PICO-GUARD™
Fiber Optic Safety System

Controller Instruction Manual
Models SFCDT-4A1, SFCDT-4A1C

Section Contents

the machine safety specialist

9714 10th Avenue North • Minneapolis, MN 55441
Phone: 763.544.3164 • http://www.bannerengineering.com
Email: sensors@bannerengineering.com

Patent Pending

Printed in USA 04/04 P/N 69761 rev. B

Table of Contents

Important ...
read this page before proceeding!

In the United States, the functions that PICO-GUARD Systems are intended to perform are regulated by the Occupational Safety and Health Administration (OSHA). Outside of the United States, these functions are regulated by a variety of agencies, organizations, and governments. Whether or not any particular PICO-GUARD System installation meets all applicable requirements depends upon factors that are beyond the control of Banner Engineering Corp. These factors include the details of how the PICO-GUARD System is applied, installed, wired, operated, and maintained. **It is the responsibility of the purchaser and user to apply this PICO-GUARD System in full compliance with all relevant applicable regulations and standards.**

PICO-GUARD Systems can guard against accidents only when they are properly installed and integrated into the machine, properly operated, and properly maintained. Banner Engineering Corp. has attempted to provide complete application, installation, operation, and maintenance instructions. In addition, we suggest that any questions regarding application or use of PICO-GUARD Systems be directed to the factory applications department at the telephone number or addresses shown on the back cover.

In addition to OSHA regulations, several other organizations provide information about the use of safeguarding devices. Refer to the American National Standards Institute (ANSI), the Robotics Industries Association (RIA), the Association for Manufacturing Technology (AMT), 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 safeguarding 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.

U.S. Standards Applicable to Use of PICO-GUARD Systems

ANSI B11 Standards	***Safeguarding of Machine Tools***
ANSI/RIA R15.06	***Safety Requirements for Robot Systems***
NFPA 79	***Electrical Standard for Industrial Machinery***

See inside back cover for information on these and other applicable standards, and where to acquire copies.

1. System Overview

1.1 Description

The Banner PICO-GUARD fiber optic safety system is a diverse-redundant microprocessor-controlled optoelectronic guarding system. This system consists of a controller, flexible optical fiber, protective sheathing and optical elements (fiber optic interlock switches, beams and grids). The system can be used with various combinations of optical elements using the four independent optical channels.

The controller also has electrical Universal Safety Stop Interface (USSI) inputs that can connect to other safeguards, E-stop devices, process controls or actuators. Regardless of the combination of optical elements and external safeguards used, when the system detects an interruption of an optical path or receives a safety stop request, it will provide a stop signal to the machine control circuit. The machine control circuit then reacts to protect personnel from hazards, or to protect equipment, critical tooling, or critical materials in process.

The controller has two solid-state diverse-redundant safety outputs (OSSDs) to control 24V dc loads. If an ac-powered MPCE or other load is required, an accessory interface module or redundant positive-guided contactors may be used to convert the PICO-GUARD outputs to isolated, forced-guided relay contacts (e.g., model IM-T-9A or IM-T-11A, see Section 2.3 for more information.)

The OSSD (Output Signal Switching Device) safety outputs are capable of performing a “handshake” communication with the Muteable Safety Stop Interface (MSSI) or Universal Safety Stop Interface (USSI) found on other Banner Engineering safety products. The handshake protocol is satisfied by any Banner Engineering Safety Category 4 (per ISO 13849-1/ EN954-1) device with OSSD outputs or MSSI/USSI inputs. This handshake verifies that the interface between the two devices is capable of detecting certain unsafe failures that may occur (such as a short circuit to a secondary source of power or to the other channel, high input resistance or loss of signal ground).

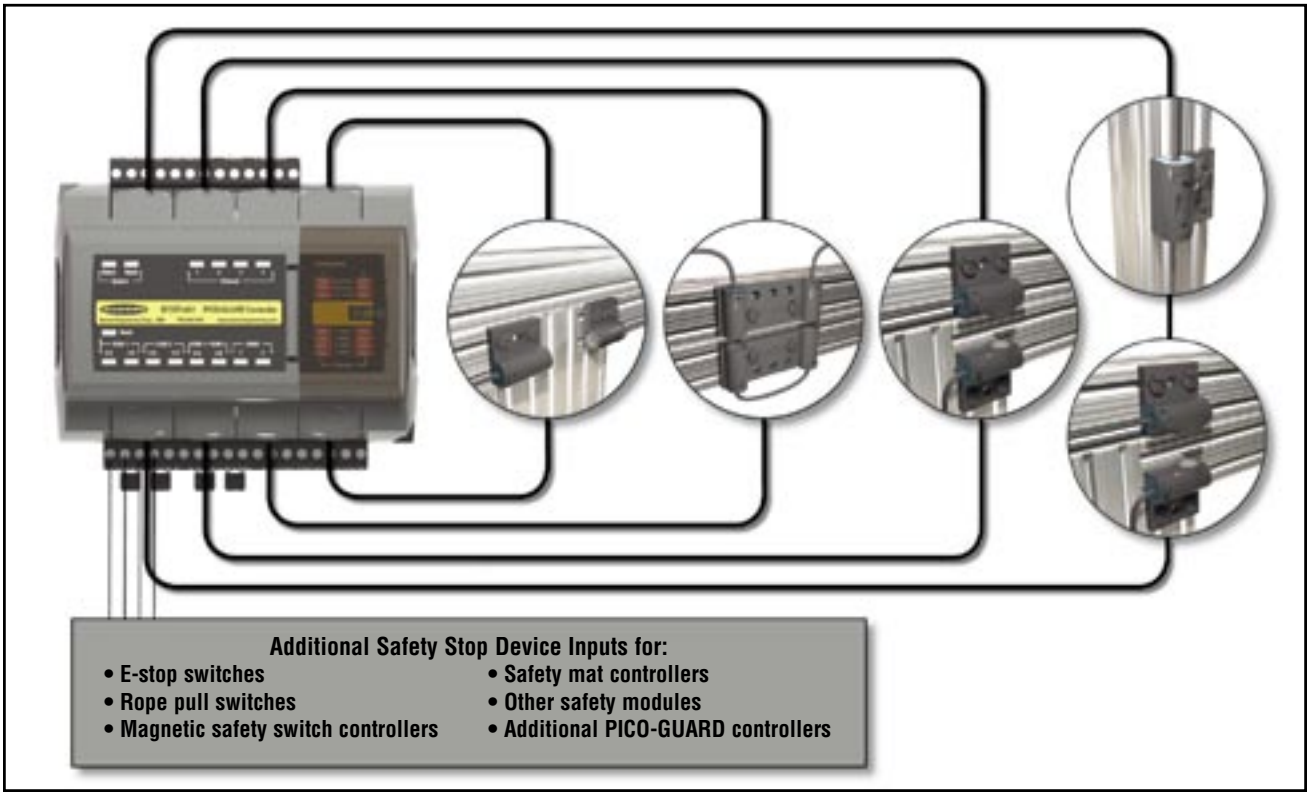


Figure 1-1. PICO-GUARD System Overview

The optical elements (such as fiber optic safety interlock switches, points or grids) are available in a variety of configurations to allow easy installation and proper operation on a variety of doors and other hard guarding applications.

Each optical element can be used as either an emitter or a receiver; they have no electrical connection. This can greatly reduce the required inventory and simplifies installation.

Plastic fibers are available in three versions: solid-core fiber, solid-core fiber with integral fluoropolymer sheathing and solid-core fiber with integral PVC sheathing (see Section 2.2).

Removable terminals simplify the wiring process. See Sections 3.4, 3.7, and 3.9 for electrical connection instructions.

1.2 Applications and Limitations

The Banner PICO-GUARD fiber optic safety system is intended to be used in a variety of safeguarding applications.

For appropriate applications and complete installation information, please refer to the bullet items below, individual sections contained within this manual, the *PICO-GUARD Application and Design Guide*, the PICO-GUARD optical element data sheets, and manuals regarding any external safeguarding device interfaced with the PICO-GUARD system. The user must determine whether the use of a particular safeguard or the Banner PICO-GUARD fiber optic safety system is allowed.

Appropriate Applications
The PICO-GUARD system is typically used in access-guarding, perimeter-guarding or interlock barrier guarding applications for the following types of machines:

- Assembly stations
- Manufacturing cells
- Automated production equipment
- Robotic work cells

Generally, use of the Banner PICO-GUARD System is not allowed:

- On machinery that has inadequate or inconsistent machine response time and stopping performance, or
- On machinery with long or excessive stopping times without a guard-locking mechanism, or
- To guard any machine that ejects materials or component parts in such a manner that the material or component parts are not contained and are considered to be a hazard, or
- In any environment that is likely to adversely affect photoelectric sensing system efficiency. For example, corrosive chemicals or fluids or unusually severe levels of smoke or dust, if not controlled, may degrade the efficiency or effectiveness of the safeguarding function.

The PICO-GUARD Controller and any electrically based device(s) connected to the PICO-GUARD controller must be mounted and used outside of the potentially explosive area or within appropriate explosion-proof enclosures. Approvals are pending. See www.bannerengineering.com for further information.

2. System Components and Specifications

Each PICO-GUARD Fiber Optic Safety System requires a controller, optical fiber and one or more pairs of optical elements. Controllers include the controller instruction manual (this document), the application and design guide, and controller mounting hardware. See the Banner Engineering Machine Safety Catalog or www.bannerengineering.com for available optical elements.

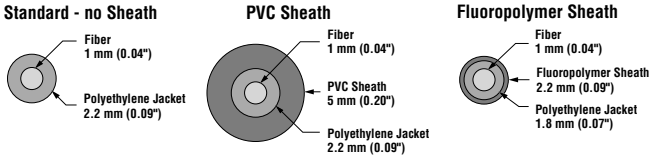
2.1 Controller

4-channel PICO-GUARD controller **SFCDT-4A1**

4-channel PICO-GUARD controller with auxiliary channel outputs **SFCDT-4A1C**

2.2 Plastic Optical Fiber

Plastic optical fiber for use with Banner PICO-GUARD optical elements is available in bulk form (to be cut to length in the field) or precut lengths with polished ends for maximum excess gain. Both are available in three styles: standard polyethylene jacketed solid-core plastic fiber for most applications; polyethylene jacketed solid-core plastic fiber with a PVC sheath to withstand mechanical abrasion or harsh duty; and polyethylene jacketed solid-core plastic fiber with fluoropolymer sheathing to withstand harsh chemicals or gases. Accessory sheathing is also available to provide additional protection for any of these fibers. A fiber cutter (for bulk fiber) is shipped with each PICO-GUARD controller.



Length	Standard Polyethylene Jacket	PVC Sheath	PVC Sheath
Bulk Fiber			
9 m (30')	**PIU430U**	**PIU430UXP**	**PIU430UXT**
18 m (60')	**PIU460U**	**PIU460UXP**	**PIU460UXT**
30.5 m (100')	**PIU4100U**	**PIU4100UXP**	**PIU4100U**
61 m (200')	**PIU4200U**	**PIU4200UXP**	**PIU4200U**
100.5 m (330')	**PIU4330U**	**PIU4330UXP**	**PIU4330U**
488 m (1600')	**PIU41600U**	**PIU41600UXP**	**PIU41600U**
Cut Lengths With Polished Ends			
0.3 m (1')	**PWS43P**	**PWXP43P**	**PWXT43P**
0.5 m (1.6')	**PWS45P**	**PWXP45P**	**PWXT45P**
0.7 m (2.3')	**PWS47P**	**PWXP47P**	**PWXT47P**
1 m (3.3')	**PWS410P**	**PWXP410P**	**PWXT410P**
1.5 m (4.9')	**PWS415P**	**PWXP415P**	**PWXT415P**
2 m (6.5')	**PWS420P**	**PWXP420P**	**PWXT420P**
2.5 m (8.2')	**PWS425P**	**PWXP425P**	**PWXT425P**
3 m (9.8')	**PWS430P**	**PWXP430P**	**PWXT430P**
3.5 m (11.5')	**PWS435P**	**PWXP435P**	**PWXT435P**
4 m (13.1')	**PWS440P**	**PWXP440P**	**PWXT440P**
4.5 m (14.7')	**PWS445P**	**PWXP445P**	**PWXT445P**
5 m (16.4')	**PWS450P**	**PWXP450P**	**PWXT450P**
6 m (19.7')	**PWS460P**	**PWXP460P**	**PWXT460P**
7 m (23.0')	**PWS470P**	**PWXP470P**	**PWXT470P**
8 m (26.2')	**PWS480P**	**PWXP480P**	**PWXT480P**
9 m (29.5')	**PWS490P**	**PWXP490P**	**PWXT490P**
10 m (32.8')	**PWS4100P**	**PWXP4100P**	**PWXT4100P**
11 m (36')	**PWS4110P**	**PWXP4110P**	**PWXT4110P**
12 m (39.4')	**PWS4120P**	**PWXP4120P**	**PWXT4120P**
13 m (42.6')	**PWS4130P**	**PWXP4130P**	**PWXT4130P**
14 m (46')	**PWS4140P**	**PWXP4140P**	**PWXT4140P**
15 m (49.2')	**PWS4150P**	**PWXP4150P**	**PWXT4150P**
20 m (65.6')	**PWS4200P**	**PWXP4200P**	**PWXT4200P**
25 m (82')	**PWS4250P**	**PWXT4250P**	**PWXT4250P**
30 m (98.4')	**PWS4300P**	**PWXP4300P**	**PWXT4300P**

2.3 Accessories

SFA-FA	In-line signal attenuator
SFA-FS	Fiber splice
SFA-RD	Remote display
PFC-2-25	Bag of 25 PFC-2 plastic optical fiber cutters
FS64P100	Black PVC sheathing, 100'
MGA-KSO-1	SPST keyed reset switch
IM-T-9A	Interface module (3 N/O redundant-output contacts)
IM-T-11A	Interface module (2 N/O redundant-output contacts plus 1 N/C auxiliary contact)
11-BG00-31-D-024	10 amp positive-guided contactor 3 N/O, 1 N/C*
11-BF16C01-024	16 amp positive-guided contactor 3 N/O, 1 N/C*

*** NOTE: If used, two contactors per controller are required. See Figures 3.7 and 3.10.**

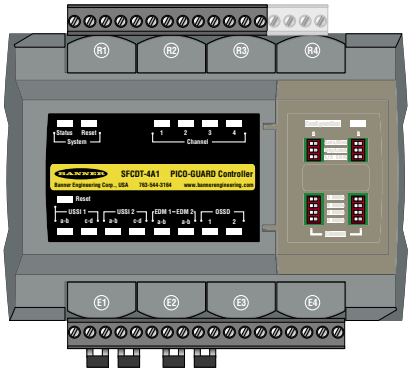
2.4 Replacement Parts

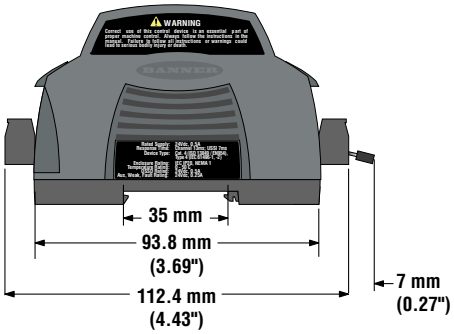
SFA-CTB1	PICO-GUARD Controller 4-position terminal block
SFA-CTB2	Fiber splice
SFA-CTB3	Remote display
SFA-CTB4	Bag of 25 PFC-2 plastic optical fiber cutters
SFA-CMH	Black PVC sheathing, 100'
SFA-IAG	SPST keyed reset switch

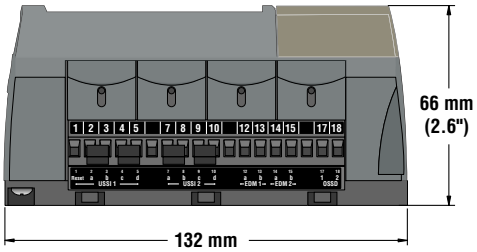
2.5 Literature

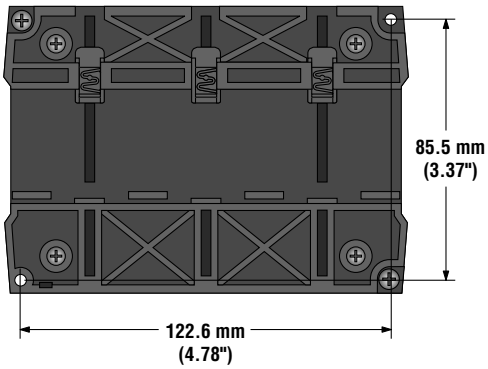
69761	PICO-GUARD Controller Manual
69765	Daily Checkout Card
69766	Semi-Annual Checkout Card
69763	PICO-GUARD Application and Design Guide
109963	PICO-GUARD CD with Software Programs

