Light Curtain Installation

It is important that the user be familiar with the installation requirements, safe mounting distance, controls and features before using a safety light curtain. Omron STI has found that light curtain installation is most easily accomplished if it broken down into discrete steps. These steps include:
1. Understanding the usage requirements for a safety light curtain.
2. Calculating the minimum safe distance.
3. Physically mounting the light curtain.
4. Preparation of the control enclosure.
5. Configuring the features of the light curtain.
6. Connection of power and termination of outputs.
7. Application of power and safety light curtain alignment.
8. Testing of the safety light curtain for proper operation.

**Two and Three-Box Systems**

Note: Omron STI safety light curtains are available in two different system configurations. The first configuration is referred to as a "two-box" system. This means that the transmitter and receiver do not connect to a central controller. All light curtain inputs and outputs are made at the receiver. In most cases, the transmitter simply requires power to be fully functional. The transmitter and receiver are not physically connected but are optically synchronized via one of the infrared beams. The second configuration uses cables to connect the transmitter and receiver to a central controller or "third box". This controller contains control reliable circuitry and serves as a convenient central location for all light curtain inputs and outputs.

**MiniSafe® MS4600**
The MiniSafe MS4600 Light Curtain is a "two-box" light curtain.

**MiniSafe® MS4700**
The MiniSafe MS4700 Light Curtain is a "three-box" light curtain.

**WARNING:** The information provided in this section is general in nature and is written to provide an overview of the safety light curtain installation process. A safety light curtain should only be installed, checked out, and maintained by a qualified person. A qualified person is defined as "an individual who understands, is trained on, and demonstrates competence with the construction, operation or maintenance of the machinery and the hazards involved.” (ANSI/PMMI B155.1-2006)
**Step 1. Usage Requirements**

A safety light curtain is a safety device, designed to protect operators and other personnel working around a potentially dangerous machine. Before installing or using a safety light curtain the following requirements must be met:

- The machine on which a safety light curtain is installed must be capable of stopping motion anywhere in its stroke or cycle. For example, do not use a light curtain on a power press with a full-revolution clutch.
- Do not use a light curtain on any device with an inconsistent stopping time or inadequate control devices or mechanisms.
- Do not use a light curtain where the environment; such as severe smoke, particulate matter or corrosive chemicals; may degrade the efficiency of the light curtain.
- Be aware - light curtains do not offer protection from flying objects.
- In any installation where the light curtain is used as a safety device, the employer has the responsibility to ensure that all applicable federal, state and local government requirements are satisfied. In addition, the employer must ensure that all machine operators, die setters, maintenance personnel, electricians, supervisors, foremen, etc.

are familiar with and understand all instructions regarding the proper use of the light curtain, the machinery on which it is installed and the appropriate safety regulations.

- All safety-related machine control circuit elements, including pneumatic, electric, or hydraulic controls must be control reliable. See *Theory of Operation and Terminology* for a definition of control reliable.
- Any power press which uses a light curtain must meet the requirements and inspection procedures of OSHA regulation 1910.217, ANSI standards B11.1 and B11.19, plus any other applicable state and local regulations. All other machinery or equipment must meet OSHA standard 1910.212 on general machine guarding plus any other applicable regulations, codes and standards.
- Do not use a 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 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 associate controls are not working properly, the machine may not stop safely even though the light curtain is functioning properly.
- The test procedure 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 or Floating Blanking is enabled or disabled. Testing ensures that the light curtain and the machine control system work properly to stop the machine. A sample test procedure is included in this section.
- All procedures in the installation and operating manual must be followed for proper operation of the light curtain.

The enforcement of these requirements is beyond Omron STI’s control. The employer has the sole responsibility to follow the preceding requirements and any other procedures, conditions and requirements specific to your machinery.
Step 2. Calculating the Minimum Safe Distance

What is the Minimum Safe Distance?

One of the most important criteria for proper use of a safety light curtain for machine guarding involves the minimum safe distance. A light curtain must be mounted far enough away from the point of hazardous operation so the machine will stop before the operator’s hand or other body part can reach this hazardous point. The minimum safe distance, 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 B11.19-2003 (6.2), “When required by this standard, the guard or safeguarding device shall be located at a distance from its associated hazard such that individuals cannot reach the hazard before cessation of hazardous motion (or situation).”

