



# GuardShield Safety Light Curtain

Catalog Numbers 450L-B4FNxYD, 450L-B4HNxYD,  
450L-E4AxLxYD, 450L-E4FLxYD, 450L-E4HLxYD



**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.

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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.

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**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.

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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.

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**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.

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**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).

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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.



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## Typical Installations

**Notes:**



This manual describes how to install, wire, and troubleshoot the 450L-B and 450L-E POC and the 450L GuardShield™ PAC Safety Light Curtains.

## Who Should Use This Manual

Use this manual if you design, install, program, or troubleshoot systems that use the 450L GuardShield safety light curtain.

You must have a basic understanding of electrical circuitry and familiarity with safety-related systems. Obtain the proper training before using this product.

Qualified personnel must perform the following tasks:

- Conduct all inspections.
- Undergo the appropriate technical training.
- Instruct personnel in the operation of the machine and the current safety guidelines.
- Read and have access to the user manual.
- Install the safety light curtain and only use the safety light curtain on that specific machine.

## Summary of Changes

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## Terminology

Abbreviation	Definition
EDM	External Device Monitoring
ESPE	Electro-sensitive Protective Equipment
FSD	Final Switching Device
NC	Not Connected
NEC	National Electric Code (U.S.)
OID	Optical Interface Device
OSSD	Output Signal Switching Device: Typically designates a pair of solid-state signals that are pulled up to the DC source supply. The signals are tested for short circuits to the DC power supply, short circuits to the DC common, and short circuits between the two signals.
PAC	Perimeter Access Control: A safety light curtain that is designed for whole body detection to create a safety perimeter around a machine.
POC	Point of Operation Control: A safety light curtain that is designed for installation close to the hazard where personnel could frequently interact with the machine as part of the process. These safety light curtains are therefore designed for partial body detection. The 450L safety light curtain family offers finger and hand detection.
PL	Performance Level
QD	Quick Disconnect
RB	Restart Button
Rx	Receiver
SIL	Safety Integrity Level
Tx	Transmitter

## Product Firmware and Release Notes

Product firmware and release notes are available online within the Product Compatibility and Download Center.

1. Go to [rok.auto/pcdc](http://rok.auto/pcdc).
2. Search for your product.
3. On the search results page, find the firmware and release notes for your product. If no firmware/release notes are available, the module is still shipping with its original firmware release.

## Additional Resources

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

Resource	Description
450L GuardShield Safety Light Curtain Release Notes, publication <a href="#">450L-RN001</a>	Release notes through firmware version 5.004.
450L GuardShield Safety Light Curtain Quick Start, publication <a href="#">450L-QS001</a>	Provides a quick start information to configure and run a system using 450L safety light curtains.
450L GuardShield Light-Curtain Weld-Shield Installation Instructions, publication <a href="#">450L-IN001</a>	Provides installation information for weld shield kits.
Side Mount Bracket Set for GuardShield Light Curtains Installation Instructions, publication <a href="#">450L-IN002</a>	Provides installation information for side mount brackets.
GuardShield Light Curtain Optical Interface Device Installation Instructions, publication <a href="#">450L-IN003</a>	Provides installation information for the optical interface device.
GuardShield Safety Light Curtain Installation Instructions, publication <a href="#">450L-IN004</a>	Provides installation information for 450L-B and 450L-E POC safety light curtains.
GuardShield Muting Distribution Block Installation Instructions, publication <a href="#">450L-IN005</a>	Provides installation information for the 450L muting distribution block.
GuardShield Safety Light Curtain Status Light Installation Instructions, publication <a href="#">450L-IN007</a>	Provides installation information for the 450L status light.
GuardShield 450L PAC Safety Light Curtain Installation Instructions, publication <a href="#">450L-IN009</a>	Provides installation information for the 450L PAC safety light curtains.
Safety Book 5, Safety-related Control Systems for Machinery, publication <a href="#">SAFE5K-RM002</a>	Provides principles, standards, and implementation of safety-related control systems for machinery.
CIP Security with Rockwell Automation Products Application Technique, publication <a href="#">SECURE-AT001</a>	Provides implementation information for the CIP Security™ standard in your industrial automation control system (IACS).
FactoryTalk Security Application Technique, publication <a href="#">SECURE-AT002</a>	Provides guidelines for how to configure and use FactoryTalk® Security in an Integrated Architect system.
System Security Design Guidelines Reference Manual, publication <a href="#">SECURE-RM001</a>	Provides guidelines for how to use Rockwell Automation® products to improve the security of your industrial automation system.
Configure System Security Features User Manual, publication <a href="#">SECURE-UM001</a>	Describes the system-level configuration requirements to use a ControlLogix® 5580 controller.
Industrial Automation Wiring and Grounding Guidelines, publication <a href="#">1770-4.1</a>	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website: <a href="http://rok.auto/certifications">rok.auto/certifications</a>	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at [rok.auto/literature](http://rok.auto/literature).



**Notes:**

## Product Overview

### General Description

The 450L GuardShield™ safety light curtain family consists of general-purpose presence sensing devices that are designed for use on hazardous machinery for both Perimeter Access Control (PAC) and Point of Operation Control (POC) applications. The product family is certified as Type 4 electro-sensitive protective equipment (ESPE) (as defined by EN 61496-1 and IEC 61496-2). This certification allows you to use this product in applications that require PLe category 4 according to EN ISO 13849-1.

The 450L PAC safety light curtains are based on the 450L-E POC safety light curtain models and are offered in single-beam (Area Access Control [AAC]), 2-beam, 3-beam, and 4-beam options and range in length 150...1050 mm (5.91...41.34 in.).

The 450L POC safety light curtains are offered in multiple lengths 150...1950 mm (5.9...76.77 in.) in increments of 150 mm (5.9 in.). Each length is available in finger [14 mm (0.56 in.)] or hand [30 mm (1.19 in.)] resolution with a basic set of sensing functions.

The 450L POC safety light curtain family consists of two product lines:

- 450L-B (basic)
- 450L-E (enhanced)

The 450L-B safety light curtain is suitable for basic on/off applications, whereas the 450L-E safety light curtain provides enhanced features for more sophisticated applications. [Table 1](#) shows the differences between the two product versions.

**Table 1 - 450L-B and 450L-E/450L PAC Safety Light Curtain System Comparison**

Description	450L-B	450L-E and 450L PAC
Alignment aid	Two zone indicator light-emitting diode (LED)	Integrated laser alignment and two zone indicator LED
Operation range finger resolution, min...max	0.5...4 m (1.6...13.12 ft)	0.5...9.0 m (1.64...29.53 ft) <sup>(1)</sup>
Operation range hand resolution, min...max	0.9...7.0 m (2.95...22.97 ft)	0.9...16.2 m (2.95...53.15 ft)
Functionality	Start modes External device monitoring (EDM) Operation range	Start modes EDM Operation range Beam coding Blanking <sup>(2)</sup> Muting Cascading
CIP Safety™ functionality <sup>(3)</sup>	Yes	Yes

(1) Not applicable for 450L PAC safety light curtain models, which is based on 450L-E safety light curtain hand resolution.

(2) Blanking is not available on 450L PAC safety light curtain models.

(3) Only with appropriate plug-in and module. CIP safety is not available on 450L PAC models.

The two 450L safety light curtain versions have no differences in cross section, protective heights, resolutions, sealing, operating/storage temperature, length passive zones at the ends of each stick, or mounting options. The 450L PAC safety light curtain also has the same cross section, sealing, operating/storage temperatures, and mounting options.

The GuardShield safety light curtain system is unique from other safety light curtain transmitter and receiver solutions because the system consists of two identical transceiver sticks. These safety light curtains are not designated as transmitter or receiver right out-of-the-box. The configuration of a stick as a transmitter or a receiver is done by inserting either:

- A dedicated transmitter or receiver plug-in into the transceiver sticks.
- A universal plug-in module in each transceiver stick, which allows a selection for the transmitter or the receiver function by wiring.

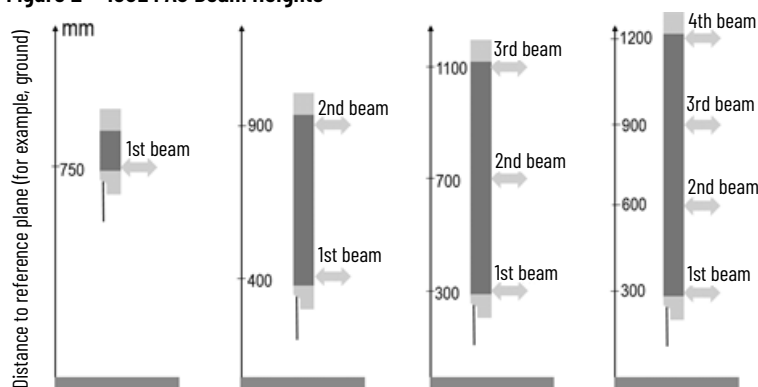
The GuardShield 450L POC safety light curtain is a two-box system, which has no inactive sensing area or dead/blind zones at the top and bottom of each stick. This design allows an easy integration in individual machine designs.

The GuardShield 450L PAC safety light curtain is also a two-box system. PAC systems have several single-beam light barriers, or, for 450L PAC safety light curtains, a combination of active and passive elements in accordance with EN ISO 13855 [2010].

**Figure 1 - 450L PAC Front View - Active and Passive Zones (2-beam Model Shown)**



**Figure 2 - 450L PAC Beam Heights**



Selectable function depends on the installed receiver plug-in, which you can insert in a GuardShield safety light curtain transceiver stick. Select different operation modes via the DIP switch on the receiver plug-ins.



Depending on the type of plug-in that you install in a GuardShield stick, the system offers:

- Connectivity to ArmorBlock® Guard I/O™ (5-pin M12 QD) for network connectivity, providing CIP Safety over DeviceNet® or EtherNet/IP™ (not applicable for 450L PAC safety light curtains).
- Auto or Manual Start modes.
- External device monitoring (EDM).
- Beam coding.
- Muting, blanking, and cascading capabilities (450L-E safety light curtain only).



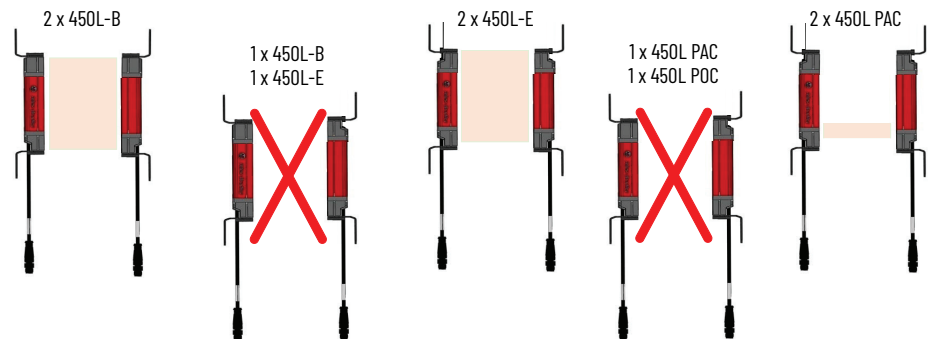
**LASER LIGHT CLASS 2 HAZARD:** Do not stare into the beam. The 450L-E safety light curtains have an integrated laser alignment help option (see [Laser Alignment on page 25](#)).

We apply recognized technical regulations and ISO 9001 quality assurance procedures in the development and production of Allen-Bradley® GuardShield® products.

### IMPORTANT

A 450L-B safety light curtain transceiver stick cannot operate with a A 450L-E safety light curtain transceiver stick. A 450L PAC safety light curtain transceiver stick cannot operate with a 450L POC safety light curtain transceiver stick of either kind.

**Figure 3 - Compatibility Limitations**



**Figure 4 - Assembly Overview (450L-B Safety Light Curtain System)**

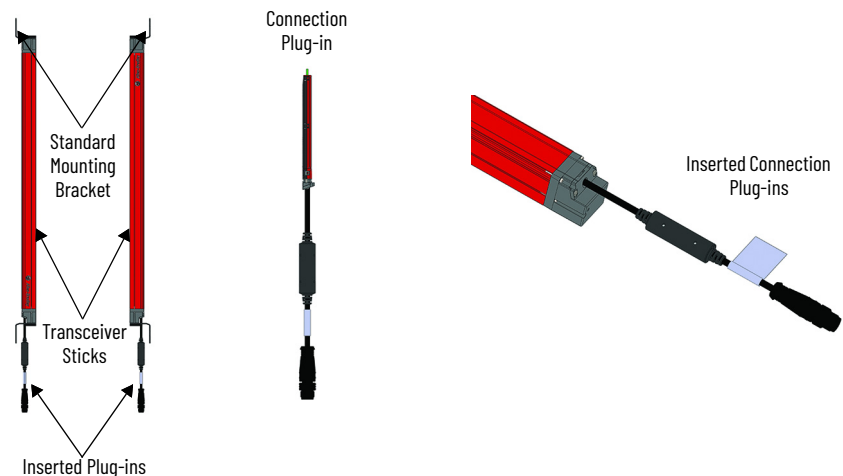
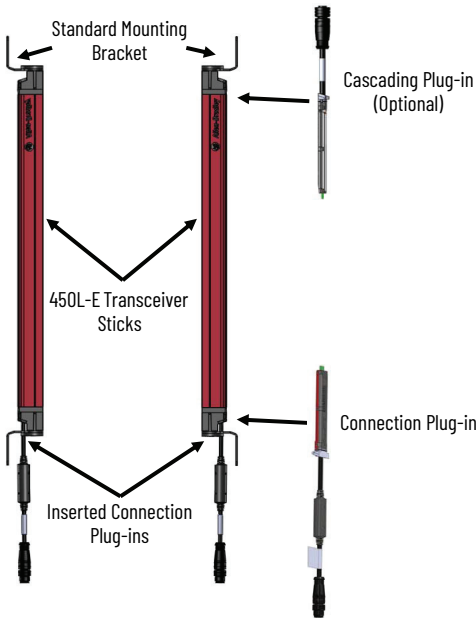


Figure 5 - Assembly Overview (450L PAC and 450L-E POC Safety Light Curtain System)



The 450L-E and 450L PAC safety light curtain also provide the option to insert a cascading plug-in into the opposite stick end at the gray slot cover (see [Cascading on page 45](#) and [Figure 7 on page 17](#)).

Package Contents

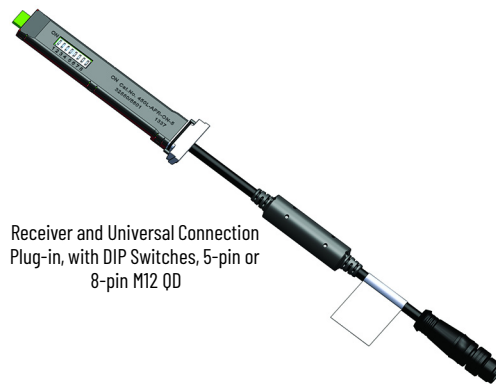
A GuardShield safety light curtain is normally shipped as an individual component (single transceiver). A functional system includes four individual boxes.

Table 2 - List for a Complete System

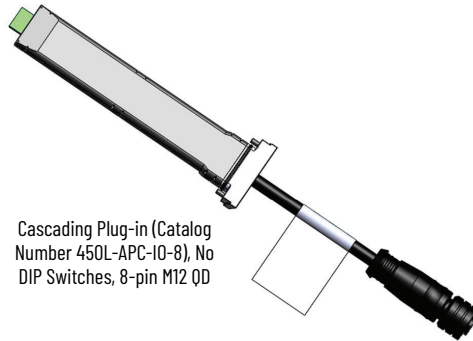
Item	Required Quantity	Description	Remark
1	2	450L GuardShield safety light curtain transceiver stick	Each box contains: <ul style="list-style-type: none"><li>• One stick</li><li>• Mounting kit (top and bottom)</li><li>• Test rod</li><li>• Short instruction manual</li></ul>
2	1	Transmitter plug-in	150 mm (5.9 in.) pigtail with M12 QD connector (plug)
3	1	Receiver plug-in	150 mm (5.9 in.) pigtail with M12 QD connector (plug)

Figure 6 - Contents of 450L POC Safety Light Curtain Transceiver Stick Box

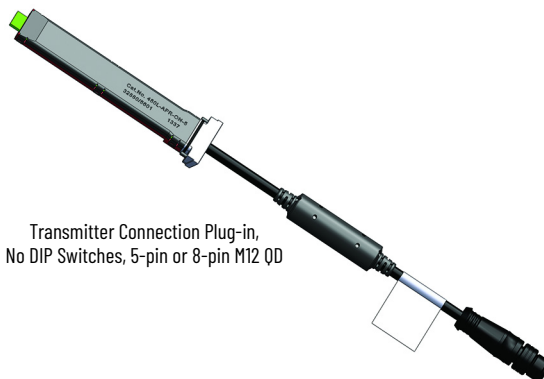


**Figure 7 - Plug-ins**

Receiver and Universal Connection  
Plug-in, with DIP Switches, 5-pin or  
8-pin M12 QD



Cascading Plug-in (Catalog  
Number 450L-APC-10-8), No  
DIP Switches, 8-pin M12 QD



Transmitter Connection Plug-in,  
No DIP Switches, 5-pin or 8-pin M12 QD

## Firmware Revisions

The feature list of the 450L-B and of the 450L-E safety light curtains continuously expands. [Table 3](#) lists the components with firmware that you can upgrade with ControlFLASH™ software.

**Table 3 - Firmware Revisions of 450L Safety Light Curtains**

Family	Version	Description
450L-B	1.001	Initial Release. Does not support Connected Components Workbench™ software.
	2.001	Support Connected Components Workbench software diagnosis and connection with T-connector. Can be used as the last pair of cascading.
	3.001	Same feature as 2.001 but 4K security key. Engineering version only - not released to users.
	4.001	Support Connected Components Workbench software diagnosis.
	5.001	Same feature as 4.001 4K security key.
	5.002	Initial release to support CIP Safety functionality.
	5.003	Engineering version only - not released to users.
	5.004	Introduction of interference rejection option.
450L-E	5.005	Maintenance release (see publication <a href="#">450L-RN001</a> )
	2.001	Initial release and supports Connected Components Workbench software diagnosis. Supports Dry Contact Switch,. Cascaded safety light curtains Tx side cannot use universal plug-in, the host pairs can still use universal plug-in.
	3.001	Same feature as 2.001. Engineering version only - not released to users.
	4.001	Support Connected Components Workbench software diagnosis, configuration, and E-stop. Not backward compatible with 450L-APC-IO-8.
	5.001	Same feature as 4.001 4K security key.
	5.002	Initial release to support CIP Safety functionality.
	5.003	Engineering version only - not released to users.
	5.004	Introduction of interference rejection option.
450L PAC	5.005	Maintenance release (see publication <a href="#">450L-RN001</a> )
	1.001	Initial Release. Does not support Connected Components Workbench software, or Studio 5000® (CIP Safety).
450L-APC-IO-8	1.001	Initial Release.
	2.001	Allows 450L-APU-UN-8 to be used as a transmitter in a cascaded stick.
	3.001	Same feature as 2.001.
	4.001	Backward compatible with LC.
	5.001	Same feature as 4.001 4K security key.
450L-OID	1.001	Initial release, does not support the 450L-E safety light curtain. Upgrade to 1.002 or later if you receive the warning message: The connection to the 450L safety light curtain will be terminated because of repeatedly mismatched checksum calculation errors.
	1.002	Supports LC diagnosis and firmware update.
	3.001	Backward compatible with LC. Supports LC firmware 3.001 diagnosis, firmware update, reset, confirm, and blanking teach command. Added 4K key certificate support.
	4.001	Backward compatible with LC. Example: 2.001, 3.001, 4.001 LC can work with 5.001 OID, but 3.001, 4.001 OID cannot work with 5.001 LC.
	5.001	Backward compatible with LC 4K security key.

For maintenance reasons, a 450L safety light curtain stick with an old firmware revision can operate with a 450L safety light curtain stick with newer firmware.

## Safety Concepts

This section describes the safety Performance Level concept and explains how the 450L safety light curtains meet the requirements for SIL 3 and PLe for Category 4 architectures.

### Safety Standards Applied to GuardShield

The 450L safety light curtain satisfies applicable requirements in the following standards that relate to functional and machinery assembly:

- IEC 61496-1/-2 (Type 4)
- IEC 61508 (SIL 3)
- IEC 62061 (SIL CL 3)
- EN/ISO 13849-1 (Performance Level e (PLe), Category 4)
- UL 508

The 450L-E safety light curtain satisfies the applicable requirements that IEC 60825-1 provides for the integrated laser alignment aid (see [Laser Alignment on page 25](#)).

See the Declaration of Conformity at [rok.auto/certifications](http://rok.auto/certifications) for published dates of the individual standards.

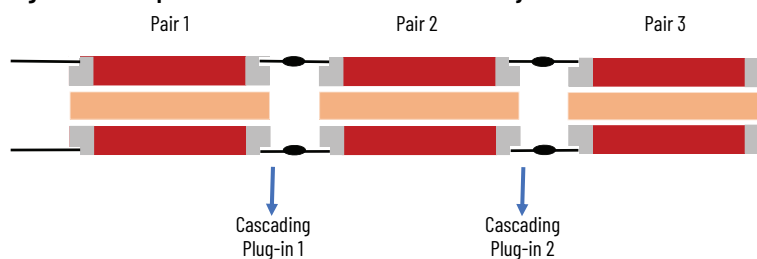
### Functional Safety Data

The functional safety data are listed in [Table 72 on page 171](#). These values refer to the longest safety light curtain system length (1950 mm [76.77 in.]) with the smallest resolution (14 mm[0.55 in.]).

For cascaded 450L-E safety light curtain applications, the final PFH value of the complete system is the sum of the individual PFH values of each pair plus the sum of the PFH values of the cascading plug-in.

[Figure 8](#) shows the calculation of the PFH of a cascaded system with 450L-E safety light curtain and two cascading plug-ins.

**Figure 8 - Example and PFH Calculation of Cascaded Systems**



$$\text{PFH (total)} = 3 \times \text{PFH (450L pair)} + 2 \times \text{PFH (cascading plug-in)}$$

**IMPORTANT** For 450L-E safety light curtains: If cascading, consider the PFH of each cascade and each cascading plug-in.



## Safety Certification

Each 450L safety light curtain is a Type 4 ESPE as defined by IEC 61496-1 and CLC/TS 61496-2. The safety light curtains are allowed for use with controls in compliance with the following certifications:

- PLe (in a Category 4 architecture) in compliance with EN ISO 13849
- SIL CL3 in accordance with EN 62061
- SIL 3 in accordance with IEC 61508

Safety requirements are based on the standards applicable at the time of certification with a proof test interval of 20 years.

The device is suitable for:

- Point of Operation Control (POC) finger and hand detection
- Hazardous area protection
- Access protection

Only allow access to the hazardous point through the protective field. The machine/system is not allowed to start as long as personnel are within the hazardous area (see [Correct Installation on page 72](#)).

Depending on the application, mechanical protective devices can be required with the safety light curtain.

TÜV Rheinland has approved the 450L GuardShield™ safety light curtains for use in safety-related applications where Performance Level (PL) up to E and safety integrity level up to SIL 3 are required.

TÜV Rheinland confirmed that the integrated laser alignment aid in 450L-E GuardShield safety light curtains conforms to the classification of laser class two according to IEC 60825-1.

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**IMPORTANT** Observe the following directives, rules, and regulations to help conform to proper and safe use of the GuardShield safety light curtain.

---

The national/international rules and regulations apply to the installation, use, and periodic technical inspections of the safety light curtain, in particular:

- Machine Directive
- Low Voltage Directive
- Equipment Usage Directive
- Work safety regulations/safety rules
- Other relevant health and safety regulations

Published dates of the individual standards are given in the Declaration of Conformity (see [Certifications on page 175](#)).

Manufacturers and users of the machine with which the safety light curtain is used must obtain and observe all applicable safety regulations and rules:

- Observe the notices of this user manual, in particular the test regulations (for example, on use, mounting, installation, or integration into the existing machine controller).
- Specialist personnel or specially qualified and authorized personnel must implement, record, and document the tests so the tests can be reconstructed and retraced at any time.
- This user manual must be available to the user of the machine where the GuardShield safety light curtain is installed. The machine operator must be instructed in the use of the device by specialist personnel.

## Installation Requirements

Install the GuardShield safety light curtains in accordance with applicable regulations and standards.

While you can use GuardShield safety light curtains for SIL 3, PLe, and Category 4 applications, you must comply with the minimum (safe) distance requirements; for example, according to EN ISO 13855, if installed in the European Union.

The installed system, including the safety control system and the machine stop mechanism, must achieve the needed safety Performance Level. The GuardShield safety light curtains are only one element in the safety system. See publication [SAFE BK-RM002](#) for additional guidance.

## Possible Misuse

GuardShield safety light curtains are used as electro-sensitive protective equipment in the sense of the Machinery Directive. Use these devices only in applications such as:

- POC device
- Access control device
- Hazardous area control device



**ATTENTION:** The following applications and/or environmental conditions can lead to misuse and potentially cause severe injuries or death (for more information see IEC 62046).

---

- Machines, which eject materials, swarf, or component parts
- Risk of injury from thermal or other radiation
- Unacceptable noise levels
- Transparent objects are detected
- Environment that exceeds the specification (see [Specifications on page 171](#))

Some, but not all, possible limits are electrostatic discharge, radio frequency interference, vibration/shock, ambient light, pollution, temperature, and humidity.

Without additional measures (IEC 62998), do not use GuardShield safety light curtains for the following applications:

- Outdoors
- Under water
- Explosive atmospheres
- Altitudes over 3000 m (1.86 miles) above sea level
- With enhanced ionizing or radar radiation

**Notes:**

## Operation

This chapter provides information on the special features and properties of the 450L safety light curtain. This chapter also describes the structure and functions of the unit, particularly the different operating modes.

### Principle of Operation

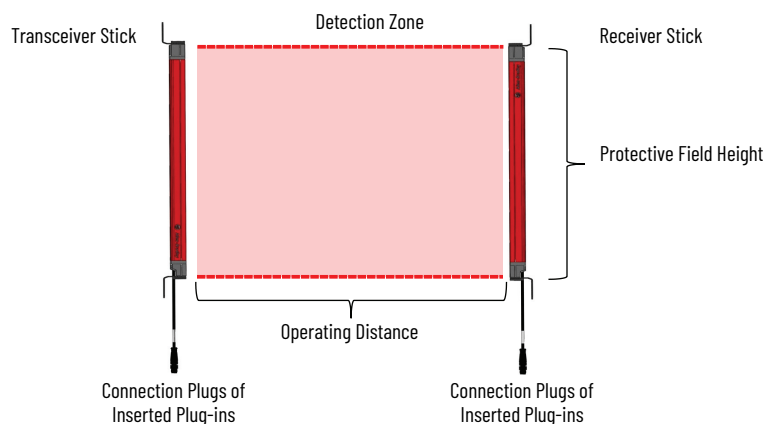
A functional GuardShield™ safety light curtain system includes:

- Two transceiver sticks (same model, length, and resolution)
- A transmitter plug-in
- A receiver plug-in

The type of plug-in defines whether a transceiver stick performs as a transmitter or as a receiver. The maximum distance between transmitter and receiver sticks is referred to as the operating distance or operating range (see [Figure 9](#)). The GuardShield systems also require a minimum operating distance. If you install a system below this distance, the safety outputs do not switch to on. The maximum operating range reduces by using deflector mirrors and/or weld shields.

The protective field height of a GuardShield safety light curtain is equal to the total length of the stick.

**Figure 9 - Principle Operation of a 450L Safety Light Curtain System**



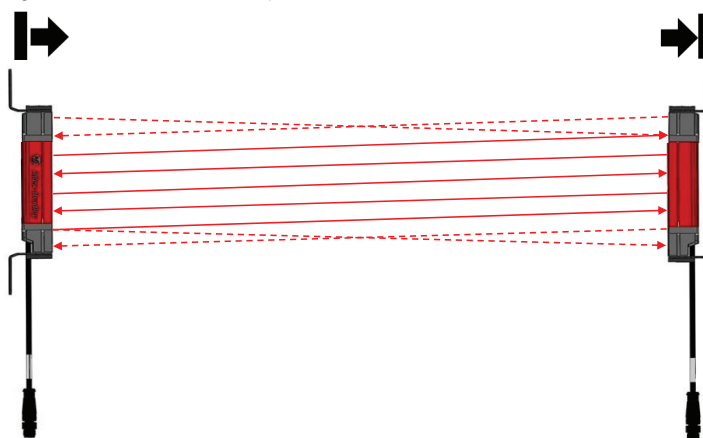
A short time after the power-up and alignment of a system, invisible infrared light beams build up a plane of detection (protective field) between the two sticks. The axis of the detection zone is vertical to the front window of the safety light curtain sticks.

Infrared light pulses between the two sticks in sequence. The receiver analyzes and processes the beam status. When one or more beams interrupt, the two output signal switching devices (OSSDs) turn off. A safety control, safety relay, or safety contactor evaluates the signal to stop the dangerous state of the machine.

The first laser beam, or the last beam near the end of the sticks, optically synchronizes the timing of the emission and reception of infrared light pulses. These beams are synchronization beams. Because the GuardShield systems optically synchronize, no electrical connection is required between the transmitter and receiver sticks.

The unique design of the GuardShield platform allows every 450L safety light curtain transceiver to transmit and receive infrared light. In contrast to the classical architecture of common pure transmitter and receiver safety light curtain systems, GuardShield transceiver sticks exchange protective field information via infrared light. Therefore, infrared light is not only sent from a transceiver working as a transmitter to a receiver. As indicated in [Figure 10](#), a transceiver stick configured as a receiver transmits some infrared light to the transmitter. The dashed lines in [Figure 10](#) indicate the synchronization beams.

**Figure 10 - Schematic Display of Beam Center Lines**



The slightly slanted beams and the maximum operating angle of the infrared light require that you install a transmitter and a receiver stick beyond a minimum operating distance. A 450L safety light curtain system is safe against manipulation, as you cannot install a transmitter stick directly in front of a receiver stick.

A GuardShield transceiver, which acts as a receiver, has two OSSD safety outputs and, depending on the plug-in that is used, one additional non-safety auxiliary output. When the GuardShield transmitter and receiver are properly powered, aligned, not obstructed, and the Start/Restart mode is correctly initiated, both the OSSDs and the auxiliary output are on (output voltage = +24V DC). The two safety OSSDs are cross-fault monitored and short-circuit protected.



**ATTENTION:** The auxiliary output is only a status output for diagnosis purposes to connect, for example, an indicator lamp. Do not use this output for safety purposes.

Interruption of the sensing field causes the receiver OSSD to switch off (sourced current 0 mA DC, source voltage 0V DC).

For automatic restart: No obstruction of the GuardShield sensing field causes the two safety outputs (OSSD) to switch to the active high (on) state (+24V DC).

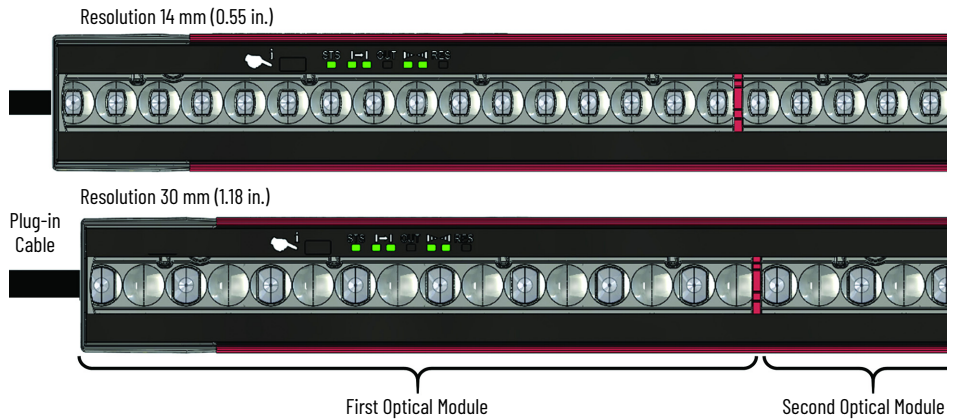
With the appropriate resolution, the GuardShield safety light curtain system provides finger or hand protection. The resolution corresponds to the diameter of the provided test rod belonging to the safety light curtain. The test rod is reliably detected when positioned in the protective field. The resolution of a GuardShield stick is printed on the product label.



**ATTENTION:** The resolution of a 450L-E safety light curtain system that is configured with blanking changes depending on the configuration (see [Blanking and Reduced Resolution on page 30](#)). Consider any change in the resolution in the safety distance calculation (see [Determine the Safety Distance on page 64](#)) and in the installation.

[Figure 11](#) shows the active lenses for the two resolutions of the safety light curtain.

**Figure 11 - Active Lenses for Different Resolutions**



Resolution [mm (in.)]	Lens Number Per Module															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
14 (0.56)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
30 (1.19)	X	—	X	—	X	—	X	—	X	—	X	—	X	—	X	—

**IMPORTANT** The gap [approximately 1.5 mm (0.05 in.)] between adjacent modules, which are red (indicated in [Figure 11](#) for hand and finger resolution), has no impact on resolution.

## Laser Alignment

All 450L-E and 450L PAC safety light curtain transceiver sticks have an integrated laser alignment system (ILAS). The laser works with visible light, which makes the alignment of a 450L-E and 450L PAC safety light curtain system much easier.



**LASER LIGHT HAZARD:** Do not stare into the beam. Each 450L-E and 450L PAC safety light curtain has a built-in laser alignment system.  
LASER CLASS 2 (IEC 60825-1).  
Conforms to 21 CFR 1040.10.

You can switch the ILAS on and off by simply placing a finger on the optical push button, which is near to the hand symbol on the front window (see [Figure 33 on page 62](#)). Once the laser activates, several red laser beams transmit (see [Figure 12 on page 26](#)) from a source close to the optical push button.

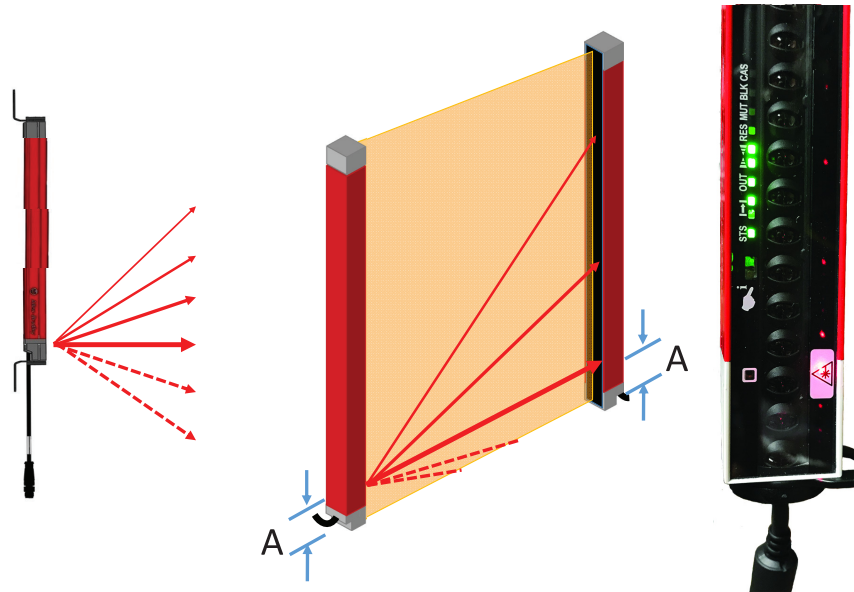
[Figure 12](#) shows the principle operation of the ILAS. The brightest beam transmits perpendicular to the front window, which is also parallel to the infrared light of the stick. Position the brightest beam at the opposite stick at the same level as indicated with distance A in [Figure 12](#). Target the other slanted laser beams between the optics center and the housing of the opposite stick on the front window. The quantity of slanted beams on the opposite stick depends on the installation distance. To find optimum alignment for a 450L-E and 450L PAC safety light curtain system, the laser of each stick must align to the opposite stick.

---

**IMPORTANT** A white background (for example, paper) makes it easy to identify the brightest beam.

---

**Figure 12 - Principal Function of the Integrated Laser Alignment System**




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**IMPORTANT** [Figure 12](#) indicates additional visible laser beams (dotted) to the connection end of the stick. Such beams do not have to be considered for the alignment procedure.

---

In a cascading system, each integrated laser system works independently and can be switched on or off individually.

The 450L-B safety light curtain sticks have no integrated laser alignment system. For those sticks, an optional external alignment aid (see [Figure 136 on page 184](#)) with a mounting clamp ([Figure 137 on page 184](#)) is available.



## Safety Function

The 450L safety light curtain offers a range of functions that are integral to the safety system. You can select the functions via DIP switch settings on the receiver plug-in.

Confirmation of a new configuration at the receiver stick is only required if the stick previously operated with another DIP switch setting or with another plug-in type (see [Confirmation of a New System Configuration on page 61](#)).

Confirmation of a new configuration at the transmitter stick is only required if the stick was previously operated with another beam coding (see [Beam Coding on page 29](#)).



**ATTENTION:** Test the protective system for proper operation after each change to the configuration.

---

You can select some safety functions only with the 450L-E safety light curtain. A complete overview is provided in [Table 1 on page 13](#).

## Start Modes

The four start modes are configurable for all GuardShield™ product lines (450L PAC and both 450L-B and 450L-E POC safety light curtain product lines). Manual reset options are only provided for 8-pin connection plug-ins. 5-pin plug-ins have only the automatic start/restart option.

---

**IMPORTANT** You can use the Start button to power cycle a receiver stick if there is a lockout. A receiver stick performs the power off/on cycle if the input of the Start button activates for a minimum of 10 seconds, but not longer than 20 seconds. This function is also available if you configure automatic start for receiver plug-ins, which allow a start mode selection, see [Restart Button on page 94](#) for additional information.

---

### Automatic Start/Restart (Default)

When in the Automatic Start mode of operation (also known as Guard Only mode), the safety light curtain operates as an on/off device. The OSSD outputs switch off, according to an interruption of the sensing field, and automatically switch on when the protective field is clear. The GuardShield pairs that are equipped with bottom plug-ins and factory-default DIP switch settings work in Automatic Start mode.

## Manual Start/Restart

The Manual Start mode of operation (also known as restart interlock) helps prevent the OSSD outputs from switching on automatically after interruption and clearance of the protective field or power-up. The GuardShield system requires a manual start. Start up the system with a momentary N.O. push button or keyswitch. An orange status indicator (RES) on the 450L safety light curtain receiver indicates that the system is ready for manual restart.

Manual start is not available in GuardShield safety light curtains with ArmorBlock® Guard I/O™ connectivity (5-pin bottom plug-in).

Press the Start button for a minimum of 50 ms. The maximum time for accepting the start pulse is 5 seconds. If the pulse width is too short or too long, the start function does not execute. The start reacts on the falling edge of the start pulse.

## Manual Cold Start

The manual cold start (also known as start interlock) helps prevent the OSSD outputs from switching on after power-up of the system, even when the protective field is unobstructed. After each power-up, the system requires a one-time manual start for the GuardShield system OSSD outputs to enter the on-state.

Press the Start button for a minimum of 50 ms. The maximum time for accepting the start pulse is 5 seconds. If the pulse width is too short or too long, the start function does not execute. The start reacts on the falling edge of the start pulse.

After the initial powerup and manual start, the safety light curtain system operates in the Automatic Start mode. DIP switch settings activate this mode of operation and selection of the starting method. An orange status indicator (RES) on the GuardShield receiver indicates that the system is ready to start manually.

Manual cold start is not available in GuardShield safety light curtains with ArmorBlock Guard I/O connectivity (5-pin bottom plug-in).

## Manual Start/Restart with Off Function

This start mode allows the OSSD outputs to switch on manually (if the protection field is unobstructed) and switch off manually. Use the same push button or keyswitch that is used for manual start to turn off the OSSD outputs manually. When the OSSD outputs switch off because of an interruption of the protective field, clear the protective field and operate the push button or key again.

DIP switch settings activate and configure this mode of operation. An orange status indicator (RES) on the GuardShield receiver indicates that the system is ready to start manually.

## Power Cycle

When a GuardShield receiver goes into a lockout state, correct the cause of the lockout and cycle power. You can use the Start input signal and the optical push button to cycle power. Press and hold the Start button or the optical push button 10...20 seconds. The power cycle function is available for all start modes, including automatic.

## External Device Monitoring (EDM)

External device monitoring is configurable for both GuardShield product lines.

EDM is an input signal to the GuardShield receiver. EDM monitors the state of the primary control contactors of the guarded machinery or other final switching devices (FSD). The EDM input looks for a change of state of the contactors/FSD within a time period of 300 ms before the system faults. A fault causes the safety light curtain to enter a lockout condition (OSSDs off and error indication). One use of the EDM function is to detect an unsafe condition such as welded contacts in one of the FSD. DIP switch settings on the GuardShield receiver plug-in activate this mode of operation, or you can enable this function in the General settings in the Connected Components Workbench™ software.

EDM is not available in GuardShield safety light curtains with ArmorBlock Guard I/O connectivity (M12 5-pin QD plug-in).

## Low Operating Range

Low operating range minimizes the influence of neighboring optical sensors on the performance of the 450L safety light curtain. This feature is available on all 450L GuardShield safety light curtains. Low operating range narrows the operating distance. The maximum operating distance is reduced, and the minimum operating distance is increased.

Configure a low operating range by enabling the appropriate DIP switch on the receiver plug-in, or by enabling the function in the General settings in the Connected Components Workbench software. The default setting is disabled.

The regional intensity status indicators on the transmitter and receiver indicate the activation of the low range function.

## Beam Coding

Beam coding is only configurable for 450L-E and 450L PAC safety light curtains.

If several safety light curtains operate close to one another, one 450L-E/450L PAC safety light curtain system can see the transmitter infrared light from another 450L-E/450L PAC safety light curtain receiver. Such a situation is called optical cross talk (see [Mount Multiple 450L GuardShield Safety Light Curtains on page 75](#)) and can cause an unsafe installation. To reduce the probability of optical cross talk, the 450L-E/450L PAC safety light curtain can exchange the addresses of the paired sticks and generate an alternate transmitter pulse pattern. This process is referred to as beam coding.

Two settings are available in the 450L-E and 450L PAC safety light curtain — non-coded and coded. The factory default is non-coded.

If you select beam coding, you must perform a teach-in procedure once at the transmitter and the corresponding receiver to pair the two sticks.

The pairing procedure for out-of-box systems is only required at the Rx and at the Tx transceiver stick when you select the beam coding function. Perform the pairing procedure only once after the first power-up.

Set beam coding with the appropriate DIP switch on the plug-in of the receiver (Rx) stick and power the system up. If the Rx stick was operated before, first perform a configuration confirmation at the Rx and then the confirmation for the pairing.

The STS status indicator at the transmitter flashes red/green to indicate that the Tx stick beam coding must be paired with the Rx stick. Follow the procedure in [Confirmation of a New System Configuration on page 61](#).



**ATTENTION:** If several systems are in the area, only one single transmitter is allowed to pair with a given receiver. Confirm that any other adjacent installed safety light curtain system is switched off during the pairing process. The beam coding settings have an impact on the response time (see [Response Time on page 48](#)).

## Interference Rejection

Interference rejection is only configurable for the 450L-E safety light curtain and is permanently enabled on the 450L PAC safety light curtain.

Interference rejection is an enhancement to beam coding to mitigate optical interference and cross talk. In applications where enabling beam coding alone does not mitigate interference, enable the interference rejection feature to alter the scan pattern, which restricts stray light from a neighboring 450L-E safety light curtain from affecting operation. Set interference rejection with the appropriate DIP switch<sup>(a)</sup> on the plug-in of the receiver.

Another application for interference rejection is in cascaded systems, as the sticks can mount closely without needing to adhere to the minimum distance spacing requirements.

---

**IMPORTANT** The use of interference rejection affects the response time, which can impact safety distance. Always verify safety distance when using this feature.

---

## Blanking and Reduced Resolution

Blanking and reduced resolution is only configurable for the 450L-E safety light curtain.

Blanking and reduced resolutions are typically used to allow objects wider than the optical resolution to stay in or to pass through the protective field during normal operation without causing a fault or stop condition (for blanking application, see [Fixed Blanking Application on page 188](#)).

Both are available in the 450L-E safety light curtain per DIP switch configuration:

- Fixed Teach-in Blanking (see [Figure 143 on page 188](#))
- Reduced Resolution (see [Reduced Resolution \(Object Number Limited\) on page 34](#)).

---

**IMPORTANT** Verify for all Blanking and Reduced Resolution modes that no undetected access is possible into the danger zone via the blanked protective field throughout the whole width of the protective field (also left and right of the blanked object). Maintain this restriction, for example, with additional mechanical barriers.

The blanking settings have an impact on the response time (see [Response Time on page 48](#)).

You cannot configure muting and blanking simultaneously. You can activate fixed blanking and reduced resolution simultaneously.

---

(a) Setting interference rejection by DIP switch assumes the worst case scenario of protection from a neighboring 1950 mm (76.78 in.) length stick with finger resolution, irrespective of the actual length or resolution of the sticks. See [Table 18 on page 51](#). You can refine and greatly reduce response time by configuring interference rejection in the software, see [Table 19 on page 52](#).

## Teach-in Fixed Blanking

Beams are taught to ignore up to four fixed objects in the sensing field. The blanked fixtures or objects must remain in the sensing field or the 450L-E safety light curtain enters a Fault state (OSSDs off).

At minimum, the first two active lenses in the protective field at the connection end or the last two active lenses at the cascading end must be unblocked ([Table 4](#)).

---

**IMPORTANT** Blanked areas can require an additional risk analysis. If you do not use mechanical or other guarding to restrict access to the hazard, consider the blanked area in the calculation of the safety distance.

---

The fixed Teach-in Blanking mode of operation activates through DIP switch settings that are on the following plug-ins:

- 450L-APR-BL-5 ([Table 25 on page 58](#))
- 450L-APR-MU-8 ([Table 26 on page 59](#))

To teach the beams to be blanked, activate the Optical Teach button (near the hand symbol on the 450L-E safety light curtain front window, see [Figure 14 on page 32](#)), in a specific sequence (see [Figure 15 on page 33](#)) while the object is in the 450L-E safety light curtain sensing field. The safety light curtain Fixed Blanking mode of operation is not active until the teach procedure is complete.

The Fixed Blanking mode of operation is always monitored. If you remove any part or all blanked objects from the protective field, the OSSD outputs of the 450L-E safety light curtain go to the off-state and the Rx stick displays a blanking error (see [Table 53 on page 104](#)).

Due to vibrations often present in industrial applications, the number of physically interrupted beams is one less than the specified number of beams. A local adjustment of this tolerance value (-1) is not possible with DIP switches.

If the fixed blanked object only blocks one beam, the tolerance value is zero. This value means that a minimum of one beam must be blocked; there is no tolerance.

The 450L-E safety light curtain can perform fixed blanking of one or more adjacent beams. At minimum, one of the two synchronization beams ([Figure 13 on page 32](#)) must be unblocked before and during the Teach-in procedure.

A teach-in error occurs if one of the cases in [Table 4](#) (see [Figure 13 on page 32](#) for illustration) happens.

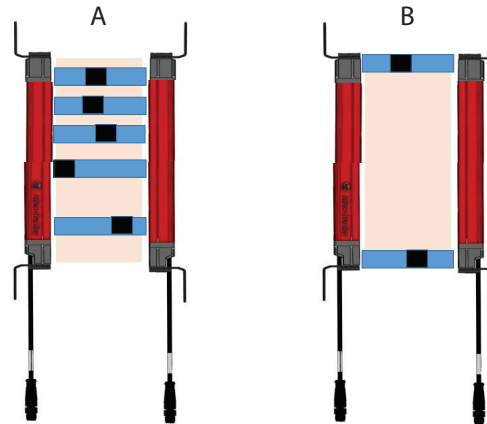
**Table 4 - Teach-in Errors and Behavior**

Case	Description	Behavior
1	More than four independent objects are in the protective field	The first four interrupted objects that start from the connection plug-in are taught, all other objects are not taught. As a result, the OSSDs stay in the off condition as long as the additional objects are in the protective field.
2	The beams at top and bottom are simultaneously blocked	The teach-in command is ignored and the 450L-E safety light curtain continues to operate with the previously taught objects.
3	One object is moving during teach-in	The teach-in command completes, but the error indication at the end of the teach-in process warns that the taught limits can cause sporadic OSSD switching.

Two setups that cause a teach-in blanking error:

- Case A: Number of objects > 4
- Case B: Top and Bottom end interrupted

Figure 13 - Teach-in Blanking Error



### IMPORTANT

Fully test the protective field with the provided test rods, according to [Regular Inspection on page 115](#).

The configuration and activation of fixed blanking creates a hole to the left and/or right of the object in the protective field (objects are indicated in black in [Figure 13](#).) If the fixed object that is in the protective field does not entirely fill the area between the GuardShield transmitter and receiver, to obstruct access to the hazard by additional means. You can use mechanical barriers (hard guard) to obstruct the open area. Open areas are indicated as blue in [Figure 13](#).



**ATTENTION:** A fixed blanking zone changes the resolution of the 450L-E safety light curtain system (see [Resolution with Blanking on page 36](#)). Considered this change when you calculate the safety distance.

[Table 6 on page 35](#) shows the reaction of the OSSD outputs with Fixed Blanking deactivated and activated for different use cases.

## Teach-in Blanking Procedure

The procedure to teach a new fixed blanked object is similar to the procedure to conduct a confirmation of a changed configuration ([Confirmation of a New System Configuration on page 61](#)) with use of the optical push button.

Activate the optical push button ([Figure 14](#)) two times for 5 seconds ([Figure 15 on page 33](#)). Between the two activations, a break of a maximum of 2 seconds is allowed.

Figure 14 - Position of Optical Push Button, ILAS, and Status Indicators

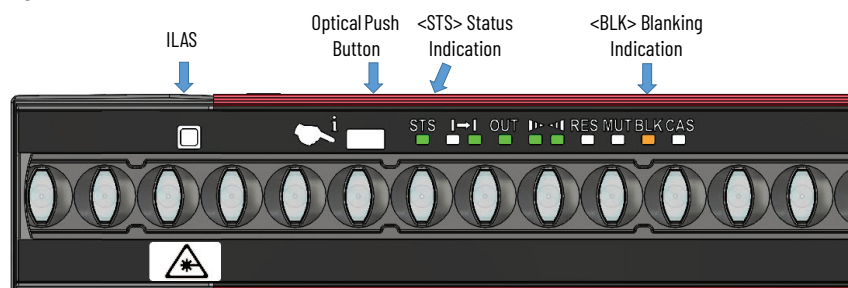
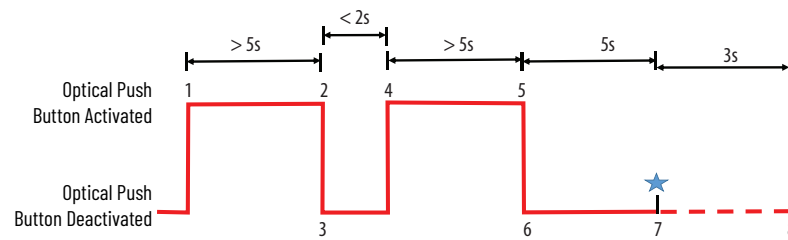


Figure 15 - Teach-In Blanking Configuration Process



## Configuration Process

1. The status indicator STS is green, which indicates normal operation (no fault).
2. Actuate the optical push button ([Figure 14 on page 32](#)) for 5 seconds.
3. The STS remains continuously green.
4. Once the status indicator STS flashes green, release the optical push button.
5. Release is indicated with a change of frequency 10...1 Hz (status indicator STS flashes green and a 50:50 duty cycle).
6. Within 2 seconds, actuate the optical push button.
7. The status indicator STS flashes green to indicate the activation and the status indicator BLK flashes orange at a frequency of 10 Hz and a 50% duty cycle to indicate the activation.
8. Actuate the optical push button for at least for 5 seconds.
9. Once the status indicator and the blanking indicator changes frequency 10...1 Hz, release the optical push button.
10. After you release the optical push button, the status indicator STS is steady green and the status indicator BLK continues to flash for 5 seconds.
11. In these 5 seconds, remove your hand and all objects that are not being taught.
12. At the end of these 5 seconds, the 450L-E safety light curtain teaches all interrupted beams.
13. The status indicator BLK flashes orange for 3 seconds and STS is steady green to indicate a successful Teach-in.
14. The status indicator BLK flashes orange for 3 seconds and STS flashes green/red to indicate a failed Teach-in.

---

**IMPORTANT** If there is an error in the Teach-in procedure, the new fixed blanking zone limits are not accepted and the safety light curtain continues working with the previously taught zone limits.  
Once the configuration confirmation procedure is completed, verify the changed resolution.

---

You can also conduct a Teach-in procedure with the Rockwell Automation Connected Components Workbench software and an installed optical interface device (see [Optical Interface Device \(OID\) on page 112](#)).

The following options lead to the deletion of taught fixed blanking areas:

- Change the DIP switch setting and confirm the new DIP setting.
- Insert and confirm another plug-in type.



## Reduced Resolution (Object Number Limited)

Reduced resolution is a type of blanking without monitoring whether the beams are interrupted. The comparable blanking function with monitoring is called floating blanking. Floating blanking and reduced resolution have similar functionality, the difference, according to the standard IEC 61496, is the object monitoring.

Reduced resolution is always specified in combination with a beam number. There are different types of reduced resolution:

- All blanked beams must be adjacent. The maximum size of the object is equal to the beam value. This type is only good for one single object (reduced resolution, single object).
- Blanked beams can be adjacent, but not required. The sum of the size of all objects in the protective field is not larger than the beam value (reduced resolution, multiple objects, object number limited).
- Blanked beams can be adjacent, but not required. The size of each object in the protective field is not larger than the beam value (reduced resolution, multiple objects, object number unlimited).

The reduced resolution that you can activate with a DIP switch in a 450L-E safety light curtain refers to the definition (b) multiple objects, object number limited.

Reduced resolution is not available on 450L PAC safety light curtains.

---

**IMPORTANT** The blanking modes that you can activate with the DIP switches in a 450L-E safety light curtain system are equal to the blanking modes that can be activated in a 440L safety light curtain system.

---

DIP switch settings activate the Reduced Resolution mode of operation on the following plug-ins:

- 450L-APR-BL-5 ([Table 25 on page 58](#))
- 450L-APR-MU-8 ([Table 26 on page 59](#))

Reduced resolution of one beam or reduced resolution of two beams allows you to blank out one or two beams anywhere in the protective field. An example is when blocked beams are ignored and the 450L-E safety light curtain remains with OSSD outputs active. Reduced resolution allows an object to float in (move within, or in and out of) the 450L-E safety light curtain protective field without causing the safety light curtain outputs to change to the off-state. For details, see [Table 7 on page 35](#) and [Table 8 on page 35](#).

For reduced resolution with the object number limited, the maximum number of blanked objects is equal to the beam number (see [Table 6 on page 35](#)).

If activated by the DIP switch, the reduced resolution is active over the entire protective field, except the zones that are already taught with another blanking type.

---

**IMPORTANT** With reduced resolution active, protective field holes can occur that are left and/or right of the protective field. This occurrence means that at times when no object is blocking the protective field, there is a danger that a person can reach through the protective field without deactivating the machine.

