



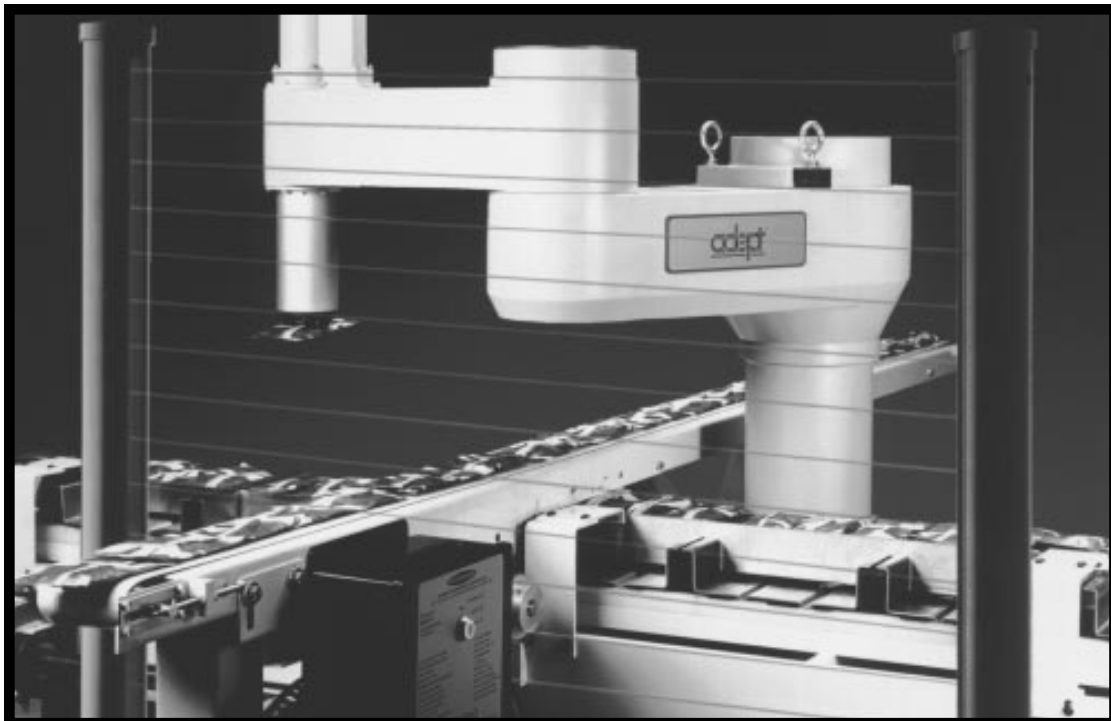
# BEAM-ARRAY™ PERIMETER-GUARD System Instruction Manual

- An optoelectronic perimeter guarding device for production machinery such as robots, packaging machines, and similar automated production equipment (page 3)
- Creates a curtain of synchronized, modulated infrared sensing beams from 6 inches to 6 feet high (12 length increments, see page 2); system has 3x excess gain remaining at specified maximum range of 45 feet
- Use with MGM Series Corner Mirrors to enable a single PERIMETER-GUARD System to guard more than one side of an area
- FMEA tested to ensure control reliability
- Opposed mode configuration reliably penetrates dust, dirt, oil, fog, and mist found in real-life applications
- Replaceable redundant output relays with "forced guided" contacts to ensure control reliability
- Two available blanking types, *floating blanking* and *exact blanking*, easily configured inside control box
- Controller uses "diverse redundancy" design concept to achieve a higher level of control reliability
- Highly immune to EMI, RFI, and ambient light; highly immune to strobe light
- Modular design with no "matched sets" necessary: any emitter and receiver (of equal length) may be used together with any P-G System control box
- Epoxy-encapsulated, vibration-tolerant, factory burned-in sensor circuitry for toughness and dependability
- Versatile swivel mounting brackets and small, light-weight tubular sensors for easy installation and alignment both on new equipment and in retrofit applications

**ISO9002**  
DOCUMENTED QUALITY

 Listed  
Presence  
Sensing Device  
10Y8 SA8959

LR 41887



Spanish language instruction manuals and product labels are available by request. See page 38.  
Los manuales de instrucciones y las etiquetas de los productos están disponibles en español si usted lo pide. Ver la pagina 38.

**Banner PERIMETER-GUARD Systems are designed and built in the U.S.A.**

# Important... read this page first!



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

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

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

The user of the PERIMETER-GUARD System shall ensure that all machine operators, maintenance personnel, electricians, and supervisors are thoroughly familiar with and understand all instructions regarding the use and maintenance of the PERIMETER GUARD System and the machinery with which it is being operated, as well as all appropriate safety regulations.

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

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

## Caution!!

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

### U.S. Standards Applicable to Use of PERIMETER-GUARD™ Systems

**ANSI B11.19**    **Safeguarding of Machine Tools**  
**ANSI/RIA 15.06**    **Safety Requirements for Robot Systems**

Copies are available from:

Safety Director  
 National Machine Tool Builders Association  
 7901 Westpark Drive  
 McLean, VA 22101-4269

See page 35 for a detailed listing of applicable standards and requirements

## PERIMETER-GUARD System

Emitter/receiver Models	Height of Defined Area
MGE616A emitter	6 inches (152 mm)
MGR616A receiver	
MGE1216A emitter	12 inches (305 mm)
MGR1216A receiver	
MGE1816A emitter	18 inches (457 mm)
MGR1816A receiver	
MGE2416A emitter	24 inches (610 mm)
MGR2416A receiver	
MGE3016A emitter	30 inches (762 mm)
MGR3016A receiver	
MGE3616A emitter	36 inches (914 mm)
MGR3616A receiver	
MGE4216A emitter	42 inches (1067 mm)
MGR4216A receiver	
MGE4816A emitter	48 inches (1219 mm)
MGR4816A receiver	
MGE5416A emitter	54 inches (1372 mm)
MGR5416A receiver	
MGE6016A emitter	60 inches (1524 mm)
MGR6016A receiver	
MGE6616A emitter	66 inches (1676 mm)
MGR6616A receiver	
MGE7216A emitter	72 inches (1829 mm)
MGR7216A receiver	
PGCA-1A	115V ac control box (one per system)
PGCB-1A	230V ac control box (one per system)
<b>Cables</b>	(one per sensor; two required per system*)
<b>QDC-525</b>	25' cable, straight QD connector
<b>QDC-550</b>	50' cable, straight QD connector
<b>QDC-5100</b>	100' cable, straight QD connector
<b>QDC-5150</b>	150' cable, straight QD connector

## *Applications and Limitations of PERIMETER-GUARD Systems*

### **PERIMETER-GUARD Systems are typically used in the following applications:**

**Automated production equipment** such as:

Assembly robots	Welding robots
Material transport systems	Packaging machines
Stretch wrap equipment	Unitizers/palletizers

**Presses and molding machines** such as:

Automated punch presses	Extruders
Plastic/glass molding machines	Die casting machines
Metal compacting machines	Filter presses

### **PERIMETER-GUARD Systems may NOT be used with the following machinery:**

Any machine that cannot be stopped immediately after a stop signal is issued, such as single stroke (also known as "full-revolution") clutched machinery.

Any machine with inadequate or inconsistent machine response time and stopping performance.

Any machine that ejects materials or component parts through the defined area.

PERIMETER-GUARD Systems may not be used in any environment that is likely to adversely affect the efficiency of a photoelectric sensing system. For example, corrosive chemicals or fluids or unusually severe levels of smoke or dust, if not controlled, may degrade the efficiency of Banner PERIMETER-GUARD Systems.

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

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

*See warranty-related return shipping information on page 27.*

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# 1. PERIMETER-GUARD System Introduction

The Banner PERIMETER-GUARD System is a microprocessor-controlled opposed mode optoelectronic "curtain of light". It is designed for use as a perimeter guarding device for hazardous areas.

Banner's microprocessor-based circuit establishes a higher level of control reliability in perimeter guard design. The PERIMETER-GUARD System uses the design concept of "diverse redundancy", in which two microprocessors of different design, running from two different instruction sets, constantly check all system components, including each other. Banner PERIMETER-GUARD Systems are extensively FMEA (Failure Mode and Effects Analysis) tested to establish an extremely high degree of confidence that no system component will ever, even if it does fail, cause a *failure to danger*.

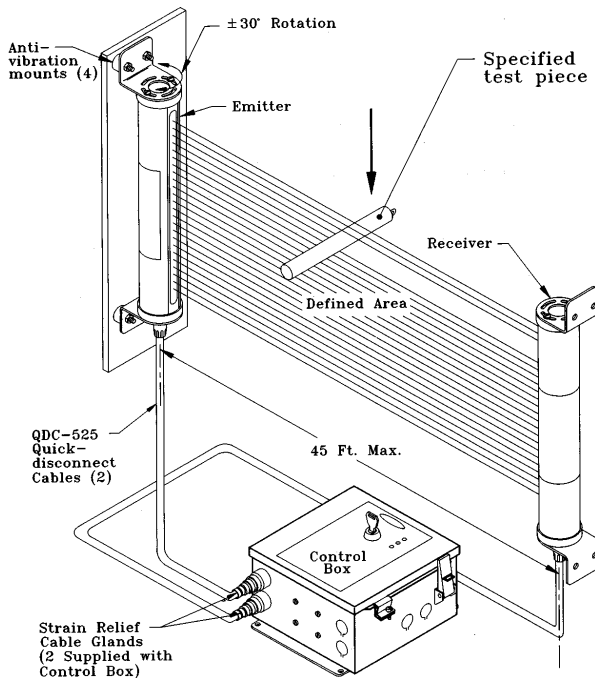
In typical operation, if any opaque object larger than 1.5 inches in cross section enters the curtain of light (also called the *defined area*) generated by the PERIMETER-GUARD, the PERIMETER-GUARD's output relays will open. The contacts of these output relays are connected to the control elements of the dangerous machinery inside the guarded area. When the output relay contacts open, a stop signal is sent to the dangerous machinery, causing the dangerous motion of the machinery to stop. The output relays remain open ("latched" open), even after the object is withdrawn from the defined area, until the system is manually reset at the control box. The output relays have forced-guided contacts for enhanced control reliability.

The PERIMETER-GUARD System provides for portions of the curtain to be blanked ("made blind") to allow for:

- 1) The continued presence of brackets, fixtures, etc. in the path of the curtain (using *exact blanking*), and
- 2) The movement of a workpiece of up to one inch in cross section through the curtain at any point (using *floating blanking*).

The Banner PERIMETER-GUARD is a modular system. Each system is made up of an MGE Series emitter unit, an MGR Series receiver unit, and a model PGCA-1A or PGCB-1A control box (see Figure 1 and cover photo). Emitter units consist of a row of synchronized modulated infrared (invisible) light emitting diodes (LEDs) in a tubular metal housing. Receiver units consist of a corresponding row of synchronized phototransistors in a tubular metal housing. Emitters and receivers are available in various sizes (based on the height of the defined area), in 12 different lengths between 6 inches and 6 feet. The tubular sensor design includes a swivel bracket at each end for quick mounting and easy alignment. Special mirrors (listed

**Figure 1. Banner PERIMETER-GUARD Basic System: emitter, receiver, control box, and QD-style interconnecting cable (cable is purchased separately)**



**WARNING** The PERIMETER-GUARD System uses **one pair** of sensors connected to **one** control box. Connection of multiple pairs of sensors to a single control box can result in a dangerous situation, and is prohibited.

*PERIMETER-GUARD Systems support the use of corner mirrors (see Figure 2).*

on page 37) may be used to enable a system to "see" around the corner(s) of the area to be guarded. Figure 2 shows three of the several possible system configurations.

The control box contains a power supply (to power the control box itself along with an emitter and receiver), a plug-in microprocessor controller module to control sensing logic, and a relay board with replaceable output relays. Panel-mounted LEDs indicate the operating status of the system. Diagnostic LEDs on the controller module identify seven trouble causes. There is a keyed panel switch for resetting the system from *latch* and *lockout* (fault) conditions. The three main system components are interconnected using two 5-wire cables that have QD (Quick Disconnect) connectors on their emitter and receiver ends.

Banner Engineering Corp. is the photoelectric industry leader in the design of high-power modulated infrared presence sensors. The Banner PERIMETER-GUARD System is conservatively rated at a range of 45 feet, at which point a reserve of optical sensing energy remains\*. The PERIMETER-GUARD System produces many times the optical sensing power of competitive units to reliably penetrate the dust, dirt, oil, fog, and mist that are often present in industrial applications. The patented receiver circuit design produces exceptionally high immunity to ambient light interference.

Banner PERIMETER-GUARDS are designed for convenient and dependable operation in difficult industrial environments. The microprocessor controller module has UL recognized conformal coating and a plug-in design for easy configuring or replacement. Output relays are easily replaceable. Emitter and receiver circuits are epoxy-encapsulated and designed to meet high standards for vibration resistance. The control box enclosure is rated NEMA 13 (IP 64) and has a lockable latch.

All PERIMETER-GUARD System sensors and controller modules are serialized and undergo extensive burn-in testing at the factory.

Any PERIMETER-GUARD System emitter and receiver (of equal length) may be used together with any control box. Unlike some competitive systems, matched sets are *not* required.

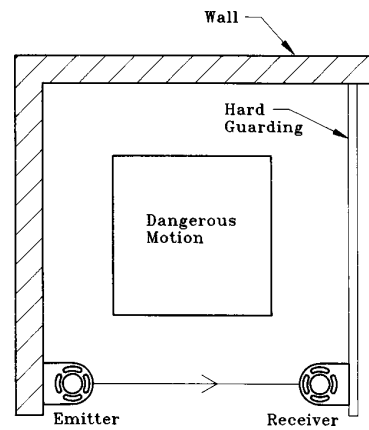
A functional schematic diagram of the PERIMETER-GUARD System appears on the next page. See page 20 for a dimension drawing. For PERIMETER-GUARD System specifications, see page 36.

## 2. Overview of System Operation

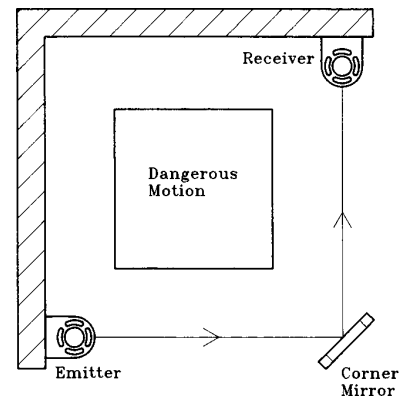
In operation, an emitter and receiver (of equal length) are mounted and aligned in optical sight of each other (corner mirrors may be part of the system) at a separation distance of up to 45 feet (14 meters)\*. This establishes a curtain of invisible infrared light beams called the *defined area*. Center-to-center spacing between adjacent sensing beams is .75 inch. This 45 foot maximum separation distance must be reduced somewhat when mirrors are used (see Section 6.1).

**Figure 2. Three of Several Possible PERIMETER-GUARD Configurations**

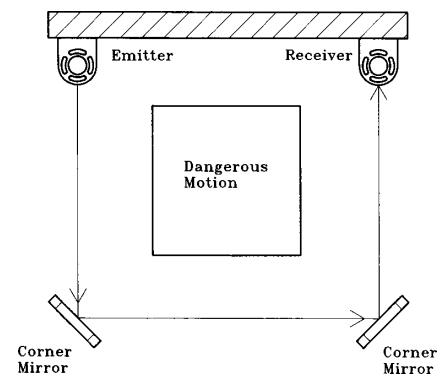
Two-point with hard-guarding



Three-point



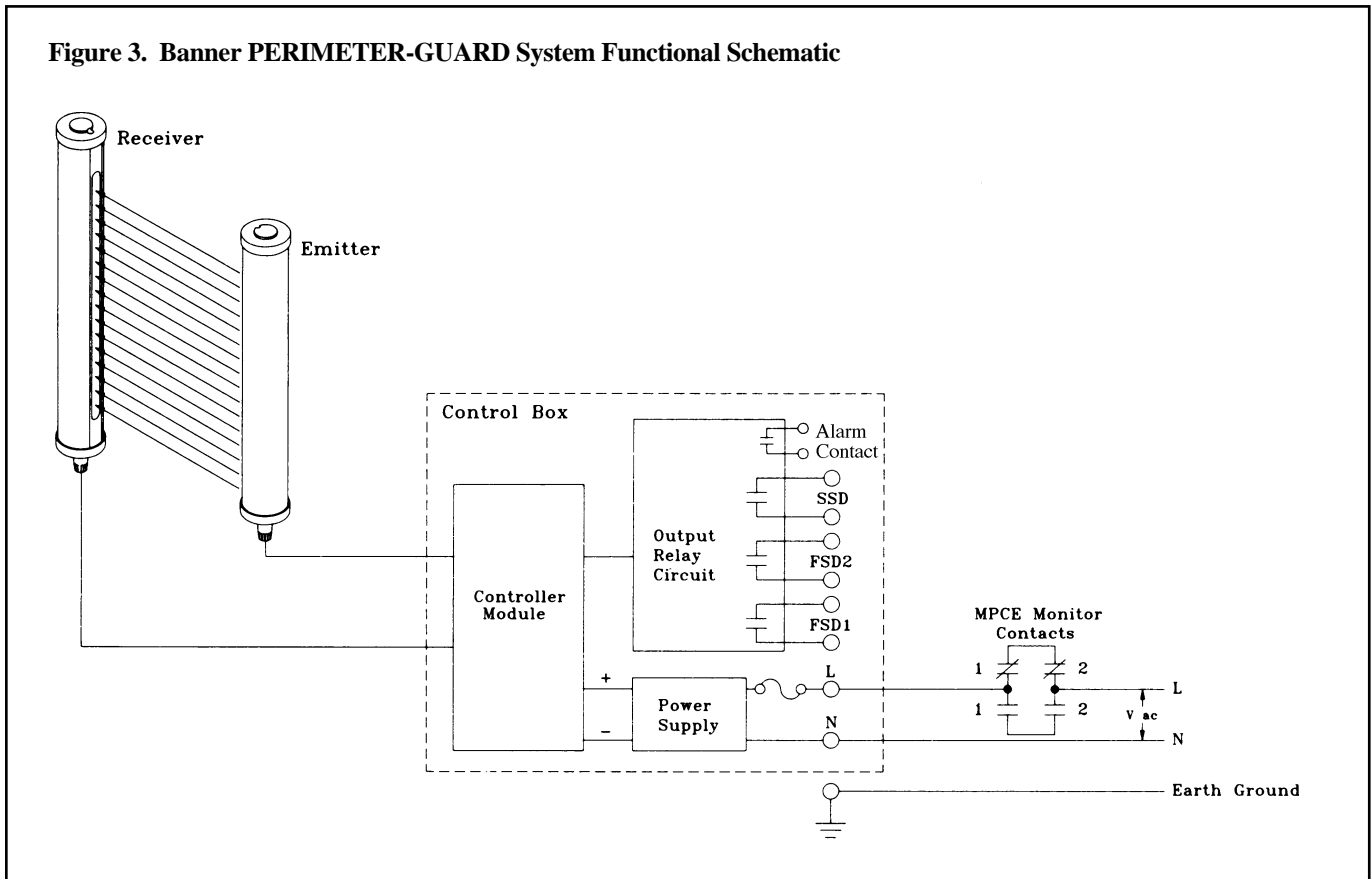
Four-point



*The use of corner mirrors somewhat decreases the maximum allowable width of the defined area. See page 28 for a complete discussion.*

\* The PERIMETER-GUARD System has 3X excess gain remaining at an emitter-receiver separation distance of 45 feet.

