



MICRO-SCREEN™ Instruction Manual

For systems using control module USDINT-1T2 and USDINT-2T2 with Trip Output

MICRO-SCREEN Features

- A compact, modular optoelectronic point-of-operation guarding device for smaller light- to medium-duty production machinery
- Choose sensitive Standard Series or cost-effective V-Series emitters and receivers
- Creates a synchronized, modulated infrared light screen in 15 sizes from 100 mm to 1.8 m (4" to 6') high
- 35 mm DIN-rail-mountable control module
- Control-reliable redundant output relays
- Emergency Stop input
- Two-digit Diagnostic Display
- Easily configured one- or two-beam floating blanking
- Control Module USDINT-1T2 without fixed blanking or Control Module USDINT-2T2 with fixed blanking
- FMEA tested to ensure control reliability
- LEDs on control module and receiver indicate system status and emitter/receiver alignment



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Applications and Limitations of MICRO-SCREEN™ Systems

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

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

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

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

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

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Important ... read this page before proceeding!

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

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

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

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

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

Caution!!

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

U.S. Standards Applicable to Use of MICRO-SCREEN™ Systems	
ANSI B11 Standards	<i>Safeguarding of Machine Tools</i>
ANSI/RIA R15.06	<i>Safety Requirements for Robot Systems</i>
NFPA 79	<i>Electrical standard for Industrial Machinery</i>
<i>See page 63 and 64 for information on these and other applicable standards, and where to acquire copies.</i>	

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System Introduction

1. MICRO-SCREEN System Introduction

The Banner MICRO-SCREEN System is a microprocessor-controlled opposed-mode opto-electronic “curtain of light” (or “light screen”). It is designed for use as a point-of-operation guarding device, and is especially suited to smaller production machinery.

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

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

Portions of the light screen may be “blanked” (made blind) to allow for:

- 1) The movement of one or multiple workpiece(s) through the light screen (floating blanking), or
- 2) The continued presence of brackets, fixtures, etc. in the plane of the light screen (optional fixed blanking).

The Banner MICRO-SCREEN System is a modular machine guard system. Each System is made up of a USE Series emitter unit, a USR Series receiver unit, and a control module (see Figure 1 and cover photo). The three MICRO-SCREEN System components are interconnected using two 5-wire shielded cables. Emitters and receivers may have an attached QD connector, a 300 mm (12") QD pigtail, or an integral, unterminated 7.6 m (25') cable; units with the QD connector or pigtail also require a QD mating cable (see page 60).

NOTE: The control module must be protected inside a lockable enclosure with a NEMA 3 (IP54) or better rating.

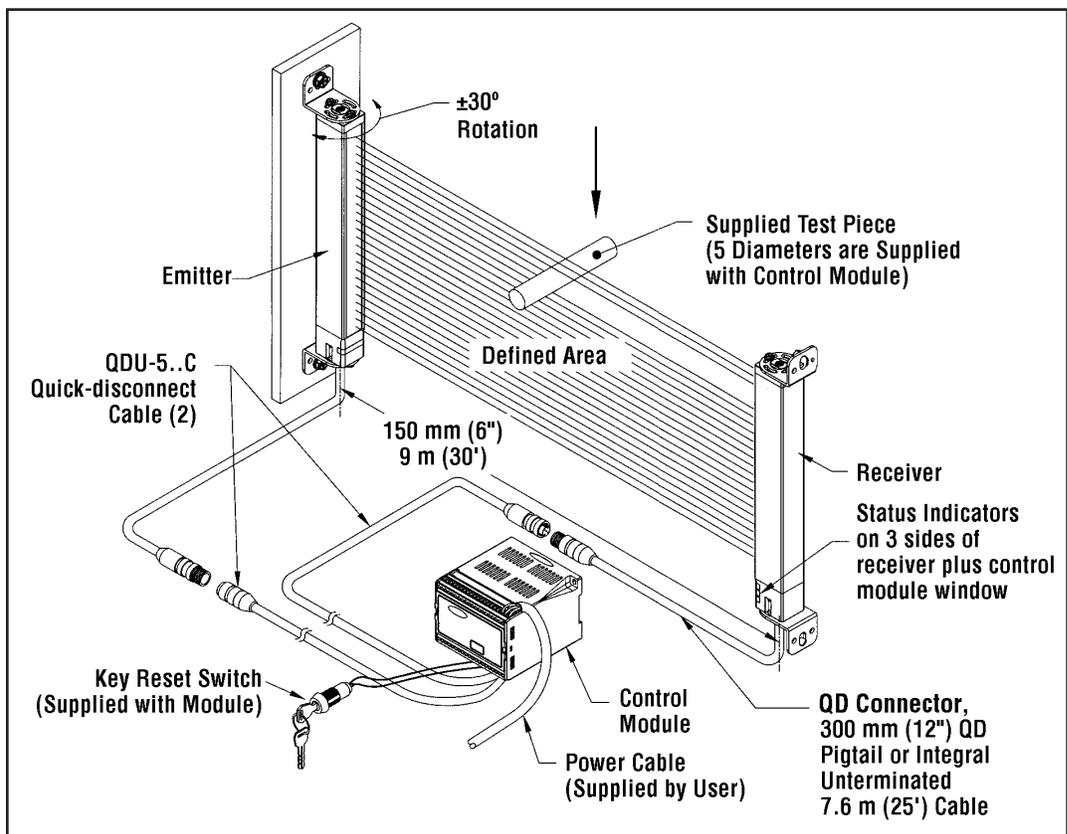


Figure 1. Banner MICRO-SCREEN System: emitter, receiver, control module, and two interconnecting cables

Emitter units have a row of synchronized modulated infrared (invisible) light emitting diodes (LEDs) in a compact rectangular metal housing. Receiver units have a corresponding row of synchronized phototransistors. Emitters and receivers are available in 15 lengths (based on the height of the defined area) ranging from 100 mm to 1.8 m (4" to 6") (see page 59). The rectangular sensor design includes a swivel bracket at each end for quick mounting and ease of alignment. Longer sensors also include one or two center brackets for additional support. Control modules and receivers have LED indicators for system operating status and alignment. Each receiver has three status indicators (visible from the front and both sides) for high visibility. Emitters have a Power ON indicator.

Emitter/receiver pairs from 102 to 1219 mm (4" to 48") long may be spaced from 15 cm to 9 m (6" to 30') apart. Emitter/receiver pairs 1422 to 1892 mm (56" to 72") long may be spaced from 15 cm to 6 m (6" to 20') apart. The maximum distance between an emitter and its receiver is reduced if corner mirrors are used (see alignment information on page 48). The width and height so described are known as the *defined area*.

The minimum object sensitivity is the minimum-diameter object that the light screen can reliably detect anywhere within the defined area. Minimum object sensitivity directly affects the minimum allowable distance between the defined area of the light screen and the nearest hazard point (the separation distance). See Section 3.2.

The minimum object sensitivity is 19 mm (0.75") for Standard Series sensor lengths from 4" to 48", and 32 mm (1.25") for V-Series sensor lengths from 24" to 72" when no blanking is in use.

The control module has a "trip" output which automatically resets the output relays as soon as the defined area is clear. The control module is powered by 24V dc. The control module automatically recognizes the length and style of the sensor pair wired to it – no programming is necessary.

The selectable Auto Power-up feature makes a Key Reset unnecessary at system power-up when the defined area is clear.

The control module contains a power supply board (to power the control module itself, plus an emitter and receiver) with the forced-guided output relays, and a microprocessor controller board to control sensing logic. A two-digit Diagnostic Display on the microprocessor controller board (visible through a clear window in the control module cover) identifies one of 13 possible lockout conditions, as well as the total number of beams blocked.

The control module also has provision to connect an optional Emergency Stop (E-stop) switch. Resetting the System from an emergency stop, a fault condition, or at system power-up is accomplished using a Key Reset switch, supplied with each control module.

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

Unlike some competitive systems, matched sets of MICRO-SCREEN components are not required. Any MICRO-SCREEN System emitter and receiver (of equal length and having the same number of beams) may be used together with any control module.

A functional schematic diagram of the MICRO-SCREEN System appears on page 12. For MICRO-SCREEN System dimension drawings, see pages 23 and 24. For specifications, see pages 56-58.

MICRO-SCREEN system components may be purchased separately, or they may be purchased bundled together in kit form. The components are listed on page 59.



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

The MICRO-SCREEN System uses *one pair of sensors* connected to *one control module*. Connection of multiple pairs of sensors to a single control module can result in serious injury or death, and is prohibited.

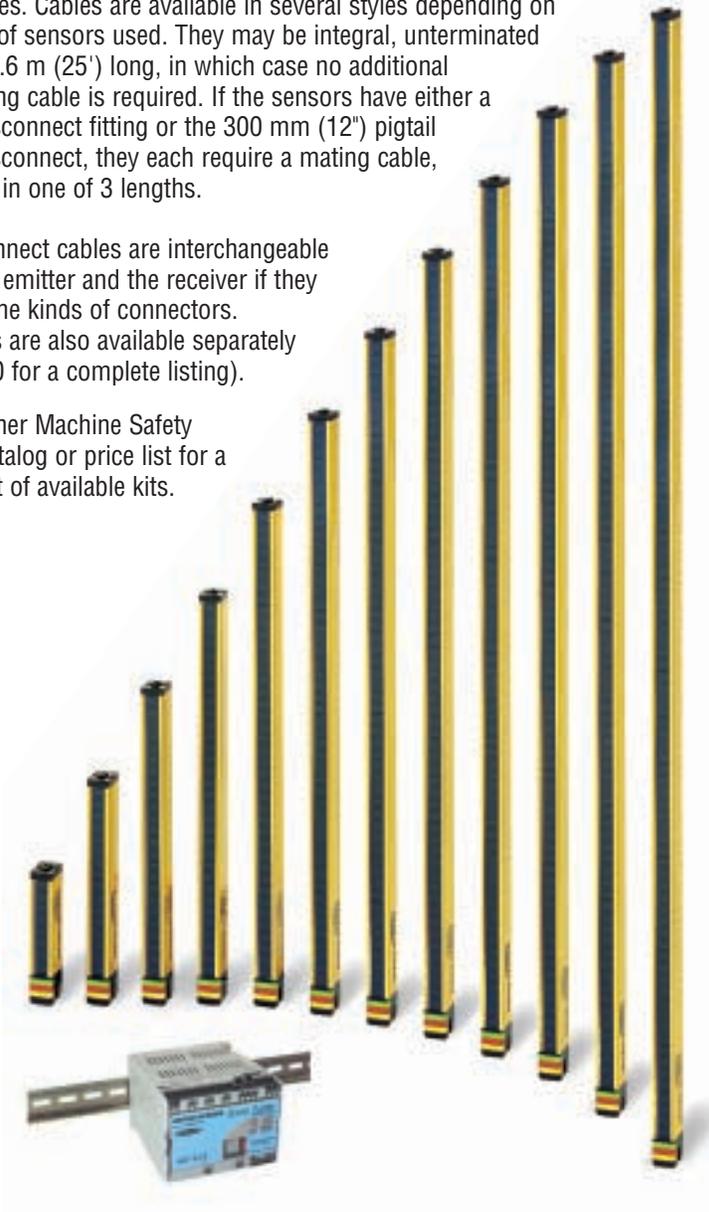
1.1 MICRO-SCREEN Components and Kits

MICRO-SCREEN Systems are sold as kits which include:

- A control module;
- An emitter and receiver of equal length and having an equal number of beams;
- Emitter and receiver mounting hardware, and
- Two cables. Cables are available in several styles depending on the type of sensors used. They may be integral, unterminated cables, 7.6 m (25') long, in which case no additional connecting cable is required. If the sensors have either a quick-disconnect fitting or the 300 mm (12") pigtail quick-disconnect, they each require a mating cable, available in one of 3 lengths.

Quick-disconnect cables are interchangeable between the emitter and the receiver if they have the same kinds of connectors. Components are also available separately (see page 60 for a complete listing).

See the Banner Machine Safety Products Catalog or price list for a complete list of available kits.



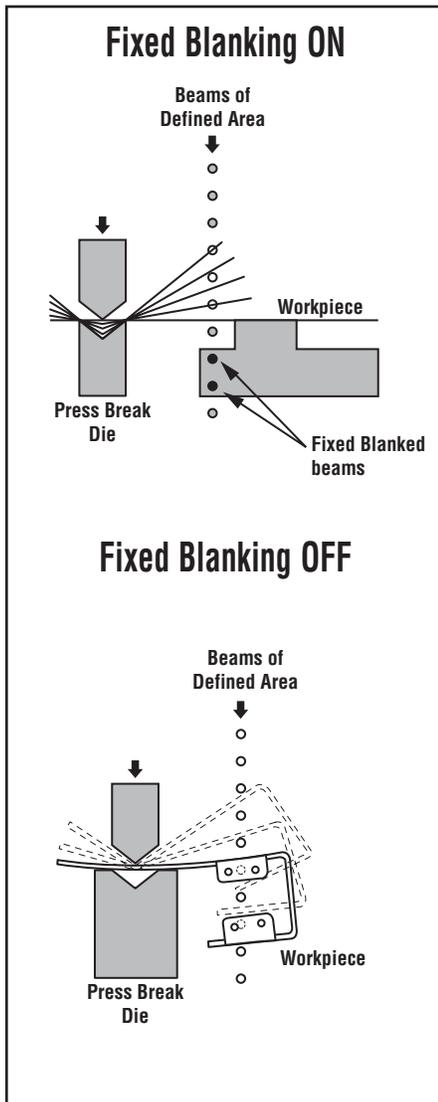


Figure 2. Floating blanking

2. Overview of MICRO-SCREEN System Operation

In operation, an emitter and receiver (of equal length) are mounted and aligned opposite each other. This establishes a curtain of invisible infrared light beams called the defined area (Figure 1). Center-to-center spacing between adjacent light beams is 12.7 mm (0.5") for 102 to 1219 mm (4" to 48") emitter and receiver lengths, and 25.4 mm (1.0") for V-Series 610 to 1892 mm (24" to 72") long.

Individual features of the MICRO-SCREEN System are discussed in the following subsections:

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

2.1 Blanking

The MICRO-SCREEN System features floating blanking and optional fixed blanking (if control module model USDINT-2T2 is used); see Figure 2.

Fixed blanking allows fixed objects (such as brackets, fixtures, etc.) to be ignored in the defined area, as long as they never move or change size.

Fixed blanking requires an emitter and receiver with 16 or more light beams (see page 59). Fixed blanking is easy to set up. With the object(s) to be ignored in place, the user “teaches” the controller which beams to blank by simply pushing a button located inside the control module. The Diagnostic Display will indicate the total number of blanked beams.

Fixed blanking is limited to 30% of the total number of beams in the array, up to a maximum of 12 beams. Contact the factory Applications Department if your application requires fixed blanking of a greater number of beams. Blanking information is stored in non-volatile memory to prevent setup loss when power is removed. Once fixed blanking is programmed, removing or moving any fixed object within the defined area will cause a lockout condition (see Section 2.3). See pages 26 and 31 for programming information.

Floating blanking is the “blinding” of one or two sensing beams which will appear to change position (“float”) in order to allow one or more objects (usually workpiece materials) to move through the defined area, at any point, without tripping the final switching device relays (FSDs) of the MICRO-SCREEN System.

There is the choice of either one-beam or two-beam floating blanking. The ignored object size and resultant minimum object sensitivity are listed in the table on page 8.

System Overview

Minimum Object Sensitivity

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

NOTES:

- 1) The size listed in the table for objects which move undetected through the light screen assumes that those objects move through the screen exactly perpendicular to the plane of the light beams.
- 2) Control module USDINT-1T2, without fixed blanking: Selecting one- or two-beam floating blanking will affect the overall minimum object sensitivity, which allows multiple objects to move through the defined area (see table, above). This is also called “reduced resolution” or “multiple-point floating blanking.”
- 3) Control module USDINT-2T2, with fixed blanking: When fixed blanking is not enabled, selecting one- or two-beam floating blanking will affect the overall minimum object sensitivity, which allows multiple objects to move through the defined area. When fixed blanking is used, selecting one- or two-beam floating blanking will create a single “hole” in the sensing field, which allows a single object of a certain size to move through the defined area without being detected (see table, above).

In all cases, when floating blanking is selected, the resultant worst case *minimum object sensitivity* (sometimes called minimum object detection size or MODS) must be used to calculate *separation (safety) distance* (see Section 3.2.1).

The minimum object sensitivity is the minimum diameter of an object that the light screen can reliably detect anywhere within its defined area. Minimum object sensitivity directly affects the minimum allowable distance between the defined area of a light screen and the nearest hazard point (the separation distance). See section 3.2.

Floating blanking preference is set via a pair of DIP switches on the controller board inside the control module (see Figure 20 and section 3.4, both on page 25, for details).

Note: *Blanking ON* is indicated by a flashing green status indicator.

2.2 Auto Power-up

Normal operation of the MICRO-SCREEN System requires a Key Reset each time power is applied to the system. This is usually a desired response to a power failure or interrupt, and is required by some design standards. In applications where the machine control circuits are used to power up a series of machines, selecting the Auto Power-up feature puts the MICRO-SCREEN System directly into RUN mode when power is applied and the defined area is clear. See WARNING, at right.

Auto Power-up is enabled or disabled via a pair of configuration DIP switches located on the controller board inside the control module. See Figure 20 and Section 3.4 on pages 25 and 26 for details.



WARNING . . . Use of Auto Power-up

Application of power to the MICRO-SCREEN

System must NOT initiate dangerous machine motion. Machine control circuitry must be designed so that one or more initiation devices be engaged to start the machine, after the MICRO-SCREEN is placed in RUN mode.

2.3 Lockout Conditions and Key Resets

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

Power-up/Power Interrupt Lockouts

- Routinely upon power-up of the MICRO-SCREEN System (unless Auto Power-up is ON; see Figure 5, page 10); or
- If power to the MICRO-SCREEN System is interrupted (unless Auto Power-up is ON; see Figure 5).

Internal Lockout Conditions

- If the Control Module Key switch is in the RESET position, at power-up, (with Auto Power-up ON); or if the Key switch is switched to RESET while the System is in the RUN mode;
- If the Program/Run switch (Figure 20) is in the PROGRAM position at power-up;
- If Floating Blanking switches are in the ON position when Program/Run switch is switched to the PROGRAM position;
- If both 1-beam and 2-beam Floating Blanking switches are in the ON position;
- If fixed blanking is NOT SET within approximately 4 minutes of moving the Program/Run switch to the PROGRAM position;
- If fixed blanking has been programmed, and any fixed object is removed from or moved within the defined area;
- If an FSD (Final Switching Device – see Glossary) relay does not “drop out” within its specified time;
- If the SSD (Secondary Switching Device – see Glossary) relay has de-energized;
- If the control module switch settings are inconsistent with each other or if they are changed while the system is in RUN mode;
- If the self-checking circuits of the microprocessor detect a component failure within the MICRO-SCREEN System itself; or
- If either (or both) Emergency Stop switch contacts open.

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

Power-up/power interrupt lockouts (Auto Power-up OFF, conditions as indicated above, yellow status indicator only double-flashing) are normal and require a Key Reset for operation to continue.

Internal lockout conditions result from component failures or incorrect controller settings, which must be corrected before the system will allow operation to continue (Section 2.8). A Diagnostic Display (located inside the control module on the controller board, and visible through a window in the control module cover) will indicate the cause of the lockout (Section 2.5). Internal lockout conditions also require a reset of the Key switch (a Key Reset) to return the system to RUN mode. To perform a Key Reset, turn the Key switch clockwise to the RESET position, hold it there *for at least 1/2 second*, and then return the Key switch to the RUN position.

2.4 Operating Status Indicators

The control module and the receiver have the following operating status indicators (see Figures 3 and 4): green (CLEAR), red (BLOCKED), and yellow (RESET). Their indications are as follows:

Red ON steadily and Yellow single-flashing* (Blocked): the MICRO-SCREEN System has been reset and is in RUN mode, but either there is an obstruction in the defined area or the emitter and receiver are misaligned. FSD1 and FSD2 contacts are open (de-energized). SSD relay is closed (energized).

A flashing yellow status indicator displays sensor alignment. The faster the flash rate, the more beams are “made,” and the fewer beams are blocked or “not made.” This feature is very helpful for emitter/receiver alignment (Section 6.1). When alignment is correct, the green indicator will come ON (to join yellow) when the obstruction is removed. If alignment is not correct, the green indicator will remain OFF when the obstruction is removed.

Green and Yellow ON steadily:** the MICRO-SCREEN System has been reset and is in RUN mode, the defined area is clear of obstructions, and the emitter and receiver are properly aligned. SSD, FSD1, and FSD2 contacts are closed (energized).

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

Yellow (only) ON and double-flashing: a *double-flashing* yellow status indicator indicates a power-up or power interrupt lockout condition. *These lockouts occur in the normal course of powering up the MICRO-SCREEN System or upon an interruption of power to the System* (unless Auto Power-up is ON; see page 26). SSD, FSD1 and FSD2 contacts are open (de-energized).

