

LINAM UGFI

Underground Fault Indicator

Instruction Manual



20250228

SEL SCHWEITZER ENGINEERING LABORATORIES

© 2025 Schweitzer Engineering Laboratories, Inc. All rights reserved.

Content subject to change without notice. Unless otherwise agreed in writing, all SEL product sales are subject to SEL's terms and conditions located here: <https://selinc.com/company/termsandconditions/>.

Table of Contents

Preface

Overview.....	ix
Safety Information.....	x
Technical Support.....	xiii

Section 1: Introduction and Specifications

Overview.....	1
Features.....	1
Options.....	2
Accessories.....	3
Dimensions.....	4
Specifications.....	4

Section 2: Applications

Selecting the Appropriate Reset Option for Your Application.....	10
--	----

Section 3: Installation and Connections

Installation.....	13
Minimum Installation Distance.....	14
Minimizing the Influence of Adjacent Phase Current.....	15
Use With RadioRANGER.....	16
Positioning the Remote Indicator.....	16
Cable Training—What Not to Do.....	17
Recommended Neutral Training.....	18

Section 4: Manual Test Activation and Reset

Manual Reset.....	20
Manual Test.....	20
Factory Reset.....	20

Section 5: Troubleshooting Guide

Troubleshooting Options.....	21
Troubleshooting Procedures.....	21
Technical Support.....	22

Appendix A: Firmware and Manual Versions

Firmware.....	23
Instruction Manual.....	24

Appendix B: Operational Behavior

AutoRANGER Self-Adjusting Algorithm.....	25
Adjacent Phase Rejection Technology.....	28
Reset and Arming Requirements.....	28
Timed Reset Charging Curves.....	30
Indicator Behavior.....	32

This page intentionally left blank

List of Figures

Figure 1.1	UGFI Front Panel.....	1
Figure 1.2	UGFI Dimensions.....	4
Figure 2.1	Underground Fault Detection and Indication.....	9
Figure 2.2	Remote Indication Options.....	9
Figure 2.3	Current Reset Diagrams.....	10
Figure 2.4	Timed Reset Diagrams.....	11
Figure 2.5	Timed Reset With Current Reset Override.....	12
Figure 3.1	Installation Procedure.....	13
Figure 3.2	Small and Large Cable Clasp Arm Positioning.....	14
Figure 3.3	Recommended Distance From Adjacent Phase.....	14
Figure 3.4	Safe Operating Zones.....	15
Figure 3.5	RadioRANGER With UGFI.....	16
Figure 3.6	Remote Mechanical Target Display.....	16
Figure 3.7	Cable Routing Recommendations.....	16
Figure 3.8	Cable Training—What Not to Do.....	17
Figure 4.1	CRSRTT Tool to UGFI.....	19
Figure B.1	AutoRANGER Activities Over an 8-Day Period.....	25
Figure B.2	Inrush Restraint.....	26
Figure B.3	AutoRANGER With Ramping Current.....	26
Figure B.4	Lost Diversity.....	27
Figure B.5	Progression of Fault Detection and Indication.....	27
Figure B.6	Adjacent Conductor and Primary Conductor to UGFI.....	28
Figure B.7	Current Reset.....	29
Figure B.8	Timed Reset.....	29
Figure B.9	Timed Reset With Current Reset Override.....	30
Figure B.10	2-Hour Timed Reset Charging Curve.....	31
Figure B.11	4-, 8-, and 12-Hour Timed Reset Charging Curve.....	31
Figure B.12	Fiber-Optic LED Indicator.....	32
Figure B.13	Built-In Mechanical Target.....	32
Figure B.14	Auxiliary Contact Output.....	33
Figure B.15	Attached RadioRANGER Probe.....	33
Figure B.16	RadioRANGER Connected to UGFI.....	34

This page intentionally left blank

List of Tables

Table 1.1	UGFI Orderable Accessories.....	3
Table 3.1	Explanation of Conductors in Figure 3.4.....	15
Table 3.2	Cable Training Recommendations.....	18
Table 4.1	Magnet Tool (CRSRTT) Actions.....	19
Table 4.2	Manual Device Test.....	20
Table 5.1	Troubleshooting.....	21
Table A.1	Firmware Revision History.....	23
Table A.2	Manual Revision History.....	24
Table B.1	AutoRANGER Trip Thresholds for Measured Load Current.....	25
Table B.2	Inrush Restraint Thresholds.....	27
Table B.3	Auxiliary Contact Diagram.....	33

This page intentionally left blank

Preface

Overview

This manual describes the specifications, installation, and features entailed in the common use and application thereof of the LINAM Underground Fault Indicator (UGFI). This manual also includes all the necessary information to install and use the UGFI for all applications and locations of the device.

Preface. Provides the manual overview, as well as safety and general information about the product

Section 1: Introduction and Specifications. Introduces the UGFI features, options, and accessories. This section also summarizes the function, specifications, and general use guidelines.

Section 2: Applications. Describes the general applications of the UGFI for underground systems and how to ensure the device fits the intended use of the application.

Section 3: Installation and Connections. Discusses the correct installation procedures and the efficient operation of the UGFI; offers insights into making connections with external devices and indicators to enhance the overall installation process for optimal performance.

Section 4: Manual Test Activation and Reset. Describes the interface for testing and resetting the UGFI and settings.

Section 5: Troubleshooting Guide. Describes techniques for testing, troubleshooting, and resolving issues that may arise following the installation and operation of the UGFI.

Appendix A: Firmware and Manual Versions. Lists the current firmware and manual versions and details differences between the current and previous versions.

Appendix B: Operational Behavior. Provides comprehensive insights into operation and device functionalities, encompassing key elements such as the AutoRANGER, fault detection, adjacent phase rejection, reset and arming requirements, and indicator behavior.

Safety Information

Dangers, Warnings, and Cautions

This manual uses three kinds of hazard statements, defined as follows:

DANGER

Indicates a potentially hazardous situation that, if not avoided, **will** result in death or serious injury.

WARNING










Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that, if not avoided, **may** result in minor or moderate injury or equipment damage.

Safety Symbols

The following symbols are often marked on SEL products.

	 CAUTION Refer to accompanying documents.	 ATTENTION Se reporter à la documentation.
	Earth (ground)	Terre
	Protective earth (ground)	Terre de protection
	Direct current	Courant continu
	Alternating current	Courant alternatif
	Both direct and alternating current	Courant continu et alternatif
	Instruction manual	Manuel d'instructions

Safety Marks

The following statements apply to this device.

<p>⚠ WARNING – EXPLOSION HAZARD Open circuit before removing cover.</p>	<p>⚠ AVERTISSEMENT – DANGER D'EXPLOSION Ouvrir le circuit avant de déposer le couvercle.</p>
<p>⚠ DANGER Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.</p>	<p>⚠ DANGER Débrancher tous les raccordements externes avant d'ouvrir cet appareil. Tout contact avec des tensions ou courants internes à l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.</p>
<p>⚠ DANGER Contact with instrument terminals can cause electrical shock that can result in injury or death.</p>	<p>⚠ DANGER Tout contact avec les bornes de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.</p>
<p>⚠ WARNING Use of this equipment in a manner other than specified in this manual can impair operator safety safeguards provided by this equipment.</p>	<p>⚠ AVERTISSEMENT L'utilisation de cet appareil suivant des procédures différentes de celles indiquées dans ce manuel peut désarmer les dispositifs de protection d'opérateur normalement actifs sur cet équipement.</p>
<p>⚠ WARNING Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.</p>	<p>⚠ AVERTISSEMENT Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.</p>
<p>⚠ WARNING Do not look into the fiber ports/connectors.</p>	<p>⚠ AVERTISSEMENT Ne pas regarder vers les ports ou connecteurs de fibres optiques.</p>
<p>⚠ WARNING Do not look into the end of an optical cable connected to an optical output.</p>	<p>⚠ AVERTISSEMENT Ne pas regarder vers l'extrémité d'un câble optique raccordé à une sortie optique.</p>
<p>⚠ WARNING Do not perform any procedures or adjustments that this instruction manual does not describe.</p>	<p>⚠ AVERTISSEMENT Ne pas appliquer une procédure ou un ajustement qui n'est pas décrit explicitement dans ce manuel d'instruction.</p>
<p>⚠ WARNING During installation, maintenance, or testing of the optical ports, use only test equipment qualified for Class 1 laser products.</p>	<p>⚠ AVERTISSEMENT Durant l'installation, la maintenance ou le test des ports optiques, utilisez exclusivement des équipements de test homologués comme produits de type laser de Classe 1.</p>
<p>⚠ WARNING Incorporated components, such as LEDs and transceivers are not user serviceable. Return units to SEL for repair or replacement.</p>	<p>⚠ AVERTISSEMENT Les composants internes tels que les leds (diodes électroluminescentes) et émetteurs-récepteurs ne peuvent pas être entretenus par l'utilisateur. Retourner les unités à SEL pour réparation ou remplacement.</p>
<p>⚠ WARNING Do not handle the cable clamping mechanism except when opening the clamp with a glove.</p>	<p>⚠ AVERTISSEMENT Ne manipulez pas le mécanisme de serrage du câble, sauf pour ouvrir la pince avec un gant.</p>
<p>⚠ WARNING Live conductors can cause injury. Follow the posted environmental safety regulations.</p>	<p>⚠ AVERTISSEMENT Les conducteurs sous tension peuvent provoquer des blessures. Respectez les règles de sécurité environnementales en vigueur.</p>

<p>⚠ WARNING The cable clamping area is dangerous and spring-loaded. Use caution and safety when the clamps are open.</p>	<p>⚠ AVERTISSEMENT La zone de serrage du câble est dangereuse et à ressort. Faites preuve de prudence et de sécurité lorsque les pinces sont ouvertes.</p>
<p>⚠ CAUTION Use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.</p>	<p>⚠ ATTENTION L'utilisation de commandes ou de réglages, ou l'application de tests de fonctionnement différents de ceux décrits ci-après peuvent entraîner l'exposition à des radiations dangereuses.</p>
<p>⚠ CAUTION For use in a controlled environment.</p>	<p>⚠ ATTENTION Pour utilisation dans un environnement contrôlé.</p>
<p>⚠ CAUTION To ensure proper safety and operation, the equipment ratings, installation instructions, and operating instructions must be checked before commissioning or maintenance of the equipment. The integrity of any protective conductor connection must be checked before carrying out any other actions. It is the responsibility of the user to ensure that the equipment is installed, operated, and used for its intended function in the manner specified in this manual. If misused, any safety protection provided by the equipment may be impaired.</p>	<p>⚠ ATTENTION Pour assurer la sécurité et le bon fonctionnement, il faut vérifier les classements d'équipement ainsi que les instructions d'installation et d'opération avant la mise en service ou l'entretien de l'équipement. Il faut vérifier l'intégrité de toute connexion de conducteur de protection avant de réaliser d'autres actions. L'utilisateur est responsable d'assurer l'installation, l'opération et l'utilisation de l'équipement pour la fonction prévue et de la manière indiquée dans ce manuel. Une mauvaise utilisation pourrait diminuer toute protection de sécurité fournie par l'équipement.</p>
For use in Pollution Degree 4 environment.	Pour utilisation dans un environnement de Degré de Pollution 4.
The UGFI does not have any field-serviceable parts. Return a faulty or failed unit to the factory for repair or replacement.	Le UGFI ne comporte aucune pièce remplaçable sur le terrain. Renvoyer une unité défectueuse à l'usine afin de la réparer ou la remplacer.
Insulation Class: I	Classe d'isolation : I
IP Rating: IP68	Indice de protection : IP68
Operating Temperature Range: -40°C to +85°C (-40°F to +185°F).	Plage de température de fonctionnement : -40 °C à +85 °C (-40 °F à +185 °F).

