

Link Lite 305 Black Max

User Requirements
Installation Information
Operating Instructions



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Black Max

MANUAL
INCLUDES
SECTIONS
1,3, &4

Link Lite Black Max Section 1 - User Requirements

1. IMPORTANT REQUIREMENTS AND RESPONSIBILITIES THAT THE USER/EMPLOYER MUST MEET WHEN USING LINK LITE BLACK MAX LIGHT CURTAINS

The Link Lite Black Max light curtain is a presence sensing device whose most common use is to enhance protection of personnel from point of operation hazards on industrial machinery. A light curtain performs the simple function of a light activated switch that can be used to provide a signal as to whether something or someone is in the sensing field between its transmitter and receiver units. It cannot, as a stand alone component, provide personnel safety enhancement or other function. Only when a light curtain is properly applied, installed, adjusted, and used as a component of a production system whose other components also meet the requirements for use of a light curtain does it act, in conjunction with other components of the system, to enhance personnel safety. Because only the user/employer has continuous knowledge and control over all elements of production system design and use (and attendant hazards), both OSHA regulations and ANSI standards assign the employer the responsibility for providing and insuring the use of properly applied and adjusted point of operation safeguarding.

It is the user's/employer's responsibility to read, understand, and enforce the following requirements when using a Link Lite Black Max as a safeguarding device. Link Electric and Safety Control Co. takes no responsibility where its light curtains are improperly installed, adjusted, or used, and where machines on which its light curtains are used are not properly maintained.

1.1. Machine and Machine Control Construction Requirements

All light curtains depend on the electrical, mechanical, pneumatic, and/or hydraulic control components and drive systems of the machine to stop hazardous motion when the light curtain gives a stop signal to the machine control. If machine control components or drive systems fail to function properly, the machine may fail to stop, or may not stop quickly, even though the Black Max is functioning properly. Install Black Max light curtains for safeguarding only on machines or production systems that meet the following requirements.

1. The machine construction must comply with any applicable OSHA or ANSI standards for such a machine.
2. The machine design and construction must allow hazardous action to be stopped quickly at any time or position within its cycle.

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| <p>WARNING! Do not install the Black Max on full revolution mechanical power presses or any other machinery that can only be stopped at the end of a complete cycle. Serious injury may result, because the machine cannot immediately respond to a stop signal.</p> |
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3. The machine action must be electrically controllable.
4. The electrical, pneumatic, and/or hydraulic control system that governs machine action must be designed and constructed so that de-energization of electrical components or loss of pressure results in stopping the machine action.

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5. Machine controls must be designed for "Control Reliability", i.e., so that a single failure in electrical, pneumatic, or hydraulic components does not prevent the normal stopping of machine action when required but does prevent initiation of further machine action.

WARNING! If machine controls are not designed to stop hazardous machine action if a component fails, the control may not stop the machine action when the Link Lite Black Max sends a stop signal, with possible consequent serious injury or death to personnel.

6. The machine must require manual initiation of action after power is turned on, after changes in operating modes, and each time a stop signal is applied to the control.

7. Where presence sensing devices such as the Black Max are used to safeguard part revolution mechanical power presses, the control system must include a brake monitor"! See 1910.217(b)(14) of OSHA's General Industry Standards.

NOTE! Link Systems' engineers will provide assistance upon request in evaluating your machine tool as to compliance with control requirements. Link Systems can provide control systems for part revolution mechanical power presses and mechanical press brakes, and interface systems for many hydraulic presses and press brakes that meet OSHA and ANSI requirements for the use of the Link Lite Black Max as safeguarding device. Link Electric and Safety Control Co. assumes no responsibility when the Black Max is used on machines with controls that do not comply with the above requirements or where controls not

supplied by Link fail in such a manner as to not stop the machine action when the Black Max provides a stop signal to the controls.

1.2. Installation

It is the user's/employer's responsibility to properly install (or have installed) the Link Lite Black Max, using qualified installers. Proper installation of any necessary supplemental barriers or safety devices, or alternative safeguarding methods is the responsibility of the user/employer.

1.3. Use Requirements

1.3.1. Safeguarding Configuration

It is the user's/employer's responsibility to perform a hazard analysis for every job performed by a machine or production system using a Black Max light curtain as a safety component. The user/employer must determine and implement a safeguarding configuration of Black Max units, any necessary supplemental barriers, and/or alternative safeguarding components to enhance personnel safety on every job performed.

1.3.2. Training

It is the employer's responsibility to train all setup personnel, operators, maintenance personnel, and supervisors in all aspects of the safe setup and use of the production system for every job performed on the machine. Training must include the following items.

1. The required safeguarding configuration for each job.

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2. The specific duties and actions to be performed by setup and operator personnel for each job relative to both production and safety. These work practices must be in conformance with any OSHA or ANSI standards that apply.
3. The machine manufacturer's operating instructions.
4. Instructions to never use the machine in such a manner or for any job that will exceed any rated capacity for the machine.
5. All operating instructions and warnings in the Link Lite Black Max Technical Manual including the "Safety System Setup" and "Operator Safety System Checkout" prescribed in section 4 of this manual.
6. Instructions to never operate the machine or production process if the checkouts required in item 5 of this list reveals that any safeguarding component is not properly set up and functional, or that the machine is not working properly.
7. Instructions to never remove, bypass, or rewire the Link Lite Black Max or other safety devices, controls, or guards on the machine.

WARNING! Failure to train personnel in the correct setup and use of the production system, including the safety components can lead to unsafe production systems and work practices with consequent severe injury or death to personnel.

NOTE! Where illiteracy or a language barrier would keep a person from reading (or listening) and understanding warnings and training instructions, the employer

must read or provide translation of these instructions to the person. The employer must ascertain that the instructions are understood.

1.3.3. Supervision

OSHA requires the employer not only to provide but to "insure" the use of properly applied and adjusted point of operation safeguarding. Supervisors must understand and enforce all items covered in the preceding Training section for the safe setup and operation of the machine.

1.4. Maintenance

OSHA requires the employer to establish and follow a maintenance program for industrial machinery. No presence sensing device, including the Black Max, will protect personnel from abnormal hazardous machine action(s) that result from failure, wear, or misadjustment of mechanical, hydraulic, pneumatic or electrical drive components of the machine upon which it is installed. Inspection and preventative maintenance of drive systems that govern machine action is necessary to reduce risks of abnormal machine action(s) that cannot be stopped by the machine control (and hence the stop signal from the Black Max). Maintenance must also be performed as required to keep stopping time of machine action less than the stopping time that the safety distance, D_s , explained in the Installation and Operating Instruction sections of this manual is based upon. Maintenance personnel must always follow any OSHA required lockout procedures when working on the machine and never work on the machine while production is being run.

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WARNING! Failure to maintain machines, or improper repairs or adjustments to machines on which the Link Lite Black Max is used as a safeguarding component, may result in abnormal, uncontrollable machine action(s) that cause serious injury or death even though the Black Max is functioning properly.

Where a production system uses auxiliary equipment for scrap chopping, material feeding, part removal, part transfer, or other purposes, and where any hazard to personnel posed by auxiliary equipment is also to be safeguarded by the Link Lite Black Max, maintenance of this equipment for the purposes of safety is also a must.

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3 INSTALLATION

3.1 General Requirements

Both OSHA and ANSI standards make it the user/employer's responsibility to see that safety components of the production system are installed, adjusted, and used properly to enhance personnel protection. One or more installers, chosen from qualified employees or contracted from outside sources, may be used to install the Black Max and any necessary auxiliary or supplemental safeguarding. Each installer must be qualified to do the task assigned to him in accordance with the requirements of this manual and standards or regulatory agencies.

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| <p>WARNING!! The Link Lite Black Max must be installed by qualified persons. If the Black Max is not properly installed, it will not afford the protection intended from hazardous machine action which can cause serious injury or death.</p> |
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3.2 Summary of Installation Requirements

Installation procedures and requirements for the Link Lite Black Max and any necessary supplemental safeguarding components are summarized in this section to provide an overview of the tasks that installers must perform.

INSTALLERS! Read this manual completely through before beginning the installation of a Link Lite Black Max on any machine as a safety device.

3.2.1 Summary of Black Max Installation Requirements

Installation of the Link Lite Black Max must include the following procedures and requirements. These procedures and requirements are discussed in more detail in sections 3.3 through 3.8. The installer(s) of the Black Max must:

1. Calculate, or obtain from other persons qualified to calculate, the Safety Distance, D_s at which the sensing field of the Black Max(s) must be located from the nearest hazard to prevent a person from reaching the hazard before the machine can stop.
2. Determine the mounting location and orientation of the Black Max(s) with consideration of the safety distance and other operational and safety requirements and mount the Black Max transmitter and receiver units.
3. Electrically interface the Black Max(s) to power and the machine control(s).
4. Set the Black Max(s) power level.
5. Align the Black Max(s) transmitter(s) and receiver(s).
6. Perform a checkout sequence to verify proper operation of the Black Max(s), machine control, and machine.

3.2.2 Summary of Supplemental Guard Requirements

When barriers are necessary (or used by design of the safety system) to supplement protection provided by the sensing field provided by Black Max units, the designated employees or outside contractor(s)

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selected by the user/employer to install the barriers must:

1. Determine where barriers are necessary and the location and size of barriers.
2. Design and fabricate (or have fabricated) the necessary barriers.
3. Mount the barriers and confirm their effectiveness and that pinch points or other hazards are not created between barriers and moving machine parts.

Supplemental guard requirements are discussed in more detail in section 3.9.

3.3 Calculating the Required Black Max Safety Distance.

Every machine requires a period of time (stopping time) to stop hazardous action after a stop signal is applied to its control system because of reaction times in control components, valves, and actuators and because of inertial effects of moving machine parts. All light curtains also have a reaction time to detect an object in their sensing field and send a stop signal. The Link Lite Black Max must be installed to provide an OSHA and ANSI required minimum safety distance, D_s , between its primary sensing field and the nearest point of operation hazard, or other moving machine hazard to be safeguarded. This safety distance must be calculated by a formula specified by OSHA and ANSI standards. The safety distance is intended to prevent injury by requiring a longer time for a person to reach the hazardous area after interrupting the presence sensing field than the time it takes to stop the machine action that poses the hazard. Figure 3.1 depicts one application of the safety distance.

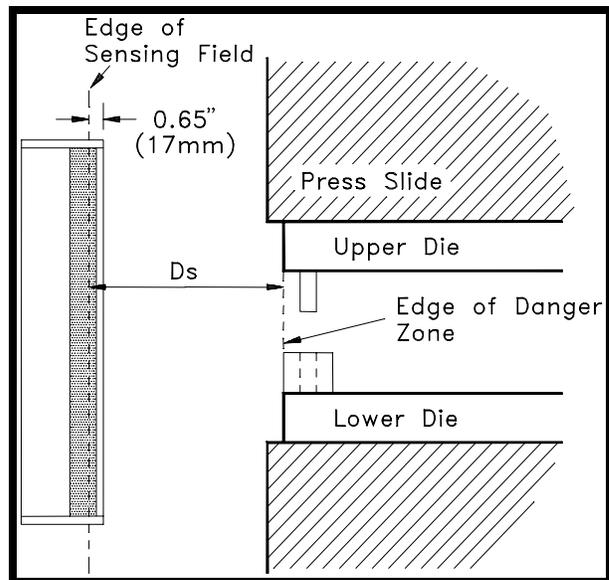


Figure 3.1: Minimum Safety Distance

WARNING!! The Link Lite Black Max must be installed at a distance greater than or equal to the safety distance, D_s . Failure to do so can result in serious injury to personnel because it may be possible to reach into the hazardous area before the machine can stop.

The Minimum safety distance in the most recent ANSI standards is calculated by the formula:

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

Where:

D_s = the required minimum safety distance

K = 63 in/sec (the average handspeed constant)

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T_s = the stop time (in seconds) of the machine measured from the control output stop signal to the actuator(s) (valves, etc.) that govern machine motion till the machine actually stops.

T_c = the response time (in seconds) of the machine control to a stop signal from the presence sensing device (Black Max).

NOTE! If the Link Lite Black Max output contacts are connected to the emergency stop circuit of relay controls, most control designs will cause the Black Max contacts to directly remove power from the actuators that cause motion without waiting for other control elements to de-energize. This means that $T_c=0$ in the case of these controls. If the machine is a part revolution mechanical power press and is equipped with Link Electric and Safety Control Co.'s SS501 controls or OmniLink 5000 controls, use $T_c=0.005$ seconds (5 milliseconds).

T_r = the response time of the presence sensing device (Response time for Black Max units is less than 20 ms - see unit label for specific time).

T_{bm} = the additional amount of time over the actual average stopping time allowed by a brake monitor (stopping performance monitor) to permit some normal wear of friction brakes and other components before the safety distance, D_s , is violated and the brake monitor prevents successive strokes.

NOTE! Stopping performance monitors (brake monitors) are required on part revolution presses when light curtains are used for safeguarding mechanical power

presses. See ANSI B11.1 1988 sections 6.3.2(15) and 4.11 and OSHA's CFR 1910.217 sections (c)(5) and (b)(14). Where time based monitors with the ability to set predetermined stop time limits are provided on machines, T_{bm} is determined by the relation:

$T_{bm} = \text{Brake Monitor Time Setting} - T_s$

Where T_s is the actual machine stop time already described.

NOTE! On machines where stopping time performance monitors are not required, a marginal amount of stopping time to allow for some normal wear or degradation of machine stopping mechanisms without violating safety distance must be substituted for T_{bm} . Link recommends that a value from 10% to 20% of the actual machine stopping time T_s , i.e. from $.1T_s$ to $.2T_s$, be used in place of T_{bm} . Periodic measurement of actual stopping time must be performed to prevent stopping time increase beyond the allowed margin.

D_{pf} = the added safety distance required to compensate for the possibility that fingers or hand could penetrate beyond the plane of the light curtain sensing field plane before the profile of the finger/hand/arm is large enough to be detected by the sensing field.

All presence sensing devices have a limited object sensitivity, i.e., it takes a certain size object to be detected at all points in the sensing field. Penetration depth depends on the minimum object sensitivity, M.O.S., of the light curtain. M.O.S. is defined as the smallest object profile that will be detected at all points in the active sensing field of the light curtain. The penetration depth factor, in inches, is described by the

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following formula. Use this formula only for M.O.S. less than 2.75 inches.

$$D_{pf} = 3.4 (M.O.S. - .276)$$

Figure 3.2 illustrates the penetration depth factor in graphical form

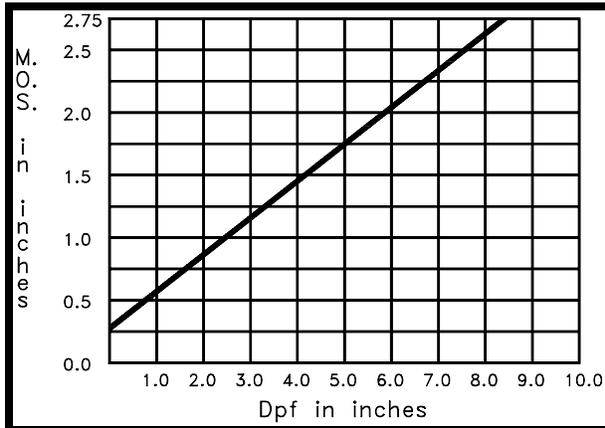


Figure 3.2: Graphical Representation of penetration depth factor, D_{pf} , vs. minimum object sensitivity.

The minimum object sensitivity in inches for Link Lite Black Max light curtains is specified on a label on both transmitter and receiver enclosures. Standard range units (to 50') for primary point of operation guarding have a M.O.S. of .95 inches. Long range units (to 100') for primary point of operation guard-ing have a M.O.S. of 1.25 inches. Perimeter guarding models and supplemental remote extension guard-ing units may have larger M.O.S.. Always determine M.O.S. from the labels on the actual units used. Always verify that both receiver and transmitter units have the same M.O.S. stated on their labels before installing.

PLEASE NOTE! When individual channels are to be blanked (turned off) to allow fixtures or obstructions that extend into the primary Black Max sensing field, additional safety distance may be necessary

to account for the increase in M.O.S. due to blanking. Blanking is possible on Black Max units with .95" M.O.S. and 1.25" M.O.S.. Each contiguous (side by side) channel blanked increases the M.O.S. by .75".

When the Link Lite Black Max is used on machines such as power presses, press brakes, and other machines that have slides used to impart motion and force to tooling, the stop time must be measured at approximately midstroke in the closing (hazardous) portion of the stroke. The best stopping performance of a machine will be attained when all machine adjustments that affect stopping time are adjusted within the machine manufacturer's specifications. It is the user/employer responsibility to always maintain mechanisms that affect stopping time in good repair and adjustment where safety devices like the Black Max depend on the stopping action of the machine to protect personnel.

