



Dual MINI-SCREEN®

Dual Safety Light Screen System Instruction Manual

For Systems Using Control Module MDSINT-1T2 (Trip Output) or MDSINT-1L2 (Latch Output)

Dual MINI-SCREEN Features

- An optoelectronic point-of-operation guarding device for production machinery
- One control module operates two emitter/receiver sensor pairs
- Compact package for smaller production machines
- Creates a curtain of synchronized, modulated infrared sensing beams from 4" to 4' high (in 12 lengths)
- Sensors are available with choice of black or safety yellow finish and with sensing range of either 9 m (30') or 18 m (60'), depending on models selected (see page 6).
- Control module may be bolted directly to enclosure back plate or mounted on standard 35 mm DIN rail
- Includes input for emergency stop switch
- Easily configured for floating blanking (one- or two-beam), and/or auto power-up
- Diagnostic Display visible through module cover
- Separate alignment indicators for each sensor pair
- "Diverse redundant" controller design provides a high level of control reliability
- FMEA (Failure Mode and Effects Analysis) tested to ensure control reliability
- Replaceable redundant output safety relays with forced-guided contacts for enhanced control reliability
- Highly immune to EMI , RFI, ambient light, weld flash, and strobe light
- Vibration-tolerant factory burned-in emitter and receiver circuitry for toughness and dependability; anti-vibration mounts provided with sensors



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the machine safety specialist

9714 10th Avenue North • Minneapolis, MN 55441
Phone: 763.544.3164 • <http://www.bannerengineering.com>
Email: sensors@bannerengineering.com

Applications and Limitations of Dual MINI-SCREEN® Systems

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

- Hydraulic and pneumatic power presses
- Molding presses
- Automated production equipment

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

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

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

Important ... read this page before proceeding!

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

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

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

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

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

Caution!!

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

U.S. Standards Applicable to Use of Dual MINI-SCREEN® Systems

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

See pages 61 and 62 for information on these and other applicable standards, and where to acquire copies.

Banner Engineering Corp.
9714 - 10th Avenue No.
Minneapolis, MN 55441
Email: sensors@baneng.com

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1. MINI-SCREEN System Introduction

The Banner Dual MINI-SCREEN System is a microprocessor-controlled opposed mode light screen system which uses *two* pairs of sensors. The two pairs of sensors are typically used to provide point-of-operation guarding for two areas on the same machine.

This five-piece system consists of two emitters, two receivers, and one of two available control modules (MDSDINT-1T2 with trip output and MDSDINT-1L2 with latching output). The two sensor pairs may be of any length. The sensors connect to the control module using four 5-wire shielded cables, (purchased separately), which have quick-disconnect fittings on their sensor end. The controller automatically recognizes the size and type of the two sensor pairs wired to it - no programming is necessary. The control module is powered by 24V dc.

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

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

The Dual MINI-SCREEN System features selectable *floating blanking* which allows for the movement of multiple work-pieces through one or both light screens. The controller is easily configured for either one- or two-beam floating blanking. The two light screens are configured separately. Use of floating blanking affects the *minimum object sensitivity*. See Section 2.1 for complete information.

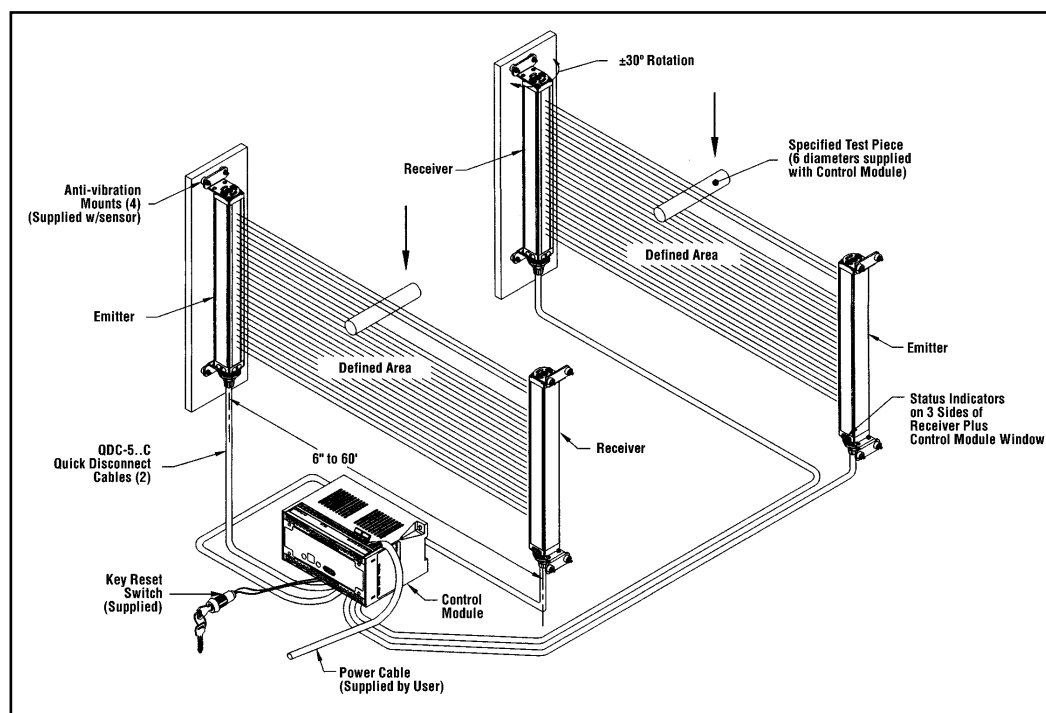


Figure 1. Banner Dual MINI-SCREEN System: two emitters, two receivers, control module, and four interconnecting cables.

Emitters have a row of synchronized modulated infrared (invisible) light emitting diodes (LEDs). Receivers have a corresponding row of synchronized phototransistors.

Emitters and receivers are available in lengths ranging from 4" to 4' (see next page). This length determines the height of the defined area. The sensor design includes a swivel bracket at each end for quick mounting and ease of alignment.

MINI-SCREEN emitters and receivers are available with the choice of two sensing ranges (maximum emitter-to-receiver separation): 9 m (30') or 18 m (60'). Certain range restrictions apply when using corner mirrors (see Section 6). The patented modulated receiver design produces exceptionally high immunity to ambient light interference.

The *minimum object sensitivity* of 30' range sensor pairs is 19 mm (0.75") when no blanking is in use. The *minimum object sensitivity* of 60' range sensor pairs is 25 mm (1.0") when no blanking is in use.

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 (i. e. - the separation distance). See Section 3.2.

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



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

The Dual MINI-SCREEN System uses *two pairs of sensors connected to one control module*. **Connection of more than two pairs of sensors to a single control module can result in serious injury or death.**

The control module features two alignment indicators – one for each light screen – to simplify system setup and monitoring. In addition, MINI-SCREEN receivers each have three sets of easily visible LED indicators for system operating status, including alignment. Alignment indicators flash to indicate the interruption of one or more beams due to blockage or misalignment.

The control module contains a power supply (to power the controller itself and the two sensor pairs), a microprocessor controller module to control sensing logic, and a replaceable relay board with forced-guided output relays. A single-digit Diagnostic Display, visible through a clear window in the control module cover, identifies trouble causes.

The control module also has provision for connection of an optional emergency stop switch. Resetting the system from an emergency stop, a fault condition, or at system power-up is accomplished using a keyed panel switch, which is supplied with each control module.

The selectable auto power-up feature makes a key reset at system power-up unnecessary for those applications where a key reset is difficult to perform.

A functional schematic diagram of the Dual MINI-SCREEN System appears on page 12. For Dual MINI-SCREEN System dimension drawings, see pages 23 and 24. For specifications, see pages 56-57.

The components of a Dual MINI-SCREEN system are purchased separately. The components are listed on the next page.

1.1 MINI-SCREEN Components and Kits

Dual MINI-SCREEN Systems consist of one control module, two sensor pairs, and four cables. All components are ordered separately. The only requirement is that each emitter and its corresponding receiver must be of equal length and sensing range. However, the two sensor pairs may be different lengths. Cables are interchangeable between emitters and receivers. See pages 59-60 for system accessories.

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

Defined Area	Models				Number of Beams
	Black Anodized		Yellow Painted		
	9 m (30') Range	18 m (60') Range	9 m (30') Range	18 m (60') Range	
114 mm (4.5")	MSE424 MSR424	MSXLE424 MSXLR424	MSE424Y MSR424Y	MSXLE424Y MSXLR424Y	8
215 mm (8.5")	MSE824 MSR824	MSXLE824 MSXLR824	MSE824Y MSR824Y	MSXLE824Y MSXLR824Y	16
305 mm (12")	MSE1224 MSR1224	MSXLE1224 MSXLR1224	MSE1224Y MSR1224Y	MSXLE1224Y MSXLR1224Y	24
406 mm (16")	MSE1624 MSR1624	MSXLE1624 MSXLR1624	MSE1624Y MSR1624Y	MSXLE1624Y MSXLR1624Y	32
508 mm (20")	MSE2024 MSR2024	MSXLE2024 MSXLR2024	MSE2024Y MSR2024Y	MSXLE2024Y MSXLR2024Y	40
610 mm (24")	MSE2424 MSR2424	MSXLE2424 MSXLR2424	MSE2424Y MSR2424Y	MSXLE2424Y MSXLR2424Y	48
711 mm (28")	MSE2824 MSR2824	MSXLE2824 MSXLR2824	MSE2824Y MSR2824Y	MSXLE2824Y MSXLR2824Y	56
813 mm (32")	MSE3224 MSR3224	MSXLE3224 MSXLR3224	MSE3224Y MSR3224Y	MSXLE3224Y MSXLR3224Y	64
914 mm (36")	MSE3624 MSR3624	MSXLE3624 MSXLR3624	MSE3624Y MSR3624Y	MSXLE3624Y MSXLR3624Y	72
1016 mm (40")	MSE4024 MSR4024	MSXLE4024 MSXLR4024	MSE4024Y MSR4024Y	MSXLE4024Y MSXLR4024Y	80
1118 mm (44")	MSE4424 MSR4424	MSXLE4424 MSXLR4424	MSE4424Y MSR4424Y	MSXLE4424Y MSXLR4424Y	88
1219 mm (48")	MSE4824 MSR4824	MSXLE4824 MSXLR4824	MSE4824Y MSR4824Y	MSXLE4824Y MSXLR4824Y	96

Pigtail Quick-Disconnect Option

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

Controllers (One per system)

MDSINT-1T2 24V dc control module, Trip Output

MDSINT-1L2 24V dc control module, Latch Output

Cables (Two required per system)*

QDC-515C 4.5 m (15') cable, straight QD connector. One cable per sensor.

QDC-525C 7.6 m (25') cable, straight QD connector. One cable per sensor.

QDC-550C 15 m (50') cable, straight QD connector. One cable per sensor.

QDC-5100 30 m (100') cable, straight QD connector. One cable per sensor.

QDC-5150 45 m (150') cable, straight QD connector. One cable per sensor.

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

2. Overview of Dual MINI-SCREEN System Operation

In operation, two sensor pairs are separately mounted and aligned. This establishes two screens of invisible infrared light beams called the *defined areas* (Figure 1, page 4).

The following features of the Dual MINI-SCREEN System are discussed in the listed subsections:

- Blanking (Section 2.1)
- Auto power-up (Section 2.2)
- Lockout Conditions and Key Resets (Section 2.3)
- Operating Status Indicator Lights (Section 2.4)
- Diagnostic Indicator LEDs (Section 2.5)
- Emergency Stop Switch Input (Section 2.6)
- Output Relay Operation (Section 2.7)
- Control Reliability: Redundancy & Self-checking (Section 2.8)
- Remote Test Input (Section 2.9)

2.1 Blanking

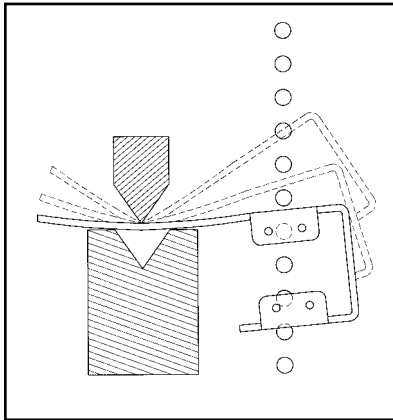


Figure 2. Floating blanking

Dual MINI-SCREEN Systems may be configured to be “blind” to the passage of multiple objects of limited size through either or (both) defined area. This is useful in press brake and other applications where multiple blanked zones (moveable or stationary) are needed.

Floating blanking is the “blinding” of one or groups of two adjacent sensing beams, which will appear to change position (“float”) in order to allow multiple objects (usually workpiece material) to move through the defined area, at any point, without tripping the final switching device relays of the MINI-SCREEN System. *With floating blanking ON, any and every one- or two-beam blockage(s) will be ignored.* See Figure 2.

Floating blanking is separately programmed for each of the two light screens. 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.

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

*NOTE: The size listed in the table for objects which move undetected through the light screen assumes that those objects move exactly perpendicular to the plane of the light beams.

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 a light screen and the nearest hazard point (i. e. - 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 18 and Section 3.4, both on page 25, for details). NOTE: Blanking ON is indicated by a flashing green Status Indicator LED.

2.2 Auto Power-up

Normal operation of the Dual MINI-SCREEN System requires a key reset each time power is applied to the system. This is usually a desired response to a power failure or interrupt, and is required by some design standards. In applications where a key reset is difficult to perform, the auto power-up feature puts the Dual MINI-SCREEN System directly into RUN mode when power is applied.

Auto power-up is enabled or disabled via a pair of DIP switches located on the controller board inside the control module. See Figure 18 and Section 3.4 on page 25 for details.

2.3 Lockout Conditions and Key Resets

A *lockout condition* of the Dual MINI-SCREEN System causes *all* of its output relays to open, sending a "stop" signal to the guarded machine.

A Power-up/Power Interrupt Lockout condition will occur:

- Upon power-up of the Dual MINI-SCREEN System (unless Auto Power-up is ON; see Figure 5, page 11), or
- If power to the Dual MINI-SCREEN System is interrupted (unless Auto Power-up is ON; see Figure 5).

An Internal Lockout condition will occur:

- If the control box key switch is in the RESET position at power-up (with Auto Power-up ON); or if the key switch is switched to RESET while the system is in RUN mode,
- If a Final Switching Device (FSD - see Glossary) relay does not "drop out" within its specified time,
- If the Secondary Switching Device (SSD - see Glossary) relay has de-energized,
- If the controller module switch settings are inconsistent with each other or if they were changed while the system was in RUN mode, or
- If the self-checking circuits of the microprocessor detect a component failure within the Dual MINI-SCREEN System itself, or
- If either (or both) emergency stop switch contacts open.

A lockout condition resulting from an internal system fault is indicated by a flashing red status indicator LED on the control box and the receiver unit. The green and yellow LEDs will be OFF. See Figure 5, page 11.

Power-up/power interrupt lockouts (yellow LED only double-flashing) are normal and require a *key reset* for operation to continue.

Internal lockout conditions result from component failures or incorrect controller settings, which must be corrected before the system will allow operation to continue (Section 2.7). A numeric diagnostic indicator, visible through a window in the control box cover, indicates the cause of the lockout (Section 2.5). Internal lockout conditions also require a reset of the control module's keyed switch (a *key reset*) to return the system to RUN mode. A valid *key reset* consists of turning the key switch to the RESET position, holding it there for at least 1/2 second, and then returning the key switch to the RUN position.

2.4 Operating Status Indicators

Indicators on the control module provide complete information on operating status.

2.4.1 Alignment Indicators

There are two yellow alignment indicators - one for each sensor pair. They are labeled "SCREEN 1 ALIGNMENT" and "SCREEN 2 ALIGNMENT". When each sensor pair is properly aligned, its alignment indicator will be ON steadily. A flashing Alignment LED indicates either sensor misalignment or an object detected in the defined area. With all obstructions removed from the defined area, the alignment indicator flashes faster with better alignment, until it locks ON solid with proper alignment.

"SCREEN 1" and "SCREEN 2" are determined by which terminals of the control module each sensor pair is wired to (see Figure 20, page 28). The (three) yellow indicators on each MINI-SCREEN receiver (Figure 4) follow the action of the associated Alignment indicator on the control module.

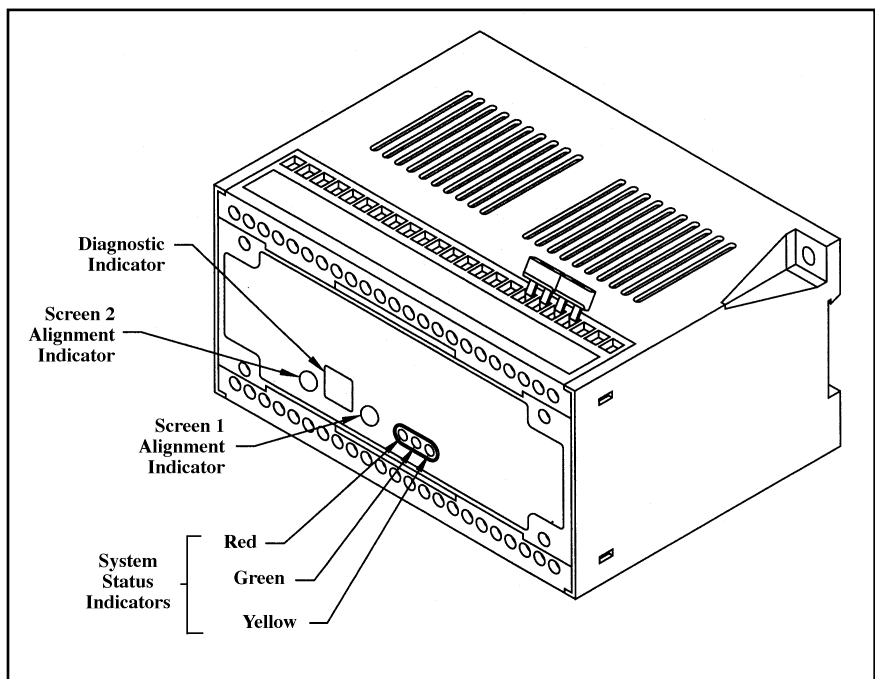


Figure 3. Control Module features

2.4.2 System Status Indicators

There are three system status indicators located on the front panel of the Dual MINI-SCREEN control box (see Figure 3, page 9). The functions are as follows:

Red ON steadily and Yellow single-flashing* (blocked or latched condition): the Dual MINI-SCREEN System has been reset and is in RUN mode, but either there is an obstruction in one or both of the defined areas, or the emitter and receiver of one or both light screens are misaligned. FSD1 and FSD2 contacts are open (de-energized). SSD relay is closed (energized).

A flashing yellow LED indicates 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 of both light screens is correct, the green light will come ON (to join yellow) when the obstruction is removed. If alignment is not correct, the green light will remain OFF when the obstruction is removed.

