Faulted circuit indicators

Catalog information

Powering Business Worldwide

Faulted circuit indicators catalog contents

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Faulted circuit indicator application guide

General

Fault indicators are devices which indicate the passage of fault current. When properly applied, they can reduce operating costs and reduce service interruptions by identifying the section of cable that has failed. At the same time, fault indicators can increase safety and reduce equipment damage by reducing the need for hazardous fault chasing procedures. To provide the greatest benefit, the fault indicator must indicate reliably when fault current passes through the cable to which the fault indicator is mounted. Misapplication or improper selection of the fault indicator can reduce reliability.

Figure 1 illustrates a typical looped underground distribution system. The underground cable is looped into and out of each transformer to the open point. Typically one fault indicator is placed on each incoming phase of the transformer. Figure 1 shows the fault indicator target position after a cable fault caused the tap fuse to operate. If the line is followed from the source, the fault would be located between the last tripped indicator and the first non-tripped (normal) indicator. Visual inspection of the fault indicator eliminates the need for trial and error sectionalizing of the system, thus reducing service restoration time.

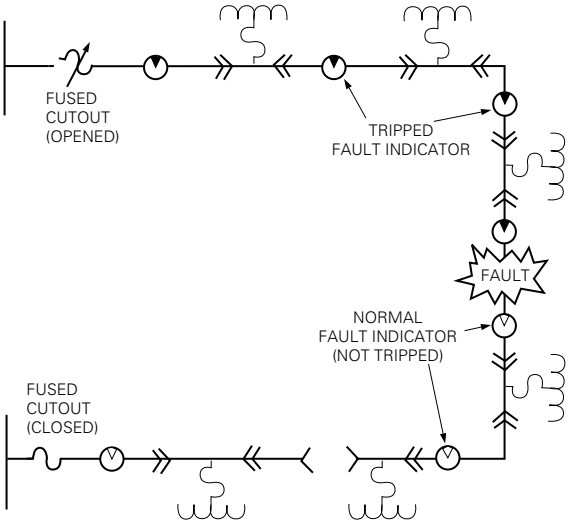

Figure 1. Typical looped underground system application.

Figure 2 illustrates a typical overhead application with a main sectionalizing fuse and unfused laterals. With a fault indicator on each lateral, the lateral on which the fault is located can easily be determined. This saves time in locating the fault, especially on lines located on terrain that makes visual inspection of the line difficult (i.e. swamps, wooded areas, mountain terrain).

Fault indicators can be installed on transformers, switchgear, sectionalizing cabinets, bushing terminators, overhead lines and underground cable. The quantity and location of the fault indicators should be sufficient to eliminate the need for the sectionalizing fault chasing method.

Overview of fault indicators

Eaton offers a wide variety of fault indicators ranging from basic circuitry models in the delayed reset style to the more sophisticated circuitry of the test point reset and electrostatic reset types. Eaton offers five basic types of FCIs in its Cooper Power™ series S.T.A.R.™ faulted circuit indicator product line and each unit is tailored to be the most reliable for the intended application. Each type varies by reset method and the type of system it connects to.

All S.T.A.R. faulted circuit indicators reset automatically upon restoration of system power or after a predetermined time period. Automatic resetting fault indicators sense either voltage or current to determine that power has been restored to the system. The units then reset to the normal position to eliminate the need for line personnel to manually reset the units. This saves time, money and makes the fault indication more reliable.

Table 1 shows an overview of Eaton's faulted circuit indicator product line. It shows the fault indicator types based on reset method and lists the typical system application, physical mounting location and resetting requirements for each type.

Test point reset faulted circuit indicators are mounted to the test point of cable terminators (loadbreak elbows, deadbreak elbows, etc.). They are economical and simple to apply on underground distribution systems. Test point reset fault indicators require no special cable preparation in order to install and fit all major manufacturers voltage test points.

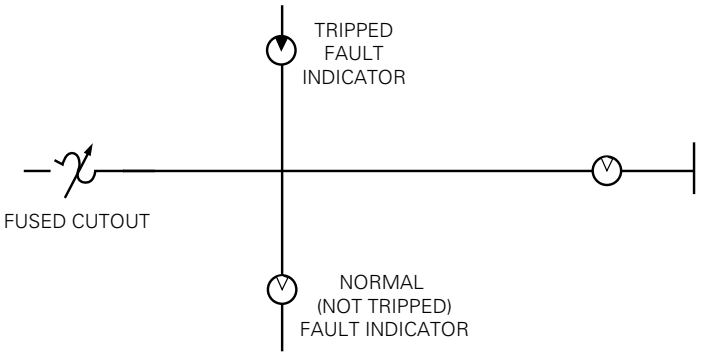

Figure 2. Typical overhead application.

Table 1. Faulted Circuit Indicators

Type Description	Typical System Application	Physical Mounting Location	Voltage/Current Requirements
Test Point Reset	Underground	On the test point of the connector	Min 5 kV L-G
Low-Voltage Reset	Underground	On the URD shielded cable below the connector	A secondary voltage source (min. 105 volts)
Electrostatic Reset	Overhead	On bare or insulated non-shielded cable	Min. 6.9 kV L-G
Current Reset	Underground	On the URD shielded cable below the connector	Min. 2.4 A continuous
	and Overhead	and on bare or insulated non-shielded cable.	
Delayed Reset	Underground	On the URD shielded cable below the connector	None (Lithium Ion battery powered with timed reset)
	and Overhead	and on bare or insulated non-shielded cable	

Low voltage reset faulted circuit indicators are commonly used on underground systems where a voltage test point is not available on the cable terminator. It utilizes the secondary voltage provided by a distribution transformer to power the device. This fault indicator is ideal for single-phase pad-mounted transformers where a secondary voltage source is readily available.

Electrostatic reset faulted circuit indicators are powered and reset by the electrostatic field surrounding a bare or insulated, non-shielded conductor. These fault indicators are ideal for overhead distribution systems. A minimum line-to-ground voltage of 6.9 kV is sufficient to produce the potential gradient needed to power the device.

Current reset faulted circuit indicators can be applied on systems where a voltage source is not readily available. A minimum continuous load current of 2.4 A must be present to power the fault indicator. Current reset fault indicators can be applied to either underground or overhead systems, provided the cable shield does not allow a return path for current to pass through the FCI sensor area.

Delayed reset faulted circuit Indicators automatically reset back to the normal position when reset time has expired. They can also be reset with a manual testing/reset tool. This economical unit is ideally suitable for temporary use as a testing tool, since it does not contain all the standard features of the rest of the S.T.A.R. line. The unit is powered by a long lasting, lithium ion battery that provides the power to indicate the faulted conditions via a high intensity LED display.

Fault indicator reliability

Eaton's faulted circuit indicators result in reliable operation when applied properly. To select a reliable fault indicator, one must consider the various operating conditions that can affect operation.

Reliability can have many different meanings. For some, fault indicator reliability means that the fault indicator operates every time a fault occurs on the distribution circuit. However, fault indicators may operate erroneously when not applied properly. A better definition of fault indicator reliability is that the faulted circuit indicators show proper indication each time they operate. This means that the units may only operate 95% of the time, but that the fault indicators will operate correctly each time they operate. Most operations personnel would agree that FCI misoperation causes more problems than FCI non-operation.

Eaton has been providing fault indicators to the utility market in its Cooper Power series product line for over 20 years. Experience shows that in order to achieve reliable indication, the proper fault indicator, with the appropriate features must be applied to the distribution system. In many cases, customers reporting inaccurate operation of fault indicators are applying a fault indicator that does not have the proper features for the application. Furthermore, the primary reason for the wrong fault indicator being used was the fact that the utility had such a large variety of units that line personnel became confused as to the proper FCI to use for a given application.

A project began in 1991 to better understand what system variables can affect fault indicator operation. The goal of the study was to determine why fault indicators misoperate and how to correct the problems. In conjunction with a major customer, several underground distribution circuits, where known problems existed, were modeled. What was found provided a better understanding of what features should be standard on all faulted circuit indicators.

System conditions that affect FCI operation

Inrush current

Inrush currents can occur any time an electrical distribution system is energized. Inrush currents can exceed normal load currents by 12 to 60 times the normal load current. These higher than normal currents can falsely trip a faulted circuit indicator since fault indicators are typically peak sensing devices. Fortunately, system energization occurs in two distinct instances. The first being when the system has been without power for an extended period of time and the second being during a recloser operation.

If an automatic resetting faulted circuit indicator is being used, initial system energization will not affect the FCI indication, because the FCI will automatically reset to the normal position if the system remains energized.