**Figure 3. Banner PERIMETER-GUARD System Functional Schematic**



The following features of the PERIMETER-GUARD System are discussed in the listed subsections:

- Output Relay Operation (Section 2.1)
- Blanking (2.2)
- Lockout Conditions and Key Resets (2.3)
- Operating Status Indicator Lights (2.4)
- Control Reliability: Redundancy & Self-checking (2.5)
- Diagnostic Indicator LEDs (2.6)

### 2.1 Output Relay Operation

The PERIMETER-GUARD System control box has three output relays plus an Alarm Relay. See Figure 3. The three output relays are labeled "FSD1", "FSD2", and "SSD". The contacts of the Final Switching Device (FSD) relays (FSD1 and FSD2) are connected to the Machine Primary Control Elements (MPCEs) of the machine to be controlled. (An MPCE is an electrically powered element of a machine that directly controls the machine's normal operating motion in such a way that it is last, in time, to operate when motion is either initiated or arrested.) The Secondary Switching Device (SSD) relay contacts are connected to the machine's Machine Secondary Control Element (MSCE), an electrically powered element of the machine (independent of both MPCEs) that is capable of removing power from the prime mover of the dangerous part of the machine in the event of a system fault. The two MPCEs must each (alone) be capable

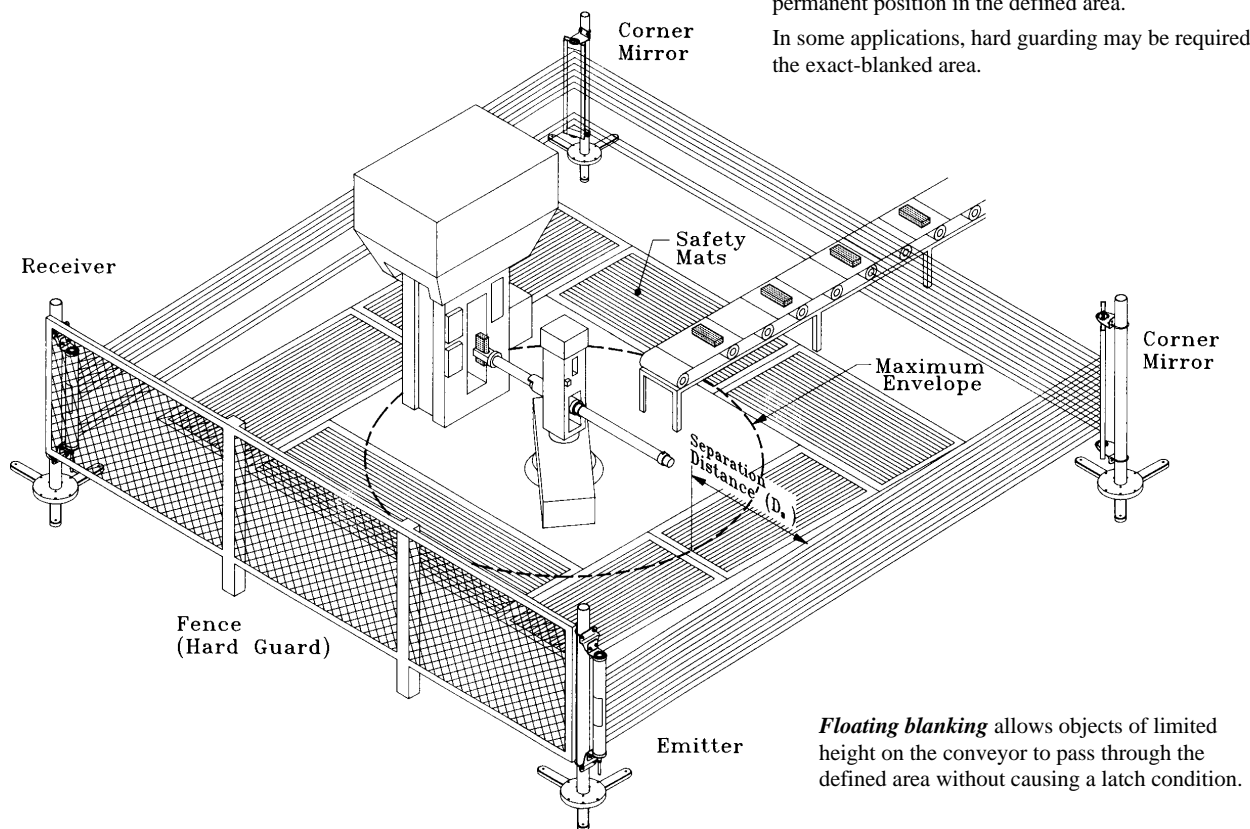
of stopping the dangerous motion of the machine in an emergency. The opening of any output relay contact results in the removal of power to either an MPCE or MSCE (or both), which will stop the motion of the guarded machine.

With all blanking "off", any object that blocks one or more beams will be detected, and will cause a *latch condition*, in which output relays FSD1 and FSD2 (but not SSD) in the control box open their contacts. *All three* output relays (FSD1, FSD2, and SSD) will open their contacts in response to any one or more of seven *lockout conditions*, including component failure within the PERIMETER-GUARD System itself (see *Control Reliability*, Section 2.5). A *latch condition* holds output relay contacts FSD1 and FSD2 open until a *key reset* is performed at the control box. Recovery from all *lockout conditions* requires correction of the cause of the lockout, followed by a key reset (Section 2.3).

The Alarm Relay is a separate relay whose contacts close whenever an object of over 1.5 inches\* in cross section (floating blanking not in use) enters the defined area after the system has been cleared for operation by a key reset (*latch condition*), and in all *lockout conditions* (see Section 2.3). The alarm relay contacts may be used to control a visual or aural alarm or signal a PLC, but may **not** be used for safety-related switching functions.

\* If floating blanking is in use, this object size becomes 2.3 inches.

**Figure 4. Examples of Exact Blanking and Floating Blanking**



## 2.2 Blanking

PERIMETER-GUARD Systems may be configured to be "blind" to the *continued presence* of an object or the *passage* of an object of limited size through the defined area. The general term used to identify these features is *blanking* (Figure 4). (NOTE: Blanking "on" is indicated by a flashing green control box front-panel Status Indicator LED.)

*Exact blanking* allows a specified number of sensing beams, from 1 to 15 total beams\*\* (not necessarily continuous) to be configured to ignore the presence of objects such as brackets, fixtures, or guards that will *always be present* in the defined area during operation of the guarded machine. In Figure 4, several light beams are blanked to ignore the continuing presence of the conveyor within the defined area. *Hard guarding* may be required when exact blanking is used (see Section 3.2.2).

Unlike competitive blanking systems, PERIMETER-GUARD exact blanking is not totally blind, but rather always "knows" whether or not the configured number of light beams is blocked. If a situation occurs in which fewer than the configured number of beams are blocked (i.e., if an object is removed without the exact blanking being properly reprogrammed) the PERIMETER-GUARD System goes into a lockout condition (Section 2.3) to prevent further machine operation until the configuration is corrected. The object must be visible to the machine operator (see WARNING, page 24, top).

*Floating blanking* is the "blinding" of one sensing beam, which will appear to change position ("float") in order to allow an object (usually workpiece material of less than 1 inch in cross section) to move through the defined area, *at any point*, without latching the final switching device (FSD relays) of the PERIMETER-GUARD System. Use of floating blanking changes the *minimum object sensitivity* of the system (see Section 3.2). In Figure 4, floating blanking enables the PERIMETER-GUARD to ignore objects of limited height that pass through the defined area on the conveyor.

Exact and floating blanking parameters are set (configured) at a row of DIP switches on the controller module inside the control box (see Figure 11 on page 15, and related text, for details). The control box is supplied with a lockable latch to prevent unauthorized access to blanking settings. Exact blanking and floating blanking **may** be used simultaneously.

\*\*Up to 7 beams may be blanked in Systems using 6" sensors.

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### 2.3 Lockout Conditions and Key Resets

A *lockout condition* causes the alarm relay contacts to close (except in conditions 1 and 2, below) and *all* of the output relays to open, sending a "stop" signal to the machine. A lockout condition will occur:

- 1) Upon "power-up" of the PERIMETER-GUARD System (unless Auto Power-up is "on"; see Figure 6),
- 2) If ac power to the PERIMETER-GUARD System is interrupted (unless Auto Power-up is "on"; Figure 6),
- 3) If only one FSD (Final Switching Device) relay has gone to the "off" state (de-energized),
- 4) If the SSD (Secondary Switching Device) relay has de-energized,
- 5) If fewer than the configured number of light beams are blocked when using *exact blanking*,
- 6) If the controller module internal switch settings are inconsistent with each other or incorrect for the emitter/receiver array length in use, or
- 7) If the self-checking circuits of the microprocessor detect a component failure.

Refer to Figure 6, page 9. The existence of lockout conditions is indicated by the three Operating Status Indicator LEDs (green, red, and yellow) on the control box panel. In the case of a *power-up/power-interrupt lockout* (conditions #1 and 2; Auto Power-up "off"), the yellow LED will flash and the green and red LEDs will be "off".

Lockout conditions #3, 4, 5, 6, and 7, called *internal lockouts*, result from component failures or incorrect controller settings which must be corrected before the system will allow operation to continue (Section 2.6). When an internal lockout occurs, the red LED will flash and the yellow and green LEDs will remain "off". Diagnostic Indicator LEDs (inside the control box on the controller module) indicate the cause of the lockout (Section 2.7). Lockout conditions #1 & 2 reset automatically if the controller's Auto Power-up feature is "on"; otherwise a RESET of the keyed switch on the control box front panel (a *key reset*) is required. Lockout conditions #3-7 *always* require a key reset to return the system to the RUN mode (Section 2.3). A valid *key reset* consists of turning the key switch to the RESET position for at least 1/2 second, and then returning the key switch to the RUN position.

### 2.4 Operating Status Indicator lights

The control box panel has three Operating Status Indicator LEDs (see Figures 5 and 6): green (CLEAR), red (LATCHED), and yellow (RESET) located next to the key reset switch. The LED indications are as follows:

**RED (only) "on" and flashing:** a lockout condition due to an internal PERIMETER-GUARD System problem exists. SSD, FSD1, and FSD2 contacts are all open (de-energized). The alarm relay contacts are closed. See Section 2.3.

**YELLOW (only) "on" and flashing:** a power-up or power interrupt lockout condition exists. *These lockouts occur in the normal course of powering up the System or upon an interruption of power to the System* (unless Auto Power-up is "on"; see Figure 6). SSD, FSD1, FSD2, and the Alarm Relay contacts are all open (de-energized). See Section 2.3.

**YELLOW (only) "on" steadily:** key switch is in the RESET position. FSD1, FSD2, and Alarm Relay contacts are open (de-energized). SSD contacts are closed (energized).

**RED and YELLOW "on" steadily (latch condition):** the PERIMETER-GUARD System has been reset and is in the RUN mode, but either there is an obstruction in the defined area or the emitter and receiver are misaligned. FSD1 and FSD2 are open (de-energized). SSD relay is closed (energized). Alarm relay contacts are closed. If alignment is correct, the GREEN light will come "on" (to join RED and YELLOW) when the obstruction is removed. If alignment is not correct, the GREEN light will remain "off" when the obstruction is removed. NOTE: The GREEN light is used to align the system (Section 6.1).

**GREEN "on" steadily (or flashing\*) and YELLOW "on" steadily:** the PERIMETER-GUARD System has been reset and is in the RUN mode, the defined area is clear of obstructions, and the emitter and receiver are aligned. All output relays are closed (SSD, FSD1, FSD2, and the Alarm Relay is open (de-energized). \*GREEN LED *flashes* if blanking is "on".

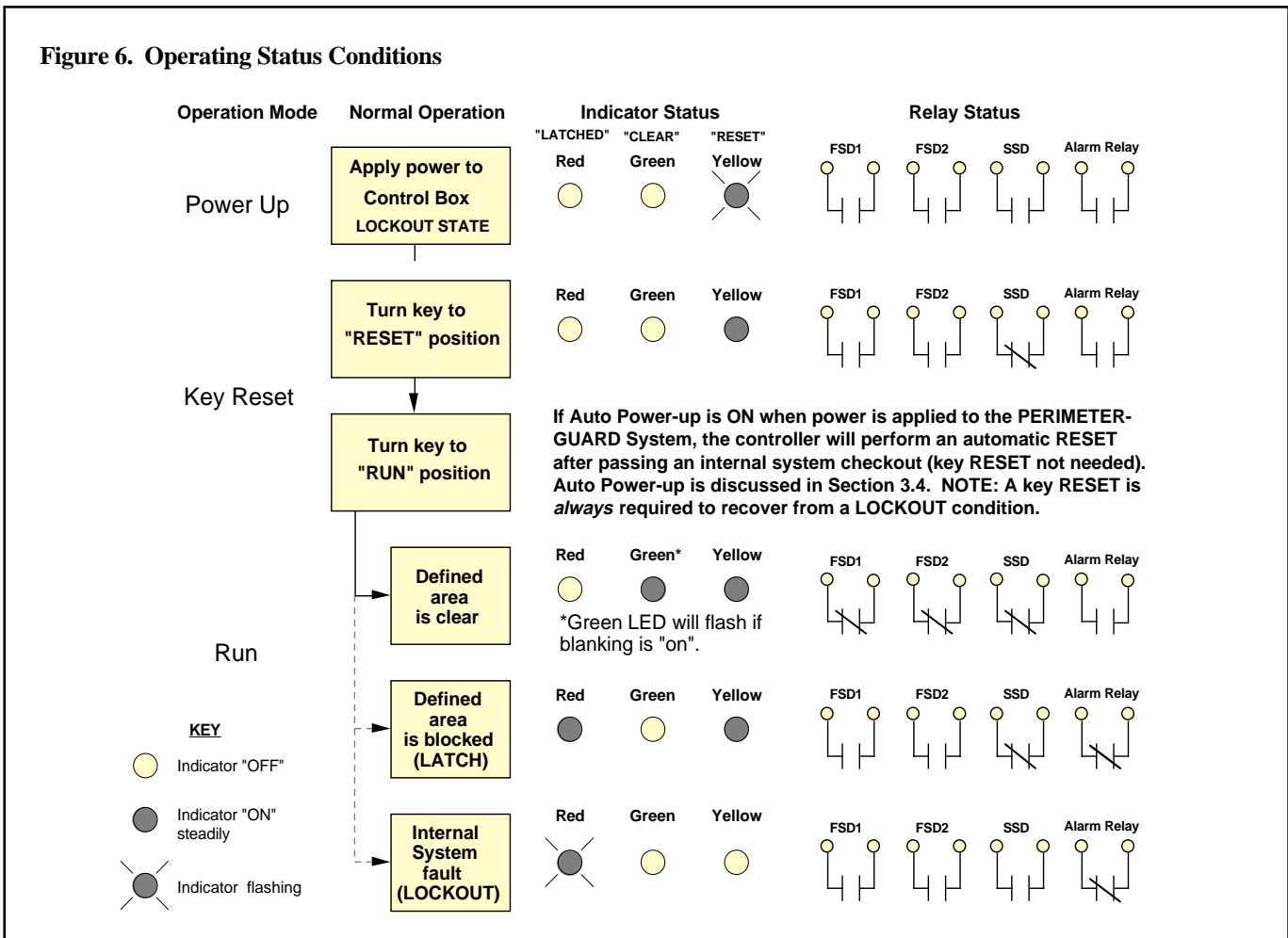
**All three LEDs flashing:** the key reset switch has been turned to the RESET position while the PERIMETER-GUARD System was operating properly. To resume operation, turn the keyreset switch to the RUN position, then to the RESET position and back again to the RUN position.

