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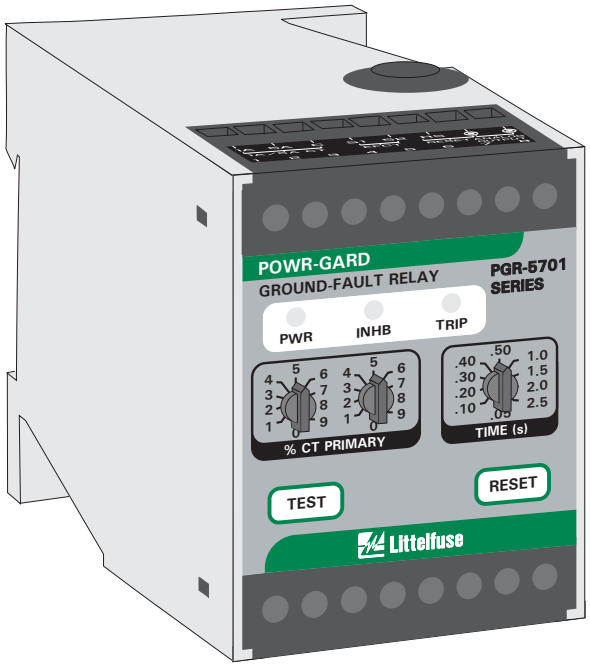
POWR-GARD®
Ground-Fault Protection
PGR-5701 SERIES
Ground-Fault Relay

PGR-5701 MANUAL

GROUND-FAULT RELAY

JUNE 8, 2009

REVISION 6



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DISCLAIMER

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1. INTRODUCTION

1.1 General

The PGR-5701 is a microprocessor-based ground-fault relay for resistance-grounded and solidly grounded systems. It is uniquely suited for use on systems with significant harmonic content. Its output relay can operate in the fail-safe or non-fail-safe mode for undervoltage or shunt-trip applications. The PGR-5701 has one output relay with isolated normally open and normally closed contacts for use in independent control circuits. Additional features include LED trip, power, and inhibit indication, autoreset or latching trips with front-panel and remote reset, trip memory, test switch, self diagnostics, 0- to 5-V analog output, inputs for standard and sensitive ground-fault current transformers, CT verification for sensitive current transformers, digital selector switches, switch-selectable algorithms for fixed-frequency or variable-frequency applications, and an inhibit that can be enabled to prevent the output relay from operating during a high-current ground fault.

Ground-fault current is sensed by a core-balance zero-sequence current transformer (CT). The trip level of the ground-fault circuit is switch selectable in 1% increments from 1 to 99% of the CT-primary rating.

1.2 Current-Transformer Selection

A PGR-5701 has inputs for 1-, 5-A, and sensitive 50-mA-secondary CT's. Choose a CT that provides the required ground-fault-trip range.

For ground-fault detection, the ground-fault trip level must be substantially below the prospective ground-fault current. In a solidly grounded system, prospective ground-fault current is similar to phase-fault current. In a resistance-grounded system, prospective ground-fault current is defined by the neutral-grounding-resistor let-through-current rating.

In a solidly grounded system, protection against arcing ground faults requires a ground-fault CT that will detect low-level fault current but not saturate up to the operating value of the system overcurrent protection. In general, immunity to saturation is proportional to CT mass.

To eliminate nuisance tripping, surge current must not saturate the CT.

For low-level ground-fault protection use a PGC-3026 PGC-3082, or PGC-3140, sensitive earth-fault CT with a 5-A-primary rating. However, protection at this level might not be possible because of high surge current or prospective ground-fault current.

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 ground-fault circuit is not tripped. In the fail-safe mode, non-volatile memory retains the trip status of the PGR-5701. If tripped, and the supply voltage is cycled, the PGR-5701 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 a ground-fault trip occurs. In the non-fail-safe mode, trip status is not retained in non-volatile memory.

2.1.2 Trip Inhibit

Switch 2 is used to select Class I or Class II operation. In the OFF position, high-current trip inhibit is off for Class I operation. In the ON position, high-current inhibit is on for Class II operation. If high-current trip inhibit is on and ground-fault current escalates above eleven times the CT-primary rating before the ground-fault circuit trips, the output relay will not operate until ground-fault current falls below eight times the CT-primary rating. This feature allows overcurrent protection to operate in applications where the ground-fault current can be larger than the interrupting capacity of the device tripped by the PGR-5701.

2.1.3 CT Verification

Switch 3 is used to enable CT verification with a PGC-3000-series CT. In the ON position, a trip will occur if the CT is disconnected. Switch 3 must be in the OFF position when a PGC-3000-series CT is not used.

2.1.4 Filter Selection

Switch 4 is used to select the filtering algorithm for a fixed-frequency (50/60 Hz) or variable-frequency application. 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.

2.1.5 Reset Mode

Switch 5 is used to select autoreset or latching trips. See Section 2.2.3.

2.2 Front-Panel Controls

2.2.1 Ground-Fault Trip Level

The % CT PRIMARY selector switches are used to set the ground-fault trip level as a percentage of the CT-primary rating.