The vast majority of FCI inrush operations are due to recloser operations. On most distribution systems, a reclosing device is almost always present somewhere on the system, either at the substation or further out on the feeder circuit. In the case of three-phase applications, recloser operation can cause tripping of fault indicators on phases not involved in the fault. The best method for dealing with inrush due to recloser operations is to inhibit the trip circuit following a momentary interruption of service. Fault indicators equipped with inrush restraint, will sense the momentary service interruption and keep the fault indicators in the normal position (see Fault Indicator Inrush Operation on page 6). If the reclose sequence is successful, the units will automatically reset and arm for the next operation. For simplicity of application, it is recommended that inrush restraint be specified on all faulted circuit indicators.

Cable discharge

Cable discharge is a phenomenon that occurs at the instant of fault occurrence and manifests itself by tripping indicators beyond the fault. The 1991 system study showed that if a substantial length of cable exists beyond the fault, the charge on that cable can discharge to the fault. This cable discharge is usually of short duration, but can be of high enough magnitude to trip one or two indicators beyond the location of the fault, especially if the fault indicator has a relatively low trip rating.

Since the frequency of the cable discharge is in the several kilohertz range, it becomes possible to filter out the high frequency signals. This effectively eliminates the cable discharge as a source of FCI operation. The application of a low pass filter in the fault indicator sensing circuit will efficiently perform this function. The frequency of the low pass filter is set at a precise level that filters out the cable discharge, while allowing the fault indicator to indicate if a current limiting fuse is protecting the circuit.

Figure 3 shows a simplified 25 kV distribution cable system with a fault having a variable amount of cable behind it. Assuming that the copper, 1/0 cable has an L=196.3µH per foot and C=59nF per foot the discharge frequency can be calculated:

$f = 1/(2\pi\sqrt{LC})$

If there is 1000' of cable behind the fault then f = 46.77 kHz.

Increasing the length of the cable behind the fault will not significantly change the peak outrush current that discharges into the fault. The frequency of the transient inrush current oscillation is however proportional to the length of the cable behind the fault. For example if 3000' were behind the fault the frequency would be reduced to 15.59 kHz.

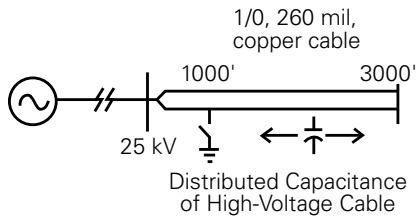

Figure 3. A simplified 25 kV distribution cable system.

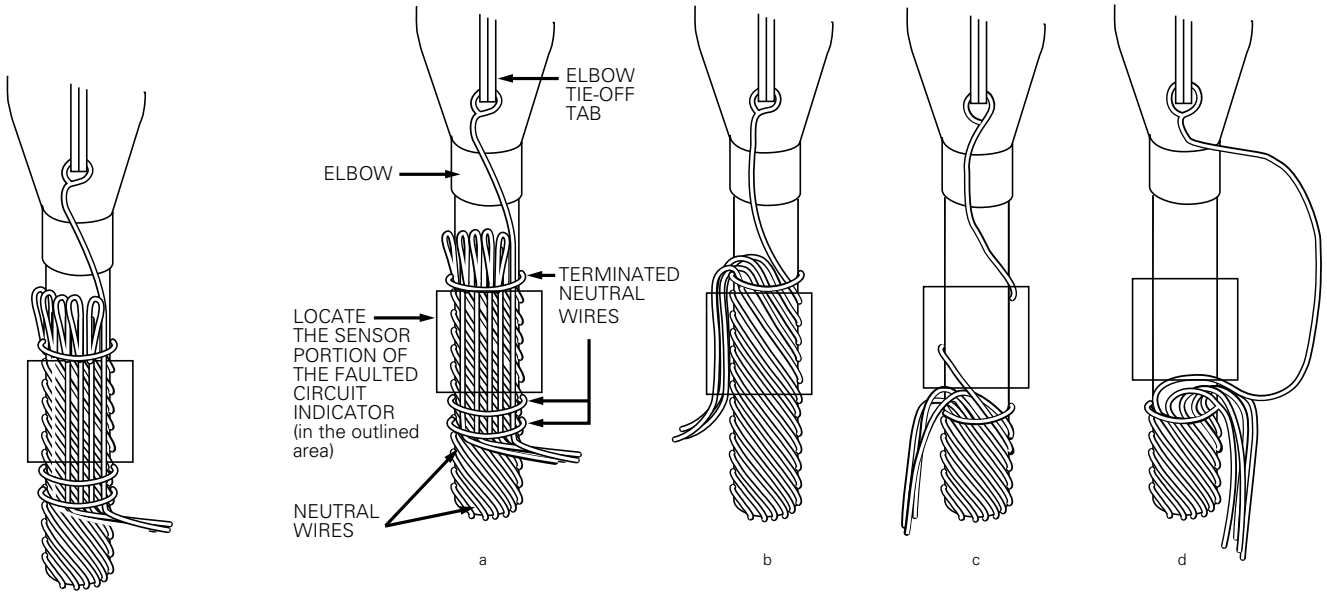

Figure 4. Recommended methods of concentric neutral primary cable preparation.

Proximity effect

Proximity effect is defined as the current from an adjacent cable affecting the operation of a fault indicator on the desired cable of operation. Proximity effect has two different modes in which it can affect fault indicator operation.

First, on multi-phase circuits, conductors of different phases can be in very close proximity to one another. This is especially true on underground applications. Due to the distance between the conductors, it becomes difficult for the fault indicator to distinguish between the magnetic field of the desired conductor and that of the adjacent conductor. Therefore, a fault on the adjacent conductor can cause the fault indicator on another cable to trip in error.

The second way proximity effect can influence cause fault indicator operation is when cables of the same phase are in close proximity to one another. For example, in a typical single-phase transformer application, incoming and outgoing primary cables are usually in close proximity to one another. In this case, the fault current would be traveling in one direction through the incoming cable and going in nearly the opposite direction through the outgoing cable. The current in the outgoing cable can then generate a magnetic field that effectively cancels the magnetic field generated in the incoming cable. This is especially true for low trip level fault indicators, because they are much more sensitive to the adjacent magnetic field.

Proximity effect can be eliminated in two ways. First, selecting a high trip rating can make the fault indicator less sensitive to adjacent phases. The second and most effective method for eliminating proximity effect is by the use of a current transformer (either open or closed core) to concentrate the flux from the desired phase and therefore reduce the sensitivity of the sensor to adjacent phases.

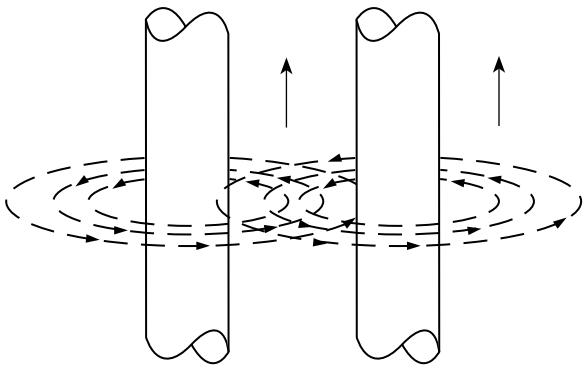

Figure 5. Proximity effect illustration.

Backfeed voltages and currents

Automatic-resetting fault indicators that use either voltage or current to reset the unit when system power is restored can be affected by the system connection. Typically on systems where delta connections exist, single-phase sectionalizing can cause voltage or current backfeed which may cause tripped fault indicators to reset.

It is difficult to quantify the exact magnitude of the backfeed current without doing an in-depth system study. However, voltage backfeed can be quantified. Due to typical transformer connections, the maximum voltage backfeed that a fault indicator may see is 60% of the nominal system voltage.

This fact provides a means by which voltage backfeed can be eliminated as a cause of FCI resetting. A reset restraint circuit, with the threshold set above the 60% level will prevent the fault indicator from resetting in error.

Temperature compensation

Temperature compensation is a feature that allows the fault indicators to provide a more accurate and reliable output between -40 °C and +85 °C.

S.T.A.R. fault indicators use a current transformer design to implement the low pass filter circuit and to minimize the affects of adjacent magnetic fields. These features provide a significant performance improvement over the use of a reed switch sensing circuit.

The copper coil of the current transformer changes resistance as the temperature varies, therefore, the output will also change due to variable temperature ranges. Eaton designed and integrated a circuit that compensated for the temperature changes, therefore, providing an accurate output.