Regardless of the calculated distance, OSHA requires that a light curtain never be mounted closer to the pinch point than the equivalent distance allowed for a physical guard. This is outlined by OSHA Table 0-10 in OSHA 1910.217. Do not use the Table 0-10 distance for your application - you must perform the calculations to find the minimum safe distance. The OSHA Table 0-10 distances depend on the light curtain minimum object resolution.

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

The American National Standards Institute (ANSI) standard B11.19-2003 uses a newer formula which takes into consideration more factors in calculating the minimum safe distance than the OSHA formula. Omron STI suggests using the ANSI formula and presents it here.

If your installation uses a horizontal mounting of the light curtain, please skip ahead a few pages to that section.

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

ANSI Minimum Safe Distance Formula

The basis for the following information is ANSI standard B11.19-2003.

The ANSI formula consists of:

\[ D_s = K (T_s + T_c + T_r + T_{spm}) + D_{pf} \]

Where:

- \( D_s \) = The minimum safe distance, in inches, between the light curtain sensing field and the nearest point of operation hazard.
- \( K \) = The maximum speed at which an individual can approach the hazard, expressed in inches per second. To quote ANSI B11.19-2003, “The factor \( K \) is the speed constant and includes hand and body movements of an individual approaching a hazard area. The following factors should be considered when determining \( K \):
  - a) Hand and arm movement;
  - b) Twisting of the body or shoulder, or bending at the waist;
  - c) Walking or running.

One of the accepted values for \( K \) is the hand speed constant (it is usually considered as the horizontal motion of the hand and arm while seated). Its common value is 63 in./s although other values (typically higher) are also used. The hand speed constant does not
include other body movements, which can affect the actual approach speed. Consideration of the above factors should be included when determining the speed constant for a given application.”

\( T_s \) = The total time that it takes, in seconds, for the hazardous motion to stop, or for the hazardous portion of the machine cycle to be completed. Note that different machine types have different stopping methods and mechanisms. Informative Annex D of ANSI B11.19-2003 contains excellent information on these considerations and factors.

\( T_c \) = The response time, in seconds, of the machine control circuit to activate the machine's brake.

NOTE: \( T_s + T_c \) are usually measured together by a stopping performance monitor.

\( T_r \) = The response time, in seconds, of the safety mat system. This is provided in the installation manual.

\( T_{spm} \) = The additional stopping time, in seconds, allowed by the stopping performance monitor before it detects stop time deterioration. A stopping performance monitor will halt the machine when the stop time of the machinery exceeds the set limit. This indicates that excessive brake wear has occurred.

What should you do if your machine does not have a stopping performance monitor? Add a percentage increase factor to the safety light curtains.
measured stop time \((T_s + T_c)\) to allow for braking system wear. For example, stopping performance monitors usually add an extra 20% to the measured stop time. We recommend that you contact the manufacturer of your machine for guidance in selecting a percentage increase factor.

\[ D_{pf} = \text{The added distance, in inches, due to the depth penetration factor from figure 4.3 or table 4.2.} \]

This is related to the minimum object sensitivity of the light curtain and how far an object can move through the sensing field before the light curtain reacts. By knowing the minimum object resolution, \(S\), of the light curtain, \(D_{pf}\) is read directly from figure 4.3 or table 4.2.

This table assumes that Channel Select or Floating Blanking is not in use. If Channel Select or Floating Blanking are active, their effect must be considered in the calculation of \(D_{pf}\). This effect is explained in the section “Channel Select and Floating Blanking.”

Additionally, please note that the \(D_{pf}\) values provided in this section are for safety light curtains which are installed vertically. For horizontal or ground level mounting schemes, refer to the example given later in this section. For safety light curtains with a minimum object sensitivity greater than 2.5 inches, please refer to Annex D of ANSI B11.19-2003.
Example 1. ANSI Safety Distance Calculation with Brake Monitor

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 stop time performance monitor is set for 0.240 seconds. The response time of a MicroSafe MC4700-20 (solid-state output version) with a protected height of 24 in. (600 mm) is 10 mS (0.010 s).

Determine \(T_{spm}\) and \(D_{pf}\). From the stopping performance monitor set point:

\[
T_{spm} = \text{stopping time performance monitor set point} - (T_s + T_c)
\]

\[
T_{spm} = 0.240 \text{ sec.} - 0.200 \text{ sec.} = 0.040 \text{ sec.}
\]

A MicroSafe MC4700 has a minimum object sensitivity \((S)\) of 0.80 in. (20 mm).

From figure 4.3, the depth penetration factor, \(D_{pf}\), is 1.7 inches (44 mm).

