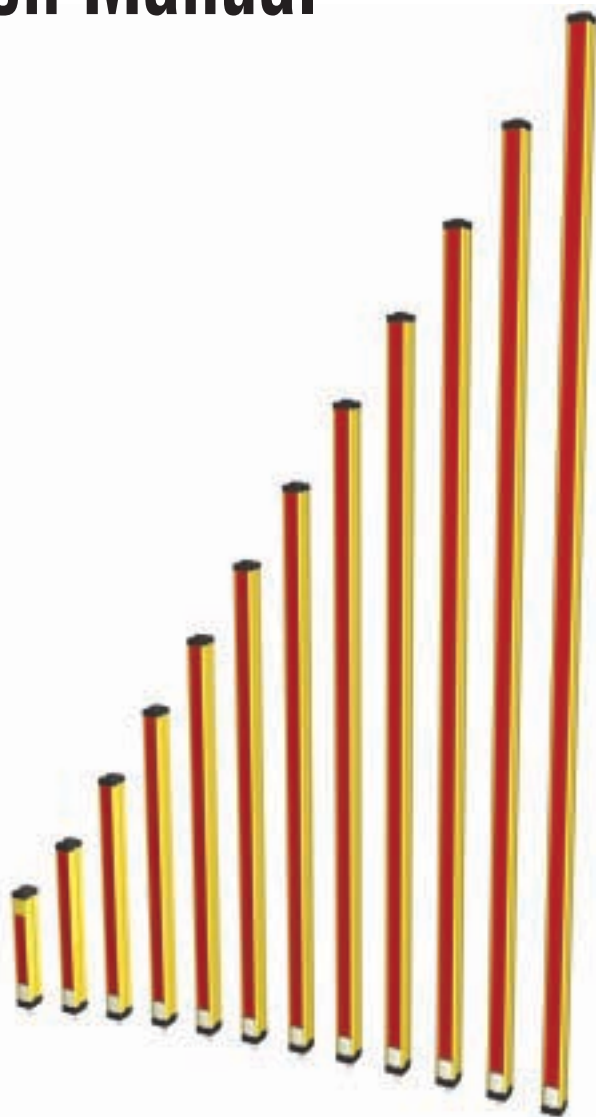




# EZ-SCREEN™ System Instruction Manual

## Features

- An optoelectronic safeguarding device
- Compact package for smaller production machines, robust for large power presses
- Creates a screen of synchronized, modulated infrared sensing beams. Choose from 20 sizes in 150 mm (6") increments:
  - 14 mm (0.55") resolution models with defined areas from 150 mm to 1.2 m (6" to 48")
  - 30 mm (1.18") resolution models with defined areas from 150 mm to 1.8 m (6" to 71")
- Remote Test input terminals for simulating a "blocked" condition
- Easily configured Reduced Resolution (Floating Blanking)
- Three-digit display provides diagnostic information and indicates number of beams blocked
- Zone indicators identify blocked beams
- FMEA tested to ensure control reliability
- Receiver LEDs provide system status and emitter/receiver alignment indications
- Highly immune to EMI, RFI, ambient light, weld flash, and strobe light
- Two-piece design with External Device Monitoring
- Vibration-tolerant, factory burned-in emitter and receiver circuitry for toughness and dependability



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## Important ...

## read this page before proceeding!

In the United States, the functions that EZ-SCREEN Systems are intended to perform are regulated by the Occupational Safety and Health Administration (OSHA). Outside of the United States, these functions are regulated by other agencies, organizations, and governments. Whether or not any particular EZ-SCREEN System installation meets all applicable requirements depends upon factors that are beyond the control of Banner Engineering Corp. These factors include the details of how the EZ-SCREEN System is applied, installed, wired, operated, and maintained. **It is the responsibility of the purchaser and user to apply this EZ-SCREEN System in full compliance with all relevant applicable regulations and standards.**

EZ-SCREEN Systems can guard against accidents only when they are properly installed and integrated into the machine, properly operated, and properly maintained. Banner Engineering Corp. has attempted to provide complete application, installation, operation, and maintenance instructions. In addition, please direct any questions regarding application or use of EZ-SCREEN Systems to the factory applications department at the telephone number or addresses shown on the back cover.

In addition to OSHA regulations, several other organizations provide information about the use of safeguarding devices. Refer to the American National Standards Institute (ANSI), the Robotics Industries Association (RIA), the Association for Manufacturing Technology (AMT), and others (see below). 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 safeguarding 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.**

## U.S. Standards Applicable to Use of EZ-SCREEN Systems

OSHA 29CFR1910 Occupational Safety and Health Standards  
 ANSI B11 Standards Safeguarding of Machine Tools  
 ANSI/RIA R15.06 Safety Requirements for Robot Systems  
 NFPA 79 Electrical Standard for Industrial Machinery

*See inside back cover for information pertaining to applicable U.S., European and International standards, and where to acquire copies.*

## 1. System Overview

### 1.1 Introduction

The Banner EZ-SCREEN System provides a redundant, microprocessor-controlled, opposed-mode optoelectronic “curtain of light,” or “safety light screen.” It is generally used as a point-of-operation safeguarding device, and is suited to safeguard a variety of machinery.

EZ-SCREEN Systems are extensively FMEA (Failure Mode and Effects Analysis) tested to establish an extremely high degree of confidence that when properly installed, no system component will (even if it should fail) cause a failure to danger.

In typical operation, if any part of an operator's body (or any opaque object) of more than a pre-determined cross section is detected, the OSSD solid-state safety outputs will turn off. These safety outputs are connected to the guarded machine's Final Switching Devices (FSDs) that control the primary control elements (MPCEs) which immediately stop the motion of the guarded machine.

The OSSD (Output Signal Switching Device) safety outputs are capable of performing a “handshake” communication with the Muteable Safety Stop Interface (MSSI) or Universal Safety Stop Interface (USSI) found on other Banner Engineering safety products. The handshake protocol is satisfied by any Banner Engineering Safety Category 4 (per ISO 13849-1/EN954-1) device with OSSD outputs or MSSI/USSI inputs. This handshake verifies that the interface between the two devices is capable of detecting certain unsafe failures that may occur (such as a short circuit to a secondary source of power or to the other channel, high input resistance or loss of signal ground).

Banner EZ-SCREEN Systems can be described as “two-piece” or “two-box” systems – comprising an emitter and a receiver, but no external controller. The External Device Monitoring (EDM) function ensures the fault detection capability required by U.S. Control Reliability and ISO13849-1 Categories 3 and 4 without a third box, a controller or a “smart” (i.e., self-checking) safety module required of systems without EDM.

Emitters have a row of synchronized modulated infrared (invisible) light-emitting diodes (LEDs) in a compact rectangular metal housing. Receivers have a corresponding row of synchronized photodetectors. The dimensions of the light screen created by the emitter and receiver are called the “defined area”; its width and height are determined by the length of the sensor pair and the distance between them. The maximum range is dependent on the resolution, which decreases if corner mirrors are used. Emitter and receiver pairs with 14 mm (0.55") resolution have a maximum range of 6 m (20'), and pairs with 30 mm (1.18") resolution have a maximum range of 18 m (60').

Electrical connections are made through M12 (or Euro-style) quick-disconnects. The emitter has a 5-pin connector for power, ground and Test input. The receiver has an 8-pin connector for power, ground, reset, EDM #1 and #2, and OSSD #1 and #2.

Functions such as Trip/Latch select, Reduced Resolution (Floating Blanking), Scan Code select, and External Device Monitoring are described in Section 1.4. All models require a supply voltage of +24V dc  $\pm 15\%$ . Optional interface modules are also available with 3 N.O. output relays @ 6 amps (IM-T-9A) or with 2 N.O. and 1 N.C. output relays @ 6 amps (IM-T-11A).

Both emitter and receiver feature 7-segment Diagnostic Displays and individual LEDs to provide continuous indication of the System's operating status, configuration and error conditions. See Section 1.4.6 for more information.

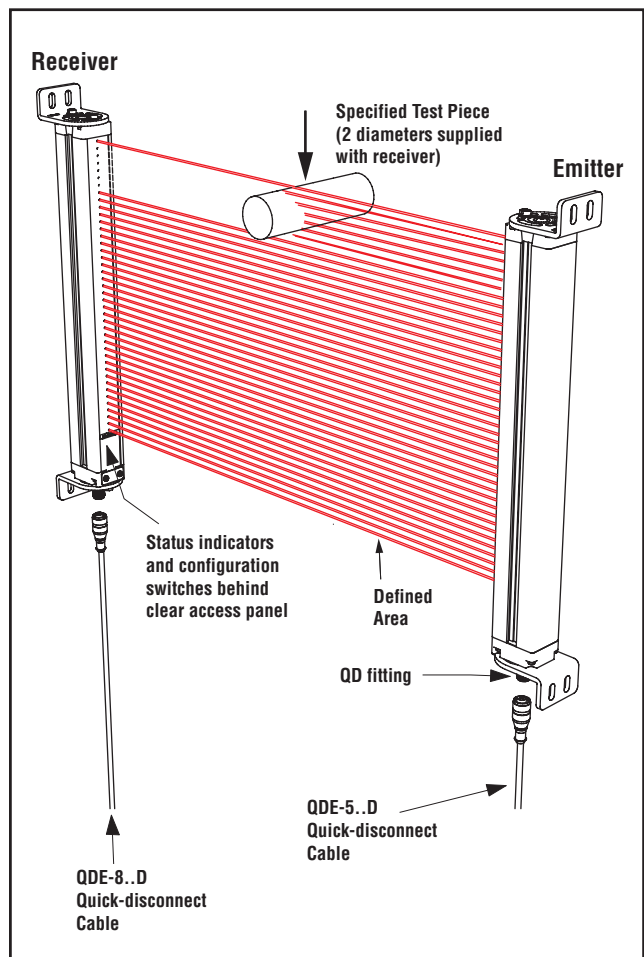


Figure 1-1. Banner EZ-SCREEN High-Resolution System: emitter, receiver, and two interconnecting cables

### 1.2 Applications and Limitations

The Banner EZ-SCREEN system is intended for point-of-operation machine guarding applications and other safeguarding applications. It is the user's responsibility to verify whether the safeguarding is appropriate for the application and is installed, as instructed by this manual, by a Qualified Person.

**Before installing the EZ-SCREEN System, read this manual in its entirety, paying particular attention to this section and all of Section 3.** The System's ability to perform its safeguarding function depends upon the appropriateness of the application and upon its proper mechanical and electrical installation and interfacing to the guarded machine. **If all mounting, installation, interfacing, and checkout procedures are not followed properly, the System cannot provide the protection for which it was designed.**

**EZ-SCREEN Systems are typically used, but are not limited to, the following applications:**

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

**EZ-SCREEN Systems may NOT be used with the following machinery or unsuitable applications:**

- Any machine that cannot be stopped immediately after a stop signal is issued, such as single-stroke (or "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.
- 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 the System.
- As tripping devices to initiate machine motion (PSDI applications) on mechanical power presses, per OSHA regulation 29 CFR 1910.217.

If an EZ-SCREEN System is installed for use as a perimeter guarding system (i.e., where a pass-through hazard may exist), the **dangerous machine motion can be initiated by normal means only after the safeguarded area is clear of individuals and the EZ-SCREEN System has been reset. See Section 3.2.1 for further information.**

Approvals are pending. See [www.bannerengineering.com](http://www.bannerengineering.com) for further information.



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

**The user is responsible for satisfying all local, state, and national laws, rules, codes, or regulations relating to the installation and use of this control system in any particular application.** Take extreme care to meet all legal requirements and follow all installation and maintenance instructions contained in this manual.

**The user has the sole responsibility to ensure that the EZ-SCREEN System is installed and interfaced to the guarded machine by Qualified Persons in accordance with this manual and applicable safety regulations.**

Carefully read this manual in its entirety, paying particular attention to Section 1.2 and all of Section 3, before installing the System. **Failure to follow these instructions could result in serious bodily injury or death.**



#### **CAUTION . . . Install System Only on Appropriate Applications**

Banner EZ-SCREEN Systems are for use only on machinery that can be stopped immediately after a stop signal is issued at any point in the machine's stroke or cycle, such as part-revolution clutched machines. Under no circumstances may the EZ-SCREEN System be used on full-revolution clutched machinery or in unsuitable applications as those listed at left. **If there is any doubt about whether or not your machinery is compatible with the EZ-SCREEN System, contact Banner's Application Engineers at the factory.**

### 1.3 Control Reliability: Redundancy and Self-Checking

Redundancy requires that EZ-SCREEN System circuit components be "backed up" to the extent that, if the failure of a single component will prevent effective machine stopping action when needed, that component must have a redundant counterpart which will perform the same function. The EZ-SCREEN System is designed with redundant microprocessors.

Redundancy must be maintained for as long as the EZ-SCREEN System is in operation. Because a redundant system is no longer redundant after a component has failed, the System is designed to monitor itself continuously. 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 System into a Lockout condition.

Recovery from this type of Lockout condition requires:

- replacement of the failed component (to restore redundancy) and
- the appropriate reset procedure (see Section 1.4.7).

The Diagnostic Display is used to diagnose causes of a Lockout condition (see Section 5.1).

## 1.4 Operating Features

The Banner EZ-SCREEN Systems described by this manual feature several standard selectable functions:

- Reduced Resolution (Floating Blanking),
- Trip or Latch Output,
- External Device Monitoring (EDM), and
- Scan Code setting.

These functions are configured within the sensors, behind the access port on the front of each sensor and in the sensor wiring configuration; see Sections 3.4.2 and 4.2 for more information and configuration DIP switches.

The resolution and the maximum range can be determined by the model number on the emitter and receiver. See Section 2.1 for a list of model numbers.

### 1.4.1 Selectable Trip/Latch Output

The setting for Trip or Latch Output also determines whether the System will enter RUN mode automatically or if it will require a manual reset first (see Sections 1.4.7 and 4.2). If the System is set for Trip Output, other measures must be taken to prevent a pass-through hazard; see Section 3.1.2 and the warning below for more information.



#### **WARNING ... Use of Trip/Latch Output**

**Application of power to the EZ-SCREEN System, the clearing of the defined area, or the reset of a Latch condition MUST NOT**

**initiate dangerous machine motion.** Machine control circuitry must be designed so that one or more initiation devices must be engaged (i.e., a conscious act) to start the machine – in addition to the EZ-SCREEN System going into RUN mode.

**Failure to follow these instructions could result in serious bodily injury or death.**

If Trip Output is selected, the OSSD outputs will turn ON after power is applied, and the receiver passes its internal self-test/synchronization and recognizes that all beams are clear. The Trip Output will also automatically reset after all interruptions of one or more beams are cleared. If Latch Output is selected, the EZ-SCREEN requires a manual reset for the OSSD outputs to turn ON, after power is applied and all beams are clear (see Section 4.5).

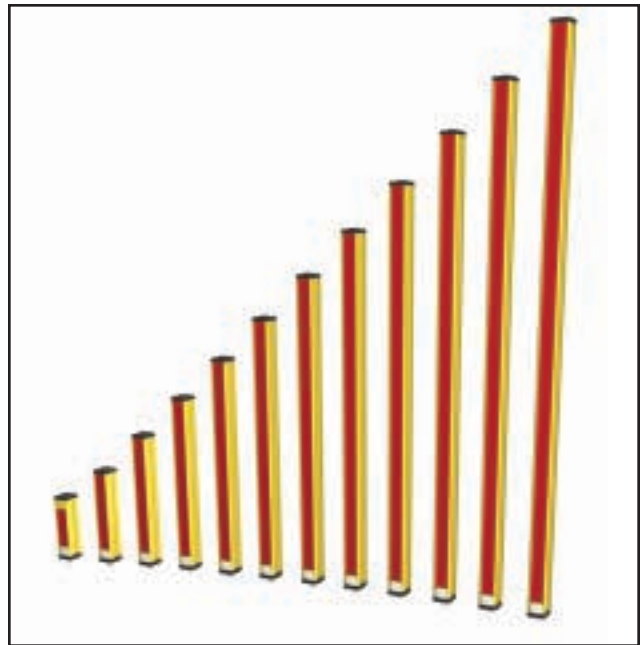


Figure 1-2. EZ-SCREEN emitter and receiver models

### 1.4.2 External Device Monitoring (EDM)

This feature allows the EZ-SCREEN System to monitor the status of external devices, such as MPCEs. The choices are One- or Two-Channel Monitoring, or No Monitoring. EDM is used when the EZ-SCREEN OSSD outputs directly control the energizing and de-energizing of the MPCEs or other external devices; see Sections 3.5.3 and 4.2 for more information.

### 1.4.3 Remote Test Input

A pair of wires is provided from the emitter (see Section 3.5.6) for an external switch, typically a normally open contact, held closed. Opening a switch connected between these two terminals “turns off” the emitter, simulating an interruption of one or more light beams. This remote Test input may be useful for EZ-SCREEN System setup and to verify machine control circuit operation.

### 1.4.4 Scan Code Configuration

The emitter and receiver may be configured to one of two Scan Code positions (1 or 2). Scan codes enable a receiver to recognize beams only from an emitter with the same Scan Code setting. This helps minimize the effects of crosstalk between multiple emitter/receiver pairs, and allows multiple pairs to operate in close proximity in certain situations. See Sections 3.1.5 and 3.1.8 for proper mounting configurations. The Scan Code is set using the selection switch in each sensor's configuration port; see Section 4.2 for more information. Both the emitter and its corresponding receiver must be set to the identical setting.



## 1.4.5 Reduced Resolution (Floating Blanking)

Reduced Resolution increases the minimum diameter of an object that the light screen can reliably detect anywhere within its defined area. Reduced Resolution is generally used to allow one or more objects (usually workpiece materials) to move through the defined area, at any point, without tripping the OSSD safety outputs.

Selecting two-beam Reduced Resolution will reduce the overall minimum object sensitivity, which allows multiple objects to move through the defined area (see Section 3.4.2). The effect is every two consecutive beams can be blocked, but not cause a Trip condition (OSSDs turn OFF). This is also called “multiple-point Floating Blanking.”

Resolution directly affects the minimum allowable distance between the defined area of a light screen and the nearest

hazard point (separation distance, see Section 3.1.1). The green status indicator on the receiver flashes when Reduced Resolution is enabled. The ignored object size and resultant Reduced Resolution are listed in Section 3.1.1.

## 1.4.6 Status Indicators

Status indicators on both the emitter and receiver are clearly visible on each sensor's front panel.

### • Emitter:

*Bi-color red/green Status indicator* – shows whether power is applied, and whether the emitter is in RUN mode, TEST mode, or Lockout condition.

*1-Digit Diagnostic Display* – indicates specific error or configuration conditions.

### • Receiver:

*Bi-color red/green Zone indicators* – show status of a group of beams:

- aligned and clear, or
- blocked and/or misaligned.

*Yellow Reset indicator* – shows System status:

- RUN mode or
- waiting for a reset.

*Bi-color red/green Status indicator* – shows System status:

- Reduced Resolution enabled,
- outputs are ON or OFF, or
- the System is in Lockout condition.

*3-Digit Diagnostic Display* – indicates specific error, configuration conditions, or total number of blocked beams.

See Sections 4.4 and 5.1 for more information about specific indicator and Diagnostic Display code meanings.

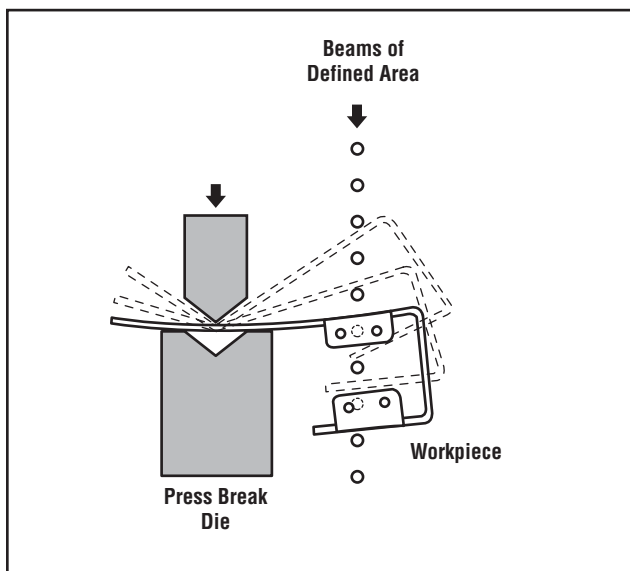


Figure 1-3. Reduced Resolution

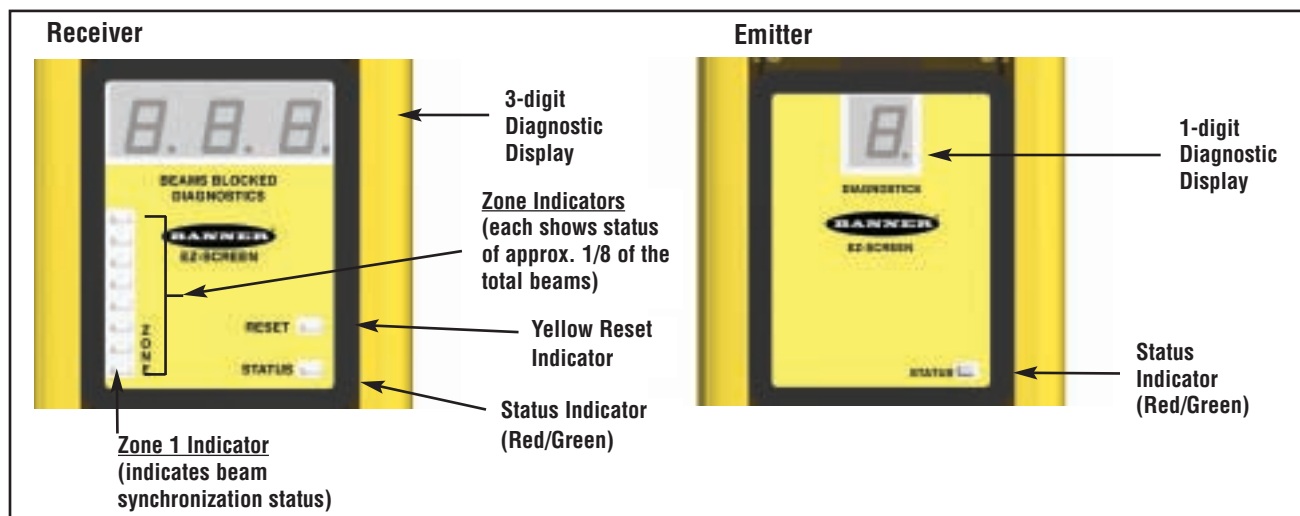


Figure 1-4. EZ-SCREEN emitter and receiver status indicators

### **1.4.7 Manual Resets and Lockout Conditions**

#### **Reset Routine**

The EZ-SCREEN System requires a manual reset to clear a Power-Up Lockout or Latch condition, and after correcting the cause of a Lockout condition. This function is designed to provide a “monitored manual reset” (i.e., open-closed-open action), such that a shorted or tied-down button cannot cause a reset. When a key-operated switch is used, this is typically called a key reset.