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

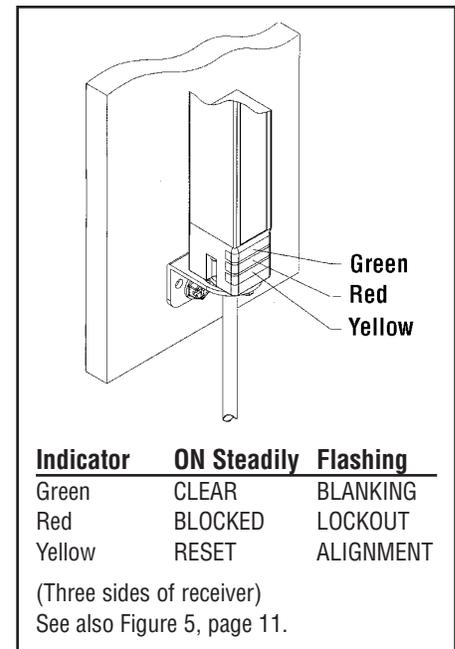


Figure 3. Status indicators (receiver)

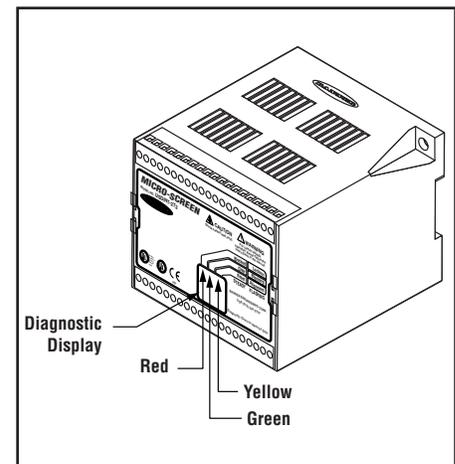


Figure 4. Control module indicator LEDs

* If the Test Input terminals are shorted and the defined area is clear, the yellow status indicator will be ON steadily (see Section 3.5.9).

** A flashing green status indicator indicates fixed and/or floating blanking is ON.

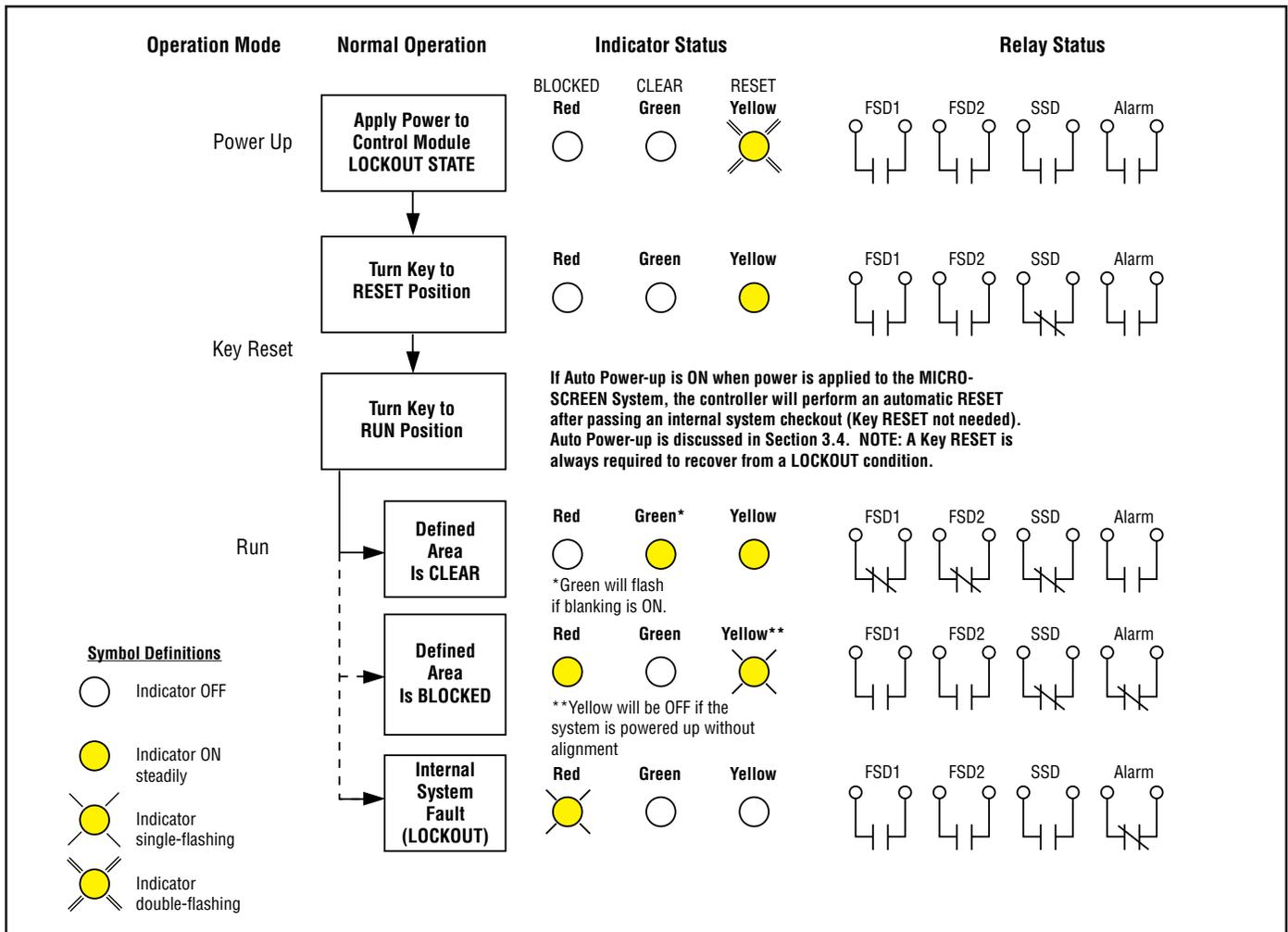


Figure 5. Operating status conditions

2.5 Diagnostic Display

A two-digit numeric display, visible through a clear window in the MICRO-SCREEN control module cover, makes system troubleshooting an easy task.

- It indicates an error code corresponding to the cause of a fault (lockout) condition. Error codes are listed and interpreted in Figure 25 on page 39.
- During programming of fixed blanking (control module model USDINT-2T2), it indicates the number of blanked beams.
- During normal operation, it indicates the total number of blocked beams, including fixed blanked beams.
- In addition, the decimal point of the display will flash to indicate a high level of electrical or optical interference in the area of the MICRO-SCREEN System.
- Under normal RUN conditions, and with no beams blocked, the right-hand digit will display a horizontal bar (the center segment of the display will be lit).

System Overview

2.6 Emergency Stop Switch Input

The MICRO-SCREEN control module has a provision for the connection of an optional Emergency Stop switch. See Section 3.5.2 for complete information.

2.7 Output Relay Operation

The MICRO-SCREEN System control module has three output relays (see Figure 6 below), labeled “FSD1,” “FSD2,” and “SSD.” The contacts of the Final Switching Device (FSD) relays (FSD1 and FSD2) are connected to the Machine Primary Control Elements (MPCEs) of the guarded machine. An MPCE is an electrically powered element of the guarded machine that directly controls the machine’s normal operating motion so that it is last (in time) to operate when motion is either initiated or arrested. The Secondary Switching Device (SSD) relay contacts are connected to the guarded machine’s Machine Secondary Control Element (MSCE), an electrically powered element of the guarded machine (independent of both MPCEs) that is capable of removing power from the prime mover of the dangerous part of the machine in the event of a system fault. The two MPCEs must each (alone) be capable of stopping the motion of the guarded machine in an emergency. The opening of any FSD1, FSD2, or SSD relay contact results in the removal of power to either an MPCE or MSCE (or both), which will stop the motion in the guarded machine.

Any object that blocks one or more *unblanked* beams will be detected, and will cause a trip condition: output relays FSD1 and FSD2 (but not SSD) in the control module open their contacts. *All three* output relays (FSD1, FSD2, and SSD) will open their contacts in response to any one or more lockout conditions, including component failure within the MICRO-SCREEN System itself (see Control Reliability, Section 2.8). The MICRO-SCREEN System automatically resets itself from a trip condition when the object that caused the trip is removed.

Internal lockout conditions require a Key Reset to return the system to RUN mode. (To perform a Key Reset, turn the Key switch clockwise to the RESET position, hold it there *for at least 1/2 second*, and then return the Key switch to the RUN position.)

The AUX Non-Safety Output is a separate relay **intended for non-safety-related purposes**. It is typically used to signal a programmable logic controller (PLC) when output relay contacts FSD1 and FSD2 open or close. See Section 3.5.8 for more information.

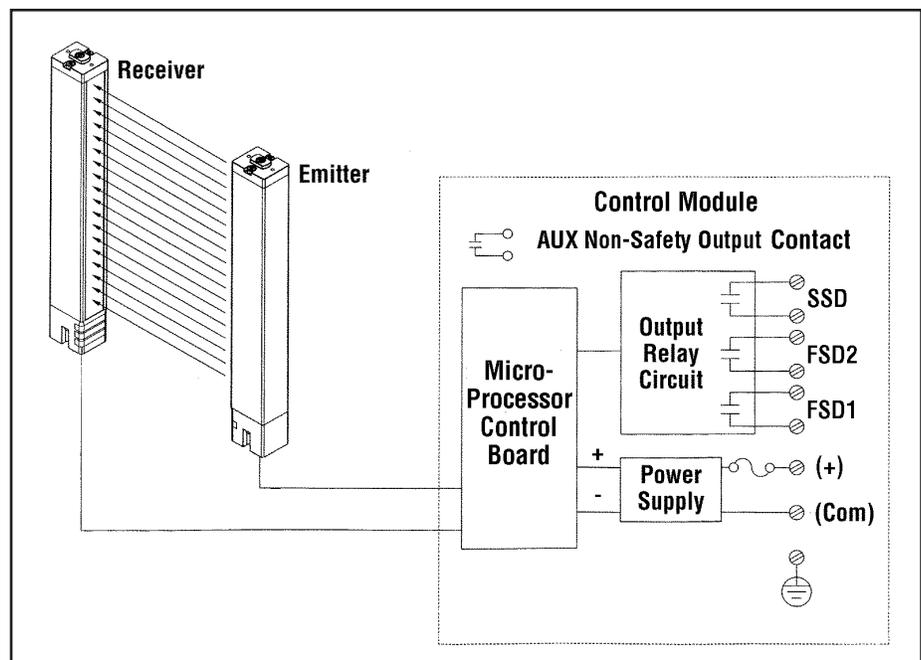


Figure 6. Banner MICRO-SCREEN System functional schematic

2.8 Control Reliability: Redundancy and Self-checking

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

- 1) The MICRO-SCREEN System must provide a “stop” signal to the guarded machine, within 38 milliseconds, whenever the defined area is interrupted.

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

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

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

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

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

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

Recovery from this type of lockout condition requires replacement of the failed component (to restore redundancy) and a Key Reset (see page 12). Possible causes are listed in Section 2.3. The Diagnostic Display is used to diagnose internal causes of a lockout condition (Section 5.1).

2.9 Remote Test Input

A pair of terminals is provided (see Figure 21, page 28) for an external normally open switch. These terminals are labeled “TEST 1” and “TEST 2.” Closing a switch connected between these two terminals simulates an interruption of one of the light beams. The device used must be capable of switching from 15 to 50V dc at 20 to 100 mA. The switch must be held closed for a minimum of 0.05 seconds to guarantee system response. This remote test input is sometimes useful for system setup and checkout procedures.

3. System Installation and Alignment

3.1 Appropriate Application

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

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

- With single stroke (also called “full revolution”) clutched machinery, as this type of machinery is incapable of stopping immediately.
- On certain other types of machinery, including any machine with inadequate or inconsistent stopping response time, or any machine that ejects materials or component parts through the defined area.
- In any environment likely to adversely affect the efficiency of a photoelectric sensing system. For example, corrosive chemicals or fluids or unusually severe levels of smoke or dust, if not controlled, may degrade the efficiency of the MICRO-SCREEN System.
- As a tripping device to initiate machine motion (PSDI applications) on mechanical power presses, per OSHA regulation 29 CFR 1910.217.



CAUTION . . . Install System Only on Appropriate Applications

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



WARNING . . .

Read this Section Carefully Before Installing the System

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

The user has the sole responsibility to ensure that the Banner MICRO-SCREEN System is installed and interfaced to the guarded machine by Qualified Persons in accordance with this manual and applicable safety regulations. A “Qualified Person” is defined as “a person or persons who, by possession of a recognized degree or certificate of professional training, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve problems relating to the subject matter and work” (ANSI/ASME B30.2-1983).



WARNING . . .

Installation of MICRO-SCREEN Systems with Trip Output for Perimeter Guarding Applications

The control modules described in this manual produce a “trip” output which automatically resets the output relays as soon as the defined area is clear. **Use of a trip output is dangerous for perimeter guarding applications where it is possible for personnel to move through the defined area and locate themselves inside the guarded area of dangerous machine motion.**

Banner offers control modules with “latching” output response, which are designed for perimeter guarding applications. See the Banner Machine Safety Products catalog or contact the Banner Factory Applications Engineers for information on control modules with latching response. **If a control module with trip output response is used for a perimeter guarding application, the following conditions must be met:**

- 1) **The dangerous machine motion** must be able to be initiated following an interruption of the defined area **only** after actuation of a Reset switch.
- 2) **The Machine Primary Control Elements (MPCEs) of the guarded machine must be wired** so that the FSD outputs of the control module cause a latched response of the MPCEs.
- 3) **The MPCEs must be reset only by actuation of a Reset switch.** The Reset switch must be located outside the area of dangerous motion, and must be positioned so that the area of dangerous motion may be observed by the switch operator during the Reset operation.

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



WARNING . . . Position Components Carefully

The emitter and receiver must be positioned such that the hazard can not be accessed by reaching over, under, around or through the sensing field. Additional guarding may be required; see Hard Guarding, Section 3.2.2.



WARNING . . . Proper Separation Distance

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



WARNING . . . Determine Correct Stop Time

The measurement of stop time (T_S) must include the response time of *all* devices or controls that react to stop the machine. If all devices are not included, the calculated separation distance (D_S) will be too short. This can lead to serious bodily injury or death. **Be sure to include the stop time of all relevant devices and controls in your calculations.**



CAUTION . . . Proper Installation When Using Floating Blanking

Floating blanking increases D_{pf} (see values at right). You must increase the penetration factor to calculate the separation distance whenever floating blanking is used.

Always turn floating blanking OFF when the larger minimum object detection size is not required.

3.2 Mechanical Installation Considerations

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

- Separation distance, and
- Hard guarding.

3.2.1 Separation Distance

The MICRO-SCREEN System must be able to react fast enough, when a hand or other object is inserted into the defined area, to send a "stop" signal to the guarded machine *before the object or hand reaches the closest reachable hazard point on the machine.* The separation distance (or safety distance) is the minimum distance that is required between the midpoint of the defined area and the closest reachable hazard point. The actual separation distance required depends upon several factors, including the speed of the hand (or object), the total system stopping time (of which there are several response time components), and the depth penetration factor. The formula used to calculate the separation distance is:

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

where:

D_S = the separation distance;

K = the OSHA-recommended hand speed constant of 63" per second (NOTE 1, below);

T_S = the overall stop time of the machine measured from the application of the "stop" signal to the final ceasing of all motion (including stop times of all relevant control elements, and measured at maximum machine velocity). See the WARNINGS (left), NOTE 2 (below), and the NOTICE Regarding MPCEs (page 33).

T_R = the response time of the MICRO-SCREEN System: .038 seconds

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

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

NOTES:

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

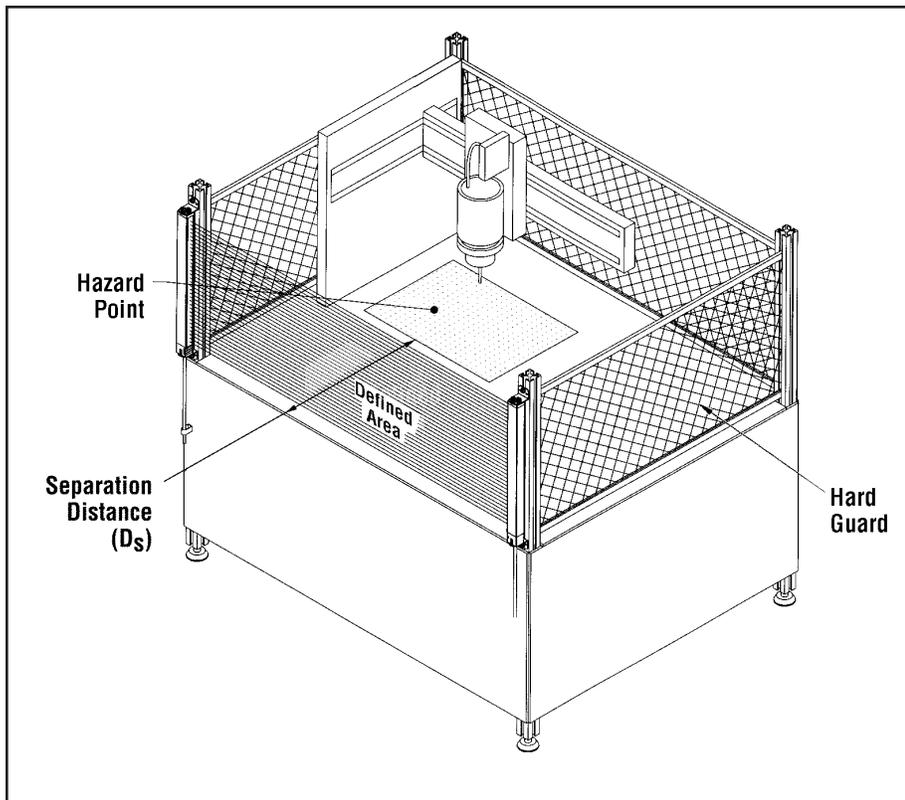


Figure 7. Separation distance



WARNING . . .
V-Series Sensors Require
Greater Separation
Distance

The beam spacing for V-Series emitters and receivers is greater than for standard sensors. This means that the minimum object sensitivity is greater and also the resulting depth penetration factor (D_{pf}) used to calculate the separation distance is greater for V-Series sensors (see D_{pf} value chart on page 15).

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

Example: Separation Distance (D_S) Calculation

The following example shows how to use the formula from page 15 to calculate separation (safety) distance (D_S). We will use these numbers for the variables in the formula:

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

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

$T_r = .038$ second (the specified response time of the MICRO-SCREEN System)

Our example uses two-beam floating blanking with a 24" standard emitter and receiver, so we use a D_{pf} of 5" (page 15). Response time for this example is .038 second. Substitute the numbers into the formula as follows:

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

$$D_S = 63 \times (.250 \times 1.2^* + .038) + 5 = 26"$$

Therefore, in this example, the MICRO-SCREEN emitter and receiver must be mounted so that no part of the defined area will be closer than 26" to the closest reachable hazard point on the guarded machine.

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

3.2.2 Hard Guarding



**WARNING . . .
The Point of Operation
Must be Accessible *Only*
Through the Defined Area**

Mechanical barriers (screens, bars, etc.), or supplemental presence sensing devices (*supplemental guarding*) must be installed, wherever needed, to prevent any person from reaching around, under, or over the defined area and into the point of operation, and also to prevent any person from entering the space between the defined area and the point of operation (see OSHA 1910.212). The use of mechanical barriers for this purpose is called “hard guarding.” There must be no gaps between the hard guarding and the edges of the defined area. Openings in the hard guard material must meet OSHA criteria (see OSHA 1910.217, Table O-10).

Supplemental presence-sensing devices, such as safety mats, must be used if the space between the defined area and the nearest danger point is large enough to allow a person to stand undetected by the MICRO-SCREEN System. **Failure to do so could result in serious bodily injury or death.**

ANSI B11.1-1988, 6.3.2 (14) requires that “all areas of entry to the point of operation not protected by the presence-sensing device shall be otherwise safeguarded.” The hazard point must be accessible *only* through the defined area. This means that mechanical barriers (screens, bars, etc.), or supplemental presence sensing devices (*supplemental guarding*) must be installed, wherever needed, to prevent any person from reaching around, under, or over the defined area and into the hazard point. The use of mechanical barriers for this purpose is called “hard guarding” (see the WARNING at left and Figure 8, below).

There must be no gaps between the hard guarding and the edges of the defined area. Furthermore, fixed objects in the defined area which require use of fixed banking must occupy the entire width of the defined area. Otherwise, hard guarding must be installed to prevent access to any hazard point through the blanked area.

