S2B Safety Light Curtain

Instruction Manual

Original Instructions
228093 Rev. B
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228093

Contents

1 About This Document

1.1 Important... Read This Before Proceeding!

It is the responsibility of the machine designer, controls engineer, machine builder, machine operator, and/or maintenance personnel or 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 to ensure proper understanding of the operation, installation, and maintenance.* Please direct any questions regarding the application or use of the device to Banner.

For more information regarding U.S. and international institutions that provide safeguarding application and safeguarding device performance standards, see Standards and Regulations on page 5.

WARNING:

- The user is responsible for following these instructions.
- **Failure to follow any of these responsibilities may potentially create a dangerous condition that could result in serious injury or death.**
- Carefully read, understand, and comply with all instructions for this device.
- Perform a risk assessment that includes the specific machine guarding application. Guidance on a compliant methodology can be found in ISO 12100 or ANSI B11.0.
- Determine what safeguarding devices and methods are appropriate per the results of the risk assessment and implement per all applicable local, state, and national codes and regulations. See ISO 13849-1, ANSI B11.19, and/or other appropriate standards.
- Verify that the entire safeguarding system (including input devices, control systems, and output devices) is properly configured and installed, operational, and working as intended for the application.
- Periodically re-verify, as needed, that the entire safeguarding system is working as intended for the application.

1.2 Use of Warnings and Cautions

The precautions and statements used throughout this document are indicated by alert symbols and must be followed for the safe use of the S2B Safety Light Curtain. Failure to follow all precautions and alerts may result in unsafe use or operation. The following signal words and alert symbols are defined as follows:

Signal Word	Definition	Symbol
WARNING:	**Warnings** refer to potentially hazardous situations which, if not avoided, could result in serious injury or death.	
CAUTION:	**Cautions** refer to potentially hazardous situations which, if not avoided, could result in minor or moderate injury.	

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 S2B Safety Light Curtain to meet the various safeguarding application requirements. These individuals are responsible to read and abide by these statements.

2 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.

2.1 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
NFPA 79 Electrical Standard for Industrial Machinery
ANSI/PMMI B155.1 Package Machinery and Packaging-Related Converting Machinery — Safety Requirements

2.2 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

2.3 International/European Standards

EN ISO 12100 Safety of Machinery – General Principles for Design — Risk Assessment and Risk Reduction
ISO 13857 Safety of Machinery – Safety Distances to Prevent Hazard Zones Being Reached
ISO 13850 (EN 418) Emergency Stop Devices, Functional Aspects – Principles for Design
ISO 13851 Two-Hand Control Devices – Principles for Design and Selection
IEC 62061 Functional Safety of Safety-Related Electrical, Electronic and Programmable Control Systems
EN ISO 13849-1 Safety-Related Parts of Control Systems

EN 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
EN 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
IEC 62046 Safety of Machinery – Applications of Protective Equipment to Detect the Presence of Persons
ISO 3691-4 Industrial Trucks—Safety Requirements and Verification, Part 4 Driverless Industrial trucks and their Systems

3 Introduction

3.1 Features

- A two-piece optoelectronic safeguarding device
- Creates a screen of synchronized, modulated infrared sensing beams
- 30 mm resolution
- Defined areas of 2025 mm (79.7 in), 2325 mm (91.5 in), and 2500 mm (98.4 in)
- 0.1 m to 3 m (4 in to 9.8 ft) sensing range
- Zone and Status indicators for diagnostics
- FMEA tested to ensure control reliability
- Highly immune to EMI, RFI, ambient light, weld flash, and strobe light
- 1 kHz Signal Output (OSSD1)
- Standard, current-sourcing OSSD2 with 300 mA maximum output current
- Test Input on Emitter

3.2 System Description

Banner S2B emitters and receivers provide a redundant, microprocessor-controlled, opposed-mode optoelectronic safety light screen. S2B typically is used for point-of-operation safeguarding, and is suited to safeguard a variety of machinery.

The S2B emitters have a row of synchronized modulated infrared (invisible) light-emitting diodes (LEDs) in a compact 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 sensing range is 3 m (9.8 ft), which decreases if corner mirrors are used.

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 typically connected to an external monitoring device such as a Banner XS26-2 Safety Controller.

Electrical connections (power, ground, inputs, and outputs) are made via M8 quick-disconnect connections.

All models require a supply voltage of +15 V DC ±10% .

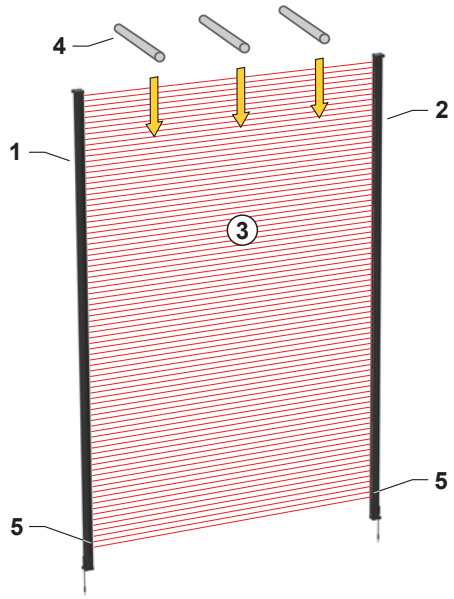
Both the emitter and the receiver feature LEDs to provide continuous indication of operating status and error conditions.

All models include the ability to select between two scan codes.

3.2.1 Components

An S2B “System” refers to a compatible emitter and receiver (equal length and resolution), and cordset(s) for each. End mounting brackets are factory installed on each sensor. Optional side mounting brackets are sold separately.

Figure 1. Main Components



1. Receiver
2. Emitter
3. Defined area
4. Specified test piece
5. Location of the status indicators

3.2.2 Models

All models are 30 mm Optic Resolution					
Emitter	**Receiver**	**Defined Area (mm)**	**Response Time, Tr (ms)**	**Recovery Time, OSSDs OFF to ON (ms, typical)**	
				Non-Sync Beam Blocked	**All Beams Blocked**
S2B1E30-2025B-P4P	**S2B1R30-2025B-P6P**	2025	23.0	108	193
S2B1E30-2325B-P4P	**S2B1R30-2325B-P6P**	2325	25.5	120	216
S2B1E30-2500B-P4P	**S2B1R30-2500B-P6P**	2500	27.0	128	229

3.3 Appropriate Applications and Limitations

WARNING:

- **Read this Section Carefully Before Installing the System**
- **Failure to follow these instructions could result in serious injury or death.**
- If all mounting, installation, interfacing, and checkout procedures are not followed properly, this Banner device cannot provide the protection for which it was designed.
- The user is responsible for ensuring 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. A Qualified person is 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.

The Banner S2B 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.

The S2B 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 S2B cannot provide the protection for which it was designed**.

WARNING:

- **Install System Only on Appropriate Applications**
- Failure to follow these instructions could result in serious injury or death.
- Use Banner's S2B 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 S2B be used on full-revolution clutched machinery or in unsuitable applications.
- If there is any doubt about whether or not your machinery is compatible with the S2B, contact Banner Engineering.

3.3.1 Examples: Inappropriate Applications

Do not use the S2B 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, NFPA 79, ANSI B11.19, ISO 12100, IEC 60204-1, IEC 61496-1, or other appropriate standard)

If the S2B is installed for use as a perimeter guard (where a pass-through hazard may exist, see Reducing or Eliminating Pass-Through Hazards on page 15), the dangerous machine motion can be initiated by normal means only after the safeguarded area is clear of individuals and the external safety monitoring device has been manually reset.

3.4 Control Reliability and Safety Categories

To summarize the expected safety circuit performance in high-risk situations, requirements of Control Reliability (OSHA 29CFR1910.217 and ANSI B11.19) and Category 3 or 4 and PL d or PL e (EN ISO 13849-1) demand that a reasonably foreseeable, single failure does not lead to the loss of the safety function, and does not prevent a normal or immediate stop from occurring. The failure or the fault must be detected at or before the next demand of safety (e.g., at the beginning or end of a cycle, or when a safeguard is actuated). The safety-related part of the control system then must issue an immediate stop command, or prevent the next machine cycle or hazardous situation until the failure or fault is corrected.

The effect of ANSI B11.19, and EN ISO 13849-1 is to set a baseline for situations in which a minimum level of performance has been mandated or in cases where a risk assessment has determined a need for Control Reliability, Category 3 or Category 4 level of performance.

In lower-risk safety applications, safeguards and safety circuits do not require the level of performance and fault tolerance described by Control Reliability, Category 3 or 4 and PL d or PL e. Applications involving situations that could result in a slight or normally reversible injury (e.g., only requiring first aid, as defined by OSHA 29CFR1904) can be solved by EN ISO 13849-1 Category 2 PL c.

EN ISO 13849-1 Category 2 does not require the same level of performance and fault tolerance as required by Control Reliability, Category 3 or Category 4. Safety-related parts of control systems designed to Category 2 “shall be designed so that their function(s) are checked at suitable intervals by the machine control system.” This allows a single fault to lead to the loss of the safety function between the check [test] of the system, but the loss of safety function is detected by the check. By comparison, in a system designed to EN ISO 13849-1 Category 4, a single fault or an accumulation of faults will not lead to a loss of the safety function.

While EN ISO 13849-1 generally applies to the machine level, IEC61496-1/-2 specifies requirements for the design, construction and testing for two levels or “types” of active opto-electronic protective devices (AOPDs) or light curtains (light screens). “Type 2” and “Type 4” describe differing requirements to ensure that appropriate safety-related performance is achieved. The appropriate type is dependent on the overall degree of risk reduction, as determined by the machine’s Risk Assessment (see ISO 12100, ANSI B11.19, or other relevant standard).

