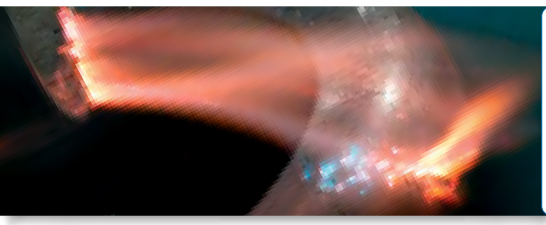
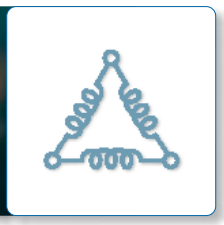
GARD

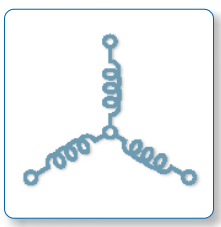
Unparalleled Protection

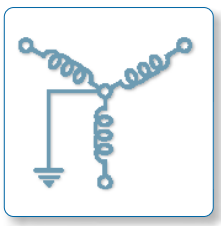
SENTRI

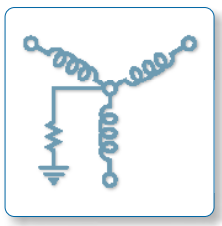
GROUND FAULT PROTECTION
GROUND FAULT RELAY











C-421EM Instruction Manual, April 10042026

ABOUT I-GARD

I-Gard's commitment to electrical safety provides both industrial and commercial customers with the products needed to protect their electrical equipment and the people that operate them.

As the only electrical-safety focused company whose product portfolio includes neutral grounding resistors, high-resistance grounding systems and optical arc mitigation, we take pride in our technologies that reduce the frequency and impact of electrical hazards, such as arc flash and ground faults.

For those customers who have purchased from us over the last 30 years, you know us for the quality and robustness of our products, our focus on customer service and technical leadership. We build on this foundation by investing in developing new products in electrical safety education - including EFC scholarship program - by actively participating in the IEEE community programs on technical and electrical safety standard, and working with local universities at discovering new technologies. We remain unrelenting in our goal of improving electrical safety in the workplace.

Our commitment to excellence is validated by long-standing relationships with industry leaders in fields as diverse as petroleum and gas, hospitals, automotive, data centers, food processing, aerospace, water and waste water plants, and telecommunications. We provide our customers with the product and application support required to ensure that their electrical distribution system is safe and reliable.

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1. FEATURES

- WIDE RANGE OF TRIP LEVELS FROM 100 mA TO 1,200 A.
- WIDE RANGE OF DELAYS FROM INSTANTANEOUS (<20ms) TO 5 SECONDS
- OPTICAL INPUTS FOR SENSING HIGH INTENSITY FLASHES
- WIDE RANGE AC AND/OR DC CONTROL VOLTAGE
- 1 AMP AND 5 AMP SENSOR INPUTS
- CONNECTS TO mGARD-SYM REMOTE INDICATOR
    - MODBUS CONNECTION TO EXTERNAL NETWORK
    - MONITOR SYSTEM LEAKAGE CURRENT
    - REMOTE RELAY SETUP AND RESET
    - MONITORS UP TO 50 DEVICES ON A SINGLE MODBUS ADDRESS

2. INTRODUCTION

To provide a total solution and coordination with other devices, the SENTRI relay ranges in trip levels from 100mA up to 1200A. This versatile relay can be used in solidly grounded and resistance grounded systems. Too often, systems are protected with just one relay on the main service breaker, which leads to power interruption of the entire service if a ground fault occurs at any location. Consequently, in an effort to minimize disruptions, the protection on the main breaker is often set to maximum pickup and delay settings, or worse, disconnected entirely. This can lead to substantial equipment damage, due to increased clearing time. Minimizing damage, downtime and maintaining service, I-Gard provides the SENTRI relay with integral zone selective instantaneous protection (ZSIP) to protect systems, at LV and MV system levels, with optimized coordination. Maximum protection with minimum service disruption.

The main output relay has Form “Z” (4 terminal) N.O. and N.C. contacts which may be used to operate the upstream protective device and to indicate a failure of the system. The relay can be set to operate in failsafe (relay normally energized) and non-failsafe (relay normally de-energized) modes.

In addition to ground fault, the SENTRI relay provides three optical sensor inputs. Optical inputs monitor for high intensity flashes upon which the relay trips with under 1ms delay (this does not include the time for the breaker to open). Three separate trip relays correspond to the three flash sensor inputs. These three relays are a combination of solid state technology which can achieve trip speeds of less than 1ms as well as dry contact relays as a backup.

By pressing the ‘Test’ button, a functional test of the SENTRI is invoked. If flash relay number three is set for service entrance test mode (see Table #3), then the test button causes relay three to close and allow a test of the system by direct injection into the current sensor.

The SENTRI operates on any control voltage from 60 to 240V AC or DC, and contains an isolated power supply. The green LED flashes slowly to indicate that control power is applied to terminals N- and L+. Four red trip LED's indicate a trip on current or flash. The relay can also be connected to an mGARD-SYM remote indicator (with modbus connectivity) for remote indication, test, reset and setup.

With the use of an mGARD-SYM the SENTRI trip level and delay can be set to any level without the restriction of discrete settings on the faceplate. This can be advantageous when the trip levels and delays provided on the face-plate of the SENTRI do not meet the requirements for adequate protection.

3. SETUP

The SENTRI relay can be used and set up with an mGARD-SYM remote display. However, this display is optional, the table below illustrates all the possible settings when an mGARD-SYM is not available.

3.1 DIP SWITCH SETTINGS

The DIP switches are mounted inside of the relay and are accessible through the front cover. It is recommended that all of the switches be set at one time. Please refer to Table 3.0, for a list of DIP switch settings.

Table 3.0 SENTRI DIP switch settings (In the table b▼w denotes ▲ and denotes on)

SWITCH	FUNCTION	SET TO	MEANING
1	mGARD-SYM Setup	▲	Enabled
		▼	Disabled ◆
2	Delay Curve	▲	Inverse
		▼	Definite ◆
3 4	Ground Fault Level Multiplier	▼ ▼	x1 configuration A ◆
		▼ ▲	x10 configuration B
		▲ ▼	x100 configuration C
		▲ ▲	x1000 configuration D
5	Main Trip Relay Mode	▲	Failsafe
		▼	Non-failsafe ◆
6	Flash 1 Relay Control	▲	Flash 1 Trip Relay
		▼	Disabled ◆
7	Flash 2 Relay Control	▲	Flash 2 Trip Relay
		▼	Auxiliary Current Trip Relay ◆
8	Flash 3 Relay Control	▲	Flash 3 Trip Relay
		▼	SE Test Relay ◆

-Factory Setting ◆

3.1.1 MGARD-SYM SETUP:

This DIP switch number 1 enables relay setup through a remote display (mGARD-SYM). Once the relay is set-up using the mGARD-SYM, it retains the new setup values in memory and the mGARD-SYM can be disconnected.

To use the setting on the relay faceplate make sure DIP switch number 1 is set to the off position.

If DIP switch number 1 is on, and the setup with the mGARD-SYM is not complete, the relay will default to the settings on the faceplate switches. However, if the settings have been programmed with the mGARD-SYM, the relay will retain and use the settings in memory regardless of whether the mGARD-SYM is connected or not, so long as DIP switch number 1 is in the on position.

The mGARD-SYM allows the user to lock the current settings so that they can no longer be changed. The mGARD-SYM becomes a viewing only device. To reset this lock, toggle the mGARD-SYM enable DIP switch number 1 on the SENTRI relay.

3.1.2 DELAY CURVE DIP SWITCH NUMBER 2:

Selects between DMT (Definite Minimum Time) delay timing and IDMT (Inverse Definite Minimum Time) timing. See Section 3.3 for a detailed description.

3.1.3 GROUND FAULT LEVEL MULTIPLIER DIP SWITCHES NUMBER 3 AND NUMBER 4:

Two DIP switches control the current trip level multiplier. These switches determine the range of trip levels that can be set using the trip level rotary switch. Table 3.1 outlines the current level range for each DIP switch multiplier setting.

3.1.4 MAIN TRIP RELAY MODE DIP SWITCH NUMBER 5:

This DIP switch selects the operating mode of the main relay. If the DIP switch is (up) in the on position; then the main relay is in failsafe mode. This means that it is normally energized. Thus if the relay loses control power, the main relay contacts will stop holding and the relay will trip (hence it is failsafe).

If this switch is (down) in the off position; then the main relay is normally de-energized and only energizes when the relay trips. If the SENTRI loses control power, it will not cause the relay to trip. (Hence non-failsafe since the relay remains disabled without control power, and it does not trip).

This DIP switch only toggles the mode of the main relay. It has no effect on any of the flash relays or the pre-trip relay.

3.1.5 FLASH 1 RELAY CONTROL DIP SWITCH NUMBER 6:

This DIP switch enables monitoring of flash sensor number 1. When turned off the DIP switch disables indication of an open-circuit flash sensor. However it does not disable the flash sensor itself. A proper signal from the flash sensor will cause a trip on the flash relay output contacts between terminals 25 and 26 to close, regardless of the position of this DIP switch.

