

## GROUND-FAULT PROTECTION

Create safer working environments and reduce incidents of Arc Flash without affecting the uptime of critical operations. Vital in manufacturing and processing environments, sensitive ground-fault relays with advanced filtering will detect breakdown in insulation resistance without nuisance trips. Breakdown in insulation resistance can be caused by moisture, vibration, chemicals and dust.

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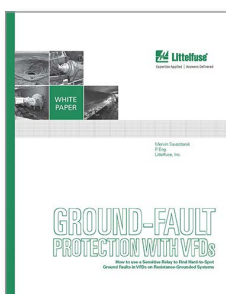
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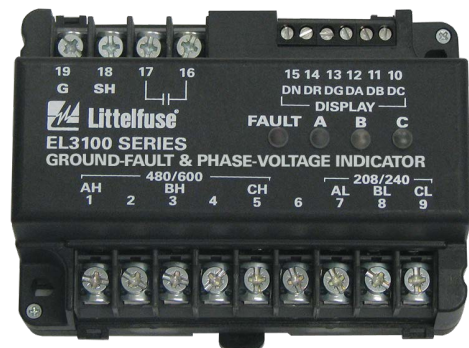
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For More Information...  
 and to download our White Paper  
 on Ground-Fault Protection with  
 VFDs, visit  
**[Littelfuse.com/TechnicalCenter](http://Littelfuse.com/TechnicalCenter)**

# EL3100 SERIES

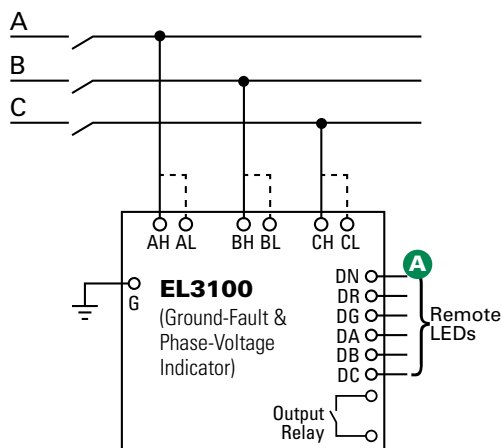
## Ground-Fault & Phase-Voltage Indicator



### Description

The EL3100 is a self-powered ground-fault and phase-voltage indication system for 3-phase systems. The EL3100 meets the National Electrical Code (NEC) and the Canadian Electrical Code (CEC) requirements for ground detectors for ungrounded alternating-current systems. Voltage connections are provided on the EL3100 for 208, 240, 480, and 600-V systems. Three green LED's on the EL3100 indicate the presence of phase-to-ground voltage and one red LED indicates a ground fault. The EL3100 can operate stand-alone or with up to five remote LED indicators. A solid-state relay output provides indication of a ground fault. The output relay is closed when the 3-phase neutral voltage shifts as the result of ground leakage.

### Simplified Circuit Diagram



### Features & Benefits

FEATURES	BENEFITS
<b>NEC® and CEC Code compliant</b>	Meets National Electrical Code (NEC®) Article 250.21 and Canadian Electrical Code Part 1, Section 10-106 (2) requirements for ungrounded systems
<b>Low-voltage remote LEDs</b>	System voltage is not present at the remote LED location
<b>Phase-voltage indication</b>	Indicates the presence of voltage on both grounded and ungrounded systems
<b>Output relay</b>	Allows for remote ground-fault indication

### Accessories



#### Remote LEDs

High-intensity 16-mm IP67 LED lamps available in red and green colors.

### Ordering Information

ORDERING NUMBER	MOUNTING
EL3100-00	DIN, Surface
ACCESSORIES	REQUIREMENT
RK-310X-0Y	Optional

Note: X=R for red LED and G for green LED  
Y=0 for no label and 1 for a ground-fault label

### Specifications

<b>Input Voltage</b>	Input L: 208/240 Vac Input H: 480/600 Vac
<b>Dimensions</b>	<b>H</b> 87.0 mm (3.43"); <b>W</b> 112.5 mm (4.43") <b>D</b> 56.0 mm (2.2")
<b>Approvals</b>	CSA certified, UL Listed (E340889), RCM (Australia)
<b>Conformally Coated</b>	Standard feature
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface

# PGR-3100 SERIES

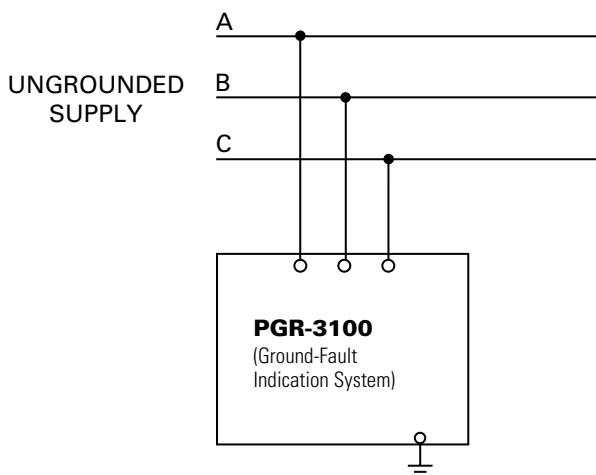
## Ground-Fault Indication System



### Description

The PGR-3100 indicates the presence of voltage on each phase of a three-phase system. The LEDs on the panel illuminate when voltage is present. When a ground-fault occurs, the voltage on the faulted phase reduces to ground potential, causing the LEDs for the faulted phase to dim and the LEDs for the unfaulted phases to become brighter. Ungrounded ac systems are required by the National Electrical Code (NEC) Article 250.21(B) and the Canadian Electrical Code Part 1, Section 10-106 (2) to have ground detectors, such as the PGR-3100, installed on the system. External potential transformers (PTs) can be used to step down system voltage, allowing the PGR-3100 to be applied to any system voltage. PTs are not required for system voltages up to 600 Vac.

### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	MOUNTING
PGR-3100	Panel mount

ACCESSORIES					
ORDERING NUMBER	OPTIONS	POWER SUPPLY	ENCLOSURE	INDICATION	
PGR-3100-PNL	-	A	B	-	C D
	0 = No Options, customer supplied 120 V lamp test 1 = Transformer included for 120 V lamp test	0 = Low Voltage (120, 208, 240), c/w fusing 1 = High Voltage (480, 600), c/w fusing	0 = NEMA 4 Enclosure 1 = 316 Stainless Steel		Future Options

### Features & Benefits

FEATURES	BENEFITS
<b>NEC and CEC Code compliant</b>	Meets National Electrical Code (NEC) Article 250.21(B) and Canadian Electrical Code Part 1, Section 10-106 (2) requirements for ungrounded systems
<b>Phase LEDs</b>	Indicates presence of a ground fault and the faulted phase as well as phase-to-ground voltage on an energized bus
<b>Redundant LEDs</b>	Redundant long-life LEDs (two per phase) to ensure reliability
<b>Lamp test button</b>	Verifies LEDs are operating

### Accessories



#### PGR-3100-PNL Panel-Mount Enclosure

PGR-3100-PNL is the PGR-3100 integrated into compact stainless steel enclosure for ease of installation and retrofits. Options include visual alarm, audible alarm with silence and reset. Dimensions are 8"W x 8"H x 4" D.

### Specifications

<b>Input Voltage</b>	Up to 600 Vac 50/60 Hz
<b>Indicator Off Voltage</b>	< 30 Vac line to ground
<b>Dimensions</b>	<b>H</b> 88.9 mm (3.5"); <b>W</b> 108 mm (4.3"); <b>D</b> 54 mm (2.1")
<b>Test Button</b>	Local
<b>Approvals</b>	CSA certified, UL Listed
<b>Conformally Coated</b>	Standard feature
<b>Warranty</b>	5 years
<b>Mounting</b>	Panel

# PGR-3200 SERIES

## Insulation Monitor



1 GROUND-FAULT PROTECTION

### Description

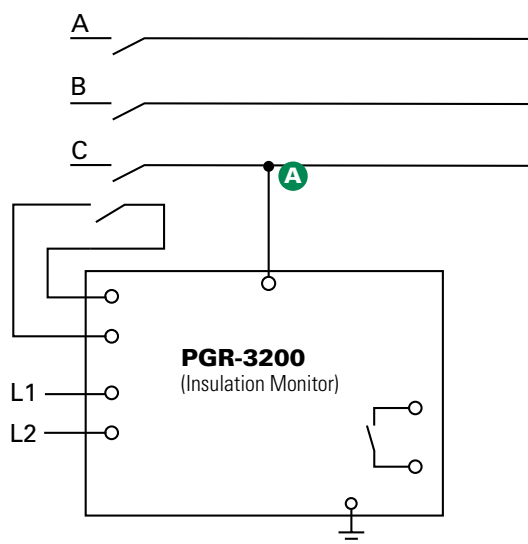
The PGR-3200 detects ground faults by continuously monitoring the insulation integrity of ungrounded electrical systems. The relay monitors the insulation for damage and assists with predictive maintenance and troubleshooting of developing ground faults by providing two warning and an alarm level. The PGR-3200 operates on one- or three-phase ungrounded systems up to 6 kV.

The PGR-3200 can also be used on a grounded system to monitor the insulation for damage, while the power system is de-energized. The mode-of-operation terminals (27-28) are connected to the circuit breaker or contactor auxiliary contacts to toggle the relay off when the contactor or breaker is closed.

### Features & Benefits

FEATURES	BENEFITS
<b>NEC® and CEC Code compliant</b>	Meets National Electrical Code (NEC®) Article 250.21(B) and Canadian Electrical Code Part 1, Section 10-106 (2) requirements for ungrounded systems
<b>Output contact (50 kΩ)</b>	Form C output contact for alarming when the insulation resistance is below 50 kΩ
<b>Output contact (10 kΩ)</b>	Form C output contact for tripping when the insulation resistance is below 10 kΩ
<b>Analog output (0-1 mA)</b>	Provides means for connecting to an optional meter (PGA-0510) or control system
<b>DIN-rail or surface mount</b>	Flexible options for ease of installation

### Simplified Circuit Diagram



### Accessories



#### PGH Series High-Tension Coupler

A PGH Series high-tension coupler is required for systems between 1,300 V and 6,000 V.



#### PGA-0510 Analog Ohm Meter

Optional PGA-0510 Analog Meter allows for metering of insulation resistance.

### Ordering Information

ORDERING NUMBER	CONTROL POWER
PGR-3200	240 Vac <sup>(1)</sup>
PGR-3200-120	120 Vac
ACCESSORIES	REQUIREMENT
PGH Series	Required >1,300 V
PGA-0510	Optional

Note: For optional conformal coating please consult factory. To convert to a resistance grounded system, see neutral-grounding-resistors packages.

(1) UL Not Available

### Specifications

<b>IEEE Device Numbers</b>	Undervoltage Relay (27) Ground Detector Relay (64)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 75 mm (3"); <b>W</b> 100 mm (3.9"); <b>D</b> 115 mm (4.5")
<b>Resistance Ratings</b>	Insulation warning (30 kΩ and 50 kΩ) Insulation alarm (10 kΩ)
<b>Contact Operating Mode</b>	Non-fail-safe
<b>Test Button</b>	Local
<b>Reset Button</b>	Local and remote
<b>Output Contacts</b>	Two Form C
<b>Analog Output</b>	0-1 mA
<b>Conformally Coated</b>	Consult factory
<b>Approvals</b>	UL Listed (E183688)
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface

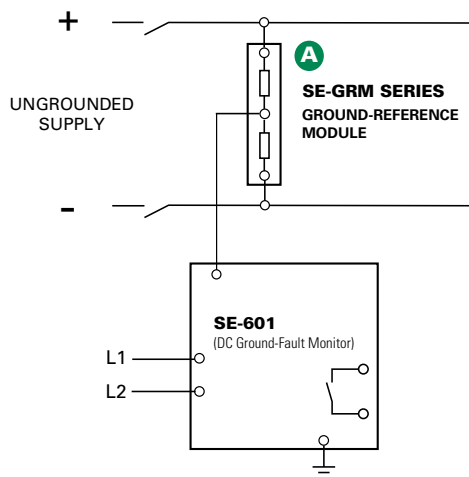


# SE-601 SERIES (PGR-2601)

## DC Ground-Fault Monitor



### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	CONTROL POWER
SE-601-OU	120/240 Vac/Vdc
SE-601-OD	12/24 Vdc
SE-601-OT	48 Vdc
ACCESSORIES	REQUIREMENT
SE-GRM SERIES	Required
PGA-0500	Optional
PMA-55	Optional
PMA-60	Optional

Note: For optional conformal coating please consult factory.

### Description

The SE-601 is a microprocessor-based ground-fault relay for ungrounded dc systems. It provides sensitive ground-fault protection without the problems associated with nuisance tripping. Ground-fault current is sensed using an SE-GRM Series Ground-Reference Module—a resistor network that limits ground-fault current to 25 mA. The SE-601 is used on ungrounded dc systems ranging from industrial 24-Vdc control circuits to 1000-Vdc solar and transportation systems.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable pickup (1-20 mA)</b>	Ten settings provide a wide range of low-level protection
<b>Adjustable time delay (50 ms-2.5 s)</b>	Adjustable trip delay allows quick protection or delayed response
<b>Output contacts</b>	Form A and Form B output contacts for operation of separate annunciation and trip circuits
<b>Analog output (0-5 V)</b>	Provides means for connecting to a meter (PGA-0500) or a control system
<b>Non-volatile trip Memory</b>	Retains trip state when de-energized to simplify troubleshooting
<b>Selectable contact operating mode</b>	Selectable fail-safe or non-fail-safe operating modes allow connection to shunt or undervoltage breaker coil
<b>Microprocessor based</b>	No calibration required saves on maintenance cost

### Accessories

**A** **SE-GRM Series Ground-Reference Module**  
Required accessory, used to connect the SE-601 DC Ground-Fault Monitor to the DC bus.

**PGA-0500 Analog % Current Meter**  
Optional panel-mounted analog meter displays ground-fault current as a percentage of 22 mA.

### Specifications

<b>IEEE Device Numbers</b>	DC Overcurrent Relay (76G)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 75 mm (3.0"); <b>W</b> 55 mm (2.2"); <b>D</b> 115 mm (4.5")
<b>Trip Level Settings</b>	1-20 mA
<b>Trip Time Settings</b>	0.05-2.5 s
<b>Output Contacts</b>	Isolated Form A and Form B
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe
<b>Test Button</b>	Local
<b>Reset Button</b>	Local and remote
<b>Analog Output</b>	0-5 V
<b>Conformally Coated</b>	Consult factory
<b>Approvals</b>	CSA certified, UL Listed (E340889), CE (European Union), C-Tick (Australian)
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface (standard) Panel (with PMA-55 or PMA-60 adapter)

# EL731 SERIES

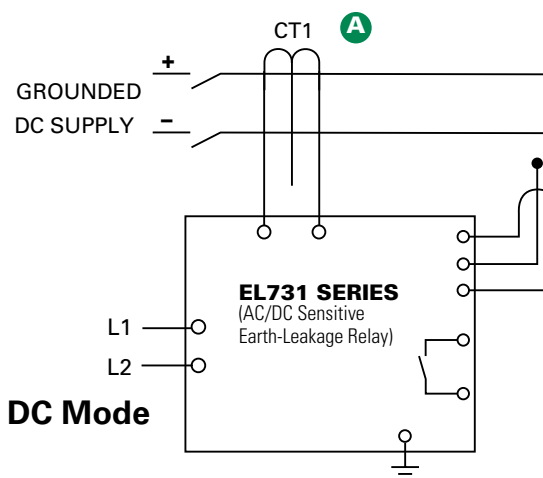
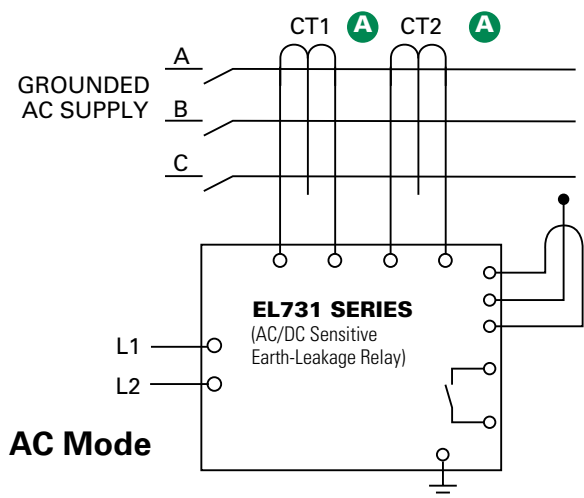
## AC/DC Sensitive Earth-Leakage Relay



### Description

The EL731 is a microprocessor-based AC/DC Sensitive Earth-Leakage Relay that offers complete coverage for all frequencies from 0 to 6,000 Hz. Two CTs are required for the entire frequency range, or one CT can be used for only low- or high-frequency detection. An RTD/PTC sensor input allows over-temperature protection for a motor or drive. The EL731 offers metering, password-protected alarm and trip settings and optional network communications. It is primarily used to add low-level ground-fault protection to variable-speed drives, and to dc circuits.

### Simplified Circuit Diagram



For detailed wiring diagram, see adjacent page.

### Ordering Information

ORDERING NUMBER	CONTROL POWER	COMMUNICATIONS
EL731-00-X0	120/240 Vac/Vdc	None
EL731-01-X0	120/240 Vac/Vdc	DeviceNet™
EL731-02-X0	120/240 Vac/Vdc	Profibus®
EL731-03-X0	120/240 Vac/Vdc	EtherNet/IP™
EL731-04-X0	120/240 Vac/Vdc	Modbus® TCP
EL731-10-X0	48 Vdc & 24 Vac	None
EL731-11-X0	48 Vdc & 24 Vac	DeviceNet™
EL731-12-X0	48 Vdc & 24 Vac	Profibus®
EL731-13-X0	48 Vdc & 24 Vac	EtherNet/IP™
EL731-14-X0	48 Vdc & 24 Vac	Modbus® TCP
EL731-20-X0	24 Vdc	None
EL731-21-X0	24 Vdc	DeviceNet™
EL731-22-X0	24 Vdc	Profibus®
EL731-23-X0	24 Vdc	EtherNet/IP™
EL731-24-X0	24 Vdc	Modbus® TCP

### Accessories

**A EFCT Series Earth-Fault Current Transformer**  
Required zero-sequence current transformer specifically designed for low level detection.

**AC700-CUA Series Communication Adapter**  
Optional network-interface and firmware-upgrade communications adapters field-install in EL731.

**AC700-SMK DIN-rail & Surface-mount Adapter**  
EL731 plugs into adapter for back-plane mounting.

ACCESSORIES	REQUIREMENT
EFCT Series CT	One Required
AC700-CUA Series Com. Unit	Optional
AC700-SMK Surface-Mount Kit	Optional
AC700-CVR-00 Watertight Cover (IP66) for Panel-Mount Applications	Optional
PGA-0520 Analog Meter	Optional

Note: When building a part number, replace the "X" with "1" for AS/NZS 2081:2011 Compliant product, "0" otherwise.

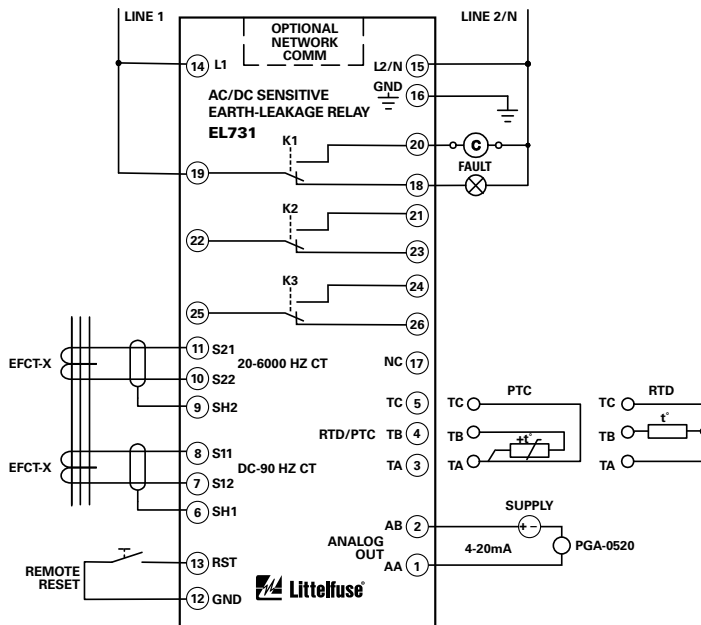
# EL731 SERIES

## AC/DC Sensitive Earth-Leakage Relay

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable pickup (30-5,000 mA)</b>	Adjustable trip setting provides a wide range of low-level protection and system coordination
<b>Frequency range (0-90 Hz, 20-6,000 Hz)</b>	Operate in either AC or DC mode or both. Use single or combined ranges. Separate metering
<b>32-char OLED display</b>	Earth-leakage metering, setup and programming
<b>Local LED indication</b>	Visual Trip, Alarm, CT connection indication
<b>CT-Loop monitoring</b>	Alarms when CT is not connected
<b>Analog output (4-20 mA)</b>	Connect to DCS. Allows connection to an optional meter (PGA-0520) or control system
<b>Adjustable time delay</b>	Adjustable trip delay for quick protection and system coordination
<b>Alarm and trip settings</b>	Detect a deteriorating condition before damage occurs
<b>Temperature-sensor input</b>	Drive or motor temperature protection
<b>Output contacts</b>	3 programmable: Operate 2 alarm and 1 trip circuit
<b>Network communication</b>	Optional connection to plant network
<b>Harmonic filtering</b>	Eliminates nuisance tripping due to harmonic noise
<b>Microprocessor based</b>	No required calibration saves maintenance cost
<b>Universal power supply</b>	Provides flexibility for numerous applications

### Wiring Diagram



### Specifications

<b>IEEE Device Numbers</b>	AC ground fault (50G/N, 51G/N), DC ground fault (79G), PTC overtemperature (49), RTD temperature (38, 49)
<b>Supply Voltage</b>	120/240 Vac/Vdc, 24 Vdc, 48 Vdc/24 Vac
<b>Trip Level Settings</b>	30-5,000 mA AC and DC
<b>Alarm Level Settings</b>	30-5,000 mA AC and DC
<b>Trip Delay</b>	0.05-2 s
<b>Output Contacts</b>	3 Form C (programmable)
<b>Contact Operating Mode</b>	Fail-safe & non-fail-safe
<b>Reset</b>	Front panel and remote
<b>Freq. Response, CT1</b>	0-90 Hz
<b>Freq. Response, CT2</b>	20-6,000, 190-6,000, 20-90, 20-3,000 Hz; selectable
<b>Current Transformer CT Detection</b>	EFCT-x series
<b>Terminals</b>	Open & short detection Plug-in, wire clamping, 24 to 12 AWG (0.2-2.5 mm <sup>2</sup> )
<b>Communications</b>	EtherNet/IP™, DeviceNet™, Profibus®, Modbus® TCP (optional)
<b>Analog Output</b>	4-20 mA (selectable 0-5 A or 0-100% trip-level setting)
<b>Conformal Coating</b>	Standard feature
<b>Dimensions</b>	<b>H</b> 48 mm (1.9"); <b>W</b> 96 mm (3.8"); <b>D</b> 129 mm (5.0")
<b>Approvals</b>	UL Listed (E340889), CSA, RCM (Australia), CE
<b>Warranty</b>	5 years
<b>Mounting</b>	Panel; Surface and DIN (with optional AC700-SMK)

# SE-701 SERIES (PGR-5701)

## Ground-Fault Monitor



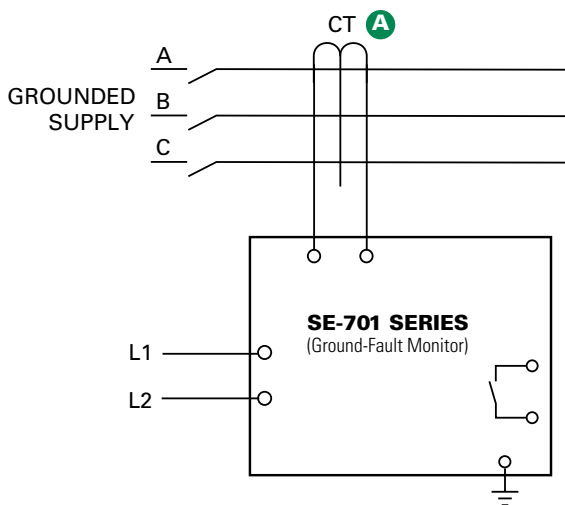
### Description

The SE-701 is a microprocessor-based ground-fault relay for resistance- and solidly-grounded systems. In addition to common systems, it is uniquely suited for use on systems with significant harmonic content. The SE-701 can provide main-plant protection, feeder-level protection, or individual-load protection. Proper current transformer selection provides the desired pickup range. The output contacts can be connected for use in protective tripping circuits or in alarm indication circuits. The analog output can be used with a PLC or a meter.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable pickup (1-99%)</b>	Trip setting based on input CT primary, allows use with any CT. Minimum 50 mA with EFCT Series.
<b>Adjustable time delay (50 ms - 2.5 s)</b>	Adjustable trip delay allows quick protection and system coordination
<b>Output contacts</b>	Form A and Form B ground-fault output contacts for operation of separate annunciation and trip circuits
<b>Analog output (0-5 V)</b>	Allows for connecting an optional meter (PGA-0500) or a control system
<b>CT-Loop monitoring</b>	Alarms when CT is not connected
<b>Selectable DFT or peak detection filtering</b>	Compatible with variable-speed drives
<b>Harmonic filtering</b>	Eliminates nuisance tripping
<b>Non-volatile trip memory</b>	Retains trip state while de-energized to simplify troubleshooting
<b>Microprocessor based</b>	No calibration required, saves on maintenance cost
<b>Universal power supply</b>	Allows operation in application where one side of PT is faulted, provides flexibility for numerous applications

### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	CONTROL POWER
SE-701-OU	120/240 Vac/Vdc
SE-701-OD	12/24 Vdc
SE-701-OT	48 Vdc
SE-701-O3	24 Vac

ACCESSORIES	REQUIREMENT
Current Transformer	Required
PGA-0500	Optional
PMA-55, PMA-60	Optional
SE-EFVC Voltage Clamp	Optional

Note: For optional conformal coating please consult factory.

### Accessories

- A Ground-Fault Current Transformer**  
Required current transformer model depends on application. We offer a variety of sensitive CTs with 5- and 30-A primaries.
- B PGA-0500 Analog % Current Meter**  
Optional panel-mounted analog meter displays ground-fault current as a percentage of the CT primary rating.

### Specifications

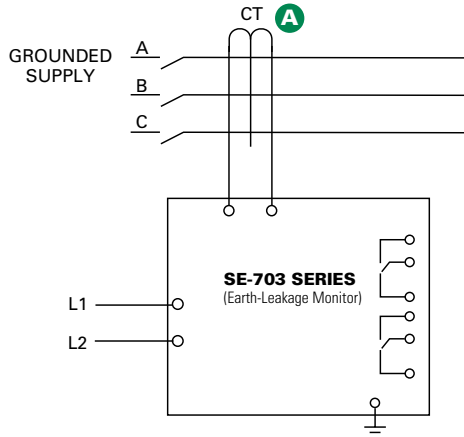
<b>IEEE Device Numbers</b>	Ground fault (50G/N, 51G/N)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 75 mm (3.0"); <b>W</b> 55 mm (2.2"); <b>D</b> 115 mm (4.5")
<b>Trip Level Settings</b>	1-99% CT-Primary Rating
<b>Trip Time Settings</b>	0.05-2.5 s
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe
<b>Harmonic Filtering</b>	Standard feature
<b>Test Button</b>	Standard feature
<b>Reset Button</b>	Standard feature
<b>CT-Loop Monitoring</b>	Standard feature
<b>Output Contacts</b>	Isolated Form A and Form B
<b>Approvals</b>	CSA certified, UL Listed (E340889), CE (European Union), C-Tick (Australian)
<b>Analog Output</b>	0-5 V
<b>Conformally coated</b>	Consult factory
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface (standard) Panel (with PMA-55 or PMA-60 adapter)

# SE-703 SERIES

## Earth-Leakage Monitor



### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	CONTROL POWER
SE-703-0U-0x	120/240 Vac/Vdc
SE-703-0D-0x	12/24 Vdc
SE-703-0T-0x	48 Vdc
SE-703-03-0x	24 Vac

Note: x=0 for AS/NZS 2081:2011 compliance (fail-safe output contacts)  
x=2 for AS/NZS 2081:2002 compliance (selectable fail-safe or non-fail-safe output contacts)

ACCESSORIES	REQUIREMENT
EFCT Series	Required
PGA-0500	Optional
PMA-55	Optional
PMA-60	Optional
SE-EFVC Voltage Clamp	Optional

### Description

The SE-703 is a microprocessor-based earth-fault relay for resistance- and solidly earthed systems. It offers sensitive earth-fault detection as low as 25 mA and can be used on systems with significant harmonic content. The SE-703 provides feeder-level protection or individual-load protection. The output contacts can be connected for use in protective tripping circuits or in alarm indication circuits. The analog output can be used with a PLC or a meter. The SE-703 is specifically designed to be AS/NZS 2081 compliant to either 2011 or 2002 (see ordering options).

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable pickup (25-500 mA)</b>	Adjustable trip setting provides a wide range of low-level protection and system coordination
<b>Adjustable time delay (INST-500 ms)</b>	Adjustable trip delay allows quick protection and system coordination
<b>Output contacts</b>	2 Form C ground-fault output contacts for operation of separate annunciation and trip circuits
<b>Analog output (0-5 V)</b>	Allows for connecting an optional meter (PGA-0500) or control system
<b>CT-Loop monitoring</b>	Alarms when CT is not connected
<b>Contact operating mode</b>	Fail-safe operating mode for undervoltage applications, optional non-fail-safe mode available
<b>Harmonic filtering</b>	Eliminates nuisance tripping
<b>Non-volatile trip memory</b>	Retains trip state while de-energized to simplify troubleshooting
<b>Microprocessor based</b>	No calibration required, saves maintenance cost
<b>Universal power supply</b>	Allows operation in application where one side of PT is faulted, provides flexibility for numerous applications
<b>Global certifications</b>	Compliant with US, Canadian, European, and Australian standards for applications in almost any country

### Accessories

- A** **EFCT Series Ground-Fault Current Transformer**  
Required zero-sequence current transformer specifically designed for low-level detection.
- PGA-0500 Analog % Current Meter**  
Optional panel-mounted analog meter displays ground-fault current as a percentage of the set-point or 5 A.
- PMA-60 Series – Mounting Adapter**  
Required when panel mounting for AS/NZS 2081:2011 compliance

### Specifications

<b>IEEE Device Numbers</b>	Ground fault (50G/N, 51G/N)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 75 mm (3.0"); <b>W</b> 55 mm (2.2"); <b>D</b> 115 mm (4.5")
<b>Trip Level Settings</b>	25-500 mA
<b>Trip Time Settings</b>	INST-500 ms
<b>Contact Operating Mode</b>	Fail-safe (x=0 models) or selectable (x=2 models)
<b>Harmonic Filtering</b>	Standard feature
<b>Test Button</b>	Standard feature
<b>Reset Button</b>	Standard feature
<b>CT-Loop Monitoring</b>	Standard feature
<b>Output Contacts</b>	Two isolated Form C contacts
<b>Approvals</b>	CSA certified, UL Listed (E340889), CE (European Union), RCM (Australian)
<b>Compliance</b>	AS/NZS 2081:2011 (x=0 models) or AS/NZS 2081:2002 (x=2 models)
<b>Analog Output</b>	0-5 V
<b>Conformally coated</b>	Yes
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface (standard) Panel (with PMA-55 or PMA-60 adapter)



# SE-704 SERIES (PGR-4704)

## Earth-Leakage Monitor



GROUND-FAULT PROTECTION



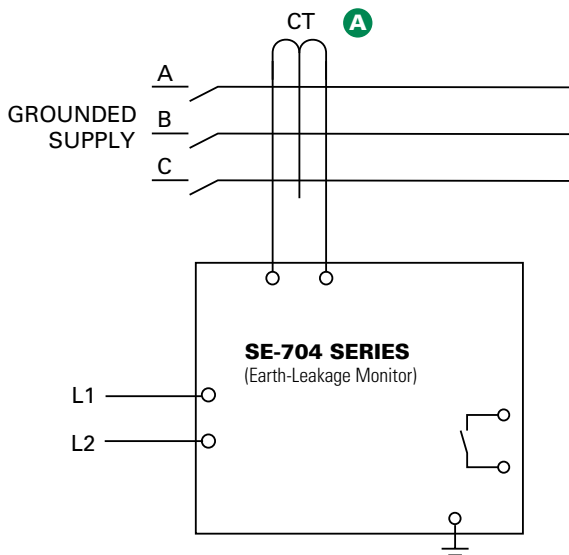
### Description

The SE-704 is a microprocessor-based ground-fault relay for resistance- and solidly-grounded systems. It offers very sensitive ground-fault detection as low as 10 mA and can be used on systems with significant harmonic content. The SE-704 provides feeder-level protection or individual-load protection. The output contacts can be connected for use in protective tripping circuits or in alarm indication circuits. The analog output can be used with a PLC or a meter.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable pickup (10 mA-5 A)</b>	Adjustable trip setting provides a wide range of low-level protection and system coordination
<b>Adjustable time delay (30 ms-2.0 s)</b>	Adjustable trip delay allows quick protection and system coordination
<b>Output contacts</b>	Form A and Form B ground-fault output contacts for operation of separate annunciation and trip circuits
<b>Analog output (0-5 V &amp; 0-1 mA)</b>	Allows for connecting an optional meter (PGA-0500) or control system
<b>CT-Loop monitoring</b>	Alarms when CT is not connected
<b>Selectable contact operating mode</b>	Selectable fail-safe or non-fail-safe operating modes allows connection to shunt or undervoltage breaker coil
<b>Harmonic filtering</b>	Eliminates nuisance tripping
<b>Non-volatile trip memory</b>	Retains trip state when de-energized to simplify troubleshooting
<b>Microprocessor based</b>	No calibration required saves maintenance cost
<b>Universal power supply</b>	Allows operation in application where one side of PT is faulted, provides flexibility for numerous applications

### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	CONTROL POWER
SE-704-OU	120/240 Vac/Vdc
SE-704-OD	12/24 Vdc
SE-704-OT	48 Vdc
SE-704-03	24 Vac

ACCESSORIES	REQUIREMENT
SE-CS30 Series	Required
PGA-0500	Optional
PMA-55, PMA-60	Optional

Note: For optional conformal coating please consult factory.

### Accessories

- A SE-CS30 Series Ground-Fault Transformer**  
Required zero-sequence current transformer specifically designed for low level detection. Flux conditioner is included to prevent saturation.
- B PGA-0500 Analog % Current Meter**  
Optional panel-mounted analog meter displays ground-fault current as a percentage of the set-point or 5 A.

### Specifications

<b>IEEE Device Numbers</b>	Ground fault (50G/N, 51G/N)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 75 mm (3.0"); <b>W</b> 55 mm (2.2"); <b>D</b> 115 mm (4.5")
<b>Trip Level Settings</b>	10 mA-5.0 A
<b>Trip Time Settings</b>	30-2000 ms
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe
<b>Harmonic Filtering</b>	Standard feature
<b>Test Button</b>	Standard feature
<b>Reset Button</b>	Standard feature
<b>CT-Loop Monitoring</b>	Standard feature
<b>Output Contacts</b>	Isolated Form A and Form B
<b>Approvals</b>	UL Listed (E340889), CSA, CE (European Union) RCM (Australian)
<b>Analog Output</b>	0-5 V & 0-1 mA
<b>Conformally coated</b>	Optional
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface (standard) Panel (with PMA-55 or PMA-60 adapter)

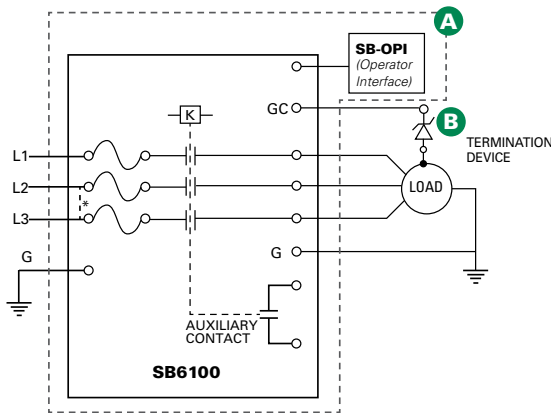


# SB6000 SERIES



\*Patented

## Simplified Circuit Diagram



ENCLOSED SB6100 MODELS  
\* For a single-phase load; Jumper L2 & L3 & use L1 & L2 as the input terminals

## Ordering Information

ORDERING NUMBER	VOLTAGE (V)	TRIP LEVEL (mA)	UL CATEGORY/CLASS
SB6100-00X-0	208	20(Fixed)	UL 943C Class C special-purpose GFCI
SB6100-10X-0	240		
SB6100-20X-0	480		
SB6100-30X-0	600		UL 943C Class D special-purpose GFCI
SB6100-01X-0	208	6, 10-100 in increments of 10	UL 943/UL 1053 Equipment ground-fault protective device (EGFPD)
SB6100-11X-0	240		
SB6100-21X-0	480		
SB6100-31X-0	600		

Note: x=0 for open-chassis models and 1 for enclosed models

## Description

### Special-Purpose Ground-Fault Circuit Interrupter (GFCI), Class C and Class D

Industrial Shock Block (ISB) is a personnel protection device designed to meet the new requirements for special-purpose GFCIs defined by UL 943C. ISB is the first and only permanently connected Class C and Class D GFCI on the market. Class C GFCIs are intended to be used on systems where the line-to-line voltage is 480 V or less with a trip level of 20 mA, while Class D GFCIs are intended to be used on 600 V systems. These improvements to the standard Class A GFCI (6 mA trip level used on 240 V systems or less) were made to allow the use of GFCIs in industrial facilities. The ISB includes an automatic self-test feature and is compliant to the UL1998 Software in Programmable Components standard.

### Equipment Ground-Fault Protective Device (EGFPD)

ISB is also available with adjustable protection settings as an EGFPD. The EGFPD models can be set to trip at 6 mA or from 10-100 mA in increments of 10 mA. This offers more flexibility since GFCI devices are not allowed to have an adjustable trip level.

### Rating and Models

ISB (GFCI & EGFPD) is available for voltages from 208 to 600 V with a maximum full load current of 100 A, and a built-in overcurrent protection supplied by Littelfuse Class T fuses. The load can be 1-phase (line-to-line) or 3-phase, however, cannot have a neutral. The power system can either be solidly-grounded or high-resistance grounded.

Two options for enclosures are available: UL-recognized open-chassis models are available for installation in existing electrical enclosures and UL-listed enclosed models include a NEMA-4X enclosure for stand-alone installations.

### Ground Wire (Load-Ground) Monitor

The ISB also monitors the ground wire (load-ground) connection between the ISB and load. This is a required feature for GFCI devices and is optional for EGFPD devices. If the connection is broken, the ISB will provide an alarm by changing the state of the alarm contacts. This monitoring circuit includes an extra wire (pilot wire) between the ISB and load (since the monitoring current is low, only a small wire is required). At the load, the pilot wire is connected to a termination device. The other end of the termination device is connected to the load ground (typically the enclosure).

## Features & Benefits

FEATURES	BENEFITS
<b>UL 943 inverse time trip curve</b>	Detects and interrupts to protect people and reduce the probability of nuisance tripping
<b>Minimum trip time &lt; 20 msec</b>	Reduces the risk of ventricular fibrillation for leakage current of 250 mA and above
<b>UL 943C fixed trip level (GFCI 20 mA)</b>	Personnel protection for systems with leakage current higher than the standard 6 mA required by UL 943 Class A
<b>Selectable trip levels (EGFPD)</b>	Provides extra safety when a customer is able to operate with a setting below 20 mA (GFCI) and the settings above 20 mA can reduce nuisance tripping on systems with high leakage current.
<b>UL 943C ground monitor/interrupt</b>	Protects from shock by tripping if continuity of ground wire between Industrial Shock-Block and load is broken.
<b>Undervoltage, brownout, chatter detection</b>	Ensures proper operation and prolongs the internal contactor lifetime
<b>3 x Class T, 600 V incoming fuses</b>	The fuses provide overcurrent protection for a 100 A circuit and a higher short-circuit current rating (SCCR) of 50 kA.
<b>Conformal coating</b>	Internal circuits are conformally coated to protect against corrosion and moisture, yet still repairable
<b>Operator Interface</b>	Shows unit status, alarm types, percentage of leakage current, and allows for Test and Reset capabilities
<b>Auxiliary Contact</b>	Provides a normally-open contact for remote indication
<b>Automatic Self-Test</b>	All ISB options (revision 01 or higher) include an automatic self-test feature
<b>Motor Starter</b>	Allows the user to start and stop the motor from the interface

1  
GROUND-FAULT PROTECTION

# SB6000 SERIES

## Accessories



**Operator Interface (AC6000-OPI-00)**



**1N5339B - Termination Device**  
Axial-lead ground-check termination, included with SB6000 series



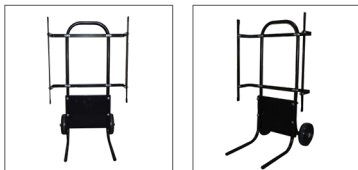
**SE-TA6 - Termination Assembly**  
Optional termination assembly with terminals and mounting holes



**SE-TA6-SM Stud-Mount Termination Assembly**  
Optional ground-check termination for submersible pumps



**AC6000-CART-00 Two-wheeled Cart**  
Optional for mounting ISB to allow for moving the unit while power is off



**AC6000-MNT-00 Mounting Frame**  
Optional for mounting ISB to a cart or other surface. Included with the AC6000-CART-00.

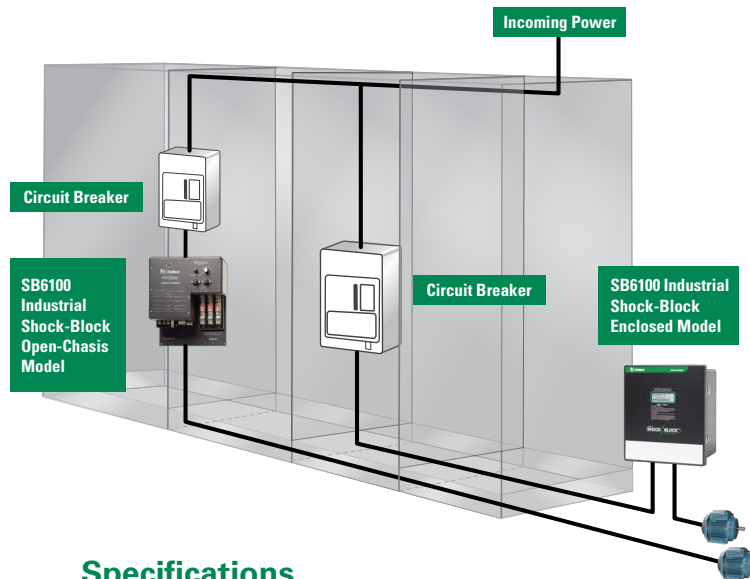
## Ordering Information - Accessories

ACCESSORIES	REQUIREMENT	PAGE
AC6000-OPI-00	Included	N/A
1N5339B	Included	477
SE-TA6	Optional	477
SE-TA6-SM	Optional	477
SE-TA6ASF-WL	Optional	477
AC6000-CART-00	Optional	N/A
AC6000-MNT-00	Optional	N/A

## Connection Diagram

The SB6100 is installed in-line between incoming power or existing over-current protection device and the load.

The open-chassis SB6100 can be installed in electrical equipment and the enclosed version is typically wall-mounted.

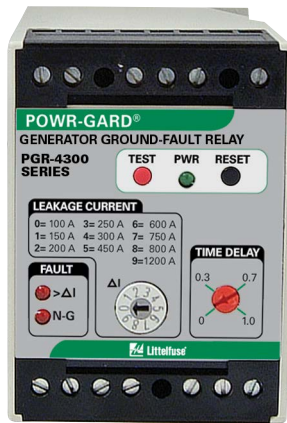


## Specifications

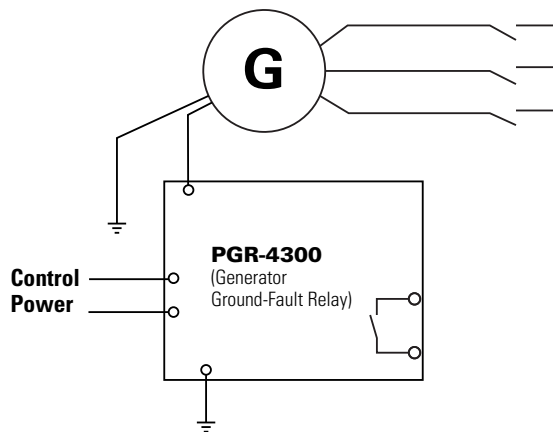
<b>Voltage Rating</b>	See ordering information
<b>Current Rating</b>	100 A (continuous)
<b>Load</b>	3-phase, 3-wire (no neutral) or 1-phase (line-to-line), 60 Hz
<b>Short-Circuit Current Rating</b>	50,000 A
<b>Trip Level Settings</b>	Selectable (6, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 mA), or fixed at 20 mA
<b>Trip Time Setting</b>	Inverse time trip curve
<b>Enclosure</b>	NEMA 4X, Polyester, Lockable
<b>Operating Temperature</b>	-35°C (-31°F) to +40°C(104°F), up to +66°C (151°F) with derating
<b>Wiring Requirements</b>	2/0 AWG (maximum)
<b>Approval</b>	GFCI: UL Listed (enclosed models) and UL Recognized component (open-chassis models) EGFPD: cULus Listed (enclosed models) and cURus Recognized Component (open-chassis models); UL1998 Compliant (revision 01 or higher); All models CSA Certified
<b>Dimensions</b>	<b>Enclosed:</b> H 453.8 mm (17.9"); W 406.2 mm (16.0"); D 223.3 mm (8.8") <b>Open-chassis:</b> H 455.0 mm (17.9"); W 340.7 mm (13.4"); D 174.9 mm (6.8")
<b>Warranty</b>	1 year

# PGR-4300 SERIES (GFA300)

## Generator Ground-Fault Relay



### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	CONTROL POWER
PGR-4300-12	12 Vdc
PGR-4300-24	24 Vdc
PGR-4300-120	120 Vac
ACCESSORIES	REQUIREMENT
PGA-0500	Optional
PMA-55	Optional
PMA-60	Optional

Note: For optional conformal coating please consult factory.

### Description

The PGR-4300 Generator Ground-Fault Relay provides a simple method for detecting a ground-fault condition on generators without the need for current transformers (CTs). This greatly simplifies the installation. In addition, it is compatible with both three- and four-pole transfer switches. This relay also monitors the neutral-to-ground path for continuity. The PGR-4300 is ideal for any generator or application where there is not sufficient space to install CTs.

### Features & Benefits

FEATURES	BENEFITS
<b>No CTs required</b>	Saves space and simplifies installation
<b>Adjustable pickup (100 - 1200 A)</b>	Adjustable trip setting provides a wide range of protection and allows system coordination
<b>Adjustable time delay (0 - 1.0 s)</b>	Adjustable trip delay allows quick protection and system coordination
<b>Output contacts</b>	Form C ground-fault output contacts for alarming or tripping purposes
<b>Analog output (0-1 mA)</b>	Provides means for connecting to an optional meter (PGA-0500) or control system
<b>N-G continuity alarm</b>	Monitors neutral-to-ground integrity and alarms if ground path becomes open circuit
<b>Passive filtering</b>	Eliminates nuisance tripping

### Accessories



**PGA-0500 Analog % Current Meter**  
Optional panel-mounted analog meter displays ground-fault current as a percentage of the set-point.

### Specifications

<b>IEEE Device Numbers</b>	Ground Fault (50G/N, 51G/N)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 75 mm (3.0"); <b>W</b> 55 mm (2.2"); <b>D</b> 115 mm (4.5")
<b>Trip Level Settings</b>	100-1200 A
<b>Trip Time Delay Settings</b>	0-1.0 s
<b>Contact Operating Mode</b>	Non-fail-safe
<b>Test Button</b>	Local
<b>Reset Button</b>	Local and remote
<b>Output Contacts</b>	Form C
<b>Analog Output</b>	0-1 mA
<b>Conformally Coated</b>	Consult factory
<b>Approvals</b>	UL Listed (E183688)
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface (standard) Panel (with PMA-55 or PMA-60 adapter)

1 GROUND-FAULT PROTECTION



## GROUND-CONDUCTOR MONITORING

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Continuously monitor the integrity of the ground conductor to protect portable equipment from hazardous voltages caused by ground faults.

SE-105 / SE-107 Series	Ground-Fault Ground-Check Monitor.....	58
SE-134C / SE-135 Series	Ground-Fault Ground-Check Monitor.....	59

For More Information...  
and to download our technical note on  
Ground-Fault Ground-Check, visit  
**[Littelfuse.com/Ground-faultPaper](http://Littelfuse.com/Ground-faultPaper)**

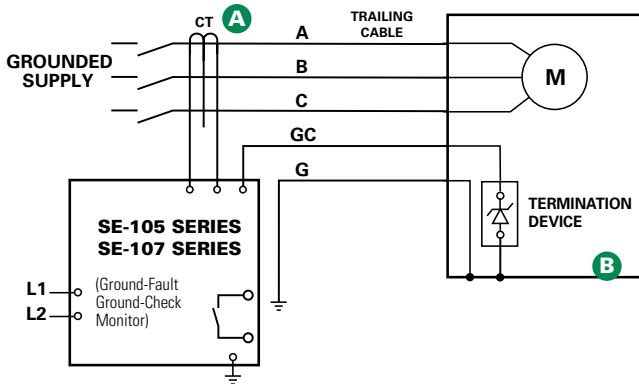
# SE-105 / SE-107 SERIES

## Ground-Fault Ground-Check Monitor



GROUND-CONDUCTOR MONITORING

### Simplified Circuit Diagram







### Description

The SE-105/SE-107 is a combination ground-wire monitor and ground-fault relay for resistance-grounded systems. It continuously monitors the integrity of the ground conductor to protect portable equipment from hazardous voltages caused by ground faults. The SE-105/SE-107 is an excellent choice for trailing cables 5 kV and under in underground mining applications. For higher voltages or long-cable applications, see the SE-134C/SE-135.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable pickup (0.5, 2.0, 4.0 A)</b>	Unit can be used on a wide variety of trailing cable applications
<b>Adjustable time delay (0.1-2.0 s)</b>	Adjustable trip delay for quick protection and system coordination
<b>Harmonic filter</b>	Prevents false operation
<b>Zener-characteristic termination assembly</b>	Provides reliable ground-check loop verification
<b>Fail-safe ground-check circuit</b>	Ensures ground-check circuit remains safe even in the event of equipment failure
<b>Conformal coating</b>	Additional coating protects circuit boards against harsh environment
<b>SE-105: selectable UV- or shunt-trip mode</b>	Provides flexibility for different applications
<b>SE-107: UV-trip mode only</b>	Eliminates chance of unauthorized change to trip circuit

### Accessories

- A**  **CT200 Series Current Transformer**  
Required CT detects ground-fault current.
- B**  **1N5339B Termination Device**  
5 W axial-lead ground-check termination; included with SE-105/SE-107.
-  **SE-TA6 Termination Assembly**  
Optional termination assembly with convenient terminals and mounting holes
-  **SE-TA6-SM Stud-Mount Termination Assembly**  
Optional 50 W ground-check termination that is robust and compact for submersible pumps. Wire lead simplifies installation.

### Ordering Information

ORDERING NUMBER	CONTROL POWER
SE-105	120 Vac
SE-105D	120 Vac/Vdc
SE-105E	240 Vac
SE-107	120 Vac
SE-107D	120 Vac/Vdc
SE-107E	240 Vac

Consult manual online for additional ordering options.

ACCESSORIES	REQUIREMENT
CT200 Series	Required
1N5339B	Included
SE-TA6, SE-TA6-SM	Optional
SE-TA6A Series	Optional
RK-102, RK-105, RK-105I	Optional
RK-13	Optional
PPI-600V	Optional

### Specifications

<b>IEEE Device Numbers</b>	Checking or Interlocking Relay (3GC), Ground Fault (50G/N, 51G/N)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 150 mm (5.9"); <b>W</b> 109 mm (4.3"); <b>D</b> 100 mm (4.0")
<b>Trip Level Settings</b>	0.5, 2.0, 4.0 A
<b>Trip Time Settings</b>	0.1-1.0 s
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe (SE-105) Fail-safe only (SE-107)
<b>Harmonic Filtering</b>	Standard feature
<b>Reset Button</b>	Local and remote
<b>Output Contacts</b>	Isolated Form A
<b>Approvals</b>	CSA certified, UL Listed (E340889), C-Tick (Australian)
<b>Conformally Coated</b>	Standard feature
<b>Warranty</b>	5 years
<b>Mounting</b>	Surface

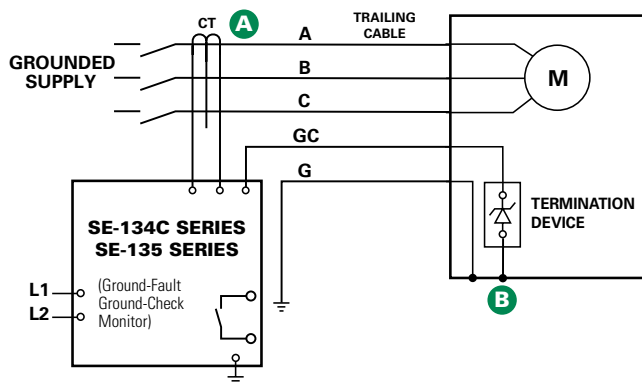


# SE-134C / SE-135 SERIES

## Ground-Fault Ground-Check Monitor



### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	OPTION	POWER SUPPLY	COMM
SE-134C	Blank or XGC	0=120/240 Vac/Vdc 1=24/48 Vdc <sup>(1)</sup>	0=None
SE-135	Blank or XGC	0=120/240 Vac/Vdc 1=24/48 Vdc <sup>(1)(2)</sup>	0=None 3=Ethernet <sup>(1)</sup>

ACCESSORIES	REQUIREMENT
SE-CS10 Series	Required
SE-CS40 Series (for SE-135)	Optional
SE-TA6A Series (for SE-134C)	Required
SE-TA12A/SE-TA12B Combination (for SE-134C)	Optional
SE-TA12A Series (for SE-135)	Required
SE-IP65CVR-G	Optional
RK-132	Optional
PPI-600V	Optional

(1) CE/C-Tick not available.  
(2) Not available with Ethernet option 3.  
(3) See ordering information.  
See Current Transformer Selection Guide and Accessory Information.



### Description

The SE-134C/SE-135 is a microprocessor-based, combination ground-wire monitor and ground-fault relay for resistance-grounded or solidly grounded systems. It continuously monitors the integrity of the ground conductor to protect portable equipment from hazardous voltages caused by ground faults. The SE-134C/SE-135 is field proven in monitoring trailing cables on large mobile equipment such as drag-lines, mining shovels, shore-to-ship power cables, dock-side cranes, stacker-reclaimers, submersible pumps, and portable conveyors.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable pickup</b> (0.5 - 12.5 A for SE-CS10) (2 - 50 A for SE-CS40)	Unit can be used on a wide variety of trailing cable applications
<b>Adjustable time delay</b> (0.1 - 2.5 s)	Adjustable trip delay for quick protection and system coordination
<b>Output contacts</b>	Separate annunciation of ground-fault and ground-check faults
<b>Ground-check LED indication</b>	Indication of open or short ground-check wire makes it easier to find faults
<b>CT-loop monitoring</b>	Alarms when CT is not connected
<b>High-induced-ac rejection</b>	Makes unit suitable for applications with high voltages and long cables
<b>DFT (Harmonic) filter</b>	Prevents false operation
<b>Zener-characteristic termination assembly</b>	Provides reliable ground-check loop verification
<b>Fail-safe circuits</b>	Ensures ground-check and ground-fault circuits remain safe even in the event of equipment failure
<b>Conformal coating</b>	Additional coating protects circuit boards against harsh environment
<b>XGC option</b>	Increases maximum cable length for ground-check monitoring (10 km typical)

### Accessories

- A**  **SE-CS10 or SE-CS40 Series Ground-Fault Current Transformer**  
Required zero-sequence current transformer detects ground-fault current.
- B**  **SE-TA6A Series, SE-TA12A Series Termination Assembly**  
Required termination assembly; temperature compensated.

### Specifications

<b>IEEE Device Numbers</b>	Checking or Interlocking Relay (3GC), Ground fault (50G/N, 51G/N)
<b>Input Voltage</b>	65-265 Vac; 85-275 Vdc; 18-72 Vdc
<b>Dimensions</b>	<b>H</b> 213 mm (8.4"); <b>W</b> 99 mm (3.9"); <b>D</b> 132 mm (5.2")
<b>Trip Level Settings</b>	0.5 - 12.5 A for SE-CS10, 2 - 50 A for SE-CS40
<b>Trip Time Settings</b>	0.1 - 2.5 s
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe
<b>Harmonic Filtering</b>	Standard feature
<b>Test Button</b>	Standard feature
<b>Reset Button</b>	Standard feature
<b>Output Contacts</b>	Isolated Form A and Form B, Two Form C
<b>Approvals</b>	CSA certified, UL Listed (E340889), C-Tick (Australia) <sup>(3)</sup> , CE <sup>(3)</sup>
<b>Conformally Coated</b>	Standard feature
<b>Warranty</b>	5 years
<b>Mounting</b>	Panel, Surface
<b>GC Trip Resistance</b>	28Ω (Standard), 45Ω (XGC Option)

2 GROUND-CONDUCTOR MONITORING



## RESISTANCE GROUNDING/NGR MONITORING

3 RESISTANCE GROUNDING/NGR MONITORING

Continuously monitoring the neutral-grounding resistor (NGR) and the neutral-to-ground path is critical to ensure the system operates as expected. Current-sensing ground-fault relays will not operate if the NGR or system ground is open circuit.

Neutral Grounding Resistor Sizing Chart..... 61

SE-325 Series Neutral Grounding Resistor Monitor..... 62

SE-330 / SE-330HV Series Neutral Grounding Resistor Monitor..... 63

SE-330AU Series Neutral Earthing-Resistor Monitor..... 65

NGR Series–US Neutral Grounding Resistor System..... 66

NGR Series–Canada Neutral Grounding Resistor System..... 75

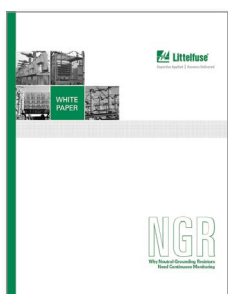
NGRM-ENC Series Enclosed Neutral Grounding Resistor Monitor ... 81

### Neutral Grounding Resistor Sizing Chart

System Voltage (Line-to-line)	NGR Let-Through Current and Resistance	Time Rating
208 V	5 A / 24 Ohms	Continuous
480 V	5 A / 55 Ohms	Continuous
600 V	5 A / 69 Ohms	Continuous
2,400 V	5 A / 277 Ohms or 10 A / 139 Ohms	Continuous or 10 sec
4,160 V	5 A / 480 Ohms or 10 A / 240 Ohms	Continuous or 10 sec
13,800 V	10 A / 798 Ohms or 200 A / 40 Ohms	10 seconds
25,000 V	200 A / 72 Ohms or 400 A / 36 Ohms	10 seconds
34,500 V	200 A / 100 Ohms or 400 A / 50 Ohms	10 seconds

Note: The values shown are for any size transformer and are typical.

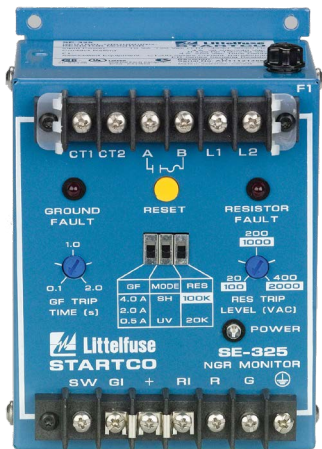
Note: The above table is for illustrative purposes only. Actual values may differ based on a variety of individual system considerations, such as capacitive charging current and co-ordination study results.



For More Information... and to download our White Paper Why NGRs Need Continuous Monitoring, visit [Littelfuse.com/TechnicalCenter](http://Littelfuse.com/TechnicalCenter)

# SE-325 SERIES (PGM-8325)

## Neutral Grounding Resistor Monitor



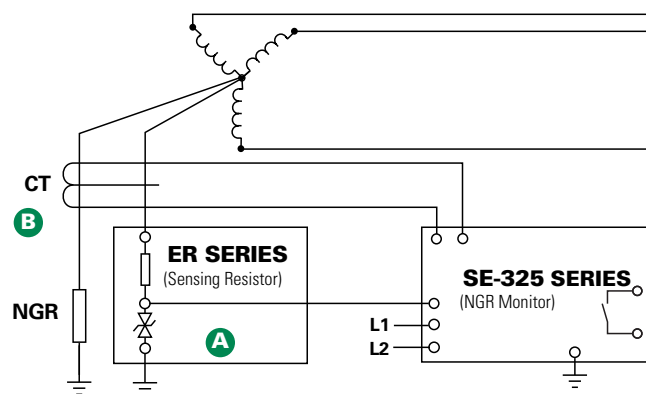
### Description

The SE-325 Neutral Grounding Resistor Monitor is used on resistance-grounded systems up to 25 kV to monitor the integrity of the neutral-to-ground path and to detect ground faults. It measures current and voltage in a transformer or generator neutral-to-ground connection and continuity of the neutral-grounding resistor (NGR). The SE-325 coordinates these three measurements to detect a loose connection, corrosion, ground fault, or NGR failure, and provides one alarm or trip output contact.

### Features & Benefits

FEATURES	BENEFITS
<b>Continuous NGR monitoring</b>	Detects resistor failure within seconds, reduces transient-overvoltage risk, removes risk of ground-fault-detection failure
<b>Ground-fault Detection</b>	Main or backup protection to detect a ground fault anywhere on the monitored system
<b>Adjustable pickup (0.5-4 A)</b>	Select greatest sensitivity without false operation
<b>Adjustable time delay (0.1-2 s)</b>	Adjustable trip delay allows system coordination
<b>Output contacts</b>	Form A output contact
<b>Selectable contact operating mode</b>	Selectable fail-safe or non-fail-safe operating modes allows connection to shunt or undervoltage breaker coil or alarm system

### Simplified Circuit Diagram






### Ordering Information

ORDERING NUMBER	CONTROL POWER
SE-325	120 Vac
SE-325D	120 Vac/Vdc
SE-325E	240 Vac

Consult manual online for additional ordering options.

ACCESSORIES	REQUIREMENT
CT200 Series	Required
ER Series	Required
SE-MRE-600	Optional
RK-325, RK-325I, RK-302	Optional
RK-13	Optional
NGRM-ENC	Optional

### Accessories

- A**  **ER Series Sensing Resistor**  
Required interface between the power system and the SE-325. Eliminates hazardous voltage levels at the monitor.
- B**  **CT200 Series Current Transformer**  
Required CT detects ground-fault current.
-  **RK Series Remote Indication and Reset**  
Optional panel-mounted remote indication and reset assemblies. Available in NEMA 1 or NEMA 4 configurations.

### Specifications

<b>IEEE Device Numbers</b>	Ground Fault (50G/N, 51G/N), Overvoltage (59N), Lockout Relay (86), Checking Relay (3)
<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 150 mm (5.9"); <b>W</b> 109 mm (4.3"); <b>D</b> 100 mm (4.0")
<b>GF Trip Level Settings</b>	0.5-4.0 A
<b>GF Trip Time Settings</b>	0.1-2.0 s
<b>RF Trip-Level Settings</b>	20-400 Vac ( $\leq 5$ kV systems) 100-2,000 Vac ( $> 5$ kV systems)
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe
<b>Reset Button</b>	Standard feature
<b>Output Contacts</b>	Form A
<b>Approvals</b>	CSA certified, UL Listed (E340889), C-Tick (Australian)
<b>Conformally coated</b>	Standard feature
<b>Warranty</b>	5 years
<b>Mounting</b>	Surface

RESISTANCE GROUNDING/NGR MONITORING

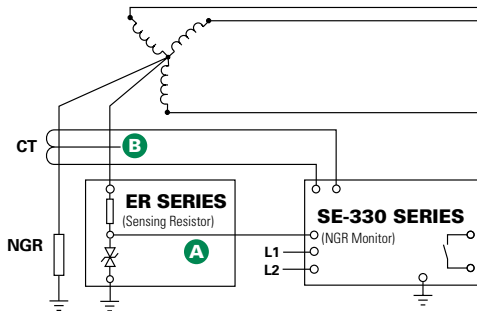
3

# SE-330, SE-330HV SERIES

## Neutral Grounding Resistor Monitor



### Simplified Circuit Diagram



For detailed wiring diagram, see adjacent page.

### Ordering Information

ORDERING NUMBER	POWER SUPPLY	COMM		K4 UNIT HEALTHY CONTACT
SE-330	- X	X	- 0	X
SE-330 for applications 35 kV or less SE-330HV for 72 kV applications	0=120/240 V ac/V dc 2=48 Vdc	0=USB Only 1=DeviceNet 3=EtherNet (Dual RJ45) 4=EtherNet (SC Fiber & RJ45) 5=EtherNet (Dual SC Fiber) 6=IEC61850 (Dual RJ45) 7=IEC61850 (SC Fiber & RJ45) 8=IEC61850 (Dual SC Fiber)		0=Normally Open 1=Normally Closed

NOTE: For Australian applications, see the SE-330AU.

ACCESSORIES	REQUIREMENT
ER Series Sensing Resistor	Required
Current Transformer	Required
SE-IP65CVR-G	Optional
SE-MRE-600	Optional
RK-332	Optional
NGRM-ENC	Optional
PGA-0520	Optional
SE-330-SMA	Optional

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### Description

The SE-330 is an advanced ground-fault and neutral-grounding-resistor monitoring relay that is compliant with Rule10-302 of the 2018 Canadian Electrical Code Part I (CE Code). It measures neutral current, neutral-to-ground voltage, and neutral-to-ground resistance. It provides continuous monitoring of the neutral-to-ground path to verify that the neutral-grounding resistor (NGR) is intact and that it has not been bypassed or shorted. An open NGR renders current-sensing ground-fault protection inoperative and could result in a false belief that the system is functioning properly. A shorted NGR results in higher-than-expected ground-fault current. The SE-330 can be used with low- and medium-voltage transformers and generators with low- or high-resistance grounding used in processing, manufacturing, chemical, pulp and paper, petroleum, and water-treatment facilities. For high-voltage applications, use the SE-330HV. For applications that require conformance to Australian standards, use the SE-330AU.

### Resistor Monitoring

The SE-330 combines the measured values of resistance, current, and voltage to continuously determine that an NGR is intact. It is able to detect an open or shorted resistor with or without a ground fault present. Sensing resistors are matched to the system voltage and are used to monitor NGRs on systems up to 72 kV.

### Ground-Fault Monitoring

The SE-330 uses an application-appropriate current transformer to reliably detect ground-fault currents as small as 100 mA. Discrete-Fourier Transform (DFT) filtering ensures that false trips due to harmonic noise from adjustable-speed drives do not occur. Should the resistor open and a ground fault subsequently occur, the SE-330 will detect the fault through voltage measurement, while other current-only sensing relays would be ineffective.

### Pulsing Ground-Fault Location

The SE-330 is capable of controlling a pulsing contactor, which is used to switch the NGR resistance in a pulsing-compatible NGR package. The resulting ground-fault current is distinguishable from charging currents and noise and will only appear upstream of the ground fault, making fault location fast and easy, even without isolating feeders or interrupting loads.

### Accessories

- A ER Series Sensing Resistor**  
Required interface between the power system and the SE-330/SE-330HV. Eliminates hazardous voltage levels at the relay.
- B ELCT5 Series Ground-Fault Current Transformer**  
Sensitive ground-fault current detection (5 A primary).
- ELCT30 Series Ground-Fault Current Transformer**  
Sensitive ground-fault current detection (30 A primary).
- Other Current Transformer**  
For low-resistance NGRs choose a CT primary approximately equal to the NGR rating. Inputs are provided for 1- and 5- A- secondary CTs.
- SE-IP65CVR-G Hinged Transparent Cover**  
Watertight cover, tamper resistant, IP65 protection.

3 RESISTANCE GROUNDING/NGR MONITORING

# SE-330, SE-330HV SERIES

## Neutral Grounding Resistor Monitor

### Features & Benefits

FEATURES	IEEE #	BENEFITS
<b>Continuous NGR monitoring</b>	3	Detects resistor failure within seconds, reduces transient-overvoltage risk, removes risk of ground-fault-detection failure
<b>Shorted NGR detection</b>	3	Detects a ground fault on the neutral that could bypass the resistor, ensures fault current is not higher than expected
<b>Ground-fault detection</b>	50G/N, 51G/N, 59N	Main or backup protection to detect a ground fault anywhere on the monitored system
<b>Adjustable pickup (2–100 %)</b>		Select greatest sensitivity without false operation, adjustable in 1% increments (MEM setting)
<b>Adjustable time delay (0.1–10 s)</b>		Adjustable trip delay allows quick protection and system coordination
<b>Universal CT compatibility</b>		Allows the use of a CT that gives required ground-fault settings
<b>Programmable output contacts</b>		Two programmable Form C and One programmable Form A (Ground Fault, Resistor Fault, Unit Health)
<b>Selectable contact operating mode</b>		Selectable fail-safe or non-fail-safe operating modes allows connection to shunt or undervoltage breaker coil or alarm circuit (K1, K2, and K3 output contacts)
<b>Analog output (4–20 mA)</b>		Connect an optional PGA-0520 meter or control system
<b>Pulsing output (SE-330 only)</b>		Control the operation of a pulsing ground-fault-location circuit
<b>Trip records</b>		On-board 100-event (with date and time) recorder helps with system diagnostics
<b>Harmonic filtering (DFT)</b>		Eliminate false trips due to harmonic noise from ASDs
<b>Local communications</b>		Mini USB port to view measured values, configure settings, and check event records
<b>Data logging</b>		On-board microSD card (included) can be used for long-term data logging
<b>Network communications</b>		Remotely view measured values and event records, reset trips, and cause a remote trip Available Protocol Options: <b>IEC 61850</b> – with dual RJ45, SC Fiber and RJ45, or Dual SC Fiber Interface <b>Modbus TCP and Ethernet/IP</b> – with dual RJ45, SC Fiber and RJ45, or Dual SC Fiber Interface <b>DeviceNet</b> – with CAN interface
<b>Software</b>		PC-interface software (SE-MON330) is available at <a href="http://Littelfuse.com/RelaySoftware">Littelfuse.com/RelaySoftware</a>
<b>Selectable reset mode</b>		Selectable latching or auto-reset operation
<b>Unit-healthy output</b>		Verifies SE-330 is operating correctly, available as Form A or Form B output contact
<b>Conformal coating</b>		Internal circuits are conformally coated to protect against corrosion and moisture

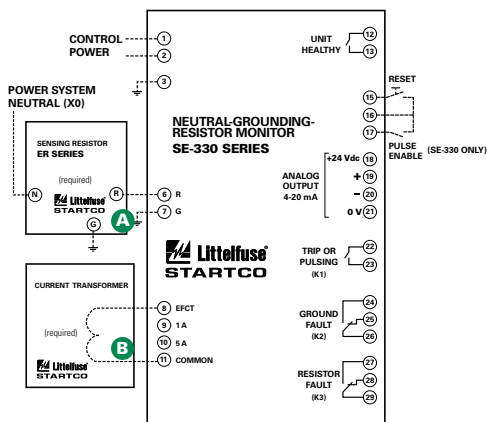
RESISTANCE GROUNDING/NGR MONITORING

### Typical Values

SYSTEM VOLTAGE (VOLTS)	NEUTRAL-GROUNDING RESISTOR		SENSING RESISTOR		GROUND-FAULT PICKUP LEVEL (AMPERES)	V <sub>N</sub> PICKUP LEVEL (VOLTS)
	CURRENT (AMPERES)	RESISTANCE (OHMS)	MODEL	RESISTANCE (SWITCH S5 SETTING)		
480	5	55	ER-600VC	20 kΩ	2.5	170
600	5	69	ER-600VC	20 kΩ	2.5	200
2,400	5	277	ER-5KV	20 kΩ	2.5	800
4,160	5	480	ER-5KV	20 kΩ	3	1,700
7,200	10	416	ER-15KV	100 kΩ	2	170 x 5 = 850
14,400	15	554	ER-15KV	100 kΩ	3	340 x 5 = 1,700

DISCLAIMER: The above table is for illustrative purposes only. Actual values may differ based on a variety of individual system considerations, such as capacitive charging current and coordination study results.

### Wiring Diagram



### Specifications

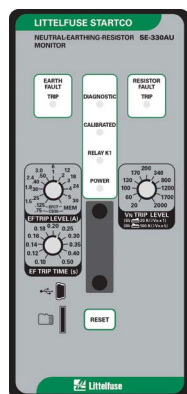
- IEEE Device Numbers**
  - Input Voltage**
  - Dimensions**
  - GF Trip-Level Settings**
  - GF Trip-Time Settings**
  - V<sub>n</sub> Trip-Level Settings**
  - Contact Operating Mode**
  - Harmonic Filtering**
  - Reset Button**
  - Output Contacts**
  - Pulsing Circuit**
  - Approvals**
  - Communications**
  - Analog Output**
  - Conformally Coated**
  - Warranty**
  - Mounting**
- Ground Fault (50G/N, 51G/N, 59N), Checking Relay (3), Lockout Relay (86)  
See ordering information  
**H** 213 mm (8.4"); **W** 98 mm (3.9"); **D** 132 mm (5.2")  
2–100 % of CT-Primary Rating in 1% increments  
0.1–10 s  
20–2,000 V ac (≤5 kV systems) 100–10,000 V ac (>5 kV systems)  
Selectable fail-safe or non-fail-safe (K1, K2, K3)  
Standard feature  
Standard feature  
Two Form A and two Form C  
1.0–3.0 s in 0.2 s increments (SE-330 only)  
CSA certified, UL Listed (E340889), CE (European Union), RCM (Australian)  
Mini USB (standard); DeviceNet (optional), IEC 61850 (optional),  
Modbus TCP and EtherNet/IP (optional)  
4–20 mA, self or loop powered  
Standard feature  
5 years  
Panel and surface (optional)

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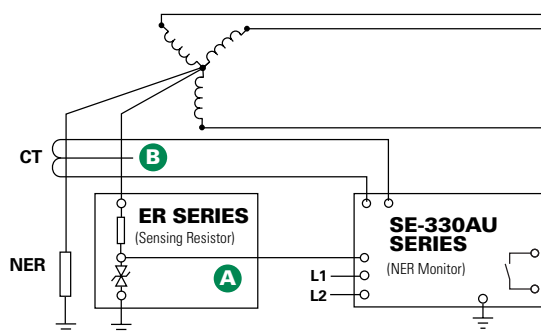


# SE-330AU SERIES

## Neutral Earthing Resistor Monitor



### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	POWER SUPPLY	COMM		K4 UNIT HEALTHY CONTACT
SE-330AU	- X	X	-	0 X
SE-330AU for all apps. 35 kV or less	0=120/240 Vac/Vdc	0=USB Only 1=DeviceNet 3=EtherNet (Dual RJ45) 4=EtherNet (SC Fiber & RJ45) 5=EtherNet (Dual SC Fiber) 6=IEC61850 (Dual RJ45) 7=IEC61850 (SC Fiber & RJ45) 8=IEC61850 (Dual SC Fiber)		0=Normally Open 1=Normally Closed
SE-330HV for 72 kV apps.	2=48 Vdc			

ACCESSORIES	REQUIREMENT
ER Series Sensing Resistor	Required
Current Transformer	Required
SE-IP65CVR-G	Optional
SE-MRE-600	Optional
RK-332	Optional

### Description



The SE-330AU Series is an advanced earth-fault and earthing-resistor monitoring relay for low- and medium-voltage transformers and generators. It monitors neutral current, neutral-to-earth voltage, and neutral-to-earth resistance. It provides continuous monitoring of the neutral-to-earth path to verify that the neutral-earthing resistor (NER) is intact. This is of utmost importance—an open NER renders current-sensing earth-fault protection inoperative and could result in a false belief that the system is functioning properly. The SE-330AU earth-fault function complies with AS/NZS 2081.3:2002. Outputs include four relay outputs, and an analog output. A mini USB port is included to view measured values, configure settings, and check event records. An on-board micro SD card can be used for long-term data logging. Network communications options are available. For non-AS/NZS 2081 applications, see the SE-330 or SE-330HV Series.




### Resistor Monitoring

The SE-330AU combines the measured values of resistance, current, and voltage to continuously determine that the NER is intact. It is able to detect a resistor failure with or without an earth fault present. Sensing resistors are matched to the system voltage and are used to monitor NGRs on systems up to 35 kV.

### Earth-Fault Monitoring

The SE-330AU uses a 5- or 30-A-primary current transformer to provide a pickup-setting range of 0.125 to 5 A or 0.75 to 30 A to comply with AS/NZS 2081.3:2002. DFT filtering ensures that false trips due to harmonic noise from adjustable-speed drives do not occur. Open-CT detection is provided.

### Accessories

- A**  **ER Series Sensing Resistor**  
Required interface between the power system and the SE-330AU. Eliminates hazardous voltage levels at the relay.
- B**  **EFCT Series Earth-Fault Current Transformer**  
Sensitive earth-fault current detection (5 A primary).
-  **SE-CS30 Series Earth-Fault Current Transformer**  
Sensitive earth-fault current detection (30 A primary).

### Specifications

<b>Input Voltage</b>	See ordering information
<b>Dimensions</b>	<b>H</b> 213 mm (8.4"); <b>W</b> 98 mm (3.9"); <b>D</b> 132 mm (5.2")
<b>GF Trip-Level Settings</b>	0.125 to 30 A
<b>GF Trip-Time Settings</b>	0.1 to 0.5 s
<b>Vn Trip-Level Settings</b>	20-2,000 Vac (≤5 kV systems) 100-10,000 Vac (>5 kV systems)
<b>Output Contacts</b>	Two Form A, Two Form C
<b>Operating Mode</b>	Fail-Safe
<b>Harmonic Filtering</b>	Standard feature
<b>Reset</b>	Front panel push button and remote input
<b>Approvals</b>	C-Tick (Australian), CE
<b>Communications</b>	Mini USB (standard); DeviceNet (optional), IEC 61850 (optional), Modbus TCP and EtherNet/IP (optional)
<b>Analog Output</b>	4-20 mA, self or loop powered
<b>Conformal Coating</b>	Standard feature
<b>Warranty</b>	5 years
<b>Mounting</b>	Panel, Surface (optional)

## NGR SERIES – US

### Neutral Grounding Resistor System



3

RESISTANCE GROUNDING/NGR MONITORING

### Description

High-resistance grounding prevents many of the problems that are associated with ungrounded and solidly grounded electrical distribution and utilization systems. High-resistance grounding can limit point-of-fault damage, eliminate transient overvoltages, reduce the arc-flash hazards, limit voltage exposure to personnel, and provide adequate tripping levels for selective current-based ground-fault detection and coordination.

The Littelfuse Neutral Grounding Resistor System is a neutral grounding resistor (NGR), current transformer, and sensing resistor installed in a NEMA 3R enclosure used to high-resistance ground transformers and generators. The NGR system is designed for use with Littelfuse Neutral Grounding Resistor Monitors for complete system grounding and grounding protection.

The NGR series – US systems are designed for use in US applications and all other parts of the world, not including Canada. For applications in Canada, please use the NGR series – Canada.

### Applications

High-resistance grounding is applied on transformers and generators where safety and continuity of service are important. A faulted feeder may remain in operation until it is safe to repair the fault, where allowed by the local electrical code.

### Features



#### Enclosure

The NGR Series – US comes pre-installed in a ventilated NEMA 3R galvanized steel enclosure and components are pre-wired to terminals for ease of installation. Back view shown on left.

#### ER Series Sensing Resistor

Use with the SE-325 or the SE-330 to continuously monitor the continuity of a neutral-grounding resistor and eliminate hazardous voltage levels at the relay.



- ER-600VC is designed for use on systems up to 600 V for indoor applications. Available in optional moisture-proof enclosure (shown on left) for outdoor applications.



- ER-5KV for use on systems up to 4160 V for indoor applications.



- ER-5WP is designed for use on systems up to 4160 V and comes with weather-protected terminals for outdoor installations.

#### Earth-Fault Current Transformer

Used with the SE-325 or the SE-330 to measure ac current flowing through the NGR for use with the continuity monitoring circuit and to detect ground faults.



- ELCT5-31 used with SE-330 for 5 A and 10 A NGRs.



- SE-CS10-2.5 used with SE-330 for 10 A and 15 A NGRs.



- CT200 used with the SE-325 for all applications.

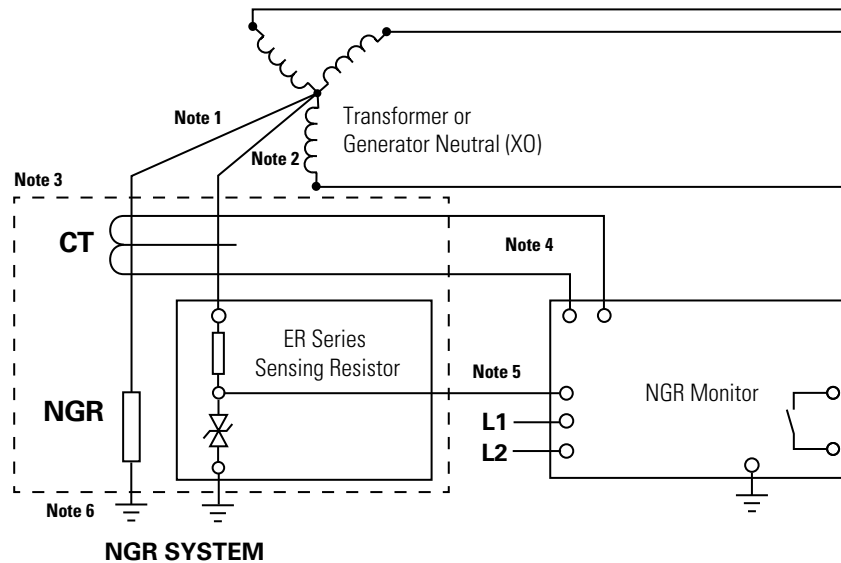
- 5SHT-101-E (not shown) used with SE-330 for 25 A NGRs.

### Benefits

- Eliminate phase-to-ground arc-flash incidents
- Eliminate transient overvoltages
- Reduce point-of-fault damage
- Can provide continuity of service during a ground fault
- Includes current transformer and ER series sensing resistor for use with Littelfuse monitoring relay and for ease of installation.

## NGR SERIES – US

### Simplified Circuit Diagram with Littelfuse Neutral Grounding Resistor Monitor



- Note 1:** Use minimum #8 AWG white or grey conductor insulated to system voltage to connect NGR to neutral.
- Note 2:** Use conductor insulated to system voltage (#14 AWG is typically used) and a separate lug at the X0 point to connect ER Series Sensing Resistor to neutral.
- Note 3:** Locate NGR system near transformer or generator.
- Note 4:** Two-conductor twisted cable required, shielded recommended.
- Note 5:** Voltage between ER Series Sensing Resistor terminals R and G is limited to 100 V by internal clamp.
- Note 6:** Use minimum #8 AWG green or bare conductor to connect NGR to ground.

### NGR SERIES – US

#### Ordering Information

PART NUMBER	LINE-LINE VOLTAGE (V)	LET-THROUGH CURRENT (A)	IMPEDANCE (OHMS)	TIME RATING	CURRENT TRANSFORMER	CT PRIMARY RATING (A)	CT SECONDARY RATING (A)	SENSING RESISTOR	ENCLOSURE
NGRUS138	480	2	138	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R
NGRUS278	480	2	138	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS314	480	2	138	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGRUS315	480	2	138	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS003	480	5	55.4	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R
NGRUS194	480	5	55.4	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS316	480	5	55.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGRUS317	480	5	55.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS318	600	2	173.5	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGRUS319	600	2	173.5	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS354	600	2	173.5	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R
NGRUS355	600	2	173.5	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS169	600	5	69.4	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R
NGRUS170	600	5	69.4	Continuous	CT200	200***	5.0	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS320	600	5	69.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGRUS321	600	5	69.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGRUS114	4160	5	480.9	Continuous	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS115	4160	5	480.9	Continuous	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS322	4160	5	480.9	10 s	ELCT5-31	5*	0.05	ER-5KV	NEMA 3R
NGRUS323	4160	5	480.9	10 s	ELCT5-31	5*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS324	4160	5	480.9	Continuous	ELCT5-31	5*	0.05	ER-5KV	NEMA 3R
NGRUS325	4160	5	480.9	Continuous	ELCT5-31	5*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS356	4160	5	480.9	10s	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS357	4160	5	480.9	10s	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS326	4160	10	240.5	10 s	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGRUS327	4160	10	240.5	10 s	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor

3 RESISTANCE GROUNDING/NGR MONITORING

## NGR SERIES – US

### Ordering Information

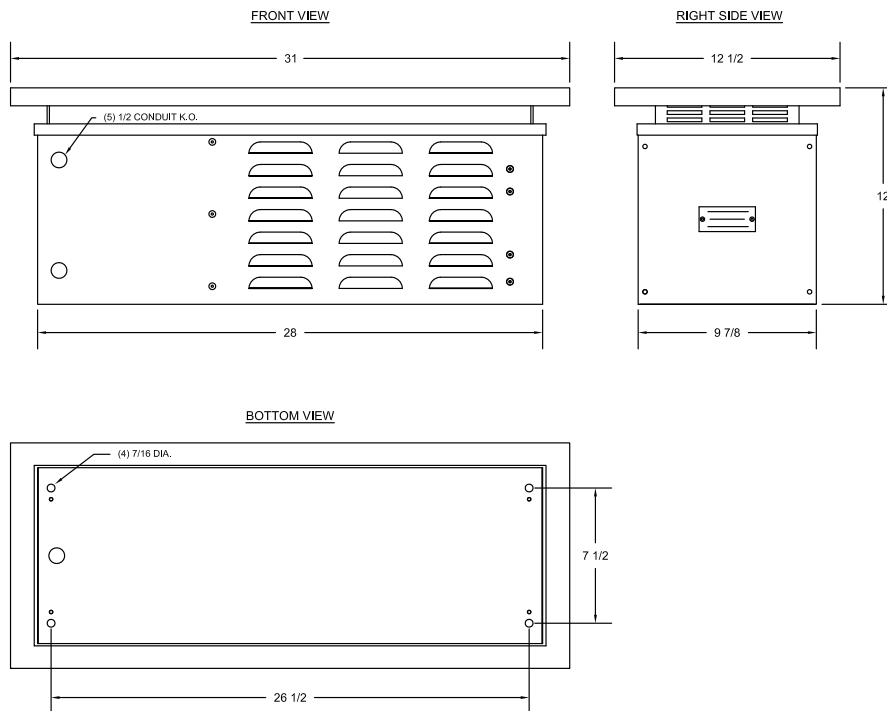
PART NUMBER	LINE-LINE VOLTAGE (V)	LET-THROUGH CURRENT (A)	IMPEDANCE (OHMS)	TIME RATING	CURRENT TRANSFORMER	CT PRIMARY RATING (A)	CT SECONDARY RATING (A)	SENSING RESISTOR	ENCLOSURE
NGRUS328	4160	10	240.5	Continuous	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGRUS329	4160	10	240.5	Continuous	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS358	4160	10	240.5	10s	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS359	4160	10	240.5	10s	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS360	4160	10	240.5	Continuous	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS361	4160	10	240.5	Continuous	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS330	4160	15	160.3	10 s	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGRUS331	4160	15	160.3	10 s	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS332	4160	15	160.3	Continuous	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGRUS333	4160	15	160.3	Continuous	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS362	4160	15	160.3	10s	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS363	4160	15	160.3	10s	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS364	4160	15	160.3	Continuous	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS365	4160	15	160.3	Continuous	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS244	4160	25	96.2	10s	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS334	4160	25	96.2	10 s	5SHT-101-E	20**	1	ER-5KV	NEMA 3R
NGRUS335	4160	25	96.2	10 s	5SHT-101-E	20**	1	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS336	4160	25	96.2	Continuous	5SHT-101-E	20**	1	ER-5KV	NEMA 3R
NGRUS337	4160	25	96.2	Continuous	5SHT-101-E	20**	1	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS366	4160	25	96.2	10s	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGRUS367	4160	25	96.2	Continuous	CT200	200***	5.0	ER-5KV	NEMA 3R
NGRUS368	4160	25	96.2	Continuous	CT200	200***	5.0	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor

\* Connect to SE-330 terminals 8 and 11  
 \*\* Connect to SE-330 terminals 9 and 11  
 \*\*\* Connect to SE-325 terminals CT1 and CT2

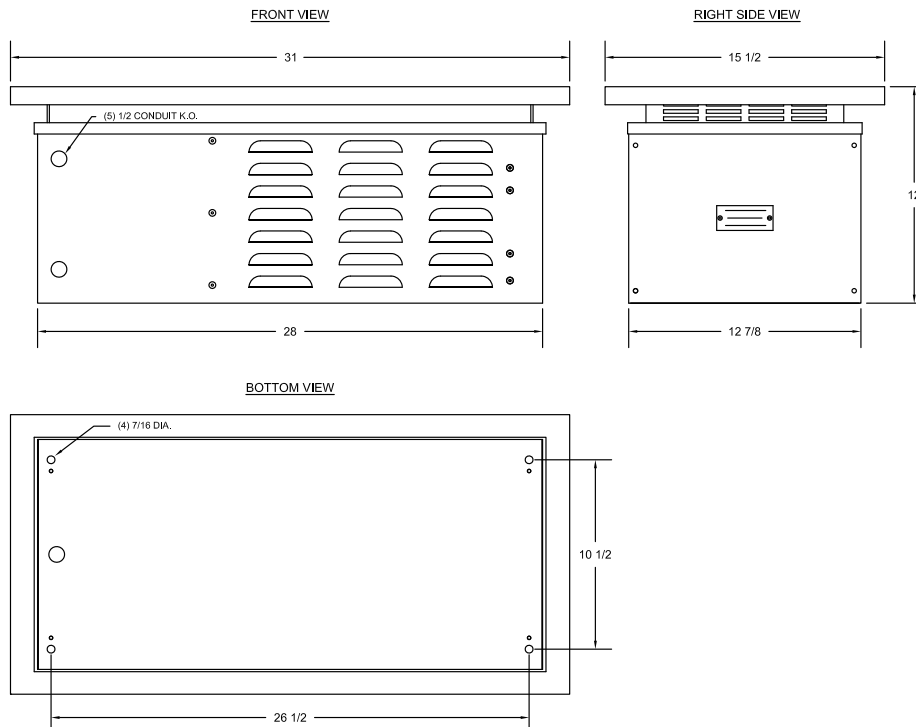
## Dimensions (in inches) and Mounting Diagrams

### 480 V & 600 V NGR Systems:

- NGRUS314
- NGRUS316
- NGRUS318
- NGRUS320



- NGRUS315
- NGRUS317
- NGRUS319
- NGRUS321



3 RESISTANCE GROUNDING/NGR MONITORING

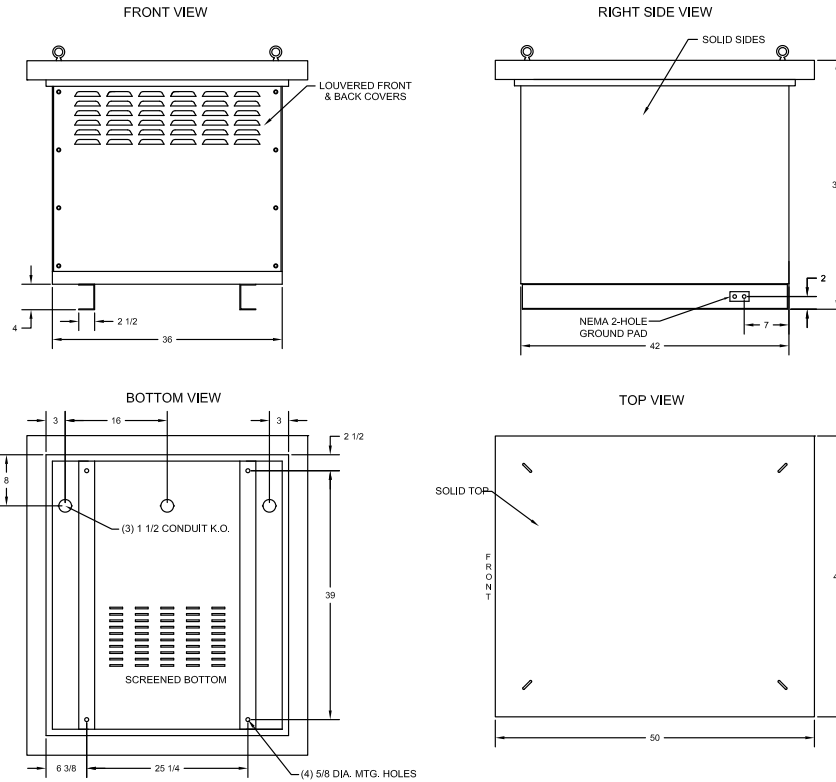




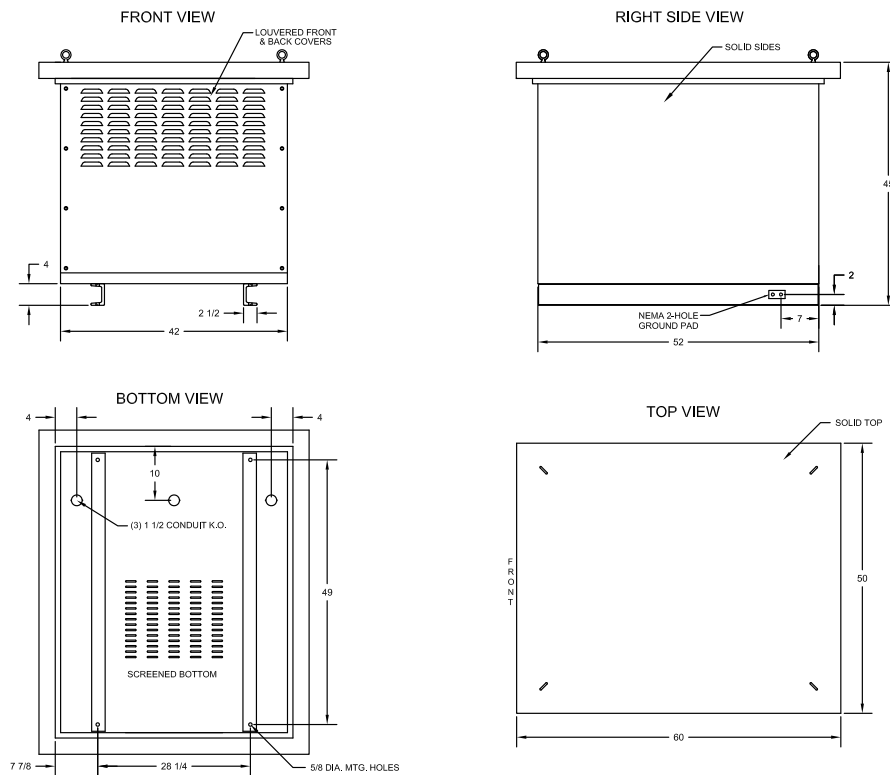
### Dimensions (in inches) and Mounting Diagrams

#### 4160 V NGR Systems:

- NGRUS328
- NGRUS329
- NGRUS332
- NGRUS333



- NGRUS336
- NGRUS337



RESISTANCE GROUNDING/NGR MONITORING

3

## NGR SERIES – US

### Specifications: 480 V NGR Systems

<b>Voltage</b>	480 V line-to-line, 277 V line-to-neutral
<b>Let-Through Current</b>	2 A or 5 A
<b>Resistance</b>	138.5 Ω (2 A) or 55.4 Ω (5 A)
<b>Tolerance</b>	+/- 10 % resistance
<b>Duty Cycle</b>	Continuous rated
<b>Current Transformer</b>	<b>ELCT5-31:</b> For use with SE-330 NGR Monitor Turns Ratio: 100:1 Current Rating: 5:0.05 A Primary Rating with SE-330: 5 A when connected to terminals 8 and 11 GF Trip Range: 100 mA to 5 A Window Diameter: 31 mm (1.22") <b>CT200:</b> For use with SE-325 NGR Monitor Turns Ratio: 200:5 Current Rating: 200:5 A GF Trip Range: 0.5, 2.0, 4.0 A Window Diameter: 56 mm (2.2")
<b>Sensing Resistor</b>	ER-600VC; Optional installation in NEMA 4 enclosure for outdoor applications
<b>Insulation Level</b>	11 KV BIL
<b>Temperature Rise</b>	385 °C (725 °F)
<b>Resistor Type</b>	Stainless steel wire wound
<b>Dimensions</b>	Refer to dimensions drawings
<b>Weight</b>	23 kg (50 lbs)
<b>Altitude</b>	0–2000 masl
<b>Enclosure Style</b>	NEMA 3R, galvanized steel
<b>Finish</b>	Powder coated
<b>Color</b>	ANSI 61 grey
<b>Mounting</b>	Floor mount
<b>Siesmic Bracing</b>	Included
<b>Approvals</b>	cULus or CSA at customer request
<b>Warranty</b>	12 months in service or 18 months from the date of shipment whichever occurs first

### Specifications: 600 V NGR Systems

<b>Voltage</b>	600 V line-to-line, 347 V line-to-neutral
<b>Let-Through Current</b>	2 A or 5 A
<b>Resistance</b>	174 Ω (2 A) or 69 Ω (5 A)
<b>Tolerance</b>	+/- 10 % resistance
<b>Duty Cycle</b>	Continuous rated
<b>Frequency</b>	50–60 Hz
<b>Current Transformer</b>	<b>ELCT5-31:</b> For use with SE-330 NGR Monitor Turns Ratio: 100:1 Current Rating: 5:0.05 A Primary Rating with SE-330: 5 A when connected to terminals 8 and 11 GF Trip Range: 100 mA to 5 A Window Diameter: 31 mm (1.22") <b>CT200:</b> For use with SE-325 NGR Monitor Turns Ratio: 200:5 Current Rating: 200:5 A GF Trip Range: 0.5, 2.0, 4.0 A Window Diameter: 56 mm (2.2")
<b>Sensing Resistor</b>	ER-600VC; Optional installation in NEMA 4 enclosure for outdoor applications
<b>Insulation Level</b>	11 KV BIL
<b>Temperature Rise</b>	385 °C (725 °F)
<b>Resistor Type</b>	Stainless steel wire wound
<b>Dimensions</b>	Refer to dimensions drawings
<b>Weight</b>	23 kg (50 lbs)
<b>Altitude</b>	0–2000 masl
<b>Enclosure Style</b>	NEMA 3R, galvanized steel
<b>Finish</b>	Powder coated
<b>Color</b>	ANSI 61 grey
<b>Mounting</b>	Floor mount
<b>Siesmic Bracing</b>	Included
<b>Approvals</b>	cULus or CSA at customer request
<b>Warranty</b>	12 months in service or 18 months from the date of shipment whichever occurs first

## NGR SERIES – US

### Specifications: 4160 V NGR Systems

<b>Voltage</b>	4160 V line-to-line, 2400 V line-to-neutral
<b>Let-Through Current</b>	5 A, 10 A, 15 A, or 25 A
<b>Resistance</b>	480 Ω (5 A), 240 Ω (10 A), 160 Ω (15 A), or 96 Ω (25 A)
<b>Tolerance</b>	+/- 10 % resistance
<b>Duty Cycle</b>	Continuous-duty or 10-second-duty rating
<b>Frequency</b>	50-60 Hz
<b>Current Transformer</b>	<b>ELCT5-31:</b>

For use with SE-330 NGR Monitor  
Turns Ratio: 100:1  
Current Rating: 5:0.05 A  
Primary Rating with SE-330: 5 A when connected to terminals 8 and 11  
GF Trip Range: 100 mA to 5 A  
Window Diameter: 31 mm (1.22")

**SE-CS10-2.5:**  
For use with SE-330 NGR Monitor  
Turns Ratio: 200:1  
Current Rating: 12.5:0.0625 A  
Primary Rating with SE-330: 10 A when connected to terminals 8 and 11  
GF Trip Range: 200 mA to 10 A  
Window Diameter: 63.5 mm (2.5")  
Turns Ratio: 100:5

Current Rating: 100:5 A  
Primary Rating with SE-330: 20 A when connected to terminals 9 and 11  
GF Trip Range: 400 mA to 20 A  
Window Diameter: 40 mm (1.56")

**CT200:**  
For use with SE-325 NGR Monitor  
Turns Ratio: 200:5  
Current Rating: 200:5 A  
GF Trip Range: 0.5, 2.0, 4.0 A  
Window Diameter: 56 mm (2.2")

ER-5KV  
Optional ER-5WP for outdoor applications  
75 KV BIL  
Continuous-duty rated: 385 °C (725 °F)  
10-second-duty rated: 760 °C (1400 °F)  
Stainless Steel Wire Wound  
Refer to dimensions drawings

**Sensing Resistor**

**Insulation Level**  
**Temperature Rise**

**Resistor Type**  
**Dimensions**

**Weights**

<b>5 A, continuous-duty rated:</b>	192 kg (424 lbs)
<b>10 A, continuous-duty rated:</b>	235 kg (519 lbs)
<b>15 A, continuous-duty rated:</b>	258 kg (568 lbs)
<b>25 A, continuous-duty rated:</b>	320 kg (705 lbs)
<b>5 A, 10-second-duty rated:</b>	136 kg (300 lbs)
<b>10 A, 10-second-duty rated:</b>	136 kg (300 lbs)
<b>15 A, 10-second-duty rated:</b>	136 kg (300 lbs)
<b>25 A, 10-second-duty rated:</b>	136 kg (300 lbs)

<b>Altitude</b>	0-1000 masl
<b>Enclosure Style</b>	NEMA 3R, galvanized steel
<b>Finish</b>	Powder coated
<b>Color</b>	ANSI 61 grey

**Mounting**  
**Siesmic Bracing**  
**Approvals**  
**Warranty**

Floor mount  
Included  
cULus or CSA at customer request  
12 months in service or 18 months from the date of shipment, whichever occurs first

### Accessories



**SE-325 Neutral Grounding Resistor Monitor**  
Basic ground-fault and neutral-grounding resistor monitoring relay that measures neutral current, neutral-to-ground voltage, and neutral-to-ground continuity.



