

AKUSENSE

AS-21C User Manual



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1. Document Description

1.1 Reminder

This manual provides methods and precautions for proper use of the AS-21C LiDAR product. In order to use this product safely, users should also pay attention:

- Obey the necessary safety production guidelines.
- Follow the AS-21C workplace safety regulations and general safety regulations.

This manual is intended for electrical and electronics professionals.

Important note

Before operating the AS-21C, please read this manual carefully to familiarize yourself with the features and functions of the AS-21C.

This manual does not cover the use of other equipment and equipment in the installation and use of the AS-21C. If you need this information, please read the documentation for such equipment.

1.2 Content Description

This manual is intended to provide technicians with information on the installation, electrical connections, equipment configuration, and maintenance of the AS-21C. Please read the sections of this manual in order. The contents of this manual (in order) include:

- Basic operation and precautions
- Product manual
- Product application
- Device installation
- Electrical Installation
- Device Configuration
- Equipment maintenance
- Troubleshooting
- Specifications

Table 1.1 Product basic information

Working environment	Indoor / outdoor
Light source	Infrared laser (905nm)
Laser safety Class	Class 1 (GB 7247.1-2012, human eye safety)

Scan angle range	300° (-60°~+240°)
Scanning frequency	25Hz(system default)/12.5Hz/6.25Hz
Scan angle resolution	0.5°(system default)/0.25°/0.125°
Measuring range	0.1m~20m
10% reflectance range	15m
Built-in application	Regional monitoring
Operating Voltage	10V~30V DC
Power consumption	3.4W(Measuring) , 7.6W@DC12V / 6W@DC24V (Heating)
Shell Protection Class	IP65 (GB 4208-2008)
Weight	0.6Kg
Dimension (L × W × H)	83.5×85×104.9(mm)
Working temperature range	-25°C~+50°C
Storage temperature range	-30°C~+70°C
Ambient illumination range	≤80,000lux

Important note

For complete technical information, please read "10 Technical Specifications."

Please use the "LiDAR Diagnostic and Configuration Software (FILPS)" to diagnose and configure the AS-21C. How to use FILPS Please read the "LiDAR Diagnostic and Configuration Software (FILPS) User's Manual".

1.3 Pattern symbol description

This manual uses the following pattern symbols to identify various important precautions. Pay special attention when reading to avoid personal injury and equipment damage.

Danger**Meaning:**

Urgent and dangerous situations, if not guarded, may cause

serious personal injury.

Caveat**Meaning:**

Potentially dangerous situations, if not prevented, may cause serious personal injury.

Cautious operation**Meaning:**

Potentially dangerous situations, if not prevented, may result in general personal injury.

Note**Meaning:**

Potentially harmful conditions, if not prevented, may result in equipment damage.

Important note**Meaning:**

Helpful advice and tips for efficient and smooth use of the device.

Main point**Meaning:**

Information about important features of the device.

Explain**Meaning:**

Technical background knowledge.

Instructions**Meaning:**

Can provide more information related documents.

Related Reading**Meaning:**

You need to use the FILPS software to complete the equipment inspection and configuration.

1.4 Extended reading

- **LiDAR Diagnostic and Configuration Software (FILPS):** Windows installation package and user manual for FILPS software.
- **LiDAR Application Development SDK:** The basic C++ code library, Windows dynamic library, demo program, and SDK user's manual for LiDAR application development.

2. Basic operation and precautions

This chapter explains the basic operations and precautions involving personal safety and equipment safety. Please read it carefully before using the AS-21C.

2.1 Correct method of use

AS-21C is an optical sensor for non-contact distance measurement. It can be used alone, or it can be used on the network. It is mainly used to accurately measure the surrounding environment and target contour, and it can also be used to build safety precautions. Security protection, positioning and navigation applications.

The AS-21C can only be operated by professionals and used in a compliant environment.

Important note

For the requirements of the AS-21C use environment, please read "10.1 Data Book".

2.2 Incorrect usage warning

- AS-21C can only be used for safety warning purposes and cannot physically protect personal safety in hazardous environments.
- AS-21C cannot be used in hazardous environments with explosive hazards.
- The use of accessories not provided by Akusense is at the user's own risk.

2.3 Networking instructions

The AS-21C uses standard TCP/IP technology for device networking. When actual networking, you need to ensure the following prerequisites:

- Users need to ensure the integrity and confidentiality of the data transmitted on the network.
- Necessary network security measures, such as network isolation, firewalls, and anti-virus software, need to be planned and implemented by users themselves.

2.4 Disclaimer of equipment damage

Akusense is not liable for equipment damage due to the following reasons:

- Did not read the manual carefully.
- Failure to properly use the equipment as required.
- Operated by unqualified personnel.
- Equipment dismantling without Akusense approval.
- Modification of equipment without Akusense approval.

- Technical transformation of the equipment.
- Use self-made accessories.

2.5 Laser radiation instructions

AS-21C is measured with an infrared laser with a wavelength of 905 nm. The laser beam is invisible to the naked eye.

Cautious operation

AS-21C meets the requirements of a class of laser safety levels as specified in GB 7247.1-2012. Under normal conditions of use, it is harmless to the human eye and the skin. However, incorrect use of the AS-21C may bring security risks. The matters are as follows:

- Do not open the cover of the AS-21C. The powered AS-21C will not stop laser firing when the cover is opened.
- Do not look directly into the laser output side of the AS-21C for a long time, especially children, and may cause blindness.

The laser output surface of AS-21C is an optical transmissive cover. The laser warning mark is located on the top cover of the device, as shown in "Figure 2.1 Laser output surface and laser warning sign".

Figure 2. 5Laser light output surface and laser warning sign

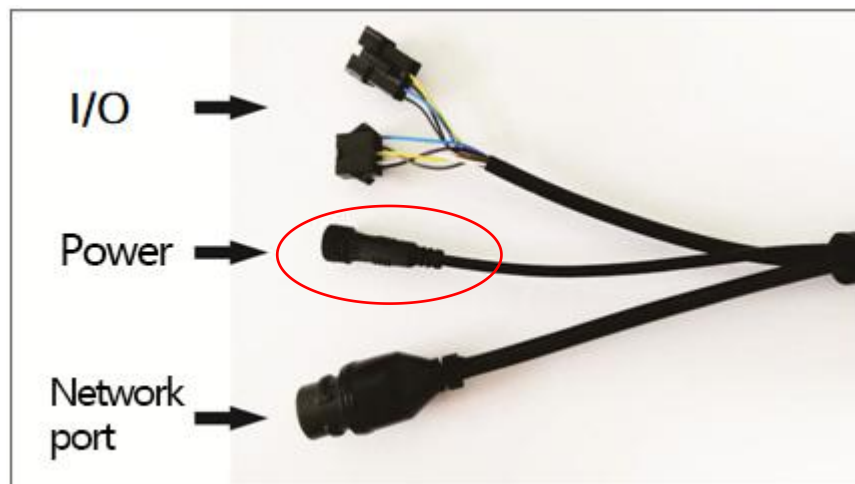


2.6 Power supply and quick start and stop

The AS-21C is powered by the DC002-type circular waterproof power socket in the interface cable on the side of the device, as shown in the "Figure 2.2 Power Outlet". the

power supply voltage is 10V~30V DC, and the power is in normal operation. The power consumption is 3.4W and the maximum power consumption is 3.9W. When the internal temperature is lower than 28 °C, the built-in heating module will start automatically, and when it is higher than 40 °C, the heating will stop automatically. When the heating module is started, the power consumption of the whole machine is 8.6W under the DC12V power supply voltage, and the power consumption of the whole machine is 19.4W under the DC24V power supply voltage. Please provide power according to the above standards when using.

Figure 2. 6 Power Outlet



Important note

Please read "10.1 Data Sheet" for the complete requirements of AS-21C for power supply. The user shall comply with local regulations and perform necessary protection of the power supply cable of AS-21C to avoid short circuit or overload of the power supply. In addition, an emergency circuit breaker shall be installed on the power supply cable for emergency use. Cut off the power supply quickly.

- Shutdown method: Turn off the power, or unplug the power cable from the power outlet.
- Power on method: Connect the power cable of the power outlet and turn on the power switch.

The device configuration information of AS-21C is stored in a non-volatile storage medium. Starting and stopping the device will not cause the loss of this information.

2.7 Maintain

Note

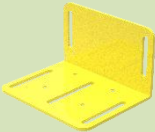
AS-21C must be maintained by Akusense or Akusense designated agency staff. If repaired by other personnel, it may cause damage to the equipment. Under such circumstances, Akusense will not be responsible for subsequent maintenance.

3. Product description

3.1 Deliveries

AS-21C's product deliverables are shown in Table 3.1 product deliverables list.

Table 3. 1 Product deliverables list

Deliverables	qty	unit	Description
Certificate	1	piece	
Warranty Card	1	piece	
 AS-21C	1	piece	LiDAR
 AS-21C-AT	1	piece	Side-mounted/sitting composite bracket
 AS-21C-EC	1	piece	Power cable
 AS-21C-WJ	1	piece	Network cable crystal head waterproof jacket
Hexagonal M4*8 screws, Gasket, M4 hexagon wrench	1	set	

3.2 Product characteristics

Table 3. 2 Product characteristics

Working environment	● Supply voltage range: 10V~30V DC. ● 3.4W(Measuring), 7.6W@DC12V / 6W@DC24V (Heating) ● Comprehensive outdoor work ability: anti-dirty, anti-sunlight, support rain and fog penetration. ● IP65 shell protection class; ● -25°C~+50°C operating temperature range;
Distance measurement	● Pulsed flight time measurement technology system; ● 905nm infrared laser measurement, class 1 safety laser (GB 7247.1-2012, human eye safety); ● Maximum range is 20 meters, and the 10% reflectance range is 15 meters;
Scanning	● Mechanical scanning; ● 300° scan range, 0.5°(system default)/0.25°/0.125° scan angle resolution; ● 25Hz(system default)/12.5Hz/6.25Hz scanning frequency;
Device interface	● Ethernet interface Function: device configuration/measurement data output/ monitoring signal output ● I/O interface Function: peripheral control, area monitoring function operation control and monitoring signal output, Device ready indication
Built-in application	Regional monitoring ● Monitoring mode: point monitoring / target width monitoring / contour monitoring; ● 16 modifiable preset area groups, support background contour self-learning; ● Up to 16 concurrent work area groups; ● Can detect targets of any shape and support normal target self-learning (customized function); ● Disarming and forced alarms via I/O input terminals; ● Monitor the signal through the I/O output terminal and Ethernet (TCP message) output area; ● Guided network cameras (IPC) for video location and tracking of

	alarm locations and alarm targets via Ethernet and ONVIF protocols; Support without PC configuration.
Availability reliability	- Anti-sunlight, anti-dirty, with rain and fog penetration ability (optional); - Self-checking capability of equipment failure, including transparent cover, dirty cover, temperature over-standard, Blocked by dense fog; - Output device self-test information through indicators and TCP packets.

Figure 3.1 Measuring Coordinate System/Scan Range/Range

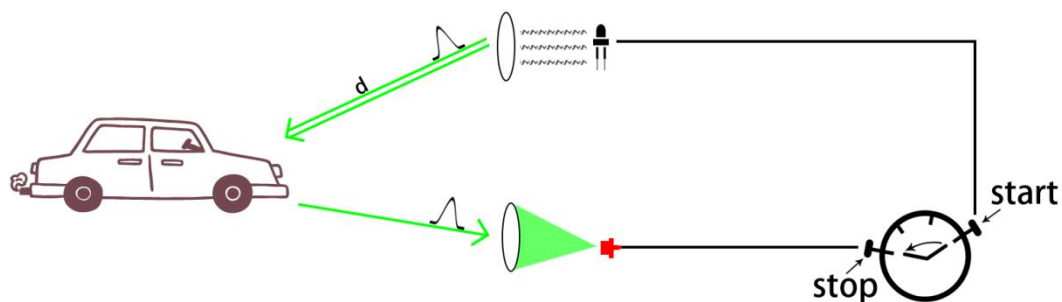


3.3 Operational principle

3.3.1 Distance measurement

The basic operating principle of the AS-21C distance measurement is based on time-of-flight laser ranging. The AS-21C emits a laser pulse and measures the time it takes for the pulse to return after being reflected by the surface of the measured target, and then converts it into distance data, as shown in "Figure 3.2 operating principle of time of flight measurement"

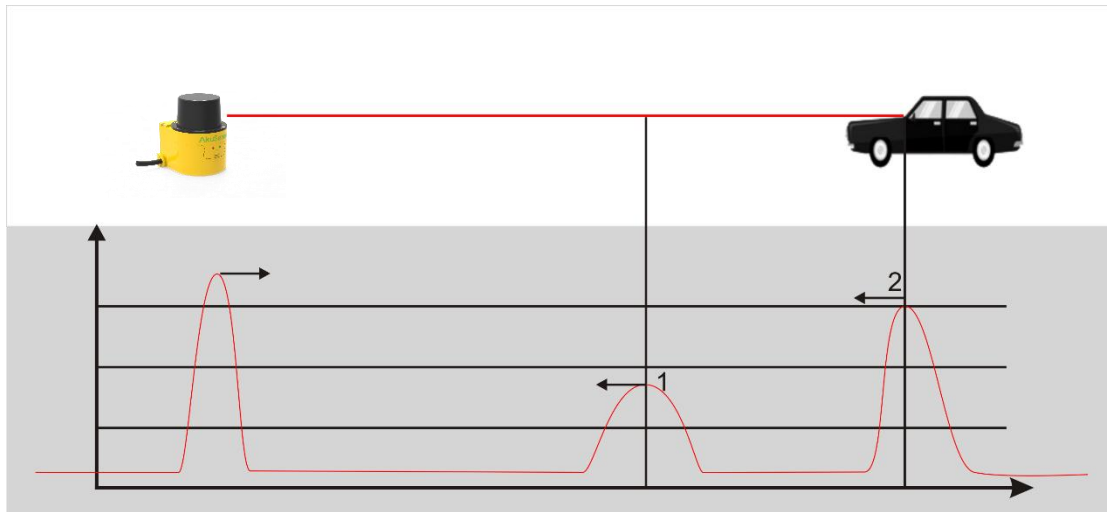
Figure 3.2 operating principle of time of flight measurement



AS-21C has multiple echo analysis capabilities. In the rain and fog and soot working environment, atmospheric impurities will also reflect the distance measuring laser pulse, forming a reflected echo pulse, and together with the reflected echo pulse of the measured target, reach the photoelectric receiving system. The AS-21C analyzes all

received reflected echo pulses, rejects interfering pulses, and outputs true measured target distance data, as shown in Figure 3.3 Reflected Echo Filter.

Figure 3. 1 Reflected Echo Filter



3.3.2 Two-dimensional scanning

AS-21C passes a 90 degree deflection to the range laser pulse through a reflector with an angle of 45 degrees with the original emitter path. The mirror is driven by the motor, and the rotation axis is parallel to the original emitter path, so that the actual distance path is distributed on the scanning plane perpendicular to the axis of rotation, and the azimuth angle of the range is rotated with the motor. The azimuth angle is the same, thus the two-dimensional optical scanning is realized, and the distance between the points on the cross section of the range scanning plane can be obtained, such as "Figure 3.4 scanning measuring mechanism" and "figure 3.5 two-dimensional cross section scanning". AS-21C uses a specific TCP network message to provide users with two-dimensional scanning data with fixed scan frequency through Ethernet port.

Figure 3.4 scanning measuring mechanism

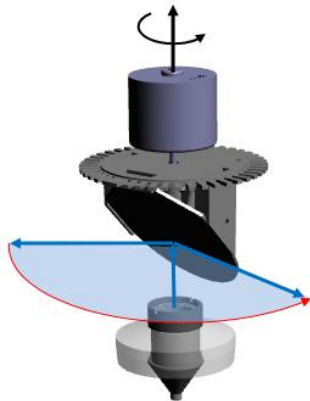
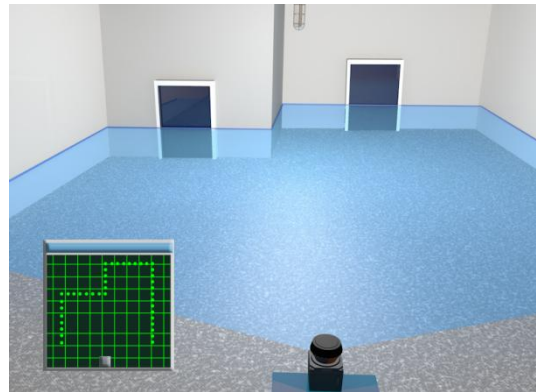


Figure 3.5 two-dimensional cross section scanning



3.3.3 Scene measurement and regional monitoring

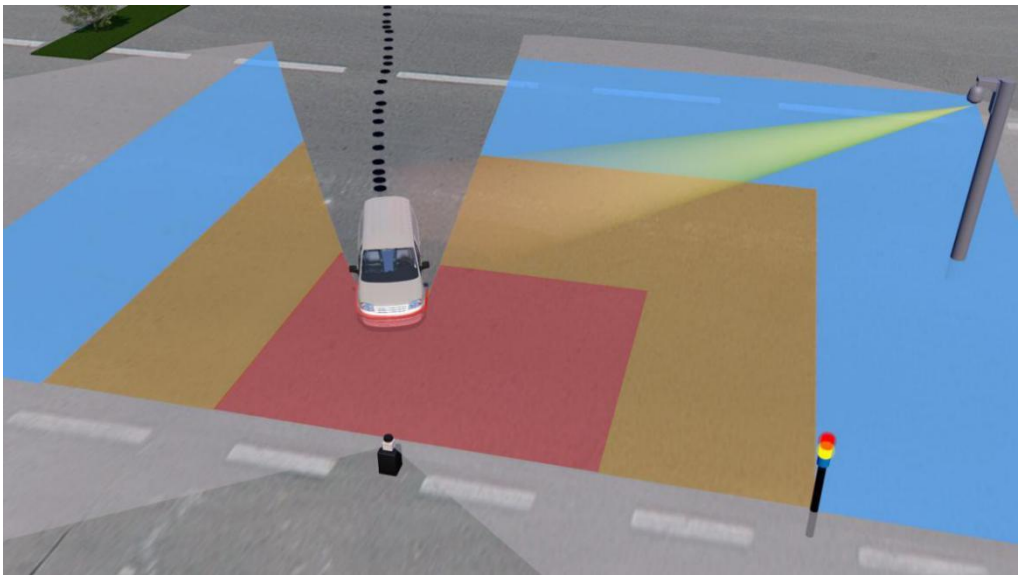
By analyzing and processing the distance data obtained from two-dimensional scanning, the application system can measure and monitor the scene, detect and locate various targets in the scene, measure its appearance, and implement scene analysis through intelligent algorithms. The target is subject to spatio-temporal domain tracking, type identification, and behavior analysis. Finally, the analysis results are output according to application requirements, such as alarm, sorting, and guidance.

