEP7: Read the device index to get the device type and version (can be omitted).

The application can query the radar device type and version index,
The command to query device type and version is:

instruction	<STX>sRN{SPC}DeviceIdent<ETX>	
Actually send instructions (Hex)	02 73 52 4E 20 44 65 76 69 63 65 49 64 65 6E 03 74	
Header	<STX>	02
Data content	sRN	73 52 4E
	Space (SPC)	20
	DeviceIdent	44 65 76 69 63 65 49 64 65 6E 74
Footer	<ETX>	03

If the command is successfully sent, you will receive the following feedback from the radar to inform the device index:

ASCII	<STX>sRA{SPC}DeviceIdent{SPC}8{SPC}FOSLS121{SPC}4{SPC}V1.0<ETX>
Hex	02 73 **52 41** 20 44 **65 76 69 63 65 49 64 65 6E 74** 20 38 20 46 4F 53 4C 53 31 32 31 20 34 20 56 31 2E 30 03

(Routine 4) Read device index

```
byte[]  ident  = { 0x02, 0x73, 0x52, 0x4E, 0x20, 0x44, 0x65, 0x76, 0x69, 0x63, 0x65,
0x49, 0x64, 0x65, 0x6E, 0x74, 0x03 };          / / Ask for device index
clientStream.Write(   ident , 0,    ident .Length)  ;      / / Send login instructions to radar
if (clientStream.CanRead)
```

```
{
   byte[]   identanswer  = new byte[1024];                        // Open up cache
   StringBuilder myCompleteMessage = new StringBuilder();     // Receive result variable
   int numberOfBytesRead = 0;
   do
   {
    numberof BytesRead = clientStream.Read( identanswer, 0,   identanswer.Length);
     // Read TCPIP communication receive buffer
     myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(identanswer,
0,  numberOfBytesRead)); // Write all the information stack read by the network port to the receiving result variable
     }while (clientStream.DataAvailable);  // If the data does not arrive, the loop is received
 // You can continue to operate the acceptance information in myCompleteMessage to determine further operations.
    The following continues to extract key instruction information, which may contain ETX, STX, you need to further
    elaborate processing
     string result = myCompleteMessage.ToString();
     string[] split = result.Split(new char[] { ' ' });// Use spaces to split the received string into
     an array of N strings.
     lidarname.Text = split[2];//  The second part is the device name +ETX, which can be
    used to remove the last byte.
```

STEP8 8: Read device status.

The application can query the radar device status index,
The command to query the device status is:

instruction	<STX>sRN{SPC}SCdevicestate<ETX>	
Actually send instructions (Hex)	02 73 52 4E20 53 43 64 65 76 69 63 65 73 74 61 0374 65	
Header	<STX>	02
Data content	sRN	73 52 4E
	Space (SPC)	20
	SCdevicestate	53 43 64 65 76 69 63 65 73 74 61 74 65
Footer	<ETX>	03

If the command is successfully sent, you will receive the following feedback from the radar to inform the device index:

instruction	<STX>sRA{SPC}SCdevicestate{SPC}0<ETX>	
Actually send instructions (Hex)	02 73 52 4120 53 43 64 65 76 69 63 65 73 74 61 2074 3065 03	
Header	<STX>	02

Data content	SRA	73 52 41
	Space (SPC)	20
	SCdevicestate	53 43 64 65 76 69 63 65 73 74 61 74 65
	Space (SPC)	20
Variable data bits	0 (device is busy)	30
	1 (device is ready)	31
	2 (error)	32
Footer	<ETX>	03

(Routine 5) Read device status

```
byte[]   status   ={ 0x02, 0x73, 0x52, 0x4E, 0x20, 0x4C, 0x43, 0x4D, 0x73, 0x74, 0x61,
0x74, 0x65, 0x03 };      / / (Routine 5) Read device status
clientStream.Write(   status , 0,   status .Length)  ;     / / Send login instructions to radar
if   (clientStream.CanRead)
{
   byte[]   stateanswer  = new byte[1024];                          / / Open up cache
   StringBuilder myCompleteMessage = new StringBuilder();   / / Receive result variable
   int numberOfBytesRead = 0;
   do
   {
   numberof BytesRead = clientStream.Read(  stateanswer , 0,   stateanswer .Length);
    / / Read TCPIP communication receive buffer
    myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(stateanswer ,
0,   numberOfBytesRead));
    / / Write all the information stack read by the network port to the receiving result variable
    }
        while (clientStream.DataAvailable);  / / If the data does not arrive, the loop is received
    / / You can continue to operate the acceptance information in myCompleteMessage to
   determine further operations. The following continues to extract key instruction information,
   which may contain ETX, STX, you need to further elaborate processing
    string result = myCompleteMessage.ToString();
    string[] split = result.Split(new char[] { ' ' });//  Divide the received character string into N
    character string arrays with spaces.
    lidarstatestr= split[3]          / / lidarstatestr     The first byte in is the radar status
```

STEP9: Set the scanning parameters.

XD-TOF series completes the setting of radar sweep parameters through commands
The command to set the scan parameters is:

instruction (50Hz)	<STX>sMN{SPC}mLMPsetscancfg{SPC}1388{SPC}1{SPC}1388{SPC}FFF92230{SPC}225510<ETX>	
instruction (25Hz)	<STX>sMN{SPC}mLMPsetscancfg{SPC}9C4{SPC}1{SPC}9C4{SPC}FFF92230{SPC}225510<ETX>	
Actual delivery Command 50Hz (Hex)	02 73 4D 4E20 6D 4C 4D 50 73 65 74 73 63 61 6E 63 66 6720 31 33 38 3820 31 20 31 33 38 38 20 46 46 46 39 32 32 33 3020 32 32 35 35 31 3003	
Actual delivery Command 25Hz (Hex)	02 73 4D 4E20 6D 4C 4D 50 73 65 74 73 63 61 6E 63 66 67 20 39 43 34 20 31 20 39 43 3420 46 46 46 39 32 32 33 3020 32 32 35 35 31 30 03	
Header	<STX>	02
Data content	sMN	73 4D 4E
	Space (SPC)	20
	mLMPsetscancfg	6D 4C 4D 50 73 65 74 73 63 61 6E 63 66 67
Optional I (speed)	1388 (5000) (50Hz)	31 33 38 38
	9C4 (2500) (25Hz)	39 43 34
Data content	Space (SPC)	20
	1 (configurable area)	31
	Space (SPC)	20
Optional II (angular resolution)	1388 (5000) (0.5°)	31 33 38 38
	9C4 (2500) (0.25°)	39 43 34
	Space (SPC)	20
Data content	FFF92230 (− 450000) (Starting angle -45°)	46 46 46 39 32 32 33 30
	空格 (SPC)	20
	225510 (+2250000) (Termination angle +225°)	32 32 35 35 31 30
Footer	<ETX>	03

For FO-SLS-31 and FO-SLS-51, this command is actually to choose a scan frequency of 50Hz or a scan frequency of 25Hz. Optional configurations include speed (50Hz, 25Hz), configurable area (1, no other options), Angular resolution (0.5°, 0.25°), starting angle (-45°), ending angle (+225°). It is worth noting that

For these two radars, once the scanning frequency is determined, the configurable area (ie -45° to 225° sector area), the angular resolution will be fixed accordingly (50Hz corresponds to 0.5°, 25Hz corresponds to 0.25°), and crossover cannot be generated Parameter combination.

If the scan parameters are configured successfully, your application will receive:

instruction (50Hz)	<STX>sAN{SPC}mLMPsetscancfg{SPC}0{SPC}1388{SPC}1{SPC}1388{SPC}FFF92230{SPC}225510<ETX>	
instruction (25Hz)	<STX>sAN{SPC}mLMPsetscancfg{SPC}0{SPC}9C4{SPC}1{SPC}9C4{SPC}FFF92230{SPC}225510<ETX>	
Actual delivery Command 50Hz (Hex)	02 73 41 4E 20 **6D 4C 4D 50 73 65 74 73 63 61 6E 63 66 67** 20 30 20 31 33 38 38 20 31 20 31 33 38 38 20 46 46 46 39 32 32 33 30 20 32 32 35 35 31 30 03	
Actual delivery Command 25Hz (Hex)	02 73 41 4E 20 **6D 4C 4D 50 73 65 74 73 63 61 6E 63 66 67** 20 30 20 39 43 34 20 31 20 39 43 34 20 46 46 46 39 32 32 33 30 20 32 32 35 35 31 30 03	
Header	<STX>	02
Data content	sAN	73 41 4E
	Space (SPC)	20
	mLMPsetscancfg	6D **4C 4D 50 73 65 74 73 63 61** 6E 63 66 67
	Space (SPC)	20
	0(Configuration is complete)	30
	Space (SPC)	20
Optional I (speed)	+5000 (50Hz)	31 33 38 38
	+2500 (25Hz)	39 43 34
Data content	Space (SPC)	20
	1(Configurable area)	31
	Space (SPC)	20
Optional II (angular resolution)	1388 (0.5°)	31 33 38 38
	9C4 (0.25°)	39 43 34
	Space (SPC)	20
Data content	FFF92230(Starting angle -45°)	46 46 46 39 32 32 33 30

	Space (SPC)	20
	225510(Termination angle +225°)	32 32 35 35 31 30
Footer	<ETX>	03

It should also be noted that before setting the scan parameters, you need to send STEP5 (login device) to obtain the modification authority. After setting the scan parameters, you need to send a save command to solidify the current parameters to the radar to ensure that it will be used when the radar is powered on next time. The scan parameter settings you currently set. Please refer to STEP11 for details of saving instructions.

(Routine 6) Set scan parameters

```
byte[]  setscancfg 50={0 x02 , 0x73 , 0x4D, 0x4E , 0x20 , 0x6D, 0x4C, 0x4D, 0x50 , 0x73 ,
0x65 , 0x74 , 0x73 , 0x63 , 0x61 , 0x6E , 0x63 , 0x66 , 0x67 , 0x20 , 0x31 , 0x33 , 0x38 , 0x38 ,
0x20 , 0x31 , 0x20 , 0x31 , 0x33 , 0x38 , 0x38 , 0x20 , 0x46 , 0x46 , 0x46 , 0x39 , 0x32 , 0x32 ,
0x33 , 0x30 , 0x20 , 0x32 , 0x32 , 0x35 , 0x35 , 0x31 , 0x30 , 0x03 };    // Set 50Hz speed
clientStream.Write(  setscancfg 50, 0,   setscancfg 50) ;// Send login instructions to radar
if (clientStream.CanRead)
{
   byte[]  scancfganwser = new byte[1024];                    //  Open up cache
   StringBuilder myCompleteMessage = new StringBuilder();     //  Receive result variable
   int numberOfBytesRead = 0;
   do
   {
   num berof BytesRead=clientStream.Read( scancfganwser,0,  scancfganwser.Length);
    // Read TCPIP communication receive buffer
  myComplet eMessage.AppendFormat("{0}",Encoding.ASCII.GetString(  scancfganwser,
0,  numberOfBytesRead));
    // Write all the information stack read by the network port to the receiving result variable
    }
     while (clientStream.DataAvailable);   // If the data does not arrive, the loop is received
   // You can continue to operate the acceptance information in myCompleteMessage to determine
      further operations. The following continues to extract key instruction information, which may contain
      ETX, STX, you need to further elaborate processing
    string result = myCompleteMessage.ToString();
    string[] split = result.Split(new char[] {' '});//Divide the received character string into N
character string arrays with spaces.
    scancfgreply  = split[3]       // 0  Set up successfully
```

STEP10: Set the scan data output angle range

The XD-TOF series completes the configuration of the angle range of the radar data output through commands, The command to set the scan data output angle range is:

instruction （50Hz ）	<STX>sWN{SPC}LMPoutputRange{SPC}1{SPC}1388{SPC}0{SPC}DBBA0<ETX> (The output angle range is set to 0 degrees to 90 degrees)	
Actually send instructions	02 73 57 4E 20 4C 4D 50 6F 75 74 70 75 74 52 61 6E 67 65 20 31 20 31 33 38 38 20 30 20 44 42 42 41 30 03	
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	LMPoutputRange	4C 4D 50 6F 75 74 70 75 74 52 61 6E 67 65
Data content	Space (SPC)	20
	1 (configurable area)	31
	Space (SPC)	20
Speed configuration	+5000（50Hz ）	31 33 38 38
	Space (SPC)	20
Optional configuration I (Data output start angle)	0（0）（0°）	30
	Space (SPC)	20
Optional configuration II (Angle of data output end)	DBBA0 （900000）（90°）	44 42 42 41 30
Footer	<ETX>	03

For XD-TOF-30 and XD-TOF-50 , this command can optionally configure the starting angle (-45°) and ending angle (+225°).
It is worth noting that for these two radars, the starting angle must not be less than -45° (FFF92230), and the ending angle must not be greater than 225° (225510). ※The speed configuration appearing in this instruction is only to meet the data format requirements, and cannot The real speed of the system is changed.

