MICRO-SCREEN® Instruction Manual

For systems using control module USCC-1L2M and **USCC-2L2M with Mute Function and Latch Output**

MICRO-SCREEN Features

- A compact, modular optoelectronic safeguarding device for smaller light- to medium-duty production machinery
- Choose Standard Series or V-Series emitters and receivers
- Creates a synchronized, modulated infrared light screen in 15 sizes from 100 mm to 1.8 m (4" to 6') 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
- Emergency stop input
- Selectable External Device Monitoring (EDM)
- Control-reliable redundant output relays
- 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
- Two models of heavy-duty control boxes available:
  - USCC-1L2M without fixed blanking
  - USCC-2L2M with fixed blanking

Section Contents

the machine safety specialist

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Applications and Limitations of MICRO-SCREEN® Systems

MICRO-SCREEN Systems *are typically used* in the following applications:

- Small assembly equipment
- Molding presses
- Automated production equipment
- Robotic work cells

MICRO-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.
- MICRO-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 MICRO-SCREEN Systems.

Banner MICRO-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 MICRO-SCREEN™ Systems are intended to perform are regulated by the Occupational Safety and Health Administration (OSHA). However, whether or not any particular MICRO-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 MICRO-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 MICRO-SCREEN Systems be directed to the factory applications department at the telephone number or addresses shown at the bottom of this page.

Banner MICRO-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 MICRO-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 MICRO-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 MICRO-SCREEN System be used on full-revolution clutched machinery.** Banner MICRO-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 MICRO-SCREEN® Systems

ANSI B11 Standards	***Safeguarding of Machine Tools***
ANSI/RIA R15.06	***Safety Requirements for Robot Systems***
NFPA 79	***Electrical Standard for Industrial Machinery***

See pages 90 and 91 for information on these and other applicable standards, and where to acquire copies.

Table of Contents

1. MICRO-SCREEN System Introduction

The Banner MICRO-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.

The USCC-xxxM control box includes 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.

Banner’s microprocessor-based circuit raises the level of control reliability in machine guard design. The MICRO-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 MICRO-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.

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 MICRO-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.

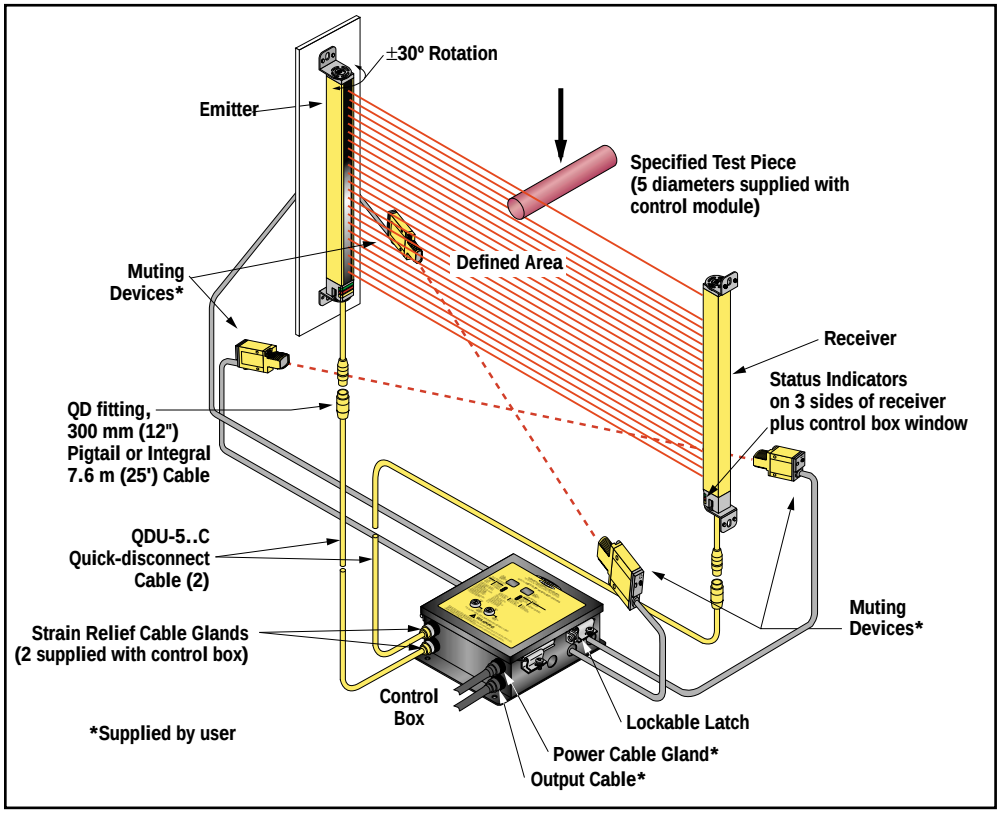


Figure 1-1. Banner MICRO-SCREEN System with Mute Function: emitter, receiver, control module, and two interconnecting cables plus two or four opposed-mode mute input devices and connecting cables

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

Emitters and receivers may have an attached QD (quick-disconnect) connector, a 300 mm (12") pigtail terminated with a QD connector, or an integral, unterminated 7.6 m (25') cable; sensors with the QD connector or pigtail also require a QD mating cable (see page 87).

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 15 lengths (determined by the required height of the defined area) ranging from 100 mm to 1.8 m (4" to 6') (see page 86). The rectangular sensor design includes a swivel bracket at each end for quick mounting and ease of alignment. Longer sensors also include one or two center brackets for additional support. 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.

Emitter/receiver pairs from 102 to 1219 mm (4" to 48") long may be spaced from 15 cm to 9 m (6" to 30') apart. Emitter/receiver pairs 1422 to 1892 mm (56" to 72") long may be spaced from 15 cm to 6 m (6" to 20') apart. The maximum distance between an emitter and its receiver is reduced if corner mirrors are used (see alignment information on page 66). 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 minimum object sensitivity is 19 mm (0.75") for Standard Series sensors, and 32 mm (1.25") for V-Series sensors, when no blanking is in use.

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 style 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.

The control box has the provision to connect an optional Emergency Stop (E-Stop) switch. Resetting the system from an emergency stop, 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 MICRO-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 MICRO-SCREEN Components and Kits

MICRO-SCREEN system components may be purchased separately, or they may be purchased bundled together in kit form. The components are listed on pages 86 and 87.

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 MICRO-SCREEN components are not required. Any MICRO-SCREEN System emitter and receiver (having the same lengths and number of beams) may be used together with any control box.

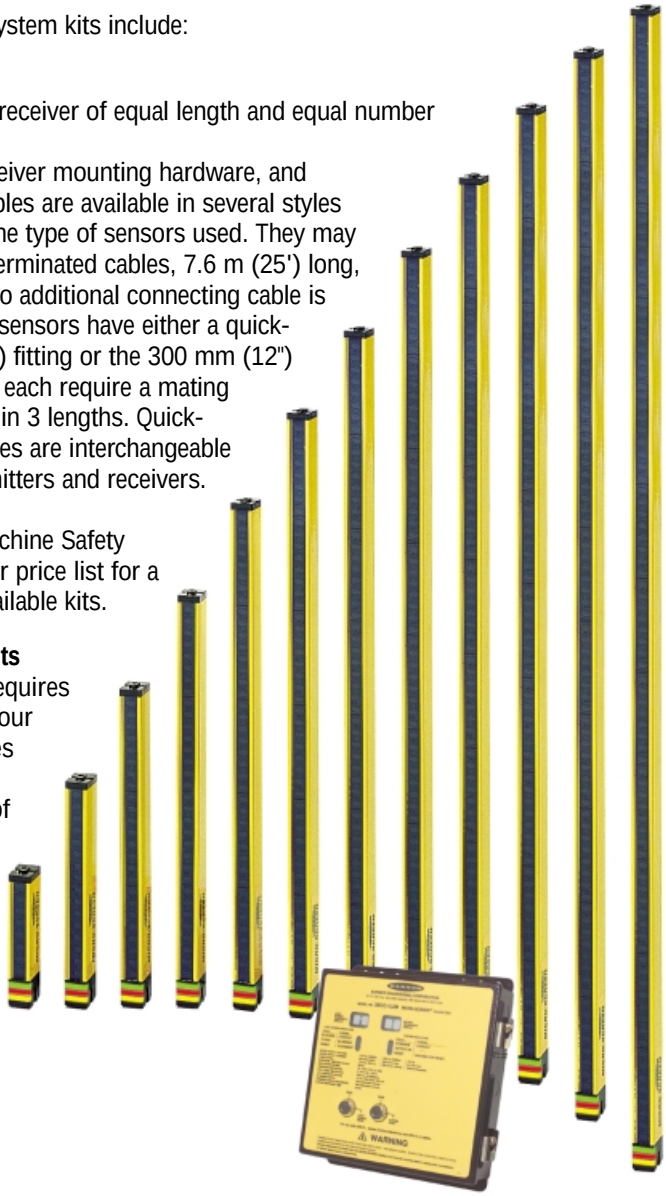
A functional schematic diagram of the MICRO-SCREEN System appears on page 16. For MICRO-SCREEN System dimension drawings, see pages 32 and 33. For specifications, see pages 83-85.

MICRO-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. Cables are available in several styles depending on the type of sensors used. They may be integral, unterminated cables, 7.6 m (25') long, in which case no additional connecting cable is required. If the sensors have either a quick-disconnect (QD) fitting or the 300 mm (12") pigtail QD, they each require a mating cable, available in 3 lengths. 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 A of this manual.



2. Overview of MICRO-SCREEN System Operation

In operation, an emitter and receiver (of equal length) 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") for Standard Series emitters and receivers, and 25.4 mm (1.0") for V-Series emitters and receivers.

Individual features of the MICRO-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)
- Emergency Stop Switch Input (Section 2.6)
- Output Relay Operation (Section 2.7)
- Control Reliability: Redundancy and Self-Checking (Section 2.8)
- Remote Test Input (Section 2.9)
- External Device Monitoring (Section 2.10)
- Mute Functions (Section 2.11)

2.1 Blanking

The MICRO-SCREEN System features floating blanking and optional fixed blanking (available on control box model USCC-2L2M); 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 MICRO-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

Floating Blanking Program	Standard Series Sensors		V-Series Sensors	
	Maximum Size of Undetected Objects	Minimum Object Sensitivity	Maximum Size of Undetected Objects	Minimum Object Sensitivity
OFF	(Not applicable)	19.1 mm (0.75")	(Not applicable)	31.8 mm (1.25")
1-beam	7.6 mm (0.30")	31.8 mm (1.25")	20.3 mm (0.80")	57.5 mm (2.25")
2-beam	20.3 mm (0.80")	44.5 mm (1.75")	45.7 mm (1.80")	82.6 mm (3.25")

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) **Control Box USCC-1L2M, without fixed blanking:** Selecting one- or two-beam floating blanking will affect the overall minimum object sensitivity, which allows multiple objects to move through the defined area (see table, above). This is also called "reduced resolution" or "multiple-point floating blanking."

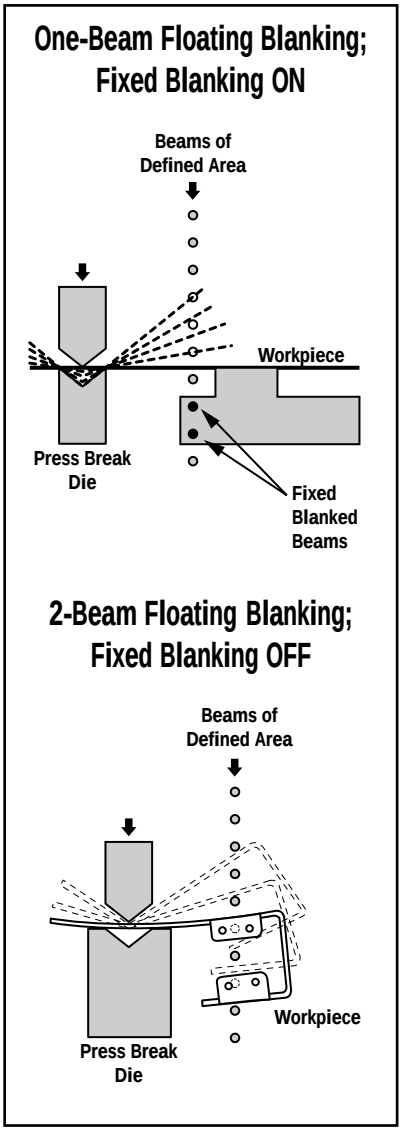


Figure 2-1. Floating and fixed blanking

3) **Control Box USCC-2L2M, with fixed blanking:** 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, on page 8).

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 module (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 34 and 46 for programming information.

2.2 Auto Power-up

Normal operation of the MICRO-SCREEN System with Muting (USCC-xL2M) 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 automatically power up when power is applied and the defined area is clear.

WARNING . . .
Use of Auto Power-up
Application of power to the MICRO-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 MICRO-SCREEN is placed in RUN mode.

2.3 Lockout Conditions and Key Resets

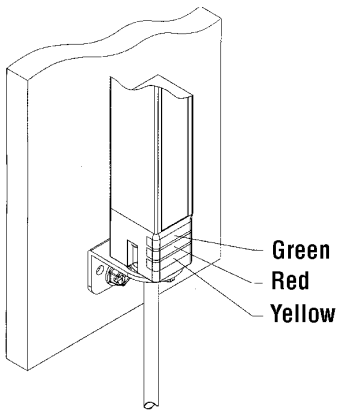
Lockouts
A lockout condition of the MICRO-SCREEN System causes all of its output relays to open, sending a “stop” signal to the guarded machine. A description of possible lockouts, their causes, troubleshooting hints, and Key Reset sequences are listed in section 5.

A lockout condition of the Light Screen portion of the System is indicated by a flashing red status indicator on the MICRO-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 33, “Mounting the Control Box”).



Indicator	On Steady	Flashing
Green	CLEAR	BLANKING
Red	BLOCKED	LOCKOUT
Yellow	RESET	ALIGNMENT

(Three sides of receiver) See also Figures 2-4 and 2-5, pages 13-14.

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

2.4 Operating Status Indicators

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

The MICRO-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 steadily 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 3.5.16, page 52).

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.

Yellow (only) double-flashing: A power-up or power interrupt lockout condition exists. *These lockouts occur in the normal course of powering up the MICRO-SCREEN System or upon an interruption of power to the System* (unless Auto Power-up is ON; see pages 34-35).

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 MICRO-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 2.11.6 for description.

Red (only) single-flashing: A lockout condition of the System controller board has occurred. See Section 5, page 55 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 MICRO-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).

