Important Safety Message

A safety light curtain is a general purpose presence sensing device designed to guard personnel working around moving machinery. The use of this type of guarding system is regulated in the United States by the Occupational Safety and Health Administration (OSHA).

In addition to the OSHA regulations there are other organizations which provide information on proper machine guarding. The American National Standard Institute (ANSI) B11 series is referred to in this manual. A partial list of names and addresses is provided in *Appendix E – Additional Information*. Please contact STI at 1-888-510-4357 for additional information or assistance.

Whether a specific machine application and safety light curtain installation complies with OSHA regulations depends upon several items, including: the proper application, installation, maintenance and operation of the safety light curtain. These items are the sole responsibility of the purchaser, installer and employer.

The employer is also responsible for the selection and training of the personnel necessary to properly install, operate and maintain the machine and its safeguarding systems. A safety light curtain should only be installed, checked out and maintained by a *qualified* person, 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 B30.2-1983)

The *user* is that person(s) identified and designated by the employer as being appropriately trained and qualified to perform a specific procedure. Often the user is the installer, die setter, electrician, maintenance personnel, supervisor, foreman, etc. involved with the setup, test and checkout of the machine and all safety devices.

The *machine operator* must receive specific proper training on exactly which machinery is protected by a safety light curtain, the machine operating controls, warning signs and safety instruction. The machine operator must thoroughly understand and follow the company's safety rules and always use the safeguards and proper hand tools provided by the employer. The operator must notify management if the machine, tooling or safety devices are not operating properly. Never use the machine if it or the safety equipment is not in proper working order.

The following is a list of additional requirements that must be met before using a safety light curtain.

- The machine(s) on which the safety light curtain is installed must be capable of stopping motion anywhere in its stroke or cycle. Do not use a safety light curtain on a power press with a full-revolution clutch.
- Light curtains do not offer protection from flying objects.
- Do not use a safety light curtain on any device with an inconsistent stopping time or inadequate control devices or mechanisms.

• Do not use a safety light curtain where the environment, such as severe smoke, particulate matter, or corrosive chemicals, may degrade the efficiency of the safety light curtain.

• When a light curtain is utilized as a safety device, the employer has the responsibility to ensure that all applicable federal, state and local OSHA requirements and other such rules, codes and regulations are satisfied.

• All safety-related machine control circuit elements, including pneumatic, electric or hydraulic controls must be *control reliable*. See *Appendix D – OSHA Regulations – Selected Passages*.

• Any power press which uses a safety light curtain must meet the requirements and inspection procedures of OSHA regulation 1910.217 (c), ANSI standards B11.1-1988 and B11.19-1990 plus any other applicable state and local regulations. All other machinery or equipment must meet the OSHA standard 1910.212 on general machine guarding plus any other applicable regulations, codes and standards.

• Do not use a safety light curtain as a lockout device to satisfy the US Federal OSHA lockout/tagout requirements.

• Additional guarding, such as mechanical guards, may be required if the safety light curtain does not protect all areas of entry to the point of operation hazard.

• All brakes and other stopping mechanisms and controls must be inspected regularly to ensure proper working order. If the stop mechanisms and associated controls are not working properly, the machine may not stop safely even though the safety light curtain is functioning properly.

• The STI Test Procedure must be performed at installation, or after any adjustments, maintenance, modification or repair of the machine controls or the safety light curtain. The Test Procedure is listed in this manual and attached to the controller enclosure. The user must also regularly perform (at least every three months, more often with continuous use) the recommended preventive maintenance procedures. See *Section 5 – Warranty, Troubleshooting and Preventive Maintenance*.

• Only *qualified* personnel must install and test a safety light curtain. Do not perform any test or repairs other than those outlined in this manual. All electrical wiring must be installed in accordance with local electrical codes and regulations.

• The user must follow all procedures in this manual for proper operation of a safety light curtain.

The enforcement of these requirements is beyond the control of STI. The employer has the sole responsibility to follow the preceding requirements and any other procedures, conditions and requirements specific to your machinery.

NOTE: The illustrations and examples described in this Installation and Operating Manual are for informational and instructional purposes only. Actual installations will differ from those indicated.

Table of Contents

List of Figures

1 Introduction

⚠WARNING: Use a safety light curtain only on machines that can be stopped anywhere in their cycle immediately after they receive a stop signal. With mechanical power presses, it can be used only on a part revolution clutch press that can stop at any point in its stroke.

Under no circumstances may a safety light curtain be used on a full revolution clutched machine or power press. These machines cannot stop at any point in their stroke.

The safety light curtain concept involves connecting a transmitter and receiver to a controller/power supply capable of providing outputs for machine control. The Universal Controller is capable of accepting the following STI safety light curtain transmitters and receivers: MiniSafe MS4300, FlexSafe FS4300, FlexSafe FS4400, MiniSafe MS4400, OptoSafe P4100, OptoFence OF4100 and Perimeter Access PA4400.

A safety light curtain safety light curtain consists of three main assemblies:

1. The *Controller/ Power Supply* enclosure with all user controls, a power supply, supporting logic, and output relays. This is the central location to connect all wiring.

2. At least one (more if FlexSafe receivers are installed) *Receiver* unit which contains the receiving circuitry, consisting of an array of phototransistors and supporting electronics.

3. A least one (more if FlexSafe transmitters are installed) *Transmitter* unit which has the same dimensions as the receiver unit. The internal circuitry has an array of infrared light emitting diodes (LED) and supporting electronics. The transmitters also contain three indicator lights – red, green and yellow.

The transmitter LED emit harmless pulses of invisible infrared light when triggered by the controller. These infrared light pulses are sequenced (one LED after another) and modulated (pulsed at a specific frequency).

Each infrared LED signal is detected by a corresponding phototransistor in the receiver unit. The phototransistor in the sequence is only energized when the light pulse is anticipated. The controller electronics must detect the activation of the phototransistor when the infrared beam is received and verify that the phototransistor has deactivated when the light pulse has ended. Should anything interrupt this process, the controller will send a stop signal to the protected machine.

Ambient light levels, sources of continuous light, fluorescent, and pulsed light sources will not effect the safety light curtain. Safety light curtains respond only to a sequenced and modulated source of infrared light of the correct frequency.

A channel is comprised of an LED/phototransistor pair. The pulsed sequence is, in practical terms, so fast that the effect is an array of nearly continuous light beams across the guarded area called the sensing field.

The controller uses self-checking circuitry to monitor the system for component failures. Should a critical component fail, the light curtain will detect it and send stop signal to the connected machine. The safety light curtain will go into a alarm fault or lockout condition. Only after replacement of the failed component and a push button reset will the controller allow machine operation.

A further example of this internal diagnostic safety feature is the use of *two* machine control output relays. Both relays operate simultaneously in response to the control logic. The controller also monitors the status of the relays. Thus, if one relay contact should weld closed, the second relay would de-energize and send a stop signal to the machine.

STI safety light curtains are designed to be control reliable. *Control reliable* means "*... the device, system or interface shall be designed, constructed and installed such that single component failure within the device, interface or system shall not prevent normal stopping action from taking place but shall prevent a successive machine cycle....*" (ANSI B11.19-1990, 5.5).

Note: For information specific to the use and installation of the DIN-rail mounted version of the Universal controller, please read and follow the instruction presented in Appendix F.

2 Description of Controls

This section is to familiarize the reader with the user controls and indicators. Read this section prior to installing a safety light curtain system.

To locate the controls described below inside the controller/power supply, please refer to figure 2.1. Operation of these controls with be explained in depth in succeeding sections of this manual.

Except where noted, the following controls are found inside the controller/power supply enclosure.

LOCKABLE ENCLOSURE

The standard STI controller enclosure includes a hasp for use with a user provided padlock.

MODE SELECT SLIDE SWITCH (SW4)

- **Operate**

The OPERATE position provides standard operation with Channel Select deactivated.

- **Channel Select**

The CHANNEL SELECT position enables an operational mode where individual channels are masked.

- **Program**

The PROGRAM position allows the user to create a Channel Select mask.

TEST/STORE PUSH BUTTON (SW2)

Initiates self test. In Program mode, also stores Channel Select mask and sensing field lengths.

RESET PUSH BUTTON (SW3)

Initializes and clears the controller from an alarm condition (both Clear & Block lights are on).

STATUS INDICATOR LIGHTS

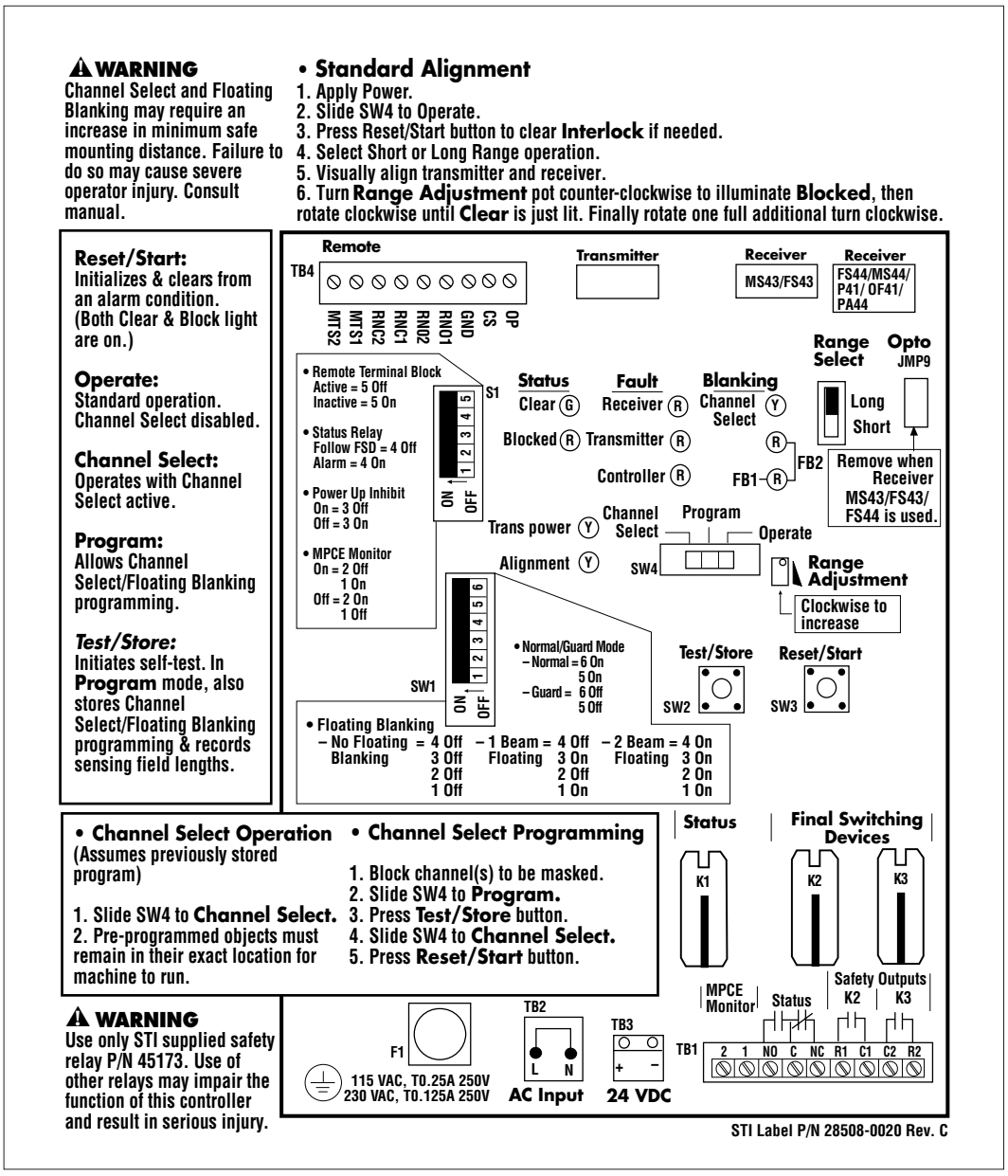
- **Clear**

This green indicator is illuminated when the safety light curtain is properly aligned and the sensing field is not obstructed. The guarded machine will be allowed to operate when this light is on.

- **Block**

This red indicator is illuminated when the sensing field is obstructed. When this indicator and the Clear indicator are illuminated simultaneously, an alarm condition has occurred.

Figure 2.1 Universal Controller



• Alignment

This yellow indicator, when flashing or illuminated, warns of a possible misalignment condition. On a properly installed safety light curtain, the indicator should be off. Under the following conditions, the Alignment indicator may illuminate or flash intermittently:

– If the safety light curtain is exposed to a bright light, such as a strobe, operation of the light curtain is not affected.

– If an object is blocking the sensing field. This is normal.

– With the slide switch in the Channel Select mode, with an object interrupting the sensing field it is normal for the indicator to be on.

• Transmitter Power

This yellow indicator provides a visual display of the transmitter power level. The brightness of the indicator is proportional to the intensity of the infrared LED in the transmitter.

FAULT INDICATOR LIGHTS

Three red indicators labelled RECEIVER, TRANSMITTER and CONTROLLER provide diagnostic information to help pinpoint a source of trouble.

BLANKING INDICATOR LIGHTS

• Channel Select

This yellow indicator is illuminated when Channel Select is active.

• Floating Blanking

When both of these red indicators are illuminated, two-beam Floating Blanking is active. When only the bottom red indicator is illuminated, one-beam Floating Blanking is active.

FIVE-POSITION FEATURE SELECTION SWITCH

This five-position DIP switch (S1) is used to select the way four light curtain features (Remote Terminal Block, Status Relay, Power Up Inhibit, MPCE Monitor) function.

SIX-POSITION FLOATING BLANKING, NORMAL/GUARD MODE SWITCH

This six-position DIP switch (SW1) to used to select Normal or Guard Mode operation and program the safety light curtain for zero, one or two-beam Floating Blanking.

RANGE ADJUSTMENT POTENTIOMETER

The RANGE ADJUSTMENT potentiometer increases or decreases output power to the transmitter.

RANGE SELECTION SWITCH

This slide switch is used to select long or short range.

REMOTE FUNCTION TERMINAL BLOCK

This terminal (TB4) supplies the connections for the following functions: remote mode selection (between Channel Select and standard Operation), Remote Run/Start to (reset the safety light curtain) and Machine Test Signal. No extermal voltage is to be applied to these terminals at TB4. Refer to pages 37 to 41, figures 3.11 to 3.14 for wiring information.

COVER MOUNTED RUN/START SWITCH (OPTIONAL)

Located on the cover of the controller enclosure, this key-operated switch is used to reset the controller from an interlock condition.

CONTROL RELAYS

Three separate double-pole double-throw, force-guided contact relays are provided. These are factory installed in the controller. Two are used as the safety output relays, (also called the Final Switching Devices). The third relay is used as a status relay (also called Secondary Switching Device). One normally open (NO) contact from each of the two output relays is wired to terminal block TB1 in the controller. The normally open contacts are held closed only in a safe condition, with beams unbroken. An external jumper (JMP) is provided between the two NO output connections which wires the two NO contacts in series. See *Section 3 – Installation* for further information.

⚠WARNING: Never use only a single relay to control the machine. Should this single relay fail, the machine may not stop, resulting in severe operator injury. The machine must be connected to both output relays.

One set of contacts on each relay is wired to TB1 for use as an output connection. The other set on each relay is monitored by the relay checking circuitry. If a relay were to fail, the circuitry will detect this, de-energize both output relays and thus send a stop signal to the machine. In addition, the red, Power Supply Fault Indicator is lit and the status relay is de-energized, switching the alarm contacts. This relay checking circuit prohibits the unit from operating with only one safety output relay installed.

⚠WARNING: If a replacement relay is required, only use STI-supplied replacement relays. Never attempt to replace a control relay with a part from another manufacturer, or you will impair the operation of the safety light curtain, possibly resulting in a severe hazard to the operator.

STATUS RELAY

⚠WARNING: Never use only the status relay to control the machine! It is a single relay and thus is not redundant. A fault in a single relay could result in a failure of the machine to stop, causing severe operator injuries.

3 Installation

⚠WARNING: Please read this information completely before starting the installation procedure. The safety light curtain should only be installed, checked out and maintained by a *qualified* person (as defined on page 1). It is important that the user be familiar with the installation requirements, safe mounting distance, controls and features before using the light curtain.

INSTALLATION OVERVIEW

Hint: Prior to installation, it may be helpful to initially power up the light curtain on a table or bench top to become familiar with the controls and features of the unit.

The installation procedure is outlined in the following sequence:

1. Carefully read and follow the information presented in the *Important Safety Message* on pages 1 and 2 of this manual.
2. Calculate the minimum safe distance to mount the transmitter and receiver from the point of hazardous operation.
3. Mount the transmitter and receiver on the machine to be guarded.
4. Prepare the controller enclosure.
5. Configure the controller.
6. Connect power and outputs.
7. Apply power and align.
8. Test the safety light curtain for proper operation.

STEP 1. READ AND FOLLOW IMPORTANT SAFETY MESSAGE

Pages 1 and 2 of this manual contain safety information pertinent to the installation of a safety light curtain system. It is important that this message be read and understood. Call STI at 1-888-510-HELP with any questions.

STEP 2. MINIMUM SAFE DISTANCE CALCULATION

The transmitter and receiver connected to the controller must be mounted far enough away from the point of operation (also called pinch point, danger zone or hazardous area) so that the machine will stop before the operator's hand reaches the pinch point. This distance, called the *minimum safe distance* (see figure 3.1) is based on the stopping time of your machine. It is a calculated number based on a formula.

The purpose of this calculation is best described by ANSI B11.19-1990 (4.2.3.3.5), "*The effective sensing field ... shall be located at a distance from the nearest recognized hazard such that the operator or others cannot reach the hazard with a hand or other body part before cessation of motion during the hazardous portion of the machine cycle.*"

Regardless of the calculated distance, you should never mount a safety light curtain closer than allowed by OSHA Table 0-10 in OSHA 1910.217 and table 1 in ANSI B11.19-1990. Table 0-10 is included in *Appendix D – OSHA Regulations – Selected Passages* of this manual.

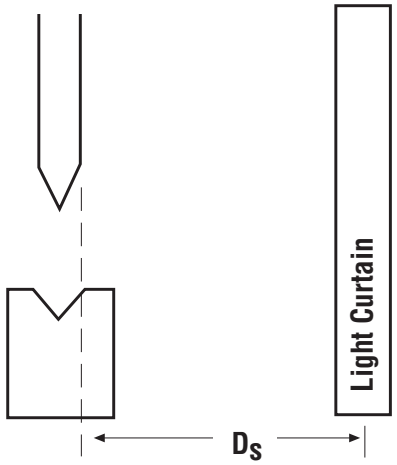
There are two formulas used to calculate the safety distance. One formula is outlined in OSHA 1910.217 and applies to the guarding of mechanical power presses, but should serve as a guideline for other machine applications.

The American National Standards Institute (ANSI) standards B11.1-1988 and B11.19-1990 use a newer formula which takes into consideration more factors in calculating the minimum safe distance than the OSHA formula. STI suggests using the ANSI formula which is presented in the following section.

If the installation uses a horizontal mounting of a light curtain, please refer to page 19.

⚠WARNING: The proper calculation of the safety distance is an important installation step. Never just install a light curtain at any convenient location without regard to the safety distance. If the transmitter and receiver are mounted too close to the point of operation hazard, the machine may not stop in time to prevent an operator injury.

Figure 3.1 Minimum Safe Distance



D_S is the minimum safe distance between the light curtain sensing field and the point of operation hazard (pinch point).

ANSI Minimum Safe Distance Formula

The ANSI formula is presented first since it is the recommended method:

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

Where:

D_s = Minimum safe distance, in inches, between the safety light curtain sensing field and the nearest point of operation hazard.

K = hand speed constant in inches per second. The ANSI standard value is 63 inches/sec, which assumes the operator starts a hand motion toward the point of operation from rest. To quote from ANSI B11.19 -1990, *"The value of the 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 considered conclusive determinations. The user should consider all factors, including the physical ability of the operator, when determining the value of K to be used."*

T_s = the stop time of the press (or machine) in seconds measured from the final de-energized control element, such as the air valve. It is measured at maximum closing velocity, such as approximately 90° of crankshaft rotation. A brake monitor, is often used to measure the machine stop time.

T_c = the response time, in seconds, of the press or machine control circuit to activate the machine's brake.

Note: $T_s + T_c$ are usually measured together by a stop time measuring device.

T_r = the response of the safety light curtain controller, in seconds. The response time of the STI Universal controller is 0.045 seconds(1).

T_{bm} = the additional stopping time, in seconds, allowed by the brake performance monitor before it detects stop time deterioration.

A brake monitor will halt the press (or machine) when the stop time of the machinery exceeds the limit set. This indicates excessive brake wear has occurred. The T_{bm} factor allows consideration for brake wear, adding the extra stop time allowed by the brake monitor. Thus,

T_{bm} = brake monitor set point – ($T_s + T_c$)

But what happens if the machine does not have a brake monitor? Add a percentage increase factor to the measured ($T_s + T_c$) stop time to allow for braking system wear. For example, brake monitors usually add an extra 20% to the measured stop time. In your case, contact the machine manufacturer for guidance in selecting a percentage increase factor.

(1) A Universal controller with the Extreme Welding modification will have a different response time.

D_{pf} = the added distance due to the depth penetration factor. This is related to the minimum object sensitivity of the light curtain and how far an object can move through the sensing field before an light curtain reacts. By knowing the minimum object sensitivity, S, of the light curtain, D_{pf} is read directly from figure 3.2.

For example when using a MiniSafe MS4300 transmitter and receiver with 0.50 in (13 mm) beam spacing:

S = 0.75 in (19 mm), and D_{pf} = 1.6 in (41 mm)

This assumes no Channel Select or Floating Blanking is in use. If either of these features are active, its effect **must** be considered in the calculation of D_{pf}. This effect is explained in *Section 4 - Channel Select, Floating Blanking and Guard Mode*. Values of S for other transmitter and receivers which may be used with the Universal controller are shown in table 3.1.

Example 1. ANSI Safety Distance Calculation with Brake Monitor

⚠WARNING: the example below uses minimum object sensitivity figures from the MiniSafe MS4300 series. D_{pf} values will vary according to which safety light curtain transmitter and receiver set being used.

Presume a mechanical press has a stopping time ($T_s + T_c$) of 0.200 seconds. This includes the response time of both the press brake mechanism and the control circuits. The brake monitor is set for 0.240 seconds. The response time of the controller is 0.045 seconds. K is chosen to be 63 in/sec. No Channel Select will be used.

Determine T_{bm} and D_{pf}. From the brake monitor set point:

T_{bm} = brake monitor set point – ($T_s + T_c$)

= 0.240 sec - 0.200 sec

= 0.040 sec.

A MiniSafe MS4300 transmitter and receiver have a minimum object sensitivity (S) of 0.75 in. (19 mm).

From figure 3.2 on page 18, the depth penetration factor, D_{pf}, is 1.6 inches (41 mm).

Now, everything needed is available. The formula is:

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

Substituting values:

$D_s = 63$ in/sec x (0.200 sec + 0.045 sec + 0.040 sec) + 1.6 in

Add the values in the parentheses first:

$D_s = 63$ in/sec x (0.285 sec) + 1.6 in

Multiply the result in parentheses by 63:

$D_s = 18.0$ in + 1.6 in

Add the results:

$D_s = 19.6$ in (498 mm)

Thus, in this example, the light curtain must be mounted greater than 19.6 inches (498 mm) from the pinch point when measured to the center of the transmitter and receiver plastic bezels.

Example 2. ANSI Safety Distance Calculation, No Brake Monitor

Presume an automated assembly machine has a manufacturer specified total stop time of 0.150 seconds. The machine does not have a brake monitor and the manufacturer suggests adding 20% to the specified stop time. The Universal controller has a response time of 0.045 sec, K is chosen to be 63 in/sec, Channel Select is not used.

Determine T_{bm}. The additional braking factor is 20% more than the specified stop time, so,

$T_{bm} = 20\% \times (T_s + T_c)$
$= 0.20 \times 0.150$ sec
$= 0.030$ sec

D_{pf} is 1.6 in (41 mm), the same as in example 1.

Using the formula as before:

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

Substituting values:

$D_s = 63$ in/sec x (0.150 sec + 0.045 sec + 0.030 sec) + 1.6 in.
$= 63 \times (0.225) + 1.6$
$= 15.8$ in (401 mm)

Read *Section 4 – Channel Select, Floating Blanking and Guard Mode* to see the effect of adding channel select on this example.

The OSHA Minimum Safety Distance Formula

The OSHA regulation 1910.217(c) covers the explanation of the OSHA formula:

$$D_s = K \times T_s$$

Where:
K = OSHA-recommended hand speed constant of 63 in/ sec (1600 mm/sec).

