Overhead AutoRANGER® (AR-OH/AR360) Instruction Manual

AR-OH

AR360

Overview

The SEL Overhead AutoRANGER® (AR-OH/AR360) faulted circuit indicator (FCI) directs utility personnel to the faulted line section of an overhead distribution circuit. The FCI indicates passage of fault current through the line on which it is installed and uses flashing light-emitting diodes (LEDs) to provide distinct indication of momentary versus permanent fault conditions.

The Overhead AutoRANGER can adapt to different system applications by dynamically changing its trip threshold according to measured line current.

The SEL Overhead AutoRANGER improves distribution circuit reliability by allowing crews to locate faults and isolate faulted sections faster than with such traditional methods as refusing and sectionalizing or detailed patrols of the whole system. The practice of refusing and sectionalizing exposes utility equipment such as transformers, fuses, and conductors to high levels of damaging current. By decreasing the time crews spend patrolling a circuit, the Overhead AutoRANGER reduces crew exposure to unsafe situations and reduces labor and costs associated with power system downtime. This results in fewer and shorter outages for electricity customers and less lost revenue for electricity providers.

SEL AR-OH and AR360 fault indicators can lead line crews directly to the faulted circuit section of a line. System troubleshooters will find that the faulted section of line is between the last tripped indicator and the first reset indicator, as *Figure 1* shows.