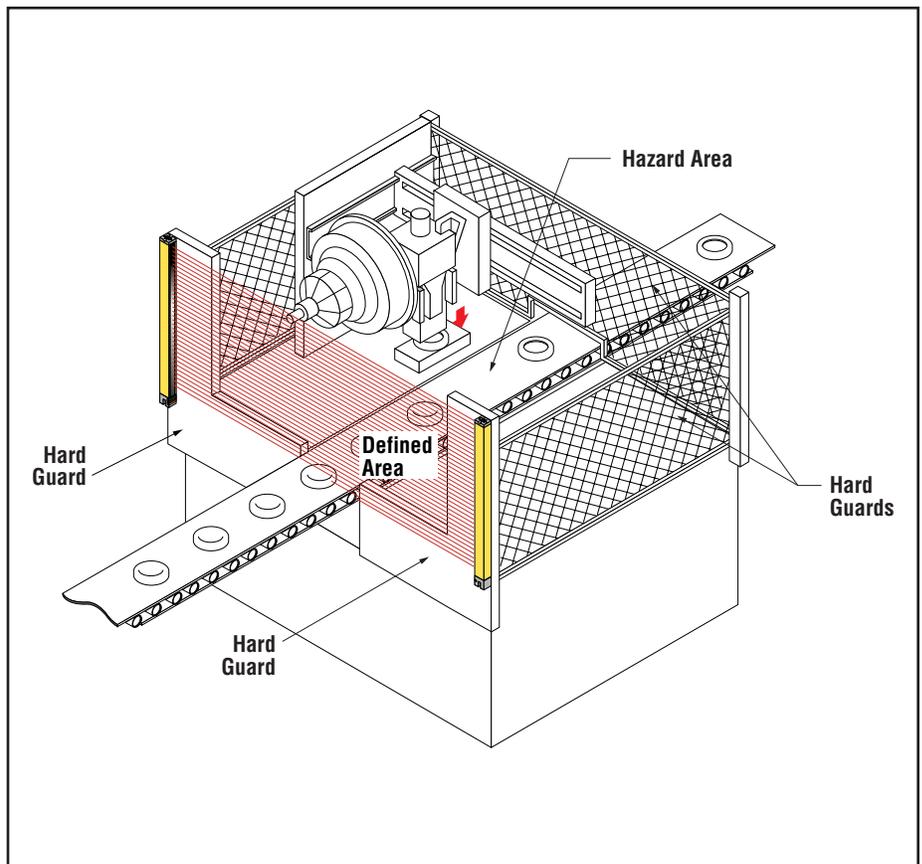


Figure 8. Example of hard guarding

3.2.3 Emitter and Receiver Orientation

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

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



WARNING . . .
Proper Orientation of
System Emitters and
Receivers

The emitters and receivers of the MICRO-SCREEN System must be installed with their corresponding ends (either cabled ends or non-cabled ends) pointing in the same direction (both cabled ends “up,” both cabled ends “down,” etc.). Failure to do this will impair the performance of the MICRO-SCREEN System and result in incomplete guarding; see Figure 10a. **Failure to observe this warning could result in serious bodily injury or death.**

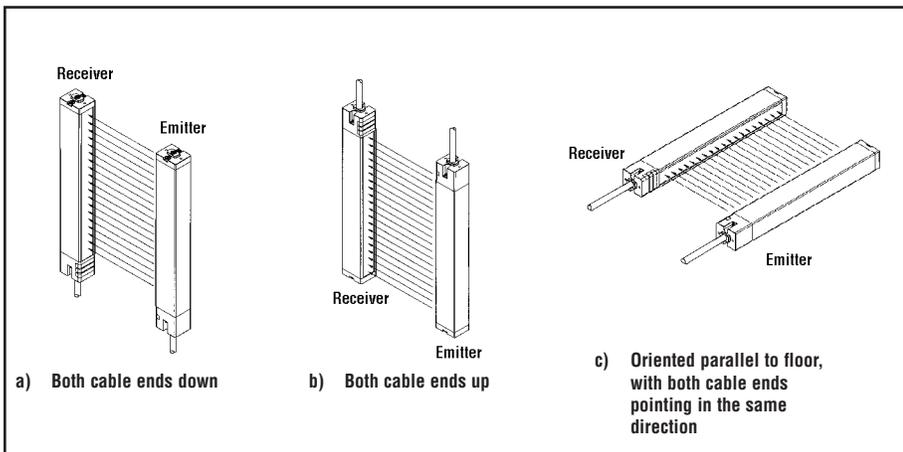


Figure 9. Correct emitter and receiver orientation

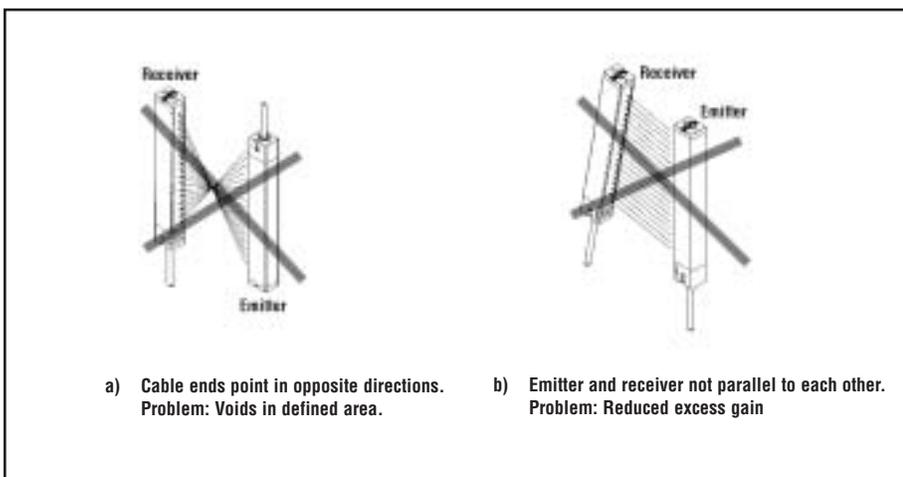


Figure 10. Incorrect emitter and receiver orientation



WARNING . . . Installation Near Reflective Surfaces

A highly reflective surface (such as a shiny machine surface or a shiny workpiece) may reflect sensing light around an object in the defined area, preventing that object from being detected. This potentially dangerous condition is discovered using the “trip test” as described in the Initial Checkout Procedure (Section 3.5.5), the Alignment Procedure (Section 6.1), and the periodic checkout procedures (Sections 6.2, 6.3, and 6.4).

When this condition is discovered, eliminate the problem reflection(s):

- **If possible, relocate the sensors** to move the light screen beams away from the reflective surface(s), being careful to retain at least the required separation distance (Section 3.2.1).
- **Otherwise, paint, mask, or roughen the interfering shiny surface** to reduce its reflectivity.

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



WARNING . . . Avoid Retroreflective Installation

Never use MICRO-SCREEN sensors in retroreflective mode, as illustrated in Figure 11.

The MICRO-SCREEN System is not designed for use in retroreflective mode (where the sensors are mounted adjacent to each other and the light from the emitter is bounced back directly to the receiver by a mirror or other reflective surface). **Sensing is unreliable in this mode and could result in serious injury or death.**

3.2.4 Adjacent Reflective Surfaces

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

A reflective surface may be a part of the machine or the workpiece and may include shiny metal or plastic or surfaces with glossy paint. Where possible, reflective surfaces adjacent to the defined area should be roughened or covered with a dull material. Where this is not possible (as with a reflective workpiece), the sensor mounting should include a means of restricting the field of view of the receiver or the spread of the light from the emitter.

Beams deflected by reflective surfaces are discovered during the initial checkout procedure (Section 3.5.5), the final alignment and checkout procedure (Section 6.1), and also by the periodic checkout procedures (Sections 6.2, 6.3, and 6.4).

3.2.5 Use of Corner Mirrors

MICRO-SCREEN sensors may be used with one or more corner mirrors. The use of corner mirrors somewhat reduces the maximum specified emitter/receiver separation. (See page 45.) Corner mirrors and stands are available from Banner. Contact the factory Applications Engineering Department for information, or see page 61.

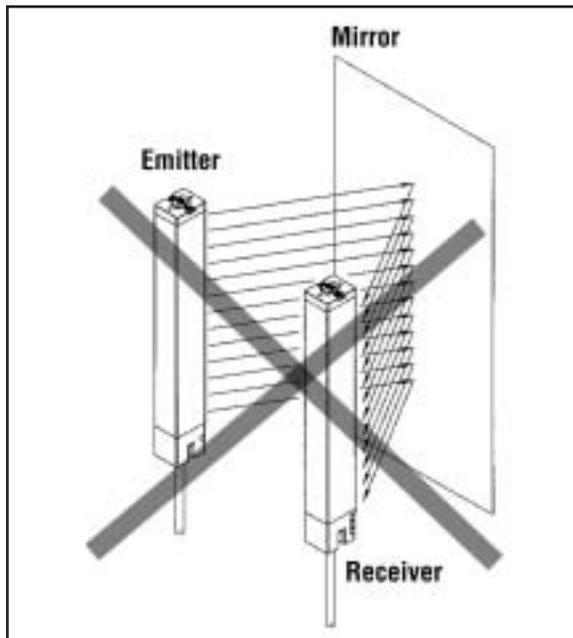


Figure 11. Never use MICRO-SCREEN sensors in retroreflective mode.

3.2.6 Installation of Multiple MICRO-SCREEN Systems

Whenever the emitter and receiver pairs of two or more MICRO-SCREEN Systems are located adjacent to one another, there is potential for optical crosstalk to take place between systems. To minimize optical crosstalk, it is recommended to alternate emitters and receivers, as shown in Figure 12.

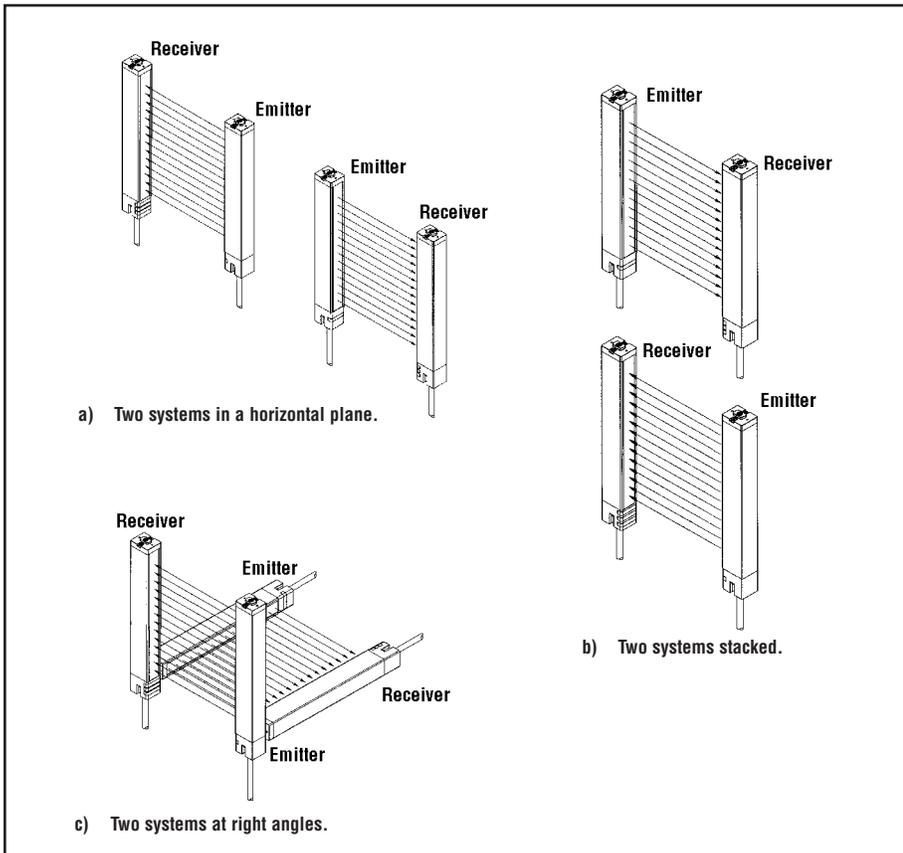


Figure 12. Installation of multiple MICRO-SCREEN systems. Alternate emitters and receivers to avoid optical crosstalk.

When three or more systems are installed in a horizontal plane, (as shown for two pairs in Figure 12a), optical crosstalk may occur between sensor pairs whose emitter and receiver lenses are oriented in the same direction. In this situation, optical crosstalk may be controlled by mounting these sensor pairs exactly in line with each other within one plane, or by adding a mechanical light barrier between the pairs.

3.3 Mounting Procedure

Sensor Mounting

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

Emitter/receiver pairs from 102 to 1219 mm (4" to 48") long may be spaced from 15 cm to 9 m (6" to 30') apart. Emitter/receiver pairs 1422 to 1892 mm (56" to 72") long may be spaced from 15 cm to 6 m (6" to 20') apart. The maximum distance between an emitter and its receiver is reduced if corner mirrors are used (see alignment information, page 45).

From a common point of reference, make measurements to locate the emitter and receiver in the same plane with their midpoints directly opposite each other. **Important: The connector ends of both sensors must point in the same direction (see drawings and WARNING, page 18).** Mount the emitter and receiver brackets using M6 bolts and Keps nuts (all supplied); see Figure 14.

Mount the emitter and receiver in their brackets and position the windows of the two units directly facing each other. Measure from one or more reference planes (e.g., the building floor) to the same point(s) on the emitter and receiver to verify their mechanical alignment. If the units are positioned exactly vertical or horizontal to the floor, a carpenter's level is useful for checking alignment. A straightedge or a string extended between the sensors also helps with positioning. Also check "by eye" for line-of-sight alignment. Make any necessary final mechanical adjustments, and hand-tighten the bracket hardware. A detailed alignment procedure is given in Section 6.1.

Center Bracket Mounting

Center mounting brackets must be used with longer sensors to provide sensor stability. Sensors 40" to 48" long are supplied with one center bracket, which should be positioned at the center of the sensor's length. Sensors 56" to 72" long are supplied with two center brackets, which should be positioned 1/3 of the sensor's length from each sensor end (see Figure 14). Refer to Figure 14 for the following steps.

- 1) Spread the clamp and snap over the back of the sensor so that the clamp is securely fastened to the sensor without blocking any beams.

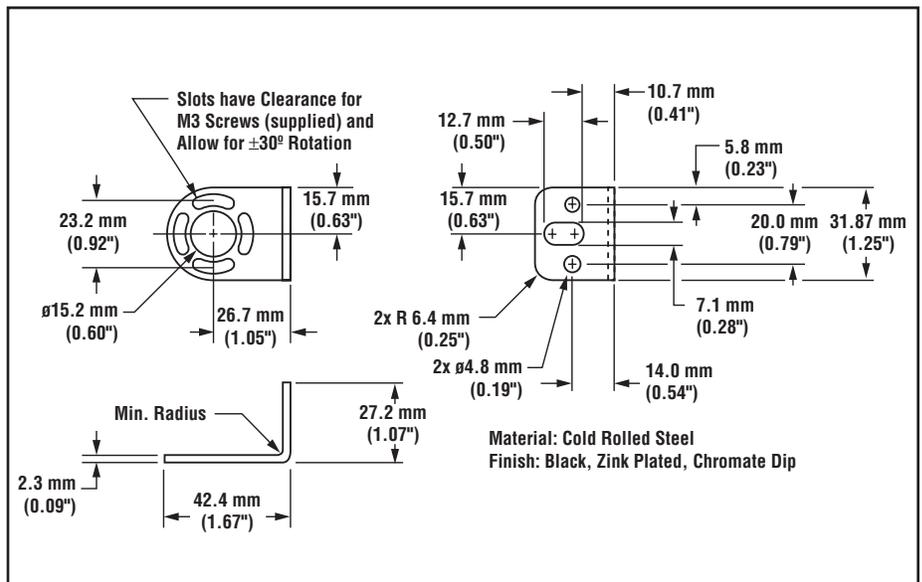


Figure 13. Emitter and receiver mounting bracket dimensions

System Installation and Alignment

- 2) Compress the foam spacer and slide the clamp along the length of the sensor housing to align the clamp with the center mounting bracket as shown in Figure 14. Three separate mounting holes are provided on the clamp to allow for all possible mounting configurations.
- 3) Connect the clamp to the center bracket using the M3 screw supplied.
- 4) Loosen all the mounting screws to the sensor, align the sensors and then tighten the end screws. Finally, tighten the M3 screw joining the clamp to the center mounting bracket.

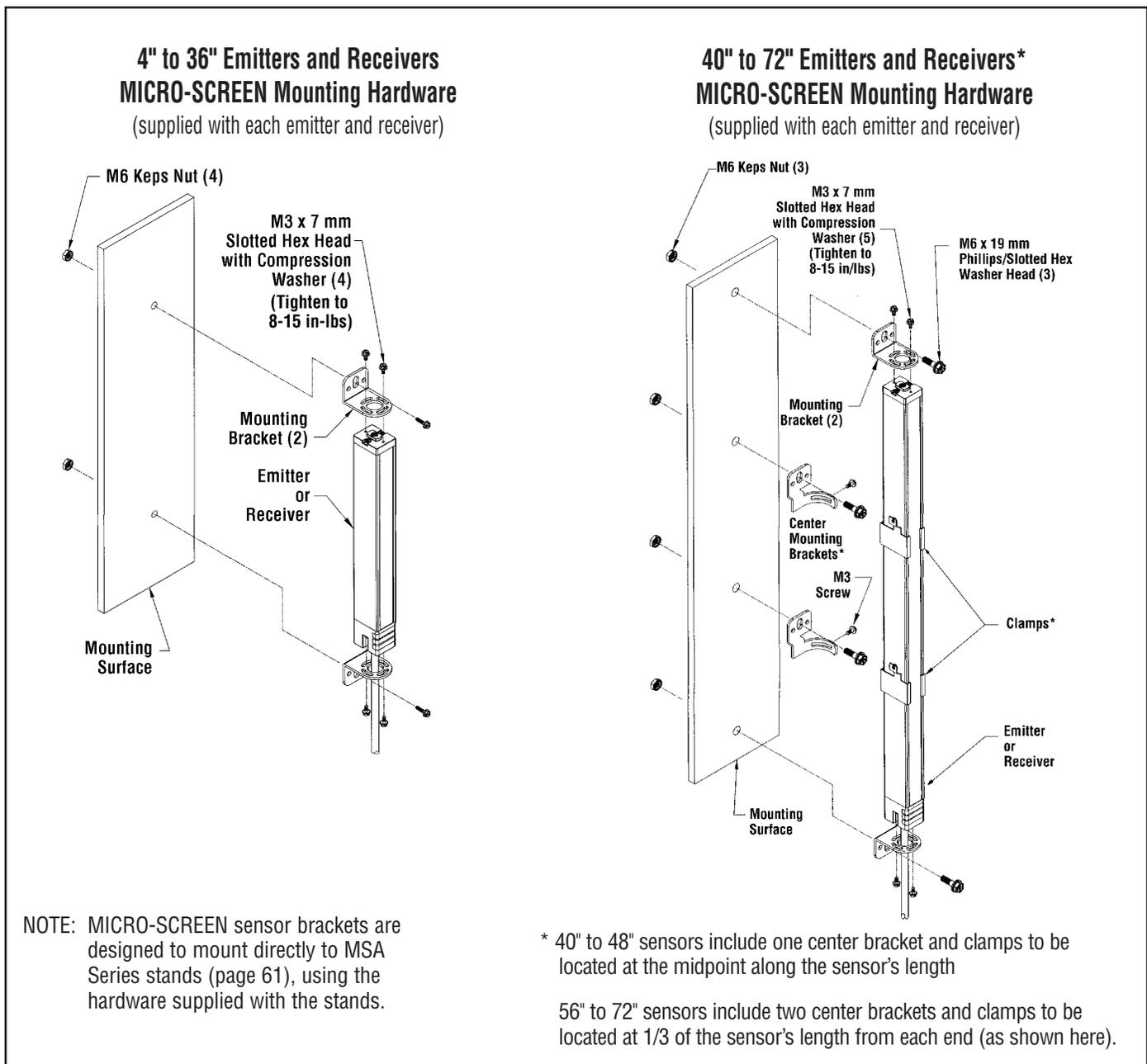


Figure 14. Emitter and receiver mounting

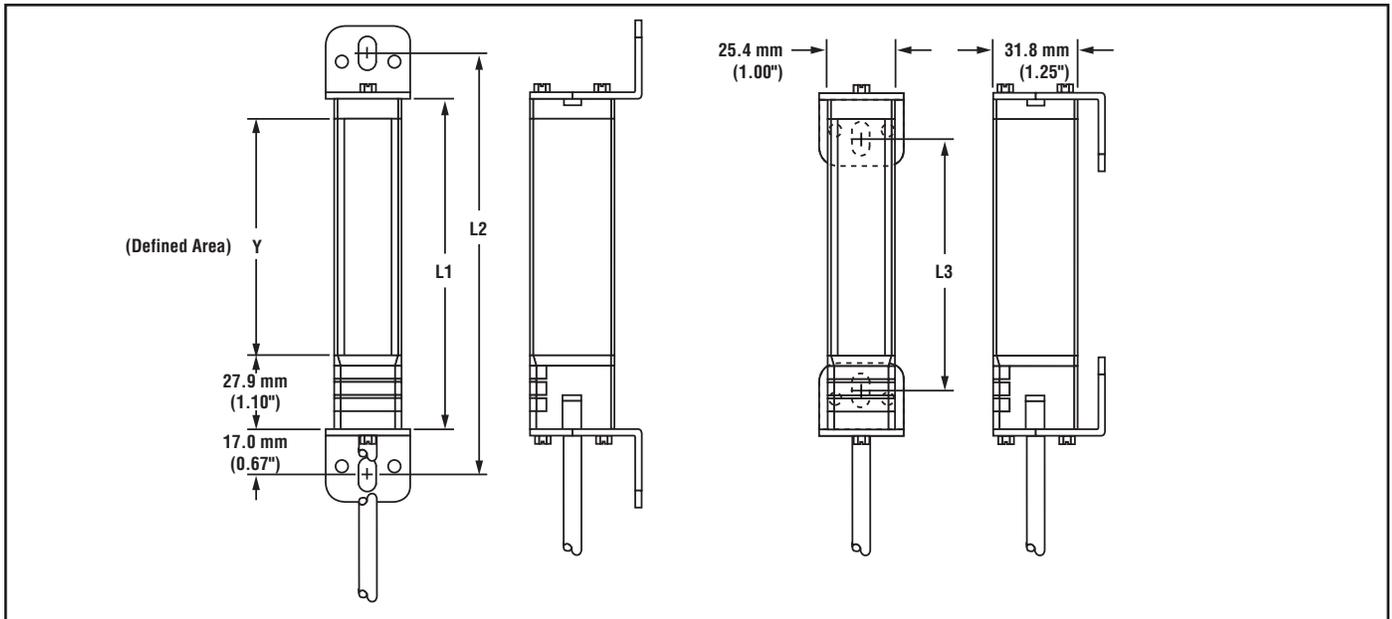


Figure 15. Emitter and receiver mounting dimensions and location of defined area

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

System Installation and Alignment

Connect the shielded cables to the emitter and receiver (quick-disconnect models) and route them (per local wiring code for low-voltage dc control cables) to the control module mounting location. The same cable type is used for both emitter and receiver. Cables may be cut to length at the time of installation. Emitter and receiver cable lengths may not exceed 50' (each). Contact factory Applications Department if either or both cables must be longer than 50'. Do not trim the cables until you are certain that you have routed all cables properly. The cable braid at the control module connection points may be either removed or twisted together with the drain wire (see page 28). **IMPORTANT: Use ONLY Banner MICRO-SCREEN cables** (see page 60).