The AS-21C has a built-in area monitoring function that enables perimeter protection, intrusion detection, contour monitoring and other functions, as shown in "Figure 3.6 Area Monitoring Function". The area monitoring function can be configured via the "LiDAR Diagnostic and Configuration Software (FILPS)", or the monitoring arming conditions can be set via the I/O input terminals. The monitoring results are output via TCP network messages and also through the AKU-LS-D20. -300 I/O output terminals for real-time output.

The AS-21C incorporates an IPC control module that supports the ONVIF protocol. It can directly guide the IP camera through the Ethernet port to perform video positioning and tracking of alarm locations or monitored targets.

The AS-21C's built-in zone monitoring also supports PC-less configuration mode. You can use the I/O input terminals to select built-in monitoring area groups of different shapes and sizes. You can also execute the background self-learning function through the front panel operation buttons to automatically adapt the AS-21C to the current use environment. Equipment configuration can be completed and put into use. The no-PC configuration mode provides flexibility in use for security applications in mobile applications and industrial sites.

Figure 3.6 Area Monitoring Function



3.4 Device interface

The interface cable on the side of the AS-21C is a composite cable with a length of 1 meter. There are three external interfaces, including “power interface”, “Ethernet interface” and “I/O interface”, such as “Figure 3.7 Device interface.”The type of each interface is as shown in “Table 3.3 Device Interface”, and the interface signal definition is as shown in “Table 3.4 Device Interface Signal Definition”.

Figure 3.7 Device interface

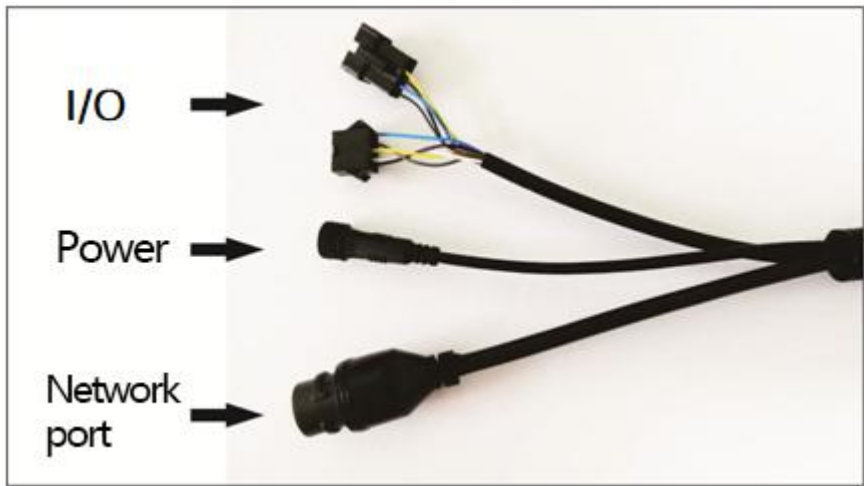


Table 3. 3 Device Interface

Outlet	Type	Core qty
Power interface	DC002 type, Female	2
Ethernet interface	RJ45 socket	4
I/O interface	SM2.54,5P,Female & Male	10

Related Reading

Please read "10.1 Data Sheet" for the electrical characteristics of each socket.

Table 3. 4 Device Interface Signal Definition

Interface	Signal	Explanation
Power interface	V	Power
	GND	GND
Ethernet interface	RX+	Data reception positive end
	RX-	Data receiving negative end
	TX+	Data reception positive end
	TX-	Data receiving negative end
I/O interface	IN1	Universal input 1# positive end
	IN2	Universal input 2# positive end
	IN3	Universal input 3# positive end
	IN4	Universal input 4# positive end
	GND IN	Universal input GND
	OUT1A	Universal output 1# positive end
	OUT2A	Universal output 2# positive end
	OUT3A	Universal output 3# positive end
	OUT4A	Universal output 4# positive end
	OUT B	Universal Output Port

Related Reading

For signal definitions for each outlet, read "6.3 Device Interface Signal Definitions."

3.5 Equipment control and operating status display

3.5.1 Equipment control method

After the AS-21C is powered on, it automatically enters the operating state according to the current configuration of the system without intervention. If you need to control, configure, or query the running status of AS-21C, there are three ways:

- **Diagnostic and Configuration Software (FILPS):** FILPS interacts with the AS-21C using TCP messages via the Ethernet interface for comprehensive configuration

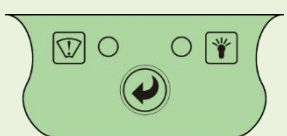
and operational control of the AS-21C. Please read "7 Device Configuration" for details. And test run test".

- **Front panel SLR operation button** : Use SLR operation button to start the background self-learning and delete the background two functions, please read "3.6.3 front panel operation button" for details.
- **I/O input terminal**: By entering an effective control level to the I/O input terminal, control functions such as area monitoring disarming and forced alarming can be realized. For details, please read "4.5 I/O Interface Operation Instructions and Application Development".

3.5.2 Indicator light Indicator

After the AS-21C starts working, the basic operating status is displayed by the indicator on the front panel. The meaning of each indicator is shown in Table 3.5 Indicator Description.

Table 3. 5 Indicator Description

		Description
	 ERR	Work fault indicator ◆ startup status: bright (About 27s) ◆ Off: No fault ◆ Steady light: Internal fault/Abnormal measurement ◆ Long flicker (0.5 Hz): High temperature / low temperature alarm ◆ Short flicker (1Hz): Transmissive cover is dirty/occluded¹
	 HTR	Work status indicator ◆ Startup state: off ◆ Off: The device does not start measurement/ready to reboot ◆ Bright: Normal measurement of equipment ◆ Flashing 1 (0.5Hz): Monitor signal output ◆ Flashing 2 (1Hz): Self-learning² ◆ Flashing 3 (2.5Hz) : Ready for self-learning²
	 SLR	Operation button ◆ Short press (1s~5s): Start background

		self-learning
		◆ Long press (≥6s): delete background

- 1: Including the content blocked by dense fog and monitored area;
- 2 : Including "background self-learning" and "normal goal self-learning"(customized function).

3.5.3 Front panel operation buttons

After the AS-21C starts working,Background self-learning of regional monitoring functions can be realized through the SLR operation button on the front panel. The definition of each operation is shown in “Table 3.6 Front Panel Operation Button Operation Instructions”.

Figure 3.9 Front Panel SLR Operation Buttons



Table 3. 6 Front Panel Operation Button Operation Instructions

Press duration	Functional definition	Operating	Device status	Indicator
1s - 5s	Start background self-learning	Press (1s — 5s)	Ready to start background self-learning	 Flicker 3
		Release (0s — 6s)	Ready to start background self-learning	 Flicker3
		Release (6s — 12s)	Background self-learning	 Flicker2
≥5s	Delete background	Press (≥5s)	Prepare to restart the device	 Light off
		Release	Device restart	No influence

Main point

After the AS-21C enters the "Ready to start background self-learning" and "Start self-learning" states, if the SLR operation button is pressed, the background self-learning will

continue until completion, and the button operation will not work.

After the device is configured, the SLR operation button can be disabled by using the “Diagnostics and Configuration Software FILPS” to prevent accidental changes to the background of the area monitoring function caused by misoperation of the SLR operation buttons.

4. Applications

4.1 Technical Application

In practical applications, the measurement range and measurement effect of AS-21C are affected by many environmental factors. Special attention must be paid to these factors and effects, and appropriate measures must be taken to deal with them.

4.1.1 Actual range

The actual measurement of a specific target by the AS-21C is affected by the following factors:

- **Actual diffuse reflectance:** The actual diffuse reflectance of the portion of the target surface that is illuminated by the measuring laser spot emitted by the AS-21C. The actual diffuse reflectance is not only related to the material but also related to the surface orientation. The higher the actual diffuse reflectance, the farther the actual range becomes.
- **Reflection area:** The area of the target surface covered by the laser spot. The larger the coverage area, the farther the actual measurement distance is.
- **Transmissive cover contamination degree:** AS-21C's translucent cover will cause the light transmission performance to decline, the more light transmission performance will decrease, the worse the measurement capability, the light transmission rate will drop to 60%. The ability may completely fail.
- **Atmospheric conditions:** The actual measurement capability of the AS-21C is also affected by atmospheric conditions, especially when working outdoors. The worse the light transmission capability of the atmosphere, the lower the actual measurement capability of the AS-21C. In extreme weather conditions (such as dense fog), the measurement capability completely fails.

Main point

When using AS-21C to set up an application system, it is necessary to set the working range of AS-21C based on a comprehensive consideration of various application requirements. These factors include:

- The minimum actual diffuse reflectance and minimum size of the target that needs to be found.
- The cleanliness of the AS-21C work environment, and whether it can be maintained in a timely manner, such as cleaning the translucent cover.

4.1.2 The relationship between spot diameter and target size

The laser beam emitted by the AS-21C has a certain divergence angle. The relationship between the spot diameter r and the measurement distance d of the AS-21C at a specific measurement distance is:

$$r = r_0 + \alpha \cdot d$$

among them:

r_0 is the spot exit aperture, for AS-21C, $r_0 = 0.008\text{m}$.

α is the divergence angle of the spot, for AS-21C, $\alpha = 0.0125$

Instructions

The farther the measurement distance is, the larger the spot diameter is. For a specific target, the probability of the spot completely hitting the target surface is lower, and the effective reflective area ratio of the target surface is lower. Therefore, for a target with the same actual surface diffuse reflectance, the smaller the target size, the closer the actual range will be.

4.1.3 Rain fog and dust penetration

When the fog and dust penetration function is turned on, the AS-21C will filter the weak reflection measurement data within a certain distance so as to avoid the measurement result triggered by the mist and dust to replace the measurement result of the real target over a longer distance, such as Figure 3.3 Reflected Echo Filtering, but this also makes the AS-21C target with a very low overall reflectivity (eg, less than 5%) at close range (eg, 2-4 meters) or The ability to measure small targets (such as flying insects, linear targets) drops or fails.

Software operation

For the opening and closing of the fog and dust, please read the manual of "laser LiDAR diagnosis and configuration software (FILPS)" section 6.3 "running configuration parameters".

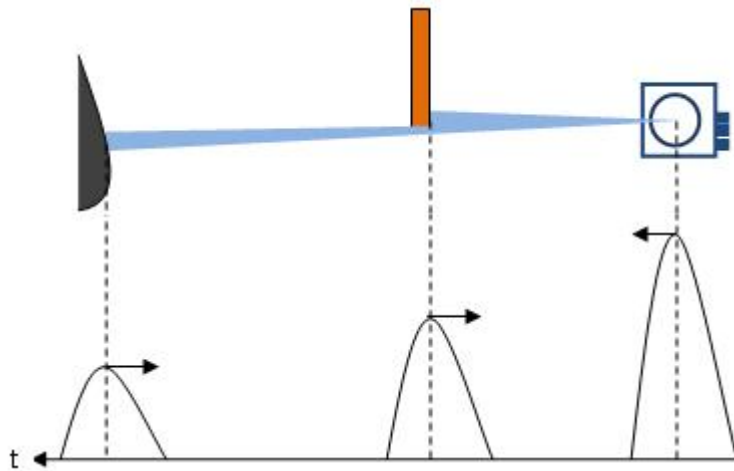
Main point

It is necessary to choose carefully according to the application requirements if the rain fog and dust penetration function is started.

4.1.4 Pseudo edge point

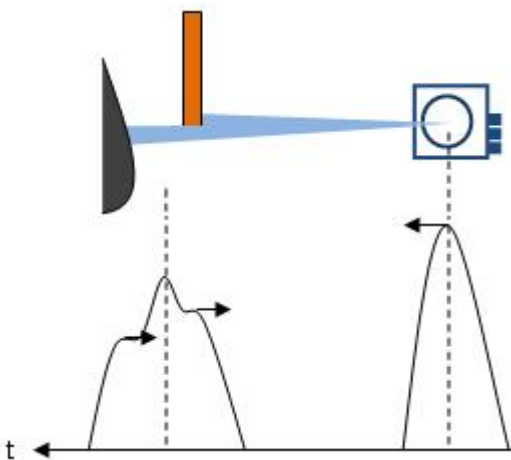
When the laser spot hits the target edge, AS-21C also receives **two** reflection echoes, one from the target surface and the other from the same angle, as shown by the "figure 4.1 edge point measurement".

Figure 4.1 edge point measurement



If the distance between the target and the background is close, the two echo echoes will overlap each other, which will lead to the inaccuracy of the measurement and the "pseudo edge point", which is far farther away than the actual distance from the target edge, as shown by the "Figure 4.2 pseudo edge point". The difference between the measured values and the real values of the pseudo edge points may reach 15cm.

Figure 4.2 pseudo edge point



Main point

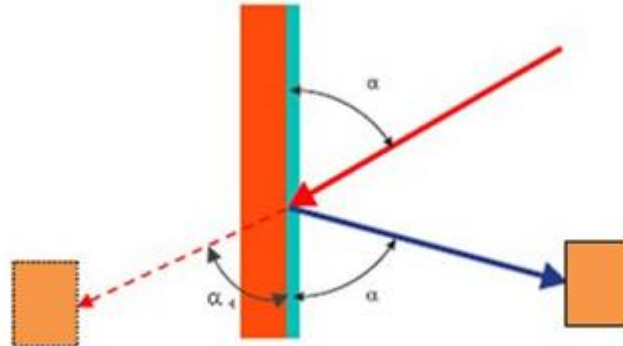
The false edge points will have a certain influence on the accurate location of the target. In a class of applications that need accurate positioning of the target, special treatment should be done to the target edge points.

4.1.5 Mirror target

When measuring the mirror target, only when the target surface is perpendicular to the incident laser can be measured effectively. If the incident angle of the laser is not vertical and the diffuse reflectance is very low, it can not be effectively measured. The

actual measurement result is the mirror target distance of the mirror reflecting light path, as shown in "Figure 4.3 mirror measurement".

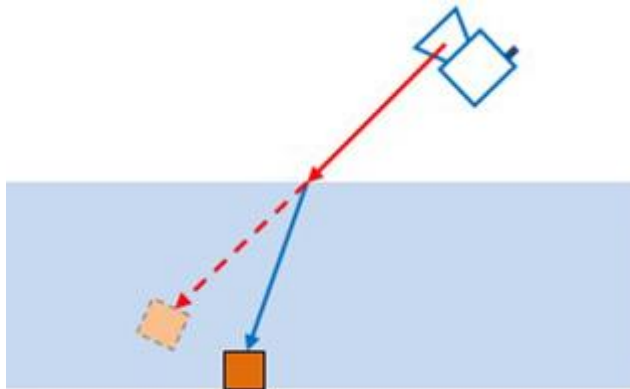
Figure 4.3 mirror measurement



4.1.6 Transparent medium

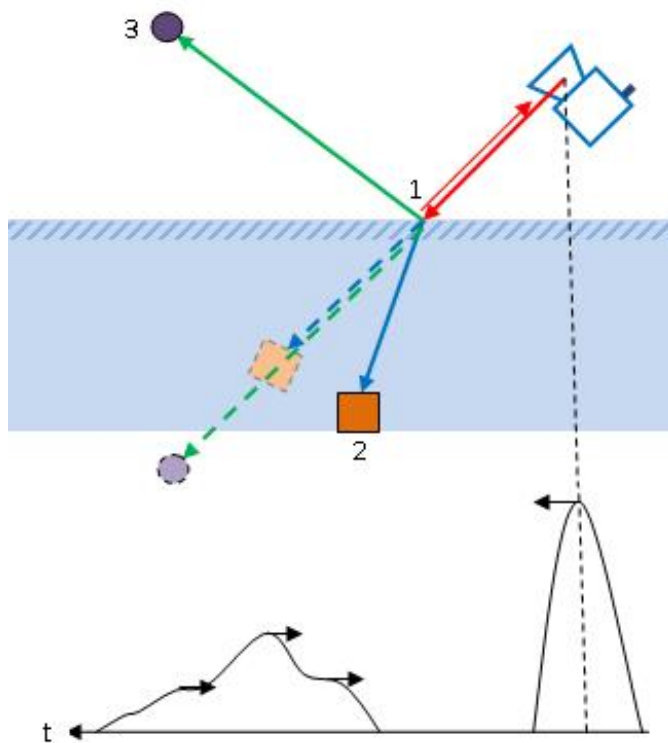
When there is a transparent medium in the surrounding environment (such as clean water), the target located inside or behind the transparent medium can be measured. Due to the refraction of light in the transparent medium, the measured target is in the light path of refraction, and the measurement result is on the straight line. The measured target position will be deviated, such as "Figure 4.4 transparent medium measurement".