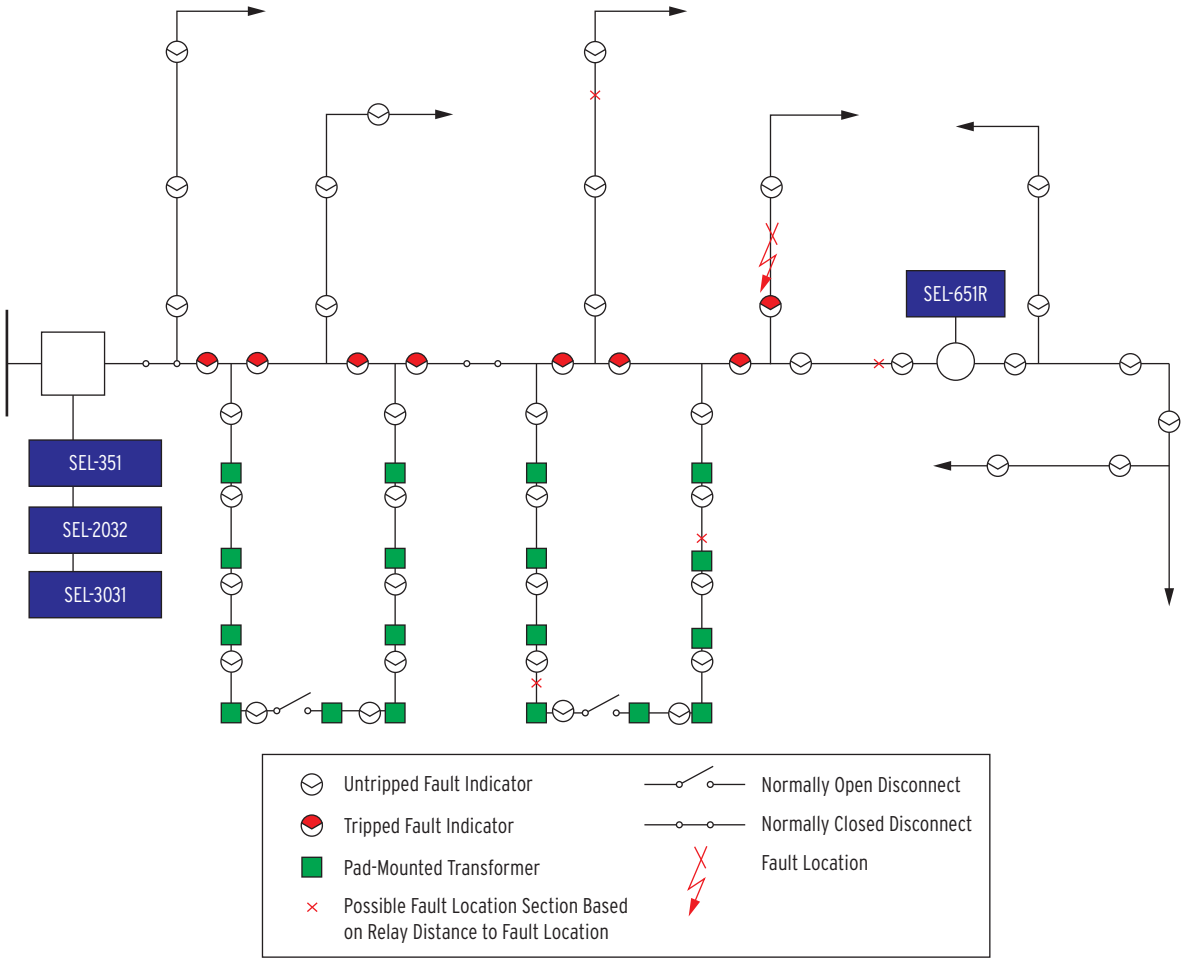


Figure 1 Example of a Distribution System With SEL Overhead AutoRANGER FCIs

Physical Design

Housing

The design of the AR-OH and AR360 allows them to be installed through use of a single hot stick. The housing material is UV-stabilized polycarbonate. The housing for the AR-OH is translucent, to allow internal LEDs to shine through to indicate a fault condition. The metal components attached to the FCI housing are stainless steel. The spring clamp (see *Figure 2* and *Figure 3*) is designed to prevent mechanical shock, wind, or vibration removing the FCI from an overhead conductor. The AR-OH and AR360 are applicable on a wide range of conductors with outer diameters from 0.162 inches to 1.5 inches (4.06 mm to 38.1 mm).

The AR-OH and AR360 operate from –40° to +185°F (–40° to +85°C) and are designed to meet the IEEE 495 standard.

Figure 2 AR-OH Spring Clamp

Figure 3 AR360 Spring Clamp

Dimensions

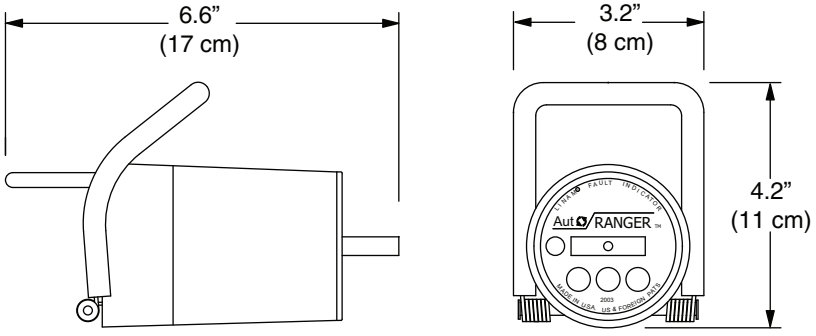


Figure 4 AR-OH Dimensions

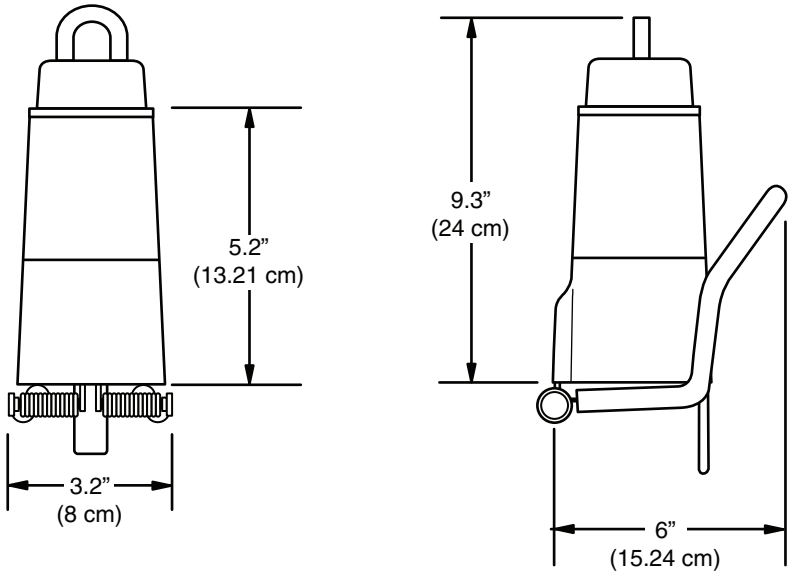


Figure 5 AR360 Dimensions

Current Detect

The AR-OH and AR360 have an open core current transformer (see *Figure 2* and *Figure 3*) to sense the load current of the conductor.

Voltage Detect

The black conductive sleeve on the spring clamp (see *Figure 2* and *Figure 3*) makes direct contact with the line, senses line voltage, and passes this information to the circuit for detecting system voltage. The AR-OH and AR360 can detect voltages as low as 2.4 kV (L-G).