**SE-330 Neutral Grounding Resistor Monitor**  
Advanced ground-fault and neutral-grounding resistor monitoring relay that measures neutral current, neutral-to-ground voltage, and neutral-to-ground resistance.



**NGRM-ENC Enclosed Neutral Grounding Resistor (NGR) Monitor**  
Type 4X enclosure housing a Littelfuse Startco SE-325 or SE-330 Neutral Grounding Resistor Monitor and optional accessories that include a 480/600 V control power transformer (CPT), faulted-phase indication (FPI; implemented with an EL3100 Ground-Fault & Phase-Voltage Indicator), earth-leakage panel meter, pulse-enable control, and mounting options. Appropriate fusing is included and field wiring is to terminal blocks.

### Custom NGR Systems

Additional custom NGR systems are also available from Littelfuse. For NGR systems not listed on this sheet please contact Littelfuse by emailing [NGRquotes@Littelfuse.com](mailto:NGRquotes@Littelfuse.com)

3 RESISTANCE GROUNDING/NGR MONITORING

## NGR SERIES – CANADA

### Neutral Grounding Resistor System



### Description

High-resistance grounding prevents many of the problems that are associated with ungrounded and solidly grounded electrical distribution and utilization systems. High-resistance grounding can limit point-of-fault damage, eliminate transient overvoltages, reduce the arc-flash hazards, limit voltage exposure to personnel, and provide adequate tripping levels for selective current-based ground-fault detection and coordination.

The Littelfuse Neutral Grounding Resistor System is a neutral grounding resistor (NGR), current transformer, and sensing resistor installed in a NEMA 3R enclosure used to high-resistance ground transformers and generators. The NGR system is designed for use with Littelfuse Neutral Grounding Resistor Monitors for complete system grounding and grounding protection.

The NGR series – Canada systems are specifically designed for use in Canadian applications. For applications in the US and other parts of the world, please use the NGR series – US.

### Applications

High-resistance grounding is applied on transformers and generators where safety and continuity of service are important. A faulted feeder may remain in operation until it is safe to repair the fault, where allowed by the local electrical code.

### Features



#### Enclosure

The NGR Series - Canada comes pre-installed in a ventilated NEMA 3R galvanized steel enclosure and components are pre-wired to terminals for ease of installation. Back view shown on left.

#### ER Series Sensing Resistor

Use with the SE-330 to continuously monitor the continuity of a neutral-grounding resistor and eliminate hazardous voltage levels at the relay.



- ER-600VC is designed for use on systems up to 600 V for indoor applications. Available in optional moisture-proof enclosure (shown on left) for outdoor applications.



- ER-5KV for use on systems up to 4160 V for indoor applications.



- ER-5WP is designed for use on systems up to 4160 V and comes with weather-protected terminals for outdoor installations.

#### Earth-Fault Current Transformer

Used with the SE-330 to measure ac current flowing through the NGR for use with the continuity monitoring circuit and to detect ground faults.



- ELCT5-31 used with SE-330 for 5 A and 10 A NGRs.



- SE-CS10-2.5 used with SE-330 for 10 A and 15 A NGRs.

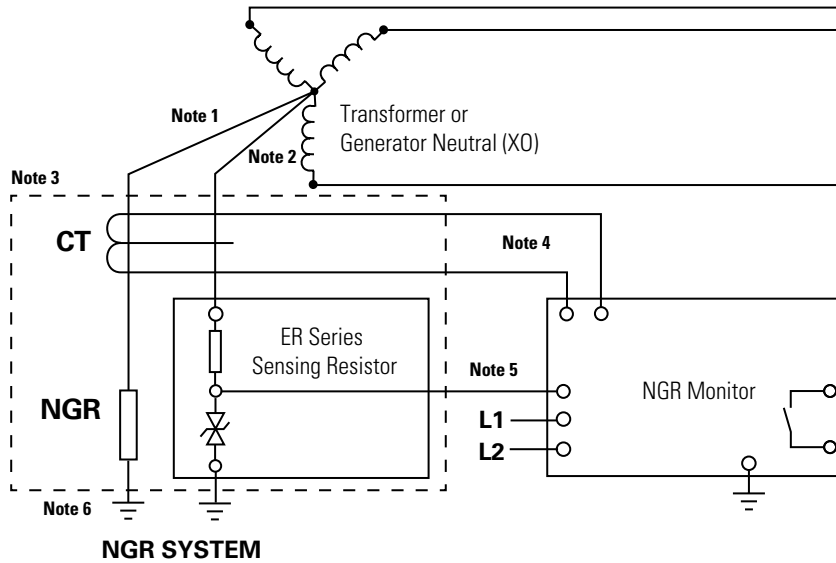
- 5SHT-101-E used with SE-330 for 25 A NGRs.

### Benefits

- Eliminate phase-to-ground arc-flash incidents
- Eliminate transient overvoltages
- Reduce point-of-fault damage
- Can provide continuity of service during a ground fault
- Includes current transformer and ER series sensing resistor for use with Littelfuse monitoring relay and for ease of installation.

## NGR SERIES – CANADA

### Simplified Circuit Diagram with Littelfuse Neutral Grounding Resistor Monitor



- Note 1:** Use minimum #8 AWG white or grey conductor insulated to system voltage to connect NGR to neutral.
- Note 2:** Use conductor insulated to system voltage (#14 AWG is typically used) and a separate lug at the X0 point to connect ER Series Sensing Resistor to neutral.
- Note 3:** Locate NGR system near transformer or generator.
- Note 4:** Two-conductor twisted cable required, shielded recommended.
- Note 5:** Voltage between ER Series Sensing Resistor terminals R and G is limited to 100 V by internal clamp.
- Note 6:** Use minimum #8 AWG green or bare conductor to connect NGR to ground.

3 RESISTANCE GROUNDING/NGR MONITORING



## NGR SERIES – CANADA

### Ordering Information

PART NUMBER	LINE-LINE VOLTAGE (V)	LET-THROUGH CURRENT (A)	IMPEDANCE (OHMS)	TIME RATING	CURRENT TRANSFORMER	CT PRIMARY RATING (A)	CT SECONDARY RATING (A)	SENSING RESISTOR	ENCLOSURE
NGR1050	480	2	138	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGR1041	480	2	138	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGR1036	480	5	55.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGR1051	480	5	55.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGR1052	600	2	173.5	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGR1053	600	2	173.5	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGR1038	600	5	69.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGR1045	600	5	69.4	Continuous	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R; Weather Protected Sensing Resistor
NGR1066	4160	5	480.9	10 s	ELCT5-31	5*	0.05	ER-600VC	NEMA 3R
NGR1067	4160	5	480.9	10 s	ELCT5-31	5*	0.05	ER-5KV	NEMA 3R; Weather Protected Sensing Resistor
NGR1068	4160	5	480.9	Continuous	ELCT5-31	5*	0.05	ER-5WP	NEMA 3R
NGR1069	4160	5	480.9	Continuous	SE-CS10-2.5	5*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGR1070	4160	10	240.5	10 s	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGR1071	4160	10	240.5	10 s	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGR1072	4160	10	240.5	Continuous	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGR1073	4160	10	240.5	Continuous	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGR1074	4160	15	160.3	10 s	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGR1075	4160	15	160.3	10 s	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGR1076	4160	15	160.3	Continuous	SE-CS10-2.5	10*	0.05	ER-5KV	NEMA 3R
NGR1077	4160	15	160.3	Continuous	SE-CS10-2.5	10*	0.05	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGR1078	4160	25	96.2	10 s	5SHT-101-E	20**	1	ER-5KV	NEMA 3R
NGR1079	4160	25	96.2	10 s	5SHT-101-E	20**	1	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor
NGR1080	4160	25	96.2	Continuous	5SHT-101-E	20**	1	ER-5KV	NEMA 3R
NGR1081	4160	25	96.2	Continuous	5SHT-101-E	20**	1	ER-5WP	NEMA 3R; Weather Protected Sensing Resistor

\* Connect to SE-330 terminals 8 and 11

\*\* Connect to SE-330 terminals 9 and 11

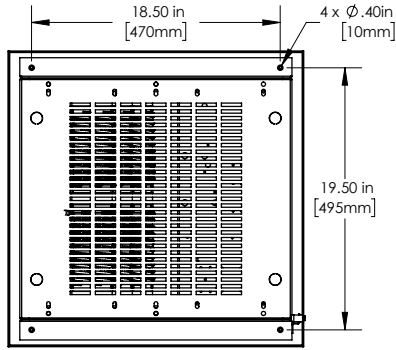
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RESISTANCE GROUNDING/NGR MONITORING

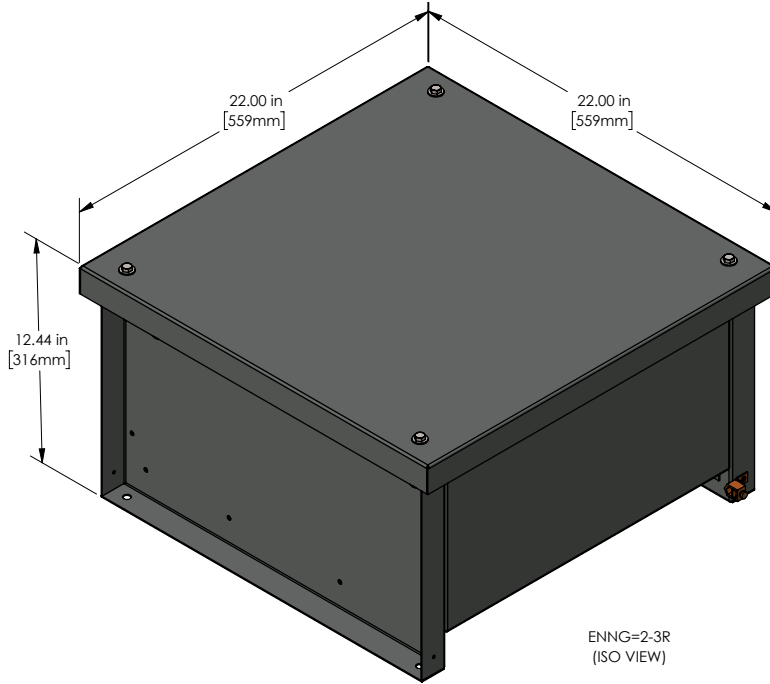
**Dimensions and Mounting Diagrams**

For 480 V NGR Systems:

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RESISTANCE GROUNDING/NGR MONITORING

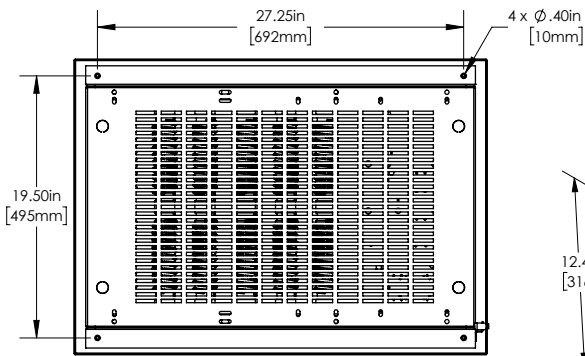


BOTTOM VIEW  
(MOUNTING DIMENSIONS)

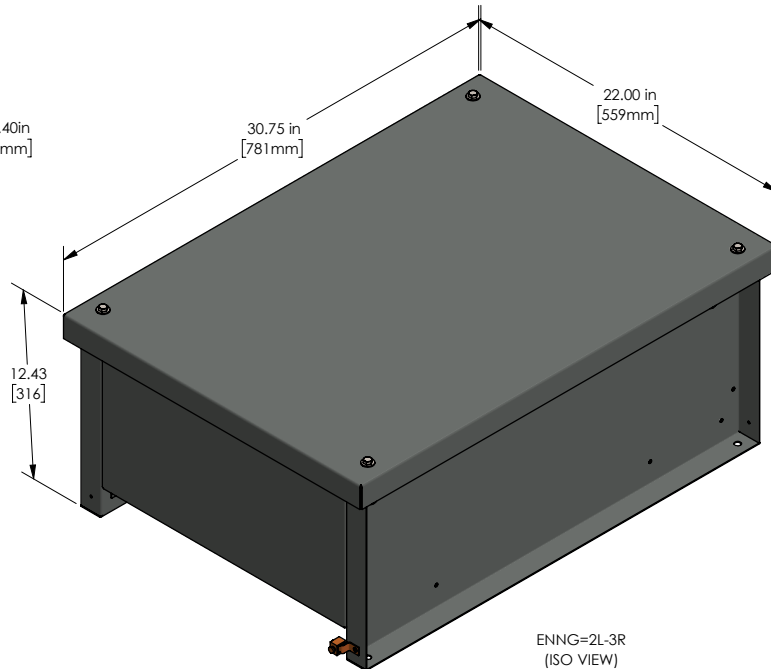


ENNG=2-3R  
(ISO VIEW)

For 600 V NGR Systems:



BOTTOM VIEW  
(MOUNTING DIMENSIONS)



ENNG=2L-3R  
(ISO VIEW)

## NGR SERIES – CANADA

### Specifications: 480 V NGR Systems

<b>Voltage</b>	480 V line-to-line, 277 V line-to-neutral
<b>Let-Through Current</b>	2 A or 5 A
<b>Resistance</b>	138.5 $\Omega$ (2 A) or 55.4 $\Omega$ (5 A)
<b>Tolerance</b>	+/- 10 % resistance
<b>Duty Cycle</b>	Continuous rated
<b>Current Transformer</b>	<b>ELCT5-31:</b> For use with SE-330 NGR Monitor Turns Ratio: 100:1 Current Rating: 5:0.05 A Primary Rating with SE-330: 5 A when connected to terminals 8 and 11 GF Trip Range: 100 mA to 5 A Window Diameter: 31 mm (1.22") ER-600VC; Optional installation in NEMA 4 enclosure for outdoor applications
<b>Sensing Resistor</b>	11 KV BIL
<b>Insulation Level</b>	385 °C (725 °F)
<b>Temperature Rise</b>	Stainless steel wire wound
<b>Resistor Type</b>	<b>H</b> 324 mm (12.75"); <b>W</b> 558 mm (22.00"); <b>D</b> 558 mm (22.00")
<b>Dimensions</b>	23 kg (50 lbs)
<b>Weight</b>	0–2000 masl
<b>Altitude</b>	NEMA 3R, galvanized steel
<b>Enclosure Style</b>	Powder coated
<b>Finish</b>	ANSI 61 grey
<b>Color</b>	Floor mount
<b>Mounting</b>	Included
<b>Siesmic Bracing</b>	cULus
<b>Approvals</b>	12 months in service or 18 months from the date of shipment whichever occurs first
<b>Warranty</b>	

### Specifications: 600 V NGR Systems

<b>Voltage</b>	600 V line-to-line, 347 V line-to-neutral
<b>Let-Through Current</b>	2 A or 5 A
<b>Resistance</b>	174 $\Omega$ (2 A) or 69 $\Omega$ (5 A)
<b>Tolerance</b>	+/- 10 % resistance
<b>Duty Cycle</b>	Continuous rated
<b>Frequency</b>	50–60 Hz
<b>Current Transformer</b>	<b>ELCT5-31:</b> For use with SE-330 NGR Monitor Turns Ratio: 100:1 Current Rating: 5:0.05 A Primary Rating with SE-330: 5 A when connected to terminals 8 and 11 GF Trip Range: 100 mA to 5 A Window Diameter: 31 mm (1.22") ER-600VC; Optional installation in NEMA 4 enclosure for outdoor applications
<b>Sensing Resistor</b>	11 KV BIL
<b>Insulation Level</b>	385 °C (725 °F)
<b>Temperature Rise</b>	Stainless steel wire wound
<b>Resistor Type</b>	<b>H</b> 324 mm (12.75"); <b>W</b> 558 mm (22.00"); <b>D</b> 558 mm (22.00")
<b>Dimensions</b>	23 kg (50 lbs)
<b>Weight</b>	0–2000 masl
<b>Altitude</b>	NEMA 3R, galvanized steel
<b>Enclosure Style</b>	Powder coated
<b>Finish</b>	ANSI 61 grey
<b>Color</b>	Floor mount
<b>Mounting</b>	Included
<b>Siesmic Bracing</b>	cULus
<b>Approvals</b>	12 months in service or 18 months from the date of shipment whichever occurs first
<b>Warranty</b>	

## NGR SERIES – CANADA

### Specifications: 4160 V NGR Systems

**Voltage** 4160 V line-to-line, 2400 V line-to-neutral  
**Let-Through Current** 5 A, 10 A, 15 A, or 25 A  
**Resistance** 480 Ω (5 A), 240 Ω (10 A), 160 Ω (15 A), or 96 Ω (25 A)

**Tolerance** +/- 10 % resistance  
**Duty Cycle** Continuous-duty or 10-second-duty rating  
**Frequency** 50-60 Hz

**Current Transformer**

**ELCT5-31:**  
 For use with SE-330 NGR Monitor  
 Turns Ratio: 100:1  
 Current Rating: 5:0.05 A  
 Primary Rating with SE-330: 5 A when connected to terminals 8 and 11  
 GF Trip Range: 100 mA to 5 A  
 Window Diameter: 31 mm (1.22")

**SE-CS10-2.5:**  
 For use with SE-330 NGR Monitor  
 Turns Ratio: 200:1  
 Current Rating: 12.5:0.0625 A  
 Primary Rating with SE-330: 10 A when connected to terminals 8 and 11  
 GF Trip Range: 200 mA to 10 A  
 Window Diameter: 63.5 mm (2.5")  
 Turns Ratio: 100:5  
 Current Rating: 100:5 A  
 Primary Rating with SE-330: 20 A when connected to terminals 9 and 11  
 GF Trip Range: 400 mA to 20 A  
 Window Diameter: 40 mm (1.56")

**Sensing Resistor**

ER-5KV  
 Optional ER-5WP for outdoor applications  
 75 KV BIL  
 Continuous-duty rated: 385 °C (725 °F)  
 10-second-duty rated: 760 °C (1400 °F)  
 Stainless Steel Wire Wound

**Insulation Level Temperature Rise**

**Resistor Type**

**Weights and Dimensions**

- 5 A, continuous-duty rated:** **H** 1226 mm (48.28"); **W** 1143 mm (45.00"); **D** 940 mm (37.00"); 192 kg (424 lbs)
- 10 A, continuous-duty rated:** **H** 1214 mm (47.78"); **W** 1270 mm (50.00"); **D** 1143 mm (45.00"); 235 kg (519 lbs)
- 15 A, continuous-duty rated:** **H** 1214 mm (47.78"); **W** 1270 mm (50.00"); **D** 1143 mm (45.00"); 258 kg (568 lbs)
- 25 A, continuous-duty rated:** **H** 1283 mm (50.50"); **W** 1575 mm (62.00"); **D** 1143 mm (45.00"); 320 kg (705 lbs)
- 5 A, 10-second-duty rated:** **H** 749 mm (29.50"); **W** 1143 mm (45.00"); **D** 940 mm (37.00"); 136 kg (300 lbs)
- 10 A, 10-second-duty rated:** **H** 749 mm (29.50"); **W** 1143 mm (45.00"); **D** 940 mm (37.00"); 136 kg (300 lbs)
- 15 A, 10-second-duty rated:** **H** 749 mm (29.50"); **W** 1143 mm (45.00"); **D** 940 mm (37.00"); 136 kg (300 lbs)
- 25 A, 10-second-duty rated:** **H** 749 mm (29.50"); **W** 1143 mm (45.00"); **D** 940 mm (37.00"); 136 kg (300 lbs)

**Altitude** 0-1000 masl  
**Enclosure Style** NEMA 3R, galvanized steel  
**Finish** Powder coated  
**Color** ANSI 61 grey  
**Mounting** Floor mount  
**Siesmic Bracing** Included  
**Approvals** cULus  
**Warranty** 12 months in service or 18 months from the date of shipment, whichever occurs first

### Accessories



**SE-330 Neutral Grounding Resistor Monitor**

Advanced ground-fault and neutral-grounding resistor monitoring relay that measures neutral current, neutral-to-ground voltage, and neutral-to-ground resistance.



**NGRM-ENC Enclosed Neutral Grounding Resistor (NGR) Monitor**

Type 4X enclosure housing a Littelfuse Startco SE-330 Neutral Grounding Resistor Monitor and optional accessories that include a 480/600 V control power transformer (CPT), faulted-phase indication (FPI; implemented with an EL3100 Ground-Fault & Phase-Voltage Indicator), earth-leakage panel meter, pulse-enable control, and mounting options. Appropriate fusing is included and field wiring is to terminal blocks.

### Custom NGR Systems

Additional custom NGR systems are also available from Littelfuse. For NGR systems not listed on this sheet please contact Littelfuse by emailing [NGRquotes@Littelfuse.com](mailto:NGRquotes@Littelfuse.com)

3 RESISTANCE GROUNDING/NGR MONITORING

# NGRM-ENC SERIES

## NGRM-ENC



### Description

The NGRM-ENC Enclosed Neutral Grounding Resistor (NGR) Monitor series is a Type 4X enclosure housing a Littelfuse Startco SE-325 or SE-330 Neutral Grounding Resistor Monitor and optional accessories that include a 480/600-V control power transformer (CPT), faulted-phase indication (FPI; implemented with an EL3100 Ground-Fault & Phase-Voltage Indicator), earth-leakage panel meter, pulse-enable control, and mounting options. Appropriate fusing is included and field wiring is to terminal blocks.

### Options



**SE-325 Neutral Grounding Resistor Monitor**  
Measures current and voltage in a transformer or generator neutral-to-ground connection and continuity of the neutral-grounding resistor.



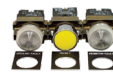
**SE-330 Neutral Grounding Resistor Monitor**  
Advanced ground-fault and neutral-grounding resistor monitoring relay that measures neutral current, neutral-to-ground voltage, and neutral-to-ground resistance.



**EL3100 Ground-Fault & Phase-Voltage Indicator**  
Three panel-mounted LEDs indicate the ground-faulted phase.

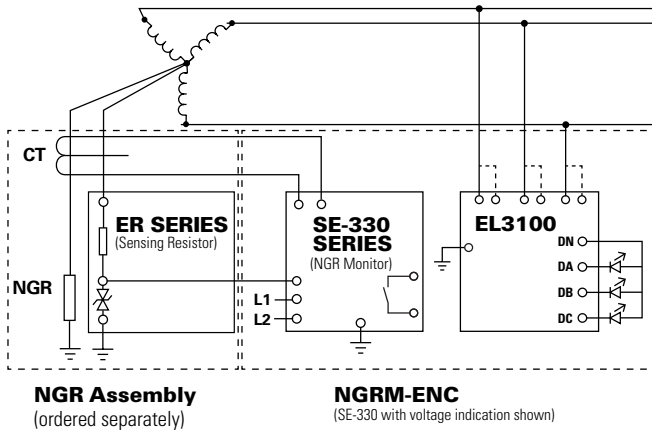


**Panel Meter**  
Panel-mounted meter displays earth leakage current as a percentage of the ground-fault-CT-primary rating.



**RK-332/RK-302 Remote Indication and Reset**  
Panel-mounted remote indication and reset assemblies are included with SE-325 and surface-mounted SE-330 configurations.

### Simplified Circuit Diagram



### Ordering Information

The following options are available with a faster shipping time:

ORDERING NUMBER	PROTECTION RELAY OPTION	NGR MONITOR MOUNTING OPTION	AMMETER & PULSE CONTROL OPTION	COMMS	CONTROL-POWER TRANSFORMER OPTION
NGRM-ENC-000-01	SE-325	Surface mounted	None	None	CPT
NGRM-ENC-200-01	SE-330 (K4=NO)	Surface mounted	None	None	CPT
NGRM-ENC-201-01	SE-330 (K4=NO)	Panel mounted	None	None	CPT
NGRM-ENC-201-11	SE-330 (K4=NO)	Panel mounted	Ammeter	None	CPT
NGRM-ENC-230-01	SE-330 (K4=NO)	Surface mounted	None	Ethernet/2 RJ45 ports	CPT
NGRM-ENC-231-01	SE-330 (K4=NO)	Panel mounted	None	Ethernet/2 RJ45 ports	CPT

3 RESISTANCE GROUNDING/NGR MONITORING

### NGRM-ENC SERIES

#### Ordering Information

	PROTECTION RELAY OPTION	NETWORK COMMUNICATIONS OPTION	NGR MONITOR MOUNTING OPTION		AMMETER & PULSE CONTROL OPTION	CONTROL-POWER TRANSFORMER OPTION
NGRM-ENC-	X	X	X	-	X	X
	0=SE-325 1=SE-325 & voltage indication <sup>(1)</sup> 2=SE-330 (N.O. K4) 3=SE-330 (N.O. K4) & voltage indication <sup>(1)</sup> 4=SE-330 (N.C. K4) 5=SE-330 (N.C. K4) & voltage indication <sup>(1)</sup> 6=SE-330HV (N.O. K4) 7=SE-330HV (N.O. K4) & voltage indication <sup>(1)</sup> 8=SE-330HV (N.C. K4) 9=SE-330HV (N.C. K4) & voltage indication <sup>(1)</sup>	0=No network communications 1=DeviceNet <sup>(2)</sup> 3=Ethernet, dual RJ45 <sup>(2)</sup> 4=Ethernet, 1 RJ45 & 1 fiber <sup>(2)</sup> 5=Ethernet, dual fiber <sup>(2)</sup> 6=IEC 61850, dual RJ45 <sup>(2)</sup> 7=IEC 61850, 1 RJ45 & 1 fiber <sup>(2)</sup> 8=IEC 61850, dual fiber <sup>(2)</sup>	0=Surface-mounted NGR monitor <sup>(4)</sup> 1=Panel-mounted NGR monitor <sup>(5)</sup>		0=No ammeter 1=Earth-leakage panel meter <sup>(2)</sup> 2=Earth-leakage panel meter & pulse-enable switch <sup>(3)</sup>	0=No CPT 1=480/600-V CPT <sup>(1)</sup>

Note (1) - Includes fuses, (2) - SE-330 models only, (3) - SE-330 models only, excluding SE-330HV models, (4) - Includes panel-mounted indication & reset, and USB connector for SE-330 models, (5) - SE-330 models only; includes IP65 hinged transparent cover

#### Specifications

<b>Enclosure</b>	Polyester, Lockable. SE-330 panel-mount options are rated to IP65. All other options are rated to Type 4X.
<b>Dimensions</b>	<b>H</b> 454 mm (17.9"); <b>W</b> 406 mm (16"); <b>D</b> 264 mm (10.4") Clearance required to open SE-IP65CVR-G 112 mm (4.4")
<b>Approvals</b>	cCSAus
<b>Warranty</b>	1 year

3

RESISTANCE GROUNDING/NGR MONITORING



## FEEDER PROTECTION

---

Protect feeder circuits from overcurrents, earth faults, phase loss and other detrimental conditions in critical applications and processes. They provide essential data for predictive and preventive maintenance, extending the life of equipment, enhancing safety and maximizing efficiency.

FPU-32 Series	Feeder Protection Unit .....	84
FPS Series	Feeder Protection System .....	85

For More Information...  
and to download datasheets and manuals on our  
Feeder Protection Relays, click Technical Resources at  
**[Littelfuse.com/FeederProtection](http://Littelfuse.com/FeederProtection)**

# FPU-32 SERIES (PGR-7200)

## Feeder Protection Unit



NOTE: The FPU-32 consists of the Feeder Protection Unit (pictured above) and the MPU-CIM Current Input Module (not pictured).

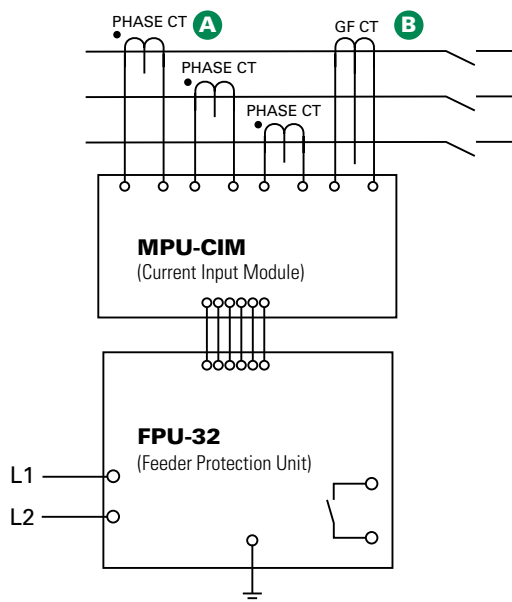
### Description

The FPU-32 Feeder Protection Unit provides integrated protection, metering, and data-logging functions. It is an excellent choice for retrofitting and upgrading older relays because of its compact size and ability to use existing CTs. The FPU-32 is used to protect distribution feeders in processing, manufacturing, petroleum, chemical, and wastewater treatment facilities.

### Features & Benefits

FEATURES	BENEFITS
<b>IEC &amp; IEEE overcurrent protection curves</b>	Definite and inverse time settings for system coordination; prevents catastrophic failures
<b>Two setpoint groups</b>	Create distinctive settings for maintenance or for two different loads
<b>Reduced overcurrent mode</b>	Maintenance mode setting to reduce the risk of arc-flash hazards
<b>Data logging</b>	On-board 100-event recorder and remote data logging helps with system diagnostics
<b>Overload</b>	Thermal protection for connected load
<b>Phase loss/Phase reverse (current)</b>	Detects unhealthy supply conditions
<b>Unbalance (current)</b>	Prevents overheating due to unbalanced phases
<b>Communications</b>	Remotely view measured values, event records & reset trips

### Simplified Circuit Diagram



### Accessories

- A Phase Current Transformers**  
Phase CTs are required to detect phase currents.
- B Ground-Fault Transformer**  
Zero-sequence current transformer detects ground-fault current. Available with 5-A and 30-A primary ratings for low-level pickup.

### Specifications

<b>Protective Functions (IEEE #)</b>	Overload (49, 51) Phase sequence (46) Unbalance (46) Phase loss (46)	Definite-time overcurrent (50, 51) Inverse-time overcurrent (50, 51) Ground fault (50G/N, 51G/N) RTD/PTC temperature (49)
<b>Input Voltage</b>	65-265 Vac, 30 VA; 80-275 Vdc, 25 W	
<b>Power-Up Time</b>	800 ms at 120 vac	
<b>Ride-Through Time</b>	100 ms minimum	
<b>24-Vdc Source</b>	400 mA maximum	
<b>AC Measurements</b>	True RMS and DFT, Peak 32 samples/cycle and positive and negative sequence of fundamental	
<b>Frequency</b>	50, 60 Hz	
<b>Output Contacts</b>	Three Form C	
<b>Approvals</b>	CSA certified, CE, C-Tick (Australian), UL Recognized	
<b>Communications</b>	TIA-232 (standard); TIA-485, DeviceNet™, Ethernet (optional)	
<b>Analog Output</b>	4-20 mA, programmable	
<b>Conformally Coated</b>	Standard feature	
<b>Warranty</b>	10 years	
<b>Mounting (Control Unit)</b>	Panel (standard) Surface (with MPU-32-SMK converter kit)	
<b>(Current Input Module)</b>	DIN, Surface	

### Ordering Information

ORDERING NUMBER	COMMUNICATIONS
FPU-32-00-00	TIA-232
FPU-32-01-00	TIA-232 & RS-485
FPU-32-02-00	TIA-232 & DeviceNet™
FPU-32-04-00	TIA-232 & Ethernet

NOTE: One of the following is required: MPU-CIM-00-00 Current Input Module, or MPU-CTI-RT-00 Current Input Module with ring-tonque terminals.

ACCESSORIES	REQUIREMENT
Phase CTs	Recommended
Ground-Fault CT	Optional
MPU-16A-Y92A-96N	Optional

4 REFEEDER PROTECTION

# FPS SERIES

## Feeder Protection System



1



2

### Description

The FPS Feeder Protection System monitors voltage and current to provide a comprehensive package of 17 protective functions. The FPS is a modular system with integrated protection, breaker control, metering, and data-logging functions.

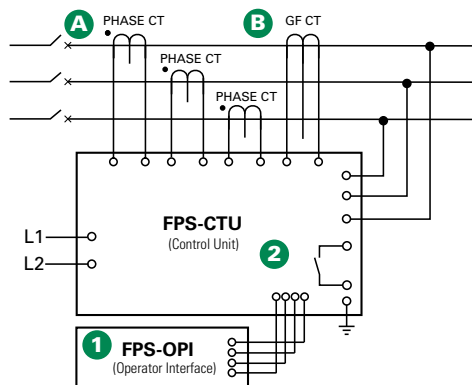
#### 1 Operator Interface (FPS-OPI)

- Large, bright, 4 x 20 vacuum-fluorescent display
- Display metered values
- Access set points
- Powered by Control Unit
- Panel mount or attach directly to Control Unit
- Remote mounting (1.2 km or 4000 ft maximum loop length)
- 1/2 DIN size
- Hazardous-location certified

#### 2 Control Unit (FPS-CTU)

- Current inputs—5-A or 1-A secondary phase current transformers
- Voltage inputs—up to 600 V without PTs
- Earth-leakage input—5-A or 1-A secondary or sensitive transformer
- 8 digital inputs, 5 relay outputs, 1 analog input and output
- 24-Vdc supply for OPI and RTD modules, and for digital inputs
- IRIG-B time-code input
- 1/2 DIN size, surface mount
- RS-485 network communications (Standard)
- DeviceNet™, Profibus®, or Ethernet communications available

### Simplified Circuit Diagram



### Ordering Information

ORDERING NUMBER	COMMUNICATIONS
FPS-CTU-01-00	RS-485
FPS-CTU-02-00	RS-485 & DeviceNet™
FPS-CTU-03-00	RS-485 & Profibus®
FPS-CTU-04-00	RS-485 & Ethernet

ACCESSORIES	REQUIREMENT
FPS-OPI-01-00	Recommended
SE-IP65CVR-M	Optional
Phase CTs	Required
Ground-Fault CT	Recommended
MPS-RTD-01-00	Optional

### Accessories

**A Phase Current Transformers**  
Phase CTs are required to detect phase currents.

**B Ground-Fault Current Transformer**  
Zero-sequence current transformer detects ground-fault current. Available with 5-A and 30-A primary ratings for low-level pickup.

**C MPS-RTD Temperature Input Module**  
Optional module provides 8 inputs to connect Pt100, Ni100, Ni120, and Cu10 RTDs.

**SE-IP65CVR-M Cover**  
Optional gasketed, transparent cover for limited access and IP65 protection for an Operator Interface Module.

4 FEEDER PROTECTION

# FPS SERIES

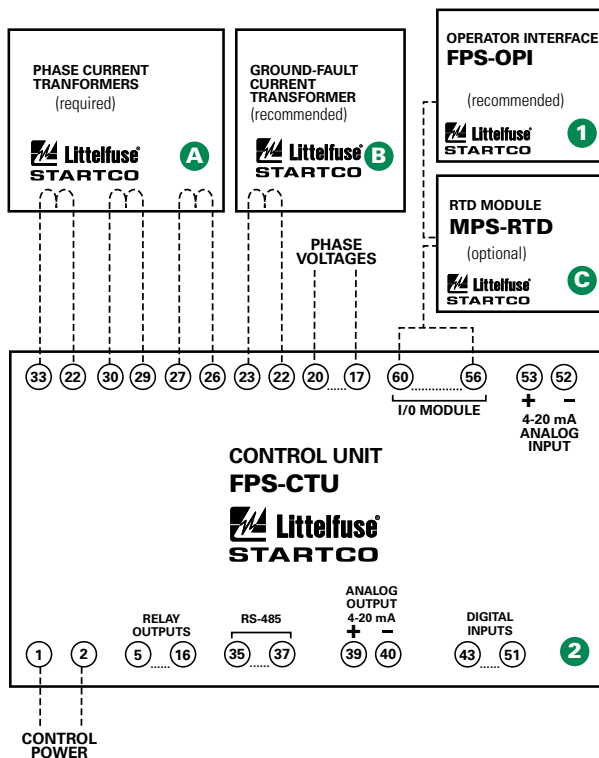
## Feeder Protection System

### Features & Benefits

FEATURES	IEEE #	BENEFITS
<b>Overload</b>	49, 51	Long-time overcurrent provides thermal protection for feeder or load
<b>Inverse-time overcurrent</b>	50, 51	Coordination using IEEE and IEC Curves
<b>Definite-time overcurrent</b>	50, 51	Instantaneous overcurrent to detect catastrophic failure
<b>Current unbalance/ Phase loss/Phase reverse</b>	46	Detects an open or high-impedance phase
<b>Ground fault</b>	50G/N, 51G/N	Inverse and definite time. Early insulation-failure detection.
<b>RTD temperature</b>	38, 49	Optional protection (MPS-RTD module) for load-temperature monitoring
<b>Overvoltage</b>	59	Limits stress to insulation
<b>Undervoltage</b>	27	Detects a damaging brown-out condition
<b>Voltage unbalance</b>	47	Detects unhealthy supply voltage
<b>Two setting groups</b>		Minimizes Arc-Flash hazards during maintenance
<b>Breaker control</b>		Allows local and remote operation; reduces component count
<b>Metering</b>		Displays the measured and calculated parameters
<b>Data logging</b>		On-board 64-event recorder helps with system diagnosis
<b>Communications</b>		Remotely view measured values, event records, & reset trips
<b>Conformal coating</b>		Internal circuits are conformally coated to protect against corrosion and moisture

4  
RFEEDER PROTECTION

### Wiring Diagram



### Specifications

<b>Protective Functions (IEEE Device Numbers)</b>	Overload (49, 51)	Unbalance (current) (46)	
	Phase reverse (current) (46)	Phase loss (voltage) (47)	
	Overfrequency (81)	Overvoltage (59)	
	Overcurrent (50, 51)	Phase loss (current) (46)	
	Underfrequency (81)	Undervoltage (27)	
	Ground fault (50G/N, 51G/N)	Phase reverse (voltage) (47)	
	Unbalance (voltage) (47)	Power factor (55)	
	RTD temperature (38, 49)		
	<b>Input Voltage</b>	65-265 Vac, 25 VA; 80-275 Vdc, 25 W	
	<b>Power-Up Time</b>	800 ms at 120 Vac	
<b>Ride-Through Time</b>	100 ms minimum		
<b>24-Vdc Source</b>	100 mA maximum		
<b>AC Measurements</b>	True RMS and DFT, Peak, 16 samples/cycle, and positive and negative sequence of fundamental 50 or 60 Hz		
<b>Frequency Inputs</b>	Phase current, Earth-leakage current, Phase voltage, 7 digital, 1 analog		
<b>Output Contacts</b>	5 contacts — See Product Manual		
<b>Approvals</b>	CSA certified, C-Tick (Australian)		
<b>Communications</b>	Allen-Bradley® DFI and Modbus® RTU (Standard); DeviceNet™, Profibus®, Ethernet (Optional)		
<b>Conformal Coating</b>	Standard feature		
<b>Warranty</b>	10 years		
<b>Mounting:</b>	<b>Control Unit</b>	Surface	
	<b>Operator Interface</b>	Panel, Control-Unit mounted	

## ARC-FLASH PROTECTION

Rapidly detects developing Arc-Flash incidents and sends a trip signal to interrupt power before significant damage occurs.

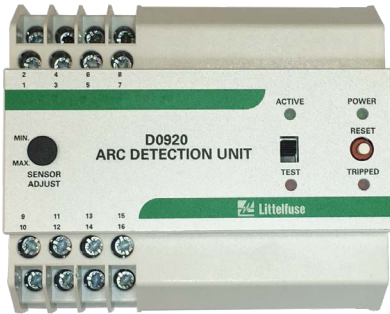
D0920	Arc Detection Unit .....	88
PGR-8800 Series	Arc-Flash Relay .....	89
AF0500 Series	Arc-Flash Relay .....	91
AF0100 Series	Arc-Flash Relay .....	93
A0220 Series	Light Sensor .....	94
PGA-1100	Diode Logic.....	95



For More Information...  
and to download our White Paper on  
Key Considerations for Selecting an  
Arc-Flash Relay or our Arc-Flash Energy  
Reduction Workbook, visit  
**[Littelfuse.com/ArcFlash](http://Littelfuse.com/ArcFlash)**

# D0920 ARC DETECTION UNIT

## Arc Detection Unit

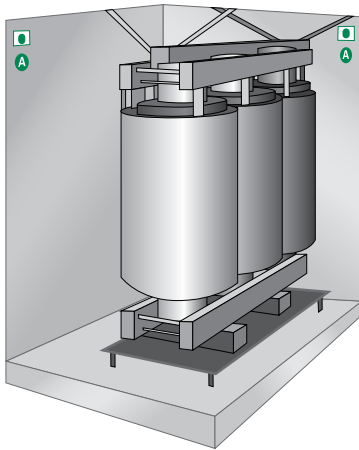


### Description

The D0920 Arc-Flash relay provides a simple and cost effective solution for Arc-Flash monitoring. Two light sensors can be connected directly to one relay.

**Light Sensors** react to light and have a 180° detection zone. Sensors are supplied with 10 or 15 m of cable. 1-2 sensors are recommended per cubicle or drawer.

### Installation Diagram



Install sensors in line of sight to possible arc faults.

### Features & Benefits

FEATURES	BENEFITS
<b>Compact module</b>	Fits into wide range of Arc-Flash applications
<b>Trip time &lt;1 ms</b>	Limits Arc-Flash damage and risk of injury
<b>Two optical sensor cable lengths</b>	Point sensors with 10 or 15 m of cable
<b>Inputs for two sensors</b>	Single Arc-Flash relay can monitor 2 sensors
<b>Adjustable light sensitivity</b>	Allows operation in bright environments and maximum sensitivity in dark environments
<b>Service mode</b>	Allows relay and sensor test without tripping system

### Accessories

**A0220 Light Sensors**  
Line-of-sight light sensor detects an arc as small as 3 kA within a 2-m half-sphere. Available with 10 or 15 m cable.

**PGA-1100/D1100 Diode Logic Unit**  
For tripping one circuit breaker with multiple D0920 Relays

### Ordering Information

ORDERING NUMBER	DESCRIPTION
D0920.0060	230 V AC +15, -30%, remains powered on after trip, slide switch instead of key switch, electronic reset button instead of mechanical reset button, CCC approved

ACCESSORIES	REQUIREMENT
A0033.0010 Detector cable 2 x 0.25 mm <sup>2</sup> w/screen. 100 m	Optional
A0220.0010 Arc Detector V-Type; 10 m cable	Required: At least one sensor per monitored zone
A0220.0020 Arc Detector V-Type; 15 m cable	
PGA-1100/D1100 Diode Logic Unit	Optional

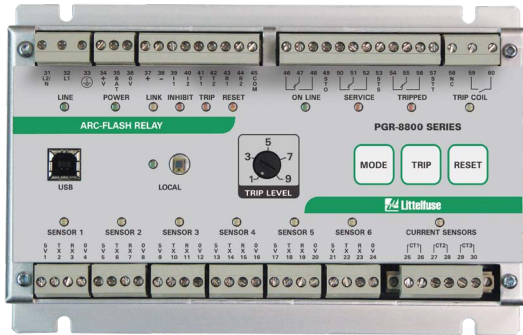
### Specifications

<b>Supply Voltage</b>	230 V AC +15,-30%
<b>Thyristor Output</b>	325 V DC from charged capacitor, nominal energy 3.5 J
<b>Sensitivity</b>	Adjustable 2 - 24 klux
<b>Number of Sensors</b>	Max. 2
<b>Response Time</b>	Less than 1 ms
<b>Power Consumption</b>	3.5 VA
<b>Ambient Temperature</b>	-25°C to 70°C
<b>Dimensions</b>	<b>H</b> 90 mm (3.5"); <b>W</b> 105 mm (4.1"); <b>D</b> 61 mm (2.4")
<b>Certification</b>	CE, CCC

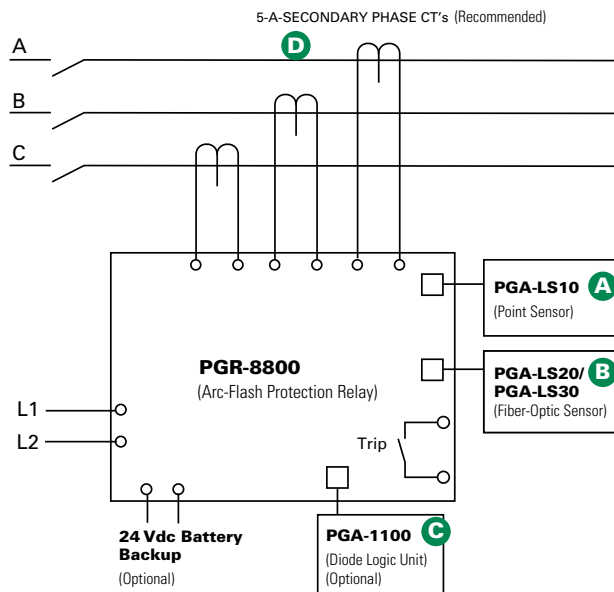


# PGR-8800 SERIES (D1000)

## Arc-Flash Relay



### Simplified Circuit Diagram



For detailed wiring diagram, see adjacent page.

### Ordering Information

ORDERING NUMBER	DESCRIPTION
PGR-8800-00 (UL, CE, CSA, RCM)	Arc-Flash Relay
PGR-8800-00-CC (UL, CE, CSA, RCM)	Arc-Flash Relay, Conformally Coated
ACCESSORIES	REQUIREMENT
PGA-LS10	Required*
PGA-LS20, PGA-LS30	Required*
PGA-1100	Optional
Current Transformer	Recommended

\*At least one sensor is required. However, the exact number of sensors for proper coverage depends on the application.

### Description

The PGR-8800 Series is a microprocessor-based relay that limits arc-fault damage by detecting the light from an arc flash and rapidly tripping. Phase-current-transformer inputs are provided for current-constrained arc-flash protection and, when so equipped, a programmable definite-time overcurrent function can be enabled. An optical sensor on the PGR-8800 and adjustable trip level reduce the chance of nuisance tripping by setting a threshold for ambient light. Sensors, inputs, and connections are monitored to ensure fail-safe operation. A secondary solid-state trip circuit provides a redundant trip path. A USB port is used for configuration and access to event logs and graphs.

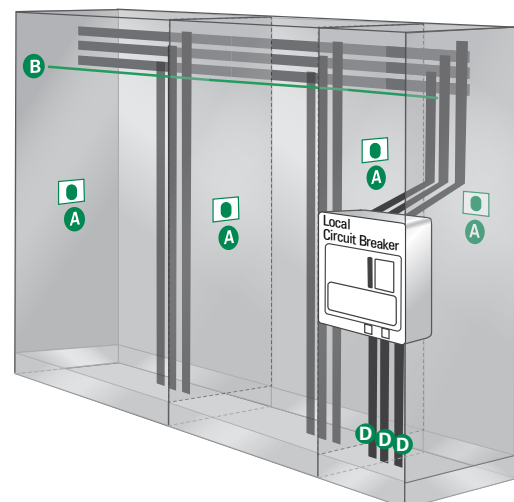
### Optical Sensors

The PGR-8800 accepts both PGA-LS10 and PGA-LS20/PGA-LS30 optical sensors, designed to collect light over a wide angle and with high sensitivity. For fast fault location, front-panel and sensor LED's indicate sensor health and which sensor detected an arc fault.

### Sensor Placement

The PGR-8800 Arc-Flash Relay and sensors are easily installed in retrofit projects and new switchgear with little or no re-configuration. Even elaborate systems with multiple power sources take minutes to configure using the relay's built-in USB interface software.

Generally, it is recommended to mount 1 or 2 sensors per cubicle to cover all horizontal and vertical bus bars, breaker compartments, drawers, and anywhere that there is potential for an arc-fault. Threading a fiber-optic sensor through the cabinets and in areas where point-sensor coverage is uncertain results in complete coverage and an added level of redundancy. Even if policy is to only work on de-energized systems, all maintenance areas should be monitored to prevent potential damage and additional cost. At least one sensor should have visibility of an arc fault if a person blocks the other sensor(s).

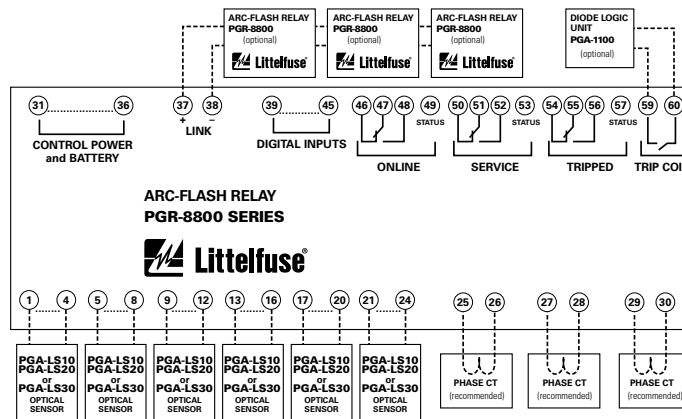


# PGR-8800 SERIES (D1000)

## Features & Benefits

FEATURES	BENEFITS
<b>Arc-Flash trip time &lt;1 ms</b>	Limits arc-flash damage and risk of injury
<b>Multiple sensors (up to 24)</b>	Single module can monitor 6 sensors. Up to 4 PGR-8800 units can be linked into one system
<b>Fail-safe system</b>	Continuous monitoring of optical sensors and inputs ensures protection
<b>Redundant trip circuit</b>	Solid-state backup arc-detection circuit adds a second layer of safety
<b>Adjustable light sensitivity</b>	Allows for operation in bright environments and maximum sensitivity in dark environments
<b>LED indication (on unit and each sensor)</b>	18 LEDs provide at-a-glance status for module and I/O state
<b>Current detection</b>	Phase-CT inputs provide overcurrent protection and prevent nuisance trips
<b>Optical detection</b>	Point and fiber-optic sensors provide wide detection area with sensor health trip indication
<b>Digital inputs (6)</b>	Two each: remote trip, inhibit, and reset inputs
<b>Service mode</b>	Allows for system test without tripping
<b>Trip coil contact</b>	Solid-state 24-300 Vdc/24-300 Vac IGBT
<b>Indication contacts</b>	Form C and status outputs
<b>USB interface</b>	Data logging and configuration software uses a USB interface with no drivers or software installation
<b>Built-in sensor</b>	Can be used in single-sensor systems, as a seventh sensor, and for calibration
<b>Universal power supply/Battery backup</b>	100-240 Vac, 14-48 Vdc, or 110-250 Vdc supply accepted. Ability to charge and run off an external, user-supplied 24 Vdc battery
<b>Data logging</b>	On-board event recorder helps with system diagnostics
<b>Modbus</b>	Remotely view measured values, event records & reset trips
<b>Upstream Tripping</b>	Ability to trip upstream device if the local breaker fails to clear the fault

## Wiring Diagram



## Accessories

- A** **PGA-LS10 Point Sensor**  
Line-of-sight light sensor detects an arc as small as 3 kA within a 2-m half-sphere. Sensor health and trip indication. Dimensions: See PGR-8800 Manual
- B** **PGA-LS20/PGA-LS30 Fiber-Optic Sensor**  
360° light sensor for tricky installations with many shadows or to run along bus bars. Sensor health and trip indication. Dimensions: See PGR-8800 Manual
- C** **PGA-1100 Diode Logic Unit**  
This module allows multiple PGR-8800 relays to trip the same breaker, for example an upstream or a tie-breaker. Dimensions: **H** 80mm (3.15"); **W** 20mm (0.79"); **D** 70mm (2.76")
- D** **Current Transformers**  
Eliminate nuisance arc-flash trips and use for overcurrent protection.

## Specifications

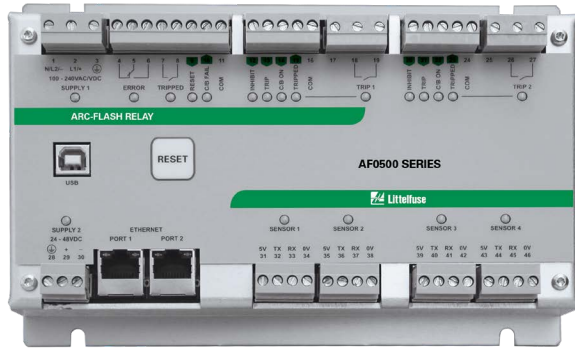
<b>IEEE Device Numbers</b>	Overcurrent (50), Arc Flash (AFD)
<b>Input Voltage</b>	100-240 Vac, 14-48 Vdc, and 110-250 Vdc
<b>Dimensions</b>	<b>H</b> 130 mm (5.1"); <b>W</b> 200 mm (7.9"); <b>D</b> 54 mm (2.1")
<b>Optical Trip Settings</b>	9-25 klux, 800 μs-20 s
<b>Current Trip Setting (A)</b>	Programmable
<b>Indication Contact Mode</b>	Fail-safe
<b>Trip Coil Voltage<sup>(1)</sup></b>	24-300 Vdc, 24-300 Vac
<b>Trip Coil Contact Mode</b>	Selectable fail-safe or non-fail-safe
<b>Redundant Trip Circuit</b>	Standard feature
<b>Input Monitoring</b>	Standard feature
<b>USB Interface</b>	Standard feature
<b>Trip, Reset, Service Buttons</b>	Standard feature
<b>Expandable System</b>	Link up to 4 PGR-8800 units
<b>Warranty</b>	5 years
<b>Mounting</b>	Surface, DIN (with D0050 adapter clips)
<b>Approvals</b>	UL, CE, CSA, RCM, FCC, DNV type approval, ABS type approval

NOTE (1) - Contact Littelfuse for trip coil voltages higher than 300 Vdc/Vac.

Littelfuse reserves the right to make product changes, without notice. Material in this document is as accurate as known at the time of publication. Visit Littelfuse.com for the most up-to-date information.

# AF0500 SERIES

## Arc-Flash Relay



### Description

The AF0500 is a microprocessor-based arc-flash relay that limits arc-fault damage by detecting the light from an arc flash and rapidly tripping the feeder breaker. The unit is well suited for switchgear, transformer and power converter applications.

Sensors, inputs, and connections are health monitored to ensure fail-safe operation. A secondary solid-state trip circuit provides a redundant trip path. A USB port is used for configuration and access to event logs.

AF0500 includes an Ethernet interface and supports Modbus® TCP communication. Zone tripping, upstream breaker tripping and tie breaker tripping applications can be easily configured.

A number of control inputs allows interconnection of multiple AF0500 units to form a system.

### Features & Benefits

FEATURES	BENEFITS
<b>4 arc sensor inputs</b>	Supports both point and fiber sensors
<b>Arc-Flash trip time &lt;1ms</b>	Limits arc-flash damage and risk of injury
<b>2 IGBT high speed trip outputs</b>	Supports applications such as upstream breaker tripping or tie breaker tripping
<b>Universal Power Supply</b>	100-240 Vac, 24-48 Vdc, or 110-250 Vdc supply
<b>Fail-safe system</b>	Continuous monitoring of optical sensors and inputs ensures protection
<b>LED indication (on unit and each sensor)</b>	Trip and sensor status indicated both on relay and sensors
<b>Discrete wire networking</b>	Multiple AF0500 units can be interconnected to form a system
<b>USB interface</b>	Data logging and configuration software uses a USB interface with no drivers or software installation
<b>Data logging</b>	On-board event recorder for system diagnostics (2048 log lines)
<b>Ethernet interface</b>	Modbus® TCP communication

### Ordering Information

ORDERING NUMBER	DESCRIPTION
AF0500-00	Arc-Flash Relay
AF0500-00-CC	Arc-Flash Relay, Conformally Coated

ACCESSORIES	REQUIREMENT
PGA-LS10	Required*
PGA-LS20, PGA-LS30	Required*
PGA-1100	Optional

### Optical Sensors

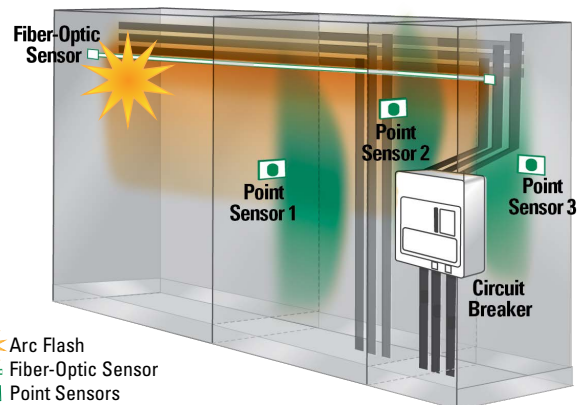
The AF0500 accepts both PGA-LS10 point sensors and PGA-LS20/PGA-LS30 fiber-optical sensors. Thus any combination of fiber or point sensors is supported.

For fast fault location, front-panel and sensor LEDs indicate sensor health and which sensor detected an arc fault.

### Sensor Placement

The AF0500 Arc-Flash Relay and sensors are easily installed in retrofit projects and new switchgear with little or no re-configuration. Simple applications work straight out of the box with no need of PC configuration. More complex systems with multiple power sources are configured using the relay's built-in USB interface software.

Generally, it is recommended to mount 1 or 2 sensors per cubicle to cover all horizontal and vertical bus bars, breaker compartments, drawers, and anywhere that there is a risk for an arc fault. Threading a fiber-optic sensor through the cabinets and in areas where point-sensor coverage is uncertain results in complete coverage and an added level of redundancy. Even if policy is to only work on de-energized systems, all maintenance areas should be monitored to prevent potential damage and additional cost.



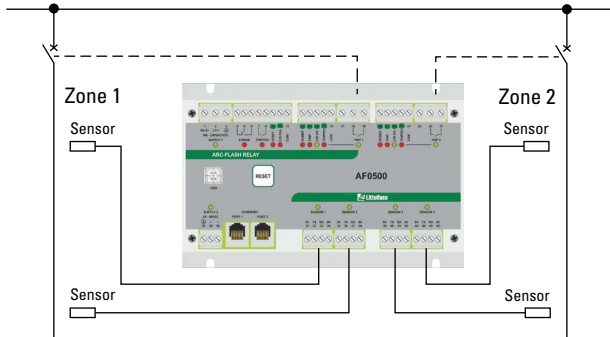
5 ARC-FLASH PROTECTION

# AF0500 SERIES

## Applications

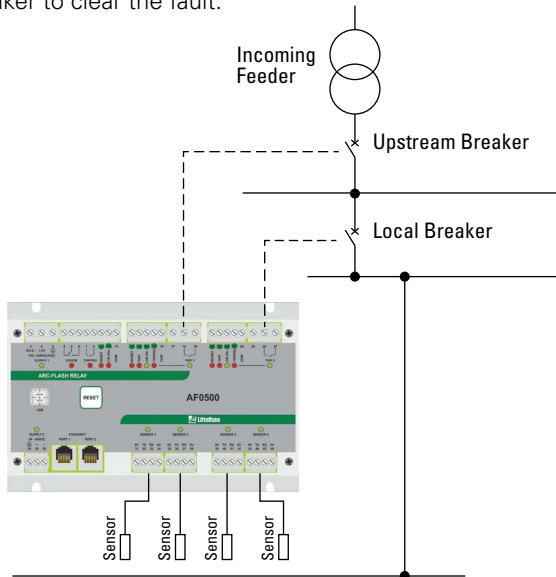
### Zone Tripping

AF0500 can trip 2 separate zones. Sensors can be assigned to the zones individually through PC configuration.



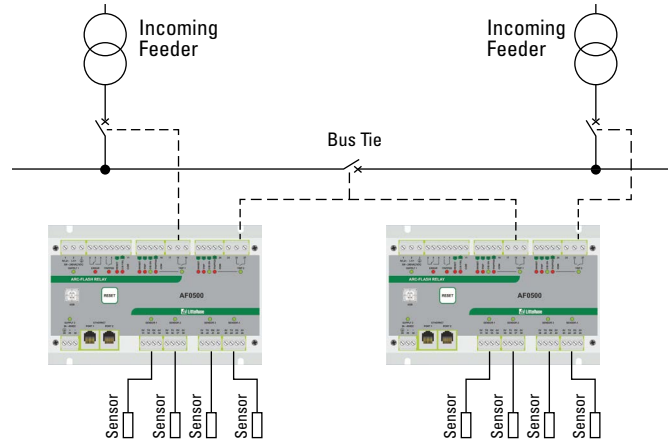
### Upstream Breaker Tripping

In case of failure of the local circuit breaker to open, another trip command is sent after a short delay to an upstream breaker to clear the fault.



### Tie Breaker Tripping

In case of an arc in one section of the switchboard, the AF0500 can trip both the incoming feeder and the tie breaker simultaneously. Thus the affected part of the switchboard is isolated from the non-affected part.



## Accessories



### PGA-LS10 Point Sensor

Line-of-sight light sensor detects an arc as small as 3 kA within a 2-m half-sphere. Includes Sensor health and trip indication.



### PGA-LS20/PGA-LS30 Fiber-Optic Sensor

360° light sensor to run along bus bars. Sensor health and trip indication.



### PGA-1100 Diode Logic Unit

This module allows multiple arc-flash relays to trip a common breaker, for example a tie-breaker.

## Specifications

### Power Supply

**Universal** 100 to 240 Vac (+10%, -15%) 50/60 Hz, 20 VA,  
110 to 250 Vdc (+10%, -20%) 8 W

**Low Voltage Sensor Inputs** 24 to 48 Vdc (+10%, -20%), 4 W  
4 light sensor inputs for PGA-LS10, PGA-LS20 and PGA-LS30 sensors

**Trip Outputs** 2 IGBT switches

**UL Rating** 120/240 Vac, 1800 VA, 0.75 A maximum continuous,  
125/250 Vdc, 138 VA, 0.75 A maximum continuous

### Supplemental Rating

**Make/Carry** 30 A for 0.2s

**Voltage Rating** 24 to 300 Vac, 24 to 300 Vdc

**Current Rating** 20 A for 2 s, 10 A for 5 s

### Communication

Ethernet, 2 ports with internal Ethernet switch,  
Modbus<sup>®</sup> TCP

### Dimensions

**H** 130 mm (5.1"); **W** 200 mm (7.9"); **D** 54 mm (2.1")

### Shipping Weight

0.9 kg (2 lb)

### Operating Temp.

-40°C to +70°C (-40°F to 158°F)

### Approvals

UL Listed (UL508), CE, RCM, FCC, CSA

### Warranty

5 years

### Mounting

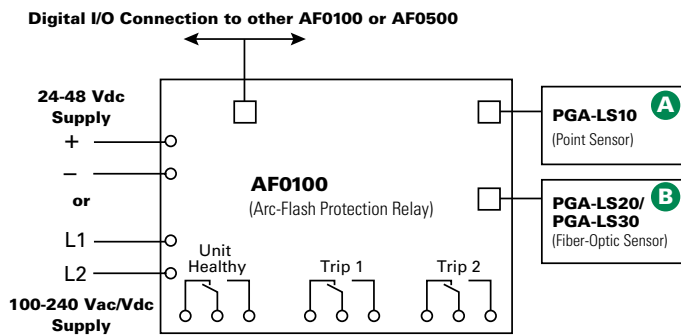
Surface, DIN (with optional D0050 adapter clips)

# AF0100 SERIES

## Arc-Flash Relay



### Simplified Circuit Diagram



For dimensional drawing see: Appendix page 510, Figure 11.

### Ordering Information

ORDERING NUMBER	DESCRIPTION
AF0100-00	Arc-Flash Relay, Universal Supply
AF0100-10	Arc-Flash Relay, 24-48 Vdc

### Specifications

<b>Input Voltage</b>	
<b>AF0100-00</b>	100-240 Vac/Vdc, 24-48 Vdc
<b>AF0100-10</b>	24-48 Vdc
<b>Dimensions</b>	<b>H</b> 90 mm (3.5"); <b>W</b> 128 mm (5.0"); <b>D</b> 60 mm (2.4")
<b>Trip, Error Relays</b>	Form C, 250 Vac/30 Vdc, 6 A resistive
<b>Sensitivity</b>	10-25 klux programmable
<b>Mounting</b>	Surface, DIN rail
<b>Operating Temperature</b>	-40°C to +70°C (-40°F to 158°F)
<b>Shipping Weight</b>	1.0 kg (2.2 lb)
<b>Certifications</b>	Contact factory
<b>Warranty</b>	5 years

### Description

The AF0100 Series arc-flash relay is a cost-effective solution that reduces arc-fault damage by detecting the light from an arc flash and rapidly tripping. Two remote light sensors can be connected to one relay and multiple AF0100 and/or AF0500 relays can be connected to monitor additional sensors, providing complete coverage for a wide range of applications. The compact, DIN-rail or surface-mountable body makes this an ideal solution for equipment manufacturers.

Two isolated Form-C contacts are provided for applications with multiple devices that must be tripped. This is especially useful for generator applications where the generator and breaker need to be tripped in case of an arc flash.

The AF0100 accepts PGA-LS10 point sensors and PGA-LS20/PGA-LS30 fiber-optic sensors in any combination. Sensor health is continuously monitored to ensure fail-safe operation. A solid-state redundant trip circuit provides an internal fail-safe mechanism and fast arc-flash response during power up.

Front-panel and sensor LEDs indicate sensor health and fault location.

### Features & Benefits

FEATURES	BENEFITS
<b>Compact</b>	Fits into a wide range of arc-flash applications
<b>Two optical sensor types</b>	Point sensors or fiber-optic sensors can be used in any combination for coverage flexibility
<b>Dual sensor inputs</b>	One relay can monitor two arc-flash sensors
<b>Adjustable light sensitivity</b>	Allows for operation in bright environments and maximum sensitivity in dark environments
<b>Discrete wire networking</b>	Multiple AF0100 or AF0500 units can be interconnected to form a system
<b>Fail-safe system</b>	Continuous monitoring of optical sensors and inputs ensures protection
<b>USB interface</b>	Configuration software is easy to use with no drivers or software installation
<b>Unit health</b>	Ensures continuous protection with self diagnostic and remote unit-healthy indication
<b>LED Indication</b>	Trip and sensor status indication both on relay and sensors

### Accessories

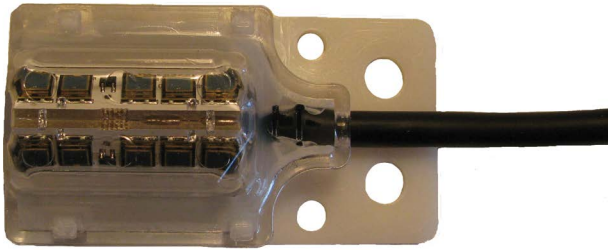
**A** **PGA-LS10 Point Sensor**  
Line-of-sight light sensor detects an arc as small as 3 kA within a 2-m half-sphere. Includes sensor health and trip indication.

**B** **PGA-LS20/PGA-LS30 Fiber-Optic Sensor**  
360° light sensor to run along bus bars. Includes sensor health and trip indication.



# A0220 SERIES

## Arc Detecting Point Sensor



### Description

The A0220 Arc Detector is a photo electric sensor. It has a sensitive area of 180°. Sensor signal is a mA current signal of 0.5 mA/klux. The sensor includes 10 m of shielded two-wire electrical cable which can easily be shortened or extended to a maximum of 50 m. Use Belden 85240 or equivalent cable (2 x 0.50 mm<sup>2</sup>).

The sensor is compatible with the D0920, D1000 and PGR-8800 Littelfuse Arc Flash Relays.

### A0220 Sensor Installation

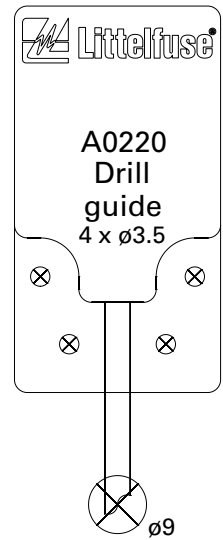
The sensors include an adhesive-backed drill template for easy surface or panel-mount installation. All dimensions are shown in millimetres.

Affix the drill template where the sensor is to be mounted. Either M4 or M5 screws or pop rivets (4 mm or 5 mm) can be used.

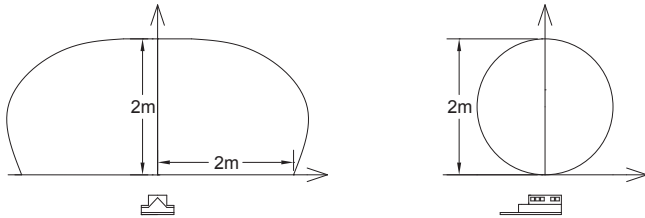
Mounting screws are M4 for the top holes. This template matches the mounting dimensions for the A1000 or PGA-LS10 sensor.

The bottom mounting holes are either for 5mm self-drilling screws (3.5mm drill) or for M5 (4.2 mm drill). This template matches the mounting dimensions for the A0200 and A0300 sensors.

For placement of sensors please refer to the relay manual.



### Detection range for a 3kA fault



### Ordering Information

ORDERING NUMBER	CONTROL POWER
A0220.0010	Arc Detector type V, 10 m
A0220.0020	Arc Detector type V, 15 m
A0220.0030	Arc Detector type V, 10 m, CCC approved
A0220.0040	Arc Detector type V, 15 m, CCC approved

### Connection to D0920 relay

SENSOR WIRE	TERMINAL
Red	1
Green	2
Screen	3

### Connection to PGR-8800 relay

SENSOR WIRE	SENSOR 1 TERMINAL	SENSOR 2 TERMINAL	SENSOR 3 TERMINAL	SENSOR 4 TERMINAL	SENSOR 5 TERMINAL	SENSOR 6 TERMINAL
Green	4	8	12	16	20	24
Red	3	7	11	15	19	23
Screen	Chassis	Chassis	Chassis	Chassis	Chassis	Chassis

### Specifications

<b>Sensitivity</b>	0.5 mA/ klux
<b>Range for D0920</b>	2 klux to 30 klux
<b>Range for PGR-8800</b>	10 klux to 30 klux
<b>Ambient temperature</b>	-25°C to +70°C
<b>Degree of protection</b>	IP65

#### Type Selection Table:

A0220 Arc Detector includes 10m cable



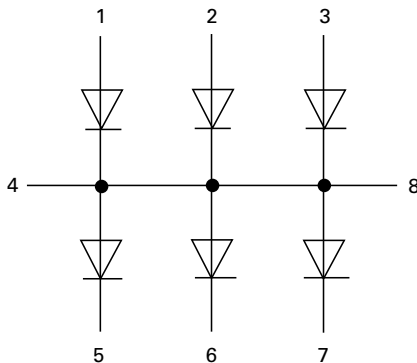
# PGA-1100 (D1100)

## Diode Logic

CE



### Simplified Circuit Diagram



### Description

The PGA-1100 Diode Logic module is an optional accessory for the Littelfuse Arc-Flash Relays.

It is used in installations with more than one breaker and more than one Arc-Flash Relay. Purpose of the unit is to separate the trip paths, so the breakers can be tripped independently from each other.

Typical applications are a switchboards with two incoming feeders and one tie breaker or switchboards with several protected zones and tripping of a common upstream circuit breaker.

The unit has three input diodes to handle the outputs of three Arc-Flash relays and three output diodes to handle the trip coils of three circuit breakers. If more than three relays/circuit breakers are needed, more units can be added by connecting terminal 8 of one box to terminal 4 of the next one, thus increasing the number of inputs and outputs with multiples of three.

For more application information please refer to the arc-flash relay manuals.

### Specifications

<b>Diodes</b>	1000V reverse voltage, 3A continuous, 25A for 1 second
<b>Certification</b>	CE
<b>Dimensions</b>	<b>H</b> 70 mm (2.76"); <b>W</b> 20 mm (0.79"); <b>D</b> 80 mm (3.15")

### Ordering Information

ORDERING NUMBER	DESCRIPTION
PGA-1100.0010	Diode logic unit

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ARC-FLASH PROTECTION



## SWITCHING RELAYS & CONTROLS

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Simple controls perform a specific function such as changing lamp intensity; vary the speed of a motor; or manage temperature of a heater.

PHS Series	Phase Control.....	98
SIR Series	Solid-State Relay - Isolated .....	100
SLR Series	Solid-State Relay - Non-Isolated .....	102
TCR9C	Temperature Controller .....	104

# PHS SERIES

## Phase Control



### Description

The PHS Series is an ideal method of changing lamp intensity, varying the speed of a fan/motor, or controlling the temperature of a heater. The effective output voltage is adjusted with an accessory external potentiometer suitable for line voltage applications.

#### Operation

Upon application of input voltage, effective output voltage can be varied by changing the external resistance value. As the external resistance increases, the effective output voltage decreases. The inverse is also true.

### Features & Benefits

FEATURES	BENEFITS
<b>External adjustment - 230VAC rated potentiometer</b>	Allows control of heavy loads directly, solid state design will provide long life
<b>Up to 20A steady state - 200A inrush</b>	Allows control of heavy loads directly, solid state design will provide long life
<b>Single hole surface mounting</b>	Provides quick and easy installation

### Accessories



**P1004-174** (100kΩ 1W), **P1004-175** (200kΩ 2W)  
**Versa-Pot**  
Panel mountable, industrial potentiometer recommended for remote time delay adjustment.



**P0700-7 Versa-Knob**  
Designed for 0.25 in. (6.35 mm) shaft of Versa-Pot. Semi-gloss industrial black finish.



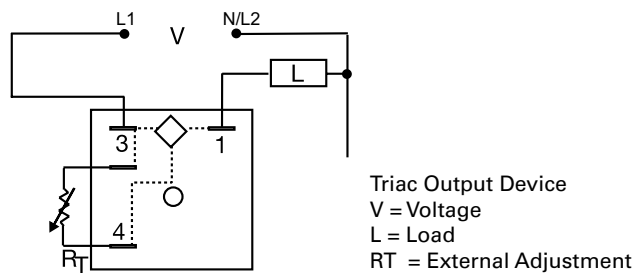
**P1015-64** (AWG 14/16)  
**Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**  
Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.

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### Wiring Diagram



For dimensional drawing see: Appendix, page 512, Figure 19.

### Ordering Information

MODEL	INPUT VOLTAGE	RATING
PHS120A10	120VAC	10A
PHS120A20	120VAC	20A
PHS120A6	120VAC	6A
PHS230A10	230VAC	10A
PHS230A20	230VAC	20A
PHS230A6	230VAC	6A

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# PHS SERIES

## Specifications

### Output

#### Type

#### Rating

Variable voltage phase angle control

#### Steady State (at 100% On)      Inrush\*

1A	10A
6A	60A
10A	100A
20A	200A

#### Minimum Load Current

100mA

#### Voltage Drop

≅ 2.0V at rated current

### Input

#### Voltage

120 or 230VAC

#### Tolerance

±20%

#### AC Line Frequency

50/60Hz

### Protection

#### Dielectric Breakdown

≥ 2000V RMS terminals to mounting surface

#### Insulation Resistance

≥100MΩ

### Mechanical

#### Mounting \*

Surface mount with one #10 (M5 x 0.8) screw

#### Dimensions

**H** 50.8 mm (2"); **W** 50.8 mm (2");

**D** 38.4 mm (1.51")

#### Termination

0.25 in. (6.35 mm) male quick connect terminals

### Environmental

#### Operating/Storage

##### Temperature

-20° to 60°C / -40° to 85°C

##### Humidity

95% relative, non-condensing

##### Weight

1A: ≅ 2.4 oz (68 g)

6, 10, & 20A: ≅ 3.9 oz (111 g)

### External Adjustment

#### Potentiometer

##### 120VAC

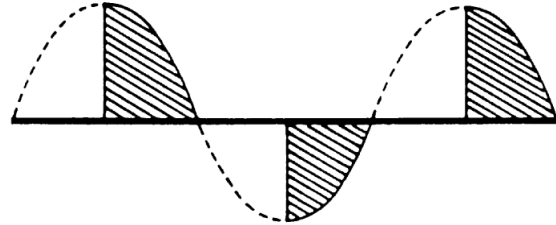
100KΩ rated at 1W

##### 230VAC

200KΩ rated at 2W

Must have insulation resistance suitable for line voltage applications.

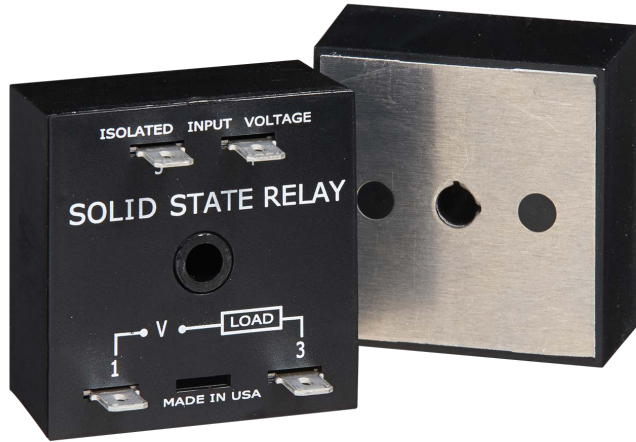
## Typical Output Waveform



\*Units rated ≥ 6A must be bolted to a metal surface using the included heat sink compound. The maximum mounting surface temperature is 90°C. Inrush: Non-repetitive for 16ms.

# SIR SERIES

## Solid-State Relay - Isolated



### Description

The SIR Series is designed for industrial applications requiring rugged reliable operation. Provides an optically isolated, high capacity, solid-state output, with power switching capability up to 20A steady state, 200A inrush. Zero voltage switching SIR2 extends the life of an incandescent lamp up to 10 times. Random switching SIR1 is ideal for inductive loads. When fully insulated female terminals are used on the connection wires, the system meets the requirements for touch-proof connections.

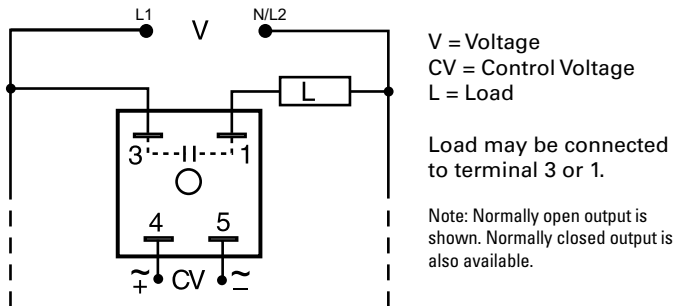
### Operation

The solid-state output is located between terminals 1 and 3, and is normally open or normally closed without control voltage applied to terminals 4 and 5. When control voltage is applied to terminals 4 and 5, the solid-state output opens or closes respectively.

**Reset:** Removing control voltage resets the output. The unit is also reset if output voltage is removed.

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### Wiring Diagram



For dimensional drawing see: Appendix, page 512, Figure 19.

### Features & Benefits

FEATURES	BENEFITS
<b>Compact design measures 2 in. (50.8mm) square</b>	Perfect for OEM applications where space is limited
<b>Totally solid state and encapsulated</b>	No moving parts to arc and wear out over time and encapsulated to protect against shock, vibration and humidity
<b>Up to 20A, 200A inrush output rating</b>	Provides direct control of heavy inductive, incandescent or resistive loads
<b>Switching output is optically isolated from the control input</b>	Provides the ability to interface between 2 different electrical circuits
<b>SIR1 models provide random switching</b>	Designed for use with resistive and incandescent loads, extending lamp life up to 10 times
<b>SIR2 models provide zero voltage switching</b>	Perfect for resistive and incandescent loads
<b>Metalized mounting surface</b>	Facilitates heat transfer in high current applications

### Ordering Information

MODEL	SWITCHING	CONTROL VOLTAGE	RATING	OUTPUT FORM	OUTPUT VOLTAGE
SIR1A1A4	Random	9 to 30VAC or DC	3A	Normally open	120VAC
SIR1A20A4	Random	9 to 30VAC or DC	20A	Normally open	120VAC
SIR1B6B4	Random	90 to 150VAC or DC	6A	Normally closed	120VAC
SIR1C20B6	Random	190 to 290VAC or DC	20A	Normally closed	230VAC
SIR2A20A4	Zero voltage	9 to 30VAC or DC	20A	Normally open	120VAC
SIR2B20A4	Zero voltage	90 to 150VAC or DC	20A	Normally open	120VAC
SIR2B20B4	Zero voltage	90 to 150VAC or DC	20A	Normally closed	120VAC

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# SIR SERIES

## Accessories

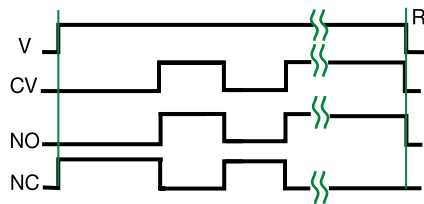


**P1015-13** (AWG 10/12), **P1015-64** (AWG 14/16), **P1015-14** (AWG 18/22) **Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**  
Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.

## Function Diagram



V = Voltage  
CV = Control Voltage  
NO = Normally Open Contact  
NC = Normally Closed Contact  
R = Reset  
— = Undefined Time

## Specifications

### Output

**Type** Optical isolation, totally solid state

**Form** SPST, NO or NC

**Voltage** 24, 120, or 230VAC

**Tolerance** ±20%

### Ratings

Steady State	Inrush*	Output Device
3A	30A	Triac
6A	60A	Triac
10A	100A	Triac
20A	200A	Triac

**Minimum Load Current** ≅ 50mA

**Voltage Drop** ≅ 2.0V at rated current

**Leakage Current (Open State)** ≅ 6mA

### Input

**Type** Optical isolation LED/photo transistor

**Control Voltage** 9 to 290VAC/DC in 3 ranges

**Power Consumption** ≤ 0.5W

### Protection

**Circuitry** Encapsulated

**Dielectric Breakdown** ≥ 2000V RMS terminals to mounting surface

**Insulation Resistance** ≥ 100 MΩ

### Mechanical

**Mounting\*** Surface mount with one #10 (M5 x 0.8) screw

**Dimensions** **H** 50.8 mm (2.0"); **W** 50.8 mm (2.0");

**D** 38.4 mm (1.51")

**Termination** 0.25 in. (6.35 mm) male quick connect terminals

### Environmental

#### Operating/Storage

**Temperature**

-40° to 60°C / -55° to 85°C

**Humidity**

95% relative, non-condensing

**Weight**

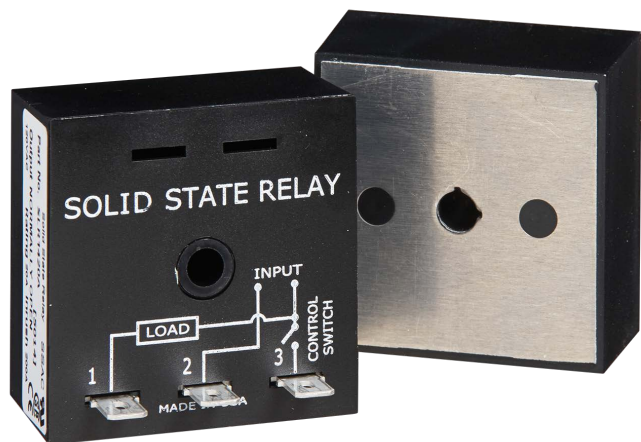
≅ 3.9 oz (111 g)

\*Must be bolted to a metal surface using the included heat sink compound. The maximum mounting surface temperature is 90°C. Inrush: Non-repetitive for 16ms.



# SLR SERIES

## Solid-State Relay - Non-Isolated



### Description

The SLR Series has no isolation between the control switch input and the solid-state output. Select the SLR for applications where the control switch is the same voltage source as the load. Provides the noiseless, reliability and long life of a solid-state relay, without the cost of isolation circuitry. The SLR Series offers random switching and is normally used for inductive loads. When fully insulated female terminals are used on the connection wires, the system meets the requirements for touch-proof connections.

### Operation

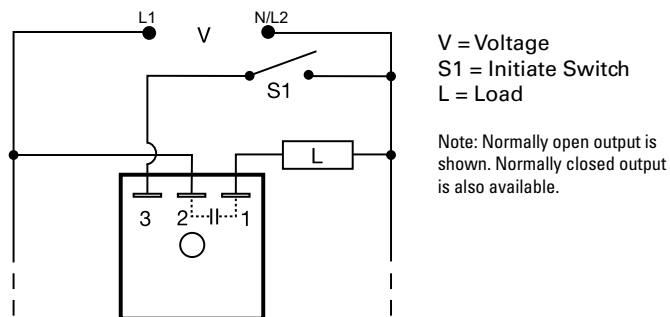
The solid-state output is located between terminals 1 and 2 and can be ordered as either normally open or normally closed, when voltage is applied and S1 is open. When S1 is closed, the solid-state output between terminals 1 and 2 closes (or opens). If S1 is opened, the solid-state output will open (or close).

**Reset:** Opening S1 resets the output to its original state. Reset is also accomplished by removing input voltage.

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SWITCHING RELAYS & CONTROLS

### Wiring Diagram



For dimensional drawing see: Appendix, page 512, Figure 19.

### Ordering Information

MODEL	SWITCHING	INPUT VOLTAGE	OUTPUT RATING	OUTPUT FORM
SLR1420A	Random	120VAC	20A	Normally open
SLR1610A	Random	230VAC	10A	Normally open

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### Features & Benefits

FEATURES	BENEFITS
<b>Compact design measures 2 in. (50.8mm) square</b>	Perfect for OEM applications where space is limited
<b>Totally solid state and encapsulated</b>	No moving parts to arc and wear out over time and encapsulated to protect against shock, vibration, and humidity
<b>Up to 20A steady, 200A inrush output rating</b>	Provides direct control of heavy inductive, resistive, or incandescent loads
<b>Metalized mounting surface</b>	Facilitates heat transfer in high current applications

### Accessories



**P1015-13** (AWG 10/12), **P1015-64** (AWG 14/16), **P1015-14** (AWG 18/22) **Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**  
Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.

# SLR SERIES

## Specifications

### Output (Contact)

<b>Type</b>	Non-isolated solid state		
<b>Form</b>	SPST, NO or NC		
<b>Voltage</b>	24, 120, or 230VAC		
<b>Tolerance</b>	±20%		
<b>Ratings</b>	<b>Steady State</b>	<b>Inrush*</b>	<b>Output Device</b>
	1A	10A	SCR & Bridge Rectifier
	6 A	60A	Triac
	10A	100A	Triac
	20A	200A	Triac

### Minimum Load Current

≅ 50mA

### Voltage Drop

(at Rated Current) ≅ 2.0V - 6, 10, & 20A units; ≅ 2.5V - 1A units

### Leakage Current (Open State)

≤ 5mA

### Initiate Switch Voltage

Same as the output voltage

### Power Consumption

≤ 0.5W

### Protection

#### Circuitry

Encapsulated

#### Dielectric Breakdown

≥ 2000V RMS terminals to mounting surface

#### Insulation Resistance

≥ 100MΩ

### Mechanical

#### Mounting\*

Surface mount with one #10 (M5 x 0.8) screw

#### Dimensions

**H** 50.8 mm (2.0"); **W** 50.8 mm (2.0");

**D** 38.4 mm (1.51")

#### Termination

0.25 in. (6.35 mm) male quick connect terminals

### Environmental

#### Operating/Storage

##### Temperature

-20° to 60°C / -40° to 85°C

##### Humidity

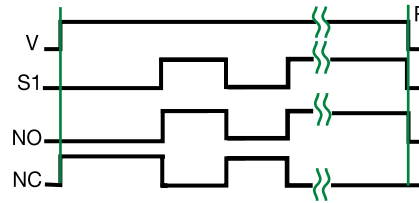
95% relative, non-condensing

##### Weight

1A units: ≅ 2.4 oz (68 g);

6, 10, 20A units: ≅ 3.9 oz (111 g)

## Function Diagram

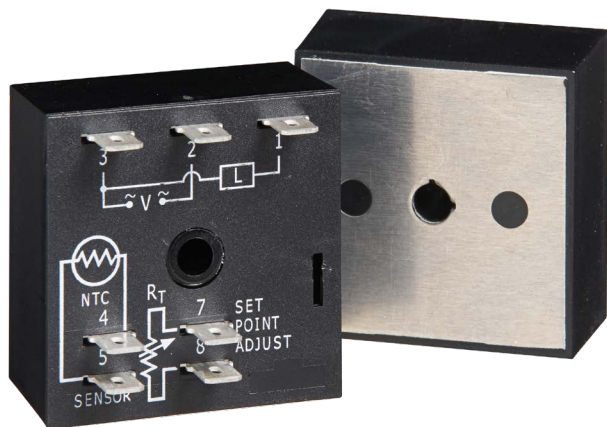


V = Voltage  
S1 = Initiate Switch  
NO = Normally Open Contact  
NC = Normally Closed Contact  
R = Reset  
— ≡ = Undefined Time

\*Must be bolted to a metal surface using the included heat sink compound. The maximum mounting surface temperature is 90°C. Inrush: Non-repetitive for 16ms.

# TCR9C

## Temperature Controller



### Description

The TCR9C of solid-state temperature control is a low cost modular approach to accurate control of temperature. The high power output is available in 20 amperes and provides setpoint temperature control. The efficient mounting surface allows for utilization of equipment as the heat sink. Designed for use with resistive loads.

### Operation

**Setpoint Control:** TCR9C is a single setpoint temperature controller. When the thermistor resistance is high (above the setpoint), the solid-state output is ON. When the thermistor resistance decreases (temperature increases) to setpoint or below, the output turns OFF. It must be recognized that temperature differential (under and overshoot) is largely due to the system as a whole. The mass of the system, size of the heaters and sensor all play an important part. Single setpoint control is best when there is little or no lag time between heater and sensor, and when the heater is not oversized.

### Features & Benefits

- NTC thermistor sensing for low cost setpoint control
- Solid-state output to control resistive heaters
- External adjustment of the setpoint
- Small package, encapsulated, single-screw mounting
- Metal mounting surface utilizes equipment as heat sink

### Accessories



**P1015-13** (AWG 10/12), **P1015-64** (AWG 14/16), **P1015-14** (AWG 18/22) **Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.

