EZ-SCREEN® Safety Light Screen V-Series

Instruction Manual

Original Instructions
166975 Rev. D
9 May 2014

BANNER®

166975

Contents

1 About This Document

1.1 Important . . . Read This Before Proceeding!

It is the responsibility of the machine designer, controls engineer, machine builder, and/or maintenance electrician to apply and maintain this device in full compliance with all applicable regulations and standards. The device can provide the required safeguarding function only if it is properly installed, properly operated, and properly maintained. This manual attempts to provide complete installation, operation, and maintenance instruction. *Reading the manual in its entirety is highly recommended.* Please direct any questions regarding the application or use of the device to Banner Engineering.

For more information regarding U.S. and international institutions that provide safeguarding application and safeguarding device performance standards, see *Standards and Regulations* on page 56.

WARNING: User Responsibility

The user is responsible to:

- Carefully read, understand, and follow the information in all documentation for this device.
- Perform a risk assessment of the specific machine guarding application. See ISO 12100 or ANSI B11.0.
- Determine what safeguarding devices and methods are appropriate per the requirements defined in ISO 13849-1, ANSI B11.19, and other appropriate standards.
- Create and confirm each configuration and then verify that the entire safeguarding system (including input devices and output devices) is operational and working as intended.
- Periodically re-verify, as needed, that the entire safeguarding system is working as intended.

Failure to follow any of these responsibilities may potentially create a dangerous condition that may lead to serious injury or death.

1.1.1 Use of Warnings and Cautions

This manual contains numerous WARNING and CAUTION statements:

- Warnings refer to potentially hazardous situations which, if not avoided, may lead to serious injury or death.
- Cautions refer to potentially hazardous situations which, if not avoided, which may lead to minor or moderate injury or potential damage to equipment. Cautions are also used to alert against unsafe practices.

These statements are intended to inform the machine designer and manufacturer, the end user, and maintenance personnel, how to avoid misapplication and effectively apply the EZ-SCREEN V-Series Safety Light Screens to meet the various safeguarding application requirements. These individuals are responsible to read and abide by these statements.

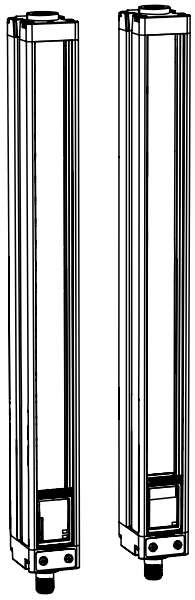
1.1.2 EC Declaration of Conformity (DOC)

Banner Engineering Corp. herewith declares that the EZ-SCREEN V-Series Safety Light Screen are in conformity with the provisions of the Machinery Directive (2006/42/EC) and all essential health and safety requirements have been met.

Representative in EU: Peter Mertens, Managing Director Banner Engineering Europe. Address: Park Lane, Culliganlaan 2F, 1831 Diegem, Belgium.

2 Introduction

2.1 Features



- An optoelectronic safeguarding device
- Can be used alone or as an end unit in a cascade system
- Compatible with other EZ-SCREEN® systems
- Compact package for smaller production machines, robust for large power presses
- Creates a screen of synchronized, modulated infrared sensing beams, sized in 150 mm (6 in) increments: 30 mm (1.18 in) resolution models with defined areas from 150 mm to 1.8 m (6 in. to 71 in)
- Three-digit display provides diagnostic information and indicates the 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
- Safety PLC input compatible (per OSSD specifications)

2.2 System Description

NOTE: This manual refers to an emitter and its receiver, and their cabling as "a System".

Banner EZ-SCREEN V-Series emitters and receivers provide a redundant, microprocessor-controlled, opposed-mode optoelectronic "curtain of light", or "safety light screen". EZ-SCREEN V-Series typically is used for point-of-operation safeguarding, and is suited to safeguard a variety of machinery.

The EZ-SCREEN V-Series is a two-piece (two-box) system comprising an emitter and a receiver, but no external controller. The external device monitoring (EDM) function ensures the fault detection capability required by EN ISO 13849-1 Categories 3 and 4 without a third box, a controller or a "smart" (self-checking) safety module required of systems without EDM.

The EZ-SCREEN V-Series emitters have a row of synchronized modulated infrared (invisible) light-emitting diodes (LEDs) in a compact metal housing. Receivers have a corresponding row of synchronized photodetectors. The light screen created by the emitter and receiver is 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 resolution; range decreases if corner mirrors are used. Emitter and receiver pairs with 30 mm (1.18 in) resolution have a maximum range of 18 m (60 ft).

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 solid-state Output Signal Switching Device (OSSD) safety outputs turn OFF. These safety outputs are connected to the guarded machine’s Final Switching Devices (FSDs) that control the machine primary control elements (MPCEs), which immediately stop the motion of the guarded machine.

The OSSD 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.

Electrical connections are made through M12 (or Euro-style) quick-disconnects. Emitters and all receivers have an 8-pin connector for power, ground, inputs, and outputs.

Functions such as Trip/Output, Cascading, Scan Code Select, and External Device Monitoring are described in *Operating Features* on page 7. All models require a supply voltage of +24V dc ±15%.

Both emitter and the receiver feature 7-segment diagnostic displays and individual LEDs to provide continuous indication of operating status, configuration, and error conditions.

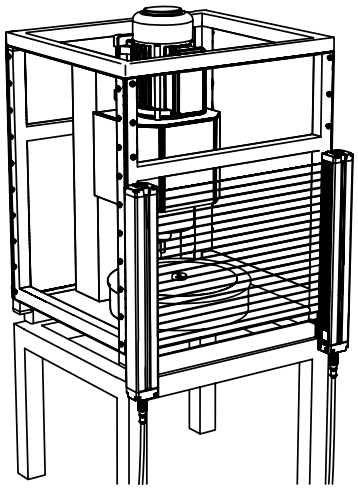


Figure 1. EZ-SCREEN: Typical Application

2.3 Appropriate Applications and Limitations

WARNING: Read this Section Carefully Before Installing the System

If all mounting, installation, interfacing, and checkout procedures are not followed properly, the Banner device cannot provide the protection for which it was designed. The user has the responsibility to ensure that all local, state, and national laws, rules, codes, or regulations relating to the installation and use of this control system in any particular application are satisfied. Ensure that all legal requirements have been met and that all technical installation and maintenance instructions contained in this manual are followed.

The user has the sole responsibility to ensure that this Banner device is installed and interfaced to the guarded machine by Qualified Persons, in accordance with this manual and applicable safety regulations.

The Banner EZ-SCREEN V-Series Safety Light Screens is intended for point-of-operation machine guarding 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 (as defined in the *Glossary* on page 58).

The EZ-SCREEN V-Series 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 EZ-SCREEN V-Series cannot provide the protection for which it was designed.

CAUTION: Install System Only on Appropriate Applications

Banner EZ-SCREEN V-Series is 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 V-Series be used on full-revolution clutched machinery or in unsuitable applications as those listed. If there is any doubt about whether or not your machinery is compatible with the EZ-SCREEN V-Series, contact Banner Engineering.

2.3.1 Examples: Appropriate Applications

EZ-SCREEN V-Series is typically used for, but is not limited to, the following applications:

- Small assembly equipment
- Automated production equipment
- Robotic work cells
- Molding and power presses
- Assembly and packaging machines
- Lean manufacturing systems

2.3.2 Examples: Inappropriate Applications

Do not use EZ-SCREEN V-Series in the following applications:

- With any machine that cannot be stopped immediately after a stop signal is issued, such as single-stroke (or full-revolution) clutched machinery
- With any machine with inadequate or inconsistent machine response time and stopping performance
- With any machine that ejects materials or component parts through the defined area
- In any environment that is likely to adversely affect photoelectric sensing efficiency. For example, corrosive chemicals or fluids or unusually severe levels of smoke or dust, if not controlled, may degrade sensing efficiency
- As a tripping device to initiate or reinitiate machine motion (PSDI applications), unless the machine and its control system fully comply with the relevant standard or regulation (see OSHA 29CFR1910.217, ANSI/NFPA 79, ANSI B11.19, ISO 12100, IEC 60204-1, IEC 61496-1, or other appropriate standard)

If an EZ-SCREEN V-Series is installed for use as a perimeter guard (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 safety related part of the machine control has been manually reset.

2.4 Control Reliability: Redundancy and Self-Checking

Redundancy requires that EZ-SCREEN V-Series 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 V-Series is designed with redundant microprocessors.

Redundancy must be maintained whenever the EZ-SCREEN V-Series is in operation. Because a redundant system is no longer redundant after a component has failed, EZ-SCREEN V-Series 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 EZ-SCREEN V-Series into a Lockout condition.

A recovery from this type of Lockout condition requires:

- Replacement of the failed component (to restore redundancy)
- The appropriate reset procedure

The Diagnostic Display is used to diagnose causes of a Lockout condition. See *Troubleshooting and Lockout Conditions* on page 35.

2.5 Operating Features

The Banner EZ-SCREEN V-Series Safety Light Screen models described by this manual feature standard functions:

- Trip Output
- External Device Monitoring (EDM)
- End unit of a cascade system

These functions are pre-configured within the sensors and in the sensor wiring configuration.

2.5.1 Trip Output

The System is configured for Trip Output which allows the System to enter Run mode automatically. Other measures must be taken to prevent a pass-through hazard; see *Reducing or Eliminating Pass-Through Hazards* on page 12 and the warning below for more information.

The OSSD outputs 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 also automatically resets after all beams are cleared.

WARNING: Use of Trip Output

Application of power to the Banner device, the clearing of the defined area, or the reset of an error condition must not initiate dangerous machine motion. Machine control circuitry must be designed so that one or more initiation devices must be engaged to start the machine (a conscious act), in addition to the Banner device entering Run mode. Failure to follow these instructions may result in a serious bodily injury or death.

2.5.2 Emitter QD and Hookup Options

An EZ-SCREEN V-Series Safety Light Screen emitter with an 8-pin connector can be connected to its own power supply or to the receiver cable color-for-color (see *Figure 17* on page 29 and *Generic Emitter Wiring Diagram* on page 29). The color-for-color hookup allows the emitter and receiver positions to be interchanged without rewiring.

2.5.3 External Device Monitoring (EDM)

The External Device Monitoring (EDM) feature allows the EZ-SCREEN V-Series to monitor the status of external devices, such as MPCEs. The choices are 1- or 2-channel monitoring or no monitoring. EDM is used when the EZ-SCREEN V-Series OSSD outputs directly control the MPCEs or other external devices.

2.5.4 Scan Code Configuration

The EZ-SCREEN V-Series SLSVA..30 emitter and receivers are configured for Scan Code 1 (SC1). Scan Codes enable a receiver to recognize beams only from an emitter with the same Scan Code setting. This minimizes the effects of crosstalk between multiple emitter/receiver pairs, and allows multiple pairs to operate in close proximity in certain situations. If a crosstalk situation occurs, see *Emitter and Receiver Orientation* on page 14 and *Installation of Multiple Systems* on page 17 for proper mounting configurations. If the situation is not resolved, the standard EZ-SCREEN SLS..30-.. System configured for Scan Code 2 (SC2) can replace the EZ-SCREEN V-Series System without changes in wiring. Both the emitter and its corresponding receiver must be set to the same Scan Code.

2.5.5 Status Indicators

Emitter:

Key	Description
A	Status Indicator (Red/Green)—shows whether power is applied, and whether the emitter is in Run mode or Lockout condition.
B	7-segment Diagnostic Display—indicates specific error or configuration conditions.

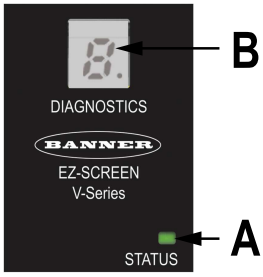


Figure 2. Emitter

Receiver:

Key	Description
A	Reset indicator (Yellow)—shows System status: • Run mode (ON) • Power-up or Lockout (OFF)
B	Status indicator (Red/Green)—shows System status: • Outputs are ON or OFF (green ON or red ON) • The System is in Lockout condition (flashing red)
C	3-Digit Diagnostic Display—indicates specific error, configuration conditions, or total number of blocked beams.
D	Zone indicators (Red/Green)—each shows status of approximately 1/8 of the total beams: • Aligned and clear (green ON) • Blocked and/or misaligned (red ON)
E	Zone 1 Indicator—indicates beam synchronization status

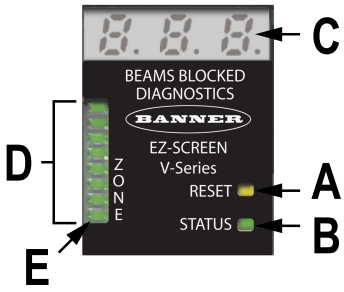


Figure 3. Receiver

2.5.6 Manual Resets and Lockout Conditions

Reset Routine

The EZ-SCREEN V-Series requires a manual reset to clear some Lockout conditions after the cause of the condition is corrected This function is designed to provide a monitored manual reset (that is, an open-closed-open action), such that a shorted or tied-down button cannot cause a reset. When a key-operated switch is used, it 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.

A Lockout condition causes the EZ-SCREEN V-Series OSSD outputs to turn Off. A Lockout condition is indicated by a flashing red emitter or receiver 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 *Troubleshooting and Lockout Conditions* on page 35.

Trip Output/Auto Reset

While the use of a reset switch is recommended, it is not required for EZ-SCREEN V-Series receivers that are configured for Trip Output (automatic reset). Cycling the supply power (Off for > 2 seconds, then On) also clears lockouts if their cause has been corrected. If a reset switch is not used, leave pin 8 (violet wire) not connected (open) and secure it against shorting to a source of power or ground.

2.5.7 Cascade Systems

EZ-SCREEN V-Series emitters and receivers can be used as the end system in a cascade installation with EZ-SCREEN models SLSC..[1]. See EZ-SCREEN Instruction Manual, p/n 112852, for further information on cascading EZ-SCREEN safety light screens.

[1] Models SLSC..-150 not available.

3 Mechanical Installation

The EZ-SCREEN V-Series system performance as a safety guarding device depends on:

- The suitability of the application
- The proper mechanical and electrical installation and interfacing to the guarded machine

WARNING: Read this Section Carefully Before Installing the System

If all mounting, installation, interfacing, and checkout procedures are not followed properly, the Banner device cannot provide the protection for which it was designed. The user has the responsibility to ensure that all local, state, and national laws, rules, codes, or regulations relating to the installation and use of this control system in any particular application are satisfied. Ensure that all legal requirements have been met and that all technical installation and maintenance instructions contained in this manual are followed.

The user has the sole responsibility to ensure that this Banner device is installed and interfaced to the guarded machine by Qualified Persons, in accordance with this manual and applicable safety regulations.

3.1 Mechanical Installation Considerations

The two primary factors that influence the layout of the EZ-SCREEN V-Series system mechanical installation are the Safety Distance (Minimum Distance) (see *Calculating the Safety Distance (Minimum Distance)* on page 10) and the supplemental safeguarding/eliminating pass-through hazards (see *Reducing or Eliminating Pass-Through Hazards* on page 12). Other considerations include:

- *Emitter and Receiver Orientation* on page 14
- *Adjacent Reflective Surfaces* on page 15
- *Use of Corner Mirrors* on page 16
- *Installation of Multiple Systems* on page 17

WARNING: Position Components Carefully

The emitter and receiver must be positioned such that the hazard cannot be accessed by reaching over, under, around, or through the sensing field. Additional and supplemental guarding may be required.

3.1.1 Calculating the Safety Distance (Minimum Distance)

Safety Distance (Ds), also called Minimum Distance (S), is the minimum distance required between the defined area and the closest reachable hazard point. The distance is calculated so that when an object or a person is detected (by blocking a sensing beam), the EZ-SCREEN V-Series sends a stop signal to the machine, causing it to stop by the time the object or person can reach any machine hazard point.

The distance is calculated differently for U.S. and European installations. Both methods take 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 distance has been determined, record the calculated distance on the Daily Checkout Card.

WARNING: Safety Distance (Minimum Distance)

The Banner 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. This distance can be calculated using the formulas in this section, as described by ANSI B11.19 and ISO 13855, and must be greater than 100 mm (4 in) regardless of calculated value. Failure to establish and maintain the minimum distance may result in serious bodily injury or death.