Note: See the ANSI formula on page 14 for a discussion on an alternative hand speed constant.

T_s = the maximum stopping time of the machine or press in seconds. It is measured at the maximum closing velocity (approximately 90° of crankshaft rotation for a press). T_s must include the response time of the controls, clutch, braking system, safety light curtain and the time for the machine to cease hazardous motion. Add a percentage increase factor, as recommended by the machine manufacturer, to allow for deterioration of the clutch and braking system.

Example 3. OSHA Formula Safety Distance Calculation

Presume a new machine has a total stopping time, as measured by the manufacturer, of 0.160 seconds. This includes the reaction time of the clutch, brake and all other devices to stop the machine, but does not include the response time of the Universal controller, which is 0.045(1) seconds. An additional 20% is added to the machine stop time to allow for deterioration of the braking system.

First, calculate T_s:
T_s = machine stop time + braking factor + light curtain response
= 0.160 sec + (20% x 0.160 sec) + 0.045 sec
= 0.237 sec

Now for the OSHA formula:
$D_s = K \times T_s$
= 63 in/sec x 0.237 sec
= 14.93 in (379 mm)

(1) A Universal controller with the Extreme Welding modification will have a different response time.

Figure 3.2 Depth Penetration Factor

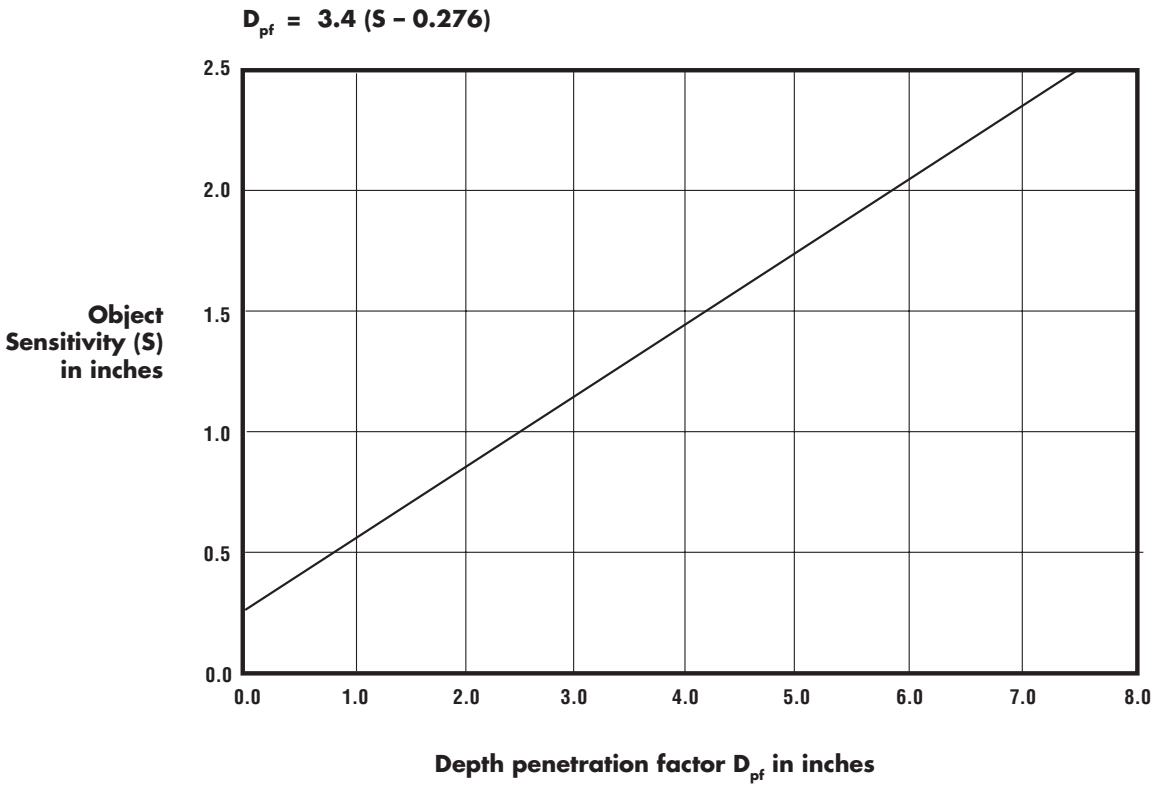


Table 3.1

Transmitter/Receiver Set	S Value (inches)	D_{pf} Value (inches)
MiniSafe MS4300	0.75	1.6
FlexSafe FS4300	0.75	1.6
FlexSafe FS4400	1.00	2.5
MiniSafe MS4400	1.00	2.5
OptoSafe P4100	1.25	3.1
OptoFence OF4100	2.00	5.9
Perimeter Access PA4424	18.0	60.3
Perimeter Access PA4436	14.0	46.7
Perimeter Access PA4440	10.0	33.0
Perimeter Access PA4452	10.0	33.0
Perimeter Access PA4464	10.0	33.0

Horizontal Light Curtain Installations

Certain applications may use horizontal mounting of the light curtain to detect instrusion into a hazardous area. For the purposes of this section, the formula used for horizontal mounting assumes that the angle of approach by an object through the sensing field is less than 30°, as shown in figure 3.3. Applications where the angle of approach is 30° or greater to the sensing field should use the ANSI formula on page 14.

The following discussion is based on the European standard prEN999 (revision 6/94) regarding the positioning of protective equipment. In this standard, the safe mounting distance ($D_{s)}$ is measured from the point of operation to the sensing field beam **farthest away**, as shown in figure 3.3.

To calculate D_S, use the ANSI safe distance formula, but use D_H in place of D_{pf}, where:

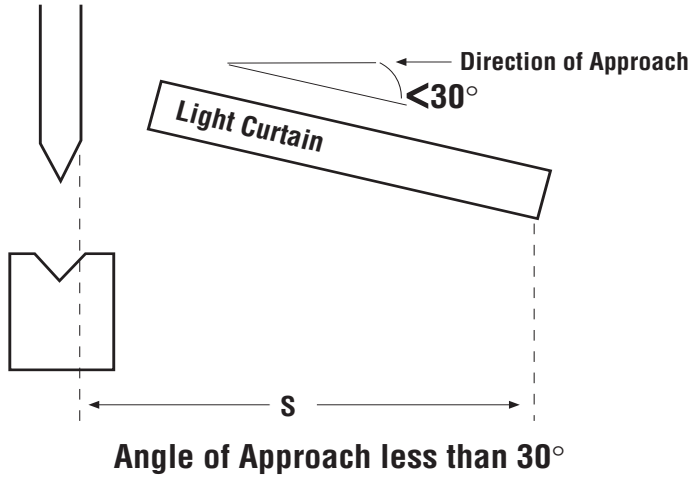
D_H = 48 in – (0.4 x H); but D_H is never less than 34 inches,

H = Height of the light curtain sensing zone above the floor in inches, measured from the lowest beam of the sensing field.

The complete formula for horizontal mounting is thus:

$$D_S = K \times (T_S + T_C + T_R + T_{bm}) + D_H$$

Figure 3.3 Horizontal Light Curtain Installation



Example 4. Horizontal Light Curtain Installation

An automated machine has a stop time as specified by the manufacturer of 0.125 seconds. A Universal controller with a MiniSafe MS4300 transmitter and receiver with a response time of 0.045 seconds is mounted horizontally in front of the operator load station. The mounting height of the lowest light curtain beam above the floor is 30 inches. The hand speed constant K is selected as 63 in/sec.

$D_S = K \times (T_S + T_C + T_R + T_{bm}) + D_H$

First, calculate D_H to ensure that it is not less than 34 inches.

$D_H = 48 - (0.4 \times H) = 48 - (0.4 \times 30)$

$D_H = 36$ inches

(If D_H was calculated to be less than 34 inches, then use 34 inches.)

Now, that D_H is known, calculate the remaining portion of the distance formula. Note that $T_S + T_C = 0.125$ second.

$D_S = 63 \times (0.125 + 0.045 + 0) + 36$

$= 63 \times (0.170) + 36$

$= 10.7 + 36$

$D_S = 46.7$ inches (1186 mm)

Reflective Surface Interference

A reflective surface adjacent to the sensing field can deflect the optical beam and may cause an obstruction in the sensing field not to be detected. (See fig. 3.4). Reflective surfaces may be part of the machine, mechanical guard or workpiece. Some examples of reflective surfaces may include shiny metal, glossy paint, foil, plastic or other similar material. The Test Procedure (Appendix C) must be used to test for this condition.

Poor alignment between the transmitter and receiver and/or improper *Range Adjustment* setting may aggravate reflective surface interference. Correction of this condition consists of relocating the sensing field further away from the reflecting surface (increase 'a' in fig. 3.4), reducing the reflectivity of the surface by painting, masking or substituting materials, realigning the light curtain or readjusting the Range Adjustment. After correcting, repeat the Test Procedure. (See *Step 7 – Power On and Alignment*)

The following calculation provides the installer with a means of anticipating reflective surface interference. The light curtain must be installed such that no reflective surfaces are inside the beam angle of the transmitter and receiver.

Figure 3.4 Reflective Surface Interference

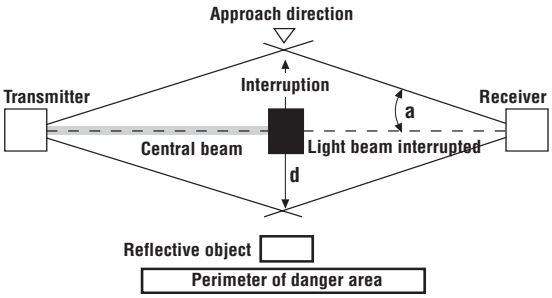


Figure 3.4a Example of correct mounting with proper alignment. The interruption is clearly detected. The reflective object is outside of the beam angle.

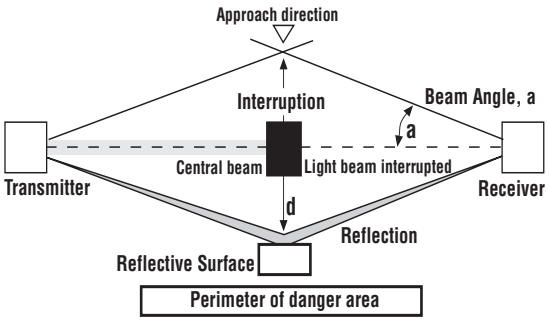


Figure 3.4b **Unsafe!** Example of unsafe mounting. The interruption is not detected because of reflection. The reflective object inside the beam angle.

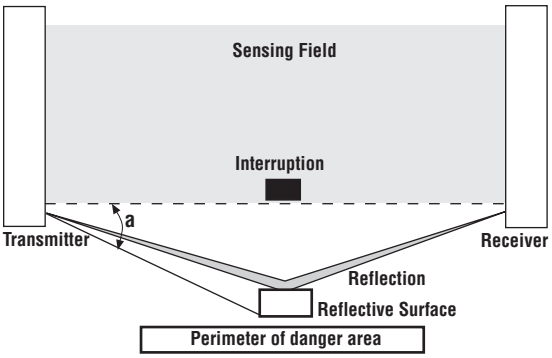


Fig. 3.4c **Unsafe!** Interruption is not detected because of reflection. Reflective surfaces interference may also appear above and below the sensing field.

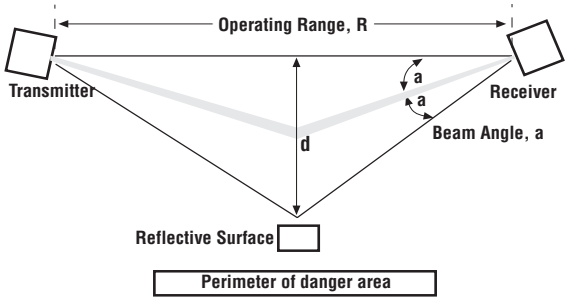


Figure 3.4d Worst case alignment shows minimum distance from reflective surface, d, to one side of the beam center line.

The minimum distance from the sensing field to the reflective surface, d, may be calculated from the formula given below. This assumes a worst case condition where the transmitter and receiver are not in true alignment, as indicated in figure 3.4c. The formula also requires the Range Adjustment potentiometer be properly set according to the procedure on page 46.

The worst case distance, d, is calculated from the formula:

d = R/2 (tan 2a) where a = 6° and R is the operating range of the light curtain.

Light Curtain	***a* value***
FlexSafe FS4300	6°
FlexSafe FS4400	2.5°
MiniSafe MS4300	6°
MiniSafe MS4400	2.5°
OptoSafe P4100	3.5°
OptoFence OF4100	3.5°
Perimeter Access PA4400	2.5°

*With transmitter/receiver properly aligned and adjusted.

For example, a safety light curtain with a MiniSafe MS4300 transmitter and receiver is installed on an assembly machine. The distance between the receiver and transmitter is 6 ft (1.8 m). What is the minimum distance a reflective object is permitted from the sensing field?

The calculations:

d = R/2 (tan 2a)

R = 6ft, a = 6°, thus

d = 6/2 [tan 2(6°)]

= 3 tan 12°

= 3 (0.2125)

= 0.64 ft or 7.7 in (194 mm)

Thus, the center of the transmitter/receiver beam line must be placed greater than 7.7 in (194 mm) from a reflective surface.

STEP 3. MOUNTING

Now that the minimum safe distance is known, the transmitter and receiver may now be mounted accordingly on the machine, stands or other mounting fixtures.

Installation of Multiple Safety Light Curtains

For installations where two or more light curtains are mounted in close proximity and in alignment with each other, precautions should be taken to avoid one curtain interfering with another. This can occur when the receiver of one unit "sees" the transmitter of another. The first unit will respond with a red Beam Break condition.

Correction involves orienting the light curtains such that the transmitters or receivers are mounted back-to-back to each other as explained in figure 3.5. Contact STI should you need additional assistance.

Figure 3.5 Multiple Light Curtain Installation

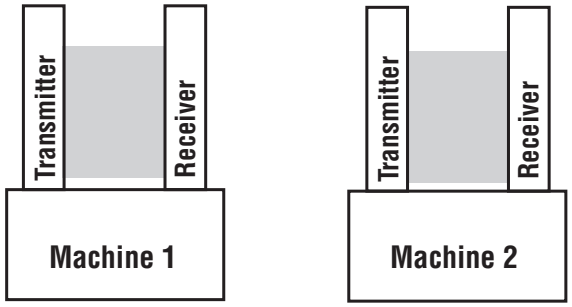


Figure 3.5a **Not Recommended.** This arrangement may be subject to interference between the two light curtains.

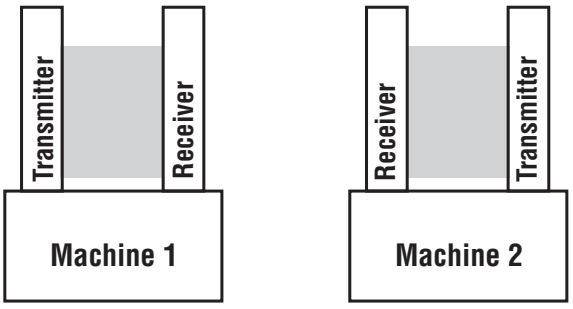
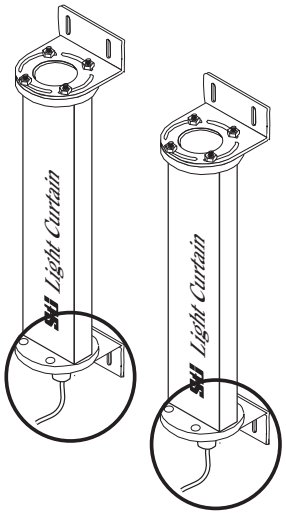
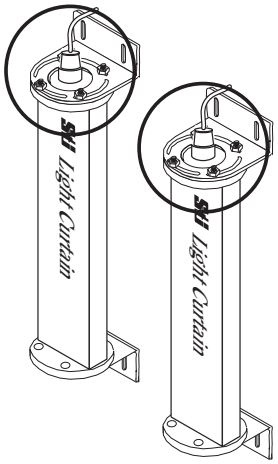


Figure 3.5b **Preferred.** The suggested orientation. The receivers are mounted back to back.

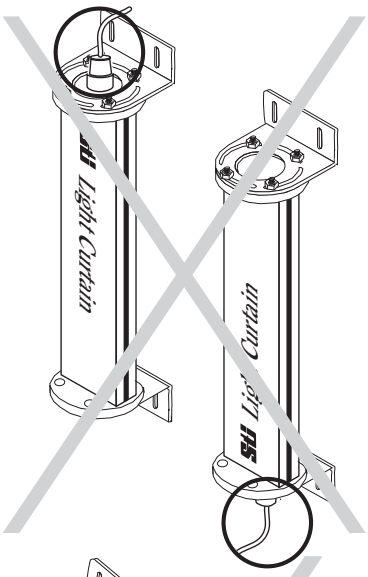
Figure 3.6 Light Curtain Mounting Orientation

Correct

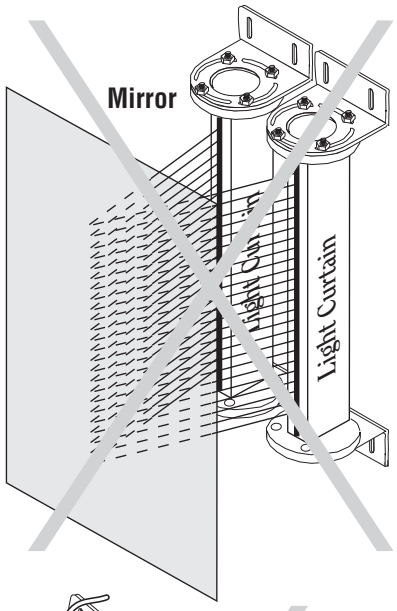


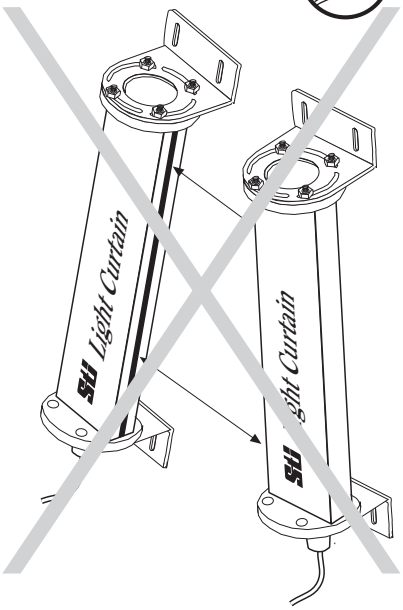


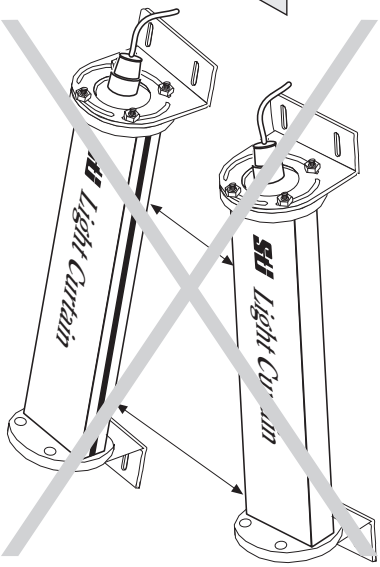
Incorrect



⚠WARNING:
Unsafe! The light curtain is not designed to be used in a mirror bounce back mode. In this configuration, an object may not be reliably detected and may cause severe operator injury.







Mounting Considerations

All electrical connections are made inside the controller/power supply enclosure. Thus, mounting the controller/power supply near the machine controls would seem like the first choice. However, the user adjustments, the Test Procedure label and Channel Select controls are contained within this enclosure. Therefore, place the controller/power supply where it is accessible. A clear area 20 inches in front of the enclosure is required for access to user controls.

The transmitter and receiver must be securely mounted at a distance from the pinch point greater than minimum safe distance. Other items to consider when selecting a mounting location include:

1. If the light curtain does not protect all access to the danger point, the unprotected access must be protected by other approved devices or supplemental guarding. An operator must not be able to reach around the light curtain in any way to gain access to a hazardous location of the machine or stand between the machine and the light curtain. A mechanical barrier in front of the hazardous machine area should be used to prevent personnel from standing between the light curtain and the machine. (See figure 3.8).

2. Use caution when installing any light curtain where the perimeter of the sensing field is adjacent to a reflective surface. (See figure 3.4). Failure to correct this condition can result in a severe operator injury. Perform the *Test Procedure* to test for this condition.

3. The units and cabling should be out of the way of feedstock, raw material, parts, tool and die changes, fork lifts, etc.

4. As long as both transmitter and receiver are mounted with their cable connectors in the same orientation, they may be mounted either horizontally or vertically.

Figure 3.7 Incorrect FlexSafe Mounting

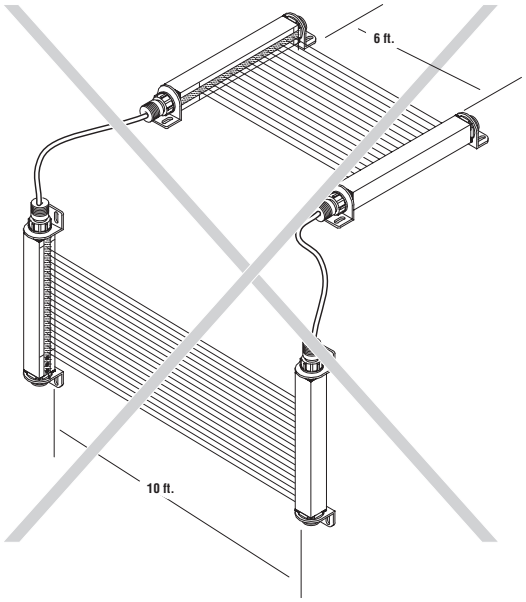
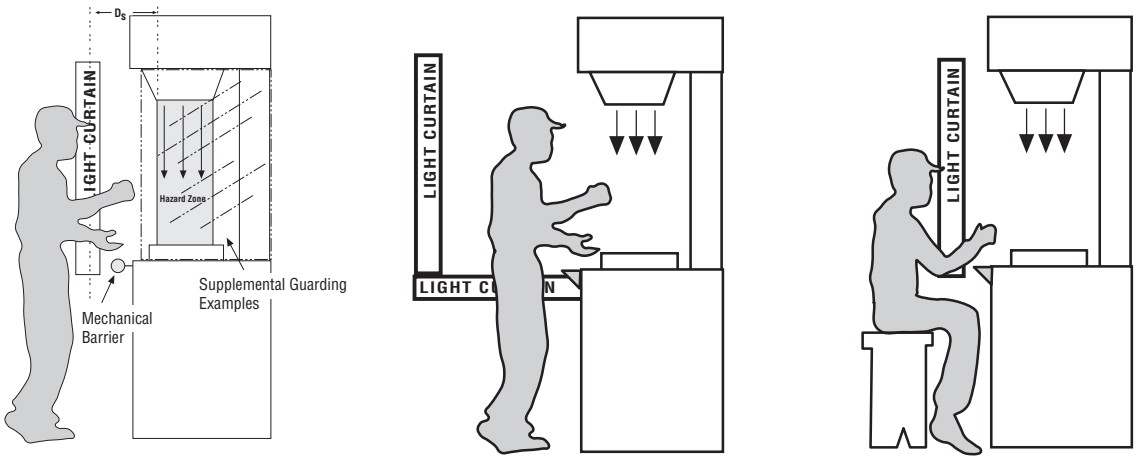


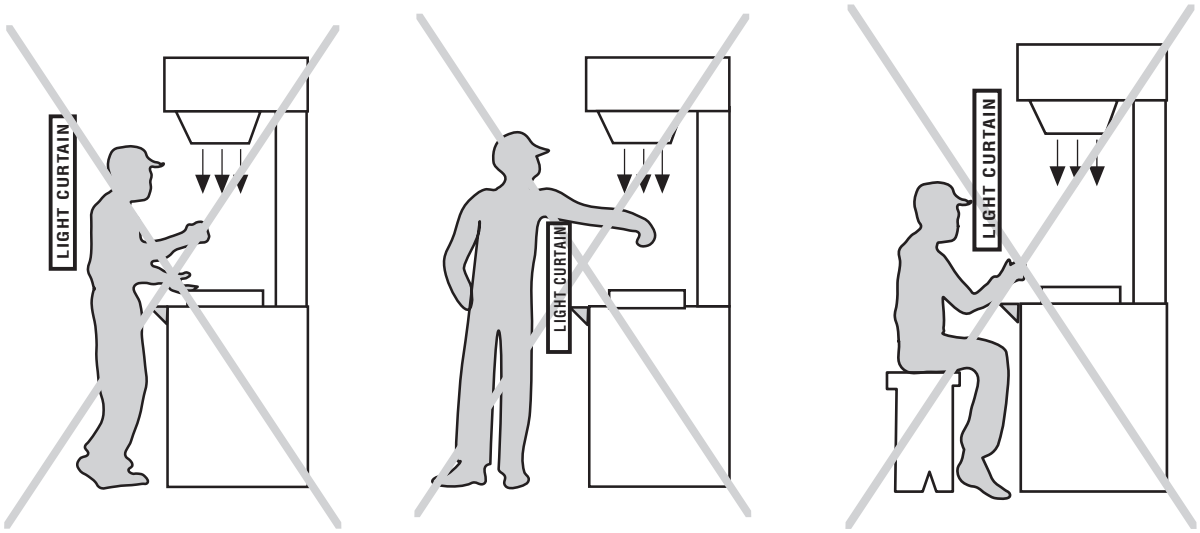
Figure 3.8 Correct/Incorrect Light Curtain Installation Examples

Figure 3.8a Correct Light Curtain Installation Examples



NOTE: Additional supplemental guarding is required where unprotected entry to the hazard zone is accessible, such as along the sides and rear of the machine. A mechanical barrier should be used to prevent personnel from standing between the light curtain and the machine. These drawings are for illustrative purposes only. Your installation may differ from this example.