Where a time-base brake monitor is used on a press or other machine that is to have a Black Max installed for point-of-operation safeguarding, the stopping time, T_s , can be determined by use of the brake monitor. On time base brake monitors equipped with stop time display, stop the machine at approximately the mid point of the die closing portion of the stroke and read the stopping time displayed. For a time based brake monitor with no direct display of stopping time but that has a dial or other method of setting allowable stop time, make repeated machine stops near midstroke, adjusting the time setting each time until the lowest time setting that results in the brake monitor allowing a successive stroke without resetting is found. This is the stop time, T_s , that must be used.

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When no stopping performance monitor is used on a machine (you must use one when required by OSHA or ANSI standards) and there is no statutory or standards requirement to use a stopping performance monitor, a stop time measurement device can be used to measure T_s . These are portable devices that usually attach to the moving slide of the machine to detect when the slide is stopped after another mechanism of the device gives a stop signal.

3.4 Mounting Considerations and Requirements

Any installation of Link Lite Black Max light curtains as a safety component of a production or other system must include determination of mounting locations and orientations of the components of the Black Max(s) that meet both the safety and operational requirements of the production system. General mounting requirements of various Black Max components are provided in the following subsections. Any special requirements must be determined by the user/employer and must not violate the general requirements.

3.4.1 Black Max Main Transmitter and Receiver Units.

All Black Max installations will have main transmitter and receiver units that must be located and oriented to create a primary sensing field whose function is to detect a person's hand or other body part and to provide a stop signal to the machine control to prevent or stop hazardous machine action(s) when the hand or other body part is detected. The main Link Lite Black Max transmitter and receiver units may be mounted vertically, horizontally, or at an angle as long as the following general requirements are met.

1. Any location and orientation of the main Black Max transmitter and receiver units must place the sensing field at a distance from the hazard greater than or equal to the safety distance required in section 3.3 of this manual, i.e. so, that hands or fingers are D_s from the hazard when the sensing field is interrupted by any part of the body.

2. Locate the main Black Max transmitter and receiver units at the same height and orient at the same angle. The numbers beside the acrylic lens on the front of the transmitter unit and the receiver unit designate the transmitter and sensor channels. Each transmitter channel number must be directly across from each similarly numbered receiver channel. See Figures 3.3.a and 3.3b.

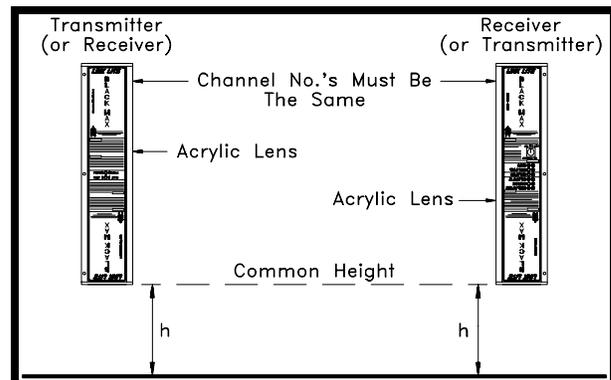


Figure 3.3a: Front view of transmitter and receiver units mounted at a common height.

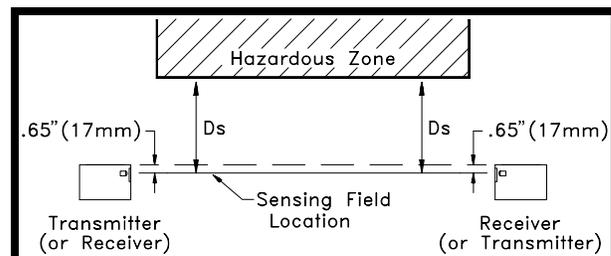


Figure 3.3b: Top view of transmitter and receiver units.

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3. The mounting location or method must leave access for work pieces, tool changes, and other operational requirements.

4. The main transmitter and receiver must be mounted so that the indicator lights and warning messages on their enclosure doors are clearly visible to operators and supervisors and so that the enclosure door can be opened.

5. The main transmitter and receiver may be mounted directly to the machine, on brackets attached to the machine, or on floor stands as long as safety distance and operational requirements are met. Mounting brackets must be sturdy to provide a rigid mounting support that is not easily knocked out of alignment. When prefabricated brackets are not provided, the installer must design and make suitable mounting brackets.

6. When Black Max light curtains are to be installed on two or more machines that are arranged in a row, alternate the transmitter and receiver units (as to which unit is mounted on the left and which on the right side of the machine) on each adjacent machine as shown in Figure 3.4 to reduce the possibility of crosstalk. Crosstalk occurs when light pulses from transmitter unit mounted on one machine are "seen" not only by the intended receiver unit, but also by receiver units on other machines. For many infrared light curtains on the market today this creates a danger to operators because their receiver units accept crosstalk pulses just as they accept pulses from the correct transmitter. An operator may have a hand or arm in a light curtain sensing field, blocking light pulses from the transmitter on his machine, and a transmitter on another machine can pass over or under his arm, "fooling" the receiver into not providing a stop signal to

the machine control as required. The Black Max is designed to detect crosstalk from other light curtains and to provide a stop signal if it occurs. It is important to install Black Max light curtains in such a manner as to avoid nuisance machine stops caused by crosstalk.

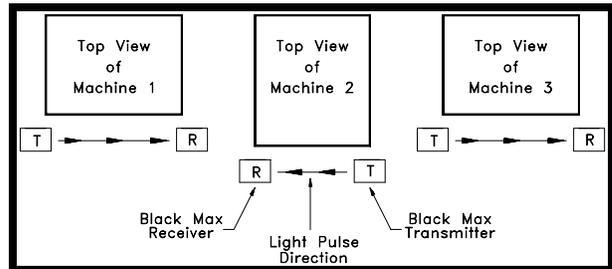


Figure 3.4: Mounting scheme to minimize crosstalk.

The scheme shown in Figure 3.4 should also be followed when infrared light curtains other than the Black Max are used on adjacent machines.

7. Mount the Black Max main transmitter and receiver units on the rubber shock mounts provided in the shipment box using one of the two mounting methods shown in Figure 3.5.

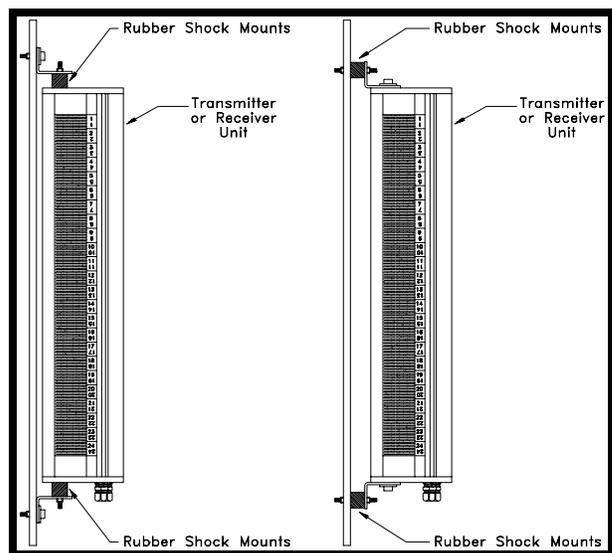


Figure 3.5: Use of rubber shock mounts.

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8. The Black Max transmitter and receiver each have four mounting holes, two in each end mounting flange. See Figure ---, page ---, for mounting hole dimensions and patterns for various length units.

3.4.2 Black Max Remote Segment Transmitter and Receiver Units.

Black Max remote segment transmitter and receiver units are housed in separate enclosures from the main Black Max transmitter and receiver. When electrically connected to the main transmitter and receiver units, they provide additional channels of emitters and receptors which are sequenced by the logic electronics in the main transmitter and receiver, respectively. Remote segment units will be part of the installation only when the user/employer has purchased them as

components of the safety system to supplement the protection provided by the main transmitter and receiver units.

Since the remote segments are in separate enclosures from the main Black Max units, they can be used to create "L" shaped or other sensing field shapes when combined with the main transmitter and receiver units. When safety distance requirements, machine configuration, or operational requirements place the primary sensing field between the main transmitter and receiver at a location that allows a person to pass completely through the primary sensing field toward the hazard, horizontally oriented remote segment Black Max units can be used to detect a person standing inside the sensing field as shown in Figure 3.6.

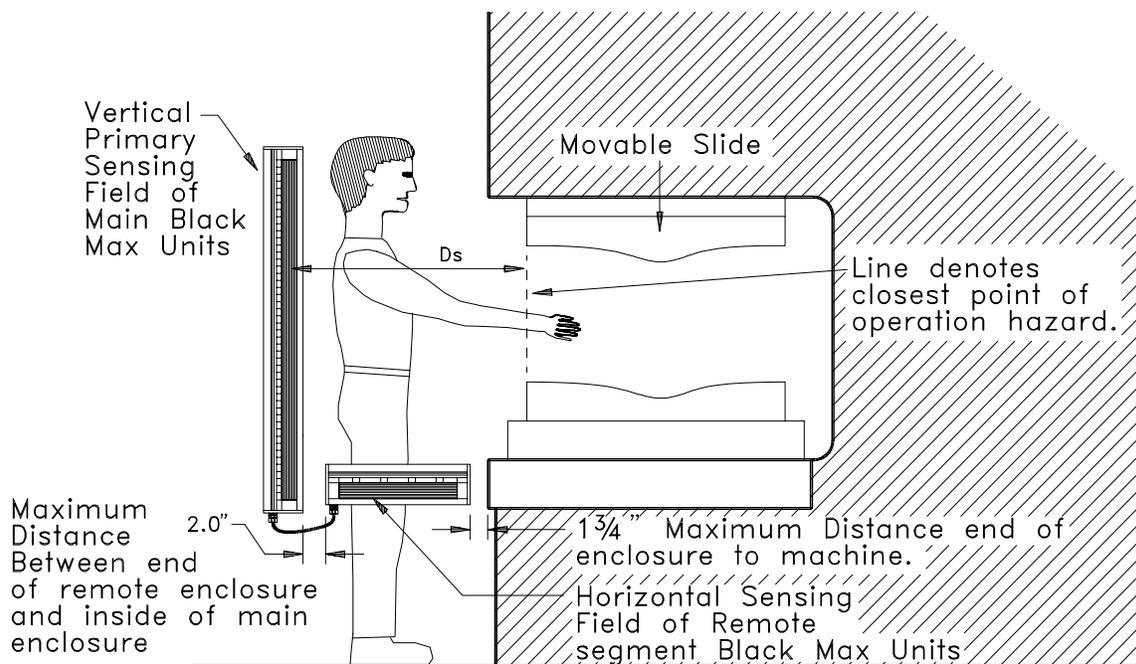
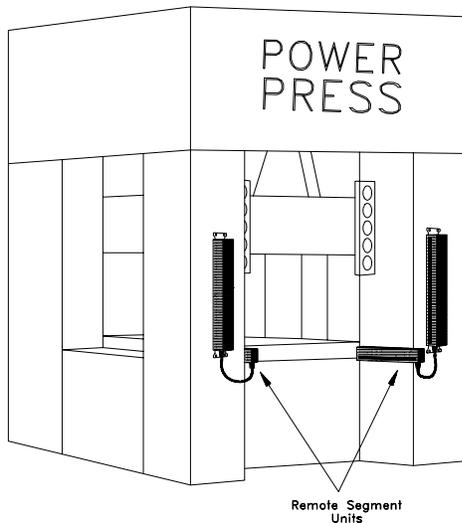


Figure 3.6: Horizontally mounted remote segment Black Max units to detect a person inside the main sensing field.

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Figure 3.7. Shows remote segment units mounted on a straight side press with columns extended beyond the bed and slide.



The mounting requirements for remote segment Black Max units are generally the same as for main transmitter and receiver units except that when used for supplemental guarding between the main sensing field and the hazard, there is no safety distance, D_s , requirement for the location of remote segment units.

NOTE! If remote segment units are used in any manner intended to extend and be part of the main sensing field, safety distance requirements will then apply to the remote segment units.

Figure 3.7: Remote segment Black Max units mounted between columns of straight side power press to detect a person standing inside the primary sensing field.

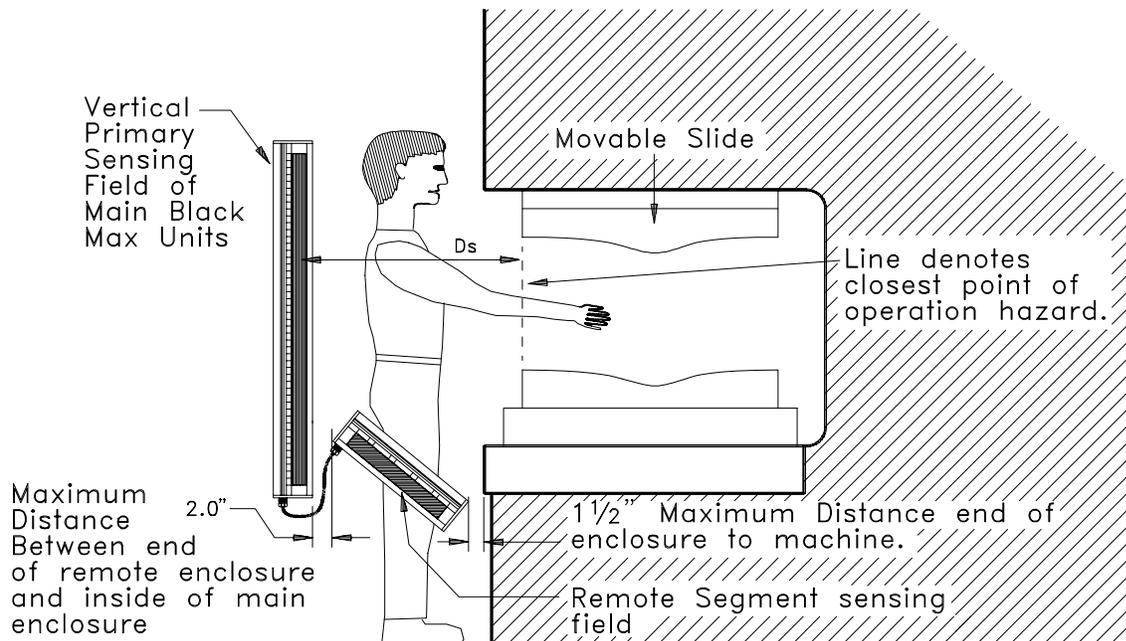


Figure 3.8: Remote segment Black Max units oriented at an angle to sense a person between the primary sensing field and the hazard.

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Also, the mounting arrangement is somewhat different for the remote segment units as shown in Figures 3.9a and 3.9b.

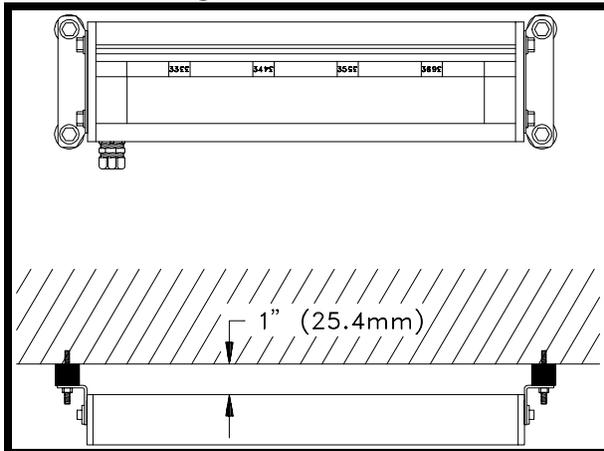


Figure 3.9a: Example of remote segment Black Max unit mounting.

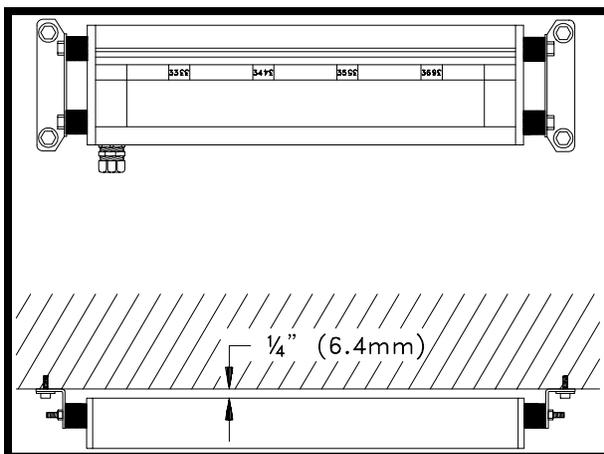


Figure 3.9b: Alternate remote segment Black Max unit mounting.

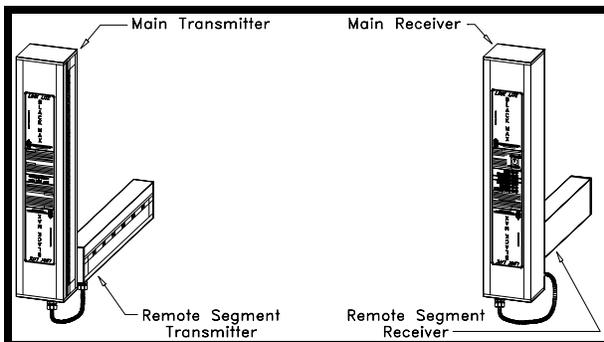


Figure 3.10: Mount main and remote transmitter and receiver units on the same respective sides.