**Figure 5.**  
**PERIMETER-GUARD System**  
**Operating Status LEDs**





**Figure 6. Operating Status Conditions**



### 2.5 Control Reliability: Redundancy & Self-checking

PERIMETER-GUARD Systems meet certain U.S. and international *control reliability* standards for safety. Banner PERIMETER-GUARD Systems must reliably send a "stop" signal to a guarded machine in the following situations:

- 1) The PERIMETER-GUARD System must provide a "stop" signal to the guarded machine, within either 40 or 55 milliseconds (see Response Time specification, page 36), whenever the defined area is interrupted, and
- 2) The PERIMETER-GUARD System must provide a "stop" signal to the guarded machine whenever internal component failures have occurred which compromise the integrity of the PERIMETER-GUARD System itself.

**Regarding the first situation:** In order for the machinery guarded by the PERIMETER-GUARD System to be stopped as described, *the guarded machine must be capable of stopping at any point in its machine cycle.* This means that the PERIMETER-GUARD System cannot be used with certain types of machinery that do not meet this requirement (see page 3). If there is any doubt about whether or not your

machinery is compatible, contact the Banner factory Application Engineers.

**Regarding the second situation:** This type of component failure includes any internal PERIMETER-GUARD System failure which could prevent or delay the output relays of the PERIMETER-GUARD System from going to a *latch condition* or a *lockout condition* in response to a situation which, in normal operation, would cause them to do so. The ability of the PERIMETER-GUARD System to send a "stop" signal even when such a component failure has occurred depends upon the design principle of *redundancy*.

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

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

Redundancy must be maintained for as long as the PERIMETER GUARD System is in operation. Since a redundant system is no longer redundant once a component has failed, PERIMETER-GUARD Systems are designed to be continuously *self-checking* (see Sections 2.6 and 5.1). A component failure detected by or within the self-checking system causes a "stop" signal to be sent to the guarded machine *and* puts the PERIMETER-GUARD System into a *lockout condition*. Recovery from this type of lockout condition requires replacement of the failed component (to restore redundancy) and a *key reset*. Possible causes of lockout conditions are listed in Section 2.3. The PERIMETER-GUARD System's Diagnostic Indicator LEDs (Figure 17, page 25) are used to diagnose internal causes of lockout conditions (Section 5.1).

## 2.6 Diagnostic Indicator LEDs

There are four Diagnostic Indicator LEDs located on the edge of the controller module assembly. Refer to Figure 17, page 25. The purpose of these LEDs is to indicate the causes of any internal PERIMETER-GUARD System problems (lockouts) that are discovered as a result of the controller's self-checking function.

The green diagnostic LED is always "on", as long as power is applied to the controller, *except* when a controller micro-processor has failed (in which case the green LED will not light). The message of the four Diagnostic Indicator LEDs is interpreted using the table in Figure 17 (page 25).

## 3. System Installation & Alignment

### 3.1 Appropriate Application

The PERIMETER-GUARD System may only be used to guard machinery that is *capable of stopping motion immedi-*



## CAUTION

In order for the machinery guarded by the PERIMETER-GUARD System to be stopped as described, *that machinery must be capable of stopping at any point in its machine cycle*. This means that the PERIMETER-GUARD System cannot be used with certain types of machinery (see listing, page 3). **If there is any doubt about whether or not your machinery is compatible with the PERIMETER-GUARD System, contact the Banner Application Engineers at the factory.**

*ately* upon receiving a stop signal and at any point in its machine cycle.

The PERIMETER-GUARD System may *not* be used with single stroke (also called "full revolution") clutched machinery, as this type of machinery is incapable of stopping immediately.

Banner PERIMETER-GUARD Systems may also not be used on certain other types of machinery. See page 3 for application limitations.

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



## WARNING

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

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



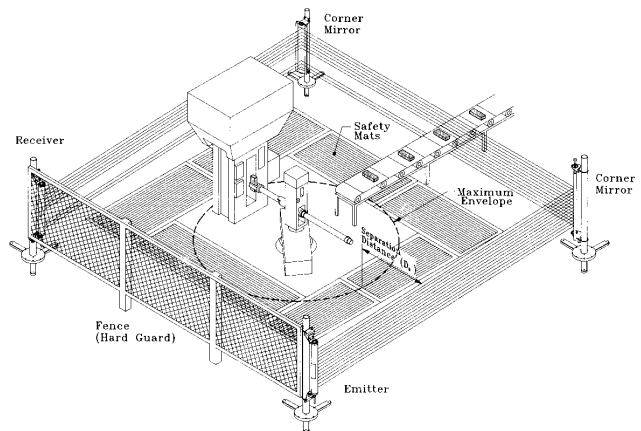
## WARNING

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

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

*An example of a separation distance calculation is given on page 12.*

**Figure 7. Separation Distance**



*The farthest extremes of machine motion (represented by "maximum envelope", above) must be taken into account when calculating the Separation Distance  $D_s$ .*

## 3.2 Mechanical Installation Considerations

The two considerations that influence the layout of the PERIMETER-GUARD System's mechanical installation the most are:

- separation distance, and*
- hard guarding requirements.*

### 3.2.1 Separation Distance

The PERIMETER-GUARD System and the control system of the guarded machine must be able to react fast enough, when an object enters the defined area, to stop the machine before the object reaches the closest reachable point of dangerous machine motion. The *separation distance* is the minimum distance that is required between the plane of the defined area and the closest reachable danger point (see Figure 7 for example). The actual separation distance required depends upon several factors, including the *speed of the object*, the *total system stopping time* (of which there are several response time components), and the *penetration depth factor*. The formula used to calculate the separation distance is (see also example, page 12):

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

where:

$D_s$  = the separation distance.

$K$  = the OSHA-recommended hand speed constant of 63 inches per second (see NOTE 1 at right).

$T_s$  = the overall stop time of the machine measured from the application of the "stop" signal to the final ceasing of all motion (including stop times of all relevant control elements, and measured at maximum machine velocity). See NOTE 2 (right), WARNING (above), and NOTICE (page 18).

$T_r$  = the response time of the PERIMETER-GUARD System, .040 or .055 seconds (NOTE 4, below).

$D_{pf}$  = the added distance as recommended in the table (page 12). If exact and/or floating blanking are used,  $D_{pf}$  must be adjusted as shown in there.

NOTE 1: The OSHA-recommended hand speed constant  $K$  has been determined by various studies, and although these studies indicate speeds of 63 in/sec to over 100 in/sec, they are not conclusive determinations. The employer should consider all factors, including the physical ability of the operator, when determining the value of  $K$  to be used.

NOTE 2:  $T_s$  is usually measured by a stop-time measuring device. If the specified machine stop time is used, we recommend that at least 20% be added as a safety factor to account for clutch/brake system deterioration.

NOTE 3: No increase in separation distance  $D_s$  is required for exact blanking applications as long as the blanked area is *entirely occupied* by the material or fixtures and/or protected by hard guarding (Section 3.2.2).

NOTE 4: Systems using sensors 48 inches long and shorter have a system response time of 40 milliseconds (.040 seconds); systems using sensors longer than 48 inches have a system response time of 55 milliseconds (.055 seconds).

NOTE 5: Use of floating blanking will always cause required  $D_s$  to increase.

### 3.2.2 Hard Guarding Requirements

**ANSI B11.1-1988, E6.3.2 (14)** requires that "all areas of entry to the point of operation not protected by the presence-sensing device shall be otherwise safeguarded". Compliance with this requirement is discussed in the WARNING on page 13.



## CAUTION

Floating blanking increases  $D_{pf}$ . You must add the penetration factor ( $D_{pf} = 7$  inches\*) to calculate the separation distance whenever floating blanking is used.

Always turn floating blanking "off", when not required, in order to return minimum object sensitivity to 1.50 inch and  $D_{pf}$  to 4 inches. \*NOTE: The value of  $D_{pf}$  may be greater than 7 inches when exact blanking is also used.

## Example:

### Separation Distance ( $D_s$ ) Calculation

The following is an example showing how to use the formula from page 11 to calculate the safety distance ( $D_s$ ).

We will use these numbers for the variables in the formula:

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

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

$T_r = .055$  second (the specified response time of the PERIMETER-GUARD System\*\*)

Our example uses floating blanking (1 beam); therefore  $D_{pf}$  is 7 inches (from table, right). Substitute the numbers into the formula as follows:

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

$$D_s = 63 \times (.250 \times 1.2^* + .055^{**}) + 7 \text{ inches} = 29 \text{ inches}$$

Therefore, in this example, the PERIMETER-GUARD emitter and receiver must be mounted such that no part of the defined area will be closer than 29 inches to the closest reachable danger point on the guarded machine.

\* 20% safety factor (see NOTE 2 on page 11)

\*\* Example uses sensors longer than 48 inches (NOTE 4)

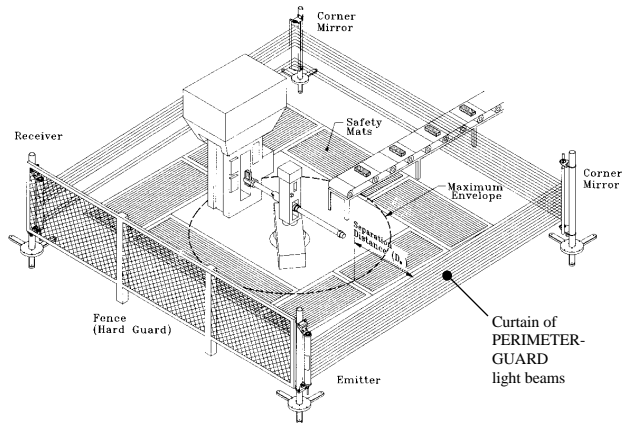


## CAUTION

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

If hard guarding is not possible, the separation distance must be increased by the penetration factor ( $D_{pf}$ ) from the table (right).

Figure 8. Hard Guarding Requirements



**NOTE: All areas of entry to the point of operation not protected by the PERIMETER-GUARD System must be otherwise safeguarded. Refer to Section 3.2.2. Safety mats (as shown above) are required (see WARNING, page 13).**

Penetration Factor ( $D_{pf}$ ) per ANSI B11.1 and OSHA 1910.217

$D_{pf} = 3.4 (S - .276)$  inches       $S =$  Minimum object sensitivity

Number of Blanked Channels	Minimum Object Sensitivity	Penetration Depth Factor ( $D_{pf}$ )
No Blanking	1.5"	4"
1 Blanked Channel	2.3"	7"
2 Blanked Channels	3.0"	9"
3 Blanked Channels	3.8"	12"
4 Blanked Channels	4.5"	14"
5 Blanked Channels	5.3"	17"
6 Blanked Channels	6.0"	19"
7 Blanked Channels	6.8"	22"
8 Blanked Channels	7.5"	25"
9 Blanked Channels	8.3"	27"
10 Blanked Channels	9.0"	30"
11 Blanked Channels	9.8"	32"
12 Blanked Channels	10.5"	35"
13 Blanked Channels	11.3"	37"
14 Blanked Channels	12.0"	40"
15 Blanked Channels	12.8"	43"
16 Blanked Channels*	13.5"	45"

\*16 Blanked Channels = 15 exact, plus one floating blanked

### 3.3 Mounting Procedure

Alignment of the shorter sensor models (and of all models at shorter separation distances) can usually be accomplished simply by mounting the emitter and receiver in the same plane with their midpoints optically facing each other (via corner mirrors, if used). Sensors (and mirrors) may be mounted on a stable surface or, for maximum convenience and ease of alignment, on Banner MGA Series Stand Poles (see page 37). Stand pole mounting enables adjustment in all axes. Stands are recommended, especially for the longer sensor models at longer distances. The mounting brackets supplied with the sensors and mirrors allow  $\pm 30$  degrees of rotation.


**NOTE:** The use of corner mirrors somewhat decreases the maximum specified emitter/receiver separation distance of 45 feet. See page 28. *In order to maximize System sensing power (excess gain), we recommend liberal use of hard-guarding and use of as few corner mirrors as possible.*

If you use a wall or other surface, Figure 9 shows an exploded view of mounting hardware (supplied with each sensor). Figure 16 (pages 20-21) gives bracket dimension details and dimensions for the mounting hole pattern of the different emitter and receiver models with mounting brackets attached. The mounting dimensions given in Figure 16 assume that the mounting brackets are installed as shown, with their flanges facing *away* from the ends of the sensors. Alternatively, one or both of the mounting brackets may be installed in the opposite orientation (bracket flange pointed inward) to conserve mounting area. If this is done, however, the mounting "footprint" will change. Mirror mounting information is included with the mirrors.

**The connector ends of both sensors must point in the same direction (either up or down). See drawing and WARNING, page 20.** From a common point of reference, make measurements to locate the emitter and receiver in the same plane with their midpoints directly opposite each other (or facing the corner mirror(s), if used, at identical angles. Remember that the angle of incidence to a mirror equals the angle of reflectance from the mirror. Mount the emitter and receiver brackets using the vibration isolators and 1/4"-20 Keps nuts (see Figure 9; all hardware is supplied). Standard 1/4" bolts may be substituted where the emitter and receiver are not subject to shock or vibration forces. While the internal circuits of the emitter and receiver are able to withstand heavy impulse forces, the vibration isolators dampen impulse forces and prevent possible damage due to resonant vibration of the emitter or receiver assembly.

Mount the emitter and receiver in their brackets and position the red lenses of the two units directly facing each other (or facing the corner mirror at equal but opposite angles). Measure from one or more reference planes (e.g. the building floor) to the same point(s) on the emitter and receiver to verify

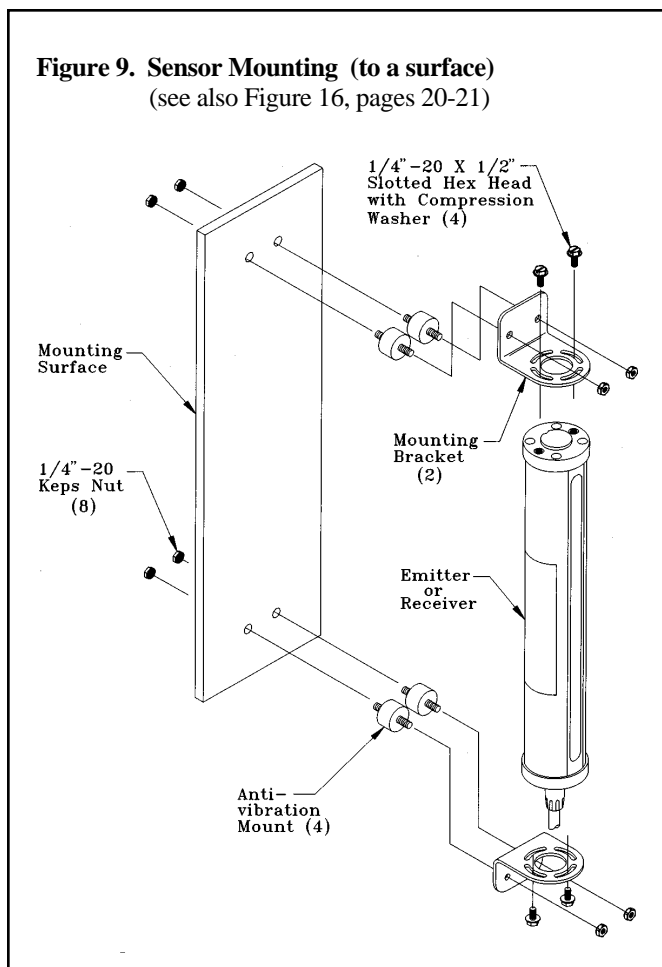
their mechanical alignment. Check "by eye" for line-of-sight alignment. If the units are to be positioned exactly vertical or horizontal to the floor, a carpenter's level is useful for verify-



## WARNING

The point of operation must be accessible *only* through the defined area. Mechanical barriers (screens, bars, etc.), or supplemental presence sensing devices (*supplemental guarding*) must be installed, wherever needed, to prevent any person from reaching around, under, or over the curtain of light beams and into the point of operation, and also to prevent any person from entering the space between the curtain and the point of operation. (See OSHA 1910.212). See Figure 8. The use of mechanical barriers for this purpose is called "hard guarding". There must be no gaps between the hard guarding and the edges of the curtain. Openings in the hard guard material must meet OSHA criteria (see OSHA 1910.217, Table O-10).

Supplemental presence sensing devices, such as safety mats (Figure 8), must be used if the space between the curtain and the nearest danger point is large enough to allow a person to stand undetected by the PERIMETER-GUARD System.



ing alignment. PERIMETER-GUARD corner mirrors are constructed somewhat longer than their sensors to simplify alignment and for greater efficiency at longer sensing distances. Make any necessary final mechanical adjustments, and hand-tighten the bracket hardware. *Final alignment is covered in Section 6.1.*

Connect the quick-disconnect (QD) cables to the emitter and receiver and route them, per local wiring code for low-voltage dc control cables, to the control box mounting location. The large knockouts on the control box are intended for the sensor cables. The same cable type is used for both emitter and receiver. Two cables are required per system. These cables, purchased separately, may be cut to length at the time of installation. See page 37 for cable model numbers.

