Operation Manual

GuardShield™ Micro400

Safety Light Curtain

Important User Information

Solid state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (Publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://literature.rockwellautomation.com/) describes some important differences between solid state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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

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

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

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.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.
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 consequences.
SHOCK HAZARD 	Labels may be on or inside the equipment (for example, drive or motor) to alert people that dangerous voltage may be present.
BURN HAZARD 	Labels may be on or inside the equipment (for example, drive or motor) to alert people that surfaces may reach dangerous temperatures.

Conditions required for proper use of the GuardShield Safety Light Curtain

Please make sure you read and understand these requirements before you select and install the GuardShield safety light curtain. GuardShield safety light curtains are point of operation safeguarding devices. These safety light curtains are intended to be used to provide point of operation safeguarding of personnel on a variety of machinery.

The GuardShield family of safety light curtains are general purpose presence sensing devices which are designed to protect personnel working on or near machinery.

The installation of the GuardShield safety light curtain must comply with all applicable federal, state and local rules, regulations, and codes.

It is the responsibility of the employer to properly install, operate and maintain the product as well as the machinery on which the GuardShield presence sensing device is installed.

GuardShield safety light curtains must be properly installed by qualified personnel.

GuardShield safety light curtains are presence sensing devices and will not protect personnel from heat, chemicals or flying parts. They are intended to signal a stop of hazardous machine motion when the sensing field is broken.

GuardShield safety light curtains can only be used on machinery which can be stopped anywhere in it's stroke or cycle.

GuardShield safety light curtains should never be used on full revolution clutched machinery.

The effectiveness of the GuardShield safety light curtains depend upon the integrity of the machine control circuit. The machinery that the GuardShield presence sensing device is installed should have control circuitry that is fail safe in design.

All stopping mechanisms for the machinery should be inspected regularly to ensure proper operation. The protected machinery must have a consistent reliable and repeatable stopping time.

ATTENTION! Failure to read and follow these instructions can lead to misapplication or misuse of the GuardShield safety light curtains, resulting in personal injury and damage to equipment.

Allen-Bradley
GuardMaster®

Content

1. Approvals and Conformity

TÜV Rheinland Product Safety GmbH performed the CE-type examination according to the machinery directive EC/98/37, appendix 4 and the respective standards IEC 61496.

The CE-conformity declaration and the product approval certification (TÜV) is available on line at www.ab.com/safety

These products are developed and manufactured following generally accepted rules in industry and in compliance with a total quality management system ISO 9001: 2000.

⚠ ATTENTION
GuardShield Micro 400 is only a safety protection device if all instructions in this manual and in the related documents are carefully followed and fully complied with. In addition the installer is responsible to comply with all local laws and standards.
Should some of these instructions not be carefully followed, serious injury or death may occur. The installer or system integrator will be fully responsible for a safe integration of the light curtain.

⚠ IMPORTANT: Save This Manual
This operation manual is part of the GuardShield Micro 400 safety light curtain system. It must be kept accessible during the whole life cycle for all personnel who are responsible for installation, operation, maintenance and safety control.

2. Introduction

GuardShield Micro 400 light curtains are Active Optoelectronic Protective Device (AOPD). Installed rigidly in a machine, they will detect the entry of personnel and can in this way safeguard dangerous areas before unauthorized interference or entry can occur. One of the special characteristics of the system is its extremely small profile.

To obtain a safety category 4, a GuardShield Micro 400 light curtain must be connected to an MSR 4X Series safety control module. A GuardShield Micro 400 system complies to annex IV of the European Machinery Directive EC/98/37 and is a certified type 4 safety light curtain according to IEC 61496-1, -2.

Furthermore the safety light curtain GuardShield Micro 400 in conjunction with the safety control unit MSR 4X Series fulfills the Safety Integrity Level 3 (SIL3) according to EN 61508.

2.1. System design

GuardShield Micro 400 light curtains consist of a transmitter and a receiver unit (*Figure 1*).

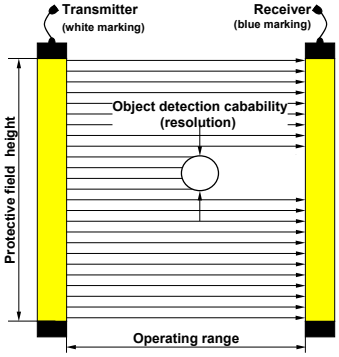


Figure 1: Main system parameter

The products are of modular construction, housed in very compact and sturdy extruded aluminum profiles.

Both the receiver and the transmitter come standard with a M12 micro quick disconnect connection cable. An overview of the available lengths of the connection cables are given in *Table 4*. An RJ45 connector guarantees a quick, uncomplicated and reliable connection to the MSR4X Series safety control unit.

The GuardShield Micro 400 is also offered in a “Cascadeable” configuration. GuardShield Cascadeable Micro 400 safety light curtains allow the interconnection of multiple segments of the Micro 400 safety light curtain with a common pair of safety outputs. This Cascadeable configurability of the GuardShield Micro 400 reduces overall system wiring and allows the GuardShield Micro 400 to be fitted into a variety of applications where the safety distances for mounting the light curtain may allow personnel to stand between the light curtain’s sensing field and the hazard or where multiple sided guarding is required and the use of corner mirrors is not possible.