Cable preparation: URD

Proper primary cable preparation is necessary for fault indicators to work reliably. The unit cannot be installed directly over the concentric neutral, because the unit monitors current. If the current in the neutral (return path) is high it could cancel the effects of the field from the fault current in the conductor. The net result could be less than the trip rating; therefore, the fault indicator would not trip. The line crew, upon investigation, would be misled by the false indication. The unit can, however, be mounted over the neutral if the neutral is double backed as shown in Figure 4 a and b. Doubling the neutral allows the FCI to detect the field from the fault current in the conductor because it eliminates a return path. Refer to Figure 4 for the recommended methods of concentric neutral primary cable preparation.

Fault indicators can be used on tape shield conductor or drain wire cable. If the cable shielding does not provide the return path for the indicator, the indicator can be installed directly to the cable. If the cable shielding provides the return path for the fault current, the indicator will not reliably detect a fault, as described above, and will require the use of a tape shield or a drain wire adapter. (An adapter must be installed approximately four inches below the elbow to allow ample space to mount the fault indicator on the cable.)

Simplify fault indicator application

Reliable fault indicator application can be achieved by selecting the proper faulted circuit indicator for the job, but in addition, the fault indicator must be applied properly in the field. The best method to assure proper field application is to make the application rules simple for field personnel.

Due to the characteristics of a typical distribution system, it is possible to achieve a high degree of fault indicator reliability while using just one or two trip ratings for the entire system. The application of the fault indicators then becomes a matter of applying the right fault indicator for the given system type.

In 1983, EPRI published a study called "Distribution Fault Current Analysis." This study showed typical fault current characteristics for a cross-section of distribution feeders throughout the United States. The results of the study showed that faults typically have less than two ohms of impedance. Furthermore, it showed that system fault calculations were relatively accurate when a zero fault impedance was used to calculate line-to-ground fault current magnitudes.

This information suggests that since the maximum line-to-ground fault current will flow to the fault, selecting a low trip rating on a fault indicator provides little added sensitivity over a fault indicator with a higher trip rating. As a matter of fact, due to phenomena like proximity effect, a lower trip rating can make the fault indicator less reliable than one with a higher rating. Therefore it makes sense to set the fault indicator trip rating based on the available fault current levels, not the load current level.

A better method for selecting a trip rating is to analyze the system parameters and select a trip rating based on a generalized system. For example, a typical 200 A underground system rarely carries more than 50 to 100 A, but is designed to carry a maximum of 200 A. While a trip rating just above the 100 A level could be selected, selecting a trip rating greater than the 200 A maximum continuous load current will allow the load current to vary anywhere in the acceptable current range. This trip setting can then be used for any 200 A underground distribution system. The only criteria that needs to be satisfied to make this philosophy work is that the fault indicator must respond faster than any protective device on the system.

As seen in Figure 6, the fault indicator will allow the load current to vary within the acceptable range without tripping. The FCI will trip when fault current reaches approximately 400 A, which is beyond any expected continuous load current, and less than the typical expected minimum fault current. And, because response time of the fault indicator is faster than protective equipment, the unit will indicate a faulted condition before any protective devices operate.

This philosophy will work for overhead distribution as well. A system that is protected by fused cutouts, can have fuse ratings from 1 A through 200 A. Since 200 A tin links can carry 150% rated load, the possible load currents could vary anywhere from a few amperes up to a maximum of 300 A. If a faulted circuit indicator with a trip rating of greater than 300 A is used, that trip rating could be used anywhere on the overhead system, provided the fault indicator is fast enough to beat out the fuse for any fault occurrence.

When using this application philosophy, one can also ignore any variations in the fault indicator trip rating due to changing cable dimensions, because as long as the trip rating is substantially larger than the maximum load current, the exact trip rating does not matter. The maximum line-to-ground fault current will flow to the fault, effectively tripping a fault indicator that is slightly higher in rating. This further allows the fault indicator to be applied generally to any system.

In general, a fault indicator applied to a 200 A URD loop should have a LOW trip rating (around 400 A) and a 600 A system should utilize a HIGH trip rating (around 800 A).

The last step to making the application of the faulted circuit indicator simpler is to make all the features that may be needed in any application standard on the fault indicator specified. For example, it is recommended that all fault indicators have inrush restraint. This means that this fault indicator can be applied anywhere on the system, even where a recloser is not being used. Therefore, the line personnel won't have to decide between a unit without inrush restraint and one with inrush restraint.

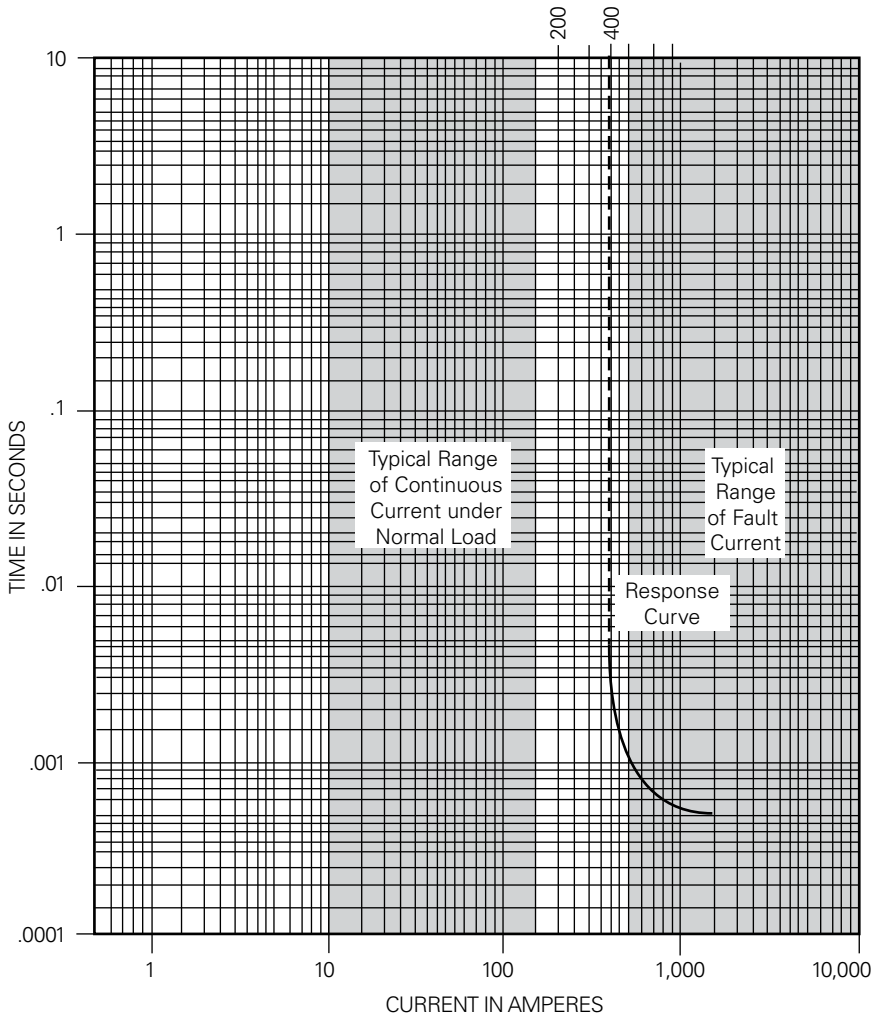

Figure 6. Low voltage reset faulted circuit indicator (low trip rating) response curve as applied to a typical 200 A underground system.

Fault indicator inrush operation

The following is a description of how a system operates during inrush when fault indicators equipped with inrush restraint are applied.

Three-Phase System

(Refer to Figure 7)

- Fault occurs on Phase A. Fault current levels exceed trip rating of indicators and, thus, all indicators (#1 and #2) between recloser and fault trip.
- Recloser opens. Indicators, with inrush restraint, on Phase B and C detect loss of power. Dead time is sufficient to fully discharge the trip capacitors.
- Recloser closes back in. Phase A sees fault current again. #1 and #2 indicators remain tripped while B and C phases experience inrush. Trip circuits for indicators on B and C phases have already been inhibited and, thus, will not trip.
- The recloser cycles until recloser lock-out occurs. The only tripped indicators are #1 and #2, thus, locating the fault between #2 and #3 on the A-phase.

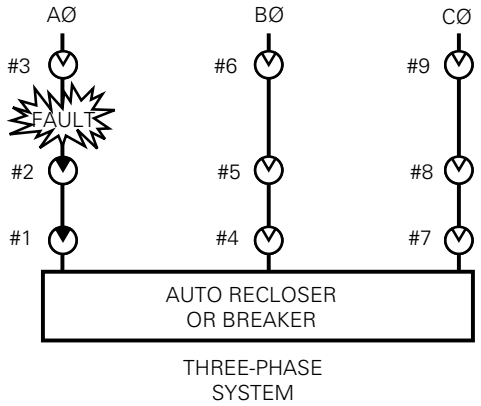

Figure 7. Typical three-phase application of fault indicators with the inrush restraint option.

