Littelfuse
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SE-330AU MANUAL

NEUTRAL-EARTHING-RESISTOR MONITOR

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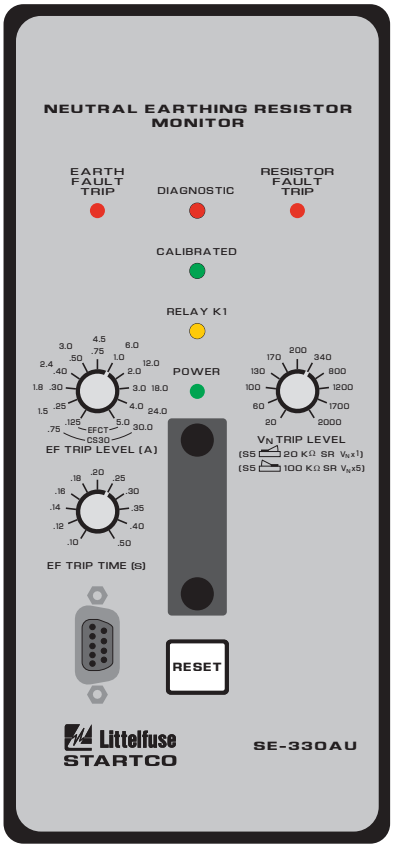
Revision 1



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DISCLAIMER

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1. GENERAL

1.1 MODERN RESISTANCE-EARTHED SYSTEMS

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

NER selection depends on system charging current. System charging current is the capacitive current that flows to earth when a bolted earth fault occurs. This current can be calculated or measured. For small systems, the magnitude of charging current is typically ½ A per 1,000 kVA on low-voltage systems and 1 A per 1,000 kVA on medium-voltage systems.

Choose an NER with a let-through current larger than the system charging current. Set the pick-up current of earth-fault devices at or below 10% of the NER let-through current for systems up to 1.1 KV and 20% of the NER let through current for systems above 1.1 KV.

Use earth-fault devices with a definite-time characteristic to achieve time coordination. Use the same pick-up current for all earth-fault devices—this value must be larger than the charging current of the largest feeder. Select an NER with a let-through current between five and ten times the pick-up current of the earth-fault devices.

Do not use an earthing 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 an earth fault through a rectifier can make earth-fault protection inoperative.
- Transformer inrush current up to twelve times rated current can cause an earth-fault voltage larger than expected.
- A parallel transformer winding makes it difficult to monitor NER continuity.
- A transformer can provide the inductance necessary to cause ferroresonance if the NER opens.

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

1.2 SE-330AU NER MONITORING

The SE-330AU is a microprocessor-based neutral-earthing-resistor monitor that detects NER failures and earth faults in resistance-earthed systems. The SE-330AU measures NER resistance, NER current, and transformer or generator neutral-to-earth voltage. The components required to monitor an NER are an SE-330AU, an ER-series sensing resistor, and a current transformer (CT).

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

Earth-fault current is sensed by a sensitive CT (EFCT-x or SE-CS30-x). The trip level of the earth-fault circuit is adjustable from 0.125 to 5 A for the EFCT-x and 0.75 to 30 A for the SE-CS30-x. Trip time is adjustable from 0.1 to 0.5 seconds. Open-CT detection is provided with a fixed 2-second time delay.

The SE-330AU has four output relays. Relay K1 is the trip relay. Relays K2 and K3 provide earth-fault and resistor-fault indication. K4 is a solid-state relay that provides UNIT HEALTHY indication. Relay K1 operates in the fail-safe mode for undervoltage applications.

Additional features include LED trip indication, trip memory, front-panel and remote reset, 4–20-mA analog output, RS-232 local communications, and optional network communications.

The SE-330AU is compatible with lockout earth-fault protection devices—the on line phase-to-earth resistance added by coupling components must be above the SE-330AU NER-failure-detection resistance.

2. OPERATION

2.1 SETTINGS

2.1.1 EF TRIP TIME

EF TRIP TIME (definite time) is adjustable from 0.1 to 0.5 seconds. Time-coordinated earth-fault protection requires this setting to be longer than the trip times of downstream earth-fault devices.

A trip-time accumulator provides an earth-fault memory function for detection of intermittent faults. The accumulated time increases when an earth fault is detected and decreases when an earth 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 EF TRIP LEVEL

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

Choose an NER let-through current and an earth-fault trip level according to the guidelines in Section 1.1. Typical values are shown in Table 1.

2.1.3 V_N TRIP LEVEL

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

Calculate the voltage across the NER when NER current is equal to the pick-up current of the earth-fault circuit. Set the V_N TRIP LEVEL at the next largest value. 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. See Fig. 1 and Section 2.1.4.3.

If neutral voltage is greater than the V_N TRIP LEVEL setting for 12 seconds and earth-fault current is less than 5% of the CT rating, the SE-330AU 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 EF TRIP TIME setting, the earth-fault circuit will also trip.

Typical values for NER systems are shown in Table 1.

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

TABLE 1. TYPICAL VALUES FOR TRIPPING SYSTEMS

System Voltage (Volts)		Neutral-Earthing Resistor		Earth-Fault Trip Level (Amperes)		V_N Trip Level (Volts)	Sensing Resistor	S5
Line to Line	Line to Neutral	Current (Amperes)	Resistance (Ohms)	EFCT-x (5-A Rating)	SE-CS30-x (30-A Rating)			
110 (3)	55	5	11	0.5	(1)	20	ER-600VC	20 kΩ
120 (3)	60	5	12	0.5	(1)	20	ER-600VC	20 kΩ
110	64	5	13	0.5	(1)	20	ER-600VC	20 kΩ
127	73	5	15	0.5	(1)	20	ER-600VC	20 kΩ
240 (3)	120	5	24	0.5	(1)	20	ER-600VC	20 kΩ
240	139	5	28	0.5	(1)	20	ER-600VC	20 kΩ
270	156	5	31	0.5	(1)	20	ER-600VC	20 kΩ
415	240	5	48	0.5	(1)	60	ER-600VC	20 kΩ
433	250	5	50	0.5	(1)	60	ER-600VC	20 kΩ
690	398	5	80	0.5	(1)	60	ER-600VC	20 kΩ
970	560	5	112	0.5	(1)	60	ER-5KV	20 kΩ
1,000	575	5	115	0.5	(1)	60	ER-5KV	20 kΩ
1,050	605	5	121	0.5	(1)	100	ER-5KV	20 kΩ
1,100	635	5	127	0.5	(1)	100	ER-5KV	20 kΩ
1,140	658	5	132	0.5	(1)	100	ER-5KV	20 kΩ
3,300	1,905	5	381	0.5	(1)	200	ER-5KV	20 kΩ
6,600	3,810	5	762	0.5	(1)	500	ER-15KV	100 kΩ
6,600	3,810	10	381	1.0	0.75	500	ER-15KV	100 kΩ
6,600	3,810	25	152	2.0	1.5	500	ER-15KV	100 kΩ
11,000	6,350	5	1,270	0.5	(1)	650	ER-15KV	100 kΩ
11,000	6,350	10	635	1.0	0.75	650	ER-15KV	100 kΩ
11,000	6,350	20	318	2.0	1.5	650	ER-15KV	100 kΩ
11,000	6,350	25	254	2.0	2.4	650	ER-15KV	100 kΩ
22,000	12,700	5	2,540	0.5	(1)	1,700	ER-25KV	100 kΩ
22,000	12,700	10	1,270	1.0	0.75	1,700	ER-25KV	100 kΩ
22,000	12,700	20	635	2.0	1.5	1,700	ER-25KV	100 kΩ
22,000	12,700	25	508	2.0	2.4	1,700	ER-25KV	100 kΩ
22,000	12,700	50	254	(2)	24	8,500	ER-25KV	100 kΩ
33,000	19,050	50	380	(2)	24	10,000	ER-35KV	100 kΩ

(1) Minimum setting is 0.75 A. Use EFCT-x for AS/NZS 2081 compliance.
(2) Maximum setting is 5 A. AS/NZS 2081 allows 25 A.
(3) Single phase, centre tap.

2.1.4 CONFIGURATION SETTINGS

Eight configuration switches (S1 to S8) and a calibration push button are located behind the access cover on the front panel. See Fig. 1. Switches S1, S2 and S7 are not used.

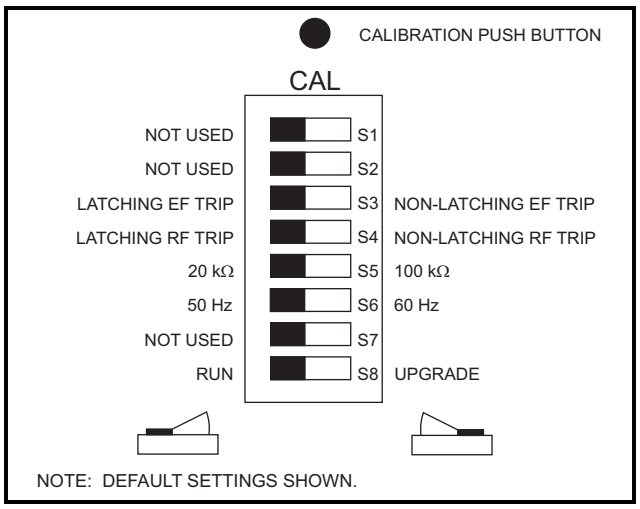


FIGURE 1. Configuration Switches.

2.1.4.1 EARTH-FAULT-TRIP LATCH (S3)

Set switch S3 to select latching or non-latching earth-fault-circuit operation. See Section 2.4.

2.1.4.2 RESISTOR-FAULT-TRIP LATCH (S4)

Set switch S4 to select latching or non-latching resistor-fault-circuit operation. See Section 2.4

2.1.4.3 SENSING-RESISTOR SELECTION (S5)

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

2.1.4.4 FREQUENCY (S6)

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

2.1.4.5 UPGRADE ENABLE (S8)

Set switch S8 to RUN for normal operation or to UPGRADE to enable firmware upgrades. Changes in switch S8 settings are recognized only when supply voltage is cycled. Protection is disabled after supply voltage is cycled with S8 in the UPGRADE position. See Section 4.1.3.

2.2 CALIBRATION

The SE-330AU measures the resistance change of the NER relative to the NER-resistance value determined at the time of calibration. Calibrate the SE-330AU on new installations, if the NER is changed, or if the sensing resistor is changed.

The CALIBRATION push 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-330AU connected to the sensing resistor and NER of the installed system.

NOTE: Where used, coupling components for lockout earth-fault protection devices must be disconnected from the supply during calibration.

To calibrate, press and hold the CALIBRATION push 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.