Control Module Mounting

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

The MICRO-SCREEN control module should be configured before initial checkout and use. Control module configuration is done at the two banks of DIP switches located along the edge of the controller board (see Figure 20). The controller will automatically sense the length of the emitter and receiver, and set its response time accordingly.

Key Reset Switch Mounting

The Key Reset switch mounts through a 19 mm (.75") diameter hole (see Figure 18). Wires for connecting the Key Reset switch to the control module are user-supplied (also see Section 3.5.1). **The Key Reset switch (supplied with the control module) must be positioned outside of the guarded area at a location that provides the switch operator with an unobstructed view of the entire guarded area, including all danger points. In addition, it must NOT be possible to reach the Key Reset switch from inside the guarded area.** The switch mounts through a 19 mm (.75") diameter hole (Figure 18).

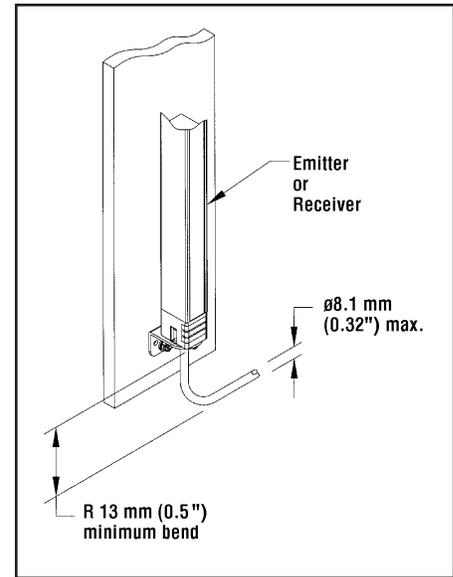


Figure 16. Cable clearance dimensions

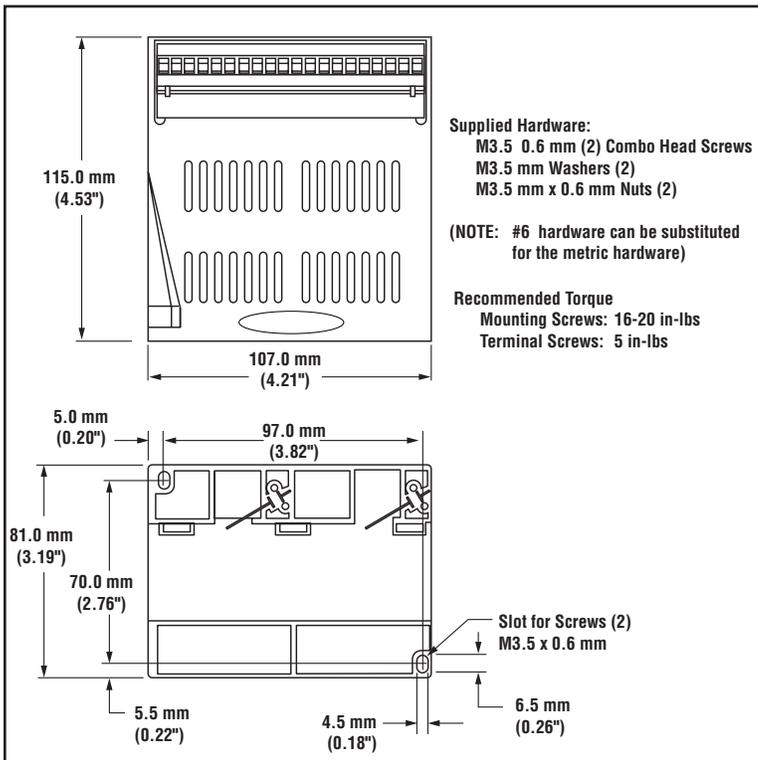


Figure 17. Control module dimensions and mounting hole locations

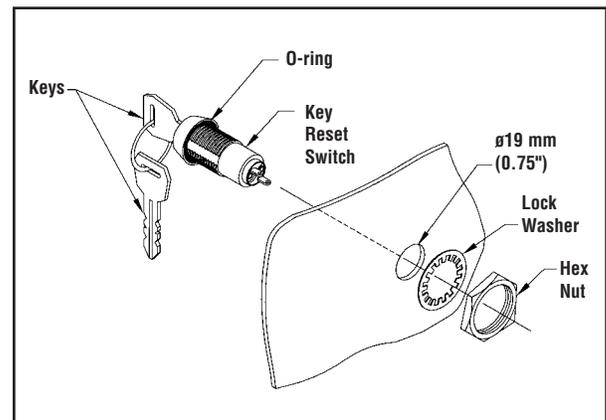


Figure 18. MICRO-SCREEN Key Reset switch mounting

3.4 Controller Board Configuration

The parameters to be manually configured are:

- One- and two-beam floating blanking ON or OFF
- Auto Power-up ON or OFF
- Fixed blanking (control module model USDINT-2T2, only)

NOTE: The factory setting for all parameters is OFF.

Because it has redundant microprocessors, the controller module has two identical DIP switch banks (bank A and bank B) which must be set identically. Failure to set both banks identically will cause a lockout condition when power is applied to the control box. **Power to the MICRO-SCREEN System must always be OFF when changing DIP switch settings.** Changing DIP switch settings with power ON will cause a lockout condition. See the inset in Figure 20 for DIP switch ON and OFF positions.

Configuration DIP Switch Settings for Floating Blanking

Locate the floating blanking (FB) configuration switches in banks A and B (see Figure 20). Set the switches identically at both banks. Be aware of the differences in minimum object sensitivity, penetration factor, and required light screen separation distance between the settings (see sections 2.1 and 3.2.1). Floating blanking causes the MICRO-SCREEN System to ignore objects of up to the sizes listed in the table below.

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

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

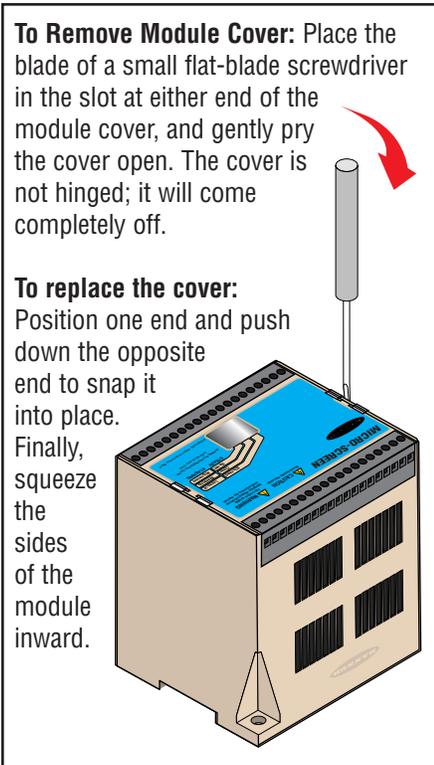


Figure 19. Control module cover removal

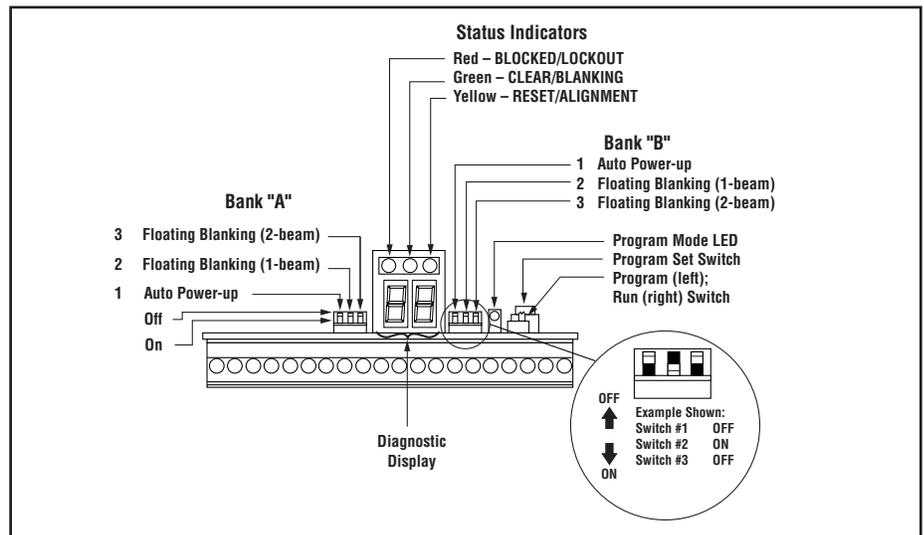


Figure 20. Controller board configuration DIP switches

System Installation and Alignment

Configuration DIP Switch settings for Auto Power-up Feature ON or OFF

Locate the Auto Power-up (AP) configuration DIP switches (see Figure 20) in banks A and B. If Auto Power-up is ON and the defined area is clear when power is applied to the MICRO-SCREEN System, the controller will automatically reset after conducting and passing an internal system checkout. If the switches are OFF, this initial reset is manual (via the Key Reset switch). Regardless of the setting of the Auto Power-up switches, a Key Reset is always necessary to recover from an internal lockout condition. To select Auto Power-up, remove the protective coating on both switches and push them to the ON position. The switches must be set identically at both banks A and B.

Configuration DIP Switch Settings for Fixed Blanking (control module USDINT-2T2 only)

Fixed blanking (if used) is programmed during the initial checkout procedure using the Program switches located on the controller board (as shown in Figure 20). See Section 3.5.5 for complete information.

3.5 Electrical Hookup and Checkouts

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

The following wiring connections are made to the control module:

- Key Reset switch,
- Emitter and receiver cables,
- System power,
- Output relay connections (FSD1, FSD2, and SSD),
- AUX non-safety output,
- Remote test input, and
- Emergency Stop switch.

NOTE: The wiring barriers on the module can accept a conductor no larger than #12 AWG. Also, the barriers may be unplugged to allow module or board replacement, without disturbing the wiring.

3.5.1 Key Reset Switch Hookup

Wire is supplied by the user. Shielded cable and/or separate, grounded conduit is recommended. The wires from the Key Reset switch connect to terminals 13 and 14 of the control module (Figure 21).



WARNING . . .
Proper Electrical Hookup
Is Imperative

- **Electrical hookup must be made by Qualified Personnel** and must comply with NEC (National Electrical Code) and local standards.
- **Make no more connections to the MICRO-SCREEN System than are described in Sections 3.5.1 through 3.5.8 of this manual.**

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



WARNING . . . **Emergency Stop Switch** **Wiring**

- Whenever two or more Emergency Stop switches are connected to the same MICRO-SCREEN control module, contacts of the corresponding pole of each switch must be connected together in series. This series combination is then wired to the respective module input (to either 33 and 34 or 35 and 36). **Never connect the contacts of multiple Emergency Stop switches in parallel to the MICRO-SCREEN control module inputs.** Parallel connection of two or more Emergency Stop switches to one MICRO-SCREEN control module defeats the switch contact monitoring ability of the module and creates an unsafe condition which could result in serious injury or death.
- Also, when two or more Emergency Stop switches are used, **each switch must be individually actuated (engaged), then re-armed and the MICRO-SCREEN controller reset.** This allows the controller to check each switch and its wiring to detect faults. Failure to test each switch individually in this manner could result in undetected faults and create an unsafe condition which could result in serious injury or death. This check must be performed during periodic checkouts (see Section 6).
- The Emergency Stop function of this control module will be ineffective if the contacts of any muting or bypass circuitry is wired in parallel with the FSD contacts.

3.5.2 Emergency Stop Switch Hookup

The MICRO-SCREEN control module offers an input circuit at terminals 33, 34, 35 and 36 for connection of an optional customer-supplied Emergency Stop switch. As shown in Figure 21, the Emergency Stop switch must provide two separate contacts which are closed when the switch is in the RUN (armed or disengaged) position. Once engaged, the Emergency Stop switch must mechanically trip both contacts in the open position. The switch may be returned to the closed-contact position only by a deliberate action such as twisting, pulling, unlocking, etc. Additionally, NFPA 29, section 13.2 Emergency Stop Devices specifies the following switch (“stop control”) requirements:

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

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

Connect the two poles of the Emergency Stop switch as shown in Figure 21. The switch in Figure 21 is shown in its “armed” position with both contacts closed. Multiple Emergency Stop switches connected to one module must use a series connection (see Warning, left).

NOTES:

- 1) E-stop requirements contained within NFPA 79 Electrical Standard for Industrial Machinery should be met.
- 2) Jumpers for terminals 33 to 34 and 35 to 36 are provided and must be installed if an E-stop switch is not used.
- 3) A Key Reset is required after re-arming (closing) the E-Stop Switch (see Section 5.1).
- 4) E-stop switch contacts “a/b” and “c/d” must open simultaneously, or a lockout condition will occur. If a lockout occurs, remove the fault, then cycle (remove and reapply) the power.

System Installation and Alignment

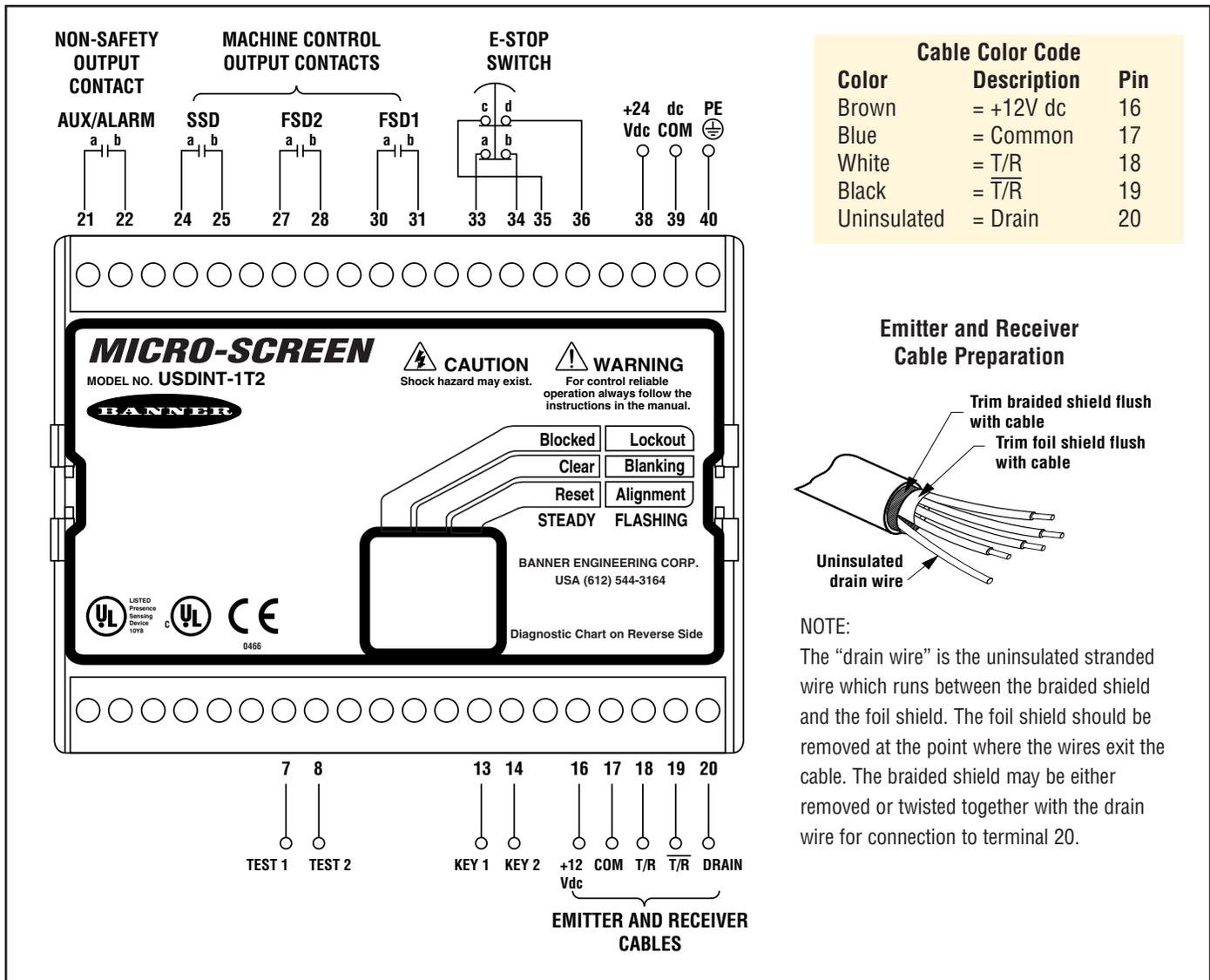


Figure 21. MICRO-SCREEN System electrical connections

3.5.3 Emitter and Receiver Hookup

Emitter and receiver cables both connect to wiring barrier terminals 16 through 20 (Figure 21, above). *Only the use of Banner QDU Series cables (see page 60) will ensure reliable communication of data between the controller and the sensors.* Match the color-coded terminals of the module to colors of the wires in each 5-conductor cable.

Double-check your wiring. Incorrect wiring can lead to component damage.

There are no user adjustments or connections inside the MICRO-SCREEN sensors themselves.

3.5.4 System Power (Temporary Connection)

For permanent installation, the dc lines to the control module connect through the MPCE monitor contacts of the guarded machine (see Figure 24, page 34). **However, do not wire to the MPCEs at this time.** Instead, temporarily connect power directly at terminals 38 (+24V dc) and 39 (dc common) of the control module. Connect earth ground at terminal 40. This will allow the MICRO-SCREEN System to be checked out, by itself, before permanent power connections through the guarded machine's monitor contacts are made. Permanent power connection will be made after MICRO-SCREEN System initial checkout, and is covered in Section 3.5.7.

3.5.5 MICRO-SCREEN System Initial Checkout

This initial checkout procedure must be performed by a Qualified Person (see Warning, page 14). It must be done after connecting the emitter and receiver (Section 3.5.3) and temporary power (Section 3.5.4) to the MICRO-SCREEN control module, but before the MICRO-SCREEN System is connected to the machine to be guarded.

Initial checkout of the MICRO-SCREEN System must always be performed by a Qualified Person (see Section 3.1). The procedure is performed on two occasions:

- To ensure proper installation when the system is first installed, and
- To ensure proper system function whenever any maintenance or modification is performed on the system or on the machinery being guarded by the system. (See Section 4.2 for a schedule of required checkouts.)

