Littelfuse
STARTCO

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SE-330 MANUAL

NEUTRAL-GROUNDING-RESISTOR MONITOR

REVISION 10-J-062215

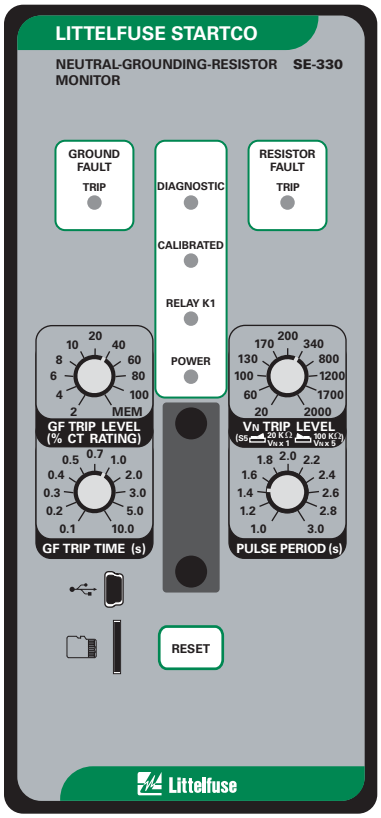

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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1. GENERAL

1.1 MODERN RESISTANCE-GROUNDED SYSTEMS

A high-resistance-grounded system uses a neutral-grounding resistor (NGR) with a low let-through current to limit ground-fault current. This is an improvement over low-resistance or solidly-grounded systems because, in those systems, a ground-fault flash hazard exists and a ground fault can result in substantial point-of-fault damage. High-resistance grounding eliminates these problems and modern ground-fault protection operates reliably at low current levels. Furthermore, the probability of an arc-flash incident is significantly reduced in a high-resistance-grounded system.

NGR selection depends on system charging current and whether the system is an alarm-only or a tripping system. Alarm-only systems are usually restricted to system voltages up to 5 kV with NGR let-through currents of 5 A or less. Occasionally, alarm-only systems up to 15 kV and up to 10 A are used; however, they are not common because a ground fault on such a system tends to escalate to a phase-to-phase fault before the ground fault can be located and cleared. Consult CEC 10-1102, NEC 250.36, and NEC 250.186 for application details.

System charging current is the capacitive current that flows to ground when a bolted ground fault occurs. This current can be calculated or measured. For small systems, the magnitude of charging current can be conservatively estimated as ½ A per 1,000 kVA on low-voltage systems and 1 A per 1,000 kVA on medium-voltage systems.

In an alarm-only system or in a tripping system without selective coordination, choose an NGR with a let-through current larger than the system charging current and set the pick-up current of ground-fault devices at or below 50% of the NGR let-through current.

In a tripping system with selective coordination, use ground-fault devices with a definite-time characteristic to achieve time coordination. Use the same pick-up current for all ground-fault devices—this value must be larger than the charging current of the largest feeder. Select an NGR with a let-through current between five and 10 times the pick-up current of the ground-fault devices.

Do not use a grounding transformer with a low-voltage resistor:

- The combined cost of a transformer and a low-voltage resistor is more than the cost of a resistor rated for line-to-neutral voltage.
- A transformer saturated by a ground fault through a rectifier can make ground-fault protection inoperative.
- Transformer inrush current up to 12 times rated current can cause a ground-fault voltage larger than expected.
- A parallel transformer winding makes it difficult to monitor NGR continuity.
- A transformer can provide the inductance necessary to cause ferroresonance if the NGR opens.

Following these guidelines will reduce the flash hazard, reduce point-of-fault damage, achieve reliable ground-fault protection, and ensure a stable system not subject to ferroresonance.

1.2 SE-330 NGR MONITORING

The SE-330 is a microprocessor-based neutral-grounding-resistor monitor that detects NGR failures and ground faults in resistance-grounded systems. The SE-330 measures NGR resistance, NGR current, and transformer or generator neutral-to-ground voltage. The components required to monitor an NGR are an SE-330, a 20- or 100-kΩ ER-series sensing resistor, and a current transformer (CT).

Power-circuit elements, other than neutral-connected NGR's, that purposefully connect the power system to ground are often not compatible with SE-330 NGR monitoring. These elements include single-phase grounding transformers, grounded-wye-primary potential transformers (PT's), and grounded-wye-primary power transformers.

The SE-330 continuously measures NGR resistance in an unfaulted system. It will trip on resistor fault if NGR resistance varies from its calibrated value. When a ground fault occurs, voltage is present on the neutral and NGR current will flow if the NGR is healthy. The SE-330 will trip on ground fault if fault current exceeds the GF TRIP LEVEL setting for an interval equal to the GF TRIP TIME setting. However, if the NGR fails open during a ground fault, it is possible for fault resistance to satisfy the NGR resistance measurement. To detect this double-fault condition, the SE-330 measures neutral voltage. If neutral voltage exceeds the V_N TRIP LEVEL setting and if NGR current is less than 5% of the current transformer (CT) rating, the SE-330 will trip on resistor fault. If the resistor-fault circuit is tripped and the neutral voltage exceeds the V_N TRIP LEVEL setting for an interval greater than the GF TRIP TIME setting, the ground-fault circuit will also trip.

Ground-fault current is sensed by a CT with a 1- or 5-A secondary, or by a CT (EFCT-x or SE-CS30-x) with a 50-mA secondary. The trip level of the ground-fault circuit is adjustable from 2 to 100% of the CT rating and trip time is adjustable from 0.1 to 10.0 seconds.

The SE-330 has four output relays. Relay K1 can be assigned a trip or a pulsing function. Relays K2 and K3 provide ground-fault and resistor-fault indication. K4 is a solid-state relay that provides UNIT HEALTHY indication. When relay K1 is assigned the trip function, it will operate on either a resistor fault or ground fault, and it can be set to operate in the fail-safe or non-fail-safe mode for undervoltage or shunt-trip applications. When

the pulsing function is selected, relay K1 is used to control a contactor to assist in locating faults.

Additional features include LED trip indication, trip memory, front-panel and remote reset, 4-20-mA analog output, trip event recorder, USB local communications, microSD™ data logging, and optional network communications.

The SE-330 provides additional features over the SE-330 legacy model (revision 04 or less):

- When the trip level is set to MEM, the ground-fault trip setting is defined by an internal non-volatile memory variable. Range is 2 to 100% in 1% increments of the CT-primary rating.
- Indication relays can be set to fail-safe or non-fail-safe.
- The number of trip records has been increased to 100 and includes date and time stamping.
- A microSD™ card interface can be used for long-term data logging and firmware updates. A microSD™ card and a microSD-to-SD adapter is included. See Section 4.1.
- For ease of connection to new devices, the RS-232 interface has been replaced by a Mini B USB port.
- Dual Ethernet ports are available with support for fiber-optic and RJ45 interfaces.
- The IEC 61850 protocol has been added.

2. OPERATION

2.1 SETTINGS

2.1.1 GF TRIP TIME

GF TRIP TIME (definite time) is adjustable from 0.1 to 10.0 seconds. Time-coordinated ground-fault protection requires this setting to be longer than the trip times of downstream ground-fault devices.

A trip-time accumulator provides a ground-fault memory function for detection of intermittent faults. The accumulated time increases when a ground fault is detected and decreases when a ground fault is not detected. A trip will eventually occur when the time for fault current above the trip level is greater than the time for fault current below the trip level.

2.1.2 GF TRIP LEVEL

The SE-330 uses a Discrete-Fourier Transform (DFT) Algorithm to measure the fundamental component of NGR current.

Choose an NGR let-through current and a ground-fault trip level according to the guidelines in Section 1.1. Set the ground-fault trip level as a percentage (2 to 100) of the CT-primary rating. When the GF Trip Level is set to MEM, the ground-fault setting stored in non-volatile memory is used. This parameter must be set using a PC running the SE-MON330 software connected to the USB interface. The setting range is 2 to 100% of CT primary rating in 1% increments. The default value is 15%. Inputs are provided for 5-, 1-, and 0.05-A-secondary CT's. Typical values for 5-, 15-, and 25-A tripping systems are shown in Table 1. Ground-fault trip levels for selected CT's are shown in Table 2. For other systems, refer to the NGR Monitor Set-Point Assistant at www.littelfuse.com/relayscontrols. The Set-Point Assistant is included with the SE-MON330 software.

2.1.3 V_N TRIP LEVEL

The SE-330 uses a DFT algorithm to measure the fundamental component of neutral voltage (V_N).

If neutral voltage is greater than the V_N TRIP LEVEL setting for the duration of the resistor-fault trip time and ground-fault current is less than 5% of the CT rating, the SE-330 will trip on resistor fault. If the resistor-fault circuit is tripped and the neutral voltage exceeds the V_N TRIP LEVEL setting for an interval greater than the GF TRIP TIME setting, the ground-fault circuit will also trip.

The V_N TRIP LEVEL range is 20 to 2,000 V with switch S5 in the 20-kΩ (Vx1) position, and the range is 100 to 10,000 V with switch S5 in the 100-kΩ (Vx5) position. Calculate the voltage across the NGR when NGR current is equal to the pick-up current of the ground-fault circuit. Set the V_N TRIP LEVEL at the next largest value. See Fig. 1 and Section 2.1.5.5.

Typical values for 5-, 15-, and 25-A tripping systems are shown in Table 1. For an NGR resistance greater than 2 kΩ, use a 100-kΩ sensing resistor. For other systems, refer to the NGR Monitor Set-Point Assistant at www.littelfuse.com/relayscontrols.

NOTE: A resistor-fault trip is held off if the ground-fault current is above 5% of the CT rating.

TABLE 1. TYPICAL VALUES FOR TRIPPING SYSTEMS

SYSTEM VOLTAGE	NEUTRAL-GROUNDING RESISTOR		SENSING RESISTOR		GROUND-FAULT TRIP LEVEL	V_N TRIP LEVEL
(VOLTS)	CURRENT (AMPERES)	RESISTANCE (OHMS)	MODEL	RESISTANCE (SWITCH S5 SETTING)	(AMPERES)	(VOLTS)
480	5	55	ER-600VC	20 kΩ	1.0	60
600	5	69	ER-600VC	20 kΩ	1.0	100
2,400	5	277	ER-5KV	20 kΩ	1.0	340
4,160	5	480	ER-5KV	20 kΩ	1.0	800
480	15	18	ER-600VC	20 kΩ	3.0	60
600	15	23	ER-600VC	20 kΩ	3.0	100
2,400	15	92	ER-5KV	20 kΩ	3.0	340
4,160	15	160	ER-5KV	20 kΩ	3.0	800
7,200	15	277	ER-15KV	100 kΩ	3.0	170x5=850
14,400	15	554	ER-15KV	100 kΩ	3.0	340x5=1,700
4,160	25	96	ER-5KV	20 kΩ	5.0	800
7,200	25	166	ER-15KV	100 kΩ	5.0	170x5=850
14,400	25	332	ER-15KV	100 kΩ	5.0	340x5=1,700
25,000	25	577	ER-25KV	100 kΩ	5.0	800x5=4,000
35,000	25	808	ER-35KV	100 kΩ	5.0	1,200x5=6,000

TABLE 2. GROUND-FAULT TRIP LEVELS FOR SELECTED CT'S

GF TRIP LEVEL[1] (%)	EFCT-x 5:0.05 (AMPERES)	SE-CS30-x 30:0.05 (AMPERES)	50:1 50:5 (AMPERES)	100:1 100:5 (AMPERES)	200:1 200:5 (AMPERES)	400:1 400:5 (AMPERES)
2	0.10	0.60	*	*	*	*
4	0.20	1.20	*	*	*	16
6	0.30	1.80	*	*	12	24
8	0.40	2.40	*	8	16	36
10	0.50	3.00	5	10	20	40
20	1.00	6.00	10	20	40	80
40	2.00	12.0	20	40	80	160
60	3.00	18.0	30	60	120	240
80	4.00	24.0	40	80	160	320
100	5.00	30.0	50	100	200	400

[1] When set to MEM, range is 2 to 100% in 1% increments.
* Setting not recommended.

2.1.4 PULSE-PERIOD ADJUSTMENT

Pulse period is the cycle time of relay K1 when the SE-330 is configured for pulsing operation. Pulse period is adjustable from 1.0 to 3.0 seconds with a fixed duty cycle of 50%. For example, with the 1.0-s setting, relay K1 will alternately be energized for 0.5 seconds and de-energized for 0.5 seconds when pulsing is enabled.

See Section 2.3 for detailed pulsing operation information.

NOTE: For pulsing configuration, set switch S1 to K1 = PULSING and install an external pulse-enable switch.

2.1.5 CONFIGURATION SETTINGS

Eight configuration switches (S1 to S8) and a calibration button are located behind the access cover on the front panel. See Fig. 1.

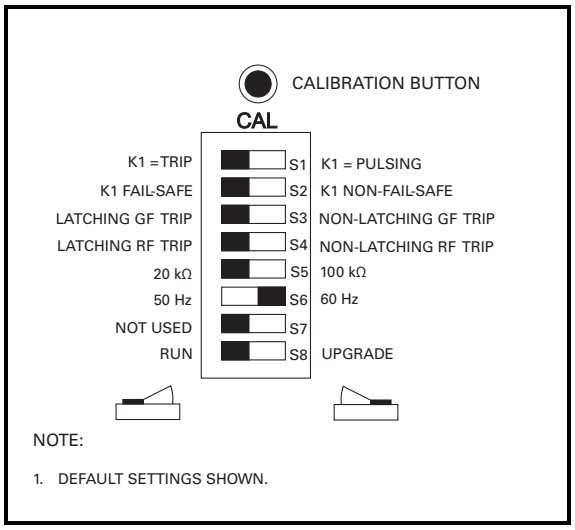


FIGURE 1. Configuration Switches.

2.1.5.1 RELAY K1 FUNCTION (S1)

Set switch S1 to K1 = TRIP to assign the trip function to relay K1 and to activate switch S2. Relay K1 will change state when a resistor-fault or ground-fault trip occurs.

Set switch S1 to K1 = PULSING to configure relay K1 for pulsing operation. See Section 2.3.

2.1.5.2 TRIP-RELAY MODE AND TRIP-MEMORY MODE (S2)

Set switch S2 to select the operating mode of trip relay K1. In the non-fail-safe mode, relay K1 energizes and its contact closes when a trip occurs. The non-fail-safe mode can be used to trip shunt-trip circuit breakers. In the non-fail-safe mode, SE-330 trips are reset when supply voltage is cycled.

In the fail-safe mode, relay K1 energizes and its contact closes if there are no trips. Contacts open if there is a trip, a loss of supply voltage, or a processor failure. In the fail-safe mode, SE-330 trips are not reset when supply voltage is cycled.

NOTE: Switch S2 does not affect the operating modes of relays K2, K3, and K4.

NOTE: Switch S2 only affects relay K1 operating mode when K1 is assigned the trip function (switch S1 set to K1 = TRIP). Trip memory is enabled when K1 is set to the fail-safe mode, regardless of the switch S1 setting.

2.1.5.3 GROUND-FAULT-TRIP LATCH (S3)

Set switch S3 to select latching or non-latching ground-fault-circuit operation. Non-latching operation defeats ground-fault-trip memory. See Sections 2.1.5.2 and 2.4.

2.1.5.4 RESISTOR-FAULT-TRIP LATCH (S4)

Set switch S4 to select latching or non-latching resistor-fault-circuit operation. Non-latching operation defeats resistor-fault-trip memory. See Sections 2.1.5.2 and 2.4

2.1.5.5 SENSING-RESISTOR SELECTION (S5)

Set switch S5 to the resistance of the sensing resistor. For the ER-600VC, ER-5KV, and ER-5WP, select 20 kΩ. For the ER-15KV, ER-25KV, and ER-35KV, select 100 kΩ. Switch S5 sets the resistor-fault trip value and the V_N TRIP LEVEL range. See Section 2.1.3.

2.1.5.6 FREQUENCY (S6)

Set switch S6 to 50 or 60 Hz to tune the digital filter to the line frequency of the monitored system.

2.1.5.7 UPGRADE MODE (S8)

The microSD™ card is used for firmware upgrades. See Section 4.1.2 for upgrade instructions.

NOTE: An upgrade causes an SE-330 restart and this may cycle the output relays.

2.1.6 RESISTOR-FAULT TRIP TIME

The resistor-fault trip time can be adjusted from 12 (default) to 60 seconds using the SE-MON330 software or via network communications.

2.1.7 RESISTOR-FAULT TRIP LEVEL

The resistor-fault trip level can be adjusted using the SE-MON330 software or via network communications. See Section 6.1.

2.1.8 GEO-MAGNETIC FILTER

A low-frequency ground current can be caused by the Earth's magnetic field and from charged clouds passing overhead during a thunderstorm. In some rare conditions, this can cause a false resistor-fault trip. Enabling the geo-magnetic filter and increasing the resistor-fault trip time can help counteract these effects.

A trip time of 30 seconds is recommended when the geo-magnetic filter is enabled.

The geo-magnetic filter is disabled by default, but can be enabled using the SE-MON330 software or via network communications.

2.2 CALIBRATION

The SE-330 measures the resistance change of the NGR relative to the NGR-resistance value determined at the time of calibration. When the resistance change is greater than a threshold amount (500 Ω for 20-kΩ systems, 2,500 Ω for 100-kΩ systems), a resistor-fault trip occurs. Calibrate the SE-330 on new installations, if the NGR is changed, or if the sensing resistor is changed.

NOTE: If the SE-330 is not calibrated and is supplied from the load side of the breaker (non-fail-safe mode), calibrate within the resistor-fault trip time after power-up or it may trip and interrupt its supply. See Section 2.1.6.

The CALIBRATION button is located behind the access cover on the front panel, and it is recessed to prevent inadvertent activation.

NOTE: Calibration must be performed with the SE-330 connected to the sensing resistor and NGR of the installed system.

To calibrate, press and hold the CALIBRATION button until the green CALIBRATED LED turns off and returns to on (if the LED is already off, press and hold until the LED turns on). Calibration takes approximately two seconds. If calibration is not successful, a resistor-fault trip occurs, the RESISTOR FAULT TRIP LED will be on, the CALIBRATED LED will be off, and the DIAGNOSTIC LED will flash the calibration-error code. See Section 2.8.