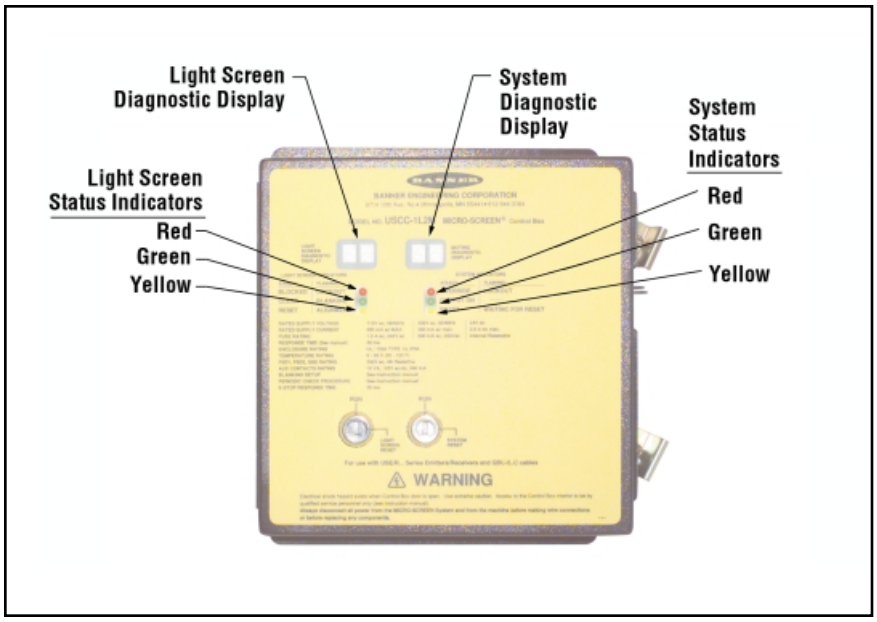


Figure 2-3. Control box indicator LEDs

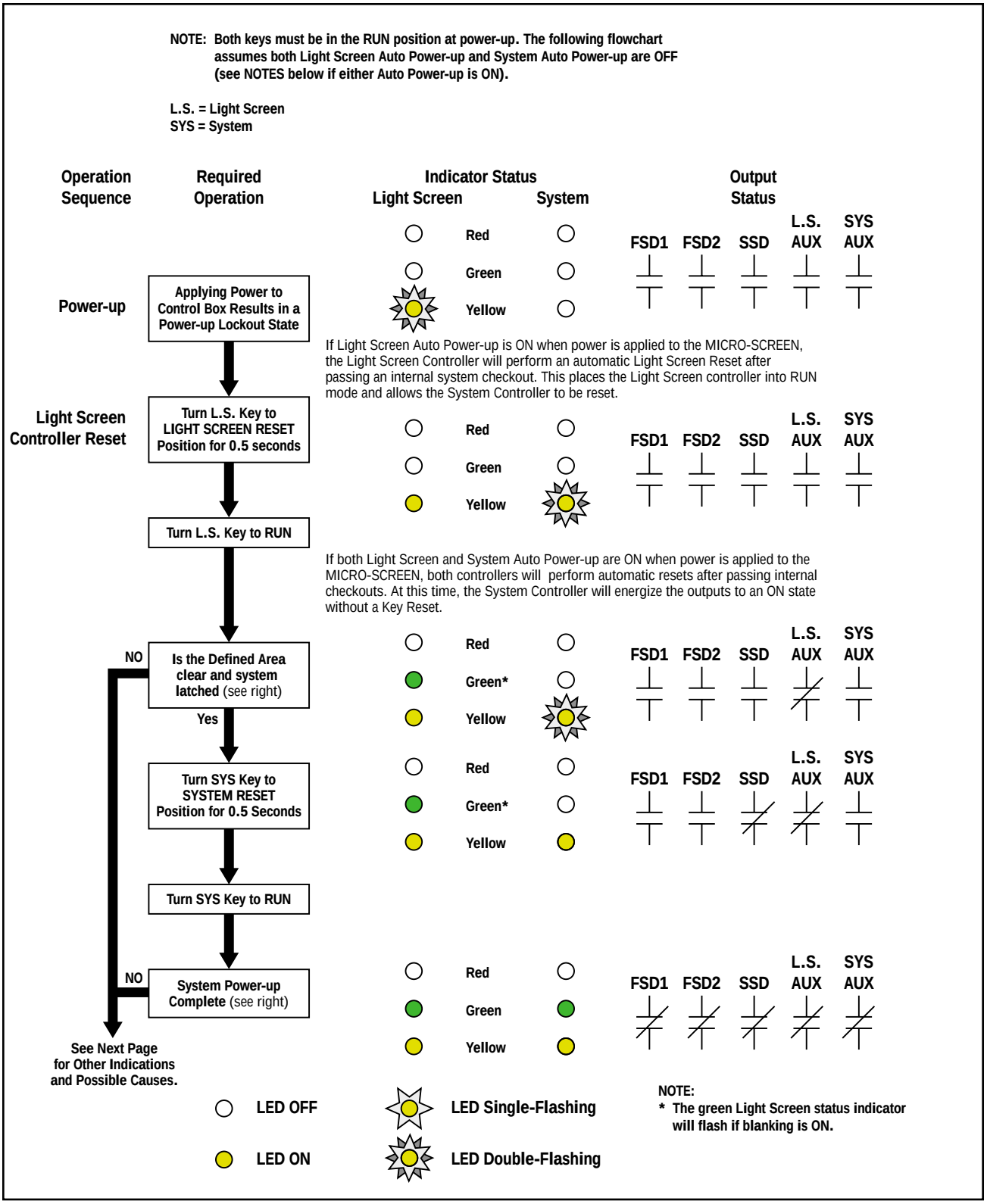


Figure 2-4. Operating status conditions

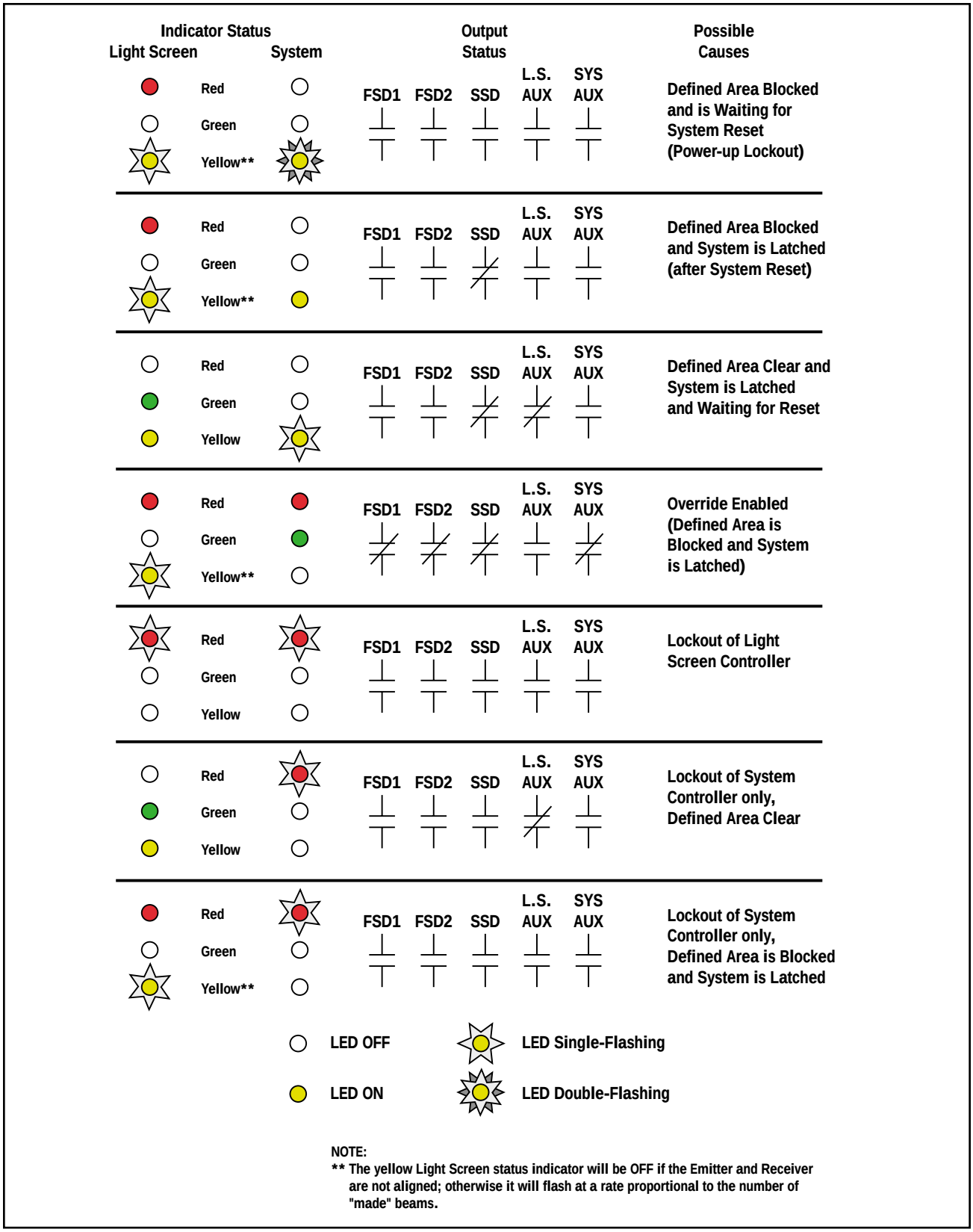


Figure 2-5. Using the controller's Indicator LEDs to check System status and troubleshoot problems

2.5 Diagnostic Displays

Dual two-digit numeric displays, visible through clear windows in the MICRO-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 normal operation.
- The total number of blocked beams, during programming of fixed blanking (control box USCC-2L2M).
- High levels of electrical and optical noise (the decimal point of the display will flash).
- Normal conditions, and no beams blocked (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 Emergency Stop Switch Input

The control box has a provision to connect an optional Emergency Stop switch. This dual-channel input is always functional, even when the MICRO-SCREEN FSD outputs are muted. See section 3.5.10 for complete information.

2.7 Output Relay Operation

The MICRO-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.

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 MICRO-SCREEN System itself (see Control Reliability, Section 2.8).

The MICRO-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.) and the System Auxiliary (Sys. Aux.) 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.

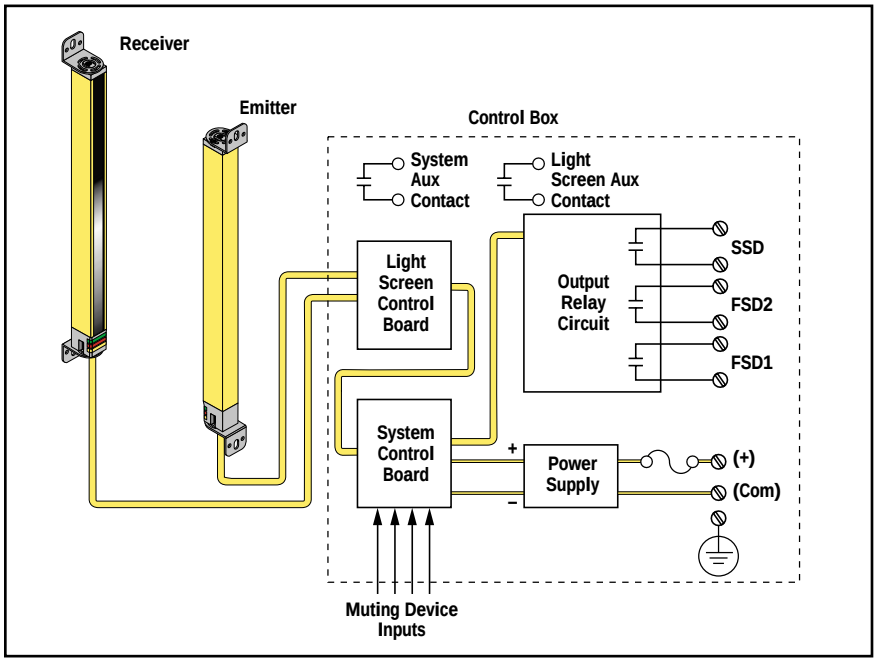


Figure 2-6. Banner MICRO-SCREEN System with Muting functional schematic

2.8 Control Reliability: Redundancy and Self-Checking

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

1) The MICRO-SCREEN System must provide a "stop" signal to the guarded machine, within 48 milliseconds, whenever the defined area is interrupted.

   In order for the machinery guarded by the MICRO-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 MICRO-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 MICRO-SCREEN System must provide a "stop" signal to the guarded machine when internal component failures have occurred which compromise the integrity of the MICRO-SCREEN System itself.

   This type of component failure includes any internal MICRO-SCREEN System failure which could prevent or delay the output relays of the MICRO-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 MICRO-SCREEN System to send a "stop" signal even when such a component failure has occurred depends upon its redundant design.

Redundancy requires that MICRO-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 MICRO-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 MICRO-SCREEN System is in operation. Since a redundant system is no longer redundant once a component has failed, MICRO-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 MICRO-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 56). Possible causes are listed in Section 5. The Diagnostic Display is used to diagnose internal causes of a lockout condition (Section 5.1).

2.9 Remote Test Input

A pair of terminals is provided (see Figure 3-14, page 37) for an external normally open switch. These terminals are labeled “TEST a” and “TEST b” at TB1. 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.

2.10 External Device Monitoring (EDM)

Two pairs of terminals are provided (see Figure 3-14, page 37) for monitoring the state of external devices, such as MPCEs. These terminals are labeled “Monitoring 1a-1b and 2a-2b” at TB8. The MICRO-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 MICRO-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 MICRO-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 58).

- **Two-Channel Monitoring:** a parallel connection of closed monitor contacts that are forced-guided (or captive contact) from each device controlled by the MICRO-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 58).

- **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 2.8, 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).

2.11 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 MICRO-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.

2.11.1 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 39. 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 39 and Appendix B for a partial list of Banner sensors and switches that can be used as muting devices.)

2.11.2 Mute Enable

The Mute Enable input is a non-safety rated input. When the input is closed, the USCC-xL2M 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.

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.

2.11.3 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.

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.

2.11.4 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 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 MICRO-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.

2.11.5 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.

2.11.6 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.

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 pendent) 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.

2.11.7 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, and 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 MICRO-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 MICRO-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 MICRO-SCREEN System.
- As a tripping device to initiate machine motion (PSDI applications) on

CAUTION . . . Install System Only on Appropriate Applications

In order for the machinery guarded by the MICRO-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 MICRO-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 MICRO-SCREEN System, contact Banner’s Application Engineers at the factory.**

WARNING . . .

Read this Section Carefully Before Installing the System

The Banner MICRO-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 MICRO-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 MICRO-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 MICRO-SCREEN System is installed and interfaced to the guarded machine by Qualified Persons in accordance with this manual and applicable safety regulations. A “Qualified Person” is defined as “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/ASME B30.2-1983).

WARNING . . .
Position Components Carefully

The emitter and receiver must be positioned such 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 MICRO-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 MICRO-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.

mechanical power presses, per OSHA regulation 29 CFR 1910.217.

3.2 Installing the Light Screen

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

- Separation distance, and
- Hard guarding.

3.2.1 Separation Distance

The MICRO-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 MICRO-SCREEN System: .048 seconds

D_{pf} =

Floating Blanking	Standard Series Sensors	V-Series Sensors
Floating blanking OFF	D_{pf} = 1.6"	D_{pf} = 3.3"
1-beam blanking ON	D_{pf} = 3.3"	D_{pf} = 6.7"
2-beam blanking ON	D_{pf} = 5.0"	D_{pf} = 31.5" [4]

NOTES:

1) The OSHA-recommended hand-speed constant K has been determined by various studies, and although these studies indicate speeds of 63 in/sec to more than 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, at least 20% should 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.

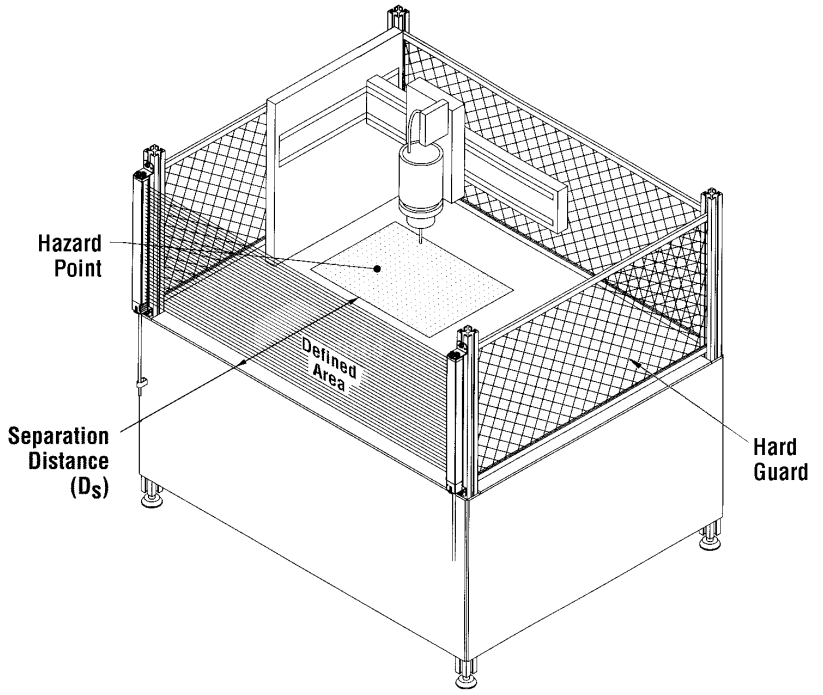


Figure 3-1. Determining separation distance

WARNING . . .

V-Series Sensors Require Greater Separation Distance

The beam spacing for V-Series 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 (Dpf) used to calculate the separation distance is greater for V-Series sensors (see Dpf value chart on page 23).

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

Example: Separation Distance (D_S) Calculation

The following example shows how to use the formula from page 23 to calculate separation (safety) distance (D_S). It uses these numbers for the variables in the formula:

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

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

T_r = .048 second (the specified response time of the MICRO-SCREEN System)

Our example uses two-beam floating blanking with a 24" standard emitter and receiver, so D_{pf} is 5" (page 23). Response time for this example is .048 second. Substitute the numbers into the formula as follows:

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

$D_S = 63 \times (.250 \times 1.2* + .048) + 5 = 27"$

Therefore, in this example, the MICRO-SCREEN emitter and receiver must be mounted so that no part of the defined area will be closer than 27" to the closest reachable hazard point on the guarded machine.

*20% safety factor (see NOTE 2, 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 97-102 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 MICRO-SCREEN Systems for Perimeter Guarding

If a MICRO-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 MICRO-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 for Machine Tools, 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 MICRO-SCREEN System. **Failure to observe this warning could result in serious bodily injury or death.**

4) This number is based on object sensitivity larger than 2.5" and may vary, depending on the standard used, such as ANSI/RIA R15.06 (1999) and EN999.

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

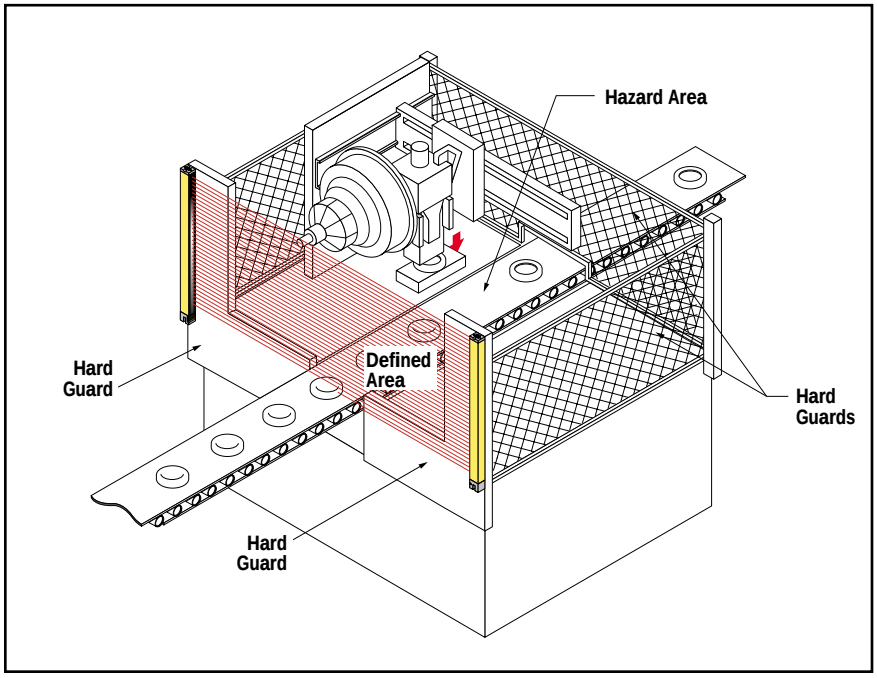


Figure 3-2. Example of hard guarding

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 MICRO-SCREEN System.

WARNING . . .
Proper Orientation of System Emitters and Receivers

The emitters and receivers of the MICRO-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 MICRO-SCREEN System and result in incomplete guarding; see Figure 3-4.

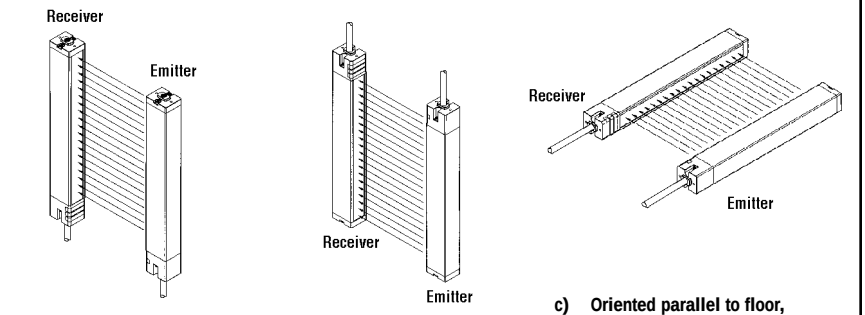
Failure to observe this warning could result in serious bodily injury or death.

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.

3.2.3 Emitter and Receiver Orientation

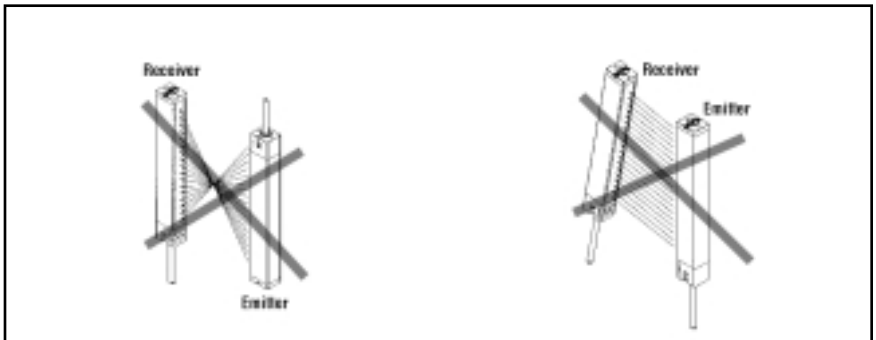
It is absolutely necessary that the emitter and receiver are mounted perfectly parallel to each other and aligned in a common plane with both cable ends pointing in the same direction. Never mount the emitter with its cable end oriented opposite to the cable end of the receiver, or there will be voids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

The emitter and receiver may be oriented in a horizontal plane, in a vertical plane 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 com-



a) Both cable ends down
b) Both cable ends up
c) Oriented parallel to floor, with both cable ends pointing in the same direction

Figure 3-3. Correct emitter and receiver orientation



a) Cable ends point in opposite directions. Problem: Voids in defined area.
b) Emitter and receiver not parallel to each other. Problem: Reduced excess gain

Figure 3-4. Incorrect emitter and receiver orientation

pletely covers all access to the hazard point which is not already protected by hard guarding or another means of supplemental guarding.

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

MICRO-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 66).

Mirrors are not allowed for applications using the MICRO-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.)

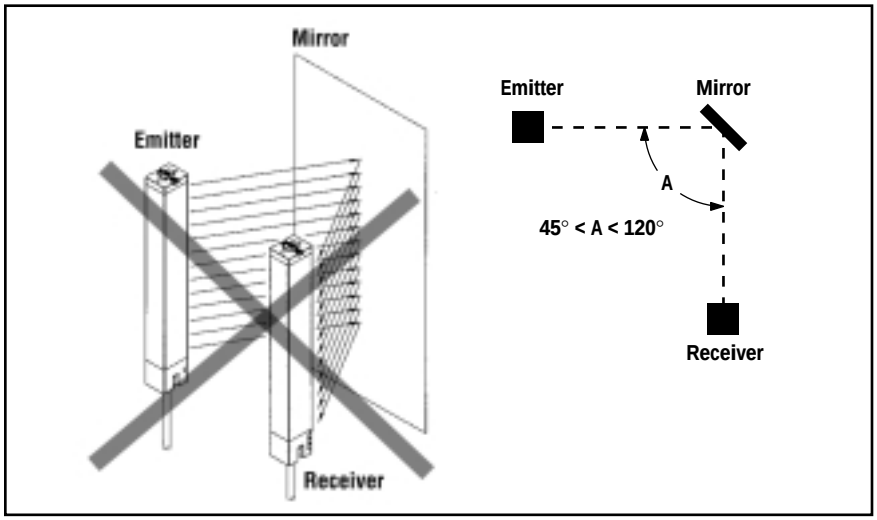


Figure 3-5. If mirrors must be used in a perimeter-guarding application, the difference between the angle of incidence from the emitter to the mirror and from the mirror to the receiver must be between 45° and 120°.

