MX4000 Series Safety Light Curtains

MX4100/MX4200 Instruction Manual

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0 Document information

0.1 Revision history

Version	*Date*	*Description*	*Author/s*
1.00	2012-10-12	First public release. Completed safety-related information.	FP
1.01	2012-10-30	Removed references to MX4300 and multi-column.	FP
1.02	2012-10-31	Added CE Declaration of Conformity certificate	FP
1.03	2013-06-07	Updated part numbers, renamed PTK/PTB & minor fixes	FP

0.2 Approvals

Name	*Position/Department*	*Date*	*Signature*
F. Picca	Project Manager	2013-11-18	

0.3 Document distribution

Name	*Position/Department*	*Date*	*Signature*

NOTE: This is a copy of an “electronic master”, the user is responsible to always check paper copy for the latest revision. The master copy of this document is kept on file in corporate document and data control.

0 Document information

The information on this manual has been carefully checked and is believed to be accurate; however, no responsibility is assumed for proof-reading or typographical errors or omission. This document is subject to technical modifications without prior notice.

Table of Contents

Tables

Figures

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1 Introduction

Please make sure you read this instruction manual carefully before using the ISB MX4000 Safety Light Curtain in order to understand the product features and functions. Please consult with your local ISB representative if you have any questions or comments.

This document contains information on mounting, installation, configuration, commissioning, operation and maintenance of the MX4000 series of ISB safety light curtains in accordance with their intended applications. However, specialized technical knowledge not provided in this manual is also required for the planning and implementation of safety light curtains on power driven machinery.

As the required knowledge may not be completely included in this manual, we suggest the customer to contact the specialized organizations and local authorities such as the body responsible for prescribing and/or enforcing machinery safety regulations in the location where the equipment is to be used.

This document is part of the MX4000 safety light curtain and it must be kept accessible throughout its whole life cycle to all the personnel responsible for its installation, configuration, commissioning, operation, maintenance and safety control.

This manual applies to all members of the MX4000 family of safety light curtains, therefore, not all the functions described herein are available in all models.

If an MX4000 system is purchased by a buyer (e.g. OEM, integrator) to be resold or delivered to a third party, the buyer must provide such third party with a copy of this manual and all the pertaining documentation included in the original product.

1.1 Abbreviations

AOPD	Active Optoelectronic Protective Device
DC	Detection Capability
EAA	Effective Aperture Angle
EDM	External Device Monitoring
ESPE	Electro Sensitive Protective Equipment
IR	Infrared
OSSD	Output Signal Switching Device
PSDI	Presence Sensing Device Initiation
RST	Reset
RUN/PGM	Run/Program mode key-switch
SEL	Parameter select push-button

1.2 Symbols used

This manual uses the following symbols to emphasize sections or paragraphs of particular importance to those using or setting up the device. Strict adherence to the instructions next to these symbols should be observed at all times.

Table 1.1: Symbols descriptions

	*The warning symbol indicates an actual or potential risk or health hazard which, if not avoided, may result in significant harm to the machine operators, including serious injury or death. Additionally there may be significant property damage or economic loss. Please pay especially close attention to these instructions!*
	*This symbol is used to indicate detailed notes and descriptions of specific features of the device. Read carefully and follow the instructions.*

2 Safety considerations

The information provided in this chapter is very important for your own safety and for the safety of the personnel operating the equipment protected with an MX4000 safety light curtain. Please read this chapter accurately and carefully observe the following safety instructions.

Before using the MX4000 safety light curtain, a risk evaluation must be performed according to valid standards (e.g. EN ISO 1411, EN ISO 12100-1, ISO 13849-1, IEC 61508, EN 62061) and applicable regulations and codes. The result of the risk assessment determines the required safety level of the light curtain.

When selecting an MX4000 safety light curtain, it must be ensured that its safety-related capability meets or exceeds the required safety level ascertained in the risk assessment.

2.1 Proper application and use

The MX4000 safety light curtains are active optoelectronic protection devices (AOPD) designed to protect people or objects from going into hazardous areas in which they can come in contact with moving parts of machinery or automated systems which present a risk of physical injury or property damage.

The MX4000 safety light curtains are designed as Type 4 electro-sensitive protection equipment (ESPE) in accordance with IEC 61496-1 and IEC 61496-2 standards and therefore are suitable for hazardous point protection, hazardous area protection and access protection. See section 12.2 (page 74) for certification details.

The MX4000 safety light curtain must only be used after it has been selected in accordance with all the applicable national and international standards, rules and regulations regarding labour protection and occupational safety, and after it has been installed, configured and commissioned by qualified personnel and conforming with the procedures described in this manual.

2.1.1 Application requirements

- It must be possible to control the machine stop electrically and the stop time must be known.
- The hazardous moving parts of the machine must always be able to be stopped immediately at any stage of its operation cycle and must achieve a safe position or complete standstill within the specified stop time of the machine.
- Access to hazardous areas must be allowed only through the protective field of the safety light curtain. Additional safeguarding or guards may be necessary to prevent access over, under or around the safety light curtain or from other areas of a particular machine not protected by the safety light curtain.

2.1.2 Application restrictions

- The MX4000 safety light curtains are not designed for compliance with ATEX directives. Therefore they are not approved for use in explosive atmospheres.
- The protective field of the MX4000 safety light curtains is based on infrared technology and cannot detect transparent and/or translucent objects.
- As an AOPD, safety light curtains provide indirect protection only, hence cannot provide protection against objects or materials which may be expelled from the hazardous area.
- The MX4000 cannot be used in PSDI mode unless appropriate external safety devices are used and the machine and its control system comply with all the applicable standards and regulations.

- The MX4000 safety light curtain cannot be used on mechanical presses with single stroke or full-revolution clutch (see 2.1.1 above).

2.2 Qualified personnel

The requisite qualifications for the personnel responsible for the installation, configuration and commissioning include a suitable technical education and the appropriate knowledge of the machine on which the safety light curtain is going to be installed. They must also have been instructed by the responsible person in the operation of the machine and its current safety guidelines.

The qualified personnel also must be acquainted with the applicable regulations for occupational safety, safety at work and safety technology in order to assess the safety of the machine.

A thorough understanding of all safety notes and procedures described in this instruction manual is also part of this competence.

2.3 Responsibilities and liability

Whether a particular installation of an MX4000 safety light curtain does in fact meet all applicable requirements depends upon how MX4000 units are applied, installed, commissioned, operated and maintained. These are factors beyond the control of ISB and therefore, ISB declines any responsibility in case of faulty installation and/or manipulation of MX4000 safety light curtains.

ISB also does not assume responsibility for unauthorized repairs to the MX4000 units, even though defective.

Every effort has been made to provide complete application, installation, operation and maintenance instructions in this manual. Effective use of this information to provide full compliance with the applicable regulations is the responsibility of the equipment purchaser and/or user.

3 Product description

The MX4000 safety light curtains are available in five physical resolutions while the protective field height covers from 300 mm up to 1800 mm. Table 3.1 shows the detection capabilities and protective field heights for the complete product line.

Table 3.1: MX4000 Protective field heights

Detection Capability	***Available Protective Field Heights [mm]***										
	300	450	600	750	900	1050	1200	1350	1500	1650	1800
14 mm	●	●	●	●	●	●	●				
22 mm	●	●	●	●	●	●	●	●	●	●	●
30 mm	●	●	●	●	●	●	●	●	●	●	●
38 mm	●	●	●	●	●	●	●	●	●	●	●
82 mm	●	●	●	●	●	●	●	●	●	●	●

The maximum operating range (protective field width) depends on model and physical resolution. Long range units are also available for special applications. Please refer to section 10 (page 65) for detailed specifications and section 11 (page 69) for ordering information.

3.1 Product family

In order to offer an optimal solution for each specific application, the MX4000 safety light curtains are available in two different ranges of functionality: MX4100 and MX4200, each one tailored to meet the requirements of particular application markets.

Among the common features, all models include individual beam status indicators, EDM function, emitter test function, and a multi-purpose auxiliary output.

The MX4100 model provides basic safety light curtain functions and it is mainly intended for simple applications while the MX4200 model includes all the basic functions of the MX4100 plus muting and blanking capability, making it the most versatile product of the MX4000 series.

The following table resumes the characteristics of each family member in regard to their special functions and detection capability:

Table 3.2: MX4000 Functions and features

	Functions					***Detection Capability***				
	Emitter test	Interlock	EDM	Muting	Blanking	14 mm	22 mm	30 mm	38mm	82 mm
MX4100	●	●	●			●	●	●	●	●
MX4200	●	●	●	●	●	●	●	●	●	●
● Function available										

All the special functions available to a particular model can be individually parameterized as required by the end-user application. A complete description of each function is provided in section 3.4 (page 19).

3.2 Operating principle

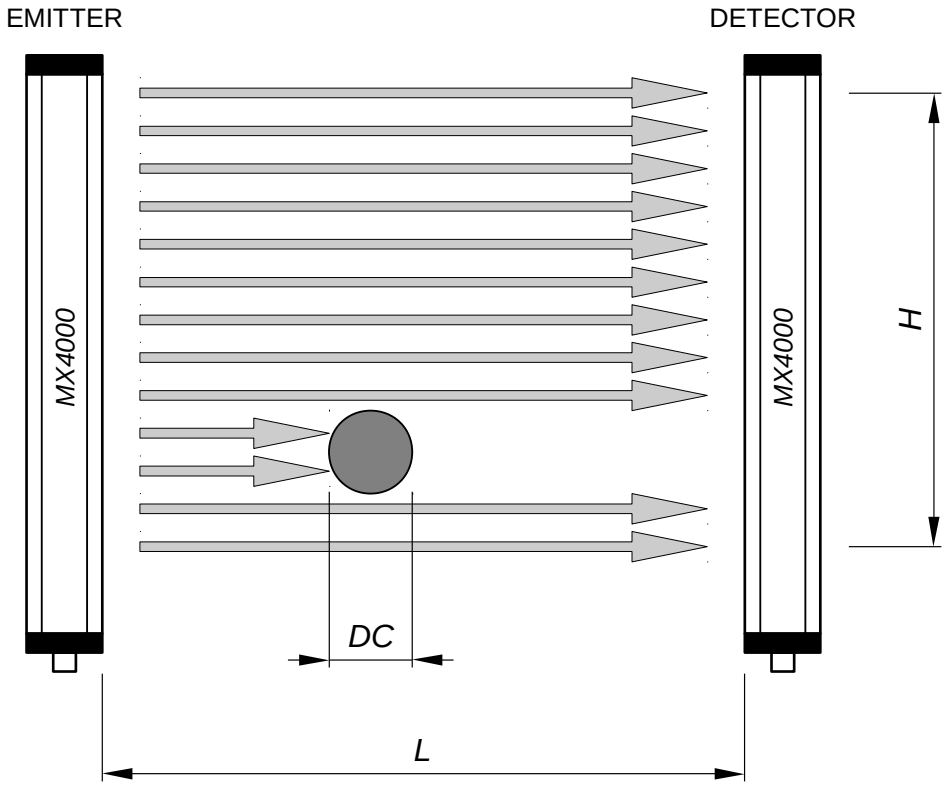
The MX4000 safety light curtain consists of an emitter unit containing a linear array of infrared (IR) emitters and a detector unit with a complementary array of IR photo-sensors. The IR light beams generated by the emitter unit and received by the detector unit determine a protective field whose coverage is defined by the number of beams and their relative spacing.

The nominal detection capability (DC) of the safety light curtain is defined as the minimum diameter of an opaque object that will be reliably detected. It depends only on the beam lenses geometry and the distance between their optical centres. However, the effective detection capability of a light curtain may increase due to the use of blanking functions (see 3.4.5 on page 24 for further information).

Any opaque object of size equal or greater than the effective detection capability of the light curtain, positioned anywhere within its protective field will be detected causing its safety outputs to be deactivated (OFF state).

Figure 3.1 shows a conceptual drawing of a safety light curtain system, where DC represents its detection capability, *H* is the protective field height, and *L* is the protective field width (or range).

Figure 3.1: Protective field and detection capability



The emitter and detector units are housed inside sturdy extruded aluminium housings. The external connections are easily made through industry standard M12 connectors located at the end of the MX4000 enclosure.

Typical applications areas include:

- presses, punching machines, benders and cutters
- automatic and semi-automatic assembly lines
- packaging and handling machines
- automatic warehouses
- textile machines, woodworking, glass and ceramic processing machinery

3.2.1 Sync beam

The MX4000 system requires no electrical connection between the emitter and the detector columns as the synchronization between them is carried out optically through a dedicated IR beam of the light curtain.

This special beam is named “sync beam” and it is the farthest one from the end that has the display panel. For proper operation, this beam must not be obstructed, otherwise, the system will go into OFF state until it is cleared to resume normal operation.

3.3 Status indicators

Status indicators on the emitter and detector units provide the operator with information about the current operating status of the MX4000 safety light curtain.

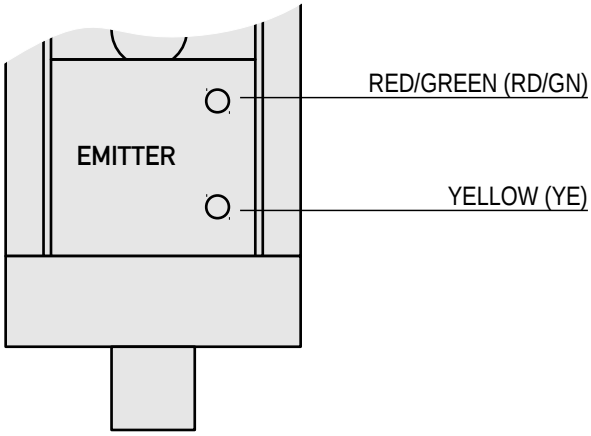
The indicators are located on the front panel of each column and use clearly visible light emitting diodes (LED). The function of each indicator is clearly identified by using different colours and blinking patterns.

The MX4000 units are designed to offer an optimal visibility of the status indicators when the emitter and detector units are mounted, respectively, to the left-hand side and to the right-hand side of the operator.

3.3.1 Emitter units indicators

The operating status of the emitter columns is shown through the two visible LED indicators located at the bottom of the units, as shown on the following illustration:

Figure 3.2: Emitter unit indicator



The indicator at the top (RD/GN) is a bi-colour LED that constantly lights in green (GN) when the emitter unit is working normally, and it changes to red (RD) when the emitter unit is set on test

mode or during lock-out conditions). Since this indicator is always lit (in either colour), it also serves as a power-on indicator.

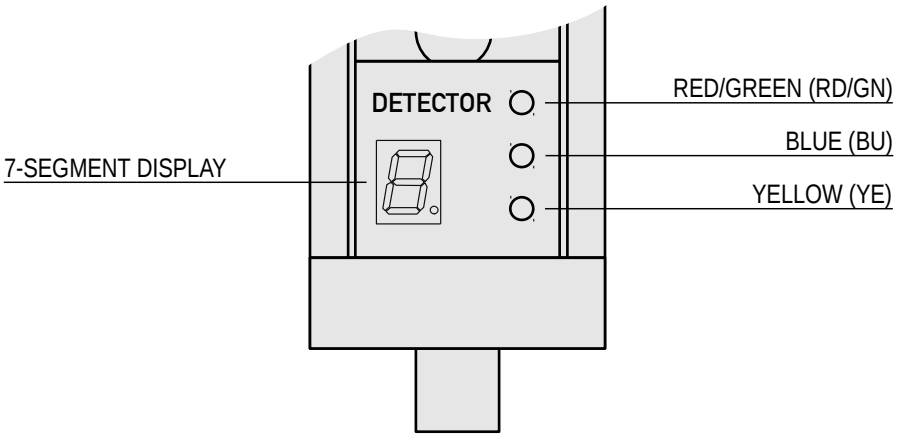
The yellow indicator (YE), will illuminate constantly when an error or lock-out condition is detected in the emitter unit. Under normal operating conditions, this indicator is turned off.

Immediately after switching on the power supply, both indicators will illuminate briefly (the first in red) and then the first LED will turn green while the yellow turns off. Before going to constant illumination, the green LED will blink once or twice to indicate which scan code is in use (one blink means code A, two blinks means code B). This illumination pattern will also help to spot a faulty LED.

3.3.2 Detector units indicators

The indicator panel of the detector columns consists of three visible status indicators and, on main units only, a seven-segment display, as shown on the following illustration.

Figure 3.3: Detector unit indicators



The topmost indicator (RD/GN) is a bi-colour LED that provides a visual feedback of the status of the safety outputs. This indicator will light in green (GN) only when both OSSD output channels are activated (ON state). Otherwise, it will stay lit in red (RD). Since this indicator is always lit (in either colour), it also serves as a power-on indicator.

The yellow LED (YE) will illuminate constantly when in lock-out condition, or it will flash if any of the interlock functions (start interlock or restart interlock) is engaged, thus indicating a reset signal request. Once the reset signal has been asserted and the system has resumed its normal operation, it will turn off.

The blue LED (BU) is constantly lit when a blanking function (of any type) is active and it blinks when the protective field is muted.

The seven-segment display is used to show supplementary status information, when required. During normal operation, it is turned off. The most common status codes are shown on table 3.3. Additional codes can be displayed in lock-out or system error conditions (please refer to chapter 8 on page 61 for further information on fault diagnosis).

Table 3.3: Display codes

Display codes	
Display	***Meaning***
-	Operation with scan code A (shown for 1 s after the start-up lamp test)
=	Operation with scan code B (shown for 1 s after the start-up lamp test)
≡	Sync beam obstructed, misaligned or wrong scan code
b	Blanking not satisfied.
P	Parameterization mode
o	Override mode
t	Teach-in mode
C	Clearing mode
m	Muting error (override conditions satisfied)

If necessary, the display orientation can be rotated 180° for proper reading when the MX4000 columns are mounted upside down (see 5.3.3.1, page 53 for details).

Immediately after switching on the power supply, all the indicator LEDs on the display panel will be turned on sequentially so that a defective LED can be easily spotted.

After the lamp test, the detector unit will show a special symbol on the display (see table above) indicating the scan code in use.