Trademarks

All brand or product names appearing in this document are the trademark or registered trademark of their respective holders. No SEL trademarks may be used without written permission.

SEL trademarks appearing in this manual are shown in the following table.

AutoRANGER®	LINAM®
-------------	--------

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

This page intentionally left blank

Introduction and Specifications

Overview

The UGFI detects the fault current in an underground cable and indicates when a fault occurs. You can choose from multiple indicator options including an auxiliary contact that provides a status output for a fault indication to a pad-mount or underground distribution panel.



Figure 1.1 UGFI Front Panel

Features

- Coordinate the trip threshold with a seven-day load current profile by using the self-adjusting AutoRANGER algorithm. A fixed trip threshold is also available as an ordering option.
- Automatically reset a fault indication based on the ordered configuration. Current reset only, timed reset only, or timed reset with current reset override (the reset triggered by the first condition to be met) are available as ordering options.
- Ensure secure device operation with adjacent phase rejection technology and robust current measurement by using the Rogowski coil.
- Install the UGFI with a standard ratcheting-type hot stick tool.
- Seamlessly integrate the UGFI into a SCADA system for fault detection with an optional auxiliary contact.

- Select from a variety of indicator types and locations (built-in or remote) when ordering a UGFI.
- Monitor the UGFI status remotely by using the RadioRANGER probe, eliminating the need to access underground vaults (RadioRanger is sold separately).

Options

When ordering the UGFI, consider the following available options. Ordering information is available at selinc.com.

- Fault detection type: AutoRANGER or fixed trip threshold
 - For AutoRANGER, choose 25, 50, 100, 200, 300, 450, 600, 900, or 1200 for the minimum trip threshold.
 - For fixed trip threshold, choose 25, 50, 100, 200, 300, 400, 450, 600, 900, 1200, or 1600 for the fixed threshold.
- Automatic reset type:
 - Current reset only
 - Timed reset only
 - Timed reset with current reset override (reset is triggered by the first condition to be met)
- Timed reset duration:
 - 2 hours
 - 4 hours
 - 8 hours
 - 12 hours
- Indicator type:
 - Built-in mechanical target
 - Built-in LED with fiber-optic port (available with timed reset options)
- Remote indicator options:
 - Auxiliary contact
 - Cable length first option (cable to auxiliary contact box):
 - 1.83 m (6.00 ft)
 - Cable length second option (auxiliary contact box to remote cable leads):
 - 1.83 m (6.00 ft)
 - 3.66 m (12.00 ft)
 - 6.10 m (20.00 ft)
 - 9.14 m (30.00 ft)
 - RadioRANGER magnetic probe
 - Cable length options:
 - 1.83 m (6.00 ft)
 - 3.66 m (12.00 ft)
 - 6.10 m (20.00 ft)

- Remote mechanical target (not available with the built-in mechanical target)

Cable length options:

- 1.83 m (6.00 ft)
 - 3.66 m (12.00 ft)
 - 6.10 m (20.00 ft)
- Remote metallic tamper-proof bolt (requires an HHT Silver Bolt Test Tool, which is sold separately)

Cable length options:

- 1.83 m (6.00 ft)
- 3.66 m (12.00 ft)
- 6.10 m (20.00 ft)

Accessories

Contact your Technical Support or the SEL factory for additional details and ordering information for the following accessories:

Table 1.1 UGFI Orderable Accessories

Accessory	Part Number
Remote Fiber-Optic Cable, 1.83 m (6.00 ft) Cable Length (Indicator Lens Included)	915990106
Remote Fiber-Optic Cable 2.44 m (8 ft) Cable Length (Indicator Lens Included)	915990108
Remote Fiber-Optic Cable 3.05 m (10 ft) Cable Length (Indicator Lens Included)	915990110
Remote Fiber-Optic Cable 4.57 m (15 ft) Cable Length (Indicator Lens Included)	915990115
Remote Fiber-Optic Cable, 6.10 m (20.00 ft) Cable Length (Indicator Lens Included)	915990120
HHT Silver Bolt Test Tool	HHT
CRSRTT Magnet Tool	CRSRTT
Magnetic Cable Guide (White)	MCG
Magnetic Cable Guide (Blue)	MCGB

- **Remote Fiber-Optic Cables:** Transmit the light from the built-in LED of a UGFI to an external panel by using SEL remote fiber-optic cables.
- **HHT Silver Bolt Test Tool:** Use to determine if the UGFI tripped or not. (Works with the remote metallic tamper-proof bolt.)
- **CRSRTT Magnet Tool:** Use to manually test or reset the UGFI.
- **Magnetic Cable Guides:** Keep the sensor and I/O cables neat and secure with the cable guides in metallic pad-mount enclosures, available in white or blue.

Dimensions

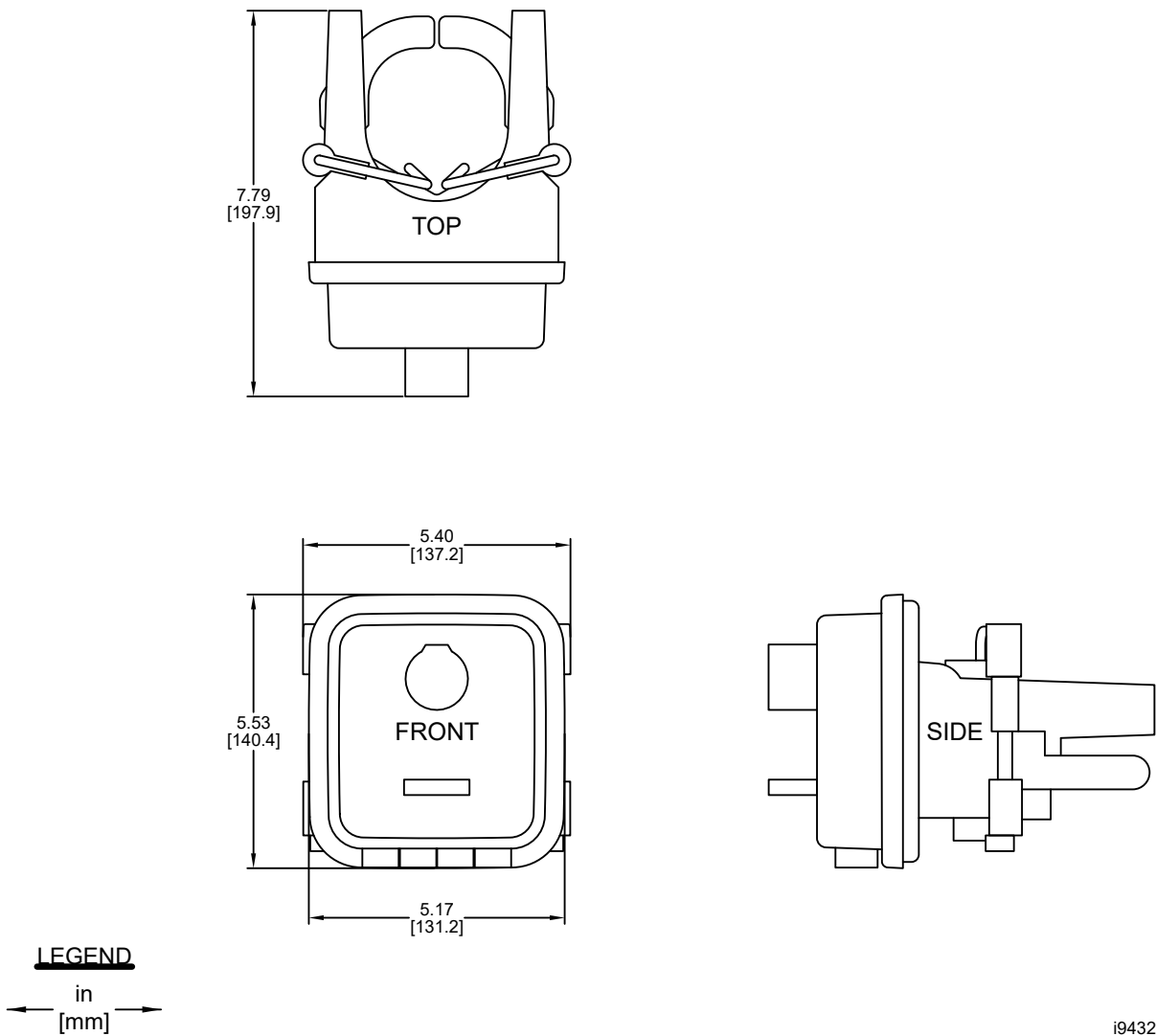


Figure 1.2 UGFI Dimensions

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system

47 CFR 15B, Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

General

Voltage Range:	All medium voltage-insulated shielded distribution cables where the installation surface is within the clamping range.
Clamping Range:	15.2 mm to 55.9 mm (0.6 in to 2.2 in)
Weight:	453.59 g (3 lb)
Rated Frequency:	60 Hz
Maximum Rated Continuous Current:	1200 A \leq 4 hr

Fault Detection

Trip Threshold Range:	25–1600 A
Fault Detection Accuracy:	$\pm 10\% \pm 2$ A
Minimum Fault Detection Time While Device Is Energized:	≥ 1.5 cycles; 2 cycles typical
Minimum Fault Detection Time While Device Is De-Energized:	≥ 2.25 cycles
Maximum Rated Fault Current Withstand:	40 kA for 10 cycles

Minimum Load Current for Fault Indicator Display Options

15 A Continuous Load Current to Charge Energy Storage	Built-In LED Display
No Minimum Load Current	Built-In Mechanical Target Display Remote Mechanical Target Display Remote Tamper Proof Bolt RadioRANGER Probe

See *Appendix B: Operational Behavior*.

Automatic Reset

Timed Reset:	2, 4, 8, or 12 hr ($\pm 5\%$) (minimum load current of 15 A; see <i>Timed Reset Charging Curves on page 30</i>)
Current Reset:	≥ 1.0 A \leq 10 min
Timed Reset With Current Reset:	Timed reset (as specified in <i>Timed Reset</i>) duration (2, 4, 8, or 12 hr; $\pm 5\%$) or ≥ 1 A (whichever occurs first)

The LINAM UGFI supports manual test activation, reset, and factory reset via the optional magnet tool (CRSRTT). The magnet tool may be attached to a hot stick (not provided) to extend the reach of the operator.