Mount the PERIMETER-GUARD System control box in a convenient location that is both visible to the operator and free from heavy impulse force and high-amplitude vibration. Control box mounting footprint information is given in Figure 16 (page 20). NOTE: The controller module will be installed later in Section 3.5.3.

### 3.4 Controller Module Configuration

The PERIMETER-GUARD Controller module must be properly configured *before* initial checkout and use. Controller configuration is done at the row of DIP switches along the edge of the controller module (Figure 11, page 15).

The system parameters that must be set are:

- PERIMETER-GUARD array size,
- number of beams (0 to 15\*) for exact blanking,
- number of beams (0 or 1) for floating blanking, and
- auto power-up "on" or "off".



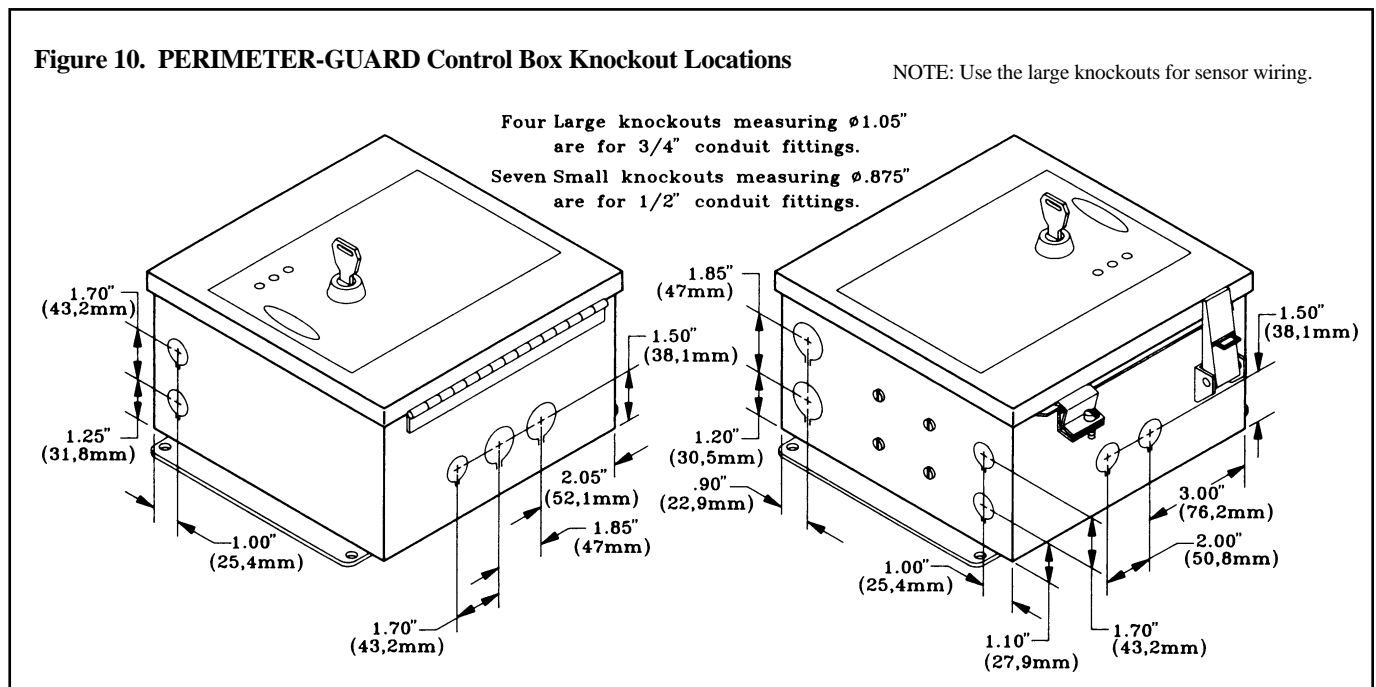
## CAUTION

It may be possible for a highly reflective surface (such as a shiny machine surface or a shiny workpiece) to reflect sensing light around an object in the curtain, thus preventing that object from being detected. This potentially dangerous condition is discovered using the "latch test" as described in the Initial Checkout Procedure (Section 3.5.3), the Alignment Procedure (Section 6.1), and the periodic checkout procedures (Sections 6.2, 6.3, and 6.4).

When this condition is discovered, eliminate the problem reflection(s). If possible, relocate the sensors to move the curtain of light beams away from the reflective surface(s). If relocating the sensors, be careful to retain at least the required separation distance (Section 3.2.1). Otherwise, paint, mask, or roughen the interfering shiny surface to reduce its reflectivity. Use the latch test to verify that these changes have eliminated the problem reflection(s).

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

Because it has redundant microprocessors, the controller module has two identical DIP switch banks (bank A and bank B) which must be set identically. Failure to set both banks identically will bring about a lockout condition when power is applied to the control box. A switch pushed to the left is "on"; a switch pushed to the right is "off". Set the configuration switches as follows:



### Array size configuration

Locate the array size configuration switches (Figure 11). Set switch banks A and B identically for the number of light beams in the emitter and receiver in use, as follows\*:

6" models	8 beams	Switch #4 "on"
12" models	16 beams	Switches #2, 3, and 5 "on"
18" models	24 beams	Switches #3 and 6 "on"
24" models	32 beams	Switches #2, 5, and 6 "on"
30" models	40 beams	Switch #7 "on"
36" models	48 beams	Switches #4 and 7 "on"
42" models	56 beams	Switches #2, 3, 5, and 7 "on"
48" models	64 beams	Switches #3, 6, and 7 "on"
54" models	72 beams	Switches #2, 5, 6, and 7 "on"
60" models	80 beams	Switch #8 "on"
66" models	88 beams	Switches #4 and 8 "on"
72" models	96 beams	Switches #2, 3, 5, and 8 "on"

\*Set all other switches to "off". Refer to page 2 or page 36, if necessary, for emitter/receiver lengths and corresponding model numbers.

### Exact Blanking configuration

Locate the exact blanking configuration switches in bank A. The first switch blanks 1 beam, the second blanks 2 beams, the third blanks 4 beams, and the fourth switch blanks 8 beams. The number of beams blanked is the total represented by the switches that are set to the "on" position. Up to 15 total beams (up to 7 beams for 6" long arrays) may be "exact blanked". Blanked beams need not be consecutive. Count the number of light beams that must be blanked to ignore any brackets, fixtures, etc. that will remain in the defined area during operation. Figure 12 shows the switch combinations necessary to blank 0 to 15 beams. The configured number must be precisely the number of beams required. Set the exact blanking switches at banks A and B accordingly.

### Floating Blanking configuration

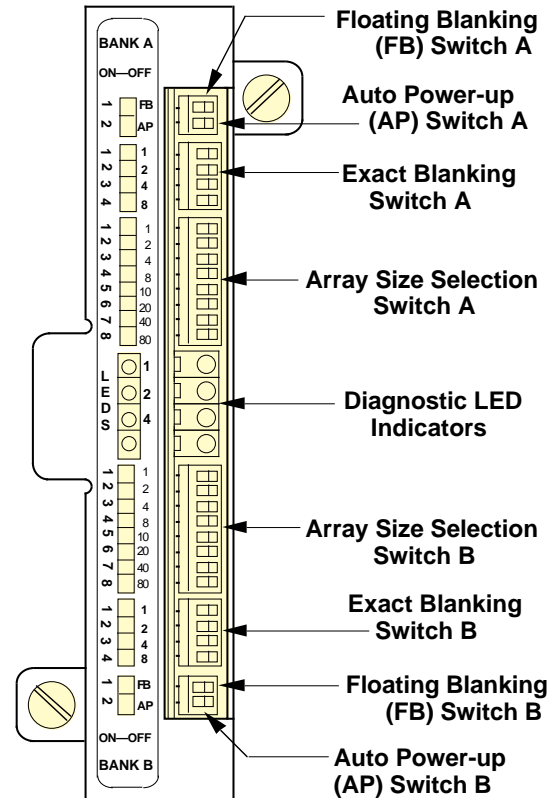
Locate the floating blanking configuration switch (FB) in bank A. One light beam may be "floating blanked". One blanked beam will allow an object of less than one inch in cross section to be inserted through the defined area at any point without tripping the FSD output relays (Section 2.2). Push the switch "on" (left) to blank one beam. If no floating blanking is desired, set switch #1 to "off". Set the switches identically at banks A and B.

### Auto Power-up ON or OFF

Locate the Auto Power-up configuration switch (AP) in bank A. If this switch is "on" (pushed to the left), when power is applied to the PERIMETER-GUARD System the controller will automatically reset after conducting and passing an internal system checkout. If the switch is "off" (pushed to the right), this initial reset must be manual (via the key reset switch on the front panel). Regardless of the setting of this switch, a key reset is always necessary to recover from lockout conditions #3 through #7 (see page 8). The switches must be set identically at banks A and B.

**For the purpose of initial system checkout (Section 3.5) set both Auto-Power-up configuration switches to "off".**

**Figure 11. Controller Configuration Switches**



Push DIP switches to left for "on"; push switches to right for "off".

**Figure 12.**

**Table: Exact Blanking Switch Configuration**

Total number of beams to be blanked	Turn these switches "on"*
0 .....	none
1 .....	#1
2 .....	#2
3 .....	#1 and #2
4 .....	#3
5 .....	#1 and #3
6 .....	#2 and #3
7 .....	#1, #2, and #3
8 .....	#4
9 .....	#1 and #4
10 .....	#2 and #4
11 .....	#1, #2, and #4
12 .....	#3 and #4
13 .....	#1, #3, and #4
14 .....	#2, #3, and #4
15 .....	#1, #2, #3, and #4

\* All other switches are "off".

### 3.5 Electrical Hookup and Checkouts

Make the electrical connections in the order that they are presented in Sections 3.5.1 through 3.5.5. If the controller module has already been installed in the control box, loosen the two captive screws and gently slide the module out. Removing the module protects it from possible damage and facilitates box "knockout" removal and internal wiring.

The following wiring connects inside the control box:

- Emitter and receiver cables,
- AC power,
- Output relay connections (FSD1, FSD2, and SSD),
- Alarm Relay, and
- Remote devices (LED Status Displays, key switch, etc.)

Several conduit knockouts are provided around the sides of the control box. There are seven knockouts for 1/2" conduit and four for 3/4" conduit (shown in Figure 10, page 14). As you complete the wiring in the following sections, select knockout locations which allow easy and neat routing of cables to and from the control box. NOTE: Except for emitter and receiver cable entries (for which cable glands are supplied), it is the user's responsibility to maintain NEMA 13 sealing at all cable entries into the control box. Note that the wiring barriers inside the control box can accept conductors no larger than #14 AWG. Also, the wires used should have an insulation temperature rating of at least 90°C (194°F).



## WARNING

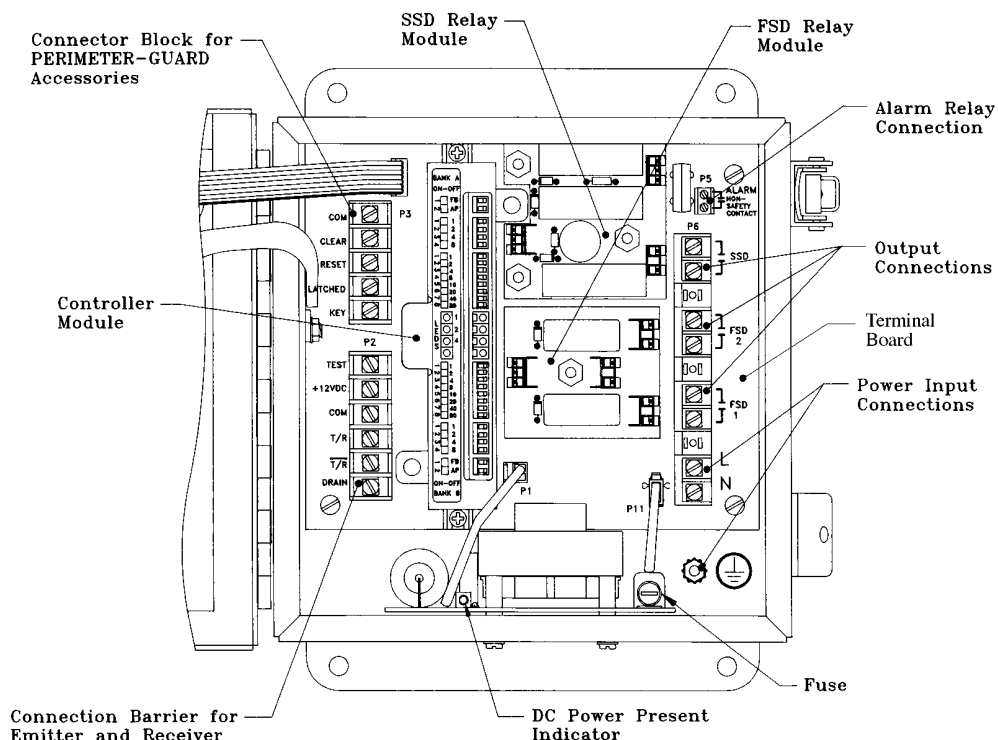
Electrical hookup must be made by a qualified electrician, and must comply with NEC (National Electrical Code) and local standards. Make no more connections to the PERIMETER-GUARD System than are described in Sections 3.5.1 through 3.5.7. Connection of other wiring or equipment to the System could result in a dangerous situation.

### 3.5.1 Emitter and Receiver Hookup

The emitter and receiver cables require two of the 3/4" knockouts (1.12" diameter holes). Two cable gland strain relief fittings are supplied with each control box for the entrance of the emitter and receiver cables into the control box. The emitter and receiver cables both connect to wiring barrier P2 (Figure 13). *Only the use of Banner QDC Series cables can ensure reliable communication of data between the controller and the sensors. Match the color-coded terminals of wiring barrier P2 to colors of the wires in the two 5-conductor cables. Double-check your wiring. Incorrect wiring can lead to component damage.* There are no user connections or adjustments inside the PERIMETER-GUARD sensors themselves.

**Figure 13. PERIMETER-GUARD System Electrical Connections**

NOTE 1: It is the user's responsibility to provide NEMA 13 (IP 64) sealing at the ac power and output relay control box cable entries.  
NOTE 2: Wiring barrier P3 is used for hookup of remote accessories. Refer to the hookup information included with each accessory.







## CAUTION

Dangerous voltages are present inside the PERIMETER-GUARD System control box whenever ac power to the system is "on".

Close the hinged control box cover and secure the latches before performing the checkout procedure of Section 3.5.3.

### 3.5.2 AC Power (temporary connection)

As shown in Figure 15 (page 19), the ac lines to the control box must connect through the MPCE monitor contacts of the machine. However, *do not* wire to the MPCEs at this time. Instead, *temporarily* connect ac power directly at the L and N terminals of control box wiring barrier P6. Connect earth ground at the ground lug provided. This allows the PERIMETER GUARD System to be checked out and aligned, by itself, before permanent ac connections through the machine's monitor contacts are made. *Permanent ac power connection* will be made after PERIMETER-GUARD System initial checkout and alignment, and is covered in Section 3.5.5.

### 3.5.3 PERIMETER-GUARD System Initial Checkout and Alignment

This initial checkout and alignment procedure must be performed by a *qualified person*. It must be done **after** connecting the emitter and receiver (Section 3.5.1) and temporary ac power (Section 3.5.2) to the PERIMETER-GUARD control box, but **before** the PERIMETER-GUARD System is connected to the machine to be controlled.

This initial checkout and alignment procedure must be performed when the PERIMETER-GUARD System is first installed, and also *whenever any maintenance or modification is performed on the PERIMETER-GUARD System or on the machinery guarded by the PERIMETER-GUARD System*. A schedule of required checkouts is given in Section 4.2.



## WARNING

Electrical shock hazard exists when the PERIMETER-GUARD System has power applied to it and the control box door is open. Use extreme

caution to avoid electrical shock during installation or servicing or when the control box door is open to change the switch configuration or observe the diagnostic indicators. **Always disconnect all power from the PERIMETER-GUARD System and the guarded machine before making any connections or replacing any component.**

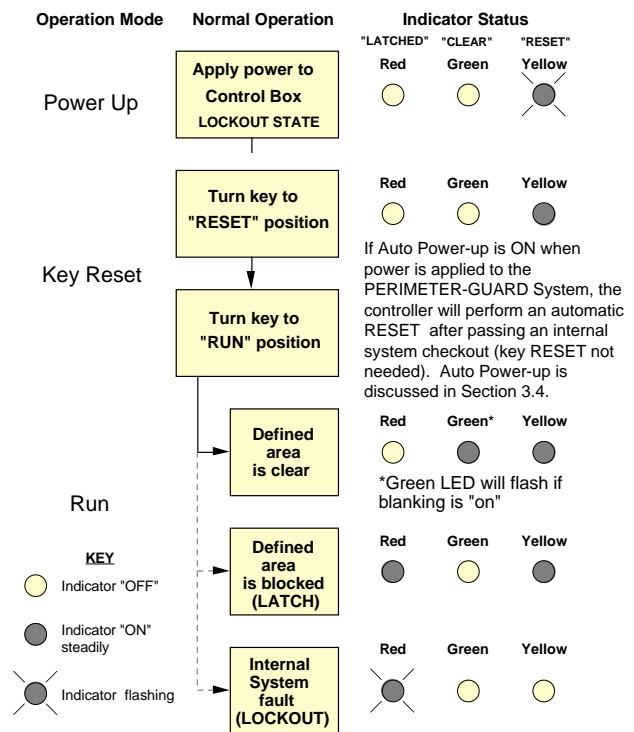
You may now install the controller module. **Before doing so, make sure that ac power to the PERIMETER-GUARD System is turned off.** Then refer to Figure 13 (page 16) and gently slide the module into position, and tighten its two captive holddown screws.