2.2. Special features

The outstanding features of the GuardShield Micro 400 safety light curtains in combination with a MSR 4X Series safety control module are:

- ☑ Small profile of only 15 x 20 mm
- ☑ Finger protection (resolution: 14 mm)
- ☑ Hand protection (resolution: 30 mm)
- ☑ Integrated intensity display
- ☑ Range; 0 m to 5 m with a very compact design
- ☑ Profile length up to 1,200 mm
- ☑ Protective field height; in increments of 150 mm
- ☑ Max. number of beams: 255
- ☑ Unaffected by dust and dirt
- ☑ Easy installation
- ☑ Maintenance free

3. Applications and conditions

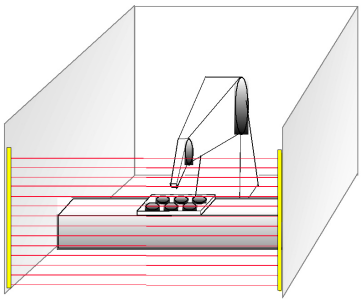
3.1. Areas of Application

GuardShield Micro 400 systems can be used as (*Figure 2*):

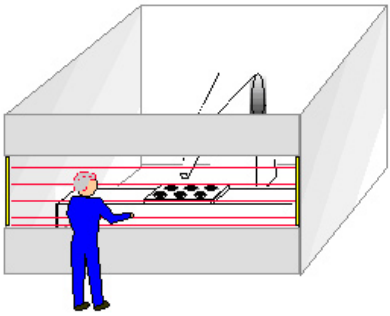
- ☑ Point-of-operation safeguarding
- ☑ Hazard area safeguarding
- ☑ Entry safeguarding (entry or exit)
- ☑ Combination of entry and hazard area safeguarding
- ☑ Combination of entry, point-of-operation and hazard area safeguarding

Typical areas of application are:

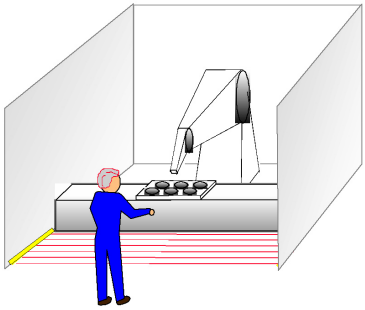
- ☑ Robotic assembly lines
- ☑ Welding robots
- ☑ Storage facilities
- ☑ Automated assembly stations
- ☑ Small presses
- ☑ Automated conveyor belts



Exit / Entry Safeguarding



Point-of-Operation Safeguarding



Hazardous Zone Safeguarding

Figure 2: Areas of Applications

In different industries:

- ☑ Automotive
- ☑ Apparatus
- ☑ Semiconductor materials
- ☑ Metal processing
- ☑ Paper processing
- ☑ Micro electronics
- ☑ Glass manufacturing

And anywhere working personnel need protection from dangerous machinery.

3.2. Application Restrictions

The application of a GuardShield Micro 400 system is not intended for the following usages:

- In an explosive environment (EX).
- In radioactive areas.
- Outside of a temperature range of 0 - 55°C.

3.3. Application Conditions

The correct use of a GuardShield Micro 400 requires certain precautions:

1. The control unit of the machine or system must be able to be electrically stopped and the stop time must be known.
2. The hazardous moving parts of the machine must always be stoppable and must achieve a safe position or complete standstill within the specified stop time of the machine.
3. When installing your GuardShield Micro 400, the only way to access the hazard must be through the sensing field of the GuardShield Micro 400.

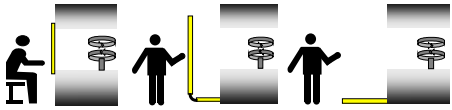


Figure 3: Correct applications

Figure 4: Incorrect applications

For the professional installation and operation, please consult the relevant laws and regulations. The safety officer of the manufacturing facility, the local authorities (OSHA in USA, HSE in GB), or the respective industry associations.

4. Principles of operation

The transmitter sends coded infrared light pulses (940 nm wavelength) to the receiver, which evaluates them. If an object at least the size of the resolution of the system penetrates the protective field, at least one light beam is interrupted. This interruption is evaluated by the MSR4X Series safety control unit and leads to the opening of the configured safety outputs. For the configuration see:

"Operation manual for MSR 4X Series

4.1. LED indicators

There is an integrated red and a green LED in the connection module to each profile (near the cable), which clearly signals the status of the protective field.

Figure 5: LED display

Table 1: LED meanings

LED	Description	Color	Meaning
Green	Light curtain OK	Off	Light curtain interrupted
		Green	Light curtain not interrupted
		Green Flashing	Intensity inadequate
Red	Light curtain status	Off	Light curtain not interrupted
		Red	Light curtain interrupted
		Red Flashing	Error

All indicators relevant to the control of light curtain systems are situated directly on the MSR 4X Series safety control module.

4.2. Cascading using extension modules

For simpler connection between neighboring protective fields, the GuardShield Micro 400 light curtain can be easily cascaded using extension modules (*Figure 6*). One such cascaded system allows the connection of e.g. front, back and topsides of a machine using only one light curtain system. The individual cascaded elements can be connected quickly and simply using the convenient M12 qd connectors.

Only the following limitations need to be considered:

- A maximum of 255 light beams per system
- Protection area extensions in increments of 150 mm
- **10 m maximum total length for light curtains, extension modules and connection cable combined** (*Figure 7*)
- Only a GuardShield Micro 400 prefabricated cable may be used between the light curtain and the MSR 4X Series safety control module.

The extension modules are connected to the main system via M12 qd connection cables.
The customer defines:

- Length of the connection cable
- Protective field height and Resolution
- Length of the extension cable
- Extension modules (protective field height)

A complete mounting kit and test rods are provided standard with every system.

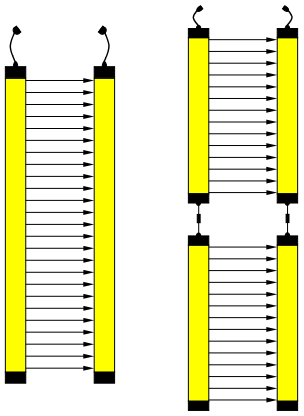


Figure 6: Example for standard and cascading systems

Note:
In cascaded systems only the LED in the first safety light curtain will illuminate (closest to the safety controller).

4.3. Cascadeable System

A GuardShield Cascadeable Micro 400 safety light curtain system is comprised of one or two pair of Cascadeable Micro 400 light curtains as well as a standard Micro 400 pair as the last segment pair in the Cascaded system.

⚠ **ATTENTION:** The standard GuardShield Micro 400 must always be the last segment in a Cascaded Micro 400 system.