3.3.3 Beam status indicators

A distinctive feature of the MX4000 safety light curtains is that each infrared beam has its own status indicator on the detector units. The indicator consist of a red LED at the left side of each lens.

During normal operation, each status indicator will illuminate when its respective infrared beam is blocked, providing the machine operator with a clear and unambiguous indication of the location of the obstruction within the protective field.

When using fixed blanking functions (either monitored or partially monitored), the status indicators will also blink to indicate current blanking conditions. Further details on the operation of blanking mode indicators are provided in section 3.4.5 (page 24).

After switching on the power supply, all the beam status indicators will blink simultaneously to ease the detection of a defective indicator.

3.4 Special functions

This section describes the special functions available in the MX4000 series of safety light curtains. The availability of these functions depends on the particular model. Please refer to table 3.2 (page 15) for further information.

All the special functions available to a particular model can be individually parameterized, as needed by the end-user application. Please refer to chapter 5 (page 51) for a detailed description of the parameterization procedure.

3.4.1 Emitter test

This function is available in all members of the MX4000 family of safety light curtains and it is intended to verify that the emitter-detector pair should properly deactivate its OSSD outputs when an obstruction is detected within its protective field[1].

The test is activated by an external signal on the emitter unit. When this signal is deactivated (turned OFF), the emitter unit will suspend the light emission, thus simulating a complete obstruction of the protective field.

When the emitter unit is set on test mode, it shows this condition by changing the colour of the bi-colour LED from green to red (see 3.3.1, page 17).

If the emitter test function is not used, the TEST input should be connected to the power line (24 V DC). Otherwise, the safety light curtain will remain in OFF state.

The electrical connection of the TEST input is described in section 4.4.3 (page 43).

3.4.2 Start and Restart interlocks

The MX4100 and MX4200 models provide two separate interlock functions:

The start interlock function is intended to hold the OSSD outputs into its OFF state after a power up, even if the protective field is clear. Its main application is to prevent the unexpected start-up of the protected machine after a power outage or power cycle.

It is mandatory to use the start interlock function whenever it is possible to stand, walk or slip behind the safety light curtain.

The restart interlock function is intended to hold the OSSD outputs into its OFF state after an interruption of the protective field, preventing the automatic restarting of the machine when the protective field gets cleared.

Once any of the interlock functions has been engaged, the situation is signalled by blinking the yellow LED of the detector unit (see 3.3.2, page 18) and the OSSD outputs will not be switched back to the ON state until actuation of the RST/EDM input (usually through a push button switch).

In order to reset an engaged interlock (any type), the protective field must be clear, otherwise the reset action/s will be ignored.

The reset push button (or any other means to release the interlock) must be installed in a location that provides a clear view of the hazardous zone and must be ensured that it cannot be operated from within the hazardous zone.

Figure 3.4 shows a simplified timing diagram for the start and restart interlock functions. The duration of the reset pulse (t_R) shall be at least 0.5 second and no more than 5 seconds. Shorter pulses will be ignored and pulses longer than the maximum value will cause the detector unit to enter into lockout state.

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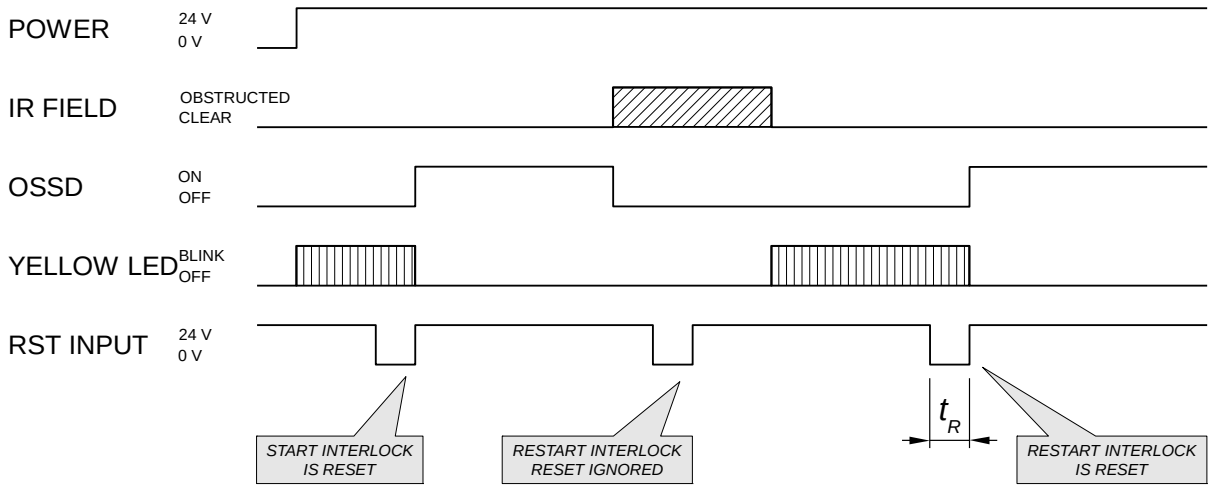
[1] When used in combination with the restart interlock function, the TEST input can be used by an external controller to force an interlock condition when the configuration or operation mode of the guarded machine has been modified.

Figure 3.4: Interlock function timing diagram



Both interlock functions are disabled by default when the system is delivered. If an interlock function is required, it should be enabled through the parameterization procedure (see 5.3.3.3, page 54).

The electrical connections for the interlock reset input are described in section 4.4.4 (page 44).

3.4.3 External Device Monitoring

The EDM function is intended to monitor the state of external contacts and its primary application is to detect malfunctions (e.g. contact welding) in the external relays, contactors or valve solenoids connected to the outputs of the MX4000 safety light curtain. For proper utilization of this function, positive-guided feedback contacts should be used.

When the EDM function is enabled, the MX4000 will continuously monitor that the state of the EDM input follows the changes of the OSSD output. Whenever the EDM input does not match the expected state, the system will deactivate the OSSD outputs and will enter into lock-out condition. For proper operation with slow switching devices, the EDM input tolerates an operation delay of up to 300 ms with respect to changes in the OSSD state.

The EDM function is available on all models and it is disabled by default when system is delivered. If required, the EDM function can be enabled through the parameterization procedure (see 5.3.3.4, page 54).

The polarity of the EDM input shall be inverted with respect to that of the OSSDs outputs. The electrical connections for using the EDM function are described in section 4.4.4.2 (page 45).

3.4.4 Muting (MX4200 only)

Muting is a deliberate and controlled suppression of the safety function of the MX4000 safety light curtain. As long as the muting function is active, the OSSD outputs will remain in the ON state even if the protective field is interrupted.

The intended use of the muting function is to suspend temporarily the safety function when the operating conditions require an object (e.g. a pallet over a conveyor or an automatic guided vehicle) to pass through the protective field.

The muting function is disabled by default when the product is delivered but it can be enabled through the configuration procedure, if required (see 5.3.3.6, page 55, for further details).

Since the muting function disables the safety functions of the protective device, additional safety measures are required in order to ensure the safety of the machine while the muting function is activated.

The MX4200 has two dedicated inputs (MS1 and MS2) for activating the muting function through external muting sensors. These inputs can be connected to limit switches, inductive proximity sensors, photo-electric sensors, etc. The muting function is initiated when all of the following conditions are satisfied:

- The protective field is clear and the OSSD outputs are in their ON state.
- One muting input (either MS1 or MS2) is activated (turned ON) within a predefined time window (T1 = 0.03 to 3 seconds) after the activation of the other muting input (MS2 or MS1).

Once the muting function has been initiated, it will be terminated if either of the following conditions is present:

- Either of the muting inputs is deactivated (turned OFF) for more than 0.03 seconds.
- The duration of the muted condition extends over the maximum allowed time limit
- The light curtain goes into lock-out condition
- The power supply is interrupted or cycled

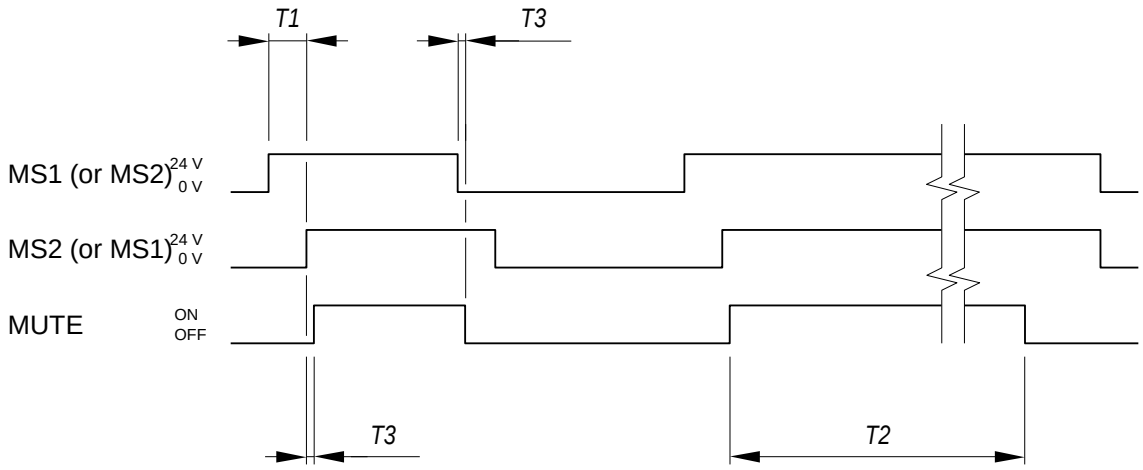
The maximum duration for the muting condition (T2) can be selected when enabling the mute function. The allowed options are 60 s, 300 s and 600 s. (see 5.3.3.6, page 55 for parameterization details). If the duration of the muting condition exceeds the preset timer value, the OSSD outputs will be deactivated and the system will enter into lockout state.

Depending on the particular application, the muting inputs can be operated by external sensors (e.g. light barriers, induction loops, limit switches, etc.). The electrical connections for the muting inputs is described in section 4.4.4.4 (page 47).

When the muting input signals are operated through external sensors, they must be installed in a way that they cannot be activated by simple manipulations or by the detection of a person passing by.

The following figure shows the timing diagram of the muting function:

Figure 3.5: Mute function timing diagram



On the above diagram, T1 represents the required delay between the activation of mute inputs for proper muting (0.03 s < T1 < 3 s) while T2 is the muting timeout (user configurable parameter).

T3 is the mute activation/deactivation delay intrinsic to the MX4200 (T3 < 150 ms).

3.4.4.1 Muting signalling

When using the mute function, the MX4200 will blink the blue LED to show that the safety light curtain is in a muted condition. Additionally, the auxiliary output can be configured to signal the current state of the muting function through an external indicator lamp.

Some local regulations (e.g. UL standards in USA) require that the state of the muting function shall be properly signalled with external indicators located where they are clearly visible to machine operators. If applicable, make sure that the external mute signalling function is enabled in the configuration of the MX4200.

Compliance with the applicable local regulations regarding mute signalling must be ensured during the installation and/or parameterization by qualified personnel.

When the external mute signalling is enabled, the MX4200 monitors the current through the external lamp to prevent muting operation with a defective lamp. If the lamp current deviates from the required value (100 mA .. 400 mA), the OSSDs will be turned off and the MX4200 will enter into lockout state.

For further information on the auxiliary output, please refer to section 3.4.6 (page 31). The wiring diagram for the auxiliary output is described in section 4.4.4.3 (page 47).

3.4.4.2 Muting override

The muting override function allows the user to force a muting condition even if the prerequisite of a clear protective field is not satisfied.

This function is intended mainly for automation applications (e.g. conveyors and packaging machinery) where it may be required to momentarily restart the machine in order to remove any object that may have clogged in the protective field due to a fault in the muting sequence.

The muting override can be initiated only if all of the following conditions are satisfied:

- at least one beam of the protective field is obstructed.
- at least one of the mute inputs is active

When the above conditions are met, the blue LED will blink and a special symbol will be shown on the display (⊓) indicating that a muting override can be initiated. To start the override, the operator must operate the mode key-switch and the SEL push-button according to the following sequence (see 4.4.4.5 on page 48 for wiring details):

First, the mode key-switch must be switched to its PGM position. A flashing '▫' will be shown on the display for 30 seconds. During this time window, you have to confirm the operation by depressing the SEL push-button three times in succession. The length of the pulses, and the time between them must be at least 0.2 seconds (and 3 seconds maximum).

If the sequence is not carried out properly (either because the pulses do not meet the timing requirements or because they are not applied within the time-out window) the display is turned off and the override initiation sequence is ignored.

If the initiation sequence is passed, the blinking '▫' on the display will change to a steady state and the muting override function will be activated for a pre-set time during which the operator can manually turn on and off the safety outputs as needed by depressing the SEL push-button.

When using the muting override function, the safety outputs of the light curtain can be manually operated beyond the control of the MX4000 system. Therefore, the operation of this function must be carried out under strict supervision of qualified personnel. Failure to do so may result in serious injury or death.

During the override time-frame, the protective field will be evaluated. If the non blanked areas of the protective field are cleared, the override function will be automatically cancelled and the MX4200 system will resume its normal operation[2].

After expiration of the maximum override time, the safety outputs will be automatically deactivated regardless of the state of the SEL button (the '▫' on the display is turned off). If the muting fault persists, it will be necessary to re-start the complete sequence from the beginning in order to reactivate the override function.

Even though the muting override deactivates itself after the time-out period, make sure to return the mode key-switch to its RUN position and remove the key after completing the override. Otherwise, if the key-switch is left on its PGM position for more than 45 seconds, the MX4000 will enter into lock-out state.

The muting override function uses the same timeout values as the mute function. See 5.3.3.6 (page 55) for parameterization details.

3.4.5 Blanking (MX4200 only)

The blanking function is a special function which allows an object of a size greater than the detection capability of the safety light curtain to be inside the protective field without switching off the safety outputs of the ESPE.

The intended uses of this function are those applications where a machinery part is required to be present in the protective field without impairing the manufacturing process or the functionality of the machine.

The operation principle of the blanking function implies the deactivation of a specific zone of the detection area, effectively creating a "hole" in the protective field. Therefore, a thorough risk analysis must be carried out to determine whether the use of the blanking function is actually needed.

[2] If the restart interlock function is enabled, it will engage and should be reset as normal. See 3.4.2 on page 20.

In order to cope with the constraints of particular applications, the MX4000 system offers three different blanking modes:

A) fixed monitored blanking,

B) fixed partially monitored blanking, and

C) floating blanking.

Each mode can be independently configured through the parameterization procedure (see chapter 5 on page 51 for further details).

3.4.5.1 Special considerations

The following operating and safety considerations must be taken into account when using the blanking function:

- For all blanking modes, the sync beam must be excluded from the blanking pattern (see 3.2.1, page 17 for details on the sync beam).
- Blanking modes can be combined as needed.

When using the blanking function, the objects in the blanked areas must extend across the dangerous zone of the protective field or must be appropriately extended by mechanical barriers so that nothing can enter from the sides. Otherwise, the safety distance must be re-calculated according to the effective device resolution resulting from the activation of the blanking function.

The blanking function may only be used if the objects introduced in the protective field do not have any reflective surfaces. Only matt surfaces are permitted!

3.4.5.2 Fixed monitored blanking

The fixed monitored blanking allows an object of a fixed size to be located at a specific position in the protective field without deactivating the safety outputs of the light curtain.

The actual size and position of the object are continuously monitored and, as soon as these parameters differ from the programmed values (if the object is moved or removed) the safety outputs of the light curtain will be immediately deactivated (OFF state).

This blanking mode is intended to allow a fixed part of the machinery (e.g. part feeder, support arm, conveyor, etc.) to be present within the protective field without impairing the operation of the machine.

The fixed monitored blanking function must be used only in combination with start/restart interlock to prevent the unexpected restarting of the guarded machine with a missing object, possibly caused by operator entry into the protective field at the point where the object is supposed to be.

When the blanking conditions are satisfied, the status indicators of the blanked beams will be turned off to avoid distracting the operator. On the contrary, when the blanked object is not present or it is improperly positioned, the indicators of the blanked beams will blink fast in order to turn the operator's attention to the location of the misplaced object. Also, the 7-segment display on the detector column will show the letter 'b' (which stands for “blanking”).

Other than the restrictions imposed by the length of the column to the size of the objects, there is no limit for the number of blanked objects as long as one beam is left free between one object and another (including the blanking tolerance beams, if any).

The desired blanking pattern is easily defined through a simple teach-in procedure, as explained in 3.4.5.4 (page 26).

3.4.5.3 Fixed partially monitored blanking

This is a special case of a fixed blanking mode in which the object can (but does not need to) interrupt the protective field without switching off the safety outputs.

In this mode, the monitoring of the size of the blanked object is partial and limited to checking that it does not exceed the predefined maximum size. The object position is monitored and constrained to be within the boundaries of the predefined maximum object size.

This blanking mode is particularly useful in those cases where an object is required to enter the protective field at the same position during the machine operation, e.g. parts over a conveyor, robotic feeders, etc.

When using the partially monitored fixed blanking, the effective detection capability is increased up to the size of the blanked object, and hence the safety distance must also be increased. The safety distance must be re-calculated according to 4.1 (page 33) and the safety light curtain must be repositioned accordingly.

When a partially monitored blanking is in use, the beam status indicators of the whole blanked area will blink slowly and continuously to warn the operator of the hole in the protective field.

Only one partially monitored fixed blanking is allowed and it can be easily defined through a simple teach-in procedure, as described below.

3.4.5.4 Teach-in procedure for fixed blanking (fully monitored and partially monitored)

The programming of fixed blanking patterns (either fully or partially monitored) is easily carried out by placing the object to be blanked at the desired position within the protective field and then following a simple teach in procedure.

A teach-in procedure changes the size and/or position of the blanked areas, hence the effective detection capability of the light curtain and shall be carried out by qualified personnel only. It is the responsibility of the supervisor to only give access to the keys for the mode switch to authorized personnel.

The teach-in procedure can be initiated only if all of the following conditions are satisfied:

- The MX4200 system must be in OFF state. This precondition is automatically satisfied when placing the object to be blanked into the protective field. If the restart interlock function is enabled, the interlock will engage and the yellow LED will start blinking.
- Both mute inputs (MS1 and MS2) must be in OFF state.