### Initial Checkout Procedure

The PERIMETER-GUARD System has three operating modes: POWER UP, KEY RESET, and RUN. Monitor the three control box panel LEDs (red, yellow, and green, on the front panel) and refer to Figure 14. Note CAUTION, above left. The initial checkout procedure is as follows:

- 1) **Enter the POWER UP mode** by applying ac power to the control box. The System will "power up" into a *power-up lockout condition* (yellow LED only flashing).
- 2) **Enter the key RESET mode** by turning the key to the RESET position. The yellow panel LED will glow steadily. *Leave the switch in the RESET position for at least one-half second.* This allows time for the microprocessors to run a startup diagnostic check routine.
- 3) **Enter the RUN mode** by turning the key to the RUN position. If the optical alignment of the system is correct, the green and yellow LEDs will be "on" steadily (the green LED will *flash* if blanking is "on").

Figure 14. Operating Status LED Conditions



NOTE: A key RESET is *always* required to recover from a LOCKOUT condition.

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

If the red and yellow LEDs come "on" and glow steadily, the defined area is not clear (one or more light beams are obstructed), or the system may be out of alignment. This is a *latch condition*. If this occurs, check the defined area for obstructions. Remove the obstruction(s), and RESET the system (repeat step #2).

If the PERIMETER-GUARD System is properly aligned and all obstructing objects are removed from the defined area, the green and yellow LEDs should be "on" after step #3 has been performed.

***If you are setting up the PERIMETER-GUARD System for the first time, or if the green LED does not come "on" in step #3, perform the alignment procedure in Section 6.1, page 28.*** When you are certain that the emitter, receiver, and mirrors (if used) are properly aligned, tighten the emitter, receiver, and mirror mounting hardware in position and repeat steps #1-3 above. NOTE: If the key is inadvertently turned to RESET while the system is operating normally, all three LEDs will flash. When the key is turned back to RUN, the red light will continue to flash, indicating a lockout condition. To return the system to the RUN condition, the key must again be turned to RESET and then back to RUN.



## WARNING

The PERIMETER-GUARD System's output relays must be the *final switching devices* for the machinery being guarded. Do not wire in any intermediate control devices between the output relays and the control elements of the guarded machinery. To do so could result in serious injury or death.

*Never connect the PERIMETER-GUARD System to the top stop circuitry of a press.*

4) Next, "latch test" the PERIMETER-GUARD for object detection capability using the 1.5" diameter specified test piece supplied with the control box. There are two latch test procedures. The one to perform depends upon whether or not floating blanking is being used. To perform the latch test, the key switch must be in the RUN position and the green and yellow LEDs must be "on" (the green LED will *flash* if blanking is "on").

a) **If floating blanking is not being used**, pass the specified test piece, very slowly, down the length of the defined area in three paths: close to the emitter unit, close to the receiver unit, and at a point close to midway between the emitter and receiver units. When the test piece enters the defined area, the red and yellow (only) LEDs must come

## NOTICE regarding MPCEs

Each of the two Machine Primary Control Elements (MPCE 1 and MPCE 2, Section 3.5.4) must be capable of immediately stopping the dangerous machine motion, irrespective of the state of the other. These two channels of machine control need not be identical, but the stop time performance of the machine ( $T_s$ , used to calculate the separation distance) must take into account the *slower* of the two channels.

Some machines offer only one primary control element. For such machines, it is necessary to duplicate the circuit of the single MPCE to add a second machine primary control element. Refer to Figure 15 (page 19), or consult the machine manufacturer for additional information.

## NOTICE regarding MPCE Monitoring Hookup

It is strongly recommended that one normally open and one normally closed auxiliary contact of each MPCE be wired (as shown in Figure 15, page 19) as MPCE monitor contacts. If this is done, any inconsistency of action between the two MPCEs will remove power from the PERIMETER-GUARD System, causing a lockout condition. ***The use of MPCE auxiliary contacts as MPCE monitor contacts is necessary in order to maintain redundancy.*** MPCE auxiliary contacts used for this purpose must be rated at 130V ac minimum, 50 VA minimum.

**In order to maintain redundancy, the MPCE monitor contacts must be wired as described in section 3.5.5 and Figure 15, page 19.**

"on", and the green LED must go "off". The green LED must remain "off" for as long as the test piece is in the defined area. When the test piece leaves the defined area, the red and yellow LEDs must remain "on", and the green LED must light.

b) **If floating blanking is being used**, temporarily block *one beam only* of the defined area using heavy opaque tape or an opaque object. It is usually easiest to block either the lowest or highest beam that is not affected by exact blanking. With this one beam blocked, proceed as in paragraph 4a (above).

If the PERIMETER-GUARD System passes all of the checks in Section 3.5.3, go on to Section 3.5.4. If the PERIMETER-GUARD System fails any of these checks, *do not attempt to use it until the reason for the failure(s) is identified and the failures are corrected.* **NOTE:** Consider the caution about reflective surfaces (page 14) when assessing the cause of a failed latch test.

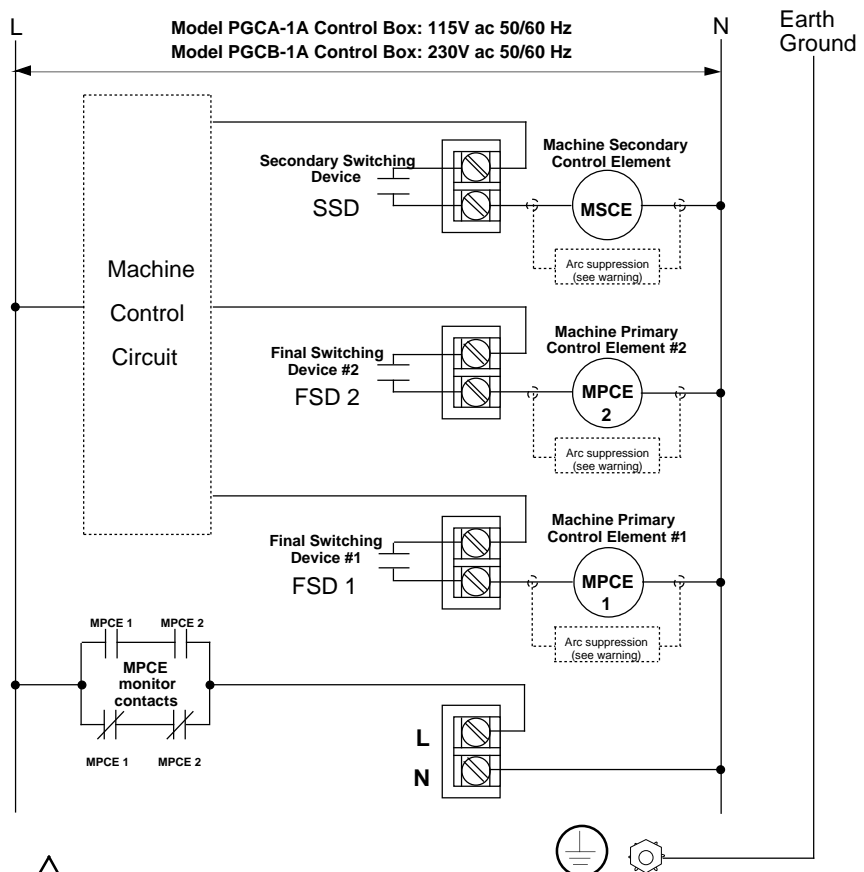
### 3.5.4 Output Relay Connections

Output relay connections are made at the **FSD1** (Final Switching Device 1), **FSD2** (Final Switching Device 2), and **SSD** (Secondary Switching Device) terminals on wiring barrier P6. In normal operation, these relays are energized (contacts closed) with no obstructions in the defined area. **All** relays become de-energized (their contacts open) in a lockout condition. Relays **FSD1** and **FSD2** (only) de-energize in a latch condition. Before continuing, read the **NOTICE regarding MPCEs**, page 18.

**The FSD1 output relay** connects to Machine Primary Control Element #1 (MPCE 1) on the machine. MPCE 1 is an electrically powered element of the machine that directly controls the machine's normal operating motion in such a way that it is last (in time) to operate when motion is either initiated or arrested. The output contact of relay FSD1 must be connected, as shown in Figure 15, to control power to Machine Primary Control Element #1. The switching capacity of relay FSD1 is 250V ac max., 4 amps max. (resistive load).

**The FSD2 output relay** connects to Machine Primary Control Element #2 (MPCE 2) on the machine. MPCE 2 is an electrically powered element of the machine (in a different control path than MPCE 1) that directly controls the machine's normal operating motion in such a way that it is last (in time) to operate when motion is either initiated or arrested. The output contact of relay FSD2 must

**Figure 15. Generic Machine Interface**



### ! WARNING

If arc suppressors are used, they **MUST BE INSTALLED AS SHOWN ACROSS THE COILS OF THE MACHINE CONTROL ELEMENTS. NEVER INSTALL SUPPRESSORS DIRECTLY ACROSS THE CONTACTS OF THE PERIMETER-GUARD SWITCHING DEVICES!** It is possible for suppressors to fail as a short circuit. If installed directly across the contacts of a PERIMETER-GUARD switching device, a short-circuited suppressor will create an unsafe condition.

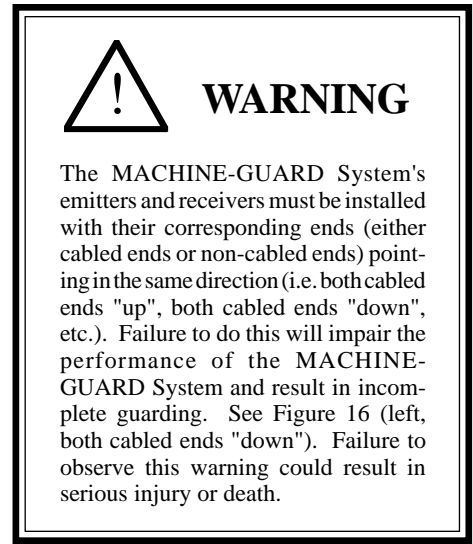
### ! WARNING

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

(continued on page 22)

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## Figure 16. PERIMETER-GUARD Basic System

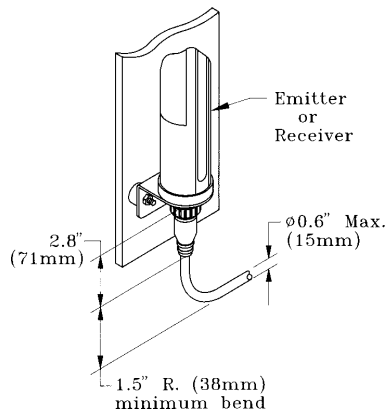


## Quick Disconnect Cable

Emitter and receiver cables must be ordered separately from the rest of the system. Banner cables have a straight QD (Quick Disconnect) connector molded onto the sensor end. Cables measure .5-inch in diameter, and are PVC-jacketed. Conductors are 16-gauge.

Cables are available in lengths of 25, 50, 100, and 150 feet. Total length of the emitter and receiver cables must not exceed 175 feet. See page 37 for cable models.

The threaded, knurled connector is aluminum. Two liquid-tight cable gland/strain relief fittings are supplied with each control box to admit the emitter and receiver cables through the selected knockouts on the control box wall.



Sensor Models	Ht. of Defined Area (Y)	Mounting Dimensions (L1) (L2)	
MGE616A emitter MGR616A receiver	6 inches (152 mm)	11.7" (297 mm)	9.6" (244 mm)
MGE1216A emitter MGR1216A receiver	12 inches (305 mm)	17.7" (449 mm)	15.6" (396 mm)
MGE1816A emitter MGR1816A receiver	18 inches (457 mm)	23.7" (602 mm)	21.6" (549 mm)
MGE2416A emitter MGR2416A receiver	24 inches (610 mm)	29.8" (757 mm)	27.6" (701 mm)
MGE3016A emitter MGR3016A receiver	30 inches (762 mm)	35.8" (909 mm)	33.6" (853 mm)
MGE3616A emitter MGR3616A receiver	36 inches (914 mm)	41.8" (1062 mm)	39.7" (1008 mm)
MGE4216A emitter MGR4216A receiver	42 inches (1067 mm)	47.8" (1214 mm)	45.7" (1161 mm)
MGE4816A emitter MGR4816A receiver	48 inches (1219 mm)	53.9" (1369 mm)	51.7" (1313 mm)
MGE5416A emitter MGR5416A receiver	54 inches (1372 mm)	59.9" (1521 mm)	57.7" (1466 mm)
MGE6016A emitter MGR6016A receiver	60 inches (1524 mm)	65.9" (1674 mm)	63.7" (1618 mm)
MGE6616A emitter MGR6616A receiver	66 inches (1676 mm)	71.9" (1826 mm)	69.7" (1770 mm)
MGE7216A emitter MGR7216A receiver	72 inches (1829 mm)	77.9" (1979 mm)	73.7" (1872 mm)

## Emitter/receiver Mounting Bracket Dimensions

be connected, as shown in Figure 15, to control power to Machine Primary Control Element #2. The switching capacity of relay FSD2 is 250V ac max., 4 amps max. (resistive load).

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

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

**The SSD output relay** connects to the Machine Secondary Control Element (MSCE) on the guarded machine. The MSCE is an electrically powered element of the machine (independent of the MPCEs) that is capable of removing power from the prime mover of the dangerous part of the machine in the event of an emergency. The output contacts of the SSD relay must be connected, as shown in Figure 15, to the Machine Secondary Control Element such that, if a lockout condition occurs, the motive power will be removed from the machine. The switching capacity of the SSD relay is 250V ac max., 4 amps max. (resistive load).

**Figure 15 shows output relay connections in a generic interfacing situation.** The connections between the PERIMETER-GUARD System outputs and the machine primary and secondary control elements must be direct, and arranged so that any single line fault or earth fault will not result in a circuit failure to a potentially dangerous state.



## WARNING

The Banner PERIMETER-GUARD System can do the job for which it was designed only if it and the guarded machine are operating properly, both separately and together. It is your responsibility to verify this, on a regular basis, as instructed in Section 4.2 and Section 6.

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

### 3.5.5 AC Power (permanent connection)

After the initial checkout of Section 3.5.3 and the alignment procedure of Section 6.2 have been successfully completed, the ac lines to the PERIMETER-GUARD System must be rerouted to their permanent hookup, through the guarded machine's MPCE monitor contacts. This is important because it ensures that any inconsistency in action between the two MPCEs will remove power from the system. This is shown in Figure 15, page 19.

Connection to ac power is at the **L** and **N** terminals of control box wiring barrier P6. The PERIMETER-GUARD System requires 115V ac, 50/60Hz using control box PGCA-1A, or 230V ac using model PGCB-1A. Three-wire connection (ac "hot", ac "neutral", and earth ground) to ac power mains must be done according to NEC and local wiring codes. **Do not operate the PERIMETER-GUARD System without an earth ground connection.**

After ac power has been connected to the PERIMETER-GUARD System and the output relay contacts have been connected to the machine to be controlled, the operation of the PERIMETER-GUARD System with the guarded machine must be verified before the combined system may be put into service. To do this, **a qualified person must perform the Commissioning Checkout Procedure given in Section 6.2 on page 31.**

### 3.5.6 Alarm Relay

The Alarm Relay contacts **close** in lockout and latch conditions. *The Alarm Relay contact is a light-duty contact used for control or alarm functions that are not safety-related.* A typical use is to key a visual or aural alarm or to communicate with a programmable logic controller (PLC). The switching capacity of the Alarm Relay is 125V ac or dc max., 500mA max. Connection to the Alarm Relay contact is made at wiring barrier P5.

### 3.5.7 Accessory Connections at Terminal Strip P3

Terminal strip P3 at the upper left corner of the control box (see Figure 13, page 16) allows connection of accessories such as the model MGA-LR-1 LED Remote Display, the model MGA-LRKS-1 LED Remote Display with keyed reset switch, and the model MGA-KSO-1 Remote Keyed Reset Switch. Refer to the data sheets for these products for hookup information. **If the connected accessory is or includes a remote reset switch, the accessory must be positioned at a location that provides an unobstructed view of the entire hazardous area being guarded by the PERIMETER-GUARD System.**

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### 3.6 Control Box Latch Adjustment

The tightness of the upper (locking) latch on the control box is adjustable. Rotating the threaded clasp of the latch counterclockwise loosens the latch, while rotating the clasp clockwise tightens the latch. Adjust the threaded clasp so that the box cover is held closed snugly when the latch is in the closed (locked down) position.

## 4. Operating Instructions

### 4.1 Security Protocol

The PERIMETER-GUARD control box has a **locking latch** and a **key-operated front-panel RESET switch**.