---



Table 5 - Nomenclature for Table 6...Table 8

Symbol	Description
○	Beam not interrupted
⊗	Beam interrupted
□	The beam is activated for Fixed Blanking and not interrupted
⊠	Beam is activated for Fixed Blanking and interrupted

Table 6 - Status of OSSDs for Different Situations in Case of Fixed Teach-in Blanking

Case	1	2	3	4	5	6	7	8
IR-Beam	No Blanking	Fixed Teach-in Blanking						
N	○	○	○	○	○	○	○	○
N+1	○	⊠	⊠	□	⊠	□	⊠	⊠
N+2	⊗	⊠	□	⊠	□	□	□	□
N+3	○	○	○	○	○	○	○	○
N+4	○	○	○	○	⊗	○	⊠	⊠
N+5	○	○	○	○	○	○	○	⊗
N+6	○	○	○	○	○	○	○	○
Status OSSDs	Off	On	On	On	Off	Off	On	Off

**IMPORTANT** For case 3 and case 4 in Table 6, the OSSDs stay on because of the tolerance (-1).

Table 7 - Status of OSSDs for Different Reduced Resolution Instances

Case	1	2	3	4	5	6	7	8	9	10	11	12
IR-Beam	Reduced Resolution Deactivated	Reduced Resolution 1 Beam Active				Reduced Resolution 2 Beams Active						
N	○	○	○	○	○	○	○	○	○	○	○	○
N+1	○	○	⊗	⊗	⊗	○	⊗	⊗	⊗	⊗	⊗	⊗
N+2	⊗	○	○	○	⊗	○	○	○	⊗	⊗	⊗	○
N+3	○	○	○	⊗	○	○	○	⊗	○	⊗	○	⊗
N+4	○	○	○	○	○	○	○	○	○	○	⊗	○
N+5	○	○	○	○	○	○	○	○	○	○	○	⊗
N+6	○	○	○	○	○	○	○	○	○	○	○	○
Status OSSDs	Off	On	On	Off	Off	On	On	On	On	Off	Off	Off

Table 8 - Status of OSSDs for Different Cases of Reduced Resolution in Combination with Fixed Teach in Blanking

Case	1	2	3	4	5	6	7	8	9	10	11	12
IR-Beam	Reduced Resolution Deactivated	Reduced Resolution 1 Beam and Teach-in Fixed Blanking				Reduced Resolution 2 Beams and Teach-in Fixed Blanking						
N	○	○	○	○	○	○	○	○	○	○	○	○
N+1	○	○	⊗	⊗	⊗	○	⊗	⊗	⊗	⊗	⊗	⊗
N+2	⊠	⊠	⊠	⊠	□	⊠	⊠	⊠	⊠	⊠	□	⊠
N+3	○	○	○	⊗	○	○	○	⊗	○	○	○	⊗
N+4	○	○	○	○	○	○	○	○	○	○	⊗	○
N+5	○	○	○	○	○	○	○	○	○	○	○	⊗
N+6	○	○	○	○	○	○	○	○	○	⊗	○	○
Status OSSDs	On	On	On	Off	Off	On	On	On	On	Off	Off	Off

## Resolution with Blanking



**ATTENTION:** Actuation of the Reduced Resolution mode changes the resolution of the 450L-E safety light curtain.

[Table 9](#) shows the resolution of a 450L-E safety light curtain for different blanking mode combinations.

**Table 9 - Resolution**

GuardShield Resolution (No Blanking) [mm (in.)]	Configured Blanking Type	Configured Resolution [mm (in.)]
14 mm (0.56 in.)	No blanking	14 (0.56)
	Fixed blanking	Single object: 28 (1.11) Multiple objects: 42 (1.66)
	Reduced resolution one beam	23 (0.91)
	Reduced resolution one beam in combination with Fixed Teach-In blanking	42 (1.66)
	Reduced resolution two beams	33 (1.30)
	Reduced resolution two beams in combination with Fixed Teach-in blanking	52 (2.05)
30 mm (1.19 in.)	No blanking	30 (1.19)
	Fixed blanking	Single object: 53 (2.09) Multiple objects: 82 (3.23)
	Reduced resolution one beam	44 (1.74)
	Reduced resolution one beam in combination with Fixed Teach-In blanking	82 (3.23)
	Reduced resolution two beams	63 (2.49)
	Reduced resolution two beams in combination with Fixed Teach-In blanking	100 (3.94)

**IMPORTANT** After each configuration or reconfiguration of a GuardShield safety light curtain, test the configuration of the safety light curtain using an appropriate test piece.

The borders between two adjacent blanking zones are especially critical for the resolutions. [Table 9](#) provides the largest resolution for a complete safety light curtain system for different DIP switch settings.

For blanking with cascading, see [Cascading and Blanking on page 48](#).

## Muting

The cascading feature is only available for the 450L-E and 450L PAC safety light curtain. To enable the muting functionality, install the receiver plug-in 450L-APR-MU-8.

**IMPORTANT** A detailed description about muting, muting restrictions and hints for the installation are given in the standard IEC 62046. Additional hints are mentioned in the attachment A7 of IEC 61496-1. The muting function is only allowed after you complete a thorough safety analysis according to EN 13849-1 and ISO EN 12100.

Certain applications in practice require that the protective field of the 450L-E or 450L PAC safety light curtain mutes automatically without the safety outputs switching off. A typical example of such an application is a conveyor belt. You can transport the goods on a pallet through the protective field without stopping the pallet movement.

Muting is the temporary automatic suspension of the protective function of a safeguarding device like a safety light curtain. The muting function allows the transport of material through a safety light curtain without stopping a conveyor. To distinguish between material and persons, a certain sequence of events and timings are used. Muting sensors mount in a certain pattern, and the material must pass by the sensors and safety light curtain within specified time limits. If the muting sensor sequence is incorrect or the timing parameters are violated, the safeguarding device stops the conveyor. An override signal allows the movement of the material through the safety light curtain after a violation.

The 450L-E or 450L PAC safety light curtain has three distinct types of muting where the sequence and timing of signals that the safety light curtain monitors allows objects to pass through the safety light curtain without shutting down the machine process. The three available types are:

- Two sensors, T-type muting (bidirectional operation)
- Four sensors, T-type muting (bidirectional operation)
- Two sensors, L-type muting (unidirectional operation)

The two-sensor muting types can connect at the connection plug-in (see [Figure 74 on page 98](#)) or at the cascading plug-in catalog number 450L-APC-IO-8 (see [Figure 80 on page 103](#)). The four-sensor muting type can only connect at the cascading plug-in catalog number 450L-APC-IO-8.

To activate the desired muting functionality, select the DIP switches off the receiver plug-in catalog number 450L-APR-MU-8 according to [Table 26 on page 59](#) and [Table 28 on page 60](#).

You can configure each of these functions with manual or automatic reset.

---

**IMPORTANT** You must set the safety function block muting to manual reset. In case the safety light curtain is set to automatic start, the safety relay or the safety PLC manages the manual reset.

---

## Muting Lamp

Depending on the risk assessment of the application, a muting lamp is necessary to warn you when the safety light curtain is muted (see details in IEC 62046). The muting lamp is on when the safety light curtain is muted.

If an error in the muting sequence occurs, the muting lamp flashes (see [Troubleshoot on page 109](#)), which indicates that the muting condition is not initiated, or is discontinued.

## Muting Sensors

---

**IMPORTANT** Detailed information about muting sensors (for example, positioning) is given in the standard IEC 62046.

---

Mechanical muting sensors must have an opening contact. For proper operation, the muting sensors are on (N.C.) if the safety light curtain is not muted.

The safety relay, the 450L-E or 450L PAC safety light curtain, and the muting sensors must have the same reference (24V Com) for proper operation.

Photoelectric muting sensors do not need certification, according to safety Type 2 or 4 of IEC 61496-1/-2. The detection zone of the muting sensors must be within 30° of horizontal and mounted at a height suitable to detect the leg of a person (see IEC 62046).

Various positions and sizes of materials on the pallet can complicate an uninterrupted muting signal over the entire passage through the guarded area. For this reason, an off-delay time  $t_{msdel}$  for the muting sensor inputs and the safety light curtain is set to 50 ms.

---

**IMPORTANT** The muting sensors detect the material on a pallet and not the pallet itself.

---

## Mute Dependent Override Function (MDO)

Normal activation of the Manual Start button only happens if no muting sensors are active and the safety light curtain is not interrupted.

An error in the muting sequence does not allow a muting condition. If the safety light curtain is interrupted, the OSSD safety outputs of the 450L-E safety light curtain switch off. This error typically leads to a cessation of movement.

In such a case, it can be difficult to move the material out of the protected area. If you anticipate this situation (an error in the muting sequence or timing), the Reset button provides an MDO (depending on DIP switch settings). Activating the Reset button (manual start) can temporarily reactivate the OSSD safety outputs. The maximum allowable duration  $t_{mdo}$  for this MDO is provided in [Table 10 on page 40](#), [Table 11 on page 41](#), and [Table 13 on page 44](#) of the individual muting types.

---

**IMPORTANT** Confirm that you can install the MDO, based on the risk assessment of the application. Some applications can require a spring-loaded keyswitch for the reset.

---

The MDO is possible at the same pin when you configure automatic start. For this case, the connected safety relay or safety logic performs the manual reset.

---

**IMPORTANT** In muting applications, the reset of the muting function block must be a manual reset. Either the safety light curtain and/or the safety relay that connects to the safety light curtain performs the manual reset.

---

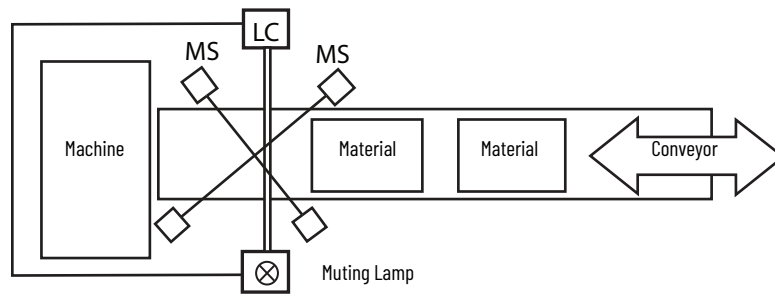
A push button or a spring-loaded keyswitch activates the MDO. The push button/keyswitch mounts where the dangerous area is visible.

The MDO automatically ends after the mute dependent override time ( $t_{mdo}$ ) elapsed, or when the safety light curtain is no longer interrupted, whichever occurs first.

The muting functionality does not have an impact on the response time of the 450L-E or 450L PAC safety light curtain.

## Two-sensor T-type Muting

The sensors and safety light curtain form the shape of an upside down T, when viewed from the side. The muting sensors (MS) mount to form an X sensing pattern where the sensing beams cross near the center of the safety light curtain (LC).

**Figure 16 - Two-sensor T-type Muting Arrangement**

The muting sensors can mount symmetrically (equal distance from the safety light curtain) or asymmetrically (unequal distance from the safety light curtain).

The material can break either the MS1 or MS2 sensor first, then the other sensor, and then the safety light curtain. As the material clears the safety light curtain, the material must then clear MS2 or MS1 first, and then the other sensor. The muting lamp turns on shortly after the second sensor is blocked, and the safety light curtain is muted.

Either of these two patterns is acceptable:

- MS1↑ MS2↓ LC↓ LC↑ MS2↑ MS1↑
- MS2↓ MS1↑ LC↓ LC↑ MS1↑ MS2↑

The cross point of the two light beams is behind the sensing field of the safety light curtain in the direction of the dangerous area.

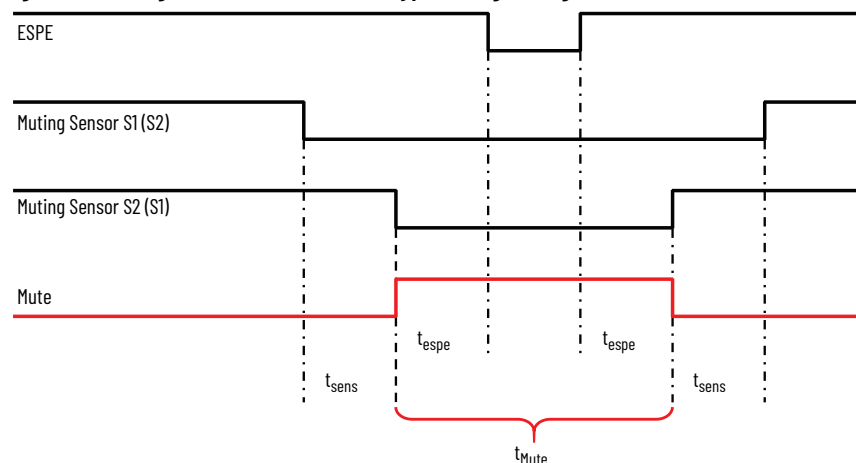
The height of the cross point of the two muting sensors is at the same level as or higher than the lowest beam of the safety light curtain.

Verify that the distance from the cross point to the protective field of the safety light curtain is as short as possible.

During the muting process, it is impossible for a person to enter the undetected dangerous area to the left or right of the object.

With proper arrangement of the sensors, the conveyor can move in the forward or reverse direction and maintain safeguard integrity.

For sensor connection, see [Table 39 on page 87](#) and [Table 43 on page 89](#) for the cascading plug-in.

**Figure 17 - Muting Time for Two-sensor T-type Muting Arrangement**

For proper operation, MS1 and MS2 must activate/deactivate within the time ( $t_{sens}$ ), and the safety light curtain must be clear before the muting time ( $t_{Mute}$ ) expires.

Muting of the safety light curtain happens when muting sensor MS1 and MS2 activate within the specified time ( $t_{sens}$ ). Since this muting mode is bidirectional, the muting sequence also functions in reverse (for example, muting sensor one before muting sensor two, or two before one are both allowed). Both signals, however, cannot arrive simultaneously ( $t_{sens}$  minimum). The muting condition stops if one of the muting sensors is not active, or if the maximum muting time ( $t_{Mute}$ ) is exceeded (muting timeout).

The minimum time between the sensors ( $t_{sens}$  minimum) is dependent on the position of the muting sensors and the speed of the object to be muted. For more dependable operation, maintain at least a delay of  $t_{sens}$  minimum.

Table 10 shows the default timing values for T-type muting. You can adjust these values with the Connected Components Workbench software.

Table 10 - Two-sensor T-type Muting Default Settings

Parameter	Default Value	Parameter	Default Value
$t_{sens}$	4 s	$t_{mdo}$	20 s
$t_{sens\ min}$	50 ms	$t_{espe}$	5 s
$t_{Mute}$	5 minutes		

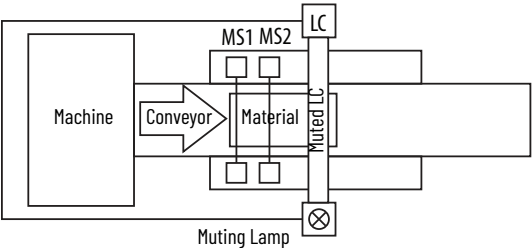
If  $t_{sens}$ ,  $t_{espe}$  or  $t_{Mute}$  exceeds, the STS and the MUT indicator flashes (Table 56 on page 110). The muting lamp output has the same characteristic as the MUT status indicator. If the material backs away from the sensors, the fault clears and the muting lamp turns off. If the material breaks the safety light curtain, the OSSD output turns off. The STS and MUT status indicator continue to flash. Use the muting override command to turn on the OSSD outputs temporarily and clear the material from the protective field.

**IMPORTANT** It must be impossible for a person to pass undetected to the left or right of the object during the muting process.

Two-sensor L-type Muting

The sensors and safety light curtain form the shape of the letter L, when viewed from the side. The muting sensors (MS) mount on one side of the safety light curtain.

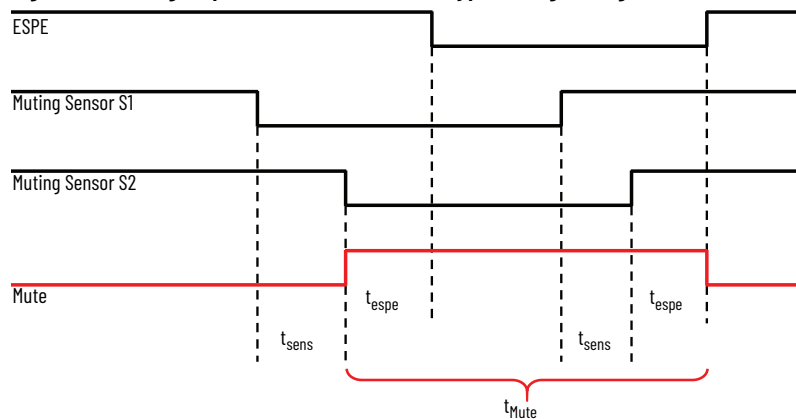
Figure 18 - Two-sensor L-type Muting Arrangement



Use this muting mode to allow a load to exit a dangerous area and help prevent access from outside the dangerous area. The object that comes from the dangerous area interrupts the two muting sensors, which initiates the muting of the safety light curtain. As the object continues to move through the protective field, muting remains active until the safety light curtain is no longer interrupted.

For sensor connection, see [Table 39 on page 87](#) and [Table 43 on page 89](#) for the cascading plug-in.

**Figure 19 - Timing Sequence for Two-sensor L-type Muting Arrangement**



Muting of the safety light curtain initiates only after muting sensor MS1 and MS2 activate within the specified time ( $t_{sens}$ ). The muting condition stops after  $t_{espe}$  is exceeded, the safety light curtain is no longer interrupted, or the maximum muting time ( $t_{Mute}$ ) is exceeded (muting timeout), which ever occurs first.

[Table 11](#) shows the default muting and synchronization times. You can adjust these values with the Connected Components Workbench software.

**Table 11 - Two-sensor L-type Muting Default Settings**

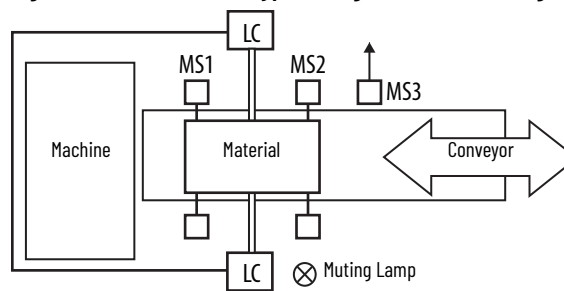
Parameter	Default Value	Parameter	Default Value
$t_{sens}$	3 s	$t_{mdo}$	20 s
$t_{sens\ min}$	50 ms	$t_{espe}$	3 s
$t_{Mute}$	5 min		

Only use the two-sensor L-type muting arrangement for material that exits the hazardous area. Do not use for material that enters the hazardous area.

It must be impossible for a person to pass undetected to the left or right of the object during the muting process.

## Two-sensor T-type Muting with Enable

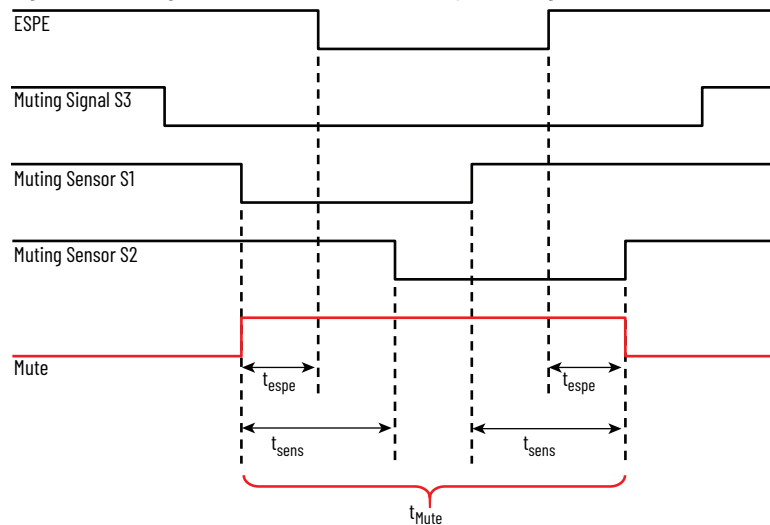
You can only configure this muting mode with Connected Components Workbench software. Use this muting mode for applications when muting is only possible at certain times; for example, only when a conveyor runs. You can also use this muting mode when the size and position of the pallet load is irregular or the size of the pallet is smaller than the width of the conveyor. Because only one optical sensor is on either side of the safety light curtain, this mode requires an additional enable signal to initiate the muting sequence (for example, a conveyor run signal). This signal must be low before muting can initiate.

**Figure 20 - Two-sensor T-type Muting with Enable Arrangement**

The height of the two muting sensors must be at the same level as or higher than the lowest beam of the safety light curtain.

The distance between the S1 or S2 sensors to the safety light curtain must be sufficient so that the leg of a person cannot activate them simultaneously [ $>250$  mm (9.8 in.)].

It must be impossible for a person to pass undetected to the left or right of the object during the muting process. [Figure 21](#) shows the corresponding timing sequence for such an arrangement.

**Figure 21 - Timing Sequence for Two-sensor T-type Muting with Enable**

Muting of the safety light curtain is active only when both enable signal S3 and sensor S1 in one direction, or enable signal S3 and sensor S2 in the opposite direction, activate simultaneously. There are no timing limitations from when the S3 signal goes LO to when the applicable muting sensor goes LO.

The object must be long enough to block both sensors.

The muted condition remains only if muting sensors S1 and S2 are active within the specified time ( $t_{sens}$ ) and less than the muting time ( $t_{Mute}$ ).

The muting condition stops if one of the following occurs:

- S3 and S1 are no longer active (one direction)
- S3 and S2 are no longer active (other direction)
- The maximum muting time ( $t_{Mute}$ ) is exceeded (muting timeout)

Only after one muting sequence is complete can a new muting sequence start. The enable signal S3 must first go HI before returning to LO, in order for a second object to pass through the safety light curtain (for example, the equivalent to a conveyor stop and restart).



[Table 12](#) shows the default settings for two-sensor L-type muting with enable. Use Connected Components Workbench software to change the settings.

**Table 12 - Two-sensor T-type Muting with Enable Default Settings**

Parameter	Default Value
$t_{sens}$	4 s
$t_{Mute}$	5 min
$t_{mdo}$	20 s
$t_{espe}$	4 s

If you get a timing error, the mute lamp flashes at 1 Hz and the mute timing error output turns on.

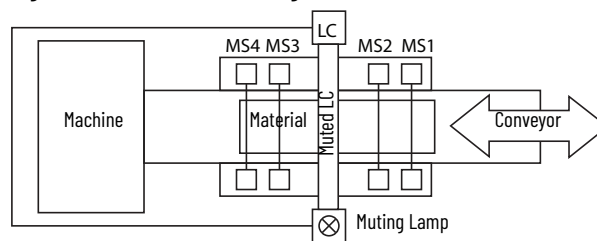
If the object stops in front of the first sensor and does not block the safety light curtain, the mute timing error goes HI and the mute lamp flashes at 1 Hz. The OSSD outputs remain on so you can reverse the conveyor and restart the muting sequence.

Use the S3 muting signal to clear the errors. When S3 goes HI, the mute timing error, the mute sequence error, and the muting error outputs clear.

## Four-sensor Muting

The sensors and safety light curtain form the shape of an upside down T when viewed from the side. Two muting sensors (MS) mount on either side of the safety light curtain (LC).

**Figure 22 - Four-sensor Muting**



The material can travel in either direction, which breaks MS1 first and MS4 last, or breaks MS4 first and MS1 last. The muting lamp turns on and the safety light curtain mutes after the second sensor is blocked. The object must be large enough to interrupt all four sensors.

For muting sensor connections, see [Table 44 on page 89](#).

Considered this muting mode when the size and position of the pallet load is irregular, or the size of the pallet is smaller than the width of the conveyor. This mode can require more space than the two-sensor T-type with Enable Signal Muting mode.

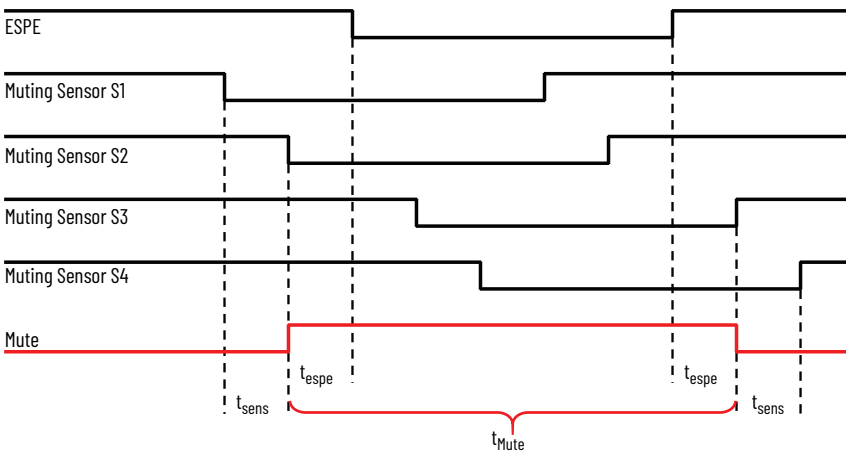
Sensors two and three (closest to the safety light curtain) mount within 200 mm (7.87 in.) of the safety light curtain. This position makes it difficult for you to enter the dangerous zone undetected by preceding or following a load system into the dangerous zone.

The distance between any two muting sensors must be greater than 250 mm (9.84 in.) so that the leg of a person cannot activate them simultaneously.

The distance between sensors MS1 and MS4 is such that a cylindrical object with a diameter of 500 mm (19.68 in.) with its axis parallel to the protective field cannot activate the muting function when moved in any point of the gate at any speed up to 1.6 m/s (see IEC 62064).

The muting sensors MS1...MS4 detect the objects on pallets and not the pallet itself. When this action is impractical, additional measures can be necessary to deter people from entering the zone by sitting on the pallet.

**Figure 23 - Timing Sequence for Four-Sensor Muting**



Muting of the 450L-E safety light curtain is achieved only when muting sensors MS1 and MS2 activate within the specified time ( $t_{sens}$ ). The delay between the sensors must be larger than  $t_{sens\ min}$  minimum. For a successful muting sequence, all four sensors must simultaneously activate for a certain time period.

The muting condition stops when either sensor MS3 or MS4 deactivates, or the maximal muting time ( $t_{Mute}$ ) is exceeded (muting timeout). Since this muting mode is bidirectional, the muting sensor sequence also functions in reverse (such as MS4 =>MS1).

[Table 13](#) shows the default time limits. Adjusted the limits with the Connected Components Workbench software.

**Table 13 - Four-sensor T-type Muting Default Time Limit Settings**

Parameter	Default Value
$t_{sens}$	4 s
$t_{sens\ min}$	50 ms
$t_{Mute}$	5 minutes
$t_{mdo}$	20 s
$t_{espe}$	5 s

A time ( $t_{sens}$ ) of 4 seconds is recommended in IEC 62046.

The behavior of the muting lamp status indicator is analogous to the behavior described in [Two-sensor T-type Muting on page 38](#).

It is impossible for a person to pass undetected to the left or right of the object during the muting process.

## Cascading

The cascading feature is only available for the 450L-E and 450L PAC safety light curtain. Only use a 450L-B safety light curtain as the last pair of a cascaded 450L-E safety light curtain system.

The insertion of an additional cascading plug-in (catalog number 450L-APC-IO-8) at the top cascading end of the stick enables cascading. Depending on the configuration of the DIP switches at the connection plug-in module, the functions of the I/O at the cascading plug-in can change (for example, for muting applications). The different settings for the pins of the cascading plug-in are provided in [Table 41 on page 88](#) ... [Table 44 on page 89](#).

---

**IMPORTANT** Unless you use either 450L-E firmware 5.004 (min) with interference rejection enabled, or 450L PAC cascading with the catalog number 450L-APC-IO-8 cascading plug-in, you require a minimum distance between two adjacent cascaded pairs ([Figure 26 on page 47](#)). See [450L Safety Light Curtain with Interference Rejection on page 79](#) for more information on interference rejection.

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Once you insert the catalog number 450L-APC-IO-8 cascading plug-in, the I/O of the cascading plug-in provides the option to connect an additional 450L safety light curtain with an 8-pin connection in series (see [Figure 25 on page 46](#)). This feature allows up to four pairs of 450L-E or 450L PAC safety light curtain transmitters and receivers to interconnect in series.

[Figure 24](#) and [Figure 25 on page 46](#) specify the nomenclature for cascaded systems.

**Figure 24 - Nomenclature Used for a Noncascaded Setup**

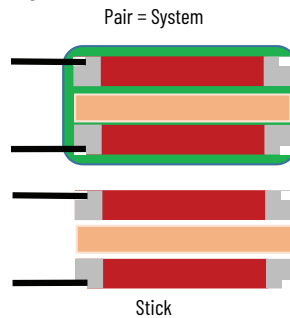
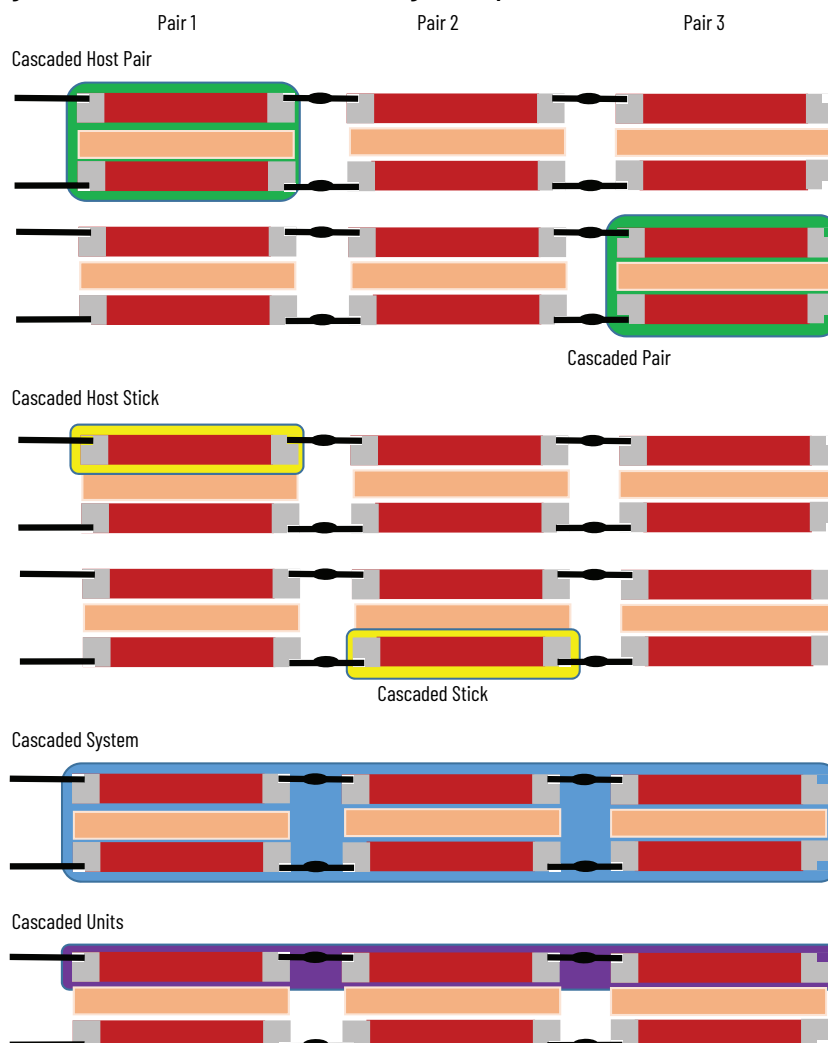


Figure 25 - Nomenclature for Cascaded Design (Example Three Cascaded Pairs)



The first pair in a cascaded system is called the host pair. The OSSD outputs of the host pair connect to safety contactors, a safety relay, or a safety PLC.

Cascading allows the 450L-E or 450L PAC safety light curtain to help protect multiple sides of a machine and to connect the complete design with only two OSSD safety outputs to the machine safety control.

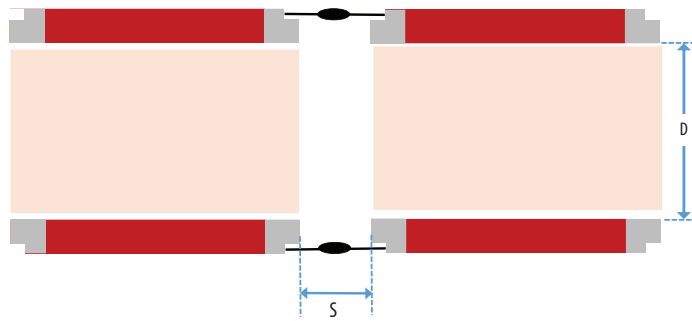
See [Cascading Application on page 189](#) for a typical application with cascading.



**ATTENTION:** Maintain a minimum spacing distance unless you use either 450L-E firmware 5.004 (min) with interference rejection enabled, or 450L PAC to avoid optical crosstalk (see [Mount Multiple 450L GuardShield Safety Light Curtains on page 75](#)) or optical interference between the two adjacent pairs. This minimum spacing distance is a function of the operating distance  $D$  between the transmitter and receiver. The spacing distance ( $S$ ) must be larger than  $0.026 \times D$ . [Figure 26 on page 47](#) identifies the spacing distance and operating distance of a cascaded pair. [Table 14 on page 47](#) shows examples of the spacing distance ( $S$ ) for typical operating distances when no additional optical barriers are installed between the pairs. See [450L Safety Light Curtain with Interference Rejection on page 79](#) for more information on interference rejection. The minimum spacing distance does not apply for 450L-E with interference rejection enabled, or 450L PAC.

[Figure 26](#) identifies the spacing and operating distance of a cascaded safety light curtain pair.

**Figure 26 - Identification of Spacing (S) and Distance (D)**



**Table 14 - Minimum Spacing Distance (S) between Cascaded Pairs without Optical Barriers**

D [m (ft)]	S [mm (in.)]
1 (3.28)	26 (1.02)
5 (16.4)	132 (5.2)
10 (32.8)	264 (10.4)
15 (49.2)	393 (15.5)

The cascade feature is available for protective field heights of 300 mm (11.81 in.) and longer. Do not use 450L safety light curtain transceiver sticks with a length of 150 mm (5.9 in.) as a host pair or a middle pair in a cascaded system. However, you can use a 150 mm (5.95 in.) 450L-E or 450L PAC safety light curtain as the last pair in a cascaded system.

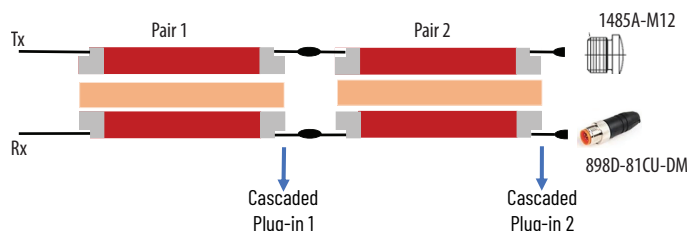
A maximum of four 450L-E or 450L PAC safety light curtains can interconnect with a common pair of OSSDs. For POC systems, each cascaded pair can have a resolution of 14 mm (0.56 in.) or 30 mm (1.19 in.) and a protective field height of up to 1950 mm (76.77 in.). PAC systems are all 30 mm (1.19 in.) resolution and all four versions (single-beam, 2-beam, 3-beam, and 4-beam) can be cascaded. An exception is noted previously for the single-beam, which you can only use as the last pair in a cascaded system. Each cascading pair operates as an independent safety light curtain.

A cable length between two cascaded sticks must not exceed 10 m (32.8 ft).

If you use a catalog number 450L-E or 450L PAC safety light curtain transceiver with an installed catalog number 450L-APC-IO-8 cascading plug-in as a standalone safety light curtain pair or as the last segment in a cascaded system, the cascading plug-in must end with:

- Termination plug catalog number 898D-81CU-DM<sup>(a)</sup> at the cascading plug-in of a transceiver that works as an Rx.
- Termination plug catalog number 898D-81CU-DM or M12 sealing cap (catalog number 1485A-M12) at the cascading plug-in of a transceiver that works as a Tx.

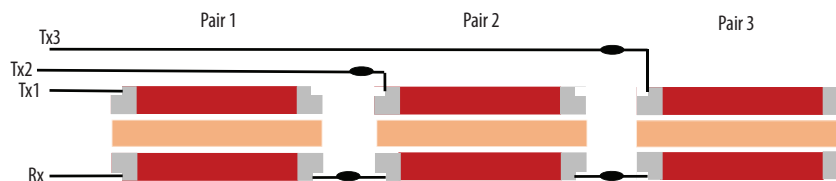
**Figure 27 - Cascaded System with Cat. No. 450L-APC-IO-8 as Last Module**



(a) The termination plug has three pins that are shorted together (pins 2, 5, and 6) and are only needed on the receiver side.

When a 450L-E or 450L PAC safety light curtain stick operates as a receiver with a catalog number 450L-APC-IO-8 cascading plug-in, the corresponding transmitter can accept, but does not require, the installation of a catalog number 450L-APC-IO-8 cascading plug-in (see [Figure 28](#)).

**Figure 28 - Cascaded System**



A cascaded system with three pairs and only two catalog number 450L-APC-IO-8 supply power for all transmitters that are wired separately.

Manual Start modes and relay monitoring (EDM) are not available on cascaded middle and end pairs of a cascading 450L safety light curtain system with DIP switch configuration. However, you can configure these operating modes at the receiver of the host pair and allow the whole cascading system to operate in these modes.

For features like beam coding or blanking, configure each cascaded pair separately.

For two-sensor muting applications, the muting function applies to the cascaded system. You cannot apply four-sensor muting to cascaded systems.

## Cascading and Blanking

When you install a 450L-E safety light curtain for cascading, each cascading 450L-E pair operates as a standalone safety light curtain pair with its OSSDs connected in series to the host pair OSSDs. Therefore, if requested, you must configure fixed blanking and/or reduced resolution in each cascaded pair. To configure, insert an 8-pin catalog number 450L-APR-MU-8 plug-in that provides the blanking functionality in each 450L-E safety light curtain receiver. First, set the DIP switches for the requested blanking function before you assemble the safety light curtain sticks. Then align all pairs and secure the brackets. Then you can teach each safety light curtain pair receiver with the Teach-In procedure. A successful completion of the teach function changes the operating mode of that pair only. During the teach-in process, the OSSDs of that pair and the OSSDs of the host segment are off (oV). You can also use Connected Components Workbench software to configure blanking for each cascaded pair.

Blanking is not available on 450L PAC safety light curtains.

## Response Time

The response time ( $T_r$ ) of the safety light curtain is the time from when the protective field of the safety light curtain is interrupted to when the safety outputs turn off. The safety light curtain features the application uses affect the response time.

## Standard Response Time, $T_s$

The standard response time refers to the response time for a standard on/off application. The standard application includes the following:

- Any start mode
- All operating ranges
- All EDM settings

The standard application excludes the following advanced features:

- Beam coding
- Interference rejection
- Blanking (fixed or floating)
- Cascading
- Multiple zones
- Muting
- Reduced resolution
- Multiple scans
- Short interruption ignore time

For the purposes of determining the response time, floating blanking is equivalent to reduced resolution.

Although muting is considered an advanced feature, muting has no effect on the response time.

The standard response time is dependent on the following:

- Safety light curtain type (PAC or POC [B or E])
- Resolution (finger or hand)
- Protective height

The standard response time for the 450L-B safety light curtain is shown in [Table 15](#). The standard response time for the 450L-E safety light curtain is shown in [Table 16 on page 50](#). In these tables,  $T_r = T_s$ .

**Table 15 - Standard Response Time for 450L-B**

Protective Height [mm (in.)]	Response Time ( $T_s$ )	
	Finger [14 mm (0.55 in.)] Resolution [ms]	Hand [30 mm (1.18 in.)] Resolution [ms]
150 (5.91)	14	14
300 (11.81)	14	14
450 (17.72)	14	14
600 (23.62)	14	14
750 (29.53)	14	14
900 (35.43)	14	14
1050 (41.34)	16	14
1200 (47.24)	17	14
1350 (53.15)	19	14
1500 (59.06)	20	14
1650 (64.96)	22	14
1800 (70.87)	23	14
1950 (76.77)	25	15

Table 16 - Standard Response Time for 450L-E

Protective Height [mm (in.)]	Response Time ( $T_s$ )	
	Finger [14 mm (0.55 in.)] Resolution [ms]	Hand [30 mm (1.18 in.)] Resolution [ms]
150 (5.91)	9	8
300 (11.81)	10	9
450 (17.72)	11	9
600 (23.62)	12	10
750 (29.53)	14	11
900 (35.43)	14	11
1050 (41.34)	14	12
1200 (47.24)	15	12
1350 (53.15)	16	13
1500 (59.06)	17	13
1650 (64.96)	18	13
1800 (70.87)	19	13
1950 (76.77)	20	13

Table 17 - Standard Response Time for 450L PAC

Number of Beams	Protective Height [mm (in.)]	Response Time ( $T_s$ ) Resolution [ms]
1	150 (5.91)	<20
2	600 (23.62)	<20
3	900 (35.43)	<20
4	1050 (41.34)	<20

## Advanced Feature Response Time, $T_a$

The response time of advanced features requires a complex algorithm. The response time is also dependent upon whether you configure the features via the DIP switches on the plug-in or the Connected Components Workbench software.

[Table 18 on page 51](#) shows response times when you use the DIP switches on the plug-in to set the advanced features. The description of each column is:

Column	Description
1	Standard operation with beam coding
2	Fixed blanking up to four zones
3	Fixed blanking up to four zones with beam coding
4	Reduced resolution, single beam
5	Reduced resolution, single beam with beam coding
6	Reduced resolution, two beams
7	Reduced resolution, two beams with beam coding
8	Fixed blanking up to four zones + reduced resolution, single beam
9	Fixed blanking up to four zones + reduced resolution, single beam with beam coding
10	Fixed blanking up to four zones + reduced resolution, two beams
11	Fixed blanking up to four zones + reduced resolution, two beams with beam coding
12	Standard operation with interference rejection



Table 18 - Response Time,  $T_a$  (Set by DIP Switches)

Protective Height [mm (in.)]	Response Time, $T_a$ (ms)											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>Finger Resolution</b>												
150 (5.91)	9	14	16	12	13	15	16	17	19	18	20	83
300 (11.81)	11	15	17	13	14	17	18	19	20	20	21	83
450 (17.72)	13	17	19	15	16	18	19	20	22	21	23	83
600 (23.62)	14	18	20	16	18	19	21	21	23	22	24	83
750 (29.53)	15	19	21	17	18	20	21	23	24	24	25	83
900 (35.43)	15	19	21	17	18	20	21	23	24	24	25	83
1050 (41.34)	16	19	22	17	20	20	23	23	26	24	27	83
1200 (47.24)	18	20	24	18	21	21	24	23	27	24	28	83
1350 (53.15)	19	21	26	19	23	22	26	24	29	25	30	83
1500 (59.06)	21	22	27	20	24	23	27	25	30	27	31	83
1650 (64.96)	22	23	29	21	26	24	29	27	32	28	33	83
1800 (70.87)	24	25	30	23	27	26	30	28	33	29	34	83
1950 (76.77)	25	26	32	24	29	27	32	29	35	30	36	83
<b>Hand Resolution</b>												
150 (5.91)	9	12	13	12	12	15	15	16	16	17	17	83
300 (11.81)	9	14	16	12	13	15	16	17	19	18	20	83
450 (17.72)	10	15	16	13	14	16	17	18	19	19	21	83
600 (23.62)	11	15	17	13	14	17	18	19	20	20	21	83
750 (29.53)	12	16	18	14	15	17	18	19	21	20	22	83
900 (35.43)	13	17	19	15	16	18	19	20	22	21	23	83
1050 (41.34)	13	17	19	15	17	18	20	20	23	21	24	83
1200 (47.24)	14	18	20	16	18	19	21	21	23	22	24	83
1350 (53.15)	14	19	21	17	18	20	21	22	24	23	25	83
1500 (59.06)	14	19	21	17	18	20	21	22	24	23	25	83
1650 (64.96)	14	19	21	17	18	20	21	22	24	23	25	83
1800 (70.87)	15	19	21	17	18	20	21	22	24	23	25	83
1950 (76.77)	16	19	22	17	19	20	22	22	25	23	26	83

[Table 19 on page 52](#) shows the worst-case response times when you use the Connected Components Workbench software to set the multiple advanced features. Shorter response times are typically achieved. The Connected Components Workbench software reports a diagnostic table that shows the actual response time.

The initial release of the 450L PAC safety light curtain does not support the Connected Components Workbench software.

**Table 19 - Response Time,  $T_a$  (Set by the Connected Components Workbench Software Configuration)**

Protective Height [mm (in.)]	Response Time, $T_a$ (ms)		
	Reduced Resolution (Floating Blanking) <sup>(1)</sup>	Reduced Resolution (Floating Blanking), with beam coding <sup>(1)</sup>	Standard Operation with Interference Rejection <sup>(2)</sup>
<b>Finger Resolution</b>			
150 (5.91)	23	24	22
300 (11.81)	26	28	27
450 (17.72)	32	35	32
600 (23.62)	33	36	37
750 (29.53)	48	51	42
900 (35.43)	48	51	47
1050 (41.34)	49	53	52
1200 (47.24)	50	54	57
1350 (53.15)	55	60	63
1500 (59.06)	57	62	68
1650 (64.96)	72	78	73
1800 (70.87)	73	79	78
1950 (76.77)	74	81	83
<b>Hand Resolution</b>			
150 (5.91)	21	22	19
300 (11.81)	23	24	22
450 (17.72)	25	27	24
600 (23.62)	26	28	27
750 (29.53)	31	34	29
900 (35.43)	32	35	32
1050 (41.34)	32	35	34
1200 (47.24)	33	36	37
1350 (53.15)	47	51	40
1500 (59.06)	47	51	42
1650 (64.96)	47	51	45
1800 (70.87)	47	51	47
1950 (76.77)	48	52	50

(1) Single-beam, reduced resolution, one object outside the blanked zones.

(2) When you use and configure the interference rejection feature with software, the system with the largest response time dictates the response time for both systems. For example, when you enable interference rejection on two systems where one system is 1200 mm (47.24 in.) finger resolution and the other system is 1650 mm (64.96 in.) hand resolution, both systems result with a response time of 57 ms.

## Multiple Scan

When you enable multiple scan, the response time increases by approximately 33%. See the diagnostic property 3.30 in the Connected Components Workbench software for the actual response time.

Not applicable for 450L PAC safety light curtains.

## Short Interruption Time

You can configure the 450L-E safety light curtain to ignore interruptions up to 174 ms. This value is added to the response time. See the diagnostic property 3.30 in the Connected Components Workbench software for the actual response time.

Not applicable for 450L PAC safety light curtains.

## Cascading Response Time, $T_c$

The response time of a cascaded safety light curtain is an adder due to the cascading plug-in (catalog number 450L-APC-IO-8). The adder must consider the total number of cascading plug-ins between the cascaded stick and the host stick. Therefore, the total response time is calculated as:

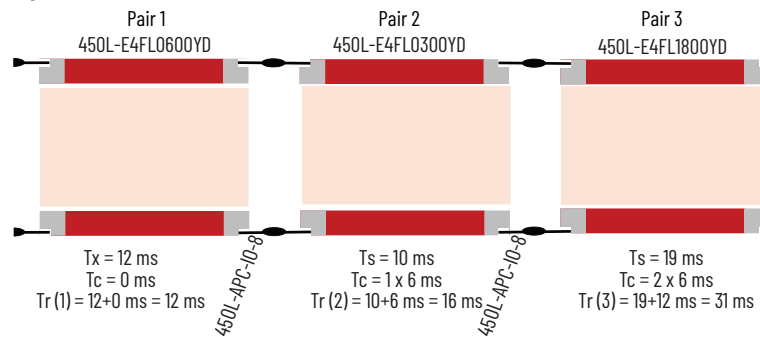
$$T_c = 6 \text{ ms}$$

$$\text{Standard features: } T_r = T_s + (n \times T_c)$$

$$\text{Advanced features: } T_r = T_a + (n \times T_c)$$

Figure 29 shows an example with three pairs of safety light curtains. The cascading adder for Pair 1 is zero, as Pair 1 is the host. Pair 2 has one cascading plug-in between itself and the host, so the adder is 6 ms. Pair 3 has two cascading plug-ins between itself and the host, so the adder to the response time is 12 ms.

**Figure 29 - Response Time Calculation for each Cascaded Pair**



## Connected Components Workbench Response Time

Connected Components Workbench software reports the response time when the configuration is locked. Figure 30 shows an example of the response time report from the Connected Components Workbench software. On the Diagnose screen, scroll down the diagnostic parameter to 3.30.

The Connected Components Workbench software does not support the initial release of 450L PAC safety light curtains.

**Figure 30 - Response Time in Connected Components Workbench Diagnostic Parameter 3.30**

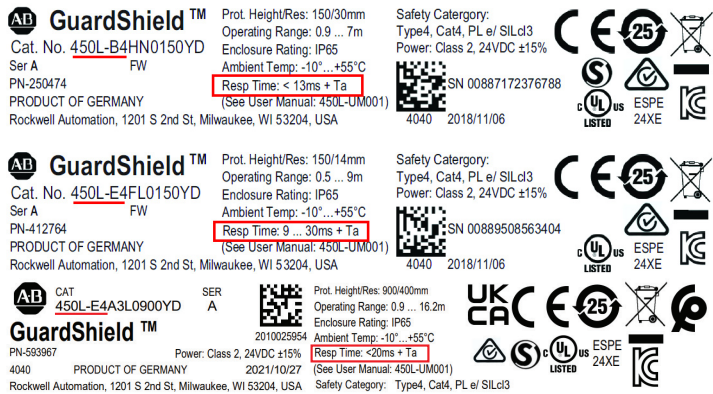
#	Name	Value	Remark	Description
3.30	Response time	17	Unit: ms	Specifies the current response time of the 450L system depending on actual DIP-Switch settings or actual SW configuration

**IMPORTANT** Determine the stop time: The stop time calculation must include the response times of all devices in the stop circuit (see [Determine the Safety Distance on page 64](#)). To not including all device and control system elements when you calculate the stop time results in an inaccurate safety distance calculation.

Product Labels

[Figure 31](#) shows examples of the response time that is printed on the GuardShield sticks. Do not use this response time to calculate the safety distance calculation. Use the information in this user manual to determine the response time. This information is removed in future changes of the label.

Figure 31 - Response Time on the Product Label



## System Configuration

An authorized person must perform the system configuration by setting the DIP switches at the receiver plug-in. First set the DIP switches, then mount the safety light curtain and establish the electrical connections.

[Table 20](#)...[Table 22 on page 56](#) show which plug-ins are available and which functionality that you can select with the receiver plug-in.

You can use the blanking and the muting plug-in to operate a 450L-B safety light curtain, but you cannot select muting, blanking, or beam coding functionality.

**Table 20 - Functionalities Available for 450L-B Safety Light Curtain**

Description	Transmitter Plug-in		Receiver Plug-in				Universal Plug-in
	450L-APT-PW-5	450L-APT-PW-8	On/Off 450L-APR-ON-5	EDM 450L-APR-ED-8	Blanking 450L-APR-BL-5	Muting 450L-APR-MU-8	450L-APU-UN-8
Number of connection pins	5	8 <sup>(1)</sup>	5	8	5	8	8
Number of DIP switches	0	0	4	8	8	8	12
Low range activation	—	—	✓	✓	✓	✓	✓
Start mode selection	—	—	—	✓	—	✓	✓
EDM	—	—	—	✓	—	✓	✓
Transmitter and receiver functionality	—	—	—	—	—	—	✓
Blanking <sup>(2)</sup>	—	—	—	—	—	—	—
Muting <sup>(2)</sup>	—	—	—	—	—	—	—
Interference rejection	—	—	—	—	—	—	—
Beam coding	—	—	—	—	—	—	—

(1) The 8-pin M12 for the transmitter is simply for the convenience of specifying two 8-conductor cordsets for the system.

(2) Not available on 450L-B safety light curtain.

**Table 21 - Functionalities Available for 450L-E Safety Light Curtain**

Description	Transmitter Plug-in		Receiver Plug-in				Universal Plug-in
	450L-APT-PW-5	450L-APT-PW-8	On/Off 450L-APR-ON-5	EDM 450L-APR-ED-8	Blanking 450L-APR-BL-5	Muting 450L-APR-MU-8	450L-APU-UN-8
Number of connection pins	5	8 <sup>(1)</sup>	5	8	5	8	8
Number of DIP switches	0	0	4	8	8	8	12
Low range activation	—	—	✓	✓	✓	✓	✓
Start mode selection	—	—	—	✓	—	✓	✓
EDM	—	—	—	✓	—	✓	✓
Transmitter and receiver functionality	—	—	—	—	—	—	✓
Blanking	—	—	—	—	✓	✓	—
Muting	—	—	—	—	—	✓	—
Interference rejection	—	—	✓	✓	✓	✓	✓
Beam coding	—	—	✓	✓	✓	✓	✓

(1) The 8-pin M12 for the transmitter is simply for the convenience of specifying two 8-conductor cordsets for the system.

Table 22 - Functionalities Available for 450L PAC Safety Light Curtain

Description	Transmitter Plug-in		Receiver Plug-in			Universal Plug-in
	450L-APT-PW-5	450L-APT-PW-8	On/Off 450L-APR-ON-5	EDM 450L-APR-ED-8	Muting 450L-APR-MU-8	450L-APU-UN-8
Number of connection pins	5	8 <sup>(1)</sup>	5	8	8	8
Number of DIP switches	0	0	4	8	8	12
Low range activation	—	—	✓	✓	✓	✓
Start mode selection	—	—	—	✓	✓	✓
EDM	—	—	—	✓	✓	✓
Transmitter and receiver functionality	—	—	—	—	—	✓
Blanking	—	—	—	—	—	—
Muting	—	—	—	—	✓	—
Interference rejection <sup>(2)</sup>	—	—	✓	✓	✓	✓
Beam coding	—	—	✓	✓	✓	✓

(1) The 8-pin M12 for the transmitter is simply for the convenience of specifying two 8-conductor cordsets for the system.

(2) IR is always enabled in 450L PAC models and is not configurable.

You can set the universal plug-in to perform as an emitter or receiver. If pins 4 and 8 of the connectors short-circuit at power-up, the stick behaves like a transmitter. In this case, the DIP switches have no functionality. Also, the beam coding functionality is still set at the 450L-E receiver (Rx). For the confirmation of the beam coding configuration and the pairing procedure, see [Confirmation of a New System Configuration on page 61](#). If pin 4 and pin 8 of the plug-in do not short circuit at power-up, the corresponding stick behaves like a receiver. In this case, the DIP switches have the same functionality as the catalog number 450L-APR-ED-8 receiver plug-in.

## Receiver Plug-in DIP Switch Settings

The transmitter plug-ins and the cascading plug-ins do not have DIP switches.

Identify and set the appropriate DIP switches for the desired configuration. [Figure 32](#) shows DIP switch identification. The number of DIP switches varies depending on the plug-in type.

Figure 32 - DIP Switch Location at Receiver Plug-in



### IMPORTANT

An error condition occurs (see [Status Indicator Error Display on page 109](#)) if you do not switch the DIP switches to off if the Switch Function is not defined.

After each reconfiguration of a safety light curtain, test the system for proper configuration and operation before placing the guarded machine in operation.



**ATTENTION:** Confirm every modification of the DIP switches with a configuration confirmation procedure after the first power-up (see [Confirmation of a New System Configuration on page 61](#)).

After you install the plug-in on the 450L-B safety light curtain transmitter stick and power-up, you can perform a configuration confirmation (signaled by the red/ green flashing of the STS status indicator). You can perform the configuration confirmation without the receiver and transmitter aligned.

[Table 23...Table 29 on page 61](#) describes the switch functions and default settings for the receiver plug-ins.