Once the above conditions are satisfied, make sure that the objects to be blanked are firmly secured at the desired position before starting the teach-in procedure. Then, complete the teach-in process by operating the mode key-switch (RUN/PGM) and the SEL push-button according to the following sequence (see 4.4.4.5 on page 48 for wiring details):

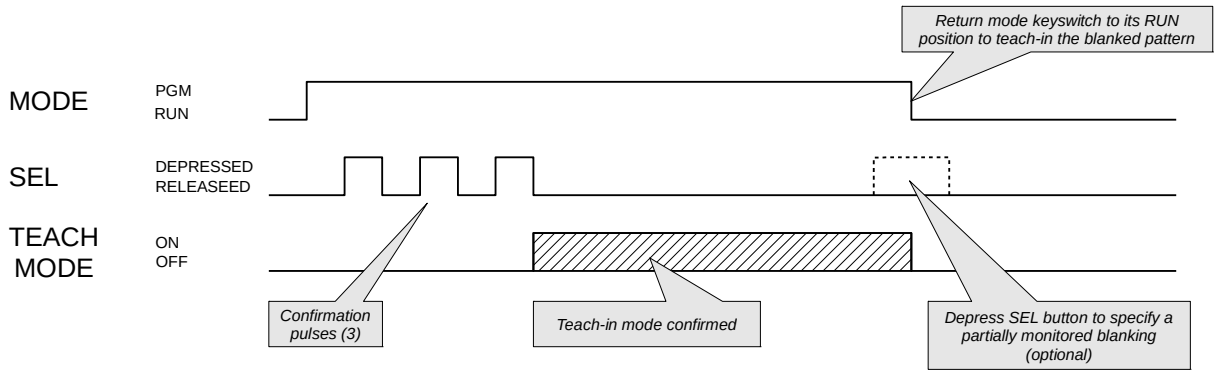
- Turn the mode key-switch to its PGM position. A flashing '⊧' will be shown on the display. From this point, you have 30 seconds to confirm the operation by depressing the SEL push-button three times in succession. The length of the pulses and the time between

them must be at least 0.2 seconds (and 3 seconds maximum). The pulses will be ignored if you do not meet these timing requirements.

- If the push-button pulse sequence is completed on time, the blinking 'Ł' on the display will change to a steady state and the MX4200 system will enter into teach-in mode. While in this mode, the OSSD outputs will not be switched on even if the protective field is cleared.
- Make sure that only the objects to be blanked are within the protective field and use the beam status indicators to check that neither the size nor the position of the blanked pattern changes during the teach-in procedure.
- Finish the teach-in procedure off by returning the mode key-switch to its RUN position. For partially monitored blanking, you will have to depress and hold the SEL push-button while turning off the mode key-switch. A result code will be shown briefly on the display (see table 3.4) before returning to normal operation.

If the teach-in procedure is completed successfully, and depending on whether the restart interlock function is disabled or not, the OSSD outputs will be switched on automatically or after pressing and releasing the RESET push-button. Figure 3.6 below shows a simplified timing diagram for the teach-in sequence.

Figure 3.6: Teach-in sequence



If the teach-in sequence is not started off properly (either because the push-button pulses do not meet the timing requirements or because they were not applied within the time-out period), the teach-in initiation will be ignored. The same applies if the teaching process is not completed within one minute after entering into teach-in mode. In both cases, the 'Ł' on the display is turned off and the MX4200 will resume its normal operation.

To clear a fixed blanking pattern, simply repeat the teach-in procedure for the same type of blanking you want to remove (full monitored or partially monitored) making sure that the protective field is completely cleared before returning the mode key switch to its RUN position.

The mode key-switch (RUN/PGM) must be installed in a location that provides a clear view of the hazardous zone and must be ensured that it cannot be operated from within the hazardous zone.

Even though the teach-in cancels itself after the time-out period, make sure to return the mode key-switch to its RUN position and remove the key after completing the teach-in procedure. Otherwise, if the key-switch is left on its PGM position for more than one minute, the MX4000 will enter into lock-out state.

3.4.5.4.1 Teach-in considerations

The following considerations must be taken into account during the teaching-in of fixed blanking patterns:

- For all use cases, the teach-in of a new fixed blanking pattern (either fully or partially monitored) overwrites any previously taught-in blanking pattern of its same type.
- For all use cases, the teach-in of a fully monitored fixed blanking also clears any previously defined partially monitored blanking.
- When both a fully monitored blanking and a partially monitored blanking are required at the same time, the teach-in of the fully monitored blanking pattern must be carried out before that of the partially monitored blanking. Once the fully monitored fixed blanking has been taught, the teach-in procedure should be repeated for the partially monitored blanked object, making sure that the fully monitored blanking is satisfied throughout the new teach-in sequence (i.e. the previously blanked object is kept in place).
- When only a partially monitored blanking is needed, before teaching-in the desired pattern, you must clear all previously taught-in blankings. To clear any previously defined blanking, follow the procedure described in 3.4.5.4.
- Only one partially monitored blanking is allowed. If more than one non-contiguous areas are detected during the teach-in, the procedure is ignored.
- Blanking tolerances (see 3.4.5.5) do not apply for the teach-in procedures. The size of the obstruction patterns detected during the teach-in are assumed as nominal.
- When inconsistency errors are detected during teach-in, the cause will be indicated by the return code (see table 3.4) and the teach-in will be ignored (i.e. the previous blanking pattern, if any, will be maintained).
- The teaching-in or clearing of any fixed blanking (either fully monitored or partially monitored) does not affect the current configuration of the floating blanking function. For further information on floating blanking please refer to 3.4.5.6 on page 30.

Table 3.4: Return codes for blanking teach-in

Teach-in return codes	
Display[3]	***Meaning***
r → 0	Teach-in completed successfully (same pattern)
r → 1	Teach-in completed successfully (pattern modified)
r → 2	Teach-in error (previous blanking pattern unchanged)

The wiring diagram for the mode switch (RUN/PGM) is described in section 4.4.4.3 (page 47).

3.4.5.5 Blanking tolerance

In some applications, the blanked object cannot be precisely positioned due to vibration, poor handling or physical limitations (e.g. flexing and twisting in large objects), hence causing size discrepancies in the sensed pattern.

[3] Result code is shown on the display one character at a time (the symbol → represents the display transition from one digit to the next).

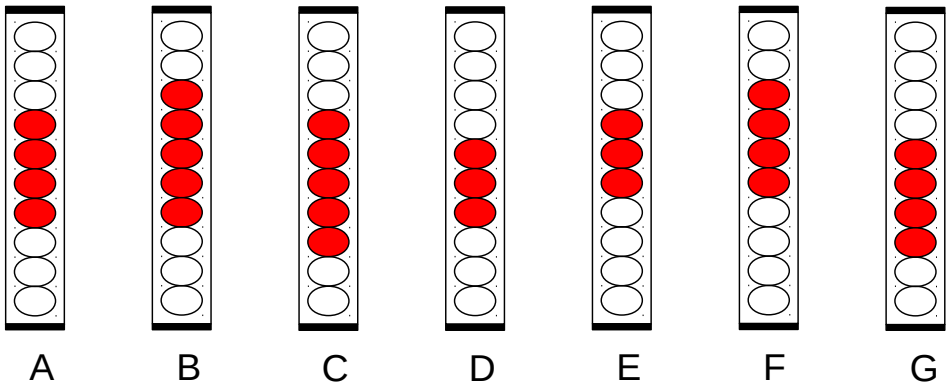
For these cases, the MX4200 can assign a blanking tolerance at each end of a fixed (monitored or partially monitored) blanking pattern.

The use of blanking tolerance inevitably implies an increase in detection capability at the edges of the blanked object. However, the detection capability at the other areas of the protected field remains unchanged.

The blanking tolerance can be selected among three possible types: plus, minus or bilateral. When plus tolerance is selected, the blanked object is only allowed to block one (or more) extra beam(s)[4], whereas the minus tolerance only allows the object to block one beam less. The bilateral tolerance allows both discrepancies to occur at the same time.

The illustration below (3.7) shows an example of beam allowances for a blanked object with +1, −1 and ±1 beam tolerances:

Figure 3.7: Beam tolerance examples



In the examples shown above, the A represents the nominal obstruction pattern of a blanked object blocking four beams. Examples B and C show the allowed obstruction pattern for the same object when subject to a beam tolerance of +1 beam, and examples D and E show the allowed obstruction pattern when the same object is subject to a tolerance of −1 beam.

If a bilateral tolerance of ±1 beam is applied to the same object, then all the obstruction patterns in the examples (A, B, C, D, E, F and G) are allowed. Examples F and G depict a particular case in which the object uses both tolerances (plus and minus) at the same time (object is shifted one beam)

When using tolerance with the fixed monitored blanking, the effective detection capability is increased at the edges of the blanked areas, and hence the safety distance must also be increased. The safety distance must be re-calculated according to the effective detection capability for the tolerance type used (as shown on table 3.5) and the safety light curtain must be repositioned accordingly.

[4] For blanked objects located at the ends of the column, positive tolerances that fall outside the protective field will be ignored and will not restrict the values for positive tolerances inside the protective field.

Table 3.5: Effective detection capability with blanking tolerance

Effective detection capability for fixed blankings with tolerance					
Tolerance, [beams]	***Nominal detection capability***				
	14 mm	*22 mm*	*30 mm*	*38 mm*	*82 mm*
−1	14 mm	30 mm	45 mm	60 mm	150 mm
+1	14 mm	30 mm	45 mm	60 mm	150 mm
+2	22 mm	45 mm	–	–	–
+3	30 mm	60 mm	–	–	–
±1	22 mm	45 mm	–	–	225 mm
−1/+2	30 mm	60 mm	–	–	–
−1/+3	38 mm	–	–	–	–

When using the blanking tolerance, the effective detection capability must be indelibly noted on the MX4200 labels so that it cannot be wiped off (see section 10.4 on page 67 for label details).

For fully monitored fixed blankings with obstruction sizes of just one beam, the application of a negative tolerance (−1 beam) will result into a partially monitored blanking.

The value of positive and negative tolerances can be chosen independently through the parameterization procedure, as described in sections 5.3.3.7/5.3.3.8 (page/s 55/56).

During the setup, the user can choose any tolerance value that best suits its application needs. However, when the free areas between two adjacent blankings are not large enough to fit the requested tolerance plus the minimum separation of one free beam, the actual positive tolerance in those areas will be automatically reduced to ensure the minimum separation of the blanked areas without affecting the tolerances on other parts of the protective field.

3.4.5.6 Floating blanking

The floating blanking mode allows a single (or multiple) object(s) of a defined maximum size to enter and move within the protective field without switching off the safety outputs of the light curtain.

This feature can be useful in those applications where it is necessary that a small object(s) can enter, leave, and move freely within the protective field during the operation cycle of the machine (e.g. hanging hoses, moving machinery parts, etc.).

The blanked objects may enter and move only in the protective field areas that are not used by fixed blankings. Also, when allowing multiple blanked objects, they cannot overlap with each other. In any case at least one unobstructed beam must be between a blanked object and another.

When using the floating blanking function, the effective detection capability of the AOPD is increased according to the number of floating beams, as shown in table 3.6. However, the effective detection capability is not affected by the number of blanked objects allowed.

The floating blanking mode is a partially monitored blanking that effectively increases the detection capability of the AOPD, and hence the safety distance must also be increased. The safety distance must be re-calculated according to the actual detection capability resulting from the activation of this function and the safety light curtain must be repositioned accordingly.

If an object is required to float freely along the entire protective field without deactivating the OSSD, its size shall be equal or smaller than the maximum object size shown also in table 3.6 (values in brackets, on the right of the effective detection capability values). Object sizes larger than indicated could also be moved freely without deactivating the OSSDs, but this is not guaranteed.

Table 3.6: Effective detection capability and maximum object size for floating blanking

Effective Detection Capability (and Maximum Object Size) for floating blanking, [mm]						
		Nominal detection capability				
		14 mm	***22 mm***	***30 mm***	***38 mm***	***82 mm***
Number of floating beams	***1***	22 (7)	38 (14)	52 (14)	–	–
	2	30 (14)	52 (30)	–	–	–
	3	38 (22)	–	–	–	–

When using the floating blanking, the effective detection capability must be indelibly noted on the MX4200 labels so that it cannot be wiped off (see section 10.4 on page 67 for label details).

When an object within the protective field meets the floating blanking conditions, the status indicators of the blocked beam(s) will stay off. On the contrary, when the size of the object exceeds the preconfigured maximum size, or when more than one blanked object is detected in single-object mode, the status indicators of the blocked beams will illuminate constantly.

The configuration of the floating blanking mode, i.e. the maximum object size and the number of blanked objects allowed (single or multiple) is independent of the configuration of the fixed blanking and it can be carried out through the parameterization procedure, as explained in sections 5.3.3.9 and 5.3.3.10 (page/s 56/56).

3.4.6 Auxiliary I/O

All safety light curtains on the MX4000 series include a multi-purpose auxiliary I/O connection on the main detector units which can be used as a signalling output for non-safety-related external devices (e.g. relays, indicator lamps, PLCs, etc.).

The auxiliary output does not constitute a part of a safety-related control system. Therefore, it is not allowed to be used for safety applications. Use of this function as a safety output may result in serious injury or death.

The operation mode of the auxiliary output can be configured through the parameterization procedure to suit the particular requirements of the user application. Two different signalling options are available as summarized below:

- Interlock indicator: the output activates when any of the interlock functions is engaged and ready to be reset (i.e. reset required).
- Muting indicator: the output is activated when the safety light curtain is in muted condition.

When the auxiliary output is configured to signal the muted condition, the output current is monitored to prevent muting operation with a defective lamp. If the lamp current deviates from the required value, the MX4200 will enter into lockout state. Please refer to section 3.4.4.1 (page 23) for further information on muting signalling.

Because the auxiliary I/O signal is also used as an input for the mode key-lock switch of the parameterization tool (RUN/PGM), it must be wired as indicated in section 4.4.4.3 (page 47). For information on configuring the auxiliary output please refer to section 5.3.3.5 (page 55).

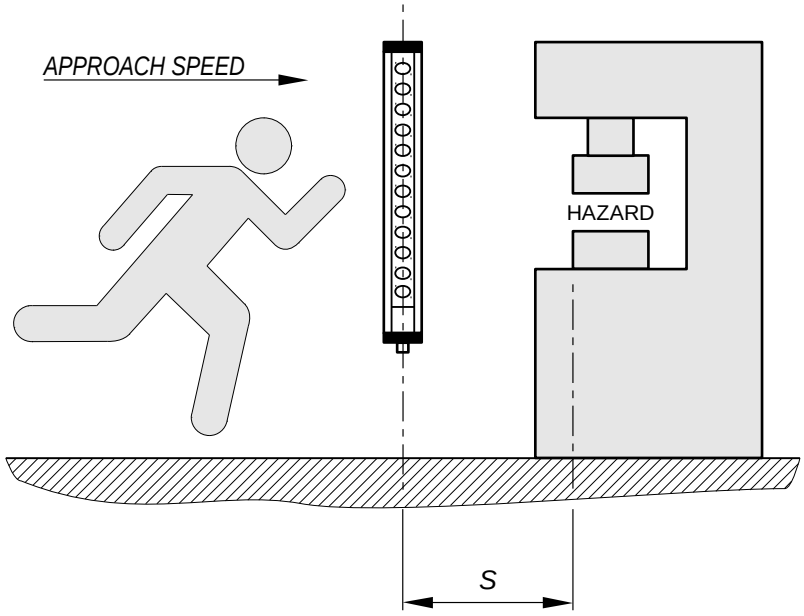
4 Installation

This chapter provides important information on the installation of the MX4000 safety light curtain. The installation procedures include the determination of the safety distance, the mechanical mounting and the electrical connections.

4.1 Safety Distance

Safety light curtains can only fulfil their protective function if they are installed to the correct safety distance (S) from the hazardous point. This safety distance ensures that a person cannot reach the hazard point until the motion of the hazardous parts of the machinery have been completely stopped.

Figure 4.1: Safety distance



In general terms, the safety distance for safety light curtains depends on the following factors:

- approach speed to the detection zone of the object requiring detection (e.g. body or parts of the body)
- overall stopping response time of the system, from the initial event leading to the activation of the safety light curtain to the full stop of the machine. This time includes the machine's stopping time, the AOPD's response time and the response times of all relevant control elements (e.g. safety relays).
- effective detection capability of the safety light curtain.
- other parameters specified by the applicable standards depending on the particular application.

The minimal required safety distance as well as the specific procedures for its determination vary according to the type of protection and the standards and regulations of the country in which the system is installed.

Make sure that the safety distance between the MX4000 safety light curtain and the hazardous point complies with all the applicable regulations. Failure to set up and maintain the minimum safety distance may result in serious injury or death.

The following sections give calculation guidelines for determining the safety distance according to common standards.

When using special functions such as fixed (monitored or partially monitored) blanking with tolerance or floating blanking, the effective detection capability of the AOPD is increased, hence the safety distance must also be increased. Always use the effective detection capability when calculating the safety distance!

4.1.1 Safety distance according to ISO 13855 for hazard point safeguarding

For hazard point safeguarding (i.e. the protective field is perpendicular to the approach direction), the safety distance can be determined using the following formula:

$$S = (K \times T) + C$$

where:

S: Safety distance, in mm. The minimum allowable distance is 100 mm (or 157 mm for non industrial applications), regardless of calculated value.

K: Approach speed to the detection zone in mm/s. It is assumed as being 2000 mm/s. If the resulting value for S is greater than 500 mm, then the calculation is repeated with a reduced speed value of 1600 mm/s, provided that the result cannot be lower than 500 mm.

T: Overall stopping response time of the machine, in s.

C: Extra distance margin, in mm, dependent of the effective detection capability of the AOPD. For devices with an effective detection capability $d \leq 40$ mm, $C = 8 \cdot (d - 14)$, where d is the effective detection capability of the device. For detection capabilities greater than 40 mm, the value of C is established at 850 mm (arm length).

