



MINI-SCREEN[®] Instruction Manual

For systems with **Mute Function** and **Latch Output**
Control Module Models **MSCC-2L2M** and **MSCC-2L3M**

MINI-SCREEN Features

- A compact, modular optoelectronic safeguarding device for production machinery
- Choose Standard Series or Long Range emitters and receivers
- Creates a synchronized, modulated infrared light screen in 12 sizes from 100 mm to 1.2 m (4" to 4') high
- Full-featured Muting function including:
 - Input from two or four Muting Devices
 - Selectable monitored Mute Lamp output
 - Selectable Backdoor Timer
 - Override inputs
 - Selectable directional muting capability
- Highly immune to EMI, RFI, ambient light, weld flash, and strobe light
- Selectable External Device Monitoring (EDM)
- Replaceable redundant output safety relays with forced-guided contacts for control reliability
- 4 amp or 6 amp outputs (depending on model)
- Uses 115/230V ac or 24V dc power
- Dual two-digit Diagnostic Displays indicate Light Screen and System status, including number of channels blocked
- LEDs on control box and receiver give system status and emitter/receiver alignment indications
- Easily configured one- or two-beam floating blanking
- Fixed blanking



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Applications and Limitations of MINI-SCREEN® Systems

MINI-SCREEN Systems are typically used in the following applications:

- Small assembly equipment
- Molding presses
- Automated production equipment
- Robotic work cells
- Hydraulic and mechanical power presses

MINI-SCREEN Systems may NOT be used with the following machinery:

- Any machine that cannot be stopped immediately after a stop signal is issued, such as single stroke (also known as “full-revolution”) clutched machinery.
- Any machine with inadequate or inconsistent machine response time and stopping performance.
- Any machine that ejects materials or component parts through the defined area.
- MINI-SCREEN Systems may not be used in any environment that is likely to adversely affect photoelectric sensing system efficiency. For example, corrosive chemicals or fluids or unusually severe levels of smoke or dust, if not controlled, may degrade the efficiency of Banner MINI-SCREEN Systems.

Banner MINI-SCREEN Systems may not be used as tripping devices to initiate machine motion (PSDI applications) on mechanical power presses, per OSHA regulation 29 CFR 1910.217.

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Important ... read this page before proceeding!

In the United States, the functions that Banner MINI-SCREEN® Systems are intended to perform are regulated by the Occupational Safety and Health Administration (OSHA). However, whether or not any particular MINI-SCREEN System installation meets all applicable OSHA requirements depends upon factors that are beyond the control of Banner Engineering Corp. These factors include the details of how the MINI-SCREEN System is applied, installed, wired, operated, and maintained.

Banner Engineering Corp. has attempted to provide complete application, installation, operation, and maintenance instructions. In addition, we suggest that any questions regarding application or use of MINI-SCREEN Systems be directed to the factory applications department at the telephone number or addresses shown at the bottom of this page.

Banner MINI-SCREEN Systems can guard against accidents only when they are properly installed and integrated into the machine, properly operated, and properly maintained. See Section 3 of this manual for installation procedures, considerations, and precautions. See Sections 4 and 5 for operating and maintenance information. **It is the responsibility of the purchaser and/or user to apply this MINI-SCREEN System in full compliance with OSHA regulations.**

In addition to OSHA regulations, several other organizations provide informational material on the use of machine guard devices. The user is referred to the American National Standards Institute (ANSI), the Robotics Industries Association (RIA), the American Metal Stamping Association (AMSA), and others. Banner Engineering Corp. makes no claim regarding a specific recommendation of any organization, the accuracy or effectiveness of any information provided, or the appropriateness of the provided information for a specific application.

The user has the responsibility to ensure that all local, state, and national laws, rules, codes, and regulations relating to the use of this machine guarding system in any particular application are satisfied. Extreme care is urged to ensure that all legal requirements have been met and that all installation and maintenance instructions contained in this manual are followed.

Caution!!

Banner MINI-SCREEN Systems are for use only on machinery that can be stopped immediately after a stop signal is issued. They may be used with part-revolution clutched machines that have the ability to stop at any point in their stroke. **Under no circumstances may the MINI-SCREEN System be used on full-revolution clutched machinery.** Banner MINI-SCREEN Systems may not be used as tripping devices to initiate machine motion (PSDI applications) on mechanical power presses, per OSHA regulation 29 CFR 1910.217.

U.S. Standards Applicable to Use of MINI-SCREEN® Systems	
ANSI B11 Standards	<i>Safeguarding of Machine Tools</i>
ANSI/RIA R15.06	<i>Safety Requirements for Robot Systems</i>
NFPA 79	<i>Electrical Standard for Industrial Machinery</i>
<i>See pages 88 and 89 for information on these and other applicable standards, and where to acquire copies.</i>	

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1. MINI-SCREEN System Introduction

The Banner MINI-SCREEN System is a microprocessor-controlled opposed-mode optoelectronic "curtain of light" (or "light screen"). It is designed for use as a safeguarding device, and is especially suited to smaller production machinery.

Two control box models are available. Both models include a Muting function, which in effect "disables" the light screen when hazardous motion is not taking place. The purpose of muting the light screen is to enable material to be manually or automatically fed, without tripping the light screen. The control boxes differ in their relay output configuration (see table, below).

Models	Safety Outputs			Non-Safety Monitoring Outputs†		
	FSD1	FSD2	SSD	CNC*	Light Screen Aux. Monitor	System Aux. Monitor
MSCC-2L2M	4A	4A	4A	None	0.5A	0.5A
MSCC-2L3M	6A	6A	4A	6A	0.5A	0.5A

* Complementary Normally Closed Auxiliary Output.
 † To be used for monitoring only; not suitable for safety control functions.

Banner's microprocessor-based circuit raises the level of control reliability in machine guard design. The MINI-SCREEN System design incorporates "diverse redundancy," in which two microprocessors of different design, running from two different instruction sets, constantly check all system components, including each other. Banner MINI-SCREEN Systems are extensively FMEA (Failure Mode and Effects Analysis) tested to establish an extremely high degree of confidence that no system component will ever, even if it does fail, cause a failure to danger.

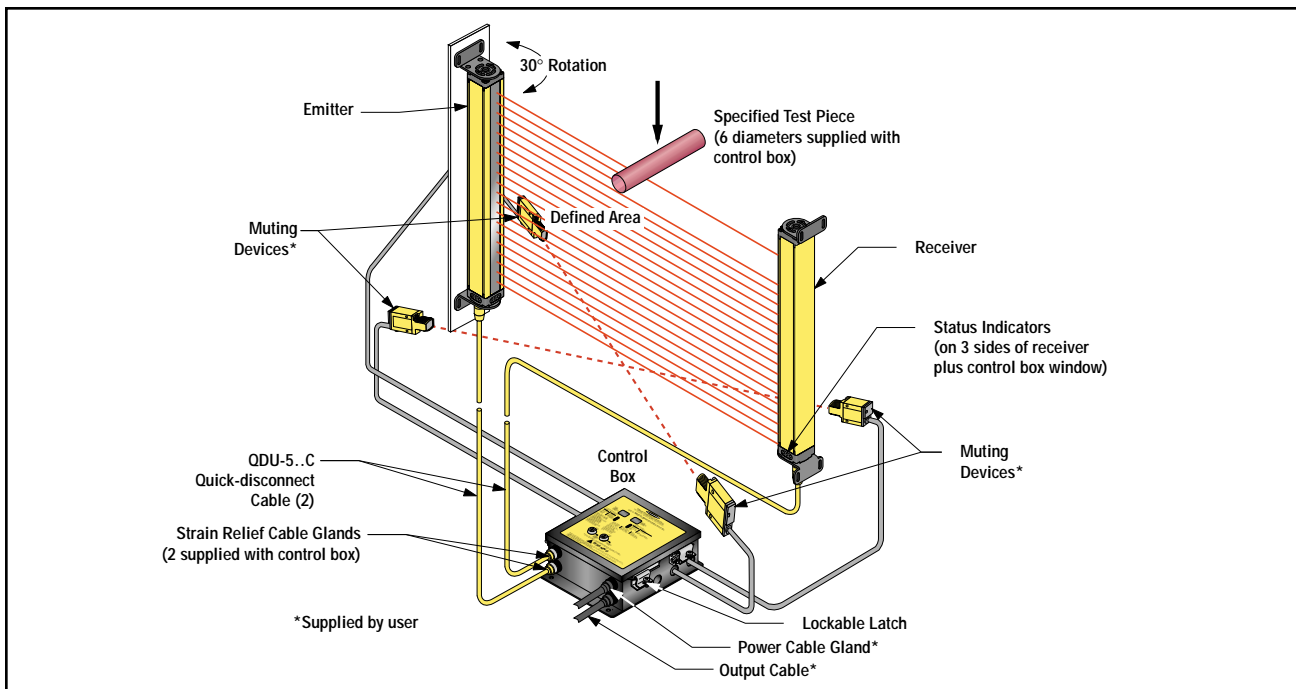


Figure 1-1. Banner MINI-SCREEN System with Mute Function: emitter, receiver, control module, and two interconnecting cables plus two or four opposed-mode mute input devices and connecting cables

In typical operation, if any part of an operator's body (or any opaque object) of more than a pre-determined cross section enters the guarded area of the machine, the output relays of the MINI-SCREEN System will open. The contacts of the output relays are connected to the guarded machine's primary control elements (MPCEs) which immediately stop the motion of the guarded machine. The output relays have forced-guided contacts for enhanced control reliability.

Portions of the light screen may be "blanked" (made blind) to allow for:

- 1) The movement of one or multiple workpiece(s) through the light screen (floating blanking), or
- 2) The continued presence of brackets, fixtures, etc. in the plane of the light screen (optional fixed blanking).

The Banner MINI-SCREEN Light Screen System is a modular machine guard system. Each System includes an MSE Series emitter, an MSR Series receiver, and a control box (see Figure 1-1 and cover photo). The three MINI-SCREEN Light Screen System components are interconnected using two 5-wire shielded cables.

Emitters and receivers have an attached QD (quick-disconnect) connector or a 300 mm (12") pigtail terminated with a QD connector. Sensors with the QD connector or pigtail also require a QD mating cable (see page 85).

Because this is a muting system, the application also requires the installation of two or four devices to function as muting inputs to the light screen. Applications vary widely, so the choice and installation of these devices also varies widely. It is important that the installer and user follow stringent requirements to ensure that muting of the light screen does not create a hazard to personnel (see Sections 2, 3, and 4 of this manual for detailed information).

Emitters have a row of synchronized modulated infrared (invisible) light emitting diodes (LEDs) in a compact rectangular metal housing. Receivers have a corresponding row of synchronized phototransistors. Emitters and receivers are available in 12 lengths (determined by the required height of the defined area) ranging from 100 mm to 1.2 m (4" to 4') (see page 84). The rectangular sensor design includes a swivel bracket at each end for quick mounting and ease of alignment. Control boxes and receivers have LED indicators for system operating status and alignment. Receiver status indicators are easily visible from the front and both sides. Emitters have a Power ON indicator, also easily visible from the front and both sides.

Standard emitter/receiver pairs may be spaced from 15 cm to 9 m (6" to 30') apart. Long range emitter/receiver pairs may be spaced from 15 cm to 18 m (6" to 60') apart. With no blanking in use, the minimum object sensitivity of 30' range sensor pairs is 19 mm (0.75"), and 25 mm (1.0") for 60' range sensor pairs. The maximum distance between an emitter and its receiver is reduced if corner mirrors are used (see alignment information on page 64). The width and height so described are known as the *defined area*.

The minimum object sensitivity is the minimum-diameter object that the light screen can reliably detect anywhere within the defined area. Minimum object sensitivity directly affects the minimum allowable distance between the defined area of the light screen and the nearest hazard point (the separation distance). See Section 3.2.

The control box has a “latch” output which requires a manual reset after the defined area is cleared, following an interruption of the light screen while the muting function is not active (while the machine’s hazardous motion is taking place). The latch output is used in applications where additional machine control (via the Latch Reset) is required, and particularly in perimeter-guarding applications where it is physically possible for personnel to enter an area of hazardous motion by passing through the defined area. The controller is powered by 115/230V ac or 24V dc. The controller automatically recognizes the length and range of the sensor pair wired to it – no programming is necessary.


The selectable Auto Power-up feature makes a Key Reset unnecessary at system power-up when the defined area is clear.

The Muting control box contains two microprocessor boards: the System Controller and the Light Screen Controller. The System Controller controls the muting and output functions of the System. The Light Screen Controller controls the light screen sensing logic. Two Diagnostic Displays, one on each microprocessor controller board, are visible through clear windows in the control box cover. Using 2-digit codes, they identify Muting System and Light Screen status at a glance. The power supply board powers and controls the Light Screen Controller, the System Controller internal controls, the emitter, the receiver, the forced-guided output relays and the muting devices.

Resetting the system from a fault condition, at power-up or following a latch condition is accomplished using one or both Key Reset switches, located on the front panel of the control box. The Key Reset switch on the left is for resetting the light screen when the light screen locks out, or when powering up the system (if it is set to Manual Power-Up). The System Key Reset switch, on the right, is for resetting from a latch condition, following a lockout, or following System power-up (if Auto Power-Up is not ON).

Muting Function

The control box has the advanced capability of monitoring signals from a variety of redundant devices to mute the System. The mute temporarily suspends the light screen’s safeguarding function by ignoring the light screen’s status, thus allowing the passage of an object through the defined area without generating a machine stop command. This should not be confused with blanking, which disables one or more light beams of the defined area and results in a larger minimum object sensitivity.



WARNING . . .
Do Not Connect Multiple Pairs of Sensors to One Control Box

The MINI-SCREEN System uses *one pair of light screen sensors* connected to *one control box*. Connection of multiple pairs of sensors to a single control box can result in serious injury or death, and is prohibited.

1.1 MINI-SCREEN Components and Kits

MINI-SCREEN system components may be purchased separately, or they may be purchased bundled together in kit form. The components are listed on pages 82 and 83.

Emitter and receiver circuits are designed to meet high standards for vibration resistance. Every emitter, receiver and control box is serialized and undergoes extensive burn-in testing at the factory.

Unlike some competitive systems, matched sets of MINI-SCREEN components are not required. Any MINI-SCREEN System emitter and receiver (having the same lengths and number of beams) may be used together with any control box.

A functional schematic diagram of the MINI-SCREEN System appears on page 16. For MINI-SCREEN System dimension drawings, see pages 31 and 32. For specifications, see pages 79-81.

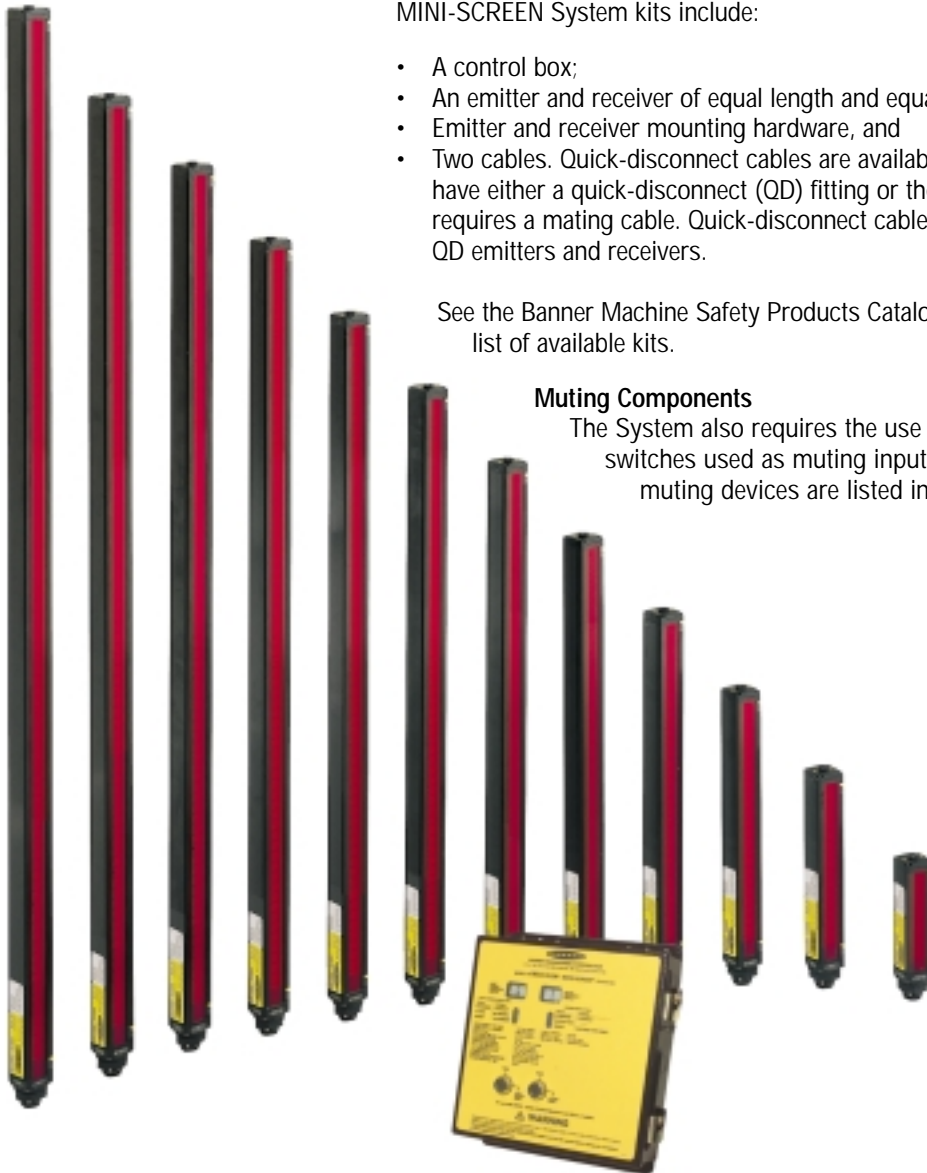
MINI-SCREEN System kits include:

- A control box;
- An emitter and receiver of equal length and equal number of beams;
- Emitter and receiver mounting hardware, and
- Two cables. Quick-disconnect cables are available in 5 lengths. The sensors have either a quick-disconnect (QD) fitting or the 300 mm (12") pigtail QD; each requires a mating cable. Quick-disconnect cables are interchangeable between QD emitters and receivers.

See the Banner Machine Safety Products Catalog or price list for a complete list of available kits.

Muting Components

The System also requires the use of two or four sensors or switches used as muting inputs. Examples of appropriate muting devices are listed in Appendix B of this manual.



2. Overview of MINI-SCREEN System Operation

In operation, an emitter and receiver (of equal length and type) are mounted and aligned opposite each other. This establishes a curtain of invisible infrared light beams called the defined area (Figure 1-1). Center-to-center spacing between adjacent light beams is 12.7 mm (0.5").

Individual features of the MINI-SCREEN System are discussed in the following subsections:

- Blanking (Section 2.1)
- Auto Power-up (Section 2.2)
- Lockout Conditions and Key Resets (Section 2.3)
- Operating Status Indicators (Section 2.4)
- Diagnostic Displays (Section 2.5)
- Output Relay Operation (Section 2.6)
- Control Reliability: Redundancy and Self-Checking (Section 2.7)
- Remote Test Input (Section 2.8)
- External Device Monitoring (Section 2.9)
- Mute Functions (Section 2.10)

2.1 Blanking

The MINI-SCREEN System features both floating and fixed blanking; see Figure 2-1.

Floating blanking is the “blinding” of one or two sensing beams which will appear to change position (“float”) in order to allow one or more objects (usually workpiece materials) to move through the defined area, at any point, without tripping the final switching device relays (FSDs) of the MINI-SCREEN System.

There is the choice of either one-beam or two-beam floating blanking. The ignored object size and resultant minimum object sensitivity are listed in the table below.

Minimum Object Sensitivity

Sensor Type	Floating Blanking	Maximum Size of Undetected Objects	Minimum Object Sensitivity
9 m (30') range	OFF	(Not Applicable)	19.1 mm (0.75")
	1-Beam	7.6 mm (0.30")	32 mm (1.25")
	2-Beam	20.3 mm (0.80")	44.5 mm (1.75")
18 m (60') range	OFF	(Not Applicable)	25.4 mm (1.00")
	1-Beam	3.8 mm (0.15")	38.1 mm (1.50")
	2-Beam	16.5 mm (0.65")	50.8 mm (2.00")

NOTES:

- 1) The size listed in the table for objects which move undetected through the light screen assumes that those objects move through the screen exactly perpendicular to the plane of the light beams.
- 2) When fixed blanking is not enabled, selecting one- or two-beam floating blanking will affect the overall minimum object sensitivity, which allows multiple objects to move through the defined area. When fixed blanking is used, selecting one- or two-beam floating blanking will create a single “hole” in the sensing field, which allows a single object of a certain size to move through the defined area without being detected (see table above).

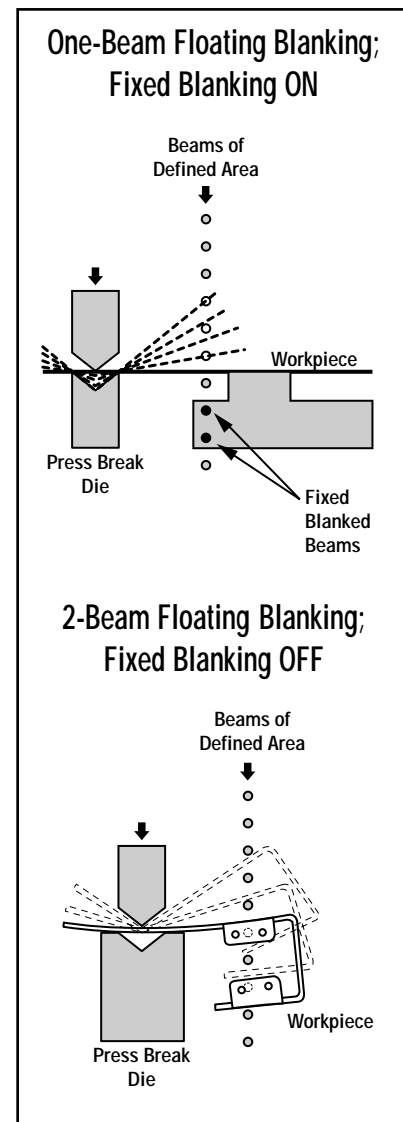


Figure 2-1. Floating and fixed blanking

In all cases, when floating blanking is selected, the resultant worst case *minimum object sensitivity* (sometimes called minimum object detection size or MODS) must be used to calculate *separation (safety) distance* (see Section 3.2.1).

The minimum object sensitivity is the minimum diameter of an object that the light screen can reliably detect anywhere within its defined area. Minimum object sensitivity directly affects the minimum allowable distance between the defined area of a light screen and the nearest hazard point (the separation distance). See section 3.2.

Floating blanking preference is set via a pair of DIP switches on the controller board inside the control box (see Figure 3-11 and section 3.4, for details). Note: *Blanking ON is indicated by a flashing green status indicator.*

Fixed blanking allows fixed objects (such as brackets, fixtures, etc.) to be ignored in the defined area, as long as they never move or change size.

Fixed blanking requires an emitter and receiver with 16 or more light beams (sensors longer than 4") and is easy to set up. With the object(s) to be ignored in place, the user "teaches" the controller which beams to blank by simply pushing a button located inside the control box. The Light Screen Diagnostic Display will indicate the total number of blanked beams (see Section 3.4.1 for blanking configuration).

Fixed blanking is limited to 30% of the total number of beams in the array, up to a maximum of 12 beams. Contact the factory Applications Department if your application requires fixed blanking of a greater number of beams. Blanking information is stored in non-volatile memory to prevent setup loss when power is removed. Once fixed blanking is programmed, removing or moving any fixed object within the defined area will cause a lockout condition (see Section 5.1). See pages 33 and 44 for programming information.

2.2 Auto Power-up

Normal operation of the MINI-SCREEN System with Muting (MSCC-2L2M) requires two Key Resets each time power is applied to the System: one to reset the Light Screen controller and one to reset the System (the Latch). This procedure is usually a desired response to a power failure or interrupt, and is required by some design standards. However, two optional procedures using Auto Power-Up allow one Key Reset or allow the System to automatically power up into RUN mode when power is applied and the defined area is clear. See WARNING at right.

Auto Power-Up is enabled or disabled via pairs of configuration DIP switches on the Light Screen and System controller boards inside the control box. See Figures 3-11 and 3-12 and Section 3.4 for details. Three configurations are possible:

- 1) Both Auto Power-ups are disabled (L.S. SW1 = OFF, SYS. SW1 = OFF); requires a Key Reset of both the Light Screen and System controllers when power is applied.
- 2) Light Screen Auto Power-up is enabled and the System Auto Power-up is disabled (L.S. SW1 = ON, SYS. SW1 = OFF); requires a Key Reset of only the System controller when power is applied.
- 3) Both Auto Power-ups are enabled (L.S. SW1 = ON, SYS. SW1 = ON); requires no Key Resets and will allow System to power up automatically when power is applied and the defined area is clear.

2.3 Lockout Conditions and Key Resets

Lockouts

A lockout condition of the MINI-SCREEN System causes all of its output relays to open, sending a "stop" signal to the guarded machine. A description of possible lockouts, their causes, troubleshooting hints, and Key Reset sequences are listed in section 5.

A lockout condition of the Light Screen portion of the System is indicated by a flashing red status indicator on the MINI-SCREEN receiver and on the Light Screen controller (left set of indicators; see Figure 2-3). The green and yellow status indicators will be OFF. When the Light Screen is in lockout, the System controller also will lock out, indicated by a red flashing System status indicator (right set of indicators).

A power-up/power interrupt lockout (Auto Power-up OFF, yellow Light Screen status indicator double flashing) is normal and requires a Light Screen Key Reset, followed by a System Key Reset.

A lockout condition within the System controller causes all of the output relays to open, except the Light Screen Auxiliary output. It will not cause a lockout of the Light Screen controller board. This lockout is indicated by a flashing red System status indicator.

Key Reset of a Latched Condition

If the defined area becomes blocked while the System is not muted, a System Key Reset will be required after the item blocking the light beam(s) has been removed. The green and yellow Light Screen status indicators must be ON, and the yellow System status indicator will flash to prompt a System Key Reset. Resets must be performed from outside the hazardous area, while the operator has full view of the hazardous area (see page 32, "Mounting the Control Box").



WARNING . . . Use of Auto Power-up

Application of power to the MINI-SCREEN

System must NOT initiate dangerous machine motion.

Machine control circuitry must be designed so that one or more initiation devices must be engaged to start the machine, after the MINI-SCREEN is placed in RUN mode.

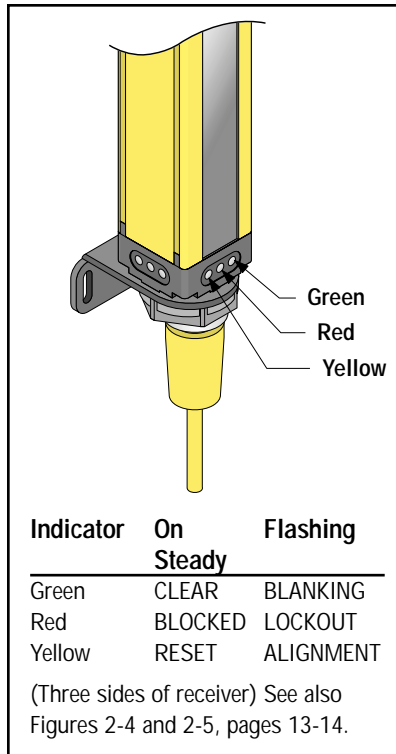


Figure 2-2. Light screen status indicators (receiver)

2.4 Operating Status Indicators

The MINI-SCREEN receiver has three Light Screen status indicators (see Figure 2-2): green (clear), red (blocked) and yellow (reset needed).

The MINI-SCREEN emitter has a green Power ON/OFF status indicator.

The control box has two groups of indicators, one group for the Light Screen and one group for the System.

2.4.1 Light Screen Status Indicators

Red ON steady and Yellow single-flashing or OFF (Blocked): The light screen has been reset and is in RUN mode, but either there is an obstruction in the defined area or the emitter and receiver are misaligned.

A flashing yellow status indicator displays sensor alignment. The faster the flash rate, the more beams are “made,” and the fewer beams are blocked or “not made.” This feature is very helpful for emitter/receiver alignment (Section 6.1). When alignment is correct, the green indicator will come ON (to join yellow) when the obstruction is removed. If alignment is not correct, the green indicator will remain OFF when the obstruction is removed.

If the Test Input terminals are shorted and the defined area is clear, the red and yellow status indicators will be ON steady (see Section 3.5.15, page 55).

Green and Yellow ON steady: The light screen has been reset and is in RUN mode, the defined area is clear of obstructions, and the emitter and receiver are properly aligned. A flashing green status indicator indicates floating and/or fixed blanking is ON.

Red (only) single-flashing: A lockout condition exists, due to an internal light screen problem. See Section 5, page 55.

Yellow (only) double-flashing: A power-up or power interrupt lockout condition exists. *These lockouts occur in the normal course of powering up the MINI-SCREEN System or upon an interruption of power to the System (unless Auto Power-up is ON; see pages 33-34).*

Yellow (only) ON steady: The Key switch has been switched to the RESET position at power-up.

2.4.2 System Status Indicators

Green and Yellow ON steady: The MINI-SCREEN System has been Reset and the outputs are closed.

Red and Green ON steady: The Override function is enabled, forcing FSD1, FSD2 and SSD outputs closed. See Section 2.10.6 for description.

Red (only) single-flashing: A lockout condition of the System controller board has occurred. See Section 5, page 56 for description.

Yellow (only) ON steady: Either the Key switch was switched to the RESET position at power-up or the Light Screen is blocked and the System is latched.

Yellow (only) single-flashing: The defined area has been interrupted and then cleared when the MINI-SCREEN was not muted, thus requiring a System Reset of a latched condition.

Yellow (only) double-flashing: Indicates a power-up or power interrupt lockout condition (Auto Power-Up is OFF).

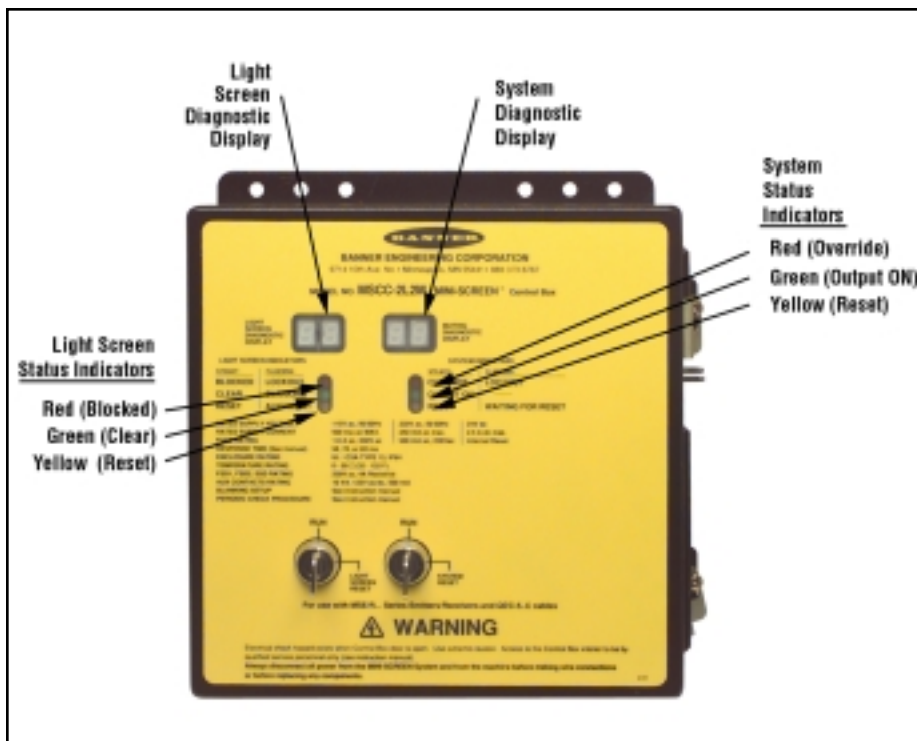


Figure 2-3. Control box indicator LEDs

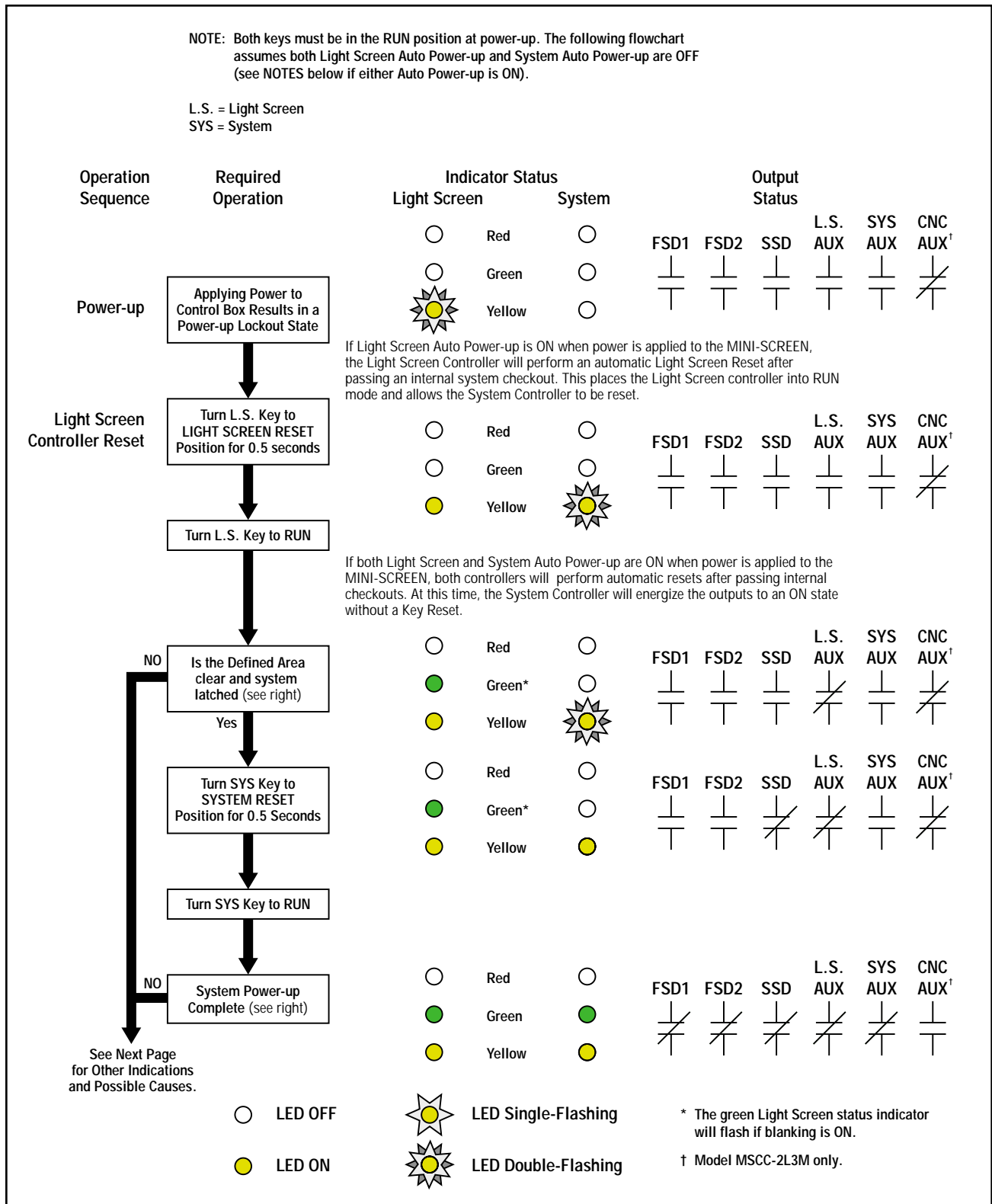


























































































Figure 2-4. System power-up sequence and resulting indicator and output status

Indicator Status		Output Status							Possible Causes
Light Screen	System	FSD1	FSD2	SSD	L.S. AUX	SYS AUX	CNC AUX [†]		
	Red								Defined Area Blocked and is Waiting for System Reset (Power-up Lockout)
	Green								
	Yellow**								
	Red								Defined Area Blocked and System is Latched (after System Reset)
	Green								
	Yellow**								
	Red								Defined Area Clear and System is Latched and Waiting for Reset
	Green								
	Yellow								
	Red								Override Enabled (Defined Area is Blocked and System is Latched)
	Green								
	Yellow**								
	Red								Lockout of Light Screen Controller
	Green								
	Yellow								
	Red								Lockout of System Controller only, Defined Area Clear
	Green								
	Yellow								
	Red								Lockout of System Controller only, Defined Area is Blocked
	Green								
	Yellow**								
			LED OFF			LED Single-Flashing			
			LED ON			LED Double-Flashing			

** The yellow Light Screen status indicator will be OFF if the Emitter and Receiver are not aligned; otherwise it will flash at a rate proportional to the number of "made" beams.