Current trace

(Refer to Figure 8)

Time A - Normal Load Current All indicators in normal state.

Time B - Fault occurs on Phase A (or A-leg of bifurcated feeder).All indicators on Phase A (or A-leg) between recloser and the fault trip.

Time C - Recloser opens. Indicators with inrush restraint on B and C-phases (or B-leg and C-leg) detect loss of power.

Time D - Dead time exceeds time necessary to trigger inrush restraint circuitry. (i.e. 300 milliseconds, but in some cases 100 milliseconds). Indicators on B and C-phases (or B-leg and C-leg) inhibit their trip function in anticipation of inrush current.

Time E - Recloser closes back-in. A-phase (or A-leg) current rises to fault level. Previously tripped indicators on A-phase (or A-leg) remain tripped. B and C-phase (or B-leg and C-leg) indicators experience inrush, but do not respond due to disabled trip function at time D.

Time F - Recloser cycles until it locks open or until the fault is isolated by the operation of a fuse link or sectionalizer. The only tripped indicators are on A-phase (or A-leg) between the recloser and the fault.

Single-phase system with laterals

(Refer to Figure 9)

- Fault occurs on A-leg of bifurcated feeder. Fault current levels exceed trip rating of indicators and, thus, all indicators (#1 and #2) between recloser and fault trip.
- Recloser opens. Indicators, with inrush restraint, on B-leg detect loss of power. Dead time is sufficient to fully discharge the trip capacitors.
- Recloser closes back in. A-leg sees fault current again. #1 and #2 indicators remain tripped while B-leg experiences inrush. Trip circuits for indicators in B-leg have already been inhibited and, thus, will not trip.
- The recloser cycles until recloser lock-out occurs. The only tripped indicators are #1 and #2, thus, locating the fault between #2 and #3 on the A-leg.

Current trace: Same as Figure 8.

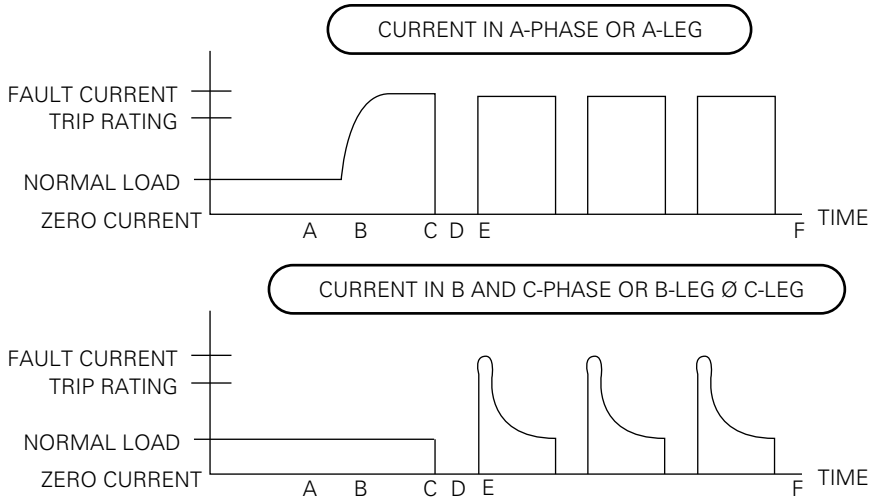

Figure 8. Current trace for three-phase application of fault indicators with the inrush restraint.

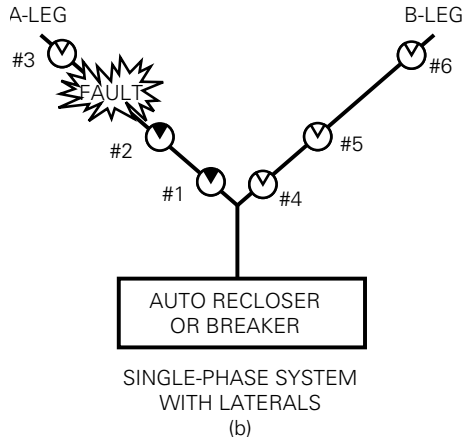

Figure 9. Typical single-phase application of fault indicators with the inrush restraint option.

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For Eaton's Cooper Power series faulted circuit indicator product information call 1-877-277-4636 or visit: www.cooperpower.com.

Powering Business Worldwide

S.T.A.R.™ test point reset faulted circuit indicators

Description

Eaton designs its Cooper Power™ series S.T.A.R.™ test point reset (TPR) faulted circuit indicators to quickly and easily locate faulted sections of underground cable systems. These faulted circuit indicators (FCIs) can be used on both 200 A separable connectors and 600 A terminators with a voltage test point. The removable sleeve allows for use on major manufacturers' loadbreak elbows. S.T.A.R. TPR FCIs feature a stored energy design that utilizes the capacitively coupled voltage present at the elbow test point. This design ensures fast, reliable and accurate operation. All FCI units are shipped to the customer in the tripped position. The magnetically latched target will not change status as a result of mechanical shock or vibration. After the unit is installed, the energized system will reset the flag from the tripped position to the normal position.

Construction

The test point reset indicator is a one-piece housing that can be easily installed with a clampstick using the pulling-eye. The sensor is designed to minimize proximity effect described as the sensitivity of FCIs to fault currents on other phases of a three-phase installation. The TPR FCI indicates the passage of fault current by showing a "fault" flag in the window of the display. The standard display consists of a highly visible orange fluorescent flag to designate a fault and a black flag to designate a normal condition. The polycarbonate display is made of Lexan® giving the exposed flag window tamperproof and scratch-resistant protection. When the system is re-energized, the indicator resets automatically.

Trip rating

The S.T.A.R. FCI is available with either a low trip rating or a high trip rating. A low trip rating will trip at approximately 400 A rms and a high trip rating will trip at approximately 800 A rms. The trip rating varies slightly with different kV class elbows and different elbow manufacturers.

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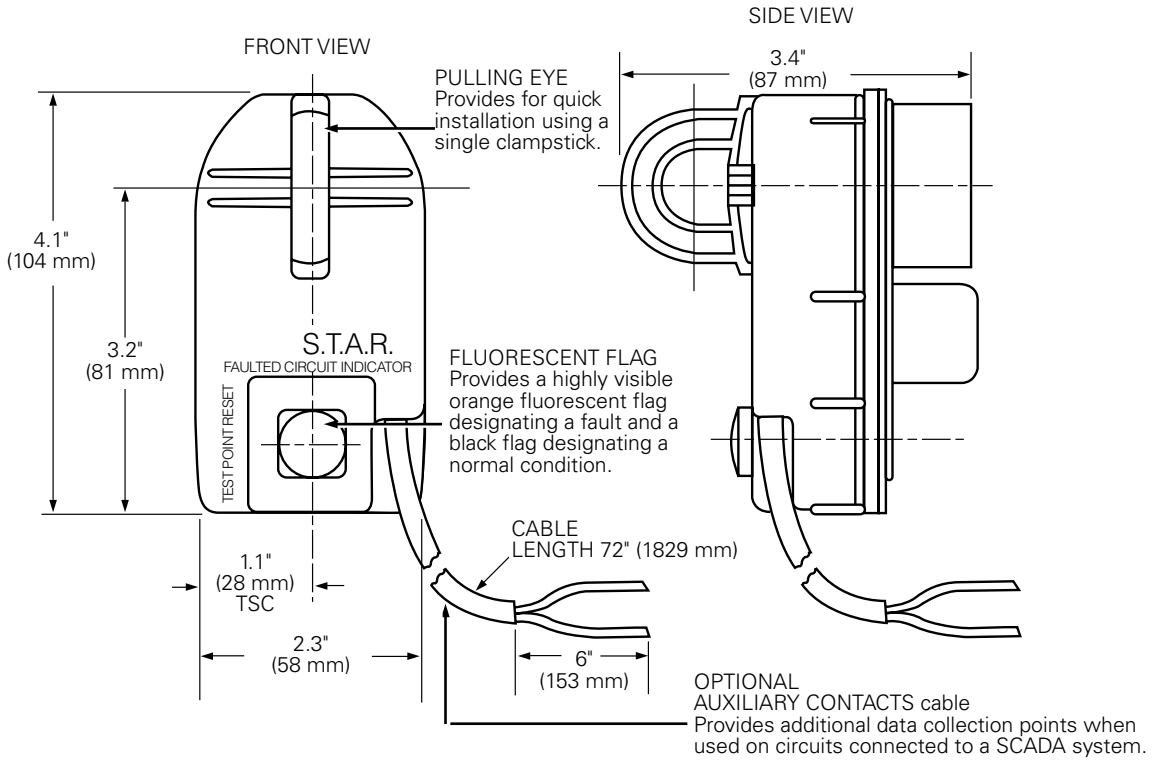


Figure 1. Features and dimensions of a TPR faulted circuit indicator with optional auxiliary contacts cable.