In tripping systems, a ground-fault trip level of 10 to 20% of the prospective ground-fault current is often used. In alarm-only systems, a value of 50% of the prospective

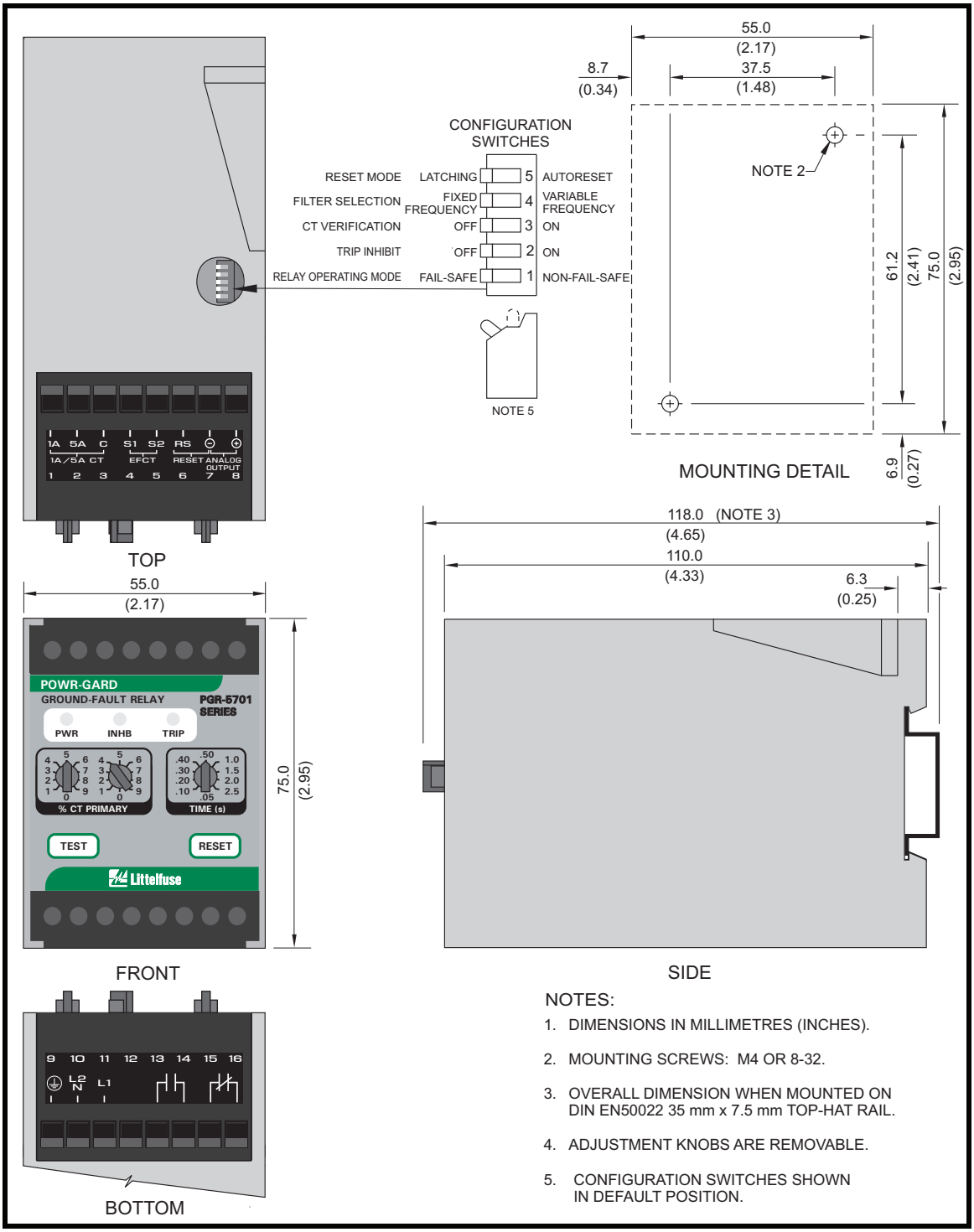


FIGURE 1. PGR-5701 Outline and Mounting Details.

ground-fault current is often used. To avoid sympathetic tripping, the trip level must be above the charging current of the protected feeder.

A 0% selection provides protection at 1%.

2.2.2 Ground-Fault Trip Time

The PGR-5701 has a definite-time trip characteristic. The TIME (s) selector switch is used to set the ground-fault trip delay time for coordination with upstream and downstream ground-fault devices. Coordination requires the same trip level for all ground-fault devices in a system and the trip time to progressively increase upstream. The amount of equipment removed from the system will be a minimum if the first ground-fault device to operate is the one immediately upstream from the fault.

2.2.3 Reset

If the Reset Mode switch is in the LATCHING position, a trip remains latched until the RESET switch is pressed or the remote-reset terminals are momentarily connected. In the non-fail-safe mode, cycling the supply voltage will also reset the PGR-5701.

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 switch will not prevent a trip. The front-panel RESET switch is inoperative when the remote-reset terminals (6 and 7) are connected.