Output Contacts

The LINAM UGFI supports one optional Form C output for fault indication.

Maximum Rated Voltage:	250 Vac/220 Vdc
Electrical Endurance:	100,000 operations minimum 250 Vac/0.25 A–62.5 VA 220 Vdc/0.27 A–60 W
Operate Time:	≤ 3 ms (max), 1 ms (typical) (resistive load)
Release Time:	3 ms (max), 1 ms (typical) (resistive load)
Contact Rating:	30 Vdc, 2 A, 60 W 110 Vdc, 0.3 A, 33 W 220 Vdc, 0.27 A, 60 W 125 Vac, 0.5 A, 62.5 W 250 Vac, 0.25 A, 62.5 W

Operating Temperature

–40° to +85°C (–40° to +185°F)

Operating Environment

Maximum Altitude Without Derating: 3000 m

Dimensions

140 mm x 137 mm x 198 mm (5.5 in x 5.4 in x 7.8 in)

Type Tests

Environmental Tests

Protection Rating:	IP68
Water Submersion:	IEEE 495-2007 Test 4.4.2: 25 ft water, 7 days, +5° to +70°C
Temperature Cycling:	IEEE 495-2007 Test 4.4.1; 2 hr. at +25°C, +85°C, +25°C, –40°C, +25°C, 5 cycles
Trip Current:	IEEE 495-2007 Test 4.4.9; –30°, +20°, and +70°C
Reset:	IEEE 495-2007 Test 4.4.10; –30°, +20°, and +70°C
Short-Time Current:	IEEE 495-2007 Test 4.4.7; 40 kA for 10 cycles
Adjacent Phase Immunity:	IEEE 495-2007 Test 4.4.8; 25 kA at 4 in
Time Current:	IEEE 495-2007
Vibration Resistance:	IEC 60255-21-1:1988 Class 2 Response IEEE 495-2007 Test 4.4.6
Shock and Bump Resistance:	IEC 60255-21-2:1988 Class 2 Shock Response IEEE 495-2007 Test 4.4.6
Seismic Resistance:	IEC 60255-21-3:1993 Class 2 (Quake Response) IEEE 495-2007 Test 4.4.6
Salt Spray:	IEEE 495-2007 Test 4.4.4 MIL-STD-810H: Method 509.8
Dry Heat Storage:	IEC 60255-27:2013 Section 10.6.1.3 IEC 60068-2-2:2007 EN 60255-27:2014 Section 10.6.1.3 EN 60068-2-2:2007
Dry Heat Operational:	EN 60255-27:2014 Section 10.6.1.1 IEC 60255-27:2013 Section 10.6.1.1 EN 60068-2-2:2007 IEC 60068-2-2:2007

Damp Heat, Cyclic:	EN 60255-27:2014 Section 10.6.1.6 IEC 60255-27:2013 Section 10.6.1.6 EN 60068-2-30:2006 IEC 60068-2-30:2005 Test Db: 25° to 55°C, 6 cycles, 93% relative humidity
Cold Operational:	EN 60255-27:2014 Section 10.6.1.2 IEC 60255-27:2013 Section 10.6.1.2 IEC/EN 60068-2-1:2007 at -40°C
Cold Storage:	EN 60255-27:2014 Section 10.6.1.4 IEC 60255-27:2013 Section 10.6.1.4 IEC/EN 60068-2-1:2007 Test Ab: -40°C, 16 hr IEEE 495-2007 Test 4.4.1
Composite Temperature/Humidity Cyclic:	IEC 60068-2-38: 2021 Test Z/AD: 25°, 65°, -10°C, 10 cycles 93% relative humidity
Damp Heat, Steady State:	EN 60255-27:2014 Section 10.6.1.5 IEC 60255-27:2013 Section 10.6.1.5 EN/IEC 60068-2-78:2001 +40°C, 93% relative humidity

Dielectric Strength and Impulse Tests

Single-Fault Condition:	IEC 60255-27: 2013 EN 60255-27: 2014 Section 10.6.5.5
-------------------------	---

RFI and Interference Tests

Electrostatic Discharge Immunity:	EN 61000-4-2:2009 IEC 61000-4-2:2008 at Level 4: 15 kV air and 8 kV contact discharge
Radiated RF Immunity:	IEC/EN 60255-26:2013 Section 7.2.4 IEC/EN 61000-4-3:2006 + A1:2007/2008 + A2:2010 IEEE C37.90.2:2004
RF Emissions:	IEC/EN 60255-26:2013 Section 7.2.7 IEC 60255-26:2023 EN 61850-3:2014 IEC 61850-3:2013 EN 55032:2015 + A11:2020 CISPR 32:2015 + A1:2019 47 CFR Part 15.107, 109 ICES-001, Issue 5
Conducted RF Immunity:	EN 61000-4-6:2014 IEC 61000-4-6:2013
Electrical Fast Transient Burst:	IEC/EN 61000-4-4:2012 at Severity Level 4
Power Frequency Magnetic Field:	IEC/EN 60255-26:2013 Section 7.2.10 EN 61000-4-8:2010 IEC 61000-4-8:2009

This page intentionally left blank

SECTION 2

Applications

Use the UGFI for efficient fault indication on underground feeders and circuits. Attach the device directly to an underground cable, and it promptly indicates when a fault is followed by a current drop (<15 percent of the trip threshold) that has occurred on the distribution feeder, as shown in *Figure 2.1*.

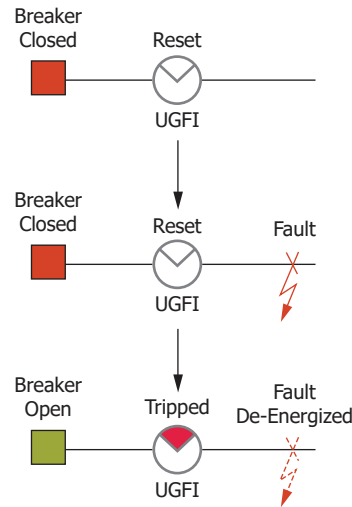


Figure 2.1 Underground Fault Detection and Indication

The UGFI has several remote indicators to help identify faults without the need to open an underground vault, or pad-mount enclosure. These options expedite locating faults for any underground cable application.

Figure 2.2 shows the some of the available remote indicator options.

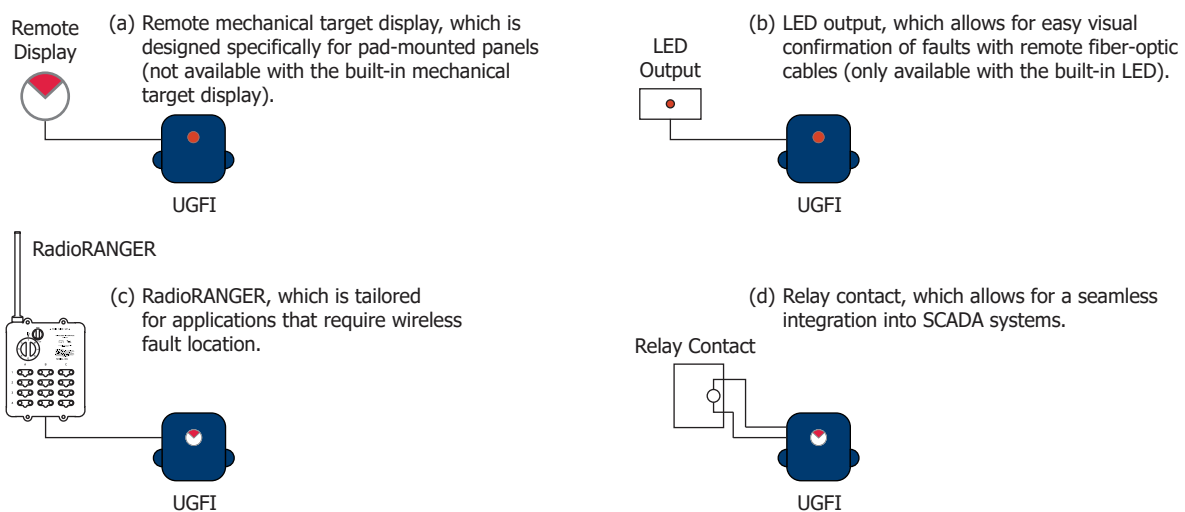


Figure 2.2 Remote Indication Options

NOTE

For personal safety, do not use a remote indicator in live front installations.

Selecting the Appropriate Reset Option for Your Application

Current Reset

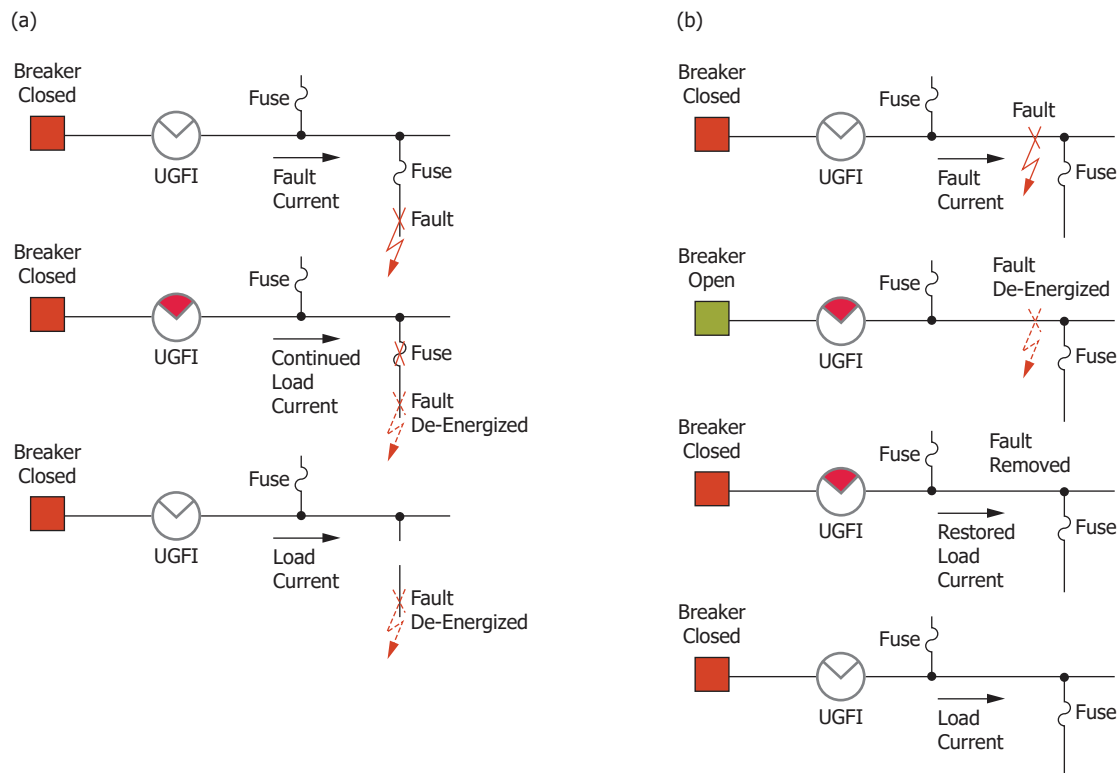


Figure 2.3 Current Reset Diagrams

The current reset type application shown in *Figure 2.3(a)* shows how permanent faults from a downstream fused lateral may cause the current to drop but the load-feeder circuit current to remain in operation. The UGFI momentarily indicates the fault through the available display's indicators including the output contact; however, the UGFI resets on continuous current.