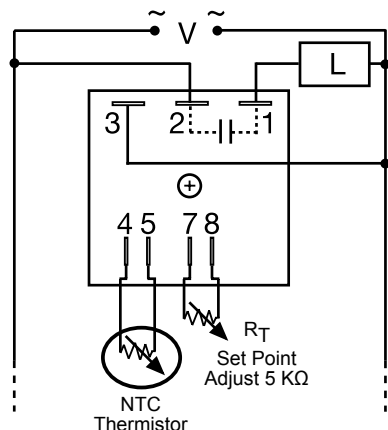
### Specifications

<b>Control Type</b>	Single setpoint, negative temperature coefficient resistance sensing
<b>Sensor Type</b>	Thermistor, negative temperature coefficient (customer supplied) Electrically insulated for 1500V RMS min.
<b>Adjustment</b>	Temperature setpoint selected by means of an external resistance
<b>Accuracy</b>	≤ ±5% of the setpoint resistance Add the tolerance of the NTC thermistor and the drift of the adj. pot over temp. range
<b>Setpoint vs. Ambient Temperature and Operating Voltage</b>	±5% of setpoint resistance
<b>Reset Time</b>	≤ 150ms
<b>Input Voltage</b>	120 - 240VAC
<b>Tolerance</b>	±15%
<b>AC Line Frequency</b>	50/60 Hz

6

SWITCHING RELAYS & CONTROLS

### Wiring Diagram



V = Voltage  
L = Load

**Caution:** NTC Thermistor must be electrically insulated, 1500 volts RMS minimum.

For dimensional drawing see: Appendix, page 512, Figure 19.

# TCR9C

**Output**

**Type** Solid state  
**Form** Non-isolated, single pole, zero voltage switching  
**Rating** **Model** C      **Steady State** 20A      **Inrush\*** 200A\*

**Minimum Load Current** 100mA  
**Voltage Drop**  $\approx$  2V at rated current  
**Off State Leakage Current**  $\approx$  5mA @ 230VAC

**Protection**

**Dielectric Breakdown**  $\geq$ 2000 volts terminals to mounting surface  
**Isolation Voltage**  $\geq$ 100m $\Omega$   
**Circuitry** Encapsulated

**Mechanical**

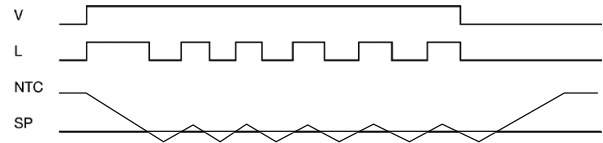
**Mounting** Surface mount with one #10 (M5 x 0.8) screw  
**Dimensions** **H** 50.8 mm (2.0"); **W** 50.8 mm (2.0");  
**D** 38.4 mm (1.51")  
**Termination** 0.25 in. (6.35mm) male quick connect terminals

**Environmental**

**Operating/Storage Temperature** -40° to 60°C / -40° to 85°C  
**Humidity** 95% relative, non-condensing  
**Weight**  $\approx$  2.7 oz (77 g)

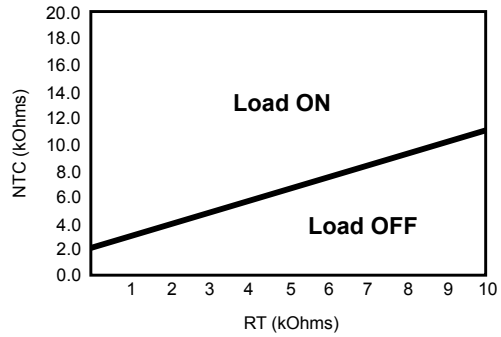
\* Must be bolted to a metal surface using the included heat sink compound. The maximum mounting surface temperature is 90°C. Inrush: non-repetitive for 16ms.

## Function Diagram



V = Voltage      NTC = Negative Temperature Coefficient Thermistor  
L = Load  
SP = Setpoint

## Adjustment vs. Thermistor Resistance



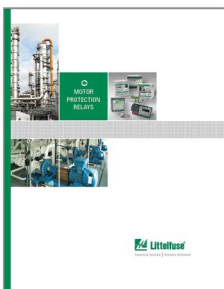
Note: If  $R_T$  value exceeds 13kOhms, the output will not energize.



## MOTOR & PUMP PROTECTION

Prevent damage to motors caused by overloads, jams, phase loss or unbalance, heat from non-electric sources, heavy start-ups and excessive operational cycles. Dynamic thermal curves, as well as integrated protection, metering, and data-logging functions extend motor life and maximize process efficiency.

PGR-6100 Series	Motor Ground-Fault & Insulation Relay ....	108
PGR-6101-120	Motor Ground-Fault & Insulation Relay ....	109
MPU-32 Series	Motor Protection Unit.....	110
MPS Series	Motor Protection System .....	112
MPU-32-X69X Series	Motor Protection Relay Retrofit Kit .....	114
MPS-469X Series	Motor Protection Relay Retrofit Kit.....	114
111-Insider-P / 231-Insider-P	Single-Phase Pump Monitor.....	115
232-Insider	Single-Phase Pump Monitor.....	118
111P / 233P / 233P-1.5 Series	Single-Phase Pump Monitor.....	120
234-P	Single-Phase Pump Monitor .....	122
235P	Single-Phase Pump Monitor.....	124
MP8000 Series	Bluetooth Current & Voltage Monitor .....	126
777 Series	3-Phase Current & Voltage Monitor .....	130
777 / 77C Series	Single-Phase Current & Voltage Monitor..	132
777-KW/HP-P2 Series	3-Phase Current & Voltage Monitor .....	134
777-AccuPower	3-Phase Current & Voltage Monitor .....	137
77C-KW/HP Series	Single-Phase Current & Voltage Monitor..	139
SIO-RTD-02-00	Temperature Input Monitor .....	142



For More Information...  
 and to download our Motor Protection  
 Brochure or White Paper, click on  
 Technical Resources at  
**[Littelfuse.com/MotorProtection](http://Littelfuse.com/MotorProtection)**

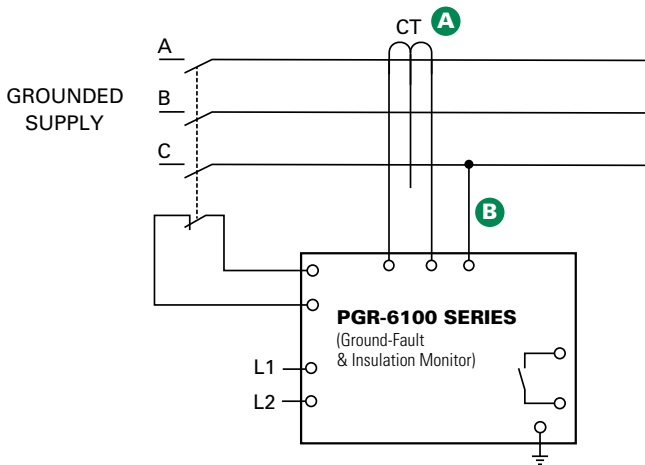
\*Bluetooth is a trademark of its respective owner.

# PGR-6100 SERIES (GFR4000)

## Ground-Fault & Insulation Monitor



### Simplified Circuit Diagram



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MOTOR & PUMP PROTECTION




### Description

The PGR-6100 combines the features of a ground-fault protection relay and insulation monitor into one unit. It protects against ground faults by monitoring insulation resistance when the motor is de-energized and by monitoring ground-fault current when the motor is energized. The PGR-6100 features two separate analog outputs for optional current and ohm meters, and two separate alarm relays. It operates on one- or three-phase solidly grounded, resistance-grounded and ungrounded systems up to 6 kV.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable GF pickup (10 mA-3 A)</b>	Trip setting provides a wide range of low-level protection and system coordination
<b>Adjustable insulation pickup (250 kΩ-2 MΩ)</b>	Customizable insulation resistance setpoints for maximum protection
<b>Adjustable time delay (50 ms-1.0 s)</b>	Adjustable trip delay for quick protection and system coordination
<b>Output contacts</b>	Two Form C output contacts for ground fault and insulation-resistance fault
<b>Analog outputs (0-1 mA)</b>	Two analog outputs indicate insulation resistance and ground-fault current
<b>CT-Loop monitoring</b>	Alarms when CT is not connected
<b>Selectable contact operating mode</b>	Selectable fail-safe or non-fail-safe operating modes allows connection to shunt or undervoltage breaker coil

### Accessories

- A**  **SE-CS30 Series Ground-Fault CTs**  
Required zero-sequence current transformer specifically designed for low level detection. Flux conditioner is included to prevent saturation.
- B**  **PGH Family High Tension Couplers**  
Required (for systems >1,300 V) PGH Family high-tension coupler must be connected between the phase conductor and the PGR-6100.
-  **PGA-0500 Analog % Current Meter**  
**PGA-0510 Analog Ohm Meter**  
Optional panel-mounted meters display ground-fault current as a percentage of the set-point and insulation resistance.

### Ordering Information

ORDERING NUMBER	CONTROL POWER
PGR-6100-120	120 Vac
PGR-6100-240 <sup>(1)</sup>	240 Vac <sup>(1)</sup>

ACCESSORIES	REQUIREMENT
SE-CS30 Series	Required
PGH Family	Required >1300 V
PGA-0500	Optional
PGA-0510	Optional

Note (1) - PGR-6100-240 ordering option is not UL Listed. For optional conformal coating please consult factory.

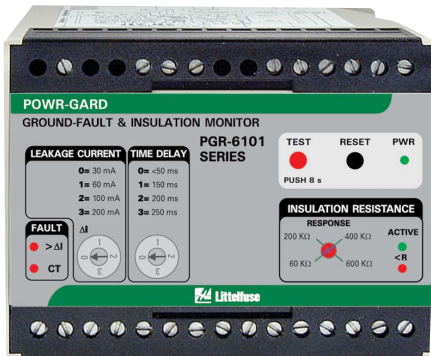
### Specifications

<b>IEEE Device Numbers</b>	Ground Fault (50G/N, 51G/N), Ground detector (64), Alarm Relay (74)
<b>Input Voltage</b>	<i>See ordering information</i>
<b>Dimensions</b>	<b>H</b> 75 mm (3"); <b>W</b> 100 mm (3.9"); <b>D</b> 115 mm (4.5")
<b>Response delay</b>	< 50 ms
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe
<b>Harmonic Filtering</b>	Standard feature
<b>Test Button</b>	Standard feature
<b>Reset Button</b>	Standard feature
<b>CT-Loop Monitoring</b>	Standard feature
<b>Output Contacts</b>	Two Form C
<b>Analog Output</b>	0-1 mA
<b>Approvals</b>	UL Listed (E183688) <sup>(1)</sup>
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface

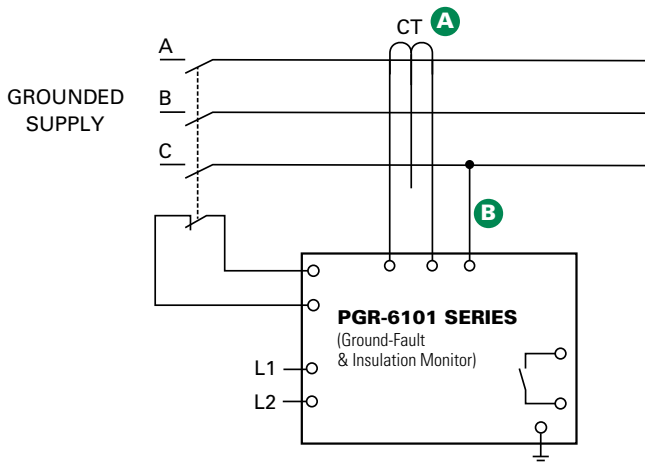


# PGR-6101-120 (GFR4001)

## Ground-Fault & Insulation Monitor



### Simplified Circuit Diagram



### Ordering Information

ACCESSORIES	REQUIREMENT
SE-CS30 Series	Required
PGH Family	Required >1300 V
PGA-0500	Optional
PGA-0510	Optional

For optional conformal coating please consult factory.




### Description

The PGR-6101-120 combines the features of a ground-fault protection relay and insulation monitor into one unit. It protects against ground faults by monitoring insulation resistance when the motor is de-energized and by monitoring ground-fault current when the motor is energized. The PGR-6101-120 features two separate analog outputs for optional current and ohm meters, and two separate alarm relays. It operates on one- or three-phase solidly grounded, resistance grounded and ungrounded systems up to 6 kV.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable GF pickup (30-200 mA)</b>	Trip setting provides a wide range of low-level protection and system coordination
<b>Adjustable insulation pickup (60-600 kΩ)</b>	Customizable insulation resistance setpoints for maximum protection
<b>Adjustable time delay (50-250 ms)</b>	Adjustable trip delay for quick protection and system coordination
<b>Output contacts</b>	Two Form C output contacts for ground fault and insulation-resistance fault
<b>Analog outputs (0-1 mA)</b>	Two analog outputs indicate insulation resistance and ground-fault current
<b>CT-Loop monitoring</b>	Alarms when CT is not connected
<b>Selectable contact operating mode</b>	Selectable fail-safe or non-fail-safe operating modes allows connection to shunt or undervoltage breaker coil

### Accessories

- A**  **SE-CS30 Series Ground-Fault Transformers**  
Required zero-sequence current transformer specifically designed for low level detection. Flux conditioner is included to prevent saturation.
- B**  **PGH Family High Tension Couplers**  
Required (for systems >1,300 V) PGH Family high-tension coupler must be connected between the phase conductor and the PGR-6101-120.
-  **PGA-0500 Analog % Current Meter**  
**PGA-0510 Analog Ohm Meter**  
Optional panel-mounted meters display ground-fault current as a percentage of the set-point and insulation resistance.

### Specifications

<b>IEEE Device Numbers</b>	Ground Fault (50G/N, 51G/N), Ground detector (64), Alarm Relay (74)
<b>Input Voltage</b>	120 Vac
<b>Dimensions</b>	<b>H</b> 75 mm (3"); <b>W</b> 100 mm (3.9"); <b>D</b> 115 mm (4.5")
<b>Response delay</b>	< 50 ms
<b>Contact Operating Mode</b>	Selectable fail-safe or non-fail-safe
<b>Harmonic Filtering</b>	Standard feature
<b>Test Button</b>	Standard feature
<b>Reset Button</b>	Standard feature
<b>CT-Loop Monitoring</b>	Standard feature
<b>Output Contacts</b>	Two Form C
<b>Analog Output</b>	0-1 mA
<b>Approvals</b>	UL Listed (E183688)
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface

# MPU-32 SERIES (PGR-6200)

## Motor Protection Unit



### Description

The MPU-32 Motor Protection Unit is used to provide current- and temperature-based protection, metering, and data logging for three-phase low-voltage medium-horsepower induction motors. This relay is ideal for retrofitting and upgrading obsolete or aging motor protection using existing CTs. See the PMA Family of Panel Mount Adapter Kits to replace common obsolete relays.

#### 1 Motor Protection Unit

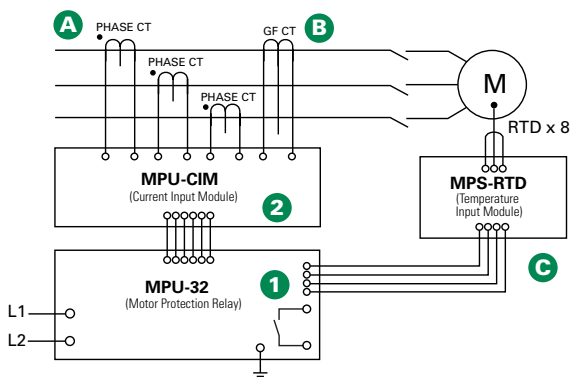
- Three ac-current inputs
- Earth-leakage-CT input
- Programmable digital input
- 24-Vdc source for digital input
- Programmable 4-20-mA analog output
- On-board temperature-sensor input,
- 100-Ω-Platinum RTD or PTC
- Three programmable output relays
- Local RS-232 communications, optional Network Communications
- PC-interface software (SE-Comm-RIS)
- 4 line x 20 character backlit LCD display
- Keypad for programming and display selection
- 4 LEDs; 1 user programmable

#### 2 Current Input Module (MPU-CIM)

The MPU-CIM Current Input Module is the interface between the MPU-32 relay and the 5-A-secondary, 1-A-secondary, and sensitive current transformers. The MPU-CIM is ordered separately from the MPU-32 and can be surface or DIN-rail mounted. Wire-clamping terminals are standard, but the MPU-CTI is available for those who require ring-tongue terminals.

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### Simplified Circuit Diagram



MOTOR & PUMP PROTECTION

### Ordering Information

ORDERING NUMBER	COMMUNICATION
MPU-32-00-00	TIA-232
MPU-32-01-00	TIA-232 & TIA-485
MPU-32-02-00	TIA-232 & DeviceNet™
MPU-32-04-00	TIA-232 & EtherNet/IP™ & Modbus® TCP

NOTE: One of the following is required: MPU-CIM-00-00 Current Input Module, or MPU-CTI-RT-00 Current Input Module with ring-tongue terminals.

ACCESSORIES	REQUIREMENT
Phase CTs	Required
MPS-RTD-01-00	Optional
MPS-DIF-01-00	Optional
MPU-32-SMK	Optional
CA-945	Optional
MPU-16A-Y92A-96N	Optional

### Accessories

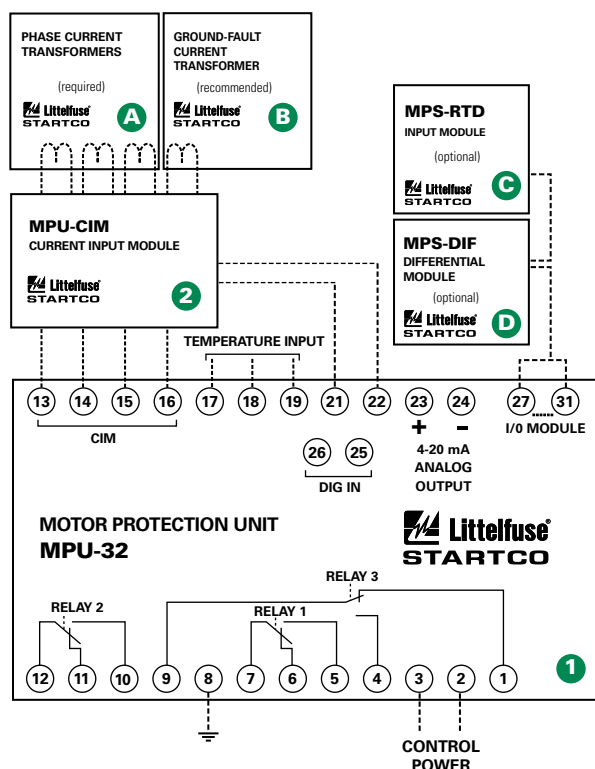
- A Phase Current Transformers**  
Phase CTs are required to detect phase currents. For upgrade applications, existing CTs can be used.
- B Ground-Fault Current Transformer**  
Optional zero-sequence current transformer detects ground-fault current. Available with 5-A and 30-A primary ratings for low-level pickup.
- C MPS-RTD Temperature Input Module**  
Optional module provides 8 inputs to connect Pt100, Ni100, Ni120, and Cu10 RTDs.
- D MPS-DIF Differential Current Module**  
Optional motor differential protection, compatible with core balance and summation current transformer connections.

# MPU-32 SERIES (PGR-6200)

## Features & Benefits

FEATURES	IEEE #	BENEFITS
<b>Overload</b>	49, 51	Extends motor life and prevents insulation failures and fires
<b>Dynamic thermal model</b>		Provides protection through starting, running, and cooling cycles
<b>Communications</b>		Remotely view measured values and event records, reset trips, and access setpoints
<b>Ground fault</b>	50G/N, 51G/N	Prevents catastrophic failures and fires
<b>Current unbalance/ Phase loss/Phase reverse</b>	46	Prevents overheating due to unbalanced phases
<b>RTD temperature</b>	38, 49	RTD temperature protection (MPS-RTD module) for high-ambient or loss-of-ventilation protection
<b>Phase loss/Phase reverse (current)</b>	46	Detects unhealthy supply conditions
<b>Overcurrent</b>	50, 51	Prevents catastrophic failures and fires; extends motor life
<b>Jam</b>		Prevents motor damage by detecting mechanical jams or excessive loading
<b>Undercurrent</b>	37	Detects low level or no-load conditions
<b>PTC overtemperature</b>	49	Overtemperature (PTC) protection for high-ambient or loss-of-ventilation detection
<b>Starts per hour</b>	66	Limits the motor starts per hour to prevent overheating
<b>Differential</b>	87	Optional MPS-DIF module for sensitive winding-fault protection
<b>Reduced overcurrent mode</b>		Minimizes arc-flash hazards during maintenance
<b>Metering</b>		View measured and calculated parameters with on-board display
<b>MPU-CIM</b>		Separate current input module to reduce risk of open-CT hazard and for convenient installation
<b>Analog output</b>		Provides means for metering selectable parameters
<b>Data logging</b>		On-board 100-event recorder for data logging
<b>Conformal coating</b>		Internal circuits are conformally coated to protect against corrosion and moisture

## Wiring Diagram



## Specifications

<b>Protective Functions (IEEE Device Numbers)</b>	Overload (49, 51) Phase reverse (current) (46) Overcurrent (50, 51) Jam Ground fault (50G/N, 51G/N) PTC overtemperature (49)	RTD temperature (38, 49) Unbalance (current) (46) Starts per hour (66) Differential (87) Phase loss (current) (46) Undercurrent (37)
<b>Input Voltage</b>	65-265 Vac, 25 VA; 80-275 Vdc, 25 W	
<b>Power-Up Time</b>	800 ms at 120 Vac	
<b>Ride-Through Time</b>	100 ms minimum	
<b>24-Vdc Source</b>	100 mA maximum	
<b>AC Measurements</b>	True RMS and DFT, Peak, 16 samples/cycle, and positive and negative sequence of fundamental 50, 60 Hz or ASD	
<b>Frequency</b>	50, 60 Hz or ASD	
<b>Output Contacts</b>	Three Form C programmables	
<b>Communications</b>	TIA-232 (standard); TIA-485, DeviceNet™, Ethernet (optional)	
<b>Analog Output</b>	4-20 mA, programmable	
<b>Conformally Coated</b>	Standard feature	
<b>Warranty</b>	10 years	
<b>Mounting (Control Unit)</b>	Panel (standard) Surface (with MPU-32-SMK converter kit)	
<b>(Current Input Module)</b>	DIN, Surface	
<b>Approvals</b>	CSA certified, CE (European Union), UL Recognized, C-Tick (Australian)	

# MPS SERIES (PGR-6300)

## Motor Protection System



### Description

The MPS Motor Protection System monitors voltage, current, and temperature to provide a comprehensive package of 22 protective functions. The MPS is a modular system with integrated protection, motor control, metering, and data-logging functions. This system is typically used to provide protection for three-phase low- and medium-voltage, medium- to high-horsepower induction motors.

#### 1 Operator Interface (MPS-OPI)

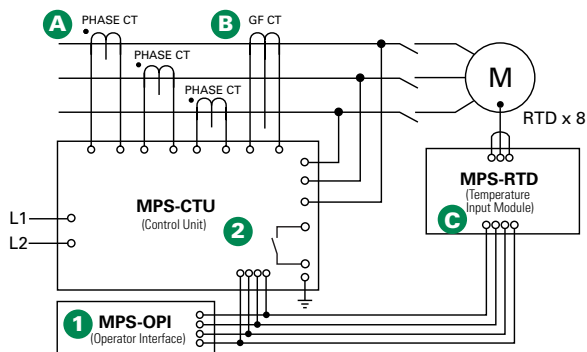
- Large, bright, 4 x 20 vacuum-fluorescent display
- Display metered values
- Access set points
- Powered by Control Unit
- Panel mount or attach directly to Control Unit
- Remote mounting (1.2 km or 4000 ft maximum loop length)
- ½ DIN size
- Hazardous-location certified

#### 2 Control Unit (MPS-CTU)

- Current inputs—5-A or 1-A secondary phase current transformers
- Voltage inputs—up to 600 V without PTs
- Earth-leakage input—5-A or 1-A secondary or sensitive transformer
- Tachometer (high-speed pulse) input
- 8 digital inputs, 5 relay outputs, 1 analog input and output
- 24-Vdc supply for OPI and RTD modules, and for digital inputs
- IRIG-B time-code input
- ½ DIN size, surface mount
- RS-485 network communications (Standard)
- DeviceNet™, Profibus®, or Ethernet communications available

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### Simplified Circuit Diagram



MOTOR & PUMP PROTECTION

### Ordering Information

ORDERING NUMBER	COMMUNICATIONS
MPS-CTU-01-00	RS-485
MPS-CTU-02-00	RS-485 & DeviceNet™
MPS-CTU-03-00	RS-485 & Profibus®
MPS-CTU-04-00	RS-485 & EtherNet/IP™ & Modbus® TCP

ACCESSORIES	REQUIREMENT
MPS-OPI-01-00	Recommended
Phase CTs	Required
Ground-Fault CT	Recommended
MPS-RTD-01-00	Optional
MPS-DIF-01-00	Optional
SE-IP65CVR-M	Optional

### Accessories

**A Phase Current Transformers**  
Phase CTs are required to detect phase currents.

**B Ground-Fault Current Transformer**  
Required zero-sequence current transformer detects ground-fault current. Available with 5-A and 30-A primary ratings for low-level pickup.

**C MPS-RTD Temperature Input Module**  
Optional module provides 8 inputs to connect Pt100, Ni100, Ni120, and Cu10 RTDs.

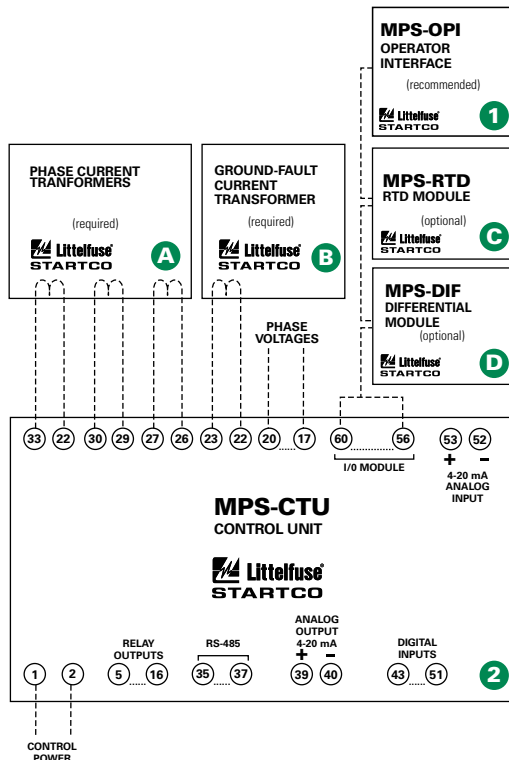
**D MPS-DIF Differential Current Module**  
Optional motor differential protection, compatible with core balance and summation current transformer connections.

# MPS SERIES (PGR-6300)

## Features & Benefits

FEATURES	IEEE #	BENEFITS
<b>Overload</b>	49, 51	Extends motor life and prevents insulation failures and fires
<b>Current unbalance/ Phase loss/Phase reverse</b>	46	Prevents overheating and extends motor life
<b>Overcurrent/Jam</b>	50, 51	Prevents catastrophic failures and fires and extends motor life
<b>Undercurrent</b>	37	Detects low-level or no-load conditions
<b>Ground fault</b>	50g/N, 51G/N	Prevents catastrophic failures and fires
<b>RTD temperature</b>	38, 49	Optional RTD temperature protection (MPS-RTD module) for high ambient or loss of ventilation protection
<b>Overvoltage</b>	59	Prevents stress to insulation
<b>Undervoltage</b>	27	Prevents a start attempt when it will damage the motor
<b>Voltage unbalance</b>	47	Detects unhealthy supply voltage
<b>Phase differential</b>	87	Provides sensitive protection for high-resistance winding faults
<b>Dynamic thermal mode</b>		Provides protection through starting, running, overload, and cooling cycles
<b>Reduced overcurrent mode</b>		Minimizes Arc-Flash hazards during maintenance
<b>Starter control</b>		Simplifies the installation by reducing component count
<b>Metering</b>		Displays the measured and calculated motor parameters
<b>Data logging</b>		On-board 64-event recorder helps with system diagnosis
<b>Communications</b>		Remotely view measured values, event records & reset trips
<b>Conformal coating</b>		Internal circuits are conformally coated to protect against corrosion and moisture

## Wiring Diagram



## Specifications

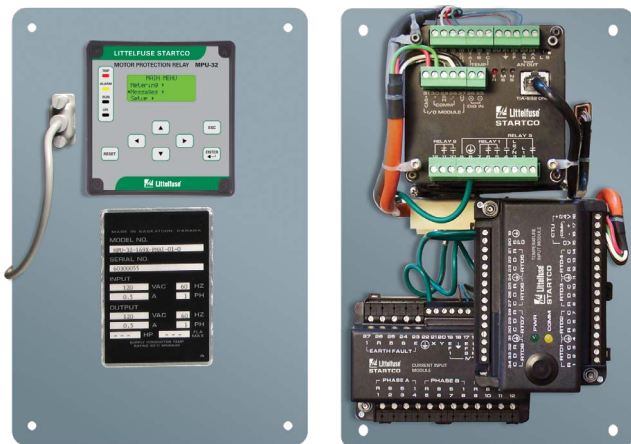
<b>Protective Functions (IEEE Device Numbers)</b>	Overload (49, 51)	Unbalance (current) (46)
	Phase reverse (current) (46)	Underspeed (14)
	Overfrequency (81)	Starts per hour (66)
	Overcurrent (50, 51)	Phase loss (voltage) (47)
	Jam	Overvoltage (59)
	Underfrequency (81)	Differential (87)
	Ground fault (50G/N, 51G/N)	Phase loss (current) (46)
	Undercurrent (37)	Undervoltage (27)
	Unbalance (voltage) (47)	Phase reverse (voltage) (47)
	Failure to accelerate	Power factor (55)
RTD temperature (38, 49)		
<b>Input Voltage</b>	65-265 Vac, 25 VA; 80-275 Vdc, 25 W	
<b>Power-Up Time</b>	800 ms at 120 Vac	
<b>Ride-Through Time</b>	100 ms minimum	
<b>24-Vdc Source</b>	100 mA maximum	
<b>AC Measurements</b>	True RMS and DFT, Peak, 16 samples/cycle, and positive and negative sequence of fundamental 50, 60 Hz or ASD	
<b>Frequency Inputs</b>	Phase current, Earth-leakage current, Phase voltage, 7 digital, tachometer, 1 analog	
<b>Output Contacts</b>	5 contacts — See Product Manual	
<b>Approvals</b>	CSA Certified, RCM (Australian), UL Recognized	
<b>Communications</b>	Allen-Bradley® DFI and Modbus® RTU (Standard); DeviceNet™, Profibus®, Ethernet (Optional)	
<b>Conformally Coated</b>	Standard feature	
<b>Warranty</b>	10 years	
<b>Mounting (Control Unit)</b>	Surface	
<b>(Operator Interface)</b>	Panel, Control-Unit mounted	



# MPU-32-X69X (PGR-6210) SERIES / MPS-469X (PGR-6310) SERIES

## Motor Protection Retrofit Kits

### 1 MPU-32-X69X



Front

Back

### 2 MPS-469X



Front

Back

## Description

Littelfuse Startco retrofit kits are an excellent choice for upgrading motor protection, providing current- and temperature-based protection, metering, and data logging.

### 1 MPU-32-X69X

The MPU-32-X69X Motor Protection Retrofit Kit is designed to replace GE Multilin 169, 269, and 369 relays. It includes the MPU-32 Motor Protection Relay, MPU-CIM Current Input Module, and optional MPS-RTD Temperature Input Modules, which are pre-wired on a panel. The kit fits in the existing space and typically can utilize existing current transformers and wiring to simplify the upgrade procedure.

### 2 MPS-469X

The MPS-469X Motor Protection Retrofit Kit replaces the GE Multilin 469 relay. It includes the MPS Motor Protection System and optional RTD and differential modules mounted on a panel that can be installed in the existing 469 cutout. Existing current transformer and wiring can be utilized, simplifying the upgrade procedure.

## Features & Benefits

FEATURES	BENEFITS
<b>Mounting</b>	Fits in existing mounting holes and panel openings
<b>Quick installation</b>	Existing CTs and RTDs can be used to reduce installation time
<b>Factory tested</b>	100% factory-tested, pre-assembled components ensure reliability
<b>Communications</b>	Add communications capability to older switchgear and improve system performance
<b>Microprocessor based</b>	No calibration required saves on maintenance cost
<b>Reduced overcurrent mode</b>	Maintenance mode setting to reduce the risk of Arc-Flash Hazards
<b>Conformal coating</b>	Protects circuit boards against corrosion and moisture
<b>Additional protection</b>	Additional protective functions, including dynamic thermal model and ability to match existing overcurrent curves

## MPU-32-X69X Ordering Information

	RTD INPUTS	MPU-32 COMMUNICATIONS	GROUND-FAULT CT	FUTURE OPTIONS
MPU-32-X69X	X	X	X	00
	0 = One Platinum 100 Ω	0 = TIA232	0 = Wired for Sensitive Ground-Fault CT (50 mA Secondary)	
	1 = One Platinum 100 Ω and 8-input MPS-RTD Module	1 = TIA232 & TIA485	1 = Wired for 1- or 5-A Secondary Ground-Fault CT	
		2 = TIA232 & DeviceNet		
		4 = TIA232 & Ethernet		

## MPS-469X Ordering Information

	MODULE CONFIGURATION	MPS COMMUNICATIONS	FUTURE OPTIONS
MPS-469X	X	X	000
	0 = None	1 = RS485	
	1 = One MPS-RTD Module	2 = RS485 & DeviceNet	
	2 = Two MPS-RTD Modules	3 = RS485 & Profibus	
	3 = One MPS-DIF Module	4 = RS485 & Ethernet	
	4 = One MPS-RTD Module and One MPS-DIF Module		

# 111-INSIDER-P / 231-INSIDER-P

## Single-Phase Pump Monitor



### Wiring Diagrams

See next page.

### Accessories



#### Informer

A hand-held diagnostic tool that uses an infrared receiver to access information which can be helpful for troubleshooting the system. Includes the Informer IR Kit-12



#### Informer IR Kit-12

12" infrared adapter cable attaches to the face of the unit to provide remote diagnostics without opening the panel. Included with the Informer

### Ordering Information

MODEL	VOLTAGE	DESCRIPTION
111-Insider-P	115VAC	1/3 - 1/2 hp, includes IR Kit-12
231-Insider-P	230VAC	1/3 - 1 hp, includes IR Kit-12

### Description

The Littelfuse 111-Insider-P single-phase products fit inside 1/3 and 1/2, 115V control boxes and the 231-Insider-P fits inside 1/3, 1/2, 3/4, and 1 hp, 230V control boxes. Both models are designed to protect single-phase pumps from dry-well, dead-head, jammed impeller, rapid-cycle, overvoltage, and undervoltage conditions.

A calibration adjustment allows the Insider to be calibrated to your specific pumping applications, thereby reducing the possibility of false or nuisance tripping. A unique microcontroller-based voltage and current-sensing circuit constantly monitors the incoming power for fluctuations, overcurrent, and undercurrent. When an abnormality, such as loss of suction is detected, the product deactivates its output relay and directly disconnects the pump motor. The unit then begins its user-selectable restart delay (dry-well recovery) timer. When the timer counts to zero or power is removed and reapplied, the unit reactivates its output relay and turns the pump back on. By leaving the restart delay knob in the reset position, the unit will operate in manual reset mode.

The Insider communicates with a hand-held diagnostics tool called the Informer (sold separately). The Informer displays parameters including calibration points, trip points, run time and last faults. An IR Kit-12 (12" fiber optic kit) is included with each Insider, allowing the Informer to access these parameters even when the Insider is enclosed in a control box. This is valuable for troubleshooting the pump while it is running.

NOTE: The 111/231-Insider-P models have a sensitivity adjustment for the dry-well trip point. After calibration is done, you can adjust the sensitivity for the dry-well/dead-head trip point from 70-90% of the full load. This makes the unit even more adaptable to varying pumping applications. If you have a very low producing well, you increase the sensitivity closer to the 90% mark, or if you have a very heavy producing well, you would decrease the sensitivity around the 70% mark.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage and current protects pumps from dry-well, dead-head, jammed impeller, rapid cycling, and voltage faults
<b>Onboard sensitivity adjustment</b>	Allows user to adjust the current sensitivity for the dry-well / dead-head trip point from 70% - 90% of the full load.
<b>Adjustable restart delay</b>	Allows user to select well recovery time delay after a dry-well condition occurs, or to select manual reset
<b>Built in IR communications link</b>	Used with the Informer, allows user to see stored faults, run time, and also troubleshoot the pump while it's running
<b>LED indication</b>	Provides status and diagnostics for troubleshooting



# 111-INSIDER-P / 231-INSIDER-P

## Specifications

### Functional Specifications

#### Adjustments/Settings

<b>Overcurrent</b>	125% of calibration point
<b>Underload (dry-well)</b>	Adjustable (70 to 90% of calibrated run power)
<b>Overvoltage</b>	
<b>111-Insider-P</b>	132.5VAC
<b>231-Insider-P</b>	265VAC
<b>Undervoltage</b>	
<b>111-Insider-P</b>	95VAC
<b>231-Insider-P</b>	190VAC
<b>Number of restarts allowed in a 60-sec. period (rapid-cycling)</b>	4
<b>Trip Delay Times</b>	
<b>Overcurrent</b>	5 seconds
<b>Dry-well</b>	4 seconds
<b>Restart Delay Times</b>	
<b>Over/Undervoltage</b>	2 seconds
<b>All other faults</b>	Manual, 2-225 minutes

### Input Characteristics

<b>Supply Voltage</b>	
<b>111-Insider-P</b>	115VAC
<b>231-Insider-P</b>	230VAC
<b>Load Range</b>	
<b>111-Insider-P</b>	1/3 – 1/2 hp
<b>231-Insider-P</b>	1/3 – 1 hp
<b>Frequency</b>	50*/60Hz

### Output Characteristics

<b>Output Contact Rating-SPST</b>	
<b>111-Insider-P</b>	1/2hp@120VAC (17 amps max.)
<b>231-Insider-P</b>	1hp@240VAC (17 amps max.)

### General Characteristics

<b>Operating Temperature</b>	-40° to 60° C (-40° to 140° F)
<b>Maximum Input Power</b>	5 W

### Safety Marks

**cUR\*\*** UL508, C22.2 No. 14

### Weight

10 oz.

**Mounting Methods** Inside a Pentek®, Franklin™, CentriPro™, Flint and Walling™, and Grundfos®\*\*\* control box

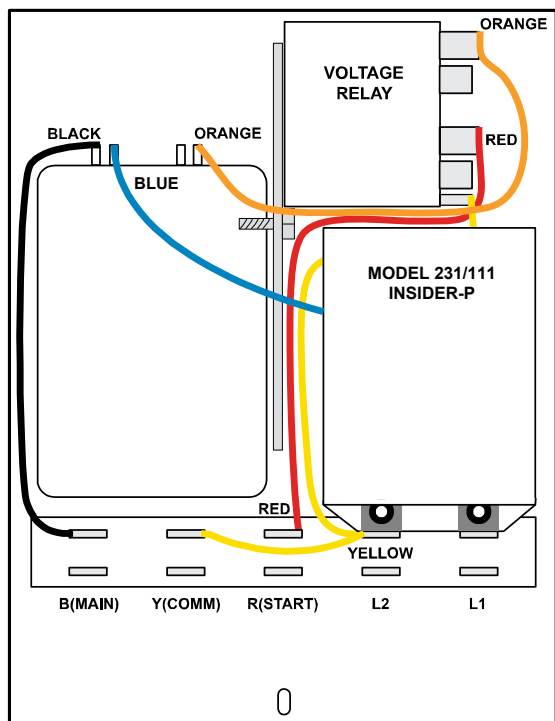
\*Note: 50Hz will increase all delay timers by 20%

\*\*The 111-Insider-P and 231-Insider-P are approved by UL for use in the Franklin™, Pentek®, and CentriPro™ type 3R control boxes when installed as described in the installation instructions. The 111-Insider-P and 231-Insider-P are not intended to provide overload protection, and should be used with thermally or impedance protected motors only.

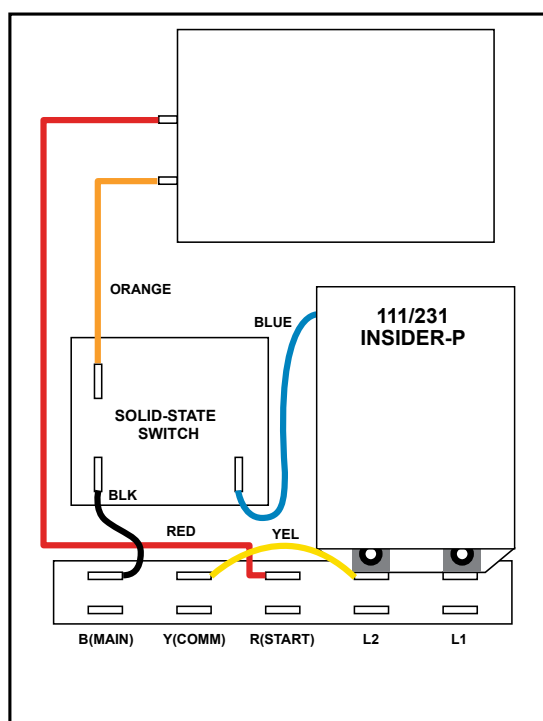
\*\*\*Grundfos control boxes manufactured after mid 2014.

## Wiring Diagrams

PENTEK® CONTROL BOX WIRING DIAGRAM

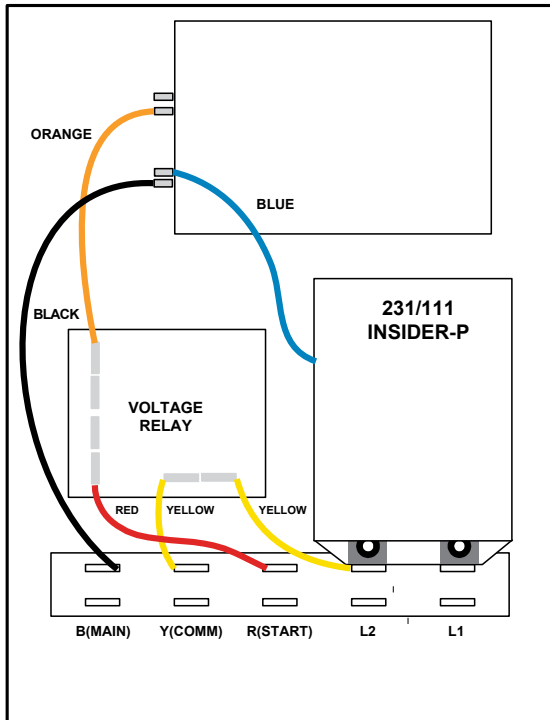


FRANKLIN™ CONTROL BOX WIRING DIAGRAM

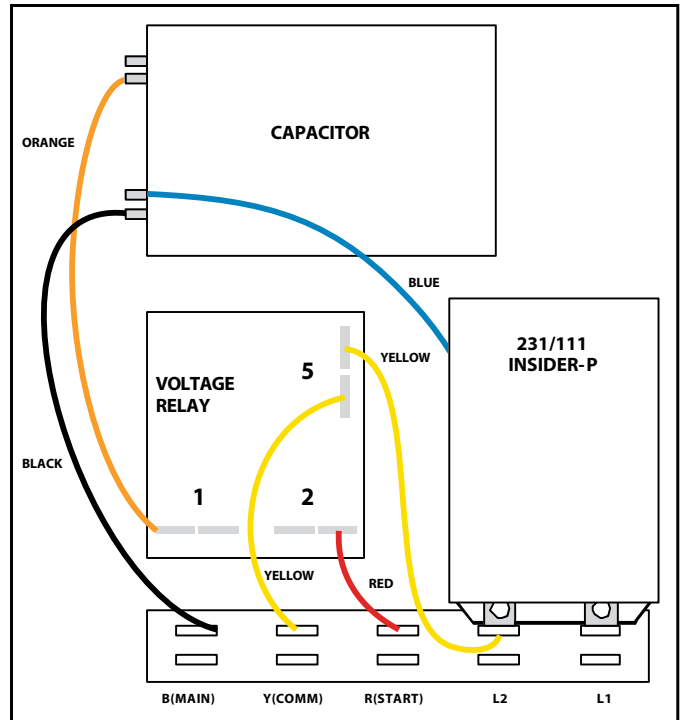


# 111-INSIDER-P / 231-INSIDER-P

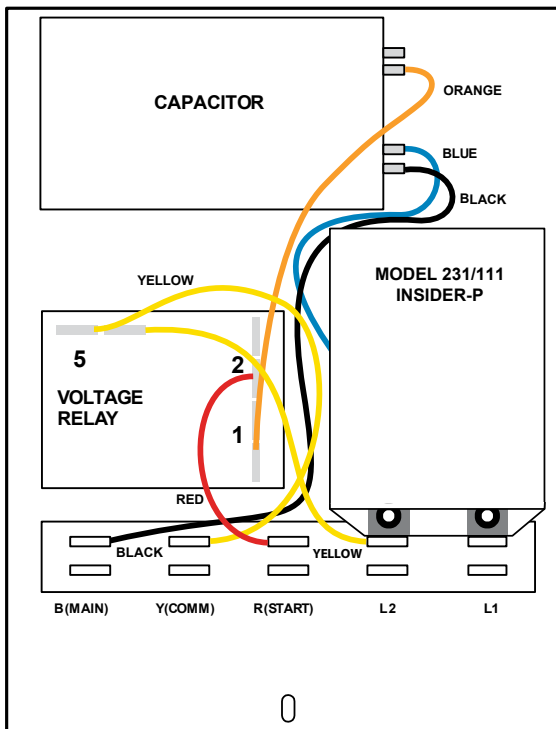
CENTRIPRO™ CONTROL BOX WIRING DIAGRAM



FLINT AND WALLING™ CONTROL BOX WIRING DIAGRAM



GRUNDFOS® CONTROL BOX\* WIRING DIAGRAM

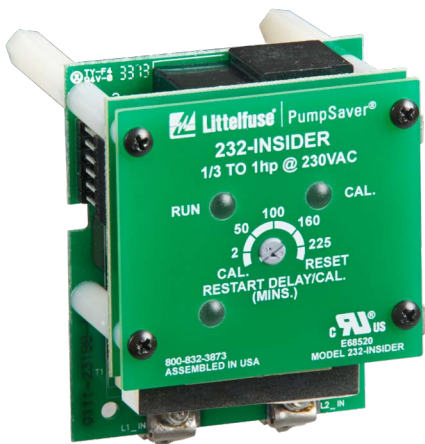


For installation instructions see the Fresh Water Pumping Catalog at [www.Littelfuse.com/PumpProtection](http://www.Littelfuse.com/PumpProtection)

\* For boxes manufactured in mid 2014 or later.  
See 232-INSIDER on next page for boxes manufactured prior to mid 2014.

# 232-INSIDER

## Single-Phase Pump Monitor



### Description

The Model 232-Insider single-phase PumpSaver® fits inside 1/3, 1/2, 3/4, and 1hp, 230V Grundfos control boxes manufactured prior to mid 2014. The PumpSaver® Model 232-Insider is a pump monitor designed to protect single-phase pumps from dry-well, dead-head, jammed impeller, overvoltage and undervoltage conditions. Typical applications include residential water wells, commercial water wells, irrigation wells, and golf course systems.

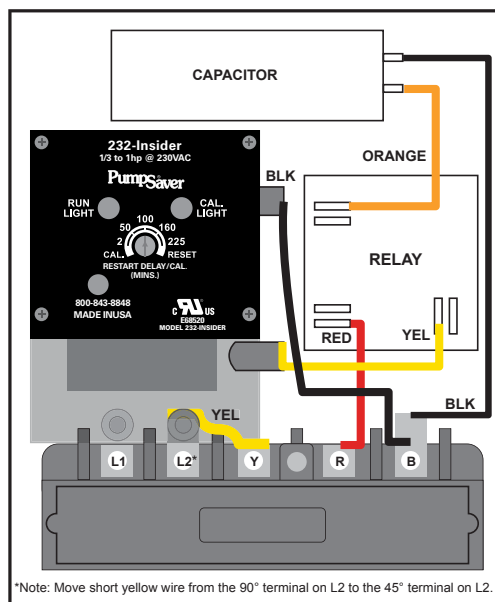
A calibration adjustment allows the 232-Insider to be calibrated to your specific pumping application, thereby reducing the possibility of false or nuisance tripping. A unique microcontroller-based voltage and current-sensing circuit constantly monitors the incoming power for fluctuations, overcurrent, and undercurrent. When an abnormality, such as loss of suction is detected, the 232-Insider deactivates its output relay and directly disconnects the pump motor. The 232-Insider then begins its user-selectable restart delay (dry-well recovery) timer. When the timer counts to zero or power is removed and reapplied, the 232-Insider reactivates its output relay and turns the pump back on. By leaving the restart delay knob in the reset position, the 232-Insider will operate in manual reset mode.

The Insider communicates with a hand-held diagnostics tool called the Informer (sold separately). The Informer displays parameters including calibration points, trip points, run time and last faults. This is valuable for troubleshooting the pump while it is running.

Note: The use of flow restrictors or unusually high head pressures at the time of calibration may interfere with the detection of dead-head conditions. Contact Littelfuse for information on a product to fit these applications.

### Wiring Diagram

232-INSIDER CONNECTIONS IN GRUNDFOS® CONTROL BOX



\*Note: Move short yellow wire from the 90° terminal on L2 to the 45° terminal on L2.

For installation instructions see the Install Bulletin.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage and current protects pumps from dry-well, dead-head, jammed impeller, and voltage faults
<b>Adjustable restart delay</b>	Allows user to select well recovery time delay after a dry-well condition occurs, or to select manual reset
<b>Built in IR communications link</b>	Used with the Informer, allows user to see stored faults, run time, and also troubleshoot the pump while it's running
<b>LED indication</b>	Provides status and diagnostics for troubleshooting

### Accessories



#### Informer

A hand-held diagnostic tool that uses an infrared receiver to access information which can be helpful for troubleshooting the system.

## 232-INSIDER

### Specifications

#### Functional

##### Adjustments/Settings

<b>Overcurrent</b>	125% of calibration point
<b>Underload (dry-well)</b>	Approx. 80% of calibration point
<b>Underload (dry well) with high sensitivity jumper removed</b>	Approx. 87% of calibration point
<b>Overvoltage</b>	265VAC
<b>Undervoltage</b>	190VAC
<b>Trip Delay Times</b>	
<b>Overcurrent</b>	5 seconds
<b>Dry-well</b>	4 seconds
<b>Restart Delay Times</b>	
<b>Over/undervoltage</b>	2 seconds
<b>All other faults (dry-well recovery timer)</b>	Manual, 2-225 minutes

#### Input Characteristics

<b>Supply Voltage</b>	230VAC
<b>Load Range</b>	1/3 – 1 hp
<b>Frequency</b>	50*/60Hz

#### Output Characteristics

<b>Output Contact Rating-SPST</b>	1hp@240VAC (17 amps max.)
-----------------------------------	---------------------------

#### General Characteristics

<b>Operating Temperature</b>	-40° to 60° C (-40° to 140° F)
<b>Maximum Input Power</b>	5 W

#### Safety Marks

<b>UL</b>	UL508
<b>CSA</b>	C22.2 No. 14
<b>Weight</b>	10 oz.

<b>Mounting Methods</b>	Grundfos <sup>®</sup> Control Box manufactured prior to mid 2014
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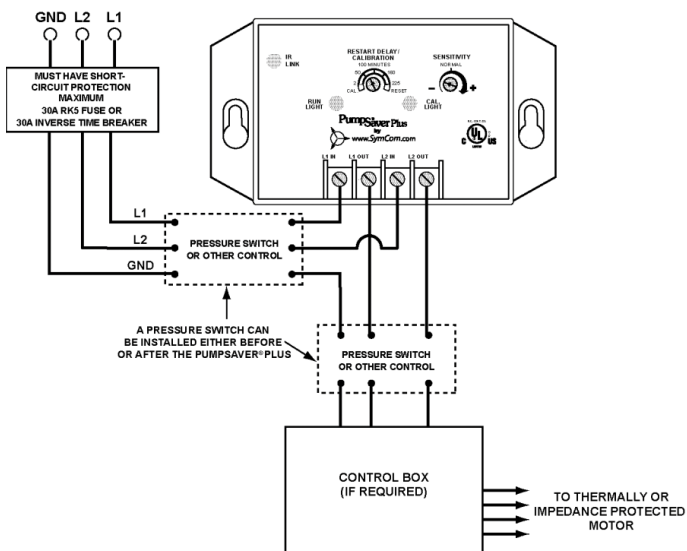
\*Note: 50 Hz will increase all delay timers by 20%

# 111P / 233P / 233P-1.5 SERIES

## Single-Phase PumpSaver®



### Wiring Diagram



For dimensional drawing see: Appendix page 511, Figure 15.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
111P	115VAC	Load Range: 1/3 - 1hp
111P-ENCL	115VAC	111P with NEMA3R enclosure
233P	230VAC	Load Range: 1/3 - 3hp
233P-ENCL	230VAC	233P with NEMA3R enclosure
233P-1.5	230VAC	Load Range: 1/3 - 1.5hp
233P-1.5-ENCL	230VAC	233P-1.5 with NEMA3R enclosure

### Description

The Littelfuse Models 111P (115 volt, 1/3 to 1hp); 233P-1.5 (230 volt, 1/3 to 1.5hp); and 233P (230 volt, 1/3 to 3hp) protect pumps from dry-well, dead-head, jammed impeller, overvoltage/undervoltage conditions and now rapid-cycle protection whether the pressure switch is mounted before or after our unit.

A calibration adjustment allows the unit to be calibrated to your specific pumping applications, thereby reducing the possibility of false or nuisance tripping. A unique microcontroller-based voltage and current-sensing circuit constantly monitors the incoming power for fluctuations, overcurrent, and undercurrent. When an abnormality, such as loss of suction is detected, the unit deactivates its output relay and directly disconnects the pump motor. The unit then begins its user-selectable restart delay (dry-well recovery) timer. When the timer counts to zero or power is removed and reapplied, the unit reactivates its output relay and turns the pump back on.

The infrared LED communicates with a hand-held diagnostics tool called the Informer (sold separately). The Informer displays parameters including calibration points, trip points, run time and last faults.

#### Special considerations for pump cables larger than #10 AWG:

In some cases where larger motors are installed with deep set pumps, pump cables are used that exceed the relay's terminal size. In these conditions, a short splice of #10 AWG or #12 AWG may be a solution at the control box. **Note:** All local, state and national electric codes should be followed when applying this solution.

**NOTE:** The 111P/233P/233P-1.5 models have a sensitivity adjustment for the dry-well trip point. After calibration is done, you can adjust the sensitivity for the dry-well/dead-head trip point from 70-90% of the full load. This makes the unit even more adaptable to varying pumping applications. If you have a very low producing well, you increase the sensitivity closer to the 90% mark, or if you have a very heavy producing well, you would decrease the sensitivity around the 70% mark.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage, power factor, current for reliable pump protection
<b>Onboard calibration process</b>	Calibrates unit to your specific individual pumping application and reduces nuisance tripping
<b>Onboard sensitivity adjustment</b>	User adjustable sensitivity knob makes the unit more adaptable to varying pumping applications

### Accessories



#### Informer

A hand-held diagnostic tool that uses an infrared receiver to access information which can be helpful for troubleshooting the system.

MOTOR & PUMP PROTECTION

7

# 111P / 233P / 233P-1.5 SERIES

## Specifications

### Functional Specifications

#### Adjustments/Settings

<b>Overcurrent</b>	125% of calibration point
<b>Underload (dry-well)</b>	Adjustable (70 to 90% of calibrated run power)
<b>Overvoltage</b>	
<b>111P</b>	132.5VAC
<b>233P, 233P-1.5</b>	265VAC
<b>Undervoltage</b>	
<b>111P</b>	95VAC
<b>233P, 233P-1.5</b>	190VAC
<b>Number of restarts allowed in a 60-sec. period (rapid-cycling)</b>	4
<b>Trip Delay Times</b>	
<b>Overcurrent</b>	5 seconds
<b>Dry-well</b>	4 seconds
<b>Restart Delay Times</b>	
<b>Over/undervoltage</b>	2 seconds
<b>All other faults</b>	Manual, 2-225 Minutes

### Input Characteristics

#### Supply Voltage

<b>111P</b>	115VAC
<b>233P-1.5, 233P</b>	230VAC
<b>Load Range:</b>	
<b>111P</b>	1/3 – 1 hp
<b>233P-1.5</b>	1/3 – 1.5 hp
<b>233P</b>	1/3 – 3 hp
<b>Frequency</b>	50*/60Hz

### Output Characteristics

#### Output Contact Rating-SPST

<b>111P</b>	1hp@120VAC (16 amps max.)
<b>233P-1.5</b>	1.5hp@240VAC (10 amps max.)
<b>233P</b>	3hp@240VAC (17 amps max.)

### General Characteristics

#### Operating Temperature

-40° to 60° C (-40° to 140° F)

#### Maximum Input Power

5 W

#### Wire Gauge

Solid or Stranded 10 - 22AWG

#### Terminal Torque

13 in.-lbs.

#### Safety Marks

#### cUL Listed

UL508, C22.2 No. 14

#### Dimensions

**H** 73.66 mm (2.9"); **W** 133.35 mm (5.25");

**D** 73.99 mm (2.913")

14 oz.

#### Weight

#### Mounting Methods

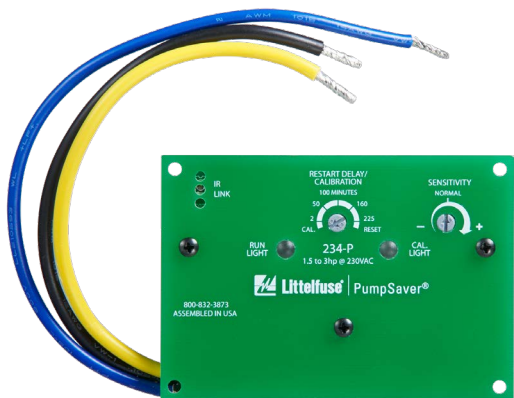
#8 screws

\*Note: 50Hz will increase all delay timers by 20%



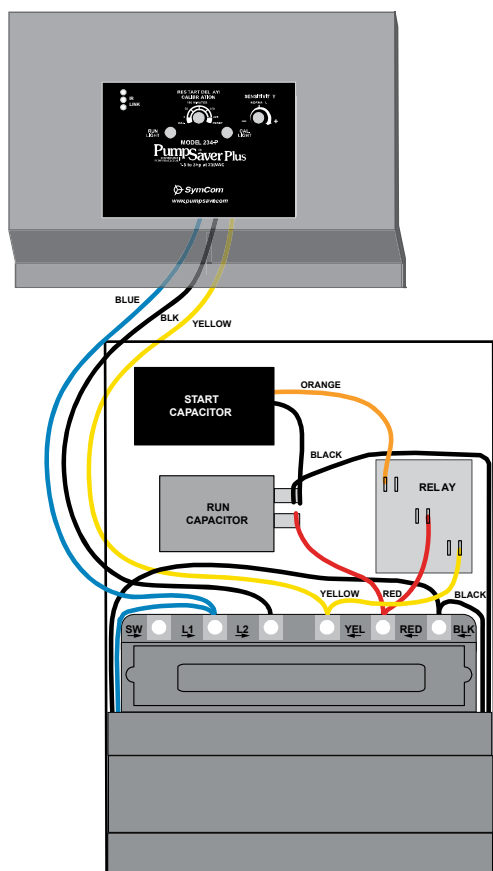
# 234-P

## Single-Phase Pump Monitor



### Wiring Diagram

234-P CONNECTIONS IN GRUNDFOS® CONTROL BOX



For installation instructions see the Install Bulletin.

### Description

The PumpSaver® Model 234-P is designed to be mounted inside a Grundfos® control box to protect 1/3 – 3hp, 2- or 3-wire, 230V pumps.

The Model 234-P protects single-phase pumps from dry-well, dead-head, rapid-cycle, jammed-impeller, and over/undervoltage conditions. Typical applications include residential waterwells, commercial waterwells, irrigation wells, and golf course and other sprinkler systems.

A calibration adjustment allows the 234-P to be calibrated to your specific pumping applications, thereby reducing the possibility of false or nuisance tripping. A unique microcontroller-based voltage and current-sensing circuit constantly monitors the incoming power for fluctuations, overcurrent, and undercurrent. When an abnormality, such as loss of suction is detected, the 234-P deactivates its output relay and directly disconnects the pump motor. The 234-P then begins its user-selectable restart delay (dry-well recovery) timer. When the timer counts to zero or power is removed and reapplied, the 234-P reactivates its output relay and turns the pump back on. By leaving the restart delay knob in the reset position, the 234-P will operate in manual reset mode.

The 234-P communicates with a hand-held diagnostics tool called the Informer (sold separately). The Informer displays parameters including calibration points, trip points, run time and last faults. An IR Kit-12 (12" fiber optic kit) allows the Informer to access these parameters even when the 234-P is enclosed in a control box. This is valuable for troubleshooting the pump while it is running.

**NOTE:** The PumpSaver® models have a sensitivity adjustment for the dry-well trip point. After calibration is done, you can adjust the sensitivity for the dry-well/dead-head trip point from 70-90% of the full load. This makes the unit even more adaptable to varying pumping applications. If you have a very low producing well, you increase the sensitivity closer to the 90% mark, or if you have a very heavy producing well, you would decrease the sensitivity around the 70% mark.

The Model 234-P is not recommended for use with the Grundfos® Deluxe Control Box.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage and current protects pumps from dry-well, dead-head, jammed impeller, rapid cycling, and voltage faults
<b>Onboard sensitivity adjustment</b>	Allows user to adjust the current sensitivity for the dry-well / dead-head trip point from 70% - 90% of the full load.
<b>Adjustable restart delay</b>	Allows user to select well recovery time delay after a dry-well condition occurs, or to select manual reset
<b>Built in IR communications link</b>	Used with the Informer, allows user to see stored faults, run time, and also troubleshoot the pump while it's running
<b>LED indication</b>	Provides status and diagnostics for troubleshooting

## 234-P

### Accessories



#### Informer

A hand-held diagnostic tool that uses an infrared receiver to access information which can be helpful for troubleshooting the system. Includes the Informer IR Kit-12



#### Informer IR Kit-12

12" infrared adapter cable attaches to the face of the unit to provide remote diagnostics without opening the panel. Included with the Informer

### Specifications

#### Functional Specifications

##### Adjustments/Settings

<b>Overcurrent</b>	125% of calibration point
<b>Underload (dry-well)</b>	Adjustable (70 - 90% of calibrated run power)
<b>Overvoltage</b>	265VAC
<b>Undervoltage</b>	190VAC

##### Number of restarts allowed in a 60-second period (rapid-cycling)

4

##### Trip Delay Times

<b>Overcurrent</b>	5 seconds
<b>Dry-well</b>	4 seconds

##### Restart Delay Times

<b>Over/undervoltage</b>	2 seconds
--------------------------	-----------

##### All other faults (dry-well recovery timer)

Manual, 2-225 Minutes

#### Input Characteristics

<b>Supply Voltage</b>	230VAC
<b>Load Range</b>	1/3 - 3 hp
<b>Frequency</b>	50*/60Hz

#### Output Characteristics

<b>Output Contact Rating (SPST)</b>	3 hp @ 240VAC (17 amps max.)
-------------------------------------	------------------------------

#### General Characteristics

<b>Operating Temperature</b>	-40° to 60° C (-40° to 140° F)
<b>Maximum Input Power</b>	5W
<b>Dimensions</b>	Fitted to Grundfos <sup>®</sup> Control Box
<b>Weight</b>	14 oz.
<b>Mounting Methods</b>	Grundfos <sup>®</sup> Control Box

#### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 2, 4kV contact, 6kV air
--------------------------------------	--

\*Note: 50 Hz will increase all delay timers by 20%

# 235P

## Single-Phase Pump Monitor



### Description

The Littelfuse 235P is designed to protect 5-15hp, 230V, single-phase pumps from dry-well, dead-head, jammed impeller and overvoltage and undervoltage conditions.

A calibration adjustment allows the 235P to be calibrated to your specific pumping applications, thereby reducing the possibility of false or nuisance tripping. A unique microcontroller-based voltage and current-sensing circuit constantly monitors the incoming power for fluctuations causing overcurrent and undercurrent. When an abnormality, such as loss of suction is detected, the 235P deactivates its output relay and directly disconnects the pump motor. The unit then begins its user-selectable restart delay (dry-well recovery) timer. When the timer counts to zero or power is removed and reapplied, the unit reactivates its output relay and turns the pump back on.

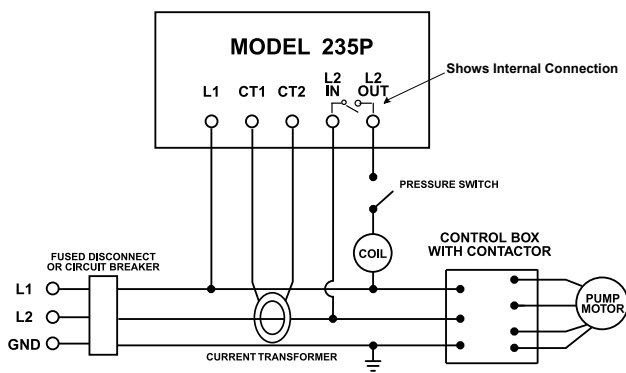
The 235P communicates with a hand-held diagnostics tool called the Informer (sold separately). The Informer displays parameters including calibration points, trip points, run time and last faults.

An external current transformer is required for operation (sold separately).

**Special considerations for pump cables larger than #10 AWG:** In some cases where larger motors are installed with deep set pumps, pump cables are used that exceed the relay's terminal size. In these conditions, a short splice of #10 AWG or #12 AWG may be a solution at the control box. **Note:** All local, state and national electric codes should be followed when applying this solution.

**NOTE:** The 235P model has a sensitivity adjustment for the dry-well trip point. After calibration is done, you can adjust the sensitivity for the dry-well/dead-head trip point from 70-90% of the full load. This makes the unit even more adaptable to varying pumping applications. If you have a very low producing well, you increase the sensitivity closer to the 90% mark, or if you have a very heavy producing well, you would decrease the sensitivity around the 70% mark.

### Wiring Diagram



For dimensional drawing see: Appendix page 511, Figure 15.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
235P	230VAC	5 - 15hp
235P-ENCL	230VAC	233P with NEMA3R enclosure

PART*	SIZE	CURRENT (A)	CT CURRENT RATIO
CT-0050-D10	5 - 7.5hp	27.5 - 42.1	50:5
CT-0075-D10	10hp	51	75:5
CT-0100-D10	15hp	75	100:5

\* Current transformer sold separately

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage and current protects pumps from dry-well, dead-head, jammed impeller, rapid cycling, and voltage faults
<b>Onboard sensitivity adjustment</b>	Allows user to adjust the current sensitivity for the dry-well / dead-head trip point from 70% - 90% of the full load.
<b>Adjustable restart delay</b>	Allows user to select well recovery time delay after a dry-well condition occurs, or to select manual reset
<b>Built in IR communications link</b>	Used with the Informer, allows user to see stored faults, run time, and also troubleshoot the pump while it's running
<b>LED indication</b>	Provides status and diagnostics for troubleshooting

# 235P

## Accessories



### Informer

A hand-held diagnostic tool that uses an infrared receiver to access information which can be helpful for troubleshooting the system. Includes the Informer IR Kit-12

## Specifications

### Functional Specifications

#### Adjustments/Settings

<b>Overcurrent</b>	125% of calibration point
<b>Underload (dry-well)</b>	Adjustable (70 to 90% of calibrated run power)
<b>Overvoltage</b>	265VAC
<b>Undervoltage</b>	190VAC
<b>Number of restarts allowed in a 60-sec. period (rapid-cycling)</b>	4
<b>Trip Delay Times</b>	
<b>Overcurrent</b>	5 seconds
<b>Dry-well</b>	4 seconds
<b>Restart Delay Times</b>	
<b>Over/undervoltage</b>	2 seconds
<b>All other faults</b>	Manual, 2-225 Minutes

### Input Characteristics

<b>Supply Voltage</b>	230VAC
<b>Load Range</b>	5 - 15 hp
<b>Frequency</b>	50*/60Hz

### Output Characteristics

<b>Output Contact Rating-SPST</b>	A300, 720A @240VAC (10 amps max.)
-----------------------------------	-----------------------------------

### General Characteristics

<b>Operating Temperature</b>	-40° to 60° C (-40° to 140° F)
<b>Maximum Input Power</b>	5 W
<b>Wire Gauge</b>	Solid or Stranded 10 - 22AWG
<b>Terminal Torque</b>	13 in.-lbs.

### Safety Marks

<b>cUL Listed</b>	UL508, C22.2 No. 14
<b>Dimensions</b>	<b>H</b> 73.66 mm (2.9"); <b>W</b> 133.35 mm (5.25"); <b>D</b> 73.99 mm (2.913")

### Weight

<b>Mounting Methods</b>	14 oz. #8 screws
-------------------------	---------------------

\*Note: 50Hz will increase all delay timers by 20%

### Dimensions

<b>Weight</b>	14 oz.
<b>Mounting Methods</b>	#8 screws

### Weight

<b>Mounting Methods</b>	#8 screws
-------------------------	-----------

# MP8000

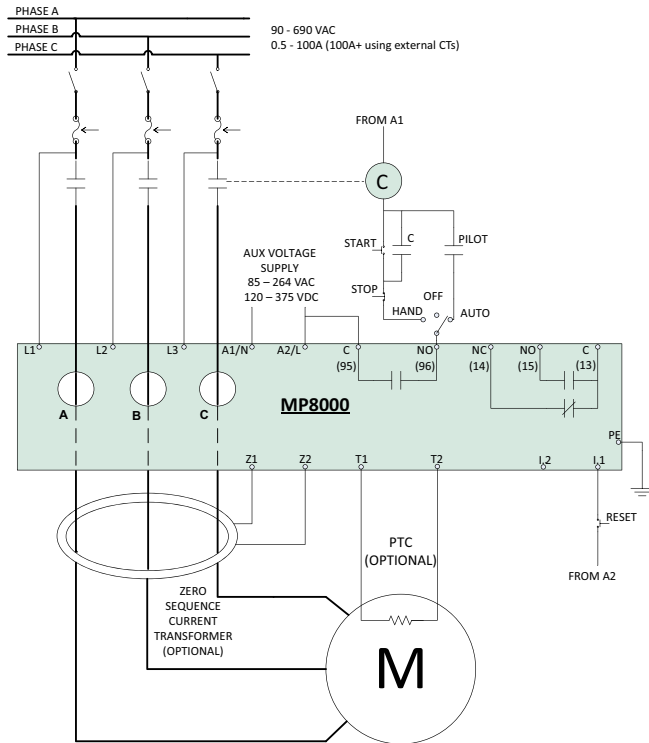
## Bluetooth Overload Relay



Patent Pending

### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR 3-PHASE



For dimensional drawing see: Appendix page 516, Figure 50.

### Description

The MP8000 is an advanced motor protection electronic overload relay that is fully programmable via Bluetooth\* using the Littelfuse app on an Android\* or iPhone\* mobile device. It is easy to use and arc-flash safety is increased because the app allows settings to be modified and real-time operational information viewed. Viewing operational information and faults on the app does not require the user to open the control panel.

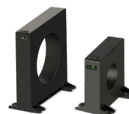
The MP8000 protects any motor drawing 0.5-1,000 full load Amps (external CTs are required above 100 amperes). It is designed for single or 3-phase systems with operating voltages of 90-690 VAC (use of external potential transformers can extend upper voltage range above 690 VAC). Common applications include conveyor systems, HVAC equipment, saws and grinders, fan motors, and almost any pumping application.

Protection is unsurpassed by combining overload, voltage, phase loss and reversal, voltage and current unbalance, power monitoring, and underload in one package. For standalone applications, the Bluetooth interface can be used when paired with a smartphone or tablet. The units also feature an Ethernet communications port that can be used to form an Ethernet Modbus TCP/IP network or Ethernet/IP. Units can be remotely monitored and controlled from a PC, or SCADA system, and data logging through a PC with the optional Solutions software or other software program using the MP8000 memory map. This capability allows for a simple cost-effective way to further enhance arc-flash safety.

### Features & Benefits

FEATURES	BENEFITS
<b>Bluetooth interface</b>	Visual indication for programming, viewing real-time voltage or current, and last fault information (date and time stamped)
<b>Programmable voltage and current settings</b>	Allows usage on wide range of systems
<b>3 selectable restart options</b>	Choose from automatic, semi-automatic, or manual to best meet individual application needs
<b>4 programmable delay timers</b>	Program separate delay times for power up, rapid cycle protection, motor cool down, and underload restarting
<b>Flexible reset</b>	Reset can be done through pushbutton on panel, remotely via the network
<b>Network communications capability</b>	Compatible with Ethernet Modbus TCP/IP and Ethernet/IP

### Accessories



#### ZSCT Series Current Transformer

Used with Littelfuse relays to detect low levels of earth-leakage current.

### Ordering Information

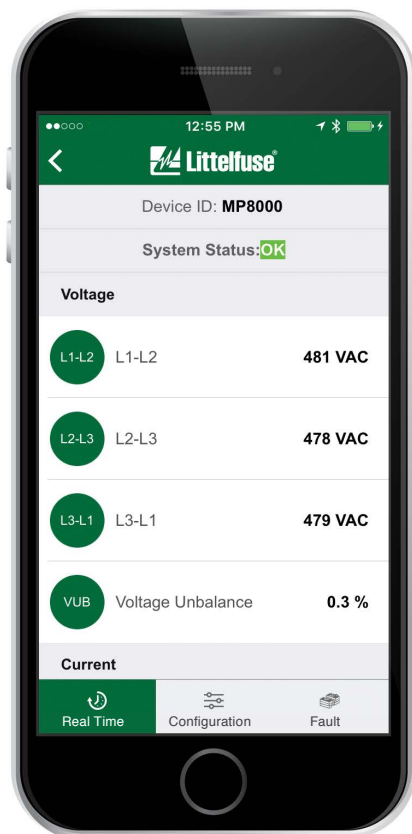
MODEL	LINE VOLTAGE	MOTOR FULL AMP RANGE	DESCRIPTION
MP8000	90-690VAC (use of external potential transformers can extend upper voltage range above 690VAC)	0.5-1,000A+ (external CTs required above 100A)	Provides remote wired communication via Ethernet Modbus TCP/IP

# MP8000

## Advanced Features

- Overload/Overpower (49)
- Underload/Underpower (37P)
- Overcurrent (51)/Jam
- Undercurrent (37)
- Current Unbalance/Phase Loss (46)
- Phase Reversal (47)
- Overvoltage (59)
- Undervoltage (27)
- Voltage Unbalance (47)
- Rapid Cycling/Jog
- Contactor Failure
- Zero-Sequence Ground Fault (50Ns)
- PTC Motor Overtemperature (49)

## Littelfuse Mobile App



## Specifications

### Functional Characteristics

**Frequency** 50/60Hz  
**TC- Overcurrent Trip Class** Trip class 02-60 or linear

### Output Characteristics

**Output Contact Rating**  
**Control relay** SPST - Form A  
**Auxiliary relay** SPDT - Form C  
**Pilot Duty Rating** B300  
**General Purpose** 5A @ 240VAC

### General Characteristics

**Ambient Temperature Range**  
**Operating** -40° to 70°C (-40° to 158°F)  
**Storage** -40° to 85°C (-40° to 185°F)

### Accuracy

**Voltage** ±1% of reading ±0.5 V  
**Current** ±2% (2 to 100 amperes direct)  
**Timing** +/-0.5% of setting +/- 1second  
**GF Current** ±5%

### Repeatability

**Voltage** ±0.5%  
**Current** ±1% (2 to 100 amps direct)  
**Power Consumption** <5 W  
**Pollution Degree** 3 (conformal coating standard)  
**Class of Protection** IP20  
**Relative Humidity** 10-95%, non-condensing per IEC 68-2-3  
**Terminal Torque (depluggable terminal blocks)** 5.5 in.-lbs.  
**Terminal Torque (Earth Ground)** 7.9 in.-lbs.

### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air  
**Radio Frequency Immunity (RFI), Conducted** IEC 61000-4-6, Level 3 10V/m  
**Radio Frequency Immunity (RFI), Radiated** IEC 61000-4-3, Level 3 10V/m  
**Fast Transient Burst Surge** IEC 61000-4-4, Level 3, 3.5kV input power  
 IEC 61000-4-5, Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground  
**FCC Rating** Part 15.107 for emissions, Part 15.247 for intentional radiators

### Short Circuit Withstand Rating

100kA symmetrical at 690VAC  
 Meets UL508 (2 x rated V +1000V for 1 minute)

### Hi-Potential Test

**Safety Marks**  
**cULus** UL60947, UL1053, C22.2 (File #E68520)  
**CE** IEC 60947 Edition 5.2, IEC 60947-8

### Maximum Conductor Size (with insulation)

0.63"  
**H** 74.42 mm (2.93"); **W** 103.63 mm (4.08");  
**D** 121.67 mm (4.79")

**Weight** 0.85 lbs (13.6 oz, 385.6 g)  
**Mounting Method** Surface mount (4 - #8 screws) or DIN-rail mount



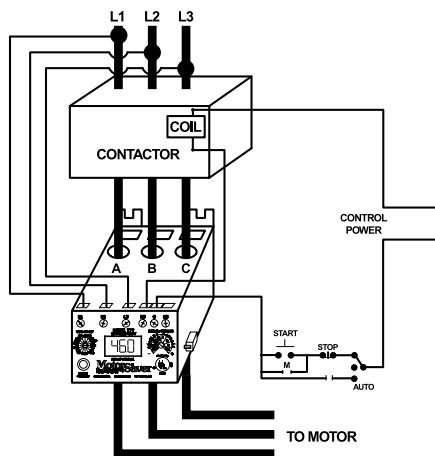
# 777 SERIES

## 3-Phase Current & Voltage Monitor

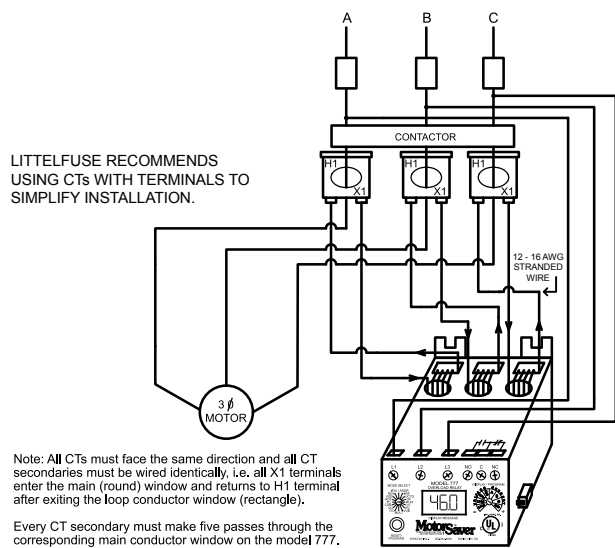


### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR MODEL 777 (2 to 90 amps)



CURRENT TRANSFORMER WIRING DIAGRAM FOR MODEL 777 (80 to 800 amps)



Note: All CTs must face the same direction and all CT secondaries must be wired identically, i.e. all X1 terminals enter the main (round) window and returns to H1 terminal after exiting the loop conductor window (rectangle).

Every CT secondary must make five passes through the corresponding main conductor window on the model 777.

Every CT secondary must make a single pass through the corresponding main conductor window on the LR versions of the 777 Plus Series.

### Description

The 777 is a fully programmable electronic overload relay designed to protect any motor drawing 2-800 full load amps (external CTs are required above 90 amps). The 777 (family of products) is for 3-phase 200-480VAC applications, with several specialized units for other voltage ranges and unique applications. Common applications include conveyor systems, HVAC equipment, saws and grinders, fan motors, and almost any pumping application. Some unique applications include use with a Subtrol® equipped Franklin submersible motor to detect high motor temperatures and applications where a fast linear trip is required.

All of the overload relays provide unsurpassed protection by combining overload, voltage, phase loss and reversal, voltage and current unbalance, power monitoring, and underload based on current in one package. For standalone applications, the units incorporate a 3-digit LED display that is used for programming, providing real-time operational information and displaying diagnostic codes to aid in troubleshooting a fault condition. The units also feature a communications port that can be used with communication modules listed in the 777 accessories section to form a Modbus, DeviceNet™, Profibus, or Ethernet network. Up to 99 units can be remotely monitored and controlled from a PC, PLC, or SCADA system, and data logging through a PC with the optional Solutions software. This capability allows for a simple, cost-effective way to meet new requirements for arc-flash safety.

### Features & Benefits

FEATURES	BENEFITS
<b>Built-in display</b>	Visual indication for programming, viewing real-time voltage or current, and last fault code
<b>Programmable voltage and current settings</b>	Allows usage on wide range of systems
<b>3 selectable restart options</b>	Choose from automatic, semi-automatic, or manual to best meet individual application needs
<b>3 programmable restart delay timers</b>	Program separate restart delay time for rapid cycle protection, motor cool down, and dry-well recovery
<b>Remote display compatibility</b>	Increases safety through remote display of real-time data and fault history, without the need to open the cabinet. Aids with arc flash safety regulations
<b>Flexible reset</b>	Reset can be done through pushbutton on relay or remotely with optional 777-MRSW or OL-RESET remote reset kit
<b>Network communications capability</b>	Compatible with Modbus, DeviceNet™, Profibus, or Ethernet using optional communications module

### Ordering Information

See next page.



## 777 SERIES

### Ordering Information

MODEL	LINE VOLTAGE	MOTOR FULL AMP RANGE	DESCRIPTION
777-P2	200-480VAC	2-800A (external CTs required above 90A)	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts
777-LR-P2	200-480VAC	1-800A (external CTs required above 9A)	Protects low range motors when wired directly or with 10-800 FLA with use of external CTs
777-HVR-P2	340-480VAC	2-800A (external CTs required above 90A)	Provides low and high power trip*, linear overcurrent trip, and 470VA @ 600VAC output SPDT relay contacts. Required when a control power transformer (CPT) is not used with a 480V system
777-HVR-LR-P2	340-480VAC	1-800A (external CTs required above 9A)	Provides low and high power trip*, linear overcurrent trip, and 470VA @ 600VAC output SPDT relay contacts. Required when a control power transformer (CPT) is not used with a 480V system
777-575-P2	500-600VAC	2-800A (external CTs required above 90A)	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. Used in Canada and NE USA where 575V utility power services are common
777-575-LR-P2	500-600VAC	1-800A (external CTs required above 9A)	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. Used in Canada and NE USA where 575V utility power services are common
777-MV-P2	100-240VAC	10-800A with external CTs	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. Designed for Medium Voltage applications where both PTs and CTs are used. Has built in multipliers for 25.5, 50.5, 100.5 CTs. The voltage unbalance, single-phase and reverse phase protection can be disabled for applications where only the PTs are used
777-HRG-P2	200-480VAC	2-90A only	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. Designed for high resistance grounding systems that incorporate an external zero-sequence CT that correspond with the built in multipliers to detect ground faults
777-LR-HRG-P2	200-480VAC	10-800A (external CTs required, external)	Overload relays designed for high resistance grounding systems that incorporate an external zero-sequence CTs that correspond with the built in multipliers to detect ground faults
777-575-HRG-P2	500-600VAC	2-90A only	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. Used in Canada and NE USA where 575V utility power services are common. Designed for high resistance grounding systems that incorporate an external zero-sequence CT that correspond with the built in multipliers to detect ground faults
777-575-LR-HRG-P2	500-600VAC	10-800A with external CTs	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. Used in Canada and NE USA where 575V utility power services are common. Designed for high resistance grounding systems that incorporate an external zero-sequence CT that correspond with the built in multipliers to detect ground faults
777-FT	200-480VAC	2-800A (external CTs required above 90A)	Provides linear overcurrent trip and 480VA @ 240VAC output SPDT relay contacts. Also known as shock relay, it is designed for fast linear trip applications. Overcurrent trip delay can be set ranging from less than 500ms - 70 seconds. Low trip delay is ideal in chain drive and drive linkage applications to prevent breaking in overload or jam situations. Other applications include sewage clarifiers, mixers, augers, and conveyors. Longer trip delay is ideal for motor test panels in rewind shops. Also includes adjustable motor acceleration time and overcurrent trip delay time when the faster linear trip mode is used
777-TS	200-480VAC	2-800A (external CTs required above 90A)	Provides 480VA @ 240VAC output SPDT relay contacts. For use with Subtrol® equipped Franklin submersible motors to detect high motor temperatures
777-LR-TS	200-480VAC	1-9A only	Provides 480VA @ 240VAC output SPDT relay contacts. For use with Subtrol® equipped Franklin submersible motors to detect high motor temperatures
777-575-TS	500-600VAC	2-800A (external CTs required above 90A)	Provides 480VA @ 240VAC output SPDT relay contacts. For use with Subtrol® equipped Franklin submersible motors with nominal 500-600VAC range to detect high motor temperatures
777VA-02	200-480VAC	2-800A (external CTs required above 90A)	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. Has restart delay 1 setpoints of 2-500 minutes and undercurrent trip delay setpoints of 2-60 minutes.
777VA-03	200-480VAC	2-800A (external CTs required above 90A)	Provides low and high power trip*, linear overcurrent trip, and 480VA @ 240VAC output SPDT relay contacts. For use with static and rotary single to 3-phase converters. High and low voltage trip feature only applies to the utility supplied power. Works well with unloaded phase converters because the relay ignores severely unbalanced voltages

\* Network programmable only

### 777 SERIES

#### Accessories



**RS485MS-2W Communication Module**  
Required to enable the Modbus communications function on Model 77X-type products.



**CIO-MB/CIO-120-MB Communication Module**  
Modbus-RTU interfaces capable of providing discrete control and monitoring of an overload relay over a Modbus network.



**CIO-DN-P/CIO-120-DN-P Communication Module**  
DeviceNet™ interfaces capable of providing discrete control and monitoring of motor starters, drives and other devices over a DeviceNet™ network.



**CIO-777-PR Communication Module**  
Profibus interface capable of providing discrete control and monitoring of motor starters, drives and other devices over a Profibus network.



**CIO-EN (non-POE) Communication Module**  
Modbus-TCP and Modbus-RTU interface capable of providing discrete control and monitoring of an overload relay over a Modbus network.



**Communication Adapters**  

- RS485-RS232–Converter with cable & plug
- RS485-USB–Converter with cable & plug
- RS232-USB–Converter

 Specifications match industry standard.



**RM1000 Remote Monitor**  
The RM1000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring for up to 16 devices.



**RM2000 Remote Monitor**  
The RM2000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring with event storage and real-time clock for date and time stamp.



**Solutions Software: Solutions-M**  
Software features include data logging, real-time data monitoring and fault and event monitoring.



**777-MRSW Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.



**OL-RESET Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.

#### Specifications

##### Functional Characteristics

<b>Frequency</b>	50/60Hz
<b>TC- Overcurrent Trip Class (777 Plus Series units)</b>	02-60, J02-J60, L00-L60 or Off
<b>TC- Overcurrent Trip Class (77C, 777 non-Plus Series units)</b>	5, 10, 15, 20, 30 (J prefix enables jam protection feature)

##### Output Characteristics

<b>Output Contact Rating (SPDT - Form C)</b>	
<b>Pilot duty rating</b>	480VA @ 240VAC, B300
<b>General purpose</b>	10A @ 240VAC
<b>Pilot duty rating for HVR models</b>	470VA @ 600VAC, B600

##### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)

##### Accuracy

<b>Voltage</b>	±1%
<b>Current</b>	±3% (<100 amps direct)
<b>GF Current</b>	±15%
<b>Timing (777 Plus Series units)</b>	±0.5 second

##### Timing (77C, 777 non-Plus Series units)

<b>Timing (77C, 777 non-Plus Series units)</b>	5% +1 second
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##### Repeatability

<b>Voltage</b>	±0.5% of nominal voltage
<b>Current</b>	±1% (<100 amps direct)

##### Maximum Input Power

<b>Maximum Input Power</b>	10 W
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##### Pollution Degree

<b>Pollution Degree</b>	3
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##### Class of Protection

<b>Class of Protection</b>	IP20
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##### Relative Humidity

<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
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##### Terminal Torque

<b>Terminal Torque</b>	7 in.-lbs.
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##### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
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##### Radio Frequency Immunity (RFI), Conducted

<b>Radio Frequency Immunity (RFI), Conducted</b>	IEC 61000-4-6, Level 3 10V/m
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##### Radio Frequency Immunity (RFI), Radiated

<b>Radio Frequency Immunity (RFI), Radiated</b>	IEC 61000-4-3, Level 3 10V/m
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##### Fast Transient Burst

<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power
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##### Short Circuit

<b>Short Circuit</b>	100kA
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##### Surge

<b>IEC</b>	61000-4-5, Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line

##### Hi-potential Test

<b>Vibration</b>	Meets UL508 (2 x rated V +1000V for 1 minute)
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##### Shock

<b>Shock</b>	IEC 68-2-27, 30g, 3 axis, 11ms duration, half-sine pulse
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## 777 SERIES

### Safety Marks

**UL** UL508, UL1053 (File #E68520)  
**CE** IEC 60947-1, IEC 60947-5-1  
**CSA** C22.2 No. 14

**Maximum Conductor Size  
(with insulation) through  
777/77C**

0.65"

**Dimensions**

**H** 77.47 mm (3.05"); **W** 97.79 mm (3.85");  
**D** 128.27 mm (5.05")

**Weight**

1.56 lbs. (24.96 oz., 707.6 g)

**Mounting Method**

Surface mount (4 - #8 screws) or DIN rail mount

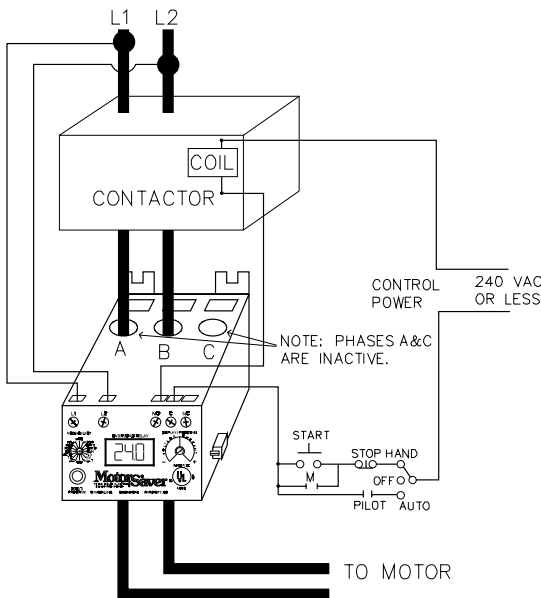
# 777 / 77C SERIES

## Single-Phase Current & Voltage Monitor

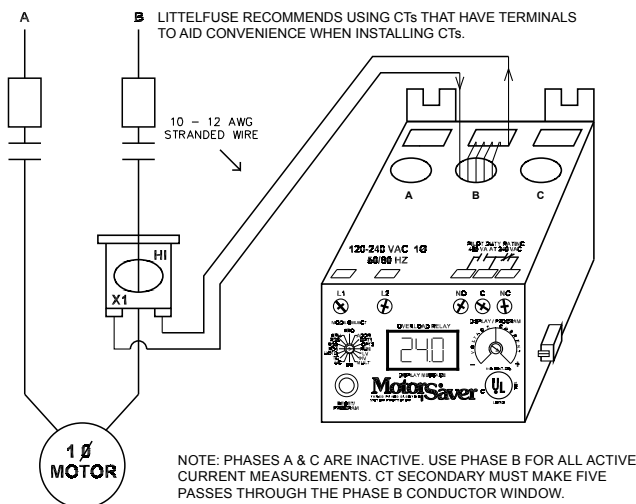


### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR MODEL 77C WITH MOTOR CONTROL



TYPICAL WIRING DIAGRAM FOR MODEL 77C WITH EXTERNAL CT



### Description

The 777/ 77C Series is a fully programmable electronic overload relay designed to protect any motor drawing 2-800 full load amps (external CTs are required above 90 amps). Common applications include conveyor systems, HVAC equipment, saws and grinders, fan motors, and almost any pumping application.

All of the overload relays provide unsurpassed protection by combining overload, underload, and voltage in one package. For standalone applications, the units incorporate a 3-digit LED display that is used for programming, providing real-time operational information and displaying diagnostic codes to aid in troubleshooting a fault condition. The units also feature a communications port that can be used with communication modules listed in the 777 accessories section to form a Modbus, DeviceNet™, Profibus, or Ethernet network. Up to 99 units can be remotely monitored and controlled from a PC, PLC, or SCADA system, and data logging through a PC with the optional Solutions software. This capability allows for a simple, cost-effective way to meet new requirements for arc-flash safety.

### Features & Benefits

FEATURES	BENEFITS
<b>Built-in display</b>	Visual indication for programming, viewing real-time voltage or current, and last fault code
<b>Programmable voltage and current settings</b>	Allows usage on wide range of systems
<b>3 selectable restart options</b>	Choose from automatic, semi-automatic, or manual to best meet individual application needs
<b>3 programmable restart delay timers</b>	Program separate restart delay time for rapid cycle protection, motor cool down, and dry-well recovery
<b>Remote display compatibility</b>	Increases safety through remote display of real-time data and fault history, without the need to open the cabinet. Aids with arc flash safety regulations
<b>Flexible reset</b>	Reset can be done through pushbutton on relay or remotely with optional 777-MRSW or OL-RESET remote reset kit
<b>Network communications capability</b>	Compatible with Modbus, DeviceNet™, Profibus, or Ethernet using optional communications module

### Ordering Information

MODEL	LINE VOLTAGE	MOTOR FULL AMP RANGE	DESCRIPTION
77C	100-240VAC	2-800A (external CTs required above 90A)	Provides 480VA @ 240VAC output SPDT relay contacts
77C-LR	100-240VAC	1-9A only	Provides 480VA @ 240VAC output SPDT relay contacts
777-HVR-SP	340-480VAC	2-800A (external CTs required above 90A)	Provides 470VA @ 600VAC output SPDT relay contacts. For systems with no control power transformer

For dimensional drawing see: Appendix page 507, Figure 1.

# 777 / 77C SERIES

## Accessories



**RS485MS-2W Communication Module**  
Required to enable the Modbus communications function on Model 77X-type products.



**Communication Adapters**

- **RS485-RS232**—Converter with cable & plug
- **RS485-USB**—Converter with cable & plug
- **RS232-USB**—Converter

Specifications match industry standard.



**RM1000 Remote Monitor**  
The RM1000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring for up to 16 devices.



**RM2000 Remote Monitor**  
The RM2000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring with event storage and real-time clock for date and time stamp.



**Solutions Software: Solutions-M**  
Software features include data logging, real-time data monitoring and fault and event monitoring.