The GuardShield Cascadeable Micro 400 system operates as a single light curtain pair with a common set of OSSDs. Each segment pair is connected in series making the complete system's response time the sum of each segment pair, plus the response time of the MSR 42 and other safety devices in the stop circuit.

GuardShield Micro 400 cascaded pairs are offered in both 14mm and 30mm resolutions in limited protected heights. It is possible to mix 14mm and 30mm resolution pairs in a Cascaded Micro 400 system.

The Cascadeable Micro 400 safety light curtains are ordered as pairs (transmitter and receiver) and are shipped under one catalog number.

After selecting the appropriate light curtain catalog numbers for a Cascaded Micro 400 system, select the standard Micro 400 pair as the last segment in the cascaded system and also select interconnecting patch

A Cascadeable pair of GuardShield Micro 400 light curtains has a 20 inch (500mm) pigtail with a female M12 qd on the bottom of the Micro 400 light curtain and a 20 inch (500mm) pigtail with a male M12 qd attached to the top of the Micro 400 transmitter and receiver.When connecting two cascadeable segments together, the resultant cable length between segments is 40 inches (1000mm).
If an additional length between segment pairs is required, Rockwell offers an M12 to M12 patch cord in 1 meter and 3 meter lengths. (445L-AC8PC1 or 445L-AC8PC3).

⚠ **ATTENTION**: The maximum Cascaded Micro 400 system length can not exceed 10 meters as measured between the RJ45 connection at the MSR 42 Controller to the last beam in the standard Micro 400, including all cable lengths. Also, in addition to the 10M maximum system length, the maximum number of beams in a cascaded Micro 400 system can not exceed 255 beams.

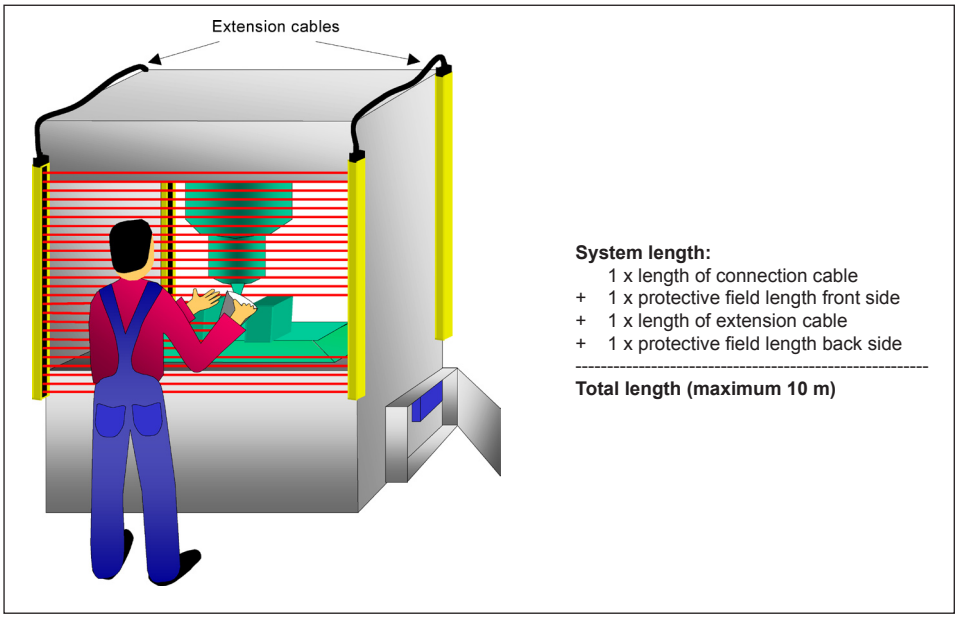


Figure 7: Connection of the back and front sides of a machine with only one GuardShield Micro 400 cascading system. The total length of the system is equal to the individual protective field lengths, plus connection and extension cables added together.

5. Installation

5.1. Regulations and standards

The compliance with the fundamental health & safety requirements as detailed in the EU Machinery Directive EC / 98/37 and control reliability according to OSHA 29 CFR 1910.212, ANSI B11.19 and ANSI B11.20 has to be achieved with the correct implementation of safety components. With the help of a hazard analysis as laid out in EN 292 and EN 1050, ANSI / RIA 15.06, etc., a comprehensive safety evaluation has to be made when designing and planning machinery and machinery control equipment. If Active Optoelectronic Protective Devices (AOPD) are used, the required safety distances, sufficient protective height and all application conditions must be considered during the planning phase.

5.1.1. IEC Safety distance to danger point

According to the standards, the GuardShield Micro 400 light curtain and the point of danger must be separated by a defined safety distance. This minimum distance safeguards that the danger point may only be reached after the hazardous motion has stopped. The safety distance (see also standards EN 294, EN 775, EN 811, EN 999) depends on

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

The approaching speed is dependent on safety distance **S** as follows

S ≤ 500 mm, speed = 2 mm / ms
S > 500 mm, speed = 1.6 mm / ms

In cases of 'vertical' installation of the light curtains within an industrial environment and a resolution of the light curtain system **d**, (where 14 mm ≤ **d** ≤ 40 mm), the safety distance **S** to the point of danger is calculated according to the formula:

For 100 mm ≤ S ≤ 500 mm:
S = 2 mm / ms x T + 8 x (d - 14)

For S > 500 mm
S = 1.6 mm / ms x T + 8 x (d - 14)

S = Safety distance in mm
T = Total response time in ms (machine stop time + GuardShield Micro 400 response time + MSR 4X Series safety controller response time + any configured delay time).
d = Resolution of GuardShield Micro 400 in mm

More detailed information regarding safety distance and safety height can be found in EN 999 or EN 294, depending on mounting type of application.

The physical resolution of a GuardShield Micro 400 light curtain system is calculated by the distance from lens to lens + the lens diameter. This resolution can be found on the product label. The current resolution is always found on the last configuration printout of the safety control unit.

5.1.2. North American Safety Distance Formulas

US Safety Distance Formula

ATTENTION: The Guardshield safety light curtains must be mounted at a sufficient distance from the pinch point or point of operation hazard so that the machine stops before a person's finger, hand, arm(s) or body reaches the hazard.