To perform a manual reset, close the normally open switch for at least 1/4 second, but no longer than 2 seconds, and then re-open the switch. See Sections 3.1.3. and 4.1 for further information.

A Lockout condition will cause the System OSSD outputs to turn OFF. A Lockout condition is indicated by a flashing Red Status indicator and an error number displayed on the Diagnostic Display. Internal Lockout conditions require a manual reset routine to return the system to RUN mode after the failure has been corrected and the input has been correctly cycled. A description of possible lockouts, their causes, and troubleshooting hints are listed in Section 5.

## 2. System Components and Specifications

An EZ-SCREEN System includes:

- An emitter and receiver of equal length, number of beams, and resolution (available separately or in pairs, including mounting hardware), and
- Two cables.

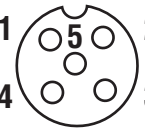
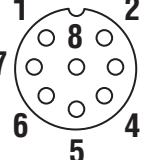
Optional interface module (model IM-T-9A or IM-T-11A), or two positively guided contactors (models 11-BG00-31-D-024, 11BF16C01-024, or user-supplied), and/or optional muting module (model MM-TA-12B) also may be used with the System.

### 2.1 Emitter and Receiver Models

Defined Area Height	14 mm Resolution Models 0.1 m to 6 m (4" to 20') range			30 mm Resolution Models 0.1 m to 18 m (4" to 60') range		
	Model	Number of Beams	Response Time	Model	Number of Beams	Response Time
150 mm (5.9")	SLSE14-150 Emitter SLSR14-150 Receiver SLSP14-150 Pair	20	11 ms	SLSE30-150 Emitter SLSR30-150 Receiver SLSP30-150 Pair	10	9 ms
300 mm (11.8")	SLSE14-300 Emitter SLSR14-300 Receiver SLSP14-300 Pair	40	15 ms	SLSE30-300 Emitter SLSR30-300 Receiver SLSP30-300 Pair	20	11 ms
450 mm (17.7")	SLSE14-450 Emitter SLSR14-450 Receiver SLSP14-450 Pair	60	19 ms	SLSE30-450 Emitter SLSR30-450 Receiver SLSP30-450 Pair	30	13 ms
600 mm (23.6")	SLSE14-600 Emitter SLSR14-600 Receiver SLSP14-600 Pair	80	23 ms	SLSE30-600 Emitter SLSR30-600 Receiver SLSP30-600 Pair	40	15 ms
750 mm (29.5")	SLSE14-750 Emitter SLSR14-750 Receiver SLSP14-750 Pair	100	27 ms	SLSE30-750 Emitter SLSR30-750 Receiver SLSP30-750 Pair	50	17 ms
900 mm (35.4")	SLSE14-900 Emitter SLSR14-900 Receiver SLSP14-900 Pair	120	32 ms	SLSE30-900 Emitter SLSR30-900 Receiver SLSP30-900 Pair	60	19 ms
1050 mm (41.3")	SLSE14-1050 Emitter SLSR14-1050 Receiver SLSP14-1050 Pair	140	36 ms	SLSE30-1050 Emitter SLSR30-1050 Receiver SLSP30-1050 Pair	70	21 ms
1200 mm (47.2")	SLSE14-1200 Emitter SLSR14-1200 Receiver SLSP14-1200 Pair	160	40 ms	SLSE30-1200 Emitter SLSR30-1200 Receiver SLSP30-1200 Pair	80	23 ms
1350 mm (53.1")				SLSE30-1350 Emitter SLSR30-1350 Receiver SLSP30-1350 Pair	90	25 ms
1500 mm (59")				SLSE30-1500 Emitter SLSR30-1500 Receiver SLSP30-1500 Pair	100	27 ms
1650 mm (65")				SLSE30-1650 Emitter SLSR30-1650 Receiver SLSP30-1650 Pair	110	30 ms
1800 mm (70.9")				SLSE30-1800 Emitter SLSR30-1800 Receiver SLSP30-1800 Pair	120	32 ms



**2.2 Cables (one 5-pin QD cable for each emitter, one 8-pin for each receiver)**

Model Number	Length	Wire	Termination	Banner Cable Pinout/Color Code			European M12 Specification*			Connector (female face view)
For Emitter				Pin	Color	Function	Pin	Color	Function	
QDE-515D	5 m (15')	22 gauge	5-pin Euro-style female connector on one end; cut to length	1	Br	+24V dc	1	Br	+24V dc	
QDE-525D	8 m (25')			2	Wh	Test #2	2	Wh	Test #2	
QDE-550D	15 m (50')			3	Bu	0V dc	3	Bu	0V dc	
QDE-575D	23 m (75')			4	Bk	Test #1	4	Bk	Test #1	
QDE-5100D	30 m (100')			5	Gn/Ye	Gnd/Chassis	5	Shield	Gnd/Chassis	
For Receiver				Pin	Color	Function	Pin	Color	Function	
QDE-815D	5 m (15')	22 gauge	8-pin Euro-style female connector on one end; cut to length	1	Bn	+24V dc	1	Wh	+24V dc	
QDE-825D	8 m (25')			2	Or/Bk	EDM #2	2	Br	EDM #2	
QDE-850D	15 m (50')			3	Or	EDM #1	3	Gn	EDM #1	
QDE-875D	23 m (75')			4	Wh	OSSD #2	4	Ye	OSSD #2	
QDE-8100D	30 m (100')			5	Bk	OSSD #1	5	Gy	OSSD #1	
				6	Bu	0V dc	6	Pk	0V dc	
				7	Gn/Ye	Gnd/Chassis	7	Bu	Gnd/Chassis	
				8	Vi	Reset	8	Rd	Reset	

\* The European M12 Specification pin assignment and color codes are listed as a customer courtesy. The user must verify suitability of these cables for each application.

**2.3 Accessories****Interface Modules**

Provide isolated safety contacts for the EZ-SCREEN System. See Banner data sheet p/n 62822, and Figures 3-18 and 3-19 for more information.

Interface module (3 N/O redundant-output contacts)	<b>IM-T-9A</b>
Interface module (2 N/O redundant-output contacts, plus 1 N/C auxiliary contact)	<b>IM-T-11A</b>

**Contactors**

If used, two contactors per controller are required. (See Figure 3-17.)

10 amp positive-guided contactor 3 N/O, 1 NC	<b>11-BG00-31-D-024</b>
16 amp positive-guided contactor 3 N/O, 1 NC	<b>11-BF16C01-024</b>

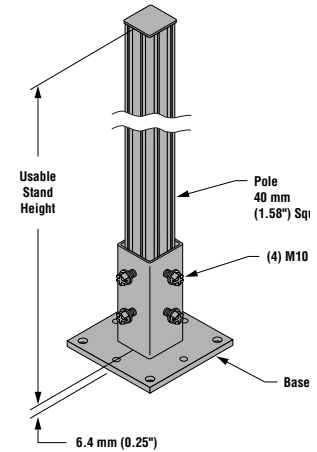
**Muting Module**

Provides muting capability for the EZ-SCREEN System. See Banner manual p/n 63517 for further information.

Muting module (2 OSSD outputs, 2 or 4 muting inputs, USSI, override input)	<b>MM-TA-12B</b>	
Cable to interface EZ-SCREEN Receiver with MM-TA-12B Muting Module – 22Ga, 8-pin Euro-style (M12) female connector to 7-pin Mini-style male connector; double-ended	2.5 m (8') 5 m (15') 8 m (25')	<b>DESE4-508D</b> <b>DESE4-515D</b> <b>DESE4-525D</b>

## MSA Series Stands

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



## Lens Shields

NOTE: The total range decreases by approximately 10% per shield.

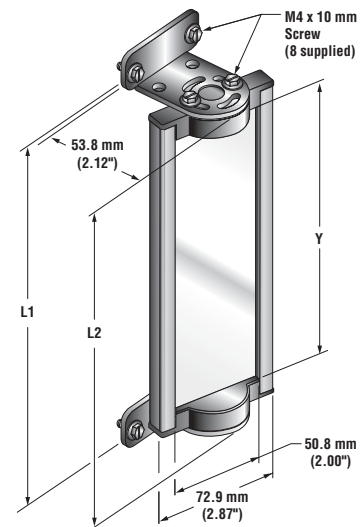
Sensor Defined Area Height	Lens Shield Length	Lens Shield Model Number	Part Number
150 mm	258 mm (10.2")	EZS-150	71452
300 mm	368 mm (14.5")	EZS-300	71453
450 mm	518 mm (20.4")	EZS-450	71454
600 mm	667 mm (26.3")	EZS-600	71455
750 mm	817 mm (32.2")	EZS-750	71456
900 mm	967 mm (38.1")	EZS-900	71457
1050 mm	1116 mm (43.9")	EZS-1050	71458
1200 mm	1266 mm (49.8")	EZS-1200	71459
1350 mm	1416 mm (55.7")	EZS-1350	71460
1500 mm	1565 mm (61.6")	EZS-1500	71461
1650 mm	1715 mm (67.5")	EZS-1650	71462
1800 mm	1865 mm (73.4")	EZS-1800	71463

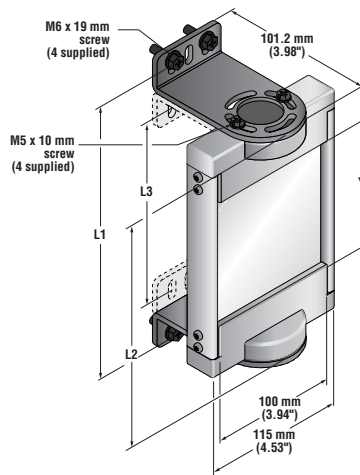


## MSM Series Corner Mirrors

NOTE: The total sensing range decreases by approximately 8% per mirror.

Sensor Length	Reflective Area Y	Mounting L1	Height L2	Mirror Model	Part Number
267 mm (10.5")	267 mm (10.5")	323 mm (12.7")	292 mm (11.5")	MSM8A	43163
356 mm (14")	356 mm (14")	411 mm (16.2")	381 mm (15")	MSM12A	43164
559 mm (22")	559 mm (22")	615 mm (24.2")	584 mm (23")	MSM20A	43166
660 mm (26")	660 mm (26")	716 mm (28.2")	686 mm (27")	MSM24A	43167
864 mm (34")	864 mm (34")	919 mm (36.2")	889 mm (35")	MSM32A	43169
965 mm (38")	965 mm (38")	1021 mm (40.2")	991 mm (39")	MSM36A	43170
1168 mm (46")	1168 mm (46")	1224 mm (48.2")	1194 mm (47")	MSM44A	43172
1270 mm (50")	1270 mm (50")	1326 mm (52.2")	1295 mm (51")	MSM48A	43173






Note: Brackets may be inverted from the positions shown above, decreasing dimension L1 by 58 mm (2.3").

### SSM Series Corner Mirrors

- Rear-surface glass mirrors rated at 85% efficiency for the guarding of multi-sided applications with one emitter/receiver pair.
- Robust construction, two mounting brackets and hardware included.
- EZA-MBK-2 adapter bracket is required for use with MSA Series stand, see page 9.
- See the specific mirror data sheet or the Banner Safety catalog for further information.
- Stainless steel reflective surface models also available. See data sheet 67200.

Defined Area Length	Mirror Model	Reflective Area Y	Mounting Height L1	Overall Height L2
150 mm (5.9")	<b>SSM-200</b>	200 mm (7.9")	278 mm (10.9")	311 mm (12.2")
300 mm (11.8")	<b>SSM-375</b>	375 mm (14.8")	486 mm (19.1")	453 mm (17.8")
450 mm (17.7")	<b>SSM-550</b>	550 mm (21.7")	661 mm (26.0")	628 mm (24.7")
600 mm (23.6")	<b>SSM-675</b>	675 mm (26.6")	786 mm (31.0")	753 mm (29.6")
750 mm (29.5")	<b>SSM-825</b>	825 mm (32.5")	936 mm (36.9")	903 mm (35.6")
900 mm (35.4")	<b>SSM-975</b>	975 mm (38.4")	1086 mm (42.8")	1053 mm (41.5")
1050 mm (41.3")	<b>SSM-1100</b>	1100 mm (43.3")	1211 mm (47.7")	1178 mm (46.4")
1200 mm (47.2")	<b>SSM-1275</b>	1275 mm (50.2")	1386 mm (54.6")	1353 mm (53.3")
1350 mm (53.1")	<b>SSM-1400</b>	1400 mm (55.1")	1511 mm (59.5")	1478 mm (58.2")
1500 mm (59.0")	<b>SSM-1550</b>	1550 mm (61.0")	1661 mm (65.4")	1628 mm (64.1")
1650 mm (65.0")	<b>SSM-1750</b>	1750 mm (68.9")	1861 mm (73.3")	1828 mm (72.0")
1800 mm (70.9")	<b>SSM-1900</b>	1900 mm (74.8")	2011 mm (79.2")	1978 mm (77.9")

### Accessory Mounting Brackets

Model		Part Number	Description
<b>EZA-MBK-13</b>		71757	Retrofit for Sick C4000, AB SafeShield/GuardShield, Omron FS3N, STI MC42/47
<b>EZA-MBK-14</b>		71758	Retrofit for STI MS4300
<b>EZA-MBK-8</b>		62771	Retrofit for Sick FGS and Leuze L-bracket
<b>EZA-MBK-15</b>		71759	Retrofit for STI MS46/47, Keyence PJ-V, SUNX SF4-AH

## Alignment Aids

Description	Model Number	Part Number
Self-contained visible-beam laser tool for aligning any EZ-SCREEN emitter/receiver pair. Includes retroreflective target material and mounting clip.	LAT-1-SS	71445
Clip-on retroreflective LAT target	EZA-LAT-2	71446
2" retroreflective tape, 100'	BRT-THG-2-100	26620
Beam Tracker	BT-1	26809



## 2.4 Replacement Parts

Description	Model Number	Part Number
Keyed reset switch	MGA-KSO-1	30140
Replacement key	MGA-K-1	28513
Polycarbonate access cover for emitter	EZA-ADE-1	71447
Polycarbonate access cover for receiver	EZA-ADR-1	71448
Access cover tamper-proof plate (includes 2 screws and wrench)	EZA-TP-1	71449
Specified test piece, 14 mm (for 14 mm resolution systems)	STP-13	71929
Specified test piece, 30 mm (for 14 mm resolution systems with 2-beam Reduced Resolution and for 30 mm resolution systems)	STP-14	71930
Specified test piece, 60 mm (for 30 mm resolution systems with 2-beam Reduced Resolution)	STP-15	71931
Standard bracket kit with hardware (2 end brackets)	EZA-MBK-11	71470
Center bracket kit (1 bracket), and retrofit for SICK and Leuze Swivel	EZA-MBK-12	71756
Mirror bracket kit	SMA-MBK-1	61933

## 2.5 Literature

The following documentation is supplied with each EZ-SCREEN receiver. Additional copies are available at no charge.

Description	Part Number
EZ-SCREEN System Instruction Manual	112852
Checkout Procedure Card (Daily)	113361
Checkout Procedure Card (Semi-Annual)	113362
Diagnostic Display Label	114189

## 2.6 Specifications

<b>Supply Voltage (V in)*</b>	24V dc $\pm 15\%$ , 10% maximum ripple <b>Emitter:</b> 100 mA max. <b>Receiver:</b> 275 mA max., exclusive of OSSD1 and OSSD2 loads (up to an additional 0.5A each)
<b>Short Circuit Protection</b>	All inputs and outputs are protected from short circuits to +24V dc or dc common
<b>Response Time</b>	Dependent on number of sensing beams (see Section 2.1 for models and number of beams): 10 beams – 9 ms      60 beams – 19 ms      110 beams – 30 ms 20 beams – 11 ms      70 beams – 21 ms      120 beams – 32 ms 30 beams – 13 ms      80 beams – 23 ms      140 beams – 36 ms 40 beams – 15 ms      90 beams – 25 ms      160 beams – 40 ms 50 beams – 17 ms      100 beams – 27 ms
<b>Safety Rating</b>	Type 4 per IEC 61496-1, -2; Category 4 per ISO 13849-1 (EN 954-1)
<b>EDM Input</b>	+24V dc signals from external device contacts can be monitored (one-channel, two-channel or no monitoring) via EDM1 and EDM2 terminals in the receiver (see Section 3.5.2). Monitored devices must respond within 200 milliseconds of an output change.
<b>Reset Input</b>	The Reset input must be high (10 to 30V dc at 30 mA) for 0.25 to 2 seconds and then low (less than 3V dc) to reset the receiver
<b>Remote Test Input</b>	TEST mode is activated either by applying a low signal (less than 3V dc) to emitter TEST #1 terminal for a minimum of 50 milliseconds, or by opening a switch connected between TEST #1 and TEST #2 terminals for a minimum of 50 milliseconds. Beam scanning stops to simulate a Blocked condition. A high signal (10 to 30V dc, 35 mA inrush, 10 mA max.) at TEST #1 terminal de-activates TEST mode and allows the emitter to operate normally. (See Section 3.5.6 for more information.)
<b>Outputs</b> (See warnings on page 29.)	Two redundant solid-state 24V dc, 0.5 A max. sourcing OSSD (Output Signal Switching Device) safety outputs. (Use optional interface modules for ac or larger dc loads.) Capable of the Banner “Safety Handshake” (see Section 1.1). <b>ON-State voltage:</b> $\geq V_{in} - 1.5V$ dc <b>OFF-State voltage:</b> 1.2V dc max. <b>Max. load resistance:</b> 1000 ohm <b>Max. load capacitance:</b> 0.1 $\mu F$
<b>Controls and Adjustments</b>	<b>Emitter:</b> <b>Scan Code selection:</b> 2-position switch (code 1 or 2). Factory default position is code 1. <b>Receiver:</b> <b>Scan Code selection:</b> 2-position switch (code 1 or 2). Factory default position is code 1. <b>Trip/Latch Output selection:</b> Redundant switches. Factory default position is T (Trip). <b>EDM/MPCE monitor selection:</b> 2-position switch selects between 1- or 2-channel monitoring. Factory default position is 2. <b>Reduced Resolution:</b> Redundant switches. Factory default is OFF.
<b>Emitter/Receiver Operating Range</b>	<b>14 mm models:</b> 0.1 m to 6 m (4" to 20') <b>30 mm models:</b> 0.1 m to 18 m (4" to 60') Range decreases with use of mirrors and/or lens shields: <b>Lens shields</b> – approximately 10% less range per shield. <b>Glass-surface mirrors</b> – approximately 8% less range per mirror. See the specific mirror data sheet or the Banner Safety Catalog for further information.
<b>Ambient Light Immunity</b>	> 10,000 lux at 5° angle of incidence
<b>Strobe Light Immunity</b>	Totally immune to one Federal Signal Corp. “Fireball” model FB2PST strobe
<b>Emitter Elements</b>	Infrared LEDs, 950 nm at peak emission
<b>Effective Aperture Angle (EAA)</b>	Meets Type 4 requirements per IEC 61496-2, Section 5.2.9 $\pm 2.5^\circ$ @ 3 m

\*The external voltage supply must be capable of buffering brief mains interruptions of 20 ms, as specified in IEC/EN 60204-1.



### 2.6 Specifications (continued)

<b>Enclosure</b>	<b>Size:</b> See Figure 2-2 <b>Materials:</b> Extruded aluminum housings with yellow polyester powder finish and well-sealed, rugged die-cast zinc end caps, acrylic lens cover, polycarbonate access door <b>Rating:</b> IEC IP65
<b>Operating Conditions</b>	<b>Temperature:</b> 0° to +50° C (+32° to 122°F) <b>Max. Relative Humidity:</b> 95% maximum relative humidity (non-condensing)
<b>Shock and Vibration</b>	EZ-SCREEN systems have passed vibration and shock tests according to IEC 61496-1. This includes vibration (10 cycles) of 10-55 Hz at 0.35 mm (0.014") single amplitude (0.70 mm peak-to-peak) and shock of 10 g for 16 milliseconds (6,000 cycles).
<b>Status Indicators</b>	<b>Emitter:</b> <b>One bi-color (red/green) Status indicator</b> – indicates operating mode (RUN or TEST), Lockout or power OFF condition <b>7-Segment Diagnostic Indicator (1 digit)</b> – indicates proper operation, scan code or error code <b>Receiver:</b> <b>Yellow Reset Indicator</b> – indicates whether system is ready for operation or requires a reset <b>Bi-Color (Red/Green) Status Indicator</b> – indicates general system and output status <b>Bi-Color (Red/Green) Zone Status Indicators</b> – indicates condition (clear or blocked beam) of a defined group of beams <b>7-Segment Diagnostic Indicator (3 digits)</b> – indicates proper operation, scan code or error code, total number of blocked beams See Figure 1-4 for indicator locations and Section 4.4 for indicator conditions.
<b>Mounting Hardware</b>	Emitter and receiver each are supplied with a pair of swivel end-mounting brackets. Models longer than 900 mm also include a swivel center-mount bracket. Mounting brackets are 8-gauge cold-rolled steel, black zinc finish.
<b>Cables and Connections</b>	See Section 2.2 for recommended QD cables. If other cables are used with this System, the user must verify suitability of these cables for each application.
<b>Certifications</b>	Approvals are pending; contact factory for further information.

