Area Access Control Safety Single-beam Sensors

Catalog Numbers 440L-R4F0020-Q, 440L-R4F1570-Q, 440L-T4F2070-Q

Allen-Bradley
by ROCKWELL AUTOMATION

Guardmaster®

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

IMPORTANT Identifies information that is critical for successful application and understanding of the product.

These labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

Table of Contents

About This Publication

These operating instructions are only applicable to the Area Access Control (AAC) Safety Single-beam Sensor.

Read this chapter carefully before you work with these operating instructions and the AAC single-beam sensor.

IMPORTANT This user manual is part of the safety light curtain product and therefore you must keep it accessible during the whole lifecycle for everyone who is in charge of installation, operation, maintenance, and safety.

These operating instructions address the technical personnel of the machine manufacturer or the machine operator regarding safe mounting, installation, configuration, electrical installation, commissioning, operation, and maintenance of the AAC safety single-beam sensor.

These operating instructions do not provide instructions for operating machines on which AAC safety single-beam sensors are integrated. This information is found in the appropriate operating instructions for the machine.

These operating instructions contain the following information about AAC safety single-beam sensors:

- Mounting
- Electrical installation
- Commissioning
- Application
- Error diagnosis and troubleshooting
- Part number
- Conformity and approval
- Care and maintenance

To plan and use protective devices such as the AAC safety single-beam sensors also requires specific technical skills, which are not detailed in this documentation.

Observe the national, local, and statutory rules and regulations when operating the AAC safety single-beam sensors.

Additional reference information is available on our website. You can find information regarding:

- Sample applications (GLSAFE-BR001)
- These operating instructions in different languages for viewing and printing (rok.auto/literature)
- Declarations of Conformity and other documents (rok.auto/certifications)

Who Would Use This Manual

These operating instructions address planning engineers, machine designers, and operators of plants and systems who are protected by the AAC safety single-beam sensors. These operating instructions also address people who integrate the AAC safety single-beam sensors into a machine, initialize its use, or who are in charge of service and maintenance of the device.

Terminology

- Abbreviations are used throughout this publication.

Table 1 - Abbreviations

Abbreviations	Definitions
AAC	Area access control
EDM	External device monitoring
ESD	Electrostatic discharge
ESPE	Electro-sensitive protective equipment
N.C.	Normally closed
N.O.	Normally open
OSSD	Output signal switching device

- Recommendations: Recommendations can help with your decision-making process regarding a certain function or a technical measure.
- Status indicator symbols describe the state of a diagnostics status indicator.

Table 2 - Status Indicator Symbol Examples

Symbol	Color	Description
	Red	The red status indicator is illuminated constantly.
	Yellow	The yellow status indicator is flashing.
	Green	The green status indicator is off.

- Transmitter and Receiver: In drawings and diagrams, the following symbols denote the transmitter and the receiver.

Table 3 - Transmitter and Receiver Symbols

Symbol	Description
	Transmitter
	Receiver

- Dangerous State: The drawings and diagrams of this document always show the dangerous state (standard term) of the machine as a movement of a machine part. In practical operation, there are a number of different dangerous states:
  - Machine movements
  - Electrical conductors
  - Visible or invisible radiation
  - A combination of several risks and hazards

IMPORTANT See important notes for special features of the device.

ATTENTION: Potentially hazardous situation, which, if not prevented, can lead to serious or deadly injury. Failure to observe can result in dangerous operation.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Updated General Safety Notes and Protective Measures	12
Updated Declaration of Conformity	41

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
UL Standards Listing for Industrial Control Products, publication CMPNTS-SR002	Assists original equipment manufacturers (OEMs) with construction of panels, to help ensure that they conform to the requirements of Underwriters Laboratories.
American Standards, Configurations, and Ratings: Introduction to Motor Circuit Design, publication IC-AT001	Provides an overview of American motor circuit design based on methods that are outlined in the NEC.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley® industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Notes:

Introduction

General Description

The AAC safety single-beam sensors are intended to provide area access control or perimeter safeguarding of personnel for various machinery and work cell applications.

Read and understand the following requirements before you locate and install the AAC safety single-beam sensor.

The installation of the AAC safety single-beam sensor must comply with all applicable federal, state, and local rules, regulations, and codes.

Only qualified personnel must properly install the AAC safety single-beam sensor.

AAC safety single-beam sensors are presence sensing devices and do not protect personnel from heat, chemicals, or flying parts. These devices are intended to signal a stop of hazardous machine motion when the sensing field is broken.

Only use AAC safety single-beam sensors on machinery that can stop anywhere in its stroke or cycle.

Never use AAC safety single-beam sensors on full revolution clutched machinery.

The effectiveness of the AAC safety single-beam sensor depends upon the integrity of the machine control circuit. The machinery on which the AAC safety single-beam sensor is installed must have control circuitry that is fail-safe in design.

Regularly inspect all stopping mechanisms for the machinery to confirm proper operation. The protected machinery must have a consistent, reliable, and repeatable stop time.

The employer is responsible for the proper installation, operation, and maintenance of the product and the machinery on which the AAC safety single-beam sensor is installed.

IMPORTANT Failure to read and follow these instructions can lead to misapplication or misuse of the AAC safety single-beam sensor, which can result in personal injury and damage to equipment.

Notes:

Safety Information

This chapter addresses your safety and the safety of the equipment operators.

IMPORTANT Read this chapter carefully before you work with AAC safety single-beam sensors or with the machine AAC safety single-beam sensors protect.

Qualified Safety Personnel

Only qualified personnel can mount, commission, and service AAC safety single-beam sensors. Qualified safety personnel are persons who complete the following:

- Have the appropriate technical training
- Have been instructed by the responsible machine operator in the operation of the machine and the current valid safety guidelines.
- Have access to these operating instructions.

Applications

AAC safety single-beam sensors are electro-sensitive protective equipment (ESPE), type 4 in accordance with IEC 61496-1 and IEC 61496-2 and can, for this reason, be used in controllers of safety category 4 in accordance with EN ISO 13849-1, SIL CL 3 in accordance with EN 62061 or up to PLe in accordance with EN ISO 13849-1. AAC safety single-beam sensors are used for:

- Hazardous area protection
- Access protection

Install the photoelectric safety single-beam sensor so that the hazardous area is only reached by interrupting the light path between sender and receiver. It must not be possible to start the machine or system as long as personnel are within the hazardous area.

AAC devices are intended only for use in industrial environments. Use in residential areas can cause radio interferences.

See Application Example on page 15 for an illustration of the protective mode and an example application.

ATTENTION: Only use AAC devices as an indirect protective measure. Opto-electronic protective devices such as AAC safety single-beam sensors cannot provide any protection against parts that are thrown out or against radiation. Transparent objects are not detected.

Depending on the application, mechanical protective devices can be required with AAC devices.

Correct Use

Only use AAC devices as specified in Applications on page 11. Only qualified safety personnel are allowed to use the devices, and only on the machine on which qualified safety personnel installed and initialized the devices, as per these operating instructions.

All warranty claims against Rockwell Automation are forfeited if any other use, or alterations are made to the AAC safety single-beam sensor, even as part of mounting or installation of the device.

General Safety Notes and Protective Measures

IMPORTANT Observe the following items to confirm the correct and safe use of AAC devices.

- National/international rules and regulations apply to the installation, commissioning, use, and periodic technical inspections of AAC devices, in particular:
  - The Machinery Directive 2006/42/EC
  - Supply of Machinery (Safety) Regulations (2008 No. 1597)
  - Provision and Use of Work Equipment Directive 89/ 655/EC
  - The work safety regulations/safety rules
  - Other relevant safety regulations
- Manufacturers and operators of the machine on which AAC devices are used are responsible to obtain and observe all applicable safety regulations and rules.
- You must follow Protective Device Checks on page 30 (Pre-commissioning Checks on page 30, Daily Checks on page 31, and Regular Inspection Tests on page 32).
- Qualified safety personnel, or specially qualified and authorized personnel, must perform the tests, record, and document the tests so the tests can be reconstructed and retraced at any time.
- The operating instructions must be available to the operator of the machine where the AAC devices are used. Qualified safety personnel must instruct the machine operator in the use of the device and to read the operating instructions.
- The external voltage supply for the devices must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204. Suitable power supplies are available from Rockwell Automation.
- Use a safety extra low voltage SELV/PELV to supply power to the AAC devices.

Environmental Protection

AAC safety single-beam sensors are constructed to minimize the adverse effects on the environment. The devices use a minimum of power and natural resources.