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 CT DETECTION

The SE-330AU monitors the continuity of the CT circuit. When an open CT circuit is detected for 2 seconds, the SE-330AU will trip on earth fault and the diagnostic LED will flash the CT-Detection-Error code. See Section 2.8. The CT-Detection-Error code remains until CT-circuit continuity is detected and RESET is pressed. If supply voltage is cycled, earth-fault trip indication is not reset but the CT-Detection-Error indication is reset. CT-Detection-Error indication will resume after 2 seconds if CT-circuit continuity is not detected.

2.4 TRIP INDICATION AND RESET

Red LED's and indication relays indicate earth-fault and resistor-fault trips—indication relays K2 and K3 are energized on trip. When a trip occurs with latching operation selected, the SE-330AU remains tripped until reset. See Sections 2.1.4.1 and 2.1.4.2. 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 switch does not prevent a trip. The front-panel RESET switch 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. Resistor-fault-trip reset can take up to one second.

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

When supply voltage is applied, the SE-330AU returns to its state prior to loss of supply voltage.

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. 14. Connect them as shown in Fig. 3. RK-332 components are not polarity sensitive.

Network-enabled SE-330AU'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 two long pulses indicates the cause of the trip.

Calibration-Error Trip (1 short):
The calibration resistance of the NER is outside the calibration range. See Section 6.1.

Remote Trip (2 short):
The SE-330AU has been tripped by a remote-trip command from the communications interface.

CT Detection Error Trip (3 short)
An open CT circuit has been detected

A/D-Converter-Error Trip (4 short):
An A/D-converter error has occurred.

Software-Interrupt Trip (5 short):
CPU reset was caused by a software interrupt.

Illegal-Opcode Trip (6 short):
CPU reset was caused by an illegal Opcode.

Watchdog Trip (7 short):
CPU reset was caused by the watchdog.

Clock-Failure Trip (8 short):
CPU reset was caused by an internal clock failure.

CPU Trip (9 short):
This code is displayed if the supply is cycled after one of the previous four errors occurred.

EEPROM-Error Trip (10 short):
An EEPROM error has been detected.

Resistor-fault trips occur with all of the above trips except the CT Detection Error. Earth-fault trips occur with all of the above trips except the calibration-error trip and the A/D-converter-error trip.
See Troubleshooting Section 5.

2.9 ANALOG OUTPUT

An isolated 4–20-mA output indicates NER 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.

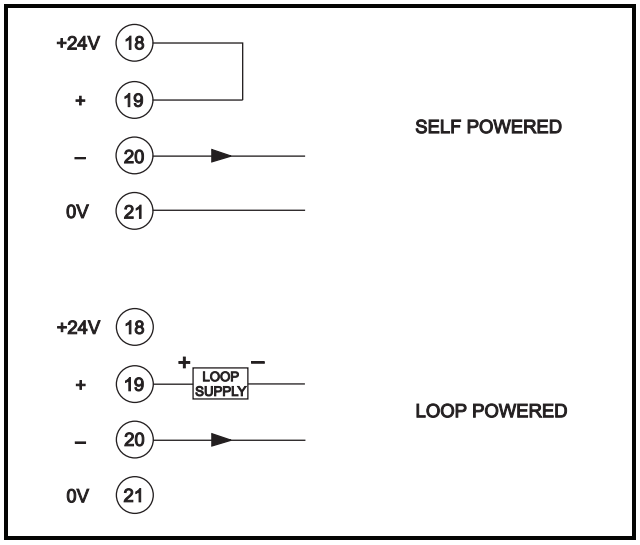


FIGURE 2. Analog-Output Connections.

3. INSTALLATION

3.1 SE-330AU

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

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

Outline dimensions and mounting details for surface mounting the SE-330AU are shown in Fig. 5. Fasten the optional SE-330-SMA 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-330AU.

Connect terminal 7 (G) to earth 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 earth. Connect terminal 4 (SPG) to terminal 5 (SPGA). Remove the terminal-4-to-5 connection for dielectric-strength testing.

NOTE: When the terminal-4-to-5 connection is removed, protective circuits inside the SE-330AU are disconnected to allow dielectric strength testing of a control panel without having to disconnect wiring to the SE-330AU. Ensure that the terminal-4-to-5 connection is replaced after testing.

3.2 SENSING RESISTOR

Outline and mounting details for ER-600VC, ER-5KV, ER-15KV, ER-25KV, and ER-35KV sensing resistors are shown in Figs. 6, 7, 8, 9, and 10. Locate the NER and the sensing resistor near the transformer or generator. Connect terminal G to earth. Pass the sensing-resistor-to-neutral conductor and the NER-to-neutral conductor through the earth-fault-CT window as shown in Fig. 3. Separately connect sensing-resistor terminal N and the NER to the neutral to include neutral connections in the monitored loop. If an earth fault in the sensing-resistor conductor is unlikely, a minimal loss of protection will result if it does not pass through the earth-fault-CT window. See Note 3 in Fig. 3.

CAUTION: Voltage at terminal N rises to line-to-neutral voltage when an earth fault occurs. The same clearances are required for sensing resistors as for NER's.

NOTE: A parallel earth path created by moisture can result in a false resistor-fault trip. Sensing-resistor terminal R and its connection to SE-330 terminal R, including interposing terminal blocks, must remain dry.

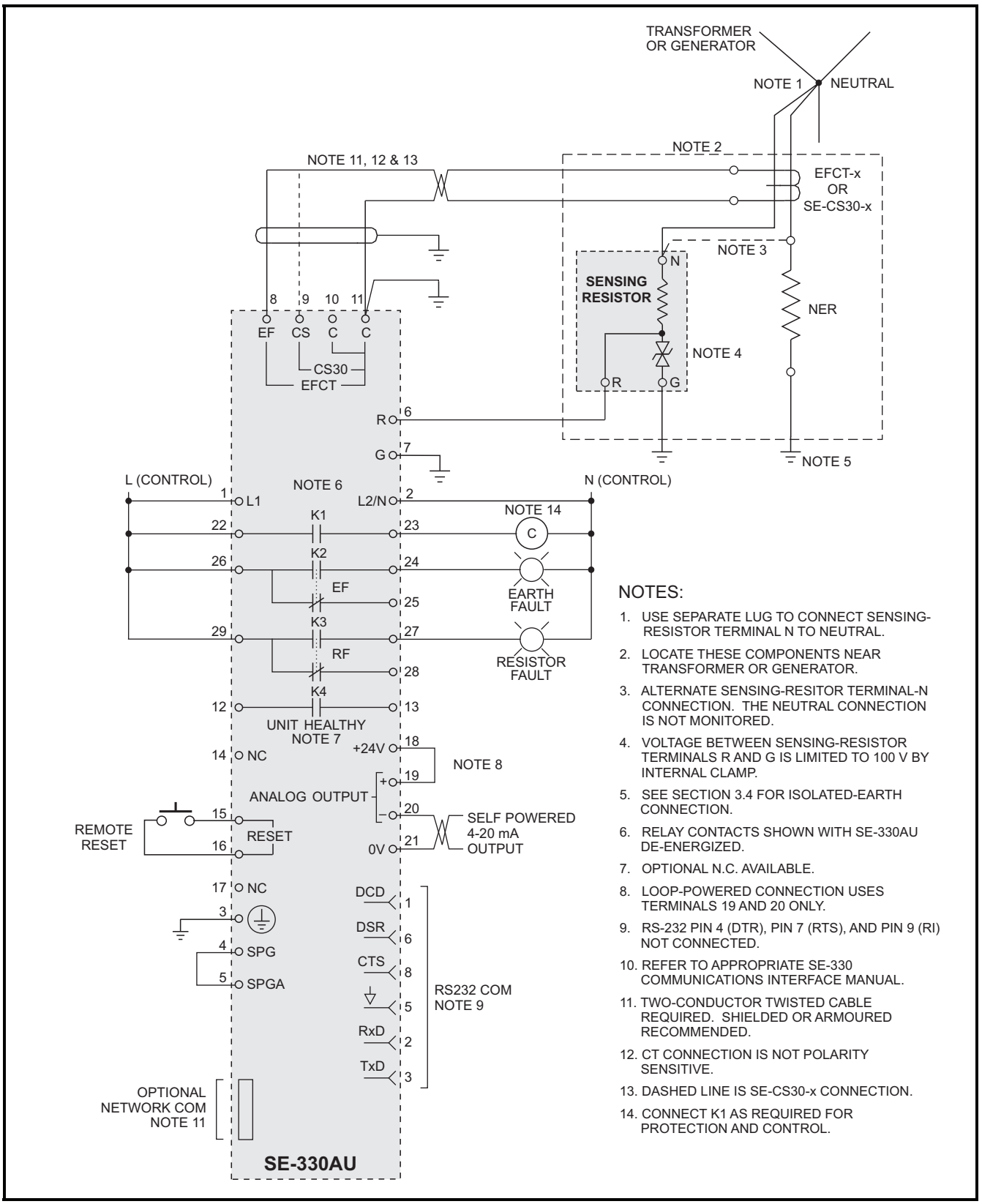
NOTE: The neutral-to-sensing-resistor-terminal-N connection is not a neutral conductor. Since current through this conductor is always less than 250 mA, a 1.5 mm^2 conductor insulated to the system voltage is more than sufficient.

NOTE: For outdoor installations, sensing resistors must be in an IP14 enclosure.

3.3 EARTH-FAULT CT

Select and install an earth-fault CT that will provide the desired trip level. Typically, the CT-primary rating should approximately equal the NER let-through-current rating. This provides an appropriate EF TRIP LEVEL setting range and analog-output scaling. The primary rating of the EFCT-series current sensors is 5 A and the primary rating of the SE-CS30-series is 30 A. See Section 2.1.2.

Outline and mounting details for the sensitive EFCT- and SE-CS30-series current sensors are shown in Figs. 11, 12, and 13. Earth-fault-CT connections and the typical earth-fault-CT location are shown in Fig. 3. If an earth fault in the NER is unlikely, a minimal loss of protection will result if the earth-fault CT monitors the NER connection to earth rather than its connection to neutral.



NOTES:

1. USE SEPARATE LUG TO CONNECT SENSING-RESISTOR TERMINAL N TO NEUTRAL.
2. LOCATE THESE COMPONENTS NEAR TRANSFORMER OR GENERATOR.
3. ALTERNATE SENSING-RESITOR 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-EARTH CONNECTION.
6. RELAY CONTACTS SHOWN WITH SE-330AU DE-ENERGIZED.
7. OPTIONAL N.C. AVAILABLE.
8. LOOP-POWERED CONNECTION USES TERMINALS 19 AND 20 ONLY.
9. RS-232 PIN 4 (DTR), PIN 7 (RTS), AND PIN 9 (RI) NOT CONNECTED.
10. REFER TO APPROPRIATE SE-330 COMMUNICATIONS INTERFACE MANUAL.
11. TWO-CONDUCTOR TWISTED CABLE REQUIRED. SHIELDED OR ARMOURED RECOMMENDED.
12. CT CONNECTION IS NOT POLARITY SENSITIVE.
13. DASHED LINE IS SE-CS30-x CONNECTION.
14. CONNECT K1 AS REQUIRED FOR PROTECTION AND CONTROL.