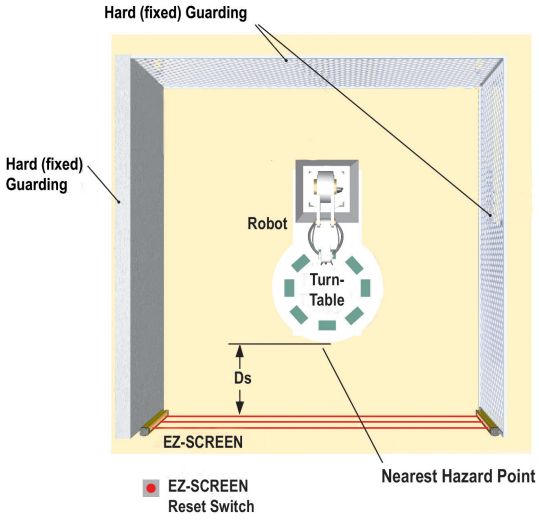


Figure 4. Safety distance and hard (fixed) guarding

Formula and Examples

U.S. Applications

The Safety (Separation) Distance formula for U.S. applications:

Ds = K x (Ts + Tr) + Dpf

Ds
: the Safety Distance, in inches

K
: 1600 mm per second (or 63 in per second), the OSHA 29CFR1910.217, and ANSI B11.19 recommended hand-speed constant (see Note 1 below)

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 (for example, IM-T-.. Interface Modules) and measured at maximum machine velocity (see Note 3 below)

Tr
: the maximum response time, in seconds, of the EZ-SCREEN V-Series emitter/receiver pair (depending on model)

Dpf
: the added distance due to the depth penetration factor as prescribed in OSHA 29CFR1910.217, and ANSI B11.19 for U.S. applications. For SLSVA..30-.. installations, the value for Dpf is 78 mm (3 in).

European Applications

The Minimum Distance formula for European applications:

S = (K x T) + C

S
: the Minimum Distance, in mm, from danger zone to light screen center line

K
: hand-speed constant (see Note 2 below); 2000 mm/s (for Minimum Distances ≤ 500 mm) 1600 mm/s (for Minimum Distances > 500 mm)

T
: the overall machine stopping response time (in seconds), from the physical initiation of the safety device and the machine coming to a stop (or the hazard removed). This can be broken down into two parts: Ts and Tr where T = Ts + Tr

C
: the additional distance, in mm, based on intrusion of a hand or object towards the danger zone prior to actuation of a safety device. Calculate using the formula:

C = 8 x (d - 14)

where d is the resolution of the light curtain (for d < 40 mm), for SLSVA..30-.. installations, the value for C is 128 mm (5 in).

Notes:

1. The OSHA-recommended hand speed constant K has been determined by various studies and, although these studies indicate speeds of 1600 mm/sec. (63 in/sec.) to more than 2500 mm/sec. (100 in/sec.), 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. The recommended hand speed constant K, derived from data on approach speeds of the body or parts of the body as stated in ISO 13855.
3. 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.

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

If required, each of the two Machine Primary Control Elements (MPCE1 and MPCE2) must be capable of immediately stopping the dangerous machine motion, regardless 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 safety distance) must take into account the slower of the two channels.

Examples

Example: U.S. Applications, Model SLSVAP30-600Q88

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

Ts = 0.32 (0.250 second is specified by the machine manufacturer; plus 20% safety factor; plus 20 ms for interface module IM-T-9A response time)

Tr = 0.15 seconds (the specified response time of an SLPM..14-550 EZ-SCREEN V-Series)

Dpf = 3 in (30 mm resolution)

Substitute the numbers into the formula as follows:

Ds = K x (Ts + Tr) + Dpf

Ds = 63 x (0.32 + 0.015) + 3 = 24.1 in

Mount the EZ-SCREEN V-Series emitter and receiver so that no part of the defined area will be closer than 24.1 in. to the closest reachable hazard point on the guarded machine.

Example: European Applications, Model SLSVAP30-600Q88

K = 1600 mm per second

T = 0.335 (0.250 second specified by machine manufacturer; plus 20% safety factor; plus 20 ms interface module response time), plus 0.15 seconds (the specified SLPM..14-550 response time)

C = 8 x (30 - 14) = 128 mm (30 mm resolution)

Substitute the numbers into the formula as follows:

S = (K x T) + C

S = (1600 x 0.335) + 128 = 664 mm

Mount the EZ-SCREEN V-Series emitter and receiver so that no part of the defined area will be closer than 664 mm to the closest reachable hazard point on the guarded machine.

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

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 safety requirements in ANSI B11.19 or other appropriate standards.

An alternative 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 the Banner device for Perimeter Guarding

If a Banner device is installed in an application that results in a pass-through hazard (for example, perimeter guarding), either the Banner device 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.

Lockout/Tagout procedures per ANSI Z244.1 may be required, or additional safeguarding, as described by ANSI B11.19 safety requirements or other appropriate standards, must be used if a passthrough hazard cannot be eliminated or reduced to an acceptable level of risk. Failure to observe this warning may 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 and guidelines below. 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 (for example, through the use of rings or guards).

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. When considering where to locate the reset switch, follow the guidelines below.

WARNING: Reset Switch Location

When considering where to locate the reset switch, you must follow the guidelines outlined in this section.

If any areas within the guarded area are not visible from the reset switch, additional safeguarding must be provided, as described by the ANSI B11.19 series or other appropriate standards.

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

All reset switches must be:

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

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

3.1.4 Supplemental Safeguarding

As described in *Calculating the Safety Distance (Minimum Distance)* on page 10, the EZ-SCREEN V-Series must be properly positioned such that an individual cannot reach through the defined area and access the hazard point before the machine has stopped.

Additionally, the hazard cannot 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 B11.19 safety requirements or other appropriate standards, must be installed. Access will then be possible only through the defined area of the EZ-SCREEN V-Series System or through other safeguarding that prevents access to the hazard (see *Figure 5* on page 14).

The mechanical barriers used for this purpose are typically called "hard (fixed) guarding"; there must be no gaps between the hard (fixed) guarding and the defined area. Any openings in the hard (fixed) guarding must comply with the safe opening requirements of ANSI B11.19 or other appropriate standard.

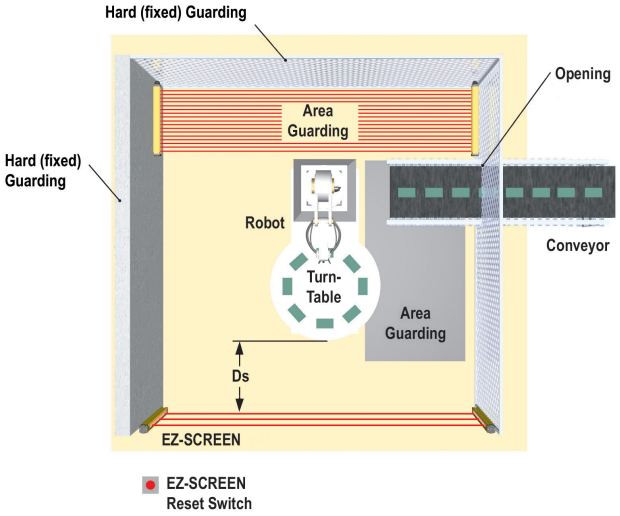


Figure 5. An example of supplemental safeguarding

Figure 5 on page 14 shows an example of supplemental safeguarding inside a robotic work cell. The EZ-SCREEN V-Series, in conjunction with the hard (fixed) guarding, is the primary safeguard. Supplemental safeguarding (such as a horizontal-mounted safety light screen as an area guard) is required in areas that cannot be viewed from the reset switch (for example, behind the robot and the conveyor). Additional supplemental safeguarding may be required to prevent clearance or trapping hazards (for example, a safety mat as an area guard between the robot, the turntable, and the conveyor).

WARNING: The Hazard Must Be Accessible Only through the Defined Area

The installation of the EZ-SCREEN V-Series must prevent any individual from reaching around, under, over or through the defined area and into the hazard without being detected. Mechanical barriers (for example, hard (fixed) guarding) or supplemental safeguarding may be required to comply with this requirement, and is described by ANSI B11.19 safety requirements or other appropriate standards.

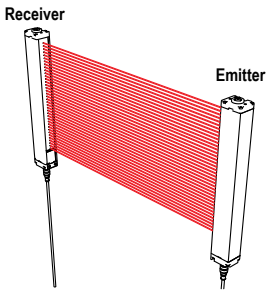
3.1.5 Emitter and Receiver Orientation

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 in the opposite direction of 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.

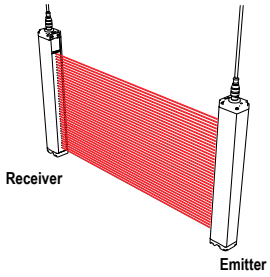
The emitter and receiver may be oriented in a vertical or horizontal plane, or at any angle between horizontal and vertical, as long as they are parallel to each other and their cable ends point in the same direction. Verify that the light screen completely covers all access to the hazard point that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

WARNING: Proper Orientation of System Emitters and Receivers

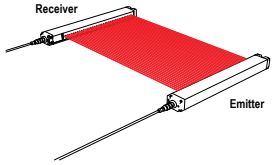
EZ-SCREEN V-Series emitters and receivers must be installed with their corresponding cabled ends pointing in the same direction (for example, both cabled ends facing up). Failure to orient them properly will impair the performance of the EZ-SCREEN V-Series System and will result in incomplete guarding,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



Both cable ends down

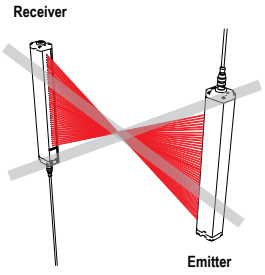


Both cable ends up



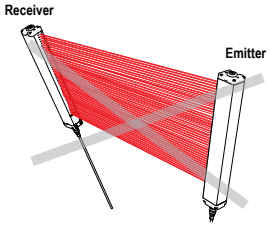
Orientation parallel to floor with both cable ends pointing in the same direction

Figure 6. Examples of Correct Emitter/Receiver Orientation



Cable ends point in opposite directions

Problem: Voids in defined area



Emitter and receiver not parallel to each other

Problem: Reduced excess gain

Figure 7. Examples of Incorrect Emitter/Receiver Orientation

3.1.6 Adjacent Reflective Surfaces

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 V-Series. Perform the trip test, as described in this manual, 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 injury or death.

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 8* on page 16).

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 and the periodic checkout procedures. 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
- Otherwise, if possible, paint, mask, or roughen the shiny surface to reduce its reflectivity
- Where these are not possible (as with a shiny workpiece or machine frame), determine the worst-case resolution resulting from the optical short circuit and use the corresponding depth penetration factor (Dpf or C) in the Safety Distance (Minimum Distance) formula; or mount the sensors in such a way that the receiver's field of view and/or the emitter's spread of light are restricted from the reflective surface

- Repeat the trip test (see *Trip Test* on page 24) 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

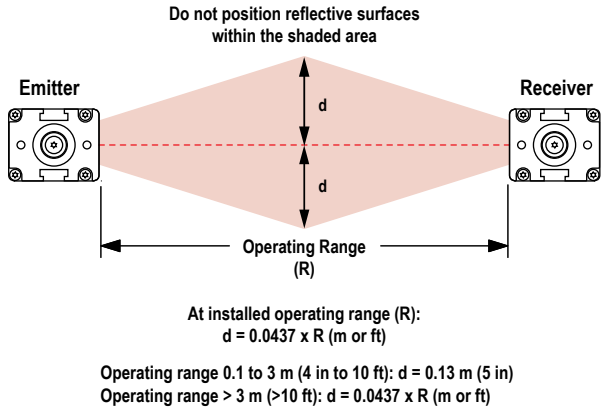


Figure 8. Adjacent Reflective Surfaces

3.1.7 Use of Corner Mirrors

EZ-SCREEN V-Series may be used with one or more corner mirrors. Mirrors are not allowed for applications that would allow undetected personnel access into the safeguarded area. The use of glass-surface corner mirrors reduces the maximum specified emitter/receiver separation by approximately 8 percent per mirror, as follows:

Table 1: SSM and MSM Series Glass-Surface Mirrors [2] —Maximum Emitter and Receiver Separation

Number of Corner Mirrors	Max. Emitter / Receiver Range	Sensor Models
1	16.6 m (54.5 ft)	30 mm Resolution Models with 18 m (60 ft) Range
2	15.3 m (50 ft)	
3	14.1 m (46.5 ft)	
4	13 m (43 ft)	

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 9* on page 17). If placed at a sharper angle, an object in the light screen may deflect beam(s) to the receiver, preventing the object from being detected, also know as false proxing. Angles greater than 120° result in difficult alignment and possible optical short circuits.

WARNING: Avoid Retroreflective Installation

Do not install emitters and receivers in "retroreflective" mode, with less than a 45° angle of incidence, as shown. Sensing may be unreliable in this configuration and result in a serious bodily injury or death.

[2] *See the specific mirror data sheet or www.bannerengineering.com for further information.*

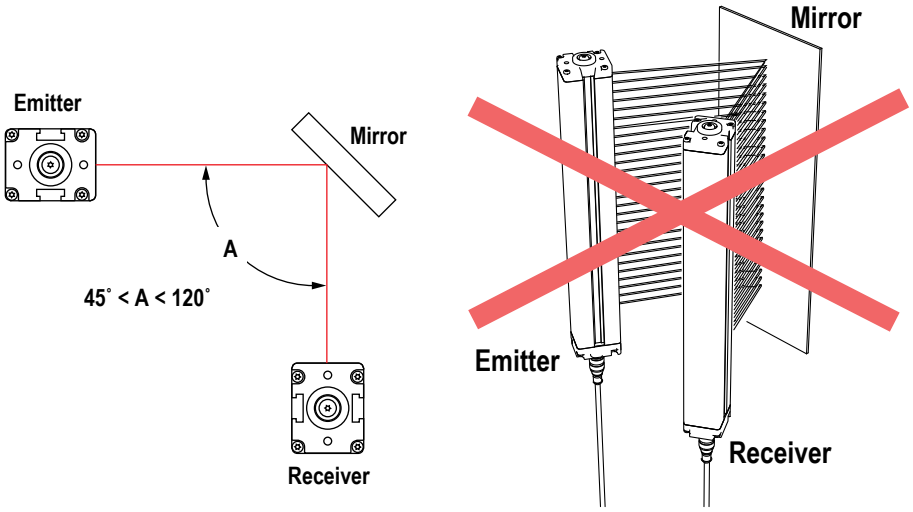


Figure 9. Using EZ-SCREEN V-Series sensors in a retroreflective mode

3.1.8 Installation of Multiple Systems

Whenever two or more EZ-SCREEN V-Series emitter and receiver pairs are adjacent to one another, optical crosstalk may take place between the systems. To minimize optical crosstalk, alternate the positions of the emitters and receivers (see *Figure 10* on page 18), or alternate Scan Codes.

When three or more systems are installed in the same plane (as shown in *Figure 10* on page 18), 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 standard EZ-SCREEN SLS..30-.. System configured for Scan Code 2 (SC2) can replace the V-Series without changes in the wiring. Both the emitter and its corresponding receiver must be set to the identical Scan Code. The EZ-SCREEN V-Series SLSVA..30 emitter and receivers are configured for Scan Code 1 (SC1).