## 450L-APR-ON-5 Connection Plug-in

Table 23 - Function and Default Settings

Switch Number	Switch Function	Default	Description
1	450L-E only: Software configuration	Off	Off: Disabled On: Enabled
2	Low range activation	Off	Off: Disabled On: Enabled
3	450L-E and 450L PAC only: Activates beam coding	Off	Off: Disabled On: Enabled
4	450L-E only: Activates interference rejection	Off	Off: Disabled On: Enabled

## 450L-APR-ED-8 Connection Plug-in

[Table 24](#) shows the function and default settings for the M12 8-pin EDM receiver plug-in (catalog number 450L-APR-ED-8) that inserts in a 450L safety light curtain transceiver stick (catalog number 450L-APR-BL-5) connection plug-in.

Table 24 - Function and Default Settings

Switch Number	Switch Function	Default	Description
1	450L-E only: Software configuration	Off	Off: Disabled On: Enabled
2	Low range activation	Off	Off: Disabled On: Enabled
3	450L-E and 450L PAC only: Activates beam coding	Off	Off: Disabled On: Enabled
4	450L-E only: Activates interference rejection	Off	Off: Disabled On: Enabled
5	Combination activates the following start modes: • Automatic Start • Manual (re) Start • Manual Cold Start • Manual Start with Off Function	Off	<ul style="list-style-type: none"> <li>DIP 5: Off, DIP 6: Off: Automatic start (default)</li> <li>DIP 5: On, DIP 6: Off: Manual (re) start</li> <li>DIP 5: Off, DIP 6: On: Manual cold start</li> <li>DIP 5: On, DIP 6: On: Manual start with off function</li> </ul>
6		Off	
7	External device monitoring	Off	Off: Disabled On: Enabled
8	—	Off	—

## 450L-APR-BL-5 Connection Plug-in

[Table 25](#) shows the function and default settings for the M12 5-pin blanking receiver (catalog number 450L-APR-BL-5) plug-in that inserts in a 450L transceiver stick. Not applicable to 450L PAC safety light curtains.

**Table 25 - Function and Default Settings**

Switch Number	Switch Function	Default	Description
1	450L-E only: Software configuration	Off	Off: Disabled On: Enabled
2	Low range activation	Off	Off: Disabled On: Enabled
3	450L-E and 450L PAC only: Activates beam coding	Off	Off: Disabled On: Enabled
4	450L-E only: Activates interference rejection	Off	Off: Disabled On: Enabled
5	450L-E only: Teach-in blanking	Off	Off: Disabled On: Enabled
6	450L-E only: Combination activates the following start modes: • No Reduced Resolution • Reduced Resolution 1 Lens • Reduced Resolution 2 Lenses	Off	<ul style="list-style-type: none"> <li>DIP 6: Off, DIP 7: Off: Reduced resolution disabled (default)</li> <li>DIP 6: Off, DIP 7: On: Reduced resolution 2 beam</li> <li>DIP 6: On, DIP 7: Off: Reduced resolution 1 beam</li> <li>DIP 6: On, DIP 7: On: Invalid selection (error)</li> </ul>
7		Off	
8	—	Off	—



## 450L-APR-MU-8 Connection Plug-in

[Table 26](#) shows the function and default settings for the M12 8-pin muting receiver plug-in (catalog number 450L-APR-MU-8) that inserts in a 450L safety light curtain transceiver stick.

**Table 26 - Function and Default Settings**

Switch Number	Switch Function	Default	Description
1	450L-E only: Software configuration	Off	Off: Disabled On: Enabled
2	Low range activation	Off	Off: Disabled On: Enabled
3	450L-E and 450L PAC only: Activates beam coding	Off	Off: Disabled On: Enabled
4	450L-E only: Activates interference rejection	Off	Off: Disabled On: Enabled
5	Combination activates one of the following start modes: • Automatic Start • Manual (re)Start • Manual Cold Start • Manual Start with Off Function	Off	<ul style="list-style-type: none"> <li>DIP 5: Off, DIP 6: Off: Automatic start (default)</li> <li>DIP 5: On, DIP 6: Off: Manual (re)start</li> <li>DIP 5: Off, DIP 6: On: Manual cold start</li> <li>DIP 5: On, DIP 6: On: Manual start with off function</li> </ul>
6		Off	
7	External device monitoring	Off	Off: Disabled On: Enabled
8	450L-E only: Muting or blanking	Off	Off: See blanking modes in <a href="#">Table 27 on page 60</a> On: See muting modes in <a href="#">Table 28 on page 60</a>
9	450L-E only: Teach-in blanking	Off	Off: Disabled On: Enabled
10	Combination activates the following start modes: • No Reduced Resolution • Reduced Resolution 1 Lens • Reduced Resolution 2 Lenses	Off	<ul style="list-style-type: none"> <li>DIP 10: Off, DIP 11: Off: Reduced resolution disabled (default)</li> <li>DIP 10: On, DIP 11: Off: Reduced resolution 1 beam</li> <li>DIP 10: Off, DIP 11: On: Reduced resolution 2 beam</li> <li>DIP 10: On, DIP 11: On: Invalid selection (error)</li> </ul>
11		Off	
12	—	Off	—

For 450L-E safety light curtain only: If you set DIP 8 to off, blanking can be activated and DIP 9...DIP12 provide a selection of different blanking configurations, see [Table 27 on page 60](#).



The 450L PAC safety light curtain does not support blanking. DIP switch 8 set to off in a 450L PAC safety light curtain results in a lockout condition.

If pin 8 is set to on: Muting is active and DIP 9...DIP 12 allow for the selection of different muting configurations, see [Table 28 on page 60](#).

[Table 27 on page 60](#) shows the function and default settings for the M12 8-pin muting receiver plug-in (catalog number 450L-APR-MU-8) that inserts in a 450L-E safety light curtain transceiver stick; DIP 8 = off.

Table 27 - Function and Default Settings

Switch Number	Switch Function	Default	Description
9	450L-E only: Teach-in blanking	Off	Off: Disabled On: Enabled
10	Combination activates one of the following configurations: • No reduced resolution • Reduced resolution 1 lens • Reduced resolution 2 lenses	Off	<ul style="list-style-type: none"> <li>DIP 10: Off, DIP 11: Off: Reduced resolution disabled (default)</li> <li>DIP 10: On, DIP 11: Off: Reduced resolution 1 beam</li> <li>DIP 10: Off, DIP 11: On: Reduced resolution 2 beams</li> <li>DIP 10: On, DIP 11: On: Invalid selection (error)</li> </ul>
11		Off	
12	—	Off	—

[Table 28](#) shows the function and default settings for the M12 8-pin muting receiver plug-in (catalog number 450L-APR-MU-8) that inserts in a 450L-E or 450L PAC safety light curtain transceiver stick; DIP 8 = on.

Table 28 - Function and Default Settings

Switch Number	Switch Function	Default	Description
9	450L-E only: Combination activates muting configurations	Off	<ul style="list-style-type: none"> <li>DIP 9: Off, DIP 10: Off, DIP 11: Off: No muting</li> <li>DIP 9: Off, DIP 10: On, DIP 11: Off 2L muting sensors that are connected to connection plug-in</li> <li>DIP 9: Off, DIP 10: On, DIP 11: On 2L muting sensors that are connected to the I/O cascading plug-in</li> <li>DIP 9: On, DIP 10: Off, DIP 11: Off 2T muting sensors that are connected to connection plug-in</li> <li>DIP 9: On, DIP 10: Off, DIP 11: On 2T muting sensors connected to cascading plug-in</li> <li>DIP 9: On, DIP 10: On, DIP 11: On 4T muting sensors connected to cascading plug-in</li> </ul>
10		Off	
11		Off	
12	—	Off	—

## 450L-APR-UN-8 Connection Plug-in

[Table 29](#) shows the function and default settings for the M12 8-pin muting receiver plug-in (catalog number 450L-APR-UN-8) that inserts in a 450L safety light curtain transceiver stick.

**Table 29 - Function and Default Settings**

Switch Number	Switch Function	Default	Description
1	450L-E only: Software configuration	Off	Off: Disabled On: Enabled
2	Low range activation	Off	Off: Disabled On: Enabled
3	450L-E and 450L PAC only: Activates beam coding	Off	Off: Disabled On: Enabled
4	450L-E only: Activates interference rejection	Off	Off: Disabled On: Enabled
5	Combination activates one of the following start modes: • Automatic Start • Manual (re)Start • Manual Cold Start • Manual Start with Off Function	Off	<ul style="list-style-type: none"> <li>DIP 5: Off, DIP 6 Off: Automatic start (default)</li> <li>DIP 5: On, DIP 6 Off: Manual (re)start</li> <li>DIP 5: Off, DIP 6 On: Manual cold start</li> <li>DIP 5: On, DIP 6 On: Manual start with off function</li> </ul>
6		Off	
7	External device monitoring	Off	Off: Disabled On: Enabled
8	—	Off	—
9	—	Off	—
10	—	Off	—
11	—	Off	—
12	—	Off	—

For the UNIV plug-in: If pin 4 and pin 8 short circuit (Transmitter mode), then the DIP switch settings have no impact on the transmitter functionality.

## Confirmation of a New System Configuration

**IMPORTANT** When you operate the receiver stick for the first time (brand new receiver), the confirmation procedure is not required. The STS status indicator flashes red/green when a confirmation is required.

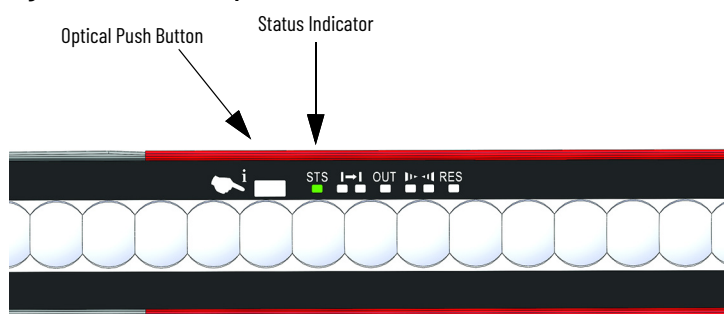
System configuration confirmation is necessary when the receiver stick was previously operated with another configuration or when the receiver stick was previously operated with another transmitter.

The configuration confirmation procedure is not required if you exchange the receiver plug-in with a new plug-in with the same plug-in type and DIP switch settings as the original.

Also, no configuration confirmation procedure is required for a complete out-of-box pair of 450L safety light curtain transceiver sticks.

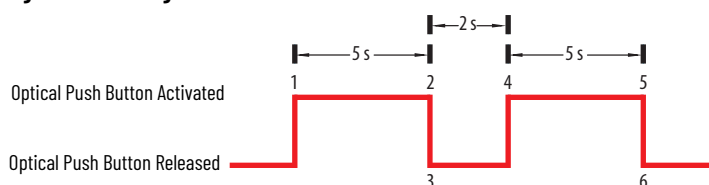
Perform a confirmation procedure of a new configuration when you change DIP switch settings and reinsert the plug-in to the safety light curtain stick. The STS status indicator flashes 1 Hz red/green to indicate a confirmation request ([Figure 33 on page 62](#)).

Performed this process only once after the first power-up of a plug-in with new settings. The process is not required at any following power-up except DIP switch changes.

**Figure 33 - Position of Optical Push Button and Status Indicator**

## Confirmation

[Figure 34](#) shows the configuration timing sequence. Activate the optical push button two times for 5 seconds with a maximum of 2 seconds between activations.

**Figure 34 - Configuration Process**

## Confirmation Procedure

To confirm a new configuration:

1. The status indicator STS flashes green/red (1 Hz, one time red, and one time green per second, 50:50 duty cycle), which indicates that the stick is in the Configuration mode.
2. Actuate the optical push button for 5 seconds.
3. STS flashes green/red to indicate actuation with a frequency of 10 Hz and 50:50 duty cycle.
4. Once the status indicator STS changes from green/red to green/off, release the optical push button.
5. A frequency change from 10 Hz to 1 Hz indicates release (status indicator STS green/off and a 50:50 duty cycle).
6. Within 2 seconds, actuate the optical push button.
7. Status indicator STS indicates the activation by a new green/red frequency of 10 Hz and a 50% duty cycle.
8. Actuate the optical push button for 5 seconds.
9. Once the status indicator changes from green/red flashing to green/off flashing, release.
10. After releasing, the status indicator STS is steady green.

If any error occurs in this procedure, the new configuration does not store and the STS status indicator starts flashing again (1 Hz, green/red, and 50:50 duty cycle). For example:

- If you release the actuator before the 5 seconds.
- If you do not actuate the actuator within the 2 seconds thereafter.

---

**IMPORTANT** Once you complete the configuration confirmation procedure, confirm that the operating mode changed to the intended configuration.

---

## Installation and Wiring



**ATTENTION:** Do not use the GuardShield™ safety light curtain with machines that cannot stop electrically in an emergency. Always maintain the required safety distance (see [Determine the Safety Distance on page 64](#)) between the GuardShield safety light curtain and dangerous machine movement.

Install additional mechanical protective devices if you can reach hazardous machine elements without passing through the protective field.

Improper installation can result in serious injury.

Never connect the safety outputs (OSSDs) to +24V DC. If the safety outputs connect to +24V DC, they are in the on-state and cannot stop hazardous machine/application movements.

Never expose the GuardShield safety light curtain to flammable or explosive gases. Do not install GuardShield safety light curtains in outdoor or underwater applications without additional measures.

Regular safety inspections are imperative (see [Maintenance on page 115](#)).

Do not open or attempt to repair or modify the GuardShield safety light curtain. Removal of either of the gray GuardShield safety light curtain end caps or the transparent front window voids the warranty terms of this product.



**LASER LIGHT CLASS 2 HAZARD:** Do not stare into the beam. The 450L-E and 450L PAC GuardShield safety light curtains are equipped with an integrated laser alignment aid (see [Laser Alignment on page 25](#)).

### IMPORTANT

Do not insert or remove plug-ins with power applied to the plug-in. Only use the GuardShield safety light curtain as defined in [Product Overview on page 13](#).

If you use the device for any other purposes or modify the device in any way, warranty claims against Rockwell Automation become null and void.

Installation must be in accordance with this manual and implemented by qualified personnel exclusively.

A GuardShield safety light curtain system is intended as part of the safety-related control system of a machine. Before installation, perform a thorough risk assessment to determine whether the specifications of this device are suitable for all foreseeable operational and environmental characteristics of the application.

See [Specifications on page 171](#) for certification information and ratings. Observe and maintain the requirements that this chapter defines (for example, power supply, cables, and ambient conditions), to allow for the safety function.

Use appropriate screws, bolts, and/or nuts to mount the sticks and plug-ins to avoid damage.

Do not over-torque the mounting hardware:

- For installation of the plug-ins, use a Phillips tip screwdriver for an M2 x 8 Phillips screw. Maximum torque is 0.38 N•m (3.36 lb•in).
- For installation of the standard top/ bottom mounting kit, use a Phillips tip screwdriver for an M3 x 10 Phillips DIN 965 A screw. Maximum torque is 0.7 N•m (6.19 lb•in).

Only use the designated mounting holes of the mounting bracket.

Use only fixed, stable, and sturdy mounting posts or frames to mount a 450L-B GuardShield safety light curtain system.

For the installation of the plug-ins, see [Electrical Installation on page 84](#).

## Determine the Safety Distance

Mount the safety light curtain with proper safety distance:

- From the point of danger
- From reflective surfaces

To help prevent a person from reaching through the protective field to a dangerous area (while the machine is still moving), consider both points in an installation.

The calculation of point one varies depending on the region (country) where the device operates.

### U.S. Safety Distance Formula

Properly calculate this distance, referred to as the safety distance, before you determine the safety light-curtain protective height and mount the safety light curtains on the machine. Failure to calculate this safety distance properly can result in operator injury.



**ATTENTION:** Mount the GuardShield safety light curtains at a sufficient distance from the pinch point or point of operation hazard. This distance helps confirm that the machine stops before a finger, hand, arms, or body reach the hazard.

Regardless of the calculated safety distance, the protective field of a GuardShield safety light curtain never mounts closer than 152.4 mm (6 in.) from the point of operation to the pinch point hazard.

In the United States, two formulas are commonly used to calculate the safety distance:

- The OSHA formula is the minimum requirement for the calculation of the safety distance.
- The ANSI formula, the formula we recommend, incorporates additional factors for consideration when calculating the safety distance.

## OSHA Safety Distance Formula

The OSHA safety distance formula as specified in CFR29 Subpart O1910.217 is as follows.

$$Ds = 63 \times T$$

Ds	Safety distance in inches (1 in. = 25.4 mm)
63	The OSHA recommended hand speed constant in inches per second (63 in/s = 1600 mm/s)
T	Total stop time of all devices in the safety circuit, which is measured in seconds. This value must include all components that are involved to stop the hazardous motion of the machinery. For a mechanical power press, the stop time is measured at approximately the 90° position of the crankshaft rotation.

---

**IMPORTANT** The T number must include the response times of all devices, including the response time of the safety light curtain, the safety light curtain controller (if used), the machine control circuit, and any other devices that react to stop the hazardous motion of the machinery. Not including the response time of a device or devices in the stop time calculation results in insufficient safety distance for the application, which results in operator injury.

---

## ANSI Safety Distance Formula

The ANSI B11.19 safety distance formula, which is the formula we recommend for USA, is as follows.

$$Ds = K \times (Tst + Tc + Tt + Tbm) + Dpf$$

Ds	Minimum safety distance between the safe guarding device and the nearest point of operation hazard (in inches).
K	Hand-speed constant in inches per second. The ANSI standard value is 63 inches per second when the operator begins reaching toward the point of operation hazard from rest.

---

**IMPORTANT** ANSI B11.19 1990 E4.2.3.3.5 states the value of the hand-speed constant (K) is determined in various studies. Although these studies indicate speeds of 63 inches/second to over 100 inches/second, they are not conclusive. The employer can consider all factors, including the physical ability of the operator, when determining the value of K to be used.

---

Tst	Stop time of the machine tool that is measured at the final control element.
Tc	Response time of the control system.
Tt	Response time of the presence sensing device (safety light curtain) and its interface, if any. The device manufacturer states this value, or you can measure it.

---

**IMPORTANT** Use a stop time device to measure Tst + Tc + Tr.

---

- T<sub>bm</sub>

Additional time that is allowed for the brake monitor to compensate for variations in normal stop time.
- D<sub>pf</sub>

Depth penetration factor is an added distance to allow for how far into the protective field an object, such as a finger or hand, can travel before detection. D<sub>pf</sub> relates to the safety light-curtain object sensitivity. Object sensitivity is the smallest diameter object that is detected anywhere in the sensing field (commonly also known as resolution).

Example for D<sub>pf</sub>

You can approximate the D<sub>pf</sub> in a perpendicular safety light curtain application with object sensitivity (effective resolution) less than 63.5 mm (2.5 in.):

$$D_{pf} \text{ (inches)} = 3.4 \times (\text{Object Sensitivity [inch]} - 0.276 \text{ [inch]}), \text{ but not less than } 0.$$

Table 30 - Depth of Penetration Factor

Description [mm (in.)]	Depth Penetration Factor [mm (in.)]
Finger resolution: 14 (0.56)	23.7 (0.935)
Hand resolution: 30 (1.19)	78.1 (3.077)

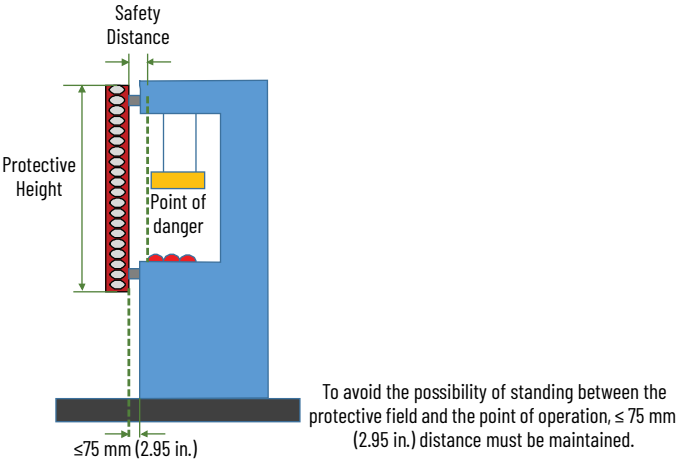
European Safety Distance Formula

Maintain a safety distance between the safety light curtain and the point of danger (see [Figure 38 on page 68](#)), as described in IEC/TS 62046. This safety distance helps confirm that you can only reach the point of danger after the dangerous state of the machine is removed.

The safety distance as defined in EN ISO 13855 and EN ISO 13857 depends on:

- Machine stop time
- Response time of the protective device (safety light curtain + control circuit)
- Resolution of the safety light curtain
- Approach speed to the danger point
- Position of the AOPD

Figure 35 - Safety Distance from the Point of Danger to the Safety Light Curtain





How to calculate the Safety Distance (S) for 450L POC safety light curtain systems according to EN ISO 13855 and EN ISO 13857:

- First, calculate S with the following formula  

$$S = 2000 \text{ [mm/s]} \times T + 8 \times (d - 14) \text{ [mm]}$$

Where:

- T = Stopping/run-down time of the machine [s] + response time  $T_t$  of the safety light curtain [s] + response time of the control circuit [s]
- d = Resolution of the safety light curtain [mm]
- S = Safety distance [mm]

The reach/approach speed is already included in the formula:

- If the result S is  $\leq 500$  mm (19.6 in.), then use the determined value as the safety distance.
- If the result S is  $> 500$  mm (19.6 in.), then recalculate S as follows:  

$$S = 1600 \times T + 8 \times (d - 14) \text{ [mm]}$$
- If the new value S is  $> 500$  mm (19.6 in.), then use the new value as the minimum safety distance.
- If the new value S is  $\leq 500$  mm (19.6 in.), then use 500 mm (19.6 in.) as the safety distance.

#### EXAMPLE:

Stopping/run-down time of the machine = 290 ms

Response time safety light curtain  $T_t < 20$  ms

Response time of the control circuit = 10 [ms]

$T = 290 \text{ [ms]} + 20 \text{ [ms]} + 10 \text{ [ms]} = 320 \text{ [ms]} = 0.32 \text{ [s]}$

Resolution of the safety light curtain = 14 mm (0.56 in.)

$S = 2000 \times 0.32 + 8 \times (14 - 14) = 640 \text{ mm (25.1 in.)}$   $S > 500$  mm, therefore:

$S = 1600 \times 0.32 + 8 \times (14 - 14) = 512 \text{ mm (20.1 in.)}$

[Figure 35 on page 66](#) also indicates the distance to avoid standing behind the safety light curtain. If you install the safety light curtain more than 75 mm (2.95 in.) from the machine:

- With auto restart
- Where the dangerous area is not visible from the Reset button, consider more protective measures (for example, an additional horizontal installed safety light curtain).

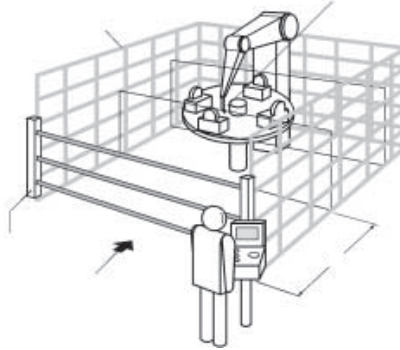
How to calculate the Safety Distance (S) for 450L PAC safety light curtain systems according to EN ISO 13855 and EN ISO 13857:

- If there are perimeter systems or safety light curtains with a resolution  $d > 40$  mm (1.57 in.), calculate the safety distance for a vertical mount of the safety light curtains and horizontal approach, according to the formula:  

$$S = (1600 \times T) + 850 \text{ mm (33.46 in.)}$$

See standard EN ISO 13855 (2010) for more detailed information regarding safety distance and safety heights.

Figure 36 - Safety Distance from the Point of Danger to the Safety Light Curtain



### Minimum Distance from Reflective Surfaces

The infrared light that transmits from the two transceivers can reflect off shiny surfaces. This condition can result in an object not being detected when it enters the GuardShield safety light curtain sensing field.

All reflective surfaces and objects (for example, material bins) must, therefore, be at a minimum distance (A) from the protective sensing field of the system. The minimum distance (A) depends on the distance (D) between the two transceivers.

Figure 37 - Minimum Distance A from Reflective Surfaces (Top View)

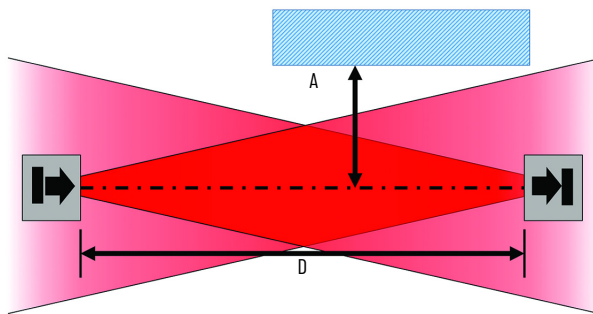
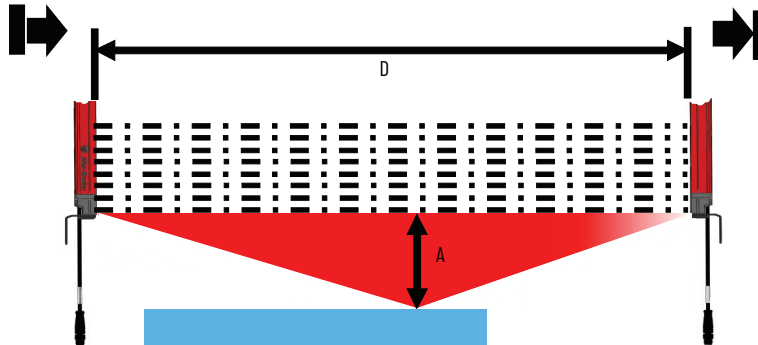
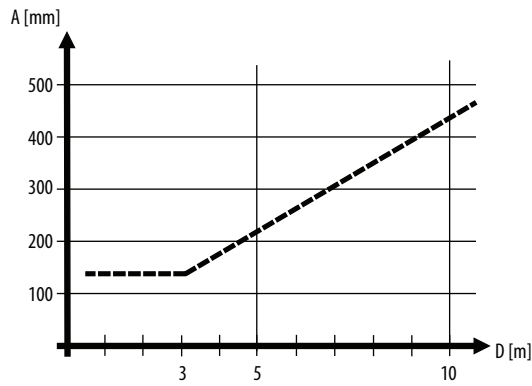


Figure 38 - Minimum Distance A from Reflective Surfaces (Side View)



To determine the minimum distance from the reflective surfaces:

- Determine the distance D [m] between transmitter and receiver
- Read the minimum distance A [mm] from [Figure 39 on page 69](#)

**Figure 39 - Minimum Distance A from Reflective Surfaces (D= Distance between Receiver and Transmitter)**

The effective aperture angle for the 450L safety light curtain system is  $\pm 2.5^\circ$  at a mounting distance of  $\geq 3.0$  m (9.8 ft). Calculate the minimum distance to reflective surfaces depending on the distance between the transmitter and the receiver, with an aperture angle of  $2.5^\circ$ .

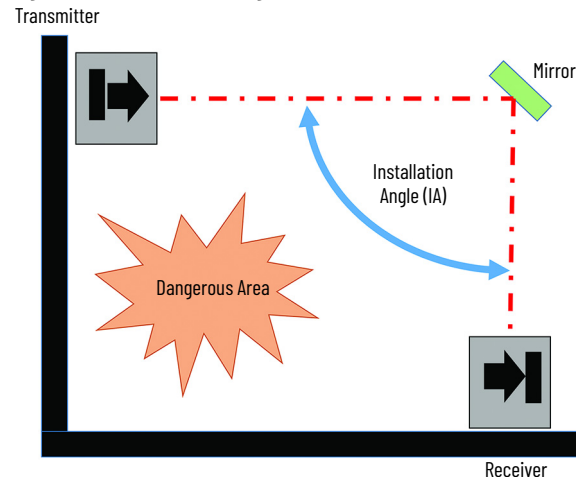
**IMPORTANT** Formula:  $A [\text{mm}] = \tan 2.5^\circ \times D = 43.7 \times D [\text{m}]$   
 A = Minimum distance to reflective surfaces  
 D = Distance between transmitter and receiver or take the appropriate value from [Table 31](#).

**Table 31 - Minimum Distance for Various Distances D Between Transmitter and Receiver**

Distance between Transmitter and Receiver (Range D) [m (ft)]	Minimum Distance A [mm (in.)]
0.5...3.0 (1.64...9.8)	135 (5.31)
4.0 (13.1)	175 (6.88)
5.0 (16.4)	220 (8.66)
6.0 (19.6)	265 (10.43)
7.0 (22.9)	310 (12.2)
10.0 (32.8)	440 (17.32)

## Mirrors

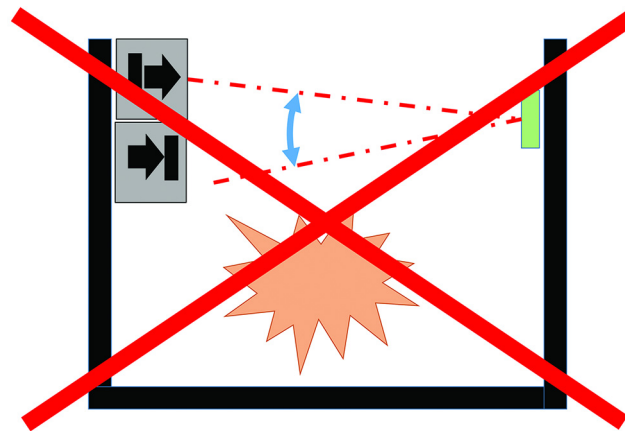
You can use the GuardShield safety light curtains with corner mirrors (see [Corner Mirror on page 181](#)). Mirrors are only allowed for applications without undetected access into the protected area.

**Figure 40 - Installation Angle for Mirrors (View from the Top)**



**ATTENTION:** When you use mirrors, all sides of the protective field must fulfill the requirements for minimum safety distance and minimum distance from the reflective surfaces. The installation angle (IA) must be between  $70^{\circ} < IA < 110^{\circ}$  otherwise serious injury or death can result.

Figure 41 - Possible Misuse of a Mirror

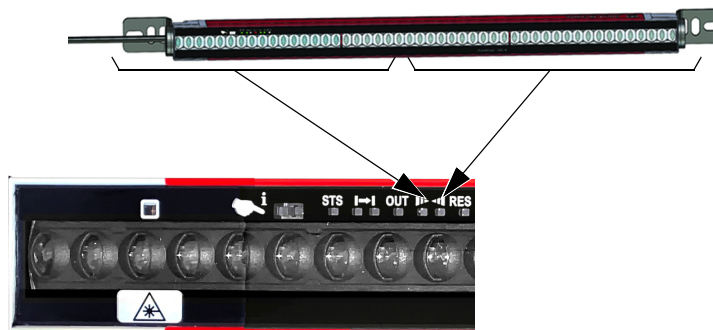


## Install and Mount

This section describes the preparation, selection, and installation of the GuardShield safety light curtain system:

- You can use a GuardShield safety light curtain system in all mounting orientations.
- The GuardShield safety light curtain has an overall status indicator (STS) and two regional light intensity level status indicators on each stick (see [Figure 42](#) and [Table 54 on page 108](#)) for aiding alignment. One regional light intensity level status indicator refers to the first half of the protective field, the other refers to the second half of the protective field. The regional light intensity level status indicators flash green when the receiver sees the infrared light from the transmitter. The status indicators turn steady green to indicate optimal alignment. STS flashes green at a rate of 10 Hz when the sticks are synchronizing. Synchronization is complete when either of the two halves of the protective field are aligned and STS shows solid green, which indicates the alignment is close.

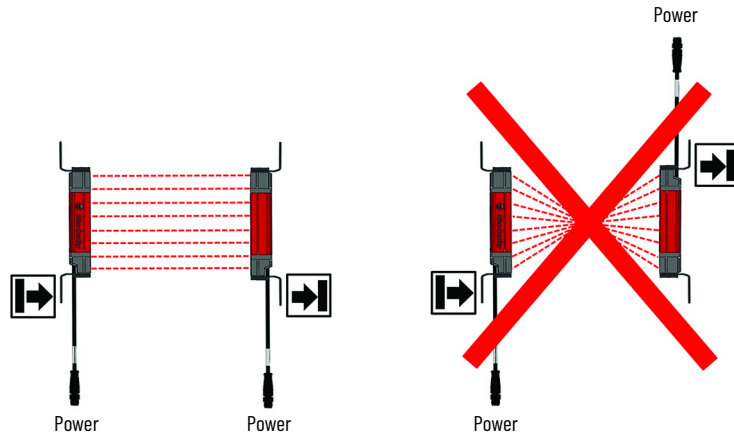
Figure 42 - Status Indicators to Display Intensity




- Mount both sticks so that the distance of the protective field is at or greater than the calculated safety distance (see [Determine the Safety Distance on page 64](#)).
- Mount both sticks away from any reflective surfaces (see [Figure 37 on page 68](#)).

- Position the sticks parallel to each other and at the same height. Point The transmitter and receiver connection plug-in locations in the same direction ([Figure 43](#)).

**Figure 43 - Correct Positioning and Incorrect Positioning of Transmitter and Receiver Sticks**



- Position the optical lens system of transmitter and receiver stick in exact opposition to each other.
- Take suitable measures to attenuate vibration.
- Mount the safety light curtain so you cannot reach the hazardous point cannot from below, above, or behind the safety light curtain and that the safety light curtain cannot be repositioned (see [Correct Installation on page 72](#) and [Incorrect Installation on page 73](#)).
- Connect both sticks.
- Turn on power to the GuardShield safety light curtain system.
- If the STS status indicator at the receiver stick displays a configuration change (flashing red/green), confirmation is required, see [Confirmation of a New System Configuration on page 61](#).
- Watch the STS and both regional light intensity status indicators on the sticks while you rotate the transmitter and receiver sticks. Find the point where the STS and both regional light intensity level status indicators show steady green. 
- Determine the maximum left and right adjustment angles and position each unit in the center. Tighten all hardware until the alignment (intensity) indicators do not flash.
- Cycle power to confirm that the system powers up, goes to the on-state (STS status indicator steady green) and the intensity status indicators show steady green.

An external laser alignment tool (catalog number 440L-ALAT) and a dedicated mounting bracket (catalog number 450L-ALAT-C) are offered as accessories (see [Alignment Tool and Bracket on page 184](#)). Use these items for alignment of the 450L-B safety light curtain for larger operating distances or when you use corner mirrors in the application.

---

**IMPORTANT** If you configure EDM or manual start functions through DIP switch settings, confirm that the proper receiver wire connections are made.

---

Always follow the minimum operating distance. Stable operation is not guaranteed when the device operates below the specified value. Position of the transmitter and the receiver stick that is closer than specified results in an interruption of the protective field and switches off the two OSSDs.

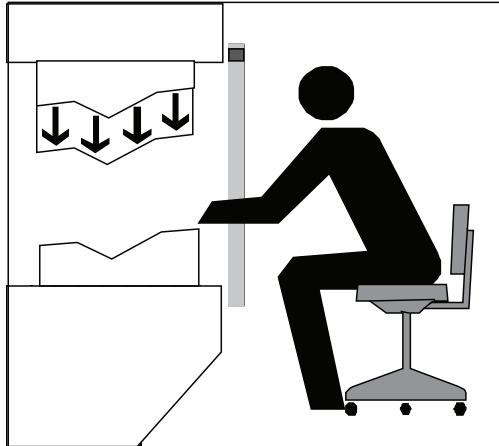
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**IMPORTANT** We recommend that you only use the mounting brackets that we offer. Take appropriate measures to dampen vibration if the vibration and shock requirements are above the specified values and test conditions.

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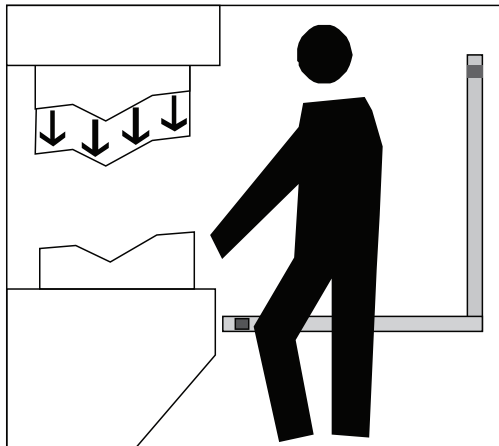
## Correct Installation

Figure 44 - Hazardous Machine Parts Unreachable without Passing Through the Protective Field



**ATTENTION:** Install the GuardShield safety light curtain so access to the hazard is only possible through the sensing field of the GuardShield safety light curtain. Auxiliary safe guarding can be required with the GuardShield safety light curtain to meet this requirement.

Figure 45 - Pass Through Prevention (Cannot Step between Protective Field and Hazardous Machine Parts)



## Incorrect Installation

Figure 46 - Hazardous Machine Parts Reachable without Passing Through the Protective Field

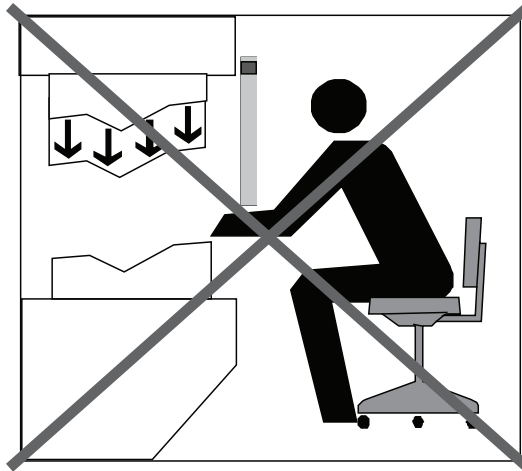
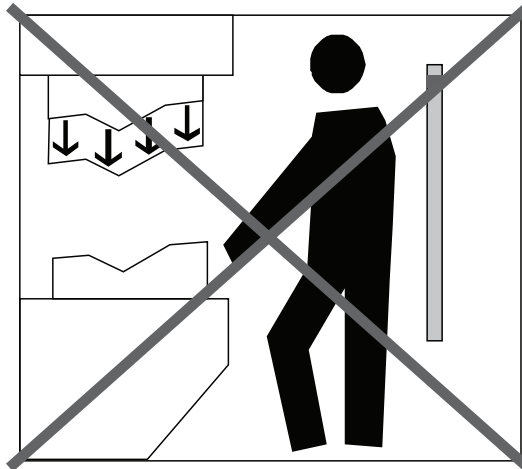
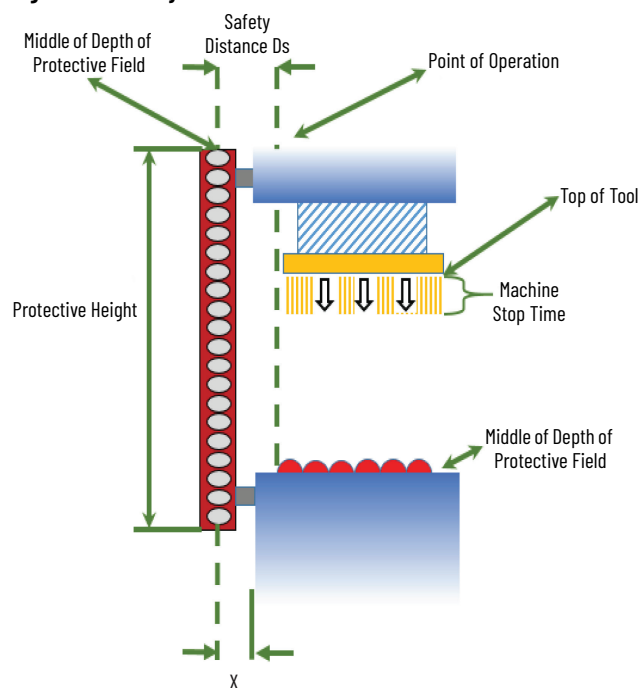


Figure 47 - Can Step between Protective Field and Hazardous Machine Parts



Mount the GuardShield safety light curtain at the proper distance from the point of operation hazard. This distance is referred to as the safety distance. If the safety distance calculation is such that a person can step between a vertically mounted safety light curtain and the machine hazard, more protective measures are required.

**Figure 48 - Safety Distance Definition**

**IMPORTANT** Confirm that you cannot stand between the protective field and the point of operation (hazard). EN ISO 13855 requires a minimum distance (X) at an installation height of 300 mm (11.9 in.). Check EN ISO 13855 for other installation heights.



## Mount Multiple 450L GuardShield Safety Light Curtains

When two or more 450L safety light curtain pairs mount closely, the following can happen.

1. Optical interference: The receiver of one pair sees infrared light from the transmitter of another pair. Optical interference between neighboring 450L safety light curtain systems can affect safety light curtain system reliability by sporadically switching off the OSSDs.
2. Optical crosstalk (see [Figure 50 on page 76](#)): The receiver of one pair communicates continuously with the transmitter of another pair. Optical crosstalk between neighboring 450L safety light curtain systems causes holes in the protective field and is therefore an unsafe installation. Optical crosstalk can only occur if:
  - a. Both systems have the same resolution and the same height of the protective field.
  - b. The height of the protective field is smaller than the minimum separation distance (S) provided in [Table 14 on page 47](#).
  - c. The space between both pairs is smaller than the minimum separation distance S provided in [Table 14 on page 47](#).



**ATTENTION:** Cross talk between adjacent installed pairs can cause an unsafe situation.

Measures to avoid optical interference or optical cross talk are:

1. Minimum installation distance (S) between adjacent installed pairs (see [Table 14 on page 47](#)).
2. Installation of optical barriers (see [Figure 51 on page 77](#)).

For 450L-E safety light curtains, the beam code function (see [Beam Coding on page 29](#)) is also a measure to help prevent optical cross talk. The beam code function also reduces, but does not eliminate, the probability for optical interferences. You can also use interference rejection, see [Interference Rejection on page 30](#).

**Figure 49 - Two Adjacent Installed Pairs without Optical Crosstalk**

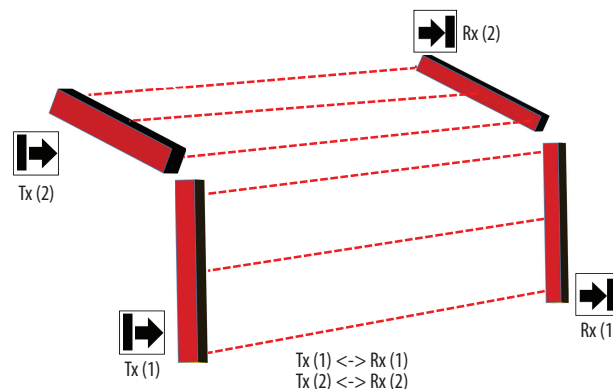
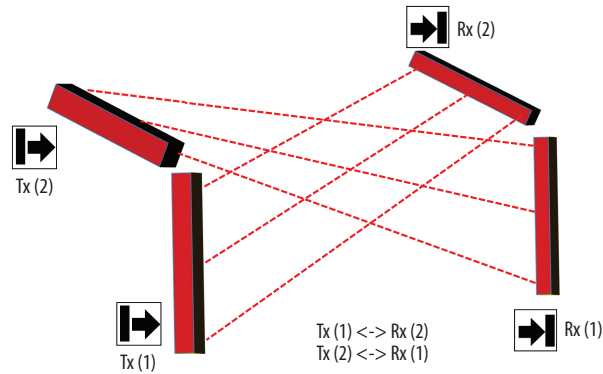


Figure 50 - Two Adjacent Installed Pairs with Optical Crosstalk



[Figure 51 on page 77](#) shows a number of installation techniques to stop optical interference or optical crosstalk between adjacent safety light curtains:

- Check that you can reduce the maximum operation range (see [Low Operating Range on page 29](#)).
- Invert adjacent pairs.
- Install mechanical (optical) barriers to help prevent optical interference ([Figure 51 on page 77](#)).
- For 450L-E safety light curtains only: Check if the beam code feature is a possible option (see [Beam Coding on page 29](#)).

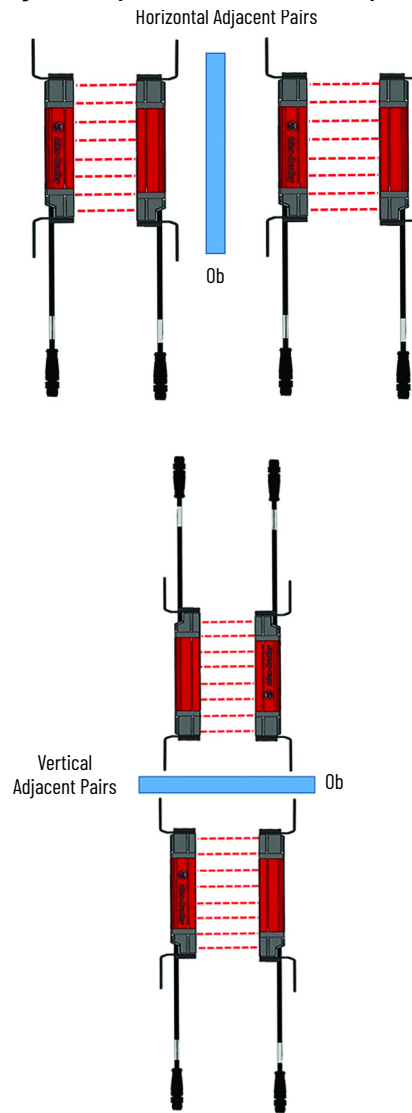
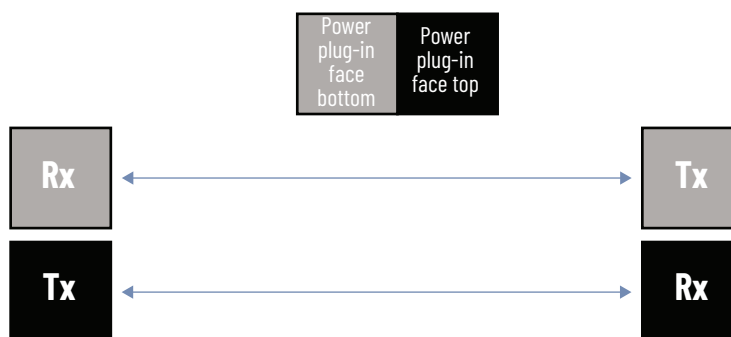
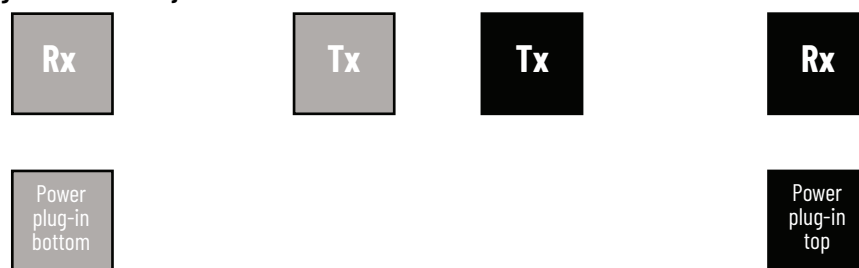
**Figure 51 - Optical Barriers (Ob) Are Required for Adjacent Safety Light Curtains Installations**

Figure 52 - Invert Adjacent Pairs



1. RX of the first and Rx of the second pair are not next to each other.
2. The first pair is face up, the second pair is face down.
3. Use reduce range. Turn on the second DIP switch on the LLC.

Invert the sticks in adjacent pairs such that the top and bottom of the sticks are opposite. The more accurate the alignment of 450L safety light curtains, the less probability there is of cross-talk/optical interference.

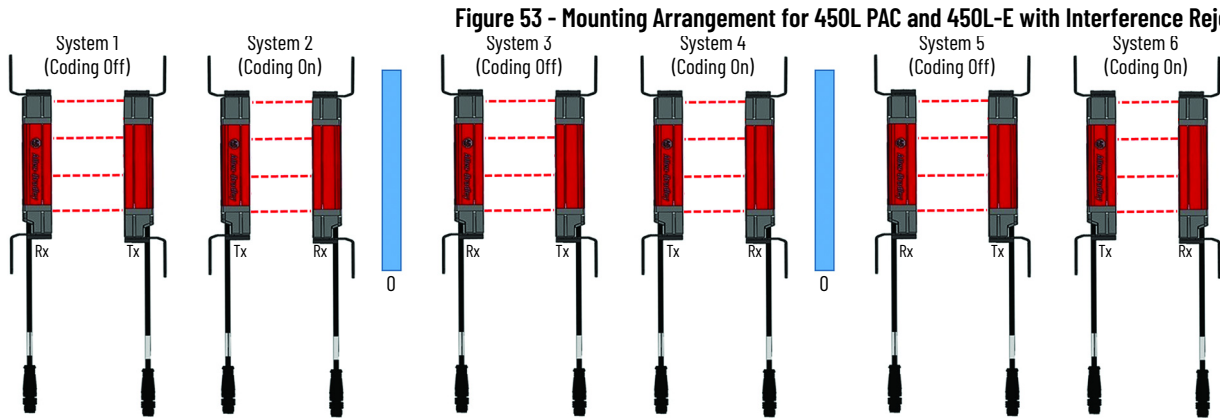
The transceiver architecture of safety light curtains does not allow a back-to-back installation of adjacent transmitters as is common with safety light curtain systems with a pure transmitter and receiver architecture.

Depending on the installed distance, you can use the reduced operating functionality (see [Low Operating Range on page 29](#)) instead of an optical barrier to stop optical interference of adjacent GuardShield safety light curtain systems.

For 450L-E safety light curtains only: To stop optical interference between neighbor 450L-E safety light curtain systems can cause a safety issue, in addition of an optical barrier, you can select the beam code feature (see [Beam Coding on page 29](#)). Beam code changes the pulse pattern of infrared light that a 450L-E safety light curtain stick emits.

## 450L Safety Light Curtain with Interference Rejection

450L PAC safety light curtains have permanently enabled interference rejection. This feature is a configurable option for 450L-E safety light curtains. This scheme allows multiple 450L PAC safety light curtain systems to mount next to others or on the same plane. Where only two pairs mount, enable only one beam code for only one of the pairs. Position the pairs with both transmitter (Tx) sticks back-to-back or both receiver (Rx) sticks back-to-back, as shown in [Figure 53](#). If both pairs power up simultaneously without this orientation, the Rx of one system can attempt to pair with the Tx of the other system, which causes both sticks to prompt for a teach-in.



## Mounting Brackets

### Standard Top/Bottom Mounting Kit

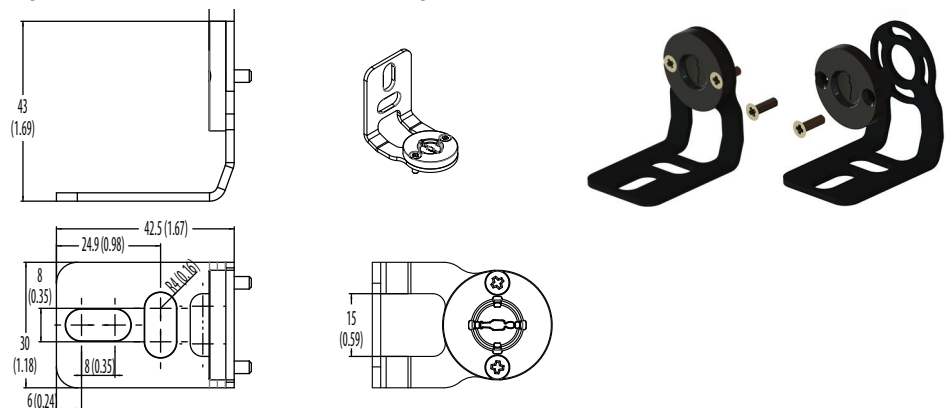
The GuardShield safety light curtain can mount using right angle brackets that attach to the end caps of both the transmitter and receiver sticks. Each stick comes with a pair of end cap mounting brackets (see [Figure 54](#)).

Use a Phillips screwdriver for M3 x 10 Phillips DIN 965 A screws to install the standard top/bottom mounting kit. Torque above the maximum 0.7 N•m (6.19 lb•in) can damage the safety light curtain.

The top/bottom mounting kit allows a rotation of  $\pm 20\%$  of the GuardShield safety light curtain aluminum profile.

The length of the transceiver stick and the vibration and shock conditions of the application often require additional side mounting brackets.

**Figure 54 - 450L-AM-TBM Standard Mounting Bracket Kit [mm (in.)]**



Mounting of each stick requires two M6 DIN 912 screws (not provided).

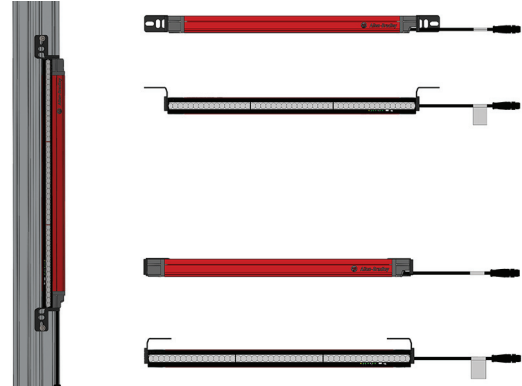
[Figure 55](#) shows different cable guide options. The bend radius of the plug-in pig tail cable is small enough so that the cable can route at a 90° angle. The minimum bend radius is specified in [Figure 80 on page 103](#).

**Figure 55 - Connection Cable Guide Options**

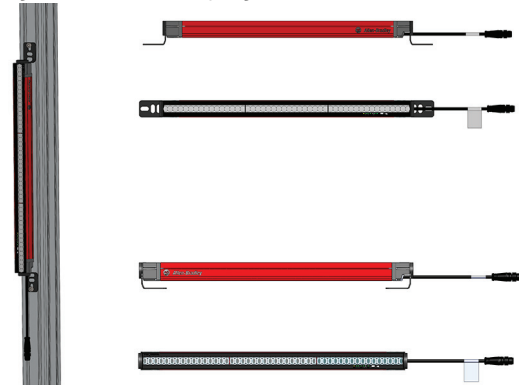


[Figure 56](#) and [Figure 57](#) show possible 450L safety light curtain attachments to extruded aluminum profiles with the standard top/bottom mounting bracket.

**Figure 56 - 450L Safety Light Curtain Mounted on an Extruded Aluminum Profile**



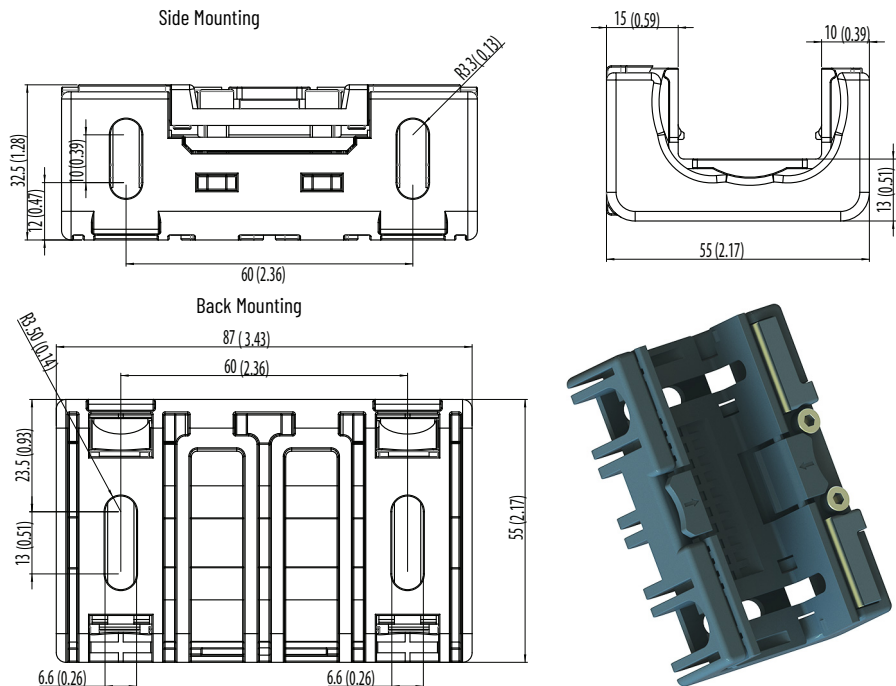
**Figure 57 - 450L Safety Light Curtain Mounted Backwards**



## Side Mounting Bracket

The side mounting bracket (Cat No. 450L-AM-SM, contains two brackets) allows the snap-in GuardShield safety light curtain profile to rotate  $\pm 5^\circ$  (see [Figure 58](#)).