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 MICRO-SCREEN sensors in retroreflective mode, as illustrated in Figure 3-5. The MICRO-SCREEN System is not designed for use in retro-reflective 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.**

Corner mirrors and stands are available from Banner; see page 88.

3.2.6 Installation of Multiple MICRO-SCREEN Systems

Whenever the emitter and receiver pairs of two or more MICRO-SCREEN Systems are located adjacent to one another, there is potential for optical crosstalk to take

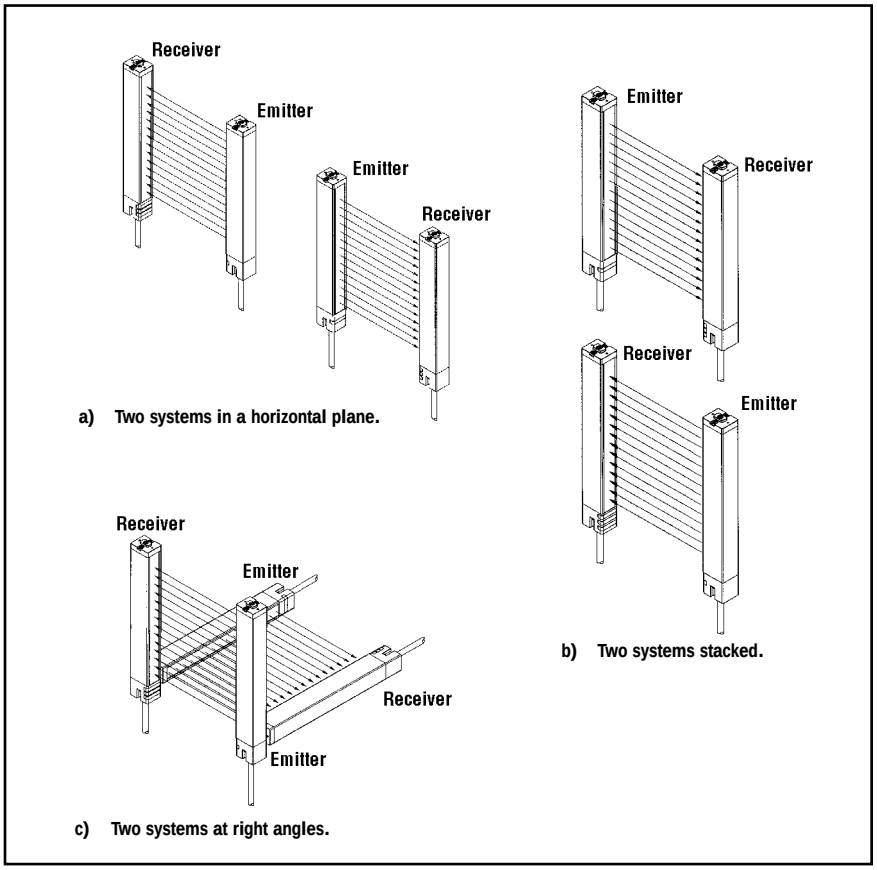


Figure 3-6. Installation of multiple MICRO-SCREEN systems. Alternate emitters and receivers to avoid optical crosstalk.

place between systems. To minimize optical crosstalk, alternate the emitters and receivers, as shown in Figure 3-6.

When three or more systems are installed in a horizontal 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 MICRO-SCREEN System emitters and receivers are small, lightweight, and easy to handle during mounting. The mounting brackets (supplied) allow ±30° rotation.

V-Series emitter/receiver pairs 1422 to 1892 mm (56" to 72") long may be spaced from 15 cm to 6 m (6" to 20') apart. All other emitter/receiver pairs may be spaced from 15 cm to 9 m (6" to 30') apart. The maximum distance between an emitter and its receiver is reduced if corner mirrors are used (see alignment information, page 66).

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 M6 bolts and Keps nuts (all supplied); see Figure 3-8.

Mount the emitter and receiver in their brackets and position the windows 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

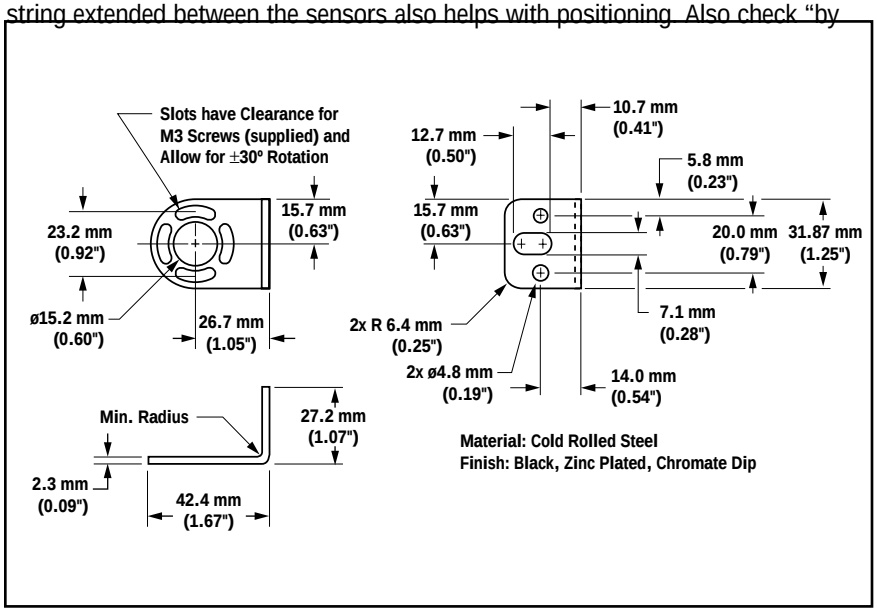


Figure 3-7. Emitter and receiver mounting bracket dimensions

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.

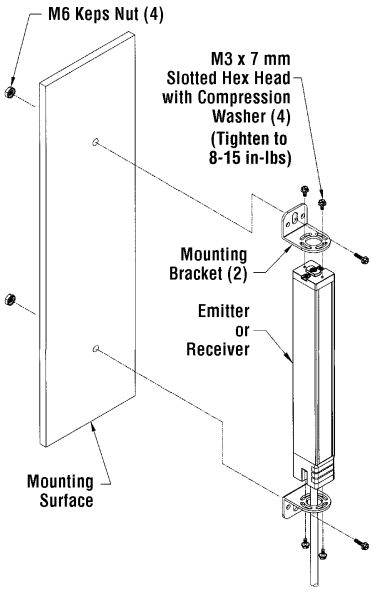
Center Bracket Mounting

Center mounting brackets must be used with longer sensors to provide sensor stability. Sensors 28" to 36" long are supplied with one center bracket, which should be positioned at the center of the sensor's length. Sensors 40" to 72" long are supplied with two center brackets, which should be positioned 1/3 of the sensor's length from each sensor end. Refer to Figure 3-8 for the following steps.

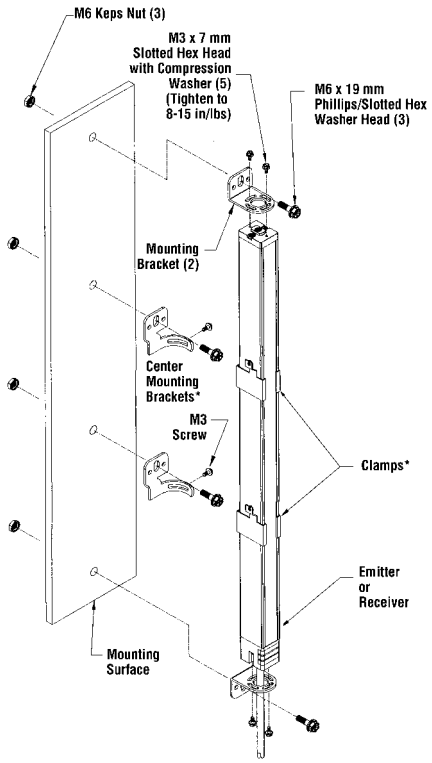
1) Spread the clamp and snap over the back of the sensor so that the clamp is securely fastened to the sensor without blocking any beams.
2) Compress the foam spacer and slide the clamp along the length of the sensor housing to align the clamp with the center mounting bracket as shown in Figure 3-8. Three separate mounting holes are provided on the clamp to allow for all possible mounting configurations.
3) Connect the clamp to the center bracket using the M3 screw supplied.

MICRO-SCREEN Mounting Hardware
(supplied with each emitter and receiver)

4" to 24" Emitters and Receivers



28" to 72" Emitters and Receivers*



NOTE: MICRO-SCREEN sensor brackets are designed to mount directly to MSA Series stands (page 88), using the hardware supplied with the stands.

* 28" to 36" sensors include one center bracket and clamps to be located at the midpoint along the sensor's length.

40" to 72" sensors include two center brackets and clamps to be located at 1/3 of the sensor's length from each end (as shown here).

Figure 3-8. Emitter and receiver mounting

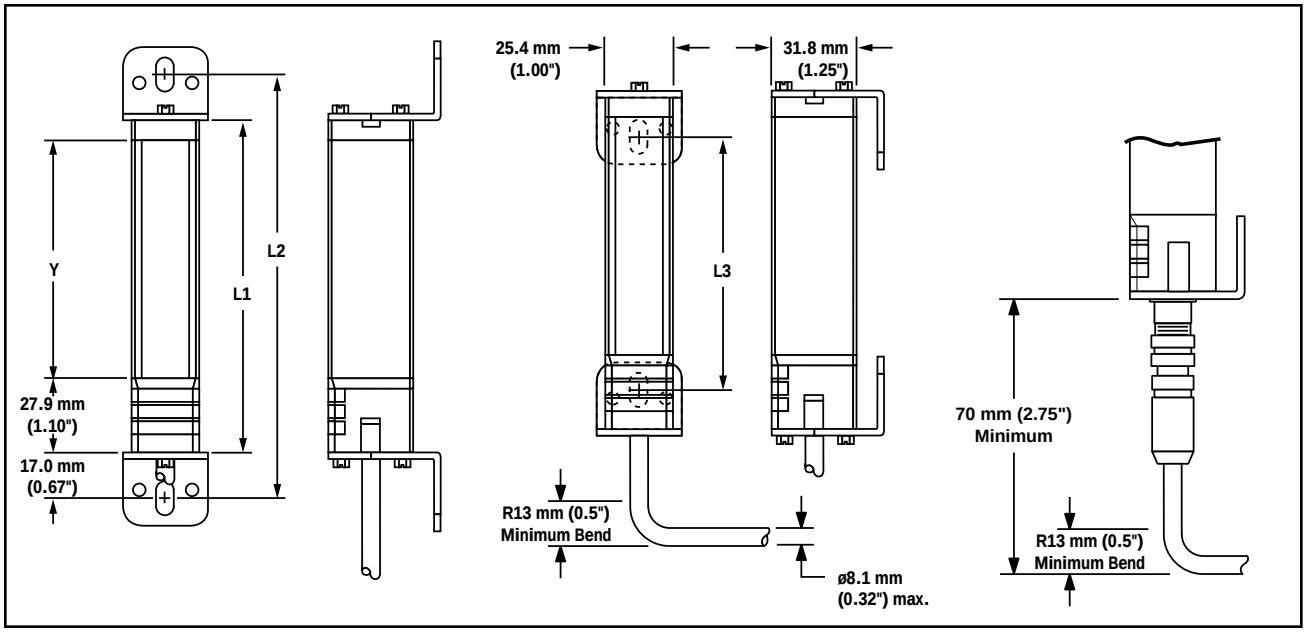


Figure 3-9. Emitter and receiver mounting dimensions and location of defined area

Standard Models	V-Series Models	Housing Length L1	Distance Between Bracket Holes L2	L3	Defined Area Y
Emitter **USE424** Receiver **USR424**		137 mm (5.4")	171 mm (6.7")	108 mm (4.2")	102 mm (4")
Emitter **USE824** Receiver **USR824**		239 mm (9.4")	273 mm (10.7")	209 mm (8.2")	203 mm (8")
Emitter **USE1224** Receiver **USR1224**		340 mm (13.4")	374 mm (14.7")	311 mm (12.2")	305 mm (12")
Emitter **USE1624** Receiver **USR1624**		442 mm (17.4")	476 mm (18.7")	412 mm (16.2")	406 mm (16")
Emitter **USE2024** Receiver **USR2024**		544 mm (21.4")	578 mm (22.7")	514 mm (20.2")	508 mm (20")
Emitter **USE2424** Receiver **USR2424**	Emitter **USE2412** Receiver **USR2412**	645 mm (25.4")	679 mm (26.7")	616 mm (24.2")	610 mm (24")
Emitter **USE2824** Receiver **USR2824**		747 mm (29.4")	781 mm (30.7")	717 mm (28.2")	711 mm (28")
Emitter **USE3224** Receiver **USR3224**	Emitter **USE3212** Receiver **USR3212**	848 mm (33.4")	882 mm (34.7")	819 mm (32.2")	813 mm (32")
Emitter **USE3624** Receiver **USR3624**		950 mm (37.4")	984 mm (38.7")	920 mm (36.2")	914 mm (36")
Emitter **USE4024** Receiver **USR4024**	Emitter **USE4012** Receiver **USR4012**	1052 mm (41.4")	1086 mm (42.7")	1022 mm (40.2")	1016 mm (40")
Emitter **USE4424** Receiver **USR4424**		1153 mm (45.4")	1187 mm (46.7")	1124 mm (44.2")	1118 mm (44")
Emitter **USE4824** Receiver **USR4824**	Emitter **USE4812** Receiver **USR4812**	1255 mm (49.4")	1289 mm (50.7")	1225 mm (48.2")	1219 mm (48")
	Emitter **USE5612** Receiver **USR5612**	1458 mm (57.4")	1491 mm (58.7")	1427 mm (56.2")	1422 mm (56")
	Emitter **USE6412** Receiver **USR6412**	1661 mm (65.4")	1694 mm (66.7")	1631 mm (64.2")	1626 mm (64")
	Emitter **USE7212** Receiver **USR7212**	1864 mm (73.4")	1897 mm (74.7")	1834 mm (72.2")	1829 mm (72")

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 50' (each). Contact factory Applications Department if either or both cables must be longer than 50'. The cable braid at the control box connection points may be either removed or twisted together with the drain wire (see page 37). IMPORTANT: Use ONLY Banner MICRO-SCREEN cables (see page 87).

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.**

Mounting the Control Box

Mount the MICRO-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 MICRO-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.

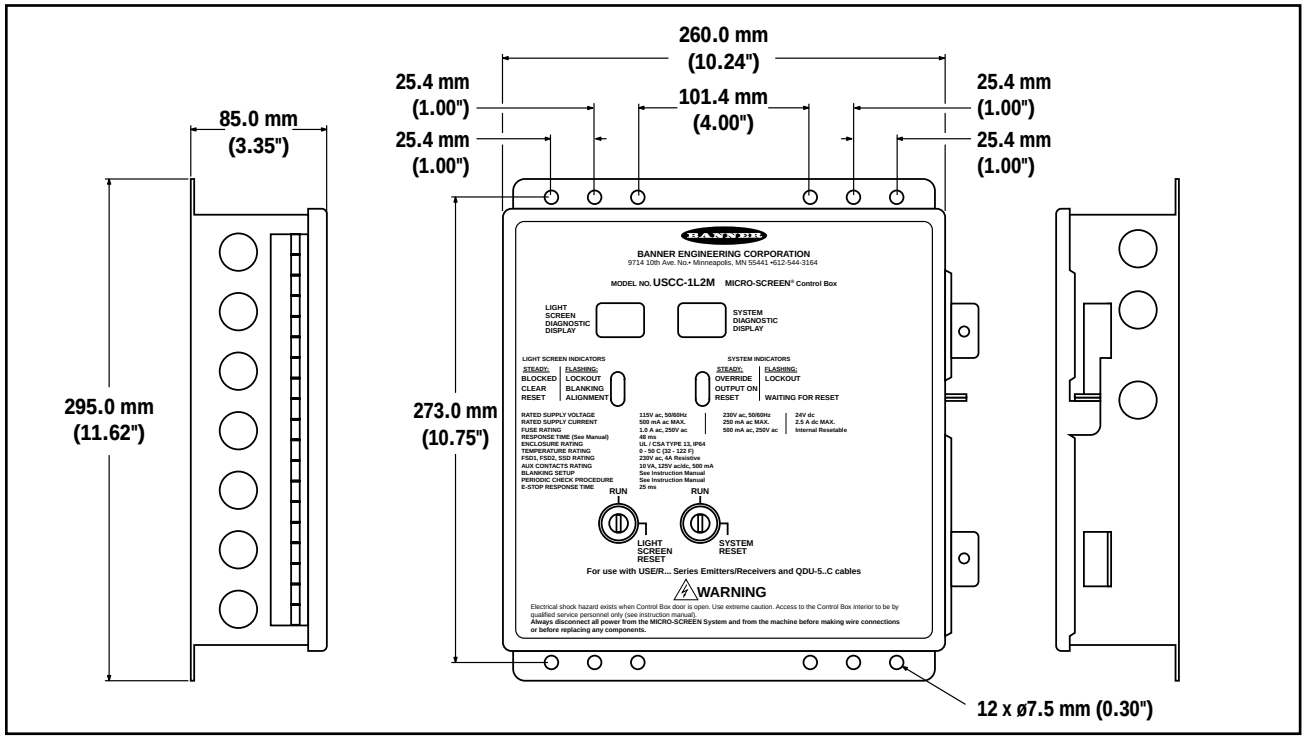


Figure 3-10. Control box dimensions and mounting hole locations

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 55-58 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)

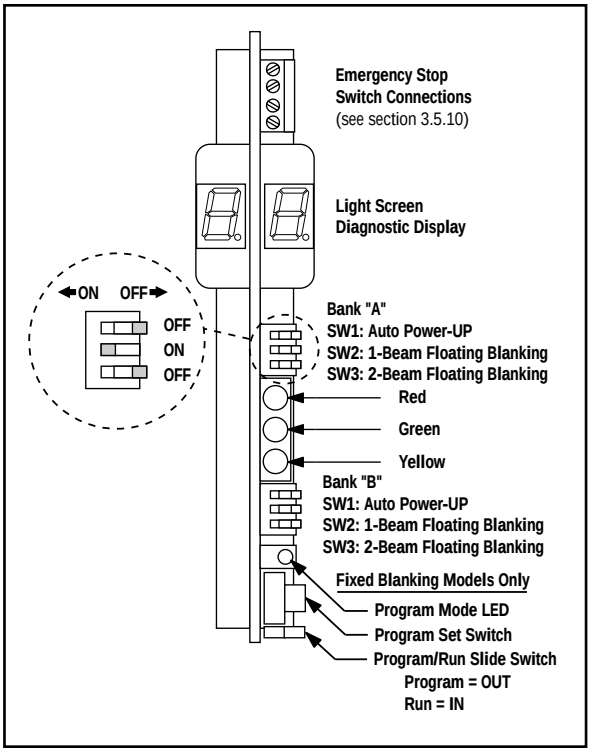


Figure 3-11. Light Screen controller board

WARNING . . .
Blanking Considerations

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

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

Fixed Blanking:
Fixed blanking (if used; available on Control Box USCC-2L2M only) 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.

Floating Blanking Program	Standard Series Sensors		V-Series Sensors	
	Maximum Size of Undetected Objects	Minimum Object Sensitivity	Maximum Size of Undetected Objects	Minimum Object Sensitivity
OFF	(Not applicable)	19.1 mm (0.75")	(Not applicable)	31.8 mm (1.25")
1-beam	7.6 mm (0.30")	31.8 mm (1.25")	20.3 mm (0.80")	57.5 mm (2.25")
2-beam	20.3 mm (0.80")	44.5 mm (1.75")	45.7 mm (1.80")	82.6 mm (3.25")

*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.