Figure 4.4 transparent medium measurement



In addition, the AS-21C may also receive two reflected echoes, one from the actual target surface inside or behind the transparent medium, and the other from the diffuse reflection from the surface of the incompletely clean transparent medium. The measurement results at this time are indefinite and may be the surface of the medium or the actual target. If the surface of the transparent medium is close to a mirror (for example, glass), a third reflected echo may be generated because the measuring laser pulse emitted by the AS-21C may be reflected and hit other targets on the reflected light path. Echoes may form complex mutual overlapping relationships based on the length of the actual optical path, resulting in indeterminate measurement results, as shown in "Figure 4.5 Specular Transparent Media Measurement."

Figure 4.5 Specular Transparent Media Measurement.

**Main point**

In practical use, transparent media in the environment, especially transparent media with a mirror-like surface, need to be specially treated to avoid unstable or erroneous measurement results. The specific processing method may be to do diffuse reflection semi-transparent treatment on the surface of the media, to reduce the transparency and reflection ability, or to shield these positions when processing the measurement data.

4.1.7 Strong light interference**Main point**

If the transmissive cover of the AS-21C is continuously illuminated by a strong light source parallel to the scanning surface, the target reflection echo within the illuminated scanning range may be flooded by the incident light, and the incident strong light may also trigger. Measurements that produce erratic, incorrect measurement results that can lead to measurement failures, may also cause false alarms for devices that “transparent masks are dirty”. In the actual deployment,

such situations should be avoided.

4.2 Application System Development Overview

The AS-21C is a measurement single-layer scanning laser LiDAR that combines cost-effectiveness and ease-of-use. It is designed for indoor applications and can also support low-degree outdoor applications. For AGV obstacle avoidance under moving installation conditions, collision avoidance applications for work vehicles, and safety protection applications under static installation conditions, the technical specifications of AS-21C can ensure that the application requirements are met. At the same time, the small device size and targeted interface design of the AS-21C also facilitates integration in application systems.

When using AS-21C to develop the application system, the application system and AS-21C interact mainly through the Ethernet interface in the way of **UDP broadcast message** and **TCP message**, use the acquired information to carry on the follow-up processing, and control the AS-21C to complete the application requirement. The functions that can be accomplished include:

- Get the configuration information of AS-21C.
- Get distance measurement data and equipment operating status.
- Read and control the I/O port.
- Regional monitoring functions, monitoring information, etc.
- According to the application requirements, the measurement data and monitoring information are processed by applying an algorithm.

The network messages used by the AS-21C are shown in Table 4.1 Application Development Network Messages. These messages are defined in detail in the LiDAR Application Development SDK.

Related Reading

For more information on network message, please read Section 4, “LIM Overview” of the Lidar Application Development SDK User's Manual.

Main point

For applications with high real-time requirements, the AS-21C I/O interface input/output terminals can be used directly to complete alarm control, alarm warning and peripheral control. for AGV and industrial field safety protection applications, it is also possible The built-in monitoring area group is selected through the I/O interface input terminals to achieve no PC configuration.

For the function and application development of the I/O interface, please read "4.5 I/O Interface User's Guide and Application Development."

Table 4. 1 Application Development Network Packets

Function	Message type code	Initiator	Response message
Heartbeat	LIM_CODE_HB	Application client	LIM_CODE_HBACK
Heartbeat reply	LIM_CODE_HBACK	AS-21C	none
Measurement data	LIM_CODE_LMD	AS-21C	none
Request measurement data	LIM_CODE_START_LMD	Application client	LIM_CODE_LMD
Stop measuring data	LIM_CODE_STOP_LMD	Application client	none
Query device ready signal	LIM_CODE_DEVICE_STATUS_QUERY	Application client	LIM_CODE_DEVICE_STATUS
Device ready signal	LIM_CODE_DEVICE_STATUS	AS-21C	none
Query area monitoring signal	LIM_CODE_FMSIG_QUERY	Application client	LIM_CODE_FMSIG
Regional monitoring signal	LIM_CODE_FMSIG	AS-21C	none
Query I/O status	LIM_CODE_IOREAD	Application client	LIM_CODE_IOSTATUS
Set the I/O output status	LIM_CODE_IOSET	Application client	LIM_CODE_IOSTATUS
Release I/O settings	LIM_CODE_IOSET_RELEASE	Application client	LIM_CODE_IOSTATUS

I / O state	LIM_CODE_IOSTATUS	AS-21C	none
Equipment alarm query	LIM_CODE_ALARM_QUERY	Application client	LIM_CODE_ALARM LIM_CODE_DISALARM
Equipment alarm	LIM_CODE_ALARM	AS-21C	none
Device cancel alarm	LIM_CODE_DISALARM	AS-21C	none
Device configuration information	LIM_CODE_LDBCONFIG	AS-21C	none
Start device configuration information broadcast	LIM_CODE_START_LDBCONFIG	Application client	LIM_CODE_LDBCONFIG
Stop device configuration information broadcast	LIM_CODE_STOP_LDBCONFIG	Application client	none
Get device configuration information	LIM_CODE_GET_LDBCONFIG	Application client	LIM_CODE_LDBCONFIG
Query device firmware version	LIM_CODE_FIRMWARE_VERSION_QUERY	Application client	LIM_CODE_FIRMWARE_VERSION
Device firmware version	LIM_CODE_FIRMWARE_VERSION	AS-21C	none
System restart	LIM_CODE_SYS_REBOOT	Application client	LIM_CODE_HBACK
System restart response	LIM_CODE_SYS_REBOOT_ACK	AS-21C	none
Rain mist filter switch	LIM_CODE_RAINDUST_FLT_SWITCH	AS-21C	none

status			
Query the rain filter status	LIM_CODE_RAINDUST_FLT_SWICHTH_STS_QUERY	Application client	LIM_CODE_RAINDUST_FLT_SWICHTH
Set the rain filter switch status	LIM_CODE_RAINDUST_FLT_SWICHTH_STS_SET	Application client	LIM_CODE_RAINDUST_FLT_SWICHTH
Static application switch status	LIM_CODE_STATIC_APP_SWICHTH	AS-21C	none
Query static application switch status	LIM_CODE_STATIC_APP_SWICHTH_STS_QUERY	Application client	LIM_CODE_STATIC_APP_SWICHTH
Set static application switch status	LIM_CODE_STATIC_APP_SWICHTH_STS_SET	Application client	LIM_CODE_STATIC_APP_SWICHTH
Spatial filtering switch state	LIM_CODE_SPATIAL_FLT_SWICHTH	AS-21C	none
Query spatial filtering switch status	LIM_CODE_SPATIAL_FLT_SWICHTH_STS_QUERY	Application client	LIM_CODE_SPATIAL_FLT_SWICHTH
Set spatial filtering switch status	LIM_CODE_SPATIAL_FLT_SWICHTH_STS_QUERY	Application client	LIM_CODE_SPATIAL_FLT_SWICHTH
Area monitoring switch status	LIM_CODE_FIELD_MNT_SWICHTH	AS-21C	none
Query area monitoring switch status	LIM_CODE_FIELD_MNT_SWICHTH_STS_QUERY	Application client	LIM_CODE_FIELD_MNT_SWICHTH
Set area monitoring	LIM_CODE_FIELD_MNT_SWICHTH_STS_SET	Application client	LIM_CODE_FIELD_MNT_SWICHTH

switch status			
Measuring switch status	LIM_CODE_MEASURE_SWIC TH	AS-21C	none
Query measuring switch status	LIM_CODE_MEASURE_SWIC TH_STS_QUERY	Application client	LIM_CODE_MEASURE _SWICTH
Set measuring switch status	LIM_CODE_MEASURE_SWIC TH_STS_SET	Application client	LIM_CODE_MEASURE _SWICTH
Dense fog blocking detection switch status	LIM_CODE_FOGCHK_SWICT H	AS-21C	none
Query dense fog blocking detection switch status	LIM_CODE_FOGCHK_SWICT H_STS_QUERY	Application client	LIM_CODE_FOGCHK_ SWICTH
Set dense fog blocking detection switch status	LIM_CODE_FOGCHK_SWICT H_STS_SET	Application client	LIM_CODE_FOGCHK_ SWICTH

4.3 Network configuration and device detection

4.3.1 Device configuration information broadcast

After AS-21C starts up, it will automatically broadcast its own configuration information to the following broadcast address and UDP port number: 237.1.1.200:2111

The type code of the device configuration information broadcast message is: **LIM_CODE_LDBCONFIG**.

The application system can listen to the device configuration information broadcast message at this address and port, obtain the configuration information of the AS-21C that has gone online, and establish a TCP connection with it. After the TCP connection is established, a "Stop Device Configuration Information Broadcast" message (type code **LIM_CODE_LDBCONFIG_STOP**) can be sent to the AS-21C, Meanwhile, the AS-21C

stops the configuration information broadcast, and it can also send a "Startup device configuration information broadcast" message (type code: LIM_CODE_LDBCONFIG_START) to the AS-21C. and AS-21C Start the configuration information broadcast again.

Related Reading

For more information about configuring the broadcast message, see Section 9 "Device Configuration Messages" of the Lidar Application Development SDK User Manual.

Software operation

FILPS automatically listens to the online AS-21C and lists all online Akusense lidar devices in the "Online Device" form. After double-clicking the device entry to establish a TCP connection with AS-21C, you can modify the Ethernet configuration on the "Device Configuration" tab.

4.4 Regional monitoring function and application development

The AS-21C has a built-in area monitoring function that can independently perform some common area monitoring applications such as AGV obstacle avoidance, intrusion detection, and target care. Correctly using the built-in area monitoring function of AS-21C can effectively reduce the system complexity and reduce the cost of system construction. This section explains the concepts, working principles, methods of use, and application development of the regional monitoring function.

4.4.1 Operating principle

The basic mod of regional monitoring function is "regional group + monitoring mode": binding a monitoring model in a regional group to form a "monitoring regional group". After the monitoring zone group is "activated", it starts to work, processes the scene measurement data, generates different "monitoring signals", and outputs them through TCP messages and I/O output ports. multiple activated monitoring zone groups can work simultaneously. The final output of the monitoring signal can also be forced to control. As shown in "Figure 4.6 Area Monitoring Function Operation".

Software operation

You can use the FILPS software to configure the AS-21C's area monitoring function. For usage, please read Chapter 8 "Zone Monitoring Configuration" of the "Lidar Diagnostic and Configuration Software (FILPS) User's Manual".

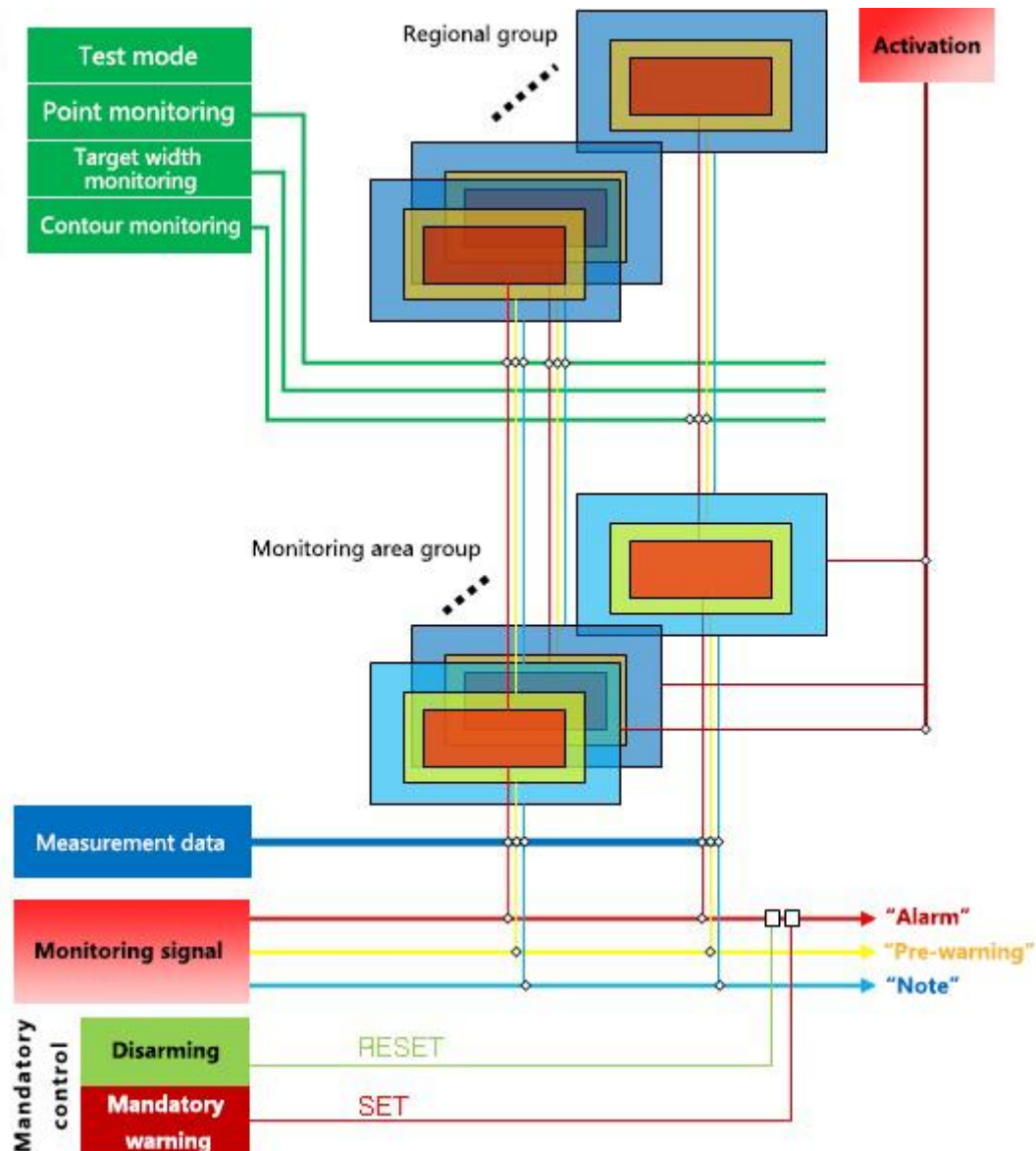
Main point

In the factory setting, the area monitoring function is activated.

Related Reading

For details on the TCP packets for the area monitoring function, please read Section 6 “Region Monitoring Packets” of the “Lidar Application Development SDK User's Manual”.

Figure 4.6 Area monitoring function operating principle



4.4.2 Regional groups and monitoring regional groups

Instructions

The AS-21C's area monitoring function is based on **regional group** work. Each regional group consists of three regions, which are the “**attention zone**”, “**pre-warning zone**” and “**alarm zone**”. Produce “**attention**”, “**pre-warning**” and “**alarm**” monitoring signals respectively. And output through

TCP messages and I/O output terminals. In general, the "attention zone" contains the "pre-warning zone" and the "pre-warning zone" contains the "alarm zone," as shown in "Figure 4.7 Zone group".

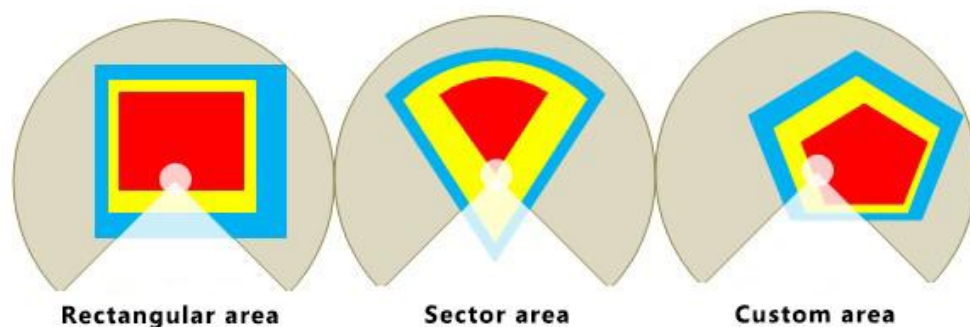
In the area group shown in "Figure 4.7 Zone Group", The rectangular area group and the sector area group are the area groups of the system's built-in shape. The user can use FILPS software to adjust the shape parameters and fine-tune the edge to obtain the desired area group. The custom area group is a group of polygon regions that are manually drawn by the user using the custom zone group function of the FILPS software, and can also finely tune the edges after drawing.

Related Reading

For the editing and drawing methods of the zone group, please read Section 8.5 "Region Editing" of "Lidar Diagnostic and Configuration Software (FILPS) User's Manual".

The AS-21C incorporates four preset groups of zones with different shapes, sizes, and locations, such as "Table 4.2 Preset Zone Groups" and "Table 4.3 Preset Zone Group Basic Parameters". When it is actually used, you can select from these four groups of regional groups as needed, use the FILPS regional group shape edit function to edit and modify, or you can create new desired area groups.

Figure 4.7 Regional Groups



Instructions

After binding one **monitoring mode** to each regional group, a **monitoring zone group** is formed and can be **activated** and put into operation. The AS-21C can have up to **16** monitoring zone groups that work concurrently.