This distance, referred to as the safety distance, must be properly calculated prior to determining the safety light curtain protective height and mounting the light curtains on the machine. Failure to properly calculate this safety distance may result in operator injury.

IMPORTANT: Regardless of the calculated safety distance, GuardShield safety light curtains should never be mounted closer than six inches from the point of operation or pinch point hazard.

In the United States there are two formulas that are used to properly calculate the safety distance. The first, the OSHA formula, is the minimum requirement for the calculation of the safety distance. For most applications, Rockwell Automation recommends the ANSI formula, which incorporates additional factors to be considered when calculating the safety distance.

OSHA Safety Distance Calculation Formula

The OSHA safety distance formula as specified in CFR Subpart O 1910.217 is as follows:

$$Ds = 63 \times T_S$$

D_s Safety Distance

63 Is the OSHA recommended hand speed constant in inches per second

T_s Is the total stop time of all devices in the safety circuit, measured in seconds. This value must include all components involved in stopping the hazardous motion of the machinery. For a mechanical power press it is the stopping time measured at approximately the 90° position of the crankshaft rotation.

Note: The T_S 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's 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 will result in insufficient safety distance for the application. This may result in operator injury.

The ANSI Safety Distance Formula

The ANSI safety distance formula is as follows:

$$D_S = K \times (T_S + T_C + T_r + T_{bm}) + D_{pf}$$

D_s 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. NOTE: ANSI B11.19 1990 E4.2.3.3.5 states "The value of the hand speed constant, K, has been determined by various studies and although these studies indicate speeds of 63 inches/second to over 100 inches/second, they are not conclusive determinations. The employer should consider all factors, including the physical ability of the operator, when determining the value of K to be used."

T_s Stop time of the machine tool measured at the final control element.

T_c Response time of the control system

Note: T_s and T_c are usually measured by a stop time measuring device.

T_r Response time of the presence sensing device (safety light curtain) and its interface, if any. This value is generally stated by the device manufacturer or it can be measured by the user.

T_{bm} Additional time allowed for the brake monitor to compensate for variations in normal stopping time.

D_{pf} Depth penetration factor. It is an added distance to allow for how far into the protective field an object, such as a finger or hand, can travel before being detected. D_{pf} is related to the safety light curtain's object sensitivity. Object sensitivity is the smallest diameter object which will always be detected anywhere in the sensing field.

5.1.3. Height of protective field

The protective field is clearly visible on the transmitter and receiver portion of the light curtain, as the blue / silver area with the optical lenses.
The protective field height **L** and the standard resolution **d** can be taken from the product label and the selection table of chapter 7.2 and 7.3.
The measurements of the GuardShield Micro 400 profile end caps are chosen so that the resolution can extend to the end of the light curtain (*Figure 8*). Depending on the application it must be checked, whether possible mirroring (e.g. a table top) has an effect on this resolution (chapter 5.1.5).

Figure 8: Resolution at the end of the light curtain (assuming no mirrored reflections)

When selecting or installing a light curtain, the pre-requisites outlined in *Figure 3* must be kept. More detailed information regarding installation height is described in EN 294.

5.1.4. Response time - light curtain

The GuardShield Micro 400 light curtain system (Light curtain and MSR4X Series safety control module) has various configurable operating modes.
The standard response time of the light curtain (t_{R-BWS}) is dependant on the physical resolution and is shown on the product label. An overview of the resolution table is also given in chapter 6.2 and 6.3.

Important information:
The response time of the GuardShield Micro 400 light curtain system is dependent on the operating mode. The minimum safety distance from the danger point to the light curtain for the current operating mode may never be undercut, and when modified, must be adapted to reflect any changes to the response time and resolution.

5.1.5. Response time – safety control units

The response time of an MSR 4X Series safety control unit is described in the corresponding configuration control document.

5.1.6. Distance to reflective surfaces

Reflective surfaces, which may cause reflections within the transmitter and receiver aperture angles, i.e. an interruption of the protective field, would not be recognized (*Figure 9*).
Should reflective surfaces arise, i.e. aluminum container passing near the light curtain or if the danger point itself is reflective, i.e. a steel blade, the safety distance must be increased, such that no reflective surface lies within the distance $\mathbf{S_2}$.

The increase of the safety distance is dependant of the actual operation range **R** according to IEC 61496 and may be calculated as follows:

GuardShield Micro 400:
S_2 = 72 mm for R < 3 m
S_2 = R x 0.0219 for R ≥ 3 m

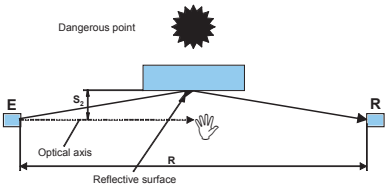


Figure 9: Distance to reflective surface

5.1.7. Multiple light curtain arrangement

When using several optoelectronic safety devices e.g. GuardShield Micro 400 systems in the same application, the systems should be installed in a way such that they cannot interfere with each other. Care must be taken so that each receiver only receives light from its own transmitter (*Figure 10*).

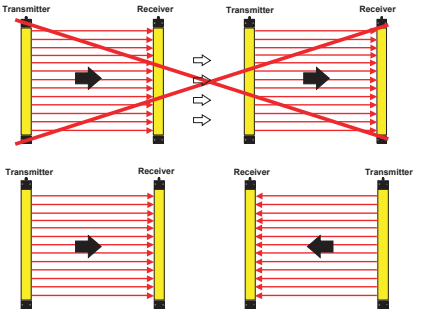


Figure 10: Multiple light curtain arrangement

The safety light curtain has been thoroughly tested against foreign light interferences according to the stringent requirements of IEC 61496. Nevertheless any direct interference into the receiver with other infrared sources like through beam photoelectric sensors, laser scanner, transmitters etc. or flashing warning lamps should be avoided.

5.2. Mechanical installation

Be aware that a rigid and flat base, isolated against shock and vibration should be selected to mount the GuardShield Micro 400. This in combination with the standard mounting bracket set will keep the initial alignment during operation even in harsh industrial environments. For the installation height and safety distance, please refer back to the previous information given.