Photo Sensor

The AR-OH and AR360 both have a photo sensor that detects ambient light and sets the display flashing pattern to day or night mode. The photo sensors are shown in *Figure 6* and *Figure 7*.

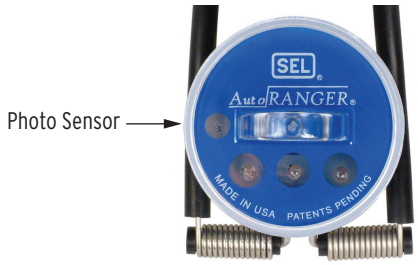


Figure 6 Photo Sensor in AR-OH

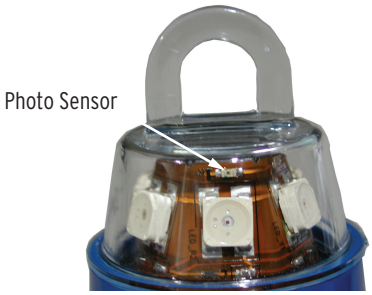


Figure 7 Photo Sensor in AR360

Display

The AR-OH display has four red LEDs and one amber LED. The amber LED is in the middle of the display, while two red LEDs are on the edge of the front face. Two additional red LEDs are inside the housing to illuminate the device body and provide 360-degree visibility in low ambient conditions.

The AR360 display has six high-intensity wide-angle LEDs around the hexagonal face. Three of these LEDs are amber, and three are red. Paired arrangement of these LEDs provides 360-degree visibility.

Reed Switch

The AR-OH and AR360 both have a reed switch by which service personnel can reset a flashing unit, set all values to default, or monitor the embedded battery status by activating the LED display. Activate the reed switch through use of a CRSRTT magnet tool.

Power Supply

Power for the AR-OH comes from a 3.6 V, 8.5 Ah capacity lithium cell with a shelf life of 20 years.

Power for the AR360 comes from a 3.6 V, 17 Ah capacity lithium cell with a shelf life of 20 years. The battery will provide 1800+ hours of LED flashing time.

Operation

Arming Requirements

NOTE: The AR-OH and AR360 must detect voltage to be armed. Without properly detecting voltage, the devices will be unarmed and will not respond to future fault events.

The AR-OH and AR360 have both minimum current and voltage requirements to enable fault detection, autoranging and inrush restraint functionality. For the AR-OH and AR360 to arm, the units need to detect a minimum of 10 A and a minimum of 2.4 kV (L-G) continuously for two minutes. If the device detects voltage but no current, the device looks for system voltage for five minutes continuously and goes into voltage only mode (see *Lightly Loaded Circuits (I < 10 A) on page 7*).

AutoRANGER

By measuring normal load current, the AR-OH and AR360 automatically select, or autorange, to one of eight distinct trip thresholds. Autoranging logic is such that the unit can range up or down one trip threshold at a time. When armed, the FCI autoranges periodically. The autoranging period (T_{AR}) is 30 seconds. Each trip threshold has an associated range of load current (see *Table 1*).

The unit measures system load current (I_{LOAD}) while autoranging. Based on this measurement, the FCI either remains at its existing trip threshold or autoranges to a different trip threshold. This feature enables the FCI to handle variable loads, including seasonal and time-of-day fluctuations.

Table 1 Trip Thresholds for Measured Load Current Ranges

Trip Threshold (A)	$I_{LOAD,min}$ (A)	$I_{LOAD,max}$ (A)
50	10	25
100	16.1	50
200	34.5	100
400	73.9	200
600	158.5	300
800	247.6	400
1000	339.7	500
1200	434.2	600

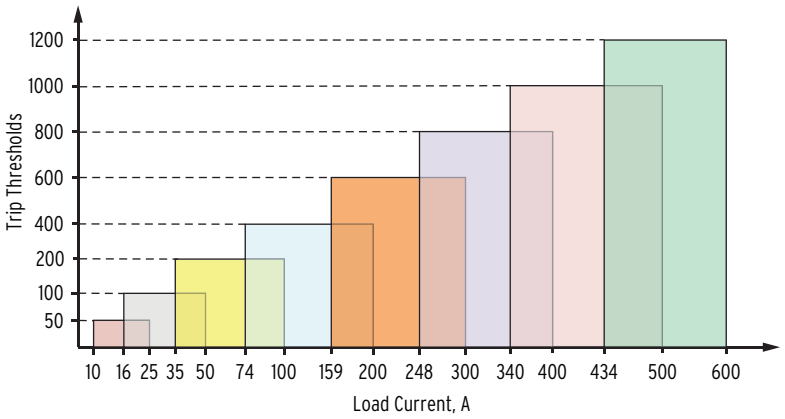


Figure 8 Self-Configured Trip Threshold as a Function of Load Current (Not to Scale)

The load current ranges overlap for each fault trip threshold, as *Figure 8* shows. This provides hysteresis to the autoranging algorithm and minimizes oscillations between trip thresholds.