The SE-330 may be calibrated remotely using the SE-MON330 software with the USB interface or the communications options.

If latching resistor fault (switch S4) is selected, the calibration-error code flashes until RESET is pressed even if the CALIBRATED LED is on.

The calibration value is stored in non-volatile memory.

2.3 Pulsing Operation

If switch S1 is set to K1 = PULSING, pulsing occurs when terminal 16 is connected to terminal 17. Relay K1 operates at a 50% duty cycle and cycle time is adjustable from 1.0 to 3.0 seconds. When terminals 16 and 17 are not connected, K1 is not energized and its contact is open.

Relay K1 can be used to control a contactor rated for use at the line-to-neutral voltage. The contactor causes changes in neutral-to-ground resistance by adding or shorting portions of the NGR. See Section 3.5. Pulsing ground-fault current appears as zero-sequence current upstream from the fault.

Pulsing ground-fault current is distinguishable from charging current and noise, and it can be traced with a clip-on ammeter or current probe. If pulsing current is detected on a cable or conduit, the fault is downstream. Systematic testing allows faults to be located without isolating feeders or interrupting loads.

Stop pulsing when a fault is located.

2.4 Trip Indication and Reset

Red LED's and indication relays indicate ground-fault and resistor-fault trips. The indication relays K2 (GF) and K3 (RF) operate in fail-safe or non-fail-safe mode. The default is non-fail-safe mode. In this mode, the relays are energized when a fault occurs. The relay mode setting is stored in non-volatile memory and can be set using the SE-MON330 software or network communications.

When a trip occurs with latching operation selected, the SE-330 remains tripped until reset with the front panel button or the remote-reset input. See Sections 2.1.5.3 and 2.1.5.4. Terminals 15 and 16 are provided for remote reset as shown in Fig. 3. The reset circuit responds only to a momentary closure so that a jammed or shorted button does not prevent a trip. The front-panel RESET button is inoperative when terminal 15 is connected to terminal 16. If non-latching operation is selected, trips and corresponding indication automatically reset when the fault clears and power-up trip memory is defeated even when configuration switch S2 is set to fail-safe. The maximum automatic reset time is 2.8 s.

The red DIAGNOSTIC LED annunciates latched calibration-error and remote trips. See Section 2.8.

When supply voltage is applied with switch S2 set to FAIL-SAFE, the SE-330 returns to its state prior to loss of supply voltage unless switch S3 or S4 is set to non-latching. When supply voltage is applied with switch S2 set to NON-FAIL-SAFE, SE-330 trips are reset. When a local, remote, or network reset is issued, both trip LED's will flash if they are off.

Resistor-fault-trip reset can take up to one second. Resistor-fault trip-memory trip can take up to three seconds after SE-330 power up.

2.5 Remote Operation

Relays K2 and K3 can be used for remote indication, and terminals 15 and 16 are provided for remote reset. RK-332 Remote Indication and Reset components are shown in Fig. 19. Connect them as shown in Fig. 3. RK-332 components are not polarity sensitive.

Indication relays can be set to fail-safe or non-fail-safe operation using the SE-MON330 software or network communications. The default mode is non-fail-safe. In non-fail-safe mode, relays energize on fault.

Network-enabled SE-330's can be remotely tripped and reset by the network master. The red DIAGNOSTIC LED indicates a network-initiated trip. See Section 2.8. Refer to the appropriate SE-330 communications manual.

2.6 Relay K1 LED

The yellow RELAY K1 LED follows the state of relay K1 and is on when K1 is energized (contact closed).

2.7 Unit Healthy Output

UNIT HEALTHY relay K4 is energized when the processor is operating. It can be ordered with N.O. or N.C. contacts. See Section 7.

NOTE: The K4 output changes state momentarily during a processor reset.

NOTE: K4-contact rating is 100 mA maximum.

2.8 Diagnostic LED

The DIAGNOSTIC LED is used to annunciate trips without individual LED indication. The number of short LED pulses between pauses indicates the cause of the trip. See Section 5.

2.9 ANALOG OUTPUT

An isolated 4–20-mA output indicates NGR current with full-scale output corresponding to the CT rating. An internal 24-Vdc supply allows the analog output to be connected as a self-powered output. Power from an external supply is required for loop-powered operation. See Fig. 2. A PGA-0520 analog meter can be panel-mounted to display the NGR current. See Fig. 20 and Section 7.

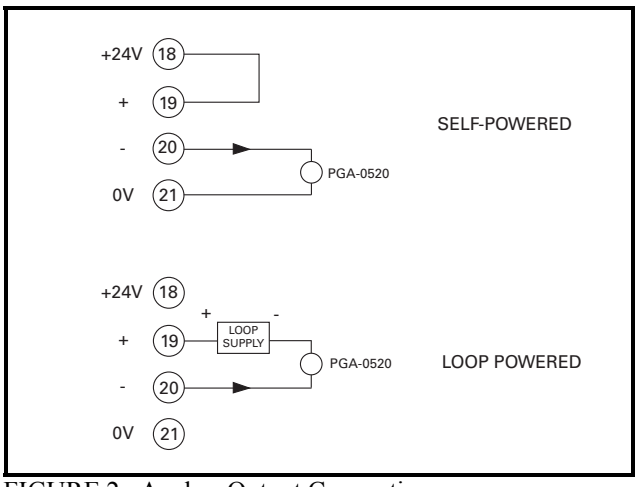


FIGURE 2. Analog-Output Connections.

3. INSTALLATION

3.1 SE-330

Outline and panel-cutout dimensions for the SE-330 are shown in Fig. 4. To panel mount the SE-330, insert it through the panel cutout and secure it with the four included 8-32 locknuts and flat washers.

If an optional SE-IP65CVR-G Hinged Cover is used, follow the included installation instructions. See Figs. 6 and 7.

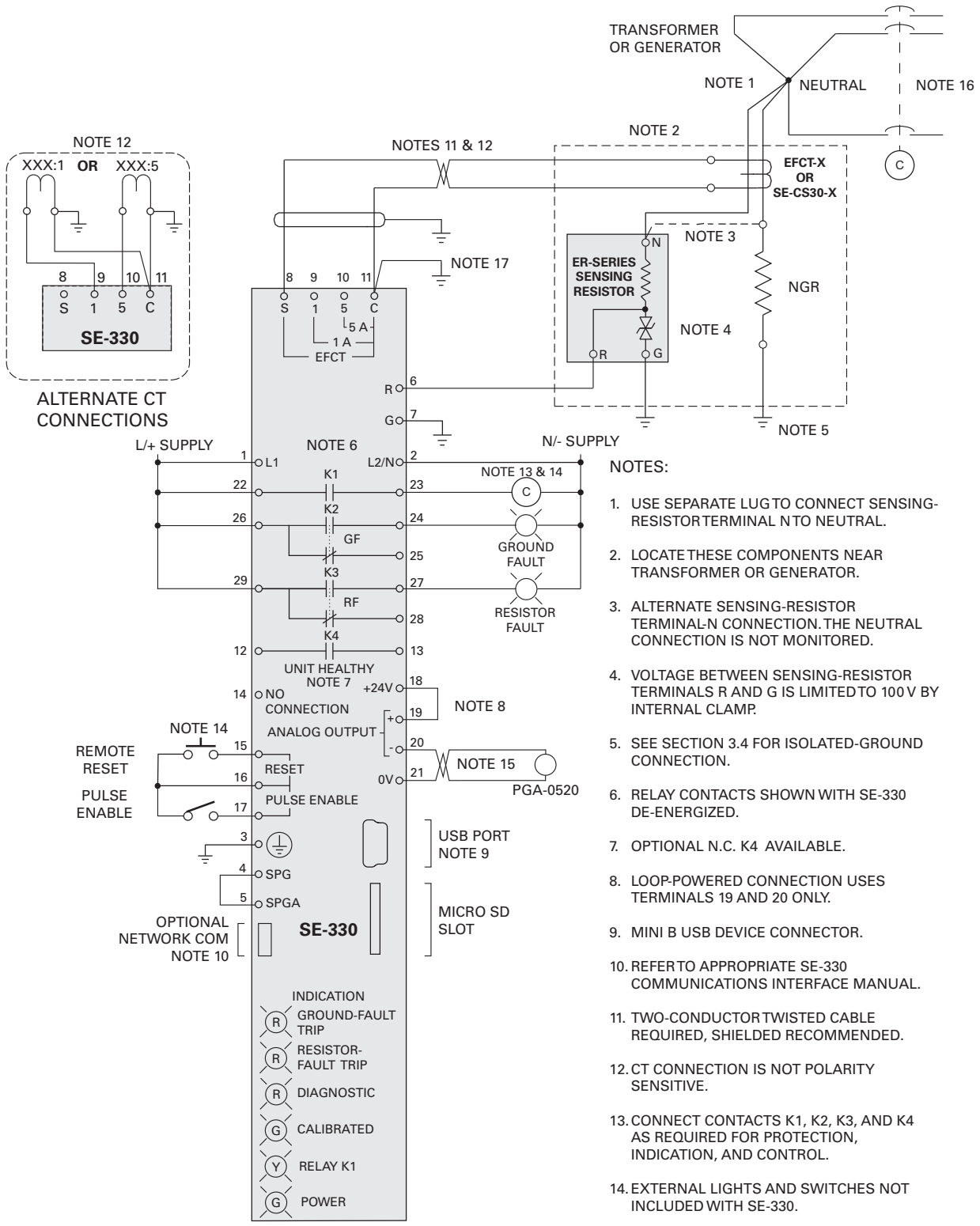
All connections to the SE-330 are made with plug-in, wire-clamping terminal blocks. Each plug-in terminal block can be secured to the SE-330 by two captive screws for reliable connections.

Outline dimensions and mounting details for surface mounting the SE-330 are shown in Fig. 5. Fasten the optional surface-mount adapter to the mounting surface and make connections to the adapter terminal blocks. Follow Fig. 5 instructions to mount or remove the SE-330.

Ground terminal 7 (G) and connect terminal 6 (R) to the sensing-resistor R terminal.

Use terminal 1 (L1) as the line terminal on ac systems, or the positive terminal on dc systems. Use terminal 2 (L2/N) as the neutral terminal on ac systems or the negative terminal on dc systems. Connect terminal 3 (⏚) to ground. Connect terminal 4 (SPG) to terminal 5 (SPGA).

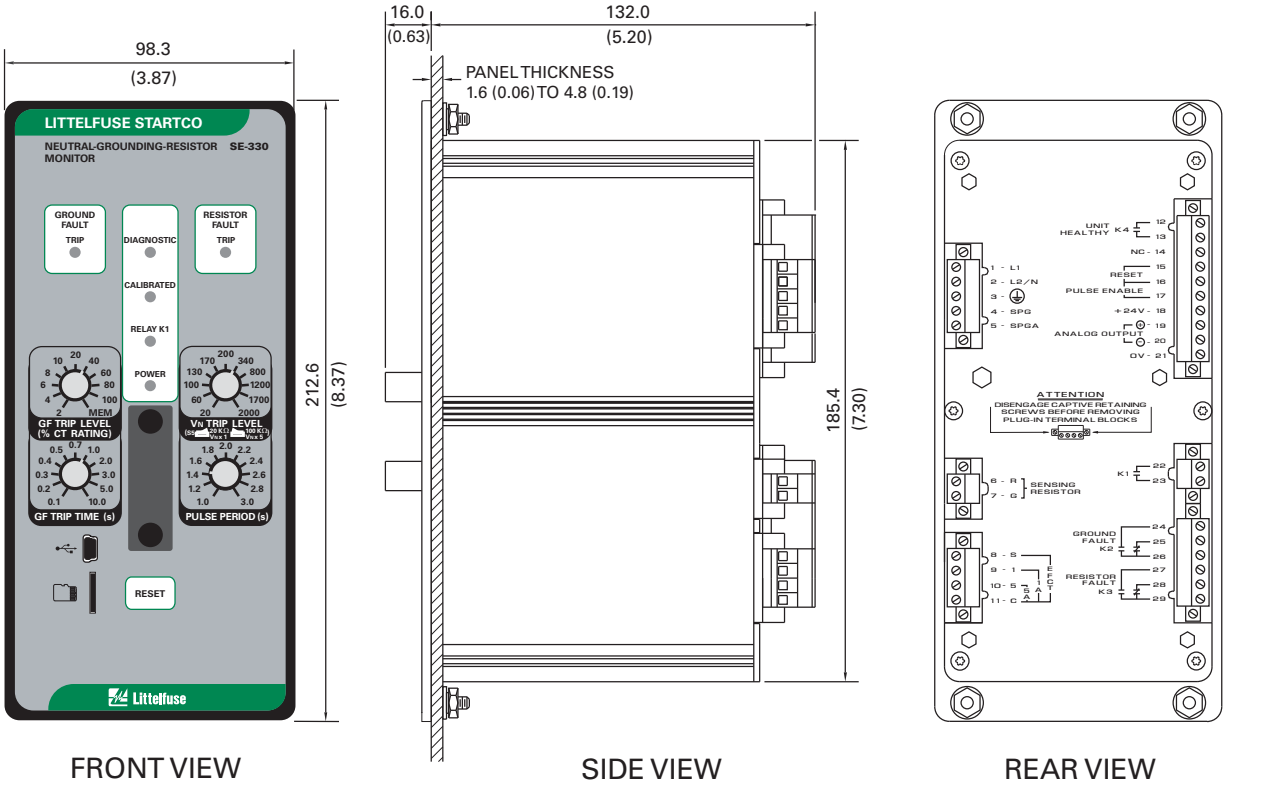
NOTE: Disconnect terminal 1 (L1) and terminal 2 (L2/N) before performing dielectric strength testing of the control panel.



NOTES:

1. USE SEPARATE LUG TO CONNECT SENSING-RESISTOR TERMINAL N TO NEUTRAL.
2. LOCATE THESE COMPONENTS NEAR TRANSFORMER OR GENERATOR.
3. ALTERNATE SENSING-RESISTOR TERMINAL-N CONNECTION. THE NEUTRAL CONNECTION IS NOT MONITORED.
4. VOLTAGE BETWEEN SENSING-RESISTOR TERMINALS R AND G IS LIMITED TO 100 V BY INTERNAL CLAMP.
5. SEE SECTION 3.4 FOR ISOLATED-GROUND CONNECTION.
6. RELAY CONTACTS SHOWN WITH SE-330 DE-ENERGIZED.
7. OPTIONAL N.C. K4 AVAILABLE.
8. LOOP-POWERED CONNECTION USES TERMINALS 19 AND 20 ONLY.
9. MINI B USB DEVICE CONNECTOR.
10. REFER TO APPROPRIATE SE-330 COMMUNICATIONS INTERFACE MANUAL.
11. TWO-CONDUCTOR TWISTED CABLE REQUIRED, SHIELDED RECOMMENDED.
12. CT CONNECTION IS NOT POLARITY SENSITIVE.
13. CONNECT CONTACTS K1, K2, K3, AND K4 AS REQUIRED FOR PROTECTION, INDICATION, AND CONTROL.
14. EXTERNAL LIGHTS AND SWITCHES NOT INCLUDED WITH SE-330.
15. SELF-POWERED 4-20 mA OUTPUT.
16. TYPICAL TRIPPING SYSTEM.
17. GROUND CURRENT SENSOR AT TERMINAL 11 ONLY.

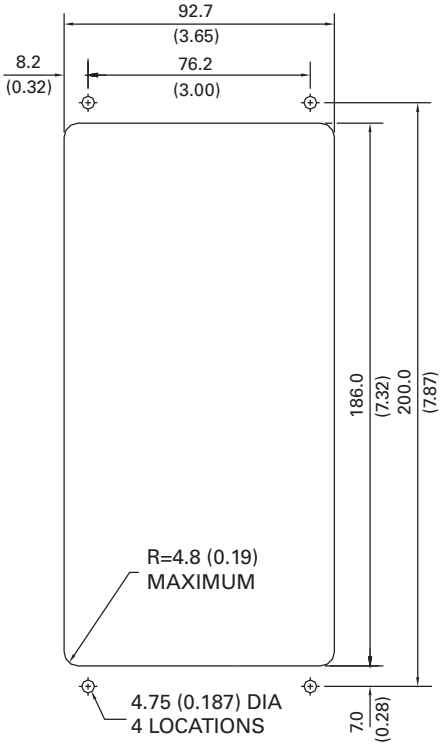
FIGURE 3. SE-330 Connection Diagram.



FRONT VIEW

SIDE VIEW

REAR VIEW

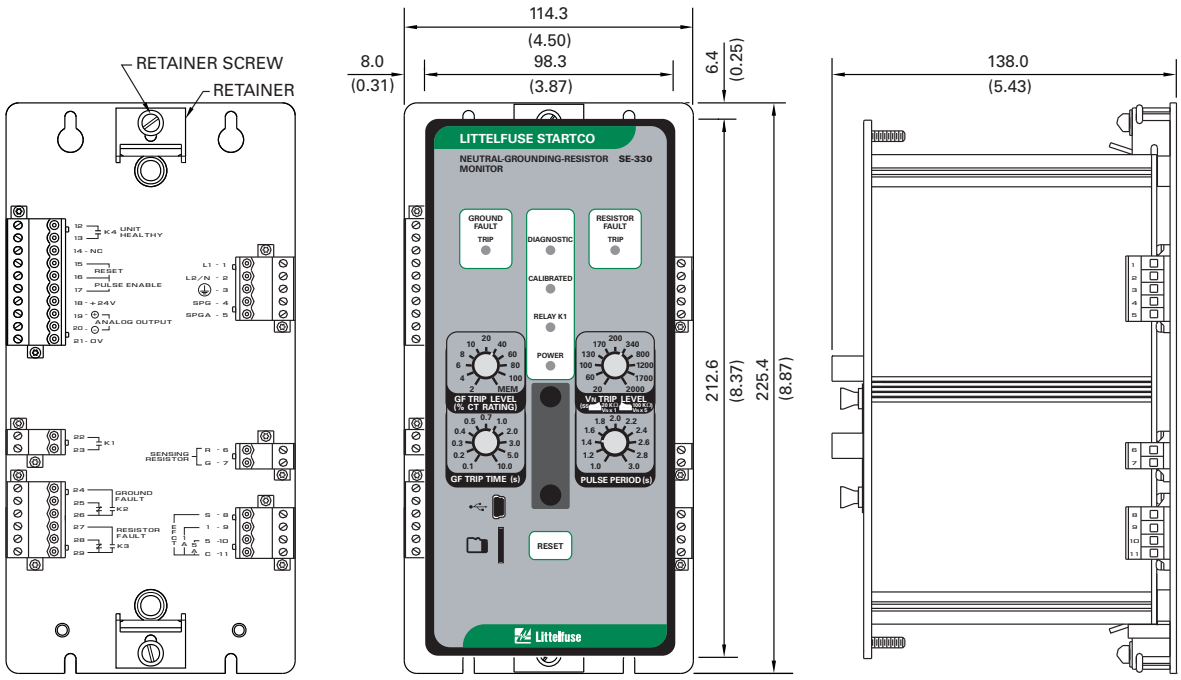


PANEL-MOUNT CUTOUT

NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).