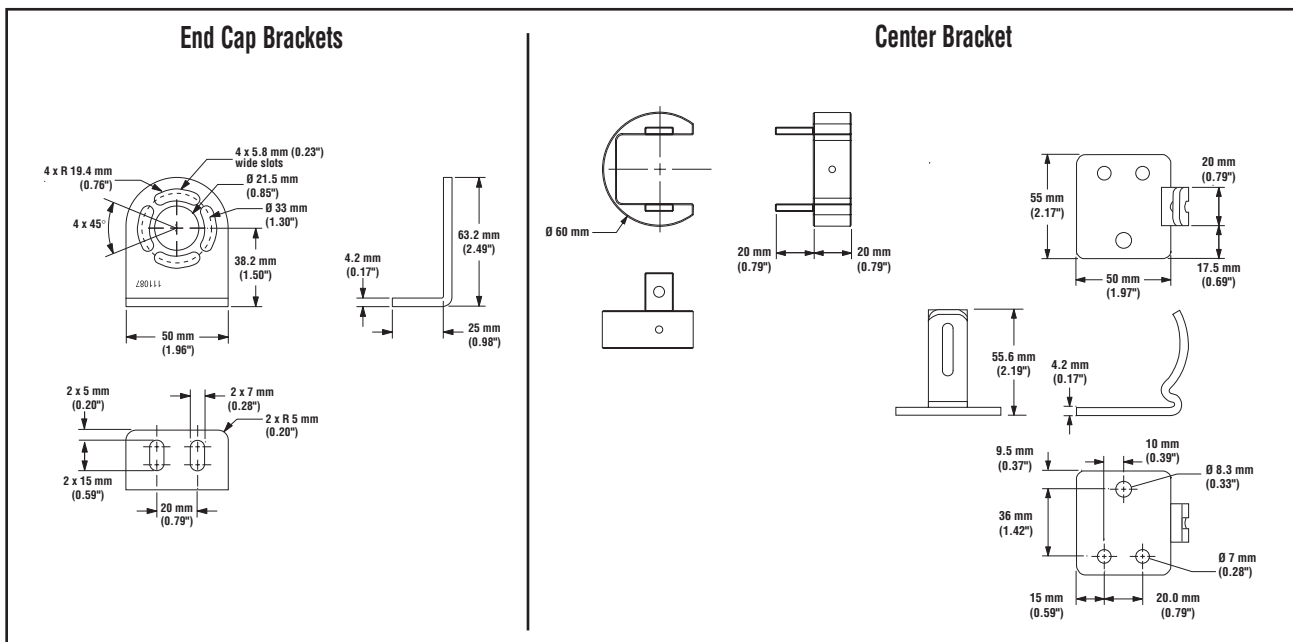
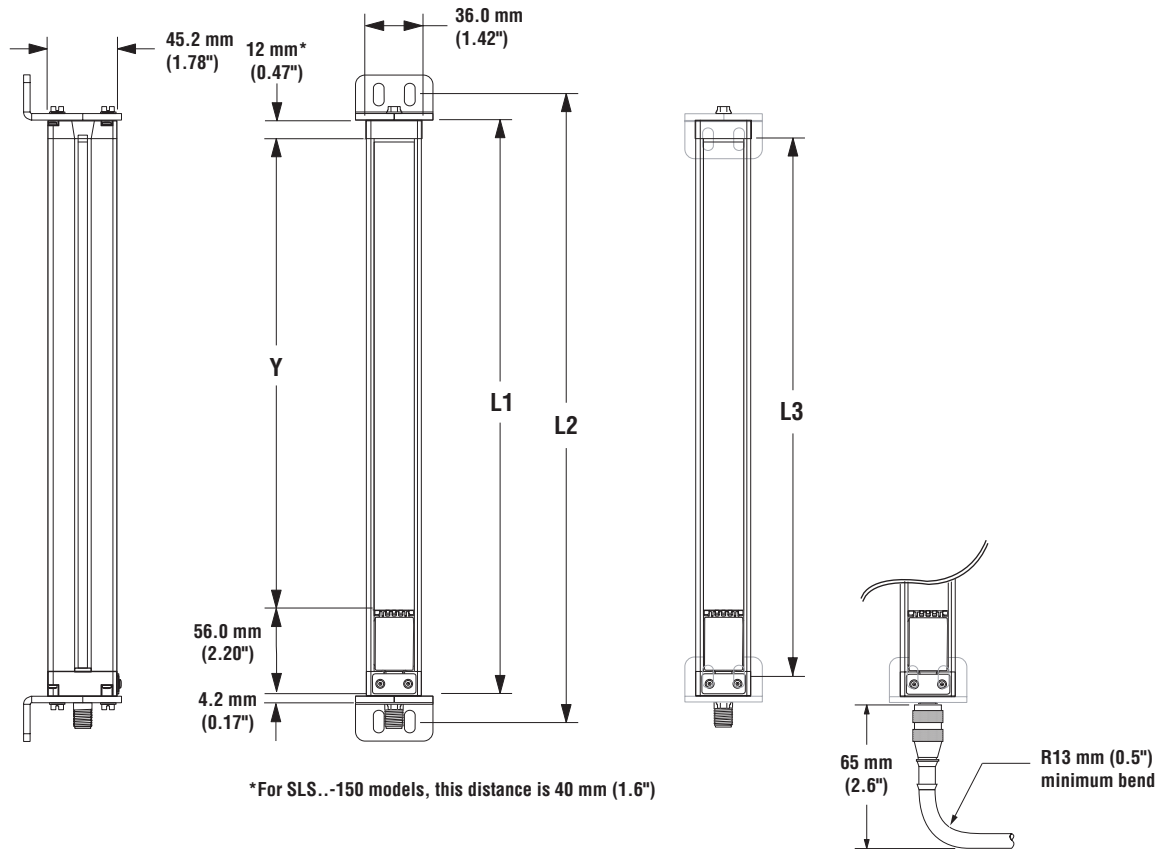


Figure 2-1. Emitter and receiver mounting bracket dimensions



Emitter or Receiver Model	Housing Length L1	Distance Between Bracket Holes L2 L3		Defined Area <sup>†</sup> Y
SLS...-150	262 mm (10.3")	295 mm (11.6")	237 mm (9.3")	150 mm (5.9")
SLS...-300	372 mm (14.6")	405 mm (16.0")	347 mm (13.7")	300 mm (11.8")
SLS...-450	522 mm (20.6")	555 mm (21.9")	497 mm (19.6")	450 mm (17.7")
SLS...-600	671 mm (26.4")	704 mm (27.7")	646 mm (25.4")	600 mm (23.6")
SLS...-750	821 mm (32.3")	854 mm (33.6")	796 mm (31.3")	750 mm (29.5")
SLS...-900	971 mm (38.2")	1004 mm (39.5")	946 mm (37.2")	900 mm (35.4")
SLS...-1050	1120 mm (44.1")	1153 mm (45.4")	1095 mm (43.1")	1050 mm (41.3")
SLS...-1200	1270 mm (50.0")	1303 mm (51.3")	1245 mm (49.0")	1200 mm (47.2")
SLS...-1350	1420 mm (55.9")	1453 mm (57.2")	1395 mm (54.9")	1350 mm (53.1")
SLS...-1500	1569 mm (61.8")	1602 mm (63.1")	1544 mm (60.8")	1500 mm (59.1")
SLS...-1650	1719 mm (67.7")	1752 mm (69.0")	1694 mm (66.7")	1650 mm (65.0")
SLS...-1800	1869 mm (73.6")	1902 mm (74.9")	1844 mm (72.6")	1800 mm (70.9")

<sup>†</sup>Nominal measurement

Figure 2-2. Emitter and receiver mounting dimensions and location of defined area

## 3. Installation and Alignment

Before installing the EZ-SCREEN System, read **Section 1.2 and Section 3 of this manual in their entirety**. The System's ability to perform its safety guarding function depends upon the appropriateness of the application and upon its proper mechanical and electrical installation and interfacing to the guarded machine. If all mounting, installation, interfacing, and checkout procedures are not followed properly, the System cannot provide the protection for which it was designed. Installation must be performed by a Qualified Person, as defined in Section 4.1. See Warning below.



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

The user is responsible for satisfying all local, state, and national codes and regulations relating to the installation and use of this control system in any particular application. Take extreme care to meet all legal requirements and follow all technical installation and maintenance instructions contained in this manual.

**The user has the sole responsibility to ensure that the EZ-SCREEN System is installed and interfaced to the guarded machine by Qualified Persons in accordance with this manual and with applicable safety regulations.**

Read Section 1.2 and all of Section 3 of this manual carefully before installing the system. **Failure to follow these instructions could result in serious bodily injury or death.**

### 3.1 Mechanical Installation Considerations

The two factors that influence the layout of the EZ-SCREEN System's mechanical installation the most are separation distance and hard guarding. Other considerations include emitter and receiver orientation, adjacent reflective surfaces, use of corner mirrors, and installation of multiple EZ-SCREEN Systems.



### **WARNING . . . Position Components Carefully**

The emitter and receiver must be positioned such that the hazard can not be accessed by reaching over, under, around or through the sensing field. Additional guarding may be required; see Separation Distance, Section 3.1.1, and Pass-Through Hazards, Section 3.1.2, and Supplemental Safeguarding, Section 3.1.3.

#### 3.1.1 Separation Distance (Safety Distance)

Minimum Separation Distance ( $D_s$ ) is the minimum distance required between the defined area and the closest reachable hazard point. Separation distance is calculated so that when an object or a person is detected (by blocking a sensing beam), the EZ-SCREEN System will send a stop signal to the machine, causing it to stop by the time the person can reach any machine hazard point.

Calculation of separation distance takes into account several factors, including a calculated human speed, the total system stopping time (which itself has several components), and the depth penetration factor. **After the separation distance ( $D_s$ ) is determined, record the calculated distance on the Daily Checkout Card.**



### **WARNING . . . Proper Separation Distance**

Banner EZ-SCREEN System emitters and receivers must be mounted at a distance from the nearest hazard such that an individual cannot reach the hazard before cessation of hazardous motion or situation. **Failure to establish and maintain the minimum separation distance could result in serious bodily injury or death.**

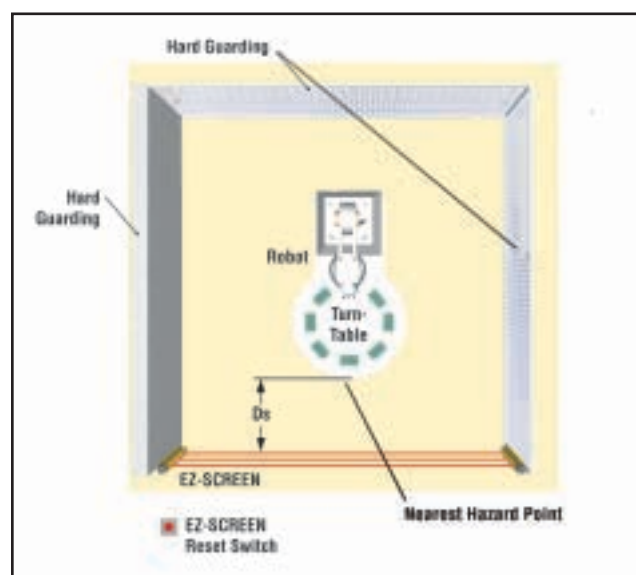


Figure 3-1. Separation distance and hard guarding

The formula used for U.S. applications (other standards may apply) to calculate separation distance is:

$$Ds = K \times (Ts + Tr) + Dpf$$

where:

- Ds** – the separation distance, in mm (inches);
- K** – 1600 mm per second (or 63" per second), the OSHA1910.217, ANSI B11, ANSI/RIA R15.06 recommended hand-speed constant (See Note 1);
- Ts** – the overall stop time of the machine (in seconds) from the initial "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 and Warning at right).
- Tr** – the maximum response time, in seconds, of the EZ-SCREEN System (see Section 2.1); and
- Dpf** – the added distance due to depth penetration factor as prescribed in OSHA1910.217, ANSI B11, ANSI/RIA R15.06 for U.S. applications (See Caution below):

Reduced Resolution	Depth Penetration Factor (Dpf)	
	14 mm Systems	30 mm Systems
OFF	24 mm (1")	78 mm (3")
ON	78 mm (3")	180 mm (7")

#### NOTES:

1. The OSHA-recommended hand speed constant K has been determined by various studies, and although these studies indicate speeds of 63"/second to more than 100"/second, they are not conclusive determinations. Consider all factors, including the physical ability of the operator, when determining the value of K to be used.
2. Ts is usually measured by a stop-time measuring device. If the machine manufacturer's specified stop time is used, at least 20% should be added to allow for possible clutch/brake system deterioration. This measurement must take into account the slower of the two MPCE channels, and the response time of all devices or controls that react to stop the machine. See Notice Regarding MPCEs. **If all devices are not included, the calculated separation distance (Ds) will be too short and serious injury could result.**



#### CAUTION . . . Proper Installation When Using Reduced Resolution

Reduced Resolution increases Dpf (see values in table). **Increase the depth penetration factor to calculate the proper separation distance whenever Reduced Resolution is used.** Always turn Reduced Resolution OFF when the larger minimum object detection size is not required.



#### WARNING . . . Determine Correct Stop Time

**Stop time (Ts) 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 (Ds) will be too short. This can lead to serious bodily injury or death. **Be sure to include the stop time of all relevant devices and controls in your calculations.**

#### Notice Regarding MPCEs

Each of the two Machine Primary Control Elements (MPCE 1 and MPCE2) 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 (Ts, used to calculate the separation distance) must take into account the slower of the two channels.

This example shows how to use the formula at left to calculate separation (safety) distance (Ds). These numbers will be used for the variables in the formula:

- K** = 63" per second (the hand speed constant set by OSHA)
- Ts** = 0.250 second (the total stop time of the example machine, specified by machine manufacturer)
- Tr** = 0.023 second (the specified response time of an SLSP14-600 EZ-SCREEN System)

Our example uses a 600 mm system with 14 mm resolution and two-beam Reduced Resolution, so Dpf is 3". Response time for this example is 0.023 second.

Substitute the numbers into the formula as follows:

$$Ds = K \times (Ts + Tr) + Dpf$$

$$Ds = 63 \times (0.250 \times 1.2^* + 0.023) + 3 = 23.5"$$

In this example, the EZ-SCREEN emitter and receiver must be mounted so that no part of the defined area will be closer than 23.5" to the closest reachable hazard point on the guarded machine.

\*20% safety factor (see NOTE 2)

Figure 3-2. Separation Distance (Ds) calculation example

## 3.1.2 Pass-Through Hazards

A “pass-through hazard” is associated with applications where personnel may pass through a safeguard (which issues a stop command to remove the hazard), and then continues into the guarded area, such as in perimeter guarding. Subsequently, their presence is no longer detected, and the related danger becomes the unexpected start or restart of the machine while personnel are within the guarded area.

In the use of safety light screens, a pass-through hazard typically results from large separation 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 75 mm (3") between the defined area and the machine frame or hard guarding.

### Reducing or Eliminating Pass-Through Hazards

Eliminate or reduce pass-through hazards whenever possible. While it is recommended to eliminate the pass-through hazard altogether, this may not be possible due to machine layout, machine capabilities, or other application considerations.

One solution is to ensure that personnel are continually sensed while within the hazardous area. This can be accomplished by using supplemental safeguarding, such as described by the ANSI B11 series of safety requirements or other appropriate standards (see Section 3.1.4).

An alternate method is to ensure that once the safeguarding device is tripped it will latch, and will require a deliberate manual action to reset. This method of 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.



### WARNING . . . Use of EZ-SCREEN Systems for Perimeter Guarding

If an EZ-SCREEN System is installed in an application that results in a pass-through hazard (e.g., perimeter guarding), either the EZ-SCREEN System or the Machine Primary Control Elements (MPCEs) of the guarded machine must cause a Latched response following an interruption of the defined area.

The reset of this Latched condition may only be achieved by actuating a reset switch that is separate from the normal means of machine cycle initiation. The switch must be positioned as described in Section 3.1.3.

Additional safeguarding, as described by ANSI B11 safety requirements or other appropriate standards, must be used if a pass-through hazard can not be eliminated or reduced to an acceptable level of risk. **Failure to observe this warning could result in serious bodily injury or death.**

## 3.1.3 Reset Switch Location

**The reset switch must be mounted at a location that complies with the warning below.**

A key-actuated reset switch provides some operator or supervisory control, as the key can be removed from the switch 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 guarded area unnoticed.

### Resetting a safeguard must not initiate hazardous motion.

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



### WARNING . . . Reset Switch Location

**All reset switches must be:**

- Outside the guarded area,
- Located to allow the switch operator full, unobstructed view of the entire guarded area while the reset is performed,
- Out of reach from within the guarded area, and
- Protected against unauthorized or inadvertent operation (such as through the use of rings or guards).

If any areas within the guarded area are **not visible** from the reset switch, **additional safeguarding must be provided**, as described by the ANSI B11 series or other appropriate standards. **Failure to do so could result in serious injury or death.**

## 3.1.4 Supplemental Safeguarding

As described in Section 3.1.1, the EZ-SCREEN System must be properly positioned such that an individual can not reach through the defined area and access the hazard.

Additionally, the hazard can not be accessible by reaching around, under, or over the defined area. To accomplish this, supplemental guarding (mechanical barriers, such as screens or bars), as described by ANSI B11 safety requirements or other appropriate standards, must be installed. Access will then be possible only through the defined area of the EZ-SCREEN System or through other safeguarding that prevents access to the hazard (see Figure 3-3).

The mechanical barriers used for this purpose are typically called “hard guarding”; there must be no gaps between the hard guarding and the defined area. Any openings in the hard guarding must comply with the safe opening requirements of ANSI B11 or other appropriate standard.





**WARNING . . . The Hazard Must Be Accessible Only through the Defined Area**

The installation of the EZ-SCREEN System must prevent any individual from reaching around, under, over or through the defined area and into the hazard without being detected. Mechanical barriers (e.g., hard guarding) or supplemental safeguarding may be required to comply with this requirement, and is described by ANSI B11 safety requirements or other appropriate standards.

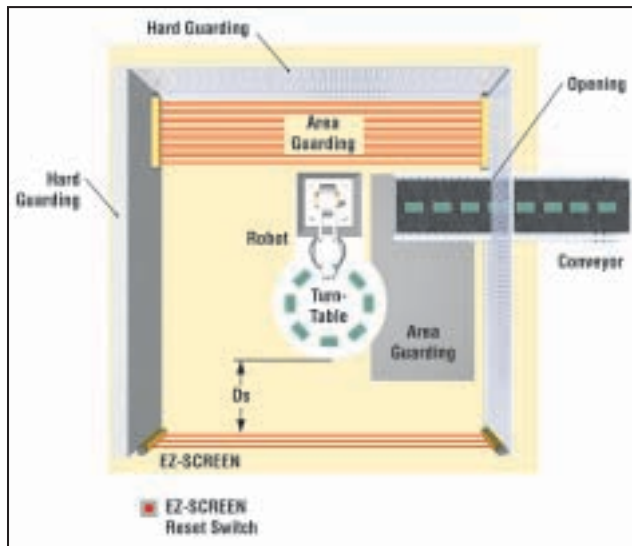


Figure 3-3. An example of supplemental safeguarding

Figure 3-3 shows an example of supplemental safeguarding inside a robotic work cell. The EZ-SCREEN, in conjunction with the hard guarding, is the primary safeguard. Supplemental safeguarding (such as a horizontal-mounted safety light screen as an area guard) is required in areas that can not be viewed from the reset switch (i.e., behind the robot and the conveyor). Additional supplemental safeguarding may be required to prevent clearance or trapping hazards (e.g., the safety mat as an area guard between the robot, the turntable, and the conveyor).



**WARNING . . . Proper Orientation of System Emitters and Receivers**

EZ-SCREEN System emitters and receivers must be installed with their corresponding cabled ends pointing in the same direction (e.g., both cabled ends “up”). Failure to orient them properly will impair the performance of the EZ-SCREEN System and will result in incomplete guarding, and could result in serious bodily injury or death.

### 3.1.5 Emitter and Receiver Orientation

The emitter and receiver must be mounted parallel to each other and aligned in a common plane, with both cable ends pointing in the same direction. **Never mount the emitter with its cable end oriented opposite the cable end of the receiver.** If this occurs, voids in the light screen may allow objects or personnel to pass through the defined area undetected (see Figure 3-4).

The emitter and receiver may be oriented in a vertical or horizontal plane, or at any angle between horizontal and vertical, as long as they are parallel and their cable ends point in the same direction. Verify that the light screen completely covers all access to the hazard point that is not already protected by hard guarding or other supplemental guarding.

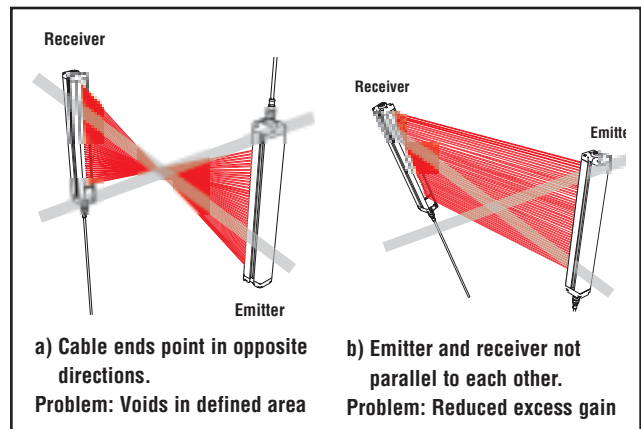


Figure 3-4. Examples of incorrect emitter / receiver orientation

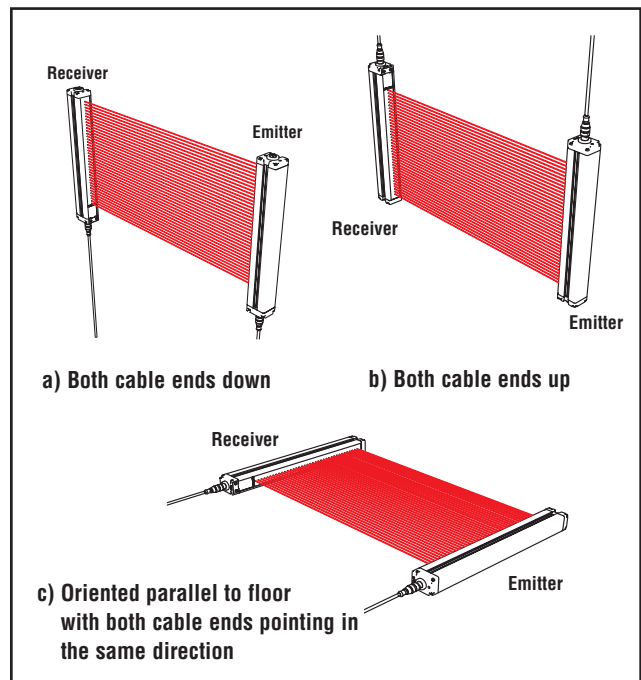


Figure 3-5. Examples of correct emitter / receiver orientation

## 3.1.6 Adjacent Reflective Surfaces

A reflective surface located adjacent to the defined area may deflect one or more beams around an object in the defined area. In the worst case, an “optical short circuit” may occur, allowing an object to pass undetected through the defined area (see Figure 3-6).

This reflective surface may result from shiny surfaces or glossy paint on the machine, the workpiece, the work surface, the floor or the walls. Beams deflected by reflective surfaces are discovered by performing the trip test portion of the final alignment procedure and the periodic checkout procedures (Section 3.4.3).

**To eliminate problem reflections:**

- **If possible, relocate the sensors** to move the beams away from the reflective surface(s), being careful to maintain adequate separation distance (see Figure 3-6).
- **Otherwise, if possible, paint, mask or roughen** the shiny surface to reduce its reflectivity.
- **Where these are not possible (as with a shiny workpiece),** mount the sensors in such a way that the receiver's field of view and/or the emitter's spread of light are restricted.
- **Repeat 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 defined area, perform the trip test with the workpiece in place.



### WARNING . . . Avoid Installation Near Reflective Surfaces

Avoid locating the defined area near a reflective surface; it could reflect sensing beam(s) around an object or person within the defined area, and prevent its detection by the EZ-SCREEN System. Perform the trip test, as described in Section 3.4.3, to detect such reflection(s) and the resultant optical short circuit.