Always act in an environmentally responsible manner.

Disposal

IMPORTANT Always dispose of unserviceable or irreparable devices in compliance with local/national rules and regulations regarding waste disposal.

See General System Data on page 37 for information on the individual materials in the AAC devices.

Product Description

This chapter provides information on the special features, operating principle, structure, and function of AAC devices.

IMPORTANT Read this chapter before you mount, install, and commission AAC devices.

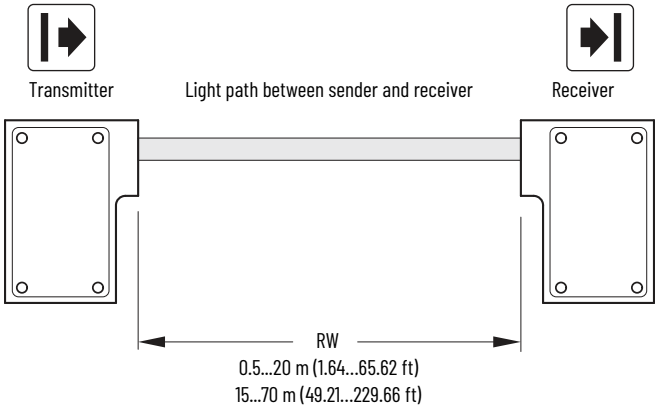
Special Features

- Relay outputs
- Rugged type of construction
- Long operating range up to 70 m (229.66 ft)
- Heated front window

Operating Principle

The AAC safety single-beam sensor consists of a transmitter unit and a receiver unit. The receiver unit receives a beam of light that the transmitter unit emits.

Figure 1 - Key Data for AAC Safety Single-beam Sensors



If an object interrupts the light beam, a switching command is triggered. The machine controller that evaluates this message must then bring the dangerous movement to a halt.

Transmitter and receiver units are equipped with status indicators for the operational check. Their function as diagnostic elements is described in Commissioning on page 29.

The diagnostics status indicators are used for fault diagnosis (see Fault Diagnosis on page 35).

These AAC devices are not equipped with an internal restart interlock.

Operating Range

ATTENTION: Use the receiver with the permitted operating range to suit the length of the light path between the sender and receiver.
- If the operating range is too low, the AAC device does not switch to green.
- If the operating range is too large, the AAC device can malfunction due to reflections. This malfunction would put the operator at risk.

Two receivers with different operating ranges are available. See Device Options on page 43.

Restart Interlock

These AAC devices do not have an internal restart interlock. You can only implement a restart interlock for the machine externally. During this process, AAC devices have no control over the restart.

IMPORTANT A restart interlock helps prevent the machine from starting again after an error or an interruption of the light path.

ATTENTION: Always operate the application with restart interlock. Confirm that an external restart interlock is always activated on the machine. These AAC devices are unable to verify if the external restart interlock of the machine is operable. If you deactivate the external restart interlock, the operator of the machine is at risk of injury.

External Device Monitoring (EDM)

AAC devices do not have any feature to monitor the downstream contactors. External device monitoring on the downstream contactors is only possible with an external circuit. See System Connection on page 26 for additional explanations on the connection of downstream contactors.

IMPORTANT An EDM checks if the downstream contactors actually de-energize when the protective device trips.

Front Window Heating

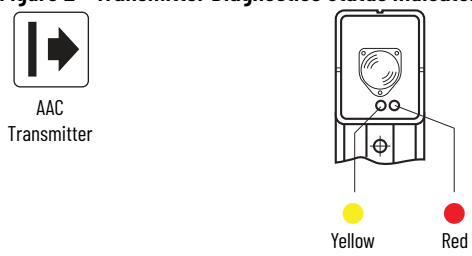
The transmitter and receiver have heated front windows. The front window heat counteracts the formation of droplets, mist, frost, and ice.

ATTENTION: Confirm that the formation of droplets, mist, frost, or ice do not change the optical properties of the front window, otherwise there is a hazard for the operator.

Structure and Function

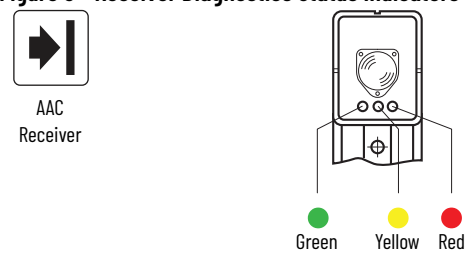
These AAC devices are equipped with diagnostics status indicators.

Figure 2 - Transmitter Diagnostics Status Indicators



Display		Description
Yellow	Red	
●	○	Device on, test inactive
●	●	Device on, test active, test contacts open

Figure 3 - Receiver Diagnostics Status Indicators

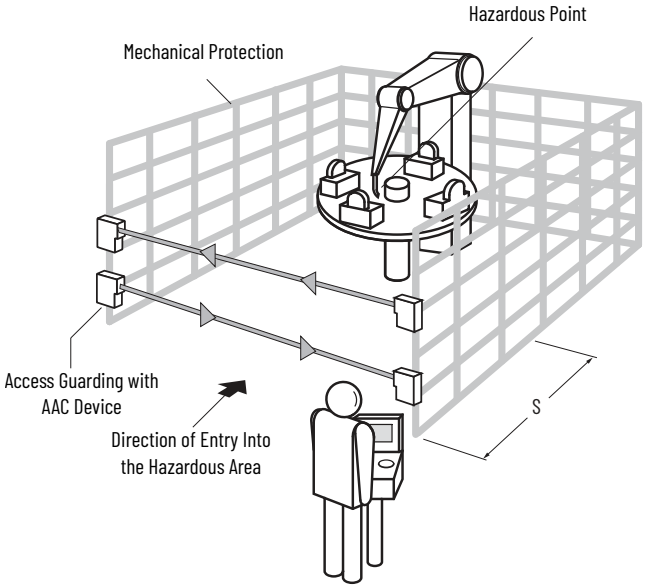


Display			Description
Green	Yellow	Red	
●	○	○	Output signal switching devices are on, the light path is unoccupied.
○	○	●	Output signal switching devices are off, the light path is interrupted, there is inadequate alignment, or the device is not yet ready after switch-on (see General System Data on page 37).
●	●	○	Output signal switching devices are on, the light path is unoccupied, and there is a weak signal.
○	●	●	Output signal switching devices are off, the light path is interrupted or there is inadequate alignment. Before the complete interruption of the light path, the signal was weak.

Application Example

AAC devices are used as access protection for hazardous areas on machines or systems (see Figure 4 on page 16). The devices are permanently mounted in the access area with the necessary safety distance from the nearest hazardous point. If an object interrupts the light beam, a switching command triggers. The machine controller that evaluates this message then brings the dangerous movement to a halt.

Figure 4 - Access Guarding with AAC Safety Single-beam Sensors



Mechanical Installation

This chapter describes the preparation and completion of the installation of the AAC devices:

- Calculating the necessary safety distance
- Calculating the distance from reflective surfaces
- Mounting the device

The following steps are necessary after mounting:

- Complete the Electrical Installation on page 25
- Align Transmitter and Receiver on page 29
- Testing the installation with Protective Device Checks on page 30

ATTENTION: No protective function without properly calculated safety distance.
The protective effect of AAC safety single-beam sensors depends on the AAC devices being mounted with the correct safety distance from the hazardous point.

Preparation for Mounting

Safety Distance for Access Protection

You must maintain a safety distance between the protective field and the hazardous point. This safety distance maintains that the hazardous point is only reachable after the dangerous state of the machine is completely stopped.

The safety distance as per EN 999+A1 [(a)] and EN ISO 13857 depends on:

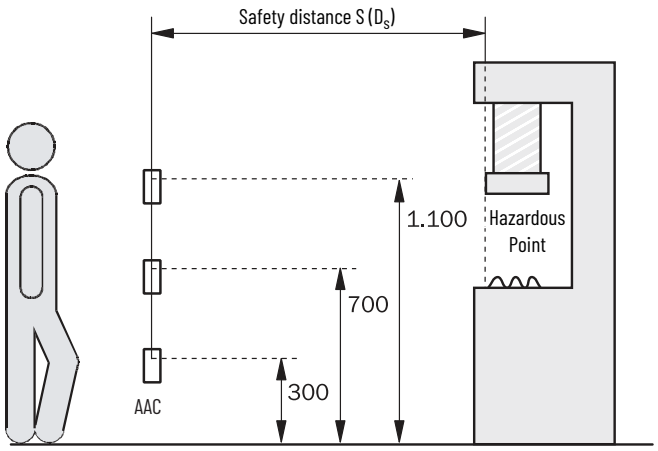
- Stop/run-down time of the machine or system (the machine documentation shows the stop/run-down time, or you must take a measurement to determine the stop/run-down time)
- Response time of the entire protective device
- Reach or approach speed
- Number of beams/beam separation

Under the authority of OSHA and ANSI the safety distance as specified by ANSI B11.19 (Annex D) E.4.2.3.3.5 and Code of Federal Regulations, Volume 29, Part 1910.217. (h) (9) (v) depends on:

- Stop/run-down time of the machine or system (the machine documentation shows the stop/run-down time, or you must take a measurement to determine the stop/run-down time)
- Response time of the entire protective device
- Reach or approach speed
- Other parameters that the standard stipulates, depending on the application

(a) In the future EN ISO 13855.