A Type 2 AOPD relies on periodic testing to detect a failure to danger. Between tests, a single fault can result in the loss of the safety function. While this level of performance and fault tolerance is generally not allowed in Category 4 situations, it is acceptable in the lower-risk situations described by Category 2.

While the S2B conducts continual internal self-tests and all single faults have been considered, the installation should provide an additional periodic test/check of the S2B and its interface to ensure the integrity of the safety function (see Emitter Test Function on page 30). A component failure detected by periodic test/check must cause a “stop” signal to be sent to the guarded machine and put the System into a Lockout condition.

Recovery from this type of Lockout condition requires:

- Replacement of the failed component (to restore the safety function)
- The appropriate reset procedure.

4 Specifications

4.1 General Specifications

Short Circuit Protection
All inputs and outputs are protected from short circuits to +15 V DC or DC common

Electrical Safety Class
III (per IEC 61140)

Safety Ratings
Type 2 per IEC 61496-1, -2
Category 2 PL c per EN ISO13849-1
SIL1 per IEC 61508
PFHd: 4.8 x 10^{-8}
MTTFd: 23 years

Effective Aperture Angle (EAA)
Meets Type 2 requirements per IEC 61496-2

Operating Conditions
–10 °C to +55 °C (+14 °F to +131 °F)
95% maximum relative humidity (non-condensing)

Storage Temperature
–30 °C to +65 °C (–22 °F to +149 °F)

Environmental Rating
For indoor use only
IP65 (EN 60529)

Resolution
30 mm

Operating Range
0.1 m to 3 m (4 in to 9.8 ft)

Enclosure
Anodized aluminum housing with well-sealed zinc die-cast end-caps, polycarbonate window

Mounting Hardware
Mounting brackets are made from glass-filled polycarbonate.

Certifications
c UL us LISTED AOPD 10GH
CE

4.2 Emitter Specifications

Supply Voltage at the Device
+15 V DC ±10% (use a SELV-rated power supply according to EN IEC 60950).
Voltage Dips and Interruptions testing, according to EN IEC 61496-1, was performed using power supply model CUI SDI36-15-U

Status Indicators
One bi-color (Red/Green) Status Indicator: indicates operating mode, lockout or power Off condition

Test Input
+15 V DC = Normal Operation
0 V DC = Test Function
Test function response time = 25 ms + Receiver Response Time Tr

Supply Current
42 mA typical
55 mA maximum [1]

Residual Ripple
± 10% maximum

Wavelength of Emitter Elements
Infrared LEDs, 860 nm at peak emission

Controls and Adjustments
Scan Code Selection: 2 dual position switches to select between scan codes (code 1 or 2). Factory default position is code 1.

[1] Maximum current occurs at a supply voltage of 13.5 V DC.

4.3 Receiver Specifications

Supply Voltage at the Device

+15 V DC ±10% (use a SELV-rated power supply according to EN IEC 60950).
Voltage Dips and Interruptions testing, according to EN IEC 61496-1, was performed using power supply model CUI SDI36-15-U

Status Indicators

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

1 kHz Signal Output (OSSD1)

1 kHz ± 2% square wave Signal Output
Light curtain clear (no object detected) = 1 kHz
Light curtain blocked (object detected) = 0 V DC
Light curtain lockout (internal fault) = 0 V DC

Note: Certain faults can occur on the 1 kHz Signal Output that result in a "stuck-at" +15 V DC condition. The external Controller must detect this condition as a fault and prevent the machine from operating.

ON-State voltage: ≥ Vin-1.5 V DC
OFF-State voltage: 0 V DC typical, 1 V DC maximum (no load)
OFF-State, maximum allowed external voltage: 1.5 V DC [3]
Maximum load capacitance: 1.0 µF
Maximum leakage current: 50 µA (with open 0 V)
Switching current: 0 to 0.3 A
Maximum cable resistance to load: 5 ohms per wire

Supply Current (no load)

76 mA typical
102 mA maximum [2]
Exclusive of OSSD1 and OSSD2 loads (up to additional 0.3 A each)

Residual Ripple

±10% maximum

Response Time

See Models on page 8

Recovery Time

Blocked to Clear (OSSDs Off to On; varies with total number of sensing beams and whether Sync beam is blocked).
See Models on page 8

Output Signal Switching Device (OSSD2)

Solid-state 15 V DC, 0.3 A max. current sourcing OSSD (Output Signal Switching Device) safety output.
ON-State voltage: ≥ Vin-1.5 V DC
OFF-State voltage: 0 V DC typical, 1 V DC maximum (no load)
OFF-State, maximum allowed external voltage: 1.5 V DC [3]
Maximum load capacitance: 1.0 µF
Maximum leakage current: 50 µA (with open 0 V)
OSSD test pulse width: 200 microseconds typical
OSSD test pulse period: 200 ms typical
Switching current: 0 to 0.3 A
Maximum cable resistance to load: 5 ohms per wire

Controls and Adjustments

Scan Code Selection: 2 dual position switches to select between scan codes (code 1 or 2). Factory default position is code 1.

[2] Maximum current occurs at a supply voltage of 13.5 V DC.
[3] The maximum voltage allowed on the OSSDs in the OFF-state without a lockout occurring. This voltage may occur, for example, from the input structure of a safety relay module connected to the S2B OSSDs.

5 Mechanical Installation

The S2B 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**
- **Failure to follow these instructions could result in serious injury or death.**
- If all mounting, installation, interfacing, and checkout procedures are not followed properly, this Banner device cannot provide the protection for which it was designed.
- The user is responsible for ensuring 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. A Qualified person is 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.

5.1 Mechanical Installation Considerations

There are two primary factors that influence the layout of the S2B system mechanical installation.

They are:

- Safety Distance (Minimum Distance) (see Calculating the Safety Distance (Minimum Distance) on page 13)
- Supplemental safeguarding/eliminating pass-through hazards (see Reducing or Eliminating Pass-Through Hazards on page 15)

Other considerations include:

- Emitter and Receiver Orientation (see Emitter and Receiver Orientation on page 18)
- Adjacent Reflective Surfaces (see Adjacent Reflective Surfaces on page 17)
- Installation of Multiple Systems (see Installation of Multiple Systems on page 19)

WARNING:

- **Position the System Components Carefully**
- Failure to observe this warning could result in serious injury or death.
- Position the system components such that the hazard cannot be accessed by reaching over, under, around, or through the sensing field. Additional and supplemental guarding may be required.

5.2 Calculating the Safety Distance (Minimum Distance)

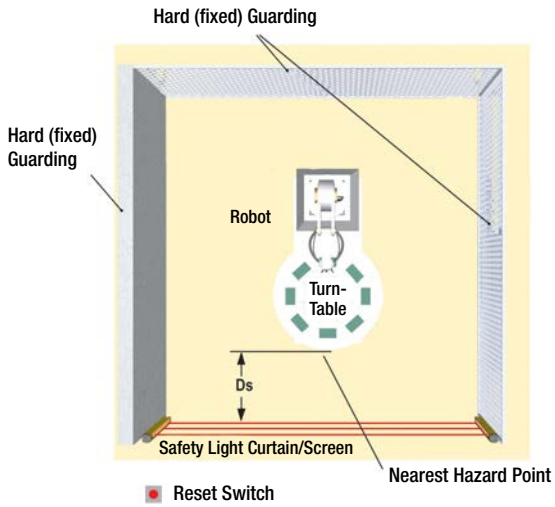
Safety Distance (Ds), also called Minimum Distance (S), is the minimum distance required between the defined area and the closest reachable hazard point. The distance is calculated so that when an object or a person is detected (by blocking a sensing beam), the S2B sends a stop signal to the machine, 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:

- **Calculate the Safety Distance (Minimum Distance)**
- Failure to establish and maintain the safety distance (minimum distance) could result in serious injury or death.
- Mount the components at a distance from the nearest hazard such that an individual cannot reach the hazard before cessation of the hazardous motion or situation. Calculate this distance using the supplied formulas, as described by ANSI B11.19 and ISO 13855. Mount the components more than 100 mm (4 in) away from the hazard, regardless of the calculated value.

Figure 2. Safety distance (minimum distance) and hard (fixed) guarding



5.2.1 Formula

U.S. Applications	European Applications
The Safety (Separation) Distance formula for U.S. applications:	The Minimum Distance formula for European applications:
`Ds = K × (Ts + Tr) + Dpf`	`S = (K × T) + C`

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, XS26-2 Safety Controllers) and measured at maximum machine velocity (see Note 3 below)

Tr

the maximum response time, in seconds, of the S2B 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. Depth Penetration Factor (Dpf) = 3.4 × (S – 7) where S is the resolution of the light curtain (for S ≤ 63 mm).

For 30 mm resolution systems like S2B, Dpf = 78.2 mm (3.08 in.)

S

the Minimum Distance, in mm, from danger zone to light screen center line; minimum allowable distance is 100 mm (175 mm for non-industrial applications), regardless of calculated value

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 (in mm):

```
C = 8 × (d – 14)
```

where `d` is the resolution of the light curtain (for `d` ≤ 40 mm), or use 850 mm for C.

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.

5.2.2 Examples

Example: U.S. Applications, Model

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

Ts = 0.31 (0.250 second is specified by the machine manufacturer; plus 20% safety factor; plus 13 ms for XS26-2 Safety Controller response time)

Tr = 0.0255 seconds (the specified response time of S2B1R30-2325)

Dpf = 3.08 in (30 mm resolution)

Substitute the numbers into the formula as follows:

```
Ds = K × ( Ts + Tr ) + Dpf
= 24.22 in
```

Mount the S2B emitter and receiver so that no part of the defined area will be closer than 24.22 inches to the closest reachable hazard point on the guarded machine.