**Failure to prevent reflection problems will result in incomplete guarding and could result in serious bodily injury or death.**

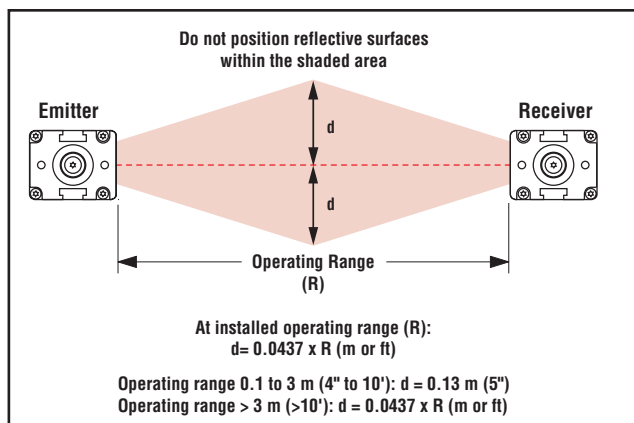


Figure 3-6. Adjacent reflective surfaces

## 3.1.7 Use of Corner Mirrors

EZ-SCREEN Systems may be used with one or more corner mirrors (see Section 2.3). The use of glass-surface corner mirrors reduces the maximum specified emitter/receiver separation by approximately 8 percent per mirror, as follows:

SSM Series Glass-Surface Mirrors – Maximum Emitter and Receiver Separation				
Sensor Models	Number of Corner Mirrors			
	1	2	3	4
14 mm Resolution Models 6 m (20') Range	5.5 m (18')	5.1 m (17')	4.7 m (15.5')	4.3 m (14')
30 mm Resolution Models 18 m (60') Range	16.6 m (54.5')	15.3 m (50')	14.1 m (46.5')	13 m (43')

See the specific mirror data sheet or the Banner Safety Catalog for further information.



### WARNING . . . Avoid Retroreflective Installation

Do not install emitters and receivers in “retroreflective” mode, with less than a 45° angle of incidence, as shown in Figure 3-7.

**Sensing could be unreliable in this configuration; serious bodily injury or death could result.**

Mirrors are not allowed for applications that would allow personnel undetected access into the safeguarded area.

If mirrors are used, the difference between the angle of incidence from the emitter to the mirror and from the mirror to the receiver must be between 45° and 120° (see Figure 3-7). If placed at a sharper angle, as shown in the example, an object in the light screen may deflect beam(s) to the receiver, preventing the object from being detected (i.e., “false proxing”). Angles greater than 120° result in difficult alignment and possible optical short circuits.

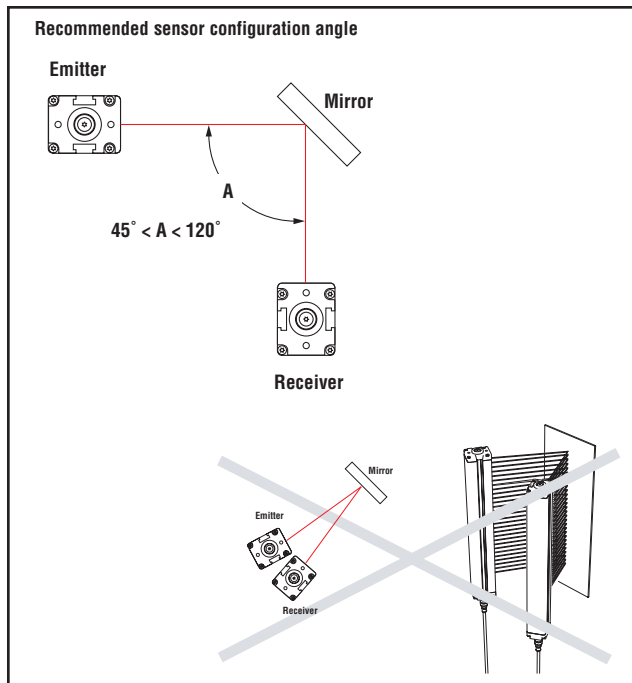


Figure 3-7. Never use EZ-SCREEN sensors in a retroreflective mode.

### 3.1.8 Installation of Multiple Systems

Whenever two or more EZ-SCREEN emitter and receiver pairs are adjacent to one another, optical crosstalk may potentially take place between systems. To minimize optical crosstalk, alternate the positions of emitters and receivers, (see Figure 3-8).

When three or more systems are installed in the same plane (as shown for two pairs in Figure 3-8), optical crosstalk may occur between sensor pairs whose emitter and receiver lenses are oriented in the same direction. In this situation, eliminate optical crosstalk by mounting these sensor pairs exactly in line with each other within one plane, or by adding a mechanical barrier between the pairs.

To further aid in avoiding crosstalk, the sensors feature two selectable Scan Codes. A receiver set to one Scan Code will not “see” an emitter set to another code (see Section 4.2).



#### WARNING . . . Scan Code

In situations where multiple systems are mounted closely together, or where a secondary emitter is in view (within  $\pm 5^\circ$ ), within range of an adjacent receiver; the adjacent systems must be configured for different Scan Codes (i.e., one system set for Scan Code 1 and the other for Scan Code 2).

If not, a receiver may synchronize to the signal from the wrong emitter, reducing the safety function of the light screen.

This situation will be discovered by performing the trip test (see Section 3.4.3).

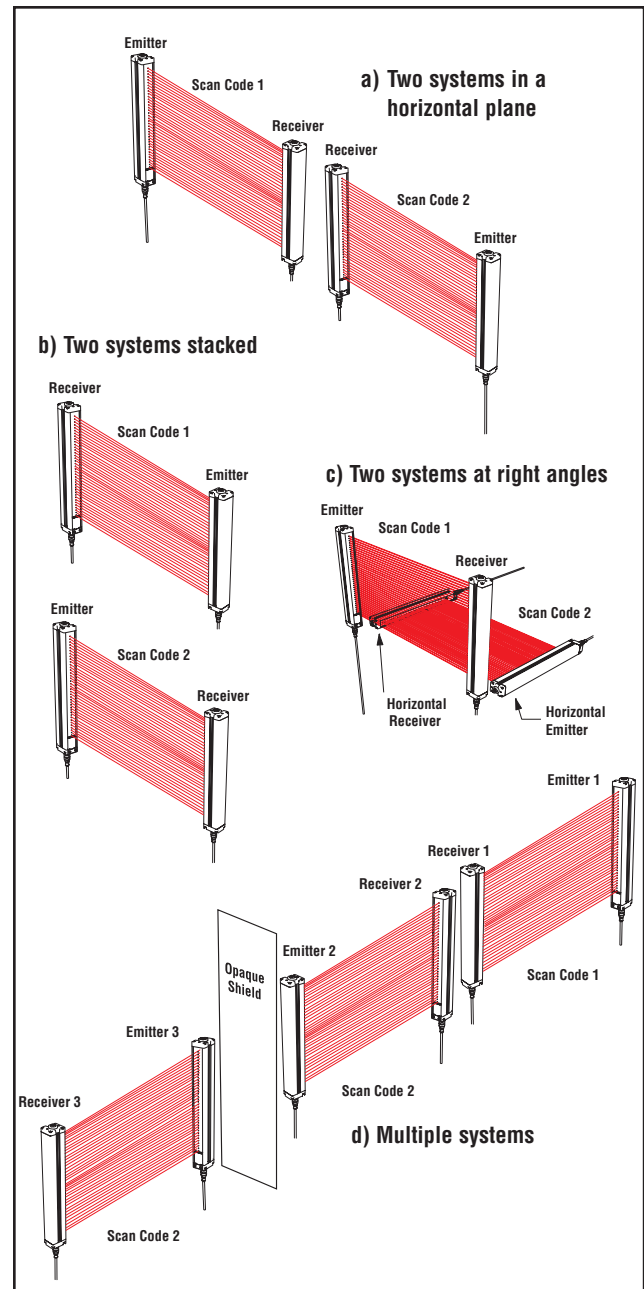


Figure 3-8. Installation of multiple systems; alternate emitters and receivers to avoid optical crosstalk.

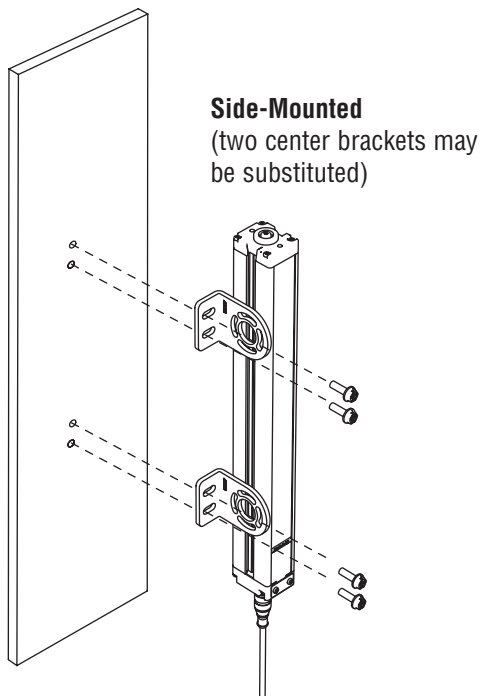
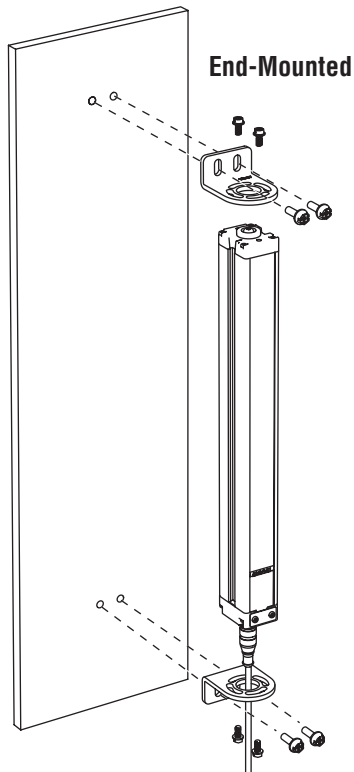


#### WARNING . . . Multiple Pairs of Sensors

Do not connect multiple pairs of sensors to one Interface Module (e.g., IM-T-9A/-11A) or otherwise parallel OSSD outputs.

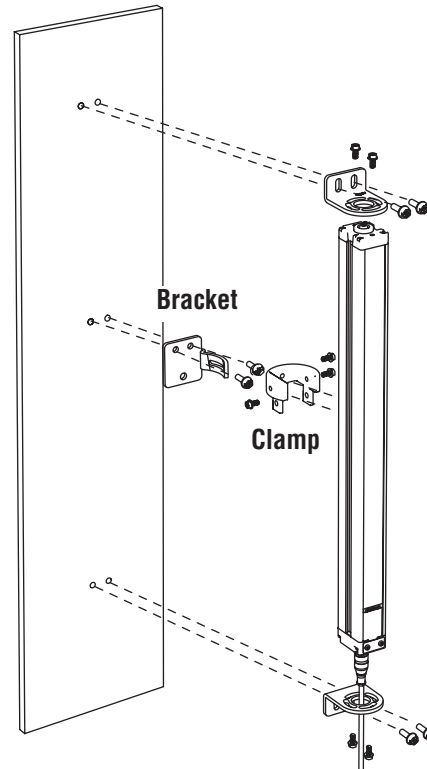
Connection of multiple OSSD safety outputs to a single device can result in serious injury or death, and is prohibited.

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



## Emitters and Receivers over 900 mm long also include swivel center bracket

Sensors are designed to be mounted with up to 900 mm unsupported distance between brackets (see Section 3.2.1).



NOTE: EZ-SCREEN sensor brackets are designed to mount directly to MSA Series stands (Section 2.3), using the hardware supplied with the stands.

Figure 3-9. Emitter and receiver mounting hardware

### 3.2 Mechanical Mounting Procedure

Once the mechanical layout considerations of Section 3.1 are addressed, mount the sensors and route the cables.

#### 3.2.1 Sensor Mounting

Emitter/receiver pairs with 14 mm (0.55") resolution may be spaced from 0.1 m to 6 m (4" to 20') apart. Emitter/receiver pairs with 30 mm (1.18") resolution may be spaced from 0.1 m to 18 m (4" to 60') apart. The maximum distance between an emitter and its receiver is reduced if corner mirrors are used (see Section 3.1.7). The supplied brackets (when mounted to the sensor end caps) allow  $\pm 30^\circ$  rotation.

From a common point of reference (ensuring the minimum separation distance calculated in Section 3.1.1), make measurements to locate the emitter and receiver in the same plane with their midpoints directly opposite each other.

**Important: The connector ends of both sensors must point in the same direction** (see Figure 3-5 and warning, Section 3.1.3). Mount the emitter and receiver mounting brackets (see below) using the supplied M6 bolts and Keps nuts, or user-supplied hardware; see Figure 3-9.

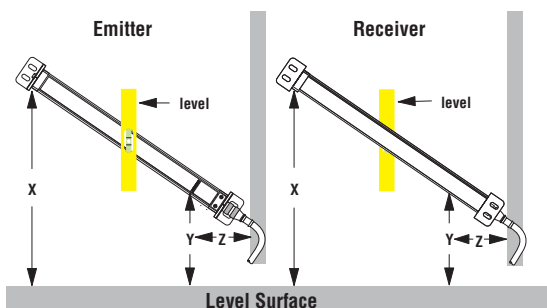
Mount the emitter and receiver in their brackets; position their windows directly facing each other. Measure from a reference plane (e.g., a level building floor) to the same point(s) on the emitter and receiver to verify their mechanical alignment. Use a carpenter's level, a plumb bob, or the optional LAT-1 Laser Alignment Tool (see Section 2.4) or check the diagonal distances between the sensors, to achieve mechanical alignment. Final alignment procedures are explained in Section 3.4.

**Center mounting brackets** must be used with longer sensors, whenever the sensors are subject to shock or vibration. In such situations, the sensors are designed to be mounted with up to 900 mm unsupported distance (between brackets). Sensors longer than 900 mm are supplied with a center bracket to be used as needed with the standard end-cap brackets (see Figure 3-7).

1. Attach the center bracket to the mounting surface when mounting the end-cap brackets.
2. Attach the clamp to both slots of the housing, using the included M5 screws and T-nuts.
3. After the sensor is mounted to the end-cap brackets, attach the clamp to the center bracket using the supplied M5 screw.

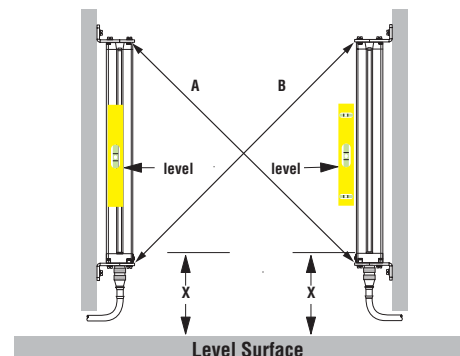
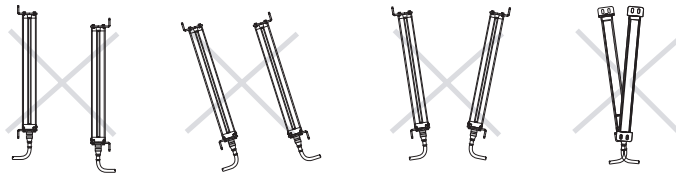
#### Verify that:

- The emitter and receiver are directly opposite each other.
- Nothing is interrupting the defined area.
- The defined area (marked on the sensors) is the same distance from a common reference plane for each sensor.
- The emitter and receiver are in the same plane and are **level/plumb and square** to each other (vertical, horizontal, or inclined at the same angle, and not tilted front-to-back or side-to-side).



#### Angled or Horizontal Installations – verify that:

- Distance X at the emitter and receiver are equal.
- Distance Y at the emitter and receiver are equal.
- Distance Z at the emitter and receiver are equal from parallel surfaces.
- Vertical face (i.e., the lens) is level/plumb.
- Defined area is square. Check diagonal measurements if possible; see Vertical Installations, at right.



#### Vertical Installations – verify that:

- Distance X at the emitter and receiver are equal.
- Both sensors are level/plumb (check both the side and face).
- Defined area is square. Check diagonal measurements if possible (Diagonal A = Diagonal B).

Figure 3-10. Sensor mounting, mechanical alignment



## 3.2.2 Mounting the Reset Switch

Mount the reset switch in a location that complies with the warning in Section 3.1.3. See Section 3.3.2 for electrical connection.

## 3.2.3 Routing Cables

Connect the 5-pin and 8-pin QD connectors and route the sensor cables to the junction box, electrical panel, or other enclosure in which the Interface Module, the redundant mechanically linked interposing relays, FSDs, or other safety-related parts of the control system are located. This must be done per local wiring code for low-voltage dc control cables and may require installation of electrical conduit. See Section 2.2 for selection of Banner-supplied cables.

The EZ-SCREEN System is designed and manufactured to be highly resistant to electrical noise and to operate reliably in industrial settings. However, extreme electrical noise may cause a random Trip or Latch condition; in extreme cases, a Lockout is possible. Emitter and receiver wiring is low voltage; routing the sensor wires alongside power wires, motor/servo wires, or other high-voltage wiring may inject noise into the EZ-SCREEN System. It is good wiring practice (and may be required by code) to isolate emitter and receiver cables from high-voltage wires, avoid routing cables close to “noisy” wiring, and provide a good connection to earth ground.

Sensor QD cabling and any interconnect wiring should meet the following specifications. The wires used should have an insulation temperature rating of at least 90°C (194°F).

Maximum cable length (ft) versus total current draw (including both OSSD loads)						
	0.5A	0.75A	1.0A	1.25A	1.5A	1.75A
18 AWG	375	250	188	148	125	109
20 AWG	240	160	120	95	80	70
22 AWG*	150	100	75	59	50	44

\*QDE-...D cables, see table 2.2

NOTE: Cable length includes power (+24V dc) and return (0V dc) wires at +25°C, and is intended to ensure that adequate power is available to the EZ-SCREEN System when the supply is operating at +24V dc - 15%.



### WARNING . . . Proper Electrical Hookup

Electrical hookup must be made by Qualified Personnel and must comply with NEC (National Electrical Code) and local standards.

**Make no more connections to the EZ-SCREEN System than are described in Sections 3.3.1 through 3.5.3 of this manual.**

**Connection of other wiring or equipment to the EZ-SCREEN System could result in serious bodily injury or death.**

## 3.3 Initial Electrical Connections

Lockout/tagout procedures may be required (refer to OSHA1910.147, ANSI Z244-1, or the appropriate standard for controlling hazardous energy). Following relevant electrical standards and wiring codes, such as the NEC, NFPA79 or IEC60204-1, always connect earth ground (green/yellow wire, see Figures 3-17 through 3-19). **Do not operate the EZ-SCREEN System without an earth ground connection.** See the warning below.

Make the electrical connections in the order described in this section. Do not remove end-caps; no internal connections are to be made. All connections are made through the 5-pin emitter QD and the 8-pin receiver QD (M12 or Euro-style).

NOTE: EZ-SCREEN wiring is low voltage; running these wires alongside power wires, motor/servo wires, or other high-voltage wiring can inject noise into the EZ-SCREEN System. It is good wiring practice (and may be required by code) to isolate EZ-SCREEN System wires from high-voltage wires.

### 3.3.1 Emitter Cable

Locate the black and the white wires at the end of the emitter cable. If Test input will be used, temporarily connect the other ends of the wires to each other (but not to an external contact at this time). If Test input will not be used, tie the black and white wires at the end of the emitter cable together and properly terminate (e.g. terminated with the included wire-nut).

### 3.3.2 Receiver Cable

**All wires will not be connected to the machine control circuits at this time.** For the initial power-up and checkout, NO EDM must be configured. Locate the orange and orange/black wires (pins 2 and 3) and temporarily connect the ends of the wires to each other (but not to the machine at this time). Take precautions to prevent the wires from shorting to ground or to other sources of energy (e.g., terminate with the included wire-nut). Final EDM wiring must be completed later.

Connect the external reset switch to the reset wire (violet) on the receiver cable and to 24V dc (see Figures 3-17, 3-18 and 3-19). See warning in Section 3.1.3 on the physical location of the external reset switch. The reset switch must be a normally open switch that is held closed for approximately 1/4 second, but no longer than 2 seconds, and then re-opened to accomplish the reset. The switch must be capable of switching 10 to 30V dc at 30 mA.

### 3.4 Light Screen Initial Checkout

The initial checkout procedure must be performed by a Qualified Person (see Section 4.1). It must be performed only after configuring the System and after connecting the emitter and receiver per Section 3.3.

#### Configuring the System for Initial Checkout

Verify that Test input is jumpered and the System is set to the factory defaults for initial checkout and optical alignment. (Factory defaults are for Trip Output, 2-Channel EDM, Reduced Resolution OFF, and Scan Code 1. See Figure 4-1.)

The procedure is performed on two occasions:

- To ensure proper installation when the System is first installed, and
- To ensure proper System function whenever any maintenance or modification is performed on the System or on the machinery being guarded by the System. (See Section 6.1 for a schedule of required checkouts.)

For the initial checkout, the EZ-SCREEN System must be checked without power being available to the guarded machine. **Final interface connections to the guarded machine cannot take place until the light screen system has been checked out.** This may require lockout/tagout procedures (refer to OSHA1910.147, ANSI Z244-1, or the appropriate standard for controlling hazardous energy). These connections will be made after the initial checkout procedure has been successfully completed.

#### Verify that:

- Power has been removed from (or is not available to) the guarded machine, its controls or actuators; and
- The machine control circuit or the Interface Module is not connected to the OSSD outputs at this time (permanent connections will be made later); and
- EDM is configured for No Monitoring, per Section 3.3.2.

#### 3.4.1 Initial Power-Up and Optical Alignment

1. **Inspect the area near the light screen for reflective surfaces**, including work pieces and the guarded machine. Reflective surfaces may cause light beams to reflect around a person in the light screen, preventing the person from being detected and not stopping the machine motion. See Section 3.1.6.

**Eliminate the reflective surfaces** as possible by relocating them, painting, masking or roughening them. Remaining problem reflections will become apparent during step 5.

2. **Verify that power is removed from the EZ-SCREEN System and from the guarded machine** and that the OSSD safety outputs are not connected. Remove all obstructions from the light screen.

Leaving power to the guarded machine OFF, make power and earth ground connections on both the emitter and

receiver cables (see Figures 3-16 to 3-19) and then power up the EZ-SCREEN System (only).

**Verify that input power is present to both emitter and receiver.** At least one indicator on both emitter and receiver should be ON and the start-up sequence should cycle.

3. Observe both the emitter and the receiver System Status indicators and the receiver Zone indicators to determine light screen alignment status:

- **A Lockout condition** (emitter or receiver) – the System Status indicator single-flashing Red, and the receiver Zone and Reset indicators OFF. Proceed to Section 5 for diagnostic information.
- **Normal operating mode** (emitter) – the System Status indicator ON Green.
- **TEST mode** (emitter) – a flashing Green System Status indicator (Test input open, see Figure 3-16 and Section 5.2).
- **A Latch condition** (receiver), all optical beams clear – the receiver System Status indicator ON Red and the Reset indicator double-flashing Yellow; Zone indicators ON Green. When the receiver is configured for Latch Output, the outputs are ON only when all beams are clear and after a manual reset (see Section 1.4.7). If a reset routine can cause a Clear (RUN) condition, optimize the alignment as described in step 4. If a Clear (RUN) condition can not be achieved, see “Blocked condition” below.
- **A Clear (RUN) condition** (receiver) – the System Status indicator ON Green (or flashing Green if Reduced Resolution is enabled), and the Reset indicator ON Yellow. All Zone indicators ON Green.

**To optimize alignment and maximize excess gain**, slightly loosen the sensor mounting screws (x4) and rotate one sensor left and right, noting the positions where the Status indicators turn Red (Blocked condition); repeat with the other sensor. Center each sensor between those two positions and tighten the end cap mounting screws, making sure to maintain the positioning as the screws are tightened. The sensor lenses should directly face each other. Proceed to System Configuration (Section 3.4.2) once optimum optical alignment is verified.