In order to prevent access by unauthorized personnel, and to ensure that all lockout conditions come to the attention of a person qualified to deal with them, a lock must be inserted in the lockable latch and the key (or combination) to this lock must be kept in the possession of a *qualified person* as defined in ANSI/ASME B30.2-1983. *Qualified persons only should have access to the interior of the PERIMETER-GUARD System control box.*

The key to the front-panel RESET switch should be available to a *designated person* or persons. A designated person is one who is identified and designated in writing, by the employer, as being appropriately trained and qualified to perform a specified checkout procedure. If the machine operator meets these requirements, he/she may be a designated person.

### 4.2 Periodic Checkout Requirements

In addition to the checkout and alignment procedures that are done by a qualified person or persons at the time that the PERIMETER-GUARD System is installed and put into service, **the functioning of the PERIMETER-GUARD System and the guarded machine must be verified on a regular periodic basis to ensure proper operation. This is absolutely vital and necessary. Failure to ensure proper operation can lead to an unsafe condition.**

Periodic checkouts must be performed as follows:

- 1) By a designated person at every power-up of the PERIMETER-GUARD System (Section 6.3, page 32),
- 2) By a qualified person following the correction of every lockout condition (Section 6.3, page 32),
- 3) By a designated person at every shift change or machine setup change (Section 6.3, page 32),
- 4) By a qualified person semi-annually (every 6 months) following installation of the PERIMETER-GUARD System (Section 6.4, page 32).

### 4.3 Normal Operation

#### 4.3.1 Power-up

When ac power is applied to the PERIMETER-GUARD System and Auto Power-up is "off", it is normal for the System to "power up" into a power-up lockout condition (yellow LED flashing). To prepare the PERIMETER-GUARD System for operation after a "power-up" lockout, the designated person must perform a key reset:

- a) Turn the key to the RESET position (yellow LED goes "on"). Wait at least 1/2 second for diagnostics, then
- b) Turn the key to the RUN position.

If Auto Power-up is "on", the PERIMETER-GUARD System will reset itself after it conducts and passes its diagnostics.

If the defined area is clear, the green and yellow LEDs will go "on" (the red LED remains "off"). NOTE: If blanking is "on", the green LED will *flash*.

If the defined area is blocked or if the emitter and receiver are misaligned, the red and yellow LEDs will go "on", indicating a "latch" condition.

If a "latch" condition exists, correct the cause and perform the checkout procedure in Section 6.3 on page 32.

*Upon power-up, and also at every shift change or machine setup change, the checkout procedure of Section 6.3 on page 32 must be performed.*

#### 4.3.2 Exact Blanking Operation

Exact blanking allows for the *permanent* presence of brackets, fixtures, etc. in the defined area (sensing path). If the appropriate number of light beams were configured (Section 3.4), the PERIMETER-GUARD System "sees" the objects in the path of those beams, but "ignores" the objects as long as the configured number of beams remain blocked. In normal operation:

- a) a lockout condition will occur if *fewer* than the configured number of beams are blocked (e.g. when a fixture is removed and blanking is not changed), and,
- b) a latch condition will occur if *more* than the configured number of beams are blocked (e.g. by a hand or other object entering the defined area).

A latch condition causes the red and yellow Status Indicator LEDs to come "on". Recovery from a latch condition requires a key reset after the defined area is cleared of obstructions.

Refer to Figure 8 (page 12) and note that changing the number of blanked beams changes the Penetration Depth Factor ( $D_{pr}$ ). This alters the required separation distance between the defined area and the closest machine danger point. If you are *decreasing* the number of blanked channels, there is no need to change the separation distance unless the overall speed of the manufacturing process is critical. However, if you



## WARNING

### Important warning when *exact blanking* is used

Exact blanking is designed to be used where some permanent mechanical obstruction is present in the guarded area (see Section 2.2, page 6, of the instruction manual). The *exact blanking* feature allows blanking of the affected beams. It is imperative that the mechanical obstruction be visible to the machine operator and that the operator be fully informed as to which beams are blanked. In addition, hard guarding may be required (see Section 3.2.2, page 11, of the instruction manual).

If for whatever reason, the mechanical obstruction is allowed to move such that the same number of beams are still blocked but now the location of the obstruction is different, then the operator must be made fully aware of this change, and the hard-guarding must be modified as necessary. If this change occurs without the operator's knowledge, it will place that operator at additional risk.

*increase* the number of blanked beams, OSHA regulations require the separation distance to be increased correspondingly. **The number of beams blanked by exact blanking does not affect  $D_{pf}$  if the entire area of blanked beams is occupied by the bracket, fixture, etc. or guarded by supplemental guarding or hard guarding.** See Section 3.2.1, NOTE 3.

### 4.3.3 Floating Blanking Operation

Floating blanking allows an object of up to one inch in cross section to break the defined area at any point without causing a latch condition (see Section 2.2).

The use of floating blanking increases the Penetration Depth Factor ( $D_{pf}$ ) and also, therefore, the separation distance required between the defined area and the closest machine danger point (see Figure 8 on page 12, and Section 3.2.1). If

the separation distance was calculated on the basis of no floating blanking and you later begin to use floating blanking, OSHA regulations require the separation distance to be increased accordingly. See Section 3.2.1.

*Upon power-up (and also at every shift change or machine setup change), checkout procedure 6.3 on page 32 must be performed.*

## 5. Troubleshooting and Maintenance

### 5.1 Troubleshooting Lockout Conditions

A PERIMETER-GUARD System lockout will occur:

- 1) Routinely upon PERIMETER-GUARD System "power-up" (see Section 4.3.1) unless Auto Power-up is "on",
- 2) If ac power to the PERIMETER-GUARD System is interrupted (unless Auto Power-up is "on"),
- 3) If only one FSD (Final Switching Device) relay has gone to the "off" state (de-energized),
- 4) If the SSD (Secondary Switching Device) relay has de-energized,
- 5) If fewer than the programmed number of light beams are blocked when using *exact blanking*,
- 6) If the controller module switch settings are incorrect for the emitter/receiver array length in use, or
- 7) If the self-checking circuits of the microprocessor detect a component failure.

A lockout condition causes the Alarm Relay contacts to close (except in conditions #1 and #2) and all output relays (FSD1, FSD2, and SSD) to open, shutting down the MPCEs and MSCE of the guarded machine. A power-up (or power interrupt) lockout is indicated by a flashing yellow (only) LED. A lockout due to condition #3, 4, 5, 6, or 7 is indicated by the red status indicator LED (only) flashing.



## WARNING

Electrical shock hazard exists when the PERIMETER-GUARD System has power applied to it and the control box door is open. Use extreme caution to avoid electrical shock during installation or servicing or when the control box door is open to change programming or observe the diagnostic indicators. **Always disconnect all power from the PERIMETER-GUARD System and the guarded machine before making any wire connections or before replacing any component.**

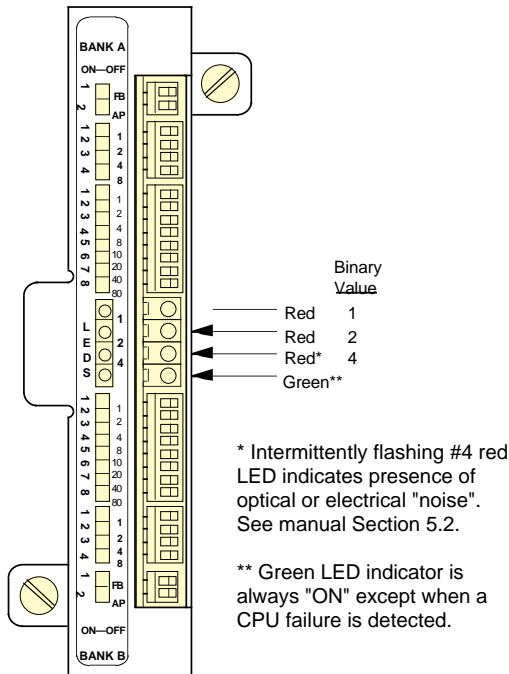
**The control box should be opened and/or serviced only by a qualified person (see Section 4.1).**



**Figure 17. Interpretation, Diagnostic Indicator LEDs**

**Diagnostic Indicator LEDs**

Controller Module Assembly



Error Number (Add binary values of lighted red LEDs)	Problem	Correction
0	System is O.K.	—————
1	A.) Relay failure B.) Controller module failure C.) Unnecessary key reset	A.) Replace relay module (MGA-RMSSD) B.) Replace controller module C.) Perform a key reset
2	A.) Waiting for a key reset B.) Relay failure C.) Key switch failure	A.) Perform a key reset B.) Replace relay module (MGA-RMSSD) C.) Replace switch (MGA-KS-1)
3	Controller module failure	Replace controller module
4*	Receiver failure	A.) Check cable connections B.) Replace receiver
5	Emitter failure	A.) Check cable connections B.) Replace emitter
6	A.) Incorrect configuration of array length. B.) Emitter failure C.) Controller module failure	A.) Check array size switch configuration (see page 15) B.) Replace emitter C.) Replace controller module
7	A.) Incorrect configuration of blanking area B.) Receiver failure C.) Controller module failure	A.) Check blanking switch configuration (see page 15) B.) Replace receiver C.) Replace controller module
8**	CPU failure	Replace controller module

If Auto Power-up is switched "on", the PERIMETER-GUARD System will reset itself to recover from lockout condition #1 or #2. If Auto Power-up is "off", use the following procedure to resume operation after a power-up (condition #1) or a power interruption (condition #2):

- a) Turn the key to the RESET position (yellow Status Indicator LED should light) and wait at least 1/2 second, then
- b) Turn the key to the RUN position.

If Auto Power-up is not switched "on", and if the lockout condition was due to power-up or to a momentary power

interruption that has been corrected, the PERIMETER-GUARD System will now operate normally.

If the defined area is clear and the emitter and receiver are properly aligned, the green and yellow LEDs will light (the green LED will *flash* if blanking is "on").

If the defined area is not clear, the red and yellow LEDs will light. If alignment is correct, removal of the obstructing object will cause the green LED to light (and the red and yellow LEDs to remain "on"). A reset at this point should cause the red LED to go "off" and yellow and green LEDs to light, signalling that the PERIMETER-GUARD System is



**WARNING**

Power failures or other PERIMETER-GUARD System lockout conditions should always be investigated immediately by a qualified person. *With the exception of lockout conditions #1 and #2 (left), lockout is a positive indication of a problem and should be investigated at once.* Attempts to operate machinery by bypassing the PERIMETER-GUARD System are dangerous and could result in injury or death.

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ready for operation.

*Upon recovery from a power interruption, checkout procedure 6.3 on page 32 must be performed.*

**If all three Status Indicator LEDs are flashing,** the key reset switch has been turned to the RESET position while the PERIMETER-GUARD System was operating normally. To continue operation, turn the key reset switch to the RUN position, then to RESET and back to RUN.

**If the red Status Indicator LED (only) flashes,** the lockout condition is due to another cause (conditions #3-7). In this case, the qualified person must open the control box cover and note the state of the Diagnostic Indicator LEDs (Figure 19, page 25).

If one or more of the red Diagnostic Indicator LEDs is "on", the cause of the lockout condition is *within* the PERIMETER-GUARD System itself. The PERIMETER-GUARD System will not operate if its self-checking circuits have detected an internal problem. Take the corrective measure(s) shown in Figure 17 for the listed *Error Number* and related *Problem*. If further assistance is required, contact your Banner field service engineer or the factory Applications Engineering Department.

If no Diagnostic Indicator LEDs are "on", ac power to the system may have been lost. The green LED on the power supply board (see Figure 13, page 16) indicates the presence (LED "on") or absence (LED "off") of **dc power at the power supply board**. It is possible for **ac power** to be present at the **input** of the power supply even if the dc power LED is "off". **Exercise care. A shock hazard may exist under these conditions.**

**Very carefully check for ac voltage across the L and N terminals of wiring barrier P6.** If ac voltage is **not** present at L and N, ac power to the PERIMETERGUARD System has been lost, and the cause is outside the system. If voltage **is** present there, remove plug P11 from the relay board and check the P11 socket (on the board) for ac voltage. If ac voltage is **not** present there, the problem is in the FSD relay module. If voltage **is** present at the P11 socket, reconnect plug P11 and check for 12V dc at connector block P2. If 12V dc is **not** present there, turn off the ac power to the control box and check the fuse. If the fuse is bad, replace it (Section 5.2.1). If the fuse is good, and 12V dc is still **not** present at P2, a power supply failure has occurred.

## 5.2 Effects of Electrical and Optical Noise

The PERIMETER-GUARD System is designed and manufactured to be highly resistant to "noise" and to operate reliably in industrial settings. However, serious electrical and/or optical "noise" may cause a random "latch" condition. In *very extreme cases*, a "lockout" is possible. In order to minimize the effects of transitory noise, the PERIMETER-GUARD System will respond to noise only if the noise is detected on two consecutive scans. Red Diagnostic Indicator LED #4 will flash to indicate the presence of electrical or optical noise. This LED can be used to track down particularly offensive noise sources. Simply observe the LED while shutting down or isolating the suspected sources.

When the model MGA-KSO-1 Remote Key Switch is used in extremely noisy conditions, we recommend the use of shielded cable between the control box and the key switch as a precautionary measure.

## 5.3 Servicing and Maintenance

### 5.3.1 Fuse Test and Replacement

**Turn off ac power to the control box and to the guarded machine before proceeding.** The PERIMETER-GUARD System control box fuse is located in a fuseholder on the power supply board (see Figure 13, page 16). Use a flat-blade screwdriver to push in and rotate the end of the fuse holder counterclockwise until it and the fuse can be pulled from the holder. Visually inspect the fuse and/or test its conductivity using an ohm meter or a continuity tester. The fuse is a 250V ac 3AG slow-blow type (see specifications, page 36).

### 5.3.2 Controller Module and Relay Replacement

PERIMETER-GUARD Systems are designed for reliability. While replacement of the controller module and relays is not normally required, these components have been designed to be easily replaceable as a convenience to the customer. ***To maintain control reliability, use only Banner-supplied replacement relays with forced-guided contacts.***

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The output relays are configured in two modules: the FSD relay module and the SSD relay module (see Figure 13 , page 16). To remove a module, remove the 3/8" nylon hex nuts and gently slide the module out of the control box to disconnect it from the mother board. To reinstall, press the module firmly and evenly onto its connector pins and replace the hex nuts.

Individual output relays are replaceable. To replace a relay, first remove the relay holddown bracket (held by two screws), and then gently and evenly pull the relay from its socket. To install a new relay, press the relay firmly and evenly into its socket, and tighten down the holddown bracket.

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

**If it ever becomes necessary to return any PERIMETER-GUARD component to the factory, pack it carefully:**

- Remove the controller module from the control box, and pack the module separately, and
- Use the original packing materials whenever possible.

*Damage that occurs in return shipping is not covered by warranty.*

### 5.3.3 Cleaning

**The PERIMETER-GUARD System control box** is constructed of welded steel with a black polyester paint finish, and is rated NEMA 13 (IP64). It may be cleaned using mild detergent or window cleaner and a soft cloth.

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



## WARNING

If replacement parts are ever required, **always use only genuine Banner-supplied replacement parts.** Do not attempt to substitute parts from another manufacturer. To do so could impair the operation of the PERIMETER-GUARD System and result in a dangerous situation and possible injury or death.

## 6. Alignment and Checkout Procedures

Study each procedure from beginning to end to make sure that you understand each step before you start.

Refer all questions to the Banner Applications Engineering Department (address, telephone, and FAX information on page 2).

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

### 6.1 Alignment of the PERIMETER-GUARD System

This alignment procedure begins with the assumption that the PERIMETER-GUARD System has been mechanically aligned as discussed in Section 3.3. As is recommended there, we suggest maximizing the sensing power of the PERIMETER-GUARD System through liberal use of hard-guarding and by keeping the number of corner mirrors in the System to a necessary minimum. Follow the measures outlined below to maximize PERIMETER-GUARD System excess gain. If there are reflective surfaces near the defined area, read alignment step #7 (page 30), before proceeding further, to prevent possible reflection problems.

(continued on page 29)



#### WARNING

You may be working close to the hazardous area of your machinery while aligning the PERIMETER-GUARD System. Aligning the PERIMETER-GUARD System while the hazardous machinery is operational could result in serious injury. *The machinery that the PERIMETER-GUARD System is connected to must not be operating at any time during the alignment procedure of Section 6.1.*

## MGM Series Mirrors and the Maximum Width of the Defined Area

Excess gain is a measurement of the sensing energy that falls upon the receiver element of a sensing system over and above the minimum level required to just operate the receiver's amplifier. Excess gain may be used to predict the reliability of a sensing system. **The higher the excess gain, the better the ability of the sensing beam to cut through fog, mist, dust, and other contamination.** Excess gain decreases as the emitter-to-receiver distance (R) increases and as corner mirrors (n) are added to the System. Minimum excess gain recommendations are given in the table at the right. Maximization of excess gain should be an important objective when designing a PERIMETER-GUARD setup.