FIGURE 3. SE-330AU Connection Diagram.

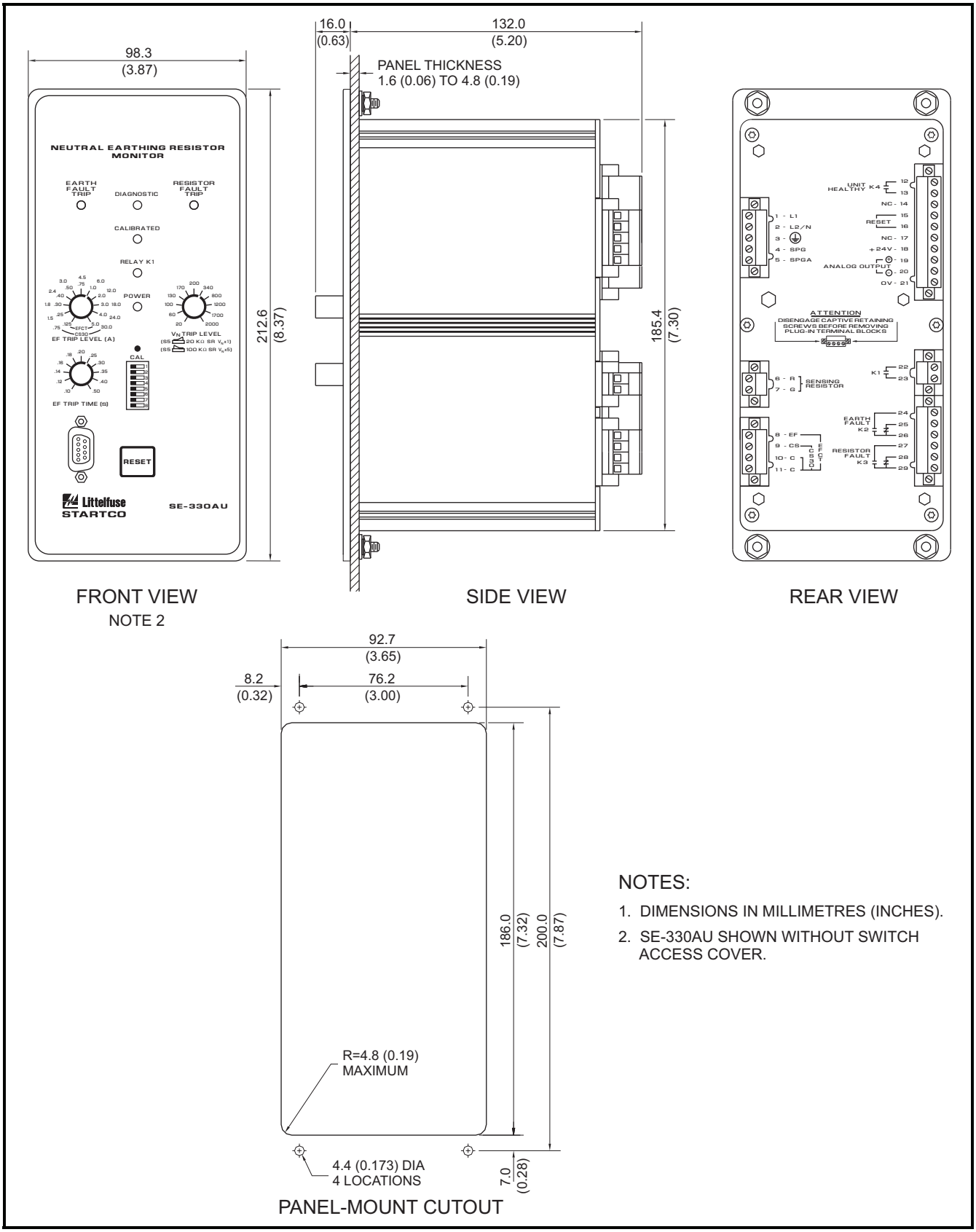
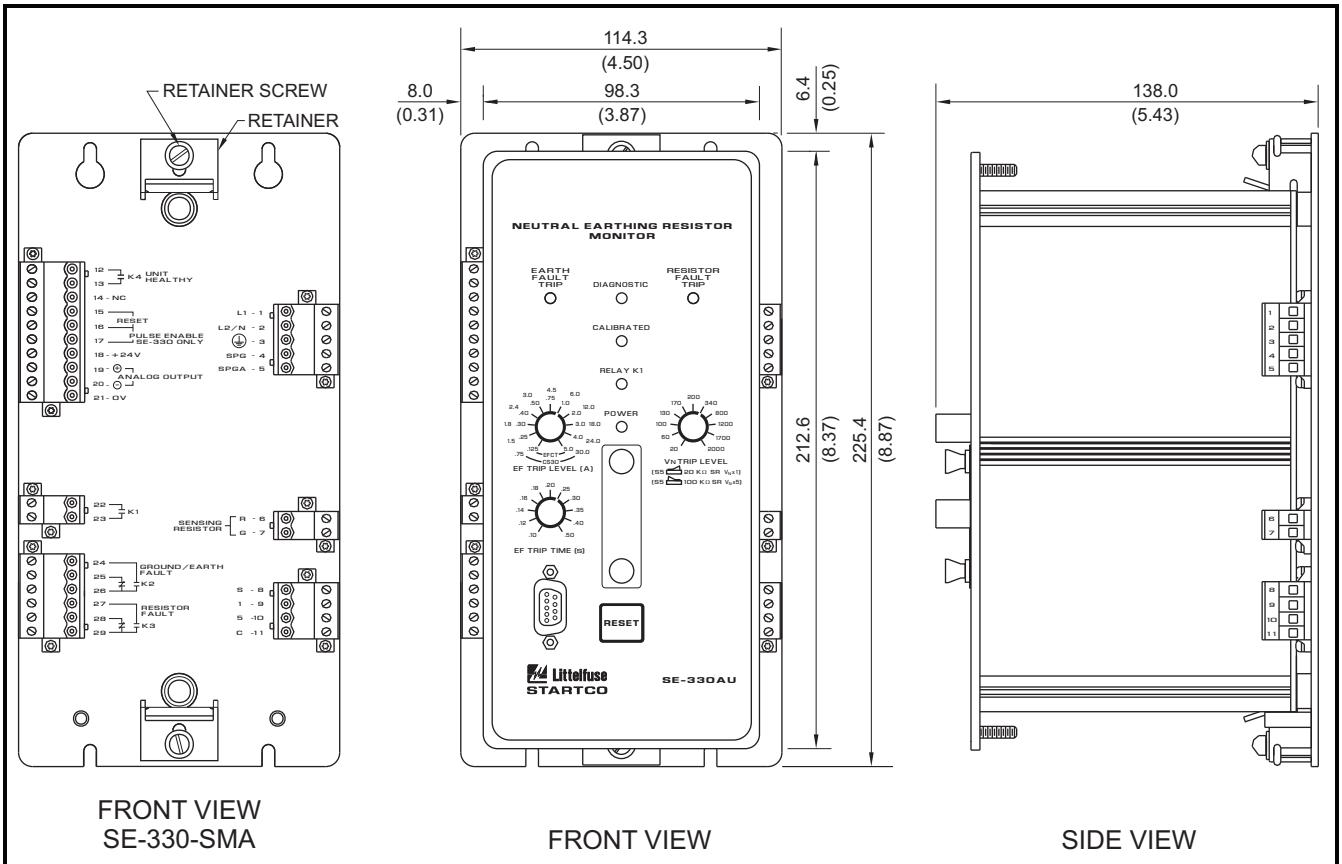
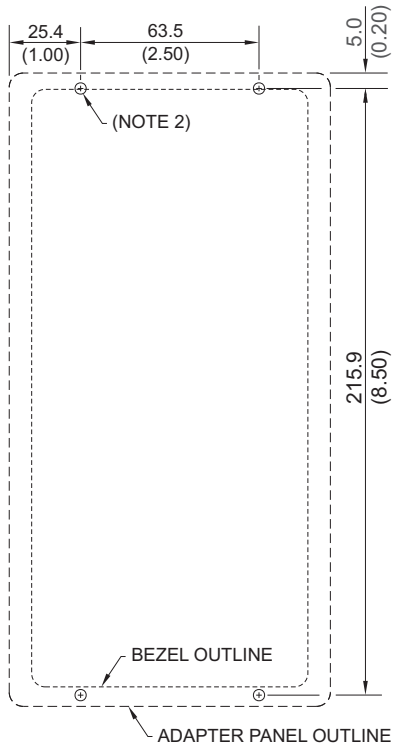


FIGURE 4. SE-330AU Outline and Panel-Mounting Details.





NOTES:

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

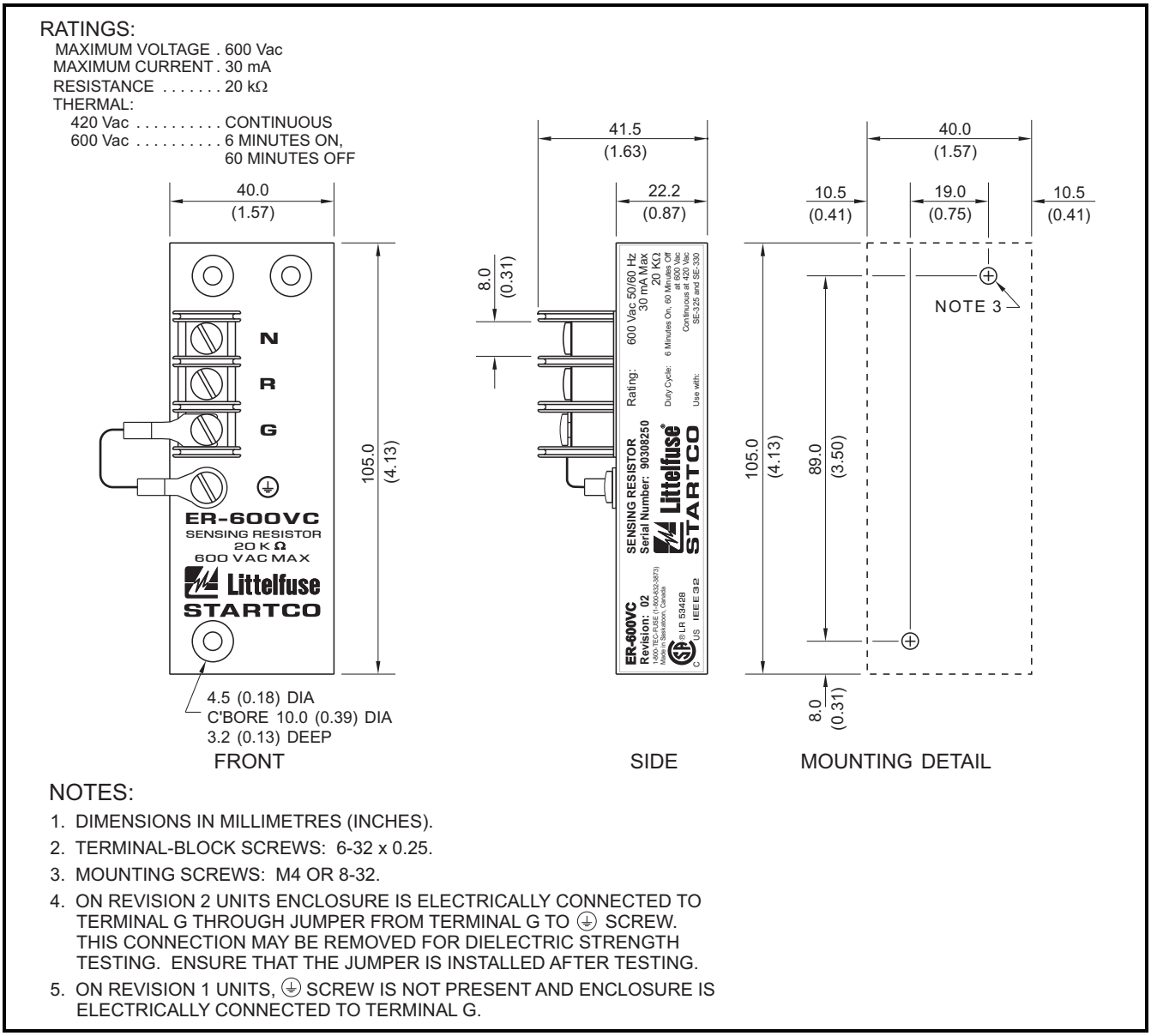
MONITOR INSTALLATION

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.

MONITOR REMOVAL

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

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

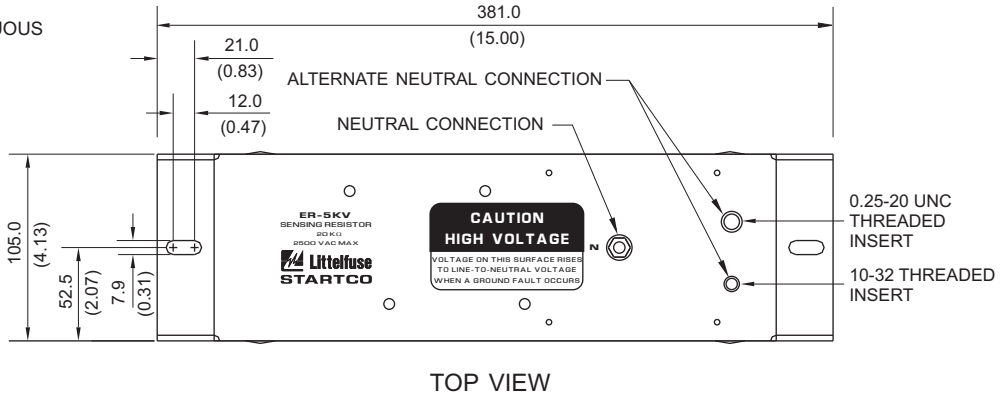


NOTES:

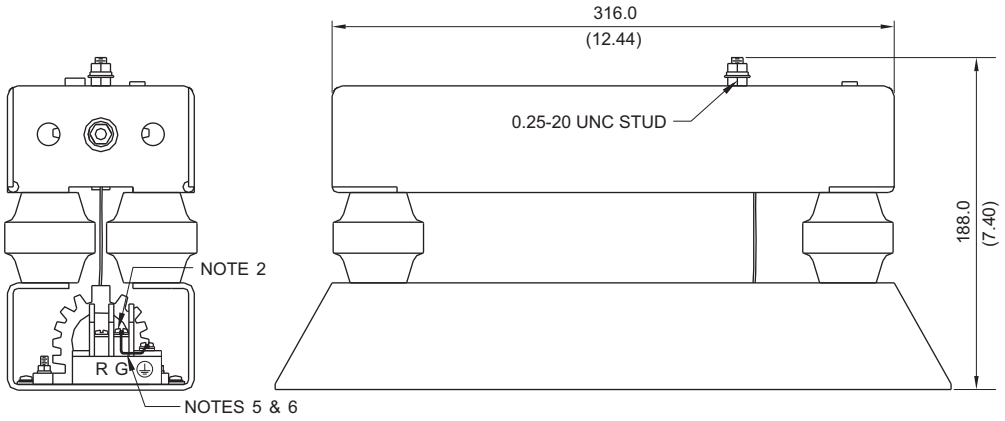
1. DIMENSIONS IN MILLIMETRES (INCHES).
2. TERMINAL-BLOCK SCREWS: 6-32 x 0.25.
3. MOUNTING SCREWS: M4 OR 8-32.
4. ON REVISION 2 UNITS ENCLOSURE IS ELECTRICALLY CONNECTED TO TERMINAL G THROUGH JUMPER FROM TERMINAL G TO ⏚ SCREW. THIS CONNECTION MAY BE REMOVED FOR DIELECTRIC STRENGTH TESTING. ENSURE THAT THE JUMPER IS INSTALLED AFTER TESTING.
5. ON REVISION 1 UNITS, ⏚ SCREW IS NOT PRESENT AND ENCLOSURE IS ELECTRICALLY CONNECTED TO TERMINAL G.

FIGURE 6. ER-600VC Sensing Resistor.

RATINGS:
MAXIMUM VOLTAGE . 2,500 Vac
MAXIMUM CURRENT . 125 mA
RESISTANCE . . . . . 20 kΩ
THERMAL . . . . . CONTINUOUS



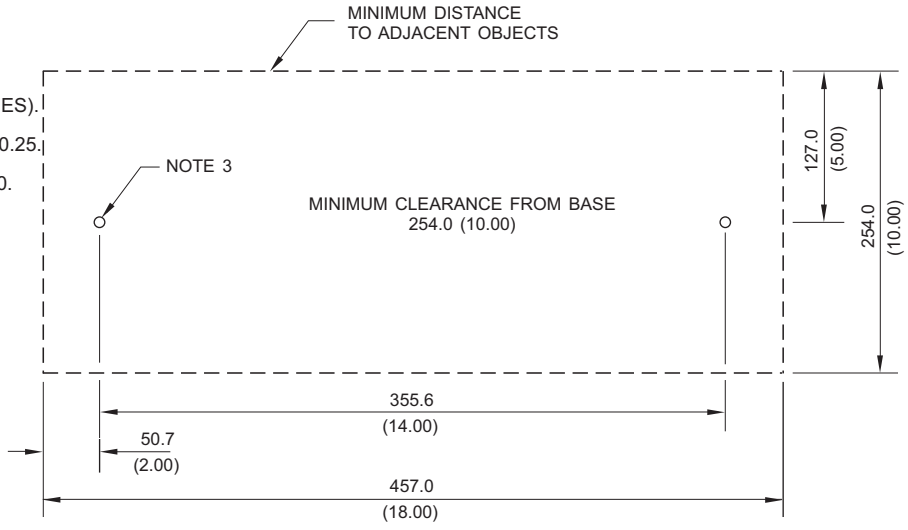
TOP VIEW



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 REV 0 & 1 UNITS ⏚ SCREW IS NOT PRESENT AND BASE IS ELECTRICALLY CONNECTED TO TERMINAL G.



MOUNTING DETAIL

FIGURE 7. ER-5KV Sensing Resistor.

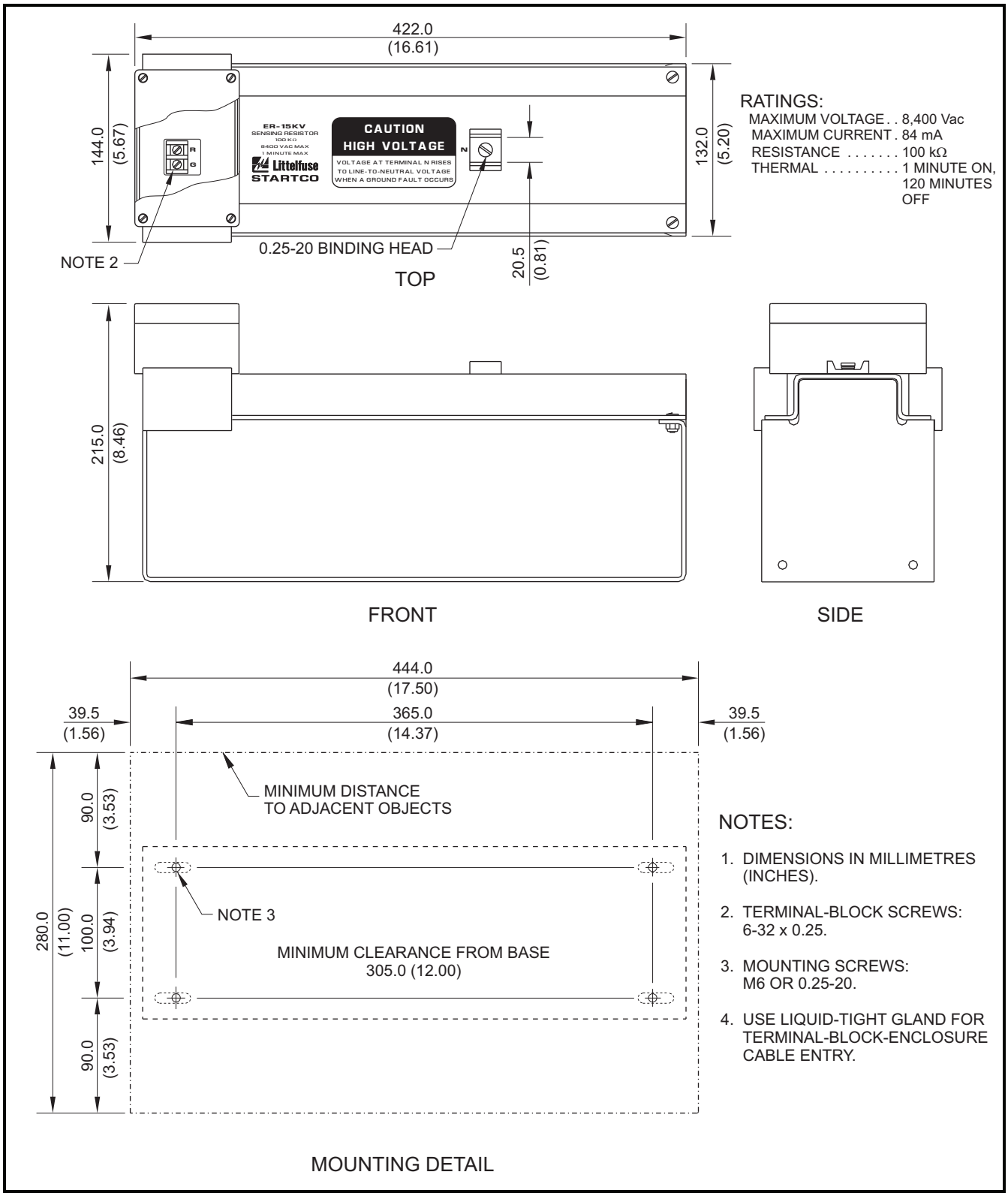


FIGURE 8. ER-15KV Sensing Resistor.

