

# SE-704 MANUAL EARTH-LEAKAGE MONITOR

REVISION 7-D-070518



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**DISCLAIMER**

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## 1. GENERAL

The SE-704 is a microprocessor-based earth-leakage monitor for ac power supply systems that require earth-leakage detection as low as 10 mA. It is uniquely suited for very sensitive earth-fault protection on systems with significant harmonic content. The SE-704's output relay can operate in a fail-safe or non-fail-safe mode for undervoltage or shunt-trip applications. The SE-704 has one output relay with isolated normally open and normally closed contacts for use in independent control circuits. Additional features include LED trip and power indication, autoreset or latching trips with front-panel and remote reset, trip memory, test button, self diagnostics, 0- to 1-mA and 0- to 5-V analog outputs, current transformer (CT) verification with LED indication, digital selector switches, and switch-selectable algorithms for fixed-frequency or variable-frequency applications.

Earth-leakage current is sensed by an ELCT30 series core-balance earth-fault CT. The trip level of the earth-leakage circuit is digital-switch selectable from 10 to 5,000 mA. The trip time is digital-switch selectable from 30 to 2,000 ms.

## 2. OPERATION

### 2.1 Configuration-Switch Settings

See Fig. 1.

#### 2.1.1 Relay Operating Mode

Switch 1 is used to set the operating mode of the output relay. In the fail-safe mode, the output relay energizes when the earth-leakage circuit is not tripped. In the non-fail-safe mode, non-volatile memory retains the trip status of the SE-704. If tripped, and the supply voltage is cycled, the SE-704 will remain tripped, with the trip relay de-energized and the TRIP LED on, until reset.

In the non-fail-safe mode, the output relay energizes when an earth-leakage trip occurs. In the non-fail-safe mode, the trip status is not retained in non-volatile memory.

#### 2.1.2 Filter Selection

Switch 2 is used to select the filtering algorithm for earth-leakage trip levels that are 500 mA or less, and for fixed-frequency (50/60 Hz) and variable-frequency applications. The peak-detection algorithm is used for settings greater than 500 mA, regardless of the filter selection.

The FIXED FREQUENCY setting uses a DFT filter that allows lower trip levels to be used by rejecting harmonics that can cause nuisance tripping. The VARIABLE FREQUENCY setting uses a peak-detection algorithm with a wider band width for fault detection in variable-frequency drive applications.

#### 2.1.3 CT Verification

Switch 3 is used to enable CT verification. In the ON position, a trip will occur if the ELCT30 current sensor is disconnected.

#### 2.1.4 Reset Mode

Switch 4 is used to select autoreset or latching trips. See Section 2.2.3.

#### 2.1.5 Analog Output

Switch 5 is used to select analog-output scaling. Selecting % OF 5A results in a full-scale output (1 mA or 5 V) when the earth-fault current is 5 A. Selecting % OF SETTING results in a full-scale output when the earth fault current is equal to the trip-level setting. See Section 2.4.

## 2.2 Front-Panel Controls

### 2.2.1 Earth-Leakage Trip Level

The LEVEL (mA) selection switch is used to set the earth-leakage trip level. For earth-leakage detection, the earth-leakage trip level must be substantially below the prospective earth-fault current. To avoid sympathetic tripping, the trip level must be above the charging current of the protected feeder.

### 2.2.2 Earth-Leakage Trip Time

The SE-704 has a definite-time trip characteristic. The TIME (ms) selector switch is used to set the earth-leakage trip time for coordination with upstream and downstream earth-fault devices. Coordination requires the same trip level for all earth-leakage devices in a system and the trip time to progressively increase upstream. The amount of equipment removed from the system will be minimal if the earth-leakage device that is immediately upstream from the fault is the first earth-leakage device to operate.

### 2.2.3 Reset

If the Reset Mode switch is in the LATCHING position, a trip remains latched until the RESET button is pressed or the remote-reset terminals (6 and 7) are momentarily connected. In the non-fail-safe relay operating mode, cycling the supply voltage will also reset the SE-704.

If the Reset Mode switch is in the AUTORESET position, a trip will reset when the fault is removed.

The reset circuit responds only to a momentary closure so that a jammed or shorted button will not prevent a trip. The front-panel RESET button is inoperative when the remote-reset terminals are connected.

