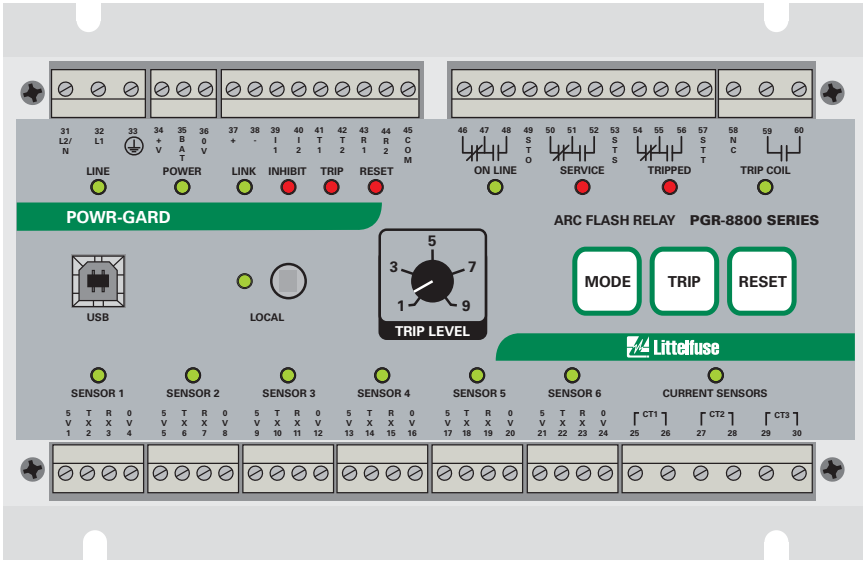
PGR-8800

ARC FLASH RELAY

November 8, 2011

REVISION 1



CONTENTS

1 INTRODUCTION

The PGR-8800 Arc Flash Relay is a high-speed, arc-detection device for electrical power-distribution systems. The PGR-8800 has one local sensor and supports both point and fiber sensor technologies for optical arc detection. There are inputs for six optical sensors and three current sensors.

On the occurrence of an arc fault, the PGR-8800 detects the fault and pulses the trip contact in less than 1 ms. The tripping pulse is typically used to trip the circuit breaker(s) supplying the installation. The total arcing time is effectively reduced to the mechanical opening time of the circuit breaker, typically between 30 and 75 ms. The trip contact is a solid-state switch (IGBT), which provides fast reaction and sufficient drive capability for circuit-breaker trip circuits.

Using optical sensors rather than relying strictly on current measurement allows for a much faster detection time than overcurrent relays or the circuit breaker alone can provide. This in turn will lower the incident energy of the arc-flash and increase worker safety, reduce fault damage, and improve uptime. Since the incident energy is decreased, the hazard risk category (HRC) and associated level of Personal Protective Equipment (PPE) may also be lowered subject to an arc flash study modeling the system parameters.

The PGR-8800 can be used on any electrical system with any voltage (ac or dc) and can be powered from either an ac or dc source, or both. If it is powered from line supply, it can charge a backup battery to power the PGR-8800 when the line supply is lost.

1.1 Current-Supervised Arc-Flash Protection

The PGR-8800 integrates three phase-current measurements which can be used to prevent optical trips when the measured current is below a user-specified level. This makes it possible to avoid nuisance tripping from external light sources such as lightning or welding arcs.

1.2 Definite-Time Overcurrent Protection

Using the phase-current inputs, the PGR-8800 is capable of tripping on overcurrent with a reaction time of less than 1 ms. There are two user-adjustable levels of overcurrent protection with independent trip times to coordinate with other protective devices. This provides protection from long-lasting overload conditions and fast reaction to overcurrent even when no arcing is detected.

1.3 Fail-Safe Operation

The PGR-8800 continuously monitors its internal circuitry as well as the connected sensors. Any system faults, including a sensor-cable fault, are indicated by a flashing LED and can be logged. A redundant trip circuit ensures that the PGR-8800 will trip on an arc flash even if a primary trip-circuit component fails. The solid-state design of the redundant trip circuit also provides a significantly faster response to an arc on power-up (for example, after maintenance during a shutdown) than is possible with microprocessor-only relays.

1.4 Fast Fault Location

Every optical sensor used with the PGR-8800 includes LED indication of health and, if it has detected an arc flash, of fault location. The PGR-8800 also has one LED per sensor to indicate which sensor(s) have caused a trip.

1.5 USB Interface

A USB interface on the front of the PGR-8800 provides easy PC access to configuration settings and access to an event log which provides detailed diagnostic information about measurements before and after a trip. No PC driver or software installation is required.

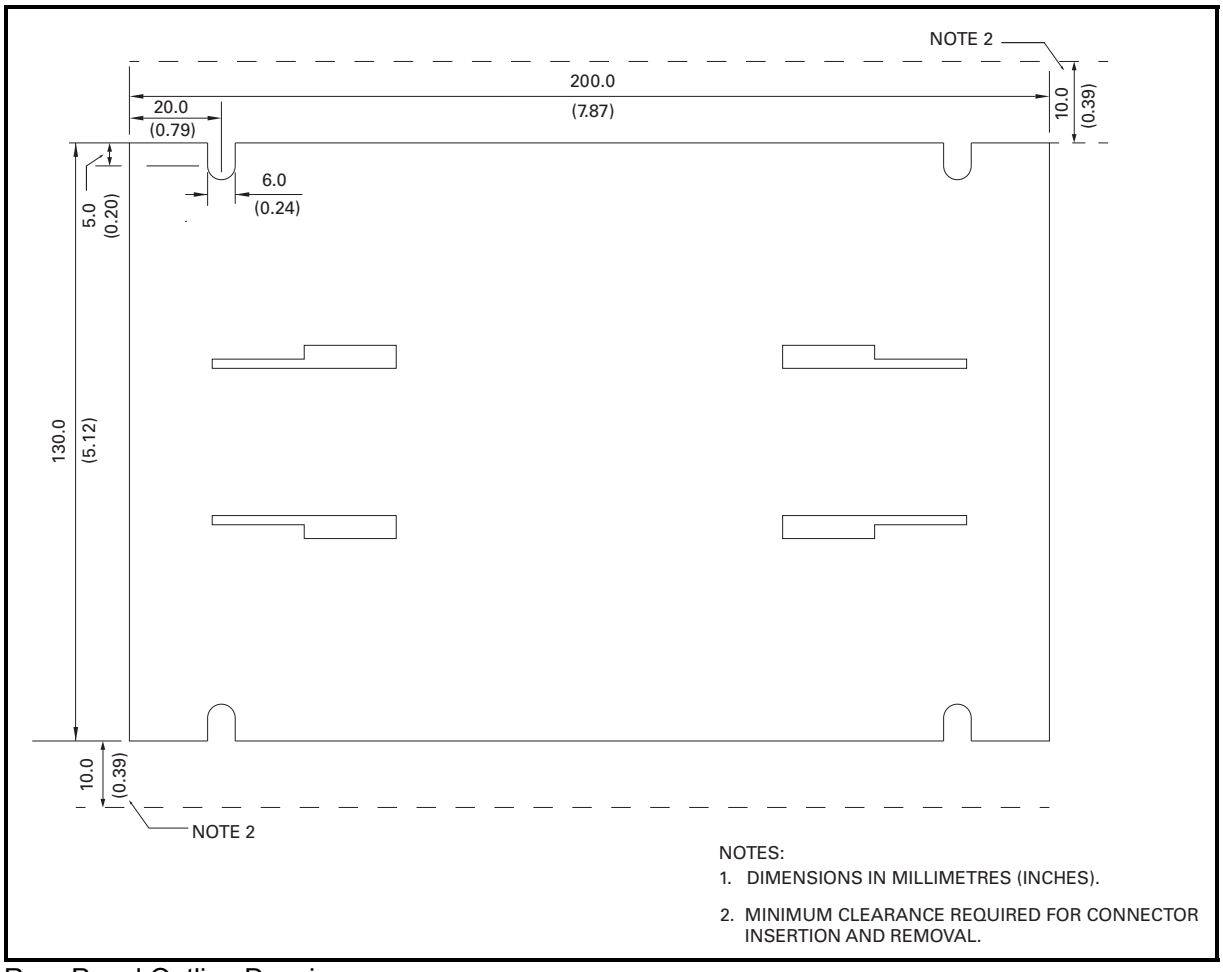
1.6 Scalable System

Up to four PGR-8800 modules can be connected into a single system, allowing a total of 24 optical sensors per system.

2 INSTALLATION

Surface-mount the PGR-8800 using four 5-mm (10-32) screws. Alternatively, attach the included DIN-rail mounting brackets (PGA-0031) to the rear slots provided.

Ensure there is enough clearance around the module to allow the plug-in terminals to be removed and inserted.



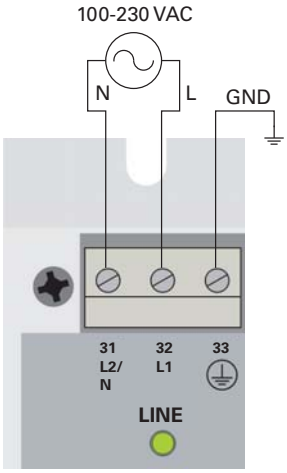
Rear Panel Outline Drawing

3 POWER SUPPLY

The PGR-8800 Arc Flash Relay can be supplied by ac or dc.

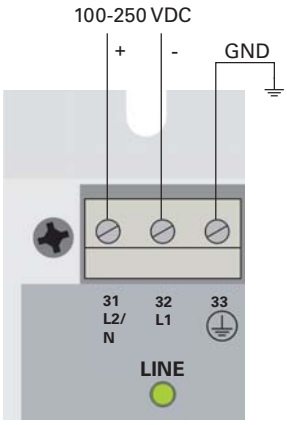
3.1 AC Supply: 100 to 230 V

Use terminals 31 and 32 for an ac supply. The supply voltage must be between 100 and 230 volts.



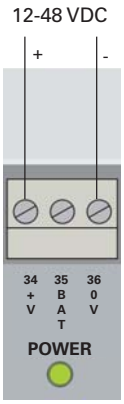
3.2 DC Supply: 100 to 250 V

Use terminals 31 and 32 for a 100 to 250 volt dc supply.