When adding a new sensor or removing an existing sensor it is a good idea to disconnect the trip contacts to avoid falsely tripping the trip relay. Once the sensor is installed, turn on the DIP switch to enable monitoring and connect the trip contacts.

3.1.6 FLASH 2 RELAY CONTROL DIP SWITCH NUMBER 7:

This DIP switch enables monitoring of flash sensor number 2. When the DIP switch is in the off position it disables the indication of an open-circuit flash sensor, however, it does not disable the flash sensor itself. A proper signal from the flash sensor will cause a trip on the flash relay output contacts between terminals 27 and 28 to close, regardless of the position of this DIP switch. However, when set to the off position and when no flash sensor is connected to the flash sensor 2 input, trip relay 2 becomes an auxiliary ground fault relay.

3.1.7 FLASH 3 RELAY CONTROL DIP SWITCH NUMBER 8:

This DIP switch enables monitoring of flash sensor number 2. When the DIP switch is in the off position it disables the indication of an open-circuit flash sensor, however, it does not disable the flash sensor itself. A proper signal from the flash sensor will cause a trip on the flash relay output contacts between terminals 27 and 28 to close, regardless of the position of this DIP switch, however when set to the off position and when no flash sensor is connected to the flash sensor 3 input, trip relay 3 becomes a 'Service Entrance Test' relay. This means that it will operate when the test button is pressed. This contact should be wired to test the SENTRI by running a current directly through the test winding of the current sensor (see Section 4.6.1).

3.2 CURRENT PICK UP LEVEL ROTARY SWITCH

Table 3.1 below shows all possible current settings that can be setup with the rotary switch. DIP switches 4 and 5 determine the multiplier. If using an mGARD-SYM remote display for setup, the fault current settings are not limited to the discrete values in the table below. See Table 3.0 for DIP switch settings.

Table 3.1: Fault current level rotary switch settings

ROTARY SWITCH POSITION	GROUND FAULT LEVEL MULTIPLIER			
	A (▼ ▼)	B (▼ ▲)	C (▲ ▼)	D (▲ ▲)
0	0.1A	1A	10A	100A
1	0.2A	2A	20A	200A
2	0.3A	3A	30A	300A
3	0.4A	4A	40A	400A
4	0.5A	5A	50A	500A
5	0.6A	6A	60A	600A
6	0.7A	7A	70A	700A
7	0.8A	8A	80A	800A
8	0.9A	9A	90A	900A
9	1.2A	12A	120A	1200A

Note: If the current pick up level is set greater or equal to 800 Amperes, the delay will automatically be limited to 1 second and IDMT mode will be disabled (In compliance with NEC/CEC standards).

3.3 FAULT TRIP DELAY LEVEL ROTARY SWITCH

The delay rotary switch allows for 10 possible delay settings. The table below outlines these options. If using an mGARD-SYM remote display for setup, the delay settings are not limited to the discrete values listed below.

Table 3.2: Fault delay level rotary switch settings

ROTARY SWITCH POSITION	DELAY (MS)	DELAY (MS) IF TRIP LEVEL >=800A
	20 (Instantaneous)	20 (Instantaneous)
0	0.1A	1A
1	0.2A	2A
2	0.3A	3A
3	0.4A	4A
4	0.5A	5A
5	0.6A	6A
6	0.7A	7A
7	0.8A	8A
8	0.9A	9A
9	1.2A	12A

The SENTRI relay has two sets of defined trip characteristics. One is called Definite Minimum Time (DMT) and the other one is Inverse Definite Minimum Time (IDMT). The user may select either of the two characteristics by using the CURVE SELECT DIP switch on the faceplate of the relay or if using the mGARD-SYM for setup, make the selection from the mGARD-SYM menu.

Note: If the current pick up level is set greater or equal to 800 Amperes, the delay will automatically be limited to 1 second and IDMT mode will be disabled (In compliance with NEC/CEC standards).

3.3.1 DEFINITE MINIMUM TIME (DMT) CHARACTERISTICS

A set of ten Definite Minimum Time (DMT) characteristics are available. The CURVE SELECT switch should be set to the DMT position. The user may select one of the ten time delays shown on table 3.2 by turning the rotary switch (see Table 3.2).

If the fault current exceeds the fault current trip level, the relay will trip at the time set by the delay rotary switch, regardless of the magnitude of the fault current.

3.3.2 INVERSE DEFINITE MINIMUM TIME CHARACTERISTICS

The trip time is represented by the following equation:

$T * M2 = K$

for $1.2 < M < 10$ (Eqn. 1)

Where;

M = Multiple of pick-up setting

T = Trip time in seconds

K = Relay Constant

As indicated, the above equation is valid for a fault current of magnitude between 1.2x pick-up to 10x pick-up. For a relay to trip according to any of the IDMT curves represented by Eqn. (1), the fault current must have a value of just above 1.2 times the pick-up. For M > 10, the trip time is definite and matches with the DMT settings. The IDMT characteristics are shown in Figure 3.0.

When using the mGARD-SYM to setup the relay, the IDMT constant can be set to any value between 0 and 1000 seconds.

Example:
For a SENTRI relay, the pick-up is set at 5.0A and the time-setting switch is set at 1.0 sec in IDMT mode. If a ground fault current of 25A (5x pickup setting) is sensed by the relay, calculate the expected trip delay:

Method:
1. FIND CONSTANT: K= T*M2
K= (1)*(10)2
K= 100
2. COMPUTE MAGNITUDE: M= 25/5
M= 5
3. COMPUTE DELAY: T= K/M2
T= 100/25
T= 4

Answer: The relay will trip in 4 seconds (verify using Figure. 3.0).

3.4 RESET

The SENTRI relay can be set to either manual or auto reset mode. The unit is shipped in the manual reset mode. To enter the auto-reset mode, press and hold the reset button for at least 5 seconds. Automatically the relay will change and stay in auto-reset mode. To change back to manual reset mode, press and hold the reset button for another 5 or more seconds. This setting is maintained even if the relay loses control power.

To determine which reset mode the relay is in, simply perform a relay self test (with optional relay trip inhibit) and wait at least 5 seconds for the unit to automatically reset. If auto-reset does not occur then the relay is in manual reset mode.

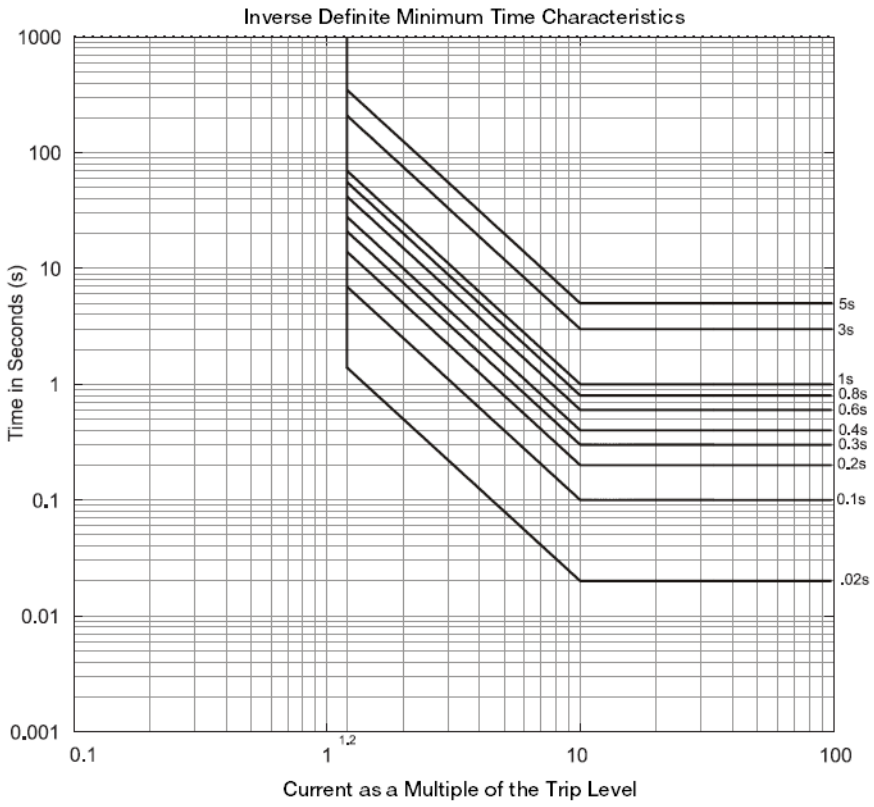

Figure 3.0 IDMT Time-Current characteristics

3.5 MGARD-SYM

The mGARD-SYM is a remote display indicator that is used in conjunction with I-Gard relays. The indicator has the capability to interconnect with any combination of up to 50 (fifty) compatible relays, but with a maximum of 42 SENTRI relays with addresses equal or greater than 8 (eight); in a bus network topology and provides detailed device status information as well as setup capability.