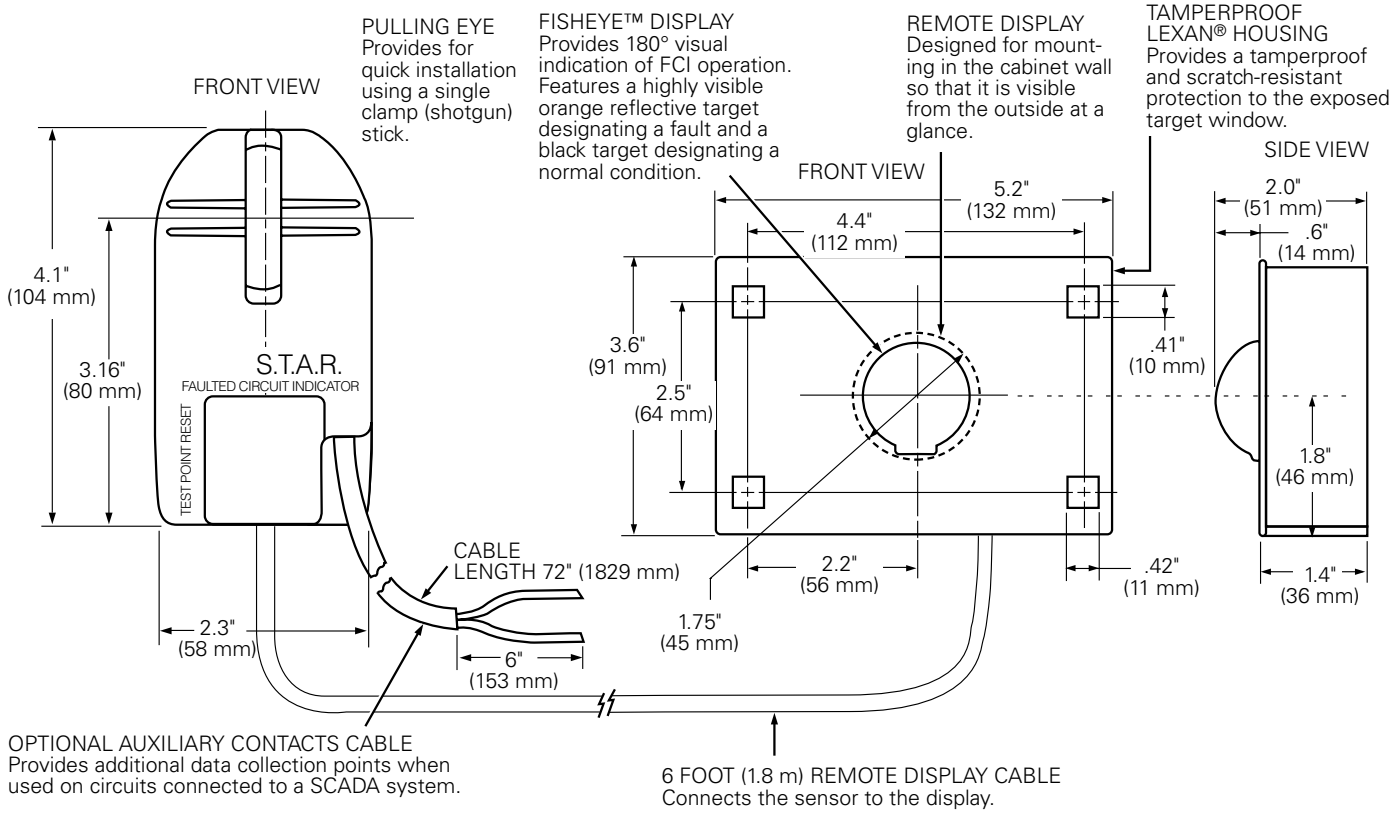


Figure 2. Features and dimensions of a TPR faulted circuit indicator with remote FISHEYE™ display and auxiliary contacts.

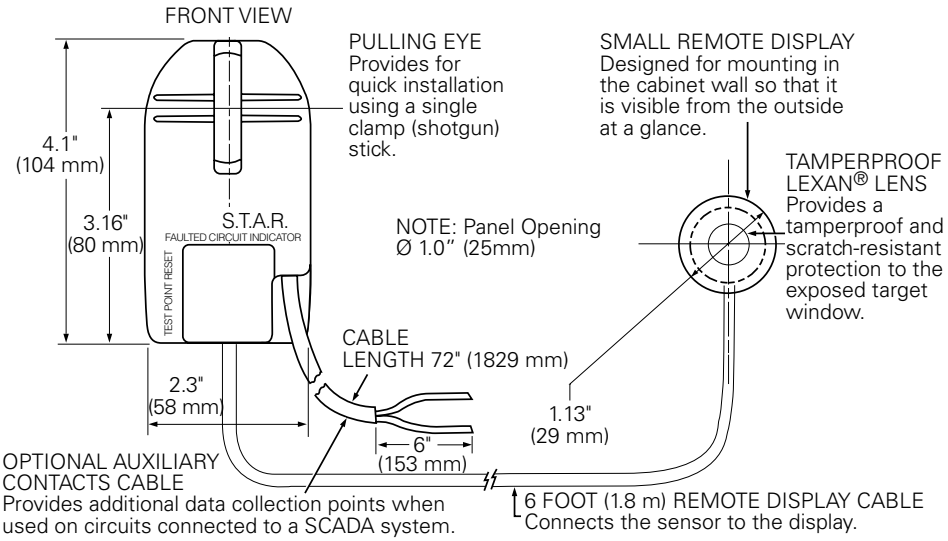


Figure 4. Features and dimensions of a TPR faulted circuit indicator with small remote display.

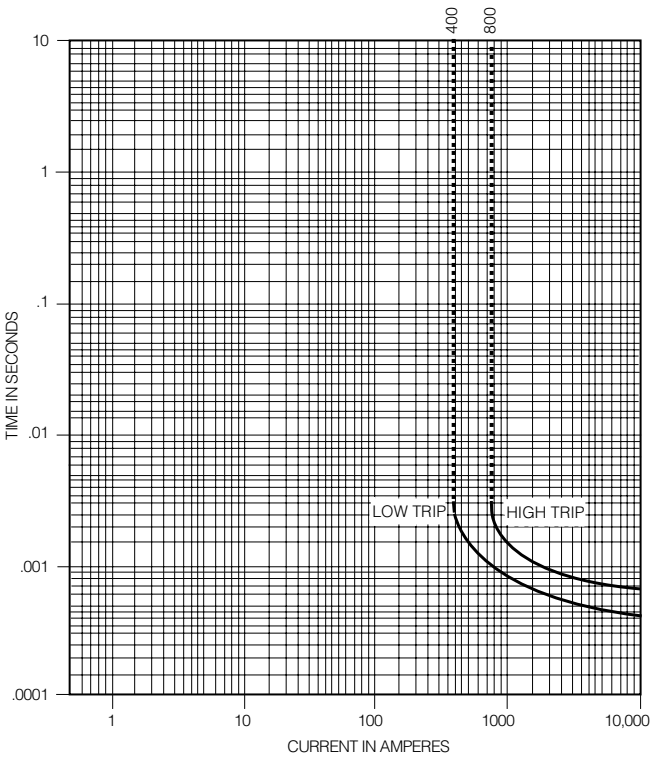


Figure 3. TPR faulted circuit indicator response curve* developed on a 25 kV Class Eaton's Cooper Power series elbow.

*Per Figure 3, for a 25 kV Class Eaton's Cooper Power series elbow the low trip rating is 400 A and the high trip rating is 800 A. The curves will shift slightly with different kV class elbows and different elbow manufacturers.

Design features

An inrush restraint feature eliminates false tripping and is standard on all units. The S.T.A.R. faulted circuit indicator will ignore inrush currents caused by reclosing operations of protective devices on the system. A dead time of 200 rms will activate the inrush restraint feature.