Likewise, be aware that the transmitter and receiver connection cables must always be located on the same end of the protective field. If this is not the case, the protective field will have dangerous unprotected areas (*Figure 11*).

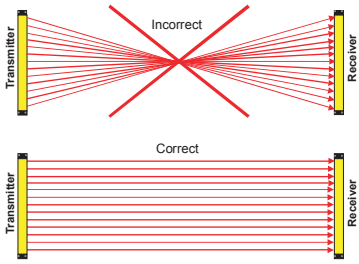


Figure 11: Layout of the transmitter / receiver

5.2.1. Mounting brackets

The backside of the light curtain profile has continuous grooves to fix the mounting brackets at any position along the light curtain housing.

Further brackets may be obtained as an option, to offer the possibility of mounting on the side or in the centre (*Figure 12*).

5.2.2. Alignment procedure

The alignment procedure can be made easier with the use of integrated indicator LEDs (*Table 1*).

1. Mount the transmitter and receiver with the previously mentioned brackets. Make sure that the longitudinal axis of both are oriented parallel. For a vertical or horizontal mounting a level might help to find the correct position.
2. Take care that the receiver and transmitter are oriented in the same direction. This means, the beginning of the protective field which is found next to the cable which leads to the MSR 42 safety control unit, must be located at the same end of the protective field. It is not allowed to mount the GuardShield Micro 400 systems turned 180° (*Figure 11*).
3. After aligning the longitudinal axis of the transmitter and receiver, rotate the receiver along the longitudinal axis to find the receiving angle. During rotation, the receiving angle is shown by the illumination of the green LED in the GuardShield Micro 400 light curtain. If this green LED is blinking, the amount of light detected by the receiver is not sufficient for stable operation. After realigning the light curtain, the protective field must be briefly interrupted.
   After removing the object from the protective field, a sufficient intensity level is indicated by the illumination of the green LED in the light curtain.
4. Adjust and mount the receiver at the centre of this operating angle.
5. After aligning the receiver, rotate the transmitter to find the emitting angle. During rotation, the emitting angle is shown by the illumination of the green LED in the GuardShield Micro 400 light curtain
6. Adjust and mount the transmitter at the centre of this operating angle.
7. Control the protective function of the GuardShield Micro 400 light curtain by using the test rod, according to *Figure 13*. The insertion of this rod into the protective field at any position has to lead to a protective field interruption (illumination of the red LED in the GuardShield Micro 400).

Standard Profile

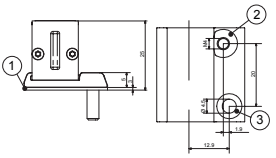
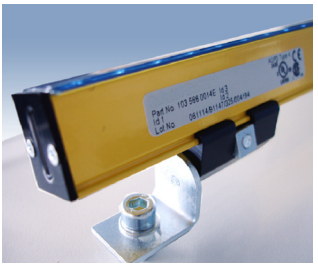
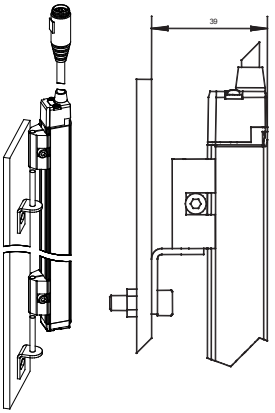
Mounting kit wide (optional) *4 pcs per kit* For side mounting from the front with one fastening and one locking screw ① - Distance plate Not necessary for wall mounting (see comment stated below), only necessary for standard profile mounting. ② - Locking screw ③ - Hole for fastening screw Note: When fitting without distance plate an opening for the retaining screw must be provided in addition to the hole for the fixing screw. Rockwell part number: 445L-AF6145		
Mounting kit 180° (standard) • Ideal for mounting in the same axis as the light curtain • Ideal for mounting from the side Rockwell part number: 445L-AF6143		

Figure 12: Mounting brackets for the standard profile

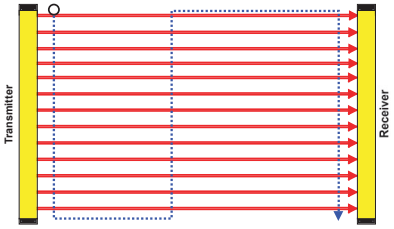


Figure 13: Correct testing of a protective field using a test rod

5.3. Electrical installation

5.3.1. Connection diagram

The connection of a GuardShield Micro 400 to a machine controller must occur using an MSR 4X Series safety control module.
The speed and ease of the connection can be improved by using connection cables provided by Rockwell Automation (*Table 4*).

The connection cables are offered with color coded rings attached to each cable, remove one color ring from the cable as necessary:

White – Transmitter
Blue – receiver

5.3.2. Test

According to EN 954-1 when connecting a MSR 4X Series safety control unit in the context of a risk assessment it may not be necessary to conduct tests with a higher level controller.

5.3.3. Power supply

The power supply and the evaluation of the protective field of a GuardShield Micro 400 light curtain can fundamentally only be carried out through a MSR 4X Series control unit.

5.3.4. Bringing into operation

The transmitter and receiver units must be connected to a MSR 4X Series safety control unit: (GuardShield Micro 400 to MSR 4X Series safety control module). then the supply voltage may be connected to the control unit. After power-up, there is an automatic self-test (duration < 5 s) of all sys-tem components.

Provided the protective field is not interrupted and the transmitter and receiver are correctly aligned, the self-test of the GuardShield Micro 400 system will be successfully ended. This is indicated by the illumination of the green LED on the GuardShield Micro 400 light curtain (*Figure 5*).

If the light curtain detects an interruption in the protective field after a successful power-up, the safety contacts of the controller unit will open within the sum of

- the response time for the light curtain

and

- the response time for the control unit

In addition the green LED turns off and red LED turns on (see *Table 1*).