As shown in Figure 3.1, the display has a 4-line screen that shows a list of connected devices. A device can be selected and viewed in detail. The relay mode, delay and trip level settings can be viewed and changed. The reset and test functions can also be performed directly from the display.

Fault levels can be displayed as a current reading in Amperes (if using an I-Gard TxA-Type sensor) or as a percentage of the sensor primary current rating. Screen navigation is done using a 4-button interface. The menus are displayed on the right side of the Liquid Crystal Display (LCD), the left side is reserved for viewing relay information.

The mGARD-SYM also provides an isolated connection to an external Modbus RTU network. All 50 devices can be monitored remotely using a single configurable modbus address. Built in electrical isolation protects the modbus network from hazardous voltages or transients. The display is compatible with several modbus speeds; 1200, 2400, 4800, 9600, 19200 and 38400 baud. Stop bits are selectable (1 or 2). Data available through modbus includes relay status and fault levels as well as remote reset.

For more information on the mGARD-SYM display, please refer to the mGARD-SYM manual (C-416EM-mGARD-SYM).

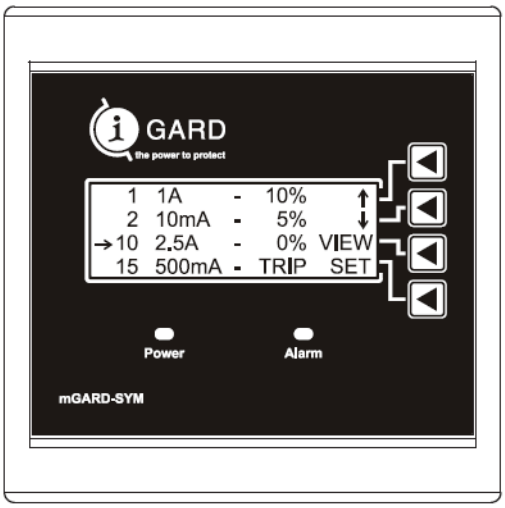

Figure 3.1 mGARD-SYM Remote Indicator

3.5.1 SETUP USING MGARD-SYM

To setup the SENTRI using the mGARD-SYM, address 8 must be selected for the first SENTRI, any additional SENTRI setup will be the next sequential address. Select the SENTRI relay from the mGARD-SYM main menu to be configured and press the 'VIEW' button. From the 'VIEW' screen press the down arrow until the final page is

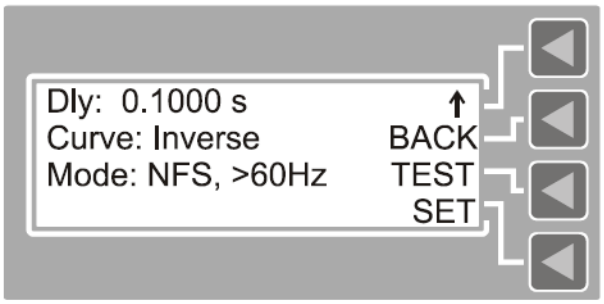

Figure 3.2 Enter SENTRI Setup mode using mGARD-SYM

If the 'SET' button is not visible, then mGARD-SYM setup mode is not enabled on the SENTRI. The first DIP switch (DIP Switch number 1) on the relay must be turned on to enable remote setup. If setup is locked, toggle DIP switch number 1 on the SENTRI to release the lock. Press the 'SET' button and a list of editable options will appear on the mGARD-SYM screen. All of these settings can now be configured using the mGARD-SYM display.

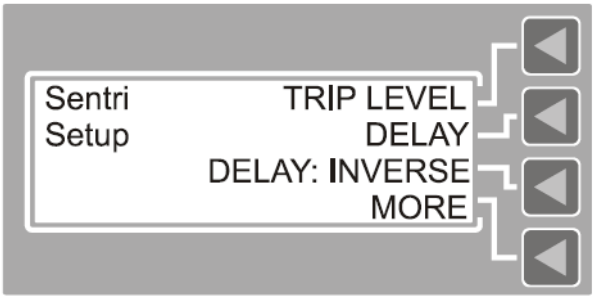

Figure 3.3 Setup Screen 1

The first setup screen appears as shown in Figure 3.3. Press the 'TRIP LEVEL' button to change the current pick up level as shown in Figure 3.4. Press the 'DELAY' button to set the delay as shown in Figure 3.5. Pressing the 'DELAY:' button will toggle the delay type between inverse, definite, ZSIP-inverse and ZSIP-definite. Pressing 'MORE' will continue to the second setup screen shown in Figure 3.6.

The trip level can be set to any level greater than 0 and less than or equal to 1200 Amps. The trip level setup screen (shown in Figure 3.4) displays the old setting as well as the new setting. Modify the new setting by increasing or decreasing each digit using buttons 1 and 2 (up and down arrows). To move to the next digit press the side arrow button. Once set, press the 'BACK' button to save the new setting in the SENTRI relay permanent memory. If the new trip level is out of the valid range then the new setting will not be saved in the SENTRI permanent memory. To leave this screen without making changes, set the new trip level to '0000.000 A' and press the back 'BACK' button.

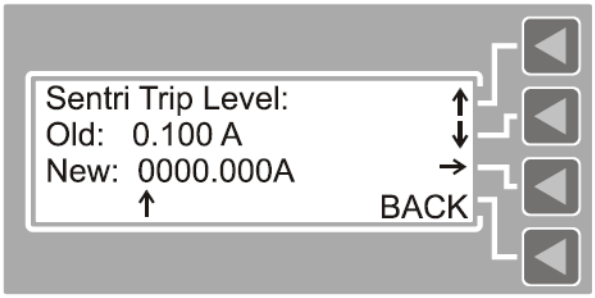

Figure 3.4 Setting the trip Level

The delay can be set to any level between and including 0 and 9999 seconds. The old and new settings are displayed on the setup screen. Adjust the trip delay by increasing or decreasing each digit (pressing the up or down arrow). To move to the next digit, press the side arrow button. Press the 'BACK' button to save the new delay in permanent memory. To cancel the change, set the new delay to equal the old delay and press the 'BACK' button.

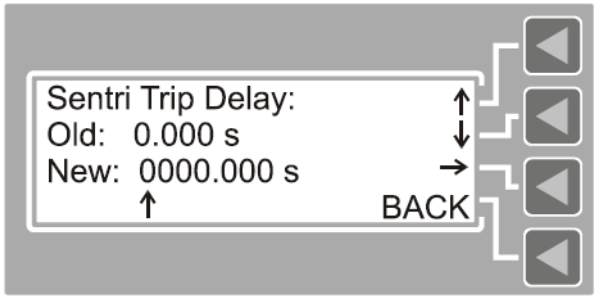

Figure 3.5 Setting the trip delay

The second setup page allows a custom pre-trip level and delay to be programmed into the SENTRI relay. The delay only operates on a (DMT) Definite Minimum Time characteristic (no inverse mode). This screen is shown in Figure 3.6 below.

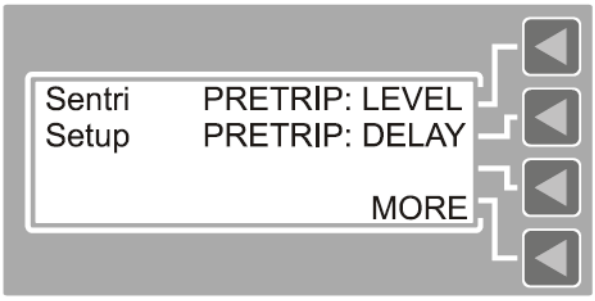

Figure 3.6 Pre-Trip setup

The third setup screen is shown in Figure 3.7. The ‘SENSOR’ button is used to toggle the display between Amps and percentage of primary. If using an I-Gard TxA-Type sensor, select the ‘A-Type’ sensor setting to display in Amps. When using a sensor (with either a 1 Amp or 5 Amp secondary), change this setting to ‘1/5 Amp’. The display will now show the current reading as a percentage of the primary current. This setting also affects the format of the current level reading using modbus.

The ‘FILTER’ button enables or disables a digital harmonic filter. Once enabled, the SENTRI reacts to currents that have a frequency below 60Hz. If disabled, the SENTRI reacts to the fundamental current plus any harmonics current circulating through the conductors. Press the ‘LOCK’ button to disable further changes to the settings through the mGARD-SYM display. This setting can only be re-set by toggling the mGARD-SYM DIP switch number 1 on the SENTRI relay faceplate. Pressing the ‘SAVE/BACK’ button will leave the setup mode and return to the SENTRI view screen. Any changes will be saved in permanent memory.

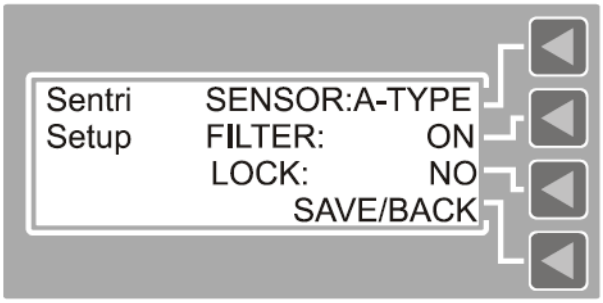

Figure 3.7 Second setup screen

Note: It is recommended to LOCK the SENTRI relay after setup is complete.