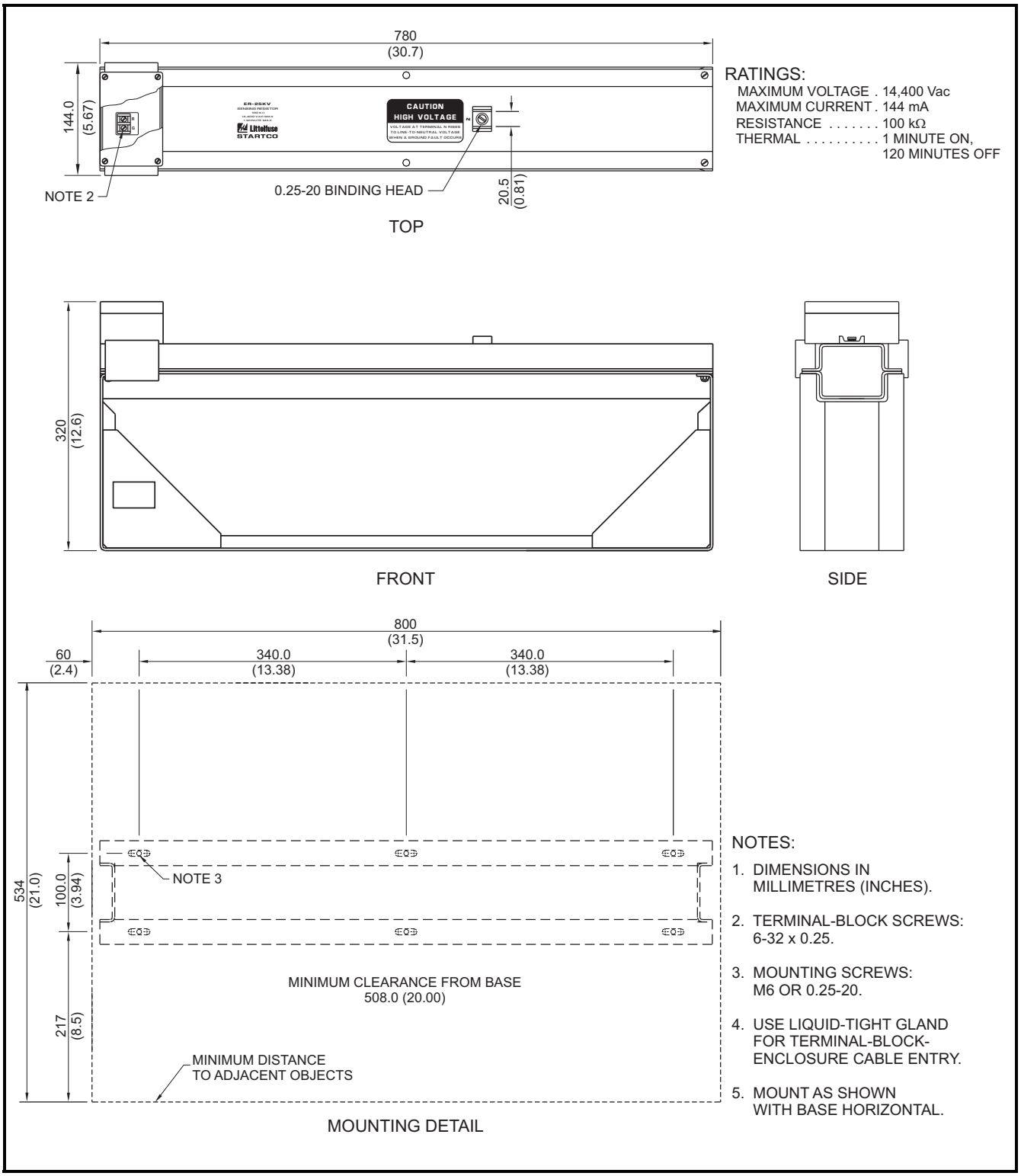
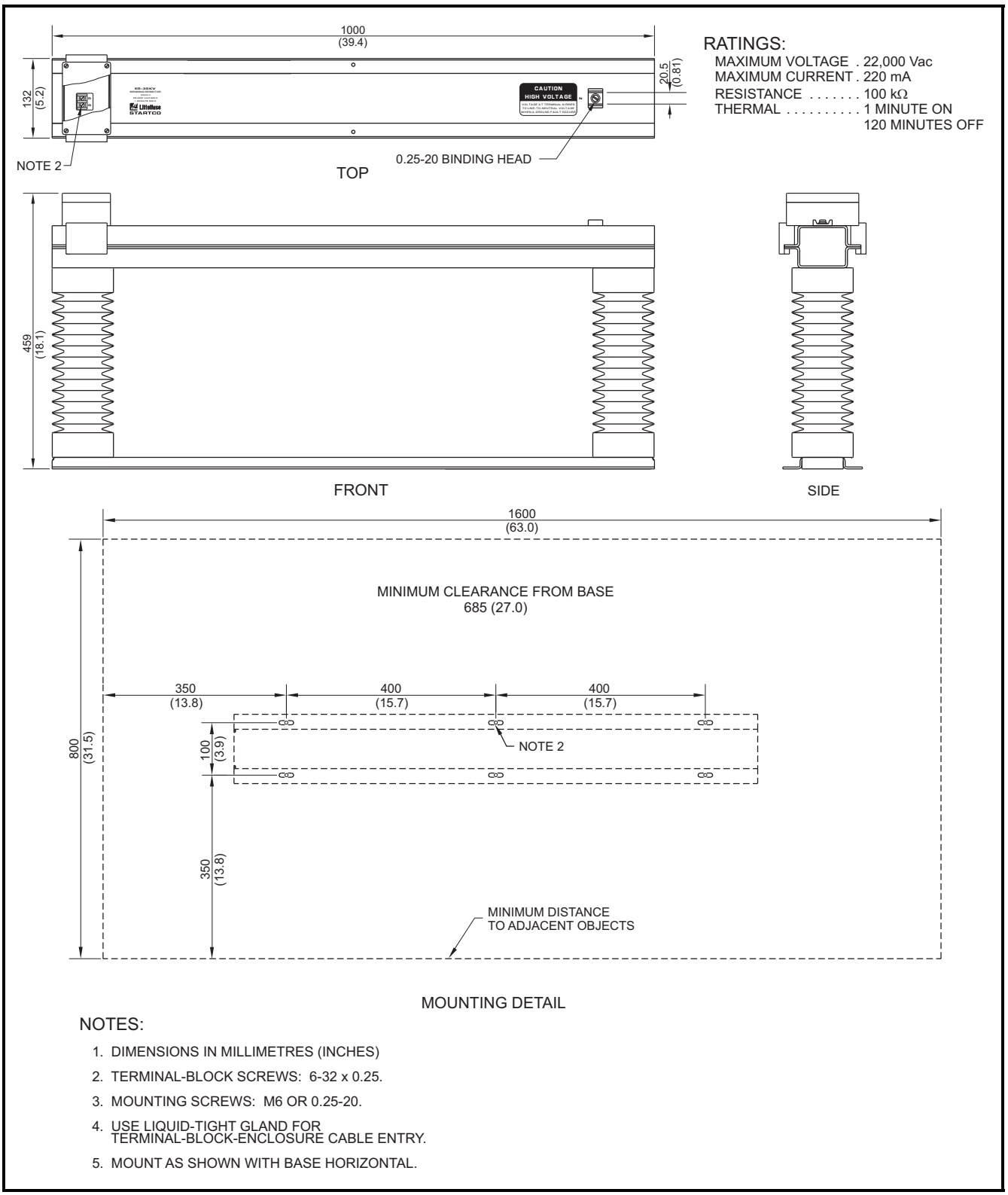