Example:

Consider a system with a total stopping time T = 0.1 s and an effective detection capability d = 22 mm. Since $d \leq 40$ mm:

$$C = 8 \times (d - 14) = 8 \times (22 - 14) = 64 \ mm$$

Therefore, using K = 2000 mm/s

$$S = (K \times T) + C = (2000 \times 0.1) + 64 = 264 \ mm$$

4.1.2 Safety distance according to ISO 13855 for danger area safeguarding

For safeguarding of danger areas (i.e. the approach direction is coplanar with the protective field), the minimum safety distance can be determined using the following formula:

$$S = (K \times T) + C$$

where:

S: Safety distance, in mm, from the hazard zone's front edge to the furthest beam of the protective field. The effective detection capability at the end of the column must be added to the calculated safety distance to compensate for the actual position of the switch point

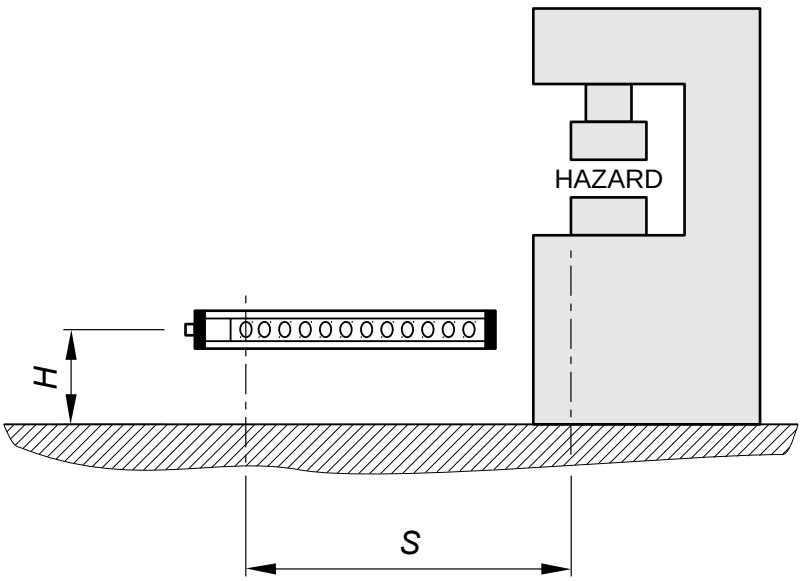
K: Approach speed to the detection zone in mm/s. The standard establishes a value of 1600 mm/s.

T: Overall stopping response time of the system, in s.

C: Additional distance margin, in mm. This parameter depends on the installation height H and it is defined as C = 1200 – (0.4 · H). It cannot be less than 850 mm (arm length), regardless of the calculated value.

H: Installation height of the protective field above the reference plane (e.g. floor), in mm. The maximum allowed height is 1000 mm. The minimum height must satisfy the following relationship: H [mm] ≥ 15·(d − 50 [mm], where d is the effective detection capability of the AOPD. However, special precautions must be taken when the installation height exceeds 300 mm, because of the risk of crawling or slipping beneath the protective field.

Figure 4.2: Danger area safeguarding



Example:

Calculate the minimum safety distance and the maximum mounting clearance from the danger area for a safety light curtain with an effective detection capability d = 82 mm and an overall system stopping time T = 0.1 s

Minimum installation height:

$$H = 15 \times (d - 50) = 15 \times (82 - 50) = 480\ mm$$

then,

$$C = 1200 - (0.4 \times H) = 1200 - (0.4 \times 480) = 1008\ mm$$

and the safety distance:

$$S' = (K \times T) + C = (1600 \times 0.1) + 1008 = 1168\ mm$$

Finally, adding the effective detection capability to compensate the switch point, the minimum safety distance is:

$$S = S' + d = 1168 + 82 = 1250\ mm$$

4.1.3 Safety distance according to ANSI B11.19 for hazard point safeguarding

For hazard point safeguarding (i.e. the protective field is perpendicular to the approach direction), the safety distance can be calculated using the following formula:

$$S = K \times (T_s + T_c + T_r + T_{bm}) + D_{pf}$$

where:

S: Minimum distance from the hazardous point to the detection point.

K: Approach speed to the detection zone. The ANSI B11.19 standard does not specify a value for K, but it is common to use the value recommended by the OSHA of 1600 mm/s.

T_s: Stopping time of the machine.

T_c: Response time of the control system.

T_r: Response time of the safeguarding device and its interface.

T_{bm}: Additional time for the brake monitor, as a percentage of (T_s + T_c). When not using brake monitors, it is recommended to use a minimum value of 20 % of (T_s + T_c).

D_{pf}: Penetration factor. For AOPDs with an effective detection capability d < 64 mm, D_{pf} can be estimated as $D_{pf} = 3.4 \cdot (d - 7)$ [mm].

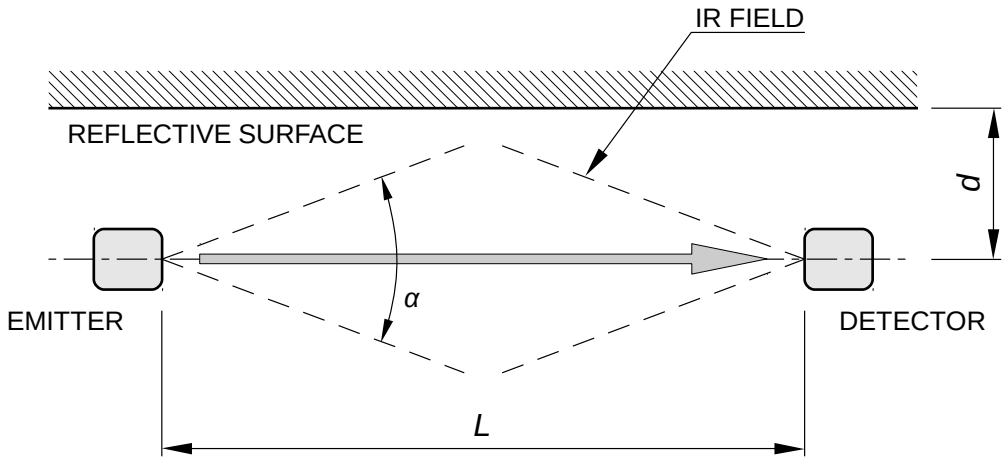
4.2 Optical considerations

4.2.1 Reflective surfaces

Reflective surfaces close to the safety light curtain (whether above, below or to the sides) can indirectly deflect the emitter's light beams into the detector unit, adversely affecting the detection of objects within the protective field, even if the object blocks the main beams.

To avoid that problem, it is of utmost importance that all reflective surfaces and objects (metallic or glossy painted walls, floors or ceilings, containers, workpieces, etc.) must therefore be kept at a minimum distance from the protective field of the safety light curtain.

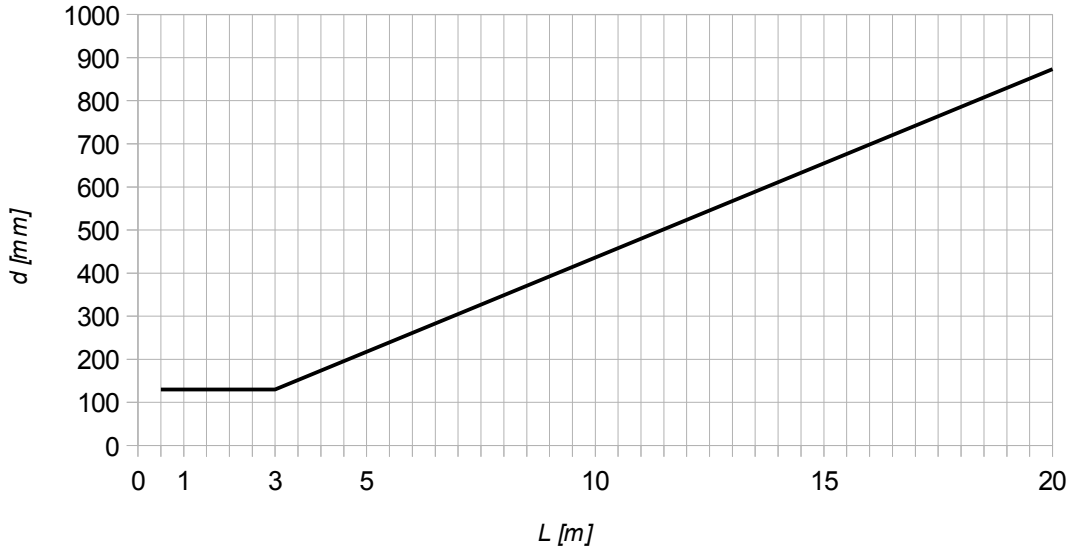
Figure 4.3: Minimum distance to reflective surfaces



An improper installation may result in a protective field which can be obstructed without detection, leading to serious injury.

The minimum distance to reflective surfaces (*d*) depends on the protective field width (*L*) and on the maximum aperture angle (*α*) of the AOPD. The following chart gives the minimum distance *'d'* from reflective surfaces for Type 4 safety light curtains, according to IEC 61496-2:

Figure 4.4: Minimum distance to reflective surfaces vs. protective field width



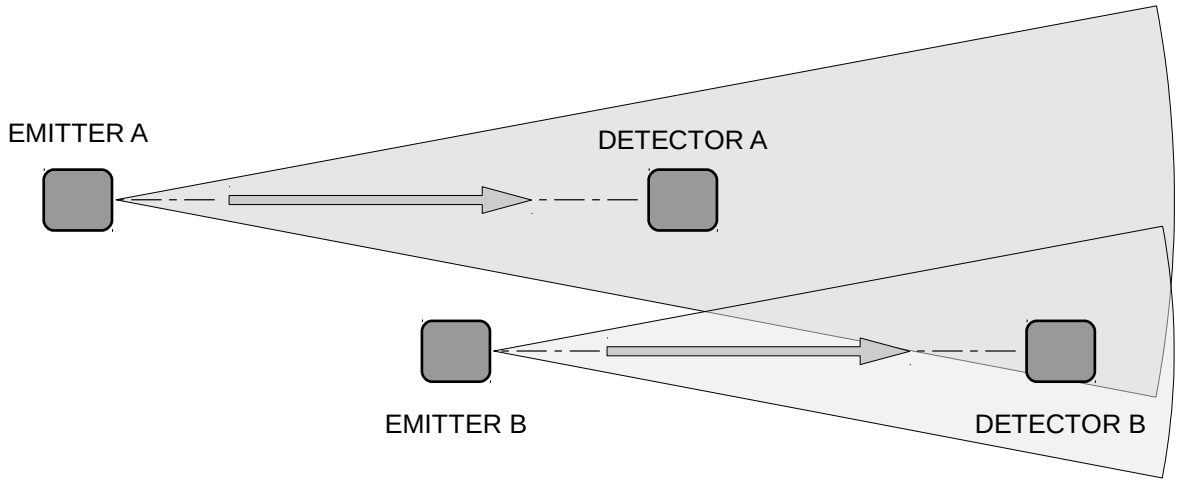
For protective field widths of less than 3 m, the minimum distance *'d'* shall be 130 mm, while for values of *L* larger than 3 m, the minimum distance *'d'* can be calculated as follows:

$$d = \frac{L}{2} \times \tan(\alpha) = \frac{L}{2} \times \tan(5°) \approx L \times 0.044$$

4.2.2 Mutual interference between multiple systems

When multiple safety light curtains need to be installed in adjacent areas, the systems must be arranged in a way such that the emitter of one system cannot interfere with the detector of another.

Figure 4.5: Mutual interference between adjacent systems



The following approaches can be used to prevent the mutual interference:

- Alternate direction of emitters
- Use an opaque screen between systems
- Configure systems with different scan codes (see 4.2.2.1, page 39)

The following pictures gives some examples of alternative arrangements that can be used to reduce mutual interference:

Figure 4.6: Back to back emitters to prevent mutual interference

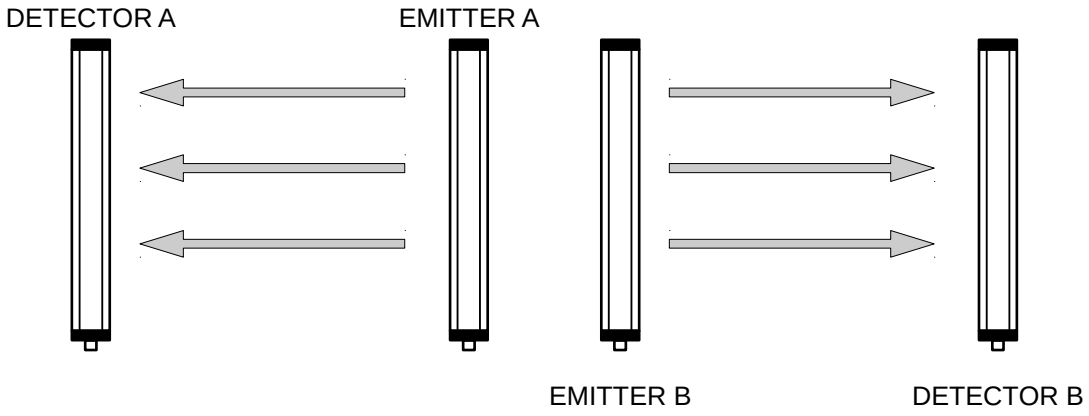
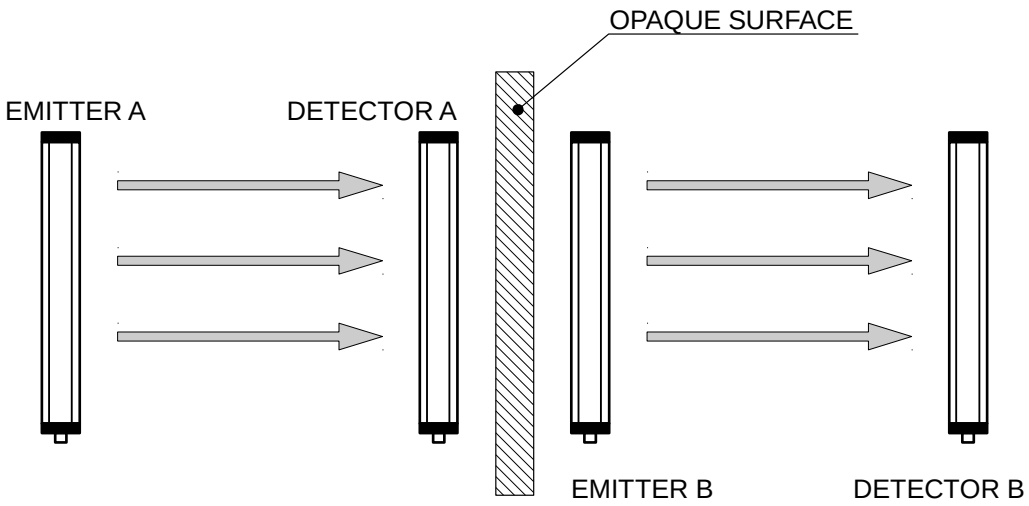
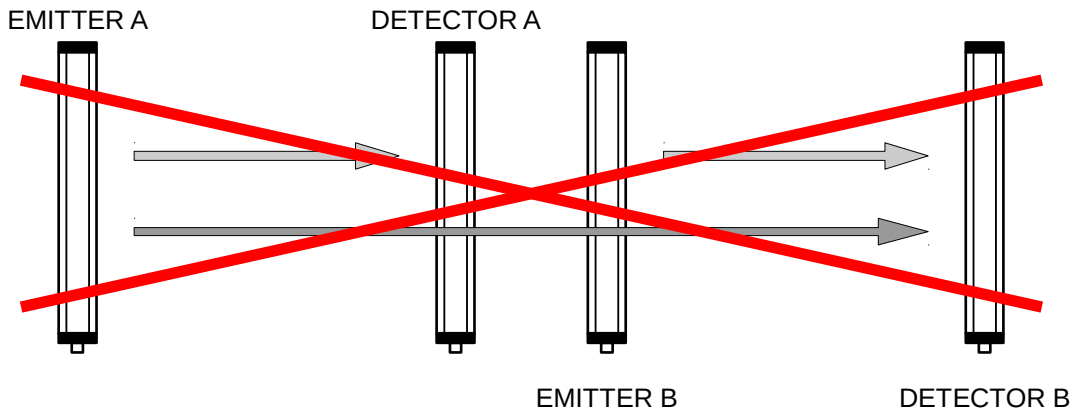


Figure 4.7: Use of an opaque screen to prevent mutual interference



The arrangement shown in figure 4.8 shall never be used because it could lead to optical interference:

Figure 4.8: Wrong arrangement for neighbouring light curtains



4.2.2.1 Scan coding

The MX4000 units provide two selectable light modulation patterns that allow two emitter-detector pairs to operate in close proximity to each other without mutual interference.

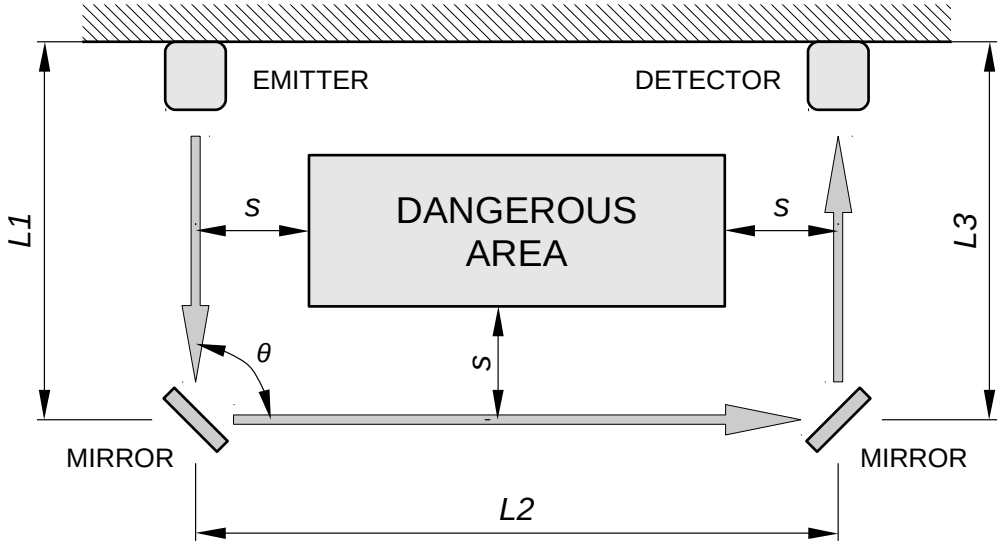
These patterns are called scan codes and are designed so that a detector column unit will only recognize the light emission from an emitter column using the same scan code.