Red, Green, and Yellow ON steadily (latching output models only): A flashing Green LED indicates that blanking is ON. Both light screens are clear, but one or both is latched, requiring a Key Reset. (All blockages in the light screen(s) have been removed.) Both the defined areas are clear of obstructions, and both emitter and receiver pairs are properly aligned. FSD1 and FSD2 contacts are open (de-energized). The SSD contact is closed (energized).

Green and Yellow ON steadily: the MINI-SCREEN System has been reset and is in RUN mode, both defined areas are clear of obstructions, and both emitter and receiver pairs are properly aligned. (A flashing Green LED indicates that blanking is ON). SSD, FSD1, and FSD2 contacts are closed (energized).

Red (only) ON and flashing: a lockout condition due to an internal MINI-SCREEN System problem exists. SSD, FSD1, and FSD2 are all open (de-energized).

Yellow (only) ON and double-flashing: a *double-flashing* Yellow LED indicates a power-up or power interrupt lockout condition. *These lockouts occur in the normal course of powering up the Dual MINI-SCREEN System or upon an interruption of power to the System* (unless Auto Power-up is ON; see page 25). SSD, FSD1 and FSD2 contacts are open (de-energized).

Yellow (only) ON steadily: the key switch has been switched to the RESET position at power-up. FSD1 and FSD2 contacts are open (de-energized). SSD contact is closed (energized).

*If the TEST INPUT terminals are shorted and the defined area is clear, the Yellow LED will be ON steadily (see Section 3.5.9).

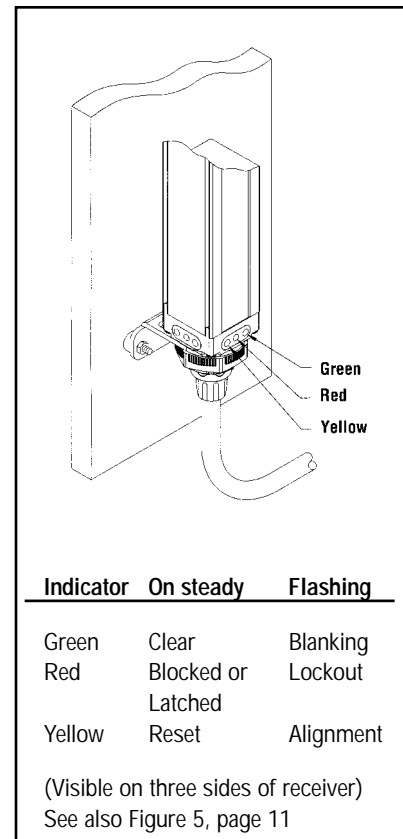


Figure 4. Status indicator LEDs (MINI-SCREEN receiver)

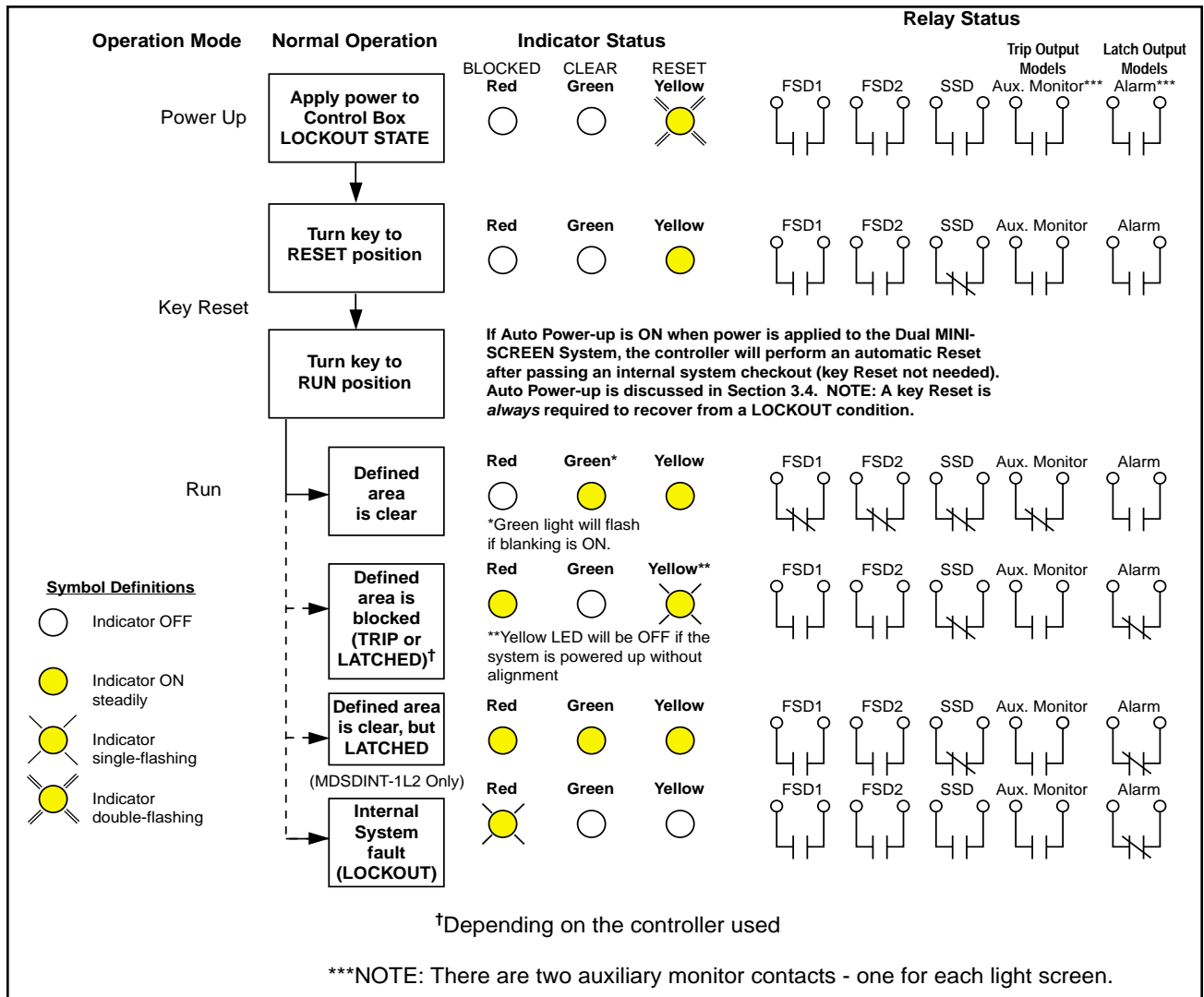


Figure 5. Dual MINI-SCREEN System status indicators and associated output conditions

2.5 Diagnostic Indicator

A single-digit numeric display located on the front panel of the Dual MINI-SCREEN control module (Figure 3) indicates an error code corresponding to the cause of a fault (lockout) condition. Error codes are listed and interpreted in Figure 24 on page 39.

In addition, the decimal point of the display flashes to indicate a high level of electrical or optical interference in the area of the Dual MINI-SCREEN System. This diagnostic feature simplifies system troubleshooting.

Under normal RUN conditions, the diagnostic indicator will display a horizontal bar (i.e., the center segment of the display will be lit).

2.6 Emergency Switch Input

The Dual MINI-SCREEN control module has provision for connection of an optional emergency stop switch. See Section 3.5.2 for complete information.

2.7 Output Relay Operation

The Dual MINI-SCREEN System control box has three output relays plus two Auxiliary Monitor Relays. Refer to Figure 6, below. The three output relays are 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 in such a way 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.

Any object that blocks one or more unblanked beams in either light screen will be detected and will cause a trip condition. Output relays FSD1 and FSD2 (but not SSD) in the control module open their contacts in response to a trip condition.

All three output relays (FSD1, FSD2, and SSD) will open their contacts in response to any one of several lockout conditions, including component failure within the Dual MINI-SCREEN System itself (see Control Reliability, Section 2.7). The Dual MINI-SCREEN System automatically resets itself from a trip condition when the object that caused the trip is removed.

There are two Auxiliary/Alarm Monitor Relays. One relay is assigned to each of the two light screens. See Figure 5 for operation. When an obstruction is sensed in one of the light screens, the associated monitor contact will switch. In addition, both monitor contacts will open for a lockout condition. These monitor contacts are rated only for 10VA, maximum, and are typically used to signal light screen activity to a process controller. The contacts of these relays are not for safety-related use.

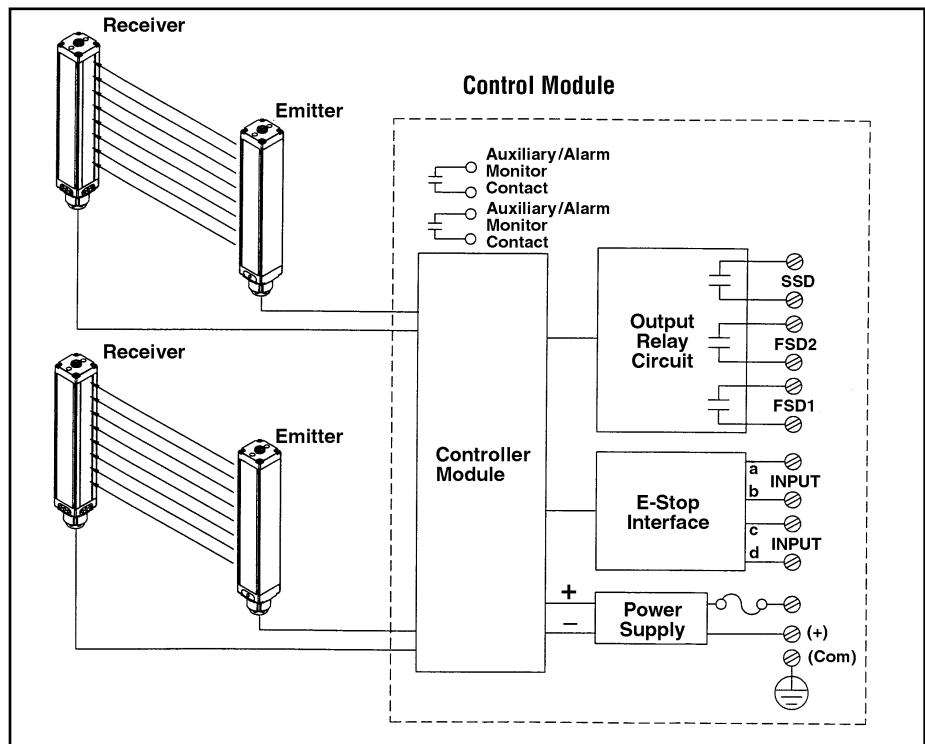


Figure 6. Banner Dual MINI-SCREEN System functional schematic

2.8 Control Reliability: Redundancy and Self-checking

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

- 1) The Dual MINI-SCREEN System must provide a “stop” signal to the guarded machine whenever the defined area is interrupted, within 48, 60, or 72 milliseconds (depending upon sensor length; see Specifications, pages 56-57).

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

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

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

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

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

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

Recovery from this type of lockout condition requires replacement of the failed component (to restore redundancy) and a key reset. Possible causes of lockout conditions are listed in Section 2.3. 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 20, page 28) for an external normally-open switch. These terminals are labeled “TEST 1” and “TEST 2”. Closing a switch connected between these two terminals simulates an interruption of one of the light screens. The device used must be capable of switching 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.

3. Installation and Alignment

3.1 Appropriate Application

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

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

- With single stroke (also called "full revolution") clutched machinery, as this type of machinery is incapable of stopping immediately.
- On certain other types of machinery, including any machine with inadequate or inconsistent stopping response time, and any machine that ejects materials or component parts through either 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 Dual MINI-SCREEN System.
- As a tripping device to initiate machine motion (PSDI applications) on mechanical power presses, per OSHA regulation 29 CFR 1910.217.



CAUTION . . .
Install System Only on Appropriate Applications

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



WARNING . . . Read this Section Carefully Before Installing the System

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

The user has the sole responsibility to ensure that the Banner Dual MINI-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 . . . Use of Dual MINI-SCREEN Systems for Perimeter Guarding

If a Dual MINI-SCREEN System is installed for use as a perimeter guarding system, the dangerous machine motion must be able to be initiated following an interruption of either defined area **only** after actuation of a reset switch. (This describes the normal operation of control module model MDSINT-1L2, which has a **Latch** output.

If control module model MDSINT-1T2 is used for perimeter guarding, the Machine Primary Control Elements (MPCEs) of the guarded machine must be wired so that the trip output of the control module causes 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 accessible from within, the area of dangerous motion, and must be positioned so that the area of dangerous motion may be observed by the switch operator during the reset operation. Additional safeguarding, as described by the ANSI B11 series of safety requirements or other appropriate standards, must be used if any space between either defined area and any danger point is large enough to allow a person to stand undetected by the Dual MINI-SCREEN System. **Failure to observe this warning could result in serious injury or death.**

3.2 Mechanical Installation Considerations

The two factors that influence the layout of the Dual MINI-SCREEN System's mechanical installation the most are:

- *separation distance*, and
- *hard guarding*.

3.2.1 Separation Distance

The Dual MINI-SCREEN System must be able to react fast enough, when a hand or other object is inserted into the defined area, to send a stop signal to the guarded machine which must stop the dangerous motion before the object or hand reaches the closest reachable hazard point on the machine. The *separation distance* is the minimum distance that is required between the midpoint of the defined area and the closest reachable hazard point. The actual separation distance required depends upon 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 (page 16), NOTE 2 (below), and the NOTICE regarding MPCs (page 32).

T_R = the response time of the Dual MINI-SCREEN System. Response time varies with sensor length. See table at left. Always use the longest response time for the two sensor pairs in use.

D_{pf} = the added distance due to depth penetration factor, as prescribed in OSHA 1910.217 and ANSI B11 standards: See table below. *Note: The D_{pf} value may be different for each of the two sensor pairs.*

Response Time	
Sensor Length	T_R
4.5" to 16"	0.048 seconds
20" to 32"	0.060 seconds
36" to 48"	0.072 seconds

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

NOTES:

- 1) The OSHA-recommended hand-speed constant K has been determined by various studies, and although these studies indicate speeds of 63"/sec to over 100"/sec, they are not conclusive determinations. The user should consider all factors, including the physical ability of the operator, when determining the value of K .
- 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_{pf} to increase.
- 4) $D_{pf} = 3.4" (S - .276)$ where S = Minimum Object Sensitivity (per ANSI B11.1 and OSHA 1910.217).

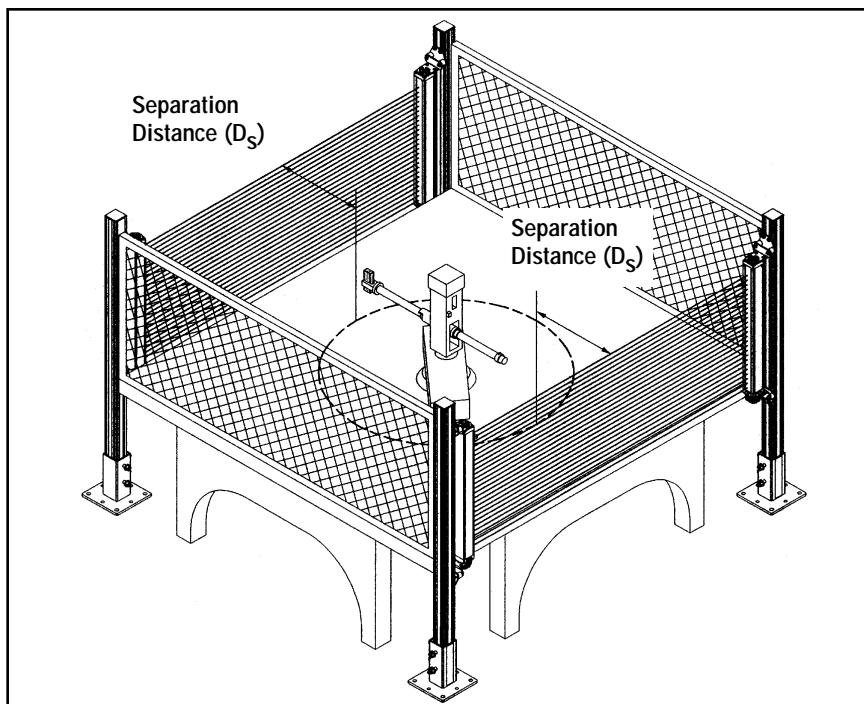


Figure 7. Separation distance

Example: Separation Distance (D_S) Calculation

The following is an example showing how to use the formula from page 15 to calculate the safety distance (D_S). These numbers will be used for the variables in the formula:

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

$T_S = 0.250$ second (the total stop time of the example machine, specified by machine manufacturer)

$T_R = 0.048, 0.060, \text{ or } 0.072$ second (the specified response time of the Dual MINI-SCREEN System; see page 15 or Specifications, pages 56-57.)

This example will assume use of one 24" and one 48" MINI-SCREEN emitter and receiver pair, each with 30' range. From the table on page 15, the value for Dual MINI-SCREEN System response is $T_R = 0.060$ seconds for the 24" sensors and $T_R = 0.072$ seconds for the 48" sensors. The longer of the two times, 0.072 seconds, is used in the formula.

This example will also assume the use of 2-beam floating blanking on both light screens, which requires the depth penetration factor $D_{pf} = 5$ for both light screens, as indicated in the table on page 15. Substitute these numbers into the safety distance formula, as follows:

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

$$D_S = 63 \times (.250 \times 1.2^* + .072) + 5 = 28"$$

Therefore, in this example, both MINI-SCREEN emitter and receiver pairs must be mounted such that no part of the defined area will be closer than 28" to the closest reachable hazard point on the guarded machine.

*20% safety factor (see NOTE 2 on page 15)



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



WARNING . . .
Include the stop time of all relevant devices and controls in your calculations. 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 injury or death.



CAUTION . . .
Floating blanking increases D_{pf}
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.



WARNING. . .
The point of operation must be accessible only through the defined areas.

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 either defined area and into the point of operation, and also to prevent any person from entering the space between either 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 areas. 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 either defined area and the nearest danger point is large enough to allow a person to stand undetected by the Dual MINI-SCREEN System.

3.2.2 Hard Guarding

ANSI B11.1-1988, E6.3.2 (14) requires that "all areas of entry to the point of operation not protected by the presence-sensing device shall be otherwise safeguarded." The hazard point must be accessible *only* through the defined areas. 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 either defined area and into the hazard point, and to prevent any person from standing between either defined area and the hazard point (see OSHA 1910.212). The use of mechanical barriers for this purpose is called "hard guarding" (see the WARNING on the left and the hard guarding example, below).

There must be no gaps between the hard guarding and the edges of the defined areas. Also, OSHA specifies a relationship between the distance of the hard guard barrier from the point of operation and the maximum allowable size of openings in that barrier (see OSHA 1910.217, Table O-10). Openings in the hard guard material must meet OSHA criteria.