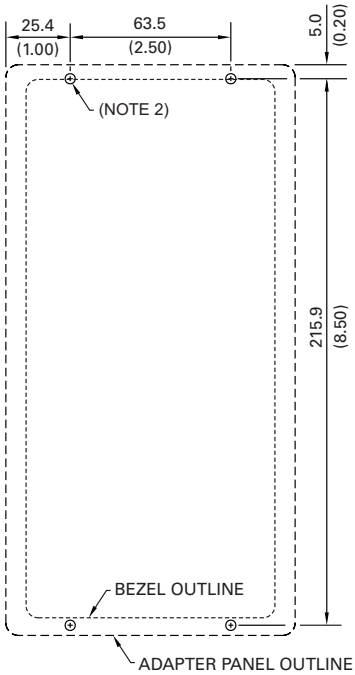
FIGURE 4. SE-330 Outline and Panel-Mounting Details.



FRONT VIEW
SE-330-SMA

FRONT VIEW

SIDE VIEW



MOUNTING DETAIL

NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. MOUNTING SCREWS: M4 OR 8-32 PANHEAD.

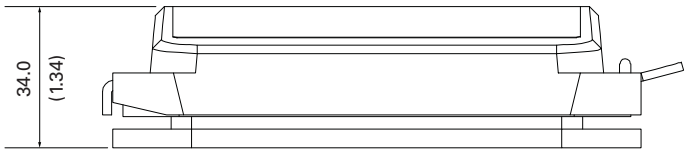
INSTALLATION

1. LOOSEN RETAINER SCREWS, MOVE RETAINERS OUTWARD AND TIGHTEN RETAINER SCREWS.
2. MATE MONITOR WITH ADAPTER PLUG-IN TERMINALS. LOOSEN RETAINER SCREWS TO LET RETAINERS SNAP OVER MONITOR BACKPLATE.
3. ENSURE THAT RETAINERS ARE AGAINST MONITOR BODY AND TIGHTEN RETAINER SCREWS.

REMOVAL

1. LOOSEN RETAINER SCREWS, SLIDE RETAINERS AWAY FROM MONITOR BODY AND TIGHTEN RETAINER SCREWS.
2. PULL MONITOR FORWARD.

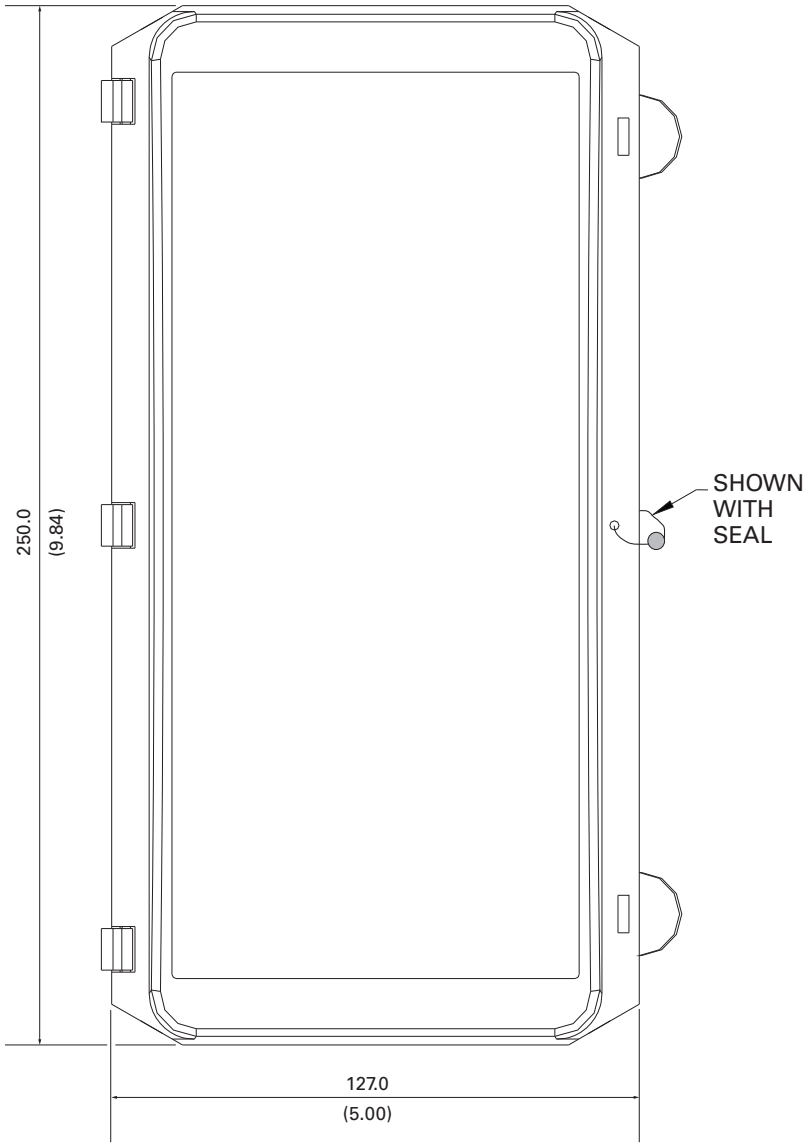
FIGURE 5. SE-330 Outline and Surface-Mounting Details.



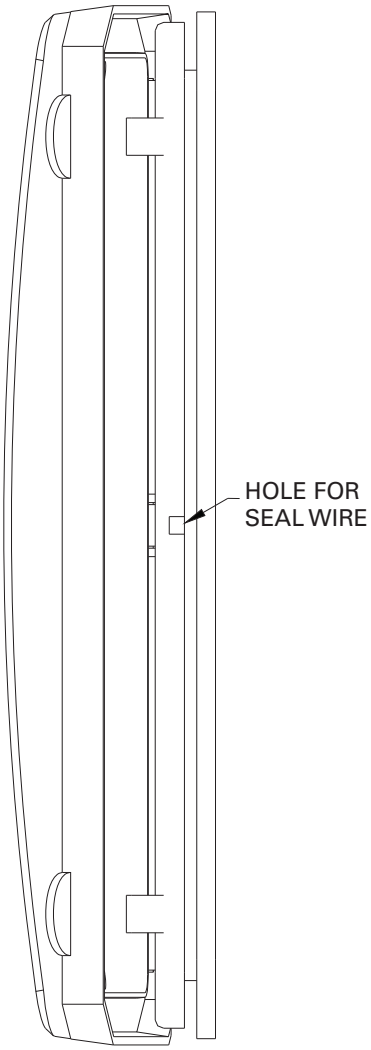
TOP VIEW

TO PREVENT UNAUTHORIZED ENTRY:

1. USE WIRE SEAL THROUGH HOLES IN WEATHERPROOF COVER ASSEMBLY, OR
2. SECURE WITH THE PLASTIC THREAD FORMING SCREW SUPPLIED IN KIT.



FRONT VIEW



SIDE VIEW

NOTES:

1. DIMENSIONS SHOWN IN MILLIMETRES (INCHES).
2. SHOWN WITH WEATHERPROOF SNAPS CLOSED.
3. REFER TO PANEL MOUNTING CUTOUT (FIGURE 4) FOR PANEL MOUNTING DETAIL.

FIGURE 6. SE-IP65CVR-G Weatherproof Cover Outline.

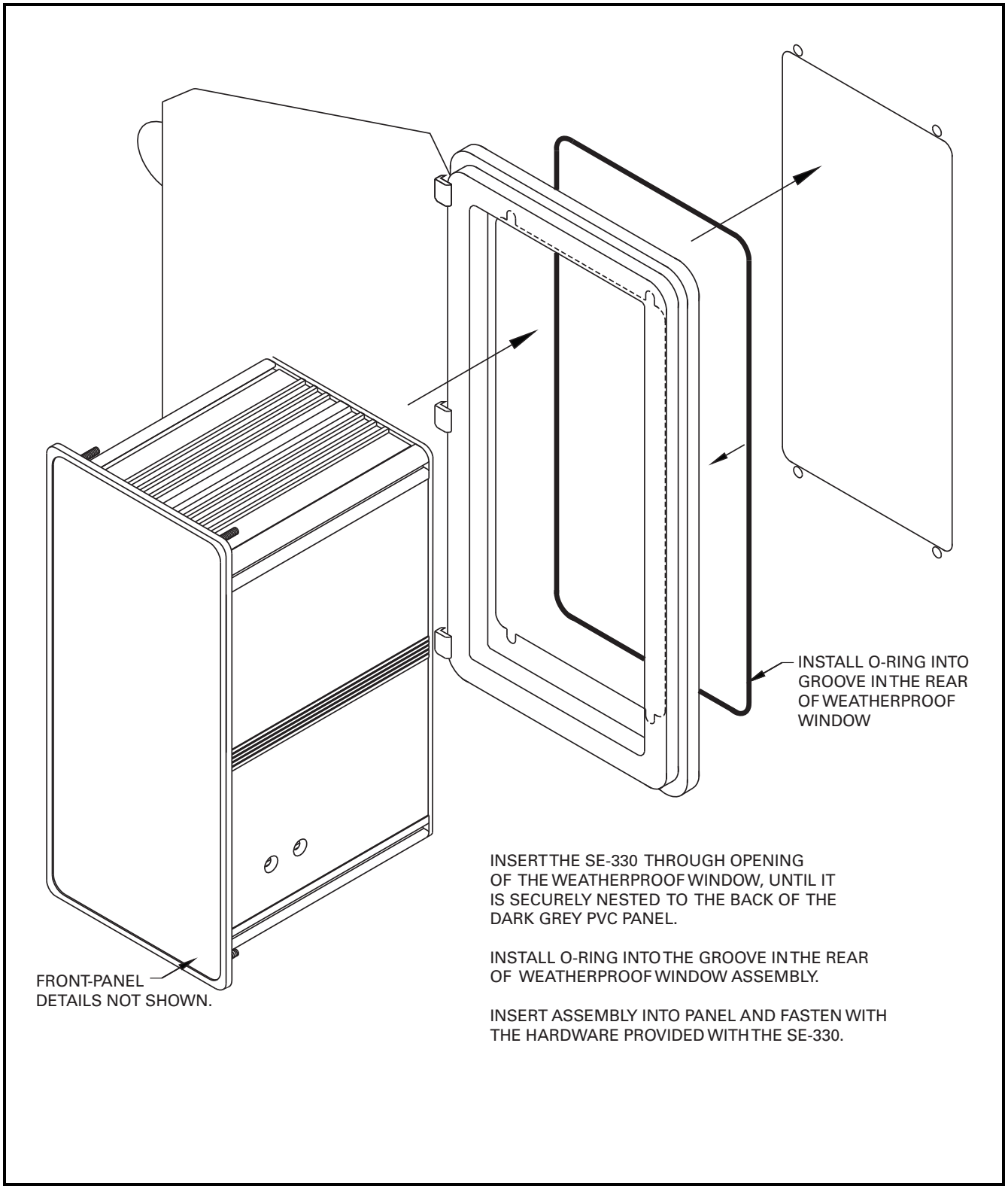


FIGURE 7. SE-IP65CVR-G Weatherproof Cover Installation.

3.2 SENSING RESISTOR

Outline and mounting details for the ER-600VC, ER-5KV, ER-5WP, ER-15KV, ER-25KV, and ER-35KV sensing resistors are shown in Figs. 8, 11, 12, 13, 14, and 15. Install the NGR and the sensing resistor near the transformer or generator. When installed outdoors, a sensing resistor must be installed in a suitable enclosure. An optional SE-MRE-600 Moisture-Resistant Enclosure is available for applications which may expose an ER-600VC to moisture. See Figs. 9 and 10. The weather-protected ER-5WP shown in Fig. 12 is an ER-5KV with moisture-resistant terminal covers. Use an ER-5WP in applications in which it might be exposed to moisture. The ER-15KV, ER-25KV, and ER-35KV include moisture-resistant terminal covers. Use suitable water-tight fittings. Ground sensing-resistor terminal G. Pass the sensing-resistor-to-neutral conductor and the NGR-to-neutral conductor through the ground-fault-CT window as shown in Fig. 3. Separately connect sensing-resistor terminal N and the NGR to the neutral to include neutral connections in the monitored loop. Alternately, if the NGR connection to system neutral need not be monitored, connect terminal N to the NGR neutral terminal.

If a ground fault in the sensing-resistor conductor is unlikely, a minimal loss of protection will result if it does not pass through the ground-fault-CT window. See Note 3 in Fig. 3.

NOTE: Voltage at terminal N rises to line-to-neutral voltage when a ground fault occurs. The same clearances are required for sensing resistors as for NGR's.

NOTE: A parallel ground path created by moisture can result in a false resistor-fault trip. Moisture sources include wind-driven rain or snow, and condensation. Sensing-resistor terminal R and its connection to SE-330 terminal R, including interposing terminal blocks, must remain dry.

NOTE: The neutral-to-sensing-resistor-terminal-N connection is not a neutral conductor as defined in Canadian Electrical Code Section 10-1108 and National Electrical Code Section 250.36(B). It is not required to be 8 AWG (8.36 mm^2) or larger. Since current through this conductor is always less than 250 mA, a 14 AWG (2.08 mm^2) conductor insulated to the system voltage is more than sufficient.

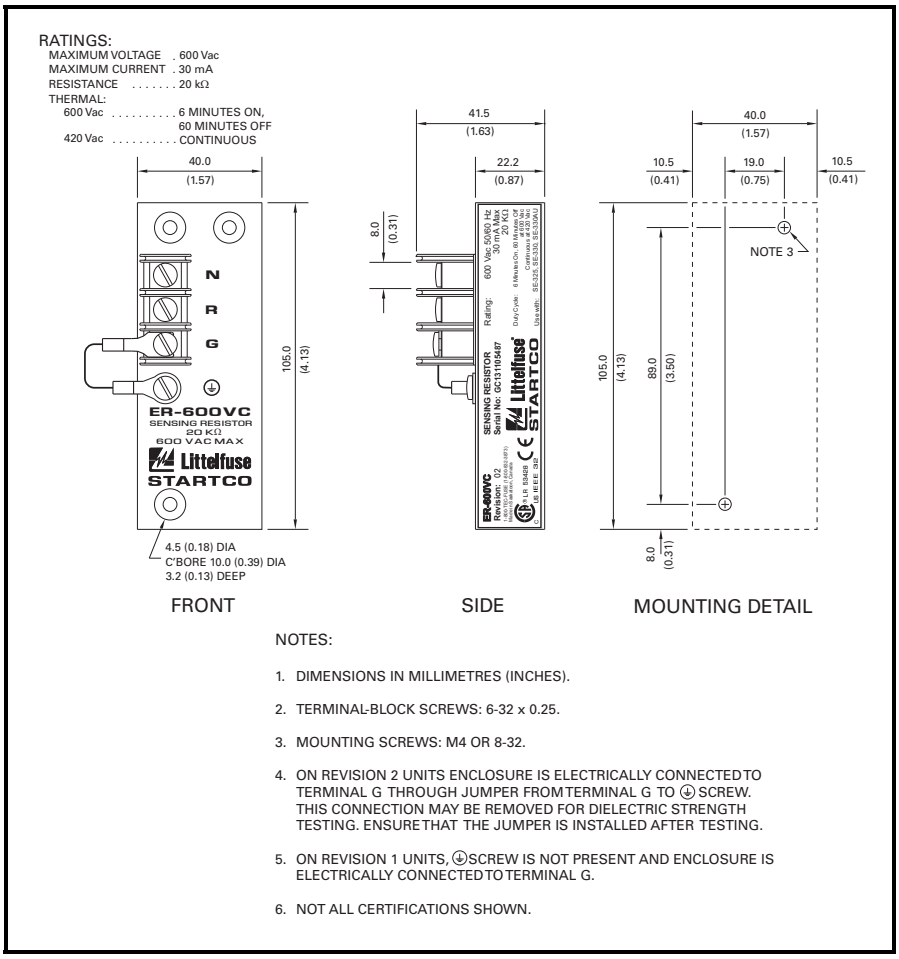
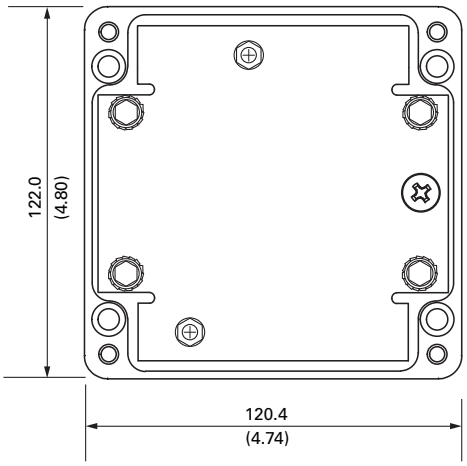
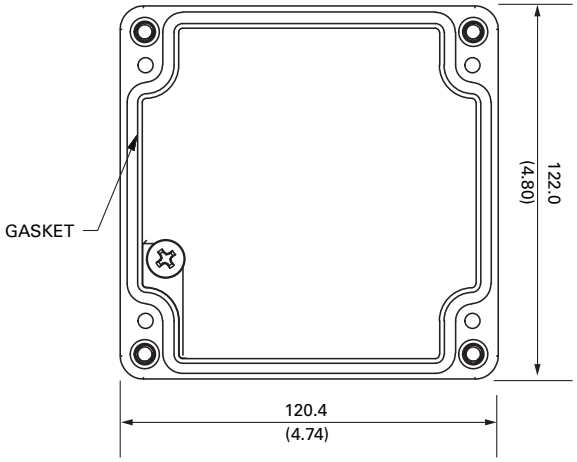


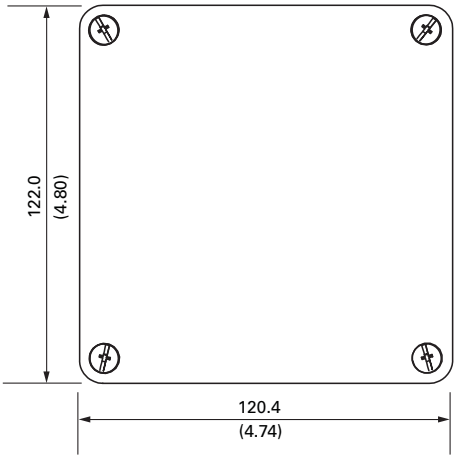
FIGURE 8. ER-600VC Sensing Resistor.