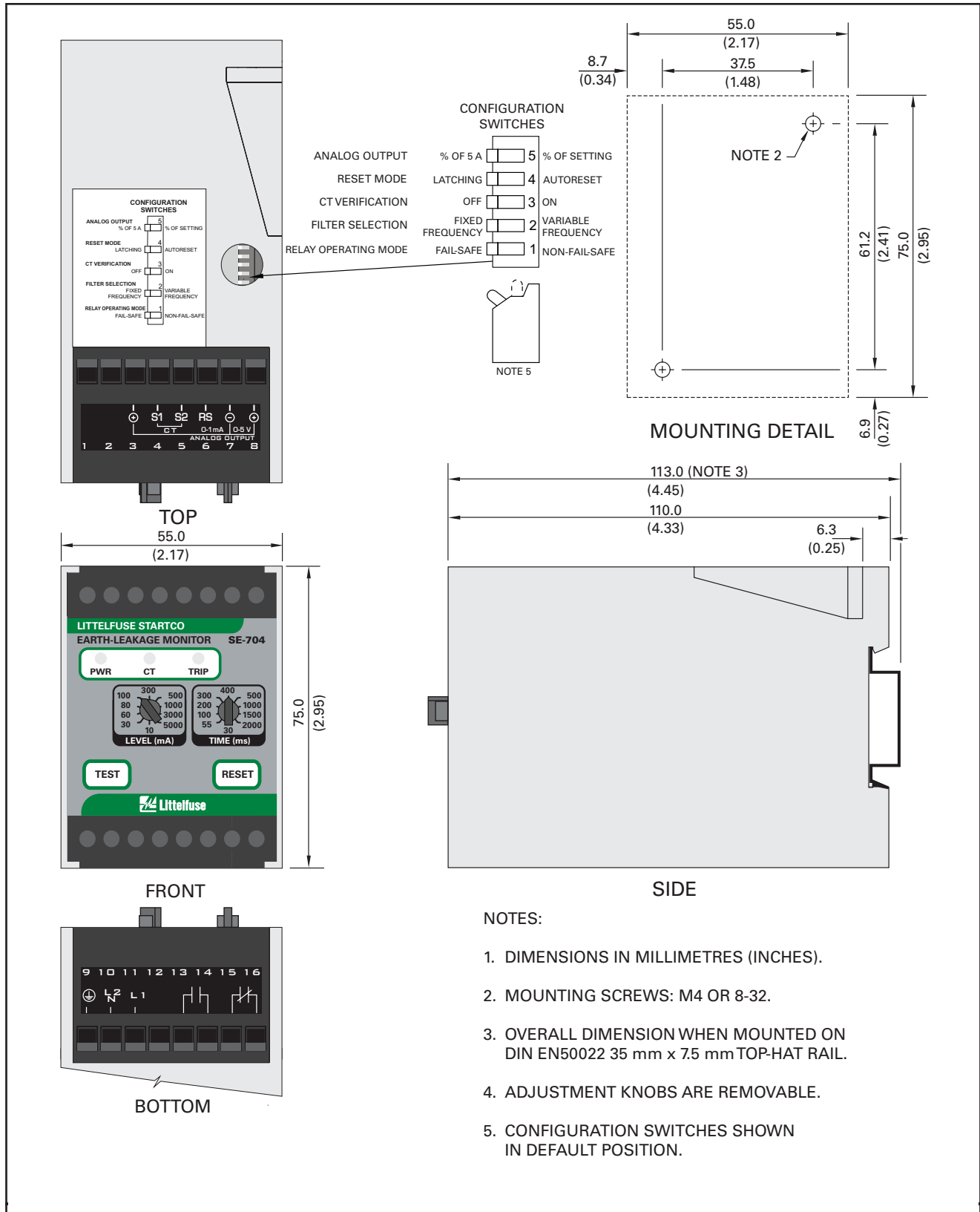


FIG. 1. SE-704 Outline and Mounting Details.

### 2.2.4 Test

The TEST button is used to test the earth-leakage circuit, the indication, and the output relay. When the TEST button is pressed for one second, a test signal is applied to the earth-leakage-detection circuit, the circuit will trip, the TRIP LED will light, and the output relay will operate.

## 2.3 Front-Panel Indication

### 2.3.1 Power

The green LED labeled “PWR” indicates presence of supply voltage.

### 2.3.2 Trip

The red LED labeled “TRIP” will indicate a trip. A solid red LED indicates an earth-leakage trip and a flashing LED indicates a trip initiated by a CT fault. Two fast flashes of the TRIP LED indicate a diagnostic trip. See Section 2.5.

### 2.3.3 CT Verification

The green LED labeled CT indicates that an ELCT30 sensor is connected, even if CT verification is disabled.

## 2.4 Analog Outputs

The non-isolated, 0- to 1-mA (terminal 3) and 0- to 5-V (terminal 8) analog outputs indicate earth-leakage current sensed by the ELCT30 series current sensor. The output is linear between zero and full scale. Use a PGA-0500 Analog Percent Current Meter to indicate earth-leakage current. See Figs. 2, 3, and 8.

## 2.5 Self Diagnostics

A diagnostic trip is indicated by two fast flashes of the TRIP LED. It can be caused by a problem detected by the watchdog timer, or from an incorrect reading from nonvolatile memory. Press RESET or cycle the supply voltage. If the problem persists, consult with the factory.

## 3. INSTALLATION

**NOTE:** Mounting, terminal-block connections and wiring must conform to applicable local electrical codes. Check all applicable codes prior to installation.

This earth-leakage monitoring system consists of an ELCT30 Earth-Leakage Monitor and an ELCT30-series current sensor connected (see Fig. 2 and Fig. 3). An SE-704 can be surface or DIN-rail mounted. See Fig. 1. Panel mounting requires a PMA-55 or PMA-60 Panel-Mount Adapter. See Fig. 6 and Fig. 7.

Use terminal 11 (L1) as the line terminal for ac systems or the positive terminal for dc systems. Use terminal 10 (L2/N) as the neutral terminal on ac systems or the negative terminal on dc systems. Connect terminal 9 (⊕) to earth.

Pass the phase conductors through the CT window and position them in the center of the opening. For 4-wire and single-phase systems, also pass the neutral conductor through the CT window, as shown in Fig. 2 and Fig. 3. Do not pass earth conductors through the CT window. In applications that require shields or drain wires to pass through the CT window, return them through the CT window before connecting them to earth. Connect the ELCT30-series current sensor to terminals 4 and 5. Connect the shield to terminal 5. and earth terminal 5. See Fig. 4 and Fig. 5 for ELCT30 current-sensor dimensional drawings.

Remove the connection to terminal 9 for dielectric strength test. All inputs and outputs have ANSI/IEEE C37.90 surge protection circuits that conduct above 300 Vac.