Example: European Applications, Model

K = 1600 mm per second

T = 0.34 (0.250 second specified by machine manufacturer; plus 20% safety factor; plus 13 ms XS26-2 Safety Controller response time), plus 0.0255 seconds (the specified response time of an S2B1R30-2325)

C = 8 × (30 – 14) = 128 mm (30 mm resolution)

Substitute the numbers into the formula as follows:

```
S = (K × T ) + C
=672 mm
```

Mount the S2B emitter and receiver so that no part of the defined area will be closer than 672 mm to the closest reachable hazard point on the guarded machine.

5.3 Reducing or Eliminating Pass-Through Hazards

A *pass-through* hazard is associated with applications where personnel may pass through a safeguard, such as the S2B Safety Light Curtain (which issues a stop command to remove the hazard), and then continues into the guarded area. This is common in access and perimeter guarding applications. 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 sensing field 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 after the safeguarding device is tripped, the corresponding safety monitoring device latches and requires 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. The S2B Safety Light Curtain does not provide a configurable Manual Start/Restart (Latch Output) function. For these applications, this function must be implemented in the external safety monitoring device.

WARNING:
- **Use of the Banner device for Access or Perimeter Guarding**
- Failure to observe this warning could result in serious injury or death.
- 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 can not be eliminated or reduced to an acceptable level of risk.

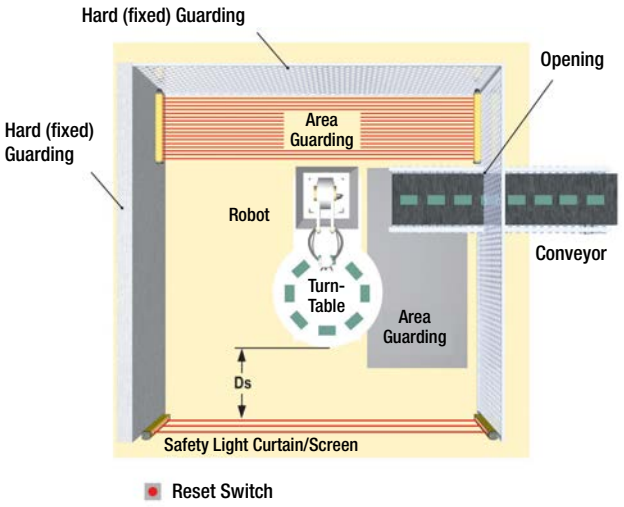
5.4 Supplemental Safeguarding

As described in Calculating the Safety Distance (Minimum Distance) on page 13, position the S2B 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 S2B System or through other safeguarding that prevents access to the hazard.

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 3. An example of supplemental safeguarding



This is an example of supplemental safeguarding inside a robotic work cell. The S2B, 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 sensing field**
- Incorrect system installation could result in serious injury or death.
- The installation of the S2B must prevent any individual from reaching around, under, over or through the defined area and into the hazard without being detected.
- See OSHA CFR 1910.217, ANSI B11.19, and/or ISO 14119, ISO 14120 and ISO 13857 for information on determining safety distances and safe opening sizes for your guarding device. Mechanical barriers (for example, hard (fixed) guarding) or supplemental safeguarding might be required to comply with these requirements.

5.5 Other Considerations

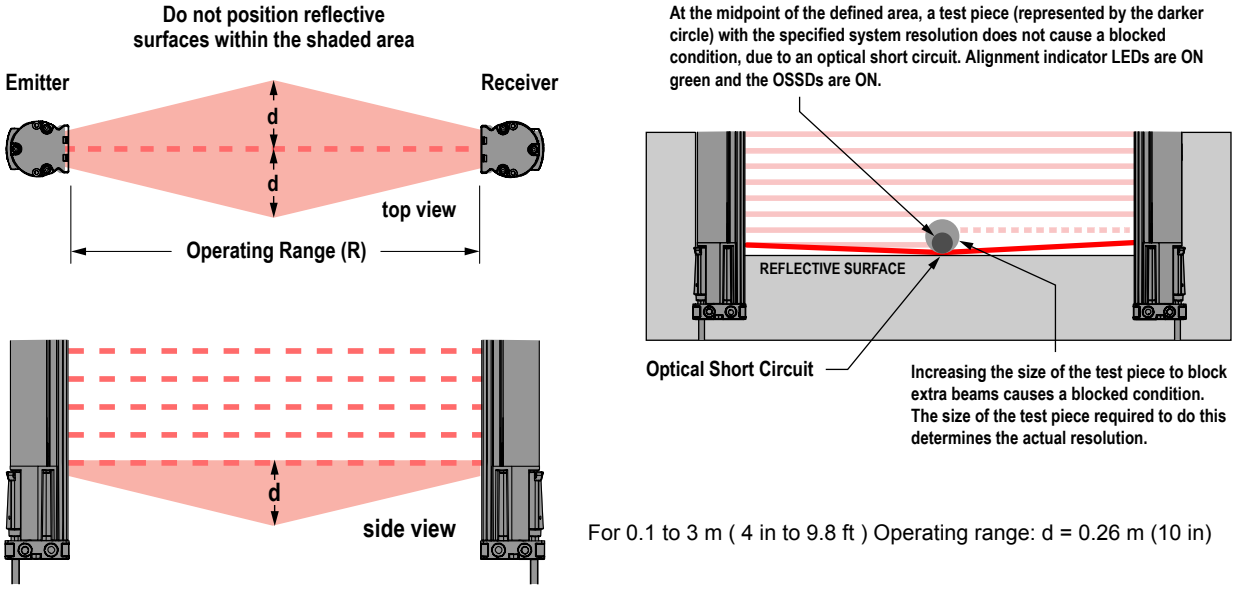
5.5.1 Adjacent Reflective Surfaces

A reflective surface located adjacent to the defined area may deflect one or more beams around an object in the defined area. In the worst case, an optical short circuit may occur, allowing an object to pass undetected through the defined area.

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 Conduct a Trip Test on page 28) to verify 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 4. Adjacent Reflective Surfaces



For 0.1 to 3 m (4 in to 9.8 ft) Operating range: d = 0.26 m (10 in)

In Figure 4 on page 17, a test piece (represented by the darker circle) with the specified system resolution, placed at the midpoint of the defined area, does not cause a blocked condition due to an optical short circuit. Green Zone indicator lights are on and the OSSDs are on. Increasing the size of the test piece to block additional beams causes a blocked condition. The size of the test piece required to do this determines the actual resolution. Use the following table to calculate Dpf or Factor "C" when a shiny surface causes an optical short circuit.

Test Piece Model	Resolution	Depth Penetration Factor for U.S. Applications	Factor "C" for European Applications
STP-14	30 mm	78 mm (3 in)	128 mm (5 in)
STP-4	32 mm	85 mm (3.3 in)	144 mm (5.7 in)
STP-17	34 mm	92 mm (3.6 in)	160 mm (6.3 in)
STP-1	38 mm	106 mm (4.2 in)	192 mm (7.6 in)
STP-3	45 mm	129 mm (5 in)	850 mm (33.5 in)

Test Piece Model	Resolution	Depth Penetration Factor for U.S. Applications	Factor "C" for European Applications
STP-8	51 mm	150 mm (5.9 in)	850 mm (33.5 in)
STP-5	58 mm	173 mm (6.8 in)	850 mm (33.5 in)
STP-15	60 mm	180 mm (7 in)	850 mm (33.5 in)
STP-12	62 mm	187 mm (7.4 in)	850 mm (33.5 in)

5.5.2 Emitter and Receiver Orientation

The emitter and receiver must be mounted parallel to each other and aligned in a common plane, with both machine interface cable ends pointing in the same direction.

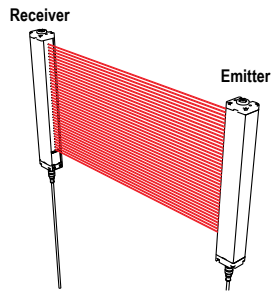
Never mount the emitter with its machine interface cable end oriented in the opposite direction of the cable end of the receiver. If this occurs, voids in the light screen may allow objects or personnel to pass through the defined area undetected.

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.

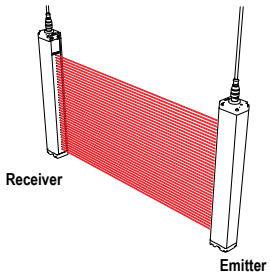
WARNING:

- **Properly install system components**
- Incorrectly orienting the system components impairs the performance of the system and results in incomplete guarding, which can result in serious injury or death.
- Install the system components with their corresponding cable ends pointing in the same direction.

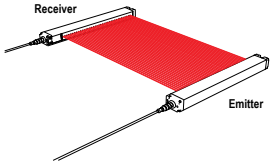
Figure 5. Examples of Correct Emitter/Receiver Orientation



Both cable ends down

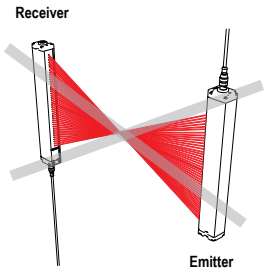


Both cable ends up



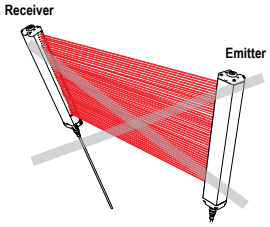
Orientation parallel to floor with both cable ends pointing in the same direction

Figure 6. Examples of Incorrect Emitter/Receiver Orientation



Cable ends point in opposite directions

Problem: Voids in defined area



Emitter and receiver not parallel to each other

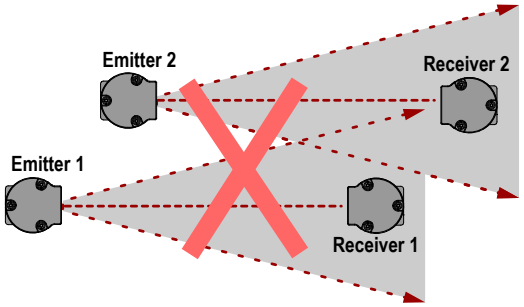
Problem: Reduced excess gain

5.5.3 Installation of Multiple Systems

Whenever two or more S2B 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 as shown in Figure 7 on page 19, or alternate scan codes.