**777-MRSW Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.



**OL-RESET Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.

## Specifications

<b>Frequency</b>	50/60Hz
<b>Functional Characteristics</b>	
<b>TC- Overcurrent Trip Class (77C, 777 non-Plus Series units)</b>	5, 10, 15, 20, 30 (J prefix enables jam protection feature)
<b>Output Characteristics</b>	
<b>Output Contact Rating (SPDT - Form C)</b>	
<b>Pilot duty rating</b>	480VA @ 240VAC, B300
<b>General purpose</b>	10A @ 240VAC
<b>Pilot duty rating for HVR models</b>	470VA @ 600VAC, B600
<b>General Characteristics</b>	
<b>Ambient Temperature Range</b>	
<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Accuracy</b>	
<b>Voltage</b>	±1%
<b>Current</b>	±3% (<100 amps direct)
<b>GF Current</b>	±15%
<b>Timing (77C, 777 non-Plus Series units)</b>	5% +1 second
<b>Repeatability</b>	
<b>Voltage</b>	±0.5% of nominal voltage
<b>Current</b>	±1% (<100 amps direct)
<b>Maximum Input Power</b>	10 W
<b>Pollution Degree</b>	3
<b>Class of Protection</b>	IP20
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	7 in.-lbs.
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity (RFI), Conducted</b>	IEC 61000-4-6, Level 3 10V/m
<b>Radio Frequency Immunity (RFI), Radiated</b>	IEC 61000-4-3, Level 3 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power
<b>Short Circuit</b>	100kA
<b>Surge</b>	
<b>IEC</b>	61000-4-5, Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line
<b>Hi-potential Test</b>	Meets UL508 (2 x rated V +1000V for 1 minute)
<b>Vibration</b>	IEC 68-2-6, 10-55Hz, 1mm peak-to-peak, 2 hours, 3 axis
<b>Shock</b>	IEC 68-2-27, 30g, 3 axis, 11ms duration, half-sine pulse
<b>Safety Marks</b>	
<b>UL</b>	UL508, UL1053 (File #E68520)
<b>CE</b>	IEC 60947-1, IEC 60947-5-1
<b>CSA</b>	C22.2
<b>Maximum Conductor Size (with insulation) through 777/77C</b>	0.65"
<b>Dimensions</b>	<b>H</b> 77.47 mm (3.05"); <b>W</b> 97.79 mm (3.85"); <b>D</b> 128.27 mm (5.05")
<b>Weight</b>	1.56 lbs. (24.96 oz., 707.6 g)
<b>Mounting Method</b>	Surface mount (4 - #8 screws) or DIN rail mount

7 MOTOR & PUMP PROTECTION



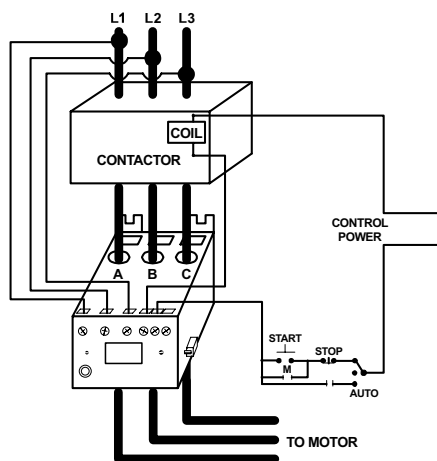
# 777-KW/HP-P2 SERIES

## 3-Phase Current & Voltage Monitor

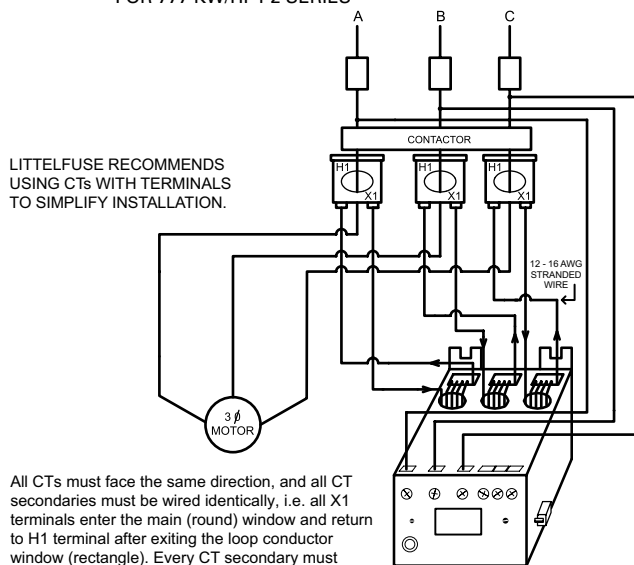


### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR 777-KW/HP-P2 SERIES



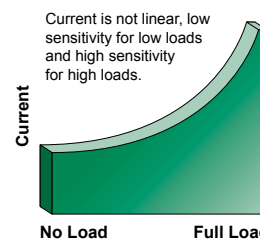
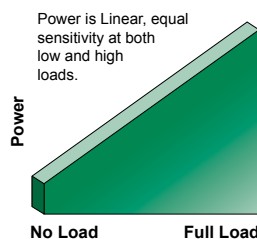
CURRENT TRANSFORMER WIRING DIAGRAM FOR 777-KW/HP-P2 SERIES



All CTs must face the same direction, and all CT secondaries must be wired identically, i.e. all X1 terminals enter the main (round) window and return to H1 terminal after exiting the loop conductor window (rectangle). Every CT secondary must make 5 passes through the corresponding main conductor window.

### Description

The 777-KW/HP-P2 Series has the overload, voltage, phase loss and reversal, voltage and current unbalance, current and power monitoring\*, and underload trip based on power in one package. The underpower trip feature is desirable anytime the current vs. load characteristic is non-linear or has little change. In general terms, smaller motors and slow-speed motors have little change in current over the normal load range. Larger motors that are running light loads will also show small current changes over the operating load range. For standalone applications, the units incorporate a 3-digit LED display that is used for programming, providing real-time operational information and displaying diagnostic codes to aid in troubleshooting a fault condition.



The units also feature a communications port that can be used with communication modules listed in the 777 accessories section to form a Modbus, DeviceNet™, Profibus, or Ethernet network. Up to 99 units can be remotely monitored and controlled from a PC, PLC, or SCADA system, and data logging through a PC with the optional Solutions software.

\* Low current trip and high power trip are network programmable only

### Features & Benefits

FEATURES	BENEFITS
<b>Low and High Power Protection</b>	Increases reliability for non-linear motors where the load characteristic has little change
<b>Built-in Display</b>	Visual indication for programming, viewing real-time voltage, current, kilowatts, or horsepower, and last fault code
<b>Programmable voltage and current settings</b>	Allows usage on wide range of systems
<b>3 selectable restart options</b>	Choose from automatic, semi-automatic, or manual to best meet individual application needs
<b>3 programmable restart delay timers</b>	Program separate restart delay time for rapid cycle protection, motor cool down, and dry-well recovery
<b>Remote display compatibility</b>	Increases safety through remote display of real-time data and fault history, without the need to open the cabinet. Aids with arc flash safety regulations
<b>Flexible reset</b>	Reset can be done through pushbutton on relay or remotely with optional 777-MRSW or OL-RESET remote reset kit
<b>Network communications capability</b>	Compatible with Modbus, DeviceNet™, Profibus, or Ethernet using optional communications module

For dimensional drawing see: Appendix page 507, Figure 1.

MOTOR & PUMP PROTECTION

7

## 777-KW/HP-P2 SERIES

### Ordering Information

MODEL	LINE VOLTAGE	MOTOR FULL AMP RANGE	DESCRIPTION
777-KW/HP-P2	200-480VAC (3-phase)	2-800A (external CTs required above 90A)	Provides 480VA @ 240VAC output SPDT relay contacts
777-LR-KW/HP-P2	200-480VAC (3-phase)	1-800A (external CTs required above 9A)	Provides 480VA @ 240VAC output SPDT relay contacts
777-HVR-KW/HP-P2	340-480VAC (3-phase)	2-800A (external CTs required above 90A)	Provides 470VA @ 600VAC output SPDT relay contacts. Required when a CPT (control power transformer) is not used on a 480V system. Commonly used in pumping applications to save the cost and extra wiring associated with a CPT
777-575-KW/HP-P2	500-600VAC (3-phase)	2-800A (external CTs required above 90A)	Provides 480VA @ 240VAC output SPDT relay contacts. Used in Canada and NE USA where 575V utility power services are common
777-MLR-KW/HP-P2	200-480VAC (3-phase)	0.5-21A and 40-740A with external CTs	Provides 480VA @ 240VAC output SPDT relay contacts. It is wired directly without the need to loop conductors for 5-21 amps (under 5 amps requires looping of conductors), and can be used with external CTs for 40-740 amps

### Accessories



#### RS485MS-2W Communication Module

Required to enable the Modbus communications function on Model 77X-type products.



#### CIO-MB/CIO-120-MB Communication Module

Modbus-RTU interfaces capable of providing discrete control and monitoring of an overload relay over a Modbus network.



#### CIO-DN-P/CIO-120-DN-P Communication Module

DeviceNet™ interfaces capable of providing discrete control and monitoring of motor starters, drives and other devices over a DeviceNet™ network.



#### CIO-777-PR Communication Module

Profibus interface capable of providing discrete control and monitoring of motor starters, drives and other devices over a Profibus network.



#### CIO-EN (non-POE) Communication Module

Modbus-TCP and Modbus-RTU interface capable of providing discrete control and monitoring of an overload relay over a Modbus network.



#### Communication Adapters

- **RS485-RS232**—Converter with cable & plug
- **RS485-USB**—Converter with cable & plug
- **RS232-USB**—Converter

Specifications match industry standard.



#### RM1000 Remote Monitor

The RM1000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring for up to 16 devices.



#### RM2000 Remote Monitor

The RM2000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring with event storage and real-time clock for date and time stamp.



#### Solutions Software: Solutions-M

Software features include data logging, real-time data monitoring and fault and event monitoring.



#### 777-MRSW Manual Remote Reset Kit

Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.



#### OL-RESET Manual Remote Reset Kit

Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.



### 777-KW/HP-P2 SERIES

#### Specifications

<b>Frequency</b>	50/60Hz
<b>Functional Characteristics</b>	
<b>TC-Overcurrent Trip Class</b>	02-60, J02-J60, L00-L60 or OFF
<b>Output Characteristics</b>	
<b>Output Contact Rating (SPDT - Form C)</b>	
<b>Pilot duty rating</b>	480VA @ 240VAC, B300
<b>General purpose</b>	10A @ 240VAC
<b>Pilot duty rating for HVR model</b>	470VA @ 600VAC, B600
<b>General Characteristics</b>	
<b>Ambient Temperature Range</b>	
<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Accuracy</b>	
<b>Voltage</b>	±1%
<b>Current</b>	±3% (<100 amps direct)
<b>Power</b>	±4% (<100 amps direct)
<b>GF Current</b>	±15%
<b>Timing</b>	±0.5 second
<b>Repeatability</b>	
<b>Voltage</b>	±0.5% of nominal voltage
<b>Current</b>	±1% (<100 amps direct)
<b>Power</b>	±2%
<b>Maximum Input Power</b>	10 W
<b>Pollution Degree</b>	3
<b>Class of Protection</b>	IP20
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	7 in.-lbs.
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity (RFI), Conducted</b>	IEC 61000-4-6, Level 3 10V/m
<b>Radio Frequency Immunity (RFI), Radiated</b>	IEC 61000-4-3, Level 3 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5 kV input power
<b>Short Circuit Rating</b>	100kA

#### Surge

<b>IEC</b>	61000-4-5, Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line
<b>Hi-potential Test</b>	Meets UL508 (2 x rated V +1000V for 1 minute)
<b>Vibration</b>	IEC 68-2-6, 10-55Hz, 1mm peak-to-peak, 2 hours, 3 axis
<b>Shock</b>	IEC 68-2-27, 30g, 3 axis, 11ms duration, half-sine pulse

#### Safety Marks

<b>UL</b>	UL508, UL1053 (File #E68520)
<b>CE</b>	IEC 60947-1, IEC 60947-5-1
<b>CSA</b>	C22.2 No. 14

#### Maximum Conductor Size (with insulation) through 777

<b>Dimensions</b>	0.65"
<b>H</b>	77.47 mm (3.05"); <b>W</b> 97.79 mm (3.85");
<b>D</b>	128.27 mm (5.05")
<b>Weight</b>	1.56 lbs. (24.96 oz., 707.6 g)
<b>Mounting Method</b>	Surface mount (4 - #8 screws) or DIN rail mount

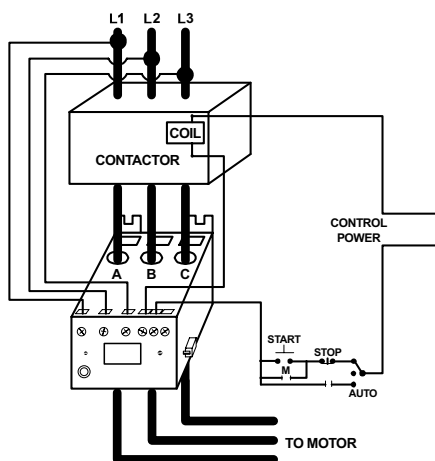
# 777-ACCUPOWER

## 3-Phase Current & Voltage Monitor

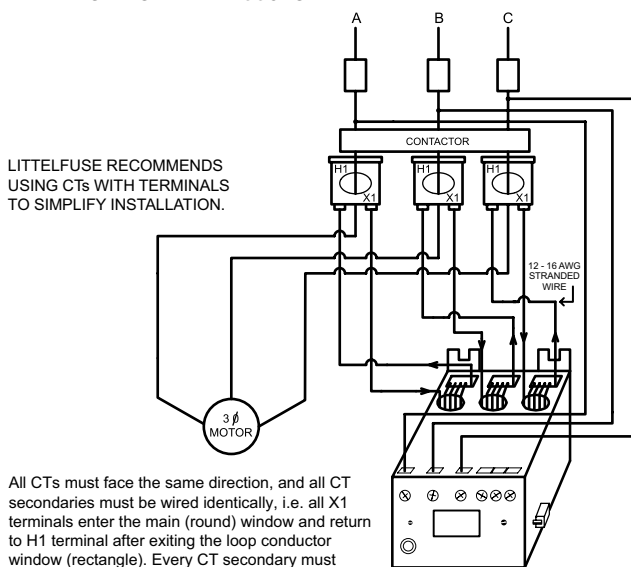


### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR MODEL 777-ACCUPOWER



CURRENT TRANSFORMER WIRING DIAGRAM OR MODEL 777-ACCUPOWER



### Description

The 777-AccuPower is a fully-programmable 3-phase motor and pump protection relay. It allows motor hp rating, full load amps, efficiency and power factor to be entered and will accurately calculate motor output power. This is most useful with mag-drive pumps or process applications where the process power is desired over the utility power. Voltage, current and power measurements can be displayed as well as fault information and setpoints. The built-in display simplifies troubleshooting and allows the user to easily and precisely configure setpoints. The 777-AccuPower can be used with the optional COM 4-20 output module to give an analog signal proportional to output shaft power, the RS485MS-2W (for limited Modbus capabilities, and for use with the RM1000/RM2000) remote displays listed in the 777 accessories section.

### Features & Benefits

FEATURES	BENEFITS
<b>Motor output power measurement</b>	Allows use of process power over utility power
<b>3 programmable restart delay timers</b>	Program separate restart delay time for rapid cycle protection, motor cool down, and dry-well recovery
<b>Built-in Display</b>	Visual indication for programming, viewing real-time voltage or current, and last fault code
<b>Remote display compatibility</b>	Increases safety through remote display of run-hour meter, last four fault codes, without the need to open the cabinet. Aids with arc flash safety regulations
<b>Network communications capability</b>	Limited Modbus capabilities using RS485MS-2W communication module

### Accessories



#### RS485MS-2W Communication Module

Required to enable the Modbus communications function on Model 77X-type products.



#### COM 4-20 Output Communication Module

This module allows communication to a PLC with an analog input and no Modbus input.



#### RM1000 Remote Monitor

The RM1000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring for up to 16 devices.



#### RM2000 Remote Monitor

The RM2000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring with event storage and real-time clock for date and time stamp.

For dimensional drawing see: Appendix page 507, Figure 1.

# 777-ACCUPOWER

## Specifications

### Input Characteristics

<b>Line Voltage</b>	200-480VAC
<b>Frequency</b>	50/60Hz
<b>Motor Full Load Amp Range</b>	2-800A (external CTs required over 90A)

### Functional Characteristics

<b>TC- Overcurrent Trip Class</b>	5, 10, 15, 20, 30 (J prefix enables jam protection feature)
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### Output Characteristics

<b>Output Contact Rating (SPDT - Form C)</b>	480VA @ 240VAC
<b>Pilot duty</b>	10A @ 240VAC
<b>General Purpose</b>	

### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)

### Accuracy

### Measured Horsepower/

<b>Kilowatt</b>	
<b>Typical</b>	±3%*
<b>Voltage</b>	±1%
<b>Current</b>	±3% (<100 amps direct)
<b>GF Current</b>	±15%
<b>Timing</b>	5% ±1 second

### Repeatability

<b>Voltage</b>	±0.5% of nominal voltage
<b>Current</b>	±1% (<100 amps direct)

### Maximum Input Power

### Pollution Degree

### Class of Protection

### Relative Humidity

### Terminal Torque

## Standards Passed

### Electrostatic Discharge (ESD)

IEC 61000-4-2, Level 3, 6kV contact, 8kV air

### Radio Frequency Immunity (RFI), Conducted

IEC 61000-4-6, Level 3 10V/m

### Radio Frequency Immunity (RFI), Radiated

IEC 61000-4-3, Level 3 10V/m

### Fast Transient Burst Short Circuit Rating

IEC 61000-4-4, Level 3, 3.5 kV input power 100kA

### Surge

### IEC

61000-4-5 Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground  
C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line  
Meets UL508 (2 x rated V + 1000V for 1 min.)  
IEC 68-2-6, 10-55Hz, 1mm peak-to-peak, 2 hrs, 3 axis  
IEC 68-2-27, 30g, 3 axis, 11ms duration, half-sine pulse

## ANSI/IEEE

### Hi-Potential Test Vibration

### Shock

### Safety Marks

<b>UL</b>	UL508, UL1053
<b>CE</b>	IEC 60947-1, IEC 60947-5-1
<b>CSA</b>	C22.2

### Max. Conductor Size through 777

0.65" with insulation

### Dimensions

**H** 77.47 mm (3.05"); **W** 97.79 mm (3.85");  
**D** 128.27 mm (5.05")

### Weight

1.3 lbs. (20.8 oz., 589.67 g)

### Mounting Method

Surface mount (4 - #8 screws) or DIN rail mount

\*On a well balanced system within recommended current range.

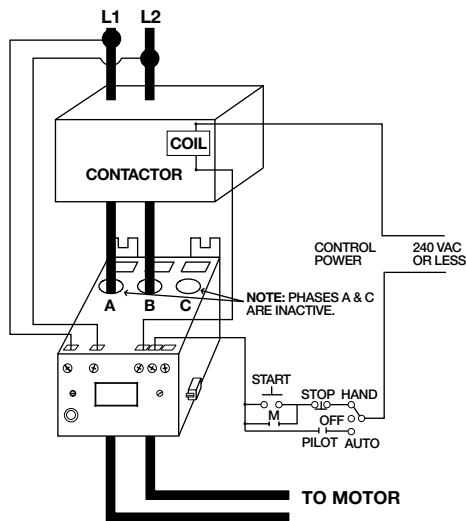
# 77C-KW/HP SERIES

## Single-Phase Current & Voltage Monitor

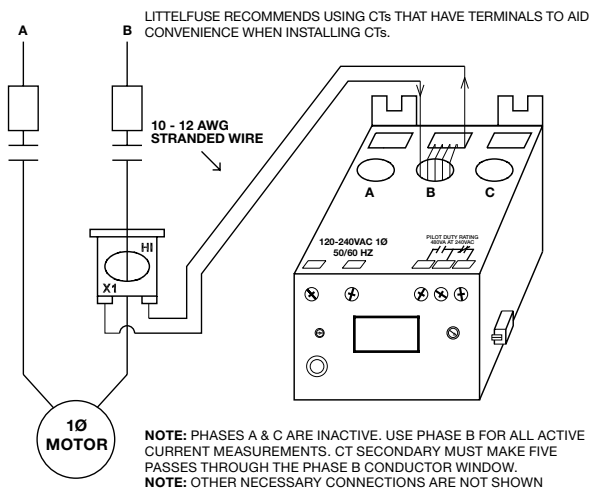


### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR MODEL 77C-KW/HP WITH MOTOR CONTROL



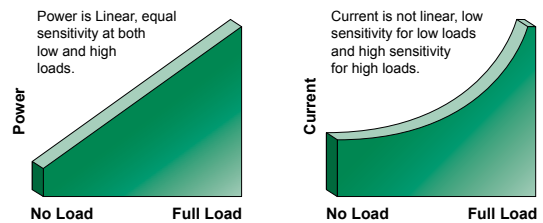
TYPICAL WIRING DIAGRAM FOR MODEL 77C-KW/HP WITH EXTERNAL CT



For dimensional drawing see: Appendix page 507, Figure 1.

### Description

The 77C-KW/HP and 77C-LR-KW/HP are fully programmable pump protection relays which will monitor the voltage and current for high or low voltage, overload and underload conditions based on power, in one package. The underpower trip feature is desirable anytime the current vs. load characteristic is non-linear or has little change. In general terms, smaller motors and slow-speed motors have little change in current over the normal load range. Larger motors that are running light loads will also show small current changes over the operating load range. Common uses include pumping applications where motors run slower than around 3400 rpm and usually have small current vs load changes; such as slow speed mixer or agitator motors up to 50 hp, and magdrive or can pumps.



The Littelfuse PumpSaver relay provides the high sensitivity of a power monitor to protect pump motors from dry run and dead-head conditions.

### Features & Benefits

FEATURES	BENEFITS
<b>Underload protection</b>	Increases reliability for non-linear motors where the load characteristic has little change
<b>Built-in display</b>	Visual indication for programming, viewing real-time voltage, current, kilowatts or horsepower, and last fault code
<b>15 programmable criteria settings</b>	Allows user flexibility to fine-tune the relay for maximum protection in any application.
<b>Last fault memory</b>	Provides instant troubleshooting diagnostics
<b>Remote display compatibility</b>	Increases safety through remote display of real-time data and fault history, without the need to open the cabinet. Aids with arc flash safety regulations.
<b>Flexible reset</b>	Reset options: automatic, manual using pushbutton on relay, or remotely with optional 777-MRSW or OL-RESET remote reset kit.
<b>Network communications capability</b>	Compatible with Modbus using optional communications module (RS485MS-2W)

### Ordering Information

MODEL	LINE VOLTAGE	MOTOR FULL AMP RANGE	DESCRIPTION
77C-KW/HP	100-240VAC	2-90A (external CTs required above 90A)	Provides 480VA @ 240VAC output SPDT (Form C) relay contacts
77C-LR-KW/HP	100-240VAC	1-9A (external CTs required above 9A)	Provides 480VA @ 240VAC output SPDT (Form C) relay contacts

### 77C-KW/HP SERIES

#### Accessories



**RS485MS-2W Communication Module**  
Required to enable the Modbus communications function on Model 77X-type products.



**Communication Adapters**

- **RS485-RS232**—Converter with cable & plug
- **RS485-USB**—Converter with cable & plug
- **RS232-USB**—Converter

Specifications match industry standard.



**RM1000 Remote Monitor**  
The RM1000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring for up to 16 devices.



**RM2000 Remote Monitor**  
The RM2000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring with event storage and real-time clock for date and time stamp.



**Solutions Software: Solutions-M**  
Software features include data logging, real-time data monitoring and fault and event monitoring.



**777-MRSW Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.



**OL-RESET Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.

#### Specifications

##### Input Characteristics

**Supply Voltage** 100-240 VAC, 1Ø  
**Frequency** 50-60 Hz

##### Motor Full Load Amp Range

**77C-KW/HP** 2-25 Amps (Loops Required)  
26-90 Amps (Direct)  
91-800 Amps (External CT's)  
**77C-LR-KW/HP** 1.0 Amps - 2.0 Amps (additional Loop)  
2.0 Amps - 9.0 Amps (Direct)

##### Short Circuit Withstand

**Rating** 100kA per UL and CSA  
**Power Consumption** 5W (Maximum)

##### Output Contact Rating SPDT (Form C)

Pilot duty rating: 480 VA @ 240 VAC  
General purpose: 10A @ 240 VAC

##### Expected Life

**Mechanical** 1 x 10<sup>6</sup> operations  
**Electrical** 1 x 10<sup>5</sup> operations at rated load

##### Accuracy at 25° C (77° F)

**Voltage** ±1%  
**Current** ±3% (Direct, No External CTs)  
**Timing** 5% ± 1 second

##### Repeatability

**Voltage** ± 0.5% of nominal voltage  
**Current** ± 1% (Direct, No External CTs)

##### Safety Marks

**UL** UL508, UL1053  
**CE** IEC 60947-1, IEC 60947-5-1  
**CSA** C22.2 No. 14

##### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air

**Radio Frequency Immunity (RFI), Conducted** IEC 61000-4-6, Level 3 10V/m

**Radio Frequency Immunity (RFI), Radiated** IEC 61000-4-3, Level 3 10V/m

**Fast Transient Burst** IEC 61000-4-4, Level 3, 3.5kV input power

##### Surge

**IEC** IEC 61000-4-5, Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground

**ANSI/IEEE** C62.41 Surge and Ring Wave compliance to a level of 6kV line-to-line

**Hi-potential Test** Meets UL508 (2 x rated V +1000V for 1 min.)

**Vibration** IEC 68-2-6, 10-55Hz, 1mm peak-to-peak, 2 hours, 3 axis

**Shock** IEC 68-2-27, 30g, 3 axis, 11ms duration, half-sine pulse

##### Mechanical

**Dimensions** **H** 77.47 mm (3.05"); **W** 97.79 mm (3.85"); **D** 128.27 mm (5.05")

**Maximum conductor size through holes** 0.65" (with insulation)

**Terminal Torque** 7 in.-lbs.

**Enclosure Material** polycarbonate

**Weight** 1.2 lbs

**Mounting Methods** 35mm DIN rail or surface mount

# 77C-KW/HP SERIES

### Environmental

#### Temperature Range

**Ambient Operating** -20° - 70° C (-4° - 158°F)

**Ambient Storage** -40° - 80° C (-40° - 176°F)

**Pollution Degree** 3

**Class of Protection** IP20, NEMA 1

**Relative Humidity** 10-95%, non-condensing per IEC 68-2-3

#### Programmable

**Operating Points** Range

**LV- Low Voltage Threshold** 85V - HV Setting

**HV- High Voltage Threshold** LV Setting - 264V

#### MULT- # of Conductors or

#### CT Ratio (XXX:5)

**77C:** 1-10 Conductors or 100-800 Ratio

**77C-LR:** 1 or 2

**OC- Overcurrent Threshold** (20-100A) ÷ MULT or 80-120% of CT Primary

**TC- Overcurrent Trip Class \*** 5, J5, 10, J10, 15, J15, 20, J20, 30, J30, or Lln (linear)

**RD1- Rapid Cycle Timer** 0, 2 - 500 Seconds

#### RD2- Restart Delay After All

#### Faults Except Undercurrent

**(motor cool down timer)\*\*** 2 - 500 Minutes/Seconds

#### RD3- Restart Delay

#### After Undercurrent

**(dry well recovery timer)** 2 - 500 Minutes/Seconds

#### #RU- Number of Restarts

**After Undercurrent** 0, 1, 2, 3, 4, A (Automatic)

**ADDR- RS485 Address** A01- A99

#### #RO- Number of Restarts

**After Overcurrent** 0, 1, 2, 3, 4, A (Automatic)

**LP/PWS (PWS = LP Range)** **1** = 0.01 - 0.99 KW    **5** = 0.01 - 1.30 HP

**2** = 1.00 - 9.95 KW    **6** = 1.34 - 13.3 HP

**3** = 10.0 - 99.5 KW    **8** = 13.4 - 133 HP

**4** = 100 - 650 KW    **9** = 134 - 871 HP

\* If J Prefix is displayed in trip class setting, jam protection is enabled. If programmed to Lln position, overcurrent trip delays are fixed linear-type delays set in OPT1 position.

\*\* RD2 & RD3 can be changed from minutes to seconds under program position OPT2.

SETTING	RD2	RD3	SETTING	RD2	RD3
0	Minutes	Minutes	2	Seconds	Minutes
1	Minutes	Seconds	3	Seconds	Seconds



# SIO-RTD-02-00

## Temperature Input Monitor



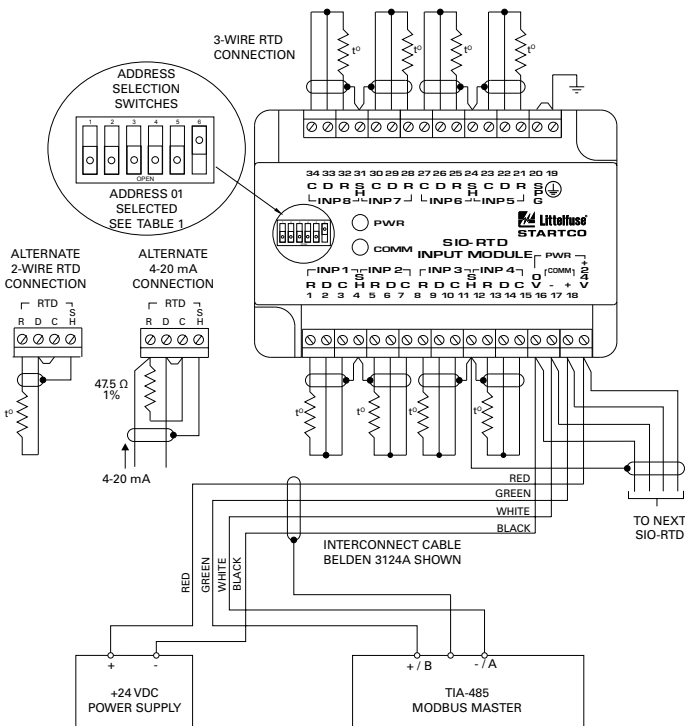
### Description

The SIO-RTD is a microprocessor-based data-acquisition system for measuring temperatures accurately with resistance temperature detectors (RTDs) and for monitoring 4-20 mA analog-output devices in industrial environments. RTD inputs are noise-filtered and automatically calibrated for lead-length compensation, ambient temperature, and other factors providing accurate readings through the specified temperature range for several types of RTD devices.

### Features & Benefits

FEATURES	BENEFITS
<b>8 inputs</b>	Single module can collect multiple data points
<b>CSA Class 1 Zone 2 Hazardous-location Certified</b>	Can be mounted in hazardous areas
<b>Individually-selectable input type</b>	Flexible; can be used with Pt100, Ni100, Ni120, Cu10 RTD or 4-20 mA inputs
<b>Conformal coating</b>	Protects circuit boards against corrosion and moisture
<b>Remote monitoring</b>	Up to 1.2 km away from network master
<b>Notch filter</b>	Rejects noise from motor monitoring applications

### Wiring Diagram



### Specifications

<b>Input Voltage</b>	18 to 32 Vdc, 2W
<b>RTD Types</b>	Pt100 (default), Ni100, Ni120, Cu10
<b>RTD Range</b>	-40 to 200 °C with open and short detection
<b>Analog Range</b>	4-20 mA
<b>Accuracy</b>	
<b>(Pt100, Ni100, Ni120)</b>	1° C
<b>(Cu10)</b>	3° C
<b>(4-20 mA)</b>	0.1 mA
<b>Lead Compensation</b>	Up to 20 Ω
<b>Communications</b>	Modbus RTU®
<b>Conformally Coated</b>	Standard feature
<b>Approvals</b>	cCSAus
<b>Dimensions</b>	<b>H</b> 87 mm (3.43"); <b>W</b> 112.5 mm (4.43"); <b>D</b> 56 mm (2.2")
<b>Warranty</b>	5 years
<b>Mounting</b>	DIN, Surface

For dimensional drawing see: Appendix page 515, Figure 49.



## PUMP CONTROLS & LIQUID LEVEL CONTROLS

Protect and disable a pump if a hazardous condition arises. PumpSaver® offers a wide variety of controls for both single phase and three phase applications. Intrinsically safe relays are specifically designed to interface between hazardous and non-hazardous areas.

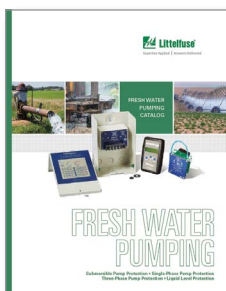
ACBC-120 Series	Alarm Controller/Battery Charging Unit....	144
PC-102 Series	Dual Channel Switch .....	146
PC-105	5-Channel Pump Controller .....	147
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For More Information...  
and to download our Fresh Water  
Pumping Catalog, visit  
[Littelfuse.com/PumpProtection](http://Littelfuse.com/PumpProtection)

# ACBC-120 SERIES

## Alarm Controller and Battery Charger for pump control panels



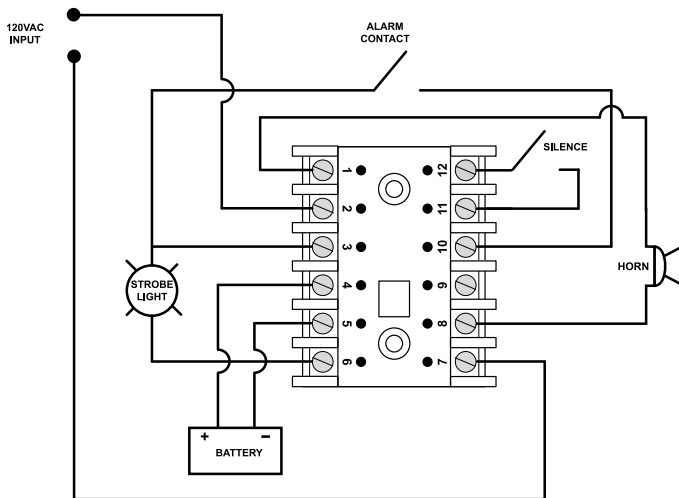
### Description

The ACBC-120 Series is a dual purpose alarm controller/battery charging unit. When there is a loss of 120VAC power, the ACBC-120's primary function as an alarm controller activates. When this power loss occurs, input power is switched to a 12VDC, lead-acid, rechargeable backup battery and a 12VDC alarm consisting of a strobe light and/or a horn is activated. The horn follows a 2 second on/2 second off pattern with a "horn silence" option to turn the sound off. An LED indicator on the unit also signals that the device has entered the alarm mode.

When 120VAC input is present the alarm circuit can be tested and the unit's secondary function as a 12VDC backup battery charger is activated. In fast charge mode, the unit has the capability to source up to 100mA of charging current. However, the device normally charges at a current of 14mA in maintenance mode. The alarm circuit can be tested by pressing the "test" button located on the front of the unit or by activating an external switch via the "alarm contact" pin.

The device has the ability to signal low battery voltage if the voltage drops below 10.5VDC. The device can also detect if no battery is present or if the battery is connected backwards. In either of these cases, the ACBC-120 will signal a battery error and will not attempt to charge.

### Wiring Diagram



For dimensional drawing see: Appendix, page 509, Figure 8.

### Must use Model SD12-PC socket for UL Rating!

\*Note: Manufacturer's recommended screw terminal torque for the SD Series Sockets is 12 in.-lbs.

### Features & Benefits

FEATURES	BENEFITS
<b>Controls 12VDC alarm circuit</b>	Activates strobe and/or horn when power loss occurs
<b>Selectable fast charge mode</b>	Unit sources higher charging current up to 100mA (normal mode is 14mA)
<b>Trip delay timer</b>	Prevents nuisance tripping
<b>Battery fault detection and reverse polarity protection</b>	Signals if battery voltage drops below 10.5VDC and can detect if no battery is present or if the battery is connected backwards
<b>LED indication</b>	Visual indication of unit status or trip
<b>Test button</b>	Preventative maintenance check of the alarm circuit by pressing the test button on the unit or externally through alarm contact connection

### Ordering Information

MODEL	LINE VOTAGE	DESCRIPTION
ACBC-120	120VAC	Does not include SD12-PC socket for mounting
ACBC-120-SD	120VAC	Includes SD12-PC socket for mounting

### Accessories



**SD12-PC 12-pin Rectangle Socket**  
Rectangle Socket for the ACBC-120.  
12-pin surface mountable.

## ACBC-120 SERIES

### Specifications

#### Input Characteristics

<b>Supply Voltage</b>	120V +/-10%
<b>AC Input Voltage</b>	50/60Hz
<b>Frequency</b>	0.018A (max.) 0.003 (typical)
<b>AC Input Current</b>	2.4W (max.) fast charge current
<b>AC Input Power</b>	0.4W (typical) maint. charge current

#### Functional Characteristics

<b>Battery Charging Characteristics</b>	
<b>Acceptable Battery Type</b>	12V lead-acid rechargeable
<b>Fast Charge Current</b>	100mA +/-10%
<b>Maintenance Charge Current</b>	14mA +/-50%
<b>Low Battery Alert Level</b>	10.5V

#### Output Characteristics

<b>Strobe Light Alarm Output</b>	12VDC@1A (max.)
<b>Horn Alarm Output</b>	12VDC@1A (max.)

#### General Characteristics

<b>Temperature Range</b>	-40° to 60°C (-40° to 140°F)
--------------------------	------------------------------

#### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency, Radiated</b>	150MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 4, 4kV input lines; 4kV signal lines

#### Safety Marks

##### UL

##### (SD12-PC socket required)

UL508 (File #E68520)

##### Dimensions

**H** 44.45 mm (1.75"); **W** 60.325 mm (2.375");  
**D** 104.775 mm (4.125") (with socket)

##### Weight

0.7 lb. (11.2 oz., 317.51 g)

##### Mounting Method

Surface mount with #8 or #10 screws  
(plug into SD12-PC socket)

##### Socket Available

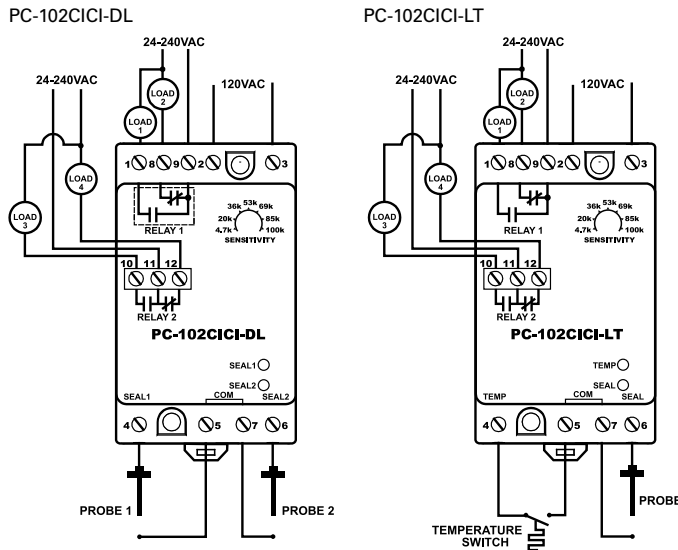
Model SD12-PC (UL Rating 600V)  
The 600V socket can be surface mounted

# PC-102 SERIES

## Dual Seal-Leak Detector or Seal-Leak & Over-Temperature Detector



### Wiring Diagram



For dimensional drawing see: Appendix, page 510, Figure 30.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
PC-102CICI-DL	120VAC nominal	Dual seal-leak detector uses inputs to sense seal failures and energize the output relay. Input logic direct or inverted is DIP switch selectable
PC-102CICI-LT	120VAC nominal	Seal-leak and over-temperature detector uses one input to sense seal failures and the temperature input to detect motor overheating. Configurable to suit various probes. Seal input logic direct or inverted, plus over-temperature trip reset automatic or manual, is DIP switch selectable

### Description

The PC-102 is a dual-channel switch that provides dual protection against seal failures and over-temperature in submersible pumping applications.

Both units have two form-C isolated output relays and two LEDs, which illuminate when each associated output relay is energized.

The sensitivity adjustment (4.7k-100kOhms) allows you to define the input impedance at which the output relays will change state. The sensitivity for the over-temperature detector can be set to 4k Ohms with use of the DIP switches.

**This unit may not be compatible with Flygt pumps.**

### Features & Benefits

FEATURES	BENEFITS
<b>Finger-safe terminals</b>	Meets IEC 61000 safety requirements
<b>Compact design for DIN rail or surface mount</b>	Allows flexibility in panel installation
<b>LED Status Indicator</b>	Visual indication of relay engagement
<b>Two input channels</b>	Flexibility for pump-up/pump-down or two-channel switch applications

### Specifications

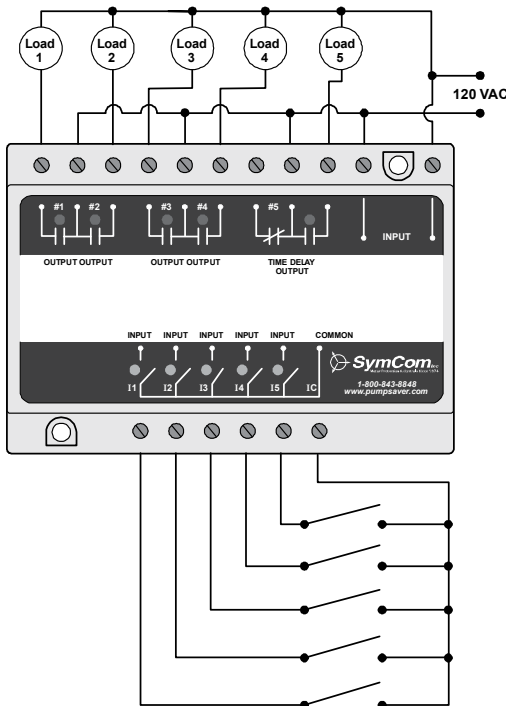
<b>Input Characteristics</b>	
<b>Frequency</b>	50/60Hz
<b>Functional Characteristics</b>	
<b>Probe Sense Voltage</b>	5vdc pulsed
<b>Sensitivity</b>	4.7k-100kΩ
<b>Sensitivity (for temp)</b>	Selectable 4kΩ with DIP switches
<b>Input Logic</b>	Direct or inverted
<b>Debounce Time Delay</b>	0.5 or 2 seconds
<b>Output Characteristics</b>	
<b>Relay Output Rating (2 Form C isolated)</b>	
<b>Pilot Duty</b>	180VA @ 120VAC, C150
<b>General Purpose</b>	5A @ 240VAC
<b>General Characteristics</b>	
<b>Temperature Range</b>	-20° to 55°C (-4° to 131°F)
<b>Maximum Input Power</b>	2 W
<b>Depluggable Connector</b>	Phoenix Contact-Series MSTB plugs
<b>Output Relay</b>	
<b>Status Indicators</b>	LEDs
<b>Terminal Torque</b>	4.5 in.-lbs.
<b>Wire range</b>	12-20 AWG
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air.
<b>Radio Frequency Immunity (RFI)</b>	IEC 61000-4-3, Level 3, 10V/m
<b>Fast Transients</b>	IEC 61000-4-4, Level 3, 4kV input power 2kV inputs/outputs
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>Dimensions</b>	<b>H</b> 88.9 mm (3.5"); <b>W</b> 52.93 mm (2.08"); <b>D</b> 59.69 mm (2.35")
<b>Weight</b>	0.9 lb. (14.4 oz., 408.23 g)
<b>Mounting Method</b>	35mm DIN rail or Surface Mount (#6 or #8 screws)

# PC-105

Pump controller with duplex, triplex or quadplex functionality or 5-channel relay



## Wiring Diagram



For dimensional drawing see: Appendix, page 511, Figure 12.

## Description

The PC-105 is a 5-channel pump controller designed to handle multiple pump applications. Alternatively, it can operate as a 5-channel switch.

The PC-105's control functions support all of the popular industry-standard multi-pump, pump-up and pump-down configurations.

It can indicate low, high and out-of-sequence alarms and use alternating and non-alternating pump control. The non-alternating pump can be used as a jockey pump or emergency pump.

Using the built-in DIP switches, individual pumps can be disabled when taken out of service for repair or maintenance.

## Features

- Compact design
- Low, high and out-of-sequence alarms
- Variable time delay/lag pump delay from 2-255 seconds
- Duplex SPS (separate pump stop) pump control
- Duplex, triplex or quadplex pump control
- Pump-up or pump-down functions
- External silence, reset and alternation configuration
- Five-channel relay configuration
- DIN rail or surface mountable

## Specifications

### Input Characteristics

**Supply Voltage** 120VAC  
**Frequency** 50\*/60Hz

### Functional Characteristics

**Probe Sense Voltage** 5vdc continuous

### Output Characteristics

**Relay Output Rating:**  
**Pilot Duty** 480VA @ 240VAC, B300  
**General Purpose** 7A @ 240VAC

### General Characteristics

**Temperature Range** -20° to 55°C (-4° to 131°F)  
**Maximum Input Power** 4 W  
**Wire range** 12 to 20 AWG  
**Terminal Torque** 4.5 in.-lbs. (max.)  
**Pump In-rush delay** 2 seconds

### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air.  
**Radio Frequency Immunity (RFI)** IEC 61000-4-3, Level 3, 10V/m  
**Fast Transients** IEC 61000-4-4, Level 3, 4kV input power 2kV inputs/outputs

### Safety Marks

**UL** UL508 (File #E68520)  
**Dimensions** **H** 94.06 mm (3.703"); **W** 127.64 mm (5.025");  
**D** 59.69 mm (2.35")

**Weight** 1.2 lbs. (19.2 oz., 544.31 g)  
**Mounting Method** 35 mm DIN rail or Surface Mount (#6 or #8 screws)

\*Note: 50Hz will increase all delay timers by 20%.

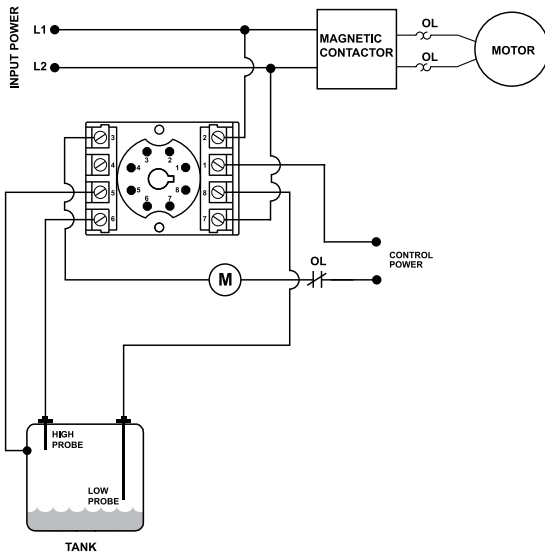
# PC-XXX-LLC-CZ / PC-XXX-LLC-GM SERIES

## Liquid Level Control

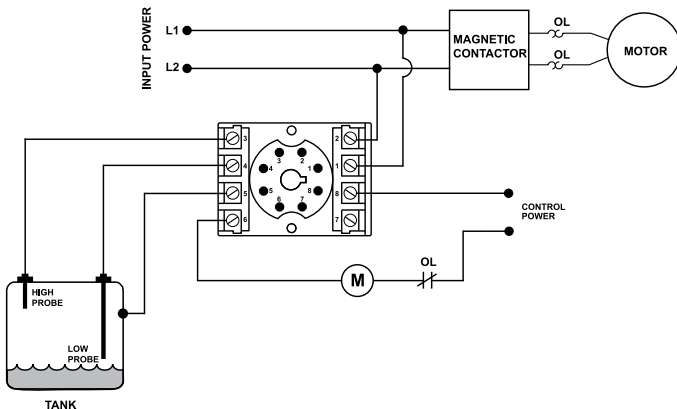


### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR PC-XXX-LLC-CZ



TYPICAL WIRING DIAGRAM FOR PC-XXX-LLC-GM



### Description

The PC-xxx-LLC-CZ and PC-xxx-LLC-GM Series are liquid level control relays used to control conductive liquid pumping operations in a pump-up or pump-down application. The units come in two different voltage ranges (see specs below).

The units have an adjustable sensitivity knob (4.7k to 100k ohms) that is set according to the resistance level at which you want the probes (sold separately) to sense the conductive liquid. The units have a built-in debounce time delay that prevents the relay from energizing if the probe resistance momentarily goes above or below the sensitivity setpoint (due to liquid splashing in the tank).

The units operate their internal relay based on inputs from a high and low probe and a common reference (when a conductive tank is used) or common probe (when a non-conductive tank is used).

#### PC-xxx-LLC-CZ

- Compatible with Crouzet's PNR & PNRU series liquid level control

#### PC-xxx-LLC-GM

- Compatible with Gems' Series 16M general purpose control

**Must use Model OT08PC or P1011-6 socket for UL Rating!**

Note: Manufacturer's recommended screw terminal torque for the OT Series Octal Sockets is 12 in.-lbs.

### Features & Benefits

FEATURES	BENEFITS
<b>Debounce time delay (2 seconds)</b>	Prevents rapid cycling of the pump due to turbulence in the tank
<b>Adjustable sensitivity (4.7 to 100Kohms)</b>	Allows user to fine tune the sensing resistance to prevent false tripping due to foam or debris
<b>Dual probe design (plus a common)</b>	Allows user the ability to set the level differential required

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
PC-100-LLC-CZ	95-120VAC	Compatible with Crouzet's PNR & PNRU Series liquid level control
PC-200-LLC-CZ	190-240VAC	Compatible with Crouzet's PNR & PNRU Series liquid level control
PC-100-LLC-GM	95-120VAC	Compatible with Gems' Series 16M liquid level control
PC-200-LLC-GM	190-240VAC	Compatible with Gems' Series 16M liquid level control

For dimensional drawing see: Appendix, page 509, Figure 8.

# PC-XXX-LLC-CZ / PC-XXX-LLC-GM SERIES

## Accessories



**OT08PC 8-pin Octal Socket**  
Octal Socket for plug-in units. 8-pin surface & DIN rail mountable. Rated for 10A @ 600VAC.

## Specifications

### Input Characteristics

<b>Supply Voltage</b>	
<b>PC-100-LLC-CZ</b>	95-120VAC
<b>PC-100-LLC-GM</b>	95-120VAC
<b>PC-200-LLC-CZ</b>	190-240VAC
<b>PC-200-LLC-GM</b>	190-240VAC
<b>Frequency</b>	50/60Hz
<b>Functional Characteristics</b>	
<b>Probe Sense Voltage</b>	5VDC pulsed
<b>Debounce Time Delay</b>	2 seconds
<b>Probe Sensitivity</b>	4.7k to 100k Adjustable
<b>Output Characteristics</b>	
<b>Output Contact Rating</b>	480VA @ 240VAC
<b>Pilot Duty</b>	10A @240VAC
<b>General Purpose</b>	

### General Characteristics

<b>Temperature Range</b>	-40° to 70°C (-40° to 158°F)
<b>Maximum Input Power</b>	5 W
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air.
<b>Radio Frequency Immunity (RFI)</b>	150MHz, 10V/m
<b>Fast Transients</b>	IEC 61000-4-4, Level 3, 2kV input power and controls
<b>Safety Marks</b>	
<b>UL (OT08PC octal socket required)</b>	UL508 (File #E68520)
<b>CE</b>	IEC60947-6-2
<b>Dimensions (when installed in socket base)</b>	
<b>H</b>	44.45 mm (1.75");
<b>W</b>	60.33 mm (2.375");
<b>D</b>	104.78 mm (4.125")
<b>Weight</b>	0.65 lb. (10.4 oz., 294.84 g)
<b>Mounting Method</b>	DIN rail or surface mount (plug into OT08PC socket)
<b>Socket Available</b>	Model OT08PC (UL Rating 600V)

The 600V socket can be surface mounted or installed on DIN Rail.



# 201-100-SLD

## Single-Channel Seal-Leak Detector



UL listed when used in combination with OT08PC socket only.



### Description

The model 201-100-SLD is an 8-pin plug-in style seal-leak detector to sense seal failures on submersible pumps. A microcontroller-based relay that monitors the shaft seal of a submersible pump motor. A resistive probe is installed in the seal cavity. If water leaks into the pump, the resistance measured by the probe decreases. When the resistance drops below the sensitivity setpoint, the unit will trip and the relay contacts will change state. The unit will automatically reset when a fault is cleared.

### Features & Benefits

- LED status indicator
- Compact plug-in design
- DIN rail or surface mountable via octal base

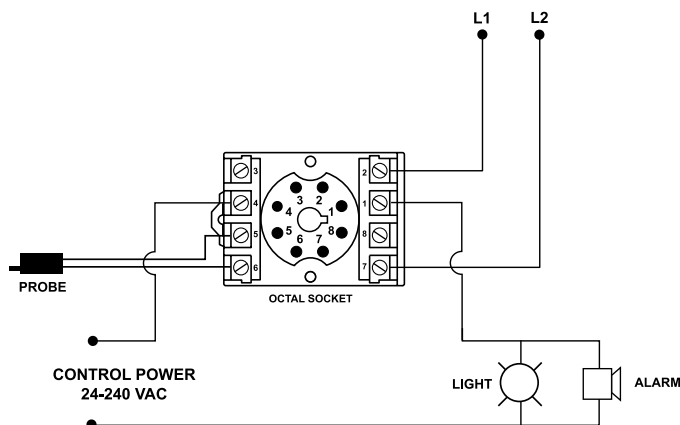
### Accessories



#### OT08PC 8-pin Octal Socket

Octal Socket for plug-in units. 8-pin surface & DIN rail mountable. Rated for 10A @ 600VAC.

### Wiring Diagram



For dimensional drawing see: Appendix, page 509, Figure 8.

### Specifications

<b>Control Voltage</b>	110/120VAC nominal
<b>Frequency</b>	50/60Hz
<b>Sensitivity</b>	4.7k-100kΩ
<b>Probe Sense Voltage</b>	5vdc pulsed
<b>Output contact Rating</b>	SPDT
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC
<b>Operating Temperature</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	5 W
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power and controls
<b>IEC</b>	IEC 61000-4-5, Level 3, 4kV line-to-line; level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line
<b>Hi-Potential Test</b>	Meets UL508 (2 x rated V + 1000V for 1 min.)
<b>UL*</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2
<b>Enclosure</b>	Polycarbonate
<b>Dimensions</b>	<b>H</b> 44.45 mm (1.75"); <b>W</b> 60.325 mm (2.375"); <b>D</b> (with socket) 104.78 mm (4.125")
<b>Weight</b>	0.7 lb. (11.2 oz., 317.51 g)
<b>Mounting Method</b>	DIN rail or surface mount (plug into OT08PC socket)
<b>Socket Available</b>	Model OT08PC (UL Rating 600V)
<b>Approvals</b>	UL, CE

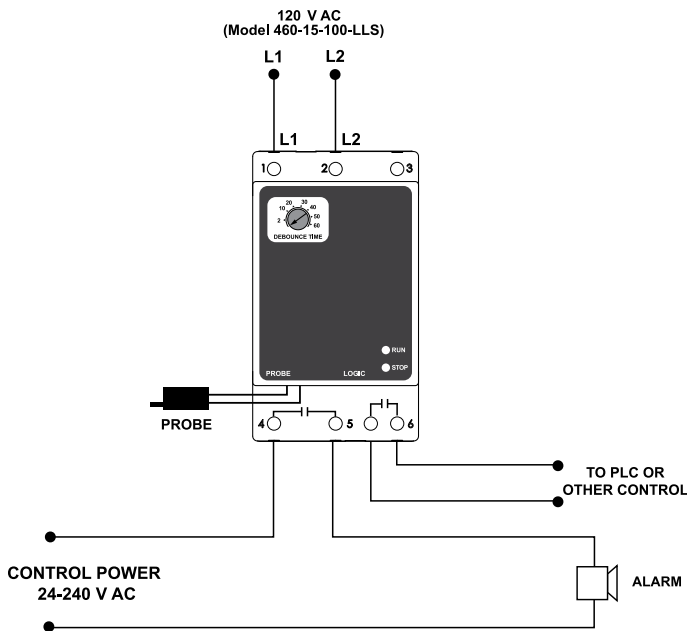
\*Must use Model OT08PC socket for UL Rating!  
The 600V socket can be surface mounted or installed on DIN Rail.

# 460-15-100-LLS

## Single-Channel Liquid Level Sensor



### Wiring Diagram



For dimensional drawing see: Appendix, page 510, Figure 10.

### Description

The 460-15-100-LLS is a liquid level sensor to detect the presence of conductive liquids. A probe is mounted at the desired tank level and connected to the PumpSaver®. When the probe is submersed, the relay's output contacts will change state as soon as the debounce time expires. The adjustable debounce timer is intended to prevent nuisance actuating due to waves or splashing in the tank.

Relay logic can be inverted so the relay's output contacts change state when the probe is no longer submersed. This makes the unit versatile for use in pump-up and pump-down applications.

### Features & Benefits

FEATURES	BENEFITS
<b>Unique Probe Protection</b>	Probes are protected from scale build up through pulsed DC signal between the probes
<b>Invertible relay logic</b>	Allows flexibility to be used in pump-up and pump-down applications
<b>Adjustable debounce timer</b>	Prevents nuisance actuating caused by waves or splashing in the tank
<b>LED status indicators</b>	Provides visual indication of the relay status

### Specifications

<b>Input Characteristics</b>	
<b>Control Voltage</b>	110/120VAC nominal
<b>Frequency</b>	50/60Hz <i>(Note: 50Hz will increase all delay timers by 20%)</i>
<b>Sensitivity</b>	100kΩ
<b>Functional Characteristics</b>	
<b>Probe Sense Voltage</b>	5vdc pulsed
<b>Debounce Time Delay</b>	2-60 seconds
<b>Output Characteristics</b>	
<b>Output contact Rating – (Two Form A - SPST)</b>	
<b>Pilot Duty</b>	360VA @ 240VAC
<b>General Purpose</b>	8A @ 240VAC
<b>General Characteristics</b>	
<b>Ambient Temperature Range</b>	
<b>Operating Storage</b>	-20° to 70°C (-4° to 158°F) -40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	2 W
<b>Class of Protection</b>	IP20, NEMA 1 (finger safe)
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	4.5 in.-lbs.
<b>Wire</b>	12-20 AWG
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150MHz, 10 V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power and controls

## 460-15-100-LLS

**Surge**

**IEC** IEC 61000-4-5, Level 3, 4kV line-to-line;  
Level 4, 4kV line-to-ground

**ANSI/IEEE** C62.41 Surge and Ring Wave Compliance to  
a level of 6kV line-to-line

**Hi-Potential Test** Meets UL508 (2 x rated V + 1000 V for 1 min.)

**Safety Marks**

**UL** UL508 (File #E68520)

**CE** IEC 60947

**Enclosure** Polycarbonate

**Dimensions** **H** 88.9 mm (3.5"); **W** 52.93 mm (2.08");

**D** 59.69mm (2.35")

**Weight** 1 lb. (16 oz., 453.59 g)

**Mounting Method** 35mm DIN rail or Surface Mount  
(#6 or #8 screws)

# 460-15-100-SLD

## Single-Channel Seal-Leak Detector



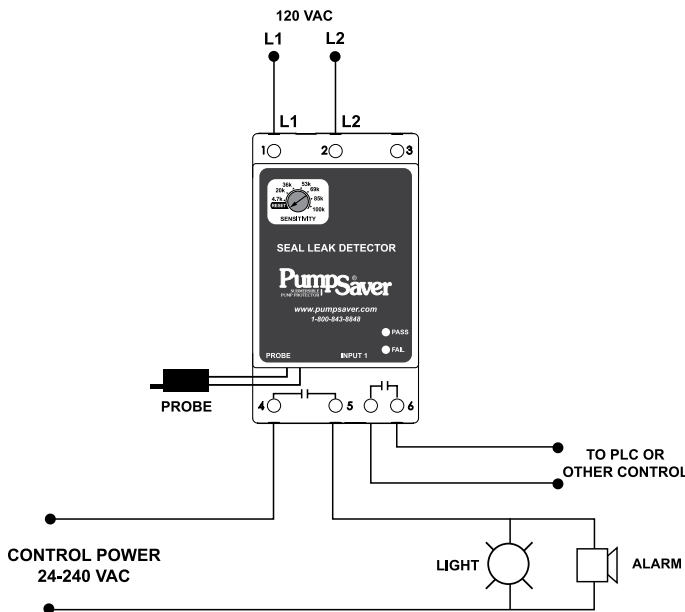
### Description

The 460-15-100-SLD is a seal-leak detector to sense seal failures on submersible pumps. A microcontroller-based relay monitors the shaft seal of a submersible pump motor. A resistive probe is installed in the seal cavity. If water leaks into the pump, the resistance measured by the probe decreases. When the resistance drops below the sensitivity setpoint, the unit will trip and the relay contacts will change state. Output relay logic can be reversed by removing an external jumper. The unit will automatically reset when a fault is cleared.

### Features & Benefits

FEATURES	BENEFITS
<b>Unique probe protection logic</b>	Probes are protected from scale build up through pulsed DC signal between the probes
<b>Invertible relay logic</b>	Allows flexibility to be used in pump-up and pump-down applications
<b>LED status indicators</b>	Provides visual indication of the relay status
<b>2 relay contacts</b>	Control independent loads on different circuits

### Wiring Diagram



For dimensional drawing see: Appendix, page 510, Figure 10.

### Specifications

<b>Input Characteristics</b>	
<b>Control Voltage</b>	110/120VAC nominal
<b>Frequency</b>	50/60Hz (Note: 50Hz will increase all delay timers by 20%)
<b>Functional Characteristics</b>	
<b>Sensitivity</b>	4.7k-100kΩ
<b>Probe Sense Voltage</b>	5vdc pulsed
<b>Output Characteristics</b>	
<b>Output contact Rating – (Two Form A - SPST)</b>	
<b>Pilot Duty</b>	360VA @ 240VAC
<b>General Purpose</b>	8A @ 240VAC
<b>General Characteristics</b>	
<b>Ambient Temperature Range</b>	
<b>Operating</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	2 W
<b>Class of Protection</b>	IP20, NEMA 1 (finger safe)
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	4.5 in.-lbs.
<b>Wire</b>	AWG 12-20 AWG
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150MHz, 10 V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power and controls

## 460-15-100-SLD

**Surge**

**IEC** IEC 61000-4-5, Level 3, 4kV line-to-line;  
Level 4, 4kV line-to-ground

**ANSI/IEEE** C62.41 Surge and Ring Wave Compliance  
to a level of 6kV line-to-line

**Hi-Potential Test** Meets UL508 (2 x rated V + 1000 V for 1 min.)

**Safety Marks**

**UL** UL508 (File #E68520)

**CE** IEC 60947

**Enclosure** Polycarbonate

**Dimensions** **H** 88.9 mm (3.5"); **W** 52.93 mm (2.08");

**D** 59.69 mm (2.35")

**Weight** 1 lb. (16 oz., 453.59 g)

**Mounting Method** 35mm DIN rail or Surface Mount  
(#6 or #8 screws)

# LLC1 SERIES

## Open Board Liquid Level Controls



### Description

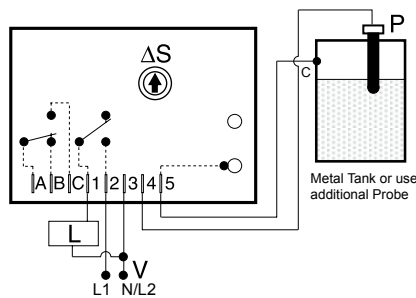
The LLC1 Series is a single probe conductive liquid level control designed for OEM equipment and commercial appliances. This unit may be ordered with fixed fill or fixed drain operation. A time delay (1-60s) prevents rapid cycling of the output relay. On adjustable units, the sensitivity adjustment allows accurate level sensing while ignoring foaming agents and floating debris. Isolated AC voltage is provided at the probe to prevent electrolysis. A trickle current of less than 1mA determines the presence or absence of liquid between the probe and common. The LLC1 Series printed circuit board is conformal coated to resist moisture and corrosion.

### Operation

**Drain (Pump-Down Mode):** When the liquid level rises and touches the probe, a fixed time delay begins. This time delay prevents rapid cycling of the output relay and its load. At the end of the time delay, the output relay energizes and remains energized until the liquid level falls below the probe. The output relay then de-energizes and remains de-energized until the liquid again touches the probe.

**Fill (Pump-Up Mode):** When the liquid level falls below the probe, a fixed time delay begins. This time delay prevents rapid cycling of the output relay and its load. At the end of the time delay, the output relay energizes and remains energized until the liquid level rises and touches the probe. The output relay then de-energizes and remains de-energized until the liquid level again falls below the probe.

### Wiring Diagram



P = Probe  
L = Load  
V = Voltage  
 $\Delta S$  = Sensitivity Adjustment

Contacts A, B & C are isolated.

Connect common to conductive tank or an additional probe as required.

For dimensional drawing see: Appendix, page 514, Figure 40.

### Features & Benefits

FEATURES	BENEFITS
<b>Isolated AC voltage on probe</b>	Prevents scale buildup on the probe
<b>Open PCB design</b>	Cost effective design for OEM equipment and commercial appliances
<b>Conformally coated PCB</b>	Protects against moisture and corrosion
<b>Sensitivity adjustment</b>	Provides accurate level sensing while ignoring foam or floating debris

### Ordering Information

MODEL	INPUT VOLTAGE	OPERATION	TIME DELAY	SENSE RESISTANCE	MOUNTING
LLC14A1AX	120VAC	Drain	1s	Adjustable	0.5 in nylon standoffs (3)
LLC14A5AX	120VAC	Drain	5s	Adjustable	0.5 in nylon standoffs (3)
LLC14B15AX	120VAC	Fill	15s	Adjustable	0.5 in nylon standoffs (3)
LLC14B1AX	120VAC	Fill	1s	Adjustable	0.5 in nylon standoffs (3)
LLC14B60AX	120VAC	Fill	60s	Adjustable	0.5 in nylon standoffs (3)
LLC16A25AX	230VAC	Drain	25s	Adjustable	0.5 in nylon standoffs (3)
LLC16A3AX	230VAC	Drain	3s	Adjustable	0.5 in nylon standoffs (3)

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### LLC1 SERIES

#### Accessories



**P1015-13** (AWG 10/12), **P1015-64** (AWG 14/16), **P1015-14** (AWG 18/22) **Female Quick Connect**  
 These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**  
 Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.



**PHST-38QTN Electrode**  
 Designed for a maximum steam pressure of 240 PSI; 400° F. UL353 Recognized.



**LLP-24 Threaded Probe (24")**  
 Threaded stainless steel probe measuring 24" (61 cm) long. For use with PHST-38QTN liquid level control electrodes.

#### Specifications

##### Control

##### Type

ON/OFF (single level) resistance sensor with built-in time delay to prevent rapid cycling

##### Sense Voltage

Low voltage AC between probe & common. Isolated from input & output.

##### Sense Resistance

Fixed or adjustable to 250KΩ

##### Sense Resistance Tolerance

Adjustable - guaranteed range

Factory fixed ±10%

##### Time Delay

##### Range

Fixed 1 - 60s in 1s increments

##### Input

##### Voltage

24, 120, or 230VAC

##### Tolerance

##### 24VAC

-15% - 20%

##### 120 & 230VAC

-20% - 10%

##### AC Line Frequency

50/60 Hz

##### Output

##### Type

Electromechanical relay

##### Form

Non-isolated, SPST & Isolated, SPDT contacts

##### Rating

10A resistive @ 120/240VAC & 28VDC;

1/3 hp @ 120/240VAC

Mechanical - 1 x 10<sup>7</sup>; Electrical - 1 x 10<sup>5</sup>

##### Life

##### Protection

##### Surge

IEEE C62.41-1991 Level A

##### Isolation Voltage

≥ 1500V RMS between input, output & probe

##### Mechanical

##### Mounting

Surface mount to probe common with two

#6 (M3.5 x 0.6) screws or 0.50 in. (12.7 mm)

nylon standoffs with three #6 (M3.5 x 0.6)

screws (use Terminal 5 for probe common)

0.25 in. (6.35 mm) male quick connect terminals

**H** 88.9 mm (3.5"); **W** 69.9 mm (2.75");

**D** 50.8 mm (2.0")

##### Termination

##### Dimensions (Open Board)

##### Environmental

##### Operating/Storage

##### Temperature

-20° to 55°C/-40° to 80°C

##### Coating

Printed circuit board is conformal coated to

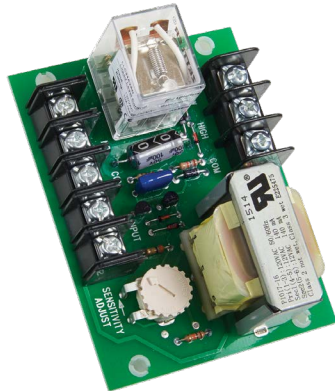
resist moisture and corrosion

##### Weight

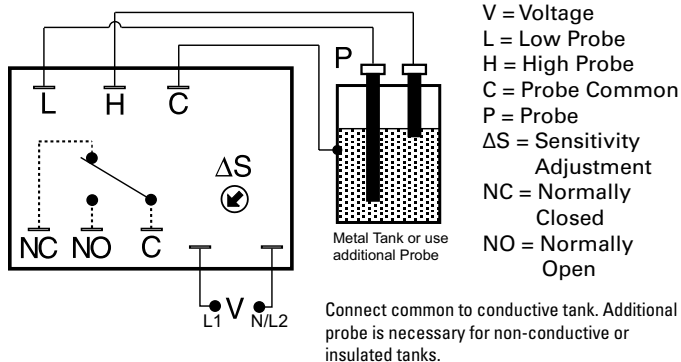
≈ 8.7 oz (247 g)

# LLC2 SERIES

## Open Board Liquid Level Controls



### Wiring Diagram



For dimensional drawing see: Appendix, page 514, Figure 41.

### Ordering Information

MODEL	INPUT VOLTAGE	OPERATION	TERMINATION	SENSE RESISTANCE
LLC24A2AN	120VAC	Drain	Terminal block	Adjustable to 100k $\Omega$
LLC24A2F50N	120VAC	Drain	Terminal block	Fixed 50k $\Omega$
LLC24B1AC	120VAC	Fill	0.25" Quick connect	Adjustable to 100k $\Omega$
LLC24B1F26C	120VAC	Fill	0.25" Quick connect	Fixed 26k $\Omega$
LLC24B2F50N	120VAC	Fill	Terminal block	Fixed 50k $\Omega$
LLC26A1F25C	230VAC	Drain	0.25" Quick connect	Fixed 25k $\Omega$

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### Description

The LLC2 Series is a dual-probe conductive liquid level control designed for OEM equipment and commercial appliance applications. Models are available for fill or drain operation. Transformer isolated 12VAC is provided at the probes to prevent electrolysis. A trickle current of less than 1mA determines the presence or absence of liquid between the probes and common. On adjustable units, the sensitivity adjustment allows accurate level sensing while ignoring foaming agents and floating debris. The LLC2 Series printed circuit board is conformal coated to resist moisture and corrosion.

#### Operation

**Drain (Pump-Down Mode):** When the liquid level rises and touches the high probe, the output relay energizes and remains energized until the liquid level falls below the low probe. The output relay then de-energizes and remains de-energized until the liquid again touches the high probe.

**Fill (Pump-Up Mode):** When the liquid level falls below the low probe, the output relay energizes and remains energized until the liquid level rises and touches the high probe. The output relay then de-energizes and remains de-energized until the liquid level again falls below the low probe.

### Features & Benefits

FEATURES	BENEFITS
<b>Isolated 12VAC probes</b>	Prevents scale buildup on the probes
<b>Open PCB design</b>	Cost effective design for OEM equipment and commercial appliances
<b>Conformally coated PCB</b>	Protects against moisture and corrosion
<b>Sensitivity adjustment</b>	Provides accurate level sensing while ignoring foam or floating debris

### Accessories



**P1015-13 (AWG 10/12), P1015-64 (AWG 14/16), P1015-14 (AWG 18/22) Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**  
Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.



**PHST-38QTN Electrode**  
Designed for a maximum steam pressure of 240 PSI; 400° F. UL353 Recognized.



**LLP-24 Threaded Probe (24")**  
Threaded stainless steel probe measuring 24" (61 cm) long. For use with PHST-38QTN liquid level control electrodes.

# LLC2 SERIES

## Specifications

### Control

**Type** Resistance sensing for high & low level detection of conductive liquids

**Sense Voltage** 12VAC at probe terminals

**Sense Resistance** Fixed or adjustable to 100KΩ

**Sense Resistance Tolerance** Adjustable: guaranteed range  
Fixed: ±10%

### Input

**Voltage** 24, 120, or 230VAC

**Tolerance**

**24VAC** -15% - 20%

**120 & 230VAC** -20% - 10%

**AC Line Frequency** 50/60 Hz

### Output

**Type** Electromechanical relay

**Form** Isolated, SPDT

**Rating** 10A resistive @ 120/240VAC & 28VDC;  
1/3 hp @ 120/240VAC

**Life** Mechanical - 1 x 10<sup>7</sup>; Electrical - 1 x 10<sup>5</sup>

### Protection

**Isolation Voltage** ≥ 1500V RMS between input, output, & probe

### Mechanical

**Mounting** Surface mount with two or four #6 (M3.5 x 0.6) screws

**Termination** 0.25 in. (6.35 mm) duplex male quick connect terminals. Terminal blocks for up to #14 AWG 2.5 mm<sup>2</sup> wire

**Dimensions (Open Board)** **H** 101.6 mm (4.0"); **W** 76.2 mm (3.0"); **D** 50.8 mm (2.0")

### Environmental

#### Operating/Storage

**Temperature** -20° to 55°C / -40° to 80°C

**Coating** Printed circuit board is conformal coated to resist moisture and corrosion

**Weight** ≈ 9 oz (255 g)

## Mounting Dimensions

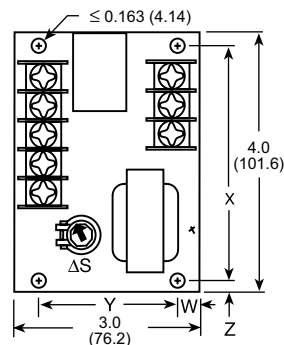


DIAGRAM KEY	MODEL NUMBERS ENDING IN:	
	N	C
W	0.440" (11.176 mm)	0.250" (6.350 mm)
X	3.620" (91.948 mm)	3.500" (88.900 mm)
Y	2.120" (53.848 mm)	2.500" (63.500 mm)
Z	0.190" (4.826 mm)	0.250" (6.350 mm)

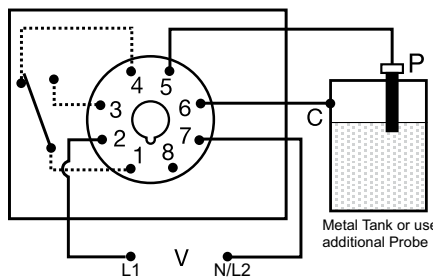
# LLC4 SERIES

## Octal Plug-In Liquid Level Controls



8-PIN

### Wiring Diagram



P = Probe  
C = Probe Common  
V = Voltage

Relay contacts are isolated.

Connect common to conductive tank. Additional probe is necessary for non-conductive or insulated tanks.

For dimensional drawing see: Appendix, page 513, Figure 33.

### Description

The LLC4 combines resistance sensing circuitry with solid-state timing to provide single probe level maintenance. On adjustable units, the sensitivity adjustment allows accurate level sensing while ignoring foaming agents and floating debris. Isolated 12VAC is provided at the probe to prevent electrolysis. A trickle current of less than 1mA determines the presence or absence of conductive liquid between the probe and common. The LLC4 Series can be used with many types of low voltage (resistance changing) transducers to perform other control functions like temperature limit control, photo limit control, condensation sensing, and ice sensing.

#### Operation

**Drain (Pump-Down Mode):** When the liquid level rises and touches the probe, the time delay begins. This time delay prevents rapid cycling of the output relay and its load. At the end of the time delay, the output relay energize and remain energized until the liquid level falls below the probe level. The output relay de-energize and remain de-energized until the liquid rises and touches the probe.

**Fill (Pump-Up Mode):** When the liquid level falls below the probe, the time delay begins. This time delay prevents rapid cycling of the output relay and its load. At the end of the time delay, the output relay energize and remain energized until the liquid level rises and touches the probe. The output relay then de-energize and remain de-energized until the liquid level again falls below the probe level.

### Features & Benefits

FEATURES	BENEFITS
<b>Isolated 12VAC probes</b>	Prevents scale buildup on probe
<b>Industry standard 8-pin octal plug connection</b>	Eliminates need for special connectors
<b>Sensitivity adjustment</b>	Provides accurate level sensing while ignoring foam or floating debris

### Ordering Information

MODEL	INPUT VOLTAGE	OPERATION	TIME DELAY	SENSE RESISTANCE	MODEL	INPUT VOLTAGE	OPERATION	TIME DELAY	SENSE RESISTANCE
LLC42A10A	24VAC	Drain	10s	Adjustable 1 - 250kΩ	LLC44B1A	24VAC	Fill		Adjustable 1 - 250kΩ
LLC42A1A	24VAC	Drain	1s	Adjustable 1 - 250kΩ	LLC44A60A	120VAC	Drain	60s	Adjustable 1 - 250kΩ
LLC42B15A	24VAC	Fill	15s	Adjustable 1 - 250kΩ	LLC44B20A	120VAC	Fill	20s	Adjustable 1 - 250kΩ
LLC44A10A	120VAC	Drain	10s	Adjustable 1 - 250kΩ	LLC44B2A	120VAC	Fill	2s	Adjustable 1 - 250kΩ
LLC44A15A	120VAC	Drain	15s	Adjustable 1 - 250kΩ	LLC44B30A	120VAC	Fill	30s	Adjustable 1 - 250kΩ
LLC44A1A	120VAC	Drain	1s	Adjustable 1 - 250kΩ	LLC44B4A	120VAC	Fill	4s	Adjustable 1 - 250kΩ
LLC44A2A	120VAC	Drain	2s	Adjustable 1 - 250kΩ	LLC44B5A	120VAC	Fill	5s	Adjustable 1 - 250kΩ
LLC44A4A	120VAC	Drain	4s	Adjustable 1 - 250kΩ	LLC44B5F100	120VAC	Fill	5s	Fixed 100kΩ
LLC44A5A	120VAC	Drain	5s	Adjustable 1 - 250kΩ					

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# LLC4 SERIES

## Accessories



**BZ1 Front Panel Mount Kit**  
Provides an easy method of through-the-panel mounting of 8- or 11-pin plug-in timers, flashers, and other controls.



**NDS-8 Octal 8-pin Socket**  
8-pin 35mm DIN rail or surface mount. Surface mounted with two #6 (M 3.5 x 0.6) screws or snaps onto a 35 mm DIN rail. Uses PSC8 hold-down clips.



**PSC8 Hold-down Clips**  
Securely mounts plug-in controls in any position. Provides protection against vibration. Use with NDS-8 Octal Socket. Sold in pairs.



**PHST-38QTN Electrode**  
Designed for a maximum steam pressure of 240 PSI; 400° F. UL353 Recognized.



**LLP-24 Threaded Probe (24")**  
Threaded stainless steel probe measuring 24" (61 cm) long. For use with PHST-38QTN liquid level control electrodes.

## Specifications

### Control Type

ON/OFF (single level) resistance sensor with built-in time delay to prevent rapid cycling  
12VAC

### Sensing Voltage Sensing Resistance Sensing Resistance Tolerance

Fixed or adjustable to 250KΩ

Adjustable: 1K ±500Ω at low end;  
250K ±25% at high end  
Factory fixed: ±10% or 500Ω, whichever is greater

### Input

#### Voltage Tolerance

24, 120, or 230VAC

#### 24VAC 120 & 230VAC

-15%, +20%  
-20%, +10%

#### AC Line Frequency

50/60 Hz

### Output

#### Type

Electromechanical relay

#### Form

Isolated, SPDT

#### Rating

4A resistive @ 240VAC;  
1/10 hp @ 240VAC

### Protection

#### Surge

IEEE C62.41-1991 Level A

#### Isolation Voltage

≥ 1500V RMS between input, output & probe

### Mechanical

#### Mounting

Plug-in socket

#### Termination

Octal 8-pin plug-in

#### Dimensions

**H** 73.9 mm (2.91"); **W** 60.7 mm (2.39");  
**D** 45.2 mm (1.78")

### Environmental

#### Operating/Storage

#### Temperature

-20° to 60°C/-40° to 80°C

#### Weight

≈ 6 oz (170 g)

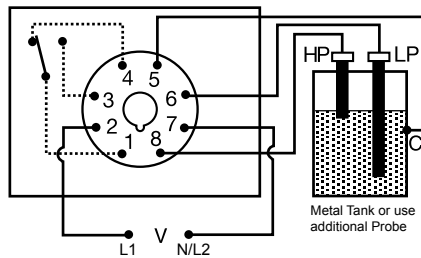
# LLC5 SERIES

## Liquid Level Controls



8-PIN

### Wiring Diagram



HP = HIGH LEVEL PROBE  
LP = LOW LEVEL PROBE  
C = PROBE COMMON  
V = VOLTAGE

Relay contacts are isolated.  
Connect common to  
conductive tank. Additional  
probe is necessary for non-  
conductive or insulated tanks.

Metal Tank or use  
additional Probe

For dimensional drawing see: Appendix, page 514, Figure 43.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
LLC52AA	24VAC	For Drain (pump-down) operation with adjustable sense resistance
LLC52BA	24VAC	For Fill (pump-up) operation with adjustable sense resistance
LLC54AA	120VAC	For Drain (pump-down) operation with adjustable sense resistance
LLC54AAS	120VAC	For Drain (pump-down) operation with adjustable sense resistance and reverse connection (#8 low, #6 high)
LLC54AF10	120VAC	For Drain (pump-down) operation with fixed sense resistance of 10 kΩ
LLC54BA	120VAC	For Fill (pump-up) operation with adjustable sense resistance
LLC54BAS	120VAC	For Fill (pump-up) operation with adjustable sense resistance and reverse connection (#8 low, #6 high)
LLC56AA	230 VAC	For Drain (pump-down) operation with adjustable sense resistance

### Description

The LLC5 provides dual probe conductive liquid level control in a convenient octal plug-in package. Models are available for fixed fill or drain operation. Isolated, pulsed DC voltage on the probes prevents electrolytic plating. Less than 1 mA of current is used to sense the presence of conductive liquid between the probes and common. On adjustable units, the sensitivity adjustment eliminates false tripping caused by floating debris and foaming agents.

#### Operation

**Drain (Pump-Down Mode):** When the liquid level rises and touches the high level probe, the output relay and LED energize and remain energized until the liquid level falls below the low level probe. The output relay and LED de-energize and remain de-energized until the liquid rises and touches the high level probe.

**Fill (Pump-Up Mode):** When the liquid level falls below the low level probe, the output relay and LED energize and remain energized until the liquid level rises and touches the high level probe. The output relay and LED de-energize and remain de-energized until the liquid level again falls below the low level probe.

### Features & Benefits

FEATURES	BENEFITS
<b>Unique Probe Protection logic</b>	Probes are protected from scale build up through pulsed DC signal between the probes.
<b>LED status indicator</b>	Visual indication of relay engagement in pump-up or pump-down activity
<b>Isolated 5A SPDT contacts</b>	Allows control of loads for AC voltage

### Accessories



#### BZ1 Front Panel Mount Kit

Provides an easy method of through-the-panel mounting of 8- or 11-pin plug-in timers, flashers, and other controls.



#### NDS-8 Octal 8-pin Socket

8-pin 35mm DIN rail or surface mount. Rated at 10A @ 300VAC. Surface mounted with two #6 (M 3.5 x 0.6) screws or snaps onto a 35 mm DIN rail. Uses PSC8 hold-down clips.



#### PSC8 Hold-down Clips

Securely mounts plug-in controls in any position. Provides protection against vibration. Use with NDS-8 Octal Socket. Sold in pairs.

**Note:** use of the PSC8 clips partly covers the LED window of the LLC5 unit. Use of alternative socket base P1011-6 with its corresponding hold down clips PSCRB8 do not cover up the LED window, but the socket base is not DIN rail mountable.

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# LLC5 SERIES

## Accessories



### PHST-38QTN Electrode

Designed for a maximum steam pressure of 240 PSI; 400° F. UL353 Recognized.



### LLP-24 Threaded Probe (24")

Threaded stainless steel probe measuring 24" (61 cm) long. For use with PHST-38QTN liquid level control electrodes.

## Specifications

### Control

#### Type

Resistance sensing for high & low level detection of conductive liquids  
Pulsed DC at probe terminals  
Factory fixed or adjustable to 100KΩ

#### Sensing Voltage

#### Sensing Resistance

#### Sensing Resistance

#### Tolerance

Adjustable: 1K ±500Ω at low end;  
100KΩ ±25%, 0% at high end  
Factory fixed: ±10% or 500Ω whichever is greater

#### Response Time

#### Input

#### Tolerance

#### 24VAC

#### 120 & 230VAC

#### AC Line Frequency

-15%, +20%

-20%, +10%

50/60 Hz

#### Output

#### Type

#### Form

#### Rating

#### Protection

#### Isolation Voltage

#### Mechanical

#### Mounting

#### Dimensions

Electromechanical relay

Isolated, SPDT

5A resistive @ 240VAC, 1/10 hp @ 240VAC

≥ 1500V RMS between input, output, & probe

Plug-in socket

**H** 60.7 mm (2.39"); **W** 45.2 mm (1.78");

**D** 76.5 mm (3.01")

#### Termination

#### Environmental

#### Operating/Storage

#### Temperature

#### Weight

Octal 8-pin plug-in

-20° to 60°C / -40° to 80°C

6 oz (170 g) approx.

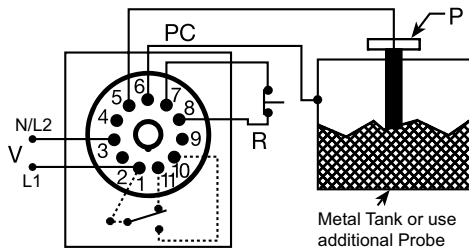
## LLC6 SERIES

### Low Level Cutoff Liquid Level Controls



11-PIN

### Wiring Diagram



PC = Probe  
Common  
P = Probe  
V = Voltage  
R = Optional NC  
Reset Switch

Connect common to conductive tank. Additional probe is necessary for non-conductive or insulated tanks.

For dimensional drawing see: Appendix, page 513, Figure 33.

### Description

The LLC6 Series is a plug-in, single-probe conductive liquid level control designed for low liquid level cutoff protection. It offers a factory fixed time delay of 1 - 60s and is available in input voltages of 24, 120, or 230VAC. LED indicator illuminates whenever the LLC6's 10A, SPDT output relay is energized. Available with automatic/manual reset or a special manual reset with power outage feature, which auto resets the unit when power is restored and the water level is acceptable. 24VAC and 120VAC units are recognized as limit switches under UL353 (230VAC units are UL508) and CSA certified under Standard 14.

### Operation

**Automatic Reset (Reset terminals not connected):** When liquid rises to the low level cutoff probe, the output relay and the LED indicator energize. When the liquid falls below low level cutoff probe, the output relay and the LED indicator de-energize after a fixed time delay.

**Manual Reset (Reset switch connected):** When the liquid level falls below the low level probe, the output relay and LED de-energize after a fixed time delay. When the liquid level rises to the low level probe, the output relay and LED indicator remain de-energized until the manual reset switch is opened; then they energize immediately.

**Power Outage Manual Reset (Reset switch connected):** A power outage causes the output relay and LED indicator to de-energize. Upon restoration of power, if the liquid level is above the low level probe, the output relay and LED indicator will re-energize. If the liquid level is below the low level probe, the output relay and LED indicator remain de-energized until the Normally Closed (NC) reset switch is opened.

### Features & Benefits

FEATURES	BENEFITS
<b>Isolated 12VAC on probe</b>	Prevents electrolysis
<b>Industry standard 11-pin octal plug connection</b>	Eliminates need for special connectors
<b>LED indication</b>	Visual indication output relay is energized
<b>Power outage protection (see ordering table for models)</b>	Automatically resets the unit when power is restored and the water level is acceptable

### Ordering Information

MODEL	INPUT VOLTAGE	TIME DELAY (FIXED)	SENSE RESISTANCE	RESET
LLC6210F10M	24VAC	10s	10kΩ	Manual/Automatic
LLC6410F10M	120VAC	10s	10kΩ	Manual/Automatic
LLC643F26M	120VAC	3s	26kΩ	Manual/Automatic
LLC6610F5P	230VAC	10s	5kΩ	Power Outage Manual Reset

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# LLC6 SERIES

## Accessories



### BZ1 Front Panel Mount Kit

Provides an easy method of through-the-panel mounting of 8- or 11-pin plug-in timers, flashers, and other controls.



### NDS-11 11-pin Socket

11-pin 35mm DIN rail or surface mount. Surface mounted with two #6 (M 3.5 x 0.6) screws or snaps onto a 35 mm DIN rail. Uses PSC11 hold-down clips.



### PSC11 Hold-down Clips

Securely mounts plug-in controls in any position. Provides protection against vibration. Use with NDS-11 Socket. Sold in pairs.



### PHST-38QTN Electrode

Designed for a maximum steam pressure of 240 PSI; 400° F. UL353 Recognized.



### LLP-24 Threaded Probe (24")

Threaded stainless steel probe measuring 24" (61 cm) long. For use with PHST-38QTN liquid level control electrodes.

## Specifications

### Control

#### Type

ON/OFF (single level) resistance sensor with built-in time delay to prevent rapid cycling  
12VAC nominal at probe terminals

#### Sense Voltage

#### Sense Resistance

Fixed 5K - 250KΩ

#### Sense Resistance Tolerance

Fixed ±10%

### Time Delay

#### Range

1 - 60s in 1s increments

#### Tolerance

±20%

#### Repeat Accuracy

±10%

#### Time Delay vs Temp.

±10%

#### & Voltage

#### Power Outage Reset Delay

≤ 1s

### Input

#### Voltage

24, 120, or 230VAC

#### Tolerance

#### 24VAC

+20% to -15%

#### 120 or 230VAC

+10% to -20%

#### AC Line Frequency

50/60 Hz

### Output

#### Type

Electromechanical relay

#### Form

Non-isolated, SPDT

#### Rating

10A resistive @ 240VAC; 1/4 hp @ 125VAC;

1/2 hp @ 250VAC

### Protection

#### Surge

IEEE C62.41-1991 Level A

#### Isolation Voltage

≥ 2500V RMS between input & output terminals

### Mechanical

#### Mounting

Plug-in socket

#### Termination

11-pin relay type

#### Dimensions

**H** 73.9 mm (2.91"); **W** 60.7 mm (2.39");

**D** 45.2 mm (1.78")

### Environmental

#### Operating/Storage

#### Temperature

-40° to 60°C / -40° to 80°C

#### Humidity

95% relative, non-condensing

#### Weight

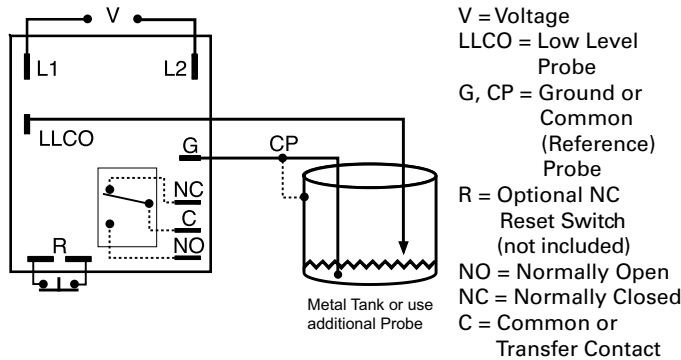
≈ 7.3 oz (207 g)

# LLC8 SERIES

## Low Level Cutoff Liquid Level Controls



### Wiring Diagram



Relay contacts are isolated. Connect common to conductive tank. Additional probe is necessary for non-conductive or insulated tanks.

For dimensional drawing see: Appendix, page 514, Figure 42.

### Ordering Information

MODEL	INPUT VOLTAGE	TIME DELAY (FIXED)	SENSE RESISTANCE	RESET
LLC825F5M	24VAC	5s	5kΩ	Manual/automatic
LLC842F103M	120VAC	2s	10kΩ	Manual/automatic
LLC843F10M	120VAC	3s	10kΩ	Manual/automatic
LLC843F10P	120VAC	3s	10kΩ	Power outage manual reset
LLC843F26M	120VAC	3s	26kΩ	Manual/automatic
LLC843F26P	120VAC	3s	26kΩ	Power outage manual reset
LLC845F25P	120VAC	5s	25kΩ	Power outage manual reset
LLC8430F250P	120VAC	30s	250kΩ	Power outage manual reset
LLC8430F26P	120VAC	30s	26kΩ	Power outage manual reset
LLC8610F12M	230VAC	10s	12kΩ	Manual/automatic
LLC863F26P	230VAC	3s	26kΩ	Power outage manual reset

If you don't find the part you need, call us for a custom product 800-843-8848

### Description

The LLC8 Series is a low cost, single-probe conductive liquid level control designed for low liquid level cutoff protection. It offers a factory fixed time delay of 1 - 60s and is available for input voltages of 24, 120, or 230VAC. LED indicator illuminates whenever the LLC8's isolated, 10A, SPDT output relay is energized. Sense resistance is fixed from 5K - 250KΩ. Available with manual/automatic reset or a special manual reset with a power outage feature that auto resets the unit when power is restored and the water level is acceptable. 24 and 120VAC units are UL recognized as limit switches under UL353 (230VAC units are UL 508) and CSA certified under Standard 14.

### Operation

**Automatic Reset (Reset switch not connected):** When liquid rises to low level cutoff probe, output relay and LED indicator energize. When liquid falls below the low level cutoff probe, the output relay and LED indicator de-energize after a fixed time delay.

**Manual Reset (Reset switch connected):** When the liquid level falls below low level probe, the output relay and LED de-energize after a fixed time delay. When the liquid level rises to low level probe, the output relay and LED indicator remain de-energized until the NC manual reset switch is opened; then they energize immediately.

**Power Outage Manual Reset (Reset switch connected):** A power outage causes the output relay and LED indicator to de-energize. Upon restoration of power, if the liquid is touching the low level probe, the output relay and LED indicator will re-energize. If the liquid level is below the low level probe, the output relay and LED indicator remain de-energized until the NC reset switch is opened.

### Features & Benefits

FEATURES	BENEFITS
<b>Isolated 12VAC probes</b>	Prevents scale buildup on probe
<b>Open PCB design</b>	Cost effective design for OEM low liquid level cutoff protection
<b>Conformally coated PCB</b>	Protects against moisture and corrosion
<b>LED indication</b>	Visual indication output relay is energized
<b>Power outage protection (see ordering table for models)</b>	Automatically resets the unit when power is restored and the water level is acceptable
<b>24VAC &amp; 120VAC models meet UL353</b>	Required for use as a low level limit switch

### LLC8 SERIES

#### Accessories



**P1015-13** (AWG 10/12), **P1015-64** (AWG 14/16), **P1015-14** (AWG 18/22) **Female Quick Connect**  
 These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**  
 Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.



**PHST-38QTN Electrode**  
 Designed for a maximum steam pressure of 240 PSI; 400° F. UL353 Recognized.



**LLP-24 Threaded Probe (24")**  
 Threaded stainless steel probe measuring 24" (61 cm) long. For use with PHST-38QTN liquid level control electrodes.

#### Specifications

##### Control

##### Type

Resistance sensing for conductive liquids with time delay

##### Sense Voltage

12VAC nominal at probe terminals

##### Sense Resistance

Fixed 5K - 250KΩ

##### Sense Resistance Tolerance

±10%

##### Time Delay

##### Tolerance

±20%

##### Repeat Accuracy

±10%

##### Time Delay vs Temp.

##### & Voltage

±10%

##### Power Outage Reset Delay

≤1s

##### Input

##### Voltage

24, 120, or 230VAC

##### Tolerance

##### 24VAC

-15% - 20%

##### 120 or 230VAC

-20% - 10%

##### AC Line Frequency

50/60 Hz

##### Output

##### Type

Electromechanical relay

##### Form

Isolated SPDT

##### Rating

10A resistive @ 120/240VAC;

1/4 hp @ 125VAC; 1/2 hp @ 250VAC

##### Protection

##### Surge

IEEE C62.41-1991 Level A

##### Isolation Voltage

≥ 2500V RMS input to output terminals

##### Mechanical

##### Mounting

0.5 in. (12.7 mm) x .187 (4.76 mm) dia. nylon standoffs (3)

##### Termination

##### Dimensions

**H** 63.5 mm (2.5"); **W** 55.6 mm (2.19");

**D** 47.8 mm (1.88")

##### Electrical

##### Reset Switch & Probe(s)

0.25 in. (6.35 mm) male quick connect terminals

0.187 x 0.03 in. (4.75 x 0.76 mm) male quick connect terminals

connect terminals

##### Environmental

##### Operating/Storage

##### Temperature

-40° to 60°C / -40° to 80°C

##### Coating

Printed circuit board is conformal coated to resist moisture & corrosion

##### Humidity

95% relative, non-condensing

##### Weight

≈ 5 oz (141.7 g)

# Protection Relays

## Pump Controls and Liquid Level Controls – Alternating Relays

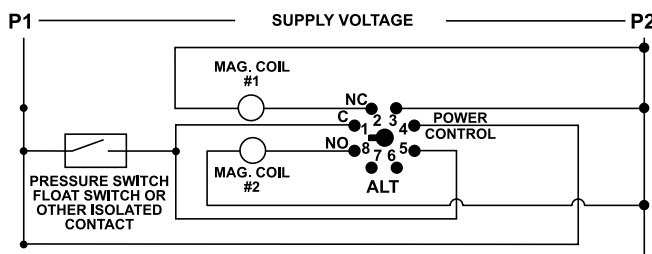
### ALT SERIES

#### 8-pin Plug-in Alternating Relay

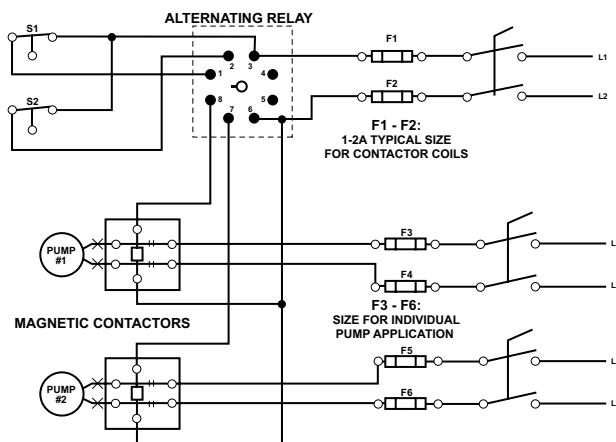


#### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR THE ALT-S



TYPICAL WIRING DIAGRAM FOR THE ALT-X (CROSS CONNECTED)



For dimensional drawing see: Appendix, page 509, Figure 8.