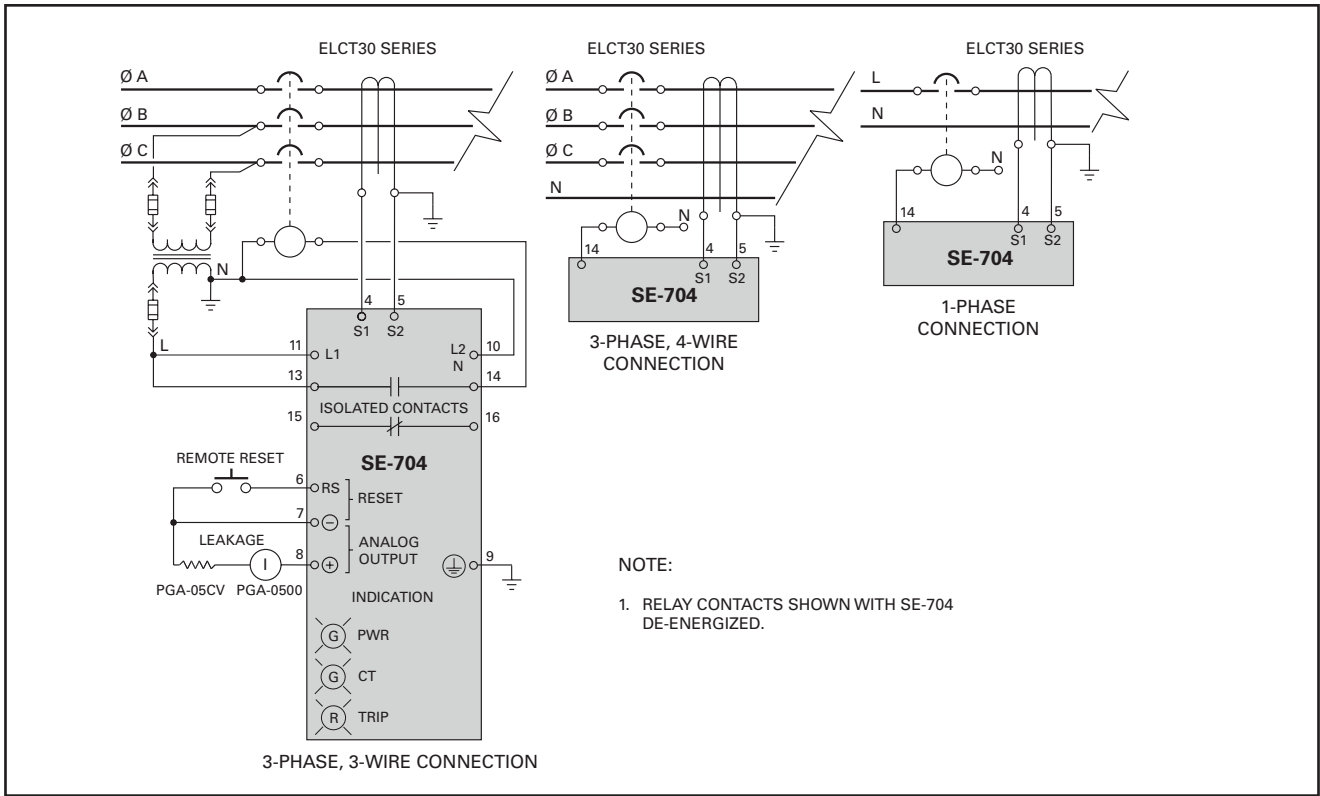


FIG. 2. Typical Connection Diagrams.

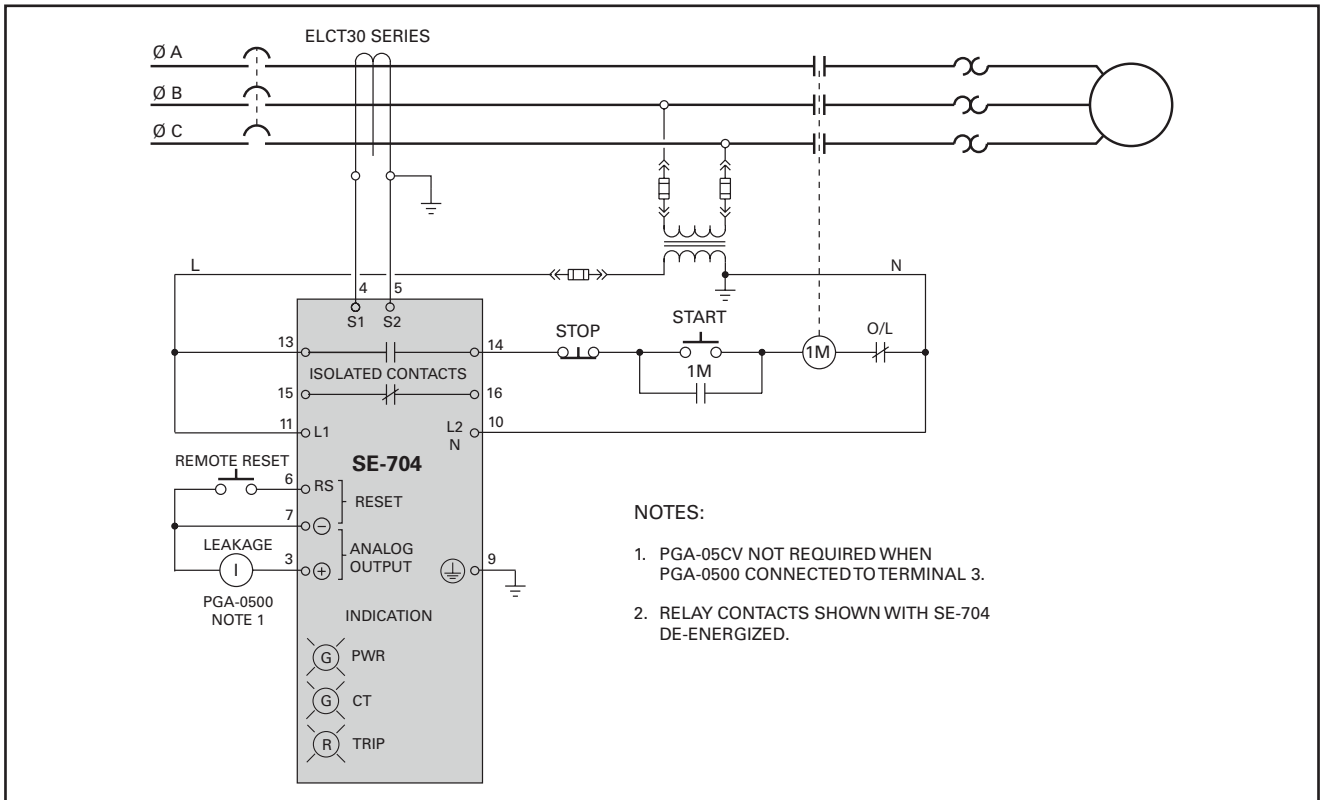


FIG. 3. Typical Three-Phase-Starter Connection.



#### 4. SE-704 COMPATIBILITY

The updated SE-704 has been enhanced with the addition of non-volatile trip memory for the fail-safe relay operating mode. Prior to hardware revision 01, a mechanical flag was used instead of a non-volatile trip memory. The updated revision of the SE-704 can directly replace previous revision-00 units. The hardware-revision number is listed on the SE-704 model/serial-number label affixed to the SE-704 enclosure. SE-704 generations are compared in Table 1.

The SE-704 was previously available with SE-704-01 120-Vac and SE-704-02 240-Vac control-voltage options. These have been discontinued. An SE-704-0U universal 120/240-Vac/Vdc unit can directly replace an SE-704-01 or SE-704-02.

TABLE 1. TRIP-FEATURES COMPARISON

|   |               | HARDWARE REVISION   |   |
|---|---------------|---|---|
|   |               | 00  | ≥01                                       |
| LED trip indication   |               | Yes   | Yes                                       |
| Mechanical flag trip indication   |               | Yes   | No  |
| Non-volatile trip memory  |               | No  | Yes                                       |
| Device state after supply voltage cycled when tripped (earth fault removed) | Fail-safe     | Trip LED: Off<br>Trip relay: Energized<br>Trip flag: Red    | Trip LED: On<br>Trip relay: De-energized  |
|   | Non-fail-safe | Trip LED: Off<br>Trip relay: De-energized<br>Trip flag: Red | Trip LED: Off<br>Trip relay: De-energized |