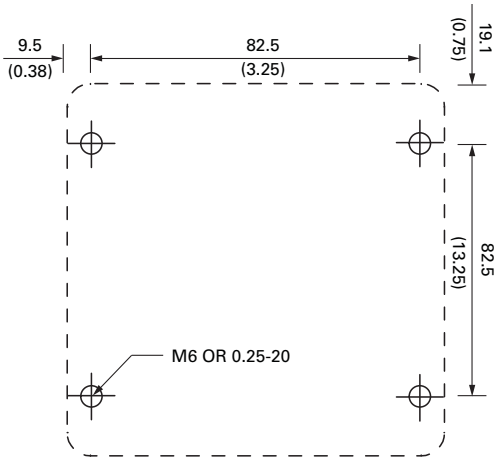
ENCLOSURE - TOP VIEW
(COVER REMOVED)



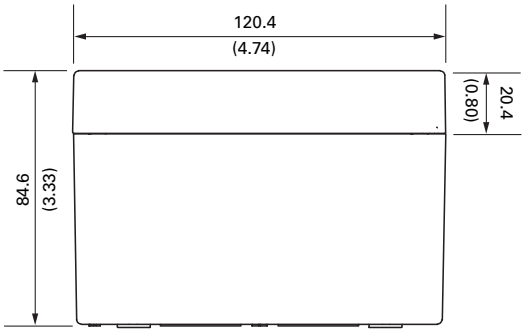
COVER - INSIDE VIEW



ENCLOSURE - TOP VIEW



MOUNTING DETAIL

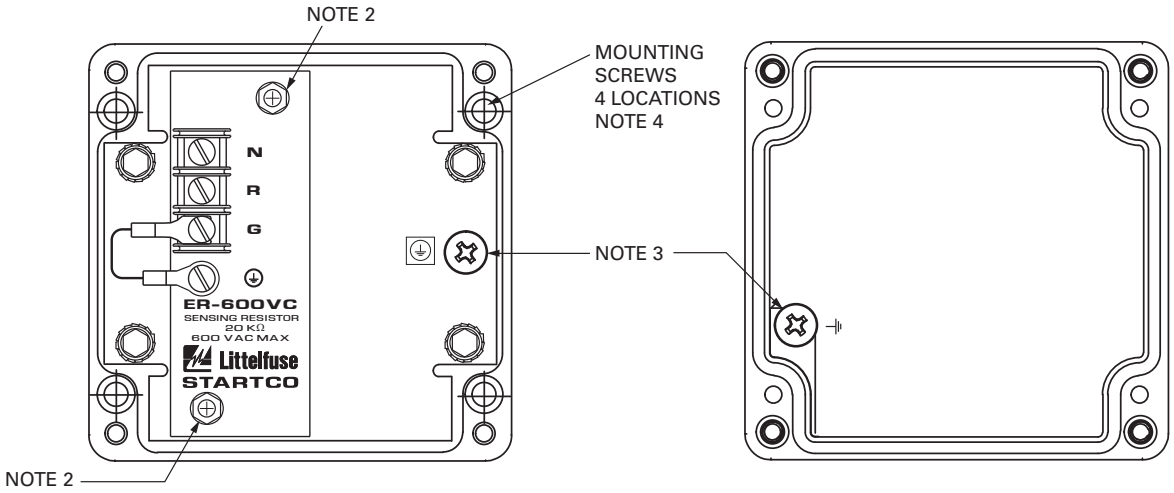


ENCLOSURE - SIDE VIEW

NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. MOUNTING SCREWS: M6 OR 0.25-20.

FIGURE 9. SE-MRE-600 Moisture-Resistant Enclosure Outline.



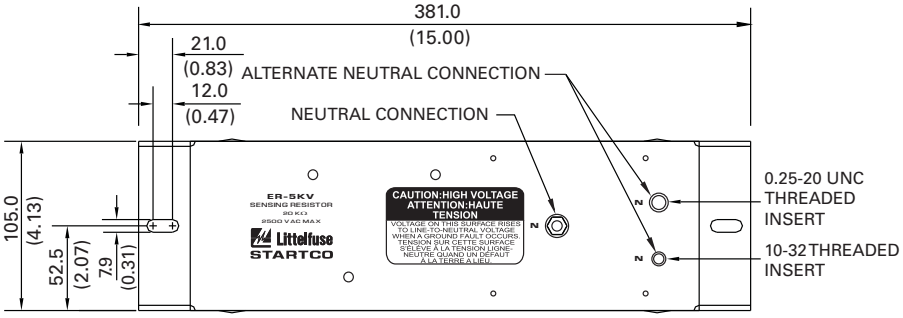
ASSEMBLY INSTRUCTIONS

1. DRILL HOLE FOR ENCLOSURE WIRE ENTRY. USE LIQUID-TIGHT FITTING.
2. REMOVE NYLON NUTS AND WASHERS. INSERT ER-600VC INTO ENCLOSURE. REPLACE NUTS AND WASHERS.
3. ATTACH GROUND WIRE FROM ENCLOSURE TO COVER AND TO ER-600VC TERMINAL G.
4. MOUNT SE-MRE-600 IN PLACE USING M6 OR 0.25-20.
5. COMPLETE OTHER WIRING AND REPLACE COVER.

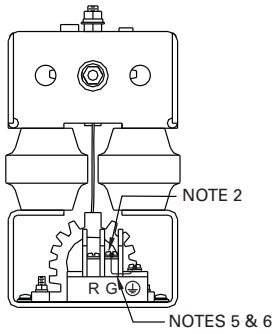
FIGURE 10. ER-600VC Installed in SE-MRE-600.

RATINGS:

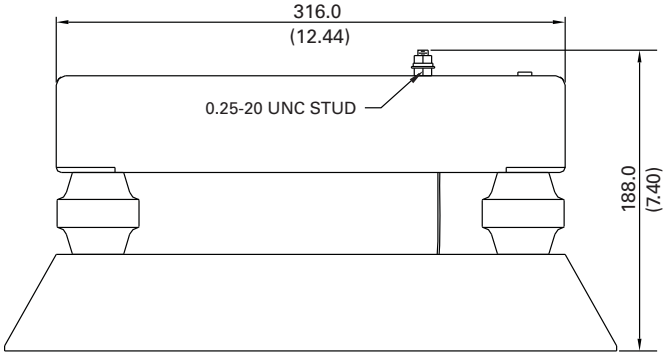
MAXIMUM VOLTAGE . 2,500 Vac
MAXIMUM CURRENT. 125 mA
RESISTANCE . . . . . 20 kΩ
THERMAL . . . . . CONTINUOUS
TORQUE
TERMINAL N (3 LOCATIONS)
10-32 INSERT. . . . . 5.6 N-m (50 in-lb)
OTHERS . . . . . 9.0 N-m (80 in-lb)



TOP VIEW



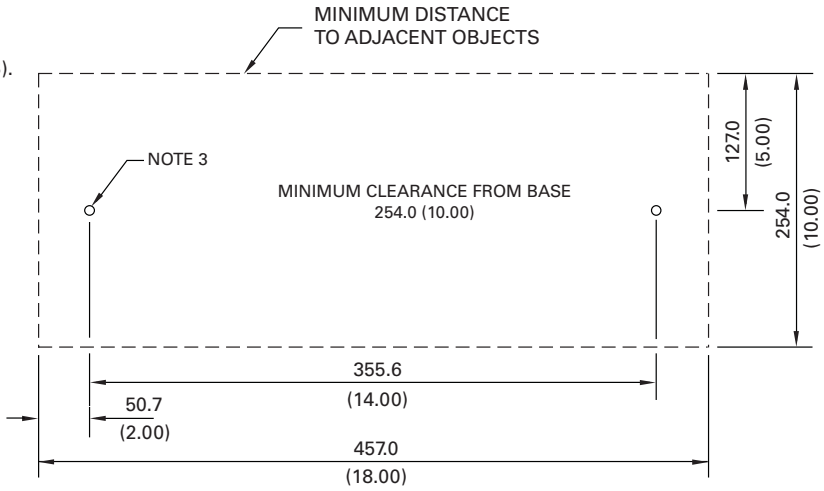
SIDE VIEW



FRONT VIEW

NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. TERMINAL-BLOCK SCREWS: 6-32 x 0.25.
3. MOUNTING SCREWS: M6 OR 0.25-20.
4. THIS DEVICE CAN DISSIPATE 300 WATTS. TO MINIMIZE SURFACE TEMPERATURES FOR SYSTEMS ALLOWED TO OPERATE CONTINUOUSLY WITH A GROUND FAULT, MOUNT VERTICALLY WITH R & G TERMINALS DOWN.
5. ON REVISION 2 UNITS BASE IS ELECTRICALLY CONNECTED TO TERMINAL G THROUGH JUMPER FROM TERMINAL G TO ⏚ SCREW. THIS CONNECTION MAY BE REMOVED FOR DIELECTRIC STRENGTH TESTING. ENSURE THAT THE JUMPER IS INSTALLED AFTER TESTING.
6. ON REVISION 0 & 1 UNITS ⏚ SCREW IS NOT PRESENT AND BASE IS ELECTRICALLY CONNECTED TO TERMINAL G.
7. CERTIFICATIONS NOT SHOWN.

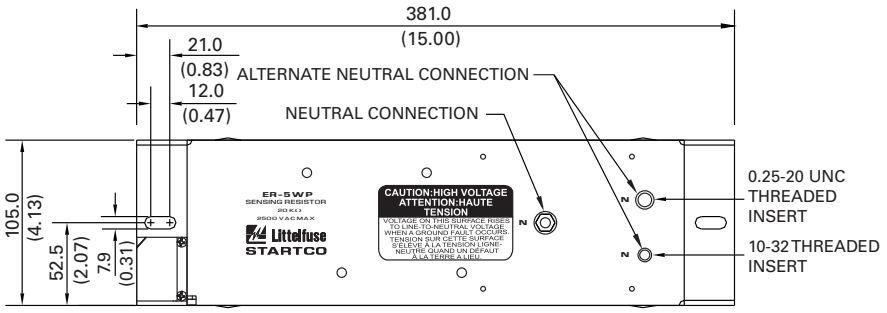


MOUNTING DETAIL

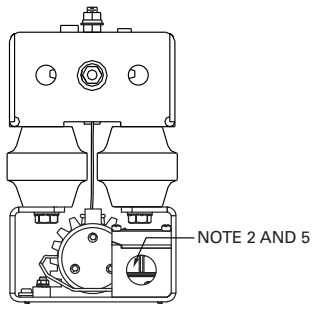
FIGURE 11. ER-5KV Sensing Resistor.

RATINGS:

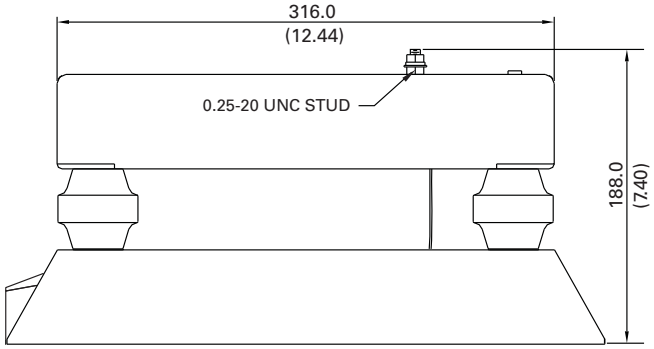
MAXIMUM VOLTAGE . 2,500 Vac
MAXIMUM CURRENT. 125 mA
RESISTANCE . . . . . 20 kΩ
THERMAL . . . . . CONTINUOUS
TORQUE
TERMINAL N (3 LOCATIONS)
10-32 INSERT. . . . . 5.6 N-m (50 in-lb)
OTHERS . . . . . 9.0 N-m (80 in-lb)



TOP VIEW



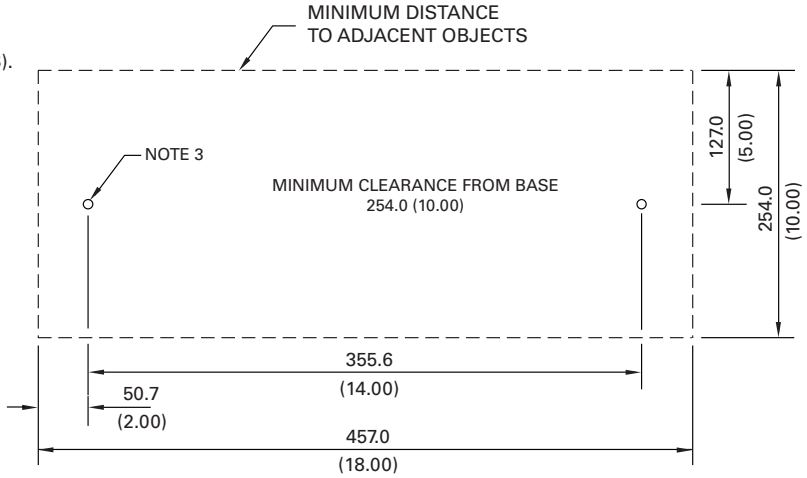
SIDE VIEW



FRONT VIEW

NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. TERMINAL-BLOCK SCREWS: 6-32 x 0.25 CABLE ACCESS OPENING IS 1/2 NPT. USE A LIQUID-TIGHT FITTING FOR CABLE ENTRY.
3. MOUNTING SCREWS: M6 OR 0.25-20.
4. THIS DEVICE CAN DISSIPATE 300 WATTS. TO MINIMIZE SURFACE TEMPERATURES FOR SYSTEMS ALLOWED TO OPERATE CONTINUOUSLY WITH A GROUND FAULT, MOUNT VERTICALLY WITH R & G TERMINALS DOWN.
5. BASE IS ELECTRICALLY CONNECTED TO TERMINAL G THROUGH JUMPER FROM TERMINAL G TO ⏚ SCREW. THIS CONNECTION MAY BE REMOVED FOR DIELECTRIC STRENGTH TESTING. ENSURE THAT THE JUMPER IS INSTALLED AFTER TESTING.
6. CERTIFICATIONS NOT SHOWN.



MOUNTING DETAIL

FIGURE 12. ER-5WP Sensing Resistor.

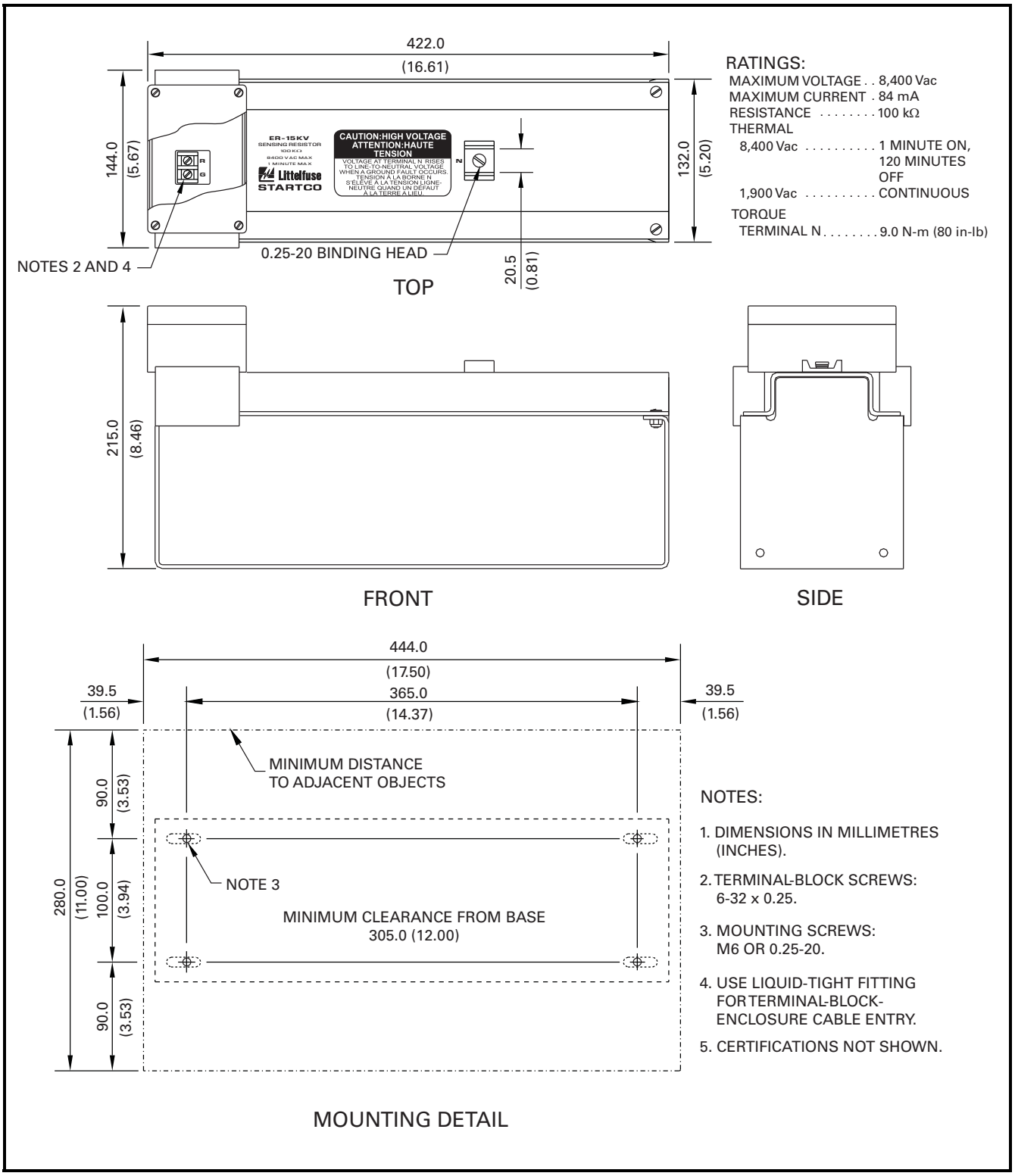


FIGURE 13. ER-15KV Sensing Resistor.