2.6 Dimensions









2.7 Specifications

Patent Pending

System Power Requirements*	24V dc ±15%, 10% maximum ripple; 250 mA max., exclusive of output loads.
Short Circuit Protection	All inputs and outputs are protected from short circuits to +24V dc or dc common.
Response Time	**Optical Channel:** 13 milliseconds max. (Time between the opening of an optical switch and the OSSD safety outputs turning off.) **USSI Inputs:** 7 milliseconds max. (Time between actuation of the safety stop input device and the OSSD safety outputs turning off.)
Safety Rating	Type 4 per IEC 61496-1; Category 4 per ISO 13849-1 (EN 954-1).
EDM Input	Two inputs for external device monitoring (EDM). Each input monitors the status of a normally closed, forced-guided monitor contact of an external safety device or MPCE. The EDM inputs must be high (10 to 30V dc) when the external device or MPCE is OFF, and must be low (less than 3V dc) when the external device or MPCE is ON. External devices or MPCEs must meet certain timing requirements, depending on the configuration setting (see Section 3.9.3).
System Reset Input	The Reset input must be high (10 to 30V dc) for 0.25 to 2 seconds and then low (less than 3V dc) to reset the system from a manual power-up, optical channel latch or system lockout condition.
USSI 1 Reset Input	The Reset input must be high (10 to 30V dc) for 0.25 to 2 seconds and then low (less than 3V dc) to reset the system from a USSI 1 latch condition.
USSI 1 Input	Dual-channel, redundant inputs for monitoring output contacts or "handshake" compatible safety solid-state outputs of other safety stop devices. OFF (stop) signals cause the PICO-GUARD OSSDs to latch OFF (Latch condition). (See Section 3.7.)
USSI 2 Input	Dual-channel, redundant inputs for monitoring output contacts or "handshake" compatible safety solid-state outputs of other safety stop devices. OFF (stop) signals cause the PICO-GUARD OSSDs to turn OFF (Trip condition). (See Section 3.7.)
OSSD Outputs	Two redundant solid-state 24V dc, 0.5A max. sourcing OSSD (Output Signal Switching Device) safety outputs. (Use optional interface modules for ac or larger dc loads.) Capable of the Banner "Safety Handshake" (see Section 1.1). **ON-state voltage:** ≥ Vin-1.5V dc **OFF-state voltage:** 1.2V dc max. **Max. load resistance:** 1,000 ohm **Max. load capacitance:** 0.1 µF **OSSD test pulse width:** 100 µs to 300 µs **OSSD test pulse period:** 6 ms
Non-Safety Outputs (Aux., Weak Signal, Fault, Ch1-4)	Solid state 24V dc (≥ Vin – 1.5V dc), 0.25A max. sourcing non-safety outputs
Remote Status Interface	Isolated RS-232 non-safety output (4800 Baud rate) for setup or monitoring the system status. Connections provided for a Remote Display unit (see Section 2.3, Accessories).
Controls and Adjustments	Redundant switches for Auto/Manual power-up, Trip/Latch output operation and 1- or 2-channel EDM operation. Redundant switches for ON/OFF of each optical channel. (NOTE: At least one optical channel must be ON.)
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 Element	Visible red LED, 660 nm at peak emission
Enclosure Rating	IEC IP20 (see Section 3.3.1)
Operating Conditions	**Temperature:** 0° to +50° C (+32° to 122° F) **Relative Humidity:** 95% maximum (non-condensing)

*External supply must be in accordance with IEC 61558 (EN 60742).

2.7 Specifications, continued

Status Indicators	**System Status (bi-color Red/Green):** overall status of the PICO-GUARD system **System Reset (bi-color Yellow/Red):** status of the input; indicates system reset needed **Channel (4 bi-color Red/Green):** each shows the status of one optical channel **USSI (2 bi-color Red/Green):** status of the USSI input channels (a-b and c-d) **USSI 1 Reset (bi-color Yellow/Red):** status of USSI 1 reset input; indicates USSI 1 reset needed **EDM (bi-color Red/Green):** status of the EDM input channels **OSSD (bi-color Red/Green):** status of the OSSD outputs **Config (bi-color Red/Green):** status of the system configuration	
Certifications	**Model SFCDT-4A1** c UL us LISTED Presence Sensing Device 10Y8 CE	**Model SFCDT-4A1C** Approvals pending

3. Installation and Alignment

Before installing the PICO-GUARD System, read Sections 1.2 and 3 of this manual, as well as the Application and Design Guide, and the data sheets for the optical elements to be used, in their entirety. The PICO-GUARD System's ability to perform its safety guarding function depends upon the appropriateness of the application and upon its proper mechanical and electrical installation and interfacing to the guarded machine. If all mounting, installation, interfacing, and checkout procedures are not followed properly, the System cannot provide the protection for which it was designed. Installation must be performed by a Qualified Person, as defined in Section 3.2. See Warning below.

WARNING . . . Read this Section Carefully Before Installing the System
The user is responsible for satisfying all local, state, and national laws, rules, codes, or regulations relating to the installation and use of this control system in any particular application.

Extreme care should be taken to meet all legal requirements and follow all technical installation and maintenance instructions contained in this manual.

The user has the sole responsibility to ensure that the PICO-GUARD System is installed and interfaced to the guarded machine by Qualified Persons in accordance with this manual and applicable safety regulations.

Read Section 1.2 and all of Section 3 of this manual carefully before installing the system. **Failure to follow these instructions could result in serious bodily injury or death.**

3.1 Excess Gain

The PICO-GUARD System requires that light signals of sufficient intensity be detected by the receiver circuit. The amount of light that reaches the receiver that is in excess of the minimum amount required to be detected is called the "Excess Gain." Excess gain values are used to predict the reliability of an Optical Element operating in a known environment.

The light signals are attenuated as they pass through the fiber optic cable and optical elements. The amount of signal attenuation in a given system is determined by the following factors:

- The number and type of optical elements in the loop,
- The distance between, and alignment of, the optical elements,
- The length of the fiber optic cable,
- The number and degree of fiber bends, and
- The termination of the fiber optic cable (polished or cut).

To calculate or verify the amount of excess gain, see "Excess Gain" in the *PICO-GUARD Application and Design Guide*. See Section 5.3 in this manual for troubleshooting weak signal (low excess gain) conditions.

3.2 Security Protocol

Certain procedures for installing, maintaining and operating the PICO-GUARD System must be performed by either Designated Persons or Qualified Persons.

A **Designated Person** is identified and designated in writing, by the employer, as being appropriately trained and qualified to perform the specified checkout procedures on the PICO-GUARD System. The Designated Person is empowered to:

- Perform manual resets and hold possession of the reset key, code or other security means, and
- Perform the Daily Checkout Procedure (see Section 6).

A **Qualified Person**, by possession of a recognized degree or certificate of professional training, or by extensive knowledge, training and experience, has successfully demonstrated the ability to solve problems relating to the installation of the PICO-GUARD System and its integration with the guarded machine. In addition to everything for which the Designated Person is empowered, the Qualified Person is empowered to:

- Install the PICO-GUARD System,
- Perform all checkout procedures (see Section 6),
- Have access and make changes to the system configuration settings, and
- Reset the system following a lockout condition.

Manual Resets
Manual Resets are performed using external reset switches (System Reset and External Stop Device Reset). See Section 3.3.2 for reset switch mounting and location requirements, and Section 4.3 for reset procedures.

A reset switch might be a normally open, momentarily held-closed push button, although some applications may require a level of supervisory control. In this case, a key switch can be used where the key is secured and used by a Designated or Qualified Person, as appropriate.

Using a key switch provides some level of personnel or supervisory control, because the key may be removed from the switch. This will hinder a reset while the key is under the control of an individual, but must not be relied upon solely to guard against accidental or unauthorized reset. Spare keys in the possession of others, or additional personnel entering the safeguarded area unnoticed may create a hazardous situation.

3.3 Controller Installation

3.3.1 Mounting the Controller

Mount the PICO-GUARD controller inside a lockable enclosure with a minimum rating of IEC IP54. The control module may be mounted onto standard 35 mm DIN rail or directly to the backplate of the lockable enclosure, using the supplied hardware.

3.3.2 Mounting the Reset Switches

Reset switches are user supplied. An optional SPST key reset switch is available. See Section 2.3, Accessories.

All reset switches must be mounted outside the guarded area, and out of reach from within the guarded area. The entire safeguarded area should be visible from the Reset switch location. If any areas are not visible, other means must be used to ensure that no personnel are within the safeguarded area when the system is reset (see Warning below).

Reset switches must be protected from accidental operations and, depending on the applicable standards, from unauthorized operation (e.g., through the use of a key, guards, or rings).

WARNING . . . Reset Switch Location

All reset switches must be:

- **Outside the hazardous area,** in a location that allows the switch operator full view of the entire guarded area,
- **Out of reach** from within the safeguarded space, and
- **Protected** against unauthorized or inadvertent operation.

If any areas within the guarded area are not visible from the Reset switch, additional means of safeguarding must be provided, as described by the ANSI B11 series or other appropriate standards. Failure to do so could result in serious injury or death.

3.3.3 Mounting the Optional Remote Display

A remote display is available (see Section 2.3) for remote monitoring of the system's status. Up to four remote display units may be connected to one controller. See installation instructions included with the remote display for more information.

3.4 Electrical Connections

Make the electrical connections in the order described in this section.

NOTE: PICO-GUARD wiring is low voltage; running these wires alongside power wires, motor/servo wires, or other high-voltage wiring can inject noise into the PICO-GUARD System. It is good wiring practice (and may be required by code) to isolate PICO-GUARD System wires from high-voltage wires.

For easy wiring, the controller has removable modular terminal blocks. These terminal blocks can accept individual conductors from #26 to #12 AWG (0.2 mm2 to 2.5 mm2) or two stranded conductors from #26 to #14 AWG (0.2 mm2 to 1.5 mm2). The wires used should have an insulation temperature rating of at least 90° C (194° F).

To connect wires to the terminal blocks strip the individual wire insulation approximately 6 mm (0.25") and make connections to terminals as directed in the following sections. Torque each terminal screw to 0.57 to 0.90 Nm (5 to 8 in.-lbs.) recommended torque.

Refer to Figures 3-7, 3-8, 3-9 and 3-10.

3.4.1 System Reset and USSI 1 Reset Switch Hookup

The System Reset and USSI 1 Reset switches are generally individual switches to allow separate control of the two reset functions (see Section 4.3 for reset procedures).

The System Reset and USSI 1 Reset switches may be a single switch, but **must use electrically isolated** normally open contacts (e.g., DPST or 2-Form-A). The reset inputs are monitored such that a short circuit between terminals 1 and 23 will cause a lockout condition, but will allow connection to a common source of +24V dc. Refer to Figures 3-7, 3-8, 3-9 and 3-10.

Connect the external System Reset switch to the System Reset terminal (23) and to the +24V dc supply.

Connect the USSI 1 Reset switch (if used) to the USSI 1 Reset terminal (1) and to the +24V dc supply.

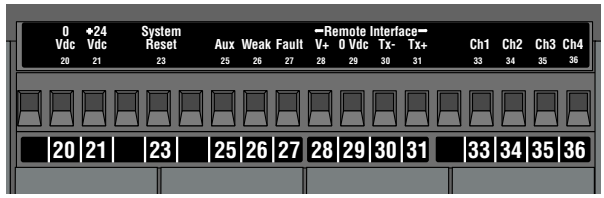
3.4.2 System Power Hookup

DO NOT apply power to the controller at this time. Power will be applied during the initial system checkout.

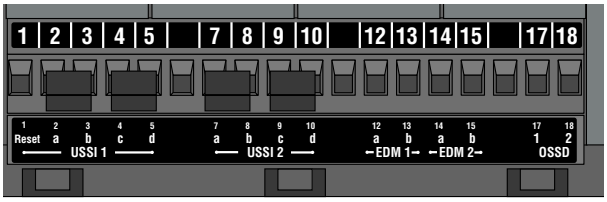
Connect the system power wires to the +24V dc terminal (21) and the 0V dc terminal (20).

3.5 Optical Fiber Installation

Use only the Banner fiber optic cable listed in Section 2, or call Banner factory applications department to determine fiber suitability. For best operation, minimize the fiber lengths, number of splices, number of tight bends and operating



Top View



Bottom View

Figure 3-1. Controller terminal locations

distance of the optical devices. See Section 3.1 of this manual and also see the *PICO-GUARD Application and Design Guide*.

If using the unsheathed fiber, each fiber must be installed such that the black jacket of the optical fiber is protected from nicks, cuts or crushing; each fiber must be routed separately.

If using PVC sheathed fiber, sheathing must be removed without damaging the black jacket of the fiber; a 10 gauge or 3 mm (0.12") wire stripper is recommended. Remove 15-20 mm (0.6" to 0.75") of the PVC sheath from each end of the fiber to allow proper insertion into the optical elements and controller.

Use the Banner plastic fiber cutter model PFC-2 to make finished cuts to minimize signal loss. Polished fiber lengths are available for maximum excess gain (see Section 2.2). *Use each cutting port only once.*

To connect the fibers to the controller, simply slide the cap to open the fiber ports, push the prepared fiber in as far as it will go, then slide the fiber port closed (see Figure 3-3).

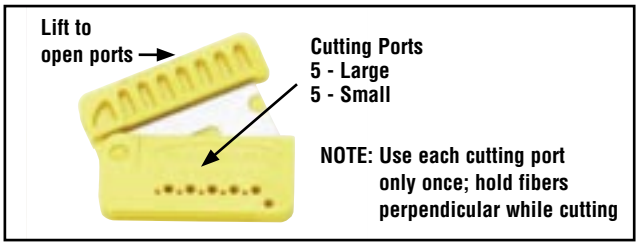


Figure 3-2. Trimming the fibers with the Model PFC-2 Fiber Cutter

Figure 3-3. Installing the prepared fiber ends into the controller

3.6 Optical Element Installation

Install the optical elements per the PICO-GUARD Application and Design Guide, the optical element data sheet(s) and all relevant applicable regulations and standards.

3.7 External Stop Device Installation

The PICO-GUARD controller provides two Universal Safety Stop Interface (USSI) inputs. Each two-channel input is designed to monitor stop signals from various types of stop controls or devices, including:

- E-stop switches
- Rope pull switches
- Mechanical safety interlock switches
- Safety outputs from safety light screens (contacts or Banner "handshake"-compatible solid-state safety outputs)
- Safety outputs from safety modules (contacts or Banner "handshake"-compatible solid-state safety outputs)
- Safety outputs from other PICO-GUARD controllers (Banner "handshake"-compatible solid-state safety outputs)

Two types of USSI inputs are provided (see Section 4.5.2 for detailed USSI input operation information):

USSI 1 (Latch) — an Open/OFF input signal causes a Latch condition (Manual reset required).

USSI 2 (Trip) — an Open/OFF input signal causes a Trip condition (Auto reset).

Both USSI inputs are designed to satisfy Functional Stop Category 0, where the opening of either of the two USSI input channels immediately removes electrical power from the machine control elements (see Figures 3-4 and 3-5).

The inputs of each USSI (a/b and c/d) must meet a simultaneity requirement of 3.0 seconds upon closing and opening. A mismatch of more than 3.0 seconds will result in a lockout. The USSI is a dual-channel input; an individual USSI can not be wired in a single-channel manner.

If the PICO-GUARD controller detects a failure of an external stop device output connected to the USSI inputs, both PICO-GUARD safety outputs (OSSD 1 and OSSD 2) are disabled (OFF) and the controller will establish a lockout condition. (See Section 5 for resolution of lockout conditions.)

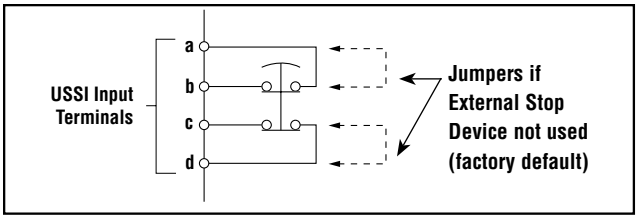


Figure 3-4. External Stop Device hookup (emergency stop switch shown)

The USSI input response time (7 milliseconds) must be included in the separation distance calculation of the external stop device being installed.

Before connecting them to the USSI input terminals, install the external stop devices and conduct checkout procedures in accordance with the manufacturer's instructions, the *PICO-GUARD Application and Design Guide* and all applicable standards.

If a USSI input is unused, terminal a must be jumpered to b, and c must be jumpered to d. To use the input, the factory-installed jumpers must be removed.

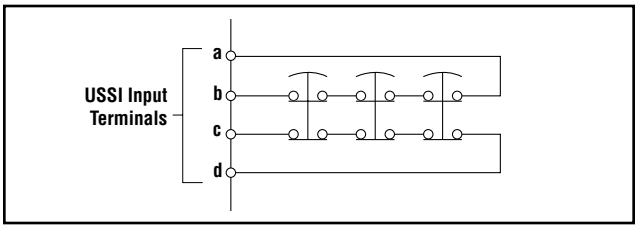


Figure 3-5. Multiple External Stop Device hookup (E-stop switches shown)

WARNING ... Installing Multiple External Stop Devices

Whenever two or more external stop devices (contact output) are connected to the same USSI input, contacts of each output channel must be connected together in series. This series combination is then wired to the respective USSI input (i.e., a to b, and c to d). See the PICO-GUARD Application and Design Guide for further information.