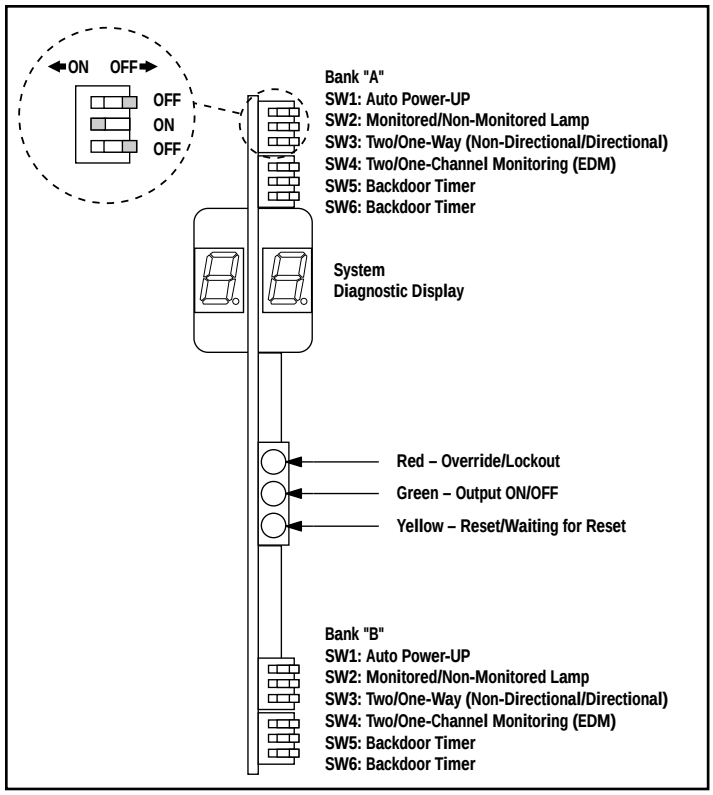


Figure 3-12. System controller board

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

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

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

SW5 ON
SW6 ON = OFF (Mute on Power-Up Enabled)
See Section 2.11.5 for complete information.

*Factory default setting.

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
- 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).

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 MICRO-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 MICRO-SCREEN System could result in serious bodily injury or death.

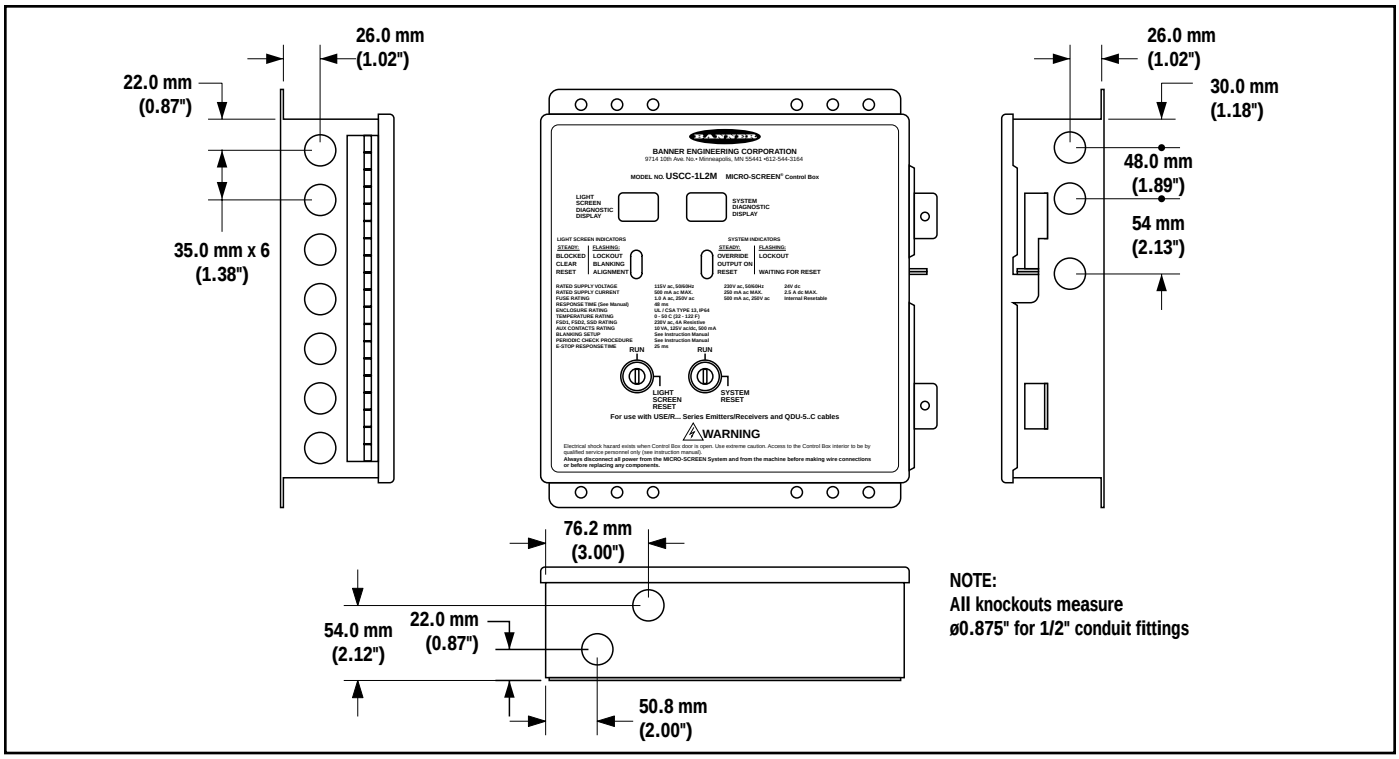


Figure 3-13. MINI-SCREEN with Muting control box knockout locations

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.

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 87) 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 MICRO-SCREEN emitter or receiver.

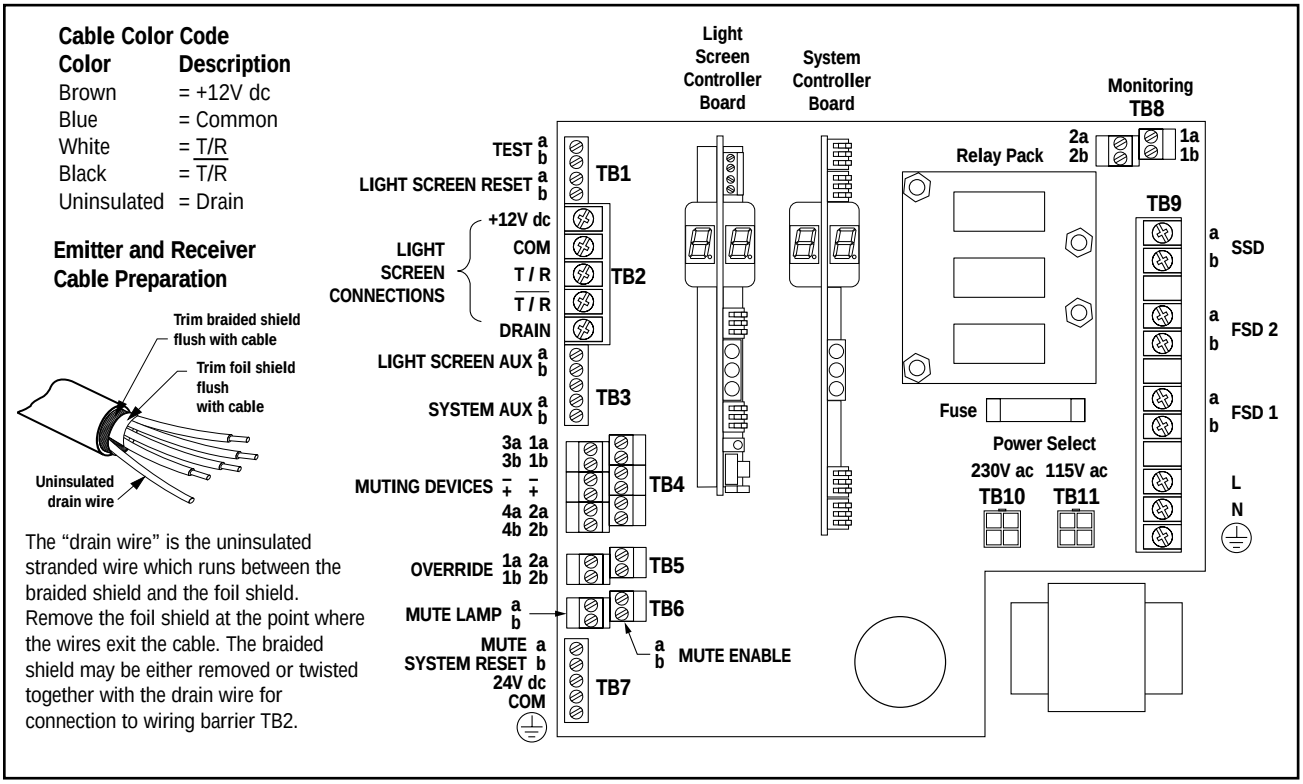


Figure 3-14. MICRO-SCREEN System electrical connections

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 independent safety light screen circuits, each with its own muting circuit and sensors to protect 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).

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. **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.

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 85). 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).

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.

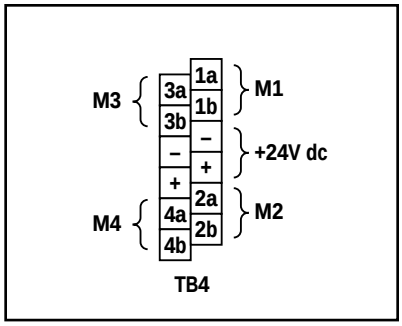


Figure 3-15. TB4 hookup

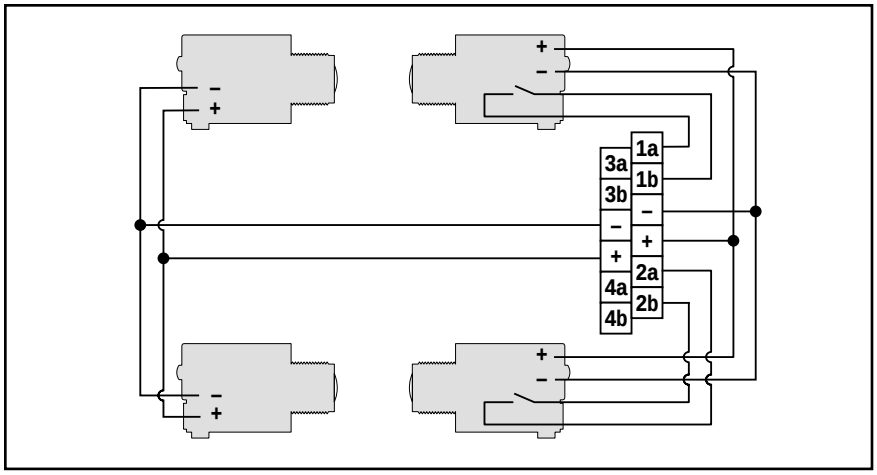


Figure 3-16. Two photoelectrics as M1 and M2, using relay output

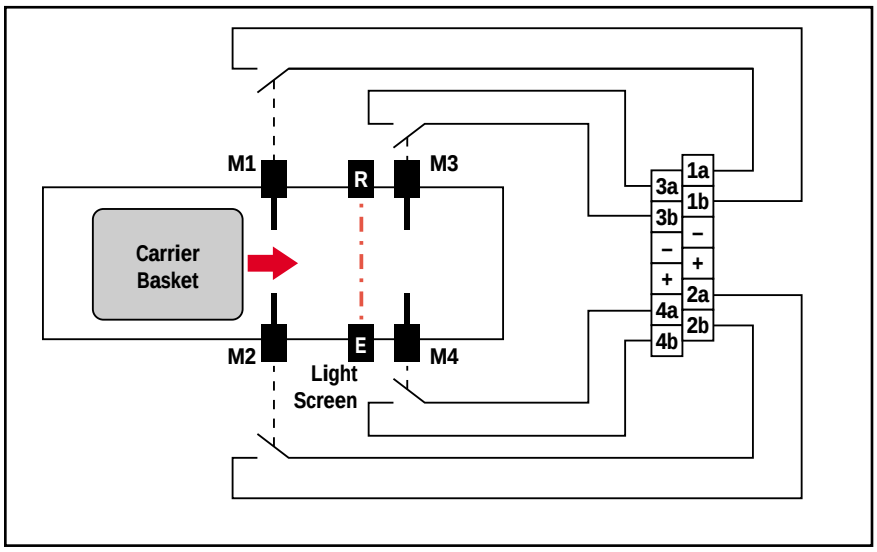


Figure 3-17. Four limit switches as M1, M2, M3, and M4

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.

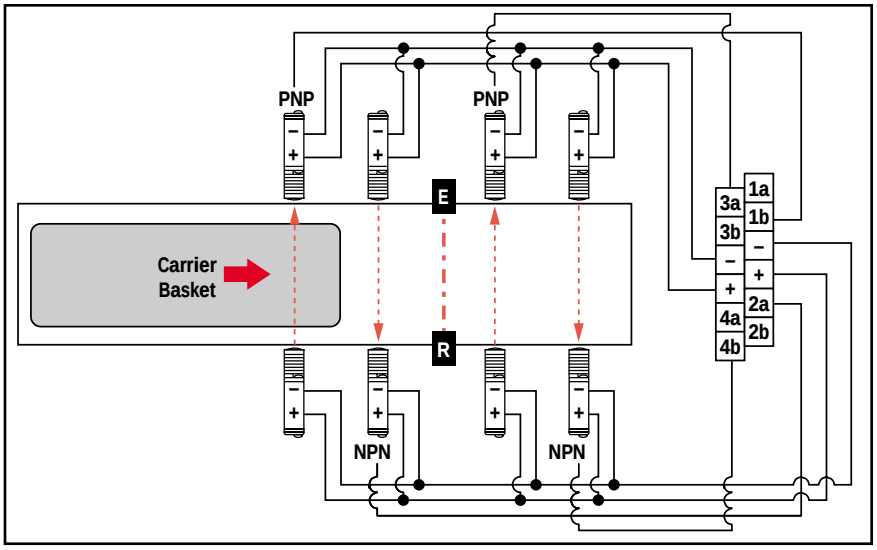


Figure 3-18. Four sensors as M1, M2, M3, and M4 using semiconductor outputs and power connections

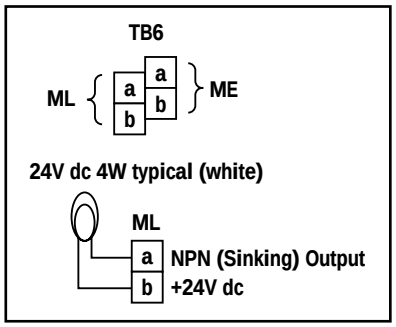


Figure 3-19. Monitored lamp hookup

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 2.11.3).

The System controller board can be configured for a monitored or non-monitored mute lamp (see 3.4.2, page 35). If the installation is governed by European (CE) regulations, the mute lamp must be “monitored” (SW2 = ON, banks A and B). 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 500 mA.

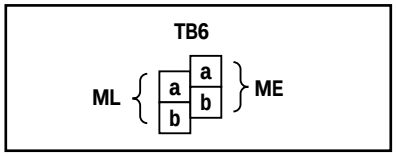


Figure 3-20. Mute Enable hookup

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 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 2.11.5).

3) Jumpered input to allow a mute, if mute enable is not used.

4) Open to prevent the initiation of the mute function.

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

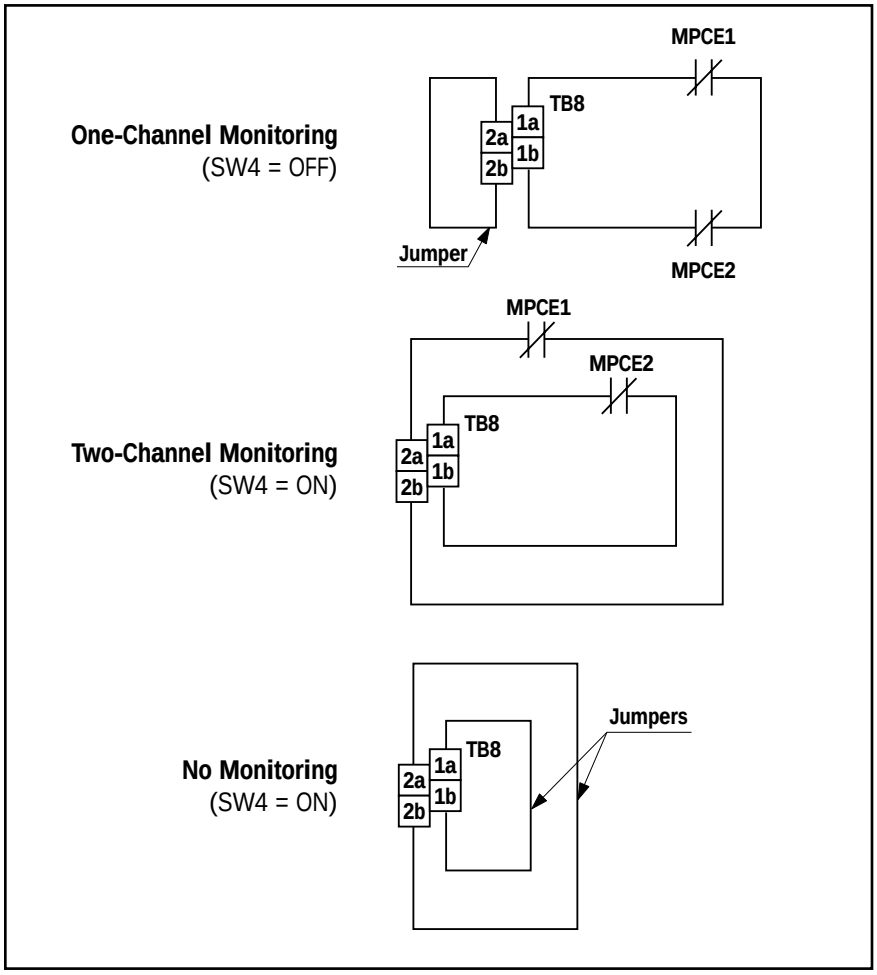


Figure 3-21. External Device Monitoring hookups

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

3.5.9 Override Switch Hookup

The control box provides connection terminals for the Override switches (see Figure 3-22). See Section 2.11.6 and the warning at right before connecting switches.

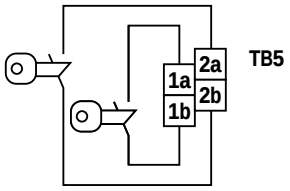


Figure 3-22. Override switch hookup

WARNING . . .
Emergency Stop Switch Wiring

- Whenever two or more Emergency Stop switches are connected to the same MICRO-SCREEN control box, contacts of the corresponding pole of each switch must be connected together in series. **Never connect the contacts of multiple Emergency Stop switches in parallel to the MICRO-SCREEN controller.** Parallel connection of two or more Emergency Stop switches to one MICRO-SCREEN controller defeats the switch contact monitoring ability of the module and creates an unsafe condition which could result in serious injury or death.
- Also, when two or more Emergency Stop switches are used, **each switch must be individually actuated (engaged), then re-armed and the MICRO-SCREEN System controller reset.** This allows the controller to check each switch and its wiring to detect faults. Failure to test each switch individually in this manner could result in undetected faults and create an unsafe condition which could result in serious injury or death. This check must be performed during periodic checkouts (see Section 6).

3.5.10 Emergency Stop Switch Hookup

As shown in Figure 3-23 the E-stop switch must provide one or two contacts which are closed when the switch is armed. Once activated, the E-stop switch must open all its contacts, and must be returned to the closed contact position *only* by means of a deliberate action (such as twisting, pulling, or unlocking). The switch should be a "positive-opening type," as described by IEC947-5-1. A mechanical force applied to such a button (or switch) is transmitted directly to the contacts, forcing them open. This ensures that the switch contacts will open whenever the switch is activated. NFPA 79 section 13.2, Emergency Stop Devices, specifies the following additional switch ("stop control") requirements:

- Emergency Stop push buttons shall be located at each operator control station and at other operating stations where emergency shutdown shall be required.
- Stop and Emergency Stop push buttons shall be continuously operable from all control and operating stations where located.
- Actuators of Emergency Stop devices shall be colored RED. The background immediately around the device actuator shall be colored YELLOW. The actuator of a push-button-operated device shall be of the palm or mushroom-head type.
- The Emergency Stop actuator shall be a self-latching type.