Figure 3.8b Incorrect Installation Examples



5. See figures 3.7 and 3.8 for additional mounting considerations.

STI offers a variety of mirrors, stands and mounting kits and cabling to simplify special installation requirements. Please refer to *Section 6 – Accessories and Spare Parts* for further information.

STEP 4. CONTROLLER ENCLOSURE

Connect input power, output machine control, and, if used, remote function control to the controller/power supply by means of cable protected by conduit. When the conduit connections have been determined, mark the appropriate knockouts on the outside of the enclosure. The procedure to remove the knockouts follows in the next section. There are two 3/4-inch knockouts on the bottom of the controller box.

STI recommends a clearance of approximately 4 inches (100 mm) between the receiver or transmitter cables and any AC power lines.

Electrical Conduit Installation

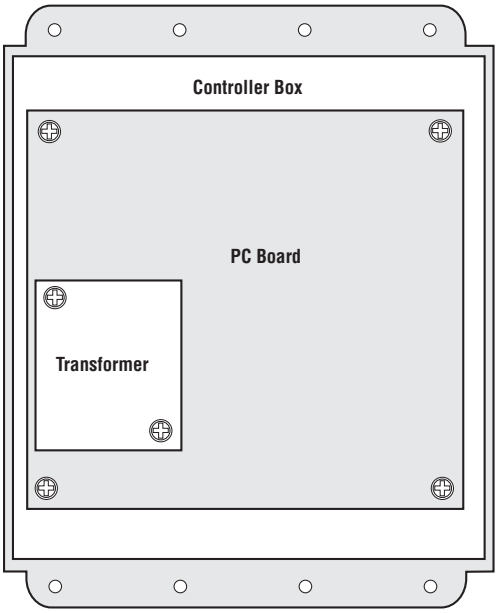
Disconnect primary power and remove all external connections from the controller enclosure before proceeding further. The following tools are needed: a No. 2 Phillips screwdriver and a clean, padded surface.

When all external connections have been disconnected, orient the controller enclosure in front of the user with the open hinged lid on the left. Then follow steps 1 through 6:

1. Identify and mark the desired conduit entry points.

2. With a No. 2 Phillips screwdriver, remove the screws indicated in figure 3.9.

Figure 3.9 Mounting Screw Locations



3. Holding the controller board assembly horizontally by the transformer and the PC board edge, gently remove the complete assembly. Place the assembly on a clean, padded surface to avoid damaging the electrical connections. Be sure to save the mounting screws.

4. Remove the desired knockouts and clean any metal filings from the enclosure.

5. Mount the appropriate conduit insulated-throat fittings to the enclosure holes.

6. At this time, verify all configuration jumpers are in the desired positions. Please read *Step 5 – Configuring Your Light Curtain* before doing this step. Reinstall the controller board, then the transformer by reversing steps 2 and 3.

It is the responsibility of the installer to use the proper conduit or cord grip fittings to maintain the NEMA12 and Ingress Protection (IP65) design integrity of the controller enclosure.

Cable Assembly

Systems are shipped with the cables specified on the purchase order installed in the Controller/Power Supply assembly ready for use. If your installation requires the placement of transmitter and receiver cables in conduit or raceways, STI recommends systems which are large enough to permit installation without modification of the cable assemblies. If this is not possible, the cables must be disassembled, and reassembled, at the Controller end.

Before proceeding with this operation, note carefully how the cables have been installed at the factory and be prepared to reinstall them exactly the same way. The following diagrams show the wiring of both cables to assist in this operation.

For proper cable connection, please follow the diagram in figure 3.10.

NOTE: On the controller board, two receiver sockets are provided. Also, when MS4300 or FS4300 transmitters and receivers are installed JMP9 must be removed. See table below for details.

Transmitter/Receiver Models Installed

	FS4300 or MS4300	FS4400 MS4400 OF4100 P4100 PA4400
Receiver Socket	Receiver 43	Receiver Opto
Jumper JMP9 Setting	Removed	Installed

Figure 3.10 Cable Wiring Diagrams

Figure 3.10a All Light Curtain Transmitter Cable Wiring Diagram

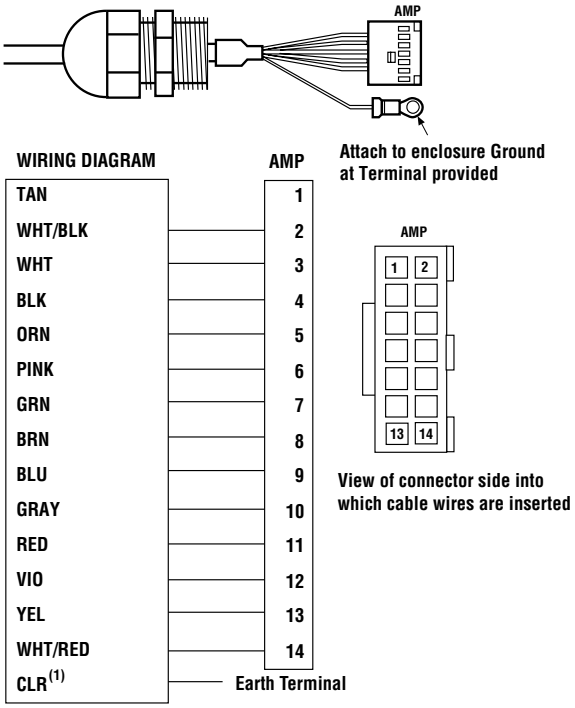


Figure 3.10b MS43/FS43 Receiver Cable Wiring Diagram

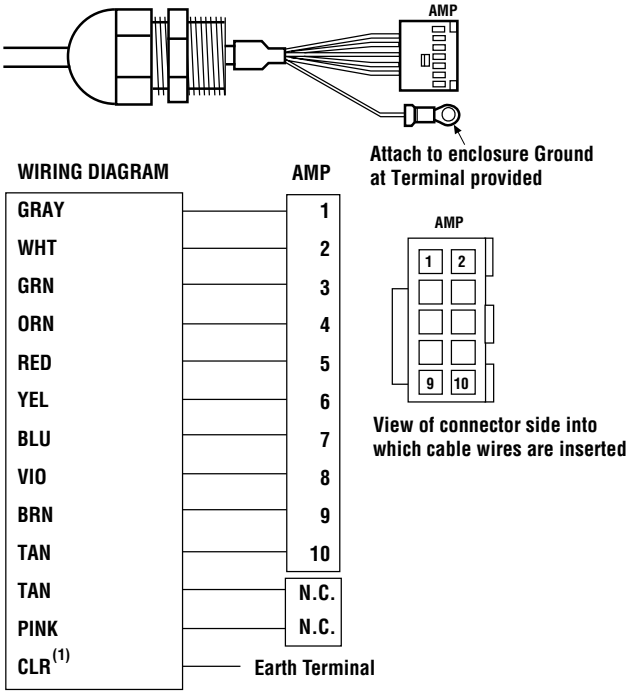
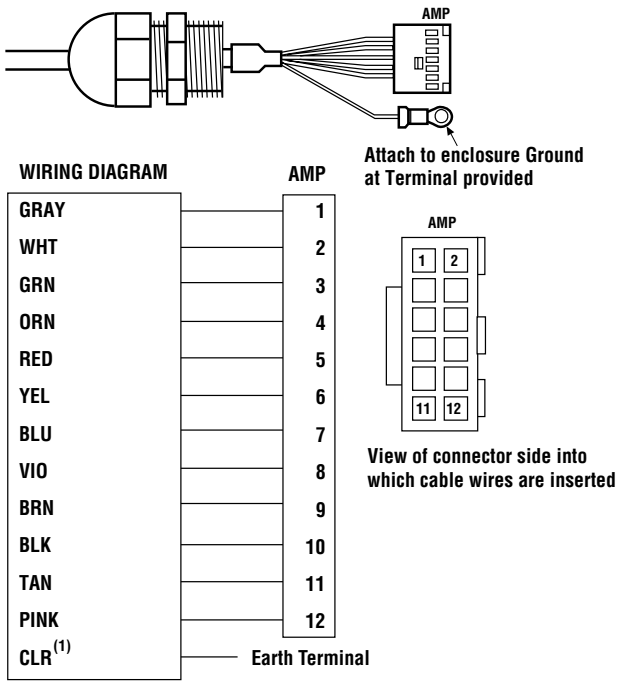


Figure 3.10c FS44/MS44/P41/OF41/PA44 Receiver Cable Wiring Diagram



Disconnecting and Reconnecting Cables

Should it ever be necessary to disconnect or install a cable from the controller/power supply to the transmitter or receiver unit, follow these steps:

1. Always turn off the power to the controller before connecting or reconnecting any cables.
2. Gently rock the cable connectors. The cable connectors should lift up when pulled. Do not pull the connector by the wires.
3. When installing the cables, remember that the connectors are keyed to fit in the mating socket only one way. Check the orientation before inserting.
4. Perform the Test Procedure.

STEP 5. SAFETY LIGHT CURTAIN CONFIGURATION

This step describes the configuration options in detail.

Power Up Inhibit

When Power Up Inhibit is enabled the Safety light curtain will enter a Beam Block state when power is applied. A reset command is required for normal operation.

Systems are normally shipped with the Power Up Inhibit feature disabled. To enable this function, set position 3 of S1 to the OFF position.

Status Relay Selection

The modes are selected by setting position 4 of S1. Normally open (NO) and normally closed (NC) contacts are available as outputs on TB1.

In the Follow FSD (Final Switching Device) mode the STATUS RELAY is used as an auxiliary set of contacts to signal the light curtain output relay status. This is useful for applications where the conditions of the sensing field and light curtain are monitored separately from the output relays. The status relay corresponds to the output relay state. Thus, the contacts switch when the sensing field is interrupted, if the light curtains are out of alignment, or in an alarm condition. The status relay contacts are monitored by the controller.

In the Alarm mode, this relay indicates a fault condition such as an output relay failure. Should this occur, the controller would use the other output relays (remember, at least two relays are used) to send a stop signal to the machine. The status relay would change from an energized to an de-energized state to signal that this condition occurred.

It is important to understand that changing the status relay switch only affects the way the status relay is operated. The relay checking of the two output control relays continues to function regardless of the selection.

The following table outlines the various conditions of the status relay, depending upon the function selection and the light curtain status:

Mode Selection	Safety Light Curtain Condition	Status Relay Coil	Status Relay NO Contact	Status Relay NC Contact
Alarm mode	Non-alarm condition	Energized	Closed	Open
Alarm mode	Alarm	De-energized	Open	Closed
Follow FSD mode	Green transmitter light on, sensing field not interrupted	Energized	Closed	Open
Follow FSD mode	Red transmitter light on, sensing field interrupted	De-energized	Open	Closed
Follow FSD mode	Red transmitter light on, alarm	De-energized	Open	Closed
Any	Power off	De-energized	Open	Closed

The status relay, when in the Alarm mode, is energized in a non-alarm condition and de-energized in an alarm condition. Thus if the status relay coil failed, the status relay would switch to show an alarm condition and the light curtain would enter an alarm state.

The next step, *Step 6 - Electrical Wiring,* contains some suggestions on uses for the status relay.

Connections to the status relay should be made with copper conductor wire only.

⚠ WARNING: Never use only the status relay to control the machine! It is a single relay and thus is not redundant. Should this single relay fail, the machine may not stop resulting in severe operator injury.

MPCE Monitor Selection

The switches which determines whether the control system will monitor the Machine Primary Control Elements are located at positions 1 and 2 on S1. Systems are shipped with these switches in the OFF position. If MPCE monitoring is desired, the switches should be moved to the appropriate position, and the MPCE monitor positions on the terminal block TB1 should be wired according to one of the recommended configurations shown in figures 3.11, 3.12 & 3.13.

STEP 6. ELECTRICAL WIRING

⚠WARNING: All electrical connections must be made by *qualified* personnel only and in accordance with your local and national electrical codes and regulations. Shut off all power to the machine and the controller before connecting. Never allow any metal filings or chips to enter the controller enclosure and possibly impair the proper operation of the safety light curtain.

Input Power Connections

The Universal controller is available in two different AC input power configurations: 115 VAC, 50/60 Hz; or 230 VAC, 50/60 Hz. Check the product label on the enclosure to determine the AC voltage which may be used.

It is the responsibility of the installer to use the proper conduit or cord grip fittings to maintain the NEMA12 and Ingress Protection (IP65) design integrity of the controller enclosure.

For AC line voltage models, bring line, neutral and ground wiring to the controller/power supply. If using a flexible electrical code connection rather than solid conduit, it is recommended tha H05RN-f 1.0mm^2 flexible cord be used. Be sure to trim conductor ends so that the ground wire is longer than the other two wires.

For DC models, a source of 24 VDC at 1.0 A is connected to TB3 which is located to the right of the power transformer.

Do not apply power yet. Use copper conductors only and insulation with a temperature rating of 60°C. Terminal screws should be tightened to a torque of 12 in-lb.

It is recommended the safety light curtain be dedicated to its own source of input power. Also, do not connect other devices to the internal power supply of the light curtain.

Machine Control Circuit connections

The safety light curtain has the flexibility to connect to the machine circuit in several different configurations, depending on the machine controller design.

When deciding which method is best for the application, keep in mind the following important points:

– The safety light curtain must be wired to the machine control circuit at a point where its stop signal results in an **immediate halt** at any point in the machine cycle or stroke. On mechanical power press, **never** connect a light curtain to the top-stop circuit. The press will be unable to stop at any other point in its stroke.

– Safety light curtains are general purpose safety devices and are not designed for any specific type, model or brand of machine.

– All safety-related machine control circuit elements, including pneumatic, electric or hydraulic controls must be control reliable. *Control reliable* means ...“*the device, system or interface shall be designed, constructed and installed such that single component failure within the device, interface or system shall not prevent normal stopping action from taking place but shall prevent a successive machine cycle...*” (ANSI B11.19-1990, 5.5).

– Light curtains may not be used as a tripping means to initiate mechanical power press motion except when used and installed in conformance with the OSHA PSDI requirements of OSHA 1910.217(h).

– Always use **both** control safety output relays (also called final switching devices) to connect to your machine. Should one relay fail, the other is used to stop the machine. The preferred scheme includes using the status relay as a third control element.

– STI recommends contacting the machine manufacturer for advice and assistance on the connection of any safety device.

– If PLC (programmable logic controller) are used as machine controllers, see the section on *Suggested PLC Connection.*

Both the two controlled safety output relays (final switching devices) and the one status relay are rated for 220 VAC at 8 Amps. These are dry contacts, i.e. there is no voltage present.

The installer should read through all four of the following connection methods before selecting the one most appropriate for the machine application.

⚠WARNING: Contact the protected machine manufacturer for assistance on how to wire a safety light curtain to the machine control circuit. It is critical that the safety light curtain be properly connected or it will not provide maximum protection to the machine operators and could result in serious injury. The machine control circuit wiring is the sole responsibility of the employer.

Wiring To The Output Terminals

Output terminal block TB1 use a vertical entry cage – clamp style connector. The connector is designed to accept wire gauges AWG 26 through 14.

To remove a wire, simply depress the lever and extract the wire.

Perimeter Guarding Special Requirements

Perimeter guarding refers to installation where a light curtain is generally positioned around the outside perimeter of the machine or robot to be guarded. This could leave sufficient space for an operator to stand between the light curtain and the machine. Horizontal mounting of the light curtain may prevent this.

For perimeter guarding installation, the guarded machine or robot must be wired such that any detected interruption of the sensing field will cause an immediate stop of the hazardous motion. The machine or robot must only be restarted by actuation of a reset switch. This reset switch must be located outside the area of hazardous motion and positioned such that the hazardous area shall be observed by the switch operator. This would prevent a machine from automatically restarting once the obstruction is no longer detected by the light curtain.

The emergency stop circuit may possibly be used to interconnect a perimeter guard in certain installations where an external reset push button or keyswitch is used. Always contact the machine manufacturer for advice and assistance on the connection of any safety device.

⚠WARNING: Perimeter guarding installations must not allow a machine or robot to restart automatically. Use a reset switch placed outside and within view of the hazard area.

Machine Primary Control Elements (MPCE)

The monitoring of the machine control elements is an important part of a safety system installation. First, a definition of a machine control element.

Redundant machine control circuits must have two machine primary control elements (MPCE). These are defined as "*The electrically powered element that directly controls the normal operation of a machine in such a way that it is the last element (in time) to function when machine operation is to be initiated or arrested*." (IEC 61496)

The method to arrest hazardous machine motion will vary depending on the type of machine and may include hydraulic, pneumatic, clutch and mechanical braking systems. Thus, there are several variations of MPCE, for example, relays, contactor, solenoids or electromechanical valves.

The MPCE is monitored to make sure it is responding correctly to the safety output relays and to detect any inconsistency between the two MPCEs. Monitoring of the light curtain to machine control interface is necessary to detect a malfunction within the interface that would prevent a stop signal from the light curtain from reaching the machine controller. This is required by OSHA for control reliability of the machine controller to safety device wiring.

If relays are used, the MPCE **must** use captive contact type, machine control relays to be effective for the MPCE monitoring wiring.

Machine Secondary Control Element (MSCE)

The Machine Secondary Control Element (MSCE) is defined as *"a machine control element, independent of the machine primary control element(s) that is capable of removing the source of power from the prime mover of the relevant hazardous parts."* (IEC 61496) For example, the MSCE may be a relay used to interrupt power to the machine motor.

The MSCE is normally controlled by the Status Relay operating in the Alarm setting.

Two Normally Open Preferred Connection Method

The following connection scheme uses all three relays to control the machine. This is the preferred wiring method.

The method to arrest hazardous machine motion will vary depending on the type of machine. Control methodologies include hydraulic, pneumatic, clutch and mechanical braking systems. Thus, there are several variations of MPCE, including relays, contactor, solenoids and electromechanical valves.

If unsure of the proper connection location to use for the machine's control systems, STI recommends contacting the machine manufacturer for assistance.

The safety light curtain is shipped with an external jumper between common terminals C1 and C2 on TB1. For this connection scheme, remove this jumper.

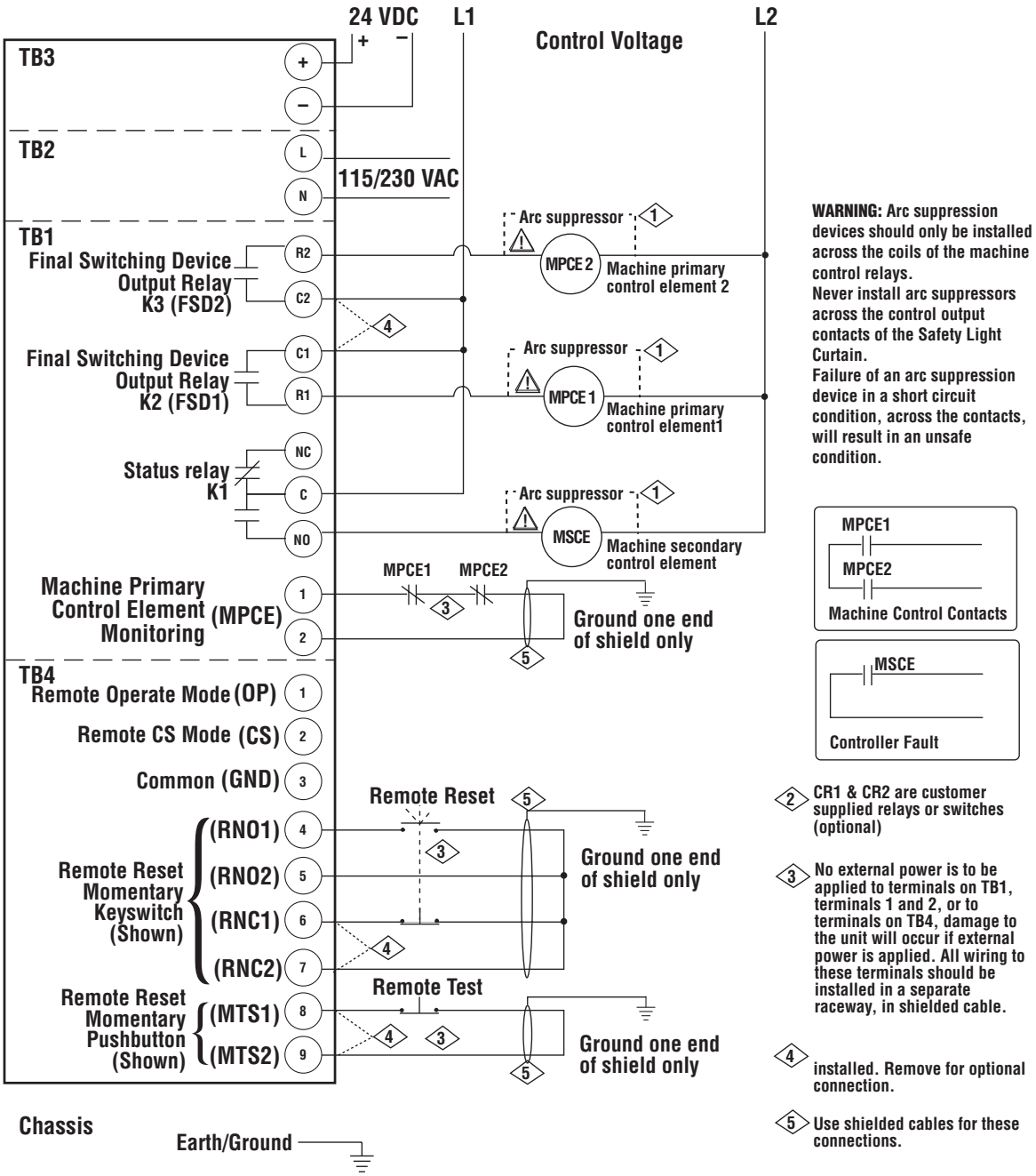
Wire the output of control relay, located at terminals R1 and C1 on TB1 to the relay coil of MPCE 1 on the appropriate machine. See figure 3.11(or figure F3.2 for LCC-DN DIN railmount controller.)

Wire the output of control relay, located at terminals R2 and C2 to the relay coil of MPCE 2 on the appropriate machine.

Next, wire the NO contacts of the status relay, located at terminals NO and C on TB1 to the MSCE. Set the status relay function selection switch to the alarm setting. In this mode, an alarm (lockout) condition will de-energize the MSCE. The next step is to wire the MPCE monitoring connections.

Figure 3.11 Machine Control Circuit Connection Diagram – Two Normally Open Preferred Method

Note: This connection diagram is for NEMA metal enclosure controller version. See figure F3.2 for DIN rail mount controller. Select the proper voltage input for your requirements. Supply 24 VDC or 115/230 VAC (set switch for correct voltage). Do not supply both voltages.



Machine Control Circuit Connection – Normally Open/Normally Closed

Some machine controller connection schemes require the use of two separate inputs to the machine controller, a NO and a NC contact arrangement. The controller output arrangements makes this connection design feasible.

All three output relays of the controller used in the connection scheme. The NO signal is obtained by connecting one wire to R1 and the return wire to R2. The controller is shipped with an external jumper between C1 and C2 on TB1. Make sure the jumper is installed. This will actually provide two NO contacts in series. See figure 3.12 (or figure F3.3 for LCC-DN DIN rail mount controller).