5.3.5. Outputs

A GuardShield Micro 400 safety light curtain pair has no outputs, which could be used for direct connection to a machine controller. Every connection to a machine controller or a safety circuit is done through an MSR 4X safety control unit. This means that these may only be connected to the machine controller for information purposes. They may under no circumstances be used within the safety circuit of the machine.
The status outputs of the control units are not safety related.

5.3.6. Trouble shooting

With the help of the LED display, all system conditions and faults of the GuardShield Micro 400 systems are indicated.

The possible conditions of the LED are shown in *Table 1*. The conditions of the status outputs may also be obtained from the operation manual of the MSR 4X Series safety control module.

External faults: These fault conditions can be reduced when the installation is rectified:

1. None or not enough supply voltage to the safety control unit.
2. Transmitter and receiver not correctly aligned
3. Transmitter and receiver light curtains are reversed in the MSR 4X Series safety control module.
4. Incorrect assembly in the case of cascaded systems.
5. Connectors make poor contact.

Internal faults (LED of the GuardShield Micro 400 blinking red):

1. Examine connections of transmitter and receiver.
2. Turn the supply voltage off and on again.

If the LED of the safety light curtain is still blinking red, please contact Rockwell Automation technical support.

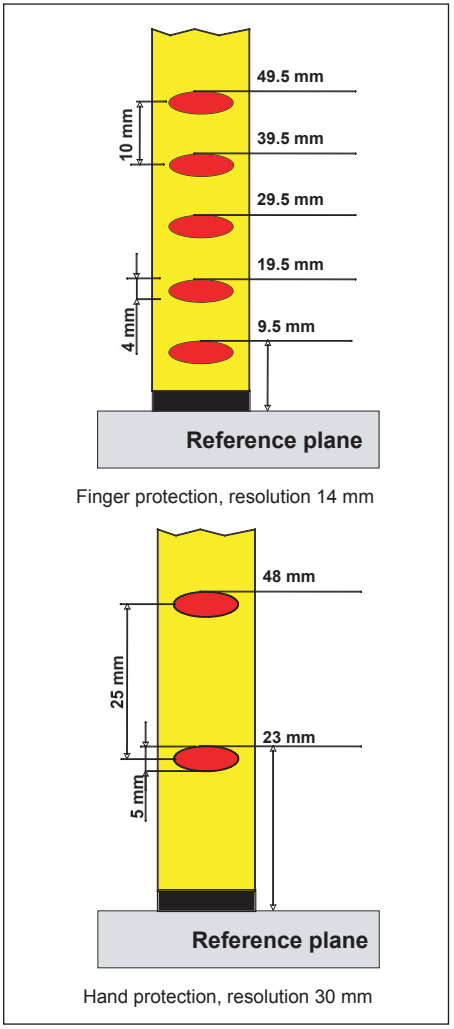


Figure 14: Beam geometry for systems with finger protection and for systems with hand protection

6. Selection of a safety light curtain

6.1. Check list

To select a GuardShield Micro 400 safety light curtain, please follow the questions below:

1. Regulations
Look up carefully the current regulations and codes applicable to the particular application in your country. Local authorities and professional organizations as well as Rockwell Automation representatives will provide necessary assistance.

USA: Occupation Safety and Health Administration OSHA, others like ANSI, RIA and further professional organizations.
GB: Health and Safety Executive HSE, safety consultants and professional organizations.

2. Protective field
Determination of
- Required operating range (up to 5 m)
- Protective field height (in increments of 150 mm)
- Resolution (object detection capability 14 mm and 30 mm)
- Position of the light curtain (e.g. length of protective fields for cascaded systems, length of extension cables)
- Length of connection cable to GuardShield Micro 400 or a MSR 4X Series safety control units

Operating range, protective field height and special configuration must be chosen so that the danger points are only accessible through the protective field.

3. Response time
The response time $t_{R\text{-}BWS}$ of the GuardShield Micro 400 can be found on the product label and in the selection table in the next section.

The response time of one system, which has cascaded light curtains, (chapter 6.2 and 6.3) is the sum of all of the beams (sum of the total control height A). The response time of the complete system can be found on the product label.

Example:
To safeguard a machine, a cascaded system must be made up of horizontal and vertical segments to prevent someone from standing between the vertical light curtain and the danger point. The vertical part has a protective height of 900 mm; the horizontal module is 600 mm. The response time of this set-up is identical to a light curtain with the protective height of 1'500 mm.

4. Corner mirrors
Using corner mirrors allows the combination one protective field with another. Each corner mirror reduces the range by approx. 15 %.

Table 2

GuardShield Micro 400 Protective Height (mm)	Narrow Corner Mirror, short range 0...4M	Catalog Number	Wide Corner Mirror, Long range 4...15M	Catalog Number
150		440L-AM0750300		440L-AM1250300
300		440L-AM0750300		440L-AM1250300
450		440L-AM0750450		440L-AM1250450
600		440L-AM0750600		440L-AM1250600
750		440L-AM0750750		440L-AM1250750
900		440L-AM0750900		440L-AM1250900
1050		440L-AM0751050		440L-AM1251050
1200		440L-AM0751200		440L-AM1251200

6.2. Selection table (14 mm resolution)

Table 3

Catalog No.	Protection height L (mm)	Total length (mm)[2]	Max. response time $t_{R\text{-}BWS}$ (ms) [3]	Weight per system incl. packaging (ca. kg)	Packaging L x W x H (mm)
445L-P4C0150FP	150	170	≤ 14.6	1.6	770 x 165 x 90
445L-P4C0300FP	300	320	≤ 18.5	1.7	770 x 165 x 90
445L-P4C0450FP	450	470	≤ 22.4	1.8	770 x 165 x 90
445L-P4C0600FP	600	620	≤ 26.3	1.9	770 x 165 x 90
445L-P4C0750FP	750	770	≤ 30.2	2.3	1415 x 165 x 90
445L-P4C0900FP	900	920	≤ 34.1	2.4	1415 x 165 x 90
445L-P4C1050FP	1050	1070	≤ 38.0	2.5	1415 x 165 x 90
445L-P4C1200FP	1’200	1’220	≤ 41.9	2.7	1415 x 165 x 90