Figure 5 - Safety Distance S to the Light Beam



Calculate the Safety Distance S

According to the EN 999+A1 [(a)] EN ISO 13857:

IMPORTANT The following is an example calculation of the safety distance. Depending on the application and the ambient conditions, another calculation can be necessary.

S = K x T + C [mm]

T	Stop/run-down time of the machine response time of the AAC safety single-beam sensor after light path interruption [s]
S	Safety distance [mm]
K	Approach speed 1.6 [m/s]
C	Depending on the number of beams (1, 2, 3 or 4), see Table 4

Table 4 - Height of the Beams Above the Floor

Number of Beams	1	2	3	4
Height of beams above the floor [mm]	750	400 900	300 700 1100	300 600 900 1200
C	1200	850	850	850

Example Calculation

Access guarding with two beams C = 850 mm
Stop/run-down time of the machine = 290 ms
Response time after light path interruption = 22 ms
Approach speed = 1.6 m/s

T = 290 ms + 22 ms = 312 ms = 0.31 s
S = 1600 x 0.31 + 850 = 1346 mm

Calculate the Safety Distance D_s

According to ANSI B11.19 (Annex D) E.4.2.3.3.5 and Code of Federal Regulations, Volume 29, Part 1910.217. (h) (9) (v)

IMPORTANT The following is an example calculation of the safety distance. Depending on the application and the ambient conditions, another calculation can be necessary.

$D_s = H_s \times (T_s + T_c + T_r + T_{bm}) + D_{pt}$

D_s	The minimum distance in inches (or millimeters) from the hazardous point to the protective device
H_s	A parameter in in./s or mm/s, derived from data on approach speeds of the body or parts of the body. Often 63 in./s is used for HS.
T_s	Stop/run down time of the machine tool that is measured at the final control element
T_c	Stop/run-down time of the control system
T_r	Response time of the entire protective device after light path interruption
T_{bm}	Additional response time allowed for brake monitor to compensate for wear (1)
D_{pt}	An additional distance added to the overall safety distance required. This value is based on intrusion toward the hazardous point before actuation of the electro-sensitive protective equipment (ESPE). For applications that can be reached over, the value D_{pt} = 1.2 m. For beam arrangements that permit reaching in with the arms or the detectable object size is greater than 63 mm, the value D_{pt} = 0.9 m.

(1) Any additional response times must be accounted for in this calculation.

ATTENTION: Maintain the safety distance.
You must install the AAC devices so when the light beam interrupts, the hazardous point is only reachable when the dangerous state is no longer present.

ATTENTION: Risk of failure to detect.
AAC safety single-beam sensors do not detect persons who are in the hazardous area, but not in the light path between sender and receiver. It is therefore necessary to confirm that the hazardous area is fully visible and any dangerous state can only initiate if there are no personnel in the hazardous area.
The AAC devices are not allowed to be used for hand and finger protection.

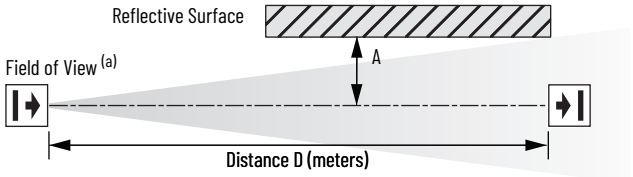
The applicable legal and official regulations apply to the use and mounting of the protective device. These regulations vary depending on the application.

Minimum Distance from Reflective Surfaces

The light beams from the sender can reflect off reflective surfaces.

All reflective surfaces and objects (for example, material bins) must therefore be at the minimum distance (A) from the light path between the sender and receiver of the AAC devices. The minimum distance (A) depends on the distance (D) between the sender and receiver.

Figure 6 - Minimum Distance from Reflecting Surfaces



(a) Transmitter and receiver optics have the same field of view.

ATTENTION: The minimum distances to reflective surfaces only apply when the sensing field is not interrupted.

Determine the Minimum Distance from the Reflective Surfaces

- Determine the distance D [m] sender-receiver
- Read the minimum distance A [mm] in Figure 7

Figure 7 - Minimum Distance from Reflective Surfaces

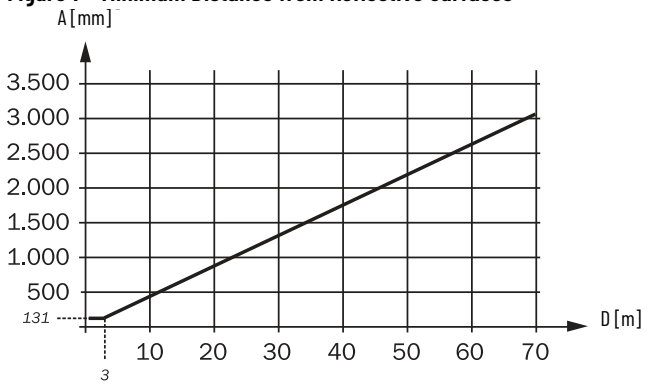


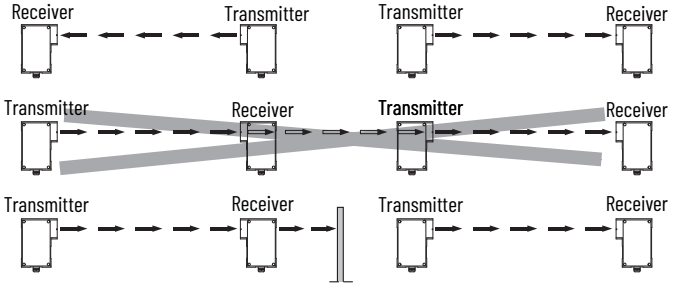
Table 5 - Minimum Safety Distance to Reflective Surfaces

Distance Between Transmitter and Receiver	Minimum Distance
D ≤ 3 m	A = 131 mm
D > 3 m	A = tan (2.5°) x 1000 x D [m] = 43.66 x D [m]

Mutual Interference of Nearby Systems

ATTENTION: Help prevent the mutual interference of systems mounted nearby.
If several AAC devices operate in close physical proximity, the transmitted beams from one device can interfere with the receiver for another device so the protective function of the different AAC devices is no longer achieved and there is a hazard for the operator. You must avoid such mounting scenarios or take appropriate measures. For example, mount non-reflective sight protection walls, or reverse the transmission direction of a device.