NOTE: Some applications may have additional requirements. The user must refer to all relevant regulations.

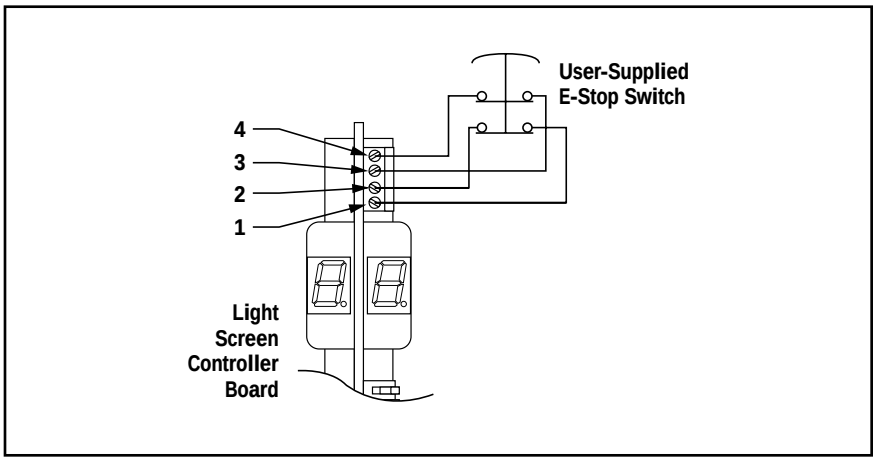


Figure 3-23. Emergency Stop Switch hookup

3.5.11 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 MICRO-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 MICRO-SCREEN initial checkout (see Section 3.5.12.).

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 MICRO-SCREEN System without a proper earth ground connection at either of the ⏚ symbols.

3.5.12 MICRO-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 MICRO-SCREEN control box, but before the MICRO-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.)

3.5.12.1 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 the 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 (available on control box USCC-2L2M only). 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 MICRO-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 MICRO-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 3.5.12.2, 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 46).

D) The green status indicators will flash to indicate use of fixed and/or floating blanking.

4) Fixed blanking (control box model USCC-2L2M only). 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 Series	4"	8	0	N.A.
	8"	16	4	2.2"
	12"	24	7	3.7"
	16"	32	9	4.7"
	20" to 48"	40 to 96	12	6.2"
V-Series	24"	24	7	7.7"
	32"	32	9	9.7"
	40" to 72"	40 to 72	12	12.7"

*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:

a) Remove all power from the control box (and from the machine to be controlled, if the System is already wired to the machine).

b) 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.

c) 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 MICRO-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 MICRO-SCREEN System and the guarded machine before making any connections or replacing any component.**

WARNING . . .
Final Switching Device

The output relays of the MICRO-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 57 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 MICRO-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.

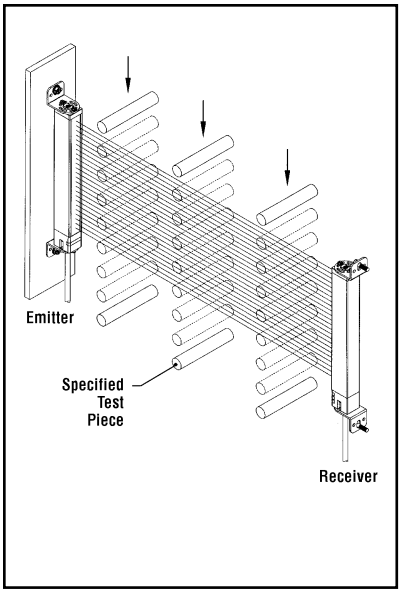


Figure 3-24. MICRO-SCREEN System trip test

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	**Standard Series Emitters and Receivers**	**V-Series Emitters and Receivers**
Floating blanking OFF	19.1 mm (0.75") dia. Model **STP-2**	31.8 mm (1.25") dia. Model **STP-4**
1-beam floating blanking ON	31.8 mm (1.25") dia. Model **STP-4**	57.5 mm (2.25") dia. Model **STP-5**
2-beam floating blanking ON	44.5 mm (1.75") dia. Model **STP-3**	82.6 mm (3.25") dia. Model **STP-9**

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 MICRO-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 MICRO-SCREEN System passes all of the checks in Section 3.5.12.1, go on to Section 3.5.12.2, Muting Initial Checkout Procedure.

If Muting or Override is not used, then proceed to Section 3.5.13.

3.5.12.2 Muting Initial Checkout Procedure

Ensure that the system passes the initial checkout procedure described in Section 3.5.12.1.

1) Continuing from section 3.5.12.1, verify that the MICRO-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 MICRO-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 3.5.12.3.

   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) Mute the System by blocking (or activating) both mute devices (typically M1-M2) simultaneously (within 3 seconds).

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. 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) M3-M4 before M1-M2. **Do not expose any individual to hazard while attempting to mute the System.**

3.5.12.3 Override Checkout Procedure

If the Override feature is used, the following checkout procedure must be completed; otherwise proceed to Section 3.5.13.

Ensure that the System passes the initial checkout procedures described in Sections 3.5.12.1 and 3.5.12.2.

Continuing from Section 3.5.12.2, 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 System status indicator(s) begin 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.

3.5.13 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.

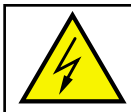
The FSD1 output relay connects to Machine Primary Control Element #1 (MPCE 1) on the guarded machine. MPCE 1 is an electrically powered element of the guarded machine that directly controls the normal operating motion of the machine; it must be last (in time) to operate when motion is either initiated 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. The switching capacity of relay FSD1 is 250V ac max., 4 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. The switching capacity of relay FSD2 is 250V ac max., 4 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 MICRO-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 MICRO-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 MICRO-SCREEN System and the guarded machine before making any connections or replacing any component.**

WARNING . . .
Final Switching Device

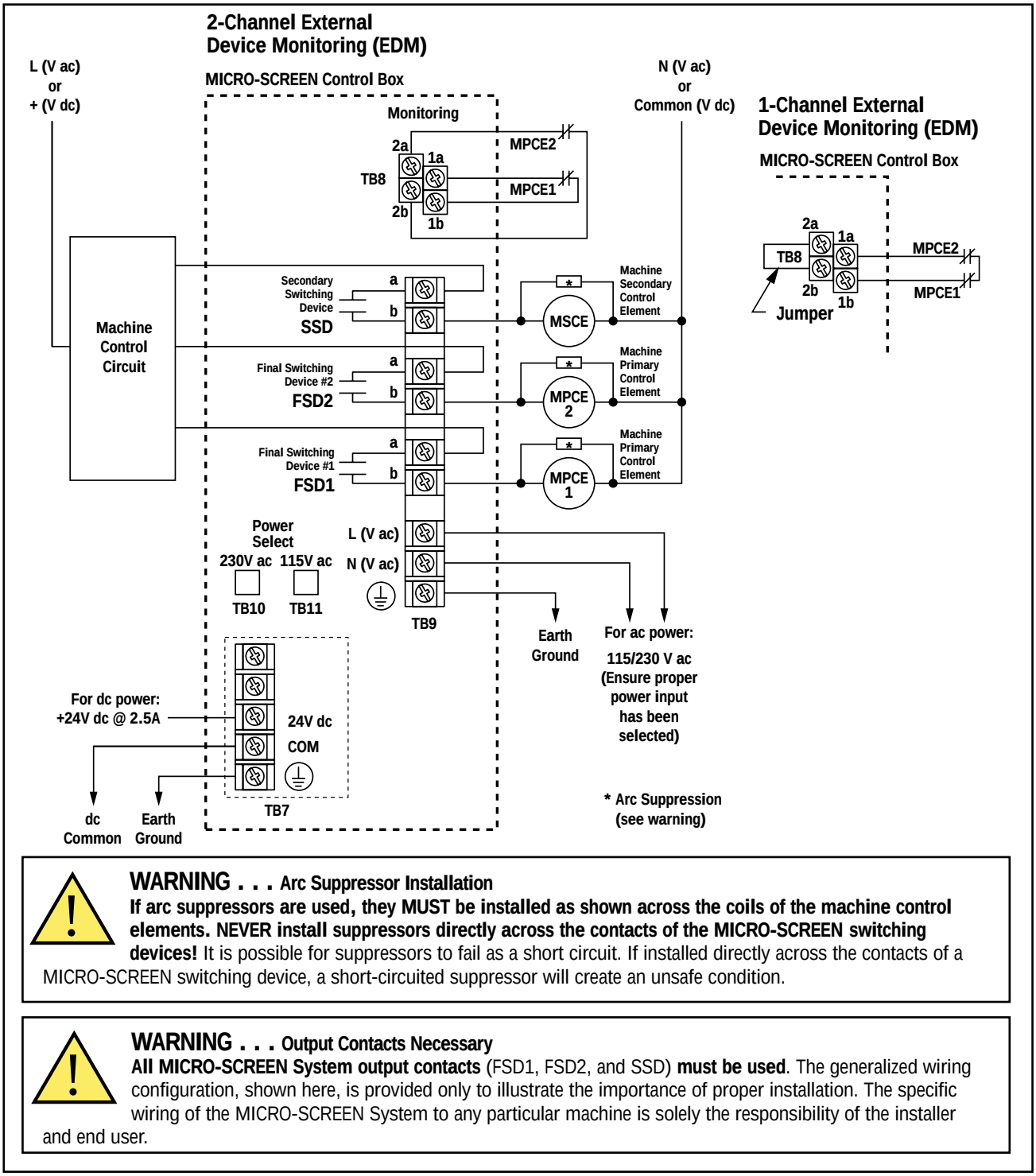
The output relays of the MICRO-SCREEN System must be the *final switching devices* for the machinery being guarded. **Never wire an intermediate device (e.g., a programmable logic controller - PLC), other than a safety relay, between either FSD and the machine primary control elements** (Reference ANSI 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 MICRO-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.



WARNING . . . Arc Suppressor Installation
If arc suppressors are used, they MUST be installed as shown across the coils of the machine control elements. NEVER install suppressors directly across the contacts of the MICRO-SCREEN switching devices! It is possible for suppressors to fail as a short circuit. If installed directly across the contacts of a MICRO-SCREEN switching device, a short-circuited suppressor will create an unsafe condition.

WARNING . . . Output Contacts Necessary
All MICRO-SCREEN System output contacts (FSD1, FSD2, and SSD) **must be used**. The generalized wiring configuration, shown here, is provided only to illustrate the importance of proper installation. The specific wiring of the MICRO-SCREEN System to any particular machine is solely the responsibility of the installer and end user.

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

3.5.14 External Device Monitoring (Permanent Connection)

After the initial checkout of Section 3.5.12 has been successfully completed, the EDM bypass circuit, installed in Section 3.5.11, 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 2.10, 3.4.2 and 3.5.8). Refer to the NOTICE Regarding MPCE Monitoring Hookup, at right.

After power is connected to the MICRO-SCREEN System and the output relay contacts are connected to the machine to be guarded, the operation of the MICRO-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.

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 51) 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.

3.5.15 Monitor Relay Outputs

Two non-safety-related relay outputs are available at TB3: Light Screen AUX and System AUX. **These monitoring contacts are for light-duty, 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).

3.5.16 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 37). 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 Figure 3-14, page 37). 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 Figure 3-14, page 37). 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.

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 MICRO-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 MICRO-SCREEN System control box.**

The key to the front-panel Reset switches should be available only to a 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 MICRO-SCREEN System is installed and put into service, **the functioning of the MICRO-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 MICRO-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 MICRO-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.

5. Troubleshooting and Maintenance

WARNING . . .
Power Failures

Power failures or other MICRO-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 MICRO-SCREEN System are dangerous and could result in serious bodily injury or death.**

CAUTION . . .
High Voltage

Dangerous voltages are present inside the MICRO-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!**

5.1 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 MICRO-SCREEN System (unless Auto Power-up is ON; see Figures 2-4 and 2-5, pages 13 and 14); or
- If power to the MICRO-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;
- If the self-checking circuits of either microprocessor detect a component failure within the MICRO-SCREEN System itself; or
- If either (or both) Emergency Stop switch contacts open.

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 2.11.6, 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 57 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 58 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 MICRO-SCREEN will now operate normally. **Upon recovery from a power interruption, checkout procedure 6.3 on page 72 must be performed.**

Error No.	Error Type/Action
-	**System is OK**
0	**E-Stop Open** • Check E-Stop Circuit • Replace Light Screen Controller • Replace Relay/Power Supply
1	**Relay Signal Error** • Replace Relay/Power Supply • Replace Light Screen Controller
2	**Key Input Error** • Check Key Position • Invalid Key Reset • Replace Key Switch
3	**Controller Error** • Replace Light Screen Controller
4	**Receiver Error** • Check Receiver Cable • Replace Receiver
5	**Emitter Error** • Check Emitter Cable • Replace Emitter
6	**Communication Error** • Check Cable Connections • Observe Noise Indicator • Replace Emitter/Receiver
7	**DIP Switch Error** • Check Switch Settings • Replace Light Screen Controller
8	**CPU Error** • Replace Light Screen Controller
9	**E-Stop Input Error** • Check E-Stop Circuit • Replace Light Screen Controller • Replace Relay/Power Supply
10	**System Error** • Check Fixed Beams
11	**Power Up Error** • Check Prog/Run Switch
12	**Programming Error** • Too Much Time • Floating Blanking ON
NOTE: Flashing decimal point indicates noisy environment	

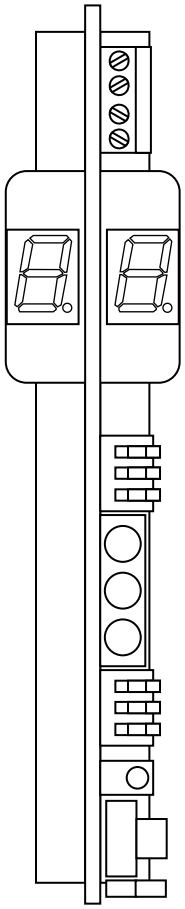


Figure 5-1. Light Screen Controller Board Diagnostic Display and interpretation of error codes

5.2 Diagnostic Displays

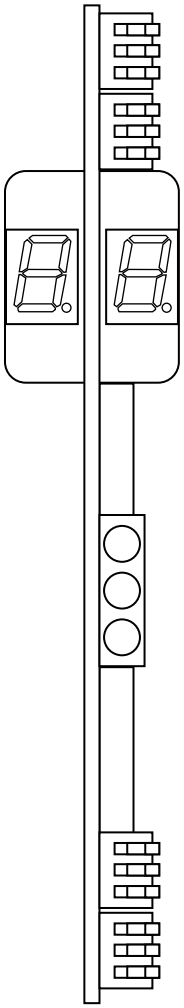
A lockout condition resulting from an internal System fault is indicated by the red status indicators flashing, and an error code number appearing in either or both of the Diagnostic Displays. In this case, the Qualified Person must note the error code and interpret the cause of the lockout from the 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 MICRO-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 MICRO-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.



Error No.	Error Type/Action
-	**System is OK**
31	**Relay Signal Error** • Replace Relay/Power Supply • Replace System Controller
32	**System Reset Key Input Error** • Check System Reset Key Position • Invalid System Key Reset • Replace System Key Switch
33	**Muting Controller Error** • Replace System Controller
34	**Light Curtain Error** • Check Light Screen Diagnostics • Replace Light Screen Controller
35	**Override Input Error** • Check Override Input Wiring • Replace Override Input Switch
36	**Muting Lamp Error** • Check Muting Lamp Connection • Replace Light Bulb
37	**DIP Switch Error** • Check Switch Settings • Replace System Controller
38	**MPCE 1 Error** • Check MPCE 1 Monitors Wiring • Check DIP Switch Settings • Replace System Controller
39	**MPCE 2 Error** • Check MPCE 2 Monitors Wiring • Check DIP Switch Settings • Replace System Controller
40	**Two-Channel Monitor Error** • Check Wiring of MPCE 1 and MPCE 2 • Replace Muting System Controller
50	**Back Door Timing Expired** • See Manual (Section 3.4.2)
51	**Muting Simultaneity Error** • See Manual (Section 3.5.4)

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 MICRO-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 MICRO-SCREEN System. **Servicing the MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-SCREEN System control box fuse is located in a fuseholder on the power supply board (see Figure 3-14, page 37). 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 84).

5.4.2 Control Boards and Relay/Power Supply Replacement

MICRO-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 89.

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 61). **Do not attempt to substitute parts from another manufacturer. To do so could impair the operation of the MICRO-SCREEN System and could result in serious bodily injury or death.**

5.4.3 Cleaning

The MICRO-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.

MICRO-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 MICRO-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: 888.373.6767
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 MICRO-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 MICRO-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: 888.373.6767
email: sensors@baneng.com

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

Checkouts must be performed according to checkout procedure 6.3, page 72, as follows:

1) By a Designated Person at every power-up of the MICRO-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 76, as follows:

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

See Figures 6-1 and 6-2 on pages 62 and 63 for operating status conditions.

V-Series emitter/receiver pairs 1422 to 1892 mm (56" to 72") long may be spaced from 15 cm to 6 m (6" to 20') apart. All other 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 66).

6.1 MICRO-SCREEN System Alignment

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

Follow the measures outlined below to maximize MICRO-SCREEN System excess gain. If reflective surfaces are near the defined area, read alignment step #5 (pages 64-65) before proceeding further, to prevent possible reflection problems.

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

1) Turn OFF power to the MICRO-SCREEN System and to the guarded machine. Leave power to the guarded machine OFF, and power-up the MICRO-SCREEN System only with both keys in the RUN position.

2) The MICRO-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.