Never connect the contacts of multiple external stop devices in parallel to the PICO-GUARD USSI inputs. Parallel connection of two or more contacts to one USSI input defeats the switch contact monitoring ability of the PICO-GUARD controller and creates an unsafe condition, which could result in serious injury or death.

When two or more external stop devices are used, each device must be individually actuated (engaged), then re-armed. Also, if using USSI 1 input, the PICO-GUARD controller must be reset. This allows the monitoring circuits to check each switch and its wiring to detect faults.

Failure to test each switch individually in this manner could result in undetected faults and create an unsafe condition, which could result in serious injury or death.

WARNING ... External Stop Device Response Time Affects Separation Distance

The USSI response time must be included in the separation distance calculation of the external stop device being installed.

Failure to properly determine the separation distance could result in serious bodily injury or death.

3.7.1 External Stop Device Requirements/Hookup

Refer to Figures 3-7, 3-8, 3-9 and 3-10 for detailed hookup information.

For external stop devices with contact outputs, the contacts must be redundant and capable of switching 15-30V dc @ 10-50 mA. Contacts must switch simultaneously (within 3 seconds of each other). For USSI 1 connection, connect one contact output of the external stop device between PICO-GUARD controller terminals 2-3, and the other contact output between terminals 4-5. For USSI 2 connection, connect one contact output of the external stop device between PICO-GUARD controller terminals 7-8, and the other contact output between terminals 9-10.

NOTE: For external stop devices with solid-state outputs, the outputs must be Banner Engineering safety devices with "handshake" verification. Connect the compatible solid-state outputs to terminals 2 and 4 for USSI 1 connection, or terminals 7 and 9 for USSI 2 connection. **0V dc must be common between the external stop device and the PICO-GUARD controller (terminal 20).**

3.7.2 Other PICO-GUARD Modules

PICO-GUARD controllers may be connected together in applications where more than four optical channels are needed. Connect the OSSD 1 and OSSD 2 outputs of one PICO-GUARD controller to the appropriate USSI input of another PICO-GUARD controller as shown in Figure 3-10. **0V dc must be common between the external stop device and the PICO-GUARD controller (terminal 20).**

3.8 Initial System Checkout

The initial checkout procedure must be performed by a Qualified Person (see Section 3.2). It must be performed only after configuring the System and after installing and connecting the optical elements per the applicable instructions and standards.

The procedure is performed on two occasions:

- To ensure proper installation when the System is first installed, and
- To ensure proper System function whenever any maintenance or modification is performed on the System or on the machinery being guarded by the System. (See Section 6.1 for a schedule of required checkouts.)

For the initial checkout, the PICO-GUARD System must be checked without power being available to the guarded machine. **Final interface connections to the guarded machine cannot take place until the system has been checked out.**

Verify that:

- Power has been removed from (or is not available to) the guarded machine, its controls or actuators; and
- The machine control circuit is not connected to the OSSD outputs at this time (permanent connections will be made following this initial checkout)
- If the inputs are to be used, verify the system(s) checkout procedures for the external safety systems or other devices connected to the external stop device inputs as described by the appropriate manuals. **Do not proceed until all checkout procedures are completed successfully and all problems have been corrected.**

3.8.1 Configure the Controller for Initial Checkout

Controller configuration is done at the two banks of DIP switches located under the clear access cover on the right side of the controller (see Figure 3-6). Verify that the system is set for initial checkout and optical alignment (Manual Power-Up, Latch, 2-Channel EDM and All used Optical Channels ON, unused Optical Channels OFF. If changes to the DIP switch settings are needed, see Section 4.2 for details.)

- Temporarily connect a jumper (supplied) between EDM 1 b (terminal 13) and EDM 2 b (terminal 15) to configure EDM for No Monitoring.
- Apply power to the controller. The System Reset indicator should be double flashing.
- Perform a system reset (close the System Reset switch for 1/4 to 2 seconds, then open it; see Section 4.3). The System Reset indicator should go OFF and the System Status indicator should come ON (Red or Green).

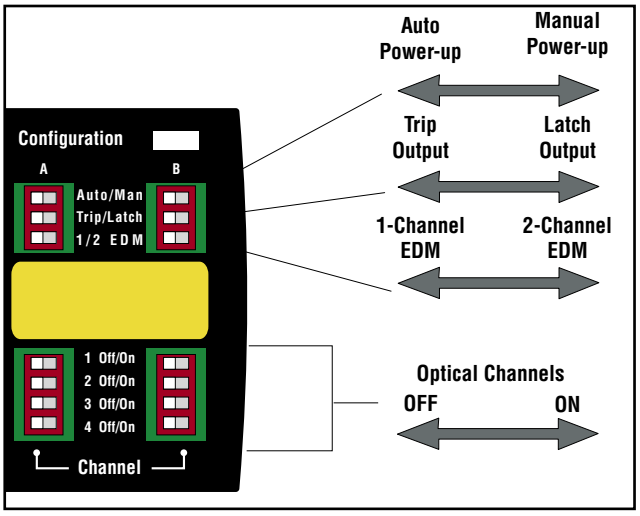


Figure 3-6. Configuration DIP switches

3.8.2 Optical Element Alignment

Align all optical elements of each optical channel, per the instructions for the individual devices (see the appropriate device instruction manuals and the *PICO-GUARD Application and Design Guide).*

3.8.3 Verify System Operation

Perform the Trip Test. The procedure for the Trip Test is dependent on the types of optical element(s) used. Refer to the appropriate Daily Checkout procedure(s) for Trip Testing the optical element(s) used in your application.

Do not continue operation until the entire checkout procedure is completed and all problems are corrected.

3.9 Electrical Interface to the Guarded Machine (Permanent Hookup)

Make the electrical connections as described in Sections 3.9.1 to 3.9.5 as required by each individual application.

System power and the System Reset switch should already be connected by this point. The PICO-GUARD system must also have been aligned and passed the Initial System Checkout, as described in Section 3.8. The final connections to be made are:

- OSSD outputs
- FSD interfacing
- MPCE/EDM connections

3.9.1 OSSD Output Connections

Both Output Signal Switching Device (OSSD) outputs must be connected to the machine control so that the machine's safety-related control system interrupts the circuit or power to the Machine Primary Control Element(s) (MPCE), resulting in a non-hazardous condition.

Final Switching Devices (FSDs) typically accomplish this when the OSSDs go to an OFF state. See Figure 3-7.

Refer to the output specifications in Section 2.7 and the following Warnings before making OSSD output connections and interfacing the PICO-GUARD System to the machine.

WARNING . . . Interfacing of Both OSSDs

Both of the OSSD (Output Signal Switching Device) outputs must be connected to the machine control so that the machine's safety-related control system interrupts the circuit to the machine primary control element(s), resulting in a non-hazardous condition.

Never wire any intermediate device(s) in such a manner that the safety function can be suspended, overridden, or defeated, unless accomplished in a manner at the same or greater degree of safety.

WARNING . . . OSSD Interfacing

To ensure proper operation, the PICO-GUARD OSSD output specifications and machine input parameters must be considered when interfacing the PICO-GUARD solid-state OSSD outputs to machine inputs (see Section 2.7).

Machine control circuitry must be designed so that the maximum load resistance value is not exceeded and so that the maximum specified OSSD OFF-state voltage does not result in an ON condition.

Failure to properly interface the OSSD outputs to the guarded machine could result in serious bodily injury or death.

3.9.2 MPCE and FSD Interfacing Connections

Each of the two machine primary control elements (MPCE1 and MPCE2) must be capable of immediately stopping the dangerous machine motion, irrespective of the state of the other. These two machine control channels need not be identical, but the stop time performance of the machine (Ts, used to calculate the separation distance; see *PICO-GUARD Application and Design Guide*, p/n 69763) 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. Refer to Figures 3-8 and 3-9 or consult the machine manufacturer for additional information.

Final Switching Devices (FSDs) can take many forms, though the most common are forced-guided, mechanically linked relays or interface modules. The mechanical linkage between the contacts allows the device to be monitored by the external device monitoring (EDM) circuit for certain failures.

Depending on the application, the use of FSDs can facilitate controlling voltage and current that differs from the OSSD outputs of the PICO-GUARD. FSDs can also be used to control an additional number of hazards by creating multiple safety stop circuits.

Safety Stop Circuits

A safety stop allows for an orderly cessation of motion for safeguarding purposes, which results in a stopping of motion and removal of power from the MPCEs (assuming this does not create additional hazards). A safety stop circuit typically comprises a minimum of two normally open (N.O.) contacts from forced-guided, mechanically linked relays, which are monitored (through EDM) to detect certain failures in order to prevent the loss of the safety function. Such a circuit can be described as a "safe switching point." Typically, safety stop circuits are either single channel, which is a series connection of at least two N.O. contacts; or dual channel, which is a separate connection of two N.O. contacts. In either method, the safety function relies on the use of redundant contacts to control a single hazard (if one contact fails ON, the second contact will prevent the next cycle from occurring).

The interfacing of the safety stop circuits must be accomplished so that the safety function can not be suspended, overridden, or defeated, unless accomplished in a manner at the same or greater degree of safety as the machine's safety related control system that includes the PICO-GUARD.

The normally open safety outputs from an interface module provide a series connection of redundant contacts that form safety stop circuits for use in either single channel or dual channel control. (See Figures 3-8 and 3-9.)

Dual Channel Control

Dual channel control provides the ability to electrically extend the safe switching point beyond the FSD contacts. With proper monitoring (i.e., EDM), this method of interfacing is capable of detecting certain failures in the control wiring between the safety stop circuit and the MPCEs. These failures include a short-circuit of one channel to a secondary source of energy or voltage, or the loss of the switching ability of one of the FSD outputs. Such failures could lead to the loss of redundancy — or to a complete loss of safety, if not detected and corrected.

The possibility of a failure to the wiring increases as the physical distance between the FSD safety stop circuits and the MPCEs increase, as the length or the routing of the interconnecting wires increases, or if the FSD safety stop circuits and the MPCEs are located in different enclosures. For this reason, dual channel control with EDM monitoring should be used in any installation where the FSDs are located remotely from the MPCEs.

Single Channel Control

Single channel control, as mentioned, uses a series connection of FSD contacts to form a safe switching point. After this point in the machine's safety-related control system, failures can occur that would result in the loss of the safety function (such as a short-circuit to a secondary source of energy or voltage).

For this reason, single channel control interfacing should be used only in installations where FSD safety stop circuits and the MPCEs are mounted within the same control panel, adjacent to each other, and are directly connected to each other; or where the possibility of such a failure can be excluded. If this can not be achieved, then dual channel control should be used.

Methods to exclude the possibility of these failures include, but are not limited to:

- Physically separating interconnecting control wires from each other and from secondary sources of power.
- Routing interconnecting control wires in separate conduit, runs, or channels.
- Locating all elements (modules, switches, and devices under control) within one control panel, adjacent to each other, and directly connected with short wires.
- Properly installing multi-conductor cabling and multiple wires through strain-relief fittings. (Over-tightening of a strain-relief can cause short-circuits at that point.)
- Using positive-opening or direct-drive components, installed and mounted in a positive mode.

3.9.3 EDM Inputs

External Device Monitoring

It is strongly recommended that one normally closed, forced-guided monitoring contact of each MPCE (or FSD) be connected to EDM inputs (see Figures 3-7 to 3-10). If this is done, proper operation of the MPCEs will be verified. Monitoring MPCE contacts is one method of maintaining control reliability.

CAUTION . . . EDM Monitoring
If the system is configured for No Monitoring, it is the user's responsibility to ensure that this does not create a hazardous situation.

External Device Monitoring Hookup: Controller terminals 12-15 provide connection for the External Device Monitoring inputs. External device monitoring (EDM) must be wired in one of the three following configurations and must agree with the controller's EDM DIP switch settings (see Section 4.1). One- and two-channel EDM are used when the PICO-GUARD OSSD outputs directly control the energizing and de-energizing of the guarded machine's MPCEs.

- **One-channel monitoring** is a series connection of closed monitor contacts that are forced-guided, mechanically linked from each device controlled by PICO-GUARD. One-channel monitoring uses EDM 1 input only. EDM 2 input must be left open (no connection). At power up, EDM 1 input will be verified to be in the closed state.

  When the OSSD outputs have changed from ON to OFF, EDM 1 input will be verified to be in the closed state within 250 ms.

When the OSSD outputs change from OFF to ON, EDM 1 input will be verified to be open within 250 ms. Once EDM 1 input has been verified to be open, EDM 1 input is allowed to be either open or closed, for as long as the OSSD outputs remain ON.

Refer to Figure 3-9 for one-channel EDM hookup. Connect the monitor contacts between EDM 1 a and b (terminals 12 and 13) or between +24V dc and EDM 1 b (terminal 13). Leave EDM 2 open (terminals 14 and 15, no connection). Set the configuration DIP switches to "1," per Section 4.1.

- **Two-channel monitoring** is a separate connection of closed monitor contacts that are forced-guided (captive contact) from each device controlled by the PICO-GUARD. The monitoring contacts should always close within 250 milliseconds of the corresponding OSSD turning OFF; they stay closed for as long as the OSSD outputs are OFF. When the OSSD outputs are ON, both monitor contacts must be in the same state (either open or closed) within 250 milliseconds of each other.

  Refer to Figures 3-7 or 3-8 for 2-channel EDM hookup. Connect the monitor contacts as shown between EDM 1 a and b (terminals 12 and 13) and between EDM 2 a and b (terminals 14 and 15). Alternately, the monitor contacts may be connected between +24V dc and EDM 1 b (terminal 13) and between +24V dc and EDM 2 b (terminal 15). Set the configuration DIP switches to 2, per Section 4.1.

- **No monitoring.** Use this setting initially, in order to perform the initial checkout; see Section 3.8. *If No Monitoring is selected, the user must ensure that any single failure of the external devices does not result in a hazardous condition and, in such a case, that a successive machine cycle will be prevented* (see Note below, EDM and Control Reliability).

  To configure the System for No Monitoring, set the configuration DIP switches to 2, per Section 4.2, and connect a jumper (supplied) between EDM 1 b (terminal 13) and EDM 2 b (terminal 15). See the top PICO-GUARD controller in Figure 3-10.

NOTE: EDM AND CONTROL RELIABILITY

In the U.S., Control Reliability requires that a single failure does not prevent a normal stop from occurring, or issues an immediate stop command, and the next cycle is prevented from occurring until the fault is corrected.

A common method of satisfying these requirements is through the use of dual channel control with monitoring, where a normally closed, forced-guided contact of each MPCE (or FSD) is wired as described in Section 3.9.3 and as shown in Figures 3-7, 3-8, 3-9, and 3-10.

3.9.4 Remote Interface Output Connections

The Remote Interface output is to be used for non-safety-related diagnostic or system-monitoring purposes only. The Remote Interface output (terminals 28 – 31) is used for setup or to monitor system operation of the PICO-GUARD system. See Section 4.6 for operation and Section 2.7 for output specifications.

The Remote Interface may be used with up to four optional Remote Display units. Use the instructions that come with the Remote Display to connect to the controller's Remote Interface.

To connect a PC, PLC or other monitoring device using the RS-232 terminals (30 and 31), connect the data signal line (DB9 connector pin 2) to the Tx + terminal (31) and connect the signal ground (DB9 connector pin 5) to the Tx – terminal (30); see Figure 3-1 and Section 4.6.

3.9.5 Non-Safety Output Connections

Auxiliary, Weak Signal, Fault, and optional Channel Outputs are non-safety outputs, used to monitor system operation of the PICO-GUARD system. See Section 4.5.7 for operation and Section 2.7 for output specifications.

Connect the Auxiliary load wires to the Aux terminal (25) and to 0V dc.

Connect the Weak Signal load wires to the Weak terminal (26) and to 0V dc.

Connect the Fault load wires to the Fault terminal (27) and to 0V dc.

Connect the Channel 1 load wires to the Ch1 terminal (33) and to 0V dc.