Figure 9 illustrates how overlapping load current cutoffs for adjacent trip thresholds stabilize the AutoRANGER logic, allowing the FCI to remain at the same trip threshold when current fluctuates.

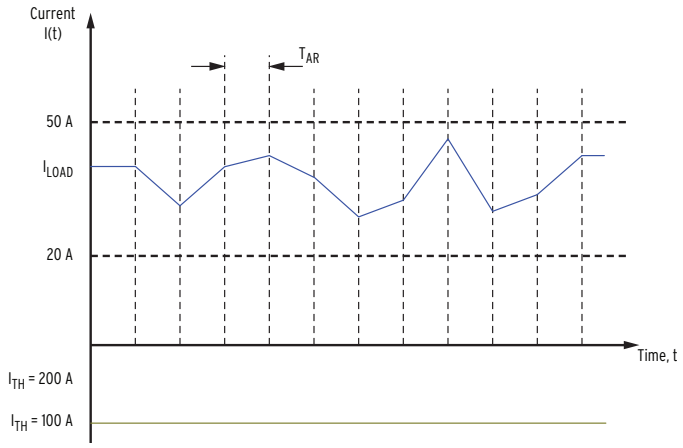


Figure 9 Stable Autoranging Algorithm

The fault thresholds are calibrated for an outside mounting diameter of 0.75" at +25°C. The fault magnitude necessary to exceed the calculated trip threshold will increase with larger mounting diameters and decrease with smaller mounting diameters.

Rampdown Restraint™

The AR-OH and AR360 employ a Rampdown Restraint™ algorithm that prevents the indicator from selecting a lower trip threshold when the circuit is locked out. The unit will not autorange down if the device detects less than 10 A, or if the unit does not sense voltage for more than five minutes.

For example, a unit is installed on a conductor with 425 A of load current, and the unit will autorange to a 1000 A trip threshold. If the system is reconfigured to have 15 A of load at this location, the unit will rampdown one trip threshold at a time till it reaches the appropriate trip threshold of 50 A. It waits for one autorange period (T_{AR} = 30 seconds) to perform its first range down of one trip threshold to 800 A. After another T_{AR} period, it goes down to a 600 A trip threshold and so on until it reaches the correct calculated trip threshold. The unit performs in a similar manner if load current is changed from 15 A to 425 A.

Fault Detection

The AR-OH and AR360 must be armed to enable fault detection (see *Arming Requirements on page 5*). The AR-OH and AR360 monitor instantaneous current on the conductors upon which they are mounted. There are two requirements for the units to detect a fault condition. First, the fault current magnitude must exceed the self-configured trip threshold. Second, the current must exceed the trip threshold for three half cycles (24 ms at 60 Hz). The unit will count each half cycle that is above the trip threshold within 20 ms of the previous registered half cycle above the trip threshold. If the unit does not detect current above the trip threshold within 20 ms of the previous half cycle, then the counter is reset.

Inrush Restraint (IR)

A fault indicator applied on a circuit that uses a reclosing scheme should be immune to inrush currents occurring during reclose attempts. Reclosing operations could falsely trip indicators installed on non-faulted line sections if these indicators lack an inrush restraint (IR) feature. The AR-OH and AR360 are equipped with two inrush restraint activation means: loss-of-voltage activated IR and loss-of-current activated IR.

Any time the measured system current drops below 10 A for 100 ms (nominal), the indicator enters the loss-of-current activated inrush restraint (CIR) mode. The FCI then enters a lockout for three minutes, rendering itself insensitive to any events, including current inrush followed by the reclosing operation. If the measured system voltage drops below 2.3 kV (L-G) for 100 ms (nominal), the indicator enters the loss-of-voltage inrush restraint (VIR) mode for three minutes.

Figure 10 shows an example of a momentary loss of current followed by a recloser event. The current inrush on the recloser event exceeds the trip threshold, but the FCI is in the IR mode and does not indicate a fault.