If the configuration of the angle range for radar data output is successful, your application will receive:

ASCII	<STX>sWA{SPC}LMPoutputRange<ETX>
Hex	02 73 57 41 20 4C 4D 50 6F 75 74 70 75 74 52 61 6E 67 65 03

It should also be noted that before setting the output angle range, you need to send STEP5 (login device) to obtain the modification authority. After setting the output angle range, you need to send a save command to solidify the current parameters to the radar to ensure that the The next time the radar is powered on, it uses the output angle range setting you currently set. Please refer to STEP11 for details of saving instructions.

(Routine 7) Configuration of the angular range of radar data output

```
byte[]  output Range={0x02 , 0x73 , 0x57 , 0x4E , 0x20 , 0x4C , 0x4D , 0x50 , 0x6F , 0x75 ,
0x74 , 0x70 , 0x75 , 0x74 , 0x52 , 0x61 , 0x6E , 0x67 , 0x65 , 0x20 , 0x31 , 0x20 , 0x31 , 0x33 ,
0x38 , 0x38 , 0x20 , 0x30 , 0x20 , 0x44 , 0x42 , 0x42 , 0x41 , 0x30 , 0x03};   //
The output angle range is set to 0 degrees to 90 degrees
clientStream.Write(  output Range, 0,  output Range);    // Send instructions to the radar
if (clientStream.CanRead)
{
  byte[]  output Rangeanwser = new byte[1024];                  // Open up cache
  StringBuilder myCompleteMessage = new StringBuilder();     // Receive result variable
  int numberOfBytesRead = 0;
  do
  {
  numberof BytesRead = clientStream.Read(  output Rangeanwser, 0,
output RangeanwserLength);
   // Read TCPIP communication receive buffer
   myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(output Rangeanw
ser, 0,   numberOfBytesRead));
   // Write all the information stack read by the network port to the receiving result variable
   }
      while (clientStream.DataAvailable);      // If the data does not arrive, the loop is received
   //You can continue to operate the acceptance information in myCompleteMessage to determine
     further operations. The following continues to extract key instruction information, which may contain
     ETX, STX, you need to further elaborate processing
   string result = myCompleteMessage.ToString();
   string[] split = result.Split(new char[] { ' ' });// Divide the received character string into N
  character string arrays with spaces.
```

STEP11: Store the current configuration.

Note that before sending and storing the current configuration command, you need to send a STEP5 login command to obtain the authority. If you are currently logged in, you do not need to send this command. After sending and storing the current configuration command, the above network basic information settings, the speed and angular resolution of STEP9 configuration, the angle range of data output of STEP10 configuration, and the encoder information, time stamp information, pulse intensity information, and secondary echo information below It will be stored in the radar and will not change even if the power is turned off.

The storage current configuration instruction is:

instruction	<STX>sMN{SPC}mEEwriteall<ETX>	
Actually send instructions (Hex)	02 73 4D 4E 20 6D 45 45 77 72 69 74 65 61 6C 6C 03	
Header	<STX>	02
Data content	sMN	73 4D 4E
	Space (SPC)	20
	mEEwriteall	6D 45 45 77 72 69 74 65 61 6C 6C
Footer	<ETX>	03

After successful storage, your application will receive:

ASCII	<STX>sAN{SPC}mEEwriteall{SPC}1<ETX>
Hex	02 73 41 4E 20 6D 45 45 77 72 69 74 65 61 6C 6C 20 31 03

(Routine 8) Storage configuration

```
byte[] wirteall ={0x02,0x73,0x4D,0x4E,0x20,0x6D,0x45,0x45,0x77,0x72,0x69,
0x74, 0x65, 0x61, 0x6C, 0x6C, 0x03 };     //Store command
clientStream.Write( wirteall , 0, wirteall ) ;    //Send login instructions to radar
if (clientStream.CanRead)
{
    byte[] writeanwser = new byte[1024];                    //Open up cache
    StringBuilder myCompleteMessage = new StringBuilder();  //Receive result variable
    int numberOfBytesRead = 0;
    do
    {
    numberof BytesRead = clientStream.Read( writeanwser , 0, writeanwser .Length);
     //Read TCPIP communication receive buffer
     myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString( writeanwser ,
0, numberOfBytesRead));// Write all the information stack read by the network port to the receiving result variable
     }while (clientStream.DataAvailable); //If the data does not arrive, the loop is received
     //You can continue to operate the acceptance information in myCompleteMessage to determine
       further operations. The following continues to extract key instruction information, which may contain
       ETX, STX, you need to further elaborate processing
     string result = myCompleteMessage.ToString();
     string[] split = result.Split(new char[] {' '});// Divide the received character string into N
    character string arrays with spaces.
     writereply = split[3]    // The first byte is the storage success status is
```

STEP 12: Log out and run the radar according to the configuration.

The logout and run instructions are:

instruction	<STX>sMN{SPC}Run<ETX>	
Actually send instructions Hex	02 73 4D 4E 20 52 75 6E 03	
Header	<STX>	02
Data content	sMN	73 4D 4E
	Space (SPC)	20
	Run	52 75 6E
Footer	<ETX>	03

When the radar is operating normally, you will receive:

ASCII	<STX>sAN{SPC}Run{SPC}1<ETX>
Hex	02 73 41 4E 20 52 75 6E 20 31 03

It is worth noting that after this command is sent, your authority to modify the radar-related configuration obtained by logging in to the device as a client by sending a command via STEP5 will be invalid. After that, the radar will only receive the request data command by default, and its modification configuration-related commands (including Network information, scanning parameters, angle range, timestamp synchronization, alarm zone settings, etc.) have replies but cannot take effect.

(Routine 9) Log out and run

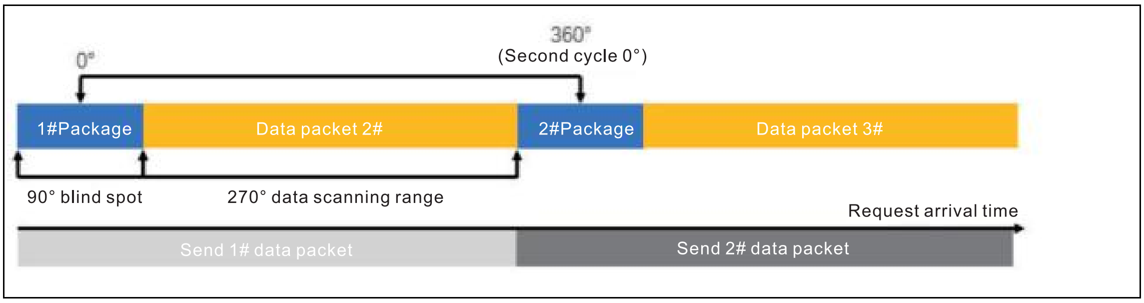
```
byte[]  logout ={ 0x02, 0x73, 0x4D, 0x4E, 0x20, 0x52, 0x75, 0x6E, 0x03 };  / / Store command

clientStream.Write(   logout , 0,    logout ) ;      / / Send login instructions to radar
if (clientStream.CanRead)
{
    byte[]    runanwser = new byte[1024];                         / / Open up cache
    StringBuilder myCompleteMessage = new StringBuilder();     / / Receive result variable
    int numberOfBytesRead = 0;
    do
    {
    numberof BytesRead = clientStream.Read(  runanwser, 0,    runanwser.Length);
     / / Read TCPIP communication receive buffer
     myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(runanwser, 0,
numberOfBytesRead));
 / / Write all the information stack read by the network port to the receiving result variable
```

```
    }while (clientStream.DataAvailable);    / / If the data does not arrive, the loop is received
    / / You can continue to operate the acceptance information in myCompleteMessage to
determine further operations. The following continues to extract key instruction information,
which may contain ETX, STX, you need to further elaborate processing
```

STEP 12: Request data (single time).

※After the speed of the radar is configured, it cannot respond to the data request of the application for about 30S. Similarly, the data request cannot be responded within tens of seconds after the radar restarts or is powered off and then on.
※For a single data request, the FO-SLS series radar will send the data obtained by the last scan to ensure the timeliness of the data received by the customer, as shown in the following figure, so the longest delay may result in 20ms between the output data and the request time Delay.



The data request (single) instruction is:

ASCII	<STX>sRN{SPC}LMDscandata<ETX>
Hex	02 73 52 4E 20 4C 4D 44 73 63 61 6E 64 61 74 03 61

After receiving a single request, the radar will reply to you the data packet that has been packaged in the previous cycle. Again, this data packet has a delay of

Header	<STX>	02
Command information	sSN	73 53 4E
	Space (SPC)	20
	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
	Space (SPC)	20
version number	1	31
	Space (SPC)	20
device ID	1	31
	Space (SPC)	20
serial number	105B132	31 30 35 42 31 33 32

	Space (SPC)	20
Variable device status	0 (OK) 1 (Error) 2 (Optical cover contamination)	30 20 30 30 20 31 30 20 32
	Space (SPC)	20
Cumulative send counter	0000—FFFF	30 30 30 30—46 46 46 46
	Space (SPC)	20
Cumulative scan counter	0000—FFFF	30 30 30 30—46 46 46 46
	Space (SPC)	20
Device start timer	00000000—FFFFFFFF	30 30 30 30 30 30 30 30 —46 46 46 46 46 46 46 46
	Space (SPC)	20
Packet wait timer	00000000—FFFFFFFF	30 30 30 30 30 30 30 30 —46 46 46 46 46 46 46 46
	Space (SPC)	20
Default state I (Engineering mode)	0 0	30 20 30
	Space (SPC)	20
Default state II (Engineering mode)	4 0	34 20 30
	Space (SPC)	20
Default state III (Engineering mode)	0	30
	Space (SPC)	20
Rotating speed	09c4h 2500d(25Hz) 1388h 5000d(50Hz)	30 39 43 34 31 33 38 38
	Space (SPC)	20
Pulse repetition frequency	168h 360d(36kHz)	31 36 38
	Space (SPC)	20
Encoder status related (need to contact us)	0 (Please ignore the following two parameters about the encoder, and this packet does not contain these two parameters)	30 31

	1	
	Space (SPC)	20
Encoder count	00000000—FFFFFFFF	30 30 30 30 30 30 30 30 —46 46 46 46 46 46 46 46
	Space (SPC)	20
Encoder speed	00000000—FFFFFFFF	30 30 30 30 30 30 30 30 —46 46 46 46 46 46 46 46
	Space (SPC)	20
Default state IV (Engineering mode)	1	31
	Space (SPC)	20
Packet content	DIST1 (one echo) RSSI1 (one echo pulse width information) DIST2 (secondary echo) RSSI2 (second echo pulse width information)	44 49 53 54 31 52 53 53 49 31 44 49 53 54 32 52 53 53 49 32
	Space (SPC)	20
Default state V (Engineering mode)		33 46 38 30 30 30 30
	Space (SPC)	20
Default state VI (Engineering mode)		30 30 30 30 30 30 30 30
	Space (SPC)	20
Starting angle	-45°	46 46 46 39 32 32 33 30
	Space (SPC)	20
Angular resolution	09c4h 0.25(25Hz) 1388h 0.5 (50Hz)	30 39 43 34 31 33 38 38
	Space (SPC)	20
The number of data points contained in a frame	1081d 0439h(25Hz) 541d 021Dh (50Hz)	30 34 33 39 30 32 31 44
	Space (SPC)	20

Data content	541 data (at 50Hz) Total 541x5 = 2705 bytes 1081 data (at 25Hz), 1081x5 = 5405 bytes in total, All ASCII codes. To convert them to real data, first convert the ASCII codes to hexadecimal numbers, and then convert the hexadecimal numbers to decimal numbers, which is the final distance in mm.	XX XX XX XX 20 XX XX XX XX 20 XX ……XX 20 XX XX XX XX XX XX XX XX 20 XX XX XX XX 20 XX ……XX 20 XX XX XX XX XX XX XX XX is the hexadecimal ASCII code of the data, XD-TOF-30 corresponds to the hexadecimal data range is 0000h (30 30 30 30) to 7530 (37 35 33 30) XD-TOF-50 corresponds to the hexadecimal data range from 0000 (30 30 30 30) to C350 (43 33 35 30)
	Space (SPC)	20
Default status bit VII		30 2030 20 30 20 30
	Space (SPC)	20
Timestamp flag (Refer to P41 to set the radar internal time for details)	0 (represents that this packet does not contain a timestamp, please ignore the following description about timestamp) 1	30 31
	Space (SPC)	20
Timestamp year	0000h-FFFFh (0-65535) Example:07B2h (1970)	30 37 42 32
	Space (SPC)	20
Timestamp month	00h-0Ch (0-12) Example:01h(1)	30 31
	Space (SPC)	20
Day of timestamp	00h-1Fh(0-31) Example:01h(1)	30 31