The excess gain formula for the PERIMETER-GUARD System with MGM Series mirrors is:

$$G_F = \frac{6075 (\text{REF})^n}{R^2}$$

where:  $G_F$  = final excess gain

n = the number of mirrors used

REF = reflectance: .85 (glass mirrors) or .70 (acrylic)

R = the total distance that the light travels (overall width of the defined area)

#### Example:

The excess gain of a 2-mirror PERIMETER-GUARD System (glass mirrors) that is set up to guard a total distance of 33 feet would be:

$$G_F = \frac{6075 (.85)^2}{33^2} \approx 4$$

#### Guidelines for Excess Gain Values

Minimum Excess Gain Required	Operating Environment
1.5X	<b>Clean air:</b> no dirt buildup on lenses or mirrors.
5X	<b>Slightly dirty:</b> slight buildup of dust, dirt, oil, moisture, etc. on lenses or mirrors. Lenses and mirrors cleaned on a regular schedule.
10X	<b>Moderately dirty:</b> obvious contamination of lenses or mirrors (but not obscured). Lenses and mirrors cleaned occasionally or when necessary.
50X	<b>Very dirty:</b> heavy contamination of lenses and mirrors. Heavy fog, mist, dust, smoke, or oil film. Minimal cleaning of lenses and mirrors.

**Always maintain at least the minimum excess gain indicated in the table (above) for the environment in which you are operating. Tips for maximizing excess gain are:**

- 1) Use "hard guarding" where possible to reduce the overall defined area width and the number of mirrors required.
- 2) Keep sensors and mirrors properly aligned,
- 3) Keep red sensor lens covers and mirrors clean.

## Alignment of the PERIMETER-GUARD System (continued)

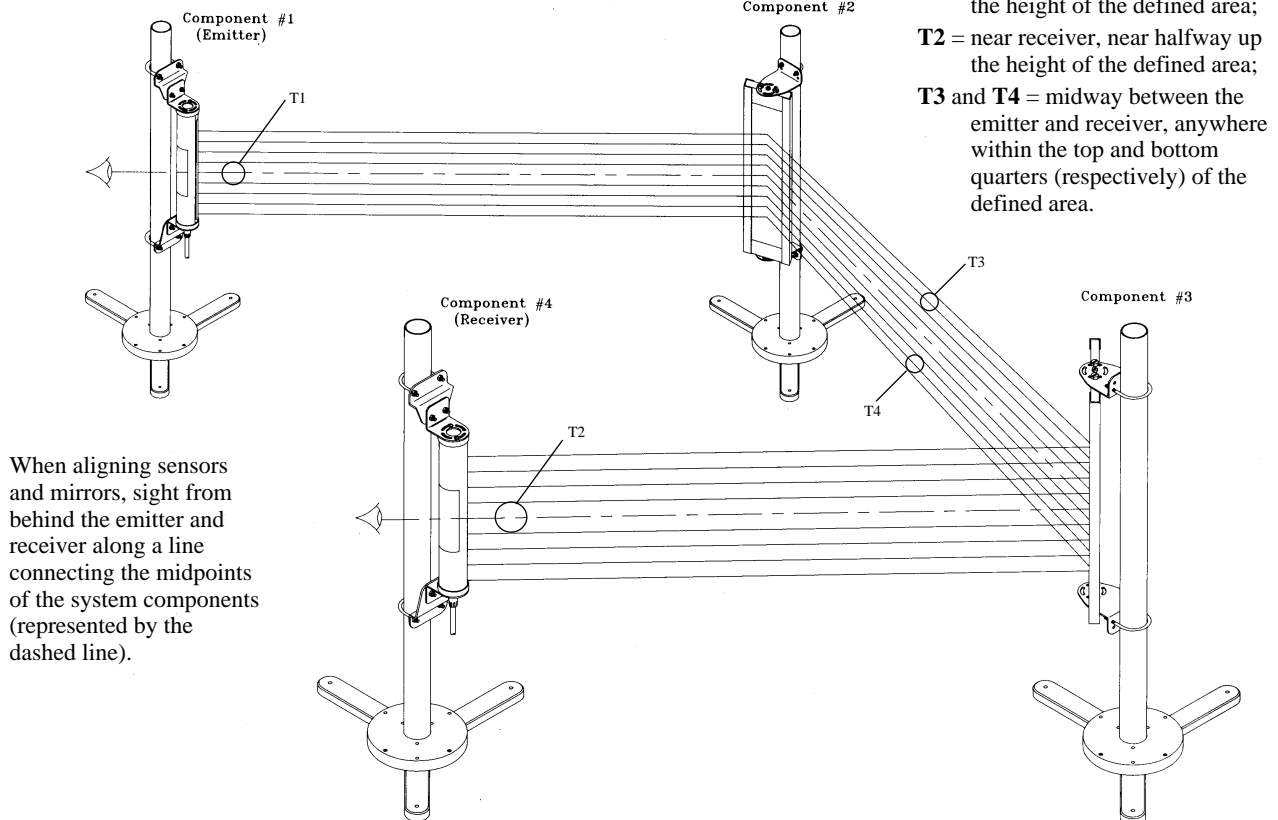
Only a *qualified person* may align the PERIMETER-GUARD System, as follows (refer to Figure 6, page 9):

- 1) Turn off power to the PERIMETER-GUARD System and to the guarded machine.  
Leave power to the guarded machine "off", and power-up the PERIMETER-GUARD System only.
- 2) If Auto Power-up is "off", the PERIMETER-GUARD will power up into a *power-up lockout condition*. Reset the P-G System as follows:  
Turn the control box front-panel key reset switch to the RESET position,  
Leave the key in the RESET position for at least 1/2 second to allow time for internal P-G System checks, and  
Turn the key switch to the RUN position.
- 3) Upon the completion of step #2, the PERIMETER-GUARD System enters either a LATCH or a CLEAR condition.  
LATCH condition: YELLOW and RED indicators (only) "on" steadily. Go to Step #4.  
CLEAR condition: YELLOW and GREEN\* indicators (only) "on" steadily. Go to step #5.
- 4) A LATCH condition after a RESET indicates that the PERIMETER-GUARD receiver is not seeing the light from the emitter. If this situation occurs,
  - a) Monitor the GREEN indicator on the front panel of the control box. Recheck the mechanical alignment of the PERIMETER-GUARD System (Section 3.3). Begin with the emitter and receiver at their desired locations. Adjust the corner mirrors so that the angle of incidence to the mirror equals the angle of reflectance from the mirror. Make sure that the emitter and receiver and all mirrors are in the same plane (use a level if necessary), and that the midpoints of all sensors and mirrors in the system (indicated by the broken line in Figure 18) are at the same level.
  - b) When the receiver sees the light from the emitter, the GREEN indicator on the control box panel will light\*. When the GREEN indicator comes "on", go to step #5. (At this point, the GREEN\*, YELLOW, and RED indicators will all be "on".)

\*The GREEN LED will flash if blanking is "on".

(continued on page 30)

Figure 18. PERIMETER-GUARD System, Alignment and Latch Test



## Alignment of the PERIMETER-GUARD System (continued)

- 5) Whatever the conditions of the YELLOW and RED indicators, if the GREEN\* indicator is "on", the receiver is seeing light from the emitter. In steps a, b, and c (below), alignment will be optimized to ensure that the PERIMETER-GUARD System is operating with the maximum possible excess gain for the distances involved.
- Carefully move the emitter (or the receiver) up and down along its long axis. Find the midpoint between extremes of movement within which the GREEN\* indicator stays "on". Temporarily secure the sensor at this point.
  - Carefully rotate the same sensor in its mounting brackets, this time looking for the midpoint between the extremes of rotation within which the GREEN\* indicator stays "on". The optimization of 5a and 5b constitutes optimal sensor alignment. Secure the sensor at this position. Repeat step 5b using the other sensor, and secure it in position.
  - Repeat step 5b for each mirror in the System. Secure the mirror(s) at their optimum position(s).
- 6) "Latch test" the PERIMETER-GUARD System for object detection capability using the 1.5" diameter specified test piece supplied with the control box. To perform this test, the key switch must be in the RUN position and the green and yellow LEDs (only) must be "on". Reset the system (key reset) if necessary.

\*GREEN LED will flash if blanking is "on".

### Perform the latch test as follows:

Insert the specified test piece into the defined area at test location T1 (see Figure 18, page 29). The red and yellow indicators must come "on" (indicating a LATCH condition) when the test piece enters the defined area, and must remain "on" when the test piece is removed from the defined area. The green indicator must go "off" and remain "off" for as long as the test piece is in the defined area. When the specified test piece is removed from the defined area, perform a key reset and re-enter the RUN mode. Perform this same latch test at test locations T2, T3, and T4. Following each latch and subsequent key reset, the PERIMETER-GUARD System should operate normally.

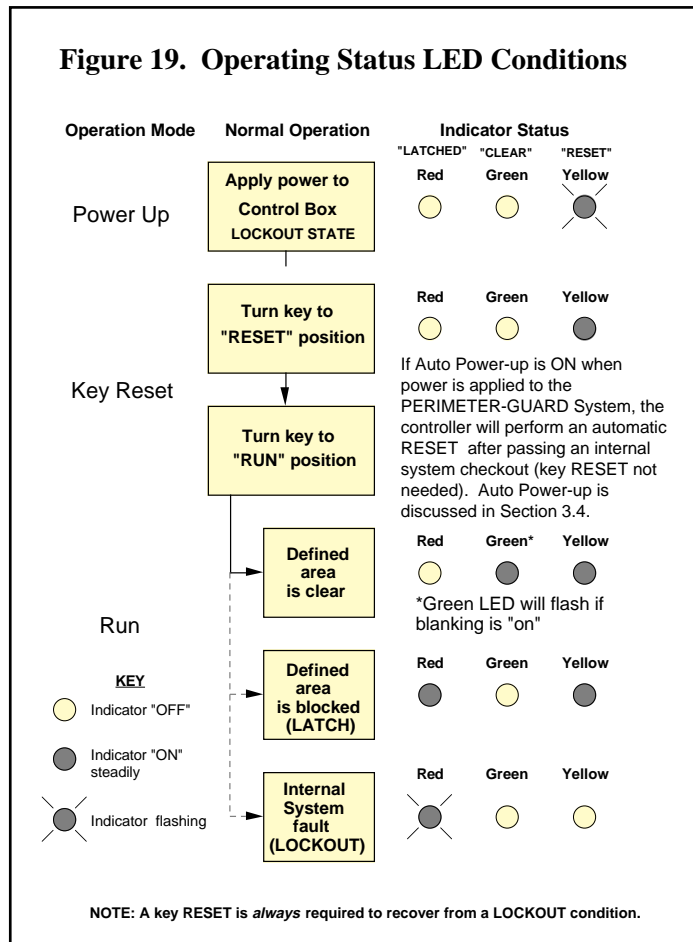
- 7) If the green and yellow indicators are "on" but the PERIMETER-GUARD System does not respond as described to all aspects of the latch test (step #6), the lack of response may be due to nearby reflective surfaces reflecting light from the emitter to the receiver via an alternate route. Move the defined area or the reflective surface (be sure to maintain at least the minimum required separation distance), or take measures to reduce the reflectivity of the interfering surface (i.e. angling, painting, masking, etc).



**WARNING**

If the PERIMETER-GUARD System does not respond properly to the latch test, do not attempt to use the System. If the PERIMETER-GUARD does not respond properly to the latch test, it cannot be relied upon to stop dangerous machine motion when a person or object enters the defined area. Serious injury or death could result.

Figure 19. Operating Status LED Conditions



## 6.2 Commissioning Checkout To Be Performed at Time of Installation

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

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

### The *qualified person* must:

- 1) Examine the guarded machine to verify that it is of a type and design that are compatible with the PERIMETER-GUARD System. See page 3 for a list of misapplications.
- 2) Verify that the minimum separation distance from the closest danger point of the guarded machine to the defined area is not less than the calculated distance. See Section 3.2.1.
- 3) Verify that access to the dangerous parts of the guarded machine is not possible from any direction not protected by the PERIMETER-GUARD System, hard guarding, or supplemental guarding, and verify that all supplemental guarding devices and hard guarding are in place and operating properly. Verify that supplemental guarding (e.g. safety mat, etc.) is used in any area where it is possible for personnel to stand between the defined area of the PERIMETER-GUARD and a danger point.
- 4) Examine the electrical wiring connections between the PERIMETER-GUARD output relays and the guarded machine's control elements to verify that the requirements stated in Section 3.5.4 are met.



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

- 5) Test the effectiveness of the PERIMETER-GUARD System with power "on", as described in steps (a) through (d), below.  
**If floating blanking is in use, first block one sensing beam as described in Section 3.5.3.**
  - a) Verify that the PERIMETER-GUARD System is in the RUN mode (green\* and yellow Status Indicator LEDs only "on"). See Section 4.3 for RESET procedure. \*The green Status Indicator LED will be *flashing* if blanking is "on".
  - b) With the guarded machine at rest, insert the 1.50-inch diameter *specified test piece* (supplied with the control box ) into the defined area close to the receiver column. The red and yellow indicators (only) should come "on" and remain "on" after the test piece is removed from the defined area. The green LED must go "off" and remain "off" for as long as the test piece is in the defined area. Reset the System (keyed reset) and repeat this step (5b) at test points T1, T2, T3, and T4 (shown in Figure 18, page 29). If the green indicator comes "on" at any time when the test piece is within the defined area, check for reflective surfaces (see Caution, page 14).
  - c) Initiate machine motion of the guarded machine and, during motion, insert the 1.50-inch diameter *specified test piece* into the defined area (at right angles to the defined area). *Do not attempt to insert the test piece into the dangerous parts of the machine.* Upon insertion of the test piece into the defined area at any time during machine motion, the dangerous parts of the machine should come to a stop with no apparent delay. Upon removal of the test piece from the defined area, verify that the machine does **not** automatically restart, and that the PERIMETER-GUARD System control box must be reset (keyed reset) and that the guarded machinery's initiation devices must be exercised to restart the machine.
  - d) With the guarded machine at rest, insert the 1.50-inch diameter *specified test piece* into the defined area and verify that it is not possible for the guarded machine to be put into motion while the specified test piece is within the defined area.
- 6) Remove electrical power to the PERIMETER-GUARD System. All output relays should immediately de-energize, and should not be capable of being reactivated until power is reapplied and a key RESET is performed.
- 7) Test the machine stopping response time using an instrument designed for that purpose to verify that it is the same or less than the overall system response time specified by the machine manufacturer. (NOTE: Banner's Applications Engineering Department can recommend a suitable instrument.)



### WARNING

If *all* of the above checks cannot be verified, the PERIMETER-GUARD System/guarded machine should not be used until the defect or problem has been corrected (see "Troubleshooting", page 24). Injury or death to personnel may result from attempts to use the guarded machine under such conditions.

## 6.3 To be Performed at Every Power-up, Shift Change, and Machine Setup Change

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

### The *designated person* must:

- 1) Verify that access to the dangerous parts of the guarded machine is not possible from any direction not protected by the PERIMETER-GUARD System, hard guarding, or supplemental guarding, and verify that all supplemental guarding devices and hard guarding are in place and operating properly.
- 2) Verify that the minimum separation distance from the closest danger point of the guarded machine to the defined area is not less than the calculated distance. See Section 3.2.1.
- 3) Verify that the PERIMETER-GUARD control box is latched and locked. The key or combination to the control box latch lock should be in the possession of a *qualified person*.



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

- 4) Test the effectiveness of the PERIMETER-GUARD System with power "on", as described in steps (a) through (d), below.  
**If floating blanking is in use, first block one sensing beam as described in Section 3.5.3.**
  - a) Verify that the PERIMETER-GUARD System is in the RUN mode (green\* and yellow Status Indicator LEDs only "on"). See Section 4.3 for RESET procedure. \*The green Status Indicator LED will be *flashing* if blanking is "on".
  - b) With the guarded machine at rest, insert the 1.50-inch diameter *specified test piece* (supplied) into the defined area close to the receiver column. The red and yellow indicators (only) should come "on" and remain "on" after the test piece is removed from the defined area. The green LED must go "off" and remain "off" for as long as the test piece is in the defined area. Reset the System (keyed reset) and repeat this step (step 4b) at test points T1, T2, T3, and T4 (Figure 18, page 29). If the green indicator comes "on" at any time when the test piece is within the defined area, check for reflective surfaces (see Caution, page 14).
  - c) Initiate machine motion of the guarded machine and, during motion, insert the 1.50-inch diameter *specified test piece* into the defined area (at right angles to the defined area). *Do not attempt to insert the test piece into the dangerous parts of the machine.* Upon insertion of the test piece into the defined area at any time during machine motion, the dangerous parts of the machine should come to a stop with no apparent delay. Upon removal of the test piece from the defined area, verify that the machine does **not** automatically restart, and that the PERIMETER-GUARD System control box must be reset (keyed reset) and that the guarded machinery's initiation devices must be exercised to restart the machine.
  - d) With the guarded machine at rest, insert the 1.50-inch diameter *specified test piece* into the defined area and verify that it is not possible for the guarded machine to be put into motion while the specified test piece is within the defined area.
- 5) Check carefully for external signs of damage to the PERIMETER-GUARD System, the guarded machine, and their electrical wiring. Any damage found should be immediately reported to management.

## 6.4 To be Performed at Six Month Intervals (Semi-annually)

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



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

### The *qualified person* must:

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



### WARNING

If *all* of the above checks cannot be verified, the PERIMETER-GUARD System/guarded machine should not be used until the defect or problem has been corrected (see "Troubleshooting", page 24). Injury or death to personnel may result from attempts to use the guarded machine under such conditions.



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# Glossary of Terms

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

**ANSI (American National Standards Institute):** the American National Standards Institute, is an association of industry representatives which develops technical standards which include safety standards. These standards comprise a consensus from a variety of industries on good practice and design. ANSI standards relevant to application of the MACHINE-GUARD System include ANSI B11.1 (mechanical power presses), ANSI B11.2 (hydraulic power presses), and ANSI/RIA R15.06 (industrial robots and robot systems).