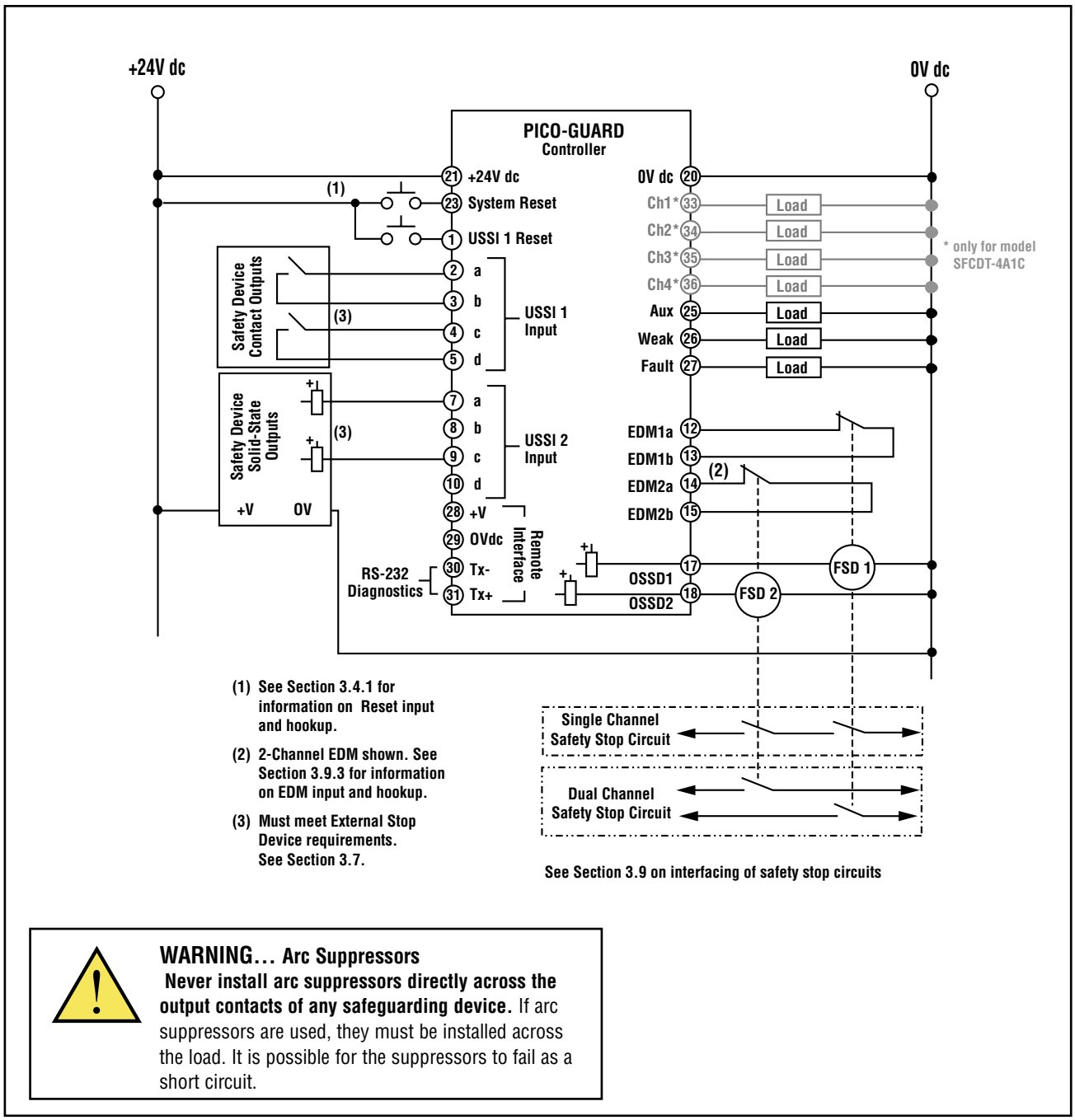
Connect the Channel 2 load wires to the Ch2 terminal (34) and to 0V dc.

Connect the Channel 3 load wires to the Ch3 terminal (35) and to 0V dc.

Connect the Channel 4 load wires to the Ch4 terminal (36) and to 0V dc.

3.10 Preparing for System Operation

Perform the Commissioning Checkout, as described in Section 6.3.



WARNING... Arc Suppressors
Never install arc suppressors directly across the output contacts of any safeguarding device. If arc suppressors are used, they must be installed across the load. It is possible for the suppressors to fail as a short circuit.

Figure 3-7. PICO-GUARD System generic FSD hookup; two-channel EDM

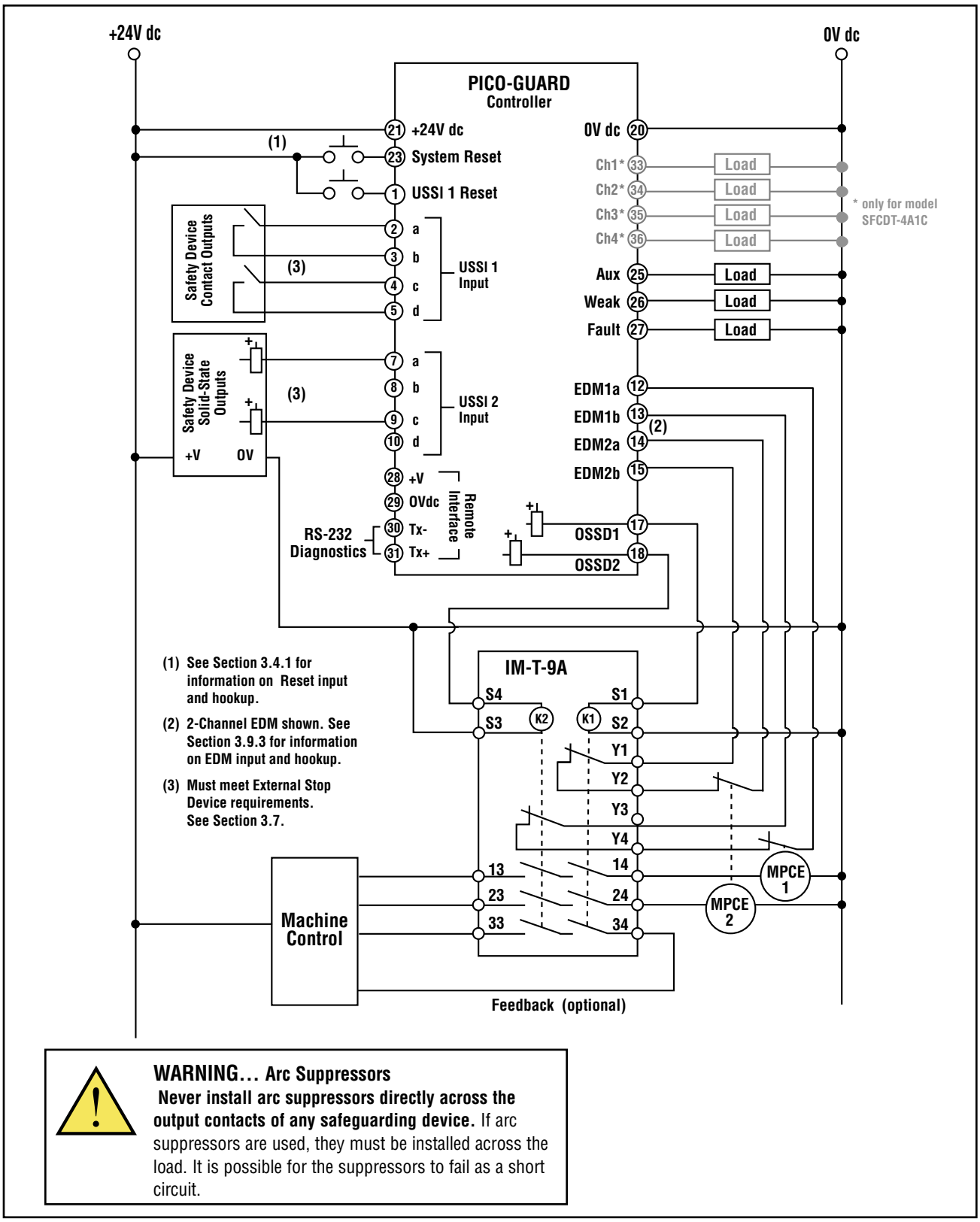
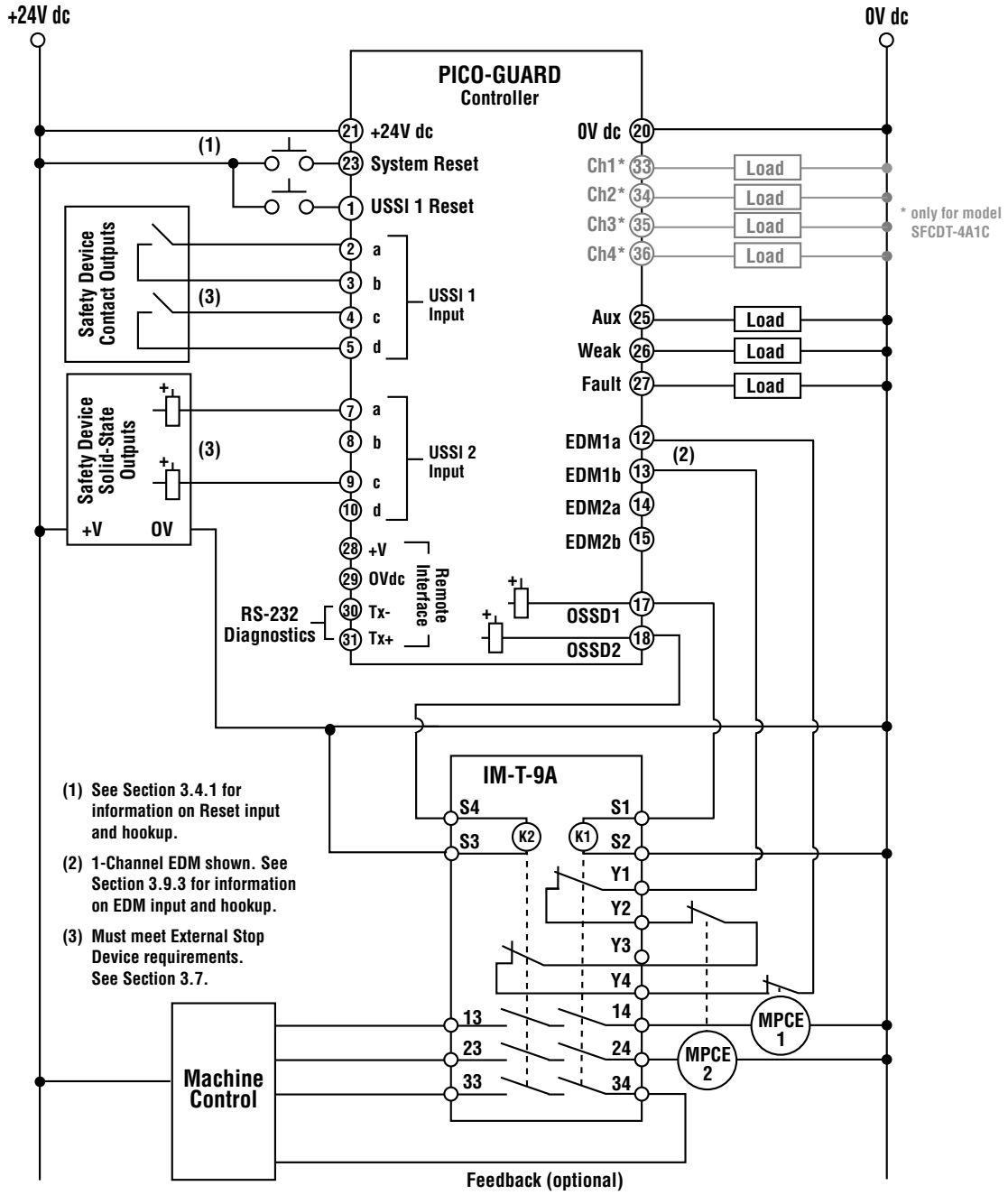
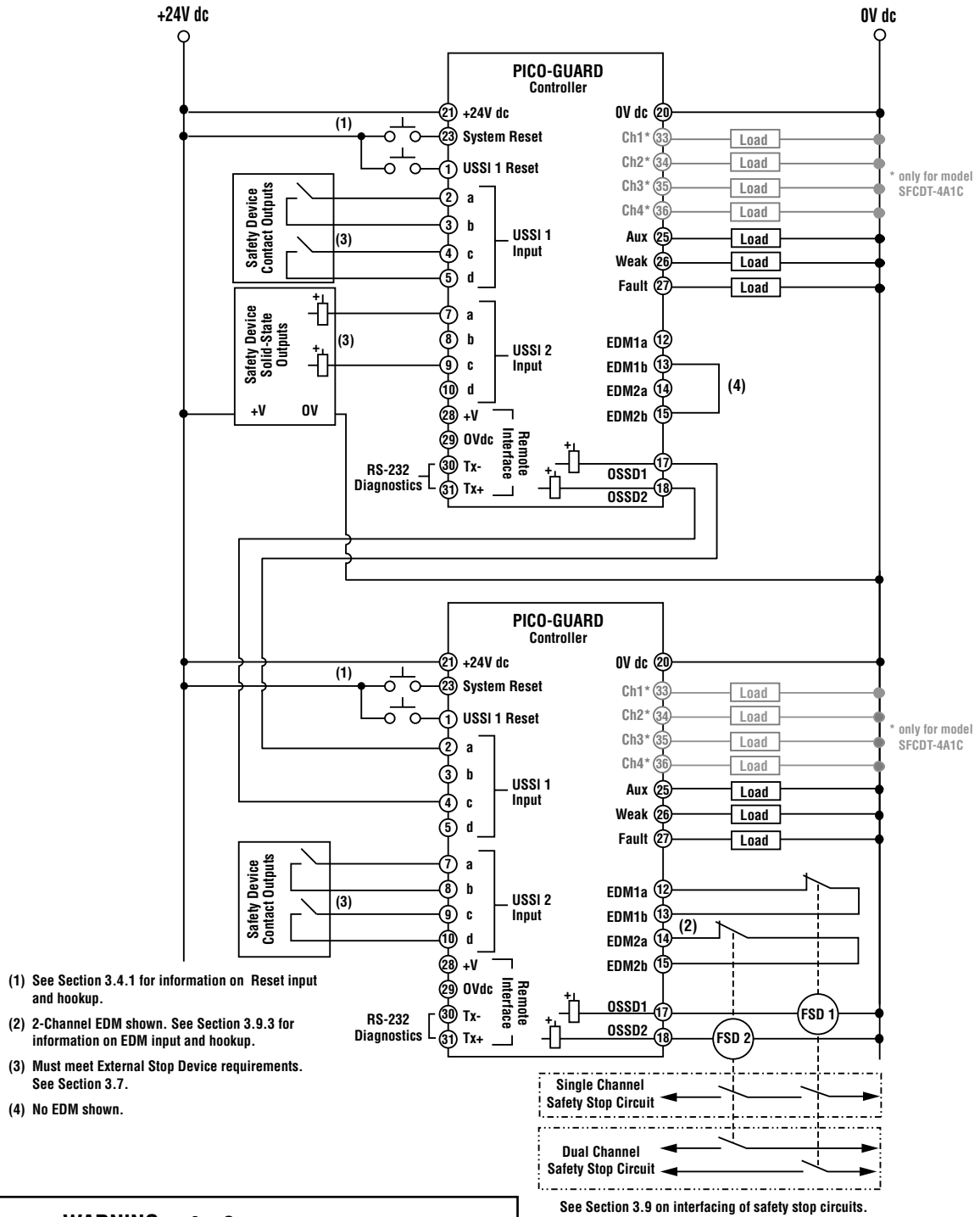


Figure 3-8. PICO-GUARD System interface module (IM-T-9A) hookup; two-channel EDM



WARNING... Arc Suppressors
Never install arc suppressors directly across the output contacts of any safeguarding device. If arc suppressors are used, they must be installed across the load. It is possible for the suppressors to fail as a short circuit.

Figure 3-9. PICO-GUARD System interface module (IM-T-9A) hookup; one-channel EDM



WARNING… Arc Suppressors
Never install arc suppressors directly across the output contacts of any safeguarding device. If arc suppressors are used, they must be installed across the load. It is possible for the suppressors to fail as a short circuit.

Figure 3-10. PICO-GUARD System generic FSD hookup; two-channel EDM and two PICO-GUARD Systems

4. System Operation

4.1 Periodic Checkout Requirements

To ensure continued reliable operation, the System must be checked out periodically.

At every shift change, power-up and machine setup change, the Daily checkout should be performed; this checkout may be performed by a Designated or Qualified Person (see Section 6.4).

Semi-annually, the system and its interface to the guarded machine should be thoroughly checked out; this checkout must be performed by a Qualified Person (see Section 6.5). A copy of these test results should be posted on or near the machine.

Whenever changes are made to the System (either a new configuration of the PICO-GUARD System or changes to the machine), the Commissioning Checkout should be performed (see Section 6.3)

4.2 System Configuration Settings

System configuration settings are made to two identical banks of DIP switches on the controller's configuration panel. The configuration panel is located behind the access cover. The access cover is opened using the security hex wrench provided (see Figure 4-1).

Change configuration settings *only* when the system is OFF.

NOTE: **The corresponding pairs of DIP switches must be set identically** (e.g., both banks set for Auto Power-Up) for the System to operate. If they have different settings, a fault condition will occur. See Section 5 for fault identification and troubleshooting procedures.