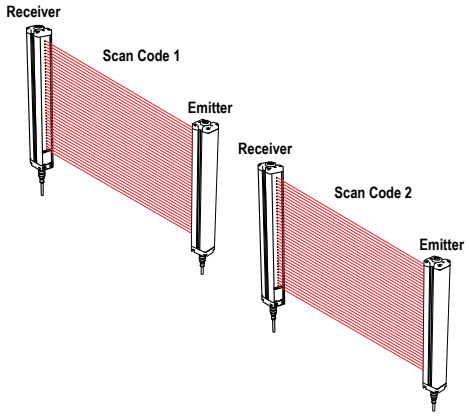
When three or more systems are installed in the same plane, optical crosstalk may occur between sensor pairs whose emitter and receiver lenses are oriented in the same direction. In this situation, eliminate optical crosstalk by mounting these sensor pairs exactly in line with each other within one plane, or by adding a mechanical barrier between the pairs as shown in Figure 7 on page 19.



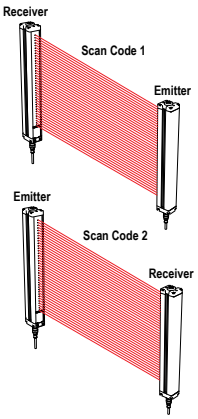
To further aid in avoiding crosstalk, the sensors feature two selectable scan codes. A receiver set to one scan code will not respond to an emitter set to another code. The emitter and receiver within a system must be set to the same scan code.

Scan codes are set via the switches in the removable DES2P-... cordsets on the emitters and receivers. See Scan Code Selection on page 25 for the switch settings.

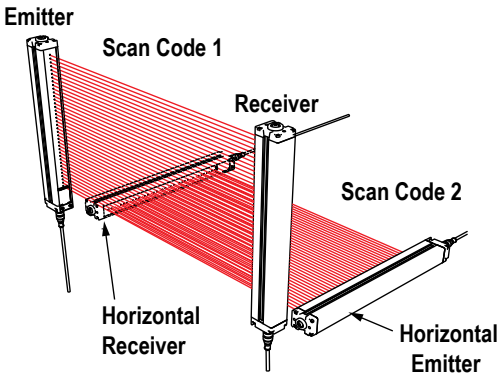
Figure 7. Installation of Multiple Systems



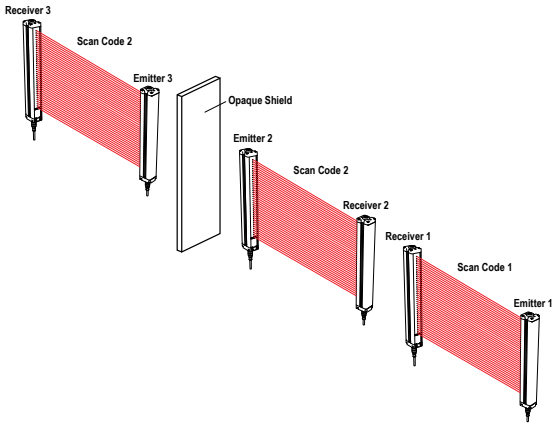
a. Two systems in a horizontal plane



b. Two or three systems stacked (or alternate receiver/ emitter positions)



c. Two systems at right angles



d. Multiple systems

WARNING:
- **Properly connect multiple pairs of sensors**
- Connecting multiple output signal switching devices (OSSD) safety outputs to one interface module or otherwise parallel OSSD outputs can result in serious bodily injury or death, and is prohibited.
- Do not connect multiple pairs of sensors to a single device.

5.6 Mounting System Components

5.6.1 Mounting Hardware

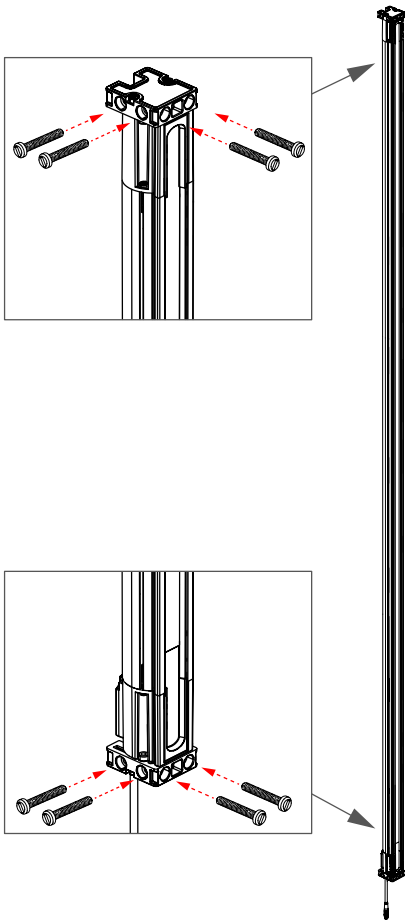
Emitter/receiver pairs can be spaced from 0.1 m (4 in) to 3 m (9.8 ft) apart.

Fixed end-cap brackets do not allow any rotation. Optional side brackets may be used for additional support in high vibration applications.

5.6.2 Mounting Using the End Brackets

Use the following procedure to mount the S2B using the end brackets.

Figure 8. End-Mount Brackets

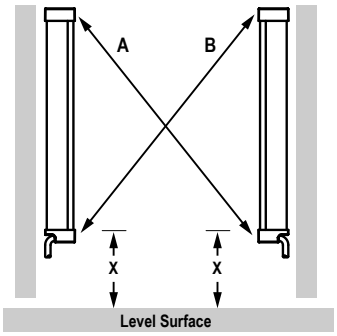


- End brackets pre-installed on each emitter/receiver
- The M4 hardware shown can be mounted from either side. Tighten to 2.15 N·m (19 in·lbs).

1. From a common point of reference (ensuring the calculated minimum safety distance), measure to position the emitter and receiver in the same plane, with their midpoints directly opposite each other.
2. Position the emitter and receiver, with their brackets installed, as shown in Emitter and Receiver Orientation on page 18.
3. Verify that the sensor windows directly face each other.

a) 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.
b) Use a carpenter's level, a plumb bob, or check the diagonal distances between the sensors, to achieve mechanical alignment.

Figure 9. Vertical Alignment



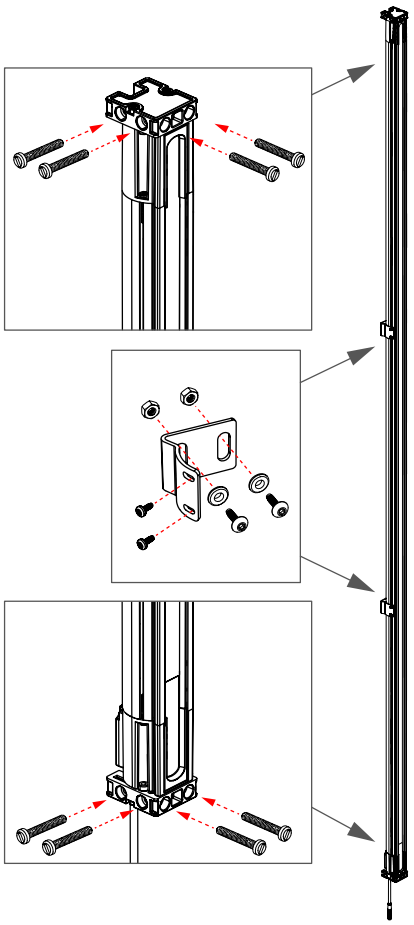
Final alignment procedures are explained in Electrical Installation and Testing on page 25.

4. 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)
5. Mount the emitter and receiver to the desired surface with user-supplied M4 or #8 bolts and nuts.
6. Tighten all fasteners to 2.15 N·m (19 in·lbs).

5.6.3 Mounting Using the Side Brackets

Use the following procedure to attach the optional side brackets to the S2B.

Figure 10. Side-Mount Brackets



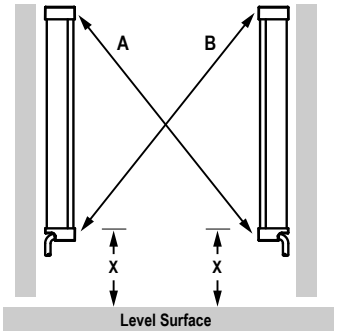
- Designed to mount the sensors with up to 900 mm of unsupported distance between brackets when they are subject to shock or vibration
- Use the side brackets in conjunction with the end brackets
- Tighten the M4 fasteners to 2.15 N·m (19 in·lbs)

1. From a common point of reference (ensuring the calculated minimum safety distance), measure to position the emitter and receiver in the same plane, with their midpoints directly opposite each other.
2. Install the side brackets on the desired surface as shown in Figure 10 on page 22, using the supplied plastic sleeve washers, and user-supplied M4 or #8 fasteners and nuts.

Note:
- Fasteners must be button heads to prevent interference with sensors.
- The supplied plastic sleeve washers and polyimide tape on bracket are necessary for electrical isolation to the desired surface. Do not remove or discard.
- Do not attach the side brackets to the sensors before installing the brackets on the desired surface.