4. OPERATION

4.1 INDICATION

Power LED indicator:

A green LED on the front of the SENTRI displays the status of the control voltage:

- LED Off: No control voltage or SENTRI defective
- LED Slow Flashing: Normal, control voltage normal
- LED Quick Flashing: Test mode, control voltage normal
- LED Steady On: Control voltage too low or SENTRI defective

Arc Flash Trip LED:

Corresponding red LED:

- LED Off: No trip
- LED Flashing: Sensor is missing or defective, sensor wires are shorted or opened
- LED Steady On: Sensor detected a flash and tripped the relay

Ground Fault Trip LED:

Corresponding red LED:

- LED Off: No trip
- LED Flashing: Pre-trip; current through ZSCS exceeded pre-trip level for duration of pre-trip delay.
- LED Steady On: Trip; current through ZSCS exceeded trip level for duration of trip delay time.

4.1.1 LATCHING TRIP INDICATOR:

The SENTRI has an electromagnetic status indicator which provides trip indication. The indicator will show 'red' after tripping due to a fault or flash. The indicator will maintain the same status even when the control power is lost after tripping the breaker (If the control power supply of the relay is taken from the load side of a breaker). When the breaker is switched on, the relay will re-energize and will automatically reset the indicator to 'black'. If the supply is taken from the line side of breaker or from UPS, the electromagnetic status indicator (target) can be manually reset by a momentary push button on the faceplate, auto-reset or using the mGARD-SYM remote display.

4.2 PRE TRIP ALARM

Terminals number 23 and number 24 are provided for the remote indication of elevated ground fault current. This is a NORMALLY OPEN, DRY contact which CLOSES to annunciate an ALARM condition to a remote panel, PLC or monitor. The contacts automatically open one second after the fault is cleared without the need for a manual RESET. The default pre-trip alarm level is 50% of the main trip level setting. When the main trip level is changed, the pre-trip level automatically changes to 50% of the new trip setting. However, using the mGARD-SYM display, the pre-trip level can be set to any current level. Once it is set using the display, it does not change when changing the main trip setting, unless the memory is re-set.

Similar to the pre-trip alarm level; the delay is always 25% of the main trip delay unless it is set using the mGARD-SYM display.

In addition, the pre-trip contacts close if any of the three flash sensors become either short or open circuit. Under this condition, the relay will reset itself one second after the open/short is cleared.

Once the pre-trip relay activates, the trip LED will begin flashing to indicate a pre-trip condition.

4.3 ZONE SELECTIVE INSTANTANEOUS PROTECTION (ZSIP)

The ZSIP system (Zone Selective Instantaneous Protection) allows the instantaneous operation of relays in different levels (zones) whenever a fault is detected which is within their zone only. Higher level relays will not trip because they will operate with user-set time delays, thus preserving coordination of the system. For this operation it is necessary to connect a restraint signal (ZSIP OUT) from each relay to the relay in the level above (ZSIP IN terminal). The scheme can be extended to any number of levels. Also a number of downstream relays can be connected to restrain a single main relay or more if necessary. Three terminals are provided on each relay ZSIP-IN, ZSIP-OUT and COMMON. The COMMON is connected to all other COMMON terminals in the system. The ZSIP OUT of all downstream relays at a particular level is connected to the ZSIP-IN of the relay, at the next level up. It is recommended that wiring between terminals 10 and 11 be done with No. 14 AWG wire. The one-line diagram in Figure 4.0 illustrates examples of a 3 level ZSIP system.

The mGARD-SYM remote display must be used to enable ZSIP mode. Once enabled, the relay will trip unless a restraint signal is sent from a downstream relay.

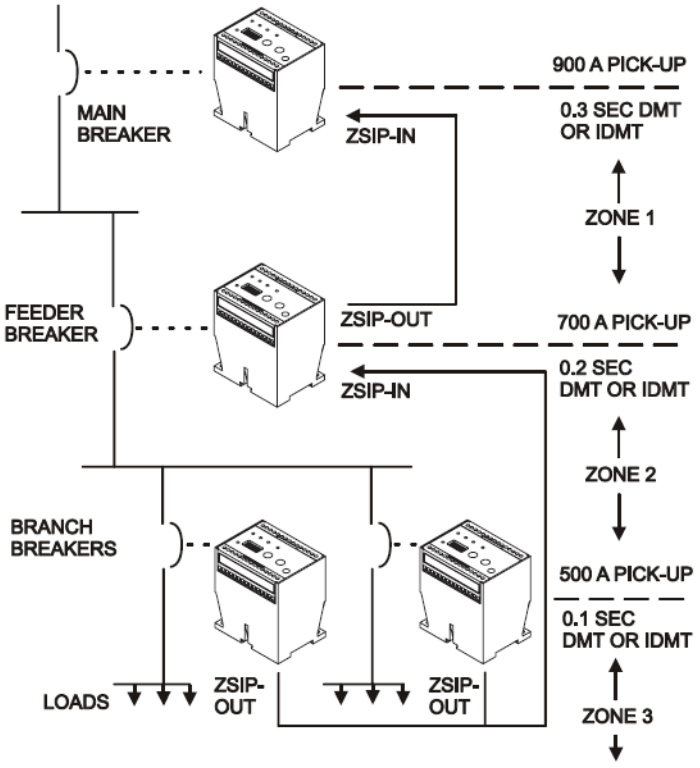

Figure 4.0 Three level ZSIP connection

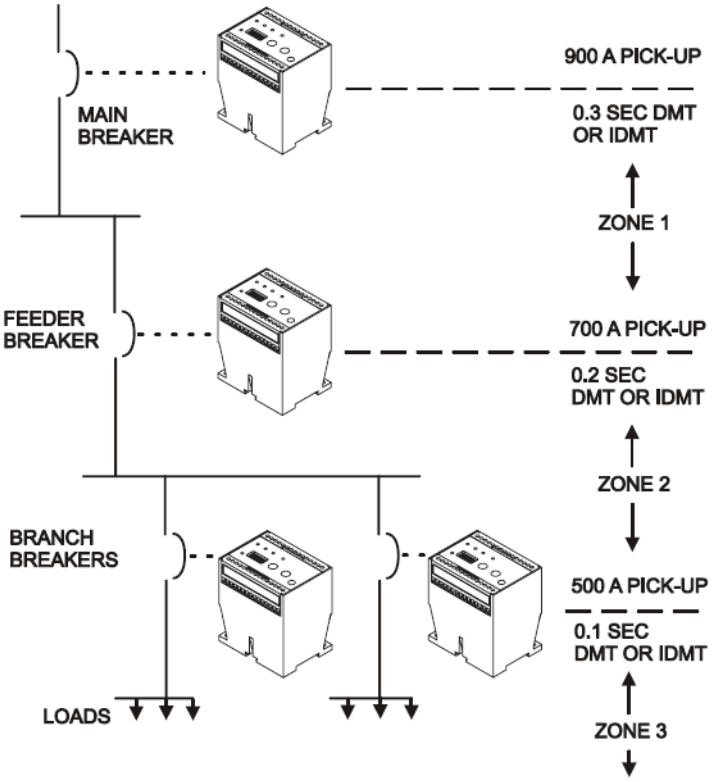

Figure 4.1 Three level TCP connection

Figure 4.1 shows a single line drawing of a Time Coordinated Protection (TCP) system. For proper coordination in the TCP mode the CURVE SELECT switch in upstream and downstream relays should be set to the same position (DMT or IDMT).

4.4 FLASH SENSORS

The SENTRI has built in provisions for three optical flash sensors. Each optical sensor can detect a high intensity flash and is tuned to pick up in the infra-red range on the electromagnetic spectrum. Figure 4.2 shows the frequency response of the sensors. Once a flash is detected, the SENTRI will trip the corresponding flash relay in under 1ms, as well as the main trip relay (in approximately 7ms). Flash sensor 1 corresponds to Flash relay 1 and so on.

When not in use, the flash sensor LED's can be disabled using the DIP Switches (see numbers 6, 7 and 8. Section 3.1). If a flash sensor is enabled but not connected (open circuit), the SENTRI will flash the red LED that corresponds to that sensor, warning the user that there is a problem. Similarly it does so when the sensor wires are shorted. Flash sensor status is also displayed on the mGARD-SYM display when one is in use. If a flash sensor DIP switch is disabled, but a flash sensor is connected to the corresponding terminals. The flash sensor will continue to trip the flash relay when a flash occurs. However, there will be no indication for open circuit sensors.

Flash sensors cannot be enabled/disabled using the mGARD-SYM display; this must be done using the DIP switches (numbers 6, 7 and 8) on the relay faceplate.