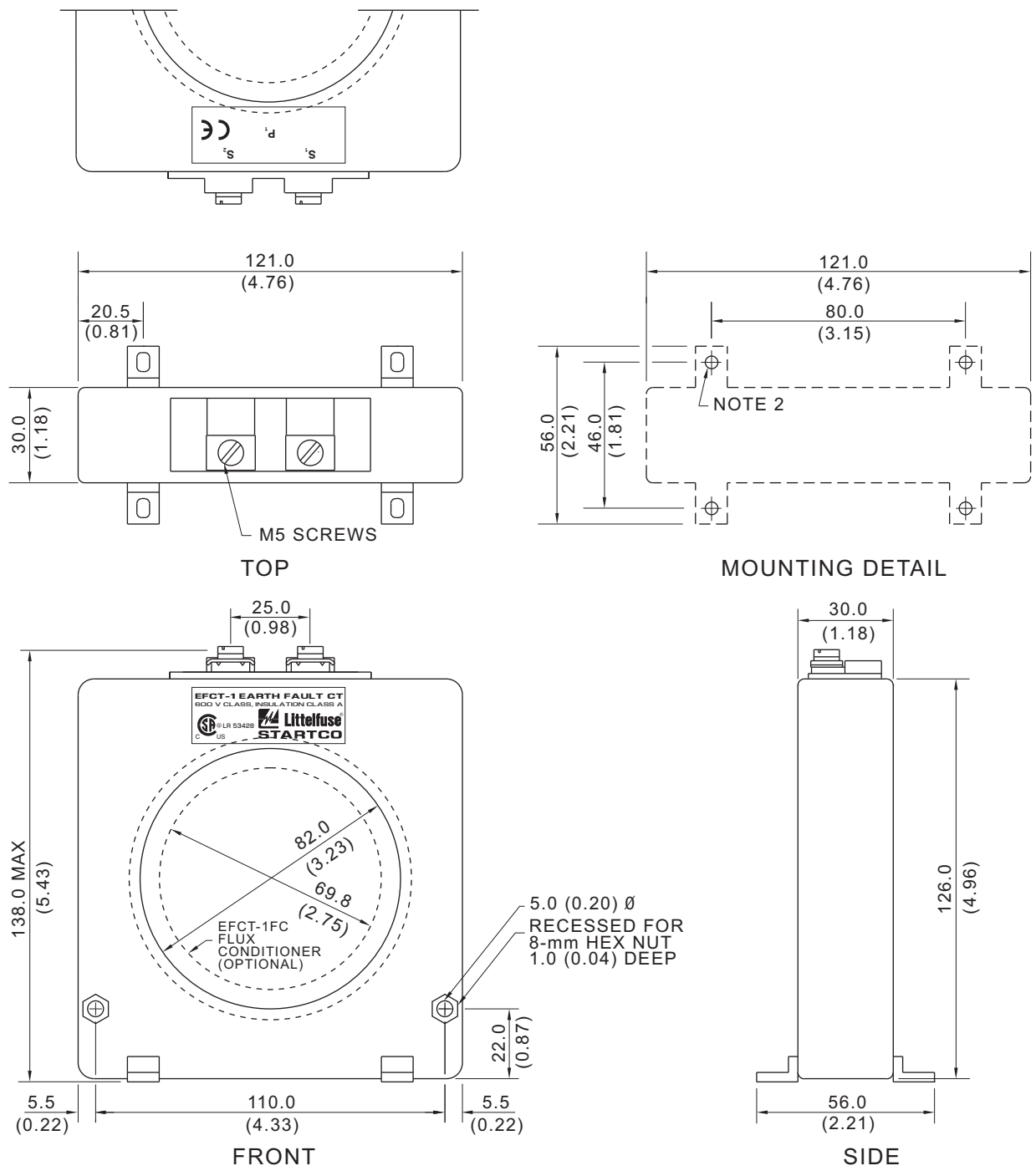
FIGURE 9. ER-25KV Sensing Resistor.



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 GLAND FOR TERMINAL-BLOCK-ENCLOSURE CABLE ENTRY.
5. MOUNT AS SHOWN WITH BASE HORIZONTAL.

FIGURE 10. ER-35KV Sensing Resistor.



NOTES:

1. DIMENSIONS IN MILLIMETRES (INCHES).
2. MOUNTING SCREWS: M4 OR 8-32.
3. PRESS MOUNTING FEET IN PLACE USING INSTALLATION TOOL PROVIDED.

FIGURE 11. EFCT-1 Sensitive Earth-Fault Current Sensor.

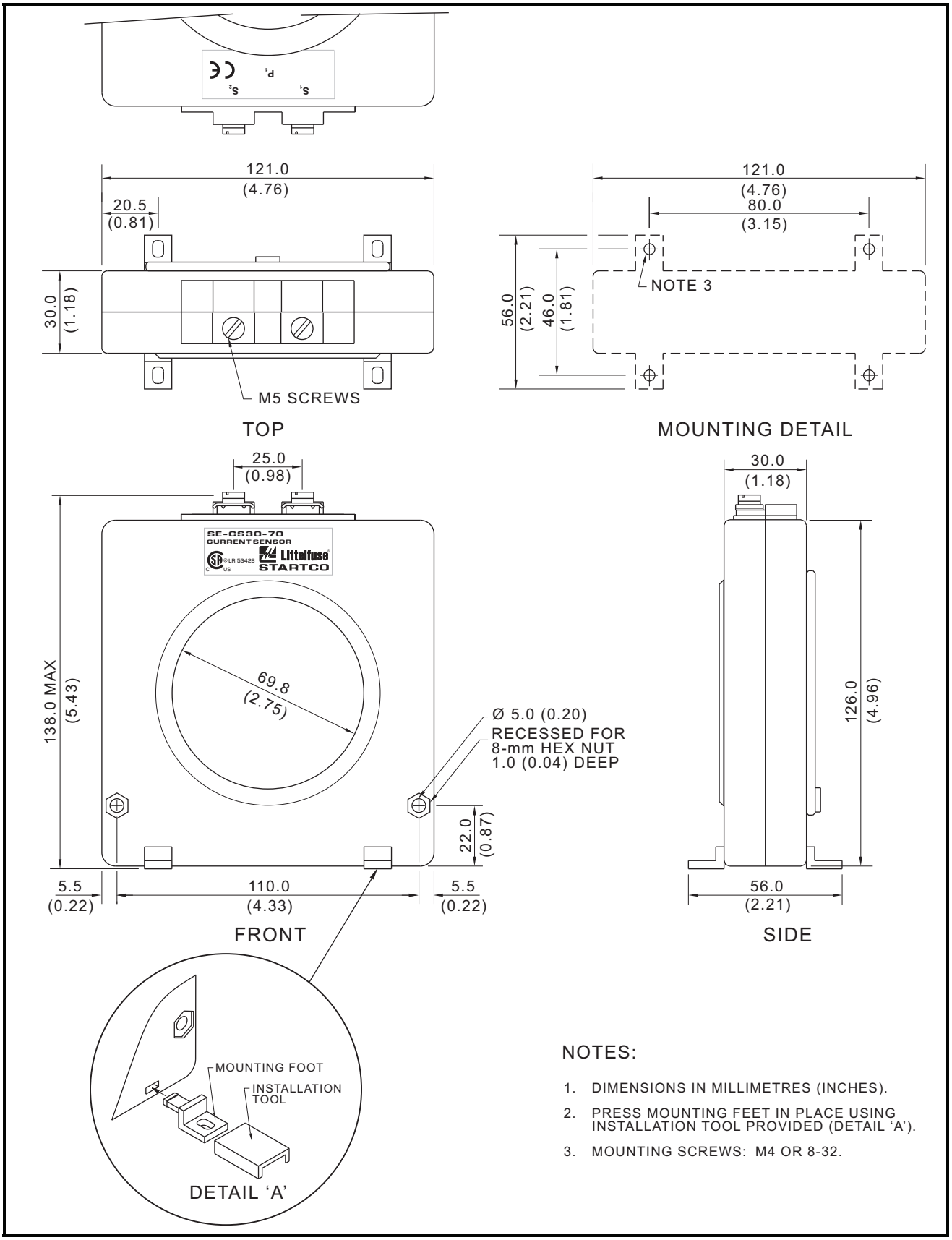


FIGURE 12. SE-CS30-70 Sensitive Earth-Fault Current Sensor.

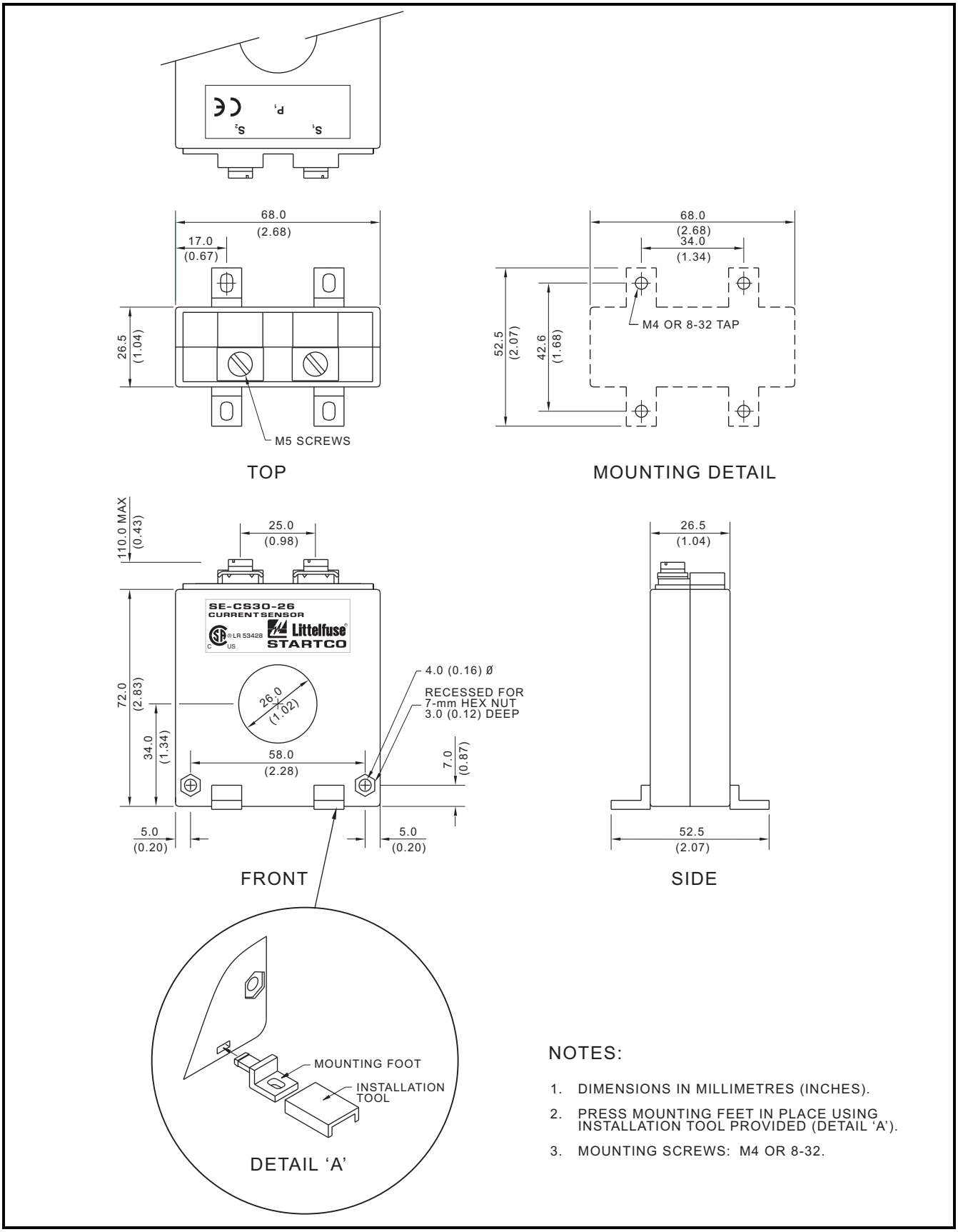


FIGURE 13. EFCT-26 and SE-CS30-26 Sensitive Earth-Fault Current Sensors.