3.3 DC Supply: 12 to 48 V

Use terminals 34 and 36 for a low-voltage dc supply. The supply voltage must be between 12 and 48 volts.



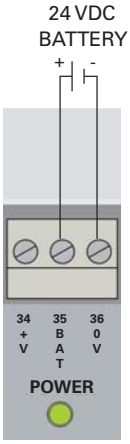
3.4 Battery Supply: 24 V

Use terminals 35 and 36 to connect a 24-Vdc backup battery. The PGR-8800 will charge the battery when there is rated voltage on power-supply terminals 31 and 32 (ac or dc). The PGR-8000 supplies a constant-current, constant-voltage (CCCV) of 27 V with no load and maximum available current of 200 mA. A sealed lead-acid battery with a capacity between 2 and 15 Ah, such as a pair of Panasonic VRLA LC-R122R2P, should be used and exchanged regularly according to the manufacturer's trickle-charge life.

NOTE: The power supply on terminals 34 and 36 will not charge the battery.

If the PGR-8800 is running solely on the battery and the battery voltage drops below 20 V, the PGR-8800 will shut down to protect the battery.

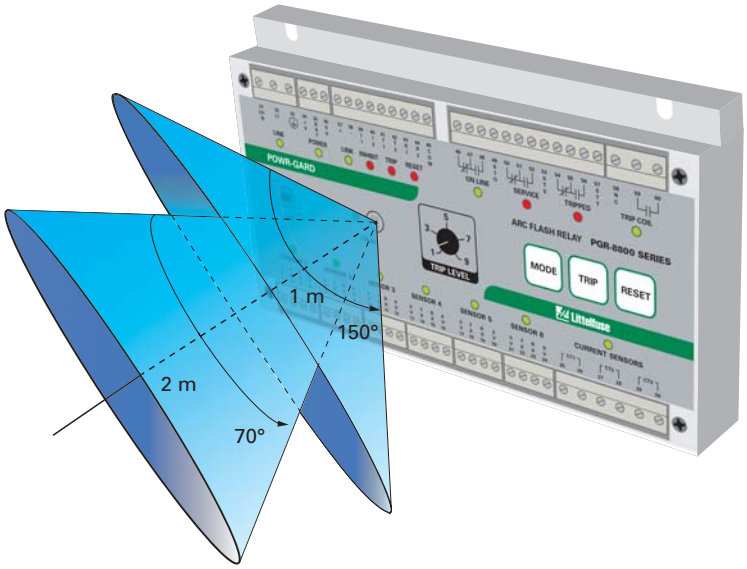
NOTE: Arc monitoring is disabled when the PGR-8800 is powered down.



4 OPTICAL SENSORS

The PGR-8800 has one local sensor and six inputs for external optical sensors. The Local Sensor is primarily used for commissioning and can also be enabled for arc-flash protection. Its light-detection zone is illustrated in the diagram below.

LOCAL SENSOR: DETECTION ZONE OF A 3 KA FAULT



Two external sensor types are supported:

- PGA-LS10 Photoelectric Point Sensors with sensor check
- PGA-LS20 Fiber-Optic Sensors with sensor check

The sensors can be used together, in any combination.

Both sensor types have LED indication of sensor health and fault location. A sensor-check circuit tests the sensor once per second to verify that the sensor assembly is functioning correctly. A healthy sensor will give two quick red flashes of its internal LED every few seconds. A sensor that has detected an arc will slowly flash red.

The sensors connect to the PGR-8800 with shielded three-wire 0.5 mm^2 (20 AWG) electrical cable. Each sensor includes 10 m of cable which can be shortened or extended up to 50 m. These cables should be treated as though at ground potential when considering clearances.

PGA-LS10

PGA-LS20

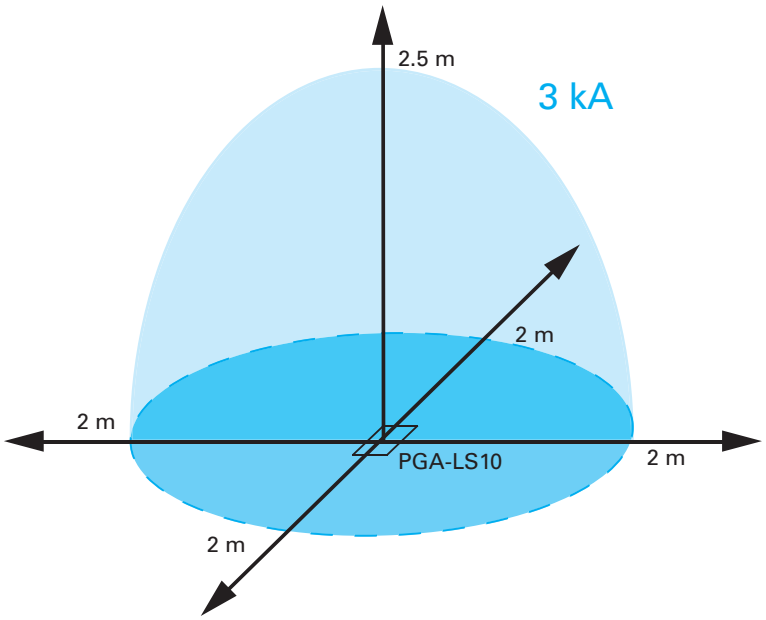
4.1 PGA-LS10 Photoelectric Point Sensors with Sensor Check

This sensor has a detection area of a 2-m half-sphere for arcs of 3 kA or more.

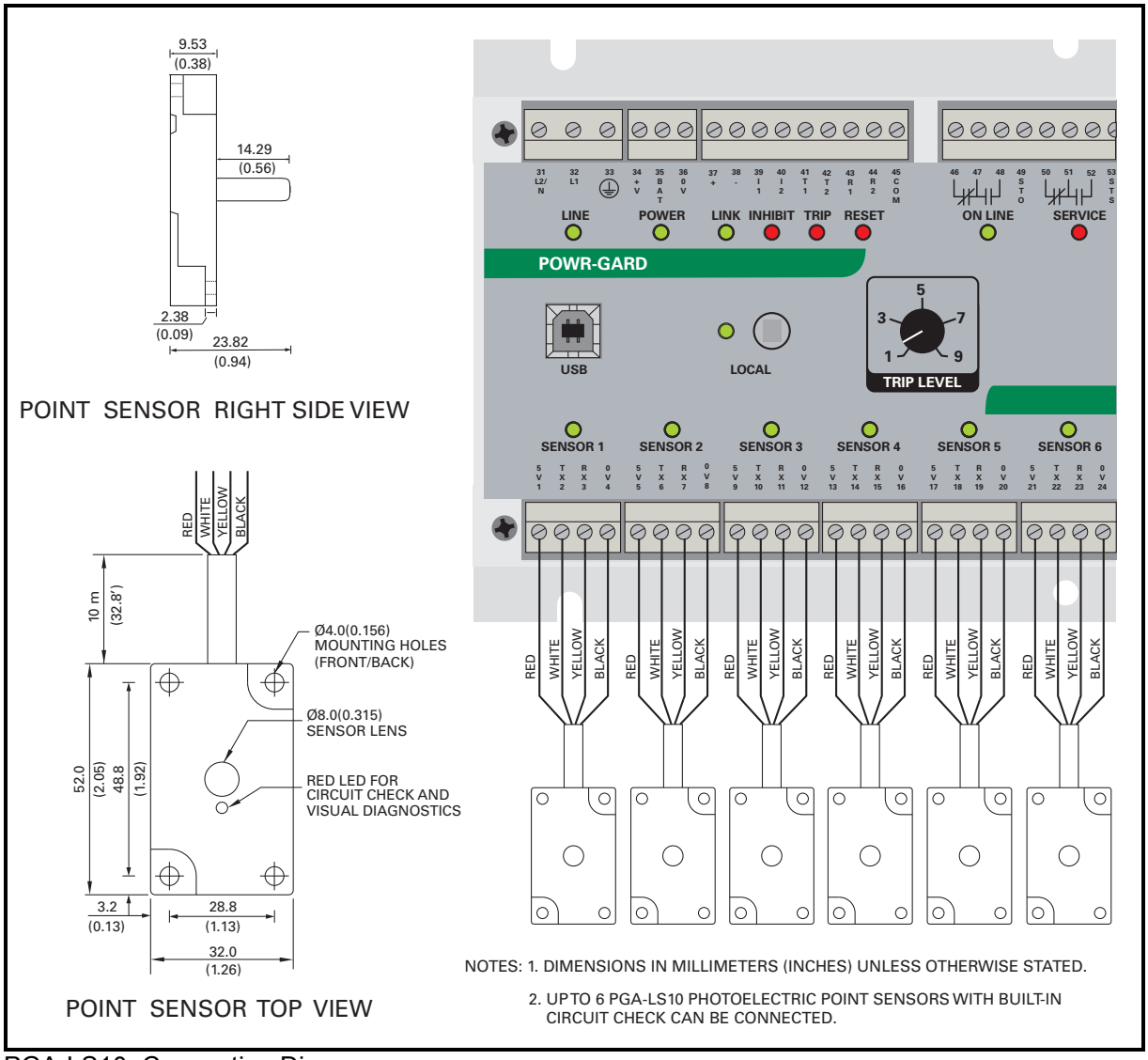
A built-in LED that flashes once per second enables the PGR-8800 to verify the function of the light sensor, wiring, and electronics. If the sensor does not detect the sensor-check LED, a sensor-fail alarm will occur. The ONLINE output will change state and the ONLINE LED will begin to short flash (see Section 9).

The sensor includes 10 m of shielded three-wire electrical cable which can easily be shortened or extended to a maximum of 50 m.