- **A Blocked condition** (receiver) is indicated by the System Status indicator ON Red, the yellow Reset indicator ON, and one or more Zone indicator(s) ON Red, identifying the location of the blocked beams, and the number of blocked beams will be displayed. Proceed to step #4.

NOTE: If beam 1 is blocked, Zone indicator 1 will be Red and all others will be OFF, because beam 1 provides the synchronization signal for all the beams.

NOTE: If the Test input is open, the 3-digit Diagnostic Display will indicate the total number of beams in the system (minus one) and all Zone indicators will be Red.

## 4. Optical Alignment

**CAUTION:** Ensure that no individuals are exposed to any hazard if the EZ-SCREEN receiver turns ON the OSSD outputs when the System becomes aligned.

**Verify Sensor Mounting per section 3.2.**

**Verify Optimal Alignment** (Rotational Adjustment with power ON)

a. **Ensure the emitter and receiver are pointed squarely at each other.** A straightedge (e.g., a level) can determine the direction the sensor is facing (see Figure 3-11). The sensor face must be perpendicular to the optical axis.

**NOTE:** At power-up, all indicators are tested (flash), then the Scan Code is displayed.

b. **If Channel #1 beam is not aligned,** the Status and Zone 1 indicators are Red and the Diagnostic Display indicates "CH1". Zone indicators 2-8 will be OFF.

c. **If the Green Status and Yellow Reset indicators are ON,** go to step "d". **If not, rotate each sensor** (one at a time) left and right until the Green Status indicator comes ON. As the sensor rotates out of alignment, the Red Status indicator will come ON steady. As more beams are made, the Zone indicators will turn from Red to Green and the number of blocked beams displayed will decrease.

**NOTE:** If the Emitter's Test input is open, the 7-segment display will indicate the total number of beams (minus one) in the System and all Zone indicators will be Red (except for 10-beam systems, where the Zone 1 indicator will be Green).

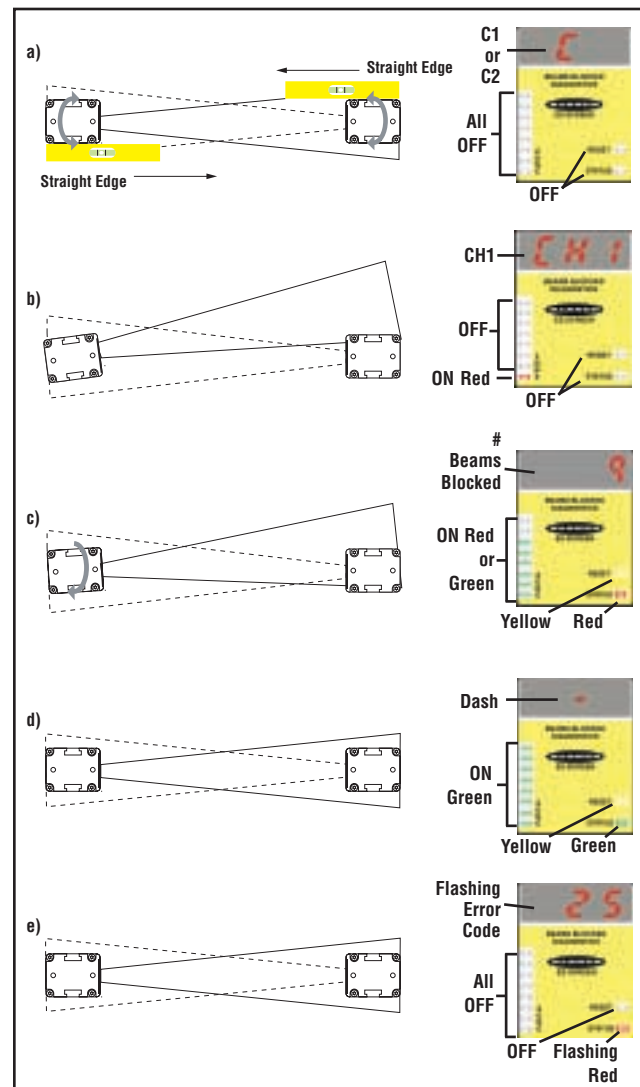
d. **To optimize alignment,** note the position where the Red Status indicator comes ON when the sensor is rotated both left and right. Center the sensor between the two positions, and tighten the end cap mounting screws, making sure the positioning does not drift as the screws are tightened.

For situations where alignment is difficult, a **LAT-1 Laser Alignment Tool** can be used to assist or confirm alignment by providing a visible red dot along the sensor's optical axis (see Figure 3-13).

e. If, at any time, the Red Status indicator begins to flash steadily, the System has entered a Lockout condition. See Section 5.1.1 for further information.

### Optical Alignment Procedure with Mirrors

EZ-SCREEN sensors may be used with one or more corner mirrors for guarding more than one side of an area. The MSM... and SSM... rear-surface glass mirrors are rated at 85% efficiency. Thus, **excess gain and sensing range are reduced when using mirrors; see Section 3.1.7.**



**Figure 3-11. Optimum optical alignment**

In addition to the standard optical alignment procedure, verify (see Figure 3-12):

- That the emitter, receiver, and all mirrors are level and plumb,
- The middle of the defined area and the center point of the mirrors are approximately the same distance from a common reference point, such as the same height above a level floor. Ensure that there are equal amounts of mirror surface above and below the defined area such that the optical beams are not passing below or above the mirror.

During any adjustments, allow only one individual to adjust any one item at any one time.

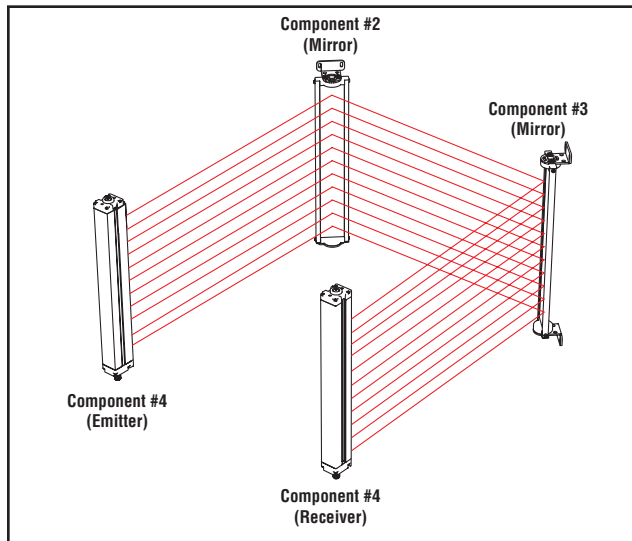


Figure 3-12. Corner mirror alignment

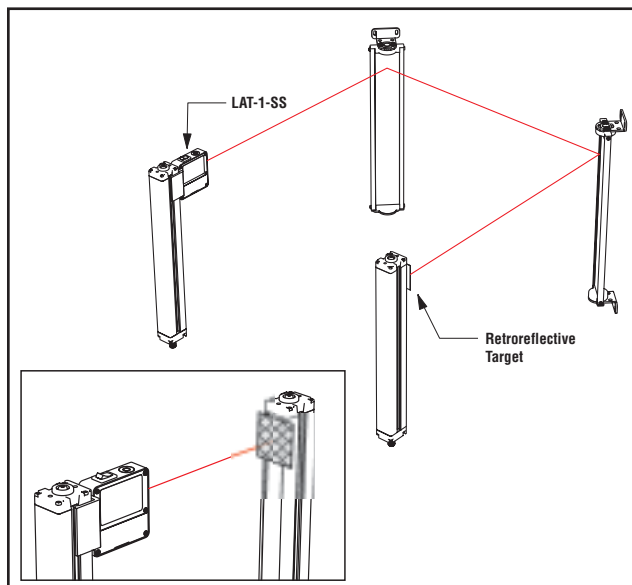


Figure 3-13. Optical alignment using the LAT-1

NOTE: A **LAT-1 Laser Alignment Tool** is very helpful by providing a visible red dot along the optical axis. See Figure 3-13 and Banner Safety Applications Note SA104 (P/N 57477) for further information.

### 3.4.2 Configure Reduced Resolution (Floating Blanking)

Reduced Resolution allows objects of a certain maximum size to interrupt the defined area without causing a Trip condition (i.e., the OSSDs turn OFF). **Use Reduced Resolution only when necessary.** In Reduced Resolution applications, the separation distance always increases due to the larger depth penetration factor (Dpf). In either case see Section 3.1.1 to determine separation distance.

Because it has redundant microprocessors, the receiver has two DIP switch banks (bank A and bank B) which must be set identically (see Section 4.2). Failure to do so will cause a Lockout condition when power is applied. **Power to the EZ-SCREEN receiver should be OFF when changing DIP switch settings or a Lockout will occur.** See Figure 4-1 for DIP switch configuration.

Model	Reduced Resolution Setting	Maximum Size of Undetected Objects	Resulting Resolution
14 mm Resolution	OFF	(Not applicable)	14 mm (0.55")
	ON (2-beam)	8.5 mm (0.34")	30 mm (1.18")
30 mm Resolution	OFF	(Not applicable)	30 mm (1.18")
	ON (2-beam)	17 mm (0.67")	60 mm (2.36")



#### WARNING . . . Use of Reduced Resolution

**Use Reduced Resolution only when necessary.**

Any holes created in the defined area either must be completely filled by the blanked object or the separation distance must be increased to account for the larger resolution (see Section 3.1.1).

## 3.4.3 Trip Test

After optimizing the optical alignment and configuring Reduced Resolution (if applicable), perform the trip test to verify the detection capability of the EZ-SCREEN System. This test will also verify correct sensor orientation (Section 3.1.5), identify optical short circuits (Section 3.1.6), and verify the expected resolution for applications using Reduced Resolution (Section 3.4.2). Once the installation has passed the trip test, the safety outputs may be connected and the commissioning checkout may be performed (initial installations only).

Appropriate Test Pieces for Trip Test		
Reduced Resolution	14 mm MODS Models	30 mm MODS Models
OFF	14 mm (0.55") dia. Model <b>STP-13</b>	30 mm (1.18") dia. Model <b>STP-14</b>
ON (2-beam)	30 mm (1.18") dia. Model <b>STP-14</b>	60 mm (2.36") dia. Model <b>STP-15</b>

1. Select the proper test piece (see table above), supplied with the receiver.
2. Verify that the System is in RUN mode with the Green Status indicator ON (or flashing if Reduced Resolution is enabled), all Zone indicators are Green, and the Yellow Status indicator ON. A manual reset may be required in Latch mode (see Sections 4.2 and 4.3).
3. Pass the specified test piece through the defined area in three paths: near the emitter, near the receiver, and midway between the emitter and receiver (Figure 3-14).
4. During each pass, while the test piece is interrupting the defined area, at least one Zone indicator **must be Red**. The **Red Zone indicator must change with the position of the test piece within the defined area**.
  - **Trip Output Operation:** The Status Indicator must turn Red and remain Red for as long as the test piece remains in the defined area. If not, the installation has failed the trip test.
  - **Latch Output Operation:** The Status indicator must turn Red and remain Red. The Yellow Reset indicator must remain ON steady. If the Reset indicator begins to flash at any time while the test piece is interrupting the defined area, the installation has failed the trip test.

If all Zone indicators turn Green or fail to follow the position of the test piece while it is within the defined area, the installation has failed the trip test. Check for correct sensor orientation, reflective surfaces and unguarded areas created due to the use of Blanking. Do not continue until the situation is corrected.

When the test piece is removed from the defined area, in Trip Output Operation, the Status indicator must turn ON Green (or flash Green, if Reduced Resolution is enabled). In Latch Output Operation, the Status indicator will remain Red until a manual reset is performed (the Yellow Reset indicator will be flashing).

**If mirrors are used in the application:** Test the defined area on each leg of the sensing path (e.g. emitter to mirror, between mirror and receiver, see Figure 3-15).

**If the EZ-SCREEN System passes** all three checks during the trip test, go on to Section 3.5.

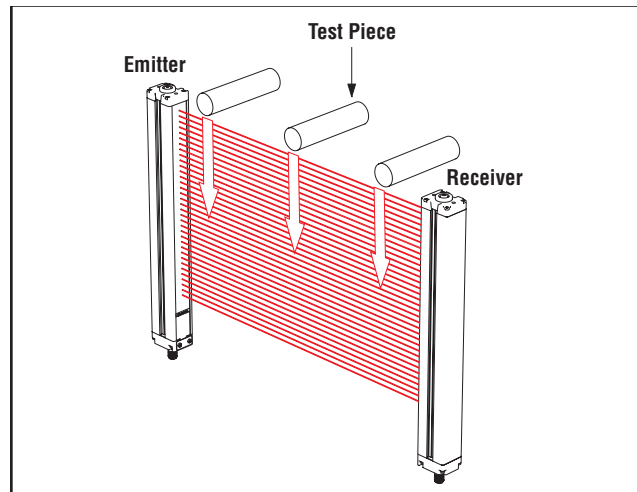


Figure 3-14. EZ-SCREEN trip test



### WARNING . . . If Trip Test Indicates a Problem

**If the EZ-SCREEN System does not respond properly to the trip test, do not attempt to use the System.**

If this occurs, the System cannot be relied on to stop dangerous machine motion when a person or object enters the defined area.

**Serious bodily injury or death could result.**

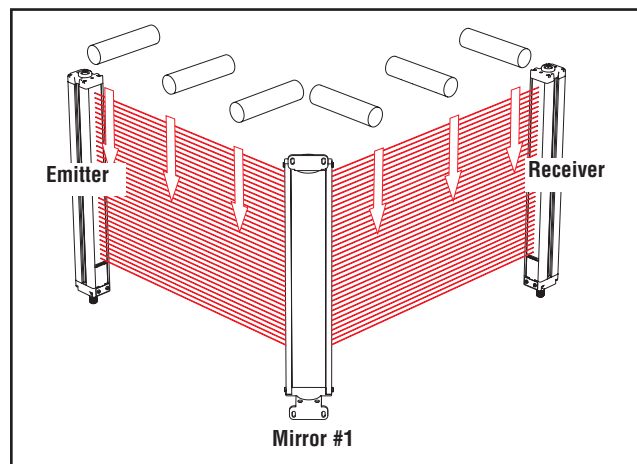


Figure 3-15. EZ-SCREEN Screen trip test with corner mirrors



### 3.5 Electrical Interface to the Guarded Machine (Permanent Hookup)

Make the electrical connections as described in Sections 3.5.1 to 3.5.6 as required by each individual application.

Lockout/tagout procedures may be required (refer to OSHA 1910.147, ANSI Z244-1, or the appropriate standard for controlling hazardous energy). Follow relevant electrical standards and wiring codes, such as the NEC, NFPA79 or IEC 60204-1. See the warning in Section 3.3.

Supply power and the external reset switch should already be connected. The EZ-SCREEN must also have been aligned and passed the Initial Checkout, as described in Section 3.4.3.

The final connections to be made are:

- OSSD outputs
- FSD interfacing
- MPCE/EDM connections
- Remote Test



#### **WARNING . . . Interfacing of Both OSSDs**

**Both of the OSSD (Output Signal Switching Device) outputs must be connected to the machine control** so that the machine's safety-related control system interrupts the circuit to the machine primary control element(s), resulting in a non-hazardous condition.

**Never wire an intermediate device(s) (e.g., PLC, PES, PC) that can fail in such a manner that there is the loss of the safety stop command, OR in such a manner that the safety function can be suspended, overridden, or defeated, unless accomplished with the same or greater degree of safety.**



#### **WARNING . . . OSSD Interfacing**

To ensure proper operation, the EZ-SCREEN OSSD output parameters and machine input parameters must be considered when interfacing the EZ-SCREEN solid-state OSSD outputs to machine inputs.

Machine control circuitry must be designed so that the maximum load resistance value is not exceeded and that the maximum specified OSSD OFF-state voltage does not result in an ON condition.

**Failure to properly interface the OSSD outputs to the guarded machine could result in serious bodily injury or death.**



#### **CAUTION . . . Shock Hazard**

**Always disconnect all power from the EZ-SCREEN System and the guarded machine before making any connections or replacing any component.** Use extreme caution to avoid electrical shock at all times.

### 3.5.1 OSSD Output Connections

Both the Output Signal Switching Device (OSSD) outputs must be connected to the machine control so that the machine's safety-related control system interrupts the circuit or power to the Machine Primary Control Element(s) (MPCE), resulting in a non-hazardous condition.

Final Switching Devices (FSDs) typically accomplish this when the OSSDs go to an OFF state. See Figure 3-17.

Refer to the output specifications in Section 2.6 and the warning at left before making OSSD output connections and interfacing the EZ-SCREEN System to the machine.

### 3.5.2 FSD Interfacing Connections

FSDs (Final Switching Devices) can take many forms, though the most common are forced-guided, mechanically linked relays or an interface module. The mechanical linkage between the contacts allows the device to be monitored by the External Device Monitoring circuit for certain failures.

Depending on the application, the use of FSDs can facilitate controlling voltage and current that differs from the OSSD outputs of the EZ-SCREEN. FSDs can also be used to control an additional number of hazards by creating multiple safety stop circuits.

#### **Safety Stop Circuits**

A safety stop allows for an orderly cessation of motion for safeguarding purposes, which results in a stop of motion and removal of power from the MPCEs (assuming this does not create additional hazards). A safety stop circuit typically comprises a minimum of two normally open (N.O.) contacts from forced-guided, mechanically linked relays, which are monitored (through External Device Monitoring) to detect certain failures in order to prevent the loss of the safety function. Such a circuit can be described as a "safe switching point." Typically, safety stop circuits are either single-channel, which is a series connection of at least two N.O. contacts; or dual-channel, which is a separate connection of two N.O. contacts. In either method, the safety function relies on the use of redundant contacts to control a single hazard (if one contact fails ON, the second contact will arrest the hazard and prevent the next cycle from occurring).

The interfacing of the safety stop circuits must be accomplished so that the safety function can not be suspended, overridden, or defeated, unless accomplished in a manner at the same or greater degree of safety as the machine's safety related control system that includes the EZ-SCREEN.

The normally open safety outputs from an interface module provide a series connection of redundant contacts that form safety stop circuits for use in either single-channel or dual-channel control. (See Figures 3-18 and 3-19.)

### Dual-Channel Control

Dual-channel control provides the ability to electrically extend the safe switching point beyond the FSD contacts. With proper monitoring (i.e., EDM), this method of interfacing is capable of detecting certain failures in the control wiring between the safety stop circuit and the MPCEs. These failures include a short-circuit of one channel to a secondary source of energy or voltage, or the loss of the switching ability of one of the FSD outputs. Such failures could lead to the loss of redundancy — or to a complete loss of safety, if not detected and corrected.

The possibility of a failure to the wiring increases as the physical distance between the FSD safety stop circuits and the MPCEs increase, as the length or the routing of the interconnecting wires increases, or if the FSD safety stop circuits and the MPCEs are located in different enclosures. For this reason, dual-channel control with EDM monitoring should be used in any installation where the FSDs are located remotely from the MPCEs.

### Single-Channel Control

Single-channel control uses a series connection of FSD contacts to form a safe switching point. After this point in the machine's safety-related control system, failures can occur that would result in the loss of the safety function (such as a short-circuit to a secondary source of energy or voltage).

For this reason, single-channel control interfacing should be used only in installations where FSD safety stop circuits and the MPCEs are mounted within the same control panel, adjacent to each other, and are directly connected to each other; or where the possibility of such a failure can be excluded. If this can not be achieved, then dual-channel control should be used.

Methods to exclude the possibility of these failures include, but are not limited to:

- Physically separating interconnecting control wires from each other and from secondary sources of power.
- Routing interconnecting control wires in separate conduit, runs, or channels.

- Locating all elements (modules, switches, and devices under control) within one control panel, adjacent to each other, and directly connected with short wires.
- Properly installing multi-conductor cabling and multiple wires through strain relief fittings. (Over-tightening of a strain-relief can cause short-circuits at that point.)
- Using positive-opening or direct-drive components, installed and mounted in a positive mode.

### 3.5.3 Machine Primary Control Elements and EDM Inputs

Each of the two Machine Primary Control Elements (MPCE1 and MPCE2) 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, see Section 3.3.1) 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. Refer to Figures 3-18 and 3-19 or consult the machine manufacturer for additional information.

**External Device Monitoring:** It is strongly recommended that one normally closed, forced-guided monitoring contact of each FSD and MPCE be connected to EDM inputs (see Figures 3-17, 3-18, and 3-19). If this is done, proper operation of the MPCEs will be verified. Monitoring MPCE contacts is one method of maintaining control reliability.

#### NOTE: External Device Monitoring and Control Reliability

Control Reliability (OSHA 29CFR1910.217, ANSI B11, and ANSI/RIA R15.06) and Category 3 and 4 (ISO13849-1) requirements demand that a single failure does not lead to the loss of the safety function, or does not prevent a normal or immediate stop from occurring. The failure or the fault must be detected at or before the next demand of safety (e.g., at the beginning or end of a cycle, or when a safeguard is actuated). The safety-related function of the machine control then must issue an immediate stop command or prevent the next machine cycle or hazardous situation until the failure or fault is corrected. The user must refer to the relevant standard(s) for complete information.

A common method of satisfying these requirements is the use of dual-channel control, as described at left, with External Device Monitoring, where a normally closed, forced-guided contact of each MPCE is wired as described in Section 3.5.3 and as shown in Figures 3-18 and 3-19.

### External Device Monitoring Hookup

If not connected previously, it is again strongly recommended that one normally closed, forced-guided monitoring contact of each FSD and MPCE be wired as shown in the monitoring circuit (see Figures 3-17, 3-18, and 3-19). If this is done, proper operation of the FSDs and MPCEs will be verified. Monitoring MPCE contacts is one method of maintaining control reliability. (See the Note Regarding External Device Monitoring on page 30).

Receiver pins 2 and 3 of the receiver terminal block provide connection for the external device monitoring input. External Device Monitoring (EDM) must be wired in one of three configurations and must agree with the DIP switch EDM settings on the receiver (see Section 4.2). One- and Two-Channel EDM are used when the EZ-SCREEN OSSD outputs directly control the energizing and de-energizing of the guarded machine's MPCEs.