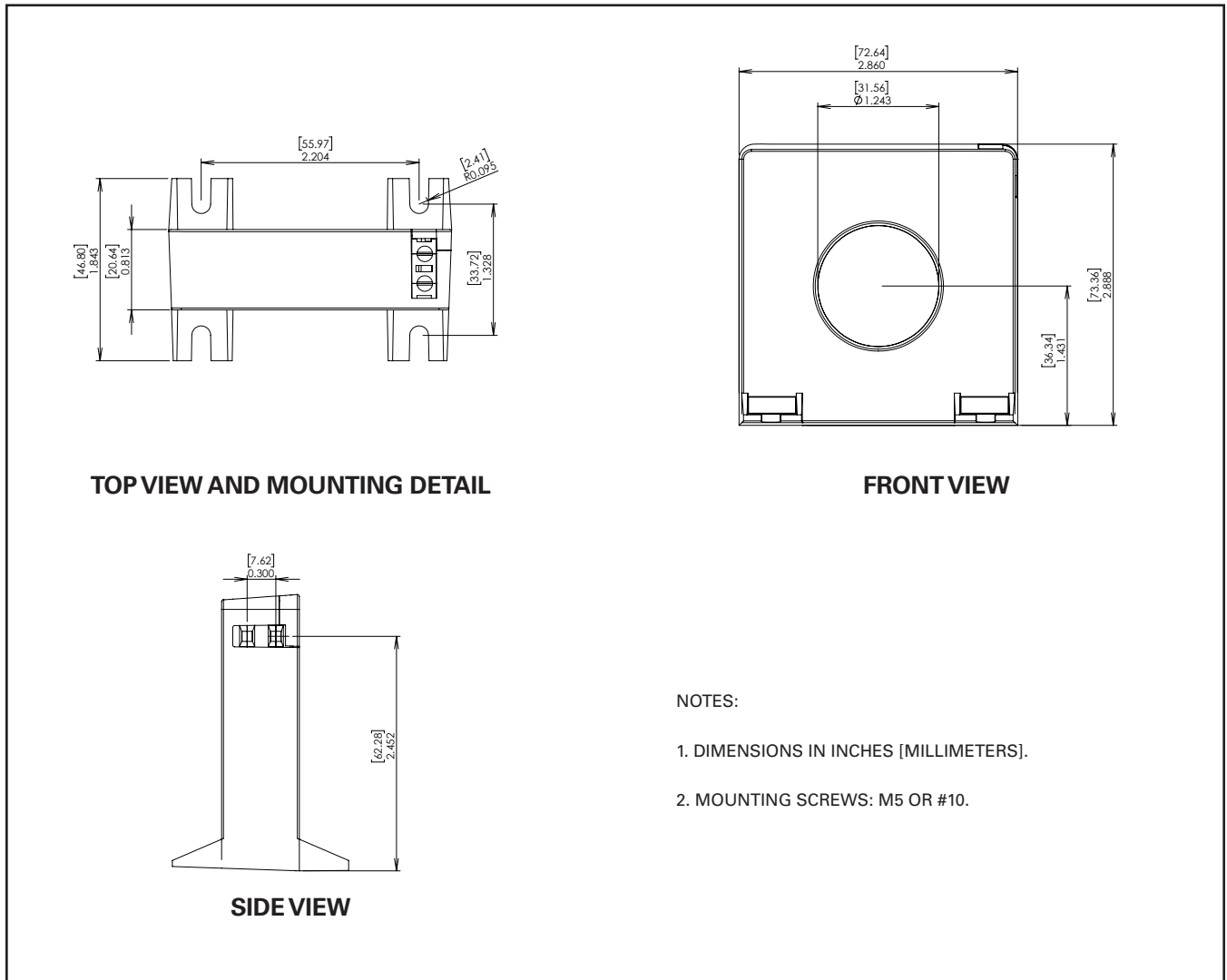


FIG. 4. ELCT30-31 Current Sensor.

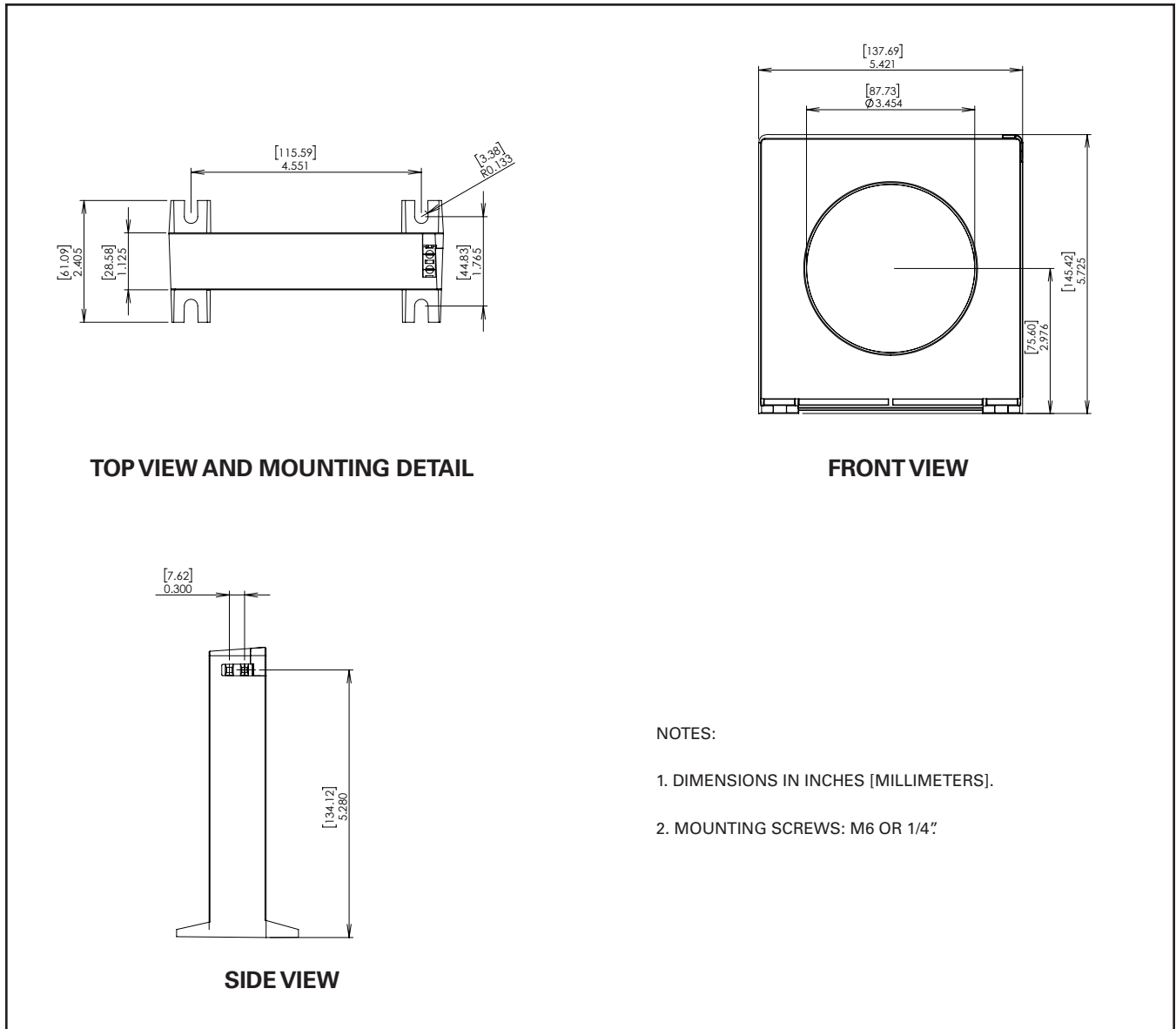


FIG. 5. ELCT30-88 Current Sensor.