† Model MSCC-2L3M only.

Figure 2-5. Using the controller's Indicator LEDs to check System status and troubleshoot problems

2.5 Diagnostic Displays

Dual two-digit numeric displays, visible through clear windows in the MINI-SCREEN control box cover, simplify system configuration and troubleshooting.

The Light Screen Controller Diagnostic Display indicates:

- Error codes that correspond to the cause of a fault or configuration error which results in a lockout. See Section 5 for error codes and corrective actions.
- The total number of blocked beams, during programming of fixed blanking.
- High levels of electrical and optical noise (the decimal point of the display will flash).
- Normal conditions (a horizontal bar will be displayed).

The System Controller Diagnostic Display indicates:

- Error codes that correspond to the cause of a fault or configuration error which results in a lockout. See Section 5 for error codes and corrective actions.
- Normal conditions, and no beams blocked (a horizontal bar will be displayed).
- A muted condition, with the backdoor timer disabled (the horizontal bar will be flashing).
- The amount of time (in seconds) until the backdoor timer expires and the mute ends.

2.6 Output Relay Operation

The MINI-SCREEN System control box has three safety output relays (see Figure 2-6), labeled "FSD1," "FSD2," and "SSD." The contacts of the Final Switching Device (FSD) relays (FSD1 and FSD2) are connected to the Machine Primary Control Elements (MPCEs) of the guarded machine. An MPCE is an electrically powered element of the guarded machine that directly controls the machine's normal operating motion so that it is last (in time) to operate when motion is either initiated or arrested. The Secondary Switching Device (SSD) relay contacts are connected to the guarded machine's Machine Secondary Control Element (MSCE), an electrically powered element of the guarded machine (independent of both MPCEs) that is capable of removing power from the prime mover of the dangerous part of the machine in the event of a system fault. The two MPCEs must each (alone) be capable of stopping the motion of the guarded machine in an emergency. The opening of any FSD1, FSD2, or SSD relay contact results in the removal of power to either an MPCE or MSCE (or both), which will stop the motion in the guarded machine.

Model MSCC-2L3M

The Complementary Normally Closed Auxiliary output ("CNC AUX") is typically used for monitoring purposes and is not suitable for safety applications. The CNC AUX output status is the opposite of the FSD1 and FSD2 safety outputs.

If the System is muted, any blocked beams in the defined area will be ignored and FSD1 and FSD2 will remain closed.

If the System is not muted, any object that blocks one or more *unblanked* beams will be detected, and will cause a latch condition: output relays FSD1 and FSD2 (but not SSD) in the control module open their contacts. All three output relays (FSD1, FSD2, and SSD) will open their contacts in response to any one or more lockout conditions, including component failure within the MINI-SCREEN System itself (see Control Reliability, Section 2.8).

The MINI-SCREEN System requires a System Key Reset to reset the latch and resume operation following a blocked condition. To perform a System Key Reset, turn the System Key Reset switch clockwise to the RESET position, hold it there for at least 1/2 second, and then return the key to the RUN position.

Internal lockout conditions also require a System Key Reset to return the System to RUN mode.

The Light Screen Auxiliary (L.S. Aux.), the System Auxiliary (Sys. Aux.), and the Complementary Normally Closed Auxiliary (CNC AUX, model MSCC-2L3M only) monitoring relays are intended for non-safety-related purposes. These auxiliary outputs reflect their respective green status indicators (ON=closed). See Section 3.5.15 for more information.

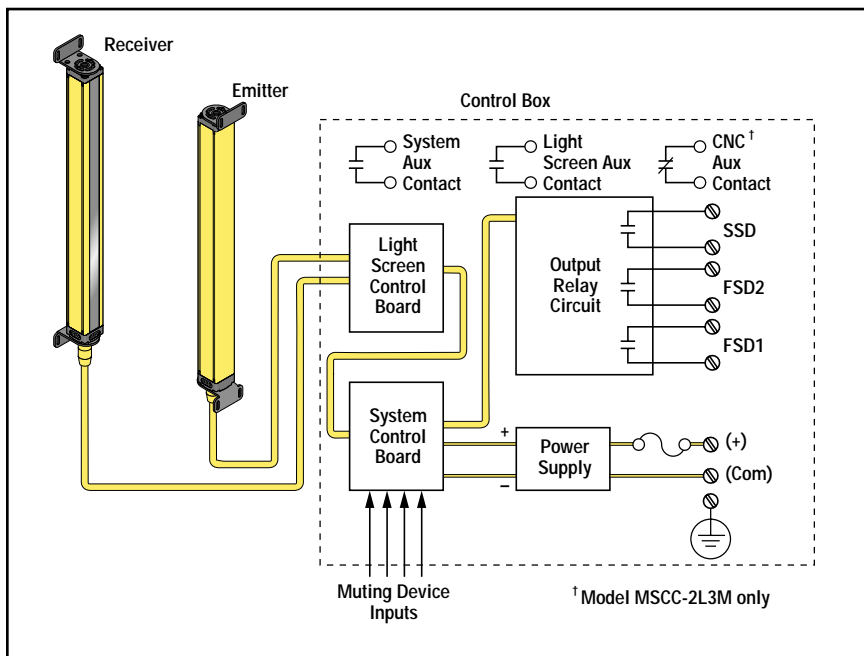


Figure 2-6. Banner MINI-SCREEN System with Muting functional schematic

2.7 Control Reliability: Redundancy and Self-Checking

MINI-SCREEN Systems meet certain U.S. and international control reliability standards for safety. Banner MINI-SCREEN Systems must reliably send a “stop” signal to a guarded machine as follows:

- 1) The MINI-SCREEN System must provide a “stop” signal to the guarded machine, within the system response time, whenever the defined area is interrupted.

In order for the machinery guarded by the MINI-SCREEN System to be stopped as described, *the guarded machine must be capable of stopping at any point in its machine cycle*. This means that the MINI-SCREEN System cannot be used with certain types of machinery, such as single stroke (also known as “full-revolution” clutched) machinery, or any machine with inconsistent machine response time and stopping performance. If there is any doubt about whether or not your machinery is compatible, contact the Banner Factory Application Engineers.

- 2) The MINI-SCREEN System must provide a “stop” signal to the guarded machine when internal component failures have occurred which compromise the integrity of the MINI-SCREEN System itself.

This type of component failure includes any internal MINI-SCREEN System failure which could prevent or delay the output relays of the MINI-SCREEN System from going to a latch condition or a lockout condition in response to a situation which, in normal operation, would cause them to do so. The ability of the MINI-SCREEN System to send a “stop” signal even when such a component failure has occurred depends upon its redundant design.

Redundancy requires that MINI-SCREEN System circuit components be “backed up” to the extent that, if the failure of any single component will prevent effective stopping action when needed, that component must have a redundant counterpart which will perform the same function.

The microprocessor-controlled MINI-SCREEN System is designed with *diverse redundancy*. Diverse redundant components are of different designs, and microprocessor programs used by them run from different instruction sets.

Redundancy must be maintained for as long as the MINI-SCREEN System is in operation. Since a redundant system is no longer redundant once a component has failed, MINI-SCREEN Systems are designed to be continuously *self-checking*. A component failure detected by or within the self-checking system causes a “stop” signal to be sent to the guarded machine *and* puts the MINI-SCREEN System into a lockout condition.

Recovery from this type of lockout condition requires replacement of the failed component (to restore redundancy) and the appropriate Key Reset (see page 54). Possible causes are listed in Section 5. The Diagnostic Display is used to diagnose internal causes of a lockout condition (Section 5.1).

2.8 Remote Test Input

A pair of terminals is provided (see Figure 3-14, page 36) for an external normally open switch. These terminals are labeled "TEST a" and "TEST b" at TB1. In a non-muted condition, closing a switch connected between these two terminals simulates an interruption of one of the light beams. All outputs except the SSD will be open. The device used must be capable of switching from 15 to 50V dc at 20 to 100 mA. The switch must be held closed for a minimum of 0.05 seconds to guarantee system response. This remote test input is sometimes useful for system setup and checkout procedures.

2.9 External Device Monitoring (EDM)

Two pairs of terminals are provided (see Figure 3-14, page 36) for monitoring the state of external devices, such as MPCEs. These terminals are labeled "Monitoring 1a-1b and 2a-2b" at TB8. The MINI-SCREEN EDM inputs can be configured in three ways (see Section 3.5.8 for DIP switch settings and external hookup):

- One-channel monitoring,
- Two-channel monitoring, or
- No monitoring.

One- and two-channel EDM is used when the MINI-SCREEN FSD outputs directly control the energizing and de-energizing of the MPCEs.

- **One-Channel Monitoring:** a series connection of closed monitor contacts that are forced-guided (or captive contact) from each device controlled by the MINI-SCREEN. The monitor contacts should open within 200 milliseconds of the FSD outputs closing (a clear condition) and should close within 200 milliseconds of the FSD outputs opening (a blocked condition) or a lockout will occur (see Diagnostics, page 56).
- **Two-Channel Monitoring:** a separate connection of closed monitor contacts that are forced-guided (or captive contact) from each device controlled by the MINI-SCREEN. The monitoring contacts should always change state (either both open, or both closed) within 200 milliseconds of the corresponding FSD state change or a lockout will occur (see Diagnostics, page 56).
- **No Monitoring:** uses the two-channel configuration with inputs 1a to 1b and 2a to 2b jumpered. *If external device monitoring is set for No Monitoring, the user must ensure that any single failure of the external devices does not result in a hazardous condition and will prevent a successive machine cycle* (see section 2.7, Control Reliability).



WARNING . . .
Muting Limitations
Muting is allowed
only during the non-
hazardous portion of the machine
cycle. A muting application must be designed so that no single component failure can prevent the stop command or allow subsequent machine cycles until the failure is corrected. (per OSHA 1910.217 (c)(3)(iii)(d), ANSI B11.19 section 4.2.3.3.7).

2.10 Mute Functions

Application of the Muting Function

In this manual, the term “muting” refers to the automatic suspension of the safeguarding function of a safety device during a non-hazardous portion of the machine cycle. (During the non-hazardous portion of the machine cycle, personnel are not exposed to harm.)

To mute the System appropriately, the design of a muting system must:

- 1) Identify the non-hazardous portion of the machine cycle,
- 2) Involve the selection of the proper muting devices, and
- 3) Include proper mounting of those devices.

The MINI-SCREEN control box can monitor and respond to redundant signals that initiate the mute. The mute then suspends the safeguarding function by ignoring the blockages in the light screen; this allows an object or person to pass through the defined area without generating a stop command. (This should not be confused with blanking, which disables one or more light beams in the array, resulting in larger minimum object sensitivity.) See Appendix A for example mute timing sequences.

The mute may be triggered by a variety of external devices (see Section 2.11.1). This feature provides a variety of options (see Sections 2.11.2 - 2.11.7) to tailor the System to the requirements of a specific application.

Each pair of muting devices must be triggered simultaneously (within 3 seconds of one another). This reduces the chance of common mode failures or defeat.



WARNING . . .
Mute Inputs Must Be
Redundant
It is not acceptable to use a single
switch, device, or relay with two
N.O. contacts for the mute inputs. This single device, with multiple outputs, may fail in a state such as to mute the System at an inappropriate time that may result in a hazardous situation.

2.10.1 Mute Devices

The beginning and end of a mute must be triggered by outputs from either two or four muting devices, depending on the application. The mute devices must have normally open contacts, or one device with a PNP output and one device with a NPN output, both of which fulfill the “muting device requirements” on page 38. These contacts must close (conducting) when the switch is actuated to initiate the mute, and must open (non-conducting) when the switch is not actuated and in a power-OFF condition.

The control box monitors the redundant mute devices and verifies that the inputs close within 3 seconds of each other. If the inputs do not meet this simultaneity requirement, a mute condition can not occur.

Several different types and combinations of mute devices can be used, including: limit switches, photoelectrics, positive-drive safety switches, inductive proximity, and “whisker” switches. When photoelectric sensors are used as muting devices, opposed-mode sensors set to dark operate typically should be used. (See Muting Device Requirements on page 38 and Appendix B for a partial list of Banner sensors and switches that can be used as muting devices.)

2.10.2 Mute Enable

The Mute Enable input is a non-safety rated input. When the input is closed, the MSCC-2L2M will allow a mute condition to occur; opening this input while the System is muted will have no effect. If the application does not require Mute Enable, the input must be jumpered. See Section 3.5.7 for further information.

Four typical Mute Enable functions are:

- 1) Contact(s) from machine control logic to create a “window” for a mute to begin.
- 2) Closed or jumpered contact(s) to allow a mute on power-up (when selected; see section 2.11.5).
- 3) Jumpered input to allow a mute if mute enable is not used.
- 4) Open to prevent the initiation of the mute function.

2.10.3 Mute Lamp Output


Many applications require that a lamp (or other means) be used to indicate when the light screen is muted; the control box provides for this (see WARNING at right). This indication is selectable between a monitored mute lamp, or a non-monitored low-current signal (NPN sinking) to logic inputs. The monitored output will prevent the initiation of a mute if an indicator failure is detected (current draw falls below 10 mA or goes above 360 mA). If the muting function is to be used in a country governed by EN regulation (requiring the CE mark), Lamp Monitoring must be selected and the lamp must meet applicable requirements.

2.10.4 Backdoor Timer

The Backdoor Timer allows the user to select a maximum period of time that muting is allowed to occur. The Backdoor Timer helps to hinder the intentional defeat of the muting devices for the purpose of initiating an inappropriate mute. It is also useful in detecting a common mode failure that would affect all mute devices in the application.

The timer begins when the second muting device makes the simultaneity requirement (within 3 seconds of the first muting device being actuated), and will allow a mute to continue for the predetermined time. After the timer expires, the mute ends – no matter what the signal from the mute devices indicates. If the defined area is blocked, the FSD outputs will open and the latch must be reset (System Key Reset), or the Override function must be activated (see Section 2.11.6) to clear the defined area of the obstruction.

Regardless of the state of the Light Screen (clear or blocked), if the mute inputs are closed when the timer expires, the FSD contacts and the System Aux will open, Error #50 will be displayed by the System Diagnostic Display, and a System Key Reset must be performed.



WARNING . . .
Mute Status Must Be Readily Detectable

Indication that the safety light screen is muted must be provided and must be readily observable (per ANSI B11.19 section 4.2.3.3.3).

Lamp monitoring must be selected if the system is to be used in a country governed by EN regulation (i.e. requiring the CE marking), and the lamp should be white in color (per IEC 61496-1).

Failure of this indication should be detectable and prevent the next mute, or the operation of the indicator should be verified at suitable intervals.



WARNING . . .
Mute On Power-Up

The Mute on Power-up function should be used only in applications where:

- Muting the System (M1 and M2 closed) when power is applied to the MINI-SCREEN is required, and
- Using it can not, in any situation, expose personnel to any hazard.



WARNING . . .
Limit Use of Override Function

The Override function is not for machine setup or production; it is to be used only to clear the defined area if material becomes “stuck” in the defined area.

When Override is used, it is the user's responsibility to install and use it according to current standards (see Section 2.11.6).

In addition, the requirements listed in standards NFPA79 (Section 9.15) and IEC204-1 (Section 9.2.4) must be satisfied.

2.10.5 Mute On Power-Up

The Backdoor Timer DIP switches will also enable or disable the Mute on Power-Up function (See Figure 3-12, page 35). Mute Enable must be closed to allow Mute on Power-Up. (See WARNING to left and Section 2.11.2, Mute Enable.) When selected, the Mute on Power-Up function will initiate a mute when power is applied if the Mute Enable is closed, the defined area is clear, and either M1-M2 or M3-M4 (but not all four) are closed.

2.10.6 Override

The Override function allows the user to manually force the FSD contacts closed for 10 seconds if an object becomes “stuck” in the defined area after the mute ends (e.g., a car body on a transfer line entering a work cell). The feature is intended to allow the user to “jog” the part out of the defined area.

Three seconds after the system enters a latched/blocked condition, an override can be initiated.

This input requires two normally open switches, both of which must be closed within 3 seconds of each other. The Override cycle will last a maximum of 10 seconds, after which the Override input must be released for at least 3 seconds prior to the next Override cycle. An Override can be initiated only after tripping of the light screen causes the control box to latch the FSD outputs. After the defined area is cleared, a System Key Reset must be performed to reset the latch.

When Override is used, the following precautions must be taken:

- Prevent exposure to any hazard during an Override cycle,
- Provide a readily observable indication of an Override, and
- Provide supplemental safeguarding, per NFPA79 (section 9.15) and IEC204-1 (section 9.2.4).

The Override switches must be supervised and must prevent automatic operation. Also, one or more of the following must be true:

- Motion is initiated by a hold-to-run or similar device,
- If a portable control station (e.g., a pendant) with an emergency stop device is used, motion may be initiated only from that station,
- Motion, speed, or power of the machine is limited, or
- The machine's range of motion is limited.

2.10.7 One-Way/Two-Way Muting

One-way (directional) muting allows the System to become muted only if mute devices are actuated in the order M1-M2, (mute initiated), M3-M4. This method allows for a one-way direction of material flow and reduces the possibility of intentional defeat of the muting devices.

Two-way (non-directional) muting allows the System to become muted any time the actuation of M1 and M2, or M3 and M4 meets the 3-second simultaneity requirement. This allows the flow of material from either direction (two-way material flow).

NOTE: When using four mute devices (M1, M2, M3 and M4), in order to extend the mute until the light screen is clear, the object must activate all four of the devices at one time during the mute cycle.

3. System Installation and Alignment

3.1 Appropriate Application

The MINI-SCREEN System may only be used to guard machinery that is *capable of stopping motion immediately* upon receiving a stop signal and at any point in its machine cycle.

The MINI-SCREEN System may not be used for the following:

- With single stroke (also called “full revolution”) clutched machinery, as this type of machinery is incapable of stopping immediately.
- On certain other types of machinery, including any machine with inadequate or inconsistent stopping response time, or any machine that ejects materials or component parts through the defined area.
- In any environment likely to adversely affect the efficiency of a photoelectric sensing system. For example, corrosive chemicals or fluids or unusually severe levels of smoke or dust, if not controlled, may degrade the efficiency of the MINI-SCREEN System.
- As a tripping device to initiate machine motion (PSDI applications) on mechanical power presses, per OSHA regulation 29 CFR 1910.217.



CAUTION . . . Install System Only on Appropriate Applications

In order for the machinery guarded by the MINI-SCREEN System to be stopped as described, *that machinery must be capable of stopping at any point in its machine cycle*. This means that the MINI-SCREEN System cannot be used with certain types of machinery (see listing above). **If there is any doubt about whether or not your machinery is compatible with the MINI-SCREEN System, contact Banner's Application Engineers at the factory.**




WARNING . . .


Read this Section Carefully Before Installing the System

The Banner MINI-SCREEN System is a point-of-operation machine guarding device. **Its ability to perform this function depends upon the appropriateness of the application and upon the MINI-SCREEN System's proper mechanical and electrical installation and interfacing to the machine to be guarded.** If all mounting, installation, interfacing, and checkout procedures are not followed properly, the MINI-SCREEN System cannot provide the protection for which it was designed. **The user has the responsibility to ensure that all local, state, and national laws, rules, codes, or regulations relating to the installation and use of this control system in any particular application are satisfied.** Extreme care should be taken to ensure that all legal requirements have been met and that all technical installation and maintenance instructions contained in this manual are followed. **Read Section 3 (and its subsections) of this manual carefully before installing the system. Failure to follow these instructions could result in serious bodily injury or death.**


The user has the sole responsibility to ensure that the Banner MINI-SCREEN System is installed and interfaced to the guarded machine by Qualified Persons in accordance with this manual and applicable safety regulations. (See Safety Glossary and ANSI/ASME B30.2-1983).




WARNING . . .
Position Components Carefully
 The emitter and receiver must be positioned so that the hazard can not be accessed by reaching over, under, around or through the sensing field. Additional guarding may be required; see Hard Guarding, Section 3.2.2.



WARNING . . .
Proper Separation Distance
 Banner MINI-SCREEN System emitters and receivers must be mounted at a distance from moving machine parts that is determined by OSHA standards found in Section 1910.217 (c)(3)(iii)(e). Failure to establish and maintain the required separation distance exactly as described in Section 3.2 of the MINI-SCREEN manual could result in serious bodily injury or death.



WARNING . . .
Determine Correct Stop Time
 The measurement of stop time (T_s) must include the response time of all devices or controls that react to stop the machine. If all devices are not included, the calculated safety distance (D_s) will be too short. This can lead to serious bodily injury or death. Be sure to include the stop time of all relevant devices and controls in your calculations.



CAUTION . . .
Increase Separation Distance When Using Floating Blanking
 Floating blanking increases D_{pf} (see values at right). Increase the penetration factor to calculate the separation distance whenever floating blanking is used.
 Always turn floating blanking OFF when the larger minimum object detection size is not required.

3.2 Installing the Light Screen

Two factors have the greatest influence on the layout of the MINI-SCREEN Light Screen's mechanical installation:

- Separation distance, and
- Hard guarding.

3.2.1 Separation Distance

The MINI-SCREEN System must be able to react fast enough, when a hand or other object is inserted into the defined area, to send a "stop" signal to the guarded machine *before the object or hand reaches the closest reachable hazard point on the machine*. The separation distance (or safety distance) is the minimum distance required between the midpoint of the defined area and the closest reachable hazard point. The calculation of the separation distance takes into account several factors, including the speed of the hand (or object), the total system stopping time (of which there are several response time components), and the depth penetration factor. The formula used to calculate the separation distance is:

$$D_s = K \times (T_s + T_r) + D_{pf}$$

where:

D_s = the separation distance;

K = the OSHA-recommended hand speed constant of 63" per second (NOTE 1, below);

T_s = the overall stop time of the machine measured from the application of the "stop" signal to the final ceasing of all motion (including stop times of all relevant control elements, and measured at maximum machine velocity). See the WARNINGS (left), NOTE 2 (below), and the NOTICE Regarding MPCES (page 50).

T_r = the response time of the MINI-SCREEN System:

- .058 seconds for 4.5" to 16" emitter/receiver
- .070 seconds for 20" to 32" emitter/receiver
- .082 seconds for 36" to 48" emitter/receiver

D_{pf} = the added distance due to depth penetration factor, as prescribed in OSHA 1910.217 and ANSI B11 standards:

Floating Blanking	30' Range Sensors	60' Range Sensors
Floating blanking OFF	$D_{pf} = 1.6"$	$D_{pf} = 2.5"$
1-beam blanking ON	$D_{pf} = 3.3"$	$D_{pf} = 4.2"$
2-beam blanking ON	$D_{pf} = 5.0"$	$D_{pf} = 5.9"$

NOTES:

- 1) The OSHA-recommended hand-speed constant K has been determined by various studies, and although these studies indicate speeds of 63"/sec to over 100"/sec, they are not conclusive determinations. The employer should consider all factors, including the physical ability of the operator, when determining the value of K to be used.
- 2) T_s is usually measured by a stop-time measuring device. If the specified machine stop time is used, we recommend that at least 20% be added as a safety factor to account for clutch/brake system deterioration.
- 3) Use of floating blanking will always cause the required D_s to increase.

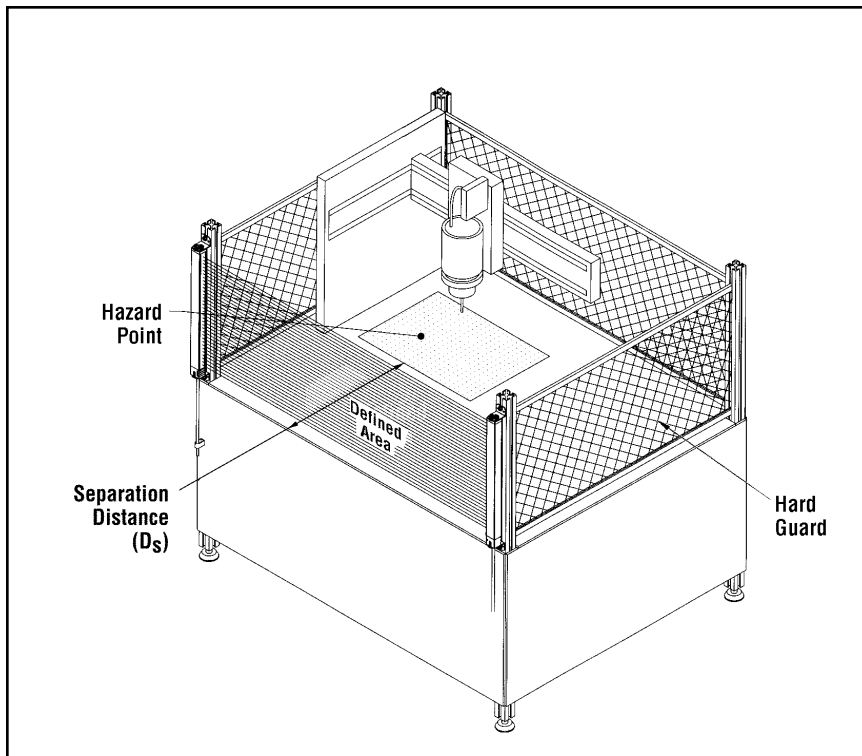


Figure 3-1. Determining separation distance



WARNING . . .

Long-Range Sensors Require Greater Separation Distance

The beam diameter for the long range emitters and receivers is greater than for standard sensors. This means that the minimum object sensitivity is greater and also the resulting depth penetration factor (D_{pf}) used to calculate the separation distance is greater for long range sensors (see D_{pf} value chart on page 23).

Carefully check the labels on the emitter and receiver to determine the proper value of D_{pf} to use in the separation distance formula. **Insufficient separation distance will result in an unsafe installation.**

Example: Separation Distance (D_S) Calculation

The following is an example showing how to use the formula from page 23 to calculate the safety distance (D_S). We will use these numbers for the variables in the formula:

Sensors in this example have a 9 m (30') range.

$K = 63$ " per second (the hand speed constant set by OSHA)

$T_S = .250$ second (the total stop time of the example machine, specified by machine manufacturer)

$T_R = .058, .070, \text{ or } .082$ second (the specified response time of the MINI-SCREEN System; see Specifications, page 82 or page 23.)

Our example uses floating blanking, so we use a D_{pf} of 5" (page 23).

Response time for this example is .070 second. Substitute the numbers into the formula as follows:

$$D_S = K \times (T_S + T_R) + D_{pf}$$

$$D_S = 63 \times (.250 \times 1.2^* + .070) + 5 = 28.3"$$

Therefore, in this example, the MINI-SCREEN emitter and receiver must be mounted such that no part of the defined area will be closer than 28.3" to the closest reachable hazard point on the guarded machine.

**20% safety factor (see NOTE 2, on page 23)*



WARNING . . .

Pass-Through Hazards and Muting

If the safety light screen is safeguarding an application in which personnel have access into the defined area (for example, a machine operator at the point of operation) while the light screen is muted, all pass-through hazards must be eliminated.

The individual must be sensed continually while in the safeguarded area; this will prevent initiation of a machine cycle if the mute ends while the individual is within the hazardous area. See Appendix C, pages 95-100 for examples.

If the pass-through hazard cannot be eliminated, as in entry/exit applications, the individual must be detected entering the safeguarded area and the hazardous motion must stop immediately.



WARNING . . .
Use of MINI-SCREEN
Systems for
Perimeter Guarding

If a MINI-SCREEN System is installed for perimeter guarding, the system MUST require actuation of a Reset switch before initiating the dangerous machine motion following an interruption of the defined area.

If a MINI-SCREEN System is used for perimeter guarding, the Machine Primary Control Elements (MPCEs) of the guarded machine must be wired so that **the FSD outputs of the control box cause a latched response of the MPCEs. The MPCEs must be reset only by actuation of a Reset switch.**

The Reset switch must be located outside of, and not be accessible from within, the area of dangerous motion, and it must be positioned so that the area of dangerous motion may be observed by the switch operator during the reset operation.

Additional safeguarding, as described by the ANSI B11 series of safety requirements or other appropriate standards, must be used if any space between either defined area and any danger point is large enough to allow a person to stand undetected by the MINI-SCREEN System. **Failure to observe this warning could result in serious bodily injury or death.**

3.2.1.1 Pass-Through Hazards

A “pass-through hazard” is associated with applications where personnel may pass through a safeguard (at which point the hazard stops or is removed), and then may continue into the hazardous area. Subsequently, their presence is no longer detected, and the safeguard can not prevent the start or restart of the machine. The related danger is the unexpected start or restart of the machine while personnel are within the hazardous area.

In the use of safety light screens, a pass-through hazard typically results from large separation/safety distances calculated from long stopping times, large minimum object sensitivities, reach over, reach through, or other installation considerations. A pass-through hazard can be generated with as little as 75mm (3") between the defined area and the machine frame or hard guarding.

Reducing or Eliminating Pass-Through Hazards

Measures must be taken to eliminate or reduce pass-through hazards. One solution is to ensure that personnel are continually sensed while within the hazardous area. This can be accomplished by using supplemental safeguarding, including: safety mats, area scanners, and horizontally mounted safety light screens. While it is recommended to eliminate the pass-through hazard altogether, this may not be possible due to cell or machine layout, machine capabilities, or other application considerations.

An alternate method is to ensure that once the safeguarding device is tripped it will latch, and require a deliberate manual action to reset. This type of supplemental safeguarding relies upon the location of the Reset switch as well as safe work practices and procedures to prevent an unexpected start or restart of the guarded machine.

The Reset switch or actuating control must be positioned outside the guarded area, and provide the switch operator with a full unobstructed view of the entire guarded area and any associated hazards as the Reset is performed. The Reset switch or actuating control must not be reachable from within the guarded area and must be protected (through the use of rings or guards) against unauthorized or inadvertent operation. A key-actuated Reset switch provides some operator control, as it can be removed by the operator and taken into the guarded area. However, this does not prevent unauthorized or inadvertent Resets due to spare keys in the possession of others, or additional personnel entering the safeguarded area unnoticed.

The Reset of a safeguard must not initiate hazardous motion. Also, before each Reset of the safeguard is performed, safe work procedures require that a start-up procedure be followed and that the individual verifies that the entire hazardous area is clear of all personnel. If any areas can not be observed from the Reset switch location, additional supplemental safeguarding must be used: at minimum, visual and audible warnings of machine start-up.

3.2.2 Hard Guarding

ANSI B11.1-1988, 6.3.2 (14) requires that “all areas of entry to the point of operation not protected by the presence-sensing device shall be otherwise safe-guarded.” The hazard point must be accessible *only* through the defined area. This means that mechanical barriers (screens, bars, etc.), or supplemental presence-sensing devices (*supplemental guarding*) must be installed, wherever needed, to prevent any person from reaching around, under, or over the defined area and into the hazard point. The use of mechanical barriers for this purpose is called “hard guarding” (see the WARNING at right and Figure 3-2, below).

There must be no gaps between the hard guarding and the edges of the defined area. Furthermore, fixed objects in the defined area which require use of fixed blanking must occupy the entire width of the defined area. Otherwise, hard guarding must be installed to prevent access to any hazard point through the blanked area.

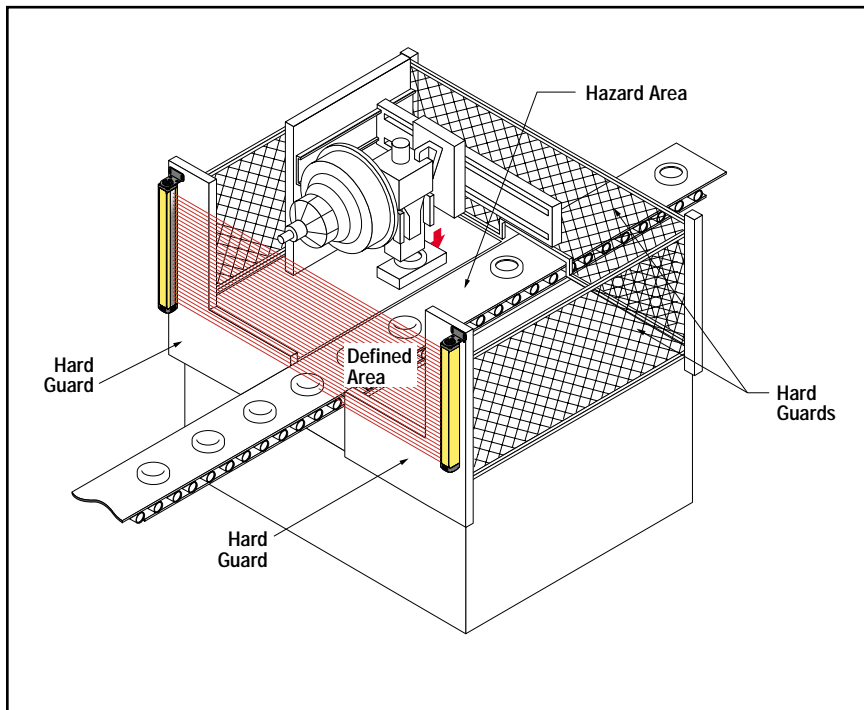


Figure 3-2. Example of hard guarding



WARNING . . .
The Point of Operation
Must Be Accessible
Only Through the
Defined Area.

Mechanical barriers (screens, bars, etc.), or supplemental presence-sensing devices (*supplemental guarding*) must be installed, wherever needed, to prevent any person from reaching around, under, or over the defined area and into the point of operation, and also to prevent any person from entering the space between the defined area and the point of operation (see OSHA 1910.212). The use of mechanical barriers for this purpose is called “hard guarding.” There must be no gaps between the hard guarding and the edges of the defined area. Openings in the hard guard material must meet OSHA criteria (see OSHA 1910.217, Table O-10).

Additional safeguarding, as described by the ANSI B11 series of safety requirements or other appropriate standards, must be used if the space between the defined area and the nearest danger point is large enough to allow a person to stand undetected by the MINI-SCREEN System.



WARNING . . .
Proper Orientation of
System Emitters and
Receivers

The emitters and receivers of the MINI-SCREEN System must be installed with their corresponding ends (either cabled ends or non-cabled ends) pointing in the same direction (both cabled ends "up," both cabled ends "down," etc.). Failure to do this will impair the performance of the MINI-SCREEN System and result in incomplete guarding; see Figure 3-4.

Failure to observe this warning could result in serious bodily injury or death.

3.2.3 Emitter and Receiver Orientation

It is absolutely necessary that the emitter and receiver are mounted perfectly parallel to each other with both cable ends pointing in the same direction. Never mount the emitter with its cable end oriented opposite to the cable end of the receiver, or there will be voids in the light screen through which objects can pass undetected (see Figure 3-4).

The emitter and receiver may be oriented horizontally, vertically or at any angle between horizontal and vertical. However, the cable ends must always point in the same direction. Always be certain that the light screen completely covers all access to the hazard point which is not already protected by hard guarding or another means of supplemental guarding.