The NC output is provided by connecting to the status relay at C and NC on TB1. The STATUS RELAY must be configured in the Output Follow mode, as explained on page 30.

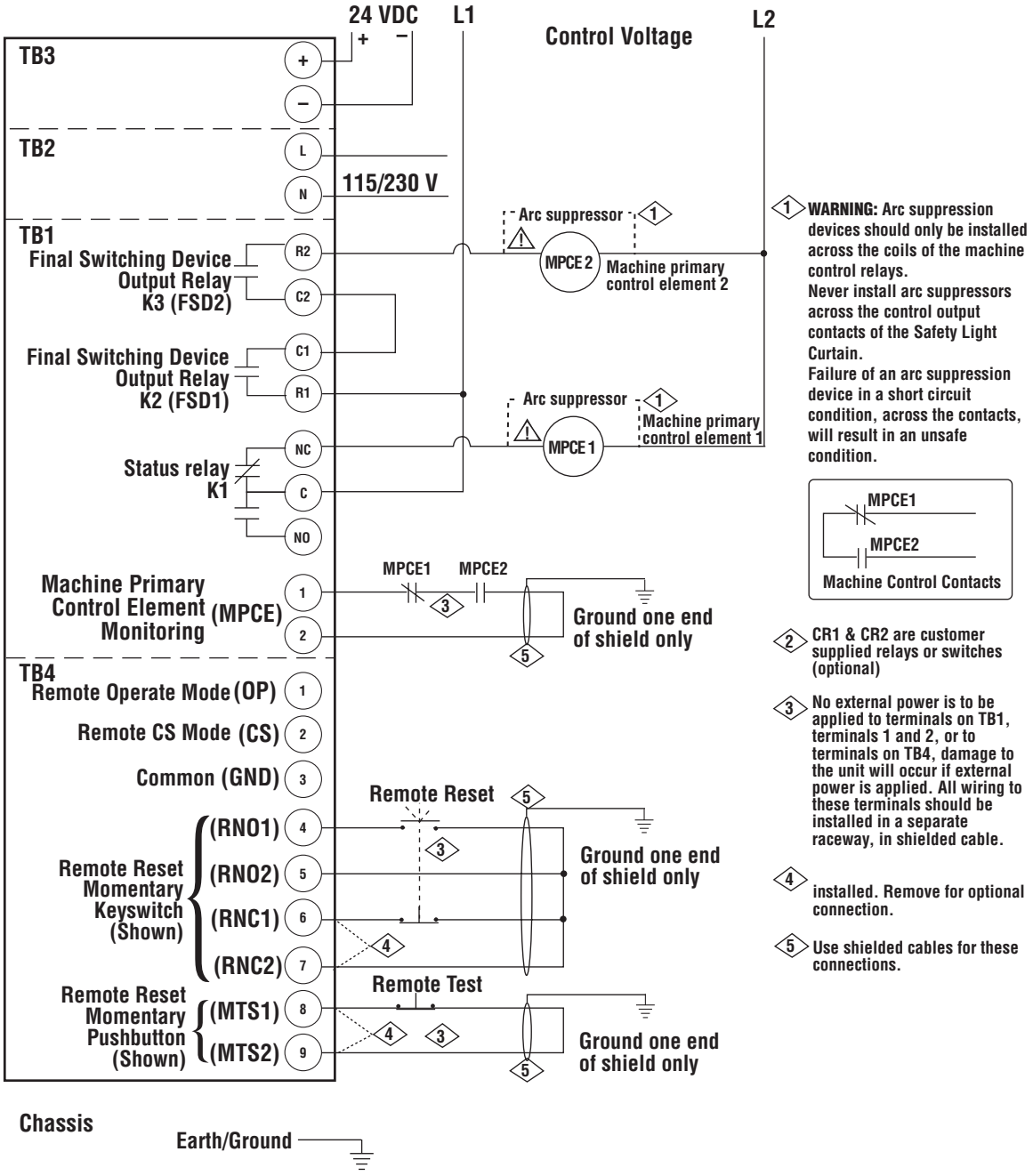
The MPCE monitoring connections as indicated on figure 3.12 must be installed. Note that a NC contact on MPCE1 is wired in series with a NO contact on MPCE 2. This is in conjunction with the connection wiring to the MPCE.

Using Arc Suppression Devices

Users must to use arc suppression devices (supplied by STI), also called snubbers, across the coils of the machine control contactors. These devices may extend relay contact life of equipment connected to the machine control circuit.

Figure 3.12 Machine Control Circuit Connection Diagram – Normally Open/Normally Closed

Note: This connection diagram is for NEMA metal enclosure controller version. See figure F3.3 for DIN rail mount controller. Select the proper voltage input for your requirements. Supply 24 VDC or 115/230 VAC (set switch for correct voltage). Do not supply both voltages.



Suggested PLC Connection

The wiring from the light curtain to the machine control must be control reliable, as explained in ANSI B11.19-1990 section 5.5 (or OSHA 1910.217(b)(13) included in Appendix D). Normally, PLCs are not designed to be control reliable and thus safety devices, such as light curtains, must not depend on a PLC to stop a guarded machine.

Figure 3.13 (figure F3.4 for LCC-DN DIN rail mount controller) shows a connection diagram which provides for an extra set of contacts on each MPCE to be used as a signal input to a PLC device. Notice that in this diagram, the PLC is not wired directly to the light curtain and thus removes the PLC from the light curtain stop signal circuit.

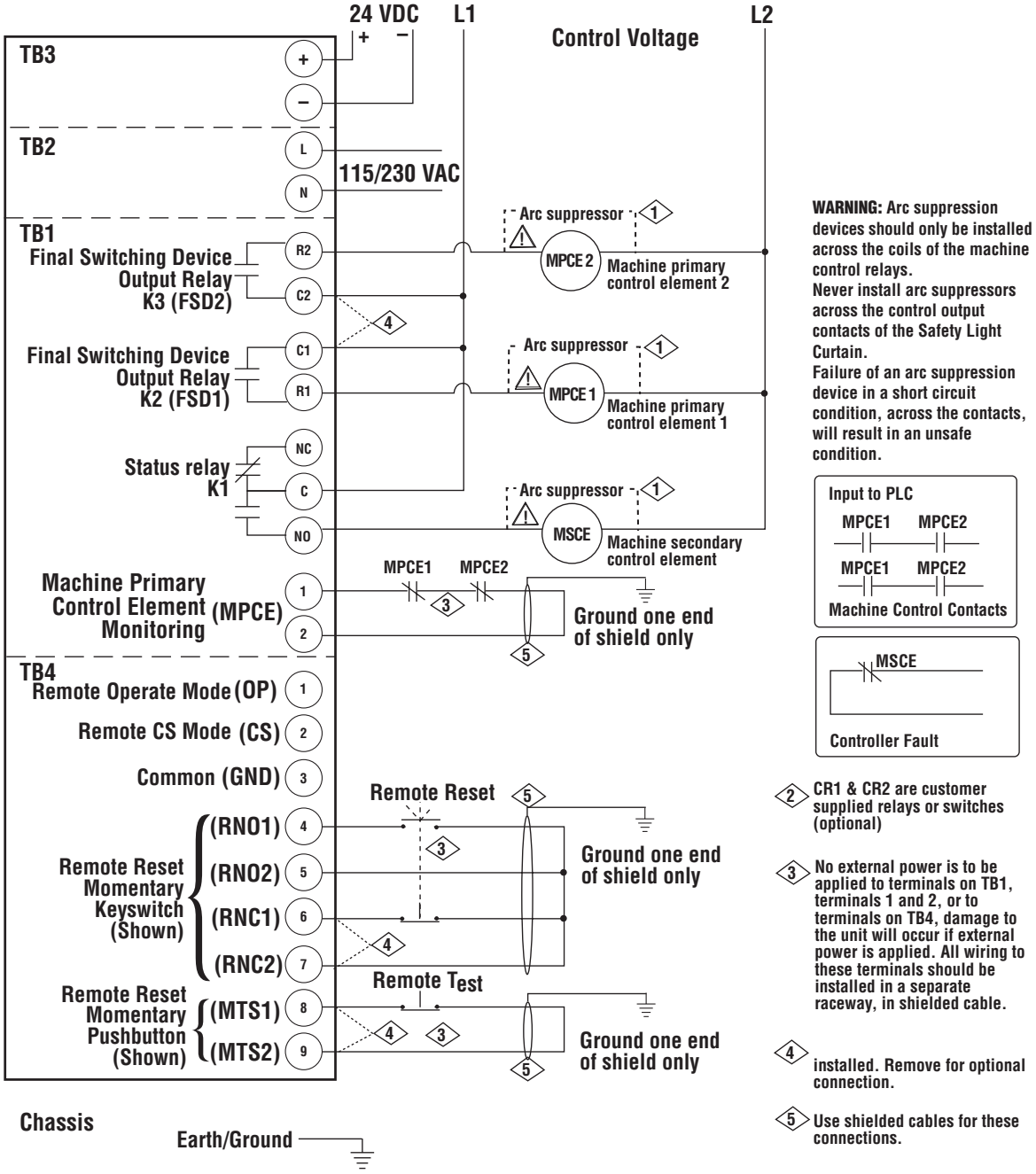
An output signal is also available from the STATUS RELAY. It is required that this be connected to a MSCE which is arranged as an alternate means to stop the machine. If you want the MSCE to trip only during an alarm condition, set the status relay for the alarm mode. If the MSCE should trip whenever the sensing field is interrupted, then set the status relay for the Follow FSD mode.

Always contact the manufacturers of the PLC and the guarded machine before using a PLC in conjunction with an operator safety control.

The PLC control system design, wiring installation and programming is the sole responsibility of the employer.

Figure 3.13 Suggested PLC Connection Diagram

Note: This connection diagram is for NEMA metal enclosure controller version. See figure F3.4 for DIN rail mount controller. Select the proper voltage input for your requirements. Supply 24 VDC or 115/230 VAC (set switch for correct voltage). Do not supply both voltages.



The MPCE Monitoring Function

The MPCE monitoring feature offers a convenient means of self-monitoring the light curtain to machine controller interface connections such that a malfunction within the interface would not prevent a stop signal from the safety light curtain reaching the machine controller. The MPCE control monitoring checks each MPCE to make sure it is responding correctly to the safety output relays and to detect any inconsistency between the two MPCE. If the MPCE do not follow the light curtain safety output relays within 300 milliseconds, the light curtain controller will enter a lockout condition. The controller offers two wiring methods for monitoring of the MPCE. The first involves initializing the built-in MPCE monitoring function. The second involves the connections of the power wiring through the MPCE spare contacts.

The MPCE monitoring feature is activated by correctly positioning the two switches on S1. The extra wiring necessary for MPCE monitoring is explained in the wiring connection diagrams, figure 3.11 to figure 3.13.

Using the MPCE monitoring feature will establish a condition where if the light curtain sensing field is not interrupted (green Beam Clear) and the machine is not running, the safety light curtain will fault. This is caused by the MPCE not immediately responding to the light curtain machine run command after the sensing field is clear. It is suggested than an external push button or key-operated remote reset switch alternately be located near the operator control panel, or wired to the machine start switch.

Second Method of Monitoring MPCE

This method involves routing the power line wiring through one NO and NC closed contact on each MPCE as shown in the wiring connection diagrams. **Important Note:** Power Up Inhibit **must** be active in order to use this MPCE monitoring method. An inconsistency between the MPCE would interrupt power to the controller and cause a stop signal to be sent to the machine. Since Power Up Inhibit is active, a reset is needed to restart the operation of the safety light curtain.

MPCE Monitoring with an Auxiliary Relay

In some machine controller designs, the light curtain outputs are connected to two auxiliary or pilot duty relays. These relays, in turn, drive the MPCE. The monitoring function must still be with the MPCE and not with the auxiliary

relay.

Remote Run/Start function

Terminal Block TB4 is used for connecting the remote *Run/Start*. No external voltage is to be applied to these therminals at TB4. Refer to pages 37 to 41, *figures 3.11 to 3.13* for wiring information.

Remote Reset

Reset may be initiated remotely by switching the Reset terminal of TB4 to ground through a switch or contact relay. The reset signal is nearly instantaneous.

STEP 7. POWER ON AND ALIGNMENT

At this point, the transmitter and receiver units have been loosely installed and are approximately aligned. The controller has been mounted. All wiring – to the light curtain transmitter and receiver heads, to primary power, and to the machine control system – has been installed. Power, both to the safety light curtain system and to the machine to be controlled, is off.

This section is concerned with two factors. First, the physical alignment of the transmitter and receivers, and second, setting the power and range selection of the electronics system in the controller.

Range Set Switch

The range setting switch is located to the right of the Blanking Indicators slide switch. This switch is factory shipped in the LONG RANGE position.

If the light curtain is to be used at a range of less than 3 ft. (1 m), this switch must be set in the SHORT RANGE position. At distance between 3 to 7.5 ft (1 to 2.3 m), it may be set in either SHORT RANGE or LONG RANGE position.

⚠WARNING: Misalignment, improper Range Adjustment and Range switch settings may increase reflective surface interference as explained in figure 3.4. Both physical alignment of transmitter and receiver heads and the power settings of the control system electronics should be performed carefully upon installation, and checked periodically thereafter.

Alignment and Range Adjustment Procedure

The Range Adjustment potentiometer increases or decrease output power to the transmitter. This enables the user to adjust the light curtain for optimal performance anywhere within its operating range. Rotating the pot clockwise increases the power level. This, in turn, increases the amount of infrared light emitted by the transmitter's LED. The potentiometer is located to the right of the Mode Selection Switch.

The Yellow transmitter power will glow brighter as more power is applied via the transmitter power adjustment potentiometer. Also notice the green Beam Clear light. When illuminated, the sensing field is not interrupted and the receiver and transmitter units are in proper alignment.

To set the Range Adjustment first visually inspect the area to make sure the sensing field is not obstructed, even partially, by an object.

1. Using the adjustment tool provided, rotate the 20-turn Range Adjustment potentiometer fully counterclockwise to minimize power setting. Apply power. Turn power on to the light curtain only. **Do not** apply power to the machine at this time. If Power Up Inhibit feature is active, the unit should energize with both red and green indicators on the transmitter head illuminated. Press the RESET push button.

2. Turn the Range Adjustment clockwise until the green Clear light is illuminated on the user control panel and on the transmitter. The red Block light and the yellow Alignment lights on the user control panel will go out at the same time. If the transmitter and receiver are properly oriented and are even roughly aligned, this condition should be easily achieved.

3. Now turn the Range Adjustment counterclockwise unit the green Clear light just goes out and the red Blocked light is on. Physically adjust the positioning (vertically, horizontally, and rotationally) of the transmitter and/or receiver until the green Clear light turns on again. You are optimizing (or fine turning) the alignment of the transmitter and receiver. If slight physical adjustments of the transmitter and receiver do not produce a green Clear indication, then your initial position was good. Secure the head mounting bolts.

4. Continue to reduce drive level and adjust transmitter and receiver positions relative to each other until it is no longer possible to achieve a green Clear condition. The heads are now physically aligned. Secure the head mounting bolts.

5. To complete the electrical alignment, reduce the Range Adjustment level until the green Clear lamp is out and the red Block lamp is lit. Adjust the Range Adjustment clockwise until the green Clear lamp is just lit. Then turn the control one more turn clockwise. If the range is less than 3 ft, turn the control two more turns clockwise.

This completes the alignment and Range Adjustment procedure.

⚠WARNING: Before operating the machinery, always perform the Test Procedure after any adjustment to the Range Set Jumper/Range Adjustment or other maintenance, adjustment or modification to the light curtain or machine. Testing is critical to verify the safe installation of the light curtain. Failure to properly test may result in serious injury to personnel.

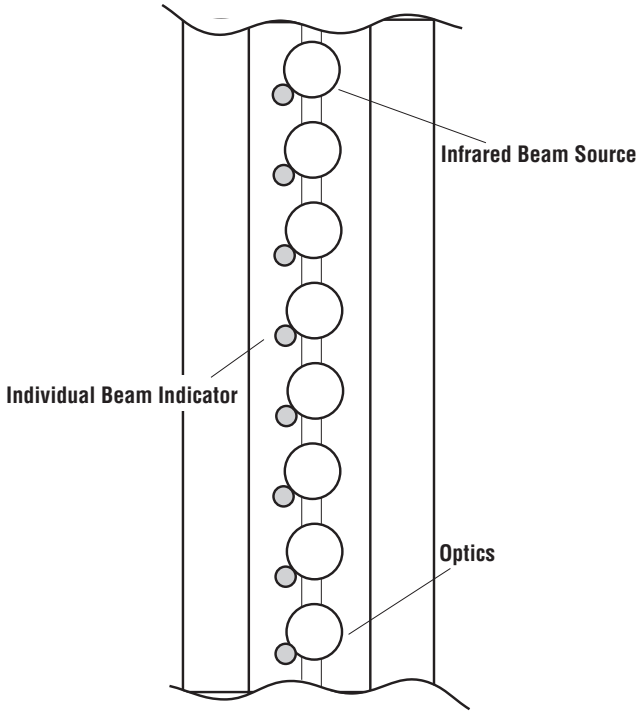
Individual Beam Indicators

The receiver units for FlexSafe FS4400, MiniSafe MS4400, OptoFence OF4100, OptoSafe P4100, and Perimeter Access PA4400 are equipped with Individual Beam Indicators. Each infrared beam has its own visible, red indicator located near each phototransistor. The Individual Beam Indicators are useful during alignment by displaying whether a beam is interrupted, out of alignment or deselected. See figure 3.14.

If a light curtain with Individual Beam Indicators is in the Operate mode and a beam is blocked by an object or is not in alignment, the indicator with light for each channel affected.

Individual Beam Indicators are used as a visible alignment aid. They are not considered a critical component of the safety circuit. An indicator failure by itself will not cause an alarm fault and the light curtain will continue to function.

Figure 3.14 Individual Beam Indicator



Mirror Alignment Hints

If difficulty arises when using the light curtain with STI mirrors, try the following steps:

1. The mirrors must be perpendicular to the sensing field. If not, the beams will not be reflected evenly to the next mirror or to the receiver.

2. Try looking from behind either the transmitter or receiver to locate an image of the corresponding unit reflected in the mirror(s). Have an assistant adjust the mirrors until the other unit is reflected fully in the mirror.

⚠WARNING: Make sure the machinery is disabled before working in a hazardous area!

Alarm Conditions

Several conditions may occur which will cause the unit to go into an alarm state. Examples include the detection of a relay failure, such as a welded contact or failed coil; a disconnected transmitter or receiver or intermediate slide switch position. The controller is designed such that it will not operate until the alarm condition has been corrected and the unit has been reset.

If an alarm fault occurs while you are setting up the light curtain, please see *Section 6 - Warranty, Troubleshooting and Preventive Maintenance* on how to reset from an Alarm mode.

⚠WARNING: After your light curtain is aligned, you must next follow all the checkout and test procedures before using the machinery. This is to make sure the safety light curtain and machinery are operating correctly.

STEP 8. INITIAL CHECKOUT AND TEST PROCEDURES

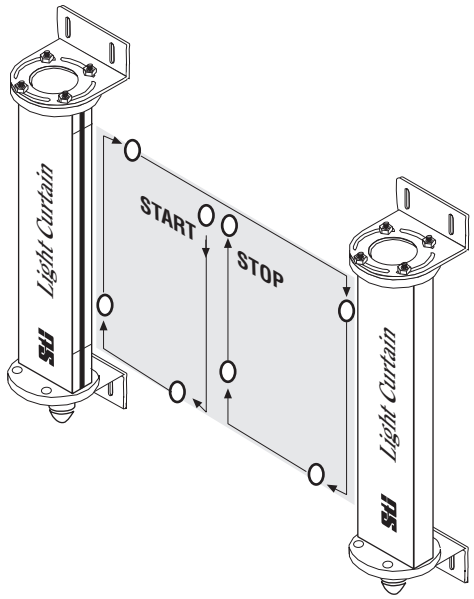
Now your light curtain is mounted, configured, aligned and connected to your machinery. The machine power is off.

Using the Checkout Procedure Log located in Appendix B as a guide, an initial checkout of the machine guarding system must be performed by a *qualified* person. A copy of the checkout results should be kept with the machine maintenance and inspection records. Use caution when working around hazardous voltages which may be present during these procedures.

Using the Test Object

Use the test object to interrupt the sensing field along the center, bottom, sides and top of the sensing field. See figure 3.15

Figure 3.15 Test Object



STEP 9. TEST PROCEDURE

⚠WARNING: The following tests must be performed after any maintenance, adjustment, repair, or modification to the light curtain or the machine. In addition, the tests must also be performed after Channel Select (CS Operate) and/or Floating Blanking is enabled or disabled. Testing ensures that the light curtain and the machine's control system work properly to stop the machine. Failure to test properly could result in serious injury to personnel.

The Test Procedure as outlined in Appendix B must always be performed by *qualified* personnel after the mounting, alignment and wiring steps are completed and before the light curtain is used to control the machine. To test the light curtain, use the correct size test object.

If you are using the Channel Select feature, and the object to be ignored does not completely prevent access to the hazardous area then either:

1. Use a mechanical guard or other means to block access or
2. Increase the minimum safe distance and use the larger test object diameter as explained in *Section 4 – Channel Select, Floating Blanking and Guard Mode.*

4

Channel Select, Floating Blanking and Guard Mode

CHANNEL SELECT

The Channel Select option is used to disable selected, fixed areas in the sensing field. This is accomplished by masking off various channels at fixed locations. This is helpful when stationary objects such as tooling, fixtures, conveyors, work tables, etc. obstruct a specific portion of the sensing field.

The system employed is called Exact Channel Select and requires that any beams which are masked remain blocked. This provision prevents stationary objects and tooling from being removed from the sensing field or relocated to another position within the sensing field. If a beam which is programmed to be blocked is not, a stop signal is sent to the machine. Remember, the top beam (the beam furthest from the cable connector) cannot be deselected.

The term Muting is defined as bypassing the protective function of the safety light curtain and is only permitted by ANSI B11.19 after the hazardous portion of the press stroke has been completed. The light curtain itself does not provide a means for muting.

A light curtain with Channel Select must use a lock on the enclosure or some other means of providing supervisory control. The standard STI enclosure includes a hasp for use with a user-provided padlock.

FLOATING BLANKING

Floating Blanking allows up to two beams to be disabled at any location in the sensing field (except for the top beam) without tripping the output relays. The name Floating Blanking originated because the disabled beams are not fixed at a single location but *float* through the sensing field.

Floating Blanking and Channel Select can be used together to allow additional flexibility in your equipment guarding needs. It is important to carefully follow the instructions in the next section describing this combination of features.

USING FLOATING BLANKING WITH CHANNEL SELECT

Floating Blanking alters Channel Select when both are active. Let's examine why.

Assume the Mode Select slide switch is in the Operate position, Channel Select and Floating Blanking are both off. Any interruption of the sensing field will send a stop signal to the guarded machine.

Now, let's add one beam Floating Blanking. If one beam is blocked, the machine will still be able to run.

Next, with one beam Floating Blanking still active, move the Mode Select slide switch to the Channel Select position, initiating a previously stored Channel Select of three beams. Channel Select requires the beams which are programmed to be blocked actually be blocked. Floating Blanking modifies this requirement

by allowing an exception. In this case, if one beam of the three that are Channel Select programmed to be **blocked** is **unblocked** one beam Floating Blanking allows this one exception and allows a machine run condition.

To summarize, a beam which has been programmed to be **unblocked** and is actually **blocked** is counted as one beam floating. Likewise, a beam programmed to be **blocked** and is actually **unblocked** is also considered as one beam floating.

Example of Using Floating Blanking with Channel Select

Consider a perimeter guarding application on a robot work cell. Feedstock enters through the light curtain sensing field. The feedstock is large enough to cover two beams in the sensing field. During part of the robot cycle the feedstock shifts position by one beam.

Use Channel Select to program as blocked the three beams involved – the two beams normally covered and the third beam when the feedstock shifts. Now add one beam Floating Blanking. This will offset the one exception caused by the one unblocked Channel Selected beam and allow a machine run condition to continue as the feedstock changes position. Should any other beam in the sensing field be blocked, a machine stop signal would occur.

Important Considerations when Using Floating Blanking with Channel Select

Remember to consider the case when all of the Channel Selected beams are blocked. This then allows Floating Blanking to be active anywhere in the sensing field. In the preceding example, if all three of the Channel Select beams are blocked, then one beam Floating Blanking has desensitized the non-Channel Selected area of the sensing field.

WARNING: Using Floating Blanking with Channel Select is an advanced feature. All situations which may occur to the sensing field must be carefully considered beforehand because the light curtain may be less sensitive to objects in the sensing field. The minimum safe distance must be increased. Failure to do so may cause serious operator injury.