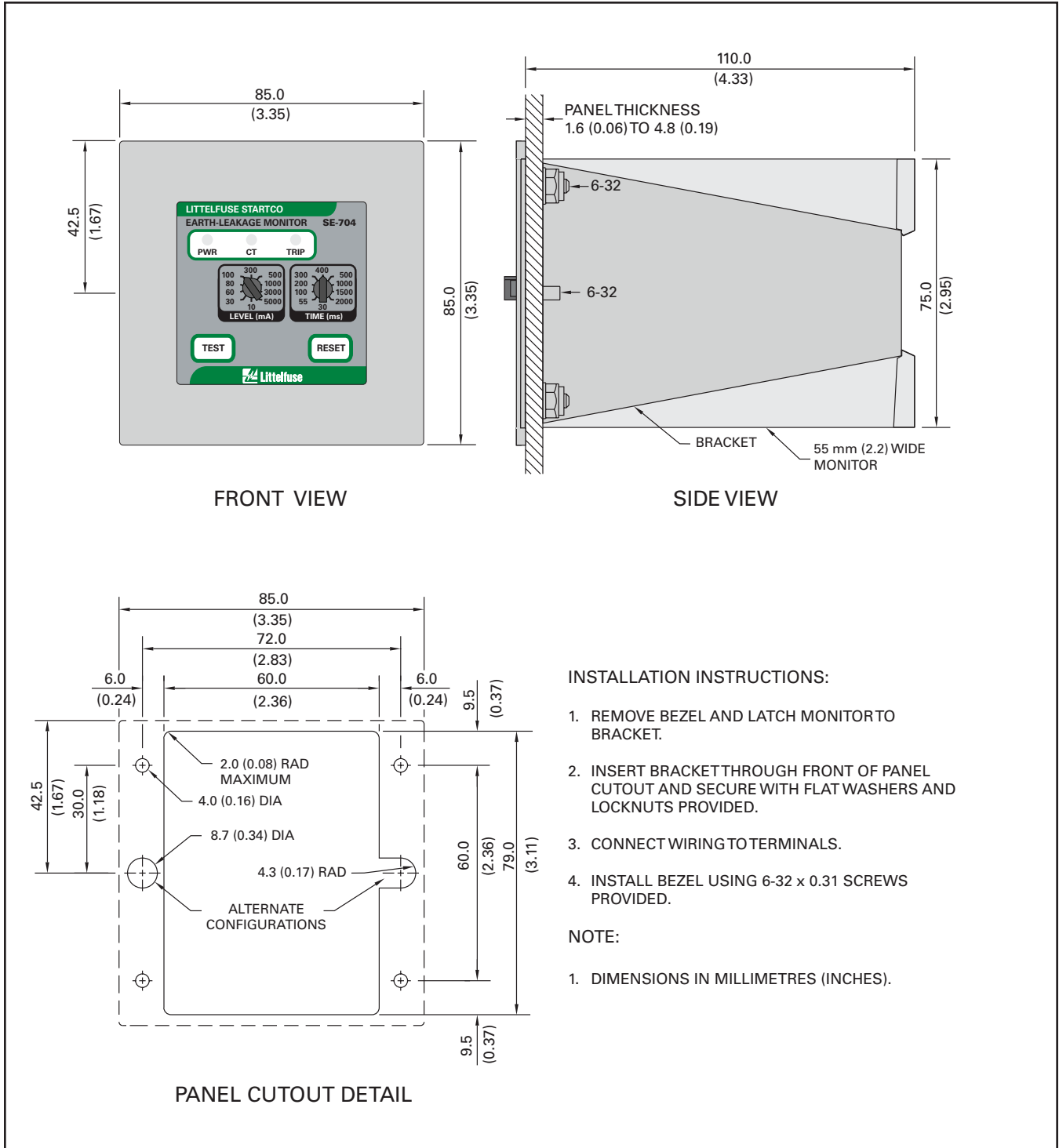


FIG. 6. PMA-55 Panel-Mount Adapter.