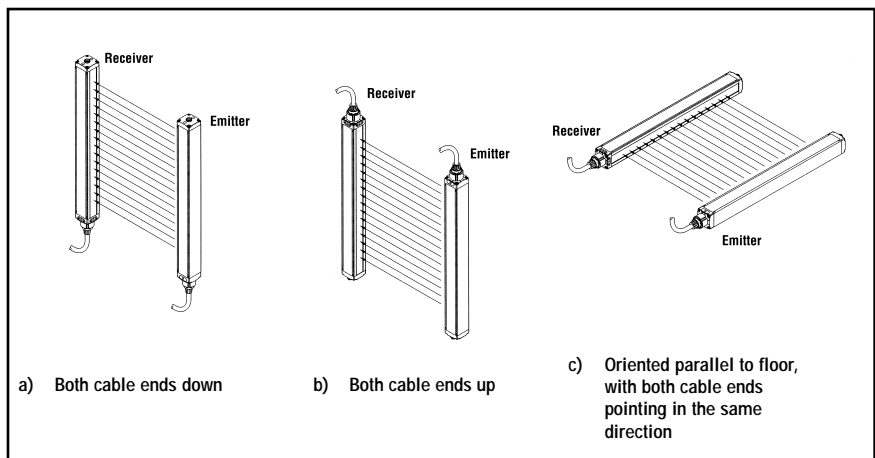


Figure 3-3. Correct emitter and receiver orientation

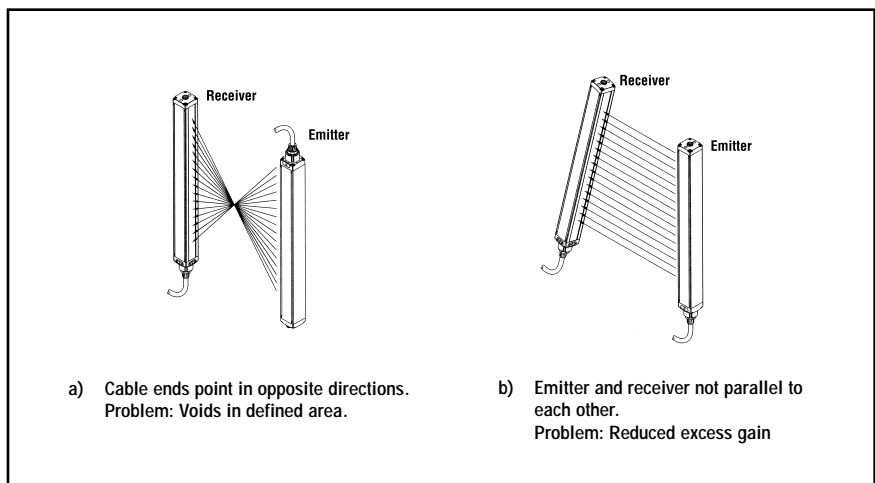


Figure 3-4. Incorrect emitter and receiver orientation

3.2.4 Adjacent Reflective Surfaces

A reflective surface located adjacent to the defined area may deflect one or more beams of the light screen around an object in the defined area. In the worst case, such a situation may allow an object to pass through the defined area undetected.

The reflective surface may be a part of the machine or the workpiece and may include shiny metal or plastic or surfaces with glossy paint. Where possible, reflective surfaces adjacent to the defined area should be roughened or covered with a dull material. Where this is not possible (as with a reflective workpiece), the sensor mounting should include a means of restricting the field of view of the receiver or the spread of the light from the emitter.

Beams deflected by reflective surfaces are discovered during the initial checkout procedure (Section 3.5.12), the final alignment and checkout procedure (Section 6.1), and also by the periodic checkout procedures (Sections 6.2, 6.3, and 6.4).

3.2.5 Use of Corner Mirrors

MINI-SCREEN sensors may be used with one or more corner mirrors. The use of corner mirrors somewhat reduces the maximum specified emitter/receiver separation (see page 64).

Mirrors are not allowed for applications using the MINI-SCREEN with Muting, if their use allows personnel undetected access into the safeguarded area. If a mirror must be used, the angle between the receiver and the emitter must be at least 45°, but less than 120°. (See Figure 3-5.)

Corner mirrors and stands are available from Banner; see pages 86 and 87.

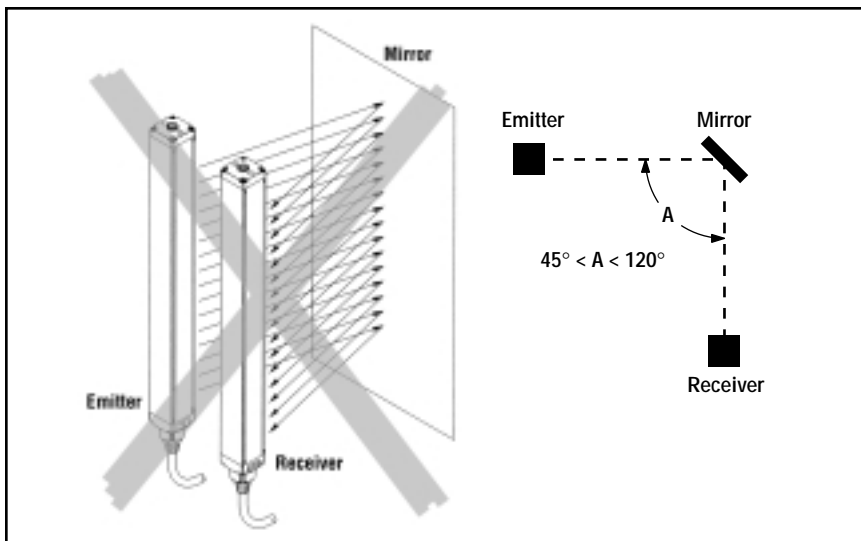


Figure 3-5. If mirrors must be used in a perimeter-guarding application, the difference between the angle of incidence from the emitter to the mirror and from the mirror to the receiver must be between 45° and 120°.



WARNING . . . Avoid Mirrors

DO NOT use mirrors to guard multiple areas if personnel can enter the hazardous area while the System is muted and not be detected by supplemental safeguarding that will issue a stop command to the machine. (See Section 3.2.1.1, Pass-through hazards.)



WARNING . . . Installation Near Reflective Surfaces

A highly reflective surface (such as a shiny machine surface or a shiny workpiece) may reflect sensing light around an object in the defined area, preventing that object from being detected. This potentially dangerous condition is discovered using the “trip test” as described in the Initial Checkout Procedure (Section 3.5.12), the Alignment Procedure (Section 6.1), and the periodic checkout procedures (Sections 6.2, 6.3, and 6.4).

When this condition is discovered, eliminate the problem reflection(s):

- **If possible, relocate the sensors** to move the light screen beams away from the reflective surface(s), being careful to retain at least the required separation distance (Section 3.2.1).
- **Otherwise, paint, mask, or roughen the interfering shiny surface** to reduce its reflectivity.

Repeat the trip test to verify that these changes have eliminated the problem reflection(s). (NOTE: If the workpiece is especially reflective and comes close to the light screen, perform the trip test with the shiny workpiece in place.)



WARNING . . . Avoid Retroreflective Installation

Never use MINI-SCREEN sensors in retroreflective mode, as illustrated in Figure 3-5. The MINI-SCREEN System is not designed for use in retroreflective mode (where the sensors are mounted adjacent to each other and the light from the emitter is bounced back directly to the receiver by a mirror or other reflective surface). **Sensing is unreliable in this mode and could result in serious injury or death.**

3.2.6 Installation of Multiple MINI-SCREEN Systems

Whenever the emitter and receiver pairs of two or more MINI-SCREEN Systems are located adjacent to one another, there is potential for optical crosstalk to take place between systems. To minimize optical crosstalk, alternate the emitters and receivers, as shown in Figure 3-6.

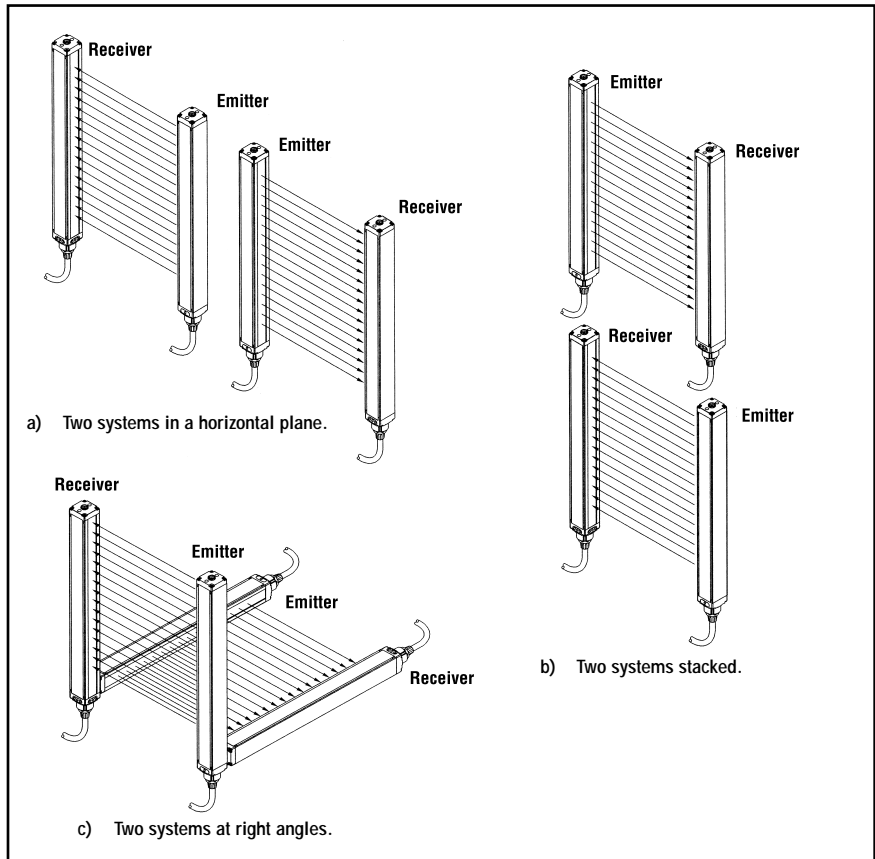


Figure 3-6. Installation of multiple MINI-SCREEN systems. Alternate emitters and receivers to avoid optical crosstalk.

When three or more systems are installed in one plane, (as shown for two pairs in Figure 3-6), optical crosstalk may occur between sensor pairs whose emitter and receiver lenses are oriented in the same direction. In this situation, optical crosstalk may be controlled by mounting these sensor pairs exactly in line with each other within one plane, or by adding a mechanical light barrier between the pairs.

3.3 Mounting Procedure

Sensor Mounting

Banner MINI-SCREEN System emitters and receivers are small, lightweight, and easy to handle during mounting. The mounting brackets (supplied) allow ± 30 degrees rotation. From a common point of reference, make measurements to locate the emitter and receiver in the same plane with their midpoints directly opposite each other.

Important: The connector ends of both sensors must point in the same direction (see drawings and WARNING, page 27).

Mount the emitter and receiver brackets using the vibration isolators and M4 Keps nuts (all supplied). See Figure 3-7. Standard #8-32 bolts may be substituted (and the vibration isolators eliminated) in situations where the emitter and receiver are not subjected to shock or vibration forces. While the internal circuits of the emitter and receiver are able to withstand heavy impulse forces, the vibration isolators dampen impulse forces and prevent possible damage due to resonant vibration of the emitter or receiver assembly.

Mount the emitter and receiver in their brackets and position the red lenses of the two units directly facing each other. Measure from one or more reference planes (e.g., the building floor) to the same point(s) on the emitter and receiver to verify their mechanical alignment. If the units are positioned exactly vertical or horizontal to the floor, a carpenter's level is useful for checking alignment. A straightedge or a string extended between the sensors also helps with positioning. Also check "by eye" for line-of-sight alignment. Make any necessary final mechanical adjustments, and hand-tighten the bracket hardware. A detailed alignment procedure is given in Section 6.1.

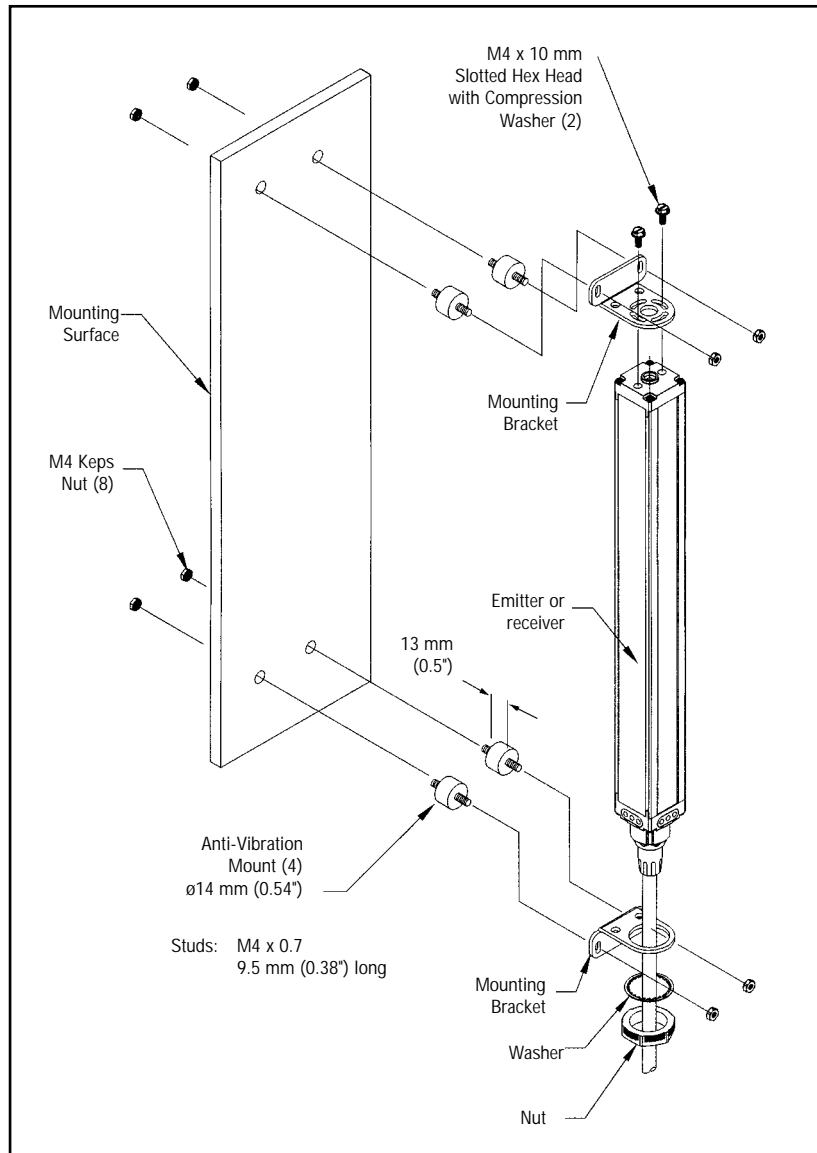


Figure 3-7. Emitter and receiver mounting

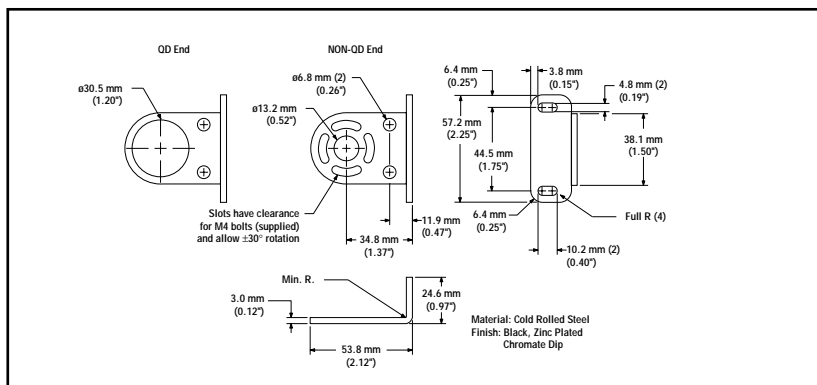


Figure 3-8. Emitter and receiver mounting bracket dimensions

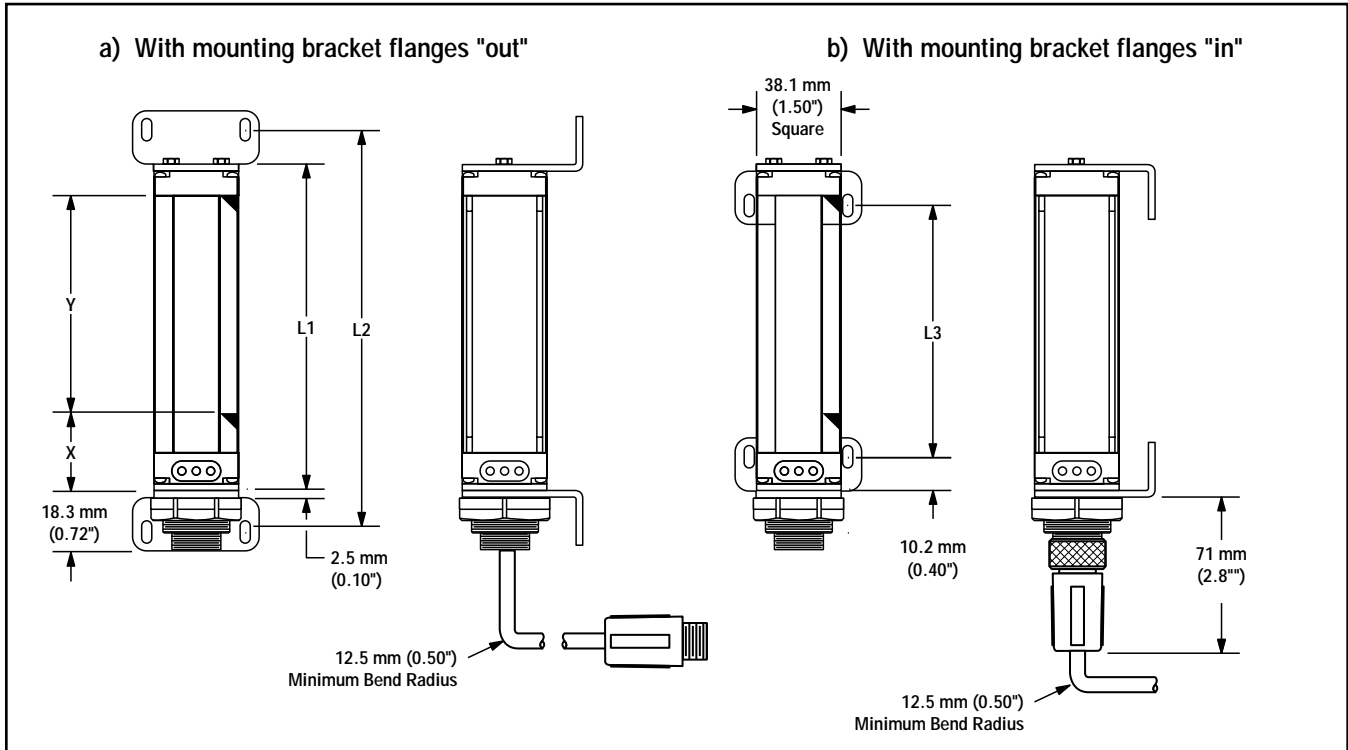


Figure 3-9. Emitter and receiver mounting dimensions and location of defined area

Models	Housing Length		Distance Between Bracket Holes		Defined Area	
	L1	L2	L3	X	Y	
MSE424 emitter MSR424 receiver	153 mm (6.0")	188 mm (7.4")	130 mm (5.1")	28 mm (1.1")	114 mm (4.5")	
MSE824 emitter MSR824 receiver	254 mm (10.0")	287 mm (11.3")	231 mm (9.1")	28 mm (1.1")	215 mm (8.5")	
MSE1224 emitter MSR1224 receiver	356 mm (14.0")	389 mm (15.3")	333 mm (13.1")	30 mm (1.2")	305 mm (12.0")	
MSE1624 emitter MSR1624 receiver	457 mm (18.0")	490 mm (19.3")	434 mm (17.1")	30 mm (1.2")	406 mm (16.0")	
MSE2024 emitter MSR2024 receiver	558 mm (22.0")	592 mm (23.3")	536 mm (21.1")	30 mm (1.2")	508 mm (20.0")	
MSE2424 emitter MSR2424 receiver	659 mm (26.0")	693 mm (27.3")	637 mm (25.1")	30 mm (1.2")	610 mm (24.0")	
MSE2824 emitter MSR2824 receiver	761 mm (30.0")	795 mm (31.3")	739 mm (29.1")	33 mm (1.3")	711 mm (28.0")	
MSE3224 emitter MSR3224 receiver	862 mm (33.9")	896 mm (35.3")	838 mm (33.0")	33 mm (1.3")	813 mm (32.0")	
MSE3624 emitter MSR3624 receiver	963 mm (37.9")	998 mm (39.3")	940 mm (37.0")	33 mm (1.3")	914 mm (36.0")	
MSE4024 emitter MSR4024 receiver	1064 mm (41.9")	1100 mm (43.3")	1041 mm (41.0")	33 mm (1.3")	1016 mm (40.0")	
MSE4424 emitter MSR4424 receiver	1166 mm (45.9")	1201 mm (47.3")	1143 mm (45.0")	33 mm (1.3")	1118 mm (44.0")	
MSE4824 emitter MSR4824 receiver	1267 mm (49.9")	1300 mm (51.2")	1245 mm (49.0")	33 mm (1.3")	1219 mm (48.0")	


Routing the Cables

Connect the shielded cables to the emitter and receiver (quick-disconnect models). Route them (per local wiring code for low-voltage dc control cables) to the control box mounting location. The same cable type is used for both emitter and receiver. The cables should also be trimmed to length; do not trim the cables until you are certain that you have routed all cables properly. Emitter and receiver cable lengths may not exceed 175' total. The cable braid at the control box connection points may be either removed or twisted together with the drain wire (see page 36). **IMPORTANT:** Use ONLY Banner MINI-SCREEN cables (see page 83).

Mounting the Control Box

Mount the MINI-SCREEN System control box in a convenient location that is free from heavy impulse force and high-amplitude vibration. The control box and any auxiliary Reset switches must be located outside the guarded area, where the switch operator has a full unobstructed view of the entire guarded area and any associated hazards as the Reset is performed. The control box and any auxiliary Reset switches must not be reachable from within the guarded area and must be protected (through the use of rings or guards, for example) against unauthorized or inadvertent operation. Mounting hole information is given in Figure 3-10 (below).

The MINI-SCREEN controllers should be configured before initial checkout and use. Controller configuration is done at the banks of DIP switches along the edge of each controller module (Figures 3-11 and 3-12). The controller will automatically sense the length and style of the emitter and receiver, and set its response time accordingly.



WARNING . . .
The Control Box must be mounted outside the guarded area at a location which provides an unobstructed view of the entire guarded area, including all danger points. In addition, it must NOT be possible to reach the Key Reset switch from inside the guarded area. Failure to do so could result in serious injury or death.

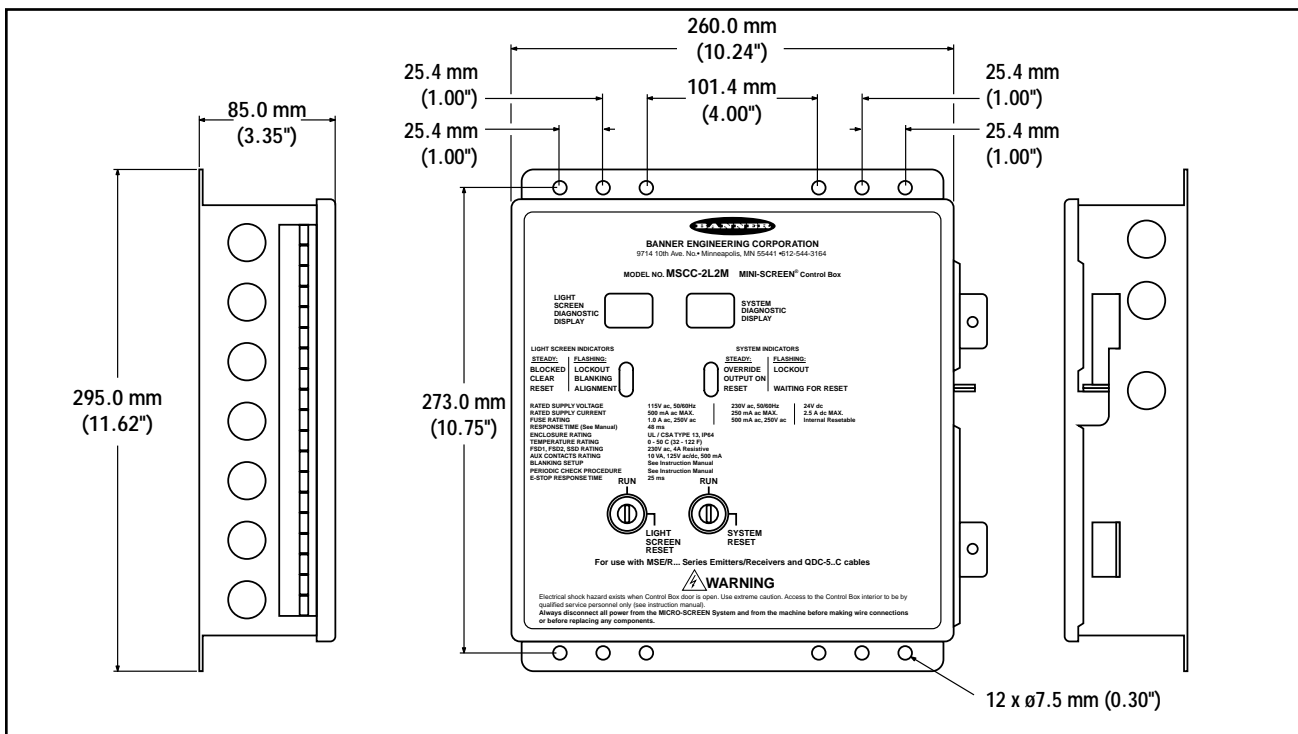


Figure 3-10. Control box dimensions and mounting hole locations

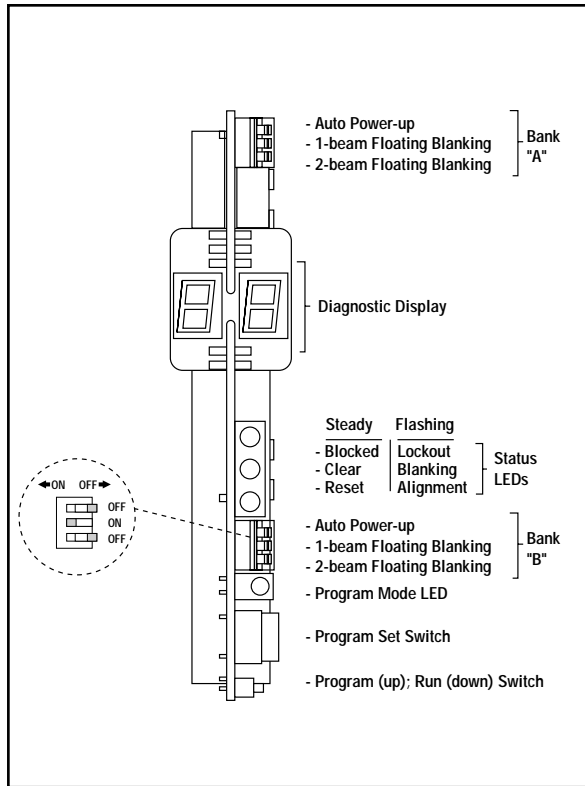


Figure 3-11. Light Screen controller board

WARNING . . .
Blanking Considerations

If blanking is enabled (either fixed or floating), be aware of the differences in minimum object sensitivity, depth penetration factor (D_{pf}), and required light screen separation distance for the various settings. See Section 3.2.1 for further information.

3.4 Controller Board Configuration

Because the Light Screen Controller and the System Controller each have redundant microprocessors, each board has two identical DIP switch banks (Bank A and Bank B); each pair must be set identically. Failure to set Banks A and B identically will cause a lockout condition.

Power must always be OFF when changing DIP switch settings. Changing DIP switch settings with power ON will cause a lockout condition (See Section 5, pages 53-58 for Key Reset routines and troubleshooting).

3.4.1 Light Screen Controller Board Configuration

The parameters to be manually configured on the Light Screen controller are:

- Light Screen Controller Auto Power-up,
- One- or Two-Beam Floating Blanking,
- Fixed Blanking (if available).

NOTE: Switch numbers, e.g. "SW1," refer to both switch banks A and B.

System Auto Power-up:

SW1 ON = Auto Power-up Enabled
 SW1 OFF = Auto Power-up Disabled *
 (See Section 2.2)

1-Beam Floating Blanking:

SW2 ON = 1-Beam floating blanking enabled
 SW2 OFF = 1-Beam floating blanking disabled *
 (See Section 2.1)

2-Beam Floating Blanking:

SW3 ON = 2-Beam floating blanking enabled
 SW3 OFF = 2-Beam floating blanking disabled *
 (See Section 2.1)

NOTE: Both 1- and 2-Beam Floating Blanking switches set to ON will cause a lockout.

Sensor Range	Floating Blanking	Maximum Size of Undetected Objects	Minimum Object Sensitivity
9 m (30')	off	(Not applicable)	19.1 mm (0.75")
	1-beam	7.6 mm (0.30")	32 mm (1.25")
	2-beam	20.3 mm (0.80")	44.5 mm (1.75")
18 m (60')	off	(Not applicable)	25.4 mm (1.00")
	1-beam	3.8 mm (0.15")	38.1 mm (1.50")
	2-beam	16.5 mm (0.65")	50.8 mm (2.00")

Fixed Blanking:

Fixed blanking, if used, is programmed during the initial checkout procedure using the Program switches located on the light screen controller board (see Figure 3-11). See Section 3.5.12.1 for complete information.

*Factory default setting.

3.4.2 System Controller Board Configuration

The parameters to be manually configured on the System controller are:

- System Auto Power-up,
- Monitored Mute Lamp output,
- One-Way (directional) or Two-Way (non-directional) Mute Initiate Sequence
- One-Channel or Two-Channel EDM, and
- Backdoor Time Out.

NOTE: Switch numbers, e.g. "SW1," refer to both switch banks A and B.

System Auto Power-up:

SW1 ON = Auto Power-up Enabled
 SW1 OFF = Auto Power-up Disabled*
 (See Section 2.2)

Monitored or Non-Monitored Mute Lamp:

SW2 ON = Monitored mute lamp output*
 SW2 OFF = Mute lamp output not monitored
 (See Section 2.11.3)

One-Way or Two-Way Mute Initiate:

SW3 ON = Two-way muting
 SW3 OFF = One-way muting*
 (See Section 2.11.7)

One-Channel or Two-Channel EDM:

SW4 ON = Two-channel EDM enabled*
 SW4 OFF = One-channel EDM enabled
 (See Section 2.10)

Backdoor Timer Settings:

SW5 OFF = 30 sec. (Mute on Power-Up Disabled)*
 SW6 OFF = 30 sec. (Mute on Power-Up Disabled)*

SW5 OFF = 60 sec. (Mute on Power-Up Disabled)
 SW6 ON = 60 sec. (Mute on Power-Up Disabled)

SW5 ON = OFF (Mute on Power-Up Disabled)
 SW6 OFF = OFF (Mute on Power-Up Disabled)

SW5 ON = OFF (Mute on Power-Up Enabled)
 SW6 ON = OFF (Mute on Power-Up Enabled)

See Section 2.11.5 for complete information.

*Factory default setting.

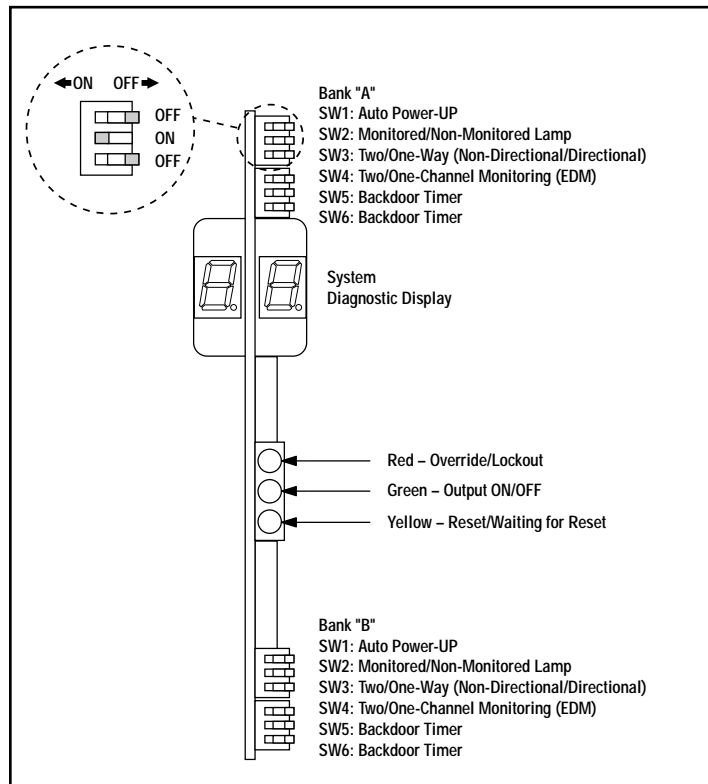



Figure 3-12. System controller board



WARNING . . .
Proper Electrical Hookup

- Electrical hookup must be made by **Qualified Personnel** and must comply with NEC (National Electrical Code) and local standards.
- **Make no more connections to the MINI-SCREEN System than are described in Sections 3.5.1 through 3.5.14 of this manual.** Connection of other wiring or equipment to the MINI-SCREEN System could result in serious bodily injury or death.

3.5 Electrical Hookup and Checkouts

Make the electrical connections in the order presented in Sections 3.5.1 through 3.5.16. **Exercise care when removing control box knockouts, to prevent damaging the contents of the control box.**

The following wiring connections are located inside the control box:

- Emitter and receiver cables
- System power
- Output relay connections (FSD1, FSD2, and SSD)
- Monitor Relays – Light Screen and System
- CNC AUX Monitor Relay (model MSCC-2L3M only)
- Light Screen Key Reset switch and test input
- Muting device connections
- Override connections
- Mute lamp
- System Key Reset switch
- Mute enable input
- EDM inputs

Several conduit knockouts are provided around the sides of the control box. When completing the wiring in the following sections, select the knockout locations closest to the internal control box connection points to be accessed (refer to Figures 3-14 and 3-15).

NOTE: Except for emitter and receiver cable entries (for which cable glands are supplied), **it is the user's responsibility to maintain NEMA 13 sealing at all cable entries into the control box.** Wiring barriers inside the control box can accept conductors no larger than #14 AWG. The wires used should have an insulation temperature rating of at least 90°C (194°F).