PGA-LS10: DETECTION RANGE OF A 3 KA FAULT



4.1.1 PGA-LS10 Connection

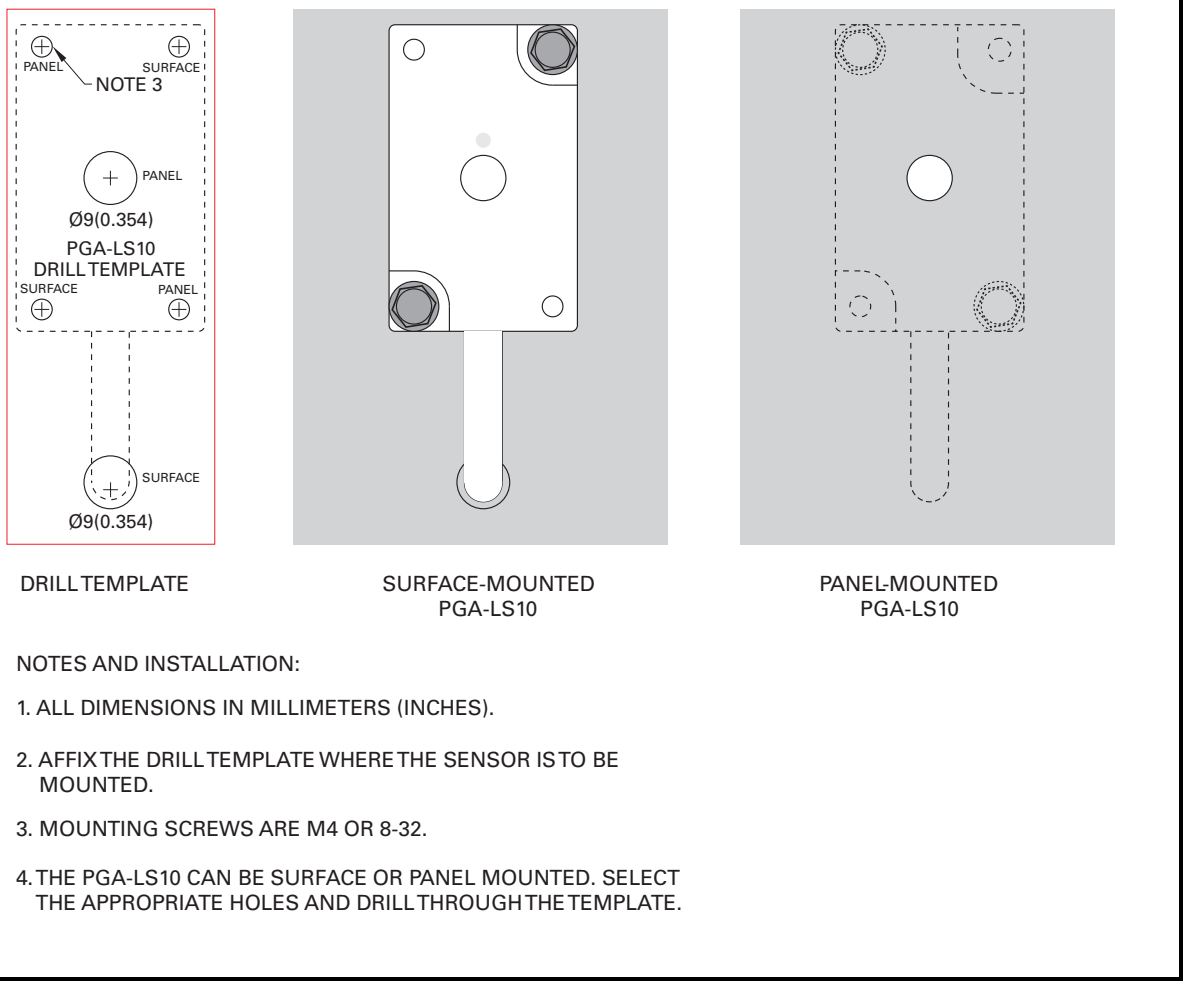


PGA-LS10 Connection Diagram.

Terminal	Function	Color
Terminal 5V	Supply	Red
Terminal TX	Circuit Check Transmit	White
Terminal RX	Receive	Yellow
Terminal 0V	Shield	Black / Copper

4.1.2 PGA-LS10 Installation

Point sensors are delivered with an adhesive-backed drill template for easy surface or panel-mount installation.



PGA-LS10 Mounting Details.

4.2 PGA-LS20 Fiber-Optic Sensor with Sensor Check

The PGA-LS20 has a 360° detection zone along the fiber's length. A built-in LED that flashes once per second enables the PGR-8800 to verify the function of the light sensor, wiring, and electronics. If the sensor does not detect the sensor-check LED, a sensor-fail alarm will occur. The ONLINE output will change state and the ONLINE LED will begin to short flash (see Section 9).

The PGA-LS20 sensor has three components:

1. An 8-m fiber-optic cable, with an end covered with a black sleeve, and an uncovered end.
2. A transmitter with a white enclosure and a white thumb nut.
3. A receiver with a white enclosure, a black thumb nut, and an adjustment screw behind an access hole.

Both the receiver and the transmitter connect to the PGR-8800 using shielded three-wire electrical cable. All three components are monitored to ensure continuity and correct operation.

4.2.1 Fiber

The fiber is the light-collecting element of the PGA-LS20. It must be installed so it has line-of-sight to all current-carrying parts. In some cases this may be accomplished by following the bus bars along the back wall of the cabinets.

Connect the black-sleeve-covered end to the receiver using the thumb nut and the white uncovered end to the transmitter using the white thumb nut. Ensure the fiber is inserted completely into the transmitter and receiver and the nuts are tightened. Pull gently on the cable to ensure a secure connection.

The fiber should not be sharply bent or pinched. The minimum bending radius is 5 cm.

Drill holes using the included drill template and fasten the transmitter and receiver to the cabinet walls using rivets or screws. Connect the attached cables to the PGR-8800. The wires of the transmitter and receiver must be connected as follows.

4.2.2 Receiver

Connect the red wire to 5V.
Connect the yellow wire to RX.
Connect the white wire **and** the shield to 0V.

See PGA-LS20 Connection Diagram.

4.2.3 Transmitter

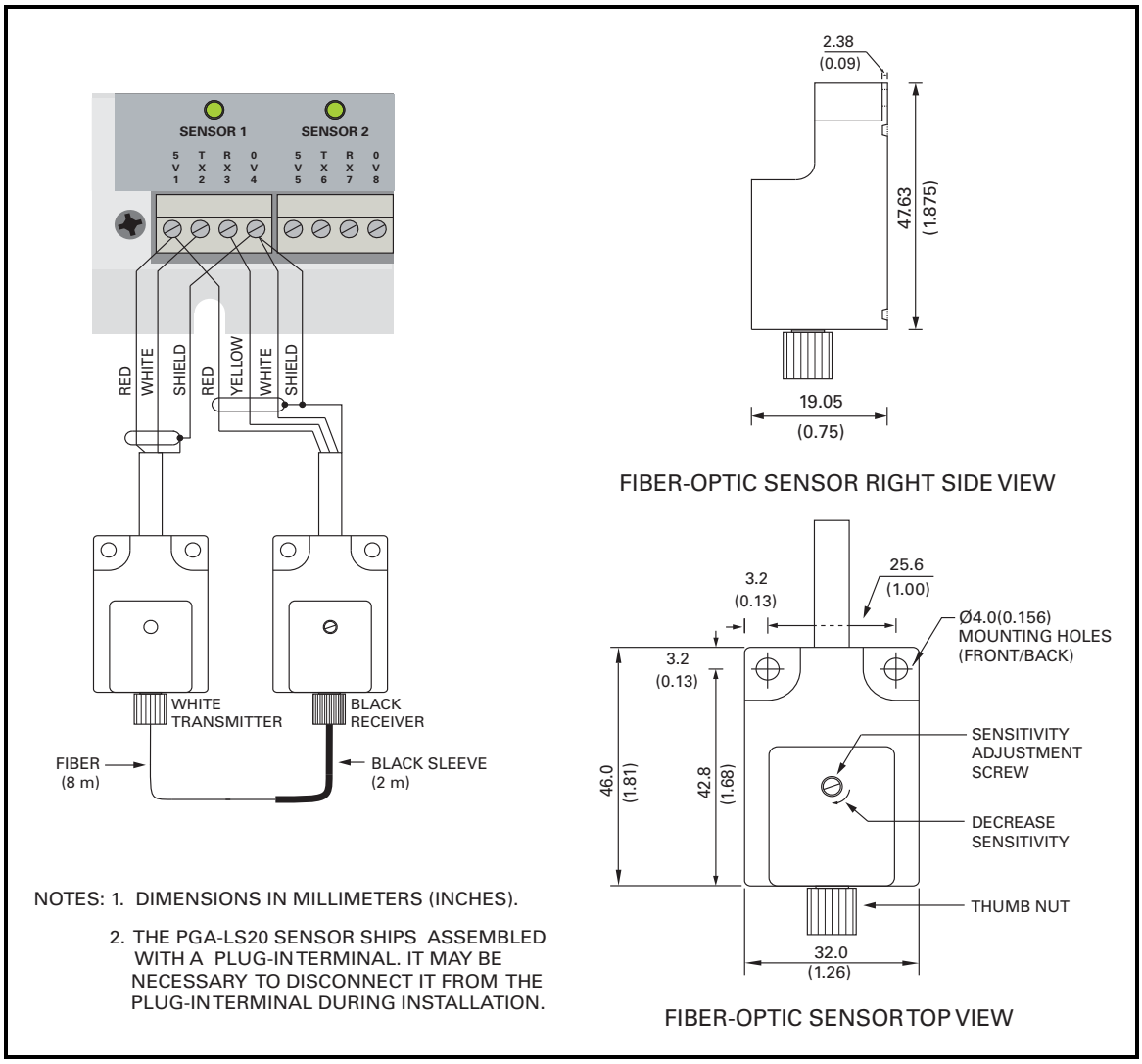
Connect the red wire to 5V.
Connect the white wire to TX.
Connect the shield to 0V.

See PGA-LS20 Connection Diagram.

4.2.4 PGA-LS20 Connection

The sensor is shipped with the wires mounted in a terminal block. See PGA-LS20 Connection Diagram.

The transmitter and receiver are provided with 10 meters of shielded three-wire electrical cable which can be shortened or extended up to 50 meters. Transmitter and receiver cables can be different lengths and must be independently shielded. Failure to do so can lead to false positives for the circuit check – a faulty sensor could be falsely detected as continuous. So long as there is no sensor fault, arc-flash detection will function normally in this condition.



PGA-LS20 Connection Diagram.