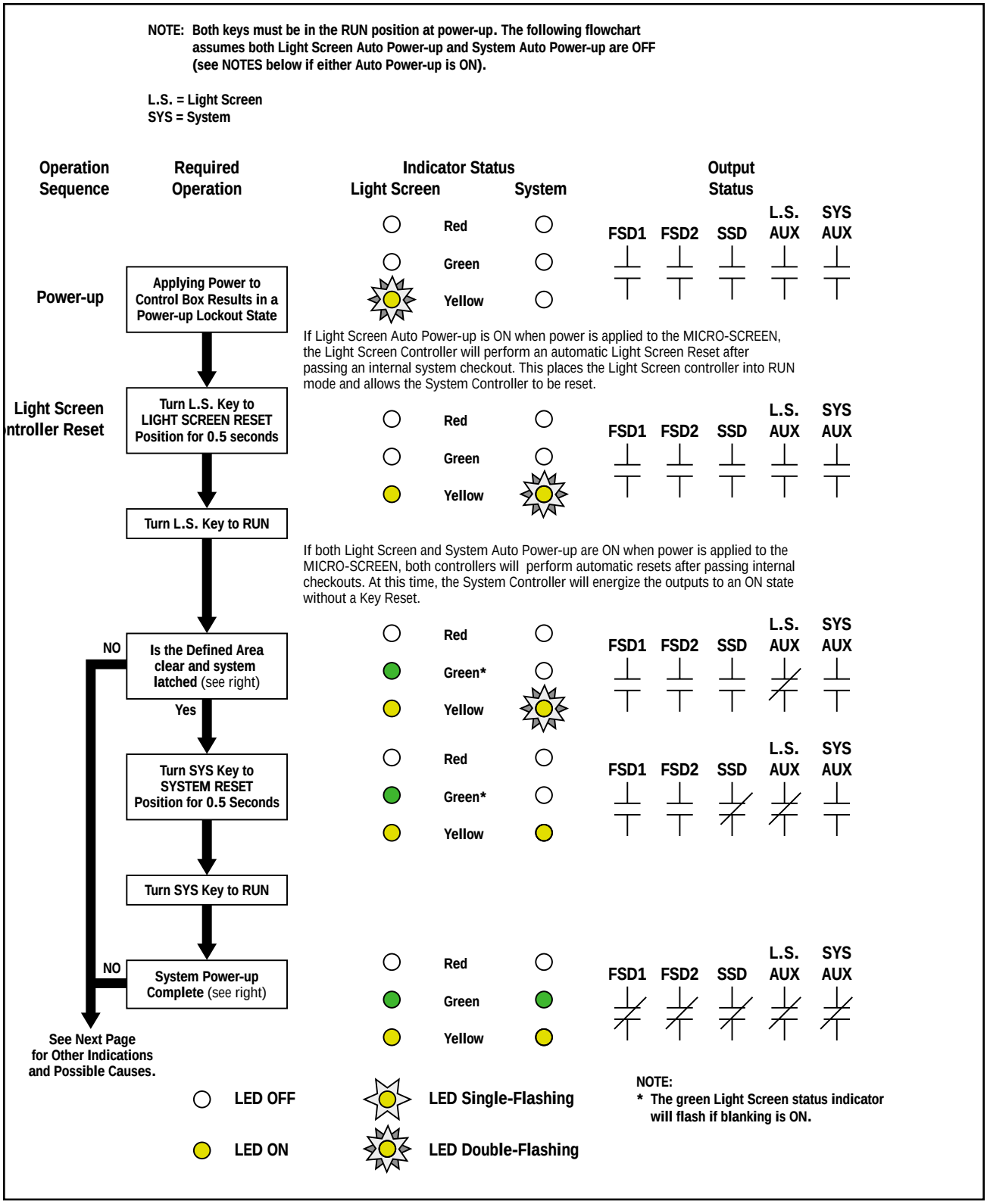


Figure 6-1. Operating status conditions

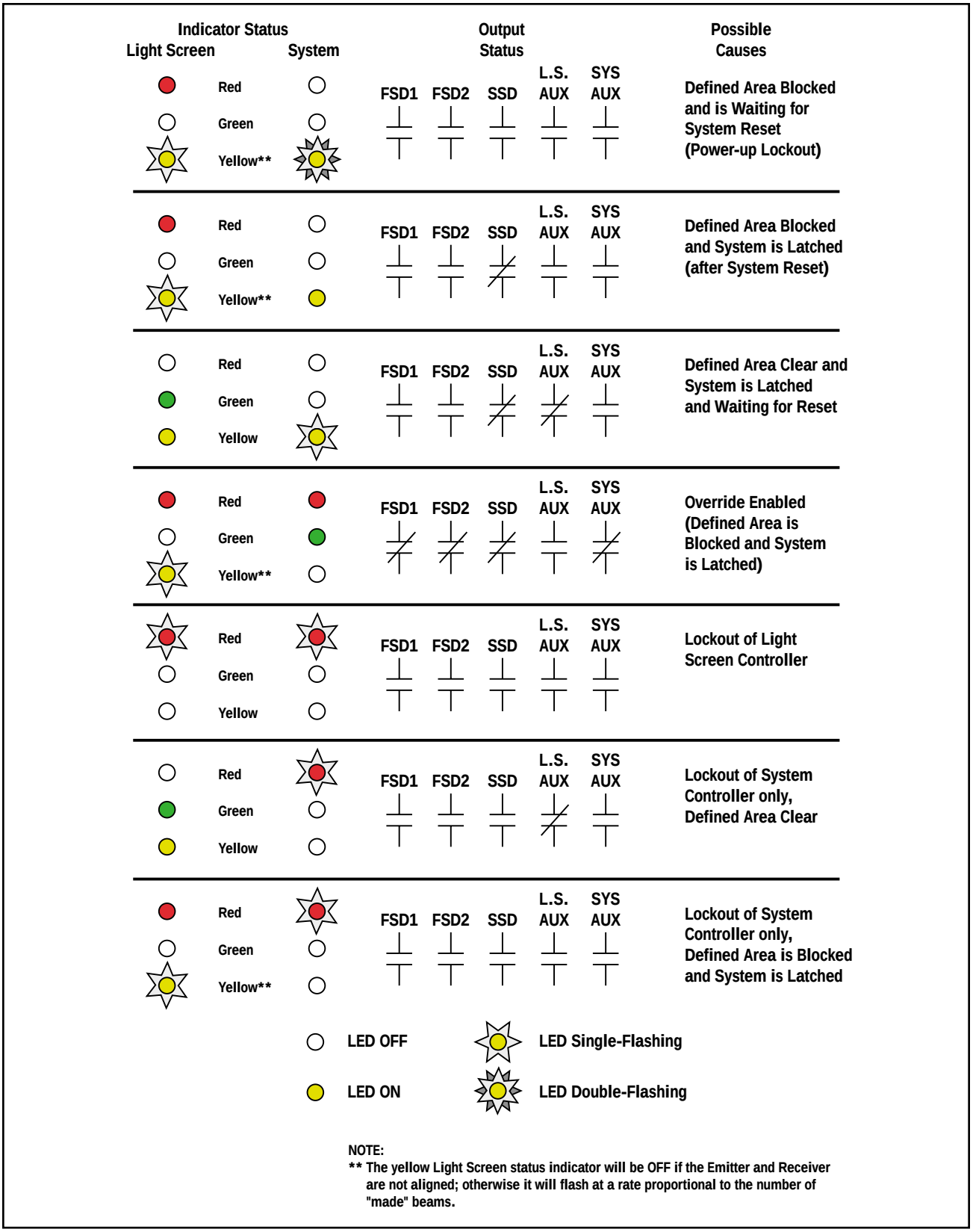


Figure 6-2. Operating status conditions

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** is indicated by the red indicator ON steady and the yellow indicator flashing at a rate proportional to the number of aligned, unblocked beams. The Light Screen Digital Display on the control box will indicate the total number of blocked beams. If all the beams are blocked, the yellow Light Screen status indicator will be OFF. Go to step #4.

   b) **A clear condition** is indicated by the red indicator OFF and the green and yellow indicators ON steadily (green will flash if blanking is ON). Further alignment is not necessary.

   c) **A lockout condition** is indicated by a 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 MICRO-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 Series Emitters and Receivers	V-Series Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model **STP-2**	31.8 mm (1.25") dia. Model **STP-4**
1-beam floating blanking ON	31.8 mm (1.25") dia. Model **STP-4**	57.5 mm (2.25") dia. Model **STP-5**
2-beam floating blanking ON	44.5 mm (1.75") dia. Model **STP-3**	82.6 mm (3.25") dia. Model **STP-9**

WARNING . . .
If Trip Test Indicates a Problem

If the MICRO-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.

In each case, the red Light Screen status indicator must come ON and remain ON for as long as the test piece is within the defined area.

The green Light Screen status indicator should come ON only when the test piece is withdrawn from the defined area. 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 76). **Do not continue until the situation is corrected.**

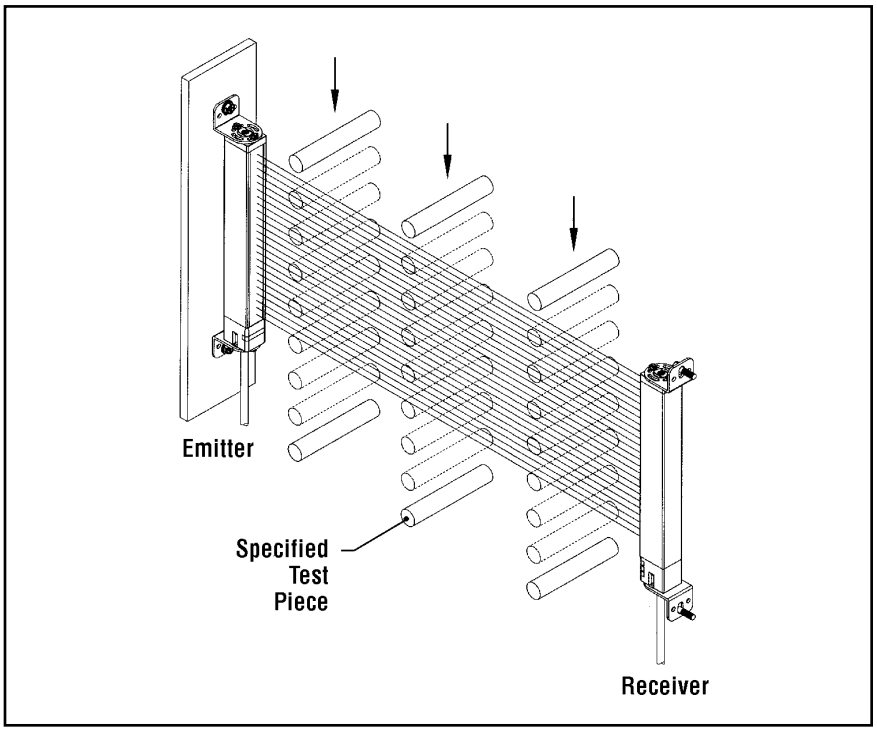


Figure 6-3. MICRO-SCREEN trip test

Use of Corner Mirrors
MICRO-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 88). 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**
Sensor lengths from 102 mm to 1219 mm (4" to 48")	8.5 m (28')	7.8 m (25.5')	7.2 m (23.5')	6.7 m (22')

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 MICRO-SCREEN sensors are indicated by the ends of each sensor window, and are dimensioned in the chart on page 32.

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 87).

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 43658) packed with each MSM Series corner mirror for complete information on the use of corner mirrors.

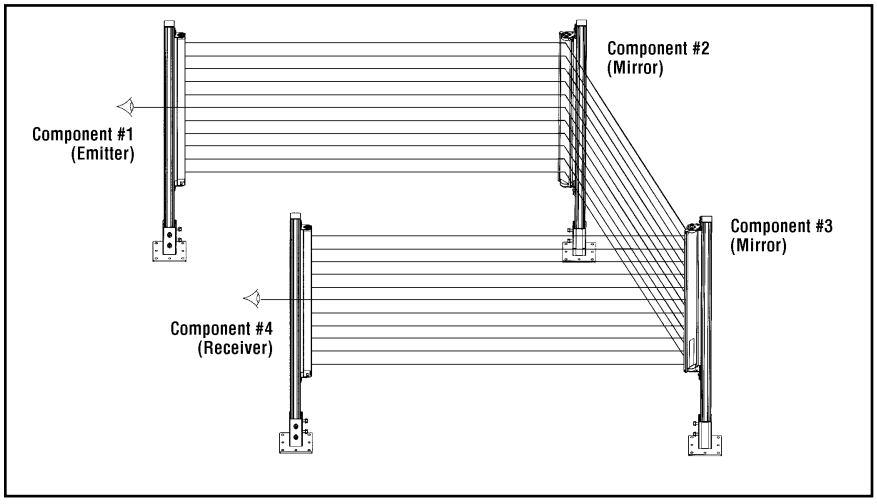
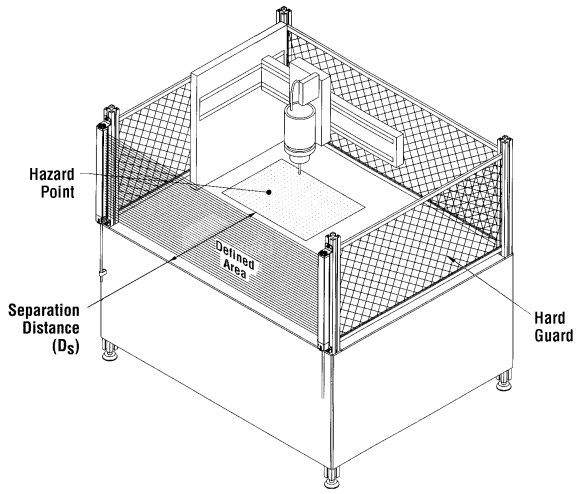


Figure 6-4. Corner mirror alignment

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 MICRO-SCREEN System: .048 Seconds

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

Floating Blanking Program	4" to 48" sensor pairs	24" to 72" V-Series sensor pairs
Floating blanking OFF	D_{pf} = 1.6"	D_{pf} = 3.3"
1-beam blanking ON	D_{pf} = 3.3"	D_{pf} = 6.7"
2-beam blanking ON	D_{pf} = 5.0"	D_{pf} = 31.5" [4]

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.
4) This number is based on object sensitivity larger than 2.5" and may vary, depending on the standard used, such as ANSI/RIA R15.06 (1999) and EN999.

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 MICRO-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 MICRO-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 MICRO-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) 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 MICRO-SCREEN System.
5) Examine the electrical wiring connections between the MICRO-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 MICRO-SCREEN System with system power ON, as described in steps (a) through (d), below. The MICRO-SCREEN control module comes with three specified test pieces. Select the proper test piece based on system configuration, per the following chart:

   a) Verify that the MICRO-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. Ensure muting is not enabled.

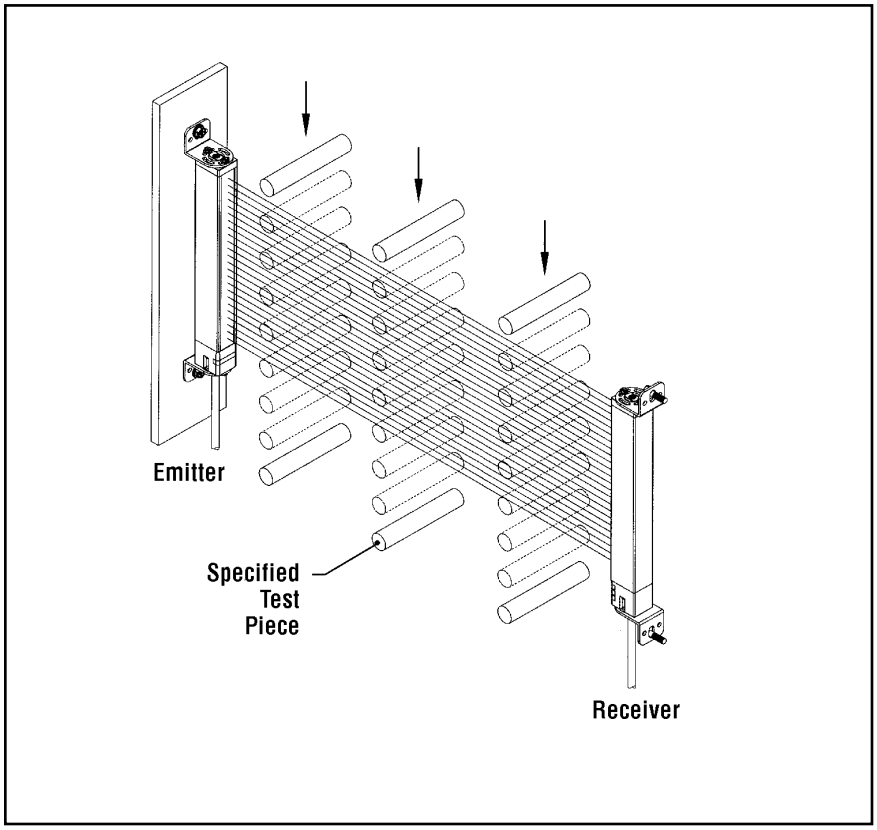


Figure 6-6. MICRO-SCREEN trip test

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	**Standard Series Emitters and Receivers**	**V-Series Emitters and Receivers**
Floating blanking OFF	19.1 mm (0.75") dia. Model **STP-2**	31.8 mm (1.25") dia. Model **STP-4**
1-beam floating blanking ON	31.8 mm (1.25") dia. Model **STP-4**	57.5 mm (2.25") dia. Model **STP-5**
2-beam floating blanking ON	44.5 mm (1.75") dia. Model **STP-3**	82.6 mm (3.25") dia. Model **STP-9**

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

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

b) With the guarded machine at rest, slowly pass the appropriate specified test piece downward through the defined area at three points, taking care to hold the test piece perpendicular to the defined area: close to the receiver column, close to the emitter column, and midway between the emitter and receiver columns (Figure 6-6). In each case, the red Light Screen status indicator should come ON and remain ON and the green System status indicator must go OFF for as long as the test piece is within the defined area. When the test piece is withdrawn from the defined area, the green Light Screen status indicator should come ON. If the green Light Screen 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 76). **Do not continue until the situation is corrected.** (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.

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 defined area (perpendicular to the defined area). **Do not attempt to insert the test piece into the dangerous parts of the machine.** Upon insertion of the test piece into the defined area at any time during machine motion, the dangerous parts of the machine should come to a stop with no apparent delay. Upon removal of the test piece from the defined area and System Key Reset of the latch output, verify that the machine does **not** automatically restart, and that 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 it is not possible for the guarded machine to be put into motion while the specified test piece is within the defined area.

7) Test the Emergency Stop switch (if one is connected to the system). With the machine running, engage the Emergency Stop switch (to open its contacts). Verify that the dangerous machine motion stops with no apparent delay. Test each Emergency Stop switch, individually, when two or more switches are series-connected to a MICRO-SCREEN control module. See Warning on page 43.

8) Remove electrical power to the MICRO-SCREEN System. All output relays should immediately de-energize, and should not be capable of being reactivated until power is re-applied and a System Key Reset is performed (unless both Auto Power-up feature are ON).

9) 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) Ensure that the MICRO-SCREEN Light Screen and System have 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 MICRO-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) Mute the System by blocking (or activating) both mute devices (typically M1 and M2), simultaneously (within 3 seconds).

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; verify that 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 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 that the green and yellow Light Screen status indicators come ON. Clear (or deactivate) the mute devices and verify that 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 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 62 and 63.

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

1) 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.

2) With Muting de-activated, interrupt the safety light screen with the appropriate test piece; verify the red Light Screen status indicator comes ON, the green Light Screen indicator is OFF, and the yellow Light Screen indicator is flashing. Also, verify that the green System status indicator is OFF and yellow System status indicator is ON.

3) After interrupting the defined area for 3 seconds, initiate an override cycle by turning both Override switches to ON (and hold in the 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) 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; 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.

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 intervals not to exceed 24 hours. A copy of checkout results should be kept on or near the machine: see OSHA 1910.217(e)(1).

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 MICRO-SCREEN System, hard guarding, or supplemental guarding, and verify that all supplemental guarding devices and hard guarding are in place and operating properly.
2) Verify that the minimum separation distance from the closest danger point of the guarded machine to the defined area is not less than the calculated distance. See Section 3.2.1.
3) Ensure 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 safeguarding is in place and functioning properly in any space between the defined area and any danger point which is large enough to allow a person to stand undetected by the MICRO-SCREEN System.
4) Verify that the enclosure for the MICRO-SCREEN control box is latched and locked. The key (or combination or tool) to the locking mechanism should be in the possession of a Qualified Person.

WARNING . . . Be Sure Lockable Enclosure is Closed Before Proceeding
A shock hazard exists while the lockable enclosure is open. **Before continuing, verify that the lockable enclosure is closed and latched.**

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	**Standard Series Emitters and Receivers**	**V-Series Emitters and Receivers**
Floating blanking OFF	19.1 mm (0.75") diameter Model **STP-2**	31.8 mm (1.25") diameter Model **STP-4**
1-beam floating blanking ON	31.8 mm (1.25") diameter Model **STP-4**	57.5 mm (2.25") diameter Model **STP-5**
2-beam floating blanking ON	44.5 mm (1.75") diameter Model **STP-3**	82.6 mm (3.25") diameter Model **STP-9**

5) Test the effectiveness of the MICRO-SCREEN with power ON, as described in steps (a) through (d), below.

   a) Verify that the MICRO-SCREEN System is in RUN mode (green and yellow System status indicators ON). See Section 5.1 for Reset procedure. Verify that the Muting function is not enabled.

b) With the guarded machine at rest, pass the *appropriate specified test piece* downward through the defined area at three points, perpendicular to the defined area: close to the receiver column, close to the emitter column, and midway between the emitter and receiver columns (see Figure 6-6). In each case, the red indicator must come ON and remain ON for as long as the test piece is within the defined area. When the test piece is removed from the defined area, the green Light Screen status indicator should come ON (if blanking is ON, the green Light Screen status indicator will be flashing). 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 the use of fixed blanking (see WARNINGS, page 76). **Do not continue until the situation is corrected.** (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.

c) Initiate machine motion of the guarded machine and, during motion, insert the specified test piece into the defined area (perpendicular to the defined area). **Do not attempt to insert the test piece into the dangerous parts of the machine.** Upon insertion of the test piece into the defined area at any time during machine motion, the dangerous parts of the machine should come to a stop with no apparent delay. Upon removal of the test piece from the defined area and System Key Reset of the latch output, verify that the machine does **not** automatically restart, and that the initiation devices must be engaged to restart the machine.

d) With the guarded machine at rest, insert the specified test piece into the defined area and verify that it is not possible for the guarded machine to be put into motion while the specified test piece is within the defined area.