Figure 8 - Mount Two AAC Safety Single-beam Sensors in Series

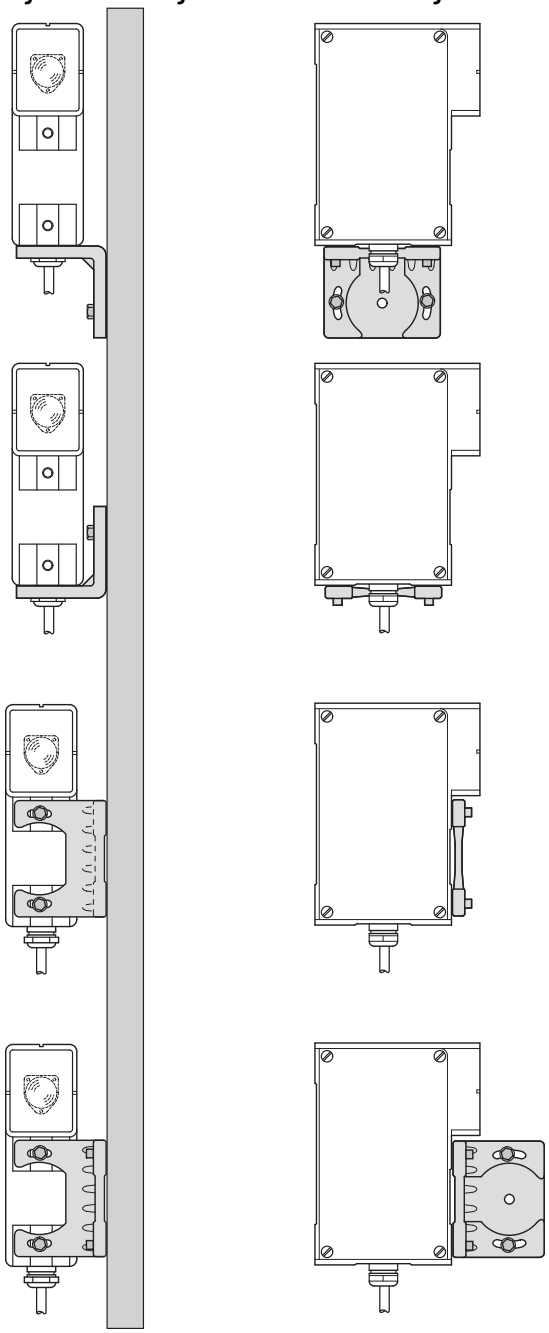


Mechanical Mounting

Mount the AAC transmitter and receiver to suit the local conditions on one side of the unit housing, or use the mounting bracket. The mounting bracket significantly eases alignment. The device can operate in any position. However, you must mount the transmitter and receivers so the axis of the beam that the transmitter emits always aligns with the axis of the receiver optics (alignment sight, see Figure 18 on page 30).

IMPORTANT Attach the mounting brackets so all screws are easily accessible for alignment. Attach the devices so you can use the alignment sight to align with the opposite related device.

Figure 9 - Mounting Possibilities with Mounting Brackets



Corner Mirror

You can achieve access protection on several sides using corner mirrors (see Figure 10 on page 22) with the AAC devices.

IMPORTANT	The usage of corner mirrors reduces the effective operating range of the AAC system as specified in Table 6 on page 22.

IMPORTANT	The use of mirrors (see Figure 11 on page 23) requires precise alignment. We recommend you use the laser alignment aid. The alignment aid is available as an accessory (see Table 14 on page 44).

Figure 10 - Hazardous Area Protection on Several Sides

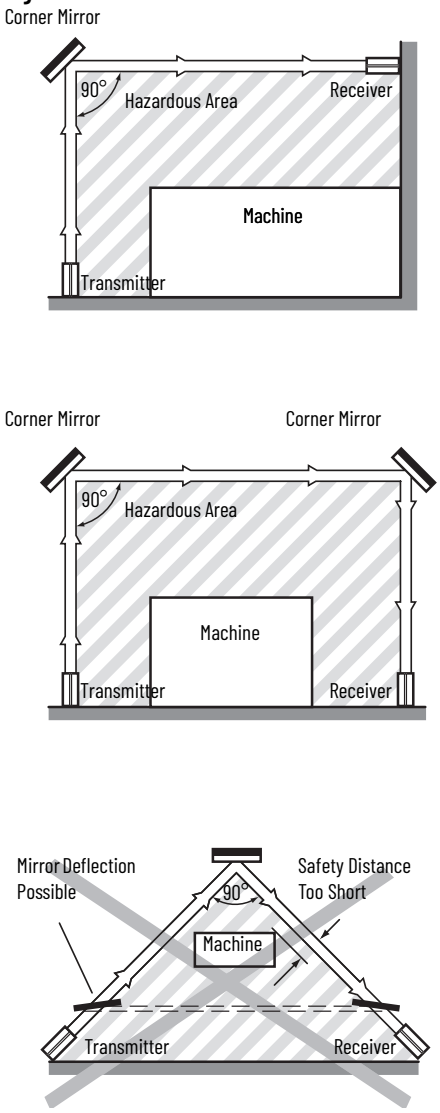


Table 6 - Reduction in the Operating Range with Corner Mirrors

Number of Mirrors	AAC Receiver - Low Operating Range [m (ft)]	AAC Receiver - High Operating Range [m (ft)]
1	0.5...18 (1.64...59.05)	14.2...63 (46.59...206.69)
2	0.5...16 (1.64...52.49)	13.5...56 (44.29...183.73)
3	0.5...14.3 (1.64...46.92)	12.8...50 (41.99...164.04)
4	0.5...12.8 (1.64...41.99)	12.2...45 (40.03...147.64)

Figure 11 - Two-beam Protection with One AAC System

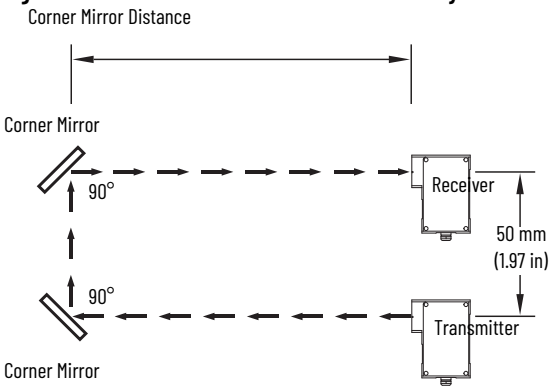


Table 7 - Corner Mirror Distance

AAC Receiver	Corner Mirror Distance [m (ft)]
Low operating range	0.5...7.5 (1.64...24.61)
High operating range	> 7.5 (24.61)

IMPORTANT If reflective surfaces are in the area of the light path between the transmitter and receiver, or such surfaces can occur, you must adjust the alignment of the system.

The transmitter and receiver must always align so there are no reflective surfaces in the area of the field of view (see Figure 13 on page 23).

Figure 12 - Incorrect Alignment of Transmitter and Receiver

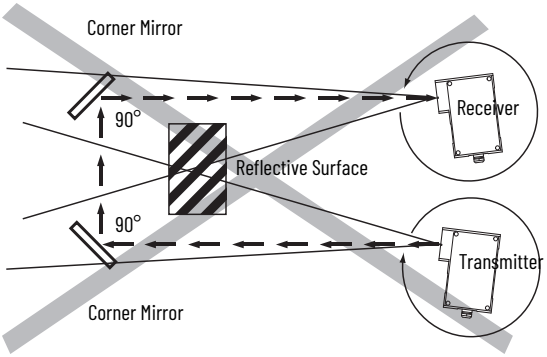
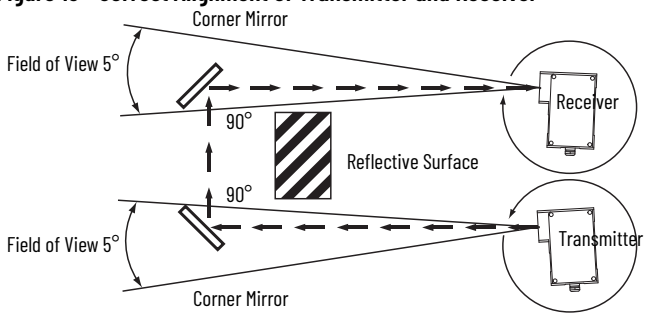


Figure 13 - Correct Alignment of Transmitter and Receiver



Notes:

Electrical Installation

ATTENTION: Switch the entire machine/system offline before installation. The machine/system could inadvertently start up while you are connecting the devices. Confirm that the entire machine/system is disconnected during the electrical installation.

Important Information

- The AAC single-beam photoelectric safety single-beam sensor meets the interference suppression requirements (EMC) for industrial use (interference suppression class A). Use in residential areas can cause interference.
- Use a safety extra low voltage SELV/PELV to supply power to AAC devices.
- The external voltage supply must bridge a brief mains failure of 20 ms (EN 60204). Suitable power supplies are available as accessories from Rockwell Automation.
- You must electronically isolate all cables for the supply voltage and the relay connections before you open the cover (see Approximate Dimensions on page 39).
- Only open the device with appropriate protection against ESD; pay attention to grounding. In the device, only touch the connection terminals, not the other parts of the electronics. Only qualified safety personnel can perform all work on the open device.
- If the cover is open, the device does not provide any protective function.
- The connecting cables must be laid directly to the terminal strip.
- After mounting, you must check the firm seating of the connecting cables in the connection terminals.
- Observe the torque figure for the protective conductor connection (PE) (see System Connection on page 26).
- On the installation of another PG connector, you must comply with the torque data for the PG connector (see Approximate Dimensions on page 39).
- Before you screw the cover in place, check the seal for contamination and damage. Fasten the cover to the related torque (see Approximate Dimensions on page 39).
- After you have opened the cover, perform the complete commissioning function test (see Commissioning on page 29).