#### Accessories



##### OT08PC Octal 8-pin Socket

8-pin 35mm DIN rail or surface mount. Rated at 10A @ 600VAC. Surface mounted with two #6 screws or snaps onto a 35 mm DIN rail.

#### Description

The ALT alternating relays are used to alternate between two loads. The ALT is commonly used in duplex pumping applications to balance the runtime of both pumps.

The **ALT-S** is used in single high-level float applications. When the float switch opens, the alternating relay changes state, forcing the other pump to run the next time the float closes. All ALT relays have a built-in debounce feature that prevents the relay from changing state if the switch or float contact bounces momentarily.

The **ALT-X** has an internal cross-connected relay and is used in dual high-level float applications. These floats are commonly referred to as lead and lag floats.

The pumps alternate as in the ALT-S version but the cross-connected relay configuration allows both pumps to run simultaneously when both the lead and lag floats are closed.

These relays are also available with a built-in switch (SW option) that is used to manually force one of the pumps to run every time the float switch is closed. This is helpful when a pump has been removed for repair or for test purposes. In the case of the **ALT-X-SW**, the switch essentially forces one pump to be the lead pump, while still allowing the second to run when both floats are closed.

**Must use the OT08PC socket for UL Rating!**

\*Note: Manufacturer's recommended screw terminal torque for the OT Series Octal Sockets is 12 in.-lbs.

#### Features & Benefits

FEATURES	BENEFITS
<b>Debounce time delay</b>	Prevents nuisance actuating causes by waves or spashing in the tank
<b>Built-in manual/auto switch</b>	Force lead pump operation when a pump is removed for repair or testing (on select models)

#### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
ALT024-S <sup>†</sup>	20-26VAC or VDC	For single high-level float applications
ALT024-S-SW <sup>†</sup>	20-26VAC or VDC	For single high-level float applications with built in manual switch
ALT115-S	95-125VAC	For single high-level float applications
ALT115-S-SW	95-125VAC	For single high-level float applications with built in manual switch
ALT115-X	95-125VAC	For dual high-level (lead and lag) float applications
ALT115-X-SW	95-125VAC	For dual high-level (lead and lag) float applications with built in manual switch
ALT230-S	195-250VAC	For single high-level float applications
ALT230-S-SW	195-250VAC	For single high-level float applications with built in manual switch
ALT230-X	195-250VAC	For dual high-level (lead and lag) float applications
ALT230-X-SW	195-250VAC	For dual high-level (lead and lag) float applications with built in manual switch

<sup>†</sup>ALT024-S and ALT024-S-SW are not UL Listed



### ALT SERIES

#### Specifications

<b>Input Characteristics</b>	
<b>Supply Current</b>	40mA
<b>Functional Characteristics</b>	
<b>Debounce Time Delay</b>	0.5 second
<b>Control Input Impedance (min)</b>	
<b>24</b>	10kΩ
<b>115</b>	56kΩ
<b>230</b>	100kΩ
<b>Output Characteristics</b>	
<b>Output Contact Rating</b>	480VA @ 240VAC

#### General Characteristics

<b>Temperature Range</b>	-40° to 50°C (-40° to 122°F)
<b>Maximum Input Power</b>	5 W
<b>Safety Marks</b>	
<b>UL (OT08PC octal socket required)</b>	UL508 (File #E68520) C22.2 No. 14 (File #46510)
<b>CSA</b>	
<b>Dimensions (with socket)</b>	<b>H</b> 44.45 mm (1.75"); <b>W</b> 60.33 mm (2.375"); <b>D</b> 104.78 mm (4.125")
<b>Weight</b>	0.38 lb. (6.08 oz., 172.67 g)
<b>Mounting Method</b>	DIN rail or surface mount (plug into OT08PC socket)
<b>Socket Available</b>	OT08PC (UL Rating 600V)

The 600V socket can be surface mounted or installed on DIN Rail.

# ALT-XXX-1-SW / ALT-XXX-3-SW SERIES

## Alternating Relay



### Description

The ALT-xxx-1-SW/ALT-xxx-3-SW Series are used to alternate between two loads and are commonly used in duplex pump-up and pump-down applications to balance the runtime of both pumps.

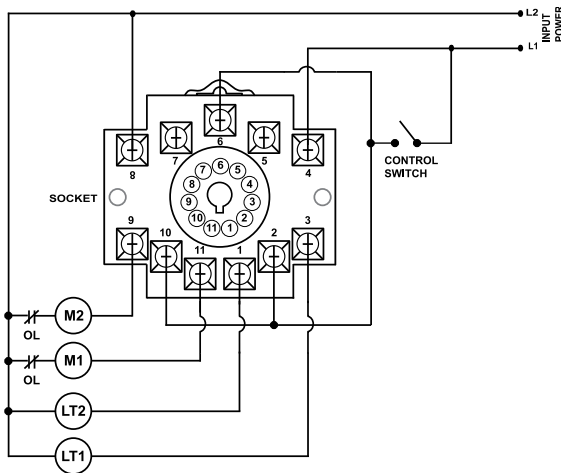
The ALT relays have a built-in debounce time delay that prevents the relay from changing state if the float momentarily bounces, and they have a built-in switch to manually force a specific load (pump) to operate each time the input float closes. This is helpful when performing periodic maintenance or pump repair.

**Must use the OT08PC socket for the 8-pin models, and the OT11PC socket for the 11-pin models, for UL Rating!**

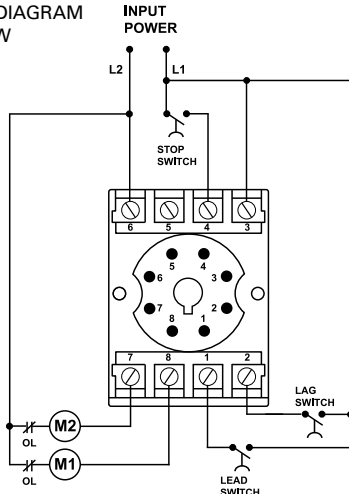
\*Note: Manufacturer's recommended screw terminal torque for the OT Series Octal Sockets is 12 in.-lbs.

### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR ALT-XXX-1-SW



TYPICAL WIRING DIAGRAM FOR ALT-XXX-3-SW



### Features & Benefits

FEATURES	BENEFITS
<b>Debounce time delay</b>	Prevents rapid cycling caused by waves or splashing in the tank
<b>LED indicators</b>	Visual indication of load operation in duplex application
<b>Built-in manual switch to force load operation</b>	Helpful to control load operation when performing periodic maintenance or pump repair
<b>ALT-xxx-3-SW offers duplexing</b>	Allows lag pump to energize if lead pump can't handle current demand

### Accessories



#### OT08PC 8-pin Octal Socket

Octal Socket for plug-in units. 8-pin surface & DIN rail mountable. Rated for 10A @ 600VAC.



#### OT11PC 11-pin Magnal Socket

11-pin surface & DIN rail mountable. Rated for 10A @ 300VAC

### Ordering Information

MODEL	LINE VOLTAGE	MOUNTING	DESCRIPTION
ALT-100-1-SW	95-120VAC	11-pin magnal	Single float input, two isolated Form C relays (DPDT), 2 LEDs for load indication
ALT-100-3-SW	95-120VAC	8-pin octal	Three float inputs (lead, lag, stop floats), actuating latching relays on lead/lag floats, 2 LEDs for load indication
ALT-200-3-SW	190-240VAC	8-pin octal	Three float inputs (lead, lag, stop floats), actuating latching relays on lead/lag floats, 2 LEDs for load indication

For dimensional drawing see: Appendix, page 509, Figure 8.

## ALT-XXX-1-SW / ALT-XXX-3-SW SERIES

### Specifications

#### Input Characteristics

##### Supply Voltage

**ALT-100-1-SW,** 95-120VAC

**ALT-100-3-SW,** 190-240VAC

**ALT-200-3-SW** 50/60Hz

#### Functional Characteristics

##### Debounce Time Delay

**ALT-100-1-SW,** 1 second

**ALT-100-3-SW,** 5 seconds

**ALT-200-3-SW**

#### Output Characteristics

##### Output Relay (DPDT)

**Pilot Duty** 480VA @ 240VAC

**General Purpose** 10A @ 240VAC

#### General Characteristics

**Temperature Range** -40° to 70°C (-40° to 158°F)

**Maximum Input Power** 5 W

#### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air  
**Radio Frequency, Radiated** 150MHz, 10V/m

**Fast Transient Burst** IEC 61000-4-4, Level 3, 3.5kV  
input power and controls

#### Safety Marks

**UL (OT08PC or OT11PC**  
**octal socket required)**

UL508 (File #E68520)

#### CE

IEC 60947-6-2

#### Dimensions

**H** 44.45 mm (1.75"); **W** 60.33 mm (2.375");

**D** 104.78 mm (4.125") (with socket)

#### Weight

0.65 lb. (10.4 oz., 294.84 g)

#### Mounting Method

DIN rail or surface mount (plug into OT08PC  
or OT11PC socket)

#### Sockets Available

**Model OT08PC**

UL Rating 600V

**Model OT11PC**

UL Rating 300V

The sockets can be surface mounted or installed on DIN Rail.

# ARP SERIES

## Alternating Relay



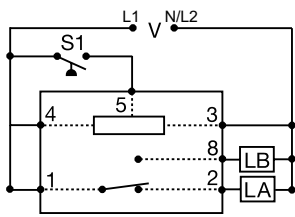
8-PIN



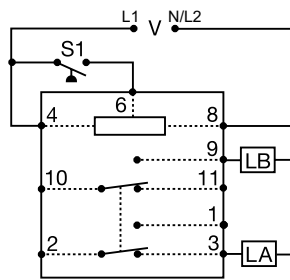
11-PIN

### Wiring Diagram

SPDT 8-PIN

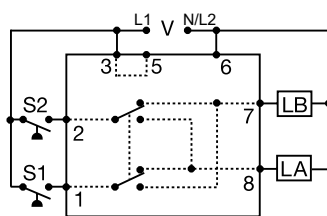


DPDT 11-PIN



Relay contacts in above are isolated.

DPDT 8-PIN CROSS WIRED



V = VOLTAGE  
LA = LOAD A  
LB = LOAD B  
S1 = PRIMARY CONTROL SWITCH  
S2 = LAG LOAD SWITCH

For dimensional drawing see: Appendix, page 514, Figure 46.

### Description

The ARP Series is used in systems where equal run time for two motors is desirable. The selector switch allows selection of alternation or for continuous operation of either load. LED's indicate the status of the output relay. This versatile series may be front panel mounted (BZ1 accessory required) or 35 mm DIN rail mounted with an accessory socket.

### Operation

**Alternating:** When the rotary switch is in the "alternate" position, alternating operation of Load A and Load B occurs upon the opening of the control switch S1. To terminate alternating operation and cause only the selected load to operate, rotate the switch to position "A" to lock Load A or position "B" to lock Load B. The LEDs indicate the status of the internal relay and which load is selected to operate.

**Note:** Input voltage must be applied at all times for proper alternation. The use of a solid-state control switch for S1 may not initiate alternation correctly. S1 voltage must be from the same supply as the unit's input voltage (see connection diagrams). Loss of input voltage resets the unit; Load A becomes the lead load for the next operation.

**Duplexing (Cross-Wired):** Duplexing models operate the same as alternating relays and when both the Control (S1) and Lag Load (S2) Switches are closed, Load A and Load B energize simultaneously.

The DPDT 8-pin, cross-wired option, allows extra system load capacity through simultaneous operation of both motors when needed. Relay contacts are not isolated.

### Features & Benefits

FEATURES	BENEFITS
<b>Alternating or electrically locked operation</b>	Flexibility to run unit alternating between the two loads as normal or lock the relay to one specific load.
<b>Low profile selector switch</b>	Prevents accidental actuation
<b>LED status indication</b>	Visual indication of which load is engaged
<b>Industry standard base connection</b>	Flexibility to use in many applications

### Ordering Information

MODEL	LINE VOLTAGE	OUTPUT FORM	DESCRIPTION
AR120A-3095	120VAC	SPDT	8-pin for alternating applications. Rotary switch allows user to lock internal relay to one specific load.
ARP23S	24VAC	DPDT	8-pin cross-wired for duplexing applications. Rotary switch allows user to lock internal relay to one specific load.
ARP41	120VAC	SPDT	8-pin for alternating applications.
ARP41S	120VAC	SPDT	8-pin for alternating applications. Rotary switch allows user to lock internal relay to one specific load.
ARP42S	120VAC	DPDT	11-pin for alternating applications. Rotary switch allows user to lock internal relay to one specific load.
ARP43	120VAC	DPDT	8-pin cross-wired for duplexing applications.
ARP43S	120VAC	DPDT	8-pin cross-wired for duplexing applications. Rotary switch allows user to lock internal relay to one specific load.
ARP61S	230VAC	SPDT	8-pin for alternating applications. Rotary switch allows user to lock internal relay to one specific load.
ARP62S	230VAC	DPDT	11-pin for alternating applications. Rotary switch allows user to lock internal relay to one specific load.
ARP63S	230VAC	DPDT	8-pin cross-wired for duplexing applications. Rotary switch allows user to lock internal relay to one specific load.

If you don't find the part you need, call us for a custom product 800-843-8848

## ARP SERIES

### Accessories



#### BZ1 Front Panel Mount Kit

Provides an easy method of through-the-panel mounting of 8- or 11-pin plug-in timers, flashers, and other controls.



#### NDS-8 Octal 8-pin Socket

8-pin 35mm DIN rail or surface mount. Rated at 10A @ 300VAC. Surface mounted with two #6 (M 3.5 x 0.6) screws or snaps onto a 35 mm DIN rail. Uses PSC8 hold-down clips.



#### NDS-11 11-pin Socket

1-pin 35mm DIN rail or surface mount. Rated at 10A @ 300VAC. Surface mounted with two #6 (M 3.5 x 0.6) screws or snaps onto a 35 mm DIN rail. Uses PSC11 hold-down clips.



#### PSC8 or PSC11 Hold-down Clips

Securely mounts plug-in controls in any position. Provides protection against vibration. Use PSC8 with NDS-8 Octal Socket or PSC11 with NDS-11 Socket. Sold in pairs.



#### C103PM (AL) DIN Rail

35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.

### Specifications

#### Input

##### Tolerance

**24VAC**

-15% to 20%

**120 & 230VAC**

-20% to 10%

##### AC Line Frequency

50/60Hz

#### Output

##### Type

Electromechanical relay

##### Form

SPDT, DPDT, or cross-wired DPDT

##### Rating

10A resistive @ 120/240VAC & 28 VDC;

1/3 hp @ 120/240VAC

250VAC

Mechanical - 1 x 10<sup>7</sup>; Electrical - 1 x 10<sup>6</sup>

##### Maximum Voltage

##### Life

##### Protection

##### Isolation Voltage

≥ 1500V RMS input to output

#### Mechanical

##### Mounting

Plug-in socket

##### Dimensions

H 60.7 mm (2.39"); W 45.2 mm (1.78");

D 81.3 mm (3.2")

##### Termination

##### Environmental

##### Operating/Storage

##### Temperature

-20° to 60°C / -30° to 85°C

##### Weight

5.6 oz (159 g) approx.

NOTE: Unit does not have debounce time delay.

# 50R-400-ALT

480VAC Application, Panel Mount

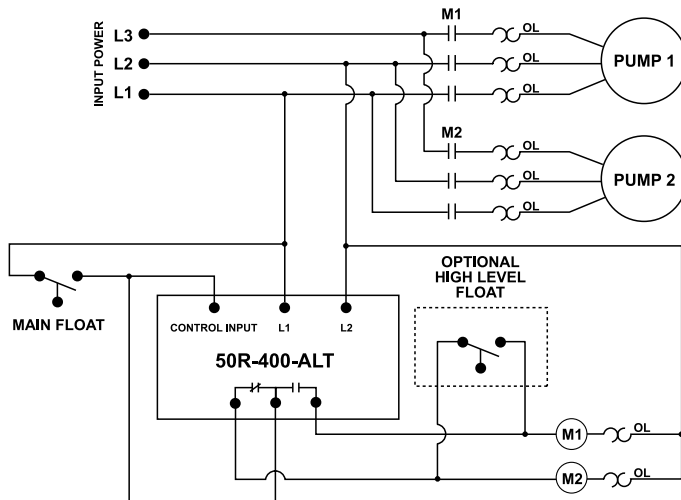


## Description

The 50R-400-ALT alternating relays are used to alternate between two loads, most commonly in duplex pumping and compressor applications to balance the runtime of both loads. When used in single float applications, the alternating relay changes state after the float switch opens\*, forcing the other pump to run the next time the float closes. When used in dual float applications, the alternating relay will allow both pumps to run simultaneously when the lead and lag floats are both closed. An adjustment knob provides the option to force one pump to run every time the float switch is closed. This is helpful when one pump has been removed for repair or for test purposes. A built-in debounce feature prevents the alternating relay from changing state if the float contact bounces momentarily.

\*The alternating relay will not switch states while current is flowing. Switching will only occur after current has been sensed, followed by loss of current for the duration of the debounce time delay.

## Wiring Diagram



For dimensional drawing see: Appendix, page 509, Figure 6.

## Features & Benefits

FEATURES	BENEFITS
<b>Debounce time delay</b>	Prevents rapid cycling caused by waves or splashing in the tank
<b>LED indicators</b>	Visual indication of load operation in duplex application
<b>Built-in manual switch to force load operation</b>	Helpful to control load operation when performing periodic maintenance or pump repair
<b>Operates from 380 - 480VAC</b>	No transformer required to provide 120 - 240V for control circuit

## Specifications

<b>Input Characteristics</b>	
<b>Supply Voltage</b>	380-480VAC
<b>Supply Current</b>	40mA
<b>Functional Characteristics</b>	
<b>Control Input Impedance (min)</b>	1MΩ
<b>Output Characteristics</b>	
<b>Output Contact Rating</b>	
<b>Pilot Duty</b>	470VA @ 600VAC
<b>General Purpose</b>	10A
<b>Debounce Time Delay</b>	1 second
<b>General Characteristics</b>	
<b>Maximum Input Power</b>	5 W
<b>Terminal</b>	
<b>Torque</b>	7 in.-lbs.
<b>Wire Size</b>	12-18AWG
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947
<b>Dimensions</b>	<b>H</b> 74.4 mm (2.93"); <b>W</b> 133.9 mm (5.27"); <b>D</b> 74.9 mm (2.95")
<b>Weight</b>	0.98 lb. (15.68 oz., 444.52 g)
<b>Mounting Method</b>	#8 screws



# ISS-100

## Single-Channel Intrinsically Safe Switch



### Description

The ISS-100 switches are UL 913 listed as an associated apparatus for interfacing between hazardous and non-hazardous areas. These units must be installed in a non-hazardous area.

### Features & Benefits

FEATURES	BENEFITS
<b>Finger-safe terminals</b>	Meets IEC 61000 safety requirements
<b>Compact design for DIN rail or surface mount</b>	Allows flexibility in panel installation
<b>LED Status Indicator</b>	Visual indication of relay engagement
<b>Isolated output relay</b>	Allows connection to PLC or control voltage

### Specifications

#### Input Characteristics

**Supply Voltage** 90-120VAC

#### Functional Characteristics

**Probe Sense Voltage** 5vdc continuous

#### Output Characteristics

##### Output Contact Rating

**Pilot Duty** 180VA @120VAC, C300

**General Purpose** 8A @120VAC

**Relay Contact Life (Electrical)** 100,000 cycles min. @ rated load

**Relay Contact Life (Mechanical)** 10,000,000 cycles

#### General Characteristics

**Temperature Range** -20° to 55°C (-4° to 131°F)

**Maximum Input Power** 1.5 W

**Wire range** 12 to 20 AWG

**Terminal Torque** 3.5 to 4.5 in.-lbs. (max. 4.5 in.-lbs.)

#### Provides Intrinsically-Safe Circuits in the following locations:

Division 1 and 2  
Class I, Groups A,B,C,D;  
Class II, Groups E,F,G;  
and Class III

#### Entity Parameters

$V_{oc} = 16.8V$      $P_o = \frac{V_{oc} \cdot I_{sc}}{4}$   
 $I_{sc} = 1.2mA$   
 $L_a = 100mH$   
 $C_a = 0.39\mu F$

#### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air

**Radio Frequency Immunity (RFI)** IEC 61000-4-3, Level 3, 10V/m

**Fast Transients** IEC 61000-4-4, Level 3, 4kV input power

#### Safety Mark

#### UL

UL913 Sixth Edition (File #E233355)

#### Dimensions

**H** 88.9 mm (3.5"); **W** 52.93 mm (2.08");  
**D** 59.69 mm (2.35")

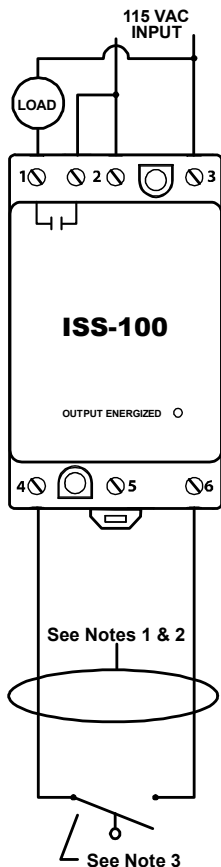
#### Weight

0.5 lb. (8 oz., 226.8 g)

#### Mounting Method

35mm DIN rail or Surface Mount  
(#6 or #8 screws)

### Wiring Diagram



1. Maximum distance between unit and switch contact is 10,000 feet.
2. All non-intrinsically safe wiring shall be separated from intrinsically safe wiring. Description of special wiring methods can be found in the National Electrical Code ANSI/NFPA 70, Article 504 Intrinsically Safe Systems. Check your state and local codes for additional requirements.
3. All switch contacts shall be non-energy storing, containing no inductance or capacitance.

See Notes 1 & 2

See Note 3

For dimensional drawing see: Appendix, page 510, Figure 10.

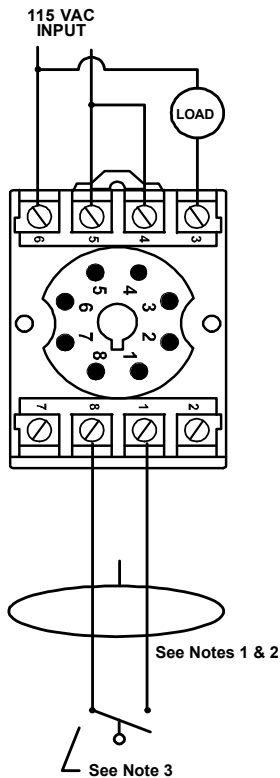
# ISS-101

## Single-Channel Intrinsically Safe Switch



### Wiring Diagram

CONTROL DRAWING ISS-101



**NOTES:**

1. Maximum distance between unit and switch contact is 10,000 feet.
2. All non-intrinsically safe wiring shall be separated from intrinsically safe wiring. Description of special wiring methods can be found in the National Electrical Code ANSI/NFPA 70, Article 504 Intrinsically Safe Systems. Check your state and local codes for additional requirements.
3. All switch contacts shall be non-energy storing, containing no inductance or capacitance.

**See Install Bulletin for full instructions and Hazardous Location information.**

### Description

The ISS-101 switches are UL 913 listed as an associated apparatus for interfacing between hazardous and non-hazardous areas. These units must be installed in a non-hazardous area.

**Must use Model OT08PC socket for UL Rating!**

Note: Manufacturer's recommended screw terminal torque for the OT Series Octal Sockets is 12 in.-lbs.

### Features & Benefits

FEATURES	BENEFITS
<b>Compact design for DIN rail or surface mount via octal base</b>	Allows flexibility in panel installation
<b>LED status indicator</b>	Visual indication of relay engagement
<b>Isolated output relay</b>	Allows connection to PLC or control voltage
<b>Standard 8-pin socket</b>	Pop-in replacement for other manufacturers' parts

### Accessories (included)



**OT08PC 8-pin Octal Socket**

Octal Socket for plug-in units. 8-pin surface & DIN rail mountable. Rated for 10A @ 600VAC.

### Specifications

<b>Input Characteristics</b>	
<b>Supply Voltage</b>	90-120VAC
<b>Functional Characteristics</b>	
<b>Probe Sense Voltage</b>	5VDC continuous
<b>Output Characteristics</b>	
<b>Output Contact Rating</b>	
<b>Pilot Duty</b>	180VA @120VAC, C300
<b>General Purpose</b>	8A @120VAC
<b>Relay Contact Life (Electrical)</b>	100,000 cycles min. @ rated load
<b>Relay Contact Life (Mechanical)</b>	10,000,000 cycles
<b>General Characteristics</b>	
<b>Temperature Range</b>	-20° to 55°C (-4° to 131°F)
<b>Maximum Input Power</b>	1.5 W
<b>Wire range</b>	12 to 20 AWG
<b>Terminal Torque</b>	3.5 to 4.5 in.-lbs. (max. 4.5 in.-lbs.)
<b>Provides Intrinsically-Safe Circuits in the following locations:</b>	Division 1 and 2 Class I, Groups A,B,C,D; Class II, Groups E,F,G; and Class III
<b>Entity Parameters</b>	$V_{oc} = 16.8V$ $P_o = \frac{V_{oc} * I_{sc}}{4}$ $I_{sc} = 1.2mA$ $L_a = 100mH$ $C_a = 0.39uF$

For dimensional drawing see: Appendix, page 509, Figure 8.

## ISS-101

### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air

### Radio Frequency

**Immunity (RFI)** IEC 61000-4-3, Level 3, 10V/m

**Fast Transients** IEC 61000-4-4, Level 3, 4kV input power

### Safety Mark

**UL** UL913 Sixth Edition (File #E233355)

**Dimensions** **H** 44.45 mm (1.75"); **W** 60.33 mm (2.375");

**D** 104.78 mm (4.125")

**Weight** 0.5 lb. (8 oz., 226.8 g)

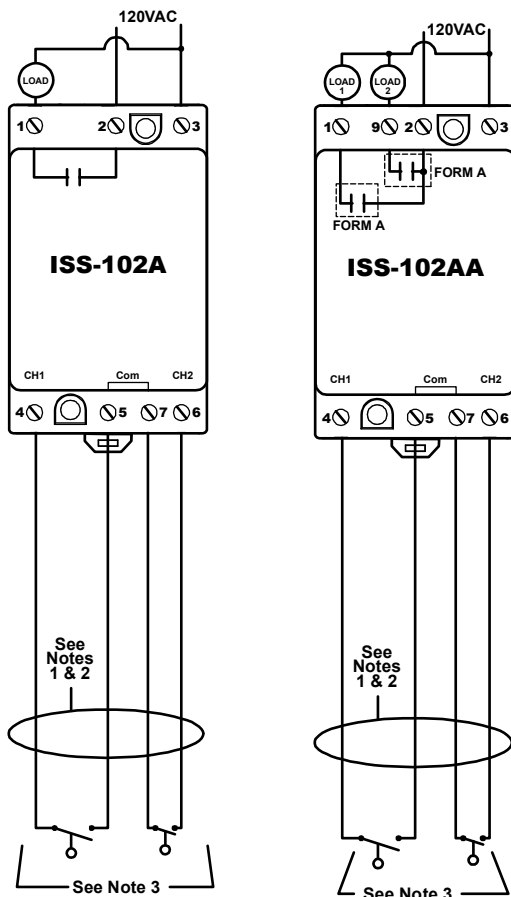
**Mounting Method** DIN rail or surface mount  
(plug into OT08PC socket)

# ISS-102 SERIES

## Two-Channel Intrinsically Safe Switch



### Wiring Diagrams



### Description

The ISS-102 is a two-channel, intrinsically-safe switch designed for multiple uses including a pump-up/pump-down (latching) controller or two-channel switch. LEDs indicate the state of the intrinsically-safe inputs and output relays and user-selectable options are available including a variable resistance threshold for float inputs. The ISS-102 enclosure is surface or DIN rail mountable.

**-LC** Each input channel is active when the corresponding switch is closed. When the lag input (CH2) is activated, the output closes. Applying latching logic, the output contact remains closed until the lead (CH1) and the lag (CH2) inputs are deactivated. Sensitivity is fixed at 100kOhms with a debounce time delay of 2 seconds.

**-DCS** This dual-channel switch has two Form A output relays. Two LEDs illuminate the output state of their respective Form A relay. Resistance probes or switches can be used on its inputs. Sensitivity is fixed at 100kOhms with a debounce time delay of 0.5 seconds.

**-MC** By selecting the proper functionality through the DIP switches, you can define a pump-up or pump-down, single or dual channel non-latching switch. The sensitivity adjustment (4.7k-100kOhms) allows you to define the input impedance at which the output relays (one Form A & one Form C) will change state, with a debounce time delay of 0.5 or 2 seconds.

### Features & Benefits

FEATURES	BENEFITS
<b>Finger-safe terminals</b>	Meets IEC 61000 safety requirements
<b>Compact design for DIN rail or surface mount</b>	Allows flexibility in panel installation
<b>LED status indicator</b>	Visual indication of relay engagement
<b>Two input channels</b>	Flexibility for pump up/pump down latching controller or two-channel switch applications

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
ISS-102A-LC	120VAC	Latching Controller
ISS-102AA-DCS	120VAC	Dual Channel Switch
ISS-102ACI-MC	120VAC	Multi-function Controller
ISS-102C-M-LC	120VAC	MSHA* evaluated
ISS-102CCI-M-MC	120VAC	MSHA* evaluated

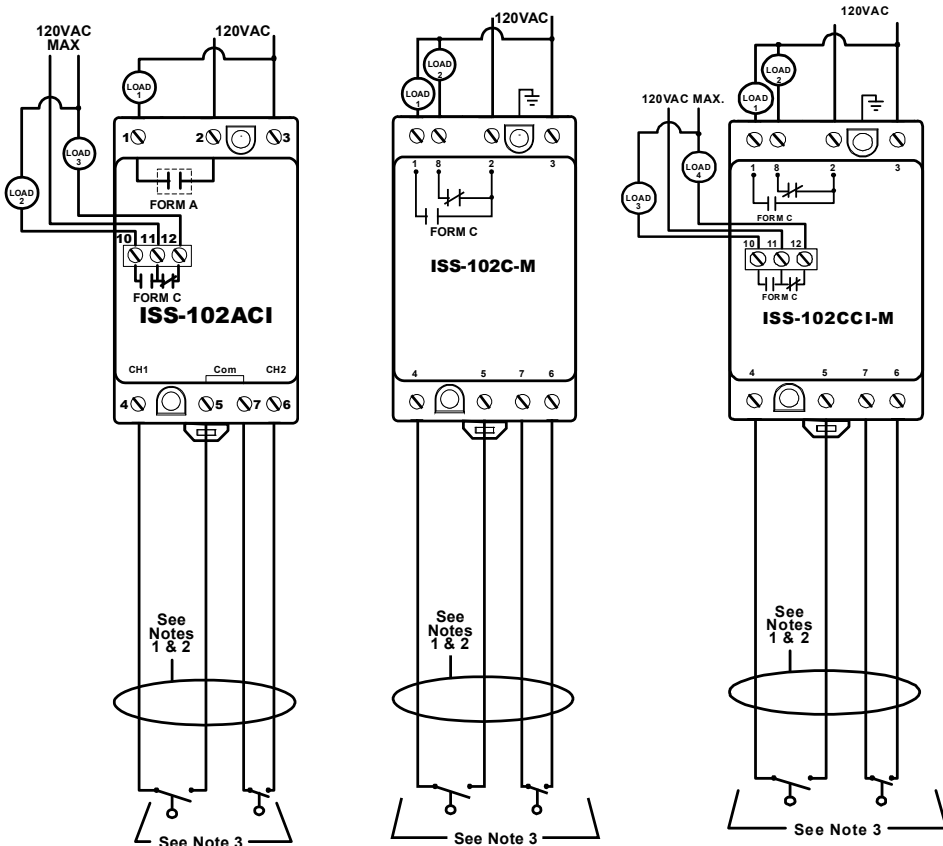
\* Mine Safety and Health Administration

For more wiring diagrams and notes, see next page.

For dimensional drawing see: Appendix, page 510, Figure 10.

# ISS-102 SERIES

## Wiring Diagrams (continued)



**NOTES:**

1. Maximum distance between unit and switch contact is 10,000 feet.
2. All non-intrinsically-safe wiring shall be separated from intrinsically-safe wiring. Description of special wiring methods can be found in the National Electrical Code ANSI/NFPA 70, Article 504 Intrinsically-Safe Systems. Check your state and local codes for additional requirements.
3. All switch contacts shall be non-energy storing, containing no inductance or capacitance.

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PUMP CONTROLS & LIQUID LEVEL CONTROLS

## Specifications

### Functional Characteristics

<b>Debounce Time</b>	0.5 or 2 seconds
<b>Probe Sense Voltage</b>	5vdc pulsed
<b>Output Characteristics</b>	
<b>Output Contact Rating</b>	
<b>Pilot Duty</b>	180VA @120VAC, C150
<b>General Purpose</b>	5A @120VAC
<b>Relay Contact Life (Electrical)</b>	100,000 cycles min. @ rated load
<b>Relay Contact Life (Mechanical)</b>	10,000,000 cycles
<b>Output Relay Type</b>	
<b>ISS-102A-LC</b>	One Form A
<b>ISS-102AA-DCS</b>	Two Form A
<b>ISS-102ACI-MC</b>	One Form A & One isolated Form C
<b>ISS-102C-M-LC</b>	One Form C
<b>ISS-102CCI-M-MC</b>	Two Form C (one isolated)

### General Characteristics

<b>Temperature Range</b>	-20° to 55°C (-4° to 131°F)
<b>Maximum Input Power</b>	2 W
<b>Wire Range</b>	12 to 20 AWG
<b>Terminal Torque</b>	3.5 to 4.5 in.-lbs. (max. 4.5 in.-lbs.)

### Provides Intrinsically-Safe Circuits in the following locations:

Division 1 and 2  
Class I, Groups A,B,C,D;  
Class II, Groups E,F,G;  
Class III  
 $V_{oc} = 16.8V$        $P_o = \frac{V_{oc} * I_{sc}}{4}$   
 $I_{sc} = 1.2mA$   
 $L_a = 100mH$   
 $C_a = 0.39uF$

### Entity Parameters

### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air.  
**Radio Frequency Immunity (RFI)** IEC 61000-4-3, Level 3, 10V/m  
**Fast Transients** IEC 61000-4-4, Level 3, 4kV input power

### Safety Mark

### UL

UL913 Sixth Edition (File #E233355)  
(except Models ISS-102C-M-LC & ISS-102CCI-M-MC which have been evaluated by MSHA)  
**H** 88.9 mm (3.5"); **W** 52.93 mm (2.08");  
**D** 59.69 mm (2.35")  
0.7 lb. (11.2 oz., 317.51 g)  
35mm DIN rail or Surface Mount  
(#6 or #8 screws)

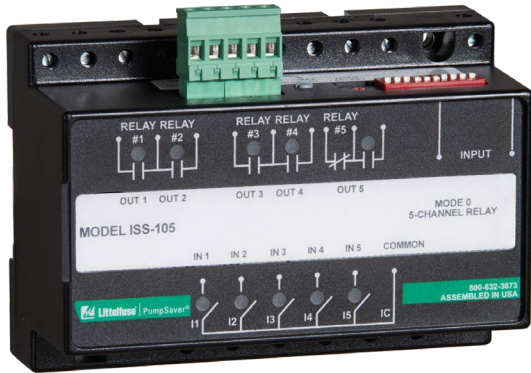
### Dimensions

### Weight

### Mounting Method

# ISS-105 SERIES

## Five-Channel Intrinsically Safe Switch



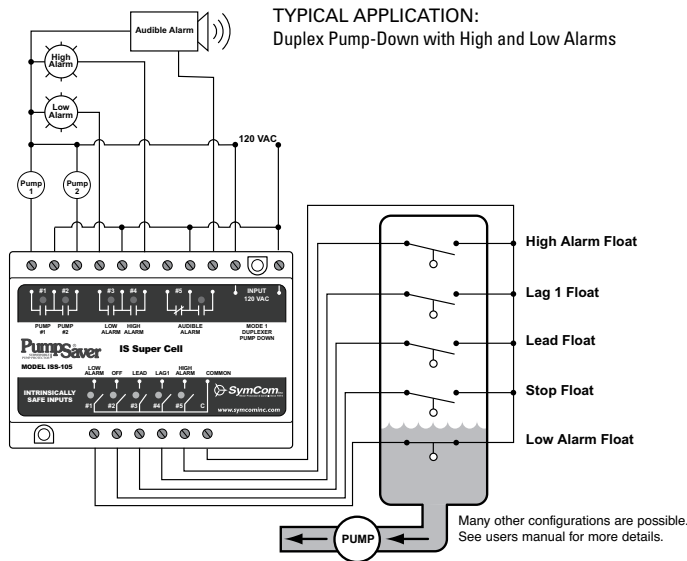
### Description

The ISS-105 is a “smart” five-channel intrinsically safe relay and pump controller. The ISS-105 can be configured for pump-up or pump-down applications or as a five-channel relay covering a wide variety of applications.

The ISS-105 has a long list of features that are needed for multiple pump applications and can indicate low, high and out-of-sequence alarms. If an out-of-sequence alarm occurs, the skipped pump(s) will be started as intended.

The Model ISS-105 can be set-up to do non-alternating control, alternating control and alternating control with one non-alternating pump. The non-alternating pump is intended for use with an emergency or jockey pump. The ISS-105 can start an emergency pump once every 50 cycles to keep it working freely. Using the built-in DIP switches, individual pumps can be disabled when taken out of service for repair or maintenance.

### Wiring Diagram



For dimensional drawing see: Appendix, page 511, Figure 12.

### Features & Benefits

- 5 intrinsically-safe input channels meeting UL913 Sixth Edition
- 4 normally open output relays and 1 SPDT output relay
- Field selectable pump control options
- Monitors float sequencing and sends signal to alarm if out-of-sequence condition occurs
- High and/or low alarm options depending on the number of pumps and settings
- Output contacts for audible alarm
- Meets IEC EMC standards for Electrical Fast Transients (EFT), Electrostatic Discharge (ESD) and Radio Frequency Immunity (RFI)
- DIN rail or surface mountable allows flexibility in panel installation
- User-selectable alternator/non-alternator option
- Non-alternating pump option for emergency or jockey applications
- Pump disable switches make it easy to disable individual pumps when they are out for service or repair
- Adjustable lag pump delay for all pumping modes
- Adjustable delay-on-make/break timer in five-channel relay mode
- Finger-safe terminals meet IEC 61000 safety requirements

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
ISS-105	120VAC	Intrinsically-Safe & Pump Controller
ISS-105-ISO	120VAC	Intrinsically-Safe Only
ISS-105-ISO-3	120VAC	3-Channel Intrinsically-Safe Only
ISS-105-ISO-4	120VAC	4-Channel Intrinsically-Safe Only
ISS-105-ISO-F	120VAC	ISO with Fast Trip Relays



### ISS-105

#### Specifications

##### Input Characteristics

**Supply Voltage** 120VAC  
**Frequency** 50\*/60Hz

##### Functional Characteristics

**Probe Sense Voltage** 5vdc continuous

##### Output Characteristics

**Relay Output Rating** 480VA @ 240VAC, B300  
**Pilot Duty** 7A @ 240VAC  
**General Purpose** 100,000 cycles min. @ rated load  
**Relay Contact Life (Electrical)** 10,000,000 cycles  
**Relay Contact Life (Mechanical)** 10,000,000 cycles

##### General Characteristics

**Temperature Range** -40° to 55°C (-40° to 131°F)  
**Maximum Input Power** 5 W  
**Wire range** 12 to 20 AWG  
**Recommended Terminal Torque** 3.5 to 4.5 in.-lbs. (max. 4.5 in.-lbs.)

##### Provides Intrinsically-Safe

**Circuits in the following locations:**

Division 1 and 2  
 Class I, Groups A,B,C,D;  
 Class II, Groups E,F,G;  
 and Class III

#### Entity Parameters

$V_{oc} = 16.8V$        $P_o = \frac{V_{oc} \cdot I_{sc}}{4}$   
 $I_{sc} = 1.2mA$   
 $L_a = 100mH$   
 $C_a = 0.39\mu F$

#### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air.  
**Radio Frequency Immunity (RFI)** IEC 61000-4-3, Level 3, 10V/m  
**Fast Transients** IEC 61000-4-4, Level 3, 4kV input power  
 2kV inputs/outputs

#### Safety Marks

**UL** UL913 Sixth Edition (File #E233355)  
**Dimensions** **H** 94.06 mm (3.703"); **W** 127.64 mm (5.025");  
**D** 59.69 mm (2.350")

**Weight** 1.2 lbs. (19.2 oz., 544.31 g)  
**Mounting Method** 35 mm DIN rail or Surface Mount  
 (#6 or #8 screws)

\*Note: 50Hz will increase all delay timers by 20%.

## AC SYSTEM MONITORS/LOAD SENSORS

Current monitors provide protection against both supply line and load side faults when the motor is running. They protect against single-phasing and current unbalance problems that can be caused by voltage supply problems, bad contactors, loose wiring, bad wires, or damaged motors. They also provide very reliable overload and underload protection.

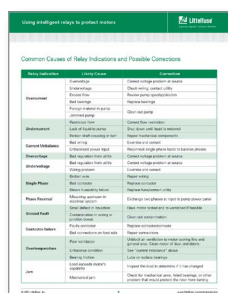
Littelfuse voltage monitors are microcontroller based and factory calibrated for highly accurate and precise voltage measurements providing high sensitivity while minimizing nuisance tripping. This precise operation can detect a single-phase condition or voltage unbalance even with regenerated voltages present.

### Current Monitoring Relays and Transducers

CP5 Series	Single-Phase Current Monitor.....	182
LSR-0	Load Sensor, Low Cost Relay .....	183
LSR-XXX Series	Load Sensors .....	184
LSRU Series	Load Sensors .....	185
LSRX / LSRX-C Series	Load Sensors, Low Cost Relays .....	187
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### Voltage Monitoring Relays

50R Series .....	202
201-XXX-SP Series.....	204
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For More Information...  
on common faults and how  
to fix them, visit  
[Littelfuse.com/MotorProtection](http://Littelfuse.com/MotorProtection)

# CP5 SERIES

## Single-Phase Current Monitor



### Description

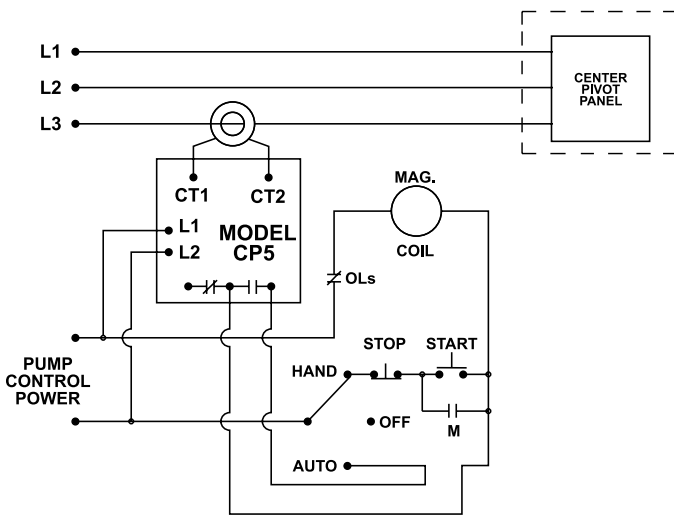
The CP5 Series are undercurrent monitors designed to monitor one leg of a 3-phase system. It is commonly used as a tower monitor on center pivot irrigation systems to detect stalled or jammed towers to prevent over watering.

The CP5 Series has both an adjustable trip level and an adjustable trip delay timer. When the current is sensed, the CP5 Series activates its output relay, thus starting the motor/pump. When the current in the monitored power line falls below the user-selectable trip point, the unit goes through a trip delay timer and then deactivates the output relay if the monitored current does not recover first.

### Features & Benefits

FEATURES	BENEFITS
<b>Adjustable trip level (0-5A)</b>	Provides ability to precisely set the current trip point for any application
<b>Adjustable trip delay (0-10m)</b>	Prevents nuisance tripping due to power line fluctuations
<b>600V rated relay contacts available on CP5-460 model</b>	Eliminates the need for a control transformer to step voltage down to 120 - 240V for a control circuit

### Wiring Diagram



For dimensional drawing see: Appendix page 509, Figure 6.

### Specifications

#### Input Characteristics

<b>Nominal Input Voltage</b>	
CP5115	115VAC
CP5460	460VAC
<b>Frequency</b>	50*/60Hz

#### Functional Characteristics

<b>Operating Points</b>	
<b>Trip Level</b>	0-5 Amps
<b>Trip Delay</b>	0-10 minutes
<b>Restart</b>	1 second

#### Output Characteristics

<b>Output Contact Rating (SPDT)</b>	
<b>Pilot Duty</b>	
CP5115	480VA @ 240VAC
CP5460	470VA @ 600VAC

#### General Characteristics

<b>Terminal Torque</b>	7 in.-lbs.
<b>Wire Size</b>	12-18AWG
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>Dimensions</b>	<b>H</b> 74.4 mm (2.93"); <b>W</b> 133.9 mm (5.27"); <b>D</b> 74.9 mm (2.95")
<b>Weight</b>	1 lb. (16 oz., 453.59 g)
<b>Mounting Method</b>	#8 screws

\*Note: 50Hz will increase all delay timers by 20%

9 AC SYSTEM MONITORS/LOAD SENSORS

### Ordering Information

MODEL	LINE VOLTAGE
CP5115	115VAC
CP5460	460VAC

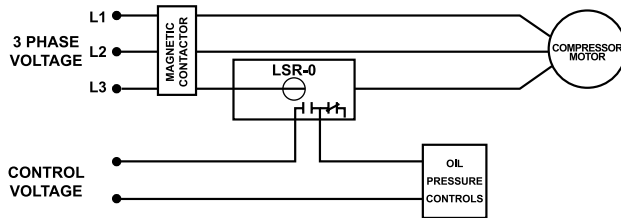
# LSR-0

## Self-Powered Load Sensor/Low-Cost Proof Relay

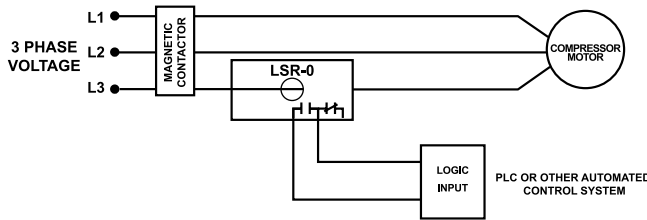


### Wiring Diagram

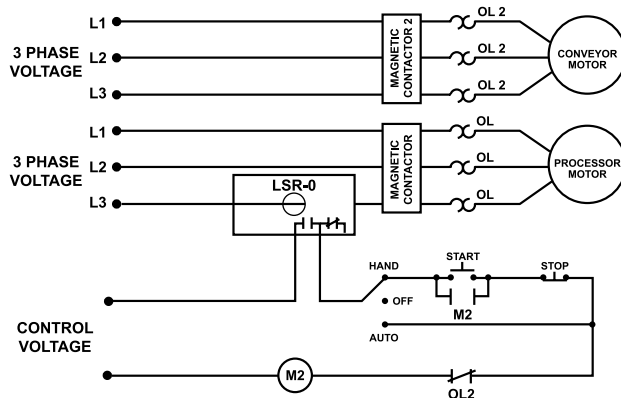
TYPICAL WIRING DIAGRAM FOR REFRIGERATION AND OIL FAILURE CONTROL



TYPICAL WIRING DIAGRAM FOR BUILDING AUTOMATION



TYPICAL WIRING DIAGRAM FOR BUILDING AUTOMATION



### Description

The LSR-0 is a self-powered load sensor intended for use as a proof relay. It is used to verify that current is flowing as intended. It has a guaranteed 15A pull-in current and 2.5A drop-out current. Proof relays are typically used to interlock fans, compressors, motors, heating elements and other devices. The LSR-0 is self-powered, that is, it draws its power from the wire being monitored so it does not require separate control power wiring.

### Features

- Self-powered
- Low cost proof relay
- Can monitor up to 135A loads

### Specifications

<b>Max Current Ratings</b>	135A continuous
<b>Functional Characteristics</b>	
<b>Turn-on Threshold</b>	Fixed, 15A (max.)*
<b>Turn-off Threshold</b>	2.5A (min.)
<b>Power</b>	Induced from conductor
<b>Isolation</b>	600VAC rms
<b>Output Characteristics</b>	
<b>Relay Output Rating:</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A
<b>General Characteristics</b>	
<b>Temperature Range</b>	-20° to 70°C (-4° to 158°F)
<b>Wire Size</b>	#12-24AWG
<b>Hole Size</b>	0.725" diameter
<b>Terminal Torque</b>	7 in.-lbs.
<b>Safety Marks</b>	
<b>CSA, CSA-NRTL/C</b>	(File #46510)
<b>CE</b>	
<b>Dimensions</b>	<b>H</b> 42.42 mm (1.67"); <b>W</b> 58.42 mm (2.3"); <b>D</b> 90.43 mm (3.56")
<b>Weight</b>	0.35 lb. (5.6 oz., 158.76 g)
<b>Mounting Method</b>	Four #6 screws 3/4" in length

\*Conductors may be looped for smaller motor applications.

**Caution:** This product should not be relied upon solely for safety of life or safety applications.

For dimensional drawing see: Appendix, page 511, Figure 14.

# LSR-XXX SERIES

## Load Sensor



### Description

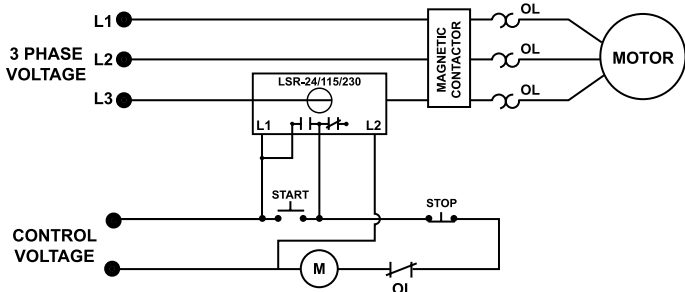
The LSR-xxx Series load sensors use current levels to determine feed rates, tool wear, loss of prime on pumps, mixer viscosity and all types of overload and underload conditions. They may also be used to stage pump motors, chillers and other machinery. These devices combine a current transformer (CT) with Form C (SPDT) relay contacts to switch alarm circuits, contactors or any resistive or inductive load. One simple screwdriver adjustment will calibrate the sensor for all single-phase or 3-phase applications up to 100hp.

### Features

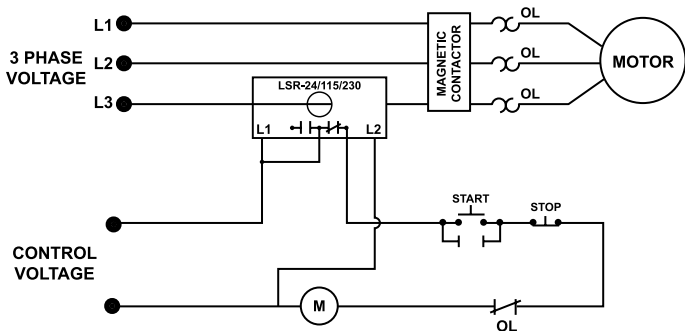
- Can monitor current of motors up to 100Hp
- Fine adjustment with 20-turn pot
- Status LEDs

### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR LOAD LOSS DETECTION



TYPICAL WIRING DIAGRAM FOR OVERLOAD DETECTION



For dimensional drawing see: Appendix, page 511, Figure 14.

### Specifications

#### Functional Characteristics

<b>Isolation</b>	600VAC rms
<b>Current Adjustment Range (Typical)</b>	2-100A
<b>Current Adjustment Range (Min-Max)</b>	0.5-135A
<b>Trip Setpoint</b>	Adjustable to ±1% range

#### Input Characteristics

<b>Control Power:</b>	
<b>LSR-24</b>	24VAC
<b>LSR-115</b>	115VAC
<b>LSR-230</b>	230VAC
<b>Max Current Ratings</b>	135A max. continuous

#### Output Characteristics

<b>Output Contact Rating (SPDT):</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A

#### General Characteristics

<b>Temperature Range</b>	-20° to 70°C (-4° to 158°F)
<b>Wire Size</b>	#12-24AWG
<b>Hole Size</b>	0.725" diameter
<b>Terminal Torque</b>	7 in.-lbs.

<b>Safety Marks</b>	(File #46510)
<b>CSA, CSA-NRTL/C</b>	IEC 60947
<b>CE</b>	

**Dimensions** H 42.42 mm (1.67"); W 58.42 mm (2.3");

D 90.43 mm (3.56")

**Weight** 0.4 lb. (6.4 oz., 181.44 g)

**Mounting Method** Four #6 screws 3/4" in length

Caution: This product should not be relied upon solely for safety of life or safety applications.

### Ordering Information

MODEL	LINE VOTAGE
LSR-24	24VAC
LSR-115	115VAC
LSR-230	230VAC

9 AC SYSTEM MONITORS/LOAD SENSORS

# LSRU SERIES

## Load Sensor



### Description

The LSRU Series is a microcontroller-based family of load sensors. The LSRU family of products employ three basic types of control logic: motor control logic, alarm logic and feed control logic.

#### Motor Control Logic

Several combinations of functions are available in the LSRU, including overcurrent and undercurrent or either overcurrent or undercurrent with variable trip, restart or extended restart delay settings. These various versions of the LSRU trip on the respective fault and then automatically reset after the restart delay expires, in preparation for the next motor start. LSRUs do not trip on undercurrent when the load turns off, this is recognized as a normal condition.

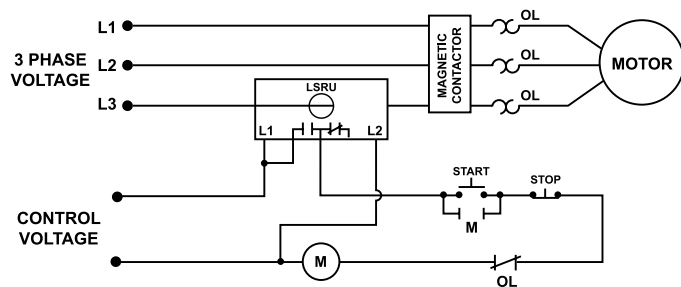
#### Alarm Logic

The LSRU-AL simply indicates whether the current is between the setpoints or outside of the setpoints. This product is best used with a PLC or other controller where status indication is desired.

#### Feed Control

The LSRU-FC is a load monitor intended to control feeder mechanisms in a variety of applications. It stops the feeder when the grinder, chipper, saw, auger, etc. nears overload. When the load is reduced to a preset level, the feeder is restarted.

### Wiring Diagram



For dimensional drawing see: Appendix, page 511, Figure 14.

### Ordering Information

See next page.

### Features & Benefits

FEATURES	BENEFITS
<b>LED indicator</b>	Visual indication of relay status
<b>Built in current sensor</b>	Eliminates the need for a stand alone current transformer and also provides isolation between the monitored and control circuits
<b>Adjustable current sensing range</b>	Provides ability to precisely set the current trip point for any application



# LSRU SERIES

## Ordering Information

MODEL	LINE VOLTAGE	CURRENT RANGE	DESCRIPTION
LSRU-024-AL-2	24VAC	5-25A	Alarm logic
LSRU-024-AL-3	24VAC	25-100A	Alarm logic
LSRU-115-AL-1.5	115VAC	0-10A	Alarm logic
LSRU-115-AL-2	115VAC	5-25A	Alarm logic
LSRU-115-AL-3	115VAC	25-100A	Alarm logic
LSRU-115-FC-1.5	115VAC	0-10A	Feed control logic
LSRU-115-OT-1.5	115VAC	0-10A	Motor control logic with overcurrent trip, adj trip delay (0.5-60s)
LSRU-115-OT-2	115VAC	5-25A	Motor control logic with overcurrent trip, adj trip delay (0.5-60s)
LSRU-115-OT-3	115VAC	25-100A	Motor control logic with overcurrent trip, adj trip delay (0.5-60s)
LSRU-115-OR-1.5	115VAC	0-10A	Motor control logic with overcurrent trip, adj restart delay (0.5-300s, manual)
LSRU-115-OR-2	115VAC	5-25A	Motor control logic with overcurrent trip, adj restart delay (0.5-300s, manual)
LSRU-115-UE-2	115VAC	5-25A	Motor control logic with undercurrent trip, adj ext restart delay (2-300m, manual)
LSRU-115-UT-2	115VAC	5-25A	Motor control logic with undercurrent trip, adj trip delay (0.5-60s)
LSRU-115-UT-3	115VAC	25-100A	Motor control logic with undercurrent trip, adj trip delay (0.5-60s)
LSRU-115-UR-2	115VAC	5-25A	Motor control logic with undercurrent trip, adj restart delay (0.5-300s, manual)
LSRU-115-OU-1.5	115VAC	0-10A	Motor control logic with overcurrent and undercurrent trip
LSRU-115-OU-2	115VAC	5-25A	Motor control logic with overcurrent and undercurrent trip
LSRU-115-OU-3	115VAC	25-100A	Motor control logic with overcurrent and undercurrent trip

### PART # KEY

O = Overcurrent Trip	1.5 = 0-10 Amps
U = Undercurrent Trip	2 = 5-25 Amps
T = Adj. Trip Delay (0.5-60 seconds)	3 = 25-100 Amps
R = Adj. Restart Delay (0.5-300 seconds, Manual)	
E = Adj. Extended Restart Delay (2-300 minutes, Manual)	

## Specifications

### Functional Characteristics

<b>Isolation</b>	600VAC rms
<b>Power</b>	2 Watts
<b>Motor Acceleration Time</b>	2 seconds
<b>When not selected as an option:</b>	
<b>Fixed Trip Delay (-AL, -FC)</b>	0.5 second
	1 second
<b>Fixed Restart Delay (-AL only)</b>	1 second
	as soon as current is within limits
<b>(-FC only)</b>	0.5 second

### Input Characteristics

**Control Power** 24VAC or 115VAC

### Output Characteristics

**Output Contact Rating (SPDT)**

**Pilot Duty** 480VA @ 240VAC

**General Purpose** 10A @ 240VAC

### General Characteristics

<b>Temperature Range</b>	-40° to 70°C (-40° to 158°F)
<b>Wire Size</b>	#12-24AWG
<b>Hole Size</b>	0.725" diameter
<b>Terminal Torque</b>	7 in.-lbs.
<b>Safety Marks</b>	
<b>CSA, CSA-NRTL/C</b>	(File #46510)
<b>CE</b>	
<b>Dimensions</b>	<b>H</b> 42.42 mm (1.67"); <b>W</b> 58.42 mm (2.3"); <b>D</b> 90.43 mm (3.56")
<b>Weight</b>	0.5 lb. (8 oz., 226.8 g)
<b>Mounting Method</b>	Four #6 screws 3/4" in length

**Caution:** This product should not be relied upon solely for safety of life or safety applications.

# LSRX / LSRX-C SERIES

Self-Powered Load Sensor, Low-Cost Proof Relay



## Description

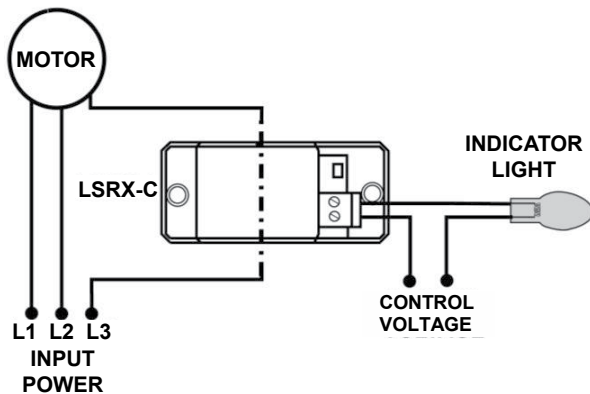
The LSRX/LSRX-C Series are AC current sensors designed to energize the output contact whenever 4.5 Amps or greater is present. The LSRX/LSRX-C Series is used commonly as an AC current proof relay to indicate if a motor is operating. It can also be used to interlock fans, compressors and motors; to indicate equipment status such as feed rates, tool wear, loss of prime on pumps, mixer viscosity and all types of current sensing conditions or to stage pump motors, chillers, or other machinery.

This device combines a current transformer (CT), transducer and high current output relay together to switch alarm circuits, contactors and most resistive or inductive loads. The LSRX/LSRX-C Series can perform the function of an auxiliary contact, yet has the advantages of universal application and isolation.

## Features & Benefits

FEATURES	BENEFITS
<b>Self-powered</b>	Eliminates need for separate control voltage. Draws power from wire being monitored
<b>Quick-connect terminals</b>	Saves time at installation
<b>LED indication</b>	Visual indication of relay status
<b>Built in current sensor will monitor up to 200A loads</b>	Eliminates the need for a stand alone current transformer and also provides isolation between the monitored and control circuits

## Wiring Diagram



For dimensional drawing see: Appendix, page 511, Figure 13.

## Ordering Information

MODEL	DESCRIPTION
LSRX	Fast-on terminal
LSRX-C	Depluggable screw terminals
LSRX-OEM	Fast-on terminals, 10 pack

## Accessories



**Informer IR Kit-36 (36" infrared adapter cable)**  
Attaches to the face of the unit to provide remote diagnostics without opening the panel.

## Specifications

### Input Characteristics

<b>Operating Current</b>	5-200A Continuous
<b>Minimum Pull-in Current</b>	4.5A (typical), 7.0A (max)*
<b>Power</b>	Induced from AC conductor

### Output Characteristics

<b>Relay Output Rating (SPST - Form A)</b>	480VA @ 240VAC, B300
<b>Pilot Duty</b>	5A @ 240VAC
<b>General Purpose</b>	1x10 <sup>5</sup>
<b>Electrical Life</b>	1x10 <sup>7</sup>
<b>Mechanical Life</b>	
<b>Maximum Conductor Diameter</b>	0.7 in.
<b>Output Terminals</b>	
<b>LSRX</b>	0.25" quick-connect fast-ons
<b>LSRX-C</b>	depluggable screw terminals
<b>Torque Rating</b>	3.0 in.-lbs.

## LSRX / LSRX-C SERIES

### General Characteristics

**Temperature Range:**

**Operating** -20° to 70°C (-4° to 158°F)

**Storage** -40° to 80°C (-40° to 176°F)

**Hole Size** 0.72" diameter

**Wire Size** 12-26 AWG

**Output Relay Status Indicator** LED

**Relative Humidity** 10-95%, non-condensing per IEC 68-2-3

### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 2, 4kV contact, 4kV air

**Fast Transient Burst** IEC 61000-4-4, Level 3, 2kV power, 1kV input/output

### Surge

**IEC** 61000-4-5, Level 3, 2kV line-to-line; 2kV line-to-ground

### Safety Marks

**UL** UL508 Recognized (File #E68520)

**CE** IEC 60947

**Dimensions** **H** 68.58 mm (2.7"); **W** 28.7 mm (1.13");

**D** 63.5 mm (2.5")

**Weight** 0.3 lb. (4.8 oz., 136.08 g)

**Mounting Method** Surface Mount

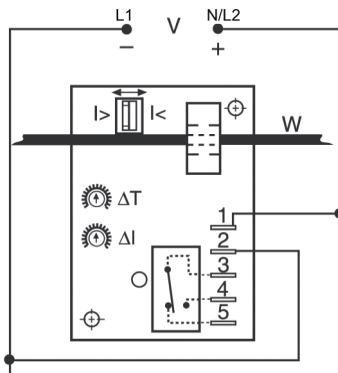
\*Conductors may be looped for smaller motor applications.

# ECS SERIES

## Current Sensors



### Wiring Diagram



V = Voltage  
I> = Overcurrent  
I< = Undercurrent  
W = Insulated Wire Carrying Monitored Current

Relay contacts are isolated.  
Arrow on the toroid points toward the load.

For dimensional drawing see: Appendix, page 513, Figure 34.

### Ordering Information

See next page.

### Description

The ECS Series of single-phase AC current sensors is a universal, overcurrent or undercurrent sensing control. Its built-in toroidal sensor eliminates the inconvenience of installing a stand-alone current transformer. Includes onboard adjustments for current sensing mode, trip point, and trip delay. Detects over or undercurrent events like locked rotor, loss of load, an open heater or lamp load, or proves an operation is taking place or has ended.

#### Operation

Input voltage must be supplied at all times for proper operation. When a fault is sensed throughout the trip delay, the output relay is energized. When the current returns to the normal run condition or zero, the output and the delay are reset. If a fault is sensed and then corrected before the trip delay is completed, the relay will not energize and the trip delay is reset to zero.

#### Adjustment

Select the desired function, over or under current sensing. Set the trip point and trip delay to approximate settings. Apply power to the ECS and the monitored load. Turn adjustment and watch the LED. LED will light; turn slightly in opposite direction until LED is off. Adjustment can be done while connected to the control circuitry if the trip delay is set at maximum. To increase sensitivity, multiple turns may be made through the ECS's toroidal sensor. The appropriate trip point range is determined by multiplying the amperage load by the number of turns/passes through the toroidal sensor. When using an external CT, select a 2VA, 0-5A output CT rated for the current to be monitored. Select ECS adjustment range 0. Pass one secondary wire lead through the ECS toroid and connect the secondary leads together.

### Features & Benefits

FEATURES	BENEFITS
<b>Built-in toroidal current sensing</b>	Eliminates need to install stand-alone current transformer and provides isolation from monitored circuit
<b>Encapsulated</b>	Protects against shock, vibration, and humidity
<b>Adjustable mode, trip point and trip delay</b>	Provides flexibility for use in many applications
<b>10A, SPDT isolated relay output</b>	Allows control of AC voltage loads

### Accessories



**P1015-13** (AWG 10/12), **P1015-64** (AWG 14/16), **P1015-14** (AWG 18/22) **Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.

### ECS SERIES

#### Ordering Information

MODEL	SENSING	INPUT VOLTAGE	TRIP POINT ADJUSTABLE	TRIP DELAY	SENSING DELAY ON STARTUP
ECS20BC	Selectable, over or undercurrent	24VAC	0.5 - 5A	0.5 - 50s	1s
ECS21BC	Selectable, over or undercurrent	24VAC	2 - 20A	0.5 - 50s	1s
ECS2HBC	Selectable, over or undercurrent	24VAC	5 - 50A	0.5 - 50s	1s
ECS30AC	Selectable, over or undercurrent	24VDC	0.5 - 5A	0.150 - 7s	1s
ECS40A	Selectable, over or undercurrent	120VAC	0.5 - 5A	0.150 - 7s	0s
ECS40AC	Selectable, over or undercurrent	120VAC	0.5 - 5A	0.150 - 7s	1s
ECS40BC	Selectable, over or undercurrent	120VAC	0.5 - 5A	0.5 - 50s	1s
ECS41A	Selectable, over or undercurrent	120VAC	2 - 20A	0.150 - 7s	0s
ECS41AC	Selectable, over or undercurrent	120VAC	2 - 20A	0.150 - 7s	1s
ECS41BC	Selectable, over or undercurrent	120VAC	2 - 20A	0.5 - 50s	1s
ECS41BD	Selectable, over or undercurrent	120VAC	2 - 20A	0.5 - 50s	2s
ECS41BH	Selectable, over or undercurrent	120VAC	2 - 20A	0.5 - 50s	6s
ECS4HBC	Selectable, over or undercurrent	120VAC	5 - 50A	0.5 - 50s	1s
ECS4HBH	Selectable, over or undercurrent	120VAC	5 - 50A	0.5 - 50s	6s
ECS60AH	Selectable, over or undercurrent	230VAC	0.5 - 5A	0.150 - 7s	6s
ECS60BC	Selectable, over or undercurrent	230VAC	0.5 - 5A	0.5 - 50s	1s
ECS61BC	Selectable, over or undercurrent	230VAC	2 - 20A	0.5 - 50s	1s
ECS6HAH	Selectable, over or undercurrent	230VAC	5 - 50A	0.150 - 7s	6s
ECSH21F2.5C	Overcurrent	24VAC	2 - 20A	2.5s	1s
ECSH30AC	Overcurrent	24VDC	0.5 - 5A	0.150 - 7s	1s
ECSH31AD	Overcurrent	24VDC	2 - 20A	0.150 - 7s	2s
ECSH31F.08D	Overcurrent	24VDC	2 - 20A	0.08s	2s
ECSH3HF0.08D	Overcurrent	24VDC	5 - 50A	0.08s	2s
ECSH34F.08C	Overcurrent	24VDC	4A non-adjustable	0.08s	1s
ECSH40A	Overcurrent	120VAC	0.5 - 5A	0.150 - 7s	0s
ECSH40AC	Overcurrent	120VAC	0.5 - 5A	0.150 - 7s	1s
ECSH40AD	Overcurrent	120VAC	0.5 - 5A	0.150 - 7s	2s
ECSH41AC	Overcurrent	120VAC	2 - 20A	0.150 - 7s	1s
ECSH41AD	Overcurrent	120VAC	2 - 20A	0.150 - 7s	2s
ECSH41BC	Overcurrent	120VAC	2 - 20A	0.5 - 50s	1s
ECSH41F.08D	Overcurrent	120VAC	2 - 20A	0.08s	2s
ECSH4HAD	Overcurrent	120VAC	5 - 50A	0.150 - 7s	2s
ECSH4HF.08D	Overcurrent	120VAC	5 - 50A	0.08s	2s
ECSH61AD	Overcurrent	230VAC	2 - 20A	0.150 - 7s	2s
ECSL31A	Undercurrent	24VDC	2 - 20A	0.150 - 7s	0s
ECSL40AC	Undercurrent	120VAC	0.5 - 5A	0.150 - 7s	1s
ECSL40B	Undercurrent	120VAC	0.5 - 5A	0.5 - 50s	0s
ECSL40BH	Undercurrent	120VAC	0.5 - 5A	0.5 - 50s	6s
ECSL41A	Undercurrent	120VAC	2 - 20A	0.150 - 7s	0s
ECSL41AD	Undercurrent	120VAC	2 - 20A	0.150 - 7s	2s
ECSH4HAD	Overcurrent	120VAC	5 - 50A	0.150 - 7s	2s
ECSL41AH	Undercurrent	120VAC	2 - 20A	0.150 - 7s	6s
ECSL4HAC	Undercurrent	120VAC	5 - 50A	0.150 - 7s	1s
ECSL4HBH	Undercurrent	120VAC	5 - 50A	0.5 - 50s	6s
ECSL61AH	Undercurrent	230VAC	2 - 20A	0.150 - 7s	6s
ECSL6HAC	Undercurrent	230VAC	5 - 50A	0.150 - 7s	1s

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9 AC SYSTEM MONITORS/LOAD SENSORS

## ECS SERIES

### Specifications

#### Sensor

**Type** Toroidal through hole wiring  
**Mode** Over or undercurrent, switch selectable on the unit or factory fixed

**Trip Point Range** 0.5 - 50A in 3 adjustable ranges or fixed

#### Tolerance

##### Adjustable

Guaranteed range

##### Fixed

0.5 - 25A: 0.5A or  $\pm 5\%$  whichever is less;  
26 - 50A:  $\pm 2.5\%$

#### Maximum Allowable Current

Steady - 50A turns;  
Inrush - 300A turns for 10s

#### Trip Point Hysteresis

$\approx \pm 5\%$

#### Trip Point vs. Temperature

$\pm 5\%$

#### Response Time

$\leq 75\text{ms}$

#### Frequency

45/500 Hz

#### Type of Detection

Peak detection

#### Trip Delay

##### Type

Analog

##### Range

##### Adjustable

0.150 - 7s; 0.5 - 50s (guaranteed ranges)

##### Factory Fixed

$\pm 10\%$

##### Delay vs. Temperature

$\pm 15\%$

##### Sensing Delay on Startup

Factory fixed 0 - 6s:  $+40\%$ ,  $-0\%$

#### Input

##### Voltage

24, 120, or 230VAC; 12 or 24VDC

##### Tolerance

##### 12VDC & 24VDC/AC

-15 - 20%

##### 120 & 230VAC

-20 - 10%

##### AC Line Frequency

50/60 Hz

#### Output

##### Type

Electromechanical relay

##### Form

Isolated, SPDT

##### Rating

10A resistive @ 240VAC; 1/4 hp @ 125VAC;

1/2 hp @ 250VAC

#### Life

Mechanical -  $1 \times 10^6$ ; Electrical -  $1 \times 10^5$

#### Protection

##### Circuitry

Encapsulated

##### Isolation Voltage

$\geq 2500\text{V}$  RMS input to output

##### Insulation Resistance

$\geq 100 \text{ M}\Omega$

#### Mechanical

##### Mounting

Surface mount with two #6 (M3.5 x 0.6) screws

##### Dimensions

**H** 88.9 mm (3.5"); **W** 63.5 mm (2.5");

**D** 44.5 mm (1.75")

##### Termination

0.25 in. (6.35 mm) male quick connect terminals (5)

#### Environmental

##### Operating/Storage

##### Temperature

$-40^\circ$  to  $60^\circ\text{C}$  /  $-40^\circ$  to  $85^\circ\text{C}$

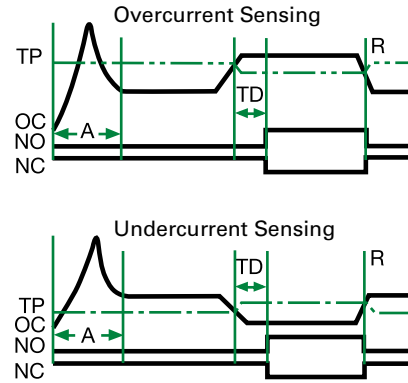
##### Humidity

95% relative, non-condensing

##### Weight

$\approx 6.4 \text{ oz}$  (181 g)

### Function Diagrams



NO = Normally Open Contact  
NC = Normally Closed Contact  
A = Sensing Delay On Start Up  
TD = Trip Delay  
TP = Trip Point  
R = Reset  
OC = Monitored Current

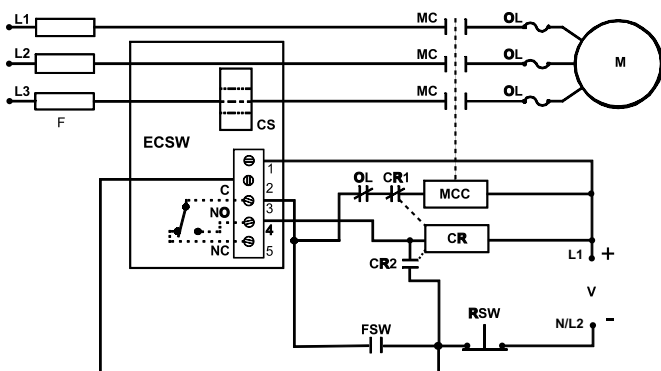


# ECSW SERIES

## Current Sensors

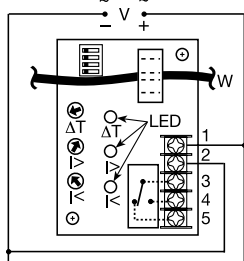


### Wiring Diagram



MC = Motor Contactor  
M = Motor  
F = Fuses  
OL = Overload

RSW = Reset Switch  
FSW = Fan or Float Contacts  
CR = Control Relay  
CS = Current Sensor  
MCC = Motor Contactor Coil



V = Voltage  
I > = Adjustable Overcurrent  
I < = Adjustable Undercurrent  
W = Monitored Wire  
ΔT = Adjustable Trip Delay

### Description

The ECSW Series of single-phase, AC window, current sensors includes adjustable overcurrent and undercurrent trip points. Detects locked rotor, jam, loss of load, an open heater or lamp load, a broken belt, or loss of suction. LED's aid in trip point adjustment and provide fault indication. The built-in toroidal sensor eliminates the need for an external current transformer. The output can be electrically latched after a fault, or automatically reset. Remote resetting of a latched output by removing input voltage. The unit includes switch selectable zero current detection and normally de-energized or energized output operation. Time delays are included to improve operation and eliminate nuisance tripping.

### Features & Benefits

FEATURES	BENEFITS
<b>Built-in toroidal current sensing</b>	Eliminates need to install stand alone current transformer and provides isolation from monitored circuit
<b>Encapsulated</b>	Protects against shock, vibration, and humidity
<b>LED indication</b>	Visual indication for trip point adjustment and fault indication
<b>Multiple switch selectable features</b>	User selectable zero current detection, latched, normally de-energized, or energized output adds application flexibility
<b>Adjustable trip delay</b>	Eliminates nuisance tripping and prevents rapid cycling
<b>Isolated 10A, SPDT output contacts</b>	Allows control of loads for AC or DC voltages

### Operation

When the input voltage is applied, sensing delay on startup begins and the output transfers (if normally energized is selected). Upon completion of the startup delay, sensing of the monitored current begins. As long as current is above undercurrent trip point and below the overcurrent trip point (inside the window), the output relay remains in its normal operating condition and both red LED's are OFF. The green LED glows when the output is energized. If current varies outside the window, the associated red LED glows, and the trip delay begins. If the current remains outside the window for the full

For dimensional drawing see: Appendix, page 513, Figure 34.

### Ordering Information

MODEL	INPUT VOLTAGE	TRIP POINT ADJUST.	TRIP DELAY	SENSING DELAY ON STARTUP	CONNECT.
ECSW3LABT	24VDC	0.5 - 5A	0.150 - 7s	0.1s	Terminal blocks
ECSW4HBHT	120VAC	5 - 50A	0.5 - 50s	6s	Terminal blocks
ECSW4LADT	120VAC	0.5 - 5A	0.150 - 7s	2s	Terminal blocks
ECSW4LBHT	120VAC	0.5 - 5A	0.5 - 50s	6s	Terminal blocks
ECSW4MACT	120VAC	2 - 20A	0.150 - 7s	1s	Terminal blocks
ECSW4MBHT	120VAC	2 - 20A	0.5 - 50s	6s	Terminal blocks
ECSW4MBGT	120VAC	2 - 20A	0.5 - 50s	5s	Terminal blocks
ECSW6MBHT	230VAC	2 - 20A	0.5 - 50s	6s	Terminal blocks

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## ECSW SERIES

trip delay, the relay transfers to fault condition state. If the current returns to normal levels (inside the window) during the trip delay, the red LED goes OFF, the trip delay is reset, and the output remains in the normal condition.

**Reset:** Remove input voltage or open latch switch. If zero current detection is selected, the unit will reset as soon as zero current is detected.

**Operation With Zero Current Detection Enabled:** If the current decreases to zero within the trip delay period, then zero current is viewed as an acceptable current level. The unit's output remains in its normal operating state. This allows the monitored load to cycle ON and OFF without nuisance tripping the ECSW. Zero current is defined as current flow of less than 250 milliamp-turns.

*Note: When zero current detect is selected, the latching operation of switch SW2 is canceled; the output will not latch after a fault trip.*

### Notes on Operation

1. There is no hysteresis on the trip points. The overcurrent and undercurrent trip points should be adjusted to provide adequate protection against short cycling.
2. If the upper setpoint is set below the lower setpoint, both red LED's will glow indicating a setting error.
3. If zero current detection is selected (SW2 ON), and the system is wired to disconnect the monitored load, the system may short cycle. After the unit trips, the load de-energizes, and zero current is detected. The ECSW resets, and the load energizes again immediately and may be short cycled.
4. The sensing delay on start up only occurs when input voltage is applied. When zero current detection is selected, the trip delay must be longer than the duration of the inrush current or the unit will trip on the inrush current.

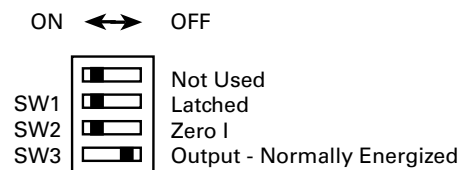
### Typical Pump or Fan Protection Circuit Operation

**Window Current Sensing:** With the ECSW connected as shown in the diagram, a load may be monitored and controlled for over and undercurrent. The ECSW Series' on board CT (CS) may be placed on the line or load side of the contactor. The ECSW selection switches are set for zero current sensing (see Selector Switch SW2) and the output selection is normally de-energized (see Selector Switch SW3). The input voltage (V) is applied to the ECSW continually. As the control switch (FSW) is closed, the input voltage (V) is applied to the motor contactor coil (MCC), and the motor (M) energizes. As long as the current remains below the overcurrent and above the undercurrent trip points, the ECSW's output contacts remain de-energized. If the load current should rise above or fall below a trip point,

for the full trip delay, the normally open (NO) contact will close, energizing the control relay (CR) coil. The CR normally closed contact (CR1) opens and the MCC de-energizes and CR latches on through its normally open contacts (CR2). Reset is accomplished by momentarily opening the normally closed reset switch (RSW).

*Note: If the current falls to zero within the trip delay, the ECSW remains de-energized. The sensing delay on startup occurs when input voltage is applied therefore trip delay must be longer than the duration of the motor's inrush current. The external latching relay CR2 is required in this system to prevent rapid cycling. A timer can be added to provide an automatic reset.*

### Selector Switch



### Mode Selection Switches

- SW1 = Latched or Auto reset selector  
 OFF - Automatic reset after a fault  
 ON - Output relay latches after a fault trips the unit
- SW2 = Zero current detection (below 250 mA)  
 OFF - Zero current detection disabled  
 ON - Zero current detection enabled
- SW3 = Output during normal operation  
 OFF - Output relay de-energized  
 ON - Output relay energized

## ECSW SERIES

### Specifications

<b>Sensor Type</b>	Toroid, through hole wiring for up to #4 AWG (21.1 mm <sup>2</sup> ) THHN wire
<b>Mode</b>	Over & undercurrent trip points (window current sensing)
<b>Trip Point Range</b>	0.5 - 50A in 3 adjustable ranges
<b>Tolerance</b>	Guaranteed range
<b>Maximum Allowable Current</b>	Steady - 50A turns; Inrush - 300A turns for 10s
<b>Time Point vs Temp. &amp; Voltage</b>	±5%
<b>Response Time</b>	≤ 75ms
<b>Frequency</b>	45/500 Hz
<b>Type of Detection</b>	Peak detection
<b>Zero Current Detection</b>	< 250mA turns typical
<b>Time Delay Range</b>	0.15 - 50s in 2 adjustable ranges or 0.1 - 50s fixed
<b>Tolerance</b>	Adjustable: guaranteed range; Fixed: ±10%
<b>Sensing Delay On Start Up</b>	Fixed ≈ 0.1 - 6s in 1s increments
<b>Tolerance</b>	+40% -0%
<b>Delay vs. Temp. &amp; Voltage</b>	±15%
<b>Input Voltage</b>	24, 120, or 230VAC; 12 or 24VDC
<b>Tolerance</b>	
<b>12VDC &amp; 24VDC/AC</b>	-15% - 20%
<b>120 &amp; 230VAC</b>	-20% - 10%
<b>AC Line Frequency</b>	50/60 Hz
<b>Output Type</b>	Electromechanical relay
<b>Mode: Switch Selectable ON</b>	Energized during normal operation, de-energized after a fault
<b>OFF</b>	De-energized during normal operation, energizes during a fault
<b>Form Rating</b>	Isolated, SPDT
<b>Rating</b>	10A resistive @ 240VAC; 1/4 hp @ 125VAC; 1/2 hp @ 250VAC
<b>Life</b>	Mechanical - 1 x 10 <sup>6</sup> ; Electrical - 1 x 10 <sup>5</sup>
<b>Latch Type</b>	Electrical
<b>Reset</b>	Remove input voltage
<b>Function</b>	Switch selectable latching function

### Protection

<b>Surge Circuitry</b>	IEEE C62.41-1991 Level A
<b>Isolation Voltage</b>	Encapsulated
<b>Insulation Resistance</b>	≥ 2500V RMS input to output
<b>Mechanical</b>	≥ 100 MΩ

### Mechanical

<b>Mounting Dimensions</b>	Surface mount with two #6 (M3.5 x 0.6) screws
<b>Termination</b>	<b>H</b> 88.9 mm (3.5"); <b>W</b> 63.5 mm (2.5"); <b>D</b> 44.5 mm (1.75")
	0.197 in. (5 mm) terminal blocks for up to #12 (3.2 mm <sup>2</sup> ) AWG wire

### Environmental

<b>Operating/Storage Temperature</b>	-40° to 60° C / -40° to 85° C
<b>Humidity</b>	95% relative, non-condensing
<b>Weight</b>	≈ 6.4 oz (181 g)

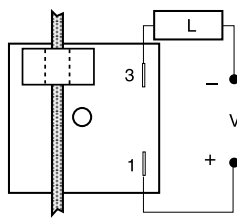
# TCS SERIES

## Current Sensor

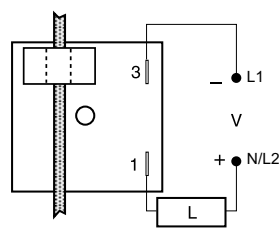


### Wiring Diagram

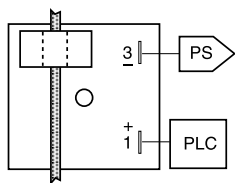
#### POSITIVE SWITCHING



#### NEGATIVE SWITCHING

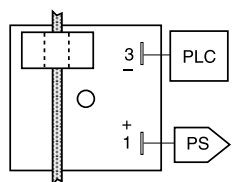


#### SINKING



L = Load  
V = Voltage  
PS = Power Supply  
PLC = PLC Digital Input Module

#### SOURCING



Monitored AC conductor must be insulated.

### Description

The TCS Series is a low cost method of go/no go current detection. It includes a solid-state output to sink or source current when connected directly to a standard PLC digital input module. Its normally open or normally closed output can also be used to control relays, lamps, valves, and small heaters rated up to 1A steady, 10A inrush. The TCS is self-powered (no external power required to operate the unit) and available with an adjustable actuation range of 2 - 20A or factory fixed actuation points from 2 - 45A.

#### Operation

**Normally Open:** When a current equal to or greater than the actuate current is passed through the toroidal sensor, the output closes. When the current is reduced to 95% of the actuate current or less, the output opens.

**Normally Closed:** When the current through the toroid is equal to or greater than the actuate current, the output opens. When the current is reduced below 95% of the actuate current, the output closes. To increase sensitivity, multiple turns may be made through the TCS's toroidal sensor. The trip point range is divided by the number of turns through the toroidal sensor to create a new range. When using an external CT, select a 2VA, 0-20A output CT rated for the current to be monitored. Select TCS adjustment range 0. Pass one secondary wire lead through the TCS' toroid and connect the secondary leads together.

### Features & Benefits

FEATURES	BENEFITS
<b>Self powered</b>	No control voltage is required to operate the unit
<b>Totally solid state and encapsulated</b>	No moving parts to arc and wear out over time and encapsulated to protect against shock, vibration, and humidity
<b>Can connect directly to PLC</b>	Solid state output to sink or source current can be connected directly to a standard PLC digital input module
<b>1A steady, 10A inrush solid-state output</b>	Provides 100 million operations in typical conditions
<b>Complete isolation between sensed current and control circuit</b>	Allows you to monitor a load in a separate electrical system

For dimensional drawing see: Appendix, page 513, Figure 35.

### Ordering Information

MODEL	OUTPUT VOLTAGE	ACTUATE CURRENT	OUTPUT FORM	MODEL	OUTPUT VOLTAGE	ACTUATE CURRENT	OUTPUT FORM
TCSG2A	3 to 50VDC	Fixed, 2A	Normally open	TCSH2B	24 to 240VAC	Fixed, 2A	Normally closed
TCSGAA	3 to 50VDC	2-20A adjustable	Normally open	TCSH5B	24 to 240VAC	Fixed, 5A	Normally closed
TCSGAB	3 to 50VDC	2-20A adjustable	Normally closed	TCSHAA	24 to 240VAC	2-20A adjustable	Normally open
TCSH2A	24 to 240VAC	Fixed, 2A	Normally open	TCSHAB	24 to 240VAC	2-20A adjustable	Normally closed

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# TCS SERIES

## Accessories



**P1023-6 Mounting bracket**  
The 90° orientation of mounting slots makes installation/removal of modules quick and easy.



**P1015-64 (AWG 14/16) Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**  
Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.

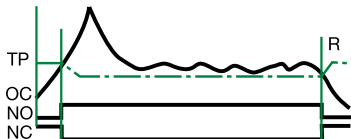


**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.



**P1023-20 DIN Rail Adapter**  
Allows module to be mounted on a 35 mm DIN type rail with two #10 screws.

## Function Diagram



TP = Trip Point  
OC = Monitored Current  
NO = Normally Open Output  
NC = Normally Closed Output  
R = Reset

## Specifications

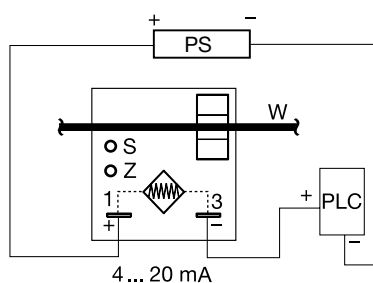
<b>Sensor Type</b>	Toroid, through hole wiring, alternating current, monitored wire must be properly insulated
<b>Current to Actuate</b>	Adjustable: - 2 - 20A, guaranteed range Fixed: - 2 - 45A, +0/-20%
<b>Reset Current</b>	≅ 95% of the actuate current
<b>Maximum Allowable Current</b>	Steady - 50A turns Inrush - 300A turns for 10s
<b>Actuate Current vs. Temp. &amp; Voltage</b>	≤ ±5%
<b>Response Times</b>	Overcurrent - ≤ 200ms Undercurrent - ≤ 1s
<b>Burden</b>	< 0.5VA
<b>Output Type</b>	Solid state
<b>Form</b>	NO or NC
<b>Rating</b>	1A steady, 10A inrush
<b>Voltage</b>	AC - 24 to 240VAC +10/-20% DC - 3 to 50VDC
<b>Voltage Drop</b>	AC NO & NC - ≅ 2.5V DC NO & NC - ≅ 1.2V
<b>Protection Circuitry</b>	Encapsulated
<b>Dielectric Breakdown</b>	≥ 2000V RMS terminals to mounting surface
<b>Insulation Resistance</b>	≥ 100 MΩ
<b>Mechanical Mounting</b>	Surface mount with one #10 (M5 x 0.8) screw
<b>Dimensions</b>	<b>H</b> 50.8 mm (2"); <b>W</b> 50.8 mm (2"); <b>D</b> 44.5 mm (1.75")
<b>Termination</b>	0.25 in. (6.35 mm) male quick connect terminals (2)
<b>Sensor Hole</b>	0.36 in. (9.14 mm) for up to #4 AWG (21.1 mm <sup>2</sup> ) THHN wire
<b>Environmental Operating/Storage Temperature</b>	-20° to 60°C / -40° to 85°C
<b>Humidity</b>	95% relative, non-condensing
<b>Weight</b>	≅ 2.6 oz (74 g)

# TCSA SERIES

## Current Transducers



### Wiring Diagram



PS = Power Supply  
Z = Zero Adjust  
S = Span Adjust  
W = Insulated Wire Carrying Monitored Current  
PLC = PLC Analog Input or Meter Input

For dimensional drawing see: Appendix, page 513, Figure 35.

### Ordering Information

MODEL	CURRENT RANGE
TCSA5	0-5A
TCSA10	0-10A
TCSA20	0-20A
TCSA50	0-50A

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### Description

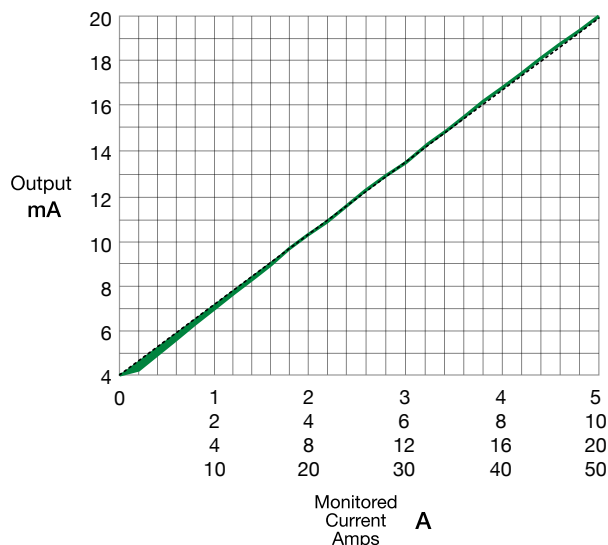
The TCSA Series is a loop-powered, linear output current transducer that provides an output that is directly proportional to the RMS AC current passing through the onboard toroid. The TCSA provides a 4 - 20mA output over a power supply range of 10 - 30VDC. Each unit is factory calibrated for monitoring in one of four ranges; 0-5, 0-10, 0-20, or 0-50A. The 0 - 5A range allows the use of external current transformers so loads up to 1200AC amps can be monitored.

### Operation

The TCSA varies the effective resistance of its output in direct proportion to the current flowing in the monitored conductor. The unit is factory calibrated so that 0 amps provides a 4mA output and full span provides a 20mA output. Zero and span adjustments are provided for minor calibration adjustments in the field (if required).

### Using an External Current Transformer (CT)

Select a 2VA, 0 to 5A output CT, rated for the current to be monitored. Select TCSA5. Pass one of the CT's secondary wire leads through the TCSA's toroid. Connect the CT's secondary leads together.



### Features

- Monitors 0 - 50A in 4 ranges
- Loop powered from 10 to 30VDC
- Linear output from 4 - 20mA
- Zero & span adjustments
- Complete isolation between sensed current & control circuit

## TCSA SERIES

### Accessories



**P1023-6 Mounting bracket**

The 90° orientation of mounting slots makes installation/removal of modules quick and easy.



**P1015-64 (AWG 14/16) Female Quick Connect**

These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1015-18 Quick Connect to Screw Adapter**

Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.



**C103PM (AL) DIN Rail**

35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.



**P1023-20 DIN Rail Adapter**

Allows module to be mounted on a 35 mm DIN type rail with two #10 screws.

### Specifications

**Sensor**

**Type**

Toroid, through hole wiring, alternating current, monitored conductor must be properly insulated  
0 - 50A

**Monitored AC Current Ranges**

**4 Factory Calibrated Ranges** 0 - 5A, 0 - 10A, 0 - 20A, or 0 - 50A

**Factory Calibration**  $\leq \pm 2\%$  of full scale

**Maximum Allowable Current** Steady - 50A turns;

Inrush - 300A turns for 10s

**Repeat Accuracy**  $\leq \pm 0.25\%$  of full scale under fixed conditions

**Response Time**  $\approx 300$ ms

**Burden**  $\leq 0.5$ VA

**AC Line Frequency**

**0 - 20A / 21 - 50A**

20 - 100Hz / 30 - 100Hz

**Temperature Coefficient**

$\pm 0.05\%/^{\circ}\text{C}$

**Output**

**Type: Series Connection**

Current directly proportional to monitored current

**Range**

4 - 20mA

**Sensor Supply Voltage\***

10 to 30VDC

**Momentary Voltage**

40VDC for 1m

**Zero Adjust**

$\approx 3.75 - 4.25$ mA

**Span Adjust**

18mA - 22mA

**Adjustment**

Mini-screw, 25-turn potentiometer

**Protection**

**Dielectric Breakdown**

$\geq 2000$ V RMS terminals to mounting surface

**Insulation Resistance**

$\geq 100$  M $\Omega$

**Polarity**

Units are reverse polarity protected

**Mechanical**

**Mounting**

Surface mount with one #10 (M5 x 0.8) screw

**Dimensions**

**H** 50.8 mm (2.0"); **W** 50.8 mm (2.0");

**D** 44.5 mm (1.75")

**Termination**

0.25 in. (6.35 mm) male quick connect terminals

**Sensor Hole**

0.36 in. (9.14 mm) for up to #4 AWG (21.1 mm<sup>2</sup>)

THHN wire

**Environmental**

**Operating/Storage**

**Temperature**

-30° to 60°C/-40° to 85°C

**Humidity**

95% relative, non-condensing

**Weight**

$\approx 2.4$  oz (68 g)

\*Minimum loop-power supply voltage equals the minimum sensor voltage 10VDC plus the voltage drop developed across all the other loop devices at 20mA.