Black Max remote segment transmitter and receiver units must always be mounted on the same side of the machine, respectively, as the main transmitter and receiver units as shown in Figure 3.10

3.4.3 Use of Mirrors for Multi-Sided Point of Operation or Perimeter Safeguarding Applications

In some safeguarding applications mirrors may be used to "bend" the sensing field provided by main Black Max units to provide two or more sided safeguarding for point of operation or perimeter safeguarding. Mirrors for this purpose can be purchased from Link Systems. Since even the finest quality mirrors do not reflect 100% of incident light and some diffusion of light occurs, the maximum sensing field distance between transmitter and receiver will be reduced by about 10% per mirror used. Figure 3.11 illustrates a three sided point of operation safeguarding application.

NOTE! Safety Distance, D_S , must be maintained on all sides of sensing field.

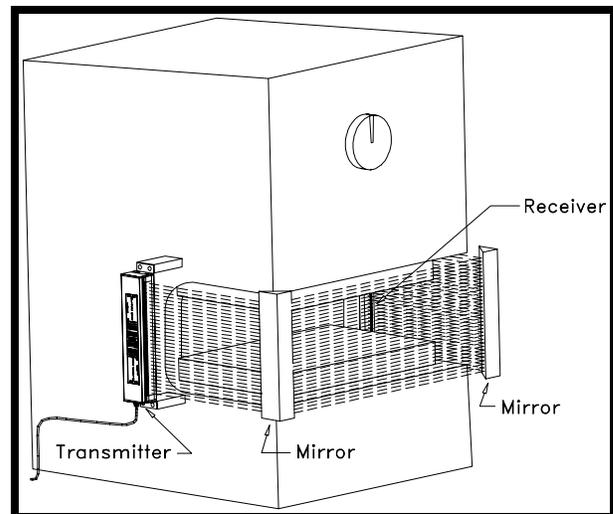


Figure 3.11: Example of three sided point of operation guarding on C frame press.

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Figure 3.12 Illustrates a four sided perimeter guarding application.

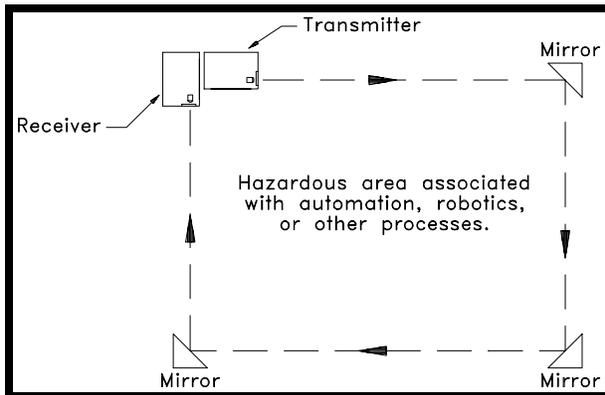


Figure 3.12: Top view of four sided perimeter guarding application.

3.5 Electrical Wiring to Interface Link Lite Black Max Units to Power and the Machine Control.

When all Link Lite Black Max transmitter and receiver units have been mounted, you are ready to make electrical connections to interface the Black Max(s) to power and the machine control. Also, if remote segment Black Max units are used, you must connect the remote segment transmitter unit to the main transmitter unit and the remote segment receiver unit to the main receiver unit with the cables provided.

WARNING! To prevent electrical shock hazards lock all power to the machine off before beginning the wiring procedures for the Link Lite Black Max. In the U.S., follow OSHA Lockout regulations.

3.5.1 Conduit Requirements

The main Black Max transmitter and receiver units both have a 7/8" hole to

accommodate a 1/2" conduit fitting. Run a 1/2" conduit from the machine control enclosure to each main Black Max transmitter unit. Similarly, run a 1/2" conduit from the machine control enclosure to each main Black Max receiver unit. All wires required for the transmitter and receiver should be pulled through the 1/2" conduit. Use of flexible conduit with integral armor and ground wire, such as Seal Tite, is preferable. When such flexible conduit is used, it is also desirable to route it in such a way as to leave slack that will allow the Black Max units to be moved further away from the machine if future setups necessitate moving the transmitter(s) and receiver(s) to meet safety distance requirements.

There are also two holes that are sized for 3/4" fittings, one in both ends of the main transmitter and receiver units. These holes are closed with screw in type plugs. They should only be used for cable connections between main transmitter and receiver units and remote segment receiver and transmitter units. **DO NOT** use the plugged openings for conduit between the main Black Max units and the control enclosure. Use the open 7/8" hole only.

3.5.2 Power Connections

Both the transmitter and receiver units of the Black Max must be supplied with 115 VAC (Nominal) power. Generally, this power should be supplied from a transformer with 115 VAC secondary in the machine control. Pull a "hot" wire, a neutral wire, and a ground wire through the conduit from the control enclosure to the Black Max main transmitter unit. Refer to Figure 3.13 for the location of the combination three connection power terminal and plug in connector.

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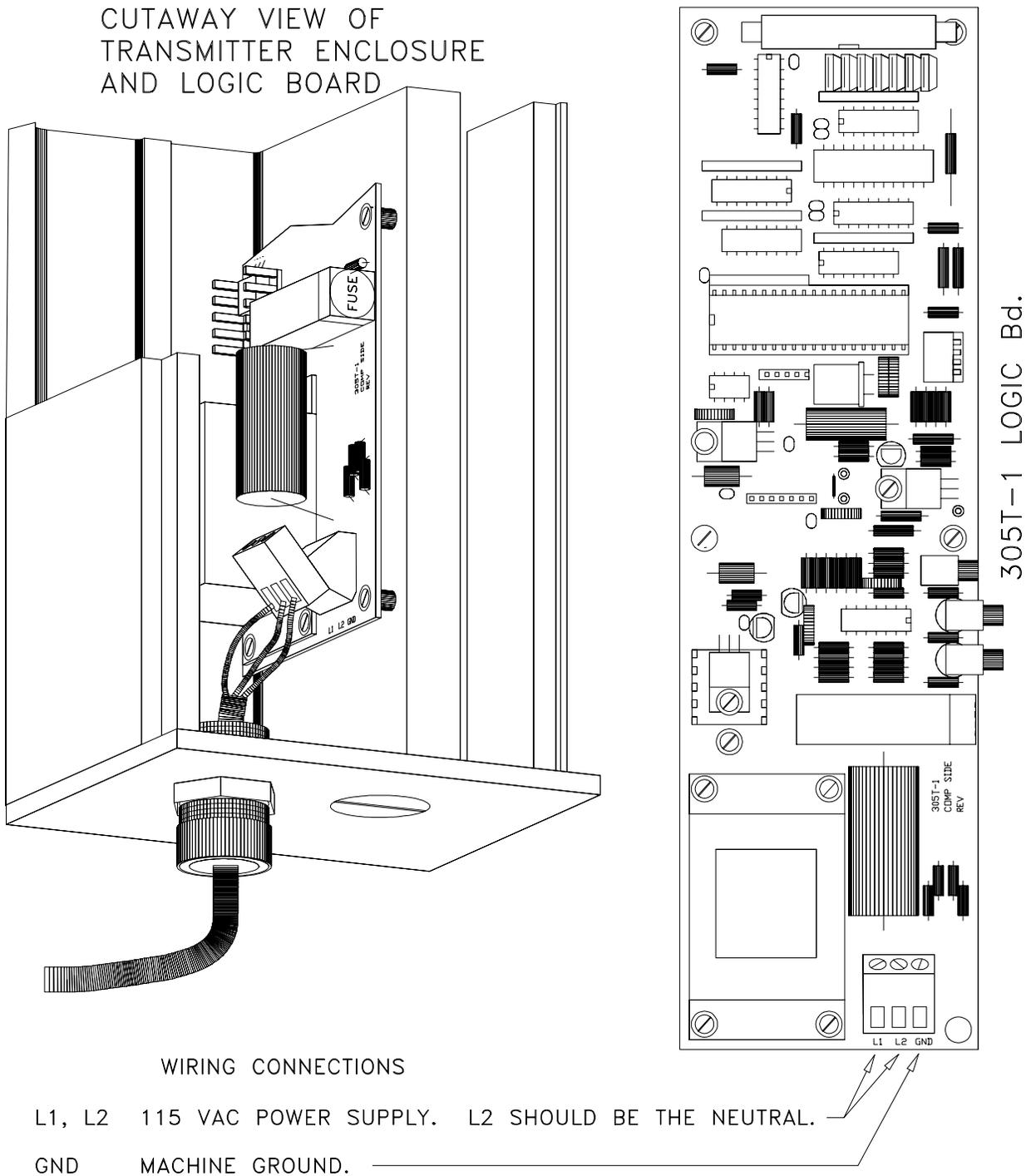


Figure 3.13: Location of transmitter power connector.

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Unplug the terminal/connector from its socket and turn the three wire clamp screws counterclockwise so that the power wires can be inserted into the wire clamping slots. Strip the three power wires about 1/4" from their ends, insert them into the wire clamping slots, and tighten the clamping screws in the following order.

- "Hot"** wire connects to terminal marked L1
- Neutral** wire connects to terminal marked L2
- Ground** wire connects to terminal marked GND

When finished connecting the wires, plug the terminal/connector back into its socket.

Three power wires must also be pulled through the conduit from the machine control to the main Black Max unit. The location of the three connection power terminal/connector is shown in Figure 3.14 for the receiver unit. Connect the power wires to the receiver to the power terminal/connector by following the same procedures outlined for transmitter power connections.

3.5.3 Control Connections

Link Lite Black Max(s) must be wired into the machine control circuit in such a

WARNING! Improper connection of Link Lite Black Max(s) to the machine control can cause the Black Max to be ineffective as a safety device with possible consequent injury to personnel by the machine hazard intended to be safeguarded.

manner that their stop signal to the control results in the control immediately initiating machine stopping action.

All control wiring connections to the Link Lite Black Max are made to the eight position terminal/connector located on the relay board in the main Black Max receiver enclosure, accessible by opening the door to the receiver enclosure as shown in Figure 3.14. Run wires through the 1/2" flexible conduit from the machine control enclosure to the main Black Max receiver unit to interconnect the light curtain to the control.

Two normally open (N.O.) and one normally closed (N.C.) contact paths are supplied in the Link Lite Black Max receiver unit for interconnection to machine control circuits. Two separate relay contacts whose operation is checked by Black Max logic circuits are used in each path as shown in Figure 3.14. The interconnection of the Black Max(s) to the control circuit depends on the design and configuration of the machine control circuit. When the Black Max is used with a machine control supplied by Link Systems, schematics will be provided that show the connections that must be made between the Black Max light curtain and the control. Wire as shown in the schematic. Do not deviate from the schematic unless Link gives written approval of an alternative wiring scheme.

When interconnecting Black Max units to controls not supplied by Link, at least one of the normally open contact paths must be used to provide the stop signal to the machine control in such a manner that the control immediately initiates machine stopping action. In some cases use of both normally open contact paths of the Black Max may be necessary. The normally closed contact path between terminals 3 and 4 must never be used to provide the stop signal to the press control. Link provides these terminals for use in addition to normally open contact

Link Lite Black Max Section 3 - Installation

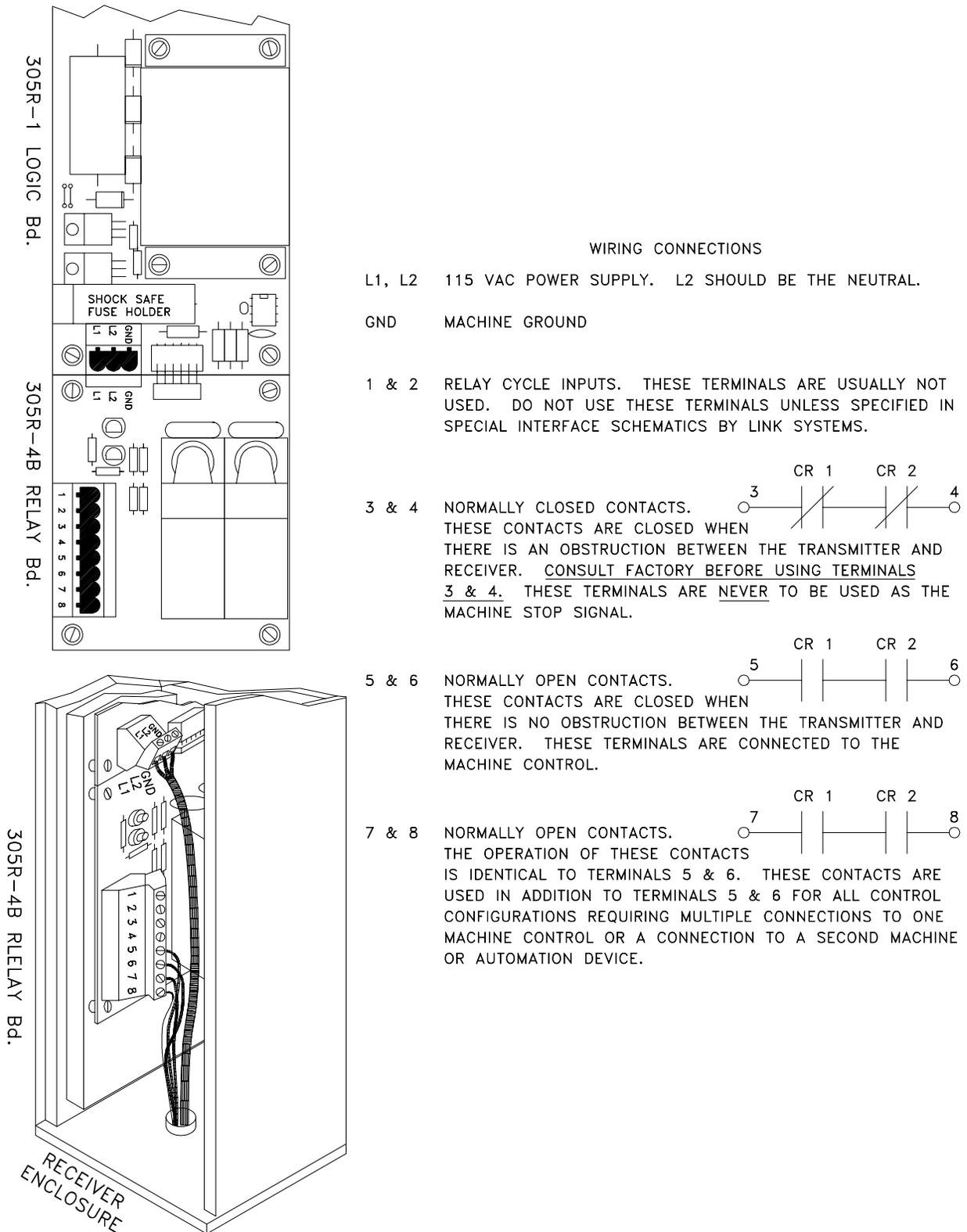


Figure 3.14: Power and relay connections for Black Max receiver.

Link Lite Black Max Section 3 - Installation

paths in special interfaces between the Black Max and the machine controls designed by Link Systems.

WARNING! Never use the normally closed contact path only to provide a stop signal to the machine control. A loose connection or broken wire would result in no stop signal being supplied to the control by the Black Max even though the Black Max itself was operating properly.

Link Systems will evaluate existing machine controls as to their suitability for use with the Link Lite Black Max upon customer request and provision of schematics, and will mark schematics for interconnection with the Black Max when such controls are suitable for use with the Black Max.

WARNING! When Link Systems provides machine controls or marks existing machine control schematics for interconnection with Black Max units, always wire as shown by Link on schematics. Improper connection of Black Max units to the machine control may result in failure of the machine to stop even though the Black Max component is functioning properly with possible serious injury or death to personnel.

In some cases, Link Systems may have to provide an interface circuit to accomplish proper interconnection of the Link Lite Black Max with a customer's existing control circuit.

On linearly stroking machines such as

mechanical power presses, hydraulic power presses, power press brakes, etc., OSHA and ANSI allow presence sensing devices such as the Link Lite Black Max to be interconnected or interfaced with the machine control so that the protective function is bypassed (muted) during the non-hazardous portion of the stroking cycle only. Never simply use unmonitored limit switch contacts to mute the Black Max in the non-hazardous part of a machine cycle. Interfacing to maintain "control reliability" in the event of a component fault in the muting circuit is necessary.