After configuration settings are set and verified, close the access cover and secure it using the security hex wrench.

WARNING!
Configuration settings are to be made by Qualified Persons only.

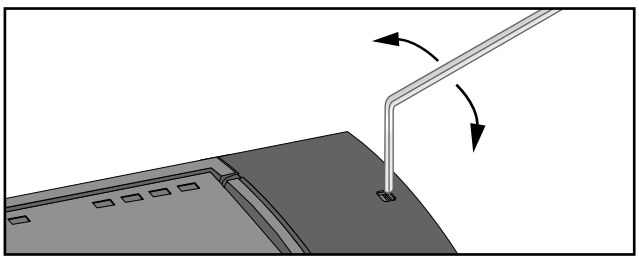


Figure 4-1. Accessing the controller's configuration panel

Auto/Manual Power-Up is selected on two DIP switches as shown in Figure 4-2. If the switches are set for Auto Power-Up, the controller will automatically perform a system reset on power-up, after the internal system tests are completed. If the switches are set for Manual Power-Up, the controller will require a system reset at power-up. The controller indicates it is ready for a system reset after power-up by double-flashing the System Reset indicator (see Figure 4-3).

Trip or Latch Output is selected on two DIP switches as shown in Figure 4-2. If the switches are set for Trip Output (T), the controller will turn the OSSD outputs ON automatically when all active (ON) optical channels are closed (light received). If the switches are set for Latch Output (L), the controller will require a system reset when all active (ON) optical channels are closed (light received). The controller indicates it is ready for a system reset to clear the latch condition by single-flashing the System Reset indicator (see Figure 4-3).

EDM options are selected via two DIP switches as shown in Figure 4-2. For 1-Channel Monitoring, set both EDM DIP switches to 1. For 2-Channel Monitoring or No Monitoring, set both EDM DIP switches to 2. See Section 3.9.3 for more information.

Optical Channels are enabled via four pairs of DIP switches as shown in Figure 4-2. Each optical channel is enabled by setting its pair of switches to ON, or disabled by setting them to OFF. At least one optical channel must be ON at all times or a fault condition will occur.

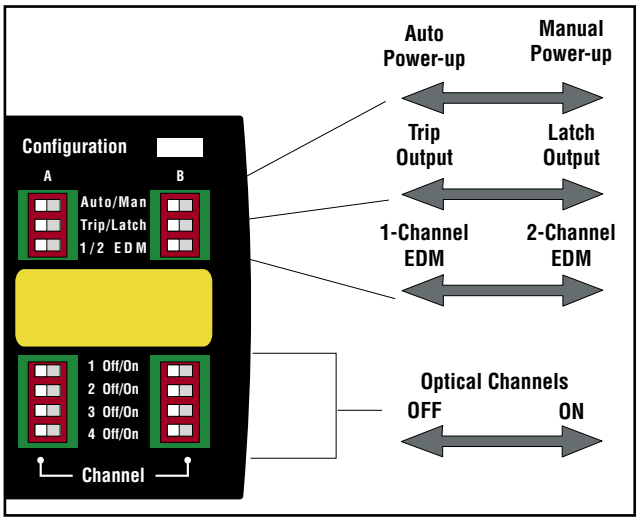


Figure 4-2. PICO-GUARD controller configuration switches

4.3 Resetting the Controller

The System Reset input is separate and operates independently from the USSI 1 Reset input.

System resets are needed in the following situations:

- **For Manual Power-up operation,** system resets are required after each controller power-up.
- **For Latch Output operation,** a system reset is required after each optical channel latch condition occurs.
- **To recover from a Lockout condition** (except USSI 1 input errors), a system reset is required after the cause of the lockout has been corrected.

USSI 1 resets are needed after a stop signal from the external stop device on USSI 1 input has been cleared (both channels of USSI 1 are closed/ON).

4.3.1 System Reset Procedure

The PICO-GUARD controller has a System Reset input (terminal 23), that allows the system to be manually reset. To reset the system, close the System Reset switch for 1/4 to 2 seconds, then open it. (If Reset switch model MGA-KS0-1, listed in Section 2, is used, close the switch by turning the key 1/4 turn clockwise; open it by turning the key counterclockwise, back to its original position.)

NOTE: Closing the Reset switch too long will cause the system to ignore the reset request; the switch must be closed at least 1/4 second, *but no longer than 2 seconds.*

4.3.2 USSI 1 Reset Procedure

The PICO-GUARD controller has a USSI 1 Reset input (terminal 1) that allows the system to be manually reset from a USSI 1 latch. To reset the system, close the USSI 1 Reset switch for 1/4 to 2 seconds, then open it. (If Reset switch model MGA-KS0-1, listed in Section 2, is used, close the switch by turning the key 1/4 turn clockwise; open it by turning the key counterclockwise, back to its original position.)

NOTE: Closing the USSI 1 Reset switch too long will cause the system to ignore the reset request; the switch must be closed at least 1/4 second, *but no longer than 2 seconds.*

4.4 Status Indicators

A variety of controller status indicators clearly show the system's status and operating conditions (see Figure 4-3).

4.5 Normal Operation

4.5.1 System Power-Up

The controller will power up in one of two ways, depending on the Auto/Man configuration setting. If the controller is set for Auto Power-Up, it will power up and reset automatically; if it is set for Manual Power-Up, a system reset procedure will be required after power-up (System Reset indicator double-flashes). See Section 4.5.5.

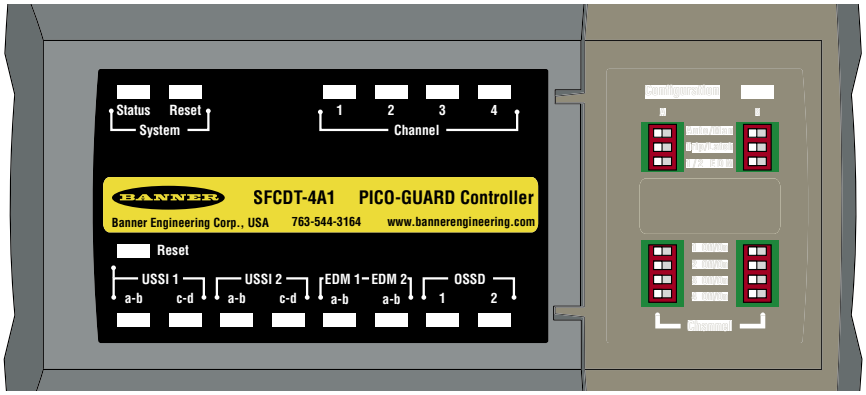
Auto Power-Up: When power is applied, the controller will conduct self-tests to detect critical internal faults, determine configuration settings, and prepare the system for operation. (If a critical fault is detected, the OSSD outputs remain OFF and diagnostic information is displayed via the controller's status indicators.) If no faults are detected, the controller will automatically begin normal operation. No system reset procedure is required.

Manual Power-Up: When power is applied, the controller will conduct self-tests to detect critical internal faults, determine configuration settings, and prepare the system for operation. (If a critical fault is detected, the OSSD outputs remain OFF and diagnostic information is displayed via the controller's status indicators.) If no faults are detected, the controller will double-flash the System Reset indicator to indicate it is ready and waiting for a system reset. After a valid system reset, the system will begin normal operation.

4.5.2 Inputs and Outputs

Trip Output Configuration (or Automatic Reset): If any optical channel becomes open (blocked) while the system is running with Trip output selected, the OSSD outputs turn OFF within 13 milliseconds (the maximum optical channel response time). If all of the active (ON) optical channels then become closed (clear) and USSI 1 and USSI 2 are not in a Latch or Stop condition, the OSSD outputs come back ON. No resets of any kind are needed; all required machine control resets are provided by the machine control circuit.

Latch Output Configuration (or Monitored Manual Reset): If any optical channel becomes open (blocked) while the System is running with Latch output selected, the OSSD outputs turn OFF within 13 milliseconds (the maximum optical channel response time). If all of the active (ON) optical channels then become closed (clear), the Channel status indicators of channels that have not been blocked since the last reset will be Green (indicators of disabled channels will be OFF), the indicators of the channels that have been blocked but are clear again are double flashing, and the System Reset indicator will single-flash, indicating the controller is waiting for a system reset to clear the latch condition. When Latch is selected, the outputs come back ON only when all active channels are clear and after a system reset. The controller will wait for a system reset; when a valid system reset signal is received and all active channels remain clear/closed and USSI 1 and USSI 2 are not in a Latch or Stop condition, the OSSD outputs turn ON.



"System Status" Indicator (bi-color Red/Green): overall status of the PICO-GUARD system

Green – Run condition
Red – Stop or Latch conditions
Red Flashing – Lockout conditions
Flashing Burst* (Red or Green) – electrical noise in the system

"System Reset" Indicator (bi-color Yellow/Red): status of the System Reset input or System Reset needed

Yellow Double-Flashing – waiting for system reset after power-up
Yellow Single-Flashing – waiting for system reset after latch condition
Yellow – input signal is high
Red Flashing – external fault of the input detected
OFF – input signal is low or during lockout (except for System Reset faults)
Red Flashing Burst* – noise on the System Reset input

Optical "Channel" Indicators (bi-color Red/Green): status of the optical channels (one indicator for each optical channel)

Green – channel is closed (clear)
Green Double-Flash – channel was interrupted, but is closed again (latch mode only)
Flickers Green – weak or marginal signal
Red – channel is open (blocked)
Red Flashing – channel fault detected
OFF – channel is disabled or during lockout (except for optical channel faults)
Flashing Burst* (Red or Green) – noise on the channel

"USSI" Indicators (bi-color Red/Green): status of the USSI input channels (a-b and c-d), two indicators per USSI input (one for each input channel)

Green – an input channel is closed (high)
Red Flashing – external fault of the input channel detected
Both Synchronized Red Flashing – fault detected, but the specific input channel cannot be determined
OFF – an input channel is open (low) or during lockout (except for USSI channel faults)
Flashing Burst* (Red or Green) – noise on the input channel

"USSI 1 Reset" Indicator (bi-color Yellow/Red): status of the USSI 1 reset input, or USSI 1 reset needed

Yellow – input signal is high
Yellow Flashing – waiting for USSI 1 latch reset
Red Flashing – external fault of the input detected
OFF – input signal is low or during lockout (except for USSI 1 Reset faults)
Red Flashing Burst* – noise on the USSI 1 reset input

"EDM" Indicators (bi-color Red/Green): status of the EDM inputs (one indicator for each input)

Green – input signal is high
Red Flashing – external fault of the input detected
Both Synchronized Red Flashing – EDM fault detected; specific input cannot be determined
OFF – input signal is low or during lockout (except for EDM input faults)
Flashing Burst* (Red or Green) – noise on an EDM input channel

"OSSD" Indicators (bi-color Red/Green): status of each OSSD output (one indicator for each output)

Green – OSSD is ON
Red – OSSD is OFF
Red Flashing – external output fault detected
Both Synchronized Red Flashing – specific OSSD output fault cannot be determined
OFF – lockout (except for OSSD output faults)

"Config" Indicator (bi-color Red/Green): status of the system configuration

Green – configuration switch state is valid
Red Flashing – configuration switch state is invalid
OFF – lockout (except for configuration faults)

* A flashing burst is three short consecutive flashes, followed by a pause.

Figure 4-3. PICO-GUARD controller status indicators

USSI 1 Operation: USSI input is used to connect various external devices or controls to provide a stop signal to the PICO-GUARD system (see Section 3.7 for installation requirements). USSI 1 is used when a latching type of stop response is needed. When a stop signal is received by the USSI 1 input, the controller will turn OFF the OSSD outputs within 7 milliseconds (the maximum USSI response time) and hold them OFF until the USSI 1 stop signal has been removed (both USSI 1 input channels ON/closed) and a valid USSI 1 Reset is received. After a successful reset of the USSI 1 latch condition, the controller will resume normal operation.

NOTE: If the OSSD outputs do not turn ON after a USSI 1 reset, check for a USSI 2 stop condition or for an optical channel open (blocked) or latch condition. The USSI 1 input must be jumpered if it is unused (see Section 3.7), and it will have no effect on the operation of the PICO-GUARD system.

USSI 2 Operation: USSI 2 input is used to connect various external devices or controls to provide a stop signal to the PICO-GUARD system (see Section 3.7 for installation requirements). USSI 2 is used when a trip type of stop response is needed. When a stop signal is received by the USSI 2 input, the controller will turn OFF the OSSD outputs within 7 milliseconds (the maximum USSI response time). Once the USSI 2 stop signal has been removed (both USSI 2 input channels ON/closed), the controller will resume normal operation.

NOTE: If the OSSD outputs do not turn ON after the USSI 2 stop signal is cleared, check for a USSI stop or latch condition or for an optical channel open (blocked) or latch condition. The USSI 2 input must be jumpered if it is unused (see Section 3.7), and it will have no effect on the operation of the PICO-GUARD system.

4.5.3 System Lockout Conditions

External/Internal Faults

If the PICO-GUARD controller detects a critical fault, the OSSD, Aux and Weak outputs turn OFF, the Fault output turns ON and diagnostic information is displayed via the controller's status indicators (and the remote interface, if used). See Section 5 for resolution of error/fault conditions.

4.5.4 Optical Channel Operation (Auto Power-Up, Trip Output, USSI 1 and 2 Closed or Jumpered)

System Status	Required Event	Status Indicator	System Reset Indicator	Channel Indicators	Configuration Indicator	EDM Indicators	OSSD Output Indicators	OSSD Outputs
Power-up	Apply power	Flash Red Flash Green OFF	Flash Red Flash Yellow OFF	Flash Red Flash Green OFF	Flash Red Flash Green OFF	Flash Red Flash Green OFF	Flash Red Flash Green OFF	OFF
Run	Pass internal tests and all optical channels clear	Green	OFF	All Green (1)	Green	OFF	Green	ON
Stop	One or more optical channels blocked	Red	OFF	Red: Blocked/ Open Green: Clear/ Closed	Green	ON (7)	Red	OFF
Lockout	Fault detected	Red Flashing	OFF (2)	OFF (3)	OFF (4)	ON (6)	OFF(5)	OFF

NOTES:
1. Green Flicker if an optical channel has a weak signal
2. OFF unless System Reset fault, then Red Flashing
3. OFF unless Optical Channel fault, then Red Flashing
4. OFF unless Configuration fault, then Red Flashing
5. OFF unless OSSD fault, then Red Flashing
6. OFF unless EDM fault, then Red Flashing
7. **2-channel EDM:** both indicators ON;
   1-channel EDM: EDM 1 indicator ON only

4.5.5 Optical Channel Operation (Manual Power-Up, Latch Output, USSI 1 and 2 Closed or Jumpered)

System Status	Required Event	Status Indicator	System Reset Indicator	Channel Indicators	Configuration Indicator	EDM Indicators	OSSD Output Indicators	OSSD Outputs
Power-up	Apply power	Flash Red Flash Green OFF	Flash Red Flash Yellow OFF	Flash Red Flash Green OFF	Flash Red Flash Green OFF	Flash Red Flash Green OFF	Flash Red Flash Green OFF	OFF
Power-up Reset	Pass internal tests	Red	Double Flashing Yellow	Red: Blocked/ Open Green: Clear/ Closed	Green	ON (7)	Red	OFF
Run	System is reset and all optical channels clear	Green	OFF	All Green (1)	Green	OFF	Green	ON
Stop	One or more optical channels blocked	Red	OFF	Red: Blocked/ Open Green: Clear/ Closed	Green	ON (7)	Red	OFF
Latched	All optical channels clear	Red	Single Flashing	Green (11) Double Flashing (12)	Green	ON (7)	Red	OFF
Lockout	Fault detected	Red Flashing	OFF (2)	OFF (3)	OFF (4)	OFF (6)	OFF(5)	OFF

4.5.6 USSI 1 and 2 Operation (Auto Power-Up, Trip Output, All Optical Channels Clear/Closed)

System Status	Required Event	USSI 1 Indicator	USSI 1 Reset Indicator	USSI 2 Indicators	OSSD Output Indicator	OSSD Outputs
Power-up	Apply power	Flash Red Flash Green OFF	Flash Red Flash Yellow OFF	Flash Red Flash Green OFF	Flash Red Flash Green OFF	OFF
Run	Pass internal tests USSI 1 and 2 Closed/ON	Green	OFF	Green	Green	ON
USSI 1 Stop	USSI 1 Open/OFF	OFF	OFF	Green	Red	OFF
USSI 1 Latch	USSI 1 Closed ON	Green	Single Flashing Yellow	Green	Green	OFF
Run	USSI reset received	Green	OFF	Green	Green	OFF
USSI 2 Stop	USSI 2 Open/OFF	Green	OFF	OFF	Red	OFF
Run	USSI 2 Closed/ON	Green	OFF	Green	Green	ON
Lockout	Fault detected	OFF (8)	OFF (9)	OFF (10)	OFF (5)	OFF

NOTES:
1. Green Flicker if an optical channel has a weak signal
2. OFF unless System Reset fault, then Red Flashing
3. OFF unless Optical Channel fault, then Red Flashing
4. OFF unless Configuration fault, then Red Flashing
5. OFF unless OSSD fault, then Red Flashing
6. OFF unless EDM fault, then Red Flashing
7. **2-channel EDM:** both indicators ON;
   1-channel EDM: EDM 1 indicator ON only
8. OFF unless USSI 1 fault, then Red Flashing
9. OFF unless USSI 1 Reset fault, then Red Flashing
10. OFF unless USSI 2 fault, then Red Flashing
11. Solid Green on channels that were not blocked since last reset
12. Channels that have been interrupted and cleared again since last reset

4.5.7 Non-Safety Outputs

Auxiliary Output: The action of the Auxiliary output "follows" the action of the OSSD outputs. See Figure 4-4 for Auxiliary output operation. The Auxiliary output is a light-duty, 24V dc, solid-state output used for control functions that are not safety-related. A typical use is to communicate with a programmable electronic system (PES), such as a PLC. See Section 2.7 for output specifications.