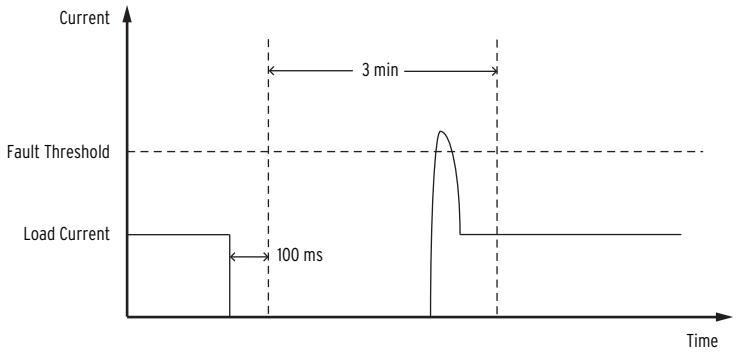


Figure 10 Inrush Restraint (IR) Example

TR (TV)™

NOTE: The TR (TV) feature is applicable on AR-OH or AR360 models ordered with a four-hour permanent fault reset time-out.

Timed reset as a function of trip threshold is a feature that automatically sets the time-out period for permanent faults at eight hours if the trip threshold is either 50 A or 100 A. This feature provides service personnel more time to locate faults located at ends of feeder applications or in rural areas.

Lightly Loaded Circuits (I < 10 A)

When the AR-OH or the AR360 is applied on a lightly loaded circuit on which nominal load current is less than 10 A, some of its operational characteristics change. This can occur in two scenarios: out-of-the-box installation and when load current normally above 10 A drops below this current threshold.

Upon installation the units will monitor continuous voltage and current for two minutes. When load current is below 10 A, the units will monitor continuous voltage for another three minutes. After five minutes of sampling voltage, the units will enter into voltage-only mode and configure a trip threshold of 50 A.

When the units are on a live line and load current drops below 10 A, the units will immediately enter a loss-of-current inrush restraint (CIR) mode. After the three-minute lockout, the units will monitor continuous voltage and current for two minutes. If load current is below 10 A, the units monitor continuous voltage for another three minutes. After five minutes of sampling voltage, the units will enter into voltage-only mode and configure a trip threshold of 50 A.

While in this voltage-only mode, the AR-OH and AR360 are unable to distinguish between momentary and permanent faults. Subsequently, if a fault is detected, the units will flash for eight hours in Permanent Fault Mode as *Figure 12* and *Figure 15* show.

Reed Switch

The AR-OH and AR360 have a reed switch with which a user can reset a flashing unit (either permanent or momentary mode flashing) and monitor the embedded battery status. The CRSRTT tool (*Figure 17*) is used to open and close the switch. This tool closes the switch only if applied to a certain location on the devices, as *Figure 18* and *Figure 19* show. To reset a flashing unit or to check battery status, apply the CRSRTT as described in *Test Activation and Manual Reset on page 13*.

Display

The AR-OH and AR360 each have their own unique display. They both have amber and red LEDs to distinguish between permanent faults and momentary faults, respectively. For momentary faults, only the amber LED(s) flash(es). For permanent faults, the AR360 uses both red and amber LEDs to indicate a fault, while the AR-OH only uses the red LEDs. When these LEDs flash to indicate a fault, they follow a certain pattern or sequence. *Figure 11–Figure 15* show these patterns.

AR-OH

Momentary Flash Mode

When the unit detects a momentary fault, a single amber LED flashes twice every three seconds.

Figure 11 AR-OH Momentary Fault Display

Permanent Flash Mode

When the unit detects a permanent fault, two red LEDs flashes three times every three seconds.

Figure 12 AR-OH Permanent Fault Display

Low Ambient Light Mode

When the unit photosensor detects low ambient light and a permanent fault has been detected, the unit flashes two LEDs inside the translucent housing in conjunction with the two red LEDs on the face of the unit.

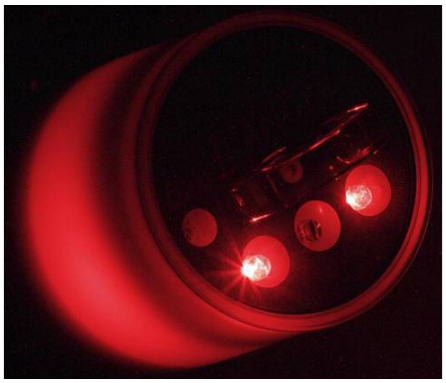


Figure 13 AR-OH Low Ambient Light Permanent Fault Display

AR360

Momentary Flash Mode

When the unit detects a momentary fault, the three amber LEDs flash simultaneously three times every three seconds.