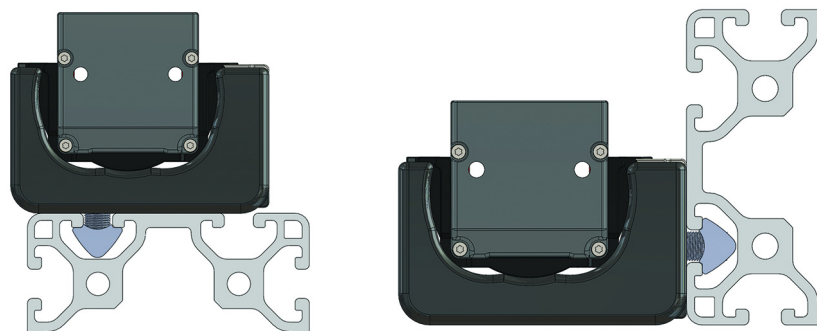
**Figure 58 - Side Mounting Bracket (mm [in.])**



**Figure 59 - Side Mounting Bracket with Attached 450L Safety Light Curtain [mm (in.)]**



**Figure 60 - Side Mounting Bracket with Attached 450L Safety Light Curtain on Extruded Aluminum Profile**



You require a minimum of two M6 DIN 912 screws (not provided) to mount each bracket properly.

**IMPORTANT** Use side mounting brackets and/or the top/bottom mounting kits in vibration applications.

Use additional side mounting brackets in vibration applications for protective heights of 1050 mm (41.3 in.) and larger. Position and mount the additional bracket in the middle of each stick.

Table 32 - Number of Side Mounting Brackets without Top/Bottom Brackets

Stick Length [mm (in.)]	Number of Side Mounting Brackets Per Stick
150 (5.9)	1
300...900 (11.8...35.43)	2
1050...1950 (41.34...76.77)	2 (3 for vibration applications)

Table 33 - Number of Side Mounting Brackets and Top/Bottom Brackets

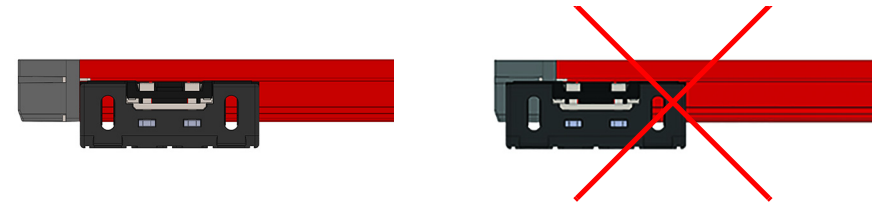
Stick Length [mm (in.)]	Number of Side Mounting Brackets Per Stick
150...900 (5.9...35.43)	0
1050...1950 (41.34...76.77)	1 for vibration applications

You require a hex tip screwdriver for M6 screws to mount the side mounting kit.



**ATTENTION:** You can damage the safety light curtain if you exceed the maximum 11 N•m (97.36 lb•in). Do not clamp the gray plastic end cap (see [Figure 61](#)).

Figure 61 - Correct and Incorrect Positioning of the Side Mounting Bracket



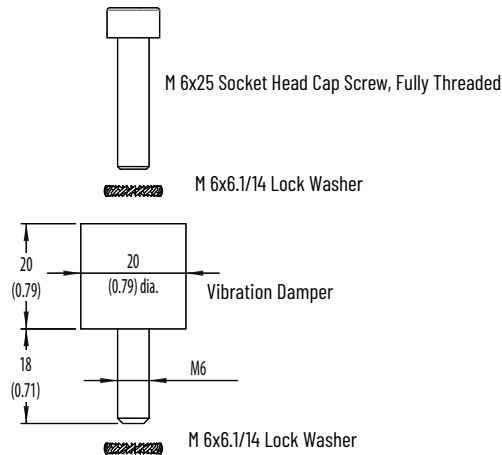
Position the side mounting brackets close to the gray end cap. Position additional brackets so that the distance between each bracket is equal (symmetric). You can also install catalog number 450L-AD-OID optical interface device (see [Optical Interface Device \(OID\) on page 112](#)) with the side mounting brackets.

**Shock Mounting Kit**

We offer special shock mounting brackets for applications that exhibit shock and vibration ([Figure 62 on page 83](#)). For vertical installations, use the vibration damper (catalog number 445L-AF6142) with the standard L-shaped top/bottom mounting bracket and side mounting bracket.



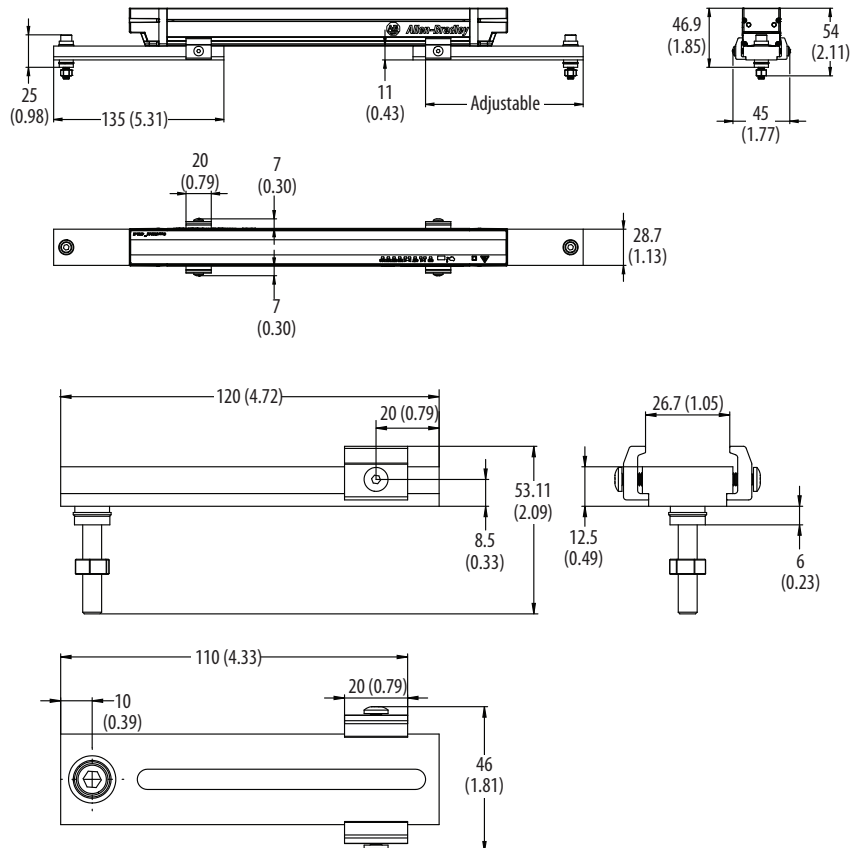
Figure 62 - 445L-AF6142 Shock Mount Brackets [mm (in.)]



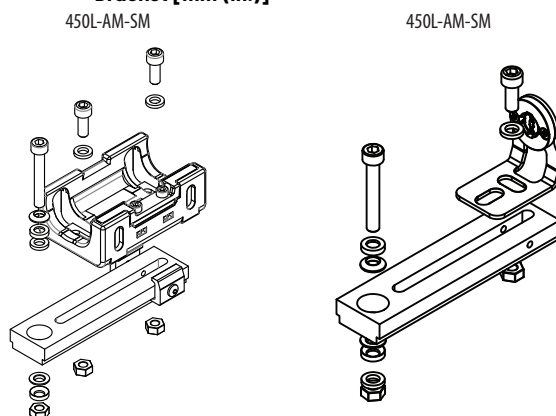
## Replacement Mounting Kit

The replacement mounting kit provides an easier mechanical conversion from installed safety light curtains to GuardShield safety light curtains if previous mounting holes are used. The GuardShield safety light curtain transceiver stick can directly mount to the replacement kit bracket. You can also use the replacement kit bracket with the default mounting kit (catalog number 450L-AM-TBM) or the optional side mounting kit (catalog number 450L-AM-SM). See [Figure 64 on page 84](#).

Figure 63 - 450L-AM-RK Replacement Mounting Kit [mm (in.)]



**Figure 64 - Replacement Kit with 450L-AM-TBM Default L-bracket and 450L-AM-SM Side Mounting Bracket [mm (in.)]**



## Electrical Installation



**ATTENTION:** Remove power from the entire machine/system line.

If you do not remove power, the machine system can inadvertently start while you connect the devices.



**ATTENTION:** Confirm that the entire system power is disconnected during the electrical installation.

## Plug-ins

To assemble a 450L safety light curtain system, you require two 450L safety light curtain sticks (two 450L-B sticks, two 450L-E sticks, or two 450L PAC sticks) — one transmitter and one receiver plug-in. Instead of one transmitter and one receiver plug-in, you can use two universal plug-ins. Unpack the plug-ins and set the DIP switches according to the required functional settings. Remove the red slot cover from the 450L safety light curtain stick and insert the connection plug-in. Remove the gray slot cover from the 450L-E or 450L PAC safety light curtain to insert a cascading plug-in, if necessary.

### IMPORTANT

The connection and the cascading plug-ins are mechanically coded. Do not attempt to insert a connection plug-in into the slot for the cascading plug-in and vice versa. If you feel resistance when you insert a plug-in into the safety light curtain, immediately remove the plug-in and confirm the plug-in is the correct type/end.

Do not insert plug-ins more than 100 times in one GuardShield safety light curtain stick.



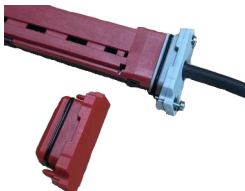
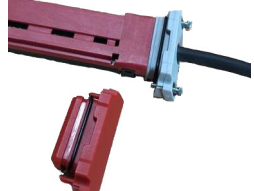

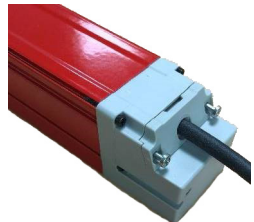


**ATTENTION:** To avoid pollution or contamination, install a plug-in into a stick in a dry and clean area. Confirm that the rubber seal at the plug-in does not get out of place when you insert the plug-in in the safety light curtain.

### Plug-in Installation

To maintain the IP65 rating, fully insert the slot covers into the safety light curtain. If you remove the slot cover, replace the cover with a plug-in and properly insert into the safety light curtain. [Figure 65](#) shows examples of correct and incorrect installation.

Figure 65 - Plug-in Installation Examples

Correct ✓	Incorrect ✗
 Cap fully seated	 Cap missing
 Gasket in groove (no nicks, splits, or flat spots)	 Gasket mis-located
 Fully seated, screws tight	 Screws not torqued

### Transmitter Plug-in

[Figure 66](#) shows the plug-ins that can make a transceiver a transmitter. [Table 34...Table 36 on page 86](#) show the pinout connections for each plug-in.

Figure 66 - Transmitter Plug-ins

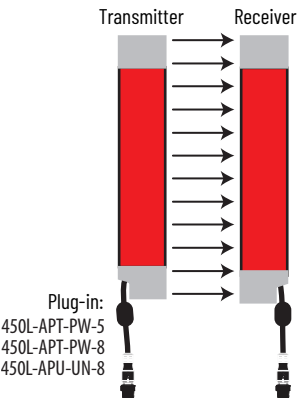


Table 34 - Pin Assignment (Cat. No. 450L-APT-PW-5)

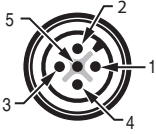
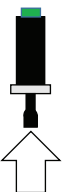
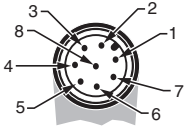

Face View of Plug M12 5-pin	View	Pin No.	Signal Transmitter
		1	24V DC
		2	No connection
		3	0V (ground)
		4	No connection
		5	Functional earth FE

Table 35 - Pin Assignment (Cat. No. 450L-APT-PW-8)

Face View of Plug M12 8-pin	View	Pin No.	Signal Transmitter
		1	Do not connect
		2	+24V DC
		3	Functional earth FE
		4	Do not connect
		5	Do not connect
		6	Auxiliary output (lockout stick) (on = 24V DC)
		7	0V (GND)
		8	Do not connect

## Receiver Plug-in

Any receiver plug-in type works with any transmitter plug-in type and vice versa (see [Figure 66 on page 85](#)).

Table 36 - Pin Assignment (Cat. Nos. 450L-APR-ON-5 and 450L-APR-BL-5)


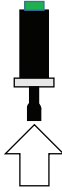
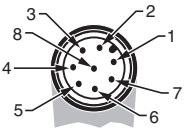

Receiver Bottom Plug-in Face View of M12 5-pin (DC Micro) Plug	View	Pin No.	Signal Receiver
		1	+24V DC
		2	OSSD1
		3	0V (GND)
		4	OSSD2
		5	Functional earth FE

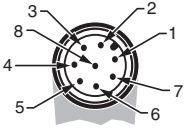
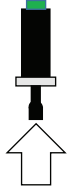
Table 37 - Pin Assignment (Cat. No. 450L-APR-ED-8)

Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Plug	View	Pin No.	Signal Receiver
		1	Auxiliary output (OSSD emulation)
		2	+24V DC
		3	Functional earth FE
		4	EDM (Input) <sup>(1)</sup>
		5	OSSD1
		6	OSSD2
		7	0V (GND)
		8	Start <sup>(1)</sup>

(1) If set with DIP switches.

[Table 38 on page 68](#) shows a configuration for either no muting, or for muting sensors that connect at the cascading plug-in (catalog number 450L-APC-IO-8).

Table 38 - Pin Assignment (Cat. No. 450L-APR-MU-8)

Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Plug	View	Pin No.	Signal Receiver
		1	Auxiliary output (OSSD emulation)
		2	+24V DC
		3	Functional earth FE
		4	EDM (Input) <sup>(1)</sup>
		5	OSSD1
		6	OSSD2
		7	OV (GND)
		8	Start <sup>(1)</sup> /mute dependent override

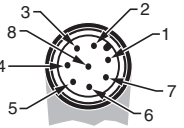
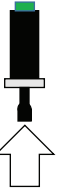
(1) If set with DIP switches.

Table 39 shows a configuration (450L-E safety light curtains only) for two-sensor muting that connects at the connection plug-in (catalog number 450L-APR-MU-8).



**ATTENTION:** The auxiliary output is only a status output for diagnosis purposes to connect, for example, an indicator lamp. Do not use this output for safety purposes.

Table 39 - Pin Assignment (Cat. No. 450L-APR-MU-8) for Two-sensor Muting

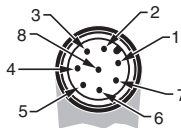
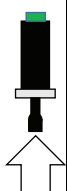
Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Plug	View	Pin No.	Signal Receiver
		1	Sensor 1
		2	+24V DC
		3	Functional earth FE
		4	Sensor 2
		5	OSSD1
		6	OSSD2
		7	OV (GND)
		8	Start <sup>(1)</sup> /mute dependent override

(1) If set with DIP switches.



**ATTENTION:** The auxiliary output is only a status output for diagnosis purposes to connect, for example, an indicator lamp. Do not connect this output to fulfill safety functions.

Table 40 - Pin Assignment (Cat. No. 450L-APU-UN-8)

Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Plug	View	Pin No.	Signal Transmitter	Signal Receiver
		1	Do not connect	Auxiliary output (OSSD emulation)
		2	+24V DC	+24V DC
		3	Functional earth FE	Functional earth FE
		4	(1)	EDM (Input) <sup>(2)</sup>
		5	Do not connect	OSSD1
		6	Auxiliary output (Lockout)	OSSD2
		7	OV (GND)	OV (GND)
		8	(1)	(2)

(1) Pin 4 connected to pin 8 (short circuit).

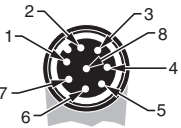

(2) If set with DIP switches.

**IMPORTANT** If pin 4 connects to pin 8, the corresponding 450L safety light curtain stick acts like a transmitter.

## Cascading

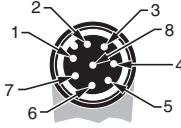
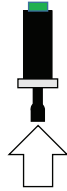
You can insert the cascading plug-in into a 450L-E POC or 450L PAC safety light curtain transceiver that operates as a transmitter (see [Table 41](#)) or as a receiver (see [Table 42 on page 89](#)...[Table 46 on page 90](#))

Table 41 - Pin Assignment of M12 8-pin Plug-in (Cat. No. 450L-APC-IO-8), 450L-E POC or 450L PAC Safety Light Curtain Operates as Rx

Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Plug	View	Pin No.	Signal Receiver
		1	No connection
		2	+24V DC
		3	Functional earth FE
		4	No connection
		5	No connection
		6	No connection
		7	OV (GND)
		8	No connection

The 450L-APC-IO-8 cascading plug-in that connects to a GuardShield safety light curtain transceiver that operates as a transmitter allows the cascading of an additional GuardShield safety light curtain transceiver that operates as a transmitter (see [Cascading on page 45](#)). However, in a cascaded system for the transceiver that works as a transmitter, you can use (not required) the 450L-APC-IO-8 cascading plug-ins (see [Figure 27 on page 47](#)).

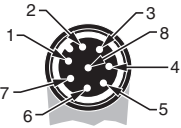
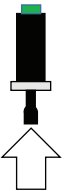
**Table 42 - Pin Assignment of Plug-in M12 8-pin (Cat. No. 450L-APC-IO-8), 450L-E POC or 450L PAC Safety Light Curtain Operates as Rx <sup>(1)</sup>**

Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Plug	View	Pin No.	Signal Receiver
		1	No connection
		2	+24V DC
		3	Functional earth FE
		4	No connection
		5	OSSD in 1
		6	OSSD in 2
		7	0V (GND)
		8	Not connected

(1) Default DIP switch connection plug-in setting.

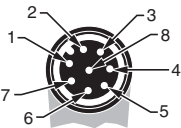
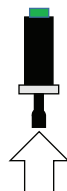
For most DIP switch configurations, the catalog number 450L-APC-IO-8 cascading plug-in allows the cascading of an additional safety light curtain. There is no DIP switch that enables the cascading option. For some DIP switch settings that enable muting functionality, use the pins of the catalog number 450L-APC-IO-8 plug-in for the connection of muting sensors. In those cases, the cascading feature is not enabled (see [Table 43](#) and [Table 44](#)).

**Table 43 - Pin Assignment of the Cascading Plug-in M12 8-pin (Cat. No. 450L-APC-IO-8), 450L-E Safety Light Curtain Operates as Rx, Two-sensor Muting <sup>(1)</sup>**

Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Plug	View	Pin No.	Signal Receiver
		1	MFO out
		2	+24V DC
		3	Functional earth FE
		4	Not connected
		5	Muting Sensor S1 In
		6	Muting Sensor S2 In
		7	0V (GND)
		8	Muting Lamp

(1) DIP switch connection is set for muting two sensors, muting sensors connect to the cascade plug-in, see [Table 28 on page 60](#).

**Table 44 - Pin Assignment of the Cascading Plug-in M12 8-pin (Cat. No. 450L-APC-IO-8) to 450L-E Safety Light Curtain, Four-sensor Muting <sup>(1)</sup>**

Receiver Bottom Plug-in Face View of M12 8-pin (DC Micro) Socket	View	Pin No.	Signal Receiver
		1	Muting Sensor S3 In
		2	+24V DC
		3	Functional earth FE
		4	Muting Sensor S4 In
		5	Muting Sensor S1 In
		6	Muting Sensor S2 In
		7	0V (GND)
		8	Muting Lamp

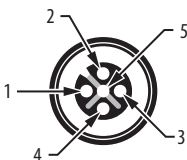
(1) DIP switch connection plug-in is set for muting four sensors, see [Table 28 on page 60](#).

## Transmitter Cable Connection

Depending on the selected plug-in, the GuardShield safety light curtain transmitter plug-in has either a 5-pin or 8-pin M12 (DC micro) plug connector. Connection cable accessories are offered from 2...30 m (6.6...98 ft) lengths.

You can use all 450L safety light curtain models with 5-pin M12 QD plug-in (catalog number 450L-APT-PW-5) with ArmorBlock® Guard I/O™ connectivity or GuardLink® systems.

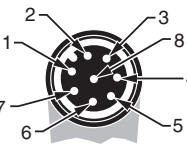
**Table 45 - Pin Assignment of Cable to M12 5-pin Tx Bottom Plug-in (Cat. No. 450L-APT-PW-5)**

Transmitter Connection Cable Face View of M12 5-pin (DC Micro) Socket	Color (Cat. No. 889D-F5BC-x) (1)	Pin No.	Signal Transmitter
	Brown	1	+24V DC
	White	2	Not connected
	Blue	3	0 (GND)
	Black	4	Not connected
	Gray	5	Functional earth FE

(1) x = 2 [2 m (6.6 ft)], 5 [5 m (16.4 ft)], 10 [10 m (32.8 ft)], 15 [15 m (49.2 ft)], 20 [20 m (65.6 ft)], or 30 [30 m (98.4 ft)] available lengths.

**IMPORTANT** The transmitter itself is not expected to connect to the ArmorBlock Guard I/O module or a GuardLink tab. Consider a separate connection cable or use the 5-pin T-connector for implementation of a transmitter (see [T-connector on page 98](#)).

**Table 46 - Pin Assignment of Cable to M12 8-pin Tx Bottom Plug-in (Cat. No. 450L-APT-PW-8)**

Transmitter Connection Cable Face View of M12 8-pin (DC Micro) Socket	Color (Cat. No. 889D-F8AB-x) (1)	Pin No.	Signal Transmitter
	White	1	Do not connect
	Brown	2	+24V DC
	Green	3	Functional earth FE
	Yellow	4	Do not connect
	Gray	5	Do not connect
	Pink	6	Auxiliary output (lockout stick) (24V = normal operation, 0V = lockout stick)
	Blue	7	0V (GND)
	Red	8	Do not connect

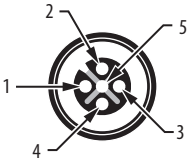
(1) x = 2 [2 m (6.6 ft)], 5 [5 m (16.4 ft)], 10 [10 m (32.8 ft)], 15 [15 m (49.2 ft)], 20 [20 m (65.6 ft)], or 30 [30 m (98.4 ft)] available lengths.

## Receiver Cable Connection

Depending on the selected plug-in, the GuardShield safety light curtain receiver plug-in has either a 5-pin or 8-pin M12 (DC micro) connector (plug). We offer connection cable accessories from 2...30 m (6.6...98 ft) lengths.

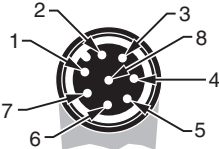


**Table 47 - Pin Assignment of Cable to M12 5-pin Rx Plug-in (Cat. No. 450L-APR-ON-5 or 450L-APR-BL-5)**

Receiver Connection Cable Face View of M12 5-pin (DC Micro) Socket	Color (Cat. No. 889D-F5BC-x) <sup>(1)</sup>	Pin No.	Signal Transmitter
	Brown	1	+24V DC
	White	2	OSSD1
	Blue	3	0V (GND)
	Black	4	OSSD2
	Gray	5	Functional earth FE

(1) x = 2 [2 m (6.6 ft)], 5 [5 m (16.4 ft)], 10 [10 m (32.8 ft)], 15 [15 m (49.2 ft)], 20 [20 m (65.6 ft)], or 30 [30 m (98.4 ft)] available lengths.

**Table 48 - Pin Assignment of Cable to M12 8-pin Rx Plug-in (Cat. No. 450L-APR-ED-8 or 450L-APR-MU-8)**

Receiver Connection Cable Face View of M12 8-pin (DC Micro) Socket	Color (Cat. No. 889D-F8AB-x) <sup>(1)</sup>	Pin No.	Signal Receiver
	White	1	Auxiliary output (OSSD high = 24V)
	Brown	2	+24V DC
	Green	3	Functional earth FE
	Yellow	4	EDM (Input) <sup>(2)</sup>
	Gray	5	OSSD1
	Pink	6	OSSD2
	Blue	7	0V (GND)
	Red	8	Start <sup>(2)</sup>

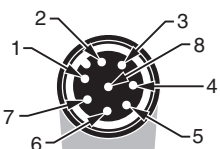
(1) x = 2 [2 m (6.6 ft)], 5 [5 m (16.4 ft)], 10 [10 m (32.8 ft)], 15 [15 m (49.2 ft)], 20 [20 m (65.6 ft)], or 30 [30 m (98.4 ft)] available lengths.

(2) If set with DIP switches.



**ATTENTION:** The auxiliary output is only a status output for diagnosis purposes to connect, for example, an indicator lamp. Do not connect this output to fulfill safety functions.

**Table 49 - Pin Assignment of Cable to M12 8-pin Universal Plug-in (Tx or Rx) (Cat. No. 450L-APU-UN-8)**

Connection Cable Face View of M12 8-pin (DC Micro) Socket	Color (Cat. No. 889D-F8AB-x) <sup>(1)</sup>	Pin No.	Signal Transmitter	Signal Receiver
	White	1	—	Auxiliary output (OSSD high = 24V)
	Brown	2	+24V DC	+24V DC
	Green	3	Functional earth FE	Functional earth FE
	Yellow	4	(2)	EDM (Input) <sup>(3)</sup>
	Gray	5	Do not connect	OSSD1
	Pink	6	Auxiliary output (Lockout) (24V = normal operation, 0V = lockout)	OSSD2
	Blue	7	0V (GND)	0V (GND)
	Red	8	(2)	(3)

(1) x = 2 [2 m (6.6 ft)], 5 [5 m (16.4 ft)], 10 [10 m (32.8 ft)], 15 [15 m (49.2 ft)], 20 [20 m (65.6 ft)], or 30 [30 m (98.4 ft)] available lengths.

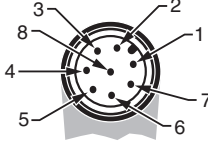
(2) Pin 4 connected to pin 8 (short circuit).

(3) If set with DIP switches.

## Cascading Cable Connection

The pin assignment for the cable that connects to a cascading plug-in (catalog number 450L-APC-IO-8) depends on if the cascading plug-in is inserted in a 450L-E safety light curtain transceiver stick working as a transmitter or as a receiver. Assignment also depends on the DIP switch settings on the Rx plug-in.

**Table 50 - Pin Assignment of Cable to M12 8-pin I/O Cascading Plug-in (Cat. No. 450L-APC-IO-8)**

Connection Cable Face View of M12 8-pin (DC Micro) Plug	Color (Cat. No. 889D-M8AB-x) <sup>(1)</sup>	Pin No.	Signal Transmitter	Signal Receiver <sup>(2)</sup>
	White	1	—	Muting sensor S3 in
	Brown	2	+24V DC	+24V DC
	Green	3	Functional earth FE	Functional earth FE
	Yellow	4	—	Muting sensor S4 in
	Gray	5	—	Muting sensor S1 in
	Pink	6	—	Muting sensor S2 in
	Blue	7	OV (GND)	OV (GND)
	Red	8	—	Muting lamp

(1) x = 2 [2 m (6.6 ft)], 5 [5 m (16.4 ft)], 10 [10 m (32.8 ft)] for the desired length.

(2) 4-sensor muting, if set with DIP switches.

## Power Supply

The external voltage supply (+24V DC) must meet the requirements of IEC 61496-1. Pay special attention to the following requirements:

- The power supply must bridge a short-term power failure of 20 ms (according to IEC 60204-1).
- The maximum deviation of the voltage levels is 24V DC  $\pm 15\%$ .
- The power supply is protected against overload (use NEC Class 2 or fuse with 4 A in the 24V DC circuit).
- Provide the safety light curtain devices with a 24V DC PELV or SELV power supply that conforms to the requirements of 414-3 or IEC 60364-4-41. These provisions are taken to maintain that, even if an internal fault occurs, the voltage at the outgoing terminals cannot exceed 60V DC.

To comply with UL restrictions, GuardShield safety light curtain sticks are powered by DC sources whose secondary circuits have double insulation or reinforced insulation to isolate them from the primary circuit. The DC power supply must satisfy the requirements for National Electric Code (NEC) Class 2.

The following are Rockwell Automation power supplies that are NEC Class 2 and PELV compliant. These devices also meet the isolation and output hold-off time requirements of two GuardShield safety light curtain transceiver sticks (GuardShield safety light curtain outputs not loaded):

- 2080-PS120-240V AC
- 1606-XLP15E
- 1606-XLP30E
- 1606-XLP50E
- 1606-XLP50EZ
- 1606-XLP72E
- 1606-XLP95E
- 1606-XLSDNET4

## Grounding

There are two types of recommended grounding for 450L safety light curtains:

- Protective earth (PE)
- Functional earth (FE)

Protective earth is intended to help protect personnel from electric shock. Protective earth is also known as dirty earth as it can contain many types of noise transients and stray currents. The 24V common side of the 24V power supply must connect to protective earth at one location.

Functional earth is intended to reduce the high frequency (RF) noise and is also known clean earth. The functional earth must carry only returning RF noise currents. Ground schemes must include a functional earth ground to minimize common mode disturbances that were capacitively coupled between cables, transients on the 24V common, or radiated noise. Functional earth must be separate from other earths and must connect to protective earth at one point.

The 450L safety light curtain plug-in modules have a pin that is labeled functional earth and a pin that is labeled oV (GND). The oV (GND) must connect to the 24V common. At some point, the 24V Com connects to protective earth. In the absence of electrical noise, the functional earth can connect to 24V Com or directly to protective earth point. In the presence of electrical noise, the functional earth connection becomes critical; the connection must return the noise to its source in as short a distance as possible.

Figure 67 shows the symbols that designate functional and protective earth grounds.

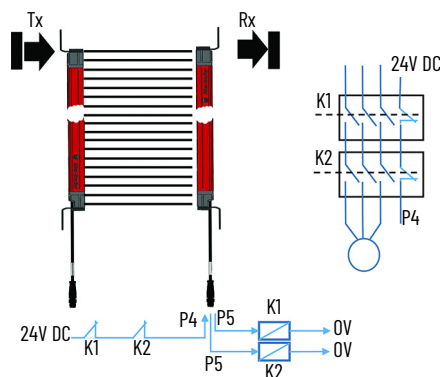
### Figure 67 - Earth Symbols



## External Device Monitoring (EDM) Connection

The External Device Monitor (EDM) describes the EDM feature. Perform the EDM function with the receiver plug-ins according to [Table 20 on page 55](#) and [Table 21 on page 55](#).

### Figure 68 - Connect the Contact Elements to the EDM Input



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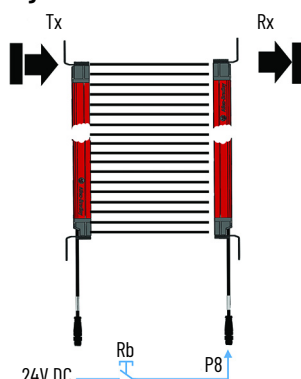
**IMPORTANT** EDM function is not available for GuardShield safety light curtain with receiver M12 5-pin plug-in (ArmorBlock Guard I/O connectivity). Surge suppression elements are often required for the contactors, depending on the contactor.

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## Restart Button

[Start Modes on page 27](#) describes the options for the individual start modes.

**Figure 69 - Connect the Restart Button to Pin 8**



Press the Start button a minimum of 50 ms. The maximum time for accepting the start is 5 seconds. The start reacts on the falling edge of the start pulse.

If there is a manual start, the Start button must be outside the hazardous area so a person working inside the hazardous area cannot operate the button. Manual start is not available in GuardShield safety light curtains with 5-pin M12 QD connection plug-ins (ArmorBlock Guard I/O connectivity).

---

**IMPORTANT** Start is not available for GuardShield safety light curtain with M12 5-pin plug-in (ArmorBlock, Guard I/O connectivity). You can also use the Start button to reset the system if there is a lockout. The stick performs a manual start if you press the button a minimum of 10 seconds and not longer than 20 seconds.

---

For more information, see [Grounding on page 93](#).

## OSSD Output

### OSSD Signal Processing

The dangerous movement of the machine must reach a safe state at any time if at least one of the two OSSDs switches off (OV).

In the application, the signals of both OSSDs must process separately. Both signals must always connect to either a safety controller, safety relay, or safety contactors. When you use safety contactors (positively guided contactors), verify the status of each (see [External Device Monitoring \(EDM\) Connection on page 93](#), [Figure 68 on page 93](#), and [Figure 70 on page 95](#)).

## OSSD Restart Time (from Off to On)

The times that are necessary to switch on the OSSDs after clearance of an interruption of the protective field if automatic reset is as follows:

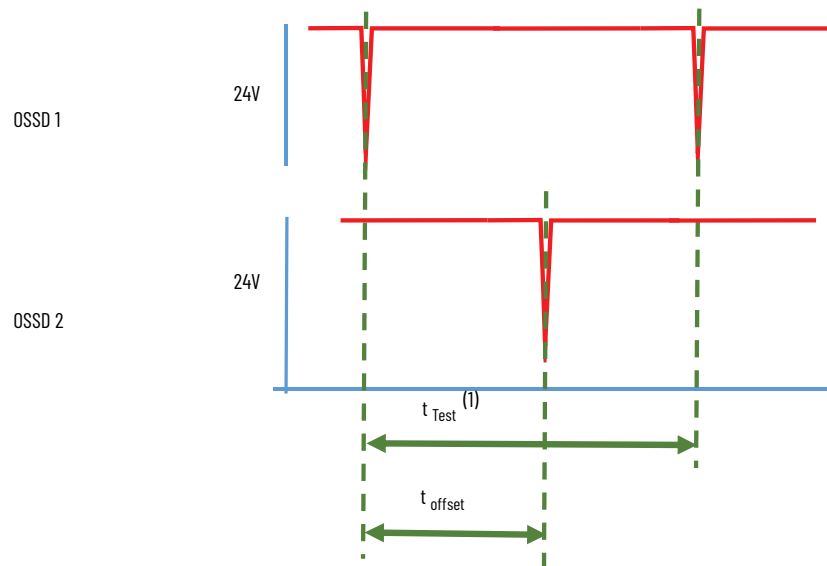
- Both synchronization beams interrupt before clearance is <210 ms
- Zero or one synchronization beams interrupt before clearance is <33 ms

Each GuardShield safety light curtain system has two synchronization beams - one beam is at the bottom and one beam is at the top of the protective field.

## Test Pulses

The safety outputs of a GuardShield safety light curtain system use test pulses to check for OSSD output faults. This process is shown in [Figure 70](#).

**Figure 70 - OSSD Safety Output Test Pulse Characteristic**



(1)  $t_{Test} = 100...125$  ms. Actual value depends on stick length. OSSD2 has the same timing between pulses as OSSD1, with the offset approximately half of  $t_{Test}$ .

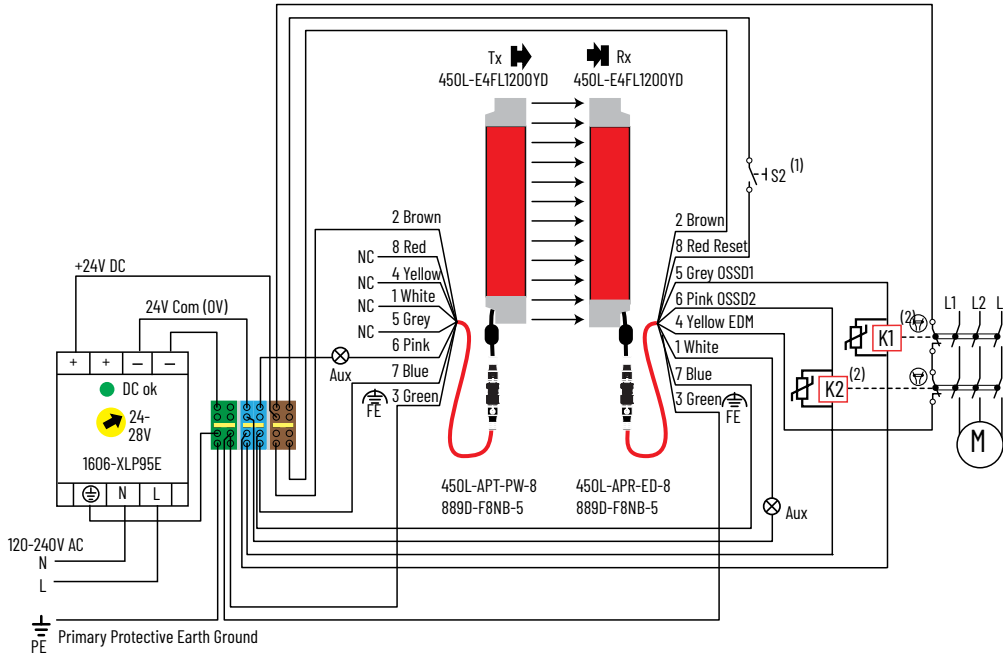
The pulse is as short as possible and depends on the load. 50  $\mu$ s is typical for the resistive load and longer if you use a capacitive load.

The test pulses can lead to the connected device being switched off sporadically if the device does not filter the test pulses correctly.

## Typical Wiring Diagram

### Direct to Contactors

Figure 71 - Example Connection to External Contactors - 450L-APR-ED-8 Receiver Plug-in, 450L-APT-PW-8 Transmitter Plug-in



(1) Manual restart

(2) Safety contactors (100S-C contactors with electronic coils). For non-motor loads, K1/K2 can be 700S-CF control relays with electronic coils.

**IMPORTANT** EDM must activate in the GuardShield safety light curtain and the application requires safety contactors (K1 and K2). EDM feedback is only available on 8-pin plug-ins.

You must use some type of surge suppression to help protect and extend the operating life of the OSSD output. The potentially high current surges that are created when switching inductive load devices, such as motor starters and solenoids, require this extra protection. Add a suppression device directly across the coil of an inductive device to help prolong the life of the outputs. This addition also reduces the effects of voltage transients and electrical noise from radiating into adjacent systems.

Figure 71 shows an output with a suppression device. We recommend that you locate the suppression device as close as possible to the load device. Since the outputs are 24V DC, we recommend 1N4001 (50V reverse voltage) to 1N4007 (1000V reverse voltage) diodes for surge suppression for the OSSD safety outputs. The diode connects as close as possible to the load coil. 100S contactors and 700S control relays with electronic coils have built-in suppression; additional components for suppression are not needed.



**ATTENTION:** The response time of the safety contactors often increases drastically when you use surge suppression diodes. Never install suppressors directly across:

- The OSSD outputs
- Contacts of the safety device or module

A short circuit fail of a surge suppressor element leads to an unsafe condition and causes serious injury or death.

## Guardmaster SI Safety Relay

Figure 72 is an example of a connection to a 450L-B safety light curtain with a 5-pin transmitter plug-in (catalog number 450L-APT-PW-5) and 5-pin receiver plug-in (catalog number 450L-APR-ON-5) to an SI safety relay (catalog number 440R-S12R2).

Figure 72 - Example Connection to 450L-B Safety Light Curtain System

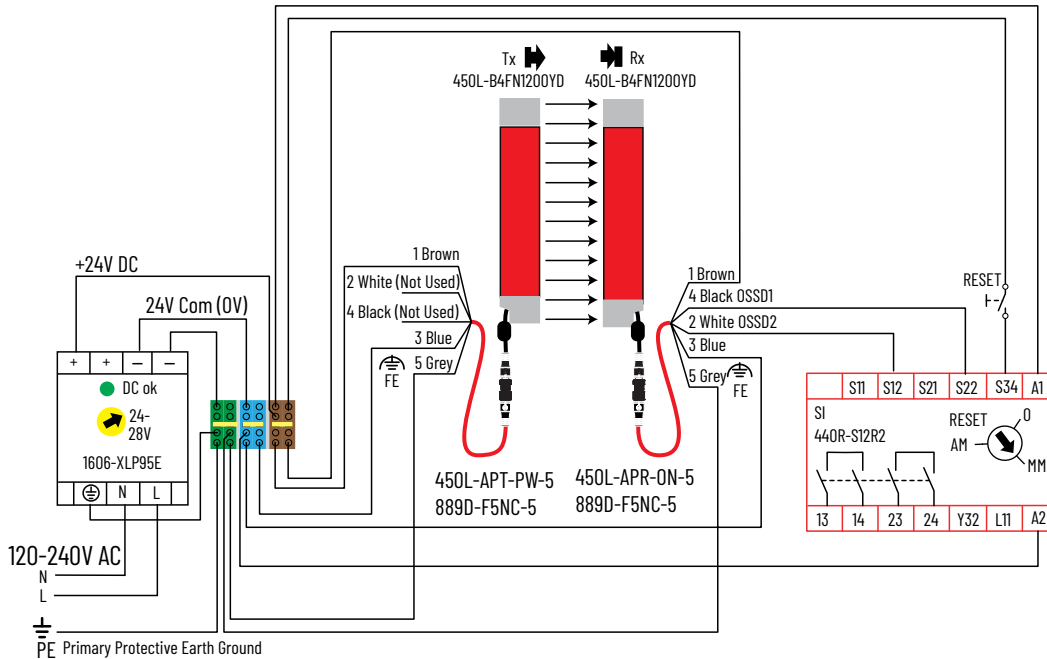
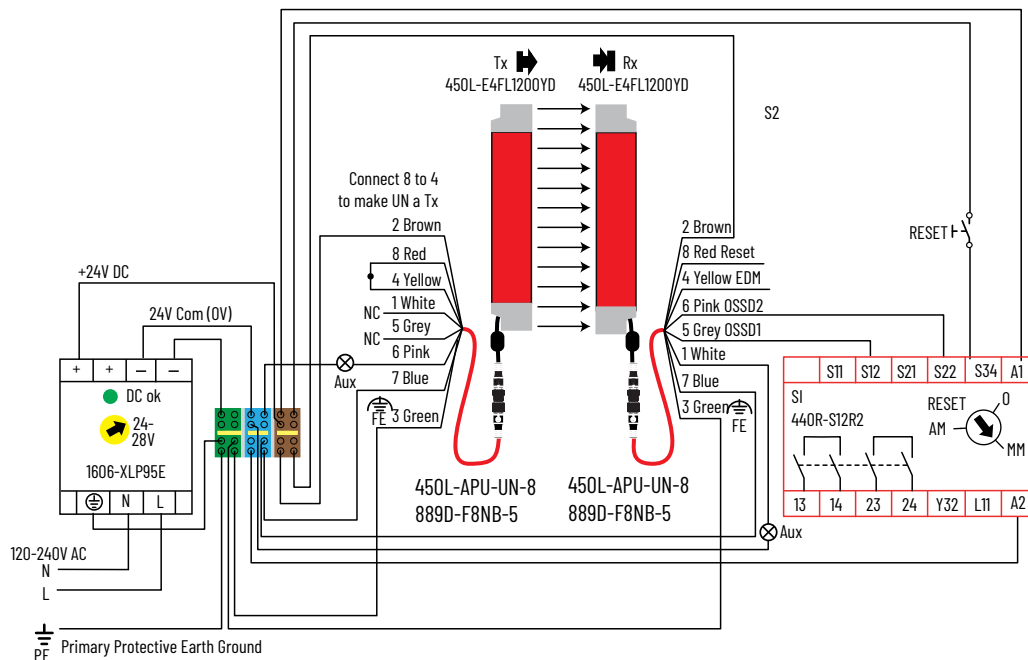
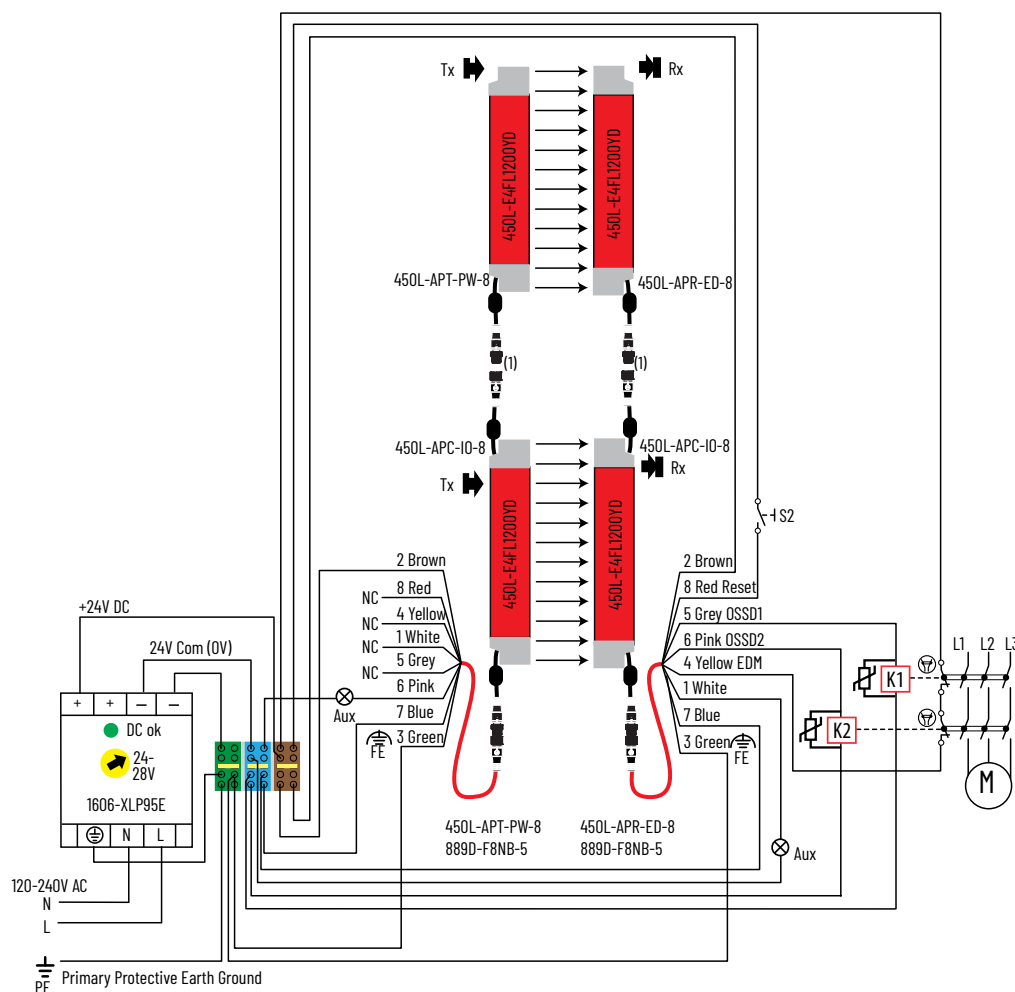


Figure 73 shows a connection example of a 450L-B safety light curtain with two universal plug-ins (catalog number 450L-APU-UN-8) to an SI safety relay (catalog number 440R-S12R2).

Figure 73 - Connection Example



### Figure 74 - Cascaded System Example

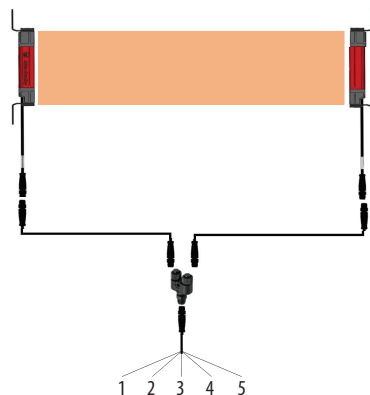


(1) Connect the plug-ins directly together or use a patchcord (such as 889D-F8NBDM-5) to extend as required.

## T-connector

If a safety light curtain system has an Rx and a Tx plug-in with M12 5-pin connectors, then you can also use a T-connector (catalog number 1485P-RDR5) to design and connect the system (see [Figure 75](#)).

### Figure 75 - Wiring with T-connector



For the description of the pins, see [Table 47 on page 91](#).





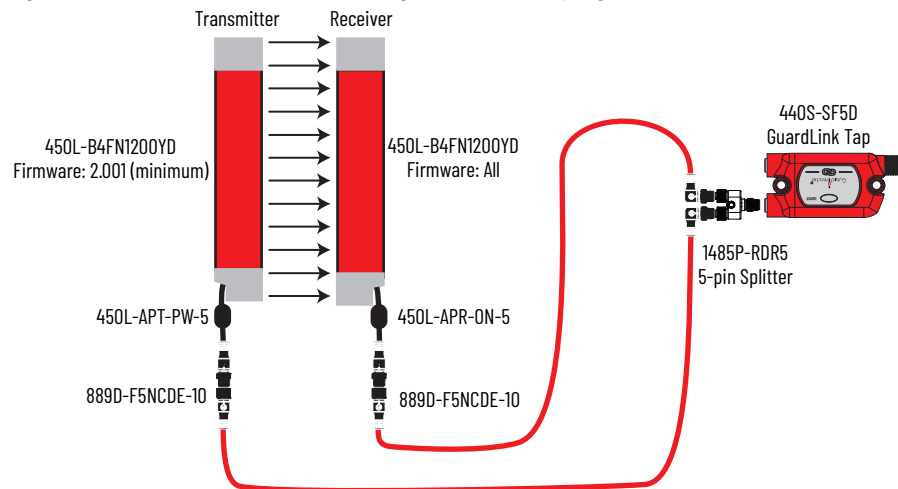
**ATTENTION:** Confirm that the connected power supply is able to source both connected sticks simultaneously (for power consumption, see [Table 73 on page 171](#)).  
The 450L safety light curtain transceiver stick working as a transmitter must have firmware 2.001 or higher.

You can also use the T-connector to attach a 450L safety light curtain system to GuardLink technology (see <https://www.rockwellautomation.com/en-us/products/hardware/allen-bradley/safety-products/guardlink-technology.html>).

## GuardLink Tap Connections

[Figure 76 on page 99](#) shows an example for the connection of a 450L-B safety light curtain with 5-pin transmitter and 5-pin receiver plug-ins to a catalog number 440S-SF5D GuardLink tap. A catalog number 1485P-RDR5 splitter (see [T-connector on page 98](#)) allows both the receiver and transmitter to connect to one tap. The firmware for the 450L safety light curtain transceiver stick working as a transmitter must be 2.001 or larger. The firmware level is on the product label (see [Product Labels on page 118](#)).

**Figure 76 - Example Schematic Connecting to 450L-B Safety Light Curtain to GuardLink Tap**



## 1732 ArmorBlock Connections

[Figure 77](#) is an example of connecting to a 450L-B safety light curtain with 5-pin transmitter and receiver plug-ins to a catalog number 1732ES-IB12XOB4 ArmorBlock module. A catalog number 1485P-RDR5 splitter (see [T-connector on page 98](#)) allows both the receiver and transmitter to connect to one input connector. The firmware for the 450L safety light curtain transceiver stick working as a transmitter must be 2.001 or larger. The firmware level is on the product label; see example of [Product Labels on page 118](#).

[Table 51 on page 100](#) shows the DIP switch settings for the receiver plug-in module. You can set switches 2 and 3 to on, if needed by the application. The transmitter plug-in does not have DIP switches.



Switch	450L-APR-ON-5	Description	Comment
1	Off	Software configuration disabled	Optional
2	Off	Low range disabled	Optional
3	Off	Beam coding disabled	Optional
4	Off	Interference rejection disabled	Optional

Figure 78 shows the screen captures of the ArmorBlock module properties setup for the example schematic.

Tab	Description
General	Configure the module definition.
Input configuration	Points 0 and 1 monitor the safety light curtain OSSD outputs. Points 4 and 5 use pulse testing to monitor the status of the output contactors K1 and K2. The Point Operation Types are set to Single to allow the logic function block to detect faults.
Test output	Point 0 must be set to Not Used as pin 5 on the connector is connected to the safety light curtain housing. Point 1 is set to Standard to allow the program to cycle the power to the safety light curtains if the safety light curtain has to be power cycled. Points 4 and 5 are the test pulses to monitor the contactors K1 and L2.
Output configuration	Points 0 and 1 turn the output contactors, K1 and K2, on and off.

Figure 78 - ArmorBlock Module Properties Setup

The figure displays four screenshots of the 'Module Properties: EN3TR (1732ES-IB12XOB4 1.011)' dialog box, showing different configuration tabs. Red boxes highlight the active tab in each screenshot.

**General Tab:** Shows module information including Vendor (Rockwell Automation/Allen-Bradley), Parent (EN3TR), Name (IB12XOB4), and Description (ArmorBlock IP). It also displays Ethernet Address (192.168.1.29) and Safety Network Number (3F7B\_0450\_9C2A).

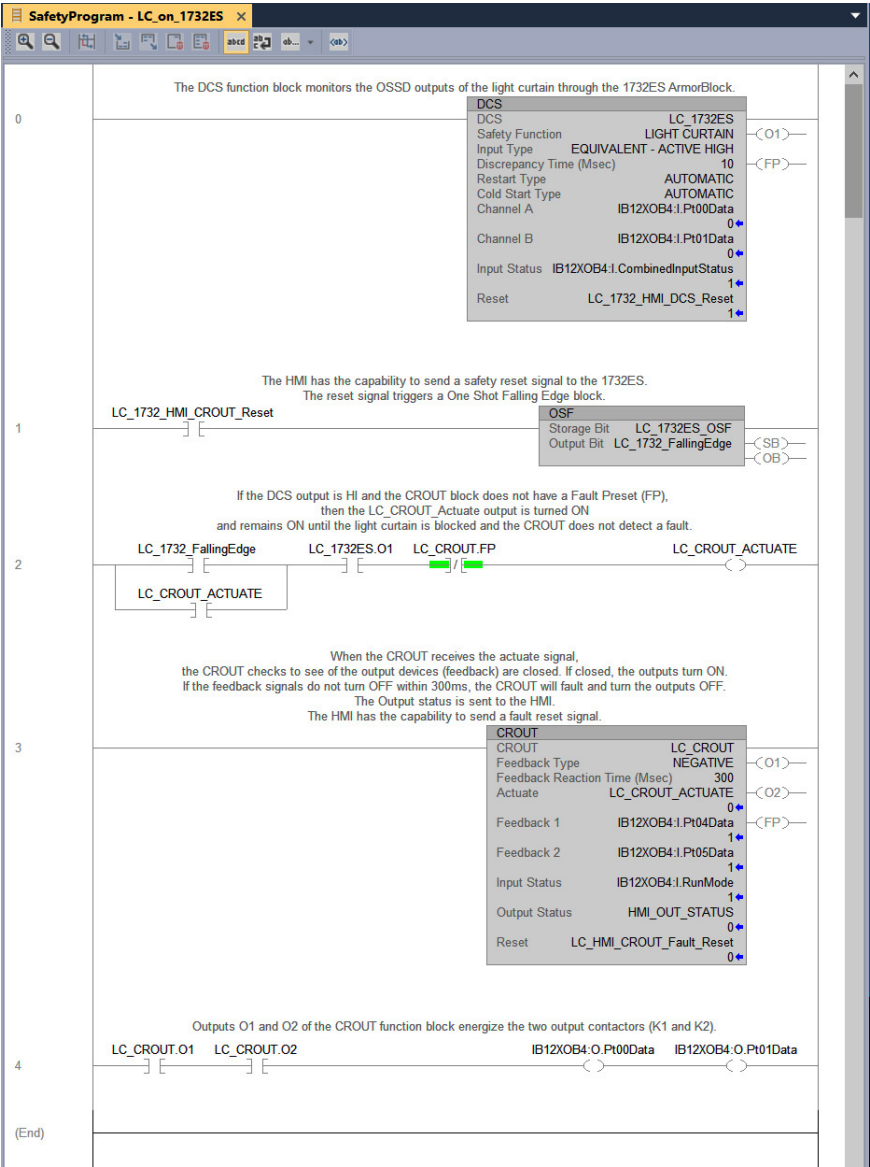
**Input Configuration Tab:** Displays a table for input points (0-11) with columns for Point, Type, Discrepancy Time (ms), Point Mode, Test Source, and Input Delay Time (ms). The table shows configurations for various input types like Single, Dual, and Safety Pulse Test.