MINIMUM SAFE DISTANCE AND MINIMUM OBJECT SENSITIVITY

When Channel Select is active, the minimum safe distance is affected, because Channel Select essentially desensitizes the light curtain and increases the size of the minimum object detected. The increase is equal to the beam spacing distance for each beam that is selected. Thus, for example, a light curtain using a MS4300 transmitter and receiver with one beam selected has a minimum object sensitivity of: 0.75 in + 0.50 in = 1.25 in (32 mm). Two beams selected would be: 0.75 + 0.50 + 0.50 = 1.75 in (45 mm).

The minimum object sensitivity is decreased for each contiguous beam that is selected. Recall that with the ANSI safety distance formula, if the object resolution of the light curtain decreases, the minimum safe distance must therefore increase. The new penetration factor, $D_{pf,}$ is obtained from figure 3.2. The following section explores one exception to the rule requiring an increase in the minimum safe distance.

THE HARD GUARDING ALTERNATIVE

The ANSI standard does allow one exception for Channel Select (or fixed channel blanking, as ANSI calls it). If the area masked off by Channel Select is entirely occupied by material, fixtures or hard guarding such that operator intrusion in this area is impossible, then no increase in the minimum safe distance is required.

Hard guarding is another term for mechanical barriers such as sheetmetal or expanded metal, etc. The relationship between any openings or gaps in the barriers and the mounting distance of the hard guard is specified in OSHA 1910.217, Table 0 - 10, which is included in Appendix D of this manual.

SAFETY DISTANCE WITH CHANNEL SELECT

In the ANSI formula, the penetration factor, D_{pf}, was discussed and how it relates to the minimum object sensitivity of the light curtain. Since the use of Channel Select makes the light curtain less sensitive, the minimum safe mounting distance must be increased. The depth penetration factor, D_{pf}, accounts for this distance.

Note: The following example uses MS4300 components. The value of S will vary depending on which light curtain is in use.

A standard Safety light curtain has an object sensitivity, S, of 0.75 in (19 mm). To determine the depth penetration factor D_{pf}, the formula is $D_{pf} = 3.4 (S – 0.276)$ where D_{pf} is in inches.

Now let's add the effect of one channel disabled by channel select. The minimum object sensitivity, S, has been changed by the distance between two beams, or 0.5 in (13 mm).

Thus, S is now:

S = 0.75 in + 0.50 in = 1.25 in (32 mm)

S = 1.25 in, D_{pf} = 3.3 in (84 mm)

Therefore, for every one channel that is masked, an additional 1.7 in (43 mm) must be added to the minimum safe distance that the transmitter and receiver are mounted from the pinch point unless access through the Channel Selected area is completely blocked by fixtures or hard guarding.

The table 4.1 show the effect of Channel Select on the minimum object sensitivity number of beams disabled for various light curtain models.

INCREASE TEST OBJECT SIZE

If you are using Channel Select and have not blocked access through the masked area then the test object size used in the Test Procedure must be increased accordingly. The new test object diameter is equal to the minimum object sensitivity, S, which can be obtained from table 4.1.

Table 4.1 Effect of Channel Select on Minimum Object Sensitivity, S, and Depth Penetration Factor, D_{pf}.

No. of contiguous	Minimum Object Sensitivity, (Total Object Diameter)					
beams disabled w/	FlexSafe	FlexSafe	MiniSafe	MiniSafe	OptoFence	OptoSafe
Channel Select	FS4300	FS4400	MS4300	MS4400	OF4100	P4100
None	0.75 in	1.00 in.	0.75 in	1.00 in	2.00 in	1.25 in
1 beams	1.25 in	1.50 in.	1.25 in	1.50 in	3.50 in	2.00 in
2 beams	1.75 in	2.00 in.	1.75 in	2.00 in	5.00 in	2.75 in
3 beams	2.25 in	2.50 in.	2.25 in	2.50 in	6.50 in	3.50 in
4 beams	2.75 in	3.00 in.	2.75 in	3.00 in	8.00 in	4.25 in
5 beams	3.25 in	3.50 in.	3.25 in	3.50 in	9.50 in	5.00 in
6 beams	3.75 in	4.00 in.	3.75 in	4.00 in	11.0 in	5.75 in
7 beams	4.25 in	4.50 in.	4.25 in	4.50 in	12.5 in	6.50 in
8 beams	4.75 in	5.00 in.	4.75 in	5.00 in	14.0 in	7.25 in
9 beams	5.25 in	5.50 in.	5.25 in	5.50 in	15.5 in	8.00 in
10 beams	5.75 in	6.00 in.	5.75 in	6.00 in	17.0 in	8.75 in
Etc.						

For number of beams greater than 10

$S = 0.75 + n\ (0.50)$

where n = number of beams disabled and S is in inches

and

$D_{pf} = 3.4\ (S - 0.276)$

where D_{pf} is in inches.

NUMBER OF BEAMS DESELECTED

If unsure of how many beams are disabled, here is a suggestion. Measure the dimension of the object in the sensing field. Next, look at table 4.1 and find the value of S, the minimum object sensitivity which matches the measurement. Use this new value to calculate $D_{pf.}$ If the measurement falls between two values of S, use the next larger number.

INITIATING CHANNEL SELECT

To initiate Channel Select, follow the instructions below:

1. Select which beam(s) to mask off by blocking these beams with the opaque obstruction. Masked beams need not be consecutive.

2. Move the Mode Select Slide Switch to the Program position.

3. Now store the selected configuration by pressing the TEST/STORE push button.

4. Move the MODE SELECT slide switch to Channel Select position.

5. Press the RESET push button. The yellow Channel Select indicators on the controller board and on the transmitters unit will illuminate.

6. Now, you must perform the Test Procedure to verify that only the desired beams have been deselected.

If the user determines the configuration to be incorrect, repeat steps 1 - 5 and then repeat the verification test, step 6.

Note: Masked beams must always be blocked or the unit will enter a Beam Blocked condition.

DISABLING CHANNEL SELECT

Move the MODE SELECT slide switch from Channel Select to Operate. The last programmed Channel Select mask is retained by the controller, even if power is lost and can be resumed by moving the MODE SELECT slide switch to Channel Select.

⚠WARNING: Channel Select causes an unprotected passage in the sensing field. Improper use of the method can result in a severe hazard to the machine operator. Make sure the user read, understands and implements all requirements of this section and the appropriate OSHA and ANSI regulations.

- Use a lock on the enclosure for supervisory control of Channel Select.
- If the object to be ignored by the Channel Selected beams does not completely prevent access to the hazardous area, then either use a hard guard barrier or other means to block access or increase the minimum safe distance, D_s, as required by the ANSI formula.
- Any beams which are not in alignment at the time of Channel Select programming may be inadvertently deselected. Use the Test Procedure to verify the correct configuration.
- If you do not prevent access through the Channel Selected area with a hard guard or other means, then you must increase the test object size.

INITIATING FLOATING BLANKING

Floating Blanking is programmed using four positions on SW1. Instruction for setting these switches are found in Figure 2.1.

GUARD MODE

Guard Mode, when activated, allows the light curtain output relays to remain in a de-energized state after a detected object has been removed from the sensing field. The output relays are restored for operation only by Reset. With Guard Mode off, the output relays would resume a "machine-run" state after a detected object is removed from the light curtain sensing field.

Guard Mode is used primarily in perimeter guarding applications. In perimeter guarding, the light curtain is positioned around the outside perimeter of the machine or robot to be guarded. Perimeter guarding applications must not allow a machine to restart automatically.

Guard Mode is selected by correctly setting positions 5 and 6 on SW1.

Guard Mode and Power Up Inhibit are two separate programming choices. It is possible to set the system to enter a machine run condition when power is applied and the sensing field is clear but to enter a "Guard Mode" condition when a beam block occurs. STI recommends activating Power Up Inhibit whenever Guard Mode is used.

5 *Warranty, Troubleshooting & Preventive Maintenance*

WARRANTY

STI warrants its products to be free from defects of material and workmanship and will, without charge, replace or repair any equipment found defective upon inspection at its factory, provided the equipment has been returned, transportation prepaid, within one year from date of installation and not to exceed 18 months from date of factory shipment.

The foregoing warranty is in lieu of and excludes all other warranties not expressly set forth herein, whether expressed or implied by operation of law or otherwise including but not limited to any implied warranties of merchantability or fitness for a particular purpose. No representation or warranty, express or implied, made by any sales representative, distributor, or other agent or representative of STI which is not specifically set forth herein shall be binding upon STI. STI shall not be liable for any incidental or consequential damages, losses or expenses directly or indirectly arising from the sale, handling, improper application or use of the goods or from any other cause relating thereto and STI's liability hereunder, in any case, is expressly limited to the repair or replacement (at STI's option) of goods.

Warranty is specifically at the factory. Any on site service will be provided at the sole expense of the purchaser at standard field service rates.

All associated equipment must be protected by properly rated electronic/electrical protection devices. STI shall not be liable for any damage due to improper engineering or installation by the purchaser or third parties. Proper installation, operation and maintenance of the product becomes the responsibility of the user upon receipt of the product.

Returns and allowances must be authorized by STI in advance. STI will assign a Returned Goods Authorization (RGA) number which must appear on all related papers and the outside of the shipping carton. All returns are subject to the final review by STI. Returns are subject to restocking charges as determined by STI.

The only user-replaceable components in the safety light curtain, are the fuse and control relays. Do not open the transmitter or receiver housing. They contain no user serviceable parts and doing so will void the warranty.

⚠ WARNING: Any attempt to repair or troubleshoot the light curtain, except as limited to the user replaceable components and the following troubleshooting guide, will void the warranty and may render the light curtain unsafe for use. The light curtain contains complex electronics which may only be tested and repaired by STI-trained technicians.

⚠ WARNING: In order to comply with the specifications and requirements of the safety light curtain, all covers and doors opened or removed during maintenance must be reinstalled prior to placing the safety light curtain back in service.

PREVENTIVE MAINTENANCE

Quarterly Checkout Procedure

The following procedure is recommended at least every three months or more frequently depending on machine usage. Only *qualified* personnel should be used to perform the procedure. Inspection logs should be kept with the machine records. A Checkout procedure form is included in Appendix B.

☑ 1. Using a stopping performance monitor (often called a brake monitor) or other device as recommended by the machine manufacturer, determine the stopping time of the machine. Compare this with the previous calculations used to determine the minimum safe distance. If the time has increased, make the necessary braking system repairs or adjustments and re-measure. If the stop time is not reduced, the safe mounting distance should be recalculated and the light curtain installed accordingly.

☑ 2. Clean the plastic, acrylic bezels of the transmitter and receiver units per the instructions in the following paragraphs.

☑ 3. Inspect the light curtain control relays as explained in the following paragraphs. Also inspect and test for proper functioning the machine primary and secondary control elements (MPCE & MSCE). Replace any worn or faulty relays.

☑ 4. Perform the *Alignment and Range Adjustment Procedure* on page 46.

☑ 5. Perform the *Initial Checkout Procedure* in Appendix B.

☑ 6. Next, complete the *Test Procedure* in Appendix C.

The guarded machine should only be placed in operation if all of the above test procedures are verified. Do not use the machine unless an identified problem was corrected.

Cleaning the Light Curtain

Oil, dirt, grease or dust can build up on the black bezel of the transmitter and receiver. This accumulation can affect the operation of the light curtain. A periodic cleaning of the black bezels will prevent problems caused by particulate build up.

Clean the bezels with a mild detergent, glass cleaner or isopropanol (isopropyl alcohol). Use a clean, soft lint-free cloth or wipe.

Painted surfaces may be cleaned with a mild de-greasing cleaner, detergent or isopropyl alcohol.

Inspecting and Replacing the Control Relays

The relays are the only mechanical component in the controller. The control relays should be periodically inspected for contact erosion, pitting, discoloration, etc. If one relay should require replacing, STI strongly recommends that all relays be replaced. Use caution when working in the controller housing, hazardous voltage may be present.

To inspect or replace the relay:

1. Turn off power to the light curtain controller and the controlled machine.
2. Open the controller/power supply enclosure.
3. Locate the three control relays: relays K1 is a status relay; relays K2 and K3 are the safety output relays.
4. Remove any optional retaining strap, if installed. Gently pull the relay from the socket.
5. Inspect the relay for contact erosion, pitting, carbon build up, discoloration or deformation that would warrant relay replacement. If one relay is bad, replace all relays. Order P/N 45173 from STI.

⚠WARNING: The control relay was selected to work with the relay checking circuitry. Never substitute another manufacturer's part. Only use STI supplied replacement relays or the operation of the light curtain may be impaired, possibly resulting in a severe hazard to the operator.

6. Reinstall the relay (or replacement) and retaining clip.
7. Turn on power and perform the *Check Out Procedure* in Appendix B.

Replacing the Fuse

1. Turn the power off.
2. Open the controller/power supply.
3. Use a flat-bladed screwdriver to turn the fuse cover on F1.
4. Check fuse. If a new fuse is needed, use only an exact replacement from STI. Order P/N 51122 for 125 VAC operation or P/N 51135 for 250 VAC operation.

Resetting From an Alarm Fault

The light curtain will only reset if the alarm fault condition has been corrected. To reset, press RESET push button.

Reset From Relay Fault Alarm

To reset from a relay fault alarm, or where the alarm condition cause is unknown:

1. If the green Clear indicator is on, the alarm condition may have been caused by a relay fault, such as a welded contact or bad relay coil. STI recommends replacing both relays if one is faulty. Follow the procedure in *Inspecting and Replacing the Control Relays*. If the status relay signals an alarm condition, but the controller Fault indicator is not on, then either the status relay is bad or the wrong status relay function is active
2. Turn power off. Wait 10 seconds and turn power on.
3. Press the RESET push button.
4. Remove any objects so the sensing field is not interrupted. The alarm condition should be reset.
5. If the alarm is still on, and it is known that all relays are new, contact STI to arrange for repair service.

Changing The Transmitter and Receiver Lengths

The light curtain controller faults if the transmitter and receiver length is changed. For example, assume a 24-inch light curtain is purchased, and later the user application needs change and 36-inch transmitter and receiver are substituted, the controller will go into a fault condition and must be reprogrammed.

To correct, place the controller with the new size sensing heads on a bench or other flat surface with no obstruction in the sensing field. The red Fault indicator will be illuminated. Move the MODE SELECT slide switch to PROGRAM and then press the TEST/STORE push button. Press RESET push button. Move the slide switch to OPERATE. The fault condition should be eliminated. Now adjust power and alignment for a green Clear condition.

TROUBLESHOOTING

Problem 1

Both red and green transmitter indicators are on and one of the red diagnostic indicators is also on.

Causes

1. The relay monitoring circuitry may have detected a faulty relay. STI recommends you replace all control relays.

2. Power may have been cycled too rapidly to the light curtain.

3. Check for a loose connection on the transmitter cable at controller board connector or at the transmitter unit.

4. Check also the receiver connector on controller board and at the receiver unit.

5. User may have attempted to deselect the top channel, or changed the length of the receiver/transmitter heads.

6. Is MPCE monitor feature being used? There may be faults in one of the MPCE or the wiring to the MPCE. Move MPCE mode switches to OFF position. If the fault is cleared, this is the case. Replace the MPCE before attempting to operate the machine.

7. Also refer to Alarm Fault Conditions for other situations which will cause this condition and adjust the unit accordingly. If none of these remedies work, the light curtain has an internal fault. Immediately remove from service and contact STI for repair service.

Problem 2

Red or green indicators on the transmitter do not light, Safety light curtain works normally, green Clear lights when sensing field is not interrupted.

Cause 2

An indicator on the transmitter is burned out. Remove from service and contact STI for assistance.

Problem 3

Both red and green transmitter housing indicators do not light. Transmitter Fault indicator is on.

Cause 3

The quick disconnect connector or transmitter cable connector is not seated properly. Try gently pressing down on the cable connector. If this does not restore the lights, the light curtain has an internal fault. Remove from service and contact STI for assistance. Remove and reinstall the transmitter quick disconnect cable.

Problem 4

Red Block light is on and sensing field is not interrupted.

Cause 4

1. The light curtain is not in alignment. Check to see if the sensing field is obstructed by an object or part of the machine. Inspect the black bezel for oil and particulate build up. If a red Fault indicator is illuminated, you have an alarm condition.

2. If Channel Select is on, check that all of the masked beams are blocked.

Problem 5

All indicator lights off, machinery does not operate.

Cause 5

Check fuse. Replace if faulty. Check power connections.

Problem 6

Status relay does not change state, or signals alarm without an alarm condition.

Cause 6

1. Status relay has failed.
2. Wrong relay function selected.

Problem 7

Machine faults at power on, but then resets and functions normally.

Cause 7

Power Up Inhibit feature is functioning. This may be desirable with your control scheme (see page 30). To turn this feature off, change setting on Feature Select Switch.

Problem 8

Extreme Welding Environments

Cause 8

An extreme welding environment in is one where weld slag is ejected through the sensing field of the light curtain. The duration of multiple weld slag particles through the sensing field may cause the light curtain to go to the Red, Beam Break Condition.

There are three possible solutions to this problem, and depending on the severity of the environment, one or all may be used. First, if the operating distance is 7.5 feet (2.3 meters) or less, move the range select switch to the Short Range setting.

The second solution involves jumpers JMP3 and JMP5 which are located on the main board as detailed on the attached photograph. These alter the time the light curtain waits before re-testing a beam and allows more time for the weld material to move through the sensing field. Both positions are factory shipped

with the yellow jumper attached to only one of two pins. Move JMP3 so it is connected across both of its pins. If the light curtain is still affected by the weld slag, also relocate the yellow jumper for JMP5 so it is connected across both of its pins.

The third condition involves extending the response time of the light curtain to also increase the opportunity for the weld particle to move through the sensing field without tripping the light curtain. This modification is made by moving the yellow jumper for JMP7 so that it is connected across both of its pins.

NOTE: This last method causes the response time of the light curtain to increase to 0.070 seconds. This will result in an increase in the safe mounting distance. The value of Tr = 0.070 seconds must be used in the ANSI safe distance formula.

Light curtains preconfigured at the factory for extreme welding applications can be special ordered. Please contact your local STI distributor or the factory at 1-888-510-4357.

SERVICE

STI offers both factory or on-site field service for fast response to repair needs. Please contact STI or the local STI distributor to arrange for the best repair solution to meet the requirements. When returning the unit to the factory for repair, please call STI at 1-888-510-4357 for a Returned Goods Authorization (RGA) number first. All on-site service will be quoted at then current STI field service rates.

6 Accessories and Spare Parts

STI STANDS, MIRRORS AND MOUNTING KITS

STI offers a mounting stand suitable for use with the light curtains or STI mirrors.

These mirrors are designed for the light curtain and are available in sizes to match the various models. See the latest STI catalog for details.

SHOCK MOUNT KIT

The STI shock mount kit is useful in reducing shock and vibrations transmitted from nearby machinery. Eight rubber shock mounts are provided. Order SHMS-18

CABLES AND INSTALLATION

The standard cables are a 15 ft (4.6 m) cable between the transmitter and the controller and a 5 ft. (1.5 m) cable between the transmitter and the controller. STI can also provide alternate cable lengths.

Appendix A

Specifications

Universal Controller Specifications

General

Response Time: < 0.045 seconds

Input Power: 115 or 230 VAC ±10%, 30 VA, 50/60 Hz, 24 VDC ±10%, 30 VA. LCC-DN version operates only from 24 VDC positive or negative ground

Safety Outputs: Two relays with force-guided contacts, NO, rated 4 amps at 230 VAC, 200 watts switched power (2.0 kVA). DC loads are limited to 100 V maximum. Estimated mechanical life is 5,000,000 operations. Electrical life is typically 100,000 operations at 200 VA.

Status Output: One relay with force-guided, NO and NC contacts, rated 4 amps resistive at 230 VAC.

Indicators: Status-clear, blocked, channel select, floating blanking 1, floating blanking 2, transmitter power, alignment; fault-transmitter, receiver, controller

Temperature: 0° to 55° C

Mechanical

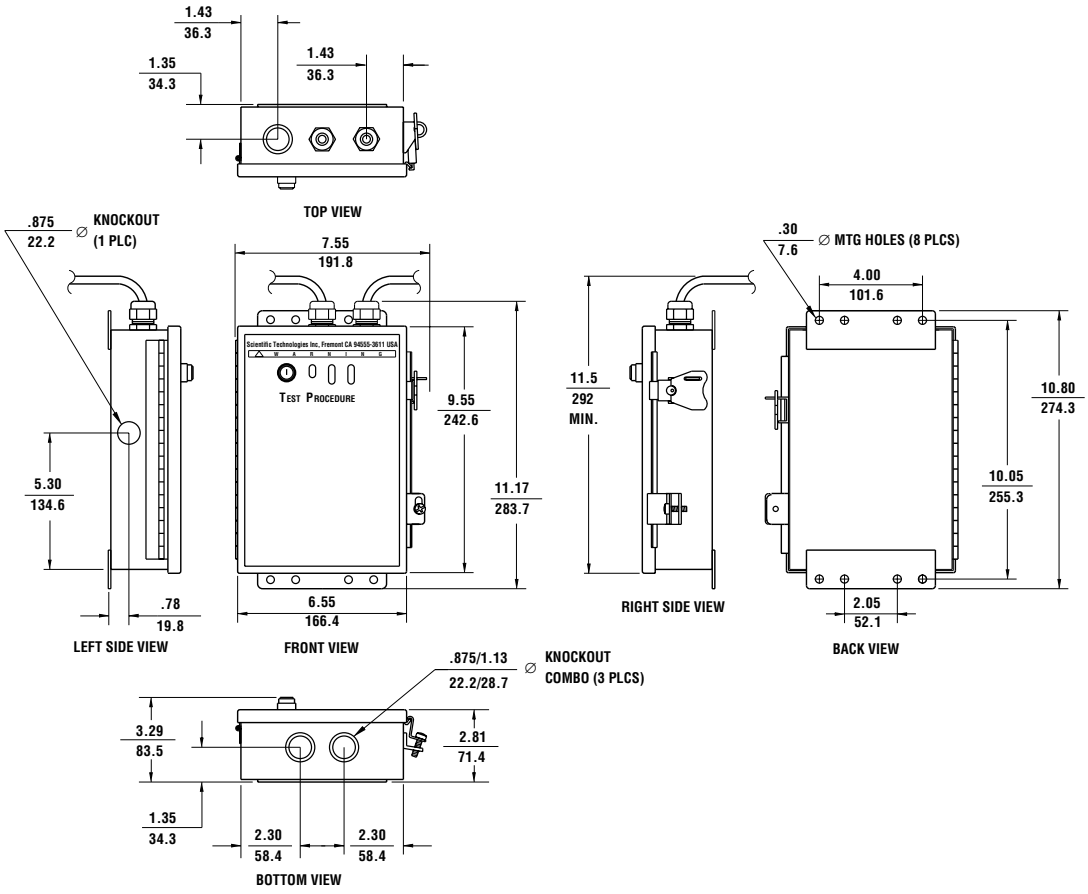
NEMA Enclosure Version: Polyurethane painted steel

DIN-Rail Mount Version: Polycarbonate

Environmental

Protection Rating for NEMA Enclosure Version: NEMA 13, IP65

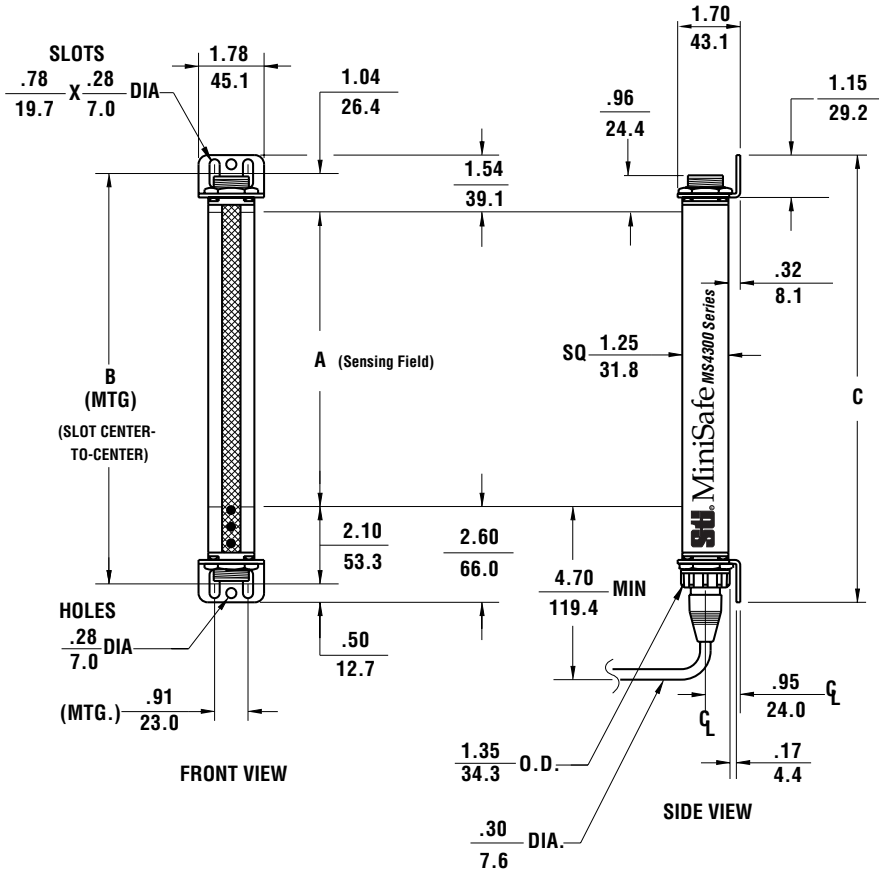
Figure A.1 Universal Controller Mechanical Drawing