2.2.4 Test

The TEST switch is used to test the ground-fault circuit, the indication, and the output relay. When the TEST switch is pressed for one second, a test signal is applied to the ground-fault-detection circuit, the circuit will trip, the TRIP LED will light, and the output relay will operate. If high-current inhibit has been selected, the INHB LED will light.

2.3 Front-Panel Indication

2.3.1 Power

The green LED labeled PWR indicates the presence of supply voltage.

2.3.2 Trip

The red LED labeled TRIP indicates a trip. A solid red LED indicates a ground-fault trip. A regularly flashing LED indicates a trip initiated by a CT fault. Two fast flashes indicate a diagnostic trip. See Section 2.5.

2.3.3 Trip Inhibit

The yellow LED labeled INHB indicates that output-relay operation was inhibited during a high-current ground fault. See Section 2.1.2. When a ground-fault trip occurs during a high-current ground fault, both the TRIP and INHB LED's will be ON. Inhibit indication is reset when the ground-fault trip is reset. Inhibit operation and indication will not respond if the Trip-Inhibit switch is in the OFF position.

2.4 Analog Output

The non-isolated, 0- to 5-V analog output indicates ground-fault current sensed by the ground-fault CT. The output is 5 V when ground-fault current is 100% of the CT-primary rating.

2.5 Self Diagnostics

A diagnostic trip is indicated by two flashes of the TRIP LED. It can be caused by a diagnostic problem detected by the watchdog timer or from an incorrect reading from non-volatile memory. Press RESET or cycle supply voltage. If the problem persists, contact 1-800-TEC-FUSE (1-800-832-3873).

3. INSTALLATION

A PGR-5701 can be surface or DIN-rail mounted. See Fig. 1. Panel mounting requires a PGK-0055 or PGK-0060 Panel-Mount Adapter. See Fig. 6.

Pass the phase conductors through the CT window as shown in Fig. 2 (for 4-wire and single-phase systems, also pass the neutral conductor through the CT window). Do not pass ground 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 ground. If a ground-fault CT with a 5-A secondary is used, connect it to terminals 2 and 3 (terminals 1 and 3 with a 1-A secondary) and ground terminal 3. If a PGC-3000-series CT is used, connect it to terminals 4 and 5, connect the shield to terminal 5, and ground terminal 5. Remove the connection to terminal 9 for dielectric-strength testing—all inputs and outputs have ANSI/IEEE C37.90 surge-protection circuits that conduct above 300 Vac. See Figs. 3, 4, and 5 for sensitive PGC-3000-series CT dimensional drawings.

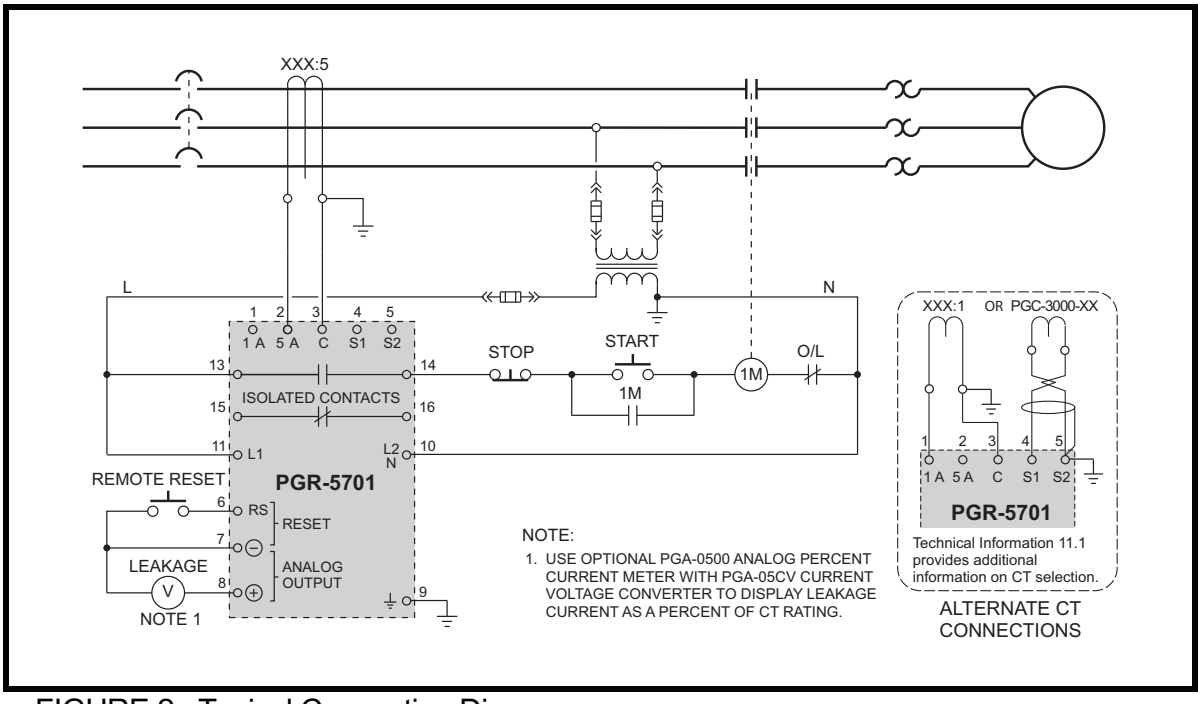


FIGURE 2. Typical Connection Diagram.