Some machine controls are designed to require cycling of light curtain output relays on each cycle of the machine even if the sensing field is not interrupted. Terminals 1 and 2 on the eight position terminal/connector provide an input to cycle the output relays. To activate the relay cycle circuit a jumper must be removed on the receiver logic board in the receiver unit. See Figure 3.15. When the jumper is removed, a voltage must be supplied between terminals 1 and 2 to energize the output relays in each receiver unit (but only when the Black Max transmitter and receiver are properly aligned and no obstruction is in the sensing field). Switching this voltage off at least 35 milliseconds will cause relays LC1 and LC2 to de-energize. If both relays switch off and the voltage is switched back onto terminals 1 and 2, the relays will again energize. This relay cycle is normally done during the non-hazardous portion of the machine stroke when the Black Max is muted to avoid stopping the machine when the relays are de-energized.

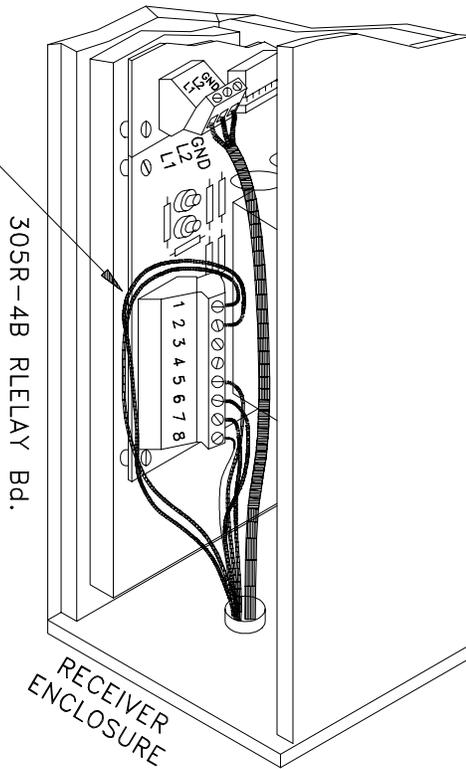
As shipped, a voltage of 12VDC to 30VDC may be used for the relay cycle input to terminals 1 and 2 when the jumper is removed. Removing jumpers **J2** and **J3** on the receiver Relay Board as

Link Lite Black Max Section 3 - Installation

Relay Cycle Input Configuration

Terminals

1 & 2 Relay Cycle Inputs. Used only when specified in special interface schematics by LINK SYSTEMS.



305R-1 LOGIC Bd.
(SHOWN WITH 305R-2
LOGIC Bd. REMOVED)

J1,J2,J3 Jumpers for configuring Relay Cycle Inputs.

1. Remove (cut) jumper J1 to enable Relay Cycle Input.
2. Remove (cut) jumpers J2 & J3 for 110 volt AC Relay Cycling. Do not remove jumpers J2 & J3 for 12 to 30 volt DC Relay Cycling.

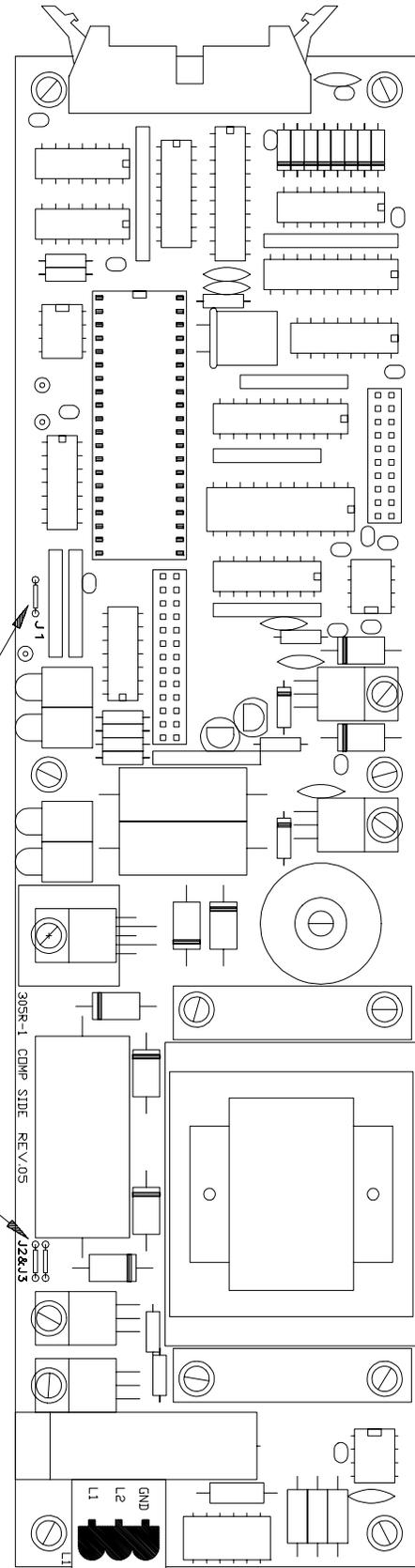


Figure 3.15: Location of relay check con-figuration jumpers.

Link Lite Black Max Section 3 - Installation

shown in Figure 3.15 will configure the relay cycle circuit for 115VAC input voltage between terminals 1 and 2.

Some machines use programmable logic controllers (PLCs) as the machine control. The Black Max must never be connected to only the inputs of a single PLC controller. Always contact Link before using a Link Lite Black Max as a protective device on a machine with a PLC control. Most PLC controls do not meet OSHA's control reliability requirement for use of a presence sensing device.

WARNING! Never use a Link Lite Black Max on a machine controlled by a PLC without first consulting Link Systems as to whether the Black Max should be used and how it should be connected to the control. Failure of the PLC control could cause the machine to fail to stop even though the Black Max is functioning properly if the control system is not designed to provide a stop signal to the machine in the event of a component failure or program fault. Serious injury or death may result from the hazard intended to be safeguarded.

3.5.4 Connections Between Main Black Max Units and Remote Segments Units

Connections between main Black Max transmitter and receiver units and remote segment units are accomplished by a cable that terminates inside the main and remote units in a ribbon cable plug-in connector. The cable enters each unit enclosure through a water and oil tight screw on fitting. See Figures 3.16 and 3.17. The remote segment unit may be connected to either end of the main unit by removing the

screw-in plug in the large hole in the end cap, running the ribbon cable through the hole, and screwing the cable fitting into the hole. Always leave the screw-in plug in place on the unused end of the main transmitter or receiver unit to retain the NEMA 4 performance of the enclosure. In some cases, two remote segment units may be used, one off of either end of the main transmitter or receiver enclosure. This is illustrated in Figure 3.18.

3.6 Setting The Black Max Transmitter Power Level

After mounting and electrically connecting the Black Max transmitter and receiver units, the transmitter power must be set for the separation distance between the transmitter and receiver. Using more power than necessary to transmit between transmitter and receiver is undesirable because of the possibility that the excess light energy can be detected by other Black Max receiver units on other machines. This cross talk would result in nuisance stops on the other machines. Also, the life of the infrared light emitting diodes in the transmitter is somewhat dependent on power level. These components will have prolonged life at lower power levels.

To set the transmitter power level, open the door of the main transmitter enclosure, locate the small 4 position DIP switch on the outside edge of the transmitter logic board, and adjust the switch positions according to the power level table located on the inside of the transmitter door. The location of the 4 position switch and power level table are shown in figure 3.19. Always adjust the power level correctly for the separation distance between the Black Max transmitter and receiver.

Link Lite Black Max Section 3 - Installation

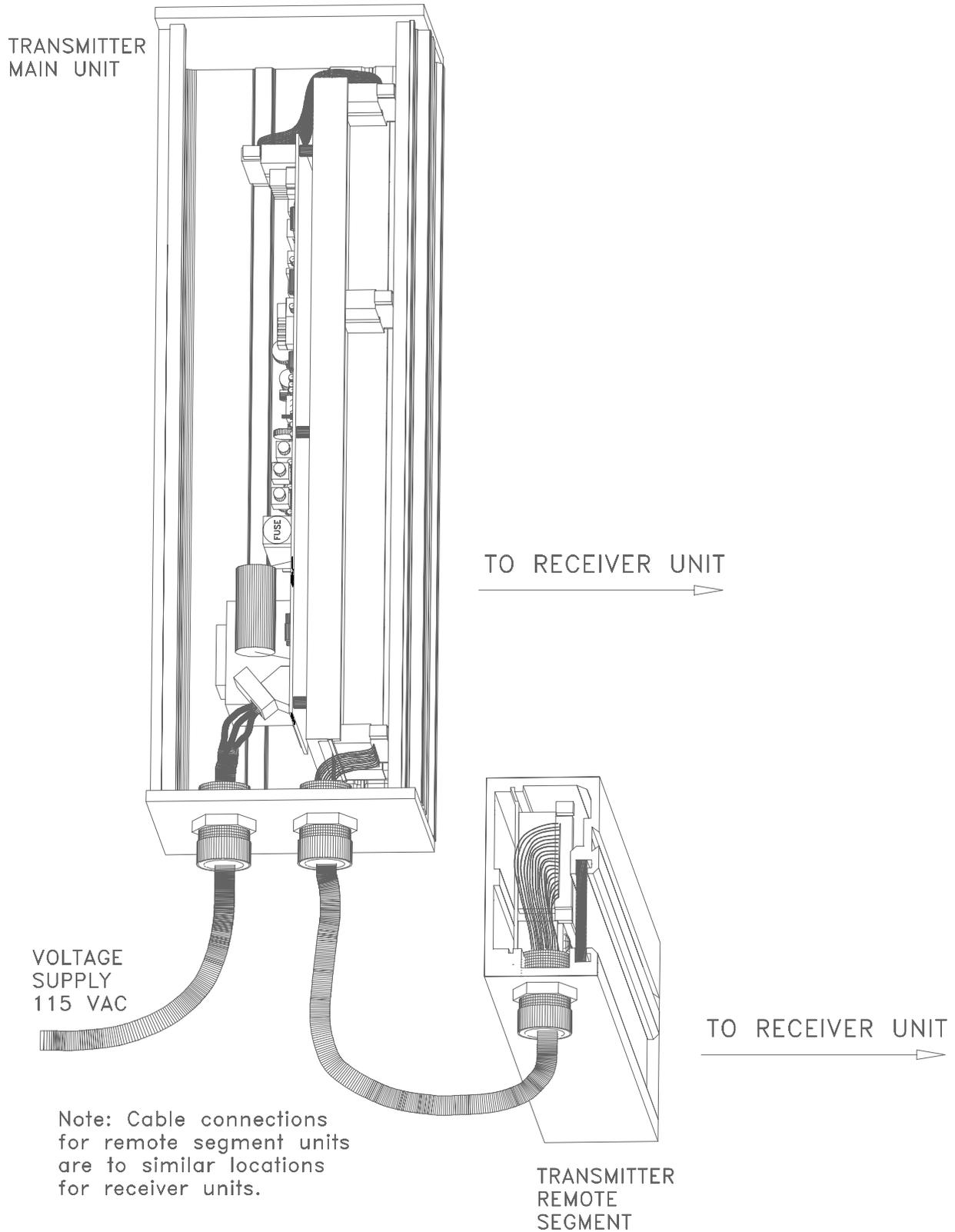


Figure 3.16: Use of remote segment at bottom of main transmitter.

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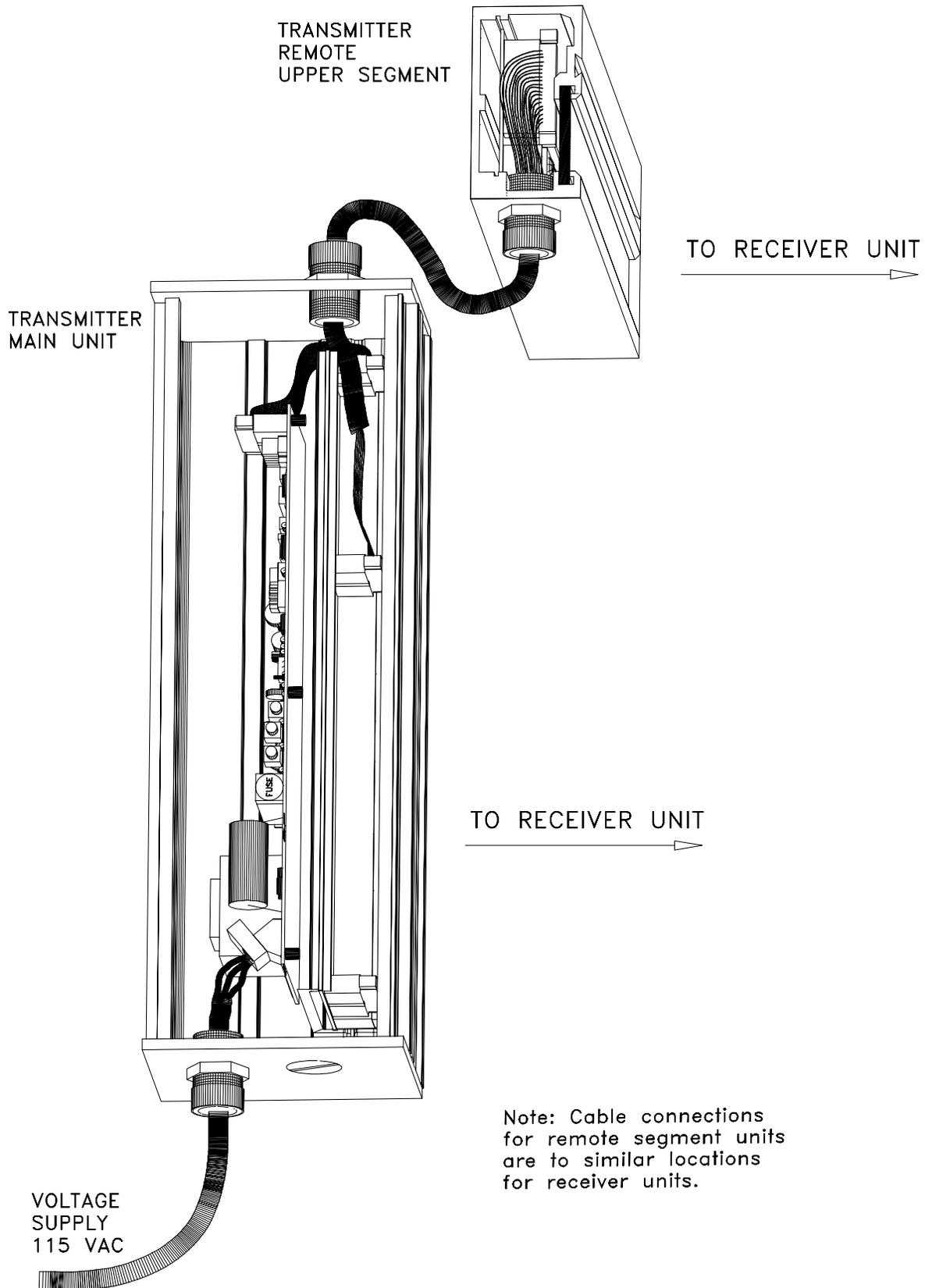


Figure 3.17: Remote segment unit used at top of main transmitter.

Link Lite Black Max Section 3 - Installation

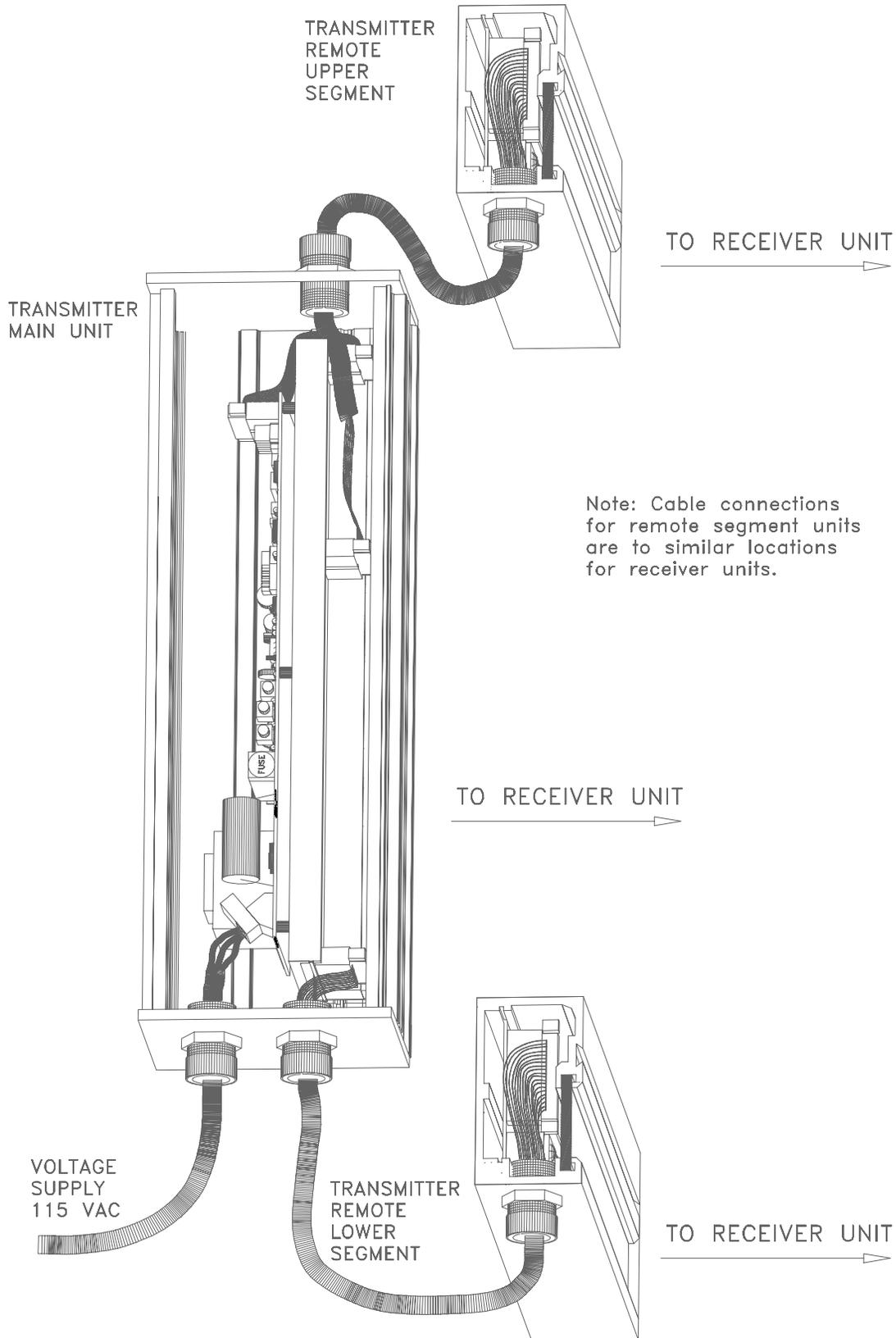


Figure 3.18: Use of two remote segment units with main transmitter.