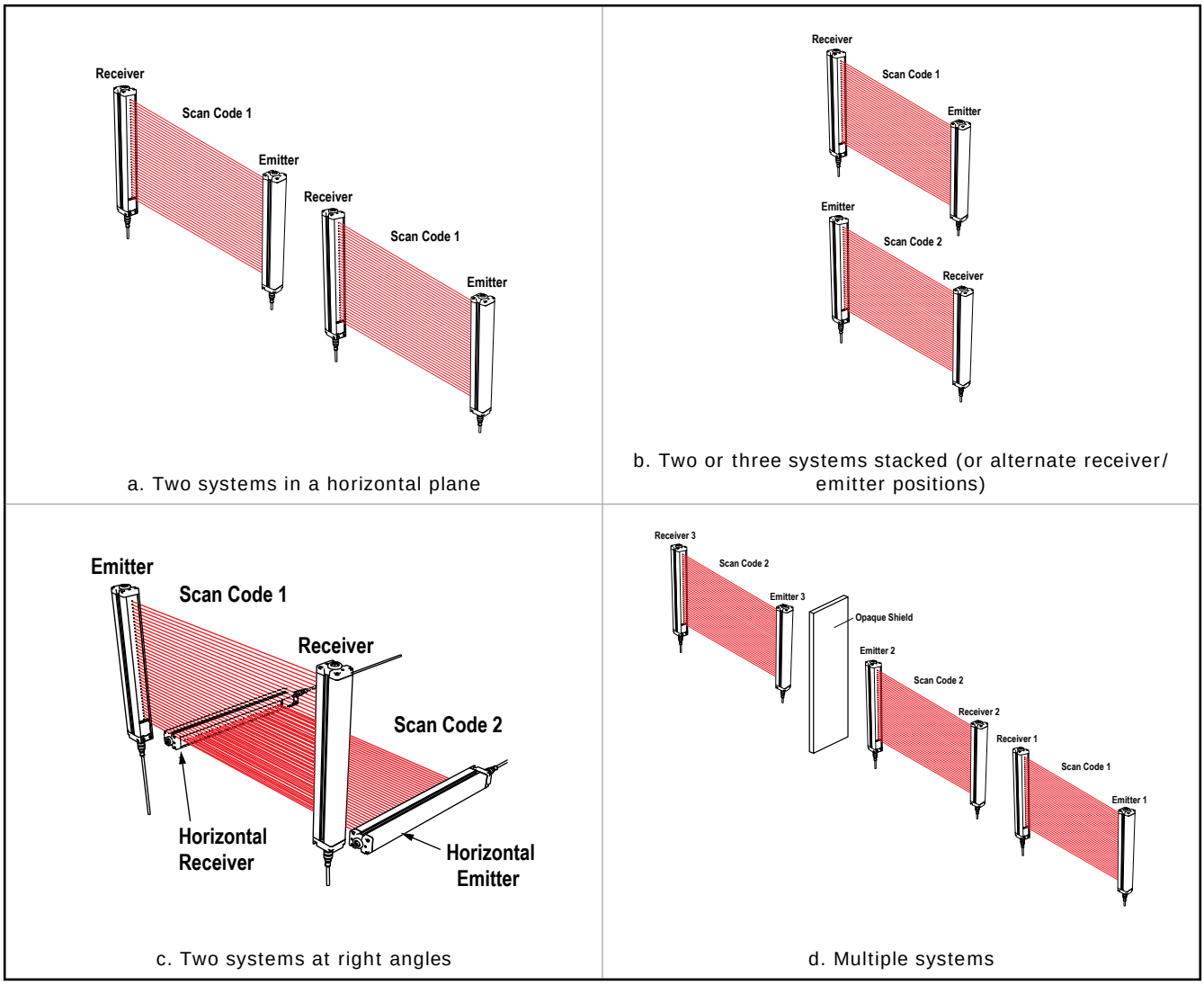


Figure 10. Installation of Multiple Systems

WARNING: Multiple Pairs of Sensors

Do not connect multiple pairs of sensors to one Interface Module (for example, IM-T-9A/-11A) or otherwise parallel OSSD outputs. Connection of multiple OSSD safety outputs to a single device may result in serious bodily injury or death, and is prohibited.

WARNING: Scan Code

In situations where multiple systems are mounted closely together, or where a secondary emitter is in view (within ±5°) and within range of an adjacent receiver, the adjacent systems must be configured for different Scan Codes (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 is discovered by performing the trip test.

3.2 Mechanical Mounting Procedure

Once the mechanical layout consideration of *Mechanical Installation Considerations* on page 10 are addressed, mount the sensors and route the cables.

3.2.1 Mounting the Emitter and Receiver

Emitter/receiver pairs with 30 mm (1.18 in) resolution may be spaced from 0.1 m to 18 m (4 in. to 60 ft) apart. The maximum distance between an emitter and its receiver is reduced if corner mirrors are used (see *Use of Corner Mirrors* on page 16). The supplied brackets allow ±30° rotation, when mounted to the sensor end caps.

From a common point of reference, ensuring the Safety Distance (Minimum Distance) calculated in *Calculating the Safety Distance (Minimum Distance)* on page 10, make measurements to locate the emitter and receiver in the same plane, with their midpoints and display ends directly opposite each other.

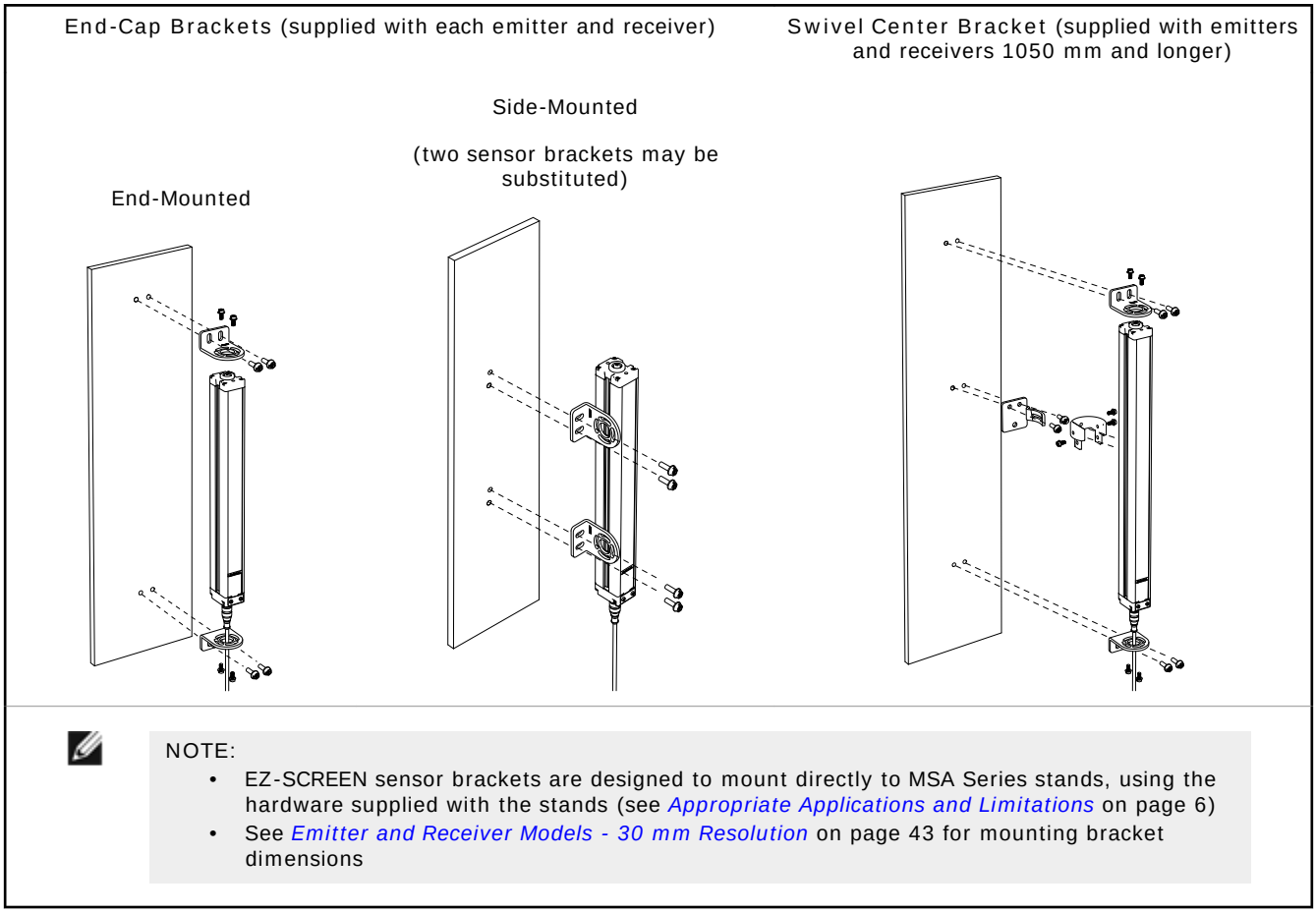
NOTE: The connector ends of both sensors must point in the same direction (see *Emitter and Receiver Orientation* on page 14).

Mount the emitter and receiver mounting brackets using the supplied M6 bolts and Keps nuts, or user-supplied hardware.

Mount the emitter and receiver in their brackets; position their windows directly facing each other. Measure from a reference plane (for example, 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 *Replacement Parts* on page 54), or check the diagonal distances between the sensors to achieve mechanical alignment. Final alignment procedures are explained in *Initial Checkout Procedure* on page 21.

Center mounting brackets must be used with longer sensors if they are subject to shock or vibration. In such situations, the sensors are designed to be mounted with up to 900 mm (35.43 in) unsupported distance (between brackets). Sensors 1050 mm (45.33 in) and longer are supplied with a center bracket to be used as needed with the standard end-cap brackets.

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.



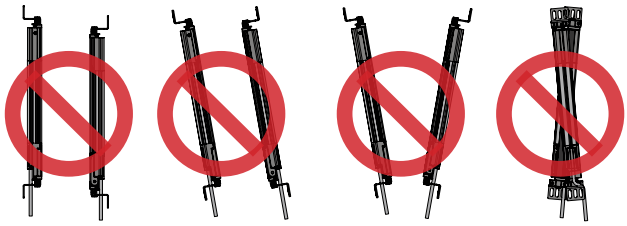
NOTE:
- EZ-SCREEN sensor brackets are designed to mount directly to MSA Series stands, using the hardware supplied with the stands (see *Appropriate Applications and Limitations* on page 6)
- See *Emitter and Receiver Models - 30 mm Resolution* on page 43 for mounting bracket dimensions

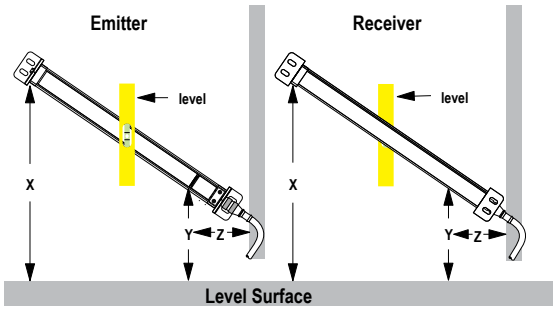
Figure 11. Sensor Brackets

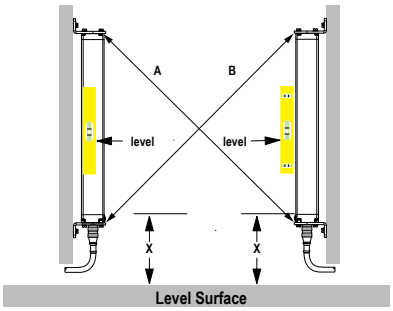
3.2.2 Sensor Mounting and Mechanical Alignment

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 (the window) is level/plumb
- Defined area is square. Check diagonal measurements if possible; see Vertical Installations, on the 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).

3.2.3 Mounting the Reset Switch

Mount the reset switch in a location that complies with the warning in *Reset Switch Location* on page 13. See *Initial Electrical Connections* on page 21 for electrical connection.

3.2.4 Routing Cordsets

Attach the required cordsets to the sensors, 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 *Cordsets* on page 47 for selection of Banner supplied cables.

EZ-SCREEN V-Series 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 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 V-Series System. It is good wiring practice, and sometimes 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 cabling and any interconnect wiring should have an insulation temperature rating of at least 90 °C (194 °F). In addition, QD cabling and any interconnect wires should meet the specifications in the following table:

Table 2: Maximum Machine Interface cable length versus total current draw (including both OSSD loads)

	0.5A	0.75A	1.0A	1.25A	1.5A	1.75A
18 AWG	114.3 m (375 ft)	76.2 m (250 ft)	57.3 m (188 ft)	45.1 m (148 ft)	38.1 m (125 ft)	33.2 m (109 ft)
20 AWG	73.1 m (240 ft)	48.8 m (160 ft)	36.6 m (120 ft)	30.0 m (95 ft)	24.4 m (80 ft)	21.3 m (70 ft)
22 AWG [3]	45.7 m (150 ft)	30.5 m (100 ft)	22.9 m (75 ft)	18.0 m (59 ft)	15.2 m (50 ft)	13.4 m (44 ft)

NOTE: Maximum cable lengths are intended to ensure that adequate power is available to the EZ-SCREEN System when the supply is operating at +24 V dc – 15%.

3.3 Initial Electrical Connections

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 V-Series System than are described in this manual. Connection of other wiring or equipment to the EZ-SCREEN V-Series System could result in serious bodily injury or death.

Lockout/tagout procedures may be required (refer to OSHA1910.147, ANSI Z244-1, ISO 14118, 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 the earth ground (green/yellow wire). Do not operate the EZ-SCREEN V-Series without an earth ground connection.

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 M12 Euro-style quick-disconnects.

When installing QD cables, do not use tools to tighten the coupling nut—hand-tighten only. Do not rotate the body of the QD, or damage to the connector can occur.

Emitter Cordset

EZ-SCREEN V-Series emitters have an 8-pin cordset, but not all conductors are used. The unused wires are in place to allow a parallel connection (color-for-color) to the receiver cable providing sensor interchangeability (or “swapability”); either sensor may be installed at either cordset connection. In addition to providing similar cabling, this wiring scheme is advantageous during installation, wiring, and troubleshooting.

Receiver Cordset

Do not connect any wires to the machine control circuits (that is, OSSD outputs) at this time. For the initial power-up and checkout, normally open 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 (for example, terminate with the included wire-nut). Final EDM wiring must be completed later.

If used, connect the external reset switch to the reset wire (violet) on the receiver cable and to 24V dc (see *Figure 19* on page 30 and *Figure 21* on page 31). See the warning in *Reset Switch Location* on page 13 about the physical location of the 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 Initial Checkout Procedure

The initial checkout procedure must be performed by a Qualified Person. It must be performed only after configuring the System and after connecting the emitter and receiver.

The procedure is performed on two occasions:

- To ensure proper installation when the System is first installed
- To ensure proper System function whenever any maintenance or modification is performed on the System or on the machinery that is guarded by the System.

[3] QDE-...D cables, see *Cordsets* on page 47

3.4.1 Configuring the System for Initial Checkout

For the initial checkout, the EZ-SCREEN V-Series System must be checked without power 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, ISO 14118, 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 and its controls or actuators
- The machine control circuit or the Interface Module is not connected to the OSSD outputs at this time (permanent connections will be made later)
- EDM is configured for *no monitoring*

3.4.2 Initial Power-Up

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 *Adjacent Reflective Surfaces* on page 15).
2. Eliminate the reflective surfaces as much possible by relocating, painting, masking, or roughening them. Remaining problem reflections will become apparent during the trip test.
3. Verify that power is removed from the EZ-SCREEN V-Series System and from the guarded machine and that the OSSD safety outputs are not connected.
4. Remove all obstructions from the light screen.
5. Leaving power to the guarded machine Off, make power and earth ground connections on both the emitter and receiver cables (see *Generic Emitter Wiring Diagram* on page 29).
6. Power up the EZ-SCREEN V-Series System only.
7. Verify that the input power is present to both the emitter and the receiver. At least one indicator on both the emitter and the receiver should be On and the start-up sequence should cycle.
8. Watch both the emitter and the receiver Status indicators and the receiver Zone indicators to determine the light screen alignment status.
    - Lockout Condition (emitter or receiver)—the Status indicator single-flashes Red, and the receiver Zone and Reset indicators are Off. Proceed to *Troubleshooting and Maintenance* on page 35 for diagnostic information.
    - Normal Operating Mode (emitter)—The Status indicator is On Green.
    - Test Mode: On the receiver, the red Status Blocked indicator is On and the green Status Clear indicator is flashing. Test input is open.
    - Clear (Run) Condition (receiver)—The Status indicator is On Green (or flashing Green if reduced resolution is enabled), and the Reset indicator is On Yellow. All Zone indicators are 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 (see *Optical Alignment* on page 22). 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 must directly face each other. Proceed to *Trip Test* on page 24 after optimum optical alignment is verified.
    - A Blocked Condition (receiver)—The Status indicator is On Red, the yellow Reset indicator is On, one or more Zone indicator(s) are On Red, identifying the location of the blocked beams, and the number of blocked beams is displayed. Proceed to *Optical Alignment* on page 22.

NOTE: If beam 1 is blocked, Zone indicator 1 is Red and all others are Off. Beam 1 provides the synchronization signal.

3.4.3 Optical Alignment

CAUTION: Ensure that no individuals are exposed to any hazard if the OSSD outputs turn ON when the emitter and receiver become aligned.

1. Verify the sensor mounting, see *Mounting the Emitter and Receiver* on page 19 .
2. Verify the optimal alignment, adjusting sensor rotation with power ON:
   a. Verify that the emitter and the receiver are pointed squarely at each other. Use a straight edge (for example, a level) to determine the direction the sensor is facing. 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.