- **One-Channel Monitoring** is a series connection of closed monitor contacts that are forced-guided (mechanically linked) from each device controlled by the EZ-SCREEN. The monitoring contacts should open within 200 milliseconds of the OSSD outputs turning ON (a Clear condition) and should close within 200 milliseconds of the OSSD outputs turning OFF (a Blocked condition) or a Lockout will occur (see Diagnostics, Section 5.1). Refer to Figure 3-19 for One-Channel EDM hookup. Connect the monitor contacts between +24V dc and EDM1 (pin 3). Leave EDM2 (pin 2) open (no connection). Set the configuration DIP switch to E1, per Section 4.2.
- **Two-Channel Monitoring** is a separate connection of closed monitor contacts that are forced-guided (mechanically linked) from each device controlled by the EZ-SCREEN. The monitoring contacts should always change state (both open or both close) within 200 milliseconds of the corresponding OSSD state change (turning ON or OFF) or a Lockout will occur (see Diagnostics, Section 5.1). Refer to Figures 3-17 or 3-18 for 2-channel EDM hookup. Connect the monitor contacts as shown between +24V dc and EDM1 (pin 3) and between +24V dc and EDM2 (pin 2). Set the configuration DIP switch to E2, per Section 4.2.
- **No Monitoring.** Use this setting initially, in order to perform the initial checkout; see Section 3.6. *If No Monitoring is selected, the user must ensure that any single failure of the external devices does not result in a hazardous condition and, in such a case, a successive machine cycle will be prevented* (see Section 1.3, Control Reliability). To configure the System for No Monitoring, set the configuration DIP switch to E2, per Section 4.2, and connect (using the supplied wire-nut) EDM1 (pin 3) to EDM2 (pin 2).



**CAUTION . . . EDM Monitoring**  
If system is configured for "No Monitoring," it is the user's responsibility to ensure that this does not create a hazardous situation.

### 3.5.6 Remote Test Input

A pair of connections is provided on the emitter (TEST1 and TEST2) for the connection of an external remote test switch (typically a normally open contact held closed). This remote Test input may be useful for EZ-SCREEN System setup and checkout procedures. Opening this switch "turns OFF" the emitter, simulating an interruption of the light beams; all OSSD outputs will turn OFF. The device used must be as specified in Section 2.6.

### 3.6 Preparing for System Operation

After the initial trip test has been accomplished, the OSSD safety outputs and EDM connections have been made to the machine to be controlled, the EZ-SCREEN System is ready for testing in combination with the guarded machine.

The operation of the EZ-SCREEN System with the guarded machine must be verified before the combined System and machine may be put into service. To do this, a **Qualified Person must perform the Commissioning Checkout Procedure** described in Section 6.2.

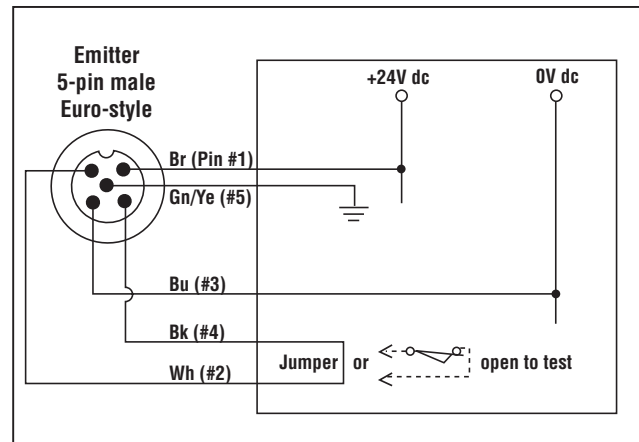


Figure 3-16. Emitter; generic hook-up



#### WARNING . . . Use of Transient Suppressors

If transient suppressors are used, they **MUST** be installed across the coils of the machine control elements. **NEVER** install suppressors directly across the contacts of the IM-T-.A Module. It is possible for suppressors to fail as a short circuit. If installed directly across the contacts of the IM-T-.A Module, a short-circuit suppressor will create an unsafe condition.

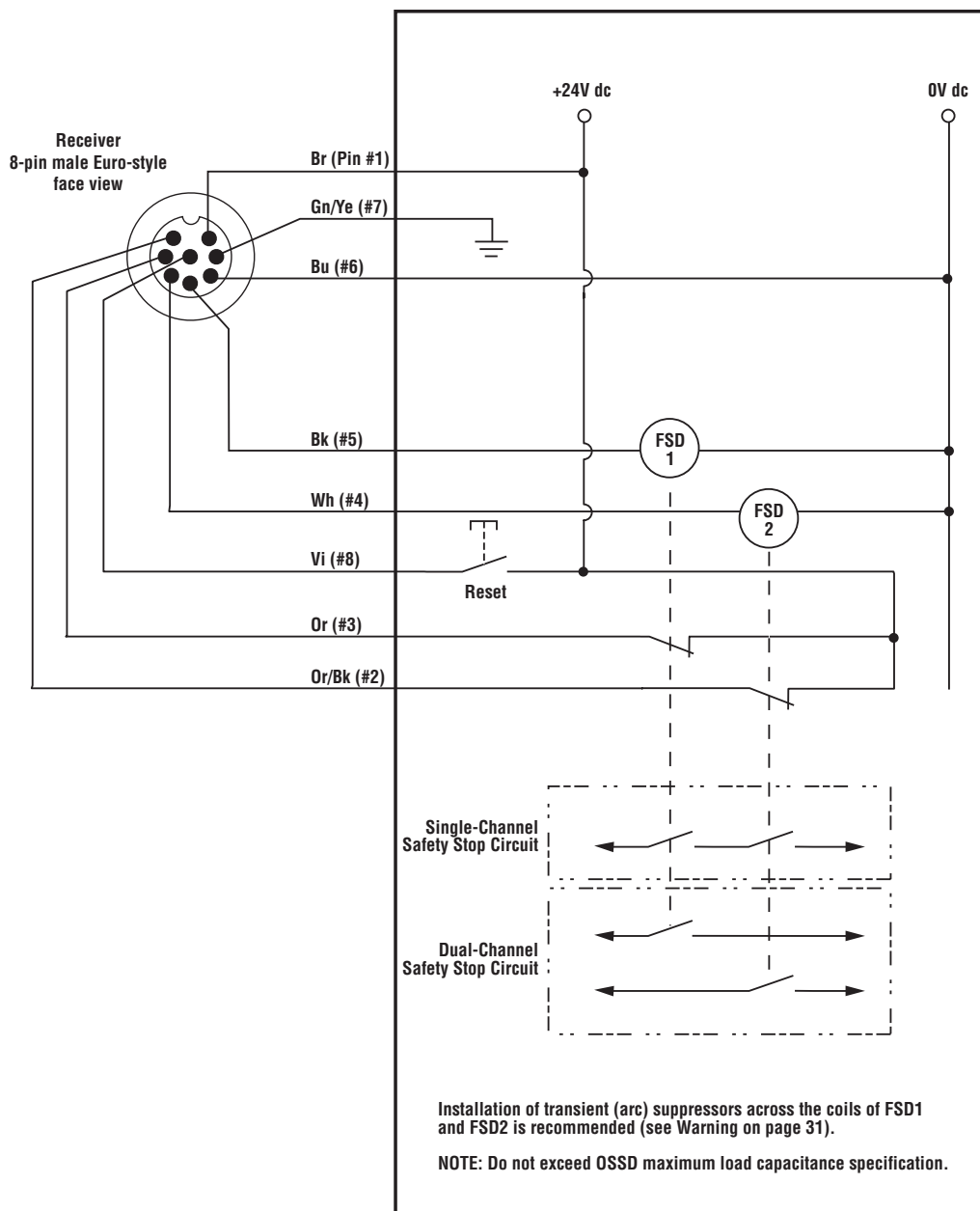


Figure 3-17. Generic hookup – FSDs (2-channel EDM, manual reset)

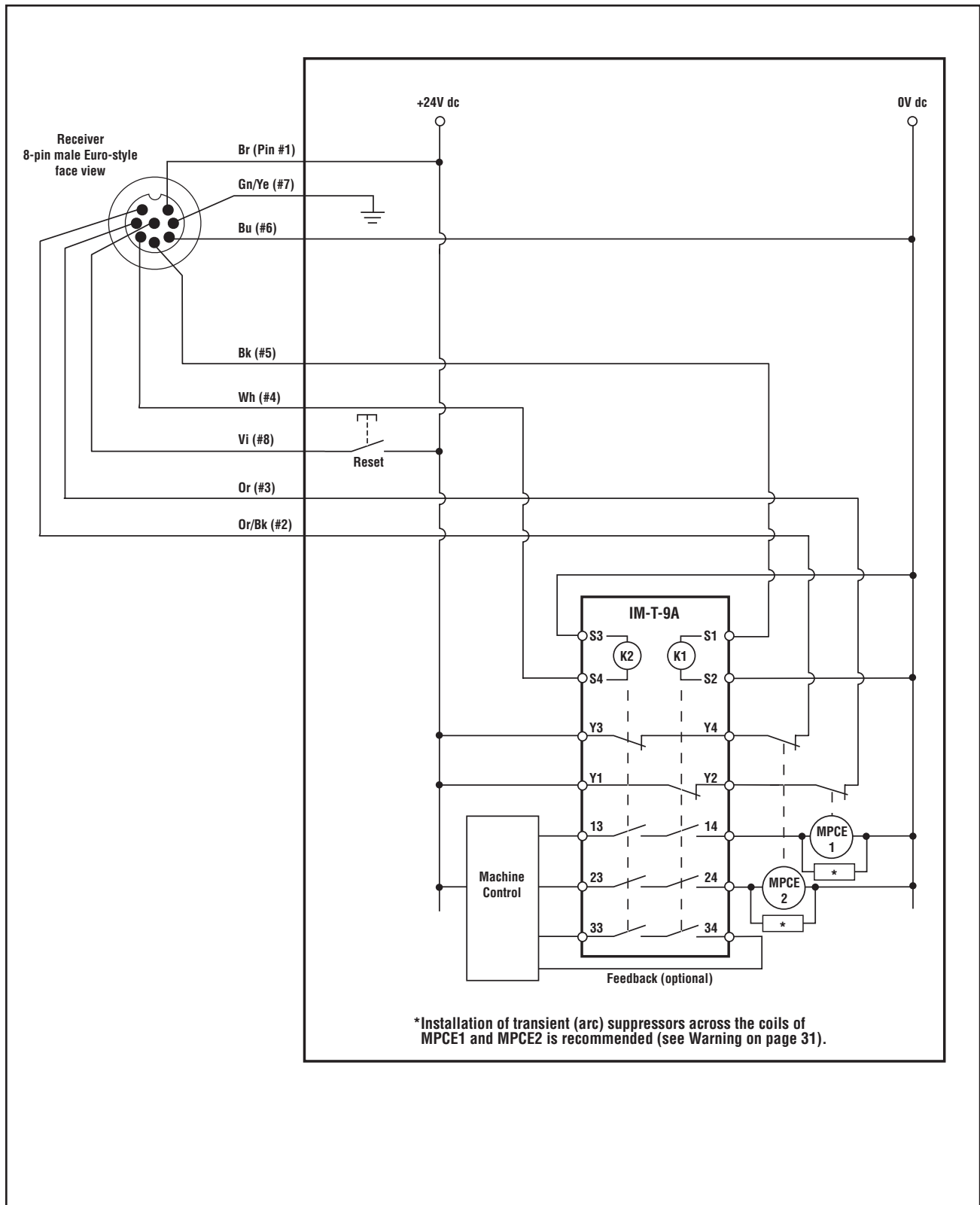


Figure 3-18. generic hookup – interface module (2-channel EDM, manual reset)

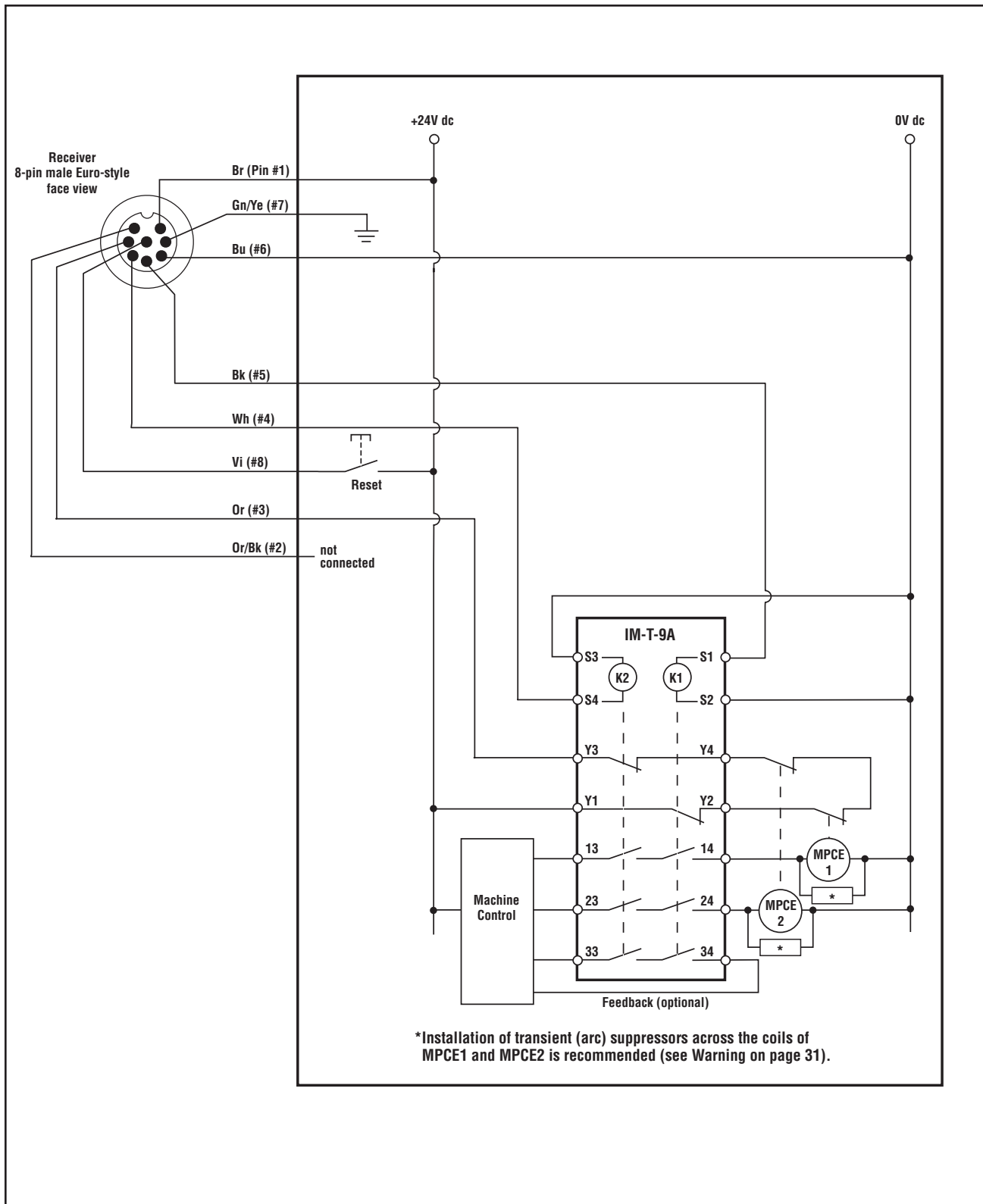


Figure 3-19. Generic hookup – interface module (1-Channel EDM, manual reset)



## 4. System Operation

### 4.1 Security Protocol

Certain procedures for installing, maintaining and operating the EZ-SCREEN system must be performed by either Designated Persons or Qualified Persons.

A **Designated Person** is identified and designated in writing, by the employer, as being appropriately trained and qualified to perform system resets and the specified checkout procedures on the EZ-SCREEN System. A machine operator so designated may be a Designated Person. The Designated Person is empowered to:

- Perform manual resets and hold possession of the reset key (see Section 4.3), and
- Perform the Daily Checkout Procedure (see Section 6).

A **Qualified Person**, by possession of a recognized degree or certificate of professional training, or by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the installation of the EZ-SCREEN System and its integration with the guarded machine. In addition to everything for which the Designated Person is empowered, the Qualified Person is empowered to:

- Install the EZ-SCREEN System,
- Perform all safety light screen checkout procedures (see Section 6),
- Have access and make changes to the internal configuration settings and
- Reset the System following a Lockout condition.

### 4.2 System Configuration Settings

If not previously configured, System settings are made on the configuration panels located on each sensor, behind the access cover. The access cover is opened by first removing the factory-installed security plate with the security hex wrench provided. It is recommended that the security plate be re-installed after any configuration changes. See Figure 4-1.

After configuration settings are verified/set, the access cover must be fully closed (snap shut) to maintain NEMA/IP ratings. **Other than Scan Code, all configuration settings should be changed only when the System is OFF.**

**NOTE: The corresponding pairs of DIP switches must be set identically for the System to operate.**

**Scan Code.** Scan Code is used to allow operation of multiple pairs of emitters and receivers in close proximity (see Sections 3.1.8 and 1.4.4). Scan Code may be set to 1 or 2, using the switch on the configuration panel. The Scan Code setting for each emitter must agree with its corresponding receiver. The Scan Code settings may be changed while in RUN mode without causing a Lockout.

**Trip or Latch Output operation** is selected on two DIP switches in the receiver configuration port; see Figure 4-1. Both switches must be set to the same setting. If they have different settings, an error code will be displayed.

If the switches are set for Trip Output (T), the System will auto-reset. If the switches are set for Latch Output (L), the System will require a manual reset.

**External Device Monitoring (EDM):** EDM mode is selected via a 2-position DIP switch in the receiver configuration port; see Figure 4-1. For 1-Channel Monitoring, set the EDM DIP switch to the E1 position. For 2-Channel Monitoring or No Monitoring, set the switch to the E2 position. See Section 3.5.3 for more information.

**Reduced Resolution:** Two-beam Reduced Resolution can be enabled by selecting "RR" on both DIP switches as labeled.

**NOTE:** Enabling Reduced Resolution will affect the Minimum Separation Distance, see Section 3.1.1.

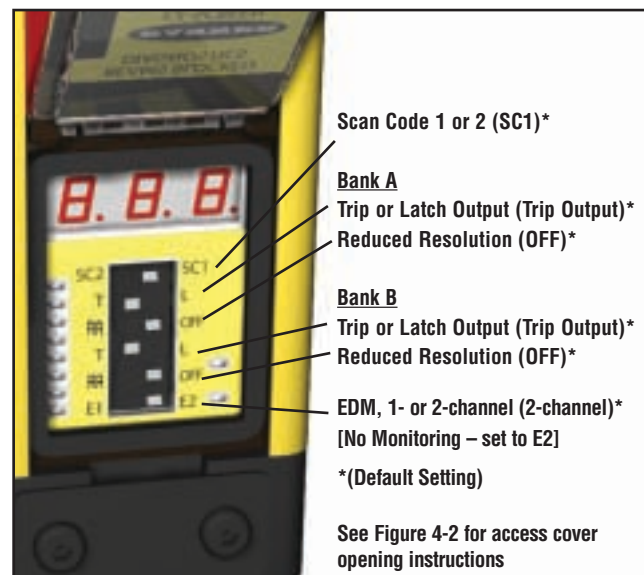


Figure 4-1. EZ-SCREEN configuration settings (receiver access panel shown)

## Accessing the Configuration Panel

To open the access cover for DIP switch configuration:

1. Remove the security plate using the special tool supplied.
2. Using a small flat blade screwdriver or the security plate tool, push the plastic tab on the access cover inwards at a 45° angle.
3. Pivot the screwdriver against the bevel until the access cover pops open.
4. To close the access cover, simply push cover into place (it will “snap” into place). The access cover has been designed to be removable, so if it should come off, simply snap it back onto the hinge and close.
5. If required, replace the security plate with tamper-resistant screws provided, using the same supplied tool.

It is important to snap-close the cover to maintain the sensors' IP 65 environmental rating. In the event an access cover is lost or damaged, a spare cover is provided in the sensor hardware pack or can be re-ordered (see Section 2.4, Replacement Parts).

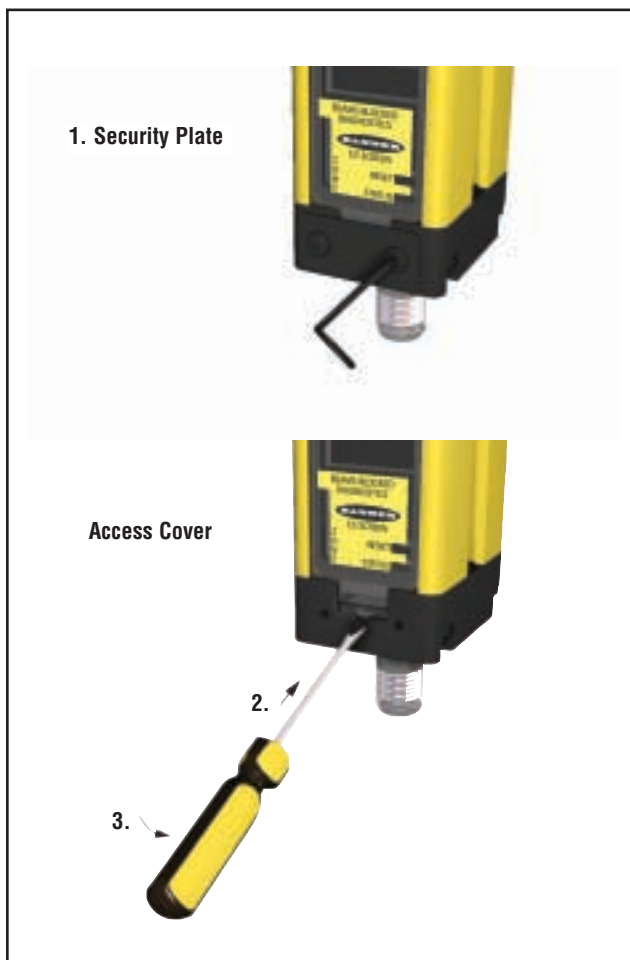


Figure 4-2. Accessing the configuration switches

## 4.3 Reset Procedures

### Resetting the System

System resets are performed using an external reset switch. This switch must be located outside the guarded area, and must not be within reach from within the guarded area (see Section 3.1.3). Its location should provide a clear view of the entire safeguarded area. If any hazardous areas are not in view from the switch location, additional means of safeguarding must be provided. The switch should be protected from accidental or unintended actuation (e.g., through the use of rings or guards).

If supervisory control of the reset switch is required, a key switch may be used, with the key kept in the possession of a Designated or Qualified Person. Using a key switch will also provide some level of personal control, since the key may be removed from the switch. This will hinder a reset while the key is under the control of an individual, but must not be relied upon solely to guard against accidental or unauthorized reset. Spare keys in the possession of others or additional personnel entering the safeguarded area unnoticed may create a hazardous situation.

### 4.3.1 Receiver Resets

The EZ-SCREEN receiver has a Reset input, pin 8 (Violet wire), that allows the System to be manually reset.

The EZ-SCREEN requires a manual reset to clear a Latch condition and resume operation following a stop command. Internal Lockout conditions also require a manual reset to return the System to RUN mode after the failure has been corrected and the input correctly cycled.

**Receiver manual resets are required in the following situations:**

- **Trip Output operation** – only after a System Lockout (see Section 5 for causes).
- **Latch Output operation** – at power-up, after each Latch condition occurs, and after a System Lockout.

### Reset Routine

To reset the receiver, close the reset switch for 1/4 to 2 seconds, then open the switch. (If reset switch model MGA-KS0-1, listed in Section 2, is used, turn the key 1/4 turn clockwise to close; turn counterclockwise, back to its original position, to open.)

NOTE: Closing the reset switch too long will cause the System to ignore the reset request; the switch must be closed from 1/4 second to 2 seconds, but no longer.

### 4.3.2 Emitter Resets

In the rare occurrence that an emitter requires a reset, power the sensor down, then power it up. Emitter resets are needed only if a Lockout occurs.