Two types of flash sensors are available; both come with a 20 foot cable (other custom lengths are available) that contains two conductors and a shield to protect against electromagnetic noise. Sensors can be mounted directly in a cell/panel (SENSOR-L1 sensor) or on the outer wall with the sensor element popping through a hole in the panel if there are space constraints (SENSOR-L2 sensor). See Section 9 for dimensional drawings.

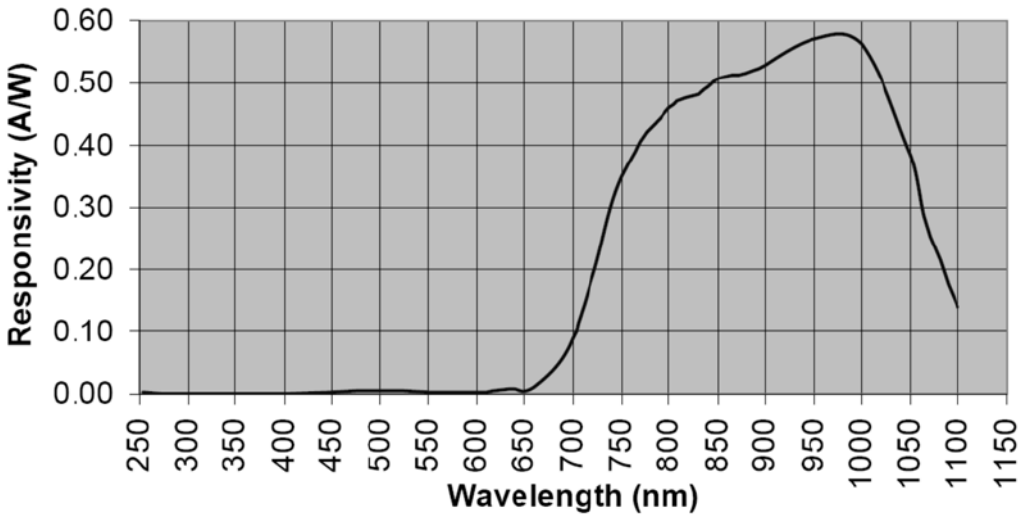

Figure 4.2: FLASH sensor spectral response

4.4.1 FLASH TRIP RELAYS

Flash relays are solid state and are capable of tripping in less than 1ms. Each solid state relay output is in parallel with a dry contact mechanical relay. This provides a backup trip for each flash relay.

4.5 REMOTE RESET

The SENTRI has two terminals (numbered 12 and 13) for a remote Normally Open (N.O.) Reset button. After a trip, the relay remains in the tripped state until the fault has been cleared and the reset button has been pressed, or the control voltage is removed from terminals L- & N+. If auto-reset is enabled, then the relay will automatically reset itself five seconds after the fault condition has been cleared.

4.6 TEST

The SENTRI relay supports two types of test operations.

1. Direct injection into the current sensor.
2. Simulated current which exceeds the trip setting by a magnitude of four.

When the relay enters any of these two test states, the power LED will begin to flash quickly. A test can be cancelled at any time by pressing the RESET button.

4.6.1 SERVICE ENTRANCE TEST RELAY

To inject current directly into the TEST winding of a current sensor, the DIP switch for flash relay 3 must be set to the off position and a flash sensor must not be connected to the flash sensor 3 terminals. Flash relay 3 becomes a test relay that can be invoked by pushing the test button.

To invoke the test relay, press and release the test button. The test relay will close once the test button is released. To hold-off the trip, press both the test button and reset button simultaneously and release. The test relay will close once the buttons are released and even if the test is successful (ie. It causes a trip), the trip contacts will not operate.

Once the relay enters test mode, the power LED will begin to flash rapidly. If the relay trips (due to the test) the Power on, green LED will return to slow flash and the relay can be reset by pressing the reset button (or by auto-reset if it is enabled).

If the relay does not trip during the test, the relay will remain in the test state for two minutes. After which it will return to normal operating mode. Thus, the test time cannot exceed two minutes.

4.6.2 SIMULATED TEST

To perform a simulated test, press and hold the test button until the power LED begins to flash rapidly (approximately 5 seconds). A simulated current which exceeds the trip current set on the trip Level rotary switch by a factor of four replaces the measured current. Once the trip delay time set on the trip delay DIP switch has elapsed, the relay will trip and the red LED will turn on.

To hold-off the trip, press and hold both the test button and reset button until the power LED begins to flash rapidly. This will perform the test without tripping the breaker.

The test state will last for a maximum time of 2 minutes. After which the relay will exit the test state regardless of whether a trip occurred or not. Thus, the trip delay should be less than 2 minutes if using the built in test features.

4.7 MODBUS

The status of the SENTRI relay as well as the fault current level can be retrieved using the mGARD-SYM modbus interface. Modbus provides an ideal means to track and record system leakage current. To connect to the mGARD-SYM using the modbus protocol refer to the mGARD-SYM manual C-416EM. Once connected, data from the mGARD-SYM can be retrieved, stored and analyzed.

Data is retrieved by reading system registers. Three 16-bit registers can be retrieved for each SENTRI relay on the network and the data contained by them is as follows:

1. SENTRI status and setup byte (Registers 40001 to 40050)
2. Current level (Registers 40051 to 40100)
3. Current trip setting (Registers 40101-40150)

The data is ordered according to the addressing of each relay on the mGARD-SYM display. For example, if the SENTRI relay has an address of 10 on the mGARD-SYM display; the relevant registers for this relay would include 40010 (status), 40060 (current level) and 40110 (current trip setting).

The status word contains bitwise data on the setup and status of the relay. Table 4.0 and Table 4.1 below outline the format of the status byte.

Table 4.0 High byte

Bit 16	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9
Address Active	Arc Sensor Status	Test Flag	Pre-trip Flag	Ground Fault trip Flag	Arc 3 Sensor Trip Flag	Arc 2 Sensor Trip Flag	Arc 1 Sensor Trip Flag

Table 4.1 Low byte

Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
ZSIP Enabled Flag	Auto-Reset Enabled Flag	Readout Flag (% or Amps)	Harmonic Filter Enabled Flag	Arc Protection Enabled Flag	Delay Curve Flag (Definite or Inverse)	Mode Flag (Failsafe or Non-Failsafe)	mGARD-SYM Lock Flag

Address Active: Reads a '1' if the address is active on the mGARD-SYM display and '0' if it has not been activated. Also reads '0' if the relay is active but not powered up or has problems communicating.
Arc Sensor Status: Reads a '1' if any of the three flash sensors are either short or open circuit.
Test Flag: Reads a '1' if the relay is in test mode. (Test button has been pressed to simulate a fault).
Pre-Trip Flag: Reads a '1' if the pre trip relay has tripped.
Ground Fault Trip Flag: Reads a '1' if the relay has tripped on ground fault.
Arc Sensor 3 Trip Flag: Reads a '1' if flash sensor 3 has tripped.
Arc Sensor 2 Trip Flag: Reads a '1' if flash sensor 2 has tripped.
Arc Sensor 1 Trip Flag: Reads a '1' if flash sensor 1 has tripped.
ZSIP Enabled Flag: Reads a '1' if ZSIP feature is enabled.
Auto-Reset Enabled Flag: Reads a '1' if the auto-reset feature is enabled.
Readout Flag: Reads a '1' if the trip level data and trip setting data are expressed as a percentage of the sensor primary. If the data is set to Amps, then this bit reads '0'.
Harmonic Filter Enabled Flag: Reads a '1' If the harmonic filter is enabled.
Arc Protection Enabled Flag: Reads a '1' If any of the three flash sensors are enabled. Reads a '0' if all three flash sensors are disabled.

Delay Curve Flag: Reads a '1' if the delay curve is set to Inverse. Reads '0' if set to Definite. Mode Flag: Reads a '1' if the relay is in failsafe mode or a '0' if the relay is in non-Failsafe mode.
mGARD-SYM Lock Flag: Reads a '1' if further editing using the mGARD-SYM display is locked (disabled).

The current level register provides the real-time current that the SENTRI relay is reading from the current sensor. This is a 16-bit register. The format is shown below in Table 4.2.

Table 4.2 Current level register

Bit 16-15	Bit 14-1
Exponent (E)	Level (L)

The ground fault current is equal to:

$$Ig = L \times 10^{-E}$$

The exponent portion 'E' can be 0, 1, 2 or 3. The current reading is either expressed in Amps or as a percentage of the sensor primary. The format is determined by Bit 6 of the status register; see Table 4.1.

The current trip setting register is a 16-bit register expressed in the same manner as the current level register shown above. This register provides the current value above which the SENTRI relay will trip, once the time delay has expired.

5. INSTALLATION INSTRUCTIONS

DANGER
Hazard of Electrical Shock, Burn or Explosion
All installation, servicing and testing referred to in this manual must be performed by qualified personnel. All power should be disconnected prior to removing covers or enclosures and where live conductors may otherwise be exposed.
Failure to observe these precautions may result in death or severe personal injury and damage to equipment. Before placing an intentional ground fault on the power system, check that a fault does not already exist. Any test ground fault equipment must be rated for full system voltage and be fused for protection.