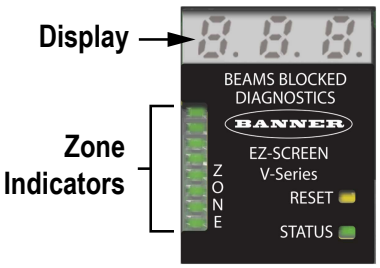
   b. Turn ON power to the emitter and the receiver. If Channel #1 beam is not aligned, the Status and Zone 1 indicators are Red, and the Diagnostics Display indicates "CH1". Zone indicators 2–8 are OFF.
   c. If the Green Status and Yellow Reset indicators are ON, go to the Next Step. If not, rotate each sensor (one at a time) left and right until the Green Status indicator is ON. (As the sensor rotates out of alignment, the Red Status indicator turns ON steady). As more beams are aligned, the Zone indicators turns from Red to Green and the number of blocked beam indicators decreases.

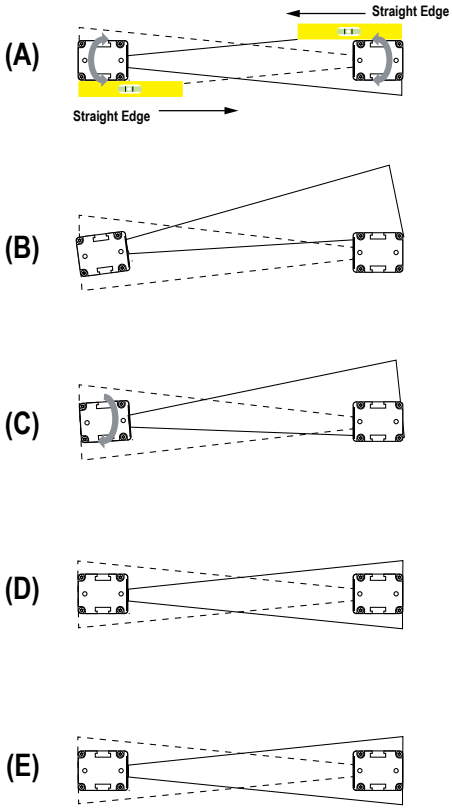
      NOTE: If the emitter Test input is open, the 7-segment Display indicates the total number of beams in the system (minus one) and all Zone indicators are Red (except for 10-beam systems, where the Zone 1 indicator is Green).

   d. To optimize the alignment, note the position where the Red Status indicator turns 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. Repeat for the second sensor.

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

NOTE: If at any time the Red Status indicator begins to flash steadily, the System has entered a Lockout condition. See *Troubleshooting and Lockout Conditions* on page 35 for further information.





3.4.4 Optical Alignment Procedure with Mirrors

EZ-SCREEN V-Series 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 *Use of Corner Mirrors* on page 16.

In addition to the standard optical alignment procedure, verify:

1. That the emitter, receiver, and all mirrors are level and plumb.
2. 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.

NOTE: A LAT-1-SS Laser Alignment Tool is very helpful by providing a visible red dot along the optical axis. See *Figure 12* on page 24 and Banner Safety Applications Note SA104 (p/n 57477) for further information.

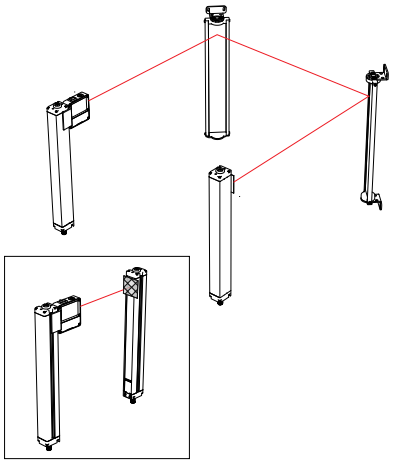


Figure 12. Optical alignment using the LAT-1-SS

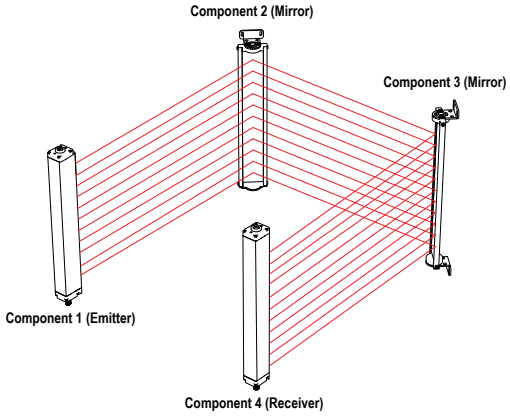


Figure 13. Corner Mirror Alignment

3.4.5 Trip Test

After optimizing the optical alignment, perform the trip test to verify the detection capability of the EZ-SCREEN V-Series System. This test will also verify correct sensor orientation and identify optical short circuits. Once the installation has passed the trip test, the safety outputs may be connected and the commissioning checkout may be performed (initial installations only).

NOTE: Cascaded systems—To test a cascaded system, each light screen must be tested individually, while monitoring the status indicator on the first receiver in the cascade.

1. Use the 30 mm (1.18 in) diameter specified test piece supplied with the receiver (Model STP-14).
2. Verify that the System is in Run mode, the Green Status indicator is ON, all Zone indicators are Green, and the Yellow Status indicator is ON.
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.

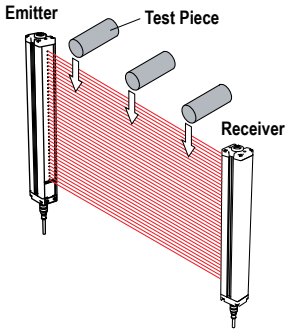


Figure 14. Trip Test

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.

    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.

    WARNING: If Trip Test Indicates a Problem

    If the EZ-SCREEN V-Series 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.

5. If mirrors are used in the application: Test the defined area on each leg of the sensing path (for example, emitter to mirror, between mirror and receiver, see *Figure 15* on page 25).

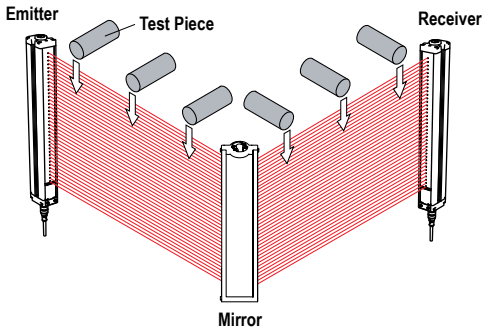


Figure 15. Trip Test with Corner Mirror

6. If the EZ-SCREEN V-Series System passes all checks during the trip test, go on to *Electrical Connections to the Guarded Machine* on page 25.

3.5 Electrical Connections to the Guarded Machine

Verify that power has been removed from the EZ-SCREEN V-Series and the guarded machine. Make the permanent electrical connections as described in *OSSD Output Connections* on page 26 and *FSD Interfacing Connections* on page 26 as required by each individual application.

Lockout/tagout procedures may be required (refer to OSHA 1910.147, ANSI Z244-1, ISO 14118, or the appropriate standard for controlling hazardous energy). Follow relevant electrical standards and wiring codes, such as the NEC, NFPA79 or IEC 60204-1.

Supply power and the external reset switch should already be connected. The EZ-SCREEN V-Series must also have been aligned and passed the Initial Checkout, as described in *Initial Checkout Procedure* on page 21.

The final connections to be made are:

- OSSD outputs
- FSD interfacing
- MPCE/EDM

CAUTION: Shock Hazard

Always disconnect power from the Banner device 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

Refer to the output specifications in *Receiver Specifications* on page 44 and the warning below before making OSSD output connections and interfacing the EZ-SCREEN V-Series to the machine.

WARNING: Interfacing of Both OSSDs

Both 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) (for example, PLC, PES, or 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 Banner device output parameters and machine input parameters must be considered when interfacing the Banner device 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 may result in serious bodily injury or death.

3.5.2 FSD Interfacing Connections

FSDs (Final Switching Devices) takes many forms. The most common are forced-guided, mechanically linked relays, or interface modules. 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 V-Series. FSDs can also be used to control an additional number of hazards by creating multiple safety stop circuits.

Protective Stop (Safety Stop) Circuits

A protective stop (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 protective stop circuit typically comprises a minimum of two normally open 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, protective stop circuits are either single-channel, which is a series connection of at least two normally open contacts; or dual-channel, which is a separate connection of two normally open 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 arrests the hazards and prevents the next cycle from occurring. See *Figure 19* on page 30.

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

The normally open safety outputs from an interface module provide a series connection of redundant contacts that form protective stop circuits for use in either single-channel or dual-channel control. See *Figure 21* on page 31.

Dual-Channel Control

Dual-channel control provides the ability to electrically extend the safe switching point beyond the FSD contacts. With proper monitoring, 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 a loss of the switching ability of one of the FSD outputs. Such failures may lead to a 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 increases, 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 a 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 cannot 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 Input

A machine primary control element (MPCE) is an electrically powered element that directly controls the normal operation of a machine in such a way that it is the last element (in time) to function when machine operation is to be initiated or arrested (per IEC61496-1). Examples include motor contactors, clutch/brakes, valves, and solenoids.

Depending on the level of risk of harm, it may be required to provide redundant MPCEs or other control devices that are capable of immediately stopping the dangerous machine motion, irrespective of the state of the other. These two machine control channels need not be identical (diverse redundant), but the stop time performance of the machine (Ts, used to calculate the safety distance, see *Calculating the Safety Distance (Minimum Distance)* on page 10) must take into account the slower of the two channels. Refer to *Figure 21* on page 31 or consult the machine manufacturer for additional information.

To ensure that an accumulation of failures does not compromise the redundant control scheme (cause a failure to danger), a method to verify the normal functioning of MPCEs or other control devices is required. EZ-SCREEN V-Series provides a convenient method for this verification: external device monitoring (EDM).

For the EZ-SCREEN V-Series external device monitoring to function properly, each device must include a normally closed, forced-guided (mechanically linked) contact that can accurately reflect the status of the device. This ensures that the normally open contacts, used for controlling hazardous motion, have a positive relationship with the normally closed monitoring contacts and can detect a failure to danger (for example, contacts that welded closed or stuck On).

It is strongly recommended that a normally closed, forced-guided monitoring contact of each FSD and MPCE be connected in series with the EDM input (see *Figure 19* on page 30 and *Figure 21* on page 31). If this is done, proper operation will be verified. Monitoring FSD and MPCE contacts is one method of maintaining control reliability (OSHA/ANSI) and Category 3 and 4 (ISO13849-1).

If monitoring contacts are not available or do not meet the design requirement of being forced-guided (mechanically linked), it is recommended to:

- Replace the devices so that they are capable of being monitored

or

- Incorporate the EDM function into the circuit as close to the MPCE as possible (for example, monitor the FSDs)

and

- Employ the use of well-tried, tested, and robust components, and generally accepted safety principles, including fault exclusion, into the design and installation to either eliminate, or reduce to an acceptable (minimal) level of risk, the possibility of undetected faults or failures that can result in the loss of the safety function.

The principle of fault exclusion allows the designer to design out the possibility of various failures and justify it through the risk assessment process to meet the required level of safety performance, such as the requirements of Category 2, 3, or 4. See ISO 13849-1/-2 for further information.

WARNING: EDM Monitoring

If the System is configured for “No Monitoring,” it is the user’s responsibility to ensure that this does not create a hazardous situation.

External Device Monitoring

EZ-SCREEN V-Series provides two possible EDM configurations: 2-channel monitoring and no monitoring. Their functions are described below. Two-channel monitoring has the ability to detect failures, such as short circuits, and should be used when those failures cannot be designed out or reasonably be excluded. Two-channel monitoring is the default setting and has the advantage of additional diagnostic capability that can identify which specific element that has slowed or failed.

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 *Figure 19* on page 30 and *Figure 21* on page 31). Pins 2 and 3 of the receiver connector provide connection for the external device monitoring input. External device monitoring (EDM) must be wired in one of two configurations described below.

Two-Channel Monitoring: This is an independent connection of closed monitor contacts that are forced-guided (mechanically linked) from each device controlled by the EZ-SCREEN. The monitor contacts must be closed before the EZ-SCREEN can be reset and the OSSDs can turn ON. Regardless of the state of the OSSDs, the monitor contacts may change state (either both open, or both closed). If the monitor contacts remain in opposite states for more than 250 milliseconds, a lockout occurs.

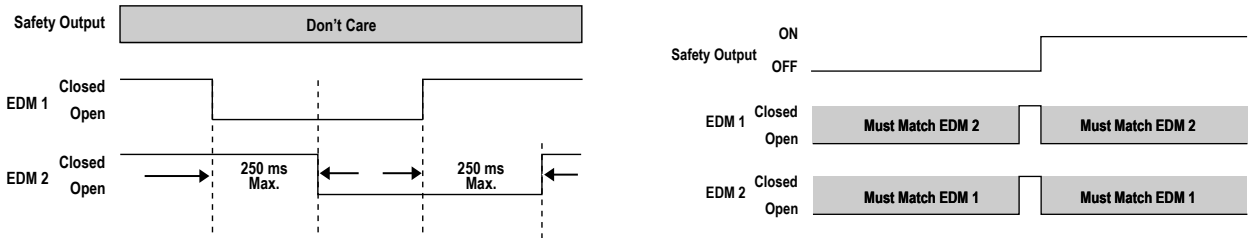


Figure 16. 2-Channel EDM Hookup

Refer to the figures above 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).

No Monitoring: Use this configuration to perform the initial checkout; see *Initial Checkout Procedure* on page 21. *If the application does not require the EDM function, it is the user's responsibility to ensure that this configuration does not create a hazardous situation.* To configure the System for No Monitoring, connect or jumper EDM1 (pin 3) to EDM2 (pin 2) using the supplied wire-nut.

Refer to *Figure 20* on page 30 for “no monitoring” hookup.

3.6 Preparing for System Operation

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

The operation of the EZ-SCREEN V-Series 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 *Commissioning Checkout* on page 40.

3.7 Sensor "Swapability"

Figure 17 on page 29 illustrates a hookup option that provides sensor interchangeability (or “swapability”)—the ability to install either sensor at either QD connection.

The resulting installation provides the ability to swap the emitter and receiver position. This hookup option provides advantages during installation, wiring, and troubleshooting.

To hook up the emitter, use only three conductors (Brown = +24V dc, Blue = 0V dc, and Green/Yellow = GND). Connect the remaining wires in a parallel connection (color-for-color) to the receiver cable.

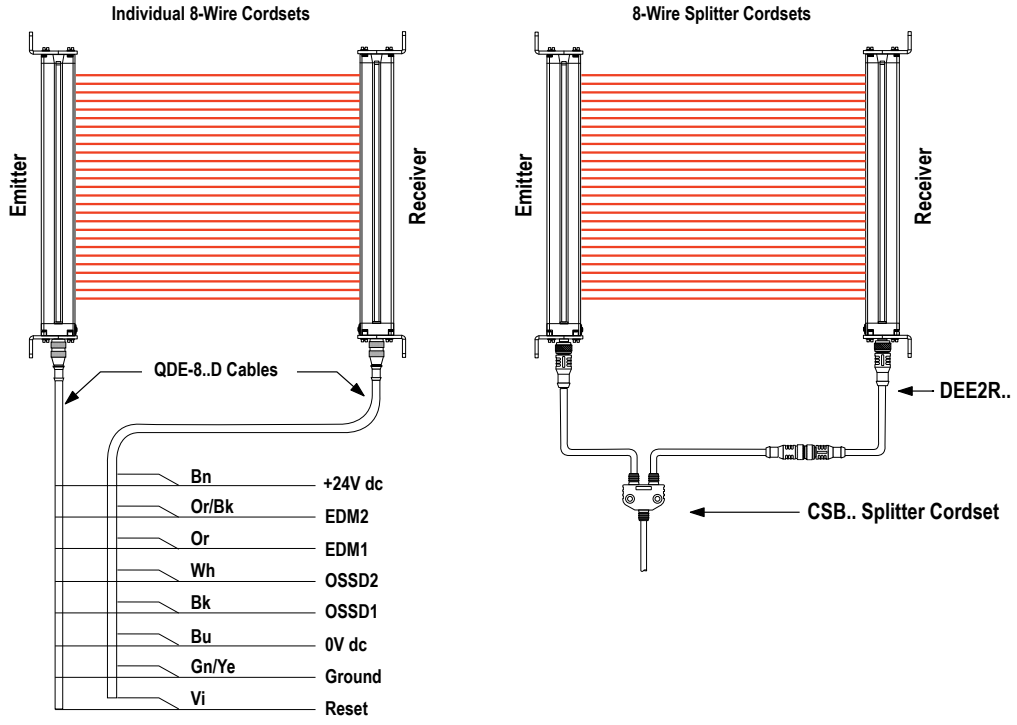


Figure 17. 8-pin connectors (optional hookup)

Model CSB.. splitter cordsets and DEE2R.. double-ended cables allow easy interconnection between an EZ-SCREEN receiver and emitter, providing a single trunk cable for the optional "swapable" hookup (see *Routing Cordsets* on page 20).