**Test Output Tab:** Displays a table for test output points (0-8) with columns for Point, Point Mode, and Test Source. The table shows configurations for various test output types like Not Used, Standard, and Pulse Test.

**Output Configuration Tab:** Displays a table for output points (0-3) with columns for Point, Point Operation, Type, and Point Mode. The table shows configurations for various output types like Dual, Safety, and Not Used.

[Figure 79 on page 102](#) shows a typical example of a ladder logic program that you can use with the example schematic. The comments that are embedded in the program explain the usage of each rung.

Figure 79 - ArmorBlock Ladder Logic Program



Two-sensor Muting with Muting Plug-in

[Figure 80 on page 103](#) is a two-sensor muting example with the 450L-E safety light curtain. The transmitter uses the 5-pin transmitter plug-in, and the receiver uses the 8-pin muting plug-in.

Figure 80 - Example Schematic for Two-sensor Muting of 450L-E Safety Light Curtain

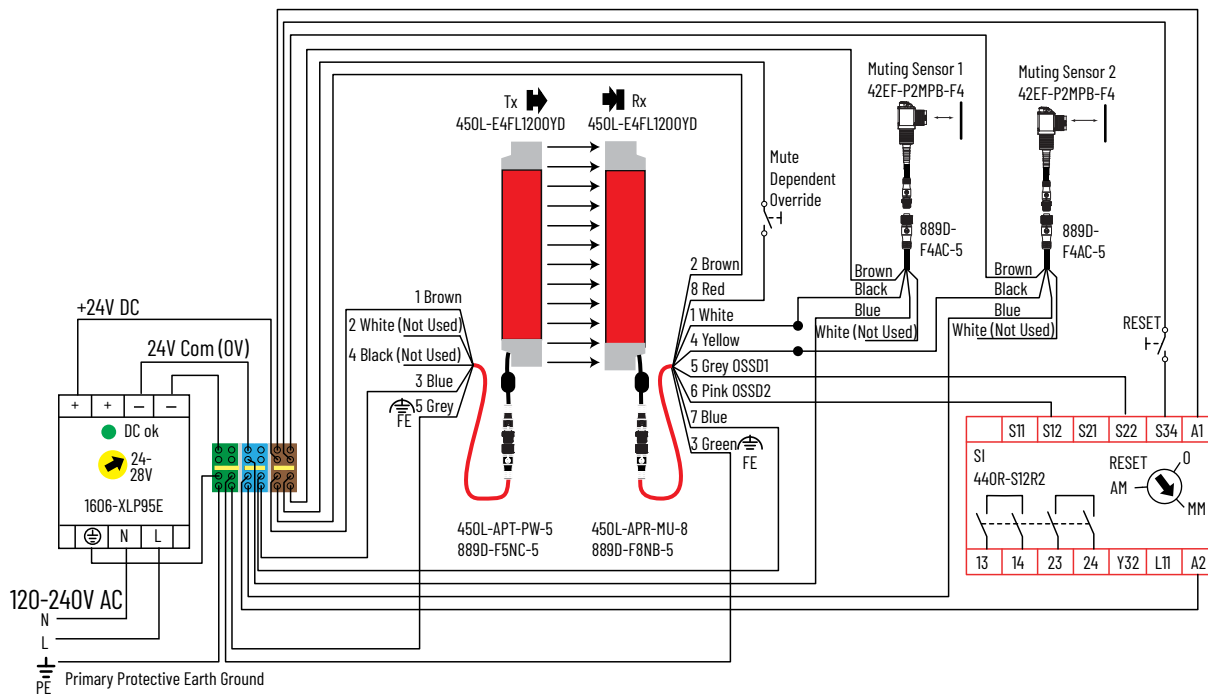


Table 52 shows the DIP switch settings for the receiver muting plug-in. You can change switches 2, 3, 5, and 6 to on, if needed by the application. Switch 7 must be off and switch 8 must be on. Switches 9, 10, and 11 determine the type of muting. The transmitter plug-in does not have DIP switches.

Table 52 - Receiver DIP Switch Settings

Switch	450L-APR-MU-8	Description	Comment
1	Off	—	—
2	Off	Low range disabled	Optional
3	Off	Beam coding disabled	Optional
4	Off	—	—
5	Off	Automatic start	Optional
6	Off		Optional
7	Off	EDM disabled	—
8	On	Muting	Required
9	Off or on	DIP 9: Off, DIP 10: On, DIP 11: Off 2L muting DIP 9: On, DIP 10: Off, DIP 11: Off 2T muting	Determines muting type
10	Off or on		
11	Off		
12	Off	—	—

### Four-sensor Muting with Muting Plug-in

Figure 81 on page 104 is a four-sensor muting example with the 450L-E safety light curtain. The transmitter uses the 5-pin transmitter plug-in. The receiver uses the 8-pin muting plug-in at the bottom and the 8-pin I/O plug-in at the top.

Figure 81 - Example Schematic for Four-sensor Muting of 450L-E Safety Light Curtain

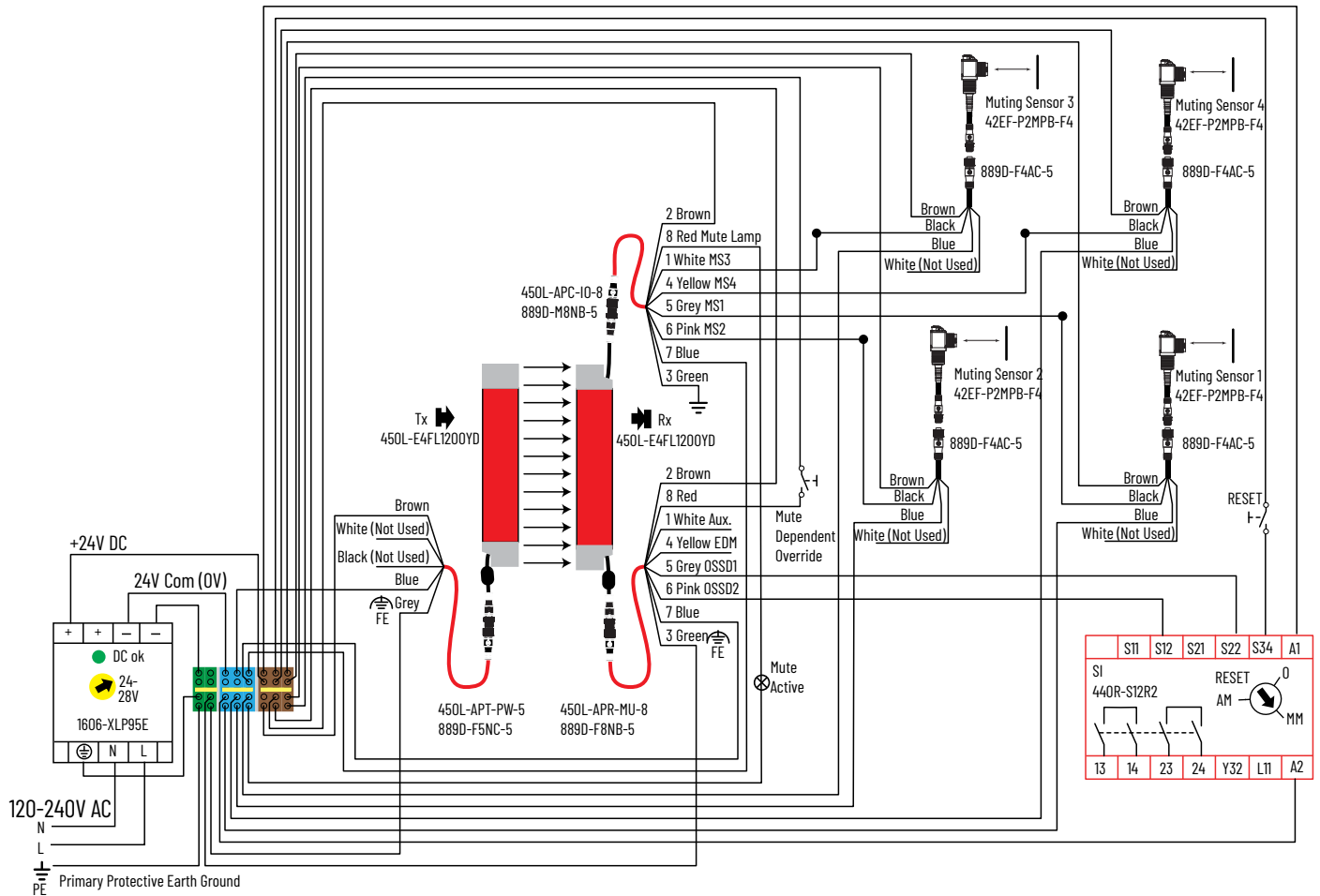


Table 53 shows the DIP switch settings for the receiver muting plug-in. You can change switches 2, 3, 5, and 6 to on, if needed by the application. Switch 7 must be off and switch 8 must be on. Switches 9, 10, and 11 must be set to on for four-sensor muting. The transmitter and I/O plug-in do not have DIP switches.

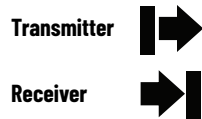
Table 53 - Receiver Muting Plug-in DIP Switch Settings

Switch	450L-APR-MU-8	Description	Comment
1	Off	—	—
2	Off	Low range disabled	Optional
3	Off	Beam coding disabled	Optional
4	Off	—	—
5	Off	Automatic start	Optional
6	Off		Optional
7	Off	EDM disabled	—
8	On	Muting	Required
9	Off or on	DIP 9: Off, DIP 10: On, DIP 11: Off 2L muting DIP 9: On, DIP 10: Off, DIP 11: Off 2T muting DIP9: On, DIP 10: On DIP: 11 On 4T muting.	Determines muting type
10	Off or on		
11	Off or on		
12	Off	—	—

## Status Indicators and Troubleshooting

### Status Indicators

The safety light curtain conducts an internal self-test after startup. If an error occurs, an appropriate signal combination displays the indicator status. If a GuardShield™ safety light curtain acts like a transmitter or as a receiver, it is also shown on the plug-in label.




---

**IMPORTANT** If you use a universal plug-in, only the status indicators or the wiring can inform you if a safety light curtain is a transmitter or a receiver.

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A quick categorization of an error can be done by checking the status indicator STS (see [Table 55 on page 109](#) and [Table 56 on page 110](#)).

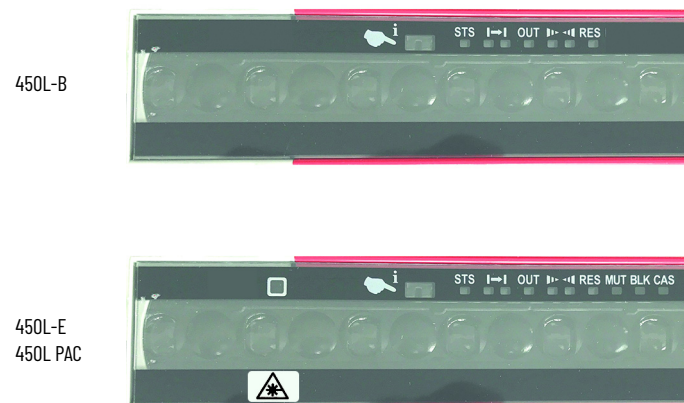
### System Status Indicators

There are different status indicators in the area closest to the connection plug-in. The number of indicators depends on the stick type:

- 450L-B: Seven indicators
- 450L-E and 450L PAC: Ten indicators

The STS and OUT status indicators are bicolor. Functions and colors are defined in [Table 54 on page 108](#).

**Figure 82 - Status Indicators of a 450L Safety Light Curtain**







The transceiver architecture of the 450L safety light curtain results in the Rx and Tx having the same status indicators.

## Status Indicator for Normal Operation

[Table 54](#) lists normal operation status indicators on a 450L safety light curtain (colors and functions) for normal operation.

**Table 54 - Status Indicators**

No.	Marking	Status Indicator Name	Color		Behavior	Description	System Status
1	STS	Status indicator	Green		On	Power on and system is OK	No
			Green	Red	Flashing	Configuration change or the receiver operated previously with another transmitter	No
			Green	Off	Flashing (98:2)	Interference rejection is enabled	No
			Green	Red	Flashing (90:10)	Optical interference is detected (this status is indicated, even if interference rejection is already enabled)	No
			Green	Off	Flashing 10 Hz (50:50)	Sync mode - attempting to synchronize	Yes
			Green	Off	Flashing	See <a href="#">Troubleshoot on page 109</a>	No
			Off	Red	Flashing		No
			Red		On		No
2		Transmitter	Green		On	Plug-in identifies stick as a transmitter	No
					Flashing 1 Hz (50:50)	See <a href="#">Troubleshoot on page 109</a>	No
					Flashing 1 Hz (98:2)	Reduced range and/or beam coding is activated	No
					Off	Stick is receiver	No
3		Receiver	Green		On	Plug-in identifies stick as a receiver	No
					Flashing 1 Hz (98:2)	Reduced range and/or beam coding is activated	No
					Off	Stick is transmitter	No
			4	OUT	Safety outputs	Green	
Red		On				Safety outputs are off (receiver)	No
—		Off				Transmitter	No
5		Regional light intensity level 1				Green	
			Flashing 1 Hz (50:50)	Bottom half zone intensity is at the limit	Yes		
			—		Off	Bottom half zone interrupted	Yes
			6		Regional light intensity level 2	Green	
Flashing 1 Hz (50:50)	Top half zone intensity is at the limit	Yes					
—		Off				Top half zone interrupted	Yes
7	RES	Start				Amber	
			—		Off	No start is required (receiver)	No
8	MUT	Muting	Orange		Off	Safety light curtain that is not muted	No
					On	Safety light curtain that is muted	No
			Orange	Off	Flashing	Muting error	No
9	BLK	Blanking	Orange		Off	No blanking feature selected	No
			Orange		On	Blanking feature that is selected	No
			Orange	Off	Flashing	Blanking error	No
10	CAS	Cascading	Red		Off	No cascading plug-in that is inserted or Tx OSSDs of the connected cascade are in on-state (Rx only)	No
					On	OSSDs of connected cascade are in off-state (Rx only)	No
			Red	Off	Flashing	Error cascading plug-in	No

The last column in [Table 54](#) describes whether the signal displays simultaneously at both sticks:

- No - the status indicator shows only the status of the individual stick.
- Yes - the status indicator shows the status of the complete system.



## Optical Push Button

The optical push button is on the front window next to the status indicators. To activate, place your finger on the square (see [Figure 83](#)). The optical push button operates with infrared light and can be used to:

- Confirm a new configuration (see [Confirmation of a New System Configuration on page 61](#)).
- Switch on/off the integrated laser alignments system (450L-E safety light curtain only) ([Principle of Operation on page 23](#)).
- Start power off/on cycle if there is a lockout. For recycling, press the optical push button between 10...20 seconds. Otherwise, the recycle command is ignored (see [Table 56 on page 110](#)).
- Communicate with the Optical Interface Device (see [Optical Interface Device \(OID\) on page 112](#)).

Figure 83 - Optical Push Button



## Troubleshoot

### Status Indicator Error Display

If the STS status indicator is steady red, flashes red, or flashes green, an error occurred which stops the system from working in normal operation.

Figure 84 - Status Indicators



Error types are differentiated according to [Table 55](#).

Table 55 - Error Types

Number	STS Code	Error Type
1	Steady red	Internal error
2	Flashes red	External error
3	Flashes green 1 Hz (50:50) <sup>(1)</sup>	Invalid DIP switch settings
4	Flashes green/red	Configuration changed

(1) A flash rate of 10 Hz does not indicate an error, but that the safety light curtain is in Sync mode.

Errors can be caused externally (STS = flashing red) and internally (STS = steady red). Examples of external recoverable errors include ambient light and/or Start button fault.

If there is an error, the second status indicator provides more information about the root cause ([Table 56 on page 110](#)).



**ATTENTION:** To indicate if a system is in the Configuration mode, the STS status indicator flashes alternately red/green (50:50; 1 Hz). The Configuration mode is not an error, but indicates that the DIP switch configuration and/ or plug-in changed and must be confirmed. For normal operation, first confirm the configuration. This procedure is described in [Confirmation of a New System Configuration on page 61](#).

The timing of the status indicator flashes defines a frequency and a duty cycle. The frequency defines one sequence of on and off, as a default frequency is 1 Hz, if not otherwise mentioned. The duty cycle defines the ratio of the on duration and the off duration of the status indicator. If not otherwise mentioned, the default value for the duty cycle is 50:50, meaning 50% on, 50% off.

Table 56 - Status Indicators for External Errors and System Errors

No.	Error	First Status Indicator				Second Status Indicator			
	Short Description	Marking (Name)	Color	Flash Frequency	Duty Cycle (On/Off)	Marking (Name)	Color	Flash Frequency	Duty Cycle <sup>(1)</sup>
0	Configuration changed	STS	Red/ Green	1 Hz	50:50	—	—	—	—
1	Internal lockout <sup>(2)</sup>	STS	Red	On	100:0	—	—	—	—
2	EDM error <sup>(2)</sup>	STS	Red	1 Hz	50:50	RES	Amber	1 Hz	10:90
3	Start error <sup>(3)</sup>	STS	Red	1 Hz	50:50	RES	Amber	1 Hz	90:10
4	Ambient light or EMC disturbances <sup>(3)</sup>	STS	Red/ Green	1 Hz	10:90	—	—	—	—
5	Short circuit between OSSDs to 24V DC (lockout) <sup>(2)(4)</sup>	STS	Red	1 Hz	50:50	OUT	Red	1 Hz	50:50
6	Error supply voltage <sup>(2)</sup>	STS	Red	1 Hz	50:50	Stick type (transmitter or receiver)	Green	1 Hz	50:50
7	24V DC connected to transmitter plug-in input	STS (Tx)	Green	On	100:0	Stick type transmitter	Green	1 Hz	50:50
8	Mixed design of 450L-B and 450L-E sticks or stick identification mismatch when beam coding is used <sup>(2)</sup>	STS (Tx)	Red	1 Hz	50:50	Regional light intensity level 1 and level 2	Green	1 Hz	50:50
9	Invalid DIP switch setting <sup>(2)</sup>	STS	Green	1 Hz	50:50	Stick type receiver	Green	1 Hz	50:50
10	Muting timing error (450L-E only) <sup>(3)</sup>	STS (Rx)	Red	1 Hz	50:50	MUT	Amber	1 Hz	90:10
11	Muting sequence error (450L-E only) <sup>(3)</sup>	STS (Rx)	Red	1 Hz	50:50	MUT	Amber	1 Hz	10:90
12	Blank error (450L-E only) <sup>(3)</sup>	STS	Red	1 Hz	50:50	BLK	Amber	1 Hz	50:50
13	Cascade error (450L-E only)	STS	Red	1 Hz	50:50	CAS	Red	1 Hz	50:50
14	Failure in a safety component or logic that is connected to a top I/O-plug-in <sup>(2)</sup>	STS	Red	1 Hz	50:50	Regional light intensity level 2	Green	1 Hz	50:50
15	Failure in a safety component or logic that is connected to a bottom plug-in <sup>(2)</sup>	STS	Red	1 Hz	50:50	Regional light intensity level 1	Green	1 Hz	50:50

(1) The interpretation is first value on time, second value off time, for example, 10:90 means 10% on, 90% off.

(2) If there is a lockout, remove the lockout source. Lockout requires power recycling or adequate action (see [Table 57 on page 111](#)), [Manual Start/Restart on page 28](#), and [Optical Push Button on page 109](#).

(3) Error: If there is an error, remove the error source. For manual restart, activate the Restart button.

(4) Both regional light intensity status indicators showing steady green indicates OSSD Off test transient failures. This indication shows briefly when 2V DC (or >2V DC) is shorted to one of the OSSD lines for less than 1 second



**ATTENTION:** If you use automatic restart, the system starts immediately.

For fault conditions 0...13 and corrective actions, see [Table 57 on page 111](#).

Table 57 - Errors, Lockouts, and Corrections

Condition	Error Description	Action
0	Confirmation changed	See <a href="#">Confirmation of a New System Configuration on page 61</a> .
1	Internal lockout	<p>Make sure that the correct plug-in is inserted and that the DIP switch settings of the plug-in are in the correct position.</p> <p>One of the following methods clears the Lockout mode of a transmitter stick:</p> <ol style="list-style-type: none"> <li>1. Power down, then power up. If the fault is still present, the module lockout occurs again.</li> <li>2. A reset signal longer than 10 seconds and less than 20 seconds acts like a power-up.</li> <li>3. Press your finger on the optical push button longer than 10 seconds and less than 20 seconds (<a href="#">Optical Push Button on page 109</a>)</li> </ol> <p>If the fault persists, replace the 450L-B safety light curtain transceiver stick.</p> <p>Further diagnosis options are possible with the Connected Components Workbench™ software in combination with the USB/ optical interface device (OID; Cat No. 450L-AD-OID). If the 450L-B safety light curtain unit has a lockout, the exact fault description can be determined with these tools.</p>
2	EDM feedback signal at receiver plug-in not okay (external error)	<p>Short circuit between or to ground or over current at OSSDs</p> <ol style="list-style-type: none"> <li>1. Check wiring and function of external contactor</li> <li>2. Check connected relay for closed contact (if OSSD on-input Relay monitoring must have GND level, if OSSD off-input Relay monitoring must have +24V)</li> <li>3. Repower the system or use adequate action after the lockout source is removed.</li> </ol>
3	Start signal not okay	Check signal status and signal timing at receiver plug-in for the manual start
4	Ambient light can lead to short sporadic switch off the OSSD.	<p>Check system set-up and remove foreign ambient light source. Ambient light sources can be:</p> <ul style="list-style-type: none"> <li>• Strong flashing beacon</li> <li>• Infrared remote controls</li> <li>• Laser pointers</li> <li>• Infrared light sensors</li> </ul>
5	Short circuit between or to ground or over current at OSSDs	Check wiring and connected components at the two OSSDs
6	Error supply voltage	Check the 24V DC power supply to the stick
7	Voltage that is connected to transmitter plug-in input	Make sure DIP switch 4 is set to the default position (off). Make sure that the 24V DC voltage is not supplied to pin 4 of the Cat. No. 450L-APT-PW-5 part or voltage supply to pin 1 of the Cat. No. 450L-APT-PW-8 plug-in connector.
8	Stick identification mismatch when beam coding is used	Check design according to chapter: Beam coding on page 30
9	Invalid DIP switch setting	Confirm the DIP switch settings of the inserted plug-in, see <a href="#">Receiver Plug-in DIP Switch Settings on page 56</a>
10	Muting timing error (450L-E only)	Make sure that of the muting times are not above maximum or below minimum limits (see <a href="#">Muting on page 36</a> )
11	Muting sequence error (450L-E only)	Make sure that the connected muting sensors are interrupted in the right sequence (see <a href="#">Muting on page 36</a> )
12	Blanking error (450L-E only)	Make sure that beams of fixed blanked objects are always interrupted (see <a href="#">Teach-in Fixed Blanking on page 31</a> )
13	Cascading error (450L-E only)	Make sure that the OSSDs of the connected safety component do not exhibit an error (see <a href="#">Cascading on page 45</a> ).
14	System cannot be aligned	<p>Make sure that both edges are parallel and installed at the same level.</p> <p>Make sure that the transparent front cover is clean, no dust and is not scratched.</p> <p>Make sure that the distance between transmitter and receiver is above the minimum distance.</p> <p>Make sure that the distance between transmitter and receiver is below the maximum distance.</p> <p>Make sure that low operation range is not activated if operated above the maximum range of the low operation range function</p>
15	OSSD outputs switch off sporadically	<p>Check all hints of condition <a href="#">14</a> first</p> <p>Check that no ambient light from other sensors, the sun, or adjacent safety light curtain systems can impact the performance of a GuardShield safety light curtain system.</p> <p>Make sure that the power supply is adequate and the devices that are connected to the OSSD outputs are within the limits.</p> <p>Make sure that the GuardShield safety light curtain connection cables are not parallel to high-power supply cables of the application</p>

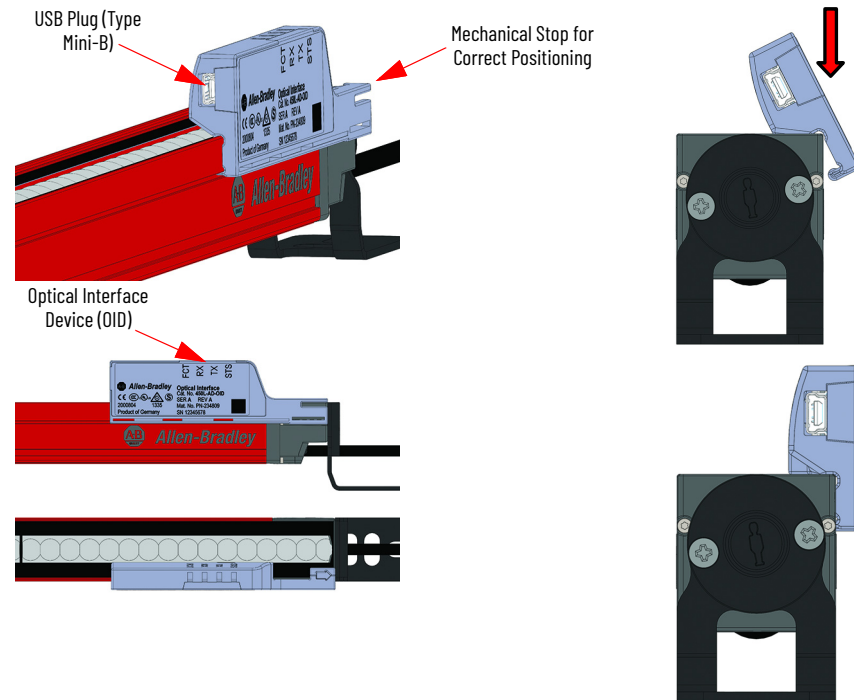
**IMPORTANT** Conditions 0...13 of [Table 56 on page 110](#) show the status indicator for condition numbers 0...13 in [Table 57](#).

## Optical Interface Device (OID)

More service information is available by using the optical interface device (catalog number 450L-AD-OID) and the Rockwell Automation Connected Components Workbench package. This device can snap onto a stick; you can use the device, for example, to visualize the protective field status if connected to a computer via a USB interface. The required Connected Components Workbench software is available from [rok.auto/ccw](http://rok.auto/ccw).

The initial release of the 450L PAC safety light curtain does not support the Connected Components Workbench software.

**Figure 85 - Optical Interface Device Snapped on a GuardShield Safety Light Curtain**



The Optical Interface Device (OID) has a USB interface for connection to a personal computer for diagnostic purposes. Use a standard USB A plug to USB Mini-B plug cable for connecting to the OID. The OID includes a USB (Type A <=> Type Mini-B) 1 m (3.28 ft) long connection cable (catalog number 2711C-CBL-UU02). Position the device correctly at the end of the protective field (2) above the status indicators to allow communication. First move the latch of the interface so that the latch touches the bottom of the end cap and rotate to snap the latch in.

You can use the OID when the safety light curtain mounts with the top/bottom and/or the side mounting kit. If there is a weld shield, remove the weld shield before you install the OID.

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**IMPORTANT** We continuously improve and expand the functionality of the GuardShield safety light curtain product line. Therefore, new firmware releases can be available. For diagnostic purposes, confirm that both sticks (Rx and Tx) and the OID operate with the latest available firmware revision.

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## Troubleshoot with Software

When the Connected Component Workbench connects to the GuardShield safety light curtain through the USB port with the Optical Interface Device, the diagnosis function displays the status of the connected stick. If there is an error, detailed diagnostic information of the corresponding stick is provided.

---

<b>IMPORTANT</b>	We continuously improve and expand the functionality of Connected Components Workbench software. Therefore, new software releases can be available. For diagnostic purposes, confirm that the Connected Components Workbench software and the OID operate with the latest firmware revision. Update the Connected Components Workbench software to the latest version.
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**Notes:**

## Safety Instructions



**LASER LIGHT CLASS 2 HAZARD:** Do not stare into the beam. The 450L-E and 450L PAC GuardShield™ safety light curtains are equipped with an integrated laser alignment aid (see [Laser Alignment on page 25](#)).

## Maintenance



**ATTENTION:** Never operate the 450L safety light curtain before you conduct the [Regular Inspection](#). Improper inspection can lead to serious, or even deadly, injury. Disconnect all power to the machine and safety system during electrical installation. Before you power up the 450L safety light curtain system, review the checklist:

- For safety reasons, record all inspection results.
- Only perform the inspection if you clearly understand the function of the 450L safety light curtain and the machine.

The installer, engineer, and operator must all have sufficient information available for the inspection.

## Regular Inspection

Perform the following inspection actions regularly, daily or according to the risk assessment.

1. You must pass through the GuardShield safety light curtain protective field to approach the hazardous machine parts.
2. You cannot step through the sensing area while working on dangerous machine parts.
3. The safety distance of the application is bigger than the calculated value.
4. The optic front cover is not scratched or dirty.

The inspection interval for [step 1](#)...[step 4](#) are:

- Daily or whenever the machine setting changes (electrical or mechanical).
- Whenever you replace a safety light curtain component (stick and/or plug-in).
- According to the requirements of local regulation or an application-specific standard.
- According to the inspection instruction and the risk assessment of the application.

Operate the machine and check if the hazardous movement stops under the following circumstances:

- You interrupt the protective field.
- If you place the test rod directly in front of the transmitter or receiver, or between the transmitter and receiver, and the protective field interrupts, the hazardous machine movement stops immediately (see [Figure 86](#)).
- There is no hazardous machine movement while the test rod is anywhere within the protective field.
- Confirm that there are no reflective surfaces within the calculated distance (see [Minimum Distance from Reflective Surfaces on page 68](#)).

Before you introduce the test rod, verify that the protective field is free. Both intensity status indicators are green at the stick that acts as the receiver (see [Figure 42 on page 70](#)). If the two intensity status indicators are not green, adjust the sticks until the intensity status indicators are green. Move the test rod through the protective field as indicated in [Figure 86](#). Use test rod catalog number 450L-AT-14 for the safety light curtain with finger resolution [14 mm (0.56 in.)] and test rod catalog number 450L-AT-30 for the safety light curtain with hand resolution [30 mm (1.19 in.)]. The catalog number of the test rod is printed on a label on each rod. The protective field must always interrupt:

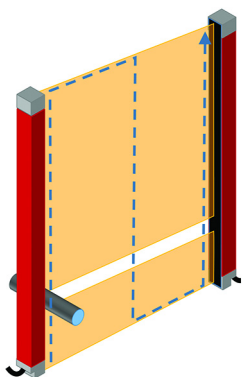
- If you place the test rod at any angle anywhere within the protective field (static).
- If you move the test rod (according to [Figure 86](#)) with the axis of the test rod normal to the plane of the detection zone, at any speed from 0...0.3 m/s (dynamic).

The interruption of the protective field displays at the status indicators. Verify that the minimum of one intensity status indicator (see [Figure 42 on page 70](#)) is off as long as the test rod is in the protective field. If both intensity status indicators are simultaneously green or flashing green during the static and dynamic testing, the resolution to operate the application is not fulfilled.



**ATTENTION:** If any of the previous conditions do not stop the hazardous motion of the machine or simultaneously lead to two green intensity status indicators (see [Figure 42 on page 70](#)), then do not place the machine into operation.

**Figure 86 - Proper Testing of Protective Field Using Test Rod**



**IMPORTANT**

If one you use or more mirrors (see [Mirrors on page 69](#)), inspect each protective field separately. Perform the movement of the test rod is directly in front of the mirrors.



Additionally, conduct a more detailed inspection:

- Whenever a machine setting changes.
- The local regulation or an application-specific standard requires an inspection.
- According to the inspection instruction and the risk assessment of the application.
- Frequently (for example, every 6 months).

A more detailed inspection must consider these actions:

- The machine stops or does not obstruct any safety function.
- The latest machine or connection modifications have no effect on the control system.
- The outputs of the GuardShield safety light curtain properly connect to the machine.
- The total response time of the machine is shorter than the calculated value.
- Cables and plugs of the GuardShield safety light curtain are in flawless condition.
- Mounting brackets, caps, and cables are tightly secured.
- Optical windows and components (mirrors or weld shields) are clean.

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**IMPORTANT** Document the test results, sign, and file them appropriately.

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## Verify 450L PAC

The 450L PAC is a Perimeter Access Control safety light curtain that is designed for whole body detection to create a safety perimeter around a machine or hazardous location. To verify correct operation, first place the machine or hazardous location in a safe state. Then interrupt the beams, refer to [Figure 2 on page 14](#) for the beam positions of different models. Confirm that the OSSD safety output switches to the off-state and remains off for as long as the beams are interrupted.

## Clean Optic Front Window

The effectiveness and the reliability of the safety light curtain system is reduced if the optic front window of the GuardShield safety light curtain is dirty. Regularly clean the window with a soft cloth and rub without pressure. Do not apply aggressive or abrasive agents, which can attack the surface.



**LASER LIGHT CLASS 2 HAZARD:** Do not stare into the beam. The 450L-E and 450L PAC GuardShield safety light curtains are equipped with an integrated laser alignment aid (see [Laser Alignment on page 25](#)).

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## Disposal

The GuardShield safety light curtain is designed according to the main environmental protection directives (for example, RoHS). Always dispose of unserviceable devices in compliance with local/national rules and regulations.

## Product Labels

The address that is printed on the stick and on the plug-in products and packaging labels refers to the Rockwell Automation global address. For the regional office addresses, see the listing on the back cover of this publication.

### Stick Labels

The following labels are for illustration only and are subject to change.

Figure 87 - Explanation of Date Code on a Stick (Printed Before November 2018)

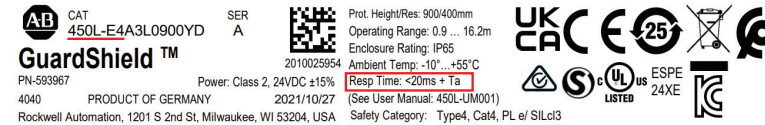


In [Figure 87](#), 1335 = year 2013, week: 35; the serial number for 450L-B is 1068700055 and 450L-E is 1068800055.

Figure 88 - 450L POC Transceiver Stick Label (Printed Since November 2018)



Figure 89 - 450L PAC Transceiver Stick Label (Printed Since September 2021)



In [Figure 88](#) and [Figure 89](#), the production date code format is yyyy/mm/dd.

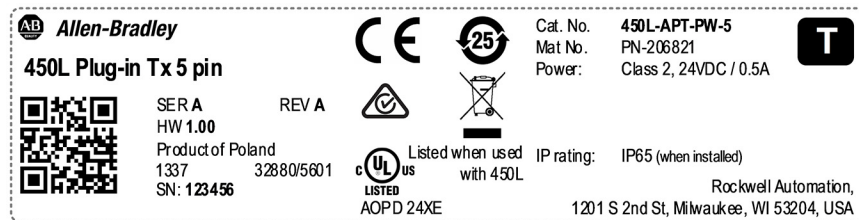
Figure 90 - 450L-E and 450L PAC Laser Warning Label



[Figure 90](#) is on the backside of the aluminum profile.

## Plug-in Label

### Figure 91 - Explanation of Date Code at a 450L Plug-in



In [Figure 91](#), 1337 = year 2013, week 37; the serial number is 123456.

A black square with a gray letter indicates the principle type of plug-in (see [Figure 91](#)), where:

- C = Cascading
- R = Receiver
- T = Transmitter
- U = Universal

**IMPORTANT** The catalog number is also printed on the plug-in housing, which is inside the transceiver stick.

**Notes:**

## Connected Components Workbench Software

### Overview

Use the Connected Components Workbench™ software to monitor the 450L POC safety light curtains and to configure the 450L-E safety light curtain. The 450L POC safety light curtain has two versions:

- 450L-B - basic on/off
- 450L-E - enhanced features

The Connected Components Workbench software can monitor and configure only the 450L-B version of the safety light curtain; the 450L-B safety light curtain does not have configurable parameters. Use the Connected Components Workbench software to do the following:

- Setup
  - Muting
  - Floating blanking
  - Reduced resolution
  - Fixed blanking
  - A combination of floating, reduced resolution, and fixed blanking
- Diagnostics
  - Know which beams are blanked or blocked
  - Review last 10 lockout codes
- Export the configuration to a file

The Connected Components Workbench software performs its function with the 450L-OID Optical Interface Device (OID). For more information on the OID, [Optical Interface Device \(OID\) on page 112](#).

The initial release of the 450L PAC safety light curtain does not support the Connected Components Workbench software.

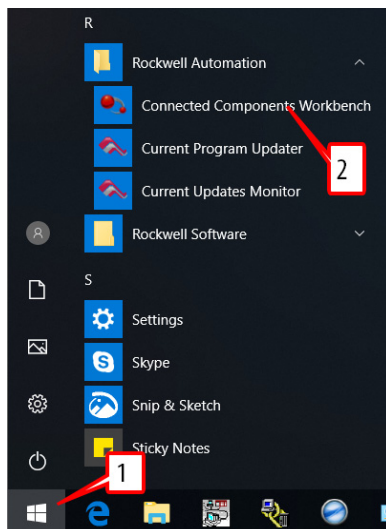
### Multiple Subconfigurations

This manual assumes that you have loaded the Connected Components Workbench software, version 12 or later.

### Start a New Project

The following example uses the Connected Components Workbench software (version 12) loaded onto a Windows® 10 environment.

1. Select the Start icon.
2. Scroll down to Rockwell Automation. Expand the list and select Connected Components Workbench.

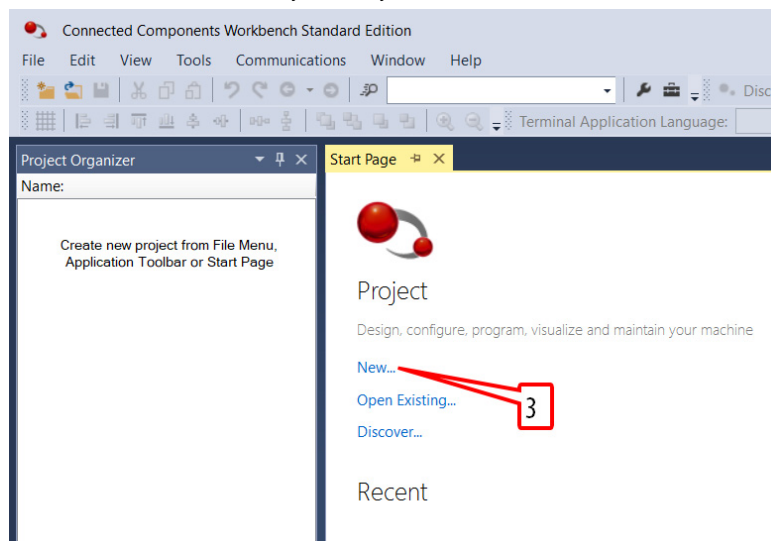


On the Connected Components Workbench Start page, you can:

- Create a project
- Open an existing project
- Open a recent project
- Open online training videos (requires an internet connection)

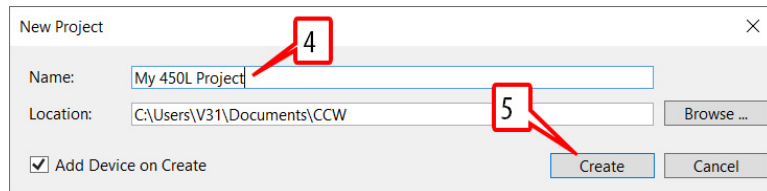
You can clear the Show page on the startup checkbox to bypass this page.

3. Start a new project three ways:
  - Select New... under the Project heading.
  - Select File in the main menu, then select New.
  - Press Ctrl-N on your keyboard.

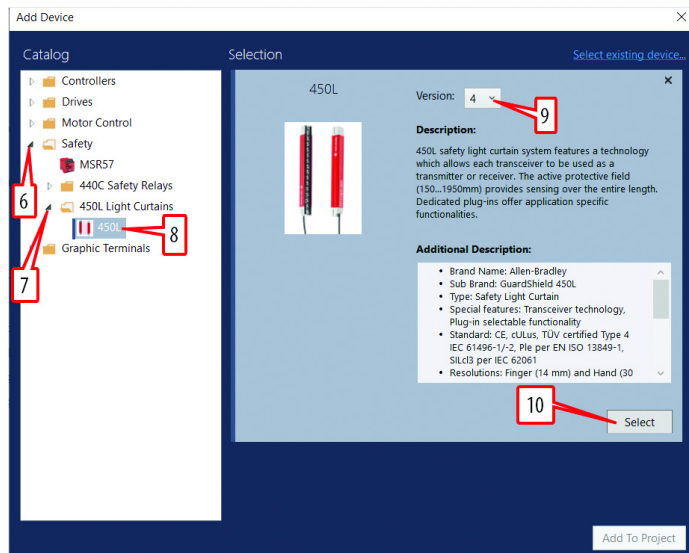


The Connected Components Workbench software maintains a list of projects to help prevent overwriting of an existing project. The name of each new project increments by one (for example, Project90). In the New Project window, you can customize the name and browse for a location for the file.

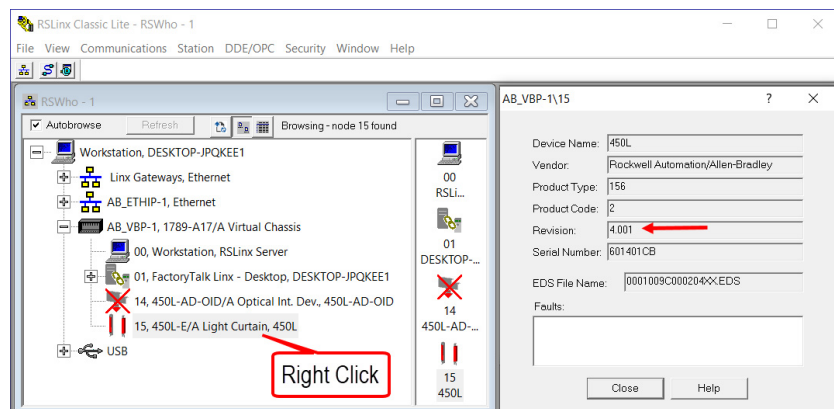
4. Type a new name, for example, My 450L Project.
5. Select Create.



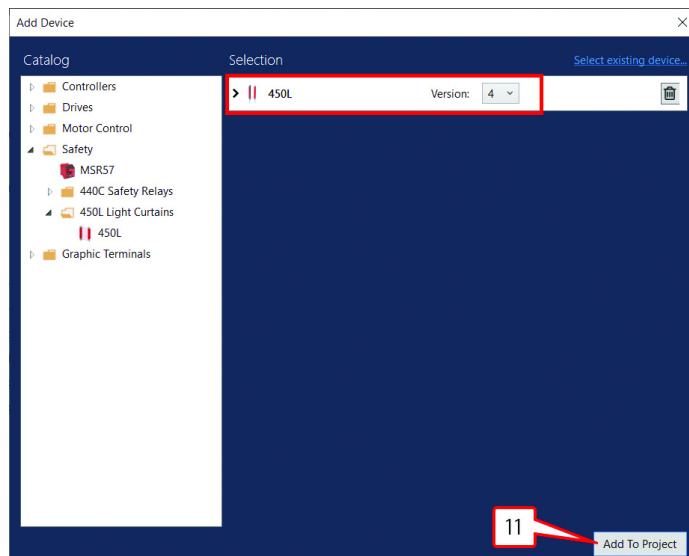
6. Expand the Safety listing.
7. Expand 450L Safety Light Curtains.
8. Select 450L.
9. Select the version number that matches the stick firmware.
10. Select the Select button.



To determine the current firmware revision of the safety light curtain, open the RSLinx® software, right-click 450L, and select Device Properties. An example is shown in the following image.



11. Verify that the selection and firmware revision are correct and select Add to Project.



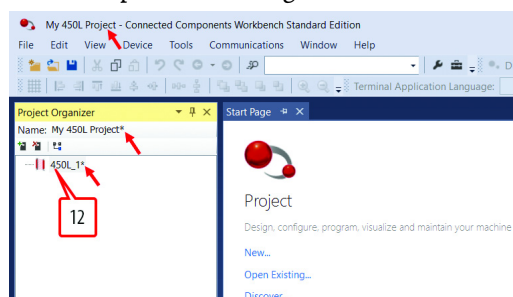
The project name appears in the title of the window and in the Project Organizer. In this example, the safety light curtain project name is My 450L Project.

The 450L safety light curtain appears in the Project Organizer with the default name 450L\_1. If desired, but not required, change the name of the safety controller. Select the name to change the name of the safety light curtain (or right-click and select Rename). The name that you choose must follow these rules:

- No special characters, except underscore
- No double underscore
- 1...32 characters

An asterisk appears after the controller name and project name to indicate that a valid project is not yet saved.

12. In the Project Organizer, double-click the device name or icon to open the product configuration tab.



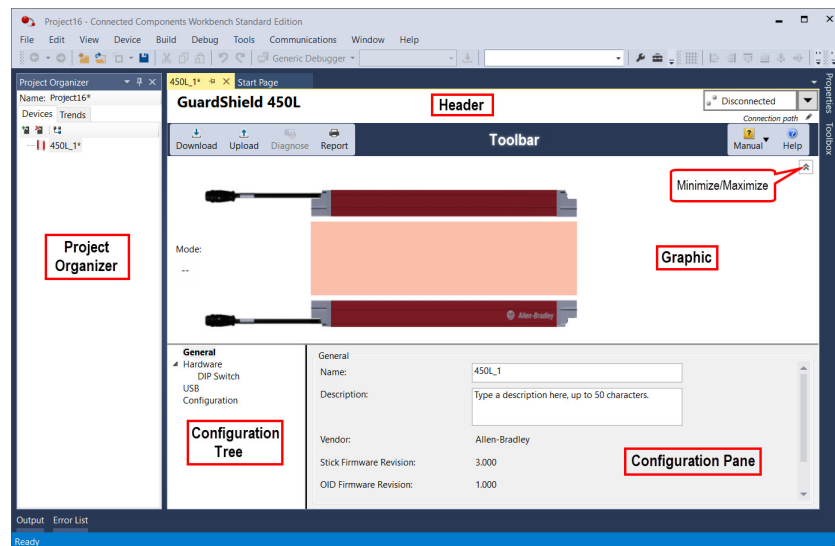


## Workbench Layout

Figure 92 shows the six major sections of the workbench layout:

- Project Organizer – shows all devices that the project contains.
- Header – shows the device identity and the connection information.
- Toolbar – shows the operations/commands for the 450L safety light curtain. The set of operations for 450L-B and 450L-E devices (DIP switch 1 = off) are: Diagnose, Report, Manual, Help. The set of operations for the 450L-E device (DIP switch 1=on) is: Download, Upload, Diagnose, Report, Manual, and Help.
- Graphic – shows a graphical representation of the safety light curtain device and the system mode status. You can minimize the graphic pane to expand the Configuration Pane and Diagnostic Information.
- Configuration Tree – provides the navigation to the configuration of a safety light curtain.
- Configuration Pane – sets the configuration details of the 450L-E safety light curtain. The content of this pane coincides with the selection in the Configuration Tree.

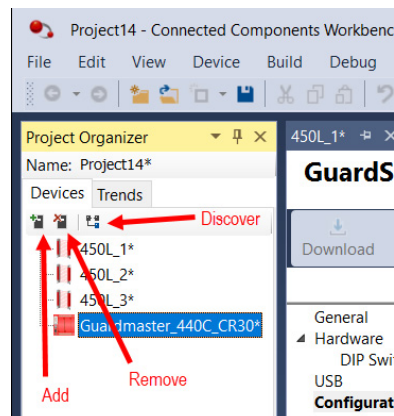
Figure 92 - Project Opened - Workbench Layout



## Project Organizer

Figure 93 shows an example with multiple devices that are used in the project. Select the icons in the Project Organizer add, remove, or discover devices.

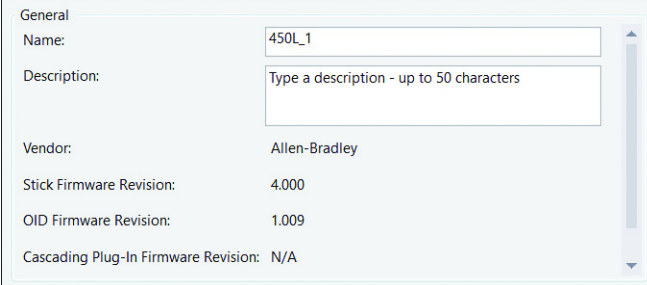
Figure 93 - Add, Remove, and Discover Devices



## General

[Figure 94](#) shows the General setup. The device is automatically assigned the name 450L\_1 and you can customize this name. You can also enter a 50-character description. This description shows the Vendor, Stick Firmware Revision, and OID Firmware Revision. If installed, the Cascading Plug-in Firmware Revision also appears.

**Figure 94 - General Setup**

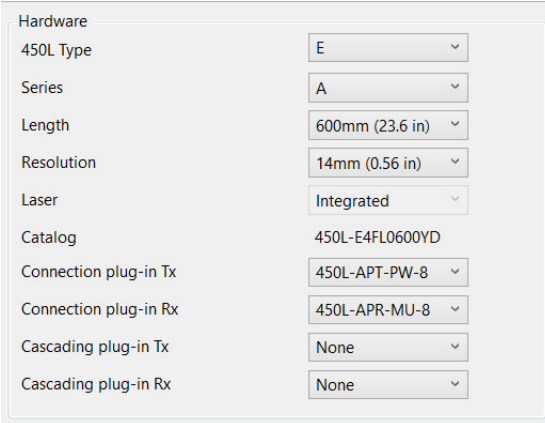


General	
Name:	450L_1
Description:	Type a description - up to 50 characters
Vendor:	Allen-Bradley
Stick Firmware Revision:	4.000
OID Firmware Revision:	1.009
Cascading Plug-In Firmware Revision:	N/A

## Hardware

[Figure 95](#) shows the hardware setup. Select the appropriate values to match the safety light curtain in use.

**Figure 95 - Hardware Setup**

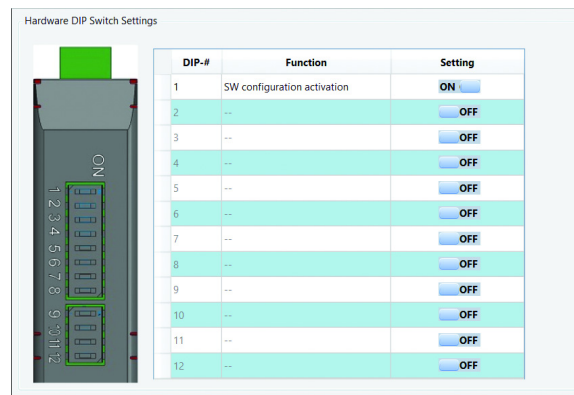


Hardware	
450L Type	E
Series	A
Length	600mm (23.6 in)
Resolution	14mm (0.56 in)
Laser	Integrated
Catalog	450L-E4FL0600YD
Connection plug-in Tx	450L-APT-PW-8
Connection plug-in Rx	450L-APR-MU-8
Cascading plug-in Tx	None
Cascading plug-in Rx	None

## DIP Switch

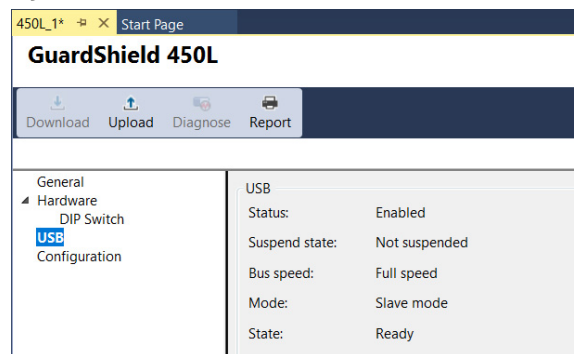
[Figure 96 on page 127](#) shows the hardware DIP switch settings for the connection plug-in. The graphic updates to match the actual switch settings when you make a connection to the device.

To use the Connected Components Workbench software to configure the 450L-E safety light curtains, switch 1 must ON and all other switches are OFF. If switch 1 is OFF, then the Connected Components Workbench software shows the status of the safety light curtain.

**Figure 96 - Hardware DIP Switch Settings**

## USB Status

[Figure 97](#) shows the status of the USB connection. The status is read-only.

**Figure 97 - USB Status**

## Subconfigurations

[Figure 98 on page 128](#) shows the subconfiguration setup. The subconfiguration setup is only available when the OID connects to a receiver; the transmitter does not require a configuration.

Key elements of subconfigurations include the following:

- With DIP switch 1 set to ON, you can create up to four subconfigurations.
- You can adjust the General, Muting, and Blanking settings for each sub-configuration.
- If you install a cascading plug-in, the Cascaded Safety Component automatically refreshes when a configuration uploads from the safety light curtain.
- The four configurations use the same GPIO.
- If DIP switch 1 is set back to 0, the configuration via the Connected Components Workbench software erases.

Figure 98 - Sub-Configuration Setup

Configuration

Number of sub-configurations: 1

Sub-Config 1 GPIO

General

General settings Enabled Settings

Muting

Muting Type: Disabled Settings

Blanking

Configuration Type: Disabled Settings

Cascaded Safety Component

Safety Component Disabled

General Settings

Figure 99 shows the default General Settings. The general settings apply to both the muting and blanking functions, if these functions are enabled. See Table 58 on page 129 for descriptions of each setting.