**Auxiliary monitor contact:** a low load capacity, non safety-related relay contact within the PERIMETER-GUARD System that follows the action of output relays FSD1 and FSD2, and whose primary purpose is to communicate with a PLC.

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

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

**Controller module:** a removeable printed circuit board, located within the PERIMETER-GUARD System control box, which contains the microprocessors and related electronic circuits.

**Defined area:** the "curtain of light" generated by the PERIMETER-GUARD System. When the defined area is interrupted by an opaque object of a specified cross section, a *trip condition* results (see Figure 1).

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

**Diverse redundancy:** in diverse redundancy, the redundant components are of different design, and any microprocessor programs used must run from different instruction sets written by different programmers.

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

**Failure to danger:** a failure which prevents or delays the output relays of the PERIMETER-GUARD System from going to a *trip condition* or a *lockout condition* in response to a condition which, in normal operation, would result in their so doing.

**Final switching device (FSD):** the two output relays (FSD1 and FSD2) of the PERIMETER-GUARD System which respond to an interruption of the defined area by interrupting the circuit connecting them to the *Machine Primary Control Elements (MPCEs)* of the *guarded machine*.

**Floating blanking:** a feature that allows the PERIMETER-GUARD System to be programmed to produce an intentionally disabled light beam, within the "curtain of light", which appears to move up and down ("float") in order to allow the feeding of an object through the curtain (the *defined area*) at any point along the length of the curtain without causing a *trip condition*. The PERIMETER-GUARD System allows one sensing beam to be floating blanked.

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

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

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

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

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

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

**Lockout condition:** a condition of the PERIMETER-GUARD System that is automatically attained both: (1) when its ac supply mains are interrupted and restored, and (2) in response to certain failure signals. When a lockout condition occurs, the PERIMETER-GUARD System's *FSD*, *SSD*, and *Auxiliary Monitor Relay* contacts open, and a *key reset* is required to return the system to the RUN condition.

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

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

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

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

**MPCE monitor contacts:** the normally open and normally closed contacts of a *guarded machine's MPCEs* which are connected in series with the ac power supply to the PERIMETER-GUARD System. Any inconsistency of action between the two sets of monitor contacts will remove power from the PERIMETER-GUARD System and cause a *lockout condition*. See Figure 15.

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

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

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

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

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

**Power supply board:** a removeable printed circuit board which contains the power supply circuit and is located inside the PERIMETER-GUARD System *control box*. A green LED on the power supply board lights whenever dc power is present on the board.

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

*PSDI devices on mechanical power presses, per OSHA regulation 29 CFR 1910.217.*

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

**Receiver:** the light-receiving component of the PERIMETER-GUARD System, consisting of a row of synchronized phototransistors. The receiver, together with the *emitter* (placed opposite), creates a "curtain of light" called the *defined area*.

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

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

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

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

**Specified test piece:** an opaque object of the minimum cross section required to place the PERIMETER-GUARD System into a *trip condition* when inserted into any part of the *defined area*. The Banner-supplied specified test piece is 1.50" in diameter. See also *minimum object sensitivity*.

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

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

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

# Standards Applicable to P-G Systems

## ANSI Standards: Standards Applicable to Use of Safety Light Curtains

### ANSI B11.1-1988

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

### ANSI B11.2-1982

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

### ANSI B11.3-1982 (R1988)

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

### ANSI B11.4-1983

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

### ANSI B11.5-1988

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

### ANSI B11.6-1984

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

### ANSI B11.7-1985

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

### ANSI B11.8-1983

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

### ANSI B11.9-1975 (R1987)

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

### ANSI B11.10-1990

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

### ANSI B11.11-1985

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

### ANSI B11.12-1983 (R1989)

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

### ANSI B11.13-1992

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

### ANSI B11.14-1983

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

### ANSI B11.15-1984 (R1989)

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

### ANSI B11.16-1988

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

### ANSI B11.17-1982 (R1989)

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

### ANSI B11.18-1985

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

### ANSI B11.19-1990

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

### ANSI B11.20-1991

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

### ANSI/RIA 15.06

Safety Requirements for Industrial Robots  
and Robot Systems

### ANSI B11 Documents

Part of:

Code of Federal Regulations  
Title 29, Parts 1900 to 1910

Address:

Superintendent of Documents  
Government Printing Office  
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Telephone: 202-783-3238

### ANSI/RIA Documents

Obtain from ANSI (left) or:

Robotic Industries Association  
900 Victors Way, P.O. Box 3724  
Ann Arbor, MI 48106  
Telephone: 313-994-6088

## U.S. Federal Regulations Applicable to Use of Safety Light Curtains

### OSHA 29 CFR 1910.212

General Requirements for (guarding of)  
All Machines

### OSHA 29 CFR 1910.217

(Guarding of) Mechanical Power Presses

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Telephone: 202-783-3238

## Standards Applicable to Design of Safety Light Curtains

### UL 491

The Standard for Power-operated  
Machine Controls and Systems

Address:

Underwriters Laboratories Inc.  
333 Pfingsten Road  
Northbrook, IL 60062-2096  
Telephone: 708-272-8800

### BS 6491

General Requirements for Electro-  
sensitive  
Safety Systems for Industrial Machines

Address:

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

# PERIMETER-GUARD System Specifications

## Width of defined area:

6 inches (15 cm) minimum, 3x excess gain at 45 feet (14 meters); somewhat less when lens shields or corner mirrors are used (see p. 28)

## Minimum object sensitivity:

1.5 inches (38,1 mm); assumes no floating blanking in use. See table in Figure 8 for more information.

**Response time:** Less than 40 milliseconds when used with an emitter and receiver up to and including 4 feet in length; less than 55 milliseconds when used with an emitter and receiver of 54 to 72 inches in length.

**Self-checking interval:** 20 milliseconds

**Ambient light immunity:** >10,000 lux at 5° angle of incidence

**Strobe light immunity:** Totally immune to one Federal Signal Corp. "Fireball" model FB2PST strobe.

**Emitter elements:** Infrared LEDs; 880nm peak emission

## Enclosures:

### Emitter and receiver:

Size: see Figure 16, page 20

Material: Aluminum, with black anodized finish; acrylic lens cover

Rating: NEMA 4, 13 (IP 65)

### Control box:

Size: see Figure 16, page 20

Material: Welded steel box with black polyester powder paint finish

Rating: NEMA 13 (IP 64)

## Mounting hardware:

Emitter and receiver are each supplied with a pair of mounting brackets. Mounting brackets are 11-gauge cold-rolled black zinc chromate finished steel. A set of four vibration dampening mounts is also supplied.

## Cables:

*NOTE: Use only Banner cables, which incorporate a "twisted pair" for noise immunity on RS485 com lines. Use of other cables can result in "nuisance" lockouts.* Emitter and receiver cables are ordered separately. Banner 5-conductor cables have a straight QD (Quick Disconnect) connector molded onto the sensor end. Cables measure .5" in diameter, and are PVC-jacketed. Conductors are 16-gauge. Two liquid-tight cable gland/strain relief fittings are supplied with each control box to admit the emitter and receiver cables through the selected knockouts on the control box wall. *Total emitter/receiver cable length may not exceed 175 feet.*

See page 21 for a dimension drawing of the QD-style connector.

## System power requirements:

Control box PGCA-1A: 115V ac (50/60Hz), 50 VA

Control box PGCB-1A: 230V ac (50/60Hz), 50 VA

## Fuse rating:

Control box PGCA-1A: 1/2 amp, 250V ac (3AG slow blow)

Control box PGCB-1A: 1/4 amp, 250V ac (3AG slow blow)

## Status indicators (on control box):

Red =	LATCHED	Flashing red =	LOCKOUT
Green =	CLEAR	Flashing green =	BLANKING "on"
Yellow =	RESET	Flashing yellow =	waiting for power-up key reset

## Diagnostic indicators:

Four LEDs indicate 7 system status conditions (see Fig. 17, page 25).

## Controls and adjustments:

Keyed RESET of system lockout conditions

ARRAY SIZE selection switches

BLANKING function selection switches

AUTO POWER-UP selection switches

## Alarm relay:

Reed relay; 125V ac or dc max., 500 mA. max.

(10VA maximum, resistive load)

## Output configuration (FSD1, FSD2, and SSD):

Forced-guided contact relays, 250V ac max., 4 amps max. (resistive load).

*Mechanical life* 10,000,000 operations (minimum). *Electrical life* (at full rated load) 100,000 operations (typical). *Arc suppression is recommended when switching inductive loads.* See Figure 15, page 19.

**Operating temperature:** 0 to +50°C (+32 to 122°F)

**Relative humidity:** 95% maximum (non-condensing)

## FMEA (Failure Mode and Effects Analysis) tested:

per requirements of proposed first edition of UL 491 Standard, Section SA4.



LR 41887



# Components and Accessories

## for PERIMETER-GUARD Systems

### PERIMETER-GUARD System

Emitter/receiver Models	Height of Defined Area
MGE616A emitter	6 inches (152 mm)
MGR616A receiver	
MGE1216A emitter	12 inches (305 mm)
MGR1216A receiver	
MGE1816A emitter	18 inches (457 mm)
MGR1816A receiver	
MGE2416A emitter	24 inches (610 mm)
MGR2416A receiver	
MGE3016A emitter	30 inches (762 mm)
MGR3016A receiver	
MGE3616A emitter	36 inches (914 mm)
MGR3616A receiver	
MGE4216A emitter	42 inches (1067 mm)
MGR4216A receiver	
MGE4816A emitter	48 inches (1219 mm)
MGR4816A receiver	
MGE5416A emitter	54 inches (1372 mm)
MGR5416A receiver	
MGE6016A emitter	60 inches (1524 mm)
MGR6016A receiver	
MGE6616A emitter	66 inches (1676 mm)
MGR6616A receiver	
MGE7216A emitter	72 inches (1829 mm)
MGR7216A receiver	
PGCA-1A	115V ac control box (one per system)
PGCB-1A	230V ac control box (one per system)

### Cables (2 required per system)

<b>QDC-525</b>	25' cable, straight QD connector. One cable per sensor.
<b>QDC-550</b>	50' cable, straight QD connector. One cable per sensor.
<b>QDC-5100</b>	100' cable, straight QD connector. One cable per sensor.
<b>QDC-5150</b>	150' cable, straight QD connector. One cable per sensor.

**NOTE:** The total length of the emitter/receiver cables may not exceed 175 feet.

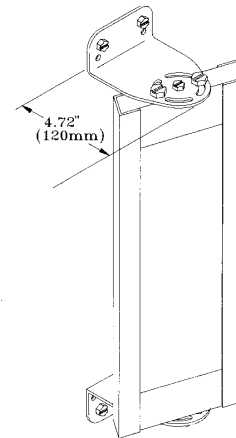
### Instruction Manual

For PGCA-1A and PGCB-1A Systems,  
order manual 33132F5D.

### Corner Mirrors & Stands

Mirror Model*	Use with Sensors	Height of Reflective Area
<b>MGM6A</b>	MGE/MGR616A	12 inches (305 millimeters)
<b>MGM12A</b>	MGE/MGR1216A	18 inches (457 millimeters)
<b>MGM18A</b>	MGE/MGR1816A	24 inches (610 millimeters)
<b>MGM24A</b>	MGE/MGR2416A	30 inches (762 millimeters)
<b>MGM30A</b>	MGE/MGR3016A	36 inches (914 millimeters)
<b>MGM36A</b>	MGE/MGR3616A	42 inches (1067 millimeters)
<b>MGM42A</b>	MGE/MGR4216A	48 inches (1219 millimeters)
<b>MGM48A</b>	MGE/MGR4816A	54 inches (1372 millimeters)
<b>MGM54A</b>	MGE/MGR5416A	60 inches (1524 millimeters)
<b>MGM60A</b>	MGE/MGR6016A	66 inches (1676 millimeters)
<b>MGM66A</b>	MGE/MGR6616A	72 inches (1829 millimeters)
<b>MGM72A</b>	MGE/MGR7216A	78 inches (1981 millimeters)

*MG Series Corner Mirror  
(2 brackets included)*



\*Mirrors are glass. Acrylic mirrors are also available (by special order). Acrylic mirrors have slightly lower reflectance than glass.

**MGA-S72-1** Free-standing 72" tall aluminum stand pole & base (recommended for sensors and mirrors up to 48" models).

**MGA-S90-1** Free-standing 90" tall aluminum stand pole & base (recommended for sensors and mirrors up to 72" models).

Each pole supports one mirror or sensor. See photo below.



*MGA Series Stand Pole  
(hardware and post level included)*

# Accessories

## for PERIMETER-GUARD Systems

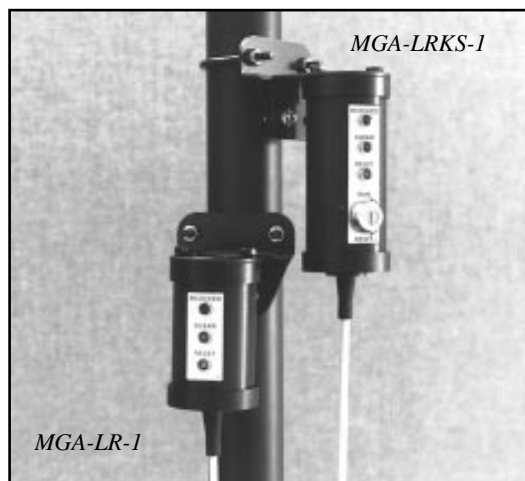
### Replacement Parts

27850	MGA-GS-1	ground strap, control box door
28513	MGA-K-1	replacement key
28509	MGA-KS-1	key switch
28508	MGA-LP-1	LED display, control box door
28506	MGA-MH-1	control box mounting hardware
28510	MGA-RC-1	ribbon cable
33629	MGA-RMFSD	FSD relay module
33630	MGA-RMSSD	SSD relay module
28518	MGA-STP-1	specified test piece
34069	PGA-TBA1-1	replacement terminal board
30699	PGAB-1	microprocessor control module*
30697	PGA-PSA-1	power supply, 115V ac
30696	PGA-PSB-1	power supply, 230V ac

\*NOTE: When ordering a replacement receiver or a replacement microprocessor control module, please supply the serial number of your present receiver and control module. This information is necessary to ensure system compatibility of the replacement item. If necessary, contact the factory applications department for ordering assistance.

### Remote Displays (photo below)

<b>MGA-LR-1</b>	LED remote display
<b>MGA-LRKS-1</b>	LED remote display with key switch



### Spanish Language Documentation

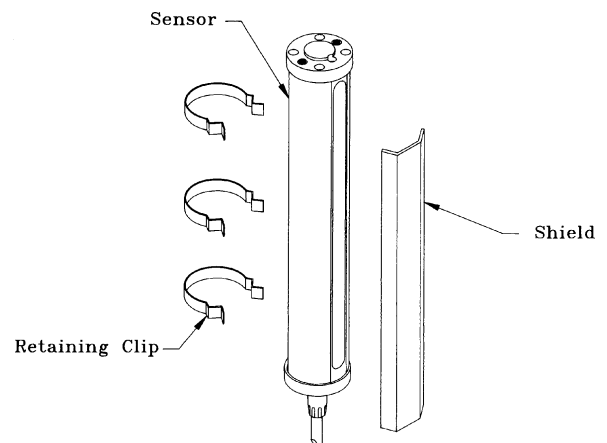
For systems using the PGCA-1A control box:  
 Order p/n 39048 for manual, checkout cards, and product labels.  
 Order p/n 38915 for product labels only.

For systems using the PGCB-1A control box:  
 Order p/n 39049 for manual, checkout cards, and product labels.  
 Order p/n 38916 for product labels only.

### Accessories: lens shield kits

These are replaceable protective covers for MACHINE-GUARD and PERIMETER-GUARD Sensors. They are constructed of clear LEXAN® polycarbonate, and are supplied with corrosion-protected steel retaining clips. Shields may be quickly installed or removed without disturbing sensor alignment. Use of these shields results in somewhat reduced sensing range. Contact the factory for more information. **See drawing, below.**

<b>MGS6A</b>	Shield kit for 6" sensor
<b>MGS12A</b>	Shield kit for 12" sensor
<b>MGS18A</b>	Shield kit for 18" sensor
<b>MGS24A</b>	Shield kit for 24" sensor
<b>MGS30A</b>	Shield kit for 30" sensor
<b>MGS36A</b>	Shield kit for 36" sensor
<b>MGS42A</b>	Shield kit for 42" sensor
<b>MGS48A</b>	Shield kit for 48" sensor
<b>MGS54A</b>	Shield kit for 54" sensor
<b>MGS60A</b>	Shield kit for 60" sensor
<b>MGS66A</b>	Shield kit for 66" sensor
<b>MGS72A</b>	Shield kit for 72" sensor



### Documentación en español

Para sistemas que utilicen la caja de control PGCA-1A:  
 Pedir el número de pieza 39048 para recibir el manual, las tarjetas de verificación y las etiquetas del producto.  
 Pedir el número de pieza 38915 para recibir las etiquetas del producto solamente.

Para sistemas que utilicen la caja de control PGCB-1A:  
 Pedir el número de pieza 39049 para recibir el manual, las tarjetas de verificación y las etiquetas del producto.  
 Pedir el número de pieza 38916 para recibir las etiquetas del producto solamente.





**the photoelectric specialist**