For further details on scan code configuration, refer to chapter 5 (page 51).

4.2.3 Use of deflection mirrors

In some uses, multiple sides of a hazard point or a danger area can be safeguarded with a single safety light curtain by using deflection mirrors. A typical application example is shown in figure 4.9:

Figure 4.9: Use of corner mirrors



The overall operating range is given by the sum of the lengths of all sides that make up the protective field (*L1*, *L2*, *L3*). The minimum safety distance (*s*) must be maintained for each side of the protective field. Note that the use of deflection mirrors reduces the overall operating range of the light curtain by approximately 20 % per mirror. The use of more than two mirrors will make the alignment more difficult.

The reflective properties of mirrors are adversely affected by dust accumulation or moisture condensation on its surfaces. Use of deflection mirrors in such circumstances may result in serious injury or death.

When using deflection mirrors, the total reflection angle *θ* (the sum of the incident angle and the reflection angle) must be between 45° and 120°. Angles smaller than 45° could result in unwanted reflections from an object in the protective field towards the detector, hindering its detection. Angles greater than 120° are also not recommended due to alignment difficulties and the risk of optical bypassing.

The minimum safety distance must be maintained for each side of the protective field.

The use of muting or blanking functions with deflection mirrors is not recommended. The activation of these functions with deflection mirrors will suspend the safety function of the light curtain on all sides of the protective field. If the use of these functions is strictly necessary at one side of the protective field, all other sides must be protected with mechanical barriers to prevent access and to close any gaps in the protective field.

Failure to follow these procedures may result in serious injury or death.

Deflection mirrors are available as standard accessories (see page 72 for ordering information).

4.3 Mechanical mounting

The MX4000 emitter and detector units can be mounted directly on the machine frame or on rugged mounting adapters to the machine frame.

4.3.1 General considerations

The following considerations must be taken into account when mounting the MX4000 safety light curtain:

- The emitter and detector units must be mounted parallel to each other at the same height and aligned in the same plane. The small specified angle of beam spread of ± 2.5° requires increased precision in aligning the two columns with each other before the columns are tightly secured into place.
- The distance between the emitter and detector units must be within the specified detection range of the particular MX4000 model.
- The emitter and detector units can be mounted at either side of the machine. However, the beam status indicators are easier to see when the detector unit is mounted at the right-hand side. Always make sure that the status indicator lights are clearly visible to the operator.

Access to hazardous areas must be allowed only through the protective field of the safety light curtain. Additional safeguarding or guards may be necessary to prevent access over, under or around the safety light curtain or from other areas of a particular machine not protected by the safety light curtain.

4.3.2 Mounting brackets

The MX4000 safety light curtain systems are delivered with an appropriate set of sliding nuts that can be placed at any position along the sliding rail at the rear side of the column profile.

Using the sliding nuts for fastening requires levelled and precisely aligned mounting surfaces. If this requirement can not be satisfied, optional swivelling brackets can be ordered.

When the shock and/or vibration conditions exceeds the maximum specifications of the MX4000 (see 10.1, page 65), e.g. when used in large presses or heavy stamping, the MX4000 safety light curtain must be mounted using the optional shock and vibration isolation mounting brackets.

Please refer to section 11.2.2 on page 72 for ordering information on mounting accessories.

4.4 Electrical installation

4.4.1 Connectors and cables

All the external connections on the MX4000 system are made through industry standard M12 circular connectors (IEC 61076-2-101) located at the bottom end of the unit's housing.

In order to prevent accidental misconnection, the main connectors on the emitter and detector units have different number of contacts.

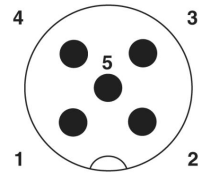
In most situations, the functional earth (FE) connection can be left unconnected. However, in cases of extreme electromagnetic interference, the use of shielded connection cables is recommended and the cable shield and the FE should be connected together on a large metal surface.

Pre-assembled connection cables and extensions can be ordered in different lengths. Please see 11.2.1 on page for ordering information.

4.4.1.1 Emitter unit main connector

On emitter units (all models), the main connector is of male type and has five (5) positions. Table 4.1 shows the connector diagram with the signal names and descriptions.

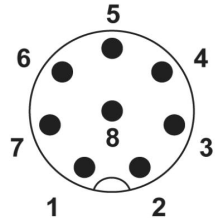
Table 4.1: Emitter unit main connector assignments

Contact numbering		***Signal***	
Diagram[5]	***Position***	***Name***	***Description***
	1	L+	Power input (24 V DC)
	2	CS	Code selection input
	3	L−	Power and signal common (0 V DC)
	4	TEST	Test input
	5	FE	Functional earthing

4.4.1.2 Detector unit main connector

The main connector of MX4100 detector units is of male type and has eight (8) positions. A connector diagram with contact numbering, signal names and descriptionsis shown in table 4.2.

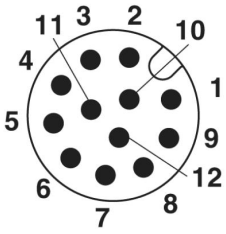
Table 4.2: Detector unit connector assignments (MX4100 only)

Contact numbering		***Signal***	
Diagram[5]	***Position***	***Name***	***Description***
	1	SEL	Parameterization tool button input
	2	L+	Power input (24 V DC)
	3	AUX	Auxiliary I/O
	4	RST/EDM	Reset/External device monitoring input
	5	OSSD1	Safety output channel 1
	6	OSSD2	Safety output channel 2
	7	L−	Power and signal ground (0 V DC)
	8	FE	Functional earthing

On the MX4200, the main detector units have a male type, twelve (12) positions connector. The connector diagram with contact numbering, signal names and descriptions is shown in table 4.3.

[5] Connector diagrams shown as seen from the bottom end of the column.

Table 4.3: Detector unit connector assignments (MX4200)

Contact numbering		Signal	
Diagram[6]	***Position***	***Name***	***Description***
	1	L+	Power input (24 V DC)
	2	L−	Power and signal ground (0 V DC)
	3	SEL	Parameterization tool button input
	4	AUX	Auxiliary I/O
	5	OSSD2	Safety output channel 2
	6	RST/EDM	Reset/External device monitoring input
	7	MS1	Mute sensor input 1
	8	OSSD1	Safety output channel 1
	9	MS2	Mute sensor input 2
	10	FE	Functional earthing
	11	−	Not used
	12	−	Not used

4.4.2 Power supply

In order to comply with the IEC 61496-1 standard, the external DC power supply must satisfy all of the following conditions:

- Must be within the rated power voltage (24 V DC ± 20 %)
- Must comply with EMC directives for industrial environments
- Must have double or reinforced insulation between the primary and secondary circuits according to PELV/SELV standards.
- Must exhibit an output holding time equal or greater than 20 ms
- Must satisfy output characteristics requirements for class 2 circuit or limited voltage current circuit.
- Must comply with laws and regulations, regarding EMC and electrical equipment safety of the country or region where the MX4000 is used.

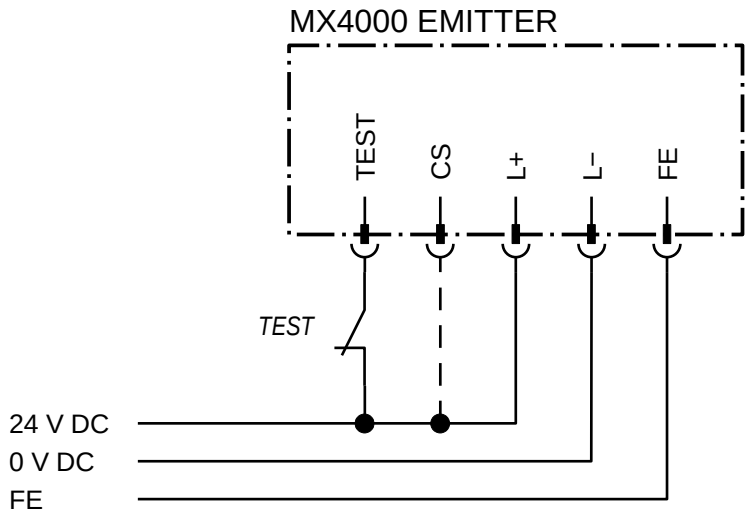
A suitable power supply unit compliant with the above requirements can be ordered as an optional accessory (see 11.2 on page 72).

4.4.3 Emitter unit wiring diagram

The schematic diagram on figure 4.10 shows the typical connections of the emitter unit for all the members of the MX4000 series of safety light curtains:

[6] Connector diagrams shown as seen from the bottom end of the column.

Figure 4.10: Emitter unit wiring diagram



The TEST input is connected to 24 V DC through the normally closed contact of a push-button, relay, etc. The emitter unit will enter into test mode whenever the TEST input circuit is open.

If the emitter test function is not used, the TEST input should be connected to the power line (24 V DC). Otherwise, the safety light curtain will remain in OFF state.

The CS (code selection) input is used to select the scan code of the emitter unit at power-up. For the default scan code (CODE A) this signal can be left open or connected to 0 V DC. Otherwise, for the alternate scan code (CODE B), it must be connected to 24 V DC.Refer to section 5.2 (page 51) for further information on CS input operation.

Any change in the state of the CS input after the power-up will bring the emitter unit into lockout state.

For detailed information on the emitter unit connector, pin assignments and wire colours, please see table 4.1 on page 42.

4.4.4 Detector unit wiring diagrams

The following sections show the typical wiring of each different function on the detector columns. Since detector units have different connectors you should check the pin numbers and wire colours for each model on the tables of section 4.4.1.2 (page 42).

4.4.4.1 OSSD Outputs

Safety outputs OSSD1 and OSSD2 must be connected separately as shown on figure 4.11, otherwise, safety will not be insured.

Under no circumstances should safety outputs OSSD1 and OSSD2 be wired together. Otherwise, or if only one safety output is used, the safety category of the light curtain will be reduced from Type 4 to Type 2.

Figure 4.11: OSSD Wiring Diagram

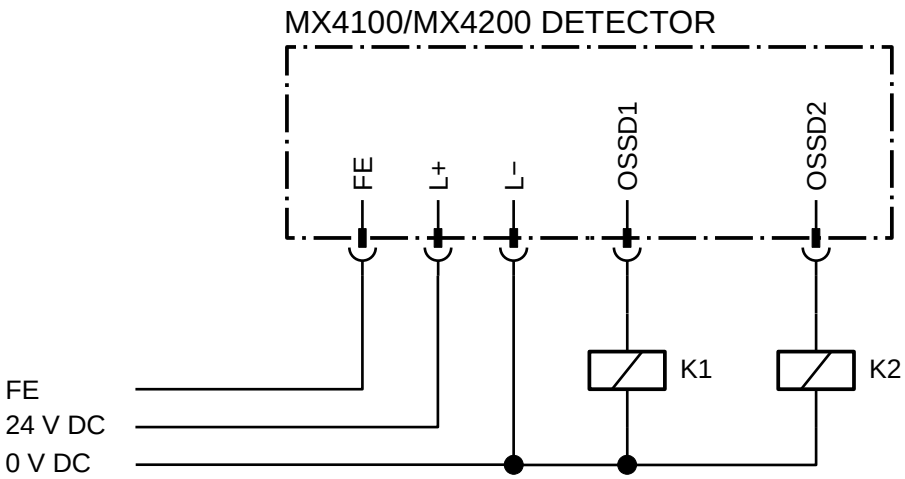
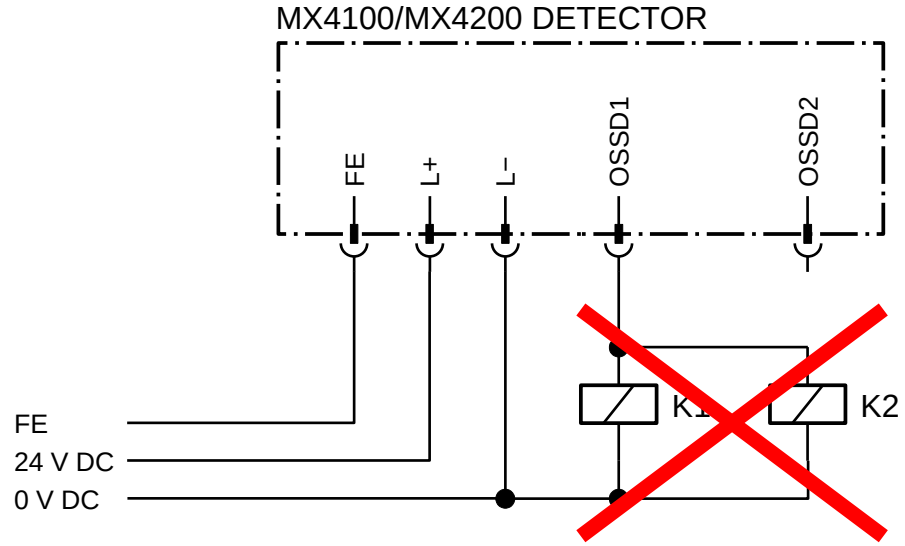


Figure 4.12: Wrong wiring of OSSDs



Monitoring pulses are periodically applied to the safety outputs during ON state in order to detect short-circuit conditions, either to 24 V DC, 0 V DC or between outputs.

If safety relays are used, check that they are able to operate properly in presence of the monitoring pulses. Suitable safety relays can be ordered from ISB as an optional accessory (see 11.2.3 on page 72).

4.4.4.2 RST/EDM input connections

This input is used for both the interlock reset push-button and for the EDM function. The external wiring will depend on which of these functions is used. For further details on the operation of interlock and EDM functions, refer to sections 3.4.2 and 3.4.3 (pages 20/21).

The reset push button (or any other means to release the interlock) must be installed in a location that provides a clear view of the hazardous zone and must be ensured that it cannot be operated from within the hazardous zone.

If only the start/restart interlock function is used, the interlock reset push-button must be wired as shown on figure 4.13. Make sure that the EDM function is disabled in the configuration, otherwise, the MX4000 will enter into lockout state.

Figure 4.13: RESET Push-button wiring diagram

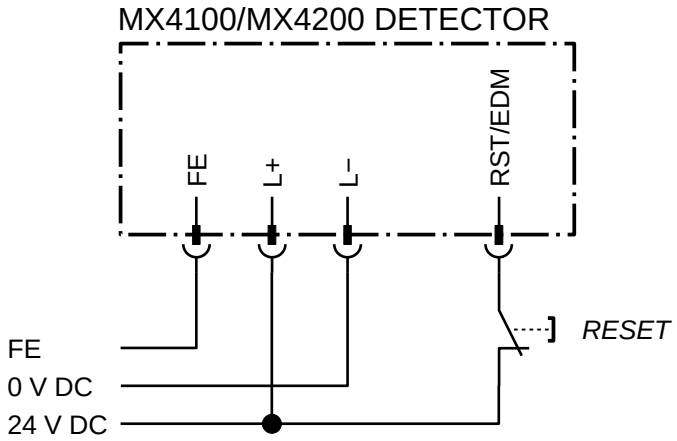
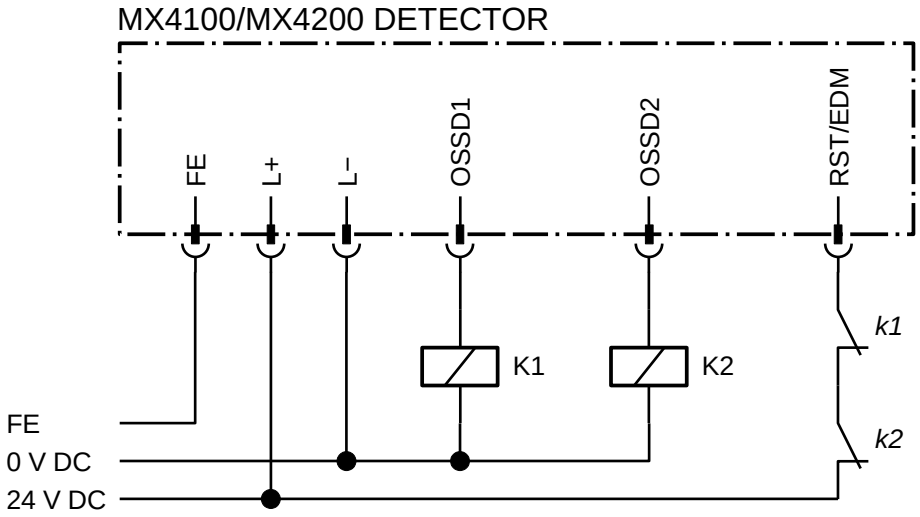


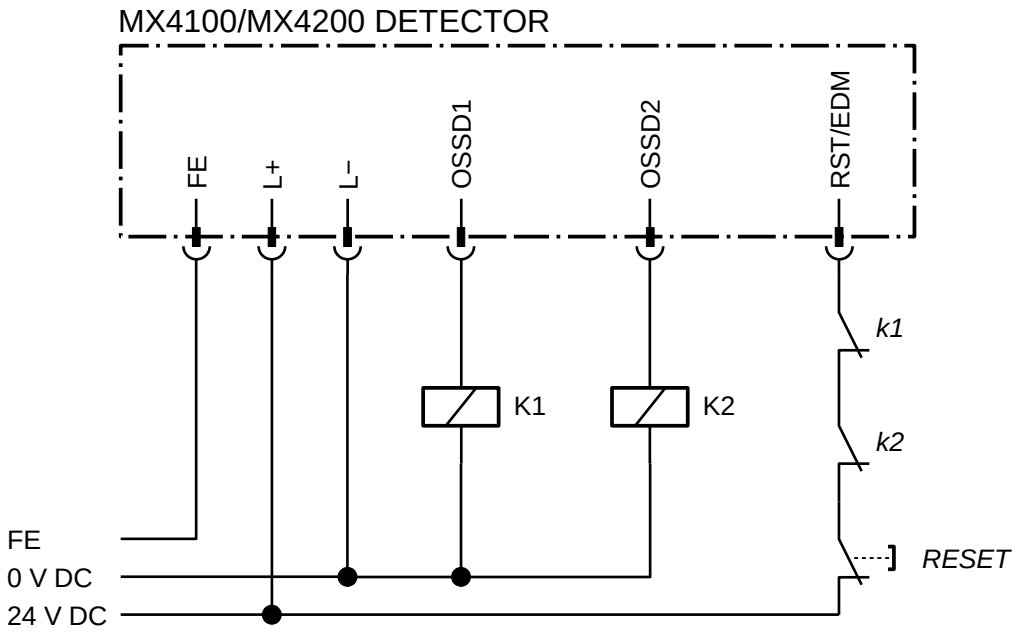
Figure 4.14 shows the external wiring for operation with EDM function only. In this case, the EDM function must be enabled through the parameterization procedure.