Figure 2.3(b) shows current being restored quickly after an upstream recloser clears a non-permanent fault. In this example, a UGFI with current reset indicates a fault until the current on the feeder is restored.

Timed Reset

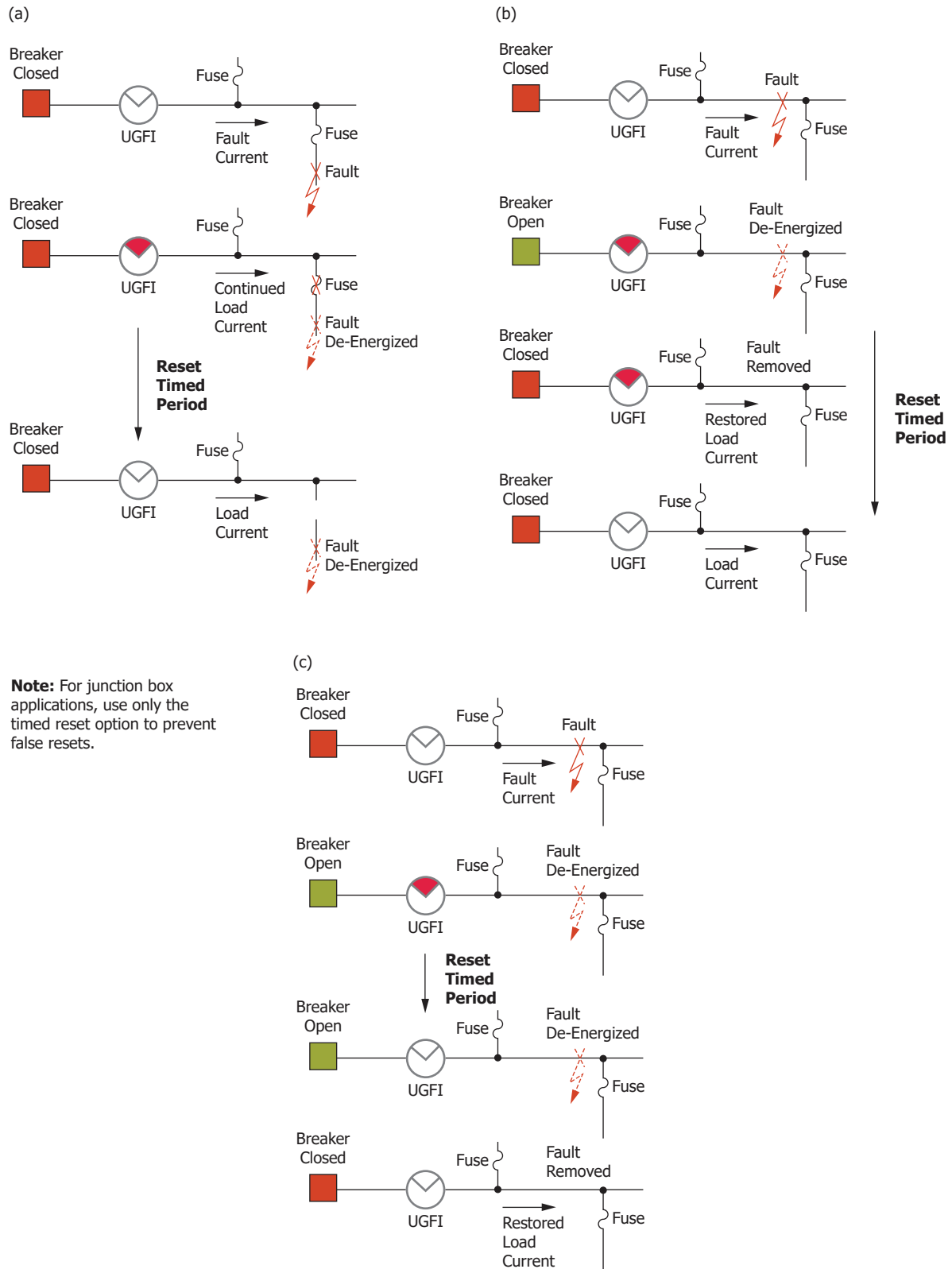


Figure 2.4 Timed Reset Diagrams

Figure 2.4(a) depicts a scenario where the feeder experiences a faulted lateral and requires a fault indication for a set amount of time (2, 4, 8, or 12 hours). Additionally, Figure 2.4(a) shows a breaker that successfully remained closed after a fuse opened for a fault. This is particularly useful in applications such as Fault Location, Isolation, and Service Restoration (FLISR) and sectionalizer schemes.

Figure 2.4(b) illustrates an application that allows users to follow the fault on the feeder, even after current has been restored. In contrast, Figure 2.4(c) shows a fault that was resolved on the conductor, but the current has not yet been restored. For backfeed suppression, SEL recommends using a timed-reset only device, because it remains unaffected by backfeed occurrences. Examples of situations where this is applicable include transformers, such as four-wire delta grounding banks, and inductive loads, such as large motors.

Timed Reset With Current Reset Override

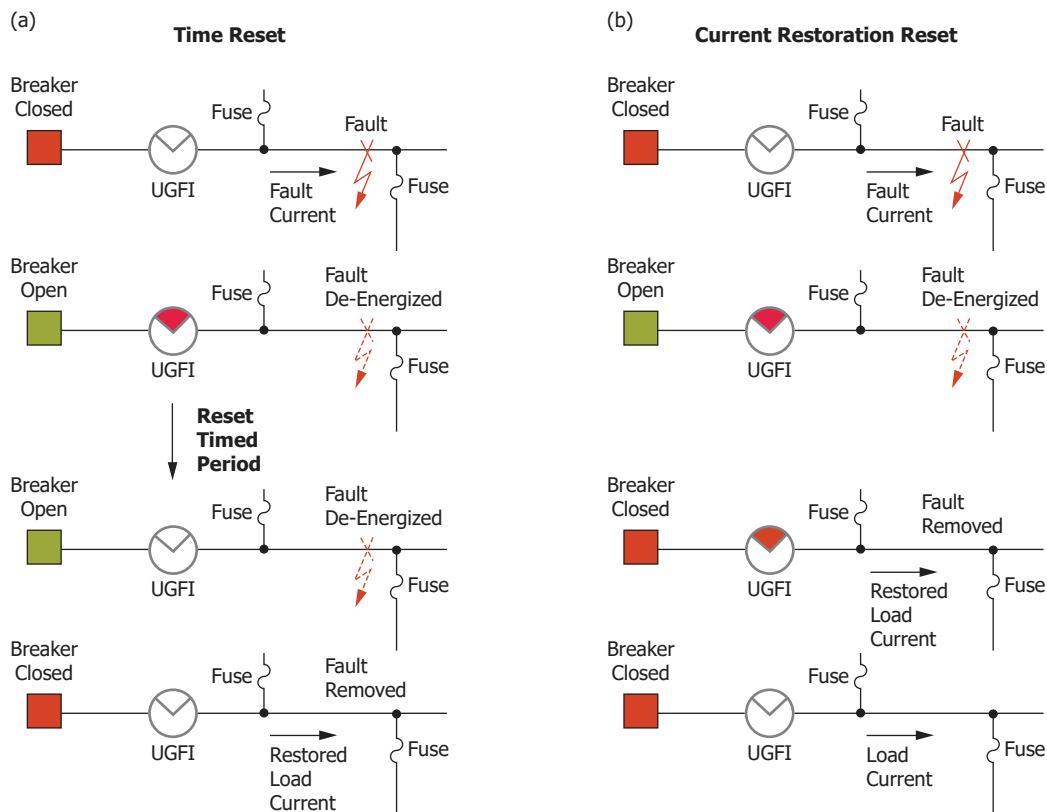


Figure 2.5 Timed Reset With Current Reset Override

As shown in Figure 2.5(a), the device always resets within a specified time if no current is restored. However, as shown in Figure 2.5(b), if current is restored first, the device resets quickly. Specifically, once power has been restored, as shown in Figure 2.5(b), the reset may take as long as 10 minutes to reset during low-load current levels.

Installation and Connections

Installation

To install the UGFI, use the following steps:

- Step 1. Identify a shield-trained section of underground cable that is appropriate for the device, as shown in *Table 3.2*.
- Step 2. Open the clasp arms one at a time, ensuring the arms are locked open. As the clasp arms open, the prop and action lever moves up and hold open the clasp arms. Once open, the UGFI is ready for installation.
- Step 3. During installation, use a standard ratcheting-type hot stick to secure the UGFI to the cable from a distance.
- Step 4. Apply sufficient force to the prop and action mechanism to ensure that both clasp arms anchor firmly around the underground cable. To securely position the UGFI to grip the underground cable, consult the supplied underground cable diagram in *Figure 3.2*, which illustrates the correct placement for both small and large cable conductors.
- Step 5. After the UGFI has successfully gripped the cable, remove the hot stick and verify that the device remains securely in place without any unintended movement about the cable. If the device moves in an unintended way, remove the device and reinstall in a location with less lubrication.

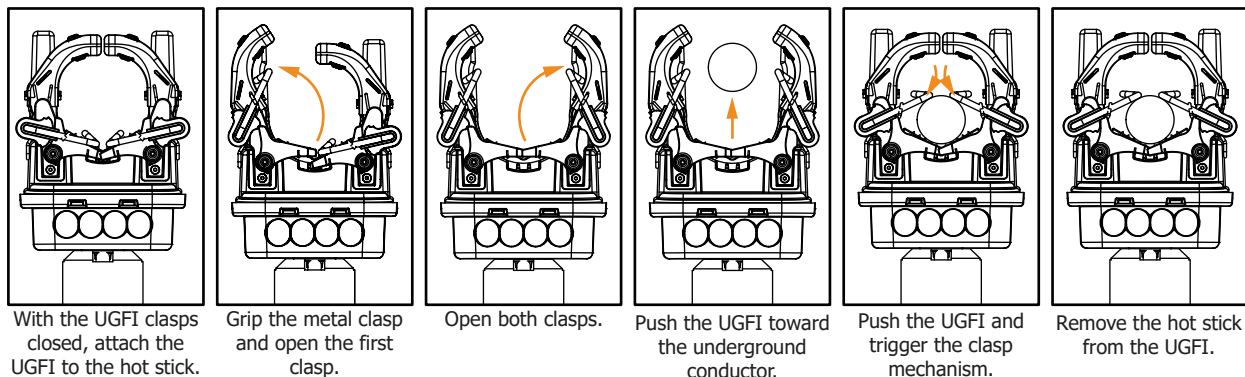


Figure 3.1 Installation Procedure

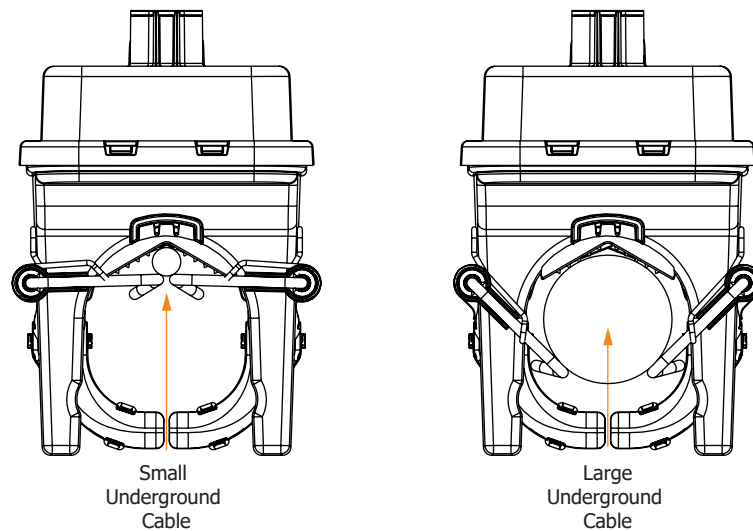


Figure 3.2 Small and Large Cable Clasp Arm Positioning

⚠ WARNING

Do not handle the cable clamping mechanism except when opening the clamp with a glove.