A **low pass filter**, also a standard feature, will prevent the S.T.A.R. faulted circuit indicator from tripping on high frequency transients like those caused by cable capacitive discharges.

In addition, the S.T.A.R. faulted circuit indicator is equipped with **temperature compensation** circuitry to assure accurate reliable performance over the entire specified temperature range.

The quick response time of the S.T.A.R. test point reset faulted circuit indicator allows easy coordination with current-limiting fuses (see Figure 3). This unique combination of standard features makes the S.T.A.R. faulted circuit indicator extremely reliable.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials, meeting or exceeding ANSI/IEEE Std 495™-1986 standard "Guide for Testing Faulted Circuit Indicators". 100% automated production testing verifies the trip rating, the reset voltage, and the inrush restraint feature.

The electronic components are completely encapsulated to prevent environmental damage.

Installation

Installation is quick and easy using a single clampstick. No special tools are required. The TPR FCI easily adapts to most manufacturers' separable connector products. An additional adapter kit may be needed for some manufacturers' older style test points. Please refer to *Service Information S320-40-1 S.T.A.R. Type TPR Faulted Circuit Indicator Installation Instructions* for installation details.

Options

Auxiliary contacts

Auxiliary contacts can be added to the standard unit and would provide an additional data collection point when used on circuits connected to a SCADA system. The magnetic latching circuit that operates the auxiliary contact ensures a reliable indication.

Remote FISHEYE™ display

Eaton provides 180° visual indication of FCI operation in its Cooper Power series remote FISHEYE™ display. This unique orange reflective target fits a standard remote indicator window that exists in many pad-mounted transformer specifications.

Figure 5. Remote FISHEYE display.

Small remote display

Eaton's TPR FCI is also available with a small remote flip-target display. This display can be easily retrofitted for pad-mounted cabinets with a single-hole installation. Refer to *Service Information S320-40-1 S.T.A.R. Type TPR Faulted Circuit Indicator Installation Instructions* for installation details.

Figure 6. TPR faulted circuit indicator with small remote display.

Ordering information

To order an Eaton's Cooper Power series S.T.A.R. Test Point Reset Type faulted circuit indicator specify the catalog number from Table 2 by selecting the appropriate codes.

Contact your Eaton representative for additional information.

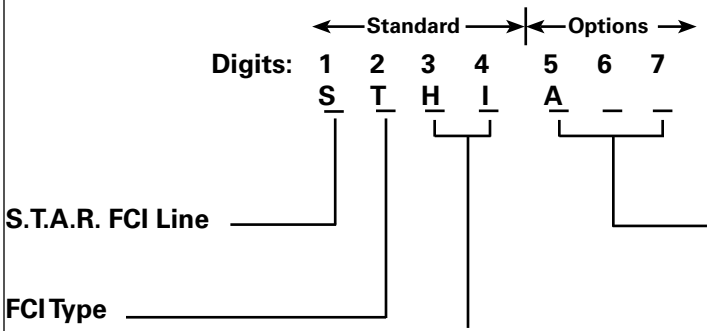
Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Requirements	Min. 5 kV L-G
Reset Time	Max. 3 min. at 5 kV
Trip Current	Factory Preset (High and Low)
Trip Accuracy	+/- 10%
Trip Response Speed	Response Curve, Figure 4
Fault Withstand Capability	25 kA for 10 cycles per ANSI/IEEE Std 495™-1986 standard
Temperature Range	-40 °C to +85 °C
Materials (Conductive EPDM Rubber)	Corrosion resistant & submersible per ANSI/IEEE Std 495™-1986 standard
Weight	8.56 ounces (0.24 Kg)
Elbow Rating (All Manufacturers)	200 & 600 A and 15, 25 & 35 kV Class
Auxiliary Contact Ratings	1 A 30 Vdc
	0.5 A 125 Vac
	0.3 A 110 Vac

Table 2. S.T.A.R. Faulted Circuit Indicator Ordering Information

Catalog Number

Example: A Test Point Reset FCI with a high trip rating and standard 6 ft. auxiliary contacts would have a catalog number STHIA (as shown below).



Digit 2	Type
T	Test Point Reset

Description	Catalog No.
Adapter Kit for Non-standard Test Points	STAK

Digits 3	Digits 4	Trip Rating
L	O	Low
H	I	High

Digits 5	Digits 6	Digits 7	Descriptions
A			Standard Indicator with auxiliary contacts
R			*Standard Indicator with remote FISHEYE display
A	R		*Standard Indicator with auxiliary contacts and remote FISHEYE display
S			*Standard Indicator with small remote display
A	S		*Standard Indicator with auxiliary contacts and small remote display.

* Standard indicator with remote display and/or auxiliary contacts provided with 6 ft. cable lengths as standard.

Notes:

1. The S.T.A.R. FCI catalog number may vary in length from 4 digits to 7 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-4. Options may be selected by adding the appropriate code to digits 5, 6, and/or 7.

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Publication No. CA320002EN

For Eaton's Cooper Power series test point reset faulted circuit indicator product information call 1-877-277-4636 or visit: www.cooperpower.com.

Powering Business Worldwide

S.T.A.R.™ PATHFINDER™ variable trip test point faulted circuit indicators

Description

Eaton designs its Cooper Power™ series S.T.A.R.™ PATHFINDER™ variable trip test point faulted circuit indicators (FCI) to quickly and easily locate faulted sections of underground cable systems. These FCIs can be used on both 200 A separable connectors and 600 A terminators with a voltage test point. The removable sleeve allows for use on major manufacturers' loadbreak elbows.

The PATHFINDER variable trip test point FCI features a trip design that senses normal load current and indicates a fault when a significant rise in current, followed by a loss of voltage, is detected. Hence, there is no need to specify a particular trip rating when ordering the variable trip test point FCI. This design ensures fast, reliable and accurate operation.

A long-life Lithium Ion battery provides power to indicate the faulted conditions using a high intensity light-emitting diode (LED) display. The unit will flash for a period of four hours after a fault has occurred. After the four hour period, the LED will stop flashing to conserve battery power; however, the unit retains a record of the fault event, and can be interrogated after the four hour period, using the manual testing/reset tool. The unit retains the memory of the fault event until reset manually, or until normal system power is restored.

Variable trip FCIs provide a reliable means of fault location and isolation. They also eliminate fault chasing methods that are costly and time consuming, and stressful on system components exposed to fault currents.

Construction

The variable trip FCI is a one-piece housing that can be easily installed with a single shotgun stick using the pulling eye on the FCI. The sensor is designed to minimize proximity effect described as the sensitivity of FCIs to fault currents on other phases of a three-phase installation. The variable trip FCI indicates the passage of fault current by an integral high intensity LED display powered by a Lithium Ion battery.

The sensor housing is made of durable, corrosion resistant materials. The electronic components are completely encapsulated to prevent environmental damage.

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S.T.A.R. PATHFINDER variable trip test point faulted circuit indicator

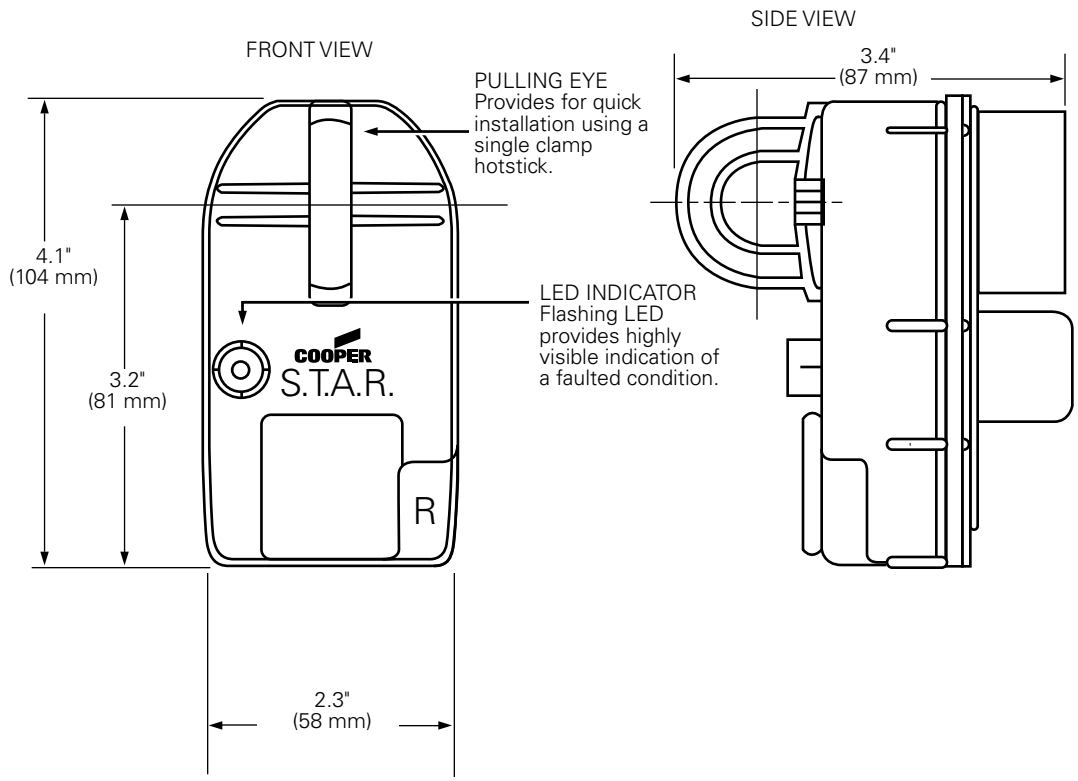


Figure 1. Features and dimensions of the PATHFINDER Variable Trip faulted circuit indicator.