3. Tighten the fasteners just enough to hold the side brackets in position, but still be able to move them by hand.
4. Position the emitter and receiver on the desired surface as shown in Emitter and Receiver Orientation on page 18, using user-supplied M4 or #8 fasteners in the end brackets.
5. Tighten the fasteners just enough to hold the sensors in position, but still be able to move them by hand.
6. Verify that the sensor windows directly face each other.
   a) 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.
   b) Use a carpenter's level, a plumb bob, or check the diagonal distances between the sensors, to achieve mechanical alignment.

Figure 11. Vertical Alignment



Final alignment procedures are explained in Electrical Installation and Testing on page 25.

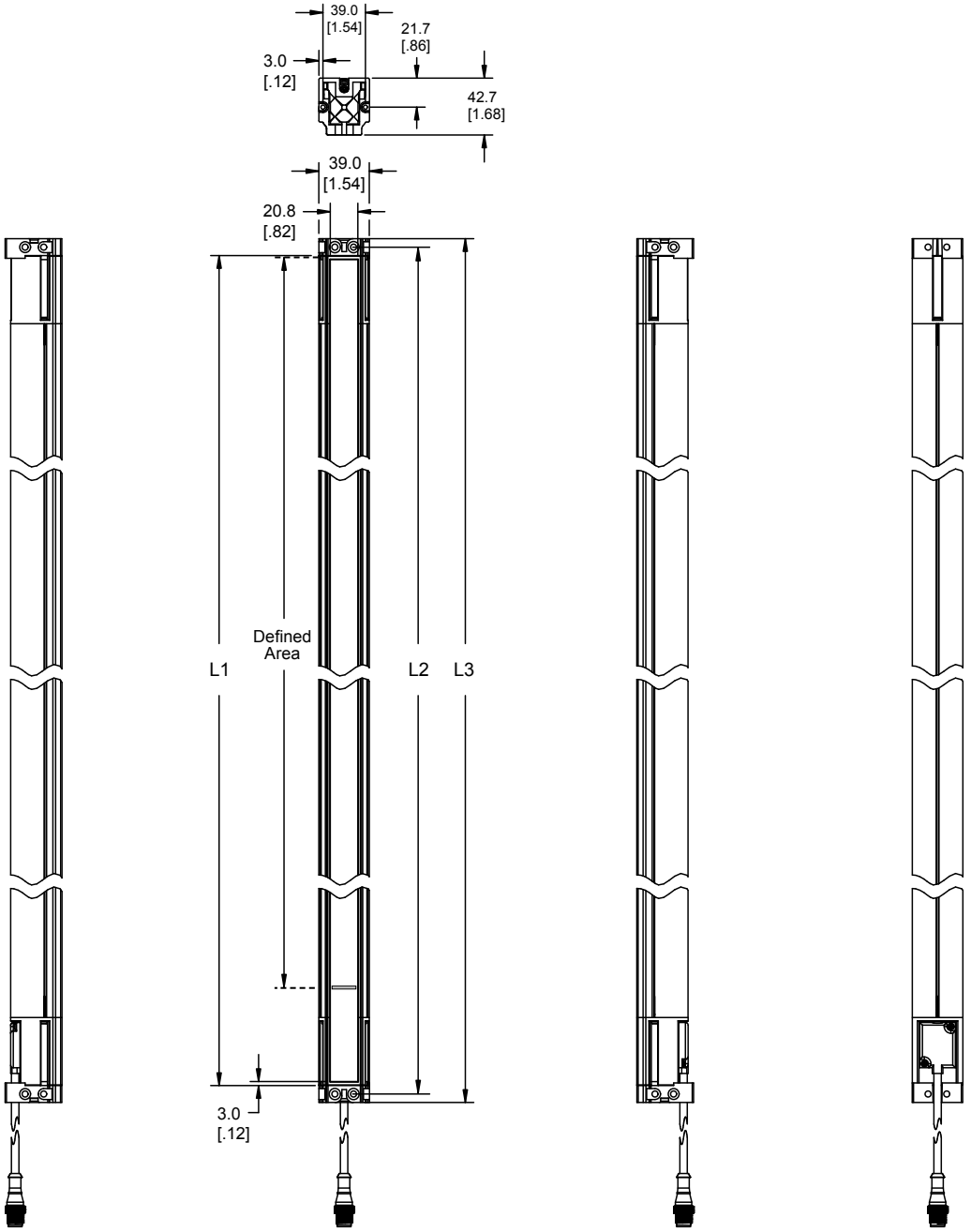
7. Verify that:
   - Distance X at the emitter and receiver are equal
   - Both sensors are level/plumb (check both the side and face)
   - Defined area is square. Check diagonal measurements if possible (Diagonal A = Diagonal B)
8. After the sensors are properly aligned, mate the side brackets to the sensor housing by holding them against the sensor (do not attach with screws).

   Mark the bracket positions on the desired surface in preparation for the next step.
9. Temporarily remove the sensors and tighten the side bracket M4 or #8 fasteners to 2.15 N·m (19 in·lbs), keeping the side brackets in locations determined in the previous step.
10. Re-position the sensors on the desired surface by mating the sensor housings to the side brackets and re-inserting the end bracket screws.
11. Make sure the sensors are properly aligned.
12. After the sensors are aligned, and maintaining the alignment, tighten the end bracket M4 or #8 fasteners to 2.15 N·m (19 in·lbs).
13. Insert the supplied side bracket sensor mounting screws through side bracket into the sensor housing.
14. Hand tighten all side bracket screws.

Note: Do not over-tighten the screws because the threads in the sensor housing could strip.

5.6.4 Mounting Dimensions and Defined Area

All measurements are listed in millimeters [inches], unless noted otherwise.



Emitter/Receiver Model	Housing Length (L1)	End Bracket Hole to Hole Length (L2)	End Bracket to End Bracket Length (L3)	Defined Area (mm)
S2B1...-2025	2097 mm	2109.6 mm	2122.4 mm	2025
S2B1...-2325	2395 mm	2407.6 mm	2420.3 mm	2325
S2B1...-2500	2544 mm	2556.3 mm	2569.0 mm	2500

6 Electrical Installation and Testing

The following are the main steps to electrically install the S2B components and interface with the guarded machine.

WARNING:

- **Read this Section Carefully Before Installing the System**
- **Failure to follow these instructions could result in serious injury or death.**
- If all mounting, installation, interfacing, and checkout procedures are not followed properly, this Banner device cannot provide the protection for which it was designed.
- The user is responsible for ensuring 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. A Qualified person is 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.

1. Routing cordsets and making initial electrical connections (see Routing Cordsets on page 25 and Initial Electrical Connections on page 26).
2. Apply power to each emitter/receiver pair (see Initial Electrical Connections on page 26).
3. Perform an Initial Checkout Procedure (see Initial Checkout Procedure on page 27).
4. Make all electrical interface connections to the guarded machine (see Electrical Connections to the Guarded Machine on page 29).
5. Perform a commissioning checkout procedure (see Commissioning Checkout on page 31).

6.1 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 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 Accessories on page 40 for selection of Banner-supplied cables.

The S2B 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 S2B System. It is good wiring practice, and sometimes may be required by code, to isolate emitter and receiver cables from high-voltage wires and to avoid routing cables close to sources of noise.

Sensor cabling and any interconnect wiring should have an insulation temperature rating of at least 90 °C (194 °F).

6.2 Scan Code Selection

The emitter and receiver may be configured to one of two Scan Codes (1 or 2).

A receiver recognizes light only from an emitter with the same scan code. Both the emitter and its corresponding receiver must have the same scan code setting. The scan code must be configured with power off because the DES2P-.. RD to M8 cordset assemblies must be removed from the units.

The default scan code setting is scan code 1.

To change the scan code setting, use the following instructions.

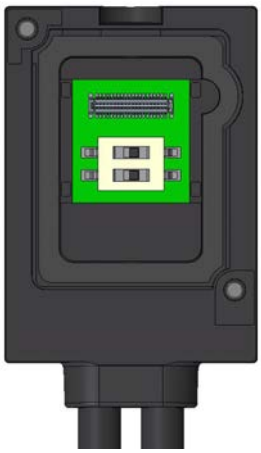
1. Remove the DES2P-..RD cordset from the sensor by loosening the two screws (#1 Phillips drive).

Note: The screws are captive screws and should not be removed from the cordset assembly.

Figure 12. Remove the Corset

2. Flip the cordset over to see the two switches.

Figure 13. Scan Code Switches



Scan Code 1: Both switches in the left position

Scan Code 2: Both switches in the right position (as shown)

3. Position the cordset onto the sensor.
4. Hand tighten the two screws.

6.3 Initial Electrical Connections

Make the electrical connections in the order described in this section. Do not remove end-caps; no internal connections are to be made.

WARNING:

- **Risk of electric shock**
- Use extreme caution to avoid electrical shock. Serious injury or death could result.
- Always disconnect power from the safety system (for example, device, module, interfacing, etc.), guarded machine, and/or the machine being controlled before making any connections or replacing any component. Lockout/tagout procedures might be required. Refer to OSHA 29CFR1910.147, ANSI Z244-1, or the applicable standard for controlling hazardous energy.
- Make no more connections to the device or system than are described in this manual. Electrical installation and wiring must be made by a Qualified Person [4] and must comply with the applicable electrical standards and wiring codes, such as the NEC (National Electrical Code), NFPA 79, or IEC 60204-1, and all applicable local standards and codes.

Lockout/tagout procedures may be required (refer to OSHA1910.147, ANSI Z244-1, ISO 14118, or the appropriate standard for controlling hazardous energy).