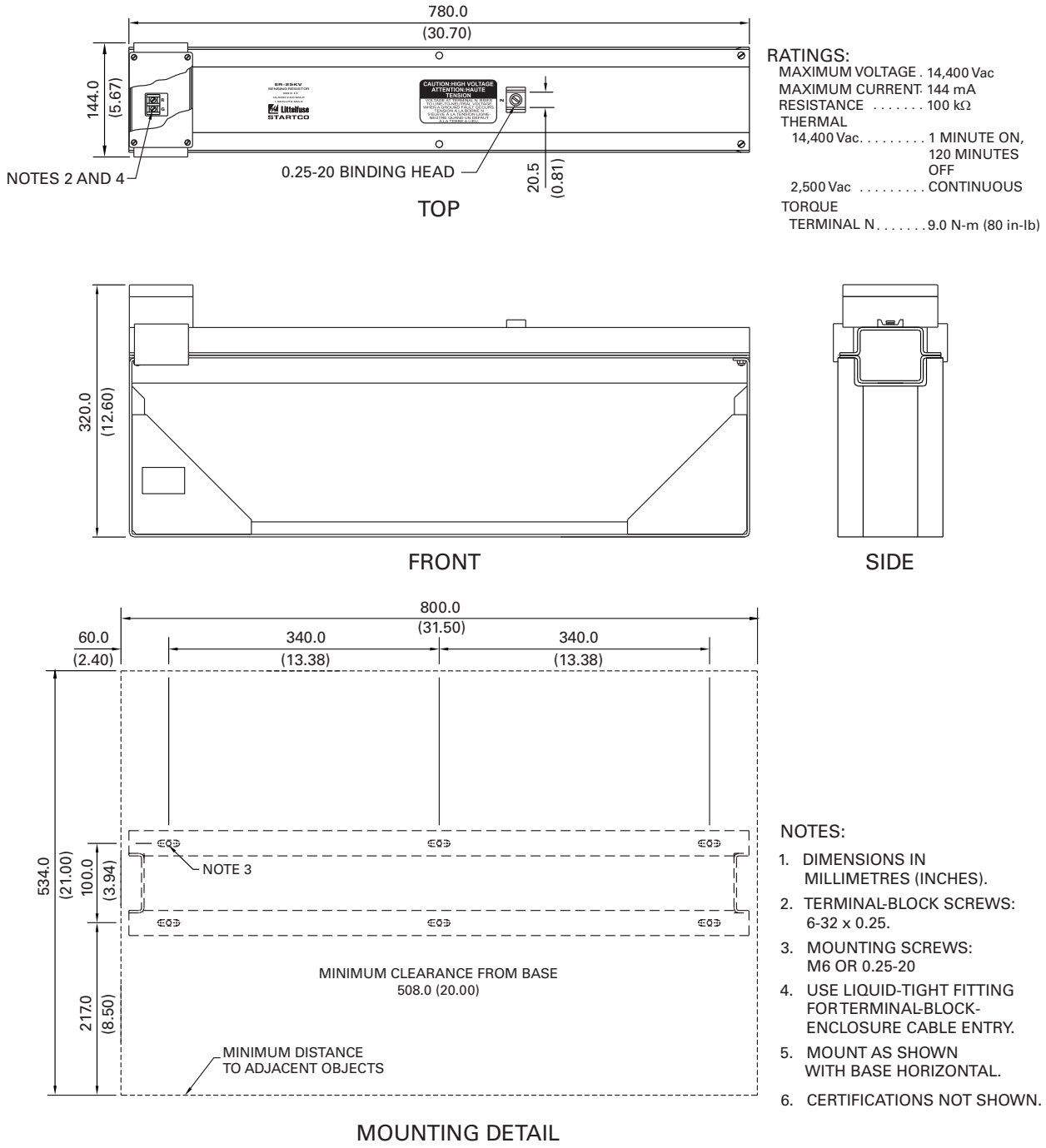
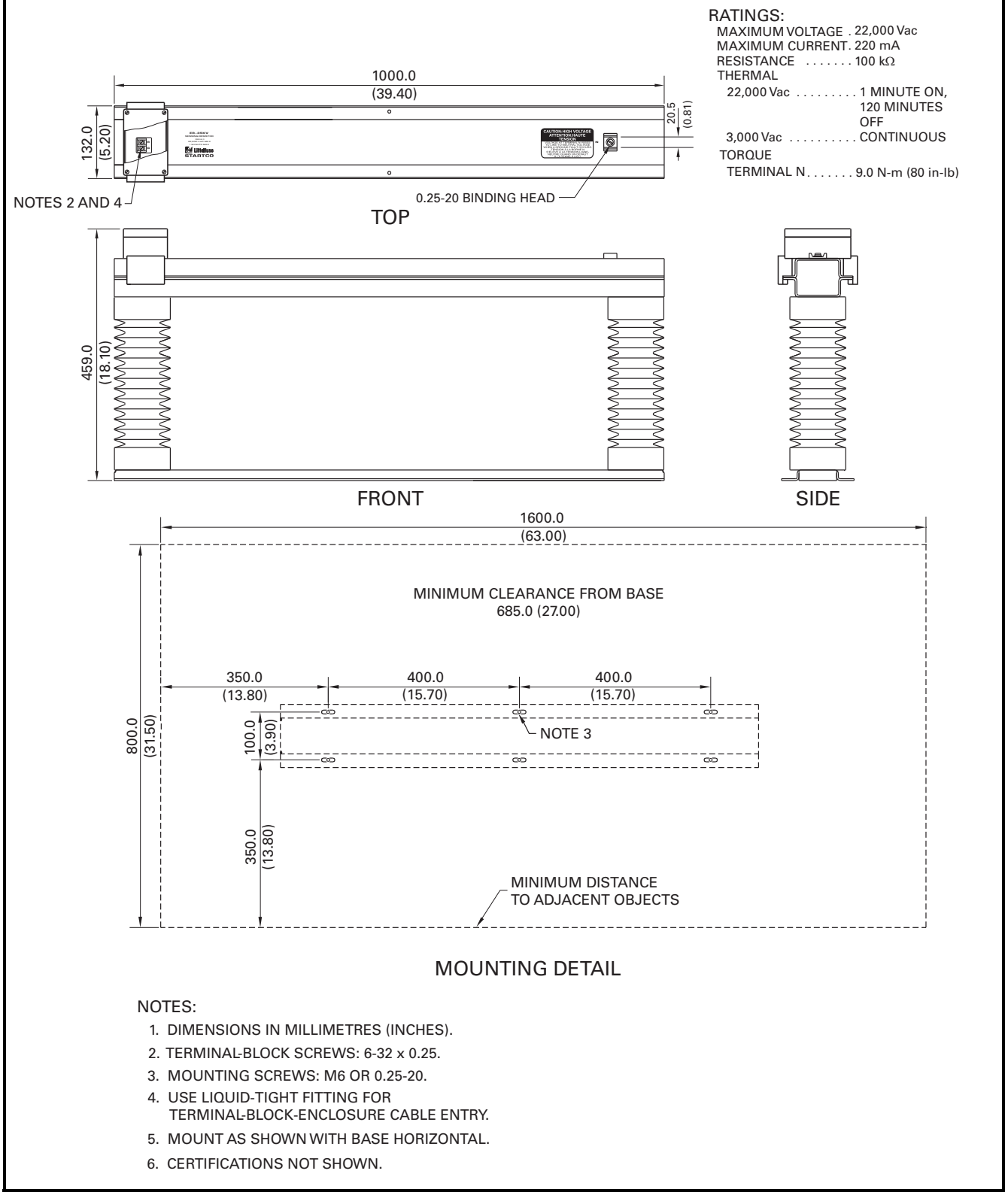


FIGURE 14. ER-25KV Sensing Resistor.



NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. TERMINAL-BLOCK SCREWS: 6-32 x 0.25.
3. MOUNTING SCREWS: M6 OR 0.25-20.
4. USE LIQUID-TIGHT FITTING FOR TERMINAL-BLOCK-ENCLOSURE CABLE ENTRY.
5. MOUNT AS SHOWN WITH BASE HORIZONTAL.
6. CERTIFICATIONS NOT SHOWN.

FIGURE 15. ER-35KV Sensing Resistor.

3.3 GROUND-FAULT CT

Select and install a ground-fault CT that will provide the desired trip level. Typically, the CT-primary rating should be approximately equal to the NGR let-through-current rating. This provides an appropriate GF TRIP LEVEL setting range and analog-output scaling. See Sections 2.1.2 and 2.9.

Outline and mounting details for the EFCT- and SE-CS30-series current sensors are shown in Figs. 16, 17, and 18. Ground-fault-CT connections and the typical ground-fault-CT location are shown in Fig. 3.

For SE-325 replacement applications, the existing CT200 current sensor will typically have to be replaced. However, where replacement is not necessary or possible, the CT200 can be connected to either the 1- or 5-A input. This CT has a 200:5 current ratio. If connected to the 1-A input, the ground-fault trip level will be a percentage of 40 A. See Section 2.1.2.

The accuracy of a typical current sensor, including the CT200, decreases below 5% of its current rating. CT-primary current-injection testing is recommended to verify trip levels below 5% of the CT-primary rating. See Section 9.4. Littelfuse Startco current sensors are designed for use at low levels and respond linearly to 2% current rating.

NOTE: The current-sensor insulation class is of no consequence if its secondary is grounded and the conductors through its window are insulated for the system voltage. Medium-voltage systems may require a bushing-type CT.

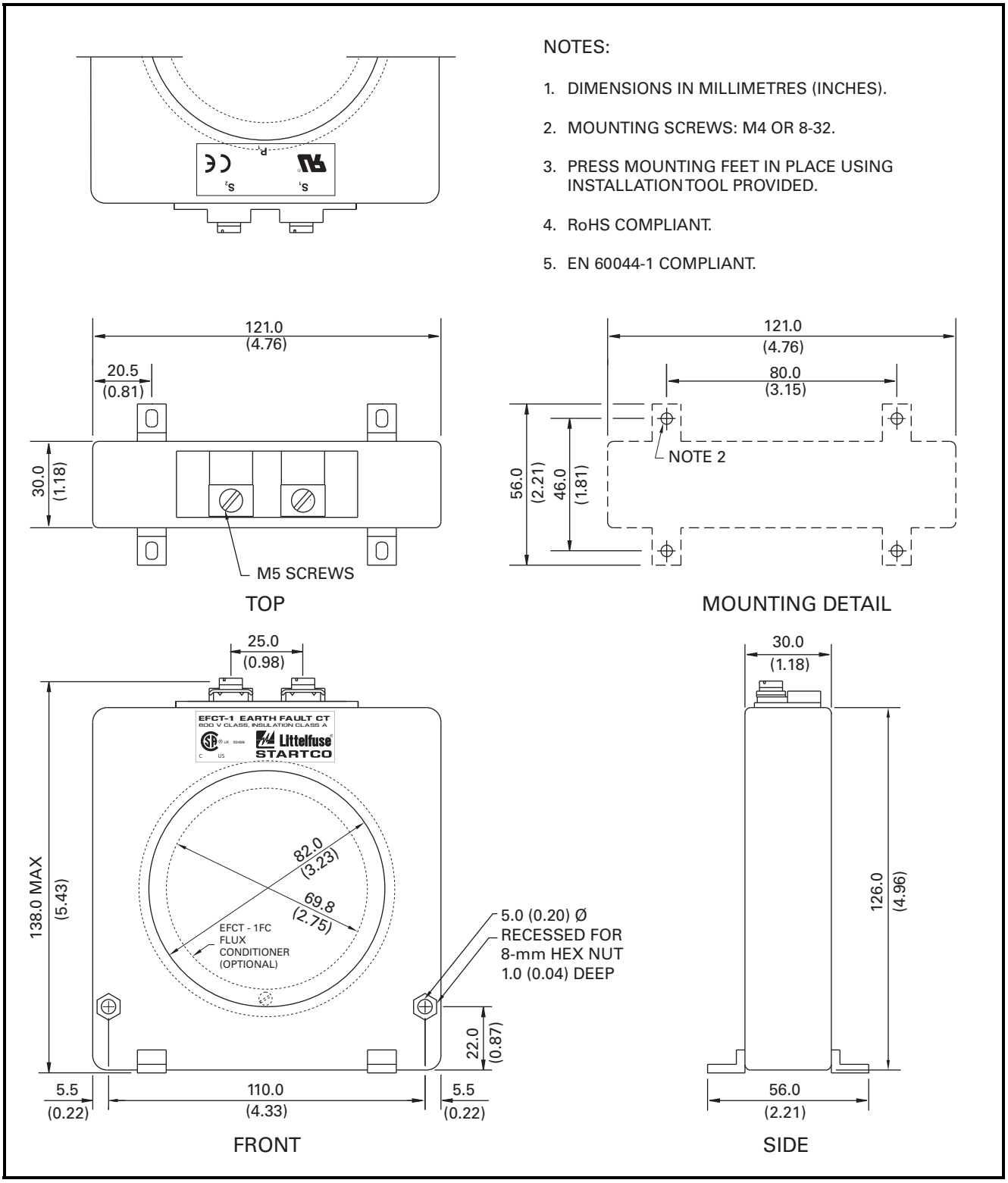
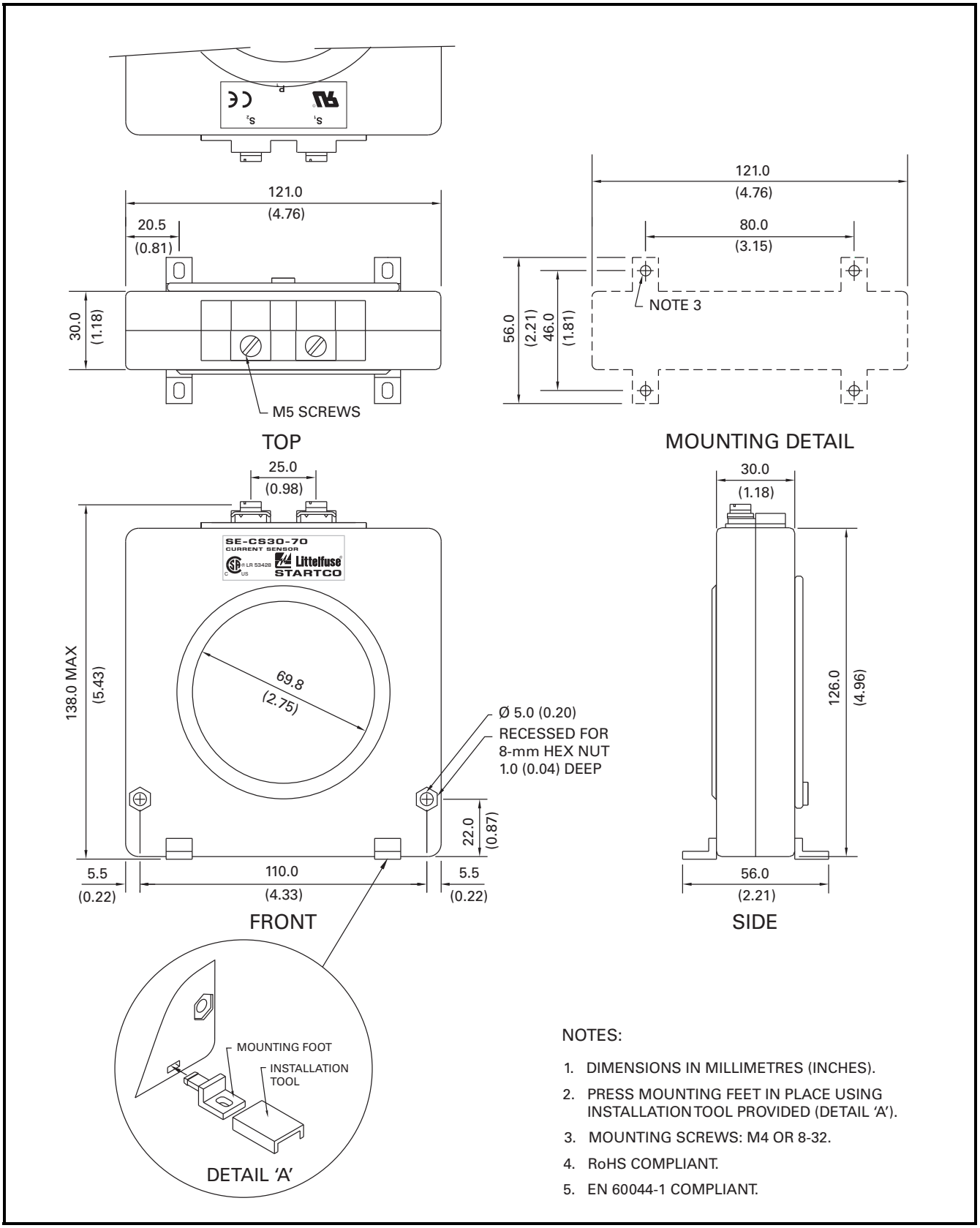