3.8 Generic Emitter Wiring Diagram

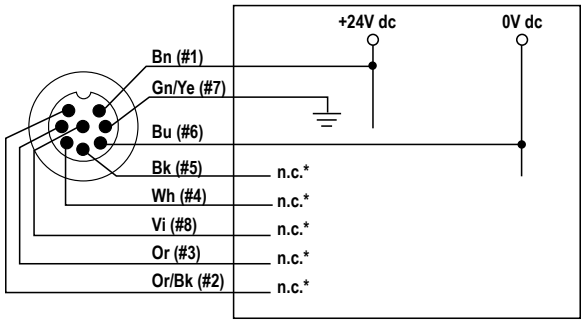


Figure 18. Emitter—Generic hookup

NOTE: *Pins 2, 3, 4, 5, and 8 are not connected or are connected in parallel to the same color wire from the receiver cable.

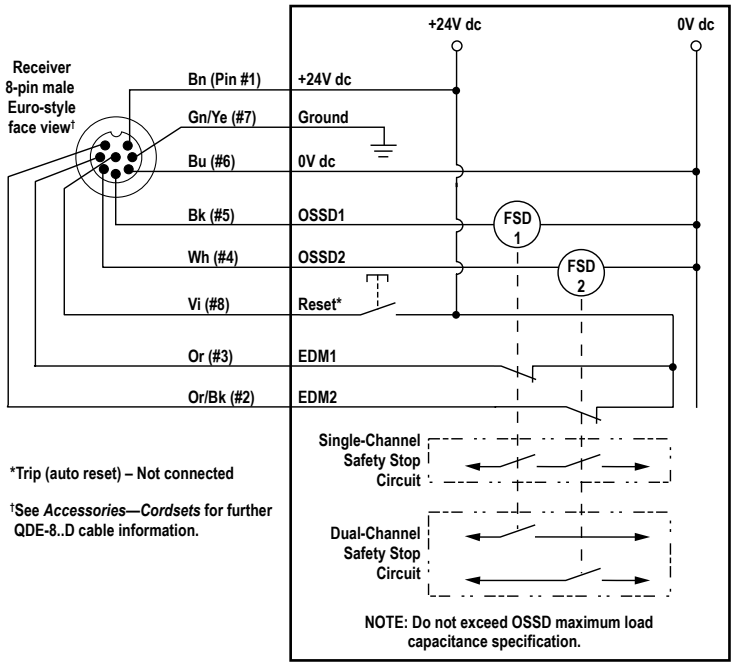


Figure 19. Generic hookup—FSDs (2-channel EDM, with reset)

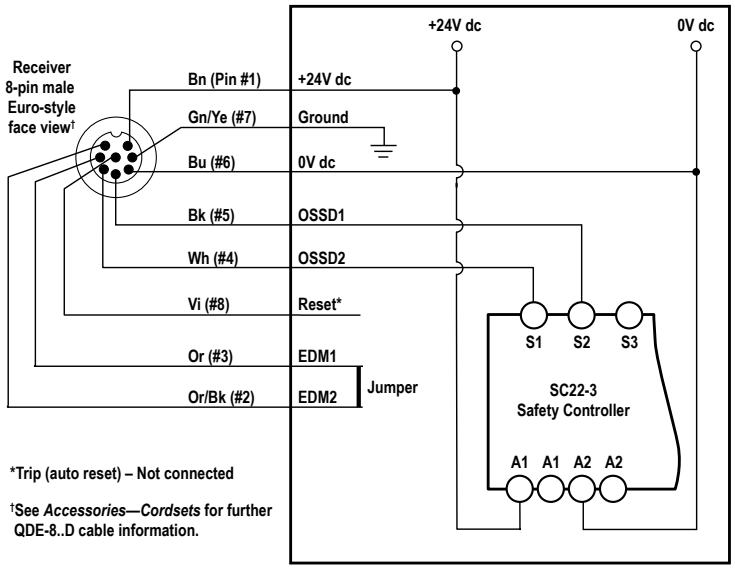


Figure 20. Generic hookup—self-checking Safety Module, Safety Controller, Safety PLC (no monitoring, no reset)

NOTE: DEE8-..D Adapter Cordsets can be used in a similar manner as the QDE-8..D. See *Cordsets* on page 47 for more information.

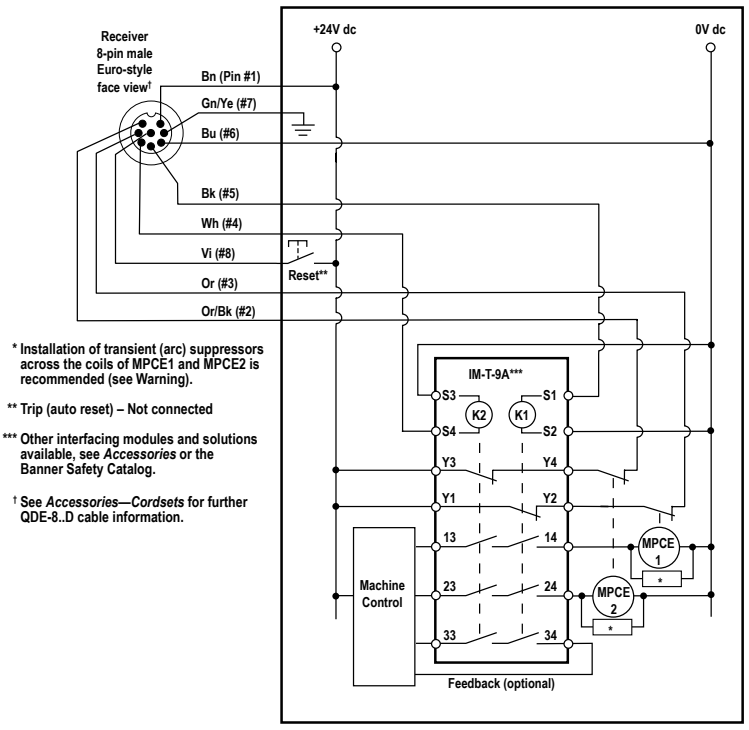


Figure 21. Generic hookup—Interface Module (2-channel EDM, with reset)

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 creates an unsafe condition.

4 System Operation

4.1 Security Protocol

Certain procedures for installing, maintaining, and operating the EZ-SCREEN V-Series 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 V-Series. The Designated Person is empowered to:

- Perform manual resets and hold possession of the reset key (see *Reset Procedures* on page 32)
- Perform the Daily Checkout Procedure

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 V-Series 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 V-Series System
- Perform all checkout procedures
- Make changes to the internal configuration settings
- Reset the System following a Lockout condition

4.2 Reset Procedures

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 *Reset Switch Location* on page 13). 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 (for example, 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 provides some level of personal control, since the key may be removed from the switch. This hinders 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.

4.2.1 Receiver Resets

The EZ-SCREEN V-Series receiver has a Reset input, pin 8 (violet wire), that provides for a manual reset input signal.

Internal Lockout conditions require a manual reset to return the System to Run mode after the failure has been corrected and the input correctly cycled, or system power must be cycled (ON, OFF > 2 seconds, ON).

Reset Routine

To reset the receiver, close the reset switch for 1/4 to 2 seconds, then open it. An alternative method to reset either component is to power the sensor down, then power it up.

If reset switch model MGA-KSO-1 (see *Remote Reset Switch* on page 50) 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 sensor to ignore the reset request; the switch must be closed from 1/4 seconds to 2 seconds, but no longer.

4.2.2 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.

4.3 Status Indicators

A variety of status indicators are clearly visible on each emitter and receiver face (see *Status Indicators* on page 8 and *Optical Alignment* on page 22).

4.3.1 Emitter

A single bi-color Red/Green Status indicator shows whether power is applied, and whether the emitter is in Run mode or Lockout status. A Diagnostic Display indicates a specific error code when the emitter is in Lockout; the display also momentarily indicates the scan code at power-up or when changed.

Operating Status	Required Event	Status Indicator	Diagnostic Display
Power-up	Apply Power	Red single-flash	Scan code flash 3 times, alternates  or 
Run Mode	Passes internal tests	Green	
Lockout	Internal/external fault	Flashing Red	Displays error code (see *Troubleshooting and Lockout Conditions* on page 35)

4.3.2 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. 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). The Diagnostic Display indicates the receiver's trip (–) configuration setting and displays a specific error code when the receiver is in Lockout. The Diagnostic Display also momentarily indicates the scan code at power-up or when changed.

Trip Output Configured

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 flashes 3 times, alternates  or 			Off
Alignment Mode - Beam 1 Blocked	Pass internal tests	Off	Off	Zone 1 Red[4] 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	On	All On Green	Off		Off	On
Run Mode - Blocked	Beam(s) blocked	On	Red	Red or Green[4]	Total number of blocked beams			Off
Noise Detected - Reset Interface					Flashing 	Continues previous reading	Continues previous reading	

[4] 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
Noise Detected - EDM Interface					Continues previous reading	Continues previous reading	Flashing 	
Lockout	Internal/ external fault	Off	Flashing Red	All Off	Displays error code (see *Troubleshooting and Lockout Conditions* on page 35)			Off

4.4 Normal Operation

4.4.1 System Power-Up

The EZ-SCREEN V-Series powers up and resets automatically.

Trip Output Power-Up: When power is applied, each sensor conducts self-tests to detect critical internal faults, determine configuration settings, and prepare the EZ-SCREEN V-Series for operation. If either sensor detects a critical fault, scanning ceases, the receiver outputs remain Off and diagnostic information displays on the sensor's Diagnostic Display. If no faults are detected, the EZ-SCREEN V-Series automatically enters Alignment mode, and the receiver looks for an optical sync pattern from the emitter. If the receiver is aligned and receives 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.

4.4.2 Run Mode

Trip Output Configuration: If any beams become blocked while the EZ-SCREEN V-Series is running with trip output, the receiver outputs turn OFF within the stated EZ-SCREEN V-Series response time (see *General Specifications* on page 44). 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.

Internal Faults (Lockouts): If either sensor detects a critical fault, scanning ceases, the receiver outputs turn OFF and diagnostic information displays on the sensor's Diagnostic Display. See *Troubleshooting and Lockout Conditions* on page 35 for resolution of error/fault conditions.

4.5 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.

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 *Checkout Procedure Schedule* on page 40). 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 V-Series System or changes to the machine), the Commissioning Checkout should be performed (see *Commissioning Checkout* on page 40).

NOTE: Verify Proper Operation

The EZ-SCREEN V-Series can operate as it is designed only if it and the guarded machine are operating properly, both separately and together. It is the user's responsibility to verify this, on a regular basis, as instructed in *Checkout Procedure Schedule* on page 40 . Failure to correct such problems can result in an increased risk of harm.

Before the System is put back into service, verify that the EZ-SCREEN V-Series System and the guarded machine perform exactly as outlined in the checkout procedures and any problem(s) are found and corrected.

5 Troubleshooting and Maintenance

5.1 Troubleshooting and Lockout Conditions

Evaluate status indicators per *Status Indicators* on page 32 .

A Lockout condition causes all of the EZ-SCREEN V-Series 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 *Receiver Error Codes* on page 36 and *Emitter Error Codes* on page 38 or the Diagnostic Error Code label supplied in the documentation pack).

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

Receiver		Emitter	
Reset indicator	OFF	Status indicator	Flashing Red
Status indicator	Flashing Red	Diagnostic Display	Error code (flashing)
Zone indicators	OFF		
Diagnostic display	Error code (flashing)		

5.2 Recovery Procedures

To recover from a Lockout condition, all errors must be corrected and a single sensor reset sequence must be performed as described below.

5.2.1 Receiver Reset

Receiver Reset

Close the remote reset switch for 1/4 to 2 seconds and then open the switch (per *Reset Procedures* on page 32), or power the sensor down, wait a second or two, then power it up.

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 Banner device or other safeguards is dangerous and may result in serious bodily injury or death.

WARNING: Shut Down Machinery Before Servicing

The machinery to which the Banner device 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, ISO 14118 or the appropriate standard for controlling hazardous energy). Servicing the Banner device while the hazardous machinery is operational may result in serious bodily injury or death.

Receiver Error Codes

Diagnostic Display	Error Descriptions and Causes	Appropriate Action
	Output Error This error is caused by: • One or both outputs being shorted to a power supply (high or low) • By shorting OSSD 1 to OSSD 2 • By an overload (greater than 0.5A)	Disconnect the OSSD loads and reset the receiver. • If the error clears, the problem is in the OSSD load(s) or in the load wiring. • If the error continues with no load connected, replace the receiver.
	Reset Input Error This error occurs when the Reset switch is closed (or the wiring is shorted to +24V) during power-up.	Verify that the reset switch is in the open position. Reset the receiver per *Reset Procedures* on page 32. • If the error remains, disconnect the reset wire at pin 8; cycle the power. • If the error clears, the problem is in the reset switch or in the wiring. • If the error persists, replace the receiver.
	EDM Input Error This error can occur for the following reasons: • EDM wiring is incorrect • No connection to EDM connections • Both EDM inputs fail to respond within 250 ms of each other • Excessive noise on EDM inputs • Loose QD connection(s)	Verify that the EDM wiring is correct for the EDM type configured (see *Machine Primary Control Elements and EDM Input* on page 27). • If the error continues, remove power to the guarded machine, disconnect the OSSD loads, disconnect the EDM input signals, configure EDM for No Monitoring (see *Machine Primary Control Elements and EDM Input* on page 27), and conduct the Initial Checkout procedure in *Initial Checkout Procedure* on page 21. • If the error clears, 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 *Machine Primary Control Elements and EDM Input* on page 27. • If the error continues, check for noise on the EDM inputs (see *Electrical and Optical Noise* on page 38). If the error persists, replace the receiver.
	Receiver Error This error occurs due to excessive electrical noise or an internal failure.	Reset the receiver per *Reset Procedures* on page 32. • If the error clears, perform a Daily Checkout procedure (per EZ-SCREEN Checkout Procedures: Shift and Daily Checkout Procedure; Daily Checkout Card). If the System checks out, resume operation. If the System fails, replace the receiver. • If the error continues, check the ground connection (pin 7). • If the sensor has a good earth ground connection to pin 7, perform the Initial Checkout procedure (per *Initial Checkout Procedure* on page 21). • If the error clears, check the external connections and configuration settings. • If the error persists, replace the receiver.
	DIP Switch Error This error is caused by an internal failure.	Reset the receiver per *Reset Procedures* on page 32. • If the error persists, replace the receiver.

Diagnostic Display	Error Descriptions and Causes	Appropriate Action
	EDM Error This error occurs when the EDM1 wire is connected to +24V.	Verify that the EDM wiring is correct and that the external devices meet the requirements described in *Machine Primary Control Elements and EDM Input* on page 27. • If the error continues, remove power to the guarded machine, disconnect the OSSD loads, disconnect the EDM input signals, configure EDM for No Monitoring (per *Machine Primary Control Elements and EDM Input* on page 27) and conduct the Initial Checkout procedure in *Initial Checkout Procedure* on page 21. • If the error clears, 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 *Machine Primary Control Elements and EDM Input* on page 27. • If the error continues, check for noise on the EDM inputs (see *Electrical and Optical Noise* on page 38).
	EDM 2 Error The EDM 2 configuration is not valid.	• Verify that the EDM wiring is correct and that the external devices meet the requirements described in *Machine Primary Control Elements and EDM Input* on page 27. • If the error continues, remove power to the guarded machine, disconnect the OSSD loads, disconnect the EDM input signals, configure EDM for No Monitoring (per *Machine Primary Control Elements and EDM Input* on page 27), and conduct the Initial Checkout procedure (see *Initial Checkout Procedure* on page 21). • If the error clears, 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 *Machine Primary Control Elements and EDM Input* on page 27. • If the error continues, check for noise on the EDM inputs (see *Electrical and Optical Noise* on page 38).
	Fixed Blanking Error This error is caused by an internal failure.	Reset the receiver per *Reset Procedures* on page 32. • If the error persists, replace the receiver.
	Programming Timeout Error This error is caused by an internal failure.	Reset the receiver per *Reset Procedures* on page 32. • If the error persists, replace the receiver.
	Cascade Configuration Error This error is caused by an internal failure.	Reset the receiver per *Reset Procedures* on page 32. • If the error persists, replace the receiver.
	Excessive Noise Error – Reset Interface This error occurs due to excessive levels of electrical noise.	Reset the receiver per *Reset Procedures* on page 32. • If the error clears, perform a Daily Checkout procedure (per EZ-SCREEN Checkout Procedures: Shift and Daily Checkout Procedure; Daily Checkout Card). If the System checks out, resume operation. If the System fails, replace the receiver. • If the error continues, check the ground connection (pin 7). • If the sensor has a good earth ground connection to pin 7, perform the Initial Checkout procedure (see *Trip Test* on page 24). • If the error clears, check for sources of electrical noise (see *Electrical and Optical Noise* on page 38). • If the error persists, replace the receiver.
	Excessive Noise Error – EDM Interface This error occurs due to excessive levels of electrical noise.	