## 4.4 Status Indicators

A variety of status indicators are clearly visible on each emitter and receiver front panel (see Figure 1-4 and Section 3.4.1, steps #3 and #4).

**Emitter:** A single bi-color Red/Green Status indicator shows whether power is applied, and whether the emitter is in RUN mode, TEST mode, or Lockout status. A 7-segment Diagnostic Display indicates a specific error code when the emitter is in Lockout; the display also momentarily indicates the Scan Code setting at power-up or when changed.

**Receiver:** Bi-color Red/Green Zone indicators show whether a section of the defined area is aligned and clear, or is blocked and/or misaligned. A Yellow Reset indicator shows when the System is in RUN mode or is waiting for a reset. There are 8 Zone indicators for all model lengths, each of which indicates Blocked/Clear conditions for approximately 1/8 of the total light screen.

A bi-color Red/Green Status indicator shows when the OSSD outputs are ON (Green) or OFF (Red), or the System is in Lockout status (flashing Red). A 3-digit 7-segment Diagnostic Display indicates the receiver's Trip (–) or Latch (L) configuration setting and displays a specific error code when the receiver is in Lockout. The 7-segment display also momentarily indicates the Scan Code setting at power-up or when changed.







Operating Status	Required Event	Status Indicator	Diagnostic Display
Power-up	Apply power	Red single-flash	Scan code flash 3x – alternates  then  or  then 
RUN Mode	Passes internal tests	Green	Dash 
TEST Mode	Open Test switch	Flashing Green	Dash 
Lockout	Internal/external fault	Flashing Red	Displays error code (see Section 5.1)

Figure 4-3. Emitter status indicator operation

























Operating Mode	Required Event	Reset Indicator	Status Indicator	Zone Indicators*	Diagnostic Displays			OSSD Outputs
Power-up	Apply Power	OFF	Single-Flash Red	All Single-Flash Red		Scan code flash 3x – alternates  then  or  then 		OFF
ALIGNMENT Mode – Beam 1 Blocked	Pass Internal Tests	OFF	OFF	Zone 1 Red* Others OFF				OFF
ALIGNMENT Mode – Beam 1 Clear	Align Beam 1	ON	Red	Zone 1 Green Others Red or Green	Total number of blocked beams			OFF
Run Mode – Clear	Align All Beams	ON	Green	All ON Green	OFF		OFF	ON
Run Mode – Blocked	Beam(s) Blocked	ON	Red	Red or Green*	Total number of blocked beams			OFF
Noise Detected – Reset Interface					Flashing 	Continues previous reading	Continues previous reading	
Noise Detected – EDM Interface					Continues previous reading	Continues previous reading	Flashing 	
Lockout	Internal/External Fault	OFF	Flashing Red	All OFF	Displays error code (see Section 5.1)			OFF

Figure 4-4. Receiver status indicator operation (Trip Output configured)

\*NOTE: If beam 1 is blocked, Zone indicators 2-8 will be OFF, because beam 1 provides the synchronization signal for all the beams.

Operating Mode	Required Event	Reset Indicator	Status Indicator	Zone Indicators*	Diagnostic Displays			OSSD Outputs
Power-up	Apply Power	OFF	Single-Flash Red	All Single-Flash Red		Scan code flash 3x – alternates  then  or  then 		OFF
ALIGNMENT Mode – Beam 1 Blocked	Passes Internal Tests	OFF	OFF	Zone 1 Red*, Others OFF				OFF
ALIGNMENT Mode – Beam 1 Clear	Align Beam 1	ON	Red	Beam 1 Green Others Red or Green	Total number of blocked beams			OFF
ALIGNMENT Mode – All Beams Clear	Align All Beams	Double-Flash	Red	All ON Green	OFF	OFF	OFF	OFF
RUN Mode – Clear	Perform Reset	ON	Green	All ON Green	OFF		OFF	ON
Latched – Blocked Beam 1 Blocked	Block Beam 1	ON	Red	Red or Green*				OFF
Latched – Blocked Beam 1 Clear	Block 1 or more beams	ON	Red	Red or Green*	Total number of blocked beams			OFF
Latched – Clear	Clear All Beams	Flashing	Red	All ON Green	OFF		OFF	OFF
Noise Detected – Reset Interface					Flashing 	Continues previous reading	Continues previous reading	
Noise Detected – EDM Interface					Continues previous reading	Continues previous reading	Flashing 	
Lockout	Internal/External Fault	OFF	Flashing Red	OFF	Displays error code (see Section 5.1)			OFF

**Figure 4-5. Receiver status indicator operation (Latch Output configured)**

\*NOTE: If beam 1 is blocked, Zone indicators 2-8 will be OFF, because beam 1 provides the synchronization signal for all the beams.

## 4.5 Normal Operation

### System Power-Up

The System will power up in one of two ways, depending on the Trip/Latch Output configuration. If the System is set for Trip Output, it will power up and reset automatically; if the System is set for Latch Output, it will require a manual reset procedure after power-up and sensor alignment.

**Trip Output Power-Up:** When power is applied, each sensor will conduct self-tests to detect critical internal faults, determine configuration settings, and prepare the System for operation. (If either sensor detects a critical fault, scanning ceases, the receiver outputs remain OFF and diagnostic information is displayed through the sensor's front window.) If no faults are detected, the System will automatically enter ALIGNMENT mode, with the receiver looking for an optical sync pattern from the emitter. If the receiver is aligned and receiving the proper sync pattern, it enters RUN mode and begins scanning to determine the blocked or clear status of each beam. No manual reset operation is required.

**Latch Output Power-Up:** When power is applied, each sensor will conduct self-tests to detect critical internal faults, determine configuration settings, and prepare the System for operation. (If either sensor detects a critical fault, scanning ceases, the receiver outputs remain OFF and diagnostic information is displayed through the sensor's front window.) If no faults are detected, the System will automatically enter ALIGNMENT mode, with the receiver looking for an optical sync pattern from the emitter. If the receiver is aligned and receiving the proper sync pattern, it begins scanning to determine the blocked or clear status of each beam. When all beams are aligned, the Yellow Reset indicator will double-flash to indicate the System is waiting for a manual reset. After a valid manual reset, the System enters RUN mode and continues scanning.

### During RUN Mode

**Trip Output Configuration:** If any beams become blocked while the System is running with Trip Output selected, the receiver outputs turn OFF within the stated System response time (see Specifications). If all the beams then become clear, the receiver outputs come back ON. No resets of any kind are needed. All required machine control resets are provided by the machine control circuit.

**Latch Output Configuration:** If any beams become blocked while the System is running with Latch Output selected, the receiver outputs turn OFF within the stated System response time (see Specifications). If all the beams then become clear, the receiver Zone indicators will all be Green and the Reset indicator will single-flash, indicating the System is waiting for a manual latch reset. In Latch Output operation, the outputs come back ON only when all beams are clear and after a manual reset. The System will wait for a manual reset; when a valid reset signal is received and all beams remain clear, the receiver outputs turn ON.

**Internal Faults (Lockouts):** If either sensor detects a critical fault, scanning ceases, the receiver outputs turn OFF and diagnostic information is displayed through the sensor's front window. See Section 5 for resolution of error/fault conditions.

## 4.6 Periodic Checkout Requirements

To ensure continued reliable operation, the System must be checked out periodically.

**At every shift change, power-up and machine setup change,** the Daily checkout should be performed; this checkout may be performed by a Designated or Qualified Person (see Section 6.3 and the Daily Checkout Card for the procedure).

**Semi-annually,** the System and its interface to the guarded machine should be thoroughly checked out; this checkout must be performed by a Qualified Person (see Section 6.4). A copy of these test results should be posted on or near the machine.

**Whenever changes are made to the System** (either a new configuration of the EZ-SCREEN System or changes to the machine), the Commissioning Checkout should be performed (see Section 6.2).



### WARNING . . . Verify Proper Operation

It is the user's responsibility to verify proper operation, on a regular basis, as instructed in Section 6.

**Failure to correct such problems can result in serious bodily injury or death.**

## 5. Troubleshooting and Maintenance

### 5.1 Troubleshooting Lockout Conditions

Evaluate status indicators per Section 4.4. See Section 5.2 for Test mode indication.

A Lockout condition causes all of the EZ-SCREEN OSSD outputs to turn or remain OFF, sending a stop signal to the guarded machine. Each sensor provides diagnostic error codes to assist in the identification of the cause(s) of lockouts (see Sections 5.1.1 and 5.1.2).

The System provides easy methods for determining operating problems. A Lockout condition is indicated by the following:

#### Emitter

Status indicator	Flashing Red
Diagnostic Display	Error code (flashing)

#### Receiver

Reset indicator	OFF
Status indicator	Flashing Red
Zone Indicators	OFF
Diagnostic Display	Error code (flashing)

#### Recovery Procedures

To recover from a Lockout condition, all errors must be corrected and sensor resets must be performed as shown below.

NOTE: An emitter reset is required only if the emitter is in a Lockout condition.

#### Receiver Reset

Close the receiver Reset switch for 1/4 to 2 seconds and then open the switch (per Section 4.2) or power the sensor down, wait a second or two, then power it up.

NOTE: If the power down/up method is used and the System is set for Latch Output, a manual reset, as described in Section 4.4, is required to resume full operation.

#### Emitter Reset

Power the sensor down, wait a second or two, and then power it up.



#### WARNING . . . Lockouts and Power Failures

Power failures and Lockout conditions are indication of a problem and must be investigated immediately by a Qualified Person. **Attempts to continue to operate machinery by bypassing the EZ-SCREEN System or other safeguards is dangerous and could result in serious bodily injury or death.**









#### WARNING . . . Shut Down Machinery Before Servicing




The machinery to which the EZ-SCREEN System is connected **must not be operating at any time during major service or maintenance**. This may require lockout/tagout procedures (refer to OSHA1910.147, ANSI Z244-1, or the appropriate standard for controlling hazardous energy). **Servicing the EZ-SCREEN System while the hazardous machinery is operational could result in serious bodily injury or death.**





## 5.1.1 Receiver Error Codes

Diagnostic Display	Error Description	Appropriate Action
	<b>Output Error</b> <b>Error is caused by:</b> <ul style="list-style-type: none"> <li>• one or both outputs being shorted to a power supply (high or low),</li> <li>• by shorting OSSD 1 to OSSD 2, or</li> <li>• by an overload (greater than 0.5A).</li> </ul>	<ul style="list-style-type: none"> <li>• Disconnect the OSSD loads and reset the receiver.</li> <li>• <b>If the error clears</b>, the problem is in the OSSD load(s) or in the load wiring.</li> <li>• <b>If the error continues</b> with no load connected, replace the receiver.</li> </ul>
	<b>Reset Input Error</b> This error occurs when the Reset switch is closed (or the wiring is shorted to +24V) during power-up.	<ul style="list-style-type: none"> <li>• Verify that the reset switch is in the open position.</li> <li>• Reset the receiver per Section 4.3.</li> <li>• <b>If the error remains</b>, disconnect the reset wire at pin 8; remove and reapply input power.</li> <li>• <b>If the error clears</b>, the problem is in the reset switch or in the wiring.</li> <li>• <b>If the error continues</b> when the reset wire is disconnected, replace the receiver.</li> </ul>
	<b>EDM Input Error</b> <b>Can occur for the following reasons:</b> <ul style="list-style-type: none"> <li>• EDM wiring configuration does not match the EDM switch configuration.</li> <li>• No connection to EDM connections.</li> <li>• <i>Both</i> EDM inputs fail to respond within 200 ms of the OSSDs changing state (ON or OFF).</li> <li>• Excessive noise on EDM inputs.</li> </ul>	<ul style="list-style-type: none"> <li>• Verify that the EDM configuration switches are set correctly and that the wiring is correct for the EDM type configured (see Section 3.5.3).</li> <li>• Reset the receiver.</li> <li>• <b>If the error continues</b>, remove power to the guarded machine, disconnect the OSSD loads, disconnect the EDM input signals, configure EDM for No Monitoring (Section 3.5.3) and conduct the Initial Checkout procedure in Section 3.4.</li> <li>• <b>If the error clears</b>, the problem is in the external device contacts or wiring, or is a response-time problem of the external devices. Verify that the EDM wiring is correct and that the external devices meet the requirements described in Section 3.5.3.</li> <li>• <b>If the error continues</b>, check for excessive noise on the EDM inputs (see Section 5.3).</li> <li>• <b>If the error continues</b> after verifying electrical noise is not present, replace the receiver.</li> </ul>
	<b>Receiver Error</b> This error can occur due to either excessive electrical noise or an internal failure.	<ul style="list-style-type: none"> <li>• Perform a reset per Section 4.3.</li> <li>• <b>If the error clears</b>, perform a Daily Checkout procedure (per Section 6.3; Daily Checkout Card) and if OK, resume operation. If the System fails the Daily Checkout procedure, replace the receiver.</li> <li>• <b>If the error continues</b>, check the ground connection (pin 7).</li> <li>• <b>If the sensor has a good earth ground</b> connection to pin 7, perform the Initial Checkout procedure (per Section 3.4).</li> <li>• <b>If the error clears</b>, check the external connections and configuration settings.</li> <li>• <b>If the error continues</b>, replace the receiver.</li> </ul>
	<b>Excessive Noise Error – Reset Interface</b> This error can occur due to excessive levels of electrical noise.	<ul style="list-style-type: none"> <li>• Perform a reset per Section 4.3.</li> <li>• <b>If the error clears</b>, perform a Daily Checkout procedure (per Section 6.3; Daily Checkout Card) and if OK, resume operation. If the System fails the Daily Checkout procedure, replace the receiver.</li> <li>• <b>If the error continues</b>, check the ground connection (pin 7).</li> </ul>
	<b>Excessive Noise Error – EDM Interface</b> This error can occur due to excessive levels of electrical noise.	<ul style="list-style-type: none"> <li>• <b>If the sensor has a good earth ground</b> connection to pin 7, perform the Initial Checkout procedure (Section 3.4).</li> <li>• <b>If the error clears</b>, check for sources of electrical noise (see Section 5.3).</li> <li>• <b>If the error continues</b> when performing the Initial Checkout procedure, replace the receiver.</li> </ul>

## 5.1.1 Receiver Error Codes (continued)

Diagnostic Display	Error Description	Appropriate Action
	<b>DIP Switch Error</b> This error can be caused by incorrect DIP switch settings or by changes to the DIP switch settings when the system is ON.	<ul style="list-style-type: none"> <li>• Verify that the DIP switch settings are valid (per Section 4.2). Make any corrections necessary and perform a receiver reset.</li> <li>• <b>If the error occurred</b> due to a change of the DIP switch settings while the System was in RUN mode, verify the switch settings and perform a receiver reset to resume operation with the new switch settings and modified System configuration.</li> <li>• <b>If the error continues</b>, replace the receiver.</li> </ul>
	<b>EDM 1 Error</b> This error can occur due to EDM 1 input signal failing to respond within 200 ms of OSSD 1 changing state (ON or OFF) or by EDM 1 input signal changing state when OSSD 1 did not change.	<ul style="list-style-type: none"> <li>• Verify that the EDM wiring is correct and that the external devices meet the requirements described in Section 3.5.3.</li> <li>• <b>If the error continues</b>, remove power to the guarded machine, disconnect the OSSD loads, disconnect the EDM input signals, configure EDM for No Monitoring (per Section 3.5.3) and conduct the Initial Checkout procedure in Section 3.4.</li> <li>• <b>If the error clears</b>, the problem is in the External Device contacts or wiring, or is a response-time problem of the external devices. Verify that the EDM wiring is correct and that the external devices meet the requirements described in Section 3.5.3.</li> <li>• <b>If the error continues</b>, check for excessive noise on the EDM inputs (see Section 5.3).</li> </ul>
	<b>EDM 2 Error</b> This error can occur due to EDM 2 input signal failing to respond within 200 ms of OSSD 2 changing state (ON or OFF), or by the EDM 2 input signal changing state when OSSD 2 did not change.	<ul style="list-style-type: none"> <li>• Verify that the EDM wiring is correct and that the external devices meet the requirements described in Section 3.5.3.</li> <li>• <b>If the error continues</b>, remove power to the guarded machine, disconnect the OSSD loads, disconnect the EDM input signals, configure EDM for No Monitoring (per Section 3.5.3) and conduct the Initial Checkout procedure (Section 3.4).</li> <li>• <b>If the error clears</b>, the problem is in the External Device contacts or wiring, or is a response-time problem of the external devices. Verify that the EDM wiring is correct and that the external devices meet the requirements described in Section 3.5.3.</li> <li>• <b>If the error continues</b>, check for excessive noise on the EDM inputs (see Section 5.3).</li> </ul>

### 5.1.2 Emitter Error Codes

Diagnostic Display	Error Description	Cause of Error
 then	<b>Emitter Error*</b> This error can occur either due to excessive electrical noise or due to an internal failure.	<ul style="list-style-type: none"> <li>Reset the emitter by disconnecting and reapplying power to the emitter (see Section 4.3.2).</li> <li><b>If the error clears</b>, perform a Daily Checkout procedure (Section 6.3) and if OK, resume operation. If the System fails the Daily Checkout procedure, replace the emitter.</li> <li><b>If the error continues</b>, check the ground connection (pin 5).</li> <li><b>If the sensor has a good earth ground</b> connection to pin 5, check for electrical noise (see Section 5.3).</li> <li><b>If the error continues</b>, replace the emitter.</li> </ul>
 then	<b>Excessive Noise Error*</b> This error can occur due to excessive electrical noise.	<ul style="list-style-type: none"> <li>Reset the emitter by disconnecting and reapplying power to the emitter (see Section 4.3.2).</li> <li><b>If the error clears</b>, perform a Daily Checkout procedure (Section 6.3) and if OK, resume operation. If the System fails the Daily Checkout procedure, replace the emitter.</li> <li><b>If the error continues</b>, check the ground connection (pin 5).</li> <li><b>If the sensor has a good earth ground</b> connection to pin 5, check for electrical noise (see Section 5.3).</li> <li><b>If the error continues</b>, replace the emitter.</li> </ul>

\* Emitter has only 1-digit display. Two-digit codes are displayed sequentially.

### 5.2 TEST Mode

**If System can not be aligned or it will not go to a Green/Clear condition, the emitter's TEST input may be open.** When this occurs, the receiver Reset indicator is Yellow, all Zone indicators will be Red or Green, and the system Status LED will be Red; the 3-digit display will show a numerical value equal to one less than the total number of beams. For example, if an array has 48 beams total, the display would show 47. The emitter's Status indicator will flash Green. See Section 3.5.6. (However, on a 10-beam system only, the Zone 1 indicator will be Green, and all others Red.

Opening a switch or relay contacts connected to the TEST1 and TEST2 connections of the emitter, or supplying a voltage of less than 3V dc to TEST1 only, simulates a Blocked condition, for testing purposes.

To verify proper operation, measure the voltage between TEST1 (pin 4, black) and dc COM (pin 3, blue) of the emitter:

- If the voltage is 10 to 30V dc, the emitter should be in RUN mode and beam scanning should be occurring. If not, check the +24V dc (pin 1, brown) to verify proper supply voltage. If the supply voltage is not within the rated supply voltage specifications, correct the supply voltage and recheck emitter operation. If the supply voltage is correct, TEST1 is 10 to 30V dc and the emitter does not operate properly (RUN mode with beam scanning). Replace emitter.
- If the voltage is less than 3V dc, the emitter should be in TEST mode and no scanning should be occurring. If not in TEST mode, replace emitter.

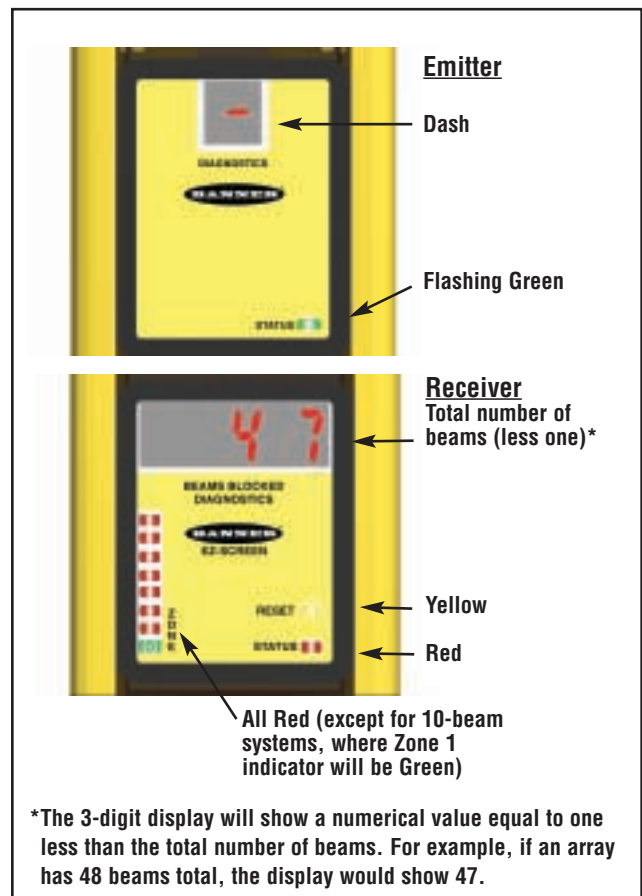


Figure 5-1. TEST mode status indicators

## 5.3 Electrical and Optical Noise

The EZ-SCREEN System is designed and manufactured to be highly resistant to electrical and optical noise and to operate reliably in industrial settings. However, serious electrical and/or optical noise may cause a random Trip or Latch condition. In very extreme electrical noise cases, a Lockout is possible. In order to minimize the effects of transitory noise, the EZ-SCREEN System will respond to noise only if the noise is detected on multiple consecutive scans.

If random nuisance Trips occur, check the following:

- Poor connection between the sensor and earth ground;
- Optical interference from adjacent light screens or other photoelectrics; or
- Sensor input or output wires routed too close to “noisy” wiring.

**Checking for sources of electrical noise:** It is very important that the light screen sensors have a good earth ground. Without this, the System can act like an antenna and random Trips and Lockouts can occur.

All EZ-SCREEN System wiring is low voltage; running these wires alongside power wires, motor/servo wires, or other high-voltage wiring, can inject noise into the EZ-SCREEN system. It is good wiring practice (and may be required by code) to isolate EZ-SCREEN System wires from high-voltage wires.

The Banner model BT-1 Beam Tracker (see Section 2.3) is a very good tool for detecting electrical noise. It can be used to detect electrical transient spikes and surges. Cover the lens of the BT-1 with electrical tape to block optical light from getting into the receiver lens. Press the “RCV” button on the BT-1 and position the Beam Tracker on the wires going to the EZ-SCREEN or any other nearby wires. Noise caused by the switching of inductive loads should be addressed by installing proper transient suppression across the load.

**Checking for sources of optical noise:** Turn off the emitter, completely block the emitter, or open the Test input, then use a Banner BT-1 Beam Tracker to check for light at the receiver. Press the “RCV” button on the BT-1 and move it across the full length of the receiver’s sensing window. If the BT-1’s indicator lights, check for light from other sources (other safety light screens, screens or points, or standard photoelectric sensors) by “tracking down” the emitted light from them.