⚠ WARNING

Live conductors can cause injury. Follow the posted environmental safety regulations.

⚠ WARNING

The cable clamping area is dangerous and spring-loaded. Use caution and safety when the clamps are open.

Minimum Installation Distance

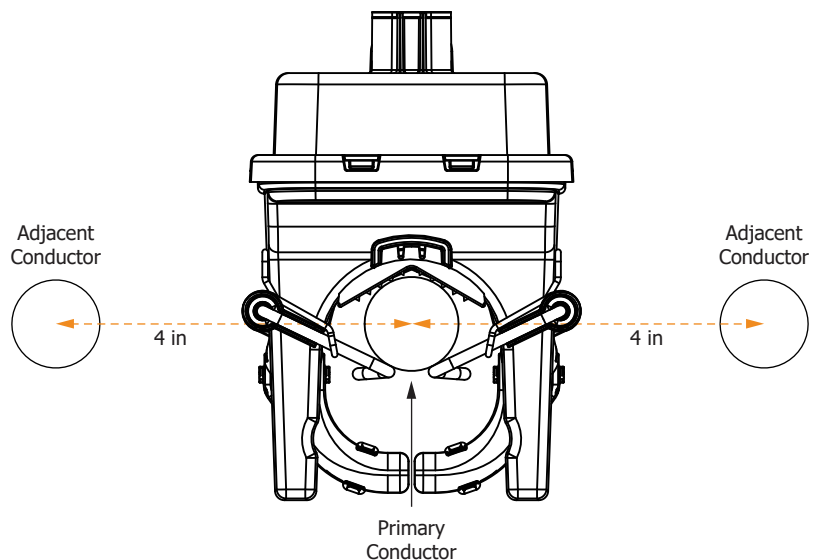


Figure 3.3 Recommended Distance From Adjacent Phase

During installation, maintain a minimum distance of 4 in between the center of the primary conductor and the center of the adjacent conductors to prevent false current detection, as shown in *Figure 3.3*. Following this recommendation enhances the accuracy and reliability of the UGFI, promoting optimal operation, selectivity, and security against false trips.

Minimizing the Influence of Adjacent Phase Current

Follow these installation guidelines to prevent false trips. When installing the UGFI for optimal performance of the adjacent phase rejection technology, position the adjacent phase conductors within designated safe zones around the UGFI. *Figure 3.4* shows the unsecure operating zones for adjacent conductors. Placing the phase conductors within the safe operating zones ensures accurate fault indication without false alarms, thereby maximizing the benefits of the UGFI technology.

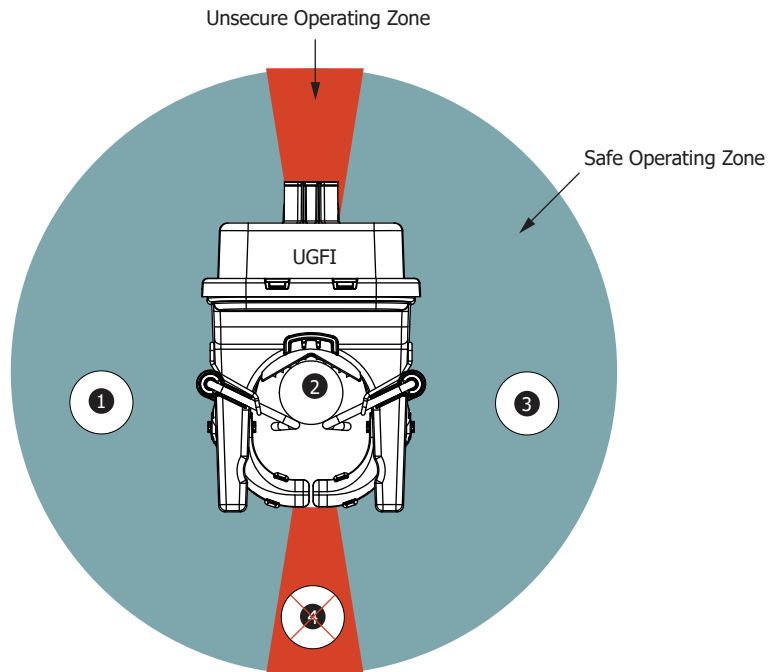


Figure 3.4 Safe Operating Zones

Table 3.1 Explanation of Conductors in Figure 3.4

Conductor Number	Operating Recommendation
Conductor 1	Adjacent phase to the UGFI. The conductor is in a safe operating zone.
Conductor 2	Primary phase in the UGFI. Fault detection is performed on this conductor. The UGFI monitors this phase while also rejecting currents from Conductors 1 and 3 but this phase may be influenced by Conductor 4.
Conductor 3	Adjacent phase to the UGFI. The conductor is in a safe operating zone.
Conductor 4	Adjacent phase to the UGFI. The conductor is in an unsecure operating zone that should be avoided to ensure correct device operation.

Use With RadioRANGER



Figure 3.5 RadioRANGER With UGFI

The UGFI is available as part of the RadioRANGER Underground Wireless Fault Indication System. RadioRANGER sends the status of the UGFI—tripped or reset—to a handheld Remote Fault Reader via a radio signal, keeping line crews safe and shortening fault location times. SEL offers the UGFI with both RadioRANGER and either the LED or mechanical target (built-in and remote) option. For more information on the RadioRANGER to UGFI integration, refer to *Appendix B: Operational Behavior*. Visit <https://selinc.com/solutions/fault-indicators-and-sensors/> for more information about these models and configurations.

Positioning the Remote Indicator



Figure 3.6 Remote Mechanical Target Display

The UGFI with a remote mechanical target display allows targets to be visible from the exterior of the cabinet or enclosure where the UGFI is installed.

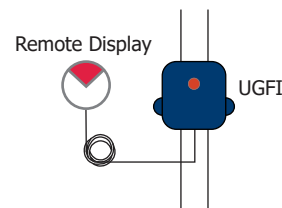


Figure 3.7 Cable Routing Recommendations

To maintain optimal performance and prevent external interference with the remote indicator, route the remote indicator cables away from other devices and power cables. Coil excess remote display cables near the remote indicator, ensuring they are kept clear of external influences. Minimize proximity with the conductors and maintain a recommended distance of 8 in. between the coil and the conductors whenever possible.

Cable Training—What Not to Do

Do not bundle the UGFI external leads onto one another, tie them tightly with cable ties, or wrap them together, as shown in *Figure 3.8(a)*.

Do not place the coiled UGFI external leads on the primary cables, as shown in *Figure 3.8(b)*.

Do not train the UGFI external leads along primary cable runs, as shown in *Figure 3.8(c)*.

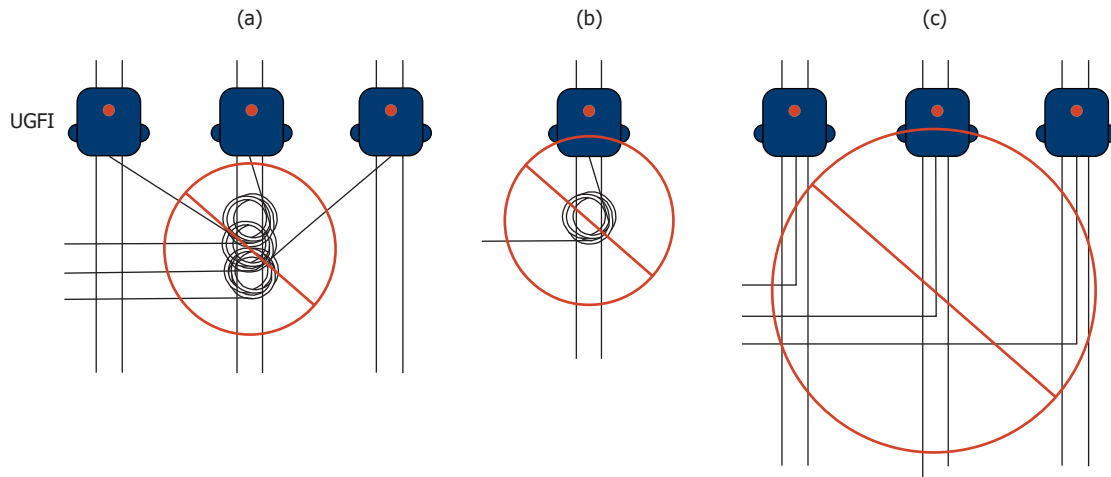
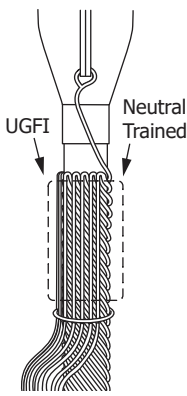
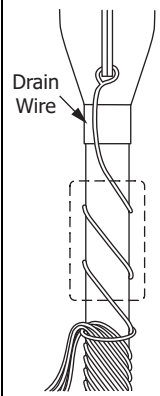
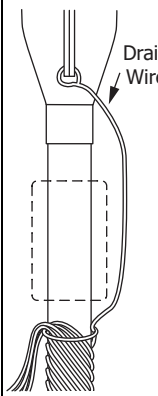
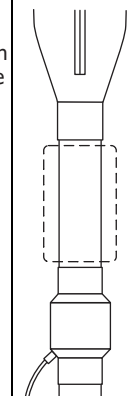
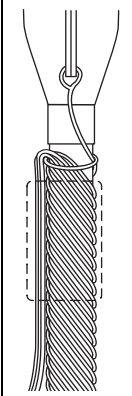
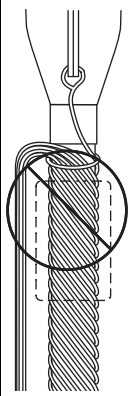


Figure 3.8 Cable Training—What Not to Do

Recommended Neutral Training

Table 3.2 Cable Training Recommendations

Acceptable					Incorrect	Neutral Training for Phase Sensor
						<p>The way the neutral is trained and the correct placement of all UGFIs are essential for proper function of the UGFI.</p> <p>Shown are several methods of neutral training. Note the position of each UGFI device.</p> <p>Double-back training is the preferred method.</p> <p>Five acceptable methods are shown.</p> <p>The last method prevents proper UGFI function. <i>Do not use this method</i> when applying UGFIs.</p>

The UGFI senses changes in the primary conductor magnetic field; shields (foil or concentric neutral) may cancel out the primary magnetic field.