Diagnostic Display	Error Descriptions and Causes	Appropriate Action
	Excessive Noise Error – Cascade Input This error occurs due to excessive levels of electrical noise.	
	Cascade Input Simultaneity This error is caused by an internal failure.	Reset the receiver per *Reset Procedures* on page 32. • If the error persists, replace the receiver.

Emitter Error Codes

The emitter has only a 1-digit display. Two-digit codes are displayed sequentially.

Diagnostic Display	Error Description	Cause of Error and Appropriate Action
 then	Emitter Error This error can occur either due to excessive electrical noise or due to an internal failure.	Reset the emitter per *Reset Procedures* on page 32. • If the error clears, perform the daily checkout procedure (per EZ-SCREEN Checkout Procedures: Shift and Daily Checkout Procedure; Daily Checkout Card). If the System checks out, resume operation. If the System fails, replace the emitter. • If the error continues, check the ground connection (see *Cordsets* on page 47). • If the sensor has a good earth ground connection, check for electrical noise (see *Electrical and Optical Noise* on page 38). • If the error persists, replace the emitter.
 then	Excessive Noise Error This error can occur due to excessive electrical noise.	Reset the emitter per *Reset Procedures* on page 32. • If the error clears, perform the daily checkout procedure (per EZ-SCREEN Checkout Procedures: Shift and Daily Checkout Procedure; Daily Checkout Card). If the System checks out, resume operation. If the System fails, replace the emitter. • If the error continues, check the ground connection (see *Cordsets* on page 47). • If the sensor has a good earth ground connection, check for electrical noise (see *Electrical and Optical Noise* on page 38). • If the error persists, replace the emitter.

5.3 Electrical and Optical Noise

The EZ-SCREEN V-Series 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. In very extreme electrical noise cases, a Lockout is possible. To minimize the effects of transitory noise, the EZ-SCREEN V-Series responds 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
- Sensor input or output wires routed too close to noisy wiring

5.3.1 Sources of Electrical Noise

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 V-Series 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 V-Series System. It is good wiring practice (and may be required by code) to isolate EZ-SCREEN V-Series wires from high-voltage wires.

The Banner model BT-1 Beam Tracker (see *Alignment Aids* on page 52) 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 entering the receiver lens. Press the RCV button on the BT-1 and position the Beam Tracker on the wires going to the EZ-SCREEN V-Series or any other nearby wires. The noise caused by switching of the inductive loads should be addressed by installing proper transient suppression across the load.

5.3.2 Sources of Optical Noise

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 (see *Alignment Aids* on page 52) 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 emitted light from other sources (other safety light screens, screens or points, or standard photoelectric sensors).

5.4 Servicing and Maintenance

5.4.1 Cleaning

EZ-SCREEN V-Series 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.

5.4.2 Warranty Service

Contact Banner Engineering for troubleshooting of this device. Do not attempt any repairs to this Banner device; it contains no field-replaceable parts or components. If the device, device part, or device component is determined to be defective by a Banner Applications Engineer, they will advise you of Banner's RMA (Return Merchandise Authorization) procedure.

Important: If instructed to return the device, pack it with care. Damage that occurs in return shipping is not covered by warranty.

5.4.3 Manufacturing Date

Every EZ-SCREEN V-Series produced is marked with a code that defines the week of manufacture and manufacturing location.

The code format (U.S. Standard format) is:

YYWWL

- YY = year of manufacture, 2 digits
- WW = week of manufacture, 2 digits
- L = manufacturing location, 1 digit

Example: 1135H = 2011, week 35, Huron

5.4.4 Disposal

Devices that are no longer in use should be disposed of according to the applicable national and local regulations.

6 Checkout Procedure Schedule

This section lists the schedule of checkout procedures and describes where each procedure is documented. Checkouts must be performed as described. Results should be recorded and kept in the appropriate place (for example, near the machine, and/or in a technical file).

6.1 Schedule of Checkouts

Checkout cards and this manual can be downloaded at *http://www.bannerengineering.com*.

Checkout Procedure	When to Perform	Where to Find the Procedure	Who Must Perform the Procedure
Trip Test	• At Installation • Any time the System, the guarded machine, or any part of the application is altered.	*Trip Test* on page 24	Qualified Person
Commissioning Checkout	• At Installation • Whenever changes are made to the System (for example, either a new configuration of the EZ-SCREEN V-Series or changes to the guarded machine).	*Commissioning Checkout* on page 40	Qualified Person
Shift/Daily Checkout	• At each shift change • Machine setup change • Whenever the System is powered up During continuous machine run periods, this checkout should be performed at intervals not to exceed 24 hours.	Daily Checkout Card (Banner p/n 113361) A copy of the checkout results should be recorded and kept in the appropriate place (for example, near or on the machine, in the machine's technical file).	Designated Person or Qualified Person
Semi-Annual Checkout	Every six months following System installation, or whenever changes are made to the System (either a new configuration of the EZ-SCREEN V-Series or changes to the machine).	Semi-Annual Checkout Card (Banner p/n 113362) A copy of the checkout results should be recorded and kept in the appropriate place (for example, near or on the machine, in the machine's technical file).	Qualified Person

6.2 Commissioning Checkout

WARNING: Do Not Use Machine Until System Is Working Properly

If all of these checks cannot be verified, do not attempt to use the safety system that includes the Banner device and the guarded machine until the defect or problem has been corrected. Attempts to use the guarded machine under such conditions may result in serious bodily injury or death.

Perform this checkout procedure as part of the System installation after the System has been interfaced to the guarded machine, or whenever changes are made to the System (either a new configuration of the EZ-SCREEN V-Series or changes to the machine). A Qualified Person 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 V-Series System. See *Examples: Inappropriate Applications* on page 7 for a list of misapplications.
2. Verify that the EZ-SCREEN V-Series is configured for the intended application.
3. Verify that the safety distance (minimum distance) from the closest danger point of the guarded machine to the defined area is not less than the calculated distance, per *Calculating the Safety Distance (Minimum Distance)* on page 10.
4. Verify that:
    - Access to any dangerous parts of the guarded machine is not possible from any direction not protected by the EZ-SCREEN V-Series System, hard (fixed) 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 (fixed) 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 V-Series.

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.
6. Examine the electrical wiring connections between the EZ-SCREEN V-Series OSSD outputs and the guarded machine's control elements to verify that the wiring meets the requirements stated in *Electrical Connections to the Guarded Machine* on page 25.
7. Inspect the area near the defined area (including work pieces and the guarded machine) for reflective surfaces (see *Adjacent Reflective Surfaces* on page 15). Remove the reflective surfaces if possible by relocating them, painting, masking or roughening them. Remaining problem reflections will become apparent during the Trip Test.
8. Verify that power to the guarded machine is Off. Remove all obstructions from the defined area. Apply power to the EZ-SCREEN V-Series System.
9. Observe the Status indicators and 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
10. A Blocked condition indicates that one or more of the beams is misaligned or interrupted. See the Alignment procedure in *Optical Alignment* on page 22 to correct this situation.
11. After the Green and Yellow Status indicators are On, perform the trip test (*Trip Test* on page 24) on each sensing field to verify proper System operation and to detect possible optical short circuits or reflection problems. Do not continue until the EZ-SCREEN V-Series passes the trip test.

Important: 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 may result in serious bodily injury or death.

12. Apply power to the guarded machine and verify that the machine does not start up.
13. Interrupt (block) the defined area with the appropriate supplied test piece (see the table in *Trip Test* on page 24) and verify that it is not possible for the guarded machine to be put into motion while the beam(s) is blocked.
14. 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 must come to a stop with no apparent delay.
15. 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.
16. Remove electrical power to the EZ-SCREEN V-Series. Both OSSD outputs should immediately turn Off, and the machine must not be capable of starting until power is re-applied to the EZ-SCREEN V-Series.
17. 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. A Banner Applications Engineer can recommend a suitable instrument.

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

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 *Glossary* on page 58) must perform the procedure. A copy of checkout results should be recorded and kept in the appropriate place (for example, near or on the machine, in the machine's technical file).

Refer to the procedure detailed on the Daily Checkout card (Banner p/n 113361 for SLS.. models) in the documentation packet included with the receiver. If the Daily Checkout card is missing, contact Banner Engineering or download a copy of the card at *http://www.bannerengineering.com*.

6.4 Semi-Annual (Six-Month) Checkout

Perform the procedure 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 or changes to the machine).

A Qualified Person (as defined in the *Glossary* on page 58) must perform the procedure. A copy of checkout results should be recorded and kept in the appropriate place (for example, near or on the machine, in the machine's technical file).

Refer to the procedure on the Semi-Annual Checkout card (Banner p/n 113362) in the documentation packet included with the receiver. If the Semi-Annual Checkout card is missing, contact Banner Engineering or download a copy of the card at *http://www.bannerengineering.com*.

7 Specifications and Accessories

An EZ-SCREEN V-Series System includes a compatible emitter and receiver (equal length; available separately or in pairs), and two cables. Mounting hardware is included with each emitter and receiver. Interfacing solutions include IM-T-.. modules, or redundant positively guided contactors, safety controllers, or an optional muting module; see *Interface Modules* on page 48.

Models feature a yellow painted aluminum housing and are configured for Trip Output, 2-channel EDM, and Scan Code 1. EZ-SCREEN V-Series Systems are plug compatible with other 8-pin M12 QD EZ-SCREEN Systems (SLS..30 and SLSC..30 models) that match the EZ-SCREEN V-Series configuration listed and are the same length and resolutions. Contact Banner Engineering for additional options, including housing, finishes, alternative configurations, and interfacing solutions.

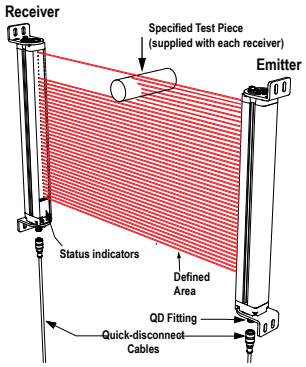


Figure 22. Banner EZ-SCREEN V-Series: emitter, receiver, and two interconnecting cables

7.1 Emitter and Receiver Models - 30 mm Resolution

Order one 8-pin cable for each 8-pin emitter or receiver, see *Cordsets* on page 47.

Models			Defined Area	Number of Beams	Response Time (Tr)
Emitter (8-pin)	Receiver	Emitter/Receiver Pair			
SLSVAE30-150Q8	SLSVAR30-150Q8	SLSVAP30-150Q88	150 mm (5.9 in)	10	9 ms
SLSVAE30-300Q8	SLSVAR30-300Q8	SLSVAP30-300Q88	300 mm (11.8 in)	20	11 ms
SLSVAE30-450Q8	SLSVAR30-450Q8	SLSVAP30-450Q88	450 mm (17.7 in)	30	13 ms
SLSVAE30-600Q8	SLSVAR30-600Q8	SLSVAP30-600Q88	600 mm (23.6 in)	40	15 ms
SLSVAE30-750Q8	SLSVAR30-750Q8	SLSVAP30-750Q88	750 mm (29.5 in)	50	17 ms
SLSVAE30-900Q8	SLSVAR30-900Q8	SLSVAP30-900Q88	900 mm (35.4 in)	60	19 ms
SLSVAE30-1050Q8	SLSVAR30-1050Q8	SLSVAP30-1050Q88	1050 mm (41.3 in)	70	21 ms
SLSVAE30-1200Q8	SLSVAR30-1200Q8	SLSVAP30-1200Q88	1200 mm (47.2 in)	80	23 ms
SLSVAE30-1350Q8	SLSVAR30-1350Q8	SLSVAP30-1350Q88	1350 mm (53.1 in)	90	25 ms
SLSVAE30-1500Q8	SLSVAR30-1500Q8	SLSVAP30-1500Q88	1500 mm (59 in)	100	27 ms
SLSVAE30-1650Q8	SLSVAR30-1650Q8	SLSVAP30-1650Q88	1650 mm (65in)	110	30 ms
SLSVAE30-1800Q8	SLSVAR30-1800Q8	SLSVAP30-1800Q88	1800 mm (70.9 in)	120	32 ms

7.2 Specifications

7.2.1 General Specifications

Short Circuit Protection
All inputs and outputs are protected from short circuits to +24 V dc or dc common

Electrical Safety Class
III (per IEC 61140: 1997)

Safety Rating
Type 4 per IEC 61496-1, -2
Category 4 PL e per EN ISO13849-1
SIL3 per IEC 61508; SIL CL3 per IEC 62061

Operating Range
0.1 m to 18 m (4 in. to 60 ft) — Range decreases with use of mirrors and/or lens shields:

- Lens shields — approx 10% less range per shield
- Glass-surface mirrors — approx 8% less range per mirror

See the specific mirror datasheet for more information.

Resolution
30 mm

Effective Aperture Angle (EAA)
Meets Type 4 requirements per IEC 61496-2, Section 5.2.9
±2.5° at 3 m

Operating Conditions
Temperature: 0 °C to +55 °C (+32 °F to +131 °F)
Humidity: 95% maximum relative humidity (non-condensing)

Enclosure
Extruded aluminum housing with yellow polyester powder finish standard and well-sealed, rugged die-cast zinc end caps, acrylic lens cover

Environmental Rating
IP65

Shock and Vibration
Components 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 in) single amplitude (0.70 mm peak-to-peak) and shock of 10 g for 16 milliseconds (6,000 cycles).

Mounting Hardware
Emitter and receiver each are supplied with a pair of swivel end-mounting brackets. Models 1050 mm and longer also include a swivel center-mount bracket. Mounting brackets are 8-gauge cold-rolled steel, black zinc finish.

Cables and Connections
See *Cordsets* on page 47

Certifications

7.2.2 Receiver Specifications

Supply Voltage at the Device
24 V dc ±15% (use a SELV-rated power supply according to EN IEC 60950). The external voltage supply must be capable of buffering brief mains interruptions of 20 ms, as specified in IEC/EN 60204-1.

Residual Ripple
±10% maximum

Supply Current (no load)
275 mA max., 160 mA at 24 V dc typical, exclusive of OSSD1 and OSSD2 loads (up to additional 0.5 A each)

Response Time
Dependent on number of sensing beams; see models table for number of beams and response time.

EDM Input
+24 V dc signals from external device contacts can be monitored (two-channel or no monitoring) via EDM1 terminal in the receiver.
High Signal: 10 to 30 V dc at 30 mA typical
Low Signal: 0 to 3 V dc
Dropout Time: 200 ms max.

Recovery Time Blocked to Clear (OSSDs turn On; varies with total number of sensing beams and whether Sync beam is blocked):

Model	Beam 1 (Sync Beam)	All Other Beams
30 mm	81 ms to 495 ms	25 ms to 152 ms

Strobe Light Immunity
Totally immune to one Federal Signal Corp. "Fireball" model FB2PST strobe

Output Signal Switching Devices (OSSDs)
Two redundant solid-state 24 V 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".
ON-State voltage: ≥ Vin-1.5V dc
OFF-State voltage: 1.2V dc max. (0 to 1.2V dc)
Max. load capacitance: 1.0 µF
Min. load inductance: 10 H
Leakage Current: 0.50 mA max.
Cable Resistance: 10 Ω max.
OSSD test pulse width: 100 to 300 microseconds typical
OSSD test pulse period: 10 ms to 27 ms (varies with number of beams)
Switching Current: 0 to 0.5 A

Status Indicators
Yellow Reset Indicator: indicates whether the System is ready for operation or requires a reset
Bi-color (Red/Green) Status indicator: indicates general system and output status
Bi-color (Red/Green) Zone Status indicators: indicate condition (clear or blocked beam) of a defined group of beams
7-Segment Diagnostic indicator (3 digits): indicates proper operation, scan code, error code, or total number of blocked beams

Ambient Light Immunity
10,000 lux at 5° angle of incidence

Reset Input
Reset input must be high for ¼ to 2 seconds and then low to reset the receiver
High Signal: 10 to 30 V dc at 30 mA typical
Low Signal: 0 to 3 V dc
Closed Switch Time: ¼ to 2 seconds

7.2.3 Emitter Specifications

Supply Voltage at the Device
24 V dc ±15% (use a SELV-rated power supply according to EN IEC 60950). The external voltage supply must be capable of buffering brief mains interruptions of 20 ms, as specified in IEC/EN 60204-1.