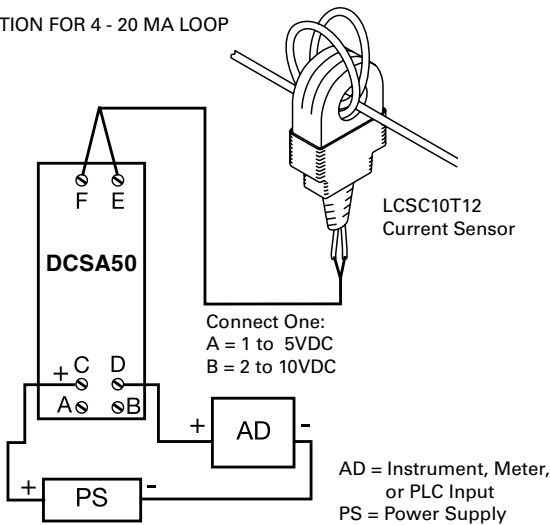
# DCSA SERIES

## Current Transducers

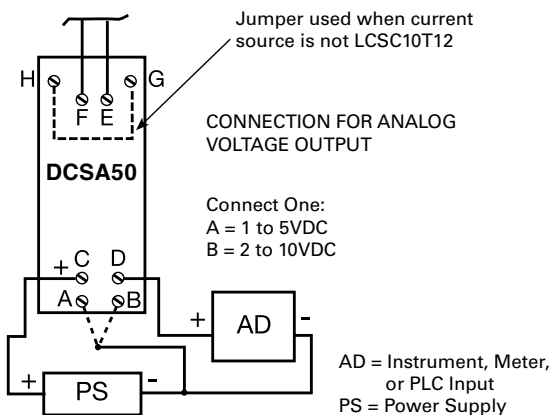


### Wiring Diagram

CONNECTION FOR 4 - 20 MA LOOP



To LCSC10T12 Current Sensor



For dimensional drawing see: Appendix, page 513, Figure 36.

### Description

The DCSA Series is a loop-powered, linear output current transducer that provides an output that is directly proportional to the RMS AC current passing through the LCSC10T12 sensor. The DCSA Series provides either an analog current or voltage: 4-20 mA, 1 to 5VDC, or 2 to 10VDC. Each unit is factory calibrated for monitoring (with the LCSC10T12 connected) in one of four ranges; 0-5, 0-10, 0-20, or 0-50A. Zero and span adjustments allow field calibration if needed. The DCSA Series mounts on both DIN 1 and DIN 3 rails.

### Operation

The DCSA Series varies the effective resistance of its output in direct proportion to the current flowing in the conductor monitored by the LCSC10T12. Connecting the power supply to terminals C & D provides a 4 to 20mA DC current. Connect the power supply to terminals C & A to get 1 to 5VDC at terminal D. Connect the power supply to terminals C & B to get 2 to 10VDC at terminal D.

### Features

- Mounts on DIN 1 or DIN 3 rail
- 0-50A in 4 ranges using LCSC10T12 sensor
- Loop powered from 10 to 30VDC
- Linear output from 4-20mA, 1-10VDC
- Zero & span adjustments
- Separate sensor & control unit

### Accessories



**LCSC10T12 Toroidal Current Sensor**  
Remote monitoring of currents up to 50A.

### Ordering Information

MODEL	CURRENT RANGE WITH LCSC10T12	INPUT RANGE (F TO E)
DCSA5	0-5A	0-5mA AC
DCSA20	0-20A	0-20mA AC
DCSA50	0-50A	0-50mA AC

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# DCSA SERIES

## Specifications

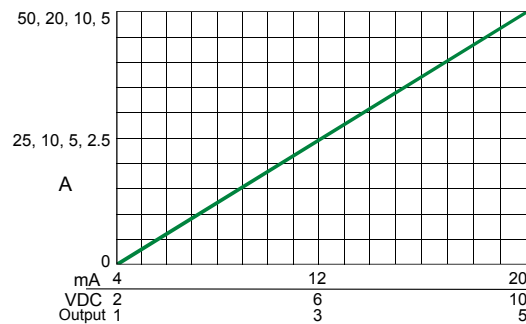
<b>Input</b>	
<b>Ranges (without LCSC10T12 connected)</b>	
<b>4 factory calibrated ranges in mA AC</b>	0 - 5mA, 0 - 10mA, 0 - 20mA, or 0 - 50mA AC
<b>Factory calibration</b>	±0.5% of full scale
<b>Repeat Accuracy</b>	±0.25% of full scale under fixed conditions
<b>Response Time</b>	≅ 300ms
<b>Temperature Coefficient</b>	±0.05%/°C
<b>Input to Output</b>	Not isolated
<b>Output Type</b>	
<b>Analog Range</b>	Current directly proportional to input current
<b>Supply Voltage*</b>	4 - 20mA, or 1 to 5VDC or 2 to 10VDC
<b>Momentary Voltage</b>	10 to 30VDC
<b>Zero Adjust</b>	40VDC for 1m
<b>Span Adjust</b>	≅ 3.75 - 4.25mA
<b>Adjustment</b>	18mA - 22mA
<b>Protection</b>	Mini-screw, multi-turn potentiometer
<b>Dielectric Breakdown</b>	≥ 2500V RMS terminals to mounting surface
<b>Insulation Resistance</b>	≥ 100 MΩ
<b>Polarity</b>	Units are reverse polarity protected
<b>Mechanical</b>	
<b>Mounting</b>	DIN 1 & DIN 3 rail mounting
<b>Termination</b>	
<b>Wire clamp</b>	For 22 - 14AWG (.336 mm <sup>2</sup> ... 2.5 mm <sup>2</sup> )
<b>Environmental</b>	
<b>Operating/Storage</b>	
<b>Temperature</b>	-30° to 60°C / -40° to 85°C
<b>Humidity</b>	95% relative, non-condensing
<b>Weight</b>	≅ 1.6 oz (45.4 g)

### Accessory - LCSC10T12 Toroidal Sensor

<b>Number of Turns</b>	1000
<b>Nominal Output Current</b>	
<b>Full Range</b>	0 - 50 mA
<b>Maximum Allowable Current</b>	Steady 50A turns; Inrush 300A turns for 10s
<b>Burden</b>	≤ 0.5 VA
<b>Frequency</b>	
<b>0 - 20A / 21 - 50A</b>	20/100 Hz / 30/100 Hz
<b>Sensor Hole</b>	0.36 in. (9.14 mm) for up to #4 AWG (21.1 mm <sup>2</sup> ) THHN wire
<b>Weight</b>	≅ 1 oz (28.3 g)

\*Minimum loop-power supply voltage equals the minimum sensor voltage 10VDC plus the voltage drop developed across all the other loop devices at 20mA.

## Monitored Current Amps Diagram

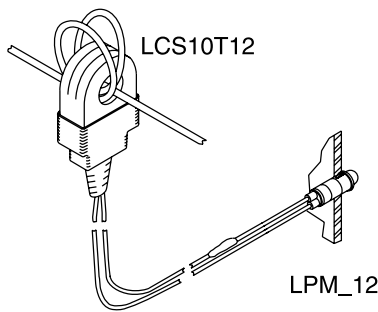


# LCS10T12 / LPM SERIES

## Current Indicators



### Wiring Diagram



Wire Length: 500 ft. (152.4m) max. (Customer Supplied)

**CAUTION:** The LCS10T12 must be connected to the LPM12 or LPMG12 before current flows to prevent damage or shock hazard. Monitored wires must be properly insulated.

### Description

The LCS10T12 connected to the LPM12 or LPMG12 indicator is a low cost, easy to use, go/no-go indication system for the remote monitoring of current flow. The LCS10T12 is installed on an adequately insulated wire of the monitored load. Its 12in. (30.4cm) leads are connected to the LPM12 or LPMG12 panel mount indicator directly or via customer supplied wires up to 500 feet (152.4m) long.

### Operation

When the monitored current is 5A turns, the panel mount LPM indicator will glow. The LCS10T12 is designed to maximize the light output of the panel mount indicator. It can be used to monitor current flow of less than 5A by passing the monitored conductor 2 or more times through the sensor.

**CAUTION:** The LCS10T12 must be connected to the LPM12 or LPMG12 before current flows to prevent damage or a shock hazard. Monitored wires must be properly insulated.

Panel mount indicator designed to match the output of the LCS10T12. The LPM12 and LPMG12 come with 12 in. (30.4 cm) wires and a one piece mounting clip. Both devices install quickly in a 0.25 in. (6.35 mm) hole in panels from 0.031 - 0.062 in. (0.79 - 1.6 mm) thick.

### Features

- Low cost go/no go indication
- May be connected to wires up to 500 feet (152.4 m) long
- Remote monitoring of currents up to 50A
- Green or red LED indicator available

### Specifications

#### Monitored Current

Current Range	2 - 50A AC			
Wire Passes	Min. Current	Max. Current	Max. Inrush	Max. Wire Dia.
1	5A	50A	120A	0.355 in. (9.0 mm)
2	2.5A	25A	60A	0.187 in. (4.7 mm)
3	1.7A	16.6A	40A	0.15 in. (3.8 mm)
4	1.3A	12.5A	30A	0.125 in. (3.2 mm)
5	5/X	50/X	120/X	

**Maximum Current** 50A turns continuous

**AC Line Frequency** 50/60Hz

**DC Resistance of Current Limiter** 65 Ω

**Mechanical Sensor Hole** 0.36 in. (9.14 mm) for up to #4 AWG (21.1 mm<sup>2</sup>) THHN wire

**Termination Environmental** 12 in. (30.4 cm) wire leads

**Operating/Storage Temperature** -40° to 60°C/-40° to 85°C

**Weight** LCS: ≅ 0.8 oz (23 g)

LPM: ≅ 0.2 oz (6 g)

For dimensional drawing see: Appendix, page 513, Figure 37 and 38.

### Ordering Information

MODEL	DESCRIPTION
LCS10T12	AC Current Sensor
LPM12	Red LED Indicator
LPMG12	Green LED Indicator

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# 50R SERIES

## Single-Phase Voltage Monitor



### Description

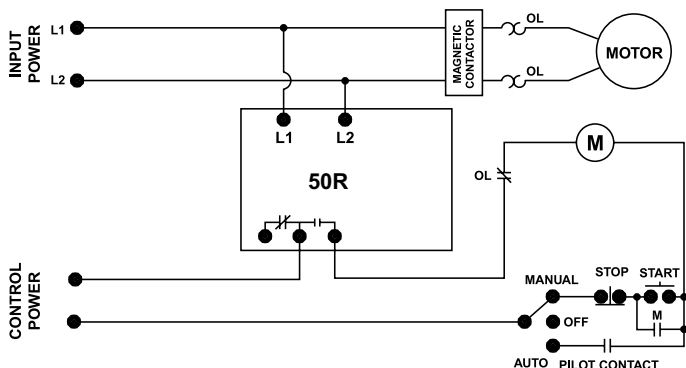
The 50R Series single-phase voltage monitor has a voltage-sensing circuit which constantly monitors the single-phase power for a low voltage condition. Single-phase motors on fans, compressors, air conditioners, heat pumps, well pumps, sump pumps and small conveyor motors are all applicable to the 50R Series.

When a harmful condition is detected, the MotorSaver's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to an acceptable level and a specified amount of time has elapsed (restart delay). The trip delay prevents nuisance tripping due to rapidly fluctuating power line conditions.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary voltage sensing circuitry</b>	Constant monitoring of single-phase power for a low voltage condition
<b>Adjustable trip delay (-3 models) and restart delay (-2 models) settings</b>	Prevent nuisance tripping due to rapidly fluctuating power line conditions and allows staggered start up of multiple motors, after a fault, to prevent a low voltage condition
<b>High voltage detection (-9 models)</b>	Trips and resets at a fixed percentage of the setpoint: trip 110%, reset 107%.
<b>600V rated relay contacts available on some models</b>	Eliminates the need for a control transformer to step voltage down to 120 - 240V for a control circuit

### Wiring Diagram



For dimensional drawing see: Appendix page 509, Figure 6.

### Ordering Information

MODEL	LINE VOTAGE	DESCRIPTION
50R-100	95-120VAC	Fixed trip and restart delay
50R-100-2	95-120VAC	Fixed trip and variable restart delay (manual, 2-300s)
50R200	190-240VAC	Fixed trip and restart delay
50R2002	190-240VAC	Fixed trip and variable restart delay (manual, 2-300s)
50R2003	190-240VAC	Fixed restart and variable trip delay (2-30s)
50R20029	190-240VAC	Fixed trip and variable restart delay (manual, 2-300s) plus high voltage detection
50R400	380-480VAC	Fixed trip and restart delay
50R4002	380-480VAC	Fixed trip and variable restart delay (manual, 2-300s)
50R4003	380-480VAC	Fixed restart and variable trip delay (2-30s)
50R40029	380-480VAC	Fixed trip and variable restart delay (manual, 2-300s) plus high voltage detection

9 AC SYSTEM MONITORS/LOAD SENSORS

## 50R SERIES

### Specifications

#### Input Characteristics

##### Line Voltage

<b>50R-100</b>	95-120VAC
<b>50R200</b>	190-240VAC
<b>50R400</b>	380-480VAC
<b>Frequency</b>	50*/60Hz

#### Functional Characteristics

##### Low Voltage:

<b>Trip (% of setpoint)</b>	90%
<b>Reset (% of setpoint)</b>	93%
<b>Delay Time (Nominal)</b>	
<b>Trip</b>	4 seconds
<b>Restart (low voltage)</b>	2 seconds
<b>Restart (complete power loss)</b>	2 seconds

#### Output Characteristics

##### Output Contact Rating (SPDT - 1 Form C)

<b>50R-100, 50R200</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC
<b>50R400</b>	
<b>Pilot Duty</b>	470VA @ 600VAC

#### General Characteristics

##### Ambient Temperature Range

<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	5 W
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal</b>	
<b>Torque</b>	7 in.-lbs.
<b>Wire Size</b>	12-18AWG
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power and controls

##### Transient Protection

<b>(Internal)</b>	IEC 61000-4-5; 1995 ±6kV
-------------------	--------------------------

##### Safety Marks

<b>UL</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2

##### Dimensions

**H** 74.4 mm (2.93"); **W** 133.9 mm (5.27");

**D** 74.9 mm (2.95")

**Weight** 0.98 lb. (15.68 oz., 444.52 g)

**Mounting Method** #8 screws

### Special Options

**Opt. 2: Variable Restart Delay** Manual, 2-300 seconds

**Opt. 3: Variable Trip Delay** 2-30 seconds

#### Opt. 9: High Voltage Detection Operating Points

<b>Trip (% of Setpoint)</b>	110%
<b>Reset (% of Setpoint)</b>	107%

\*Note: 50Hz will increase all delay timers by 20%

# 201-XXX-SP SERIES

## Single-Phase Voltage/Phase Monitor

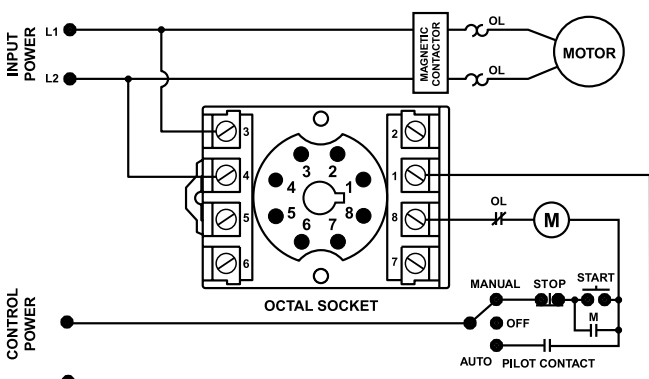


### Description

The 201-xxx-SP Series is an 8-pin octal-base, plug-in voltage monitor designed to protect single-phase motors regardless of size. The 201-100-SP is used on 95-120VAC, 50/60Hz motors to prevent damage caused by low voltage. The 201-200-SP is used on 190-240VAC, 50/60Hz motors. The 201-200-SP-T-9 is a pin-for-pin replacement for a Time Mark® #260 Series voltage monitor. High voltage protection is included in the 201-200-SP-T-9.

The unique microcontroller-based voltage and voltage-sensing circuit constantly monitors the voltage to detect harmful power line conditions. When a harmful condition is detected, the MotorSaver's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to an acceptable level and a specified amount of time has elapsed (restart delay). The trip delay prevents nuisance tripping due to rapidly fluctuating power line conditions.

### Wiring Diagram



**Must use Model OT08PC socket for UL Rating!**

Note: Manufacturer's recommended screw terminal torque for the RB Series and OT Series Octal Sockets is 12 in.-lbs.

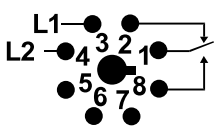
### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage to detect harmful power line conditions, even before the motor starts
<b>Fixed trip delay 4s</b>	Prevents nuisance tripping due to rapidly fluctuating power line conditions
<b>Advanced LED indication</b>	Provides diagnostics which can be used for troubleshooting and to determine relay status
<b>Compact design for 8-pin; DIN rail or surface mount</b>	Allows flexibility in panel installation

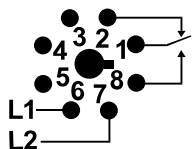
### Accessories



**OT08PC 8-pin Octal Socket**  
Octal Socket for plug-in units. 8-pin surface & DIN rail mountable. Rated for 10A @ 600VAC.



PIN-OUT 1 (201-XXX-SP)  
(view of socket)



PIN-OUT 2 (201-200-SP-T-9)  
(view of socket)

For dimensional drawing see: Appendix, page 509, Figure 8.

### Ordering Information

MODEL	LINE VOTAGE	DESCRIPTION
201-100-SP	95-120VAC	SPDT, protects single phase motors
201-200-SP	190-240VAC	SPDT, protects single phase motors
201-200-SP-T-9	190-240VAC	SPDT, direct replacement for Time Mark® #260 series

9 AC SYSTEM MONITORS/LOAD SENSORS

## 201-XXX-SP SERIES

### Specifications

#### Input Characteristics

<b>Line Voltage:</b>	
<b>201-100-SP</b>	95-120VAC
<b>201-200-SP, 201-200-SP-T-9</b>	190-240VAC
<b>Frequency</b>	50/60Hz

#### Functional Characteristics

<b>Low Voltage (% of setpoint)</b>	
<b>Trip</b>	90%
<b>Reset</b>	93%
<b>For 201-200-SP-T-9 only:</b>	
<b>High Voltage (% of setpoint)</b>	
<b>Trip</b>	110%
<b>Reset</b>	107%
<b>Trip Delay Time:</b>	
<b>High/Low Voltage Fault</b>	4 seconds
<b>Restart Delay Time:</b>	
<b>After a Fault</b>	2 seconds
<b>After a Complete Power Loss</b>	2 seconds

#### Output Characteristics

<b>Output Contact Rating (SPDT)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC

#### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	5 W
<b>Transient Protection (Internal)</b>	2500V for 10 ms
<b>Safety Marks</b>	
<b>UL (OT08PC octal socket required)</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2
<b>Dimensions</b>	<b>H</b> 44.45 mm (1.75"); <b>W</b> 60.325 mm (2.375"); <b>D</b> 104.775 mm (4.125") (with socket)
<b>Weight</b>	0.8 lb. (12.8 oz., 362.87 g)
<b>Mounting Method</b>	DIN rail or surface mount (plug in to OT08PC socket)
<b>Socket Available</b>	Model OT08PC (UL Rating 600V)

The 600V socket can be surface mounted or installed on DIN Rail.



# 201-XXX-SP-DPDT SERIES

## Single-Phase Voltage/Phase Monitor



### Description

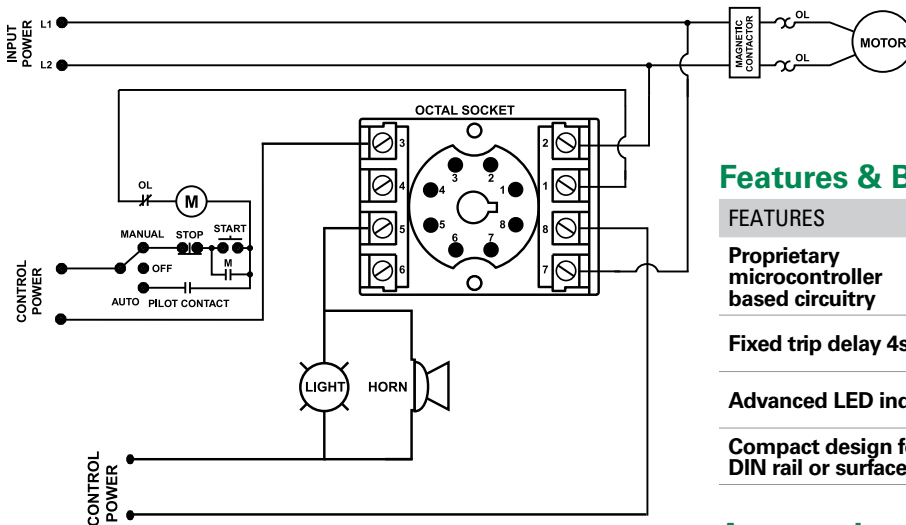
The 201-xxx-SP-DPDT Series is an 8-pin octal-base, plug-in voltage monitor designed to protect single-phase motors regardless of size. The 201-100-SP-DPDT is used on 95-120VAC, 50/60Hz motors to prevent damage caused by low voltage. The 201-200-SP-DPDT is used on 190-240VAC, 50/60Hz motors. The units feature two isolated sets of contacts that are ideal for use with two control circuits with different voltages.

The unique microcontroller-based voltage and voltage-sensing circuit constantly monitors the voltage to detect harmful power line conditions. When a harmful condition is detected, the MotorSaver's output relays are deactivated after a specified trip delay. The output relays reactivate after power line conditions return to an acceptable level and a specified amount of time has elapsed (restart delay). The trip delay prevents nuisance tripping due to rapidly fluctuating power line conditions.

**Must use Model OT08PC socket for UL Rating!**

Note: Manufacturer's recommended screw terminal torque for the RB Series and OT Series Octal Sockets is 12 in.-lbs.

### Wiring Diagram



### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage to detect harmful power line conditions, even before the motor starts
<b>Fixed trip delay 4s</b>	Prevents nuisance tripping due to rapidly fluctuating power line conditions
<b>Advanced LED indication</b>	Provides diagnostics which can be used for troubleshooting and to determine relay status
<b>Compact design for 8-pin; DIN rail or surface mount</b>	Allows flexibility in panel installation

### Accessories



#### OT08PC 8-pin Octal Socket

Octal Socket for plug-in units. 8-pin surface & DIN rail mountable. Rated for 10A @ 600VAC.

For dimensional drawing see: Appendix, page 509, Figure 8.

### Ordering Information

MODEL	INPUT VOTAGE	DESCRIPTION
201-100-SP-DPDT	95-120VAC	Two isolated Form C relays
201-200-SP-DPDT	190-240VAC	Two isolated Form C relays

## 201-XXX-SP-DPDT SERIES

### Specifications

#### Input Characteristics

<b>Line Voltage:</b>	
<b>201-100-SP-DPDT</b>	95-120VAC
<b>201-200-SP-DPDT</b>	190-240VAC
<b>Frequency</b>	50/60Hz

#### Functional Characteristics

<b>Low Voltage (% of setpoint):</b>	
<b>Trip</b>	90% +/-1%
<b>Reset</b>	93% +/-1%
<b>Trip Delay Times:</b>	
<b>Low Voltage</b>	4 seconds
<b>Restart Delay Times:</b>	
<b>After a Fault or Complete Power Loss</b>	2 seconds

#### Output Characteristics

<b>Output Contact Rating (DPDT)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC

#### General Characteristics

<b>Ambient Temperature Range:</b>	
<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	5 W
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3

#### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power and controls

#### Safety Marks

<b>UL (OT08PC octal socket required)</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2

#### Dimensions

**H** 44.45 mm (1.75"); **W** 60.325 mm (2.375");  
**D** 104.775 mm (4.125") (with socket)

#### Weight

0.65 lb. (10.4 oz., 294.84 g)

#### Mounting Method

DIN rail or surface mount  
(plug in to OT08PC socket)

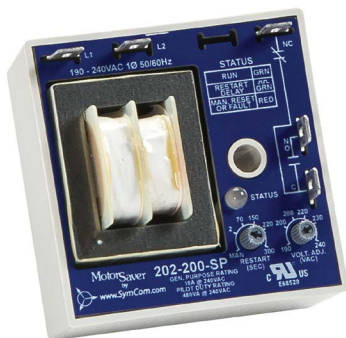
#### Socket Available

Model OT08PC (UL Rating 600V)

The 600V socket can be surface mounted or installed on DIN Rail

# 202-200-SP SERIES

## Single-Phase Voltage Monitor



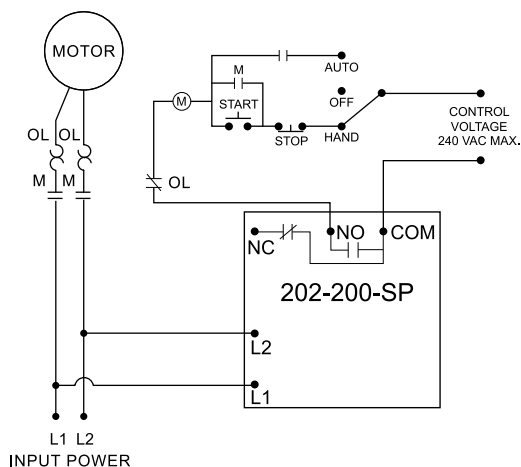
### Description

The 202-200-SP Series voltage monitor is designed to protect single-phase motors regardless of size. It can be used with 190V-240VAC, 50/60Hz motors to prevent damage caused by incoming power problems.

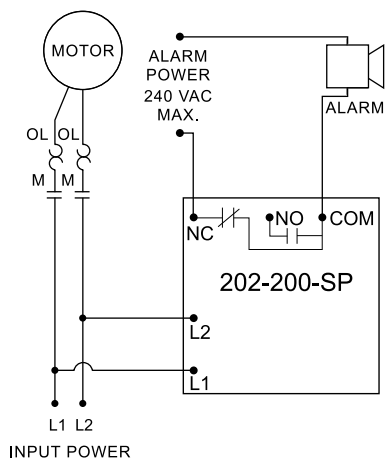
A unique microcontroller-based voltage-sensing circuit constantly monitors the voltage to detect harmful power line conditions. When a harmful condition is detected, the MotorSaver's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to an acceptable level and a specified amount of time has elapsed (restart delay). The trip delay prevents nuisance tripping due to rapidly fluctuating power line conditions.

### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR MODEL 202-200-SP WITH MOTOR CONTROL



TYPICAL WIRING DIAGRAM FOR MODEL 202-200-SP WITH ALARM CONTROL



### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage to detect harmful power line conditions, even before a motor starts
<b>Fixed trip delay 4s</b>	Prevents nuisance tripping due to rapidly fluctuating power line conditions
<b>Adjustable restart delay (Manual, 2-300s)</b>	Allows staggered start up of multiple motors, after a fault, to prevent a low voltage condition
<b>Advanced LED indication</b>	Provides diagnostics which can be used for troubleshooting and to determine relay status
<b>One screw mounting and standard 1/4" quick connect terminals</b>	Fast installation and compact size perfect for panel assembly or OEM applications

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
202-200-SP	190-240VAC	SPDT, high and low voltage protection
202-200-SP-NHV	190-240VAC	SPDT, low voltage protection only

For dimensional drawing see: Appendix, page 509, Figure 7.

## 202-200-SP SERIES

### Specifications

#### Input Characteristics

**Line Voltage:**

**202-200-SP, 202-200-SP-NHV** 190-240VAC

**Frequency** 50\*/60Hz

#### Functional Characteristics

**Low Voltage (% of setpoint)**

**Trip** 90%

**Reset** 93%

**High Voltage (% of setpoint)**

(not available on -NHV model)

**Trip** 110%

**Reset** 107%

**Trip Delay Time:**

**High and Low Voltage** 4 seconds

**Restart Delay Time:**

**After a Fault or Complete**

**Power Loss** Manual, 2-300 seconds adj.

#### Output Characteristics

**Output Contact Rating (SPDT)**

**Pilot Duty** 480VA @ 240VAC

**General Purpose** 10A @ 240VAC

### General Characteristics

**Temperature Range**

-40° to 70°C (-40° to 158°F)

**Trip & Reset Accuracy**

±1%

**Repeatability**

±0.5%

**Input to Output Dielectric**

1480 Vrms (min.)

**Termination**

0.25" male quick connect

**Maximum Input Power**

5 W

**Relative Humidity**

95%, non-condensing

**Transient Protection**

IEC 61000-4-5, ±4kV

**Safety Marks**

**UL, UL Recognized**

UL508 (File #E68520)

**Dimensions**

**H** 63.5 mm (2.5"); **W** 63.5 mm (2.5");

**D** 35.56 mm (1.4")

**Weight**

0.5 lb. (8 oz., 226.8 g)

**Mounting Method**

1/4" socket head cap screw  
(customer supplied)

\*Note: 50Hz will increase all delay timers by 20%.

# 460-XXX-SP SERIES

## Single-Phase Voltage Monitor



### Description

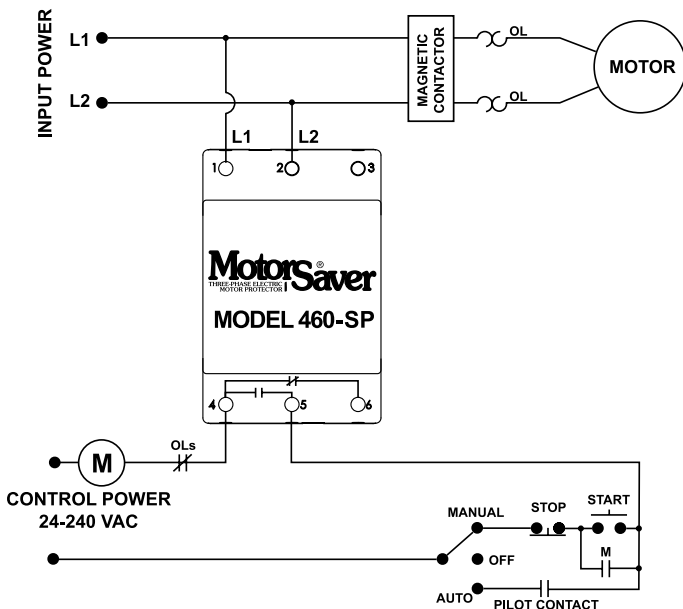
The 460-100-SP is used on 95-120VAC, 50\*/60Hz single-phase motors and the 460-200-SP is used on 190-240VAC, 50\*/60Hz single-phase motors to protect them from damaging high and low voltage conditions. An adjustment knob allows the user to set a 1-500 second restart delay. The variable restart delay is also a power-up delay and can be utilized to stagger-start motors on the same system.

A unique microcontroller-based, voltage-sensing circuit constantly monitors the voltage to detect harmful power line conditions. When a harmful condition is detected, the MotorSaver's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to an acceptable level and a specified amount of time has elapsed (restart delay). The trip delay prevents nuisance tripping due to rapidly fluctuating power line conditions.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of voltage to detect harmful power line conditions, even before a motor starts
<b>Fixed trip delay 4s</b>	Prevents nuisance tripping due to rapidly fluctuating power line conditions
<b>Adjustable restart delay (1-500s)</b>	Allows staggered start up of multiple motors on the same system to prevent a low voltage condition
<b>Advanced LED indication</b>	Provides diagnostics which can be used for troubleshooting and to determine relay status
<b>DIN rail or surface mountable</b>	Allows flexibility for panel assembly

### Wiring Diagram



For dimensional drawing see: Appendix, page 510, Figure 10.

### Ordering Information

MODEL	LINE VOTAGE
460-100-SP	95-120VAC
460-200-SP	190-240VAC

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## 460-XXX-SP SERIES

### Specifications

#### Input Characteristics

<b>Line Voltage</b>	
<b>460-100-SP</b>	95-120VAC
<b>460-200-SP</b>	190-240VAC
<b>Frequency</b>	50*/60Hz

#### Functional Characteristics

<b>Low Voltage (% of setpoint):</b>	
<b>Trip</b>	90% ±1%
<b>Reset</b>	93% ±1%
<b>High Voltage (% of setpoint)</b>	
<b>Trip</b>	110% ±1%
<b>Reset</b>	107% ±1%
<b>Trip Delay Time</b>	
<b>Low or High Voltage</b>	4 seconds fixed
<b>Restart Delay Time</b>	
<b>After a Fault</b>	1-500 seconds adjustable
<b>After a Complete Power Loss</b>	1-500 seconds adjustable

#### Output Characteristics

<b>Output Contact Rating (1 Form C)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC, B300
<b>General Purpose</b>	10A @ 240VAC

#### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	6 W
<b>Class of Protection</b>	IP20, NEMA 1 (finger safe)
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	4.5 in.-lbs.
<b>Wire Type</b>	Stranded or solid 12-20 AWG, one per terminal

#### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150 MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5 kV input power and controls
<b>Surge IEC</b>	IEC 61000-4-5, Level 3, 4kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line Meets UL508 (2 x rated V +1000V for 1 min)
<b>Hi-potential Test</b>	
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2
<b>Enclosure</b>	Polycarbonate
<b>Dimensions</b>	<b>H</b> 88.9 mm (3.5"); <b>W</b> 52.93 mm (2.084"); <b>D</b> 59.69 mm (2.35")
<b>Weight</b>	0.9 lb. (14.4 oz., 408.23 g)
<b>Mounting Method</b>	35mm DIN rail or Surface Mount (#6 or #8 screws)

\*Note: 50 Hz will increase all delay timers by 20%

# 102A SERIES

## 3-Phase Voltage/Phase Monitor



### Description

The 102A is a 3-phase, auto-ranging, dual-range voltage monitor that protects 190-480VAC, 50/60Hz motors regardless of size. The product provides a user selectable nominal voltage setpoint and the voltage monitor automatically selects between the 200V and 400V range.

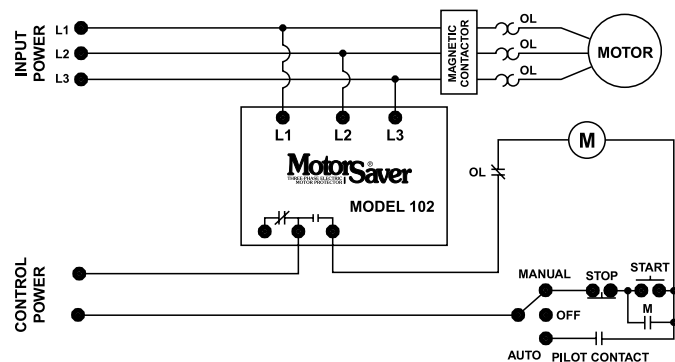
A unique microcontroller-based voltage and phase-sensing circuit constantly monitors the 3-phase voltages to detect harmful power line conditions. When a harmful condition is detected, the output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to acceptable levels. The Model 102A includes advanced single LED diagnostics. Five different light patterns distinguish between faults and normal conditions.

### Features & Benefits

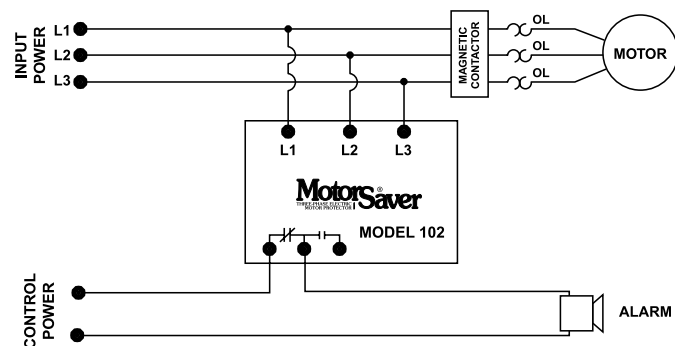
FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of single-phase, low voltage, high voltage (102A-9), voltage unbalance, phase reversal, harmful power line conditions.
<b>Auto-sensing wide voltage range</b>	Automatically senses system voltage between 190 - 480VAC. Saves setup time.
<b>Advanced LED diagnostics</b>	Quick visual indicator for cause of trip. LED indications include: normal operation, power-up restart delay, reverse-phase trip, unbalance/single-phase trip, high or low voltage trip
<b>Adjustable trip delay (102A2)</b>	Prevent nuisance tripping due to rapidly fluctuating power line conditions.

### Wiring Diagram

102 WITH MOTOR CONTROL



102 WITH ALARM CONTROL



### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
102A	190-480VAC	Fixed low voltage trip delay (4 sec), fixed restart delay (2 sec)
102A2	190-480VAC	Has variable restart delay (manual or adjustable 2-300 seconds)
102A3	190-480VAC	Has adjustable trip delay at 2-30 seconds (unbalance and phasing trip delays remain at 2 seconds).
102A-9	190-480VAC	Has high voltage protection. High Voltage Trip is 110% of setpoint, Reset is 107% of setpoint.
102600	475-600VAC	Fixed low voltage trip delay (4 sec), fixed restart delay (2 sec)

For dimensional drawing see: Appendix page 509, Figure 6.

9 AC SYSTEM MONITORS/LOAD SENSORS



## 102A SERIES

### Specifications

<b>Frequency</b>	50*/60Hz
<b>Functional Characteristics</b>	
<b>Low Voltage (% of setpoint)</b>	
<b>Trip</b>	90%
<b>Reset</b>	93%
<b>Voltage Unbalance (NEMA)</b>	
<b>Trip</b>	6%
<b>Reset</b>	4.5%
<b>Trip Delay Time</b>	
<b>Low/High Voltage</b>	4 seconds (standard)
<b>Unbalance &amp; Phasing Faults</b>	2 seconds
<b>Restart Delay Time</b>	
<b>After a Fault</b>	2 seconds (standard)
<b>After a Complete Power Loss</b>	2 seconds (standard)
<b>Output Characteristics</b>	
<b>Output Contact Rating (SPDT - 1 Form C)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC

### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Trip &amp; Reset Accuracy</b>	±1%
<b>Maximum Input Power</b>	5 W
<b>Terminal</b>	
<b>Torque</b>	7 in.-lbs.
<b>Wire Size</b>	12-18AWG
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 4kV input, 2kV input/output
<b>Transient Protection (Internal)</b>	IEC 61000-4-5; 1995 ±6kV
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CSA</b>	22.2 No. 14 (File #46510)
<b>CE</b>	IEC 60947-6-2
<b>Dimensions</b>	
<b>Weight</b>	1.05 lbs. (16.8 oz., 476.27 g)
<b>Mounting Method</b>	#8 screws

\*Note: 50Hz will increase all delay timers by 20%.

# 201A SERIES

## 3-Phase Voltage/Phase Monitor



### Description

The 201A is a 3-phase, auto-ranging, dual-range voltage monitor that protects 190-480VAC, 50/60Hz motors regardless of size. The product provides a user selectable nominal voltage setpoint and the voltage monitor automatically selects between the 200V and 400V range. The 201A includes advanced single LED diagnostics, where color and light patterns distinguish between faults and normal conditions.

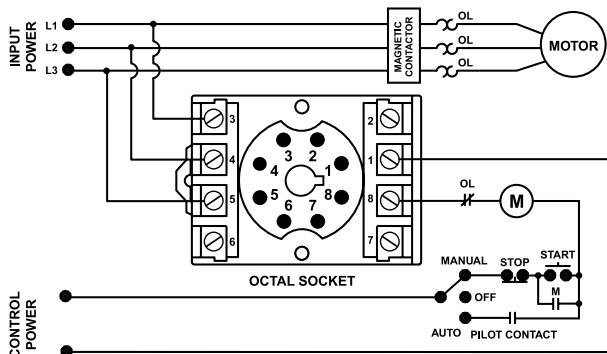
This unique microcontroller-based voltage and phase-sensing device constantly monitors the 3-phase voltages to detect harmful power line conditions. When a harmful condition is detected, the 201A's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to acceptable levels for a specified restart delay time.

### Features & Benefits

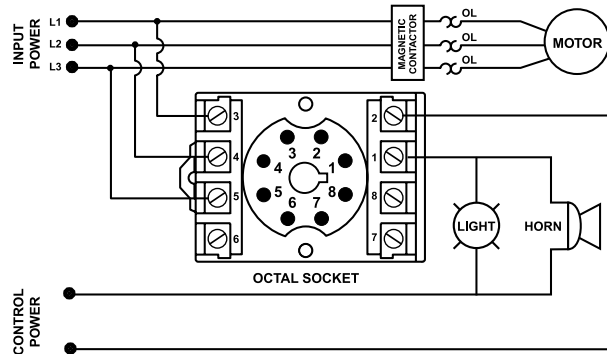
FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of single-phase, low voltage, voltage unbalance, phase reversal, harmful power line conditions. High voltage monitoring optional.
<b>Compact design for 8-pin; DIN rail or surface mount</b>	Allows flexibility in panel installation
<b>Auto-sensing wide voltage range</b>	Automatically senses system voltage between 190 - 480VAC. Saves setup time.
<b>Advanced LED diagnostics</b>	Quick visual indicator for cause of trip. LED indications include: normal operation, power-up restart delay, reverse-phase trip, unbalance/single-phase trip, high/low voltage trip

### Wiring Diagram

201A WITH MOTOR CONTROL



201A WITH ALARM CONTROL



### Accessories



#### OT08PC Octal 8-pin Socket

8-pin 35mm DIN rail or surface mount. Rated at 10A @ 600VAC. Surface mounted with two #6 screws or snaps onto a 35 mm DIN rail.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
201A	190-480VAC	DIN rail or surface mountable
201A-9	190-480VAC	Includes high voltage detection. DIN rail or surface mountable

For dimensional drawing see: Appendix, page 509, Figure 8.

9 AC SYSTEM MONITORS/LOAD SENSORS

## 201A SERIES

### Specifications

<b>Frequency</b>	50/60Hz
<b>Functional Characteristics</b>	
<b>Low Voltage (% of setpoint)</b>	
<b>Trip</b>	90% ±1%
<b>Reset</b>	93% ±1%
<b>Voltage Unbalance (NEMA)</b>	
<b>Trip</b>	6%
<b>Reset</b>	4.5%
<b>Optional High Voltage (% of setpoint)</b>	
<b>Trip</b>	110% ±1%
<b>Reset</b>	107% ±1%
<b>Trip Delay Time</b>	
<b>High/Low Voltage Fault</b>	4 seconds
<b>Unbalance &amp; Phasing Faults</b>	2 seconds
<b>Restart Delay Time</b>	
<b>After a Fault</b>	2 seconds
<b>After a Complete Power Loss</b>	2 seconds
<b>Output Characteristics</b>	
<b>Output Contact Rating (SPDT)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC
<b>General Characteristics</b>	
<b>Temperature Range</b>	-20° to 70°C (-4° to 158°F)
<b>Trip &amp; Reset Accuracy</b>	±1%
<b>Maximum Input Power</b>	5 W
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	12 in.-lbs. (for OT08-PC socket)
<b>Wire Gauge</b>	12-22 AWG solid or stranded
<b>Transient Protection (Internal)</b>	2500V for 10 ms

### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity (RFI), Radiated</b>	150MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power & controls

### Surge

<b>Immunity IEC</b>	IEC 61000-4-5, Level 3, 4kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line
<b>Hi-potential Test</b>	Meets UL508 (2 x rated V + 1000V for 1 min.)

### Safety Marks

<b>UL (OT08PC octal socket required)</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2
<b>Dimensions</b>	<b>H</b> 44.45 mm (1.75"); <b>W</b> 60.33 mm (2.38"); <b>D</b> (with socket) 104.78 mm (4.13")
<b>Weight</b>	0.7 lbs. (11.2 oz., 317.51 g)
<b>Mounting Method</b>	DIN rail or surface mount (plug in to OT08PC socket)
<b>Socket Available</b>	Model OT08PC (UL Rating 600V)

The 600V socket can be surface mounted or installed on DIN Rail.

Note: Manufacturer's recommended screw terminal torque for the OT Series Octal Sockets is 12 in.-lbs.

**Must use Model OT08PC socket for UL Rating!**

# 201A-AU SERIES

## 3-Phase Voltage/Phase Monitor



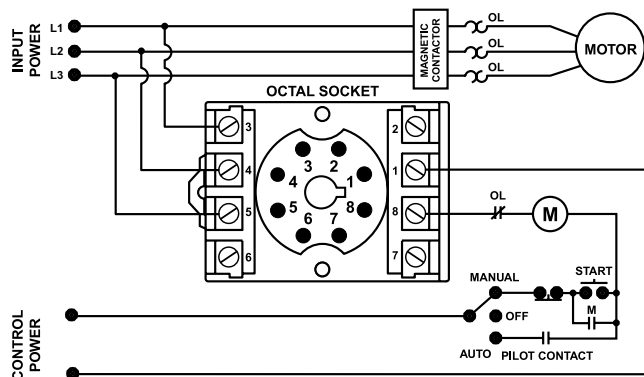
### Description

The 201A-AU is a 3-phase, auto-ranging, dual-range voltage monitor that protects 190-480VAC, 50/60Hz motors regardless of size. The product provides a user selectable nominal voltage setpoint and the voltage monitor automatically selects between the 200V and 400V range. Additional adjustment knobs allow the user to set a 1-30 second trip delay, a manual restart or 1-500 second restart delay and a 2-8% voltage unbalance trip point. The Model 201A-AU includes advanced single LED diagnostics, where color and light patterns distinguish between faults and normal conditions.

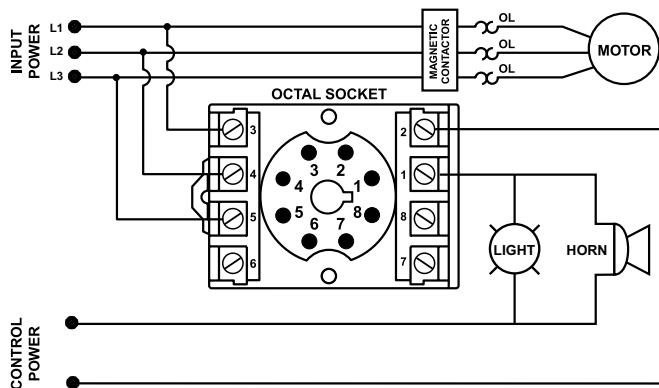
This unique microcontroller-based voltage and phase-sensing device constantly monitors the 3-phase voltages to detect harmful power line conditions. When a harmful condition is detected, the 201A-AU's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to acceptable levels for a specified amount or restart delay time (or manual reset).

### Wiring Diagram

201A-AU WITH MOTOR CONTROL



201A-AU WITH ALARM CONTROL



### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of loss of any phase, low voltage, high voltage, voltage unbalance, phase reversal, rapid cycling, harmful power line conditions
<b>Compact design for 8-pin; DIN rail or surface mount</b>	Allows flexibility in panel installation
<b>Auto-sensing wide voltage range</b>	Automatically senses system voltage between 190 - 480VAC. Saves setup time.
<b>Advanced LED diagnostics</b>	Quick visual indicator for cause of trip.
<b>Adjustable voltage unbalance trip setting</b>	Allows compatibility with a variety of motors and reduces nuisance tripping.
<b>Adjustable trip &amp; restart delay settings</b>	Prevent nuisance tripping due to rapidly fluctuating power line conditions.

### Accessories



#### OT08PC Octal 8-pin Socket

8-pin 35mm DIN rail or surface mount. Rated at 10A @ 600VAC. Surface mounted with two #6 screws or snaps onto a 35 mm DIN rail.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
201A-AU	190-480VAC	DIN rail or surface mountable
201575-AU	475-600VAC	DIN rail or surface mountable
201A-AU-OT	190-480VAC	Sold with OT08PC socket
201-575-AU-OT	475-600VAC	Sold with OT08PC socket

For dimensional drawing see: Appendix, page 509, Figure 8.

## 201A-AU SERIES

### Specifications

<b>Frequency</b>	50/60Hz
<b>Functional Characteristics</b>	
<b>Low Voltage (% of setpoint)</b>	
<b>Trip</b>	90% ±1%
<b>Reset</b>	93% ±1%
<b>High Voltage (% of setpoint)</b>	
<b>Trip</b>	110% ±1%
<b>Reset</b>	107% ±1%
<b>Voltage Unbalance (NEMA)</b>	
<b>Trip</b>	2-8% adjustable
<b>Reset</b>	Trip Setting Minus 1% (5-8%) Trip Setting Minus 0.5% (2-4%)
<b>Trip Delay Time</b>	
<b>High, Low and Unbalanced Voltage</b>	
<b>Single-Phasing Faults</b>	1-30 seconds adjustable
<b>Restart Delay Time</b>	1 second fixed
<b>After a Fault</b>	Manual, 1-500 seconds adj.
<b>After a Complete Power Loss</b>	Manual, 1-500 seconds adj.
<b>Output Characteristics</b>	
<b>Output Contact Rating (1-Form C)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC, B300
<b>General Purpose</b>	10A @ 240VAC
<b>General Characteristics</b>	
<b>Ambient Temperature Range</b>	
<b>Operating</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Trip &amp; Reset Accuracy</b>	±1%
<b>Maximum Input Power</b>	5 W
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	12 in.-lbs. (for OT08-PC socket)
<b>Wire Gauge</b>	12-22 AWG solid or stranded

### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150 MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power and controls
<b>Surge</b>	
<b>IEC</b>	IEC 61000-4-5, Level 3, 4kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line Meets UL508 (2 x rated V +1000V for 1 min.)
<b>Hj-potential Test</b>	
<b>Safety Marks</b>	
<b>UL (OT08PC octal socket required)</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2
<b>Enclosure</b>	Polycarbonate
<b>Dimensions</b>	<b>H</b> 44.45 mm (1.75"); <b>W</b> 60.325 mm (2.375"); <b>D</b> 104.775 mm (4.125") (with socket)
<b>Weight</b>	0.7 lb. (11.2 oz., 317.51 g)
<b>Mounting Method</b>	DIN rail or surface mount (plug in to OT08PC socket)
<b>Socket Available</b>	OT08PC (UL Rating 600V)

The 600V socket can be surface mounted or installed on DIN Rail.

Note: Manufacturer's recommended screw terminal torque for the OT Series Octal Sockets is 12 in.-lbs.

**Must use Model OT08PC socket for UL Rating!**

# 201-XXX-DPDT SERIES

## 3-Phase Voltage/Phase Monitor



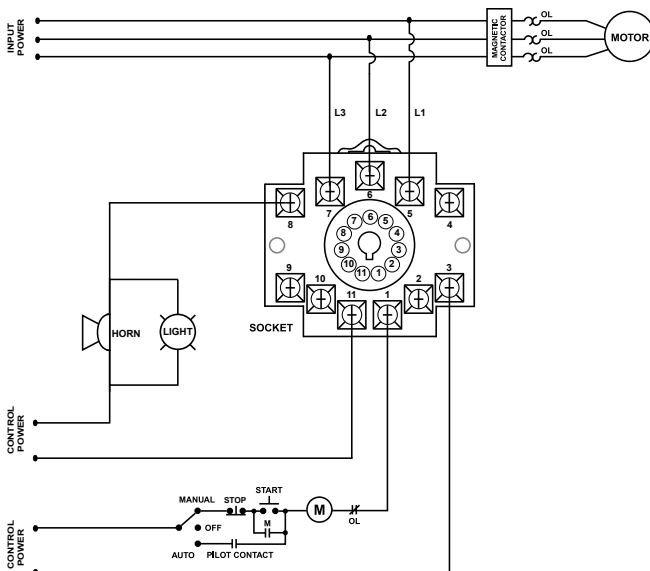
### Description

The 201-xxx-DPDT Series is an 11-pin octal base plug-in voltage monitor designed to protect 3-phase motors regardless of size. The 201-100-DPDT is used on 95-120VAC, 50/60Hz motors and the 201-200-DPDT is used on 190-240VAC, 50/60Hz motors to prevent damage caused by incoming voltage problems. The units feature two isolated sets of contacts that are ideal for use with two control circuits with different voltages.

The unique microcontroller-based voltage and phase-sensing circuit constantly monitors the voltages to detect harmful power line conditions. When a harmful condition is detected, the MotorSaver's output relays are deactivated after a specified trip delay. The output relays reactivate after power line conditions return to an acceptable level and a specified amount of time has elapsed (restart delay). The trip delay prevents nuisance tripping due to rapidly fluctuating power line conditions.

This unit is also available with a shorter trip delay and faster restart delay. The 201-xxx-DPDT-60mS has a trip delay of 0.5 seconds and a restart delay of 60 milliseconds.

### Wiring Diagram



### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constantly monitors 3 phase voltage to protect against harmful line conditions, even before the motor is started
<b>Compact design for 11-pin; DIN rail or surface mount</b>	Allows flexibility in panel installation
<b>Advanced LED indication</b>	Provides diagnostics which can be used for troubleshooting and to determine relay status
<b>Two isolated Form C relays (DPDT)</b>	Ideal for use in systems which have two control circuits with different voltages

### Accessories



#### OT11PC Octal Socket

11-pin surface & DIN rail mountable. Rated for 10A @ 300VAC

For dimensional drawing see: Appendix, page 509, Figure 8.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
201-100-DPDT	95-120VAC	Fixed unbalance, trip delay 4s for low voltage fault and 2s for unbalance and phase loss, restart delay 2s
201-200-DPDT	190-240VAC	Fixed unbalance, trip delay 4s for low voltage fault and 2s for unbalance and phase loss, restart delay 2s
201-100-DPDT-60mS	95-120VAC	Fixed unbalance, trip delay 0.5s, restart delay 60mS

## 201-XXX-DPDT SERIES

### Specifications

#### Input Characteristics

##### Line Voltage

**201-100-DPDT,**  
**201-100-DPDT-60mS** 95-120VAC

**201-200-DPDT,**  
**201-200-DPDT-60mS** 190-240VAC

**Frequency** 50/60Hz

#### Functional Characteristics

##### Low Voltage (% of setpoint)

**Trip** 90% +/-1%

**Reset** 93% +/-1%

##### Voltage Unbalance

**Trip** 6%

**Reset.** 4.5%

##### Trip Delay Times

**Low Voltage** 4 seconds

**Unbalance, Phasing Faults** 2 seconds

**Models with -60ms option** 0.5 second

##### Restart Delay Times

**After a Fault or Complete**  
**Power Loss** 2 seconds

**Models with -60mS option** 60 milliseconds

#### Output Characteristics

##### Output Contact Rating (DPDT)

**Pilot Duty** 480VA @ 240VAC

**General Purpose** 10A @ 240VAC

### General Characteristics

**Temperature Range** -40° to 70°C (-40° to 158°F)

**Maximum Input Power** 5 W

#### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air

#### Radio Frequency

**Immunity, Radiated** 150MHz, 10V/m

**Fast Transient Burst** IEC 61000-4-4, Level 3, 2.5kV input power

#### Safety Marks

**UL (OT11PC octal**  
**socket required)** UL508 (File #E68520)

**CE** IEC 60947-6-2

#### Dimensions

**H** 44.45 mm (1.75"); **W** 60.33 mm (2.38");  
**D** 104.78 mm (4.125")

#### Weight

0.65 lb. (10.4 oz., 294.84 g)

#### Mounting Method

DIN rail or surface mount (plug in to  
OT11PC socket)

#### Socket Available

Model OT11PC (UL Rated 300V)

The 300V socket can be surface mounted or installed on DIN Rail.

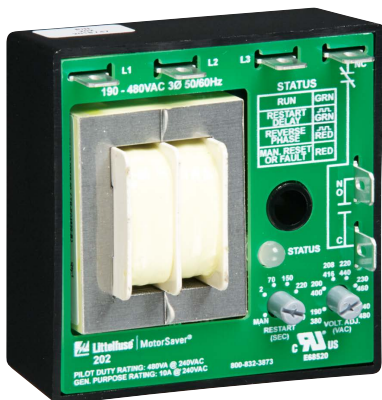
Must use Model OT11PC socket for UL Rating!

\*Note: Manufacturer's recommended screw terminal torque for the RB Series and OT Series Octal Sockets is 12 in.-lbs.



# 202 SERIES

## 3-Phase Voltage/Phase Monitor



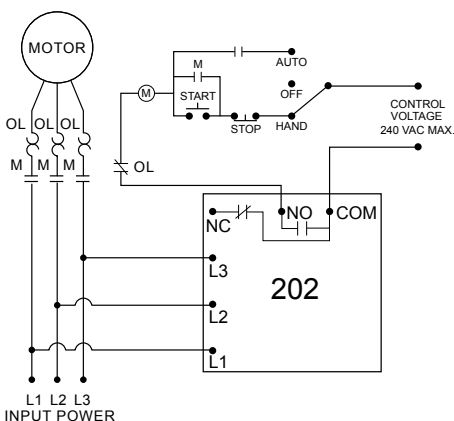
### Description

The 202 Series is a 3-phase, auto-ranging, dual-range voltage monitor that protects 190-480VAC, 50\*/60Hz motors regardless of size. The 202-RP (and the 202-575-RP for 475-600VAC) monitors the phase rotation of 3-phase systems and trips on reverse-phase only. Critical applications include fan motors, scroll compressors, grinders, conveyor systems, elevators and escalators. Both products provide a user selectable nominal voltage setpoint and automatically select between the 200V and 400V range.

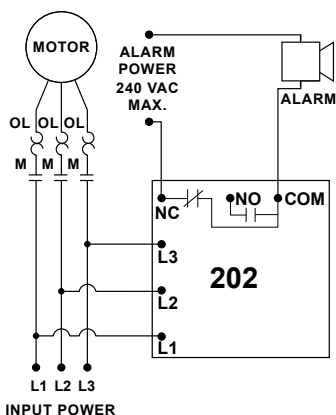
This unique microcontroller-based voltage and phase-sensing device constantly monitors the 3-phase voltages to detect harmful power line conditions. When a harmful condition is detected, the MotorSaver's output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to acceptable levels for a specified amount of restart delay time (or a manual reset). The 202 Series includes advanced single LED diagnostics. Five different light patterns distinguish between faults and normal conditions. The status light turns green and the relay is activated when rotation is correct.

### Wiring Diagram

202 WITH MOTOR CONTROL



202 WITH ALARM CIRCUIT



### Features & Benefits

FEATURES	BENEFITS
<b>Compact, quick mounting design</b>	1-screw mounting saves time and space. Small footprint ideal for assembly into panels.
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of single-phase, low voltage, high voltage, voltage unbalance, phase reversal, harmful power line conditions.
<b>Auto-sensing wide voltage range (202 &amp; 202-RP)</b>	Automatically senses system voltage between 90 - 480VAC. Saves setup time.
<b>Advanced LED diagnostics</b>	Quick visual indicator for cause of trip. LED indications include: normal operation, restart delay, reverse-phase trip, fault
<b>Adjustable trip delay (202)</b>	Prevent nuisance tripping due to rapidly fluctuating power line conditions.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
202	190-480VAC	Standard protection with low/high voltage trip, voltage unbalance
202-RP	190-480VAC	Trips on reverse-phase only
202-575-RP	475-600VAC	Designed for higher voltage systems and trips on reverse-phase only

For dimensional drawing see: Appendix, page 509, Figure 7.

9 AC SYSTEM MONITORS/LOAD SENSORS

## 202 SERIES

### Specifications

<b>Frequency</b>	50*/60Hz
<b>Functional Characteristics</b>	
<b>Phase Sequence</b>	ABC
<b>Low Voltage (% of setpoint)</b>	
<b>Trip</b>	90%
<b>Reset</b>	93%
<b>High Voltage (% of setpoint)</b>	
<b>Trip</b>	110%
<b>Reset</b>	107%
<b>Voltage Unbalance (NEMA)</b>	
<b>Trip</b>	6%
<b>Reset</b>	4.5%
<b>Trip Delay Time</b>	
<b>High and Low Voltage</b>	4 seconds
<b>Unbalance &amp; Phasing Faults</b>	2 seconds
<b>Restart Delay Time</b>	
<b>After a Fault</b>	Manual, 2-300 seconds adj.
<b>After a Complete Power Loss</b>	Manual, 2-300 seconds adj.

### Output Characteristics

<b>Output Contact Rating (SPDT)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC
<b>General Characteristics</b>	
<b>Temperature Range</b>	-40° to 70°C (-40° to 158°F)
<b>Trip &amp; Reset Accuracy</b>	±1%
<b>Repeatability</b>	±0.5%
<b>Maximum Input Power</b>	5 W
<b>Relative Humidity</b>	95%, non-condensing
<b>Transient Protection</b>	IEC 61000-4-5, ±4kV
<b>Hi-potential Test</b>	Meets UL508 (2x rated V+1000V for 1 minute)
<b>Termination</b>	0.25" male quick connect

### Termination

### Safety Marks

### UL Recognized

### Dimensions

### Weight

### Mounting Method

UL508 (File #E68520)
<b>H</b> 63.5 mm (2.5"); <b>W</b> 63.5 mm (2.5");
<b>D</b> 35.56 mm (1.4")
0.5 lb. (8 oz., 226.8 g)
1/4" socket head cap screw (customer supplied)

\*Note: 50Hz will increase all delay timers by 20%. CE Pending

# 250A SERIES

## 3-Phase Voltage/Phase Monitor

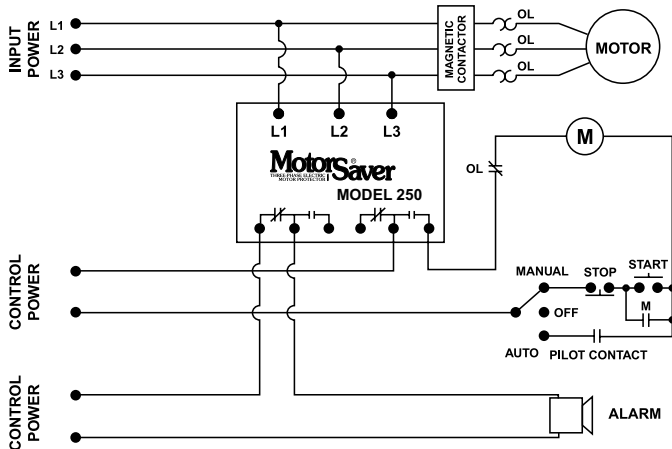


### Description

The 250A is a 3-phase, auto-ranging, dual-range voltage monitor that protects 190-480VAC, 50/60Hz motors regardless of size from low and high voltage, unbalance/single-phase, and reverse-phase. The product provides a user selectable nominal voltage setpoint and the voltage monitor automatically selects between the 200V and 400V range. The 250A also features adjustable or manual restart delay.

This unique microcontroller-based voltage and phase-sensing device constantly monitors the 3-phase voltages to detect harmful power line conditions. When a harmful condition is detected, the output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to acceptable levels. The Model 250A includes advanced single LED diagnostics. Five different light patterns distinguish between faults and normal conditions.

### Wiring Diagram



For dimensional drawing see: Appendix page 509, Figure 6.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of single-phase, low voltage, voltage unbalance, phase reversal, harmful power line conditions.
<b>Auto-sensing wide voltage range</b>	Automatically senses system voltage between 190 - 480VAC. Saves setup time.
<b>Advanced LED diagnostics</b>	Quick visual indicator for cause of trip. LED indications include: normal operation, power-up restart delay, reverse-phase trip, unbalance/single-phase trip, high or low voltage trip
<b>DPDT relay output</b>	Allows for versatility to meet wide application needs
<b>Manual Reset</b>	Allows for inspection of equipment before system is re-energized

### Ordering Information

MODEL	LINE VOLTAGE	% OF SETPOINT				DESCRIPTION
		LOW VOLTAGE TRIP	LOW VOLTAGE RESET	HIGH VOLTAGE TRIP	HIGH VOLTAGE RESET	
250A	190-480VAC	90%	93%	110%	107%	Provides high and low voltage protection at fixed percentage of nominal voltage.
250600	475-600VAC	90%	93%	110%	107%	Provides high and low voltage protection at fixed percentage of nominal voltage.
250A-MET	190-480VAC	85%	88%	N/A	N/A	Designed for use with Fire Control Panels. Has 2 Form C contacts that operate independently. Left Form C energizes when voltage conditions are good and de-energize when a fault condition is detected. Right Form C only energizes during a reverse-phase condition. No high voltage protection.
250-100-MET	95-120VAC	85%	88%	N/A	N/A	Designed for use with Fire Control Panels. Has 2 Form C contacts that operate independently. Left Form C energizes when voltage conditions are good and de-energize when a fault condition is detected. Right Form C only energizes during a reverse-phase condition. No high voltage protection.

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## 250A SERIES

### Specifications

<b>Frequency</b>	50*/60Hz Low Voltage
<b>Functional Characteristics</b>	
<b>Voltage Unbalance (NEMA)</b>	
<b>Trip</b>	6%
<b>Reset</b>	4.5%
<b>Trip Delay Time</b>	
<b>Low Voltage, High Voltage</b>	4 seconds
<b>Unbalance, Phasing Faults</b>	2 seconds
<b>Restart Delay Time</b>	
<b>After a Fault or Complete Power Loss</b>	
	Manual, 2-300 seconds adj.
<b>Output Characteristics</b>	
<b>Output Contact Rating (DPDT - 2 Form C)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC
<b>Temperature Range</b>	-40° to 70°C (-40° to 158°F)
<b>Trip &amp; Reset Accuracy</b>	±1%
<b>Maximum Input Power</b>	5 W
<b>Relative Humidity</b>	Up to 95% non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	7 in.-lbs.
<b>Wire Size</b>	12-18AWG
<b>Transient Protection (Internal)</b>	
	IEC 61000-4-5;1995 ±6kV
<b>Approvals</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CSA</b>	CSA 22.2 No. 14 (File#46510)
<b>CE</b>	CE IEC 60947-6-2
<b>Dimensions</b>	
	<b>H</b> 74.4 mm (2.93"); <b>W</b> 133.9 mm (5.27");
	<b>D</b> 74.9 mm (2.95")
<b>Weight</b>	1.02 lb. (16.32 oz., 462.66 g)
<b>Mounting Method</b>	#8 screws

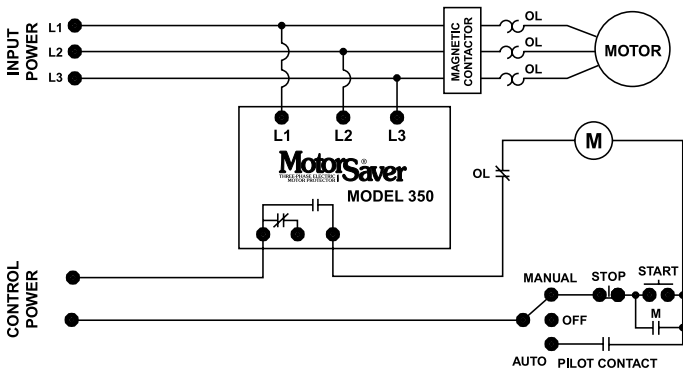
\*Note: 50Hz will increase all delay timers by 20%.

# 350 SERIES

## 3-Phase Voltage/Phase Monitor



### Wiring Diagram



For dimensional drawing see: Appendix page 509, Figure 6.

### Description

The 350 Series is a heavy-duty voltage monitor. This product should be used when high current relays or dual contacts are required, or 480V controls are used. Since the 350 Series uses heavy-duty relays, it comes in fixed voltage range models rather than a dual auto-ranging version like the Model 250.

The 350200 has a 15A general purpose contact. The 350400 provides a SPDT (Form C) relay rated to switch up to 600V, allowing the use of 480V controls, eliminating the need for a control power transformer to step the voltage down to 120-240V. Several DPDT (two Form C contacts) relay models are also available.

The 350 microcontroller-based family of products are low cost yet highly advanced solutions to heavy-duty problems. The 350 includes advanced single LED diagnostics. Five different light patterns distinguish faults and normal operating conditions. Other options such as high voltage trip and adjustable restart delay are available.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constantly monitors 3 phase voltage to protect against harmful line conditions, even before the motor is started
<b>Advanced LED indication</b>	Provides diagnostics which can be used for troubleshooting and to determine relay status
<b>Adjustable restart delay (-2 models) settings</b>	Allows staggered start up of multiple motors, after a fault, to prevent a low voltage condition
<b>600V rated relay contacts available on some models</b>	Eliminates the need for a control transformer to step voltage down to 120 - 240V for a control circuit

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION	MODEL	LINE VOLTAGE	DESCRIPTION
350200	190-240VAC	SPDT, fixed trip and restart delay	35040026	380-480VAC	DPDT, 2 relays (1)10a. (1) 15A; fixed trip and variable restart delay (manual, 2-300s)
3502002	190-240VAC	SPDT, fixed trip and variable restart delay (manual, 2-300s)	35040028**	380-480VAC	DPDT, 2 relays 15A; variable restart delay (no manual reset)
35020026	190-240VAC	DPDT, 2 relays (1)10a. (1) 15A; fixed trip and variable restart delay (manual, 2-300s)	35040029	380-480VAC	SPDT, fixed trip and variable restart delay (manual, 2-300s), plus high voltage detection
35020028**	190-240VAC	DPDT, 2 relays 15A; variable restart delay (no manual reset)	350600	475-600VAC	SPDT, fixed trip and restart delay
35020029	190-240VAC	SPDT, fixed trip and variable restart delay (manual, 2-300s), plus high voltage detection	3506002	475-600VAC	SPDT, fixed trip and restart delay (manual, 2-300s)
350400	380-480VAC	SPDT, fixed trip and restart delay	35060026	475-600VAC	DPDT, 2 relays (1)10a. (1) 15A; fixed trip and variable restart delay (manual, 2-300s)
3504002	380-480VAC	SPDT, fixed trip and variable restart delay (manual, 2-300s)	35060028**	475-600VAC	DPDT, 2 relays 15A; variable restart delay (no manual reset)
35040025	380-480VAC	DPDT, fixed trip and variable restart delay (manual, 2-300s)	35060029	475-600VAC	SPDT, fixed trip and variable restart delay (manual, 2-300s), plus high voltage detection

\*\* These units are not equipped with Manual Reset.

9 AC SYSTEM MONITORS/LOAD SENSORS

## 350 SERIES

### Specifications

#### Input Characteristics

##### Line Voltage

<b>350200</b>	190-240VAC
<b>350400</b>	380-480VAC
<b>350600</b>	475-600VAC

<b>Frequency</b>	50*/60Hz
------------------	----------

#### Functional Characteristics

##### Low Voltage (% of setpoint)

<b>Trip</b>	90%
<b>Reset</b>	93%

##### Voltage Unbalance (NEMA)

<b>Trip</b>	6%
<b>Reset</b>	4.5%

##### Trip Delay Time:

<b>Low Voltage</b>	4 seconds
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<b>Unbalance &amp; Phasing Faults</b>	2 seconds
---------------------------------------	-----------

##### Restart Delay Time

<b>After a Fault</b>	2 seconds
----------------------	-----------

<b>After a Complete Power Loss</b>	2 seconds
------------------------------------	-----------

#### Output Characteristics

##### Output Contact Rating

##### SPDT (350200)

<b>Pilot Duty</b>	480VA @ 240VAC
-------------------	----------------

##### General Purpose

<b>SPDT (350-400, 350-600)</b>	470VA @ 600VAC
--------------------------------	----------------

##### DPDT (-6 Option)

1-10A General Purpose
480VA @ 240VAC Pilot Duty
1-15A General Purpose
480VA @ 240VAC Pilot Duty
1hp @ 240VAC

##### DPDT (-8 Option)

2-15A General Purpose
480VA @ 240VAC Pilot Duty
1hp @ 240VAC

### General Characteristics

#### Ambient Temperature Range

<b>Operating</b>	-40° to 70°C (-40° to 158°F)
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<b>Storage</b>	-40° to 80°C (-40° to 176°F)
----------------	------------------------------

<b>Trip &amp; Reset Accuracy</b>	±1%
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<b>Maximum Input Power</b>	5 W
----------------------------	-----

#### Terminal

<b>Torque</b>	7 in.-lbs.
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<b>Wire Size</b>	12-18AWG
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#### Transient Protection

<b>(Internal)</b>	IEC 61000-4-5;1995 ±6kV
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#### Safety Marks

<b>UL</b>	UL508 (File #E68520)
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<b>CSA</b>	22.2 No. 14 (File #46510)
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<b>CE</b>	IEC 60947-6-2
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<b>Dimensions</b>	<b>H</b> 74.42 mm (2.93"); <b>W</b> 133.86 mm (5.27");
-------------------	--

	<b>D</b> 74.93 mm (2.95")
--	---------------------------

<b>Weight</b>	1.05 lbs. (16.8 oz., 476.27 g)
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<b>Mounting Method</b>	#8 screws
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#### Special Options

<b>Opt. 2: Variable Restart Delay</b>	Manual, 2-300 seconds adj.
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#### Opt. 5: DPDT Relay

#### Opt. 6: 2 Relays (1) 10A, (1) 15A

#### Opt. 8: 2 Relays (2) 15A

#### Opt. 9: High Voltage (% of setpoint)

<b>Trip</b>	110%
-------------	------

<b>Reset</b>	107%
--------------	------

\*Note: 50Hz will increase all delay timers by 20%.



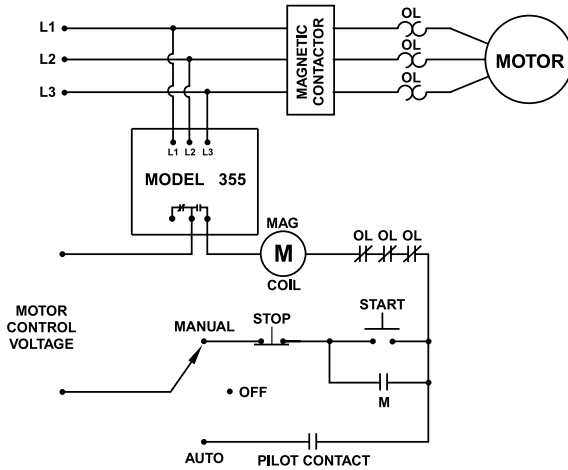
# 355 SERIES

## 3-Phase Voltage/Phase Monitor

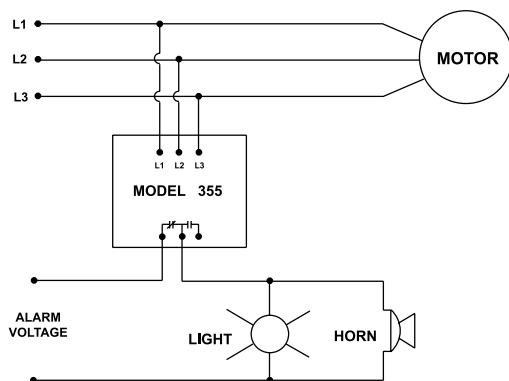


### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR MODEL 355 WITH MOTOR CONTROL



TYPICAL WIRING DIAGRAM FOR MODEL 355 WITH ALARM CONTROL



For dimensional drawing see: Appendix page 509, Figure 6.

### Description

The 355 Series is a 3-phase voltage monitor with adjustable trip and restart delay, adjustable voltage unbalance and multiple diagnostic lights. It is perfect for heavy-duty applications that need both protection and simple user-friendly diagnostics. Applications include pump panels, commercial HVAC, oil rigs and others.

The 355 Series uses microcontroller technology to monitor incoming voltage and de-energize its output relay if power problems exist. The 355 Series can protect motors from damage caused by single-phasing, high and low voltage, phase reversal and voltage unbalance. It has four diagnostic LEDs that clearly show overvoltage, undervoltage, voltage unbalance, reverse-phase and normal conditions.

The 355200 is equipped with a heavy-duty 10A general purpose SPDT relay. The 355400 and 355600 are equipped with a 470VA @ 600VAC pilot duty SPDT relay. A high voltage (600V) DPDT relay output option is available with the 400V model.

### Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constantly monitors 3 phase voltage to protect against harmful line conditions, even before the motor is started
<b>Advanced LED indication</b>	Provides diagnostics which can be used for troubleshooting and to determine relay status
<b>Adjustable trip and restart delay settings</b>	Prevent nuisance tripping due to rapidly fluctuating power line conditions and allows staggered start up of multiple motors, after a fault, to prevent a low voltage condition
<b>Combines protection and diagnostics</b>	Perfect for heavy duty applications: pump panels, commercial HVAC, and oil rigs
<b>600V rated relay contacts available on some models</b>	Eliminates the need for a control transformer to step voltage down to 120 - 240V for a control circuit

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
355200	190-240VAC	SPDT
355400	380-480VAC	SPDT
3554005	380-480VAC	DPDT
355600	475-600VAC	SPDT

9 AC SYSTEM MONITORS/LOAD SENSORS



## 355 SERIES

### Specifications

#### Input Characteristics

##### Line Voltage

<b>355200</b>	190-240VAC
<b>355400</b>	380-480VAC
<b>355600</b>	475-600VAC

(Specify voltage range)

<b>Frequency</b>	50*/60Hz
------------------	----------

#### Functional Characteristics

##### Low Voltage (% of setpoint)

<b>Trip</b>	90% ±1%
<b>Reset</b>	93% ±1%

##### High Voltage (% of setpoint)

<b>Trip</b>	110% ±1%
<b>Reset</b>	107% ±1%

##### Voltage Unbalance (NEMA)

<b>Trip</b>	2-8% adjustable
<b>Reset</b>	Trip setting minus 1%

##### Trip Delay Time:

<b>Low &amp; High Voltage and Unbalance</b>	2-30 seconds adjustable
---	-------------------------

##### Single-phasing Faults (>25% UB)

2 seconds

##### Restart Delay Time

After a Fault or Power Loss Manual, 2-300 seconds adj.

#### Output Characteristics

##### Output Contact Rating

##### SPDT (355200)

<b>Pilot Duty</b>	480VA at 240VAC
<b>General Purpose</b>	10A

##### SPDT (355400, 355600)

<b>Pilot Duty</b>	470VA @ 600VAC
<b>DPDT (-5 Option)</b>	
<b>Pilot Duty</b>	470VA @ 600VAC

### General Characteristics

#### Temperature Range

**Operating** -40° to 70°C (-40° to 158°F)

**Storage** -40° to 80°C (-40° to 176°F)

#### Repeat Accuracy

±0.1%

#### Fixed Conditions

#### Maximum Input Power

6 W

#### Terminal

#### Torque

7 in.-lbs.

#### Wire Size

12-18AWG

#### Transient Protection

#### (Internal)

2500V for 10 ms

#### Safety Marks

#### UL

UL508 (File #E68520)

#### Dimensions

**H** 74.42 mm (2.93"); **W** 133.86 mm (5.27");

**D** 74.93 mm (2.95")

#### Weight

0.94 lb. (15.04 oz., 426.38 g)

#### Mounting Method

#8 screws

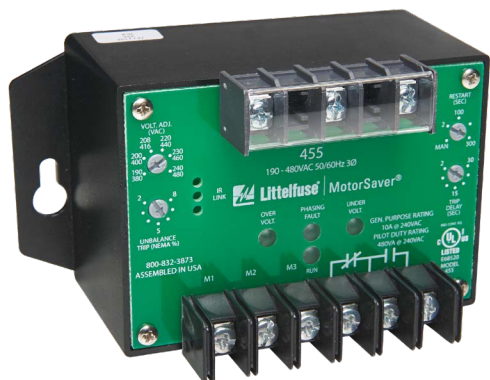
#### Special Options

#### Option 5 - DPDT Relay

\*Note: 50Hz will increase all delay times by 20%.

# 455 SERIES

## 3-Phase Voltage/Phase Monitor



### Description

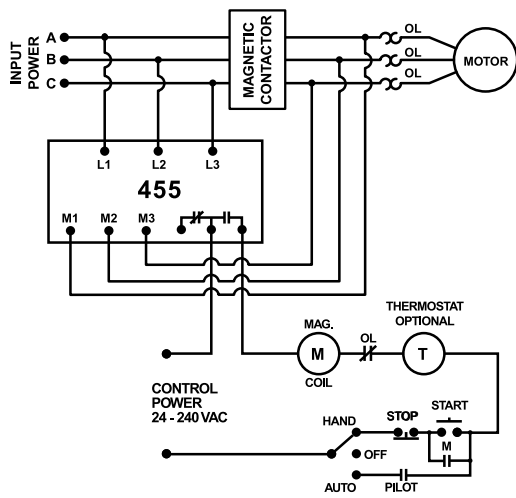
The 455 Series are 3-phase voltage monitors that combine load and line side monitoring to offer complete protection. Monitoring the load side will alert the user of contactor failure or impending contactor failure. Line side monitoring will also protect the motor from damaging fault conditions that may be present prior to the motor starting. With other line/load side monitors, the motor must be started before a voltage fault is detected. With the 455, your motor is fully protected at all times.

The 455 Series are 3-phase, dual range voltage monitors that protect 190-480VAC, 50\*/60Hz motors, regardless of their size. It automatically selects between the 200V and 400V range when the user selects the nominal voltage setpoint. Other adjustments include a 2-30 second trip delay, a 2-300 second restart delay (and manual restart) and a voltage unbalance trip point of 2-8%. The voltage monitor's circuitry is powered through the line side connections, so there is no need for separate control power, making it easy to install.

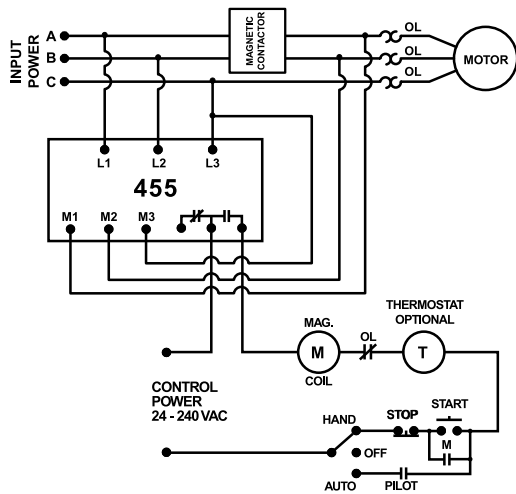
Equipped with an infrared LED, the 455 Series can communicate to the optional hand-held diagnostic tool, Informer-MS to obtain valuable information such as real-time voltage, voltage unbalance on both line and load sides, motor run hours, last 20 faults, last 32 motor starts, high and low voltage trip points, voltage unbalance trip point, restart and trip delay settings, LED status and more.

### Wiring Diagram

MODEL 455 WITH MOTOR CONTROL USING A 3-POLE CONTACTOR



MODEL 455 WITH MOTOR CONTROL USING A 2-POLE CONTACTOR



### Features & Benefits

FEATURES	BENEFITS
<b>Load side monitoring of contactor</b>	Protects motor from contactor failure or worn contacts.
<b>Monitors contactor or starter</b>	Prevents rapid cycling
<b>Infrared LED Capable</b>	Increases personnel safety line of sight monitoring using optional Informer-MS

### Accessories



#### Informer-MS

A hand-held diagnostic tool designed for use with Littelfuse® 455 equipped with an infrared LED transmitter



#### Informer IR Kit-36

36" infrared adapter cable attaches to the face of the unit to provide remote diagnostics without opening the panel.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
455	190-480VAC	Universal line and load side monitor
455480R	380-480VAC	Used in high voltage applications with pilot duty 470VA @ 600VAC
455575	475-600VAC	For use in Canada or NE USA where 575V utility power services are common.

For dimensional drawing see: Appendix page 509, Figure 6.

## 455 SERIES

### Specifications

<b>Frequency</b>	50*/60Hz
<b>Low Voltage (% of setpoint)</b>	
<b>Trip</b>	90% ±1%
<b>Reset</b>	93% ±1%
<b>High Voltage (% of setpoint)</b>	
<b>Trip</b>	110% ±1%
<b>Reset</b>	107% ±1%
<b>Voltage Unbalance (NEMA)</b>	
<b>Trip</b>	2-8% adjustable
<b>Reset</b>	Trip setting minus 1%
<b>Trip Delay Time</b>	
<b>Low &amp; High Voltage and Unbalance</b>	2-30 seconds adjustable
<b>Single-phasing Faults (&gt;25% UB)</b>	2 seconds fixed
<b>Restart Delay Time</b>	
<b>After a Fault</b>	Manual, 2-300 seconds adj.
<b>After a Complete Power Loss</b>	Manual, 2-300 seconds adj.
<b>After a Motor Shut-down</b>	Manual, 2-300 seconds adj.
<b>Output Characteristics</b>	
<b>Output Contact Rating (SPDT)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A
<b>High Voltage Relay (-480R)</b>	
<b>Pilot Duty</b>	470VA @ 600VAC

### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-40° to 70°C (-40° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Repeat Accuracy</b>	
<b>Fixed Conditions</b>	±0.1%
<b>Maximum Input Power</b>	6 W
<b>Terminal</b>	
<b>Torque</b>	7 in.-lbs.
<b>Wire Size</b>	12-18AWG
<b>Transient Protection (Internal)</b>	IEC 61000-4-5;1995 ±6kV
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CSA</b>	C22.2 No. 14 (File #46510)
<b>CE</b>	IEC 60947-6-2
<b>Dimensions</b>	<b>H</b> 74.4 mm (2.93"); <b>W</b> 133.9 mm (5.27"); <b>D</b> 74.9 mm (2.95")
<b>Weight</b>	1.1 lbs. (17.6 oz., 498.95 g)
<b>Mounting Method</b>	#8 screws

\*Note: 50Hz will increase all delay times by 20%.

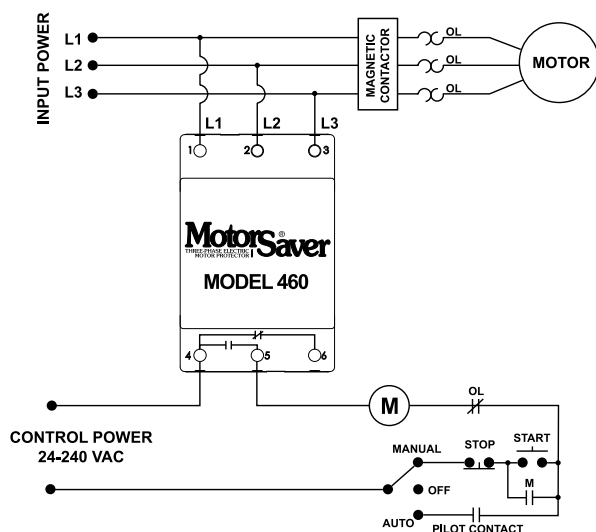
# 460 SERIES

## 3-Phase Voltage Monitor



### Wiring Diagram

TYPICAL WIRING DIAGRAM FOR MODEL 460 WITH MOTOR CONTROL



### Description

The 460 is a 3-phase voltage monitor that protects 190-480VAC or 475-600V, 50/60Hz motors regardless of size. The product provides a user selectable nominal voltage setpoint and the voltage monitor automatically senses line voltage.

This unique microcontroller-based voltage and phase-sensing device constantly monitors the 3-phase voltages to detect harmful power line conditions such as low, high, and unbalanced voltage, loss of any phase, and phase reversal. When a harmful condition is detected, the MotorSaver® output relay is deactivated after a specified trip delay. The output relay reactivates after power line conditions return to an acceptable level for a specified amount of time (restart delay). The trip and restart delays prevent nuisance tripping due to rapidly fluctuating power line conditions.

All 460 models feature adjustable 1-30 second trip delay, 1-500 second restart delay, 2-8% voltage unbalance trip point, and one form C contact except where noted below.

### Features & Benefits

FEATURES	BENEFITS
<b>Auto-sensing wide voltage range</b>	Automatically senses system voltage between 190 - 480VAC or 475-600VAC. Saves set-up time
<b>Adjustable trip &amp; restart delay settings</b>	Prevent nuisance tripping due to rapidly fluctuating power line conditions
<b>Microcontroller based circuitry</b>	Improved accuracy and higher reliability
<b>Advanced LED diagnostics</b>	Quick visual indicator for cause of trip and relay status
<b>Adjustable voltage unbalance trip setting</b>	Provides reliable protection when regenerative voltage is present

For dimensional drawing see: Appendix, page 510, Figure 10.

### Ordering Information

MODEL	VOLTAGE	DESCRIPTION
460	190-480VAC	Automatically senses line voltage, adjustable 1-30 second trip delay, 1-500 second restart delay, and 2-8% voltage unbalance trip point
460-L	190-480VAC	Fixed 4 second trip delay and 1 second for single-phase faults, and fixed 6% voltage unbalance trip point
460-14	190-480VAC	Equipped with 2 sets of contacts: Form A (NO) and Form B (NC). Used for applications requiring 2 different voltages such as 5VDC for a PLC input and 115VAC for an alarm
460-575	475-600VAC	Commonly used in Eastern Canada and on generator units that generate 600 VAC power
460-575-14	475-600VAC	Commonly used in Eastern Canada and on generator units that generate 600 VAC power. Equipped with 2 sets of contacts: Form A and Form B
460-15	190-480VAC	Equipped with 2 sets of Form A (NO) contacts. Used on applications where two different units are to be controlled at once such as a unit that has separate contacts for a compressor and a fan
460-MR	190-480VAC	Equipped with a 2-prong connection for a normally open push button mounted outside the panel. Used in applications requiring an external manual reset button
460-VBM	190-480VAC	Fixed 6% voltage unbalance trip point. User adjustable low and high voltage trip points
460-400HZ	190-480VAC	For use with 400Hz power supply
460-OEM	190-480VAC	Bulk package of 460, 20 units
460L-OEM	190-480VAC	Bulk package of 460-L, 20 units

## 460 SERIES

### Specifications

<b>Frequency</b>	50/60Hz
<b>Low Voltage (% of setpoint)</b>	
<b>Trip</b>	90% ±1%
<b>Reset</b>	93% ±1%
<b>High Voltage (% of setpoint)</b>	
<b>Trip</b>	110% ±1%
<b>Reset</b>	107% ±1%
<b>Voltage Unbalance (NEMA)</b>	
<b>Trip</b>	2-8% adjustable
<b>Reset</b>	Trip setting minus 1% (5-8%) Trip setting minus 0.5% (2-4%) 6% UB fixed (4.5% reset)
<b>460L</b>	
<b>Trip Delay Time</b>	
<b>Low, High and Unbalanced Voltage</b>	1-30 seconds adjustable
<b>460L</b>	4 seconds fixed
<b>Single-Phase Faults (&gt;15% UB)</b>	1 second fixed
<b>Restart Delay Time</b>	
<b>After a Fault</b>	1-500 seconds adjustable
<b>After a Complete Power Loss</b>	1-500 seconds adjustable
<b>Output Contact Rating</b>	
<b>Form C</b>	
<b>Pilot Duty</b>	480VA @ 240VAC, B300
<b>General Purpose</b>	10A @ 240VAC
<b>Form A &amp; Form B</b>	
<b>Pilot Duty</b>	360VA @ 240VAC, B300
<b>General Purpose</b>	8A @ 240VAC

### Ambient Temperature Range

<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Maximum Input Power</b>	6 W
<b>Class of Protection</b>	IP20, NEMA 1 (finger safe)
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	4.5 in.-lbs.
<b>Wire Type</b>	Stranded or solid 12-20 AWG, one per terminal
<b>Standards Passed</b>	
<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>RFI, Radiated</b>	150 MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power and controls

### Surge

<b>IEC</b>	IEC 61000-4-5, Level 3, 4kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line Meets UL508 (2 x rated V +1000V for 1 minute)

### Hi-potential Test

<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-6-2
<b>Enclosure</b>	Polycarbonate
<b>Dimensions</b>	<b>H</b> 88.9 mm (3.5"); <b>W</b> 52.9 mm (2.08"); <b>D</b> 59.69 mm (2.35")
<b>Weight</b>	0.7 lb. (11.2 oz., 317.51 g)
<b>Mounting Method</b>	35 mm DIN rail or Surface Mount (#6 or #8 screws)
<b>460-MR (manual reset)</b>	External NO pushbutton required.

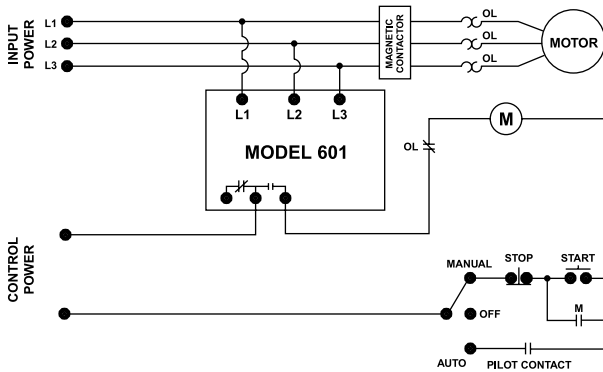
# 601 SERIES

## 3-Phase Voltage & Frequency Monitor



### Wiring Diagram

MODEL 601 WITH MOTOR CONTROL



For dimensional drawing see: Appendix page 507, Figure 1.

### Ordering Information

MODEL	LINE VOLTAGE	DESCRIPTION
601	190-480VAC	Universal 3-Phase Voltage & Frequency Monitor
601575	500-600VAC	Used primarily in Canada and NE USA where 575V utility power services are common

### Description

The Model 601 is a fully-programmable voltage monitor designed to protect 3-phase motors from loss of any phase (single-phasing), phase reversal, low or high voltage, voltage unbalance, low or high frequency, and rapid cycling. It can be used as a stand-alone product or networked with an RM1000, RM2000, PLC, computer or SCADA system.

When a harmful condition is detected, the 601's output relay is deactivated after the specified trip delay. The output relay reactivates after power line conditions return to an acceptable level for the programmed restart delay (RD2).

Eleven (11) setpoints are viewable with the 3-digit LED display or from a networked device:

- low voltage
- high voltage
- voltage unbalance
- low frequency
- high frequency
- RS485 address
- trip delay for voltage/frequency faults
- trip delay for single-phase faults
- rapid-cycle timer (RD1)
- restart delay after all faults (RD2)
- type of restart after all faults (manual or automatic)

Six (6) parameters are viewable while the motor is running:

- L1-L2 voltage
- L2-L3 voltage
- L1-L3 voltage
- average voltage
- voltage unbalance (%)
- frequency

When used with the RS485MS-2W communications module, the 601 can communicate with most Modbus RTU master devices. Voltage conditions can be monitored and setpoints can be changed remotely using Solutions software, an RM1000, RM2000 or other device.

### Features & Benefits

FEATURES	BENEFITS
<b>Built-in display</b>	Provides real time information and diagnostics to help with troubleshooting
<b>Programmable voltage and frequency settings</b>	Allows usage on wide range of systems
<b>2 programmable restart delay timers</b>	Program separate restart delay time for rapid cycle protection and motor cool down
<b>2 programmable trip delay timers</b>	1 trip delay specifically for Phase Loss/Single-Phase fault condition, 1 trip delay for all other fault conditions
<b>Programmable restart control</b>	Choose between an adjustable automatic or manual restart to best meet individual application needs
<b>Flexible reset</b>	Reset options include pushbutton on relay or remote reset with optional 777-MRSW or OL-RESET remote reset kit
<b>Remote display compatibility</b>	Increases safety through remote display of real-time data and fault history, without the need to open the cabinet. Aids with arc flash safety regulations
<b>Network communications capability</b>	Compatible with RS-485 Modbus communications module

9 AC SYSTEM MONITORS/LOAD SENSORS

## 601 SERIES

### Accessories



**RS485MS-2W Communication Module**  
(for limited Modbus capabilities) Required to enable the Modbus communications function on Model 77X-type products.



**RM1000 Remote Monitor**  
The RM1000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring for up to 16 devices.



**RM2000 Remote Monitor**  
The RM2000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring with event storage and real-time clock for date and time stamp.



**777-MRSW Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.



**OL-RESET Manual Remote Reset Kit**  
Allows the 777 line of MotorSaver® and PumpSaver® products to be manually reset without opening the panel door.