Weak Signal Output: The Weak Signal output is ON when one or more of the optical channels has a weak signal. See Figure 4-4 for Auxiliary output operation and see Section 4.4 for Optical Channel Indicators. The Weak Signal output is a light-duty, 24V dc, solid-state output used for non-safety-related monitoring of the optical channels. A typical use is to communicate with a programmable electronic system (PES), such as a PLC, that a low signal condition exists. See Section 2.7 for output specifications.

Fault Output: The Fault output is ON when a Lockout condition exists due to an internal or external PICO-GUARD system error or fault. See Figure 4-4 for Auxiliary output operation and see Section 5 for resolution of error/fault conditions. The Fault output is a light-duty, 24V dc, solid-state output used for system monitoring functions that are not safety-related. A typical use is to communicate with a programmable electronic system (PES), such as a PLC, that a fault has been detected and a Lockout condition exists. See Section 2.7 for output specifications.

Channel Outputs: (Optional, see Section 2.1 for models with Channel outputs). The four Channel outputs (Ch1, Ch2, Ch3, Ch4) are ON when the corresponding optical channel is blocked/open. See Figure 4-4 for channel output operation and see Section 4.4 for optical channel indicators. A typical use is to communicate with a programmable electronic system (PES), such as a PLC. See Section 2.7 for output specifications.

System Status	Aux. Output	Weak Output	Fault Output	Ch1 Output	Ch2 Output	Ch3 Output	Ch4 Output
Power-up	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Run	ON	(1)	OFF	OFF	OFF	OFF	OFF
Stop	OFF	(1)	OFF	(2)	(2)	(2)	(2)
Latched	OFF	(1)	OFF	(2)	(2)	(2)	(2)
Lockout	OFF	OFF	ON	OFF	OFF	OFF	OFF

(1) ON if any channel has a weak signal
OFF if all channels have either no signal or strong signal
(2) ON if the channel is blocked/open
OFF if the channel is clear/closed

Figure 4-4. Operation of non-safety outputs

4.6 Remote Interface

The remote interface (terminals 28-31) provides for remote monitoring of the system status via the optional remote display (see Section 2.3 Accessories) or via a computer, PLC/PES or other monitoring device.

The optional remote display provides the same status information as the controller status indicators (see Section 4.4).

A diagnostic software program is available on the PICO-GUARD CD to use with PC-compatible computers for easy viewing of System status and/or diagnosis of System errors (see Figure 4-5). The CD opens with an Autorun screen that contains an installation read-me file, followed by the installation of the software.

The RS-232 output of the remote interface provides continuously streaming, ASCII encoded hexadecimal data. Data packets include 48 ASCII characters (46 data characters followed by a carriage return and line feed). See Figure 4-6.

The RS-232 output data protocol is:

- 4800 baud rate
- 8 data bits
- No parity
- 1 stop bit

} 8-N-1

- No flow control

When the isolated RS-232 output (terminals 30 and 31) is connected to a computer, PES or other monitoring device, the status and diagnostic information shown in Figure 4-7 is available. Two data packet characters are used to decode each diagnostic data byte.

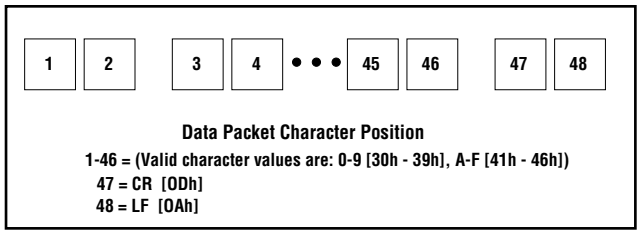


Figure 4-6. RS-232 Output Data Packet

For example, assume that data characters 39 and 40 are ASCII “C” and “8,” respectively. ASCII “C” is 12 in decimal or 1100 in binary. ASCII “8” is 8 decimal or 1000 in binary. This means that the diagnostic byte for data packets 39 and 40 is 11001000. From this information, Figure 4-7 tells us that:

Channel 1 is ON.

Channel 1 is Clear.

Channel 1 is not weak.

Noise is not detected on Channel 1.

Channel 2 is ON.

Channel 2 is Blocked.

Channel 2 is not weak.

Noise is not detected on Channel 2.

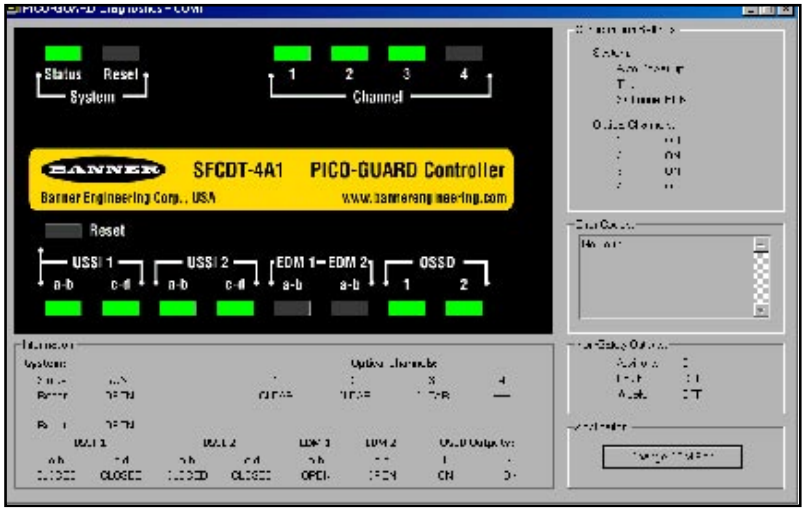


Figure 4-5. A sample screen display of the diagnostic software program

Data Packet Character Position		Purpose	Decoded Diagnostic Data Byte							
			Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	2	ID Byte	0	0	0	0	0	0	1	0
3	4	Operating Condition	Reserved	Aux Output	Weak Output	Fault Output	Reserved	**System Status** 000 Reserved 001 Power-up Reset 010 Latched 011 Run 100 Lockout 101 Power-up		
5	6	OSSDs	OSSD1 State Invalid	OSSD1 OC Fault Invalid	OSSD 1 State	OSSD1 OC Fault	OSSD2 State Invalid	OSSD2 OC Fault Invalid	OSSD2 State	OSSD2 OC Fault
7	8	Number of Channels and Latches	0	1 (4 Channels)	0	0	System Noise Detected	Two Channel EDM	Channel Latch	USSI Latch
9	10	EDMs and Resets	EDM 2 Open	Reserved	EDM 1 Open	EDM 1 Noisy	USSI Reset Closed	External Stop Device Reset Noisy	System Reset Closed	System Reset Noisy
11	12	Configuration Settings	Reserved	Reserved	Reserved	Reserved	One-channel EDM	Trip Mode Selected	Auto Power-up	Configur-ation Invalid
13	14	USSI 1	USSI Input a-b State Invalid	Reserved	USSI Input c-d Invalid	Reserved	USSI 1 Input a-b State	USSI 1 Input a-b Noisy	USSI 1 Input c-d State	USSI 1 Input c-d Noisy
15	16	USSI 2	USSI 2 Input a-b State Invalid	Reserved	USSI 2 Input c-d Invalid	Reserved	USSI 2 Input a-b State	USSI 2 Input a-b Noisy	USSI 2 Input c-d State	USSI 2 Input c-d Noisy
17	18	USSI Input Types and Channel Data Invalid	Channel Data Invalid	Reserved	Reserved	Reserved	USSI Type Contact	USSI 1 Type Unknown	USSI 2 Type Contact	USSI 2 Type Unknown
19	20	Reserved								
21	22	System Error Code (see Figure 5-1)								
23	24	Microcontroller-A Advanced Diagnostic Code (0-255)								
25	26	Microcontroller-B Advanced Diagnostic Code (0-255)								
27	28	Reserved								
29	30									
31	32									
33	34									
35	36									
37	38									
39	40	Optical Channels 1 and 2	Channel 1 Enabled	Channel 1 Clear	Channel 1 Weak	Channel 1 Noisy	Channel 2 Enabled	Channel 2 Clear	Channel 2 Weak	Channel 2 Noisy
41	42	Optical Channels 3 and 4	Channel 3 Enabled	Channel 3 Clear	Channel 3 Weak	Channel 3 Noisy	Channel 4 Enabled	Channel 4 Clear	Channel 4 Weak	Channel 4 Noisy
43	44	Reserved								
45	46	Reserved								

Figure 4-7. RS-232 diagnostic data

4.6.1 Diagnostic Data Explanations

Aux Output
1: ON
0: OFF

Weak Output
1: ON
0: OFF

Fault Output
1: ON
0: OFF

System Status
001: The PICO-GUARD is in Manual Power-up mode and is waiting for a System Reset.
010: The PICO-GUARD is in a Latched Condition
011: The PICO-GUARD is in a Run Condition
100: The PICO-GUARD is in a Lockout Condition
101: The PICO-GUARD is in a Power-up Condition

OSSD1 State Invalid
1: The state of the OSSD1 Output is unknown (not available).
0: The state of the OSSD1 Output is known.

OSSD1 OC Fault Invalid State
1: The state of the OSSD1 OC Fault is unknown (not available).
0: The state of the OSSD1 OC Fault is known.

OSSD1 State
1: ON
0: OFF

OSSD1 OC Fault
1: OSSD1 Overcurrent Fault has been detected.
0: OSSD1 Overcurrent Fault has not been detected.

OSSD2 State Invalid
1: The state of the OSSD2 Output is unknown (not available).
0: The state of the OSSD2 Output is known.

OSSD2 OC Fault Invalid State
1: The state of the OSSD2 OC Fault is unknown (not available).
0: The state of the OSSD2 OC Fault is known.

OSSD2 State
1: ON
0: OFF

OSSD2 OC Fault
1: OSSD2 Overcurrent Fault has been detected.
0: OSSD2 Overcurrent Fault has not been detected.

Number of Optical Channels
The total number of optical channels of the controller. A value of 4 indicates a 4-channel controller.

System Noise Detected
1: Noise detected.
0: No noise detected.

Two-Channel EDM
1: Two-Channel EDM selected.
0: One-Channel EDM bit = 1: One-Channel EDM selected.
One-Channel EDM bit = 0: No EDM selected.

Channel Latch
1: An Optical Channel Latch has occurred.
0: An Optical Channel Latch has not occurred or has been reset.

USSI 1 Latch
1: USSI 1 Latch has occurred.
0: USSI 1 Latch has not occurred or has been reset.

EDM 2 Open
1: EDM 2 Input is Open (low).
0: EDM 2 Input is Closed (high).

EDM 2 Noisy
1: Noise detected on EDM 2 Input.
0: No noise detected on EDM 2 Input.

EDM 1 Open
1: EDM 1 Input is Open (low).
0: EDM 1 Input is Closed (high).

EDM 1 Noisy
1: Noise detected on EDM 1 Input.
0: No noise detected on EDM 1 Input.

USSI 1 Reset Closed
1: USSI 1 Reset Input is Closed (high).
0: USSI 1 Reset Input is Open (low).

USSI 1 Reset Noisy
1: Noise detected on USSI 1 Reset Input.
0: No noise detected on USSI 1 Reset Input.

System Reset Closed
1: System Reset Input is Closed (high).
0: System Reset Input is Open (low).

System Reset Noisy
1: Noise detected on System Reset Input.
0: No noise detected on System Reset Input.

One-Channel EDM
(Config Invalid bit must be 0)
1: EDM Switches are set to “1”; system is set for one-channel EDM.
0: EDM Switches are set to “2” and
Two-Channel EDM bit = 1 – system is set for two-channel EDM.
Two-Channel EDM bit = 0 – system is set for No EDM.

Trip Mode Selected
(Config Invalid bit must be 0)
1: Trip/Latch Switches are set to “T”; Trip output selected.
0: Trip/Latch Switches are set to “L”; Latch output selected.

Auto Power-up
(Config Invalid bit must be 0)
1: Auto/Man Switches are set to “Auto”; system is set for Auto Power-up.
0: Auto/Man Switches are set to “Man”; system is set for Manual Power-up.

Configuration Invalid
1: The system configuration is invalid or unknown (not available).
0: The system configuration is valid.

4.6.1 Diagnostic Data Explanations, continued

USSI 1 Input a-b State Invalid
1: The state of the USSI 1 Input a-b is unknown (not available).
0: The state of the USSI 1 Input a-b is known.

USSI 1 Input c-d State Invalid
1: The state of the USSI 1 Input c-d is unknown (not available).
0: The state of the USSI 1 Input c-d is known.

USSI 1 Input a-b State
1: USSI 1 a-b Input is Closed (high).
0: USSI 1 a-b Input is Open (low).

USSI 1 Input a-b Noisy
1: Noise detected on USSI 1 Input a-b.
0: No noise detected on USSI 1 Input a-b.

USSI 1 Input c-d State
1: USSI 1 c-d Input is Closed (high).
0: USSI 1 c-d Input is Open (low).

USSI 1 Input c-d Noisy
1: Noise detected on USSI 1 Input c-d.
0: No noise detected on USSI 1 Input c-d.

USSI 2 Input a-b State Invalid
1: The state of the USSI 2 Input a-b is unknown (not available).
0: The state of the USSI 2 Input a-b is known.

USSI 2 Input c-d State Invalid
1: The state of the USSI 2 Input c-d is unknown (not available).
0: The state of the USSI 2 Input c-d is known.

USSI 2 Input a-b State
1: USSI 2 a-b Input is Closed (high).
0: USSI 2 a-b Input is Open (low).

USSI 2 Input a-b Noisy
1: Noise detected on USSI 2 Input a-b.
0: No noise detected on USSI 2 Input a-b.

USSI 2 Input c-d State
1: USSI 2 c-d Input is Closed (high).
0: USSI 2 c-d Input is Open (low).

USSI 2 Input c-d Noisy
1: Noise detected on USSI 2 Input c-d.
0: No noise detected on USSI 2 Input c-d.

System Error Code
The value of this byte indicates the System Error Code number. (See Figure 5-1)

Microcontroller-A Advanced Diagnostic Code
The value of this byte indicates the Microcontroller-A Advanced Diagnostic Code number. (Factory use only)

Microcontroller-B Advanced Diagnostic Code
The value of this byte indicates the Microcontroller-B Advanced Diagnostic Code number. (Factory use only)

Channel 1 Enabled
(Config Invalid bit must be 0)
1: Channel 1 Switch is set to ON
0: Channel 1 Switch is set to OFF

Channel 1 Clear
1: Channel 1 is Clear. (Strong signal)
0: Channel 1 is Blocked. (No signal)

Channel 1 Weak
1: Channel 1 is Clear but has a weak signal.
0: Channel 1 is not weak. (Clear/strong or Blocked)

Channel 1 Noisy
1: Noise detected on Channel 1.
0: No noise detected on Channel 1.

Channel 2 Enabled
(Config Invalid bit must be 0)
1: Channel 2 Switch is set to ON
0: Channel 2 Switch is set to OFF

Channel 2 Clear
1: Channel 2 is Clear (strong signal).
0: Channel 2 is Blocked (no signal).

Channel 2 Weak
1: Channel 2 is Clear but has a weak signal.
0: Channel 2 is not weak (Clear/strong or Blocked).

Channel 2 Noisy
1: Noise detected on Channel 2.
0: No noise detected on Channel 2.

Channel 3 Enabled
(Config Invalid bit must be 0)
1: Channel 3 Switch is set to ON
0: Channel 3 Switch is set to OFF

Channel 3 Clear
1: Channel 3 is Clear (strong signal).
0: Channel 3 is Blocked (no signal).

Channel 3 Weak
1: Channel 3 is Clear but has a weak signal.
0: Channel 3 is not weak (Clear/strong or Blocked).

Channel 3 Noisy
1: Noise detected on Channel 3.
0: No noise detected on Channel 3.