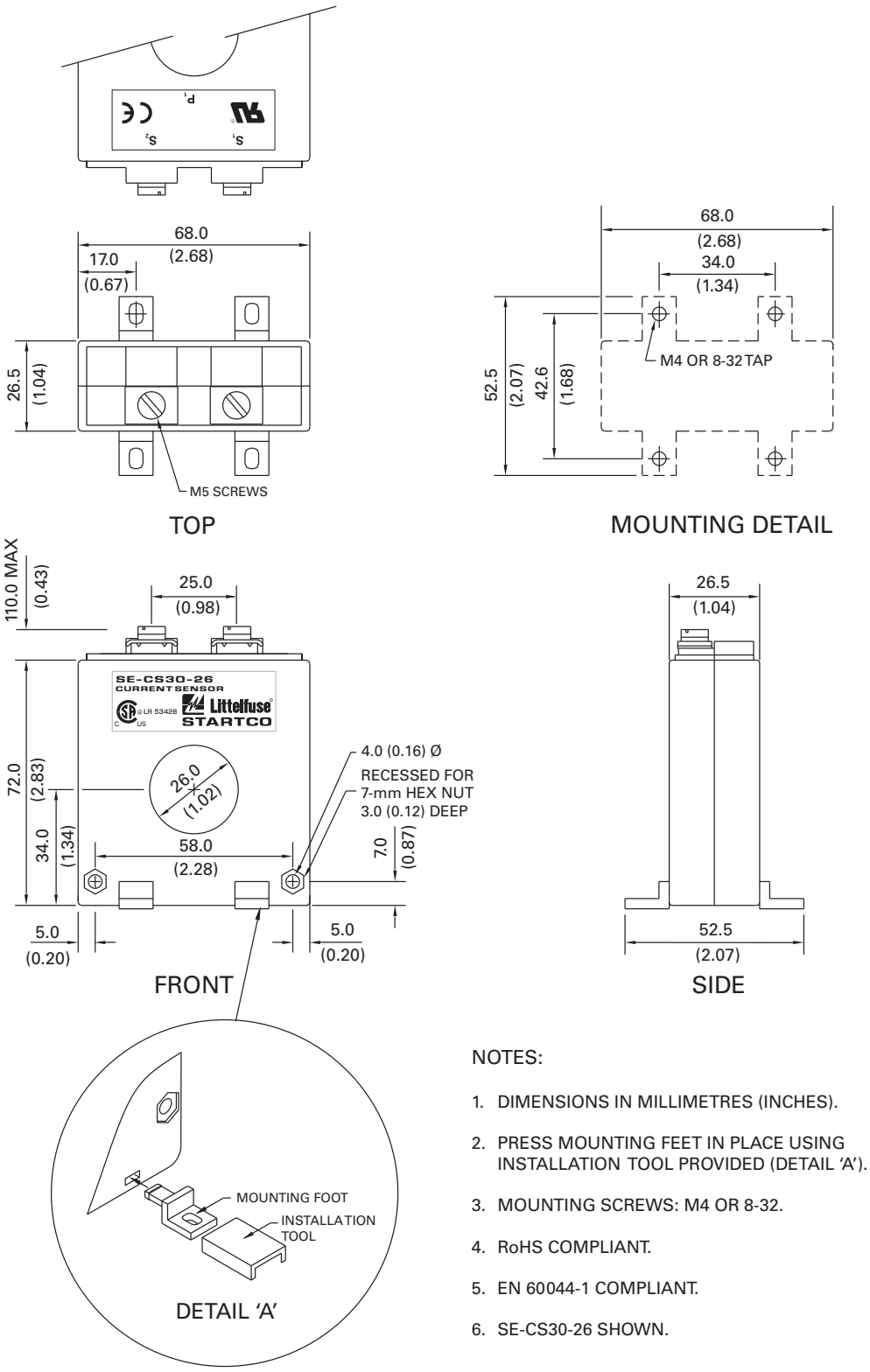
FIGURE 16. EFCT-1 Ground-Fault Current Sensor.



NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. PRESS MOUNTING FEET IN PLACE USING INSTALLATION TOOL PROVIDED (DETAIL 'A').
3. MOUNTING SCREWS: M4 OR 8-32.
4. RoHS COMPLIANT.
5. EN 60044-1 COMPLIANT.

FIGURE 17. SE-CS30-70 Ground-Fault Current Sensor.



NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. PRESS MOUNTING FEET IN PLACE USING INSTALLATION TOOL PROVIDED (DETAIL 'A').
3. MOUNTING SCREWS: M4 OR 8-32.
4. RoHS COMPLIANT.
5. EN 60044-1 COMPLIANT.
6. SE-CS30-26 SHOWN.

FIGURE 18. EFCT-26 and SE-CS30-26 Ground-Fault Current Sensors.

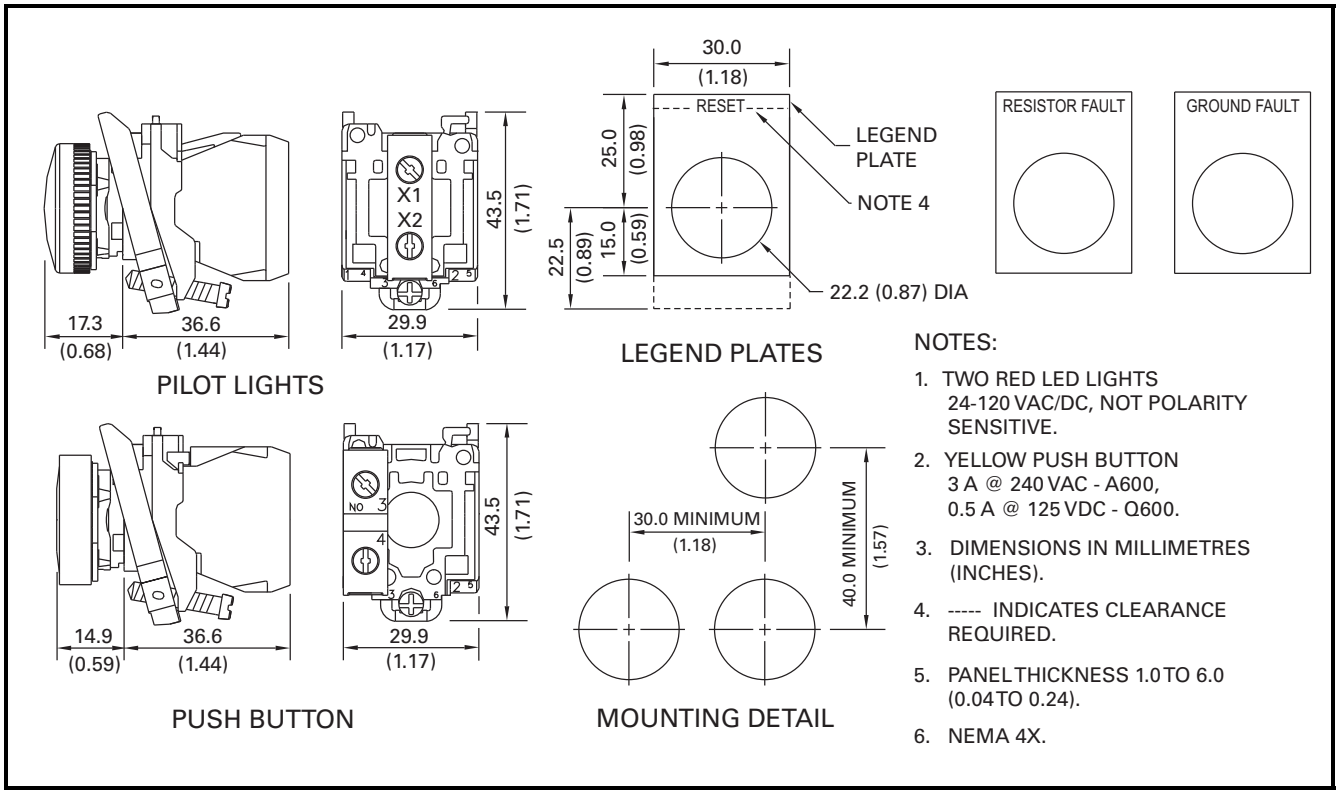


FIGURE 19. RK-332 Remote Indication and Reset.

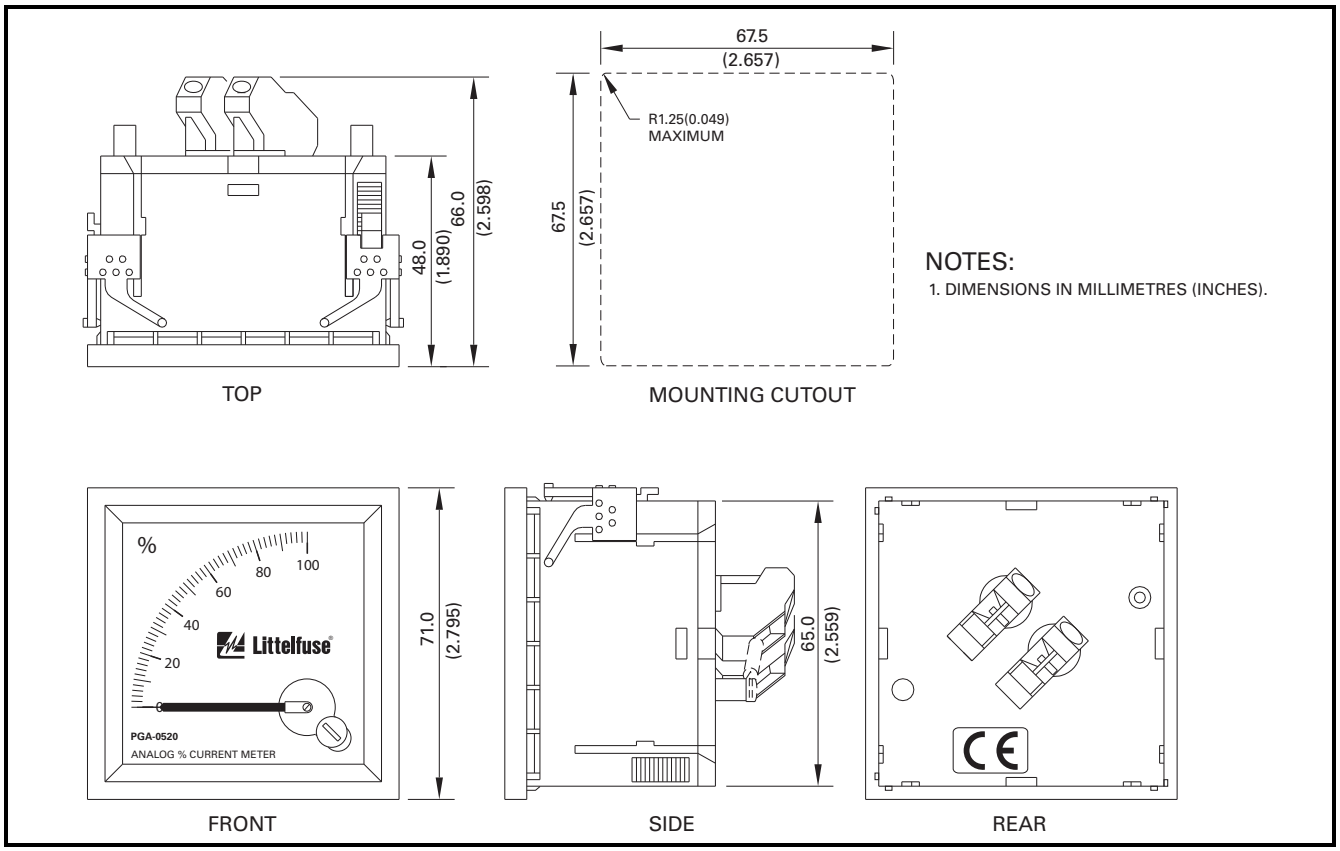


FIGURE 20. PGA-0520 Analog Percent Current Meter.

3.4 ISOLATED GROUND CONNECTION

An isolated ground bed can prevent a ground potential rise (GPR) from being transferred to remote equipment. If the G terminals on the sensing resistor and the SE-330 are connected to an isolated ground, the SE-330 will be exposed to the GPR. If the GPR is greater than the terminal-block rating, the SE-330 must be isolated from station ground and precautions must be taken with the power supply and the trip contacts. See Technical Note RG-1 "NGR Monitoring with Isolated Ground Beds" at www.littelfuse.com/relayscontrols.

A configuration which allows an SE-330 to be connected to station ground is shown in Fig. 21. The SE-330 monitors the series combination of the NGR and the two ground beds. This configuration is acceptable provided the series resistance of the NGR and the ground beds is within the NGR calibration range and ground-bed- resistance changes remain within the trip range. See Section 6.1.

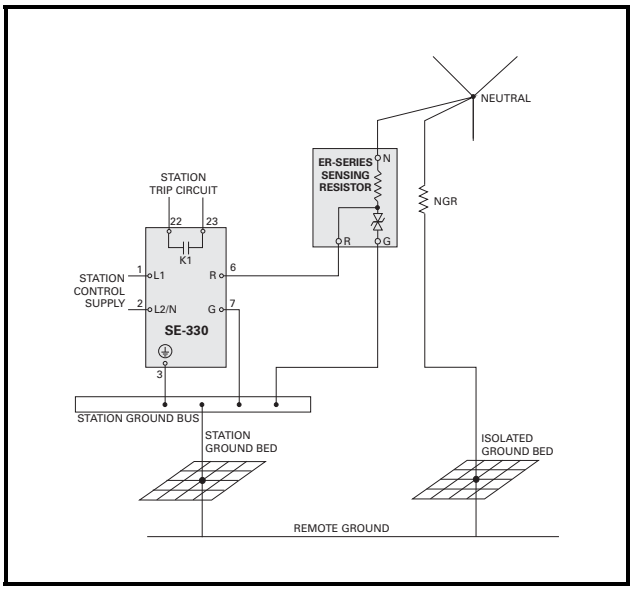


FIGURE 21. Simplified Isolated-Ground Connection.

3.5 PULSING CONNECTION

Set switch S1 to K1 = PULSING and use an external switch as shown in Fig. 22 to use relay K1 to control a pulsing contactor. Relays K2 and K3 can be used for tripping and can be configured in the fail-safe or non-fail-safe mode using the SE-MON330 software.

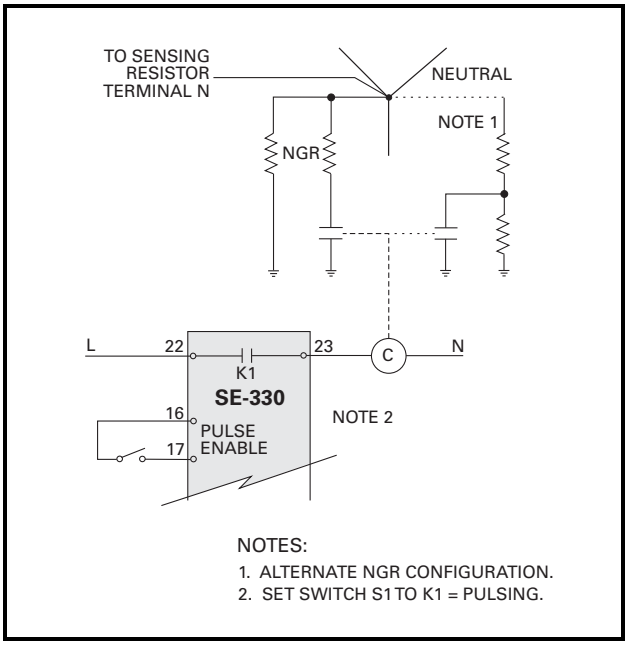


FIGURE 22. Simplified Pulsing Connection.

4. DATA INTERFACES

4.1 SD CARD

The SE-330 supports microSD™ data storage. The microSD™ card port is located on the front panel just below the USB port. The microSD™ card is used for long-term data logging of measured values and for firmware upgrades.

4.1.1 DATALOGGING

When a microSD™ card is installed, the SE-330 looks for a directory called "Datalogging". If this directory exists, data logging will automatically start after the card is indexed (indexing may take several minutes depending on the size of the card and the number of files).

The log is updated every two seconds and it includes measured values, configuration parameters, and trip status. A new log file is created at the start of each day. If previous log files exist and the microSD™ card has less than 20 MB of free space, the oldest datalogging file will automatically be deleted before a new file is created.

The red DIAGNOSTIC LED may indicate an SD Card error. See Section 5. Approximately 3 GB of data is generated per year of logging.

4.1.2 FIRMWARE UPGRADE

Firmware upgrades are performed using a microSD™ card in conjunction with configuration switch S8. See Section 2.1.5.7.

To upgrade the SE-330 firmware, insert a microSD™ card containing the firmware upgrade file (.S19 format) and set switch S8 to UPGRADE within 30 s. If S8 is switched to UPGRADE after 30 s, the upgrade process will not occur. If the microSD™ card is inserted after S8 is switched to UPGRADE, switch S8 to RUN and then back to UPGRADE. The SE-330 evaluates firmware upgrade files found in the base directory of the microSD™ card and uses the first valid file.

Ensure that the DIAGNOSTIC LED is off before beginning the firmware upgrade process.

The red DIAGNOSTIC LED blinks rapidly while the firmware upgrade is running and the SE-330 will restart when the upgrade is complete. If the upgrade is not successful, the DIAGNOSTIC LED will indicate an SD Upgrade Error. See Section 5. Set switch S8 back to RUN for normal operation. If a firmware upgrade fails, the existing firmware is not overwritten.

A record of the upgrade can be found in "upgrade_log_<SN>.txt" on the microSD™ card. This file is updated each time an upgrade is performed.

NOTE: The included microSD™ card has a temperature rating of -25 to 85°C (-13 to 140°F). For applications colder than -25°C (-13°F), use an Industrial-Grade microSD™ card.

NOTE: The maximum recommended microSD™ card storage capacity is 4 GB.

4.2 USB INTERFACE

Use the SE-MON330 software (version 3.5 or newer) to access set-points, measured values, and trip records through the mini B USB interface located on the front panel. The following data can be viewed:

- Front-panel and configuration-switch settings
- Neutral voltage and neutral current
- Resistance change from the calibrated value
- Trip status
- Trip records, 100 date and time stamped
- Firmware version and serial number

The following values can be viewed and adjusted:

- Ground-fault trip setting (when front-panel GF Trip Level is set to MEM)
- K2 ground-fault relay output operating mode
- K3 resistor-fault relay output operating mode
- Clock settings
- Trip records can be cleared
- Remote calibration
- Resistor-fault trip time
- Resistor-fault trip level
- Geo-magnetic filter

Ensure the real-time clock is set to the correct time prior to normal operation. Trip records and on-board datalogging information include date and time readings from the clock. Refer to the SE-MON330 software help file.