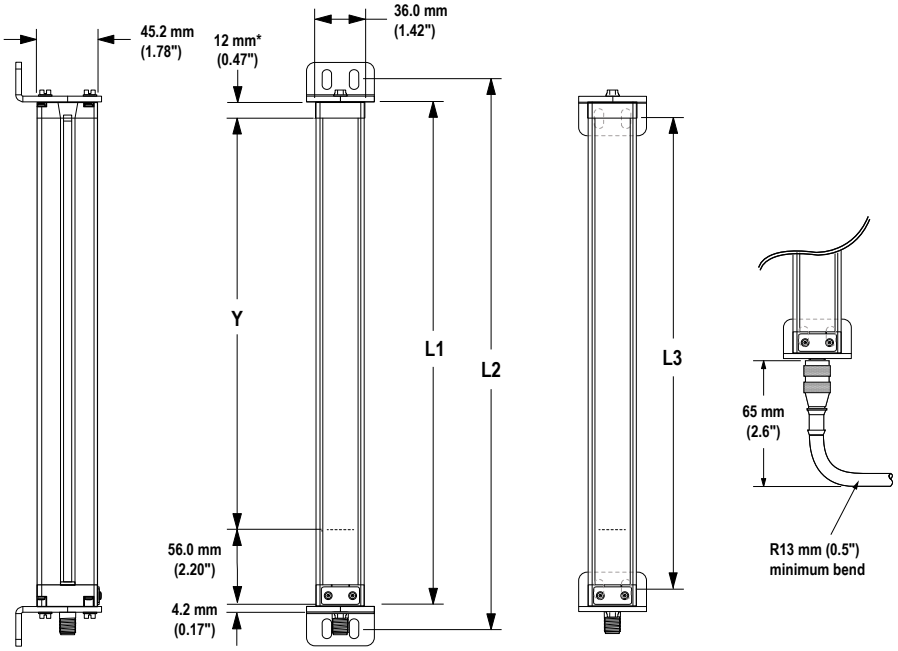
Residual Ripple
± 10% maximum

Supply Current
100 mA max; 40 mA at 24 V dc typical

Status Indicators
One bi-color (Red/Green) Status Indicator: indicates operating mode, lockout or power Off condition
7-Segment Diagnostic indicator (1 digit): indicates proper operation, scan code, or error code

Wavelength of Emitter Elements
Infrared LEDs, 850 nm at peak emission

7.2.4 Emitter and Receiver Mounting Dimensions and Location of Defined Area

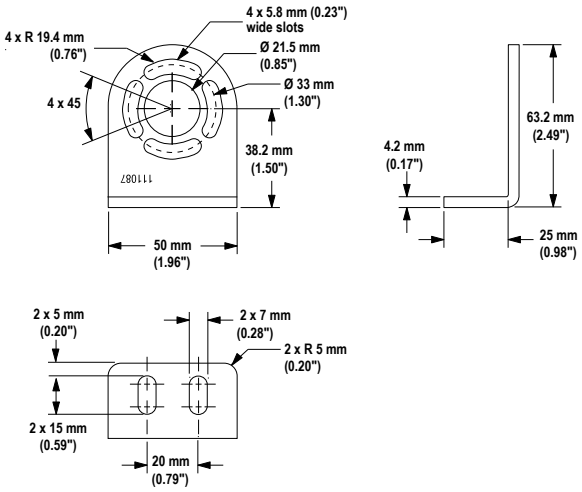


*For SLS..-150 models, this distance is 52 mm (2")

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

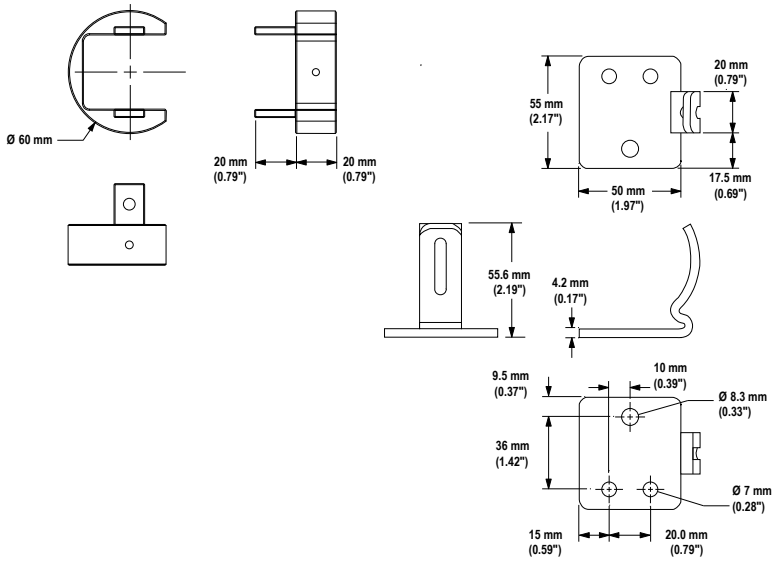
7.2.5 End Cap Brackets

Model EZA-MBK-11: End cap brackets are included for emitter or receiver. Dimensions are identical for stainless steel model EZA-MBK-11N for ESD model emitters and receivers.



7.2.6 Center Bracket

Model EZA-MBK-12: The center bracket is supplied with emitters and receivers over 1050 mm (3.4 ft) and longer. Dimensions are identical for stainless steel model EZA-MBK-12N for ESD model emitters and receivers.



7.3 Accessories

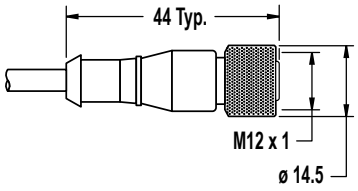
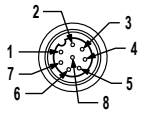
Additional interfacing solutions and accessories continue to be added; refer to *http://www.bannerengineering.com* for a current list.

7.3.1 Cordsets

Machine interface cordsets provide power to the first emitter/receiver pair. Sensor interconnect cables provide power to subsequent emitters and receivers in the cascade.

Single-Ended (Machine Interface) Cables (one cable for each emitter and receiver)

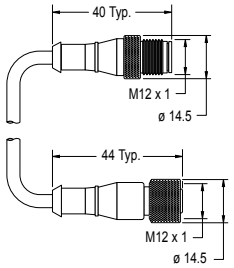
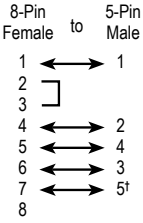
Overmold and cables are PVC-jacketed. Cables are unterminated on one end to interface with the guarded machine. Only pins 1, 6, and 7 are connected on 8-pin emitters (see *Figure 18* on page 29).

8-Pin Threaded M12/Euro-Style Cordsets				
Model	Length	Style	Dimensions	Pinout
QDE-815D	4.57 m (15 ft)	Straight		 1 = Brown 5 = Black 2 = Or/Bl 6 = Blue 3 = Orange 7 = Gn/Ye 4 = White 8 = Violet
QDE-825D	7.62 m (25 ft)			
QDE-850D	15.2 m (50 ft)			
QDE-875D	22.9 m (75 ft)			
QDE-8100D	30.5 m (100 ft)			

Double-Ended (Sensor Interconnect) Cables

Double ended cables are generally used to interconnect multiple emitters or receivers within a cascade system. They are also useful for extending either the branch or trunk cables of a model CSB splitter cordset used in sensor "swapability" installations. When combining cables in a multiple-light-screen cascade, refer to *Routing Cordsets* on page 20 for maximum cable lengths.

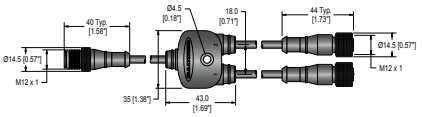
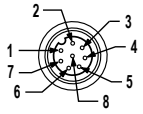
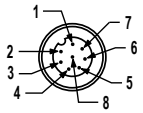
DEE8-..D cordsets are used to connect 8-pin female QD to a 4-pin or 5-pin cordset or QD connection to a safety BUS gateway/node, a “smart” self-monitored safety module, safety controller, or safety PLC. Overmold and cables are PVC-jacketed.

8-Pin Threaded M12/Euro-Style Cordsets—Double Ended						
Model[5]			Length	Style	Dimensions	DEE8-..D Pinout
8-pin/8-pin	8-pin/4-pin[6]	8-pin/5-pin[7]				
DEE2R-81D	DEE8-41D	DEE8-51D	0.3 m (1 ft)	Female Straight/ Male Straight		
DEE2R-83D	-	-	0.91 m (3 ft)			
DEE2R-88D	DEE8-48D	DEE8-58D	2.44 m (8 ft)			
DEE2R-815D	DEE8-415D	DEE8-515D	4.57 m (15 ft)			
DEE2R-825D	DEE8-425D	DEE8-525D	7.62 m (25 ft)			
DEE2R-850D	-	-	15.2 m (50 ft)			
DEE2R-875D	-	-	22.9 m (75 ft)			
DEE2R-8100D	-	-	30.5 m (100 ft)			

5 Standard cordsets are yellow PVC with black overmold. For black PVC and overmold, add suffix "B" to model number (example, DEE2R-81DB)
6 For connection to safety BUS gateway/node, a “smart” self-monitored safety module, safety controller or safety PLC. DEE8-4..D do not have the pin 5 GND/chassis connection. GND/chassis connection should be made via the mounting hardware.
7 For connection to safety BUS gateway/node, a “smart” self-monitored safety module, safety controller or safety PLC.

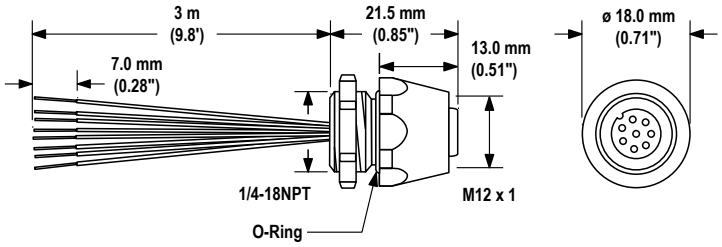
Splitter Cordsets

Model CSB splitter cordsets allow easy interconnection between an EZ-SCREEN 8-pin receiver and its 8-pin emitter, providing a single trunk cable for the optional “swapable” hookup (see *Figure 17* on page 29). The model DEE2R-.. double-ended cables described in *Double-Ended (Sensor Interconnect) Cables* on page 47 may be used to extend the lengths of the QD trunk, branch #1, or branch #2. Branch #1 and branch #2 cable sections are 300 mm (11.8 in) long. The model QDE-8..D single-ended cables may be used to extend the QD trunk for cut-to-length applications.

8-Pin Threaded M12/Euro-Style Splitter Cordsets—Flat Junction				
Model	Trunk (Male)	Branches (Female)	Dimensions	Pinout
CSB-M1280M1280	No trunk	No branches		Female  Male  1 = Brown 5 = Black 2 = Or/Bk 6 = Blue 3 = Orange 7 = Gn/Ye 4 = White 8 = Violet
CSB-M1281M1281	0.3 m (1 ft)	2 x 0.3 m (1 ft)		
CSB-M1288M1281	2.44 m (8 ft)			
CSB-M12815M1281	4.57 m (15 ft)			
CSB-M12825M1281	7.62 m (25 ft)			
CSB-UNT825M1281 [8]	7.62 m (25 ft) Unterminated			

Bulkhead Connector

Connector for panel connection of EZ-SCREEN V-Series emitter and receiver cables.

Model	Connection	Dimensions
PMEF-810D	8-pin Euro-style female connector 3 m (10 ft) wires, cut to length (Banner color code); 22 AWG/0.33 mm².	

7.3.2 Interface Modules

Interface modules provide forced-guided, mechanically-linked relay (safety) outputs for the EZ-SCREEN V-Series System. See Banner data sheet p/n 62822 and *Figure 19* on page 30 for more information.

Model	Description
IM-T-9A	Interface module, 3 N.O. redundant-output 6 amp contacts
IM-T-11A	Interface module, 2 N.O. redundant-output 6 amp contacts, plus 1 N.C. auxiliary contact

[8] Standard cordsets are yellow PVC with black overmold. For black PVC and overmold, add suffix B to model number (example, CSB-M1280M1280B).

7.3.3 Contactors

The normally closed contacts are used in an external device monitoring (EDM) circuit. If used, two contactors per EZ-SCREEN V-Series System are required.

Model	Description
11-BG00-31-D-024	10 amp positive-guided contactor, 3 N.O., 1 N.C.
BF1801L024	18 amp positive-guided contactor, 3 N.O., 1 N.C. (N.C. contact rated at 10 amps)

7.3.4 SC22-3(E) Safety Controller

Model	Terminal Type	Description
XS26-2xx	Screw-type terminals	Expandable Safety Controller. Ethernet and Display options available. 26 convertible I/Os and 2 Solid State Safety Outputs.
SC26-2xx	Screw-type terminals	Non-Expandable Safety Controller. Ethernet and Display options available. 26 convertible I/Os and 2 Solid State Safety Outputs.
SC22-3-S	Screw-type terminals	10 Auxiliary outputs, includes external memory XM card
SC22-3-C	Clamp-type terminals	
SC22-3E-S	Screw-type terminals	10 Auxiliary outputs, includes external memory XM card, plus EtherNet/IP and Modbus TCP, 32 virtual outputs
SC22-3E-C	Clamp-type terminals	

7.3.5 Muting Modules

Model	Mounting	Description
MMD-TA-11B	DIN-mount Muting module	2 N.O. safety outputs (6 amps), 2 or 4 muting inputs, SSI, override input; IP20; terminal connections
MMD-TA-12B		2 OSSD outputs, 2 or 4 muting inputs, SSI, override input; IP20; terminal connections

7.3.6 AC Boxes

AC power supply for use with EZ-SCREEN V-Series emitters and/or receivers. Models EZAC-R.. can be interfaced with up to three receivers or two cascaded emitter/receiver pairs; models EZAC-E.. can power up to four emitters. Box supplies +24V dc power at 0.7 amps (16.8 W max. power); accepts input voltages from 100 to 250V ac (50 to 60 Hz); IP65 metal housing. Models are available with external device monitoring (EDM); key reset switch on EZAC-R.. models (Emitter/Receiver models). See datasheet p/n 120321 for more information.

Emitter/Receiver Boxes					
Model	Outputs	EDM	Emitter/Receiver Connection	AC Power Connection	Output and EDM Connections
EZAC-R9-QE8	3 N.O.	Selectable 1- or 2-Channel or no EDM	8-Pin M12 Euro-style QD	Hard-wired	Hard-wired
EZAC-R11-QE8	2 N.O., 1 N.C.				
EZAC-R15A-QE8-QS83	1 N.O. + 1 SPDT (Form C)	1-Channel		3-pin Mini-style QD	8-pin Mini-style QD
EZAC-R8N-QE8-QS53	1 N.O., 1 N.C.	Power Monitoring		3-pin Mini-style QD	5-pin Mini-style QD
EZAC-R10N-QE8-QS53	2 N.O.				

Emitter-Only Boxes			
Model	For Emitter Models	Emitter Connection	AC Power Connection
EZAC-E-QE8	SLPE..-..Q8 (without Test input)	8-Pin M12 Euro-style QD	Hard-wired
EZAC-E-QE5	SLSE..-..Q5 (with Test input)	5-Pin M12 Euro-style QD	
EZAC-E-QE8-QS3	SLPE..-..Q8 (without Test input)	8-Pin M12 Euro-style QD	3-Pin Mini-style QD
EZAC-E-QE5-QS5	SLSE..-..Q5 (with Test input)	5-Pin M12 Euro-style QD	5-Pin Mini-style QD

7.3.7 Remote Reset Switch

Model	Description
EZA-RR-1	External normally open reset switch with 8-pin M12/Euro-style QD; can be interconnected using cordset models QDE-8..D, DEE2R-8..D, or CSB-..M1281.