All connections are made through the pigtail quick-disconnect connection.

[4] 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.

6.4 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 components.

Perform this procedure to:

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

6.4.1 Configuring the System for Initial Checkout

For the initial checkout, the S2B 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). The OSSD 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 Safety/Interface Module is not connected to the OSSD outputs at this time (permanent connections will be made later)

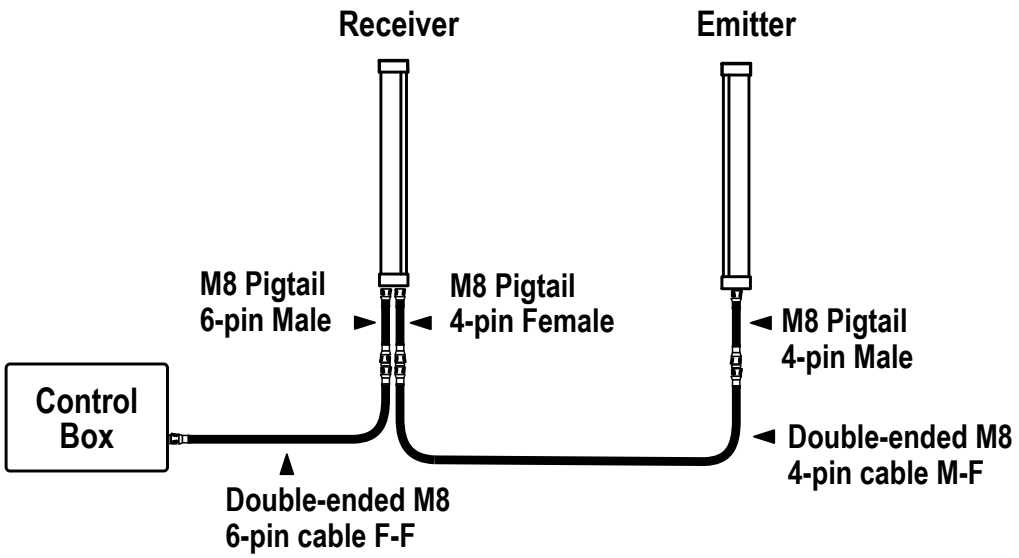
6.4.2 Initial Power-Up

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 17).
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 S2B System and from the guarded machine and that the OSSD safety outputs are not connected.
4. Remove all obstructions from the light screen.
5. With the power to the guarded machine off, connect +15 V DC and 0 V DC on both the emitter and receiver cables to a SELV-rated power supply.

   If a double-ended, 4-pin cable is used to connect the emitter to the receiver, only the receiver should be connected to the power supply. The emitter will be powered through the double-ended cable to the receiver (see Wiring Diagrams on page 32).
6. Power up the S2B 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.
   - **Emitter Lockout Condition**—the emitter's red Status indicator is single-flashing and the receiver's red Status indicator is on. Proceed to Troubleshooting on page 36 for diagnostic information.
   - **Receiver Lockout Condition** —the receiver Status indicator is single-flashing red and the Zone indicators are off. Proceed to Troubleshooting on page 36 for diagnostic information.
   - **Normal Operating Mode** (emitter)—The green Status indicator is on.
   - **Clear (Run) Condition** (receiver)—The green Status indicator is on. All green Zone indicators are on.
   - **A Blocked Condition** (receiver)—The red Status indicator is on and one or more red Zone indicator(s) are on, identifying the location of the blocked beams.

Note: If beam 1 is blocked, Zone indicator 1 is red and all others are off. Beam 1 provides the synchronization signal.

Figure 14. S2B Cables



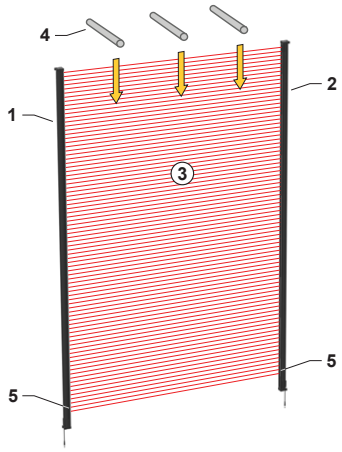
6.4.3 Conduct a Trip Test

After optimizing the optical alignment and configuring fixed blanking and/or reduced resolution (if applicable), perform a trip test to verify the detection capability of the S2B System.

This test also verifies correct sensor orientation, identifies optical short circuits, and verifies the expected resolution for applications using reduced resolution. After the installation has passed the trip test, the safety outputs may be connected and the commissioning checkout may be performed (initial installations only).

1. Select the proper test piece, supplied with the receiver.
   - Use the 30 mm (1.18 in) diameter model STP-14
2. Verify that the System is in run mode, the green Status indicator is on, and all Zone indicators are green.
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 15. Trip Test



1. Receiver
2. Emitter
3. Defined area
4. Specified test piece
5. Location of the status indicators

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.

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 or reflective surfaces. Do not continue until the situation is corrected.

When the test piece is removed from the defined area, the green Status indicator must turn on.

WARNING:
- **Trip test failure**
- Using a system that has failed a trip test can result in serious bodily injury or death. If the trip test has failed, the system might not stop dangerous machine motion when a person or object enters the sensing field.
- Do not attempt to use the system if the system does not respond properly to the trip test.

4. If the S2B System passes all checks during the trip test, connect the OSSDs to the guarded machine control system and go on to Commissioning Checkout on page 31.

6.5 Electrical Connections to the Guarded Machine

Verify that power has been removed from the S2B and the guarded machine. Make the permanent electrical connections 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 should already be connected. The S2B must also have been aligned and passed the Initial Checkout, as described in Initial Checkout Procedure on page 27.

The final connections to be made or verified are:
- OSSD outputs

WARNING:
- **Risk of electric shock**
- Failure to follow these instructions could result in serious injury or death.
- Disconnect or turn off power before installing, removing, or servicing the device.
- Install and connect the device in accordance with the National Electrical Code (NEC) and any applicable local code requirements and supply the device with an appropriate fuse box or circuit breaker (see *Specifications*).

6.5.1 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 Machine Primary Control Elements (MPCE) (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 (EDM) to detect certain failures, 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.

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 S2B.

Output Signal Switching Devices (OSSDs) and External Device Monitoring (EDM)

The S2B is able to detect faults on OSSD1 and OSSD2. These faults include short circuits to +15 V DC and 0 V, and between OSSD1 and OSSD2.

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

Final Switching Devices (FSDs) typically accomplish this when the OSSDs go to an OFF state.

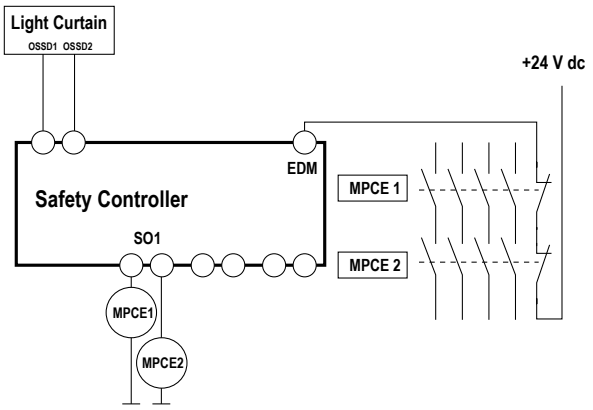
Refer to the output specifications in the Receiver Specifications and these warnings before making OSSD output connections and interfacing the S2B to the machine.

WARNING:
- Interfacing both output signal switching devices (OSSD)
- Failure to follow these instructions could result in serious injury or death.
- Unless the same degree of safety is maintained, never wire an intermediate device(s) (PLC, PES, PC) between the safety module outputs and the master stop control element it switches such that a failure causes a loss of the safety stop command or the failure allows the safety function to be suspended, overridden, or defeated.
- To achieve the highest possible safety level, connect both OSSD outputs to the machine control so that the machine's safety-related control ystem interrupts the circuit to the machine primary control element(s), resulting in a nonhazardous condition.

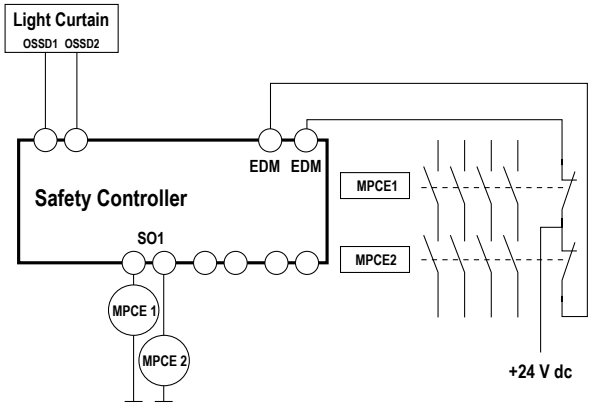
External device monitoring (EDM) is a function used to monitor the state of the external, positively guided (mechanically linked) machine control contacts (FSDs and/or MPCEs). The S2B System does not include the EDM function. As a result, the S2B System should be used with an external safety monitoring device that monitors the status of the S2B OSSDs and is capable of providing the EDM function.

WARNING:
- **OSSD Interfacing**
- Failure to properly interface the OSSD Outputs to the guarded machine could result in serious injury or death.
- 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. Design machine control circuitry so that all of the following are true:

  The maximum load resistance value is not exceeded.
  The maximum specified OSSD OFF-state voltage does not result in an ON condition.



Single-channel EDM used to monitor both MPCE feedback signals. If one or both channels do not close, the system enters a lockout mode.



Dual-channel EDM used to monitor both MPCE feedback signals. If the channels are not in the same state, the system enters a Lockout mode.