Terminal	Function	Color
Terminal 5V	Supply (transmitter and receiver)	Red
Terminal TX	Sensor Check (transmitter)	White
Terminal RX	Signal (receiver)	Yellow
Terminal 0V	Both shields and Sensor Check (receiver)	Black / Copper

4.2.5 Fiber-Optic Sensor Adjustment

The sensor is calibrated at the factory for 60 cm of fiber in each monitored compartment. When using the fiber optic sensor in compartments with less than 60 cm of fiber, the sensitivity may have to be adjusted. The sensor is unable to differentiate between 10,000 lux hitting 60 cm of fiber and 30,000 lux hitting 20 cm of fiber – the same amount of light is transmitted through the fiber to the receiver. To achieve the desired sensitivity, the receiver (with the black thumb nut) must be adjusted.

4.2.5.1 Sensor Adjustment According to Fiber Length

To adjust for fiber length, a powerful light source (at least a 100 lumen flashlight or a hotshoe camera flash) is required. Use the following procedure to calibrate the sensor:

1. Switch the PGR-8800 to Service mode by pressing the MODE button. The red SERVICE LED will light.
2. Adjust the TRIP LEVEL setting to 1 on the PGR-8800.
3. Slowly move the lamp towards the LOCAL sensor on the front of the PGR-8800.
4. Note the distance from the lamp to the sensor when the LOCAL LED starts blinking.
5. Adjust the receiver (black thumb nut) sensitivity level to the minimum by turning the small metal screw clockwise until it begins to click. This may be too low to detect the sensor-check signal and cause the related LED on the relay to flash red.
6. Place the lamp facing the fiber in the compartment closest to the transmitter end (white thumb nut) of the fiber at the distance observed in step 4. This allows for loss along the full length of the fiber.
7. Turn the metal screw on the receiver counter-clockwise until the PGR-8800 sensor-indicator LED for that sensor turns red. If the LED was already flashing red in step 5, it should turn green first.
8. Adjust the TRIP LEVEL setting back to the desired position.

The sensitivity level of the fiber-optic sensor is now correctly adjusted.

4.2.5.2 Sensor Adjustment in Small Compartments

If the fiber-optic sensor is used in multiple compartments of varying width, the sensor must be adjusted in the compartment of the narrowest width. If the lamp cannot be placed far enough away in the compartment to follow the above procedure, the sensitivity-adjustment procedure can be modified as follows:

1. Switch the PGR-8800 to service mode by pressing the MODE button.
2. In the compartment of the narrowest width, measure the distance from the fiber-optic sensor to the lamp when the lamp is placed at the point in the compartment where it is furthest away.
3. Set the TRIP LEVEL to 9 on the PGR-8800.
4. Place the lamp facing the LOCAL sensor on the PGR-8800 at the same distance as measured in step 2.
5. Turn the TRIP LEVEL dial on the PGR-8800 counter-clockwise until the LOCAL LED lights.
6. Adjust the receiver (black thumb nut) sensitivity level to the minimum by turning the small metal screw clockwise until it begins to click. This may be too low to detect the sensor-check signal and cause the related LED on the relay to flash red.
7. Place the lamp in the compartment closest to the transmitter end (white thumb nut) of the fiber at the distance observed in step 2. This allows for loss along the full length of the fiber.
8. Turn the metal screw on the receiver counter-clockwise until the PGR-8800 sensor-indicator LED for that sensor turns red. If the LED was already flashing red in step 6, it should turn green first.

Adjust the TRIP LEVEL setting back to the desired position.

5 SENSOR PLACEMENT

5.1 General Guidelines

Optical sensors require line-of-sight to areas being monitored. Ensure that the sensors and cables are not blocked by fixed or moveable objects. Areas that will be accessed for maintenance or with moveable parts (such as drawout breakers) should be considered a high priority for installation. Do not place sensors or cables on current-carrying components and avoid sharp bends in the cable, particularly when using the PGR-LS20 fiber-optic sensor. The electrical cables and sensors should be treated as though at ground potential when considering clearance.

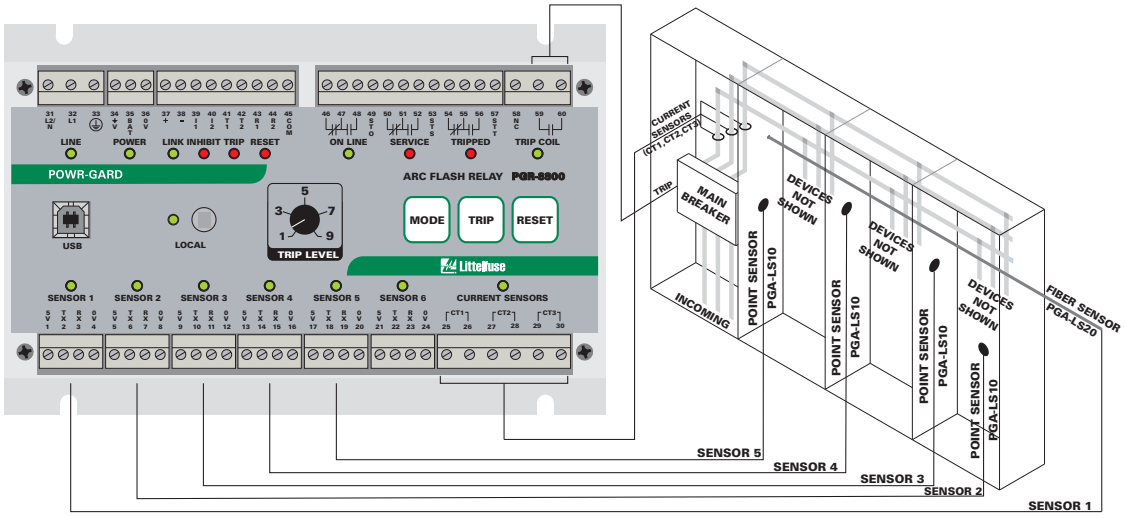
Sensors should be mounted in a location that will minimize the chance of debris or dust build-up with easy access for maintenance if needed. A point sensor mounted at the top of an enclosure and facing down is optimal for reducing dust build-up where such an installation will also provide complete coverage. It should be noted that most enclosures are metallic and the reflectivity combined with the high intensity of an arc mean that even a dirty sensor will collect a great deal of light.

Sensors can be tested individually by putting the PGR-8800 into Service mode and shining a bright light on the sensor. A trip will be indicated if the sensor is able to detect the light but a trip signal will not be sent to the breaker. If the LED on the sensor or relay isn't indicating a trip then a cleaning is necessary. Note that in Service mode, the PGR-8800 will not trip on an arc flash. Remember to return the PGR-8800 to Online mode after testing is completed. In dusty environments, sensor cleaning should be part of a regular maintenance schedule and can be performed using compressed air or a dry wipe down.

5.2 Switchgear Protection

The sensors used for arc-flash detection are optical sensors. Line-of-sight between the points where an arc could appear and the sensor is crucial.

Often one point sensor is sufficient to monitor a complete switchgear compartment. However, if there are large components such as circuit breakers that cast shadows over wider areas, more than one point sensor is required.



5.3 Transformer Protection

The Arc-Flash Relay can also be used for the protection of transformers. Two or more point sensors should be used per transformer to monitor the primary and secondary connection terminals. For the placement of the sensors, the same considerations apply as for switchgear protection.

6 CURRENT SENSORS

The PGR-8800 can measure phase currents. This can be helpful in preventing optical false trips. When this function is used, the PGR-8800 will only trip when the following conditions apply:

- An arc is detected by an optical sensor, and
- Current detected by a current sensor exceeds the user-defined threshold.

Two definite-time overcurrent protection levels are provided that will trip on current detection alone.

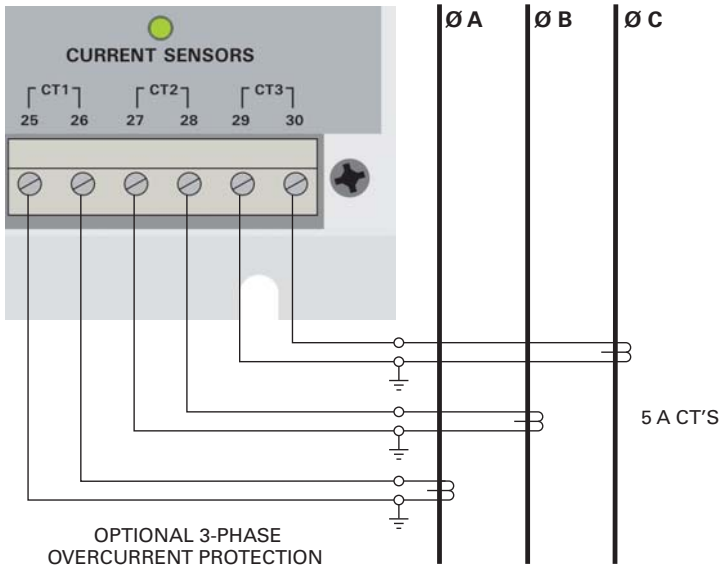
The current-sensor inputs require 5-A-secondary current transformers. Three phase CT's are required for optimal performance. The resolution is 100 mA. Due to the quick reaction time needed for arc detection, accuracy is approximately 1 A (secondary current). For best performance, select a CT with a primary rating approximately equal to the system's rated current.

NOTE: Using current-based protection on a system with fewer than three phase CT's can significantly increase trip times and levels.

The current-sensor inputs are sampled at 2 kHz and will withstand 75 A for 1 s. CT burden is less than 0.25 VA. The current-sensor inputs are isolated from all other terminals to a maximum of 500 Vac. CT-leads can be up to 2.5 mm^2 (14 AWG).The PGR-8800 measures instantaneous currents and is insensitive to phasing and polarity. Overcurrent protection is not active by default, and must be set using the configuration software. Overcurrent levels can be set from 150% to 1000% and current-supervision levels can be set from 10 to 1000% of full-load current.