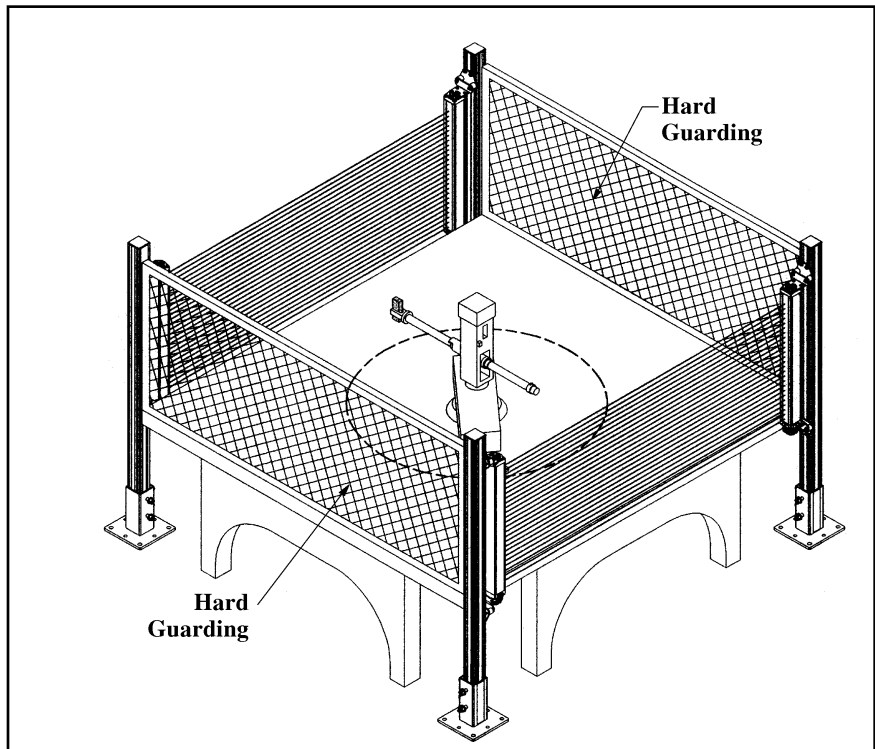


Figure 8. Example of "Hard Guarding"

3.2.2.1 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.



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

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

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

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

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



WARNING . . .
Proper Orientation
of System Emitters
and Receivers

Each emitter and receiver pair of the Dual MINI-SCREEN System must be installed with their corresponding ends (either cabled ends or non-cabled ends) pointing in the same direction (i.e. both cabled ends "up", both cabled ends "down", etc.). Failure to do this will impair the performance of the Dual MINI-SCREEN System and result in incomplete guarding; see Figure 10a. Failure to observe this warning could result in serious injury or death.

3.2.3 Emitter and Receiver Orientation

It is absolutely necessary that each emitter and receiver pair are mounted perfectly parallel to each other and aligned in a common plane with both cable ends pointing in the same direction. Never mount an emitter with its cable end oriented opposite to the cable end of its receiver. If the emitter and receiver cable ends are oriented opposite to each other, there will be voids in the light screen through which objects can pass undetected (see Figure 10a).

An emitter and receiver pair may be oriented in a vertical plane, in a horizontal plane, or at any angle between horizontal and vertical. However, the cable ends must always point in the same direction. Always be certain that each light screen completely covers all access to the hazard point which is not already protected by hard guarding or other supplemental guarding.

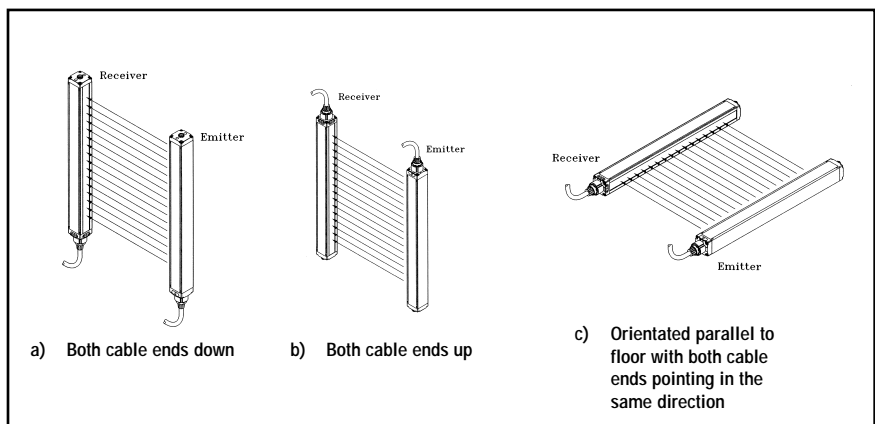


Figure 9. Examples of correct emitter and receiver orientation

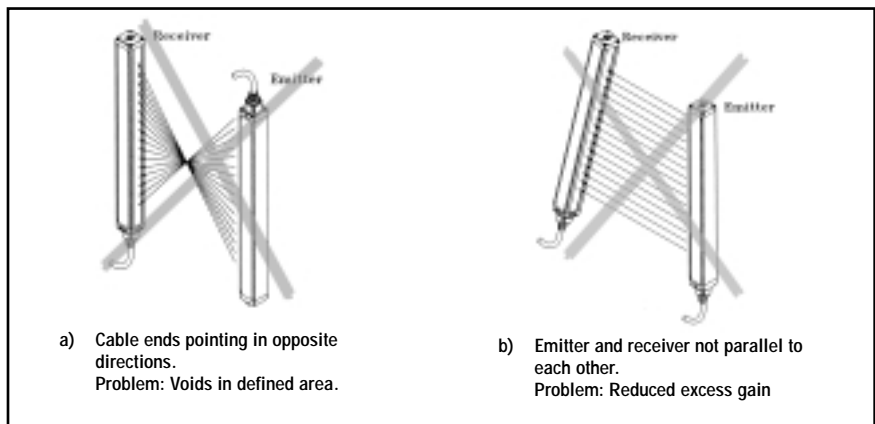


Figure 10. Examples of incorrect emitter and receiver orientation

3.2.4 Adjacent Reflective Surfaces

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

A 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 which are 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 3.5.5), the final alignment and checkout procedure (Section 6.1), and also by 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 curtain of light beams away from the reflective surface(s). If relocating the sensors, be 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.

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

3.2.5 Use of Corner Mirrors

MINI-SCREEN sensors may be used with one or more corner mirrors. The use of corner mirrors somewhat reduces the maximum specified emitter/receiver separation. Corner mirrors and stands are available from Banner. See page 45 for more information.

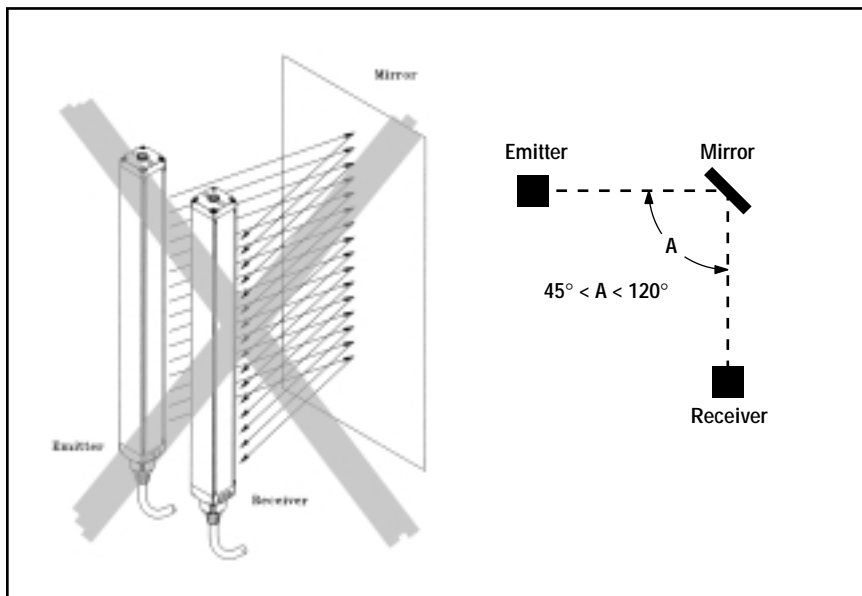


Figure 11. Never use the MINI-SCREEN Sensors in a retroreflective mode.



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 3.5.5), the Alignment Procedure (Section 6.1), and the periodic checkout procedures (Sections 6.2, 6.3, and 6.4).

See text at left for solutions to this condition.



WARNING . . .
Avoid Retroreflective Installation

The Dual MINI-SCREEN System is not designed for use in a retroreflective mode where the sensors are mounted adjacent to each other and the light from the emitter is bounced back directly to the receiver by a mirror or other reflective surface. Never use MINI-SCREEN sensors in a retroreflective mode, as illustrated in Figure 11. Sensing is unreliable in this mode and could result in serious injury or death.

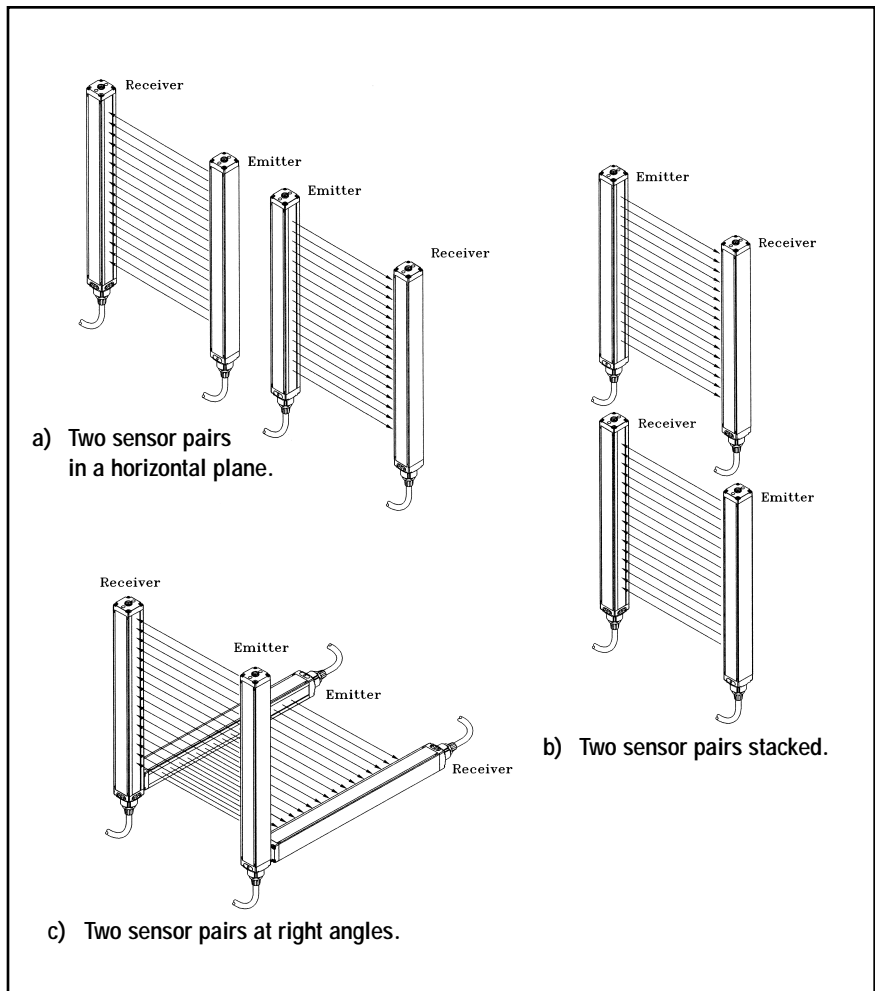


Figure 12. Installation of adjacent sensor pairs; alternate emitters and receivers to avoid optical crosstalk.

3.2.6 Installation of Adjacent Sensor Pairs

Whenever two or more sensor pairs are adjacent to one another, there is potential for optical crosstalk to take place between pairs. This potential for crosstalk exists for adjacent sensor pairs connected to different light screen systems or to the same Dual MINI-SCREEN System. To minimize optical crosstalk, it is recommended to alternate emitters and receivers, as shown in Figure 12.

When three or more sensor pairs (e.g., from multiple systems) are installed in a horizontal plane, (as shown for two pairs in Figure 12a), optical crosstalk may occur between those 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 the same plane, or by adding a mechanical light barrier between the pairs.

3.3 Mounting Procedure

Sensor Mounting

Banner MINI-SCREEN emitters and receivers are small, lightweight, and easy to handle during mounting. The mounting brackets (supplied) allow $\pm 30^\circ$ rotation.

From a common point of reference, make measurements to locate the emitter and receiver in the same plane with their midpoints directly opposite each other. Mount the emitter and receiver brackets using the vibration isolators and M4 Keps nuts (all supplied). See Figure 13. Standard #8-32 bolts may be substituted (and the vibration isolators eliminated) in situations where the emitter and receiver are not subjected to shock or vibration forces. While the internal circuits of the emitter and receiver are able to withstand heavy impulse forces, the vibration isolators dampen impulse forces and prevent possible damage due to resonant vibration of the emitter or receiver assembly.

Mechanical Alignment

Mount the emitter and receiver in their brackets and position the red lenses of the two units directly facing each other. **Important:** The connector ends of both sensors must point in the same direction (see drawings and **WARNING**, page 18). 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 sensors are positioned exactly vertical or horizontal to the floor, a carpenter's level is useful for checking alignment. A straightedge or a string extended between the sensors also helps with positioning. Also check "by eye" for line-of-sight alignment. Make any necessary final mechanical adjustments, and hand-tighten the bracket hardware. A detailed alignment procedure is given in Section 6.1.

The defined area of a MINI-SCREEN sensor is marked by two arrows on its lens side. The defined area is also specified by dimensions "X" and "Y" in Figure 15 on the next page. If corner mirrors are used the center of the length of the defined area must be aligned with the center of the length of the mirror's reflective area (see Figure 27, page 45).

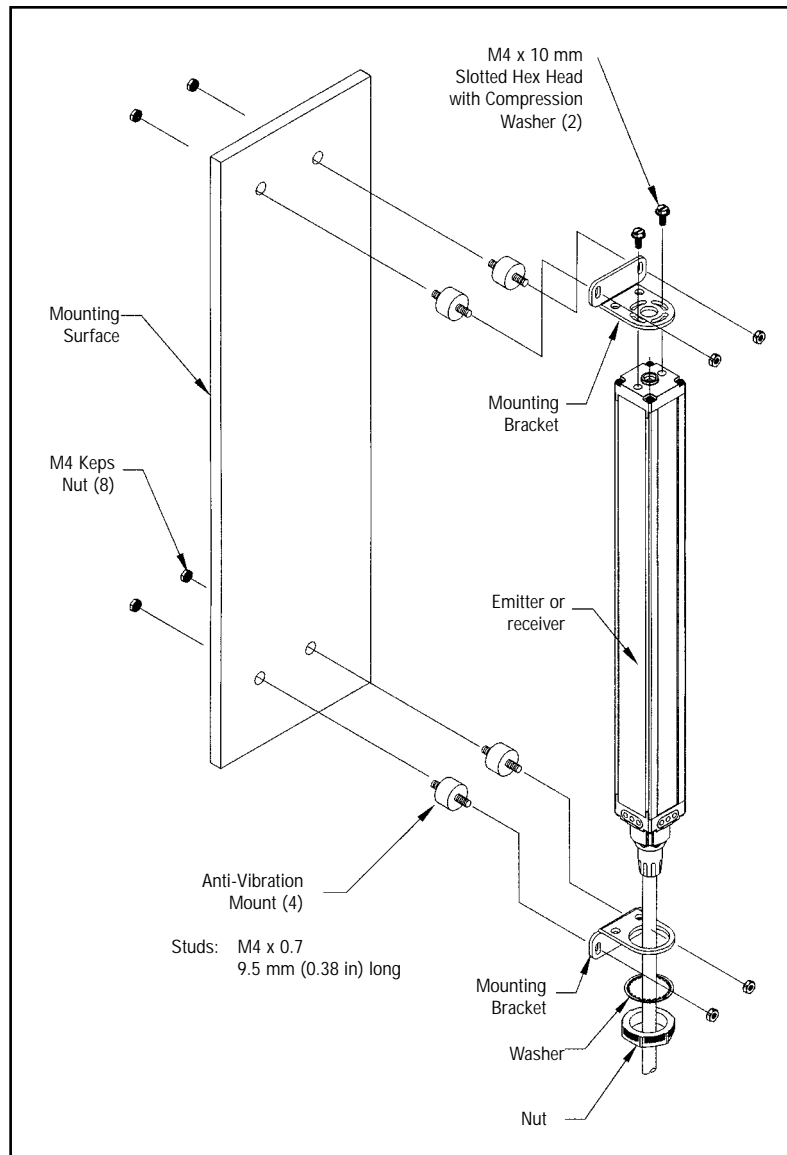


Figure 13. MINI-SCREEN emitter and receiver mounting hardware

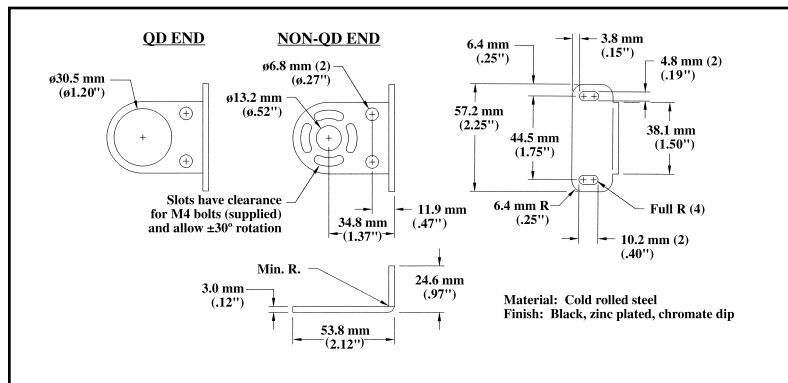


Figure 14. MINI-SCREEN emitter and receiver mounting bracket dimensions.