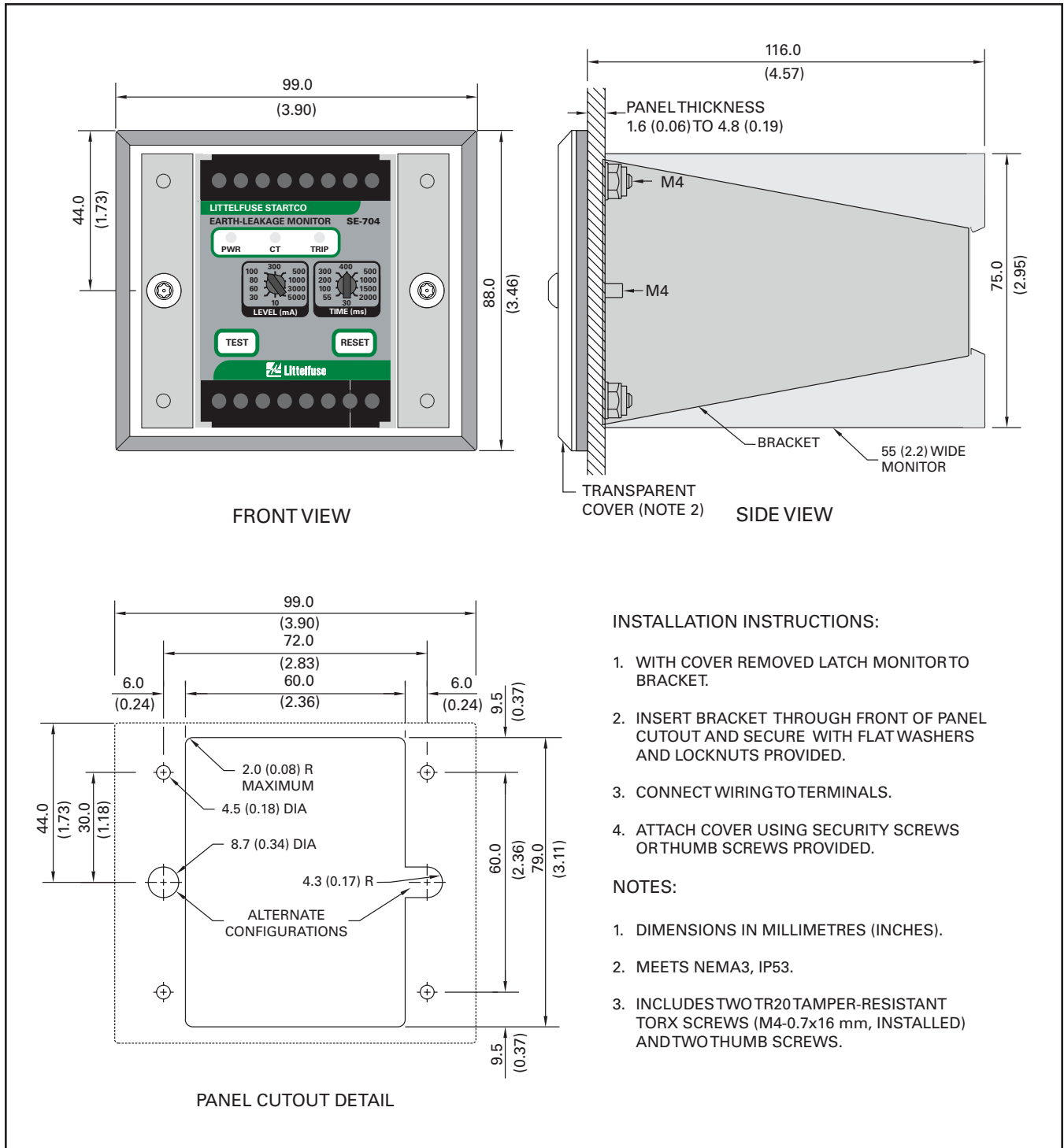


FIG. 7. PMA-60 Panel-Mount Adapter.

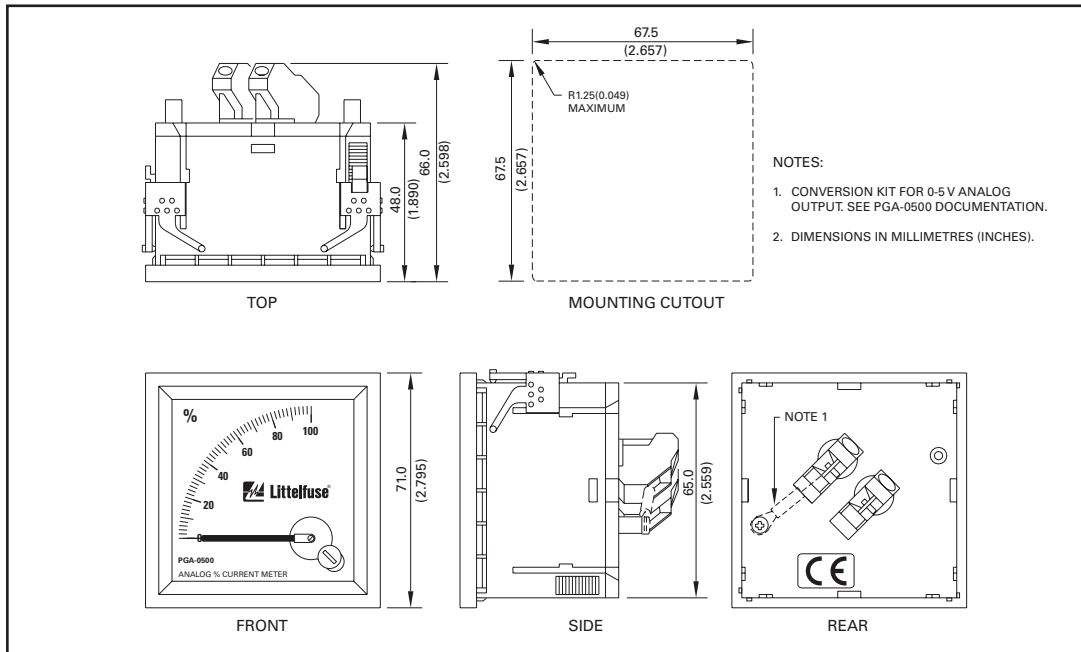


FIG. 8. PGA-0500 Analog Percent Current Meter.

## 5. TECHNICAL SPECIFICATIONS

### 5.1 SE-704

#### Supply:

|           |   |
|-----------|---|
| OU Option | 5 VA, 120 to 240 Vac,<br>(+20, -55 %) 50/60 Hz,<br>2 W, 100 to 240 Vdc,<br>(+20, -25 %) |
| OD Option | 2 W, 12 to 30 Vdc,<br>(+20, -25 %)  |
| OT Option | 2 W, 40 to 55 Vdc,<br>(+20, -25 %)  |
| O3 Option | 2.5 VA, 24 Vac,<br>(+15, -40 %), 50/60 Hz   |

|                     |   |
|---------------------|---|
| Trip-Level Settings | 10, 30, 60, 80, 100, 300,<br>500, 1,000, 3,000, and<br>5,000 mA |
|---------------------|---|

|                    |   |
|--------------------|---|
| Trip-Time Settings | 30, 55, 100, 200, 300, 400,<br>500, 1,000, 1,500, and<br>2,000 ms |
|--------------------|---|

#### Accuracies: <sup>(1, 2)</sup>

#### Trip Level: <sup>(3, 4)</sup>

#### ELCT30 series CT:

|                 |                        |
|-----------------|------------------------|
| 10 mA           | +/-4 mA                |
| 30 mA           | +0, -8 mA              |
| 60 to 500 mA    | +0 %, -12 %, 12 mA min |
| 1000 to 5000 mA | +2 %, -12 %            |

#### CS30 series CT:

|                 |                        |
|-----------------|------------------------|
| 10 mA           | +4, -1 mA              |
| 30 mA           | +0, -6 mA              |
| 60 to 500 mA    | +0 %, -10 %, 10 mA min |
| 1000 to 5000 mA | +2 %, -12 %            |

Trip Time <sup>(5)</sup> ..... 5 % of setting, 20 ms min

#### Input:

|                           |                          |
|---------------------------|--------------------------|
| Algorithms <sup>(6)</sup> | DFT Digital or Peak      |
| DFT 3 dB Frequency        |                          |
| Response                  | 32 to 86 Hz (<1,000 mA)  |
| Peak 3 dB Frequency       |                          |
| Response                  | 20 to 420 Hz (<1,000 mA) |
| Peak 3 dB Frequency       |                          |
| Response                  | 20 to 120 Hz (≥1,000 mA) |

|              |                                 |
|--------------|---------------------------------|
| CT           | ELCT30-Series Current<br>Sensor |
| CT Detection | Open-Circuit Detection          |