Figure 4.14: EDM input wiring diagram



If both the start/restart interlock and EDM functions are used at the same time, the RST/EDM input must be wired as indicated on the following diagram:

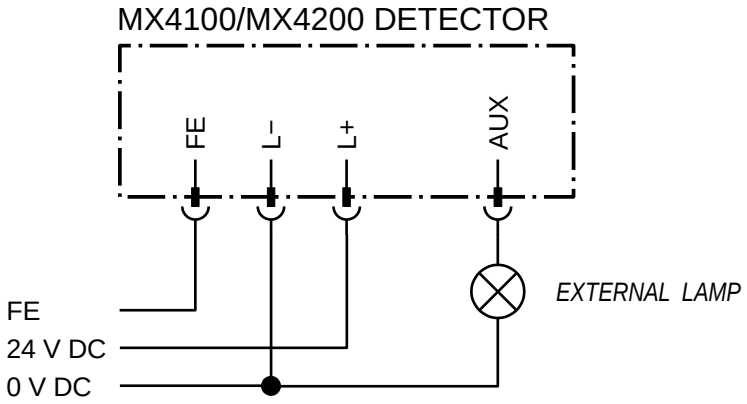
Figure 4.15: External wiring for simultaneous reset and EDM functions



4.4.4.3 Auxiliary output connections

In normal operation, the auxiliary output is used to connect an external indicator lamp or to signal external controllers. The typical wiring is shown in figure 4.16. Please refer to section 3.4.6 (page 31) for further information on the AUX output functions.

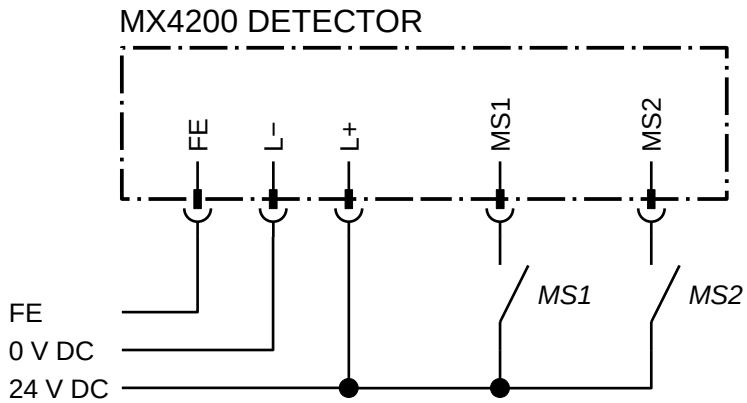
Figure 4.16: External lamp wiring



4.4.4.4 Muting inputs (MX4200 only)

The MX4200 includes two inputs for muting sensors. They accept relay (dry contacts) or solid state (PNP type) sensor outputs and can be connected to limit switches, inductive proximity sensors, photo-electric sensors, etc. Figure 4.17 shows a typical wiring diagram for the mute sensors using normal open (NO) switches:

Figure 4.17: Muting sensors wiring



For further details on the operation of the muting function, please refer to section 3.4.4 (page 21).

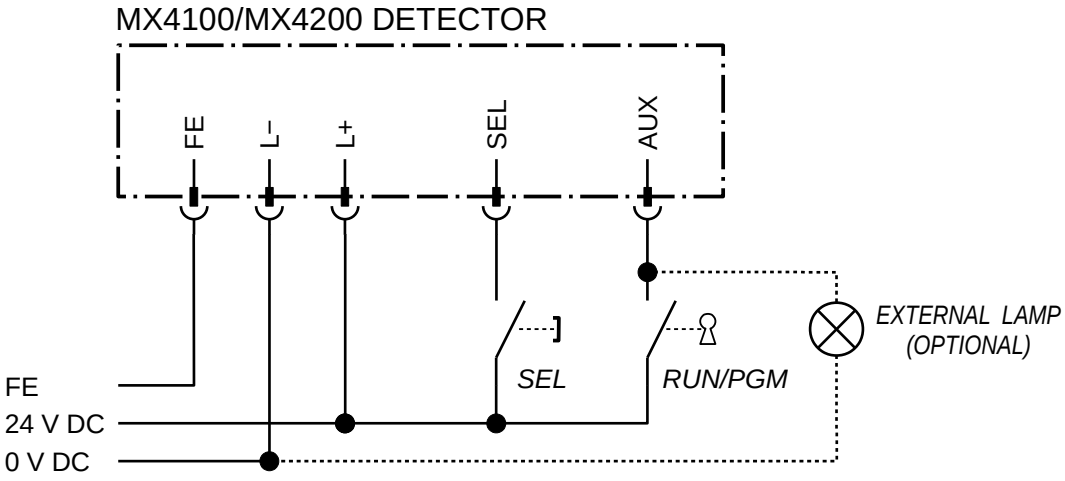
4.4.4.5 External connections for parameterization and teach-in

During parameterization or blanking teach-in, the AUX and SEL signals are used as inputs for the RUN/PGM key-lock switch and the SEL push-button. The wiring is shown in figure 4.18.

The switch used for the parameterization function (RUN/PGM) shall be of the key-lock type, preferably with spring-return action.

It is the responsibility of the supervisor to only give access to the keys for the RUN/PGM switch to authorized personnel.

Figure 4.18: External wiring for parameterization and teach-in



If an external indicator lamp is used, the operation of the RUN/PGM key-lock switch will cause the lamp to turn on during the parameterization or teach-in

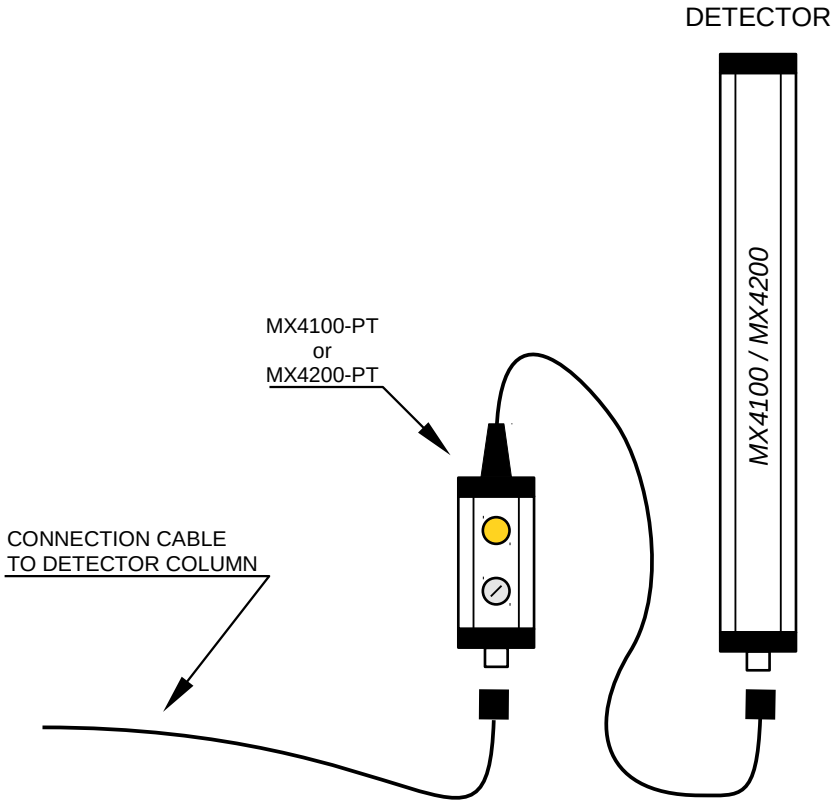
4.4.4.6 Use of pass-through parameterization tools

Two handy accessory tools are available from ISB that help you to perform parameterizations in the field in a straightforward manner without the need for additional tools or modifications to the existing wiring. The MX4100-PT and MX4200-PT tools include the RUN/PGM key-lock switch and the SEL push-button pre-wired and housed in a sturdy, hand-held, enclosure that can be conveniently carried on inside a tool box.

These tools are fitted with a standard M12 connector and a pigtail cable for a quick and easy insertion into existing installations.

To use these tools, select the appropriate type according to the detector model (i.e. MX4100 or MX4200) and just disconnect the existing cable from the detector column and insert the tool in the circuit as depicted in the figure below. Once you have finished, remove the tool and restore the original cable connection.

Figure 4.19: Use of pass-through parameterization tools



These accessories are intended for portable use, thus are not suitable for permanent installation. For fixed installations, a similar accessory tool (MX4000-PB) is also available for direct connection to a junction block. Please refer to section 11.2.3 (page 72) for ordering information.

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5 Parameterization

All the operation parameters of the MX4000 safety light curtains can be configured according the particular requirements of the end user's application. This chapter describes the configuration procedures for each function of the MX4000.

Changes to the configuration of the safety light curtain may adversely affect the effectiveness of the protective function!

After any change to the configuration parameters you must always perform a verification test according to the procedures described in chapter 7 in order to check the functionality and performance of the protective device.

5.1 Default factory settings

When the MX4000 safety light curtains are delivered, its operation parameters are pre-set at the factory as detailed on the following sections (5.2 and 5.3).

For detector units, the default factory settings can be restored at any time through a special procedure. Please refer to section 5.3.2 (page 53) for detailed information.

5.2 Emitter unit configuration

The only configurable parameter on emitter units is the scan code, which can be chosen between two possible options: CODE A and CODE B. The default scan code is CODE A.

The default scan code can be changed to the alternate code through the CS input on the main connector. If you need to change the scan code, make sure that the scan code on the emitter unit matches with that of its corresponding detector unit.

At power-up, the emitter unit will select its operating scan code based on the logic level detected at the CS input. Any change of the voltage level on this terminal after the power-up will bring the emitter unit into lockout state.

If a high logic level is detected (the input is connected to 24 V DC), the emitter unit will use CODE B. Otherwise, if the input is left open or connected to 0 V DC, the default scan code (CODE A) will be used.

Please refer to section 4.4.3 (page 43) for connection details.

5.3 Detector unit configuration

5.3.1 Parameterization procedure

The parameterization of the MX4100 and MX4200 is carried out through a special signalling sequence applied to the SEL and AUX inputs. Therefore, a push-button and a key operated switch must be connected to these signals as indicated on figure 4.18 (see page 48). For this purpose, the key-lock switch and the push-button are named, respectively, RUN/PGM and SEL.

The configuration process is carried out as follows:

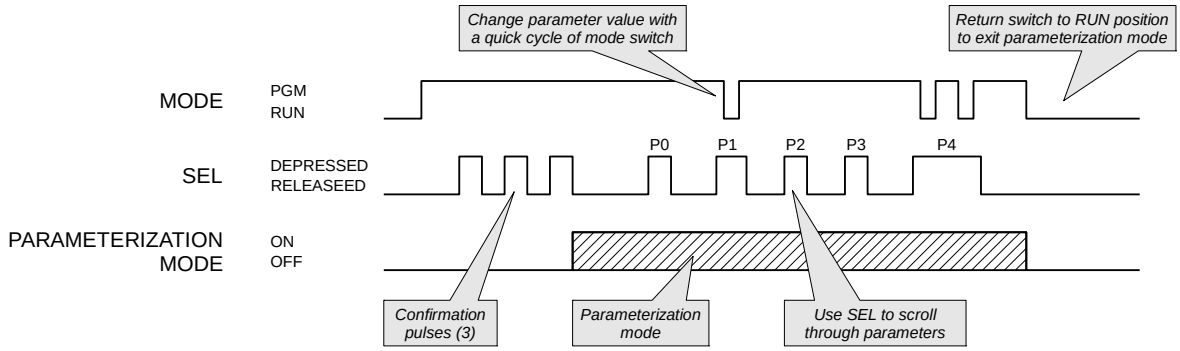
- Turn off the MX4000 system and put the RUN/PGM key-switch in its ON position; then, turn on the power supply.
- After the initial start-up, a flashing '*P*' will be shown on the display. From this point, you have 30 seconds to confirm the operation by depressing the SEL push-button three times

in succession. The length of the pulses and the time between them must be at least 0.2 seconds. The pulses will be ignored if you do not meet these timing requirements.

- If the confirmation pulses are properly applied, the blinking '*P*' on the display will change to a steady state and the MX4000 system will enter into parameterization mode. While in this mode, the OSSD outputs will not be switched on, even if the protective field is clear.
- Leave the RUN/PGM switch on its PGM position.
- During parameterization, the current value of each parameter can be shown on the display panel by depressing and holding the SEL push-button. With each successive depress of the push-button, the next parameter's code is shown on the display while its current value is indicated through the state of the blue and yellow LEDs, as described on next section (see 5.3.3). You can scroll over the parameter list by depressing the SEL push-button as needed.
- While a parameter is being shown on the display (i.e. SEL pushbutton is depressed), you can change its value by briefly[7] turning the RUN/PGM switch to its RUN position and then returning it to PGM position. The parameter's value will be updated immediately on the LEDs.
- Once you have completed the changes and have checked the correctness of all parameters, you can finish the parameterization procedure by returning the RUN/PGM switch to the RUN position. A result code will be shown briefly on the display (see table 5.1) and then the MX4000 will restart automatically. If there were no errors during the parameterization, the new settings take effect immediately after the automatic restart. Otherwise, if a parameterization error is detected, the cause will be explained by the return code and the system will go into lockout state after restarting.

The illustration below shows a simplified timing diagram of a typical parameterization sequence:

Figure 5.1: Example of a parameterization sequence



[7] If during the parameterization the RUN/PGM switch is left in the RUN position for more than 1 second, the parameterization mode will be cancelled.

Table 5.1: Return codes for parameterization procedure

Parameterization return codes	
Display[8]	***Meaning***
r → 0	Parameterization completed successfully without changes (same configuration).
r → 1	Parameterization completed successfully with changes.
r → 2	Parameterization error (the system may enter into lockout state after restarting).

If no activity is detected in parameterization mode for more than three minutes (i.e. no operation of the SEL push-button), the parameterization mode will be automatically cancelled and the MX4000 will enter into lock-out state.

5.3.2 Restoring factory configuration

Should it be necessary, all the configurable function parameters can be restored to their default values (as shipped from factory) by using the following procedure:

- Turn off the MX4000 system and put the RUN/PGM key-switch in its PGM position; then depress and hold the SEL push-button while turning on the power supply.
- After the power-up, a flashing 'C' will be shown on the display. From this point, you have 30 seconds to confirm the clearing operation by releasing and depressing the push-button three times in succession. The length of the pulses and the time between them must be at least 0.2 seconds (and 3 seconds maximum). The pulses will be ignored if you do not meet these timing requirements.
- If the push-button pulse sequence is properly applied, the blinking 'C' on the display will change to a steady state and all the user parameters will be restored to its factory default state.
- After returning the RUN/PGM switch to the RUN position the MX4000 will restart automatically with the factory default configuration.

5.3.3 Parameter descriptions

This section provides a short description of each detector parameter. Each description includes a table summarizing the parameter code and its allowed values, along with the LED indication for each value of the parameter as shown in parameterization mode (the ○ symbol represents a turned off LED while the ◉ symbol represents a turned on LED). The default factory setting for each parameter is also indicated.

In section 12.5 (page 77) you will find a quick reference table with all the parameters on a single sheet. Print a copy and keep it handy during the parameterization.

5.3.3.1 Display orientation

This parameter allows the rotation of the 7-segment display for easy reading when the MX4000 columns are mounted upside down. Changes to this parameter are applied immediately.

[8] Result code is shown on the display one character at a time (the symbol → represents the transition from one character to the next).

Table 5.2: Parameter – Display orientation

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
0	Display orientation	NORMAL (Default)	○	○
		UPSIDE DOWN	○	◉

5.3.3.2 Scan code

If you need to change the scan code, make sure that the scan code on the detector unit matches with that of its corresponding emitter unit.

Table 5.3: Parameter – Scan code

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
1	Scan code	CODE A (Default)	○	○
		CODE B	○	◉

5.3.3.3 Interlock function

This parameter enables or disables the two modes of the interlock function. For further information on the interlock functions, see 3.4.2 on page 20.

Table 5.4: Parameter – Start interlock

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
2	Interlock function	DISABLED (Default)	○	○
		START INTERLOCK	○	◉
		RESTART INTERLOCK	◉	○
		BOTH	◉	◉

5.3.3.4 EDM Function

This parameter enables or disables the external device monitoring function. For further information on this function see 3.4.3 on page 21.

Table 5.5: Parameter – EDM function

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
3	EDM Function	DISABLED (Default)	○	○
		ENABLED	○	◉

5.3.3.5 Auxiliary output function

This parameter configures the signalling options for the auxiliary output in the detector unit of the safety light curtain. Depending on the configuration selected, a high output level indicates either an interlock condition (i.e. reset required) or a mute condition. For further details on the auxiliary output functions, see 3.4.6 (page 31).

On MX4100 models, only DISABLED and INTERLOCK are available.

Table 5.6: Parameter – Auxiliary output function

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
4	Auxiliary output signalling	DISABLED (Default)	○	○
		INTERLOCK	○	◉
		MUTE (MX4200 only)	◉	○

5.3.3.6 Muting function (MX4200 only)

This parameter is used to enable or disable the muting function and also to specify the required muting timeout. Refer to 3.4.4 (page 21) for a complete description of the muting function.