Figure 2. PATHFINDER Variable Trip faulted circuit indicator with fiber optic remote display.

Trip rating

The S.T.A.R. PATHFINDER variable trip test point FCI features a load sensing design, and trips on a current rise of a particular magnitude over time. Therefore, there is no need to specify a trip rating when ordering the Variable Trip FCI.

Design features

The **Variable Trip design** eliminates the need to specify a trip rating for the FCI. The load sensing feature adjusts the FCI to normal load conditions. When a fault occurs, the unit senses the rise in system current caused by the fault, followed by the loss of system voltage due to operation of the protective device. Thus, the variable trip FCI provides a "one size fits all" FCI for voltage test points, reducing inventory and eliminating problems caused by misapplication of FCIs.

Battery Life Optimization Circuitry ensures maximum life for the battery powering the LED display. After 4 hours of flash time following a fault, the Battery Life Optimization Circuitry (BLOC) feature places the FCI in "sleep" mode. The LED will stop flashing, but the unit will retain a record of the fault occurrence in its memory. The unit can then be interrogated anytime after the 4 hours, using the manual testing/reset tool, to determine if the FCI detected a fault. The event record remains in the memory of the FCI until the unit is manually reset, or until normal system power is restored.

In addition to the variable trip design and BLOC features, an **inrush restraint** feature eliminates false tripping and is standard on all units. The S.T.A.R. PATHFINDER faulted circuit indicator will ignore inrush currents caused by reclosing operations of protective devices on the system. A dead time of 200 rms will activate the inrush restraint feature.

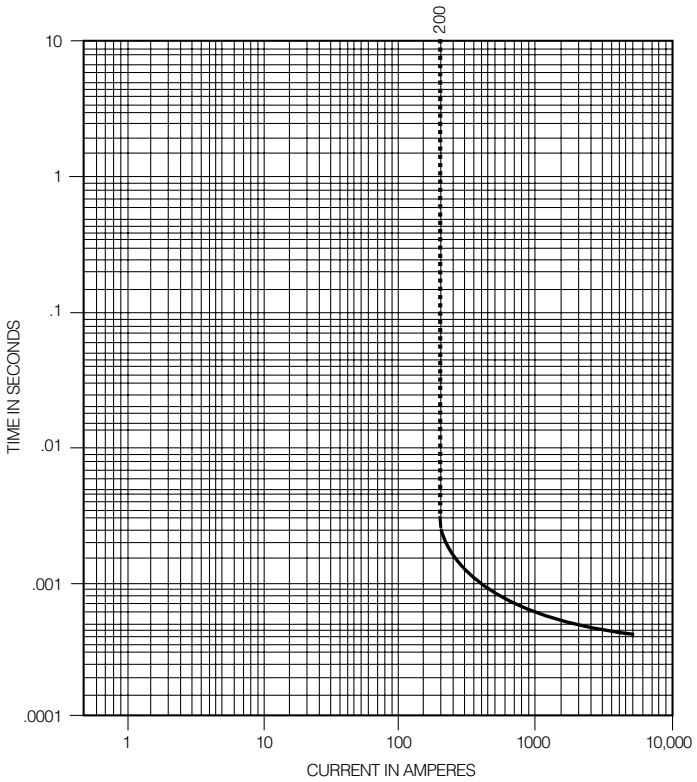


Figure 3. PATHFINDER Variable Trip faulted circuit indicator minimum response curve.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics	
Power Requirements	Min. 2.4 kV L-G	
Power Source (LED display)	1.2 AH Lithium Ion Battery (non-replaceable)	
Flashing time	800 Hrs. Minimum	
Reset Time	Factory Preset at 4 hrs.; manual reset with testing/reset tool	
Event Recording	Stores FCI status following LED reset	
Trip Current	Variable; 100 A rise from load current;	
Min. Pickup Level	200 A total (fault current + load current)	
Trip Response Speed	Response Curve, Figure 4	
Fault Withstand Capability	25 kA for 10 cycles per ANSI/IEEE Std 495™-1986 standard	
Temperature Range	-40° C to +85° C	
Materials (Conductive EPDM Rubber)	Corrosion resistant & submersible per ANSI/IEEE Std 495™-1986 standard	
Weight	8.46 ounces (0.24 kg)	
Elbow Rating (All Manufacturers)	200 & 600 A and 15, 25 & 35 kV Class	
Auxiliary Contact Rating	1 A	30 Vdc
	0.5 A	125 Vac
	0.3 A	110 Vac

A **low pass filter**, also a standard feature, will prevent the S.T.A.R. faulted circuit indicator from tripping on high frequency transients like those caused by cable capacitive discharges.

In addition, the S.T.A.R. faulted circuit indicator is equipped with **temperature compensation** circuitry to assure accurate, reliable performance over the specified temperature range.

Another standard feature is the **reset restraint** circuit. The S.T.A.R. variable trip FCI senses normal line voltage. Reset restraint prevents the fault indicator from falsely resetting due to feedback voltages of less than 80% of the normal voltage measured at the test point.

The quick response time of the S.T.A.R. variable trip faulted circuit indicator allows easy coordination with current limiting fuses. This unique combination of standard features makes the S.T.A.R. Variable Trip TPR faulted circuit indicator extremely reliable.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials, meeting or exceeding ANSI/IEEE Std 495™-1986 standard, "Guide for Testing Faulted Circuit Indicators". 100% automated production testing verifies the trip operation, and the inrush restraint and reset restraint features.

Installation

Installation is quick and easy using a single clampstick. No special tools are required. The variable trip test point FCI easily adapts to most manufacturers' separable connector products. An additional adapter kit may be needed for some manufacturers' older style test points.

Figure 4. Testing/Reset Tool.

The testing/reset tool (SMRT) can be used to test the device prior to installation, or by hotstick after the FCI is installed on a live elbow. To test the FCI, simply touch the reset tool to the Variable Trip FCI housing in the designated area. The LED display will flash slowly for 5 seconds, indicating that the unit has been reset and returned to normal status. The reset procedure also provides positive indication of battery operation. Please refer to *Service Information S320-42-1 S.T.A.R. PATHFINDER Variable Trip TPR Faulted Circuit Indicator Installation Instructions* for installation details.

Note: If the PATHFINDER variable trip TPR FCI is removed while indicating a fault, or in the energy saving (BLOC) mode, the device will only reset if installed on a system with the same line voltage at which the device had been previously installed, or, if manually reset using the testing/reset tool. It is recommended that the unit be reset manually using the testing/reset tool, to initialize the unit, after being installed.

Options

Remote fiber optic display

Eaton provides remote visual indication of the FCI operation with its Cooper Power series remote fiber optic display. This display can be mounted in transformer and sector cabinets with a single hole installation. The remote fiber optic cable can be ordered using catalog number SFOC.

Auxiliary contacts

Auxiliary contacts can be added to the standard unit and provide an additional data collection point when used on circuits connected to a SCADA system. The magnetic latching circuit that operates the auxiliary contact ensures a reliable indication.

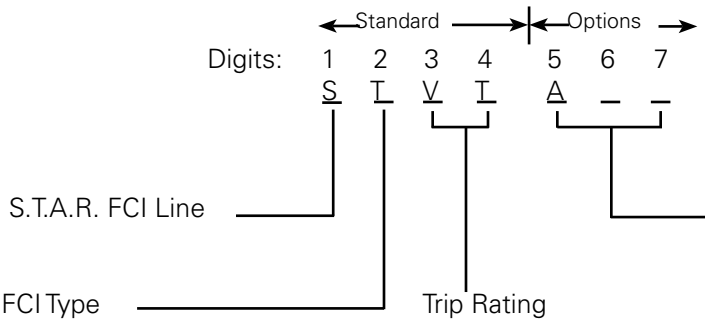
Testing/reset tool

The manual testing/reset tool can be ordered using catalog number SMRT.