### Specifications

#### Input Characteristics

**Frequency** 50/60Hz

#### Functional Characteristics

#### Programmable Operating Points

**LV - Low Voltage Threshold** 170V (450V\*) - HV Setting

**HV - High Voltage Threshold** LV Setting - 528V (660V\*)

**VUB - Voltage Unbalance Threshold** 2-15% or off

**LF - Low Frequency Threshold** 35Hz - HF Setting

**HF - High Frequency Threshold** LF Setting - 75Hz

**TD1 - Trip Delay for Voltage/Unbalance/Frequency Faults** 1-50 seconds

**TD2 - Trip Delay for Single-Phase Faults** 1-50 seconds

**RD1 - Rapid-Cycle Timer** 0, 2-500 seconds

**RD2 - Restart Delay After All Faults** 2-500 seconds

**#RF - Type of Restart** Manual or Automatic

**ADDR - RS-485 Address** A01-A99

#### Fixed Reset Points

**Overvoltage Reset** 97% of HV Setting

**Low Voltage Reset** 103% of LV Setting

**Voltage Unbalance Reset** UB Setting -1%

**Low Frequency Reset** LF Setting +0.6Hz

**High Frequency Reset** HF Setting -0.6Hz

#### Output Characteristics

**Output Contact Rating** 480VA @ 240VAC

#### General Characteristics

**Temperature Range** -20° to 70°C (-4° to 158°F)

#### Accuracy

**Voltage** ±1%

**Timing** 5% ±1 second

#### Repeatability

**Voltage** ±0.5%

**Maximum Input Power** 5 W

**Transient Protection (Internal)** 2500 V for 10 ms

#### Safety Marks

**UL** UL508 (File #E68520)

**CSA** C22.2 No. 14 (File #46510)

**CE** IEC 60947-6-2

**Dimensions** **H** 77.47 mm (3.05"); **W** 97.79 mm (3.85");

**D** 128.27 mm (5.05")

**Weight** 1.2 lbs. (19.2 oz., 544.31 g)

**Mounting Method** Surface mount (4 - #8 screws) or DIN rail mount

The 601 can be preprogrammed prior to installation by applying at least 120V to the L1 and L2 terminals.

\*575V Model



# 601-CS-D-P1

## 3-Phase Power Monitor

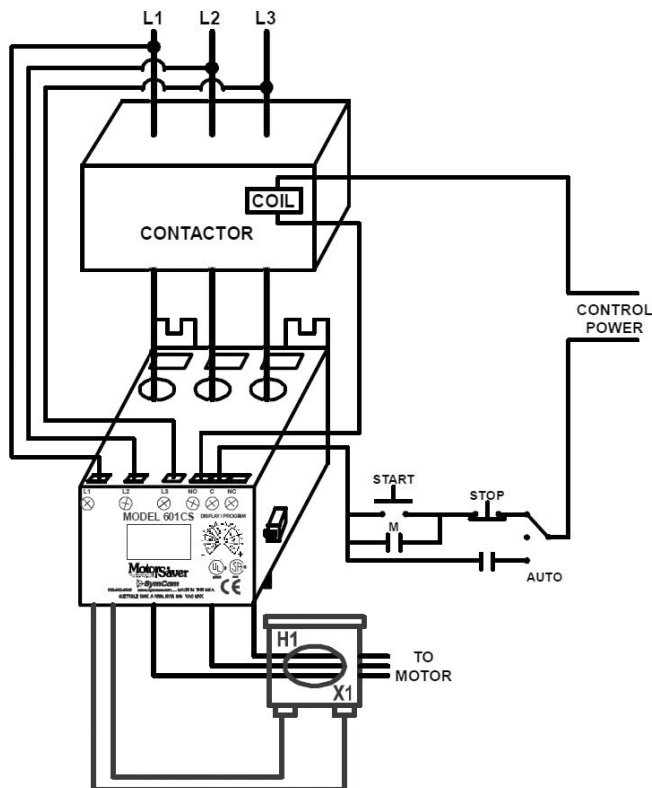


### Description

The 601-CS-D-P1 3-phase power monitor is a fully programmable electronic power monitor designed to monitor 3-phase systems. The 601-CS-D-P1 has a single relay that can be configured as a general purpose network output or to trip on ground faults. The 601-CS-D-P1 monitors ground fault current, phase currents, phase voltages, power factor and frequency. The RS485MS-2W communications module allows the 601-CS-D-P1 to communicate using the Modbus RTU protocol. The Modbus connection can be used to monitor power parameters, setup the device or control the fault relay. A DeviceNet™ communications I/O module (CIO-601CS-DN-P1) is available as well. This CIO module only works with the 601-CS-D-P1 unit. It is used for sending the information from the 601-CS-D-P1 over a DeviceNet™ network. It also provides I/O capabilities and the ability to set the parameters of the 601-CS-D-P1.

Note: This product must be used with an external Zero-Sequence CT for proper operation (not included).

### Wiring Diagram



### Features & Benefits

FEATURES	BENEFITS
<b>Built-in display</b>	Visual indication for programming and viewing real-time parameters for nominal voltage, voltage unbalance, current, current unbalance, ground fault warning, ground fault trip, and ground fault motor acceleration
<b>15 Programmable parameters to control the device operation</b>	Allows the user to customize the protection required for their system
<b>2 programmable trip delay timers</b>	Program separate trip delay time for motor acceleration and ground fault
<b>Network communications capability</b>	Compatible with Modbus RTU and DeviceNet™ protocols with the use of separate communications module

### Accessories



#### CIO-601CS-DN-P1 Module

Convenient, cost-effective DeviceNet™ interface device capable of providing discrete control and monitoring of motor starters, drives and other devices over a DeviceNet™ network.

For dimensional drawing see: Appendix page 507, Figure 1.

9 AC SYSTEM MONITORS/LOAD SENSORS

## 601-CS-D-P1

### Specifications

#### Input Characteristics

<b>Line Voltage</b>	200-480VAC
<b>Frequency</b>	50/60Hz
<b>Motor Full Load Amp Range</b>	0.5-175A (direct) 176-800A (CTs required)
<b>Input Ground Fault Current</b>	0.5-10A

#### Output Characteristics

<b>Output Contact Rating (SPDT)</b>	
<b>Pilot Duty</b>	480VA @ 240VAC
<b>General Purpose</b>	10A @ 240VAC
<b>Expected Life</b>	
<b>Mechanical</b>	1 x 10 <sup>6</sup> operations
<b>Electrical</b>	1 x 10 <sup>5</sup> operations at rated load

#### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Accuracy at 25° C (77° F)</b>	
<b>Voltage</b>	+/-1%
<b>Current</b>	+/-3% (<175A direct)
<b>GF Current</b>	+/-3%
<b>Repeatability</b>	
<b>Voltage</b>	+/-0.5% of nominal voltage
<b>Current</b>	+/-1% (<175A direct)
<b>Maximum Input Power</b>	10 W
<b>Pollution Degree</b>	3
<b>Class of Protection</b>	IP20
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Terminal Torque</b>	7in.-lbs.

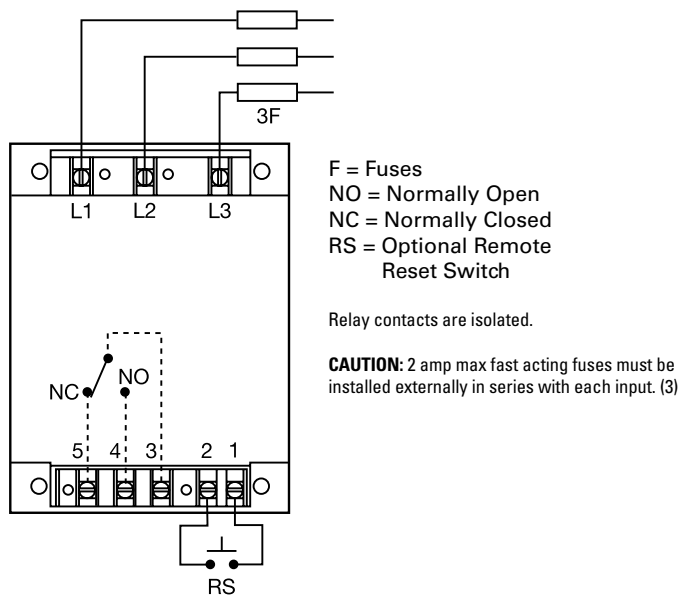
### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Conducted</b>	IEC 61000-4-6, Level 3 10V
<b>Radio Frequency Immunity, Radiated</b>	IEC 61000-4-3, Level 3, 10 V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 3.5kV input power
<b>Short Circuit Rating</b>	100kA rms, SYM, 600VAC max.
<b>Surge Immunity IEC</b>	IEC 61000-4-5, Level 3, 2kV line-to-line; Level 4, 4kV line-to-ground
<b>ANSI/IEEE</b>	C62.41 Surge and Ring Wave Compliance to a level of 6kV line-to-line
<b>High Potential Test</b>	Meets UL508 (2 x rated V +1000V for 1 minute)
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CE</b>	IEC 60947-1, IEC 60947-5-1
<b>Max Conductor Size (with insulation)</b>	0.65"
<b>Dimensions</b>	<b>H</b> 77.47 mm (3.05"); <b>W</b> 97.79 mm (3.85"); <b>D</b> 128.27 mm (5.05")
<b>Weight</b>	1.2 lbs. (19.2 oz., 544.31 g)
<b>Mounting Method</b>	Surface mount (4 - #8 screws) or DIN rail mount

# WVM SERIES



## Wiring Diagram



For dimensional drawing see: Appendix, page 513, Figure 29.

## Ordering Information

MODEL	LINE VOLTAGE	UNBALANCE	TRIP DELAY	SWITCH SELECTABLE RESET METHOD	RESTART DELAY
WVM011AL	500 to 600VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	0.25 - 64s
WVM611AH	200 to 240VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	0.25 - 64m
WVM611AL	200 to 240VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	0.25 - 64s
WVM611RL	200 to 240VAC	2 - 10%	0.25 - 30s	Auto restart upon fault correction	0.25 - 64s
WVM811AH	355 to 425VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	0.25 - 64m
WVM811RL	355 to 425VAC	2 - 10%	0.25 - 30s	Auto restart upon fault correction	0.25 - 64s
WVM911AH	400 to 480VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	0.25 - 64m
WVM911AL	400 to 480VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	0.25 - 64s
WVM911AL-60	400 to 480VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	0.25 - 64s, no random start delay
WVM911AN	400 to 480VAC	2 - 10%	0.25 - 30s	Auto restart upon fault trip	6 - 300s
WVM911RH	400 to 480VAC	2 - 10%	0.25 - 30s	Auto restart upon fault correction	0.25 - 64m
WVM911RL	400 to 480VAC	2 - 10%	0.25 - 30s	Auto restart upon fault correction	0.25 - 64s
WVM911RN-60	400 to 480VAC	2 - 10%	0.25 - 30s	Auto restart upon fault correction	6 - 300s, no random start delay

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## Description

The WVM Series provides protection against premature equipment (motor) failure caused by voltage faults on the 3-phase line. The WVM's microcontroller design provides reliable protection even if regenerated voltages are present. It combines dependable fault sensing with a 10 fault memory and a 6 LED status display. Part instrument, part control, the WVM protects your equipment when you're not there and displays what happened when you return. The WVM is fully adjustable and includes time delays to prevent nuisance tripping and improve system operation. Time delays include a 0.25 to 30s adjustable trip delay, an adjustable 0.25 to 64m (in 3 ranges) restart delay, plus a unique 3 to 15s true random start delay. The random start delay prevents voltage sags caused by simultaneous restarting of numerous motor loads after a power outage.

## Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring to protect against phase loss, phase reversal, over voltage, under voltage, unbalance, and short cycling
<b>Fault memory</b>	Stores the 10 most recent faults, which provides diagnostics for troubleshooting
<b>LED indication</b>	Provides visual indication of existing relay/fault status or faults stored in memory.
<b>Switch selectable automatic restart, delayed automatic restart, and manual reset</b>	Allows user adjustment to handle unique application requirements
<b>Random start delay</b>	Prevents voltage sags caused by simultaneous restarting of multiple motor loads after a power outage

## Operation

The output relay is energized when all conditions are acceptable and the WVM is reset. A restart and/or random start delay may occur before the output relay is energized.

**Field Adjustment:** Select the line voltage listed on the motor's name plate. This automatically sets the over and undervoltage trip points. No further adjustment should be required to achieve maximum equipment protection.

9 AC SYSTEM MONITORS/LOAD SENSORS

# WVM SERIES

**Read Memory:** Fault(s) stored in the memory are indicated when the yellow LED is flashing, up to 10 faults are noted.

**Memory Reset:** To clear the memory of all faults stored, rotate selector to Clear Memory for 5 seconds. The yellow LED will turn off.

**Memory Overload:** Only the 10 most recent faults are retained.

**Random Start Delay:** A new 3 to 15s random start delay is selected by the microcontroller when a fault is corrected and when the operating voltage (L1, L2, L3) is applied to the WVM. A random start delay does not occur when the reset is manual.

**Automatic Restart:** Upon fault correction, the output will re-energize after a random start delay.

**Automatic Restart Upon Fault Trip:** When a fault is sensed for the full trip delay, the output de-energizes and a restart delay is initiated. This delay locks out the output for the delay period. Should the fault be corrected by the end of the restart delay, the output will re-energize after a random start delay. A restart delay will also occur when operating voltage (L1, L2, L3) is applied to the WVM.

**Manual Reset:** After a fault condition is corrected, the WVM can be manually reset. There are two methods; a customer supplied remote switch, or the onboard selector switch.

**Manual Reset (Onboard):** Rotate selector switch from the Manual Reset position to Auto Restart w/Delay then back again to Manual Reset within 3 seconds. The output will immediately energize.

**Remote Reset:** Reset (Restart) is accomplished by a momentary contact closure across terminals 1 & 2. The output will immediately energize. Remote switch requirements are  $\geq 10\text{mA}$  @ 20VDC and the reset terminals are not isolated from line voltage. A resistance of  $\leq 20\text{K}\Omega$  across terminals 1 & 2 will cause immediate automatic restart.

**Automatic Restart Upon Fault Correction:** (P/N includes an R) When a fault is sensed for the full trip delay, the output relay de-energizes. Upon correction of the fault, a restart delay begins. At the end of this delay, the output will re-energize after a random start delay. If a fault occurs during restart timing, the restart time delay will be reset to zero, and the output will not energize until the restart delay is completed.

## Accessories



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



**OKLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.

## Specifications

<b>Line Voltage Type</b>	3-phase delta or wye with no connection to neutral	
<b>Operating Voltage</b>	<b>Model</b>	<b>Adj. Line Voltage Range</b>
	240	200-240VAC
	380	355-425VAC
	480	400-480VAC
	600	500-600VAC
<b>AC Line Frequency</b>	50/60 Hz	
<b>Overvoltage, Undervoltage, &amp; Voltage Unbalance</b>	109-113% of adjusted voltage	
<b>Overvoltage Trip Point</b>	-2% of trip point	
<b>Reset Voltage</b>	88-92% of adjusted voltage	
<b>Undervoltage Trip Point</b>	+2% of trip point	
<b>Reset Voltage</b>	Adjustable from 2-10%*	
<b>Voltage Unbalance</b>	Adjustable from 0.25 - 30s $\pm 15\%$	
<b>Trip Delay</b>	$\geq 15\%$ unbalance	
<b>Phase Loss</b>	$\leq 200$ ms	
<b>Response Time</b>	3 - 15s	
<b>Random Start Delay Range</b>		
<b>Reset (Restart) Delay</b>		
<b>Low Range</b>	0.25-64s $\pm 15\%$	
<b>Normal Range</b>	6-300s $\pm 15\%$	
<b>High Range</b>	0.25-64m $\pm 15\%$	
<b>Fault Memory</b>	Nonvolatile RAM	
<b>Type</b>	Stores last 10 faults	
<b>Capacity</b>	6 LEDs provide existing status & memory readout	
<b>Status Indicators</b>	<i>Note: 50% of operating line voltage must be applied to L1 &amp; L2 for operation of status indicators</i>	
<b>Output Type</b>	Electromechanical relay	
<b>Form</b>	Isolated, SPDT	
<b>Rating</b>	10A resistive @ 250VAC; 6A inductive (0.4 PF) @ 250VAC	
<b>Life</b>	Mechanical - 1 x 10 <sup>7</sup>	
<b>Protection</b>	ASME A17.1 Rule 210.6	
<b>Phase Reversal/Failure</b>	NEMA MG1 14:30, 14:35	
<b>Motors and Generators</b>	IEEE 62.41-1991 Level B	
<b>Surge</b>	$\geq 2500\text{V}$ RMS input to output	
<b>Isolation Voltage</b>		
<b>Mechanical</b>		
<b>Mounting</b>	Surface with 2 or 4 #8 (M4 x 0.7) screws	
<b>Dimensions</b>	<b>H</b> 175.3 mm (6.9"); <b>W</b> 111.8 mm (4.4"); <b>D</b> 61.0 mm (2.4")	
<b>Termination</b>	Screw terminals with captive wire clamps for up to #12 AWG (3.2 mm <sup>2</sup> ) wire	
<b>Environmental</b>		
<b>Operating/Storage Temperature</b>	-40° to 65°C / -40° to 85°C	
<b>Weight</b>	$\approx 25$ oz ( 709 g)	

\* Unbalance reset is 90% of the unbalance setting (i.e. VUB at 5% reset is 4.5%)

# DLMU SERIES



## Description

The DLMU Series is a universal voltage, 3-phase voltage monitor. It continuously measures the voltage of each of the three phases with microcontroller accuracy and compares the value to preset trip points. It separately senses phase reversal and loss; over, under and unbalanced voltages; and over or under frequency. Protection is assured during periods of large average voltage fluctuations or when regenerated voltages are present. The unit trips within 200ms when phase loss is detected. Adjustable time delays are included to prevent nuisance tripping and short cycling of sensitive equipment. The isolated, 10A, SPDT and 2A alarm output relay contacts trip when a phase voltage exceeds the trip limits for the trip delay. Nominal line voltage, voltage unbalance, and time delays are knob adjustable. The phase loss setpoint and the acceptable frequency range are fixed. Both delta and wye systems can be monitored; no connection to neutral is required.

## Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring to protect against phase loss, phase reversal, over voltage, under voltage, unbalance, short cycling and over/under frequency
<b>Universal line voltage range</b>	Flexibility to work in 200 to 480VAC or 500 to 600VAC applications
<b>DIN rail (35mm) or surface mounting</b>	Installation flexibility
<b>LED indication</b>	Provides diagnostics of relay, fault and time delay status
<b>User adjustable time delays</b>	Prevents nuisance tripping and short cycling of sensitive equipment

## Accessories



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC

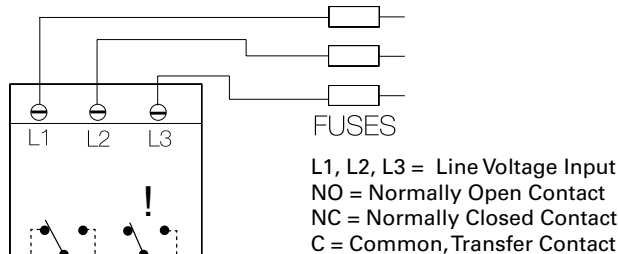


**OKLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.

## Wiring Diagram



**CAUTION:** 2 amp max. fast acting fuses are recommended to protect the equipment's wiring. They are not required to protect the DLMU.

! = Select alarm contact connection as N.O. or N.C. when ordering; N.O. Shown.

For dimensional drawing see: Appendix, page 513, Figure 30.

## Ordering Information

MODEL	LINE VOLTAGE	OUTPUT	RESTART FUNCTION	VOLTAGE UNBALANCE	TRIP DELAY	RESTART DELAY
DLMHBRAAA	500 to 600VAC	SPDT & NO	Staggered restart	Adjustable 2 - 10%	Adjustable 1 - 30s	Adjustable 0.6 - 300S
DLMUBLAAA	200 to 480VAC	SPDT & NO	Lockout, min off time	Adjustable 2 - 10%	Adjustable 1 - 30s	Adjustable 0.6 - 300S
DLMUBNAAN	200 to 480VAC	SPDT & NO	No restart delay	Adjustable 2 - 10%	Adjustable 1 - 30s	None
DLMUBRAAA	200 to 480VAC	SPDT & NO	Staggered restart	Adjustable 2 - 10%	Adjustable 1 - 30s	Adjustable 0.6 - 300S

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# DLMU SERIES

## Operation

Upon application of line voltage, the output is de-energized and the restart delay begins. If all the 3-phase voltages are within the acceptable range, the output energizes at the end of the restart delay. The microcontroller circuitry automatically senses the voltage range, and selects the correct operating frequency (50 or 60Hz). The over and undervoltage trip points are set automatically. When the measured value of any phase voltage exceeds the acceptable range limits (lower or upper) the trip delay begins. At the end of the trip delay the output relay de-energizes. If the phase voltage returns to an acceptable value before the trip delay expires, the trip delay is reset and the output remains energized. Under, over, and unbalanced voltages plus over or under frequency must be sensed for the complete trip delay before the unit trips. The unit trips in 200ms when phase loss or reversal are sensed. The unit will not energize if a fault is sensed as the line voltage is applied.

**Reset:** Reset is automatic upon correction of the voltage or frequency fault or phase sequence.

## Restart Delay Options

**L = Lockout or minimum OFF time.** The restart delay begins when the output trips. The unit cannot be re-energized until the restart delay is complete. This provides a minimum off time or lockout time to allow equipment sensitive to short cycling, time to reset. If the fault is corrected after the restart delay is complete the output energizes immediately. The restart delay also occurs when line voltage is applied/reapplied.

**R = Restart Delay on fault correction.** The restart delay begins when line voltage is reapplied or when a voltage fault is corrected. This option is normally selected when staggered restarting of multiple motors on a power system is required.

**N = No Restart Delay.** 0.6 second initialization delay on application of line voltage applies.

**Restart Notes:** All restart options remain reset when the following conditions are detected:

1. Phase loss (phase unbalance greater than 25%)
2. Average line voltage less than 120VAC
3. Phase reversal

The restart delay begins when the condition is corrected.

## LED Operation

The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during the trip delay then glows red when the output de-energizes. It flashes red/green if phase reversal is sensed. If a fault is sensed during the restart delay, the LED will glow red during that portion or the full restart delay.

## Specifications

### Line Voltage Type

3-phase delta or wye with no connection to neutral

### Operating Voltage 200-480VAC

Range	Voltage Adj. Range	Line Frequency	Line Voltage Max.
240	200-240VAC	50/60Hz	
380	340-420VAC	50Hz	
480	400-480VAC	60Hz	550VAC
600	500-600VAC	50/60Hz	600VAC

### 600VAC

### AC Line Frequency

50/60 Hz automatically detected

### Phase Loss

≥ 25% unbalance

### Response Time

≤200ms

### Undervoltage & Voltage Unbalance

#### Type

Voltage detection with delayed trip & automatic reset

### Overvoltage

#### Trip Voltage

109 - 113% of the adjusted line voltage

#### Reset Voltage

≅ -3% of the trip voltage

### Undervoltage

#### Trip Voltage

88 - 92% of the adjusted line voltage

#### Reset Voltage

≅ +3% of the trip voltage

### Voltage Unbalance

Adjustable 2 - 10% or specify fixed unbalance of 2 - 10% in 1% increments

### Reset on balance

≅ -0.7% unbalance

### Trip Delay

#### Active On

Over/undervoltage, voltage unbalance, over/under frequency

#### Range

Adjustable from 1 - 30s or specify fixed delay 1 - 30s in 1s increments

### Tolerance

#### Restart Delay

#### Range

Adjustable from 0.6 - 300s; if no restart delay is selected a 0.6s initialization delay applies

### Tolerance

#### Over/Under Frequency

± 15%

#### Phase Sequence

±4%; Reset ±3%; 50/60 Hz

#### Response Time -Phase

A, B, C, L1, L2, L3

#### Reversal & Phase Loss

≤200 ms

### Reset

Automatic

### Output

#### Type

Isolated Electromechanical Relay

#### Form C

Isolated, SPDT

#### Form C Rating

10A resistive @ 240VAC;  
8A resistive @ 277VAC; NO-1/4 hp @ 120VAC;  
1/3 hp @ 240VAC

### Form A

Isolated, NO, SPST

#### Form A Rating

2A @ 277VAC

### Life

Mechanical - 1 x 10<sup>6</sup>; Electrical - 1 x 30<sup>3</sup>

## DLMU SERIES

### Protection

#### Phase Reversal/Failure

ASME A17.1 Rule 210.6

#### Motors and Generators

NEMA MG1 14:30, 14:35

#### Surge

IEEE C62.41-1991 Level B

#### Isolation Voltage

≥ 2500V RMS input to output

### Mechanical

#### Mounting

Surface mount with 2 #8 (M4 x 0.7) screw or snap on 35mm DIN Rail

*Note: 0.25 in. (6.35 mm) spacing between units or other devices is required*

#### Dimensions

**H** 110 mm (4.33"); **W** 75 mm (2.95");

**D** 50 mm (1.97")

#### Termination

Screw terminals with captive wire clamps for up to #14 AWG (2.5 mm<sup>2</sup>) wire

4.4 in.-lbs.

#### Terminal Torque

### Environmental

#### Operating/Storage

#### Temperature

-40° to 60°C / -40° to 85°C

#### Humidity

95% relative, non-condensing

#### Weight

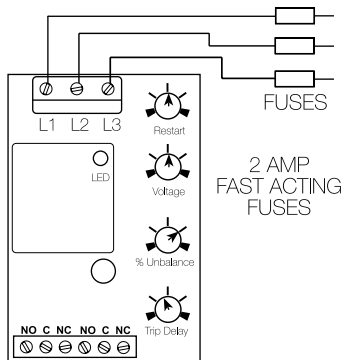
≈ 8.6 oz (244 g)



# HLMU SERIES



## Wiring Diagram



L1, L2, L3 = Line Voltage Input  
NO = Normally Open Contact  
NC = Normally Closed Contact  
C = Common, Transfer Contact

**CAUTION:** 2 amp max. fast acting fuses are recommended to protect the equipment's wiring. They are not required to protect the HLMU.

**NOTE:** Relay contacts are isolated, 277VAC max.

For dimensional drawing see: Appendix, page 513, Figure 31.

## Ordering Information

MODEL	OUTPUT	RESTART FUNCTION	VOLTAGE UNBALANCE	TRIP DELAY	RESTART DELAY
HLMUDLAAA	DPDT	Lockout, min off time	Adjust. 2 - 10%	Adjust. 1 - 30s	Adjust. 0.6 - 300s
HLMUDN0405N	DPDT	No restart delay	Fixed, 4%	Fixed, 5s	None
HLMUDNAAN	DPDT	No restart delay	Adjust. 2 - 10%	Adjust. 1 - 30s	None
HLMUDRAAA	DPDT	Staggered restart	Adjust. 2 - 10%	Adjust. 1 - 30s	Adjust. 0.6 - 300s

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## Description

The HLMU Series is a universal voltage, encapsulated, 3-phase voltage monitor. It continuously measures the voltage of each of the three phases with microcontroller accuracy and compares the value to preset trip points. It separately senses phase reversal and loss; over, under and unbalanced voltages; and over or under frequency. Protection is assured during periods of large average voltage fluctuations, or when regenerated voltages are present. The unit trips within 200ms when phase loss is detected. Adjustable time delays are included to prevent nuisance tripping and short cycling of sensitive equipment. The isolated, 10A, DPDT relay contacts trip when a phase voltage exceeds the trip limits for the trip delay. Nominal line voltage, voltage unbalance, and time delays are knob adjustable. The phase loss setpoint and the acceptable frequency range are fixed. Both delta and wye systems can be monitored; no connection to neutral is required.

## Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring to protect against phase loss, phase reversal; over, under, and unbalanced voltage; over and under frequency
<b>Universal line voltage range</b>	Flexibility to work in 200 to 480VAC applications
<b>DIN rail (35mm) or surface mounting</b>	Installation flexibility
<b>LED indication</b>	Provides diagnostics of relay, fault and time delay status
<b>Encapsulated</b>	Protects against shock, vibration, and humidity
<b>Finger-safe terminal blocks</b>	Meets IEC 61000 safety requirements

## Accessories



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



**0KLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 VAC/500 VDC



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.



**P1023-20 DIN Rail Adapter**  
Allows module to be mounted on a 35 mm DIN type rail with two #10 screws.

# HLMU SERIES

## Operation

Upon application of line voltage, the output is de-energized and the restart delay begins. If all the three-phase voltages are within the acceptable range, the output energizes at the end of the restart delay. The microcontroller circuitry automatically senses the voltage range, and selects the correct operating frequency (50 or 60Hz). The over and under voltage trip points are set at  $\pm 10\%$  of the adjusted line voltage. When the measured value of any phase voltage exceeds the acceptable range limits (lower or upper) the trip delay begins. At the end of the trip delay the output relay de-energizes. If the phase voltage returns to an acceptable value before the trip delay expires, the trip delay is reset and the output remains energized. Under, over, and unbalanced voltages plus over or under frequency must be sensed for the complete trip delay before the unit trips. The unit trips in 200ms when phase loss or reversal are sensed. The unit will not energize if a fault is sensed as the line voltage is applied.

**Reset:** Reset is automatic upon correction of the voltage or frequency fault or phase sequence.

## Restart Delay Options

**L = Lockout or minimum OFF time.** The restart delay begins when the output trips. The unit cannot be re-energized until the restart delay is complete. This provides a minimum off time or lockout time to allow equipment sensitive to short cycling, time to reset. If the fault is corrected after the restart delay is complete, the output energizes immediately. The restart delay also occurs when line voltage is applied/reapplied.

**R = Restart Delay on fault correction.** The restart delay begins when line voltage is reapplied or when a voltage fault is corrected. This option is normally selected when staggered restarting of multiple motors on a power system is required.

**N = No Restart Delay.** 0.6 second initialization delay on application of line voltage applies.

**Restart Notes:** All restart options remain reset when the following conditions are detected:

1. Phase loss (phase unbalance greater than 25%)
2. Average line voltage less than 120VAC
3. Phase reversal

The restart delay begins when the condition is corrected.

## LED Operation

The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during the trip delay then glows red when the output de-energizes. It flashes red/green if phase reversal is sensed. If a fault is sensed during the restart delay, the LED will glow red during that portion or the full restart delay.

## Specifications

### Line Voltage

**Type** 3-phase delta or wye with no connection to neutral

### Operating Voltage 200 - 480VAC

Range	Voltage Adj. Range	Frequency
240	200-240VAC	50 or 60Hz
380	340-420VAC	50Hz
480	400-480VAC	60Hz

**Line Voltage Max.** 550VAC

**AC Line Frequency** 50/60 Hz automatically detected

### Phase Loss

$\geq 25\%$  unbalance

### Response Time

$\leq 200\text{ms}$

### Undervoltage & Voltage Unbalance

#### Type

Voltage detection with delayed trip & automatic reset

#### Overvoltage

##### Trip Voltage

109 - 113% of the adjusted line voltage

##### Reset Voltage

$\approx -3\%$  of the trip voltage

#### Undervoltage

##### Trip Voltage

88 - 92% of the adjusted line voltage

##### Reset Voltage

$\approx +3\%$  of the trip voltage

#### Voltage Unbalance

##### Trip Setpoint

Adjustable 2 - 10% or specify fixed unbalance of 2 - 10% in 1% increments  
 $\approx -0.7\%$  unbalance

#### Reset on Balance

##### Trip Delay

##### Active On

Over/undervoltage, voltage unbalance, over/under frequency

#### Range

Adjustable from 1 - 30s or specify fixed delay 1 - 30s in 1s increments

#### Tolerance

##### Restart Delay

##### Range

$\pm 15\%$

Adjustable from 0.6 - 300s; if no restart delay is selected a 0.6s initialization delay applies

#### Tolerance

##### Over/Under Frequency

##### Phase Sequence

##### Response Time-Phase

##### Reversal & Phase Loss

##### Reset

##### Output

##### Type

##### Form

##### Rating

$\leq 200\text{ms}$

Automatic

Isolated Electromechanical Relay

DPDT

10A resistive @ 240VAC;

8A resistive @ 277VAC; NO-1/4 hp @ 120VAC;

1/3 hp @ 240VAC

Mechanical -  $1 \times 10^6$

Electrical (at 10A) - DPDT -  $1 \times 30^3$

#### Life

### Protection

#### Phase Reversal/Failure

#### Motors and Generators

#### Surge

#### Isolation Voltage

#### Circuitry

#### Mechanical

#### Mounting

ASME A17.1 Rule 210.6

NEMA MG1 14:30, 14:35

IEEE C62.41-1991 Level B

$\geq 2500\text{V}$  RMS input to output

Encapsulated

Surface mount with one #10 (M5 x 0.7) screw

*Note: 0.25 in. (6.35 mm) spacing between units or other devices is required*

**H** 76.7 mm (3.0"); **W** 50.8 mm (2.0");

**D** 41.7 mm (1.64")

#### Dimensions

#### Termination

Screw terminal connection up to 12 AWG

(3.3 mm<sup>2</sup>) wire

### Environmental

#### Operating/Storage

#### Temperature

$-40^\circ$  to  $60^\circ\text{C}$  /  $-40^\circ$  to  $85^\circ\text{C}$

#### Humidity

95% relative, non-condensing

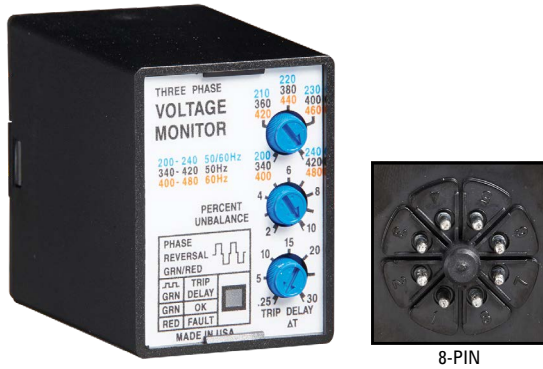
#### Weight

$\approx 3.9\text{ oz}$  (111 g)

9 AC SYSTEM MONITORS/LOAD SENSORS

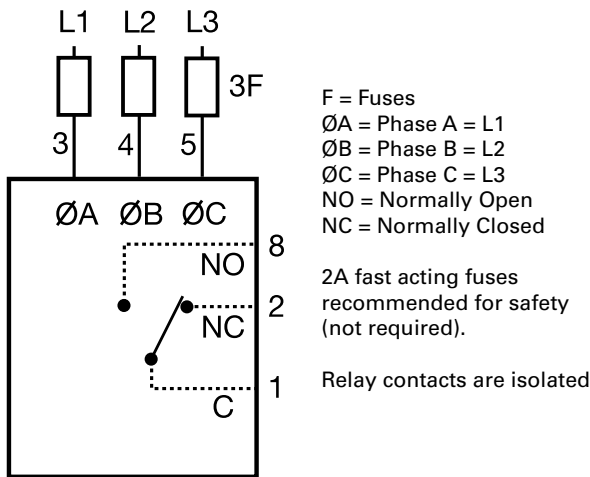
# PLMU11

## Voltage Monitor



8-PIN

### Wiring Diagram



For dimensional drawing see: Appendix, page 513, Figure 32.

### Description

The PLMU11 continuously measures the voltage of each of the three phases to provide protection for 3-phase motors and sensitive loads. Its microcontroller senses under and overvoltage, voltage unbalance, phase loss, and phase reversal. Protection is provided even when regenerated voltages are present. Universal voltage operation and standard base connection allows the PLMU11 to replace hundreds of competitive part numbers.

### Operation

Upon application of power, a 0.6s random start delay begins and the PLMU11 measures the voltage levels and line frequency and selects the voltage range. The output relay is energized and the LED glows green when all voltages are acceptable and the phase sequence is correct. LED flashes green during trip delay, glows red when output de-energizes. Undervoltage, overvoltage, and voltage unbalance must be sensed for continuous trip delay before the relay de-energizes. Re-energization is automatic upon fault correction. The output relay will not energize if a fault condition is sensed as 3-phase input voltage is applied. The LED alternately flashes red/green when phase reversal is sensed. Line voltage is selected with the knob, setting the over and under voltage trip points. Voltage range is automatically selected by the microcontroller.

LED Indicator	
Steady Green	Energized
Steady Red	De-energized (tripped on fault)
Flashing Green	Trip Delay
Alternate Flashing Red/Green	Phase Reversal

### Features & Benefits

FEATURES	BENEFITS
<b>Quick octal 8-pin mounting</b>	Small footprint with universal mounting: ideal replacement for hundreds of competitive part numbers.
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of single-phase, low voltage, high voltage, voltage unbalance, phase reversal.
<b>LED diagnostics</b>	Quick visual indicator for cause of trip. LED indications include: normal operation, trip delay, phase reversal, fault
<b>Isolated, 10A, SPDT output contacts</b>	Allows control of loads for AC voltages
<b>Simple 3-wire connection for delta or wye systems</b>	Allows flexibility across wide range of systems
<b>ASME A17.1 Rule 210.6</b>	Complies with safety codes for elevators, escalators, moving walkways
<b>NEMA MG1 14:30, 14:35</b>	Complies with safety codes for motors and generators
<b>IEEE C62.41-1991 Level B</b>	Complies with safety codes for surge and voltage protection

**PLMU11**

**Accessories**



**BZ1 Front Panel Mount Kit**  
Provides an easy method of through-the-panel mounting of 8-pin or 11-pin plug-in timers, flashers, and other controls.



**OT08PC Octal 8-pin Socket**  
8-pin 35mm DIN rail or surface mount. Rated at 10A @ 600VAC. Surface mounted with two #6 screws or snaps onto a 35 mm DIN rail.



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



**OKLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.

**Specifications**

<b>Line Voltage</b>	
<b>Type</b>	3-phase delta or wye with no connection to neutral
<b>Line Voltage</b>	200 to 480VAC ±15%, 50/60 Hz ±2 Hz
<b>Adjustable Voltage Ranges (Automatic Range Selection)</b>	200 to 240VAC, 50/60 Hz 340 to 420VAC, 50 Hz 400 to 480VAC, 60 Hz
<b>Maximum Voltage</b>	552VAC
<b>Phase Sequence</b>	ABC
<b>Power Consumption</b>	≤ 5W
<b>Overvoltage, Undervoltage, &amp; Voltage Unbalance</b>	
<b>Type</b>	Voltage detection with delayed trip and automatic reset
<b>Overvoltage &amp; Undervoltage</b>	
<b>Undervoltage Trip Point</b>	88 - 92% of adjusted line voltage
<b>Reset Voltage</b>	+2% of trip voltage
<b>Overvoltage Trip Point</b>	109 - 113% of adjusted line voltage
<b>Reset Voltage</b>	-2% of trip voltage
<b>Voltage Unbalance Trip Point</b>	Adjustable from 2 - 10%
<b>Reset on Balance (%)</b>	
<b>Selected Unbalance</b>	2 3 4 5 6 7 8 9 10
<b>Reset</b>	1.5 2.5 3.5 4.5 5.4 6.3 7.2 8.1 9
<b>Trip Delay Range</b>	Adjustable from 0.25 - 30s
<b>Severe Unbalance - 2X Selected Unbalance</b>	0.25 - 2s; disabled when the trip delay is less than 2s
<b>Random Start Delay</b>	≅ 0.6s
<b>Phase Reversal &amp; Phase Loss Trip Time</b>	≤ 150ms
<b>Phase Loss Setpoint</b>	≥ 15% unbalance
<b>Reset Type</b>	Automatic
<b>Output Type</b>	Energized when voltages are acceptable
<b>Type</b>	Electromechanical relay
<b>Form</b>	Isolated, SPDT
<b>Rating</b>	10A resistive @ 240VAC; 1/4 hp @ 125VAC; 1/3 hp @ 250VAC; max. 277VAC
<b>Life</b>	Mechanical - 1 x 10 <sup>6</sup> ; Electrical - 1 x 10 <sup>5</sup>
<b>Protection</b>	
<b>Surge</b>	IEEE C62.41-1991 Level B
<b>Isolation Voltage</b>	≥ 2500V RMS input to output
<b>Mechanical</b>	
<b>Mounting*</b>	Plug-in socket rated 600VAC
<b>Termination</b>	Octal 8-pin plug-in
<b>Dimensions</b>	<b>H</b> 77.0 mm (3.03"); <b>W</b> 60.7 mm (2.39"); <b>D</b> 45.2 mm (1.78")
<b>Environmental</b>	
<b>Operating/Storage</b>	
<b>Temperature</b>	-40° to 60°C / -40° to 85°C
<b>Weight</b>	≅ 8.6 oz (244 g)

\*CAUTION: Select an octal socket rated for 600VAC operation.

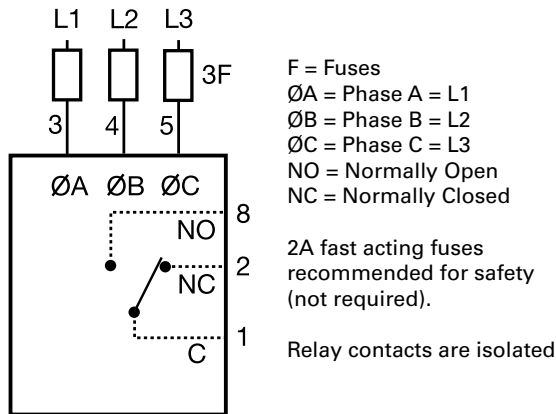
# PLM SERIES

## Voltage Monitor



8-PIN

### Wiring Diagram



For dimensional drawing see: Appendix, page 512, Figure 23.

### Ordering Information

MODEL	LINE VOLTAGE	VOLTAGE UNBALANCE (FIXED)	TRIP DELAY (FIXED)
PLM6405	240VAC	4%	5 sec
PLM6502	240VAC	5%	2 sec
PLM6805	240VAC	8%	5 sec
PLM8405	380VAC	4%	5 sec
PLM9405	480VAC	4%	5 sec
PLM9502	480VAC	5%	2 sec
PLM9805	480VAC	8%	5 sec

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### Description

The PLM Series is a 3-phase voltage monitor that continuously monitors each of the three phases. Monitors both delta and wye systems and no connection to neutral is required. The microcontroller circuit design protects against undervoltage, voltage unbalance, phase loss and phase reversal. Protection is assured when regenerated voltages are present.

### Operation

The output relay is energized and the LED glows green when all voltages are acceptable and the phase sequence is correct. Under and unbalanced voltages must be sensed for a continuous trip delay period before the relay de-energizes. Reset is automatic upon correction of the fault condition. The output relay will not energize if a fault condition is sensed as power is applied. The LED flashes red during the trip delay, then glows red when the output de-energizes. The LED flashes green/red if phase reversal is sensed.

### Field Adjustment

Set voltage adjustment knob at the desired operating line voltage for the equipment. This adjustment automatically sets the undervoltage trip point. Apply power. If the PLM fails to energize, (LED glows red) check wiring of all three phases, voltage, and phase sequence. If phase sequence is incorrect, the LED flashes green/red. To correct this, swap any two line voltage connections at the mounting socket. No further adjustment should be required.

### Features & Benefits

FEATURES	BENEFITS
<b>Quick octal 8-pin mounting</b>	Small footprint with universal mounting; ideal replacement for hundreds of competitive part numbers.
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring of single-phase, low voltage, high voltage, voltage unbalance, phase reversal.
<b>LED diagnostics</b>	Quick visual indicator for trip versus normal operation.
<b>Isolated, 10A, SPDT output contacts</b>	Allows control of loads for AC voltages
<b>Adjustable nominal voltage set point</b>	Allows setting for specific application voltage to optimize protection
<b>Simple 3-wire connection for delta or wye systems</b>	Allows flexibility across wide range of systems
<b>ASME A17.1 Rule 210.6</b>	Complies with safety codes for elevators, escalators, moving walkways
<b>NEMA MG1 14:30, 14:35</b>	Complies with safety codes for motors and generators
<b>IEEE C62.41-1991 Level B</b>	Complies with safety codes for surge and voltage protection



### PLM SERIES

#### Accessories



**BZ1 Front Panel Mount Kit**  
Provides an easy method of through-the-panel mounting of 8-pin or 11-pin plug-in timers, flashers, and other controls.



**OT08PC Octal 8-pin Socket**  
8-pin 35mm DIN rail or surface mount. Rated at 10A @ 600VAC. Surface mounted with two #6 screws or snaps onto a 35 mm DIN rail.



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



**OKLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.

#### Specifications

##### Line Voltage

**Type** 3-phase delta or wye with no connection to neutral

##### Operating Voltage

Model	Adj. Line Voltage Range	Line Voltage Max
240	200-240VAC	270VAC
380	360-430VAC	480VAC
480	400-480VAC	530VAC

**AC Line Frequency** 50/100 Hz  
**Phase Sequence** ABC  
**Power Consumption** ≅ 2W for 240V units  
≅ 3W for 380 - 480V units

##### Low Voltage & Voltage Unbalance

**Type** Voltage detection with delayed trip & automatic reset

**Low Voltage Trip** 88 - 92% of adjusted line voltage  
**Reset Voltage** Plus 3% of trip voltage

**Voltage Unbalance Trip** Factory fixed from 4 - 8%  
**Reset on Balance** -0.7% unbalance typical

**Trip Delay Range** Factory fixed from 2 - 20s  
**Tolerance** ±15%

##### Phase Reversal & Phase Loss

**Response Time** ≤ 200ms  
**Phase Loss** > 35% unbalance  
**Reset** Automatic

##### Output

**Type** Electromechanical relay  
**Form** Isolated, SPDT  
**Rating** 10A resistive @ 240VAC, 277VAC max;  
1/2 Hp @ 240VAC; 1/4 Hp @ 120VAC  
Mechanical - 1 x 10<sup>7</sup>; Electrical - 1 x 10<sup>5</sup>

##### Life

**Protection** IEEE C62.41-1991 Level B  
**Surge Isolation Voltage** ≥ 2500V RMS input to output

##### Mechanical

**Mounting\*** 8-pin plug-in socket rated 600VAC  
**Dimensions** **H** 81.3 mm (3.2"); **W** 60.7 mm (2.39");  
**D** 45.2 mm (1.78")

##### Environmental

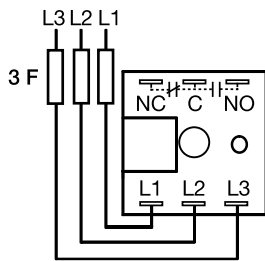
**Operating/Storage Temperature** -40° to 60°C / -40° to 85°C  
**Weight** ≅ 4.4 oz (125 g)

\*CAUTION: Select an octal socket rated for 600VAC operation.

# TVW SERIES



## Wiring Diagram



L1 = Phase A  
L2 = Phase B  
L3 = Phase C  
NO = Normally Open  
NC = Normally Closed  
C = Common, Transfer Contact

Relay contacts are isolated.

F = 2A Fast acting fuses are recommended, but not required

For dimensional drawing see: Appendix, page 514, Figure 44.

## Ordering Information

MODEL	LINE VOLTAGE	VOLTAGE UNBALANCE	TRIP DELAY	RESTART DELAY
TVW5103S5S	208 to 240VAC Selectable	Fixed, 10%	Fixed, 3s	Fixed, 5s
TVW575S1M	208 to 240VAC Selectable	Fixed, 7%	Fixed, 5s	Fixed, 1m
TVW6510S0.4S	208, 220, 230, 240VAC	Fixed, 5%	Fixed, 10s	Fixed, 0.4s
TVW8510S0.4S	380, 400 & 415VAC	Fixed, 5%	Fixed, 10s	Fixed, 0.4s
TVW9510S0.4S	430, 440, 460, 480VAC	Fixed, 5%	Fixed, 10s	Fixed, 0.4s

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## Description

The TVW Series Provides protection for motors and other sensitive loads. Continuously measures the voltage of each of the three phases using a microcontroller circuit design that senses under and overvoltage, voltage unbalance, phase loss, and phase reversal. Protection is provided even when regenerated voltages are present. Includes a trip delay to prevent nuisance tripping and a restart delay to prevent short cycling after a momentary power outage.

### Operation

Upon application of line voltage, the restart delay begins. The output is de-energized during restart delay. Under normal conditions, the output energizes after the restart delay. Undervoltage, overvoltage, and voltage unbalance must be sensed for the complete trip delay period before the output de-energizes. The restart delay begins as soon as the output de-energizes. If the restart delay is completed when a fault is corrected, the output energizes immediately. The output will not energize if a fault is sensed as the input voltage is applied. If the voltage selector is set between two voltage marks (i.e. between 220 and 230V), the LED will flash red rapidly. The TVW provides fault protection at the lower of the two line voltages (i.e. 220V).

**Reset:** Reset is automatic upon correction of a fault.

### LED Operation

The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during the trip delay then glows red when the output de-energizes. It flashes red/green if phase reversal is sensed. If the voltage selector knob is between settings, it rapidly flashes red.

## Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring to protect against phase loss, phase reversal; over, under, and unbalanced voltage; short cycling
<b>Compact design measures 2 in. (50.8mm) square</b>	Perfect for OEM applications where cost, size and ease of installation are important
<b>LED indication</b>	Provides diagnostics of relay, fault and time delay status
<b>Encapsulated</b>	Protects against shock, vibration and humidity



**TVW SERIES**

**Accessories**



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



**OKLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



**P1015-13** (AWG 10/12), **P1015-64** (AWG 14/16), **P1015-14** (AWG 18/22) **Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.



**P1023-20 DIN Rail Adapter**  
Allows module to be mounted on a 35 mm DIN type rail with two #10 screws.



**VRM6048 Voltage Reduction Module**  
Allows the voltage monitor to monitor a 3-phase 550 to 600VAC Line.

**Specifications**

**Line Voltage Type**

3-phase delta or wye with no connection to neutral

**Input Voltage/Tolerance**  
**AC Line Frequency**  
**Phase Sequence**  
**Power Consumption**

208 to 480VAC in 4 ranges/-30% - 20%  
50 - 100 Hz  
ABC  
Approx. 2W for 240V units  
Approx. 3W for 480V units

**Overvoltage, Undervoltage, & Voltage Unbalance**  
**Overvoltage & Undervoltage**

Voltage detection with delay trip & automatic reset

**Undervoltage Trip Point**  
**Reset Voltage**  
**Overvoltage Trip Point**  
**Reset Voltage**  
**Trip Variation vs Temperature**  
**Voltage Unbalance**  
**Reset On Balance**  
**Trip Delay Range**

88 - 92% of the selected line voltage  
 $\approx +3\%$  of trip voltage  
109 - 113% of the selected line voltage  
 $\approx -3\%$  of trip voltage  
 $\leq \pm 2\%$   
Factory fixed, from 4 - 10%  
 $\approx -0.7\%$  unbalance  
Fixed from 0.2 - 100s  $\pm 15\%$  or  $\pm 0.1s$ , whichever is greater  
Fixed from 0.4s - 999ms  $\pm 15\%$  or  $\pm 0.2s$ , whichever is greater

**Restart Delay Range**

Fixed from 0.2 - 100s  $\pm 15\%$  or  $\pm 0.1s$ , whichever is greater

**Phase Reversal & Phase Loss Response**  
**Phase Loss**

$\leq 200ms$ ; automatic reset  
 $\geq 25\%$  unbalance

**Output Type**

Isolated, SPDT

**Rating**  
**208 to 240VAC (55°C)**

10A resistive @ 125VAC, 5A @ 250VAC, 1/4 hp @ 125VAC

**380 to 480VAC**

10A resistive @ 240VAC, 1/4 hp @ 125VAC, 1/3 hp @ 250VAC, max. voltage 277VAC

**Life**

Mechanical -  $1 \times 10^6$ ; Electrical -  $1 \times 10^5$

**Protection**  
**Phase Reversal/Failure**  
**Motors and Generators**  
**Surge**

ASME A17.1 Rule 210.6  
NEMA MG1 14:30, 14:35  
IEEE C62.41-1991 Level B

**Dielectric Breakdown**  
**208 to 240VAC**  
**380 to 480VAC**

$\geq 1500V$  RMS input to output terminals  
 $\geq 2500V$  RMS input to output terminals

**Mechanical**  
**Mounting**  
**Dimensions**

Surface mount with one #8 (M5 x 0.8) screw  
**H** 50.8 mm (2.0"); **W** 50.8 mm (2.0");  
**D** 31.75 mm (1.25")

**Termination**

0.25 in. (6.35 mm) male quick connect terminals

**Environmental**  
**Operating/Storage Temperature**

-40° to 55°C / -40° to 85°C

**Humidity**

95% relative, non-condensing

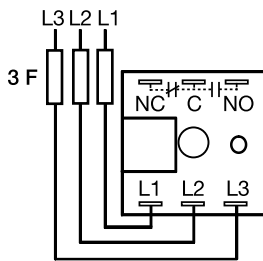
**Weight**

$\approx 2.8$  oz (79 g)

# TVM SERIES



## Wiring Diagram



L1 = Phase A  
L2 = Phase B  
L3 = Phase C  
NO = Normally Open  
NC = Normally Closed  
C = Common, Transfer Contact

Relay contacts are isolated.

F = 2A Fast acting fuses are recommended, but not required

For dimensional drawing see: Appendix, page 514, Figure 44.

## Ordering Information

MODEL	LINE VOLTAGE	VOLTAGE UNBALANCE	TRIP DELAY	RESTART DELAY
TVM208A100.5S3S	208VAC	10%	0.5s	3s
TVM230A101S1S	230VAC	10%	1s	1s
TVM460A41S5M	460VAC	4%	1s	5m
TVM460A75S2M	460VAC	7%	5s	2m
TVM480A45S5S	480VAC	4%	5s	5s
TVM480A100.5S3S	480VAC	10%	0.5s	3s

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## Description

The TVM Series Provides protection for motors and other sensitive loads. Continuously measures the voltage of each of the three phases using a microcomputer circuit design that senses under and overvoltage, voltage unbalance, phase loss, and phase reversal. Protection is provided even when regenerated voltages are present. Includes a trip delay to prevent nuisance tripping and a restart delay to prevent short cycling after a momentary power outage.

### Operation

Upon application of line voltage, the restart delay begins. The output relay is de-energized during restart delay. Under normal conditions, the output energizes after restart delay. Undervoltage, overvoltage, and voltage unbalance must be sensed for continuous trip delay period before the output is de-energized. The output will not de-energize if a fault is corrected during the trip delay. The restart delay begins as soon as the output relay de-energizes. If the restart delay is completed when the fault is corrected, the output relay will energize immediately.

The output relay will not energize if a fault or phase reversal is sensed as 3-phase input voltage is applied.

**Reset:** Reset is automatic upon correction of a fault.

### LED Operation

The LED flashes green during the restart delay, then glows green when the output energizes. It flashes red during the trip delay then glows red when the output de-energizes. It flashes red/green if phase reversal is sensed.

## Features & Benefits

FEATURES	BENEFITS
<b>Proprietary microcontroller based circuitry</b>	Constant monitoring to protect against phase loss, phase reversal; over, under, and unbalanced voltage; short cycling
<b>Compact design measures 2 in. (50.8mm) square</b>	Perfect for OEM applications where cost, size and ease of installation are important
<b>LED indication</b>	Provides diagnostics of relay, fault and time delay status
<b>Encapsulated</b>	Protects against shock, vibration and humidity

**TVM SERIES**

**Accessories**



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



**OKLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



**P1015-13 (AWG 10/12), P1015-64 (AWG 14/16), P1015-14 (AWG 18/22) Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1023-20 DIN Rail Adapter**  
Allows module to be mounted on a 35 mm DIN type rail with two #10 screws.



**VRM6048 Voltage Reduction Module**  
Allows the voltage monitor to monitor a 3-phase 550 to 600VAC Line.

**Specifications**

**Line Voltage Type**

3-phase delta or wye with no connection to neutral

**Input Voltage**

208 to 480VAC

**AC Line Frequency**

50 - 100 Hz

**Phase Sequence**

ABC

**Power Consumption**

Approx. 2W for 240V units  
Approx. 3W for 480V units

**Overvoltage, Undervoltage, & Voltage Unbalance**

**Overvoltage & Undervoltage**

Voltage detection with delay trip & automatic reset

**Undervoltage Trip Point**

88 - 92% of the selected line voltage

**Reset Voltage**

≅ +3% of trip voltage

**Overvoltage Trip Point**

109 - 113% of the selected line voltage

**Reset Voltage**

≅ -3% of trip voltage

**Trip Variation vs Temperature**

≤ ±2%

**Voltage Unbalance**

Factory fixed from 4 - 10%

**Reset On Balance**

≅ -0.7% unbalance

**Trip Delay Range**

Fixed from 0.2 - 100s ±15% or ±0.1s, whichever is greater

**Restart Delay Range**

Fixed from 0.5s - 999ms ±15% or ±0.2s, whichever is greater

**Phase Reversal & Phase**

**Loss Response**

≤ 200ms; automatic reset

**Phase Loss**

≥ 25% unbalance

**Output**

**Type**

Isolated SPDT relay contacts

**Rating**

**208 to 240VAC (55°C)**

10A resistive @ 125VAC, 5A @ 250VAC, 1/4 hp @ 125VAC

**380 to 480VAC**

10A resistive @ 240VAC, 1/4 hp @ 125VAC, 1/3 hp @ 250VAC, max. voltage 277VAC

**Life**

Mechanical - 1 x 10<sup>6</sup>; Electrical - 1 x 10<sup>5</sup>

**Protection**

**Phase Reversal/Failure**

ASME A17.1 Rule 210.6

**Motors and Generators**

NEMA MG1 14:30, 14:35

**Surge**

IEEE C62.41-1991 Level B

**Dielectric Breakdown**

**208 to 240VAC**

≥ 1500V RMS input to output terminals

**380 to 480VAC**

≥ 2500V RMS input to output terminals

**Mechanical**

**Mounting**

Surface mount with one #8 (M5 x 0.8) screw

**Dimensions**

**H** 50.8 mm (2.0"); **W** 50.8 mm (2.0");

**D** 31.75 mm (1.25")

**Termination**

0.25 in. (6.35 mm) male quick connect terminals

**Environmental**

**Operating/Storage**

**Temperature**

-40° to 55°C / -40° to 85°C

**Humidity**

95% relative, non-condensing

**Weight**

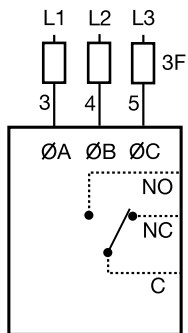
≅ 2.8 oz (79 g)

# PLR SERIES



8-PIN

## Wiring Diagram



F = Fuses  
 ØA = Phase A = L1  
 ØB = Phase B = L2  
 ØC = Phase C = L3  
 NO = Normally Open  
 NC = Normally Closed

Relay contacts are isolated

2A fast acting fuses recommended for safety (not required).

For dimensional drawing see: Appendix, page 512, Figure 23.

## Description

The PLR Series provides a cost effective means of preventing 3-phase motor startup during adverse voltage conditions. Proper A-B-C sequence must occur in order for the PLR's output contacts to energize. In addition, the relay will not energize when an undervoltage or phase loss condition is present. The PLR Series protects a motor against undervoltage operation. The adjustment knob sets the undervoltage trip point.

### Operation

The output relay is energized and the LED glows when all voltages are acceptable and the phase sequence is correct. Undervoltage must be sensed for a continuous dropout delay period before the relay de-energizes. Reset is automatic upon correction of the fault condition. The output relay will not energize if a fault condition is sensed as power is applied.

**Field Adjustment:** Turn the adjustment knob fully counterclockwise and apply three-phase power. The LED should be ON. Increase adjustment until the LED goes OFF. Decrease adjustment until LED glows again. If nuisance tripping occurs, decrease the adjustment slightly.

**NOTE:** When properly adjusted and operating in an average system, a voltage unbalance of 10% or more is required for phase loss detection. When a phase is lost while the motor is running, a voltage will be induced into the open phase nearly equal in magnitude to the normal phase-to-phase voltage. This condition is known as regeneration. When regenerated voltages are present, the voltage unbalance during single phasing may not exceed 10% for some motors. The PLR Series may not provide protection under this condition. For systems that require superior phase loss protection, select the PLMU Series.

## Features & Benefits

FEATURES	BENEFITS
<b>Continuous monitoring</b>	Prevents 3-phase motor startup when undervoltage or phase loss condition is present
<b>Industry standard 8-pin octal plug connection</b>	Eliminates need for special connectors
<b>LED indication</b>	Quick visual indication of output status and correct phase sequence

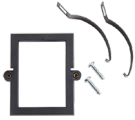
## Ordering Information

MODEL	LINE VOLTAGE
PLR120A	95 to 140VAC
PLR240A	190 to 270VAC
PLR380A	340 to 450VAC
PLR480A	380 to 500VAC

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**PLR SERIES**

**Accessories**



**BZ1 Front Panel Mount Kit**  
Provides an easy method of through-the-panel mounting of 8- or 11-pin plug-in timers, flashers, and other controls.



**OT08PC Octal 8-pin Socket**  
8-pin 35mm DIN rail or surface mount. Rated at 10A @ 600VAC. Surface mounted with two #6 screws or snaps onto a 35 mm DIN rail.



**LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders**  
Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



**OKLK002.T Midget Fuse (2 Amp)**  
10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.

**Specifications**

**Line Voltage Type**

3-phase delta or wye with no connection to neutral

**Nominal Voltage**

**120VAC**  
**240VAC**  
**380VAC**  
**480VAC**

Undervoltage Dropout Adj. Range	Line Voltage Max.
85 to 130VAC	143VAC
170 to 240VAC	270VAC
310 to 410VAC	480VAC
350 to 480VAC	530VAC

**AC Line Frequency**

50/60Hz

**Phase Sequence**

ABC

**Response Times**

**Pull-in**

≤ 400ms

**Drop-out**

≤ 100ms

**Hysteresis**

≈ 2%

**Pull-in/Drop-out**

**Output Type**

Electromechanical relay, energized when all voltages are acceptable

**Form**

SPDT

**Rating**

5A resistive @ 240VAC, 1/4 Hp @ 120VAC

**Maximum Voltage**

250VAC

**Protection**

**Phase Reversal/Failure**

ASME A17.1 Rule 210.6

**Motors and Generators**

NEMA MG1 14:30, 14:35

**Surge**

IEEE C62.41-1991 Level B

**Isolation Voltage**

**120 & 240VAC**  
**380 & 480VAC**

≥ 1500V RMS input to output  
≥ 2500V RMS input to output

**Mechanical**

**Dimensions**

**H** 81.3 mm (3.2"); **W** 60.7 mm (2.39");  
**D** 45.2 mm (1.78")

**Mounting\***

Plug-in socket

**Termination**

Octal 8-pin, plug-in

**Environmental**

**Operating/Storage**

**Temperature**

0° to 55°C / -40° to 85°C

**Weight**

≈ 6 oz (170 g)

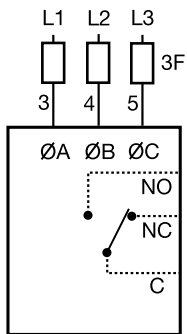
\*CAUTION: Select an octal socket rated for 600VAC operation.

# PLS SERIES



8-PIN

## Wiring Diagram



F = Fuses  
 ØA = Phase A = L1  
 ØB = Phase B = L2  
 ØC = Phase C = L3  
 NO = Normally Open  
 NC = Normally Closed

Relay contacts are isolated

2A fast acting fuses recommended for safety (not required).

## Description

The PLS Series is a low cost phase sensitive control that provides an isolated contact closure when the proper A-B-C phase sequence is applied. Protects sensitive 3-phase equipment and equipment operators from reverse rotation. Designed to be compatible with motor overloads or other 3-phase equipment protection devices. Protection for equipment control centers where frequent reconnection or electrical code makes reverse rotation protection essential. Examples include: mobile refrigerated containers, construction equipment, hoists, pumps, conveyors, elevators and escalators.

### Operation

The internal relay and LED are energized when the phase sequence is correct. The output relay will not energize if the phases are reversed. Reset is automatic upon correction of the fault.

## Features & Benefits

FEATURES	BENEFITS
<b>Continuous monitoring</b>	Cost effective protection of 3-phase equipment and operators from reverse rotation. Meets reverse rotation protection code requirements.
<b>Universal motor compatibility</b>	Designed to be compatible with motor overloads or other 3-phase equipment protection devices
<b>Industry standard 8-pin octal plug connection</b>	Eliminates need for special connectors
<b>Factory calibrated</b>	Easy to install. No field adjustment needed
<b>LED indicator</b>	Provides visual indication of relay status

For dimensional drawing see: Appendix, page 513, Figure 33.

## Ordering Information

MODEL	LINE VOLTAGE
PLS120A	120VAC
PLS240A	208/240VAC
PLS480A	440/480VAC

If you don't find the part you need, call us for a custom product 800-843-8848

## Accessories



### BZ1 Front Panel Mount Kit

Provides an easy method of through-the-panel mounting of 8- or 11-pin plug-in timers, flashers, and other controls.



### Octal 8-pin Socket

8-pin 35mm DIN rail or surface mount. Rated at 10A @ 600VAC. Surface mounted with two #6 screws or snaps onto a 35 mm DIN rail.



### LPSM003ZXID (Indicating), LPSM003Z (Non-indicating) Fuse Holders

Littelfuse POWR-SAFE Dead Front holders provide optimum protection to personnel for Class CC and Midget-Style fuses. 600 VAC/DC



### OKLK002.T Midget Fuse (2 Amp)

10 x 38 fast acting, high-interrupting capacity, current-limiting type fuse. 600 Vac/500 Vdc



### C103PM (AL) DIN Rail

35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.



## PLS SERIES

### Specifications

#### Line Voltage

<b>Type</b>	3-phase delta or wye with no connection to neutral		
<b>Nominal Voltage</b>	<b>Minimum Voltage</b>	<b>Maximum Voltage</b>	
120VAC	95VAC	135VAC	
208/240VAC	175VAC	255VAC	
380/415VAC	310VAC	430VAC	
440/480VAC	380VAC	500VAC	

#### AC Line Frequency

50/60Hz

#### Phase Sequence

ABC

#### Response Times

**Pull-in** ≤ 300ms

**Drop-out** ≤ 50ms

#### Output

**Type** Electromechanical relay, energized when the phase sequence is correct  
Isolated SPDT

#### Form

#### Rating

**120 & 240VAC** 10A resistive @ 240VAC

**380 & 480VAC** 8A resistive @ 240VAC

**Maximum Voltage** 250VAC

#### Protection

#### Isolation Voltage

**120 & 240VAC** ≥ 1500V RMS input to output

**380 & 480VAC** ≥ 2500V RMS input to output

#### Mechanical

#### Mounting\*

Plug-in socket

#### Dimensions

**H** 81.3 mm (3.2"); **W** 60.7 mm (2.39");

**D** 45.2 mm (1.78")

Octal 8-pin plug-in

#### Termination

#### Environmental

#### Operating/Storage

-40° to 55°C / -40° to 85°C

#### Temperature

#### Weight

≈ 6 oz (170 g)

\*CAUTION: Select an octal socket rated for 600VAC operation.

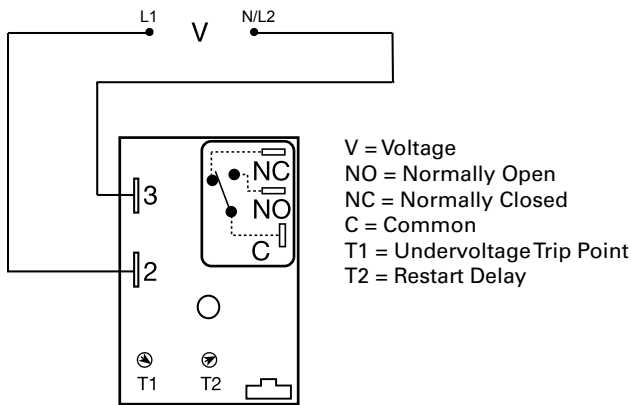


# HLVA6I23

## Single-Phase Monitor



### Wiring Diagram



For dimensional drawing see: Appendix, page 512, Figure 17.

### Description

The HLVA6I23 is a single-phase undervoltage monitor designed to protect sensitive equipment from brownout or undervoltage conditions. Time delays are included to prevent nuisance tripping and short cycling. The 30A, 1hp rated, SPDT relay contacts allow direct control of motors, solenoids and valves. The output relay can be ordered with isolated SPDT contact to allow monitoring of one voltage and switching a separate voltage. Two undervoltage trip point ranges allow monitoring of 110 to 120VAC or 208 to 240VAC systems.

### Operation

Upon application of input voltage the output relay remains de-energized. When the input voltage value is above the pull-in voltage, the restart delay begins. At the end of the restart delay, the output relay energizes. When the input voltage falls below the trip point, the trip delay begins. If the input voltage remains below the pull-in voltage for the entire trip delay the relay de-energizes. If the input voltage returns to a value above the pull-in voltage, during the trip delay, the trip delay is reset and the relay remains energized. If the input voltage falls below the trip point voltage during the restart delay, the delay is reset and the relay remains de-energized. Reset is automatic upon correction of an undervoltage fault.

**Reset:** Removing input voltage resets the output relay and the time delays.

### Features

- 30A, SPDT, NO output contacts
- 100 to 240VAC input voltage
- 70 to 220VAC adjustable undervoltage trip point in 2 ranges
- Restart delays from 3 - 300s
- Trip delay 1 - 20s fixed
- Isolated or non-isolated relay contacts

### Accessories



**P1015-13 (AWG 10/12), P1015-64 (AWG 14/16) Female Quick Connect**  
These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



**P1023-6 Mounting bracket**  
The 90° orientation of mounting slots makes installation/removal of modules quick and easy.



**P1015-18 Quick Connect to Screw Adapter**  
Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.



**C103PM (AL) DIN Rail**  
35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.



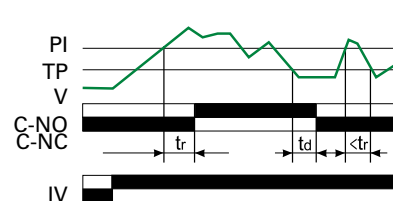
**P1023-20 DIN Rail Adapter**  
Allows module to be mounted on a 35 mm DIN type rail with two #10 screws.

# HLVA6I23

## Specifications

<b>Input</b>	
<b>Min &amp; Max RMS Voltage</b>	70 to 264VAC
<b>AC Line Frequency</b>	50/60 Hz
<b>Power Consumption</b>	AC ≤ 4VA
<b>Undervoltage Sensing</b>	
<b>Type</b>	Peak voltage sensing
<b>Ranges</b>	
<b>(4)</b>	70 to 120VAC
<b>(6)</b>	170 to 220VAC
<b>Pull-In Voltage</b>	105% or trip point voltage
<b>Trip Point Accuracy</b>	± 3% of trip point
<b>Time Delay</b>	
<b>Restart Delays</b>	3 - 300s adjustable
<b>Trip Delay</b>	1 - 20s fixed in 1s increments
<b>Repeat Accuracy</b>	±0.5% or 20ms, whichever is greater
<b>Tolerance</b>	
<b>(Factory Calibration)</b>	±5%
<b>Reset Time</b>	≤ 150ms
<b>Time Delay vs. Temp. &amp; Voltage</b>	≤ ±10%
<b>Output</b>	
<b>Type</b>	Electromechanical relay
<b>Form</b>	SPDT
<b>Ratings</b>	
	<b>SPDT-NO</b> <b>SPDT-NC</b>
<b>General Purpose</b>	125/240VAC      30A      15A
<b>Resistive</b>	125/240VAC      30A      15A
	28VDC      20A      10A
<b>Motor Load</b>	125VAC      1 hp*      1/4 hp**
	240VAC      2 hp**      1 hp**
<b>Life</b>	Mechanical - 1 x 10 <sup>6</sup> Electrical - 1 x 10 <sup>5</sup> , *3 x 10 <sup>4</sup> , **6,000
<b>Protection</b>	
<b>Surge</b>	IEEE C62.41-1991 Level A
<b>Circuitry</b>	Encapsulated
<b>Isolation Voltage</b>	≥ 1500V RMS input to output; isolated units
<b>Insulation Resistance</b>	≥ 100 MΩ
<b>Mechanical</b>	
<b>Mounting</b>	Surface mount with one #10 (M5 x 0.8) screw
<b>Dimensions</b>	<b>H</b> 76.7 mm (3"); <b>W</b> 51.3 mm (2"); <b>D</b> 38.1 mm (1.5")
<b>Termination</b>	0.25 in. (6.35 mm) male quick connects
<b>Environmental</b>	
<b>Operating/Storage Temperature</b>	-40° to 60°C / -40° to 85°C
<b>Humidity</b>	95% relative, non-condensing
<b>Weight</b>	≈ 3.9 oz (111 g)

## Function Diagram

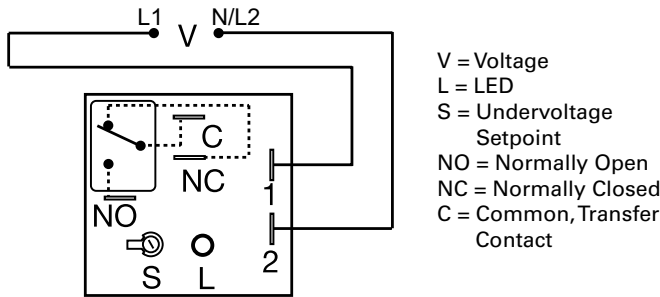


tr = Restart Delay  
td = Trip Delay  
PI = Pull-in 105% or trip point  
TP = Trip Point  
V = Monitored Voltage  
IV = Input voltage  
C-NO = Normally Open Contacts  
C-NC = Normally Closed Contacts

# KVM SERIES



## Wiring Diagram



For dimensional drawing see: Appendix, page 512, Figure 16.

## Ordering Information

MODEL	MAXIMUM LINE VOLTAGE	UNDERVOLTAGE SETPOINT
KVM4	132VAC	Adjustable, 78 to 99VAC
KVM6	264VAC	Adjustable, 156 to 199VAC

If you don't find the part you need, call us for a custom product 800-843-8848

## Description

The KVM Series is a single-phase undervoltage monitor designed to protect sensitive equipment against brownout undervoltage conditions. The compact design and encapsulated construction make the KVM Series an excellent choice for OEM equipment.

### Operation

The output relay is energized and the LED glows green when the input voltage is above the reset voltage threshold. If the input voltage drops below the undervoltage setpoint, the output relay and LED will de-energize. The output relay will remain de-energized as long as the input voltage is below the reset voltage. Reset is automatic when the input voltage returns to a normal range.

## Features & Benefits

FEATURES	BENEFITS
<b>Continuous monitoring</b>	Low cost single-phase undervoltage (brownout) protection
<b>Compact design measures 2 in. (50.8mm) square</b>	Perfect for OEM applications where, cost, size and ease of installation are important
<b>LED indication</b>	Quick visual indication of output status
<b>Encapsulated</b>	Protects against shock, vibration, and humidity

## Accessories



### P1015-64 (AWG 14/16) Female Quick Connect

These 0.25 in. (6.35 mm) female terminals are constructed with an insulator barrel to provide strain relief.



### P1015-18 Quick Connect to Screw Adapter

Screw adapter terminal designed for use with all modules with 0.25 in. (6.35 mm) male quick connect terminals.



### C103PM (AL) DIN Rail

35 mm aluminum DIN rail available in a 36 in. (91.4 cm) length.



### P1023-20 DIN Rail Adapter

Allows module to be mounted on a 35 mm DIN type rail with two #10 screws.

# KVM SERIES

## Specifications

### Line Voltage

<b>Type</b>	Single phase
<b>Input Voltage</b>	110 to 120VAC or 220 to 240VAC
<b>AC Line Frequency</b>	50/60 Hz
<b>Power Consumption</b>	2.5W @ 132VAC; 4.5W @ 264VAC
<b>Power Off Reset Time</b>	≤ 150ms

### Undervoltage Detection

<b>Undervoltage Setpoint</b>	
<b>KVM4</b>	78 to 99VAC
<b>KVM6</b>	156 to 199VAC

### Undervoltage Reset Point

<b>KVM4</b>	Fixed at 104VAC
<b>KVM6</b>	Fixed at 209VAC
<b>Repeatability</b>	± 0.5% under fixed conditions ± 1% over temperature range

### Voltage Sensing Accuracy

<b>Output</b>	± 2% at 25°C
---------------	--------------

### Output

<b>Type</b>	Electromechanical relay
<b>Form</b>	SPDT
<b>Rating</b>	8A resistive @ 120VAC, 1/3 hp @ 120/240VAC
<b>Life</b>	Mechanical - 1 x 10 <sup>6</sup> ; Electrical - 1x10 <sup>5</sup>
<b>LED Indicator</b>	Glows green when output is energized

### Protection

<b>Surge</b>	IEEE C62.41-1991 Level A
--------------	--------------------------

<b>Circuitry</b>	Encapsulated
------------------	--------------

<b>Isolation Voltage</b>	≥ 1500V RMS input to output
--------------------------	-----------------------------

<b>Insulation Resistance</b>	≥ 100 MΩ minimum
------------------------------	------------------

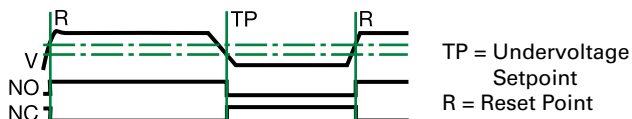
### Mechanical

<b>Mounting</b>	Surface mount with one #10 (M5 x 0.8) screw
<b>Dimensions</b>	<b>H</b> 50.8 mm (2.0"); <b>W</b> 50.8 mm (2.0"); <b>D</b> 30.7 mm (1.21")
<b>Termination</b>	0.25 in. (6.35 mm) male quick connect terminals

### Environmental

<b>Operating /Storage Temperature</b>	-25 to 55°C / -40 to 85°C
<b>Humidity</b>	95% relative, non-condensing
<b>Weight</b>	2.6 oz (74 g)

## Function Diagram



## REMOTE INDICATION & MONITORING

---

Improve safety for service and operations personnel by allowing control and monitoring of the relay without opening the electrical cabinet.

RM1000 Series	Remote Monitor .....	260
RM2000 Series	Remote Monitor .....	262
Informer	Remote Diagnostics Tool.....	264
Informer-MS	Remote Diagnostics Tool.....	266

# RM1000 SERIES

## Remote Monitor

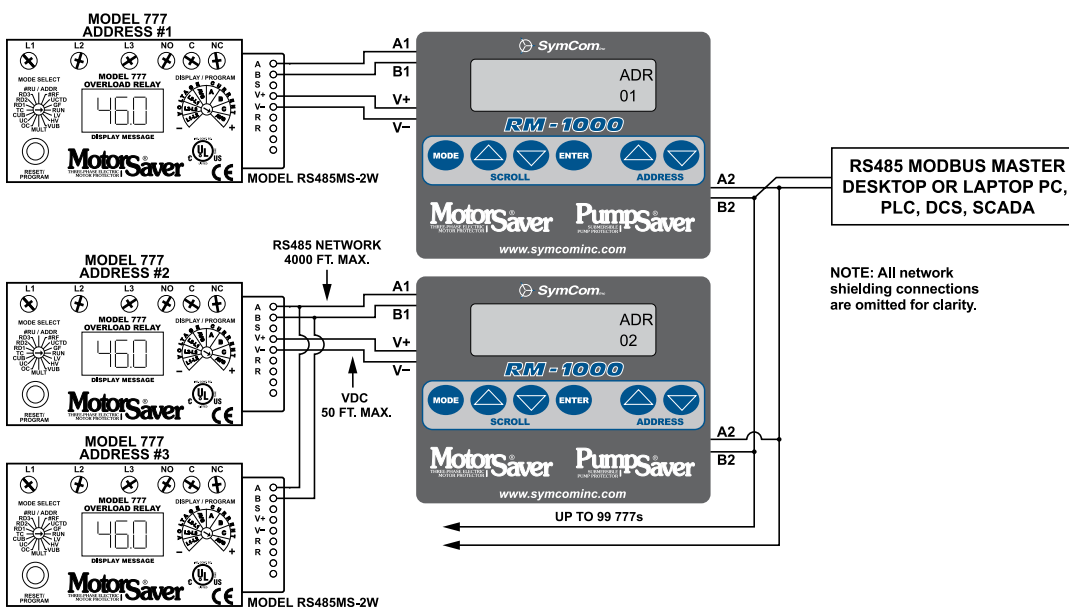


### Description

The RM1000 Series is a motor-monitoring device to be used in conjunction with the 777 family of products (excluding the P1 Series), 77C family of products and the 601 voltage monitors, via Modbus protocol with a communications module. The RM1000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring.

The RM1000 Series can monitor up to 16 MotorSaver® and/or PumpSaver® units through an RS-485 network using Modbus RTU protocol. A second communication port allows monitoring and control of up to 99 MotorSaver® and/or PumpSaver® units from a computer, PLC, DCS or SCADA system and can be accessed from the host computer or PLC with the RM1000 acting as a repeater for any of its motor protectors. In addition to the monitoring functions, the RM1000 can be used to reset a tripped MotorSaver® or PumpSaver®.

### Wiring Diagram



For dimensional drawing see: Appendix, page 508, Figure 4.

### Ordering Information

MODEL	DESCRIPTION
RM1000	NEMA 3R and/or UL Type 12
RM1000-3R	NEMA 3R
RM1000 NEMA 4	NEMA 4X

The RM1000 Series is easily mounted remotely and improves safety for service and operations personnel by allowing them to control and monitor the device without opening the electrical cabinet. Using the RM1000 is a simple, cost-effective method for aiding compliance with arc flash safety regulations. The enclosure and keypad assembly is water and ultraviolet light resistant. The enclosure is NEMA 3R or NEMA 4X (optional) rated. The RM1000 and RM1000 NEMA 4 also carry a UL Type 12 rating, whereas the RM1000-3R does not carry the UL Type 12 rating due to added weep holes. The added weep holes in the RM1000-3R make it suitable for applications subjected to condensing moisture/humidity.

10 REMOTE INDICATION & MONITORING

# RM1000 SERIES

## Features

Displays:

- Individual line currents and average current
- Current and voltage unbalance
- Individual phase voltages and average voltage
- Displays last four faults, trip reason, and restart timer status
- MotorSaver® and/or PumpSaver® setpoints
- Run-hours on each motor
- Warning of pending (imminent) faults

Controls:

- Reset run-hour meter
- Reset MotorSaver® or PumpSaver®
- Change setpoints from the RM1000

Convenience:

- Power from RS485MS-2W communications module
- Monitor up to 16 777s with one display
- NEMA 3R outdoor rated
- Secondary steel enclosure available

## Accessories



**RS485-RS232 Converter with cable & plug**  
Allows RS485 devices to be connected to a PC via the RS232 (serial) port. Provides convenient terminal blocks for making signal and DC power supply connections. Pre-wired.



**RS485-USB Converter with cable & plug/RS232:USB**  
Allows RS485 devices to be connected to a PC via the USB port. Provides convenient terminal blocks for making signal and DC power supply connections. Pre-wired.



**RM1000 ENCL**  
Steel enclosure for protecting the RM1000 remote communications monitor from adverse affects of weather and vandalism, while allowing normal communications connections to the RM1000 unit.



**Solutions Software: Solutions-M**  
Software features include data logging, real-time data monitoring and fault and event monitoring.

## Specifications

### Input Characteristics

#### Control Power

12-24VDC (Supplied by RS485MS-2W)

### Functional Characteristics

#### Communication

**Port #1 for 777(s)**    **Port #2 for PC, PLC, etc.**

#### Baud Rate

1200-28800    1200-28800

#### Setup

None, Odd, or Even Parity    None, Odd, or Even Parity

1 or 2 Stop Bits

1 or 2 Stop Bits

#### Protocol

Modbus RTU

Modbus RTU

#### Serial Interface

RS-485

RS-485

#### Available Addresses

1-99 addresses

Responds to all port #1

(max 16 per RM1000)

#### Mechanical Life

100,000 actuations

#### Overlay Material

Polyester

#### UV Exposure w/o degradation

2000 hrs

#### Terminal Torque (depluggable terminal block)

3 in.-lbs.

#### Panel Thickness

0.03" min, 0.12" max

### General Characteristics

#### Ambient Temperature Range

#### Operating

-40° to 70°C (-40° to 158°F)

#### Storage

-40° to 80°C (-40° to 176°F)

#### Maximum Input Power

100mA

#### Class of Protection

#### RM1000, RM1000 NEMA 4

NEMA 3R and/or UL Type12, NEMA 4X (optional)

#### RM1000-3R

NEMA 3R only

#### Relative Humidity

Up to 85%, non-condensing

#### Safety Marks

#### UL

UL508 (File #E68520)

#### CSA

22.2 No. 14 (File #46510)

#### CE

IEC 60947-6-2

#### Enclosure Material

Black polycarbonate

#### Display

Liquid Crystal with extended temp. range

#### Size

2 rows x 16 characters

#### Keypad

Six 0.5" stainless steel dome buttons for tactile feedback

#### Dimensions

**H** 91.92 mm (3.62"); **W** 115.42 mm (4.54");

**D** 22.86 mm (0.9")

#### Weight

1.5 lbs. (24 oz., 680.39 g)

#### Mounting Method

Surface mountable on backplane using 4 screws



# RM2000 SERIES

## Remote Monitor



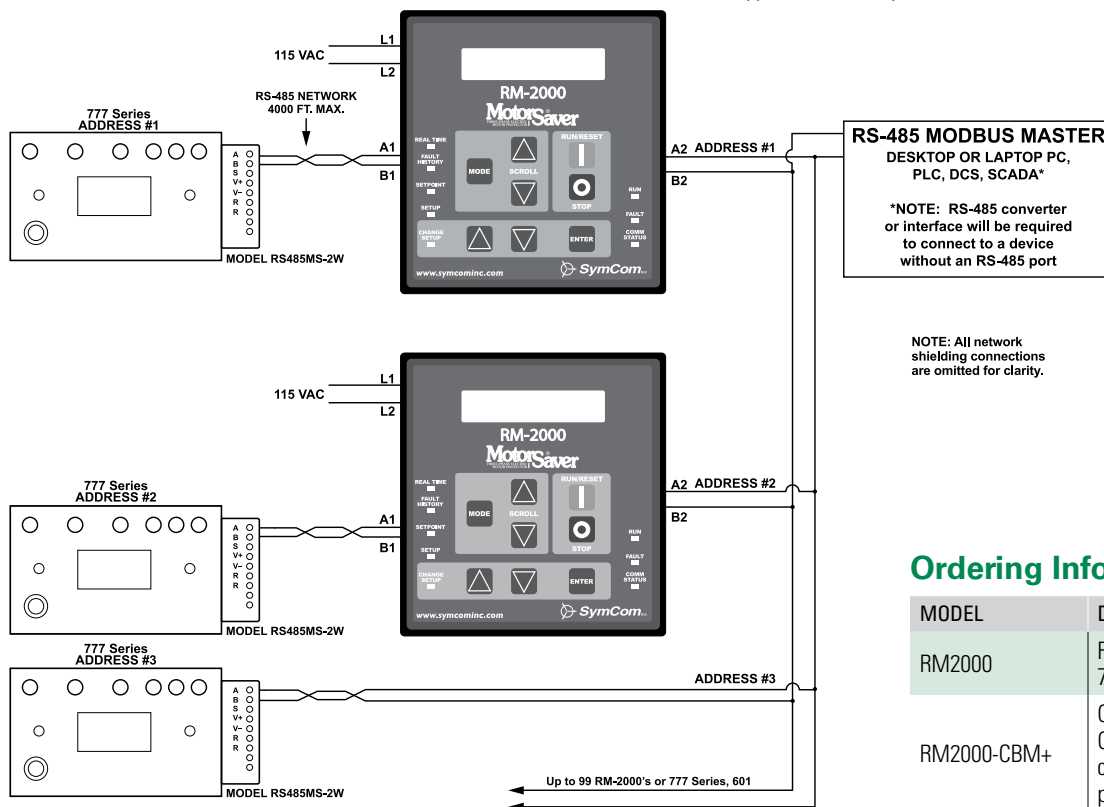
### Description

The RM2000 Series is a motor-monitoring device to be used in conjunction with the 777 family of products (excluding the P1 Series), 77C family of products and the Model 601 voltage monitors, via Modbus protocol with a communications module. The RM2000/777 motor management system combines unsurpassed electronic motor protection and critical, user-friendly, motor monitoring.

The RM2000 has membrane keypad controls which allow both monitoring and control of a 777 MotorSaver® through an RS-485 network using Modbus RTU protocol. A second communication port allows monitoring and control of up to 99 RM2000 devices from a PLC, DCS, or SCADA system or a PC with Solutions software installed. The RM2000 will act as a repeater for its motor protector when accessed from the host computer or PLC. In addition to the monitoring functions, the RM2000 can be used to reset a tripped MotorSaver® or PumpSaver®.

The RM2000 is easily mounted remotely and improves safety for service and operations personnel by allowing them to control and monitor the device without opening the electrical cabinet. Using the RM2000 is a simple, cost-effective method for aiding compliance with arc flash safety regulations. The enclosure and keypad assembly is water and ultraviolet light resistant.

### Wiring Diagram



### Ordering Information

MODEL	DESCRIPTION
RM2000	Remote display monitor for 777 family relays
RM2000-CBM+	Coal Bed Methane Special. Optimizes gas production from coal bed methane wells while protecting submersible pump
RM2000-RTDW	Includes additional input for ground-fault module

For dimensional drawing see: Appendix, page 508, Figure 5.

10

REMOTE INDICATION & MONITORING

# RM2000 SERIES

## Features

Displays:

- Average current, individual line currents and current unbalance
- Current to ground
- Average voltage, line-line voltages and voltage unbalance
- Instantaneous power
- Power factor
- Last four faults
- All parameters programmed into 777 MotorSaver®
- Remaining restart delay times

Controls:

- Start and stop buttons
- Key lock input to prevent setpoint changes
- Change 777 setpoints from keypad

The RM2000 is also equipped with a real-time clock, which allows access to the following motor management information (most readings can be reset):

- Total motor run-time
- Time and date of last four faults, along with voltage and current at time of trip
- Time and date of last 10 motor starts
- Total number of motor restarts
- Minimum time between any two starts with time and date
- Run-time since last start
- kWh consumed
- kVARs consumed

## Accessories



**RS485-RS232 Converter with cable & plug**  
Allows RS485 devices to be connected to a PC via the RS232 (serial) port. Provides convenient terminal blocks for making signal and DC power supply connections. Pre-wired.



**RS485-USB Converter with cable & plug/RS232:USB**  
Allows RS485 devices to be connected to a PC via the USB port. Provides convenient terminal blocks for making signal and DC power supply connections. Pre-wired.



**Solutions Software: Solutions-M**  
Software features include data logging, real-time data monitoring and fault and event monitoring.

## Specifications

### Input Characteristics

**Control Voltage** 115VAC ±10%; 50/60Hz

**Transient Protection (Internal)** 2500V for 10ms

### Functional Characteristics

#### Communication

##### Baud Rate

##### Setup

#### Protocol

#### Serial Interface

#### Available Addresses

#### Real-time Clock

#### Battery Back-up Life

#### Last fault memory

#### Configuration

#### Contact Material

#### Output Characteristics

#### (RM2000-RTDW version only)

#### Pilot Duty Rating

#### General Purpose Rating

#### General Characteristics

#### Ambient Temperature Range

#### Operating

#### Storage

#### Maximum Input Power

#### Class of Protection

#### Relative Humidity

#### Safety Marks

#### UL

#### CSA

#### CE

#### Enclosure

#### Material

#### Display

#### Size

#### Lighting

#### Keypad

#### Mechanical Life

#### Overlay Material

#### UV Exposure

#### w/o degradation

#### Terminal Torque

#### (depluggable terminal block)

#### Dimensions

#### Weight

#### Mounting Method

<b>Port #1 for 777</b>	<b>Port #2 for PC, PLC, etc.</b>
1200-28800	1200-28800
Even Parity	None, Odd, or Even Parity
1 Stop Bit	1 or 2 Stop Bits
Modbus RTU	Modbus RTU
RS-485	RS-485
01	A01-A99

10 years @ 25°C without external power  
Stores up to 4 faults with time and date stamp, includes voltages and currents at time of trip  
Two independent electro-mechanical Form C (SPDT)  
Silver/Tin Oxide

240VA @ 120VAC  
5A @ 120VAC

-20° to 70°C (-4° to 158°F)  
-30° to 70°C (-22° to 158°F)  
3 W  
NEMA 3R and/or UL Type 12  
Up to 85%, non-condensing

UL508 (File #E68520)  
C22.2 No. 14 (File #46510)  
IEC 60947-6-2

Black polycarbonate  
Liquid crystal with extended temp. range  
2 rows x 20 characters  
LED Backlight  
Eight 0.5" stainless steel dome buttons for tactile feedback  
100,000 actuations  
Polyester

2000 hrs.

3 in.-lbs.  
**H** 162.56 mm (6.4"); **W** 154.94 mm (6.1");  
**D** 27.94mm (1.1")

1.2 lbs. (19.2 oz., 544.31 g)  
Surface mountable on backplane using 4 screws

10  
REMOTE INDICATION & MONITORING

# INFORMER

## Remote Diagnostic Tool for use with Single-Phase Pump Relays



For dimensional drawing see: Appendix, page 510, Figure 9.

### Description

The Informer is a hand-held diagnostic tool designed for use with single-phase models equipped with infrared LED transmitters (111-Insider-P; 231-Insider-P; 232-Insider; 111P; 233P; 233P-1.5; 234-P and 235P).

The Informer uses an infrared receiver to access information sent from the relay which can be helpful for troubleshooting the system.

Each Littelfuse single-phase model listed above is equipped with an infrared LED that transmits valuable information from the device. To retrieve this information, the Informer's receiver must be directed toward the unit's LED transmitter and be within 8 feet of the unit. The green COMM STATUS light indicates when the Informer is receiving data from the unit. If communication is lost, the Informer will display the last values it received. The Informer will automatically shut off after 2 minutes of non-use.

An infrared adapter (IR Kit-12) is included with all new and updated Informers. This adapter allows communication with the unit without opening the panel door (for select models).

### Features & Benefits

The Informer displays:

- Model number
- Real-time voltage, current, and power
- Drywell and overload trip points
- Calibration voltage
- Restart delay setpoint and restart delay time remaining
- CT size (if applicable)
- Number of pump starts
- Total run-time
- Fault history for last 20, most recent, faults
- Voltage, current, power, and run-time for each fault at time of the fault
- Highest and lowest voltage and current since last calibration

### Accessories



#### Informer IR Kit-12

12" infrared adapter cable attaches to the face of the unit to provide remote diagnostics without opening the panel. Included with the Informer

# INFORMER

## Specifications

### Functional Characteristics

#### Power

##### Input

9 Volts DC  
(requires one 9-volt alkaline battery)

##### Auto Shut-off

2 minutes

### Communication

#### Signal

Infrared

#### Range

1-8 ft. (approx. 0.25 ft. when using IR Kit)

#### Data Update

4 seconds

### General Characteristics

#### Temperature Range

0 to 60°C (32° to 140°F)

#### Accuracy

##### Voltage

±2%

##### Current

±2%

##### Power

±4%

##### Maximum Input

0.25 W

### Resolution

#### Voltage

1.0VAC

#### Display

Liquid crystal

#### Size

2 rows x 16 characters

#### Keypad

Three 0.5" diameter buttons

#### Mechanical Life

100,000 actuations min.

#### Overlay Material

Polyester

### Enclosure

#### Dimensions

**H** 139.70 mm (5.50"); **W** 91.44 mm (3.60");  
**D** 28.70 mm (1.13")

#### Weight

0.375 lb. (6 oz., 170.10 g) (w/out battery);  
0.70 lb. (11.2 oz., 317.51 g) (total package)

#### Material

Black ABS 94HB

# INFORMER-MS

## Remote Diagnostic Tool for use with the 455 3-Phase, Dual-Range Voltage Monitor



For dimensional drawing see: Appendix, page 510, Figure 9.