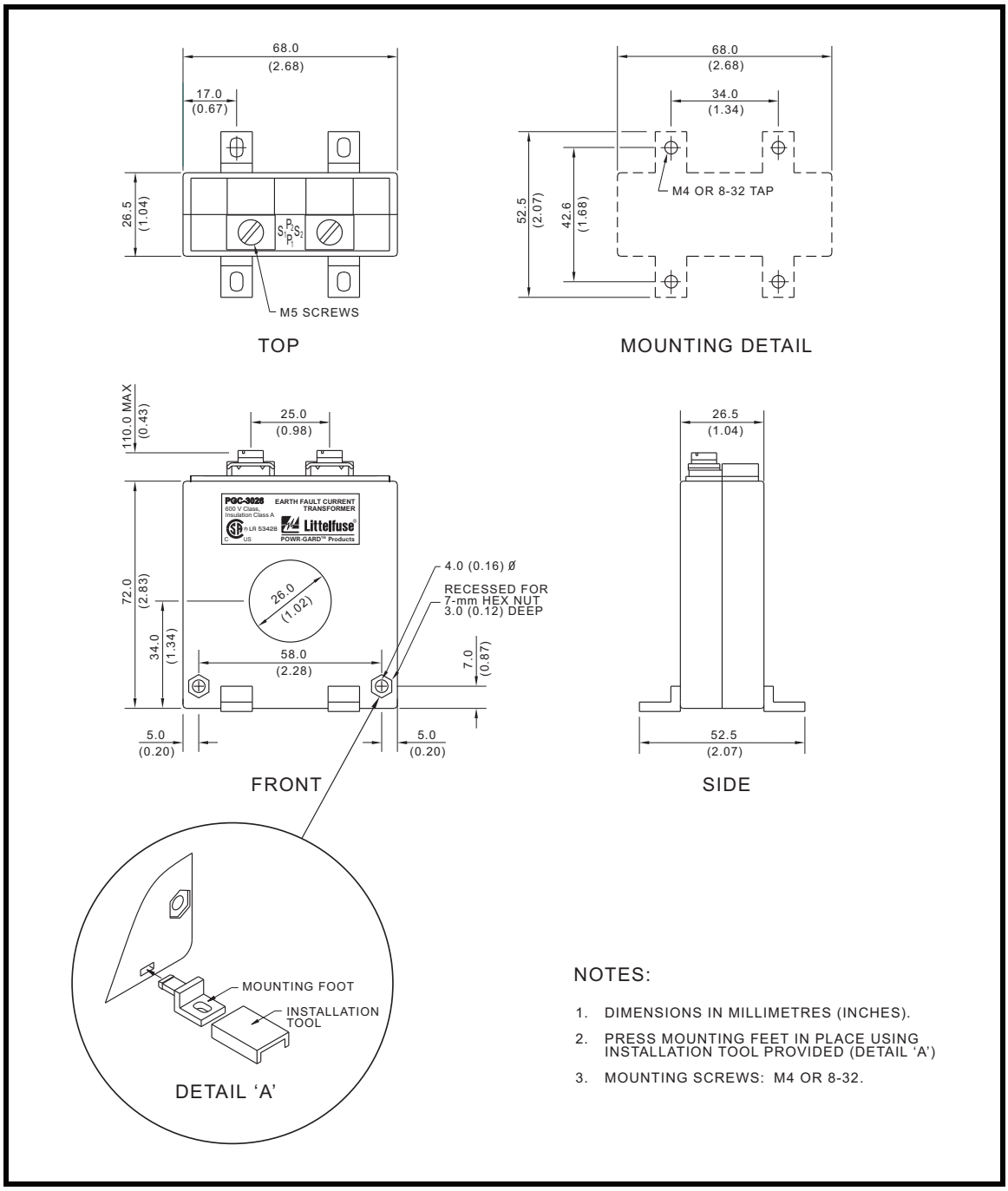
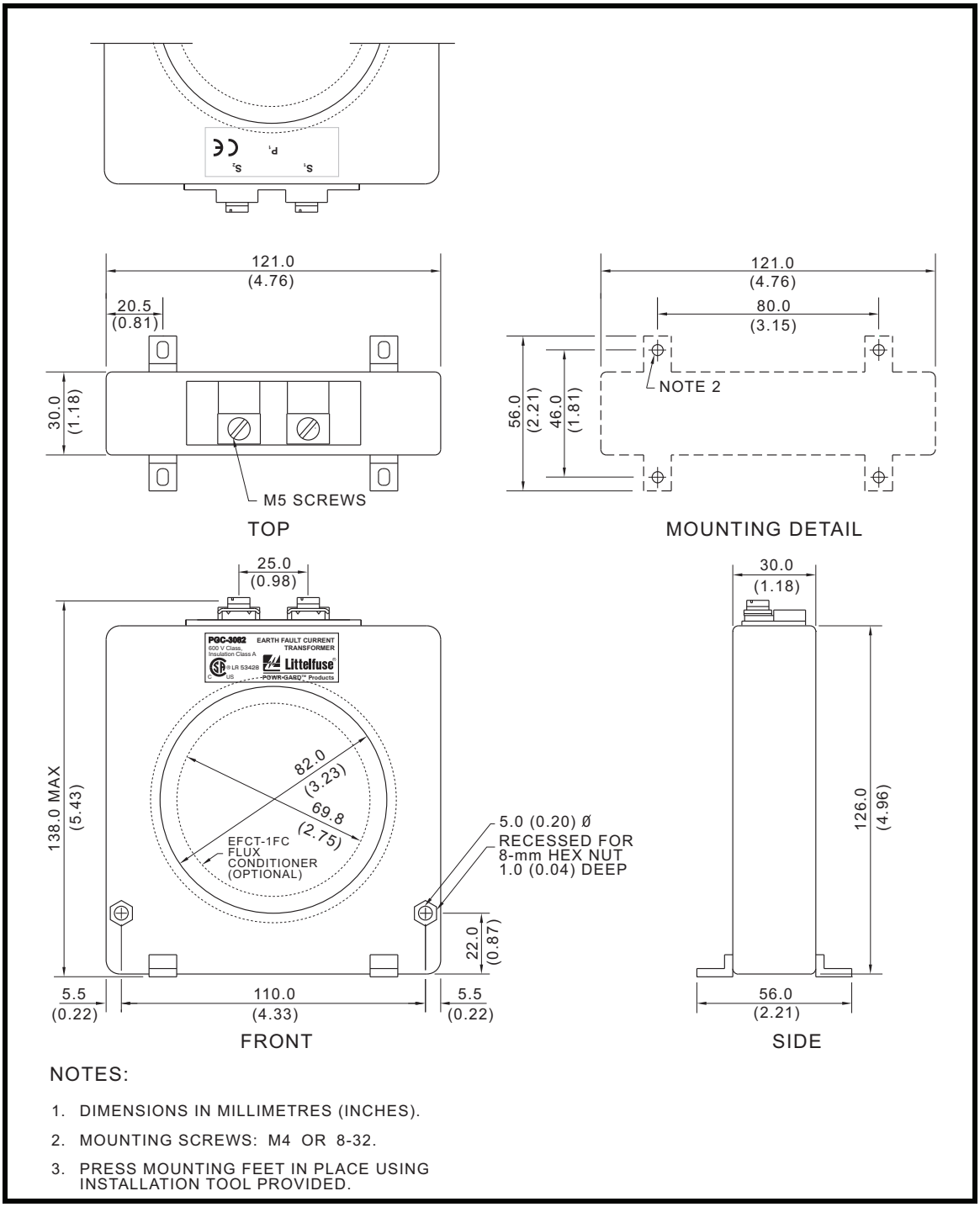