6) Test the Emergency Stop switch (if one is connected to the MICRO-SCREEN System). With the machine running, engage the Emergency Stop switch (to open its contacts). Verify that the dangerous machine motion stops with no apparent delay. Test each Emergency Stop switch, individually, when two or more switches are series-connected to a MICRO-SCREEN System. See WARNING on page 43.

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

8) If the Muting feature is used, the following checkout must be performed:

a) Verify that the Mute devices are operating properly and have not been damaged, misaligned, or otherwise blocked or tampered with.

b) Initiate a normal mute cycle by blocking (or activating) both mute devices (typically M1 and M2) simultaneously (within 3 seconds).

c) Verify that the Mute indicator comes ON.

d) Interrupt the safety light screen with the appropriate test piece. Verify that the red Light Screen status indicator comes ON, the green Light Screen indicator is OFF, and the yellow Light Screen 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.

e) Clear the defined area (before the Backdoor Timer expires) and verify that the green and yellow Light Screen status indicators come ON. Clear (or deactivate) the Mute devices and verify that the Mute indicator goes OFF. The green and yellow System status indicators should remain ON.

f) 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 then passing 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.**

g) Verify that it is not possible for personnel to pass in front of, behind, or next to the muted object (e.g. a carrier basket) without being detected and a subsequent stop command being issued to the machine.

h) If One-Way (directional) Muting is selected, verify that a mute cycle can not be initiated by blocking (or activating) M3 and M4 before M1 and M2. **Do not expose any individual to hazard while attempting to initiate a mute cycle.**

9) If the Override feature is used, the following checkout must be performed:

a) 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.

b) With muting de-activated, interrupt the safety light screen with the appropriate test piece; verify the red Light Screen status indicator comes ON, the green Light Screen indicator is OFF, and the yellow Light Screen indicator is flashing. Also, verify that the green Light Screen System status indicator is OFF and yellow System status indicator is flashing.

c) Three seconds after interrupting the defined area, initiate an override cycle by turning both Override switches to ON (hold in the ON position if necessary) simultaneously (within 3 seconds).

d) 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.

e) 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 simultaneously re-close the Override switches.

f) 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.

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.

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 to ensure that there are no other mechanical or structural problems that would prevent the machine from stopping or assuming an otherwise safe condition when signalled to do so by the MICRO-SCREEN System.

4) Examine and inspect the machine controls and connections to the MICRO-SCREEN System to ensure 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 3.5.12), 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 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 MICRO-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 MICRO-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 MICRO-SCREEN System whose primary purpose is to communicate system status to a PLC.

Auto Power-up: A feature of the MICRO-SCREEN *control module* which, when switched ON, enables the MICRO-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 MICRO-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 MICRO-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 MICRO-SCREEN System *control module*, which contains the microprocessors and related electronic circuits.

Defined area: The “light screen” or “curtain of light” generated by the MICRO-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 MICRO-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 MICRO-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 MICRO- 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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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." MICRO-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 MICRO-SCREEN Systems may not be used with full-revolution devices.

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

Internal lockout: A *lockout condition* that occurs due to an internal MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-SCREEN System) that are used to initiate a stop signal. The MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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 MICRO-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.

MICRO-SCREEN Series Sensor Specifications

	Standard Series (USE/USRxx24xxx)	V Series 24" to 48" (USE/USRxx12xxx)	V Series 56" to 72" (USE/USRxx12xxx)
Emitter/Receiver Separation (Min/Max Range)	150 mm (6") to 9 m (30')	150 mm (6") to 9 m (30')	150 mm (6") to 6 m (20')
Minimum Object Sensitivity			
Floating Blanking OFF	19.1 mm (0.75")	31.8 mm (1.25")	
1-Beam Floating Blanking ON	31.8 mm (1.25")	57.5 mm (2.25")	
2-Beam Floating Blanking ON	44.5 mm (1.75")	82.6 mm (3.25")	
Defined Area	See Models and Accessories, page 86.		
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 84). Yellow also indicates alignment. Indicators are visible on three sides of receiver or emitter base.		
Emitter and Receiver Enclosure	*Size:* See Figure 3-9, page 32 *Materials:* Aluminum; yellow polyester painted finish; acrylic lens cover *Rating:* NEMA 4, 13; IEC IP65		
Mounting Hardware	Emitter and receiver each are supplied with a pair of swivel end mounting brackets. (Sensors 28" to 36" long are supplied with one center support bracket; sensors 40" to 72" long are supplied with two center brackets.) Mounting brackets are 13-gauge cold-rolled black zinc chromate finished steel.		
Cables	**Emitters and Receivers with Integral Cables (USE/USRxxxxYI):** Cables are 7.6 meters (25') long and measure 8.1 mm (0.32") in diameter. Conductors are 20-gauge. Cables are shielded and PVC-jacketed. **Emitters and Receivers with Integral (USE/USRxxxxY) or Pigtail (USE/USRxxxxYP2) Quick Disconnect:** Integral QD connectors have a 300 mm (12") long cable, terminated with a 5-pin Euro-style quick-disconnect fitting. Mating interconnect cables are ordered separately (unless a MICRO-SCREEN kit is ordered, see Models and Accessories, page 87), and are available in lengths of 4.5 m (15'), 7.6 m (25'), and 15 m (50'). NOTE: Contact factory when cable length exceeding 15 m (50') is required. Use only Banner cables, which incorporate a shielded “twisted pair” for noise immunity on RS485 data communications lines. Use of other cables may result in “nuisance” trips or lockouts.		
Certifications	See Control Box specifications, page 85		

MICRO-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	**Light Screen:** Less than 48 milliseconds **E-Stop:** Less than 15 milliseconds		
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	**Light Screen Diagnostic Display** (left window) is a two-digit numeric display that indicates the cause of lockout conditions and total number of beams blocked. **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.		
Controls and Adjustments	• Light Screen Key Reset after power-up and light screen lockouts • Selection switches to enable floating blanking • Program switches to enable fixed blanking (USCC-2xx only) • 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		
Emergency Stop Switch Input	The Emergency Stop switch (button) must offer two normally closed contacts and be capable of switching 50 mA @ 30V dc. Total resistance, including wiring and all switches, must not exceed 30Ω for proper operation. Functional stop category 0 per NFPA 79 and EN 418, Safety Category 4 per EN 954-1.		

MICRO-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)
Output Configuration (FSD1, FSD2, SSD)	Forced-guided contact relays, 250V ac at 4 amps maximum (resistive load). **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 51
Mute Lamp Output	A monitored or non-monitored (selectable) sinking output. If monitoring has been selected, the current draw must be within 10 mA to 360 mA. **Maximum Switching Voltage:** 30V dc **Maximum Switching Current:** 360 mA **Minimum Switching Current:** 10 mA **Saturation Voltage:** ≤1.5V dc
Auxiliary DC Supply Output	24V dc ± 25%, 500 mA max
Enclosure	**Size:** See figure 3-10 on page 23 **Material:** Welded steel box with black polyester powder paint finish. **Rating:** NEMA 13; IEC IP64
Operating Conditions	**Temperature:** 0° to +50°C (+32° to 122°F) **Humidity:** 95% maximum relative humidity (non-condensing)
FMEA Tested (Failure Mode and Effects Analysis)	Per requirements of IEC61496-1 (type 4)
Certifications	Approvals in process. Contact factory for update.

MICRO-SCREEN Systems are sold in kits that include the following: a control box, an emitter and receiver of equal length and number of beams, emitter and receiver mounting hardware, and two cables. Choose 300 mm (12") pigtail quick-disconnect cables, or integral quick-disconnect fittings plus mating cables in one of 3 lengths, or unterminated, integral 7.6 m (25') 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).

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

Minimum Object Detection Size = 19 mm (0.75")

Defined Area	Number of Beams	Integral 7.6 m (25') Cable Models		Pigtail Quick-disconnect Models		Quick-disconnect Fitting Models	
		Model Number	Part Number	Model Number	Part Number	Model Number	Part Number
102 mm (4")	8	USE424YI USR424YI	42500 42501	USE424YP2 USR424YP2	49601 49602	USE424Y USR424Y	55134 55135
203 mm (8")	16	USE824YI USR824YI	42502 42503	USE824YP2 USR824YP2	49603 49604	USE824Y USR824Y	55136 55137
305 mm (12")	24	USE1224YI USR1224YI	42504 42505	USE1224YP2 USR1224YP2	49605 49606	USE1224Y USR1224Y	55138 55139
406 mm (16")	32	USE1624YI USR1624YI	42506 42507	USE1624YP2 USR1624YP2	49607 49608	USE1624Y USR1624Y	55140 55141
508 mm (20")	40	USE2024YI USR2024YI	42508 42509	USE2024YP2 USR2024YP2	49609 49610	USE2024Y USR2024Y	55143 55144
610 mm (24")	48	USE2424YI USR2424YI	42510 42511	USE2424YP2 USR2424YP2	49611 49612	USE2424Y USR2424Y	55145 55146
711 mm (28")	56	USE2824YI USR2824YI	42512 42513	USE2824YP2 USR2824YP2	49613 49614	USE2824Y USR2824Y	55147 55148
813 mm (32")	64	USE3224YI USR3224YI	42514 42515	USE3224YP2 USR3224YP2	49615 49616	USE3224Y USR3224Y	55149 55150
914 mm (36")	72	USE3624YI USR3624YI	42516 42517	USE3624YP2 USR3624YP2	49617 49618	USE3624Y USR3624Y	55151 55152
1016 mm (40")	80	USE4024YI USR4024YI	42518 42519	USE4024YP2 USR4024YP2	49619 49620	USE4024Y USR4024Y	55153 55154
1118 mm (44")	88	USE4424YI USR4424YI	42520 42521	USE4424YP2 USR4424YP2	49621 49622	USE4424Y USR4424Y	55155 55156
1219 mm (48")	96	USE4824YI USR4824YI	42522 42523	USE4824YP2 USR4824YP2	49623 49624	USE4824Y USR4824Y	55157 55158

MICRO-SCREEN V-Series Emitters (E) and Receivers (R)

Minimum Object Detection Size = 32 mm (1.25")

Defined Area	Number of Beams	Integral 7.6 m (25') Cable Models		Pigtail Quick-disconnect Models		Quick-disconnect Fitting Models	
		Model Number	Part Number	Model Number	Part Number	Model Number	Part Number
610 mm (24")	24	USE2412YI USR2412YI	54460 54461	USE2412YP2 USR2412YP2	54452 54453	USE2412Y USR2412Y	55159 55160
813 mm (32")	32	USE3212YI USR3212YI	54462 54463	USE3212YP2 USR3212YP2	54454 54455	USE3212Y USR3212Y	55161 55162
1016 mm (40")	40	USE4012YI USR4012YI	54464 54465	USE4012YP2 USR4012YP2	54456 54457	USE4012Y USR4012Y	55163 55164
1219 mm (48")	48	USE4812YI USR4812YI	54466 54467	USE4812YP2 USR4812YP2	54458 54459	USE4812Y USR4812Y	55165 55166
1422 mm (56")	56	USE5612YI USR5612YI	51314 51315	USE5612YP2 USR5612YP2	51308 51309	USE5612Y USR5612Y	55167 55168
1626 mm (64")	64	USE6412YI USR6412YI	51316 51317	USE6412YP2 USR6412YP2	51310 51311	USE6412Y USR6412Y	55169 55170
1829 mm (72")	72	USE7212YI USR7212YI	51318 51319	USE7212YP2 USR7212YP2	51312 51313	USE7212Y USR7212Y	55171 55172

Control Box (One required per system)

Description	Model Number	Part Number
Muting control box	**USCC-1L2M**	60108
Muting control box with fixed blanking	**USCC-2L2M**	TBA

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

* Not required for sensors with integral 7.6 m (25') cable.
** Contact factory Applications Department for information on cables longer than 50'.

Description	Model Number	Part Number
4.5 m (15') cable, straight QD connector	**QDU-515C**	46391
7.6 m (25') cable, straight QD connector	**QDU-525C**	46392
15 m (50') cable**, straight QD connector	**QDU-550C**	46393

Documentation

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

Description	Part Number
Instruction manual for Muting MICRO-SCREEN Systems	58764
Checkout Procedure Card (Daily)	61076
Checkout Procedure Card (Semi-annual)	48752

USA Series Protective Mounting Stands

Description	Model Number	Part Number
40-inch “L” stand (w/o base)	**USA-PMS-40**	57115
62-inch “L” stand (w/o base)	**USA-PMS-62**	57114
Stand Base	**MSA-SB-1**	57116

Retrofit Mounting Bracket Kits

Description	Model Number	Part Number
Retrofit for STI MS43	**USMB-4**	55668
Retrofit for STI MS42	**USMB-5**	55669

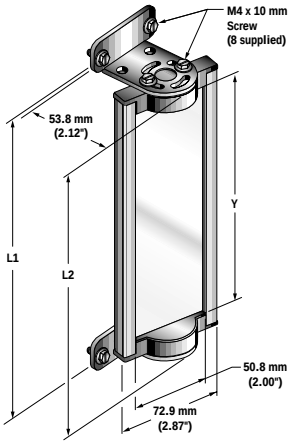
LAT-1 Laser Alignment Tool

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

Models and Accessories

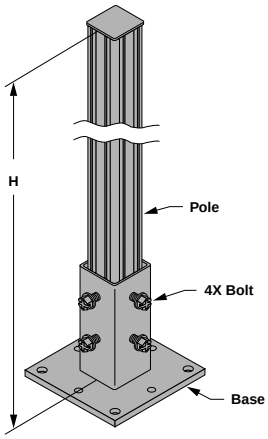
MSM Series Corner Mirrors

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



MICRO-SCREEN Lens Shields

MICRO-SCREEN Sensor Length	Lens Shield Length	Lens Shield Model Number	Part Number
4"	4.4"	**USS4**	55116
8"	8.4"	**USS8**	55117
12"	12.4"	**USS12**	55118
16"	16.4"	**USS16**	55119
20"	20.4"	**USS20**	55120
24"	24.4"	**USS24**	55121
28"	28.4"	**USS28**	55122
32"	32.4"	**USS32**	55123
36"	36.4"	**USS36**	55124
40"	40.4"	**USS40**	55125
44"	44.4"	**USS44**	55126
48"	48.4"	**USS48**	55127
56"	56.4"	**USS56**	55128
64"	64.4"	**USS64**	55129
72"	72.4"	**USS72**	55130

Replacement Parts, MICRO-SCREEN System with Muting

Description	Model Number	Part Number
Replacement key	**MGA-K-1**	28513
Key switch	**MGA-KSO-1**	30140
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 (2.25" dia.)	**STP-5**	43837
Specified test piece (3.25" dia.)	**STP-9**	50694
Mounting hardware kit for one 4" to 24" emitter or receiver	**USMB-1**	50000
Mounting hardware kit for one 28" to 36" emitter or receiver	**USCMB-1**	51651
Mounting hardware kit for one 40" to 72" emitter or receiver	**USCMB-2**	54976
Control box mounting hardware	**USA-MH-2**	60110
Replacement power supply board without fixed blanking	**USMA-PSC-1**	60642
Replacement power supply board with fixed blanking	**USMA-PSC-2**	TBA
Replacement Light Screen controller board for control box USCC-1L2M	**USAB-1**	51885
Replacement Light Screen controller board for control box USCC-2L2M	**USAB-2**	51886
Replacement System controller board for control boxes USCC-1L2M and USCC-2L2M	**USMAL**	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

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) 827-5266

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

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
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European Standards

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

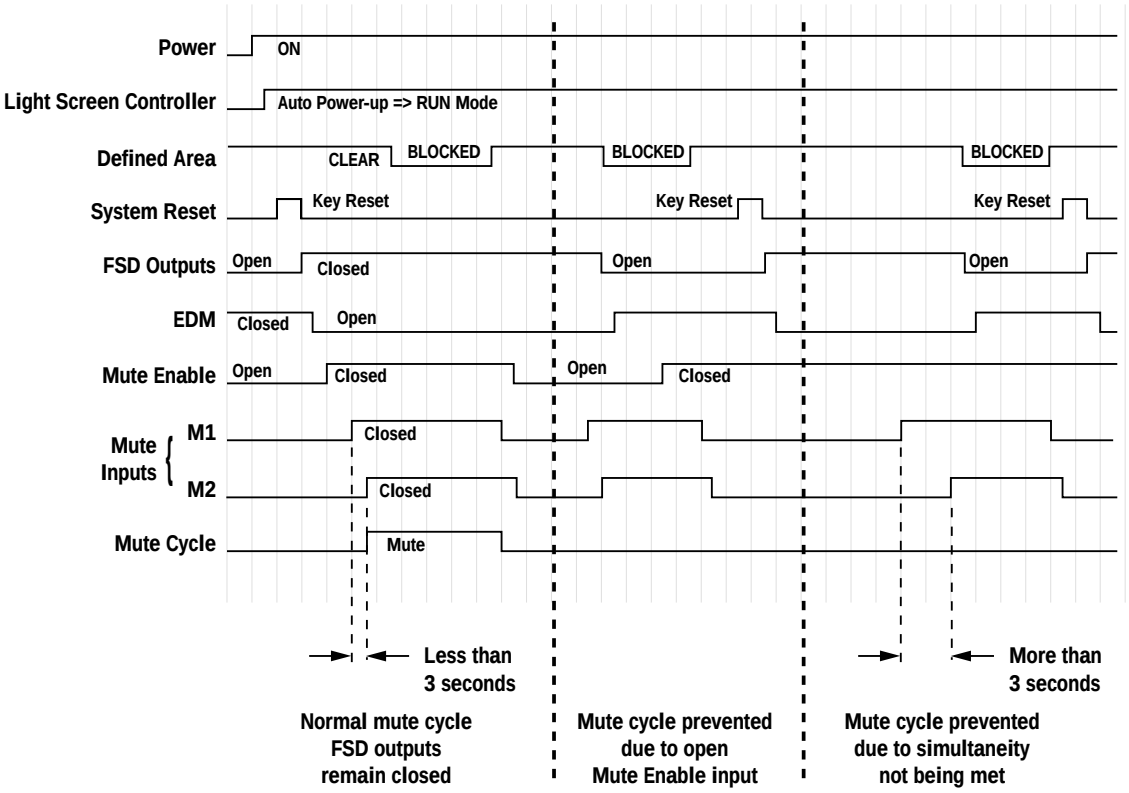
Appendix A. Mute Timing Sequences

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 disabled . . . . . .Light Screen Controller SW2 and SW3 = OFF
System Auto Power-up disabled . . . . . .System Controller SW1 = OFF
Monitored Muting Lamp . . . . . .System Controller SW2 = ON
Two-Way Muting . . . . . .System Controller SW3 = ON
One-Channel Monitoring . . . . . .System Controller SW4 = OFF
30-Second Backdoor Timer . . . . . .System 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.