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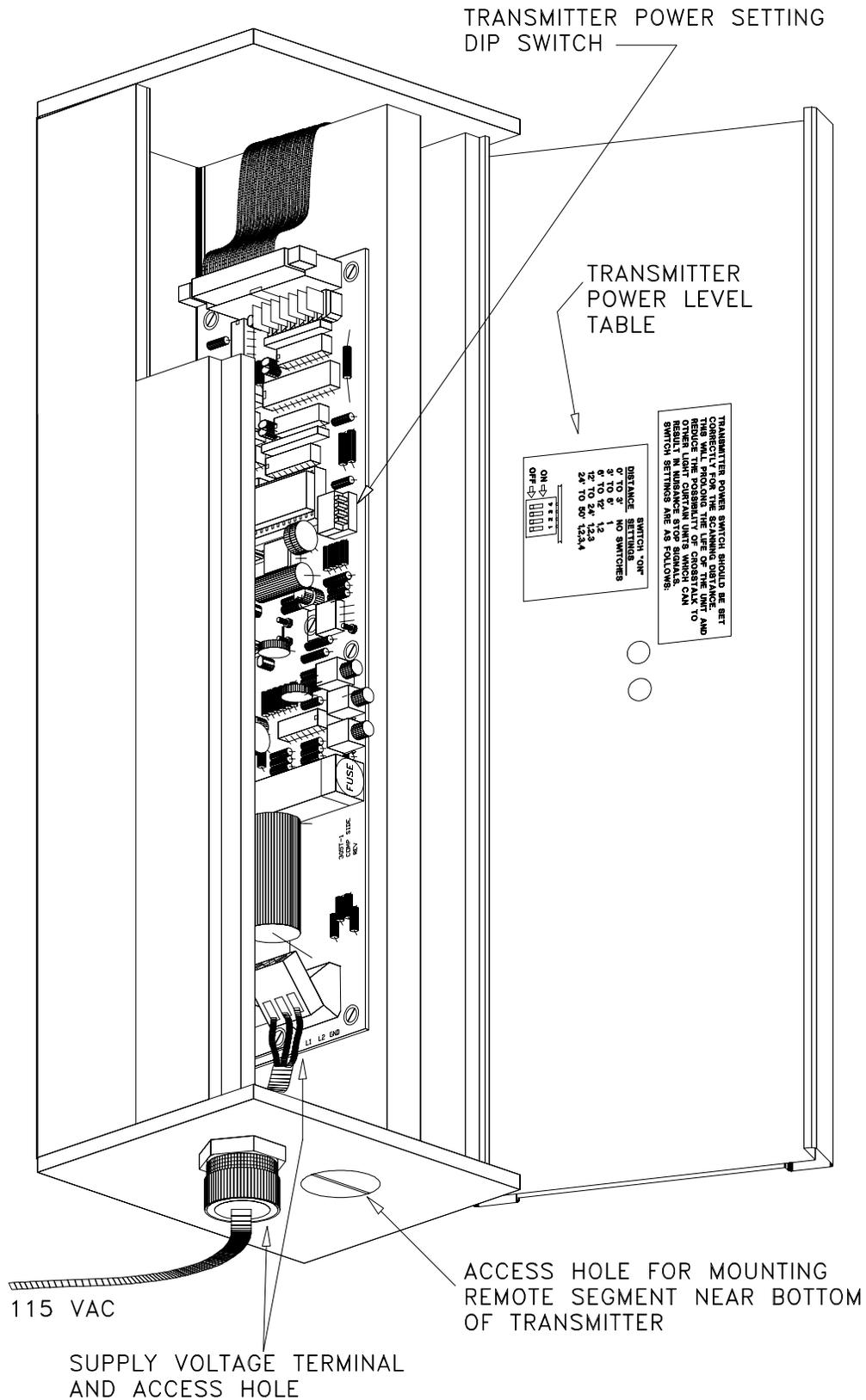


Figure 3.19: Location of the transmitter power level switch and power level table.

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NOTE! The receiver unit of the Black Max light curtain is designed to supply a stop signal when far too much light is received from the transmitter.

3.7 Aligning The Black Max Transmitter(s) and Receiver(s)

After setting the proper transmitter power level, make sure that both the Black Max transmitter and receiver enclosure doors are closed and screwed shut. If the mounting instructions in section 3.4 have been correctly followed, the acrylic lens on the transmitter and receiver units should face each other, the channel numbers beside the acrylic lens on the transmitter and receiver units should be directly across from each other, the receiver and transmitter should be mounted at the same height from the floor and in the same plane. Final alignment must now be done. Each transmitter channel of the Black Max sends out a focused cone of infrared light at a diverging angle rather like a sharply focused flashlight. This beam of light from a transmitter channel must fall upon the similarly numbered receiver channel. Also, each receiver channel has a lens to provide a limited cone of view. Each receiver channel must "look" at the transmitter channel with similar number. Figures 3.20 and 3.21 illustrate correct and incorrect alignment from front and top views, respectively.

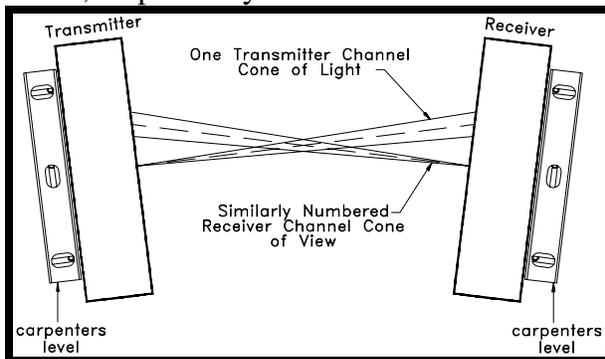


Figure 3.20a: Black Max transmitter and receiver out of alignment from front view.

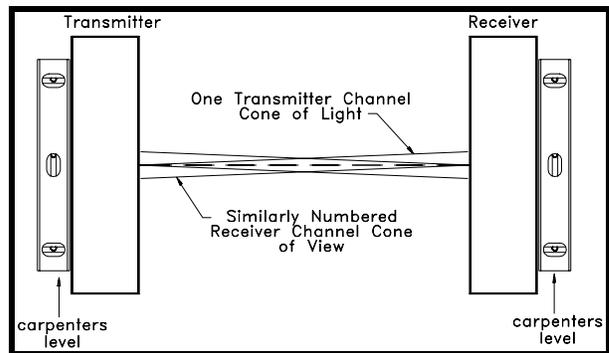


Figure 3.20b: Black Max transmitter and receiver in alignment from front view.

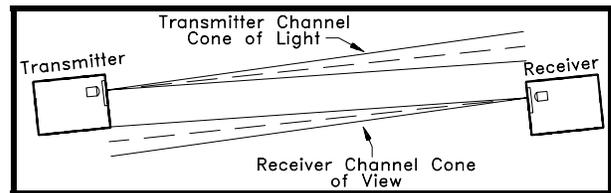


Figure 3.21a: Black Max transmitter and receiver out of alignment from top view.

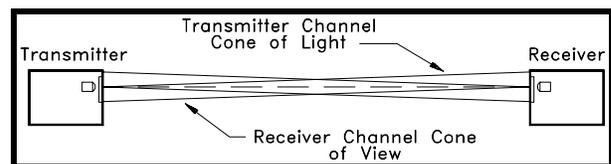


Figure 3.21b: Black Max transmitter and receiver in of alignment from top view.

Figure 3.22 illustrates alignment of transmitter and receiver from the side view. If Black Max units are not aligned properly, the receiver will not see the transmitter light, and a continuous stop signal will be

Link Lite Black Max Section 3 - Installation

sent by the Black Max receiver unit to the machine control.

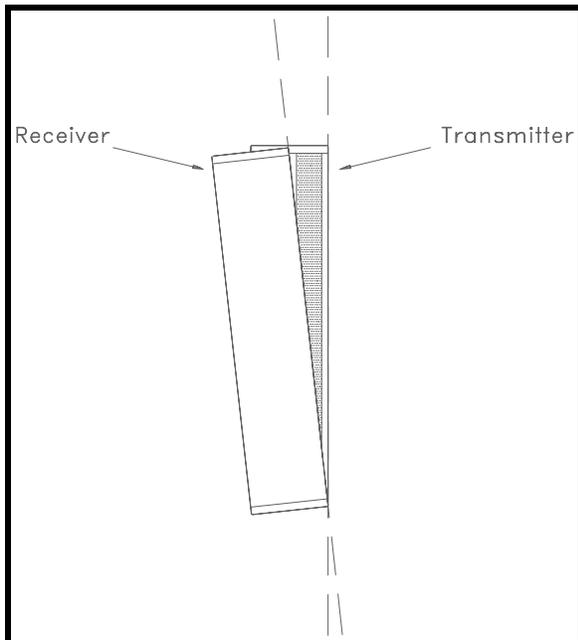


Figure 3.22a: Transmitter and receiver out of alignment from side view.

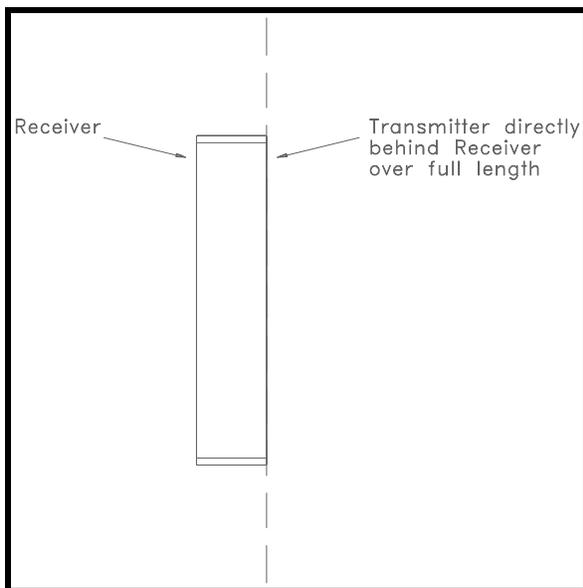


Figure 3.22b: Transmitter and receiver in alignment from side view.

To align the Black Max transmitter and receiver units perform the following steps.

1. Turn on the main disconnect switch to the machine control to supply power to the Link Lite Black Max transmitter and

receiver units. Verify that power is on the transmitter by observing that the green "POWER" LED in the front center of the transmitter unit is on. Verify that power is on the receiver by observing that either the green "CLEAR" LEDs or the red "STOP SIGNAL" LEDs in the front center of the receiver unit are on. Don't start the machine for this alignment procedure. Leave all motors off.

2. Check to make sure that no grease or dirt covers the red acrylic lens in the front of the transmitter and receiver units and that no obstruction is between the transmitter and receiver. Also, check the front of the main receiver unit to make sure that the amber colored "NO BLANKING" light is on and that the RUN-PROGRAM -SELECT switch is in the "RUN" position. If not, use the key for the RUN -PROGRAM - SELECT switch to obtain these conditions.

3. Observe the green "CLEAR" and red "STOP SIGNAL" lights on the door of the main receiver unit. If the transmitter and receiver are aligned to where some part of the cone of light from each emitter in the transmitter falls upon its similarly numbered phototransistor channel on the receiver and, if the receiver is aligned well enough that some sector of its cone of vision can see the light from the emitter, the "CLEAR" lights will be on. If not, the "STOP SIGNAL" lights will be on. Even if the "CLEAR" lights are on, indicating at least rough alignment, perform the following steps to achieve best alignment. Best alignment results when the cone of transmitted light and the cone of receiver vision are centered on each other.

4. The L shaped mounting "ears" for the Link Lite Black Max units are designed to allow easy alignment if the mounting

Link Lite Black Max Section 3 - Installation

brackets (or surface) to which the transmitter and receiver are to be mounted are in

reasonable alignment. The two mounting holes in the "ears" that bolt to the mounting surface are slotted to allow the transmitter and receiver units to be aligned lengthwise as shown in Figure 3.20b. The front mounting hole on the section of the mounting ear that attaches to the transmitter and receiver unit is slotted (the rear hole is not) to allow pivoting motion to align the transmitter and receiver in the direction shown in Figure 3.21b. To achieve best alignment, first loosen the bolts on the mounting ears of transmitter and receiver units that attach the ears to the mounting brackets or other mounting surface and use a carpenter's level to get them plumb as shown in Figure 3.20b. When plumb, tighten mounting ear bolts to the bracket or surface.

5. Now loosen the mounting ear bolts that connect the mounting ears to the transmitter and receiver units and pivot transmitter and receiver back and forth until the green "CLEAR" light comes on the door of the receiver unit. Tighten the bolts that hold the mounting ears to the receiver unit only, making certain that the green "CLEAR" light stays on as you do so.

6. Pivot the transmitter clockwise just till one or more of the red LEDs behind the acrylic lens on the front of the receiver come on, indicating that these channels have lost alignment. Then pivot the transmitter counterclockwise. The red channel LEDs should first turn off as the transmitter is rotated back into alignment, then turn back on as alignment is lost in the counterclockwise direction. Again pivot the transmitter clockwise until the transmitter is located at an angle halfway between the clockwise and counterclockwise loss of alignment angles. Tighten the bolts that

connect the mounting ears to the transmitter unit to lock the transmitter into angular alignment.

7. Loosen the bolts that connect the mounting ears to the receiver unit and repeat the procedure of step 6 with the receiver to bring the receiver into angular alignment.

NOTE! When aligning Black Max units that have remote segment units, first align main receiver and transmitter units and then remote segment receiver and transmitter units. Until both main and remote segment units are roughly aligned, the green "CLEAR" lights on the main receiver door won't come on.

3.8 Functional Checkout of the Link Lite Black Max Installation and Machine.

When the installation steps described in sections 3.3 through 3.7 have been successfully completed, a functional checkout of the operation of the machine and the Link Lite Black Max(s) must be performed before placing the machine into production, or before beginning installation of supplementary barriers if necessary.

| |
|--|
| <p>WARNING! The functional checkout of the Link Lite Black Max Installation and the machine on which it is installed must be performed to verify that the Black Max is wired into the machine control to provide on immediate initiation of stopping action and that the machine is functioning correctly. Serious injury or death can result from hazardous machine action if there are installation errors or machine misadjustments or malfunctions.</p> |
|--|

Link Lite Black Max Section 3 - Installation

Perform the following checkout steps:

1. Turn on power to the Link Lite Black Max units by turning the main disconnect to the machine control to the on position. Do not turn on machine motor(s). Verify that there are no obstructions between transmitter and receiver units.

2. Look at the door of the main Black Max receiver unit and verify that the green "CLEAR" lights are on, that the amber "NO BLANKING" light is on, and that the RUN - PROGRAM - SELECT switch is in the RUN position. If not, use the key for the RUN - PROGRAM -SELECT switch to obtain these conditions.

3. Both the main transmitter and receiver units have a label that states their minimum object sensitivity (M.O.S.). Check these labels to verify that both transmitter and receiver have the same M.O.S.. If a different M.O.S. is stated on the receiver and transmitter, a different model number transmitter and receiver have inadvertently been installed. find the transmitter or receiver that corresponds with the intended model number and exchange to correct this situation. When you have determined the M.O.S. of the installed units, obtain a test bar or strip that has a width equal to the M.O.S. of the installed Black Max system.