Channel 4 Enabled
(Config Invalid bit must be 0)
1: Channel 4 Switch is set to ON
0: Channel 4 Switch is set to OFF

Channel 4 Clear
1: Channel 4 is Clear (strong signal).
0: Channel 4 is Blocked (no signal).

Channel 4 Weak
1: Channel 4 is Clear but has a weak signal.
0: Channel 4 is not weak (Clear/strong or Blocked).

Channel 4 Noisy
1: Noise detected on Channel 4.
0: No noise detected on Channel 4.

5. Troubleshooting and Maintenance

Evaluate status indicators per Section 4.4.

5.1 Troubleshooting Lockout Conditions

A lockout condition causes all of the PICO-GUARD OSSD outputs to turn or remain OFF, sending a "stop" signal to the guarded machine. The controller provides diagnostic information via the status indicators or error codes via the RS-232 terminals of the Remote Interface (see Section 4.6) to assist in the identification of the cause(s) of lockouts.

A lockout condition is indicated by the System Status indicator Flashing Red (All errors). Figure 5.1 provides information regarding error identification, error description and appropriate action.

To recover from a Lockout condition (except USSI input errors), correct all errors and perform a system reset. See Section 4.3 for reset procedures.

For USSI input errors, lockout recovery is accomplished per the following:

1. Identify and correct the cause of the error (see Figure 5.1).
2. Cycle the external stop device connected to the USSI input (closed/ON and then open/OFF). Both channels of the external stop device must open (or go OFF) within 3 seconds of each other.

NOTE for USSI 1 errors: After lockout recovery, a USSI 1 reset is required when both channels go closed/ON.

WARNING . . . Shut Down Machinery Before Servicing

The machinery connected to the PICO-GUARD System must not be operating at any time during this procedure. Some servicing procedures may involve working close to the hazardous areas of the guarded machine.

Serious bodily injury or death could result.

CAUTION . . . Electrical Danger

Exercise care whenever troubleshooting, repairing, or modifying the PICO-GUARD System and/or the machine control system. Always disconnect all power from the PICO-GUARD System and the guarded machine before making any wire connections or before replacing any component.

Electrical connections or repairs should be done only by a Qualified Person (see Section 3.2).

WARNING . . . Power Failures and Lockouts

A lockout is a definite indication of a problem and should be investigated at once, by a Qualified Person.

Attempts to continue to operate machinery by bypassing the PICO-GUARD System are dangerous and could result in serious bodily injury or death.

5.2 Electrical and Optical Noise

The PICO-GUARD System is designed and manufactured to be highly resistant to electrical and optical noise and to operate reliably in industrial settings. However, serious electrical and/or optical noise may cause a random Trip or Latch condition. In very extreme electrical noise cases, a lockout is possible. In order to minimize the effects of transitory noise, the PICO-GUARD System will respond to noise only if the noise is detected on multiple consecutive scans.

If random nuisance trips occur, check the following:

- Loose or intermittent electrical wire or fiber optic connections;
- Optical interference from adjacent photoelectric devices; or
- Controller input or output wires routed too close to "noisy" wiring.

Monitoring for presence of noise: The PICO-GUARD system will, in many cases, indicate the presence of electrical or optical noise by flashing the appropriate controller indicators with a flashing burst (three short consecutive flashes).

For instance; if noise is detected on Channel 1, a flashing burst will appear on the Channel 1 indicator. Noise is indicated in a similar fashion for the other channel and input indicators (see Section 4.4). In addition to the controller indicators, the RS-232 diagnostic data of the Remote Interface output can provide information regarding noise detection (see Section 4.6). The noise path can be identified and the noise source can be found most quickly by monitoring the controller indicators or the RS-232 diagnostic output.

Checking for sources of electrical noise: All PICO-GUARD System wiring is low voltage; running these wires alongside power wires, motor/servo wires, or other high-voltage wiring can inject noise into the PICO-GUARD System. It is good wiring practice (and may be required by code) to isolate PICO-GUARD System wires from high-voltage wires.

The Banner BT-1 Beam Tracker is a very good tool for detecting electrical noise. It can be used to detect electrical transient spikes and surges. Cover the lens of the BT-1 with electrical tape to block light from getting into the receiver lens. Press the "RCV" button on the BT-1 and position the Beam Tracker on the wires going to the PICO-GUARD or any other nearby wires. The LED of the BT-1 will flash when noise is detected. Noise caused by the switching of inductive loads should be addressed by installing proper transient suppression across the load.

Checking for sources of optical noise: Turn off the controller, completely block the emitter beam, or disconnect the emitter channel fiber at the controller, then use a Banner BT-1 Beam Tracker to check for light at the receiving optical element. Press the "RCV" button on the BT-1 and move it near the front of the receiving optical element's sensing window. If the BT-1's indicator lights, check for light from other sources (other safety light screens, grids or points, or standard photoelectric sensors) by "tracking down" the emitted light from them.

Error Code*	Indicators Flashing Red	Error Description	Appropriate Action
0	• System Status • USSI 1 Reset	**USSI 1 Reset Error** • USSI 1 Reset switch closed on power-up or during system reset after lockout • USSI 1 Reset external wiring fault • Excessive EMI/RFI noise	• Check switch position and wiring for proper input signal. Replace switch and/or repair wiring. • Intermittent error: check for loose connections and/ or EMI/RFI noise.
1	• System Status • OSSD 1 or • System Status • OSSD 2	**OSSD Error** • OSSD 1 or 2 overload • OSSD 1 or 2 external wiring fault	• Check load rating. Must be < 0.5A dc. • Disconnect loads. If OK, then check wiring. If error continues, replace controller.
2	• System Status • System Reset	**System Reset Error** • System Reset switch closed on power-up or during recovery from a USSI lockout • System Reset external wiring fault • Excessive EMI/RFI noise	• Check switch position and wiring for proper input signal. Replace switch and/or repair wiring. • Intermittent error: check for loose connections and/ or EMI/RFI noise.
	• System Status • System Reset • USSI 1 Reset	• System Reset shorted to USSI 1 Reset	• Check wiring for short.
3	• System Status	Controller Error • Excessive EMI/RFI noise • Internal failure	• Intermittent error: check for loose connections and/ or EMI/RFI noise. • Replace controller.
4	• System Status • USSI 1 a-b • USSI 1 c-d **or** • System Status • USSI 1 a-b **or** • System Status • USSI 1 c-d	USSI 2 Error • Device OSSD type mismatch • Simultaneity error (> 3 seconds) • USSI external wiring fault • Excessive EMI/RFI noise	• Verify device OSSD types (see Section 3.7). • Check operation of device outputs. • Check wiring for shorts or opens. • Intermittent error: check for loose connections and/ or EMI/RFI noise. (See Section 5.1 for recovery procedure.)
5	• System Status • USSI 2 a-b • USSI 2 c-d **or** • System Status • USSI 2 a-b **or** • System Status • USSI 2 c-d	**External stop device 2 Error** • Device OSSD type mismatch • Simultaneity error (> 3 seconds) • external stop device external wiring fault • Excessive EMI/RFI noise	• Verify device OSSD types (see Section 3.7). • Check operation of device outputs. • Check wiring for shorts or opens. • Intermittent error: check for loose connections and/ or EMI/RFI noise. (See Section 5.1 for recovery procedure.)
*Error Code is not visible on controller. Obtain error codes via RS-232 interface to PC or other device.			

Figure 5-1. Error code troubleshooting (1 of 2)

Error Code*	Indicators Flashing Red	Error Description	Appropriate Action
6	• System Status	**System Noise Error** • Excessive EMI/RFI noise	• Check for loose connections and/or EMI/RFI noise.
7	• System Status • Configuration	**Configuration Switch Error** • All optical channels OFF (disabled) • Configuration switches mismatch • Settings changed during normal operation	• Check configuration switch settings (see Section 4.2).
8	• System Status • EDM 1	**EDM 1 Error** • Incorrect EDM configuration • EDM 1 is not high at power-up • EDM 1 is not high within 250 ms after OSSDs turn OFF • EDM 1 is not high when OSSDs are held OFF • EDM 1 is not low within 250 ms after OSSDs turn ON (1-channel EDM) • Excessive EMI/RFI noise• Check EDM configuration (see Section 3.9.3). • Check input signal level for proper operation. • Intermittent error: check for loose connections and/or EMI/RFI noise.	• Check EDM configuration (see Section 3.9.3). • Check input signal level for proper operation. • Intermittent error: check for loose connections and/or EMI/RFI noise.
9	• System Status • EDM 2	**EDM 2 Error** • Incorrect EDM configuration • EDM 2 is not high at power-up • EDM 2 is not high within 250 ms after OSSDs turn OFF • EDM 2 is not high when OSSDs are held OFF • EDM 2 is not low (1-channel EDM) • Excessive EMI/RFI noise	• Check EDM configuration (see Section 3.9.3). • Check input signal level for proper operation. • Intermittent error: check for loose connections and/or EMI/RFI noise.
10	• System Status • EDM 1 • EDM 2	**EDM Error** • Incorrect EDM configuration • EDM 1 and EDM 2 mismatch (2-channel EDM) • Excessive EMI/RFI noise on EDM 1 and EDM 2	• Check EDM configuration (see Section 3.9.3). • Check input signal level for proper operation. • Intermittent error: check for loose connections and/or EMI/RFI noise.
11	• System Status • Channel 1	**Optical Channel 1 Error** • Disabled channel goes clear • Channel signal too strong • Excessive optical or EMI/RFI noise	• Check optical channel configuration settings. • Check gain estimate (see Section 3.1). Add attenuator to channel if necessary. • Intermittent error: check for loose connections and/or EMI/RFI noise.
12	• System Status • Channel 2	**Optical Channel 2 Error** • Disabled channel goes clear • Channel signal too strong • Excessive optical or EMI/RFI noise	• Check optical channel configuration settings. • Check gain estimate (see Section 3.1). Add attenuator to channel if necessary. • Intermittent error: check for loose connections and/or EMI/RFI noise.
13	• System Status • Channel 3	**Optical Channel 3 Error** • Disabled channel goes clear • Channel signal too strong • Excessive optical or EMI/RFI noise	• Check optical channel configuration settings. • Check gain estimate (see Section 3.1). Add attenuator to channel if necessary. • Intermittent error: check for loose connections and/or EMI/RFI noise.
14	• System Status • Channel 4	**Optical Channel 4 Error** • Disabled channel goes clear • Channel signal too strong • Excessive optical or EMI/RFI noise	• Check optical channel configuration settings. • Check gain estimate (see Section 3.1). Add attenuator to channel if necessary. • Intermittent error: check for loose connections and/or EMI/RFI noise.
*Error Code is not visible on controller. Obtain error codes via RS-232 interface to PC or other device.			

Figure 5-1. Error code troubleshooting (2 of 2)

5.3 Troubleshooting Weak Signal (Low Excess Gain) Conditions

A Weak Signal (Low Excess Gain) condition causes the optical channel status LEDs to flash and turns ON the Weak Signal output. To troubleshoot a weak signal or to maximize excess gain:

1. Check the number and configuration of the optical elements in the optical channel loop. (See Section 4 of the *PICO-GUARD Applications and Design Guide*.)
2. Inspect entire fiber run for:
   - Cut or pinched fiber or jacket. Do not crush or otherwise deform the sheathing.
   - Tight bend radius (e.g., loops with tight bends). Do not exceed 1" minimum bend radius and if possible, not less than 4". (See Section 3 of the *PICO-GUARD Applications and Design Guide*.)
   - Extra splices and/or attenuators.
3. Ensure optimum optical alignment and operating distances between optical elements. Keep the operating distance as short as possible. (See the *PICO-GUARD Applications and Design Guide*.)
4. Check all fiber ends for clean, smooth cuts. Recut as necessary per Section 3.5. Replacing one or more bulk/cut fibers with polished fibers will increase excess gain (model PW...P fibers – see Section 2.2).
5. Check for obstructions (e.g., loose o-rings, sheathing debris, etc.) within optical elements at all connections.
6. Ensure proper seating of the fiber in each optical element.
7. Visually confirm light transmission at each switching point (emitter optical element). A red light should be present. If very dim, replace suspect element (emitter element or previous receiver element or splice in a fiber loop) to see if problem is resolved.
8. Ensure that the environment does not negatively affect the optical fiber or the optical elements.

5.4 Servicing and Maintenance

5.4.1 Cleaning

The PICO-GUARD System controller housing is constructed of polycarbonate and is rated IEC IP20. It may be dusted, but avoid contact with any liquids.

5.4.2 Warranty Service

The PICO-GUARD System is designed for reliability. Do not open the controller housing, other than to access the configuration switches. Do not open the housing of the interface module, if used. They contain no field-replaceable components. If repair is necessary, do not attempt to repair a PICO-GUARD controller or interface module yourself; return the unit to the factory.

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

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

   Banner Engineering Corp., Application Engineering Group
   9714 Tenth Avenue North
   Minneapolis, MN 55441

   Phone: 763.544.3164 or
   Toll-Free (US only): 888.373.6767
   email: sensors@bannerengineering.com

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

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

6. Periodic Checkout Procedures

Study each procedure in its entirety, to be sure to understand each step before beginning. Refer all questions to the Banner Applications Engineering Department at the address or numbers listed on the front cover of this manual. Checkouts must be performed as detailed in Section 6.1 below and results should be recorded and kept in the appropriate place (e.g., near the machine, and/or in a technical file).

6.1 Schedule of Checkouts

Initial Checkout: The procedure for initial checkout of the PICO-GUARD System is described in Section 3.8. This procedure is performed at installation, and at any time the system, the guarded machine, or any part of the application is installed or altered. The procedure must be performed by a Qualified Person (as defined in Section 3.2).

Commissioning Checkout: Should be performed at installation or whenever changes are made to the system (either a new configuration of the PICO-GUARD System or changes to the machine). The procedure must be performed by a Qualified Person.

Daily Checkout: The procedure for "daily" checkout of the PICO-GUARD System is to be performed at each shift change or machine setup change, whenever the system is powered up — at least daily. The procedure is listed on the Daily Checkout cards and may be performed by a Designated Person or a Qualified Person.

Semi-Annual Checkout: The procedure for initial checkout of the PICO-GUARD System is to be performed every six months, following installation of the System. The procedure must be performed by a Qualified Person.

6.2 Trip Test

The procedure for the Trip Test is dependent on the types of optical element(s) used. Refer to the appropriate Daily Checkout procedure(s) for Trip Testing the optical element(s) used in your application.

6.3 Commissioning Checkout

Perform this checkout procedure as part of System installation (after the System has been interfaced to the guarded machine as described in Section 3.9), or whenever changes are made to the System (either a new configuration of the PICO-GUARD System or changes to the machine). *Checkouts must be performed by a Qualified Person (as defined by OSHA and in the Safety Glossary of the manual). A copy of the checkout results should be kept on or near the machine: see OSHA 1910.217(e)(1).*

To prepare the System for this checkout, set the System configuration as it will be during machine operation.

The Qualified Person must:

1) ☐ Examine the guarded machine to verify that it is of a type and design compatible with the PICO-GUARD System. See Section 1.2 for a list of misapplications.

2) ☐ **Verify that the maximum gap openings or minimum separation distances** meet the calculated amounts per the *PICO-GUARD Application and Design Guide*.

3) ☐ **Verify that:**
- **Access to any dangerous parts of the guarded machine** is not possible from any direction not protected by the PICO-GUARD System, hard guarding, or supplemental safeguarding, and
- **It is not possible for a person to stand** inside the guarded area, or
- **Supplemental safeguarding and hard guarding,** as described by the appropriate safety standards, are in place and functioning properly in any space between the optical elements and any hazard which is large enough to allow a person to stand undetected by the PICO-GUARD System.

4) ☐ **Verify that:**
- **The Reset switch is mounted outside the guarded area,** out of reach of anyone inside the guarded area,
- **There are no individuals within the guarded area,** or otherwise exposed to hazards, and
- **The means of preventing inadvertent use is in place.**

5) ☐ **Examine the electrical wiring connections** between the PICO-GUARD System OSSD outputs and the guarded machine's control elements to verify that the wiring meets the requirements stated in Section 3.9.

6) ☐ **Inspect the area near the optical elements** (including guard frame pieces, work pieces and the guarded machine) for reflective surfaces. (Reflective surfaces may cause light to reflect around an object in a beam, preventing normal detection of the safeguard and not stopping the machine motion.) Remove the reflective surfaces as possible by relocating them, painting, masking or roughening them. Remaining problem reflections will become apparent during step 12.

7) ☐ **If the USSI inputs are to be used,** verify the system(s) checkout procedures for the external safety systems or other devices connected to the USSI inputs as described by the appropriate manuals.

Do not proceed until all checkout procedures are completed successfully and all problems have been corrected.

8) ☐ **Apply power to the PICO-GUARD System. Ensure that power to the guarded machine is OFF.** Remove all obstructions from the light beams. If the controller is configured for Auto Power-up, it will automatically perform a system reset on power-up, after the internal system tests are completed. If the controller is configured for Manual Power-up, verify that the System Reset indicator is double-flashing. Perform a System Reset (close the System Reset switch for 1/4 to 2 seconds, then open it). Verify that the System Reset indicator goes OFF.