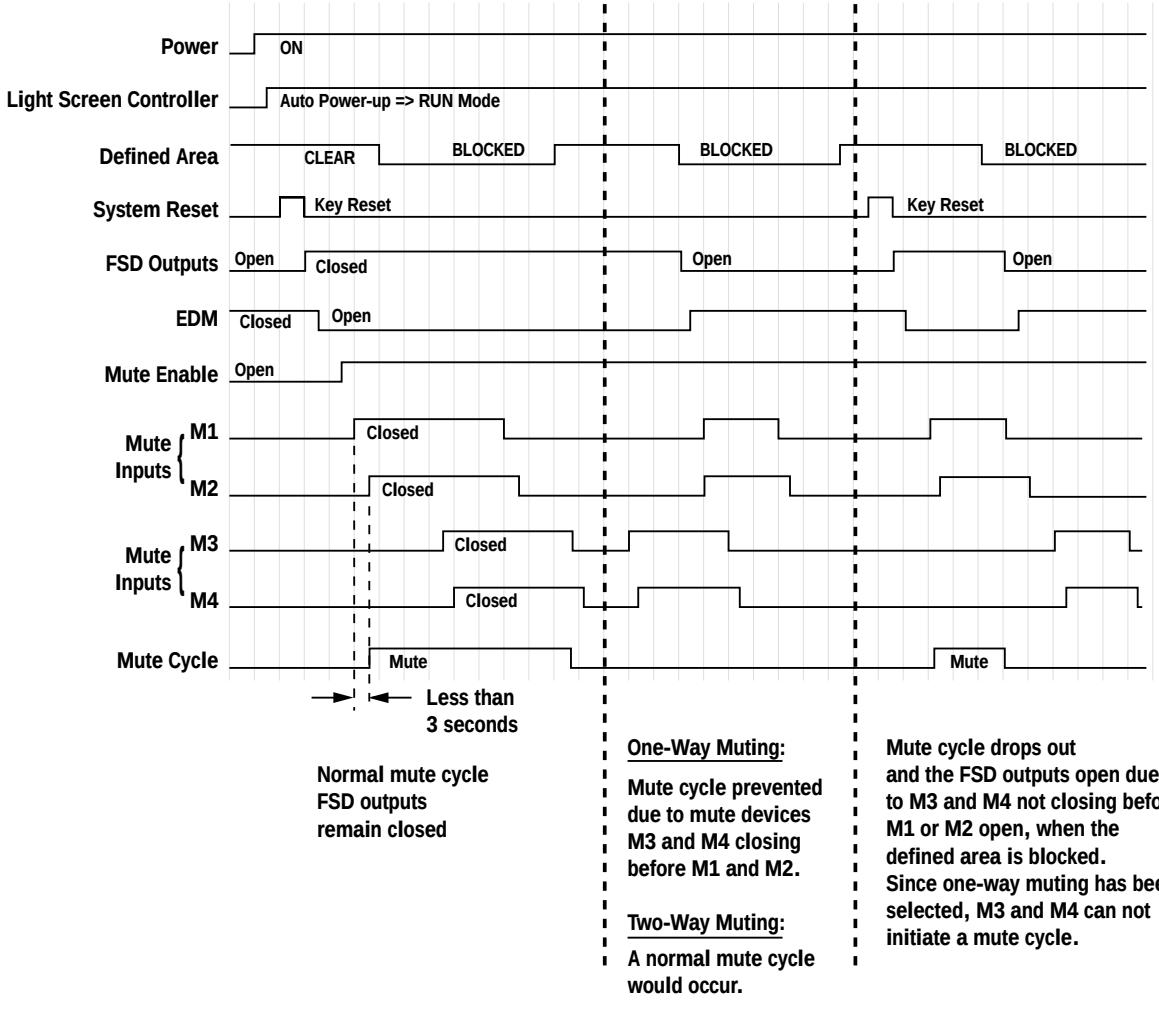


Muting Sequence with Four Muting Devices
(For example, an Entry/Exit System using four photoelectric devices; see Figure C-5, page 98)

Light Screen and System Switch Configuration*:

Light Screen Auto Power-up enabled . .Light Screen Controller SW1 = ON
Floating Blanking disabled . . . . . .Light Screen Controller SW2 and SW3 = OFF
System Auto Power-up disabled . . . . .System Controller SW1 = OFF
Monitored Muting Lamp . . . . . .System Controller SW2 = ON
One-Way muting . . . . . .System Controller SW3 = OFF
One-Channel Monitoring . . . . . .System Controller SW4 = OFF
30 Second Backdoor Timer . . . . . .System 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.



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) see connection diagram below
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" to16") 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 6m (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 . . .

- **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.

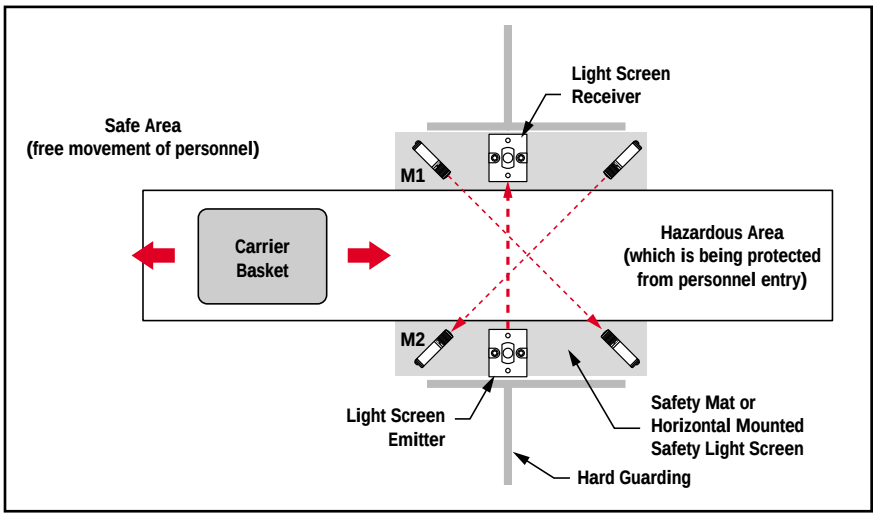


Figure C-1. "X"-Pattern Entry/Exit system using two pairs of opposed-mode photoelectric muting devices

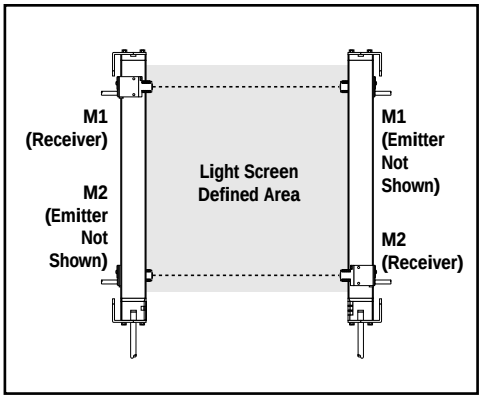


Figure C-2. Horizontal photoelectric muting devices placed at different heights

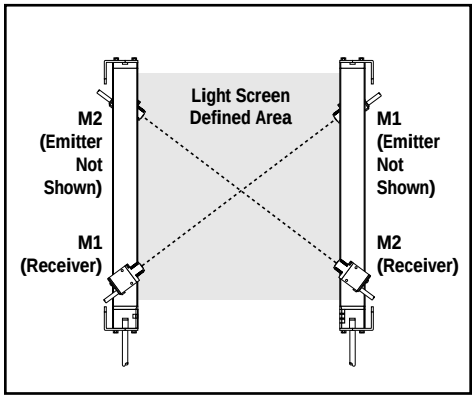
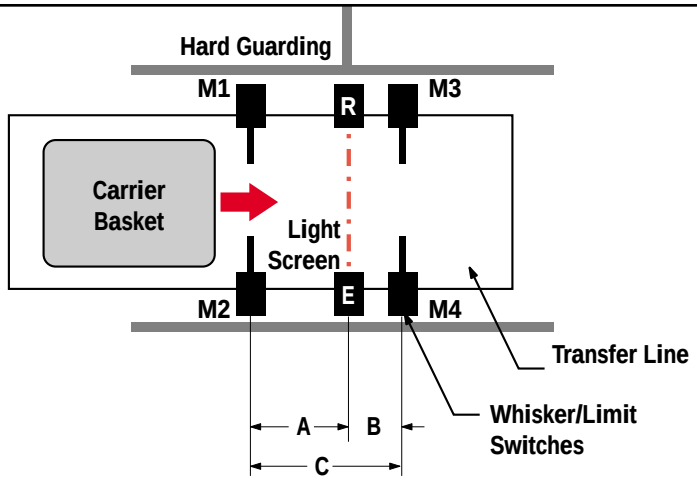


Figure C-3. Photoelectric muting devices placed diagonally

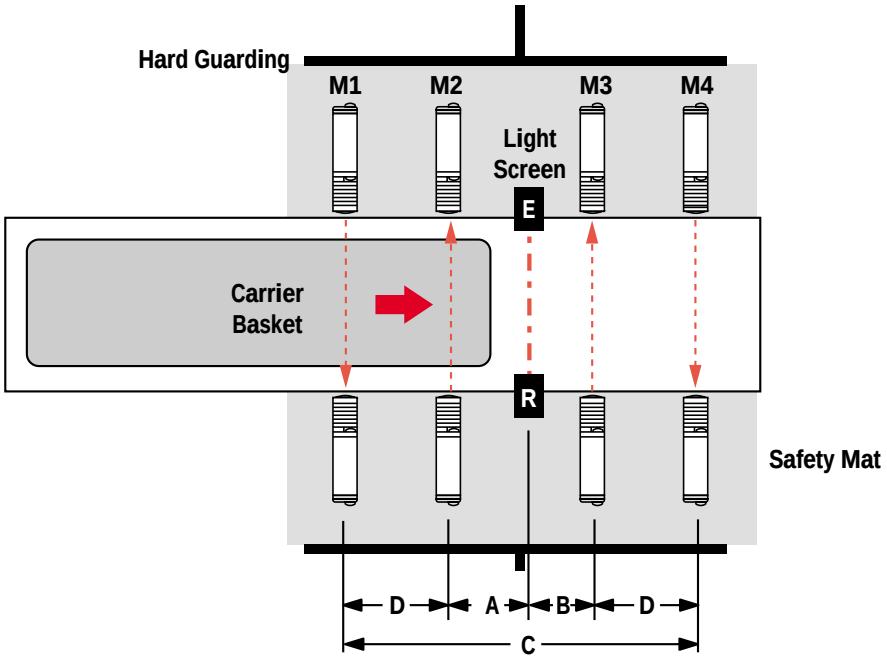


A ≥ (speed of line ft/sec) x 0.1 sec.
B ≈ 3" (suggested position must hinder personnel following muted object)
C ≤ Length of carrier basket

– Trapping hazards must be avoided and clearance requirements complied with.
– Switch actuators can not be so long that they allow a single person to initiate a muted condition.
– Polarized-retroreflective (with targets mounted on carrier) and inductive proximity sensors could be used in a similar manner, if an individual can not ride into the hazardous area.

One-way (directional) muting can be used in "Exit" applications to reduce the possibility of intentional defeat.

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



A ≥ (speed of line ft/sec) x 0.1 sec.
B ≈ 3" (suggested position must hinder personnel following muted object)
C ≤ Length of carrier basket
D < (speed of line ft/sec) x 3.0 sec., but beams M1 and M2 must be far enough apart to hinder an individual from triggering both sensors.

One-way (directional) muting can be used in "Exit" applications to reduce the possibility of intentional defeat.

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.

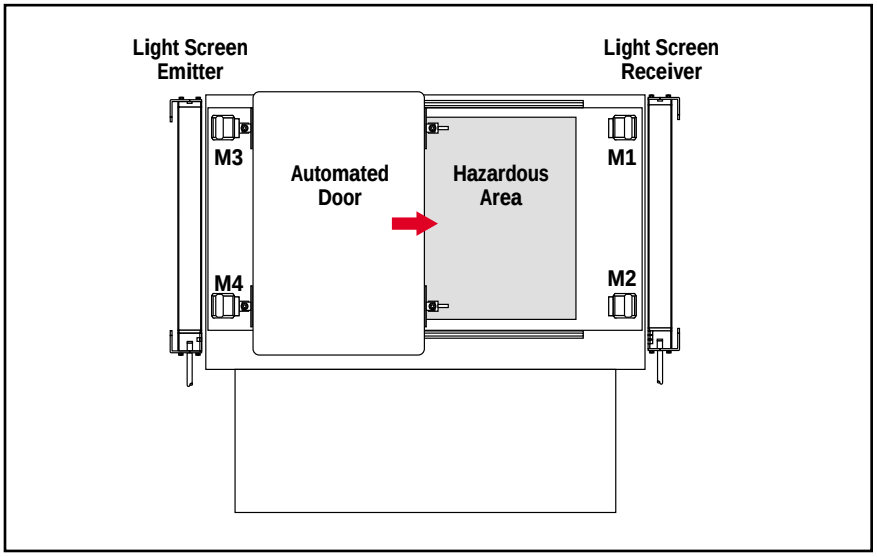


Figure C-6. A "home position" (door) muting application, using 4 safety switches as muting devices

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.

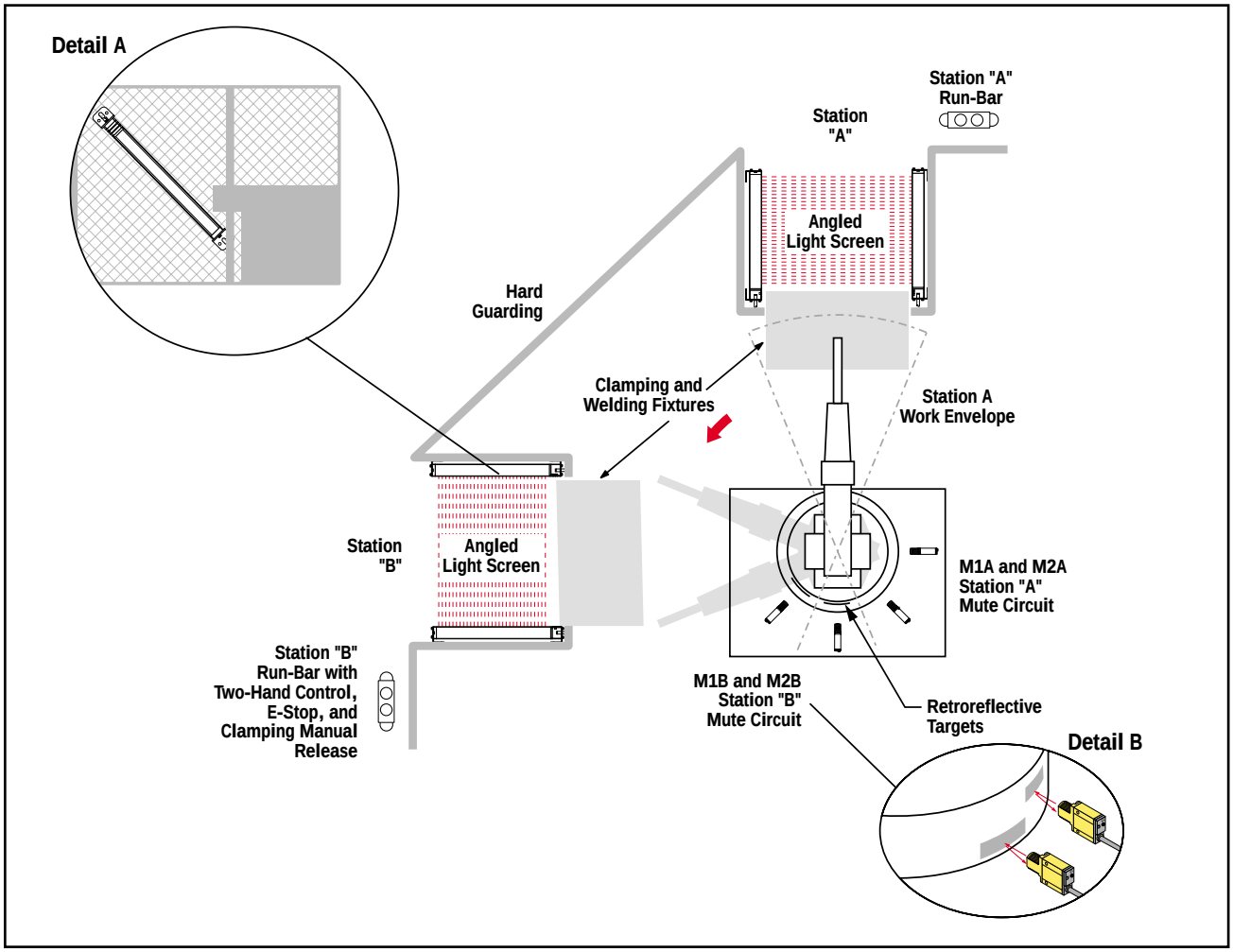


Figure C-7. A robot load/unload application with two-station home-position muting, using polarized retroreflective photoelectrics as muting devices.

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.

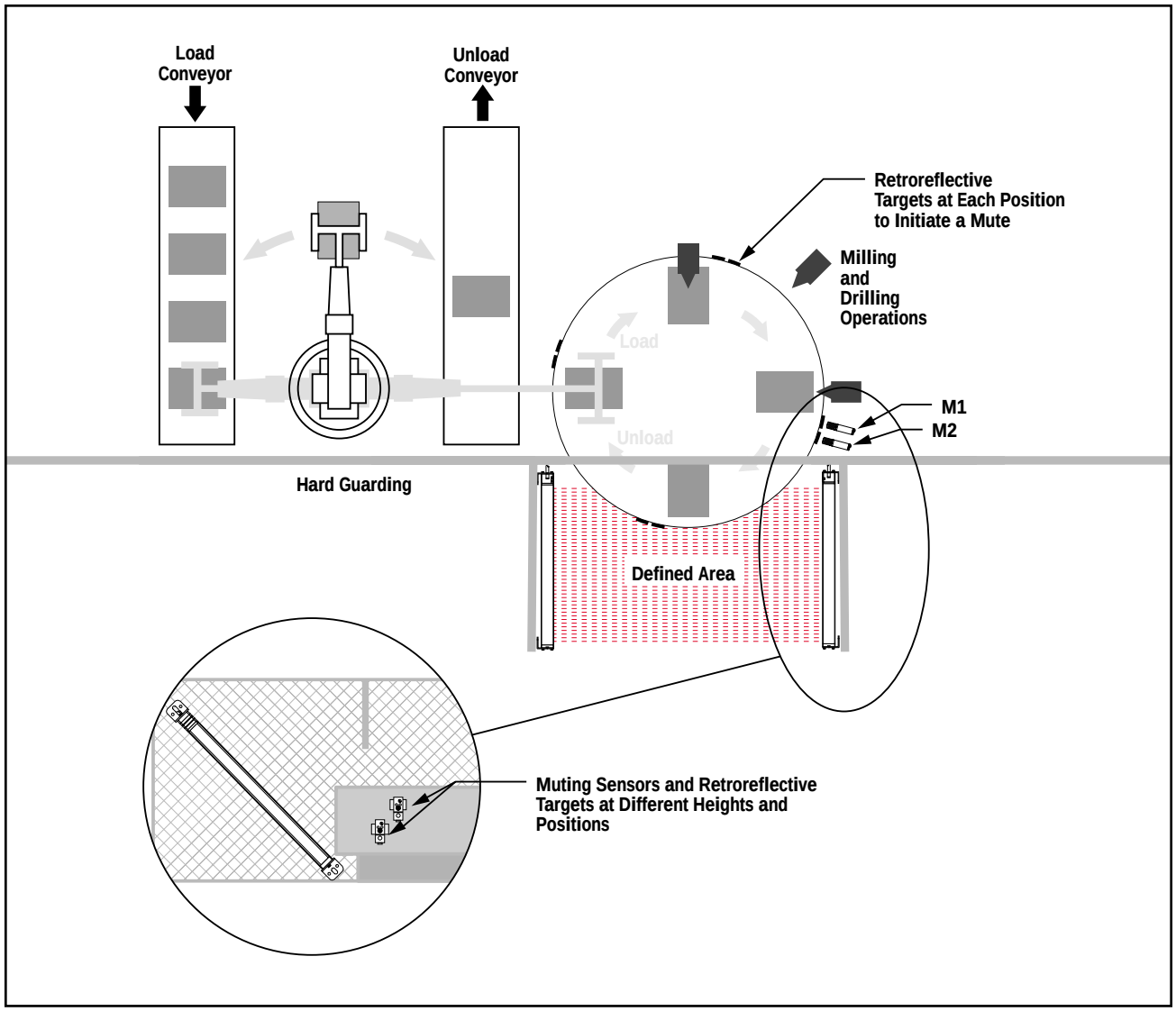


Figure C-8. A typical application for turret table inspection or operation station muting, using retroreflective photoelectric sensors as muting devices.

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.

the machine safety specialist

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