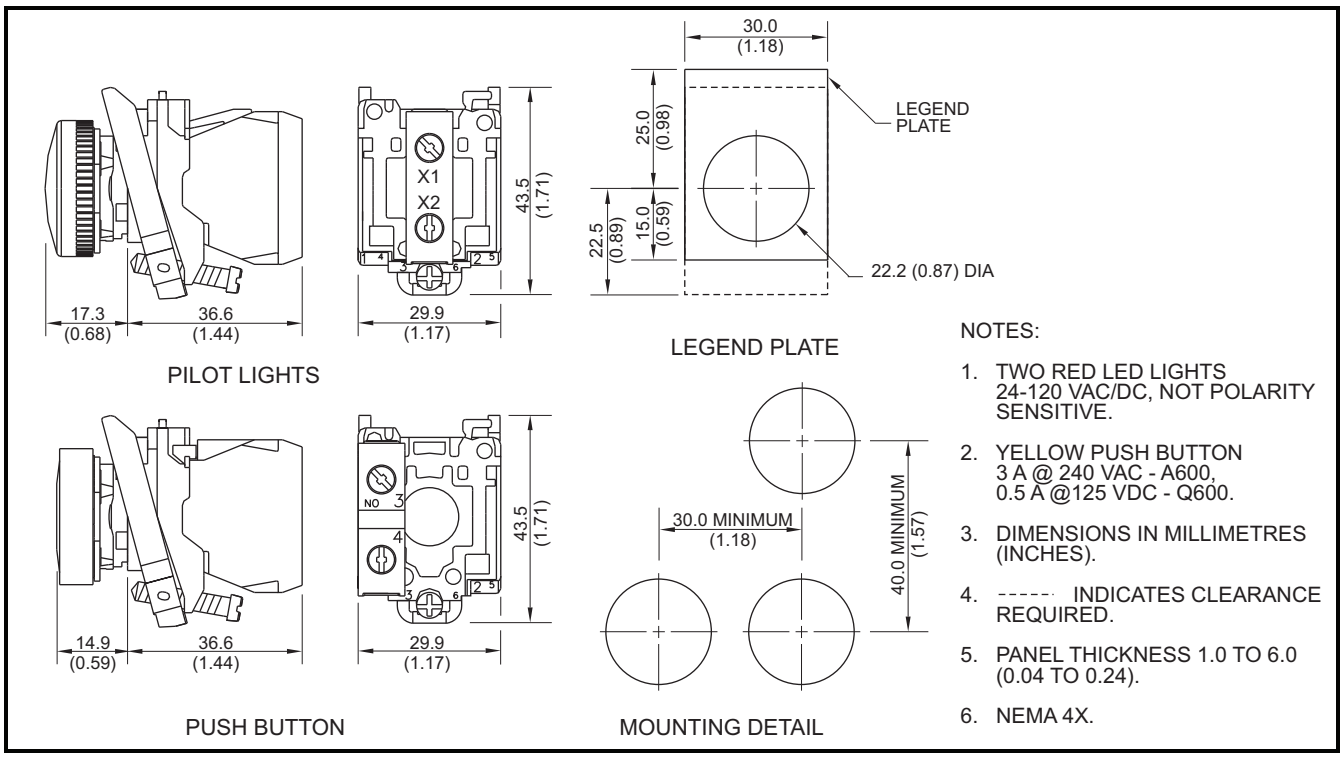


FIGURE 14. RK-332 Remote Indication and Reset.

3.4 Isolated Earth Connection

Isolated earthing can prevent an earth potential rise (EPR) from being transferred to remote equipment. If the G terminals on the sensing resistor and the SE-330AU are connected to isolated earth, the SE-330AU will be exposed to the EPR. If the EPR is greater than the terminal-block rating, the SE-330AU must be isolated from station earth 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.startco.ca.

A configuration which allows an SE-330AU to be connected to station earth is shown in Fig. 15. The SE-330AU monitors the series combination of the NER and the two earthing points. This configuration is acceptable provided the series resistance of the NER and earth is within the NER calibration range and earth-resistance changes remain within the trip range. See Section 6.1.

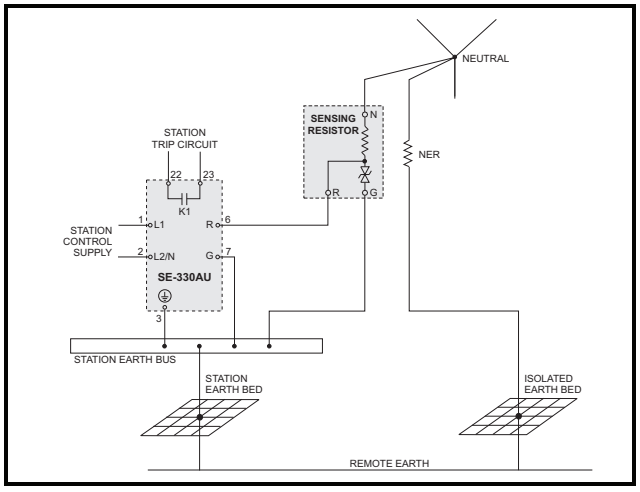


FIGURE 15. Simplified Isolated-Earth Connection.

4. COMMUNICATIONS

4.1 LOCAL COMMUNICATION PORT

The SE-330AU RS-232 port is designed for use with firmware-upgrade and system-monitoring software running on a PC.

The RS-232 port is non-isolated and operates as a DCE device with the connector (socket contacts) pin-out listed in Table 3. This port allows direct connection to a PC using standard DB-9 connector cables. Cable length should not exceed 10 metres.

TABLE 2. RS-232 DB-9 TERMINALS

PIN #	SIGNAL NAME	COMMENTS
1	DCD	470 Ω connected to +12 V
2	RD	Output to DTE from SE-330AU
3	TD	Input from DTE to SE-330AU
4	DTR	Not connected
5	SG	Signal Earth
6	DSR	470 Ω connected to +12 V
7	RTS	Not connected
8	CTS	470 Ω connected to +12 V
9	RI	Not connected

4.1.1 LOCAL DATA ACQUISITION

The SE-330AU outputs a data packet every second. Data output is in the standard UART data format of eight data bits and one stop bit. The baud rate is fixed at 38,400 bits per second. Use PC program SE-MON330 or PDA program SE-PDA330 to display the following data:

- SE-330AU settings and switch states.
- Neutral voltage and current.
- Resistance change.
- Trip status.
- Pending trips.
- Relay and LED status.
- NER calibration value.
  - Expected 20-kΩ value: R_{NER} to (R_{NER}-300)
  - Expected 100-kΩ value: R_{NER} to (R_{NER}-4000)
- Firmware revision level.
- The last ten trip records. Each record contains the trip cause and the pre-trip NER current, voltage, and resistance values.

Data can be logged to a PC file at user-defined time intervals for future analysis.

4.1.2 LOCAL COMMUNICATIONS COMMANDS

As of firmware revision 10, the SE-330AU supports event record commands through the local RS-232 communications port. Commands are input as standard ASCII characters. The latest revision of SE-MON330 supports the following commands:
'd' – Read event records.
'c' – Clear event records

4.1.3 FIRMWARE UPGRADE

The RS-232 port can be used to upgrade the SE-330AU firmware. Upgrade procedure:

1) Remove supply voltage.
2) Set switch S8 to UPGRADE.
3) Apply supply voltage. The DIAGNOSTIC LED will be on and all relays will be de-energized.
4) Run SE-FLASH and follow the instructions.
5) Remove supply voltage.
6) Set switch S8 to RUN.
7) Apply supply voltage.

SE-MON330 and SE-FLASH are available at www.startco.ca.

4.2 NETWORK COMMUNICATIONS

The SE-330AU interface for optional communications modules presently supports DeviceNet™, PROFIBUS®, and Ethernet:

DeviceNet™:
- DeviceNet Slave.
- DeviceNet specification Vol 1:2.0, Vol 2:20.

PROFIBUS®:
- PROFIBUS-DP Slave according to IEC 61158.

Ethernet:
- Modbus TCP Class 0, 1.
- Ethernet/IP Level 2 I/O Server CIP (ControlNet and DeviceNet)
- WebServer, on-board selection of IP address.

Communications options allow the user to:
- Read SE-330AU settings.
- Read neutral voltage and current.
- Read resistance change.
- Read trip status.
- Reset trips.
- Perform a remote trip.
- Access the last ten trip records. Each trip record contains the cause of trip and the pre-trip NER current, voltage, and resistance values.
- Clear event records.

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

5. TROUBLESHOOTING

PROBLEM	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 = L-S-L...*	The total resistance of the NER 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 NER, 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.
Remote Trip DIAGNOSTIC LED flash code = L-S-S-L…*	The SE-330AU was tripped by a signal from network communications. Press RESET to clear the trip.
CT-Detection-Error Trip DIAGNOSTIC LED flash code = L-S-S-S-L…*	The CT connection to the SE-330AU is open. Correct the problem and press RESET.
A/D-Converter-Error Trip DIAGNOSTIC LED flash code = L-S-S-S-S-L…*	An A/D-converter error was detected. Press RESET to clear the trip. If the problem persists, consult Littelfuse Startco.
Software-Interrupt Trip DIAGNOSTIC LED flash code = L-S-S-S-S-S-L…* **Illegal-Opcode Trip** DIAGNOSTIC LED flash code = L-S-S-S-S-S-S-L…* **Watchdog Trip** DIAGNOSTIC LED flash code = L-S-S-S-S-S-S-S-L…* **Clock-Failure Trip** DIAGNOSTIC LED flash code = L-S-S-S-S-S-S-S-S-L…*	These four errors result 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. When supply voltage is cycled, the specific error code is lost but the CPU Trip code will be displayed.
CPU Trip DIAGNOSTIC LED flash code = L-S-S-S-S-S-S-S-S-S-L…*	This code is displayed if the supply is cycled after one of the previous four errors occurred. Press RESET to clear the trip.
EEPROM-Error Trip DIAGNOSTIC LED flash code = L-S-S-S-S-S-S-S-S-S-S-L	An error was detected in the EEPROM. Press RESET to clear the trip. If the problem persists, consult Littelfuse Startco.
DIAGNOSTIC LED = Solid Red	Switch S8 is in the UPGRADE position. If firmware upgrade is not required, set switch S8 to RUN and cycle supply.
	SE-330AU processor failed to start. Cycle supply. Consult Littelfuse Startco if problem persists.
Pressing RESET does not clear trips.	Trip condition is still present. Locate and correct.
	The face-plate 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.

*L = long pause, S = short flash.