Related Reading

You can use the FILPS software to activate the AS-21C's monitoring zone group. For usage, read "Lidar Diagnostic and Configuration Software (FILPS) User's Manual," Section 8.6, "Regional Monitoring Function Operation Configuration".

Table 4. 2 Preset zone groups

Regional group No.	shape	Alarm area shape parameters		
		Central location	Alarm area length / radius	Angle range
0	rectangle	(0, 50)	100cm x100cm	
1	sector		100cm	[0°, 180°]
2	Polygonal	Pentagon		
3	Circular		100cm	

Table 4. 3 Preset Zone Group Basic Parameters

Parameter Name		Setting value	Explanation
Shielding radius		20cm	The minimum radius of the close-proximity zone. Targets smaller than this distance do not generate monitoring signals.
Warning area buffer distance	rectangle (0#)	50cm(up) / 0(down) / 20cm(left) / 20cm(right)	The buffer distance from the edge of the warning zone to the edge of the alarm zone .
	sector (1#)	50cm	
	Circular (3#)	50cm	
Attention area buffer distance	rectangle (0#)	100cm(up) / 0(down) / 40cm(left) / 40cm(right)	The buffer distance from the edge of the attention zone to the edge of the alarm zone .
	sector (1#)	100cm	
	Circular (3#)	100cm	

Main point

In a zone group, if you do not need a zone to work, you can use the FILPS software to set this zone to the "invalid" state, and the zone of the "invalid" state will not generate zone monitoring signals. For the setting method, please read Chapter 8, "Regional Monitoring Configuration" in the "Lidar Diagnostics and Configuration Software (FILPS) User Manual".

4.4.3 Monitoring area group selection mode

There are two modes for selecting and activating AS-21C monitoring area group , they are :

- **I/O input:** Use IN1~IN4 to select one of the 16 monitoring area groups and activate them. Please read "4.5.1 I/O Input Terminal Function Definitions" for usage.
- **FILPS:** Use FILPS software to select **one or more** of the 16 monitoring zone groups and activate them. For usage, read "Lidar Diagnostic and Configuration Software (FILPS) User's Manual" in Section 8.6 "Regional Monitoring Function Operation Configuration".

Main point

In the factory setting, the monitor area group selection mode of the area monitoring function of the AS-21C is "I/O input".

Software operation

You can use the FILPS software to set the monitor zone set selection mode of the AS-21C. For usage, read "LiDAR Diagnostic and Configuration Software (FILPS) User's Manual" in Section 8.6 "Regional Monitor Function Operation Configuration".

4.4.4 Background self-learning and zone group background tailoring

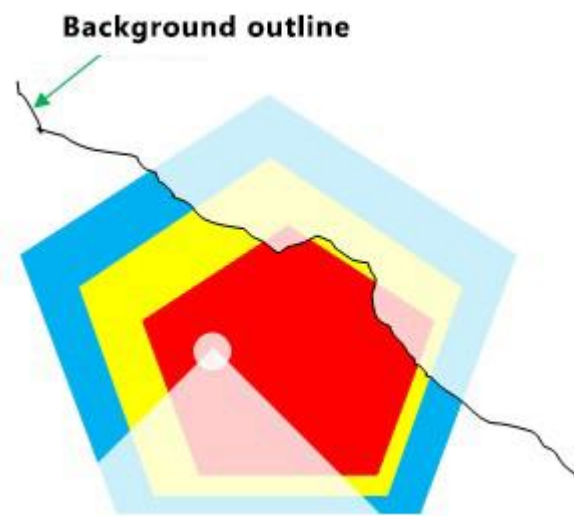
In the actual application of the area monitoring function, it is necessary to edit and draw the specific shape of the area group according to the use scene, so as to avoid triggering the monitoring signal of the fixed background target entering the monitoring area. This work is the largest part of the regional monitoring function configuration workload. It also has a great influence on the use of regional monitoring.

The AS-21C's area monitoring function has "**background self-learning**" function and "**regional group background tailoring**" function. Using these two functions can significantly reduce the workload of drawing area groups and improve system configuration efficiency.

Instructions

- **Background self-learning:** The current scene is measured for a period of time, and a stable, referenceable background profile is generated based on the accumulated measurement data. the generated background can be deleted.
- **Regional group background tailoring:** The activated monitoring area group can enable the “Region group background trimming” function, and use the background outline to trim the edited shape area group to generate the final used area group, such as “Figure 4.8 Background self-learning and area group background trimming”. Shown.
- After "background self-learning" is completed, the "background trimming function" function can be enabled for all activated monitoring area groups.

Figure 4.8 Background self-learning and area group background trimming

**Main point**

When the monitoring zone group selection mode is set to "I/O input", the "background trimming" function of the activated monitoring zone group is automatically enabled.

Related Reading

How to use the “background self-learning”, “deleting background” and “background trimming” functions please read “Lidar Diagnostic and Configuration Software (FILPS) User's Manual” in Section 8.7 “Background Learning” and

4.4.5 Monitoring mode

The AS-21C has three built-in monitoring modes. Their respective functions, conditions of use, monitoring signals output, and parameters used are shown in "Table 4.4 Monitoring Modes and Parameters."

Table 4. 4 Monitoring Modes and Parameters

Monitoring Mode	Function Description	Monitoring signal	Parameter Description		
			Parameter	Unit	Default value
Point monitoring	Count the number of target points entering the area. If the number of target points exceeds the set number threshold and the time exceeds the set response time threshold, the monitoring signal is output.	Attention Pre-warning Alarm	Number of points	pcs	6
			duration	Scan cycle	0
Target width monitoring	Detecting the target of the entering area, if there is a target whose width exceeds the set width threshold, and the existence time exceeds the set response threshold, the monitoring signal is output.	Attention Pre-warning Alarm	Target width	cm	6
			Existence time	Scan cycle	0
Contour monitoring	Detect the integrity and stability of the background contour lines obtained from the self-learning in the monitoring area group. If the background contour line exceeds a	Alarm	Change distance	cm	20
			Change length	cm	6
			Existence time	Scan cycle	0

	change in the set fluctuation distance threshold, and the total length of the fluctuation exceeds the set variation length threshold, and the duration exceeds the set response threshold, an alarm signal is output.				
--	---	--	--	--	--

Main point

In the factory setting of AS-21C, the preset monitoring mode for each zone group is "Target Width Monitoring".

Software operation

For monitoring mode selection and parameter adjustment methods, please read "LiDAR Diagnostic and Configuration Software (FILPS) User's Manual" in Section 8.6 "Regional Monitoring Function Operation Configuration".

4.4.6 Normal target self-learning and exclusion (customized function)

If the monitoring mode of a monitoring area group is "target width monitoring", the "normal target self-learning" function of the area monitoring function can be enabled for the normal objects of a specific shape appearing in a specific position in the "attention" monitoring area. Exclude normal targets and avoid unnecessary monitoring and control actions.

Description

- "Normal target self-learning": The current scene is measured for a period of time, and the normal target that enters the specific location of the monitoring area and the specific shape is detected, and a normal target contour database is generated based on the accumulated normal target contour measurement data, as shown in FIG. 4.9. Normal target self-learning is shown.
- "Normal Target Exclusion": After the "Normal Target Self-learning" is completed, whenever the intrusion target is detected in the monitoring area, the position and contour of the intrusion target are compared with the normal target database. If it is found to be a normal

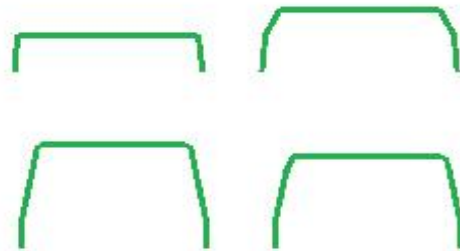
target, then Does not generate monitoring signals.

- All activated monitoring zone groups can be enabled with "normal target self-learning" and "normal target exclusion" functions.

Figure 4.9. Normal target self-learning



Normal target



Normal target profile database

4.4.7 Forced control

If the monitoring area group selection mode is set to "FILPS", the area monitoring function can be controlled through the I/O input terminal of AS-21C. The control modes include:

- **Forced cancellation:** It is forbidden to generate and output monitoring signals in some areas. The I/O terminal is IN1, and the high level is valid. At this time, some monitoring signals of the area monitoring function are shielded and not output. When IN1 goes low, the generation and output of these monitoring signals are restored. It can be used to shield the monitoring signal output under safe conditions by an external identification device such as an RFID card reader.
- **Forced effective:** Forced generation and output of some area monitoring signals, the I / O terminal is IN2, high level valid. The monitoring signal of the regional monitoring function is forced and in a valid state. When IN2 change to low level, the generation and output of these monitoring signals are restored to normal and can be used to connect the emergency alarm button.

Related Reading

For the I/O port TCP messages related to the forcible control, read "4.5 I/O Interface Usage Description and Application Development."

Main point

- In the factory setting, all area monitoring signals are forcibly controlled.
- Forced effective takes precedence over forced

cancellation.

- The area monitoring signals controlled by "forced cancellation" and "forced effective" can be set separately using FILPS software. For the setting method, please refer to Chapter 10 "Advanced Configuration" in the "Lidar Diagnostics and Configuration Software (FILPS) User Manual".

4.4.8 Monitor signal output

When the activated monitoring area group works on-line, the generated monitoring signals are output through the TCP message output, and are also output through the output end of the I/O interface for directly controlling external control devices (such as audible and visual alarms and brakes). Institutions, etc., have stronger real-time performance than TCP message output methods.

The definition of the TCP message monitoring signal and the signal output from the output of the I/O terminal is shown in "Table 4.5 Monitoring Signal Network Message". In TCP messages, the status of the monitoring signal (0/1) is given in bit0 – bit5 of Data[1], respectively. Whenever the status of a certain monitoring signal changes, including when the state of the monitoring signal changes due to the forced control being activated or released, the AS-21C will automatically send a monitoring signal TCP message to the application system.

Table 4. 5 Monitoring Signal Network Messages

Monitoring area	Monitoring signal	Network message			I/O output terminal
		Message code	Regional group number	Status ²	
Alarm area	Area	LIM_CODE_FMSIG	Data[0] ¹	Data[1]:bit0 Data[1]:bit1 ³	OUT2
Pre-warning area	Pre-warning	LIM_CODE_FMSIG	Data[0] ¹	Data[1]:bit2 Data[1]:bit3 ³	OUT3
Attention area	Attention	LIM_CODE_FMSIG	Data[0] ¹	Data[1]:bit4 Data[1]:bit5 ³	OUT4

1: Zone group number starts from 0

2: "0" indicates that the signal is invalid and "1" indicates that the signal is valid.

3: The total status of the corresponding monitoring signals for all monitoring area groups that are activated ("or" for all states).

Related Reading

For the definition of the output monitoring signal through the I/O output terminal, read "4.5 I/O Interface User's Guide and Application Development."

The status of IN1 / IN2 of the I/O interface can be read by TCP messages to determine whether the change of the monitoring signal status is forced control. In addition, the application system can send LIM_CODE_FMSIG_QUERY to the AS-21C at any time. The message is used to query the status of the monitoring signal. The AS-21C answers with the LIM_CODE_FMSIG message defined in Table 4.5 Monitoring Signal Network Messages.

Related Reading

Read the TCP messages of the I/O interface status. Please read "4.5 I/O Interface Operation Instructions and Application Development". For details of TCP messages monitoring the signal, please read Section 6 "Region Monitoring Messages" in the "Lidar Application Development SDK User's Manual".

4.5 I/O interface usage instructions and application development

4.5.1 I/O input terminal function definition

If the monitoring zone group selection mode is set to "FILPS", the preset function of the I/O input terminal is defined as disarming and forced alarm control of the zone monitoring function, if the monitoring zone group selection mode is set to "I/O input", The preset function of the I/O input terminal is defined as the monitoring zone group selection, as shown in "Table 4.6 Input terminal preset function definition".

Table 4. 6 Input terminal preset function definition

"FILPS" monitoring area group selection mode					
Function	IN1	IN2	IN3	IN4	Signal requirements
Forced cancellation	High level				Effective immediately
Forced effective		High level			Effective immediately
Power saving mode			High	Enter: high	Lasts 5s

control				level	level	
					Exit: low level	Lasts 2s
"I/O input" monitoring area group selection mode						
Function		IN1	IN2	IN3	IN4	Signal requirements
Select and activate monitoring area groups	0#	Low level	Low level	Low level	Low level	duration≥1s
	1#	High level	Low level	Low level	Low level	duration≥1s
	2#	Low level	High level	Low level	Low level	duration≥1s
	3#	High level	High level	Low level	Low level	duration≥1s
	4#	Low level	Low level	High level	Low level	duration≥1s
	5#	High level	Low level	High level	Low level	duration≥1s
	6#	Low level	High level	High level	Low level	duration≥1s
	7#	High level	High level	High level	Low level	duration≥1s
	8#	Low level	Low level	Low level	High level	duration≥1s
	9#	High level	Low level	Low level	High level	duration≥1s
	10#	Low level	High level	Low level	High level	duration≥1s
	11#	High level	High level	Low level	High level	duration≥1s
	12#	Low level	Low level	High level	High level	duration≥1s
	13#	High level	Low level	High level	High level	duration≥1s

		level	level	level	level	
	14#	Low level	High level	High level	High level	duration≥1s
	15#	High level	High level	High level	High level	duration≥1s

4.5.2 I/O output terminal function definition

The preset function of the I/O output terminal is defined as the monitor signal output of “equipment ready” and area monitoring function, as shown in “Table 4.7 Output Terminal Preset Function Definition”.

Table 4. 7 Output Terminal Preset Function Definition

Function	OUT1	OUT2	OUT3	OUT4
Signal	Device ready	Warning	Forewarning	Cautions
Effective output status (default setting)	On (high level) ¹	On (high level)	On (high level)	On (high level)
Effective output status time ² (default setting)	Null	2S	2S	2S

1. The valid output state of the device ready signal is on (high level) and cannot be changed.
2. Meaning: The minimum duration of the output state of the OUT port when the signal is active. During this period, the output state of the OUT port does not change even if the signal is not valid.

Main point

- After the device is ready, you can read the status of the I/O terminal through TCP packets or control the output status of the OUT port.
- The effective output status and time of the area monitoring signal of the OUT port can be set separately using the FILPS software. For the setting method, please refer to Chapter 10 “Advanced Configuration” in the “Lidar Diagnostics and Configuration Software (FILPS) User Manual”.
- If it is not necessary to output the device ready signal or the area monitoring signal through the OUT port, the FILPS software can be used to cancel the association of the signal with the corresponding OUT port. At this time,

the output state of the OUT port is not affected by the signal state. For the setting method, please refer to Chapter 10 "Advanced Configuration" in the "Lidar Diagnostics and Configuration Software (FILPS) User Manual".

4.5.3 I/O interface network message

The I/O terminals can be read and set via TCP messages. The message type codes are:

- Read I/O terminal status: **LIM_CODE_IOREAD**
- Set I/O Terminal Status: **LIM_CODE_IOSET** (Output Terminals Only)

After receiving the above message, AS-21C will complete the reading or setting of the I/O terminal and reply a reply message. The message type code is **LIM_CODE_IOSTATUS**.

The TCP message used by the I/O interface are shown in Table 4.8 I/O Interface Network Message.

Table 4. 8 I/O Interface Network Message

Function	Network Message			Initiator	Reply message
	Type code	Data[0]	Data[1]		
Read	LIM_CODE_IOREAD	0	0	Application side	LIM_CODE_IOSTATUS
Set	LIM_CODE_IOSET	0/1 ¹	0: OUT1 ¹ 1: OUT2 ¹ 2: OUT3 ¹ 3: OUT4 ¹	Application side	LIM_CODE_IOSTATUS
Unset	LIM_CODE_IOSET_RELEASE	0	0	Application side	LIM_CODE_IOSTATUS
I/O statue	LIM_CODE_IOSTATUS	bit0: OUT1 ¹ bit1: OUT2 ¹ bit2: OUT3 ¹ bit3: OUT4 ¹ bit4: IN1 ² bit5: IN2 ² bit6: IN3 ²	0	AS-21C	none

		bit7: IN4 ²			
--	--	------------------------	--	--	--

1: "0" means "off", "1" means "pass".

2: "0" indicates Low level, and "1" indicates High level.

Main point

When the area monitoring function is enabled, using the `LIM_CODE_IOSET` message to set the output state of the output terminal, its operation priority is higher than that of the area monitoring signal. In the subsequent time, the area monitoring signal output is masked. If you want to restore the output of the area monitoring signal, you need to send a "Release I/O Terminal Status" message to AS-21C. The message code is `LIM_CODE_IOSET_RELEASE` and the reply message code of AS-21C is `LIM_CODE_IOSTATUS`.

When the AS-21C receives the `LIM_CODE_IOSET_RELEASE` message and restores the monitoring signal output of the area monitoring function, the AS-21C will also send the application system if the ON/OFF status of the I/O output terminal changes. `LIM_CODE_FMSIG` message.

Related Reading

For more information about I/O interface TCP packets, please read Section 7 "I/O Packets" in the Lidar Application Development SDK User's Manual.

4.6 Device self-test and device ready signal

4.6.1 Equipment self-test item

As a sensor for security applications, the AS-21C can self-test its own working status and discover internal and external factors that may affect the normal measurement function and regional monitoring function, and output it through the device alarm signal. The TCP message code of the device alarm signal is `LIM_CODE_ALARM`, and Data[0] in the message is the alarm code. When the alarm is restored, the AS-21C sends a corresponding device alarm release signal to the application. The TCP packet code is `LIM_CODE_DISALARM`.