9) ☐ Observe the status indicators on the controller to determine System status:

A stop condition, indicated by:
System Status and OSSD indicators steady Red
One or more channel indicators steady Red
external stop device or external stop device 2 input indicators steady Red

A run condition, indicated by:
System Status and both OSSD indicators steady Green
Channel indicators of all enabled channels steady Green (flickers Green if excess gain is marginal)
Channel indicators for disabled channels OFF
All external stop Device Input indicators steady Green

An optical channel latch condition, indicated by:
System Status indicator steady Red
System Reset indicator flashing Yellow
Channel indicators of all enabled channels steady Green (flickers Green if excess gain is marginal)
Channel indicators for disabled channels OFF
Latch Output: outputs come back ON only when all enabled channels are clear and after a System Reset.

A External Stop Device latch condition, indicated by:
System Status indicator steady Red
external stop device Reset indicator flashing Yellow
Both external stop device input indicators Green
The external stop device latch will be cleared only when both external stop device inputs are closed (ON) and after a external stop device Reset.

A lockout condition, indicated by:
System Status indicator flashing Red
Additional indicators may also flash Red to indicate the error type

10) ☐ **If in a run condition, go to step 11.**

If in a lockout condition, refer to Section 5.

A stop condition indicates that an optical element is misaligned or interrupted or that a external stop device stop signal is present. To correct this situation:

a) Check carefully the position of optical elements (open or closed) or for any obstruction in the beam path.

b) Check for contamination. Clean the optical element windows as required (see *PICO-GUARD Application and Design Guide*).

c) If the beam path is completely clear of obstructions and all interlock switches are closed, realign the optical elements, as described in Section 3.6.

d) Check the USSI inputs and device operation per Section 4.5.

If the System is in an optical latch condition, perform a System Reset.

If the System is in a USSI 1 latch, perform a USSI 1 Reset.

WARNING . . . Before Applying Power to the Machine or Initiating Machine Motion

Verify that the guarded area is clear of personnel and unwanted materials (such as tools) before applying power to the guarded machine.

Failure to do so could result in serious bodily injury or death.

11) ☐ **Apply power to the guarded machine** and verify that the machine does not start up.

12) ☐ Once the System Status and OSSD indicators are steady Green, **perform the Trip Test** (described on the appropriate Daily Checkout Card) to verify proper System operation and proper operation of each optical element of all enabled optical channels.

WARNING . . . If Trip Test Indicates a Problem

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

13) ☐ **Initiate machine motion of the guarded machine** and, while it is moving, open (block) the beam through an optical element. Do not attempt to reach into the dangerous parts of the machine. Upon opening (blocking) the beam, the dangerous parts of the machine should come to a stop with no apparent delay. Upon closing (clearing) the beam, verify that **the machine does not automatically restart,** and that the initiation devices must be engaged to restart the machine.

14) ☐ **Block (open) a channel beam** and verify that it is not possible for the guarded machine to be put into motion while a beam is blocked (open).

15) ☐ **If USSI inputs are used,** initiate machine motion of the guarded machine and, while it is moving, generate a USSI stop signal by actuating a external stop device. Do not attempt to reach into the dangerous parts of the machine. When the USSI signal occurs, the dangerous parts of the machine should come to a stop with no apparent delay. Clear the USSI stop signal, and verify that **the machine does not automatically restart**, and that the initiation devices must be engaged to restart the machine. Repeat for all other external stop devices.

16) ☐ **Remove electrical power to the PICO-GUARD System.** All OSSD outputs should immediately turn OFF, and should not be capable of turning ON until power is re-applied and, if configured for Manual Power-up, a system reset is performed (Auto Power-up requires no system reset).

17) ☐ **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. (Banner's Applications Engineering Department can recommend a suitable instrument.)

Do not continue operation until the entire checkout procedure is complete and all problems are corrected.

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

If all of these checks cannot be verified, do not attempt to use the PICO-GUARD System/ guarded machine until the defect or problem has been corrected (see Section 5).

Attempts to use the guarded machine under such conditions could result in serious bodily injury or death.

6.4 Daily Checkout Procedure

The procedure for the Daily Checkout is dependent on the types of optical element(s) used. Refer to the appropriate Daily Checkout procedure(s) contained on the Daily Checkout cards included in the controller lit packet, for Trip Testing the optical element(s) used in your application.

If Daily Checkout cards are missing, copies are available by contacting Banner Engineering or download at www.bannerengineering.com.

6.5 Semi-Annual Checkout Procedure

To Be Performed Every Six Months Following System Installation:

Perform this checkout procedure as part of System installation (after the System has been interfaced to the guarded machine as described in Section 3.9), and every six months following the installation of the System. *Semi-Annual checkouts must be performed by a Qualified Person (as defined by OSHA and in the Safety Glossary of the manual). A copy of the checkout results should be kept on or near the machine: see OSHA 1910.217(e)(1).*

To prepare the System for this checkout, set the System configuration as it will be during machine operation.

✔ **The Qualified Person must:**

1) ☐ Examine the guarded machine to verify that it is of a type and design compatible with the PICO-GUARD System. See Section 1.2 for a list of misapplications.

2) ☐ **Verify that the maximum gap openings or minimum separation distances** meet the calculated amounts per the *PICO-GUARD Application and Design Guide*.

3) ☐ **Verify that:**
- **Access to any dangerous parts of the guarded machine** is not possible from any direction not protected by the PICO-GUARD System, hard guarding, or supplemental safeguarding, and
- **It is not possible for a person to stand** inside the guarded area, or
- **Supplemental safeguarding and hard guarding,** as described by the appropriate safety standards, are in place and functioning properly in any space between the optical elements and any hazard which is large enough to allow a person to stand undetected by the PICO-GUARD System.

4) ☐ **Verify that:**
- **The Reset switch is mounted outside the guarded area,** out of reach of anyone inside the guarded area,
- **There are no individuals within the guarded area,** or otherwise exposed to hazards, and
- **The means of preventing inadvertent use is in place.**

5) ☐ **Examine the electrical wiring connections** between the PICO-GUARD System OSSD outputs and the guarded machine's control elements to verify that the wiring meets the requirements stated in Section 3.9.

6) ☐ **Inspect the area near the optical elements** (including guard frame pieces, work pieces and the guarded machine) for reflective surfaces. (Reflective surfaces may cause light to reflect around an object in a beam, preventing normal detection of the safeguard and not stopping the machine motion.) Remove the reflective surfaces as possible by relocating them, painting, masking or roughening them. Remaining problem reflections will become apparent during step 11.

7) ☐ **If the USSI inputs are to be used,** verify the system(s) checkout procedures for the external safety systems or other devices connected to the external stop device inputs as described by the appropriate manuals.

Do not proceed until all checkout procedures are completed successfully and all problems have been corrected.

8) ☐ **Apply power to the PICO-GUARD System. Ensure that power to the guarded machine is OFF.** Remove all obstructions from the light beams. If the controller is configured for Auto Power-up, it will automatically perform a system reset on power-up, after the internal system tests are completed. If the controller is configured for Manual Power-up, verify that the System Reset indicator is double-flashing. Perform a System Reset (close the System Reset switch for 1/4 to 2 seconds, then open it). Verify that the System Reset indicator goes OFF.

9) ☐ Observe the status indicators on the controller to determine System status:

A stop condition, indicated by:
System Status and OSSD indicators steady Red
One or more channel indicators steady Red
USSI 1 or USSI 2 input indicators steady Red

A run condition, indicated by:
System Status and both OSSD indicators steady Green
Channel indicators of all enabled channels steady Green (flickers Green if excess gain is marginal)
Channel indicators for disabled channels OFF
All USSI Input indicators steady Green

An optical channel latch condition, indicated by:
System Status indicator steady Red
System Reset indicator flashing Yellow
Channel indicators of all enabled channels steady Green (flickers Green if excess gain is marginal)
Channel indicators for disabled channels OFF
Latch Output: outputs come back ON only when all enabled channels are clear and after a System Reset.

A USSI 1 latch condition, indicated by:
System Status indicator steady Red
USSI 1 Reset indicator flashing Yellow
Both USSI 1 Input indicators Green
The USSI 1 latch will be cleared only when both USSI 1 inputs are closed (ON) and after a USSI 1 Reset.

A lockout condition, indicated by:
System Status indicator flashing Red
Other indicators (indicating error type) may also flash Red

10) ☐ **If in a run condition, go to step 11.**

If in a lockout condition, refer to Section 5.

A stop condition indicates that an optical element is misaligned or interrupted or that a external stop device stop signal is present. To correct this situation:

a) Check carefully the position of optical elements (open or closed) or for any obstruction in the beam path.

b) Check for contamination. Clean the optical element windows as required (see *PICO-GUARD Application and Design Guide*).

c) If the beam path is completely clear of obstructions and all interlock switches are closed, realign the optical elements, as described in Section 3.6.

d) Check the USSI inputs and device operation per Section 4.5.

If the System is in an optical latch condition, perform a System Reset.

If the System is in a USSI 1 latch, perform a USSI 1 Reset.

WARNING . . . Before Applying Power to the Machine

Verify that the guarded area is clear of personnel and unwanted materials (such as tools) before applying power to the guarded machine.

Failure to do so could result in serious bodily injury or death.

11) ☐ **Apply power to the guarded machine** and verify that the machine does not start up.

12) ☐ Once the System Status and OSSD indicators are steady Green, **perform the Trip Test** (described on the appropriate Daily Checkout Card) to verify proper System operation and proper operation of each optical element of all enabled optical channels.

WARNING . . . If Trip Test Indicates a Problem

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

13) ☐ **Initiate machine motion of the guarded machine** and, while it is moving, open (block) the beam through an optical element. Do not attempt to reach into the dangerous parts of the machine. Upon opening (blocking) the beam, the dangerous parts of the machine should come to a stop with no apparent delay. Upon closing (clearing) the beam, verify that **the machine does not automatically restart,** and that the initiation devices must be engaged to restart the machine.

14) ☐ **Block (open) a channel beam** and verify that it is not possible for the guarded machine to be put into motion while a beam is blocked (open).

15) ☐ **If USSI inputs are used,** initiate machine motion of the guarded machine and, while it is moving, generate a USSI stop signal by actuating a external stop device. Do not attempt to reach into the dangerous parts of the machine. When the USSI signal occurs, the dangerous parts of the machine should come to a stop with no apparent delay. Clear the USSI stop signal, and verify that **the machine does not automatically restart**, and that the initiation devices must be engaged to restart the machine. Repeat for all other external stop devices.

16) ☐ **Remove electrical power to the PICO-GUARD System.** All OSSD outputs should immediately turn OFF, and should not be capable of turning ON until power is re-applied and, if configured for Manual Power-up, a system reset is performed (Auto Power-up requires no system reset).

17) ☐ **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. (Banner's Applications Engineering Department can recommend a suitable instrument.)

18) ☐ **If any decrease in machine braking ability has occurred,** make the necessary clutch/ brake repairs, readjust separation distance (Ds) appropriately, record the new Ds calculation on the daily Checkout Procedure card and/or in Section 6.4 of the manual , and re-perform the Daily Checkout Procedure.

19) ☐ **Examine and test the machine primary control elements** (MPCEs) and any intermediary controls (such as interface modules) to verify that they are functioning correctly and are not in need of maintenance or replacement.

20) ☐ **Inspect the guarded machine to verify that no other mechanical or structural problems could prevent the machine from stopping** or assuming an otherwise safe condition when signalled to do so by the PICO-GUARD System.

21) ☐ **Examine and inspect the machine controls and connections to the PICO-GUARD System** to verify that no modifications have been made which adversely affect the System.

Do not continue operation until the entire checkout procedure is complete and all problems are corrected.

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

If all of these checks cannot be verified, do not attempt to use the PICO-GUARD System/guarded machine until the defect or problem has been corrected (see Section 5 of the manual).

Attempts to use the guarded machine under such conditions could result in serious bodily injury or death.

SOURCES

OSHA Documents

Superintendent of Documents
Government Printing Office
P.O. Box 371954
Pittsburgh, PA 15250-7954
Tel: (202) 512-1800
http://www.osha.gov

ANSI Accredited Standards

American National Standards Institute (ANSI)
11 West 42nd Street
New York, NY 10036
Tel: (212) 642-4900
http://www.ansi.org

B11 Documents

Safety Director
The Association for Manufacturing Technology (AMT)
7901 Westpark Drive
McLean, VA 22102
Tel: (703) 893-2900
http://www.mfgtech.org

RIA Documents

Robotics Industries Association (RIA)
900 Victors Way, P.O. Box 3724
Ann Arbor, MI 48106
Tel: (734) 994-6088
http://www.robotics.org

NFPA Documents

National Fire Protection Association
1 Batterymarch Park
P.O. Box 9101
Quincy, MA 02269-9101
Tel: (800) 344-3555
http://www.nfpa.org

Alternate sources for these, plus ISO, IEC, EN, DIN, & BS Standards:

Global Engineering Documents
15 Inverness Way East
Englewood, CO 80112-5704
Tel: (800) 854-7179
http://www.global.ihs.com

National Standards Systems Network (NSSN)
25 West 43rd Street
New York, NY 10036
Tel: (212) 642-4980
http://www.nssn.com

Document Center, Inc.
111 zindustrial Road, Suite 9
Belmont, CA 94002
Tel: (650) 591-7600
http://www.document-center.com

U.S. Application Standards

ANSI B11.1 Mechanical Power Presses

ANSI B11.2 Hydraulic Power Presses

ANSI B11.3 Power Press Brakes

ANSI B11.4 Shears

ANSI B11.5 Iron Workers

ANSI B11.6 Lathes

ANSI B11.7 Cold Headers and Cold Formers

ANSI B11.8 Drilling, Milling, and Boring Machines

ANSI B11.9 Grinding Machines

ANSI B11.10 Metal Sawing Machines

ANSI B11.11 Gear Cutting Machines

ANSI B11.12 Roll Forming and Roll Bending Machines

ANSI B11.13 Single- and Multiple-Spindle Automatic Bar and Chucking Machines

ANSI B11.14 Coil Slitting Machines/ Systems

ANSI B11.15 Pipe, Tube, and Shape Bending Machines

ANSI B11.16 Metal Powder Compacting Presses

ANSI B11.17 Horizontal Extrusion Presses

ANSI B11.18 Machinery and Machine Systems for the Processing of Coiled Strip, Sheet, and Plate

ANSI B11.19 Performance Criteria for Safeguarding

ANSI B11.20 Manufacturing Systems/ Cells

ANSI B11.21 Machine Tools Using Lasers

ANSI B11.22 Numerically Controlled Turning Machines

ANSI B11.23 Machining Centers

ANSI B11.24 Transfer Machines

ANSI B11.TR3 Risk Assessment

ANSI/RIA R15.06 Safety Requirements for Industrial Robots and Robot Systems

NFPA 79 Electrical Standard for Industrial Machinery

OSHA Regulations

OSHA Documents listed are part of: Code of Federal Regulations Title 29, Parts 1900 to 1910

OSHA 29 CFR 1910.212 General Requirements for (Guarding of) All Machines

OSHA 29 CFR 1910.147 The Control of Hazardous Energy (lockout/tagout)

OSHA 29 CFR 1910.217 (Guarding of) Mechanical Power Presses

International/European Standards

ISO/TR 12100-1 & -2 (EN 292-1 & -2) Safety of Machinery – Basic Concepts, General Principles for Design

ISO 13852 (EN 294) Safety Distances . . . Upper Limbs

ISO 13850 (EN 418) Emergency Stop Devices, Functional Aspects – Principles for Design

ISO/DIS 13851 (EN 574) Two-Hand Control Devices – Functional Aspects – Principles for Design

ISO 13853 (prEN 811) Safety Distances . . . Lower Limbs

ISO 13849 (EN 954-1) Safety-Related Parts of Control Systems

ISO/DIS 13855 (**EN 999)** The Positioning of Protective Equipment in Respect to Approach Speeds of Parts of the Human Body

ISO 14121 (EN 1050) Principles of Risk Assessment

ISO 14119 (EN 1088) Interlocking Devices Associated with Guards – Principles for Design and Selection

IEC/EN 60204-1 Electrical Equipment of Machines Part 1: General Requirements

IEC/EN 61496 Electro-sensitive Protection Equipment

IEC 60529 Degrees of Protection Provided by Enclosures

IEC/EN 60947-5-1 Low Voltage Switchgear – Electromechanical Control Circuit Devices

IEC/EN 60947-1 Low Voltage Switchgear – General Rules

the machine safety specialist

WARRANTY: Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. 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 does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.

P/N 69761 rev. B

Banner Engineering Corp., 9714 Tenth Ave. No., Mpls., MN 55441 • Ph: 763.544.3164 • www.bannerengineering.com • Email: sensors@bannerengineering.com