System Connection

Transmitter Pin Assignment

IMPORTANT Connect the contacts on the AAC devices only to circuits that comply with the requirements for safety extra low voltage (SELV/PELV).

Figure 14 - Assignment of the Sensor Contacts - Transmitter

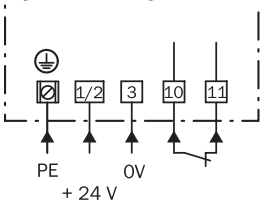


Table 8 - Assignment of the Sensor Contacts - Transmitter

Pin	Designation
1/2	Voltage supply 24V DC
3	Ground 0V
10	Test contacts
11	
PE	Protective earth (1)

(1) The torque for the PE connection is 2.0 ± 0.5 N•m (17.7 ± 4.43 lb•in).

The test checks the connected loads. For this purpose, the electrical connection between test contacts 10 and 11 on the AAC devices is interrupted for a certain amount of time (see General System Data on page 37). As a result, the transmitter does not emit a beam of light and simulates an interruption to the light path.

Machine controller must perform the test during the nonhazardous phase (for example, a nonhazardous movement). If the test is not successful, the machine must receive a shutdown signal from the machine controller.

IMPORTANT To operate the AAC devices without testing, connect a wire jumper between the test contacts 10 and 11 on the AAC transmitter.

ATTENTION: Use the test function for the purpose described.
The test input is only allowed to be used in the manner described.

Receiver Pin Assignment

Both N.O. contacts are used for safety-related functions. In a subsequent dual-channel circuit, the two N.O. outputs are connected to a safety controller with a suitable level of safety (see Figure 15 on page 27).

The N.C. contacts are not allowed to be used for safety-related functions.

If the downstream logic is realized using discrete contactors, the connectors must be positively guided and externally monitored. The AAC device cannot provide the monitoring.

Figure 15 - Connection Diagram

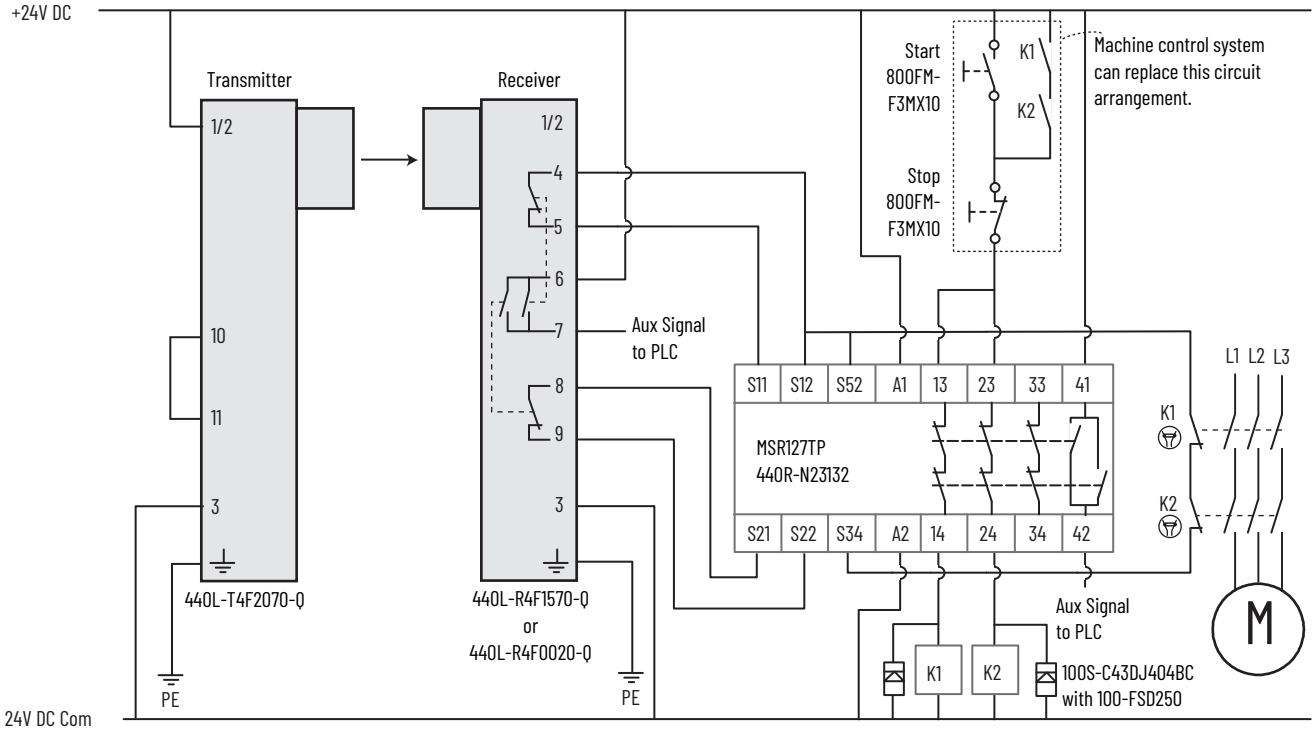


Table 9 - Assignment of the Sensor Contacts - Receiver

Pin	Designation
1/2	Voltage supply 24V DC
3	Ground OV
4	Safety relay, N.O. contact
5	
6	Safety relay 1/2, N.C. contacts connected in parallel internally
7	
8	Safety relay 2, N.O. contact
9	
PE	Protective earth (1)

(1) The torque for the PE connection is 2.0 ± 0.5 N•m (17.7 ± 4.4 lb•in).

Circuit Status

The area access control safety light curtain is not obstructed and the safety output contacts (4-5 and 8-9) are open. The outputs of the safety relay are closed, and the motor is ready to run.

Operating Principle

- Start: Press the Start button to energize contactors K1 and K2. The motor starts with the two N.O. contacts of K1 and K2 that hold the circuit as energized.
- Stop: Obstruction of the safety light curtain de-energizes the safety outputs of the MSR127 safety relay, which in turn drops out K1 and K2. The contactors disconnect the motor from its power source, and the motor coasts to a stop. Removal of the obstruction in the light curtain does not cause the motor to energize (you must press the Start button). Pressing the Stop button can also turn off the motor.

Fault Detection

Upon the successful completion of internal checks on power-up, the GuardShield™ safety light curtain energizes its outputs with no objects present. The GuardShield safety light curtain outputs turn on. If a cross fault is detected, the GuardShield safety light curtain goes to a lockout state with its outputs off. After successful completion of internal checks, the MSR127 safety relay checks the signals from the safety light curtain. If the signals check OK, the MSR127 safety relay then checks the status of the K1 and K2 contactors. If either K1 or K2 fails in the actuated state, the other contactor disconnects the motor. The MSR127 safety relay detects the faulted contactor and does not allow the motor to restart until the fault is corrected.

Ratings

This circuit meets the safety performance requirements of Category 4 of EN954-1:1996. This circuit executes a Category 0 stop.

Arc Suppression

ATTENTION: If an inductive load is present, use arc-suppression elements. Suitable arc suppressors must connect in parallel with the inductance. Connection in parallel with the output contact is not permitted. The selection of the suppressors can increase the total switch-off times.

Do not use suppression diodes as arc suppressors, as they considerably increase the switch-off time. RC elements are more suitable than varistors.

Figure 16 - Circuit for an Inductive Load

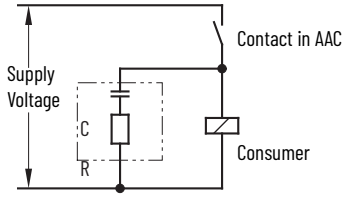


Table 10 - Examples for Arc Suppressors

Supply Voltage	R	C
115...230V	220 Ω	0.22 µF
24V	100 Ω	2.2 µF

Cross-circuit Monitoring

The AAC device receiver does not monitor the cables for the relay contacts.

ATTENTION: Take suitable measures for cross-circuit monitoring, such as:
- Lay cables from the AAC receiver to the loads protected against cross-circuits
- Screen output cables separately and connect the screen to 0V
- Integrate the two N.O. contacts at different voltage levels

Overcurrent Protection (Fuse)

Install a fuse in the control circuit with a rating to suit the maximum current on the output relay.

Commissioning

ATTENTION: Commissioning requires a thorough check by qualified safety personnel.
Before you operate a system that is protected by the AAC devices for the first time, confirm that qualified safety personnel first check and release the system. See Safety Information on page 11.

The device is switched on by applying the supply voltage to the sender and receiver unit. After 10 seconds max, AAC devices are ready for operation.