Transmitter/Receiver Specifications

	MiniSafe MS4300	MiniSafe MS4400	FlexSafe FS4300	FlexSafe FS4400	OptoFence OF4100	OptoSafe P4100	Perimeter Access PA4400
Beam Spacing	0.5 in	0.5 in	0.5 in	0.5 in.	1.5 in	0.75 in	PA4424 - 20 in PA4436 - 16 in PA4440 - 12 in PA4452 - 12 in PA4464 - 12 in
Minimum Object Resolution	0.75 in	1.00 in	0.75 in	1.00 in.	2.00 in	1.25 in	PA4424 - 18 in PA4436 - 14 in PA4440 - 10 in PA4452 - 10 in PA4464 - 10 in
Operating Range:	30 ft.	100 ft.	30 ft.	100 ft.	100 ft.	100 ft.	100 ft.
Protection Length	4-64 in	4-64 in	8-64 in	8 - 64 in.	6-96 in	12-96 in	24, 36, 40 in
Effective Aperture Angle	+6°	+2.5°	+6°	+2.5°	+3.5°	+3.5°	+2.5°
Light Source	GaAlAs Light Emitting Diode, 880 nm						
Cable Quick Disconnects	Circular, weather-tight disconnect of high strength, glass-filled nylon.						
Construction	Transmitter and receiver are polyester powder painted aluminum.						
Temperature	32°F to 131°F						

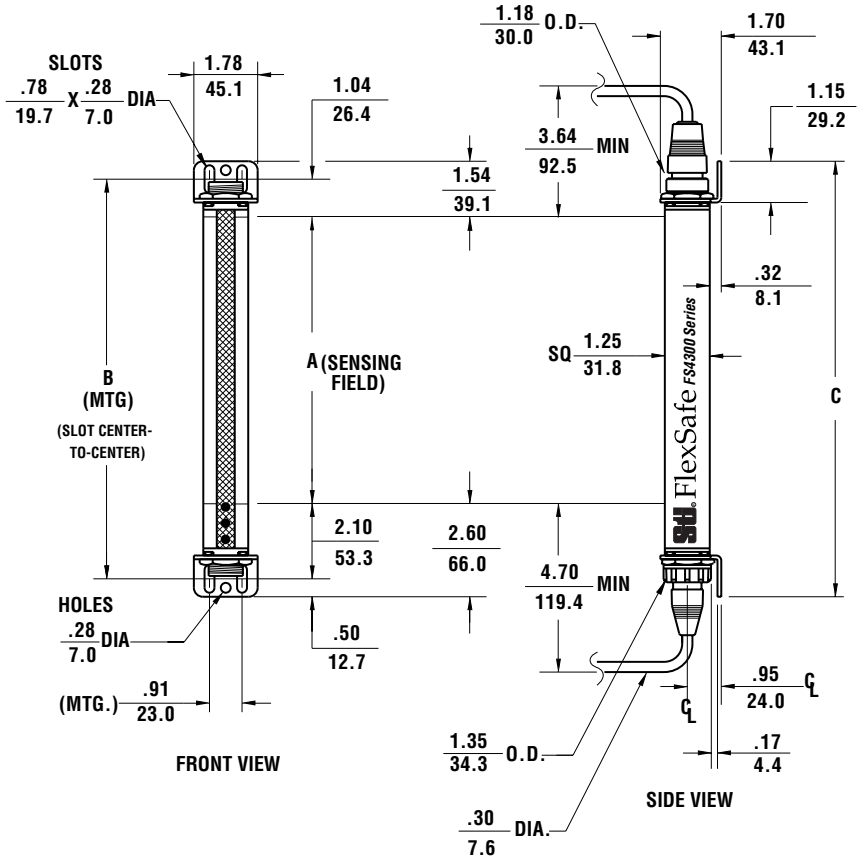
Figure A.2 MiniSafe MS4300 Housing



DIM	MS4304	MS4308	MS4312	MS4316	MS4320	MS4324	MS4328	MS4332
A in./mm	4/102	8/203	12/305	16/406	20/508	24/607	28/711	32/813
B in./mm	7.14/181	11.14/283	15.14/385	19.14/486	23.14/588	27.14/689	31.14/791	35.14/893
C in./mm	8.14/206	12.14/308	16.14/410	20.14/512	24.14/613	28.14/715	32.14/816	36.14/918
Shipping Weight								
lb./kg	16/7.3	16/7.3	17/7.7	18/8.2	18/8.2	18/8.2	19/8.6	20/9.1

DIM	MS4336	MS4340	MS4344	MS4348	MS4352	MS4356	MS4360	MS4364
A in./mm	36/914	40/1016	44/1118	48/1219	52/1321	56/1422	60/1524	64/1626
B in./mm	39.14/994	43.14/1096	47.14/1197	51.14/1299	55.14/1401	59.14/1502	63.14/1604	67.14/1705
C in./mm	40.14/1020	44.14/1121	48.14/1223	52.14/1324	56.14/1426	60.14/1528	64.14/1629	68.14/1730
Shipping Weight								
lb./kg	20/9.1	20/9.1	21/9.5	22/10	22/10	22/10	23/10.4	23/10.4

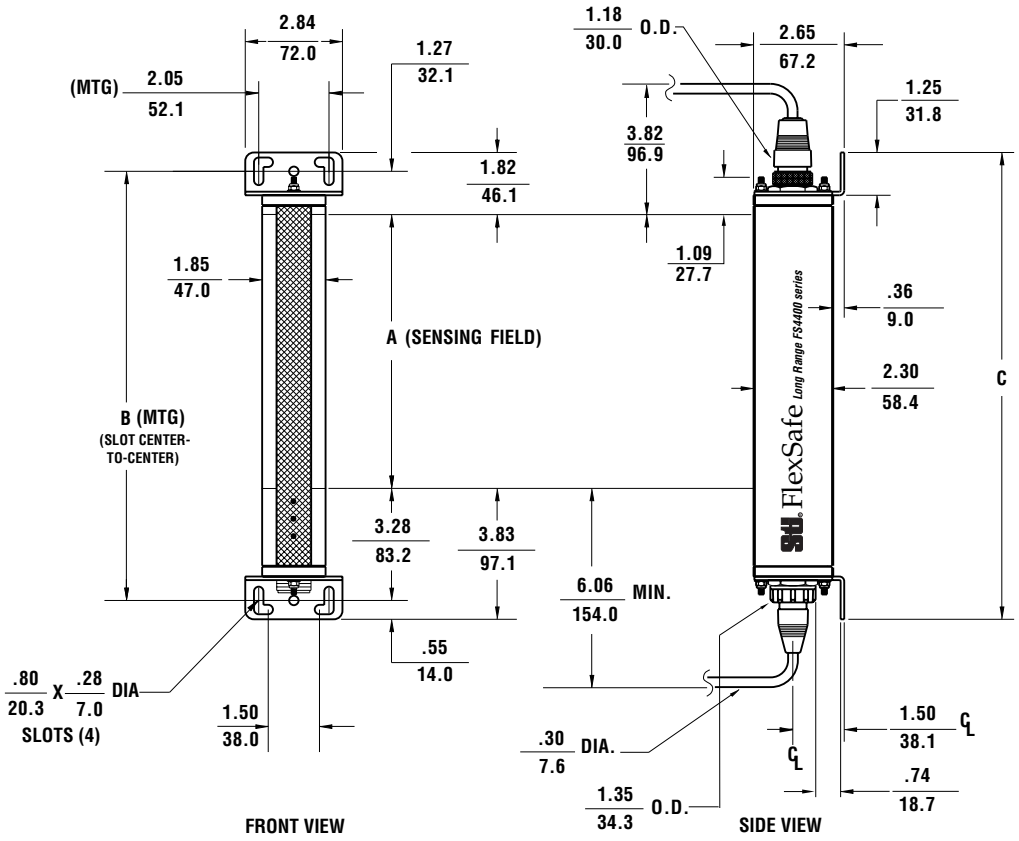
Figure A.3 FlexSafe FS4300 Housing



DIM	FS4304X-1 FS4304X-2 FS4304X-3 FS4304R-1 FS4304R-2 FS4304R-3	FS4308X-1 FS4308X-2 FS4308X-3 FS4308R-1 FS4308R-2 FS4308R-3	FS4312X-1 FS4312X-2 FS4312X-3 FS4312R-1 FS4312R-2 FS4312R-3	FS4316X-1 FS4316X-2 FS4316X-3 FS4316R-1 FS4316R-2 FS4316R-3	FS4320X-1 FS4320X-2 FS4320X-3 FS4320R-1 FS4320R-2 FS4320R-3	FS4324X-1 FS4324X-2 FS4324X-3 FS4324R-1 FS4324R-2 FS4324R-3	FS4328X-1 FS4328X-2 FS4328X-3 FS4328R-1 FS4328R-2 FS4328R-3	FS4332X-1 FS4332X-2 FS4332X-3 FS4332R-1 FS4332R-2 FS4332R-0
A in./mm	4/102	8/203	12/305	16/406	20/508	24/607	28/711	32/813
B in./mm	7.14/181	11.14/283	15.14/385	19.14/486	23.14/588	27.14/689	31.14/791	35.14/893
C in./mm	8.14/206	12.14/308	16.14/410	20.14/512	24.14/613	28.14/715	32.14/816	36.14/918
Shipping Weight								
lb./kg	Each system varies, consult factory.							

DIM	FS4336X-1 FS4336X-2 FS4336X-3 FS4336R-1 FS4336R-2 FS4336R-3	FS4340X-1 FS4340X-2 FS4340X-3 FS4340R-1 FS4340R-2 FS4340R-3	FS4344X-1 FS4344X-2 FS4344X-3 FS4344R-1 FS4344R-2 FS4344R-3	FS4348X-1 FS4348X-2 FS4348X-3 FS4348R-1 FS4348R-2 FS4348R-3	FS4352X-1 FS4352X-2 FS4352X-3 FS4352R-1 FS4352R-2 FS4352R-3	FS4356X-1 FS4356X-2 FS4356X-3 FS4356R-1 FS4356R-2 FS4356R-3	FS4360X-1 FS4360X-3 FS4360R-1 FS4360R-3
A in./mm	36/914	40/1016	44/1118	48/1219	52/1321	56/1422	60/1524
B in./mm	39.14/994	43.14/1096	47.14/1197	51.14/1299	55.14/1401	59.14/1502	63.14/1604
C in./mm	40.14/1020	44.14/1121	48.14/1223	52.14/1324	56.14/1426	60.14/1528	64.14/1629
Shipping Weight							
lb./kg	Each system varies, consult factory.						

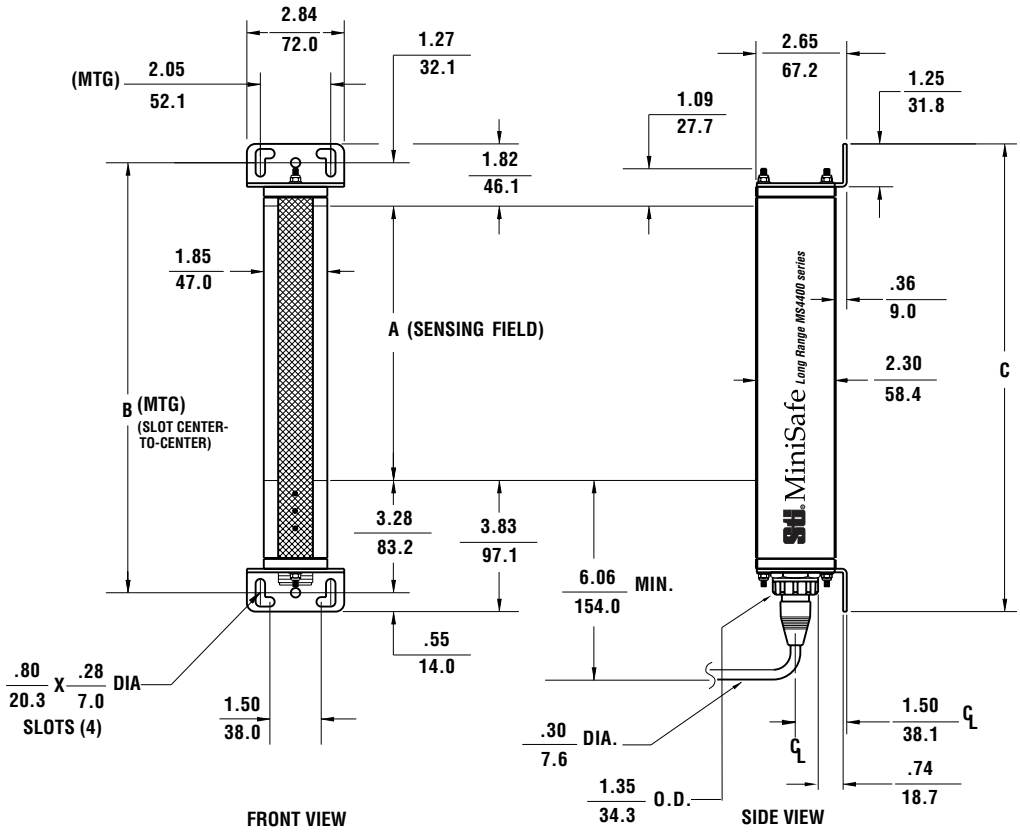
Figure A.4 FlexSafe FS4400 Housing



DIM	FS4404X-1 FS4404X-2 FS4404X-3 FS4404R-1 FS4404R-2 FS4404R-3	FS4408X-1 FS4408X-2 FS4408X-3 FS4408R-1 FS4408R-2 FS4408R-3	FS4412X-1 FS4412X-2 FS4412X-3 FS4412R-1 FS4412R-2 FS4412R-3	FS4416X-1 FS4416X-2 FS4416X-3 FS4416R-1 FS4416R-2 FS4416R-3	FS4420X-1 FS4420X-2 FS4420X-3 FS4420R-1 FS4420R-2 FS4420R-3	FS4424X-1 FS4424X-2 FS4424X-3 FS4424R-1 FS4424R-2 FS4424R-3	FS4428X-1 FS4428X-2 FS4428X-3 FS4428R-1 FS4428R-2 FS4428R-3	FS4432X-1 FS4432X-2 FS4432X-3 FS4432R-1 FS4432R-2 FS4432R-0
A in./mm	4/102	8/203	12/305	16/406	20/508	24/607	28/711	32/813
B in./mm	8.54/217	12.54/319	16.54/420	20.54/522	24.54/623	28.54/725	32.54/827	36.54/928
C in./mm	9.64/245	13.64/346	17.64/448	21.64/550	25.64/651	29.64/753	33.64/854	37.64/956
Shipping Weight								
lb./kg	Each system varies, consult factory.							

DIM	FS4436X-1 FS4436X-2 FS4436X-3 FS4436R-1 FS4436R-2 FS4436R-3	FS4440X-1 FS4440X-2 FS4440X-3 FS4440R-1 FS4440R-2 FS4440R-3	FS4444X-1 FS4444X-2 FS4444X-3 FS4444R-1 FS4444R-2 FS4444R-3	FS4448X-1 FS4448X-2 FS4448X-3 FS4448R-1 FS4448R-2 FS4448R-3	FS4452X-1 FS4452X-2 FS4452X-3 FS4452R-1 FS4452R-2 FS4452R-3	FS4456X-1 FS4456X-2 FS4456X-3 FS4456R-1 FS4456R-2 FS4456R-3	FS4460X-1 FS4460X-3 FS4460R-1 FS4460R-3
A in./mm	36/914	40/1016	44/1118	48/1219	52/1321	56/1422	60/1524
B in./mm	40.54/1030	44.54/1131	48.54/1233	52.54/1335	56.54/1436	60.54/1538	64.54/1639
C in./mm	41.64/1058	45.64/1159	49.64/1261	53.64/1362	57.64/1464	61.64/1566	65.64/1667
Shipping Weight							
lb./kg	Each system varies, consult factory.						

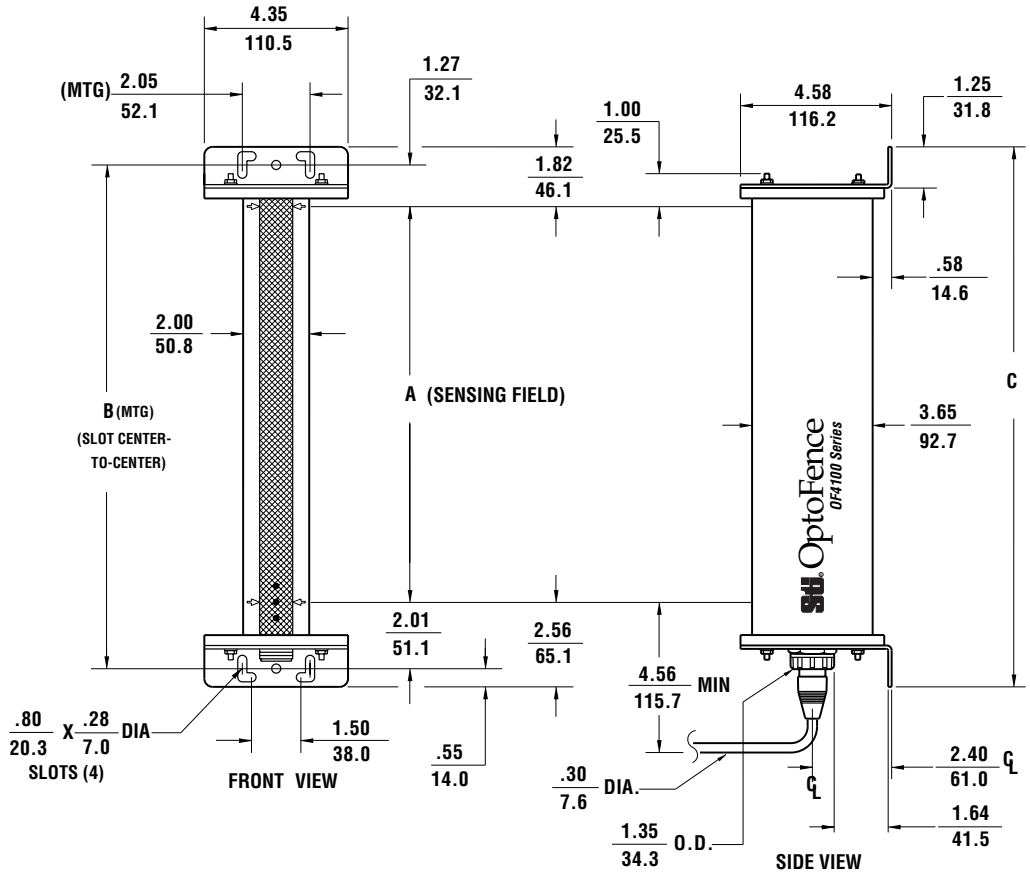
Figure A.5 MiniSafe MS4400 Housing



DIM	MS4404	MS4408	MS4412	MS4416	MS4420	MS4424	MS4428	MS4432
A in./mm	4.0/102	8/203	12/305	16/406	20/508	24/607	28/711	32/813
B in./mm	8.54/217	12.54/319	16.54/420	20.54/522	24.54/623	28.54/725	32.54/827	36.54/928
D in./mm	9.64/245	13.64/346	17.64/448	21.64/550	25.64/651	29.64/753	33.64/854	37.64/956
Shipping Weight								
lb./kg	21/9.5	22/10	22/10	23/10.4	25/11.3	26/11.8	27/12.2	28/12.7

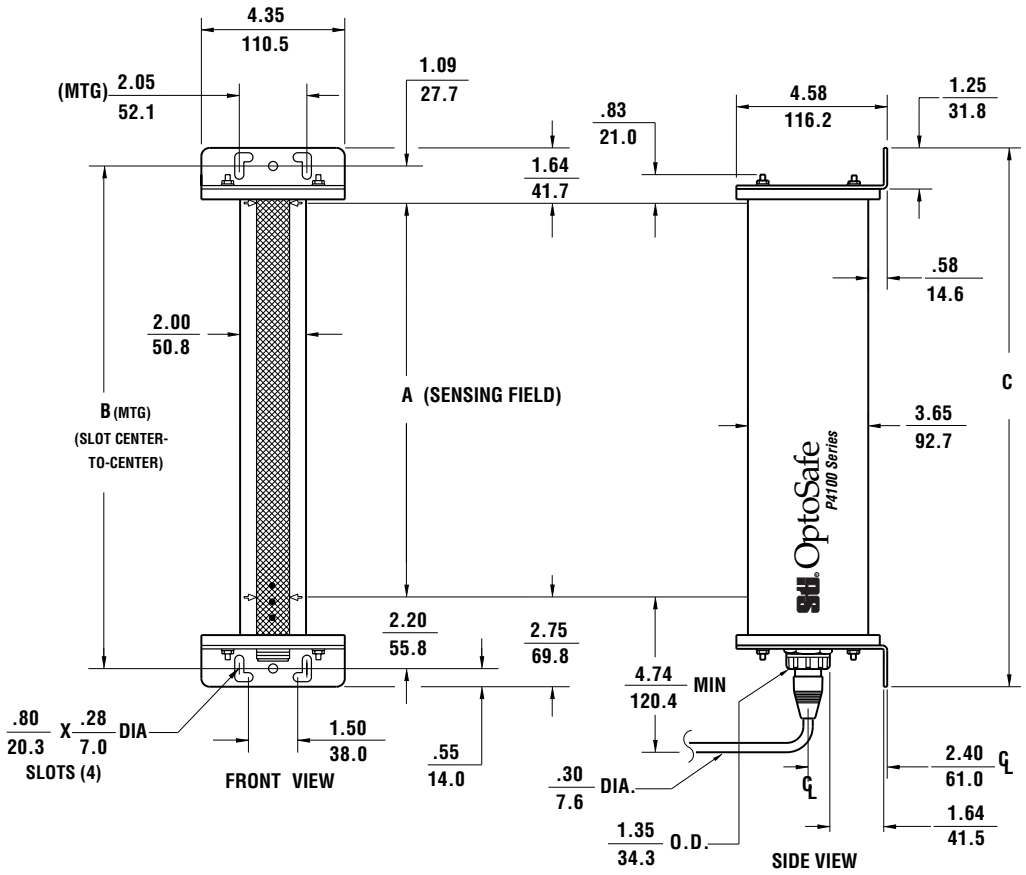
DIM	MS4436	MS4440	MS4444	MS4448	MS4452	MS4456	MS4460	MS4464
A in./mm	36/914	40/1016	44/1118	48/1219	52/1321	56/1422	60/1524	64/1626
B in./mm	40.54/1030	44.54/1131	48.54/1233	52.54/1335	56.54/1436	60.54/1538	64.54/1639	68.54/1741
D in./mm	41.64/1058	45.64/1159	49.64/1261	53.64/1362	57.64/1464	61.64/1566	65.64/1667	69.64/1769
Shipping Weight								
lb./kg	29/13.2	31/14	31/14	33/15	35/15.9	35/15.9	37/16.8	39/17.7

Figure A.6 OptoFence OF4100 Housing



DIM	OF4112	OF4124	OF4136	OF4148	OF4160	OF4172	OF4184	OF4196
A in./mm	12/305	24/610	36/914	48/1219	60/1524	72/1829	84/2134	96/2438
B in./mm	15.28/388	27.28/693	39.28/998	51.28/1303	63.28/1607	75.28/1912	87.28/2217	99.28/2522
C in./mm	16.38/416	28.38/721	40.38/1026	52.38/1330	64.38/1635	76.38/1940	88.38/2245	100.38/2550
Shipping Weight								
lb./kg	25/11.3	30/13.6	33/15	38/17.2	39/17.7	48/21.8	52/23.6	56/25.4