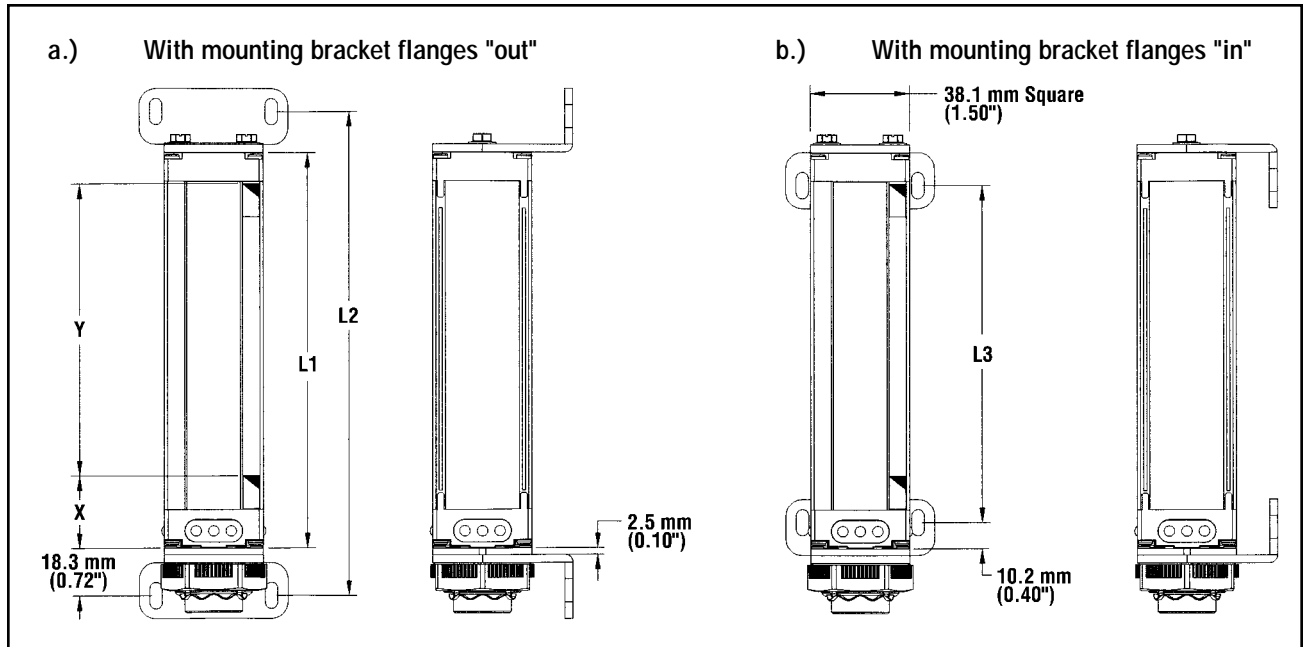


Figure 15. Emitter and receiver mounting dimensions and location of defined area

Models*	Housing Length		Distance Between Bracket Holes				Defined Area			
	L1		L2		L3		X		Y	
MSE424 emitter MSR424 receiver	6.0"	153 mm	7.4"	188 mm	5.1"	130 mm	1.1"	28 mm	4.5"	114 mm
MSE824 emitter MSR824 receiver	10.0"	254 mm	11.3"	287 mm	9.1"	231 mm	1.1"	28 mm	8.5"	215 mm
MSE1224 emitter MSR1224 receiver	14.0"	356 mm	15.3"	389 mm	13.1"	333 mm	1.2"	30 mm	12"	305 mm
MSE1624 emitter MSR1624 receiver	18.0"	457 mm	19.3"	490 mm	17.1"	434 mm	1.2"	30 mm	16"	406 mm
MSE2024 emitter MSR2024 receiver	22.0"	558 mm	23.3"	592 mm	21.1"	536 mm	1.2"	30 mm	20"	508 mm
MSE2424 emitter MSR2424 receiver	26.0"	659 mm	27.3"	693 mm	25.1"	637 mm	1.2"	30 mm	24"	610 mm
MSE2824 emitter MSR2824 receiver	30.0"	761 mm	31.3"	795 mm	29.1"	739 mm	1.3"	33 mm	28"	711 mm
MSE3224 emitter MSR3224 receiver	33.9"	862 mm	35.3"	896 mm	33.0"	838 mm	1.3"	33 mm	32"	813 mm
MSE3624 emitter MSR3624 receiver	37.9"	963 mm	39.3"	998 mm	37.0"	940 mm	1.3"	33 mm	36"	914 mm
MSE4024 emitter MSR4024 receiver	41.9"	1064 mm	43.3"	1100 mm	41.0"	1041 mm	1.3"	33 mm	40"	1016 mm
MSE4424 emitter MSR4424 receiver	45.9"	1166 mm	47.3"	1201 mm	45.0"	1143 mm	1.3"	33 mm	44"	1118mm
MSE4824 emitter MSR4824 receiver	49.9"	1267 mm	51.2"	1300 mm	49.0"	1245 mm	1.3"	33 mm	48"	1219 mm

*Dimensions are the same for "XL," 60-foot range models.

Routing the Cables

Connect the shielded cables to the emitter and receiver and route them (per local wiring code for low-voltage dc control cables) to the control module mounting location. The same cable type is used for both emitter and receiver (four cables required per system). Cables may be cut to length at the time of installation. Emitter and receiver cable lengths may not exceed 50' (each). Do not trim the cables until you are certain that you have routed all cables properly. The cable braid at the control module connection points may be either removed or twisted together with the drain wire (see page 28).

Control Module Mounting

Mount the Dual MINI-SCREEN System control module inside a lockable enclosure which as a minimum rating of NEMA 3 (IP54). The control module may be mounted onto standard 35 mm DIN rail or may instead be mounted directly to the backplate of the lockable enclosure, using the supplied hardware.

The Dual MINI-SCREEN control module should be configured before initial checkout and use. Control module configuration is done at the two banks of DIP switches located along the edge of the controller board (see Figure 18).

Key Reset Switch Mounting

The key reset switch mounts through a 19 mm (0.75") diameter hole (see Figure 19). Wires for connecting the key reset switch to the control module are user-supplied (also see Section 3.5.1).

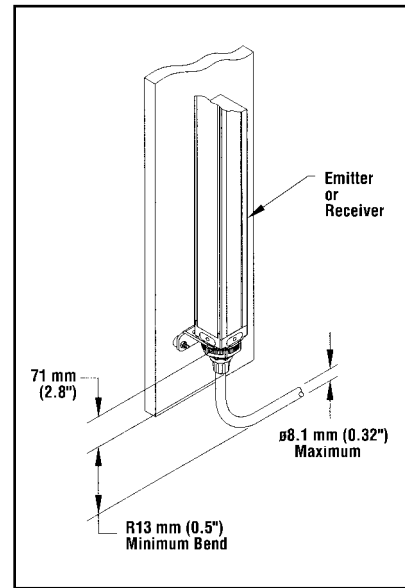


Figure 16. Quick-Disconnect cable clearance dimensions

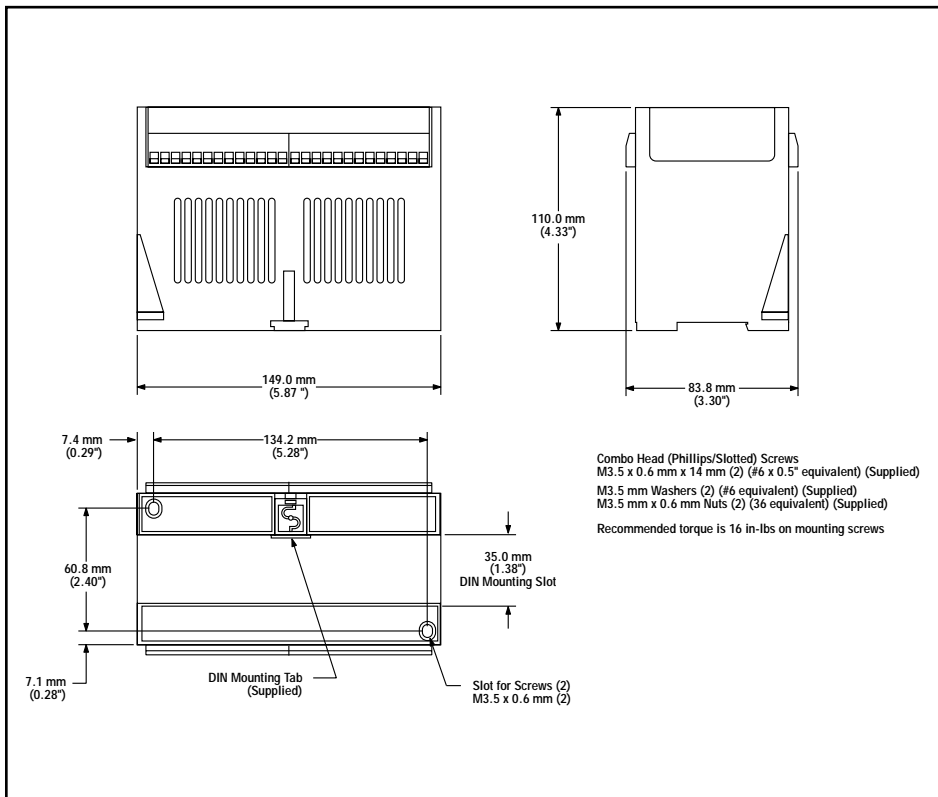


Figure 17. Control module dimensions and mounting hole locations

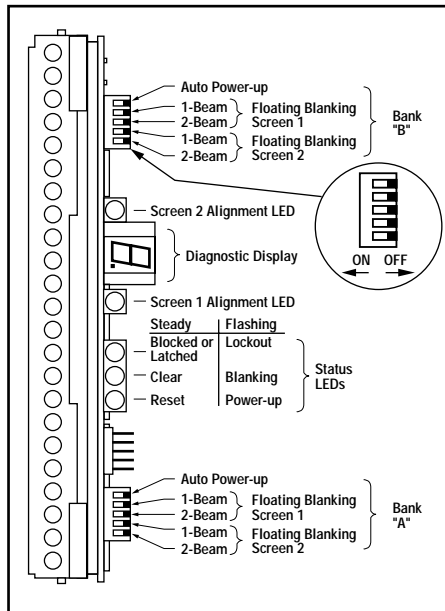


Figure 18. Controller configuration switches

3.4 Controller Module Configuration

The parameters to be manually configured are:

- Floating blanking: 1-beam, 2-beam or OFF.
- Auto Power-up: ON or OFF.

NOTE: The factory setting for both parameters is OFF.

Because it has redundant microprocessors, the controller module has two identical DIP switch banks (bank A and bank B) which must be set identically. Failure to set both banks identically will cause a lockout condition when power is applied to the control box. **Power to the Dual MINI-SCREEN System must always be OFF when changing switch settings.** Changing switch settings with power ON will cause a lockout condition. A switch pushed to the left is ON; a switch pushed to the right is OFF. Set the configuration switches as follows:

Floating Blanking ON or OFF

Locate the floating blanking (FB) configuration switches in bank A and B (see Figure 18). Set the switches identically at banks A and B. Be aware of the difference in minimum object sensitivity, penetration factor, and required light screen separation distance between the settings (refer to Sections 2.1 and 3.2.1). Floating blanking causes the Dual MINI-SCREEN System to ignore multiple objects of up to the size listed in the table, below.

NOTE: Both 1 & 2 beam floating blanking switches set to ON will cause a lockout.

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

Auto Power-up Feature ON or OFF

Locate the Auto Power-up (AP) configuration switch (see Figure 18) in banks A and B. If Auto Power-up is ON (switches pushed to the left) when power is applied to the Dual MINI-SCREEN System, the controller will automatically reset after conducting and passing an internal system checkout. If the switches are OFF (pushed to the right), this initial reset is manual (via the key reset switch). Regardless of the setting of this switch, a key reset is always necessary to recover from an internal lockout condition. To select Auto Power-up, remove the protective coating on both switches and push them to the ON position. The switches must be set identically at banks A and B.

3.5 Electrical Hookup and Checkouts

Make the electrical connections in the order that they are presented in Sections 3.5.1 through 3.5.9.

The following wiring connections are made to the control module:

- Key reset switch
- Emergency stop switch (optional)
- System power
- Output relay connections (FSD1, FSD2, and SSD)
- Auxiliary Monitor Relay connections (optional)
- Remote test device (optional)

Note that the wiring barriers on the module can accept conductors no larger than #12AWG. Also, the wires used should have an insulation temperature rating of at least 90°C (194°F).

3.5.1 Key Reset Switch Hookup

The key reset switch (supplied with the control module) must be positioned at a location that provides the switch operator with an unobstructed view of the entire defined area. The switch mounts through a 19 mm (0.75") diameter hole (Figure 19).

Wire is supplied by the user. Shielded cable and/or separate, grounded conduit is recommended. The wires from the key reset switch connect to terminals 11 and 12 of the control module (Figure 20).

For control module model MDSINT-1L2:

Because the key reset switch is used to reset the latch, its mounting location is critical. It must be mounted outside of the guarded area, and in 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.

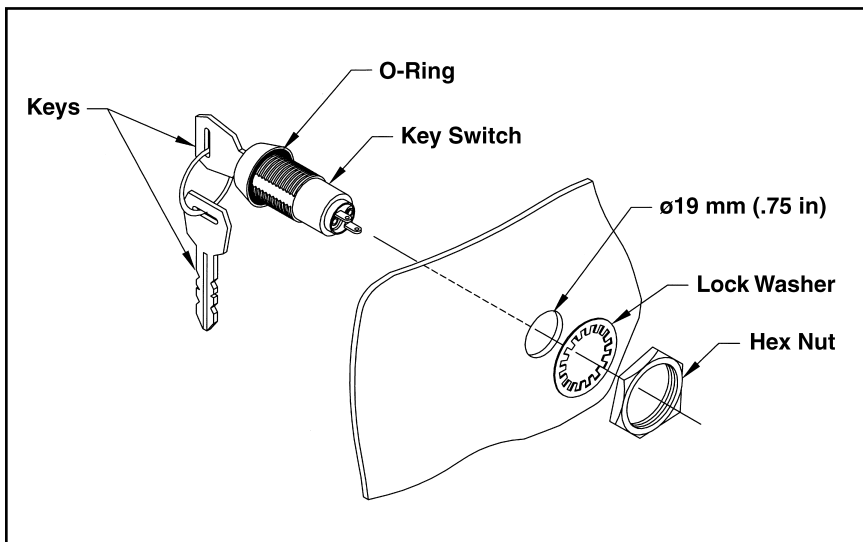


Figure 19. Mounting the Dual MINI-SCREEN key reset switch



WARNING . . .
Proper Electrical Hookup Is Imperative

- 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 Dual MINI-SCREEN System than are described in Sections 3.5.1 through 3.5.7 of this manual. Connection of other wiring or equipment to the Dual MINI-SCREEN System could result in serious injury or death.



WARNING . . .
Reset Switch Location

The Key Reset switch, or any additional Reset switch(es), must be accessible only from outside, and in full view of, the hazardous area. The Reset switch must 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 switch(es), additional means of safeguarding must be provided.



WARNING . . .
Emergency Stop
Switch Wiring

- Whenever two or more Emergency Stop switches are connected to the same MICRO-SCREEN control module, contacts of the corresponding pole of each switch must be connected together in series. This series combination is then wired to the respective module input (to either 45 and 46 or 48 and 49). **Never connect the contacts of multiple Emergency Stop switches in parallel to the MICRO-SCREEN control module inputs.** Parallel connection of two or more Emergency Stop switches to one MICRO-SCREEN control module 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 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).

3.5.2 Emergency Stop Switch Hookup

The Dual MINI-SCREEN control module offers an input circuit at terminals 45, 46, 48 and 49 for connection of an optional user-supplied Emergency Stop switch. As shown in Figure 20, the Emergency Stop switch must provide two separate contacts which are closed when the switch is in the RUN (armed or disengaged) position. Once engaged, the Emergency Stop switch must mechanically latch both contacts in the open position. The switch may be returned to the closed-contact position only by a deliberate action such as twisting, pulling, unlocking, etc. 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 29, section 13.2 Emergency Stop Devices, specifies the following additional switch (“stop control”) requirements:

- Emergency stop pushbuttons shall be located at each operator control station and at other operating stations where emergency shutdown shall be required.
- Stop and emergency stop pushbuttons 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 pushbutton-operated device shall be of the palm or mushroom-head type.
- The emergency stop actuator shall be either a momentary or self-latching type.

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

Connect the two poles of the Emergency Stop switch as shown in Figure 20. The switch in Figure 20 is shown in its “armed” position with both contacts closed. Multiple Emergency Stop switches connected to one module must use a series connection (see Warning, left).

NOTES:

- 1) E-stop requirements contained within NFPA 79 Electrical Standard for Industrial Machinery should be met.
- 2) Jumpers for terminals 45 to 46 and 48 to 49 are provided and must be installed if an E-stop switch is not used.
- 3) A Key Reset is required after re-arming (closing) the E-Stop Switch (see Section 5.1).
- 4) E-stop switch contacts “a/b” and c/d” must open simultaneously, or a lockout condition will occur. If a lockout occurs (#9 error), remove the fault, then cycle (remove and reapply) the power.



WARNING . . . Muting

Do NOT use the E-Stop inputs of this controller if the FSD output contacts are to be muted or bypassed in any way.

The E-stop function of this controller will be ineffective and may be unable to stop or remove hazardous motion if the contacts of the muting or bypassing circuitry are wired in parallel with the FSD contacts.

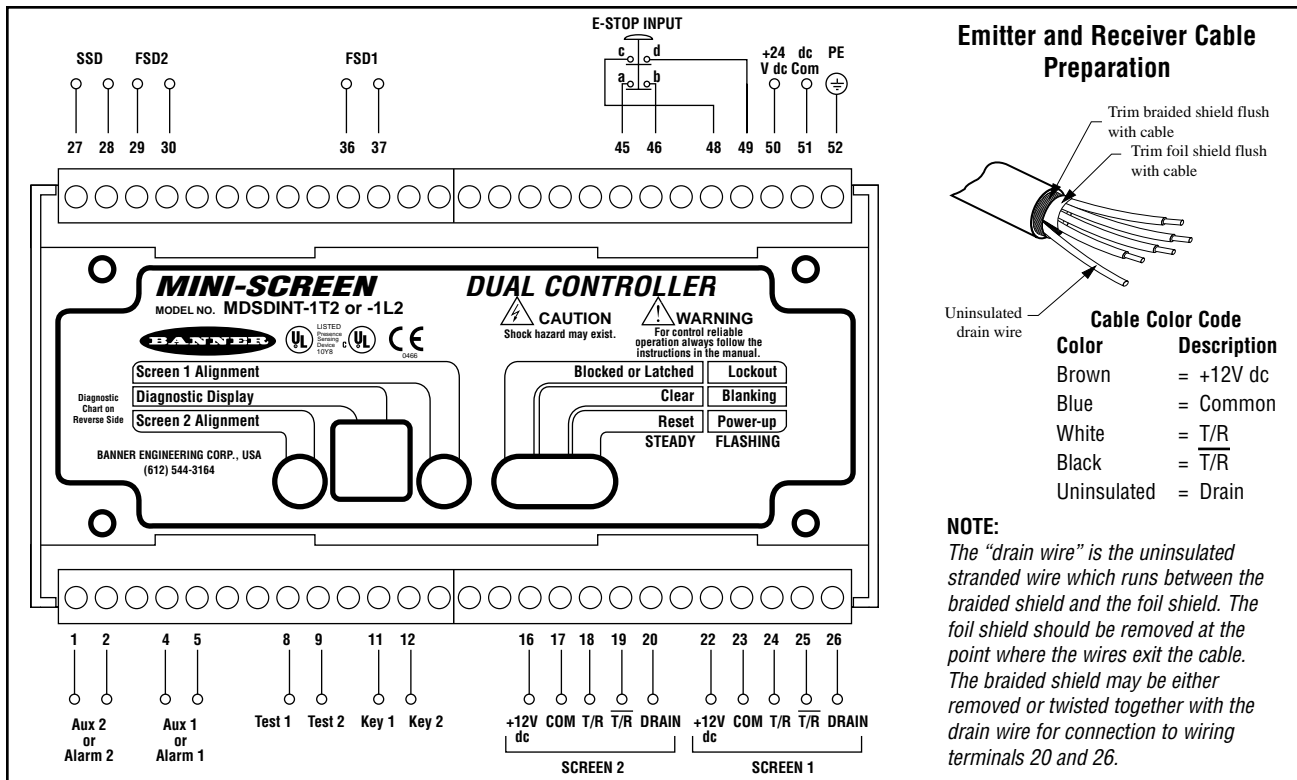


Figure 20. Dual MINI-SCREEN System electrical connections

3.5.3 Emitter and Receiver Hookup

Emitter and receiver cables for Light Screen #1 connect in parallel to wiring barrier terminals 16 through 20. Similarly, the emitter and receiver cables for Light Screen #2 connect in parallel to barrier terminals 22 through 26. *Only the use of Banner QDC Series cables (see page 58) can ensure reliable communication of data between the controller and the sensors.* Match the color-coded terminals of wiring barrier to colors of the wires in each 5-conductor cable. **Double-check your wiring. Incorrect wiring can lead to component damage.** There are no user adjustments or connections inside the MINI-SCREEN sensors themselves.