### Specifications

#### Functional Characteristics

##### Power

**Input** 9 Volts DC  
(requires one 9-volt alkaline battery)

**Consumption** 0.25 Watt (max.)

**Auto Shut-off** 2 minutes

##### Communication

**Signal** Infrared

**Range** 1-8 ft. (approx. 0.25 ft. when using IR Kit)

**Data Update** 4 seconds

##### General Characteristics

**Temperature Range** 0 to 60°C (32° to 140°F)

##### Accuracy

**Voltage** ±2%

**Maximum Input** 0.25 W

##### Resolution

**Voltage** 1.0VAC

**Voltage Unbalance** 1%

**Time** 1 minute increments

**Trip Delay** 2 second increments

**Restart Delay** 2 second increments

##### Display (liquid crystal)

**Size** 2 rows x 16 characters

##### Keypad

**(three 0.5" dia. buttons)**

**Mechanical Life** 100,000 actuations min.

**Overlay Material** Polyester

##### Enclosure

**Dimensions** **H** 139.70 mm (5.50"); **W** 91.44 mm (3.60");

**D** 28.70 mm (1.13")

**Weight** 0.375 lb. (6 oz., 170.10 g) (w/out battery);

0.70 lb. (11.2 oz., 317.51 g) (total package)

**Material** Black ABS 94HB

### Description

The Informer-MS is a hand-held diagnostic tool designed for use with the Littelfuse 455.\*

The Informer-MS uses an infrared receiver to read valuable information transmitted from the 455\*, which can be helpful for troubleshooting the system. A green communication status light indicates the Informer-MS is receiving data from the 455. If communication is lost, the Informer-MS will display the last values it received.

\*Model 455s manufactured after 03/01/06 are equipped with the infrared LED transmitter. Models manufactured prior to this date are not compatible with the Informer-MS.

An infrared adapter (IR Kit-36) can be purchased to allow communication with the Model 455 without opening the panel door.

### Features

The Informer-MS displays:

- Real-time, line and load side voltage
- Real-time, line and load side voltage unbalance
- Motor run hours
- Last 20 faults
- Last 32 motor starts
- High and low voltage trip points
- Voltage unbalance trip point
- Restart and trip delay settings
- Voltage at last fault
- Communication status LED
- Auto shut off
- Last fault with trip conditions

### Accessories



#### Informer IR Kit-36

36" infrared adapter cable attaches to the face of the model 455 to provide remote diagnostics without opening the panel.

## COMMUNICATION MODULES

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# RS485MS-2W

## Communication Module



### Description

The RS485MS-2W is required to enable the Modbus communications function on Model 77x-type products. This module is required when the RM1000, RM2000 or other Modbus capable device is used with 77x-type products.

### Features

- Optical isolation from line potentials
- Powered by the 77x product
- RS-485 compliant bus drive capability
- Remote reset input connection
- Power connection for the Model RM1000

### Accessories

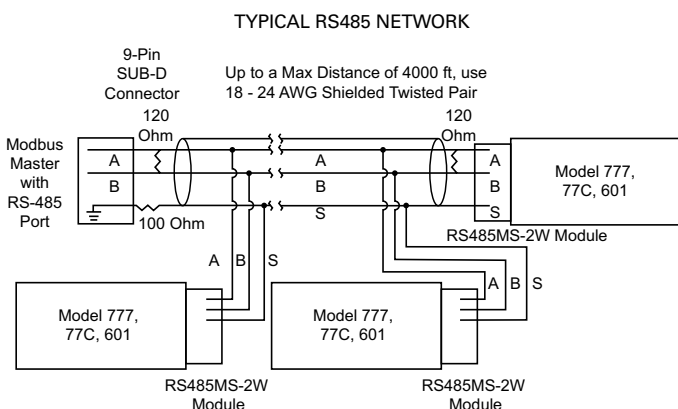


**RS485-RS232 Converter with cable & plug**  
Allows RS485 devices to be connected to a PC via the RS232 (serial) port. Provides convenient terminal blocks for making signal and DC power supply connections. Pre-wired.



**RS485-USB Converter with cable & plug/RS232:USB**  
Allows RS485 devices to be connected to a PC via the USB port. Provides convenient terminal blocks for making signal and DC power supply connections. Pre-wired.

### Wiring Diagram



Refer to the manual for basic and extended network diagrams.

For dimensional drawing see: Appendix, page 507, Figure 2.

## Specifications

### Functional Specifications

**Remote Reset (for optional use with 777 Series)**  
Normally open pushbutton rated 24VDC, 10mA (min.)

### General Characteristics

**Ambient Operating Temperature**  
-20° to 50°C (-4° to 122°F)

**Terminal (depluggable terminal block)**

**Torque**  
3 in.-lbs. (max.)

**Wire AWG**  
12-20 AWG

**Class of Protection**  
IP20

**Relative Humidity**  
10-95%, non-condensing per IEC 68-2-3

### Standards Passed

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air

### Radio Frequency

**Immunity, Radiated**  
150 MHz, 10V/m

**Fast Transient Burst**  
IEC 61000-4-4, Level 3, 4kV input power

**Hi-Potential Test**  
Meets UL508 (2 x rated V + 1000V for 1 min)

### Surge

**Input Power**  
IEC 61000-4-5, Level 1

**Inputs/Data Lines**  
IEC 61000-4-5, Level 2

### Safety Marks

**UL**  
UL508 (File #E68520)

**CE**  
IEC 60947

**Enclosure**  
Polycarbonate

**Dimensions**  
**H** 52.83 mm (2.08"); **W** 73.66 mm (2.9");

**D** 19.56 mm (.77")

**Weight**  
0.26 lb. (4.16oz., 117.93 g)

**Mounting Method**  
9-pin D-Sub connector on the side of a 777-Series



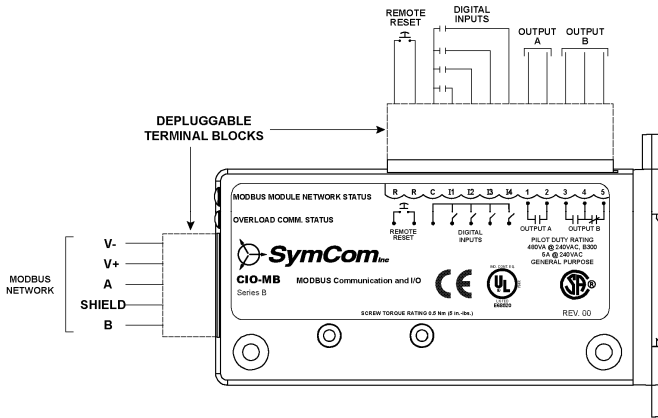
# CIO-MB / CIO-120-MB

Communication Link to PLC/SCADA/  
Monitoring Systems

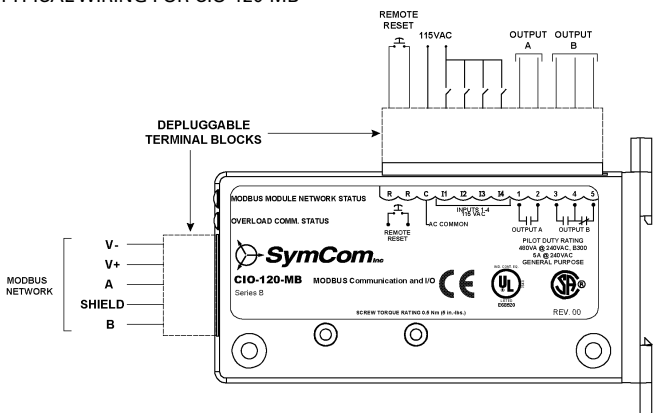


## Wiring Diagram

TYPICAL WIRING FOR CIO-MB



TYPICAL WIRING FOR CIO-120-MB



For dimensional drawing see: Appendix, page 507, Figure 3.

## Ordering Information

MODEL	LINE VOLTAGE
CIO-MB	12 to 24VDC
CIO-120-MB	90 to 130VAC

## Description

The CIO-MB/CIO-120-MB Modules are convenient and cost-effective Modbus-RTU interfaces capable of providing discrete control and monitoring of an overload relay over a Modbus network.

## Features & Benefits

FEATURES	BENEFITS
<b>Compact size</b> 3.46" H x 1.0" W x 5.0" D	Easily adapts to existing as well as new applications
<b>Flexible addressing</b> standard allows function as stand-alone interface or in conjunction with 777 series overload relay	Provides flexibility for control and monitoring
<b>Remote reset option</b>	Additional remote reset input allows user to reset 777 series relays without opening the panel
<b>DIN rail or surface mountable</b>	Allows installation flexibility
<b>Unpluggable terminal block connections</b>	Allows user to wire terminal blocks before installing the module and reduces field wiring

## Specifications

### Functional Specifications

#### Remote Reset (for use with optional 777 Series)

Normally open pushbutton rated 24VDC, 10mA (min.)

#### Power Requirements:

**Voltage** 24VDC +10%  
**Current** 95mA (max.) 70mA (typical)  
**Power** 2.28 W (max.) 1.7 W (typical)  
**Ethernet Controller Capability** IEEE 802.3 10Base-T

#### Input Characteristics General Purpose (4)

#### Voltage Range:

**CIO-MB** 12-24VDC  
**CIO-120-MB** 90-130VAC  
**Current** 2mA (typical)

#### Output Characteristics SPDT (1), SPST (1)

**Pilot Duty** 480VA & 240VAC, B300  
**General Purpose** 5A @ 240VAC

#### General Characteristics

**Ambient Operating Temperature** -20° to 70°C (-4° to 158°F)

#### Terminal (depluggable terminal block)

**Torque** 3 in.-lbs. (max.)  
**Wire AWG** 12-20 AWG  
**Class of Protection** IP20, NEMA 1 (finger safe)  
**Relative Humidity** 10-95%, non-condensing per IEC 68-2-3

## CIO-MB / CIO-120-MB

### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity,</b>	
<b>Radiated</b>	150 MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 4kV input power
<b>Hi-Potential Test</b>	Meets UL508 (2 x rated V + 1000V for 1 min)
<b>Surge</b>	
<b>Input Power</b>	IEC 61000-4-5, Level 1
<b>Inputs/Data Lines</b>	IEC 61000-4-5, Level 2
<b>Safety Marks</b>	
<b>UL</b>	UL508 (File #E68520)
<b>CSA</b>	C22.2 (File #46510)
<b>CE</b>	IEC 60947-6-2
<b>Enclosure</b>	Polycarbonate
<b>Dimensions</b>	<b>H</b> 86.36 mm (3.40"); <b>W</b> 25.40 mm (1.00"); <b>D</b> 138.68 mm (5.46") (w/depluggable connectors)
<b>Weight</b>	0.25 lb. (4 oz., 113.4 g)
<b>Mounting Methods</b>	DIN Rail or surface mount (w/two #8 screws)

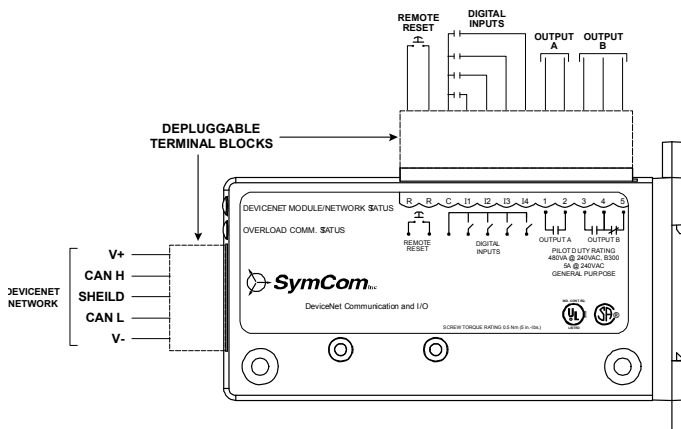
# CIO-DN-P / CIO-120-DN-P

## Communication Link to PLC/SCADA/ Monitoring Systems

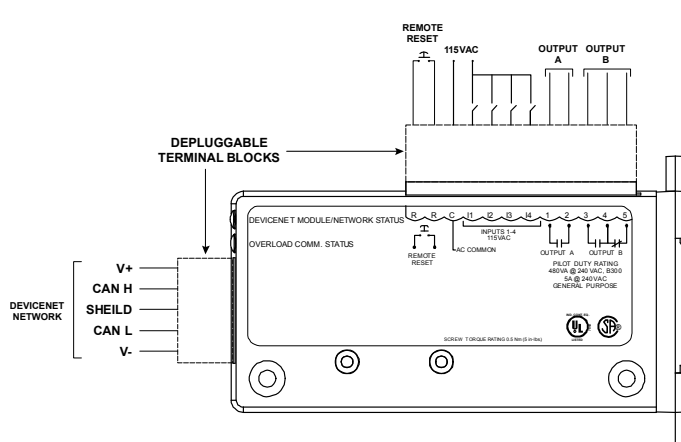


### Wiring Diagram

TYPICAL WIRING FOR CIO-DN-P



TYPICAL WIRING FOR CIO-120-DN-P



For dimensional drawing see: Appendix, page 507, Figure 3.

### Description

The CIO-DN-P/CIO-120-DN-P are convenient and cost-effective Devicenet™ interfaces capable of providing discrete control and monitoring of motor starters, drives and other devices over a Devicenet™ network.

### Features & Benefits

FEATURES	BENEFITS
<b>Compact size</b> 3.4" H x 1.0" W x 5.46" D	Easily adapts to existing as well as new applications
<b>Flexible addressing standard allows function as stand-alone interface or in conjunction with 777 series overload relay</b>	Provides flexibility for control and monitoring
<b>Remote reset option</b>	Additional remote reset input allows user to reset 777 series relays without opening the panel
<b>DIN rail or surface mountable</b>	Allows installation flexibility
<b>Unpluggable terminal block connections</b>	Allows user to wire terminal blocks before installing the module and reduces field wiring

### Ordering Information

MODEL	LINE VOLTAGE
CIO-DN-P	12 to 24VAC
CIO-120-DN-P	90 to 130VAC

## CIO-DN-P / CIO-120-DN-P

### Specifications

#### Input Characteristics

#### Power Requirements

<b>Voltage (nominal)</b>	24VDC
<b>Current</b>	137mA (max.)
<b>Power</b>	3.28 W (max.)

#### Digital Inputs

#### Voltage Range

<b>CIO-DN-P</b>	12-24 VAC
<b>CIO-120-DN-P</b>	90-130VAC

#### Frequency

50/60Hz

#### Maximum Current

2mA (typical)

#### Remote Reset

24VDC, 10mA (min.), NO pushbutton

#### Output Characteristics

#### Form A & Form C Contactors

**Pilot Duty** 480VA @ 240VAC, B300

**General Purpose** 5A @ 240VAC

#### General Characteristics

**Temperature Range** -20° to 70°C (-4° to 158°F)

**Relative Humidity** 10-95%, non-condensing

**Wire Gauge** Solid or stranded, 12-20 AWG

**Terminal Torque** 3 in.-lbs.

**Hi-Potential Test** (relays to other circuits) (2 x rated V + 1000V for 1 minute)

### EMC Standards

**Electrostatic Discharge (ESD)** IEC 61000-4-2, Level 3, 6kV contact, 8kV air

#### Radio Frequency Immunity,

#### Radiated

150 MHz, 10V/m

#### Fast Transient Burst

IEC 61000-4-4, Level 3, 4kV input power

#### Safety Marks

#### UL, ULC Listed, CSA

UL508 (File #E68520), C22.2 (File #46510)

#### Enclosure

Polycarbonate

#### Dimensions

**H** 86.36 mm (3.4"); **W** 25.4 mm (1.0");

**D** 138.68 mm (5.46")

(w/depluggable connectors)

#### Weight

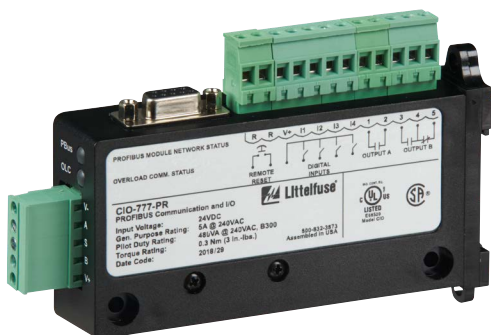
0.25 lb. (4 oz., 113.4 g) (w/depluggable connectors)

#### Mounting Methods

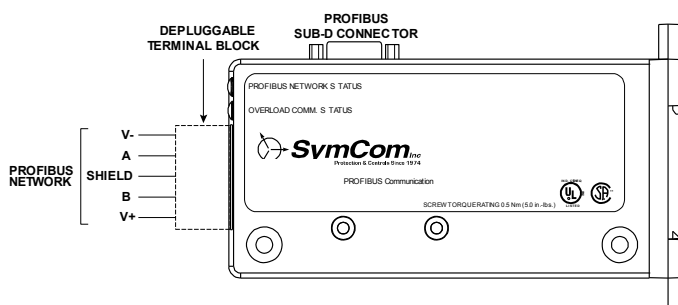
DIN Rail or surface mount (w/two #8 screws)

# CIO-777-PR

## Communication Link to PLC/SCADA/ Monitoring Systems



### Wiring Diagram



For dimensional drawing see: Appendix, page 507, Figure 3.

### Description

The CIO-777-PR Module is a convenient and cost-effective Profibus interface capable of providing discrete control and monitoring of motor starters, drives and other devices over a Profibus network.

### Features & Benefits

FEATURES	BENEFITS
<b>Compact size</b> 3.4" H x 1.0" W x 5.46" D	Easily adapts to existing as well as new applications
<b>Flexible addressing standard allows function as stand-alone interface or in conjunction with 777 series overload relay</b>	Provides flexibility for control and monitoring
<b>Remote reset option</b>	Additional remote reset input allows user to reset 777 series relays without opening the panel
<b>DIN rail or surface mountable</b>	Allows installation flexibility
<b>Built in sub-D connector</b>	Provides a quick and easy connection to a network and reduces field wiring

### Specifications

#### Input Characteristics

##### Power Requirements

<b>Voltage (nominal)</b>	12-24VDC
<b>Current</b>	150mA (max.)
<b>Power</b>	3.6 W (max.)
<b>Digital Inputs</b>	
<b>Voltage Range</b>	12-24VAC
<b>Maximum Current</b>	2mA (typical)
<b>Remote Reset</b>	24VDC, 10mA, (min.), NO pushbutton

#### Output Characteristics

##### Form A & Form C Contactors

<b>Pilot Duty</b>	480VA @ 240VAC, B300
<b>General Purpose</b>	5A @ 240VAC

#### General Characteristics

<b>Ambient Temperature Range</b>	
<b>Operating</b>	-20° to 70°C (-4° to 158°F)
<b>Storage</b>	-40° to 80°C (-40° to 176°F)
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3
<b>Wire Gauge</b>	Solid or stranded, 12-20 AWG
<b>Terminal Torque</b>	3 in.-lbs.
<b>Hi-Potential Test (relays to other circuits)</b>	Meets UL508 (2 x rated V + 1000V for 1 min.)

#### EMC Standards

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150 MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 4kV input power

#### Safety Marks

**UL, ULC Listed** UL508 (File #E68520)

**CSA** C22.2 (File #46510)

**Enclosure** Polycarbonate

**Dimensions**  
**H** 86.36 mm (3.4"); **W** 25.4 mm (1.0");  
**D** 138.68 mm (5.46")  
(w/depluggable connectors)

**Weight** 0.25 lb. (4 oz., 113.4 g)

(w/depluggable connectors)

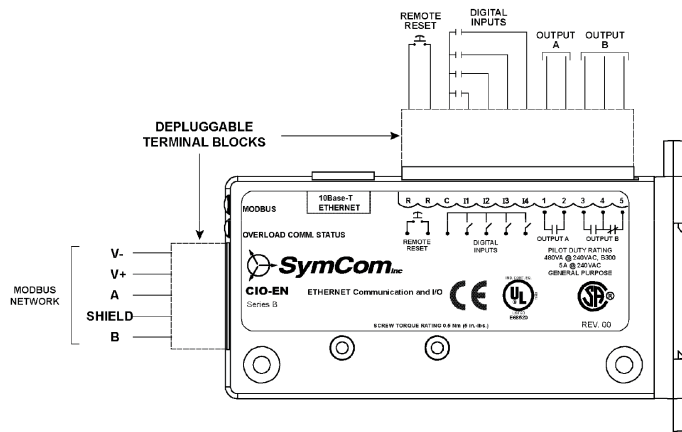
**Mounting Methods** DIN Rail or surface mount (w/ two #8 screws)

# CIO-EN

## Communication Link to PLC/SCADA/ Monitoring Systems



### Wiring Diagram



For dimensional drawing see: Appendix, page 507, Figure 3.

### Description

The CIO-EN Module (non-POE) is a convenient and cost-effective Modbus-TCP and Modbus-RTU interface capable of providing discrete control and monitoring of an overload relay over a Modbus network.

### Features & Benefits

FEATURES	BENEFITS
<b>Compact size</b> 3.4" H x 1.0" W x 5.46" D	Easily adapts to existing as well as new applications
<b>Flexible addressing standard allows function as stand-alone interface or in conjunction with 777 series overload relay</b>	Provides flexibility for control and monitoring
<b>Remote reset option</b>	Additional remote reset input allows user to reset 777 series relays without opening the panel
<b>DIN rail or surface mountable</b>	Allows installation flexibility
<b>Built in Ethernet jack</b>	Reduces field wiring

### Specifications

#### Input Characteristics

##### Power Requirements:

<b>Voltage</b>	24VDC +10%
<b>Current</b>	95mA (max.) 70mA (typical)
<b>Power</b>	2.28 W (max.) 1.7 W (typical)

##### Digital Inputs

##### General Purpose (4)

<b>Voltage Range</b>	12-24VDC
<b>Current</b>	2mA (typical)

#### Functional Specifications

##### Remote Reset (for use with optional 777 Series)

Normally open pushbutton rated 24VDC, 10mA (min.)

##### Ethernet Controller Capability

IEEE 802.3  
10Base-T

#### Output Characteristics

##### SPDT (1), SPST (1)

<b>Pilot Duty</b>	480VA & 240VAC, B300
<b>General Purpose</b>	5A @ 240VAC

#### General Characteristics

##### Ambient Operating

<b>Temperature</b>	-20° to 70°C (-4° to 158°F)
--------------------	-----------------------------

#### Terminal (depluggable terminal block)

<b>Torque</b>	3 in.-lbs. (max.)
<b>Wire AWG</b>	12-20 AWG
<b>Class of Protection</b>	IP20, NEMA 1 (finger safe)
<b>Relative Humidity</b>	10-95%, non-condensing per IEC 68-2-3

#### Standards Passed

<b>Electrostatic Discharge (ESD)</b>	IEC 61000-4-2, Level 3, 6kV contact, 8kV air
<b>Radio Frequency Immunity, Radiated</b>	150 MHz, 10V/m
<b>Fast Transient Burst</b>	IEC 61000-4-4, Level 3, 4kV input power
<b>Hi-Potential Test</b>	Meets UL508 (2 x rated V + 1000V for 1 min)
<b>Surge</b>	
<b>Input Power</b>	IEC 61000-4-5, Level 1
<b>Inputs/Data Lines</b>	IEC 61000-4-5, Level 2

#### Safety Marks

<b>UL</b>	UL508 (File #E68520)
<b>CSA</b>	C22.2 (File #46510)
<b>CE</b>	IEC 60947-6-2
<b>Enclosure</b>	Polycarbonate
<b>Dimensions</b>	<b>H</b> 86.36 mm (3.4"); <b>W</b> 25.4 mm (1.0"); <b>D</b> 138.68 mm (5.46")

#### Weight

#### Mounting Methods

0.25 lb. (4 oz., 113.4 g)  
DIN Rail or surface mount (w/two #8 screws)

11 COMMUNICATION MODULES

## COM 4-20

### Communication Link to PLC/SCADA/ Monitoring Systems



### Description

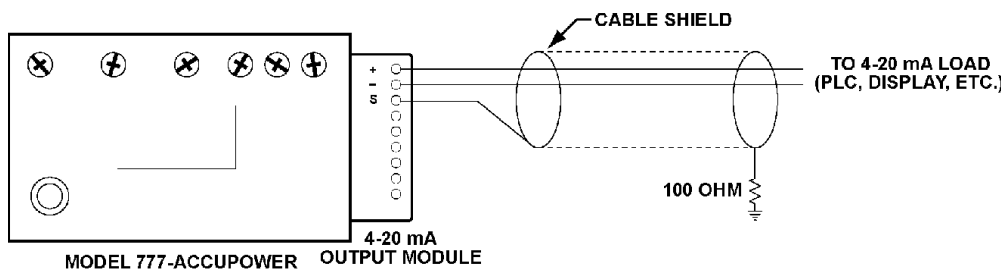
The COM 4-20 Output Module is intended for use with ONLY the Model 777-AccuPower output power monitor. The module will send a 4-20mA signal proportional to the output power. It can also be used to send the input power by setting the efficiency setting on the 777-AccuPower monitor to one. This module allows communication to a PLC with an analog input and no Modbus input.

### Features

- Powered by the 777-AccuPower
- Scalable 4-20mA output proportional to Hp or kW
- Signal can be used for displays, controllers, or PLCs

### Wiring Diagram

4-20mA OUTPUT MODULE



For dimensional drawing see: Appendix, page 507, Figure 2.

### Specifications

#### Output Characteristics

**Current** 4-20mA

#### General Characteristics

**Temperature Range** -20° to 50°C (-4° to 122°F)

**Terminal (depluggable terminal block)**

**Torque** 3 in.-lbs. (max.)

**Wire AWG** 12-20 AWG

**Class of Protection** IP20

**Relative Humidity** 10-95%, non-condensing per IEC 68-2-3

#### Standards Passed

**Electrostatic Discharge** IEC 61000-4-2, Level 3, 6kV contact, 8kV air

#### Radio Frequency

**Immunity, Radiated** 150 MHz, 10V/m

**Fast Transient Burst** IEC 61000-4-4, Level 3, 4kV input power

**Hi-Potential Test** Meets UL508 (2 x rated V + 1000V for 1 min)

#### Surge

**Input Power** IEC 61000-4-5, Level 1

**Inputs/Data Lines** IEC 61000-4-5, Level 2

#### Safety Marks

**UL** UL508 (File #E68520)

**CE** IEC 60947

#### Enclosure

**Dimensions** Polycarbonate

**H** 52.83 mm (2.08"); **W** 73.66 mm (2.9");

**D** 19.56 mm (0.77")

**Weight** 0.25 lb. (4 oz., 113.4 g)

**Mounting Method** #8 screws; mount to side of

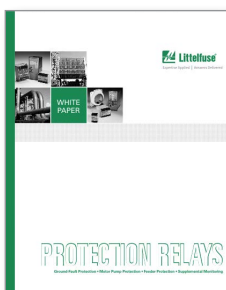
777-AccuPower unit



## OVERVIEW

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**For More Information...**  
and to download our  
Protection Relay Overview, visit  
**[Littelfuse.com/TechnicalCenter](https://www.littelfuse.com/TechnicalCenter)**

**Active Power**—Measured in kW. In a diesel generator application, it is the power produced by the engine.

**Alarm Level**—A setting on a protection relay at which an LED or output contact operates.

**Alarm Relay Contact**—An output of a relay that acts as a switch and is typically connected to a visual or audible alarm.

**Analog Output**—A discrete, continually variable 0-1 mA, 4-20 mA, or 0-5 Vdc signal from a protection relay used to pass information to a device or controller.

**Apparent Power**—The vector sum of the active and reactive power.

**Arc Flash Hazard**—A dangerous condition associated with the possible release of energy caused by an electric arc.

**Arc Flash Risk Assessment**—A study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention and to determine safe work practices, arc flash boundary, and the necessary types of personal protective equipment (PPE).

**Arc Flash Suit**—A complete arc-rated clothing and equipment system covering the entire body, except for hands and feet.

**Arc Flash Boundary**—When an arc flash hazard exists, the boundary is an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur.

**Arc Rating**—The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm<sup>2</sup> and is derived from the determined value of the arc thermal performance value (ATPV) or energy of break open threshold (EBT) (Should a material system exhibit a break open response below the ATPV value). Arc rating is reported as either ATPV or EBT, whichever is the lower value.

**Asynchronous Motor**—A motor in which the speed of the rotor is not the same as the connected system frequency.

**Charging Current**—System charging current is the current that will flow into the grounding connection when one phase of an ungrounded system is faulted to ground. Although not physically connected to ground, electrical conductors and the windings of all components are capacitively connected to ground. Consequently, a small current will flow to ground from each phase. This current does not occur at any particular location; rather, it is distributed throughout the system just as the capacitance to ground is distributed throughout the system.

**Conformal Coating**—A Silicone coating used to protect circuit boards from pollutants, corrosion, mildew, etc.

**Core-Balance Current Transformer**—See Earth-Fault Current Transformer.

**Current Transformer (CT)**—A transformer that produces a current in its secondary circuit in a known proportion to current in its primary circuit.

**CT Verification**—A continuous check of CT continuity to verify connection.

**CT Saturation**—A condition that occurs when a CT cannot maintain a secondary current proportional to a relatively large primary current.

**CT Local Saturation**—A condition where the magnetic flux is not evenly distributed throughout the CT. A resulting secondary current could be induced when no ground fault is present; it may lead to the false operation of a protective relay. This could occur if conductors are not centered in a CT window.

**CT Saturation Compensation**—A feature in which a protective relay can recognize that a CT is saturated and compensate for the condition in order to maintain service.

**Data Logging**—Collecting and storing information in a format that can be reviewed for trending, troubleshooting, and reporting.

**De-energized**—Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth.

**DFT**—See Discrete Fourier Transform.

**Differential Module**—An accessory for the MPU-32 Motor Protection Relay and MPS Motor Protection System to add phase-differential protection.

**Digital Harmonic Filter**—The use of digital signal-processing techniques such as a discrete Fourier Transform to eliminate the measurement of harmonic components. With regard to ground-fault detection, this allows for a setting below the background noise level.

**Discrete Fourier Transform**—A mathematical algorithm used to extract a single frequency, such as the fundamental frequency, from a signal.

**Earth Leakage**—See Leakage Current.

**Earth-Fault Current Transformer**—A current transformer used to measure low-level ground-fault current.

**Electrical Hazard**—A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or blast.

**Electrical Safety**—Recognizing hazards associated with the use of electrical energy and taking precautions so hazards do not cause injury or death.

**Electrically Safe Work Condition**—An electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary.

**Fail-Safe Mode (also known as Undervoltage or UV)**—An output relay is energized during normal (not tripped) operation. If the protection relay loses supply voltage, the system will trip or alarm. (Also see Non-Fail-Safe.)

**Fault Current**—A current that flows when a phase conductor is faulted to another phase or ground.

**Feeder**—All circuit conductors between the service equipment or other power-supply source and the load or branch-circuit overcurrent device.

**Feeder Protection**—Overcurrent or overvoltage devices installed on a feeder circuit to interrupt the supply in the event of a fault.

**Flux Conditioner**—A ring of magnetically permeable material inserted in an earth-fault current transformer window; used to reduce local saturation.

**Fundamental Frequency**—In an alternating-current power system, the frequency of the generated voltage. In North America this is typically 60 Hz (60 cycles per second).

**Ground Check Conductor**—An insulated conductor in a trailing cable used to assist in monitoring continuity of the ground conductor. Typically designed to be the smallest conductor, it is the first to break connection when cable couplers are disconnected.

**Ground-Check Loop**—A circuit that includes a ground-check conductor, a ground-check termination device, and a ground conductor.

**Ground-Check Termination**—A device installed at the load end of a ground-check loop.

**Ground-Continuity Monitor**—A protection relay that continuously monitors a ground-check loop and trips if the loop opens or shorts.

**Ground Fault**—An unintentional contact between a phase conductor and ground or equipment frame. The words “ground” and “earth” are used interchangeably.

**Ground-Fault Current**—A current that returns to the supply neutral through a ground-fault and ground-return path.

**Ground-Fault Current Transformer**—See **Earth-Fault Current Transformer**.

**Ground-Fault Relay**—A protection relay designed to detect a phase-to-ground fault on a system and trip or alarm when the condition exceeds its pickup setting for longer than its time delay.

**Ground-Fault Protection**—The use of a ground-fault relay or indication system in order to interrupt the supply or alarm personnel in the event of a ground fault.

**Ground Reference Module**—A resistor network that limits ground-fault current and provides a system reference for a DC ground-fault relay.

**Harmonic Filter**—A device or method to remove or ignore non-fundamental frequency components of a signal.

**Harmonic Frequency**—Harmonic-frequency components (voltage and current) are multiples of the fundamental frequency and, in a power system, can be considered noise. Harmonic-frequency components are often present with the use of adjustable-speed drives.

**High-Resistance Grounding**—Using a neutral-grounding resistor to limit the current to a low level. Typically, High-Resistance Grounding limits ground-fault current to 25 A or lower. (Also see **Low-Resistance Grounding**.)

**High Tension Coupler**—An accessory used to isolate system voltage from a protective relay.

**$I^2t$  (I squared t)**—Thermal capacity, or used thermal capacity. With regard to motor protection, thermal capacity is used to measure and describe motor heating in terms of current (I). This method is more accurate than temperature sensing because of temperature-sensor placement and the time delay inherent in temperature measurement.

**IEEE Device Numbers**—The devices in switching equipment are referred to by numbers, according to the functions they perform. These numbers are based on a system which has been adopted as standard for automatic switchgear by the IEEE. This numbering system is used on connection diagrams, in instruction literature, and in specifications.

**Incident Energy**—The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the units used to measure incident energy is calories per centimeter squared (cal/cm<sup>2</sup>).

**Incident Energy Analysis**—Used to predict the incident energy of an arc flash for a specified set of conditions.

**Insulation Monitoring**—Monitoring the resistance from phase to ground to detect insulation breakdown on a system.

**Insulation Resistance**—A measurement of the ability of an insulator, such as a cable jacket, to prevent current flow when a voltage is applied; typically measured in megaohms (MΩ). Insulation resistance change can be monitored to predict failure.

**Inverse-Time Overcurrent Protection**—A method by which time-to-trip of a protective device, such as an overcurrent or ground-fault relay, decreases as the magnitude of the fault increases.

**Leakage Current**—Low-level ground-fault current, typically measured in milliamperes (mA).

**Low-Resistance Grounding**—A Resistance-Grounding System that allows high currents to flow during a ground fault. Typically, 100 A and higher is considered Low-Resistance Grounding. (Also see **High-Resistance Grounding**.)

**LSIG Protection**—An acronym for **L**ong-time, **S**hort-time, **I**ntermediate overcurrent, and **G**round-fault protection; a term often used to describe protection required for a power-distribution feeder, or a protection relay with these functions.

**Motor Protection**—Technology designed to ensure that a motor operates within its rated thermal capacity in order to maximize its service life.

**Neutral-Grounding Resistor (NGR)**—A current-limiting resistor connecting the power-system neutral to ground.

**N.C. Contact (Normally Closed Contact)**—A relay contact that is closed when the relay is not energized.

**N.O. Contact (Normally Open Contact)**—A relay contact that is open when the relay is not energized.

**Non-Fail-Safe Mode (also known as Shunt Trip or SH)**—An output relay is energized and contacts change state when a trip occurs. If the protective device loses supply voltage, the system can continue to operate but will not be protected. (Also see **Fail-Safe Mode**.)

**Non-Volatile Memory**—Data is retained when power is removed.

**Nuisance Trip**—A false operation of a protective relay.

**Phase Current**—Current present in a phase conductor.

**Phase-Current Transformer**—A current transformer installed so that current from one phase conductor flows in its primary winding. With regard to motor protection, feeder protection, and metering in a three-phase system, three current transformers are typically used to measure phase currents.

**Phase-Differential Protection**—Protection designed to detect low-level winding-to-winding and winding-to-ground failures in an AC motor.

**Phase Voltage**—The voltage measured between a phase conductor and ground, or another phase.

**Power factor (cos $\phi$ )**—The relation between the active power [kW] and apparent power [kVA].

**Primary Rating (for CTs)**—The current rating of the primary side of a current transformer. For example, the first number in the ratio 500:5 is the primary rating. 500 A of primary current flowing through the CT will produce 5 A of current out of the secondary terminals.

**Pulsing Ground-Fault Systems**—Modulating the ground-fault current on a resistance-grounded system using a contactor to short out part of the NGR elements (or to open one of two NGRs connected in parallel). This technique is used to locate ground faults by tracing the pulsing ground-fault current to the source of the fault.

**Online or Offline Monitoring**—Monitoring system parameters such as insulation integrity when the system is energized or de-energized, respectively.

**Open-CT Hazard**—An open-circuited CT secondary which can develop a dangerously high voltage when primary current is present.

**Reactive Power**—Measured in kVAR. The power used for magnetization of asynchronous alternators, motors and transformers, coils etc. The amount of reactive power has no effect on the torque of the prime mover (e.g. diesel engine). Therefore the reactive power has no effect on the engine. It is however very important for the alternator, as the total load on the alternator is the vector sum of active and reactive load.

**Relay (1)**—An electrical switch that opens and closes a contact (or contacts) under the control of another circuit. Typically an electromagnet.

**Relay (2)**—A device that receives inputs, compares them to set points, and provides outputs based upon that comparison.

**Relay Operating Mode**—Method of operation used for undervoltage or shunt-trip breakers. (Also see **Fail-Safe Mode**, **Non-Fail-Safe Mode**.)

**Resistance-Grounded System**—An electrical system in which the transformer or generator neutral is connected to ground through a current-limiting resistor. (Also see **Solidly Grounded System**, **Ungrounded System**.)

**Reverse Power**—An active power [kW] fed into a generator that thus is working as an electric motor, turning the prime mover. As this would damage the prime mover (e.g. an internal combustion engine), reverse power relays are used in applications where generators run in parallel with each other or with the utility. These relays detect the amount and direction of the power, and in case of excessive reverse power, disconnect the generator breaker.

**Ride-Through Time**—The amount of time a protection relay can maintain operation during a supply voltage loss.

**RTD (Resistance Temperature Detector)**—A device that experiences a linear change in resistance with a change in temperature. It is used to provide temperature metering. Common RTDs are 100  $\Omega$  platinum, 100  $\Omega$  nickel, 120  $\Omega$  nickel, and 10  $\Omega$  copper.

**Sensitive Ground-Fault Protection**—Protection designed to accurately detect low-level ground-fault current.

**Shock Hazard**—A dangerous condition associated with possible release of energy caused by contact or approach to energized electrical conductors or circuit parts.

**Solidly Grounded System**—An electrical system in which the neutral point of a wye-connected supply transformer is connected directly to ground. (Also see **Resistance-Grounded System**, **Ungrounded System**.)

**Switchgear, Arc-Resistant**—Equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee.

**Time Delay**—A setting on a protection relay that determines the time between the fault detection and relay operation.

**Trailing Cable**—A power cable used to supply electrical power to mobile equipment. They typically contain three phase conductors, two ground conductors, and a pilot wire (also known as a ground-check conductor).

**Trip Level**—A setting on a protection relay at which an LED or output contact operates.

**Trip Relay Contact**—An output of a relay that acts as a switch and is typically connected to an undervoltage-release or shunt-trip coil of a circuit breaker.

**Trip State**—The state of the output contact during a relay trip.

**True RMS**—“Root-Mean-Square” calculation used to derive an average current or voltage value in a waveform.

**Ungrounded System**—An electrical system in which no point of the system is intentionally grounded, such as a delta-connected supply transformer.

**Zero-Sequence Current Transformer**—See **Earth-Fault Current Transformer**.

## I. INTRO TO PROTECTION RELAYS

### What is a protection relay?

- Inputs and Settings
- Processes
- Outputs

### How do protection relays solve electrical problems?

- Stage 1 – Early stages of a failure
- Stage 2 – During a failure
- Stage 3 – After a failure

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## I. INTRODUCTION TO PROTECTION RELAYS

### What is a Protection Relay?

A protection relay is a smart device that receives inputs, compares them to set points, and provides outputs. Inputs can include current, voltage, resistance, or temperature. Outputs can include visual feedback in the form of indicator lights and/or an alphanumeric display, communications, control warnings, alarms, and turning power off and on. A diagram is shown below.

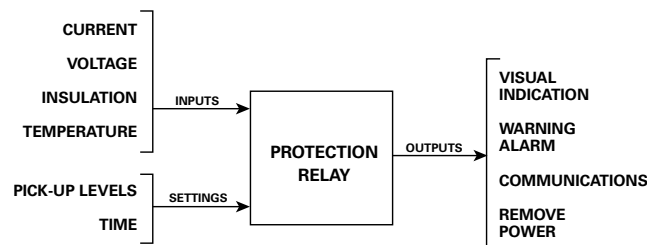


FIGURE 1

Protection relays can be either electromechanical or electronic/microprocessor-based. Electromechanical relays consist of mechanical parts that require routine calibration to stay within intended tolerances. Microprocessor-based or electronic relays provide quick, reliable, accurate, and repeatable outputs. Using an electronic or microprocessor-based relay instead of an electromechanical design provides numerous advantages including improved accuracy, additional functions, reduced maintenance, smaller space requirements and lower life-cycle costs.

### Inputs

A relay needs information from the system to make a decision. These inputs can be collected in a variety of ways. In some cases, the wires in the field can be connected directly to the relay. In other applications, additional devices are needed to convert the measured parameters to a format that the relay can process. These additional devices can be current transformers, potential transformers, high-tension couplers, RTDs, or other devices.

### Settings

Many protection relays have adjustable settings. The user selects settings (pick-up levels) that allow the relay to make a decision. The relay compares the inputs to these settings and responds accordingly.

### Processes

Once the inputs are connected and the settings are made, the relay compares these values and makes a decision. Depending on the need, different types of relays are available for different functions.



### Outputs

A relay can have several ways of communicating that a decision has been made. Typically the relay will operate a switch (relay contact) to indicate that an input has surpassed a setting, or the relay can provide notification through visual feedback such as a meter or LED. One advantage of many electronic or microprocessor-based relays is an ability to communicate with a network or a PLC.

As an example, a thermostat can be evaluated using the diagram in *Figure 1*. The input that is measured is temperature and the input device is the temperature sensor. The user sets the desired temperature setting (pick-up level). The relay measures the existing air temperature and compares it to the setting. The outputs can be used to provide controls (turning an air conditioner or furnace on and off) and visual indication on the thermostat display.

### How Do Protection Relays Solve Electrical Problems?

Similar to how the thermostat solves the problem of automating the control of the air conditioner or furnace in a home, protection relays can solve electrical problems.

The purpose of the protection relay is to detect a problem, ideally during its initial stage, and to either eliminate or significantly reduce damage to personnel and/or equipment.

The following stages illustrate how an electrical problem develops:

**Stage 1:** When conductors with good insulation are exposed to fault initiators such as moisture, dust, chemicals, persistent overloading, vibration or just normal wear, the insulation will slowly deteriorate. Such small changes will not be immediately obvious until the damage is severe enough to cause an electrical fault. Relays can detect that a problem is developing by identifying slight deviations in current, voltage, resistance, or temperature. Due to the small magnitude in change, only a sophisticated device such as a sensitive protection relay or a monitor can detect these conditions and indicate that a problem may be developing, before any further damage occurs.

**Stage 2:** As the problem becomes more severe, further changes take place such as insulation breakdown, overheating, or overvoltage. Since the change from normal to abnormal is great, traditional devices can be used to interrupt power. Protection relays can also be used to provide additional protection by detecting the fault contributors (overheating, overvoltage, etc.) not possible with fuses and circuit breakers.

**Stage 3:** At this point, the problem has occurred and caused damage. Different types of protection relays and monitors can reduce or eliminate damage because they detect problems in advance of traditional devices.

As an example, if a facility is continually resetting circuit breakers, replacing fuses, or repairing equipment and cannot locate the problem, they may be experiencing overcurrents. If this is the case, the user can install a protection relay that has

an overcurrent feature. The relay measures the current (input) and allows the user to program limits (settings). The settings typically are more sensitive than the fuses or circuit breakers. Once these limits are exceeded, the relay will operate an internal switch (relay contacts). The user has the option to use the switch to turn on a light (alarm indication) or remove power (trip) before greater problems occur. The user can use the alarm indication to help identify the faulty equipment prior to the traditional fuse or circuit breaker clearing the fault.

## II. RELAY APPLICATION

### Ground-Fault Protection

The primary purpose of grounding electrical systems is to provide protection against electrical faults. However, this was not common practice until the 1970's. Until then, most commercial and industrial systems were ungrounded. Although ungrounded systems do not cause significant damage during the first ground fault, the numerous disadvantages associated with ground faults resulted in a change to the grounding philosophy. There are other advantages for a grounded system, such as reduction of shock hazards and protection against lightning.

Electrical faults can be divided into two categories: phase-to-phase faults and ground faults. Studies have shown that 98% of all electrical faults are ground faults (Source: Woodham, Jack, P.E. "The Basics of Grounding Systems" May 1, 2003 <[http://www.ecmweb.com/mag/electric\\_basics\\_grounding\\_systems\\_2/index.html](http://www.ecmweb.com/mag/electric_basics_grounding_systems_2/index.html)>). While fuses can protect against phase-to-phase faults, additional protection, such as protection relays, are typically required to protect against ground faults.

#### Definition of Ground Fault

A ground fault is an inadvertent contact between an energized conductor and ground or the equipment frame. The return path of the fault current is through the grounding system and any equipment or personnel that becomes part of that system. Ground faults are frequently the result of insulation breakdown. It's important to note that damp, wet, and dusty environments require extra diligence in design and maintenance. Since contaminated water is conductive, it exposes degradation of insulation and increases the potential for hazards to develop.

Table 1 shows the leading initiators of electrical faults.

LEADING INITIATORS OF FAULTS	% OF ALL FAULTS
Exposure to moisture	22.5%
Shorting by tools, rodents, etc.	18.0%
Exposure to dust	14.5%
Other mechanical damage	12.1%
Exposure to chemicals	9.0%
Normal deterioration from age	7.0%

TABLE 1

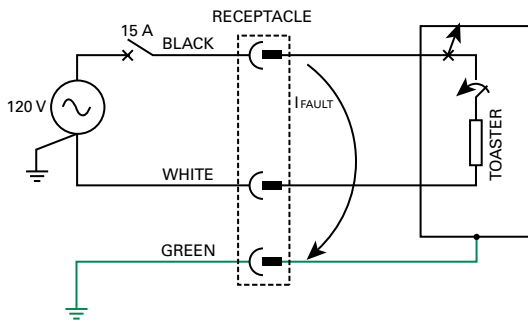


FIGURE 2

As an example, in the toaster circuit above, the black or hot wire is shorted to the metal casing of the toaster. When the circuit closes, all or part of the current is channeled through the toaster frame and then through the green ground wire. When sufficient current flows (typically  $6 \times 15 \text{ A} = 90 \text{ A}$ ), the circuit breaker will open. A protection relay could be installed to detect currents as low as 10 mA, which would open the circuit breaker at a significantly lower level, hence, much quicker than the traditional circuit breaker.

Although the example above shows a solidly grounded single-phase circuit, the philosophy is the same on three-phase circuits discussed later. Relays and monitors are specifically designed to look for the leading initiators shown in *Table 1* by detecting low-level changes in current, voltage, resistance or temperature.

### DC Systems

Direct current (DC) systems have positive and negative buses. If either bus is intentionally grounded, then it is referred to as a grounded system. If neither bus is grounded, then it is referred to as an ungrounded DC system. A ground fault on a DC system may cause damage to the source as well as in the field.

If the system is ungrounded, then it is possible to use a ground-fault relay by installing a ground-reference module between the two buses to establish a neutral point (see *Figure 3*). The ground-fault relay uses this neutral point as a reference to detect low-level ground faults.

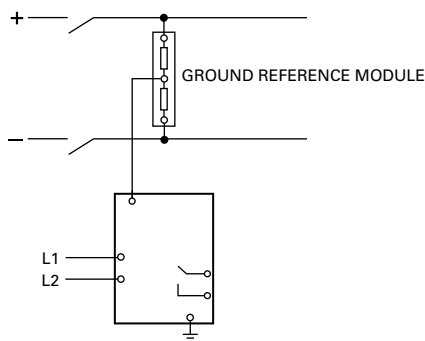


FIGURE 3

### Ungrounded AC Systems

Ungrounded AC systems, as shown in *Figure 4*, were used where continuity of power was critical. For example, chemical plants or refineries involving processes that cannot be interrupted without extensive dollar or product loss may have an ungrounded system. However, experience has proven that these systems are problematic and are being replaced with resistance grounded systems. Two major problems with ungrounded systems are transient overvoltages and difficulty locating ground faults.

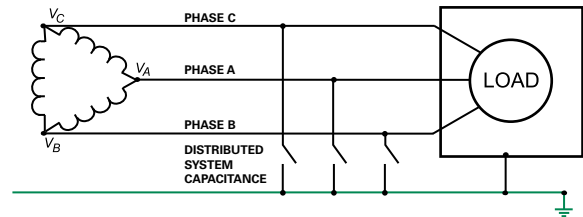


FIGURE 4

- An ungrounded system has no point in the system that is intentionally grounded (other than the normal bonding which is always present to connect the non-current-carrying metal parts to ground). Grounding occurs only through system capacitance to ground (as shown in *Figure 4*).
- Continuity of operation occurs because the system can operate with one phase faulted to ground.
- An intermittent or arcing fault can produce high transient overvoltages to ground. These voltages are impressed on the phase conductors throughout the system until the insulation at the weakest point breaks down. This breakdown can occur at any point in the electrical system, causing a phase-to-ground-to-phase fault.
- Although a ground fault can be detected or alarmed on the system, it is difficult to determine the location of the fault.

There are two methods used to detect ground faults on ungrounded systems. One method is to monitor the voltages between the phases and ground. As a ground fault develops, the faulted phase will collapse to ground potential, causing an indicator light to dim. The indicator lights on the unfaulded phases become brighter.

A second method to detect a ground fault is to measure the insulation resistance. As the insulation deteriorates, a relay continuously monitoring the insulation resistance can alarm at different levels for predictive maintenance. A visual indicator or meter can also be used.



### Solidly Grounded Systems

Due to the problem of ungrounded systems, a shift in philosophy occurred and designs moved from ungrounded to grounded systems. In most cases, the type of grounding system chosen was solidly grounded. A solidly grounded system is a system of conductors in which at least one conductor or point is intentionally grounded (usually the neutral point of transformer or generator windings). The problem with the direct connection is that ground-fault current can be excessive, causing Arc-Flash hazards, extensive equipment damage, and possible injury to personnel. A solidly grounded system cannot continue to operate with a ground fault.

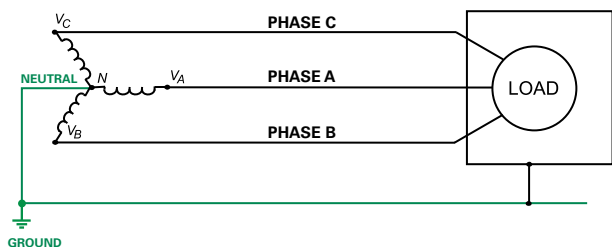


FIGURE 5

- In a solidly grounded system, the wye point (or neutral) of the power source is connected solidly to ground and offers a very stable system that maintains a fixed phase-to-ground voltage.
- The high ground-fault current is easy to detect with fuses, circuit breakers, or protection relays, allowing for selective tripping (tripping the faulted feeder and not the main feeder).
- When a ground fault occurs, high point-of-fault damage can quickly result since the energy available to the ground fault is only limited by the system impedance (which is typically very low).
- Due to excessive ground-fault current and Arc-Flash Hazards, the faulted feeder must be removed from service. This does not allow for continuous operation during a ground fault.

Figure 6 illustrates an example of the dangers associated with solidly grounded systems. In this example, a ground fault occurs and the overcurrent protection is set at 600 A.

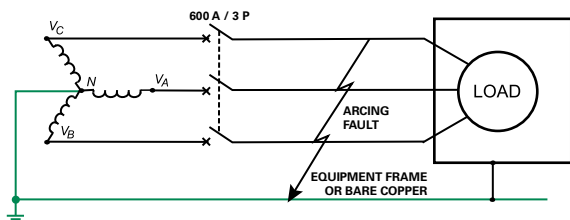


FIGURE 6

Assume that this ground-fault is not a bolted fault, but an arcing fault due to an insulation breakdown or a partial reduction of clearances between the line and ground.

- Because of the arc resistance, fault current may be as low as 38% of the bolted-fault level. This can be in the range of a normal load or a slight overload.
- The fault current may be low enough that the overcurrent device (600-A circuit breaker) does not sense a fault, or may pick it up but not trip for a long time.
- The energy being supplied by the source is concentrated at the arc and could cause severe equipment damage very quickly. This energy release could cause a fire that in turn, could damage the premises and present an extreme hazard to personnel.

Aside from converting this solidly grounded system to resistance grounding, the best way to prevent damage is to detect low-level ground leakage prior to it becoming a ground fault. In order to accomplish this, the protection relay must be able to sense a low-level ground leakage without nuisance tripping.

In modern facilities, equipment often generates noise or harmonics that can interfere with a protection relay's ability to function properly. For example, the noise or harmonics may be higher than the desired ground-fault relay settings, causing the relay to falsely operate when there is no fault on the system. The protection relay must be able to filter out noise or harmonics to provide reliable protection.

### Resistance-Grounded Systems

Resistance grounding solves the problems commonly associated with both ungrounded systems and solidly grounded systems. The name is derived from the addition of a resistor between the system neutral and ground (as shown in Figure 7). The specifications of the resistor are user-determined to achieve a desired ground-fault current, which must be greater than the system capacitive charging current (explained later in this section).

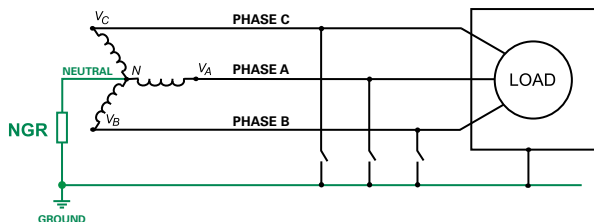


FIGURE 7

- Transient overvoltages can be eliminated by correctly sizing the neutral-grounding resistor (NGR) to provide an adequate discharge path for the system capacitance.
- Continuity of operation with one ground fault is typically allowable when ground-fault current is  $\leq 10$  A.
- The NGR limits the available ground-fault current. This eliminates or minimizes point-of-fault damage (Arc-Flash Hazards) and controls the ground-fault voltage.
- Pulsing current can be used to locate ground faults when ground-fault current is  $\leq 10$  A. Pulsing current is created by using a shorting contactor to short out half of the resistance, causing the ground-fault current to double (usually one cycle per second). A hand-held zero-sequence meter is used to detect the fluctuating ground-fault current, and locate the ground fault.
- The only disadvantage of resistance grounding is that if the resistor fails, the system will become ungrounded. Resistor monitoring is recommended to protect against this.

A protection relay for resistance-grounded systems is used to detect a ground fault and to monitor the neutral-to-ground connection. It can be used to provide alarms or to trip the feeder from service upon the detection of a ground fault. The relay can provide a pulsing circuit that can be used to locate the ground fault. The relay can also alarm or trip if the neutral-to-ground path fails. For systems 5 kV and less, high-resistance grounding can be used. High-resistance grounding typically limits the resistor current to 10 A or less. By doing so, the ground fault can remain on the system, given that the system is rated for the voltage shift.

For systems above 5 kV, neutral-grounding resistors are typically rated for 25 A or more, and ground-fault current is cleared within 10 s.

### System Capacitive Charging Current

Although not physically connected to ground, electrical conductors and the windings of all components are capacitively connected to ground. Consequently, a small current will flow to ground from each phase. This current does not occur at any particular location; rather, it is distributed throughout the system just as the capacitance to ground is distributed throughout the system. For analysis, it is convenient to consider the distributed capacitance as lumped capacitance, as shown in Figures 5, 6, 7, and 8.

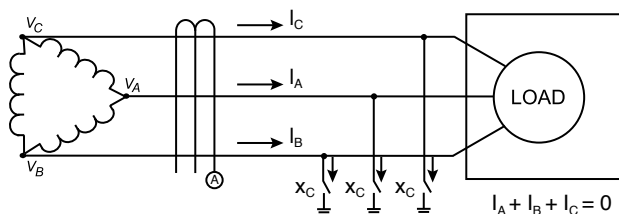


FIGURE 8

Even if the distributed capacitance is not balanced, the ammeter will read zero because all the current flowing through the CT window must return through the CT window.

System charging current is the current that will flow into the grounding connection when one phase of an ungrounded system is faulted to ground (see Figure 9). It can be measured as shown below if appropriate precautions are taken:

- If the fault occurs on the supply side of the CT, the sum of the currents in the CT window is not zero.
- Ammeter A will read the sum of the capacitive currents in the unfaulted phases. This value is the charging current of all the equipment on the load side of the CT.

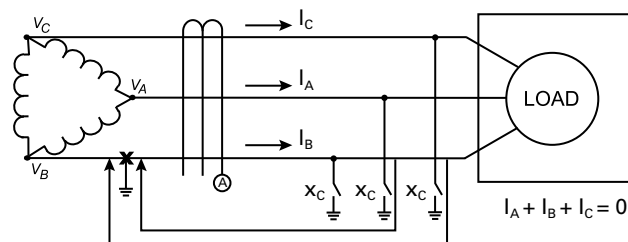


FIGURE 9

A single-line diagram of a three-feeder, resistance-grounded system with a fault on feeder 3 is shown in Figure 10.

- A CT (A1 and A2) on unfaulted feeders will detect the charging current of that feeder.
- A CT (A3) on a faulted feeder will detect the sum of the resistor current ( $I_R$ ) and the charging currents ( $I_1 + I_2$ ) of the unfaulted feeders.

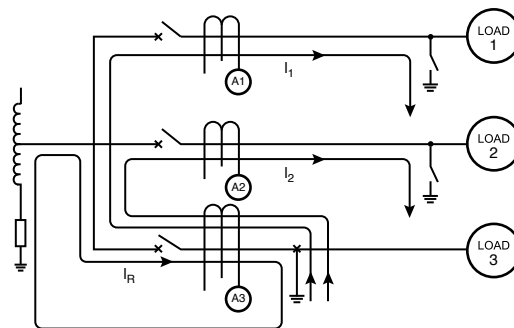


FIGURE 10

Selective coordination in a resistance-grounded system can be achieved if the pick-up setting of each ground-fault relay is greater than the charging current of the feeder it is protecting. If the pick-up setting of a ground-fault relay is less than the charging current of the feeder it is protecting, it will trip when a ground fault occurs elsewhere in the system. This is known as sympathetic tripping. Sympathetic tripping can be avoided by choosing a relay pickup setting larger than the charging current from the largest feeder. If the relative size of the feeders can change, or if the advantage of using one operating value for all ground-fault relays in a system is recognized, then it is prudent to select a pick-up setting for all ground-fault relays that is larger than the system charging current.

In order to eliminate transient overvoltages associated with an ungrounded system, it is necessary to use a grounding resistor with a let-through current equal to or larger than the system charging current.

What is the minimum acceptable NGR current? Select a pick-up setting for the ground-fault relays that exceeds the largest feeder charging current and multiply the operating value by an acceptable tripping ratio. Use the greater of this value or system charging current and select the next-largest available standard let-through current rating.

### Resistor Monitors

As discussed in the resistance-grounded systems section, a failure in the neutral-to-ground path will lead to a dangerous situation. Some examples of failure are stolen wires, loose connections, corrosion, and broken resistor elements. The resistor monitor continuously monitors the path from system neutral to ground for a problem. When a problem occurs, the monitor provides an alarm.

### Ground-Continuity Monitors

Ground-check monitors are used to detect problems in equipment ground conductors. The cable powering mobile equipment typically has an extra wire, or pilot wire, routed with the phase conductors. A monitor uses this pilot wire to send a signal to a terminating device in the equipment, where the signal is sent back on the cable ground conductor to the monitor. The monitor continuously monitors this loop for open or short circuits, indicating that a problem has occurred. The monitor provides an alarm for this condition.

As an example, portable loads are grounded via single or multiple conductors in a trailing cable. A ground fault on a portable load will cause fault current to flow through the ground conductors and all other ground-return paths. A hazardous touch voltage can develop when the ground conductor opens and a ground fault develops, assuming there is not enough current to trip a ground-fault relay. If the portable equipment has rubber tires or is not in good contact with earth, then a person who touches the equipment under fault conditions will become part of the ground-return path.

## Motor Protection

### Overview

Motors are a significant investment and often run critical processes. Motor protection relays are used to protect the windings from damage due to electrical faults and thermal overloads. Adequate motor protection not only prevents motor damage, but also ensures optimal process efficiency and minimal interruption. Cost recovery for protection is achieved by extending the life of the motor, preventing motor rewinds and reducing downtime.

### Common Motor Problems

#### Overload and Overtemperature

Insulation breakdown is a common reason for motor failure. Windings in the motor are insulated with organic materials including epoxy and paper. Insulation degradation occurs when winding temperature exceeds its rating. The National Electrical Manufacturers Association (NEMA) states that the time-to-failure of organic insulation is halved for each 8 to 10°C rise above the motor insulation-class rating. This point is illustrated in *Figure 11*.

**Solution:** An I<sup>2</sup>t Thermal Model provides thermal-overload protection of motor windings during all phases of operation. By integrating the square of the current over time, a thermal model can predict motor temperature and react much quicker than embedded temperature devices. A thermal model takes into consideration the motor service factor, full-load current and class. A dynamic thermal model adjusts the time-to-trip depending on how much motor thermal capacity has been used. *Figure 12* illustrates the adjustment in trip time for different current levels at different levels of used thermal capacity (I<sup>2</sup>t).

A dynamic thermal model allows accurate protection of a motor and allows operations to get the maximum work out of a motor without sacrificing available life. If the motor is hot (high % used thermal capacity) it will trip more rapidly during an overload than if the motor is cold (0% used thermal capacity). In the event of a stall condition, when available motor torque is lower than the torque required by the load, the motor can be de-energized before it overheats.

Many old-technology electronic thermal overloads do not take into consideration the values of load current below the full-load current (FLA) pick-up value. Modern overload relays should model currents above and below the FLA pick-up current to achieve maximum output of the motor and maximum life of insulation.

On larger induction motors, blockage or loss of ventilation can cause motor hot spots that current-based protection cannot detect without the use of temperature sensors. Resistance temperature detectors (RTDs) are inexpensive devices installed between the stator windings during manufacturing and may be included on motor-end bearings.

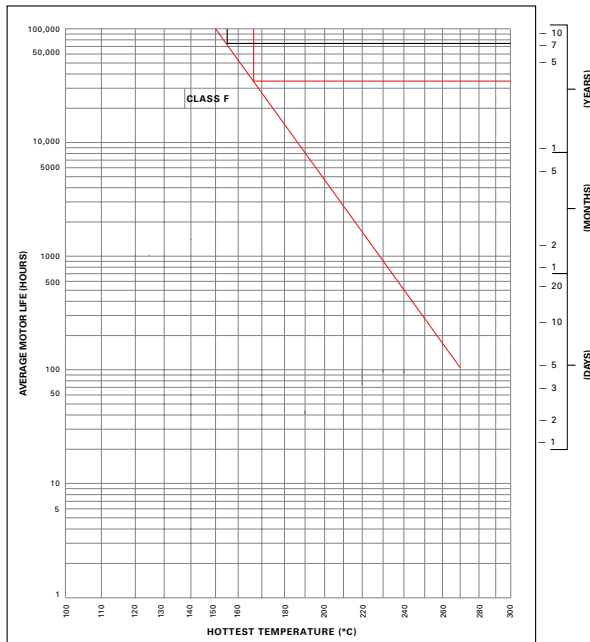


FIGURE 11

An RTD has a linear change in resistance over its rated temperature range. Using information from an RTD, motor-protection relays can provide protection for loss-of-ventilation, loss-of-cooling, or high-ambient-temperature.

The RTD temperature reading can also be used as an input to the thermal model to improve protection. When hot-motor compensation is enabled, the maximum stator-RTD temperature is used to bias the thermal model by increasing used  $I^2t$  when the RTD temperature is greater than the thermal-model temperature.

### Overcurrent, Jam and Undercurrent

Overcurrent faults, also referred to as short circuits, can cause catastrophic motor failures and fires. Overcurrents can be caused by phase-to-phase, phase-to-ground, and phase-to-ground-to-phase faults.

A mechanical jam, such as a failed bearing or load, can cause stalling and locked-rotor current to be drawn by the motor, resulting in overheating.

Undercurrent protection is loss-of-load protection and is required by some codes as a safety measure. A water pump that cavitates can be dangerous. The water typically provides pump cooling. Without the cooling water, case temperature can reach an extremely high value. If valves are opened under these conditions and cold water is allowed to reach red-hot metal parts, the resulting steam pressures can destroy the pump and pose a serious personnel hazard.

**Solution:** A multifunction motor protection relay has multiple trip and alarm settings for current protection. Overcurrent protection is typically set above locked rotor current and has a minimal delay time. Overcurrent protection may be used to

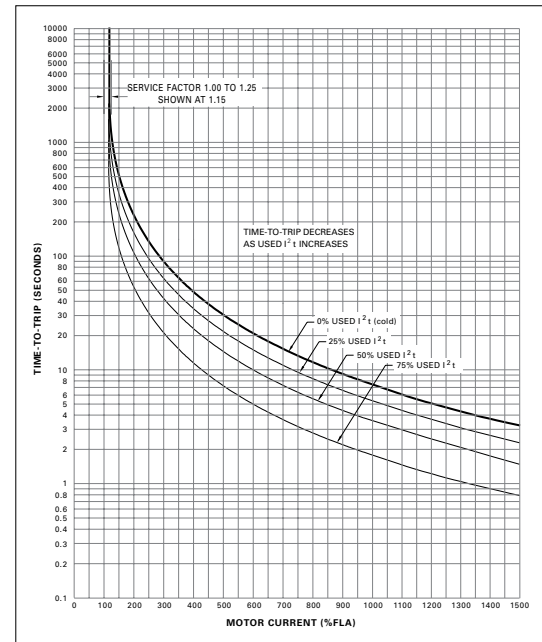


FIGURE 12

trip a breaker instead of a starter due to the high fault levels. Jam protection is set below overcurrent and has a slightly longer delay time. Jam protection prevents motor heating that would otherwise lead to an overload trip. Jam protection is enabled after the motor is running to avoid tripping on starting current. Undercurrent is set below full-load current to detect loss of load.

### Under and Overvoltage

Overvoltages cause insulation stress and premature breakdown. Undervoltages, such as those caused by brownouts, can lead to increased motor heating. Torque developed by an electric motor changes as the square of the applied voltage. A 10% reduction in voltage results in a 19% reduction in torque. If the motor load is not reduced, the motor will be overloaded.

**Solution:** Under and overvoltage protection are features found in higher-end motor protection relays. Voltage protection can be used pro-actively to inhibit a start.

### Ground Faults

Ground faults are the most common fault and can lead to more serious problems. Ground-fault protection, described elsewhere in this text, is an important consideration in motor loads.

**Solution:** The motor protection relay should be able to detect low-level ground-fault current when used on a resistance-grounded system.

### High-Resistance Winding Faults

Winding-to-winding and winding-to-ground failures inside the motor are difficult to detect using the phase and ground-fault CTs due to low magnitudes of current.

**Solution:** Differential protection in high-end motor protection relays use multiple CTs to compare the current entering and leaving the winding. If there is a difference in currents then leakage is occurring. This sensitive protection is used on very large or critical motors.

### Current and Voltage Imbalance, Phase Loss, Phase Reverse

Older motor protection devices did not consider current imbalance and today it is often overlooked. Imbalance increases negative-sequence current which causes additional rotor heating.

Phase loss is also referred to as single phasing. When a phase loss occurs, negative-sequence current is equal to the positive-sequence current and imbalance is 100%. In this condition, one motor winding attempts to do the work of three, inevitably leading to overheating.

Phase reversal causes the negative-sequence current and voltage to be greater than the positive-sequence current and voltage. Voltage-based protection is advantageous to prevent a start with incorrect sequence. In some applications attempting to spin the motor backwards will result in damage to the load. An example of this is certain impeller designs in downhole pumps.

**Solution:** Modern motor protection relays use digital signal analysis to measure true-sequence components. These sequence components are used for thermal model calculations and take the extra heating into consideration. Voltage imbalance which drives current imbalance can be used as a start inhibit. Sequence components are also used for calculating imbalance, phase loss and phase reversal.

### Motor Jogging

NEMA-designed motors are rated for two starts from cold and one start from hot per hour. Motor jogging refers to excessive starts and can cause overheating. The motor may not get up to full speed and the forced air cooling is not effective.

**Solution:** Since the thermal model accurately tracks the motor's used thermal capacity at all times, including during starts and between starts, the starts-per-hour feature may not be required.

It is included for compatibility with protection relays that do not have dynamic thermal-modeling capability.

### Motor Protection and the NEC

The NEC® requires the motor to be protected by overload devices against excessive heating due to overload and failure to start (Article 430 Section III). Article 430, Section IV also specifies the use of devices to protect against overcurrents such as short circuits and grounds. Both of these NEC® requirements and many additional functions can be met with the use of a multifunction motor protection relay.

Article 430.32 (A)(4) requires the use of a protection device having embedded temperature detectors that cause current to the motor to be interrupted when the motor attains a temperature rise greater than marked on the nameplate in an ambient temperature of 40°C for motors larger than 1500 hp.

The NEC defines minimum requirements and is intended to provide protection from fire. Protection relays can provide many enhancements above simple fire protection.

### Communications

Network communications can be added to a motor protection relay to allow remote metering of currents, voltages and temperatures. Data logging is a useful feature for troubleshooting and comparing event sequences with process stages. Analysis of information can often show operational issues.

## Arc-Flash Protection

### The Consequences of Arc Flash

Arcing and arc flashes are uncontrolled, intense, luminous discharges of electrical energy that occur when electric current flows across what is normally an insulating medium. The most common cause of arc faults is insulation failure. These failures may be caused by defective or aging insulation material, poor or incorrect maintenance, dust, moisture, vermin, and human error (touching a test probe to the wrong surface or a tool slipping and touching live conductors).

Arc-Flash events are dangerous, and potentially fatal, to personnel. According to OSHA, industrial Arc-Flash events cause about 80% of electrically-related accidents and fatalities among qualified electrical workers. Even if personnel injuries are avoided, Arc Flash can destroy equipment, resulting in costly replacement and downtime.

### Arc-Flash Safety Standards

NFPA 70E, Handbook for Electrical Safety in the Workplace, outlines the practices and standards that companies should follow to protect workers and equipment from Arc Flash and other electrical hazards. It specifies practices designed to make sure that an electrically safe work condition exists. In Canada, CSA Z462, Workplace electrical safety, specifies safe workplace practices. There are also various provincial regulations pertaining to electrical safety.

The NFPA 70E and the CSA Z462 hold both employers and their employees responsible for creating a workplace for electrical workers that is not just safe but puts in place the best possible processes and procedures that are fully understood, practiced and enforced for optimal results. Using Arc-Flash relays is one way to protect the functional reliability of the distribution board and at the same time comply with the requirements of NFPA 70E and CSA Z462.



### Arc-Flash Mitigation

NFPA 70E goes into great detail on procedures to avoid electrical shock and Arc-Flash events. Sometimes, though, it's necessary to work on live circuits. For these cases, NFPA 70E specifies approach distances and use of personal protection equipment (PPE).

Current limiting fuses or current-limiting circuit breakers help protect against arc flashes. They allow only a certain amount of energy to pass before they open a circuit. Because an Arc Flash can draw a fraction of bolted-fault current, circuit breakers cannot be relied upon to distinguish between the arcing current and a typical inrush current.

High-resistance grounding (HRG) is another technique for protecting against arc flashes. If a phase faults to ground, then the resistance limits current to just a few amps; not enough to cause downtime by tripping the overcurrent protection device, and not enough to allow an Arc Flash. It is important to remember that while resistance grounding prevents Arc Flash from phase-to-ground shorts, it has no effect on phase-to-phase shorts.

Another way to mitigate the dangers of arc flashing is by redesigning the switchgear. Switchgear cabinets can be designed to contain and channel energy away from personnel during an Arc Flash.

### Arc-Flash relays

Arc-Flash relays are microprocessor-based devices that use optical sensors to detect the onset of a flash. The sensors are strategically placed in various cubicles or drawers inside the switchboard.

Installing an Arc-Flash relay to rapidly detect developing arc flashes greatly reduces the total clearing time and the amount of energy released through an arcing fault. In turn, there is less damage to equipment and fewer and less severe injuries to nearby personnel.

### Arc-Flash Relay Selection Criteria

When selecting an Arc-Flash relay, there are six important criteria:

1. Reaction time
2. Trip reliability
3. Avoidance of nuisance tripping
4. Sensor design and installation
5. Ease of use

#### Reaction Time

Since light is the earliest detectable indication that an Arc Flash is occurring, Arc-Flash relays use optical light sensors to detect the arc that is forming. The output of the light sensor is hard-wired to the Arc-Flash relay, which trips a circuit that interrupts the energy supply in the Arc.

The response time of an Arc-Flash relay is approximately 1-5 ms at light intensities of about 10,000 lux or higher. Within that time frame, the optical sensor output can actuate a switch or circuit breaker to cut off current feeding the arc. The overall current clearing time depends on the protection strategy used and the performance of the external switch or circuit breaker used. The breaker will typically take an additional 35-50 ms to open, depending on the type of breaker and how well it is maintained.

The electronic output to turn on is a function of the type of output relay used. Solid-state outputs (for example, insulated gate bipolar transistors (IGBTs)) are much faster than electromechanical relays and can operate within 200 microseconds.

#### Trip Reliability

Reliable tripping is the most important characteristic of an Arc-Flash relay, because this ensures mitigation of an arcing fault. Two aspects of reliability should be considered: trip redundancy and system-health monitoring.

**Redundant Tripping.** Arc-Flash relays should offer a redundant tripping feature, which means it has both primary and secondary trip path logic. The primary path is controlled by the internal microprocessor and its embedded software, and works by activating the coil of the primary trip relay.

The redundant path typically uses a discrete solid-state device that does not go through the microprocessor. Any failure in the primary (microprocessor) path will cause the unit to automatically switch to its redundant path, which activates a shunt-trip relay without delay when a sensor input is above the light detection threshold.

An often overlooked advantage of a solid-state trip path compared to a microprocessor-based circuit is the reaction time when the relay is first powered up. Wiring mistakes, tools left in hazardous locations, and the regular stresses of powering up all contribute to the risk of an Arc Flash on power up. A microprocessor can require 200 ms or more before it is able to start scanning the optical sensors. However, a solid-state trip path can detect an Arc and send a trip signal in as little as 2 ms. In addition, there are fail-safe features that alert operators when, for example, the microprocessor fails.

**Health monitoring.** Health monitoring makes sure the system is in good operating condition and should extend from the light sensors to the output of the Arc-Flash relay trip circuitry. Health monitoring starts on the sensors. A signal is sent from the relay to the light sensors, where a test light is detected by the sensor and sent back to the relay. In the case of a fiber-optic sensor, this also verifies the entire length of the fiber is not pinched or broken. On-sensor health indication is critical in preventing maintenance work on equipment where protection is not working. It also has the added benefit of providing rapid fault location.

Following the path of a trip signal from the sensor, internal monitoring must also include the primary and redundant trip circuit. Low voltage across the IGBT indicates a wiring fault or an error in the trip coil, and a high voltage is a sign of an error in the IGBT switch, both of which are also reported and logged. The IGBT is also thermally protected against overloads, and will turn off if it overheats. However, the thermal protection has a 100 ms delay before acting, meaning that even a dangerously overheated coil will attempt to signal a trip before resuming thermal protection.

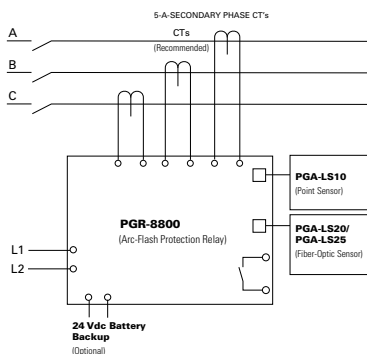
### Avoidance of Nuisance Tripping

A typical Arc-Flash Relay system has an integrated three-phase current measurement function that detects and reacts to short circuit and overcurrent conditions. Although this is not a requirement for the system to operate, this option will increase the reliability of the system (minimize unwanted tripping).

If the microprocessor logic receives an input from a light sensor, it checks for a rapidly rising input from the current transformers. Two conditions need to be fulfilled before the trip is sent to the circuit breaker: a certain current flow that exceeds the normal operating current of the system (the threshold level is adjustable from 10-1000% of the full load current) and a signal from the arc-flash sensor, implying that the sensor has reacted to a high-intensity light source.

### Sensor Design and Installation

Arc-Flash relay installations utilize multiple fixed-point light sensors near vertical and horizontal bus bars where arcing faults are apt to occur in feeder switchgear cabinets. Sufficient numbers of sensors should be installed to cover all accessible areas, even if policy is to only work on de-energized systems. At least one sensor should have visibility to an arc fault if a person blocks another sensor's field of view. Light sensors may also be installed in other electrical cabinets and on panels that are subject to routine maintenance and repairs.



A fiber-optic sensor, which have a 360° field of view for detecting light, allows more flexible positioning of the light sensing locations, as the fiber-optic strands can be looped throughout an enclosure or panel to cover challenging component layouts.

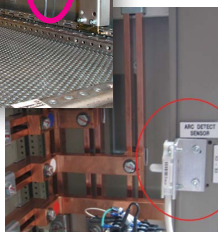
### Easy to Use Hardware and Software

Another important factor to consider is ease of use. Some relays may require field assembly, calibration, or advanced configuration before installing. It is critical to consider those extra steps and the capabilities of the operators who will be using the devices. Often, very complicated devices can be misused because of incorrect

setup or configuration, which can defeat the purpose of the device altogether. A few Arc-Flash Relays have software that provides event logging. To make troubleshooting easier, this software should record the specific sensor that initiated the fault in the data records.



Examples of Arc-Flash Relay light sensor installation in switchgear.



## III. CT APPLICATION

### Current Transformers (CTs)

A current transformer is defined as a transformer that produces a current in its secondary circuit that is in proportion to current in its primary circuit.

Although there are other types of CTs, only the window (or ring) type will be discussed here. Window-type CTs get their name from their design that consists of a ring-shaped core. This core is formed by a single length of strip ferromagnetic material tightly wound to form the ring-shaped core.

A CT operates on a principle of flux balance, as shown in *Figure 1*. If the primary winding is energized with the secondary circuit open-circuited, the transformer becomes an iron-cored inductor. The primary current generates a magnetic flux in the core as shown (flux direction can be determined by the right-hand rule). When the secondary winding is connected to a burden or is short circuited, current flows through the secondary winding creating magnetic flux in the core in opposition to the magnetizing flux created by the primary current. If losses are ignored, the secondary flux balances exactly to the primary flux. This phenomenon is known as Lenz's Law.

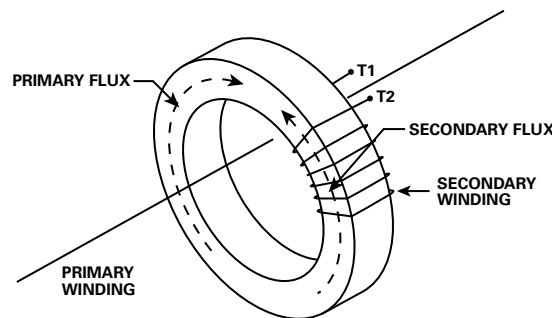


FIGURE 1

### Lead Length

The secondary lead resistance of CTs cannot be ignored, particularly with low Volt-Amperes (VA) CTs. For example, let's look at an electronic overload relay.

- The relay's CT input impedance or burden ( $Z_b$ ) = 0.01  $\Omega$
- The maximum current ( $I$ ) = 10 A
- The CT rating ( $P$ ) = 5 VA

Now let's solve for the maximum length of #14 AWG leads that will result in a rated accuracy for a 10 A secondary current. Solving for maximum total impedance ( $Z_T$ ):

$$P = I^2 Z_T$$

$$Z_T = P / I^2 = 5 / 10^2 = 0.05 \Omega$$



Solving for the maximum lead resistance ( $Z_w$ ):

$$Z_T = Z_w + Z_B$$

$$Z_w = 0.05 - 0.01 = 0.04 \Omega$$

If we look up the #14 AWG resistance we find it equals 2.6 ohms/1000 ft

Therefore, lead length =  $Z_w / \#14 \text{ AWG resistance}$

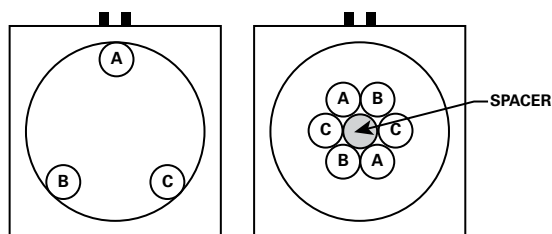
$$\text{Maximum lead length} = (0.04 \times 1000) / 2.6 = 15.4 \text{ ft}$$

### CT Installation

A CT should not be operated with its secondary open-circuited. If the secondary is opened when primary current is flowing, the secondary current will attempt to continue to flow so as to maintain the flux balance. As the secondary circuit impedance increases from a low value to a high value the voltage across the secondary winding will rise to the voltage required to maintain current flow. If the secondary voltage reaches the breakdown voltage of the secondary winding, the insulation will fail and the CT will be damaged. Furthermore, this situation presents a personnel shock hazard.

When a ring-type CT is used to monitor a single conductor or multiple conductors, the conductors should be centered in the CT window, as shown below in *Figure 2*, and should be perpendicular to the CT opening.

In some applications it is difficult or impossible to install the primary conductor through the CT window (example: existing bus bar structure). For these applications a split core CT is sometimes used. Performance of split core CTs may be less than that of solid core CTs.



Incorrect

Correct

FIGURE 2

CT characteristics are normally specified at a single frequency such as 50 or 60 Hz. Therefore the question arises: What happens when CTs are used with variable frequency drives (VFDs)? For CTs that are linear to approximately 10x rated primary current at 60 Hz, the Volts/Hertz ratio is approximately constant. That is, for all other conditions held the same at 6 Hz, the CT will be linear to only 1x rated current and at 30 Hz the CT will be linear to 5x rated current. For a standard silicon-steel-core CT, the upper bandwidth frequency is approximately 5 kHz.

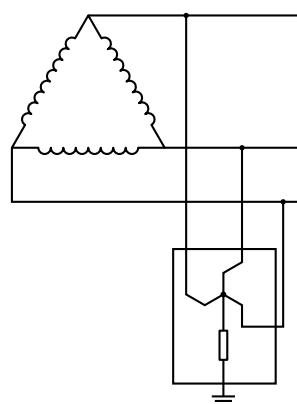
## IV. RESISTANCE-GROUNDING CONVERSION

### Convert Ungrounded to Resistance-Grounded Systems

Resistance grounding protects a system against transient overvoltages caused by intermittent ground faults and it provides a method to locate ground faults. (Transient overvoltages and inability to locate ground faults are the most common safety issues with ungrounded systems.)

Conversion of delta-connected or wye-connected sources with inaccessible neutrals require a zigzag transformer to derive an accessible neutral for connection to a neutral grounding resistor (NGR). The neutral is only used for the NGR and not for distribution. During normal operation the only current that flows in the zigzag transformer is an extremely small magnetizing current. When one phase is grounded, the NGR and the zigzag transformer provide a path for ground-fault current to flow.

Figure 1



**Design Note 1:** A zigzag conversion requires a three-phase connection to the existing power system, typically at the main transformer or switchgear. See *Figure 1*.

**Design Note 2:** The resistor let-through current must be greater than the system capacitive charging current (see *Section I*).

**Design Note 3:** Protection, coordination, and annunciation systems depend on the integrity of the NGR. NGR monitoring with an SE-330 or SE-325 is recommended.

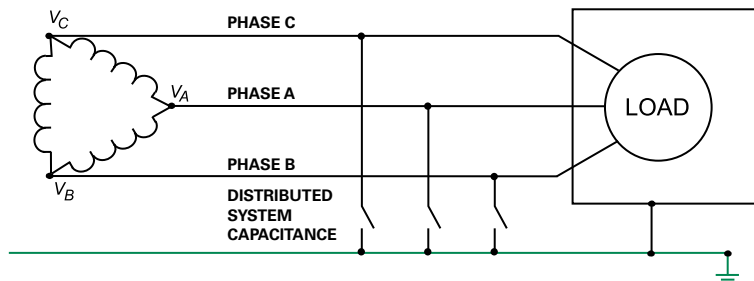
## UNGROUNDED SYSTEM

### Advantages

- Operation possible with one faulted phase

### Disadvantages

- Ground faults are difficult to locate
- Transient overvoltages damage equipment



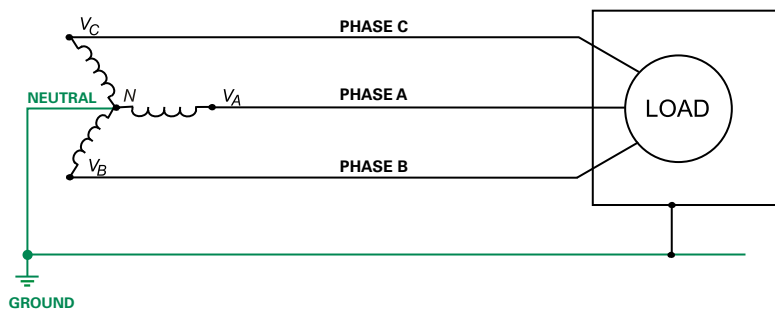
## SOLIDLY GROUNDED SYSTEM

### Advantages

- Eliminates transient overvoltages
- Selective tripping possible

### Disadvantages

- Costly point-of-fault damage
- Cannot operate with a ground fault
- Ground-fault Arc-Flash hazard
- Increased Arc-Flash risk



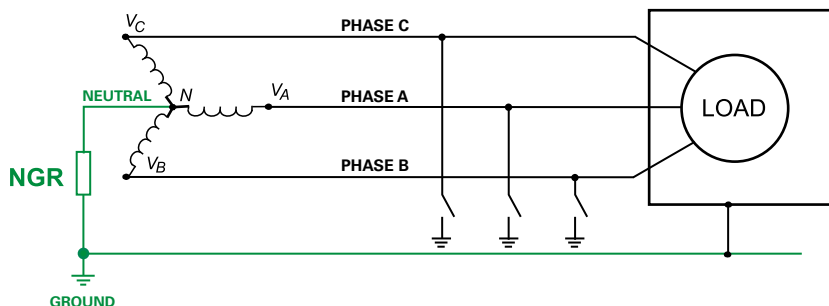
## RESISTANCE-GROUNDED SYSTEM

### Advantages

- Reduced point-of-fault damage and Arc-Flash risk
- Eliminates transient overvoltages
- Simplifies ground-fault location
- Continuous operation with a ground fault
- Selective tripping possible
- No ground-fault Arc-Flash hazard

### Disadvantages

- Failure of the neutral-grounding resistor renders current-sensing ground-fault protection inoperative



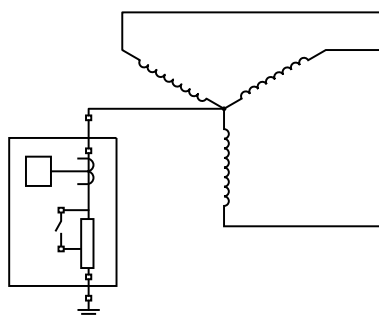
### Convert Solidly Grounded to Resistance-Grounded Systems

Resistance grounding protects a system against Arc-Flash Hazards caused by ground faults and provides a method for continuous operation or an orderly shutdown procedure. (Ground faults are estimated to be 98% of all electrical faults.)

Since the neutral point of the power source is available, the solid connection between neutral and ground is replaced with a grounding resistor. This resistor limits ground fault current to a predetermined value, typically 5 A for 480 V systems (the system capacitive charging current is usually less than 3 A). By limiting the ground-fault current to 5 A or less, there are no Arc-Flash Hazards associated with ground faults. This allows for continuous operation during the first ground fault.

During a ground fault on a resistance-grounded (RG) system, a voltage shift occurs (the same shift experienced on ungrounded systems). The faulted phase collapses to  $\sim 0$  V, the non-faulted phases rise to line-to-line voltage with respect to ground, and the neutral point rises to line-to-neutral voltage with respect to ground.

Figure 2



**Design Note 1:** An NGR conversion for a solidly grounded system requires a neutral connection to the existing power system, typically at the main transformer or switchgear. See Figure 2.

**Design Note 2:** The voltage shift requires equipment to be fully rated at line-to-line voltage with respect to ground. This may require TVSSs, VFDs, meters, etc. to be reconfigured or replaced.

**Design Note 3:** The voltage shift also restricts neutral distribution. The neutral typically cannot be distributed due to its potential rise during ground faults. Single-phase line-to-neutral-voltage loads must be served by a 1:1 isolation transformer or converted to line-to-line loads.

**Design Note 4:** The resistor let-through current must be greater than the system capacitive charging current (see Section I).

**Design Note 5:** Protection, coordination, and annunciation systems depend on the integrity of the NGR. Monitoring with an SE-330 or SE-325 NGR Monitor is recommended.

### IEEE DEVICE NUMBERS

- |   |  |   |
|---|--|---|
| <b>1</b> - Master Element                             | <b>33</b> - Position Switch                                      | <b>64</b> - Ground (Earth) Detector Relay                 |
| <b>2</b> - Time Delay Starting or Closing Relay       | <b>34</b> - Master Sequence Device                               | <b>65</b> - Governor                                      |
| <b>3</b> - Checking or Interlocking Relay             | <b>35</b> - Brush-Operating or Slip-Ring Short-Circuiting Device | <b>66</b> - Notching or Jogging Device                    |
| <b>4</b> - Master Contactor                           | <b>36</b> - Polarity or Polarizing Voltage Devices               | <b>67</b> - AC Directional Overcurrent Relay              |
| <b>5</b> - Stopping Device                            | <b>37</b> - Undercurrent or Underpower Relay                     | <b>68</b> - Blocking or "Out-of-Step" Relay               |
| <b>6</b> - Starting Circuit Breaker                   | <b>38</b> - Bearing Protective Device                            | <b>69</b> - Permissive Control Device                     |
| <b>7</b> - Rate of Change Relay                       | <b>39</b> - Mechanical Condition Monitor                         | <b>70</b> - Rheostat                                      |
| <b>8</b> - Control Power Disconnecting Device         | <b>40</b> - Field (over/under excitation) Relay                  | <b>71</b> - Liquid Level Switch                           |
| <b>9</b> - Reversing Device                           | <b>41</b> - Field Circuit Breaker                                | <b>72</b> - DC Circuit Breaker                            |
| <b>10</b> - Unit Sequence Switch                      | <b>42</b> - Running Circuit Breaker                              | <b>73</b> - Load-Resistor Contactor                       |
| <b>11</b> - Multi-function Device                     | <b>43</b> - Manual Transfer or Selector Device                   | <b>74</b> - Alarm Relay                                   |
| <b>12</b> - Overspeed Device                          | <b>44</b> - Unit Sequence Starting Relay                         | <b>75</b> - Position Changing Mechanism                   |
| <b>13</b> - Synchronous-speed Device                  | <b>45</b> - Abnormal Atmospheric Condition Monitor               | <b>76</b> - DC Overcurrent Relay                          |
| <b>14</b> - Underspeed Device                         | <b>46</b> - Reverse-phase or Phase-Balance Current Relay         | <b>77</b> - Telemetry Device                              |
| <b>15</b> - Speed - or Frequency, Matching Device     | <b>47</b> - Phase-Sequence or Phase-Balance Voltage Relay        | <b>78</b> - Phase-Angle Measuring Relay                   |
| <b>16</b> - Data Communications Device                | <b>48</b> - Incomplete Sequence Relay                            | <b>79</b> - AC Reclosing Relay                            |
| <b>17</b> - Shunting or Discharge Switch              | <b>49</b> - Machine or Transformer, Thermal Relay                | <b>80</b> - Flow Switch                                   |
| <b>18</b> - Accelerating or Decelerating Device       | <b>50</b> - Instantaneous Overcurrent Relay                      | <b>81</b> - Frequency Relay                               |
| <b>19</b> - Starting to Running Transition Contactor  | <b>51</b> - AC Inverse Time Overcurrent Relay                    | <b>82</b> - DC Reclosing Relay                            |
| <b>20</b> - Electrically Operated Valve               | <b>52</b> - AC Circuit Breaker                                   | <b>83</b> - Automatic Selective Control or Transfer Relay |
| <b>21</b> - Distance Relay                            | <b>53</b> - Exciter or DC Generator Relay                        | <b>84</b> - Operating Mechanism                           |
| <b>22</b> - Equalizer Circuit Breaker                 | <b>54</b> - Turning Gear Engaging Device                         | <b>85</b> - Communications, Carrier or Pilot-Wire Relay   |
| <b>23</b> - Temperature Control Device                | <b>55</b> - Power Factor Relay                                   | <b>86</b> - Lockout Relay                                 |
| <b>24</b> - Volts Per Hertz Relay                     | <b>56</b> - Field Application Relay                              | <b>87</b> - Differential Protective Relay                 |
| <b>25</b> - Synchronizing or Synchronism-Check Device | <b>57</b> - Short-Circuiting or Grounding (Earthing) Device      | <b>88</b> - Auxiliary Motor or Motor Generator            |
| <b>26</b> - Apparatus Thermal Device                  | <b>58</b> - Rectification Failure Relay                          | <b>89</b> - Line Switch                                   |
| <b>27</b> - Undervoltage Relay                        | <b>59</b> - Overvoltage Relay                                    | <b>90</b> - Regulating Device                             |
| <b>28</b> - Flame Detector                            | <b>60</b> - Voltage or Current Balance Relay                     | <b>91</b> - Voltage Directional Relay                     |
| <b>29</b> - Isolating Contactor or Switch             | <b>61</b> - Density Switch or Sensor                             | <b>92</b> - Voltage and Power Directional Relay           |
| <b>30</b> - Annunciator Relay                         | <b>62</b> - Time-Delay Stopping or Opening Relay                 | <b>93</b> - Field Changing Contactor                      |
| <b>31</b> - Separate Excitation Device                | <b>63</b> - Pressure Switch                                      | <b>94</b> - Tripping or Trip-Free Relay                   |

### ANSI DEVICE NUMBERS

- |  |                                       |   |
|--|---------------------------------------|---|
| <b>AFD</b> - Arc Flash Detector            | <b>HMI</b> - Human Machine Interface  | <b>PQM</b> - Power Quality Monitor                  |
| <b>CLK</b> - Clock or Timing Source        | <b>HST</b> - Historian                | <b>RIO</b> - Remote Input/Output Device             |
| <b>DDR</b> - Dynamic Disturbance Recorder  | <b>LGC</b> - Scheme Logic             | <b>RTU</b> - Remote Terminal Unit/Data Concentrator |
| <b>DFR</b> - Digital Fault Recorder        | <b>MET</b> - Substation Metering      | <b>SER</b> - Sequence of Events Recorder            |
| <b>ENV</b> - Environmental Data            | <b>PDC</b> - Phasor Data Concentrator | <b>TCM</b> - Trip Circuit Monitor                   |
| <b>HIZ</b> - High Impedance Fault Detector | <b>PMU</b> - Phasor Measurement Unit  | <b>SOTF</b> - Switch On To Fault                    |

### TYPICAL SUFFIXES

- |  |   |   |
|--|---|---|
| <b>A</b> - Alarm/Auxiliary Power   | <b>F</b> - Feeder/Field/Filament/ Filter/Fan                        | <b>T</b> - Transformer/Thyratron                |
| <b>AC</b> - Alternating Current  | <b>G</b> - Generator/Ground*  | <b>TH</b> - Transformer (High-voltage Side)     |
| <b>B</b> - Battery/Blower/Bus  | <b>M</b> - Motor/Metering   | <b>TL</b> - Transformer (Low-voltage Side)      |
| <b>BT</b> - Bus Tie  | <b>N</b> - Network/Neutral*   | <b>TT</b> - Transformer (Tertiary-voltage Side) |
| <b>C</b> - Capacitor/Condenser/Compensator/<br>Carrier Current/Case/Compressor | <b>P</b> - Pump/Phase Comparison                                    | <b>U</b> - Unit                                 |
| <b>DC</b> - Direct Current   | <b>R</b> - Reactor/Rectifier/Room                                   |   |
| <b>E</b> - Exciter   | <b>S</b> - Synchronizing/Secondary/Stainer/Sump/<br>Suction (Valve) |   |

Note: Descriptions per IEEE Std C37.2-1996

\*Suffix N is preferred when the device is connected in the residual of a polyphase circuit, is connected across broken delta, or is internally derived from the polyphase current or voltage quantities. The suffix G is preferred where the measured quantity is in the path of ground or, in the case of ground fault detectors, is the current flowing to ground.