Try to keep the exposure to mechanical shock and vibration to a minimum and place the SENTRI in a clean dry enclosure. Locate the relay close to the isolating device (circuit breaker or contactor) that is protecting the circuit being monitored.

Keep the distance between the relay and the ZSCS as short as possible. If that is not possible, use twisted cable and increase the gauge of the conductor as per the table below:

Table 5.0 ZSCS recommended secondary wire size

Maximum Cable run in feet/ Meters	Minimum Wire Gauge AWG
Up to 300 Ft. / 91 m.	16
301 ft / 92 m to 450 ft / 137 m	14

Provide maximum clearance between the SENTRI relay (and the external ZSCS if required) and any strong magnetic flux producing devices such as power transformers, autotransformers, control transformers, reactors, and high power conductors and bus work.

5.1 MOUNTING

Refer to Figure 9.0, 9.1 and 9.2 for mounting dimensions of the SENTRI relay. The SENTRI is designed to be mounted with either mounting screws or on a 35 mm DIN rail. Two #8-32 x 3/4" (M4 x 20) mounting screws are required for screw mounting. Refer to Figure 5.0 for mounting dimensions.

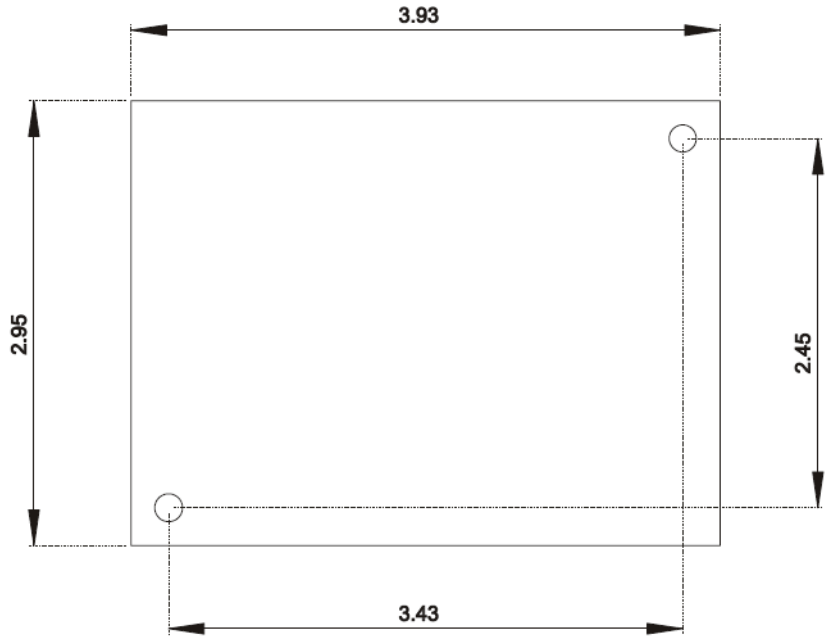

Figure 5.0 Mounting dimensions (Inches)

For DIN rail mounting, the rail should be bolted to a flat surface. Install the DIN rail horizontally. Allow at least ¾" (20 mm) of rail to extend beyond each end of the relay. Secure the relay to the DIN rail ensuring the release latch at the bottom of the relay engages the rail. If the relay is to be mounted in any other position take appropriate steps to prevent the relay from disengaging from the DIN rail.

5.2 CONNECTIONS

All connections to the SENTRI are by means of screw clamp terminals rated 10 Amps, 300V. Terminals will accept any wire gauges from #26 to #12 AWG solid or stranded conductors. Figure 5.1 illustrates terminal positions and their function.

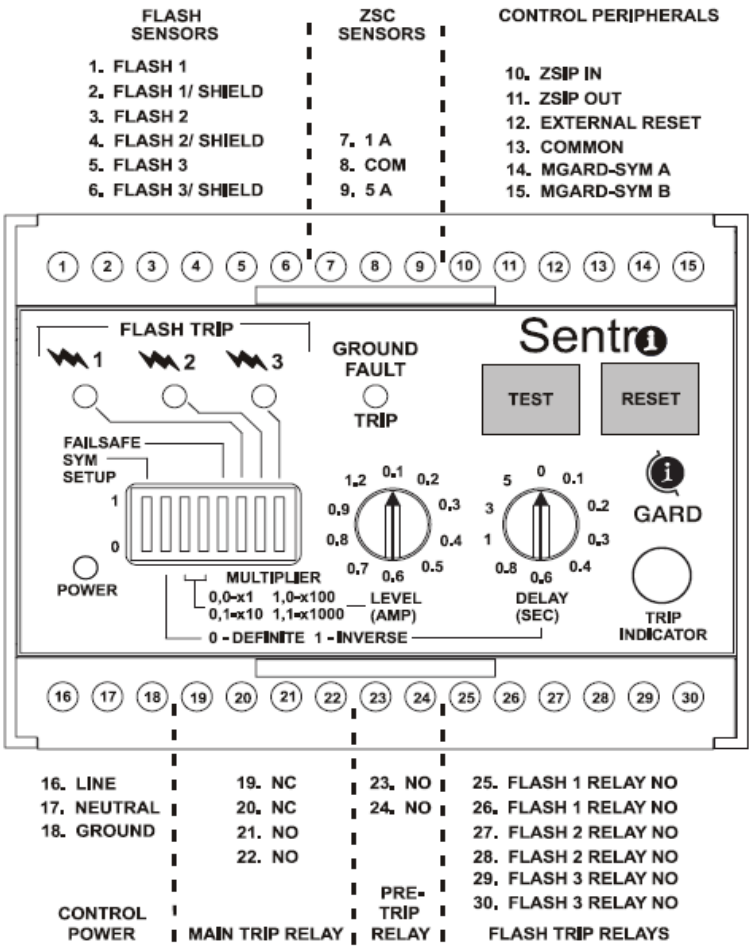

Figure 5.1 SENTRI Terminal block

Connect the two secondary terminals of the current sensor to terminals 7 and 8 if using a 1 Amp secondary sensor or terminals 8 and 9 if using a 5 Amp secondary sensor. Use 14 AWG (minimum) wire. Twist the leads to optimize electromagnetic immunity. Connect ac or dc control power to terminals 1 (L+) and 2 (N-).

In order to meet the Electromagnetic Compatibility (EMC) requirements a chassis bond is required between terminal 18 and the nearest ground point. This distance should be kept to a minimum. If the SENTRI is mounted on 35 mm DIN rail, a DIN rail mounted ground terminal block can be installed beside the relay to act as the chassis ground point.

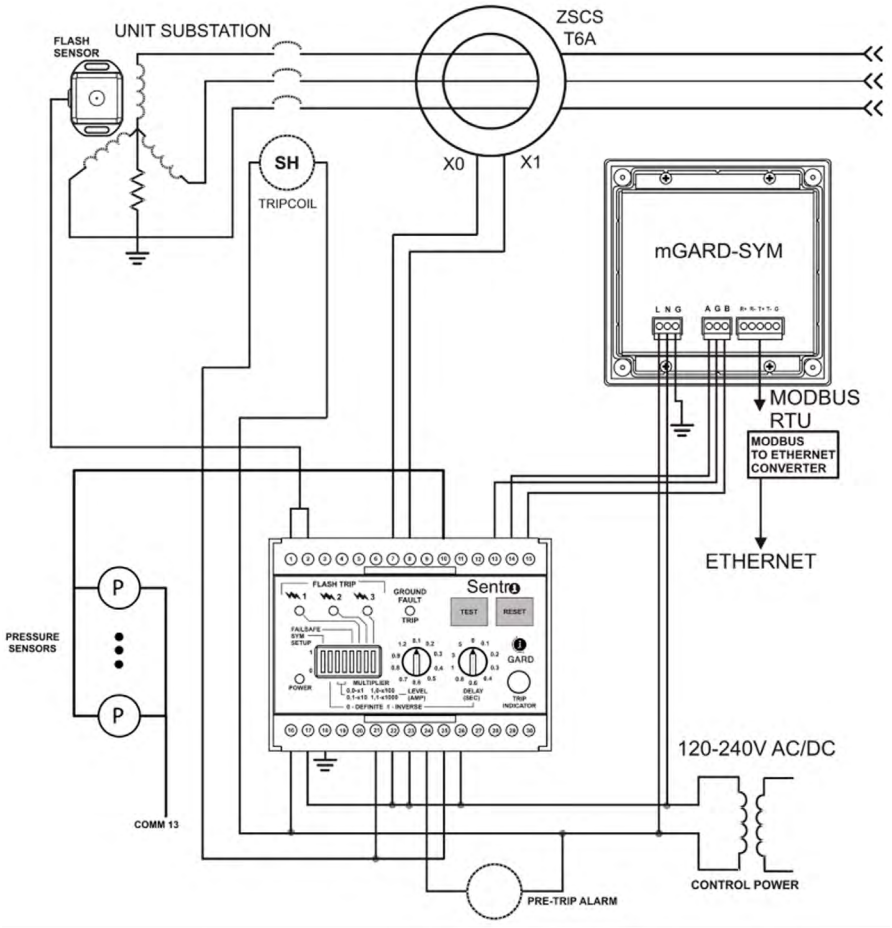

Figure 5.2 Wiring diagram

Figure 5.2 shows a typical installation with a single flash sensor connected. Make sure to disconnect the flash relay terminals when installing a new flash sensor to avoid falsely tripping the breaker.