Figure 14 AR360 Momentary Fault Display

Permanent Flash Mode

When the unit detects a permanent fault, the three amber LEDs and the three red LEDs flash in a 360-degree rotating sequence three times every second.

Figure 15 AR360 Permanent Fault Display

Installation

⚠DANGER
Install fault indicators and sensors in accordance with normal safe operating procedures. These instructions are not intended to replace or supersede existing safety or operating requirements. Only trained qualified personnel with knowledge of high voltage safety should install or operate fault indicators and sensors.

Read and understand all instructions in their entirety before installing any fault indicators. Use a single hot stick to grasp the hookeye on the face of either the AR-OH or AR360 and install the FCI on an overhead conductor. The AR-OH and AR360 can be installed on overhead conductors with diameters between 0.162" and 1.50" (4.06 mm to 38.1 mm).

The AR-OH and AR360 must be installed as shown in *Figure 16*. Additionally, the units should not be installed in a manner that would allow the product surface to reduce the insulating air gap sufficiently to initiate a flashover.

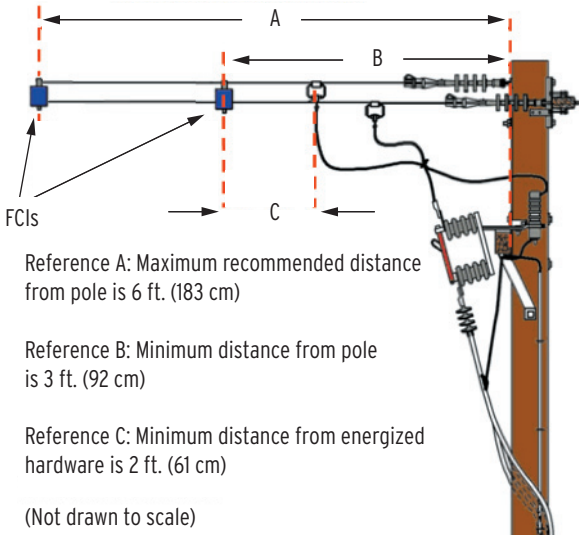
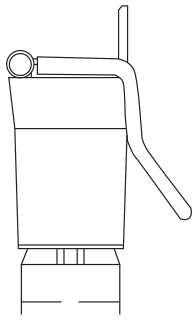


Figure 16 Proper Overhead FCI Installation

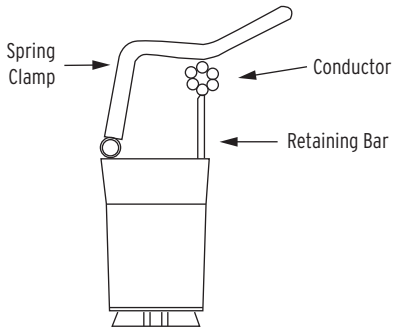
AR-OH Installation

The AR-OH can be applied on 4.16 kV to 69 kV (L-L) circuits.

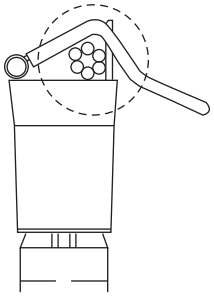
Step 1. Use a hot stick to grasp the molded hookeye on the face of the indicator.



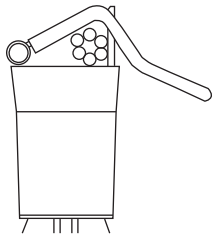
Step 2. Position the spring clamp against the conductor and retaining bar.



Step 3. Position the indicator so that the conductor is against the retaining bar and held by the spring clamp.



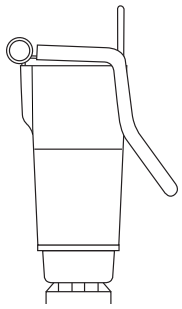
Step 4. Release the hot stick.



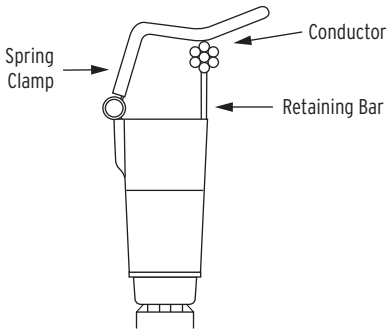
AR360 Installation

The AR360 can be applied on 4.16 kV to 34.5 kV (L-L) circuits.