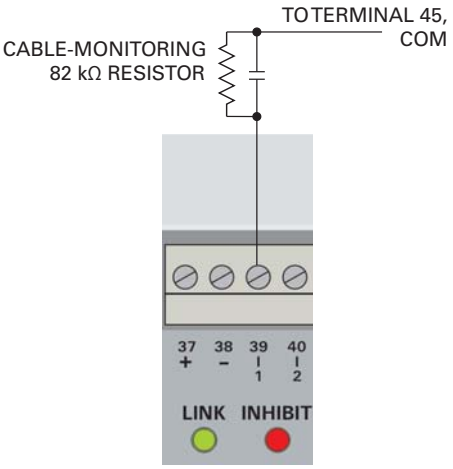
Overcurrent trip times can be set between 1 ms and 20 s. The PGR-8800 samples the current-sensor inputs at 2 kHz or once every 0.5 ms. The time for the IGBT to operate is approximately 0.2 ms. At the minimum time delay of 1 ms, the PGR-8800 will therefore trip as soon as the absolute value of one sample on any phase exceeds the trip-level setting. Otherwise, the trip decision is based on an internal counter. The PGR-8800 will increment the counter if a sample exceeds the trip-level setting and decrement it when the sample is below the setting. When the counter exceeds the number of samples necessary to exceed the time delay, the PGR-8800 will trip.

Terminal 25-26	Current Sensor Phase A
Terminal 27-28	Current Sensor Phase B
Terminal 29-30	Current Sensor Phase C



7 AUXILIARY INPUTS

The PGR-8800 has three auxiliary inputs; trip inhibit, trip and reset. Each function has two redundant inputs to simplify wiring. A circuit-check feature can be enabled for each auxiliary input. This function must be enabled in the configuration software. Circuit check requires an 82 kΩ resistor connected in parallel with the external contact. This resistor must be connected as close as possible to the contact to ensure the full-length of the cable is protected.



By default, the inputs are considered active when connected to COM (terminal 45). The inputs can be configured to be active when high or to use circuit check in the configuration software (see Section 12.7).

7.1 Inhibit

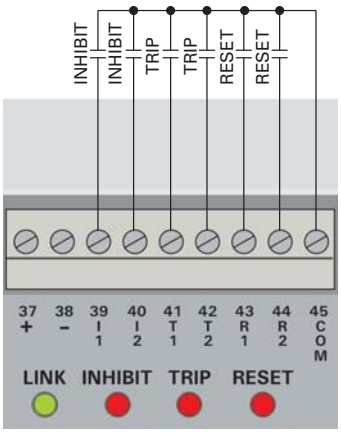
The INHIBIT function suppresses a trip signal.

There are two INHIBIT inputs: terminals 39 and 40.

When activated, the PGR-8800 will only indicate that an arc fault is being detected, but will not pulse the trip-coil output.

Inhibit can also block the remote trip command if enabled (terminals 41 and 42). See Section 12.7.

If the PGR-8800 detects an arc fault while inhibited, the sensor LED and INHIBIT LED will flash.



7.2 Trip

The TRIP input is used to remotely trip the relay. Once activated, the PGR-8800 will pulse the TRIP COIL output instantaneously.

There are two TRIP inputs: terminals 41 and 42.

In SERVICE mode, this input does not affect the TRIP COIL output.

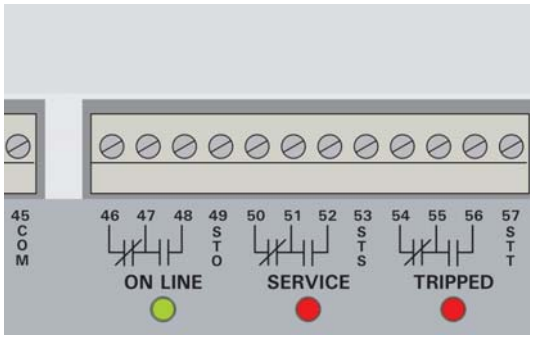
7.3 Reset

The RESET input is used as a remote reset after a fault has been detected.

There are two RESET inputs: terminals 43 and 44.

Activating this input will reset an alarm or error, clear the TRIPPED and TRIP COIL outputs, clear the indicators, and place the unit back in SERVICE or ONLINE mode, depending on the mode it was operating in prior to the trip.

8 OUTPUTS



The PGR-8800 has a Form A Trip Coil output contact and three Form C output contacts. Additionally, each Form C contact has a status output contact associated with it which is referenced to the common terminal 45. An LED provides visual indication of each output status. The output contacts are shown on the faceplate in the powered-off state.

8.1 Online

The ONLINE output consists of two contact sets:

- A voltage-free change-over contact (terminals 46-48)
- A normally-open status contact (STO, 49) with reference to COM (terminal 45)

The ONLINE output is energized unless the PGR-8800:

- detects a sensor fault,
- loses supply voltage, or
- is in service mode

8.2 Service

The SERVICE output consists of two contact sets:

- A voltage-free change-over contact (terminals 50-52)
- A normally-open status contact (STS, 53) with reference to COM (terminal 45)

The SERVICE output signals that the PGR-8800 is being commissioned or set up. The output is energized when the PGR-8800:

- is in service mode, or
- is connected via USB to a PC

8.3 Tripped

The TRIPPED output consists of two contact sets:

- A voltage-free change-over contact (terminals 54-56)
- A normally-open status contact (STT, 57) with reference to COM (terminal 45)

NOTE: The TRIPPED output is used for signalling a trip condition to a remote monitoring system. Due to the slower response time of a mechanical relay, it is NOT used to trip a circuit breaker.

The TRIPPED output will energize if the PGR-8800 detects a fault during regular operation or in service mode.

8.4 Trip Coil

The TRIP COIL output is used to trip a shunt or undervoltage circuit breaker. The operating mode is programmable in the PGR-8800 software.

The TRIP COIL output can be used for trip coils with 24 to 600 Vdc and 24 to 440 Vac supply voltages. The output is monitored to verify that there is voltage available to the tripping circuit. If voltage is not detected, the ONLINE output will change state and its LED will flash green.

The TRIP COIL output is a pulsed output. When an arc flash is detected, the TRIP COIL output is activated in less than 1 ms. When an overcurrent is detected, the TRIP COIL output is activated after an adjustable delay. The TRIP COIL output is deactivated after the adjustable pulse period delay. The output is an IGBT transistor that can carry 10 A ac or dc for five seconds.

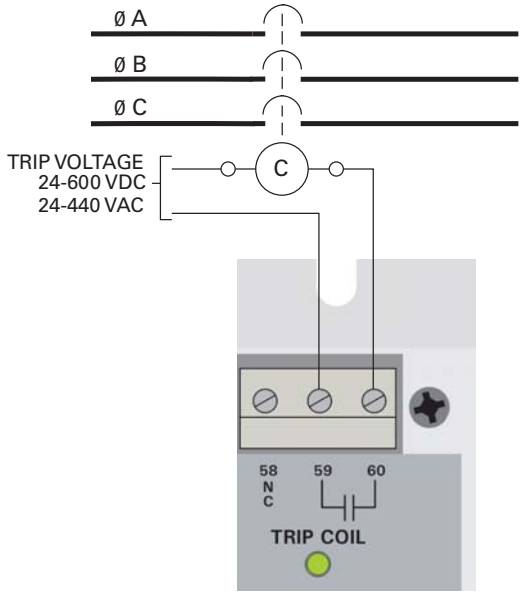
The TRIP COIL output is isolated from the rest of the unit up to 1,000 Vac.

NOTE: The TRIP COIL output is an IGBT (insulated-gate bipolar transistor) switch. There is a voltage drop of 2-4 V over the TRIP COIL output when energized.

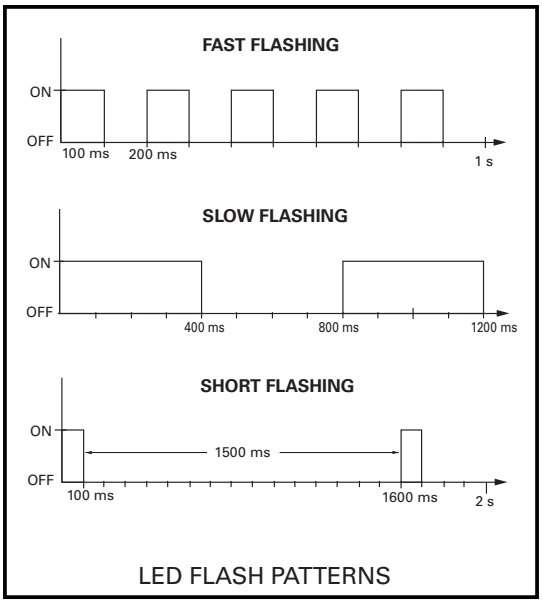
The TRIP COIL output consists of a rectifier bridge and an IGBT. The IGBT is able to switch large currents and high voltages. In combination, this creates a very fast relay-like switch which is able to trip even large circuit breakers without the added delay of a mechanical relay.

NOTE: The TRIP COIL output functions as a momentary switch and is protected against thermal overload. It will gradually lower the time the trip coil is active if the PGR-8800 is tripped repeatedly.

When the PGR-8800 is in Service Mode, the TRIP COIL output will not operate when an arc-flash or overcurrent trip occurs, but it will operate when the TRIP button is pressed for at least 1 s.