#### Thermal Withstand:

|            |                           |
|------------|---------------------------|
| Continuous | 25 A Earth-Fault Current  |
| 1-Second   | 400 A Earth-Fault Current |

|   |  |  |   |
|---|--|--|---|
| Analog Output:  |  | 3,000 m (9,843 ft) .....   | -40 to 55°C   |
| Modes .....   | % of 5 A or % of Trip-Level Setting  |  | (-40 to 131°F)  |
| Range:  |  | 5,000 m (16,404 ft) .....  | -40 to 50°C   |
| Terminal 3 .....  | 0 to 1 mA  |  | (-40 to 122°F)  |
| Terminal 8 .....  | 0 to 5 Vdc   | Storage Temperature .....  | -55 to 80°C   |
| Output Impedance:   |  |  | (-67 to 160°F)  |
| Terminal 3 .....  | 4,970 Ω  | Humidity .....   | 85% Non-Condensing  |
| Terminal 8 .....  | 220 Ω  | Altitude .....   | 5,000 m (16,404 ft) maximum   |
| Output Relay:   |  | PWB Conformal Coating .....  | MIL-1-46058 qualified<br>UL QMJU2 recognized  |
| Contact Configuration .....   | Isolated N.O. and N.C.   | Surge Withstand .....  | ANSI/IEEE 37.90.1-1989<br>(Oscillatory and Fast Transient)  |
| Operating Mode .....  | Fail-Safe or Non-Fail-Safe   | Vibration .....  | EN60255-21-1<br>(Vibration, Shock, and Seismic)<br>EN60255-21-2 (Shock and Bump)                      |
| CSA/UL Contact Rating .....   | 8 A General Use, 250 Vac,<br>8 A Resistive, 30 Vdc<br>0.25 HP, 120/240 Vac | EMC Tests:   |   |
| Supplemental Contact Ratings:   |  | Verification tested in accordance with IEC 60255-26:2013<br>Radiated and Conducted |   |
| Carry Current .....   | 8 A, maximum   | Emissions .....  | CISPR 11:2009,<br>CISPR 22:2008,<br>EN55022:2010<br>Class A   |
| Break:  |  | Current Harmonics and<br>Voltage Fluctuation .....                                 | IEC 61000-3-2 and<br>IEC 61000-3-3<br>Class A   |
| 30 Vdc .....  | 240 W Resistive,<br>170 W Inductive (L/R = 7 ms)                           | Electrostatic Discharge .....  | IEC 61000-4-2<br>± 6 kV contact discharge<br>(direct and indirect)<br>± 8 kV air discharge            |
| 120 Vdc .....   | 24 W Resistive,<br>17 W Inductive (L/R = 7 ms)                             | Radiated RF Immunity .....   | IEC 61000-4-3<br>10 V/m, 80-1000 MHz,<br>80% AM (1 kHz)<br>10 V/m, 900 MHz,<br>200 Hz pulse modulated |
| ac .....  | 2,000 VA Resistive,<br>875 VA Inductive<br>(PF = 0.4)                      | Fast Transient .....   | IEC 61000-4-4<br>±4 kV on AC mains and<br>I/O lines   |
| Subject to maximums of 8 A and 250 Vac/30 Vdc<br>or 200 mA at 120 Vdc |  |  |   |
| Trip Mode .....   | Latching or Autoreset  |  |   |
| Reset .....   | Front-Panel Button and<br>Remote N.O. Contact                              |  |   |
| Functional Test .....   | Front-Panel Button   |  |   |
| Terminals .....   | Wire Clamping,<br>24 to 12 AWG<br>(0.2 to 2.5 mm <sup>2</sup> ) conductors |  |   |
| Dimensions:   |  |  |   |
| Height .....  | 75 mm (3.0 in.)  |  |   |
| Width .....   | 55 mm (2.2 in.)  |  |   |
| Depth .....   | 113 mm (4.5 in.)   |  |   |
| Shipping Weight .....   | 0.45 kg (1 lb)   |  |   |
| Environment:  |  |  |   |
| Operating Temperature:  |  |  |   |
| Altitude:   |  |  |   |
| ≤ 1,000 m (3,281 ft) .....  | -40 to 60°C<br>(-40 to 140°F)  |  |   |

|                              |   |
|------------------------------|---|
| Surge Immunity.....          | IEC 61000-4-5<br>Zone B<br>± 1 kV differential mode<br>± 2 kV common mode                 |
| Conducted RF Immunity.....   | IEC 61000-4-6<br>10 V, 0.15-80 MHz,<br>80 % AM (1 kHz)                                    |
| Magnetic Field Immunity..... | IEC 61000-4-8<br>50 Hz and 60 Hz , 30 A/m<br>and 300 A/m                                  |
| Voltage Interruption.....    | IEC 61000-4-11,<br>IEC 61000-4-29,<br>0% for 5, 10, 20, 50, 100<br>& 200 ms 3x each       |
| Power Frequency .....        | EC 61000-4-16<br>Zone A: differential mode<br>150 Vrms<br>Zone A: common mode<br>300 Vrms |
| 1 MHz Burst.....             | IEC 61000-4-18<br>± 1 kV differential mode<br>(line-to-line)<br>± 2.5 kV common mode      |
| RFI Compliance .....         | FCC Part 15, Subpart B,<br>Class A – Unintentional<br>Radiators                           |
| Certification .....          | CSA, Canada and USA   |



UL Listed



Australia



FCC



CE, European Union



CSA C22.2 No.14 Industrial Control Equipment  
UL 508 Industrial Control Equipment  
UL 1053 Ground Fault Sensing and Relaying Equipment  
Australia, Regulatory Compliance Mark (RCM)  
CE Low Voltage Directive  
IEC 61010-1:2010/AMD1:2016  
FCC CFR47. Part 15. Subpart B.  
Class A - Unintentional Radiators

**NOTES:**

- (1) Detection limit (A) = (setting in mA – 5,610)/-1.4.
- (2) At 50 or 60 Hz unless otherwise noted.
- (3) ELCT30-series current sensor included.
- (4) Maximum lead resistance of 2 Ω.
- (5) Trip Time at 3 x trip-level setting.
- (6) Peak algorithm for trip-level setting ≥ 1,000 mA.