NOTE! If remote segment units are also used as supplementary safeguarding, the M.O.S. of these units will usually be different than the main units. Check the labels on these units for M.O.S..

4. Place the test bar or strip obtained in item 3 immediately in front of the top channel of the main receiver unit and slowly lower the bar or strip through the sensing field to the bottom channel, observing to confirm that each channel

indicator light behind the acrylic receiver lens lights as its channel is blocked, and that the red "STOP SIGNAL" lights on the receiver door stay continuously on as the bar or strip is lowered from top to bottom.

5. Repeat step 4 with the bar or strip placed immediately next to the main transmitter unit and lowered from top to bottom.

6. Repeat step 4 with the bar or strip halfway between the transmitter and receiver units and lowered from top to bottom.

7. If remote segment transmitter and receiver units are installed, block each channel of the remote segment unit and confirm that its channel indicator light located behind the acrylic lens on the remote segment receiver unit comes on and that the red "STOP SIGNAL" lights on the door of the receiver come on.

8. If any of the results in the test performed in the preceding steps are not as specified, go to the troubleshooting section of this manual or contact Link Systems to correct the problem. Do not start the machine until the problem is corrected. If the preceding tests were successful, start the machine and, with no obstruction between the Black Max transmitter and receiver units operate the machine in all modes to confirm normal operation. If the green "CLEAR" lights on the main receiver unit door are on but the machine won't operate, incorrect wiring from the Black Max to the machine control is indicated. If the machine operates properly proceed to the next step.

Link Lite Black Max Section 3 - Installation

9. Take the test bar or strip used in steps 4 through 6 and insert it into the sensing field between the transmitter and receiver. The machine stopping action should immediately be initiated when the sensing field is interrupted. An exception to this occurs when the Black Max is muted during a part of a machine cycle that is not hazardous. The interruption of the sensing field should then only stop the machine action during the hazardous portion of the cycle check to see that the machine does stop in all hazardous parts of the stroke. Repeat this test several times, making sure that the machine stops properly and that the safety distance requirement of section 3.3 is met for the stopping time encountered under the conditions of this test. If the machine that the Black max is installed on has multiple operating modes (such as Inch, Single Stroke, and Continuous on a mechanical power press) repeat this test in all modes to verify the intended stopping action. If the stopping mechanisms of the machine seem to be working improperly or erratically, notify the user/employer and request that a maintenance person qualified to adjust or repair the stopping mechanisms be assigned to do so. Don't proceed to the next step until the problem is corrected.

10. If all requirements of the preceding checkout steps are met, the installation of the Link Lite Black Max components of the safety system is complete. If the installer(s) of the Black Max components has been contracted or assigned the responsibility to provide any other necessary supplemental guarding components of the safety system, proceed to section 3.9. If someone else is to install other components of the safety system that may be required, the Black Max installer(s) should notify the user/employer that his phase of the installation is complete.

3.9 Supplemental Guard Installation Requirements

Although a safety system design for an industrial machine that uses only light curtains, such as the Link Lite Black Max units in addition to the machine components involved in stopping hazardous action can often be accomplished, it is sometimes necessary to make and install barriers to supplement the safeguarding function intended to be performed by the Black Max sensing field(s) to comply with OSHA and ANSI standards. Often, the requirement and physical configuration for barriers can only be determined after the Black Max installation. The safety distance requirement, configuration of the machine, size, and location of the light curtain and tooling can all be factors which affect the specific application. There are two areas of concern that must be considered when determining whether supplemental guards or barriers are required.

1. Any light curtain, including the Black Max, only protects people who reach through its sensing field as they approach the hazard to be safeguarded. Therefore, once the Black Max units have been installed, if it is possible to enter the hazardous area over, under, or around the Black Max(s) sensing field(s) from any normal position associated with the tasks of operators or other personnel, barriers must be installed to cause the only path to the hazard to be through the Black Max(s) sensing field(s).

2. The Black Max will not protect people if the required safety distance discussed in section 3.3 places the main transmitter and receiver far enough away from the hazard that a person can assume any normal position between the Black Max sensing field and the hazard, i.e., so that he can

Link Lite Black Max Section 3 - Installation

have a body part in the hazardous area without being detected. If remote segment Black Max units are not used to detect a person standing between the primary sensing field created by the main transmitter and receiver and the hazard (see section 3.4.2), then barriers must be installed to keep someone from passing completely through the Black Max sensing field toward the hazard.

WARNING! Failure to install supplemental barriers, when required, may result in serious injury to someone reaching the hazard through an opening or area not sensed by the Black Max light curtain(s).

Barriers installed to prevent people from reaching over, under, or around the Black Max(s) sensing field(s) must meet several OSHA construction requirements. These are:

1. The guard should prevent reaching over, under, or around the guard and into

the point of operation, except through the Black Max(s) sensing field(s).

2. Openings in the guard must meet the requirements of OSHA Table 0-10.

3. The barrier must be installed so that it doesn't create hazards (such as pinch points) between the guard and moving machine parts.

4. Unless the barrier is interlocked with the machine control to prevent hazardous action of the machine when it is not in place, it should use fasteners that require tools to remove.

Barriers to prevent someone from assuming a position between a Black Max sensing field and the hazard without being detected must be installed to prevent a persons body from passing completely through the Black Max sensing field as he approaches the hazard.

Figures 3.23 through 3.26 give general illustrations of the use of supplemental barriers.

| Table 0-10 | |
|---------------------------------------|--------------------------|
| Distance of Opening to Nearest Hazard | Maximum Width of Opening |
| 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" |

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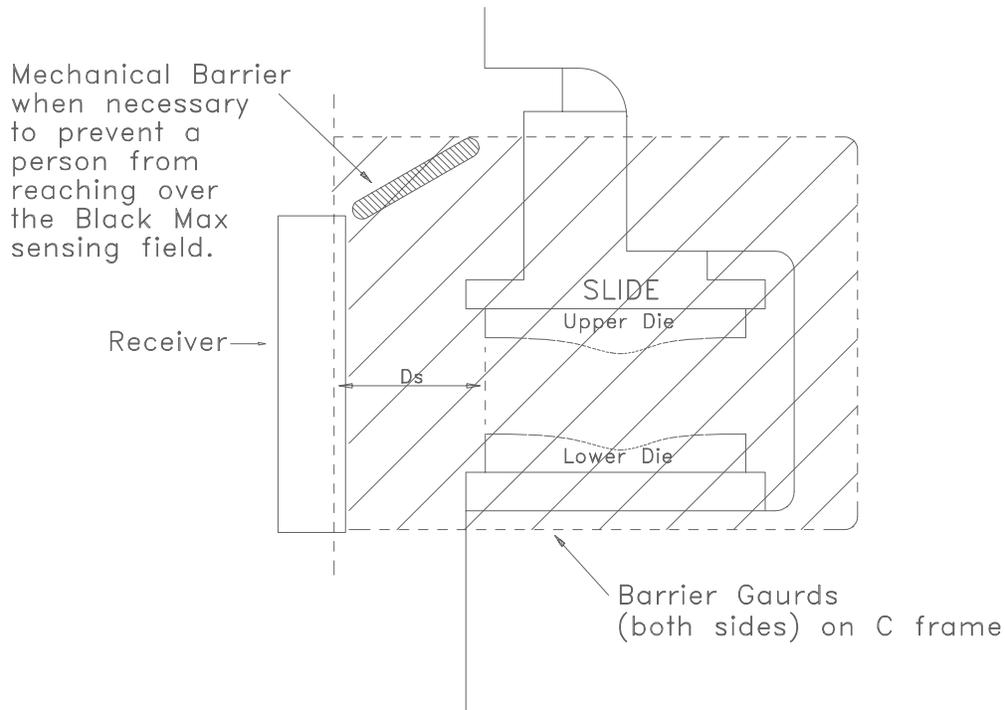
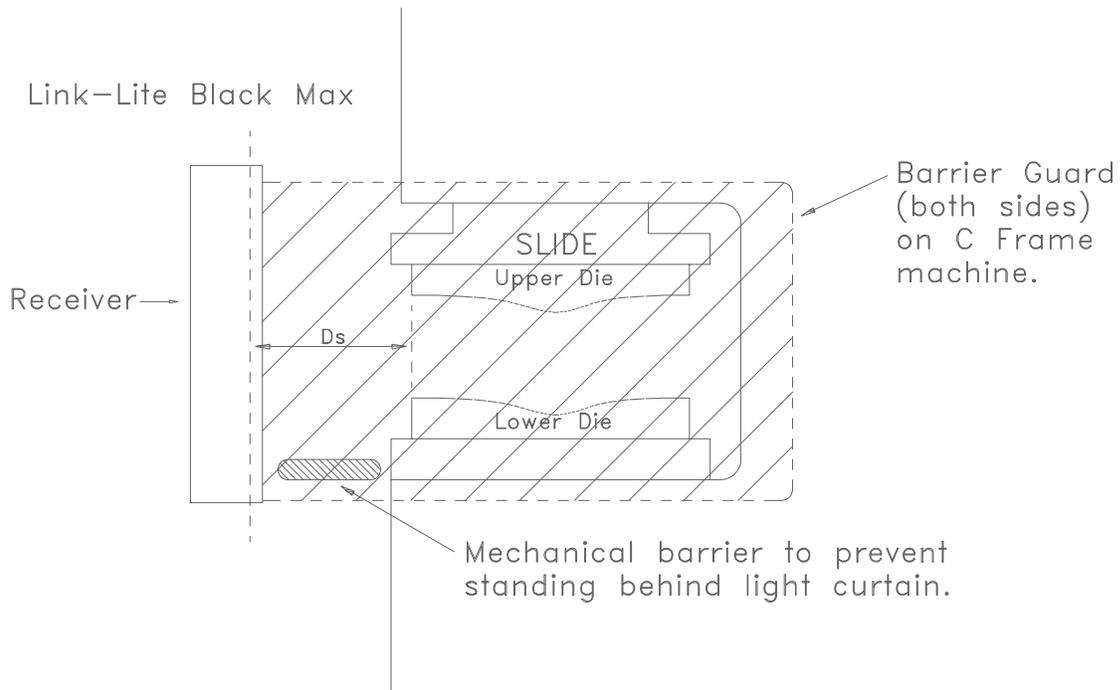


Figure 3.23: Illustration of barriers installed to prevent someone from reaching over the top of a Black Max sensing field or through the openings of a C frame machine.



Link Lite Black Max Section 3 - Installation

Figure 3.24: A Black Max with supplemental barrier to prevent standing between light curtain and hazard.

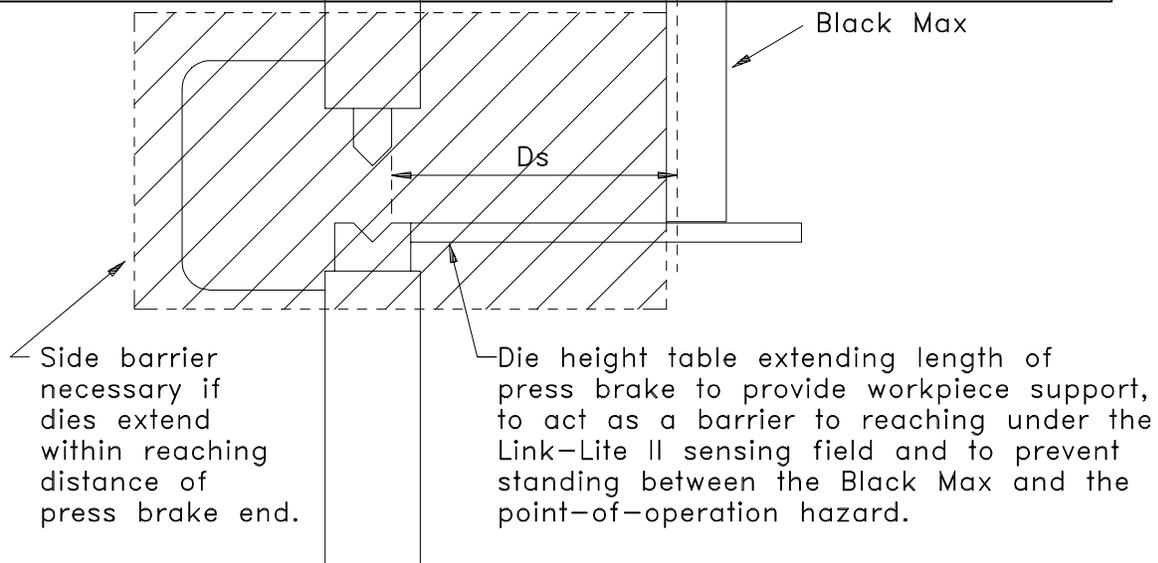


Figure 3.25: Example of a Black Max on a press brake with supplemental barriers.

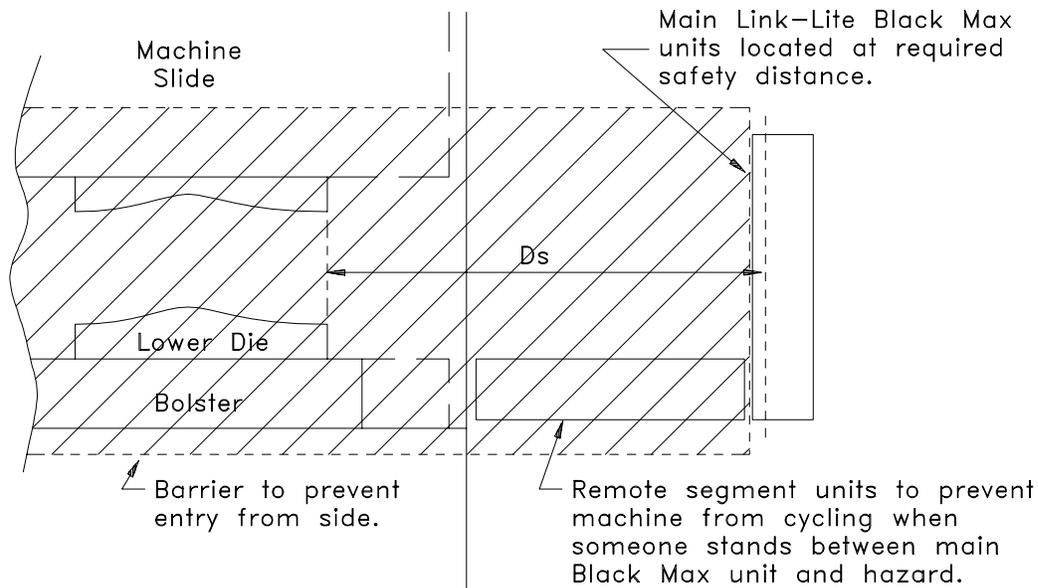


Figure 3.26: Use of Black Max remote segment units in the horizontal position to protect inside primary sensing field, and barriers to prevent entry from the side.

Link Lite Black Max Section 4 - Operating Instructions

4 OPERATING INSTRUCTIONS, REQUIREMENTS, AND PRECAUTIONS

IMPORTANT! All setup personnel, operators, supervisors, maintenance personnel, and other persons associated with the care and use of machines or production systems using Link Lite Black Max light curtains as safety components must read (or be provided with the knowledge of) the material in this *Operating Instructions, Requirements and Precautions* section to enhance safety to the fullest possible extent. OSHA and ANSI standards make it the employer's responsibility to train all employees associated with the setup, operation, and maintenance of the machine, and to provide supervision to ensure that employees follow proper setup and operation procedures.

4.1 Safeguarding System Limitations and Requirements

Link Lite Black Max light curtains are not the safety system, but rather are a component of the machine safety system. Light curtains send a stop signal to the control of a machine when someone or something blocks their sensing field light. They depend on other electrical, pneumatic, mechanical, and/or hydraulic components of the machine drive system to actually stop hazardous action when you are in the sensing field. In some cases, supplemental barriers or safety devices may be required in addition to light curtains to protect you from the machine or production system hazard(s). Light curtains must be properly installed, located, and used in conjunction with any other necessary safety components to protect you, in accordance with the following requirements.

1. Link Lite Black Max light curtain presence sensing devices are designed and manufactured to comply with OSHA and ANSI standards for construction of point of operation devices. Properly installed, located, adjusted and used presence sensing devices enhance personnel safety by preventing normal initiation of hazardous machine action or by stopping normal hazardous action in progress if the operator's (or other's) hand or other body part are in the sensing field (the plane directly between the Black Max transmitter and receiver units as shown in Figure 4.1).

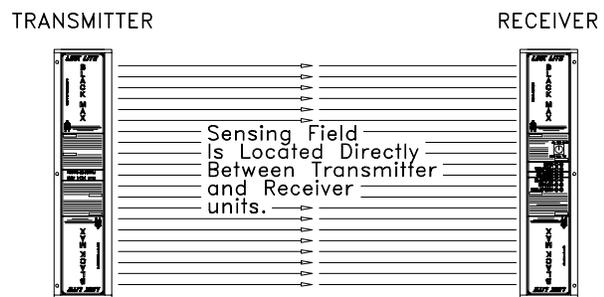


Figure 4.1: Illustration of sensing field location between main Black Max transmitter and receiver units when no blanking is used.