6. TECHNICAL SPECIFICATIONS

6.1 SE-330AU

Supply
- Option 0 ..... 30 VA, 65 to 265 Vac, 40 to 400 Hz. 20W, 80 to 275 Vdc
- Option 2 ..... 20 W, 36 to 72 Vdc 35 VA, 32 to 52 Vac 40 to 400 Hz

Power-Up Time ..... 250 ms at 120 Vac

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

Resistor-Fault Circuit:
- Neutral-To-Earth Voltage Trip Levels:
  - 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 ..... 5% of setting
- NER Calibration Range:
  - ER-600VC or ER-5KV ..... 0 to 2 kΩ
  - ER-15KV to ER-35KV ..... 0 to 10 kΩ
- Trip Resistance, $V_N = 0$:
  - ER-600VC or ER-5KV ..... 500-Ω change ± 200 Ω
  - ER-15KV to ER-35KV ..... 2.5-kΩ change ± 1 kΩ
- DC-Voltage Rejection:
  - ER-600VC or ER-5KV ..... 25 Vdc
  - ER-15KV to ER-35KV ..... 125 Vdc
- Trip Time ..... 12 ± 1 s
- Trip Hold-Off Level ..... 5% of CT-Primary Rating
- Operating Mode ..... Latching/Non-Latching

Earth-Fault Circuit:
- Trip Level:
  - EFCT-x ..... 0.125, 0.25, 0.30, 0.40, 0.50, 0.75, 1.0, 2.0, 3.0, 4.0, 5.0 A
  - SE-CS30-x ..... 0.75, 1.5, 1.8, 2.4, 3.0, 4.5, 6.0, 12.0, 18.0, 24.0, 30.0 A
- Trip Time ..... 0.1, 0.12, 0.14, 0.16, 0.18, 0.2, 0.25, 0.3, 0.35, 0.4, 0.5 s
- Trip-Level Accuracy ..... +0, -20% of setting
- Trip-Time Accuracy ..... +0, -15 ms or +0, -20% of setting
- CT-Input Burden:
  - EFCT Input ..... 11 Ω
  - CS30 Input ..... 10 Ω
- CT Detection Threshold ..... 15 Ω
- Thermal Withstand:
  - Continuous ..... 10 x CT Rating
  - 1-Second ..... 25 x CT Rating
- Measurement Range ..... 25 x CT-Primary Rating
- Operating Mode ..... Latching/Non-Latching

Trip Relay K1 Contacts:
- Configuration ..... N.O. (Form A)
- Operating Mode ..... 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)
    - ac ..... 2,000 VA resistive, 1,500 VA inductive (PF = 0.4)
  - Subject to maximums of 8 A and 250 V (ac or dc).

EF (K2) and RF (K3) Relay Contacts:
- Configuration ..... N.O. and N.C. (Form C)
- Operating Mode ..... Non-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)
    - ac ..... 2,000 VA resistive, 1,500 VA inductive (PF = 0.4)
  - Subject to maximums of 8 A and 250 V (ac or dc).

UNIT HEALTHY Output K4 (Option 00):
- Configuration ..... N.O. (Form A)
- Operating Mode ..... Closed when Healthy
- Ratings ..... 100 mA, 250 V (ac or dc)
- Closed Resistance ..... 30 Ω maximum

UNIT HEALTHY Output K4 (Option 01):
- Configuration ..... N.C. (Form B)
- Operating Mode ..... Open when Healthy
- Ratings ..... 100 mA, 250 V (ac or dc)
- Closed Resistance ..... 30 Ω 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 ..... NER Current

RS-232 Communications:
- Baud Rate ..... 38.4 kbit/s
- Protocol ..... Proprietary

Terminal-Block Ratings ..... 10 A, 300 Vac, 2.5 mm^2

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

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

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

Environment:
- Operating Temperature ..... -40 to 60°C
- Storage Temperature ..... -55 to 80°C
- Humidity ..... 85% Non-Condensing

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

EMC ..... EN 55011:1998
Compliance ..... AS/NZS 2081.3:2002

6.2 Sensing Resistors

ER-600VC:
- Maximum Voltage ..... 600 Vac
- Maximum Current ..... 30 mA
- Resistance ..... 20 kΩ
- Thermal ..... Continuous
- Shipping Weight ..... 300 g (0.7 lb)

ER-5KV:
- Maximum Voltage ..... 2,500 Vac
- Maximum Current ..... 125 mA
- Resistance ..... 20 kΩ
- Thermal ..... Continuous
- Shipping Weight ..... 5.0 kg (11 lb)

ER-15KV:
- Maximum Voltage ..... 8,400 Vac
- Maximum Current ..... 84 mA
- Resistance ..... 100 kΩ
- Thermal ..... 1 minute on, 120 minutes off
- Shipping Weight ..... 5.0 kg (11 lb)

ER-25KV:
- Maximum Voltage ..... 14,400 Vac
- Maximum Current ..... 144 mA
- Resistance ..... 100 kΩ
- Thermal ..... 1 minute on, 120 minutes off
- Shipping Weight ..... 20 kg (44 lb)

ER-35KV:
- Maximum Voltage ..... 22,000 Vac
- Maximum Current ..... 220 mA
- Resistance ..... 100 kΩ
- Thermal ..... 1 minute on, 120 minutes off
- Shipping Weight ..... 40 kg (88 lb)

6.3 Current Sensors

EFCT-1:
- Current Ratio ..... 5:0.05 A
- Insulation ..... 600-V Class
- Window Diameter ..... 82 mm (3.2")
- Shipping Weight ..... 900 g (2.0 lb)

EFCT-26
- Current Ratio ..... 5:0.05 A
- Insulation ..... 600-V Class
- Window Diameter ..... 26 mm (1.0")
- Shipping Weight ..... 450 g (1.0 lb)

SE-CS30-26
- Current Ratio ..... 30:0.05 A
- Insulation ..... 600-V Class
- Window Diameter ..... 26 mm (1.0”)
- Shipping Weight ..... 450 g (1.0 lb)

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)

7. ORDERING INFORMATION

SE-330AU-□□-□□

Options:
00 N.O. UNIT HEALTHY Contact
01 N.C. UNIT HEALTHY Contact

Network Communications:
0 None
1 DeviceNet™
2 PROFIBUS®
3 Ethernet

Supply:
0 Universal ac/dc Supply
2 48 V

Sensing Resistors:

ER-600VC	For system voltages up to 1 kVac
ER-5KV	For system voltages up to 5 kVac
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 Transformers:

EFCT-1	Sensitive Earth-Fault CT, 5-A-primary rating, 82-mm (3.2") window
EFCT-26	Sensitive Earth-Fault CT, 5-A-primary rating, 26-mm (1.0") window
SE-CS30-26	Sensitive Earth-Fault CT, 30-A-primary rating, 26-mm (1.0") window
SE-CS30-70	Sensitive Earth-Fault CT, 30-A-primary rating, 70-mm (2.7") window

Accessories:

RK-332	Remote Indication and Reset, Includes two 120-V pilot lights, a reset push button, and legend plates
SE-330-SMA	Surface-Mount Adaptor

Software: *

SE-FLASH	Firmware Upgrade Program
SE-MON330	SE-330AU Data-Display Program for PC
SE-PDA330	SE-330AU Data-Display Program for PDA

* Available at www.startco.ca.

8. WARRANTY

The SE-330AU Neutral-Earthing-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-330AU that is determined by Littelfuse Startco to be defective if it is returned to the factory, 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.

Littelfuse Startco is not liable for contingent or consequential damages; for expenses sustained as a result of incorrect application, incorrect adjustment, or a malfunction; or for expenses resulting from the use of, or inability to use, the product.

9. TEST PROCEDURES

9.1 RESISTOR-FAULT TESTS

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

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-330AU).

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 12 seconds.
  PASS: The SE-330AU 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 12 seconds.
  PASS: The SE-330AU 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 and multimeter.

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-330AU and the ER sensing resistor. The V_N TRIP LEVEL is the trip voltage at terminal N, not terminal R.

Procedure:

- Check the ER sensing resistor connection to the SE-330AU.
- Disconnect the wire from sensing-resistor terminal N.
- 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 12 seconds **PASS:** The SE-330AU should trip on RESISTOR FAULT. A time-delayed earth-fault trip follows the resistor-fault trip if neutral voltage persists after the resistor fault

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 EARTH-FAULT PERFORMANCE TEST

To meet the requirements of the AS/NZS 2081.3:2002, the overall earth-fault protection system requires a performance test. A test-record form is provided for recording the date and the final results of the performance tests. The following earth-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 location of the earth-fault current transformer. Ensure the cables pass through the earth-fault-current-transformer window. This check can be done visually with knowledge of the circuit. The connection of the current-transformer secondary to the SE-330AU is not polarity sensitive.

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

d) Verify proper reaction of the circuit-interrupting device in response to a simulated or controlled earth-fault current. To simulate earth-fault current, use CT-primary current injection. Fig. 17a 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 EF TRIP LEVEL. Fig. 17b 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. Inject the test current through the current-transformer 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, 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.

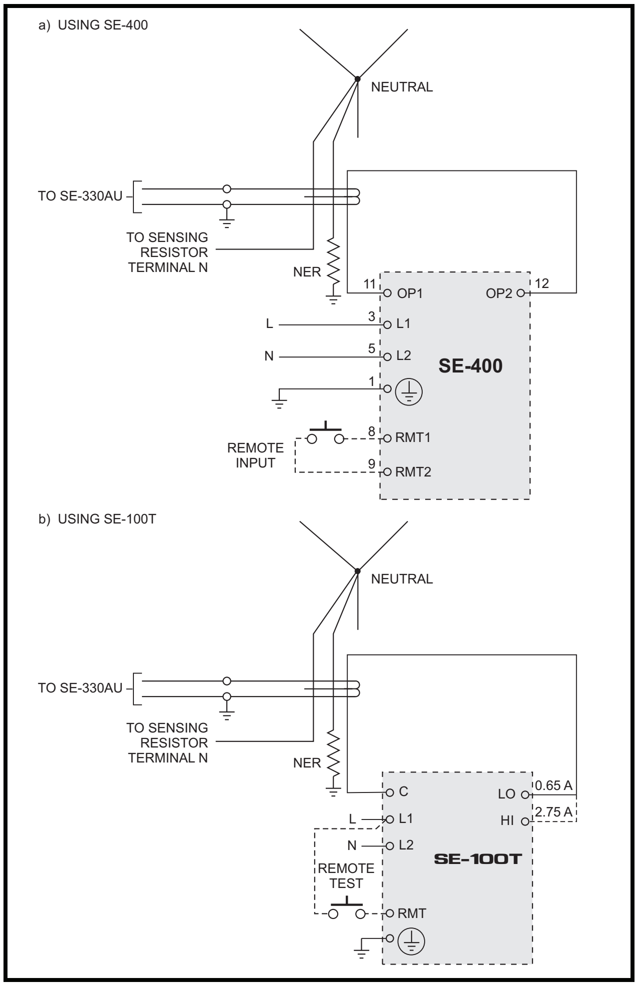


FIGURE 16. Earth-Fault-Test Circuits.

TABLE 3. EARTH-FAULT-TEST RECORD

DATE	TEST RESULTS

Retain this record for the authority having jurisdiction.