	Space (SPC)	20
Hour of timestamp	00h–17h (0–23) Example:00h(0)	30 30
	Space (SPC)	20
Timestamp minute	00h–3Bh(0–59) Example:03h(3)	30 33
	Space (SPC)	20
Timestamp in seconds	00h–3Bh(0–59) Example:06h(6)	30 36
	Space (SPC)	20
Timestamp in milliseconds	00h–3E7h (0–999) Example:000001EEh(494)	30 30 30 30 30 34 39 34
	Space (SPC)	20
Default status bit VIII		30
Footer	<ETX>	03

	Actual distance	10 hex	Hex	Hexadecimal ASCII code
FO-SLS-31	Minimum 0mm	0	0h	30
	Maximum 30000mm	30000	7530h	37 35 33 30
FO-SLS-51	Minimum 0mm	0	0h	30
	Maximum 50000mm	50000	C350h	43 33 35 30
Note: When there are actual objects in the space, the minimum value of the radar output is tested to be 3mm (33), and the radar output is 0, meaning that the radar has not detected any objects in this direction				

(Routine 9) Single access

```
byte[] get1data={0x02, 0x73,   0x52, 0x4E, 0x20, 0x4C, 0x4D, 0x44, 0x73, 0x63, 0x61,
0x6E, 0x64, 0x61, 0x74, 0x61, 0x03 }    ;  // Single access command
clientStream.Write(   get1data, 0,   get1data) ;    // Send login instructions to radar
if (clientStream.CanRead)
{
    byte[]   scandata = new byte[8000];     // Open up the cache area, the demand is
    greater when the data is fetched once
    StringBuilder myCompleteMessage = new StringBuilder();    // Receive result variable
    int numberOfBytesRead = 0;
```

```
do
{
 numberof BytesRead = clientStream.Read( scandata, 0,   scandata.Length);
 / / Read TCPIP communication receive buffer
 myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(runanwser, 0,
numberOfBytesRead)); / / Write all the information stack read by the network port to the
receiving result variable }
 while (  scandata[numberOfBytesRead - 1] != 0x03);   / / Due to the multi-segment
PSH=1 segmented transmission, the end of the trailer (ETX, 03h) must be detected before
the reception is completed. This part of the content is very important for the complete
reception of the data packet
 if  ( myCompleteMessage [0]!=0x02 )
| | ( myCompleteMessage[myCompleteMessage.Length-1]!=0x03 )
 {
   / / 检测报头报尾，如果有错误进行数据包报错操作
  }
 / / You can continue to operate the acceptance information in myCompleteMessage to determine
further operations. The following continues to extract key instruction information, which may contain ETX,
STX, you need to further elaborate processing
 string result = myCompleteMessage.ToString();
 string[] split = result.Split(new char[] { ' '              });//   Split the text into N string
 arrays with spaces.
 TelegramCounter = split[7];  / / For example, communication timer (you can extract other information as needed)
 ScanCounter = split[8];       / / For example scan counter (you can extract other information as needed)
 int ii = 0      ;
 ii = int.Parse(split[25],
System.Globalization.NumberStyles.AllowHexSpecifier);//Hexadecimal to decimal, the
25th segment represents the number of measurement data.
 int   j = 0;//     Statistics of data
 for (int i = 26; i < ii + 26; i++)// Through this cycle, all the measured data are found.
 Although he has different lengths, the format of the spaces remains unchanged,
 which is the basis of the division.
 {
 split[i]=int.Parse(split[i],
System.Globalization.NumberStyles.AllowHexSpecifier).ToString(); }
 / / split[   i]  For the i-25th data split
 j++;//  J      Statistics of measured data.
 }
```

STEP 12 ’: Continuously request data.

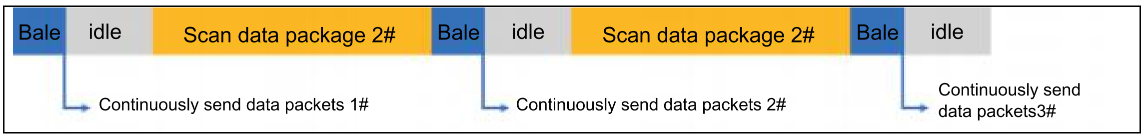
To request data continuously, your application needs to send the following communication request to the radar server:

<STX>sEN{SPC} LMDscandata{SPC} 1<ETX>		
02 73 45 4E 20 4C 4D 44 73 63 61 6E 64 61 74 20 61 31 03		
Header	<STX>	02
Data content	sEN	73 45 4E
	Space (SPC)	20
	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
	Space (SPC)	20
Start continuous ranging	1	31
Footer	<ETX>	03

After the radar receives the continuous data request, it will immediately reply the continuous mode confirmation command to your application, indicating that the radar has received the command from your client and enters the continuous ranging mode. for:

<STX>sEA{SPC} LMDscandata{SPC} 1<ETX>		
02 73 45 41 20 **4C 4D 44 73 63 61 6E 64 61 74 61** 20 31 03		
Header	<STX>	02
Data content	sEA	73 45 41
	空格（SPC）	20
	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
	空格（SPC）	20
Start continuous ranging	1	31
Footer	<ETX>	03

After that, we will continue to reply to you the data packets that have been packaged in the previous cycle, in continuous request mode. There is no delay in the data packet you receive. After the radar packs the data into the buffer, it immediately sends it to the application client as shown in the following figure:



For the format of each data frame, please refer to STEP14 (Request Data (Single)). If you need the radar to stop continuous ranging mode (stop continuously requesting data), you need to send a command to the radar, The instruction to stop continuously requesting data is:

<STX>sEN{SPC}LMDscandata{SPC}0<ETX>		
02 73 45 4E 20 4C 4D 44 73 63 61 6E 64 61 74 61 20 30 03		
Header	<STX>	02
Data content	sEN	73 45 4E
	Space (SPC)	20
	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
	Space (SPC)	20
Start continuous ranging	0	30
Footer	<ETX>	03

After the radar receives your stop command, it will immediately stop sending the next frame of data packets and send a confirmation stop command to your application client:

<STX>sEA{SPC}LMDscandata{SPC}0<ETX>		
02 73 45 41 20 **4C 4D 44 73 63 61 6E 64 61 74 61** 20 30 03		
Header	<STX>	02
Data content	sEA	73 45 41
	Space (SPC)	20
	LMDscandata	4C 4D 44 73 63 61 6E 64 61 74 61
	Space (SPC)	20
Confirm to stop continuous ranging	0	30
Footer	<ETX>	03

Read operation hours.

The radar internally contains a timer that can respond to the customer's inquiry time request. The timer records the cumulative operating time of the radar since it was shipped from the factory. This data cannot be reset or reset.

Read the power-on hours.

The radar contains a timer that can respond to the customer's inquiry time request. The timer records the cumulative running time of the radar since the current power-on. This data is cleared or reset every time the power is turned off. Single cumulative working time. Your application client needs to send the following instructions to the radar server:

<STX>sRN{SPC}ODpwrc<ETX>		
02 73 52 4E 20 4F 44 70 77 72 63 03		
Header	<STX>	02
Data content	sRN	73 52 4E
	Space (SPC)	20
	ODpwrc	**4F 44 70 77 72 63**
Footer	<ETX>	03

The radar will reply to you after receiving the order (eg 2999.7 hours):

<STX>sRA{SPC}ODpwrc{SPC}752D<ETX>		
02 73 52 41 20 4F 44 70 77 72 63 20 752D 03		
Header	<STX>	02
Data content	sRN	73 52 4E
	Space (SPC)	20
	ODpwrc	**4F 44 70 77 72 63**
	Space (SPC)	20
	29997 (2999.7 hours, unit is 0.1 hour)	752D (Note that this data is sent directly in hexadecimal data, not hexadecimal ASCII code) Data range 0000h-FFFFh
Footer	<ETX>	03

Set the internal time of the radar.

In order to facilitate you to confirm the specific moment when each packet of data is sent, we can attach the radar internal time when each packet of data is sent at the end of each packet of data (see below to set whether to send timestamp information) After the radar is powered on, configure it once to align with the time of your device. The specific configuration instructions are as follows:

<STX>sMN{SPC}LSPsetdatetime{SPC}7D9{SPC}2{SPC}11{SPC}10{SPC}22{SPC}0{SPC}0<ETX>(Configure the internal time of the radar as 2009.2.17 day 16:34:0 seconds 0 milliseconds)
02 73 4D 4E 20 4C 53 50 73 65 74 64 61 74 65 74 69 6D 65 20 37 44 39 20 32 20 31 31 20 31 30 20 32 32 20 30 20 30 03

Header	<STX>	02
Data content	sMN	73 4D 4E
	Space (SPC)	20
	LSPsetdatetime	4C 53 50 73 65 74 64 61 74 65 74 69 6D 65
Configurable content	Space (SPC)	20
	Year (7D9) (Hexadecimal)	37 44 39
	Space (SPC)	20
	Month (2) (Hexadecimal)	32
	Space (SPC)	20
	Date (11) (Hexadecimal)	31 31
	Space (SPC)	20
	Hour (10) (Hexadecimal)	31 30
	Space (SPC)	20
	Cent (22) (Hexadecimal)	32 32
	Space (SPC)	20
	Seconds (0) (hexadecimal)	30
	Space (SPC)	20
	Milliseconds (0) (hexadecimal)	30
Footer	<ETX>	03

After receiving the order, the radar will reply to you:

<STX>sAN{SPC}LSPsetdatetime{SPC}1<ETX>		
02 73 41 4E20 4C 53 50 73 65 74 64 61 74 65 74 69 6D 65 20 31 03		
Header	<STX>	02
Data content	sAN	73 41 4E
	Space (SPC)	20
	LSPsetdatetime	4C **53 50 73 65 74 64 61 74 65 74** 69 6D 65
Configurable area	Space (SPC)	20
	1：Successfully configured	31
Footer	<ETX>	03

It should be noted that before setting the radar internal time, it is necessary to send STEP5 (login device) to obtain the modification authority.

Setting login password.

In FO-SLS series radar, STEP5: The password for logging in to the device is configurable, but it must be under the condition of having authority after logging in. The factory default password is F4724744. In addition, the format of the new password must be consistent with the default password, which is an 8-digit hexadecimal number. The specific instructions are as follows (the password is changed to 1920E4C9):

<STX>sMN{SPC}SetPassword{SPC}03{SPC}1920E4C9<ETX>		
02 73 4D 4E 20 53 65 74 50 61 73 73 77 6F 72 64 20 30 33 20 31 39 32 30 45 34 43 39 03		
Header	<STX>	02
Data content	sMN	73 4D 4E
	Space (SPC)	20
	SetPassword	53 65 74 50 61 73 73 77 6F 72 64
Configurable area I	Space (SPC)	20
	Authority level (03)	30 33
Configurable area I	Space (SPC)	20
	New password (1920E4C9)	31 39 32 30 45 34 43 39
Footer	<ETX>	03

Radar will reply to you after receiving the instruction and modifying it successfully:

ASCII	<STX>sAN{SPC}SetPassword{SPC}1<ETX>
Hex	02 73 4D 4E 20 53 65 74 50 61 73 77 6F 72 64 20 31 03

Will reply to you if the modification fails

ASCII	<STX>sAN{SPC}SetPassword{SPC}0<ETX>
Hex	02 73 4D 4E 20 53 65 74 50 61 73 73 77 6F 72 64 20 30 03

It should be noted that before setting a new login password, you must send STEP5 (login device) to obtain the modification authority. After setting the new login password, you need to send a save command to solidify the current password to the radar to ensure the next time the radar Use the new password you currently set when powering on. Please refer to STEP11 for details of saving instructions.

Check the login password.