Now, everything needed is available. The formula is:

\[
D_s = K \times (T_s + T_c + T_{spm}) + D_{pf}
\]

Substituting our values:

\[
D_s = 63 \text{ in./sec.} \times (0.200 \text{ sec.} + 0.010 \text{ sec.} + 0.040 \text{ sec.}) + 1.7 \text{ in.}
\]

Add the values in the parentheses first:

\[
D_s = 63 \text{ in/sec.} \times (0.250 \text{ sec.}) + 1.7 \text{ in.}
\]

Multiply the result in parentheses by 63:

\[
D_s = 15.75 \text{ in.} + 1.7 \text{ in.}
\]

Add the results:

\[
D_s = 17.45 \text{ in.} (450 \text{ mm})
\]

Thus, in this example, the light curtain must be mounted greater than 17.45 in. (450 mm) from the pinch point when measured to the center of the MicroSafe’s front surface.

Read the section on channel select and floating blanking to see their effect on this example.

EN 999 Minimum Safe Distance Formula

Manufacturers planning to sell their products into the European market should be aware that there is a different mounting formula for presence sensing devices offered by standard EN 999. While similar to the ANSI formula given above, there are some subtle differences.

The EN 999 formula (for a normal approach) is explained here:

\[
S = K(t_1 + t_2) + C
\]

Where:

\(S = \) the minimum safe distance between the light curtain sensing field and the point of operation hazard in mm, but not less than 100 mm.

\(K = \) operator’s approach speed.

\(t_1 = \) maximum stopping time of the machine in seconds.

\(t_2 = \) response time of the safety light curtain in seconds.

\(C = \) additional safety distance in mm, depending on the detection capability of the safety light curtain. The value of \(C\) is never less than 0.

\(d = \) Minimum object resolution (detection capability) of the light curtain.

\[
C = 8(d-14) \text{ where } d \leq 40 \text{ mm}
\]

\[
C = 850 \text{ mm where } 40 < d \leq 70 \text{ mm}
\]

The following identifies several factors which affect the calculation of the safe distance formula:

First, the value of \(K\), the operator’s approach speed, depends on the application, the approach direction, the minimum distance \(S\) and the detection capability of the light curtain, \(d\). The values given below are for a normal approach direction.

<table>
<thead>
<tr>
<th>(S)</th>
<th>(K)</th>
<th>(d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100≤S≤500 mm</td>
<td>2000 mm/sec</td>
<td>(d)≤40 mm</td>
</tr>
<tr>
<td>S&gt;500 mm</td>
<td>1600 mm/sec</td>
<td>(d)≤40 mm</td>
</tr>
<tr>
<td>S&gt;850 mm</td>
<td>1600 mm/sec</td>
<td>40&lt;d≤70 mm</td>
</tr>
</tbody>
</table>

In applications where \(S\) is calculated to be greater than 500 mm using \(K= 2000 \text{ mm/sec}\), then the formula must be recalculated using \(K=1600 \text{ mm/sec}\). In this case the minimum value of “\(S\)” shall not be less than 500 mm.

Where light curtains are used for machine initiation, then \(K=2500 \text{ mm/sec}\). \(S\) must be greater than 150 mm and the minimum object resolution of the safety light curtain must be equal to or less than 30 mm.
Example 2. EN 999 Safety Distance Calculation

An automated machine has a stopping time of 0.100 seconds as rated by the manufacturer. The MicroSafe MC4700-20 safety light curtain with solid-state safety outputs and a 600 mm protected height has a response time of 0.01 seconds and a detection capability of 20 mm. The light curtain is not used to initiate the machine:

\[ S = K(t_1 + t_2) + C \]

Where:
- \( K = 2000 \text{ mm/sec.} \)
- \( t_1 = 0.100 \text{ sec.} \)
- \( t_2 = 0.01 \text{ sec.} \)
- \( C = 8(d-14) \); but \( C \) is never < 0
- \( d = 20 \text{ mm} \)
- \( S = 2000 \text{ mm/sec.} (0.100 + 0.01 \text{ sec.}) + 8(20-14) \)
- \( S = 268 \text{ mm} \)

To calculate \( D_s \), use the ANSI Safe Distance Formula, but use a figure of 48 inches for \( D_{pf} \). This effectively means that the minimum size of the sensing field on a horizontally-mounted light curtain is 48 inches when no other forms of supplemental guarding are used.

\[ D_s = K \times (T_s + T_c + T_r + T_{spm}) + D_{pf} \]

(The in this case \( D_{pf} \) is always 48 inches.) Working the formula, we get:

\[ D_s = 63 \times (0.125 + 0.025 + 0) + 48 \]
\[ = 63 \times (0.15) + 48 \]
\[ = 9.45 + 48 \]
\[ D_s = 57.45 \text{ inches} (1459 \text{ mm}) \]

Horizontal Light Curtain Installations

Certain applications may use horizontal mounting of the light curtain to detect intrusion 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 4.4. Applications where the angle of approach is 30° or greater to the sensing field should use the ANSI formula (discussed earlier).
**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. 4.5a, b, c & d.). 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. A Test Procedure, such as provided at the end of this section, must be used to test for this condition.