Device self-test items include:

- **Internal error:** Device failure due to mechanical or electrical failure.
- **Measurement failure:** The correct measurement data cannot be generated, which

may be caused by the photoelectric device or the surrounding environment being too empty.

- **Measurement stop:** The application system sends a stop measurement command to the AS-21C due to power saving, service life, etc., causing the AS-21C to enter the power save mode, and the laser emission and distance measurement are suspended.
- **Occlusion/dirty:** The AS-21C is blocked at close range or the translucent cover is dirty, which will cause the AS-21C to fail to measure and ensure the effective range.
- **High and low temperature:** The internal temperature of AS-21C is too high or too low, which will cause the AS-21C to not measure properly and ensure the effective range.
- **Blocked by dense fog:** AS-21C is blocked by dense fog that the laser cannot penetrate. If the reflected echo energy generated by the dense fog is strong, erroneous measurement data will appear, which is generally an irregular arc with a radius of 2 to 4 meters.
- **The monitoring area is occluded:** some areas of the AS-21C's activated monitoring area group are occluded, resulting in the area monitoring function not being performed properly and there is a risk of underreport.

Table 4. 9 Equipment self-test item

Self-test item	Warning code	Response message
Internal error	LIM_DATA_ALARMCODE_INTERNAL	
Measurement failure	LIM_DATA_ALARMCODE_Occluded	When the surrounding environment is relatively empty, it may cause a false alarm.
Measurement stop	LIM_DATA_ALARMCODE_High_Temperature	
Occlusion/dirty	LIM_DATA_ALARMCODE_Low_Temperature	
Excessive temperature	LIM_DATA_ALARMCODE_Measurement_Failure	Trigger when the internal temperature exceeds 65 °C.
Too low temperature	LIM_DATA_ALARMCODE_Measurement_Stopped	Trigger when internal temperature is below 10 °C
Dense fog occlusion	LIM_DATA_ALARMCODE_Fog_Occluding	Use in a small indoor space may cause false alarms and should be enabled in an outdoor environment*.

Monitoring area	LIM_DATA_ALARMCODE_MN	
Occlusion	T_Field_Occluded	

*: For the method of enabling and disabling the fog occlusion detection, please refer to Chapter 10 “Advanced Configuration” in the “Lidar Diagnostics and Configuration Software (FILPS) User Manual”.

4.6.2 Device ready signal

The equipment ready signal is associated with the device self-test item, reflecting the basic working status of the AS-21C, providing a convenient method for the application system to monitor the operation of the AS-21C. When the status of the device self-test item changes, the AS-21C updates the status of the device ready signal according to the device configuration. When the device ready signal status changes, it will output to the application system through the TCP message and the I/O output port. The TCP message code of the device ready signal is **LIM_CODE_DEVICE_STATUS**, Data[0] in the message: bit0 is the device ready state, and Data[0]: bit1~bit8 is the current state of each device self-test item defined by bit.

The generation logic of the device ready signal is: when the status of all device self-test items associated with the device ready signal is **invalid**, the status of the device ready signal is **valid**. When the status of one or some of the device self-test items associated with the device ready signal is **valid**, the status of the device ready signal is **invalid**.

The device self-test item associated with the device ready signal can be configured via FILPS software, and the I/O output port corresponding to the device ready signal is **OUT1**. When the device ready signal is active, the output state corresponding to OUT1 is **on (high level)**; whether the output device ready signal through OUT1 can also be configured through FILPS software. In actual use, the correct associated content and I/O configuration should be selected according to the application requirements.

Main point

For the setting method related to the device ready signal, please refer to Chapter 10 "Advanced Configuration" in the "Lidar Diagnostics and Configuration Software (FILPS) User Manual".

4.7 Intrinsically safe configuration

When the AS-21C's regional monitoring function is used in security protection and security applications with high security requirements, it is necessary to fully consider the security risks caused by various abnormal factors. Ensure that in the event of these abnormal conditions, the system can automatically enter the security mode to avoid security incidents. The AS-21C's regional monitoring function and device ready signal are designed to ensure the intrinsic safety of the system, including the following two aspects:

- The I/O output port valid status of the area monitoring signal can be set: the I/O output valid status of the area monitoring signal can be set to "on" or "off".
- The zone monitoring signal is associated with the device ready signal: each zone

monitoring signal can be associated with a device ready signal, and when the device ready signal transitions to "inactive", the associated zone monitoring signal automatically transitions to the "active" state.

In actual use, the correct association content and I/O configuration should be selected according to the intrinsic security requirements of the application system. For related configuration methods, please refer to Chapter 6, "Device Configuration" and Chapter 10 "Advanced Configuration" in the "Lidar Diagnostics and Configuration Software (FILPS) User Manual" .

Important note

Here are some important usage tips related to intrinsic safety:

- The application system should correctly configure the association between the device ready signal and the device self-test item according to the requirements of the actual use environment to ensure that the device ready signal can reflect the working status of the AS-21C in a timely and comprehensive manner.
- For the AS-21C device ready signal output through the TCP message and I/O output port, the application system should design the necessary processing mechanism. For example, an alarm is given by an indicator light or a buzzer to ensure that the AS-21C's working status is abnormal and can be detected and reacted as necessary.
- The effective state of the I/O output port of the area monitoring signal should be set to "off" to ensure that the electrical status of the area monitoring signal actually received by the system is consistent with the effective status when abnormal conditions such as poor contact or cable breakage occur.
- The regional monitoring signal and the equipment ready signal should be configured as necessary to ensure that when the device is ready, the relevant regional monitoring signal can be automatically turned into **effective**, so that the system automatically enters the **security mode** and waits for maintenance and overhaul.

4.8 Power saving mode

For applications such as in-vehicle applications that use batteries as the power supply and have power saving requirements, the AS-21C has a power-saving control function that can enter the power-saving mode. In the power-saving mode, the laser emission and reception of the AS-21C will stop working, the power consumption of the whole machine (excluding heating power consumption) will drop by about **35%**, and it can quickly return

to the normal working mode to avoid delay effects on the application. . There are two ways to enter the power save mode:

- TCP message: Send the measurement control switch setting message to the AS-21C (the message code is `LIM_CODE_MEASURE_SWICHTH_STS_SET`) and set Data[0] to 0.
- I/O input port: Set the I/O input port `IN4` of the AS-21C to a **high level** for **5S**.

There are two ways to restore normal measurements:

- TCP message: Send the measurement control switch setting message to the AS-21C (the message code is `LIM_CODE_MEASURE_SWICHTH_STS_SET`) and set Data[0] to 1.
- I/O input port: Set the I/O input port `IN4` of the AS-21C to **low level** for **2** seconds.

Main point

- After entering the power-saving mode, the AS-21C will issue a “**measurement stop**” device alarm, and the ERR indicator will activate the **steady-on mode**. If the device ready signal is associated with the “Measurement Stop” self test, the device ready signal will be in an **inactive** state.
- The AS-21C area group can use the I/O input port `IN4` to perform power saving control on the AS-21C only when the selection mode is "FILPS".
- The delay time to exit from the power save mode and resume normal measurement about 0~40ms.
- For details on how to use `IN4` as a power-saving control port for configurable options, please refer to Chapter 10 "Advanced Configuration" in the Lidar Diagnostics and Configuration Software (FILPS) User Manual.

4.9 Device control and function switch

The AS-21C has a number of device control and data processing functions built in. The data processing function can be selectively turned on or off for application requirements. It can make the control options take effect in real time through the running control function of the FILPS software. The device configuration function of the FILPS software enables the control options to take effect continuously and performs real-time control by sending TCP messages to the AS-21C.

These device control features include:

- **Restart the device**: Restart AS-21C. The corresponding TCP message code is `LIM_CODE_SYS_REBOOT`.
- **Stop/Start Measurement**: Stop or start measurement to cause the AS-21C to enter or exit the power save mode. For details, please refer to "4.8 Power Saving Mode". The corresponding TCP message code is `LIM_CODE_MEASURE_SWICHTH_STS_SET`.

Data processing features include:

- **Rain, fog, and dust penetration:** Turn on the rain and fog soot penetration function, and filter the close-range measurement data generated by the rain, fog, and dust to find the target at a long distance. For details, please refer to "4.1.3 Rain and Fog Penetration". The corresponding TCP message code is `LIM_CODE_RAINDUST_FLT_SWICTH_SET`.
- **Static application:** The measurement data output of AS-21C has two modes, static application mode and movement application mode. In the static application mode, the raw measurement data is filtered using a time domain filter before output. At this time, the measurement data of the target that remains stationary in the scene has a small statistical error and can ensure the real-time performance of the measurement data of the moving target. In the movement application mode, the raw measurement data is directly output to ensure the real-time performance of the measurement data of the entire scene; the corresponding TCP message code is `LIM_CODE_STATIC_APP_SWICTH_SET`;
- **Airspace filtering:** The AS-21C has a built-in airspace filtering function to filter unreliable measurement results in measurement data. For example, "pseudo edge points" (see "4.1.4 pseudo edge points"), reduce the noise in the measurement data, the corresponding TCP message code is `LIM_CODE_SPATIAL_FLT_SWICTH_SET`;
- **Area monitoring function:** Enable area monitoring function, the corresponding TCP message code is `LIM_CODE_FIELD_MNT_SWICTH_SET`.
- **Dense fog detection function:** It detects the possibility of viscous fog in the scene, and generates a device that is blocked by dense fog. The corresponding TCP message code is `LIM_CODE_FOGCHK_SWICTH_SET`.

Main point

- In the factory setting, the application mode of the AS-21C is "Movement Application Mode".
- When the real-time control function of FILPS or the start/stop control of the function switch is performed through TCP message, it is valid only for the current running cycle of the AS-21C. After the AS-21C is restarted, the initial state of each function switch is determined by the device configuration.
- If you want to control the function switch of the AS-21C continuously, you should use the "Device Configuration" and "Advanced Configuration" functions of the FILPS software to modify the configuration of the function switch and upload it to the AS-21C.

Related Reading

- For the method of device control and configuration of the AS-21C using FILPS software, please refer to the “ Lidar Diagnostics and Configuration Software (FILPS) User Manual ” Chapter 6 “ Device Configuration ” , Chapter 9 “ Operation Status Monitoring ” , Chapter 10 "Advanced configuration."
- For TCP messages for device control and function switch control of the AS-21C, please refer to Section 10 “Device Control and Function Switch Messages” in the “ Lidar Application Development SDK User Manual” .

5. Device installation

Note

AS-21C has a sealing label at the seam of the device housing. If this label is damaged or the housing is disassembled, Akusense will no longer be responsible for the warranty of the product. The shell of the AS-21C can only be disassembled by Akusense approved personnel.

5.1 Installation preparation

5.1.1 Basic requirements for installation

The total weight of AS-21C is 0.6Kg. The basic requirements when installing AS-21C are:

- Fastening.
- Keep away from vibration sources or take shock absorption measures.
- Avoid being hit.

For outdoor work AS-21C, necessary protective equipment should be installed to avoid the translucent cover from being contaminated, damaged or exposed to direct sunlight. The standard protective cover PT22@AS-21C of the AS-21C can be installed, or it can be designed by itself.

5.1.2 Mounting material

- Aside from Akusense, the AS-21C-AT side mount/seat mount bracket (supplied), as well as the necessary mounting equipment.
- Select the set of side-mounted/seat-mounted composite stand AS-21C-AT provided by Akusense and necessary installation equipment as required.
- Select one set of protective cover AS-21C-PT 1 provided by Akusense and necessary installation equipment as required.
- Or a user-designed mounting bracket with mounting angle rotation adjustment capability, and two M4 screws of appropriate length.

5.1.3 Installation location selection

Note

- Avoid direct sunlight of the AS-21C, which may cause the internal temperature of the AS-21C to become too high and fail.
- Avoid direct collision of the AS-21C. This can cause the translucent cover to be worn or broken.
- Avoid direct exposure of AS-21C to dirt, grease, dust, and

other contaminants. This can cause the translucent cover to be covered with opaque material and cause measurement failure.

If this is possible, install an appropriate protective cover for the AS-21C.

5.1.4 Special reminder

When installing the AS-21C, pay special attention to:

- Make sure that the entire translucent cover's field of view is not obstructed by the mounting parts within the 300 degree scanning range of the AS-21C.
- If the installation condition is limited, the 300 degree scanning range of AS-21C cannot be ensured by the mounting parts or the mounting surface. The effective scanning angle of AS-21C needs to be adjusted. For details, see "5.5. Adjust the scan range".
- To be able to more easily see the two lights on the AS-21C front panel.
- To be able to easily operate the AS-21C front panel SLR operation buttons .
- There should be enough space on the left side of the AS-21C to facilitate the connection of the interface cable.
- Avoid excessive vibration of the AS-21C.
- If AS-21C is installed in a vibrating environment, loosening measures should be taken for the mounting screws.
- Check the tightening of the mounting screws regularly.
- Regularly check the contamination of the translucent cover.

Note

5.2 Mounting height and pitch angle

5.2.1 Mounting height and effective working distance

The spot laser spot emitted by AS-21C is circular, and the divergence angle in the vertical direction is the same as the horizontal divergence angle, which is 12.5mrad. As the detection distance increases, the spot gradually increases and the spot size increases. Stepping down gradually, if you hit the ground or install the surface, you will not be able to measure a farther target. Therefore, there is a certain relationship between the effective

working distance and installation height of AS-21C, as shown in "Figure 5.1 Effective working distance and installation height".

Taking the horizontal floor installation as an example, the relationship between the bottom installation height h of the AS-21C and the effective working distance d'_{max} is:

$$d'_{max} = 2(h + h_0 - r_0) / \alpha$$

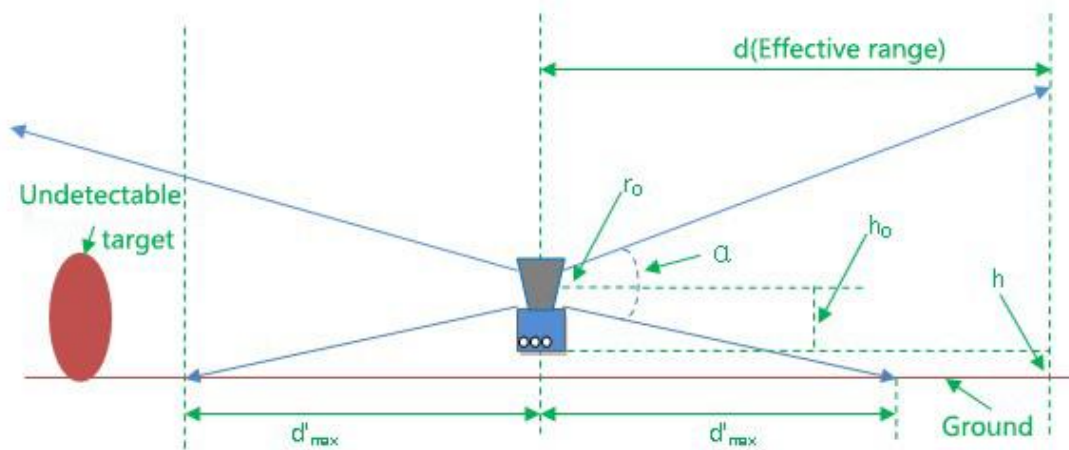
among them:

h_0 is the height of the light axis of the AS-21C relative to the bottom surface, $h_0 = 0.079\text{m}$.

r_0 is the spot exit diameter, $r_0 = 0.008\text{m}$.

α is the divergence angle of the spot, $\alpha = 0.0125$.

Figure 5.1 Effective working distance and installation height



Important note

The actual installation height of the AS-21C is to be determined based on the relative height between the ground or reference work surface at the work site and the installation position, and the working range requirements.

5.2.2 Multi-LiDAR Height and Angle Adjustment at the Same Time

If there are multiple Akusense lidars working in the environment at the same time, the laser beam emitted by one Lidar should be prevented from directly entering the other laser Lidar. Otherwise, the measurement of the two lidars may be interfered with each other. Mismeasurement data is generated at each specific scan angle. If there is such a possibility, the height or pitch angle of the laser scanning surface of the Lidar should be adjusted to avoid the mutual interference, as shown in "Figure 5.2 Scanning surface height adjustment" and "Figure 5.3 Scanning surface tilt angle adjustment".