After setting the login password, under the condition of having authority (that is, the power is not turned off after the password is changed, and STEP12: logout instruction is not issued), you can currently check whether the current password is set correctly, such as checking whether the current password is set to 1920E4C9 The specific instructions are:

<STX>sMN{SPC}CheckPassword{SPC}03{SPC}1920E4C9<ETX>		
02 73 4D 4E 20 43 68 65 63 6B 50 61 73 73 77 6F 72 64 20 30 33 20 31 39 32 30 45 34 43 39 03		
Header	<STX>	02
Data content	sMN	73 4D 4E
	Space (SPC)	20
	CheckPassword	43 68 65 63 6B 50 61 73 73 77 6F 72 64
Configurable area I	Space (SPC)	20
	Authority level (03)	30 33
Configurable area I	Space (SPC)	20
	New password (1920E4C9)	31 39 32 30 45 34 43 39
Footer	<ETX>	03

Radar will respond to you if the command is received and the current password is 1920E4C9:

ASCII	<STX>sAN{SPC}CheckPassword{SPC}1<ETX>
Hex	02 73 4D 4E 20 43 68 65 63 6B 50 61 73 73 77 6F 72 64 20 31 03

If Radar receives the command and the current password is not 1920E4C9, it will reply to you:

ASCII	<STX>sAN{SPC}CheckPassword{SPC}0<ETX>
Hex	02 73 4D 4E 20 43 68 65 63 6B 50 61 73 73 77 6F 72 64 20 30 03

Set whether to send encoder information

Encoder information can be combined with application scenarios into speed, angle and other related information to meet specific application requirements. XD-TOF series in the case of single access or continuous access, the header of each data packet can contain encoder information, and in the case of authority, you can use this command to determine the subsequent data packet Whether it contains encoder information.

The command to set whether to send encoder information is:

<STX>sWN{SPC}LICswitch{SPC}1 (0) <ETX>		
02 73 57 4E 20 4C 49 43 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20

	LICswitch	4C 49 43 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: send encoder information 0: Do not send encoder information	31 30
Footer	<ETX>	03

After receiving the command, the radar will reply:

<STX>sRA{SPC}LICswitch{SPC}1(0) <ETX>		
02 73 52 41 20 4C 49 43 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sRA	73 52 41
	Space (SPC)	20
	LICswitch	4C 49 43 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: send encoder information 0: Do not send encoder information	31 30
Footer	<ETX>	03

It should be noted that before setting the encoder information, you need to send STEP5 (login device) to obtain the modification authority. After the setting is completed, you need to send a save command to solidify the current settings to the radar to ensure that you will be entered when the radar is next powered The status of the current setting. Please refer to STEP11 for details of saving instructions.

In addition, you can also query whether the current message contains encoder information through the command,The command to query whether the

<STX>sRN{SPC}LICswitch<ETX>
02 73 52 4E 20 4C 49 43 73 77 69 74 63 68 03

The reply is the same as the reply after setting.

Set whether to send timestamp information.

In the case of single access or continuous access, the XD-TOF series can contain timestamp information at the end of each data packet (for details, see setting the radar internal time above). This instruction determines whether the timestamp information is included in the subsequent data message. The

<STX>sWN{SPC}Timepswitch{SPC}1 (0) <ETX>		
02 73 57 4E 20 54 69 6D 65 70 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	Timepswitch	54 69 6D 65 70 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: send encoder information 0: Do not send encoder information	31 30
Footer	<ETX>	03

After receiving the command, the radar will reply:

<STX>sRA{SPC}Timepswitch{SPC}1 (0) <ETX>		
02 73 52 41 20 54 69 6D 65 70 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sRA	73 52 41
	Space (SPC)	20
	Timepswitch	54 69 6D 65 70 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: send encoder information 0: Do not send encoder information	31 30
Footer	<ETX>	03

It should be noted that before setting the timestamp information, you must send STEP5 (login device) to obtain the modification authority. After the setting is completed, you need to send a save command to solidify the current settings to the radar to ensure that you will be entered when the radar is next powered on The status of the current setting. Please refer to STEP11 for details of saving instructions.

In addition, you can also query whether the current message contains timestamp information through the command,

<STX>sRN{SPC}Timepswitch<ETX>
02 73 52 4E 20 54 69 6D 65 70 73 77 69 74 63 68 03

The reply is the same as the reply after setting.

Set whether to send pulse intensity information.

In the case of continuous access, XD-TOF series can send an additional packet of pulse strength information (RSSI1) corresponding to the distance information (DIST1) after each data message , Whether the pulse intensity information is sent or not can be determined by specific instructions
The command to set the message pulse intensity information is:

<STX>sWN{SPC}Rssiswitch{SPC}1(0) <ETX>		
02 73 57 4E 20 52 73 73 69 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	Rssiswitch	52 73 73 69 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: send encoder information 0: Do not send encoder information	31 30
Footer	<ETX>	03

After receiving the command, the radar will reply:

<STX>sRA{SPC}Rssiswitch{SPC}1 (0) <ETX>		
02 73 52 41 20 52 73 73 69 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sRA	73 52 41
	Space (SPC)	20
	Rssiswitch	52 73 73 69 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: send encoder information 0: Do not send encoder information	31 30
Footer	<ETX>	03

It should be noted that before setting the pulse intensity information, you need to send STEP5 (login device) to obtain the modification authority. After the setting is completed, you need to send a save command to solidify the current settings to the radar to ensure that you will enter the next time the radar is powered on The status of the current setting. Please refer to STEP11 for details of saving instructions.

In addition, you can also query whether the pulse intensity information is currently sent through the command, The command to query the pulse intensity information of the message is:

<STX>sRN{SPC}Rssiswitch<ETX>
02 73 52 4E 20 52 73 73 69 73 77 69 74 63 68 03

The reply is the same as the reply after setting.

Set whether to send secondary echo information.

In the case of continuous access, the XD-TOF series can send an additional packet of secondary echo information (DIST2) data message corresponding to the distance information (DIST) after each data message.

If the pulse intensity information is currently sent, then a packet of pulse intensity information (RSSI2) will follow the second echo information, which means that there will be four packets of data DIST1, RSSI1, DIST2, and RSSI2.

<STX>sWN{SPC}Echoswitch{SPC}1 (0) <ETX>		
02 73 57 4E 20 45 63 68 6F 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	Echoswitch	45 63 68 6F 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: Send secondary echo information 0: Do not send secondary echo information	31 30
Footer	<ETX>	03

After receiving the command, the radar will reply:

<STX>sRA{SPC}Echoswitch{SPC}1 (0) <ETX>		
02 73 52 41 20 45 63 68 6F 73 77 69 74 63 68 20 31 (30) 03		
Header	<STX>	02
Data content	sRA	73 52 41
	Space (SPC)	20
	Echoswitch	45 63 68 6F 73 77 69 74 63 68
Configurable area I	Space (SPC)	20
	1: Send secondary echo information	31

	0: Do not send encoder information	30
Footer	<ETX>	03

It should be noted that before setting the pulse secondary echo, you must send STEP5 (login device) to obtain the modification authority. After the setting is completed, you need to send a save command to solidify the current settings to the radar to ensure that the radar will enter when it is powered on next time. The status of your current settings. Please refer to STEP11 for details of saving instructions.

In addition, you can also query whether the second echo information is currently sent through the command,The command to query the secondary echo information is:

<STX>sRN{SPC}Echoswitch<ETX>
02 73 52 4E20 45 63 68 6F 73 77 69 74 63 68 03

The reply is the same as the reply after setting.

Set the alarm area.

The XD-TOF series can set the alarm area through commands. When an object appears in the alarm area, the radar will act as a relay (requires an external voltage source). Due to the interface limitation, at present, only three alarm areas can be set inside the radar. The alarm area can be input by entering the

instruction	<STX>sWN{SPC} Alarmarea{SPC}0{SPC}4{SPC}2D{SPC}314{SPC}3D{SPC} 414{SPC}4D {SPC}514{SPC}5D{SPC}614<ETX>	
Actually send instructions	02 73 57 4E20 41 6C 61 72 6D 61 72 65 61 20 30 20 34 20 32 44 20 33 31 34 20 33 44 20 34 31 34 20 34 44 20 35 31 34 20 35 44 20 36 31 34 03	
Header	<STX>	02
Data content	sWN	73 57 4E
	Space (SPC)	20
	Alarmarea	41 6C 61 72 6D 61 72 65 61
Configurable area I	Space (SPC)	20
	0 (alarm area number, can be 0,1,2)	30
	Space (SPC)	20

Optional configuration II	4 (the number of points used to demarcate the alarm area, currently only 4)	34
	Space (SPC)	20
Optional configuration III	45 (meaning 45°, the first point angle, the selectable range is 0° to 360°)	32 44
	Space (SPC)	20
	788 (meaning 788mm, the distance from the first point to the radar, the selectable range is 0 to the maximum measurement distance of the radar)	33 31 34
	Space (SPC)	20
Optional configuration IV	61 (meaning 61°, the second point angle, the selectable range is 0° to 360°)	33 44
	Space (SPC)	20
	1044 (meaning 1044mm, the distance from the second point to the radar, the selectable range is 0 to the maximum measurement distance of the radar)	34 31 34
	Space (SPC)	20
Optional configuration V	77 (meaning 77°, the third point angle, the selectable range is 0° to 360°)	34 44
	Space (SPC)	20
	1300 (meaning 1300mm, the distance from the third point to the radar, the selectable range is 0 to the maximum measurement distance of the radar)	35 31 34

	Space (SPC)	20
Optional configuration VI	93 (meaning 93°, the fourth point angle, the selectable range is 0° to 360°)	35 44
	Space (SPC)	20
	1556 (meaning 1556mm, the distance from the fourth point to the radar, the selectable range is 0 to the maximum measurement distance of the radar)	36 31 34
Footer	<ETX>	03

It should be noted that before setting the pulse alarm area, it is necessary to send STEP5 obtain the modification authority,

If the alarm zone is set successfully, your application will receive:

ASCII	<STX>sRN{SPC}Alarmarea{SPC}1<ETX>
Hex	02 73 52 4E 20 41 6C 61 72 6D 61 72 65 20 31 03

4.3 Operation routine

To help you further understand our communication protocol, we will provide you with a general operation routine. First of all, we introduce the communication regulations and writing methods and methods of XD-TOF series radar, and finally attach a paragraph of routines and notes to establish communication with the radar for your reference.

The communication routine between the TCP/IP mode client and the radar (the specific statement may change with the development environment and development language, please consider it yourself)

(1) Connect with the device

TcpClient tcpClient = new TcpClient();
_tcpClient = tcpClient;
string ip = 192.169.1.121;
int port = 2111;
tcpClient.Connect(ip, port);