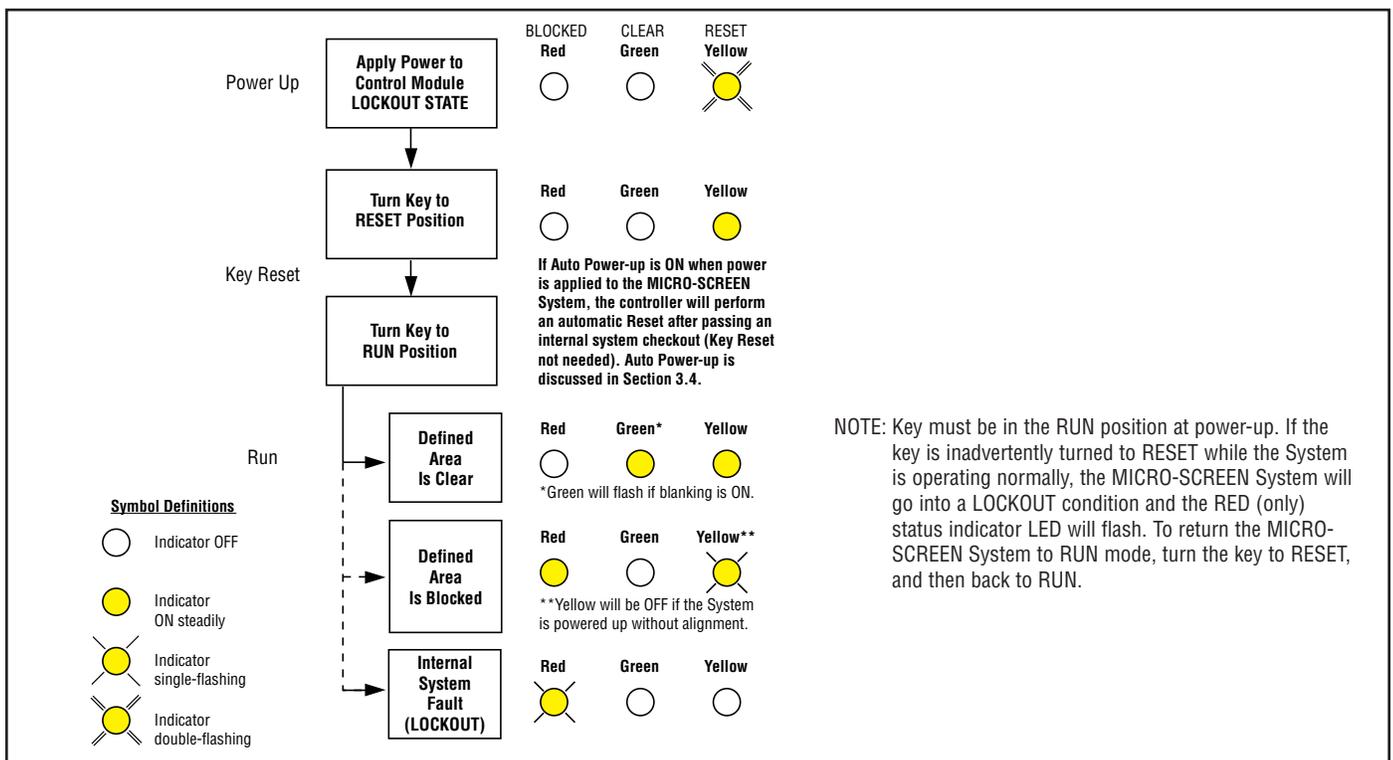


Figure 22. Operating status indicator conditions

System Installation and Alignment

Initial Checkout Procedure:

The MICRO-SCREEN System has three operating modes: POWER UP, KEY RESET and RUN. Monitor the three status indicators on the control module or the receiver (red, yellow, and green), and refer to Figure 22.

- 1) **Power Up the System** by applying power to the control module (with the key in the RUN position). With Auto Power-up OFF, the System will power up into a lockout condition (yellow indicators *only* will double-flash). With Auto Power-up ON, the System will automatically enter RUN mode; go to Step 3.

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

- 2) **Perform a Key Reset** by turning the key clockwise to RESET. The yellow indicators will glow steadily.

NOTE: Hold the key in RESET position **for at least 1/2 second**. This allows time for the microprocessors to run a startup diagnostic check routine.

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

If the red status indicator (only) lights and flashes when the system is placed in RUN mode, an internal lockout condition exists. Refer to Section 5.1 to determine the cause of the lockout.

If the red and yellow status indicators come ON, the defined area is not clear (one or more light beams are obstructed) or the system may be out of alignment. This is a trip condition. If this occurs, check the defined area for obstruction(s). The red indicator will be ON steadily. The yellow indicator will be flashing to indicate the relative number of made (cleared) light beams; the faster the flash rate, the more beams are made. The two-digit Diagnostic Display on the control module will indicate the total number of blocked beams. If all beams are blocked, the red indicator will be ON steadily, with yellow and green indicators both OFF.

If beams are obstructed by one or more objects which will remain fixed in position, the fixed blanking feature may be used (control module USDINT-2T2 only). Proceed to step 4 to program fixed blanking. *NOTE: Fixed blanking should only be used when the objects cannot be moved out of the defined area.*

If the MICRO-SCREEN System is properly aligned, the blanking is properly set, and all obstructing objects are removed from the defined area, the green and yellow indicators should come ON after step #3 has been performed (the green indicator will *flash* if blanking is ON, and the yellow indicator should be ON steadily). The system is now in RUN mode. **If you are setting up the MICRO-SCREEN System for the first time, or if the green and yellow indicators do not come ON during step #3, perform the alignment procedure in Section 6.1.** When you are certain that the emitter and receiver are aligned properly, tighten the emitter and receiver mounting hardware in position and repeat steps #1-3 above.

Fixed Blanking Notes

- A) Fixed blanking must be set within 4 minutes of turning the Program/Run switch to PROGRAM (left), or a lockout will occur, and the procedure must be restarted.
- B) Floating blanking can be selected to eliminate nuisance lockouts resulting from unstable clear beams at the edge of fixed objects.
- C) Any fixed object in the defined area must occupy the entire width (from emitter to receiver) of the defined area. Otherwise, hard guarding must be added to fill any opening in the defined area created by fixed blanking (see warning below).
- D) The green status indicators will flash to indicate use of fixed and/or floating blanking.



WARNING . . .

Hard Guarding May Also be Required

If any object that is to be ignored by fixed blanking does not, itself, completely prevent access to the danger point(s), you must install hard guarding to prevent access past the object.

Openings in the hard guarding material must meet OSHA criteria (see OSHA 1910.217, Table O-10).

Failure to hard guard any opening caused by fixed blanking or failure to adequately increase the separation distance will create an unsafe condition which could lead to serious injury or death.

- 4) **Fixed blanking (control module model USDINT-2T2 only).** The fixed blanking feature may be programmed if beams are blocked by one or more fixed objects. Fixed blanking requires an emitter/receiver pair with 16 or more beams (see page 59). **Fixed blanking is limited to 30% of the total number of beams up to a maximum of 12 beams (see chart below).** Contact factory Applications Department if your application requires fixed blanking of a greater number of beams. Programming of fixed blanking involves a simple “teaching” process; it is accomplished using the Diagnostic Display and the configuration (program) switches located on the controller board (Figure 20).

To prepare for programming:

- 1) Remove all power from the control module (and from the machine to be controlled, if the system is already wired to the machine).
- 2) Make sure that Auto Power-up and Floating Blanking configuration switches (also located on the controller board, Figure 20) are all turned to OFF.
- 3) Make sure that the Program/Run switch (Figure 20) is in the RUN (right) position.

Apply power to the control module (only). The yellow status indicator will double-flash to indicate that the system is ready for a Key Reset (do NOT perform a Key Reset at this time).

Move the Program/Run switch on the controller to the PROGRAM (left) position (Figure 20). The Program Mode LED will flash and the Diagnostic Display will indicate the total number of beams blocked.

Simulate any mechanical vibration or shock which might be encountered in the application and verify that the readout of beams blocked remains stable. Take steps to eliminate any intermittent beams.

When satisfied that the number of beams blocked is stable, push the Program switch push button on the controller (Figure 20) **for ½ to 2 seconds** and release. If the programming is accepted, the Program Mode LED will stop flashing and glow steadily. Programming will be rejected if the Program/Run switch is held depressed too long, or not long enough.

If too many beams are blocked, programming is rejected and the Diagnostic Display will flash error code 10. If this occurs, check sensor alignment and valid blanking criteria (see chart below).

Beams in Light Screen	8	16	24	32	40 to 96
Maximum Fixed Blanked Beams	0	4	7	9	12

NOTE: See page 59 for number of beams per defined area.

Turn the Program/Run switch to the RUN (right) position. The Program/Run LED will go OFF.

Now perform a Key Reset. The yellow status indicators will come ON steadily, and the green status indicators should be flashing to indicate that blanking is in use.

Remove power from the control module and reconfigure Auto Power-up and floating blanking as required for the application. Reapply power and perform a Key Reset (if Auto Power-up is not in use).

System Installation and Alignment

To clear fixed blanking, remove power from the control box and all objects in the defined area. Repeat step 4. See page 38 for error codes (most often 10, 11, 12) associated with programming.

- 5) **Next, trip test the MICRO-SCREEN system** for object detection capability using the specified test pieces supplied with the control module. To perform the trip test, the Key switch must be in the RUN (counterclockwise) position, the yellow status indicator must be ON steadily, and the green status indicator must either be ON steadily (to indicate blanking OFF) or flashing (to indicate blanking ON).

Appropriate Test Pieces for Trip Test

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

Pass the specified test piece, very slowly, down the length of the defined area in three paths: close to the emitter, close to the receiver, and midway between the emitter and receiver (Figure 23). In each case, the red status indicator should come ON and remain ON for as long as the test piece remains in the defined area. When the test piece is removed from the defined area, the green status indicator must come ON (if floating blanking is ON, the green status indicator will be flashing). If the green status indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces and unguarded areas created by use of fixed blanking (see Warnings, page 49). Do not continue until the situation is corrected.

If the MICRO-SCREEN System passes all of the checks in Section 3.5.5, go on to Section 3.5.6.

If the MICRO-SCREEN System fails any of these checks, do not attempt to use the System or the guarded machine until the reason for the failure(s) is identified and all failures are corrected.

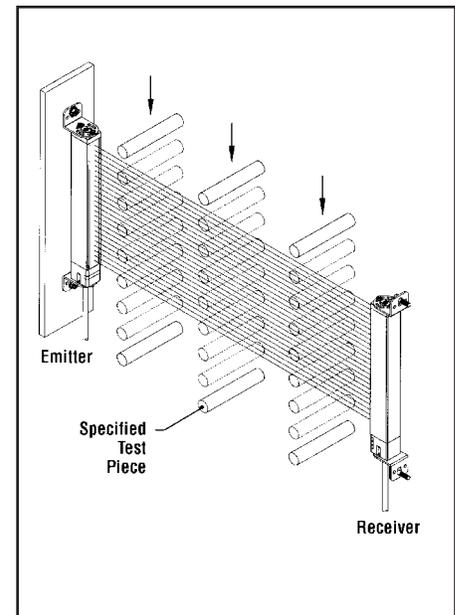


Figure 23. MICRO-SCREEN System trip test



CAUTION . . . Shock Hazard

Electrical shock hazard exists when the MICRO-SCREEN System control module is connected to the guarded machine. Use extreme caution to avoid electrical shock at all times. **Always disconnect all power from the MICRO-SCREEN System and the guarded machine before making any connections or replacing any component.**



WARNING . . . Final Switching Device

The output relays of the MICRO-SCREEN System must be the *final switching devices* for the machinery being guarded. **Never wire an intermediate device (e.g., a programmable logic controller - PLC), other than a safety relay, between either FSD and the machine primary control elements** (Reference ANSI B11.1-1988, Appendix B4). To do so could result in serious bodily injury or death.

NOTICE Regarding MPCEs

Each of the two Machine Primary Control Elements (MPCE 1 and MPCE 2) must be capable of immediately stopping the dangerous machine motion, irrespective of the state of the other. These two channels of machine control need not be identical, but the stop time performance of the machine (T_s , used to calculate the separation distance) must take into account the *slower* of the two channels.

Some machines offer only one primary control element. For such machines, it is necessary to duplicate the circuit of the single MPCE to add a second machine primary control element. Refer to Figure 24 (page 34) or consult the machine manufacturer for additional information.

3.5.6 Output Relay Connections

Output relay connections are made at the **FSD1** (Final Switching Device 1), **FSD2** (Final Switching Device 2), and **SSD** (Secondary Switching Device) terminals on the control module (Figure 21). These relays are energized (contacts closed) in normal operation when no obstructions are in the defined area. **All relays** become de-energized (their contacts open) in a lockout condition. Relays **FSD1** and **FSD2** (only) de-energize in a trip condition. Before continuing, read **NOTICE Regarding MPCEs**, below left.

The FSD1 output relay connects to Machine Primary Control Element #1 (MPCE 1) on the guarded machine. MPCE 1 is an electrically powered element of the guarded machine that directly controls the normal operating motion of the machine; it must be last (in time) to operate when motion is either initiated or arrested. The output contact of relay FSD1 must be connected, as shown in Figure 24, to control power to Machine Primary Control Element #1. The switching capacity of relay FSD1 is 250V ac max., 4 amps max. (resistive load).

The FSD2 output relay connects to Machine Primary Control Element #2 (MPCE 2) on the guarded machine. MPCE 2 is an electrically powered element of the guarded machine (in a different control path from MPCE 1) that directly controls the normal operating motion of the guarded machine; it must be last (in time) to operate when machine motion is either initiated or arrested. The output contact of relay FSD2 must be connected, as shown in Figure 24, to control power to Machine Primary Control Element #2. The switching capacity of relay FSD2 is 250V ac max., 4 amps max. (resistive load).

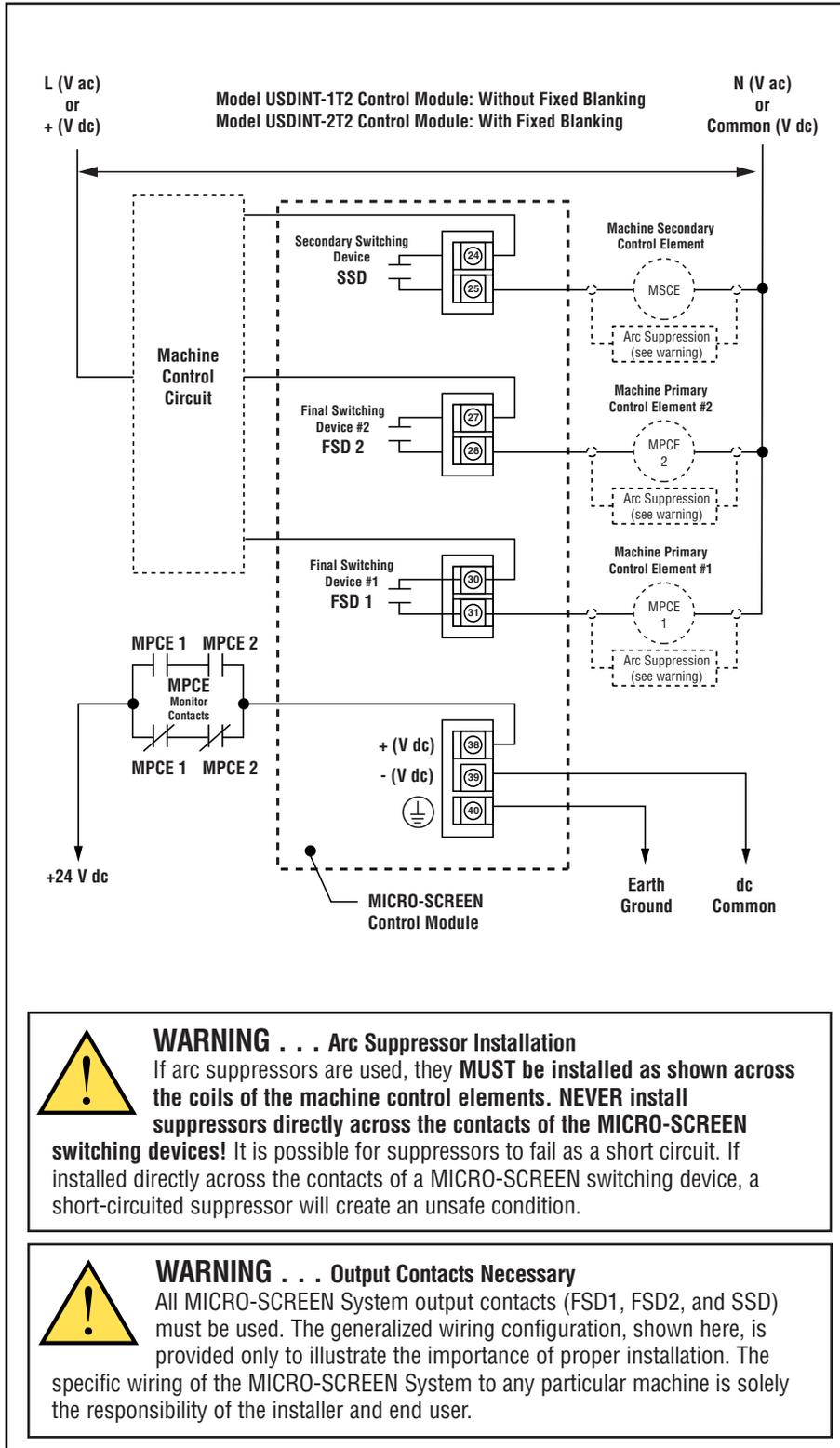
Many different types of mechanisms are used to arrest dangerous machine motion. Examples include mechanical braking systems, clutch mechanisms, and combinations of brakes and clutches. Additionally, control of the arresting scheme may be hydraulic or pneumatic.

As a result, MPCEs may be of several control types, including a wide variety of contactors and electromechanical valves. **If your machine documentation leaves any doubt about the proper connection points for the MICRO-SCREEN System output relay contacts, do not make any connections.** Contact the machine builder for clarification regarding connections to the MPCEs and MSCE.

The SSD output relay connects to the Machine Secondary Control Element (MSCE) on the guarded machine. The MSCE is an electrically powered element of the guarded machine (independent of the MPCEs) that is capable of removing power from the prime mover of the dangerous part of the machine in the event of an emergency. The output contacts of the SSD relay must be connected, as shown in Figure 24, to the Machine Secondary Control Element such that, if a lockout condition occurs, the motive power will be removed from the machine. The switching capacity of the SSD relay is 250V ac max., 4 amps max. (resistive load).

System Installation and Alignment

Figure 24 (below) shows output relay connections in a generic interfacing situation. The connections between the MICRO-SCREEN System outputs and the machine primary and secondary control elements must be direct, and arranged so that any single line fault or earth fault will not result in a circuit failure to a potentially dangerous state.



WARNING . . .

Installation of MICRO-SCREEN Systems with Trip Output for Perimeter Guarding Applications

The control modules described in this manual produce a “trip” output which automatically resets the output relays as soon as the defined area is clear. **Use of a trip output is dangerous for perimeter guarding applications where it is possible for personnel to move through the defined area and locate themselves inside the guarded area of dangerous machine motion.**

Banner offers control modules with “latching” output response, which are designed for perimeter guarding applications. See the Banner Machine Safety Products catalog or contact the Banner Factory Applications Engineers for information on control modules with latching response. **If a control module with trip output response is used for a perimeter guarding application, the following conditions must be met:**

- 1) **The dangerous machine motion must be able to be initiated following an interruption of the defined area *only* after actuation of a Reset switch.**
- 2) **The Machine Primary Control Elements (MPCEs) of the guarded machine must be wired so that the FSD outputs of the control module cause a latched response of the MPCEs.**
- 3) **The MPCEs must be reset only by actuation of a Reset switch.** The Reset switch must be located outside the area of dangerous motion, and must be positioned so that the area of dangerous motion may be observed by the switch operator during the Reset operation.

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



WARNING . . . Arc Suppressor Installation

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



WARNING . . . Output Contacts Necessary

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

Figure 24. MICRO-SCREEN System generic machine interface

NOTICE Regarding MPCE Monitoring Hookup

It is strongly recommended that one normally open and one normally closed auxiliary contact of each MPCE be wired (as shown in Figure 24, page 34) as MPCE monitor contacts. If this is done, any inconsistency of action between the two MPCEs will remove power from the MICRO-SCREEN System, causing a lockout condition[†]. **MPCE auxiliary contacts must be used as MPCE monitor contacts in order to maintain redundancy.** MPCE auxiliary contacts used for this purpose must be rated at 55 VA minimum.

In order to maintain control reliability, the MPCE monitor contacts must be wired as described in section 3.5.6 and Figure 24, pages 33-34.