The UGFI may be installed on:

- Cable sections absent of the shield.
- Cable sections over a double-back (canceled) shield.

SEL recommends using the acceptable methods shown in *Table 3.2* to avoid the device tripping upstream or downstream of a fault.

SECTION 4

Manual Test Activation and Reset

NOTE

Before attempting to test or manually reset the device, ensure the line has been energized to a minimum of 8 A.



Figure 4.1 CRSRTT Tool to UGFI

NOTE

Before using the CRSRTT tool, remove the silver shorting bar. Replace the shorting bar after use.

Use the CRSRTT magnet tool (sold separately) with the UGFI to perform a manual reset, manual test, and factory reset. Apply the tool directly to the marked reset area for specified duration.

Table 4.1 includes all the test and reset options and the magnetic tool contact time required to initiate the desired action.

Table 4.1 Magnet Tool (CRSRTT) Actions

UGFI Interaction	Tool Contact Time	Action Performed
Manual Reset	7 s (5–20 s)	Resets trip indication
Manual Test	25 s (20–40 s)	Tests the UGFI trip indication
Factory Reset	45 s (40+ s)	Restores the factory-default settings

The power level of the UGFI is directly impacted by the current on the line. Ensure the line has been energized to 8 A or greater before performing any manual test or reset. Wait a minimum of 2 min to ensure the test performs the necessary action. Manual test activation does not operate auxiliary contacts.

Manual Reset

For a manual reset of the trip indication, keep the CRSRTT tool in contact with the device for at least 5 s, with a recommended duration of 7 s, to ensure a successful trip indication reset. After removing the tool, the LED blinks twice rapidly, confirming the reset. If the UGFI is not an LED device, the display transitions from tripped to reset.

Manual Test

We can manually test all versions of the UGFI. To do so, ensure that the CRSRTT tool remains in contact with the device for at least 20 s, with a recommended 25 s duration to ensure accurate trip indication. The test causes the UGFI to indicate a fault, both on the built-in target indicator and the remote indicators (not including the auxiliary contact). For units with LED, after removing the tool, the LED blinks twice, followed by an additional number of flashes corresponding to the AutoRANGER trip threshold.

Table 4.2 Manual Device Test

AutoRANGER Trip Threshold	25	50	100	200	300	450	600	900	1200	1600
Additional Flashes	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10

Factory Reset

For a device factory reset, maintain contact with the CRSRTT tool for at least 40 s, with a recommended 45 s duration to guarantee a proper reset. The factory reset clears all saved data and resets the AutoRANGER trip threshold to the factory-configured default setting. After removing the tool, the LED indicator rapidly blinks four times before initiating the factory reset process.

NOTE
For models without an LED, only the indicators change state depending on the test or reset that is chosen.

Troubleshooting Guide

Troubleshooting Options

- **Manual Test:** Verify that all UGFI indicators are functional by performing a manual test or reset.
- **Factory Reset:** If you want to reset the AutoRANGER out-of-box settings, perform a factory reset to resolve the issues.
- **Re-Installation:** If there is a possibility that the UGFI location on the conductor is inadequate for power harvesting or if the UGFI requires a restart, remove the UGFI from the conductor, wait for 5 min, and reinstall it.
- **Review Auxiliary Wires and Outputs:** Ensure all external leads, including RadioRANGER, output contacts, and remote indicators, are correctly installed and intact.
- **Check Load Current:** Ensures the line meets the minimum operating current requirements.

Troubleshooting Procedures

Table 5.1 Troubleshooting

Symptom/Possible Problem	Diagnosis/Possible Solution
The UGFI indicates a fault on non-faulted feeder.	<p>Review the device fault detection labels to ensure a static fault threshold lower than the load current was not ordered.</p> <p>Verify adjacent phase spacing, cable configurations, and neutral training.</p> <p>Re-install the UGFI to ensure it is reading signals reliably.</p>
The UGFI resets sooner than expected after a trip.	<p>Double-check the part number and labels to identify if the UGFI has the expected reset time or has a current reset option.</p> <p>Perform a factory reset.</p>
The UGFI fails to indicate a fault after a feeder trip.	<p>Perform a manual test and verify the UGFI indicator trips.</p> <p>Review the device fault detection labels to ensure a trip threshold higher than the fault current was not ordered.</p> <p>Re-install the UGFI to verify the installation of device and the remote indicators are correct.</p>

Symptom/Possible Problem	Diagnosis/Possible Solution
The UGFI built-in display indicates trip, but the remote indicator does not indicate a trip.	Check the external wires and outputs, and carefully inspect the remote indicator cables and connectors for any damage. Perform a manual test and reset and verify device operates as expected.
The UGFI appears to be off and unresponsive.	Check the application load current to ensure the device has enough current on the conductor. Wait 10 min if the feeder has extremely low load current. Perform a manual test and reset and verify the UGFI indicator operates as expected. Remove the UGFI and re-install device on the same conductor cable. Wait 10 min to verify that the device operates as expected.

Technical Support

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

Schweitzer Engineering Laboratories, Inc.
2350 NE Hopkins Court
Pullman, WA 99163-5603 U.S.A.
Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

Firmware and Manual Versions

Firmware

Table A.1 list the firmware versions, a description of modifications, and the instruction manual date code that corresponds to firmware versions. The most recent firmware version is listed first.

The firmware version will be either a standard release or a point release. A standard release adds new functionality to the firmware beyond the specifications of the existing version. A point release is reserved for modifying firmware functionality to conform to the specifications of the existing version.

A standard release is identified by a change in the R-number of the device firmware identification (FID) number.

Existing firmware:

FID=SEL-8317-**R100**-V0-Z001001-Dxxxxxxxx

Standard release firmware:

FID=SEL-8317-**R101**-V0-Z001001-Dxxxxxxxx

A point release is identified by a change in the V-number of the device FID number.

Existing firmware:

FID=SEL-8317-R100-**V0**-Z001001-Dxxxxxxxx

Point release firmware:

FID=SEL-8317-R100-**V1**-Z001001-Dxxxxxxxx

The date code is after the D. For example, the following is firmware version number R100, date code November 3, 2010.

FID=SEL-8317-R100-V0-Z001001-**D20101103**

Changes that address security vulnerabilities are marked with “[Cybersecurity]”. Other improvements to cybersecurity functionality that should be evaluated for potential cybersecurity importance are marked with “[Cybersecurity Enhancement]”.

Table A.1 Firmware Revision History

Firmware Identification (FID) Number	Summary of Revisions	Manual Date Code
Application FID: SEL-8317-R100-V0-Z000000-D20250116 Bootloader BFID: SEL-8317B-R100-V0-Z000000-D20250116	► Initial version.	20250116

Instruction Manual

The date code at the bottom of each page of this manual reflects the creation or revision date.

Table A.2 lists the instruction manual date codes and a description of modifications. The most recent instruction manual revisions are listed at the top.

Table A.2 Manual Revision History

Revision Date	Summary of Revisions
20250228	<p>Section 2</p> <p>► Updated <i>Selecting the Appropriate Reset Option for Your Application and Minimizing the Influence of Adjacent Phase Current</i>.</p> <p>Section 3</p> <p>► Updated <i>Recommended Neutral Training</i>.</p> <p>Section 4</p> <p>► Updated <i>Manual Reset and Manual Test</i>.</p> <p>Appendix B</p> <p>► Updated <i>AutoRANGER Self-Adjusting Algorithm, Adjacent Phase Rejection Technology, Reset and Arming Requirements, and Timed Reset Charging Curves</i>.</p>
20250116	Initial version.

APPENDIX B

Operational Behavior

AutoRANGER Self-Adjusting Algorithm

Autoranging

The AutoRANGER algorithm configures itself to one of ten trip thresholds based on the load current that is being measured on the distribution feeder.

Table B.1 AutoRANGER Trip Thresholds for Measured Load Current

AutoRANGER Trip Threshold (A)	25	50	100	200	300	450	600	900	1200	1600
Load Thresholds (A)	12.5	25	50	100	150	225	300	450	600	800
Measured Load Current (A)	≤ 12.5	12.6–25	25.1–50	50.1–100	100.1–150	150.1–225	225.1–300	300.1–450	450.1–600	≥ 600.1

The UGFI with the AutoRANGER algorithm must detect the measured load current rising higher than the present load threshold for a continuous 5 min period, as specified in *Table B.1*, to establish a new AutoRANGER trip threshold.

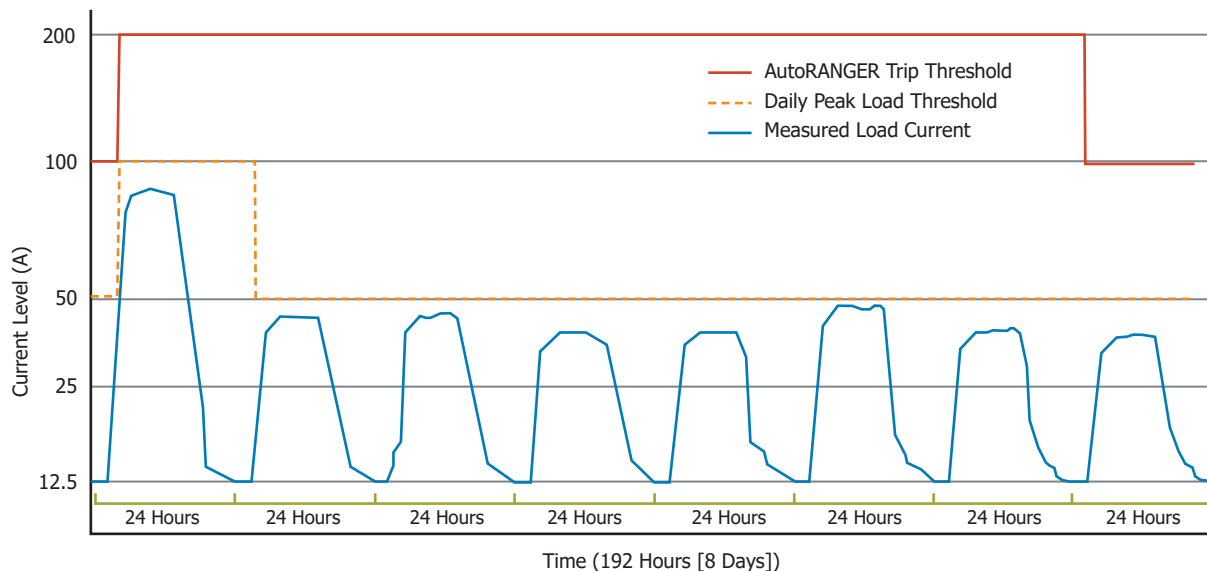


Figure B.1 AutoRANGER Activities Over an 8-Day Period

The AutoRANGER peak load threshold is stored every 24 hours for a 7-day period. As shown in *Figure B.1*, if the largest AutoRANGER peak load threshold for a 7-day period is lower than the previously set load threshold, the UGFI decreases the AutoRANGER trip threshold.