Table 5.7: Parameter – Muting function

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
5	Muting function	DISABLED (Default)	○	○
		ENABLED (timeout 60 s)	◉	○
		ENABLED (timeout 300 s)	○	◉
		ENABLED (timeout 600 s)	◉	◉

5.3.3.7 Fixed blanking tolerance, positive (MX4200 only)

This parameter configures the positive blanking tolerance, in beams, for the fixed blanking function. For further details on the use of blanking tolerances, see 3.4.5.4.1 on page 28.

Table 5.8: Parameter – Fixed blanking tolerance, positive

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
6	Blanking tolerance, positive	0 beam (Default)	○	○
		1 beam	◉	○
		2 beams	○	◉
		3 beams	◉	◉

5.3.3.8 Fixed blanking tolerance, negative (MX4200 only)

This parameter configures the negative blanking tolerance, in beams, for the fixed blanking function.

For further details on the use of blanking tolerances, see 3.4.5.4.1 on page 28.

Table 5.9: Parameter – Fixed blanking tolerance, negative

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
7	Blanking tolerance, negative	0 beam (Default)	○	○
		1 beam	◉	○

5.3.3.9 Floating blanking (MX4200 only)

This parameter configures the floating blanking function by selecting the number of floating beams allowed. The floating blanking function is described in 3.4.5.6 (page 30).

Table 5.10: Parameter – Floating blanking

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
8	Floating blanking	0 beam (Default)	○	○
		1 beam	◉	○
		2 beams	○	◉
		3 beams	◉	◉

5.3.3.10 Floating mode (MX4200 only)

This parameter is only shown when the floating blanking is enabled (number of floating beams > 0) and it specifies the number of floating objects allowed. The floating blanking function is described in 3.4.5.6 (page 30).

Table 5.11: Parameter – Floating mode

Parameter		Options		
Code	**Name**	**Value**	**BLUE**	**YELLOW**
9	Floating mode	SINGLE (Default)	○	○
		MULTIPLE	◉	○

6 Commissioning

Before putting the MX4000 into operation for the first time, the entire setup and the integration of the AOPD into the machine control system shall be inspected and tested by qualified personnel to verify that it operates as intended.

An improper setup or configuration can cause a person to go undetected, resulting in serious injury.

Before powering up the MX4000 for the first time and while the emitter and detector units are being aligned, it must also be ensured that the outputs of the AOPD do not have any effect on the machine. The switching elements that set the dangerous machine in motion must be safely switched off and secured against restarting.

6.1 Optical alignment

After the MX4000 safety light curtain has been mounted and the electrical connections have been completed, the emitter and detector units must be aligned to ensure proper system operation.

An optimal alignment is obtained when the optical axes of the first and last beam from the emitter unit coincide with those of their corresponding beams on the detector unit.

The emitter and detector units must be mounted at the same height or, if installed in a horizontal position, be at the same distance from the reference surface and slightly fastened at first. The small specified angle of beam spread of ± 2.5° requires increased precision in aligning the two columns with each other before the columns are tightly secured into place.

For MX4200 models, the optical alignment procedure shall be carried out with no blanked areas (if needed, you can erase all blanking patterns by restoring the default factory configuration as indicated in section 5.3.2, on page 53). Before starting the alignment, check that there are no interruptions on the protective field and that the optical surfaces of the emitter and detector columns are clean.

- Start the procedure by checking the alignment of the sync beam. If it is not properly aligned (or obstructed), the Ξ symbol will be shown on the display. Adjust the relative position of both columns until the display symbol is turned off. Once the sync beam has been aligned, fix the detector unit into place, while taking care not to change the alignment display status.
- Without changing the relative position of the sync beam, slightly adjust the position of the emitter unit until all the beam status indicators on the detector unit are turned off and the OSSD LED changes to green (if interlock function is enabled, the OSSD LED will stay red and the yellow LED will start blinking).
- If using swivelling brackets, slightly turn the emitter unit until the Ξ symbol appears on the display. Note this position and turn the emitter on the opposite direction until the display symbol goes off and then continue until the Ξ symbol is shown again. Now turn back the emitter to the center of the two positions found and fix the brackets so they can not be moved. This step shall be repeated for the detector unit.
- Once the optimal adjustment is achieved, all the mounting brackets must be securely fastened while checking that the alignment condition is not changed.

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7 Inspection and maintenance

7.1 Pre-commissioning tests

The purpose of these tests is to verify that the MX4000 is operating correctly in terms of functionality and performance before putting the machine into operation.

Make sure to test the operation of the safety light curtain after installation to verify that it operates as intended. Make sure to stop the machine until the test is complete. Unintended function settings can cause a person to go undetected, resulting in serious injury.

The test procedure must be carried out as follows:

- Check that the safety light curtain (and any other safety device that might be part of the guarding system) have been selected in strict compliance with all the applicable machine safety standards and local regulations regarding occupational safety and that they meet the protection levels required by the risk assessment.
- Check that the safety light curtain is properly installed and integrated into the machine control system according to the instructions described in this document. Use the checklists provided in the appendix (see 12.4 on page 76) as a guideline.
- Check the effectiveness of the safety light curtain.
- Ensure that the operators of the guarded machine are correctly trained by qualified safety personnel before being allowed to operate the machine. Instruction of machine operators is the responsibility of the machine owner.

7.2 Daily functional test

This test is intended to check the effectiveness of the protective field and should be performed by qualified personnel after every system power-up and/or configuration changes. If the system is continuously powered up, the functional test should be performed at least every 24 hours.

This test is also required after every change to the configuration parameters of the safety light curtain (e.g. blanking modes) or in the guarded machine (e.g. tool changes).

The test procedure must be carried out as follows:

- Select the appropriate test rod according to the effective detection capability of the light curtain to be tested. The test rod must be free of deformations.
- Before introducing the test rod into the protective field, verify the status of the detector unit's indicators and check that the OSSD LED (see figure 3.3, p.18) is lit in green or, if the system is going to be tested with the interlock function enabled, verify that the interlock is engaged and that the yellow LED is blinking while the OSSD LED is lit in red. If these pre-conditions are not satisfied, the test is meaningless.
- Introduce the test rod into the protective field and slowly[9] move it around the detection zone. When the restart interlock function is not used, the OSSD LED will change to red as the test rod enters into the protective field. If the restart interlock is engaged, the yellow indicator will turn off while the OSSD LED stays lit in red.
- Throughout the entire test procedure the OSSD LED must be constantly lit in red while the other LEDs must remain off.

[9] Note that, according to IEC 61496-2, the maximum rod speed must not exceed 1.6 m/s

Never operate the machine if the test does not provide the expected results. If the OSSD LED turns green or the yellow LED lights up during the test, even for a short period, the installation must be verified by qualified personnel before use.

If the fixed blanking function is in use, the test must be carried out for all sections of the protective field contained between the blanked areas. The same applies to all sides of the protective field defined by the use of deflection mirrors.

7.3 Periodic inspection

Depending on the applicable regulations, particular application and operation conditions, the MX4000 safety light curtain must be periodically tested by qualified and trained personnel.

The purpose of these inspections is to detect changes in the operational conditions of the machine (e.g. stopping time) or manipulations to the installation or protective devices that might affect the safety.

7.4 Maintenance

The MX4000 safety light curtain does not have any moving parts and so requires limited preventive maintenance.

The front shield of the light curtain should be cleaned regularly and when dirty. Depending on the degree of dirt build up, a soft brush or a soft cloth dampened with water can be used.

In no case should aggressive or abrasive cleaning agents be used to clean the front shield, otherwise the operation range could be reduced and optical degradation may occur.

The MX4000 safety light curtain does not contain any field serviceable parts. Do not try to disassemble, repair or modify this product. Doing so may cause the safety functions to stop working properly and the overall system safety cannot be guaranteed.

Any attempt to disassemble, repair or modify the MX4000 safety light curtain will void any warranty claim against ISB.

The MX4000 safety light curtain must be replaced after reaching its maximum service life indicated on the technical specifications (see page 65).

8 Troubleshooting

Upon the occurrence of certain faults or configuration errors, the MX4000 will deactivate its safety outputs and will go into lock-out state. Lock-out conditions will be indicated on the affected unit by a constant illumination of the yellow indicator.

When in lock-out condition, detector units can also provide diagnostic information through an error code shown on the seven-segment display of the detector unit. The error codes (described on table 8.1) will help you to trace the cause(s) of the problem.

To recover from a lock-out condition, the originating cause must be removed and the system must be restarted by switching off and on the power supply.

Under any lock-out or error condition, the installation must be thoroughly checked and the problem investigated by a qualified personnel. If the cause of the malfunction cannot be clearly identified the guarded machine should not be used.

Table 8.1: Lock-out codes

Lock-out codes	
Display	***Meaning***
1	Invalid EDM feedback (either invalid logic level or timing violation)
2	Short-circuit at OSSD(s) output(s), either to 24 V DC, 0 V DC or to the other OSSD
3	Short-circuit at AUX I/O, either to 24 V DC or 0 V DC (or MODE key left in PGM position)
4	RST input malfunction (permanent ON state, e.g. open circuit)
5	Muting timeout exceeded
6	External muting lamp fault (open circuit or current outside required limits)
7	Configuration parameters corrupted (use clearing procedure 5.3.2, p. 53)
F	System fault (Reset the MX4000. If the problem persist, unit must be replaced)[10]

8.1 Technical support

If you find that an error condition cannot be clearly defined and corrected with the help of the information provided in this manual, please contact your local ISB representative (see back cover for contact information).

[10] After 5 minutes in this condition, an additional error code will be shown on the display. This code is for factory internal use only.

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9 Decommissioning

The safety light curtain may only be removed if the machinery where it is installed will be put out of service definitively. This has to be done by removing the mains supply from the machinery and it must be impossible to bring it back into service without the use of tools.

If a decommissioned safety light curtain has to be disposed of, follow the current local regulations regarding waste recycling and disposal.

9 Decommissioning

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10 Technical specifications

10.1 General specifications

The following table shows the general specifications common to all MX4000 column types.

Table 10.1: General specifications

General specifications				
		Minimum	*Typical*	*Maximum*
Protective field height (depending on model)		300 mm	—	1800 mm
Detection capability (depending on model)		⌀ 14 mm	—	⌀ 82 mm
Detection range[11]		0.1 m	8 m	10 m
Effective aperture angle		—	—	± 2.5°
Supply voltage (U_s)		19.2 V	24 V	28.8 V
Residual input voltage ripple		—	—	± 10 %
Safety	Type according to IEC 61496	—	Type 4	—
	SIL according to IEC 61508	—	SIL 3	—
	SILCL according to IEC 62061	—	SILCL 3	—
	Performance level ISO 13849-1	—	PL e	—
	Category as per ISO 13849	—	Cat. 4	—
	Service life	—	—	20 years
	Probability of a failure to danger PFH_d	—	5.5E−9 h^{-1}	—
	Probability of a failure to danger $PFD_{av}(T)$	—	4.8E−4	—
	$MTTF_d$	—	1.5E6 h	—
Environmental	Enclosure rating (IEC 60529)	IP 65		
	Protection class (IEC 50178)	III		
	Operating ambient temperature	0 °C	—	50 °C
	Storage ambient temperature	−20 °C	—	60 °C
	Relative humidity	15 %	—	95 %
	Rigidity	5 g, 10..55 Hz as per IEC 60068-2-6		
	Shock	10 g, 16 ms, as per IEC 60068-2-29		
Material	Main body	Aluminium (epoxy coated, RAL 1021)		
	End caps	Aluminium (anodised, RAL 9004)		
	Front cover	Polycarbonate		
Standards	EMC	IEC 61000-4-3/4/5/6		
	Safety	IEC 61496-1 Type 4 ESPE		
		IEC 61496-2 Type 4 AOPD		
		IEC 61508 SIL3		

[11] Typical value is guaranteed for all operating conditions.

10.2 Emitter units specifications

The following table shows the specifications for the MX4000 emitter columns:

Table 10.2: Emitter units specifications

Emitter Specifications				
		Minimum	*Typical*	*Maximum*
Power consumption		—	—	0.3 A
Wavelength of IR emission		—	940 nm	—
Inputs (Test and CS)	Input voltage HIGH state	14.5 V	24 V	30 V
	Input current HIGH state	1.5 mA	5 mA	8.5 mA
	Response time (test input)	—	—	150 ms

10.3 Detector units specifications

The following table shows the specifications for the MX4000 detector units:

Table 10.3: Detector units specifications

Detector Specifications				
		Minimum	*Typical*	*Maximum*
Power consumption (no load)		—	—	0.3 A
Ambient light resistance	White incandescent lamp	—	—	5000 lx
	Sunlight	—	—	20000 lx
OSSD Outputs	Switching current[12]	—	—	500 mA
	Leakage current	—	—	100 µA
	OFF state voltage (inactive)	—	—	2.5 V
	ON state voltage (active)	U_S – 2.5 V	24 V	U_S
	Load capacitance	—	—	2.2 µF
	Load inductance	—	—	2.2 H
	Load wiring resistance	—	—	2.5 Ω
	Test pulse width	100 µs	150 µs	200 µs
	Test pulse rate	—	5 s^{-1}	—
	Response time	See section 10.3.1 (p. 67)		
AUX Output	Switching current[12]	—	—	400 mA
	Minimum load (for MUTE signalling)	100 mA	—	—
	Leakage current	—	—	100 µA
	OFF state voltage	—	—	2.5 V
	ON state voltage	U_S – 2.5 V	24 V	U_S
Inputs (all)	Input voltage HIGH state	14.5 V	24 V	30 V
	Input current HIGH state	1.5 mA	5 mA	8.5 mA
	Response time	—	—	150 ms

[12] For MX4200 models using mute signalling, maximum combined load current of all outputs (OSSD1 + OSSD2 + AUX) must not exceed 1 A

10.3.1 Response time

The response time of the MX4000 light curtain only depends on the total number of beams on the system.

The following table shows the maximum response time values of a single column system for all available combinations of protective field length and detection capability.

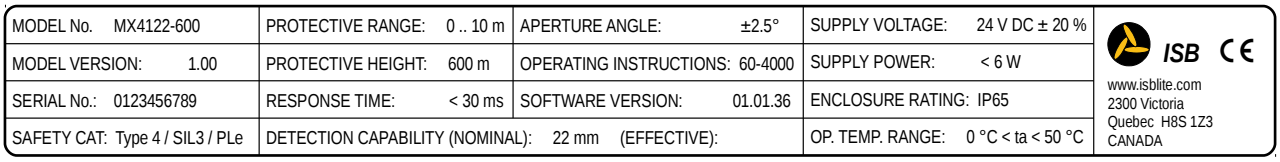
Table 10.4: Response time as function of detection capability and protective field length

Maximum Response Time [ms]					
Protective Field Length	*Detection Capability*				
	14 mm	*22 mm*	*30 mm*	*38 mm*	*82 mm*
300 mm	21	15	13	11	9
450 mm	27	18	15	13	10
600 mm	34	21	18	15	11
750 mm	40	25	20	17	12
900 mm	46	28	22	18	12
1050 mm	53	31	25	20	13
1200 mm	59	35	27	22	14
1350 mm	—	38	30	24	15
1500 mm	—	42	32	26	16
1650 mm	—	45	34	27	17
1800 mm	—	48	37	29	18

10.4 Product labels

Each column of an MX4000 safety light curtain system is marked with an identification label. The illustration below shows a sample of a typical MX4000 product label:

Figure 10.1: Product label sample

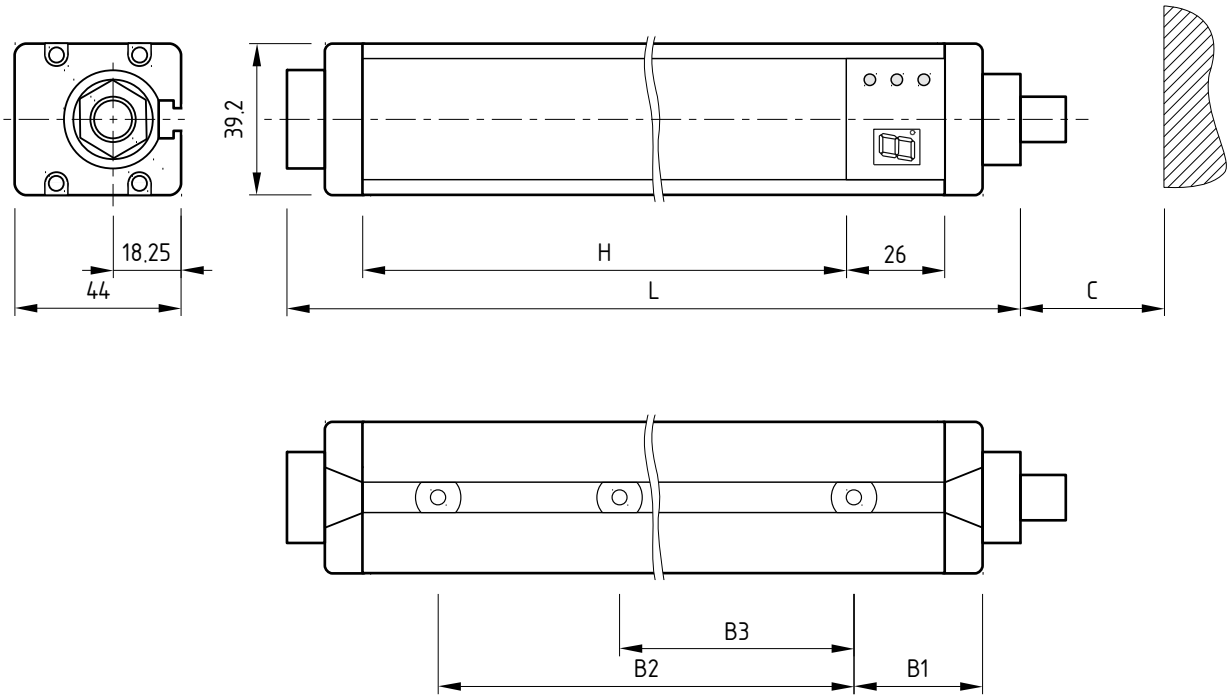


The cell for the detection capability specification includes a white space for writing the effective detection capability of the system when blanking functions are used. See 3.4.5 (page 24) for further information.