**5.2 Current Sensors**

Environment:

|                            |  |
|----------------------------|--|
| Operating Temperature..... | -40 to 60°C (-40 to 140°F)               |
| Storage Temperature .....  | -55 to 80°C (-67 to 176°F)               |
| Compliance .....           | RoHS,<br>IEC 61869-2<br>ANSI/IEEE C57.13 |

ELCT30-31:

|                       |                 |
|-----------------------|-----------------|
| Current Ratio.....    | 30:0.05A        |
| Insulation .....      | 600V            |
| Window Diameter ..... | 31mm (1.22 in.) |
| Shipping Weight.....  | 0.45 kg (1 lb)  |
| Certifications.....   | cUL<br>CE       |

ELCT30-88:

|                       |                  |
|-----------------------|------------------|
| Current Ratio.....    | 30:0.05A         |
| Insulation .....      | 600V             |
| Window Diameter ..... | 88 mm (3.46 in.) |
| Shipping Weight.....  | 0.91 kg (2 lb)   |
| Certifications.....   | cUL<br>CE        |



## 6. ORDERING INFORMATION

**SE-704-0**


Conformal Coating:  
 Blank – Partial Conformal Coating  
 CC – Full Conformal Coating  
 Supply:  
 3 – 24-Vac Supply  
 U – Universal 120/240-Vac/Vdc Supply  
 D – 12/24-Vdc Supply  
 T – 48-Vdc Supply

|                   |  |
|-------------------|--|
| ELCT30-31 .....   | Current Sensor,<br>31 mm (1.22 in.) window   |
| ELCT30-88 .....   | Current Sensor<br>88 mm (3.46 in.) window  |
| PGA-0500 .....    | Analog Percent Current<br>Meter (PGA-05CV<br>included)   |
| PMA-55 .....      | Panel-Mount Adapter,<br>NEMA 1   |
| PMA-60 .....      | Panel-Mount Adapter,<br>NEMA 3, IP53.<br>Includes two TR20<br>tamper-resistant Torx<br>screws and two thumb<br>screws. |
| AC700-HW-00 ..... | TR20 tamper-resistant<br>Torx, 0.25 in. insert bit   |
| AC700-HW-01 ..... | TR20 tamper-resistant<br>Torx driver   |
| PMA-3 .....       | Adapter Plate,<br>GEC/MCGG   |
| PMA-6 .....       | Adapter Plate,<br>FPL-GFRM   |
| PMA-15 .....      | Adapter Plate, MGFR  |

Consult factory for custom mounting adapters.

## 7. WARRANTY

The SE-704 Earth-Leakage Monitor is warranted to be free from defects in material and workmanship for a period of five years from the date of purchase.

Littelfuse will (at Littelfuse's option) repair, replace, or refund the original purchase price of an SE-704 that is determined by Littelfuse 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 does not warrant products repaired or modified by non-Littelfuse personnel.

**8. EARTH-FAULT PERFORMANCE TEST**

Some jurisdictions require periodic earth-fault performance tests. A test record form is provided for recording the date and the result of the performance tests. The following earth-fault system tests are to be conducted by qualified personnel.

1. Evaluate the interconnected system in accordance with the overall equipment manufacturer’s detailed instructions.
2. Verify proper location of the ELCT30 current sensor. Ensure the cables pass through the current sensor window. This check can be done visually with knowledge of the circuit. The connection of the current-sensor secondary to the SE-704 is not polarity sensitive.
3. Verify that the system is correctly earthed and that alternate earth paths do not exist that bypass the current sensor. High-voltage testers and resistance bridges can be used to determine the existence of alternate earth paths.
4. 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. 9 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. Fig. 9 shows the use of resistors that reduce the injected current to 10 % of the SE-400 setting. Set the test current to 120 % of the SE-704 setting. 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.
5. Record the date and the results of the test on the attached test record form.

**NOTE:** Do not inject test current directly into current sensor-input terminals 4 and 5.

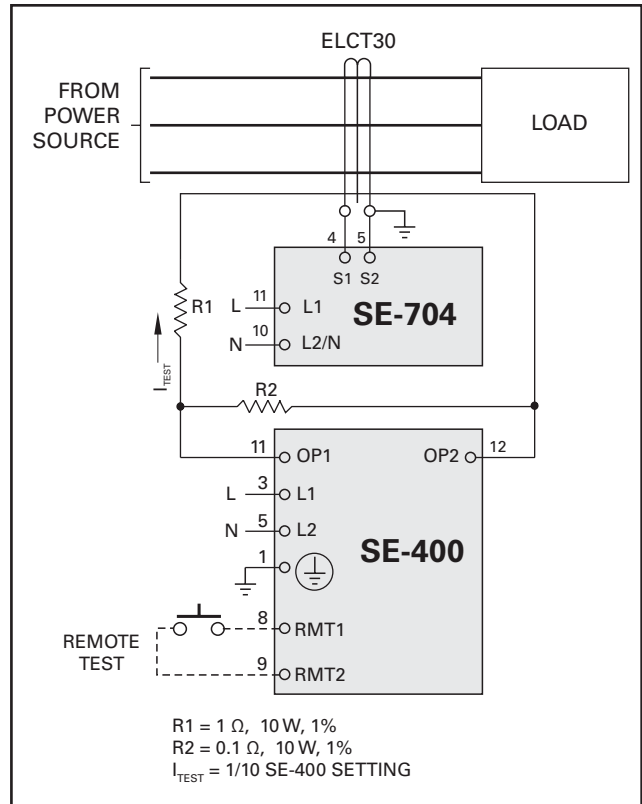


FIG. 9. Earth-Fault-Test Circuit.

TABLE 2. EARTH-FAULT-TEST RECORD

| DATE | TEST RESULTS |
|------|--------------|
|      |              |
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|      |              |

Retain this record for the authority having jurisdiction.

## APPENDIX A SE-704 REVISION HISTORY

| MANUAL RELEASE DATE | MANUAL REVISION | PRODUCT REVISION<br>(REVISION NUMBER ON PRODUCT LABEL) |
|---------------------|-----------------|--|
| July 5, 2018        | 7-D-070518      | 04   |
| August 28, 2014     | 7-C-082814      |  |
| May 21, 2014        | 7-B-052114      |  |
| April 8, 2013       | 7-A-040813      |  |

### MANUAL REVISION HISTORY

#### REVISION 7-D-070518

##### ALL SECTIONS

ELCT series added.  
CS30 series removed.

##### SECTION 5

Specifications updated.

#### REVISION 7-C-082814

##### SECTION 3

EFCT-x figures updated.

##### SECTION 4

EMC Test specifications updated.

#### REVISION 7-B-052114

##### SECTION 4

Figs. 2, 3, 4, 5, 6, and 9 updated.

##### SECTION 5

Update to include altitude and vibration specifications.  
FCC certification added.  
Update to trip-level accuracy.  
Added current sensor specifications.

##### SECTION 6

Ordering information updated.

##### SECTION 8

Fig. 10 updated.

#### REVISION 7-A-040813

##### SECTION 3

Fig. 2 updated to include PGA-05CV.

##### SECTION 4

Fig. 6 updated.

##### SECTION 5

Environment section updated to include Fahrenheit temperature range.

### APPENDIX A

Revision history added.

### PRODUCT REVISION HISTORY

#### REVISION 04

Firmware: Improved operation of front-panel test button.