FIGURE 3. PGC-3026 Earth-Fault Current Transformer.



NOTES:

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

FIGURE 4. PGC-3082 Earth-Fault Current Transformer.

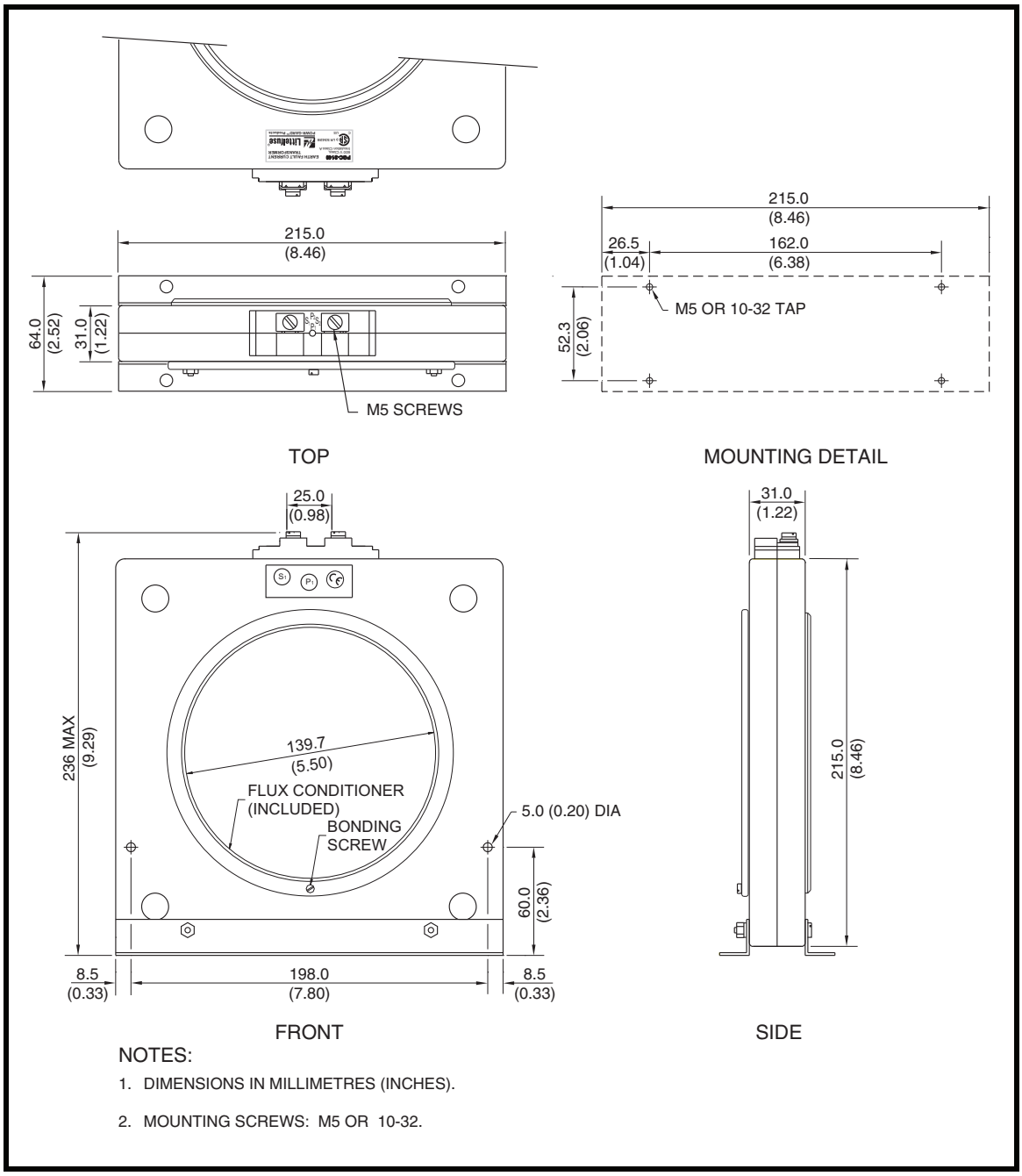


FIGURE 5. PGC-3140 Earth-Fault Current Transformer.

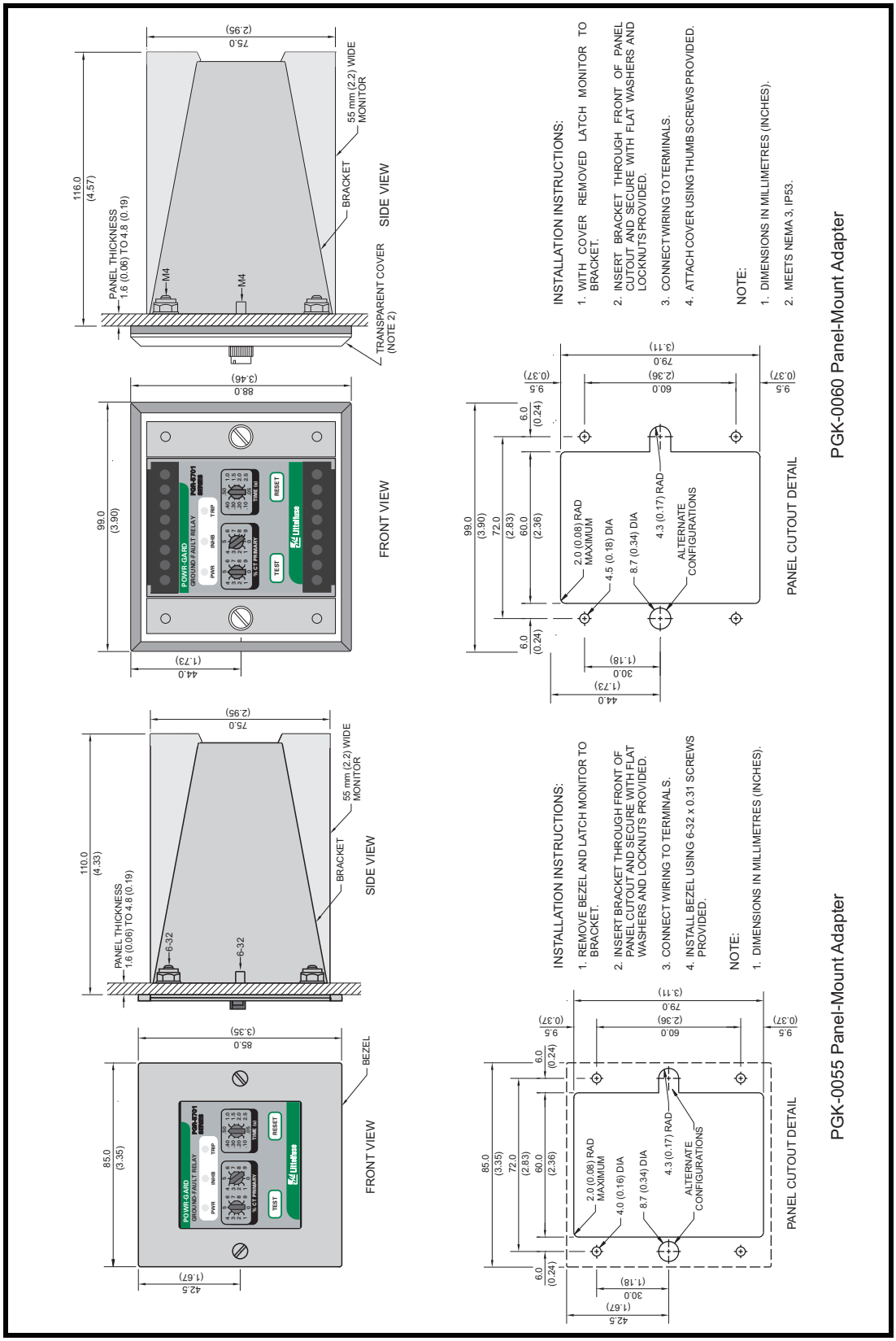


FIGURE 6. PGK-0055 and PGK-0060 Panel-Mount Adapters.