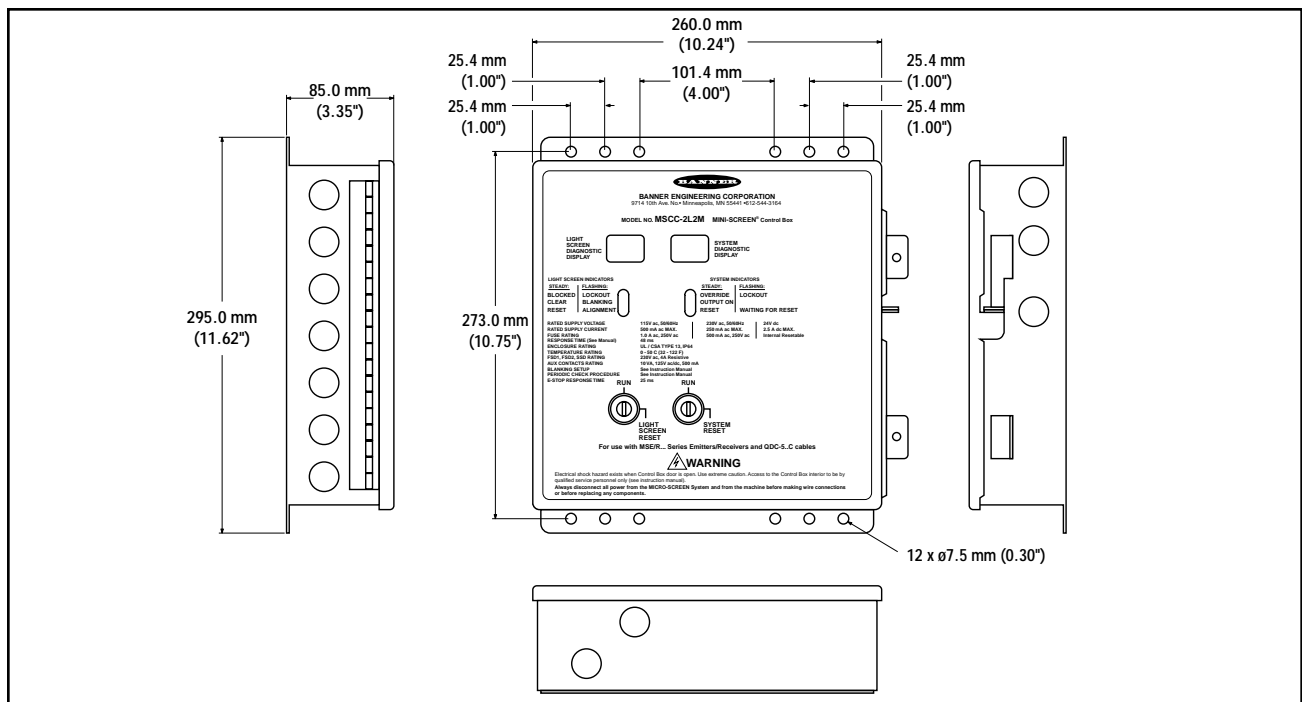


Figure 3-13. MINI-SCREEN with Muting control box knockout locations

3.5.1 External Key Reset Switches

If it is not possible to mount the control box so that it complies with the warning at left, external Reset switches must be provided for the installation that can comply with the warning.

When wiring external switches, the corresponding control box-mounted Key Reset switches should be disconnected (or, if this is not possible, the keys removed and placed under supervisory control). The Light Screen Reset connection is located at TB1 "Light Screen Reset a/b" (see Figure 3-13). The System Reset connection is located at TB7 "System Reset a/b". Loose wires from the Key Reset switches must be secured (e.g., tape or wire-tie the loose ends) so they do not cause shorts within the control box.

3.5.2 Emitter and Receiver Hookup

The emitter and receiver cables require two control box knockouts. Two cable gland strain relief fittings are supplied with each control box for the entrance of emitter and receiver cables into the control box. Emitter and receiver cables both connect to wiring barrier TB2 (Figure 3-14). Route the cables through the knockouts nearest to barrier TB2. *Only the use of Banner cables (see page 83) can ensure reliable communication of data between the controller and the sensors.* Match the color-coded terminals of wiring barrier TB2 to colors of the wires in each 5-conductor cable.

Double-check your wiring; incorrect wiring can lead to component damage. There are no user adjustments or connections inside the MINI-SCREEN emitter or receiver.



WARNING . . .
Reset Switch Location
 Light Screen and System Key Reset switches are mounted in the control box front cover. **The control box, or any external System Reset switch(es), must be accessible only from outside, and in full view of, the hazardous area. Reset switches must also be out of reach from within the safeguarded space, and must be protected against unauthorized or inadvertent operation (e.g., through the use of rings or guards).** If any areas are not visible from the Reset switches, additional means of safeguarding must be provided.

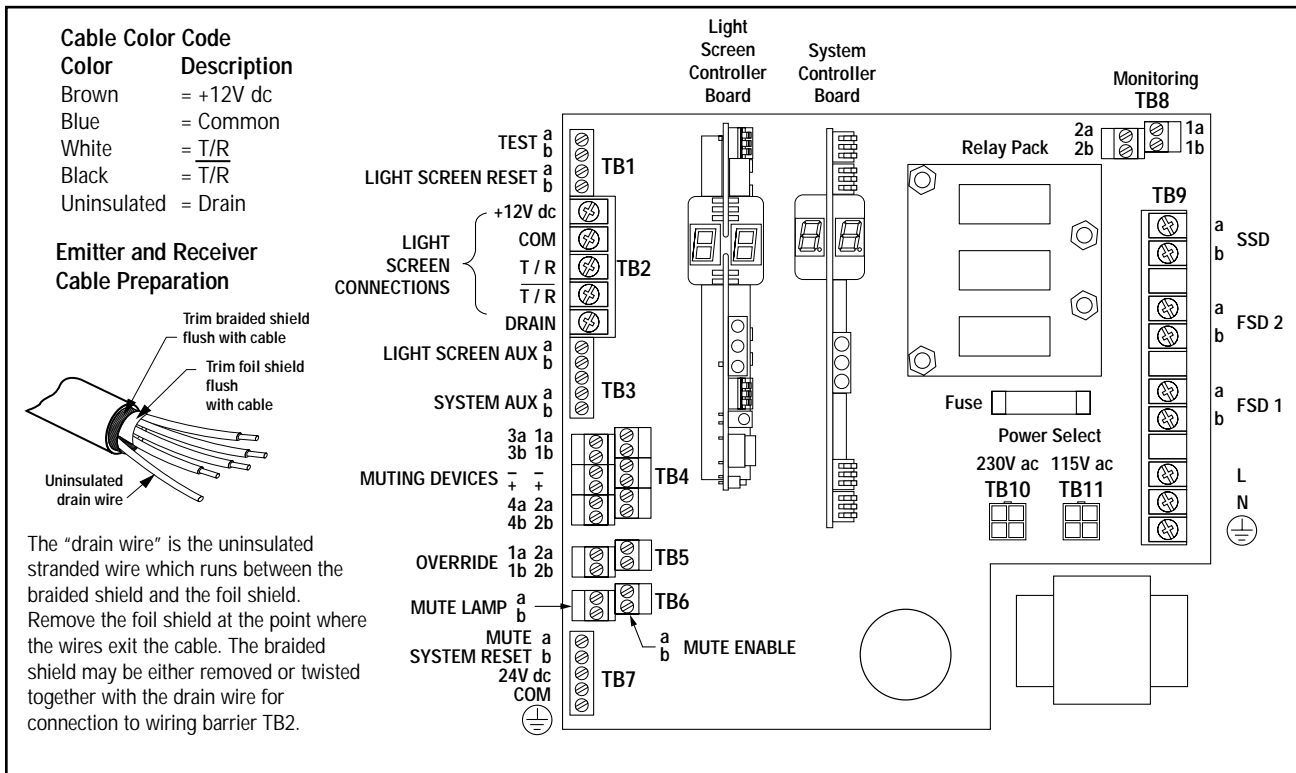


Figure 3-14. MINI-SCREEN System electrical connections (controller model MSCC-2L2M shown)



WARNING . . .
Muting is allowed
only during the non-
hazardous portion of
the machine cycle (OSHA
1910.217©(3)(iii)(d), and ANSI
B11.19(1990) section 4.2.3.3.7).



WARNING . . .
User is Responsible
for Safe Application
of this Product

The muting application examples described in Appendix C depict generalized guarding situations. Every guarding application has a unique set of application requirements. **Use extreme care to meet all legal requirements and follow all installation instructions.**

In addition, any questions regarding safeguarding should be directed to the factory applications department at the telephone number or addresses listed on the front cover.

3.5.3 Muting Application Design

Following are typical applications where muting is used. See Appendix C for more detailed information.

- **Entry/Exit Applications**

The muting devices are placed to allow the entry or exit of a pallet or cart of work materials to enter or exit a workstation without tripping the Light Screen, and without allowing the entrance of personnel into the hazardous area.

- **Home or Station Applications**

The muting devices must be placed to mute the safety light screen *only* when a hazard does not exist or is in another area so that personnel are not exposed to any hazard.

- **Robot Load/Unload Station Application**

The "Station" muting application uses multiple independent safety light screen circuits, each with its own muting circuit and sensors to protect multiple work locations. When a robot is active in Station A, for example, Station B Light Screen is muted.

- **Turret Table Application**

A "Turret Table" application is similar to the Robot Load/Unload Station muting application, except that any movement of the table ends the mute.

- **Power Press Applications**

The muting devices are placed so that the mute is initiated only during the non-hazardous, opening portion of the cycle (typically the machine upstroke).

3.5.4 Mute Device Installation and Hookup

The user is required by OSHA and ANSI to arrange, install, and operate the safety system so as to protect personnel and minimize the possibility of safeguarding defeat.

Indication that the safety light screen is muted (bypassed) must be provided and be readily observable (ANSI B11.19 section 4.2.3.3.3). Failure of this indication should be detectable and prevent the System from muting. If this is not possible, the operation of the indicator should be verified at suitable intervals.

Mute devices must meet a 3-second simultaneity requirement to activate muting; that is, they must be activated within 3 seconds of one another.

General Muting Device Requirements

The muting devices (typically sensors or switches) must, at a minimum, comply with the following requirements:

- 1) There must be a minimum of two independent hardwired muting devices.
- 2) The muting devices must either both have normally open contacts; or one device with a PNP output and one device with a NPN output, both of which must fulfill the "input requirements" listed in the specifications (page 83). These contacts must close when the switch is actuated, and must open when the switch is not actuated or in a power OFF condition.
- 3) The activation of the inputs to the muting function must be from separate sources. These sources must be mounted separately in order to prevent an unsafe muting condition resulting from misadjustment, misalignment, or a single common mode failure. (For example, physical damage to the mounting surface could cause both muting devices to be knocked out of alignment, resulting in false muting input signals.) Only one of these sources may pass through, or be affected by, a programmable logic controller or similar device.
- 4) The muting devices must be installed so that they can not be easily defeated or bypassed.
- 5) The muting devices must be mounted so that their physical position and alignment can not be easily changed.
- 6) It must not be possible for environmental conditions to initiate a mute condition (e.g., extreme airborne contamination).
- 7) The muting devices must not be set to use any delay or other timing functions (unless such functions are accomplished so that no single component failure prevents the removal of the hazard, subsequent machine cycles are prevented until the failure is corrected, and no hazard is created by extending the muted period).

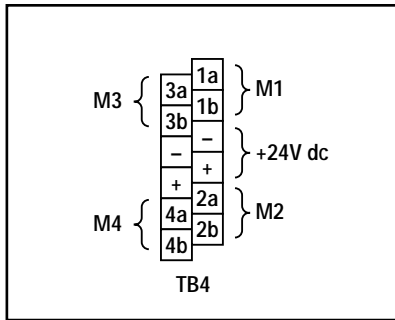


Figure 3-15. TB4 hookup

3.5.5 Mute Device Hookup

The control box provides supply voltage, if required, and input connections for the muting devices (see Figure 3-15). One or two pairs of muting devices (typically sensors or switches) must be used; these pairs are designated M1-M2 and M3-M4. The M1 input (1b) and the M3 input (3a) are PNP (sourcing). The M2 input (2a) and the M4 input (4b) are NPN (sinking). Also available are four terminals to supply power (+24V dc at 500 mA) to the muting devices, which are labeled "+" and "-."

The current draw of all devices, including the mute lamp, must not exceed 500 mA.

WARNING . . .
Avoid Hazardous Installations

Two or four independent position switches (at M1-M2 or M3-M4) must be properly adjusted or positioned so that they close only after the hazard no longer exists, and open again when the cycle is complete or the hazard is again present. If improperly adjusted or positioned, injury or death could result.

The user has the responsibility to satisfy all local, state, and national laws, rules, codes, and regulations relating to the use of safety equipment in any particular application. It is extremely important to be sure that all appropriate agency requirements have been met and that all installation and maintenance instructions contained in the appropriate manuals are followed.

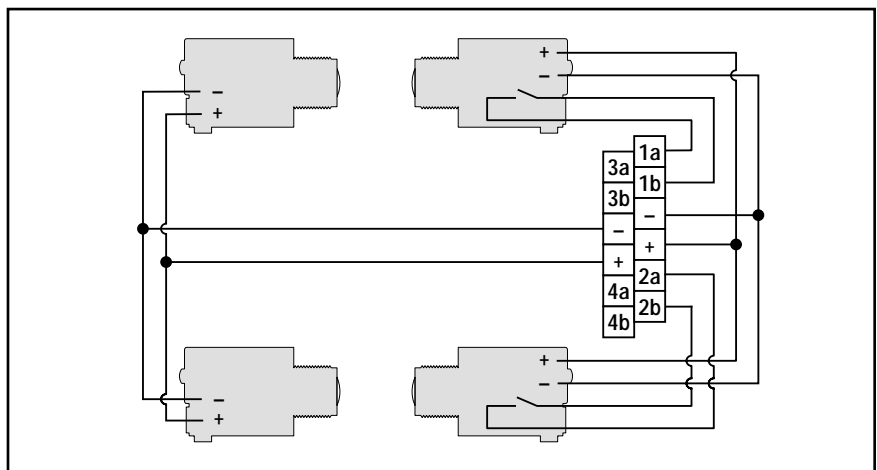


Figure 3-16. Two photoelectrics as M1 and M2, using relay output

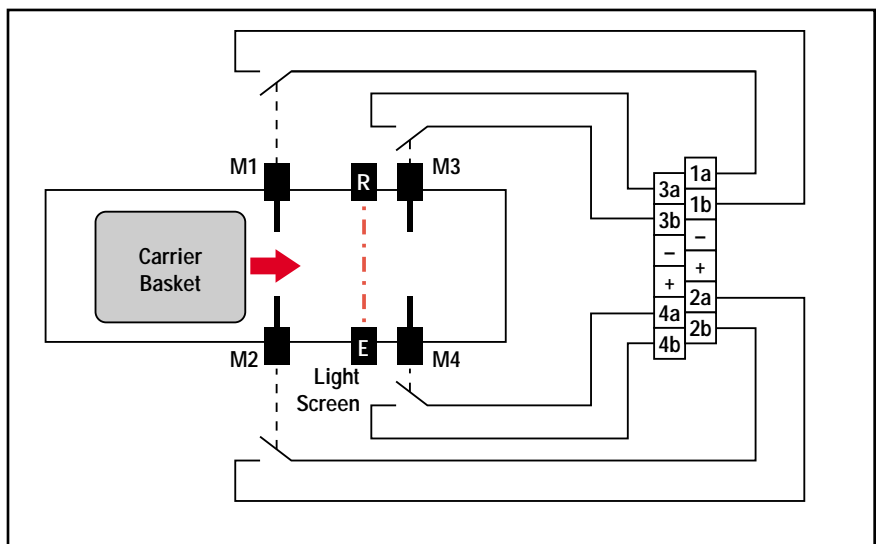


Figure 3-17. Four limit switches as M1, M2, M3, and M4

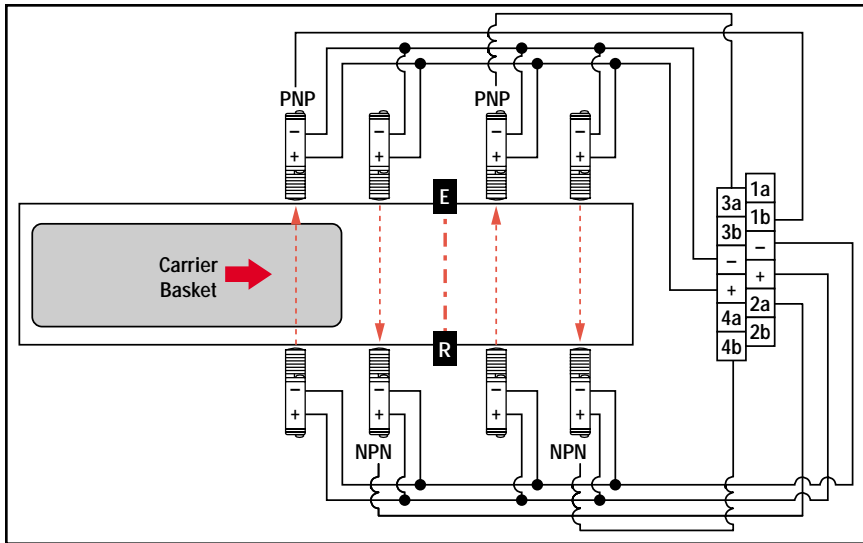


Figure 3-18. Four sensors as M1, M2, M3, and M4 using semiconductor outputs and power connections

3.5.6 Mute Lamp Location and Hookup

TB6 provides connection terminals for one input, Mute Enable (ME a/b), and one output, Mute Lamp (ML a/b) (see Figure 3-19). The Mute Lamp (ML) output is to provide a visible indication when the safeguarding function of the safety light screen is muted. This indication must be readily observable. Failure of this indication should be detectable and prevent the System from being muted, or the operation of the indicator should be verified at suitable intervals (see 2.10.3).

The System controller board can be configured for a monitored or non-monitored mute lamp (see 3.4.2, page 34). If the installation is governed by European (CE) regulations, the mute lamp must be “monitored” (SW2 = ON, banks A and B). When set for “monitored,” the current draw must be between 10 mA and 360 mA.

This output may also be used as an input to control logic (e.g., a PLC) if “non-monitored” is selected (SW2 = OFF, banks A and B). The current draw of all devices, including the mute lamp, must not exceed 360 mA.

3.5.7 Mute Enable Hookup

The control box provides connection terminals for the Mute Enable input (ME a/b) (see Figure 3-20). Mute Enable gives the user the ability to “frame” or create a “window of opportunity” when a mute can occur. The mute enable input is an isolated contact that must be closed 100 milliseconds before the System can be muted. After the System is muted, opening of the Mute Enable input has no effect, but it must be re-closed before the System can be muted again.

Typical Mute Enable functions include:

- 1) Contact(s) from machine control logic (e.g., selector switches, relay logic, or PLC/PC logic) to create a window for a mute to begin.
- 2) Closed or jumpered contact(s) to allow a mute on power up (when selected; see Section 2.10.5).
- 3) Jumpered input to allow a mute, if mute enable is not used.
- 4) Open to prevent the initiation of the mute function.

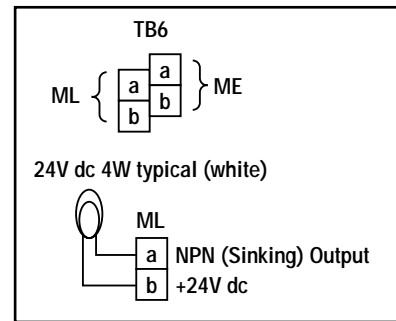


Figure 3-19. Monitored lamp hookup

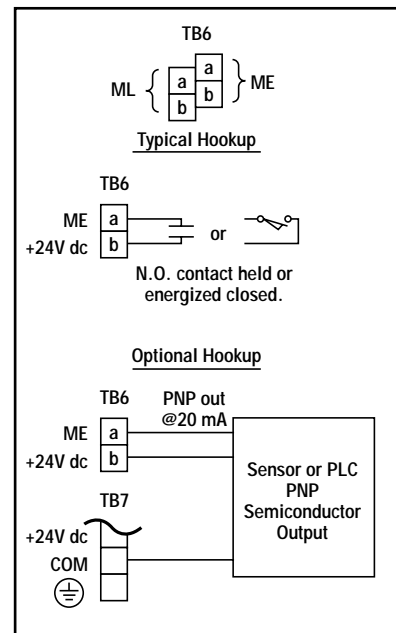


Figure 3-20. Mute Enable hookup

CAUTION . . .
Jumpers
 If the application does not require this function, the External Device Monitoring inputs must be jumpered and Two-channel EDM must be selected. It is the user's responsibility to ensure that this does not create a hazardous situation.

CAUTION . . .
Limit Use of Override Function
 The Override function is not for machine setup or production; it is to be used only to clear the defined area if material becomes "stuck" in the defined area. When Override is used, it is the user's responsibility to install and use it according to current standards (see Section 2.10.6). In addition, the requirements listed in standards NFPA79 (Section 9.15) and IEC204-1 (Section 9.2.4) must be satisfied.

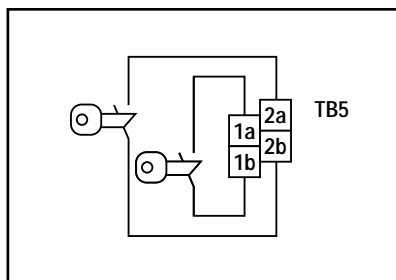


Figure 3-22. Override switch hookup

3.5.8 External Device Monitoring (EDM) Hookup

TB8 provides connection terminals for the External Device Monitoring input (1a/1b and 2a/2b), and is located above the SSD, FSD1 and FSD2 outputs. External Device Monitoring (EDM) must be wired in one of three configurations (see Section 3.4.2):

- **One-Channel Monitoring**, SW4 Bank A&B = OFF
- **Two-Channel Monitoring**, SW4 Bank A&B = ON
- **No Monitoring**, SW4 Bank A&B = ON

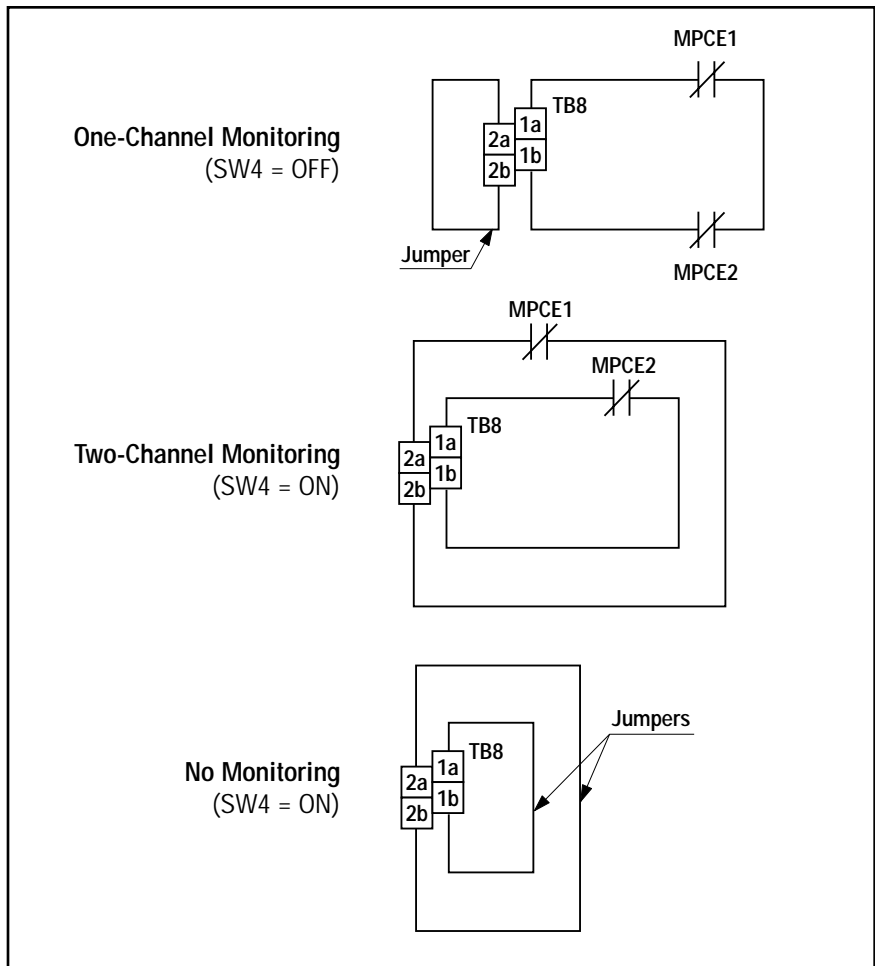


Figure 3-21. External Device Monitoring hookups

3.5.9 Override Switch Hookup

The control box provides connection terminals for the Override switches (see Figure 3-22). See Section 2.10.6 and the warning at right before connecting switches.

3.5.10 External Device Monitoring and System Power (Temporary Connection)

For the initial checkout procedure, the External Device Monitoring (EDM, see section 3.5.8) must be temporarily configured for “No Monitoring” (jumper TB8 1a-1b, jumper TB8 2a-2b, and turn SW4 switches to ON; refer to Figure 3-21). This will allow the MINI-SCREEN System to be checked out, by itself, before permanent connections are made to the guarded machine.

Ensure the power has been removed from machine or ensure that power is not available to the machine controls or actuators, and ensure the machine control (MPCEs) are not connected to the FSD and SSD outputs at this time. Permanent connections will be made after MINI-SCREEN initial checkout (see Section 3.5.11.).

Connection of System AC power is at the L and the N terminals of control box wiring barrier TB9. Ensure that the input power has been properly selected at TB10 (230V ac) and TB11 (115V ac). Connection of +24V dc is at TB7 (+24V dc and com). All wiring must comply with NEC and local wiring codes. Do not operate the MINI-SCREEN System without a proper earth ground connection at either of the ⊕ symbols.

3.5.11 MINI-SCREEN System Initial Checkout

The initial checkout procedure will first check the Safety Light Screen portion of the System. Once the Light Screen is verified, the Muting function and Override functions will be verified. Follow the checkout procedure for each of the features being used (Mute and/or Override).

This initial checkout procedure must be performed by a Qualified Person (see WARNING, Section 3.1). It must be done after configuring the system and connecting the emitter, receiver, input/output devices, and temporary EDM and power to the MINI-SCREEN control box, but before the MINI-SCREEN is connected to the machine to be guarded.

The procedure is performed on two occasions:

- To ensure proper installation when the system is first installed, and
- To ensure proper system function whenever any maintenance or modification is performed on the system or on the machinery being guarded by the System. (See Section 6 for a schedule of required checkouts.)

3.5.11.1 Safety Light Screen Initial Checkout Procedure

The Light Screen controller has three operating modes: POWER UP, Key RESET, and RUN. Monitor the six status indicators on the control box (and/or the Light Screen status indicators on the receiver) and refer to Figures 2-4 and 2-5 on pages 13 and 14.

- 1) Enter **POWER-UP mode** by applying power to the control box. With both Auto Power-ups OFF, the System will power up in a lockout condition (yellow Light Screen indicator *only* will double-flash). With Auto Power-up ON, the System will automatically enter RUN mode (step 3). *NOTE: Both Key Resets must be in the RUN position at power-up.*
- 2) Enter the **Light Screen Controller Key RESET mode** by turning the left key clockwise to the RESET position. The yellow Light Screen indicator will glow steadily.

Hold the switch in RESET position for at least 1/2 second. This allows time for the microprocessors to run a startup diagnostic check routine.

- 3) Enter **RUN mode** by turning the left key counterclockwise from RESET position to RUN position.

If one or both red status indicator(s) begins to flash when the system is placed in RUN mode, an *internal lockout condition* exists. Refer to Section 5.1 to determine the cause of the lockout.

If the red and yellow Light Screen status indicators come ON, the defined area is not clear (one or more light beams are obstructed) or the system is out of alignment. This is a *trip condition*. If this occurs, check the defined area for obstruction(s). The red Light Screen indicator will be ON steadily. The yellow Light Screen indicator will be flashing to indicate the relative number of "made" (cleared) light beams; the faster the flash rate, the more beams are made. The two-digit Light Screen Diagnostic Display on the control box will indicate the total number of blocked beams. If all beams are blocked, the red Light Screen indicator will be ON steadily, with yellow and green Light Screen indicators both OFF.

If beams are obstructed by one or more objects which will remain fixed in position, the fixed blanking feature may be used. Proceed to step 4 to program fixed blanking. *NOTE: Fixed blanking should only be used when the objects being blanked cannot be moved out of the defined area.*

If the MINI-SCREEN System is properly aligned, blanking is properly set, and all obstructing objects are removed from the defined area, the green and yellow Light Screen indicators should come ON after step 3 is performed (the green Light Screen indicator will *flash* if blanking is ON, and the yellow Light Screen indicator should be ON steady). **If the MINI-SCREEN System is being set up for the first time, or if the green and yellow Light Screen indicators do not come ON during step 3, perform the alignment procedure in Section 6.1.** When the emitter and receiver are aligned properly, tighten the emitter and receiver mounting hardware in position and repeat steps 1-3 above.

Important: Do not perform a System Key Reset at this time. Steps 4, 5 and 6 must be completed first, and then the Muting Initial Checkout procedure, Section 3.5.11.2, must be followed.

NOTE: Proceed directly to step 5 if fixed blanking is not to be programmed.

Fixed Blanking Notes

- A) Fixed blanking must be set within 4 minutes of turning the Program/Run switch to PROGRAM, or a lockout will occur, and the procedure must be restarted.
- B) Floating blanking can be selected to eliminate nuisance lockouts resulting from unstable clear beams at the edge of fixed objects.
- C) Any fixed object in the defined area must occupy the entire width (from emitter to receiver) of the defined area. Otherwise, hard guarding must be added to fill any opening in the defined area created by fixed blanking (see warning, page 44).
- D) The green status indicators will flash to indicate use of fixed and/or floating blanking.

- 4) **Fixed blanking.** The fixed blanking feature may be programmed if beams are blocked by one or more fixed objects. Fixed blanking requires an emitter/receiver pair with 16 or more beams (over 4" long). **Fixed blanking is limited to 30% of the total number of beams, up to a maximum of 12 beams** (see chart below). Contact factory Applications Department if your application requires fixed blanking of a greater number of beams. Programming of fixed blanking involves a simple "teaching" process; it is accomplished using the Diagnostic Display and the Program switches located on the Light Screen controller board (Figure 3-11).

Defined Area	Beams in Light Screen	Maximum Fixed Blanked Beams	Total Fixed Blanked Area*	
			Standard	Long Range
4"	8	0	N.A.	N.A.
8"	16	4	2.2"	2.1"
12"	24	7	3.7"	3.6"
16"	32	9	4.7"	4.6"
20" to 48"	40 to 96	12	6.2"	6.1"

*Assumes all blanked beams are adjacent; if multiple areas are blanked (multiple objects ignored) the total blanked area increases slightly.

To prepare for programming of fixed blanking, do the following:

- Remove all power from the control box (and from the machine to be controlled, if the System is already wired to the machine).
- Make sure that Auto Power-up and Floating Blanking programming switches (on the Light Screen controller board, Figure 3-11) are all turned to OFF.
- Make sure that the Program/Run switch (Figure 3-11) is in the RUN position (in).

Apply power to the control box (only). The yellow System status indicator will double-flash to indicate the System is ready for a Key Reset. **DO NOT perform a Key Reset at this time.**

Move the Program/Run switch on the Light Screen controller to the Program position (out). The Program Mode LED will flash and the Diagnostic Display will indicate the total number of beams blocked.

Simulate any mechanical vibration or shock which might be encountered in the application and verify that the readout of beams blocked remains stable. Take steps to eliminate any intermittent beams.

When the number of beams blocked is stable, as indicated by the Light Screen Diagnostic Display, push the Program Set switch push button on the Light Screen controller (Figure 3-11) **for 1/2 to 2 seconds** and release. If the programming is accepted, the Program Mode LED will stop flashing and go ON steady. Programming will be rejected if the Program Set switch is held depressed too long, or not long enough.

If too many beams are blocked, programming is rejected and the Diagnostic Display will flash error code 10. If this occurs, check sensor alignment and valid blanking criteria (see chart above).

Turn the Program/Run switch to the RUN (in) position. The Program/Run LED will go OFF.



WARNING . . .

Hard Guarding May Also Be Required

If any object that is to be ignored by fixed blanking does not, itself, completely prevent access to the danger point(s), you must install hard guarding to prevent access past the object.

Openings in the hard guarding material must meet OSHA criteria (see OSHA 1910.217, Table O-10).

Failure to hard guard any opening caused by fixed blanking or failure to adequately increase the separation distance will create an unsafe condition which could lead to serious injury or death.



CAUTION . . .

Shock Hazard

Electrical shock hazard exists when the MINI-SCREEN System control box is connected to the guarded machine. Use extreme caution to avoid electrical shock at all times. **Always disconnect all power from the MINI-SCREEN System and the guarded machine before making any connections or replacing any component.**



WARNING . . .

Final Switching Device

The output relays of the MINI-SCREEN System must be the *final switching devices* for the machinery being guarded. **Never wire an intermediate device (e.g., a programmable logic controller - PLC), other than a safety relay, between either FSD and the machine primary control elements (Reference ANSI B11.1-1988, Appendix B4). To do so could result in serious bodily injury or death.**

How to Clear Fixed Blanking

To clear fixed blanking, remove power from the control box and all objects from the defined area. Repeat step 4. See page 55 for error codes.

Now perform a Light Screen Key Reset. The yellow Light Screen status indicators will come ON steady, and the green should be flashing to indicate that blanking is in use.

Remove power from the control box and reconfigure Auto Power-Up and floating blanking as required for the application. Reapply power and perform a Light Screen Key Reset (if Auto Power-Up is not in use).

5) **Perform a System Key Reset** (same procedure as a Light Screen Key Reset, performed with the right-hand Key switch); this should result in the green and yellow System status indicators coming ON, and the FSDs closing. At any time, if one or both red status indicator(s) begins to flash when the System goes into RUN mode, an internal lockout condition exists. Refer to Section 5.1 to determine the cause of the lockout.

6) **Next, trip test the MINI-SCREEN Light Screen** for object detection capability using the specified test pieces supplied with the control box. To perform the trip test, both Key Reset switches must be in the RUN (counterclockwise) position, the yellow Light Screen status indicator must be ON steady, and the green Light Screen status indicator must either be ON steady (if blanking is OFF) or flashing (if blanking is ON).

NOTE: Verify that the Muting function is not enabled at this time.

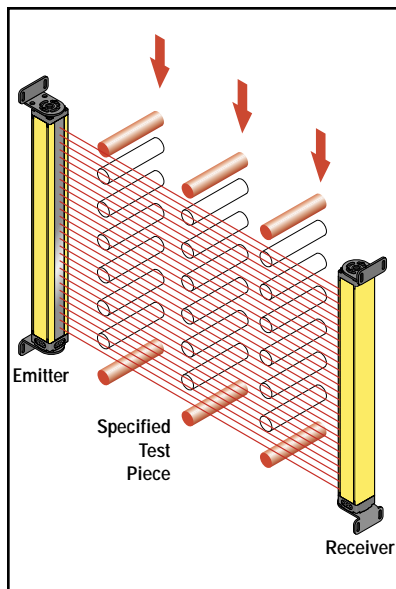


Figure 3-24. MINI-SCREEN System trip test

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	Standard Emitters and Receivers	Long-Range Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model STP-2	25.4 mm (1.00") dia. Model STP-7
1-beam floating blanking ON	31.8 mm (1.25") dia. Model STP-4	38.1 mm (1.50") dia. Model STP-1
2-beam floating blanking ON	44.5 mm (1.75") dia. Model STP-3	50.8 mm (2.00") dia. Model STP-8

Pass the specified test piece, very slowly, down the length of the defined area in three paths: close to the emitter, close to the receiver, and midway between the emitter and receiver (Figure 3-24). In each case, the red Light Screen status indicator should come ON and remain ON for as long as the test piece remains in the defined area. When the test piece is removed from the defined area, the green Light Screen status indicator must come ON (or flash, if floating blanking is ON). If the green Light Screen status indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces and unguarded areas created by the use of fixed blanking (see WARNINGS, page 28). *Do not continue until the situation is corrected.*

NOTE: The green System status indicator will be OFF after the interruption has been removed. After each pass, reset the System by performing a System Key Reset.

If the MINI-SCREEN System fails any of these checks, do not attempt to use the System or the guarded machine until the reason for the failure(s) is identified and all failures are corrected.

If the MINI-SCREEN System passes all of the checks in Section 3.5.11.1, go on to Section 3.5.11.2, Muting Initial Checkout Procedure.

If Muting or Override is not used, then proceed to Section 3.5.12.