## 5.4 Servicing and Maintenance

### **Cleaning**

EZ-SCREEN System emitters and receivers are constructed of aluminum with a yellow painted finish and are rated 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.

The accessory interface module is constructed of polycarbonate and is rated NEMA 1 (IP20). It may be dusted, but avoid contact with any liquids.

### **Warranty Service**

The EZ-SCREEN System is designed for reliability. Do not open the emitter or receiver housings, other than to access the configuration, and do not open the housing of the interface module, if used. They contain no field-replaceable components. If repair is necessary, do not attempt to repair an emitter, receiver, or interface module yourself; return the unit to the factory.

Should it become necessary to return a System 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.,  
Application Engineering Group  
9714 Tenth Avenue North  
Minneapolis, MN 55441**

**Phone: 763.544.3164 or  
Toll-Free (US only): 888.373.6767  
email: [sensors@bannerengineering.com](mailto:sensors@bannerengineering.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. Checkout Procedures

Study each procedure in its entirety, to understand each step thoroughly before beginning. Refer all questions to the Banner applications engineering department at the address or numbers listed on the cover of this manual. Checkouts must be performed as detailed in Section 6.1 below and results should be recorded and kept in the appropriate place (e.g., near the machine, and/or in a technical file).

### 6.1 Schedule of Checkouts

**Trip Test:** The procedure for EZ-SCREEN System trip test is described in Section 3.4.3. This procedure must be performed at installation, and at any time the System, the guarded machine, or any part of the application is installed or altered. The procedure must be performed by a Qualified Person.

**Commissioning Checkout:** The procedure described in Section 6.2 must be performed at installation or whenever changes are made to the System (either a new configuration of the EZ-SCREEN System or changes to the machine). The procedure must be performed by a Qualified Person.

**Shift/Daily Checkout:** The procedure for “daily” checkout of the EZ-SCREEN System is described on the supplied Daily Checkout card (Banner p/n 113361). Daily Checkout is to be performed at each shift change or machine setup change, whenever the System is powered up — at least daily. The procedure is listed on the Daily Checkout card and may be performed by a Designated Person or a Qualified Person.

**Semi-Annual Checkout:** The procedure for initial checkout of the EZ-SCREEN System is to be performed every six months, following installation of the System. The procedure is listed on the Semi-Annual Checkout card (Banner P/N 113362) and must be performed by a Qualified Person.

### 6.2 Commissioning Checkout

**Perform this checkout procedure as part of System installation (after the System has been interfaced to the guarded machine as described in Section 3.5), or whenever changes are made to the System (either a new configuration of the EZ-SCREEN System or changes to the machine).** A Qualified Person (as defined in Section 4.1) must perform the procedure; checkout results should be recorded and kept on or near the guarded machine as required by applicable standards.

To prepare the System for this checkout:

1. Examine the guarded machine to verify that it is of a type and design compatible with the EZ-SCREEN System. See Section 1.2 for a list of misapplications.
2. Verify the EZ-SCREEN System is configured for the intended application (see Section 4.2).
3. Verify that the minimum separation distance from the closest danger point of the guarded machine to the defined area is not less than the calculated distance, per Section 3.1.1 of this manual.
4. Verify that:
  - Access to any dangerous parts of the guarded machine is not possible from any direction not protected by the EZ-SCREEN System, hard guarding, or supplemental safeguarding, and
  - It is not possible for a person to stand between the defined area and the dangerous parts of the machine, or
  - Supplemental safeguarding and hard guarding, as described by the appropriate safety standards, are in place and functioning properly in any space (between the defined area and any hazard) which is large enough to allow a person to stand undetected by the EZ-SCREEN System (see Sections 3.1.2 and 3.1.4).
5. Verify that all reset switches are mounted outside and in full view of the guarded area, out of reach of anyone inside the guarded area, and that means of preventing inadvertent use is in place (see Section 3.1.3).
6. Examine the electrical wiring connections between the EZ-SCREEN System FSD outputs and the guarded machine's control elements to verify that the wiring meets the requirements stated in Section 3.5.

7. Inspect the area near the defined area (including work pieces and the guarded machine) for reflective surfaces (see Section 3.1.6). Remove the reflective surfaces as possible by relocating them, painting, masking or roughening them. Remaining problem reflections will become apparent during the Trip Test in step 11.
8. Apply power to the EZ-SCREEN System. Verify that power to the guarded machine is OFF. Remove all obstructions from the defined area. If the System is configured for Manual Power-Up, the Yellow Status indicator will be double-flashing. Perform a manual reset (close the reset switch for 1/4 to 2 seconds, then open the switch).
9. Observe the Status indicators and the Diagnostic Display:
  - **Lockout:** Status flashing Red  
All others OFF
  - **Blocked:** Status ON Red  
One or more Zone indicators ON Red  
Reset ON Yellow
  - **Clear:** Status ON Green\*  
All Zone indicators ON Green  
Reset ON Yellow
  - **Latch:** Status ON Red  
(defined All Zone indicators ON Green  
area clear) Reset flashing Yellow
- \* The Green Status indicator will be flashing if Reduced Resolution is enabled.
10. A Blocked condition indicates that one or more of the beams is misaligned or interrupted. To correct this situation see the Alignment procedure in Section 3.4. If the system is in a Latch condition, perform a manual reset.
11. Once the Green and Yellow Status indicators are ON, **perform the trip test** (described in Section 3.4.3) to verify proper System operation and to detect possible optical short circuits or reflection problems. **Do not continue until the EZ-SCREEN System passes the trip test. Do not expose any individual to any hazard during the following checks.**



### WARNING . . . Before Applying Power to the Machine

Verify that the guarded area is clear of personnel and unwanted materials (such as tools) before applying power to the guarded machine. Failure to do so could result in serious bodily injury or death.

12. Apply power to the guarded machine and verify that the machine does not start up. Interrupt (block) the defined area with the appropriate supplied test piece (see table in Section 3.4.3) and verify that it is not possible for the guarded machine to be put into motion while the beam(s) is blocked.
13. Initiate machine motion of the guarded machine and, while it is moving, use the supplied test piece to block the defined area. **Do not attempt to insert the test piece into the dangerous parts of the machine.** Upon blocking any beam, the dangerous parts of the machine should come to a stop with no apparent delay.  
  
Remove the test piece from the beam; **verify that the machine does not automatically restart**, and that the initiation devices must be engaged to restart the machine.
14. Remove electrical power to the EZ-SCREEN System. Both OSSD outputs should immediately turn OFF, and the machine should not be capable of starting until power is re-applied to the EZ-SCREEN System.
15. 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. (Banner's applications engineering department can recommend a suitable instrument.)

**Do not continue operation until the entire checkout procedure is complete and all problems are corrected.**



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

**If all of these checks cannot be verified, do not attempt to use the EZ-SCREEN**

**System/guarded machine** until the defect or problem has been corrected (see Section 5).

**Attempts to use the guarded machine under such conditions could result in serious bodily injury or death.**



### **6.3 Shift/Daily Checkout**

**Perform the procedure contained on the Daily Checkout card at every shift change, power-up and machine set-up change. During continuous machine run periods, this checkout should be performed at intervals not to exceed 24 hours.**

A Designated Person or Qualified Person (as defined in the Safety Glossary) must perform the procedure. A copy of checkout results should be recorded and kept in the appropriate place (e.g., near or on the machine, in the machine's technical file).

Refer to the procedure detailed on the Daily Checkout card (Banner part number 113361) in the lit packet included with the receiver. If the Daily Checkout card is missing, contact Banner Engineering or download at [www.bannerengineering.com](http://www.bannerengineering.com).

### **6.4 Semi-Annual (Six-Month) Checkout**

**Perform the procedure contained on the Semi-Annual Checkout card every six months following System installation, or whenever changes are made to the System (either a new configuration of the EZ-SCREEN System or changes to the machine).**

A Qualified Person (as defined in the Safety Glossary) must perform the procedure. A copy of checkout results should be recorded and kept in the appropriate place (e.g., near or on the machine, in the machine's technical file).

Refer to the procedure contained on the Semi-Annual Checkout card (Banner part number 113362) in the lit packet included with the receiver. If the Semi-Annual Checkout card is missing, contact Banner Engineering or download at [www.bannerengineering.com](http://www.bannerengineering.com).

## Glossary of Terms

**ANSI (American National Standards Institute):** the American National Standards Institute, an association of industry representatives that develops technical standards (including safety standards). These standards comprise a consensus from a variety of industries on good practice and design. ANSI standards relevant to application of safety products include the ANSI B11 Series, and ANSI/RIA R15.06. See “Safety Standards” on inside back cover.

**Antirepeat:** the part of the control system designed to limit the machine to a single stroke or cycle if the tripping or actuating means is held operated.

**Auto Power-Up:** a safety light screen system feature which, when switched ON, enables the system to be powered up (and recover from a power interruption) without requiring a manual reset. When Auto Power-Up is ON, the safety light screen controller automatically begins internal diagnostics upon power-up, and automatically resets the system if it passes the diagnostic check. When Auto Power-up is OFF, a manual reset is required.

**Blanking:** a programmable feature of a safety light screen system which allows the light screen to ignore certain objects located within the defined area. See *fixed blanking*, *Floating Blanking*, and *Reduced Resolution*.

**Blocked Condition:** A safety light screen condition, when an opaque object of sufficient size blocks/interrupts one or more light screen beams. When a Blocked condition occurs, OSSD1 and OSSD2 outputs simultaneously turn off within the system response time.

**Brake:** a mechanism for stopping or preventing motion.

**CE:** “Conformité Européenne” (French translation of “European Conformity”). The CE mark on a product or machine establishes its compliance with all relevant European Union (EU) Directives and the associated safety standards.

**Clutch:** a mechanism that, when engaged, transmits torque to impart motion from a driving member to a driven member.

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

**CSA:** Canadian Standards Association, a testing agency similar to Underwriters Laboratories, Inc. (UL) in the United States. A CSA-certified product has been type-tested and approved by the Canadian Standards Association as meeting electrical and safety codes.

**Defined Area:** the “screen of light” generated between the emitter and receiver of a safety light screen system. When the defined area is interrupted by an opaque object of a specified cross section, a Trip or Latch condition results.

**Designated Person:** an individual identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure. (See *Qualified Person*.)

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

**External Device Monitoring (EDM):** a means by which a safety device (such as a safety light screen) actively monitors the state (or status) of external devices that may be controlled by the safety device. A lockout of the safety device will result if an unsafe state is detected in the external device. External device(s) may include, but are not limited to: MPCs, captive contact relays/contactors, and safety modules.

**Failure to Danger:** a failure which delays or prevents a machine safety system from arresting dangerous machine motion.

**Final Switching Device (FSD):** the component of the machine's safety-related control system that interrupts the circuit to the machine primary control element (MPCE) when the output signal switching device (OSSD) goes to the OFF-state.

**Fixed Blanking:** a programming feature that allows a safety light screen system to ignore objects (such as brackets or fixtures) which will always be present at a specific location within the defined area. The presence of these objects will not cause the system's safety outputs (e.g., Final Switching Devices) to trip or latch. If any fixed objects are moved within or removed from the defined area, a Lockout condition results.

**Floating Blanking:** see Reduced Resolution.

**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 safety products are extensively FMEA tested.

**Forced-Guided Contacts:** relay contacts that are mechanically linked, 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.”

**Full-Revolution Devices:** a method of machine drive arranged such that, once started, the machine can be stopped only when the full cycle is complete. Examples include positive key clutches and similar mechanisms. Banner safety light screen systems may not be used with full-revolution devices.

**Guarded Machine:** The machine whose point of operation is guarded by the safety light screen system.

**Hard Guard:** screens, bars, or other mechanical barriers affixed to the frame of the machine intended to prevent entry by personnel into the hazardous area(s) of a machine, while allowing the point of operation to be viewed. The maximum size of openings is determined by the applicable standard, such as Table O-10 of OSHA 29CFR1910.217. Also called a “fixed barrier guard.”

**Hazardous Area:** an area that poses an immediate or impending physical hazard.

**Hazard Point:** the closest reachable point of the hazardous area.

**Internal Lockout:** a Lockout condition that is due to an internal safety system problem. Generally, indicated by the red Status indicator LED (only) flashing. Requires the attention of a *Qualified Person*.

**Key Reset (Manual Reset):** a key-operated switch used to reset a safety light screen system to the ON state following a Lockout condition. Also refers to the act of using the switch to reset a safety system from a Latch condition.

**Latch Condition:** the response of the Safety Outputs (e.g., OSSDs) of a safety light screen system when an object equal to or greater than the diameter of the specified test piece enters the defined area. In a Latch condition, safety outputs simultaneously de-energize and open their contacts. The contacts are held (latched) open until the object is removed from the defined area and a manual reset is performed. A latching output is used most often in perimeter guarding applications. (See *Trip Condition*.)

**Lockout Condition:** a safety light screen system condition that is automatically attained in response to certain failure signals (an internal lockout). When a Lockout condition occurs, the safety light screen system’s safety outputs turn OFF, and a manual reset is required to return the system to RUN mode.

**Machine Operator:** an individual who performs production work and who controls operation of the machine.

**Machine Primary Control Element (MPCE):** an electrically-powered element, external to the safety system, which directly controls the machine’s normal operating motion in such a way that the element is last (in time) to operate when machine motion is either initiated or arrested.

**Machine Response Time:** the time between the activation of a machine stopping device and the instant when the dangerous parts of the machine reach a safe state by being brought to rest.

**Minimum Object Sensitivity (MOS):** the minimum-diameter object that a safety light screen system can reliably detect. Objects of this diameter or greater will be detected anywhere in the defined area. A smaller object can pass undetected through the light if it passes exactly midway between two adjacent light beams. Also known as MODS (Minimum Object Detection Size). See also Specified Test Piece.

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

**OFF State:** The state in which the output circuit is interrupted and does not permit the flow of current.

**ON State:** The state in which the output circuit is complete and permits the flow of current.

**OSHA (Occupational Safety and Health Administration):** a U.S. Federal agency, Division of the U.S. Department of Labor, that is responsible for the regulation of workplace safety.

**OSSD:** Output Signal Switching Device. The safety outputs that are used to initiate a stop signal.

**Part-Revolution Clutch:** a type of clutch that may be engaged or disengaged during the machine cycle. Part-revolution clutched machines use a clutch/brake mechanism, which can arrest machine motion at any point in the stroke or cycle.

**Pass-Through Hazard:** A situation that may exist when personnel pass through a safeguard (at which point the hazard stops or is removed), and then continue into the guarded area. At this point the safeguard may not be able to prevent an unexpected start or restart of the machine with personnel within the guarded area.

**Point of Operation:** the location of a machine where material or a workpiece is positioned and a machine function is performed upon it.

**Point-of-Operation Guarding:** safeguards, such as hard guards or safety light screens, which are designed to protect personnel from hazardous machine motion when close to the machine’s point of operation.

**Power-Up/Power-Interrupt Lockout:** a Lockout condition of a safety light screen system that, if Auto Power-up is OFF, occurs when the system is powered up (including power-ups after a loss of power). Requires a manual reset by a *Designated Person*.

**PSDI (Presence-Sensing Device Initiation):** an application in which a presence-sensing device is used to actually start the cycle of a machine. In a typical situation, an operator manually positions a part in the machine for the operation. When the operator moves out of the danger area, the presence-sensing device starts the machine (no start switch is used). The machine cycle runs to completion, and the operator can then insert a new part and start another cycle. The presence-sensing device continually guards the machine. Single-break mode is used when the part is automatically ejected after the machine operation. Double-break mode is used when the part is both inserted (to begin the operation) and removed (after the operation) by the operator. PSDI is commonly confused with “Trip Initiate.” PSDI is defined in OSHA CFR1910.217. Banner safety light screen systems may not be used as PSDI devices on mechanical power presses, per OSHA regulation 29 CFR 1910.217.

**Qualified Person:** an individual who, by possession of a recognized degree or certificate of professional training, or by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work. (See *Designated Person*.)

**Receiver:** the light-receiving component of a safety light screen system, consisting of a row of synchronized phototransistors. The receiver, together with the emitter (placed opposite), creates a “screen of light” called the defined area.

**Reduced Resolution:** a feature that allows a safety light screen system to be configured to produce an intentionally disabled light beam(s) within the light screen, which increases the minimum object sensitivity. The disabled beam(s) appears to move up and down (“float”) in order to allow the feeding of an object through the defined area at any point without tripping the safety outputs (e.g., OSSDs) and causing a Trip or Latch condition. Sometimes called “Floating Blanking.”

**Reset:** The use of a manually operated switch to restore the safety outputs to the ON state from a lockout or a Latch condition.

**Resolution:** See Minimum Object Sensitivity.

**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 safety light screen systems and safety modules are self-checking.

**Separation Distance (Safety Light Screen):** the minimum distance required to allow the machine’s hazardous motion to stop completely, before a hand (or other object) can reach the nearest hazard point. Measured from the midpoint of the defined area to the nearest hazard point. Factors that influence minimum separation distance include the machine stop time, the light screen system response time, and the light screen minimum object detection size.

**Single-Stroke Press:** See *full-revolution devices*.

**Single-Cycle Machine:** a machine which is limited by anti-repeat control to one complete work-performing cycle for each machine actuation, even if the actuator is continuously operated.

**Specified Test Piece:** an opaque object of sufficient size used to block a light beam to test the operation of a safety light screen system. When inserted into any part of the defined area, it will place a system into a Trip or Latch condition. Banner supplies specified test pieces with each system. See also *Minimum Object Sensitivity*.

**Supplemental Guarding:** additional safeguarding device(s) or hard guarding, used to prevent a person from reaching over, under, through or around the primary safeguard or otherwise accessing the guarded hazard.

**Test Piece:** an opaque object of sufficient size used to block a light beam to test the operation of a safety light screen system.

**Trip Condition:** the response of the safety outputs (e.g., OSSDs) of a safety light screen system when an object equal to or greater than the diameter of the specified test piece enters the defined area. In a Trip condition, the OSSDs simultaneously de-energize. A Trip condition clears (resets) automatically when the object is removed from the defined area. (See *Latch Condition*.)

**Trip Initiate:** the resetting of a safeguard causing the initiation of machine motion or operation. **Trip Initiate is not allowed as a means to initiate a machine cycle** per NFPA 79 and ISO 60204-1, and is commonly confused with *PSDI*.

**TUV (Technischer Überwachungsverein):** independent testing and certification organization providing EMC and product safety testing, certification, and quality management systems registration.

**UL (Underwriters Laboratory):** a third-party organization that tests products for compliance with appropriate standards, electrical codes, and safety codes. Compliance is indicated by the UL listing mark on the product.

## SOURCES

### **OSHA Documents**

Superintendent of Documents  
Government Printing Office  
P.O. Box 371954  
Pittsburgh, PA 15250-7954  
Tel: (202) 512-1800  
<http://www.osha.gov>

### **ANSI Accredited Standards**

American National Standards Institute (ANSI)  
11 West 42nd Street  
New York, NY 10036  
Tel: (212) 642-4900  
<http://www.ansi.org>

### **B11 Documents**

Safety Director  
The Association for Manufacturing Technology (AMT)  
7901 Westpark Drive  
McLean, VA 22102  
Tel: (703) 893-2900  
<http://www.mfgtech.org>

### **RIA Documents**

Robotics Industries Association (RIA)  
900 Victors Way, P.O. Box 3724  
Ann Arbor, MI 48106  
Tel: (734) 994-6088  
<http://www.robotics.org>

### **NFPA Documents**

National Fire Protection Association  
1 Batterymarch Park  
P.O. Box 9101  
Quincy, MA 02269-9101  
Tel: (800) 344-3555  
<http://www.nfpa.org>

### **Alternate sources for these, plus ISO, IEC, EN, DIN, & BS Standards:**

Global Engineering Documents  
15 Inverness Way East  
Englewood, CO 80112-5704  
Tel: (800) 854-7179  
<http://www.global.ihs.com>

National Standards Systems Network (NSSN)  
25 West 43rd Street  
New York, NY 10036  
Tel: (212) 642-4980  
<http://www.nssn.com>

Document Center, Inc.  
111 Industrial Road, Suite 9  
Belmont, CA 94002  
Tel: (650) 591-7600  
<http://www.document-center.com>

## U.S. Application Standards

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**ANSI B11.1** Mechanical Power Presses

**ANSI B11.2** Hydraulic Power Presses

**ANSI B11.3** Power Press Brakes

**ANSI B11.4** Shears

**ANSI B11.5** Iron Workers

**ANSI B11.6** Lathes

**ANSI B11.7** Cold Headers and Cold Formers

**ANSI B11.8** Drilling, Milling, and Boring

**ANSI B11.9** Grinding Machines

**ANSI B11.10** Metal Sawing Machines

**ANSI B11.11** Gear Cutting Machines

**ANSI B11.12** Roll Forming and Roll Bending Machines

**ANSI B11.13** Single- and Multiple-Spindle Automatic Bar and Chucking Machines

**ANSI B11.14** Coil Slitting Machines

**ANSI B11.15** Pipe, Tube, and Shape Bending Machines

**ANSI B11.16** Metal Powder Compacting Presses

**ANSI B11.17** Horizontal Extrusion Presses

**ANSI B11.18** Machinery and Machine Systems for the Processing of Coiled Strip, Sheet, and Plate

**ANSI B11.19** Performance Criteria for Safeguarding

**ANSI B11.20** Manufacturing Systems

**ANSI B11.21** Machine Tools Using Lasers

**ANSI B11.22** Numerically Controlled Turning Machines

**ANSI B11.23** Machining Centers

**ANSI B11.24** Transfer Machines

**ANSI B11.TR3** Risk Assessment

**ANSI/RIA R15.06** Safety Requirements for Industrial Robots and Robot Systems

**NFPA 79** Electrical Standard for Industrial Machinery

## OSHA Regulations

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### **OSHA Documents listed are part of:**

Code of Federal Regulations Title 29, Parts 1900 to 1910

**OSHA 29 CFR 1910.212** General Requirements for (Guarding of) All Machines

**OSHA 29 CFR 1910.147** The Control of Hazardous Energy (lockout/tagout)

**OSHA 29 CFR 1910.217** (Guarding of) Mechanical Power Presses

## International/European Standards

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**ISO/TR 12100-1 & -2 (EN 292-1 & -2)**

Safety of Machinery – Basic Concepts, General Principles for Design

**ISO 13852 (EN 294)** Safety Distances

... Upper Limbs

**ISO 13850 (EN 418)** Emergency Stop Devices, Functional Aspects – Principles for Design

**ISO/DIS 13851 (EN 574)** Two-Hand Control Devices – Functional Aspects – Principles for Design

**ISO 13853 (prEN 811)** Safety Distances

... Lower Limbs

**ISO 13849 (EN 954-1)** Safety-Related Parts of Control Systems

**ISO/DIS 13855 (EN 999)** The Positioning of Protective Equipment in Respect to Approach Speeds of Parts of the Human Body

**ISO 14121 (EN 1050)** Principles of Risk Assessment

**ISO 14119 (EN 1088)** 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** 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



**WARRANTY:** Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.