Figure 99 - General Settings

General settings

Start mode Automatic start

Start release Disabled

EDM enable Max. EDM reaction time Disabled ms

Operating range Long range

Beam coding Disabled

Interference rejection Length Resolution Disabled

External test enable Logic external test Disabled

Multiple scan Disabled

Short interruption ignore Short interruption ignore time Disabled ms

Minimum OSSD OFF Time 250 ms

OSSD threshold time ON threshold 500 ms

OFF threshold 250 ms

Laser switch off time 240 s

Configured response time 10 ms

Configured resolution 14 mm

OK Cancel Help

Table 58 - General Setting Descriptions


Setting	Description
Start mode	<p>Can only be selected for 8-pin Rx plug-in or for 5-pin Rx plug-in with I/O cascading plug-in. The selections are:</p> <ul style="list-style-type: none"> <li>Automatic start – If the safety light curtain is clear, the OSSD outputs turn on. This mode applies to power-up and after power-up.</li> <li>Power up Start Interlock – Upon power-up, the start must be pressed and released within a window of 50...5000 ms. After power-up, the OSSD output operates automatically.</li> <li>Manual Start – Upon power-up and after the OSSDs turn off, the start must be pressed and released within a window of 50...5000 ms. The OSSD outputs energize on the trailing edge of the start signal.</li> <li>Manual Start with Off Function – Upon power-up and after the OSSDs turn off, the start must be pressed and released within a window of 50...5000 ms. The OSSD outputs energize on the trailing edge of the start signal. The OSSD outputs can also be turned off with the start.</li> </ul>
Start release	<p>Start release function can be selected with either the 8-pin Rx plug-ins or the 5-pin plug-ins with an I/O plug-in. Start Release and EDM cannot be on simultaneously. When the safety light curtain is clear, the OSSD outputs energize on the leading edge of the start release input.</p>
EDM enable	<p>EDM function can only be selected with 8-pin Rx plug-ins. Start Release and EDM cannot be on simultaneously. The EDM input must change state within the selected time. If the EDM signal does not change state, the OSSD outputs de-energize and the safety light curtain is locked out; a lockout requires a power cycle to clear the fault.</p> <ul style="list-style-type: none"> <li>Min: 50 ms</li> <li>Max: 1275 ms</li> <li>Increment: 5 ms</li> <li>Default: 300 ms (when enabled)</li> </ul>
Operating range	Allows you to set the operating range to either long range (default) or short range.
Beam coding	Enables beam coding. Beam coding helps prevents interference from neighboring safety light curtains. The response time increases if beam coding is selected.
Interference rejection	<p>Enables interference rejection. Interference rejection is an enhancement to beam coding. In applications where enabling beam coding alone does not mitigate interference, the interference rejection feature can be enabled to alter the scan pattern to restrict stray light from a neighboring 450L-E safety light curtain from affecting operation. The response time increases if interference rejection is selected, however, configuration in the Connected Components Workbench software, as opposed to by DIP switch, refines the settings and maintains that the most appropriate scan pattern is used, which can be less than the response time derived for DIP switch configuration – refer to <a href="#">Table 18 on page 51</a> and <a href="#">Table 19 on page 52</a> for response times set by DIP switch or Connected Components Workbench software.</p>
External test enables	Enables an input to either turn the OSSD outputs on or off.
Multiple scans	<p>Defines whether the safety light curtain operates in a multiple scanning mode. When enabled, multiple scan modes only turn off OSSDs if there are at least three consecutive scans with an interruption. The normal mode of operation is the Double-scan, which turns off OSSDs if there is an interruption in at least two consecutive scans. This extra measure of resiliency against spurious trips adds an additional 33% (approximately) to the response time.</p>
Short interruption ignored	<p>You can define a filter time to ignore short interruptions of the safety light curtain.</p> <ul style="list-style-type: none"> <li>Min: 0 ms</li> <li>Max: 174 ms</li> <li>Increment: 2 ms</li> </ul> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  <p><b>ATTENTION:</b> A response set time longer than 90 ms can allow a person to walk through the safety light curtain undetected. Adjust safety distance/physical barriers accordingly.</p> </div>
OSSD threshold time	<p>You can define a filter time the OSSD outputs from changing too quickly. This function is applicable when the OSSD outputs are connected to electromechanical devices like relays and contactors, and the safety light curtain is set for automatic start. If the safety light curtain is broken and cleared more than twice within the off time, the OSSD outputs turn off during the on time. The on time must be equal to or greater than the off time.</p> <ul style="list-style-type: none"> <li>Min: 30 ms</li> <li>Max: 5000 ms</li> <li>Default: On 500 ms, off 250 ms</li> </ul>

Table 58 - General Setting Descriptions (Continued)

Setting	Description
Laser switch off time	If enabled, the laser turns off automatically after the selected time expires. <ul style="list-style-type: none"><li>• Min: 0 s</li><li>• Max: 255 s</li><li>• Increment: 1 s</li></ul>
Configured response time	The response time is automatically adjusted based on protective height, multiple scanning, beam coding, and short interruption ignore functions.
Configured resolution	The resolution is automatically adjusted when reduced resolution or floating blanking are configured.

GPIO

Figure 100 shows an overview of the layout of the General Purpose Input Output (GPIO) window. The window has three significant areas:

1. Connection plug-in
2. Cascading plug-in
3. Message box — informs you whether the mandatory GPIO is specified

You cannot download the configuration to the stick until the mandatory GPIO is complete. When complete, the message box has a green background.

Figure 100 - GPIO Overview

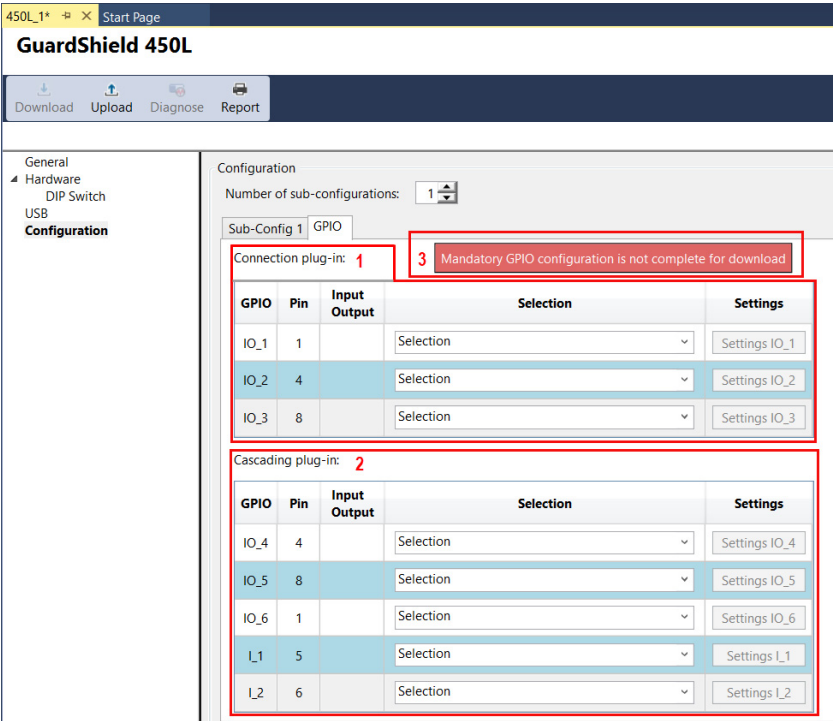


Figure 101 on page 131 shows an example of the GPIO selections. The Connected Components Workbench software automatically determines the available pins on the connection [1] and cascading [2] plug-ins. A message [3] displays to show whether mandatory configuration points are selected. When complete, the message background turns from red to green.

The subconfiguration setup automatically determines the available selections. This selection is a four-sensor muting example with two subconfigurations. The connection plug-in has three I/O and the cascading plug-in has three I/O (inputs or outputs) and two I (inputs).

The selection for IO\_1 shows seven mandatory inputs. Three of the mandatory inputs have white boxes. You must assign at least two of the three mandatory inputs to the connection plug-in. You can assign the third mandatory input to the connection or cascading plug-in. The four mandatory muting sensors are disabled as you can only assign these sensors on the cascading plug-in.

With eight potential I/O and seven mandatory inputs, you can use one of the I/O for the optional inputs or outputs.

**Figure 101 - GPIO Selection Settings**

Configuration

Number of sub-configurations: 2

Sub-Config 1 Sub-Config 2 GPIO

Connection plug-in: Mandatory GPIO configuration is not complete for download

GPIO	Pin	Input Output	Selection	Settings
IO_1	1		Selection	Settings IO_1
IO_2	4			Settings IO_2
IO_3	8		<input type="checkbox"/> Selection Mandatory inputs: <input type="checkbox"/> Activate sub-configuration 1 <input type="checkbox"/> Activate sub-configuration 2 <input type="checkbox"/> Mute dependent override input <input type="checkbox"/> Muting Sensor 1 <input type="checkbox"/> Muting Sensor 2 <input type="checkbox"/> Muting Sensor 3 <input type="checkbox"/> Muting Sensor 4	Settings IO_3
Cascading plug-in:				
GPIO	Pin	Input Output		Settings
IO_4	4			Settings IO_4
IO_5	8		Optional inputs: <input type="checkbox"/> Laser alignment ON/OFF	Settings IO_5
IO_6	1		Optional outputs: <input type="checkbox"/> Combined Status <input type="checkbox"/> Muting active <input type="checkbox"/> Muting error	Settings IO_6
I_1	5		Selection	Settings I_1
I_2	6		Selection	Settings I_2

Item	Description
1	Mandatory inputs
2	Mandatory muting sensors
3	Optional inputs or outputs

[Table 59 on page 132](#) lists the possible selections and their descriptions. The Connected Components Workbench software automatically determines the possible selection choices, depending on the hardware. See [Table 58 on page 129](#) for detailed descriptions of the selections.

Table 59 - GPIO Selections

I/O	Selection	Description
Input	Activate subconfiguration #	Activates this subconfiguration. Only one subconfiguration can be active. At least one subconfiguration must be active.
	External device monitoring	Monitors external devices that the safety light curtain OSSD outputs drive.
	Laser alignment on/off	Turns the integrated laser alignment function on and off.
	Manual (re)start	Input turns on the OSSD outputs if the safety light curtain is clear.
	Mute dependent override	Turns on the OSSD outputs if a muting error occurs and the safety light curtain is blocked.
	Muting sensor #	Indicates that a sensor is blocked.
	Start release	With the safety light curtain clear, the start release input turns on the OSSD outputs on the leading edge of the signal.
	Test input	Turns the OSSD outputs on or off, depending on the configuration.
Output	Combined status	Indicates that the logic applied to the combined status of the two parameters is satisfied.
	Muting active	Indicates when muting is active. The appropriate muting inputs (signals/sensors) go low within the T(sens) time and within the proper sequence.
	Muting error	Indicates when either a muting timing error or muting sequence error is present.
	Muting sequence error	Indicates that the muting inputs occurred in an incorrect order.
	Muting timing error	Indicates the T(sens) time or the T(espe) time are exceeded.
	Start	Indicates that the safety light curtain is waiting for the start input. After the OSSD outputs energize, the start output turns off.
	Status EDM/start release	Indicates the status of the EDM or start release input.
	Status error (lockout/external error)	Indicates that a lockout or external error has occurred.
	Status external error	Indicates that an external error has occurred.
	Status intensity (cascading end)	The intensity of one or more of the beams on the cascading half (top side) of the safety light curtain is below Good Intensity. This occurrence is reported as Diagnostic Parameter 3.14.
	Status intensity (connection end)	The intensity of one or more of the beams on the connection half (bottom side) of the safety light curtain is below Good Intensity. This occurrence is reported as Diagnostic Parameter 3.124.
	Status intensity (connection/cascading end)	The intensity of one or more of the beams on the connection half (bottom side) or the cascading side (top side) of the safety light curtain is below Good Intensity. This occurrence is reported as Diagnostic Parameter 3.12 and 3.14.
	Status lockout	Indicates that a lockout status has occurred.
	Status mutes dependent override	Indicates that the mute dependent override signal is active.
	Status OSSD outputs	Indicates the status of the OSSD outputs.
	Status helps protected field free	Indicates that the status of the whole helps the protected height (both the bottom side and the top side) of the safety light curtain.
	Status test input	Indicates the status of the test input.

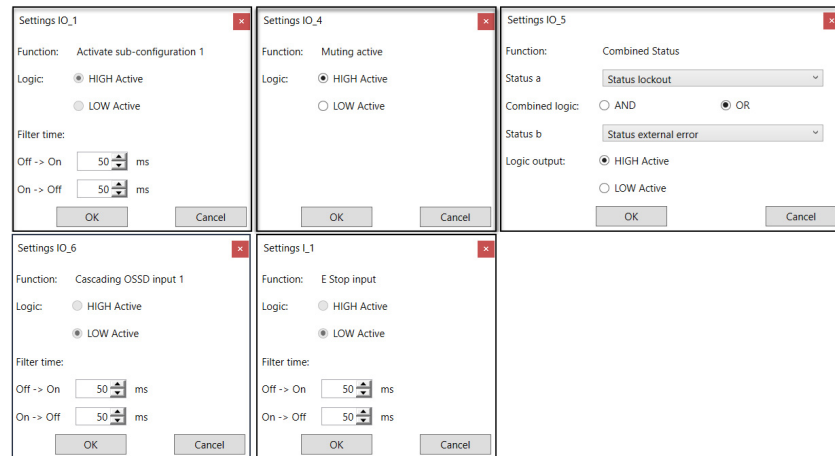
[Figure 102 on page 133](#) shows possible settings each of the I/O types. The Connected Components Workbench software automatically determines the allowable selections:

- You can assign many inputs High/Low logic and have adjustable filter times from 0...255 ms.
- Muting, Cascading OSSD and (Cascading) E-stop inputs have fixed logic at Low Active and cannot be changed.
- Cascading OSSD input filter times range from 3...255 ms.
- E-stop input filter times range from 4...255 ms.
- The outputs only have logic options.



The Combined Status output allows and/or logic to be applied to two selectable status outputs.

**Figure 102 - GPIO Selection Settings**

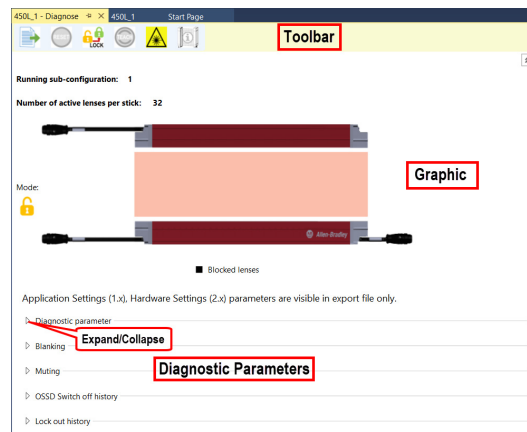


## Diagnose Window

[Figure 103](#) shows the Diagnose window layout. The Diagnose window is only available when the Connected Components Workbench software has a connection with the safety light curtain. This layout has three regions:

- Toolbar
- Graphic
- Diagnostic parameters

**Figure 103 - Diagnose Window Layout**



## Export

The Export creates a CSV file of the complete safety light curtain hardware setup and all available diagnostic data.

Before saving to a file, one dialog window that contains the default full name (path and file name) is shown. You can change the saving path or the saving name. After you press Save, the parameter information exports to the pointed folder. The default path and file name are:

- Default path: C:\Users\Current User\Documents\CCW\Project Name
- Default file name: Device Name + \_ + YYYYMMDD

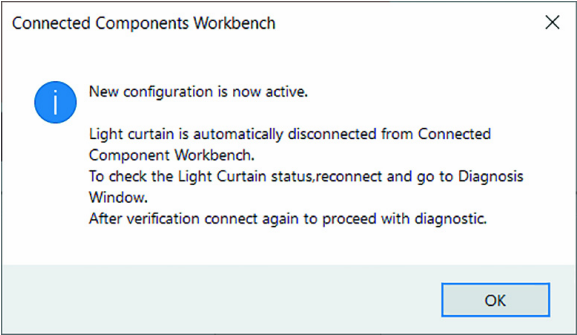
Reset

The Reset clears a safety light curtain that is locked out. After you resolve the lockout condition and press Reset, the safety light curtain powers off and then powers on. The stick disconnects from the Connected Components Workbench software because of this power off/on cycle.

Lock

Lock all new and changed configurations before Run mode. The Lock is enabled if the safety light curtain is in Unlocked mode and is disabled if the device system is in Run mode. The configuration active window in [Figure 104](#) appears after lock. The safety light curtain disconnects from the Connected Components Workbench software.

Figure 104 - Configuration Active



Mode

The Mode symbol provides a quick way to determine the operating status of the safety light curtain.

Symbol	Description	Explanation
	Error	Mouse over the icon for additional information.
	Run	The configuration is locked, and the safety light curtain is in Run mode.
	Unlocked	The safety light curtain configuration must be confirmed.
	Lock out	See the diagnostic 7.1. Upload and select Reset.

Teach

Teach only shows when the Connected Components Workbench software connects to a 450L-E safety light curtain. Teach only enables when:

- The connection plug-in is either catalog number 450L-APR-BL-5 or catalog number 450L-APR-MU-8,
- The stick status is Run mode after synchronization, and either:
  - DIP switch 1 is set to ON, and the Blanking Configuration Type is set to Push Button Teach-in, or
  - DIP switch 1 is set to OFF, and
    - Switch 5 is on when you use the catalog number 450L-APR-BL-5, or

- Switch 8 is off and switch 9 is on when you use the catalog number 450L-APR-MU-8.

You can also teach blanking in the Blanking Configuration window.

## Laser

The laser turns the Integrated Laser Alignment on and off. The Laser only shows when the Connected Components Workbench software connects to a 450L-E safety light curtain.

A confirmation window shows when the laser is turned on or off.

## Beam Status



The beam status provides a snapshot table of the status of each individual beam at each lens. The length of the table is equal to the number of lenses of the connected stick. An example of the beam status table is shown in [Figure 102 on page 133](#) and provides the following information:

- Connected stick is a Tx or an Rx
- Snapshot date
- Snapshot time
- Cascade number
- Lens number
- Beam status – Free or Blocked
- Beam intensity – Low, Med-Low, Med-High, High, N/A when the beam status is Blocked
- Blanking status – no blanking, fixed blanking, reduced resolution, or floating blanking
- Muting status – Free (not muted) or muting active

The export provides the option to export the data in a \*.CSV file:

- Default path: C:\Users\Current User\Documents\CCW\Project Name
- Default name: Device Name + \_ + BeamStatus + \_ + MMddyyyy + \_ + hhmmss

Blanking example – in [Figure 105 on page 136](#), lenses 1 and 2 are fixed blanking. Beams 3...14 are floating blanking, with beam 10 blocked. Beams 15...18 have no blanking. Beams 19...31 have reduced resolution and no beams are currently blocked. Finally, beam 32 has no blanking.

Figure 105 - Beams Status -Blanking Example

Connected Components Workbench

Snap shot beam status RX

Date (dd.mm.yyyy): 14.06.2019Time: 16:01:42

Cascade	Lens	Status	Intensity	Blanking	Muting
1	1	Blocked	N/A	Fixed Blanking	No
1	2	Blocked	N/A	Fixed Blanking	No
1	3	Free	High	Floating Blanking	No
1	4	Free	High	Floating Blanking	No
1	5	Free	High	Floating Blanking	No
1	6	Free	High	Floating Blanking	No
1	7	Free	High	Floating Blanking	No
1	8	Free	High	Floating Blanking	No
1	9	Free	High	Floating Blanking	No
1	10	Blocked	N/A	Floating Blanking	No
1	11	Free	High	Floating Blanking	No
1	12	Free	High	Floating Blanking	No
1	13	Free	High	Floating Blanking	No
1	14	Free	High	Floating Blanking	No
1	15	Free	High	No	No
1	16	Free	High	No	No
1	17	Free	High	No	No
1	18	Free	High	No	No
1	19	Free	High	Reduced Resolution One Object	No
1	20	Free	High	Reduced Resolution One Object	No
1	21	Free	High	Reduced Resolution One Object	No
1	22	Free	High	Reduced Resolution One Object	No
1	23	Free	High	Reduced Resolution One Object	No
1	24	Free	High	Reduced Resolution One Object	No
1	25	Free	High	Reduced Resolution One Object	No
1	26	Free	High	Reduced Resolution One Object	No
1	27	Free	High	Reduced Resolution One Object	No
1	28	Free	High	Reduced Resolution One Object	No
1	29	Free	High	Reduced Resolution One Object	No
1	30	Free	High	Reduced Resolution One Object	No
1	31	Free	High	Reduced Resolution One Object	No
1	32	Free	High	No	No

ExportCancel

Two-sensor Muting Schematic Example

Figure 106 on page 137 shows an example wiring diagram for two-sensor muting. The muting sensors connect to pins 1 and 4 of the connection plug-in. If you do not use the Connected Components Workbench software, the connections of the muting sensors must be as shown in the schematic. If you do use the Connected Components Workbench software, the muting sensors can connect in any of the muting wires and then configured in the Connected Components Workbench software.

Figure 106 - Example Schematic for Two Sensor Muting

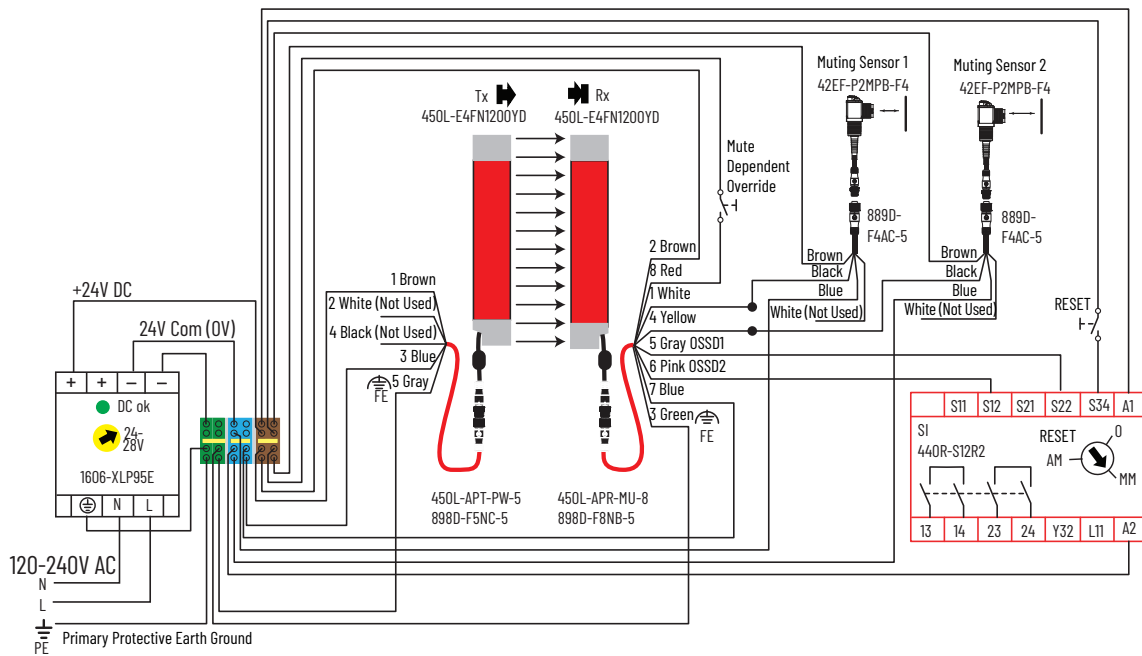


Figure 108 - Select Muting Type

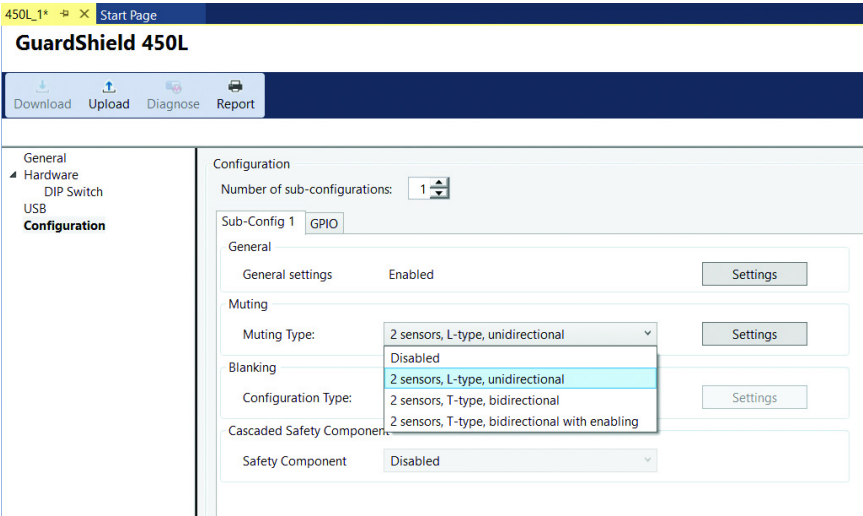


Figure 109 shows the two-sensor muting settings. These settings apply to all three types of two-sensor muting. Table 60 on page 139 describes the settings. Select the values appropriate for the application.

Figure 109 - Muting Settings

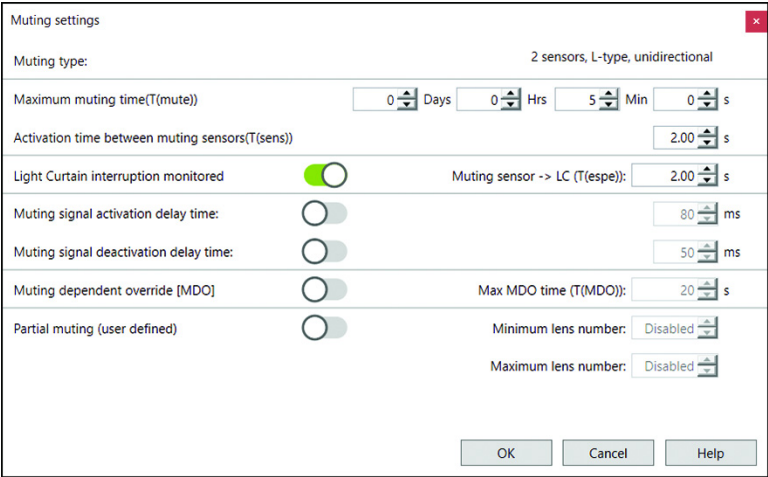


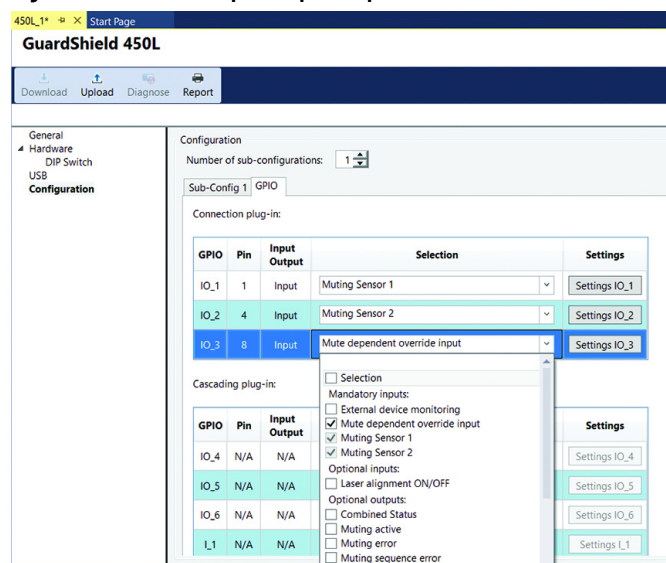
Table 60 - Muting Parameters

Parameter	Description
Muting type	This parameter is a read-only field, setup by the Configuration tab.
Maximum muting time	This parameter is the maximum time that the material can occupy the safety light curtain. If the time is exceeded, the OSSD outputs turn off and the object can be cleared by using the Mute Dependent Override.
Activation time between muting sensors T(sens)	Specifies the maximum time between sensors. This maximum is the time in which the object must block both sensors. If the time is exceeded, the muting timing error becomes active and the safety light curtain is not muted.
Safety light curtain interruption monitored T(espe)	If set to off, the time from the start of muting to when the object blocks the safety light curtain is not used in the muting sequence. If set to on, specify the time that the safety light curtain must be interrupted after the muting state has been achieved. If the time is exceeded, the OSSD outputs turn off.
Muting signal activation delay time	Specifies a delay before muting becomes activate. <ul style="list-style-type: none"> <li>Max setting: 2550 ms</li> <li>Default setting: 80 ms</li> <li>Min setting: 1 ms</li> </ul>
Muting signal deactivation delay time	Specifies a delay before muting becomes de-activated. <ul style="list-style-type: none"> <li>Max setting: 2550 ms</li> <li>Default setting: 50 ms</li> <li>Min setting: 0 ms</li> <li>Increment: 10 ms</li> </ul>
Muting dependent override (MDO)	Specifies the duration of the muting dependent override signal. Use this function to force the OSSD outputs on after a muting error has occurred. The override signal becomes active on the trailing edge. <ul style="list-style-type: none"> <li>Max setting: 1275 s</li> <li>Min setting: 0 ms</li> <li>Increment: 10 ms</li> </ul>
Partial muting (user defined)	The safety light curtain can be configured to allow muting of a specified number of lenses. Specify the first lens and last lenses to mute. If the other lenses are blocked, the OSSD outputs turn off.

## GPIO Selection and Settings

[Figure 110](#) shows the GPIO tab. Select GPIO and select the function of the three inputs. Two of the inputs must be the muting sensors. A likely choice for the third input is a mute dependent override function.

Figure 110 - General Purpose Input Output Selection



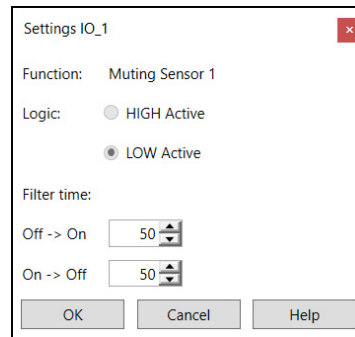
Select Settings IO\_x to set Logic and Filter times. [Figure 111 on page 140](#) shows the options for the GPIO settings.

The Logic function for muting the sensor is fixed at LOW Active. When an object passes in front of the sensor, the sensor output turns off.

Adjust the filter times to help prevent inadvertent changes from the sensor output from disrupting the muting process. You can adjust the filter times from 0...255 ms.

Select OK after adjustments are made.

**Figure 111 - General Purpose Input Output Selection**



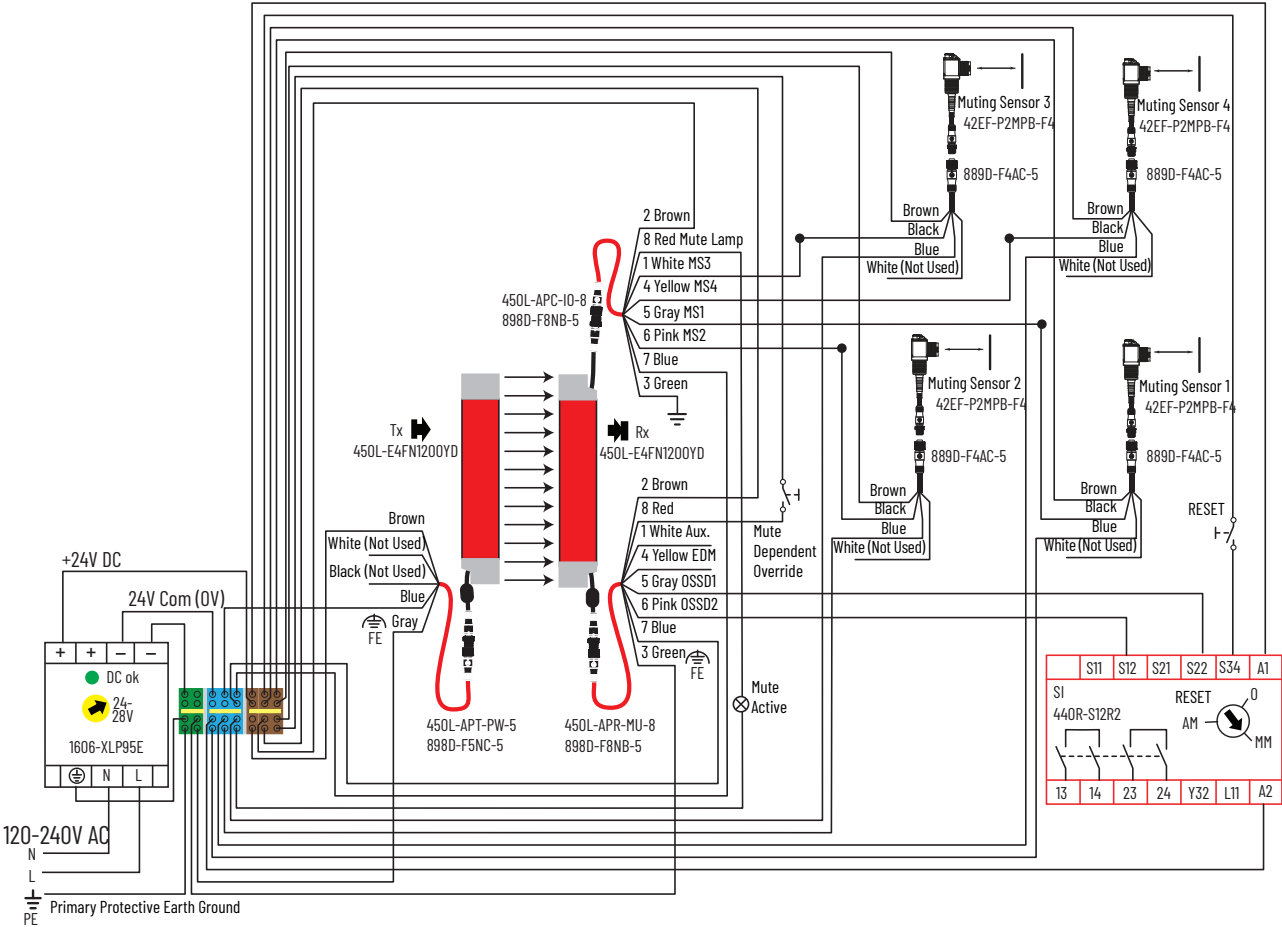
Proceed to [Download and Upload Configurations on page 160](#).

## Four-sensor Muting Schematic Example

[Figure 112 on page 141](#) shows an example wiring diagram for four-sensor muting. The muting sensors connect to the cascading plug-in. If you do not use the Connected Components Workbench software, the connections of the muting sensors must be as shown in the schematic. If you do use the Connected Components Workbench software, the muting sensors can connect in any of the muting wires and then configured in the Connected Components Workbench software.



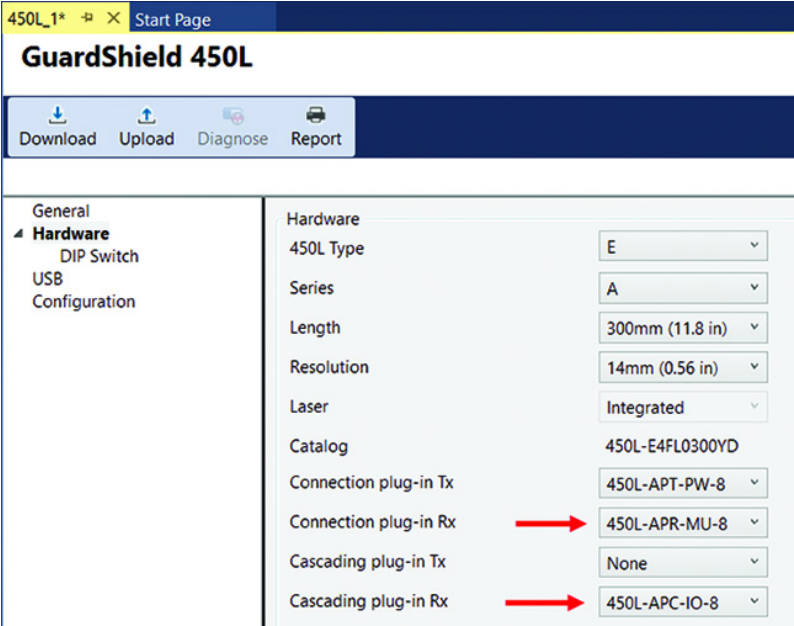
Figure 112 - Example Schematic for Four Sensor Muting



Hardware

Figure 113 shows the hardware settings for four-sensor muting. The receiver stick requires the muting connection plug-in and the cascading plug-in. When you select both plug-ins, the Connected Components Workbench software allows you to select four-sensor muting.

Figure 113 - Hardware Settings for Four Sensor Muting



Muting Type and Settings

Figure 114 shows the Configuration window. There is only one type of four-sensor muting. Select four sensors, T-type, bidirectional as the muting type. Select Settings to adjust the muting time parameters.

Figure 114 - Muting Type with Four Sensors

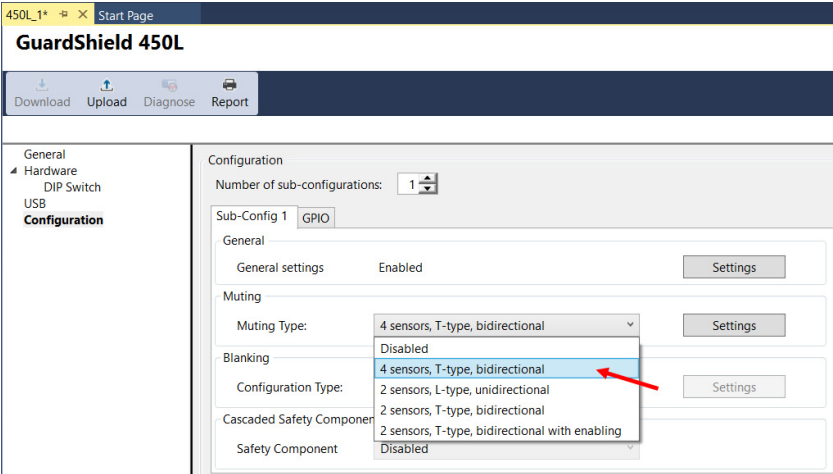


Figure 115 on page 143 shows the four-sensor muting settings. Table 61 on page 143 describes the muting settings. Select the values appropriate for the application.

**Figure 115 - Muting Settings**
**Table 61 - Muting Settings**

Setting	Description
Muting type	This setting is a read-only field, setup by the Configuration tab.
Maximum muting time	This setting is the maximum time that the material can occupy the safety light curtain.
Activation time between muting sensors T(sens)	Specifies the maximum muting time between sensors. This setting is the time in which the object must block both sensors on either side of the safety light curtain. If the time is exceeded, the muting timing error becomes active, and the light is not be muted. If the object then blocks the second sensor, the muting sequence error becomes active. The object must be removed from the sensors.
Safety light curtain interruption monitored T(espe)	If set to off, the time from the start of muting to when the object blocks the safety light curtain is not used in the muting sequence. If set to on, specify the time that the safety light curtain must be interrupted after muting starts. If the time is exceeded, the OSSD outputs turn off.
Muting signal activation delay time	Specifies a delay before muting becomes activated. <ul style="list-style-type: none"> <li>• Max setting: 2550 ms</li> <li>• Default setting: 80 ms</li> <li>• Min setting: 0 ms</li> </ul>
Muting signal deactivation delay time	Specifies a delay before muting becomes de-activated. <ul style="list-style-type: none"> <li>• Max setting: 2550 ms</li> <li>• Default setting: 50 ms</li> <li>• Min setting: 0 ms</li> </ul>
Muting dependent override (MDO)	Specifies the duration of the muting dependent override signal. Use this function to force the OSSD outputs on after a muting error has occurred. The override signal becomes active on the trailing edge. <ul style="list-style-type: none"> <li>• Max setting: 1275 s</li> <li>• Min setting: 0 s</li> </ul>
Partial muting (user defined)	The light can be configured to allow muting to a specified number of lenses. Specify the first lens and last lenses that are muted. If the other lenses are blocked, the OSSD outputs turn off.

## GPIO Selection and Settings

Once you establish the muting settings, set the General Purpose Input and Output (GPIO). Select the GPIO tab.

[Figure 116 on page 144](#) highlights three sections of the GPIO settings:

1. The connection plug-in has three wiring connections that you can use as input or output. The I/O are available on connector pins 1, 4, and 8.
2. The cascading plug-in has five wiring connections. You can use three as input or output, and two as inputs. The I/O are available on connector pins 4, 8, 1, 5, and 6.

- 3. Initially, a red message box (Mandatory GPIO configuration is not complete for download) appears. After you make the proper mandatory selections, the message turns green.

Figure 116 - GPIO Overview

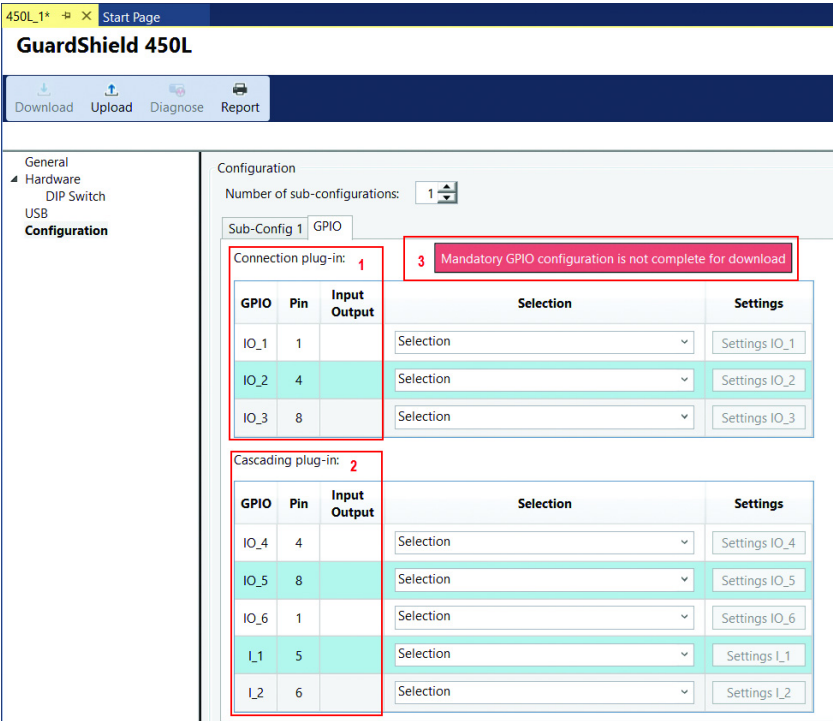


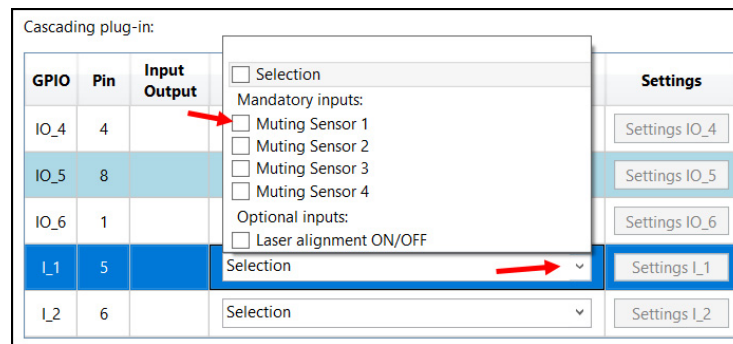
Figure 62 lists the I/O from the example schematic in Figure 112 on page 141. There are five inputs on the cascading plug-in and one output on the connection plug-in.

Table 62 - Muting I/O

Plug-in	I/O	Function	Pin
Cascading	Input	Muting sensor 1	5
		Muting sensor 2	6
		Muting sensor 3	1
		Muting sensor 4	4
	Output	Muting lamp	8
Connection	Input	Muting override	8
	Output	Mute timing error	1
		Mute sequence error	4

Figure 117 on page 145 shows the settings. Expand the Selection menu for the cascading plug-in pin 5. The four muting sensors appear as mandatory inputs. Check Muting Sensor 1, as this sensor connects to pin 5.

Figure 117 - Select I/O for Pin 5



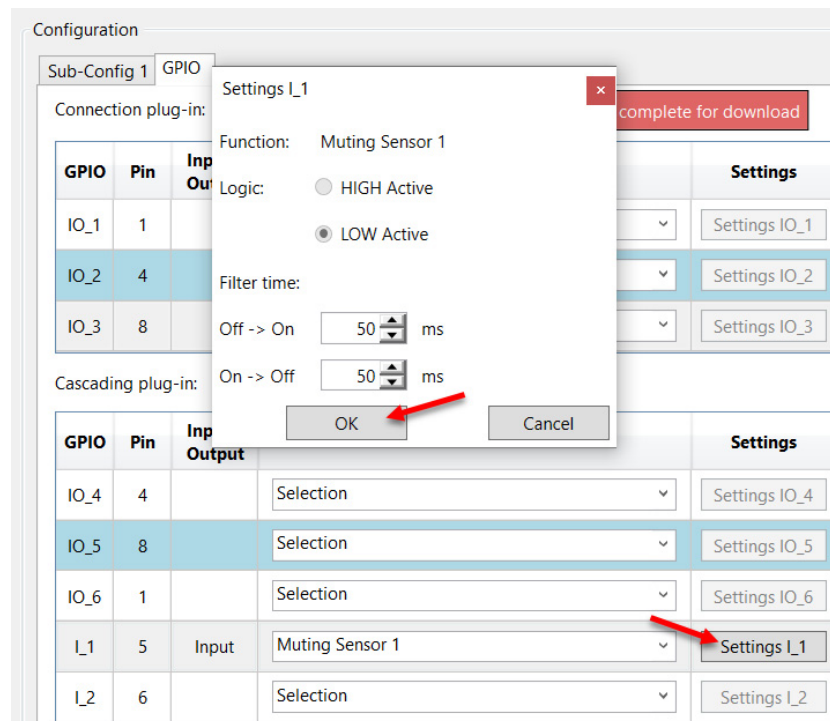
Select Settings L\_1. [Figure 118](#) shows the sensor settings to adjust the sensor logic and filter times.

The Logic function for muting the sensor is fixed at LOW Active. When an object passes in front of the sensor, the sensor output turns off.

Adjust the filter times to help prevent inadvertent changes from the sensor output from disrupting the muting process. You can adjust the filter times from 0...255 ms.

Select OK after adjustments are complete.

Figure 118 - Muting Sensor Settings



[Figure 119 on page 146](#) shows the final GPIO settings to meet the example schematic. The mandatory GPIO message box is green.

Figure 119 - Final GPIO Muting Settings

Configuration

Sub-Config 1 GPIO

Connection plug-in: Mandatory GPIO configuration complete for download

GPIO	Pin	Input Output	Selection	Settings
IO_1	1		Selection	Settings IO_1
IO_2	4		Selection	Settings IO_2
IO_3	8	Input	Mute dependent override input	Settings IO_3

Cascading plug-in:

GPIO	Pin	Input Output	Selection	Settings
IO_4	4	Input	Muting Sensor 3	Settings IO_4
IO_5	8	Input	Muting Sensor 4	Settings IO_5
IO_6	1	Output	Muting active	Settings IO_6
I_1	5	Input	Muting Sensor 1	Settings I_1
I_2	6	Input	Muting Sensor 2	Settings I_2

Proceed to [Download and Upload Configurations on page 160](#).

Blanking Overview

To use the blanking features, the transceiver must have either of these plug-ins:

- Catalog number 450L-APR-MU-8 – the muting/blanking plug-in
- Catalog number 450L-APR-BL-5 – the blanking plug-in

The 450L-E safety light curtain has three types of blanking:

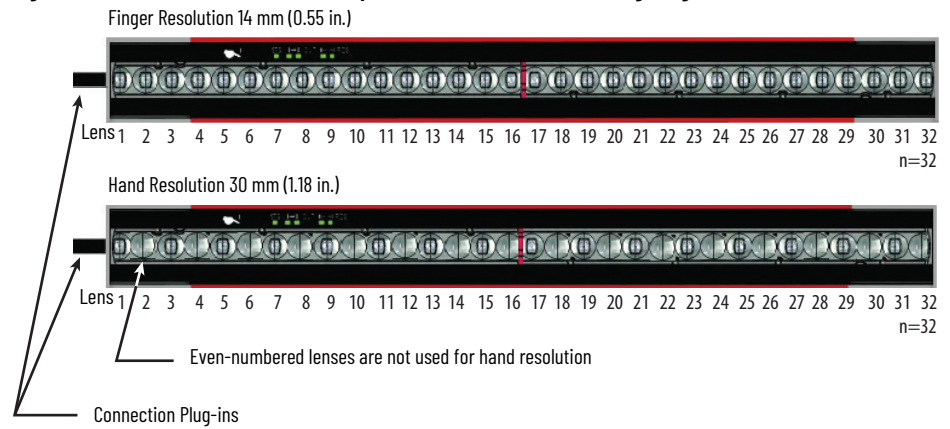
- Fixed blanking
- Floating blanking
- Reduced resolution blanking

Lens identification and zones help with the implementation of blanking.

Lens Identification

[Figure 120 on page 147](#) shows an example of the identification of the lenses for both finger and hand resolution for a safety light curtain that has a 300 mm (11.81 in.) height. Notice the following:

- Lens 1 is the lens closest to the connection plug-in (not the cascading plug-in). This arrangement is especially important for the hand resolution as lens (n) is not used.
- Both resolutions have the name number of lenses.
- The even-numbered lenses of hand resolution are not used; the lens ‘n’ is not used.
- The 450L safety light curtain transceivers are built on 16 lens segments; the number of lenses (n) is a multiple of 16.

**Figure 120 - Lens Identification Example - 300 mm (11.8 in.) Sensing Height**

## Zones

A zone is a range of lenses in the transceivers that are blanked with specific conditions. You can specify a maximum of eight zones. Use the zones in order and do not skip. Use the lenses in order, but you can skip lenses. Each zone can be:

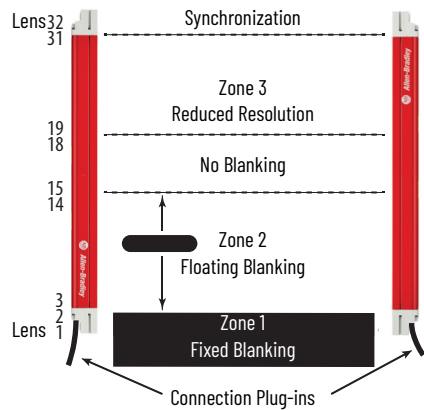
- Fixed blanking
- Floating blanking
- Reduced resolution blanking

The following rules apply to zone specification:

- Zone definition begins with the lowest lens; the lens closest to the connection plug-in.
- Zones cannot overlap.
- Each zone must be a contiguous set of lenses.
- Each zone can be either fixed, floating, or reduced resolution.
- A non-blanking area is allowed between zones or at either end of the transceiver. This area is not considered a zone.
- Non-blanked areas can be assigned either:
  - Normal operation
  - Reduced resolution one object
  - Reduced resolution two objects
- You can only block one of the synchronizations (either at the top or the bottom, but not both top and bottom).

[Figure 121 on page 148](#) shows an example with a finger resolution safety light curtain. Zone 1 applies fixed blanking (object always present and remains stationary) between lens 1 and 2. Zone 2 applies floating blanking (the object can move but must always be present) between lens 3 and 14. Zone 3 applies reduced resolution between lens 19 and 30. Lenses 31 and 32 are used for synchronization, and normal operation (finger resolution) applies. The area from lens 15...18 is also normal operation (finger resolution).

Figure 121 - Three-zone Blanking Example - Finger Resolution



Blanking settings

Reset Zone 1 to Zone 8 Teach blanking zones

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5 Zone 6 Zone 7 Zone 8

Blanking type: Fixed Blanking

Zone defined from

minimum lens number 1

to maximum lens number 2

Object monitoring Enabled

Object size tolerance -1

Type of protection for regions outside blanked zones 1..8:

Normal operation

**RULES**

- Lens number counts from connection plug-in end.
- Max lens are calculated based on stick length, neglect whether the light curtain is finger/hand resolution.
- Zones could not be skipped.
- Object size >= Object tolerance size.

Apply the configuration would require a Light Curtain power cycle. Reconnect the OID from CCW accordingly.

OK Cancel Help

Blanking settings

Reset Zone 2 to Zone 8 Teach blanking zones

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5 Zone 6 Zone 7 Zone 8

Blanking type: Floating Blanking

Zone defined from

minimum lens number 3

to maximum lens number 14

Object monitoring Enabled

Object size 2

Object size tolerance -1

Type of protection for regions outside blanked zones 1..8:

Normal operation

**RULES**

- Lens number counts from connection plug-in end.
- Max lens are calculated based on stick length, neglect whether the light curtain is finger/hand resolution.
- Zones could not be skipped.
- Object size >= Object tolerance size.

Apply the configuration would require a Light Curtain power cycle. Reconnect the OID from CCW accordingly.

OK Cancel Help

Blanking settings

Reset Zone 3 to Zone 8 Teach blanking zones

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5 Zone 6 Zone 7 Zone 8

Blanking type: Reduced Resolution

Zone defined from

minimum lens number 19

to maximum lens number 31

Object monitoring Disabled

Number of object Single Object

Maximum Object size 1

Type of protection for regions outside blanked zones 1..8:

Normal operation

**RULES**

- Lens number counts from connection plug-in end.
- Max lens are calculated based on stick length, neglect whether the light curtain is finger/hand resolution.
- Zones could not be skipped.
- Object size >= Object tolerance size.

Apply the configuration would require a Light Curtain power cycle. Reconnect the OID from CCW accordingly.

OK Cancel Help



## Configuration Options

On the configuration window, you can select three blanking types when the Connected Components Workbench software is disconnected from the safety light curtain:

- Disable – blanking is not used
- Software configuration – configure for fixed, floating, or reduced resolution
- Push button Teach-in – use the Teach command button on the Diagnose window

## Fixed Blanking

A fixed blanking zone is a set of lenses that are configured to always expect an object to block the beams. The beams must always be blocked. A fixed zone that becomes unblocked causes the OSSD outputs of the safety light curtain receiver to turn off.

The 450L-E safety light curtain accommodates changes in the set of lenses that can be blocked; this change is the object tolerance. You can set the object tolerance to zero (no lens tolerance) or to a negative number. The fixed blanking range can only be smaller by the tolerance number. A positive shift in the object size or location causes the OSSD outputs to turn off.

The 450L-E safety light curtain uses the first or last beams for synchronization. If the first beam is blocked, then the last beam cannot be blocked. In contrast, if the last beam is blocked then the first beam cannot be blocked.

## Settings

[Figure 122](#) shows the settings for fixed blanking for Zone 1. You can configure up to eight zones for fixed blanking or other types of blanking. The teach blanking zones is enabled for fixed blanking. [Table 63 on page 150](#) describes the blanking settings. Select the values appropriate for the application.

Reset Zone 1 to Zone 8 – select to clear the settings of the specified zones. The specified zones are a range from the selected zone to Zone 8.

**Figure 122 - Fixed Blanking Settings**

Blanking settings

Reset Zone 1 to Zone 8 Teach blanking zones

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5 Zone 6 Zone 7 Zone 8

Blanking type: Fixed Blanking

Zone defined from

minimum lens number 1

to maximum lens number 5

Object monitoring Enabled

Object size tolerance -2

Type of protection for regions outside blanked zones 1..8:

Normal operation

**RULES**

- Lens number counts from connection plug-in end.
- Max lens are calculated base on lens, neglect whether the light curtain is finger/hand resolution.
- Zones could not be skipped.
- Object size >= Object tolerance size.

Apply the configuration would require a Light Curtain power cycle. Reconnect the OID from CCW accordingly.

OK Cancel

Table 63 - Fixed Blanking Settings

Setting	Description
Blanking type	Select Fixed Blanking.
Minimum lens number	This number is the first lens, closest to the connection plug-in that participates in the range of lenses.
Maximum lens number	This number is the last lens that participates in the range of lenses.
Object monitoring	Always enabled for fixed blanking.
Object size tolerance	The safety light curtain allows the object size to be smaller by 0, 1, or 2 lenses for finger resolution and 0 or 1 (where 1 = 2 lenses) for hand resolution. Select the number of lenses that accommodate the variation in the fixed object height and location.
Outside blanked zones	Select normal operation, reduced resolution one object, or reduced resolution two objects for the other zones.

## Fixed Blanking Rules

[Table 64](#) shows the rules for fixed blanking within a zone. The Connected Components Workbench software automatically enforces these blanking rules. Since the transceiver sticks are synchronized with either the first or last lens, only one end of the stick can be blocked (not both ends).

Table 64 - Fixed Blanking Rules

Resolution [mm (in.)]	Object Size Tolerance	Include/Exclude Lens 1	Min Lens Value	Max Lens Value	Rules
Finger (14 [0.55])	0	Include	1	2,3,4...n-1	Since lens 1 is blanked, the last lens cannot be blanked. Max lens must be greater than min lens.
		Exclude	3,4,5...n	4,5,6...n	Since lens 1 is not blanked, lens 2 cannot be blanked. Max lens must be greater than min lens. Special case: Min lens and max lens can be n simultaneously.
	-1	Include	1	2,3,4...n-1	Since lens 1 is blocked, the last lens cannot be blocked. Max lens must be greater than min lens.
		Exclude	3,4,5...n	4,5,6...n	Max lens must be greater than min lens. Special case: Min lens and max lens can be n simultaneously.
	-2	Include	1	5,6,7...n-1	Since lens 1 is blanked, the last lens cannot be blanked. Max lens must be greater than min lens by a value of 4.
		Exclude	3,4,5...n-3	6,7,8...n	Since lens 1 is not blanked, Lens 2 cannot be blanked. Max lens must be greater than min lens by a value of 3.
Hand (30 [1.18])	0	Include	1	3,5,7...n-1	Since lens 1 is blanked, the last lens cannot be blanked. Max lens must be an odd number and greater than the min value.
		Exclude	4,6,8...n	5,7,9...n-1	Min lens must be an even number equal to or greater than 4. Max lens must be an odd number greater than the min lens.
	-1	Include	1	3,5,7...n-3	Since lens 1 is blocked, the last lens cannot be blocked. Max lens must be an odd number greater than min lens.
		Exclude	4,6,8...n-2	7,9...n-1	Min lens must be an even number equal to or greater than 4. Max lens must be an odd number greater than the min lens by a value equal to or greater than 3. Special case: Min lens and max lens can be n simultaneously.