9 PGR-8800 LED'S



LED FLASH PATTERNS

LINE

On	Supply voltage is connected
Off	Supply voltage is not connected

POWER

On	PGR-8800 is running from a supply other than battery
Slow flashing	PGR-8800 is running from the Battery input. Be aware that the PGR-8800 will shut down at 20 V to protect the battery from damage
Short flashing	PGR-8800 is charging a battery
Off	PGR-8800 is not powered

LINK

On	Link mode is enabled and active
Slow red flashing	A relay in the system is tripping. If the trip is locally inhibited, the Link LED will revert to green when the trip source is removed
Short red flashing	Link mode is enabled but not all relays are being detected
Off	Link mode is disabled

INHIBIT

On	INHIBIT input is active or current sensing is inhibiting trips (current not above setting)
Fast flashing	The PGR-8800 detects an arc (light), but the INHIBIT input or current sensing is preventing a trip
Short flashing	Circuit check failed; check the wiring of the input, or use the configuration software to disable circuit check
Off	INHIBIT input is inactive

TRIP

On	TRIP input or another trip source is active
Fast flashing	TRIP input is causing a trip
Slow flashing	Last trip was caused by this input or by the TRIP button on the front panel. Press RESET in Online mode to clear the trip
Short flashing	Circuit check failed; check the wiring of the input, or use the configuration software to disable circuit check
Off	TRIP input is inactive

RESET

On	RESET input or another reset source is active
Short flashing	Circuit check failed; check the wiring of the input, or use the configuration software to disable circuit check
Off	RESET input is inactive

ONLINE

On	PGR-8800 is online, active and operational; the TRIP COIL output will pulse if trip conditions are met
Short flashing	PGR-8800 has detected an error. The front panel LED's will provide error information. The TRIP COIL output will still operate if trip conditions are met
Off	PGR-8800 is off or in service mode

SERVICE

On	PGR-8800 is in service mode. Please note it will switch to and stay in service mode if a USB cable is attached. In service mode, the TRIP COIL output can be activated from the front panel TRIP button but not by an arc fault, overcurrent, or TRIP input
	Press and hold RESET to configure the sensors (see Section 13.1)
Short flashing	PGR-8800 in service mode, but has at some point detected an error. The front panel LED's will provide error information
Slow flashing	PGR-8800 is in the process of auto set up or firmware update
Off	PGR-8800 is without power supply or in Online mode

TRIPPED

On	The TRIP COIL output is or has been active or was prevented from activating while in service mode. Press RESET to clear the trip
Off	No unacknowledged trips

TRIP COIL

On, green	TRIP COIL output is ready and powered
Fast red flashing	TRIP COIL output is energized due to an existing trip event
Slow red flashing	TRIP COIL output has been activated but is no longer energized. Press RESET to clear the trip
Short red flashing	TRIP COIL output is blocking less than 5 V. The trip voltage is missing; check the wiring and the power supply to the trip coil

LOCAL

On	ONLINE mode: The front panel sensor is configured for use as a trip sensor The LED may also indicate that the PGR-8800 is booting if it is the only lit LED. If this condition remains after booting, it indicates unit error
Slow flashing	If the SERVICE LED is flashing, the PGR-8800 is awaiting manual confirmation of the connected sensors (see Section 13.1)
Fast flashing	The internal supervisor or a USB host is reading or writing to internal memory, or the light detected on the front sensor is close to trip level

SENSORS

On, green	SENSOR input is active and has a connected sensor
Fast green flashing	Sensor is currently detecting more than 50% of the light level needed to trip. The level at which this occurs is programmable. This is a warning only. If this warning is active during normal condition, it may indicate that the system Trip Level is set too low, which could lead to unintentional tripping
Slow red flashing	Sensor caused a trip event. Press RESET to clear the trip
Short red flashing	Sensor check of the sensor failed; check the wiring and, if using a PGA-LS20, ensure the small metal adjustment screw is not set to minimum sensitivity (see Section 4.2.5).
Off	SENSOR input is inactive

CURRENT SENSORS

On, green	Current sensors are activated and configured
Fast green flashing	Current sensors are activated and are detecting current above the Trip Level
Fast red flashing	Current is above the inhibit level or an arc was detected with current above the inhibit threshold. If the PGR-8800 isn't tripped, a high light level on an optical sensor will now cause the Trip Coil output to activate
Slow red flashing	The PGR-8800 has tripped on overcurrent. Press reset in Online mode to clear the trip
Off	Current sensors are inactive

PGA LS10, PGA-LS20

Short, double flashing	Sensor is operating normally
Slow flashing	Sensor has detected an arc
Off	Sensor disconnected or unpowered.

10 PGR-8800 PUSH BUTTONS

10.1 Mode

The MODE push button switches the PGR-8800 between Online and Service mode.

10.2 Trip

In Service mode, when the TRIP push button is pressed for more than one second, the TRIP COIL output is activated. In Online mode, the TRIP push button has no function.

10.3 Reset

When the PGR-8800 is online and tripped, the RESET push button clears the trip if trip conditions are no longer present.

In service mode, pressing the RESET push button for more than one second resets the stored configuration and activates the manual sensor confirmation sequence. See Section 13.1.

10.4 Mode + Reset

Pressing both MODE and RESET push buttons down for more than 20 seconds initiates a factory-default reset. The internal drives will be reset. Configuration settings will not be lost.

10.5 Mode + Trip

Pressing both MODE and TRIP push buttons down for more than 20 seconds initiates a reset of all configuration settings.

11 LINK

The PGR-8800 Link function allows up to four PGR-8800 modules to be connected to form a single system. This enables the PGR-8800 to share sensor inputs and relay outputs as if they were one unit.

It is necessary to configure the Link function before use.

11.1 Configuration

The Link interface and link address are set up with the configuration software.

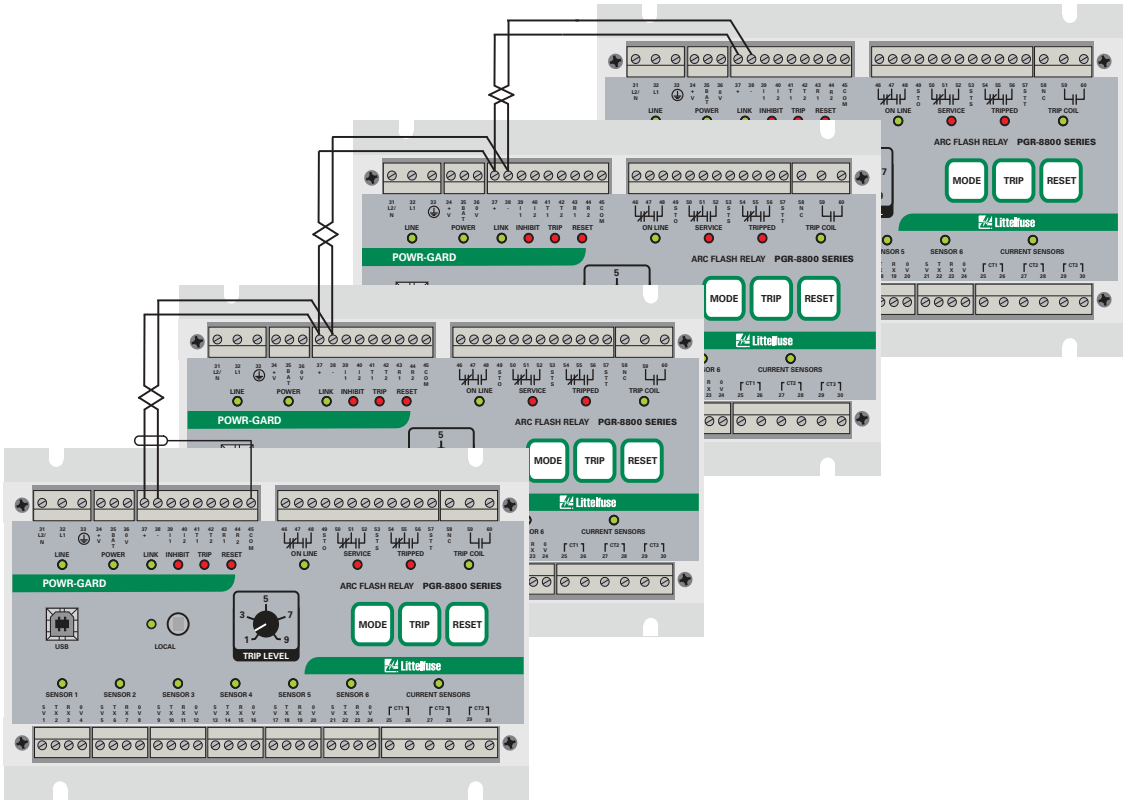
Each PGR-8800 must have a unique link address, starting from 1 for the module connected to the circuit breaker.

The PGR-8800 Link function continuously monitors for cable-break faults and it is therefore necessary to program the number of connected modules.

11.2 Push-Button Function

When a PGR-8800 is configured for the Link function, the front push buttons can be shared with all modules in the system or set to apply only to the local relay. For example, if one PGR-8800 is set to Service mode and interface sharing is enabled, all the linked modules will be placed in Service mode. This also applies to the RESET push button.

The TRIP push button is only applied locally. If the TRIP push button is pressed in Service mode, the module where the button was pressed will be the only one that trips.



Connect modules: terminal 37 to 37, and terminal 38 to 38.

12 USB INTERFACE

The PGR-8800 contains configuration software, data logs, and event records that can be accessed through the USB Interface. No drivers or software installation is required to access configuration or data, simply a USB A-B cable as shown below to connect the PGR-8800 to a computer.

Required USB A-B Cable

The PC application for configuring the PGR-8800 is pre-installed on the internal Configuration drive. When the PGR-8800 is connected to a PC, the Configuration drive (wrench icon) and the Log drive (notepad icon) will appear in the file manager as shown in Section 12.1.

NOTE: The configuration and log-viewer applications are HTML Applications (HTA). HTA is a proprietary Microsoft™ technology and is only supported by Internet Explorer 5.0 or later on Microsoft Windows systems. Once configured, the data log file can be accessed on any platform.

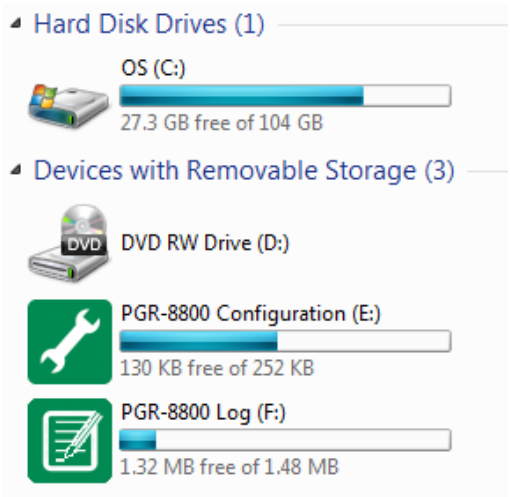
12.1 Connecting to a PC

The PGR-8800 requires supply voltage before connecting the USB cable. Although some LED's may light when connecting a USB cable to an unpowered PGR-8800, the USB interface does not supply adequate power to allow proper operation.

When a USB cable is connected to a powered PGR-8800, it will enter Service mode. In Service mode, arc-flash protection is suspended. The PGR-8800 will remain in Service mode until the USB cable is disconnected. When connected to a PC, the PGR-8800 appears as two mass-storage-devices and two drives will be displayed in the file manager. These drives are internal to the PGR-8800 and behave like any standard drive. Files can be copied to or from the drives or even dragged and dropped.