[†] NOTE: Assumes Auto Power-up feature is not in use.

3.5.7 System Power (Permanent Connection)

After the initial checkout of Section 3.5.5 has been successfully completed, the power lines to the MICRO-SCREEN System must be re-routed to their permanent hookup through the MPCE monitor contacts of the guarded machine. This is important: it ensures that any inconsistency in action between the two MPCEs will remove power from the system. (See **NOTICE Regarding MPCE Monitoring Hookup, left.**)

Connection of system power is at the +24V dc and dc common terminals of the control module (Figure 21). *Do not operate the MICRO-SCREEN System without an earth ground connection.*

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

3.5.8 AUX Non-Safety Output Contact

The action of the AUX non-safety output contact “follows” the action of output relays FSD1 and FSD2. The AUX non-safety output contact is a light-duty contact used for *control functions that are not safety-related*. A typical use is to communicate with a programmable logic controller (PLC). The switching capacity of the AUX non-safety output is 125V ac or dc max., 500mA max. Connection to the AUX non-safety output contact is made at terminals 21 and 22 (Figure 21).

3.5.9 Remote Test Input

Remote Test Input connects to the Test 1 and Test 2 terminals 7 and 8 (see Figure 21, page 28). When connected together (shorted) for a minimum of 50 milliseconds, these terminals provide the MICRO-SCREEN System with the equivalent of a BLOCKED beam condition, for testing purposes. The switch or switching device used to short the Test contacts must be capable of switching 15V dc to 50V dc at 20 mA dc to 100 mA dc.

4. Operating Instructions

4.1 Security Protocol

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

The key to the Reset switch should be available to a **Designated Person** or persons. A Designated Person is one who is identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure. A machine operator who meets these requirements may be a Designated Person.

4.2 Periodic Checkout Requirements

In addition to the checkouts that are performed by a Qualified Person or persons at the time that the MICRO-SCREEN System is installed and put into service, **the functioning of the MICRO-SCREEN System and the machine it guards must be verified on a regular periodic basis to ensure proper operation. This is absolutely vital and necessary. Failure to ensure proper operation can lead to serious injury or death.**

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

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

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

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



WARNING . . . **For Proper Operation**

The Banner MICRO-SCREEN System can do the job for which it was designed only if it and the machine it guards are operating properly, both separately and together. **It is the user's responsibility to verify proper operation, on a regular basis, as instructed in Section 4.2 and Section 6.**

If the MICRO-SCREEN System and the guarded machine do not perform *exactly* as outlined in the checkout procedures, the cause of the problem must be found and corrected before the system is put back into service. **Failure to correct such problems can result in serious bodily injury or death.**

4.3 Normal Operation

Power-up

NOTE: Key must be in the RUN position at power-up. If the Auto Power-up feature is ON when dc power is applied to the MICRO-SCREEN System, the controller performs a system checkout and resets itself. If the Auto Power-up feature is OFF when dc power is applied to the System, it is normal for it to power up into a lockout condition and the Designated Person must perform a Key Reset:

- 1) Turn the key clockwise to the RESET position (yellow indicators go ON steadily).

Wait at least one-half second, then

- 2) Turn the key counterclockwise to the RUN position.

If the defined area is clear, the green and yellow indicators will go ON (red indicator goes OFF). (NOTE: The green status indicator will flash if floating blanking is ON.)

If the emitter and receiver are misaligned, the red indicator will come ON. The yellow indicator will single-flash at a rate that indicates the relative number of light beams established. Also, the two-digit Diagnostic Display on the control module indicates the number of beams blocked.

If the defined area is blocked and the emitter and receiver are aligned, the red indicator will come ON, and the yellow indicator will single-flash at a rate that indicates the relative number of light beams established. Also, the two-digit Diagnostic Display on the control module indicates the number of beams blocked.

Fixed Blanking Operation (Control Module model USDINT-2T2)

The fixed blanking feature allows the MICRO-SCREEN to be programmed to ignore permanent objects (e.g., brackets or fixtures) within the defined area. See page 7 for the description of fixed blanking. See page 31 for programming information. Note that up to 30% of the total number of beams in the array (to a maximum of 12 beams) may be fixed blanked. Contact the factory Applications Department if your application requires fixed blanking of a greater number of beams.

Floating Blanking Operation

The MICRO-SCREEN System allows disabling of either one or two beams, to allow objects such as workpiece materials to move undetected through the defined area. See page 7 for a description of floating blanking. See page 25 for information on how to enable floating blanking. Note that use of floating blanking increases the minimum object sensitivity of the light screen and requires the separation (safety) distance to be increased.

Use of Emergency Stop Switch

Both FSD output contacts open within 15 milliseconds, in response to actuation of an optional Emergency Stop (E-stop) switch. See page 27 for wiring information. The Diagnostic Display indicates error code "0" (zero). A Key Reset is required after re-arming (closing) the E-stop switch.

NOTE: A lockout condition will occur (error code "9") if the two contacts of the E-stop switch do not open simultaneously when the E-stop switch is actuated. This lockout condition requires removal and re-application of system power, plus a Key Reset (if Auto Power-up is not in use). This fault may indicate a defective E-stop switch. The E-stop switch (or switches) must be tested regularly (see section 6.3).

5. Troubleshooting and Maintenance

5.1 Troubleshooting Lockout Conditions

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

Power-up/Power Interrupt Lockouts

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

Internal Lockout Conditions

- If the control module Key switch is in the RESET position at power-up (with Auto Power-up ON); or if the Key switch is switched to RESET while the System is in the RUN mode;
- If the Program/Run switch (Figure 20) is in the PROGRAM position at power-up;
- If Floating Blanking switches are in the ON position when the Program/Run switch is switched to the PROGRAM position;
- If both 1-beam and 2-beam Floating Blanking switches are in the ON position;
- If fixed blanking is not set within approximately 4 minutes of moving the Program/Run switch to the PROGRAM position;
- If Fixed Blanking has been programmed, and any fixed object is removed from or moved within the defined area;
- If an FSD (Final Switching Device – see Glossary) relay does not “drop out” within its specified time;
- If the SSD (Secondary Switching Device – see Glossary) relay has de-energized;
- If the control module switch settings are inconsistent with each other or if they are changed while the System is in RUN mode;
- If the self-checking circuits of the microprocessor detect a component failure within the MICRO-SCREEN System itself; or
- If either (or both) Emergency Stop switch contacts open.

A lockout condition causes output relays FSD1, FSD2, and SSD to open, shutting down the MPCEs and MSCE of the guarded machine. An internal lockout condition (resulting from an internal system fault) is indicated by the red status indicator (only) flashing.

Power-up/power interrupt lockouts (Auto Power-up OFF, conditions as described above, yellow indicator only double-flashing) are normal and require a Key Reset for operation to continue.

Key Reset. To resume operation after a power interruption:

- 1) Turn the key clockwise to RESET position (yellow status indicator should light) and wait at least one-half second, then
- 2) Turn the key counterclockwise to RUN position.

If the defined area is clear and the emitter and receiver are properly aligned, the green and yellow indicators will light.

If the lockout condition was due to a momentary power interruption that has been corrected, the MICRO-SCREEN System will now operate normally. **Upon recovery from a power interruption, checkout procedure 6.3 on page 48 must be performed.**



WARNING . . . Power Failures

Power failures or other MICRO-SCREEN System lockout conditions should always be investigated immediately by a Qualified Person. With the exception of Power-up/Power Interrupt lockout conditions (listed at left), lockout is a positive indication of a problem and should be investigated at once. Attempts to continue to operate machinery by bypassing the MICRO-SCREEN System are dangerous and could result in serious bodily injury or death.



CAUTION . . . High Voltage

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

A lockout condition resulting from an internal system fault is indicated by the red status indicators flashing, and an error code number appearing in the Diagnostic Display. In this case, the Qualified Person must note the error code and interpret the cause of the lockout from the table in Figure 25, below. This diagnostic table is also found inside the control module on the back side of the cover plate.

The MICRO-SCREEN System will not operate if its self-checking circuits detect an internal problem. A Key Reset will have no effect until the problem has been corrected. Take the corrective measure(s) corresponding to the error code and then perform a Key Reset. If further assistance is required, contact your Banner field service engineer or the factory Applications Engineering Department.

If no status indicators are ON, power to the system may have been lost. The green LED on the power supply board (remove module cover to view) indicates the presence (LED ON) or absence (LED OFF) of dc power at the power supply board. It is possible for power to be present at the input of the power supply even if the dc Power LED is OFF.

Check for voltage across the +24V dc and dc common terminals 38 and 39. If voltage is not present, power to the MICRO-SCREEN System has been lost, and the cause is outside the system. If 24V dc is present, turn off the power to the control module and check the fuse. If the fuse is bad, replace it (Section 5.3.1). If the fuse is good, and 24V dc is present at terminals 38 and 39, an internal power supply failure has occurred.

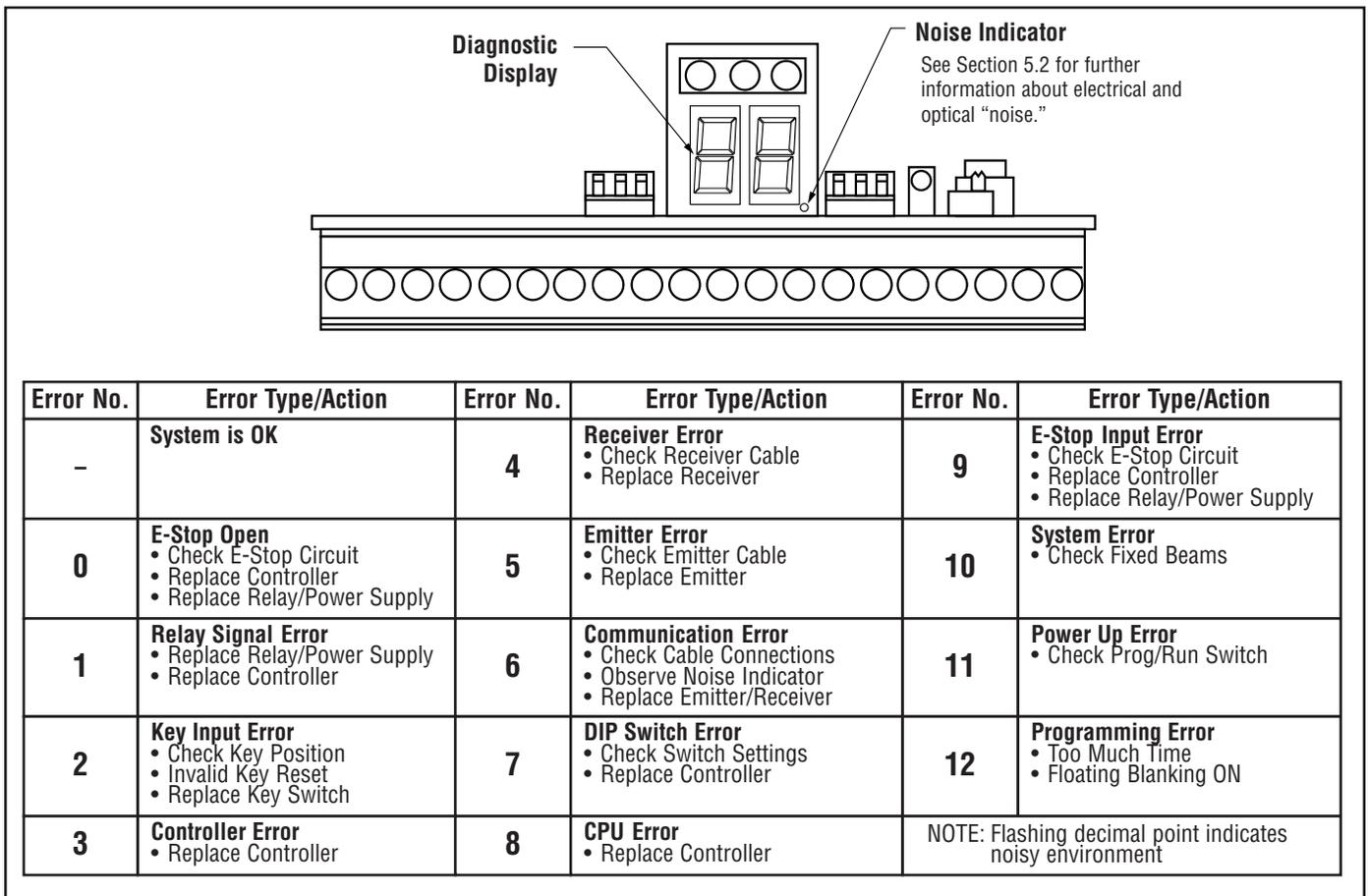


Figure 25. Interpretation of Diagnostic Display

5.2 Effects of Electrical and Optical Noise

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

5.3 Servicing and Maintenance

5.3.1 Fuse Testing and Replacement

Turn OFF power to the control module and the machine being guarded before proceeding.

The MICRO-SCREEN System control module fuse is located in a fuseholder on the power supply board, immediately beneath the removable top cover plate. Remove the control module cover plate by gently prying it up and off using a flat-blade screwdriver or similar tool (see Figure 19, page 25). Remove the fuse from the holder. Visually inspect the fuse and/or test its conductivity using an ohm meter or a continuity tester. The fuse is a 3AG or 5x20 mm slow-blow type (see specifications, page 58).

5.3.2 Controller Board and Relay/Power Supply Replacement

MICRO-SCREEN Systems are designed for reliability. While replacement of the controller or relay/power supply boards is not normally required, these components have been designed to be easily replaceable as a convenience to the customer. See the instructions included with the replacement board. **To maintain control reliability, use only Banner-supplied replacement relays with forced-guided contacts.** See Replacement Parts, page 61.

NOTE: Do not open the emitter or receiver housing. The emitter and receiver contain no field-replaceable components. If repair is necessary, return the unit to the factory. Do not attempt to repair an emitter or receiver yourself.



WARNING . . . Use Only Genuine Banner Replacement Parts

If replacement parts are ever required, **always use only genuine Banner-supplied replacement parts** (see page 61). Do not attempt to substitute parts from another manufacturer. **To do so could impair the operation of the MICRO-SCREEN System and could result in serious bodily injury or death.**

Electrical and Optical Noise

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

- Poor connection between control module and earth ground
- Drain wire of emitter and/or receiver not connected to terminal 20 (see Figure 21)
- Sensor wires or output wires routed too close to “noisy” wiring
- Optical interference from adjacent light screens or other photoelectrics



WARNING . . . Shut Down Machinery Before Servicing

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



CAUTION . . . Dangerous Voltages

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

The control box should be opened and/or serviced only by a *Qualified Person* (see Section 4.1).

5.3.3 Cleaning

The MICRO-SCREEN System control module is constructed of gray polycarbonate and is rated NEMA 1 (IP20). It may be dusted, but avoid contact with any liquids.

The MICRO-SCREEN System emitter and receiver units are constructed of aluminum with a yellow painted finish and are rated NEMA 4, 13 (IP65). Lens covers are acrylic. Emitters and receivers are best cleaned using mild detergent or window cleaner and a soft cloth. **Avoid cleaners containing alcohol**, as they may damage the acrylic lens covers.

5.3.4 Warranty Service

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

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

**Banner Engineering Corp.
9714 - 10th Avenue No.
Minneapolis, MN 55441
Phone: 612.544.3164
Fax: 612.544.3213**

They will attempt to troubleshoot the system from your description of the problem. If they conclude that a component is defective, they will issue an RMA (Return Merchandise Authorization) number for your paperwork, and give you the proper shipping address.

- 2) Pack the component(s) carefully. Damage which occurs during return shipping is not covered by warranty.

6. Alignment and Checkout

Study each procedure from beginning to end to make sure that you understand each step before you start. Refer all questions to the Banner Applications Engineering

Department: Banner Engineering Corp.
 9714 - 10th Avenue No.
 Minneapolis, MN 55441
 Phone: 612.544.3164
 Fax: 612.544.3213

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

Emitter/receiver pairs from 102 to 1219 mm (4" to 48") long may be spaced from 15 cm to 9 m (6" to 30') apart. Emitter/receiver pairs 1422 to 1892 mm (56" to 72") long may be spaced from 15 cm to 6 m (6" to 20') apart. The maximum emitter/receiver separation distance is reduced if corner mirrors are used (see alignment information on page 45). The width and height so described are known as the *defined area*.



WARNING . . .
Turn Machinery OFF Before Proceeding

You may be working close to hazardous areas of your machinery while aligning the MICRO-SCREEN System. Doing so while the hazardous machinery is operational could result in serious bodily injury. **The machinery that the MICRO-SCREEN System is connected to must not be operating at any time during the alignment procedure of Section 6.1.**

6.1 MICRO-SCREEN System Alignment

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

Follow the measures outlined below to maximize MICRO-SCREEN System excess gain. If there are reflective surfaces near the defined area, read alignment step #5 (pages 43-44) before proceeding further, to prevent possible reflection problems.

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

- 1) Turn OFF power to the MICRO-SCREEN System and to the guarded machine. Leave power to the guarded machine OFF, and power-up only the MICRO-SCREEN System with the key in the RUN position.
- 2) The MICRO-SCREEN will power up into a power-up lockout condition (unless Auto Power-up is ON; then proceed to step #3). Remove all obstructions from the defined area and reset the MICRO-SCREEN System as follows:
 - a. Turn the Key Reset switch clockwise to RESET position, and wait at least 1/2 second to allow time for internal system checks, then
 - b. Turn the Key Reset switch counter-clockwise to RUN position.

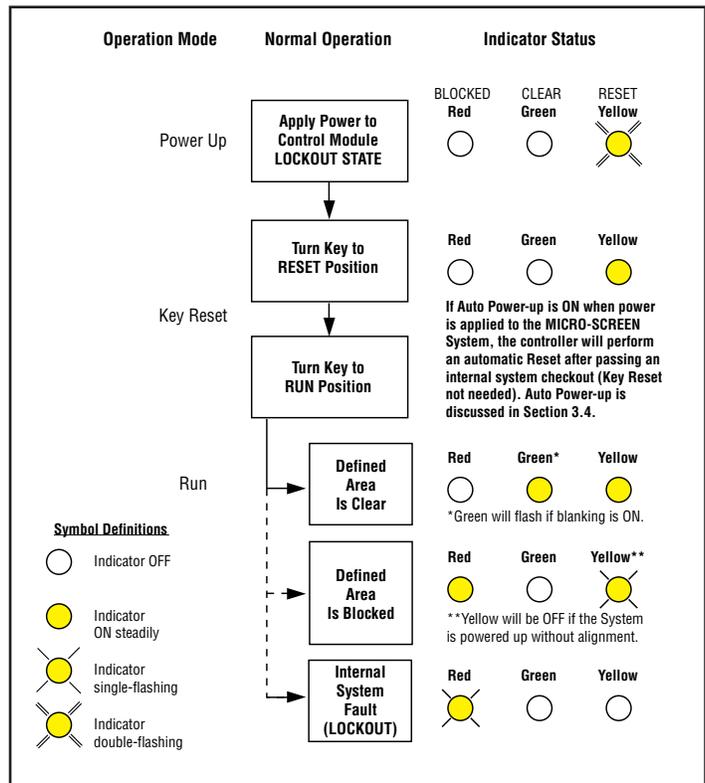


Figure 25. Operating status indicator conditions

- 3) Upon completion of the Key Reset (step #2), the MICRO-SCREEN will indicate either a BLOCKED or a CLEAR condition:
 - a) A BLOCKED condition is indicated by the red indicator ON steadily and the yellow indicator flashing at a rate which is proportional to the number of beams which are aligned and unblocked. Go to step #4. The 2-digit Diagnostic Display on the control module will also indicate the total number of blocked beams.
 - b) A CLEAR condition is indicated by the red indicator OFF and the green and yellow indicators ON steadily. (NOTE: The green status indicator will flash if floating blanking is ON.) Further alignment is not necessary.
- 4) A BLOCKED condition after Reset indicates that one or more of the beams is misaligned or interrupted. When this occurs:
 - a) Check carefully for any obstructions in the path of the beams within the defined area (the limits of which are indicated by the ends of the windows of the emitter and receiver; see Figure 15).
 - b) If the defined area is completely clear of obstructions, loosen the four slotted hex M3 screws which fasten the receiver to its mounting brackets. Slowly rotate the receiver first to the right and then to the left while watching the status indicators at the base of the receiver.
 - c) If the green indicator does not come ON, regardless of angular position of the receiver, then loosen the emitter and rotate both sensors relative to each other until the green indicator comes ON. Secure the emitter and receiver in the center of the area of rotation where the yellow and green indicators are ON steadily. (NOTE: The green status indicator will flash if floating blanking is ON.)
 - d) If the green indicator still fails to come ON, then re-check the sensor mounting per the procedure in Section 3.3, and re-align per this alignment procedure.
- 5) Trip test the MICRO-SCREEN System for object detection capability using the test piece(s) supplied with the control module. To perform this test, the Key Reset switch must be in the RUN position and the green and yellow indicators (only) must be ON steadily. (NOTE: The green status indicator will flash if floating blanking is ON.) Perform a Key Reset, if necessary, to attain this condition (see step #2).