Proceed to [Download and Upload Configurations on page 160](#).

## Teach Blanking Zones

The Connected Components Workbench software can learn new arrangements of fixed blanking. To learn new arrangements, the software reads the beams, stores the new setting in a project, and then transfers the new settings down to the safety light curtain. Follow this process.

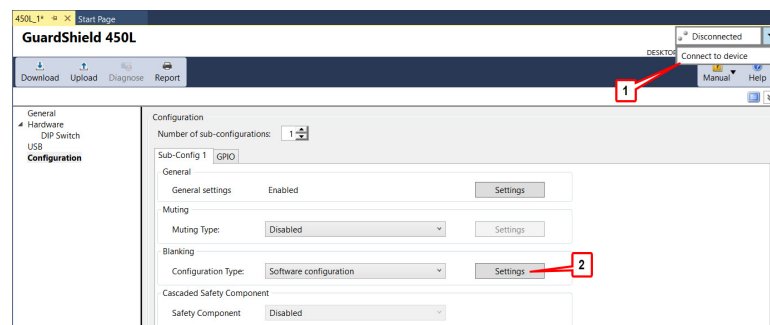
1. Arrange the fixed object within the safety light curtain field.
2. Connect the Connected Components Workbench software to the safety light curtain.

3. Teach the Connected Components Workbench software the new settings.
4. Download the new settings to the safety light curtain.
5. Upload and confirm (lock) the new settings.

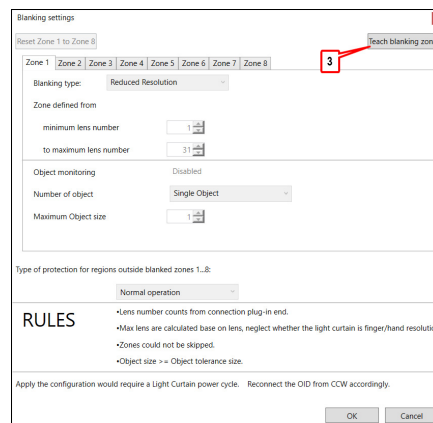
## Process Details

Place only the fixed objects in the safety light curtain field. The object can be singular or multiple fixed objects can be within the safety light curtain field. Mount the Optical Interface Device onto the receiver. Connect the USB cable from the computer with the Connected Components Workbench software to the Optical Interface Device. Turn on the power to the safety light curtain.

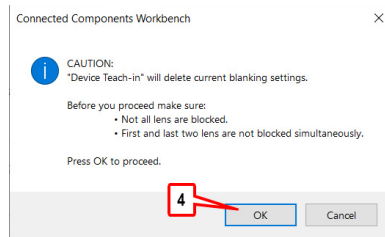
1. Select Connect to Device. Wait for the device to connect. When the connection is made, Diagnose enables, and Download and Upload disables.
2. Select Blanking Settings. The Blanking configuration type is not relevant.



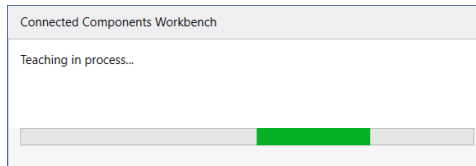
3. Teach is enabled. Select Teach Blanking Zones in the Blanking settings.



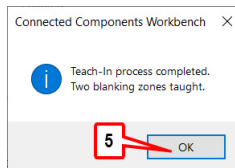
4. The caution message allows you to cancel if necessary. After you read the message, select OK.



The Teaching in Process window appears. If you configured the safety light curtain for automatic start, the OSSD outputs are on. The OSSD outputs momentarily turn off and then back on during the teaching process.



5. The teach-in process is complete. When completed, the Connected Components Workbench software generates a message and describes the number of taught blanking zones. Select OK.



6. Review the learned blanking settings in each zone. You cannot change the settings in the Connected Components Workbench software, but you can select the Teach blanking zones again for the software to relearn the settings. In this example, two zones have fixed blanking. The Connected Components Workbench software has learned the new settings. Select OK.

Blanking settings

Reset Zone 1 to Zone 8 Teach blanking zones

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5 Zone 6 Zone 7 Zone 8

Blanking type: Fixed Blanking

Zone defined from

minimum lens number 2

to maximum lens number 5

Object monitoring Enabled

Object size tolerance -1

Blanking settings

Reset Zone 2 to Zone 8 Teach blanking zones

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5 Zone 6 Zone 7 Zone 8

Blanking type: Fixed Blanking

Zone defined from

minimum lens number 10

to maximum lens number 14

Object monitoring Enabled

Object size tolerance -1

Type of protection for regions outside blanked zones 1..8:

Normal operation

**RULES**

- Lens number counts from connection plug-in end.
- Max lens are calculated base on lens, neglect whether the light curtain is finger/hand resolution.
- Zones could not be skipped.
- Object size >= Object tolerance size.

Apply the configuration would require a Light Curtain power cycle. Reconnect the OID from CCW accordingly.

6 OK Cancel

7. Select Go Offline to disconnect the Connected Components Workbench software from the safety light curtain.

450L\_1\* Start Page

GuardShield 450L

Download Upload Diagnose Report

General Hardware DIP Switch USB Configuration

Configuration

Number of sub-configurations: 1

Sub-Config 1 GPIO

General settings Enabled Settings

Muting

Muting Type: Disabled Settings

Blanking

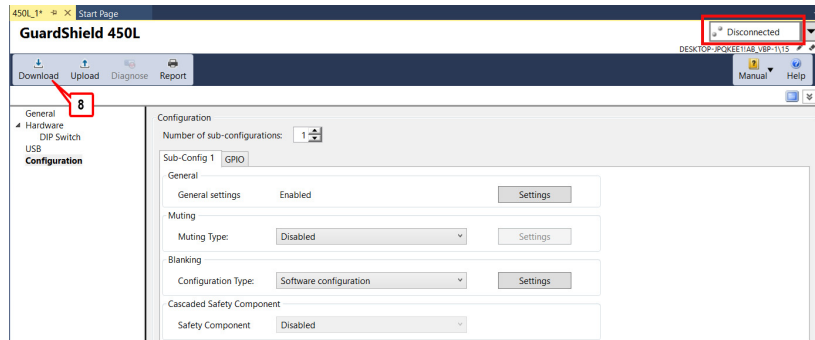
Configuration Type: Software configuration Settings

Cascaded Safety Component

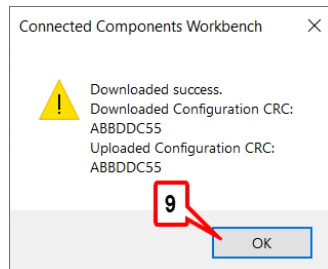
Safety Component Disabled

7 Go offline

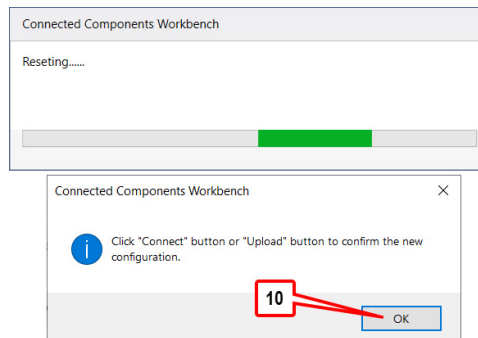
8. Select Download with the safety light curtain disconnected. The OSSD outputs turn off while the new configuration downloads.



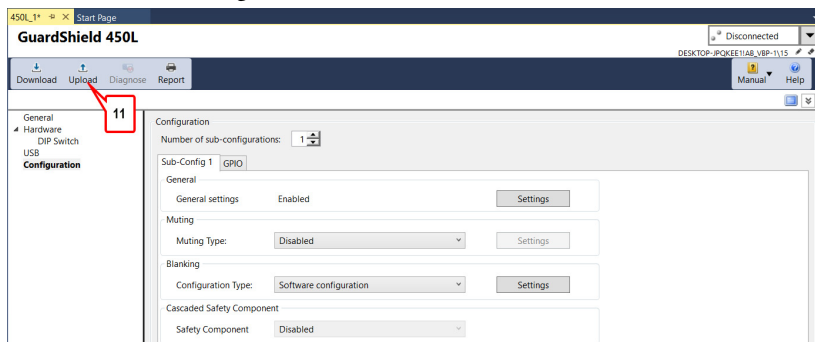
9. The download was a success. The downloaded and uploaded CRC values are the same. Select OK.



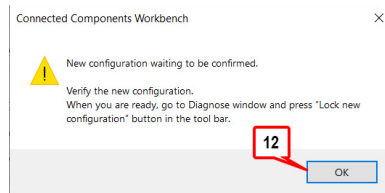
10. The Connected Components Workbench software resets. After reset, the Connected Components Workbench software disconnects from the safety light curtain, and the message box instructs you to select Upload or Connect to confirm the new configuration. On the safety light curtain, the status indicator flashes red/green. The OSSD outputs are off. The Blanking indicator is off. Select OK.



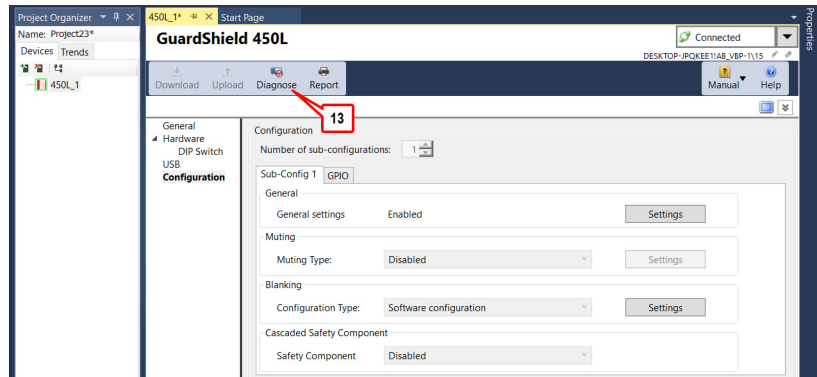
11. Select Upload. This step uploads the configuration from the safety light curtain back into the Connected Components Workbench software, so the new configuration can be confirmed.



12. The new configuration is waiting for confirmation. The conformation message provides instructions to confirm the configuration. Select OK.



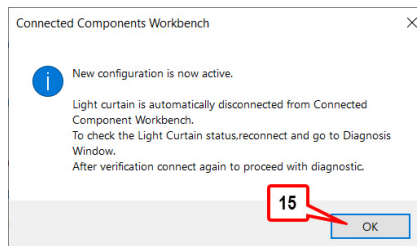
13. Select Diagnose.



14. Select Lock to confirm the configuration. The safety light curtain cycles power, and the new configuration is ready for use.



15. The configuration is now active. Select OK.



## Floating Blanking

Floating blanking allows an object to move within the specified lens range without causing the safety light curtain OSSD outputs to turn off. The safety light curtain monitors the presence of the blanking; therefore, the object must always be within the specified lens range. If the object height is less than the minimum or more than the maximum number of lenses, the safety light curtain outputs turn off.

Settings

[Figure 123](#) shows the settings for Floating Blanking. You can configure up to eight zones for floating blanking. The Teach Blanking Zones disable for floating blanking. [Table 65](#) describes the settings. Select the values appropriate for the application.

Figure 123 - Floating Blanking Settings

Blanking settings

Reset Zone 1 to Zone 8

Teach blanking zones

Zone 1 Zone 2 Zone 3 Zone 4 Zone 5 Zone 6 Zone 7 Zone 8

Blanking type: Floating Blanking

Zone defined from

minimum lens number 1

to maximum lens number 31

Object monitoring Enabled

Object size 2

Object size tolerance -1

Type of protection for regions outside blanked zones 1..8:

Normal operation

RULES

•Lens number counts from connection plug-in end.

•Max lens are calculated base on lens, neglect whether the light curtain is finger/hand resolution.

•Zones could not be skipped.

•Object size >= Object tolerance size.

Apply the configuration would require a Light Curtain power cycle. Reconnect the OID from CCW accordingly.

OK Cancel

Table 65 - Floating Blanking Settings

Setting	Description
Blanking type	Select Floating Blanking.
Minimum lens number	This setting is the first that participates in the range of lenses.
Maximum lens number	This setting is the last lens that participates in the range of lenses.
Object monitoring	Always enabled for floating blanking.
Object size	Select the number of lenses typically blocked by the object. The number is subject to certain rules (see <a href="#">Table 66 on page 157</a> ).
Object size tolerance	The safety light curtain allows the object size to be smaller by either 1 or 2 lenses for finger resolution and 1 lens for hand resolution. Select the number of lenses that accommodate the variation in object size. The number is subject to certain rules (see <a href="#">Table 66 on page 157</a> ).
Other zones	Select normal operation, reduced resolution one object, or reduced resolution two objects for the other zones.

Floating Blanking Rules

[Table 66 on page 157](#) shows the rules for floating blanking for the minimum object size. The Connected Components Workbench software enforces these blanking rules automatically. Since the transceiver sticks are synchronized with either the first or last beams, only one end of the stick can be blocked (not both ends).



Table 66 - Floating Blanking Rules

Resolution [mm (in.)]	Object Size (Min)	Object Size Tolerance	Include/Exclude Lens 1	Min Lens Value	Max Lens Value	Rules
Finger (14 [0.55])	2	-1	Include	1	6,7,8...n-1	Since lens 1 is blanked, the last lens cannot be blanked. Max lens must be at least equal to or greater than min lens by a value of 5.
			Exclude	3,4,5...n-5	8,9,10...n	Since lens 1 is not blanked, lens 2 cannot be blanked. Max lens must be at least equal to or greater than min lens by a value of 5.
	3	-2	Include	1	7,8,9...n-1	Since lens 1 is blanked, the last lens cannot be blanked. Max lens must be at least equal to or greater than min lens by a value of 6.
			Exclude	3,4,5...n-6	9,10,11...n	Since lens 1 is not blanked, lens 2 cannot be blanked. Max lens must be at least equal to or greater than min lens by a value of 6.
Hand (30 [1.18])	4	-1	Include	1	13, 15...n-3	Since lens 1 is blanked, the last lens cannot be blanked. Max lens must be an odd number at least equal to or greater than the min lens by a value of 12.
			Exclude	4,6,8...n-8	15,17...n-1	Since lens 1 is not blanked, lens 2 cannot be blanked. Min lens number must be an even number with a value at least equal or greater than 4. Max lens must be an odd number at least equal to or greater than min lens by a value of 11.

## Object Height

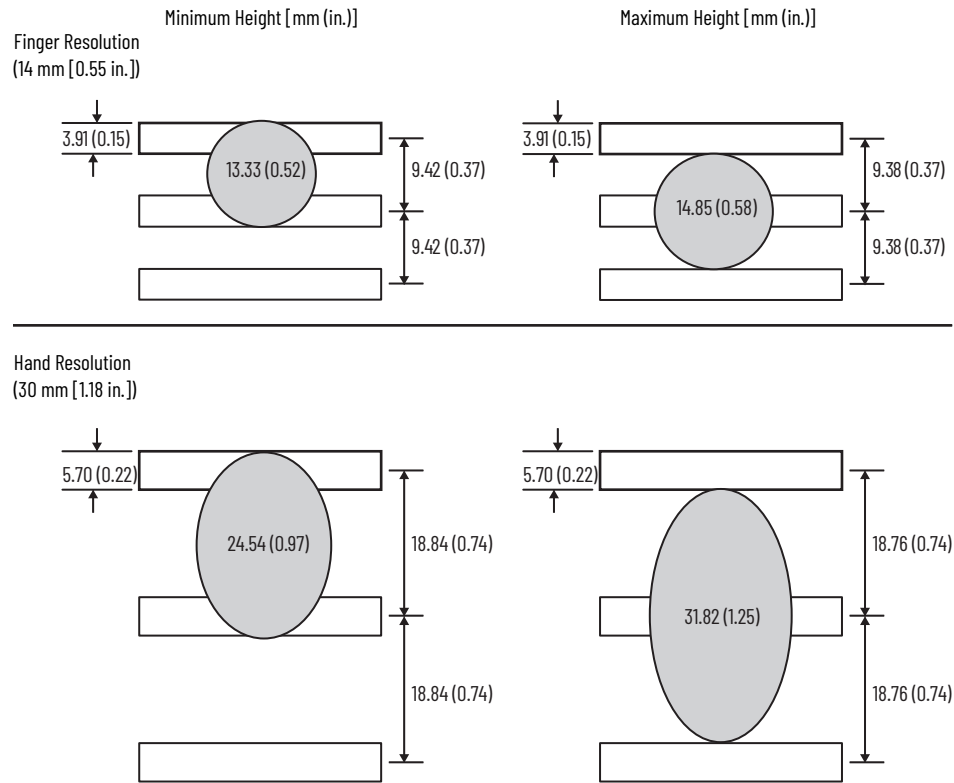
Table 67 shows the formulas for calculating the minimum and maximum object height. Maintain the height of the object between the minimum and maximum values for the OSSD outputs to remain on.

Figure 124 on page 158 shows an example of a maximum object size selection of 2 and tolerance of -1 for both finger and hand resolution. For finger resolution, the beam width is 3.91 mm (0.15 in.). The worst-case tolerance of beam spacing is 9.42 mm (0.37 in.) for minimum and 9.38 mm (0.37 in.) for maximum. An object that has a height larger than 13.33 mm (0.52 in.) and less than 14.85 mm (0.58 in.) does not cause the OSSD outputs to turn off. If the object height falls below 13.33 mm (0.52 in.) or exceeds 14.85 mm (0.58 in.), the OSSD outputs turn off.

Table 67 - Object Height Formulas

Resolution [mm (in.)]	Max/Min	Formula
Finger (14 [0.55])	Min	Min object height is $> (\text{Object Size} + \text{Object Size Tolerance}) \times 9.42 + 3.91$ Example with Object Size = 2 and Tolerance = -1 $>(2 - 1) \times 9.42 + 3.91$ $>13.33 \text{ mm (0.52 in.)}$
	Max	Max object height is $< \text{Object Size} \times 9.38 - 3.91$ Example with Object Size = 2 $<2 \times 9.38 - 3.91$ $<14.85 \text{ mm (0.58 in.)}$
Hand (30 [1.18])	Min	Min object height is $> (\text{Object Size} + \text{Object Size Tolerance}) \times 18.84 + 5.70$ Example with Object Size = 2 and Tolerance = -1 $>(2 - 1) \times 18.84 + 5.70$ $>24.54 \text{ mm (0.97 in.)}$
	Max	Max object height is $< \text{Object Size} \times 18.76 - 5.70$ Example with Object Size = 2 $<2 \times 18.76 - 5.70$ $<31.82 \text{ mm (1.25 in.)}$

Figure 124 - Object Height Example - Object Size = 2, Object Tolerance = -1



## Reduced Resolution Blanking

Reduced resolution is similar to floating blanking except the object does not need to be in the reduced resolution zone. Reduced resolution blanking is not monitored blanking.

## Settings

Figure 125 shows the setting for reduced resolution blanking. Table 68 on page 159 describes the settings.

Figure 125 - Reduced Resolution Settings

Blanking settings

Reset Zone 1 to Zone 8      Teach blanking zones

Zone 1   Zone 2   Zone 3   Zone 4   Zone 5   Zone 6   Zone 7   Zone 8

Blanking type: Reduced Resolution

Zone defined from

minimum lens number: 1

to maximum lens number: 31

Object monitoring: Disabled

Number of object: Single Object

Maximum Object size: 1

Type of protection for regions outside blanked zones 1..8: Normal operation

**RULES**

- Lens number counts from connection plug-in end.
- Max lens are calculated based on stick length, neglect whether the light curtain is finger/hand resolution.
- Zones could not be skipped.
- Object size >= Object tolerance size.

Apply the configuration would require a Light Curtain power cycle.    Reconnect the OID from CCW accordingly.

OK    Cancel

Table 68 - Reduced Resolution Settings

Setting	Description
Blanking type	Select Reduced Resolution.
Minimum lens number	This setting is the first lens that participates in the range of lenses.
Maximum lens number	This setting is the last lens that participates in the range of lenses.
Object monitoring	Always disabled for reduced resolution.
Number of objects	Select single or multiple objects. Single - The height of the single object must be less than the maximum object size. Multiple - The sum of the heights of all objects must be less than the maximum object size.
Maximum object size	Select the maximum height of the object or objects. The height is subject to certain rules (see <a href="#">Object Height</a> ).
Other zones	Select normal operation, reduced resolution one object, or reduced resolution two objects.

## Reduced Resolution Blanking Rules

[Table 69](#) shows the rules for reduced resolution blanking. The Connected Components Workbench software enforces these blanking rules automatically. Since the transceiver sticks synchronize with either the first or last lens, only one end of the stick can be blocked (not both ends).

Table 69 - Reduced Resolution Rules

Resolution [mm (in.)]	Object Size, Max	Include/Exclude Lens 1	Lens Value, Min	Lens Value, Max	Rules
Finger (14 [0.55])	1...31	Include	1	5...n-1	Since lens 1 is blanked, the last lens cannot be blanked. Max Object Size $\leq$ Max Lens - Min Lens - 3 Examples: Max Object Size = 1 and Min = 1, then Max = 5...n-1 Max Object Size = 4 and Min = 1, then Max = 8...n-1
		Exclude	3	n	Since lens 1 is not blanked, lens 2 cannot be blanked. Max Object Size $\leq$ Max Lens - Min Lens - 3 Examples: Max Object Size = 1 and Min = 3, then Max = 7...n Max Object Size = 4 and Min = 5, then Max = 12...n
Hand (30 [1.18])	2,4,6...n-12	Include	1	11,13,15...n-3	Since lens 1 is blanked, the last lens cannot be blanked. Max Object Size $\leq$ Max Lens - Min Lens - 8 Examples: Max Object Size = 2 and Min = 1, then Max = 11...n-3 Max Object Size = 4 and Min = 1, then Max = 13...n
		Exclude	4	13,15,17...n-1	Since lens 1 is not blanked, lens 3 cannot be blanked. Max Object Size $\leq$ Max Lens - Min Lens - 7 Examples: Max Object Size = 2 and Min = 4, then Max = 13...n-1 Max Object Size = 4 and Min = 6, then Max = 17...n-1

## Object Height

[Figure 126 on page 160](#) shows an example of a maximum object size selection of two for both finger and hand resolution. For finger resolution, the beam width is 3.91 mm (0.15 in.), and the worst-case tolerance for beam spacing is 9.38 mm (0.37 in.). An object that has a height of 14.85 mm (0.58 in.) never blocks more than two beams. If the third beam is blocked, the OSSD outputs turn off. Therefore, the maximum height remains less than the formulas in [Table 70 on page 160](#) to avoid nuisance tripping.

Table 70 - Formulas for Max Object Height

Resolution [mm (in.)]	Formula
Finger (14 [0.55])	Max object height is < Max Object Size Selection x 9.38 - 3.91 Example with Max Object Size = 2 < 2 x 9.38 - 3.91 < 14.85 mm (0.58 in.)
Hand (30 [1.18])	Max object height is < Max Object Size Selection x 18.76 - 5.70 Example with Max Object Size = 2 < 2 x 18.76 - 5.70 < 31.82 mm (1.25 in.)

Figure 126 - Max Object Height Example [mm (in.)]

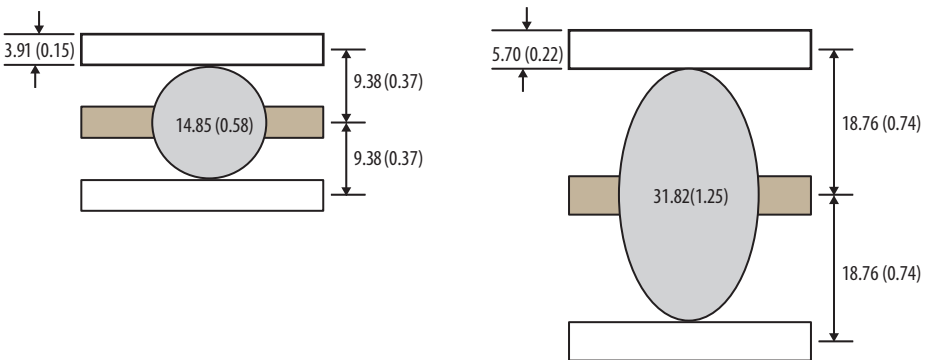


Table 71 shows maximum object size for selections 1...10. Use the appropriate formula in Table 71 for larger values.

Table 71 - Maximum Object Size Table

Select Maximum Object Size	If the object height is smaller than...	
	Finger Resolution [mm (in.)]	Hand Resolution [mm (in.)]
1	5.47 (0.22)	13.06 (0.51)
2	14.85 (0.58)	31.82 (1.25)
3	24.23 (0.95)	50.58 (1.99)
4	33.61 (1.32)	69.34 (2.73)
5	42.99 (1.69)	88.10 (3.47)
6	52.37 (2.06)	106.86 (4.21)
7	61.75 (2.43)	125.62 (4.95)
8	71.13 (2.80)	144.38 (5.68)
9	80.51 (3.17)	163.14 (6.42)
10	89.89 (3.54)	181.90 (7.16)

## Download and Upload Configurations

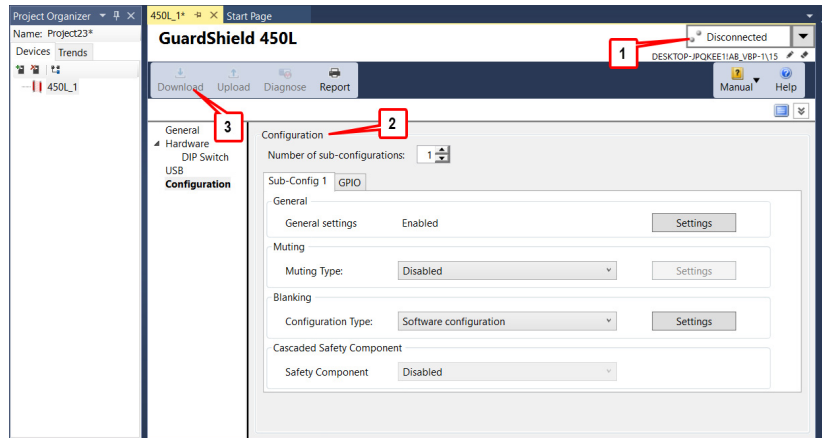
To change a configuration in the safety light curtain:

1. Download the project to the safety light curtain.
2. Upload the project from the safety light curtain.
3. Lock the configuration.

To change the configuration in the safety light curtain.

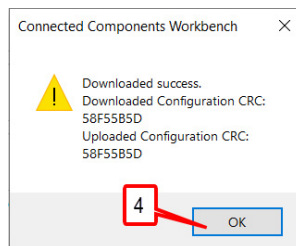
1. Go offline (disconnect).
2. Complete the configuration.

## 3. Select Download.

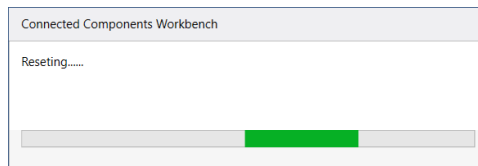


The download is successful. The downloaded and uploaded CRC are identical.

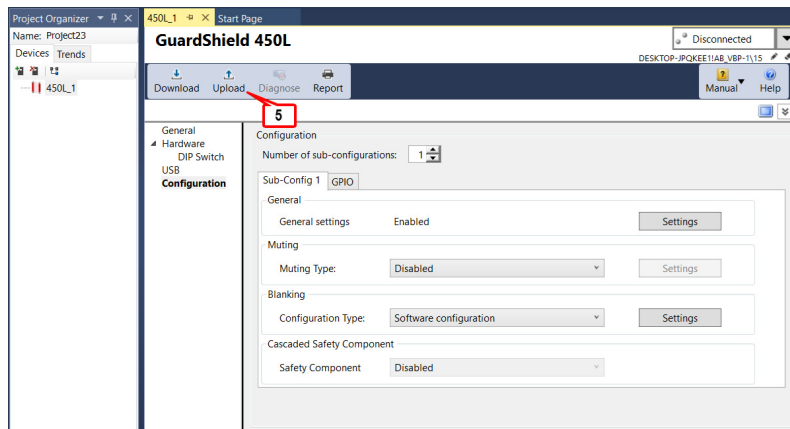
## 4. Select OK.



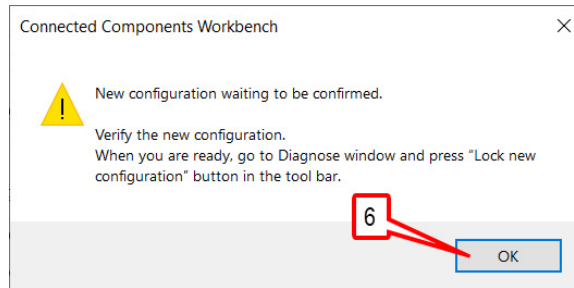
The Connected Components Workbench software generates a progress window during the resetting process.



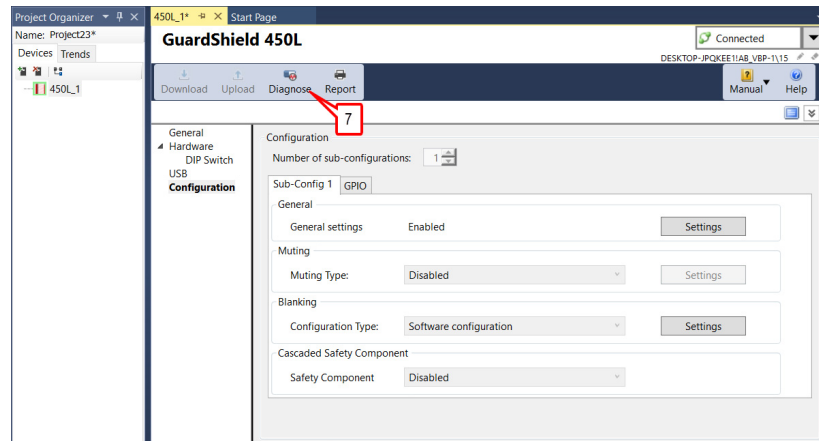
## 5. Select Upload to transfer the project from the safety light curtain back to the Connected Components Workbench software.



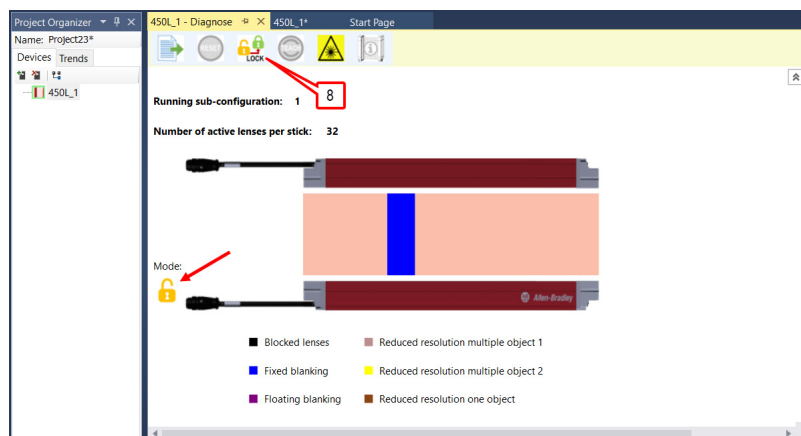
6. The waiting to confirm message shows. Select OK.



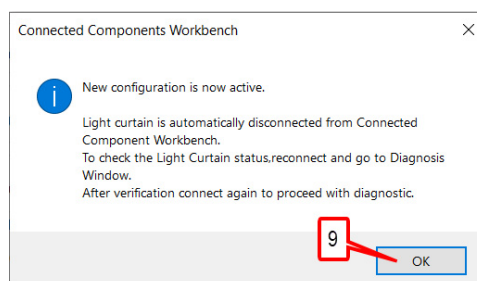
7. Select Diagnose.



8. The screen shows the unlocked Mode icon. Select Lock.

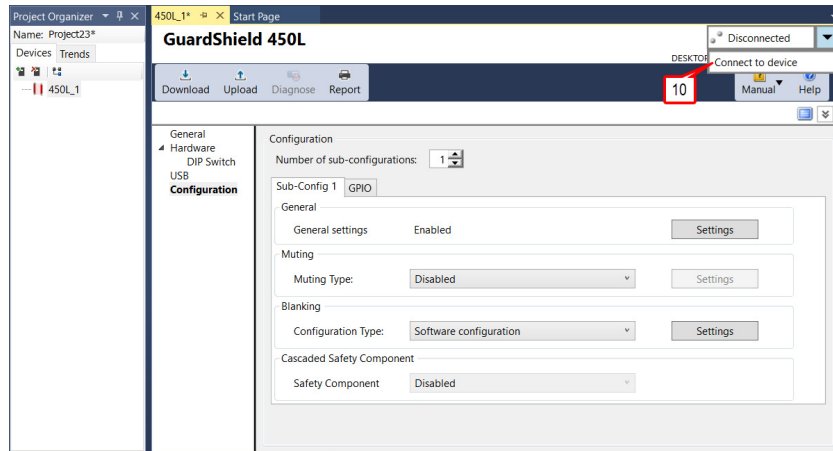


9. The configuration is now active, and the safety light curtain is ready for use. Select OK.

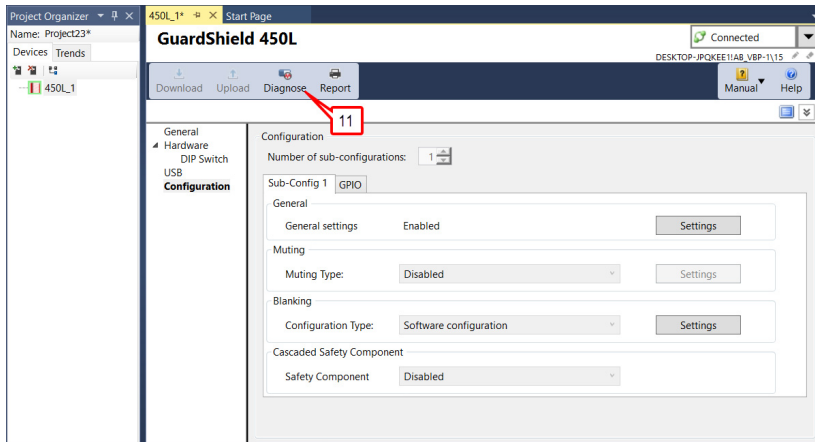


The following steps are optional to monitor the performance of the safety light curtain through the Connected Components Workbench software.

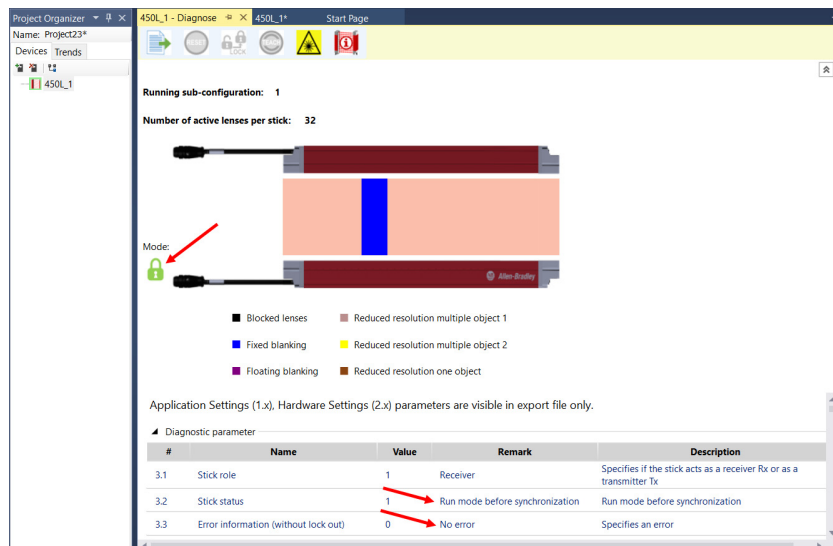
## 10. Select Connect to device.



## 11. Select Diagnose.



The diagnostic window and the safety light curtain is locked in Run mode with no errors.

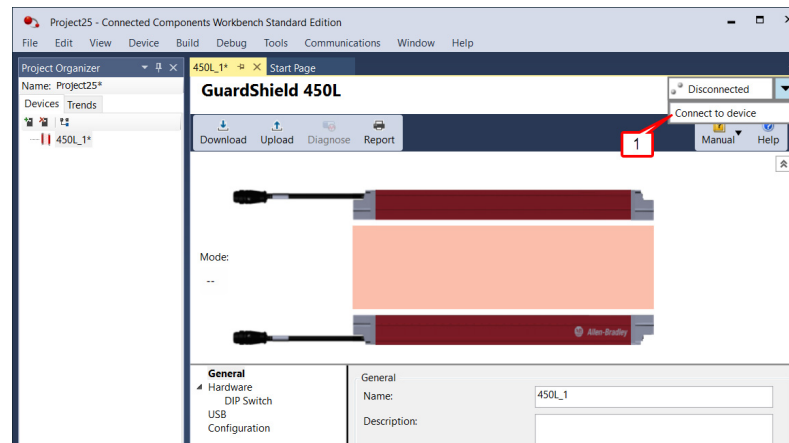


## Change Hardware

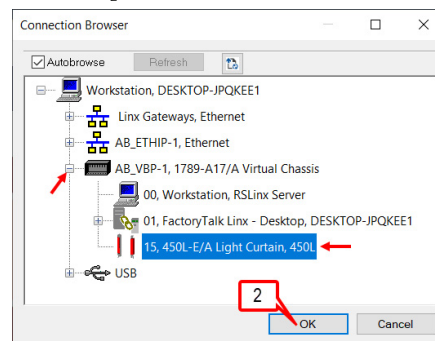
The Connected Components Workbench software must know the actual hardware setup before you download a new configuration. If the hardware changes, for instance you add a cascading plug-in or change from a muting to a blanking plug-in, perform the following steps to synchronize the hardware with the Connected Components Workbench software.

After you change the hardware, apply power to the safety light curtain.

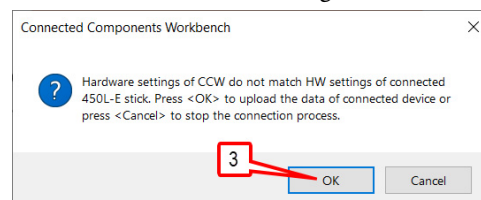
1. Select Connect to device.



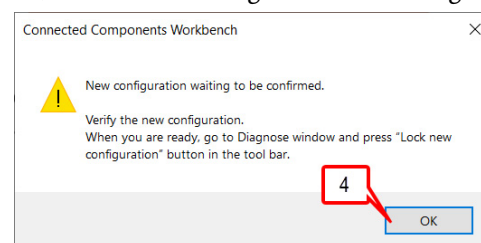
2. Expand the AB\_VPN-1 connection, select 450L, and select OK.



3. The hardware settings do not match. Select OK.

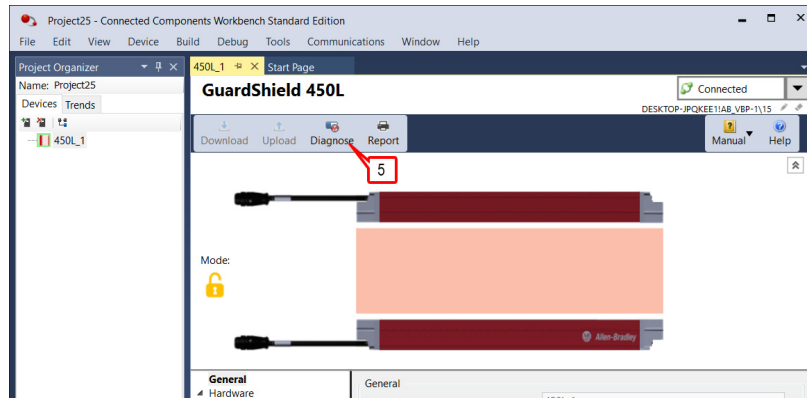


4. The new configuration awaiting confirmation. Select OK.

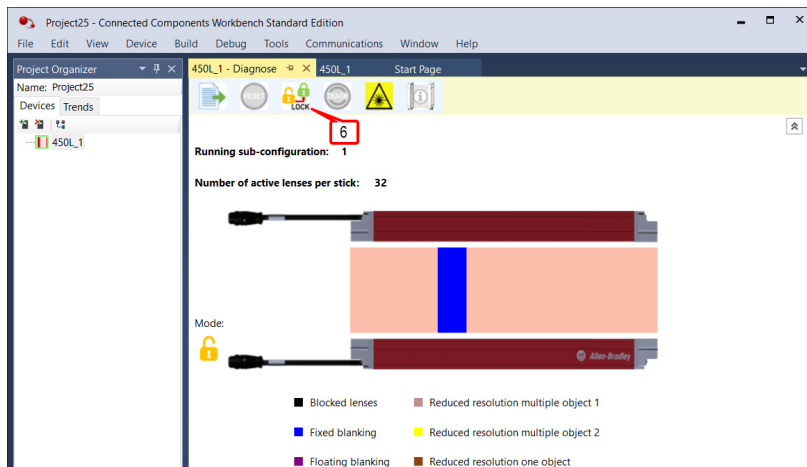




## 5. Select Diagnose.



## 6. Select Lock.



The safety light curtain can now be configured using the new hardware.

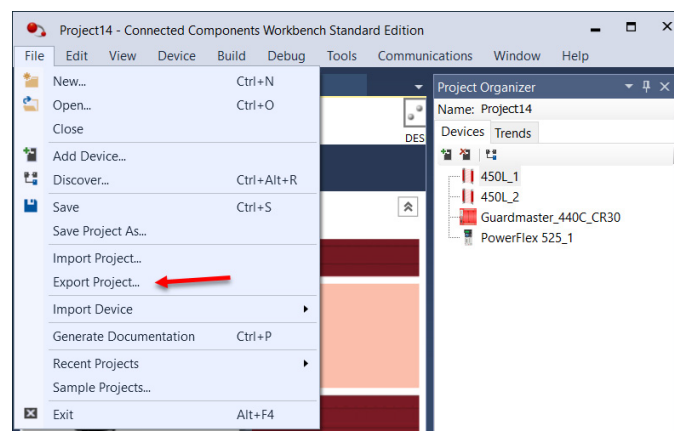
## Share Your Project (Export/Import)

You can share projects and devices with the Import and Export routines. You can export complete projects to a Connected Components Workbench software archive file and individual devices to a zip file.

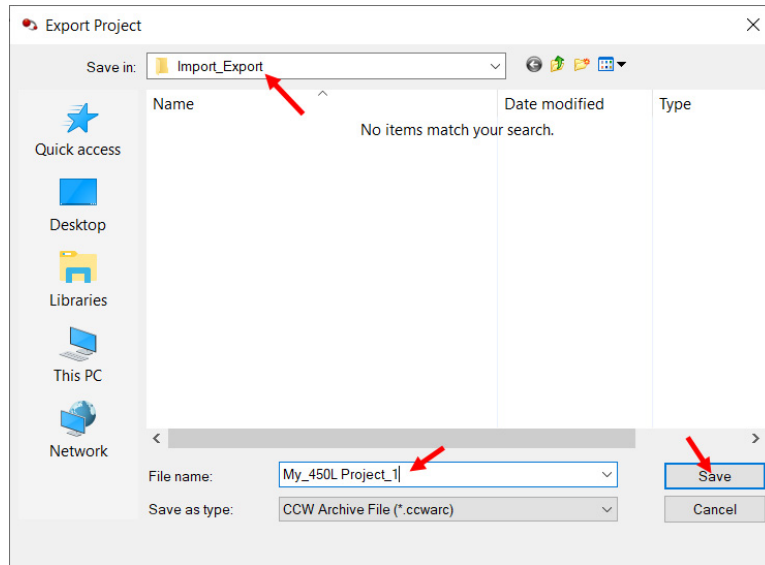
### Export Project to an Archive

#### 1. Select File > Export Project.

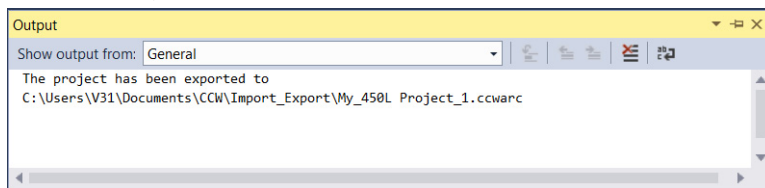
This approach creates a small file that you can import to the Connected Components Workbench software. Use this method when you have only one device, or multiple devices that are included in one project. The archive file includes all four devices.



- The Connected Components Workbench software exports the archive file in the default directory Import\_Export. Type in a filename and select Save. The only file type is \*.ccwarc.



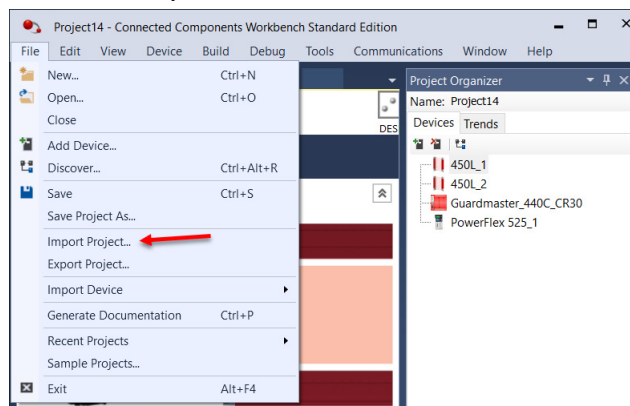
- The Connected Components Workbench software generates a confirmation and displays the message in the Output window. The message shows the file path and filename.



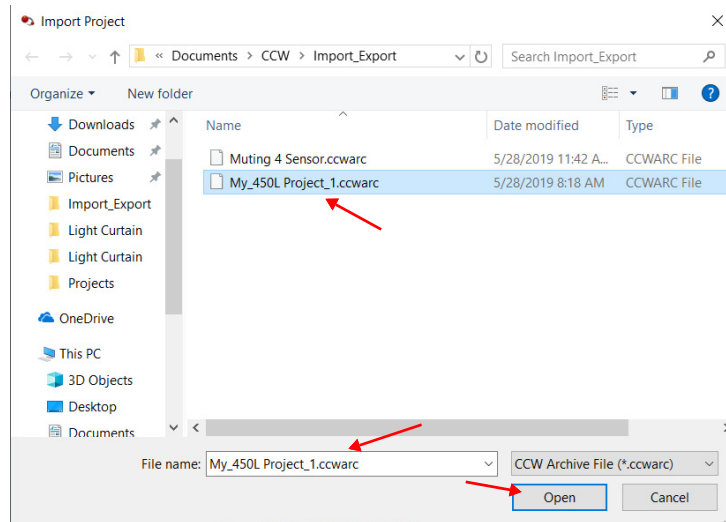
## Import Project from an Archive

When an archive file imports into the Connected Components Workbench software, the current project is closed without saving, and replaced by the imported project.

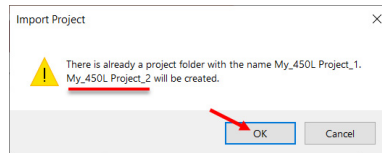
- Select File > Import Project on the main menu. The Connected Components Workbench software opens the default Import\_Export directory.



2. Select the CCWARC file to import. The name appears in the File name field. Select Open.



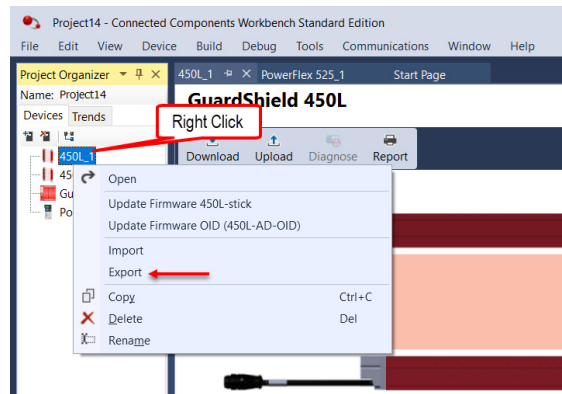
3. If the filename exists, the Connected Components Workbench software creates a project by incrementing a number at the end of the filename. My\_450L Project\_2 is created. Select OK.



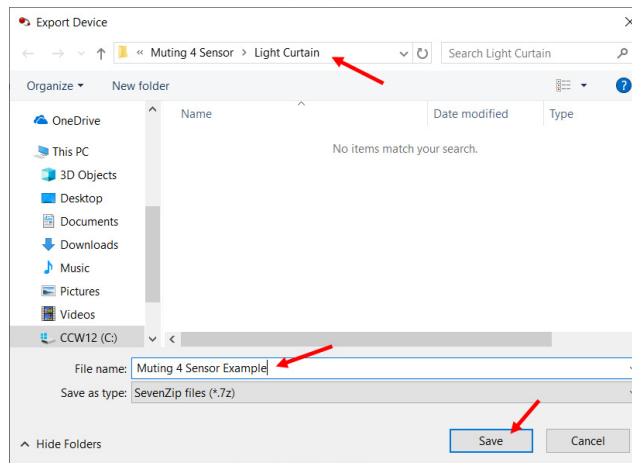
## Export Device to a Zip File

Use this method if you have multiple devices in one project and want to share the configuration of only one device. This approach creates a 7-Zip (free software) directory of files. After expanding the files, you can import the files can to the Connected Components Workbench software.

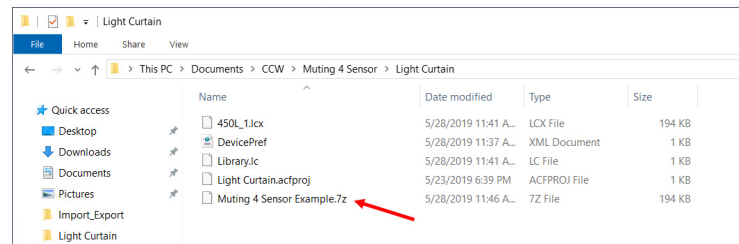
1. Right-click the device in the Project Organizer and select export.



2. Select the directory; type in a filename and select Save.

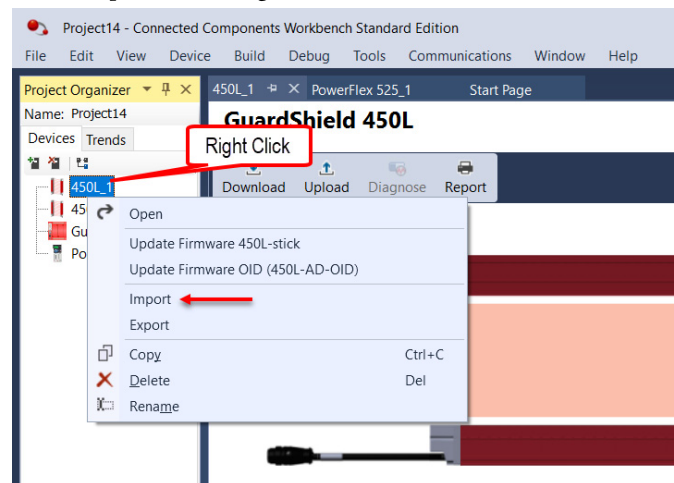


3. The Connected Components Workbench software does not provide a confirmation message. To confirm the export, follow the export file path.

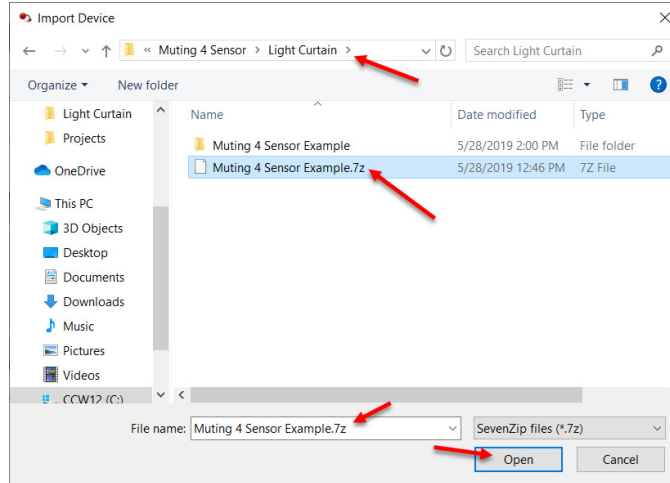


## Import a Zip File

1. Right-click the device in the Project Organizer. Then select Import. This process replaces the configuration of the selected device with the imported configuration.



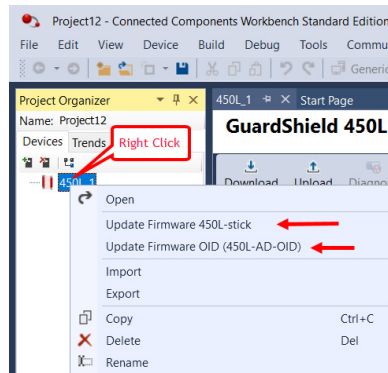
Search for the directory that contains the desired 7z file. Highlight the filename and select Open. The configuration imports to the selected Connected Components Workbench software device.



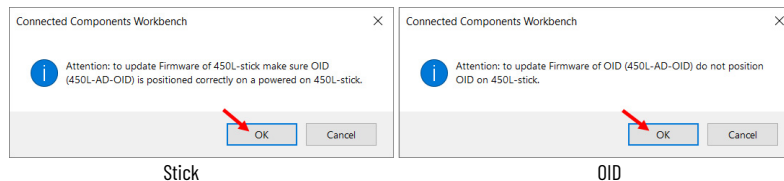
## Update Firmware

Each release of the Connected Components Workbench software includes updated versions of the firmware. Both the optical interface device and the safety light curtain contain firmware. You can also update the firmware with the ControlFLASH™ software.

1. In the Project Organizer, right-click the device name or its icon (450L\_1). Then select either Update Firmware 450K-stick or Update Firmware OID (450L-AD-OID).

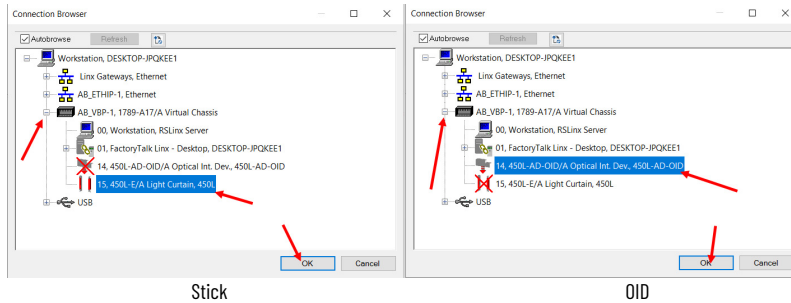


2. Follow the instructions in the message box. If you update the firmware in the OID, then the OID must not mount on the safety light curtain. If you update the firmware in the safety light curtain, then the OID must mount on the safety light curtain with the safety light curtain powered. Select OK.