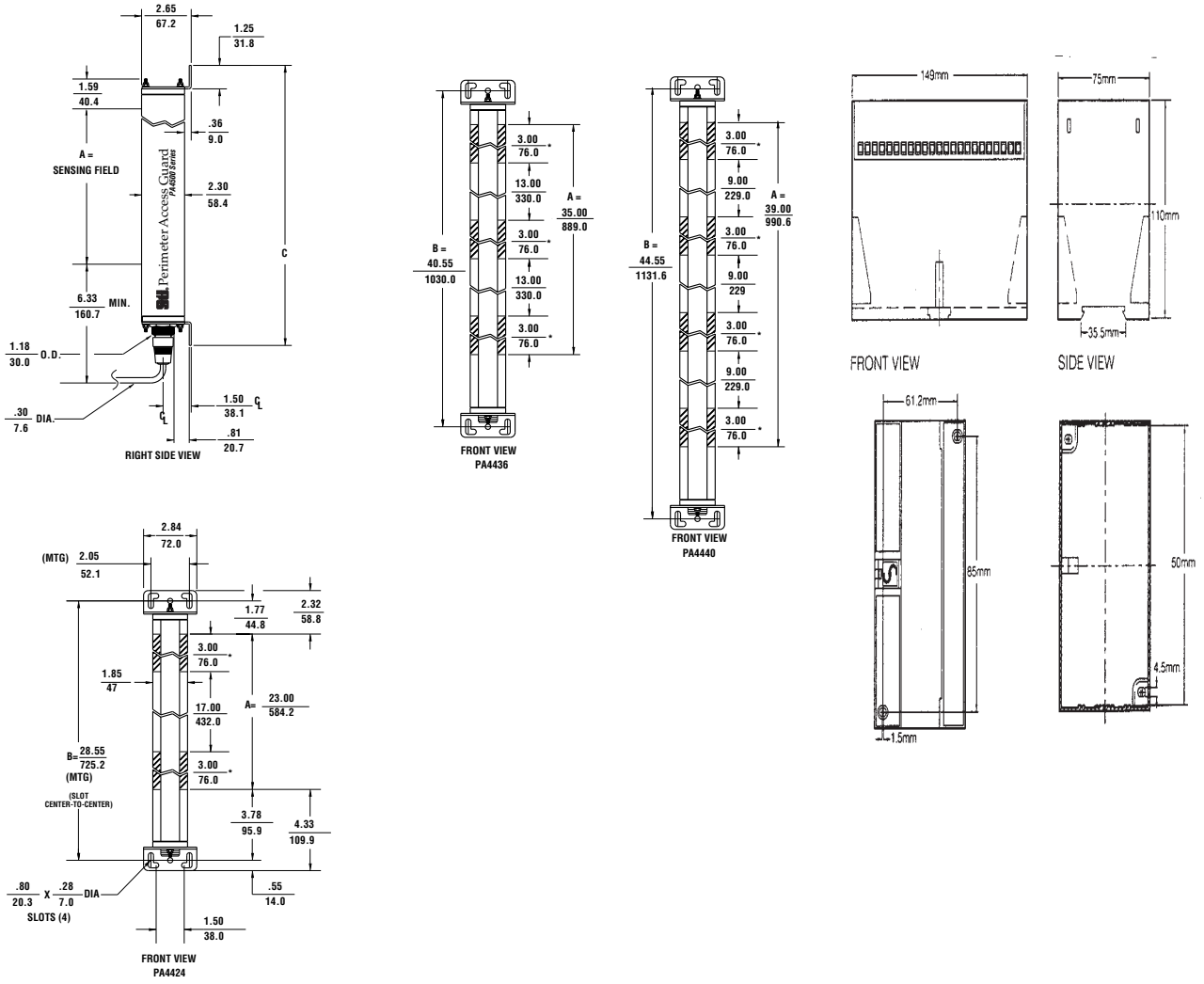
Figure A.7 OptoSafe P4100 Housing



DIM	P4106	P4112	P4118	P4124	P4130	P4236
A in./mm	6/152	12/305	18/457	24/610	30/762	36/914
B in./mm	9.28/236	15.28/388	21.28/541	27.28/693	33.28/845	39.28/998
C in./mm	10.38/264	16.38/416	22.38/568	28.38/721	34.38/873	40.38/1026
Shipping Weight						
lb./kg	24/10.9	25/11.3	28/12.7	30/13.6	31/14	33/15

DIM	P4142	P4148	P4160	P4172	P4184	P4196
A in./mm	42/1067	48/1219	60/1524	72/1829	84/2134	96/2438
B in./mm	45.28/1150	51.28/1303	63.28/1607	75.28/1912	87.28/2217	99.28/2522
C in./mm	46.38/1178	52.38/1330	64.38/1635	76.38/1940	88.38/2245	100.38/2550
Shipping Weight						
lb./kg	36/16.3	38/17.2	41/18.6	48/21.8	52/23.6	56/25.4

Figure A.8 Perimeter Access PA4400 Housing



DIM	PA4424	PA4436	PA4440	PA4452	PA4464
A in./mm	23.0/584	35.0/889	39.0/991	51.0/1295	63.0/1600
B in./mm	28.55/725	40.55/1030	44.55/1132	56.55/1436	68.55/1741
C in./mm	29.65/753	41.65/1058	45.65/1160	57.65/1464	69.65/1769
Shipping Weight					
lb./kg	26/11.8	29/13.2	31/14	34/15.5	37/16.8

Appendix B

Checkout Procedure Log

The following *Checkout Procedure* must be performed by *qualified* personnel during initial light curtain installation and at least every three months or more frequently depending on a machine usage and company guidelines.

Hint: make a copy of this blank page and use the copy as the checkout log to be kept with the machine records. Use caution when working around hazardous voltages which may be present during these procedures.

Machine Identification _____ Date _____

Item	Condition	Comments
1. Verify the guarded machine is compatible with the type of machine which may be used with a safety light curtain. See *Step 1 – Usage Requirements* for further information on incompatible machinery.	❑ Pass ❑ Fail	
2. Verify that the mounting distance of the light curtain is equal to or greater than the minimum safe distance from the point of hazardous operation. See *Step 2 – Minimum Safe Distance Calculation*.	❑ Pass ❑ Fail	
3. Determine that all access to the danger point not protected by a light curtain is guarded by other means, such as gates, fencing, wire screening or other approved methods. Verify that all additional guarding devices, interlock switches and mechanical barriers are installed and operating properly.	❑ Pass ❑ Fail	
4. Make sure the operator is not able to stand between the light curtain sensing field and the danger point of the machine. Verify that the light curtain can only be reset from a position outside and within the view of the hazardous machine area.	❑ Pass ❑ Fail	
5. With the door of the controller enclosure open, inspect the electrical connections between the guarded machine control circuitry and the light curtain. Verify that they are properly connected to the machine such that a stop signal from the light curtain results in an immediate halt at any point in the machine's cycle or stroke. See *Machine Control Circuit Connections*.	❑ Pass ❑ Fail	
6. Inspect the light curtain to ensure that the controller STATUS RELAY is properly configured for the installation. See *Step 5 – Safety Light Curtain Configuration* for further information.	❑ Pass ❑ Fail	
7. If the control wiring scheme uses the STATUS RELAY, press the TEST/STORE push button with the guarded machine controller energized to verify the proper electrical connection of the STATUS RELAY to the machine control. Even if your wiring does not use the STATUS RELAY, simulate a fault condition by pressing the TEST/STORE button. The light curtain should go into a lockout condition and the output and status relays de-energize. Press the RESET button to correct from the fault condition.	❑ Pass ❑ Fail	
8. If the MPCE monitoring feature is not used, proceed to step 9. To test the MPCE monitoring feature, verify that positions 1 and 2 on S1 are correctly set. Turn the machine power on. Cycle the machine. Place a temporary jumper wire between MPCE Monitor 1 and 2 connections on TB1. The light curtain should enter a fault condition. Remove the temporary wire. Press the Reset button to recover from the fault.	❑ Pass ❑ Fail	
9. Record the test results in the machine log. Next, perform the Test Procedure.		

Comments :

_____

_____

_____

Technician Signature_____

Appendix C

Test Procedure

The following tests must be performed at installation and after any maintenance, adjustment, repair or modification to the light curtain or the machine. In addition, the tests must also be performed after Channel Select (CS Operate) is enabled or disabled. Testing ensures that the light curtain and the machine control system work properly to stop the machine. Failure to test properly could result in serious injury to personnel.

The following *Test Procedure* must always be performed by *qualified* personnel after the mounting, alignment and wiring steps are completed and before the light curtain is used to control the machine. To test the light curtain, use the STI supplied test object or opaque object of the appropriate size.

Machine Identification_____ Date _____

Item	Condition	Comments
1. Disable the machine to be guarded. Turn power on to the light curtain. Place the slide switch in the Operate mode. (or CS Operate if you are using Channel Select).	☐ Pass ☐ Fail	
2. Visually inspect the machine to ensure that entry to the hazardous area is only through the light curtain sensing field. If not, additional guarding including mechanical barriers may be required. Verify that all additional guarding devices and barriers are installed and operating properly.	☐ Pass ☐ Fail	
3. Verify that the mounting distance of the light curtain is equal to or greater than the calculated maximum safe distance from the point of hazardous operation. See *Step 2 – Minimum Safe Distance Calculation*. Ensure that the operator is not able to stand between the Safety light curtain sensing field and point of hazardous operation.	☐ Pass ☐ Fail	
4. Check for signs of external damage to the light curtain, the machine and the electrical cables and wiring. If any damage is found, lockout the machine off and report to the supervisor.	☐ Pass ☐ Fail	
5. Next, interrupt the sensing field with the proper size test object to check the effectiveness of the light curtain. Move the test object inside the perimeter (along the top, sides and bottom) of the sensing field and up and down through the center of the sensing field. Verify that the red indicator is on and the green indicator is off while the test object is anywhere in the sensing field. Also, watch for any unprotected access to the danger point.	☐ Pass ☐ Fail	
6. Start the machine. While the machine is in motion, interrupt the sensing field with the test object. The machine should stop immediately. Never insert the test object into the dangerous parts of the machine. With the machine at rest, interrupt the sensing field with the test object. Verify that the machine will not start with the test object in the sensing field. Note: Some mechanical power presses may use muting, which bypasses the light curtain during the nonhazardous movement of the press, such as the upstroke. Interrupting the sensing field during this portion of the cycle will not stop the machine.	☐ Pass ☐ Fail	
7. Make sure that the braking system is working properly. If the machine does not stop fast enough, adjust the braking system or increase the distance from the sensing field to the point of operation hazard.	☐ Pass ☐ Fail	
8. If the safety devices or the machine fails any of these tests, **do not run the machine**. Immediately tag or lockout the machine to prevent its use and notify the supervisor.		
9. If the Channel Select is reprogrammed or disabled, these test procedure must be repeated.		
10.Close and lock the controller enclosure door after the testing is completed.		

Comments:

Technician Signature_____

⚠ **WARNING:** If the light curtain and machinery did not function exactly as described in the Test Procedure, **do not operate the machinery.** If the machine safety devices, braking systems and controls do not operate properly, they cannot stop hazardous machine motion. Serious injury to personnel could result.

⚠ **WARNING:** The following precaution is in accordance with the requirements of BS 6491. The procedure in step 5 should be employed by the user to "... ensure that the sensing unit detection capability is not adversely affected by any reflective surfaces on the machine or the material being worked." [BS 6491: Part 2 (11.3):1987] This condition would be indicated by the green light on while the test object is in the sensing field. This lack of response by the light curtain may be caused by infrared light from the transmitter reflecting off an adjacent reflective surface via an alternate path to the receiver. Failure to correct for this lack of response can result in severe operator injury. Either relocate the sensing field farther away from the reflecting surface or reduce the reflectivity of the surface by painting, masking or substituting materials. Poor alignment between the transmitter and receiver and/or improper Range Adjustment setting may aggravate interference with a reflective surface. After correcting the installation, repeat this Test Procedure.

Appendix D

OSHA Regulations – Selected Passages

The following are selected sections from the OSHA 1910.217 standards for Mechanical Power Presses concerning light curtain presence sensing devices, machine controller design and other information. Interpretations are provided with permission from the Precision Metalforming Association (PMA), formerly called the American Metal Stamping Association.

STI provides the information for user reference only and makes no claim regarding a specific recommendation of any organization, the accuracy, or effectiveness for a specific application. These excerpts are not intended to be used as a replacement for the complete OSHA standards. Addresses to obtain further information are provided in *Appendix E – Additional Information.*

OSHA 1910.217(b)(7) PART REVOLUTION CLUTCH, CONTROLS

(7) Machines using part revolution clutches.

(i) The clutch shall release and the brake shall be applied when the external clutch engaging means is removed, deactivated, or de-energized.

(ii) A red color stop control shall be provided with the clutch/brake control system. Momentary operation of the stop control shall immediately deactivate the clutch and apply the brake. The stop control shall override any other control, and reactuation of the clutch shall require use of the operating (tripping) means which has been selected.

(iii) A means of selecting of, "Inch," Single Stroke, and Continuous (when the continuous function is furnished) shall be supplied with the clutch/brake control to select type of operation of the press. Fixing of selection shall be by means capable of supervision by the employer.

PMA INTERPRETATION

(7)(ii) Refers to part revolution clutch only.

(7)(iii) Control modes cannot be readily changed by the press operator without administrative supervision. A key lock switch is a convenient way of providing supervisory control if keys are not available to operators.

OSHA 1919.217(b)(13) CONTROL RELIABILITY

(13) Control reliability. When required by paragraph (c) (5) of this section, the control system shall be constructed so that a failure within the system shall not prevent the normal stopping action from being applied to the press when required, but does prevent initiation of a successive stroke until the failure is corrected. The failure shall be detectable by a simple test, or indicated by the control system. This requirement does not apply to those elements of the control system which have no effect on the protection against point of operation injuries.

PMA INTERPRETATION

(13) The main requirements for control reliability are: 1. That no failure prevent the stopping action from occurring, and 2. That no successive stroke can be initiated until the failure is cleared. There requirements impose a need for self-checking/self-monitoring such that any failure will be detected and thus subsequent strokes will be prohibited. When the above requirements are met the requirement for indication or simple test is fully provided. The best of all indication of failure is the press won't run. Also the tests to detect a failure are done automatically. Care must be exercised when evaluating a press control system in meeting this requirement. The control system must be considered to be all the elements covered in the definition for "Control System" which effect the point of operation.

OSHA 1910.217(b)(14) BRAKE SYSTEM MONITORING

(14) Brake system monitoring. When required by paragraph (c)(5) of this section, the brake monitor shall meet the following requirements:

(i) Be so constructed as to automatically prevent the activation of a successive stroke if the stopping time or braking distance deteriorates to a point where the safety distance being utilized does not meet the requirements set forth in paragraph (c)(3)(iii)(e) or (c)(3)(vii)(c) of this section. The brake monitor used with the Type B gate or movable barrier device shall be installed in a manner to detect slide top-stop overrun beyond the normal limit reasonably established by the employer.

(ii) Be installed on a press which indicates when the performance of the braking system has deteriorated to the extent described in paragraph (b)(14)(i) of this section; and

(iii) Be constructed and installed in a manner to monitor brake system performance on each stroke.

PMA INTERPRETATION

• *Brake Monitor must check the continued effectiveness of the braking system.*

• *The Brake Monitor is not in itself a point of operation device.*

• *It must be used on a part revolution clutch press in conjunction with a two hand control, presence sensing or Type B gate (movable barrier device), when these are used as point of operation safety device with hand-in-the-die feeding.*

• *The Brake Monitor is part of the press control system and must inhibit further stroking of the press when braking action exceeds predetermined limits.*

• *The predetermined limits must be equal to or less than the stopping time used in setting the safety distance.*

• *The Brake Monitor as well as the press control must meet the "control reliability requirements" as specified in (1910.217)(b.13).*

OSHA 1910.217(c) SAFEGUARDING THE POINT OF OPERATION

(1) General Requirements.

(i) Its shall be the responsibility of the employer to provide and insure the usage of "point of operation guards" or properly applied and adjusted point of operation devices on every operation performed on a mechanical power press. See Table 0 – 10.

(ii) The requirement of subdivision (i) of this subparagraph shall not apply when the point of operation opening is one-fourth inch or less. See Table 0 – 10.

PMA INTERPRETATION

(Table 0 – 10 is reproduced at the end of this Appendix)

OSHA 1910.217 (c)(3) POINT OF OPERATION DEVICES

(i) Point of operation devices shall protect the operator by:

(a) Preventing and/or stopping normal stroking of the press if the operator's hands are inadvertently placed in the point of operation.

PMA INTERPRETATION

Presence sensing device.

OSHA 1910.217 (C)(3)(III) PRESENCE SENSING DEVICE

(iii) A presence sensing point of operation device shall protect the operator as provided in paragraph (c)(3)(i)(a) of this section, and shall be interlocked into the control circuit to prevent or stop slide motion if the operation's hand or other part of his body is within the sensing field of the device during the downstroke of the press slide.

(a) The device may not be used on machines using full revolution clutches.

(b) The device may not be used as a tripping means to initiate slide motion except when used in total conformance with paragraph (h) of this section.

(c) The device shall be constructed so that a failure within the system does not prevent the normal stopping action from being applied to the press when required, but does prevent the initiation of a successive stroke until the failure is corrected. The failure shall be indicated by the system.

(d) Muting (bypassing of the protective function) of such device, during the upstroke of the press slide, is permitted for the purpose of parts ejection, circuit checking, and feeding.

(f) Guards shall be used to protect all areas of entry to the point of operation not protected by the presence sensing device.

PMA INTERPRETATION

(c)(3)(i)(a) Refers to the functional requirement of a presence sensing device which prevents and/or stops normal stroking of the press.

(Note: paragraph (h) refers to very specialized and specific requirements for Presence Sensing Device Initiation.)

When failure occurs the best indication is the press won't run.

Top of stroke is the point at which muting shall cease as it is not possible to set a point on the downstroke as the exact position where the hazard of die closing starts.

(3)(iii)(f) Great care must be taken to assure that no access to the die area exists unguarded.

OSHA 1910.217 (c)(3)(5) ADDITIONAL REQUIREMENTS FOR SAFEGUARDING

Where the operator feeds or removes parts by placing one or both hands in the point of operation, and a two hand control, presence sensing device of Type B gate or movable barrier (on a part revolution clutch) is used for safeguarding.

(i) the employer shall use a control system and a brake monitor which comply with paragraphs (b) (13) and (14) of this section.

PMA INTERPRETATION

This paragraph tells the condition under which a brake monitoring system is required after November 1, 1975.

(b)(13) Control reliability.

(b)(14) Construction requirements.

(ii) the exception in paragraph (b)(7)(v)(d) of this section for two hand controls manufactured and installed before August 31, 1971, is not applicable under this paragraph (c)(5);

(iii) the control of air clutch machines shall be designed to prevent a significant increase in the normal stopping time due to a failure within the operating valve mechanism, and to inhibit further operation if such failure does occur, where a part revolution clutch is employed. The exception is paragraph (b)(7)(xi) of this section for controls manufactured and installed before August 31, 1971, is not applicable under this paragraph (c)(5).

When a brake monitor is required, two-hand controls manufactured and installed before August 31, 1975, must be designed to require release of all operator's hand controls before an interrupted stroke can be resumed.

When a brake monitor is required this paragraph removes the exception on valve mechanism manufactured or installed before August 31, 1971. All machines regardless of age used for hands-in-the-die-feeding or unloading and using a two hand control device, presence sensing device or type B gate must utilize a dual self-checking air valve.

OSHA 1910.217(e) INSPECTION, MAINTENANCE, AND MODIFICATION OF PRESSES

PMA INTERPRETATION

(1) Inspection and maintenance records.

(i) It shall be the responsibility of the employer to establish and follow a program of periodic and regular inspections of his power presses to insure that all their parts, auxiliary equipment, and safeguardings are in a safe operating condition and adjustment. The employer shall maintain records of these inspections which includes the date of inspection, the signature of the person who performed the inspection, and the serial number, or other identifier of the power press that was inspected.

Records of clutch and brake will be weekly. Other inspections are periodic subject to time factor determined by employer.

(ii) Each press shall be inspected and tested no less than weekly to determine the condition of the clutch/brake mechanism, antirepeat feature and single stroke mechanism. Necessary maintenance or repair or both shall be performed and completed before the press is operated. The employer shall maintain records of these inspections and the maintenance work performed. These requirements do not apply to those presses which comply with paragraphs (b)(13) and (14) of this section. The employer shall maintain a certification record of inspections, test, and maintenance work which includes the date of inspection, the signature of the person who performed the inspection, test or maintenance; and the serial number or other identifier of the press that was inspected, tested or maintained.

If a brake monitoring system is installed, weekly inspection and records are not required for clutch/brake mechanism. Other parts of the press will require periodic inspections and records.

(2) Modification. It shall be the responsibility of any person modifying a power press to furnish instructions with the modification to establish new or changed guidelines for use and care of the power press so modified.

(3) Training of maintenance personnel. It shall be the responsibility of the employer to insure the original and continuing competence of personnel caring for, inspecting , and maintaining power presses.

PMA's's training material will assist you in meeting this requirement.

OSHA 1910.217(5)(c) OPERATION OF POWER PRESSES

PMA INTERPRETATION

(2) Instructions to operators. The employer shall train and instruct the operator in the safe method of work before starting work on any operation covered by this section. The employer shall insure by adequate supervision that correct operating procedures are being followed.

PMA's new training manual for press operator will help you meet this requirement.

(3) Work area. The employer shall provide clearance between machines so that movement of one operator will not interfere with the work of another. Ample room for cleaning machines, handling material, work pieces, and scrap shall also be provided. All surrounding floors shall be kept in good condition and free from obstructions, grease, oil, and water.

Good general housekeeping is always required.

(4) Overloading. The employer shall operate his presses within the tonnage and attachment weight ratings specified by the manufacturer.

Check tonnage and weight of die at time of diesetting.

TABLE O – 10

Distance of opening from Point of Operation hazard in inches	Maximum width of opening in inches
1/2 to 1-1/2	1/4
1-1/2 to 2 1/2	3/8
2-1/2 to 3-1/2	1/2
3-1/2 to 5-1/2	5/8
5-1/2 to 6-1/2	3/4
6-1/2 to 7-1/2	7/8
7-1/2 to 12-1/2	1-1/4
12-1/2 to 15-1/2	1-1/2
15-1/2 to 17-1/2	1-7/8
17-1/2 to 31-1/2	2-1/8

This table shows the distances that guards shall be positioned from the danger line in accordance with the required openings. (from OSHA 1910.217)

Appendix E

Additional Information

REFERENCE MATERIAL

In addition to the applicable state and federal Occupational Safety and Health Administration (OSHA) regulations, several other organizations can provide informational material on the use of presence sensing devices as guards on automated machinery and presses. STI provides this information for user reference only and makes no claim regarding: a specific recommendation of any organization; the accuracy or effectiveness of any information provided; or the appropriateness of any information provided for a user's specific application.

Federal OSHA Standards
The US Government Printing Office
Order desk: (202) 512-1800

Global Engineering
2805 McGraw Ave., Irvine, CA 92714
Phone: (800) 854-7179
Global Engineering is a good source for the purchase of US and international engineering standards.

American National Standards Institute, Inc. (ANSI)
1430 Boarding, New York City, NY 10018
Sales: (212) 642-4900
The ANSI B11 series are the ANSI standards for machine tools.

The following is a partial listing of some ANSI standards which may be of interest. (Ask for the most current version when ordering).

- ANSI B11.1 Mechanical Power Presses
- ANSI B11.2 Hydraulic Power Presses
- ANSI B11.3 Power Press Brakes
- ANSI B11.10 Metal Sawing Machines
- ANSI B11.19 Safeguarding When Referenced By Other Machine Tool Safety Standards (good over view of machine guarding)
- ANSI B11.20 Manufacturing Systems/Cable

The Association for Manufacturing Technology
(formerly known as National Machine Tool Builders Association)
7901 Westpark Dr., McLean, VA 22102-4269
(703) 893-2900

Robotics Industry Association
900 Victors Way, P.O. Box 3724,
Ann Arbor, MI 48106
(313) 994-6088

Canadian Standards Association
5760 Minoru Blvd., Richmond (Vancouver),
British Columbia, Canada V6X 2A9
Phone: (604) 273-4581

Precision Metalforming Association
27027 Chardon Road, Richmond Heights, OH 44143
Phone: (216) 585-8800
Fax: (216) 585-3126

The Training Resource Directory is a compendium of training resources with application in the metalforming industries. The Safety Guidelines Checklist is a good document to evaluate your company's safety program.