6.3. Selection table (30 mm resolution)

Table 4

Catalog No.	Protection height L (mm)	Total length (mm)[1]	Max. response time $t_{R\text{-}BWS}$ (ms) [3]	Weight per system incl. packaging (ca. kg)	Packaging L x W x H (mm)
445L-P4E0150FP	150	170	≤ 12.4	1.6	770 x 165 x 90
445L-P4E0300FP	300	320	≤ 13.9	1.8	770 x 165 x 90
445L-P4E0450FP	450	470	≤ 15.5	1.8	770 x 165 x 90
440L-P4E0600FP	600	620	≤ 17.0	2.0	770 x 165 x 90
445L-P4E0750FP	750	770	≤ 18.5	2.3	1415 x 165 x 90
445L-P4E0900FP	900	920	≤ 20.2	2.4	1415 x 165 x 90
445L-P4E1050FP	1050	1070	≤ 21.7	2.4	1415 x 165 x 90
445L-P4E1200FP	1’200	1’220	≤ 23.3	2.7	1415 x 165 x 90

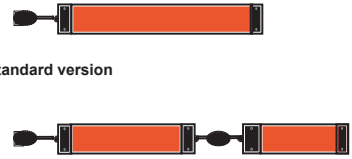
Notes:
1) Total length = Length from cable input to the end cap inclusive
2) The response time for GuardShield Micro 400 with MSR 42.
3) The mentioned response times are maximum values. The times depend on the controller type and the configuration. The real response time may be faster.

Table 5

Resolution	Catalog No.	Protection height L (mm)	Total length (mm)	Max. response time $t_{R\text{-}BWS}$ (ms)	Weight per system incl. packaging (ca. kg)	Packaging L x W x H (mm)
14mm	445L-C4C0600FP	600	620	≤ 26.3	1.9	965 x 160 x 90
	445L-C4C0900FP	900	920	≤ 34.1	2.4	1,410 x 160 x 90
	445L-C4C1200FP	1,200	1,220	≤ 41.9	2.7	1,410 x 160 x 90
30mm	440L-C4E0150FP	150	170	≤ 12.4	1.6	965 x 160 x 90
	445L-C4E0300FP	300	320	≤ 13.9	1.8	965 x 160 x 90
	445L-C4E0600FP	600	620	≤ 17	2.0	965 x 160 x 90
	445L-C4E0900FP	900	920	≤ 20.2	2.4	1,410 x 160 x 90
	445L-C4E1200FP	1,200	1,220	≤ 23.3	2.7	1,410 x 160 x 90

6.4. Cascaded systems

All of the GuardShield Micro 400 light curtains mentioned in the previous table can be cascaded by interconnecting host modules. This means, there can be multiple protective fields using simple plug-in connections to combine them with one another (*Figure 15*). Using the cascaded system, it is possible for example to monitor the front and backsides of a machine using only one light curtain system (*Figure 7*).



Standard version

Two protective fields (Cascading)

Figure 15: Possible configurations

Note:
For cascaded systems the light curtain LED's will only illuminate in the first light curtain portion (closest to the safety control unit.

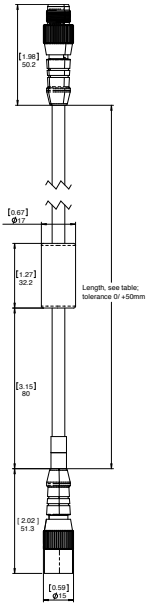
6.5. Accessories / components

Table 6

ROCKWELL Part no.	Description
445L-AC8RJ3	Connection cable, M12 to RJ45, 3 m
445L-AC8RJ5	Connection cable, M12 to RJ45, 5 m
445L-AC8RJ8	Connection cable, M12 to RJ45, 8 m
445L-AC8PC1	Patch cord for Cascaded system, M12, 8 pin, 1M
445L-AC8PC3	Patch cord for Cascaded system, M12, 8 pin, 3M
445L-AF6145	Mounting kit flat (4 pieces / set)
445L-AF6143	Mounting kit 180° (4 pieces / set)
440R-P226AGS-NNR	MSR 42 Safety control module
440R-P4NANS	Safety control module extension unit

6.6. Micro 400 Cascadeable Patch Cord

The Cascadeable Micro 400 are offered with a 500mm integrated cable with M12 connector attached to both the top and the bottom of the light curtains. When interconnecting two cascadeable light curtains, the resulting cable length between light curtains is 1000mm. If it is necessary to have a longer cable length between light curtains, Rockwell Automation offers patch cords in 1M and 3M lengths.



Cable Types		
Name/ Description	**Length [mm]**	**Length [inch]**
Cable, 1m, M12-M12, 8pol, M-F	1000	39.37
Cable, 3m, M12-M12, 8pol, M-F	3000	118.11

445L-AC8PC1	1 Meter M12 to M12 Micro 400 cascadeable patch cord
445L-AC8PC3	3 Meter M12 to M12 Micro 400 cascadeable patch cord

Figure 16

7. Inspection and Service

The light curtain is built without moving parts and so needs limited preventative maintenance.

7.1. Cleaning

The optical windows should be cleaned with a soft and damp cloth depending on the degree of dirt build-up.

ATTENTION: In no case should aggressive or abrasive materials be used to clean the GuardShield Micro 400, otherwise the range could be reduced and disturbances may occur.

7.2. Inspections

Depending on the valid regulations, the light curtain must be periodically tested by qualified and trained persons.
The function of the light curtain can be tested with the supplied test rod, which has a diameter corresponding to the resolution of the light curtain. The status is indicated through the LED display in the GuardShield Micro 400 safety light curtain.

The following statuses are possible:

Table 7

Action	Light curtain LED
Light curtain on	green
Move test rod slowly over the entire protective field	red
Remove test rod from protective field	green

The test rod should be moved through the protective field according to the diagram shown in *Figure 13*.

7.3. Decommissioning

The safety light curtain may only be removed, if the machinery or assembly line will be closed definitively and may not be brought back into operation without the use of tools.
If the light curtain has to be disposed of, it can easily be disassembled and separated using state of the art technology and following valid national regulations be recycle.