Align Transmitter and Receiver

After all parts are mounted and connected, align the related transmitter and receiver in relation to each other.

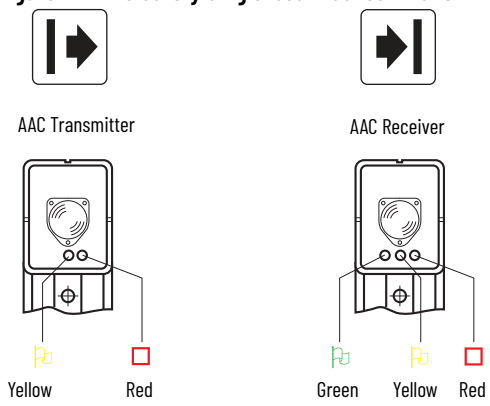
ATTENTION: Secure the system. No dangerous movement must be possible. Confirm that the dangerous state of the machine is (and remains) switched off.
During the alignment process, the outputs of AAC devices must have no effect on the machine.

Alignment with the Diagnostics Status Indicators

Switch on the power supply. The yellow diagnostics status indicator of the AAC transmitter must illuminate.

Align devices so the green diagnostics status indicator on the AAC receiver illuminates.

Figure 17 - AAC Safety Single-beam Sensor Transmitter and Receiver



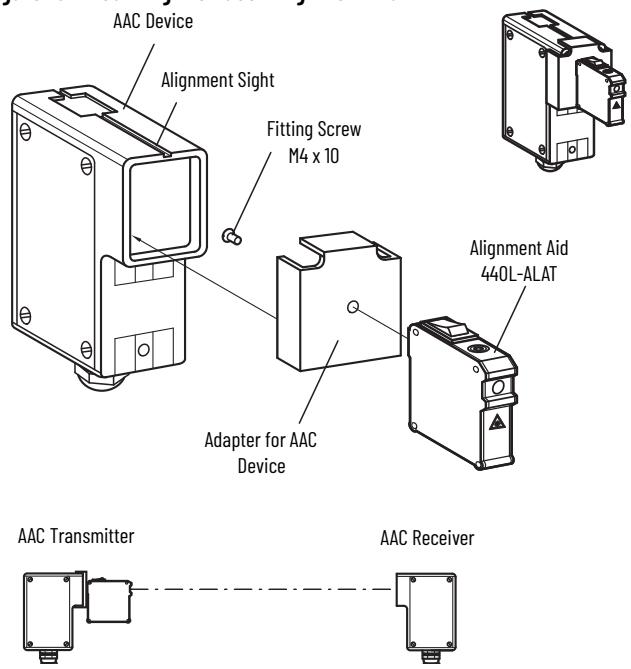
For optimal alignment of the transmitter and receiver, determine the boundaries by pivoting the transmitter unit and receiver unit horizontally and vertically. Upon leaving the related optical area, the yellow diagnostics status indicator on the AAC receiver illuminates. Then fasten the transmitter and receiver in the middle of the determined optical area.

Alignment with the Laser Alignment Aid

The laser alignment aid simplifies alignment in applications with large operating ranges, or if you use corner mirrors. The alignment aid is available as an accessory (see Accessories on page 44).

1. Screw the adapter to the laser alignment aid.
2. Mount the laser alignment in front of the transmitter (clamp).
3. Switch on laser alignment aid.
4. Attach a piece of white cardboard or with cardboard reflective tape to the receiver (the beam array is easier to detect).
5. Align the transmitter so the laser beam array is incident on the middle of the receiver optics.
6. Fasten the transmitter in this position.
7. Switch off and remove the laser alignment aid.
8. Start from the receiver and repeat the process.
9. Switch on the sensors.

Figure 18 - Mounting the Laser Alignment Aid



Protective Device Checks

Pre-commissioning Checks

The purpose of the pre-commissioning tests is to confirm the safety requirements that are specified in the national/international rules and regulations, especially in the Machine and Work Equipment Directive (EU Conformity).

To confirm the correct function, see Daily Checks.

- The number of the transmitter and receiver must match, the distance between the units must comply with the operating range that is stated in General System Data on page 37.
- You must only able to access the hazardous area through the light path between transmitter and receiver.
- You must not be able to climb over, crawl beneath, or circumnavigate the protective device.
- To check the effectiveness of the protective device that is mounted to the machine, use all selectable operating modes as specified in Checklist for ESPE Manufacturer/Installer on page 45. Use this checklist as a reference before commissioning the system for the first time.
- Confirm that qualified safety personnel correctly instruct the operating personnel of the machine (that is protected by AAC devices) before being allowed to operate the machine. The instruction of the operating personnel is the responsibility of the machine owner.

Daily Checks

You must check the effectiveness of the protective device daily or before the start of work by a specialist or by authorized personnel. Use the correct test rod.

Test the light path between the transmitter and receiver.

- Cover each light beam entirely with a test rod that is not transparent to light (at least 30 mm (1.81 in.) diameter) at the following positions:
  - Immediately in front of the sender
  - In the middle between transmitter and receiver (or between the corner mirrors)
  - Immediately in front of the receiver
  - If corner mirrors are used, immediately before and after the deflection

These tests must produce all the following results:

- The red diagnostics status indicator must illuminate on the receiver for the related AAC devices.
- As long as the light beam is interrupted, it must not be possible to initiate the dangerous state.

ATTENTION: Do not operate the machine if during the test the green diagnostics status indicator on the receiver is lit.
If the green diagnostics status indicator on the receiver lights up during the test, even for a short period, work must stop at the machine. In this case, qualified safety personnel must check the installation of AAC devices.

Further tests

- Check the protective device for damage or wear, particularly the mounting, the electrical connection and connection cable, the housing, and the front screen.
- Check that access to the hazardous area is only possible by interrupting the light path between transmitter and receiver (that is, correct mounting of mechanical protective devices).
- Check whether the protective device is effective for the set operating mode.

Regular Inspection Tests

Only by qualified safety personnel must perform these tests of the protective device.

- Following the inspection intervals that are specified in the national rules and regulations to check the system. This procedure verifies that you detect any changes on the machine or manipulations of the protective device after the initial commissioning.
- If major changes are made to the machine or the protective device, or if the AAC device is modified or repaired, check the equipment again with Checklist for ESPE Manufacturer/Installer on page 45.

Maintenance

Clean AAC Safety Single-beam Sensors

AAC devices are low maintenance. The integrated relay contacts are subject to normal wear. You must clean the front screen of the sensors regularly or if the screen is contaminated.

IMPORTANT Avoid scratching the front screens and the formation of droplets, frost, and ice on the front screens, as the optical properties can change.

Do not use abrasive or aggressive cleaning agents.

IMPORTANT Static charges cause dust particles to attract to the front screen. You can use an anti-static plastic cleaner and lens cloth to reduce this effect.

How to clean the front screen:

1. Use a clean and soft brush to remove dust from the front screen.
2. Wipe the front screen with a clean and damp cloth.

IMPORTANT After you clean the unit, check the position of the transmitter and receiver to confirm that you cannot bypass (climb over, crawl beneath, or stand behind) the protective device.

3. Verify the effectiveness of the protective device as described in Protective Device Checks on page 30.

Notes:

Fault Diagnosis

This section describes how to identify and rectify errors and malfunctions during the operation of AAC device.

ATTENTION: Cease operation if the cause of the malfunction is not clearly identified.
Stop the machine if you cannot clearly identify or allocate the error or if you cannot safely rectify the malfunction.

ATTENTION: Complete the function test after the rectification of a fault.
After rectifying a fault, perform a complete function test as per Protective Device Checks on page 30

Technical Support

If you cannot remedy an error with the help of the information that is provided in this chapter, contact your Rockwell Automation technical support staff (rok.auto/support).

Diagnostics Status Indicators

This section describes the meaning of the diagnostics status indicator and how to respond.

Table 11 - Transmitter Diagnostics Status Indicators

Display		Possible Cause	Solution
Yellow	Red		
○	○	No operating voltage, or voltage is too low	• Check the power supply and activate, if necessary.
●	● (1)	System error	• Switch off the device for a minimum of 3 seconds, then back on. • If the error continues to occur, replace.