If the device turns off because of no or low current (<5 A) during operation, this low-current event does not affect the AutoRANGER adjustments during that time. By default, the AutoRANGER comes with a 25 A fault threshold or a specified factory-configured threshold.

NOTE

For timed reset models, the 25 A AutoRANGER trip threshold is not available and the minimum trip threshold is 50 A.

Inrush Restraint

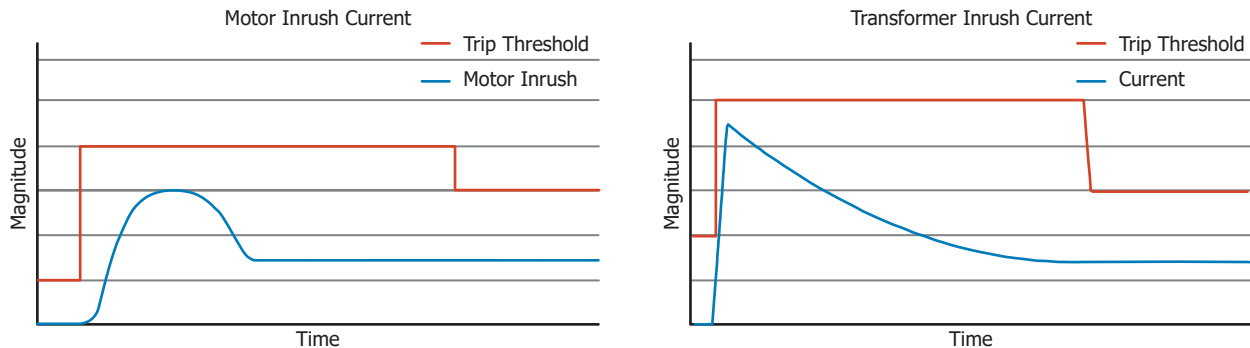


Figure B.2 Inrush Restraint

The UGFI AutoRANGER algorithm is designed to detect and restrain against current inrush conditions by increasing the autoranging (AutoRANGER) trip threshold by three times. The UGFI can discern between new load and fault conditions. Upon a cold start, the UGFI immediately transitions into inrush restraint mode.

The UGFI can sustain ramping load current without triggering a trip or setting a premature load threshold (see *Figure B.3*). The AutoRANGER algorithm detects when the load current stabilizes and adjusts accordingly.

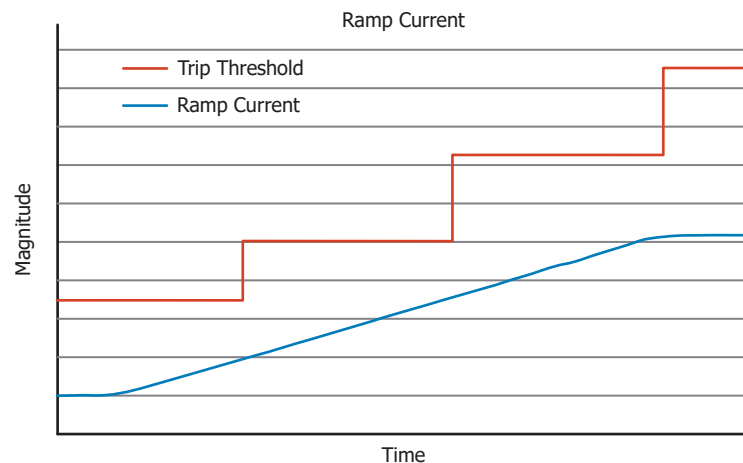


Figure B.3 AutoRANGER With Ramping Current

The UGFI also provides a lost diversity feature for sustained low or loss-of-current events by implementing the inrush enabled feature, as shown in *Figure B.4*. The autoranging algorithm detects the presence of stable load current and disables the inrush detection feature.

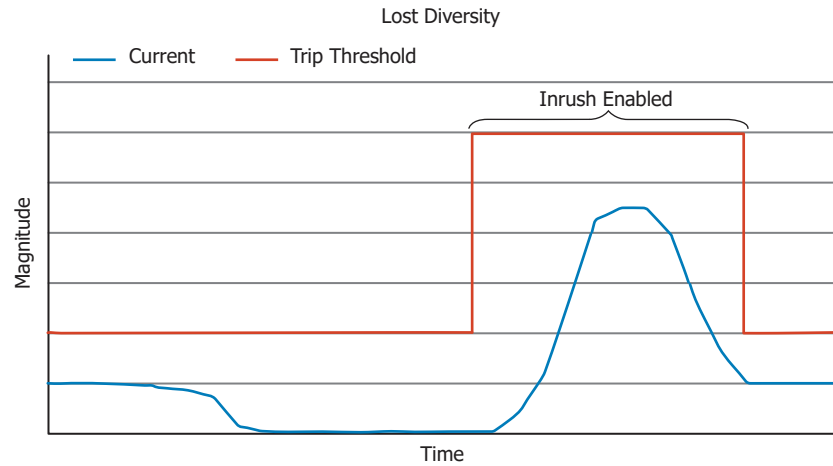


Figure B.4 Lost Diversity

Energizing Into a Fault

Table B.2 Inrush Restraint Thresholds

AutoRANGER Trip Threshold (A)	25	50	100	200	300	450	600	900	1200	1600
Inrush Trip Threshold (A)	75	150	300	600	900	1350	1800	2400	2400	2400

The UGFI is designed to detect a fault quickly even when switching from a de-energized system directly onto a fault. Because the UGFI is not powered before line energization, the device starts in the inrush protection mode when the line becomes energized. Despite beginning in this higher inrush threshold state, the UGFI can still identify and indicate high-magnitude faults (higher than 600 A) within 2.25 power system cycles.

Faults on the Power System

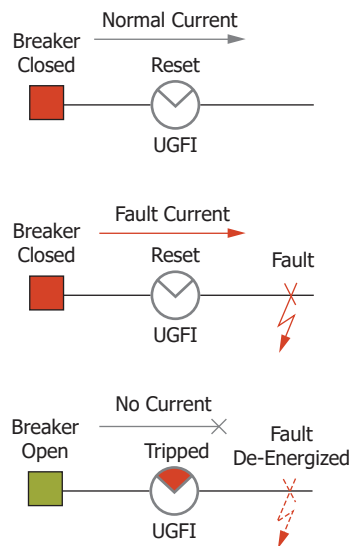


Figure B.5 Progression of Fault Detection and Indication

The UGFI detects faults on the primary conductor based on a drastic rise in system current that is higher than the trip threshold and a drop in current that is less than 15 percent of the trip threshold.

Adjacent Phase Rejection Technology

The UGFI has an adjacent phase rejection technology that provides immunity to faults on adjacent phases. As shown in *Figure B.6*, an adjacent conductor can increase the magnitude detected by the current measuring Rogowski coil of the UGFI. The device is immune to these errors and adapts to monitor the primary conductor even during high magnitude fault events as per IEEE Std 495, *IEEE Guide for Testing Faulted Circuit Indicators*.

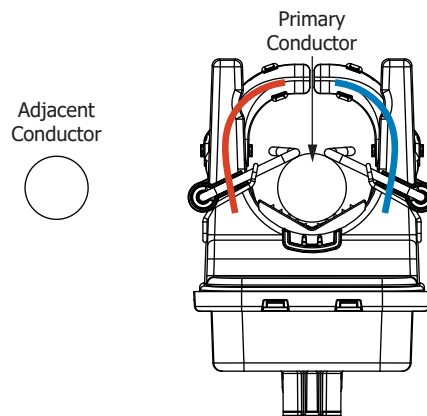


Figure B.6 Adjacent Conductor and Primary Conductor to UGFI

Reset and Arming Requirements

The UGFI features 11 reset options for clearing the fault indication. These are variations of three primary reset methods: current reset, timed reset, and timed reset with current reset override.

NOTE

All timed resets offer duration choices of 2, 4, 8, and 12 hr.

Current Reset

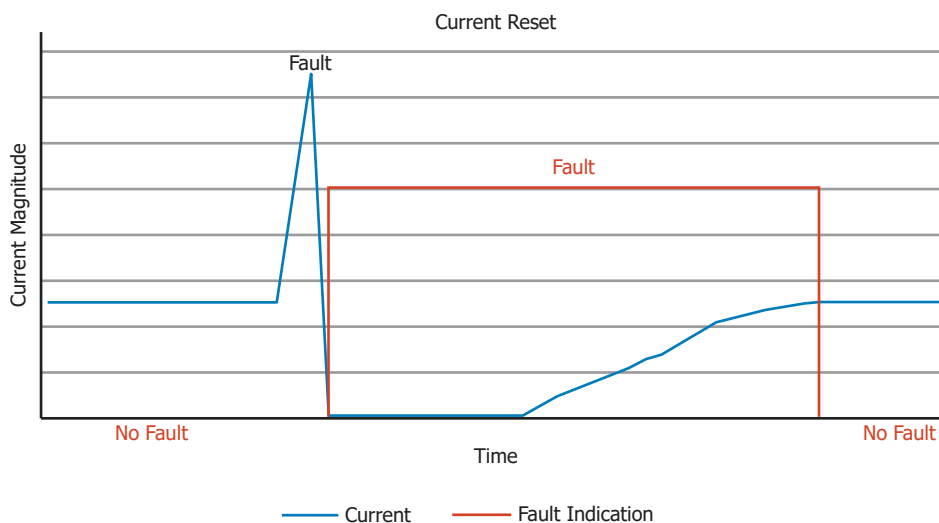


Figure B.7 Current Reset

UGFI configurations with the current reset capability automatically reset the indicator in 10 min or less after the restoration of load current to above the minimum current sensitivity.

The current reset only option is not available on LED units, because the LED option requires constant power and current reset does not include defined lengths of time for power storage.

The UGFI with the current reset option automatically resets when system load is restored. Upon re-energization of lines with 1 A of load current, it can take as long as 10 min for the UGFI to reset. When load current is higher than 5 A, the UGFI resets in less than a minute.