3.5.11.2 Muting Initial Checkout Procedure

Ensure that the system passes the initial checkout procedure described in Section 3.5.11.1.

- 1) Continuing from section 3.5.11.1, verify that the MINI-SCREEN has been reset and the green and yellow Light Screen and System Status indicators are ON. If the yellow System status indicator is double-flashing (indicating the MINI-SCREEN System is waiting for a System Reset of a latched condition), perform a System Key Reset. At any time, if one or both red status indicator(s) begins to flash, an internal lockout condition exists. Refer to Section 5.1 to determine the cause of the lockout.

If the Muting function is not used, proceed to Section 3.5.11.3.

During the initial checkout procedure of the Muting feature, if possible, verify that the power has been removed or is otherwise not available to the machine actuators responsible for hazardous motion. **At all times ensure that personnel are not exposed to any hazard.**

- 2) Initiate a normal mute cycle.
- 3) Verify that the Mute indicator comes ON. If not, check the indicator and its wiring, verify that the mute enable input is closed, and check the Diagnostic Display for error codes.
- 4) Interrupt the safety light screen's defined area with the appropriate test piece; verify the red Light Screen status indicator comes ON, the green indicator is OFF, and the yellow indicator is flashing or OFF. Also, verify that the green and yellow System status indicators are ON.

NOTE: If the 30- or 60-second Backdoor Timer feature has been selected, the System Diagnostic Display will begin to count down; otherwise a flashing dash will appear on the display.

- 5) Clear the defined area (before the Backdoor Timer expires) and verify that the green and yellow Light Screen status indicators come ON. Clear (deactivate) the mute devices before the Backdoor Timer expires and verify the Mute indicator goes OFF. The green and yellow System status indicators should remain ON.
- 6) Verify that it is not possible for a single individual to initiate a mute condition by triggering the mute devices (for example, by blocking both photoelectric beams or actuating both switches) and being able to pass through the defined area without being detected and without issuing a stop command to the machine (where the red System status indicator comes ON, the FSD contacts open, and a reset of the latch condition is required). **Do not expose any individual to hazard while attempting to mute the System.**
- 7) Verify that it is not possible for personnel to pass in front of, behind, or next to the muted object without being detected and without issuing a stop command to the machine.
- 8) If one-way (directional) muting has been selected, verify that the System can not be muted by blocking (or activating) muting devices M3-M4 before M1-M2. **Do not expose any individual to hazard while attempting to mute the System.**

3.5.11.3 Override Checkout Procedure

If the Override feature is used, the following checkout procedure must be completed; otherwise proceed to Section 3.5.12.

Ensure that the System passes the initial checkout procedures described in Sections 3.5.11.1 and 3.5.11.2.

Continuing from Section 3.5.11.2, with the Light Screen controller in RUN mode and the System has been reset (the green and yellow Light Screen and System status indicators should be ON, and the FSDs closed; refer to Figures 2-4 and 2-5, pages 13 and 14).

- 1) Ensure that the positioning of the Override switches allows the operator full view of the hazardous area and the defined area. Ensure that the location is not in reach from within the safeguarded space.
- 2) With Muting de-activated, interrupt the light screen with the appropriate test piece; verify that the red Light Screen status indicator comes ON, the green indicator is OFF, and the yellow indicator is flashing. Also, verify that the green System status indicator is OFF and yellow System status indicator is ON.
- 3) Three seconds after interrupting the defined area, initiate an Override by turning both Override switches to ON (hold in ON position if necessary) simultaneously (within 3 seconds).
- 4) With the defined area still interrupted, verify that both red status indicators are ON, the yellow Light Screen status indicator is flashing at a rate proportional to the number of clear beams, the green System status indicator is ON, and the FSDs are closed.
- 5) Continue to interrupt the defined area; after 10 seconds, verify that the Override drops out. To initiate another Override, return switches to the OFF (open) condition, wait 3 seconds, and then re-close the Override switches simultaneously (within 3 seconds).
- 6) Clear the defined area and perform a System Key Reset; the green and yellow System status indicators should come ON, and the FSDs should close. If one or both red status indicator(s) begins to flash when the System goes into RUN mode, an internal lockout condition exists. Refer to Section 5.1 to determine the cause of the lockout.

If all checks cannot be verified, do not use the machine until the problem(s) has been corrected. Refer to Section 5.

3.5.12 Output Relay Connections

Output relay connections are made at the **FSD1** (Final Switching Device 1), **FSD2** (Final Switching Device 2), and **SSD** (Secondary Switching Device) terminals on the control box (Figure 3-25). These relays are energized (contacts closed) in normal operation when no obstructions are in the defined area. **All relays** become de-energized (their contacts open) in a lockout condition. Relays **FSD1** and **FSD2** (only) de-energize in a latch condition. Before continuing, read **NOTICE Regarding MPCEs**, below right.


The FSD1 output relay connects to Machine Primary Control Element #1 (MPCE 1) on the guarded machine. MPCE 1 is an electrically powered element of the guarded machine that directly controls the normal operating motion of the machine; it must be last (in time) to operate when motion is either initiated or arrested. The output contact of relay FSD1 must be connected, as shown in Figure 3-25, to control power to Machine Primary Control Element #1. For the MSCC-2L2M, the switching capacity of relay FSD1 is 250V ac max., 4 amps max. (resistive load). For the MSCC-2L3M, the switching capacity of relay FSD1 is 250V ac max., 6 amps max. (resistive load).

The FSD2 output relay connects to Machine Primary Control Element #2 (MPCE 2) on the guarded machine. MPCE 2 is an electrically powered element of the guarded machine (in a different control path from MPCE 1) that directly controls the normal operating motion of the guarded machine; it must be last (in time) to operate when machine motion is either initiated or arrested. The output contact of relay FSD2 must be connected, as shown in Figure 3-25, to control power to Machine Primary Control Element #2. For the MSCC-2L2M, the switching capacity of relay FSD2 is 250V ac max., 4 amps max. (resistive load). For the MSCC-2L3M, the switching capacity of relay FSD2 is 250V ac max., 6 amps max. (resistive load).


Many different types of mechanisms are used to arrest dangerous machine motion. Examples include mechanical braking systems, clutch mechanisms, and combinations of brakes and clutches. Additionally, control of the arresting scheme may be hydraulic or pneumatic.

As a result, MPCEs may be of several control types, including a wide variety of contactors and electromechanical valves. **If your machine documentation leaves any doubt about the proper connection points for the MINI-SCREEN System output relay contacts, do not make any connections.** Contact the machine builder for clarification regarding connections to the MPCEs and MSCE.

The SSD output relay connects to the Machine Secondary Control Element (MSCE) on the guarded machine. The MSCE is an electrically powered element of the guarded machine (independent of the MPCEs) that is capable of removing power from the prime mover of the dangerous part of the machine in the event of an emergency. The output contacts of the SSD relay must be connected, as shown in Figure 3-25, to the Machine Secondary Control Element such that, if a lockout condition occurs, the motive power will be removed from the machine. The switching capacity of the SSD relay is 250V ac max., 4 amps max. (resistive load).



CAUTION . . .
Shock Hazard
 Electrical shock hazard exists when the MINI-SCREEN System control module is connected to the guarded machine. Use extreme caution to avoid electrical shock at all times. **Always disconnect all power from the MINI-SCREEN System and the guarded machine before making any connections or replacing any component.**



WARNING . . .
Final Switching Device
 The output relays of the MINI-SCREEN System must be the *final switching devices* for the machinery being guarded. **Never wire an intermediate device (e.g., a programmable logic controller - PLC), other than a safety relay, between either FSD and the machine primary control elements** (Reference ANSI B11.1-1988, Appendix B4). To do so could result in serious bodily injury or death.

NOTICE Regarding MPCEs

Each of the two Machine Primary Control Elements (MPCE 1 and MPCE 2) must be capable of immediately stopping the dangerous machine motion, irrespective of the state of the other. These two channels of machine control need not be identical, but the stop time performance of the machine (T_s , used to calculate the separation distance) must take into account the *slower* of the two channels.

Some machines offer only one Primary Control Element. For such machines, it is necessary to duplicate the circuit of the single MPCE to add a second Machine Primary Control Element. Refer to Figure 3-25 or consult the machine manufacturer for additional information.

Figure 3-25 (below) shows output relay connections in a generic interfacing situation. The connections between the MINI-SCREEN System outputs and the machine primary and secondary control elements must be direct, and arranged so that any single line fault or earth fault will not result in a circuit failure to a potentially dangerous state.

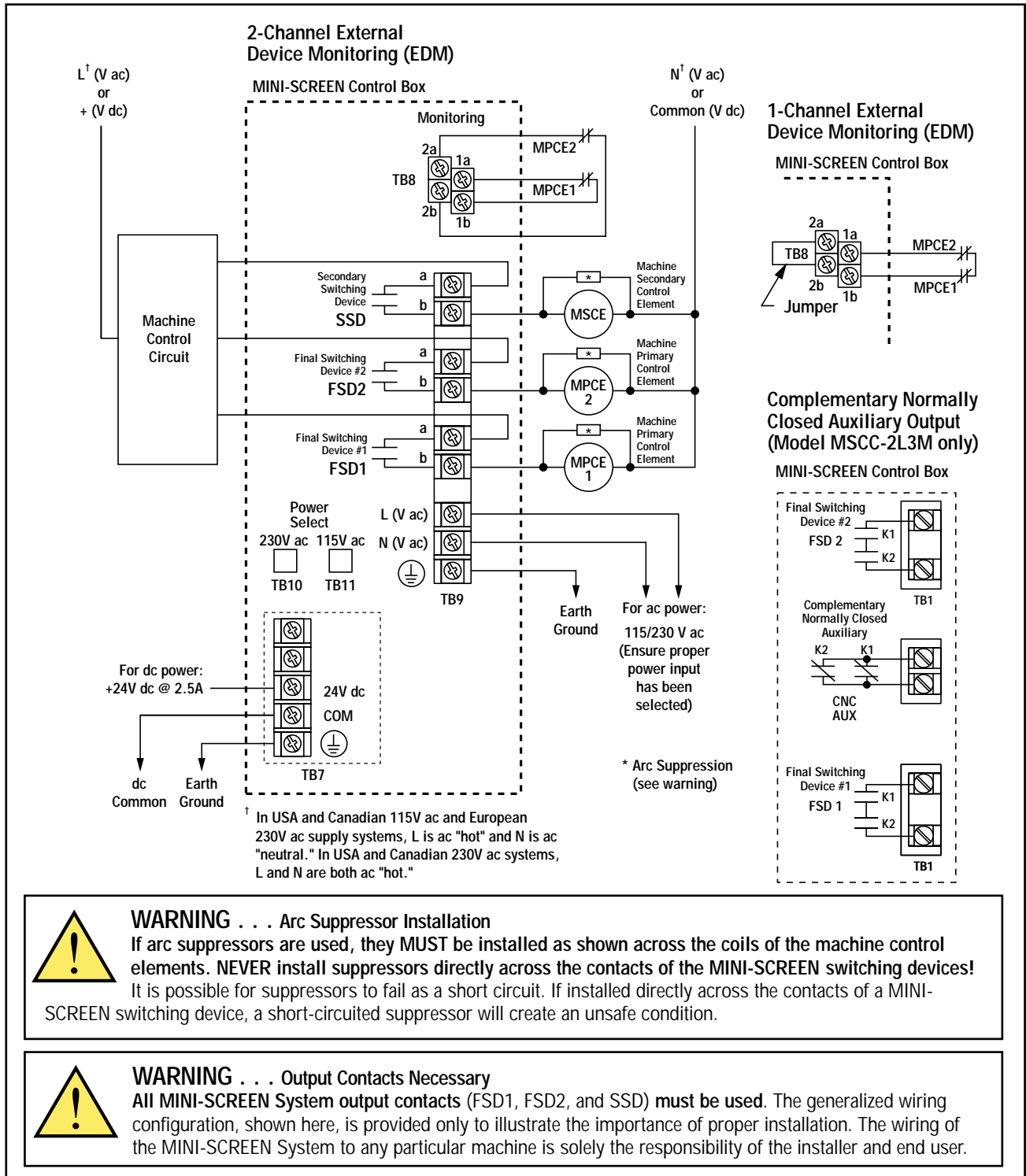


Figure 3-25. MINI-SCREEN System with Muting generic interface

3.5.13 External Device Monitoring (Permanent Connection)

After the initial checkout of Section 3.5.11 has been successfully completed, the EDM bypass circuit, installed in Section 3.5.10, must be removed completely. The External Device Monitoring input then must be properly configured and connected to the closed monitoring contacts of the MPCEs (see Sections 2.9, 3.4.2 and 3.5.8). Refer to the NOTICE Regarding MPCE Monitoring Hookup, at right.

After power is connected to the MINI-SCREEN System and the output relay contacts are connected to the machine to be guarded, the operation of the MINI-SCREEN System with the guarded machine must be verified before the combined System may be put into service. To do this, a Qualified Person must perform the Commissioning Checkout Procedure described in Section 6.2.

3.5.14 Monitor Relay Outputs

Two non-safety-related relay outputs are available at TB3: Light Screen AUX and System AUX. **These monitoring contacts are for non-safety-related control functions**, such as an input to a programmable logic controller (PLC). See Figures 2-4 and 2-5 in Section 2.4 for detailed output status in relationship to the LED status indicators and the safety outputs (FSD1, FSD2, and SSD).

For controller MSCC-2L3M, the relay pack inside the controller also has a Complementary Normally Closed Auxiliary output; the contacts are labeled CNC AUX a and b. **These monitoring contacts also are for light-duty, non-safety-related control functions.**

3.5.15 Accessory Connections

Light Screen Remote Test

Light Screen Remote Test input connects to Test a and Test b at TB1 (see Figure 3-14, page 36). When connected together (shorted) for a minimum of 50 milliseconds, a blocked beam condition is simulated for as long as the connection is made.

Light Screen Reset

Light Screen Reset input connects to Reset a and Reset b at TB1 (see Section 3.5.1 and Figure 3-14, page 36). It is functionally equivalent to the Light Screen Key Reset switch (on the left side of the control box front cover).

System Reset

System Reset input connects to TB7 terminals a and b (see Section 3.5.1 and Figure 3-14, page 36). It is functionally equivalent to the System Key Reset switch (on the right side of the control box front cover).

If an external switch is connected to either reset input, then:

- The corresponding control box Key Reset switch should be disconnected, or
- The corresponding control box Key Reset switch key should be removed and placed under supervision.

NOTICE Regarding MPCE Monitoring Hookup

It is strongly recommended that one normally closed monitoring contact of each MPCE be wired (as shown in Figure 3-25, page 49) as MPCE monitor. If this is done, proper operation of the MPCEs will be verified.

MPCE monitoring contacts must be used in order to maintain control reliability.

In any case, the control box and any external resets must be located so that System reset is possible only from outside, and in full view of, the hazardous area. The switches must also be out of reach from within the safeguarded space. If any hazardous areas are out of view from the switch location(s), additional means of safeguarding must be provided.

Using a Key switch provides some level of personal control, because the key may be removed. This will hinder a reset while the key is under the control of an individual, but must not be relied upon solely to guard against accidental or unauthorized reset.

4. Operating Instructions

4.1 Security Protocol

The MINI-SCREEN control box has a **lockable cover** and two **key-operated front-panel Reset switches**.

In order to prevent access by unauthorized personnel, and to ensure that all lockout conditions come to the attention of a person qualified to deal with them, a lock must be inserted in the lockable cover and the key (or combination) to this lock must be kept in the possession of a *Qualified Person* as defined in ANSI/ASME B30.2-1983 (see Glossary). **Qualified Persons only should have access to the interior of the MINI-SCREEN System control box.**

The key to the front-panel Reset switches should be available only to a Qualified or Designated Person or Persons. A Designated Person is one who is identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure. A machine operator who meets these requirements may be a Designated Person.

4.2 Periodic Checkout Requirements

In addition to the checkouts that are performed by a Qualified Person or persons at the time that the MINI-SCREEN System is installed and put into service, **the functioning of the MINI-SCREEN System and the machine it guards must be verified on a regular periodic basis to ensure proper operation. This is absolutely vital and necessary. Failure to ensure proper operation can lead to serious injury or death.**

See Section 6 for checkout schedules and procedures.



WARNING . . . Verify Proper Operation

The Banner MINI-SCREEN System can do the job for which it was designed only if it and the machine it guards are operating properly, both separately and together. **It is the user's responsibility to verify proper operation, on a regular basis, as instructed in Section 4.2 and Section 6.**

If the MINI-SCREEN System and the guarded machine do not perform exactly as outlined in the checkout procedures, the cause of the problem must be found and corrected before the system is put back into service. Failure to correct such problems can result in serious bodily injury or death.



WARNING . . .
Power Failures

Power failures or other MINI-SCREEN System lockout conditions should always be investigated immediately by a Qualified Person. *With the exception of power-up/power interrupt lockouts, a lockout is a definite indication of a problem and should be investigated at once. Attempts to continue to operate machinery by bypassing the MINI-SCREEN System are dangerous and could result in serious bodily injury or death.*



CAUTION . . .
High Voltage

Dangerous voltages are present inside the MINI-SCREEN System control box whenever ac power to the machine control elements is ON. **Exercise extreme caution whenever ac voltage is or may be present!**

5. Troubleshooting and Maintenance

5.1 Troubleshooting Lockout Conditions

A **lockout condition** causes the output relays FSD1, FSD2, SSD, and System AUX to open, shutting down the MPCEs and MSCE of the guarded machine. A lockout condition resulting from an internal fault is indicated by the red status indicator(s) flashing.

A **power-up/power interrupt lockout** is indicated by the yellow status indicator(s) double-flashing, and is normal if one or both Auto Power-Up features are turned OFF (factory default). This type of lockout requires only the proper Key Reset routine for operation to continue.

A lockout condition will occur:

Power-up/Power Interrupt Lockouts

- Routinely upon power-up of the MINI-SCREEN System (unless Auto Power-up is ON; see Figures 2-4 and 2-5, pages 13 and 14); or
- If power to the MINI-SCREEN System is interrupted (unless Auto Power-up is ON; see Figures 2-4 and 2-5).

Internal Lockout Conditions

- If either Key switch is in the RESET position at power-up (with Auto Power-up ON); or if either Key switch is switched to RESET while the System is in RUN mode;
- If the Program/Run switch (Figure 3-11) is in the PROGRAM position at power-up;
- If Floating Blanking switches are in the ON position when the Program/Run switch is switched to the PROGRAM position;
- If both 1-beam and 2-beam Floating Blanking switches are in the ON position;
- If fixed blanking is not set within approximately 4 minutes of moving the Program/Run switch to the PROGRAM position;
- If Fixed Blanking has been programmed, and any fixed object is removed from or moved within the defined area;
- If an FSD (Final Switching Device – see Glossary) relay does not “drop out” within its specified time;
- If the SSD (Secondary Switching Device – see Glossary) relay has de-energized;
- If corresponding control box switch settings are inconsistent with each other or if they are changed while the System is in RUN mode; or
- If the self-checking circuits of either microprocessor detect a component failure within the MINI-SCREEN System itself.

Key Reset Routine

Important: The Light Screen controller must be reset before a System Key Reset can be performed. See figures 2-4 and 2-5 (pages 13 and 14) for proper indicator and output status conditions.

If both the red Light Screen and System status indicators are flashing:

- A) Attempt to reset the Light Screen controller first by turning the Light Screen key from RUN to RESET for approximately 1/2 second (wait for solid yellow), and then returning the key to the RUN position. If the green and yellow Light Screen status indicators come ON (or begin to flash) proceed directly to step "D."
- B) If the red Light Screen status indicator stops flashing and comes ON solid (with the yellow Light Screen status indicator single-flashing or OFF), the fault has been cleared, but the light screen is either out of alignment or one or more beams are blocked. Realign or remove the obstruction (see Section 2.10.6, Override); the green and yellow Light Screen status indicators should come ON (green will flash if blanking is ON). If this is accomplished, go to step "D."
- C) If the Light Screen controller is still in a lockout condition, note the error code on the Light Screen Diagnostic Display. See page 55 for a list of Light Screen error codes and possible causes and/or corrective measures of the fault condition.

If only the System red status indicator is flashing and the green and yellow Light Screen status indicators are ON (green will flash if blanking is ON):

- D) Attempt to reset the System controller by turning the System Reset Key from RUN to RESET for approximately 1/2 second (wait for solid yellow), and then return the key to the RUN position. If the green and yellow System status indicators come ON, the System has been reset and the outputs should be closed.
- E) If the System controller is still in a lockout condition, note the error code on the Muting Diagnostic Display. See page 56 for a list of System error codes and possible causes of the fault condition.

If the lockout condition was due to a momentary power interruption that has been corrected, the MINI-SCREEN will now operate normally. **Upon recovery from a power interruption, checkout procedure 6.3 on page 70 must be performed.**

Error No.	Error Type/Action
-	System is OK
1	Relay Signal Error <ul style="list-style-type: none"> • Replace Relay/Power Supply • Replace Light Screen Controller
2	Key Input Error <ul style="list-style-type: none"> • Check Key Position • Invalid Key Reset • Replace Key Switch
3	Controller Error <ul style="list-style-type: none"> • Replace Light Screen Controller
4	Receiver Error <ul style="list-style-type: none"> • Check Receiver Cable • Replace Receiver
5	Emitter Error <ul style="list-style-type: none"> • Check Emitter Cable • Replace Emitter
6	Communication Error <ul style="list-style-type: none"> • Check Cable Connections • Observe Noise Indicator • Replace Emitter/Receiver
7	DIP Switch Error <ul style="list-style-type: none"> • Check Switch Settings • Replace Light Screen Controller
8	CPU Error <ul style="list-style-type: none"> • Replace Light Screen Controller
9	Not Used
10	System Error <ul style="list-style-type: none"> • Check Fixed Beams
11	Power Up Error <ul style="list-style-type: none"> • Check Prog/Run Switch
12	Programming Error <ul style="list-style-type: none"> • Too Much Time • Floating Blanking ON
NOTE: Flashing decimal point indicates noisy environment	

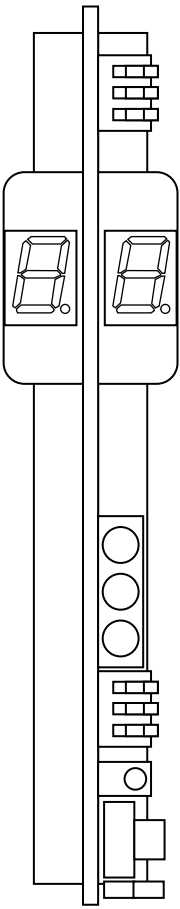


Figure 5-1. Light Screen Controller Board Diagnostic Display and interpretation of error codes

5.2 Diagnostic Displays

A lockout condition resulting from an internal System fault is indicated by the red status indicators flashing, and an error code number appearing in either or both of the Diagnostic Displays. In this case, the Qualified Person must note the error code and interpret the cause of the lockout from the tables in Figures 5-1 and 5-2. These diagnostic tables are also found inside the control box on the side of the control boards.

The MINI-SCREEN System will not operate if its self-checking circuits detect an internal problem. Neither Key Reset will have any effect until the problem is corrected. Take the corrective measure(s) corresponding to the error code, then perform the appropriate Key Reset sequence. If further assistance is required, contact your Banner field service engineer or the factory Applications Engineering Department.

If no status indicators are ON, power to the System may have been lost. The green LED on the power supply board indicates the presence (LED ON) or absence (LED OFF) of dc power at the power supply board. It is possible for power to be present at the input of the power supply even if the dc Power LED is OFF.

Very carefully check for voltage across terminals L and N (or + and -) of wiring barrier TB9 (for ac power input), or across 24V dc and COM terminals of TB7 (for dc power input). If voltage is not present, power to the MINI-SCREEN System has been lost, and the cause is outside the system.

Check for 12V dc at connector block TB2. If 12V dc is *not present* there, turn off the power to the control box and check the fuse. If the fuse is bad, replace it (Section 5.3.1). If the fuse is good, and 12V dc is still *not present* at TB2, a power supply failure has occurred.

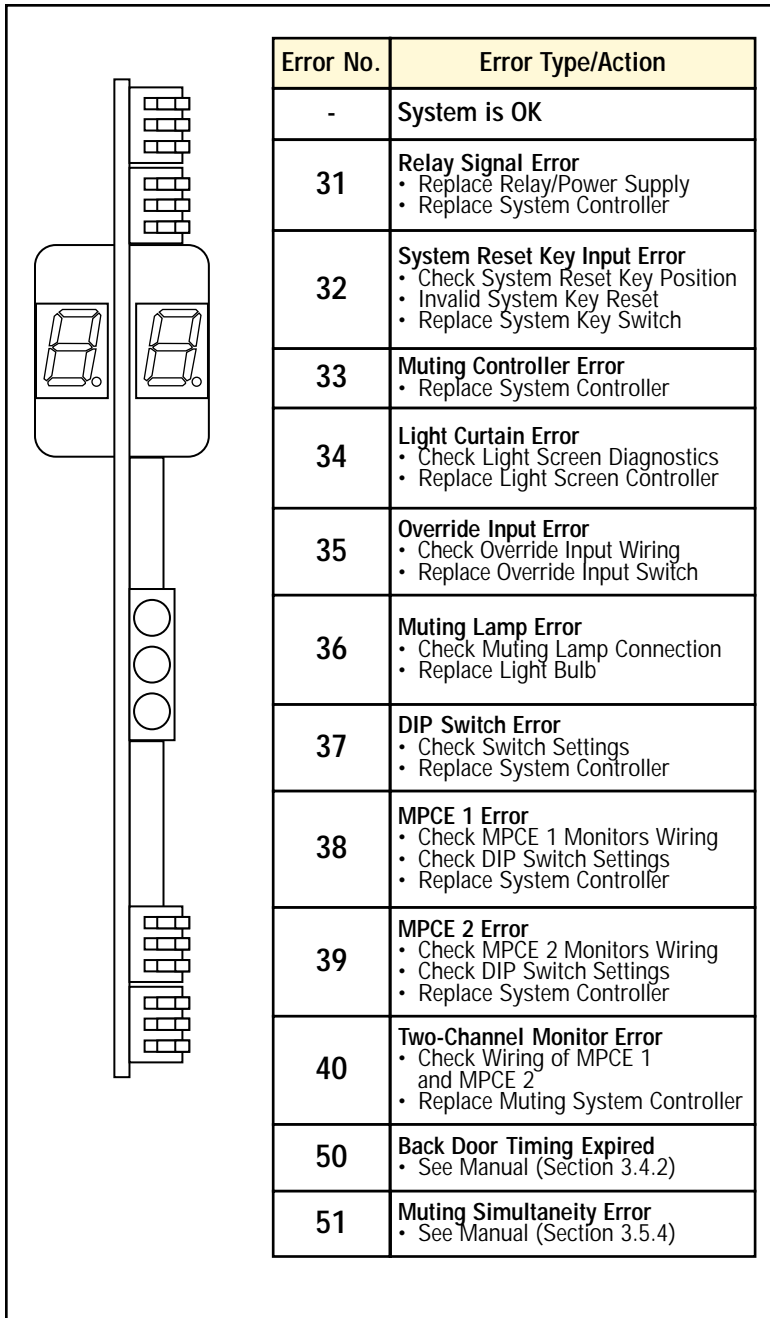


Figure 5-2. System Controller Board Diagnostic Display and interpretation of error codes

Electrical and Optical Noise

Check the following if the red decimal point of the Light Screen Diagnostic Display is flashing:

- Poor connection between control box and earth ground
- Drain wire of emitter and/or receiver not connected to TB2 (see Figure 3-14)
- Sensor wires or output wires routed too close to “noisy” wiring
- Optical interference from adjacent light screens or other photoelectrics



WARNING . . .
Shut Down Machinery Before Servicing

The machinery connected to the MINI-SCREEN System must not be operating at any time during this procedure. You may be working close to a hazardous area of your machinery while servicing the MINI-SCREEN System. **Servicing the MINI-SCREEN System while the hazardous machinery is operational could result in serious bodily injury or death.**



CAUTION . . .
AC Voltage Danger

Dangerous voltages are present inside the MINI-SCREEN System control box whenever ac power to the machine control elements is ON. **Exercise extreme caution whenever ac voltage is or may be present! Always disconnect all power from the MINI-SCREEN System and the guarded machine before making any wire connections or before replacing any component.**

The control box should be opened and/or serviced only by a *Qualified Person* (see Section 4.1).

5.3 Effects of Electrical and Optical Noise

The MINI-SCREEN System is designed and manufactured to be highly resistant to electrical and optical noise and to operate reliably in industrial settings. However, serious electrical and/or optical noise may cause a random latch condition. *In very extreme cases*, a lockout is possible. In order to minimize the effects of transitory noise, the MINI-SCREEN System will respond to noise only if the noise is detected on multiple consecutive scans. The decimal point of the Diagnostic Display will flash to indicate the presence of electrical or optical noise. This indicator can be used to track down particularly offensive noise sources (see sidebar at left). Simply observe the decimal point indicator while shutting down or isolating the suspected sources.

5.4 Servicing and Maintenance

5.4.1 Fuse Testing and Replacement

Turn OFF power to the control box and the machine being guarded before proceeding.

The MINI-SCREEN System control box fuse is located in a fuseholder on the power supply board (see Figure 3-14, page 36). Remove the fuse from the holder. Visually inspect the fuse and/or test its conductivity using an ohm meter or a continuity tester. The fuse is a 3AG or 5x20 mm slow-blow type (see specifications, page 80).

5.4.2 Control Boards and Relay/Power Supply Replacement

MINI-SCREEN Systems are designed for reliability. While replacement of the controller or relay/power supply boards is not normally required, these components have been designed to be easily replaceable as a convenience to the customer. See the instructions included with the replacement board. **To maintain control reliability, use only Banner-supplied replacement relays with forced-guided contacts.** See Replacement Parts, page 86.

NOTE: Do not open the emitter or receiver housing. The emitter and receiver contain no field-replaceable components. If repair is necessary, return the unit to the factory. Do not attempt to repair an emitter or receiver yourself.



WARNING . . .
Use Only Genuine Banner Replacement Parts

If replacement parts are ever required, **always use only genuine Banner-supplied replacement parts** (see page 88). **Do not attempt to substitute parts from another manufacturer. To do so could impair the operation of the MINI-SCREEN System and could result in serious bodily injury or death.**

5.4.3 Cleaning

The **MINI-SCREEN System control box** is constructed of welded steel with a black polyester paint finish, and is rated NEMA 13 (IP64). It may be cleaned using mild detergent or window cleaner and a soft cloth.

MINI-SCREEN emitters and receivers are constructed of aluminum with a yellow painted finish and are rated NEMA 4, 13 (IP65). Lens covers are acrylic. Emitters and receivers are best cleaned using mild detergent or window cleaner and a soft cloth. **Avoid cleaners containing alcohol**, as they may damage the acrylic lens covers.

5.4.4 Warranty Service

If it ever becomes necessary to return a MINI-SCREEN component to the factory, please do the following:

- 1) Contact the Banner Factory Application Engineering group at the address or numbers listed below.

**Banner Engineering Corp.
9714 - 10th Avenue No.
Minneapolis, MN 55441
Phone: 763.544.3164
email: sensors@baneng.com**

They will attempt to troubleshoot the system from your description of the problem. If they conclude that a component is defective, they will issue an RMA (Return Merchandise Authorization) number for your paperwork, and give you the proper shipping address.

- 2) Pack the component(s) carefully. Damage which occurs during return shipping is not covered by warranty.



WARNING . . .
Shut Down Machinery
Before Proceeding

The machinery connected to the MINI-SCREEN System must not be operating at any time during the alignment procedure of Section 6.1. You may be working close to hazardous areas of your machinery while aligning the MINI-SCREEN System. **Doing so while the hazardous machinery is operational could result in serious bodily injury.**

6. Alignment and Checkout

Study each procedure from beginning to end to make sure that you understand each step before you start. Refer all questions to the Banner Applications

Engineering Department: Banner Engineering Corp.
 9714 - 10th Avenue No.
 Minneapolis, MN 55441
 Phone: 763.544.3164
 email: sensors@baneng.com

Section 6.1 is a procedure for optically aligning a MINI-SCREEN System. Sections 6.2, 6.3, and 6.4 are periodic performance checkout procedures for the MINI-SCREEN System.

Checkouts must be performed according to checkout procedure 6.3, page 70, as follows:

- 1) By a Designated Person at every power-up of the MINI-SCREEN System;
- 2) By a Qualified Person following the correction of every lockout condition;
- 3) By a Designated Person at every shift change or machine setup change;

Checkouts must be performed according to checkout procedure 6.4, page 74, as follows:

- 1) By a Qualified Person semi-annually (every 6 months) following installation of the MINI-SCREEN System.

See Figures 6-1 and 6-2 on pages 60 and 61 for operating status conditions.

Long Range "XL" emitter/receiver pairs may be spaced from 15 cm to 18 m (6" to 60') apart. Standard emitter/receiver pairs may be spaced from 15 cm to 9 m (6" to 30') apart. The maximum distance between the sensors is reduced if corner mirrors are used (see alignment information on page 64).

6.1 MINI-SCREEN System Alignment

This alignment procedure begins with the assumption that the MINI-SCREEN System has been mechanically aligned as described in Section 3.3.

Follow the measures outlined below to maximize MINI-SCREEN System excess gain. If reflective surfaces are near the defined area, read alignment step #5 (pages 62-63) before proceeding further, to prevent possible reflection problems.

Only a **Qualified Person** may align the MINI-SCREEN System, as follows:

- 1) Turn OFF power to the MINI-SCREEN System and to the guarded machine. Leave power to the guarded machine OFF, and power-up the MINI-SCREEN System only with both keys in the RUN position.
- 2) The MINI-SCREEN will power up into a *power-up lockout condition* (unless Auto Power-up is ON; then proceed to step #3). **Remove all obstructions from the defined area and perform a Light Screen Key Reset:**
 - a) Turn the Light Screen Key clockwise to the RESET position, wait at least 1/2 second, then
 - b) Turn the Light Screen Key counter-clockwise to the RUN position.