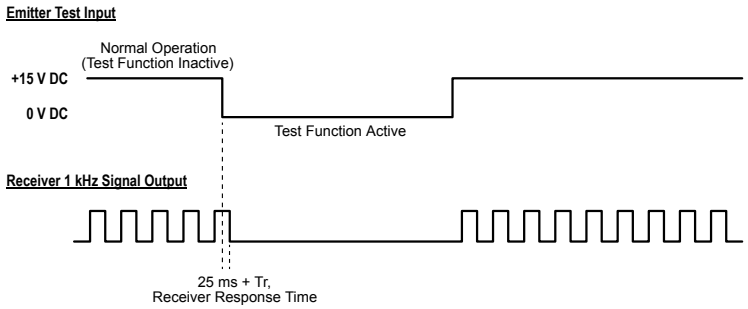
WARNING:
- The S2B does not have external device monitoring (EDM).
- If EDM is required for the application, it must be implemented in the external control.

6.5.2 Emitter Test Function

The S2B emitters include a Test Input which may be used to periodically test the system according to EN IEC 61496-1 type 2 ESPE requirements. Use the risk assessment to determine the frequency and duration of the periodic test.

When the emitter Test Input is connected to +15 V DC, the emitter Test Function is inactive and the emitter operates in normal operation, transmitting infrared light to the corresponding receiver. When the Test Input is connected to 0 V DC, the emitter Test Function is active and the emitter stops transmitting. The Emitter status indicator flashes green when Test Function is active. Verify that the corresponding receiver OSSDs turn off within the specified system response time.

Figure 16. Emitter Test Input



6.5.3 Preparing for System Operation

After the initial trip test has been accomplished, and the OSSD safety outputs connections have been made to the external control device, the S2B is ready for testing in combination with the guarded machine.

The operation of the S2B 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.

6.5.4 Commissioning Checkout

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 S2B or changes to the machine).

WARNING:
- **Do not use the system until the checkouts are verified**
- Attempts to use the guarded/controlled machine before these checks are verified could result in serious injury or death.
- If all these checks cannot be verified, do not attempt to use the safety system that includes the Banner device and the guarded/controlled machine until the defect or problem has been corrected.

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. 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 13.
2. Verify that:
   a) Access to any dangerous parts of the guarded machine is not possible from any direction not protected by the S2B System, hard (fixed) guarding, or supplemental safeguarding, and
   b) It is not possible for a person to stand between the defined area and the dangerous parts of the machine, or
   c) 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 S2B.
3. Inspect the area near the defined area (including work pieces and the guarded machine) for reflective surfaces (see Adjacent Reflective Surfaces on page 17). Remove the reflective surfaces if possible by relocating them, painting, masking or roughening them. Remaining problem reflections will become apparent during the Trip Test.
4. Verify that power to the guarded machine is Off.
5. Remove all obstructions from the defined area.
6. Apply power to the S2B System.
7. Observe the Status indicators:
   - **Lockout:** Red Status flashing; all others off
   - **Blocked:** Red Status on; one or more red Zone indicators on
   - **Clear:** Green Status on; all green Zone indicators on

   A Blocked condition indicates that one or more of the beams is misaligned or interrupted. See Mounting Using the End Brackets on page 20 to correct this situation.
8. After the green Status indicator is on, perform the trip test (Conduct a Trip Test on page 28) on each sensing field to verify proper System operation and to detect possible optical short circuits or reflection problems. **Do not continue until the S2B passes the trip test.**

Important: Do not expose any individual to any hazard during the following checks.

WARNING:
- **Clear the guarded area before applying power or resetting the system**
- Failure to clear the guarded area before applying power could result in serious injury or death.
- Verify that the guarded area is clear of personnel and any unwanted materials before applying power to the guarded machine or before resetting the system.

9. Apply power to the guarded machine and verify that the machine does not start up.
10. Interrupt (block) the defined area with the supplied test piece and verify it is not possible for the guarded machine to be put into motion while the beam(s) is blocked.
11. 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.
12. 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.
13. Remove electrical power to the S2B. Both OSSD outputs should immediately turn Off, and the machine must not be capable of starting until power is re-applied to the S2B.
14. 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.

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

6.6 Wiring Diagrams

6.6.1 Emitter Pinout

The emitter electrical connections are made through a factory-installed, 300 mm long assembly which contains a 4-pin M8 male quick-disconnect connector.

The quick-disconnect connector pinout and functions are shown below.

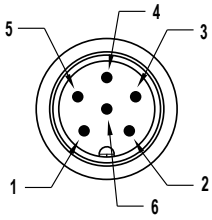
Quick-Disconnect Connector Pinout		Connector (male view)
Pin	**Emitter Function**	
1	+ 15 V DC	
2	0 V	
3	no connection	
4	Test In	

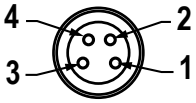
The S2B emitter can be wired either independent of the receiver, with a single-ended, 4-pin M8 cable, or directly to the mating S2B receiver 4-pin M8 quick-disconnect connector using a double-ended, 4-pin M8 cable. See System Wiring on page 33.

6.6.2 Receiver Pinout

The receiver electrical connections are made through a factory-installed assembly which contains a 250 mm long cable with 4-pin M8 female quick-disconnect connector and a 300 mm long cable with 6-pin M8 male quick-disconnect connector.

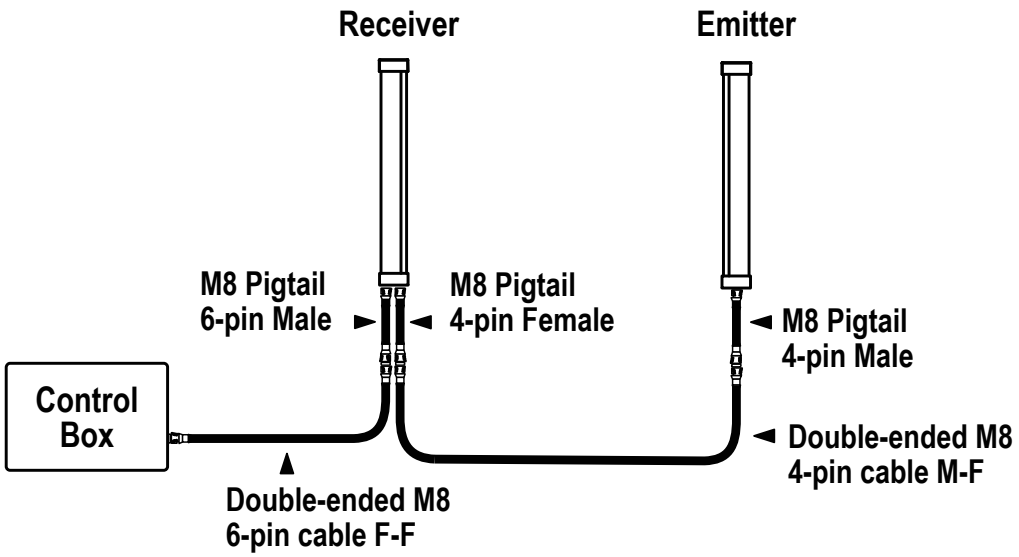
The 4-pin M8 quick-disconnect connector can be used to directly connect the emitter using a double-ended 4-pin M8 cable. The 6-pin M8 quick-disconnect connector is used to connect the machine homerun cable to the Controller. The quick-disconnect connector pinout and functions are shown below.

Quick-Disconnect Connector Pinout		Receiver Cable To Controller—Connector (male view)
6-Pin	Receiver Function	
1	+ 15 V DC	
2	0 V	
3	1 kHz signal/OSSD1	
4	Test In	
5	no connection	
6	OSSD2	

Quick-Disconnect Connector Pinout		Receiver Cable To Emitter—Connector (female view)
4-Pin	Receiver Function	
1	+ 15 V DC	
2	0 V	
3	no connection	
4	Test In (to Emitter)	

6.6.3 System Wiring

Figure 17. System Wiring



7 System Operation

7.1 Security Protocol

Certain procedures for installing, maintaining, and operating the S2B 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 S2B. The Designated Person is empowered to:

- Perform manual resets and hold possession of the reset key
- 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 S2B 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 S2B System
- Perform all checkout procedures
- Make changes to the internal configuration settings
- Reset the System following a Lockout condition

7.2 Normal Operation

7.2.1 System Power-Up

When power is applied, each sensor conducts self-tests to detect critical internal faults, determine configuration settings, and prepare the S2B for operation.

If either sensor detects a critical fault, scanning ceases, the receiver outputs remain Off and diagnostic information displays.

If no faults are detected, the S2B 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.

7.2.2 Run Mode

If any beams become blocked while the S2B is running, the receiver outputs turn Off within the stated S2B response time (see Specifications on page 11). If all the beams then become clear, the receiver outputs come back On. No resets 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. See Troubleshooting on page 36 for resolution of error/fault conditions.

7.2.3 Emitter Indicators

A single bi-color red/green Status indicator shows whether power is applied, and whether the emitter is in Run mode, Test mode, or a Lockout condition.

Emitter Operating Status	Status Indicator
Power-up	Red on for several seconds
Run Mode	Green
Lockout	Flashing Red
Test Mode	Flashing Green

7.2.4 Receiver Indicators

A single 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).

Bi-color red/green Zone indicators show whether a section of the defined area is aligned and clear, or is blocked and/or misaligned. All models have three Zone indicators, each of which indicates Blocked/Clear conditions for approximately 1/3 of the total light screen.