NOTE: The Dual MINI-SCREEN System will operate only when two emitter/receiver pairs are connected. A lockout condition will result from connection of only one sensor pair.

3.5.4 System Power (temporary connection)

The system is powered by 24V dc $\pm 15\%$ at 2.5 amps.

As shown in Figure 23 (page 33), the power supply lines to the control module connect through the MPCE monitor contacts of the guarded machine. **However, do not wire to the MPCEs at this time.** Instead, temporarily connect power directly to the control module. Connect earth ground at terminal 52. This will allow the Dual MINI-SCREEN System to be checked out, by itself, before permanent power connections through the guarded machine's monitor contacts are made. Permanent power connection will be made after Dual MINI-SCREEN System initial checkout, and is covered in Section 3.5.7.

WARNING . . .

Do NOT use the E-Stop inputs of this controller if the FSD output contacts are to be muted or bypassed in any way.

The E-stop function of this controller will be ineffective and may be unable to stop or remove hazardous motion if the contacts of the muting or bypassing circuitry are wired in parallel with the FSD contacts.

3.5.5 Dual MINI-SCREEN System Initial Checkout

This initial checkout procedure must be performed by a Qualified Person (see WARNING, page 14). It must be done after connecting the emitters and receivers (Section 3.5.1) and temporary power (Section 3.5.2) is applied to the Dual MINI-SCREEN control module, but before the Dual MINI-SCREEN System is connected to the machine to be guarded.

This initial checkout procedure must be performed by a Qualified Person:

- 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 4.2 for a schedule of required checkouts.)

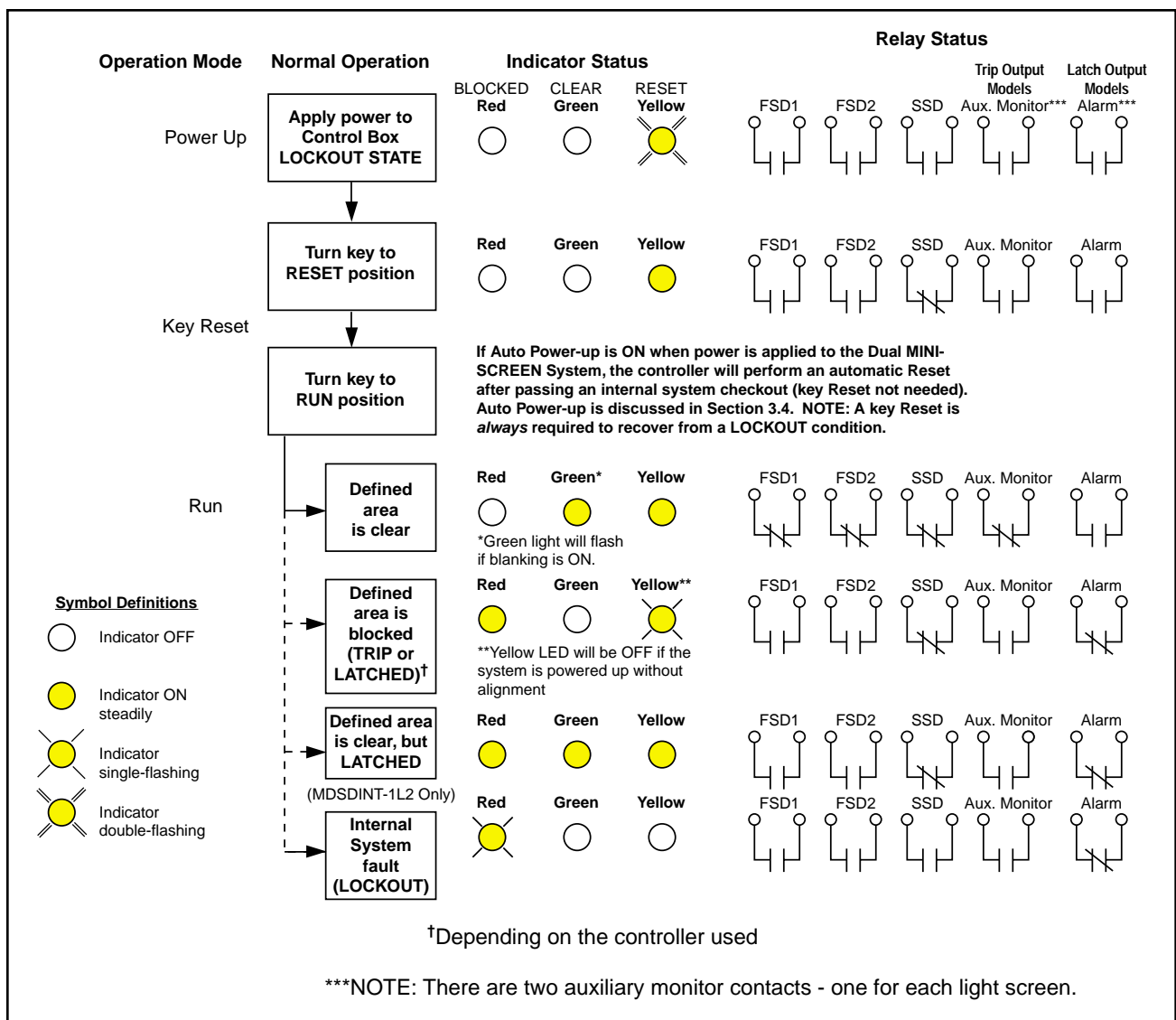


Figure 21. Operating Status LED conditions. Status indicators are located on the control module and on the receivers.

INITIAL CHECKOUT PROCEDURE:

The Dual MINI-SCREEN System has three operating modes: POWER UP, KEY RESET, and RUN. Monitor the three status LEDs (red, yellow, and green, on the control module front panel or the receiver) and refer to Figure 21.

- 1) **Enter POWER UP mode** by applying power to the control module. With Auto Power-up OFF, the System will “power up” in a lockout condition (yellow status LED only will double-flash). With Auto Power-up ON, the System will automatically enter RUN mode (step 3).
- 2) **Enter KEY RESET mode** by turning the key to the RESET position. The yellow panel LED will go ON.

Hold the switch in the RESET position for at least one-half second. This allows time for the microprocessors to run a startup diagnostic check routine.

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

If the red status LED (only) lights and flashes 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 status LEDs come ON, one (or both) defined area is not clear (one or more light beams are obstructed) or one (or both) light screen is misaligned. This is a *trip condition (for control module MDSINT-1L2, this is a latch condition)*. If this occurs, check the defined areas for obstruction(s). The red LED will be ON. One or both yellow Screen Alignment indicators on the control box will be flashing to indicate the relative number of *made (cleared)* light beams; the faster the flash rate, the more beams are “made”.

If the Dual MINI-SCREEN System is properly aligned and the blanking switches are properly set and all obstructing objects are removed from the defined area, the green and yellow status LEDs should come ON after step #3 has been performed (the green LED will *flash* if blanking is ON, but the yellow status LED should be ON steadily). **If you are setting up the Dual MINI-SCREEN System for the first time, or if the green and yellow status LEDs do not come ON in step #3, perform the alignment procedure below.**

Adjusting the Light Screen Alignment

If the red and yellow status LEDs are ON and there is no obstruction in either defined area, then one or both light screen(s) is misaligned. Monitor the yellow indicator LEDs on the receiver(s) and the two yellow Alignment indicators on the control module (one for each light screen) to determine the alignment status. If the light screen is aligned, the LEDs will be ON steady. If the alignment is inadequate, the LEDs will be flashing; the faster the flash, the better the alignment. Rotate and/or tip the emitter and receiver until the LEDs come ON steady.

When you are certain that the emitter and receiver are aligned properly, tighten all emitter and receiver hardware in position and repeat steps #1-3, above.

- 4) **Next, “trip test” the Dual MINI-SCREEN** for object detection capability using the specified test pieces supplied with the control box. To perform the trip test, the key switch must be in the RUN position, the yellow status LED must be ON steadily, and the green status LED must either be ON steadily (to indicate blanking OFF) or flashing (to indicate blanking ON).

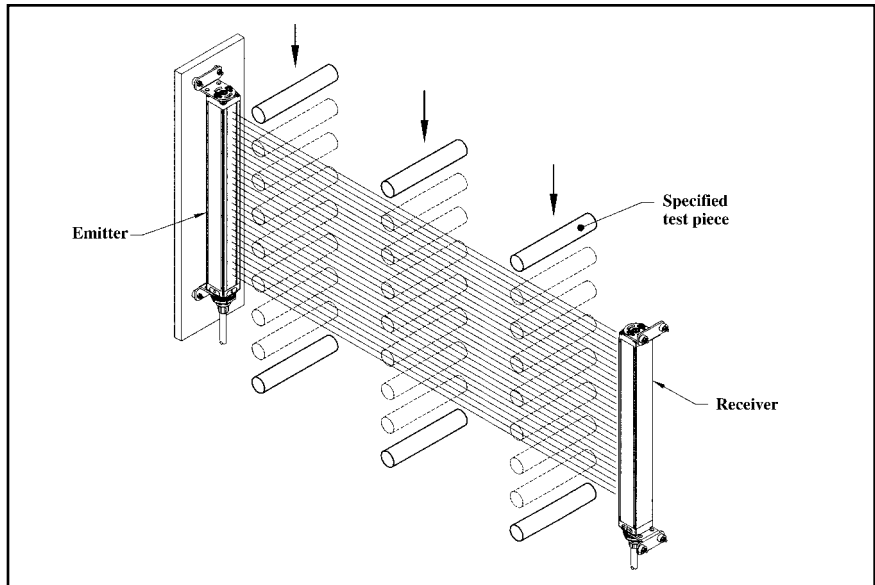


Figure 22. Dual MINI-SCREEN System Trip Test

The Dual MINI-SCREEN control box includes six specified test pieces. Select the proper test piece based on system configuration, per the following chart:

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	30' Range Emitters and Receivers	60' Range Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model STP-2	25.4 mm (1.00") dia. Model STP-7
1-beam floating blanking ON	31.8 mm (1.25") dia. Model STP-4	38.1 mm (1.50") dia. Model STP-1
2-beam floating blanking ON	44.5 mm (1.75") dia. Model STP-3	50.8 mm (2.00") dia. Model STP-8

NOTE: Light Screen 1 and Light Screen 2 may be configured independently and, therefore may require different test pieces.

Slowly pass the specified test piece down the length of the defined area of one of the light screens at three points: close to the receiver column, close to the emitter column, and midway between the emitter and receiver columns (Figure 22). In each case, the red status indicator should come ON and remain ON for as long as the test piece is within the defined area. When the test piece is withdrawn from the defined area, the green status indicator should come ON. If the green indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces, and correct the problem. Repeat this procedure for the second light screen.

For Controller MDSINT-1L2:

After performing the trip test, perform a key reset to reset the latch.

If the Dual MINI-SCREEN System passes all of the checks in Section 3.5.3, go on to Section 3.5.4.

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

3.5.6 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 module (Figure 23). These relays are energized (contacts closed) in normal operation with no obstructions 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 trip or 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 in such a way that it is 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 23, 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 than MPCE 1) that directly controls the normal operating motion of the guarded machine in such a way that it is 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 23, 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 Dual MINI-SCREEN System output relay contacts, *do not make any connections*. Contact the machine builder for clarification regarding connections to the MPCEs and MSCE.

The SSD output relay connects to the Machine Secondary Control Element (MSCE) on the guarded machine. The MSCE is an electrically powered element of the guarded machine (independent of the MPCEs) that is capable of removing power from the prime mover of the dangerous part of the machine in the event of an emergency. The output contacts of the SSD relay must be connected, as shown in Figure 23, 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. . .
Electrical shock hazard exists when the Dual MINI-SCREEN System control module is connected to the guarded machine. Use extreme caution to avoid electrical shock at all times. **Always disconnect all power from the Dual MINI-SCREEN System and the guarded machine before making any connections or replacing any component.**



WARNING. . .
The output relays of the Dual MINI-SCREEN System must be the final switching devices for the machinery being guarded. **Never wire an intermediate device (for example, a programmable logic controller - PLC), other than a safety relay, between either FSD and the machine control element switches** (Reference ANSI B11.1-1988, Appendix B4). To do so could result in serious injury or death.
Connection of the output relays to the guarded machine must be direct and must produce immediate stopping action.

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 (per ANSI B11, Section 5.5 "Control Reliability"). Refer to Figure 23 (page 33) or consult the machine manufacturer for additional information.

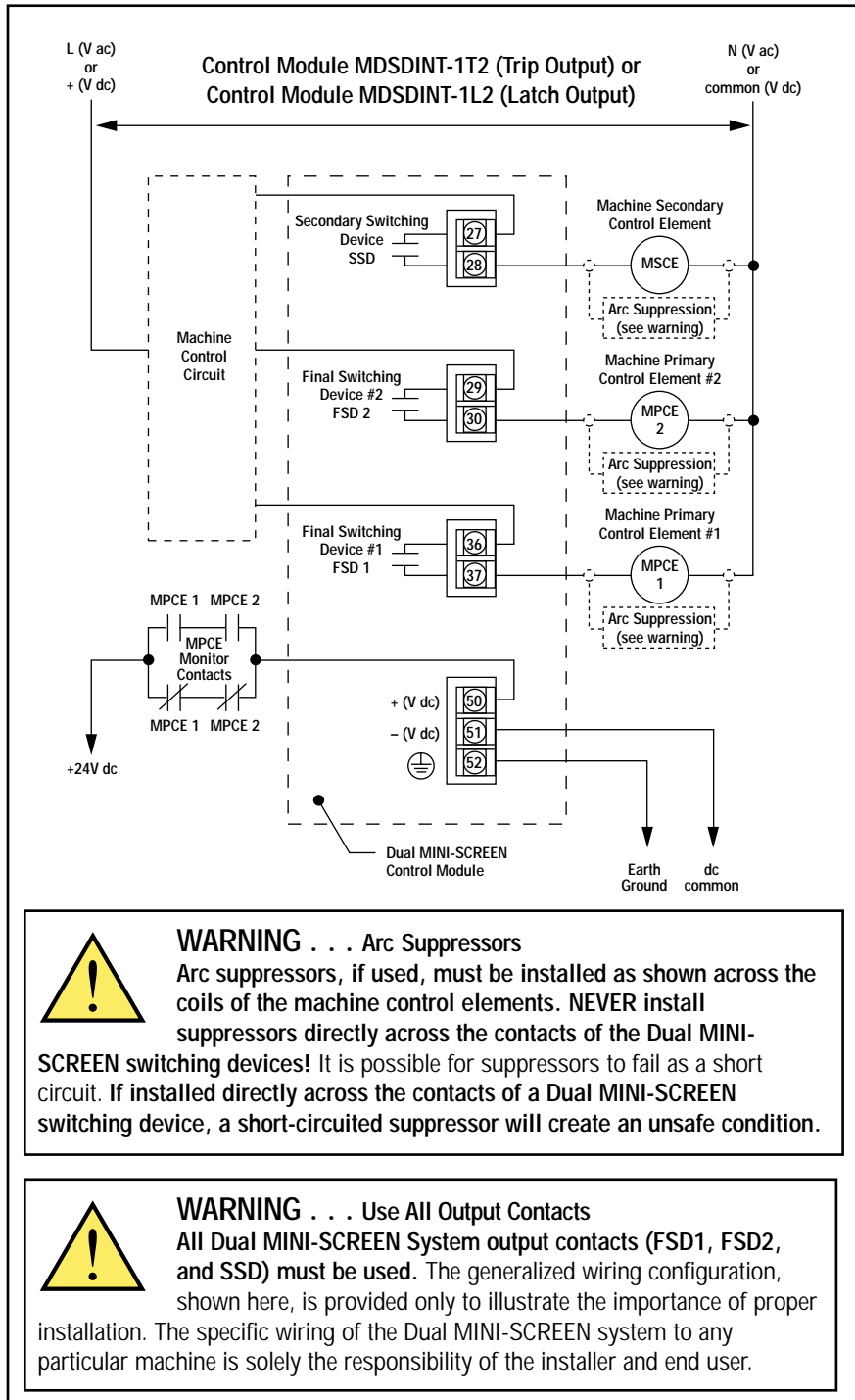


WARNING. . .
Use of Trip Output
Dual MINI-SCREEN
Systems for
Perimeter Guarding

If a Dual MINI-SCREEN System is installed for use as a perimeter guarding system, the dangerous machine motion must be able to be initiated following an interruption of either defined area **only** after actuation of a reset switch.

The reset switch must be located outside of the area of dangerous motion, and must be positioned so that the area of the dangerous motion may be observed by the switch operator during the reset operation. Additional safeguarding, as described by the ANSI B11 series of safety requirements or other appropriate standards, must be used if any space between either defined area and any danger point is large enough to allow a person to stand undetected by the Dual MINI-SCREEN System. Failure to observe this warning could result in serious injury or death.