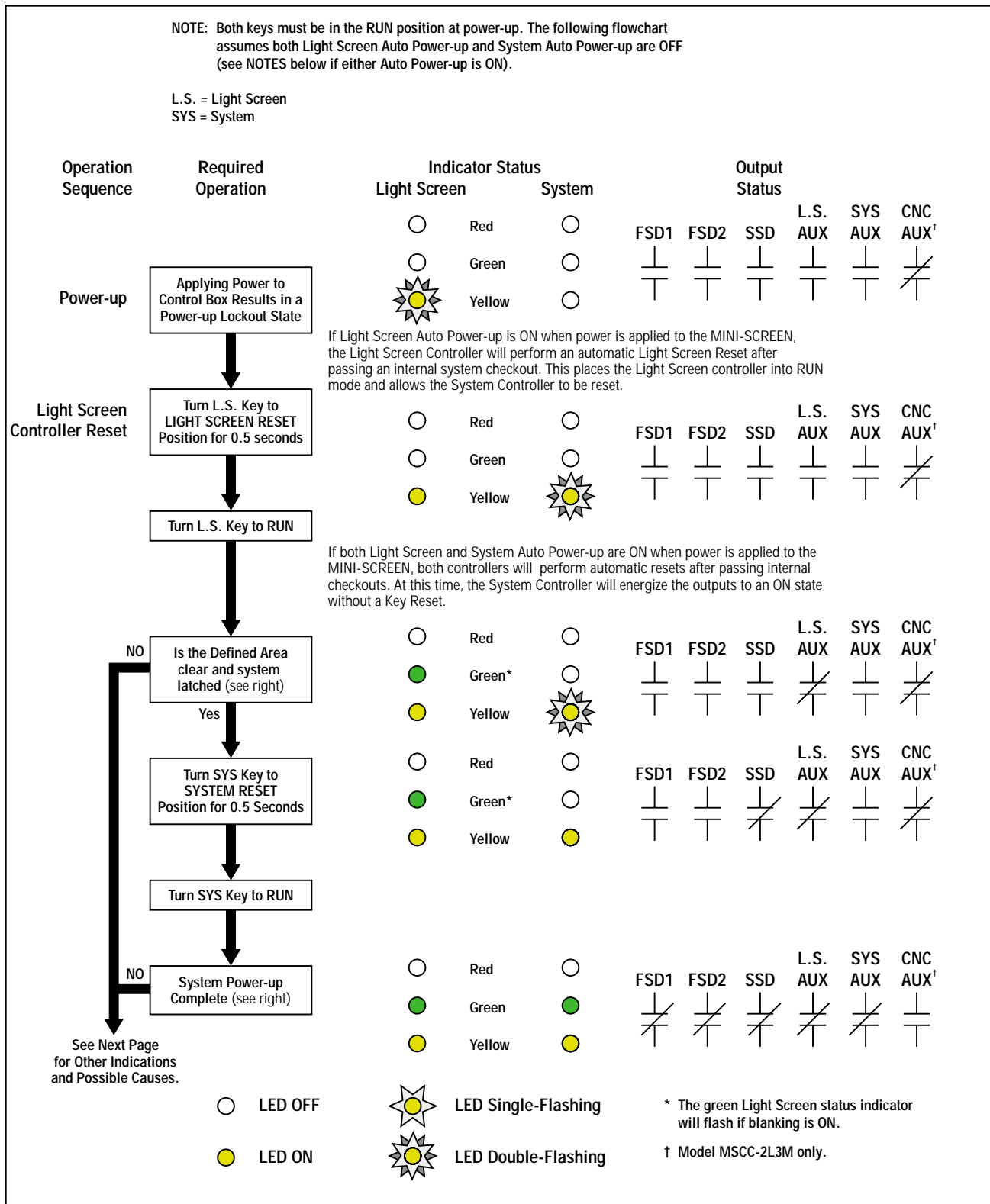






































































































































































Figure 6-1. Operating status conditions

Indicator Status			Output Status						Possible Causes
Light Screen		System	FSD1	FSD2	SSD	L.S. AUX	SYS AUX	CNC AUX [†]	
	Red								Defined Area Blocked and is Waiting for System Reset (Power-up Lockout)
	Green								
	Yellow**								
	Red								Defined Area Blocked and System is Latched (after System Reset)
	Green								
	Yellow**								
	Green								Defined Area Clear and System is Latched and Waiting for Reset
	Yellow								
	Red								
	Green								Override Enabled (Defined Area is Blocked and System is Latched)
	Yellow**								
	Red								
	Green								Lockout of Light Screen Controller
	Yellow								
	Red								
	Green								Lockout of System Controller only, Defined Area Clear
	Yellow								
	Red								
	Green								Lockout of System Controller only, Defined Area is Blocked
	Yellow**								
	LED OFF		LED Single-Flashing						
	LED ON		LED Double-Flashing						

** The yellow Light Screen status indicator will be OFF if the Emitter and Receiver are not aligned; otherwise it will flash at a rate proportional to the number of "made" beams.

† Model MSCC-2L3M only.

Figure 6-2. Operating status conditions

- 3) Upon completion of the Light Screen Key Reset (step #2), the Light Screen status indicators will indicate either a blocked or a clear condition.
 - a) **A blocked condition:**
Red indicator – ON steady
Yellow indicator – flashing at a rate proportional to the number of aligned, unblocked beams (OFF if all beams are blocked).
Light Screen Digital Display on the control box – indicates the total number of blocked beams.
 Go to step #4.
 - b) **A clear condition:**
Red indicator – OFF
Green and yellow indicators – ON steadily (green will flash if blanking is ON).
 Further alignment is not necessary.
 - c) **A lockout condition:**
 Flashing red Light Screen or System indicator.
 See Section 5 for troubleshooting.
- 4) **A blocked condition after reset** indicates that one or more of the beams is misaligned or interrupted. When this occurs:
 - a) **Check carefully for any obstructions** in the path of the beams within the defined area (the limits of which are indicated by the ends of the emitter and receiver windows; see Figure 3-9).
 - b) **If the defined area is completely clear** of obstructions, loosen the four slotted hex M3 screws which fasten the receiver to its mounting brackets. Verify that sensors are level, then slowly rotate the receiver first to the right and then to the left while watching the status indicators on the receiver base.
 - c) **If the green indicator does not come ON**, regardless of the receiver's angle, loosen the emitter and rotate both sensors relative to each other until the green indicator comes ON. Secure the emitter and receiver in the center of the area of rotation where the yellow and green indicators are ON steady (green will flash if blanking is ON).
 - d) **If the green indicator still fails to come ON**, then re-check the sensor mounting (see Section 3.3), and re-align if necessary.
- 5) **“Trip test” the MINI-SCREEN System for object detection capability** using the test piece(s) supplied with the control box. To perform this test:
 Both Key Reset switches must be in the RUN position,
 The yellow Light Screen status indicator must be ON steady, and
 The green Light Screen status indicator must be either ON steady (if blanking is OFF) or flashing (if blanking is ON). **Reset the System** (using the Key Reset procedure), if necessary, to attain this condition (see step #2).

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	Standard Emitters and Receivers	Long Range Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model STP-2	25.4 mm (1.00") dia. Model STP-7
1-beam floating blanking ON	31.8 mm (1.25") dia. Model STP-4	38.1 mm (1.50") dia. Model STP-1
2-beam floating blanking ON	44.5 mm (1.75") dia. Model STP-3	50.8 mm (2.00") dia. Model STP-8



WARNING . . .
If Trip Test Indicates a Problem

If the MINI-SCREEN System does not respond properly to the trip test, do not attempt to use the System. If this occurs, the System cannot be relied upon to stop dangerous machine motion when a person or object enters the defined area. **Serious bodily injury or death could result.**

Perform the trip test as follows:

Pass the appropriate specified test piece downward through the defined area at three points (see Figure 6-3):

- a) Close to the receiver,
- b) Close to the emitter, and
- c) Midway between the emitter and receiver.

When the test piece is within the defined area, verify:

The red Light Screen status indicator comes ON and remains ON while the test piece is within the defined area.

The green Light Screen status indicator remains OFF.

When the test piece is removed from the light screen, verify:

The green Light Screen status indicator comes ON.

If the green status indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces or unguarded areas created by use of fixed blanking (see Warnings, page 72). **Do not continue until the situation is corrected.**

NOTE: The green System status indicator will be OFF after the interruption has been removed. After each pass, reset the System by performing a System Key Reset.

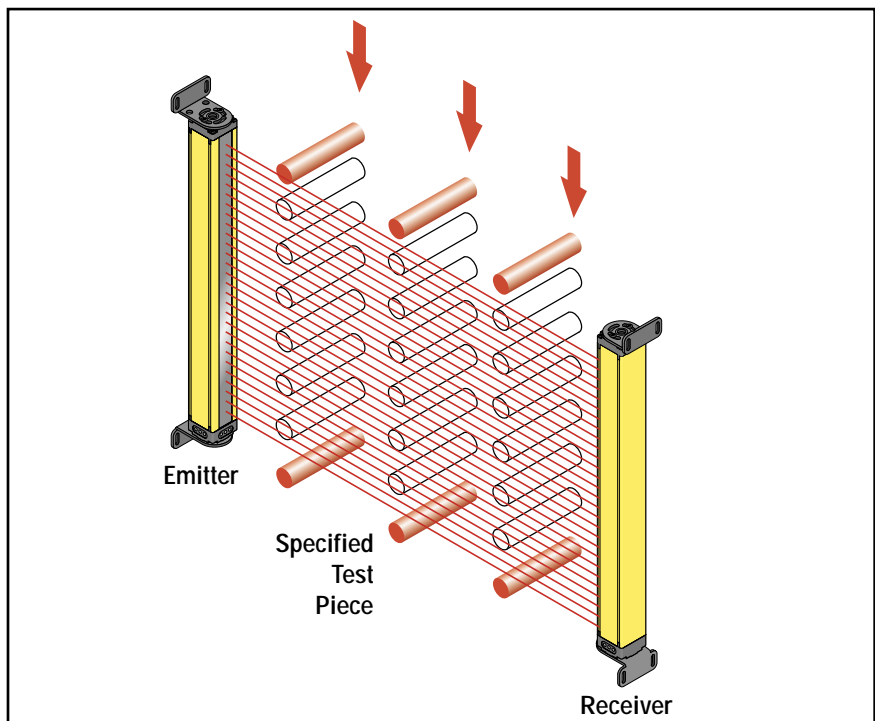


Figure 6-3. MINI-SCREEN trip test

Use of Corner Mirrors

MINI-SCREEN sensors may be used with one or more MSM Series corner mirrors for guarding along more than one side of an area.

The Accessories section lists the 12 available lengths of corner mirrors for sensors up to 48" long (see page 87). These rear-surface glass mirrors are rated at 85% efficiency; sensing range (and therefore excess gain) is reduced when using mirrors. The following table lists the resultant range when from one to four MSM Series corner mirrors are used in either sensing path.

Maximum Emitter and Receiver Separation				
Number of Corner Mirrors	1	2	3	4
9 m (30') Range Sensors	8.5 m (28')	7.8 m (25.5')	7.2 m (23.5')	6.7 m (22')
18 m (60') Range Sensors	16.8 m (55')	15.5 m (51')	14.3 m (47')	31.1 m (43')

Mirrors should be securely mounted to a solid, vibration-free surface. Using a level, mount the mirror(s) exactly parallel to (in the same plane as) the sensors, with the midpoint of the mirror(s) directly in line with the midpoint of the sensors' defined area. The upper and lower limits of the defined area of MINI-SCREEN sensors are marked by arrows along the edge of each sensor window, and are dimensioned in the chart on page 31.

Adjust the corner mirror(s) so that the angle of incidence of light to the mirror equals the angle of reflection from the mirror. Referring to Figure 6-4 below, sight from behind one of the sensors directly towards the mirror (or the first mirror in line). When alignment is correct, you will see the straight and centered reflection of the lens of the other sensor in the mirror.

Accessory Laser Alignment Tool, model LAT-1, is available to greatly simplify and speed alignment for long-range applications and applications using mirrors (see page 85).

Use the yellow alignment indicator LED corresponding to the screen being aligned for final alignment. Also, the two-digit Light Screen Diagnostic Display on the control box will indicate the total number of blocked beams. Refer to the data sheet (P/N 43685) packed with each MSM Series corner mirror for complete information on the use of corner mirrors.

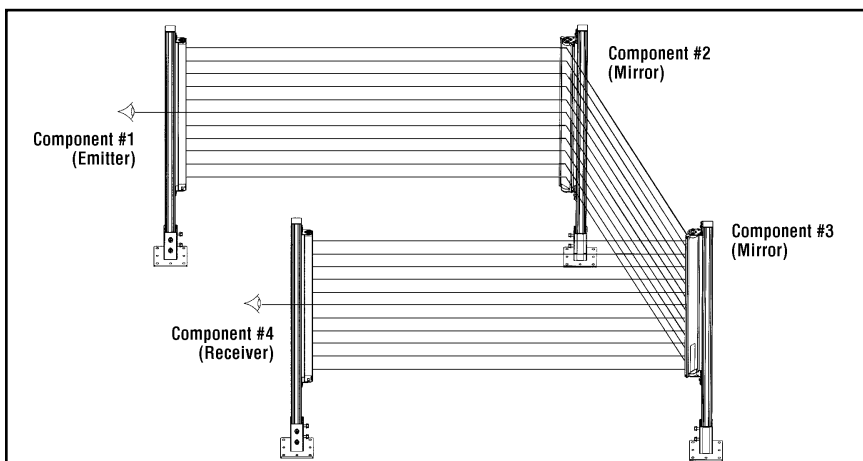



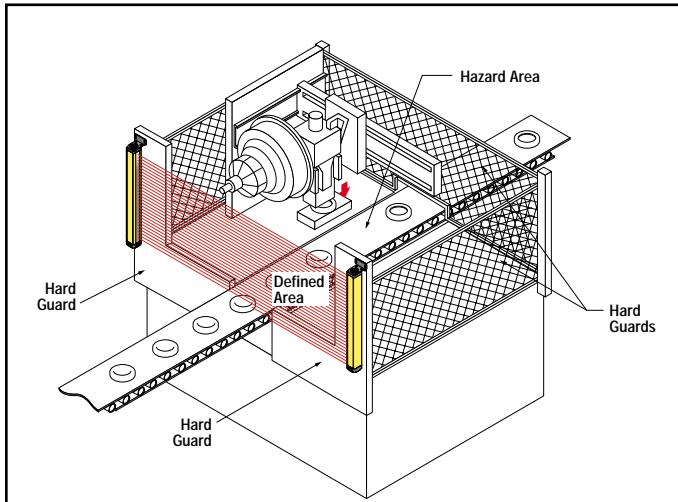
Figure 6-4. Corner mirror alignment



WARNING . . .
Mirrors and Pass-Through Hazards

DO NOT use mirrors to guard multiple areas if personnel can enter the hazardous area during the mute and not be detected by supplemental safeguarding that will issue a stop command to the machine (See Section 3.2.1.1, Pass-Through Hazards).

6.2 Commissioning Checkout (To Be Performed at Installation)



The formula used to calculate the separation distance is:

$$D_S = K \times (T_S + T_R) + D_{pf}$$

where:

- D_S = the separation distance;
- K = the OSHA-recommended hand speed constant of 63" per second (NOTE 1, below);
- T_S = the overall stop time of the machine measured from the application of the "stop" signal to the final ceasing of all motion (including stop times of all relevant control elements, measured at maximum machine velocity). See NOTE 2, below.
- T_R = the response time of the MINI-SCREEN System:
 .058 seconds for 4.5" to 16" emitter/receiver
 .070 seconds for 20" to 32" emitter/receiver
 .082 seconds for 36" to 48" emitter/receiver
- D_{pf} = the added distance due to depth penetration factor, as prescribed in OSHA 1910.217 and ANSI B11 standards:

Floating Blanking	30' Range Sensors	60' Range Sensors
Floating blanking OFF	$D_{pf} = 1.6"$	$D_{pf} = 2.5"$
1-beam blanking ON	$D_{pf} = 3.3"$	$D_{pf} = 4.2"$
2-beam blanking ON	$D_{pf} = 5.0"$	$D_{pf} = 5.9"$

NOTES:

- 1) The OSHA-recommended hand-speed constant K has been determined by various studies, and although these studies indicate speeds of 63"/sec to over 100 in/sec, they are not conclusive determinations. The employer should consider all factors, including the physical ability of the operator, when determining the value of K to be used.
- 2) T_S is usually measured by a stop-time measuring device. If the specified machine stop time is used, we recommend that at least 20% be added as a safety factor to account for clutch/brake system deterioration.
- 3) Use of floating blanking will always cause the required D_S to increase.


Figure 6-5. Calculation of D_S

This commissioning checkout must be done by a **Qualified Person** who possesses all of the manufacturer-provided information on the MINI-SCREEN System and guarded machine and who, by possession of a recognized degree or certificate of professional training or who, by extensive knowledge, training, or experience, has successfully demonstrated the ability to solve problems relating to the installation, operation, and maintenance of optoelectronic machine guards.

6.2.1 Light Screen Commissioning Checkout


A copy of checkout results should be kept in the employer's files; see OSHA 1910.217(e)(1). The Qualified Person must:

- 1) **Examine the guarded machine** to verify that it is of a type and design compatible with the MINI-SCREEN System. See page 2 for a list of misapplications.
- 2) **Verify that the minimum separation distance** from the closest hazard point of the guarded machine to the defined area is not less than the calculated distance (see Figure 6-5).
- 3) **Verify that access to any dangerous parts of the guarded machine** is not possible from any direction not protected by the MINI-SCREEN System, hard guarding, or supplemental guarding, and verify that all supplemental guarding devices and hard guarding are in place and operating properly.
- 4) **Verify that it is not possible for a person to stand between the defined area and the dangerous parts of the guarded machine.** Or, verify that supplemental presence-sensing devices (as described by ANSI B11 safety requirements or other appropriate standards) are in place and functioning properly in any space between the defined area and any danger point large enough to allow a person to stand undetected by the MINI-SCREEN System.
- 5) **Examine the electrical wiring connections** between the MINI-SCREEN output relays and the guarded machine's control elements to verify the requirements stated in Section 3.5.13.



WARNING . . . Shock Hazard


A shock hazard exists while the control box door is open. **Before continuing, verify that the door is closed and latched.**



WARNING . . . Calculate the Separation Distance Carefully

Failure to maintain appropriate separation distance can result in serious bodily injury or death.

- 6) **Test the effectiveness of the MINI-SCREEN System with system power ON.** The MINI-SCREEN control box comes with six test pieces. Select the proper test piece based on system configuration, per the chart below.
 - a) **Verify that the MINI-SCREEN System is in RUN mode:**
Green and yellow Light Screen and System status indicators ON. See Section 5.1 for Key Reset procedure. The green Light Screen indicator will flash if blanking is programmed.
Verify that muting is not enabled.



WARNING . . . Do Not Use Machine Until System Is Working Properly

If *all* of the described checks cannot be verified, **DO NOT USE** the MINI-SCREEN System-guarded machine until the defect or problem has been corrected (see Section 5). Doing so could result in serious injury or death.

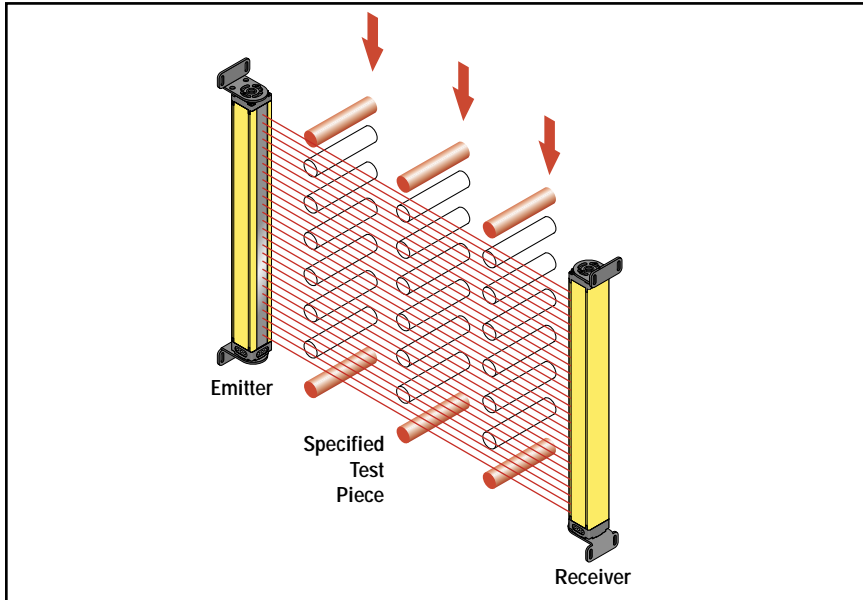


Figure 6-6. MINI-SCREEN trip test

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	Standard Emitters and Receivers	Long Range Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model STP-2	25.4 mm (1.00") dia. Model STP-7
1-beam floating blanking ON	31.8 mm (1.25") dia. Model STP-4	38.1 mm (1.50") dia. Model STP-1
2-beam floating blanking ON	44.5 mm (1.75") dia. Model STP-3	50.8 mm (2.00") dia. Model STP-8

- b) **With the guarded machine at rest**, slowly pass the appropriate specified test piece downward through the defined area at three points, perpendicular to the defined area:
- Close to the receiver,
 - Close to the emitter, and
 - Midway between the emitter and receiver.

When the test piece is within the defined area, verify:

The red Light Screen status indicator comes ON and remains ON while the test piece is within the defined area.

The green Light Screen status indicator remains OFF.

When the test piece is removed from the light screen, verify:

The green Light Screen status indicator comes ON.

If the green Light Screen status indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces or unguarded areas created by use of fixed blanking (see Warnings, page 74).

Do not continue until the situation is corrected.

- c) **Ensuring that muting is not enabled, initiate machine motion** of the guarded machine and, during motion, insert the appropriate specified test piece into the light screen, perpendicular to it. **Do not attempt to insert the test piece into the dangerous parts of the machine.**

Verify that when the test piece is inserted into the defined area at any time during machine motion, the dangerous parts of the machine come to a stop with no apparent delay.

Remove the test piece from the defined area and reset the latch output (system key reset), verify:

The machine does **not** automatically restart, and the initiation devices must be engaged to restart the machine.

- d) **With the guarded machine at rest**, insert the appropriate specified test piece into the defined area and verify that the guarded machine cannot be put into motion while the test piece is within the defined area.
- 7) **Remove electrical power to the MINI-SCREEN System. Verify:**
All output relays immediately de-energize, and can not be reactivated until power is re-applied and a System Key Reset is performed (unless both Auto Power-up features are ON).
- 8) **Test the machine stopping response time** using an instrument designed for that purpose to verify that it is the same or less than the overall system response time specified by the machine manufacturer. (NOTE: Banner's Applications Engineering Department can recommend a suitable instrument.)

If the Muting feature is used, the following checkout must be performed (after the Light Screen Commissioning Checkout has been completed).

6.2.2 Muting System Commissioning Checkout

If the Muting feature is used, the following checkout must be performed (after the Light Screen Commissioning Checkout has been completed).

- 1) **Verify that:**
The MINI-SCREEN Light Screen and System have been reset.
Green and yellow Light Screen and System status indicators are ON.
If the yellow System status indicator is double flashing (indicating the MINI-SCREEN is waiting for a System Reset of a latched condition), then perform a System Key Reset. At any time, if one or both red status indicators begin to flash, an internal lockout condition exists. Refer to Section 5.1 to determine the cause of the lockout.

During the commissioning checkout procedure of the Muting feature, at all times ensure that personnel are not exposed to any hazard.

- 2) **Initiate a normal mute cycle.**
- 3) **Verify that the Mute indicator comes ON.** If not, check the indicator and its wiring, verify that the mute enable input is closed, and check the System Diagnostic Display for error codes.
- 4) **Interrupt the safety light screen with the appropriate test piece** (see Section 6.2.1); **verify that:**
Red Light Screen status indicator comes ON, the green indicator is OFF, and the yellow indicator is flashing or OFF. Also, verify that the System green and yellow status indicators are ON.

NOTE: If the 30-second or 60-second Backdoor Timer feature is selected, the System Diagnostic Display will begin to count down; otherwise a flashing dash will appear on the display.

- 5) **Clear the defined area (before the Backdoor Timer expires) and verify:**
Green and yellow Light Screen status indicators come ON.
Clear (or deactivate) the mute devices and verify that:
The Mute indicator goes OFF.
Green and yellow System status indicators remain ON.
- 6) **Verify that it is not possible for a single individual** to initiate a mute condition (by blocking both photoelectric beams, actuating both switches, or otherwise triggering the mute devices), and pass through the defined area without being detected and without a stop command being issued to the machine. **Do not expose any individual to hazard while attempting to mute the System.**
- 7) **Verify that it is not possible for personnel** to pass in front of, behind, or next to the muted object without being detected and without a stop command being issued to the machine.
- 8) **If One-Way (directional) Muting has been selected,** verify that a mute can not be initiated by blocking (or activating) terminals M3 and M4 before M1 and M2. *Do not expose any individual to hazard while attempting to mute the System.*

6.2.3 System Override Commissioning Checkout

If the Override feature is used, the following checkout must be performed (after the Light Screen and Muting Commissioning Checkouts have been completed).

Verify that the Light Screen controller is in RUN mode and the System has been reset (the green and yellow Light Screen and System status indicators ON, and the FSDs closed). Refer to Figures 6-1 and 6-2, pages 60 and 61.

During the commissioning checkout procedure of the Override feature, at all times ensure that personnel are not exposed to any hazard.

- 1) **Verify that the positioning of the Override switches allows the operator full view of the area guarded by the safety light screen, including all hazardous areas.**
Verify that the location is not within reach from inside the safeguarded space.
- 2) **With Muting de-activated, interrupt the safety light screen with the appropriate test piece. Verify:**
Red Light Screen status indicator comes ON
Green Light Screen indicator is OFF
Yellow Light Screen indicator is flashing
Green System status indicator is OFF
Yellow System status indicator is ON
- 3) **Three seconds after interrupting the defined area,** initiate an override cycle by turning both Override switches to ON (and hold in the ON position if necessary) simultaneously (within 3 seconds).
- 4) **While the defined area is interrupted, verify:**
Both red status indicators are ON
Yellow Light Screen status indicator is flashing at a rate proportional to the number of clear beams
Green System status indicator is ON
The FSDs are closed
- 5) **After 10 seconds, verify that the Override drops out.** To initiate another override cycle, return switches to the OFF (open) condition, wait 3 seconds, and then re-close the Override switches simultaneously (within 3 seconds).
- 6) **Clear the defined area and perform a System Key Reset. Verify:**
Green and yellow System status indicators come ON
The FSDs close
If one or both red status indicator(s) begins to flash when the System goes into RUN mode, an internal lockout condition exists. Refer to Section 5.1 to determine the cause of the lockout.

If all checks cannot be verified, shut the machine down and do not use until the problem(s) has been corrected. Refer to Section 5.

6.3 Shift Change, Power-up and Machine Setup Change Checkout

Daily checkout and checkouts after tooling and machine changes must be performed by a *Designated Person* appointed and identified in writing by the employer. During continuous machine run periods, this checkout must be performed at regular intervals. A copy of checkout results should be kept on or near the machine: see OSHA 1910.217(e)(1).

The Designated Person must:

✓ The Designated Person must:

- 1) Verify that access to the dangerous parts of the guarded machine is not possible from any direction not protected by the MINI-SCREEN System or supplemental guarding.

Verify that supplemental and/or hardguarding is in place and operating properly.

- 2) Verify that the minimum distance from the closest hazard point of the guarded machine to the light screen is not less than the distance calculated in Section 3.2.1.

Calculated Distance

To be entered by a Qualified Person (as defined by ANSI B30.2-1983) at the time of installation or semi-annual checkout.

- 3) Verify that it is not possible for a person to stand inside the guarded (dangerous) area, undetected by the MINI-SCREEN System or other supplemental guarding.

Verify that hard guarding is in place and working properly to prevent access to the hazard in any area being ignored by fixed blanking.

- 4) Verify that the MINI-SCREEN control box cover is latched and locked. The key (or combination or tool) to the lock should be in the possession of a Qualified Person.

- 5) Test the effectiveness of the MINI-SCREEN system with power ON, using the chart below to select the proper test piece for your system configuration:

Floating Blanking Program	Specified Test Piece	
	Standard Models	Long-Range Models
None (OFF)	STP-2, 19.1 mm (0.75")	STP-7, 25.4 mm (1.00")
1-beam	STP-4, 31.8 mm (1.25")	STP-1, 38.1 mm (1.50")
2-beam	STP-3, 44.5 mm (1.75")	STP-8, 50.8 mm (2.00")

- 5a) Verify that the MINI-SCREEN System is in RUN mode:

Green and yellow System status indicators – ON.
(Green will flash if blanking is ON.)

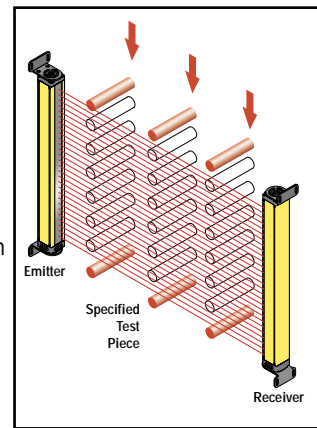
If the Auto Power-up feature is OFF when dc power is applied to the System, it is normal for it to power up into a Lockout condition. If this occurs, perform a Key Reset. (See Section 5.1 for Reset procedure).



WARNING . . . Shock Hazard
Before continuing, verify that the cover is closed and locked. A shock hazard exists while the control box cover is open.

Verify that the Muting function is not enabled.

- 5b) Trip Test. *With the guarded machine at rest*, pass the selected test piece downward through the light screen at three points, perpendicular to the light screen: near the receiver, near the emitter, and midway between them (see Figure, right).



Verify when test piece is in the light screen:
Red Light Screen Status indicator – ON

MINI-SCREEN System Trip Test

Verify when test piece is removed from the light screen:

Green Light Screen Status indicator – ON (flashing if blanking is ON)

Perform a system Key Reset to reset the latch after each pass of the test piece.

If the green indicator comes ON at any time when the test piece is in the light screen, check for reflective surfaces and unguarded areas created by use of fixed blanking (see Warnings page 74). Do not continue until the cause is discovered and the situation is resolved. (See Sections 3.2.2 and 3.2.4). Perform a system Key Reset to reset the latch after each pass of the test piece.

- 5c) *With the guarded machine moving*, insert the test piece into the light screen (perpendicular to it). Do not attempt to insert the test piece into the dangerous parts of the machine.

Verify when the test piece enters the light screen:

Machine dangerous motion stops without apparent delay.

Verify when test piece is removed from the light screen and a latch reset is performed:

Machine does not automatically restart (initiation devices must be engaged to restart the machine).

- 5d) *With the guarded machine at rest*, insert the test piece into the light screen. Verify when the test piece is in the light screen:

The guarded machine cannot move.

- 6) Check carefully for external signs of damage to the MINI-SCREEN System, the guarded machine, and their electrical wiring. Any damage found should be reported immediately to management.

7) **If the Muting feature is used:**

- 7a) Verify that the mute devices are intact and operating properly (they have not been damaged, misaligned, or otherwise blocked or tampered with).
- 7b) Initiate a normal mute cycle.
- 7c) Verify that the Mute indicator comes ON.
- 7d) **Interrupt the safety light screen with the test piece selected in step 5. Verify:**
 - Red Light Screen status indicator – comes ON
 - Green Light Screen indicator – OFF
 - Yellow Light Screen indicator – Flashing or OFF
 - Green and yellow System status indicators – ON

If the 30-second or 60-second Backdoor Timer feature is selected, the System Diagnostic Display will begin to count down; otherwise a flashing dash will appear on the display.

- 7e) **Clear the safety light screen (before the Backdoor Timer expires) and verify:**
 - Green and yellow Light Screen status indicators – ON

Clear (or deactivate) the mute devices and verify:

- Mute indicator – OFF
- Green and yellow System status indicators – ON

- 7f) Verify that it is not possible for a single individual to trigger the mute devices (block both photoelectric beams or actuate both switches) to initiate a mute and then pass through the defined area without being detected and a subsequent stop command being issued to the machine. **Do not expose any individual to hazard while attempting to initiate a mute cycle.**
- 7g) Verify that it is not possible for personnel to pass in front of, behind, or next to the muted object without being detected and a subsequent stop command being issued to the machine.
- 7h) If One-Way (directional) Muting is selected, verify that a mute cycle can not be initiated by blocking (or activating) muting devices M3 and M4 before M1 and M2. **Do not expose any individual to hazard while attempting to initiate a mute cycle.**

8) **If the Override feature is used:**

- 8a) Ensure that the positioning of the Override switches allows the operator full view of the hazardous area and the area being guarded by the safety light screen. Verify that the location is not within reach from inside the safeguarded space.
- 8b) **With muting de-activated, interrupt the safety light screen with the test piece selected in step 5. Verify:**
 - Red Light Screen status indicator – comes ON
 - Green Light Screen indicator – OFF
 - Yellow Light Screen indicator – Flashing
 - Green System status indicator – OFF
 - Yellow System status indicator – ON
- 8c) Three seconds after interrupting the light screen, initiate an override cycle: turn both Override switches to ON simultaneously (hold in the ON position if necessary).
- 8d) **While the light screen is interrupted, verify:**
 - Both red status indicators – ON
 - Yellow Light Screen indicator – Flashing (rate proportional to # of clear beams)
 - Green System status indicator – ON
 - FSDs – closed
- 8e) Verify that the Override drops out after 10 seconds. To initiate another override cycle, return switches to the OFF (open) condition, wait 3 seconds, and then simultaneously re-close the Override switches.
- 8f) **Perform a System Key Reset. Verify:**
 - Green and yellow System status indicators – ON
 - FSDs – closed

If one or both red status indicator(s) begins to flash when the system goes into RUN mode, an internal lockout condition exists. Refer to Section 5.1 to determine the cause of the lockout.
- 9) **If all checks cannot be verified, shut machine down and do not use until the problem(s) has been corrected. Refer to Section 5.**

**WARNING . . . Do Not Use Machine If the System Does Not Check Out**

If *all* of the described checks cannot be verified, **DO NOT USE** the MINI-SCREEN System or the guarded machine until the defect or problem has been corrected (see Section 5). Doing so could result in serious injury or death.

6.4 Semi-Annual Checkout (To Be Performed at Six-Month Intervals)

This semi-annual checkout must be done by a Qualified Person. A copy of the test results should be kept on or near the machine.

The Qualified Person must:

- 1) **Perform the Commissioning Checkout Procedure (Section 6.2).** If any decrease in machine braking ability has occurred, make the necessary clutch/brake repairs, readjust D_S appropriately, and re-perform the checkout sequence of Section 6.2. If D_S is altered, record the new distance in the appropriate place on the daily checkout card.
- 2) **Examine and test the machine primary control elements (MPCEs)** to ensure that they are functioning correctly and are not in need of maintenance or replacement.
- 3) **Inspect the guarded machine.** Verify that there are no mechanical or structural problems that would prevent the machine from stopping or assuming an otherwise safe condition when signalled to do so by the MINI-SCREEN System.
- 4) **Inspect the machine controls and connections to the MINI-SCREEN System.** Verify that no modifications have been made which adversely affect the system.



WARNING . . . Reflective Surfaces

It may be possible for a highly reflective surface (a shiny machine surface or a shiny workpiece) to reflect sensing light around an object in the defined area, preventing that object from being detected. This potentially dangerous condition is discovered using the trip test as described in the Initial Checkout Procedure (Section 3.5.11), the Alignment Procedure (Section 6.1), and the Periodic Checkout Procedures (Sections 6.2, 6.3, and 6.4).

When this condition is discovered, eliminate the problem reflection(s). If possible, relocate the sensors to move the defined area away from the reflective surface(s), being careful to retain at least the required separation distance (Section 3.2.1). **Otherwise, paint, mask, or roughen the interfering shiny surface** to reduce its reflectivity. Repeat the trip test to verify that these changes have eliminated the problem reflection(s). See Section 3.2.4.

NOTE: If the workpiece is especially reflective and comes close to the defined area, perform the trip test with the shiny workpiece in place.



WARNING . . .

Do Not Use Machine Until System Is Working Properly

If *all* of the described checks cannot be verified, **DO NOT USE** the MINI-SCREEN System or the guarded machine until the defect or problem has been corrected (see Section 5). Doing so could result in serious injury or death.



WARNING . . .

Hard Guarding

If any object that is to be ignored by fixed blanking does not, itself, completely prevent access to the danger point(s), you must install hard guarding to prevent access past the object, or increase the separation distance.

Openings in the hard guarding material must meet OSHA criteria (see OSHA 1910.217, Table O-10).

Failure to hard guard any opening caused by fixed blanking or failure to adequately increase the separation distance will create an unsafe condition which could lead to serious injury or death. See Section 3.2.2.

Glossary of Terms

Terms shown in *italics* in the definitions below are themselves defined elsewhere in the glossary.

ANSI (American National Standards Institute): An association of industry representatives which develops technical standards, including safety standards. These standards represent a consensus from a variety of industries on good practice and design. ANSI standards relevant to application of the MINI-SCREEN System include ANSI B11.1 (mechanical power presses), ANSI B11.2 (hydraulic power presses), and ANSI/RIA R15.06 (industrial robots and robot systems).

Auxiliary monitor or Alarm contact: A low-load-capacity, non-safety-related relay contact within the MINI-SCREEN System whose primary purpose is to communicate system status to a PLC.