Figure 5.2 Scanning surface height adjustment

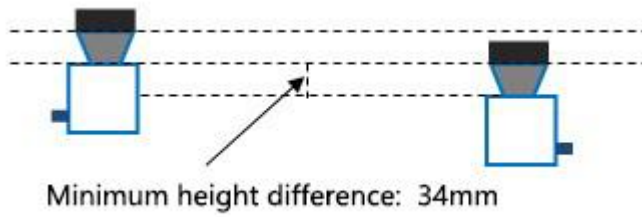
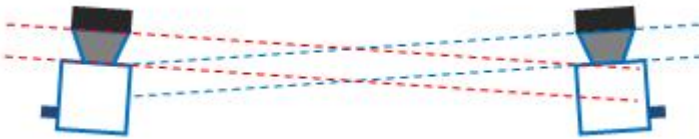


Figure 5.3 Adjustment of pitch angle of scanning surface



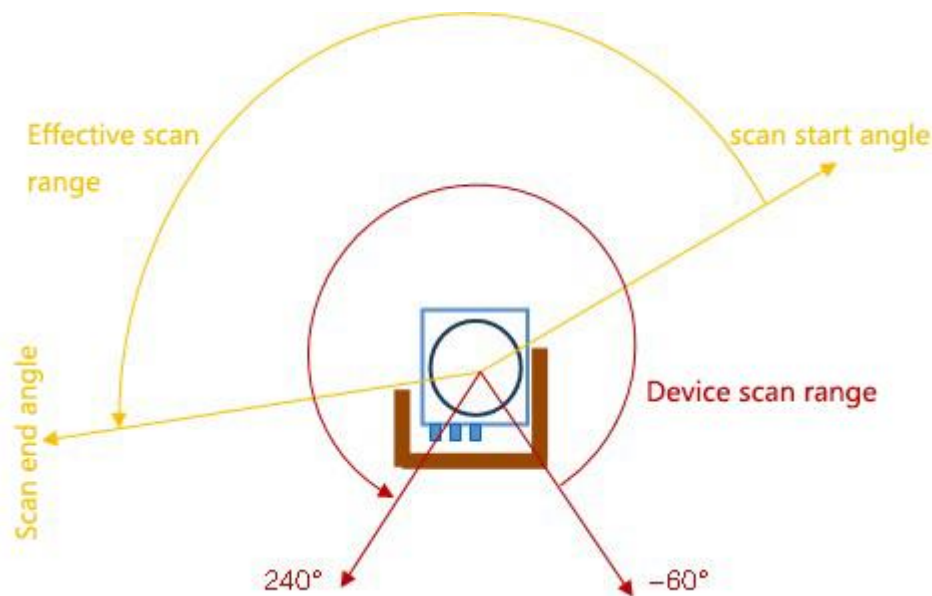
Important note

If the above installation adjustment cannot be achieved, you can try to power off and re-power the misfired laser radar until the mismeasured data disappears. Once the mismeasurement disappears, it will not reappear in a short time.

5.3 Adjust the scan range

In the factory setting, the original working scan range of the AS-21C is a device scan range of 300°, the scan start angle is -60°, and the scan end angle is 240°, as in "Figure 10.1 Measurement Coordinate System/Scan Range/range is shown. When using the AS-21C, if there is an object at a height of the laser scanning surface within the original working scanning range, if there is an object at a position not exceeding 5 cm from the transmissive cover, for example, a self-designed protective cover structure, Or the non-detachable objects or walls in the installation environment will cause the device to block alarms, and may also trigger the output monitoring signals of the area monitoring function. In order to avoid this, the scanning start angle and the scanning ending angle need to be adjusted according to the actual effective scanning range of the AS-21C in the working environment, as shown in "Figure 5.7 Effective scanning range".

Figure 5.4 Effective scanning range



You can use FILPS software to adjust the AS-21C's scan start angle and scan end angle as follows:

- Use FILPS to connect AS-21C through Ethernet to configure the device of AS-21C. Please refer to "7.3 Device Configuration" for detailed operation procedures.
- Open the "Operation Status" tab in the device window, then you can observe the measurement data of the AS-21C on the use of the scene. Use the mouse to magnify the measured scene depth image to the maximum level, then use the "Special Angle Measurement Data" function to check the occlusion angle of the occluder and determine the effective scanning range of the AS-21C, as shown in "Figure 5.8. Effective scanning range"

- On the “**Device Configuration**” tab page of the Device window, in the “**Running Configuration Parameters**” column, enter the correct starting and ending angle values in the “**Valid Angle Range**” to edit box, as shown in Figure 5.9. "Software Operation Interface" shows that FILPS will adjust the input value according to the current scanning angle resolution of AS-21C.
- Press the "**Upload to Device**" button to send the configuration data to AS-21C. At this time, AS-21C will restart automatically.

After the reboot of AS-21C, the new set of work scan range parameters start to work. At this time, AS-21C only outputs the measured data within the scope of the work scan, and the regional monitoring function only deals with the data in the scope of the work scan.

Related Reading

For details on the adjustment of the scanning angle range, please read “Lidar Diagnostic and Configuration Software (FILPS) User's Manual”, Section 7.11 “Specific Angle Measurement Data” and Section 6.3 “Operation Configuration Parameters”.

Figure 5.5 Determination of Effective Scanning Range by Measured Data

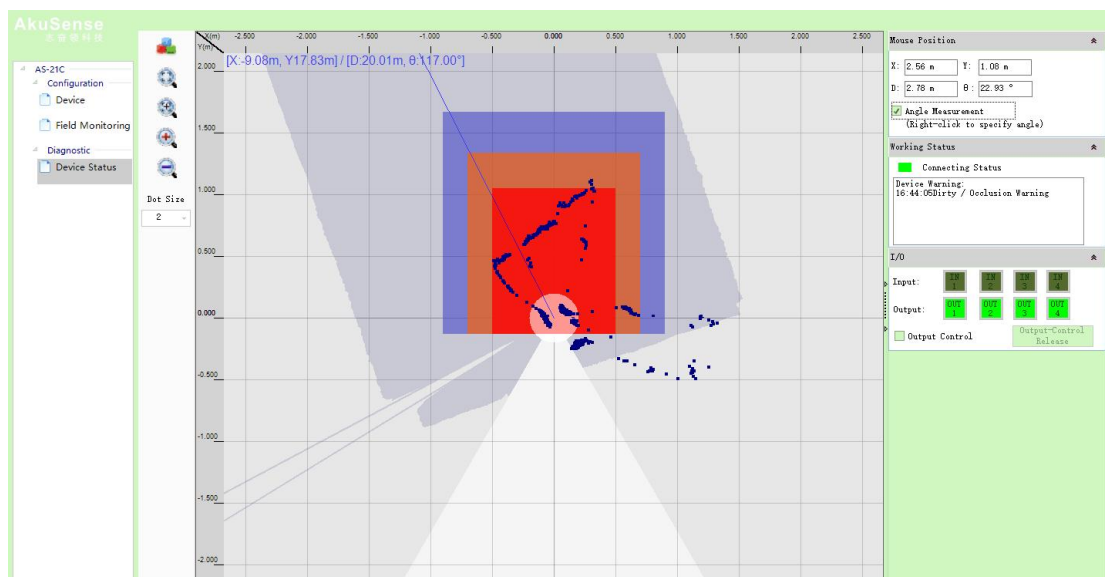
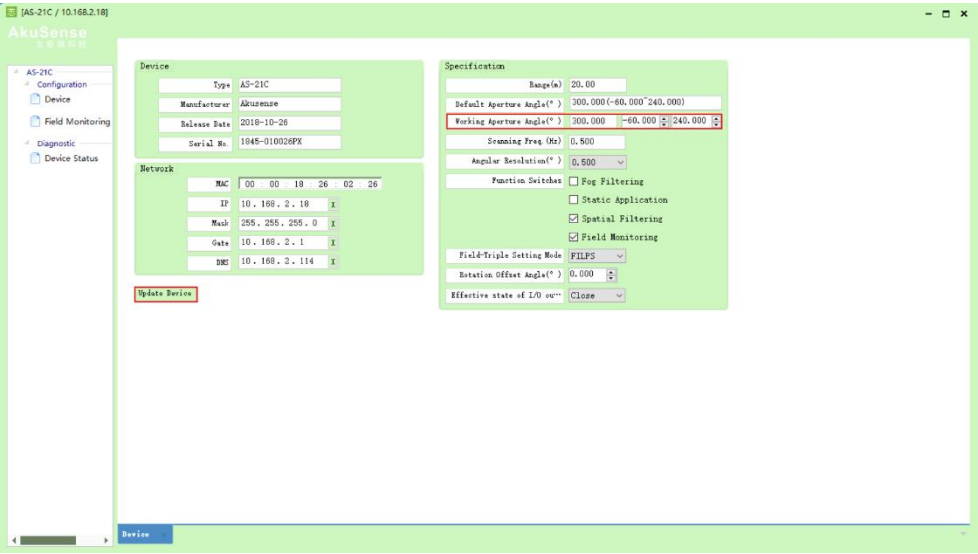


Figure 5.6 Effective Scan Range Adjustment Software Operation Interface



6. Electrical Installation

Note

When installing the AS-21C electrically, pay special attention to:

- Select personnel with electrical installation qualifications to operate.
- Avoid electrified installation, otherwise the equipment may be damaged.

6.1 Installation steps

For the electrical installation of AS-21C, please follow the following basic steps:

- Prepare the appropriate power supply for the AS-21C and complete the wiring of the power interface.
- According to the needs of the application to complete the I / O interface wiring.
- Connect to PC via Ethernet interface, ready to configure AS-21C.
- Connect the power connector and prepare for power-up operation.

6.2 Installation preparation

6.2.1 Power supply

The power supply voltage requirement of AS-21C is 10V~28V DC. The power consumption under normal operation is 5W, and the maximum power consumption is 6W. When the internal temperature is lower than 20 °C, the built-in heating module will start automatically, and when it is higher than 30 °C, the heating will stop automatically. When the heating module is started, the power consumption of the whole machine under the DC12V supply voltage is 8.6W, and the power consumption of the whole machine under the DC24V supply voltage is 19.4W. Please use the above standard to provide power when using.

Important note

Please read "10.1 Data Sheet" for the complete requirements of AS-21C for power supply. The user shall comply with local regulations and perform necessary protection of the power supply cable of AS-21C to avoid short circuit or overload of the power supply. In addition, an emergency circuit breaker shall be installed on the power supply cable for emergency use. Cut off the power supply quickly.

6.2.2 Power supply requirements and temperature characteristics for automatic heating

In order to ensure the normal operation of the equipment under low temperature conditions, and to avoid excessive temperature changes caused by ambient temperature and excessive temperature drift of the measurement results, the AS-21C has a built-in heating module. When the internal temperature is lower than 20 ° C, the built-in heating module will automatically start, and when it is higher than 30 ° C, the heating will stop automatically.

Warning

The AS-21C internal heating module and the AS-21C mainframe common power supply. If the user does not use the CB12@DC002M2LD cable, but directly uses the internal lead of the AS-21C composite interface cable, be sure to connect the pair of red wires in the lead respectively. (Vs) and black line (GND). Otherwise, when the ambient temperature is low under the DC24V power supply, the heating module automatically start up, which may cause the current of the power supply lead to exceed the lead load and cause equipment damage or fire.

When the ambient temperature is low, the device dissipates heat more quickly, the internal temperature drops faster, and the heating module will cycle periodically. The start-up cycle is related to the ambient temperature and the supply voltage. Figure 6.1 and Figure 6.2 show the start-up cycle of the automatic heating module of the device under different supply voltages when the ambient temperature is 0 ° C. The heating cycle under the DC12V supply condition is approximately About 60 minutes, and the heating cycle under DC24V power supply conditions is about 45 minutes. The application of the system in a low temperature environment requires consideration of the heating cycle factor when powering the AS-21C.

Note

In Figure 6.2, under the DC24V power supply condition, the heating plate heats up faster, and its actual temperature will be higher than the temperature of the temperature control switch. When the temperature of the temperature control switch reaches 30 ° C and the power supply of the heater is turned off, the peak temperature of the machine will eventually exceed 30 ° C under the residual temperature of the heater chip.

Figure 6.1 Heating start cycle at 0°C/DC12V

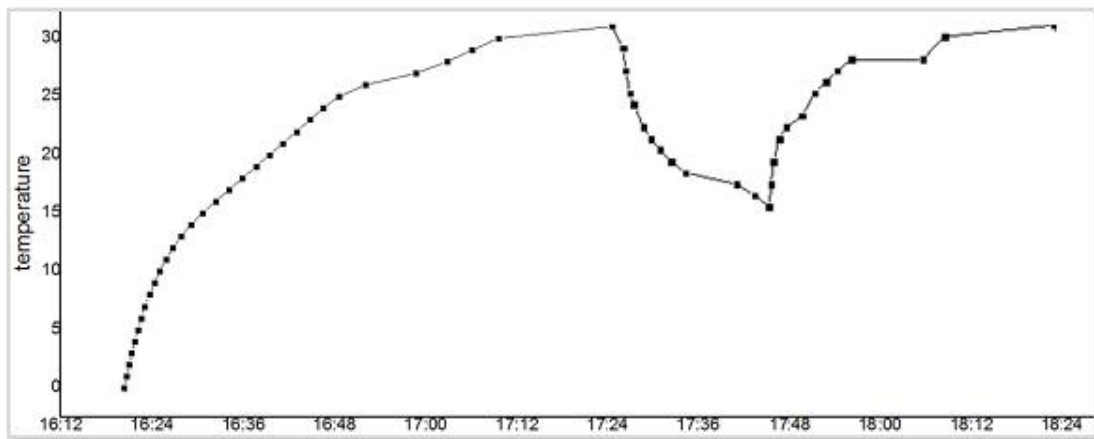
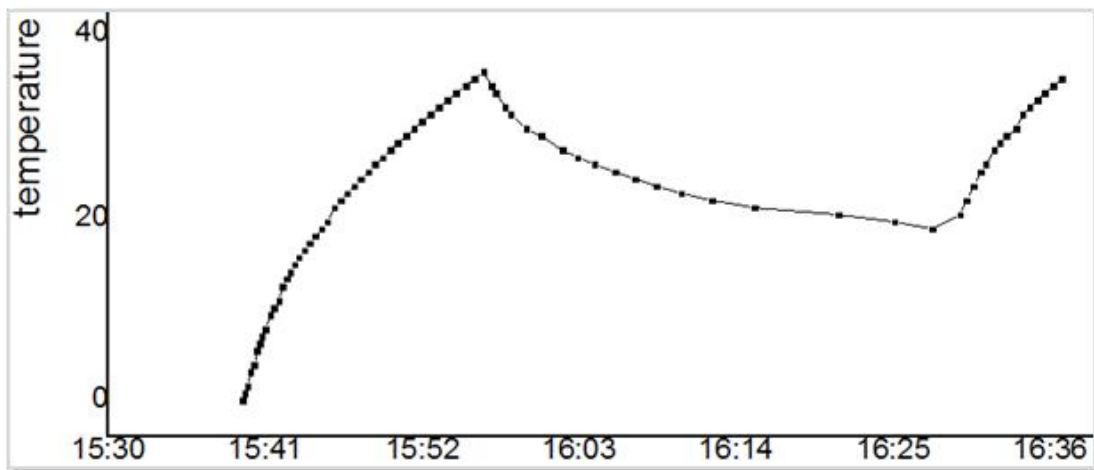


Figure 6.2 Heating start cycle at 0°C/DC24V



6.2.3 Grounding requirements

Warning

- It must be ensured that the ground of the mounting surface of the AS-21C is equipotential to the ground of the remote equipment. Otherwise, the current generated by the ground potential difference will flow through the outer casing of the AS-21C and the following potential hazards occur:
- Contact voltage is generated on the outer casing of the AS-21C and causes personal injury.
- Causes the AS-21C to not work properly.
- It causes a heating effect on the cable and creates a fire hazard.

6.2.4 Wire requirements

Please use copper wires to complete the wiring. The cross-section of the wires is as shown in “Table 6.1 Wire Requirements”.

Table 6. 1 Wire Requirements

interface	Wire cross-section area requirements
Power	Power supply installation: minimum 0.25mm ² The power supply is not installed nearby: for a DC24V power supply with a transmission distance of 20 meters, a minimum of 1mm ²
Ethernet	CAT5 standard network cable
I/O lead	Min 0.25mm ² 50m transmission distance, minimum 0.5mm ²

6.2.5 Connect PC

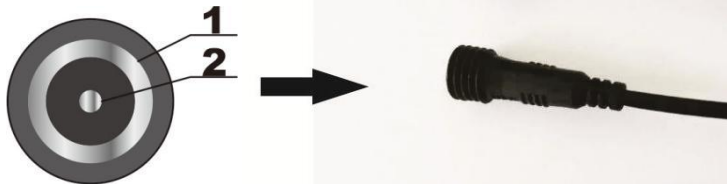
Please use RJ45 standard network cable to connect to PC through Ethernet port.

6.3 Device interface signal definition

6.3.1 Power interface signal definition

The composite interface cable of AS-21C is prefabricated with DC002 power interface socket, which can be used by users directly. The signal definition of power interface and the internal thread color of the composite interface cable are shown in “Table 6.2 Power Interface Signal Definition”.

Table 6. 2 Power Interface Signal Definition

			
Item No.	Signal name	Interface cable internal color	Function
1	GND	Black (2, need to be connected)	Power ground
2	Vs	Red (2, need to be connected)	Power

Warning

The AS-21C internal heating module shares power with the AS-21C host. If the user does not use the CB12@DC002M2LD cable, but directly uses the internal lead of the AS-21C composite interface cable, be sure to connect the pair of red wires in the leads. (Vs) and black line (GND). Otherwise, under the DC24V power supply, when the ambient temperature is low and the heating module is automatically started, the current of the power supply lead may exceed the lead load, causing damage or fire.

6.3.2 Network interface signal definition

The composite interface cable of AS-21C is prefabricated with RJ45 network interface socket, which can be directly used by the user. The signal definition of the network interface and the internal thread color of the composite interface cable are shown in "Table 6.3 Network Interface Signal Definition".

Table 6. 3 Network Interface Signal Definition

Signal	Function	Interface cable internal thread color		Network cable color	Network line sequence
		Stainless steel nut outlet seat	Plastic nut outlet seat		
RX+	Positive data reception	dark green	White green	White green	3
RX-	Negative data reception	green	green	green	6
TX+	Positive data transmission	Black red	White orange	White orange	1
TX-	Negative data transmission	Orange	Orange	Orange	2

6.3.3 I/O interface signal definition

The I/O interface of the AS-21C is the wiring of the composite interface cable. The signal definition and wire color are shown in "Table 6.4 I/O Interface Signal Definition".