Figure 23 (below) shows output relay connections in a generic interfacing situation. The connections between the Dual MINI-SCREEN System outputs and the machine primary and secondary control elements must be direct, and arranged so that any single line fault or earth fault will not result in a circuit failure to a potentially dangerous state.



WARNING . . . Arc Suppressors

Arc suppressors, if used, must be installed as shown across the coils of the machine control elements. **NEVER** install suppressors directly across the contacts of the Dual MINI-SCREEN switching devices! It is possible for suppressors to fail as a short circuit. If installed directly across the contacts of a Dual MINI-SCREEN switching device, a short-circuited suppressor will create an unsafe condition.



WARNING . . . Use All Output Contacts

All Dual MINI-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 Dual MINI-SCREEN system to any particular machine is solely the responsibility of the installer and end user.

Figure 23. Generic machine interface, Dual MINI-SCREEN System

3.5.7 System Power (permanent connection)

After the initial checkout of Section 3.5.3 has been successfully completed, the power lines to the Dual MINI-SCREEN System must be re-routed to their permanent hookup through the MPCE monitor contacts of the guarded machine. This is important: it ensures that any inconsistency in action between the two MPCEs will remove power from the system. (This is discussed in the **NOTICE regarding MPCE Monitoring Hookup**, right).

Connection of system power is at the +24V dc (terminal 50) and the dc common (terminal 51) terminals of the control module (Figure 20, page 28). Do not operate the Dual MINI-SCREEN System without an earth ground connection (terminal 52).

After power has been connected to the Dual MINI-SCREEN System and the output relay contacts have been connected to the machine to be controlled, the operation of the Dual MINI-SCREEN System with the guarded machine must be verified before the combined system may be put into service. To do this, a **Qualified Person** must perform the *Commissioning Checkout Procedure* given in Section 6.2 on page 46.

NOTICE regarding MPCE Monitoring Hookup

It is strongly recommended that one normally open and one normally closed auxiliary contact of each MPCE be wired (as shown in Figure 23, page 33) as MPCE monitor contacts. If this is done, any inconsistency of action between the two MPCEs will remove power from the Dual MINI-SCREEN System, causing a lockout condition. ***The use of MPCE auxiliary contacts as MPCE monitor contacts is necessary in order to maintain redundancy.*** MPCE auxiliary contacts used for this purpose must be rated at 55 VA minimum.

In order to maintain redundancy, the MPCE monitor contacts must be wired as described in section 3.5.6 and Figure 23, page 33.

3.5.8 Auxiliary Monitor Relay or Alarm Relay

Control module MDSINT-1T2 is equipped with two auxiliary monitor relays. These are light-duty contacts rated at 125V ac or dc max., 500 mA max. *They are not safety-related contacts*; they are meant for monitoring purposes, only, and typically communicate with a programmable logic controller (PLC) or other process monitoring device. Connections to the Auxiliary Monitor Relay contacts are at terminals 1, 2, 4 and 5 (see Figure 20, page 28).

Each relay offers a SPST contact which follows the action of one of the light screens. The contact is closed when the sensors of that light screen are aligned and unblocked. The contact opens when that light screen is interrupted. "AUX 1" monitors screen #1 and "AUX 2" monitors screen #2. In addition, both monitor contacts open with a lockout condition.

Terminals 1, 2, 4 and 5 of control module model MDSINT-1L2 (latching output) are labeled "Alarm 1" and "Alarm 2". The Alarm Relay outputs have the same description as the Auxiliary Monitor Relay (see above), except that the contact closes whenever the defined area has been blocked and causes the system to go into a latch condition. For instance, if the screen is blocked and causes a latch condition, Alarm 1 will be closed and Alarm 2 will be open. The Alarm Relay contact opens when a latch reset is performed, if the defined area is clear. The contacts of both Alarm Relays close when a system lockout occurs. See figure 21 on page 29. During power-up, both Alarm outputs are OFF (contacts open).

3.5.9 Remote Test Input

Remote Test Input connects to the TEST 1 and TEST 2 terminals of the control module (see Figure 20, page 28). When connected together (shorted) for a minimum of 50 milliseconds, these terminals provide the Dual MINI-SCREEN System with the equivalent of a BLOCKED beam condition, for testing purposes. The switch or switching device used to short the TEST contacts must be capable of switching 15 to 50V dc at 20 to 100 mA dc.

4. Operating Instructions

4.1 Security Protocol

The Dual MINI-SCREEN module must be installed inside of a lockable enclosure which has a NEMA 3 (IP54) or better rating. To prevent access by unauthorized personnel, and to ensure that all lockout conditions come to the attention of a person who is qualified to deal with them, the key (or combination or tool) to the locking mechanism must be kept in the possession of a qualified person as defined in ANSI/ASME B30.2-1983 (see Glossary Section). Only qualified persons should have access to the interior of the Dual MINI-SCREEN control module.

The key to the RESET switch should be available 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. If the machine operator meets these requirements, he/she may be a designated person.

Additional keys are available. See page 59.

4.2 Periodic Checkout Requirements

In addition to the checkouts that are performed by a qualified person or persons at the time that the Dual MINI-SCREEN System is installed and put into service, **the functioning of the Dual MINI-SCREEN System and the guarded machine 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.**

Checkouts must be performed according to checkout procedure 6.3, page 48 as follows:

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

Checkouts must be performed according to checkout procedure 6.4, page 49:

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

4.3 Normal Operation

Power-up

NOTE: Key must be in the RUN position at power-up.

If the Auto Power-up feature is ON when ac power is applied to the System, the controller performs a system checkout and resets itself, without the need for a key reset. If the Auto Power-up feature is OFF when ac power is applied to the Dual MINI-SCREEN System, it is normal for it to power up into a lockout condition.



WARNING . . . Proper Operation

The Banner Dual MINI-SCREEN System can do the job for which it was designed only if it and the guarded machine 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 Dual MINI-SCREEN System and the guarded machine do not perform exactly as outlined in the checkout procedures, **the cause of the problem must be found and corrected before the system is put back into service. Failure to correct such problems can result in serious injury or death.**

To prepare the Dual MINI-SCREEN System for operation after a power-up lockout, the Designated Person must perform a key reset:

- a) Turn the key to the RESET position (yellow status LED goes ON steadily).

Wait at least one-half second, then

- b) Turn the key to the RUN position.

If both defined areas are clear, the green and yellow status LEDs will go ON; the red LED goes OFF. (If floating blanking is ON, the green LED will be flashing.)

If either emitter and receiver pair is misaligned, the red status LED will come ON. The yellow alignment LED for the misaligned light screen will single-flash at a rate that indicates the relative number of light beams established. To align the light screen, see Sections 3.3 and 3.5.5.

If both emitters and receivers are aligned, but either or both defined areas are blocked, the red status LED will come ON, and the yellow alignment LED for the blocked light screen will single-flash at a rate that indicates the relative number of light beams established. Remove the blockage and verify that the green status LED is ON or flashing, indicating clear light screens (if will flash if blanking is ON).

Trip output models: No further action is necessary; system should be in RUN mode.

Latch output models: Perform a key reset to reset the latch. The system should go into Run mode.

Floating Blanking Operation

With floating blanking ON, multiple objects, each up to the size listed in the table below may enter the defined area at any point without causing a trip or latch condition. The use of floating blanking also increases the minimum object sensitivity, as indicated in the table below.

Floating Blanking	30' Range Emitters and Receivers		60' Range Emitters and Receivers	
	Minimum Object Sensitivity	Maximum Size of Undetected Objects	Minimum Object Sensitivity	Maximum Size of Undetected Objects
Floating Blanking OFF	19.1 mm (0.75")	Not Applicable	25.4 mm (1.00")	Not Applicable
1-beam floating blanking ON	31.8 mm (1.25")	7.6 mm (0.30")	38.1 mm (1.50")	3.8 mm (0.15")
2-beam floating blanking ON	44.5 mm (1.75")	20.3 mm (0.80")	50.8 mm (2.00")	16.5 mm (0.65")

The use of floating blanking increases the depth penetration factor (D_{pf}) and also, therefore, the separation distance required between the defined area and the closest machine danger point. If the separation distance was calculated on the basis of no floating blanking and floating blanking is later used, OSHA regulations require the separation distance to be increased accordingly. See Section 3.2.1.

Upon power-up (and also at every shift change or machine setup change), checkout procedure 6.3 on page 48 must be performed.

5. Troubleshooting and Maintenance

5.1 Troubleshooting Lockout Conditions

A *lockout condition* of the Dual MINI-SCREEN System causes *all* of its output relays to open, sending a “stop” signal to the guarded machine.

A Power-up/Power Interrupt Lockout condition will occur:

- Upon power-up of the Dual MINI-SCREEN System (unless Auto Power-up is ON; see Figure 5, page 11), or
- If power to the Dual MINI-SCREEN System is interrupted (unless Auto Power-up is ON; see Figure 5).

An Internal Lockout condition will occur:

- If the control box key switch is in the RESET position at power-up (with Auto Power-up ON); or if the key switch is switched to RESET while the system is in RUN mode,
- If a Final Switching Device (FSD - see Glossary) relay does not “drop out” within its specified time,
- If the Secondary Switching Device (SSD - see Glossary) relay has de-energized,
- If the controller module switch settings are inconsistent with each other or if they were changed while the system was in RUN mode, or
- If the self-checking circuits of the microprocessor detect a component failure within the Dual MINI-SCREEN System itself, or
- If either (or both) emergency stop switch contacts open.

A lockout condition resulting from an internal system fault is indicated by a flashing red status indicator LED on the control box and the receiver unit. The green and yellow LEDs will be OFF. See Figure 5, page 11.

Power-up/power interrupt lockouts (yellow LED only double-flashing) are normal and require a *key reset* for operation to continue.

Use the following key reset procedure to resume operation after a power interruption:

- Turn the key to the RESET position (yellow status indicator LED should light) and wait at least one-half second, then
- Turn the key to the RUN position.
If the defined area is clear and the emitter and receiver are properly aligned, the green and yellow status LEDs will light.

If the lockout condition was due to a momentary power interruption that has been corrected, the Dual MINI-SCREEN System will now operate normally.

Upon recovery from a power interruption, checkout procedure 6.3 on page 48 must be performed.



WARNING . . .
Power Failures

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



CAUTION . . .
High Voltage

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

A lockout condition resulting from an internal system fault is indicated by the red status LED flashing, and an error code number which appears on the Diagnostic Display. In this case, the Qualified Person must note the error code and interpret the cause of the lockout from the table in Figure 24, below. This diagnostic table is also found on the inside of the control module cover plate.

If the lockout is caused by one of the sensor pairs or their cables, the Diagnostic Display indicates which screen to investigate by flashing "1" or "2", along with the primary error code (see Figure 24). It is possible under some conditions that the System will not be able to discern which screen is at fault. When this happens, only the primary error code will be displayed.

The Dual MINI-SCREEN System will not operate if its self-checking circuits detect an internal problem. A key reset will have no effect. Take the corrective measure(s) corresponding to the error code. 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 (remove cover of module to view) 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.

Check for voltage across the +24V dc and dc common terminals 50 and 51. If voltage is not present, power to the Dual MINI-SCREEN System has been lost, and the cause is outside the system. If 24V dc is present, turn off the power to the control box and check the fuse (section 5.3.1). If the fuse is bad, replace it. If the fuse is good, and 24V dc is present at terminals 50 and 51, an internal power supply failure has occurred.

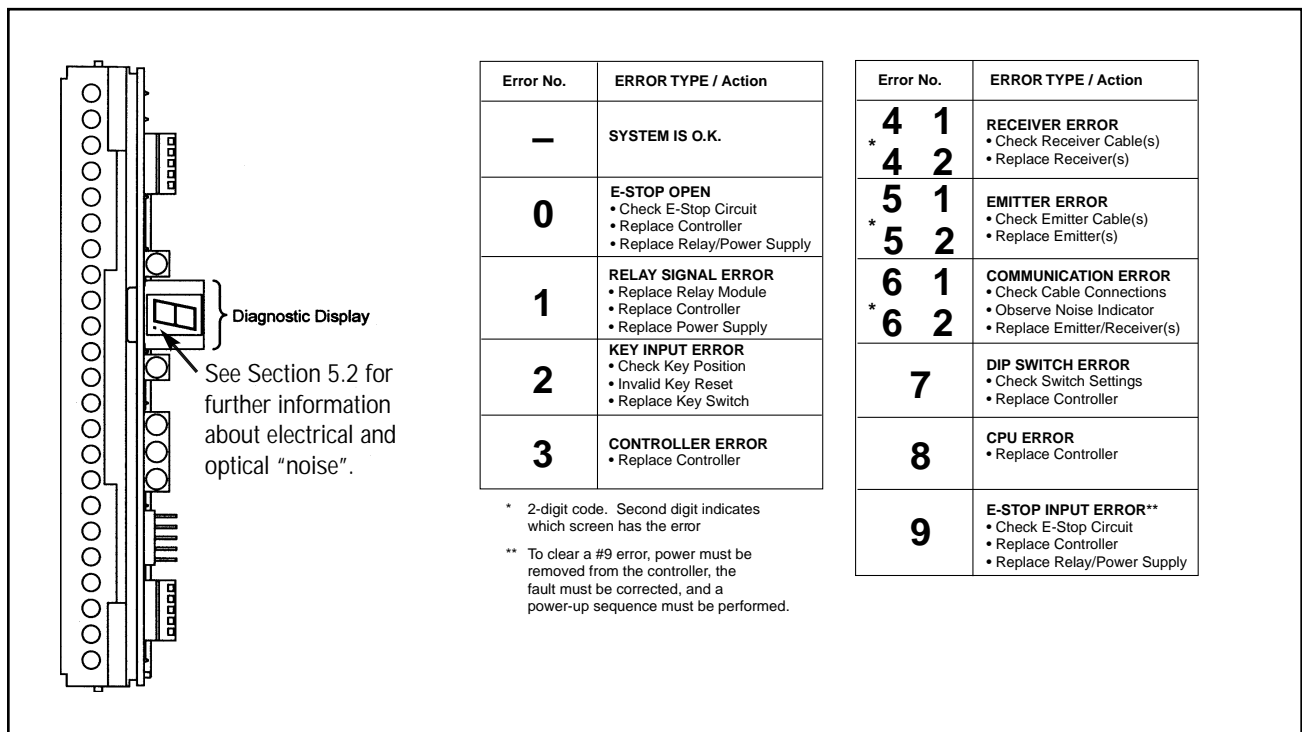


Figure 24. Interpretation of Diagnostic Display

5.2 Effects of Electrical and Optical Noise

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

5.3 Servicing and Maintenance

5.3.1 Fuse Testing and Replacement

Remove all power to the control module and to the machine being controlled before proceeding.

The Dual MINI-SCREEN System control module fuse is located in a fuseholder on the power supply board, immediately beneath the removable top cover plate. Remove the control module cover plate by gently prying it up and off using a flat-blade screwdriver or similar tool.

Remove the fuse from the fuse holder. Visually inspect the fuse and/or test its conductivity using an ohm meter or a continuity tester. The fuse is a 3AG or 5 x 20 mm slow-blow type (see Specifications, pages 56-57).

5.3.2 Control Module and Relay Replacement

Dual MINI-SCREEN Systems are designed for reliability. While replacement of the controller module and relays is not normally required, these components have been designed to be easily replaceable as a convenience to the customer. **To maintain control reliability, use only Banner-supplied replacement relays with forced-guided contacts; see page 59.**

Electrical and Optical Noise

Check the following if the red decimal point of the Diagnostic Indicator display is flashing:

- Poor connection between control box and earth ground
- Drain wire of emitter and/or receiver not connected to terminal 20 or 26 (see Figure 20)
- Sensor wires or output wires routed too close to “noisy” wiring
- Optical interference from adjacent light curtains or other photoelectrics



WARNING. . .

Servicing the Dual MINI-SCREEN System while the

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



CAUTION. . .

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

The control module should be opened and/or serviced by only a **qualified person** (see Section 4.1).



WARNING. . .
If replacement parts
are ever required,
always use only

genuine Banner-supplied replacement parts (see page 59). Do not attempt to substitute parts from another manufacturer. To do so could impair the operation of the Dual MINI-SCREEN System and could result in serious injury or death.

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 (see section 5.3.4). Do not attempt to repair an emitter or receiver yourself.

5.3.3 Cleaning

The Dual MINI-SCREEN System control module is constructed of black polycarbonate and is rated NEMA 1 (IP 20). No cleaning is recommended; avoid contact by any liquid.

MINI-SCREEN emitter and receiver units are constructed of aluminum with a black anodized or 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.

5.3.4 Warranty Service

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

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

**Banner Engineering Corp.
9714 - 10th Avenue No.
Minneapolis, MN 55441
Phone: 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.

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 (see page 2).

Section 6.1 is a procedure for optically aligning the two sensor pairs of a Dual MINI-SCREEN System. Sections 6.2, 6.3, and 6.4 are periodic performance checkout procedures for the Dual MINI-SCREEN System, and are performed according to the schedule given in Section 4.2.


6.1 MINI-SCREEN System Alignment

This alignment procedure begins with the assumption that the sensors of both light screens have been mechanically aligned as described in Section 3.3.

Follow the measures outlined below to maximize light screen excess gain. If there are reflective surfaces near either defined area, read alignment step #5 (page 43) before proceeding further, to prevent possible reflection problems.

Only a Qualified Person may align the sensors of the Dual MINI-SCREEN System, as follows:

- 1) Turn off power to the Dual MINI-SCREEN System and to the guarded machine. Leave power to the guarded machine OFF, and power-up the Dual MINI-SCREEN System only.
- 2) The Dual MINI-SCREEN will power up into a power-up lockout condition (unless Auto Power-up is ON). Remove all obstructions from the defined area of both light screens and reset the Dual MINI-SCREEN System as follows:
 - a. Turn the key reset switch to the RESET position,
 - b. Leave the key in the RESET position for at least 1/2 second to allow time for internal system checks, and
 - c. Turn the key switch to the RUN position.