Operating Mode	Status Indicator	Zone Indicators [5]	OSSD Outputs
Power up	Red on for several seconds, then green on for 1 second	Red on for several seconds, then green on for 1 second	Off
Alignment mode - beam 1 blocked	Red	Zone 1 red, others off [6]	Off
Alignment mode - beam 1 clear	Red	Red or green	Off
Run mode - clear	Green	All on green	On
Run mode - blocked	Red	Red or green	Off
Lockout	Flashing red	All off	Off

7.3 Periodic Checkout Requirements

To ensure continued reliable operation, the System must be checked out periodically. Banner Engineering highly recommends performing the System checkouts as described below. However, a Qualified Person should evaluate these recommendations, based on the specific application and the results of a machine risk assessment, to determine the appropriate content and frequency of checkouts.

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 Schedule of Checkouts on page 38). 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 S2B System or changes to the machine), perform the Commissioning Checkout (see Commissioning Checkout on page 31).

Note: Verify Proper Operation

The S2B 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 Schedule of Checkouts on page 38. Failure to correct such problems can result in an increased risk of harm.

Before the System is put back into service, verify that the S2B System and the guarded machine perform exactly as outlined in the checkout procedures and any problem(s) are found and corrected.

[5] If beam 1 is blocked, Zone indicators 2–3 will be Off, because beam 1 provides the synchronization signal for all the beams.
[6] When the Emitter Test Function is active, this can result in an Operating mode of *Alignment mode - beam 1 blocked*.

8 Troubleshooting

8.1 Lockout Conditions

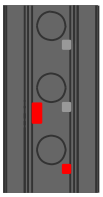
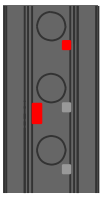
A Lockout condition causes both S2B OSSD outputs to turn off or remain off, sending a stop signal to the guarded machine. Each sensor provides diagnostic error codes to identify the cause(s) of lockouts (see Troubleshooting on page 36).
The following tables indicate a sensor lockout condition:

Receiver Lockout Conditions	
Status indicator	Flashing Red
Zone indicators	Red on See Receiver Error Codes on page 36

Emitter Lockout Conditions	
Status indicator	Flashing Red

Note that the Emitter status indicator flashes green when the emitter Test Function is active.

8.2 Receiver Error Codes

Indicators	Error Description	Cause of Error and Appropriate Action
	**Output Error** 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 0.3 A)	• 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.
	**Receiver Error** occurs because of excessive electrical noise or an internal failure	• Perform a reset per Checkout Procedures: Shift and Daily Checkout Procedure. • If the error clears, perform a Daily Checkout procedure (per Checkout Procedures: Shift and Daily Checkout Procedure; Daily Checkout Card) and if the System checks out, resume operation. If the System fails the Daily Checkout procedure, replace the receiver. • If the error clears, check the external connections and configuration settings. • If the error continues, replace the receiver.

8.3 Electrical and Optical Noise

The S2B 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 nuisance trip.

In extreme electrical noise cases, a Lockout is possible. To minimize the effects of transitory noise, the S2B responds to noise only if the noise is detected on multiple consecutive scans. If random nuisance trips occur, check the following:

- Optical interference from adjacent light screens or other photoelectrics
- Sensor input or output wires routed too close to noisy wiring

8.4 Checking for Sources of Electrical Noise

All S2B wiring is low voltage; running these wires alongside power wires, motor/servo wires, or other high-voltage wiring can inject noise into the S2B System. It is good wiring practice (and may be required by code) to isolate S2B wires from high-voltage wires.

1. Use the Banner model BT-1 Beam Tracker Alignment Aid (see Accessories on page 40) to detect electrical transient spikes and surges.

2. Cover the lens of the BT-1 with electrical tape to block optical light from entering the receiver lens.
3. Press the RCV button on the BT-1 and position the Beam Tracker on the wires going to the S2B or any other nearby wires.
4. If the BT-1's indicator lights, check for sources of electrical noise and separate the S2B cordset from any high-voltage wiring, if applicable.
5. Install proper transient suppression across the load to reduce the noise.

8.5 Check for Sources of Optical Noise

1. Turn off the emitter or completely block the emitter.
2. Press the RCV button on the Banner BT-1 Beam Tracker Alignment Aid and move it across the full length of the receiver’s sensing window to check for light at the receiver.
3. If the BT-1’s indicator lights, check for emitted light from other sources (other safety light screens, grids or points, or standard photoelectric sensors).

9 Checkout Procedures

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).

Banner Engineering highly recommends performing the System checkouts as described. However, a qualified person (or team) should evaluate these generic recommendations considering their specific application and determine the appropriate frequency of checkouts. This will generally be determined by a risk assessment, such as the one contained in ANSI B11.0. The result of the risk assessment will drive the frequency and content of the periodic checkout procedures and must be followed.

9.1 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.	Conduct a Trip Test on page 28	Qualified Person
Commissioning Checkout	At Installation Whenever changes are made to the System (for example, either a new configuration of the S2B or changes to the guarded machine).	Commissioning Checkout on page 31	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 226572) 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 S2B or changes to the machine).	**Semi-Annual Checkout Card** (Banner p/n 228592) 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

10 Product Support and Maintenance

10.1 Cleaning

S2B components are constructed of polycarbonate and are rated IP65 (EN 60529). Clean components with mild detergent or window cleaner and a soft cloth. Avoid cleaners containing alcohol, as they may damage the polycarbonate housing.

10.2 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.

10.3 Banner Engineering Corp Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. **IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.**

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For patent information, see www.bannerengineering.com/patents.

10.4 Contact Us

Banner Engineering Corp. headquarters is located at:

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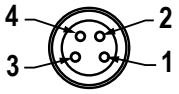
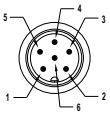
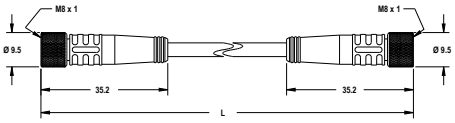
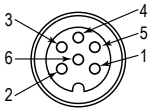
Minneapolis, MN 55441, USA
Phone: + 1 888 373 6767

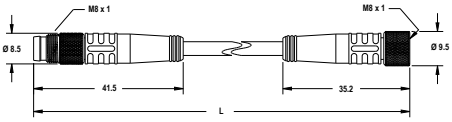
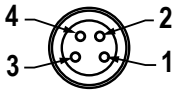
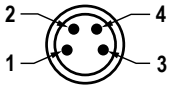
For worldwide locations and local representatives, visit www.bannerengineering.com.

11 Accessories

11.1 Cordsets & Machine Interface Cables

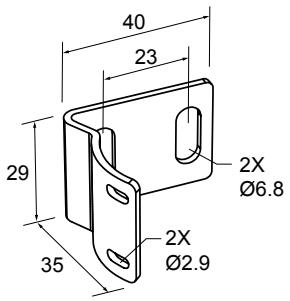
DES2P-41… RD to M8 Cordset Assemblies				
Model	**Length**	**Style**	**Images**	**Pinout**
DES2P-41G	0.3 m (1.0 ft)	4-pin Male Straight		Male 
DES2P-41D61G	0.25 m (0.8 ft) 0.3 m (1.0 ft)	4-pin Female Straight 6-pin Male Straight		Female  Male 

6-Pin Threaded M8 Cordsets—Double Ended				
Model	**Length**	**Style**	**Dimensions**	**Pinout**
PKG6M-2.1-PKG6M	2.1 m (6.9 ft)	Female Straight/ Female Straight		
PKG6M-4.1-PKG6M	4.1 m (13.5 ft)			

4-Pin Threaded M8 Cordsets—Double Ended				
Model	**Length**	**Style**	**Dimensions**	**Pinout**
PKG4M-0.80-PSG4M	0.8 m (2.6 ft)	Male Straight/ Female Straight		Female  Male 

11.2 Brackets

See Mounting System Components on page 20 for installation information.

Model	Description	
S2BA-MBK-12	• Side-mount bracket • Black • Use in high vibration applications for additional support • Distance between side brackets should be 900 mm or less	

11.3 Alignment Aids

Model	Description	
BT-1	Beam Tracker	

12 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 5.

Auto Power-Up

A safety light curtain 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 curtain system which allows the light curtain 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 curtain 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 curtain system, defined by the height and the safety distance (minimum distance) of the system.

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 curtain 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 curtain) 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 curtain 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 curtain system to Run mode following a Lockout condition, or to enable machine operation following a Manual Start/Restart (Latch) condition. Also refers to the act of using the switch.

L

Manual Start/Restart (Latch) Condition

The safety outputs of a safety light curtain system turn off when an object completely blocks a beam. In a Manual Start/Restart condition, the safety outputs stay off when the object is removed from the defined area. To re-energize the outputs, perform a proper manual reset.

Lockout Condition

A safety light curtain condition that is automatically attained in response to certain failure signals (an internal lockout). When a Lockout condition occurs, the safety light curtain'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 curtain 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 curtain 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 curtain 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 curtain system to be configured to produce an intentionally disabled light beam(s) within the light curtain, which increases the minimum object sensitivity. The disabled beam(s) appears to move up and down (float) 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 Auto Start/Restart (Trip) or Manual Start/Restart (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 Manual Start/Restart (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 curtain systems and safety modules are self-checking.

Safety Distance

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 curtain system response time, and the light curtain 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 curtain system. When inserted into the defined area and placed in front of a beam, the test piece causes the outputs to de-energize.

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 curtain system.

Auto Start/Restart (Trip) Condition

The safety outputs of a safety light curtain system turn off when an object completely blocks a beam. In an Auto Start/Restart condition, the safety outputs re-energize when the object is removed from the defined area.

Auto Start/Restart (Trip) Initiate

The resetting of a safeguard causing the initiation of machine motion or operation. Auto Start/Restart 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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