Calculations can provide 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.

The minimum distance from the sensing field to the reflective surface, $d$, is calculated from the formula. This assumes a worst case condition where the transmitter and receiver are not in true alignment, as indicated in Fig. 4.5d. The graph also requires the Range Adjustment potentiometer be properly set on those light curtains which feature one.

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

$$d = \frac{R}{2} (\tan 2a)$$

where $a$ is the angle of acceptance/divergence of the safety light curtain and $R$ is the operating distance of the light curtain installation.
When planning for or evaluating an installation, consult the appropriate operating manual to determine the proper value for a.

**Example — Reflective Surface Interference**

For example, a MicroSafe MC4700 series 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?

If you prefer, the calculations are:

\[ d = \frac{R}{2} (\tan 2a) \]

\[ R = 6 \text{ ft.}, \ a = 2.5^\circ, \text{ thus} \]

\[ d = \frac{6}{2} [\tan 2(2.5^\circ)] \]

\[ = 3 \tan 5^\circ \]

\[ = 3 (0.0874) \]

\[ = 0.26 \text{ ft. or 3.1 in. (79 mm)} \]

Thus, the center of the MicroSafe beam line must be placed greater than 3.1 in. (79 mm) from a reflective surface.

**Step 3. Physically Mounting the Light Curtain**

Now that the minimum safe distance and reflective surface distance are known, the safety light curtain may now be mounted accordingly on the machine, stands or other mounting fixtures.

**Installation of Multiple Light Curtain Units**

Installations where two or more light curtains are mounted on machines 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 Machine Stop condition.

Correction involves orienting the light curtains such that the transmitters or receivers are mounted back-to-back to each other as shown in figure 4.9a and b. Contact Omron STI should you need additional assistance.

Mounting Considerations

The transmitter and receiver units 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 fig. 4.2a & b).

2. Use caution when installing any light curtain where the perimeter of the sensing field is adjacent to a reflective surface, such as shiny metal, foil, glossy paint, plastic or other similar material. A reflective surface can deflect the

⚠️ WARNING: Unsafe! Omron STI Safety light curtains are 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.
optical beam and may cause an obstruction in the sensing field not to be detected. (See fig. 4.5). Failure to correct this condition can result in a severe operator injury. Perform the Test Procedure to test for this condition.

3. The sensing field of the light curtain is marked on the transmitter and receiver housings (see installation manual for details). The area between the housing bottom and beginning of the sensing field is not protected. Therefore, you should position the light curtain so access to the pinch point is only through the marked sensing field or provide an alternative means to prevent entry to the hazardous location.

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

5. Normally the transmitter and receiver are mounted with the cable end down and the plastic bezels facing each other. To install the units "upside down" (cable ends up), both transmitter and receiver units must be mounted with their cable connectors in the same orientation. You may also install the light curtain in a horizontal plane, provided that both units are oriented the same. See figure 4.10a.

6. If you use a mirror, such as a high quality Omron STI mirror, in your installation, do not mount the mirror in a retroreflective orientation to the transmitter and receiver units as depicted in figure 4.10b. The transmitter and receiver units must also be installed parallel to and in line with each other.

7. All cabling must be installed and routed in accordance with national and local electrical codes and good workmanship practices. Omron STI offers a variety of mirrors, stands, mounting kits, and cabling to simplify special installation requirements.

Step 4. Preparation of the Light Curtain

Input power, output machine control, and, if used, remote function control must be connected to the light curtain by means of cables protected by conduit.

It is recommended that a clearance of approximately 4 inches (100 mm) be maintained between the receiver or transmitter cables and any AC power lines. The installer is responsible to use the proper conduit cable fittings to maintain the NEMA 4 and Ingress Protection (IP) design integrity of the light curtain control enclosure (where applicable).