Auto Power-up: A feature of the MINI-SCREEN *control module* which, when switched ON, enables the MINI-SCREEN to be powered up (and recover from a power interruption) without the necessity of a *Key Reset*. When Auto Power-up is ON, the MINI-SCREEN *control module* automatically begins internal diagnostics upon power-up, and automatically resets the system if it passes the diagnostic check. With Auto Power-up OFF, a manual *Key Reset* is required.

Blanking: See *fixed blanking* and *floating blanking*.

Control reliability: A method of ensuring the performance integrity of a control system. Control circuits are designed and constructed so that a single failure or fault within the system does not prevent the normal stopping action from being applied to the machine when required, or does not create unintended machine action, but does prevent initiation of successive machine action until the failure is corrected.

Control module: Contains the circuitry (internal to the MINI-SCREEN System) that provides the proper voltages to the system, controls the sensing units, receives and processes information from the sensing units and the safety monitoring means, and provides outputs to the *Final Switching Devices (FSD1 and FSD2)*, the *Secondary Switching Device (SSD)*, and the *Auxiliary Monitor Relay*.

Controller board: A removable printed circuit board, located within the MINI-SCREEN System *control module*, which contains the microprocessors and related electronic circuits.

Defined area: The "light screen" or "curtain of light" generated by the MINI-SCREEN System. When the defined area is interrupted by an opaque object of a specified cross section or larger, a *trip condition* results (see Figure 1-1).

Designated Person: A person or persons identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure.

Diverse redundancy: A design feature in which two components of different design, running from two different instruction sets (if programmed components), constantly check all system components, including each other.

Emergency stop: The function offered by the MINI-SCREEN *control module* which produces a *lockout condition* when an (optional) Emergency Stop switch is engaged. The customer-supplied Emergency Stop switch must meet certain mechanical and electrical requirements, as described in Section 3.5.10.

Emitter: The light-emitting component of the MINI-SCREEN System, consisting of a row of synchronized modulated infrared LEDs. The emitter, together with the *receiver* (placed opposite), creates a “curtain of light” called the *defined area*.

Final Switching Device (FSD): The two output relays (FSD1 and FSD2) of the MINI-SCREEN System which respond to an intrusion of the *defined area* by interrupting the circuit connecting them to the *Machine Primary Control Elements (MPCEs)* of the *guarded machine*.

Fixed Blanking: A feature that allows the MINI-SCREEN System to be programmed to ignore objects (such as brackets or fixtures) that will always be present within the *defined area*, so that the presence of these objects will not cause the *FSDs (Final Switching Devices)* of the MINI-SCREEN System to trip (see *Trip condition*). If any of the fixed objects are moved within or removed from the defined area, a *lockout condition* results.

Floating Blanking: A feature that allows the MINI-SCREEN System to be programmed to produce an intentionally disabled light beam within the light screen, which appears to move up and down (“float”) in order to allow the feeding of an object through the light screen (the *defined area*) at any point along the length of the screen without causing a *Trip condition*.

The MINI-SCREEN System offers one- or two-beam floating blanking to allow multiple objects (usually workpiece material), to move through the *defined area* without tripping the *Final Switching Devices*.

Use of floating blanking increases *minimum object sensitivity* and the required *separation distance*.

FMEA (Failure Mode and Effects Analysis): A testing procedure by which potential failure modes in a system are analyzed to determine their results or effects on the system. Component failure modes that produce either no effect or a *lockout condition* are permitted; failures which cause an unsafe condition (a *failure to danger*) are not. Banner MINI-SCREEN Systems are extensively FMEA tested.

Forced-guided contacts: Relay contacts that are mechanically linked together, so that when the relay coil is energized or de-energized, all of the linked contacts move together. If one set of contacts in the relay becomes immobilized, no other contact of the same relay will be able to move. The function of forced-guided contacts is to enable the safety circuit to check the status of the relay. Forced-guided contacts are also known as “positive-guided contacts,” “captive contacts,” “locked contacts,” or “safety relays.” MINI-SCREEN Systems use output relays with forced-guided contacts.

Full-revolution devices: A type of machine drive arranged such that, once started, the machine can only be stopped when the full cycle is complete. Examples include positive key clutches and similar mechanisms. Banner MINI-SCREEN Systems may not be used with full-revolution devices.

Guarded machine: The machine whose point of operation is guarded by a MINI-SCREEN System, and whose *MPCEs* and *MSCE* are connected to relays *FSD1*, *FSD2*, and *SSD* of the MINI-SCREEN System.

Hard guarding: Screens, bars, or other mechanical barriers that prevent a person from reaching over, under, or around the *defined area* of an installed MINI-SCREEN System and into the *point of operation* of the *guarded machine*.

Internal lockout: A *lockout condition* that occurs due to an internal MINI-SCREEN System problem. Indicated by the red status indicator LED (only) flashing. Requires the attention of a *Qualified Person*.

Key Reset: A key-operated switch that is used to restore the *Final Switching Devices (FSDs)* and *Secondary Switching Device (SSD)* to the ON state from a *lockout condition*. Also refers to the act of using the switch to reset the MINI-SCREEN System.

Latch condition: The response of the *Final Switching devices (FSD)* relays when an object equal to or greater than the diameter of the *specified test piece* enters the *defined area*. In a Latch condition, *FSD1* and *FSD2* simultaneously de-energize and open their contacts. The latch must be reset after the *defined area* is cleared by momentarily closing the normally open contact of the Latch Reset switch. (See *Trip condition*.)

Lockout condition: A condition of the MINI-SCREEN System that is automatically attained either: (1) when its dc supply mains are interrupted and restored, or (2) in response to certain failure signals. When a lockout condition occurs, the MINI-SCREEN System's *FSD*, *SSD*, and *Auxiliary Monitor Relay* contacts open, and a *Key Reset* is required to return the system to the RUN condition.

Machine primary control element (MPCE): An electrically powered element, external to the MINI-SCREEN System, which directly controls the machine's normal operating motion in such a way that it is last (in time) to operate when motion is either initiated or arrested.

Machine response time: The time between the interruption by the *Final Switching Devices (FSDs)* of the electrical supply to the *Machine Primary Control Element(s) (MPCEs)* and the instant when the dangerous parts of the machine reach a safe state by being brought to rest.

Machine secondary control element (MSCE): A machine control element independent of the *Machine Primary Control Element(s) (MPCEs)*, capable of removing the source of power from the prime mover of the relevant dangerous machine parts.

Minimum object sensitivity: The minimum-diameter object that a light curtain system can reliably detect. Objects of this diameter or greater will be detected anywhere in the sensing field. A smaller object can pass undetected through the curtain of light if it passes exactly midway between two adjacent light beams. Same as MODS, Minimum Object Detection Size. See also *specified test piece*.

MODS (minimum object detection size): See *minimum object sensitivity*.

MPCE monitor contacts: The normally closed contacts of a *guarded machine's MPCEs* which are connected to the MINI-SCREEN System monitor inputs. These contacts must be mechanically linked to the control elements (*forced-guided*).

Muting: The automatic suspension of the safeguarding function of a safety device during a non-hazardous portion of the machine cycle.

OFF state (of Final and Secondary Switching Devices): In the OFF state, the output circuit is broken and interrupts the flow of current.

ON state (of Final and Secondary Switching Devices): In the ON state, the output circuit is complete and permits the flow of current.

OSHA (Occupational Safety and Health Administration); OSHA CFR 1910.217: Occupational Safety and Health Administration (a US Federal agency), Division of the US Department of Labor, that is responsible for the regulation of workplace safety. OSHA regulations often follow ANSI standards, including mechanical power press requirements (OSHA CFR 1910.217). These regulations become law when adopted by OSHA, and must be followed. (See page 90.)

Output relays: The devices (within the MINI-SCREEN System) that are used to initiate a stop signal. The MINI-SCREEN System's output relays (*FSD1*, *FSD2*, and *SSD*) use *forced-guided contacts*.

Point of operation: The area of the *guarded machine* where a workpiece is positioned and a machine function (i.e., shearing, forming, punching, assembling, welding, etc.) is performed upon it.

Power supply board: A removable printed circuit board which contains the power supply circuit and *output relays* and is located inside the MINI-SCREEN System *control module*. A green LED on the power supply board lights whenever dc power is present on the board.

Power-up/power interrupt lockout: A *lockout condition* of the MINI-SCREEN System that, if *Auto Power-up* is OFF, occurs when the system is powered up (including upon power-up after a loss of power). Indicated by the yellow status indicator LED (only) flashing. *Requires a Key Reset by a Designated Person.*

PSDI (Presence-Sensing-Device Initiation): An application in which a presence-sensing device is used to actually start the cycle of a machine. In a typical situation, an operator manually positions a part in the machine for the operation. When the operator moves out of the danger area, the presence-sensing device starts the machine (no start switch is used). The machine cycle runs to completion, and the operator can then insert a new part and start another cycle. The presence-sensing device continually guards the machine. Single break mode is used when the part is automatically ejected after the machine operation. Double break mode is used when the part is both inserted (to begin the operation) and removed (after the operation) by the operator. PSDI is defined in OSHA CFR 1910.217. *Banner MINI-SCREEN Systems may not be used as PSDI devices on mechanical power presses, per OSHA regulation 29 CFR 1910.217.*

Qualified Person: A person or persons who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work (ANSI B30.2-1983).

Receiver: The light-receiving component of the MINI-SCREEN System, consisting of a row of synchronized phototransistors. The receiver, together with the *emitter* (placed opposite), creates a "light screen" or "curtain of light" called the *defined area*.

Secondary switching device (SSD): The *output relay* of the MINI-SCREEN System which, in a *lockout condition*, interrupts the circuit connecting it to the *Machine Secondary Control Element (MSCE)*.

Self-checking (circuitry): A circuit with the capability to electronically verify that all of its own critical circuit components, along with their redundant backups, are operating properly. Banner MINI-SCREEN Systems are self-checking.

Separation distance: That distance, along the direction of approach, between the outermost position at which the appropriate test piece will just be detected and the nearest dangerous machine parts. Also called *safety distance*.

Single-stroke press: *See full-revolution devices.*

Specified test piece: An opaque object of the minimum cross section required to place the MINI-SCREEN System into a *trip condition* when inserted into any part of the *defined area*. *See also minimum object sensitivity.*

Supplemental guarding: Additional electrosensitive safety device(s), possibly employed along with *hard guarding* measures, used for the purpose of preventing a person from reaching over, under, or around the *defined area* of an installed MINI-SCREEN System and into the *point of operation* of the *guarded machine*.

Trip condition: The response of the *Final Switching Device (FSD)* relays when an object equal to or greater than the diameter of the *specified test piece* enters the *defined area*. In a trip condition, FSD1 and FSD2 simultaneously de-energize and open their contacts. A Trip condition clears automatically when the object is removed from the *defined area*. (See *Latch condition*.)

UL (Underwriters Laboratory): A third-party organization which tests a manufacturer's products for compliance with appropriate Standards, electrical and/or safety codes. Compliance is indicated by their listing mark on the product.

MINI-SCREEN Series Sensor Specifications		
	Standard (MSE/MSR Series)	Long Range (MSXLE/MSXLR Series)
Emitter/Receiver Separation (Min/Max Range)	150 mm (6") to 9 m (30')	150 mm (6") to 18 m (60')
Minimum Object Sensitivity		
Floating Blanking OFF	19.1 mm (0.75")	25.4 mm (1.00")
1-Beam Floating Blanking ON	31.8 mm (1.25")	38.1 mm (1.50")
2-Beam Floating Blanking ON	44.5 mm (1.75")	50.8 mm (2.00")
Defined Area	See Models and Accessories, page 82.	
Ambient Light Immunity	>10,000 lux at 5° angle of incidence	
Strobe Light Immunity	Totally immune to one Federal Signal Corp. "Fireball" model FB2PST strobe	
Emitter Elements	Infrared LEDs, 880 nm peak emission	
Status Indicators	Emitter: Green LED indicator for power ON indication Receiver: Red, yellow and green Light Screen status indicators with the same functions as those on the left side of the control box (see Control Box Specifications, page 80). Yellow also indicates alignment. Indicators are visible on three sides of receiver or emitter base.	
Emitter and Receiver Enclosure	<i>Size:</i> See Figure 3-9, page 31 <i>Materials:</i> Aluminum; yellow polyester painted finish; acrylic lens cover <i>Rating:</i> NEMA 4, 13; IEC IP65	
Mounting Hardware	Emitter and receiver each are supplied with a pair of swivel end mounting brackets. Mounting brackets are 13-gauge cold-rolled black zinc chromate finished steel (see Figure 3-8).	
Cables	<i>NOTE: Use only Banner cables, which incorporate a "twisted pair" for noise immunity on RS485 data communication lines. Use of other cables can result in "nuisance" lockouts.</i> Emitter and receiver cables are ordered separately. Banner 5-conductor shielded cables have a straight QD (quick-disconnect) connector molded onto the sensor end. Cables measure 8.1 mm (0.32") in diameter, and are shielded and PVC-jacketed. Conductors are 20-gauge. Two liquid-tight cable gland/strain relief fittings are supplied with each control box to admit the emitter and receiver cables through the selected knockouts on the control box wall. Emitter and receiver cable lengths may not exceed 53 m (175') total. See Cables, page 83. See cable and sensor drawing, page 31.	
Certifications	See Control Box specifications, page 81	

MINI-SCREEN Muting Controller Specifications			
System Power Requirements	115V ac (50/60Hz) ± 15% @ 500 mA (50 VA), 230V ac (50/60Hz) ± 15% @ 250 mA (50 VA), or 24V dc ±15%, 10% maximum ripple, @ 2.5 A (60 W)		
Fuse Rating (F2)	115V ac: 1.0 A ac @ 250V ac (supplied) 230V ac: 500 mA @ 250V ac +24V dc: Internal resettable		
Response Time	Less than 58 milliseconds using emitter/receiver with 4.5" to 16" defined area Less than 70 milliseconds using emitter/receiver with 20" to 32" defined area Less than 82 milliseconds using emitter/receiver with 36" to 16" defined area		
Status LED Indicators	Light Screen Indicators (left column of LEDs):		
		Solid LED	Flashing LED
	Red	BLOCKED	LOCKOUT
	Green	CLEAR	BLANKING ON
	Yellow	RESET (RUN mode)	Double Flash = Waiting for Light Screen Key Reset at Power-up Single Flash = ALIGNMENT. Flash rate increases with the number of sensing beams "made", solid yellow when aligned and defined area clear
	System Indicators (right column of LEDs):		
		Solid LED	Flashing LED
	Red	OVERRIDE	LOCKOUT
	Green	OUTPUT ON (FSD1 & FSD2 closed)	(Not Applicable)
	Yellow	RESET (System)	Double Flash = Waiting for System Key Reset at Power-up Single Flash = Waiting for System Key Reset of latched condition (manual reset of system after blockage has been removed)
Diagnostic Displays	<p>Light Screen Diagnostic Display (left window) is a two-digit numeric display that indicates the cause of lockout conditions.</p> <p>System Diagnostic Display (right window) is a two-digit numeric display that indicates the cause of lockout conditions and the amount of time, in seconds, remaining for the backdoor timer.</p>		
Controls and Adjustments	<ul style="list-style-type: none"> • Light Screen Key Reset after power-up and light screen lockouts • Selection switches to enable floating blanking • Program switches to enable fixed blanking • Light Screen and System Auto Power-up selection switches • System Key Reset after power-up, system lockouts, and latched conditions • Selection switches for Monitored or Non-Monitored Muting indicator • Selection switches for One-Way or Two-Way (directional/non-directional) Muting • Selection switches for One-Channel or Two-Channel Monitoring (EDM) • Selection switches for Backdoor Timer settings and Mute-on-Power-Up 		

MINI-SCREEN Muting Controller Specifications (continued)	
Light Screen Test Input	Terminals must be closed for a minimum of 0.05 seconds in order to guarantee a test. The switching device must be capable of switching 15-50V dc at 20-100 mA.
Light Screen and System Reset Inputs	Terminals must be closed for a minimum of 0.5 seconds in order to guarantee a reset. The switching device must be capable of switching 15-50V dc at 20-100 mA.
External Device Monitoring (EDM) Input(s)	Two pairs of terminals are provided to monitor the state of external devices that are being controlled by the FSD outputs. The device must be capable of switching 15-50V dc at 20-100 mA.
Mute Enable Input	Terminals must be closed in order to start a mute; opening this input after mute has begun has no effect. The switching device must be capable of switching 15-50V dc at 20-100mA.
Override Inputs	The two-channel inputs must be closed within 3 seconds of each other (simultaneity requirement) and held closed during the 10-second Override. To initiate a subsequent Override, open both channels, wait 3 seconds, and then re-close both channels (within 3 seconds). The switching devices must be capable of switching 15-50V dc at 20-100 mA.
Muting Device Input	The muting devices work in pairs (M1 and M2, M3 and M4) and are required to be "closed" within 3 seconds of each other (simultaneity requirement) to initiate a mute (assuming all other conditions are met). Each muting device must be capable of switching 15-50V dc at 20-100 mA.
Light Screen and System Aux. Monitor Relay Outputs	Reed relay; 125V ac/dc max at 500 mA max. (10VA maximum, resistive load)
CNC Aux. Monitor Relay Outputs (Model MSCC-2L3M only)	Forced-guided contact relay, 250V ac at 6 amps maximum (resistive load).
Output Configuration (FSD1, FSD2, SSD)	<p>Model MSCC-2L2M: Forced-guided contact relays, 250V ac at 4 amps maximum (resistive load). Model MSCC-2L3M: FSD1 and FSD2: Forced-guided contact relays, 250V ac at 6 amps maximum (resistive load). SSD: Forced-guided contact relay, 250V ac at 4 amps maximum (resistive load).</p> <p>Mechanical life: 10,000,000 operations (minimum) Electrical life: (at full rated load) 100,000 operations (typical) Arc suppression is recommended when switching inductive loads. See Warning on page 49.</p>
Mute Lamp Output	<p>A monitored or non-monitored (selectable) sinking output. Maximum Switching Voltage: 30V dc Monitored Switching Current: 10 mA to 360 mA Non-monitored Switching Current: 0 mA to 360 mA Saturation Voltage: $\leq 1.5V$ dc</p>
Auxiliary DC Supply Output	24V dc \pm 25%, 500 mA max
Enclosure	<p>Size: See figure 3-10 on page 32 Material: Welded steel box with black polyester powder paint finish. Rating: NEMA 13; IEC IP64</p>
Operating Conditions	<p>Temperature: 0° to +50°C (+32° to 122°F) Humidity: 95% maximum relative humidity (non-condensing)</p>
FMEA Tested (Failure Mode and Effects Analysis)	Per requirements of IEC61496-1 (type 4)
Certifications	Approvals in process. Contact factory for update.

MINI-SCREEN Standard Series Emitters (E) and Receivers (R)

MINI-SCREEN Systems are sold in kits that include the following: a control box, an emitter and receiver of equal length and range, emitter and receiver mounting hardware, and two cables. Cables are interchangeable between quick-disconnect emitters and receivers. See the Banner Machine Safety Products Catalog for a complete list of available kits. Components are also available separately (see chart below).

Defined Area	Black Anodized				Yellow Painted				Beams
	9 m (30') Range		18 m (60') Range		9 m (30') Range		18 m (60') Range		
	Model	Part No.	Model	Part No.	Model	Part No.	Model	Part No.	
114 mm (4.5")	MSE424 MSR424	37444 37445	MSXLE424 MSXLR424	52625 52626	MSE424Y MSR424Y	47650 47651	MSXLE424Y MSXLR424Y	48125 48126	8
215 mm (8.5")	MSE824 MSR824	37446 37447	MSXLE824 MSXLR824	52627 52628	MSE824Y MSR824Y	47652 47653	MSXLE824Y MSXLR824Y	48127 48128	16
305 mm (12")	MSE1224 MSR1224	37448 37449	MSXLE1224 MSXLR1224	52629 52630	MSE1224Y MSR1224Y	47654 47655	MSXLE1224Y MSXLR1224Y	48129 48130	24
406 mm (16")	MSE1624 MSR1624	37450 37451	MSXLE1624 MSXLR1624	52631 52632	MSE1624Y MSR1624Y	47656 47657	MSXLE1624Y MSXLR1624Y	48131 48132	32
508 mm (20")	MSE2024 MSR2024	37452 37453	MSXLE2024 MSXLR2024	52633 52634	MSE2024Y MSR2024Y	47658 47659	MSXLE2024Y MSXLR2024Y	48133 48134	40
610 mm (24")	MSE2424 MSR2424	37454 37455	MSXLE2424 MSXLR2424	52635 52636	MSE2424Y MSR2424Y	47660 47661	MSXLE2424Y MSXLR2424Y	48135 48136	48
711 mm (28")	MSE2824 MSR2824	37456 37457	MSXLE2824 MSXLR2824	52637 52638	MSE2824Y MSR2824Y	47662 47663	MSXLE2824Y MSXLR2824Y	48137 48138	56
813 mm (32")	MSE3224 MSR3224	37458 37459	MSXLE3224 MSXLR3224	52639 52640	MSE3224Y MSR3224Y	47664 47665	MSXLE3224Y MSXLR3224Y	48139 48140	64
914 mm (36")	MSE3624 MSR3624	37460 37461	MSXLE3624 MSXLR3624	52641 52642	MSE3624Y MSR3624Y	47666 47667	MSXLE3624Y MSXLR3624Y	48141 48142	72
1016 mm (40")	MSE4024 MSR4024	37462 37463	MSXLE4024 MSXLR4024	52643 52644	MSE4024Y MSR4024Y	47668 47669	MSXLE4024Y MSXLR4024Y	48143 48144	80
1118 mm (44")	MSE4424 MSR4424	37464 37465	MSXLE4424 MSXLR4424	52645 52646	MSE4424Y MSR4424Y	47670 47671	MSXLE4424Y MSXLR4424Y	48145 48146	88
1219 mm (48")	MSE4824 MSR4824	37466 37467	MSXLE4824 MSXLR4824	52647 52648	MSE4824Y MSR4824Y	47672 47673	MSXLE4824Y MSXLR4824Y	48147 48148	96

Pigtail Quick-Disconnect Option

Any emitter or receiver may be ordered with a 305 mm (12") cable pigtail terminated in the 5-pin male Mini-style quick-disconnect connector. This option accommodates requirements for right-angle exit of the cable from the base of the emitter and/or receiver. The same mating quick-disconnect cables, as listed on page 83 are used (ordered separately). To specify a pigtail quick-disconnect, add suffix "P" to the model number of the emitter or receiver, for example: **MSE1624YP**.



Control Box (One required per system)

Description	Model Number	Part Number
Muting control box with fixed blanking	MSCC-2L2M	62041
Muting control box with CNC Aux	MSCC-2L3M	62838



Cables (Two required per system, one per sensor)*

Description	Model Number	Part Number
4.5 m (15') cable, straight QD connector	QDC-515C	37442
7.6 m (25') cable, straight QD connector	QDC-525C	37443
15 m (50') cable, straight QD connector	QDC-550C	37498
30 m (100') cable, straight QD connector	QDC-5100	35339
45 m (150') cable, straight QD connector	QDC-5150	35341

*Note: Total cable length per emitter and receiver pair must be less than 53 m (175').

Documentation

The following documentation is supplied with each MINI-SCREEN System control box. Additional copies are available at no charge.

Description	Part Number
Instruction manual for Muting MINI-SCREEN Systems	61409
Checkout Procedure Card (Daily)	62055
Checkout Procedure Card (Semi-annual)	62056

Retrofit Mounting Bracket Kits

Description	Model Number	Part Number
Retrofit for STI MS43	MSMB-4	48954
Retrofit for Dolan Jenner Safe Scan 7	MSMB-5	59671

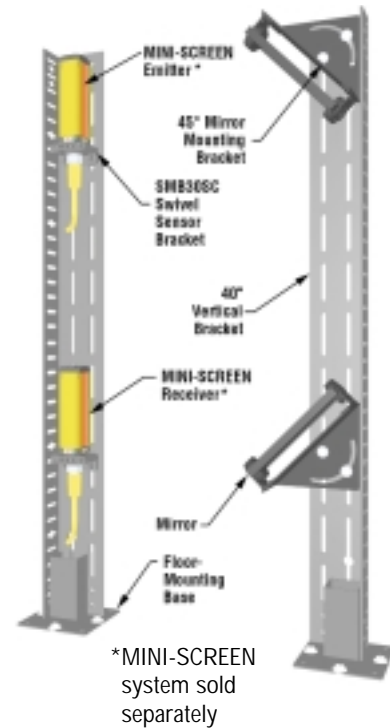
LAT-1 Laser Alignment Tool

Description	Model Number	Part Number
Self-contained visible-beam laser tool for alignment of any MINI-SCREEN emitter/receiver pair. Includes retroreflective target material and two mounting clips	LAT-1	52150

ACCESS-GUARD Kits

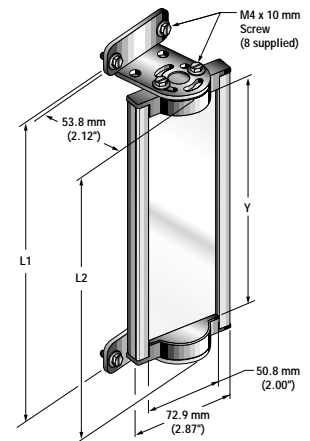
Model Number	Description	Required
MSA-PMS-K40	ACCESS-GUARD Kit	1
MSA-MBM-K45	Mirror with Bracket Kit	2

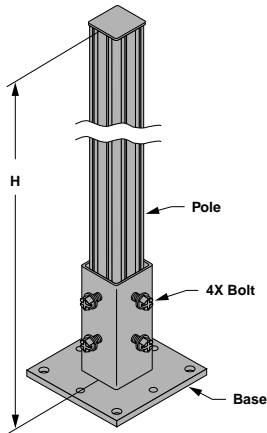
*Requires a 4.5" (112.5 mm) MINI-SCREEN System for operation; Mirror with Bracket Kit includes one mirror and one bracket, with hardware.



MSM Series Corner Mirrors

Reflective Area Y	Mounting L1	Height L2	Mirror Model	Part Number
16.5 cm (6.5")	22.1 cm (8.7")	19.1 cm (7.5")	MSM4A	43162
26.7 cm (10.5")	32.3 cm (12.7")	29.2 cm (11.5")	MSM8A	43163
35.6 cm (14")	41.1 cm (16.2")	38.1 cm (15")	MSM12A	43164
45.7 cm (18")	51.3 cm (20.2")	48.3 cm (19")	MSM16A	43165
55.9 cm (22")	61.5 cm (24.2")	58.4 cm (23")	MSM20A	43166
66.0 cm (26")	71.6 cm (28.2")	68.6 cm (27")	MSM24A	43167
76.2 cm (30")	81.8 cm (32.2")	78.7 cm (31")	MSM28A	43168
86.4 cm (34")	91.9 cm (36.2")	88.9 cm (35")	MSM32A	43169
96.5 cm (38")	102.1 cm (40.2")	99.1 cm (39")	MSM36A	43170
106.7 cm (42")	112.3 cm (44.2")	109.2 cm (43")	MSM40A	43171
116.8 cm (46")	122.4 cm (48.2")	119.4 cm (47")	MSM44A	43172
127.0 cm (50")	132.6 cm (52.2")	129.5 cm (51")	MSM48A	43173





MSA Series Stands (Base included)

Stand Height	Mirror Length (Brackets Outward)	Mirror Length (Brackets Inward)	Sensor Length (Brackets Outward)	Sensor Length (Brackets Inward)	Stand Model	Part Number
24"	4" to 8"	4" to 12"	4" to 12"	4" to 16"	MSA-S24-1	43174
42"	4" to 24"	4" to 28"	4" to 32"	4" to 36"	MSA-S42-1	43175
66"	4" to 48"	4" to 48"	4" to 48"	4" to 48"	MSA-S66-1	43176
84"	4" to 48"	4" to 48"	4" to 72"	4" to 72"	MSA-S84-1	52397

MINI-SCREEN Lens Shields

MINI-SCREEN Sensor Length	Lens Shield Length	Lens Shield Model Number	Part Number
4"	4.4"	MSS4	44308
8"	8.4"	MSS8	44309
12"	12.4"	MSS12	44310
16"	16.4"	MSS16	44311
20"	20.4"	MSS20	44312
24"	24.4"	MSS24	44313
28"	28.4"	MSS28	44314
32"	32.4"	MSS32	44315
36"	36.4"	MSS36	44316
40"	40.4"	MSS40	44317
44"	44.4"	MSS44	44318
48"	48.4"	MSS48	44319

Replacement Parts, MINI-SCREEN System with Muting

Description	Model Number	Part Number
Replacement key	MGA-K-1	28513
Key switch	MGA-KSO-1	30140
Specified test piece (1.5" dia.)	STP-1	43835
Specified test piece (.75" dia.)	STP-2	43957
Specified test piece (1.75" dia.)	STP-3	43958
Specified test piece (1.25" dia.)	STP-4	43836
Specified test piece (1.00" dia.)	STP-7	43835
Specified test piece (2.00" dia.)	STP-8	49126
Mounting hardware kit for one emitter or receiver	BA2MB	46091
Control box mounting hardware	USA-MH-2	60110
Replacement power supply board	MSMA-PSC-2	62867
Replacement Light Screen controller board	MSAB-2	47381
Replacement System controller board	USMAL-1	60643
Replacement transformer	MUSA-TA-1	43834
Replacement relay module	MSA-RM-1	39025
Replacement relay module with an additional complementary normally closed output	MSA-RM-2	59689

MINI-SCREEN

Mute Function and Latch Output

U.S. Application Standards

ANSI B11.1

Machine Tools – Mechanical Power Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.2

Hydraulic Power Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.3

Power Press Brakes – Safety Requirements for Construction, Care, and Use of

ANSI B11.4

Shears – Safety Requirements for Construction, Care, and Use of

ANSI B11.5

Machine Tools – Iron Workers – Safety Requirements for Construction, Care, and Use of

ANSI B11.6

Lathes – Safety Requirements for Construction, Care, and Use of

ANSI B11.7

Cold Headers and Cold Formers – Safety Requirements for Construction, Care, and Use of

ANSI B11.8

Drilling, Milling, and Boring Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.9

Grinding Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.10

Metal Sawing Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.11

Gear Cutting Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.12

Roll Forming and Roll Bending Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.13

Machine Tools – Single – and Multiple-Spindle Automatic Bar and Chucking Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.14

Coil Slitting Machines/Systems – Safety Requirements for Construction, Care, and Use of

ANSI B11.15

Pipe, Tube, and Shape Bending Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.16

Metal Powder Compacting Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.17

Horizontal Extrusion Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.18

Machinery and Machine Systems for the Processing of Coiled Strip, Sheet, and Plate – Safety Requirements for Construction, Care, and Use of

ANSI B11.19

Performance Criteria for the Design, Construction, Care, and Operation of Safeguarding when Referenced by the Other B11 Machine Tool Safety Standards

ANSI B11.20

Machine Tools – Manufacturing Systems/Cells – Safety Requirements for Construction, Care, and Use of

ANSI/RIA R15.06 (1999)

Safety Requirements for Industrial Robots and Robot Systems

NFPA 79

Electrical Standard for Industrial Machinery 1994 Edition

SOURCES

ANSI B11 Documents

American National Standards Institute

11 West 42nd Street
New York, NY 10036
Telephone: (212) 642-4900

-or-

Safety Director

AMT – The Association for Manufacturing Technology

7901 Westpark Drive
McLean, VA 22102-4269
Telephone: (703) 893-2900

ANSI/RIA Documents

Obtain from ANSI (above) or:

Robotics Industries Association
900 Victors Way, P.O. Box 3724

Ann Arbor, MI 48106
Telephone: (734) 994-6088

NFPA Documents

National Fire Protection Association

1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Telephone: (800) 344-3555

SOURCE

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096
Telephone: (847) 272-8800

U.S. Design Standards**UL 991**

Tests for Safety-related Controls
Employing Solid-state Devices

UL 1998

Standard for Safety Related Software

SOURCE

Part of:
Code of Federal Regulations
Title 29, Parts 1900 to 1910
Superintendent of Documents
Government Printing Office
P.O. Box 371954
Pittsburgh, PA 15250-7954
Telephone: (202) 512-1800

OSHA Regulations**OSHA 29 CFR 1910.212**

General Requirements for (Guarding
of) All Machines

OSHA 29 CFR 1910.217

(Guarding of) Mechanical Power
Presses

European Standards**SOURCES*****EN and IEC Standards***

Available from:

Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5704
Phone: 1 (800) 854-7179
Fax: (303) 397-2740

BS Documents

British Standards Association
2 Park Street
London W1A 2BS
England
Telephone: 011-44-908-1166

EN 292-1, ISO/TR 12100-1

Safety of Machinery – Basic
Concepts, General Principles for
Design Part 1: Basic Terminology,
Methodology

EN 292-2, ISO/TR 12100-2

Safety of Machinery – Basic
Concepts, General Principles for
Design Part 2: Technical Principals
and Specifications

EN 294, ISO 13852

Safety of Machinery – Safety
Distances to Prevent Danger Zones
Being Reached by the Upper Limbs

EN 418, ISO 13850

Safety of Machinery – Emergency
Stop Devices, Functional Aspects –
Principles for Design

EN 574, ISO/DIS 13851

Safety of Machinery – Two-hand
control devices – Functional Aspects
– Principles for Design

prEN 811, ISO 13853

Safety of Machinery – Safety
Distances to Prevent Danger Zones
Being Reached by the Lower Limbs

EN 954-1, ISO 13849

Safety of Machinery – Safety Related
Parts of Control Systems

EN 999, ISO/DIS 13855

Safety of Machinery – The Positioning
of Protective Equipment in Respect to
Approach Speeds of Parts of the
Human Body

EN 1050, ISO 14121

Safety of Machinery – Principles of
Risk Assessment

EN 1088, ISO 14119

Safety of Machinery – Interlocking
Devices Associated with Guards –
Principles for Design and Selection

IEC/EN 60204-1

Electrical Equipment of Machines
Part 1: General Requirements

IEC/EN 61496

Safety of Machinery – Electro-
sensitive Protection Equipment

IEC 60529

Degrees of Protection Provided by
Enclosures

IEC/EN 60947-5-1

Low Voltage Switchgear –
Electromechanical Control Circuit
Devices

IEC/EN 60947-1

Low Voltage Switchgear –
General Rules

Appendix A. Mute Timing Sequences

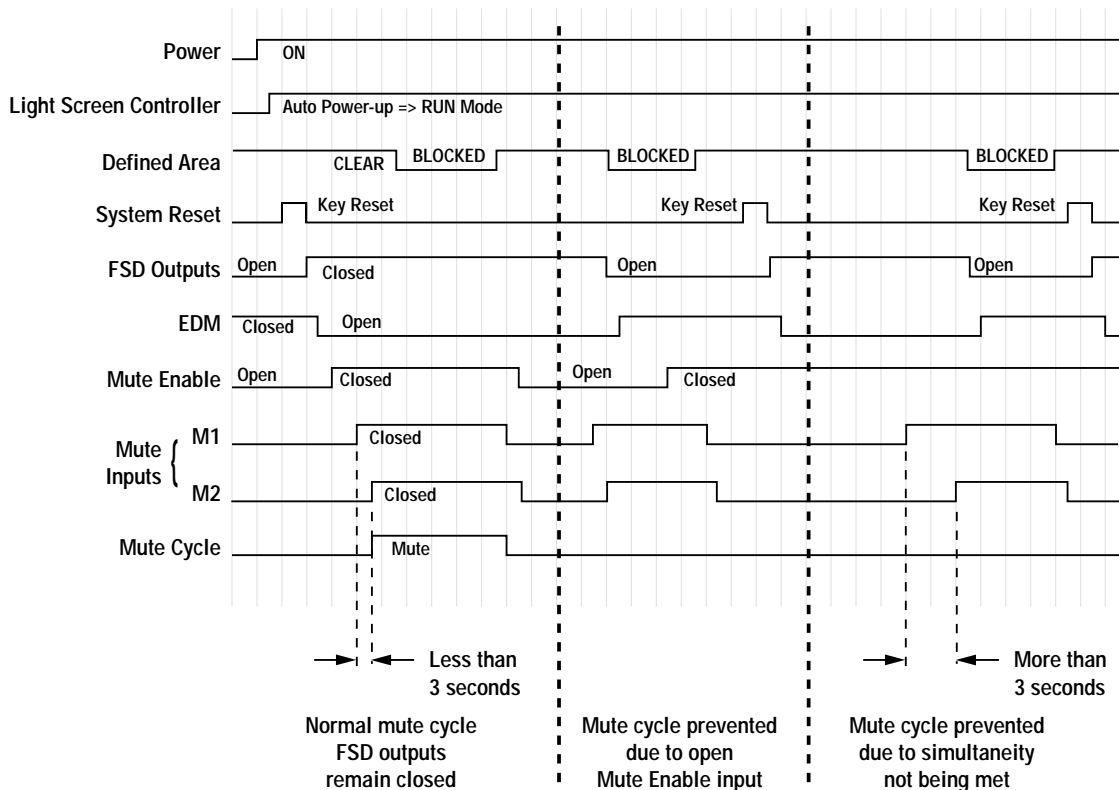
Muting Sequence with Two Muting Devices

(For example, "X"-pattern Entry/Exit System, see Figure C-1, page 97)

Light Screen and System Switch Configuration*:

- Light Screen Auto Power-up enabled . . .Light Screen Controller SW1 = ON
- Floating Blanking disabledLight Screen Controller SW2 and SW3 = OFF
- System Auto Power-up disabledSystem Controller SW1 = OFF
- Monitored Muting LampSystem Controller SW2 = ON
- Two-Way MutingSystem Controller SW3 = ON
- One-Channel MonitoringSystem Controller SW4 = OFF
- 30-Second Backdoor TimerSystem Controller SW5 and SW6 = OFF

* Configuration DIP Switches of both banks A and B on both the Light Screen controller board and the System controller board.