(1) 1 Hz power up delay 10%

Table 12 - Receiver Diagnostics Status Indicators

Display			Possible Cause	Solution
Green	Yellow	Red		
○	○	○	No operating voltage, or voltage too low	• Check the supply and activate, if necessary.
○	☀ (1)	●	System error	• Switch off the device for a minimum of 3 seconds, then back on. • If the error continues to occur, replace.
○	☀ (2)	●	Error in the supply voltage or unknown sender detected	• Switch off the device for a minimum of 3 seconds, then back on. • Check that the power supply complies with the specifications in Important Information on page 25. • Check that the power supply complies with the specifications in General System Data on page 37. • Check the distance from the protective surfaces (see Minimum Distance from Reflective Surfaces on page 19) and from other safety single-beam sensors. • If the error continues to occur, replace.

(1) 1 Hz power up delay 10%
(2) 1 Hz power up delay 90%

Specifications

General System Data

Attribute	Value
Operating range	• AAC receiver 20 m: 0.5…20 m (1.64…65.62 ft) • AAC receiver 70 m: 15…70 m (49.21…229.66 ft)
Number of beams	1
Synchronization	Optical, without separate synchronization cable
Detection capability	30 mm (1.18 in.)
Protection class (1)	Class 1 (EN 50178:1998)
Enclosure rating	IP67 (IEC 60529)
Operating mode	Protective operation without start and restart interlock
Supply voltage V_s (2)	• 19.2V DC (min) • 24V DC (typical) • 28.8V DC (max)
Residual ripple (3)	± 10%
Power-up	Delay of receiver and sender before ready: • 5 s (typical) • 10 s (max)
Type	Type 4 (IEC 61496)
Safety integrity level (4)	SIL 3 (IEC 61508), SIL CL 3 (EN 62061)
Category	Category 4 (EN ISO 13849-1)
Performance level	PLe (EN ISO 13849-1)
B_{100d} value	• AC-15, 230V, 0.4 A: 1 x 10^6 switching operations • AC-15, 230V, 2.0 A: 2.6 x 10^5 switching operations • DC-13, 24V, 0.6 A: 1 x 10^6 switching operations • DC-13, 24V, 1.5 A: 2 x 10^5 switching operations
PFH (mean average frequency of a dangerous failure per hour)	4.0 x 10^{-9}
T_M (mission time)	20 years (EN ISO 13849)

(1) Safety extra low voltage SELV/PELV is mandatory.
(2) The external voltage supply must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204. Suitable power supplies are available as accessories from Rockwell Automation.
(3) The maximum supply voltage limits must not be exceeded, minimum levels must be achieved.
(4) For detailed information on the exact design of your machine/system, contact your local Allen-Bradley® distributor or Rockwell Automation sales office.

Transmitter Unit

Attribute	Value	
Wavelength	950 nm (typical)	
Test input	Type of circuit: • Duration of the actuation of the N.C. contact • Response time to test input signal	Voltage-free N.O. contact or wire jumpers between test contacts (1)
		• 50 ms (min) • 150 ms (typical) • 200 ms (max)
Power consumption, max	6 W	
Weight, max	1 kg (22.05 lb)	

(1) Connect the contacts on the AAC device only to circuits that comply with the requirements for safety extra low voltage (SELV/PELV).

Receiver Unit

Attribute	Value
Outputs	Voltage-free relay contact, two N.O. contacts, one N.C. contact (two N.C. contacts connected in parallel)
Contact material	Ag alloy with Au coating
Switching frequency, max	0.2 Hz
Switching voltage	• 10…30V DC • 10…230V AC
Switching current	20 mA…2 A
Mechanical life relay contacts	≥ 10^7 switching operation
Electrical service life of relay contacts with reference loads	≥ 10^5 switching operation
Reference loads by usage category	• AC-15, 230V, 2 A • AC-1, 230V, 2 A • DC-1, 24V, 2 A • DC-13, 24V, 1.5 A
Response time, max	22 ms
Switch-off time, min	80 ms
Power consumption, max	8 W
Weight, max	1 kg (22.05 lb)

Operational Data

Attribute	Value
Connection	Cable gland (PG13.5)
Core cross-section, max	0.2…1.5 mm^2
Cable length of cross-section (max)	• 0.25 mm^2: 14 m (45.930 ft) • 0.75 mm^2: 42 m (137.79 ft) • 1.5 mm^2: 83 m (272.31 ft)
Ambient operating temperature	-25…+55 °C (-13…+131 °F)
Storage temperature	-25…+70 °C (-13…+158 °F)
Air humidity (no dew)	15…95%
Dimensions	See Approximate Dimensions on page 39
Vibration resistance	5 g, 10…55 Hz (EN 60068-2-6)
Shock resistance	10 g, 16 ms (EN 60068-2-29)

Environmental Data

Attribute	Value
Housing	Aluminum alloy ALSI12(CU)
Front screen	Polycarbonate (scratch-resistant coating)
Circuit boards	Glass fiber reinforced epoxy resin
Packaging	Corrugated cardboard

Approximate Dimensions

Figure 19 - AAC Safety Single-beam Sensor [mm (in.)