WARNING! No presence sensing device, including the Link-Lite Black Max, will protect you from abnormal hazardous machine action(s) caused by failure, wear, or misadjustment of mechanical, hydraulic, pneumatic, or electrical components of the machine upon which it is installed. Serious injury or death may result from such failures.

Proper machine preventative maintenance must be performed to reduce the risk of accidents that result from failure, wear, or misadjustment of machine components.

Link Lite Black Max Section 4 - Operating Instructions

2. The main Black Max sensing field must be located far enough away from the hazardous area that machine action will be stopped before a person's hand that passes through the light curtain sensing field can reach the closest hazard. This safety distance is required by both OSHA and ANSI. The minimum safety distance, D_s , is determined by a formula which is explained in section 3.3 of the installation section of this manual.

It must never be assumed that the original installation of a Black Max light curtain will always result in maintaining D_s for all setups and under all operating conditions. For several reasons, safety distance must be verified for each setup under actual operating conditions.

First, D_s depends on the stopping time, T_s , of the machine, which can vary depending on many factors, including position in stroke, cycle rate, air or hydraulic pressure, speed of moving parts (stroking speed), temperature of hydraulic fluid, weight of tooling attached to moving machine parts, and counterbalance adjustment. On machines equipped with friction clutches and brakes, clutch and brake wear over a period of time can cause the stopping time to increase. Some hydraulically operated machines have adjustments that can affect stopping time.

Second, the size and location of the tooling used in a machine often varies for each machine setup, bringing the hazardous point of operation closer or farther away from the Black Max sensing field on different setups and thus affecting D_s . For this reason the person(s) assigned to set the machine up for different production jobs must verify the safety distance for each setup. See Figure 4.2

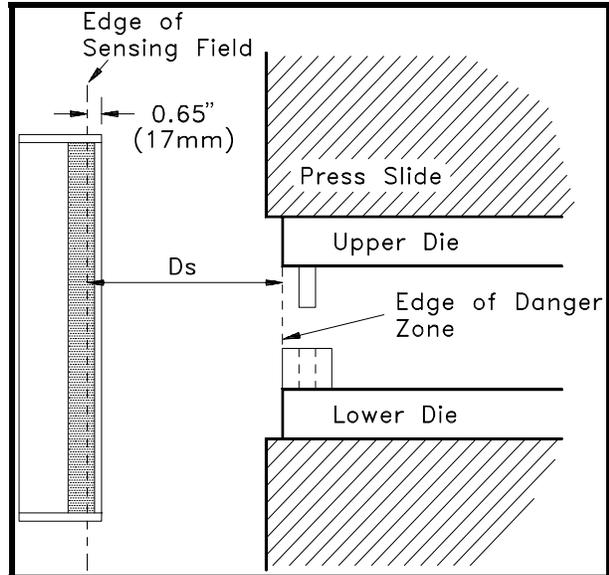


Figure 4.2: Illustration of Minimum Safety Distance Measurement

WARNING! The Link Lite Black Max sensing field must be located at a distance greater than or equal to the safety distance, D_s . Failure to do so can result in serious injury to personnel because it is possible to reach into the hazardous area before the machine can stop.

3. Light curtains, including the Black Max, only protect people who reach through their sensing field as they approach the hazard to be safeguarded.

WARNING! The Black Max light curtain will not protect you if you reach over, under, or around its sensing field and into the hazard. Serious injury may result if you can enter the hazard other than through the Black Max sensing field.

Depending on the safety system design and the machine or production system configuration, supplemental barriers may be

Link Lite Black Max Section 4 - Operating Instructions

required to prevent someone from reaching the hazardous area from any normal position associated with the employer defined tasks of operators or other personnel other than through the Black Max sensing field. These barriers must be provided and used when necessary to supplement the Black Max safeguarding component.

4. The required safety distance of item 2 may place the main Black Max sensing field far enough away from the hazard that a person can assume a normal working position between the sensing field and the hazard. A person in such a position can reach into, or enter into, the hazardous area without being detected by the main Black Max sensing field, and the Black Max will provide no protection if hazardous machine action is started.

A physical barrier to prevent persons from standing inside the main Black Max sensing field or Black Max remote extension units oriented horizontally and extending outward from the machine to detect persons inside the main sensing field and prevent normal machine action must be used if every person operating or helping with the production system doesn't have his own set of active operator controls, located on the other side of the main Black Max sensing field, from the hazard. These operator controls must be designed to be operated concurrently with all other operator controls to initiate machine action.

WARNING! The Link Lite Black Max will not protect a person in a position between the sensing field and the hazard. Serious injury or death may be inflicted by the hazard if machine or production system action is started while a person is in such a position.

5. Any task associated with a machine or production system using a Black Max as a safeguarding component that requires a person to enter into the hazardous area so that he is not protected by the Black Max or other safeguarding components must be done in accordance with OSHA's lock-out/tagout regulations, CFR1910.147, where all hazardous energy is locked out on the machine or production system by each person involved in the task. For example, tool or die repairs or adjustments in the machine and repair or adjustment of parts transfer or other feeding systems located in the hazardous area may cause the person(s) doing these tasks to assume positions or locations that aren't protected by production mode safeguarding.

WARNING! Repair, maintenance, or production system corrective measures or tasks that cause persons to enter the hazardous area and assume positions or locations so that they aren't protected by the Black Max or other safeguarding components must be performed in accordance with OSHA's CFR1910.147 lockout procedures. Serious injury or death may result from the machine or production system if lockout procedures are not followed.

6. OSHA and ANSI standards permit "muting" (bypassing the presence sensing device stop signal) in the non-hazardous portion of the cycle - such as the die opening portion of the cycle - on linearly stroking machines such as power presses and press brakes. If the muting means is improperly adjusted, the Black Max stop signal may be bypassed during all or part of the dangerous closing portion of the stroke.

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WARNING! If muting is used, and the muting means is improperly installed or adjusted, the Black Max stop signal may be bypassed in a hazardous portion of the machine cycle. Serious injury or death can result from improper muting.

When muting is used, it must be checked for proper adjustment each time maintenance is performed on the machine, the machine control, or the Black Max.

7. The use of Link Lite Black Max light curtains as a safeguarding component on a machine does not remove the need to heed the warnings and follow the operating practices and instructions supplied by the machine manufacturer.

8. Because no safeguarding system, including those that use the Link Lite Black Max as a safety component, absolutely prevents injury to personnel from all sources of human error and machine related failure, operators, die setters, maintenance personnel, and others must use the same caution and good practices in their tasks as if no safety system were present to attain greatest enhancement of safety.

4.2 Blanking Instructions and Requirements

In order to provide "windows" in the field of vision for machine setups where some object(s) must of necessity intrude into the main Link Lite Black Max sensing field, a keyed selector on the main receiver unit is provided to select VARIBLANK, FIXED BLANKING, or a combination of these two types of blanking. Only a limited number of sensors in the main Black Max

sensing field can be blanked. Sensors in remote extension Black Max units used for supplemental safeguarding cannot be blanked.

4.3 VARIBLANK

All blanking modes for the Link Lite Black Max are selected using the keyed selector switch located on the front door of the main Black Max receiver unit. The keyed selector switch has three positions - RUN, PROGRAM, and SELECT. The switch has two stable positions, i.e., positions that it will stay in when turned there by the key. These positions are RUN and PROGRAM. The key has one "momentary" position, i.e., if the key is used to turn the switch to the SELECT position, when the key is released to key and switch will return to the PROGRAM position.

To select the VARIBLANK mode, use the key to turn the RUN/PROGRAM/SELECT switch to the select position. Then release the key to let the switch return to the PROGRAM position while observing the two LED indicators beside each of the blanking mode choices located on the front door of the main Black Max receiver unit. The blanking mode choices are NO BLANKING, VARIBLANK, and FIXED BLANKING. Each time you rotate the key to the SELECT position and release it to the PROGRAM position, the lights will change to indicate a different blanking choice. To select to VARIBLANK mode only, turn the key to the SELECT position and release the key to the PROGRAM position the required number of times to get only the VARIBLANK mode indicator lights on, as shown in Figure 4.3, then turning the keyed selector to the RUN position.

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NOTE! The Black Max always gives a stop signal unless the blanking mode selector switch is in the RUN position. Always remove the key from the switch when blanking mode selection is complete.

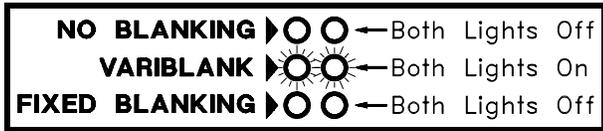


Figure 4.3: VARIBLANK mode selected.

When VARIBLANK mode is selected, it requires that any two (not necessarily side by side) sensors in the main Black Max unit sensing field be blocked before the Black Max will signal the machine or production system to stop hazardous action. This mode is sometimes useful for feeding strip stock or material that is thin enough that it will only block one sensor at a time through the sensing field of the Black Max so that it doesn't stop the machine. Of course, since its possible that a person will also now have to block two sensors to stop hazardous machine action, VARIBLANK has the effect of increasing minimum object sensitivity, M.O.S., by the space between any two adjacent sensors (.75 inches for most main Black Max units). This is the case if the material that blocks one sensor doesn't stay in place at all times and extend all the way across the Black Max sensing field. You must follow the safe blanking requirements of section 4.2.4.

4.2.2 FIXED BLANKING

Fixed blanking is the turning off of specific sensor channels in the main Black Max sensing field to allow fixed objects that are necessary to the production system to

extend through the sensing field without preventing the machine or production system from operating. No more than seven (7) sensors can be fixed blanked on a standard Black Max unit. Any combination of seven sensor channels can be blanked.

If the object that requires sensors to be blanked is perfectly stationary in the sensing field, you may use the blanking mode selector switch to select FIXED BLANKING mode by turning the key to the SELECT position and releasing the key to the PROGRAM position until only the FIXED BLANKING mode indicator lights are on, as shown in Figure 4.4.

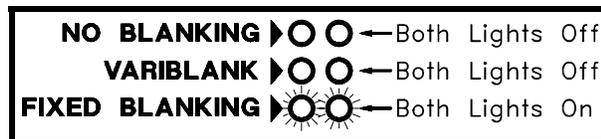


Figure 4.4: FIXED BLANKING selected.

After you have selected FIXED BLANKING return the blanking mode selector switch to the RUN position and remove the key. Any receiver sensor (but only up to seven in total number) that is blocked from receiving its signal from the transmitter by a stationary object will be automatically blanked when you turn the blanking mode selector to the RUN position, and will remain blanked as long as the object is in place. The blanked sensors will be indicated by the channel indicator lights (located behind the red acrylic lens in the front of the receiver). The indicator light for each blanked channel will blink, as opposed to being OFF when there is no obstruction or ON when there is an obstruction but the sensor is not blanked.

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NOTE! When **FIXED BLANKING** is used, removal of the object(s) that blocks the transmitter light from the receiver sensor channel will automatically unblank the sensor channel.

If the object(s) that requires sensors to be blanked moves up and down enough (through vibration or shock or other effects) in the sensing field that a sensor is sometimes blocked and sometimes not, you must use one of the seven fixed blanking tabs provided with your Black Max unit to cover the receiver sensor so that it won't automatically unblank during those times when the object doesn't block the sensor. The blanking tab is a metal strip with a locking screw that inserts into the wedge shaped channel next to the red acrylic lens on the Black Max receiver. You must slide the blanking tab into position to cover the sensor channel to be blanked and lock it in place with its set screw. Figure 4.5 illustrates the use of the blanking tab.

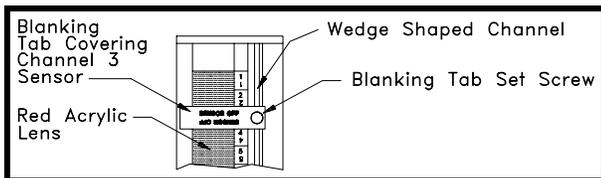


Figure 4.5: Front View of Black Max Main Receiver Unit Showing Channel 3 Sensor Blocked by Blanking Tab.

To unblank any sensor channel using fixed blanking with blanking tabs, you must remove both the object in the sensing field that requires blanking and the blanking tab. As soon as the sensor sees its transmitter light, it will automatically unblank itself.

NOTE! Because fixed blanking provides "windows" in the Black Max sensing field, you must follow the safe blanking requirement of section 4.2.4 when it is used.

4.2.3 Combination VARIBLANKING and FIXED BLANKING

You can select both **VARIBLANK** and **FIXED BLANKING** if necessary for a particular production setup. However, when you use both **VARIBLANK** and **FIXED BLANKING** only six channels may use **FIXED BLANKING**. Rotate the blanking mode selector switch to the **SELECT** position and release it to the **PROGRAM** position repetitively until both the **VARIBLANK** and **FIXED BLANKING** **MODE** indicator lights are on, as shown in Figure 4.6.

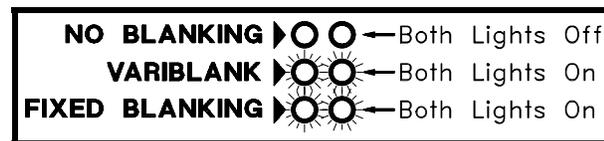


Figure 4.6: Combination **VARIBLANKING** and **FIXED BLANKING** selected.

Place any blanking tabs in place that are necessary for use with channels to use **FIXED BLANKING**, return the blanking mode switch to the **RUN** position and remove the key from the switch. Channels that use **FIXED BLANKING** will have blinking channel indicator lights or will be indicated by being covered by blanking tabs. Since **VARIBLANK** is also selected, two channels that are not **FIXED BLANKED** must be blocked for the Black Max to provide a stop signal.

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4.2.4 Requirements for Safe Use of Blanking

Since blanking leaves "windows" in the Link Lite Black Max sensing field that could allow a person to penetrate closer or completely to the hazard before being detected, the following blanking requirements must be followed.

1. Always try to design and set up the production system to avoid blanking any Black Max sensors.
2. When a necessary obstruction blocks part of the Black Max sensing field, all Black Max sensor channels that can be left active. NEVER blank any Black Max sensor that can be left on!
3. If the obstruction that requires blanking does not prevent entry through the blanked area(s) of the sensing field by extending all the way across the blanked area, supplemental barriers must be used to prevent a person from reaching through the blanked area. Alternatively, if only FIXED BLANKING is used in such a way that no two side by side sensors are blanked, or if VARIBLANK only is used, the safety distance, Ds, can be increased by 2.55 inches to account for an increased M.O.S. of .75 inches and no supplementary barriers used. If no more than any two (2) side by side sensor channels use FIXED BLANKING, or if a combination of VARIBLANK and FIXED BLANKING is used so that no side by side channels use FIXED BLANKING, the safety distance, Ds, can be increased 5.1 inches to account for an increased M.O.S. of 1.5 inches and no supplementary barriers used. For any pattern of FIXED BLANKING that blanks more than two (2) side by side sensor channels, the blanked area must be

obstructed to prevent a person from reaching through the blanked area. Otherwise item 4 of this list applies. For any combination of VARIBLANK and FIXED BLANKING that uses two or more side by side sensor channels in FIXED BLANKING, the fixed blanked area must be obstructed to prevent a person from reaching through the fixed blanked area and the safety distance, Ds, must be increased by 2.55 inches. Otherwise, item 4 of this list applies.

4. If any production job requires a set up, including blanking, such that a person can reach the hazard without being sensed by the Link Lite Black Max at the required safety distance, alternative OSHA or ANSI accepted safeguarding devices or guards must be used to protect personnel.
5. Close supervision of blanking must be maintained. Only those persons trained and authorized by the employer in the safe use of blanking and required supplemental or alternative safeguarding should be allowed access to the blanking selection key. The blanking selection key must never be left in the blanking mode selector switch.

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| <p>WARNING! Failure to follow the requirements for safe use of blanking will leave personnel unprotected or only partly protected from the hazard for which protection is intended. Serious injury or death may result because a person may be able to reach into the hazardous area while machine action is in progress.</p> |
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4.3 Safety System Setup

Each time a machine or production system is set up with new tooling, feeding equipment, or other elements to run a different job or part, the person(s) setting up the production system must perform a "Safety System Setup" before turning the machine or production system over to the operator. (In some cases the setup person and operator may be the same.) The Safety System Setup must include the following steps.