Note: A mute cycle begins 100 ms after the second mute input becomes active, if all other conditions are met.

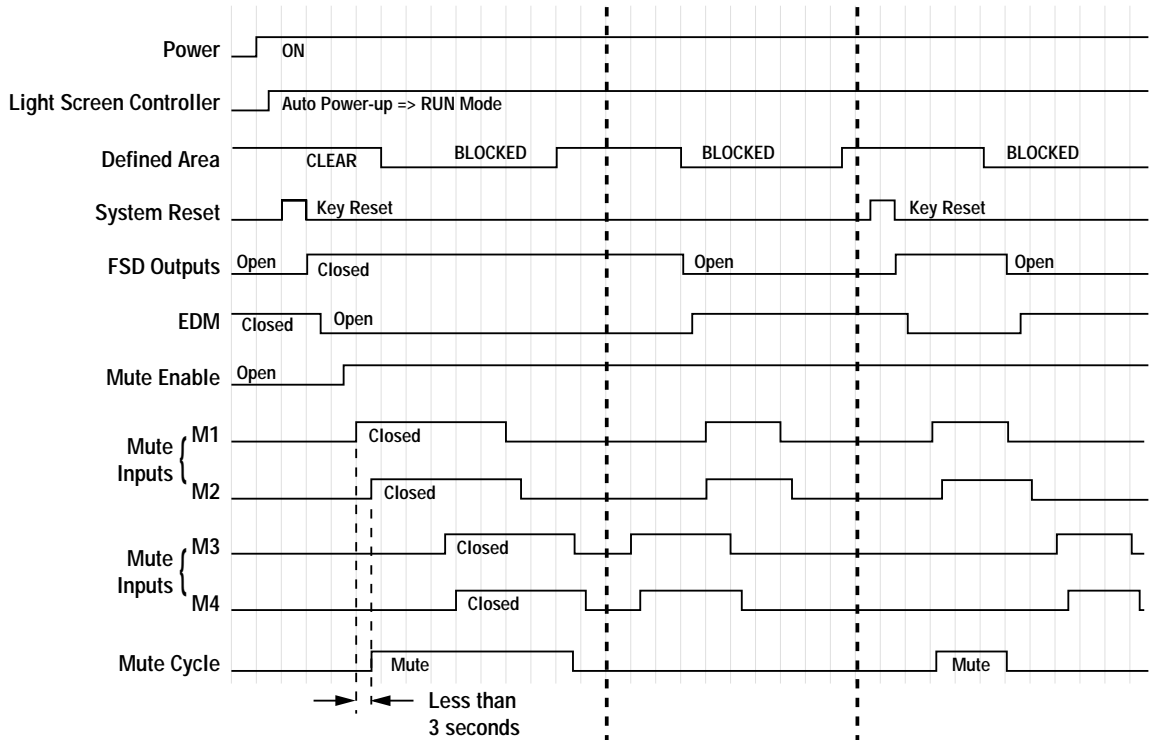
Muting Sequence with Four Muting Devices

(For example, an Entry/Exit System using four photoelectric devices; see Figure C-5, page 98)

Light Screen and System Switch Configuration*:

- Light Screen Auto Power-up enabled . . .Light Screen Controller SW1 = ON
- Floating Blanking disabledLight Screen Controller SW2 and SW3 = OFF
- System Auto Power-up disabledSystem Controller SW1 = OFF
- Monitored Muting LampSystem Controller SW2 = ON
- One-Way mutingSystem Controller SW3 = OFF
- One-Channel MonitoringSystem Controller SW4 = OFF
- 30 Second Backdoor TimerSystem Controller SW5 and SW6 = OFF

* Configuration DIP Switches of both banks A and B on both the Light Screen controller board and the System controller board.



Normal mute cycle
FSD outputs
remain closed

Note: A mute cycle begins 100 ms after the second mute input becomes active, if all other conditions are met.

One-Way Muting:
Mute cycle prevented due to mute devices M3 and M4 closing before M1 and M2.

Two-Way Muting:
A normal mute cycle would occur.

Mute cycle drops out and the FSD outputs open due to M3 and M4 not closing before M1 or M2 open, when the defined area is blocked. Since one-way muting has been selected, M3 and M4 can not initiate a mute cycle.

Appendix B. Examples of Muting Sensors and Switches

Photoelectric Sensors (opposed mode)

NOTE: Opposed-mode sensors, which initiate the muted condition when the beam path is blocked, must be configured for dark operate and have open (non-conducting) output contacts in a power OFF condition. Examples include, but are not limited to:

Q853E (emitter) and Q85VR3R-T9 (receiver)

Set to Dark Operate (DO) with No Delays (SW1=0, SW2=1, SW3=1)

N.O. Relay contact to mute device input (see Section 3.5.4).

24 to 240V ac or 12 to 240V dc

Range: maximum 23 m (75'), adjustable

EZ-Beam Family

S18, Q25, T18, S30, Q40, and T30 Opposed Mode

NPN and PNP output (one of each required)

Set to Dark Operate (N.C.) output configuration

10 to 30V dc

Range: see catalog for specifications

MINI-BEAM Family

SM31EL (emitter) and SM31RL (receiver)

Set to Dark Operate (DO)

Bipolar outputs

10 to 30V dc

Range: maximum 30 m (100'), adjustable

Q452E (emitter) and Q45VR2R (receiver)

Set to Dark Operate (DO)

N.O. Relay contact to mute device input (see section 3.5.4).

90 to 250V ac

Range: maximum 60 m (200'), adjustable

Photoelectrics (polarized-retroreflective):

Warning: The user must ensure that false "proxing" (activation due to shiny or reflective surfaces) is not possible. Banner "LP" sensors with linear polarization can greatly reduce or eliminate this effect.

NOTE: Configure sensors for Light Operate (LO or N.O.) if initiating a mute when the retroreflective target or tape is detected (e.g., home position). Configure sensors for Dark Operate (DO or N.C.) when a blocked beam path initiates the muted condition (e.g., entry/exit).

Both situations must have open (non-conducting) output contacts in a power OFF condition.

EZ-Beam Family (10 to 30V dc supply voltage)

Range values are approximate.

S18, Q25, and T18 Polarized Retroreflective Mode

NPN and PNP output (one of each required)

Range: 110 mm to 400 mm (4.3" to 16") using BRT-THG-3x3 or -3-100 tape
80 mm to 1000 mm (3.1" to 39.4") using BRT-3 3" reflector

S30, Q40, and T30 Polarized Retroreflective Mode

NPN and PNP output (one of each required)

Range: 105 mm to 1070 mm (4.1" to 42.1") using BRT-THG-3x3 or -3-100 tape
90 mm to 1300 mm (3.5" to 51.2") using BRT-3 3" reflector

Q45 (10 to 30 V dc supply voltage)

Range values are approximate.

Q45BB6LLP/ Q45BB6LP

Bipolar outputs

LLP Range: 400 mm to 1300 mm (16" to 51.2") using BRT-THG-3x3 or -3-100 tape
600 mm to 40 m (24" to 130') using BRT-2x2 reflector

LP Range: 150 mm to 6 m (6" to 20') using BRT-3 reflector

Q45 (90 to 250 V ac supply voltage)

Range values are approximate.

Q45VR2LP

N.O. Relay contact

LP Range: 150 mm to 6 m (6" to 20') using BRT-3 reflector

MINI-BEAM Family (10 to 30 V dc supply voltage)

Range values are approximate.

SM312LP

Bipolar outputs

Range (both): 25 mm to 1.1 m (1" to 44") using BRT-3 reflector
150 mm to 1370 mm (6" to 54"x) using BRT-THG-3x3 or -3-100 Tape

Positive-Drive Safety Switches

Caution: Two (or four) independent switches, each with a minimum of one N.C. safety contact, must be used. *An application using a single switch with a single actuator and two N.C. contacts could result in an unsafe situation.*

Flatpack Style

SI-QS75MC: one N.C. contact (used for muting)

SI-QS90MD: one N.C. contact (used for muting) and
one N.O. contact (used for monitoring)

SI-QS90ME: one N.C. contact (used for muting) and
one N.C. contact (used for interlocking)

SI-QS90MF: one N.C. contact (used for muting),
one N.C. contact (used for interlocking), and
one N.O. contact (used for monitoring)

See Banner Engineering Safety catalog for other available safety switches.



WARNING . . .
User is Responsible
for Safe Application
of this Product

The muting application examples described in Appendix C depict generalized guarding situations. Every guarding application has a unique set of application requirements. **Use extreme care to meet all legal requirements and follow all installation instructions.**

In addition, any questions regarding safeguarding should be directed to the factory applications department at the telephone number or addresses listed on the front cover.



WARNING . . .

- It must not be possible for an individual to block both photoelectric beams (dashed diagonal lines in Figure C-1) and initiate a mute condition. Check the installation to verify that unintentional muting is not possible. The “crossing point” of the photoelectric beams must be located in the hazardous area and not be accessible to personnel (by reaching over, under, through, or around).
- It must not be possible for personnel to walk in front of, behind, or next to the muted object (e.g., the carrier basket) without being detected and stopping the hazardous motion. Supplemental safeguarding must be used to prevent personnel from entering the hazardous area during a mute condition.

Appendix C. Typical Muting Applications

Entry/Exit Applications

The muting devices must be placed to ensure that the points that trigger the mute’s start and end are very close to the safety light screen’s sensing field. This prevents personnel from following, or being pushed by, the object into the hazardous area without interrupting the safety light screen before the mute window opens or at the time the mute window closes.

When two pairs opposed-mode photoelectrics are used as muting devices, as shown below, the crossing point of the two sensing paths must be on the hazardous side of the safety light screen. The safety light screen will be interrupted before any personnel would be able to block both beams and mute the system. The devices should detect the material and not the pallet or the transport in order to hinder an individual from riding into the hazardous area.

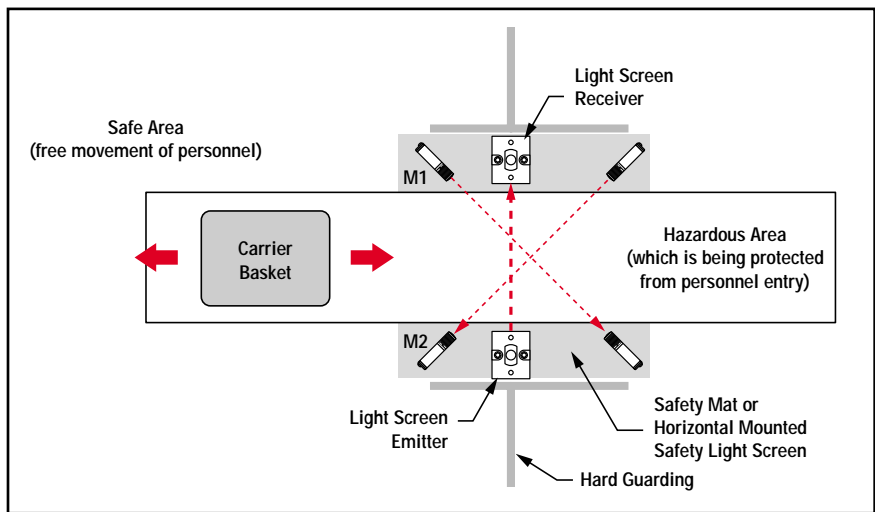


Figure C-1. “X”-Pattern Entry/Exit system using two pairs of opposed-mode photoelectric muting devices

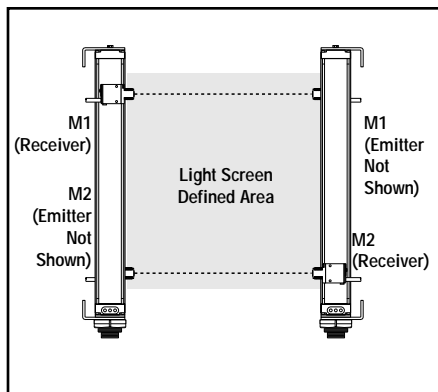


Figure C-2. Horizontal photoelectric muting devices placed at different heights

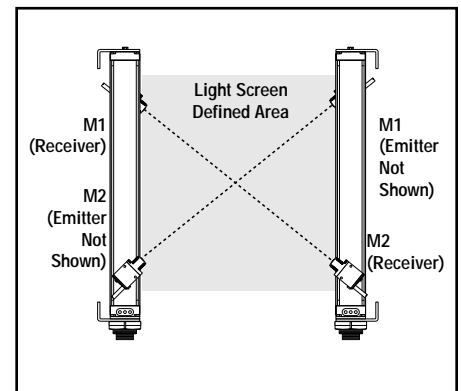


Figure C-3. Photoelectric muting devices placed diagonally

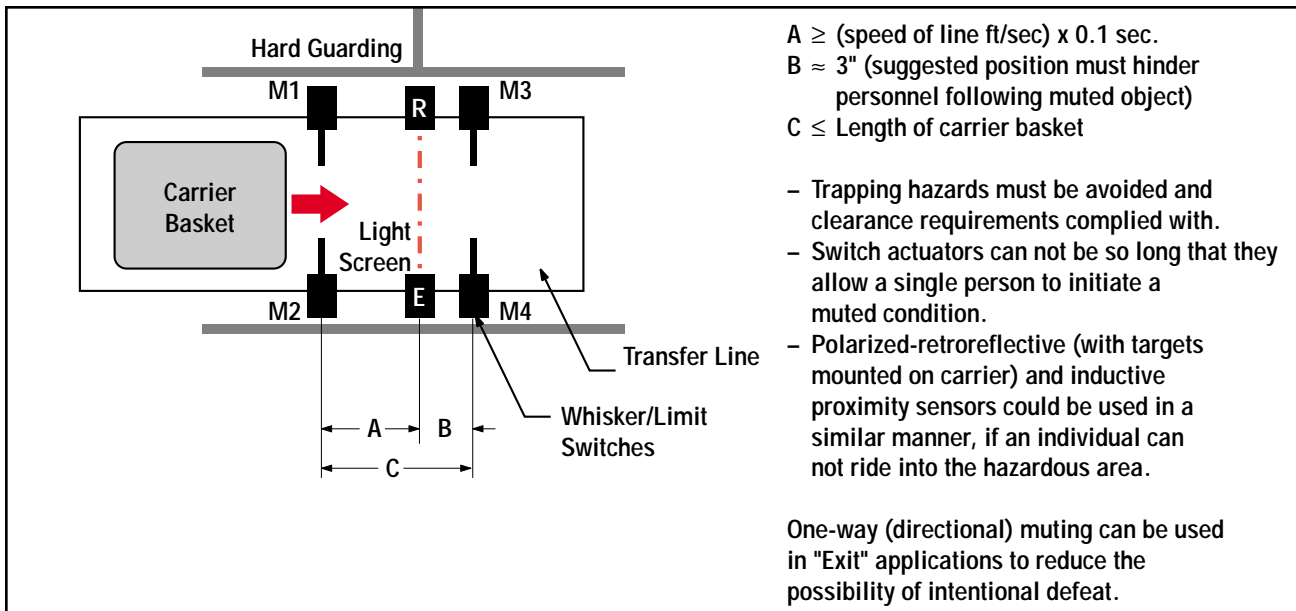


Figure C-4. Entry/exit system using 4 whisker/limit switches as muting devices

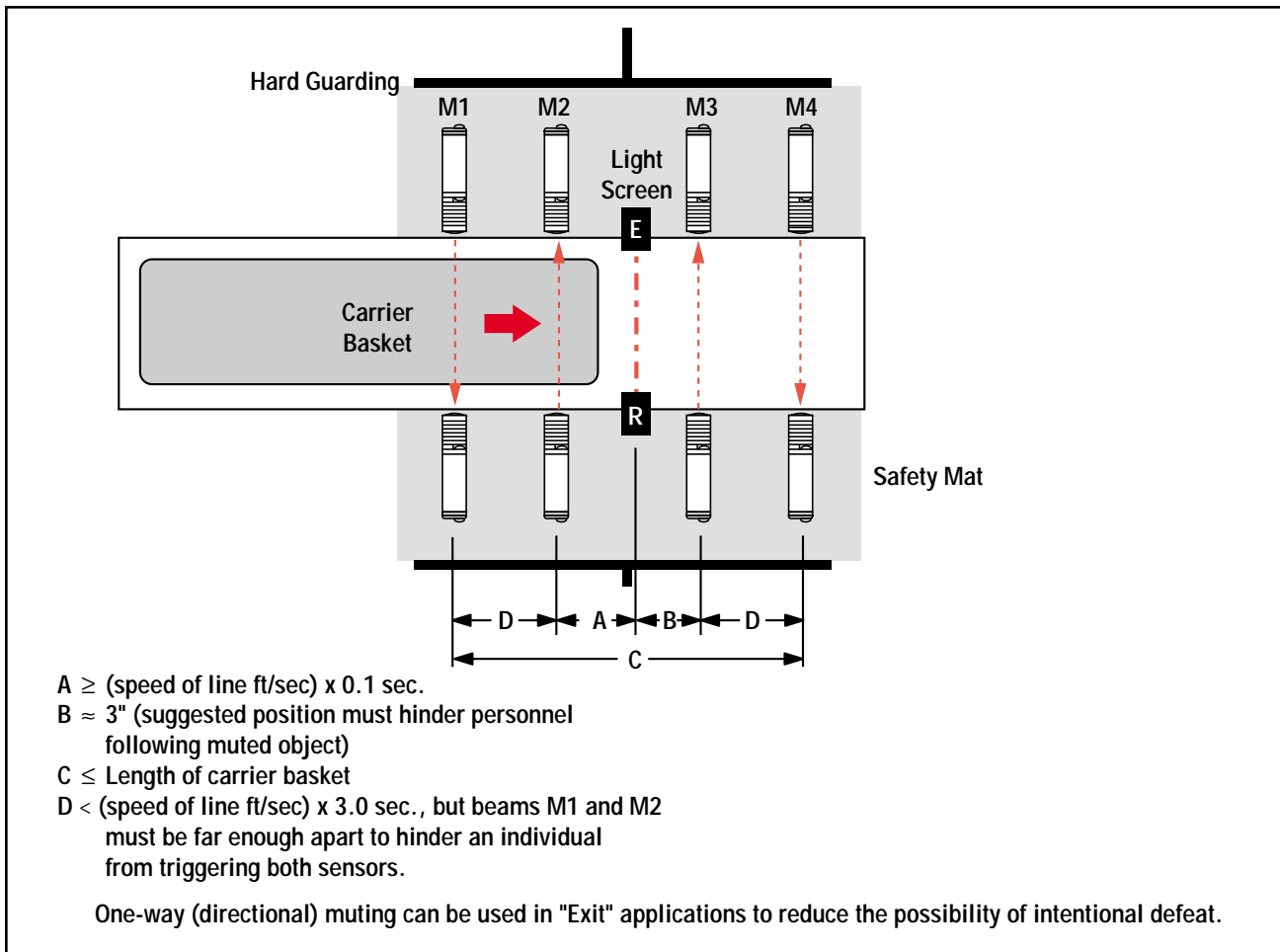


Figure C-5. An entry/exit system using four photoelectric sensors as M1, M2, M3, and M4



WARNING . . .
User is Responsible
for Safe Application
of this Product

The muting application examples described in Appendix C depict generalized guarding situations. Every guarding application has a unique set of application requirements. **Extreme care is urged to ensure that all legal requirements are met and that all installation instructions are followed.**

In addition, any questions regarding safeguarding should be directed to the factory applications department at the telephone number or addresses listed on the front cover.

Home or Station Applications

The muting devices must be placed to ensure that the safety light screen is muted *only* when the hazard does not exist or is in another area so that personnel are not exposed. The muting devices must be placed so that if a hazard arises, or the hazard enters the safeguarded area, the mute will immediately end and the safeguard will be active once again.

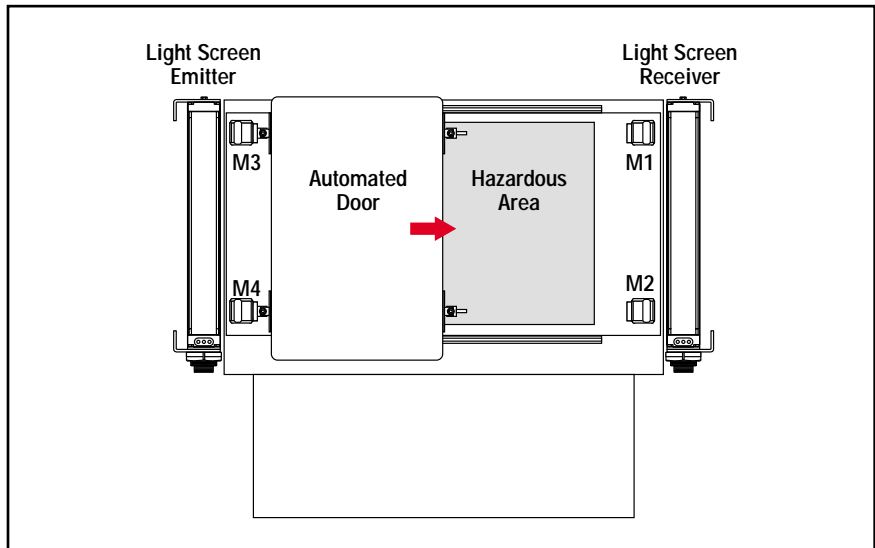


Figure C-6. A “home position” (door) muting application, using 4 safety switches as muting devices

In “home position” muting applications, the light screen is active only while motion is taking place or a hazard is present, such as the closing of an automated door. In this example, the door is interlocked and the machine can not start until the opening is completely closed. The hazard being guarded by the light screen is the pinch point caused by the door closing.

M3 and M4 could be two SI-QS75MC safety switches, each with a single safety contact used for the muting input. M1 and M2 could be SI-QS90MF safety switches, each with two safety contacts (one for muting and one for interlocking) and one monitoring contact for a logic input.

If the light screen is also guarding hazards within the enclosure when the door is open or preventing cycle initiation, then switches M3 and M4 would not be used. The door could also be “locked” by using locking style safety switches, such as the SI-QM100 or SI-LS42 as M1 and M2.

Robot Load/Unload Station Application

This “station” muting application uses two independent safety light screen circuits, each with its own muting circuit and muting devices (e.g. polarized-retroreflective photoelectrics). The application also includes run bars with two-hand control, auxiliary controls, and E-Stop. The two-hand control is provided at each station to safeguard the operator during the momentary clamping action of the fixture while the safety light screen is muted.

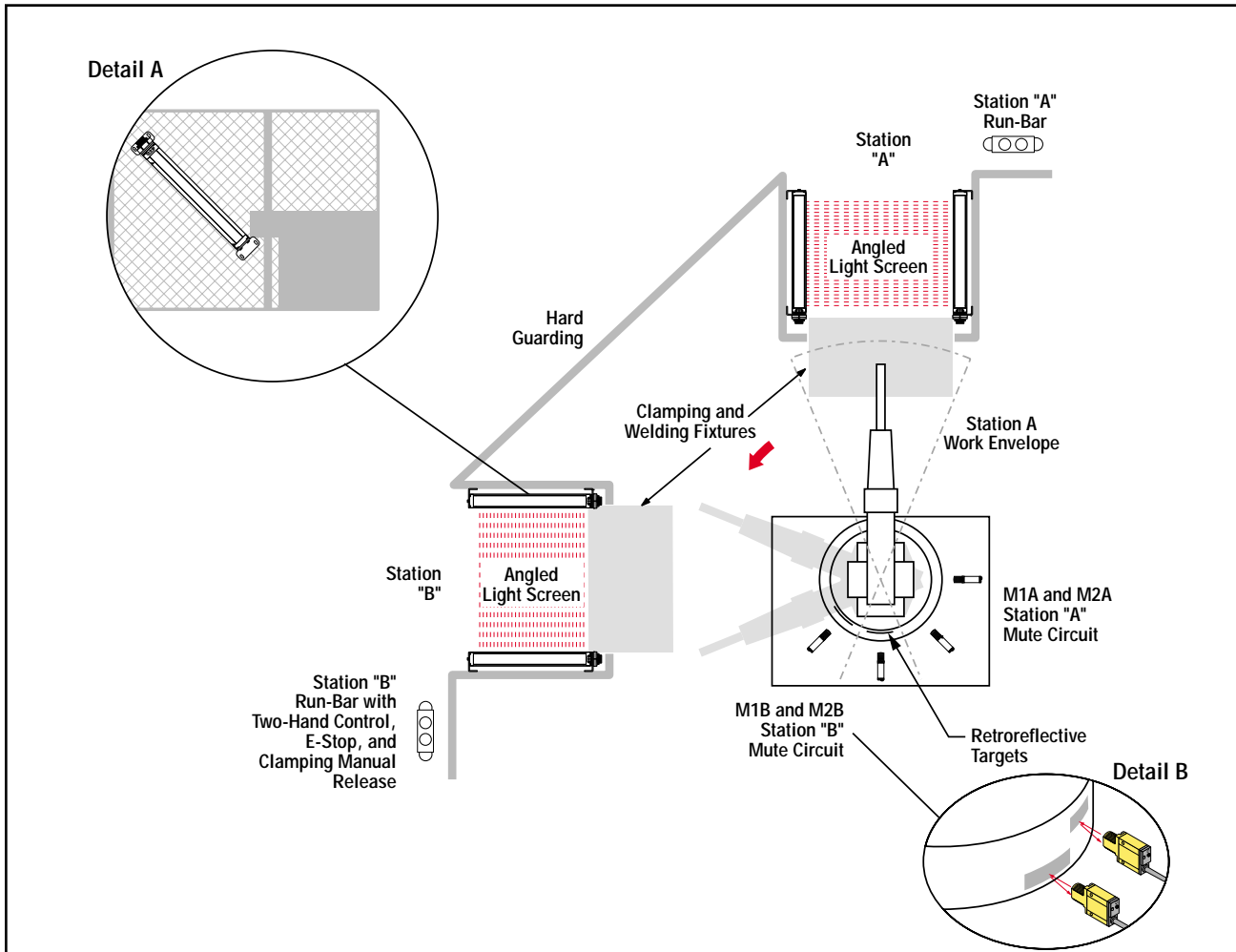


Figure C-7. A robot load/unload application with two-station home-position muting, using polarized retroreflective photoelectrics as muting devices.

In this example, the safety light screens are angled outwards (see detail A). This provides proper separation distance from the hazards created by the robot and the clamping/welding fixtures, while protecting against the possibility of pass-through hazards (section 3.2.1.1). In muting applications involving an operator, the operator must be continually detectable by the defined area. This ensures that if a hazard arises, causing the mute to end while the operator is present, the safety light screen will immediately issue a stop.

While the robot is at station “A”, the light screen at station “B” is muted (M1B and M2B are active), allowing the operator to load or unload without issuing a stop command to the robot. As the robot moves out of the “A” work envelope (as defined by Station “B” mute devices, see detail B) the mute discontinues at station “B”. If the operator is still within the protected area, a stop command is immediately issued. As the robot moves to the work envelope of station “B”, the mute devices M1A and M2A activate and mute the safety light screen at station “A.”

Turret Table Application

A "Turret Table" application is similar to the Robot Load/Unload Station muting application, except that any movement of the table ends the mute. To accomplish this, small retroreflective targets (or tape) are positioned so that they will initiate the mute (the sensors must be set to "Light Operate") only after the table has finished indexing. (NOTE: The example shows four pairs of targets, one pair for each position.) When the table begins indexing again, the polarized-retroreflective photoelectrics immediately "lose sight" of the targets and end the mute. Since the rotation of the table is the hazard, the size and positioning of the targets must prevent muting while motion is taking place.

The top of the emitter and receiver are angled outwards to maintain proper separation distance while preventing a pass-through hazard (see section 3.2.1.1). Hard guarding, or other safeguarding, must be positioned to prevent personnel from reaching through and accessing any hazard.

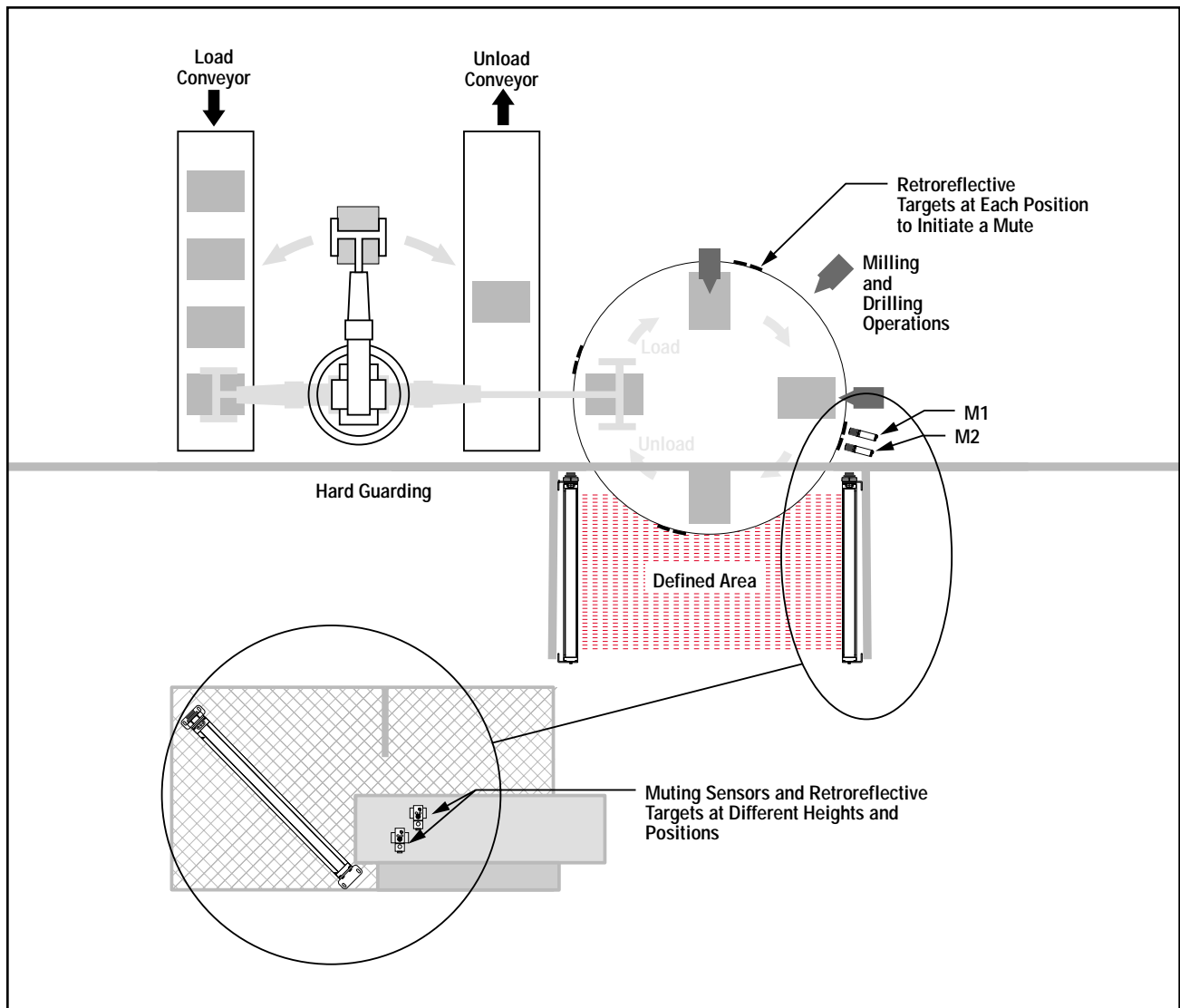


Figure C-8. A typical application for turret table inspection or operation station muting, using retroreflective photoelectric sensors as muting devices.

Power Press Applications

Muting is allowed on power presses only during the non-hazardous portion of the cycle (e.g. the upstroke), per OSHA1910.217, ANSI B11.1, B11.2, and B11.3. The mute permits the insertion or removal of material into the press that would otherwise block the sensing field of the safety light screen, causing the press to stop. Muting should not be confused with "Inch" or "Jog" modes, whose manual selection may bypass the safety light screen within the machine control.

For the proper application of muting on a power press, at a minimum, two (or four) independent position switches (such as cam-operated limit switches, inductive prox sensors, or pressure switches) must be used to initiate the mute during the non-hazardous portion of the machine cycle. These position switches would be mute devices M1/M2 (and M3/M4 if used). Typically, these switches have normally open contacts, which are held (or actuated) closed during the mute cycle.

These switches must be mounted separately to prevent misadjustment, misalignment, or a single common mode failure, which would result in an improper mute cycle or otherwise unsafe condition. They must be installed so that they can not be easily defeated or bypassed, and their adjustment should be under supervisory control.

The two (or four) muting devices must be properly adjusted (or positioned) so that they close only after the hazard no longer exists and then open when the cycle is complete (top of stroke) or when the hazard is again present. If improperly adjusted or positioned, injury or death could result.

In muting applications involving an operator, all pass-through hazards must be eliminated so that the operator is continually detected when in the defined area. This ensures that if a hazard arises, causing the mute cycle to end while the operator is present, the safety light screen will immediately issue a stop. (See below and Section 3.2.1.1 on pass-through hazards.)

A "pass-through hazard" is associated with applications that allow personnel to pass through a safeguard, which removes or stops the hazard(s), and then allows the individual to continue into the hazardous area. Subsequently the individual's presence is no longer detected, and the safeguard can not prevent the start or restart of the machine. A pass-through can be created by as little as 75 mm (3") space between the defined area and machine frame. If the safety light screen is muted while the individual passes through the defined area, a stop command will not be issued and the hazard cannot be eliminated; the individual must be detected while entering the safeguarded area and the hazardous motion must stop immediately. This is typically accomplished by supplemental safeguarding such as described in ANSI B11 standards or other appropriate standards.



WARNING . . .
Proper Installation

The user has the responsibility to ensure that all local, state, and national laws, rules, codes, and regulations in any particular application are satisfied. It is extremely important to be sure that all appropriate agency requirements have been met. See pages 90 and 91 for appropriate standards.

MINI-SCREEN

Mute Function and Latch Output



the machine safety specialist

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