WARNING . . .
Turn Machinery OFF Before Proceeding

You may be working close to the hazardous area of your machinery while aligning the Dual MINI-SCREEN System. Aligning the Dual MINI-SCREEN System while the hazardous machinery is operational could result in serious injury. **The machinery guarded by the Dual MINI-SCREEN System must not be operating at any time during the alignment procedure of Section 6.1.**

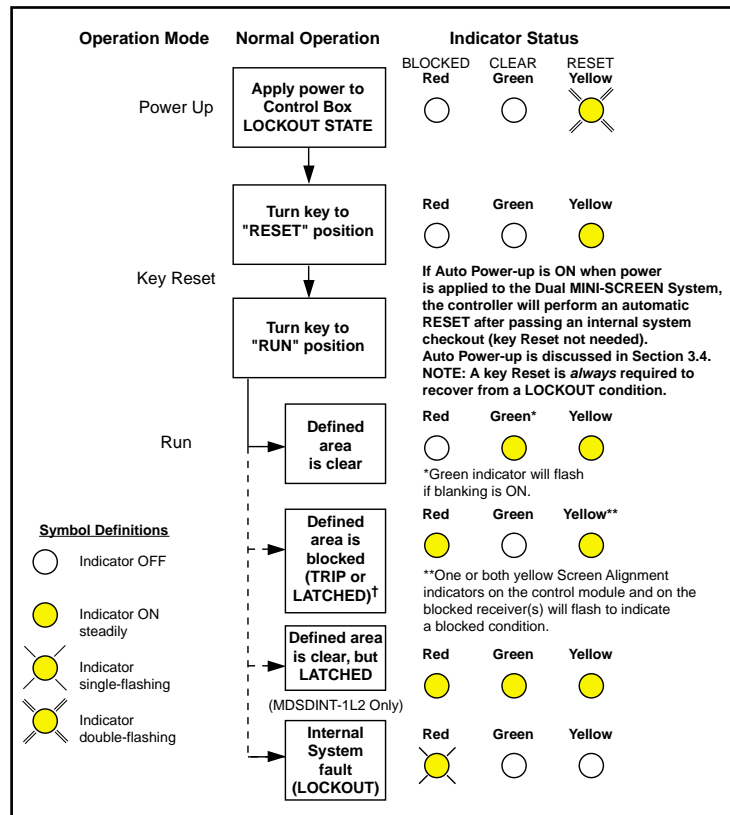


Figure 25. Operating Status LED conditions

- 3) Upon completion of the key Reset (step #2), the Dual MINI-SCREEN will indicate either a BLOCKED or a CLEAR condition:
 - a) A BLOCKED condition is indicated by the red status LED ON steadily and the yellow Alignment LED for the blocked screen(s) flashing at a rate proportional to the number of aligned, unblocked beams. Go to step #4.
 - b) A CLEAR condition is indicated by the red status LED OFF, and the green and yellow status and both yellow alignment LEDs ON steadily. (The green status LED will flash if blanking is ON for either light screen.) Further alignment is not necessary.
- 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 of the light screen to be aligned (the limits of which are indicated in Figure 15, page 23).
 - b) Loosen the hardware which fastens the receiver to its mounting brackets. Slowly rotate the receiver first to the right and then the left while watching the yellow alignment indicator corresponding to screen being aligned. The flash rate of the yellow alignment indicator increases as alignment improves.
 - c) If the green status LED does not come ON, regardless of angular position of the receiver, then loosen the emitter and rotate both sensors relative to each other until the green LED comes ON. Secure the emitter and receiver in the center of the area of rotation where the yellow alignment and green and yellow status LEDs are ON steadily. (The green status LED will flash if blanking is ON for either light screen.)
 - d) If the green and yellow status LED still fails to come ON, then re-check the sensor mounting per the procedure in Section 3.3, and then re-align per this alignment procedure.
- 5) "Trip test" the Dual MINI-SCREEN System for object detection capability using the test piece(s) supplied with the control box. To perform this test, the key switch must be in the RUN position and the green and yellow status and yellow alignment indicators LEDs must be ON steadily. (The green status LED will flash if blanking is ON for either light screen.) Reset the system (key reset), if necessary, to attain this condition.

The Dual MINI-SCREEN control box includes three specified test pieces. Select the proper test piece based on system configuration, per the following chart:

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	30' Range Emitters and Receivers	60' Range Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model STP-2	25.4 mm (1.00") dia. Model STP-7
1-beam floating blanking ON	31.8 mm (1.25") dia. Model STP-4	38.1 mm (1.50") dia. Model STP-1
2-beam floating blanking ON	44.5 mm (1.75") dia. Model STP-3	50.8 mm (2.00") dia. Model STP-8

NOTE: Screen 1 and Screen 2 can be configured independently and, therefore, may require different test pieces.

Perform the trip test in both light screens as follows:

Pass the appropriate specified test piece downward through the defined area at three points (see Figure 26):

- a) close to the receiver,
- b) close to the emitter, and
- c) midway between the emitter and receiver.

In each case, the red status indicator must come ON and remain ON for as long as the test piece is within the defined area. (For controller MDSINT-1L2: after performing each trip test, perform a Key Reset to reset the latch.)

The green status indicator must come ON only when the test piece is withdrawn from the defined area. (The yellow status indicator stays ON when the test piece is in the light screen.) If the green status indicator comes ON at any time when the test piece is within the defined area, the cause may be from light reflected from the emitter to the receiver by a nearby reflective surface (see page 19). If a reflective surface can be identified, move either the defined area (i.e., move the sensors) or the reflective surface. Be sure to maintain at least the minimum required separation distance (see Section 3.2.1). Alternately, take measures to reduce the reflectivity of the interfering surface (i.e., by angling, painting, masking, etc.).

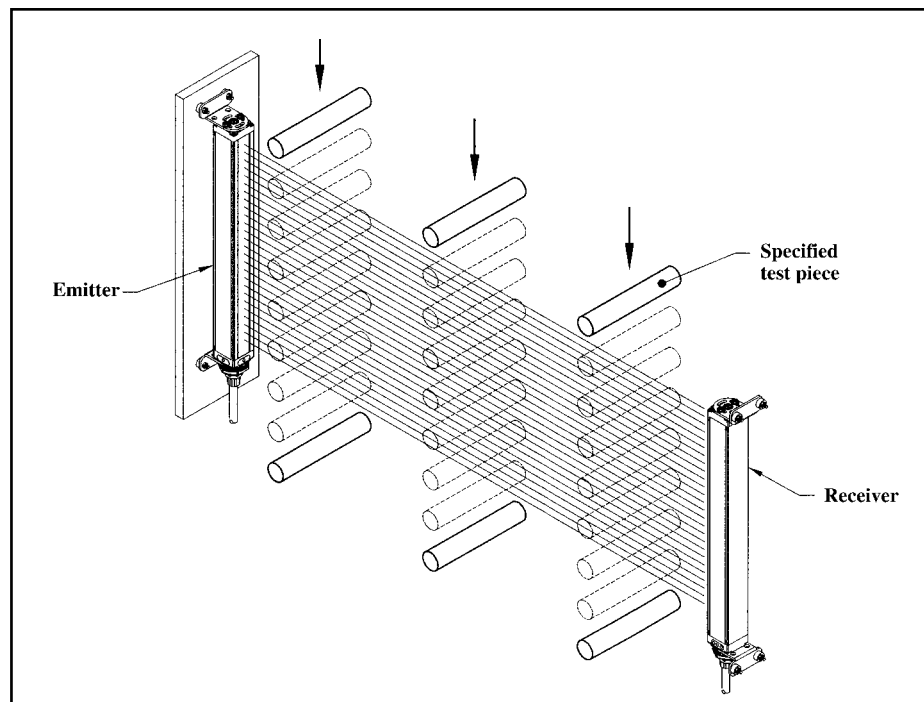


Figure 26. Dual MINI-SCREEN Trip Test. Perform the Trip Test on BOTH light screens.

Use of Corner Mirrors

The Dual MINI-SCREEN System requires connection of two sensor pairs for operation. One or both of the sensor pairs 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 (see page 60). These are rear-surface glass mirrors which are rated at 85 percent efficiency. Sensing range (and therefore excess gain) is reduced when using mirrors. The following table lists the resultant range when using from one to four MSM Series corner mirrors in either sensing path.

Maximum Emitter and Receiver Separation				
Number of Corner Mirrors	1	2	3	4
9 m (30') range sensors	8.5 m (28')	7.8 m (25.5')	7.2 m (23.5')	6.7 m (22')
18 m (60') range sensors	16.8 m (55')	15.5 m (51')	14.3 m (47')	13.1 m (43')

Mirrors should be securely mounted to a solid surface that is free from vibration. Using a level, mount the mirror(s) exactly parallel to (i. e. in the same plane as) its (their) sensors, with the midpoint of the mirror(s) directly in line with the midpoint of the sensor's defined area. The upper and lower limits of the defined area of MINI-SCREEN sensors is marked by arrows along the edge of each sensor window, and is dimensioned in the chart on page 23.

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 27, 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 assist alignment (see page 60).

Use the yellow alignment indicator LED corresponding to the screen being aligned for final alignment. Refer to the data sheet (P/N 43685) packed with each MSM Series corner mirror for complete information on the use of corner mirrors.



WARNING . . .
Use Supplemental
Sensing Devices if
Necessary

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

See, also, the warning on page 33 regarding use of the Trip Output Dual MINI-SCREEN System for perimeter guarding.

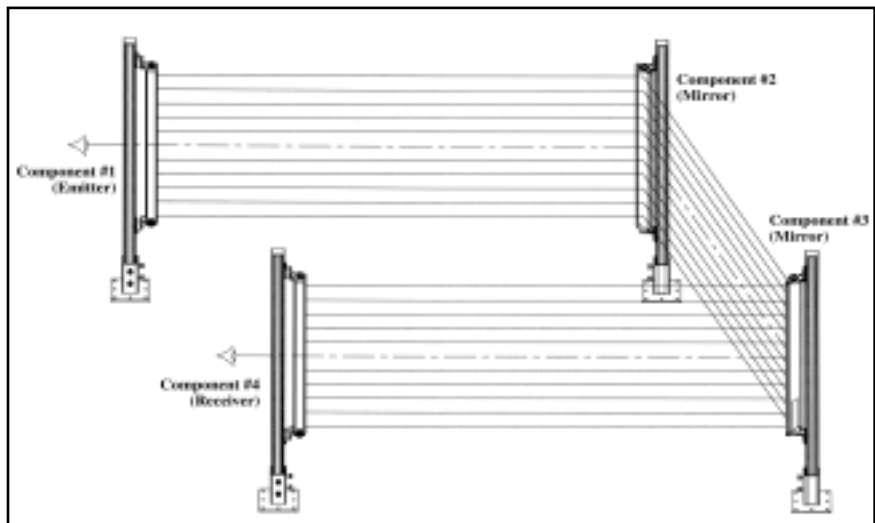


Figure 27. Corner mirror alignment

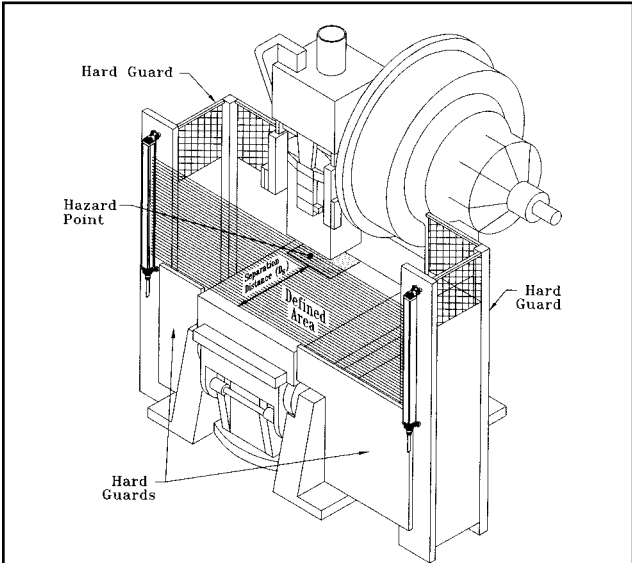
6.2 Commissioning Checkout (To Be Performed at Installation)

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

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 that is compatible with the Dual MINI-SCREEN System. See page 2 for a list of misapplications.
- 2) Verify that the minimum separation distance from the closest danger point of the guarded machine to either defined area is not less than the calculated distance (see Figure 28, below).
- 3) Verify that access to the dangerous parts of the guarded machine is not possible from any direction not protected by the Dual MINI-SCREEN System, hard guarding, or supplemental guarding, and verify that all supplemental guarding devices and hard guarding are in place and operating properly.
- 4) Verify that it is not possible for a person to stand between either defined area and the dangerous parts of the guarded machine. Or, verify that supplemental presence sensing devices, as described by ANSI B11 safety requirements or other appropriate standards, are in place and functioning properly in any space between either defined area and any danger point which is large enough to allow a person to stand undetected by the Dual MINI-SCREEN System.
- 5) Examine the electrical wiring connections between the Dual MINI-SCREEN output relays and the guarded machine's control elements to verify the requirements stated in Section 3.5.6.




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 NOTE 2, below.
 - T_r = the response time of the MINI-SCREEN System:
 .048 seconds for 4.5" to 16" emitter/receiver,
 .060 seconds for 20" to 32" emitter/receiver
 .072 seconds for 36" to 48" emitter/receiver
 - D_{pf} = the added distance due to depth penetration factor, as prescribed in OSHA 1910.217 and ANSI B11 standards:
 Note: The value for D_{pf} may be different for each of the two sensor pairs

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

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



WARNING . . . Shock Hazard
 A shock hazard exists while the lockable enclosure is open. **Before continuing, verify that the door is closed and latched.**



WARNING . . . Calculate the Safety Distance Carefully
 Failure to maintain appropriate separation distance can result in serious bodily injury or death.

Figure 28. Calculation of DS

- 6) Test the effectiveness of both Dual MINI-SCREEN light screens with system power ON, as described in steps (a) through (e), below. The Dual MINI-SCREEN control box includes six specified test pieces. Select the proper test piece based on system configuration, per the following chart:
- a) Verify that the Dual MINI-SCREEN System is in the RUN mode (green and yellow status indicator LEDs ON). See section 4.3 for RESET procedure. The green LED will flash if blanking is programmed for either light screen.

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	30' Range Emitters and Receivers	60' Range Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model STP-2	25.4 mm (1.00") dia. Model STP-7
1-beam floating blanking ON	31.8 mm (1.25") dia. Model STP-4	38.1 mm (1.50") dia. Model STP-1
2-beam floating blanking ON	44.5 mm (1.75") dia. Model STP-3	50.8 mm (2.00") dia. Model STP-8

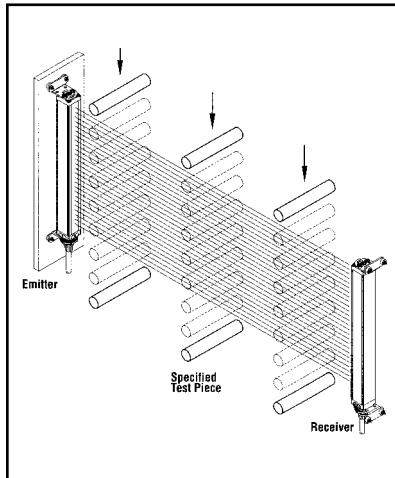



Figure 30. Use of test piece for trip test



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

If all of the described checks cannot be verified, **DO NOT USE** the Dual MINI-SCREEN System/guarded machine until the defect or problem has been corrected (see Section 5). Doing so could result in serious bodily 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: close to the receiver column, close to the emitter column, and midway between the emitter and receiver columns (Figure 29). In each case, the red status indicator should come ON and remain ON for as long as the test piece is within the defined area. When the test piece is withdrawn from the defined area, the green status indicator should come ON. If the green indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces, and do not continue until the cause is discovered and the situation is resolved. (For controller MDSINT-1L2: after performing each trip test, perform a Key Reset to reset the latch.)
- c) Initiate machine motion of the guarded machine and, during motion, insert the *appropriate specified test piece* into the defined area (at right angles 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 Key Reset of the latch output if required, 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.
- e) Repeat steps a through d for the second light screen.
- 7) Test the emergency stop switch (if one is connected to the Dual MINI-SCREEN module). With the machine running, engage the emergency stop switch (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 Dual MINI-SCREEN module.
- 8) Remove electrical power to the Dual MINI-SCREEN System. All output relays should immediately de-energize, and should not be capable of being reactivated until power is re-applied and a key Reset is performed (unless the Auto Power-up feature is 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.)

6.3 Power-up, Shift Change, 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 Dual MINI-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 either 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 either defined area and the dangerous parts of the guarded machine. Or, verify that supplemental presence sensing devices, as described by ANSI B11 safety requirements or other appropriate standards, are in place and functioning properly in any space between either defined area and any danger point which is large enough to allow a person to stand undetected by the Dual MINI-SCREEN System.
- 4) Verify that the lockable enclosure for the Dual MINI-SCREEN module is latched and locked. The key or combination to the enclosure lock should be in the possession of a Qualified Person.



WARNING . . . Shock Hazard

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

- 5) Test the effectiveness of both Dual MINI-SCREEN light screens with system power ON, as described in steps (a) through (e), below. The Dual MINI-SCREEN control box includes six specified test pieces. Select the proper test piece based on system configuration, per the following chart:

Appropriate Test Pieces for Trip Test		
Floating Blanking Program	30' Range Emitters and Receivers	60' Range Emitters and Receivers
Floating blanking OFF	19.1 mm (0.75") dia. Model STP-2	25.4 mm (1.00") dia. Model STP-7
1-beam floating blanking ON	31.8 mm (1.25") dia. Model STP-4	38.1 mm (1.50") dia. Model STP-1
2-beam floating blanking ON	44.5 mm (1.75") dia. Model STP-3	50.8 mm (2.00") dia. Model STP-8

- a) Verify that the Dual MINI-SCREEN System is in RUN mode (green and yellow Status Indicator LEDs ON). See Section 4.3 for Reset procedure. Refer to Figure 25.
- b) With the guarded machine at rest, pass the appropriate *specified test piece* downward through the defined area in three paths, perpendicular to the defined area: close to the receiver, close to the emitter, and midway between the emitter and receiver (see Figure 30). In each case, the red indicator must come ON and remain ON while the test piece is within the defined area. When the test piece is removed from the defined area, the green status indicator should come ON (or be flashing, if blanking is ON). If the green status indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces, or unguarded areas created by the use of fixed blanking (see Warnings, page 49). **Do not continue until the situation is corrected.** (See Section 3.2.2 and 3.2.4). For controller MDSINT-1T2, perform a 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 Key Reset of the latch output (if required), 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.
- e) Repeat steps a through d for the second light screen.
- 6) Test the emergency stop switch (if one is connected to the Dual MINI-SCREEN module). 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 Dual MINI-SCREEN module.
- 7) Check carefully for external signs of damage to the Dual MINI-SCREEN System, the guarded machine, and their electrical wiring. Any damage found should be immediately reported to management.

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



WARNING . . . Shock Hazard

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

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 the separation distance 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 Dual MINI-SCREEN System.
- 4) Examine and inspect the machine controls and connections to the Dual MINI-SCREEN System to ensure that no modifications have been made which adversely affect the system.



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

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



WARNING . . . Reflective Surfaces

A highly reflective surface (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 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.

Glossary of Terms

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

ANSI (American National Standards Institute): the American National Standards Institute, is an association of industry representatives which develops technical standards which include safety standards. These standards comprise a consensus from a variety of industries on good practice and design. ANSI standards relevant to application of the Dual MINI-SCREEN System include ANSI B11.1 (mechanical power presses), ANSI B11.2 (hydraulic power presses), and ANSI/RIA R15.06 (industrial robots and robot systems). See page 64.