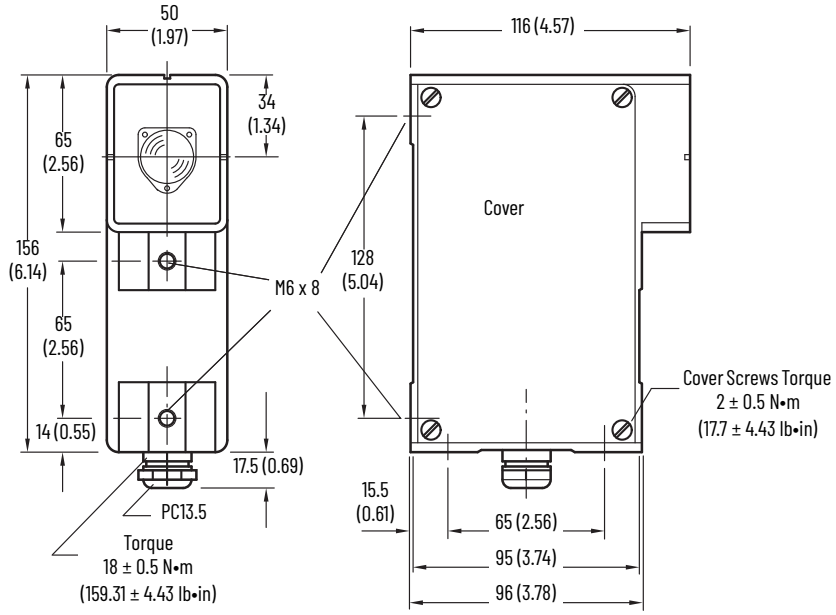


Figure 20 - Deflector Mirror 440L-AMIRR1

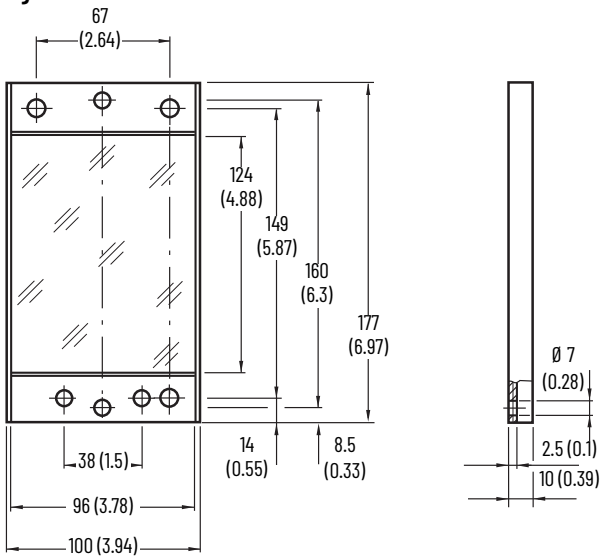


Figure 21 - Mounting Bracket 440L-AMBRK1 for Corner Mirror 1

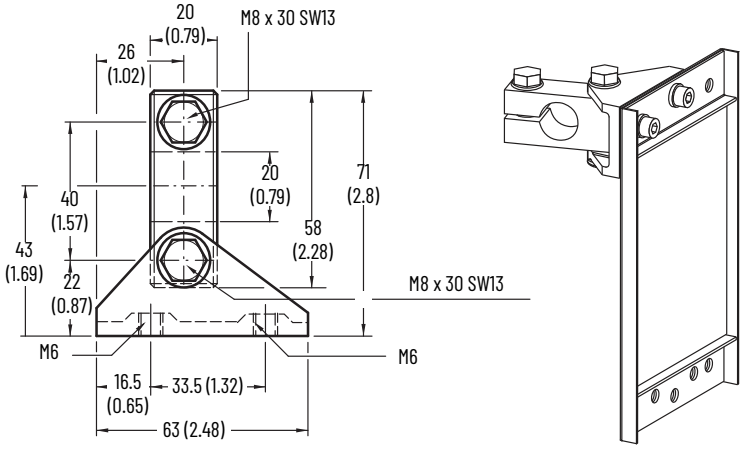


Figure 22 - Spring-fastening Mounting Kit 440L-AMKIT for Corner Mirrors

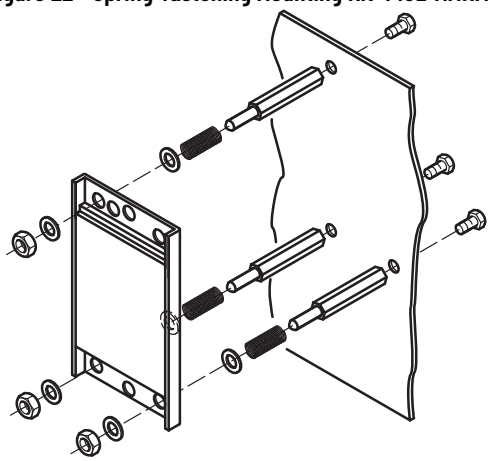


Figure 23 - Corner Mirror 440L-AMIRR2

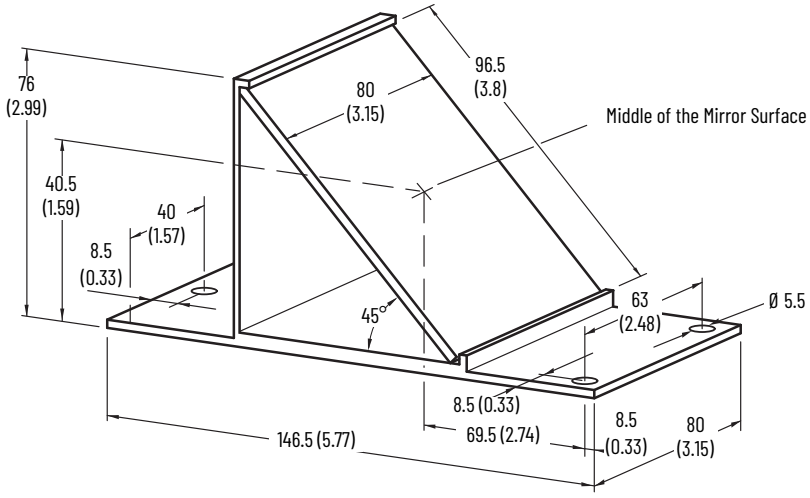
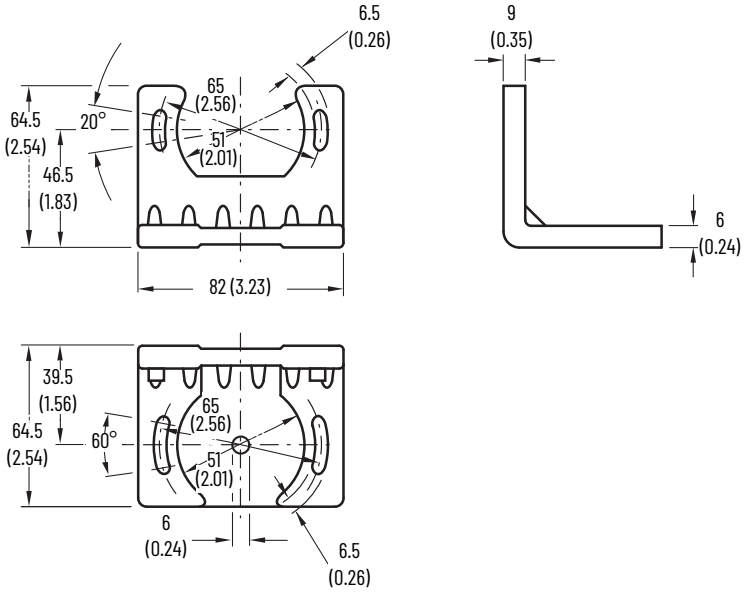


Figure 24 - Mounting Bracket 440L-AMBRK4



Declaration of Conformity

CE Conformity

Rockwell Automation NV (address: Pegasus Park De Kleetlaan 12A, 1831 Diegem, Belgium) declares that this product is in conformity with the provisions of the following EC directives (including all applicable amendments):

- 2014/30/EU EMC Directive (EMC)
- 2006/42/EC Machinery Directive (MD)

and that the respective standards and/or technical specifications have been applied. It is approved for installation within the European Union and EEA regions.

For a comprehensive CE certificate visit: rok.auto/certifications.

UKCA Conformity

Rockwell Automation declares that the products that are shown in this document are in compliance with Supply of Machinery (Safety) Regulations (2008 No. 1597) and Electromagnetic Compatibility Regulations (2016 No. 1091).

For a comprehensive UKCA certificate visit: rok.auto/certifications.

Notes:

Order Information

Device Options

Table 13 - AAC Safety Single-beam Sensor Transmitter/Receiver Catalog Numbers

Description	Cat. No. (1)
Transmitter unit	440L-T4F2070-Q
Receiver unit, operating range (low) 0.5…20 m (1.64…65.62 ft)	440L-R4F0020-Q
Receiver unit, operating range (high) 15…70 m (49.21…229.66 ft)	440L-R4F1570-Q

(1) If no series number is given, then all series are covered.

Accessories

Table 14 - Accessory Catalog Numbers

Description		Cat. No.
	Laser alignment tool	440L-ALAT
	Adapter for alignment aid	440L-ALBRK1
	Mounting bracket	440L-AMBRK4
	Corner mirror for operating range 0...30 m (0...98.42 ft)	440L-AMIRR1
	Mounting kit for 440L-AMIRR1	440L-AMKIT (see Figure 22 on page 40)
	Mounting bracket for 440L-AMIRR1	440L-AMBRK1
	Glass corner mirror, 45° angle 0...30 m (0...98.42 ft)	440L-AMIRR2

Installation Checklist

Checklist for ESPE Manufacturer/Installer

Details about the checklist items must be present at least during the first commissioning procedure. These checklist items, however, depend on the respective application. The manufacturer or installer controls these specifications.

IMPORTANT Rockwell Automation authorizes the reproduction of the following checklist for use in reoccurring tests.

Retain and keep this checklist with the machine documentation to serve as reference during reoccurring tests.

Step	Description	Completion	
1	Are the safety rules and regulations observed in compliance with the directives and standards applicable to the machine?	Yes	No
2	Are the applied directives and standards listed in the deceleration of conformity?	Yes	No
3	Does the protective device comply with the required control category?	Yes	No
4	Is access to the hazardous area or point of hazard only possible through the protective field of the ESPE?	Yes	No
5	Are appropriate measures taken to prevent (mechanical protection) or monitor an unprotected presence in the hazardous area when protecting the hazardous area or point of hazard? Are these measures secured against removal?	Yes	No
6	Are additional mechanical protective measures fitted and secured against manipulation that prevents reaching over, under, or around the ESPE?	Yes	No
7	Is the maximum stop time and/or stop/run-down time of the machine measured, specified, and documented (at the machine and/or in the machine documentation)?	Yes	No
8	Is the ESPE mounted so that it achieves the required safety distance from the nearest point?	Yes	No
9	Are the ESPE devices correctly mounted and secured against manipulation after adjustment?	Yes	No
10	Are the required protective measures against electric shock in effect (protection class)?	Yes	No
11	Is the control switch for resetting the ESPE or restarting the machine present and correctly installed?	Yes	No
12	Are the ESPE outputs (OSSD) integrated in accordance with the stipulated control category? Do they comply with the circuit diagrams?	Yes	No
13	Is the protective function checked in compliance with Protective Device Checks on page 30?	Yes	No
14	Are the given protective functions effective at every setting of the operation mode selector switch	Yes	No
15	Are the switching elements activated by the ESPE (such as contactors and valves) monitored?	Yes	No
16	Is the ESPE effective over the entire period of the dangerous state?	Yes	No
17	Once initiated, will the dangerous state stop when you switch the ESPE on or off and when you change the operating mode, or when you switch to another protective device?	Yes	No
18	Is the information label for the daily check attached so it is easily visible for the operator?	Yes	No
This checklist does not replace the initial commissioning, nor the regular inspection by qualified safety personnel.			

Notes:

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Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, and product notification updates.	rok.auto/support
Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

Documentation Feedback

Your comments help us serve your documentation needs better. If you have any suggestions on how to improve our content, complete the form at rok.auto/docfeedback.

Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

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