Note that the circuit breaker shunt is connected to both the main trip for ground fault protection and flash relay 1 in parallel. This is done since a flash does not trip the main trip relay and a ground fault does not trigger the flash relay.

Flash Sensor:

Response Time	Typical Equipment for Testing
1 ms.	150Ws strobe

Pressure Sensor:

Response Time	Lower Threshold
8 ms.	50psi

6. CATALOGUE NUMBERS

SENTRI ground fault relay, 60 – 240V AC or DC control voltage.

Table 5.1 MGFR relay catalogue numbers

Catalogue Number	Notes
SENTRI	Relay
mGARD-SYM	Remote Indicator
SENSOR-L1	Flash Sensor Type 1
SENSOR-L2	Flash Sensor Type 2

For mounting dimensions and catalogue information on I-Gard zero sequence current sensors please refer to the current I-Gard Catalogue (C-700 Current Sensors).

Table 5.2 I-Gard zero sequence current sensors

RZ10-31Catalogue Number	Notes
T2A	2 Inch diameter, Silicon steel Toroidal
T3A	3 Inch diameter, Silicon steel Toroidal
T3A-S	2.625 Inch diameter, Silicon steel
T6A	6 Inch diameter, Silicon steel Toroidal
T6A-S	5.75 Inch diameter, Silicon steel Toroidal Split Core
T9A	9 Inch diameter, Silicon steel Toroidal
R4-17A	Rectangular Silicon Steel
R7-13A	Rectangular Silicon Steel
R8-26A	Rectangular Silicon Steel
RZ5-11	Rectangular Silicon Steel*
RZR-21	Rectangular Silicon Steel*
RZ5-31	Rectangular Silicon Steel*
RZ5-35	Rectangular Silicon Steel*
RZ10-11	Rectangular Silicon Steel*
RZ10-21	Rectangular Silicon Steel*
RZ10-31	Rectangular Silicon Steel*

*For current pick-up settings between 100 and 1,200 Amperes.

A test winding is built into each sensor and four screw type terminals are provided, two for the sensing winding (W1 and W2), and two for the SELF-TEST winding (R3 and R4).

The test winding of the RZ sensors has an equal number of turns (1000) to the sensor winding, thereby providing primary injection testing with relatively little test current. (For example, if the relay is set for 1200A, the relay can be tripped with 1.2 Amperes in the test winding, i.e. 1000 x 1.2 = 1200A). Application of 120V, 60 Hz. to the test winding causes a current of about 8 to 10 Amperes to flow in it providing test current to trip the relay on all settings. All other sensors have a single test winding (i.e. 1 turn), thus an appropriately sized resistor should be used to limit the test current.

7. SERVICE

For assistance in installation, set-up or testing please call I-Gard toll free at the following number:

1-888-737-4787

(1-888-RESISTR)

DANGER
Hazard of Electrical Shock, Burn or Explosion
All installation, servicing and testing referred to in this manual must be performed by qualified personnel. All power should be disconnected prior to removing covers or enclosures and where live conductors may otherwise be exposed.
Failure to observe these precautions may result in death or severe personal injury and damage to equipment. Before placing an intentional ground fault on the power system, check that a fault does not already exist. Any test ground fault equipment must be rated for full system voltage and be fused for protection.

There are no recommended, user-serviceable parts in the SENTRI. All other service should be referred to qualified factory representatives, other than direct replacement of entire modules to I-Gard. Please visit the I-Gard website for information regarding field service representatives in your area.

8. TECHNICAL SPECIFICATIONS

Control Power:

10VA AC or 10W DC

60-240 V AC/DC ±10%

Temperature Range (Celsius):

Operating Temperature: -40°C to +65°C

Storage Temperature: -40°C to +85°C

Dielectric:

Relay contacts to chassis:

1480V rms. for 1 minute

Control terminals to chassis

1480V rms. for 1 minute

Ground Fault:

Faceplate Pickup Settings:

Configuration A: 100mA,, 200mA, 300mA, 400mA, 500mA, 600mA, 700mA, 800mA, 900mA, 1.2A

Configuration B: 1A, 2A, 3A, 4A, 5A, 6A, 7A, 8A, 9A, 12A,

Configuration C: 10A, 20A, 30A, 40A, 50A, 60A, 70A, 80A, 90A, 120A

Configuration D: 100A, 200A, 300A, 400A, 500A, 600A, 700A, 800A, 900A, 1200A

Pickup Tolerance: ±5%

Faceplate Delay Settings (Sec.):

20ms, 100ms, 200ms, 300ms, 400ms, 600ms, 800ms, 1s, 3s, 5s

Thermal Withstand: 20 times rating

Delay Tolerance: ±5%

Zero Sequence Sensors:
I-GARD TxA or Rx-yA-TYPE Use I-Gard RZ type sensor for current pick up settings between 100 and 1,200 Amperes, 1A sec. (Input impedance: 0 Ohms)

Output Contacts:

Main Trip Relay:

Type: Form Z (NO and NC pair)
Rating: 10A @ 250V AC,
10A @ 30V DC,
1/2HP @ 240V AC
Operating Time: 7ms typ. (excluding bounce)

Pre Trip Relay:

Type: "A" N.O. (Normally Open)
Rating: 10A @ 240V AC, 8A @ 24V DC,
1/2HP @ 240V AC
Operating Time: 6ms typ. (excluding bounce)

Flash Relays:

Type: "A" N.O. (Normally Open)
Rating: 10A @ 240V AC,
8A @ 24V DC,
1/2HP @ 240V AC
Operating Time: <1ms

Physical:

Weight: 0.50 kg (0.88 lbs)
Dimension: See Figs. 9.0

Mounting:

Din Rail 35mm
Two Screw #8 x 3/4" (M4 x 20 mm)

Standards: CSA

I-Gard reserves the right to change specifications of its products without notice.

9. DIMENSIONAL DRAWINGS

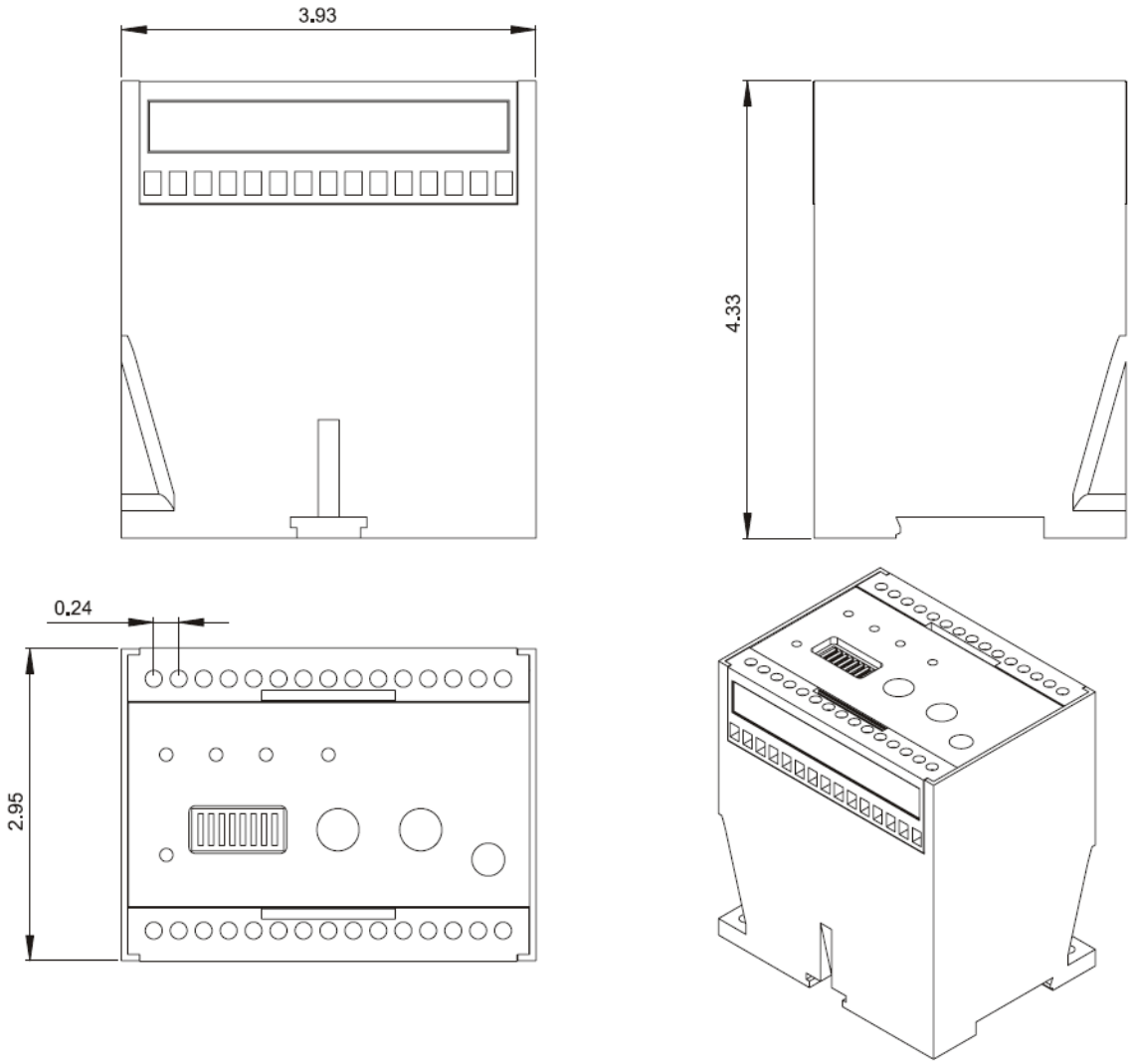

Figure 9.0: SENTRI Dimensions (Inches)