Note: The Log drive operates as a First-In, First-Out (FIFO) log. When the Log drive is full, the oldest entry will be removed to make room for a new event.

Note: The changes made in the configuration software will not be stored unless saved. The configuration changes will be activated when the USB cable is disconnected.

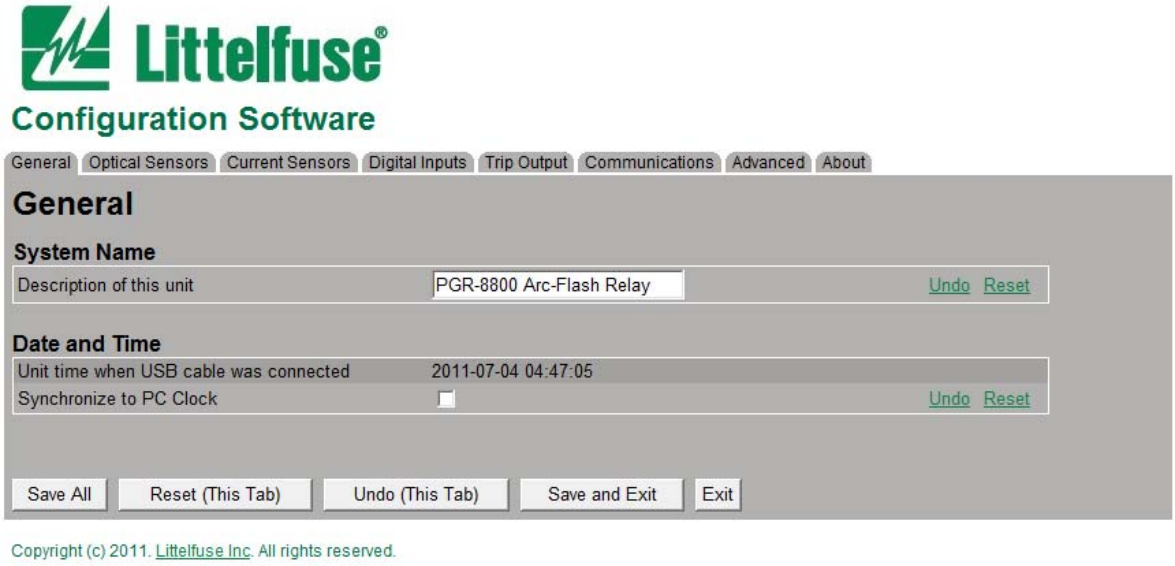


PGR-8800 Internal Drives

12.2 Configuration Software

The configuration software for the PGR-8800 is located on the Configuration drive (the wrench icon). To run the software, open the Configuration drive in the PC file manager and double-click on the ”config.hta” file. The program will open in Internet Explorer regardless of the default browser. The features of the software are outlined in subsequent sections of this manual.

For any setting or button, hovering the mouse cursor over it will display the possible values of the setting or the function of the button.



The PGR-8800 Configuration Software

12.2.1 Configuration Software Tabs

The configuration software is displayed in a window with eight tabs along the top of the screen. Click on a tab to display the relevant configuration options.

General	Set the date, time, and a general description of the relay.
Optical Sensors	Configure optical sensors and arc-detection time before tripping.
Current Sensors	Set overcurrent and current-supervised arc-flash protection parameters.
Digital Inputs	Configure or disable the operation of the digital inputs.
Trip Output	Define the behaviour and pulse time of the Trip Coil output.
Communications	Link multiple PGR-8800 relays together into a single system.
Advanced	Enable data logging or restore configuration and factory defaults.
About	View information on firmware and hardware versions.

12.2.2 Configuration Software Buttons

There are five buttons along the bottom of the configuration software window that are common to every tab.

Save All Save all configuration settings made in every tab.

Reset (This Tab) Reset all configuration settings in this tab to the factory default. Changes will not be stored until they are saved.

Undo (This Tab) Undo any changes that have been made to the current tab since opening the configuration software.

Save and Exit Save all configuration settings made in every tab and exit the configuration software.

Exit Exit the configuration software. No changes will be saved unless the “Save All” button has been pressed. If the “Save All” button is clicked accidentally, use the “Undo (This Tab)” button on any tab where changes were made and then “Save and Exit”.

There are two buttons for each configuration setting, **Undo** and **Reset**. The **Undo** button will revert any changes made to the value before the configuration software was opened. The **Reset** button will load the factory default for that setting.

12.2.3 Default Configuration

It is possible to use the basic protection features of the PGR-8800 without using the configuration software. Any connected optical sensors with circuit-check will be automatically detected and cause the relay to report an error if subsequently disconnected. The initial configuration can be stored permanently without use of the configuration software by using the commissioning procedure outlined in Section 13.1. By default, the LOCAL sensor will not cause a trip on excess light.

The PGR-8800 current sensors are disabled by default; sufficient light alone will cause an arc-flash trip and overcurrent conditions will not cause a trip. The amount of time that light must be detected to cause a trip is set at the factory to 0.5 ms. The cable-check feature for the digital inputs is disabled by default, but the inputs will function if they are connected to terminal 45. By default, the Inhibit input will not prevent a trip from the Trip input. The Trip Coil output operates in Shunt mode by default and will pulse closed for 2 s when a trip occurs. If no voltage is detected across the trip coil inputs, an error will be reported and the Trip Coil LED will have a short red flash pattern.

The configuration software is required to use data logging or link multiple PGR-8800’s.

12.2.4 General Settings

System Name

A description to identify this PGR-8800 (up to 25 characters). An example might be the switchboard name and number of the switchboard section in which the unit is mounted.

Date and Time

Shows the current date and time on the PGR-8800 and gives the option to synchronize the time and date with that of the PC on which the configuration software is running.

12.2.5 Optical Sensor Settings

Common Settings

These settings apply to all optical sensors. The arc detection time specifies the amount of time light from an arc must be detected to cause a trip. Valid settings are 0.2 ms to 2 s and the default setting is 0.5 ms. If a sensor detects light approaching the trip level, the LED for that sensor will begin to flash. The threshold for the warning flashes can be set to 50%, 75% (the default), or 90% of the trip-level setting.

Individual Sensor Settings

Optical sensors are individually configurable with a 25-character description. The PGR-8800 scans all optical sensor terminals periodically looking for sensors. Once a sensor has been found, the sensor status will change from “No sensor detected” to “Sensor detected” and a sensor will be expected at that input until the PGR-8800 supply voltage is cycled. The optical sensor inputs can be manually configured to expect a sensor or not expect a sensor through the Change Configuration drop-down list. If a sensor is disconnected or the sensor circuit check fails, the status will change to “Sensor expected, not detected.” Sensor check can also be disabled on a sensor-by-sensor basis.

The sensors can be commissioned using the procedure outlined in Section 13.1. This validates the function of the sensors and relay. A properly functioning sensor that has been commissioned using this procedure will have a “Sensor detected and commissioned” status. If the sensor is commissioned while the sensor check is not functioning (for example, with the white cable disconnected from the PGA-LS10) then the status will display “Commissioned sensor without sensor check.” The commissioning verifies that the sensor is detecting light even though the sensor circuit check is not functioning. However, if the sensor is disconnected or damaged subsequent to commissioning without sensor check, the failure will not be detected.

Local Sensor

The local sensor is located on the front of the PGR-8800. The configuration software allows a 25-character description. It is possible for light detected by the local sensor to cause a trip. This configuration is not generally recommended because the local sensor is more sensitive to the angle of light incident upon it than the PGA-LS10 or PGA-LS20 sensors.

12.2.6 Current-Sensor Settings

Setup

By default, overcurrent protection and current-supervised trip inhibit are disabled in the configuration software. The value of the rated current setpoint will not affect the operation of the PGR-8800 until one of these functions is enabled using the checkboxes. When using current sensors, the signal being applied to the sensors (ac or dc) must be defined in the “current sensor mode” drop-down list. There are two checkboxes for two separate definite-time overcurrent setpoints and one checkbox that activates the current-supervised trip inhibit function (see Section 6). The current setpoints are defined as a percentage of the value of the “Rated nominal load current”. The rated nominal load current is the typical current level that will be observed on the CT primary. The CT ratio must also be defined and the accuracy of the reading is 1 A (CT-secondary current) due to the fast reaction time of the PGR-8800 to an arc flash. It is important to set all levels and time delays with this in mind.

Trip Inhibit

The primary function of the current-sensor inputs is to provide current-supervised arc-flash protection. If light is detected by the optical sensors but the current is below the Trip Inhibit value setting, the PGR-8800 will not trip. This value is adjustable from 10 to 1,000% of the rated secondary CT current defined in the Setup box. This function is activated by the “Enable current inhibit” checkbox in the Setup box.

Overcurrent Protection

The PGR-8800 has two definite-time overcurrent set points which can be used for instantaneous, short-, and long-time overcurrent protection. They are disabled by default. To enable overcurrent protection, select one or both of the “Trip on Overcurrent” checkboxes in the Setup box of this window. The current level required to trip is set as a percentage of the rated secondary CT current, also defined in the Setup box. The overcurrent trip levels can be set from 150 to 1,000% of the rated secondary current and the time delay is adjustable from 1 ms to 20 s. The PGR-8800 samples the current-sensor inputs at 2 kHz or once every 0.5 ms. The time for the IGBT to operate is approximately 0.2 ms. At the minimum time delay of 1 ms, the PGR-8800 will therefore trip as soon as the absolute value of one sample on any phase exceeds the trip-level setting. Otherwise, the trip decision is based on an internal counter. The PGR-8800 will increment the counter if a sample exceeds the trip-level setting and decrement it when the sample is below the setting. When the counter exceeds the number of samples necessary to exceed the time delay, the PGR-8800 will trip. Overcurrent protection operates independently from arc-flash protection and the optical sensors.

12.2.7 Digital-Input Settings

By default, the digital inputs are considered active when connected to COM (terminal 45). Using the drop-down lists, the inputs can be disabled, circuit-check can be enabled (see Section 7) and the inputs can be configured to be inactive when connected to COM. The Trip input also has a checkbox that defines whether the Inhibit input can prevent a trip from the Trip input. This is disabled by default.