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

Alignment and Checkout

Perform the trip test as follows:

Pass the appropriate specified test piece downward through the defined area at three points (see Figure 27), taking care to hold the test piece perpendicular to the defined area:

- a) Close to the receiver,
- b) Close to the emitter, and
- c) Midway between the emitter and receiver.

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

The green status indicator should come ON only when the test piece is withdrawn from the defined area. If the green status indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces or unguarded areas created because fixed blanking is in use (see Warnings, page 49). **Do not continue until the situation is corrected.**



WARNING . . .
If Trip Test Indicates a Problem

If the MICRO-SCREEN System does not respond properly to the trip test, do not attempt to use the System. If this occurs, the System cannot be relied upon to stop dangerous machine motion when a person or object enters the defined area. **Serious bodily injury or death could result.**

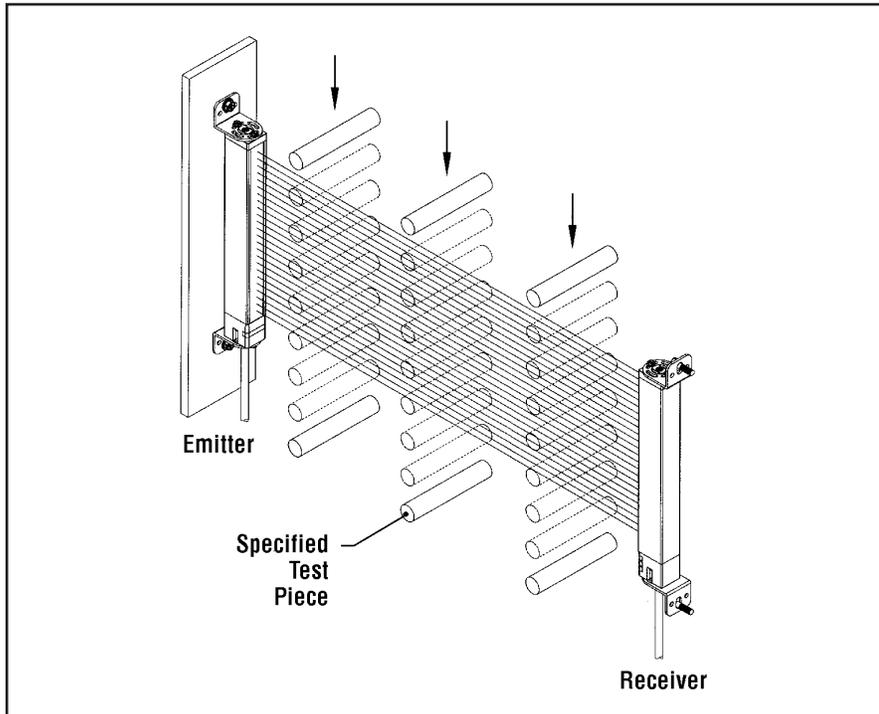


Figure 27. MICRO-SCREEN trip test

Use of Corner Mirrors

MICRO-SCREEN sensors may be used with one or more MSM Series corner mirrors for guarding along more than one side of an area.

The Accessories section lists the 12 available lengths of corner mirrors for sensors up to 48" long (see page 61). (Corner mirrors are not available for sensors longer than 48".) These rear-surface glass mirrors are rated at 85% efficiency; sensing range (and therefore excess gain) is reduced when using mirrors. The following table lists the resultant range when from one to four MSM Series corner mirrors are used in either sensing path.

Maximum Emitter and Receiver Separation				
Number of Corner Mirrors	1	2	3	4
Maximum distance between emitter and receiver	8.5 m (28')	7.8 m (25.5')	7.2 m (23.5')	6.7 m (22')

Mirrors should be securely mounted to a solid, vibration-free surface. Using a level, mount the mirror(s) exactly parallel to (in the same plane as) the sensors, with the midpoint of the mirror(s) directly in line with the midpoint of the sensors' defined area. The upper and lower limits of the defined area of MICRO-SCREEN sensors are indicated by the ends of each sensor window, and are dimensioned in the chart on page 23.

Adjust the corner mirror(s) so that the angle of incidence of light to the mirror equals the angle of reflection from the mirror. Referring to Figure 28 below, sight from behind one of the sensors directly towards the mirror (or the first mirror in line). When alignment is correct, you will see the straight and centered reflection of the lens of the other sensor in the mirror. Accessory laser alignment tool, model LAT-1, is available to greatly assist alignment (see page 60).

Use the yellow alignment indicator corresponding to the screen being aligned for final alignment. Also, the two-digit Diagnostic Display on the control module will indicate the total number of blocked beams. Refer to the data sheet (P/N 43658) packed with each MSM Series corner mirror for complete information on the use of corner mirrors.



WARNING . . .
Use with Supplemental
Sensing Devices if
Necessary

Supplemental presence-sensing devices, such as safety mats, must be used if any space between either defined area and any danger point is large enough to allow a person to stand undetected by the MICRO-SCREEN System. Failure to observe this warning could result in serious injury or death.

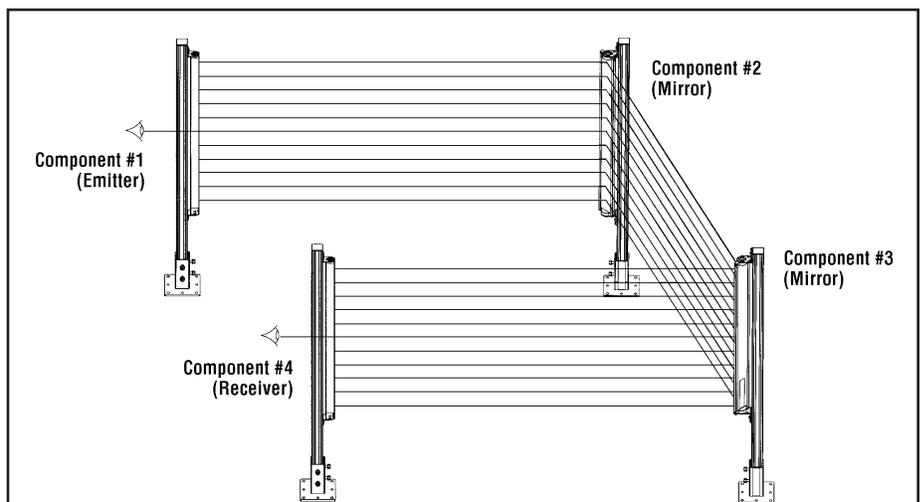


Figure 28. Corner mirror alignment

Alignment and Checkout

6.2 Commissioning Checkout (To Be Performed at Installation)

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

A copy of checkout results should be kept in the employer's files; see OSHA 1910.217(e)(1). The Qualified Person must:

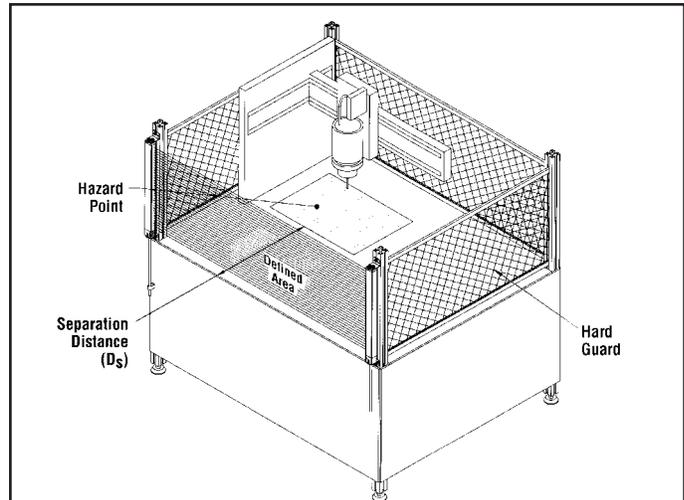
- 1) Examine the guarded machine to verify that it is of a type and design compatible with the MICRO-SCREEN System. See page 2 for a list of misapplications.
- 2) Verify that the minimum separation distance from the closest danger point of the guarded machine to the defined area is not less than the calculated distance (see Figure 29).
- 3) Verify that access to any dangerous parts of the guarded machine is not possible from any direction not protected by the MICRO-SCREEN System, hard guarding, or supplemental guarding, and verify that all supplemental guarding devices and hard guarding are in place and operating properly.
- 4) Verify that it is not possible for a person to stand between the defined area and the dangerous parts of the guarded machine. Or, verify that supplemental presence-sensing devices, such as safety mats, are in place and functioning properly in any space between the defined area and any danger point which is large enough to allow a person to stand undetected by the MICRO-SCREEN System.
- 5) Examine the electrical wiring connections between the MICRO-SCREEN output relays and the guarded machine's control elements to verify the requirements stated in Section 3.5.6.



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



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



The formula used to calculate the separation distance is:

$$D_s = K \times (T_s + T_r) + D_{pf}$$

where:

D_s = the separation distance;

K = the OSHA-recommended hand speed constant of 63 inches per second (NOTE 1, below);

T_s = the overall stop time of the machine measured from the application of the "stop" signal to the final ceasing of all motion (including stop times of all relevant control elements, measured at maximum machine velocity). See NOTE 2, below.

T_r = the response time of the MICRO-SCREEN System: .038 Seconds

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

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

NOTES:

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

Figure 29. Calculation of D_s

- 6) Test the effectiveness of the MICRO-SCREEN System with system power ON, as described in steps (a) through (d), below. The MICRO-SCREEN control module comes with three specified test pieces. Select the proper test piece based on system configuration, per the following chart:
 - a) Verify that the MICRO-SCREEN System is in RUN mode (green and yellow status indicators ON). See section 4.3 for the Key Reset procedure. The green indicator will flash if blanking is programmed.

Appropriate Test Pieces for Trip Test

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

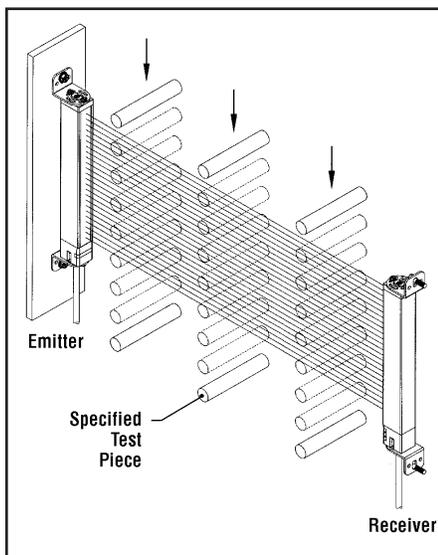


Figure 30. Use of test piece in trip test



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

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

- b) With the guarded machine at rest, slowly pass the appropriate specified test piece downward through the defined area at three points, taking care to hold the test piece perpendicular to the defined area: close to the receiver column, close to the emitter column, and midway between the emitter and receiver columns (Figure 30). In each case, the red status indicator should come ON and remain ON for as long as the test piece is within the defined area. When the test piece is withdrawn from the defined area, the green status indicator should come ON. If the green indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces, or unguarded areas created by use of fixed blanking (see Warnings, page 49). **Do not continue until the situation is corrected.** (See section 3.2.2 and 3.2.4.)
 - c) Initiate machine motion of the guarded machine and, during motion, insert the appropriate specified test piece into the defined area (perpendicular to the defined area). **Do not attempt to insert the test piece into the dangerous parts of the machine.** Upon insertion of the test piece into the defined area at any time during machine motion, the dangerous parts of the machine should come to a stop with no apparent delay. Upon removal of the test piece from the defined area, verify that the machine does **not** automatically restart, and that the initiation devices must be engaged to restart the machine.
 - d) With the guarded machine at rest, insert the appropriate specified test piece into the defined area and verify that it is not possible for the guarded machine to be put into motion while the specified test piece is within the defined area.
- 7) Test the Emergency Stop switch (if one is connected to the system). With the machine running, engage the Emergency Stop switch (to open its contacts). Verify that the dangerous machine motion stops with no apparent delay. Test each Emergency Stop switch, individually, when two or more switches are series-connected to a MICRO-SCREEN control module. See Warning on page 27.
- 8) Remove electrical power to the MICRO-SCREEN System. All output relays should immediately de-energize, and should not be capable of being reactivated until power is re-applied and a Key Reset is performed (unless the Auto Power-up feature is ON).
- 9) Test the machine stopping response time using an instrument designed for that purpose to verify that it is the same or less than the overall system response time specified by the machine manufacturer. (NOTE: Banner's Applications Engineering Department can recommend a suitable instrument.)

Alignment and Checkout

6.3 Shift Change, Power-up and Machine Setup Change Checkout

Daily checkout and checkouts after tooling and machine changes must be performed by a *Designated Person* appointed and identified in writing by the employer. During continuous machine run periods, this checkout must be performed at intervals not to exceed 24 hours. A copy of checkout results should be kept on or near the machine: see OSHA 1910.217(e)(1).

The Designated Person must:

- 1) Verify that access to the dangerous parts of the guarded machine is not possible from any direction not protected by the MICRO-SCREEN System, hard guarding, or supplemental guarding, and verify that all supplemental guarding devices and hard guarding are in place and operating properly.
- 2) Verify that the minimum separation distance from the closest danger point of the guarded machine to the defined area is not less than the calculated distance. See Section 3.2.1.
- 3) Ensure that it is not possible for a person to stand between the defined area and the dangerous parts of the guarded machine. Or, verify that supplemental presence-sensing devices, such as safety mats, are in place and functioning properly in any space between the defined area and any danger point which is large enough to allow a person to stand undetected by the MICRO-SCREEN System.
- 4) Verify that the enclosure for the MICRO-SCREEN control module is tripped and locked. The key (or combination or tool) to the locking mechanism should be in the possession of a Qualified Person.



WARNING . . . Be Sure Lockable Enclosure is Closed Before Proceeding

A shock hazard exists while the lockable enclosure is open (see page 24). **Before continuing, verify that the lockable enclosure is closed and tripped.**

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

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

- a) Verify that the MICRO-SCREEN System is in RUN mode (green and yellow Status Indicators ON). See Section 4.3 for Reset procedure.
 - b) With the guarded machine at rest, pass the appropriate specified test piece downward through the defined area at three points, perpendicular to the defined area: close to the receiver column, close to the emitter column, and midway between the emitter and receiver columns (see Figure 30). In each case, the red indicator must come ON and remain ON for as long as the test piece is within the defined area. When the test piece is removed from the defined area, the green status indicator should come ON (if blanking is ON, the green status indicator will be flashing). If the green status indicator comes ON at any time when the test piece is within the defined area, check for reflective surfaces, or unguarded areas created by the use of fixed blanking (see Warnings, page 49). **Do not continue until the situation is corrected.** (See Section 3.2.2 and 3.2.4.)
 - c) Initiate machine motion of the guarded machine and, during motion, insert the specified test piece into the defined area (perpendicular to the defined area). **Do not attempt to insert the test piece into the dangerous parts of the machine.** Upon insertion of the test piece into the defined area at any time during machine motion, the dangerous parts of the machine should come to a stop with no apparent delay. Upon removal of the test piece from the defined area, verify that the machine does **not** automatically restart, and that the initiation devices must be engaged to restart the machine.
 - d) With the guarded machine at rest, insert the specified test piece into the defined area and verify that it is not possible for the guarded machine to be put into motion while the specified test piece is within the defined area.
- 6) Test the Emergency Stop switch (if one is connected to the MICRO-SCREEN System). With the machine running, engage the Emergency Stop switch (to open its contacts). Verify that the dangerous machine motion stops with no apparent delay. Test each Emergency Stop switch, individually, when two or more switches are series-connected to a MICRO-SCREEN System. See Warning on page 27.

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

6.4 Semi-annual Checkout (To Be Performed at Six-month Intervals)

This semi-annual checkout must be done by a Qualified Person. A copy of test results should be kept on or near the machine.

The Qualified Person must:

- 1) Perform the Commissioning Checkout Procedure (Section 6.2). If any decrease in machine braking ability has occurred, make the necessary clutch/brake repairs, readjust D_S appropriately, and re-perform the checkout sequence of Section 6.2.
- 2) Examine and test the machine primary control elements (MPCEs) to ensure that they are functioning correctly and are not in need of maintenance or replacement.
- 3) Inspect the guarded machine to ensure that there are no other mechanical or structural problems that would prevent the machine from stopping or assuming an otherwise safe condition when signalled to do so by the MICRO-SCREEN System.
- 4) Examine and inspect the machine controls and connections to the MICRO-SCREEN System to ensure that no modifications have been made which adversely affect the system.



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

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



WARNING . . . Reflective Surfaces

It may be possible for a highly reflective surface (a shiny machine surface or a shiny workpiece) to reflect sensing light around an object in the defined area, preventing that object from being detected. This potentially dangerous condition is discovered using the trip test as described in the Initial Checkout Procedure (Section 3.5.4), the Alignment Procedure (Section 6.1), and the periodic checkout procedures (Sections 6.2, 6.3, and 6.4).

When this condition is discovered, eliminate the problem reflection(s). If possible, relocate the sensors to move the defined area away from the reflective surface(s), being careful to retain at least the required separation distance (Section 3.2.1). Otherwise, paint, mask, or roughen the interfering shiny surface to reduce its reflectivity. Repeat the trip test to verify that these changes have eliminated the problem reflection(s). See Section 3.2.4.

NOTE: If the workpiece is especially reflective and comes close to the defined area, perform the trip test with the shiny workpiece in place.



WARNING . . . Hard Guarding

If any object that is to be ignored by fixed blanking does not, itself, completely prevent access to the danger point(s), you must install hard guarding to prevent access past the object, or increase the separation distance.

Openings in the hard guarding material must meet OSHA criteria (see OSHA 1910.217, Table O-10).

Failure to hard guard any opening caused by fixed blanking or failure to adequately increase the separation distance will create an unsafe condition which could lead to serious injury or death. See Section 3.2.2.

Glossary of Terms

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

ANSI (American National Standards Institute): An association of industry representatives which develops technical standards, including safety standards. These standards represent a consensus from a variety of industries on good practice and design. ANSI standards relevant to application of the MICRO-SCREEN System include ANSI B11.1 (mechanical power presses), ANSI B11.2 (hydraulic power presses), and ANSI/RIA R15.06 (industrial robots and robot systems). See page 62.

Auxiliary monitor or Alarm contact: A low-load-capacity, non-safety-related relay contact within the MICRO-SCREEN System whose primary purpose is to communicate system status to a PLC.

Auto Power-up: A feature of the MICRO-SCREEN *control module* which, when switched ON, enables the MICRO-SCREEN to be powered up (and recover from a power interruption) without the necessity of a *Key Reset*. When Auto Power-up is ON, the MICRO-SCREEN *control module* automatically begins internal diagnostics upon power-up, and automatically resets the system if it passes the diagnostic check. With Auto Power-up OFF, a manual *Key Reset* is required.

Blanking: (See *fixed blanking* and *floating blanking*.)

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

Control module: Contains the circuitry (internal to the MICRO-SCREEN System) that provides the proper voltages to the system, controls the sensing units, receives and processes information from the sensing units and the safety monitoring means, and provides outputs to the *Final Switching Devices (FSD1 and FSD2)*, the *Secondary Switching Device (SSD)*, and the *Auxiliary Monitor Relay*.

Controller board: A removable printed circuit board, located within the MICRO-SCREEN System *control module*, which contains the microprocessors and related electronic circuits.

Defined area: The “light screen” or “curtain of light” generated by the MICRO-SCREEN System. When the defined area is interrupted by an opaque object of a specified cross section or larger, a *trip condition* results (see Figure 1).

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

Diverse redundancy: A design feature in which two components of different design, running from two different instruction sets (if programmed components), constantly check all system components, including each other.

Emergency stop: The function offered by the MICRO-SCREEN *control module* which produces a *lockout condition* when an (optional) Emergency Stop switch is engaged. The customer-supplied Emergency Stop switch must meet certain mechanical and electrical requirements, as described in Section 3.5.2.

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

Final Switching Device (FSD): The two output relays (FSD1 and FSD2) of the MICRO-SCREEN System which respond to an intrusion of the *defined area* by interrupting the circuit connecting them to the *Machine Primary Control Elements (MPCEs)* of the *guarded machine*.

Fixed Blanking: A feature that allows the MICRO-SCREEN System to be programmed to ignore objects (such as brackets or fixtures) that will always be present within the *defined area*, so that the presence of these objects will not cause the *FSDs (Final Switching Devices)* of the MICRO-SCREEN System to trip (see *Trip condition*). If any of the fixed objects are moved within or removed from the defined area, a *lockout condition* results.