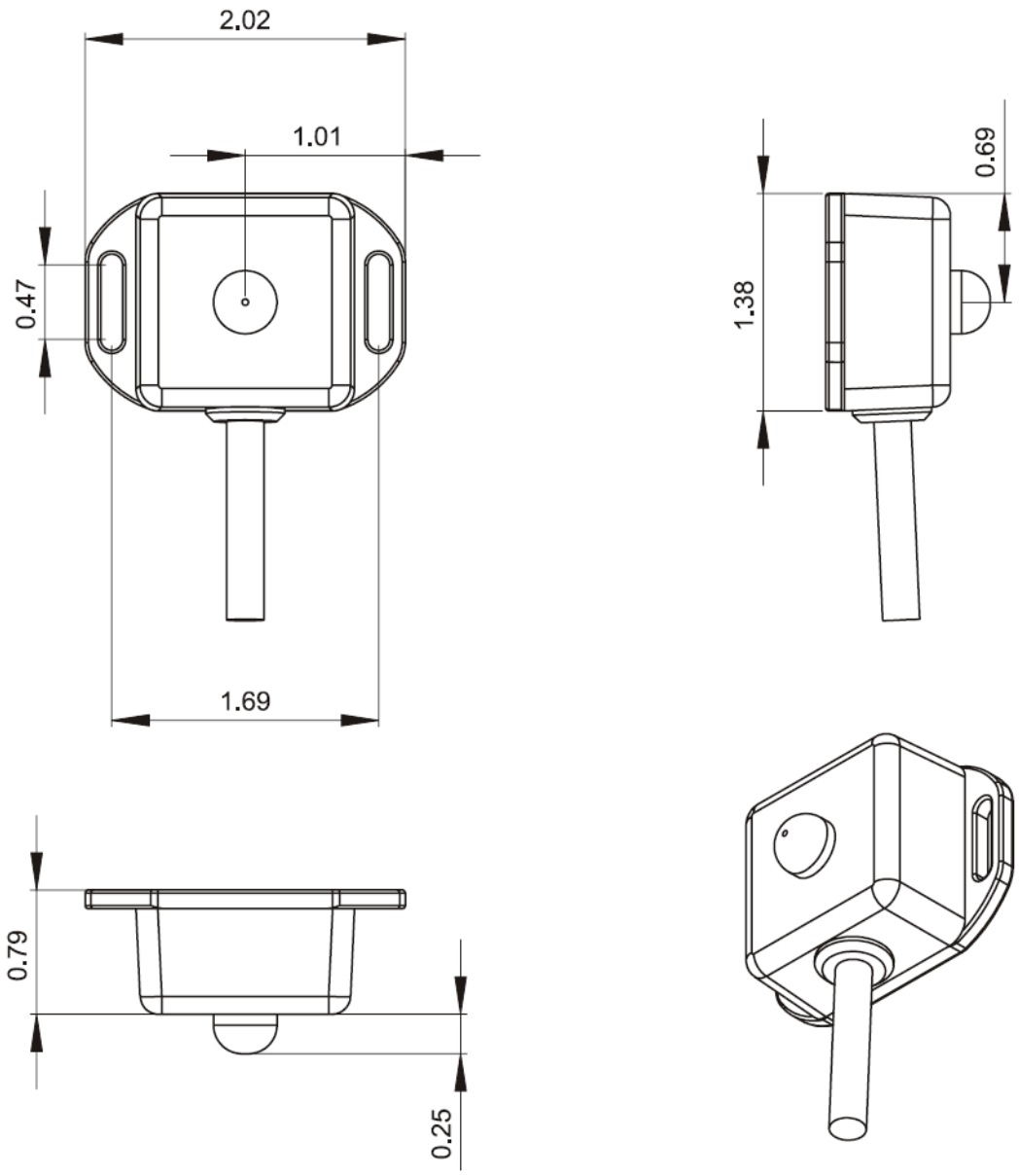

Figure 9.1 SENSOR-L1 flash sensor

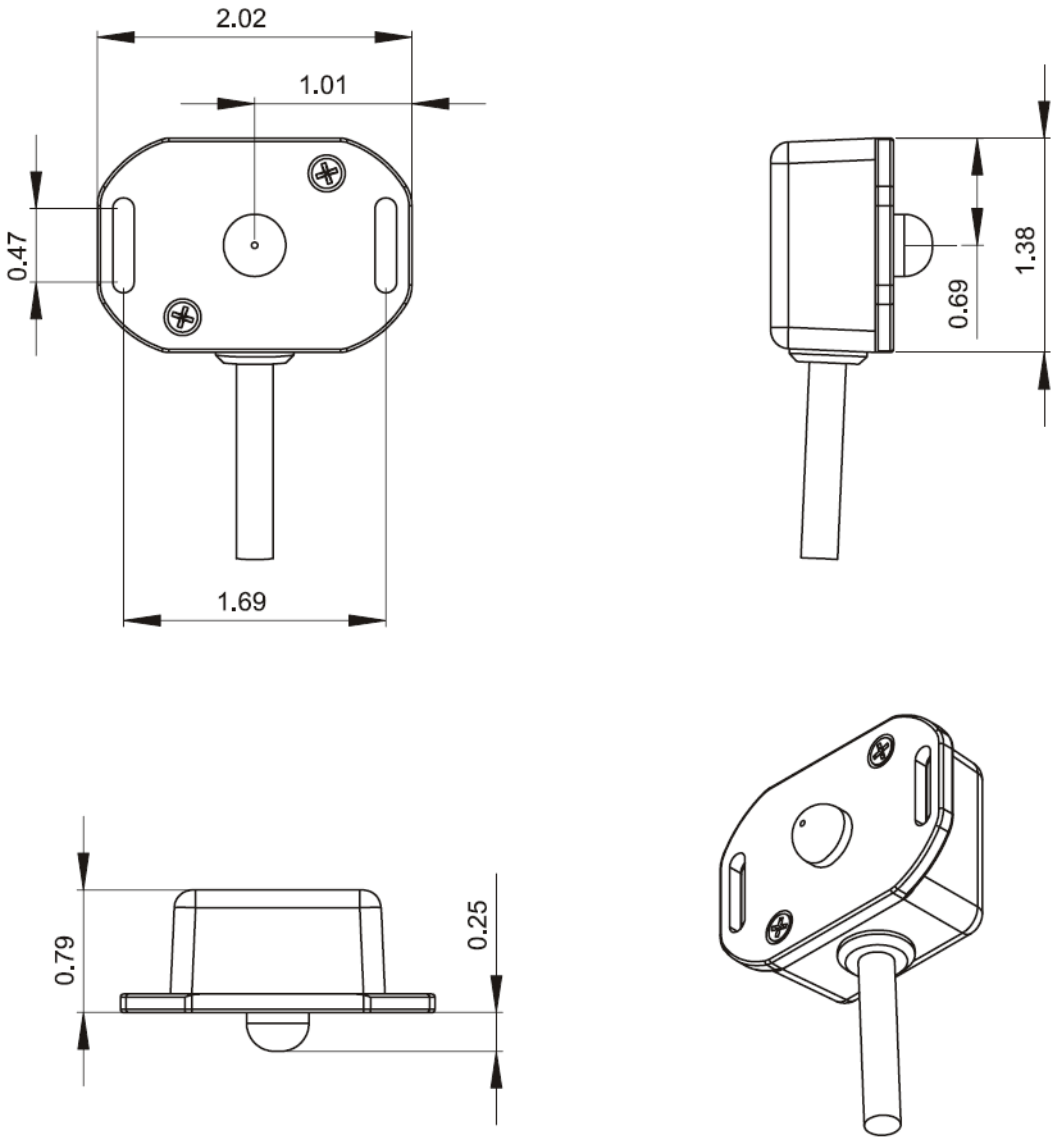

Figure 9.2 SENSOR-L2 flash sensor

NOTES

GARD

Unparalleled Protection

C-421EM SENTRI

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