12.2.8 Trip-Output Settings

The trip coil can be configured to operate a shunt or an undervoltage breaker trip coil. In shunt mode, power is required to cause the breaker to trip. Most installations will use this type of breaker because the trip times are typically faster than undervoltage breakers. However, the undervoltage breaker has the advantage of tripping when supply voltage is lost, making it a fail-safe device. The amount of time that supply voltage will be applied to a shunt breaker or removed from an undervoltage breaker is defined by the Pulse Time and can be set from 1 to 10 s. The PGR-8800 monitors the voltage applied across the Trip Coil inputs (terminals 59, 60) and can be set to report an error if no voltage is detected. For more information on trip-coil operation, see Section 8.4.

12.2.9 Communications Settings

Link Interface

The Link input on the PGR-8800 (terminals 37, 38) is a multi-function communications port. Disable the port by selecting ”Nothing” in the Link Interface drop-down list or select ”Link multiple units” to set up a system of up to four connected PGR-8800 relays. There are also options that are currently intended for factory use only: “MODBUS (beta)” and “Factory test.” Each option in the drop-down list will reveal options in a box below it, unique to that selection.

Link Configuration

These settings will not be shown in the configuration software unless “Linking multiple units” is selected in the drop-down list of the Link Interface box. Up to four PGR-8800’s can be linked in this mode, but each must be given a unique “Unit address” and the total “Number of units linked in the system” must be correct.

When in link mode, use the configuration software to select whether all relays will share a common interface (LED’s, push buttons and status) or reflect only the local relay. There is also an option to allow errors such as sensor-check failure or no voltage on the TRIP COIL to be reported. The units can be configured to also share light-sensor information in addition to a trip signal. A current-inhibited PGR-8800 detecting excess light will trip a remote PGR-8800 that is not inhibited with this setting. See Section 11 for more information on linking multiple units.

12.2.10 Advanced Settings

For all options in this tab, changes will not be implemented until the box is checked, the configuration is saved, and the USB cable is disconnected. If a box has been accidentally checked and saved but the USB cable has not been disconnected, un-check the box and save the settings again.

Data Logging

The data logging feature is disabled by default. A preliminary version of a waveform capture feature can also be enabled but this feature is still in a testing stage and is not considered complete. If the PGR-8800 will be connected in an application where tripping results in a loss of supply power, use of a backup battery supply is required when using data logging. Power supply failure while writing to the log drive can lead to loss of data.

Internal Drives & Configuration

In addition to the hardware reset procedures outlined in Section 10, the configuration software allows for partial reset of certain modules and configuration. Every parameter can be individually reset by using the Reset button associated with it (see Section 12.2.2). By using the “Reset configuration to factory defaults” checkbox, all configuration settings can be restored to their default values. Resetting the configuration drive will retain all settings but any files stored on the drive will be lost. Resetting the log drive will result in a loss of any logged events and stored data on the log drive.

12.2.11 About Tab

The About tab displays general information about the PGR-8800 such as the last time the configuration was saved, the firmware revision number, hardware revision number, and serial number.

12.3 Data Log Drive

The PGR-8800 can log all significant events including trips, errors and button presses. By default, data logging is disabled. See Section 12.2.1.

Once enabled, the row data is logged in a plain text file on the log drive. This file, ”log.txt” does not require a PC running Microsoft™ Windows. There is also the ”log.hta” data log reader which requires Internet Explorer 5.0 or greater and simply presents the log in a simplified format.

13 COMMISSIONING

Even without configuration, the PGR-8800 will work using the factory default settings (see Section 12.2.3). It will always trip if a sensor input exceeds the Trip Level setting, even if the circuit check is falsely proclaiming a cable to be broken. However, we recommend doing a few simple tests on the sensors to ensure that problems on the sensors or cabling will be detected and reported.

The PGR-8800 will detect sensors on power up and report if they disappear, but in most installations it is advantageous to store the sensor configuration permanently. This is easily done by configuring the installed sensors either via USB as shown above, or with the method described below.

13.1 Configuration of Installed Sensors

1. Press **MODE** to switch to service mode (SERVICE LED will light solid red).

2. Press and hold **RESET** for a few seconds to start the test sequence.

3. The LED's for sensors 1-6 will flash for 10 seconds while the system tests the optical sensors. This clears the sensor configuration[1].

4. Move a light source towards the LOCAL sensor until the LED turns off.

5. Observe that all connected-sensor LED's are flashing. Move the light source towards each sensor until its internal LED turns off. This should happen at approximately the same distance that was used before the LOCAL sensor reacted. The indicator LED's associated with the sensor will change to solid green at the same time.

6. Return to the central unit and confirm that all LED's for connected sensors are showing a solid green LED. Illuminate the LOCAL sensor again to store the results.

7. The system will now flash green on all sensors briefly, store the results in non-volatile memory, and return to SERVICE mode. Sensor errors that may occur when the supply voltage is cycled can now be detected.

8. Press **MODE** to switch back to ONLINE mode. The sensors are now configured permanently and the system will alarm if a sensor malfunctions.

13.2 Testing the Sensors

1. Press **MODE** to switch to service mode (SERVICE LED will light solid red).

2. Confirm that all PGR-8800 LED's at connected sensors are showing solid green.

3. Confirm that all connected-sensor LED's are giving a double-flash of red periodically, indicating that the sensor is being tested.
4. Point a light source at a sensor and check that the LED on the sensor and the unit begin to flash red continuously. On the first sensor tested, the TRIPPED LED will also turn on until the reset button is pushed.

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[1] If something is not as expected during the test, it can be cancelled by pressing RESET at any time. Reverting back to the previous configuration requires a power cycle of the unit.

5. Repeat step 4 for the remaining sensors.
6. Confirm that all LED's at connected sensors are flashing red.
7. Press **MODE** to switch back to ONLINE mode (ONLINE LED will be solid green).

The test can be cancelled at any time by pressing **MODE**, to return to online mode.

13.3 Testing the Trip Coil

1. Ensure that the system is ready for testing (TRIP COIL output will be tripped during this procedure).
2. Press **MODE** to switch to service mode (SERVICE LED will be solid red).
3. Press and hold **TRIP** for a few seconds to activate the TRIP COIL output.
4. Observe that the connected trip coil operates. The output will reset itself after the configured time, 2 s by default.
5. Reset the TRIP by pressing **RESET**.
6. Press **MODE** to switch back to ONLINE mode (ONLINE LED will be solid green).

13.4 Full Operation Test (Online)

1. Make sure that the system is ready for test (TRIP COIL output will be tripped during this procedure).
2. If necessary, press **MODE** to switch to ONLINE mode (ONLINE LED will be solid green).
3. Confirm that there is a solid PGR-8800 green light for each connected sensor. This demonstrates that sensors are connected and healthy.
4. Confirm that a short red flashing light occurs periodically in each sensor. This indicates that the sensor circuit is being checked.
5. Move a light source towards the LOCAL sensor and confirm that it starts flashing.
6. Move the light source towards a sensor. The sensor LED will start flashing green when the light intensity is approaching the Trip Level.
7. Move the light source closer to the sensor. Confirm that the TRIP COIL output trips and that the LED's of the TRIP COIL and sensor change to flashing red.
8. Reset the TRIP by pressing **RESET** to re-enable the system.
9. Repeat steps 6 to 8 for the remaining sensors.

13.5 Light Sensitivity Adjustment

1. Adjust the **TRIP LEVEL** dial; lower numbers result in higher sensitivity and greater detection range.

14 SPECIFICATIONS

PGR-8800

Supply Voltage:	100 to 230 Vac (±15%)
	12 to 48 and 100 to 250 Vdc (±15%)
	24 V Battery – Lead-acid gel cell
Average Power consumption:	< 3 W
Peak Power consumption:	7 W
Trip coil output:	IGBT switch, 200 µs on time, 2-10 s pulsed (configurable, thermally protected)
Current rating:	500 mA continuous (undervoltage mode)
	20 A for 2 s
	10 A for 5 s
Voltage range:	24 to 600 V DC / 24 to 440 V AC
Control Voltage Alarm:	5 V
Response Time:	
Normal Operation:	< 1 ms
On power-up, DC Supply:	2 - 4 ms
On power-up, AC Supply:	35 - 40 ms
Output contacts:	Online, Service, Tripped
Form C Output Contact Rating:	5 A at 250 Vac / 250 Vdc
Status Output Contact Rating:	1 A at 48 Vac / 60 Vdc
Number of optical sensors:	Up to six per unit
Optical Sensitivity:	10 to 40 klux (Trip Level adjustment 1 to 9)
Current inputs:	3-phase 5 A (15 A continuous, 75 A for 1 s)
Burden:	< 0.25 VA, inputs at 5 A
Current range:	1.5 to 15 A
Interface:	USB
Operating temperature:	-25 to 70° C
Enclosure:	IP 20
Dimensions (W x H x D):	200 x 130 x 52 mm
Mounting:	35 mm DIN Rail or surface mount
Altitude:	Below 2,000 m (6,500 ft): Normal operation
	Above 2,000 m (6,500 ft): Use 24V DC supply and shunt trip coils only, as the lower air pressure decreases cooling efficiency.
	Above 4,000 m (13,000 ft): Maximum ambient operating temperature is lowered to 50˚C. Contact Littelfuse for guidance and operating procedures.

	PGA-LS10	PGA-LS20
Type:	Point sensor	Fiber-optic sensor
Detection Zone:	180 x 360° (half sphere)	360° along fiber
Output:	0-35 mA, 0.25 mA/klux	0-35 mA, 0.25 mA/klux
Electrical Cable:	Shielded 3-wire 0.5 mm^2 (20 AWG) electrical cable	Shielded 3-wire 0.5 mm^2 (20 AWG) electrical cable
Factory Cable Length:	10 m electrical cable	10 m flexible fiber (2 m shielded), 2 x 10 m electrical cable
Max. Elec. Cable Length:	50 m	50 m
Sensor Check:	Built-in – LED for visual feedback	Built-in – LED for visual feedback
Dimensions:	32 x 52 x 21 mm	2-32 x 52 x 21 mm
Enclosure:	IP 30	IP 30

"Certification/standards: CE EMC standards: EN60255-26