4. TECHNICAL SPECIFICATIONS

Supply:
- 0U Option ..... 2.5 VA, 120 to 240 Vac (+20, -55%), 50/60 Hz, 2.0 W, 100 to 240 Vdc (+20, -25%)
- 0D Option ..... 2.0 W, 12 to 30 Vdc (+20, -25%)
- 0T Option..... 2.0 W, 40 to 55 Vdc (+20, -25%)

Trip-Level Range ..... 1 to 99% CT-Primary Rating in 1% increments (50 mA to 4.95 A with PGC-3000-series CT's)

Trip-Time Settings ..... 0.05, 0.10, 0.20, 0.30, 0.40, 0.50, 1.0, 1.5, 2.0, and 2.5 s

Accuracies [1]:
- Trip Level [2]..... Largest of 5% of Setting or:
  - 1-A input:
    - 1% setting ..... -10, +15 mA
    - 2 – 99% setting .... 10 mA
  - 5-A and EFCT [4] inputs:
    - 1% setting ..... -35, +60 mA
    - 2 – 99% setting .... 35 mA
- Trip Time [3] ..... 5% of Setting (-25, +20 ms minimum)

Trip Inhibit:
- Off ..... Class I
- On ..... Class II
  - Level ..... 11 x CT-Primary Rating

Input:
- Algorithms ..... DFT or Peak
  - DFT 3 dB Frequency Response ..... 32 to 86 Hz
  - Peak 3 dB Frequency Response ..... 20 to 420 Hz
- CT ..... 1- or 5-A Secondary Rating, or PGC-3000 series
  - CT Detection ..... Open-Circuit Detection with PGC-3000 series
- Thermal Withstand:
  - Continuous ..... 5 x CT-Secondary Rating
  - 1-Second..... 80 x CT-Secondary Rating
- Burden:
  - 5-A input..... < 0.01 Ω
  - 1-A input..... < 0.05 Ω
  - EFCT input..... 2 Ω

Analog Output:
- Range ..... 0 to 5 Vdc, 5 V = 100% CT Rating
- Output Impedance ..... 220 Ω

Reset ..... Front-Panel Switch and Remote N.O. Momentary Contact

Functional Test ..... Front-Panel Switch

Relay Contacts:
- Configuration ..... Isolated N.O. and N.C.
- Operating Mode..... Fail-Safe or Non-Fail-Safe
- CSA/UL Contact Rating..... 8 A resistive 250 Vac, 8 A resistive 30 Vdc
- Supplemental Contact Ratings:
  - Make/Carry 0.2 s ..... 20 A
  - Break:
    - dc..... 30 W resistive, 15 W inductive (L/R = 0.04)
    - ac..... 2,000 VA resistive, 1,400 VA inductive (PF = 0.4)

  Subject to maximums of 8 A and 250 V (ac or dc).

Operating Mode ..... Latching or Autoreset

Terminals ..... Wire-clamping, 24 to 12 AWG (0.2 to 2.5 mm^2) conductors

Dimensions:
- Height ..... 75 mm (3.0")
- Width..... 55 mm (2.2")
- Depth ..... 115 mm (4.5")

Shipping Weight..... 0.45 kg (1 lb.)

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

Surge Withstand ..... ANSI/IEEE 37.90.1-1989 (Oscillatory and Fast Transient)

EMC Tests:

Verification tested in accordance with EN 50263:2000
- Electrostatic Discharge ..... IEC 61000-4-2, EN 61000-4-2, 6 kV Contact Discharge, 8 kV Air Discharge

Radiated RF ..... IEC 61000-4-3, EN 61000-4-3
10 V/m, 80-1000 MHz, 80% AM (1 kHz)
10 V/m, 900 MHz, 200 Hz Pulse Modulated

Fast Transient ..... IEC 61000-4-4, EN 61000-4-4
±2 kV Common Mode, ±1 kV Differential Mode

Surge Immunity ..... IEC 61000-4-5, EN 61000-4-5
±2.0 kV Common Mode, ±1.0 kV Differential Mode

Conducted RF ..... IEC 61000-4-6, EN 61000-4-6
10Vrms, 0.15-80 MHz, 80% AM (1 kHz)

Magnetic Field ..... IEC 61000-4-8, EN 61000-4-8
50 Hz, 30 A/m (continuous)
50 Hz, 300 A/m (1 to 3 seconds)

Voltage Interruption ..... IEC 255-22-11, EN 60255-11
100% for 2, 5, 10, 20, 50, 100 & 200 ms

MHz Burst..... IEC.255-22-1, EN 60255-22-1
1 kV Differential Mode, 2.5 kV Common Mode

RFI Compliance..... FCC Part 15, Subpart B,
Class A – Unintentional Radiators

Certification..... CSA, Canada and USA

Notes:

(1) Over operating temperature range of –40 to 60°C.
(2) CT accuracy not included.
(3) Trip time at 3 x trip-level setting.
(4) For maximum lead resistance of 1 Ω.