10.5 Dimensional drawings

The following drawing shows the general dimensions of the MX4000 safety light curtains. All the mechanical dimensions indicated herein apply indifferently to both emitter and detector columns. The protective field height (*H*) and the overall column length (*L*) for each member of the MX4000 family are tabulated in table 10.5.

Figure 10.2: Dimensional drawings



When mounting the MX4000 safety light curtain, a minimum clearance (dimension *C*) of 100 mm shall be provided at the connector end(s) of the column for proper connector placement and cable dressing. It is also recommended to use the appropriate number of sliding nuts according to column length, as indicated on on table 10.5.

Table 10.5: Mechanical dimensions

Mechanical dimensions						
MODEL NUMBER	***H***	***L***	***B1***	***B2***	***B3***	***C***
MX4□□□-300	300	368	80	190	—	100
MX4□□□-450	450	518	100	300	—	100
MX4□□□-600	600	668	120	410	—	100
MX4□□□-750	750	818	150	500	—	100
MX4□□□-900	900	968	180	590	—	100
MX4□□□-1050	1050	1118	200	700	—	100
MX4□□□-1200	1200	1268	200	850	425	100
MX4□□□-1350	1350	1418	220	960	480	100
MX4□□□-1500	1500	1568	220	1110	555	100
MX4□□□-1650	1650	1718	250	1200	600	100
MX4□□□-1800	1800	1868	250	1350	675	100

11 Ordering information

In this section you will find the ordering information for the MX4000 series of safety light curtains and its most common accessories. For additional parts or other ISB products please refer to our product catalog available on our web site (see internet address on back cover).

11.1 Main columns

Table 11.1: Ordering information. Main columns

Model	***Detection capability***	***Protective field height***	***Emitter Unit Model***	***Detector Unit Model***
MX4100	14 mm	300 mm	MX4014–300	MX4114–300
		450 mm	MX4014–450	MX4114–450
		600 mm	MX4014–600	MX4114–600
		750 mm	MX4014–750	MX4114–750
		900 mm	MX4014–900	MX4114–900
		1050 mm	MX4014–1050	MX4114–1050
		1200 mm	MX4014–1200	MX4114–1200
	22 mm	300 mm	MX4022–300	MX4122–300
		450 mm	MX4022–450	MX4122–450
		600 mm	MX4022–600	MX4122–600
		750 mm	MX4022–750	MX4122–750
		900 mm	MX4022–900	MX4122–900
		1050 mm	MX4022–1050	MX4122–1050
		1200 mm	MX4022–1200	MX4122–1200
		1350 mm	MX4022–1350	MX4122–1350
		1500 mm	MX4022–1500	MX4122–1500
		1650 mm	MX4022–1650	MX4122–1650
		1800 mm	MX4022–1800	MX4122–1800
	30 mm	300 mm	MX4030–300	MX4130–300
		450 mm	MX4030–450	MX4130–450
		600 mm	MX4030–600	MX4130–600
		750 mm	MX4030–750	MX4130–750
		900 mm	MX4030–900	MX4130–900
		1050 mm	MX4030–1050	MX4130–1050
		1200 mm	MX4030–1200	MX4130–1200
		1350 mm	MX4030–1350	MX4130–1350
		1500 mm	MX4030–1500	MX4130–1500
		1650 mm	MX4030–1650	MX4130–1650
		1800 mm	MX4030–1800	MX4130–1800
	38 mm	300 mm	MX4038–300	MX4138–300
		450 mm	MX4038–450	MX4138–450
		600 mm	MX4038–600	MX4138–600
		750 mm	MX4038–750	MX4138–750
		900 mm	MX4038–900	MX4138–900

11 Ordering information

Model	*Detection capability*	*Protective field height*	*Emitter Unit Model*	*Detector Unit Model*
MX4100	38 mm	1050 mm	MX4038–1050	MX4138–1050
		1200 mm	MX4038–1200	MX4138–1200
		1350 mm	MX4038–1350	MX4138–1350
		1500 mm	MX4038–1500	MX4138–1500
		1650 mm	MX4038–1650	MX4138–1650
		1800 mm	MX4038–1800	MX4138–1800
	82 mm	300 mm	MX4082–300	MX4182–300
		450 mm	MX4082–450	MX4182–450
		600 mm	MX4082–600	MX4182–600
		750 mm	MX4082–750	MX4182–750
		900 mm	MX4082–900	MX4182–900
		1050 mm	MX4082–1050	MX4182–1050
		1200 mm	MX4082–1200	MX4182–1200
		1350 mm	MX4082–1350	MX4182–1350
		1500 mm	MX4082–1500	MX4182–1500
		1650 mm	MX4082–1650	MX4182–1650
		1800 mm	MX4082–1800	MX4182–1800
MX4200	14 mm	300 mm	MX4014–300	MX4214–300
		450 mm	MX4014–450	MX4214–450
		600 mm	MX4014–600	MX4214–600
		750 mm	MX4014–750	MX4214–750
		900 mm	MX4014–900	MX4214–900
		1050 mm	MX4014–1050	MX4214–1050
		1200 mm	MX4014–1200	MX4214–1200
	22 mm	300 mm	MX4022–300	MX4222–300
		450 mm	MX4022–450	MX4222–450
		600 mm	MX4022–600	MX4222–600
		750 mm	MX4022–750	MX4222–750
		900 mm	MX4022–900	MX4222–900
		1050 mm	MX4022–1050	MX4222–1050
		1200 mm	MX4022–1200	MX4222–1200
		1350 mm	MX4022–1350	MX4222–1350
		1500 mm	MX4022–1500	MX4222–1500
		1650 mm	MX4022–1650	MX4222–1650
		1800 mm	MX4022–1800	MX4222–1800
	30 mm	300 mm	MX4030–300	MX4230–300
		450 mm	MX4030–450	MX4230–450
		600 mm	MX4030–600	MX4230–600
		750 mm	MX4030–750	MX4230–750
		900 mm	MX4030–900	MX4230–900
		1050 mm	MX4030–1050	MX4230–1050
		1200 mm	MX4030–1200	MX4230–1200
		1350 mm	MX4030–1350	MX4230–1350
		1500 mm	MX4030–1500	MX4230–1500

Model	Detection capability	Protective field height	Emitter Unit Model	Detector Unit Model
MX4200	38 mm	1650 mm	MX4030–1650	MX4230–1650
		1800 mm	MX4030–1800	MX4230–1800
		300 mm	MX4038–300	MX4238–300
		450 mm	MX4038–450	MX4238–450
		600 mm	MX4038–600	MX4238–600
		750 mm	MX4038–750	MX4238–750
		900 mm	MX4038–900	MX4238–900
		1050 mm	MX4038–1050	MX4238–1050
		1200 mm	MX4038–1200	MX4238–1200
		1350 mm	MX4038–1350	MX4238–1350
		1500 mm	MX4038–1500	MX4238–1500
		1650 mm	MX4038–1650	MX4238–1650
		1800 mm	MX4038–1800	MX4238–1800
	82 mm	300 mm	MX4082–300	MX4282–300
		450 mm	MX4082–450	MX4282–450
		600 mm	MX4082–600	MX4282–600
		750 mm	MX4082–750	MX4282–750
		900 mm	MX4082–900	MX4282–900
		1050 mm	MX4082–1050	MX4282–1050
		1200 mm	MX4082–1200	MX4282–1200
		1350 mm	MX4082–1350	MX4282–1350
		1500 mm	MX4082–1500	MX4282–1500
		1650 mm	MX4082–1650	MX4282–1650
		1800 mm	MX4082–1800	MX4282–1800

11.2 Accessories ordering information

11.2.1 Connection Cables

Table 11.2: Ordering information. Connection cables

Part description	Model
Pre-assembled cable with 5-pin M12 female connector for all MX4000 emitter units, 5 m	55-4010-05
Pre-assembled cable with 5-pin M12 female connector for all MX4000 emitter units, 10 m	55-4010-10
Pre-assembled cable with 5-pin M12 female connector for all MX4000 emitter units, 15 m	55-4010-15
Pre-assembled cable with 8-pin M12 female connector for MX4100 detector units, 3 m	55-4011-03
Pre-assembled cable with 8-pin M12 female connector for MX4100 detector units, 5 m	55-4011-05
Pre-assembled cable with 8-pin M12 female connector for MX4100 detector units, 10 m	55-4011-10
Pre-assembled cable with 12-pin M12 female connector for MX4200 detector units, 3 m	55-4012-03
Pre-assembled cable with 12-pin M12 female connector for MX4200 detector units, 5 m	55-4012-05
Pre-assembled cable with 12-pin M12 female connector for MX4200 detector units, 10 m	55-4012-10

Part description	Model
Pre-assembled cable for MX4100 detector units with 4-port junction block, 1.5 m	55-4015
Pre-assembled cable for MX4200 detector units with 6-port junction block, 1.5 m	55-4017
Pre-assembled cable with 5-pin M12 male connector for use with all junction blocks, 3 m	55-4013-03
Pre-assembled cable with 5-pin M12 male connector for use with all junction blocks, 5 m	55-4013-05
Pre-assembled cable with 5-pin M12 male connector for use with all junction blocks, 10 m	55-4013-10
Pre-assembled extension cable with 5-pin M12 male & female connectors, 3 m	55-4004-03
Pre-assembled extension cable with 5-pin M12 male & female connectors, 5 m	55-4004-05
Pre-assembled extension cable with 5-pin M12 male & female connectors, 10 m	55-4004-10

The above cables are also available in shielded versions. For further information please refer to the ISB product catalog available on our web site (see internet address on back cover).

11.2.2 Mounting accessories

Table 11.3: Ordering information. Mounting accessories

Part description	Model
Sliding nuts (set of four, included in standard delivery)	36-2102-04
Swivelling mounting brackets (set of two)	02-4006-02

11.2.3 Additional accessories

Table 11.4: Ordering information. Additional accessories

Part description	Model
MX4100/MX4200 User manual on CD (included in standard delivery)	60-4000
Parameterization/Teach-in tool for permanent installation (MX4100 and MX4200)[13]	MX4000-PB
Parameterization/Teach-in tool with pass-through connectors for MX4100	MX4100-PT
Parameterization/Teach-in tool with pass-through connectors for MX4200	MX4200-PT
ISB Safety relay, 24 V DC, DIN rail mounting.	22-4001
Power supply, 24 V DC, 1.75 A, universal input (100 .. 240 V AC), DIN rail mounting	31-4001
Test rod, 14 mm	56-5000
Test rod, 22 mm	56-5001
Test rod, 30 mm	56-5002
Test rod, 38 mm	56-5003

[13] Plugs into standard junction blocks. See table 11.2 for suitable part numbers and ordering information.

12 Appendix

12.1 Glossary

Active Optoelectronic Protective Device (AOPD)

Device whose sensing function is performed by optoelectronic emitting and receiving elements detecting the interruption of optical radiations generated, within the device, by an opaque object present in the specified detection zone (or for a light beam device, on the axis of the light beam).

Detection capability (DC)

Is the dimension representing the diameter of the object or test piece that will actuate the sensing device when placed in the detection zone. It can also be used to mean the ability to detect an object or test piece of the specified diameter.

Effective Aperture Angle (EAA)

Is the maximum angle of deviation from the optical alignment of the emitter unit and the detector unit within which the AOPD continues normal operation.

Electro-Sensitive Protective Equipment (ESPE)

Assembly of devices and/or components working together for protective tripping or presence-sensing purposes and comprising as a minimum of: a) a sensing device, b) controlling/monitoring devices, c) output signal switching devices.

External Device Monitoring (EDM)

Means by which the electro-sensitive protective equipment (ESPE) monitors the state of control devices which are external to the ESPE (e.g. external contacts).

Lock-out condition

It is a condition of the safety light curtain initiated by a fault, that prevents the normal operation of the ESPE. When a lock-out condition occurs, the safety outputs will be deactivated (OFF state).

OFF state

The state of the safety outputs of an ESPE in which the machine under control is caused to stop running and is prevented from starting.

ON state

The state of the safety outputs of an ESPE in which the machine under control is allowed to run.

Output Signal Switching Device (OSSD)

Component of the ESPE connected to the machine control system which, when the sensing device is actuated during normal operation, responds by going to the OFF state.

Presence Sensing Device Initiation (PSDI)

Refers to the use of the sensing devices (e.g. light curtain) to activate the machine and/or manufacturing process once it has been determined that a human is no longer in the hazard area.

Response time (of a safety light curtain)

The maximum time between the occurrence of a detectable obstruction of the protective field and the deactivation of the OSSDs.

12.2 EC Declaration of Conformity

167811 Canada Inc. dba ISB
2300 Victoria Avenue
Lachine, Québec H8S 1Z3
Canada

Declares that the MX4x00 series of safety light curtains are in conformity with the requirements of the following EC machinery directives:

- 2006/42/CE Machinery Directive
- 2004/108/CE Electromagnetic Compatibility Directive
- 2006/95/CE Low Voltage Directive

and that they are developed and produced in compliance with the following standards:

- IEC 61496-1:2004 + A1:2008 and IEC 61496-2:2006
- IEC 61508-1/7:2010
- IEC 62061:2005
- ISO 13849-1:2008
- IEC 60204-1:2009
- IEC 50178:1997
- ANSI B11.19:2010
- ANSI/RIA R15.06:1999

The conformity to the EC directives and standards of the MX4000 type models herein listed has been assessed and certified by TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, 51105 Köln, Germany with certificate number 01/205/5263/12.

Québec, 2012-10-31

Jorge Torosian
R&D Manager

Armen Kazandjian
President

This EC Declaration of Conformity can also be downloaded from ISB homepage on the Internet at: www.isblite.com

12.3 Warranty

167811 Canada Inc. dba ISB warrants the MX4000 safety light curtains to be free from defects in material and workmanship, provided these defects are not caused by abuse, accident or neglect, and agrees by repair or replacement of the part, or parts, any such defect disclosed on examination by us, and which developed under normal installation, use and service for a period of one year from the date of shipment to the original purchaser when the equipment is returned to our service facility.

ISB does not assume responsibility for unauthorized repairs to MX4000 safety light curtains even though defective.

This warranty is in lieu of all other warranties expressed or implied, and no representative or person is authorized to assume for us any of the liability in connection with the sale of our products.

ISB shall not be liable for consequential damages.

Authorization to return material (RMA) must be obtained from one of our branch offices, or from our sales department. For additional information, repair or service, contact your local ISB representative (see back cover for contact information).

12.4 Verification checklist

These checklists cover the minimum requirements for verification tests. However, since additional criteria may be necessary depending on both the machine to be guarded and the applicable standards and regulations of the country or region where the system is installed, it is strongly recommended to include in this checklist the necessary additional items based on the judgement of qualified personnel.

Once completed, this checklist should be kept on record along with the machine documentation for future reference during the subsequent regular inspections.

■	Have the safety rules and regulations been observed in compliance with the directives and standards applicable to the machine to be guarded?	YES □ NO □
■	Are the applied directives and standards listed in the declaration of conformity? (for OEMs)	YES □ NO □
■	If the MX4200 is configured to use any of its blanking functions, is the effective detection capability clearly and indelibly marked on the column labels?	YES □ NO □
■	Are the emitter and detector columns properly mounted and secured to prevent displacement or rotation after the optical alignment?	YES □ NO □
■	Is the safety distance calculated in accordance with the valid formulas for the intended safeguarding application, while taking into account the effective detection capability and response time of the AOPD, the response time of safety interface devices (if used) and the overall stopping time of the guarded machine?	YES □ NO □
■	Is the minimum distance observed at all points of the protective field?	YES □ NO □
■	Is the AOPD effective during the entire dangerous movement of the machine?	YES □ NO □
■	Has the protective field been checked in compliance with the procedure described in chapter 7?	YES □ NO □
■	Does the external power supply conforms to the EMC and PELV/SELV directives and output specifications given in this document?	YES □ NO □
■	Are the electrical connections between the AOPD and machine control compliant to the circuit diagrams?	YES □ NO □
■	Are the safety outputs of the ESPE wired to the mainstream machine control in compliance with the required safety category?	YES □ NO □
■	Are all connectors and cables appropriate for the application and free from damage?	YES □ NO □
■	If the start interlock function is required, is the dangerous movement of the machine stopped immediately if the power supply voltage of the AOPD is interrupted and then restored?	YES □ NO □

12.5 Parameters quick reference

This table summarizes the MX4000 configuration parameters and the state of the LED indicators for each of their respective values. Print a copy and keep it handy during parameterization procedure.

Parameter		***Options***		
Code	***Description***	***Value***	***BLUE***	***YELLOW***
0	Display orientation	NORMAL (Default)	○	○
		UPSIDE DOWN	○	◉
1	Scan code	CODE A (Default)	○	○
		CODE B	○	◉
2	Interlock functions	DISABLED (Default)	○	○
		START INTERLOCK	○	◉
		RESTART INTERLOCK	◉	○
		BOTH	◉	◉
3	EDM function	DISABLED (Default)	○	○
		ENABLED	○	◉
4	Auxiliary output signalling	NONE (Default)	○	○
		INTERLOCK	○	◉
		MUTE (MX4200 only)	◉	○
5	Mute function (MX4200 only)	DISABLED (Default)	○	○
		ENABLED (timeout 60 s)	◉	○
		ENABLED (timeout 300 s)	○	◉
		ENABLED (timeout 600 s)	◉	◉
6	Blanking tolerance, positive (MX4200 only)	DISABLED (Default)	○	○
		1 beam	◉	○
		2 beams	○	◉
		3 beams	◉	◉
7	Blanking tolerance, negative (MX4200 only)	DISABLED (Default)	○	○
		1 beam	◉	○
8	Floating blanking (MX4200 only)	DISABLED (Default)	○	○
		1 beam	◉	○
		2 beams	○	◉
		3 beams	◉	◉
9	Floating mode (MX4200 only)	SINGLE (Default)	○	○
		MULTIPLE	◉	○

12.6 User notes

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