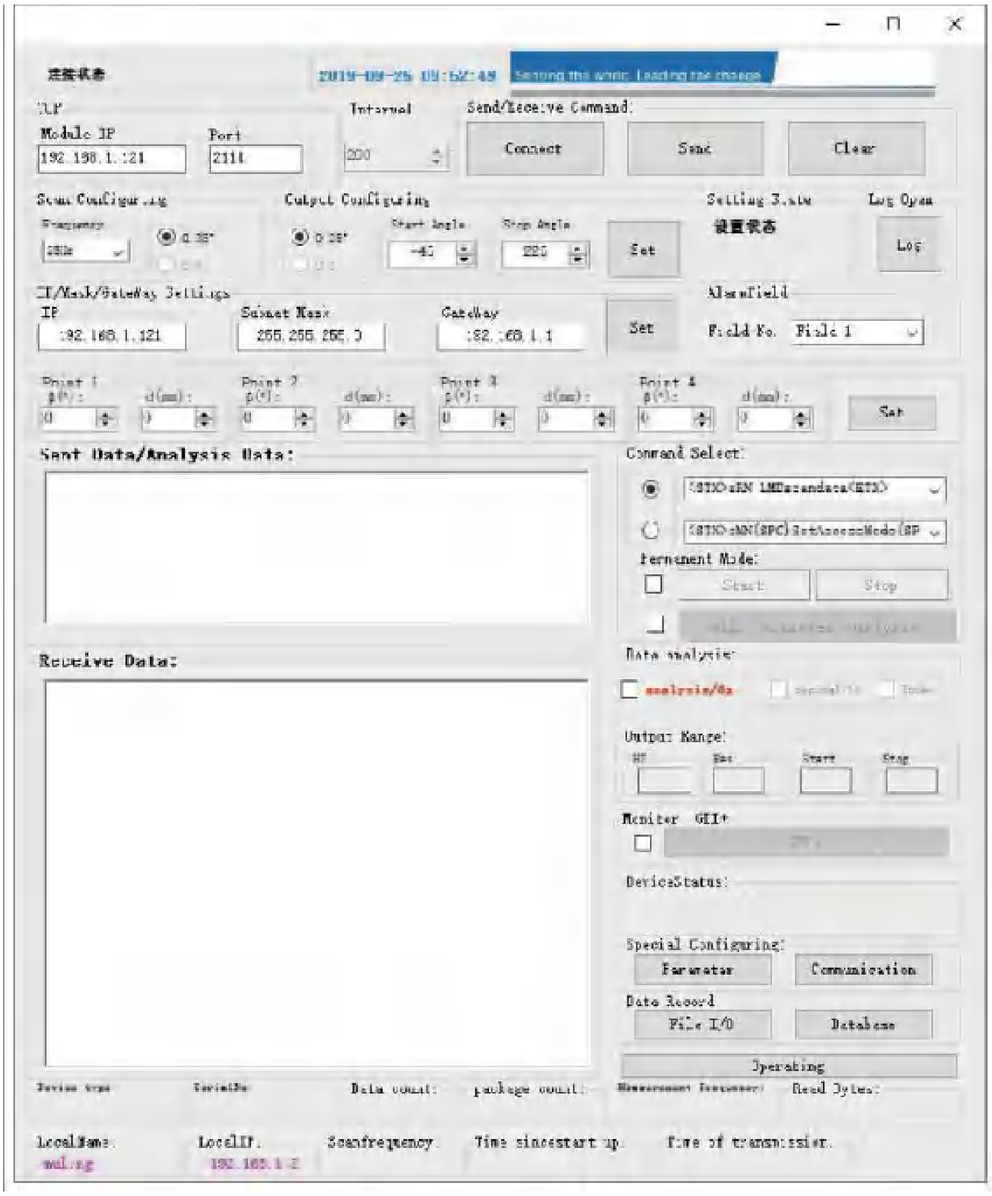
(2) Log in to the device
byte[] loginlidar ={ 0x02, 0x73, 0x4D, 0x4E, 0x20, 0x53, 0x65, 0x74, 0x41, 0x63, 0x63, 0x65, 0x73, 0x73, 0x4D, 0x6F, 0x64, 0x65, 0x20, 0x30, 0x33, 0x20, 0x46, 0x34, 0x37, 0x32, 0x34, 0x37, 0x34, 0x34, 0x03 }; clientStream.Write(loginlidar , 0, loginlidar .Length) ; if (clientStream.CanRead)

```
{
    byte[]    loginanswer   = new byte[1024];
    StringBuilder myCompleteMessage = new StringBuilder();
    int numberOfBytesRead = 0;
    do
    {
      numBytesRead = clientStream.Read(loginanswer , 0,    loginanswer .Length);
    myCompleteMessage.AppendFormat("{0}",Encoding.ASCII.GetString(myReadBuffer,
0,   numberOfBytesRead));

                                        }
                                        while (clientStream.DataAvailable);
```

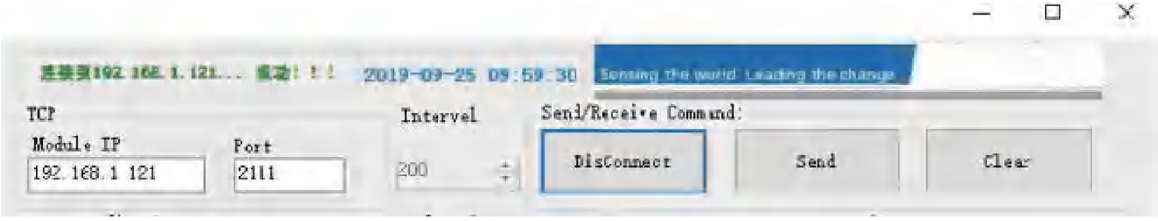
4.4 Client application

In order to facilitate your further understanding of our products, we provide the XD-TOF-XX client application. You can intuitively observe the radar data communication, scanning process, scanning results and other information through the application. You can request the application from our sales or technical staff. We will attach additional tutorials to ensure that you use this client application correctly. After the client program opens, you will see the interface as shown below:

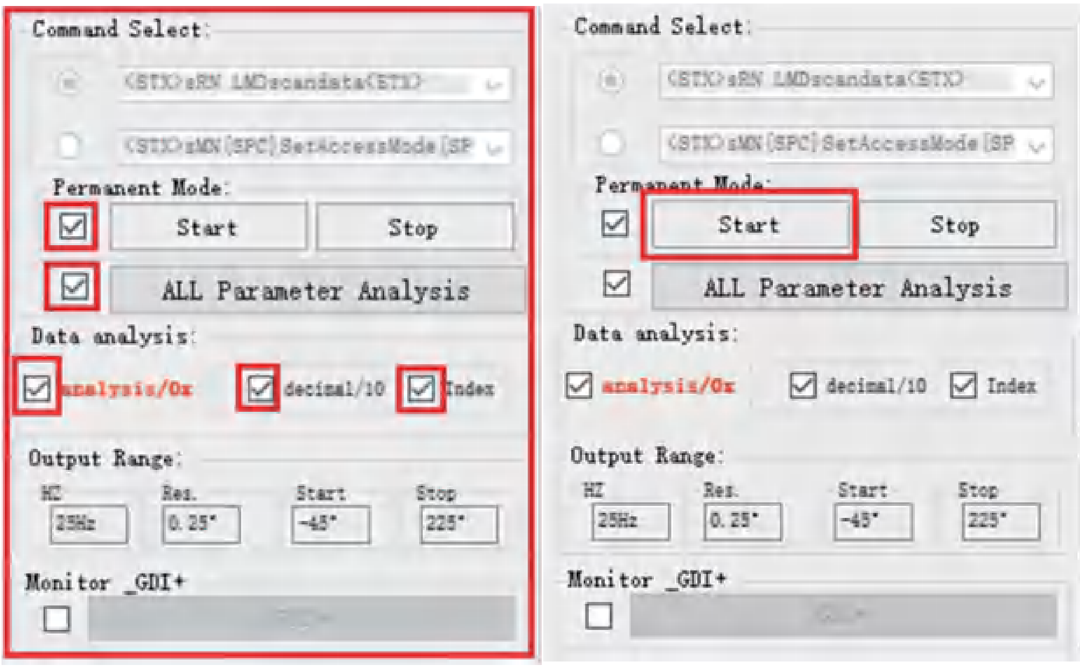


Step1: Set ip and connect. The default IP of the radar is 192.168.1.121 and the port is 2111. Please set the local computer ip, dns and corresponding gateway correctly. Then click "Connect",

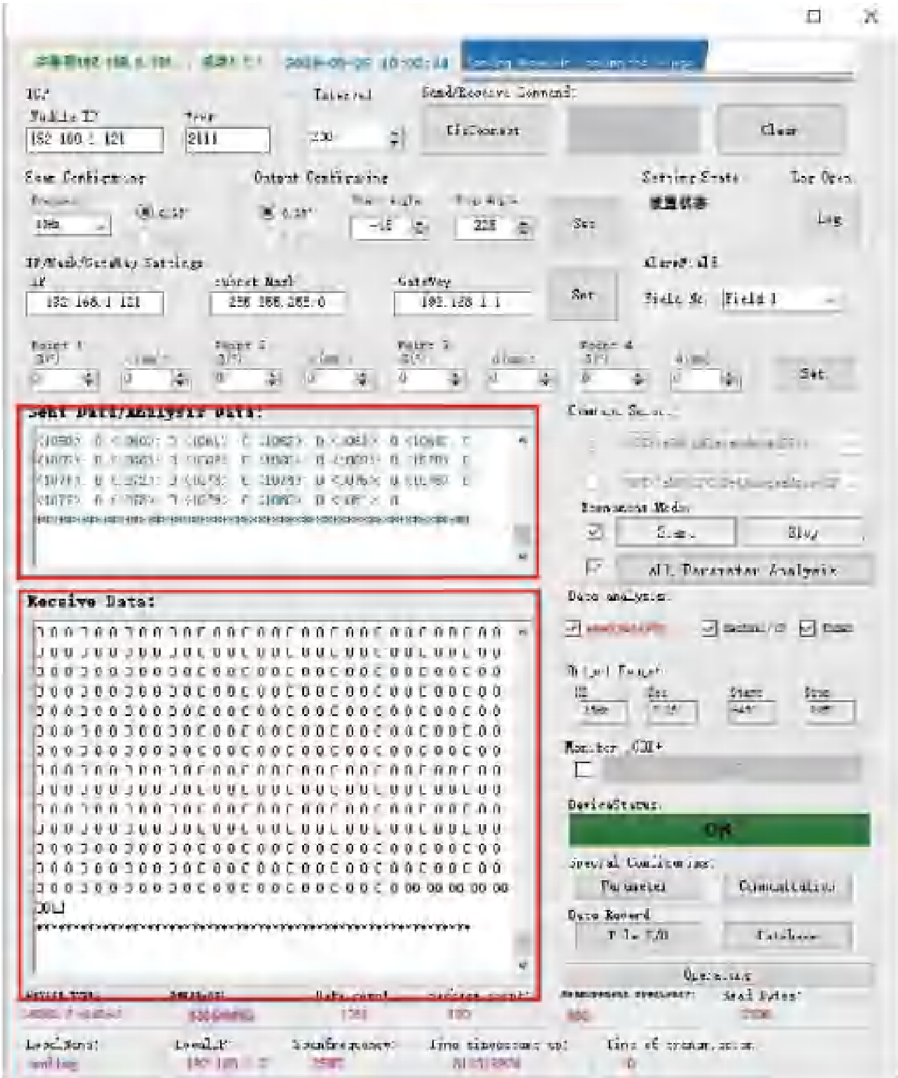
After successful connection, the upper left shows successful connection:



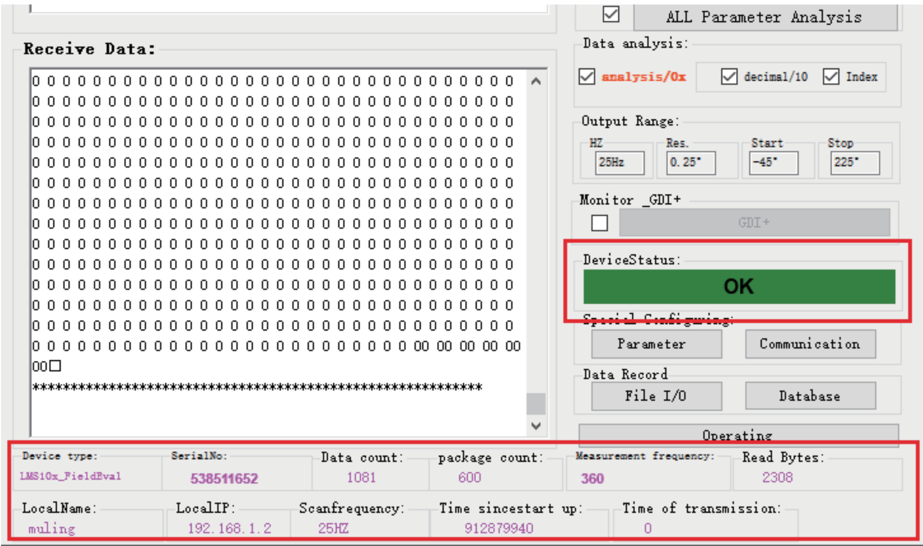
Check all the options in Permanent Mode and Data analysis, and then click the "Start" button,



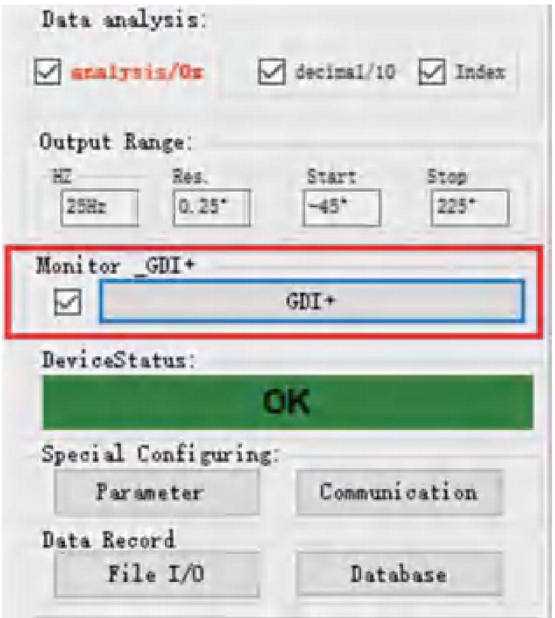
You will see the data sent by the radar to the host computer software (Sent Data) and the data received by the host computer software (Receive Data):