Step 5. Configuring the Features of the Light Curtain

Some light curtains contain installation configuration options which allow flexibility for your specific application needs. Examples of installation selections include Operation Mode, Auxiliary Relay Selection, MPCE Monitoring, MTS, Exact Channel Select, Floating Blanking, Restart Interlock Mode and Range Selection. See your installation manual or contact Omron STI for further information.
When deciding which method is best for your application, keep in mind the following important points:

- The safety light curtain must be wired to your machine control circuit at a point where a stop signal from the light curtain results in an **immediate halt** during any point in the machine’s cycle or stroke. If the machine is a 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.
- 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.
- Light curtains may not be used as a tripping means to initiate mechanical power press motion except when used and installed in total conformance with the OSHA PSDI requirements of 1910.217(h).
- You must always use both safety outputs to connect to your machine. Should one output fail, the other is used to stop the machine.
- Omron STI recommends you contact the machine manufacturer for advice and assistance on the connection of any safety device.

If a PLC (programmable logic controller) is used as the machine controller, consult the appropriate Omron STI light curtain manual for proper connection information. The installer must read and understand all instructions provided in the installation manual provided with the safety light curtain.

**WARNING:** Contact the protected machine manufacturer for assistance on where to wire the light curtain to your machine control circuit. It is critical that the 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.
PERIMETER GUARDING SPECIAL REQUIREMENTS

Perimeter guarding refers to installations where the 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. A 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 can 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 pushbutton 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.

Restart Interlock Mode

Restart Interlock (Guard) Mode allows the light curtain safety outputs to remain in a de-energized state (latch condition) after an object detected by the light curtain is removed from the sensing field.

It may be desirable to employ Restart Interlock Mode when a light curtain is used in perimeter guarding installations.

Restart Interlock and Start Interlock are two separate programming choices, so it is possible to set the system to go to a machine run operating condition when power is applied and the sensing field is clear but to latch whenever a beam is blocked. Omron STI recommends activating Start Interlock whenever Restart Interlock is enabled.

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 by IEC Standards 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.” [IEC61496-1].

It is important to note that the methods to arrest hazardous machine motion will include hydraulic, pneumatic, clutch and mechanical braking systems. Thus, there are several variations of MPCEs. For example, your MPCE may consist of relays, contactors, solenoids or electromagnetic valves.

The purpose of monitoring the action of each MPCE is to make sure it is responding correctly to the light curtain's safety outputs 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, the MPCE must use captive contact type, machine control relays to be effective for the MPCE monitoring wiring.
**PREFERRED CONNECTION METHOD WITH RELAY OUTPUTS**

The following connection scheme uses both safety output relays to control the machine. This is the preferred wiring method.

---

**PREFERRED CONNECTION DIAGRAM METHOD**

Check unit for proper voltage requirements before powering up unit.

LCM Series shown. Consult product manual for complete details.

---

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 MPCEs, including relays, contactors, solenoids and electro-mechanical valves.

If you are unsure of the proper connection location to use for your machine's control systems, Omron STI recommends you contact the machine manufacturer for assistance.

This connection scheme requires a separate normally open (NO) output from both relays and proper wiring of the MPCE monitoring connections.

A sample wiring diagram is included in fig. 4.11. Consult your light curtain's Installation Manual for specific connection terminals corresponding to the sample wiring diagram.

One NO open contact from each of two output relays are wired to two MPCE, as shown in fig. 4.11.

**Notes:**

1. Arc or transient voltage suppression devices should only be installed across the coils of the machine control relays. Never install arc or transient voltage suppressors across the contacts of the safety light curtain. Failure of the suppression in a short condition, across the contacts, will result in an unsafe condition.

2. No external power is to be applied to the terminals of TB7.

3. The relay contacts of MPCE1 and MPCE2 must be force-guided.
NORMALLY OPEN, NORMALLY CLOSED MACHINE CONTROL CIRCUIT CONNECTION WITH RELAY OUTPUTS

Both safety output relays of the light curtain are used for this connection scheme. One NO signal is obtained by connecting to a safety output relay. The NC contact is obtained from the second output relay. See figure 4.12.

This connection scheme requires a NC contact from one of the output relays.

The MPCE Monitoring connection as indicated on fig. 4.12 should also be installed. Note also that a NC contact on one MPCE is wired in series with a NO contact on the other. This is in conjunction with the connection wiring to the MPCEs.

Using Arc Suppression Devices

Users should use arc suppression devices, also called snubbers, across the coils of the machine control contactors when switching AC loads (transient voltage suppressors are used for DC loads). These devices may extend relay contact life of equipment connected to the machine control circuit.