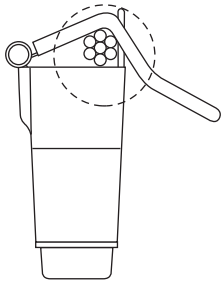
Step 1. Use a hot stick to grasp the molded hookeye on the face of the indicator.



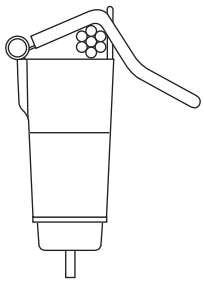
Step 2. Position the spring clamp against the conductor and retaining bar.



Step 3. Position the indicator so that the conductor is against the retaining bar and held by the spring clamp.



Step 4. Release the hot stick.



Test Activation and Manual Reset

The test-activation feature of the AR-OH and AR360 allows you to verify that the fault indicator battery is still operational. Use the test tool (SEL part number CRSRTT, *Figure 17*) for field testing the AR-OH and AR360.

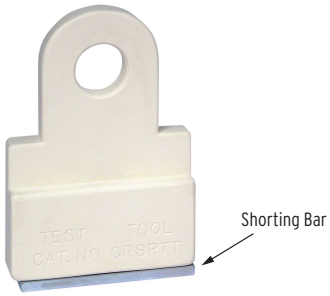


Figure 17 CRSRTT Tool With Shorting Bar

You can also use the CRSRTT tool to manually reset the AR-OH and AR360 instead of waiting for the completion of a time-out period.

Test Activation/ Manual Reset

AR-OH

To test activate or to clear the flash sequence of an AR-OH, use a CRSRTT tool.

Step 1. Remove the shorting bar from the CRSRTT tool to expose the magnet.

Step 2. Position the exposed magnet directly onto the AutoRANGER logo on the face of the FCI, holding the tool parallel to the label (*Figure 18*).

Step 3. Maintain contact between the magnet and the AutoRANGER logo for six to eight seconds, and then remove the tool.

Step 4. Verify that the AR-OH cycle flash sequence is as shown in *Figure 11* and *Figure 12*, demonstrating its activation/clearing.

The red LEDs repeat several three-flash sequences. The amber LED repeats several two-flash sequences.

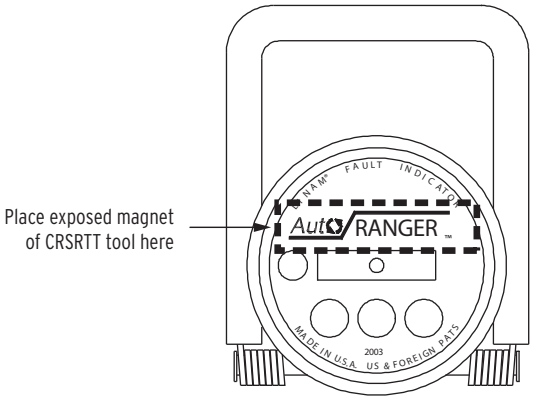


Figure 18 Placement of CRSRTT Tool on AR-OH

Step 5. Replace the shorting bar to the CRSRTT tool for storage.

AR360

To test activate or to clear the flash sequence of an AR360, use a CRSRTT tool.

Step 1. Remove the shorting bar from the CRSRTT tool to expose the magnet.

Step 2. Position the exposed magnet directly onto the AR360 logo on the side of the FCI housing, holding the tool parallel to the label.

Step 3. Maintain contact between the magnet and the AR360 logo for six to eight seconds and then remove the tool.

Step 4. Verify that the AR360 cycle flash sequence is as shown in *Figure 14* and *Figure 15*, demonstrating its activation/clearing.

The red and yellow LEDs repeat the permanent fault sequence for 40 seconds. The amber LEDs repeat single-flash sequences for 20 seconds. The unit then turns the display off automatically.

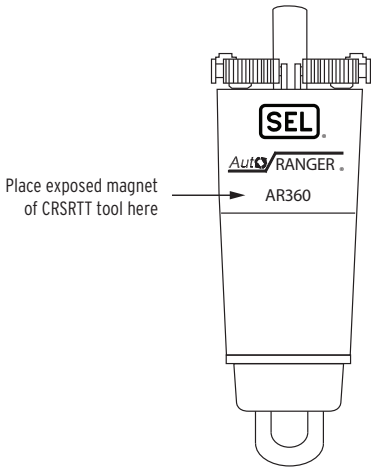


Figure 19 Placement of CRSRTT Tool on AR360

Step 5. Replace the shorting bar to the CRSRTT tool for storage.