4.3 NETWORK COMMUNICATIONS

The optional communications interfaces include a single CAN port and dual Ethernet ports supporting cable, fiber[1], or both cable and fiber. Protocols include:

- DeviceNet over CAN (ordering option 1)
- EtherNet/IP over cable or fiber (ordering options 3, 4, and 5)
- Modbus TCP over cable or fiber (ordering options 3, 4, and 5)
- IEC 61850 over cable or fiber (ordering options 6, 7, and 8)

Refer to the appropriate SE-330 communications-interface manual for details.

[1] Uses the plug-in style SC connector.

5. TROUBLESHOOTING

PROBLEM	DIAGNOSTIC LED FLASH CODE[1]	SOLUTION
POWER LED off.		Check if supply voltage is present on terminals 1 and 2. If present, an overvoltage may have caused the power supply to shutdown. Cycle supply voltage. If POWER LED remains off, return unit for repair.
POWER LED flashes.		A power-supply overload has occurred. Cycle supply voltage. If problem persists, consult Littelfuse Startco.
Calibration-Error Trip DIAGNOSTIC LED flash code	1 L - 1 S - 1 L	The total resistance of the NGR and sensing-resistor circuit is outside the calibration range. Verify that switch S5 is set to match the resistance of the sensing resistor, check the resistance of the NGR, and verify the sensing-resistor circuit. See Section 9.2 for sensing-resistor tests. Repeat the calibration procedure after the open or shorted condition has been corrected. GF LED[2]: No Change, RF LED[2]: ON, K1:Trip
Remote Trip DIAGNOSTIC LED flash code	1 L - 2 S - 1 L	The SE-330 was tripped by a signal from network communications. Press RESET to clear the trip. GF LED[2]: ON, RF LED[2]: ON, K1:Trip
A/D-Converter-Error Trip DIAGNOSTIC LED flash code	1 L - 4 S - 1 L	An A/D-converter error was detected. Press RESET to clear the trip. If the problem persists, consult Littelfuse Startco. GF LED[2]: No Change, RF LED[2]: ON, K1:Trip
SD Card DIAGNOSTIC LED flash code	1 L - 5 S - 1 L	SD Card is full or a write error occurred. Delete files or use a different microSD™ card. GF LED[2]: No Change, RF LED[2]: No Change, K1:No Change
Watchdog Trip DIAGNOSTIC LED flash code	1 L - 6 S - 1 L	A watchdog trip results in a processor reset. During reset, UNIT HEALTHY relay K4 will be de-energized. After a reset, UNIT HEALTHY relay K4 will be energized. Press RESET to clear the trip. If the problem persists, consult Littelfuse Startco. GF LED[2]: ON, RF LED[2]: ON, K1:Trip
CPU Trip DIAGNOSTIC LED flash code	1 L - 7 S - 1 L	The CPU has detected a system fault. Press RESET to clear the trip. GF LED[2]: ON, RF LED[2]: ON, K1:Trip
Non-Volatile Memory Error Trip DIAGNOSTIC LED flash code	1 L - 8 S - 1 L	An error was detected in the Non-Volatile Memory. Press RESET to clear the trip. If the problem persists, consult Littelfuse Startco. GF LED[2]: ON, RF LED[2]: ON, K1:Trip
SD Upgrade Error DIAGNOSTIC LED flash code	1 L - 9 S - 1 L	An error occurred during the flash-memory upgrade procedure. Ensure that the firmware upgrade file is correct or use a different microSD™ card. GF LED[2]: No Change, RF LED[2]: No Change, K1:No Change
DIAGNOSTIC LED = Solid Red		SE-330 processor failed to start. Cycle supply. If problem persists, consult Littelfuse Startco. K1: De-energized.
Pressing RESET does not clear trips.		Trip condition is still present. Locate and correct.
		The RESET button is disabled if remote-reset terminals 15 and 16 are connected. Replace shorted remote-reset switch or issue Reset command from the communications network.
UNIT HEALTHY relay K4 momentarily changes state.		Occurs when processor is reset.
No analog-output current.		The output at terminals 19 and 20 requires a voltage source. See Fig. 2 for analog-output connections. See Section 9.3 for the analog-output tests.

NOTES:
[1] L = long pause, S = short flash.
[2] When LED is on, corresponding indication relay is energized when in the non-fail-safe mode or de-energized when in the fail-safe mode.

6. TECHNICAL SPECIFICATIONS

6.1 SE-330

Supply:
- Option 0 ..... 30 VA, 120 to 240 Vac (+10, -45%), 50/60 Hz; 20 W, 110 to 250 Vdc (+10, -25%)
- Option 2 ..... 20 W, 48 Vdc (+50, -25%); 35 VA, 48 Vac (+10, -45%), 50/60 Hz

Power-Up Time ..... 3 s at 120 Vac

AC Measurements ..... Discrete Fourier Transform. 16 samples per cycle, 50 or 60 Hz

Resistor-Fault Circuit:
- Neutral-To-Ground Voltage Trip Levels[1]:
  - ER-600VC or ER-5KV ..... 20; 60; 100; 130; 170; 200; 340; 800; 1,200; 1,700; 2,000 Vac
  - ER-15KV to ER-35KV ..... 100; 300; 500; 650; 850; 1,000; 1,700; 4,000; 6,000; 8,500; 10,000 Vac
  - Accuracy ..... 10% of setting
  - 3 dB Frequency Response:
    - S6 = 50 Hz ..... 25 to 85 Hz
    - S6 = 60 Hz ..... 30 to 90 Hz
- NGR Calibration Range:
  - ER-600VC, ER-5KV, or ER-5WP ..... 0 to 2 kΩ
  - ER-15KV to ER-35KV ..... 0 to 10 kΩ
- Trip Resistance, $V_N = 0$:
  - ER-600VC, ER-5KV, or ER-5WP:
    - Range[5] ..... 250 to 750-Ω change ± 200 Ω
    - Default ..... 500-Ω change
  - ER-15KV to ER-35KV:
    - Range[5] ..... 1.25 to 3.75-kΩ change ± 1 kΩ
    - Default ..... 2.5-kΩ change
- Neutral-To-Ground DC-Voltage Rejection:
  - ER-600VC, ER-5KV, or ER-5WP ..... 25 Vdc
  - ER-15KV to ER-35KV ..... 125 Vdc
- Trip Time ..... 12 to 60 s ± 1 s
- Trip Hold-Off Level ..... 5% of CT-Primary Rating
- Trip Mode ..... Latching/Non-Latching

Ground-Fault Circuit:
- Trip Level ..... 2, 4, 6, 8, 10, 20, 40, 60, 80, 100% of CT-Primary Rating or 2 to 100% using MEM parameter
- Trip Time ..... 0.1, 0.2, 0.3, 0.4, 0.5, 0.7, 1.0, 2.0, 3.0, 5.0, 10.0 s
- Trip-Level Accuracy ..... Maximum of 1% of CT-Primary Rating or 3% of Setting[2]
- Trip-Time Accuracy ..... 10% of Setting, 20 ms minimum
- 3 dB Frequency Response:
  - S6 = 50 Hz ..... 25 to 85 Hz
  - S6 = 60 Hz ..... 30 to 90 Hz
- Maximum CT lead resistance:
  - EFCT & SE-CS30 ..... 5 Ω
  - Other CT's ..... Consult CT Curve.
- CT-Input Burden:
  - 5-A Input ..... < 0.01 Ω
  - 1-A Input ..... < 0.05 Ω
  - EFCT Input ..... < 10 Ω
- Thermal Withstand:
  - 1-A and 5-A Inputs:
    - Continuous ..... 2 x CT Rating
    - 1-Second ..... 20 x CT Rating
  - EFCT Input:
    - Continuous ..... 10 x CT Rating
    - 1-Second ..... 25 x CT Rating
- Measurement Range ..... 25 x CT-Primary Rating
- Trip Mode ..... Latching/Non-Latching

Pulsing Circuit:
- Pulse Period ..... 1.0 to 3.0 s, 0.2-s increments
- Duty Cycle 50%
- Time Accuracy ..... 10% of Setting

Trip/Pulsing Relay K1 Contacts:
- Configuration ..... N.O. (Form A)
- Operating Mode ..... Fail-Safe or Non-Fail-Safe
- CSA/UL Contact Ratings ..... 8 A resistive 250 Vac, 5 A resistive 30 Vdc
- Supplemental Contact Ratings:
  - Make/Carry 0.2 s ..... 30 A
  - Break:
    - dc ..... 75 W resistive, 35 W inductive (L/R = 0.04 s)
    - ac ..... 2,000 VA resistive, 1,500 VA inductive (PF = 0.4)
  - Subject to maximums of 8 A at 250 Vac, 5 A resistive at 30 Vdc, and 0.4 A resistive at 250 Vdc.

GF (K2) and RF (K3) Relay Contacts:
- Configuration ..... N.O. and N.C. (Form C)
- Operating Mode ..... Non-Fail-Safe or Fail-Safe
- CSA/UL Contact Ratings ..... 8 A resistive 250 Vac, 8 A resistive 30 Vdc
- Supplemental Contact Ratings:
  - Make/Carry 0.2s ..... 20 A
  - Break:
    - dc ..... 50 W resistive, 25 W inductive (L/R = 0.04 s)

ac ..... 2,000 VA resistive, 1,500 VA inductive (PF = 0.4)
Subject to maximums of 8 A at 250 Vac, 8 A resistive at 30 Vdc, and 0.4 A resistive at 150 Vdc.

Unit Healthy Output K4 (Option 0):
- Configuration ..... N.O. (Form A)
- Operating Mode ..... Closed when Healthy
- Ratings ..... 100 mA, 250 V (ac or dc)
- Closed Resistance ..... 30 to 50 Ω

Unit Healthy Output K4 (Option 1):
- Configuration ..... N.C. (Form B)
- Operating Mode ..... Open when Healthy
- Ratings ..... 100 mA, 250 V (ac or dc)
- Closed Resistance ..... 25 to 50 Ω

Auto-reset time ..... 2.8 s maximum

4-20-mA Analog Output:
- Type ..... Self Powered and Loop Powered
- Range ..... 4 to 22 mA
- Loop Voltage ..... 8 to 36 Vdc
- Load ..... 500 Ω (maximum with 24-Vdc supply)
- Isolation ..... 120 Vac
- Parameter ..... NGR Current, 20 mA = CT Primary Current

USB Communications:
- Baud Rate ..... 12 Mbit/s
- Protocol ..... USB Device
- Connector ..... Mini B

SD Memory Card:
- Type ..... Standard Grade
- Form Factor ..... microSD™(3)
- Format FAT32
- Capacity ..... 512 MB to 4 GB (microSD™ and microSDHC™)
- Operating Temperature:
  - Standard Grade (Included) ..... -25 to 85°C (-13 to 140°F)
  - Industrial Grade ..... -40 to 85°C (-40 to 140°F)

Terminal-Block Ratings ..... 10 A, 300 Vac, 12 AWG (2.5 mm^2)

PWB Conformal Coating ..... MIL-1-46058 qualified, UL QMJU2 recognized

Mounting Configurations ..... Panel Mount and Optional Surface Mount

Dimensions:
- Height ..... 213 mm (8.4”)
- Width ..... 99 mm (3.9”)
- Depth ..... 132 mm (5.2”)

Shipping Weight ..... 2.0 kg (4.4 lb)

Environment:
- Operating Temperature ..... -40 to 60°C (-40 to 140°F)
- Storage Temperature ..... -55 to 80°C (-67 to 176°F)
- Humidity ..... 85% Non-Condensing
- IP Rating IP30

Surge Withstand ..... ANSI/IEEE C37.90.1-1989 (Oscillatory and Fast Transient)

EMC Tests:
Verification tested in accordance with EN 60255-26:2013.

- Radiated and Conducted Emissions ..... CISPR 11:2009, CISPR 22:2008, EN 55022:2010 Class A
- Current Harmonics and Voltage Fluctuations ..... IEC 61000-3-2 and IEC 61000-3-3 Class A
- Electrostatic Discharge ..... IEC 61000-4-2
  ± 6 kV contact discharge (direct and indirect)
  ± 8 kV air discharge
- Radiated RF Immunity ..... IEC 61000-4-3
  10 V/m, 80-1,000 MHz, 80% AM (1 kHz)
  10 V/m, 1.0 to 2.7 GHz, 80% AM (1 kHz)
- Fast Transient ..... IEC 61000-4-4
  Zone B
  ± 2 kV (power supply port), ± 1 kV (all other ports)
- Surge Immunity ..... IEC 61000-4-5
  Zone B
  ± 1 kV differential mode
  ± 2 kV common mode
- Conducted RF Immunity .... IEC 61000-4-6
  10 V, 0.15-80 MHz, 80% AM (1 kHz)
- Magnetic Field Immunity ..... IEC 61000-4-8
  50 Hz and 60 Hz
  30 A/m and 300 A/m

Power Frequency[4] ..... IEC 61000-4-16
Zone A: differential mode 100 Vrms
Zone A: common mode 300 Vrms

1 MHz Burst ..... IEC 61000-4-18
± 1 kV differential mode (line-to-line)
± 2.5 kV common mode

Voltage Interruption ..... IEC 61000-4-11, IEC 61000-4-29
0% for 10, 20, 30, 50 ms (dc)
0% for 0.5, 1, 2.5, 5 cycles (60 Hz)
IEC 61000-4-17
Level 4, 15% of rated dc value

Certification ..... CSA, Canada and USA

LR 53428
C US
UL Listed

LISTED
Ground Fault Sensing and Relaying Equipment
4FX9 E340889
Australia

N11659
CE, European Union

FCC

To: CSA C22.2 No. 14 Industrial Control Equipment
UL 508 Industrial Control Equipment
UL 1053 Ground Fault Sensing and Relaying Equipment
CE Low Voltage Directive
IEC 61010-1:2010 (3rd Edition)
FCC CFR47, Part 15, Subpart B, Class A – Unintentional Radiators

Compliance ..... RoHS Pending

NOTES:
(1) See sensing resistor specifications for applicable voltage limits.
(2) Accuracy included for EFCT-x and SE-CS30-x current sensors only.
(3) microSD™ and microSDHC™ are trademarks of SD-3C, LLC.
(4) Remote-reset and pulse-enable wiring is limited to 10 m (32').
(5) This value can be modified using SE-MON330 software. See Section 4.2.

6.2 SENSING RESISTORS

Environment:
Operating Temperature ..... -40 to 60°C (-40 to 140°F)
Storage Temperature ..... -55 to 80°C (-67 to 176°F)
Extended Operating Temperature ..... -55 to 60°C (-67 to 140°F)[1]

ER-600VC:
Maximum Voltage ..... 600 Vac
Maximum Current ..... 30 mA
Resistance ..... 20 kΩ
Thermal:
420 Vac ..... Continuous
600 Vac ..... 6 minutes on, 60 minutes off
Shipping Weight ..... 300 g (0.7 lb)

ER-5KV:
Maximum Voltage ..... 2,500 Vac
Maximum Current ..... 125 mA
Resistance ..... 20 kΩ
Thermal ..... Continuous
Torque:
Terminal N:
10-32 Insert ..... 5.6 N-m (50 in-lb)
Others ..... 9.0 N-m (80 in-lb)
Shipping Weight ..... 5.0 kg (11 lb)

ER-5WP:
Maximum Voltage ..... 2,500 Vac
Maximum Current ..... 125 mA
Resistance ..... 20 kΩ
Thermal ..... Continuous
Torque:
Terminal N:
10-32 Insert ..... 5.6 N-m (50 in-lb)
Others ..... 9.0 N-m (80 in-lb)
Shipping Weight ..... 5.0 kg (11 lb)

ER-15KV:
Maximum Voltage ..... 8,400 Vac
Maximum Current ..... 84 mA
Resistance ..... 100 kΩ
Thermal:
8,400 Vac ..... 1 minute on, 120 minutes off
1,900 Vac ..... Continuous
Torque (Terminal N) ..... 9.0 N-m (80 in-lb)
Shipping Weight ..... 5.0 kg (11 lb)

ER-25KV:
- Maximum Voltage ..... 14,400 Vac
- Maximum Current ..... 144 mA
- Resistance ..... 100 kΩ
- Thermal:
  - 14,400 Vac ..... 1 minute on, 120 minutes off
  - 2,500 Vac ..... Continuous
- Torque (Terminal N) ..... 9.0 N-m (80 in-lb)
- Shipping Weight ..... 20 kg (44 lb)

ER-35KV:
- Maximum Voltage ..... 22,000 Vac
- Maximum Current ..... 220 mA
- Resistance ..... 100 kΩ
- Thermal:
  - 22,000 Vac ..... 1 minute on, 120 minutes off
  - 3,000 Vac ..... Continuous
- Torque (Terminal N) ..... 9.0 N-m (80 in-lb)
- Shipping Weight ..... 40 kg (88 lb)

Certification ..... CSA, Canada and USA

UL Listed

CE, European Union

NOTES:
(1) Electrical specifications have been verified at a Littelfuse lab.