National Safety Council
Chicago Headquarters Office
444 North Michigan Ave., Chicago, IL 60611
Phone: (800) 621-7615

The following publications are available from your local chapter of the National Safety Council: Accident Prevention Manual and the Power Press Safety Manual.

PATENTS

Elements of the electronics and optics essential to meet the specifications and performance standards of STI controls are covered by one or more of the following US Patent Numbers: 5,198,661; 5,281,809; 5,302,942; 3,774,039; 3,867,628; 3,967,111; 3,996,476; 4,007,387; 4,101,784; 5,015,840; Design 255,031, and other patents pending.

TRADEMARKS

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NOTE

This publication has been carefully checked for accuracy and is believed to be fully consistent with the products it describes. However, STI does not assume liability for the contents of this publication; the examples used within or the use of any product described herein. STI reserves the right to make changes to products and/or documentation without further notification.

Appendix
F

Universal Controller LCC-DN
DIN-rail version

An addendum to Universal Controller

Appendix F.1

Introduction

The Universal controller model LCC-DN is a DIN-rail mounted version of the standard Universal controller. The purpose of this addendum is to highlight the differences in operation and installation. For subjects not covered by this addendum, please refer to the main manual.

Appendix F.2

Dimensional Drawing

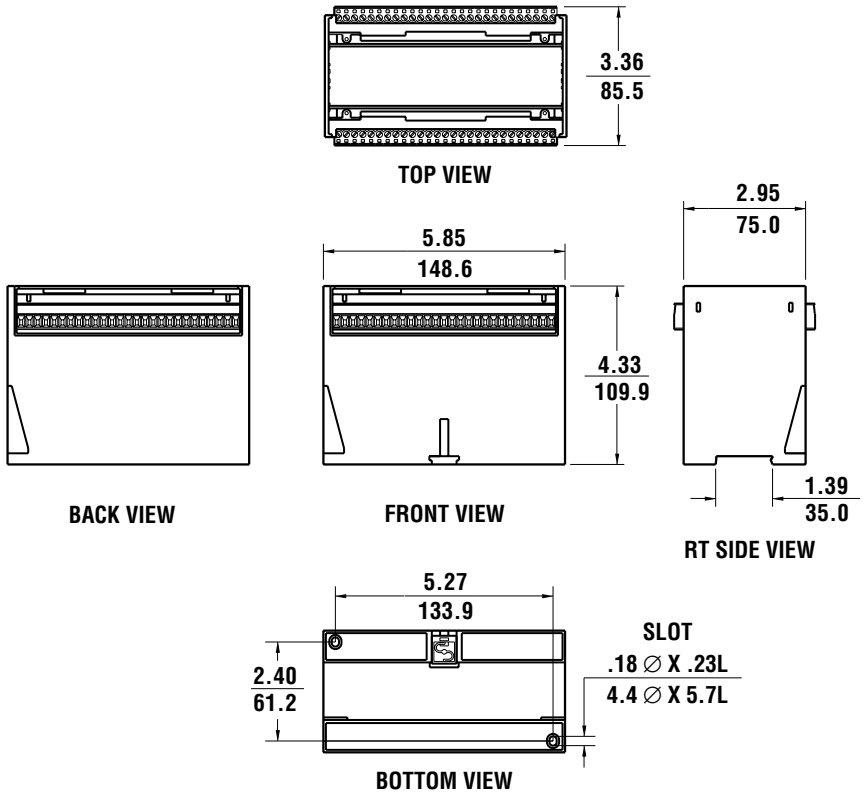


Figure F2.1 Dimensional Drawing

Appendix F.3

Description of Controls

ENCLOSURE

In order to prevent tampering with the safety light curtain set-up it is intended that this controller be mounted in a properly constructed, lockable, shielded enclosure. This allows access to the controller only by a supervisor controller key. Selection of Channel Select and Standard Operating modes, as well as system resets are accomplished with remote key switches.

The enclosure for the LCC-DN controller can be mounted to a panel via two different methods.

The first method is by using a standard 35 mm DIN rail. The second is by screwing the enclosure to the panel using the holes provided in the base of the enclosure.

A convenient feature of LCC-DN enclosure is the ability to remove the terminal blocks for wire connection. This capability allows the quick change out of a control should it be damaged. The terminal positions are labeled both on the enclosure and on the terminal block.

The front panel of the enclosure is easily removed for access to set-up and installation switches.

SWITCHES AND INDICATOR LIGHTS

The LCC-DN controller features all of the same indicator lights and programming switches as the standard Universal controller.

Those not visible through the label on the front cover can be accessed by simply removing the front cover. The front cover is removed by inserting a screwdriver or finger nail in the slot located at the top, middle of the cover and gently pulling out.

The function and settings for switches are outlined on a label on the back side of the front cover (see figure F3.1).

CABLE ASSEMBLY

Systems are shipped with the cables specified by the customer. Cables must be run from the transmitter and receiver to the controller. Please observe all warnings regarding cable runs contained in the main manual.

Cables for the LCC-DN controller can be cut to length in the field. The individual conductors in the cable should have $^1/_4$ inch of insulation removed and be properly tinned to assure good contact with the terminal block.

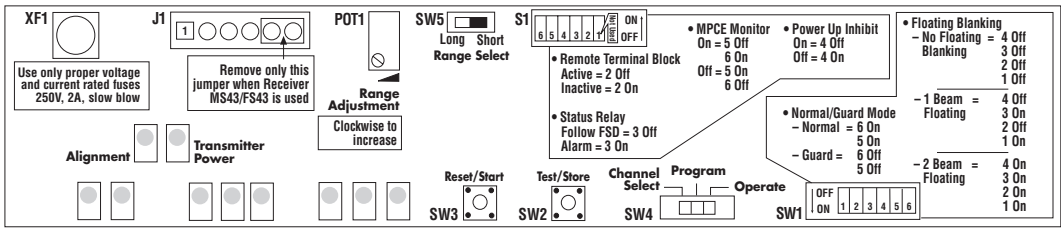


Figure F3.1 Function and Settings

See the sections which follow for proper connection information.

Note: Both transmitter and receiver cables are shipped with ferrite rings installed on the controller end of the cable. If these cables are shortened or modified, these rings must be reinstalled prior to operating the light curtain.

Transmitter Cable Connection

The quick-disconnect fitting on the transmitter cable is color-coded black. The transmitter cable has 14 insulated conductors and one braided conductor which is connected to the cable shield.

The individual conductors in the transmitter cable should be connected as follows:

Terminal Position	Conductor Color
T1	White/Black
T2	White/Red
T3	Violet
T4	Gray
T5	Brown
T6	Yellow
T7	Red
T8	Blue
T9	Orange
T10	Pink
T11	Green
T12	Tan
T13	White
T14	Black

Note: Transmitter and receiver cable shields must be grounded directly to bare metal on the enclosure.

Receiver Cable Connection

The quick-disconnect fitting on the receiver cable is color-coded red. The receiver cable has 12 insulated conductors and one braided conductor which is connected to the cable shield.

NOTE: Two termination schemes exist for the receiver cable. Please confirm which series receiver you are installing prior to proceeding.

MiniSafe MS4300, FlexSafe FS4300 Receiver Cable Connection

The following table provides receiver cable connection information only for MiniSafe MS4300 and FlexSafe FS4300 series receivers. The individual conductors in the receiver cable should be connected as follows:

Terminal Position	Conductor Color
E1	Gray
E2	Not Used
E3	Blue
E4	Not Used
E5	Not Used
E6	Red
E7	Yellow
E8	Black
E9	Violet
E10	Orange
E11	White
E12	Brown
E13	Not Used
Not Used	Tan, Pink & Green (see note below)

Note: Transmitter and receiver cable shields must be grounded directly to bare metal on the enclosure.

The conductor colors which are not used should be shortened such that they cannot be terminated.

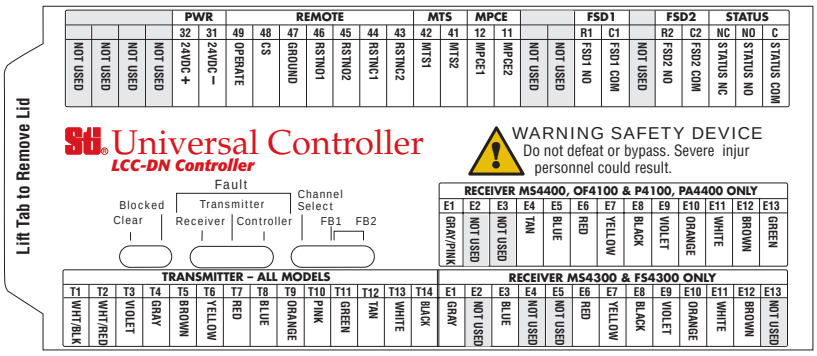


Figure F3.2 Universal Controller Wiring Information

FlexSafe FS4400, MiniSafe MS4400, OptoSafe P4100, OptoFence OF4100 and Perimeter Access PA4400 Receiver Cable Connection

The following table provides receiver cable connection information only for FlexSafe FS4400, MiniSafe MS4400, OptoSafe P4100, OptoFence OF4100 and Perimeter Access PA4400 series receivers. The individual conductors in the receiver cable should be connected as follows:

Terminal Position	Conductor Color
E1	Gray & Pink
E2	Not Used
E3	Not Used
E4	Tan
E5	Blue
E6	Red
E7	Yellow
E8	Black
E9	Violet
E10	Orange
E11	White
E12	Brown
E13	Green

Note: Transmitter and receiver cable shields must be grounded directly to bare metal on the enclosure.

Electrical Wiring Preparation and Connection

All electrical wires are connected to the removable terminal blocks on the controller. This includes input power, output machine control and monitoring, transmitter and receiver wiring, and remote function control wiring.

In order to meet electromagnetic interference requirements, and in accordance in with good electrical workmanship, the LCC-DN controller should be installed as follows:

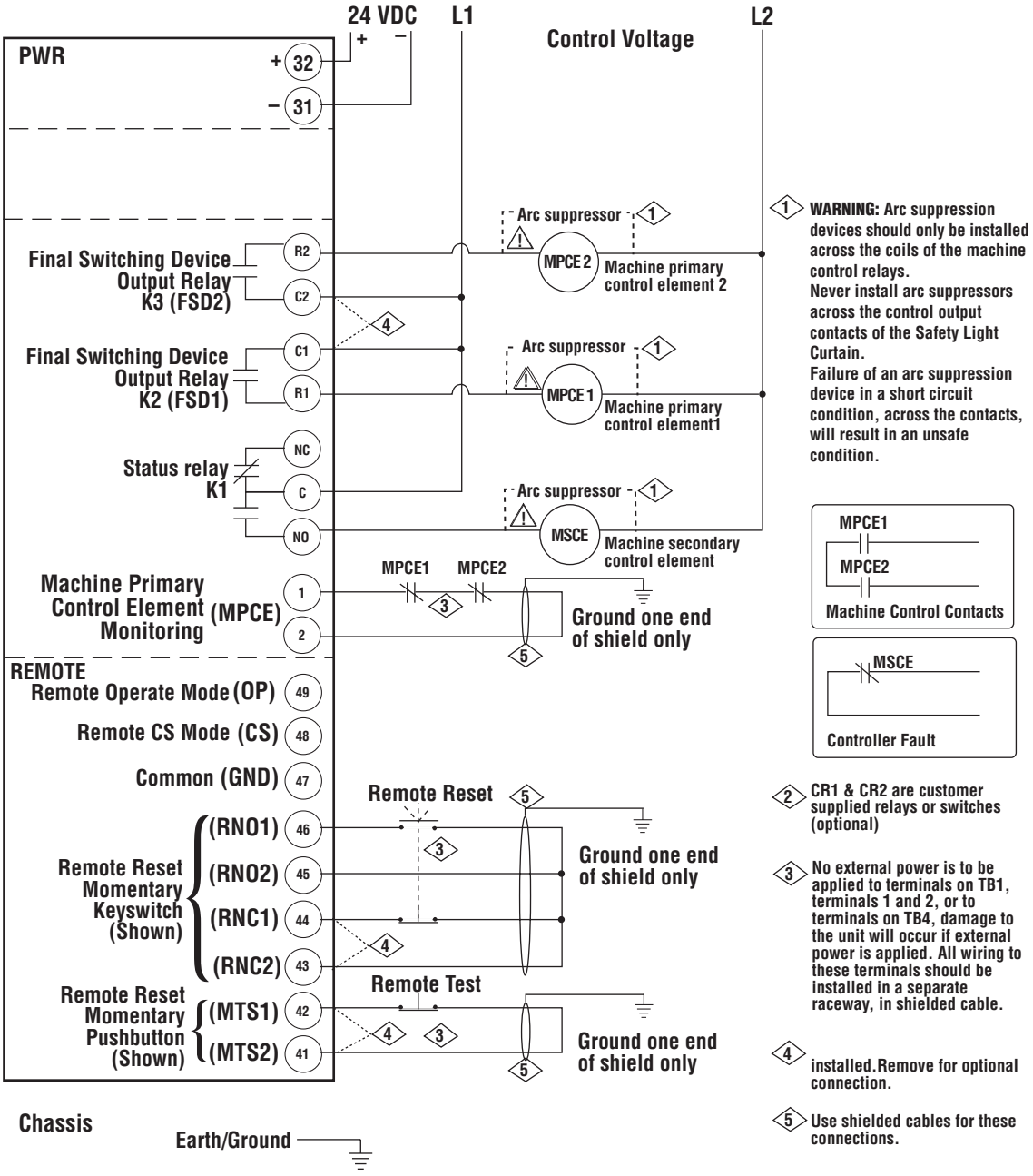
1. The controller must be mounted in a grounded metal enclosure.

2. 24 VDC power must be supplied through an approved, CE-marked power supply, such as STI model STI82K-03024.

3. Transmitter and receiver cable shields must be grounded directly to bare metal on the enclosure.

4. All wires and cables (power, transmitter, receiver, ground) should be kept as short as possible.

Figure F3.3 Machine Control CIrcuit Connection Diagram – Two Normally Open Preferred Method



1 **WARNING:** Arc suppression devices should only be installed across the coils of the machine control relays. Never install arc suppressors across the control output contacts of the Safety Light Curtain. Failure of an arc suppression device in a short circuit condition, across the contacts, will result in an unsafe condition.

2 CR1 & CR2 are customer supplied relays or switches (optional)

3 No external power is to be applied to terminals on TB1, terminals 1 and 2, or to terminals on TB4, damage to the unit will occur if external power is applied. All wiring to these terminals should be installed in a separate raceway, in shielded cable.

4 installed.Remove for optional connection.

5 Use shielded cables for these connections.

Figure F3.4 Machine Control CIrcuit Connection Diagram – One Normally Open/Normally Closed

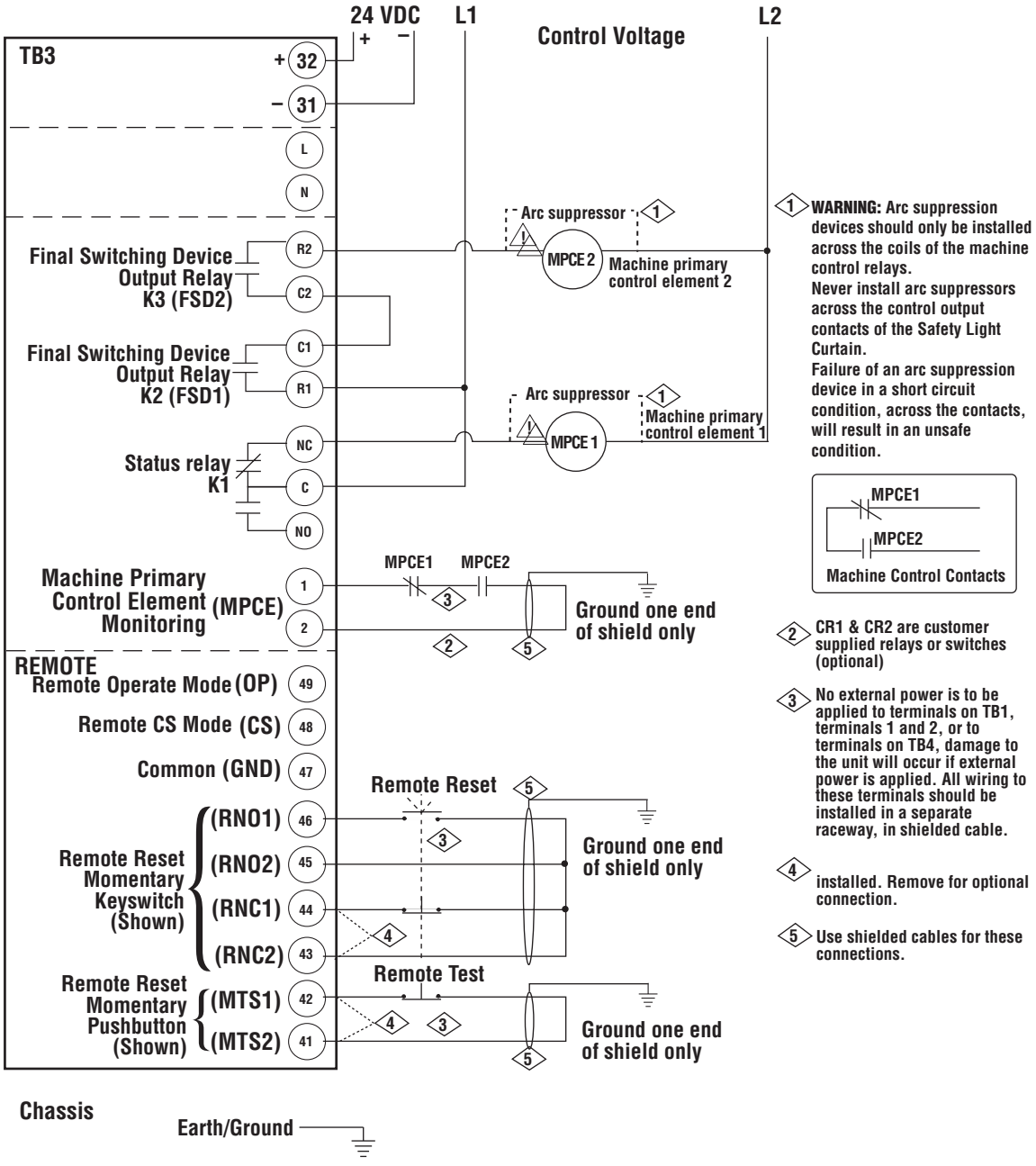
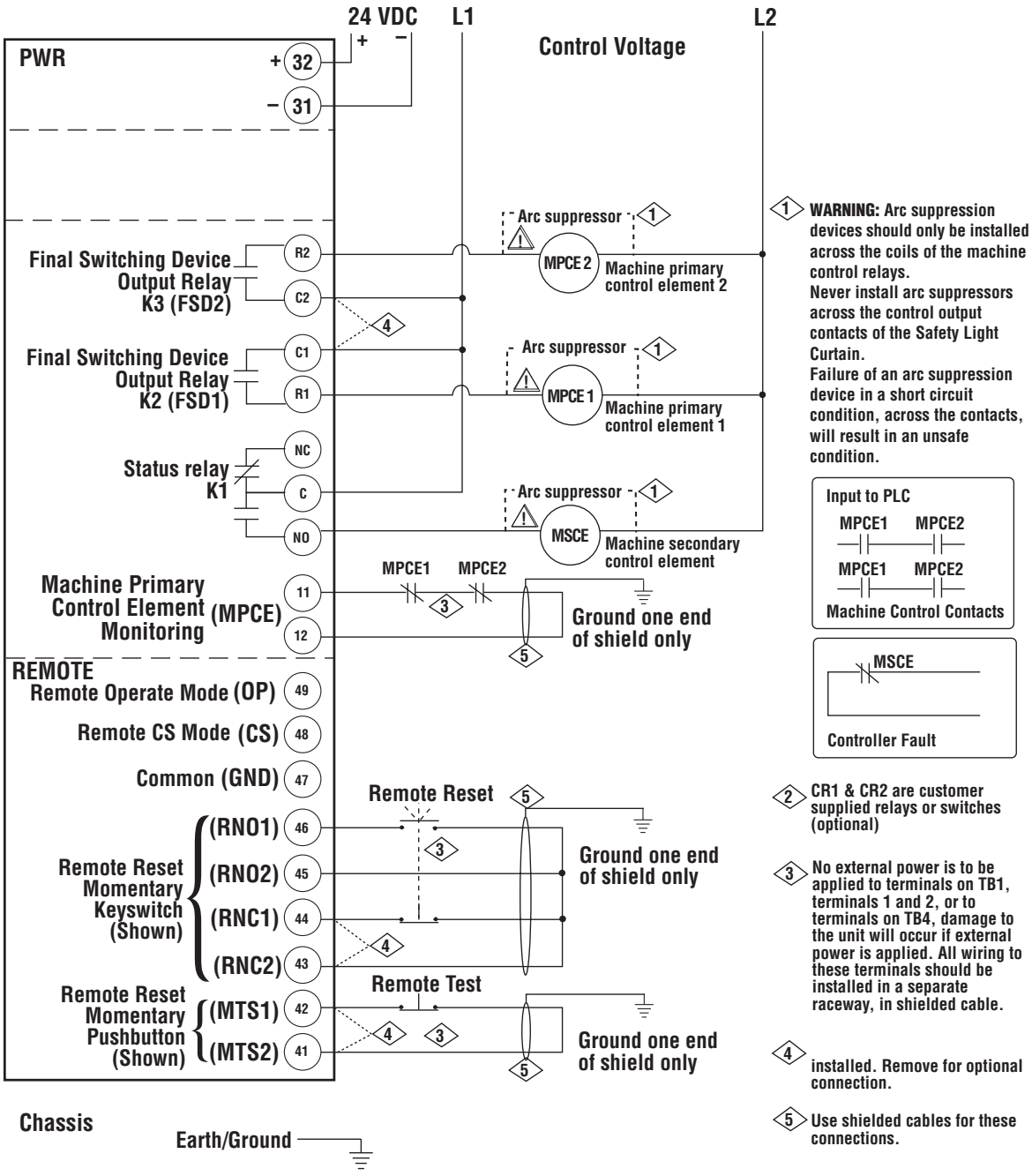


Figure F3.4 Suggested PLC Connection Diagram



Appendix G

24 V DC/DC Input Converter

INTRODUCTION

The 24V DC/DC output isolation modification allows users to power the STI light curtain from either a positive or negative ground system. In other words, the controller, when operated from 24V DC is polarity insensitive. This is a factory installed option.

DESCRIPTION

This modification replaces the standard power transformer in the STI light curtain controller with a DC/DC converter board. Please note:

1. These controllers can only be powered by 24V DC.

2. The input terminals for external power and the external power fuse are located on the converter card (see diagram below).

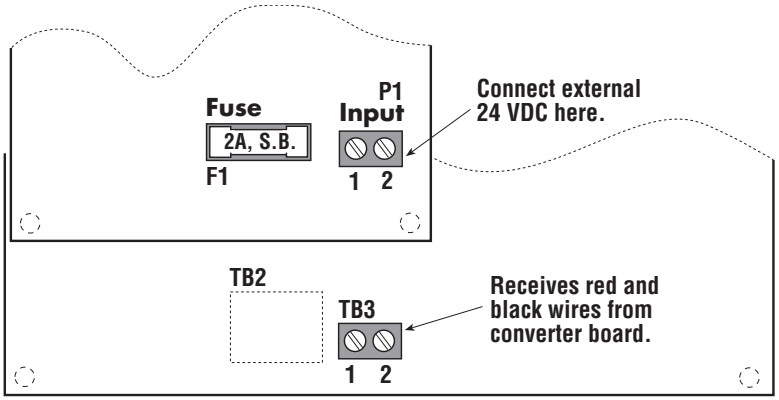
3. The standard 24V DC inputs (labeled TB3) on the main controller board receive their input from the converter board.

Instructions

1. The converter board has been properly installed at the STI factory. Simply supply 24V DC to terminals 1 and 2 on the converter board terminal labeled “input” (marked P1).

2. Continue installation and use of safety light curtain in accordance with this manual.

Figure G.1 Wiring Diagram



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• Limit and Basic Switches • Timers • Counters • Metering Devices
• Power Supplies

Safety
• Laser Scanners • Safety Mats • Edges and Bumpers • Programmable Safety Controllers • Light Curtains • Safety Relays • Safety Interlock Switches

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Printed on recycled paper.