Battery Safety

⚠CAUTION
This product is shipped with or contains a lithium metal cell. Lithium metal cells and batteries may present a risk of fire or explosion. Do not short circuit, recharge, puncture, incinerate, crush, drop, disassemble, immerse, or incorrectly install lithium metal cells or batteries. Do not expose lithium metal cells or batteries to temperatures that are above the declared operating temperature range of this product. This product must be disposed of in accordance with all applicable rules, laws, and regulations, such as EPA's Universal Waste Rule, the EU Batteries Directive and other local rules.

This product is shipped with or contains a lithium metal cell. Lithium metal cells are often classified as dangerous goods by dangerous goods shipment regulations. These regulations along with your package carrier specify the packaging and labeling to be used, along with the information to be provided when shipping dangerous goods. This product must be transported in accordance with all applicable rules, laws, and regulations, such as the rules published by the Pipeline and Hazardous Materials Safety Administration; the International Civil Aviation Organization; the International Air Transport Association; the Maritime Dangerous Goods Code; the UN Model Regulations on the Transport of Dangerous Goods and rules for inland, waterways, road and rail transportation, and others. Please consult any applicable regulations and your package carrier for proper handling of this product.

Specifications

AR-OH

Range of Trip Thresholds:	50 to 1200 A
System Voltage Range (P-P):	4.16 to 69 kV
Battery:	3.6 V high-capacity 8.5 Ah lithium battery with a 20-year shelf life
Approximate Weight:	600 g (1.30 lbs.)
Temperature Range:	–40° to +85°C (–40° to +185°F)
Number of Phases:	1
Minimum Load Current:	10 A (for currents below 10 A, device automatically uses voltage to determine system status)
Outer Clamping Diameter:	0.16" to 1.50" (4.06 mm to 38.1 mm)
Housing Material:	UV-stabilized polycarbonate resin
Clamp Material:	Stainless steel clamp with a UV-stabilized rubber sleeve

Canada ICES-001 (A) / NMB-001 (A)

AR360

Range of Trip Thresholds:	50 to 1200 A
System Voltage Range (P-P):	4.16 to 34. 5 kV
Battery:	3.6 V high-capacity 17 Ah lithium battery with a 20-year shelf life
Approximate Weight:	840 g (1.85 lbs.)
Temperature Range:	–40° to +85°C (–40° to +185°F)
Number of Phases:	1
Minimum Load Current:	10 A (for currents below 10 A, device automatically uses voltage to determine system status)
Outer Clamping Diameter:	0.16" to 1.50" (4.06 mm to 38.1 mm)
Housing Material:	UV-stabilized polycarbonate resin
Clamp Material:	Stainless steel clamp with a UV-stabilized rubber sleeve

Canada ICES-001 (A) / NMB-001 (A)

Factory Assistance

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

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Tel: +1.509.338.3838
Fax: +1.509.332.7990
Internet: selinc.com/support
Email: info@selinc.com

⚠DANGER
Contact with instrument terminals can cause electrical shock that can result in injury or death.

⚠WARNING
Operator safety may be impaired if the device is used in a manner not specified by SEL.

⚠CAUTION
Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.

⚠CAUTION
Class 1 LASER Product. This product uses visible or invisible LASERs based on model option. Looking into optical connections, fiber ends, or bulkhead connections can result in hazardous radiation exposure.

⚠DANGER
Tout contact avec les bornes de raccordement de l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.

⚠AVERTISSEMENT
La sécurité de l'opérateur peut être compromise si l'appareil est utilisé d'une façon non indiquée par SEL.

⚠ATTENTION
Les composants de cet équipement sont sensibles aux décharges électrostatiques (DES). Des dommages permanents non-décelables peuvent résulter de l'absence de précautions contre les DES. Raccordez-vous correctement à la terre, ainsi que la surface de travail et l'appareil avant d'en retirer un panneau. Si vous n'êtes pas équipés pour travailler avec ce type de composants, contacter SEL afin de retourner l'appareil pour un service en usine.

⚠ATTENTION
Produit LASER de Classe 1. Ce produit utilise des LASERS visibles ou invisibles dépendant des options du modèle. Regarder vers les connecteurs optiques, les extrémités des fibres ou les connecteurs de cloison peut entraîner une exposition à des rayonnements dangereux.

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