Auxiliary monitor contact: a low load capacity, non safety-related relay contact within the Dual MINI-SCREEN System that follows the action of the associated light screen, and whose primary purpose is to communicate system status to a PLC. The Dual MINI-SCREEN System has two auxiliary monitor contacts: one for each light screen. An auxiliary contact opens for a trip condition resulting from an interruption of the associated light screen. Both auxiliary contacts open for a lockout condition.

Auto Power-up: a feature of the Dual MINI-SCREEN control box which, when switched "on", enables the Dual MINI-SCREEN to be powered up (and recover from a power interruption) without the necessity of a *key reset*. When Auto Power-up is "on", the Dual MINI-SCREEN control box 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 reset is required.

Control reliability: A method of ensuring the integrity of performance 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 Dual MINI-SCREEN System) that provides the proper voltages to the system, controls the sensing units, receives and processes information from the sensing units and the safety monitoring means, and provides outputs to the *Final Switching Devices (FSD1 and FSD2)*, the *Secondary Switching Device (SSD)*, and the *Auxiliary Monitor Relays*.

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

Defined area: the "curtain of light" generated by the sensors of the Dual MINI-SCREEN System. When the defined area is interrupted by an opaque object of a specified cross section, a *trip condition* results (see Figure 1). The Dual MINI-SCREEN System uses two sensor pairs and, therefore, has two defined areas.

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: in diverse redundancy, the redundant components are of different design, and any microprocessor programs used must run from different instruction sets written by different programmers.

Emergency stop: the function offered by the Dual MINI-SCREEN 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 3.5.2.

Emitter: the light-emitting components of the Dual MINI-SCREEN System, consisting of a row of synchronized modulated infrared LEDs. The emitter, together with the *receiver* (placed opposite), creates a "curtain of light" called the *defined area*. The Dual MINI-SCREEN System uses two emitter/receiver pairs.

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

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

The Dual MINI-SCREEN System offers either one-beam or two-beam floating blanking. Floating blanking may be independently programmed for each of the two light screens.

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 Dual MINI-SCREEN Systems are extensively FMEA tested.

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

Full-revolution devices: a method 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 Dual MINI-SCREEN Systems may not be used with full-revolution devices.

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

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

Internal lockout: a lockout condition that is due to an internal Dual MINI-SCREEN System problem. Indicated by the red status indicator LED (only) flashing. Requires the attention of a *qualified person*.

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

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

Lockout condition: a condition of the Dual MINI-SCREEN System that is automatically attained both: (1) *when its ac supply mains are interrupted and restored, and (2) in response to certain failure signals. When a lockout condition occurs, the Dual MINI-SCREEN System's *FSD*, *SSD*, and *Auxiliary Monitor Relay* contacts open, and a *key reset* is required to return the system to the RUN condition. *Except when the system is programmed for auto power-up.

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

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

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

Minimum object sensitivity: the minimum-diameter object that a light screen 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. See also *specified test piece*.

MPCE monitor contacts: the normally open and normally closed contacts of a *guarded machine's* MPCEs which are connected in series with the power supply to the Dual MINI-SCREEN System. Any inconsistency of action between the two sets of monitor contacts will remove power from the Dual MINI-SCREEN System and cause a *lockout condition*. See Figure 23.

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 (open) and interrupts the flow of current.

ON state (of Final and Secondary Switching Devices): in the ON state, the output circuit is complete (closed) 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 61.

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

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

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

Power-up/power interrupt lockout: a *lockout condition* of the Dual MINI-SCREEN System that, if *Auto Power-up* is "off", occurs when the system is powered up (including upon power-up after a loss of power). Indicated by the yellow Status Indicator LED (only) double-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 (i.e. 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 Dual MINI-SCREEN Systems may not be used as PSDI devices on mechanical power presses, per OSHA regulation 29 CFR 1910.217.*

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

Receiver: the light-receiving components of the Dual MINI-SCREEN System, consisting of a row of synchronized phototransistors. The receiver, together with the *emitter* (placed opposite), creates a "curtain of light" called the *defined area*. The Dual MINI-SCREEN System uses two emitter/receiver pairs.

Secondary switching device (SSD): the output relay of the Dual MINI-SCREEN System which, in a *lock-out 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 Dual MINI-SCREEN Systems are self-checking.

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

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



Specified test piece: an opaque object of the minimum cross section required to place the Dual MINI-SCREEN System into a *trip condition* when inserted into any part of either *defined area*. See also *minimum object sensitivity and Section 3.2.1*.

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 areas* of an installed Dual MINI-SCREEN System and into the *point of operation* of the *guarded machine*.

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

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.

Specifications - Emitters and Receivers							
Standard Models	Long-Range Models	Defined Area	Number of Beams	Standard Models	Long-Range Models	Defined Area	Number of Beams
MSE424(Y) emitter MSR424(Y) receiver	MSXLE424(Y) emitter MSXLR424(Y) receiver	114 mm (4.5")	8	MSE2824(Y) emitter MSR2824(Y) receiver	MSXLE2824(Y) emitter MSXLR2824(Y) receiver	711 mm (28")	56
MSE824(Y) emitter MSR824(Y) receiver	MSXLE824(Y) emitter MSXLR824(Y) receiver	215 mm (8.5")	16	MSE3224(Y) emitter MSR3224(Y) receiver	MSXLE3224(Y) emitter MSXLR3224(Y) receiver	813 mm (32")	64
MSE1224(Y) emitter MSR1224(Y) receiver	MSXLE1224(Y) emitter MSXLR1224(Y) receiver	305 mm (12")	24	MSE3624(Y) emitter MSR3624(Y) receiver	MSXLE3624(Y) emitter MSXLR3624(Y) receiver	914 mm (36")	72
MSE1624(Y) emitter MSR1624(Y) receiver	MSXLE1624(Y) emitter MSXLR1624(Y) receiver	406 mm (16")	32	MSE4024(Y) emitter MSR4024(Y) receiver	MSXLE4024(Y) emitter MSXLR4024(Y) receiver	1016 mm (40")	80
MSE2024(Y) emitter MSR2024(Y) receiver	MSXLE2024(Y) emitter MSXLR2024(Y) receiver	508 mm (20")	40	MSE4424(Y) emitter MSR4424(Y) receiver	MSXLE4424(Y) emitter MSXLR4424(Y) receiver	1118 mm (44")	88
MSE2424(Y) emitter MSR2424(Y) receiver	MSXLE2424(Y) emitter MSXLR2424(Y) receiver	610 mm (24")	48	MSE4824(Y) emitter MSR4824(Y) receiver	MSXLE4824(Y) emitter MSXLR4824(Y) receiver	1219 mm (48")	96
Emitter/receiver separation		15 cm (6") to 9 m (30') for standard sensors 15 cm (6") to 18 m (60') for optional long-range sensors					
Minimum object sensitivity		19.1 mm (0.75") for 9 m (30') range sensors with floating blanking OFF 32.0 mm (1.25") for 9 m (30') range sensors with 1-beam floating blanking ON 44.5 mm (1.75") for 9 m (30') range sensors with 2-beam floating blanking ON 25.4 mm (1.00") for 18 m (60') range sensors with floating blanking OFF 38.1 mm (1.50") for 18 m (60') range sensors with 1-beam floating blanking ON 50.8 mm (2.00") for 18 m (60') range sensors with 2-beam floating blanking ON					
Response time		Less than 48 milliseconds using emitter/receiver with 4.5" to 16" defined area Less than 60 milliseconds using emitter/receiver with 20" to 32" defined area Less than 72 milliseconds using emitter/receiver with 36" to 48" defined area					
Self-checking interval		20 milliseconds					
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; 880nm peak emission					
Status indicators		Emitter: Green LED for power ON indication Receiver: Red, yellow, and green status indicators with same functions as those on control box (see Control Box Specifications). Yellow LED also indicates alignment. Indicators are visible on three sides of receiver base.					
Enclosures		<i>Size:</i> see Figure 15, page 21 <i>Material:</i> Aluminum, with black anodized or yellow polyester painted finish; acrylic lens cover <i>Rating:</i> NEMA 4, 13 (IP 65)					
Mounting hardware		Emitter and receiver are each supplied with a pair of mounting brackets. Mounting brackets are 11-gauge cold-rolled black zinc chromate finished steel. A set of four vibration dampening mounts is also supplied.					
Operating conditions		Temperature: 0° to +50°C (+32° to 122°F); Max. Relative Humidity: 95% (non-condensing)					

Specifications - Control Module	
Models	MDSINT-1T2 Trip output MDSINT-1L2 Latch output
Control Box	24V dc $\pm 15\%$, 10% maximum ripple, 2.5 amps max.
Status indicators (on control box and receiver)	<p><u>Red</u> = BLOCKED/LATCHED Flashing red = LOCKOUT <u>Green</u> = CLEAR Flashing green = BLANKING ON <u>Yellow</u> = RESET Double-flashing yellow = waiting for power-up manual key reset</p> <p>ALIGNMENT Single-flashing yellow = alignment indicator: flash rate increases with the number of sensing beams "made"; solid yellow when aligned and defined area is clear.</p> <p>Emitter has green LED to indicate power ON.</p>
Diagnostic indicator	Single-digit alphanumeric display indicates cause of lockout condition.
Controls and adjustments	Keyed RESET of system lockout conditions BLANKING selection switches AUTO POWER UP on-off switches
Emergency Stop switch input	Emergency stop switch must offer two normally closed contacts and be capable of switching 50 mA @ 30V dc. Simultaneity < 100 ms. Total resistance, including wiring and all switches, must not exceed 30 Ω for proper operation. Functional stop category 0 per NFPA 79 and EN 418, Safety Category 4 per EN 954-1.
Test input	Terminals must be closed for a minimum of 0.05 seconds in order to guarantee a test input signal. The switching device used must be capable of switching 15-50V dc at 20 to 100 mA.
Auxiliary monitor relay	Reed relay; 125V ac or dc max., 500 mA. max. (10VA maximum, resistive load)
Output configuration (FSD1, FSD2, and SSD)	Forced-guided contact relays, 250V ac max., 4 amps max. (resistive load). <i>Mechanical life</i> 10,000,000 operations (minimum). <i>Electrical life</i> (at full rated load) 100,000 operations (typical). <i>Arc suppression is recommended when switching inductive loads.</i> See Figure 23, page 33.
Enclosure	<i>Size:</i> see dimension drawing on page 24 <i>Material:</i> Polycarbonate <i>Rating:</i> NEMA 1, (IP 20)
Fuse rating	3 amp, 250V (3AG or 5x20mm slow blow)
Operating conditions	Temperature: 0° to 50°C (+32° to 122°F); Max. Relative Humidity: 95% (non-condensing)
FMEA tested (Failure Mode and Effects Analysis)	Per requirements of proposed first edition of IEC 61496-1 (type 4)
Cables	<i>NOTE: Use only Banner cables, which incorporate a "twisted pair" for noise immunity on RS485 data communication lines. Use of other cables can result in "nuisance" lockouts.</i> Emitter and receiver cables are ordered separately. Banner 5-conductor shielded cables have a straight QD (Quick Disconnect) connector molded onto the sensor end. Cables measure 8.1 mm (0.32") in diameter, and are shielded and PVC-jacketed. Conductors are 20-gauge. Two liquid-tight cable gland/strain relief fittings are supplied with each control box to admit the emitter and receiver cables through the selected knockouts on the control box wall. Emitter and receiver cables may not exceed 53 m (175') total for each emitter and receiver pair; see <i>Cables</i> , page 58.
Certifications	  

Ordering Information

Dual MINI-SCREEN Systems consist of one control box, two sensor pairs, and four cables. All components are ordered separately. The only requirement is that the emitter and receiver of either sensor pair must be of equal length. However, the two sensor pairs may be different lengths. Cables are interchangeable between emitters and receivers. See page 59 for system accessories.

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

Defined Area	Models				Number of Beams
	Black Anodized		Yellow Painted		
	9 m (30') Range	18 m (60') Range	9 m (30') Range	18 m (60') Range	
114 mm (4.5")	MSE424 MSR424	MSXLE424 MSXLR424	MSE424Y MSR424Y	MSXLE424Y MSXLR424Y	8
215 mm (8.5")	MSE824 MSR824	MSXLE824 MSXLR824	MSE824Y MSR824Y	MSXLE824Y MSXLR824Y	16
305 mm (12")	MSE1224 MSR1224	MSXLE1224 MSXLR1224	MSE1224Y MSR1224Y	MSXLE1224Y MSXLR1224Y	24
406 mm (16")	MSE1624 MSR1624	MSXLE1624 MSXLR1624	MSE1624Y MSR1624Y	MSXLE1624Y MSXLR1624Y	32
508 mm (20")	MSE2024 MSR2024	MSXLE2024 MSXLR2024	MSE2024Y MSR2024Y	MSXLE2024Y MSXLR2024Y	40
610 mm (24")	MSE2424 MSR2424	MSXLE2424 MSXLR2424	MSE2424Y MSR2424Y	MSXLE2424Y MSXLR2424Y	48
711 mm (28")	MSE2824 MSR2824	MSXLE2824 MSXLR2824	MSE2824Y MSR2824Y	MSXLE2824Y MSXLR2824Y	56
813 mm (32")	MSE3224 MSR3224	MSXLE3224 MSXLR3224	MSE3224Y MSR3224Y	MSXLE3224Y MSXLR3224Y	64
914 mm (36")	MSE3624 MSR3624	MSXLE3624 MSXLR3624	MSE3624Y MSR3624Y	MSXLE3624Y MSXLR3624Y	72
1016 mm (40")	MSE4024 MSR4024	MSXLE4024 MSXLR4024	MSE4024Y MSR4024Y	MSXLE4024Y MSXLR4024Y	80
1118 mm (44")	MSE4424 MSR4424	MSXLE4424 MSXLR4424	MSE4424Y MSR4424Y	MSXLE4424Y MSXLR4424Y	88
1219 mm (48")	MSE4824 MSR4824	MSXLE4824 MSXLR4824	MSE4824Y MSR4824Y	MSXLE4824Y MSXLR4824Y	96

Pigtail Quick-Disconnect Option

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

Controllers (One per sensor pair)

MDSINT-1T2 24V dc control module, Trip Output

MDSINT-1L2 24V dc control module, Latch Output

Cables (Two required per sensor pair)*

QDC-515C 4.5 m (15') cable, straight QD connector. One cable per sensor.

QDC-525C 7.6 m (25') cable, straight QD connector. One cable per sensor.

QDC-550C 15 m (50') cable, straight QD connector. One cable per sensor.

QDC-5100 30 m (100') cable, straight QD connector. One cable per sensor.

QDC-5150 45 m (150') cable, straight QD connector. One cable per sensor.

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

Documentation

The following documentation is supplied with each **Dual MINI-SCREEN** System Control Box. Additional copies are available at no charge.

Instruction Manual for Dual MINI-SCREEN Systems: order p/n 47297 (this manual).

Checkout Procedure Card (Daily): order p/n 47783

Checkout Procedure Card (Semi-annual): order p/n 47784

Replacement Parts, MINI-SCREEN Systems

40091	BA2MB	Mounting Hardware Kit for one emitter or receiver
28513	MGA-K-1	Replacement key
30140	MGA-KSO-1	Key switch, only (no wires)
48225	MSDA-RM-1	Replacement power supply/relay board
65785	MDSDAL-1	Replacement controller board for MDSINT-1L2
48226	MDSDAB-1	Replacement controller board for MDSINT-1T2
43835	STP-1	Specified test piece (1.50" dia.)
43957	STP-2	Specified test piece (0.75" dia.)
43958	STP-3	Specified test piece (1.75" dia.)
43836	STP-4	Specified test piece (1.25" dia.)
48981	STP-7	Specified test piece (1.00" dia.)
49126	STP-8	Specified test piece (2.00" dia.)

MSA Series Lens Shields

Model MSSxx is a replaceable protective cover for the lens of a MINI-SCREEN sensor. The shield is made of 1.5 mm (0.06") clear polycarbonate.

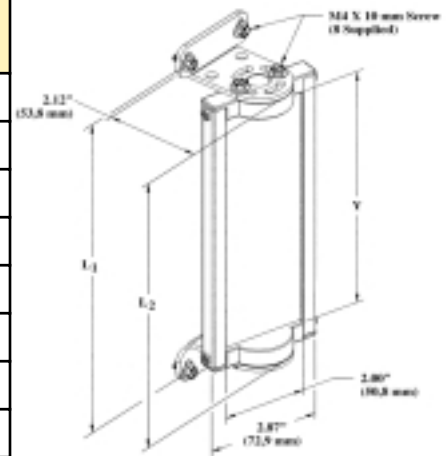
Shield models are available for every length of sensor from 4" to 48" (see chart below). The shields attach to the sensor using two adhesive-backed Neoprene foam strips.

Application Note: When shields are installed on both the emitter and receiver, excess gain is

Protective-Shield	Model Number	Assembly Number	Length
4"	MSS4	44308	5.4"
8"	MSS8	44308	9.4"
12"	MSS12	44310	13.4"
16"	MSS16	44311	17.4"
20"	MSS20	44312	21.4"
24"	MSS24	44313	25.3"
28"	MSS28	44314	29.3"
32"	MSS32	44315	33.3"
36"	MSS36	44316	37.3"
40"	MSS40	44317	41.3"
44"	MSS44	44318	41.3"
48"	MSS48	44319	49.3"

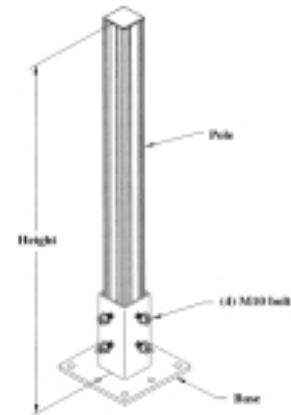
MSM Series Corner Mirrors

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



MSA Series Stands

Model of Stand	Part Number	Stand Height	Mirror Length (Brackets Outward)	Mirror Length (Brackets Inward)
MSA-S24-1	43174	24"	4" to 8"	4" to 12"
MSA-S42-1	43175	42"	4" to 24"	4" to 28"
MSA-S66-1	43176	66"	4" to 48"	4" to 48"



LAT-1 Laser Alignment Tool

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



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

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

U.S. Design Standards

UL 991

Tests for Safety-related Controls Employing Solid-state Devices

UL 1998

Standard for Safety Related Software

SOURCE

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

OSHA Regulations

OSHA 29 CFR 1910.212

General Requirements for (Guarding of) All Machines

OSHA 29 CFR 1910.217

(Guarding of) Mechanical Power Presses

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

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 Principles 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

SOURCES

EN and IEC Standards

Available from:

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

BS Documents

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



the machine safety specialist

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