Floating Blanking: A feature that allows the MICRO-SCREEN System to be programmed to produce an intentionally disabled light beam within the “light screen,” which appears to move up and down (“float”) in order to allow the feeding of an object through the light screen (the *defined area*) at any point along the length of the screen without causing a *Trip condition*.

The MICRO-SCREEN System offers one- or two-beam floating blanking to allow multiple objects (usually workpiece material), to move through the *defined area* without tripping the *Final Switching Devices*.

Use of floating blanking increases *minimum object sensitivity* and the required *separation distance*.

FMEA (Failure Mode and Effects Analysis): A testing procedure by which potential failure modes in a system are analyzed to determine their results or effects on the system. Component failure modes that produce either no effect or a *lockout condition* are permitted; failures which cause an unsafe condition (a *failure to danger*) are not. Banner MICRO-SCREEN Systems are extensively FMEA tested.

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

Glossary

Full-revolution devices: A type of machine drive arranged such that, once started, the machine can only be stopped when the full cycle is complete. Examples include positive key clutches and similar mechanisms. Banner MICRO-SCREEN Systems may not be used with full-revolution devices.

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

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

Internal lockout: A *lockout condition* that occurs due to an internal MICRO-SCREEN System problem. Indicated by the red status indicator LED (only) flashing. Requires the attention of a *Qualified Person*.

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

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

Lockout condition: A condition of the MICRO-SCREEN System that is automatically attained either: (1) when its dc supply mains are interrupted and restored, or (2) in response to certain failure signals. When a lockout condition occurs, the MICRO-SCREEN System's *FSD*, *SSD*, and *Auxiliary Monitor Relay* contacts open, and a *Key Reset* is required to return the system to the RUN condition.

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

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

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

Minimum object sensitivity: The minimum-diameter object that a light curtain system can reliably detect. Objects of this diameter or greater will be detected anywhere in the sensing field. A smaller object can pass undetected through the curtain of light if it passes exactly midway between two adjacent light beams. Same as MODS, Minimum Object Detection Size. See also *specified test piece*.

MODS (minimum object detection size): See *minimum object sensitivity*.

MPCE monitor contacts: The normally open and normally closed contacts of a *guarded machine's* MPCEs which are connected in series with the power supply to the MICRO-SCREEN System. Any inconsistency of action between the two sets of monitor contacts will remove power from the MICRO-SCREEN System and cause a *lockout condition*. (See Figure 24.)

OFF state (of Final and Secondary Switching Devices): In the OFF state, the output circuit is broken and interrupts the flow of current.

ON state (of Final and Secondary Switching Devices): In the ON state, the output circuit is complete and permits the flow of current.

OSHA (Occupational Safety and Health Administration); OSHA CFR 1910.217: Occupational Safety and Health Administration (a US Federal agency), Division of the US Department of Labor, that is responsible for the regulation of workplace safety. OSHA regulations often follow ANSI standards, including mechanical power press requirements (OSHA CFR 1910.217). These regulations become law when adopted by OSHA, and must be followed. (See page 63.)

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

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

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

Power-up/power interrupt lockout: A *lockout condition* of the MICRO-SCREEN System that, if *Auto Power-up* is OFF, occurs when the system is powered up (including upon power-up after a loss of power). Indicated by the yellow status indicator LED (only) flashing. *Requires a Key Reset by a Designated Person*.

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

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

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

Secondary switching device (SSD): The *output relay* of the MICRO-SCREEN System which, in a *lockout condition*, interrupts the circuit connecting it to the *Machine Secondary Control Element (MSCE)*.

Self-checking (circuitry): A circuit with the capability to electronically verify that all of its own critical circuit components, along with their redundant backups, are operating properly. Banner MICRO-SCREEN Systems are self-checking.

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

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

Specified test piece: An opaque object of the minimum cross section required to place the MICRO-SCREEN System into a *trip condition* when inserted into any part of the *defined area*. See also *minimum object sensitivity*.

Supplemental guarding: Additional electrosensitive safety device(s), possibly employed along with *hard guarding* measures, used for the purpose of preventing a person from reaching over, under, or around the *defined area* of an installed MICRO-SCREEN System and into the *point of operation* of the *guarded machine*.

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

UL (Underwriters Laboratory): A third-party organization which tests a manufacturer's products for compliance with appropriate Standards, electrical and/or safety codes. Compliance is indicated by their listing mark on the product.

Specifications

MICRO-SCREEN Standard Series Sensor Specifications

Models	Defined Area	Number of Beams	Models	Defined Area	Number of Beams
Emitter USE424Y Receiver USR424Y	102 mm (4")	8	Emitter USE2824Y Receiver USR2824Y	711 mm (28")	56
Emitter USE824Y Receiver USR824Y	203 mm (8")	16	Emitter USE3224Y Receiver USR3224Y	813 mm (32")	64
Emitter USE1224Y Receiver USR1224Y	305 mm (12")	24	Emitter USE3624Y Receiver USR3624Y	914 mm (36")	72
Emitter USE1624Y Receiver USR1624Y	406 mm (16")	32	Emitter USE4024Y Receiver USR4024Y	1016 mm (40")	80
Emitter USE2024Y Receiver USR2024Y	508 mm (20")	40	Emitter USE4424Y Receiver USR4424Y	1118 mm (44")	88
Emitter USE2424Y Receiver USR2424Y	610 mm (24")	48	Emitter USE4824Y Receiver USR4824Y	1219 mm (48")	96
Emitter/receiver separation	15 cm (6") to 9 m (30')				
Minimum object sensitivity	19.1 mm (0.75") floating blanking OFF 31.8 mm (1.25") 1-beam floating blanking ON 44.5 mm (1.75") 2-beam floating blanking ON				
Response time	Light Screens: Less than 38 milliseconds (all lengths) E-Stop: Less than 15 milliseconds				
Self-checking interval	20 milliseconds				
Ambient light immunity	>10,000 lux at 5° angle of incidence				
Strobe light immunity	Totally immune to one Federal Signal Corp. "Fireball" model FB2PST strobe.				
Emitter elements	Infrared LEDs; 880 nm peak emission				
Status indicators	Emitter: Green indicator for power ON indication Receiver: Red, yellow, and green status indicators with same functions as those on control module (see Control Module Specifications, page 57). Yellow also indicates alignment. Indicators are visible on three sides of receiver base.				
Emitter and receiver enclosures	<i>Size:</i> See Figure 15, page 23. <i>Materials:</i> Aluminum; yellow polyester painted finish; acrylic lens cover <i>Rating:</i> NEMA 4, 13; IEC IP65				
Mounting hardware	Emitter and receiver each are supplied with a pair of swivel end mounting brackets. (Sensor lengths 40" to 48" are supplied with one center support bracket; see page 21.) Mounting brackets are 13-gauge cold-rolled black zinc chromate finished steel. Control module is supplied with hardware for mounting directly to a flat plate; control module may instead be attached to a 35 mm DIN rail.				
Certifications	See controller specifications, page 58.				

MICRO-SCREEN V-Series Sensor Specifications					
Models	Defined Area	Number of Beams	Models	Defined Area	Number of Beams
Emitter USE2412Y Receiver USR2412Y	610 mm (24")	24	Emitter USE5612Y Receiver USR5612Y	1422 mm (56")	56
Emitter USE3212Y Receiver USR3212Y	813 mm (32")	32	Emitter USE6412Y Receiver USR6412Y	1626 mm (64")	64
Emitter USE4012Y Receiver USR4012Y	1016 mm (40")	40	Emitter USE7212Y Receiver USR7212Y	1829 mm (72")	72
Emitter USE4812Y Receiver USR4812Y	1219 mm (48")	48			
Emitter/receiver separation	24" to 48" Emitters and Receivers 15 cm (6") to 9 m (30')		56" to 72" Emitters and Receivers 15 cm (6") to 6 m (20')		
Minimum object sensitivity	31.8 mm (1.25") floating blanking OFF 57.5 mm (2.25") 1-beam floating blanking ON 82.6 mm (3.25") 2-beam floating blanking ON				
Response time	Light Screens: Less than 38 milliseconds (all lengths) E-Stop: Less than 15 milliseconds				
Self-checking interval	20 milliseconds				
Ambient light immunity	>10,000 lux at 5° angle of incidence				
Strobe light immunity	Totally immune to one Federal Signal Corp. "Fireball" model FB2PST strobe.				
Emitter elements	Infrared LEDs; 880 nm peak emission				
Status indicators	Emitter: Green indicator for power ON indication Receiver: Red, yellow, and green status indicators with same functions as those on control module (see Control Module Specifications, page 57). Yellow also indicates alignment. Indicators are visible on three sides of receiver base.				
Emitter and receiver enclosures	<i>Size:</i> See Figure 15, page 23. <i>Materials:</i> Aluminum; yellow polyester painted finish; acrylic lens cover <i>Rating:</i> NEMA 4, 13; IEC IP65				
Mounting hardware	Emitter and receiver each are supplied with a pair of swivel end mounting brackets. (Sensor lengths 40" to 48" are supplied with one center support bracket; Sensor lengths 56" to 72" are supplied with two center support brackets; see page 21.) Mounting brackets are 13-gauge cold-rolled black zinc chromate finished steel. Control module is supplied with hardware for mounting directly to a flat plate; control module may instead be attached to a 35 mm DIN rail.				
Certifications	See controller specifications, page 58.				

Specifications

MICRO-SCREEN Controller Specifications	
System power requirements	24V dc \pm 15%, 10% maximum ripple, 1.5 amps max.
Fuse rating	2 amp, 250 V (3 AG or 5 x 20 mm slow blow)
Status indicators (on control module and receiver)	<p>Control Box and Receiver :</p> <p>Red = BLOCKED Flashing red = LOCKOUT Green = CLEAR Flashing green = BLANKING ON Yellow = RESET Flashing Yellow: Double-flashing = Waiting for Power-up Manual Key Reset Single-flashing = ALIGNMENT. Flash rate increases with the number of sensing beams "made," solid yellow when aligned and defined area is clear.</p> <p>Emitter: Emitter has green status indicator to indicate power ON.</p>
Diagnostic indicator	Two-digit numeric display indicates cause of lockout condition and total number of beams blocked (see Figure 25, page 39).
Controls and adjustments	Keyed Reset of system lockout conditions Floating Blanking selection switches and Fixed Blanking programming switches Auto Power-up On-Off switches
Emergency Stop switch input	Emergency Stop switch must offer two normally closed contacts and be capable of switching 50 mA @ 30V dc. Function stop category 0 per NFPA 79 and EN 418, Safety category 4 per EN 954-1
Test input	Terminals must be closed for a minimum of 0.05 seconds in order to guarantee a test input signal. The switching device used must be capable of switching 15-50V dc at 20 to 100 mA.
AUX Non-safety output contact	Reed relay; 125V ac or dc max., 500 mA max. (10VA maximum, resistive load)
Output configuration (FSD1, FSD2, and SSD)	Forced-guided contact relays, 250V ac max., 4 amps max. (resistive load). <i>Mechanical life</i> 10,000,000 operations (minimum). <i>Electrical life</i> (at full rated load) 100,000 operations (typical). <i>Arc suppression is recommended when switching inductive loads.</i> See Figure 24, page 34.
Enclosure	<i>Size:</i> See figure 17, page 24. <i>Material:</i> gray polycarbonate, clear polycarbonate cover <i>Rating:</i> NEMA 1, (IP 20)
Operating temperature	0° to +50°C (+32° to 122°F)
Relative humidity	95% maximum (non-condensing)
FMEA tested (Failure Mode and Effects Analysis)	Per requirements IEC 61496-1
Cables	<p>Emitters and Receivers with Integral Cables: Cables are 7.6 meters (25') long and measure 8.1 mm (0.32") in diameter. Conductors are 20-gauge. Cables are shielded and PVC-jacketed.</p> <p>Emitters and Receivers with Quick-Disconnect: Sensors have 300 mm (12") long cable, pigtail-terminated with a 5-pin Euro-style quick-disconnect fitting. Mating 5-conductor shielded cables have straight QD connector molded onto one end. Mating cables are ordered separately, and are available in lengths of 4.5 m (15'), 7.6 m (25') and 15 m (50').</p> <p>NOTE: Contact factory when cable length exceeding 15 m (50') is required. Use only Banner cables, which incorporate a "twisted pair" for noise immunity on RS485 data communication lines. Use of other cables may result in "nuisance" lockouts.</p>
Certifications	   IEC 61496-1&2, Type 4

MICRO-SCREEN Systems are sold as kits including the following: a control box, an emitter and receiver of equal length and equal number of beams, emitter and receiver mounting hardware, and two cables. Choose 300 mm (12") pigtail quick-disconnect cables plus mating cables in one of 3 lengths, or unterminated, integral 7.6 m (25') cables. Cables are interchangeable between the emitter and the receiver if they have the same kinds of connectors. See the Banner Machine Safety Products Catalog for a complete list of available kits. Components are also available separately (see chart below).

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

Minimum Object Detection Size = 19 mm (0.75")

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

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

Minimum Object Detection Size = 32 mm (1.25")

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

Models and Accessories

Controller (One required per system)

Description	Model Number	Part Number
24V dc control module	USDINT-1T2	48536
24V dc control module with fixed blanking	USDINT-2T2	49785

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

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

* Not Required for sensors with integral 7.6 m (25') cable.

** Contact factory Applications Department for information on cable lengths greater than 50'.

Documentation

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

Description	Part Number
Instruction Manual for MICRO-SCREEN Systems	48753
Checkout Procedure Card (Daily)	48751
Checkout Procedure Card (Semi-annual)	48752

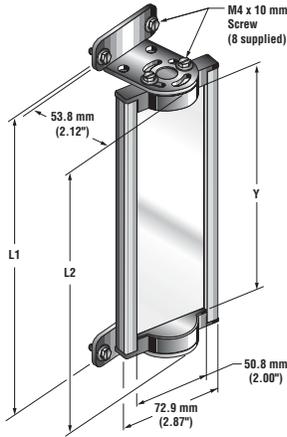
Retrofit Mounting Bracket Kits

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

LAT-1 Laser Alignment Tool

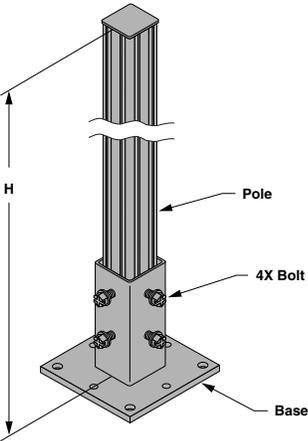
Description	Model Number	Part Number
Self-contained visible-beam laser tool for alignment of any MICRO-SCREEN emitter/receiver pair. Includes retroreflective target material and two mounting clips	LAT-1	52150





MSM Series Corner Mirrors

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



MSA Series Stands

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

MICRO-SCREEN Lens Shields



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

Models and Accessories

Replacement Parts, MICRO-SCREEN Systems

Description	Model Number	Part Number
Replacement key	MGA-K-1	28513
Key switch	MGA-KSO-1	30140
Specified test piece (.75" dia.)	STP-2	43957
Specified test piece (1.75" dia.)	STP-3	43958
Specified test piece (1.25" dia.)	STP-4	43836
Specified test piece (2.25" dia.)	STP-5	43837
Specified test piece (3.25" dia.)	STP-9	50694
Mounting hardware kit for one 4" to 36" emitter or receiver	USMB-1	50000
Mounting hardware kit for one 40" to 48" emitter or receiver	USCMB-1	51651
Mounting hardware kit for one 56" to 72" emitter or receiver	USCMB-2	54976
Replacement power supply/relay board	USDA-RM-1	50001
Replacement controller board for control module USDINT-1T2	USDAB-1	50002
Replacement controller board for control module USDINT-2T2	USDAB-2	50003
Replacement terminal block, 20 terminals, emitter/receiver hookup (for controllers without DeviceNet)	USA-PTB-1	55676
Replacement terminal block, 20 terminals, output/E-stop/power hookup	USA-PTB-4	55679

U.S. Application Standards

ANSI B11.1

Machine Tools – Mechanical Power Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.2

Hydraulic Power Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.3

Power Press Brakes – Safety Requirements for Construction, Care, and Use of

ANSI B11.4

Shears – Safety Requirements for Construction, Care, and Use of

ANSI B11.5

Machine Tools – Iron Workers – Safety Requirements for Construction, Care, and Use of

ANSI B11.6

Lathes – Safety Requirements for Construction, Care, and Use of

ANSI B11.7

Cold Headers and Cold Formers – Safety Requirements for Construction, Care, and Use of

ANSI B11.8

Drilling, Milling, and Boring Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.9)

Grinding Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.10

Metal Sawing Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.11

Gear Cutting Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.12

Roll Forming and Roll Bending Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.13

Machine Tools – Single – and Multiple-Spindle Automatic Bar and Chucking Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.14

Coil Slitting Machines/Systems – Safety Requirements for Construction, Care, and Use of

ANSI B11.15

Pipe, Tube, and Shape Bending Machines – Safety Requirements for Construction, Care, and Use of

ANSI B11.16

Metal Powder Compacting Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.17

Horizontal Extrusion Presses – Safety Requirements for Construction, Care, and Use of

ANSI B11.18

Machinery and Machine Systems for the Processing of Coiled Strip, Sheet, and Plate – Safety Requirements for Construction, Care, and Use of

ANSI B11.19

Performance Criteria for the Design, Construction, Care, and Operation of Safeguarding when Referenced by the Other B11 Machine Tool Safety Standards

ANSI B11.20

Machine Tools – Manufacturing Systems/Cells – Safety Requirements for Construction, Care, and Use of

ANSI/RIA R15.06

Safety Requirements for Industrial Robots and Robot Systems

NFPA 79

Electrical Standard for Industrial Machinery 1994 Edition

SOURCES

ANSI B11 Documents

American National Standards Institute

11 West 42nd Street
New York, NY 10036
Telephone: (212) 642-4900

-or-

Safety Director

AMT – The Association for Manufacturing Technology
7901 Westpark Drive
McLean, VA 22102-4269
Telephone: (703) 827-5266

ANSI/RIA Documents

Obtain from ANSI (above) or:

Robotics Industries Association
900 Victors Way, P.O. Box 3724
Ann Arbor, MI 48106
Telephone: (734) 994-6088

NFPA Documents

National Fire Protection Association
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Telephone: (800) 344-3555

Safety Standards

SOURCE

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

SOURCE

Part of:
Code of Federal Regulations
Title 29, Parts 1900 to 1910
Superintendent of Documents
Government Printing Office
P.O. Box 371954
Pittsburgh, PA 15250-7954
Telephone: (202) 512-1800

SOURCES

EN and IEC Standards

Available from:

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

BS Documents

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

U.S. Design Standards

UL 491

The Standard for Power-operated
Machine Controls and Systems

UL 991

Tests for Safety-related Controls
Employing Solid-state Devices

UL 1998

Standard for Safety Related Software

OSHA Regulations

OSHA 29 CFR 1910.212

General Requirements for (Guarding of)
All Machines

OSHA 29 CFR 1910.217

(Guarding of) Mechanical Power
Presses

European Standards

EN 292-1

Safety of Machinery – Basic
Concepts, General Principles for
Design Part 1: Basic Terminology,
Methodology

EN 292-2

Safety of Machinery – Basic
Concepts, General Principles for
Design Part 2: Technical Principles and
Specifications

EN 294

Safety of Machinery – Safety Distances
to Prevent Danger Zones Being
Reached by the Upper Limbs

EN 418

Safety of Machinery – Emergency Stop
Devices, Functional Aspects –
Principles for Design

prEN 574

Safety of Machinery – Two-hand
control devices – Functional Aspects –
Principles for Design

prEN 811

Safety of Machinery – Safety Distances
to Prevent Danger Zones Being
Reached by the Lower Limbs

EN 954-1

Safety of Machinery – Safety Related
Parts of Control Systems

prEN 999

Safety of Machinery – The Positioning
of Protective Equipment in Respect to
Approach Speeds of Parts of the
Human Body

EN 1050

Safety of Machinery – Principles of
Risk Assessment

prEN 1088

Safety of Machinery – Interlocking
Devices Associated with Guards –
Principles for Design and Selection

IEC 60204-1

Electrical Equipment of Machines
Part 1: General Requirements

IEC 61496

Safety of Machinery – Electro-sensitive
Protection Equipment

IEC 60529

Degrees of Protection Provided by
Enclosures

IEC 60947-5-1

Low Voltage Switchgear –
Electromechanical Control Circuit
Devices

IEC 60947-1

Low Voltage Switchgear –
General Rules



Warranty: Banner Engineering Corporation warrants its products to be free from defects for a period of one year. Banner Engineering Corporation will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty is necessarily limited to the quality of materials and workmanship in MICRO-SCREEN Systems as they are supplied to the original purchaser. Proper installation, operation, and maintenance of the MICRO-SCREEN System becomes the responsibility of the user upon receipt of the system. This warranty does not cover damage or liability for the improper application of the MICRO-SCREEN System. This warranty is in lieu of any other warranty either expressed or implied.

See also warranty-related return shipping information, page 41.