5. ORDERING INFORMATION

PGR-5701-0 [ ]

- U Universal 120/240-Vac/Vdc Supply
- D 12/24-Vdc Supply
- T 48-Vdc Supply

PGA-0500 .....Analog Percent Current Meter
PGC-3026.....Sensitive Earth-Fault CT, 5-A-primary rating, 26-mm (1”) window
PGC-3082.....Sensitive Earth-Fault CT, 5-A-primary rating, 82-mm (3.2") window
PGC-31FC.....Flux Conditioner for PGC-3082, 70-mm (2.7”) window
PGC-3140.....Sensitive Earth-Fault CT, with Flux Conditioner,
5-A-primary rating, 139-mm (5.5”) window

PGK-0055.....Panel-Mount Adapter, NEMA 1
PGK-0060.....Panel-Mount Adapter, NEMA 3, IP53
PGK-0003.....Adapter Plate, GES/MCGG
PGK-0006.....Adapter Plate, FPL-GFRM
PGT-0400……...Ground-Fault Relay Tester

6. 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 location of the ground-fault current transformer. Ensure the cables pass through the ground-fault-current-transformer window. This check can be done visually with knowledge of the circuit. The connection of the current-transformer secondary to the PGR-5701 is not polarity sensitive.

c) Verify that the system is correctly grounded and that alternate ground paths do not exist that bypass the current transformer. 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. Fig. 7 shows a test circuit using a PGT-0400 Ground-Fault-Relay Test Unit. The PGT-0400 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 the PGR-5701 setting. 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 1, 2, 3, 4, and 5.

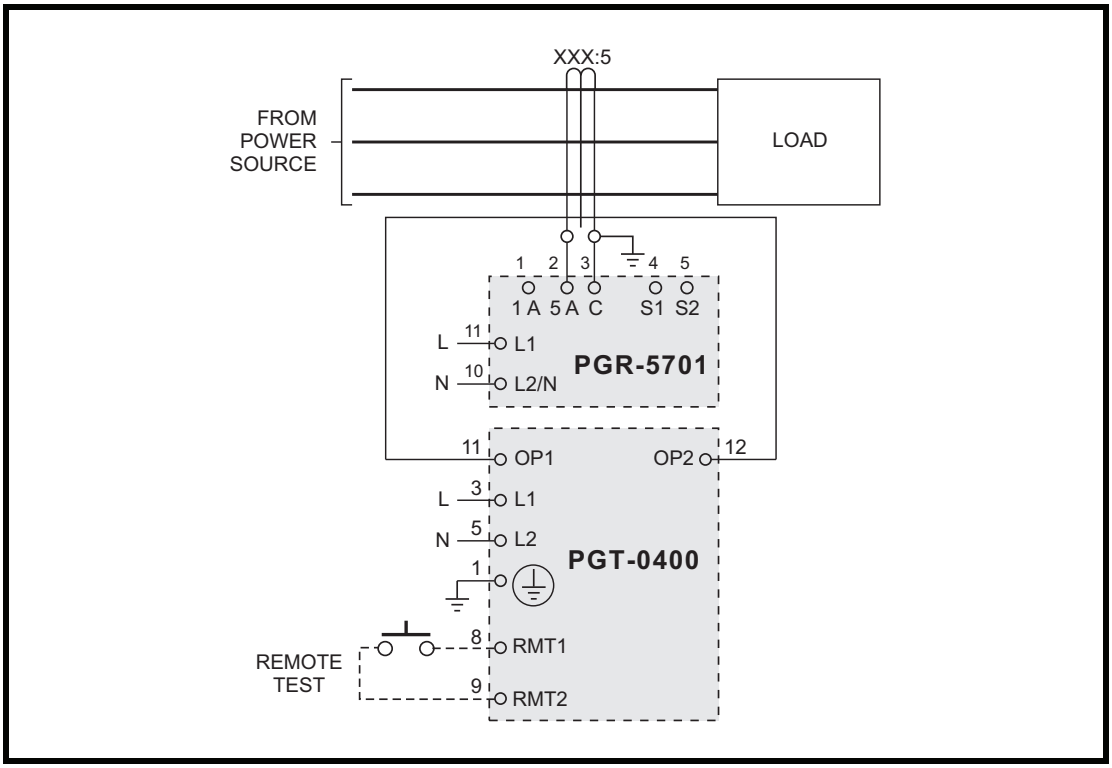


FIGURE 7. Ground-Fault-Test Circuit using PGT-0400.

TABLE 2. Ground-Fault-Test Record

DATE	TEST RESULTS

Retain this record for authority having jurisdiction.