Timed Reset

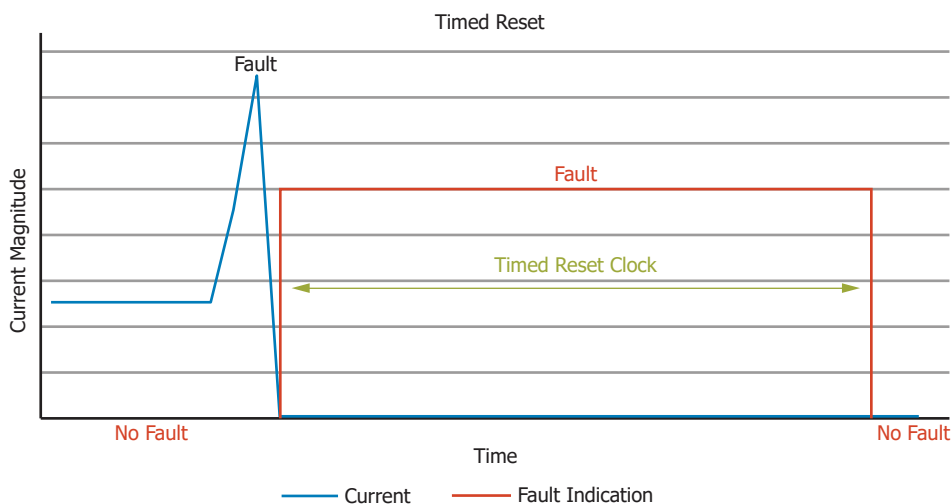


Figure B.8 Timed Reset

NOTE

For junction box applications, use only the timed reset option to prevent false resets.

The UGFIs with the timed reset option use an internal timer to determine when the fault indication expires after a trip has occurred. The internal timer has an accuracy range within ± 5 percent (e.g., 4 hr timed reset duration = 4 hr ± 12 min). The device requires a minimum of 15 A to continuously charge the timed reset option. Refer to the part number or the ordering specifications to determine the value of the timed reset duration setting.

The timed reset options are as follows:

- 2 hr
- 4 hr
- 8 hr
- 12 hr

Timed Reset With Current Reset Override

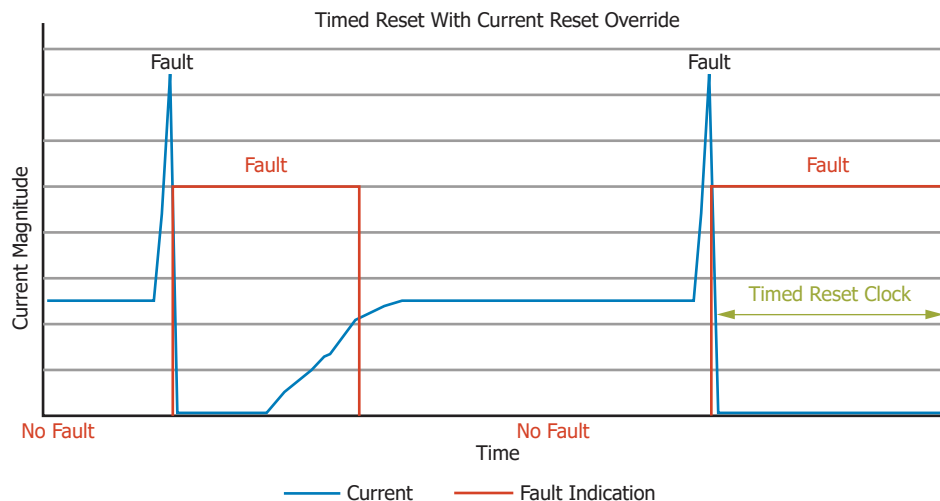


Figure B.9 Timed Reset With Current Reset Override

The timed reset with current reset override option available in the UGFI automatically resets the device with either load current or when the timer/counter expires. When a fault occurs, the UGFI triggers a countdown. If the current returns to normal, the fault indication is automatically cleared and the timer stopped. However, if the current is not restored and the countdown expires, the device automatically resets itself according to the internal timed reset period.

Timed Reset Charging Curves

The UGFI stores charge when load current is available. To initiate the charging process, a minimum load current of 15 A is required. The accompanying graphs provide a detailed illustration of the typical charging times at various load currents.

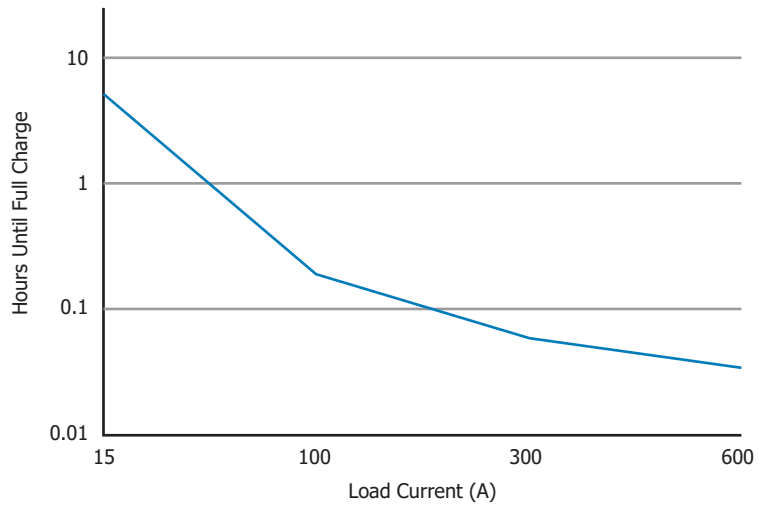


Figure B.10 2-Hour Timed Reset Charging Curve

For the 2-hour timed reset option, a different charge curve is used compared to those used for the 4-hour, 8-hour, and 12-hour timed reset options. The charging time does not influence the trip response of the UGFI. Instead, it affects the capability to execute the timed reset feature.

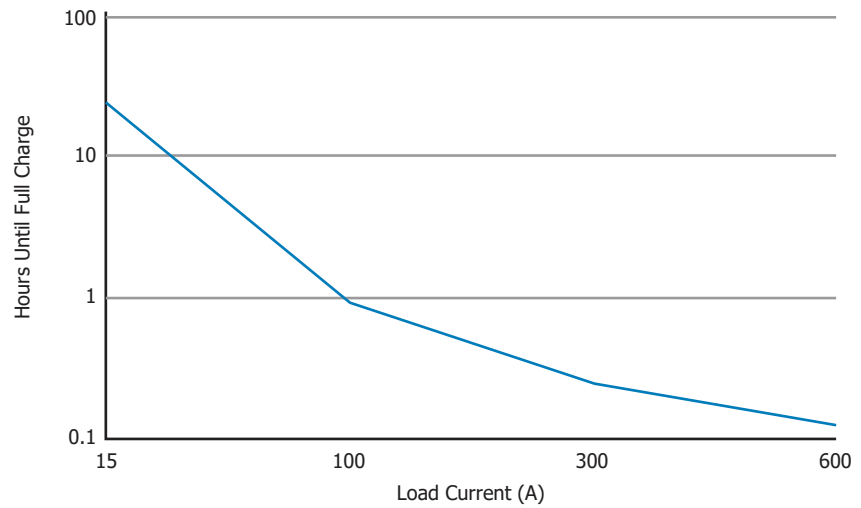


Figure B.11 4-, 8-, and 12-Hour Timed Reset Charging Curve

NOTE

For UGFIs ordered as timed reset with current reset override, the current reset occurs regardless of the device charge.

Indicator Behavior

Fiber-Optic LED Indicator

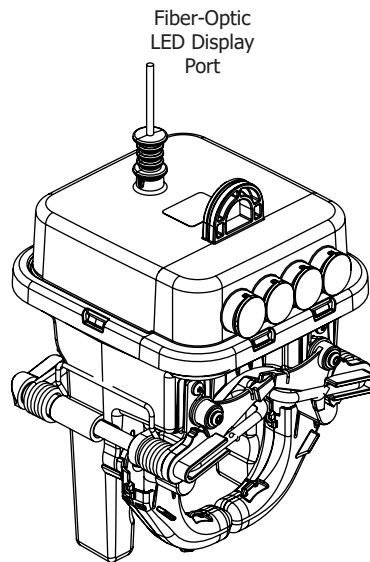


Figure B.12 Fiber-Optic LED Indicator

Some applications benefit from fault indication in the form of LEDs or fiber-optic indicators. As with remote target indicators, these remote fiber-optic indicators allow the LED indicator to be visible from the exterior of pad-mounted equipment in which the UGFIs are installed. During fault conditions, the UGFI activates a red LED with a single blink every 2 s to indicate the presence of a fault.

Mechanical Target



Figure B.13 Built-In Mechanical Target

The UGFIs with a built-in mechanical target provide a clear indication of the fault detection status on the system. A red target is indicated when a fault is detected, and the mechanical target remains activated until the device undergoes a reset (refer to *Reset and Arming Requirements* on page 28 for further details).

Auxiliary Contact

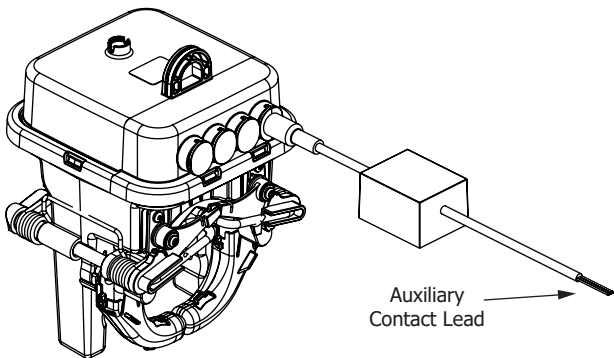
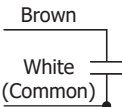
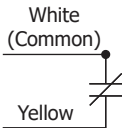


Figure B.14 Auxiliary Contact Output

You can configure the UGFI with an auxiliary contact for relays. The Form C auxiliary contact can connect directly to an IED or a protective relay by using the lead from the UGFI (see *Figure B.14*). The auxiliary contacts has a standard 6 ft initial length with an option to be ordered with 6 ft, 12 ft, 20 ft, or 30 ft cable lengths. The UGFI auxiliary contact has three wire outputs, detailed in *Table B.3*, in the following colors: brown, white, and yellow. The white output is the common conductor for both contacts.

Table B.3 Auxiliary Contact Diagram

Wires in I/O Cable	Contact Type	Contact State	
		Asserted	Deasserted
	Normally Open (N.O.)	Closed	Open
	Normally Closed (N.C.)	Open	Closed

See *Specifications* on page 4 for UGFI auxiliary contact ratings.

RadioRANGER System



Figure B.15 Attached RadioRANGER Probe

To use the RadioRANGER for wireless fault indication, order the RadioRANGER feature when configuring the UGFI. If the UGFI has a RadioRANGER probe as shown in *Figure B.15*, the device can connect and indicate a fault to the RadioRANGER that can wirelessly communicate to a handheld remote that a fault event has occurred.



Figure B.16 RadioRANGER Connected to UGFI

As shown in *Figure B.16*, connect the probe to one of the ports on the RadioRANGER interface. In the event of a fault, the RadioRANGER wirelessly communicates the trip status message to the Remote Fault Reader (SEL-8300 and or SEL-8310 [sold separately]).



SCHWEITZER ENGINEERING LABORATORIES, INC.

2350 NE Hopkins Court • Pullman, WA 99163-5603 U.S.A.
Phone: +1.509.332.1890 • Fax: +1.509.332.7990
selinc.com • info@selinc.com