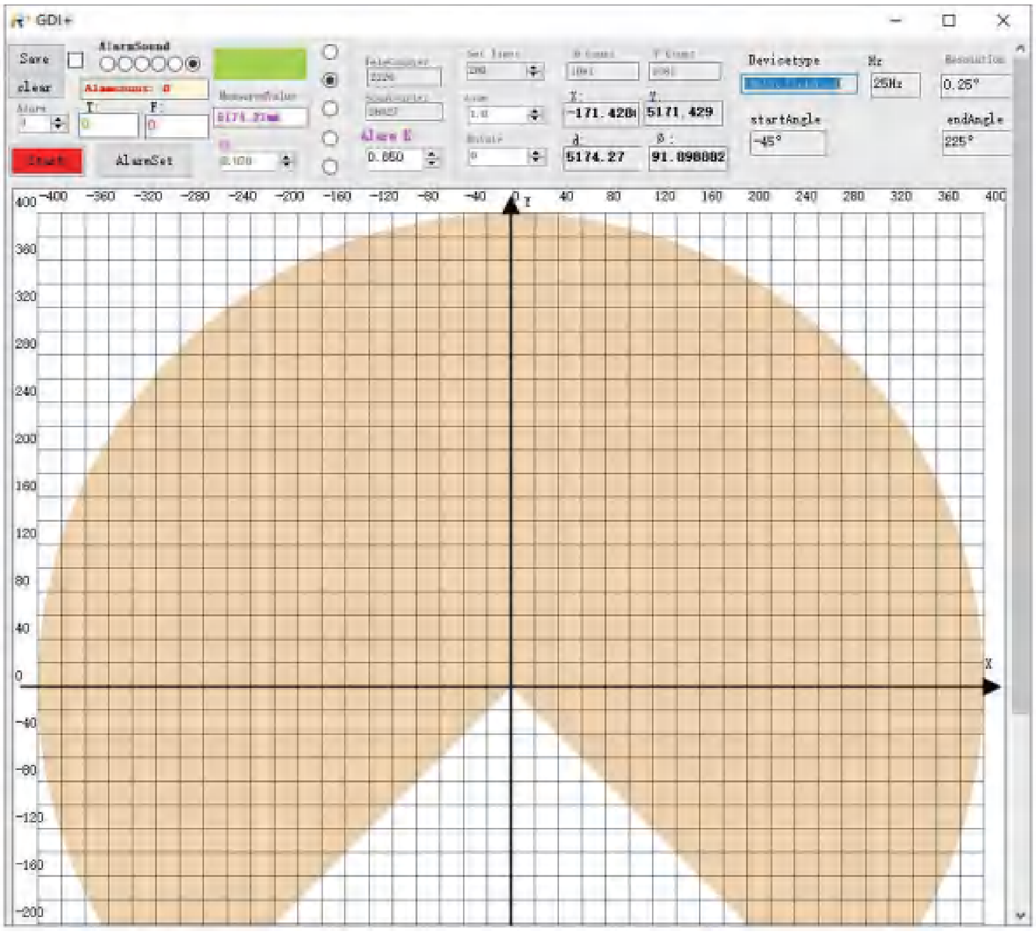
The radar status indicator (DeviceStatus) will display "OK", "pollution", "Error" and other status, and will display related information at the lower end:



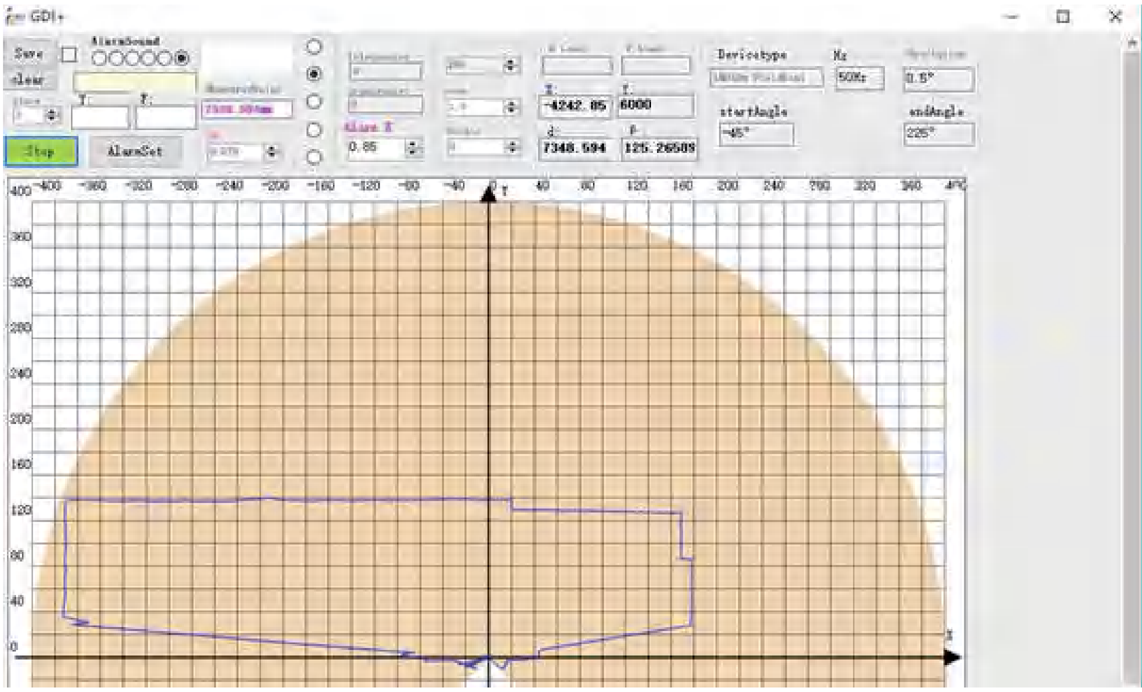
Check the GDI dialog box (Monitor_GDI+), and then click the "GDI" button



A new dialog box pops up:

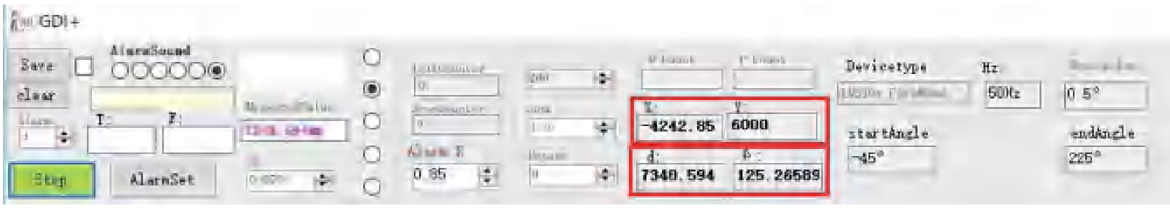


Click "start" to start drawing the scanning outline. The original start button turns green and switches to display as stop:

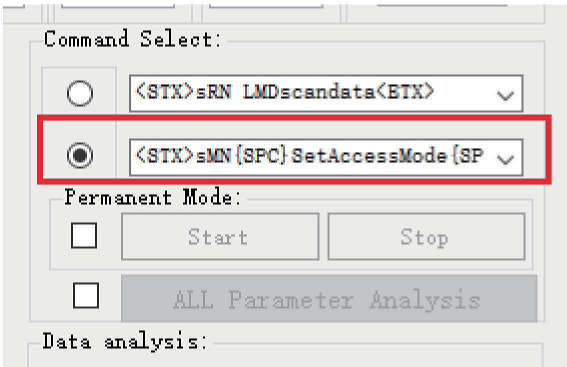


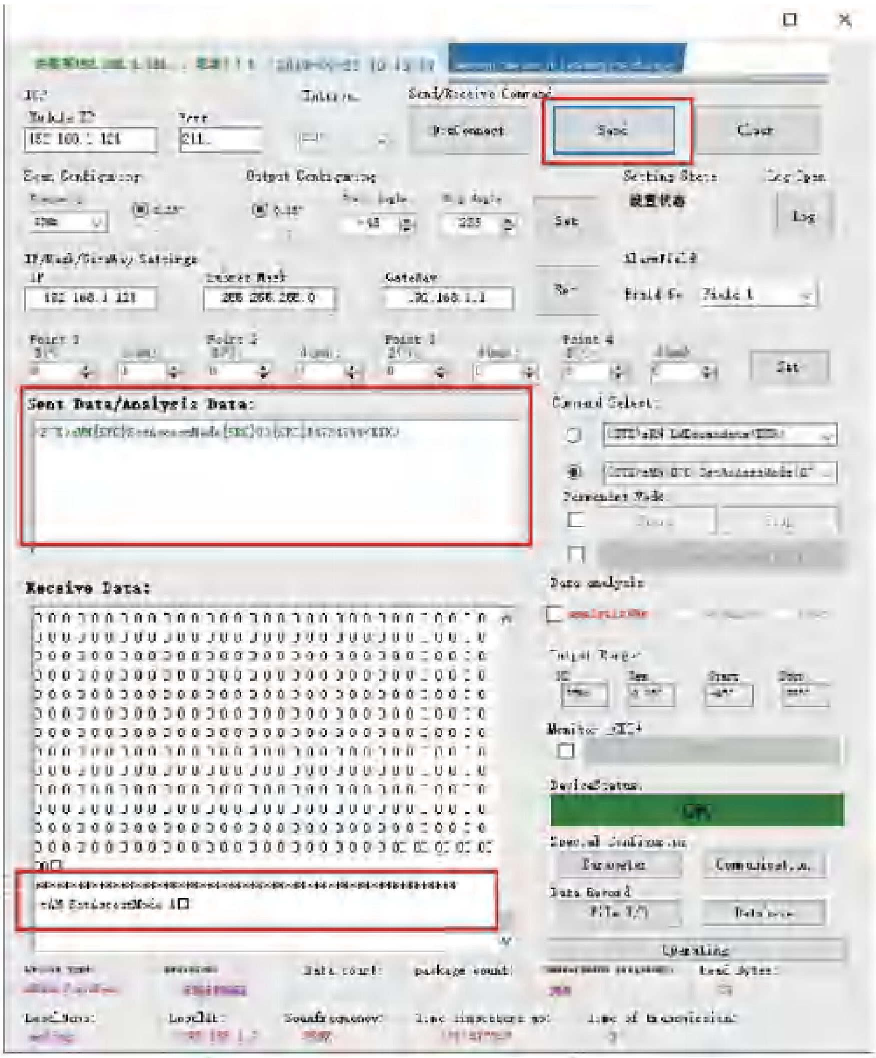
You can change the color and form of the scan image by changing the selection button shown below

The following figure indicates the X and Y coordinates of the mouse position, the distance (d) from the origin (radar center axis), and the azimuth (β) information:

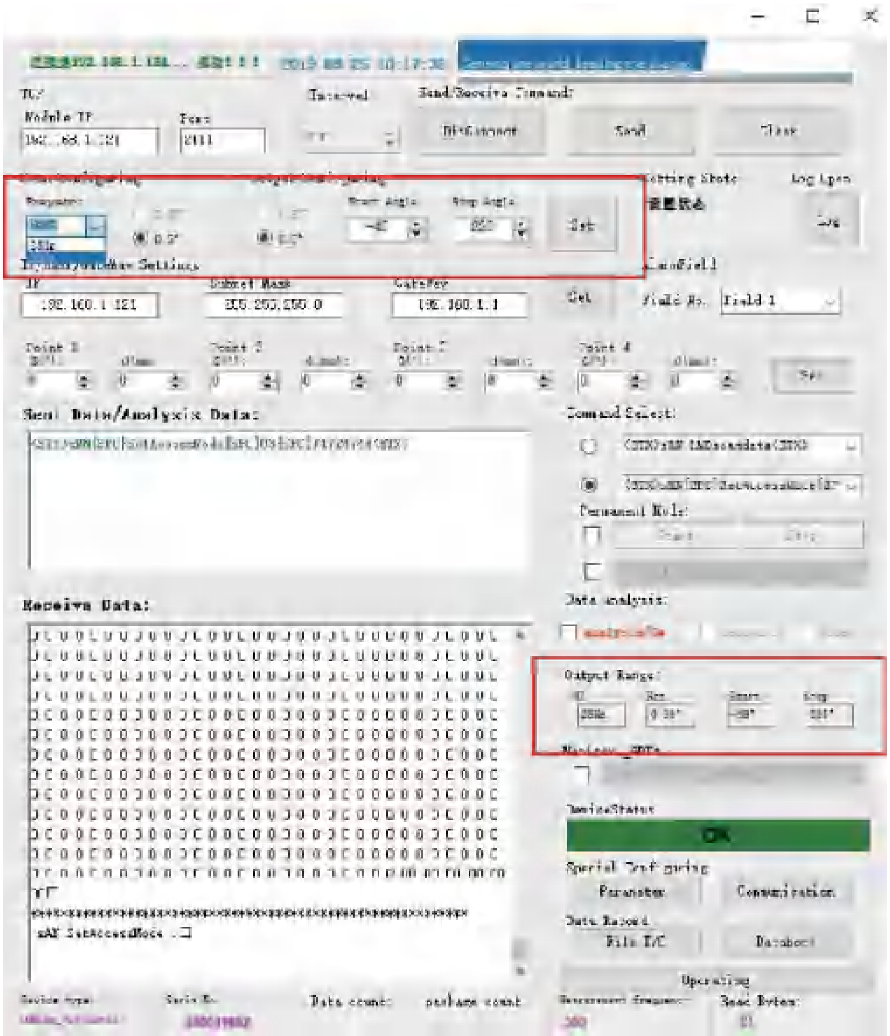


Next is a demonstration of advanced software features:
Click the second item in the instruction selection box, and select the login instruction in the drop-down instruction (the default is login), and click the send button above, the login instruction is displayed in the send box, and the radar response is displayed in the receiving box:

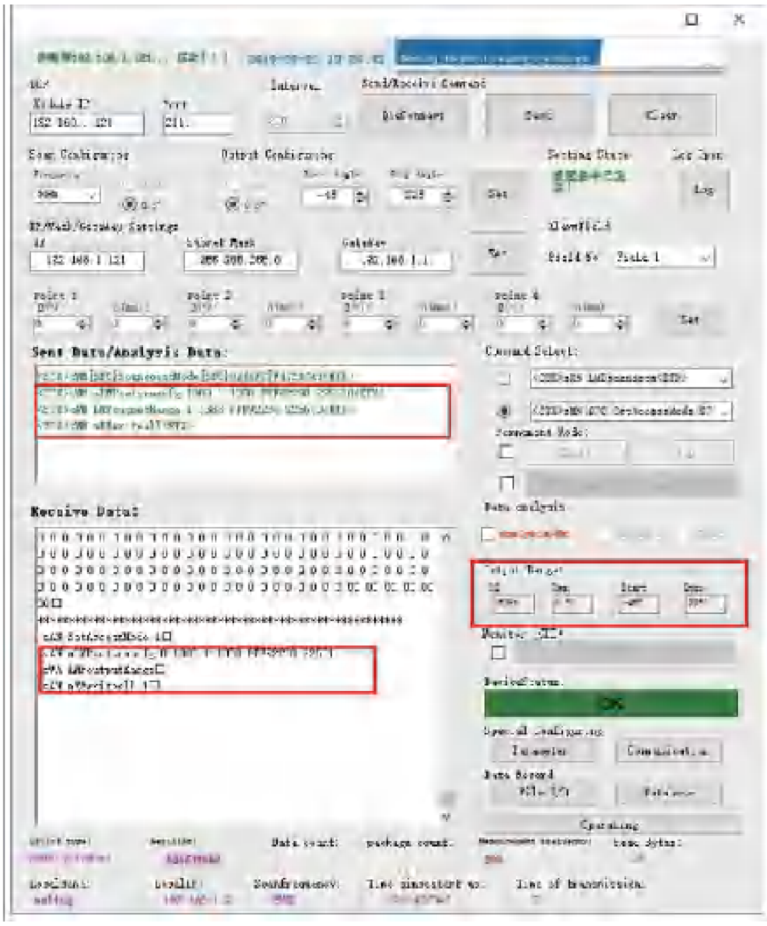




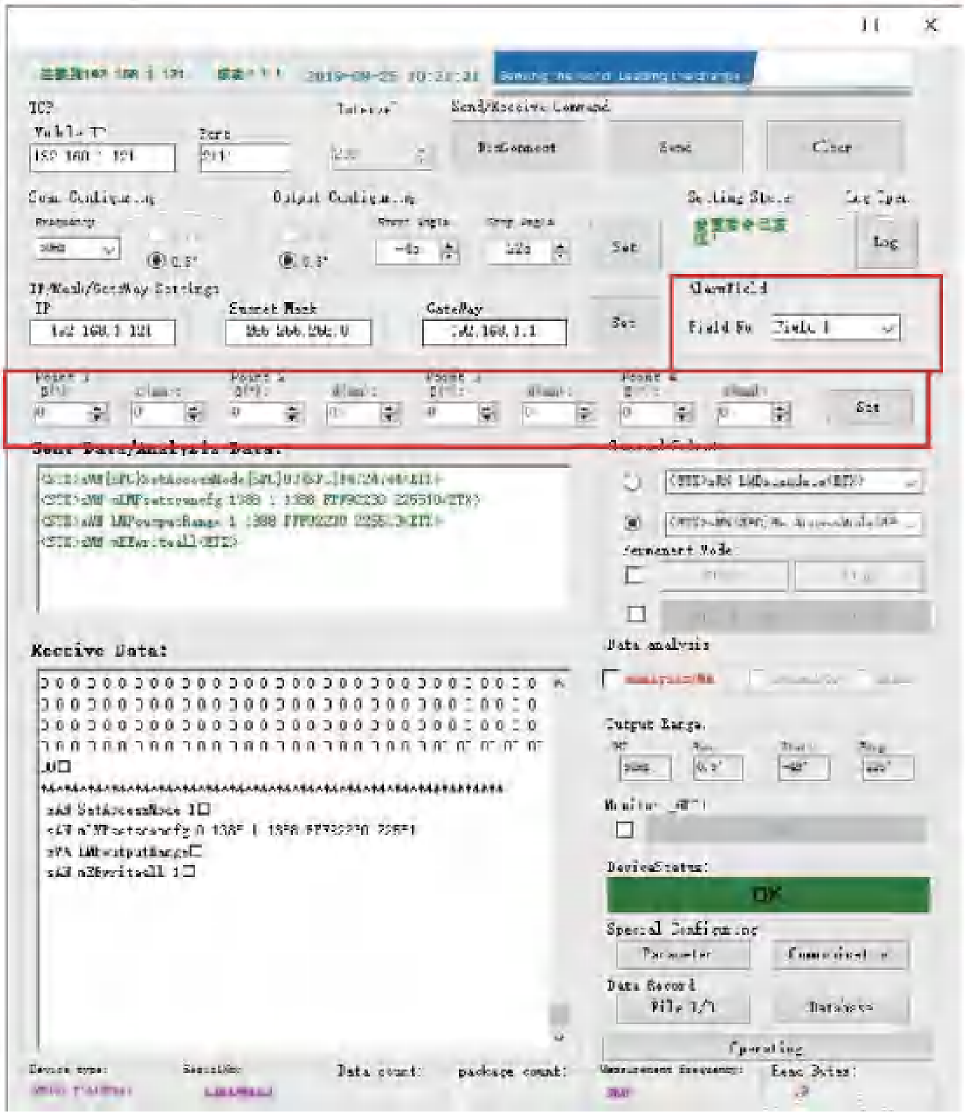
On the basis of logging in to the radar device, you can set the radar scanning parameters, IP address, gateway, subnet mask, and radar alarm area. In the output angle bar at the lower right corner, you can see the current scanning parameters of the radar. Two options of 25Hz and 50Hz can be found in the scan configuration bar of the angle. On the right is the configuration of the start angle and end angle of the radar. Select 50Hz and click the Set button on the right:


Module IP
Send/Receive Command
DisConnect
Send
Clear
Set
IP
Subnet Mask
Field 1
Receive Data:
Command Select:
Data analysis:
Output Range:
OK
Parameter
Communication
Data Record
File I/O
Database
Operating

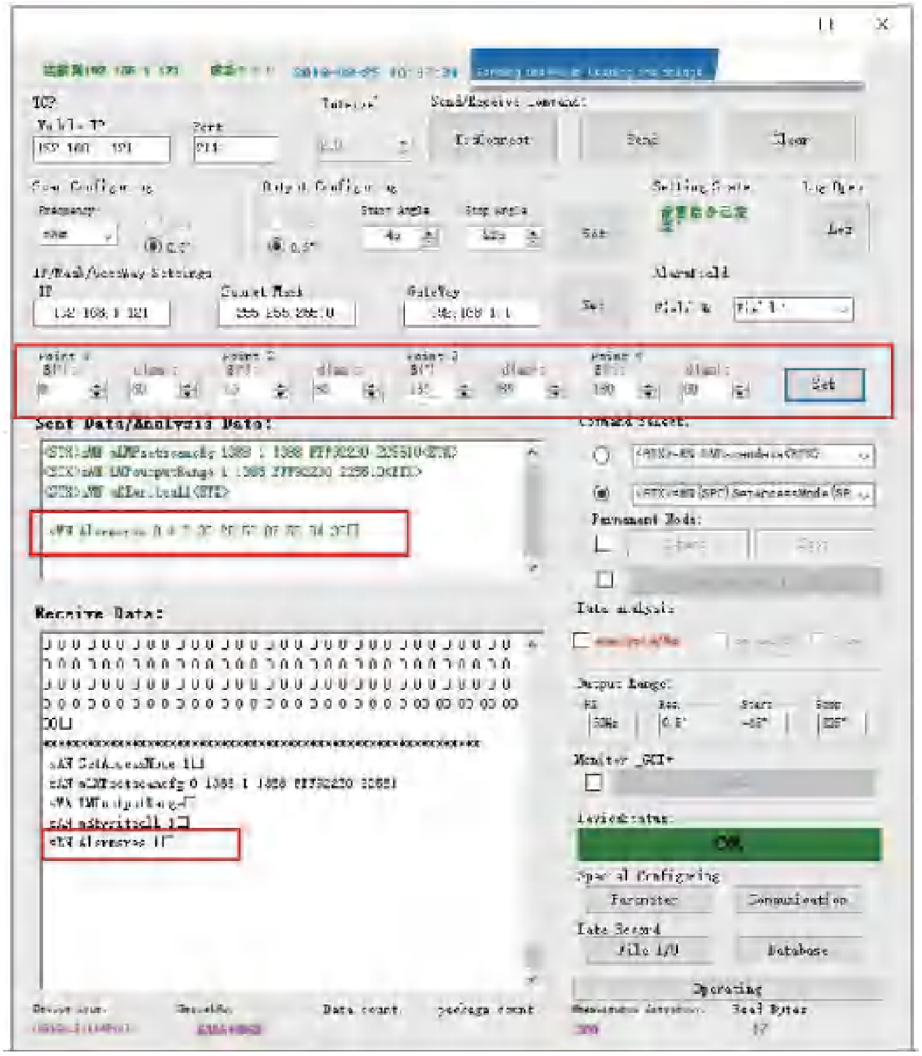
It can be found in the sending box that the software sent three instructions: modify the radar scanning frequency, modify the radar scanning start angle and end angle, and save the configuration; in the accept box, they also received the response data returned by the radar, and the radar output angle on the right The current configuration is also shown in:



Next is the configuration of the radar warning area:

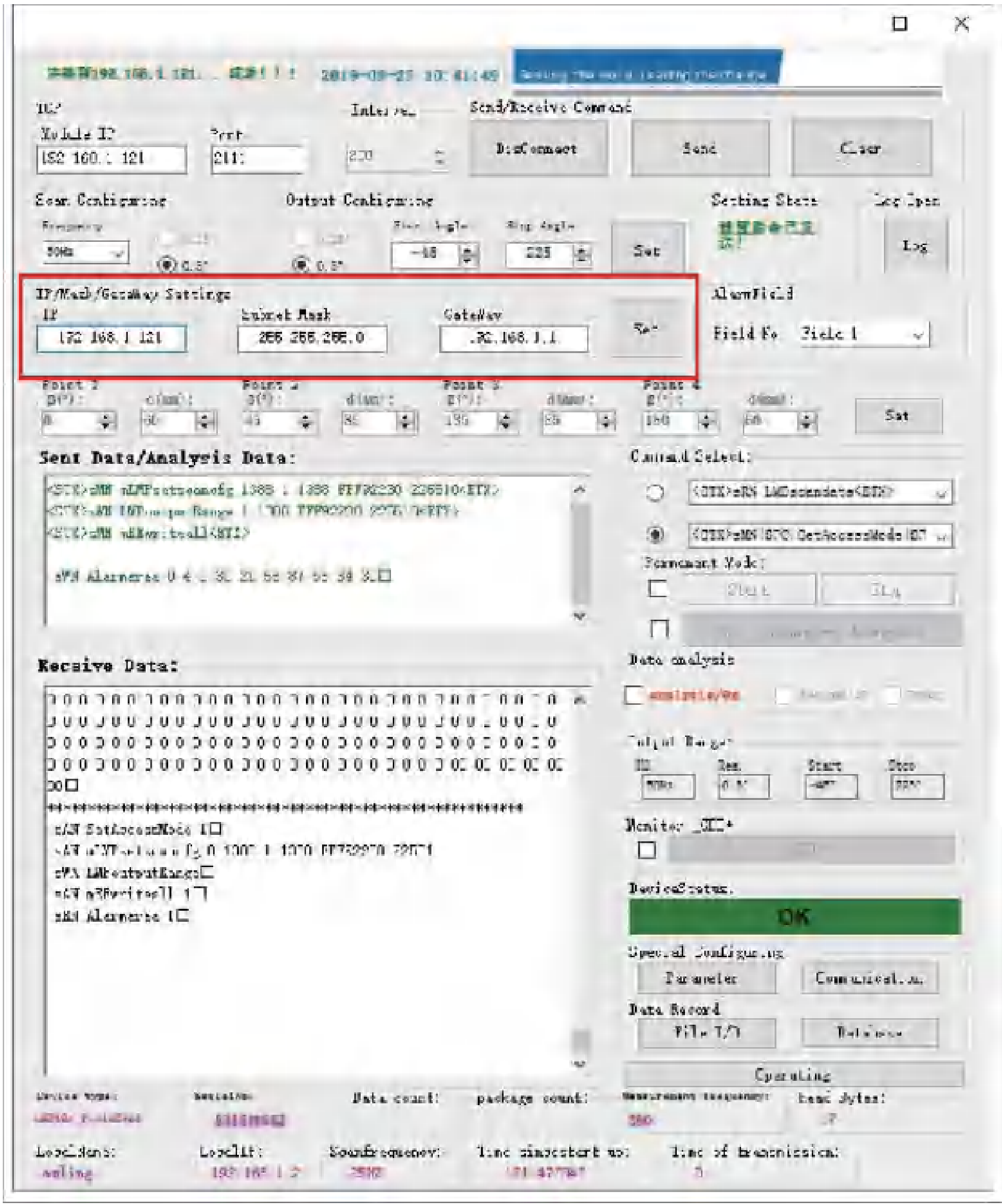


The XD-TOF-XX radar has 7 warning areas, each of which is delimited by a quadrilateral formed by 4 points defined by polar coordinates. Select the alarm area to be configured in the area selection, enter the polar coordinates of each point (the distance unit is mm) below, and click set to set successfully:

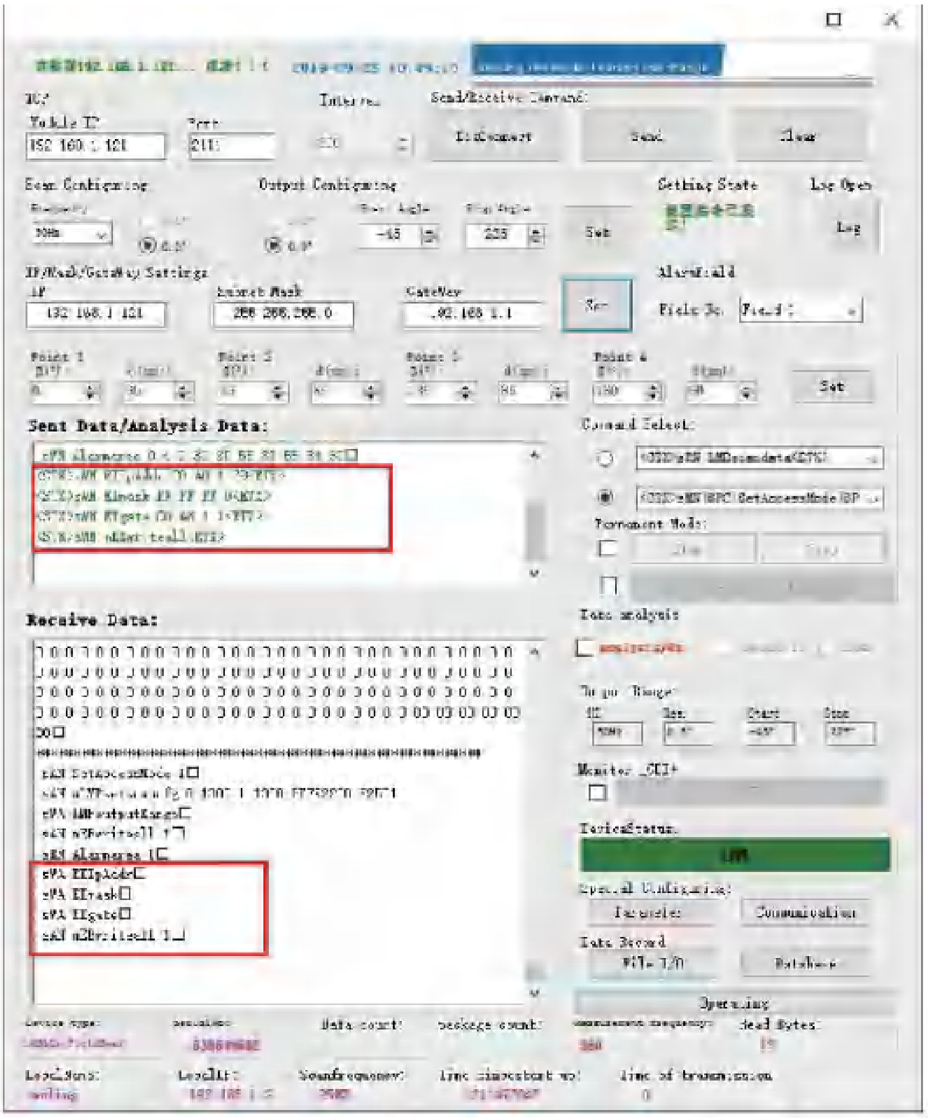


In the sending box, you can see the command sent by the radar to set the area alarm. In the receiving box, you receive a reply that the radar has successfully configured the No. 1 alarm area.

Next is the modification of the IP address:

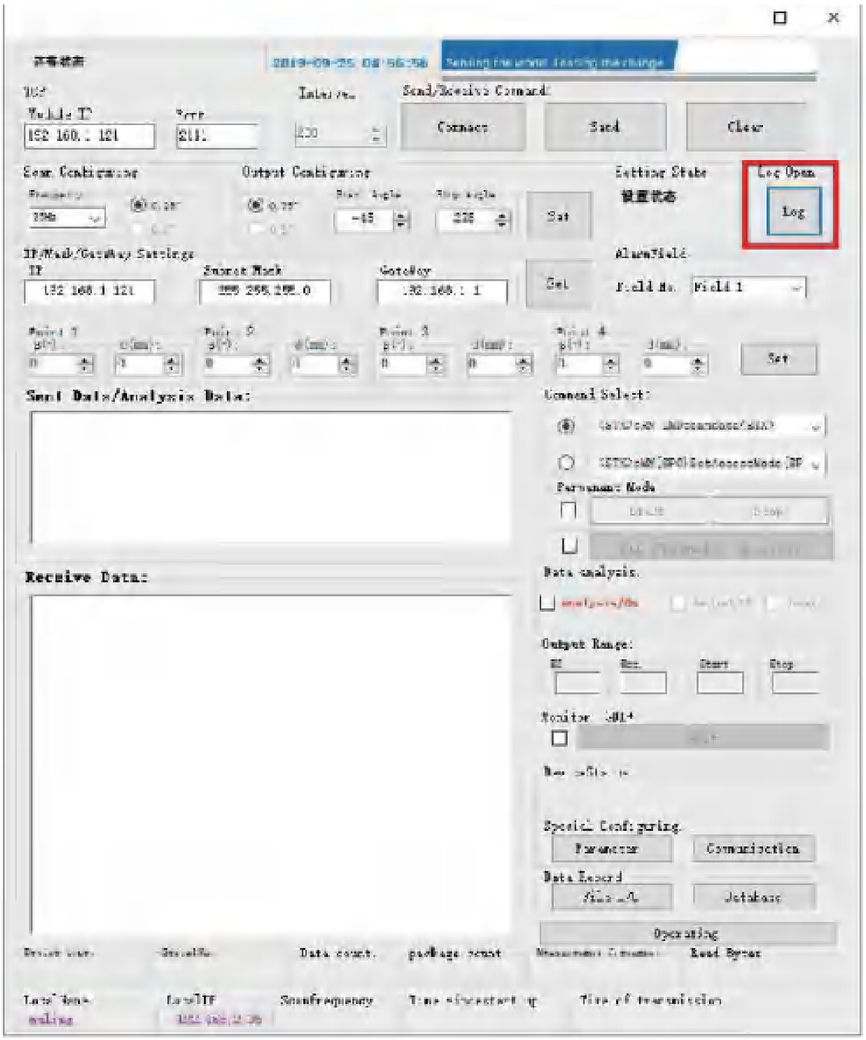


Enter the IP, mask and gateway to be configured in the box marked with red, and click set on the right to configure:



In the sending box, you can see that the software sent four instructions: modify IP, modify mask, modify gateway and save configuration. Radar also made a correct response to indicate successful configuration. However, these network-related configurations take effect only after the radar is powered off, and require you to make corresponding modifications to the local IP, mask, and gateway to successfully connect.

Operation log function:



The host computer software will generate a log folder in the FocusRay-log folder on the C drive of the computer and generate a file based on the radar serial number. The log file is an important basis for reconnecting the radar when an IP setting error occurs:

```
2019-09-25 10:03:26--->20190924--->&lt;STX&gt;sRN LMDscandata&lt;ETX&gt;
2019-09-25 10:04:27--->20190924--->&lt;STX&gt;sRN LMDscandata&lt;ETX&gt;
2019-09-25 10:05:28--->20190924--->&lt;STX&gt;sRN LMDscandata&lt;ETX&gt;
2019-09-25 10:06:31--->20190924--->&lt;STX&gt;sRN LMDscandata&lt;ETX&gt;
2019-09-25 10:07:32--->20190924--->&lt;STX&gt;sRN LMDscandata&lt;ETX&gt;
2019-09-25 10:08:33--->20190924--->&lt;STX&gt;sRN LMDscandata&lt;ETX&gt;
2019-09-25 10:13:10--->20190924--->&lt;STX&gt;sMN{SPC}SetAccessMode{SPC}03{SPC}F4724744&lt;ETX&gt;
2019-09-25 10:21:03--->20190924--->&lt;STX&gt;sMN mLMPsetscancfg 1388 1 1388 FFF92230 225510&lt;ETX&gt;
2019-09-25 10:21:03--->20190924--->&lt;STX&gt;sWN LMPoutputRange 1 1388 FFF92230 225510&lt;ETX&gt;
2019-09-25 10:21:03--->20190924--->&lt;STX&gt;sMN mEEwriteall&lt;ETX&gt;
2019-09-25 10:21:03--->20190924--->&lt;STX&gt;sRN LMPscancfg&lt;ETX&gt;
2019-09-25 10:21:03--->20190924--->&lt;STX&gt;sRN{SPC}LMPoutputRange&lt;ETX&gt;
2019-09-25 10:21:45--->20190924--->&lt;STX&gt;sMN mLMPsetscancfg 1388 1 1388 FFF92230 225510&lt;ETX&gt;
2019-09-25 10:21:45--->20190924--->&lt;STX&gt;sWN LMPoutputRange 1 1388 FFF92230 107740&lt;ETX&gt;
2019-09-25 10:21:45--->20190924--->&lt;STX&gt;sMN mEEwriteall&lt;ETX&gt;
2019-09-25 10:21:45--->20190924--->&lt;STX&gt;sRN LMPscancfg&lt;ETX&gt;
2019-09-25 10:21:45--->20190924--->&lt;STX&gt;sRN{SPC}LMPoutputRange&lt;ETX&gt;
2019-09-25 10:21:54--->20190924--->&lt;STX&gt;sMN mLMPsetscancfg 1388 1 1388 FFF92230 225510&lt;ETX&gt;
2019-09-25 10:21:54--->20190924--->&lt;STX&gt;sWN LMPoutputRange 1 1388 FFF92230 225510&lt;ETX&gt;
2019-09-25 10:21:54--->20190924--->&lt;STX&gt;sMN mEEwriteall&lt;ETX&gt;
2019-09-25 10:21:54--->20190924--->&lt;STX&gt;sRN LMPscancfg&lt;ETX&gt;
2019-09-25 10:21:54--->20190924--->&lt;STX&gt;sRN{SPC}LMPoutputRange&lt;ETX&gt;
2019-09-25 10:37:21--->20190924---> sWN Alarmarea 0 4 0 1C 20 55 97 55 B4 3C
2019-09-25 10:49:04--->20190924--->&lt;STX&gt;sWN EIIpAddr C0 A8 1 79&lt;ETX&gt;
```

CYNDAR

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