Table6. 4 I/O Interface Signal Definition

Signal	Function	Lead color
IN1	Universal input 1# positive	White
IN2	Universal input 2# positive	Yellow
IN3	Universal input 3# positive	Brown
IN4	Universal input 4# positive	Purple
GND IN	Universal input GND	Blue
OUT1A	Universal output 1#	Black White
OUT2A	Universal output 2#	Black Yellow
OUT3A	Universal output 3#	Black Brown
OUT4A	Universal output 4#	Black Purple
OUTB.0	Universal Onput GND	Black Blue

Explanation:

- The input signal of the universal input positive terminal "IN1...4" is a level input (vs. common input common ground "GND IN") and the logic states are "High level" and "Low level".
- The Universal output "OUT1...4A" is the PNP switch output (vs. power "Vs") and the logic states are "on" and "off".
- To simply wiring, V / GND can be used as the power supply for the external circuit of the I/O terminal.

Related Reading

For the electrical characteristics of the I/O signal, read "10.1 Data Sheet."

6.4 Interface cable wiring

The AS-21C has an IP67 protection rating. When connecting cables, pay attention to:

- If you use the supplied AS-21C-EC power cable for power wiring, you should pay attention to tighten the waterproof thread between the plug of the power cable and the DC outlet of the AS-21C.
- If you use a user-made power cable, you should pay attention to the waterproof connection between the cable and the DC outlet of the AS-21C.
- When RJ45 Ethernet cable is used to connect the RJ45 Ethernet socket of AS-21C, waterproof protection must be provided using the supplied AS-21C-WJ waterproof jacket.
- If you do not use the AS-21C's RJ45 Ethernet socket or I/O interface leads, waterproof protection is required. Do not expose.

Note

The deliverables of AS-21C have a AS-21C-EC finished power cable with a DC002 type plug. Normally, they can be used directly. The wiring is defined as "Table 6.5 Power Cable (AS-21C-EC) Lead Signal Definition "Shown.

Table 6. 5 Power Cable (AS-21C-EC) Lead Signal Definition



No.	Signal	Function	Lead color
-----	--------	----------	------------

1	GND	Power ground	Black
2	Vs	power supply	Red

Note

The wiring of the power interface must be completed in strict accordance with the correct wiring sequence, otherwise it may cause permanent damage to the device.

6.5 I/O interface external reference circuit

Figure 6.3 I/O Interface Input Terminal External Circuit (Ref. GND Level)

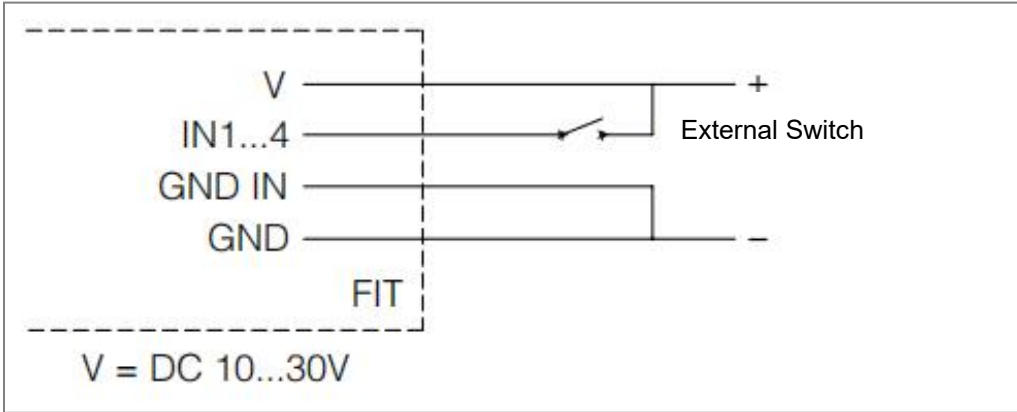
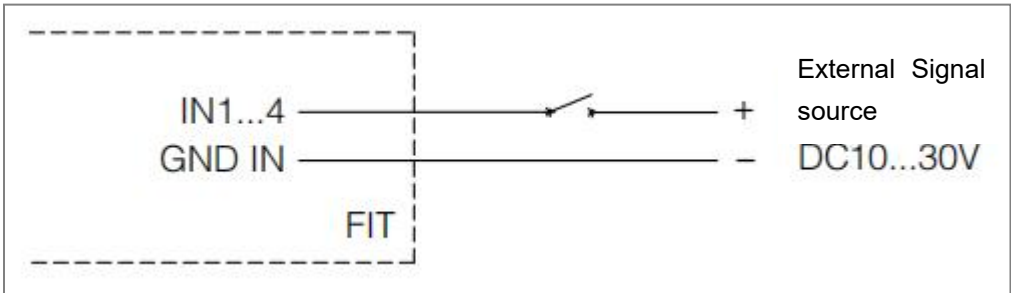


Figure 6.4 I/O Interface Input Terminal External Circuit (Floating)



Important note

In the input connection mode shown above, the voltage of the external signal power supply must be 10V~30V DC.

Figure 6.5 I/O Interface Output Terminal External Circuit (PNP Mode)

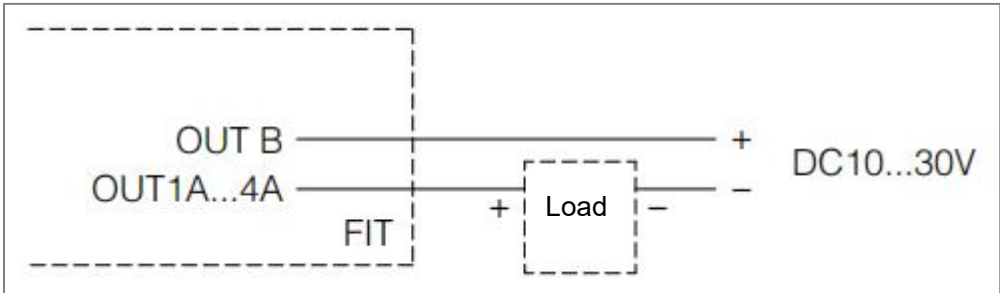
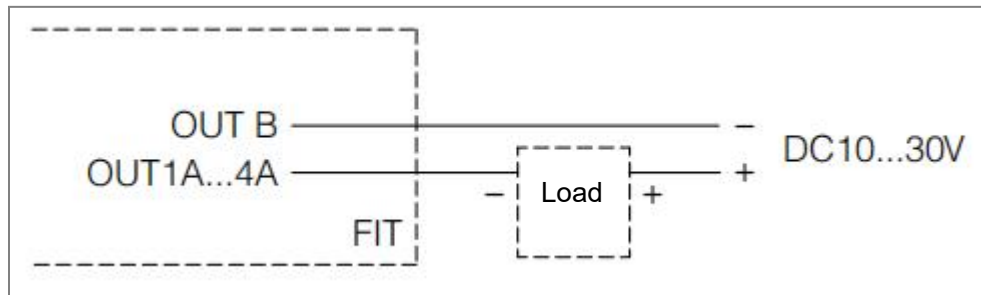


Figure 6.6 I/O Interface Output Terminal External Circuit (NPN Mode)



7. Equipment configuration and commissioning test

Caveat

Incorrect device configuration can result in equipment damage or abnormal operation. Before configuring the AS-21C, make sure that the equipment has been fully inspected. Please carefully read "2 basic operations and precautions" and make necessary preparations.

The device configuration and commissioning tests of the AS-21C require the use of "Lidar Diagnostic and Configuration Software (FILPS)". FILPS is used to configure the operating parameters of AS-21C according to the application requirements, obtain and display measurement data, and test the area monitoring function and I/O interface input and output functions.

Related Reading

For detailed usage of FILPS, please read "Lidar Diagnostic and Configuration Software (FILPS) User's Manual".

7.1 Configuration and Test Procedures

- Install FILPS software on the PC.
- Establish a TCP connection between PC and AS-21C through the Ethernet port.
- According to the requirements of the application, the equipment parameters and function parameters of AS-21C are adjusted and saved.
- Perform functional tests on the AS-21C.

7.2 Software and equipment preparation

- Install FILPS software on the PC using the "FILPS Installation Package" in "Lidar Diagnostic and Configuration Software (FILPS)".
- **Turn off the power of the AS-21C.**
- Directly connect the Ethernet port between PC and AS-21C.
- On the PC, in addition to the network adapter connected to the AS-21C, disable the other network adapters and configure "192.168.0.xxx / 255.255.255.0" for the network adapter connected to the AS-21C. IP address, x takes 0...254 can be, does not conflict with the IP address of other network adapter.
- According to AS-21C I/O lead signal definition and I/O interface input and output external circuit requires connecting external devices such as switches, indicator lights, ready to test the area monitoring function and I/O interface control function .

7.3 Basic test

In the factory setting of AS-21C, the area monitoring function is set to the start state, the monitoring area group selection mode is set to "I/O input", and AKU-21C can be used without the PC. The AKU-21C's area monitoring function performs basic tests.

- Disconnect the IN1...4 input of the I/O interface of the AS-21C. At this time, the activated monitoring area group is 0#. The alarm area is a circular area with a radius of 2 meters.
- After powering on the AS-21C, the "HTR" indicator  is off and the device enters the initialization state. After about 12 seconds, the device is turned on and the device has started normal measurement.
- Press the front panel SLR operation button of AS-21C, keep it until the "HTR" indicator enters the fast flash mode (2.5Hz), release the button, and retreat to the position outside the 0# alarm zone, wait 12 seconds. At the time of bell, AS-21C has completed background self-learning and automatically enabled "Background tailoring" for the 0# monitoring area group.
- If there is a target entering the alarm zone of the 0# monitoring zone group, the AS-21C will output an "alarm" monitoring signal on the OUT2 of the I/O interface, and the output can be observed by an external indicator on OUT2.

7.4 Device Configuration

- Power up the AS-21C and the device enters the initial state. After about 12 seconds, the "HTR" indicator lights up, and the device has started normal measurement.
- Run FILPS on the PC.
- Find the AS-21C that is being configured in the "Online Device" form on the FILPS screen, as shown in "Figure 7.1 Online Device Form". double-click on the AS-21C device icon to place the AS-21C is added to the "New Project" form. Double-click the AS-21C device icon in the project form to establish the TCP connection with the AS-21C. At this time, it is configured. The AS-21C's device form will appear as shown in the "Figure 7.2 Device Form and Device Configuration Tab".
- In the device form of the AS-21C, open the "Device Configuration" tab, as shown in Figure 7.2 Device Form and Device Configuration Tab, Modify the Ethernet configuration of the AS-21C according to the requirements of the application system and enable the area monitoring function. Press the "Upload to Device" button to send the configuration data to the AS-21C. In this case, the AS-21C will restart automatically.

Figure 7.1 Online Device Form

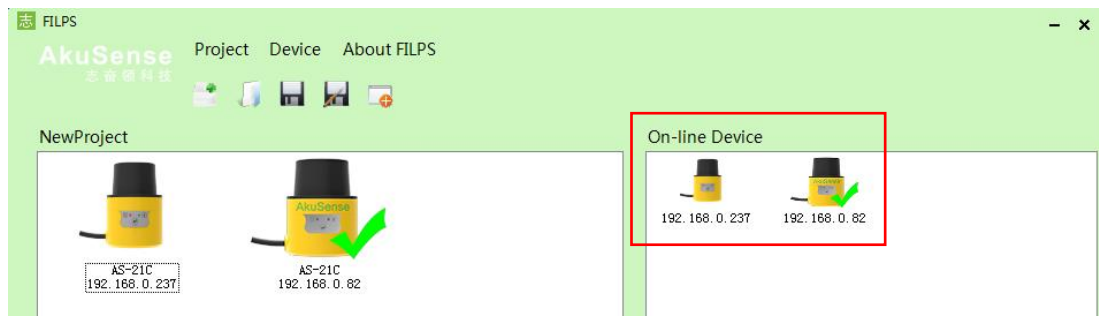
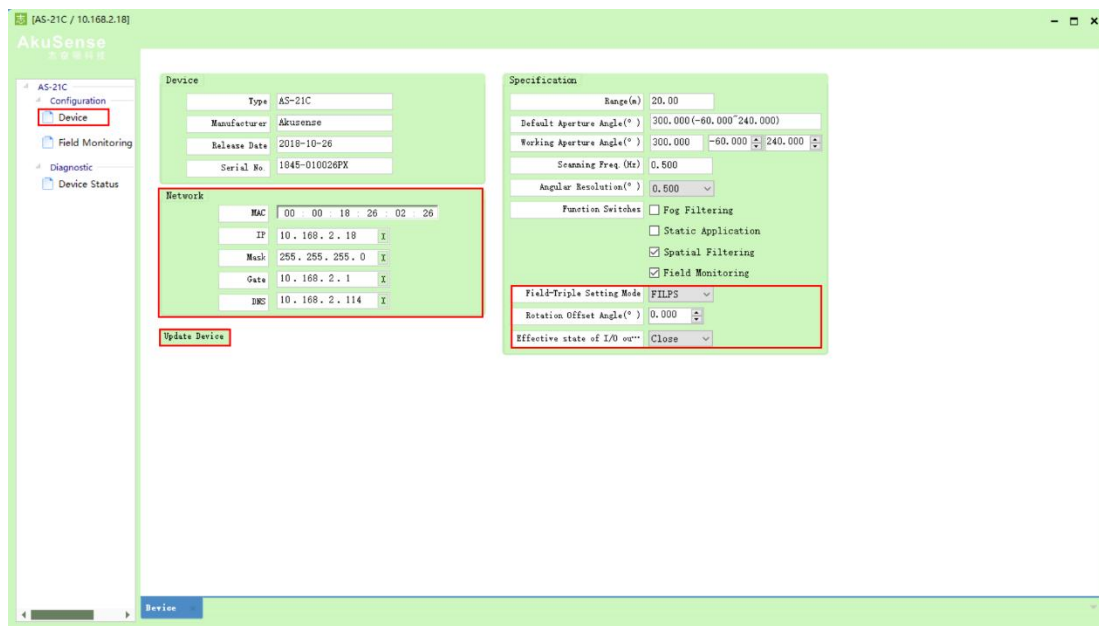


Figure 7.2 Device Form and Device Configuration Tab



7.5 Try running the test steps

When the AS-21C is restarted, and the "HTR" indicator turns to the usual light state, the FILPS is reconnected to the AS-21C to start the test run test on the device. The steps are as follows:

- Open the "Run Status" tab in the device window, as shown in "Figure 7.3 Operation Status Tab", then you can observe the measurement results of the AS-21C on the use of the site, and observe the output of the monitoring signal. At the same time, the output of the I/O interface output of the AS-21C can be observed through an external indicator, and the forced control function (disarm/force alarm) can also be tested through an external switch.
- Open the "Operation Status" tab, in the "I/O Interface" column, as shown in "Figure 7.4 I/O Interface Status" and "Figure 7.5 Output Terminal Status Control", Use external switches and indicators to test functions such as I/O reading, I/O output setting, and releasing I/O output settings.

Related Reading

Please read the "Test Run Test" section of the "AS-21C Concise User's Manual" for test preparation and basic test procedures, and design other test methods as needed.