8. Product labels

Necessary information may be found on two product labels, which are attached to both the transmitter as well as the receiver portion of the light curtain.

Explanation of terminology:

Table 8

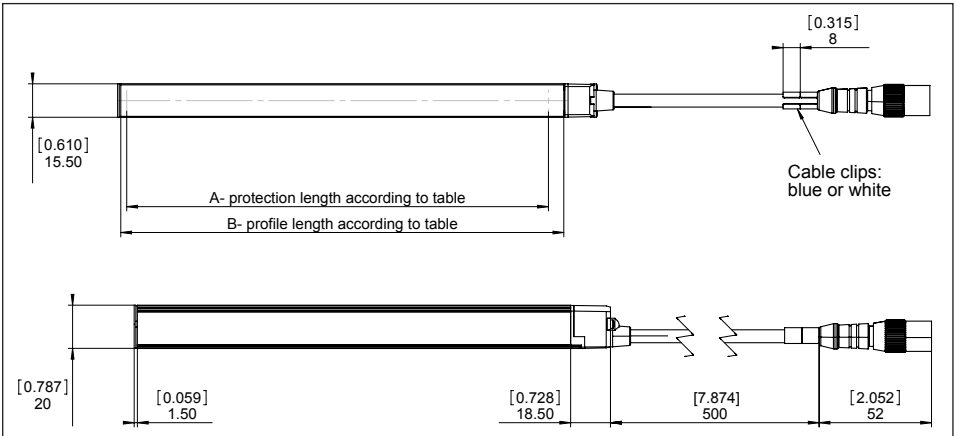
Receiver	Receiver
Transmitter	Transmitter
Type	Classification of the device
AOPD Type	Active optoelectronic protective equipment type 2 or type 4 based on IEC 61496-1, -2
Operating Range	Maximum operating range
Protective Height	Protective height
Resolution	Detection capability
Enclosure Rating	IP – enclosure rating
Response time	Response time $t_{R\text{-}BWS}$ for the protective process

9. Technical Data

Table 9

Description	Value	Comments
Protective height **L**	150 ... 1'200 mm	See *Table 3* and *Table 4*
Max. system length	1800 mm	Total of Cascaded segments
Max. system length GuardShield Micro 400: From controller to the last emitting or receiving element	10 m	See chapter 4.2, *Figure 7*
Operating range	0 ... 5 m	Resolution 14 and 30 mm
Object detection capability (resolution)	14 mm and 30 mm	
Max. number of beams	255	
Equipment class	III	VDE 0106 part 100
Time for self check when switching on U_{sp}	< 5 s	
Response time t_{R-BWS}	See *Table 3* and *Table 4*	
Connector	M12 qd and RJ45	
Connection cable	Standard 3, 5 and 8 m	Cable jacket: PVC
Safety category GuardShield Micro 400	Category 4 of EN 954-1	GuardShield Micro 400 in combination with a MSR 4X Series safety control module
Standards	IEC 61496 part 1 and 2	
EMC	IEC 61496 part 1	
Approvals	TÜV, CSA, UL, Sil3[1)]	Certificates @www.ab.com/safety
Enclosure rating	IP54	
Temperature range	0° ... +55°C -20° ...+70°C	Operation Storage and transport
Relative air humidity	15 ... 95%	Not condensing
Housing	15 x 20 mm	Extruded aluminum profile
Optical window	Polycarbonate	
Enclosure treatment	Polyester powder coated	Silicon free
Dimensions		See *Table 3* and *Table 4*
Weight		See *Table 3* and *Table 4*
Vibration resistance	per IEC 61496, IEC60068-2-6 frequency 10-55Hz, Amplitude 0.35mm	
Shock	per IEC 61996, IEC 60068-2-29 Acceleration 10g, Duration 16ms	

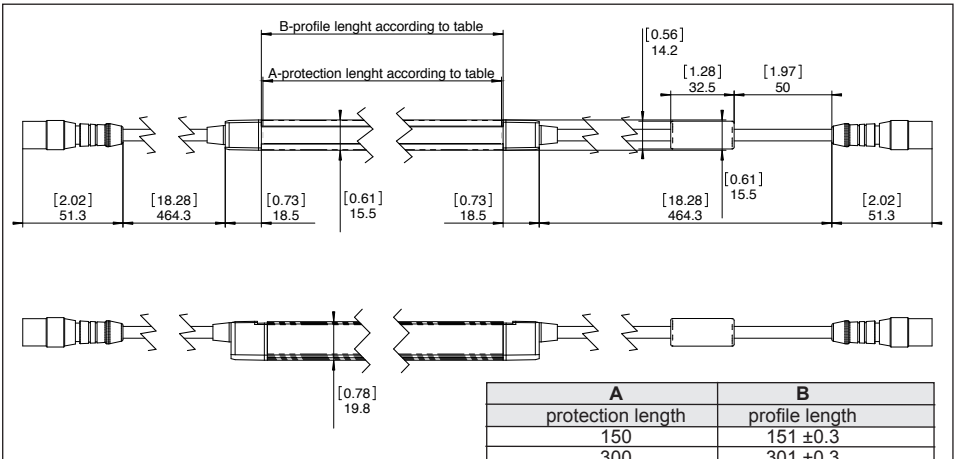
[1)] SIL3 certification only as the safety light curtain GuardShield Micro 400 and the safety control unit MSR 4X Series



A	B
protection length	profile length
150	151 ±0.3
300	301 ±0.3
450	451 ±0.3
600	601 ±0.3
750	751 ±0.3
900	901 ±0.3
1050	1051 ±0.3
1200	1201 ±0.3

All dimensions in mm [in.]

Figure 17 Standard Micro 400



A	B
protection length	profile length
150	151 ±0.3
300	301 ±0.3
600	601 ±0.3
900	901 ±0.3
1200	1201 ±0.3

Figure 18 Cascadeable Micro 400

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PN 29481
10000026004 Ver 01
March 2009