7.3.8 Lens Shields

Adhesive-Backed Model[9]	Snap-On Model[10]	Sensor Defined Area[11]	
EZS-150	EZSS-150	150 mm (5.9 in)	 EZS Models EZSS Models
EZS-300	EZSS-300	300 mm (11.8 in)	
EZS-450	EZSS-450	450 mm (17.7 in)	
EZS-600	EZSS-600	600 mm (23.6 in)	
EZS-750	EZSS-750	750 mm (29.5 in)	
EZS-900	EZSS-900	900 mm (35.4 in)	
EZS-1050	EZSS-1050	1050 mm (41.3 in)	
EZS-1200	EZSS-1200	1200 mm (47.2 in)	
EZS-1350	EZSS-1350	1350 mm (53.1 in)	
EZS-1500	EZSS-1500	1500 mm (59.1 in)	
EZS-1650	EZSS-1650	1650 mm (65.0 in)	
EZS-1800	EZSS-1800	1800 mm (70.9 in)	
The total sensing range decreases by approximately 10% per shield.			

7.3.9 Tubular Enclosures

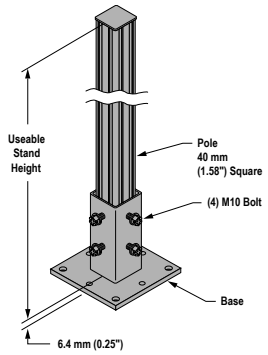
EZA-MBK-2 adapter bracket is required for use with MSA Series stand, see *MSA Series Stands* on page 51 and data sheet p/n 117107. Explosion-proof enclosures are also available.

Enclosure Model[12]	Enclosure Height	For EZ-SCREEN Models	
EZA-TE-150	439 mm (17.3 in)	SLS..-150	
EZA-TE-300	541 mm (21.3 in)	SLS..-300	
EZA-TE-450	744 mm (29.3 in)	SLS..-450	
EZA-TE-600	846 mm (33.3 in)	SLS..-600	
EZA-TE-750	1024 mm (40.3 in)	SLS..-750	
EZA-TE-900	1151 mm (45.3 in)	SLS..-900	
EZA-TE-1050	1354 mm (53.3 in)	SLS..-1050	
EZA-TE-1200	1455 mm (57.3 in)	SLS..-1200	
EZA-TE-1350	1608 mm (63.3 in)	SLS..-1350	
EZA-TE-1500	1760 mm (69.3 in)	SLS..-1500	
EZA-TE-1650	1913 mm (75.3 in)	SLS..-1650	
EZA-TE-1800	2065 mm (81.3 in)	SLS..-1800	

[9] Polycarbonate shield guards against weld splatter and weld flash with an adhesive-backed neoprene gasket (see data sheet p/n 61960).
[10] Copolyester shield provides heavy-duty, impact-resistant protection from many types of cutting fluids (see data sheet p/n 127944).
[11] Contact Banner Engineering for lens shield availability for longer sensor lengths.
[12] Contact Banner Engineering for enclosure availability for longer sensor lengths.

7.3.10 MSA Series Stands

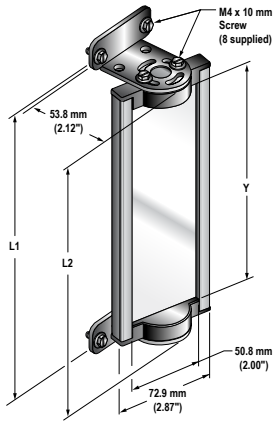
Base included. Available without a base by adding the suffix NB to the model number (for example, MSA-S42-1NB).

Stand Model	Pole Height	Useable Stand Height	Overall Stand Height	
MSA-S24-1	610 mm (24 in)	483 mm (19 in)	616 mm (24.25 in)	
MSA-S42-1	1067 mm (42 in)	940 mm (37 in)	1073 mm (42.25 in)	
MSA-S66-1	1676 mm (66 in)	1550 mm (61 in)	1682 mm (66.25 in)	
MSA-S84-1	2134 mm (84 in)	2007 mm (79 in)	2140 mm (84.25 in)	
MSA-S105-1	2667 mm (105 in)	2667 mm (100 in)	2673 mm (105.25 in)	

7.3.11 MSM Series Corner Mirrors

Rear-surface glass mirrors are rated at 85% efficiency. The total sensing range decreases by approximately 8% per mirror.

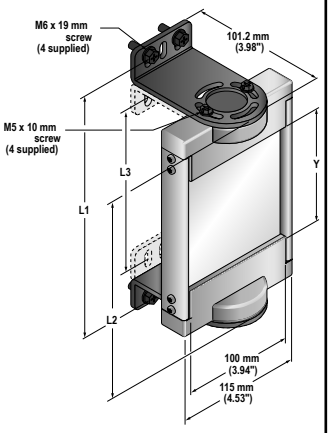
See mirror data sheet p/n 43685 or *http://www.bannerengineering.com* for further information.

Mirror Model	Defined Area Length	Reflective Area Y	Mounting L1	Mounting L2	
MSM8A	150 mm (5.9 in)	267 mm (10.5 in)	323 mm (12.7 in)	292 mm (11.5 in)	
MSM12A	300 mm (11.8 in)	356 mm (14 in)	411 mm (16.2 in)	381 mm (15 in)	
MSM20A	450 mm (17.7 in)	559 mm (22 in)	615 mm (24.2 in)	584 mm (23 in)	
MSM24A	600 mm (23.6 in)	660 mm (26 in)	716 mm (28.2 in)	686 mm (27 in)	
MSM32A	750 mm (29.5 in)	864 mm (34 in)	919 mm (36.2 in)	889 mm (35 in)	
MSM36A	900 mm (35.4 in)	965 mm (38 in)	1021 mm (40.2 in)	991 mm (39 in)	
MSM44A	1050 mm (41.3 in)	1168 mm (46 in)	1224 mm (48.2 in)	1194 mm (47 in)	
MSM48A	1200 mm (47.2 in)	1270 mm (50 in)	1326 mm (52.2 in)	1295 mm (51 in)	

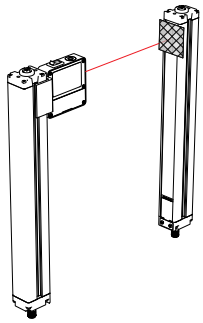
7.3.12 SSM Series Corner Mirrors

- Rear-surface glass mirrors are rated at 85% efficiency. The total sensing range decreases by approximately 8% per mirror. See mirror data sheet p/n 61934 or *http://www.bannerengineering.com* for further information.
- Stainless steel reflective surface models are also available. See datasheet p/n 67200.
- Robust construction, two mounting brackets and hardware included.
- EZA-MBK-2 adapter bracket is required for use with MSA Series stand, see *Mounting Brackets* on page 53 .

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

Mirror Model[13]	Defined Area Length	Reflective Area Y	Mounting 1	Mounting L2	
SSM-200	150 mm (5.9 in)	200 mm (7.9 in)	278 mm (10.9 in)	311 mm (12.2 in)	
SSM-375	300 mm (11.8 in)	375 mm (14.8 in)	486 mm (19.1 in)	453 mm (17.8 in)	
SSM-550	450 mm (17.7 in)	550 mm (21.7 in)	661 mm (26.0 in)	628 mm (24.7 in)	
SSM-675	600 mm (23.6 in)	675 mm (26.6 in)	786 mm (31.0 in)	753 mm (29.6 in)	
SSM-825	750 mm (29.5 in)	825 mm (32.5 in)	936 mm (36.9 in)	903 mm (35.6 in)	
SSM-975	900 mm (35.4 in)	975 mm (38.4 in)	1086 mm (42.8 in)	1053 mm (41.5 in)	
SSM-1100	1050 mm (41.3 in)	1100 mm (43.3 in)	1211 mm (47.7 in)	1178 mm (46.4 in)	
SSM-1275	1200 mm (47.2 in)	1275 mm (50.2 in)	1386 mm (54.6 in)	1353 mm (53.3 in)	
SSM-1400	1350 mm (53.1 in)	1400 mm (55.1 in)	1511 mm (59.5 in)	1478 mm (58.2 in)	
SSM-1550	1500 mm (59.0 in)	1550 mm (61.0 in)	1661 mm (65.4 in)	1628 mm (64.1 in)	
SSM-1750	1650 mm (65.0 in)	1750 mm (68.9 in)	1861 mm (73.3 in)	1828 mm (72.0 in)	
SSM-1900	1800 mm (70.9 in)	1900 mm (74.8 in)	2011 mm (79.2 in)	1978 mm (77.9 in)	

7.3.13 Alignment Aids

Model	Description	
LAT-1-SS	Self-contained visible-beam laser tool for aligning any EZ-SCREEN 14 mm and 30 mm emitter/receiver pair. Includes retroreflective target material and mounting clip.	
EZA-LAT-SS	Replacement adaptor (clip) hardware for SLS.. models	
EZA-LAT-2	Clip-on retroreflective LAT target	
BRT-THG-2-100	2 in retroreflective tape, 2.5 m (100 in)	
BT-1	Beam Tracker	

[13] Stainless steel reflective surface models are available by adding model number suffix "-S" (for example, SSM-375-S); range reduction for these models is approximately 30% per mirror. See datasheet p/n 67200.

7.3.14 Mounting Brackets

See *Replacement Parts* on page 54 for standard brackets. Contact Banner Engineering for more information. Order one EZA-MBK-.. bracket per sensor, two per pair.

EZA-MBK-2

- Adapter bracket for mounting SSM series mirror to MSA series stands

EZA-MBK-15

- Retrofit for STI MS46/47, Keyence PJ-V, SUNX SF4-AH

EZA-MBK-8

- Retrofit for Sick FGS and Leuze L-bracket

EZA-MBK-18

- Retrofit for Dolan-Jenner SS7

EZA-MBK-13

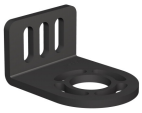
- Retrofit for Sick C4000, AB SafeShield/GuardShield, Omron FS3N, STI MC42/47

EZA-MBK-20

- Adapter brackets for mounting to engineered/ slotted aluminum framing such as 80/20™ and Unistrut™. Angled slots allow mounting to 20 mm to 40 mm dual channel and center slot. allows mounting to single channel framing
- Retrofit for Banner MINI-SCREEN®
- Order EZA-MBK-20U for bracket with M5 and M6 mounting hardware

EZA-MBK-14

- Retrofit for STI MS4300



7.3.15 EZ-LIGHT® for EZ-SCREEN®

Provides clear, 360° indication of the of the EZ-SCREEN receiver's output status. Use with a CSB splitter cable and optional DEE2R double-ended cables. See data sheet p/n 121901 for more information.

Models		Construction	Connector/LED Function/ Inputs
	M18RGX8PQ8 [14]	Nickel-plated brass housing, M18x1 thread; thermoplastic lens Fully encapsulated IP67	8-pin Euro-style Integral QD Red/Green indication follows OSSD output of the EZ-SCREEN receiver ON Red: Power ON Beam Blocked or Lockout ON Green: Power ON Beam Clear PNP (Sourcing)
	T18RGX8PQ8	Thermoplastic polyester housing, thermoplastic lens Fully encapsulated IP67	
	T30RGX8PQ8		
	K30LRGX8PQ8	Polycarbonate housing, 30 mm thermoplastic dome, 22 mm base mount Fully encapsulated, IP67	
	K50LRGX8PQ8	Polycarbonate housing, 50 mm thermoplastic dome, 30 mm base mount Fully encapsulated, IP67	
	K80LRGX8PQ8	Polycarbonate housing, 50 mm thermoplastic dome, flat or DIN mount Encapsulated electronics, IP67	

7.3.16 Replacement Parts

Model	Description	
MGA-KSO-1	Panel-mount keyed reset switch	
MGA-K-1	Replacement key for switch MGA-KSO-1	
STP-14	30 mm test piece (for 30 mm resolution systems)	
EZA-MBK-11	Black	Standard bracket kit with hardware. Includes 2 end brackets and hardware to mount to MSA Series stands; see *Figure 22* on page 43.
EZA-MBK-11N	Stainless Steel	
EZA-MBK-12	Center bracket kit. Includes 1 bracket and hardware to mount to MSA Series stands), and retrofit for SICK and Leuze Swivel (see *Figure 22* on page 43.	
SMA-MBK-1	SSM Mirror bracket kit. Includes 2 replacement brackets for one mirror.	

[14] Available in a kit that includes one M18 EZ-LIGHT, one SMB18A mounting bracket, and hardware for mounting to the side channel of an EZ-SCREEN housing (kit model number EZA-M18RGX8PQ8).

7.3.17 Documentation

Part Number	Description
166975	EZ-SCREEN System Instruction Manual
113361	Checkout Procedure Card (Daily) – Stand-Alone Systems
113362	Checkout Procedure Card (Semi-Annual)
114189	Diagnostic Display Label

8 Standards and Regulations

The list of standards below is included as a convenience for users of this Banner device. Inclusion of the standards below does not imply that the device complies specifically with any standard, other than those specified in the Specifications section of this manual.

8.1 Applicable U.S. Standards

ANSI B11.0 Safety of Machinery, General Requirements, and Risk Assessment
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/RIA R15.06 Safety Requirements for Industrial Robots and Robot Systems
ANSI NFPA 79 Electrical Standard for Industrial Machinery
ANSI/PMMI B155.1 Package Machinery and Packaging-Related Converting Machinery — Safety Requirements

8.2 OSHA Regulations

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

8.3 International/European Standards

ISO 12100 Safety of Machinery – General Principles for Design — Risk Assessment and Risk Reduction

ISO 13857 Safety Distances . . . Upper and Lower Limbs

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

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

IEC 62061 Functional Safety of Safety-Related Electrical, Electronic and Programmable Control Systems

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

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

ISO 14119 (EN 1088) Interlocking Devices Associated with Guards – Principles for Design and Selection

IEC 60204-1 Electrical Equipment of Machines Part 1: General Requirements

IEC 61496 Electro-sensitive Protection Equipment

IEC 60529 Degrees of Protection Provided by Enclosures

IEC 60947-1 Low Voltage Switchgear – General Rules

IEC 60947-5-1 Low Voltage Switchgear – Electromechanical Control Circuit Devices

IEC 60947-5-5 Low Voltage Switchgear – Electrical Emergency Stop Device with Mechanical Latching Function

IEC 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems

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10 Glossary

A

ANSI (American National Standards Institute)
Acronym for 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 *Standards and Regulations* on page 56.

Auto Power-Up
A safety light screen system feature that enables the system to be powered up into Run mode (or recover from a power interruption) without requiring a manual reset.

B

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 *Floating Blanking* and *Reduced Resolution*.

Blocked Condition
A condition that occurs 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, slowing, or preventing motion.

C

Cascade
Series connection (or "daisy-chaining") of multiple emitters and receivers.

CE
Abbreviation for "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 or device. 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
Abbreviation for 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.

D

Defined Area
The "screen of light" generated by a safety light screen system, defined by the height and the safety distance (minimum distance) of the emitter and receiver. When the defined area is interrupted by an opaque object of a specified cross section, a Trip or Latch condition results.

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

E

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: MPCEs, captive contact relays/contactors, and safety modules.

F

Failure to Danger
A failure which delays or prevents a machine safety system from arresting dangerous machine motion, thereby increasing risk to personnel.

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 (for example, 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.

G

Guarded Machine
The machine whose point of operation is guarded by the safety system.

H

Hard (Fixed) 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 the openings is determined by the applicable standard, such as Table O-10 of OSHA 29CFR1910.217, also called a "fixed barrier guard."

Harm
Physical injury or damage to the health of people, which may result through direct interaction with the machine or through indirect means, as a result of damage to property or to the environment.

Hazard Point
The closest reachable point of the hazardous area.

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

I

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.

K

Key Reset (Manual Reset)
A key-operated switch used to reset a safety light screen system to Run mode following a Lockout condition, or to enable machine operation following a Latch condition. Also refers to the act of using the switch.

L

Latch Condition
The response of the safety light screen safety outputs (for example, OSSDs) 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 condition that is automatically attained in response to certain failure signals (an internal lockout). When a Lockout condition occurs, the safety light screen's safety outputs turn Off; the failure must be corrected and a manual reset is required to return the system to Run mode.

M

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.

O

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.

P

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 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.

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

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.

Q

Qualified Person
A person who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work.

R

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 (for example, 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*

S

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.

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.

T

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 (for example, 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.

U

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.

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