⚠️ WARNING: Arc suppression and transient voltage suppression devices should only be installed across the coils of the machine control relays. Never install these devices directly across the control output contacts of the light curtain. An arc or transient voltage suppression device may fail with a short circuit and if installed across the contacts, will result in an unsafe condition.

Notes:

1. Arc or transient voltage suppression devices should only be installed across the coils of the machine control relays. Never install arc or transient voltage suppressors across the contacts of the safety light curtain. Failure of the suppression in a short condition, across the contacts, will result in an unsafe condition.

2. No external power is to be applied to the terminals of TB7.

3. The relay contacts of MPCE1 and MPCE2 must be force-guided. To activate MPCE monitoring, Jumper 2 on the main control board needs to be installed in the on position.
**CONNECTING SOLID-STATE OUTPUTS TO AN STI RELAY MODULE**

The following connection scheme shows an MS4600 light curtain with solid-state safety outputs interfacing with an RM-1 relay module. The concept is similar for other safety products with solid-state safety outputs.

The RM-1 module provides the user with two normally open (NO) safety contacts and two normally closed (NC) monitoring contacts. The NO contacts are connected to two force-guided relays, MPCE1 and MPCE2. A set of NO contacts from each MPCE (in series) should be used to control the machine's hazardous motion. In some control systems, the RM-1 can be used as the MPCE. Contact the machine manufacturer for the specifications of the control components.

MPCE monitoring is performed on the final switching devices. This consists of a set of NC contacts from MPCE1 and MPCE2 connected through the receiver's MPCE line to 0 VDC. If no external MPCE devices are used, the monitoring should be performed on the resource module in use.

For more information, please consult the appropriate operation and installation manual.

---

**WARNING:** Arc and transient voltage suppression devices should only be installed across the coils of the machine control relays. Never install arc or transient voltage suppression devices directly across the control output contacts of the safety light curtain. A suppression device installed across the contacts may fail with a short circuit and will result in an unsafe condition.

No external voltage is to be applied to terminals MTS 1 or 2. MON 1 or 2. Damage to unit will occur.

**NOTE:** MPCE1, MPCE2 are two user-supplied control relays with forced-guided contacts.
**CONNECTING SOLID-STATE OUTPUTS TO TWO FORCE-GUIDED RELAYS**

The following connection scheme shows a MS4600 light curtain with solid-state safety outputs directly driving two force-guided relays (MPCE). The concept is similar for other safety products with solid-state safety outputs.

The MS4600 receiver provides the user with 2 PNP solid-state safety outputs capable of sourcing 500 mA @ 24 VDC. These safety outputs are directly connected to the two force-guided relays, MPCE1 and MPCE2. A set of normally open contacts from each MPCE (in series) should be used to control the machine's hazardous motion.

MPCE monitoring is performed on the final switching devices. It consists of a series set of NC contacts from MPCE1 and MPCE2 tied through the receiver's MPCE line to 0 VDC.

In some control systems, the PNP safety outputs can be directly interfaced into a safety PLC. Contact the machine manufacturer for the specifications on the PLC.

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**WARNING:** Arc and transient voltage suppression devices should only be installed across the coils of the machine control relays. Never install arc or transient voltage suppression devices directly across the control output contacts of the safety light curtain. A suppression device installed across the contacts may fail with a short circuit and will result in an unsafe condition.

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**NOTE:** MPCE1, MPCE2 are two user-supplied control relays with forced-guided contacts.
Using the MPCE Monitoring Function

With the MPCE Monitoring function active, if the MPCE signal does not close within 300 milliseconds after the light curtain enters a Red Beam Blocked state, or open when the light curtain returns to a Green Beam Clear state, then the controller will Fault into a lockout condition.

The wiring for the MPCE Monitoring feature is explained in your light curtain Installation Manual.

MPCE Monitoring with an Interposing Relay

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

Step 7. Application of Power and Safety Light Curtain Alignment

This step examines the procedures to align the light curtain and adjust the operating range.

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

This section is concerned with the physical alignment of the transmitter and receiver heads. Proper setup and alignment is an important part of the installation.

Short range systems reduce the risk of interference between one light curtain system and another which may be located nearby.

Step 8. Checkout and Test Procedures

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

The following initial checkout procedure must be performed by qualified personnel. A copy of the checkout results should be kept with the machine maintenance and inspection records.

A typical Checkout Procedure Log form and Test Procedure form are shown on the following pages.