6.3 CURRENT SENSORS

Environment:
- Operating Temperature ..... -40 to 60°C (-40 to 140°F)
- Storage Temperature ..... -55 to 80°C (-67 to 176°F)

EFCT-1:
- Current Ratio ..... 5:0.05 A
- Insulation ..... 600-V Class
- Window Diameter ..... 82 mm (3.2")
- Shipping Weight ..... 0.9 kg (2.0 lb)
- Certifications ..... CSA, UL, CE
- Compliance ..... RoHS, IEC 60044-1
- Extended Operating Temperature ..... -55 to 60°C (-67 to 140°F)[1]
- Supplemental Specifications:
  - Trip Level Accuracy:
    - ≤ 1 A ..... 1% of CT-Primary Rating
    - > 1 A ..... 3% of CT-Primary Rating

EFCT-26:
- Current Ratio ..... 5:0.05 A
- Insulation ..... 600-V Class
- Window Diameter ..... 26 mm (1.0")
- Shipping Weight ..... 0.45 kg (1.0 lb)
- Certifications ..... CSA, UL, CE
- Compliance ..... RoHS, IEC 60044-1
- Extended Operating Temperature ..... -55 to 60°C (-67 to 140°F)[1]
- Supplemental Specifications:
  - Trip Level Accuracy:
    - ≤ 1 A ..... 1% of CT-Primary Rating
    - > 1 A ..... 3% of CT-Primary Rating

SE-CS10-2.5:
- Current Ratio ..... 1,000:5 A
- Insulation ..... 600-V Class
- Window Diameter ..... 63 mm (2.5")
- Shipping Weight ..... 0.7 kg (1.5 lb)
- Certifications ..... CE
- Compliance ..... IEC 60044-1

SE-CS30-26:
- Current Ratio ..... 30:0.05 A
- Insulation ..... 600-V Class
- Window Diameter ..... 26 mm (1.0")
- Shipping Weight ..... 0.45 kg (1.0 lb)
- Certifications ..... CSA, UL, CE
- Compliance ..... RoHS, IEC 60044-1
- Extended Operating Temperature ..... -55 to 60°C (-67 to 140°F)[1]

SE-CS30-70:
- Current Ratio ..... 30:0.05 A
- Insulation ..... 600-V Class
- Window Diameter ..... 70 mm (2.7")
- Shipping Weight ..... 1.2 kg (2.5 lb)
- Certifications ..... CSA, UL, CE
- Compliance ..... RoHS, IEC 60044-1
- Extended Operating Temperature ..... -55 to 60°C (-67 to 140°F)[1]

CT200:
- Current Ratio ..... 200:5 A
- Insulation ..... 600-V Class
- Window Diameter ..... 56 mm (2.2")
- Shipping Weight ..... 1 kg (2.2 lb)
- Certifications ..... CSA, UL
- Compliance ..... RoHS
- Extended Operating Temperature ..... -55 to 60°C (-67 to 140°F)[1]

NOTES:
(1) Electrical specifications have been verified at a Littelfuse lab.

7. ORDERING INFORMATION

SE-330- □□-□□

- K4 Contact:
  - 0 N.O. UNIT HEALTHY Contact
  - 1 N.C. UNIT HEALTHY Contact
- Options:
  - 0 No Options
- Network Communications:(1)
  - 0 None
  - 1 DeviceNet™
  - 3 Ethernet (Dual RJ45)
  - 4 Ethernet (SC Fiber & RJ45)
  - 5 Ethernet (Dual SC Fiber)
  - 6 IEC 61850 (Dual RJ45)
  - 7 IEC 61850 (SC Fiber & RJ45)
  - 8 IEC 61850 (Dual SC Fiber)
- Supply:
  - 0 Universal ac/dc Supply
  - 2 48 Vdc Supply

NOTE: Please refer to the SE-330 Product Change Notice (PCN) document for updated ordering information and new revision details, available at www.littelfuse.com/se-330.

NOTE: The SE-330-SMA Surface Mount Adapter is available as an accessory only.

Sensing Resistors:

ER-600VC	For system voltages up to 1 kVac
ER-5KV	For system voltages up to 5 kVac
ER-5WP	For system voltages up to 5 kVac, weather protected
ER-15KV	For system voltages up to 15 kVac
ER-25KV	For system voltages up to 25 kVac
ER-35KV	For system voltages up to 35 kVac

Current Sensors:

EFCT-1	Current Sensor, 5-A-primary rating, 82-mm (3.2”) Window, 6 m (19.5’) of 22 AWG (3.3 mm^2) shielded cable included
EFCT-26	Current Sensor, 5-A-primary rating, 26-mm (1.0”) Window, 6 m (19.5’) of 22 AWG (3.3 mm^2) shielded cable included
SE-CS10-2.5	Current Sensor, 30-A-primary rating, 63 mm (2.5”) window
SE-CS30-26	Current Sensor, 30-A-primary rating, 26-mm (1.0”) window
SE-CS30-70	Current Sensor, 30-A-primary rating, 70-mm (2.7”) window
CT200	Current Sensor, 200-A-primary rating, 56-mm (2.2”) window
5SHT-101-E	Current Sensor, 100-A-primary rating, 40-mm (1.6”) window
5SHT-151-E	Current Sensor, 150-A-primary rating, 40-mm (1.6”) window
5SHT-500-E	Current Sensor, 50-A-primary rating, 40-mm (1.6”) window
7SHT-301-E	Current Sensor, 300-A-primary rating, 64-mm (2.5”) window
7SHT-401-E	Current Sensor, 400-A-primary rating, 64-mm (2.5”) window

Accessories:

RK-332	Remote Indication and Reset, includes two 120-V pilot lights, a reset push button, and legend plates
SE-IP65CVR-G	Hinged transparent cover, IP65
SE-MRE-600	Moisture-resistant enclosure for ER-600VC
PGA-0520	Percent Analog Meter
SE-330-SMA	Surface Mount Adapter
AC300-MEM-00	Industrial-Grade microSD™ Card

Software:(2)

SE-MON330 Software	SE-330 Data-Display Program for PC, version 3.5 or newer
NGR Monitor Set-Point Assistant	Setting Guide

NOTES:
(1) Profibus models only available on legacy SE-330.
(2) Available at www.littelfuse.com/relayscontrols.

8. WARRANTY

The SE-330 Neutral-Grounding-Resistor Monitor is warranted to be free from defects in material and workmanship for a period of five years from the date of purchase.

Littelfuse Startco will (at Littelfuse Startco's option) repair, replace, or refund the original purchase price of an SE-330 that is determined by Littelfuse Startco to be defective if it is returned to Littelfuse Startco, freight prepaid, within the warranty period. This warranty does not apply to repairs required as a result of misuse, negligence, an accident, improper installation, tampering, or insufficient care. Littelfuse Startco does not warrant products repaired or modified by non-Littelfuse Startco personnel.

9. TEST PROCEDURES

NOTE: Ensure the real-time clock is set. See Section 4.2.

9.1 RESISTOR-FAULT TESTS

Perform tests with system de-energized and supply voltage applied to the SE-330.

9.1.1 CALIBRATION AND OPEN TEST

Test Equipment: 20-kΩ and 100-kΩ, 1/4-watt, 1% calibration resistors (calibration resistors are supplied with SE-330).

Procedure:

- Remove connections to terminals 6 and 7.
- Connect the 20-kΩ resistor to terminals 6 and 7.
- Set switch S5 to the 20-kΩ position.
- Perform calibration as per Section 2.2.
- The CALIBRATED LED should be on.
- Press RESET.
- Remove the 20-kΩ resistor and wait for the resistor-fault trip time.
  PASS: The SE-330 should trip on resistor fault.
- Connect the 100-kΩ resistor to terminals 6 and 7.
- Set switch S5 to the 100-kΩ position.
- Perform calibration as per Section 2.2.
  The CALIBRATED LED should be on.
- Press RESET.
- Remove the 100-kΩ resistor and wait for the resistor-fault trip time.
  PASS: The SE-330 should trip on resistor fault.

NOTE: Resistor-fault-trip reset can take up to one second.

9.1.2 VOLTAGE TEST

Test Equipment: 0 to 120 Vac voltage source, multimeter, and ER sensing resistor.

NOTE: Use an isolation transformer if the test-voltage source does not provide dc continuity for the SE-330 resistance-measuring circuit.
NOTE: Applying the test voltage to the R and G terminals will damage the SE-330 and the ER sensing resistor. The V_N TRIP LEVEL is the trip voltage at terminal N, not terminal R.

Procedure:

- Connect the ER sensing resistor to the SE-330 and calibrate the SE-330.
- Disconnect the wire from sensing-resistor terminal N. A resistor-fault trip will occur.
- Set the voltage source to 0 V.
- Connect the voltage source between sensing resistor N and G terminals.
- Set the V_N TRIP LEVEL (VAC) to 20.
- Press RESET.
- The RESISTOR FAULT TRIP LED should be off.
- Increase the test voltage to 25 Vac for 20-kΩ sensors or 120 Vac for 100-kΩ sensors and wait for the resistor-fault trip time.
  PASS: The SE-330 should trip on RESISTOR FAULT. A time-delayed ground-fault trip follows the resistor-fault trip if neutral voltage persists after the resistor fault. For legacy units with firmware revision 6 or less, this does not apply.

9.2 SENSING-RESISTOR TEST

Test Equipment: Multimeter.

Procedure:

- Disconnect the sensing resistor.
- Measure the resistance between sensing-resistor terminals R and N.
  PASS: Resistance should be between 19.6 and 20.4 kΩ for 20-kΩ sensing resistors. Resistance should be between 98 and 102 kΩ for 100-kΩ sensing resistors.
- Measure the resistance between sensing-resistor terminals R and G in both directions.
  PASS: Resistance should be greater than 10 MΩ in both directions.

9.3 ANALOG-OUTPUT TEST

Test Equipment: Multimeter with a mAdc scale.
Procedure:

- Connect the 4–20-mA output as a self-powered output as shown in Fig. 3. Measure the current from terminal 20 to terminal 21.
  PASS: With no CT current, the analog output should be 4 mA.
- Output is linear to 20 mA. Output is 20 mA when CT-primary current is equal to the CT-primary rating.

9.4 GROUND-FAULT PERFORMANCE TEST

To meet the requirements of the National Electrical Code (NEC), as applicable, the overall ground-fault protection system requires a performance test when first installed. A written record of the performance test is to be retained by those in charge of the electrical installation in order to make it available to the authority having jurisdiction. A test-record form is provided for recording the date and the final results of the performance tests. The following ground-fault system tests are to be conducted by qualified personnel:

a) Evaluate the interconnected system in accordance with the overall equipment manufacturer's detailed instructions.

b) Verify proper installation of the ground-fault current sensor. Ensure the cables pass through the ground-fault-current-sensor window. This check can be done visually with knowledge of the circuit. The connection of the current-sensor secondary to the SE-330 is not polarity sensitive.

c) Verify that the system is correctly grounded and that alternate ground paths do not exist that bypass the current sensor. High-voltage testers and resistance bridges can be used to determine the existence of alternate ground paths.

d) Verify proper reaction of the circuit-interrupting device in response to a simulated or controlled ground-fault current. To simulate ground-fault current, use CT-primary current injection (does not apply for bushing-type CT's). Fig. 23a shows a test circuit using an SE-400 Ground-Fault-Relay Test Unit. The SE-400 has a programmable output of 0.5 to 9.9 A for a duration of 0.1 to 9.9 seconds. Set the test current to 120% of GF TRIP LEVEL. Fig. 23b shows a test circuit using an SE-100T Ground-Fault-Relay Tester. The SE-100T provides a test current of 0.65 or 2.75 A for testing 0.5- and 2.0-A trip levels. Inject the test current through the current-sensor window for at least 2.5 seconds. Verify that the circuit under test has reacted properly. Correct any problems and re-test until the proper reaction is verified.

e) Record the date and the results of the test on the attached test-record form.

NOTE: Do not inject test current directly into CT-input terminals 8, 9, 10, and 11.

NOTE: For accurate trip-time measurement, the fault current should not be re-applied for the time defined by the GF TRIP TIME setting to allow the trip accumulator to initialize.

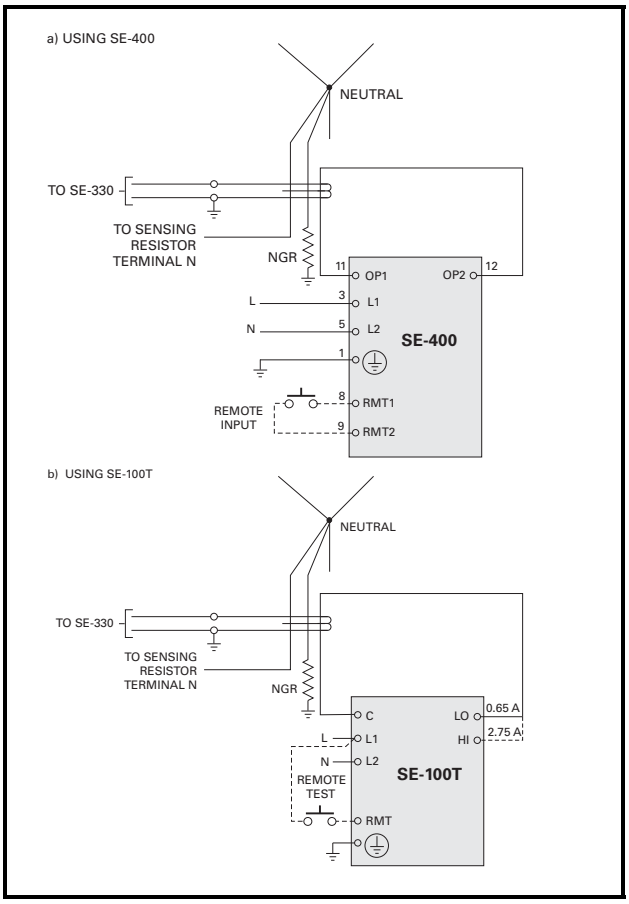


FIGURE 23. Ground-Fault-Test Circuits.

TABLE 3. GROUND-FAULT-TEST RECORD

DATE	TEST RESULTS

Retain this record for the authority having jurisdiction.

APPENDIX A
SE-330 REVISION HISTORY

MANUAL RELEASE DATE	MANUAL REVISION	HARDWARE REVISION (REVISION NUMBER ON PRODUCT LABEL)	FIRMWARE REVISION
June 22, 2015	10-J-062215	15	2.50
May 20, 2015	10-I-052015		2.40
March 3, 2015	10-H-030315		
July 7, 2014	10-G-070714	14	2.31 2.30
April 14, 2014	10-F-041414	13	2.20
January 8, 2014	10-E-010814	12	
		11	
November 29, 2013	10-D-112913	10A	2.10
October 8, 2013	10-C-100813		2.08
September 12, 2013	10-B-091213		2.07
August 30, 2013	10-A-083013	10	2.07

MANUAL REVISION HISTORY

REVISION 10-J-062215

SECTION 2

Section 2.1.7 added.

SECTION 4

SD Card approximate yearly data logging usage updated.
SE-MON330 software version updated.

SECTION 6

Resistor-fault trip level ranges added.

REVISION 10-I-030315

SECTION 4

SD Card storage capacity updated.

SECTION 6

SD Card storage capacity specification updated.

REVISION 10-H-030315

SECTION 2

Sections 2.1.6 and 2.1.7 added.

SECTION 4

Section 4.2 new features added.

SECTION 6

Resistor-fault circuit trip time updated.

REVISION 10-G-070714

SECTION 6

Added CE, C-Tick, and FCC information.

REVISION 10-F-041414

APPENDIX A

Hardware revision updated.

REVISION 10-E-010814

SECTION 6

Extended operating temperatures added to all sensing resistors and SE-CS30 current sensors.

REVISION 10-D-112913

SECTION 6

CE added to sensing resistors.

SECTION 7

Ordering information updated.

REVISION 10-C-100813

SECTION 2

Section 2.8 updated.

SECTION 4

Real Time Clock note added in Section 4.2.

SECTION 5

LED and relay status added to troubleshooting solutions.

SECTION 7

Ordering information updated.

REVISION 10-B-091213

APPENDIX A

Hardware revision updated.

REVISION 10-A-083013

SECTION 1

Faceplate updated.
New features added.

SECTION 2

Communications options updated.
Configuration switches updated.
Indication relays explanation added.
Non-volatile-memory error added.

SECTION 3

Connection drawing updated.

SECTION 4

Section heading changed to Data Interfaces.
Updated with microSD™ and USB interfaces.
Upgrade procedure added.

SECTION 5

Non-volatile-memory error added.
Switch S8 diagnostic LED error removed.

SECTION 6

Ground-fault circuit trip level updated.
USB communications specifications added.
Resistor-fault accuracy changed.
microSD™ memory card specifications added.

SECTION 7

Ordering information updated.
SE-330-SMA Surface Mount Adapter is now listed as an accessory only.

APPENDIX A

Added revision history.

HARDWARE REVISION HISTORY

HARDWARE REVISION 15

RTC circuit updated.

HARDWARE REVISION 14

Added CE and C-Tick compliance.

HARDWARE REVISION 13

Reduced ESD sensitivity of front-panel dials.

HARDWARE REVISION 12

Improved Fiber Ethernet support.

HARDWARE REVISION 11

Reduced ESD sensitivity of USB and SD card connectors.

HARDWARE REVISION 10A

Update to RTC circuit.

HARDWARE REVISION 10

Updated SE-330 platform to include USB and microSD™ interfaces, programmable trip level (MEM) feature, and ability to add future options.
Real-time clock added.
Added dual cable and fiber Ethernet ports.

FIRMWARE REVISION HISTORY

FIRMWARE REVISION 2.50

Added support for adjustable resistor-fault trip level.
Web page functionality re-enabled for Ethernet options.

FIRMWARE REVISION 2.40

Added support for geo-magnetic filter.
Added support for 12 to 60 s resistor-fault trip time.
Improved log file descriptions.
IEC 61850 GOOSE network input support now always enabled.
Improved compatibility for Modbus TCP.
Web page disabled for Ethernet options. This will be enabled in a future firmware release.
IP setting changes for Ethernet options now require power cycle to take effect.

FIRMWARE REVISION 2.31

SD Card and USB diagnostic events no longer cause a trip.

FIRMWARE REVISION 2.30

Remote calibration feature added.

FIRMWARE REVISION 2.20

Added support for EtherNet/IP protocol.
IED name now reported correctly through IEC 61850 interface.
EtherNet/IP and Modbus communications card LED status updated.
Hardware version viewable in the SE-MON330 software and through the Modbus and IEC 61850 servers.

FIRMWARE REVISION 2.10

Added support for IEC 61850 and DeviceNet protocols.

FIRMWARE REVISION 2.08

Added support for communications options.

FIRMWARE REVISION 2.07

Updated firmware to include USB and microSD™ interfaces, datalogging, and firmware update via microSD™.
K2 and K3 indication relays can be configured for fail-safe or non-fail-safe operation.
Trip records increased to 100 with date and time stamping.

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