1. The setup person must determine the designated safeguarding system configuration required to protect the operators on the production job.
2. During each change in production system setup, the setup person must check to see that the minimum safety distance requirement, D_s , from the main Black Max unit sensing fields to the hazard is met under actual working conditions, including any additional safety distance for blanking. See sections 3.3 and 4.2 of this manual.
3. If blanking of Black Max sensor channels is required, the setup person must follow the requirements of section 4.2 of this manual for each setup.
4. The setup person must make sure that all supplementary, auxiliary, or alternative safeguarding components called for by the safeguarding system configuration are in place and functional.
5. The setup person must run the machine and verify that the machine is functioning properly and that placing an object in the sensing field of each Link Lite Black Max light curtain on the machine causes the machine to stop. He should also block

each Black Max receiver channel and verify that the red LED indicator seen through the red acrylic strip next to the channel numbers turns on (except for channels with fixed blanking).

6. The machine must not be turned over to production till steps 1 through 5 of this list are satisfactorily accomplished, including any necessary maintenance or adjustment necessary to meet these requirements.

WARNING! Failure to perform the "Safety System Setup" each time the machine or production system is changed to run a new job can result in improper use of safeguarding components or failure to use required components of the safeguarding system configuration. Serious injury or death can result from a machine or production system hazard that is not properly safeguarded or a machine that is not functioning correctly.

4.4 Operator Safety System Checkout

After every new production set up, at the start of each shift, or after an operator change, the operator(s) must perform the following "Operator Safety System Checkout" to make sure that the Link Lite Black Max light curtain(s), machine control, and machine mechanical, pneumatic, and/or hydraulic drive components are working properly before operating the machine. this check must also be made to verify that all safety components are used and set up properly.

1. Observe the VARIBLANK LED indicators on the front door of the enclosure unit. If they are off, proceed to

Link Lite Black Max Section 4 - Operating Instructions

step 2. If they are on, have an authorized person use the RUN/PROGRAM/SELECT switch to turn them off while leaving any FIXED BLANKING necessary for the setup.

2. Check to see if any Black Max sensor channels are blanked, that no sensor channels are unnecessarily blanked, and that, if blanking is used, that the requirements for safe blanking in section 4.2.4 of this manual are met. If the requirements of section 4.2.4 are not met, have any authorized person set up the safeguarding system to comply with these requirements.

3. Insert a test rod or bar with a width equal to the minimum object sensitivity (M.O.S.) stated on the labels attached to the Link Lite Black max receiver and transmitter units into the Black Max sensing field next to the receiver unit. Mover the bar slowly from the top to the bottom of the receiver unit, observing to see that every receiver channel LED indicator turns on as the bar blocks its position in the sensing field, except for those channels that are blanked. Also, check to see that the red STOP SIGNAL LEDS on the front door of the receiver stay on except in blanked areas. If remote segment Black Max transmitter and receiver units (usually mounted horizontally or at an angle) are used, block each channel next to the receiver and observe that the channel indicator turns on and that the STOP SIGNAL LEDS on the main receiver unit light up.

4. Repeat step 3 of this procedure with the test bar passing through the sensing field next to the transmitter unit.

5. Repeat step 3 of this procedure with the test bar passing through the sensing field

about half way between the transmitter and receiver units.

6. Initiate machine action and insert the test bar into the Black Max sensing field in the hazardous portion of the cycle or stroke. The machine should stop with normal reaction time. (If muting is used, the machine will not stop in the non-hazardous portion of the cycle when the bar is inserted into the sensing field.)

7. Check to make sure that any other supplemental or alternative safeguarding components used with the safeguarding system configuration in addition to the Black Max safety components are in place and functioning.

8. Do not operate the machine if any result or requirement of this "Operator Safety System Checkout" is not satisfactory. Immediately notify a supervisor of any setup or equipment problem and don't run the machine until the problem is corrected.

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| <p>WARNING! MACHINE OPERATOR(S) <u>must</u> perform the "Operator Safety System Checkout" at each shift change, operator change, and production setup change to verify proper safety system operation and use. Serious injury or death can result from a machine or production system hazard that is not properly safeguarded or a machine that is not functioning correctly.</p> |
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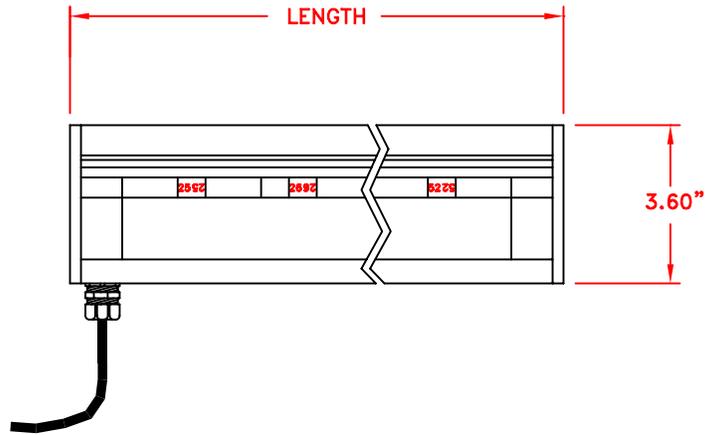
4.5 Checkout after Repair or Modification

Any time that a Link Lite Black Max is repaired or re-installed or the machine or machine control is repaired, rebuilt, or modified, the functional checkout of the Link Lite Black Max and machine de-

Link Lite Black Max Section 4 - Operating Instructions

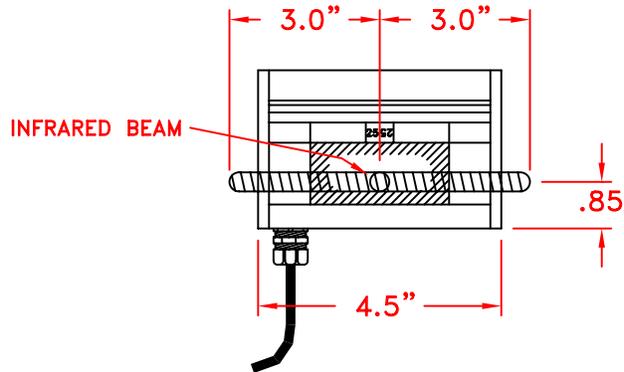
scribed in section 3.8 of this manual must be performed before placing the machine back into production.

WARNING! After repair or re-installation of a Link Lite Black Max or the machine or machine control is repaired, rebuilt, or modified, the functional checkout of the Black Max installation and the machine on which it is installed described in section 3.8 of this manual must be performed to verify that the Black Max is wired into the machine control to provide an immediate initiation of stopping action and that the machine is functioning correctly. Serious injury or death can result from hazardous machine action if there are installation errors, machine mis-adjustments, or machine malfunctions.



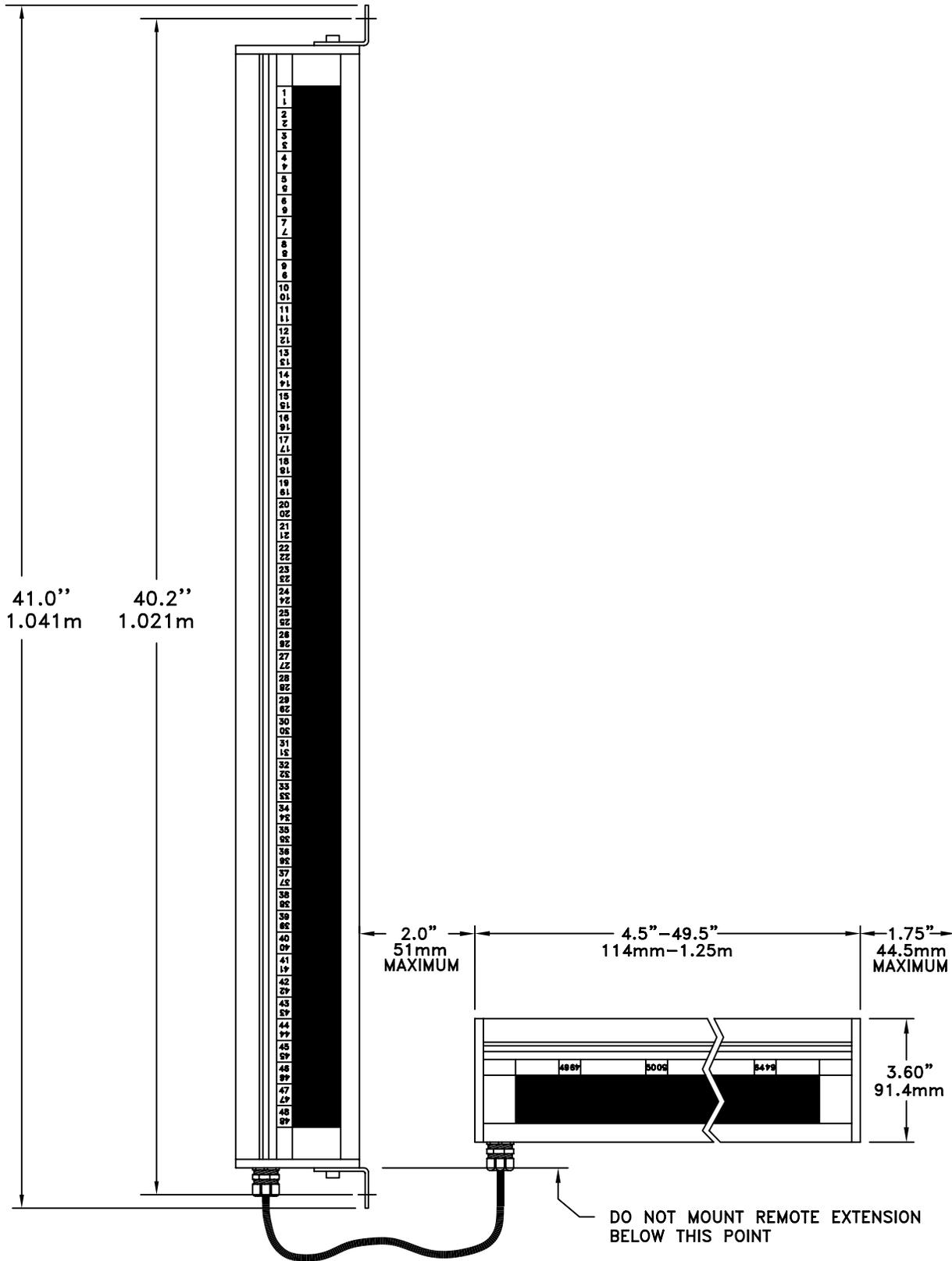
| <u>FIELD WIDTH</u> | <u>LENGTH</u> | <u>BEAMS</u> |
|--------------------|---------------|--------------|
| 6.0 | 4.5 | 1 |
| 9.0 | 7.5 | 2 |
| 12.0 | 10.5 | 3 |
| 15.0 | 13.5 | 4 |
| 18.0 | 16.5 | 5 |
| 21.0 | 19.5 | 6 |
| 24.0 | 22.5 | 7 |
| 27.0 | 25.5 | 8 |
| 30.0 | 28.5 | 9 |
| 33.0 | 31.5 | 10 |
| 36.0 | 34.5 | 11 |
| 39.0 | 37.5 | 12 |
| 42.0 | 40.5 | 13 |
| 45.0 | 43.5 | 14 |
| 48.0 | 46.5 | 15 |
| 51.0 | 49.5 | 16 |
| 54.0 | 52.5 | 17 |

TOTAL WIDTH OF SENSING FIELD = 6"
(MINIUM OBJECT SENSITIVITY 3.2")



TRANSMITTER or RECEIVER side view

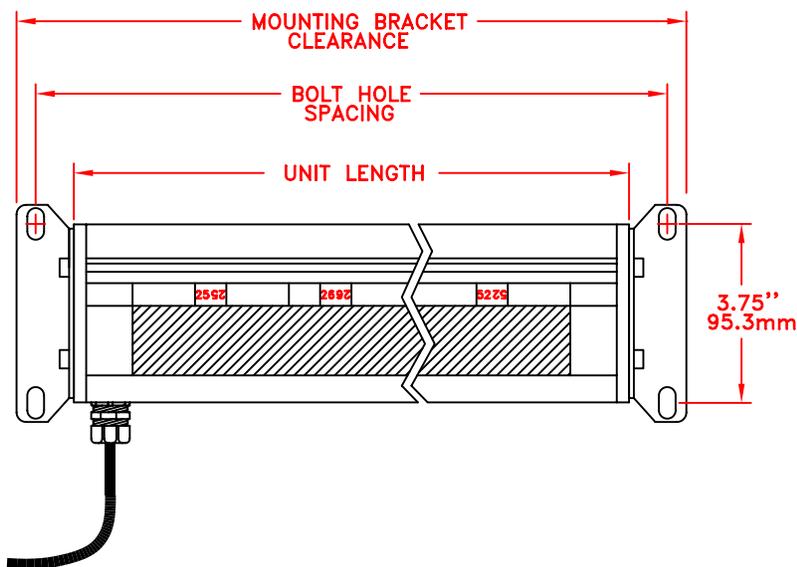
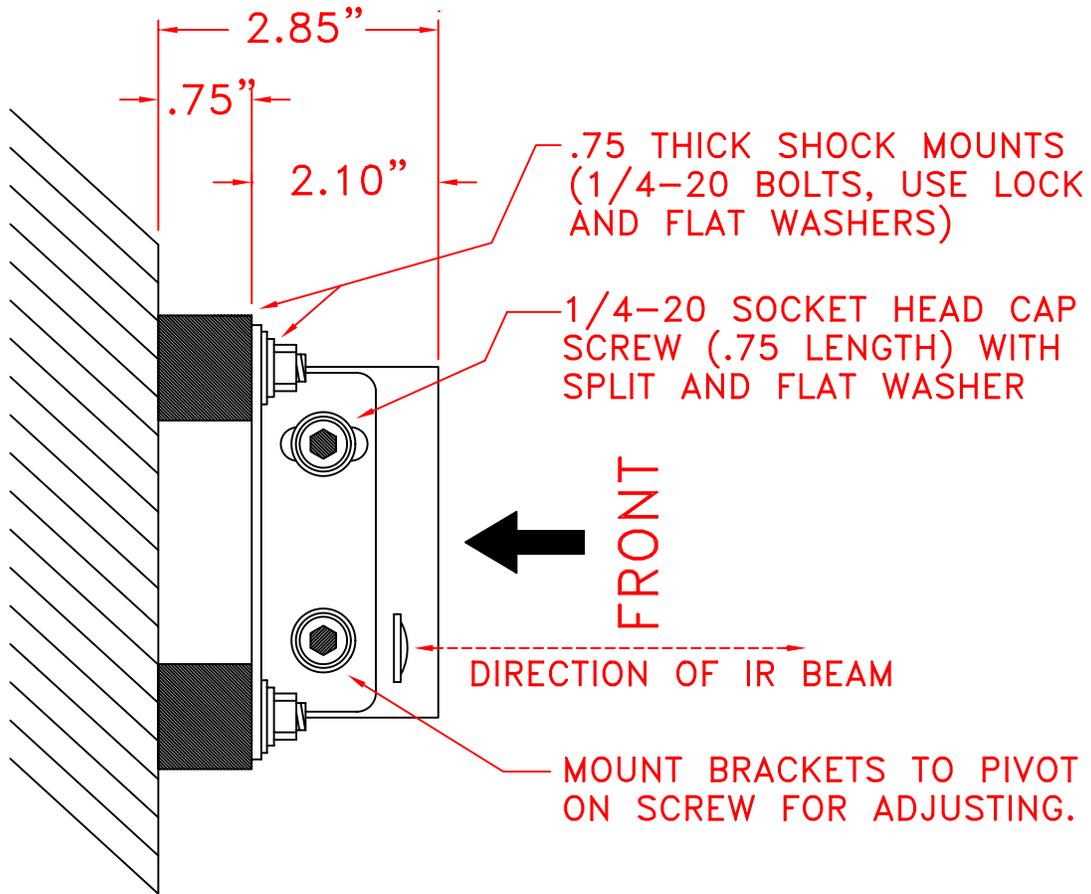
BLACK MAX REMOTE EXTENSION Sensing Field



MACHINE

TRANSMITTER side view

36" Link-Lite BLACK MAX with REMOTE EXTENSION



| UNIT LENGTH | BOLT HOLE SPACING | MOUNTING BRACKET CLEARANCE |
|----------------|----------------------|----------------------------------|
| 4.5 | 6.15 | 6.90 |
| 7.5 | 9.15 | 9.90 |
| 10.5 | 12.15 | 12.90 |
| 13.5 | 15.15 | 15.90 |
| 16.5 | 18.15 | 18.90 |
| 19.5 | 21.15 | 21.90 |
| 22.5 | 24.15 | 24.90 |
| 25.5 | 27.15 | 27.90 |
| 28.5 | 30.15 | 30.90 |
| 31.5 | 33.15 | 33.90 |
| 34.5 | 36.15 | 36.90 |
| 37.5 | 39.15 | 39.90 |
| 40.5 | 42.15 | 42.90 |
| 43.5 | 45.15 | 45.90 |
| 46.5 | 48.15 | 48.90 |
| 49.5 | 51.15 | 51.90 |
| 52.5 | 54.15 | 54.90 |

TRANSMITTER or RECEIVER side views

Link-Lite BLACK MAX Remote Extension mounting dimensions