Figure 7.3 Operation Status Tab

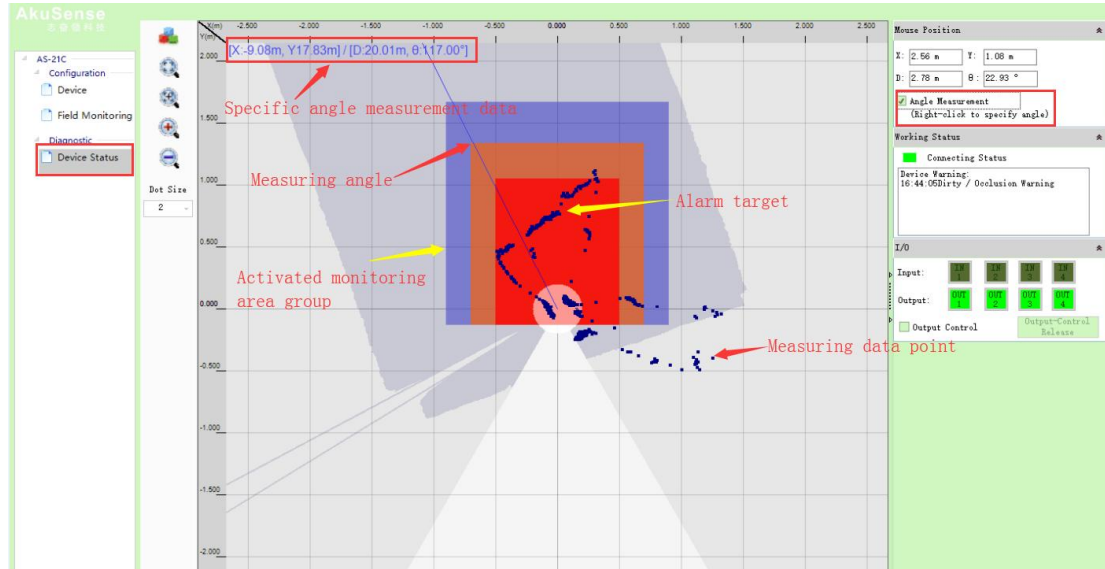


Figure 7.4 I/O Interface Status

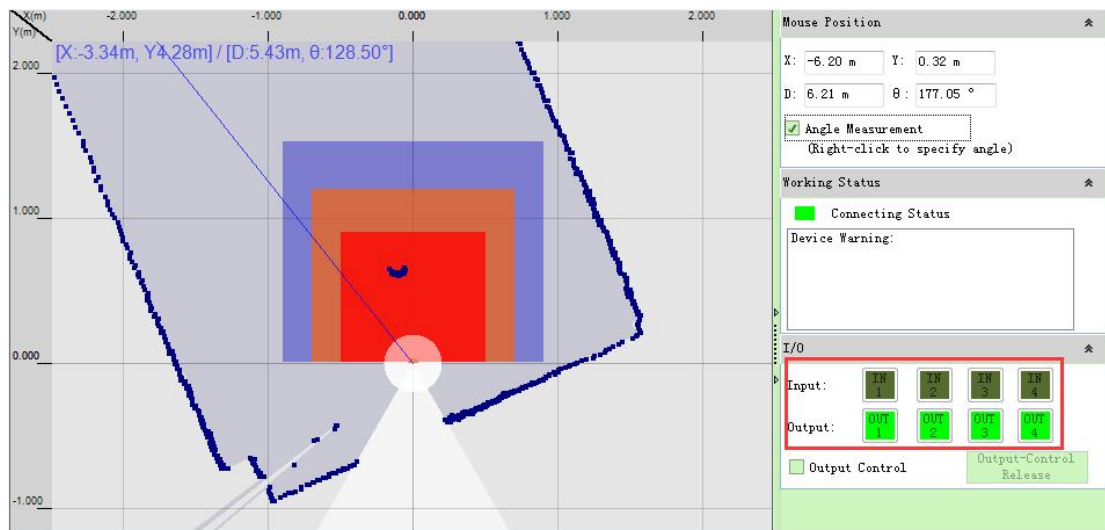
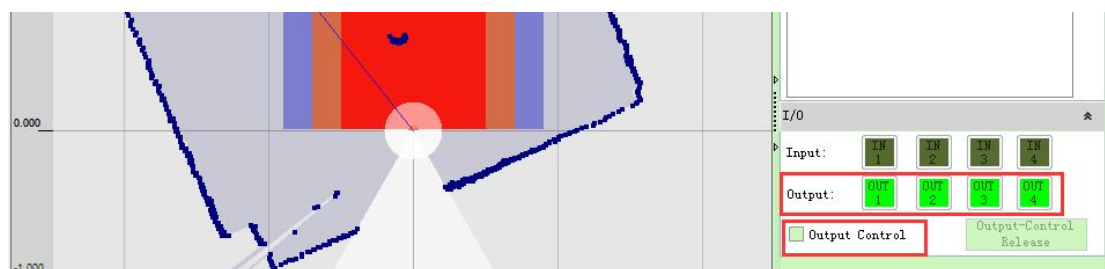


Figure 7.5 Output Terminal Status Control



8. Equipment maintenance

Note

AS-21C has a sealing label at the seam of the device housing. If this label is damaged or the housing is disassembled, Akusense will no longer be responsible for the warranty of the product. The shell of the AS-21C can only be disassembled by Akusense approved personnel.

8.1 Operation and Maintenance

The AS-21C working in a clean environment does not require maintenance. When working in an environment that may be contaminated by dirt, the main maintenance work is to clean the translucent cover. When cleaning the translucent cover, pay attention:

- Do not use corrosive or solid-containing cleaning agents.
- Do not use hard cleaning materials.

The static electricity on the translucent cover will cause the dust particles to attach easily and cause the measurement capability to decline. At this time, the lens cover should be wiped with a lens cloth with the ability to eliminate static electricity.

8.2 Replace equipment

When the failed AS-21C is replaced, if the original equipment's cables and plugs are not damaged, they do not need to be replaced. Only the failed AS-21C can be replaced. The replacement procedure is as follows:

- Turn off the power switch of the replaced AS-21C.
- Remove all connected cables.
- Install AS-21C for replacement (see "5 equipment installation" and "6 electrical installation").
- Connect all cables.
- Open the power switch.
- Configure the replacement AS-21C by PC (see "7.4 device configuration").

After the AS-21C is restarted, the system can be reused.

9. Troubleshooting

Note

There is a seal label on the joint of the equipment shell of AS-21C. If the label is damaged or the shell is disassembled, Akusense is no longer responsible for the warranty of the product. The shell of AS-21C can only be dismantled by Akusense authorized personnel.

1. The "HTR" indicator  keeps off:
After AS-21C is powered off and restarted after power failure, if multiple restarts still fail to return to normal, you need to return to the factory for maintenance.
2. The "ERR" indicator  is on or blinking continuously:

Table 9. 1 "ERR" Indicators Troubleshooting

Indicator status	reason	disposal method
Bright	internal error	After the power is turned off, the power is turned on again. If the power is turned on more than once, it cannot be returned to normal.
	Stop measurement	restart measurement with FLIPS
Short flash (1Hz)	Transmissive cover dirty / cover	Clean the translucent cover or remove the shield.
	Blocked by dense fog	If it is confirmed that it is not fogging, use FILPS to turn off "Dense fog occlusion detection" .
Long flicker (0.5Hz)	High and low temperature alarm	High temperature: power-off cooling, installation of insulation or protective cover.
		Low temperature: Continue to operate. If it does not return to normal for a long time, you need to add heating devices to the equipment.

3. FILPS cannot find the configured AS-21C / Unable to connect directly to the AS-21C with a PC:
See Chapter 10, "Troubleshooting," in the Lidar Diagnostic and Configuration Software (FILPS) User's Manual.

10. Specifications

10.1 Data sheet

Table 10. 1 Data Sheet

Function parameter	Min value	Typical value	Max value
Scan angle range	300°		
Scan angle	-60°		240°
Scan angle resolution	0.5°(system default)/0.25°/0.125°		
scanning frequency	25Hz(system default)/12.5Hz/6.25Hz		
Target reflectance	3%		1000% (reflector)
Measuring range	0.1m		20m
18% reflectance range			20m
10% reflectance range			15m
Measurement delay ¹	3.3ms	40ms	76.7ms
Measurement error			
System error		±2cm	±6cm
Statistical error (1σ)		±1cm	±2cm
Temperature drift			0.4cm/°C
Power on startup delay	25s	27s	30s
Regional monitoring function			
Monitoring mode	Point Monitoring / Target Width Monitoring / Contour Monitoring		
Number of regional groups	16		
Number of concurrent work area groups	1		16
TCP response delay ²	13.3ms	60ms	106.7ms
I/O response delay ³	13.3ms	50ms	86.7ms
General parameters	Min value	Typical value	Max value
Laser transmitter	Pulsed laser diode		

Laser wavelength	895nm	905nm	915nm
Laser Level	Class 1 (GB 7247.1-2012, Eye safety)		
Laser outlet caliber	8mm		
Laser divergence angle	11.6mrad	12.5mrad	12.8mrad
Distance from emission axis to Rear side	45mm		
Height from scanning surface optical axis to underside	79mm		
Ambient light intensity	0lux		80,000lux
Housing protection degree	IP65 (GB 4208-2008)		
Insulation resistance	1MΩ (GB 16796-2009, 5.4.4)		
Dielectric strength	0.5KV (GB 16796-2009, 5.4.3)		
EMC Test			
Electrostatic discharge	6KV (GB/T17626.2-2006, Class 3)		
Fast burst	1KV (GB/T17626.4-2008, Class 2)		
Electromagnetic radiation immunity	GB/T17626.3-2006, Class 2		
Surge immunity	GB/T17626.5-2008 Power interface: 1.2/50us, 2KV/1KA (Class 3) Ethernet interface: 10/700us, 1KV/25A (Class 2) I/O interface: 1.5/50us, 0.5KV/0.25KA (Class 1)		
Impact	GB/T 2423.5		
Single impact	15g, 11ms		
Continuous impact	10g, 16ms		
Vibration	GB/T 2423.10		

Frequency Range	10Hz		150Hz
Magnitude	5g		
Temperature	GB/T 2423.1, GB/T 2423.2		
Operating temperature	-25°C		+50°C
Storage temperature	-30°C		+70°C
Humidity	93%RH, +40°C, 2h (GB/T 2423.3)		
Altitude			5000m
Housing			
Material	Al(GD-ALSi12 3.2582.05)		
Color	White/Yellow		
Translucent cover			
Material	PC		
Surface coating	Wear-resistant coating		
Dimension ⁴			
Length	83.5mm		
Width	85mm		
Height	104.9mm		
Interface cable length	1m		
Weight	0.6Kg		
Electrical parameters	Min value	Typical value	Max value
Measuring power			
Type	DC power supply		
Supply voltage	10V	24V	30V
Starting current ⁵			0.12A
Operating current ⁵			0.14A
Power consumption	3.4W	3.4W	3.9W
Heating power			
Type	DC power supply		

Supply voltage	10V	24V	30V
Starting current ⁵			0.12A
Operating current ⁵			0.25A
Power consumption	7.6W	6W	6W
Electrical Interface	Min value	Typical value	Max value
Power interface	DC002 Round Socket, Female, 2 Core		
Ethernet interface	RJ45 socket, Female, 4-core		
Rate	10/100 Mbps		
I/O interface	SM2.54, 5P, Female & Male		
I/O interface input terminal	IN1 / IN2 / IN3 / IN4		
Quantity	4		
Type	Level input (vs. universal input common ground "GND IN")		
High level input impedance		10KΩ	
High level	10V	24V	28V
Low level			1.2V
Input capacitance		10nF	
Static input current	0.8mA	2.2mA	2.8mA
Preset function	Monitoring area group selection (IN1...4) Zone monitoring signal forced cancel (IN1) / forced active (IN2), active level: high power save mode controller (IN4), active level: high level		
I/O interface output terminal	OUT1A / OUT2A / OUT3A / OUT4A		
Quantity	4		
Type	PNP / NPN		
Switch status	off		
Switch voltage	10V	24V	30V
Output current(Simplex)			100mA
Output current(Sum)			400mA
Output capacitance			300pF
Preset function	Equipment ready (OUT1), valid state: On		

Area Monitoring Signal Output (OUT2...4), Active State: Configurable
--

- 1: It is related to the location and timing of the target being measured, and does not include TCP/UDP network transmission delay.
- 2: The delay in the sensitive parameter mode condition is related to the complexity of the area monitoring configuration, and does not include the TCP network transmission delay.
- 3: The delay in the sensitive parameter mode condition is related to the complexity of the area monitoring configuration.
- 4: No interface cable.
- 5: Operating parameters under DC24V power supply conditions.

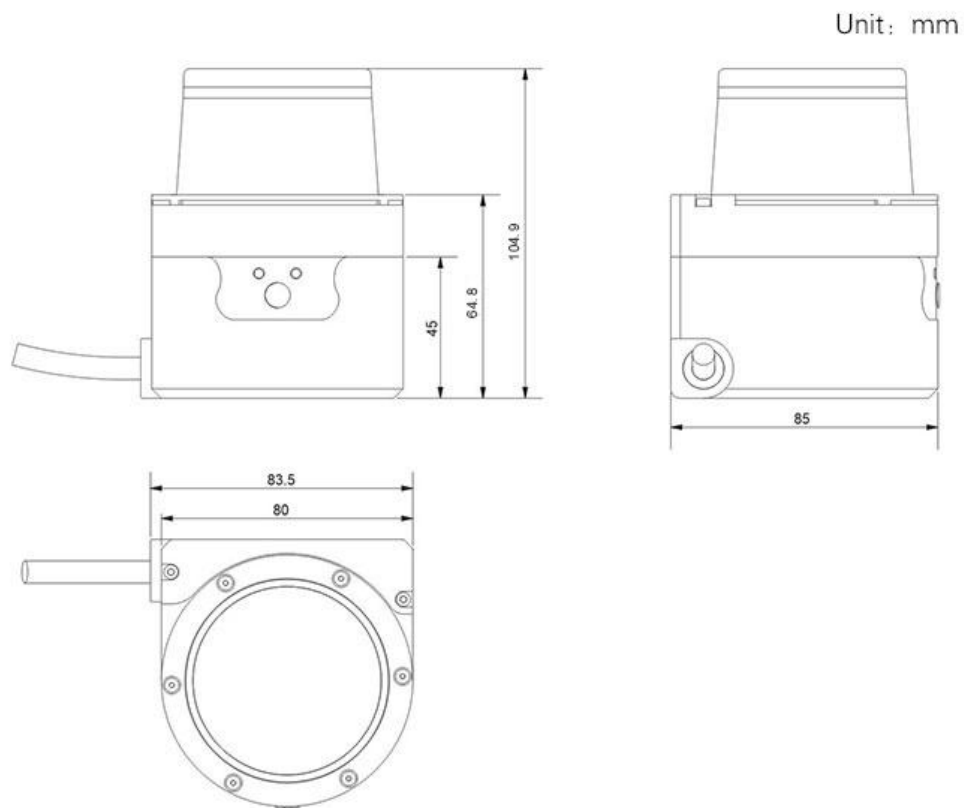
10.2 Measuring coordinate system/scan range/range

Figure 10.1 Measurement Coordinate System/Scan Range/Range



10.3 Equipment outline drawings

Figure 10.2 Equipment outline drawing



10.4 Accessories outline drawings

Figure 10.3 AS-21C-AT Outline Drawing

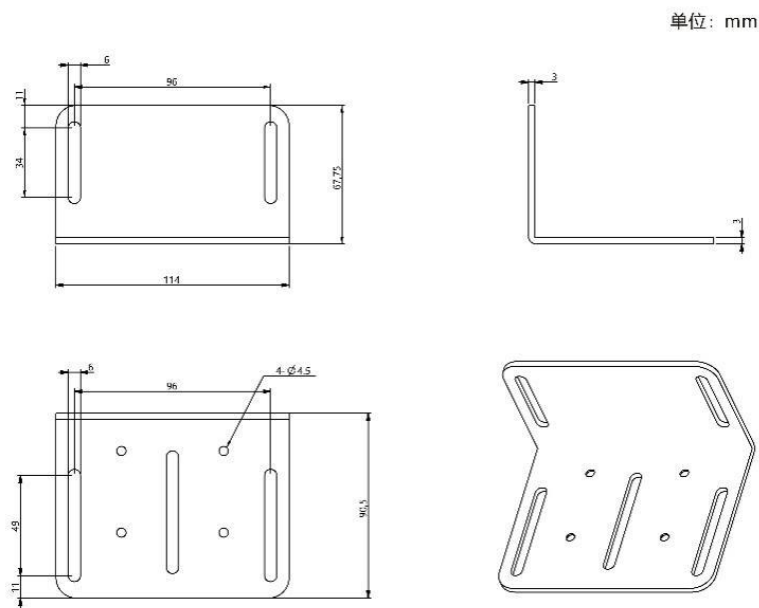
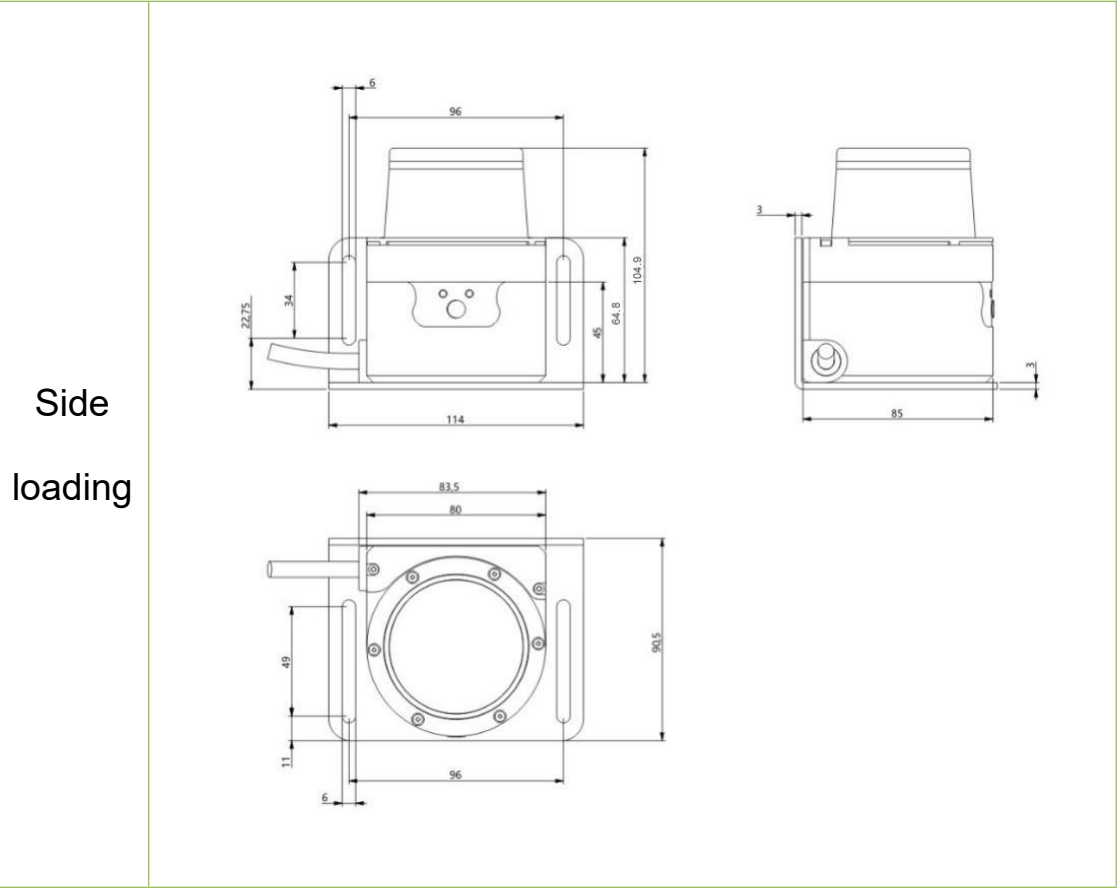


Figure 10.4 Assembly Drawing of AS-21C-AT



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