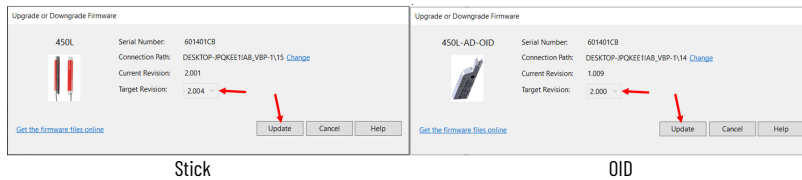


The Connection Browser with connections to the Stick and the OID.

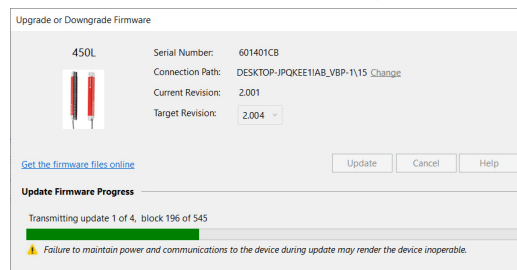
3. In the Connection Browser, expand the AB\_VBP-1. Both the OID and the safety light curtain show. One of the two always have an X over its icon. If you update the safety light curtain, the OID is not available. If you update the OID, the safety light curtain is not available. Select 450L. Select OK.



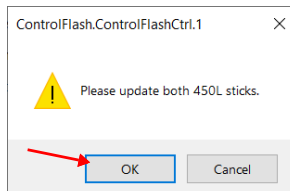
4. Verify the target revision or select a revision from the dropdown menu and select Update.



The screen shows the progress of the update.



5. The screen shows a courtesy message. If you update the sticks, you must update both sticks. Select OK.



If both sticks are powered and properly aligned, both sticks update simultaneously. If both sticks are slightly misaligned, the update can fail. If your update fails, block the top and bottom synchronization beams and update the sticks individually.

Best practice is to mount the OID on the other stick. Check the revision. If the current revision is not the same as the target revision, then repeat the update procedure.

## Specifications

This appendix provides the specifications for 450L-B and 450L-E safety light curtains.

### Safety Ratings

**Table 72 - Safety Ratings**

Attribute	Value
Standards	IEC 61508, EN/ISO 13849-1, IEC 62061, UL 508 (see <a href="http://rok.auto/certifications">rok.auto/certifications</a> for the latest Declaration of Conformity)
Safety classification	Type 4 according to IEC 61496-1/-2 Up to PLe (Category 4) per ISO 13849-1, SIL 3 per IEC 61508 SIL CL 3 per IEC 62061 Laser alignment of 450L-E safety light curtain: Laser class 2 according to IEC 60285-1.
Functional safety data	450L-B; Pair (including any connection plug-in) <ul style="list-style-type: none"> <li>• PFHD: <math>12.7 \cdot 10^{-9}</math></li> <li>• Mission time/PTI: 20 years</li> <li>• Mode of operation: High Demand mode</li> </ul> 450L-E; Pair (including any connection plug-in) <ul style="list-style-type: none"> <li>• Pair: PFHD: <math>12.7 \cdot 10^{-9}</math></li> <li>• Cascading plug-in PFHD: <math>0.96 \cdot 10^{-9}</math></li> <li>• Mission time/PTI: 20 years</li> <li>• Mode of operation: High Demand mode</li> </ul> 450L PAC; Pair (including any connection plug-in) <ul style="list-style-type: none"> <li>• 1-beam pair: <math>2.44 \cdot 10^{-9}</math></li> <li>• 2-beam pair: <math>3.87 \cdot 10^{-9}</math></li> <li>• 3-beam pair: <math>4.81 \cdot 10^{-9}</math></li> <li>• 4-beam pair: <math>5.27 \cdot 10^{-9}</math></li> <li>• Cascading plug-in PFHD: <math>0.96 \cdot 10^{-9}</math></li> <li>• Mission time/PTI: 20 years</li> <li>• Mode of operation: High Demand mode</li> </ul>

### Operating Characteristics

**Table 73 - Operating Characteristics**

Attribute	Value
Switch function	OSSDs enable (on, high, 24V DC) when protective field not interrupted
Protective field length	150...1950 mm (5.91...76.77 in.) in 150 mm (5.91 in.) increments
Resolution	Finger: 14 mm (0.56 in.); Hand: 30 mm (1.19 in.) or PAC (perimeter)
Number of active lenses (see <a href="#">Figure 11 on page 25</a> )	Finger: 16 per 150 mm (5.91 in.) increment; Hand: 8 per 150 mm (5.91 in.) increment
Operating range	450L-B: <ul style="list-style-type: none"> <li>• Resolution 14 mm (0.56 in.): 0.5...4 m (1.64...13.12 ft)</li> <li>• Resolution 30 mm (1.19 in.): 0.9...7.0 m (2.95...22.97 ft)</li> <li>• Reduced operating range (selected with DIP switch):               <ul style="list-style-type: none"> <li>- Resolution 14 mm (0.56 in.): 0.9...2 m (2.95...6.56 ft)</li> <li>- Resolution 30 mm (1.19 in.): 1.2...3.5 m (3.94...11.48 ft)</li> </ul> </li> </ul> 450L-E and 450L PAC <sup>(1)</sup> <ul style="list-style-type: none"> <li>• Resolution 14 mm (0.56 in.): 0.5...9 m (1.64...29.53 ft)</li> <li>• Resolution 30 mm (1.19 in.): 0.9...16.2 m (2.95...53.15 ft)</li> <li>• Reduced operating range (selected with DIP switch):               <ul style="list-style-type: none"> <li>- Resolution 14 mm (0.56 in.): 0.9...4.5 m (2.95...14.76 ft)</li> <li>- Resolution 30 mm (1.19 in.): 1.2...8.0 m (3.94...26.25 ft)</li> </ul> </li> </ul>

Table 73 - Operating Characteristics (Continued)

Attribute	Value
Response time	450L-B <ul style="list-style-type: none"> <li>• OSSD - on to off</li> <li>• Finger resolution &lt;25 ms</li> <li>• Hand resolution &lt;15 ms (for details see <a href="#">Response Time on page 48</a>)</li> </ul> 450L-E <ul style="list-style-type: none"> <li>• OSSD - on to off (no blanking, muting, beam coding, or cascading functionality is configured)</li> <li>• Finger resolution &lt;20 ms</li> <li>• Hand resolution &lt;13 ms (for detail see <a href="#">Response Time on page 48</a>)</li> </ul> 450L PAC <ul style="list-style-type: none"> <li>• OSSD - on to off (no muting, beam coding, or cascading functionality is configured)</li> <li>• &lt;20 ms (for detail see <a href="#">Response Time on page 48</a>)</li> </ul>
Power up time, max	5 s
OSSD restart time after clearance of the protective field if automatic reset	210 ms (see <a href="#">Response Time on page 48</a> )
Power supply	24V DC $\pm 15\%$ ; NEC Class 2 (U.S.). PELV per IEC 60204-1.
Power consumption (single stick)	450L-B protective height: <ul style="list-style-type: none"> <li>• 150 mm (5.91 in.): 64 mA maximum</li> <li>• 1950 mm (76.77 in.): 214 mA (outputs not loaded)</li> </ul> 450L-E protective height: <ul style="list-style-type: none"> <li>• 150 mm (5.91 in.): 70 mA maximum</li> <li>• 1950 mm (76.77 in.): 221 mA (output not loaded)</li> </ul> 450L-APC-IO-8: additional 40 mA (with termination plug) 450L-PAC number of beams: <ul style="list-style-type: none"> <li>• 1: 70 mA</li> <li>• 2: 108 mA</li> <li>• 3: 133 mA</li> <li>• 4: 145 mA</li> </ul> (outputs not loaded) 450L-APC-IO-8: additional 40 mA (with termination plug)
Peak current during power-up cycle	800 mA maximum (outputs not loaded)
Duration of peak current during power-up cycle	100 ms
Power down time (OSSD<2V)	3000 ms
Transmitted infrared wave length	Infrared (wave length 855 nm)
Aperture angle	Within $\pm 2.5^\circ$ at 3 m (9.8 ft)
Synchronization	Optical
DIP switch selectable functions	Depends on inserted plug-in: <ul style="list-style-type: none"> <li>• 450L-B: Start mode; external device monitoring (EDM); maximum operating range</li> <li>• 450L-E: Start mode; external device monitoring (EDM); maximum operating range, beam coding, interference rejection, blanking, muting</li> <li>• 450L PAC: Start mode; external device monitoring (EDM); maximum operating range, beam coding, muting</li> </ul>
Lifetime expectancy	<ul style="list-style-type: none"> <li>• DIP switch on plug-in: 1000 cycles</li> <li>• Plug-in on transceiver stick: 50 cycles</li> </ul>
Ambient light	<ul style="list-style-type: none"> <li>• Incandescent lamp: 3000 lux or less</li> <li>• Sunlight: 100,000 lux or less</li> </ul>

(1) 450L PAC is based on 450L-E 30 mm hardware.

## Inputs Receiver, Cascading, and Universal Plug-ins

Table 74 - Inputs Receiver Plug-in, Cascading Plug-in, and Universal Plug-in

Attribute	Value
Input manual start	Minimum duration 50 ms; maximum duration 5 seconds Voltage level for Logic Low/0: 0...5V DC Voltage level for Logic Hi/1: > 16V DC Current: 7 mA typical
Input EDM	300 ms after activation of OSSD Voltage level for Logic Low/0: 0...5V DC Voltage level for Logic Hi/1: > 16V DC Current: 7 mA typical
Input muting sensors	Voltage level for Logic Low/0: 0...5V DC Voltage level for Logic Hi/1: > 16V DC Current: 7 mA typical



## Safety Outputs (OSSDs): Receiver Plug-in

**Table 75 - Safety Outputs (OSSDs): Receiver Plug-in**

Attribute	Value
Safety outputs (OSSDs)	Two solid-state outputs
Switching capacity	500 mA each, maximum
Off-current, max	<2 mA
Residual voltage (drop from power supply)	2V (excl. voltage drop through cables), maximum
Connection cable length	100 m (330 ft) maximum with 22 AWG; Condition: power supply 24V and maximum load on outputs 50 mA total
Switching voltage to HIGH (Ueff)	11...30 V
Switching voltage to LOW	-3...2V
Load capacity	0.5 µF maximum
Short circuit protection	Yes
Test pulse data	See <a href="#">OSSD Output on page 94</a>
Short circuit detection	Yes
Galvanic isolation: I/O from Logic	No

## Status Outputs

**Table 76 - Status Outputs**

Attribute	Value
Number of status outputs	Receiver plug-in: Up to three nonsafety solid-state outputs (depends on plug-in) I/O-cascading plug-in: Up to three solid-state outputs (depends on configuration)
Switching capacity	200 mA each, maximum
Residual voltage (drop from power supply)	2V (excl. voltage drop through cables), maximum
Short circuit protection	Yes
Galvanic isolation: I/O from Logic	No

## Environmental and General Protection

**Table 77 - Environmental and General Protection**

Attribute	Value
Operating temperature	-10...+55 °C (14...131 °F)
Storage temperature	-25...+75 °C (-13...+167 °F)
Operating humidity	5... 95% (without condensation)
Enclosure rating	IP65
Vibration resistance	Per IEC 61496-1 Edition 4 (Class 3M7), IEC 60068-2-6 frequency 10...150 Hz, amplitude 10 mm (0.39 in.), acceleration 3 g
Shock	Per IEC 61496-1 Edition 4 (Class 3M7), IEC 60068-2-27, acceleration 25 g, duration 6 ms
Pollution level	2

## Electrical Protection

**Table 78 - Electrical Protection**

Attribute	Value
Short circuit protection	Incorporated
Current limitation	Incorporated
Overload protection	Incorporated
Reverse polarity protection	Incorporated
Overvoltage protection	Incorporated (up to 60V max)
Thermal shutdown/restart	Incorporated

## General

Table 79 - General

Attribute	Value
Materials	Transceiver stick (450L-B) or 450L-E (including 450L PAC models): <ul style="list-style-type: none"> <li>• Profile: Extruded aluminum, powder coated</li> <li>• End caps: Polyamide</li> <li>• Front window: Polycarbonate</li> <li>• Screws: Steel</li> </ul>
	Plug-in (450L-AP): <ul style="list-style-type: none"> <li>• Pig tail cable: Polyurethane</li> <li>• M12 Connector: Bare copper, SR-PVC, PUR</li> <li>• Body: Polyamide</li> </ul>
	Top/bottom (Cat. No. 450L-AM-TBM) mounting brackets: <ul style="list-style-type: none"> <li>• Bracket: Steel, powder coated</li> <li>• Screws: Steel</li> </ul>
	Side mounting brackets (Cat. No. 450L-AM-SM): <ul style="list-style-type: none"> <li>• Body: Polyamide</li> <li>• Screws: Steel</li> </ul>
	Replacement brackets (Cat. No. 450L-AM-RK): <ul style="list-style-type: none"> <li>• Bracket: Aluminum, black anodized</li> <li>• Screws: Steel</li> </ul>
	Laser-alignment tool bracket (Cat. No. 450L-ALAT-C): <ul style="list-style-type: none"> <li>• Bracket: Polyamide</li> <li>• Test rod: Aluminum</li> <li>• Optical interface device (Cat. No. 450L-AD-OID): Polyamide</li> </ul>
Stick dimensions	<ul style="list-style-type: none"> <li>• Cross section: 30 x 30 mm (1.19 x 1.19 in.)</li> <li>• Length: N x 150 mm (N x 5.9 in.) [N = 1 ... 13]</li> </ul>
Torque, max	<ul style="list-style-type: none"> <li>• Top/bottom mounting bracket: 0.7 N•m (6.2 lb•in) M3 x 10 Phillips screw</li> <li>• Side mounting bracket: 11 N•m (97.36 lb•in) M6; 2.8 N•m (24.78 lb•in) M4</li> <li>• Plug-in: 0.38 N•m (3.4 lb•in) M2 x 8 Phillips screw</li> </ul>
Indicators stick	450L-B, 450L-E, and 450L-PAC: <ul style="list-style-type: none"> <li>• Transceiver type (Rx or Tx)</li> <li>• Status</li> <li>• Intensity (for two regions)</li> <li>• Start/Restart</li> <li>• Output</li> </ul>
	450L-E and 450L PAC only: <ul style="list-style-type: none"> <li>• Muting</li> <li>• Blanking</li> <li>• Cascading</li> </ul>
Connection plug	Depending on installed plug-in: M12 5-pin (plug) or M12 8-pin (plug) fixed at pigtail with cable length: Connection plug-ins: 150 mm (11.81 in.) I/O cascading plug-in: 60 mm (2.36 in.); Minimum outer bend radius of pigtail: > 3xD: 5-pin: D = 4.4 mm (0.17 in.) 8-pin: D = 5.5 mm (0.22 in.)
Connection cable length	Maximum 100 m (330 ft) with wire section AWG 22 (Condition: Power supply 24V and maximum load on outputs 50 mA total)
Accessories included	Test rod, top/bottom mounting brackets and installation instruction
Silicon	The unit does not release any silicone or other LABS-critical substances and is suitable for use in paint shops.

## Certifications

See the Product Certification link at [rok.auto/certifications](http://rok.auto/certifications) for Declaration of Conformity, Certificates, and other certification details:

- cULus Listed Industrial Control Equipment, which is certified for US and Canada
- CE Marked for all applicable directives (see [CE Conformity](#))
- UKCA Marked for all applicable regulations
- RCM marked (Australia)
- TÜV Rheinland-certified for functional safety up to SIL 3 Category 4 for use in safety applications up to and including SIL 3, in accordance with IEC 61508 and EN 62061, Performance Level e and Category 4 in accordance with ISO 13849-1, ESPE type 4 safety light curtain according to EN IEC 61496. TÜV Rheinland confirmed that the laser class of the integrated laser alignment tool that is integrated in all 450L safety light curtain sticks conforms to laser class 2 of IEC 60825-1.

## CE Conformity

Rockwell Automation declares that the products that are shown in this document conform with the 2014/30/EU Electromagnetic Compatibility Directive (EMC) and 2006/42/EC Machinery Directive (MD) and that the respective standards and/or technical specifications have been applied.

For a comprehensive CE certificate visit: [rok.auto/certifications](http://rok.auto/certifications)

## UKCA Conformity

Rockwell Automation declares that the products that are shown in this document are in compliance with 2016 No. 1091 Electromagnetic Compatibility Regulations and 2008 No. 1597 Supply of Machinery (Safety) Regulations and that the respective standards and/or technical specifications have been applied.

For a comprehensive UKCA certificate visit: [rok.auto/certifications](http://rok.auto/certifications)

## Approximate Dimensions

450L-B and 450L-E safety light curtain transceiver sticks have the same dimensions. The only difference is that the 450L-E safety light curtain sticks have an additional slot, which allows the insertion of a cascading plug-in and the connection plug-in. 450L PAC safety light curtain models are based on 450L-E safety light curtain hardware.

Figure 127 - 450L Safety Light Curtain Stick Dimensions [mm (in.)] (Table 80 on page 181)

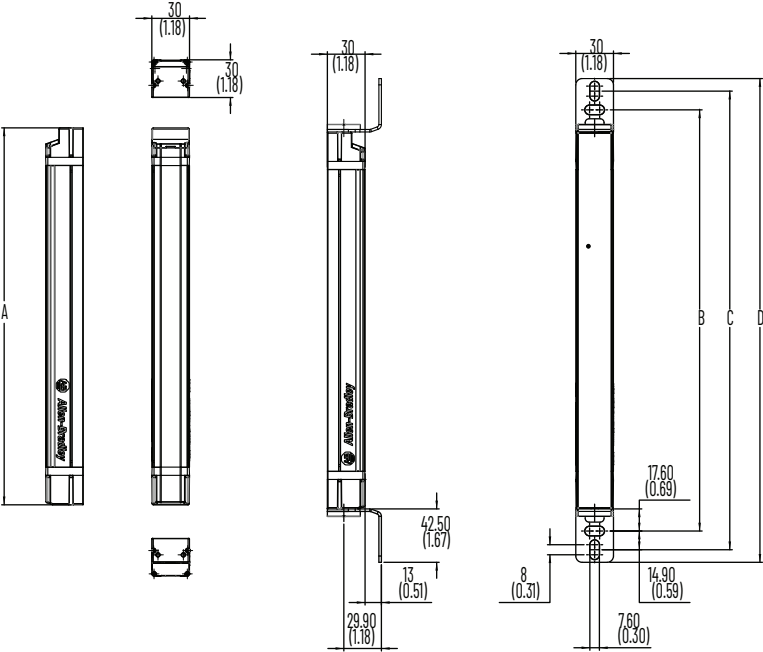
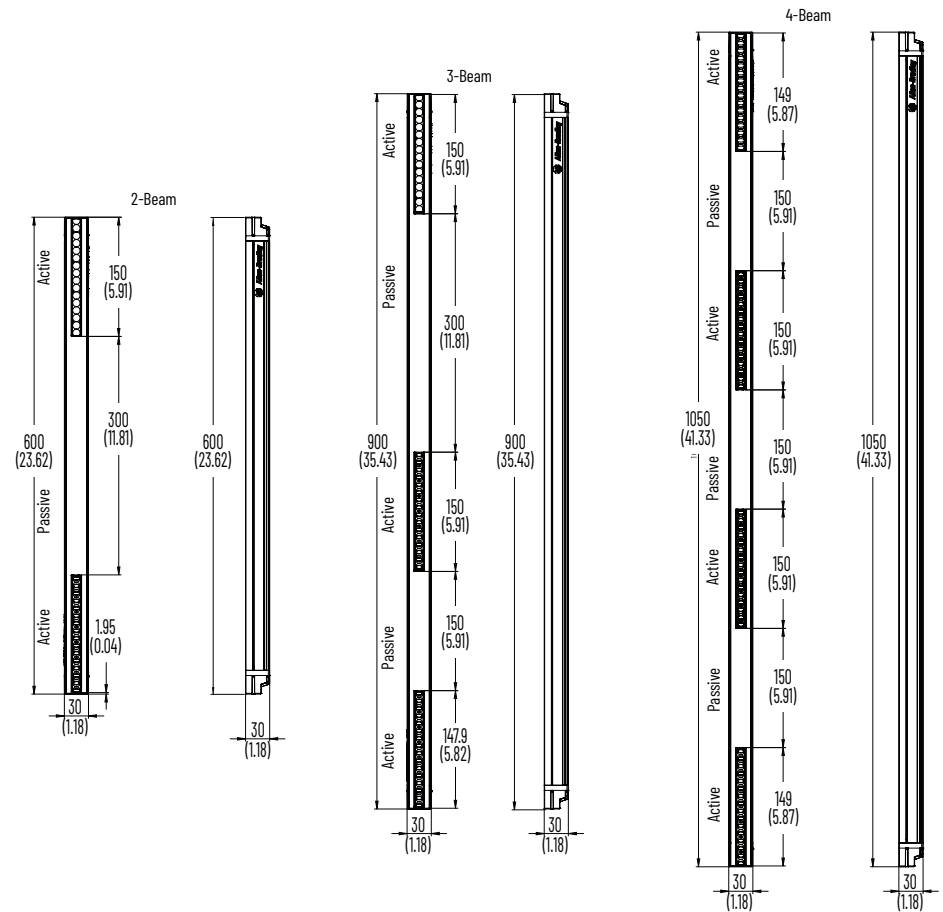


Figure 128 - 450L PAC Safety Light Curtain Stick Dimensions [mm (in.)]



## Product Selection

### Sticks

The catalog number refers to a stick, including top/bottom mounting kit and test rod.

450L -  $\frac{B}{a}$  4  $\frac{H}{b}$   $\frac{N}{c}$  -  $\frac{0750}{d}$  - Y D

a	
Transceiver Stick Type	
Code	Description
B	Basic
E	Enhanced

b	
Resolution [mm (in.)]	
Code	Description
H	Hand (30 [1.19])
F	Finger (14 [0.56])

c	
Laser Alignment	
Code	Description
N	Not integrated
L	Integrated

d			
Protected Height [mm (in.)]			
Code	Description	Code	Description
0150	150 (5.91)	1200	1200 (47.28)
0300	300 (11.82)	1350	1350 (53.19)
0450	450 (17.73)	1500	1500 (59.1)
0600	600 (23.64)	1650	1650 (65.01)
0750	750 (29.55)	1800	1800 (70.92)
0900	900 (35.46)	1950	1950 (76.83)
1050	1050 (41.37)		

Protective Field Length [mm (in.)]	Cat. No. <sup>(1)(2)</sup>		Approximate Shipping Weight (With Packaging) [kg (lb)]	Shipping Dimensions [mm (in.)]
	Resolution 14 mm (0.56 in.)	Resolution 30 mm (1.19 in.)		
150 (5.90)	450L-x4Fy0150YD	450L-x4Hy0150YD	0.59 (1.3)	860 x 111 x 68 (33.86 x 4.37 x 2.68)
300 (11.81)	450L-x4Fy0300YD	450L-x4Hy0300YD	0.72 (1.59)	860 x 111 x 68 (33.86 x 4.37 x 2.68)
450 (17.72)	450L-x4Fy0450YD	450L-x4Hy0450YD	0.85 (1.87)	860 x 111 x 68 (33.86 x 4.37 x 2.68)
600 (32.62)	450L-x4Fy0600YD	450L-x4Hy0600YD	0.98 (2.16)	1310 x 111 x 68 (51.57 x 4.37 x 2.68)
750 (29.53)	450L-x4Fy0750YD	450L-x4Hy0750YD	1.11 (2.45)	1310 x 111 x 68 (51.57 x 4.37 x 2.68)
900 (35.43)	450L-x4Fy0900YD	450L-x4Hy0900YD	1.24 (2.73)	1310 x 111 x 68 (51.57 x 4.37 x 2.68)
1050 (41.34)	450L-x4Fy1050YD	450L-x4Hy1050YD	1.37 (3.02)	1760 x 111 x 68 (69.29 x 4.37 x 2.68)
1200 (47.24)	450L-x4Fy1200YD	450L-x4Hy1200YD	1.5 (3.3)	1760 x 111 x 68 (69.29 x 4.37 x 2.68)
1350 (53.15)	450L-x4Fy1350YD	450L-x4Hy1350YD	1.63 (3.59)	1760 x 111 x 68 (69.29 x 4.37 x 2.68)
1500 (59.05)	450L-x4Fy1500YD	450L-x4Hy1500YD	1.77 (3.90)	2360 x 111 x 68 (92.91 x 4.37 x 2.68)
1650 (64.96)	450L-x4Fy1650YD	450L-x4Hy1650YD	1.91 (4.21)	2360 x 111 x 68 (92.91 x 4.37 x 2.68)
1800 (70.86)	450L-x4Fy1800YD	450L-x4Hy1800YD	2.05 (4.52)	2360 x 111 x 68 (92.91 x 4.37 x 2.68)
1950 (76.77)	450L-x4Fy1950YD	450L-x4Hy1950YD	2.18 (4.81)	2360 x 111 x 68 (92.91 x 4.37 x 2.68)

(1) x = B (450L-B), E (450L-E)  
(2) y = N (450L-B), L (450L-E)

450L PAC Catalog Number Explanation

450L - E4      A1      L      -      0150      -      Y      D  
a                      b                      c                      d

a	b		c	d	
All versions based on 450L-E	Number of Beams		Integrated Laser Alignment System	Protected Height [mm (in.)]	
	Code	Description		Code	Description
	A1	1		0150	150 (5.91)
	A2	2		0600	600 (23.64)
	A3	3		0900	900 (35.46)
	A4	4		1050	1050 (41.37)

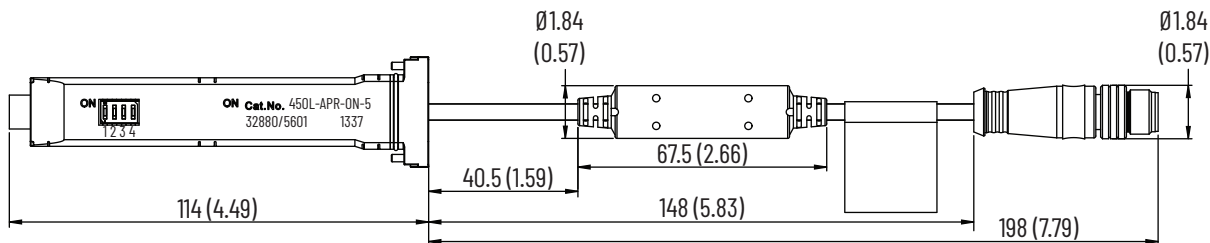
## Plug-ins

450L - APR - ON - 5N  
a b c

a		b		c	
Plug-in Type		Function		Number of Pins	
Code	Description	Code	Description	Code	Description
APR	Accessory plug-in receiver	PW	Power	5	5-pin
APT	Accessory plug-in transmitter	ON	On/Off	8	8-pin
APU	Accessory plug-in universal	ED	EDM		
APC	Accessory plug-in cascading	UN	Universal		
		BK	Blanking		
		MU	Muting		
		IO	I/O cascading		

Description	Cat. No.
450L plug-in Tx 5-pin	450L-APT-PW-5
450L plug-in Tx 8-pin	450L-APT-PW-8
450L plug-in Rx on/off 5-pin	450L-APR-ON-5
450L plug-in Rx EDM 8-pin	450L-APR-ED-8
450L plug-in universal 8-pin	450L-APU-UN-8
450L plug-in blanking 5-pin	450L-APR-BL-5
450L plug-in muting 8-pin	450L-APR-MU-8
450L plug-in cascading 8-pin	450L-APC-IO-8

Figure 129 - 450L Connection Plug-in Dimensions [mm (in.)]



## Optional Accessories

Description	Cat. No.
L-shaped end-cap mounting bracket kit (two per package), shipped with each stick (see <a href="#">Standard Top/Bottom Mounting Kit on page 79</a> )	450L-AM-TBM
Side mounting bracket (2 kits per pair) (see <a href="#">Side Mounting Bracket on page 81</a> )	450L-AM-SM
Replacement mounting kit (see <a href="#">Replacement Mounting Kit on page 83</a> )	450L-AM-RK
445L bracket (2 kits per pair)	445L-AF6140
445L bracket (180°) (2 kits per pair)	445L-AF6141
Shock mount kit (2 kits required per pair) (see <a href="#">Shock Mounting Kit on page 82</a> )	445L-AF6142
Power supply Output—24V DC, 3 amps, 72 W (see <a href="#">Power Supply on page 92</a> )	1606-XLP72E
Laser alignment tool (see <a href="#">Alignment Tool and Bracket on page 184</a> )	440L-ALAT
450L-B laser alignment tool bracket (see <a href="#">Alignment Tool and Bracket on page 184</a> )	450L-ALAT-C
Optical Interface Device (including USB cable) (see <a href="#">Optical Interface Device (OID) on page 112</a> )	450L-AD-OID
450L stick slot cover (plug-in slot, one red slot cover shipped with each 450L-B stick; one red and one gray slot cover shipped with each 450L-E stick). (see <a href="#">Cascading on page 45</a> and <a href="#">Figure 7 on page 17</a> )	450L-AS-1
Muting distribution block	450L-AMOD-MUT
Muting station	450L-AMUT-IL
Muting lamp	800F-MUT-2-MS
Mounting stand (column) (see <a href="#">Mounting Columns on page 183</a> )	440L-AMSTD
Mounting stand (column) (See publication <a href="#">445L-UM004</a> )	445L-AMSTD2M
Corner mirror (xxxx = 0300...1800 mm [11.8...70.86 in.] in 150 mm [5.9 in.] increments) (see <a href="#">Mirrors on page 69</a> )	440L-AM075xxxx
Corner mirror (xxxx = 0300...1800 mm [11.8...70.86 in.] in 150 mm [5.9 in.] increments) (see <a href="#">Mirrors on page 69</a> )	440L-AM125xxxx
Mirror mounting bracket (see <a href="#">Corner Mirror on page 181</a> )	442L-AF6106
Weld shield (xxxx = 0150...1950 mm [5.9...76.77 in.] in 150 mm [5.9 in.] increments) (see <a href="#">Weld Shields on page 185</a> )	450L-AW-xxxx
T-connector (see <a href="#">T-connector on page 98</a> )	1485P-RDR5
Guardmaster® SI safety relay (see <a href="#">Guardmaster SI Safety Relay on page 97</a> )	440R-S12R2
Guardmaster CI safety relay	440R-S13R2
Guardmaster D safety relay	440R-D22R2
Guardmaster DIS safety relay	440R-D22S2
MSR42 safety relay	440R-P226AGS-NNR
CR30 software configurable safety relay	440C-CR30-22BBB
External contactor	100S: 100S-C09QJ14BC, 100S-C43QJ22BC
	700S: 700S-CF53QDJBC (or minor variations)
Test rod 14 mm (0.55 in.) (shipped with each stick that has finger resolution) (see <a href="#">Regular Inspection on page 115</a> )	450L-AT-14
Test rod 30 mm (1.18 in.) (shipped with each stick that has hand resolution) (see <a href="#">Regular Inspection on page 115</a> )	450L-AT-30
Test rod 40 mm (1.57 in.) (see <a href="#">Regular Inspection on page 115</a> )	450L-AT-40
Termination plug, M12, 8 pin (see <a href="#">Cascading and Blanking on page 48</a> )	898D-81CU-DM
Termination cap, M12, 8 pin (see <a href="#">Cascading and Blanking on page 48</a> )	1485A-M12

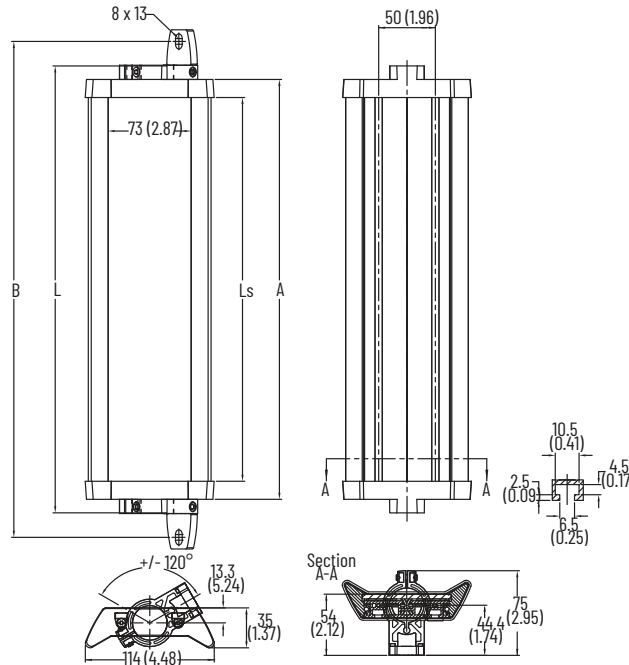


## Corner Mirror

Specially constructed glass mirrors for two-sided and three-sided safeguard applications (see [Mirrors on page 69](#) for installation).

**IMPORTANT** Each mirror reduces the maximum scan range by 10%. Each corner mirror is supplied with two end-cap mounting brackets (catalog number 442L-AF6106).

**Figure 131 - Dimensions of Narrow Mirror 440L-AM075 [mm (in.)]**



**Table 80 - Narrow Mirror (Width 75 mm [2.95 in.]) Short Range (0...4 m [0...13.12 ft])**

Cat. No.	Series	Description	L	LS	A	B	Protective Height 450L [mm]
440L-AM0750300	A	Mirror, 300 mm (11.81 in.), 0...4 m (0...13.12 ft)	396	340	372	440	300
440L-AM0750450	A	Mirror, 450 mm (17.72 in.), 0...4 m (0...13.12 ft)	546	490	522	590	450
440L-AM0750600	A	Mirror, 600 mm (23.62 in.), 0...4 m (0...13.12 ft)	696	640	672	740	600
440L-AM0750750	A	Mirror, 750 mm (29.53 in.), 0...4 m (0...13.12 ft)	846	790	822	890	750
440L-AM0750900	A	Mirror, 900 mm (35.43 in.), 0...4 m (0...13.12 ft)	996	940	972	1040	900
440L-AM0751050	A	Mirror, 1050 mm (41.34 in.), 0...4 m (0...13.12 ft)	1146	1090	1122	1190	1050
440L-AM0751200	A	Mirror, 1200 mm (47.24 in.), 0...4 m (0...13.12 ft)	1296	1240	1272	1340	1200
440L-AM0751350	A	Mirror, 1350 mm (53.15 in.), 0...4 m (0...13.12 ft)	1446	1390	1422	1490	1350
440L-AM0751500	A	Mirror, 1500 mm (59.05 in.), 0...4 m (0...13.12 ft)	1596	1540	1572	1640	1500
440L-AM0751650	A	Mirror, 1650 mm (64.96 in.), 0...4 m (0...13.12 ft)	1746	1690	1722	1790	1650
440L-AM0751800	A	Mirror, 1800 mm (70.86 in.), 0...4 m (0...13.12 ft)	1896	1840	1872	1940	1800

Figure 132 - Dimensions of Wide Mirror 440L-AM125 [mm (in.)]

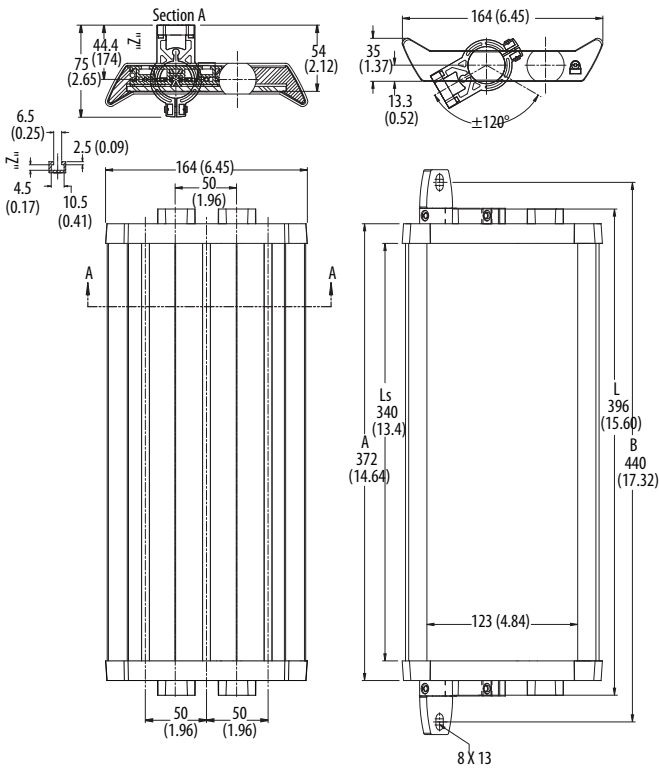
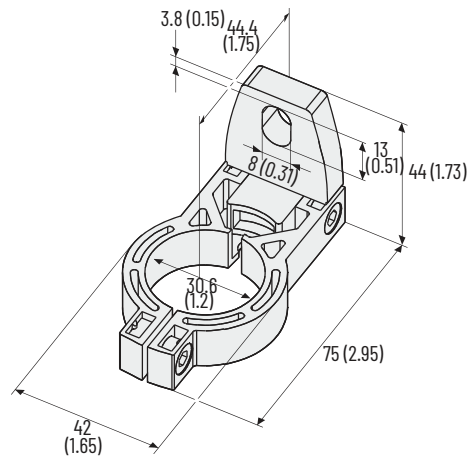


Table 81 - Wide Mirror (Width 125 mm [4.92 in.]) Long Range (4...15 m [13.12...49.21 ft])

Cat. No.	Series	Description	L	LS	A	B	Protective Height 450L [mm]
440L-AM1250300	A	Mirror, 300 mm (11.81 in.), 4...15 m (13.12...49.21 ft)	396	340	372	440	300
440L-AM1250450	A	Mirror, 450 mm (17.72 in.), 4...15 m (13.12...49.21 ft)	546	490	522	590	450
440L-AM1250600	A	Mirror, 600 mm (23.62 in.), 4...15 m (13.12...49.21 ft)	696	640	672	740	600
440L-AM1250750	A	Mirror, 750 mm (29.53 in.), 4...15 m (13.12...49.21 ft)	846	790	822	890	750
440L-AM1250900	A	Mirror, 900 mm (35.43 in.), 4...15 m (13.12...49.21 ft)	996	940	972	1040	900
440L-AM1251050	A	Mirror, 1050 mm (41.34 in.), 4...15 m (13.12...49.21 ft)	1146	1090	1122	1190	1050
440L-AM1251200	A	Mirror, 1200 mm (47.24 in.), 4...15 m (13.12...49.21 ft)	1296	1240	1272	1340	1200
440L-AM1251350	A	Mirror, 1350 mm (53.15 in.), 4...15 m (13.12...49.21 ft)	1446	1390	1422	1490	1350
440L-AM1251500	A	Mirror, 1500 mm (59.05 in.), 4...15 m (13.12...49.21 ft)	1596	1540	1572	1640	1500
440L-AM1251650	A	Mirror, 1650 mm (64.96 in.), 4...15 m (13.12...49.21 ft)	1746	1690	1722	1790	1650
440L-AM1251800	A	Mirror, 1800 mm (70.86 in.), 4...15 m (13.12...49.21 ft)	1896	1840	1872	1940	1800

**Figure 133 - 442L-AF6106 Swivel Mounting Bracket for Corner Mirrors**



## Mounting Columns

Two stands are available to mount sticks or mirrors. To mount the 450L safety light curtain transceiver stick at any height of the catalog number 440L-AMSTD, use the side-mounting kit (catalog number 450L-AM-SM).

**Figure 134 - 440L-AMSTD Mounting Column**

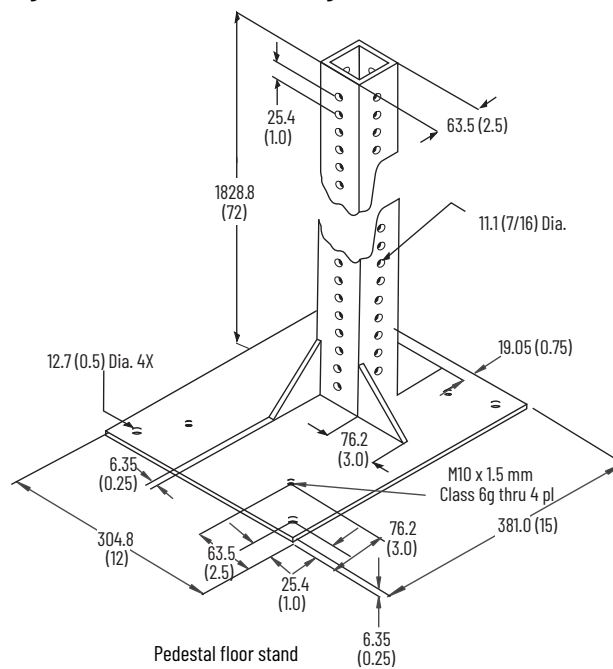
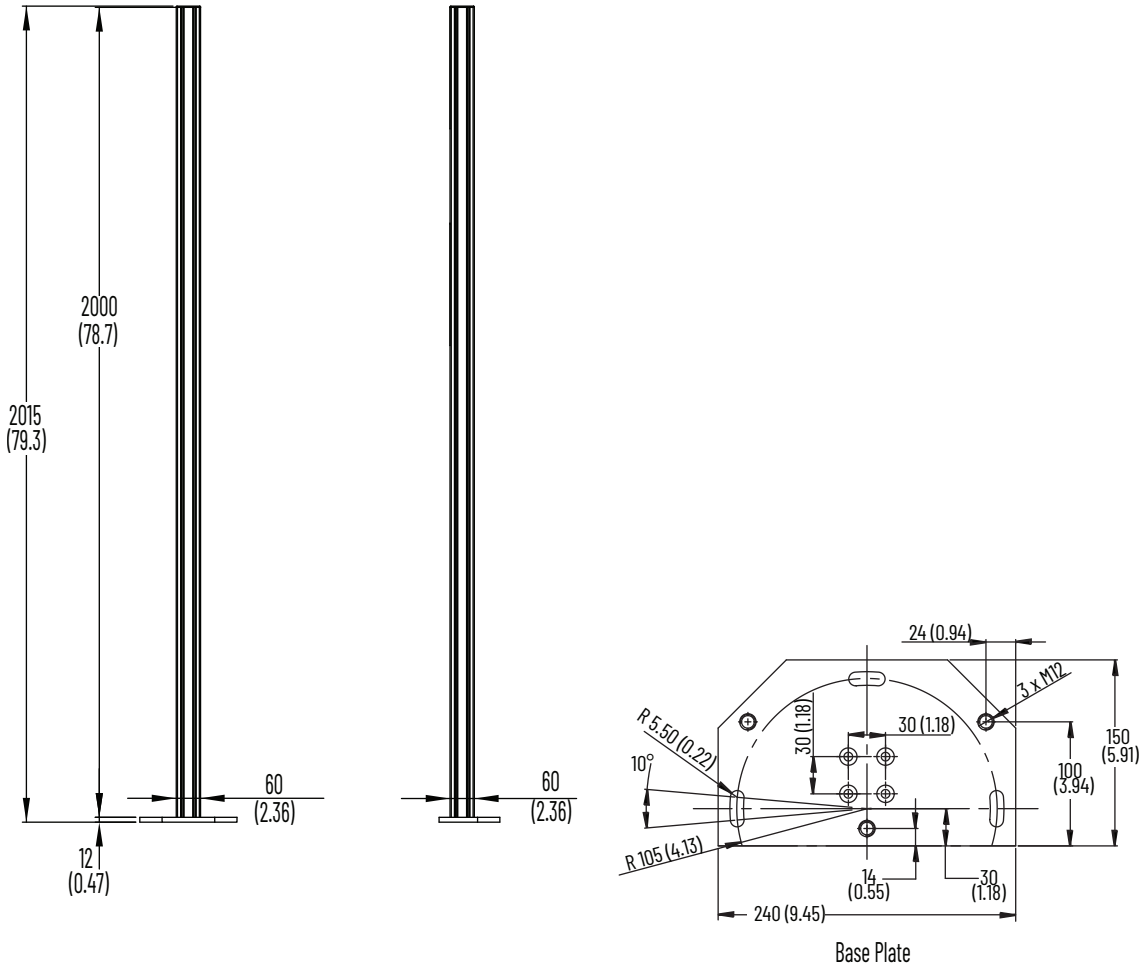


Figure 135 - 440L-AMSTD2M



**Alignment Tool and Bracket**

Optional laser-alignment tool (laser class 2) and alignment tool bracket.

Figure 136 - Laser Alignment Tool (Catalog Number 440L-ALAT)

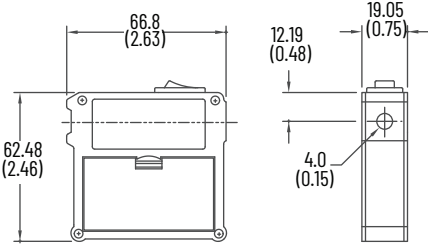
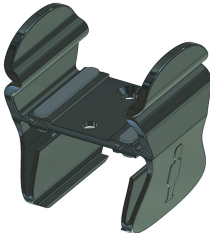
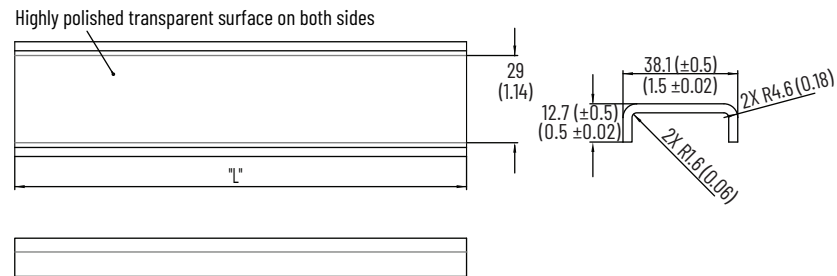


Figure 137 - Alignment Tool Bracket (Catalog Number 450L-ALAT-C)



## Weld Shields

**Figure 138 - Weld Shield Dimensions**



Weld shields for the GuardShield™ safety light curtain are sold in the same lengths as the protective field heights of the GuardShield safety light curtains. These polycarbonate weld shields are designed as disposable devices whose purpose is to help protect the front window of the GuardShield safety light curtain from damage.

One weld shield reduces the operation range by approximately 10%. For a 450L safety light curtain with finger resolution with a weld shield that is installed on each stick, the maximum range of operation reduces to: 7.0 m (22.97 ft) x 90% x 90% = 5.67 m (18.61 ft). The installation of the weld shields does not affect the minimum operation range.

**Table 82 - Weld Shield Kits**

Description	Cat. No.
Weld shield kit, two pieces per kit safety light curtain, length xxxx mm [xxxx: 0150...1950 mm (5.9...76.77 in.) in 0150 mm (5.9 in.) increments]	450L-AW-xxxx

The weld shield is supplied with precut hook and loop tape strips. Position the strips on the front window and attach the weld shields. Additional information about the weld shields is provided in the publication [450L-IN001](#).

## Cables

Depending on the plug-in, an M12 5-pin or a M12 8-pin connection cable is required to connect a transceiver stick.

Connection cables (also commonly referred to as cordsets) have an M12 socket at one end and the other end is free wires.

Extension cables (patchcords or interconnection cables) have one M12 plug at each end. Use the cables to extend the length of the connection cables or the cascading distance. Use only the M12 5-pin patchcords to connect a safety light curtain directly to a GuardShield safety light curtain ArmorBlock® module.

[Table 83](#) lists the required cables to connect a safety light curtain stick (cable color black). Check <https://www.rockwellautomation.com/products/hardware/allen-bradley/connection-devices/cables-and-cordsets/dc-micro-m12-/dc-micro-cordsets-and-patchcords.html> for additional lengths and/or cable jacket colors.

**Table 83 - Unshielded Connection Cables (Cordsets and Patchcords)**

Description	Cat. No.	
	M12 5-pin Socket <sup>(1)</sup>	M12 8-pin Socket <sup>(1)</sup>
No connector (cordset)	889D-F5BC-x	889D-F8AB-x
M12 plug connector (patchcord)	889D-F5BCDM-x	889D-F8ABDM-x <sup>(2)</sup>

(1) x = 2 (2 m [6.6 ft]), 5 (5 m [16.4 ft]), 10 (10 m [32.8 ft]), 15 (15 m [49.2 ft]), 20 (20 m [65.6 ft]), or 30 (30 m [98.4 ft]) for the desired length.

(2) Use this cable to extend the cable length between cascades.

**IMPORTANT** We highly recommend shielded cables for environments with high EMC (electromagnetic disturbances) influences.

Figure 139 - Patchcord Cable

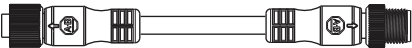
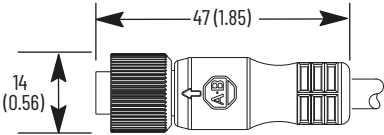


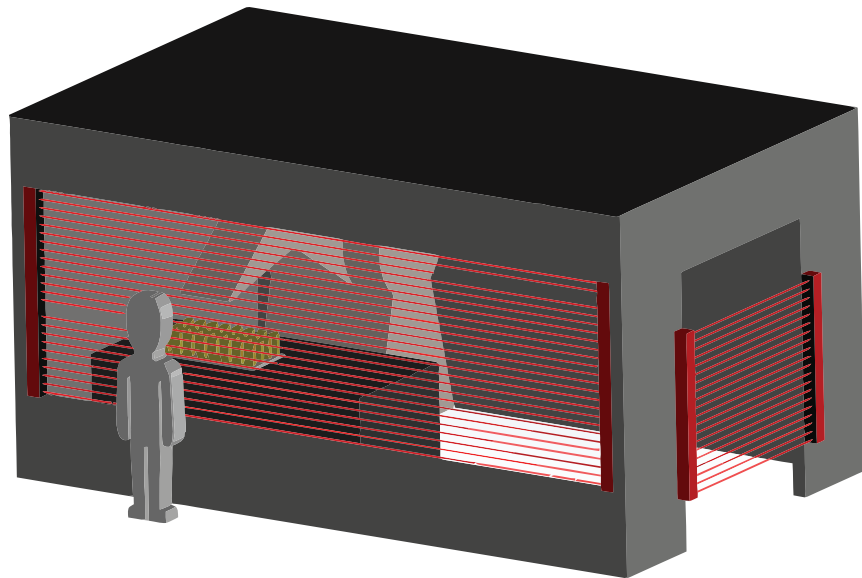
Figure 140 - M12 5-pin Plug Dimensions [mm (in.)]



## Typical Installations

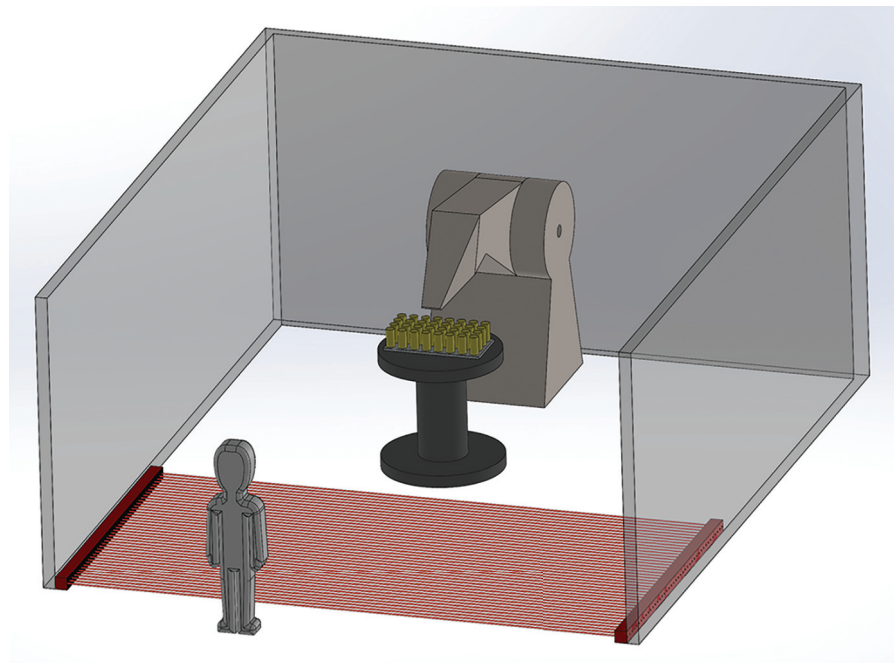
### Safety Light Curtain Mounted Vertically

Figure 141 - Point of Operation Control (POC) and Parameter Access Control (PAC)



### Safety Light Curtain Mounted Horizontally

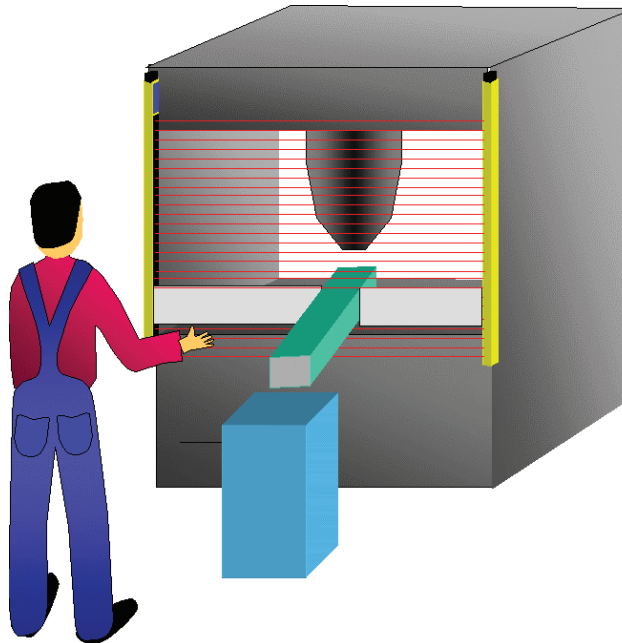
Figure 142 - Hazard Zone Safe Guard (Area Protection)



## Fixed Blanking Application

This application can include a sheet of metal that passes through the safety light curtain before an operation is performed to form the material. The safety light curtain permits the material at a specific width without causing the safety outputs to turn off. Certain applications cannot be protected in any other way. For example, if normal operation of a machine requires that material is permanently fed into the dangerous part of a machine, then a portion of the protective field is always interrupted, but the machine nevertheless continues to operate. The protection with blanking must come from a detailed risk analysis. Authorized personnel must confirm that in spite of blanking, the safety of the machine operator is adequately accounted for. When necessary, additional protective measures must be taken to shield the dangerous area. All Blanking modes can create holes in the protective field. These holes must be considered separately in the risk analysis.

**Figure 143 - Schematic Application for Fixed Teach-in Blanking**

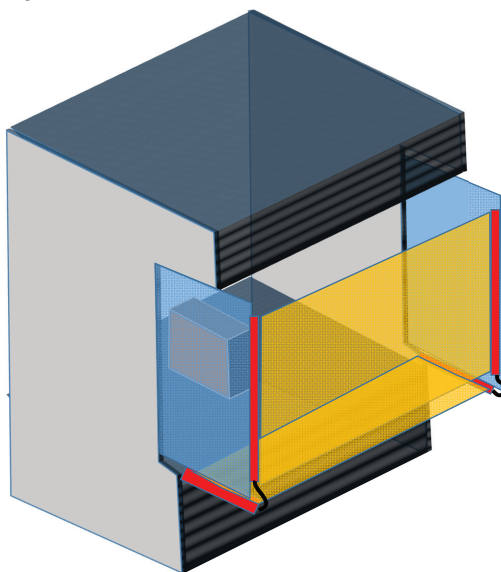


A typical example of fixed Teach-in blanking is the exit ramp on an automatic punch press. The punched part is transported out of the dangerous zone into a container. The ramp passes through the protective field, and without blanking would cause the machine to stop. The position of this ramp is monitored. During a tool change, the position of this ramp can vary slightly. This new position must be reconfigured in order for the application to run smoothly. It is possible this new position needs reconfiguration in order for the application to run smoothly.



## Cascading Application

Figure 144 - Example for a Setup with Two Cascaded Segments (L-shape Setup)



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