Table 2. S.T.A.R. PATHFINDER Variable Trip Faulted Circuit Indicator Ordering Information

Catalog Number[1, 2]

Example: A Test Point Reset FCI with a high trip rating and standard 6 ft. auxiliary contacts would have a catalog number STVTA (as shown below).



Digit 2	Type
T	Test Point Reset

Digits 3	Digits 4	Trip Rating
V	T	Variable Trip

Digits 5	Digits 6	Digits 7	Descriptions
A			Standard Indicator with auxiliary contacts

* Standard indicator with auxiliary contacts provided with 6 ft. cable length as standard.

Description	Catalog No.
Adapter Kit for Non-standard Test Points	STAK
Manual Reset/Interrogation Tool	SMRT
Fiber Optic Cable (6 ft.)	SFOC

Notes:
1. The S.T.A.R. FCI catalog number may vary in length from 4 digits to 7 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-4. Options may be selected by adding the appropriate code to digits 5, 6, and/or 7.

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For Eaton's Cooper Power series variable trip test point faulted circuit indicator product information call 1-877-277-4636 or visit: www.cooperpower.com.

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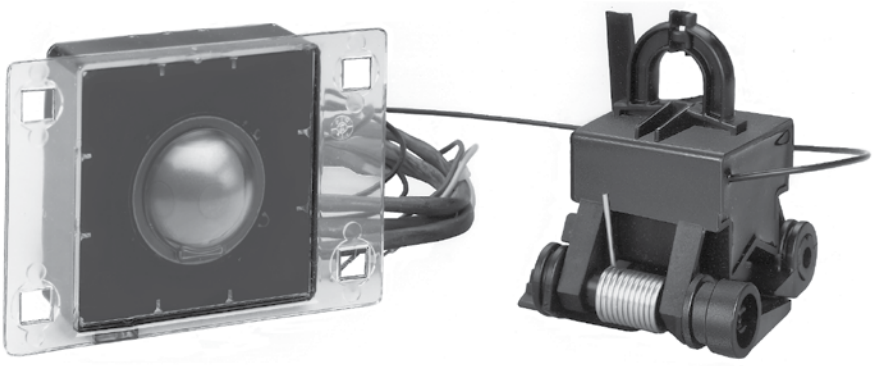
S.T.A.R.™ low voltage reset faulted circuit indicators



Description

Eaton designs its Cooper Power™ series S.T.A.R.™ low voltage reset (LVR) faulted circuit indicators to quickly and easily locate faulted sections of underground cable systems. These faulted circuit indicators (FCIs) can be installed on pad-mounted distribution transformers or wherever a secondary voltage source is available. The secondary voltage source deriving power from the monitored circuit will provide a known reliable source for operating and resetting the low voltage reset FCI, as compared to current reset devices which are subject to system loading variations. Low voltage reset faulted circuit indicators provide a reliable means of fault location and isolation. They also eliminate fault chasing methods which are costly, time consuming, and very stressful on the system components exposed to the fault currents.

Construction

The low voltage reset indicator consists of two parts – the sensor (transmitter) and the display (receiver). The sensor is designed to minimize the proximity effect described as the sensitivity of FCIs to fault currents on other phases of a three-phase transformer. Eaton provides a 180° visual indication of FCI operation with its Cooper Power series patented FISHEYE™ display. This unique orange reflective target designates a fault and a black target designates a normal condition. The sensor is attached to the primary cable and the display is mounted in the cabinet wall so that it is visible from the outside at a glance. The polycarbonate display housing is made of a Lexan® material providing the exposed target window tamperproof and scratch-resistant protection. A six foot fiber optic cable connects the sensor to the display, thereby eliminating any electrical or metallic connection between the primary side and the secondary side of the transformer. A six foot low voltage cable from the display attaches to the secondary bushing(s).

Trip rating

The S.T.A.R. FCI is available with either a low trip rating or a high trip rating. The very same FCI can be used on all cables ranging in size from 0.7 to 2.0 inches (17 to 51 mm).

Therefore, it is not necessary to specify a cable diameter when placing an order. (See Figure 2 in *Service Information S320-50-1 S.T.A.R. LVR Faulted Circuit Indicator Installation Instructions*.)

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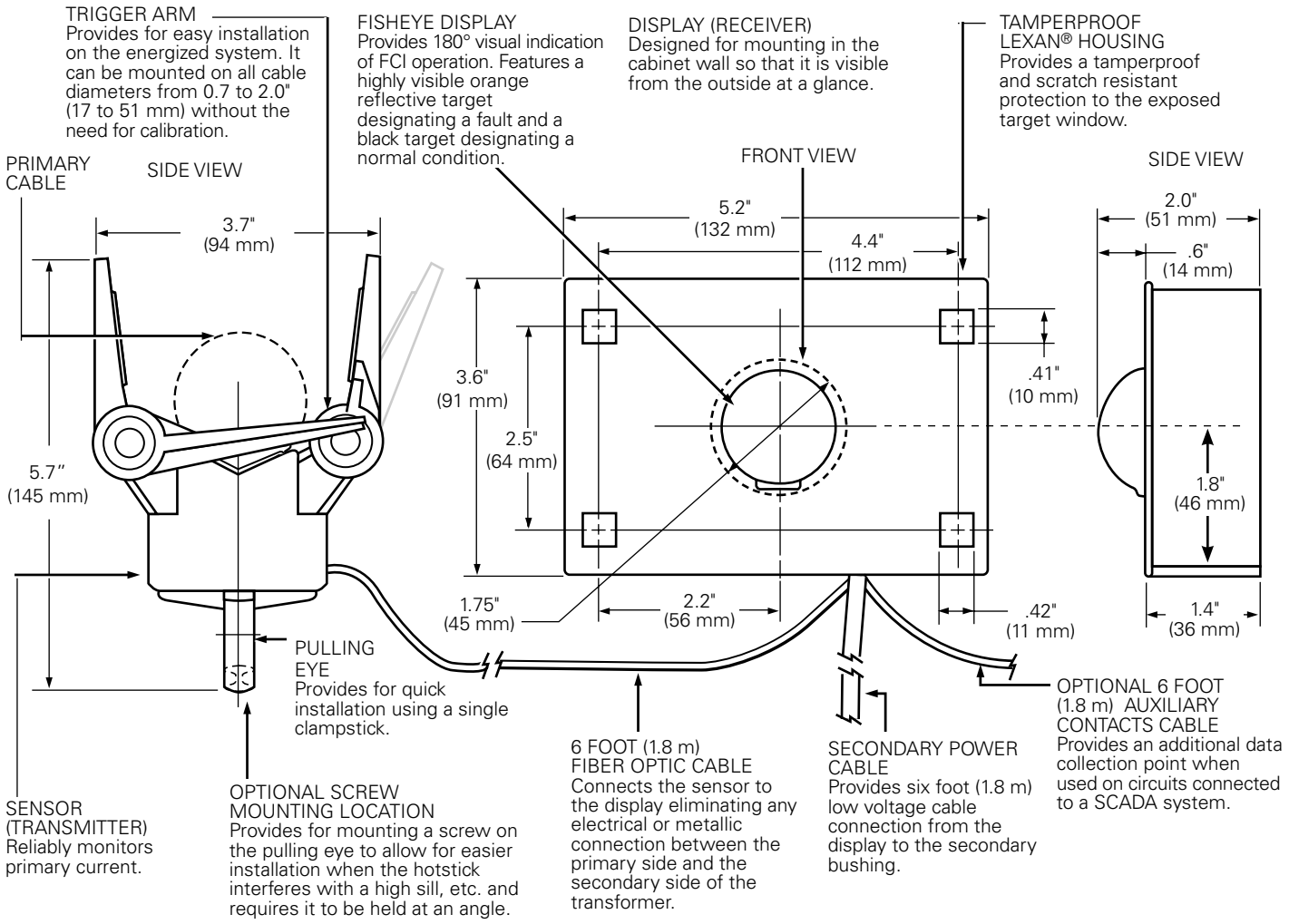


Figure 1. Features and dimensions of a LVR faulted circuit indicator (shown in the "armed" position).

Design features

An inrush restraint feature eliminates false tripping and is standard on all units. The S.T.A.R. faulted circuit indicator will ignore inrush currents caused by reclosing operations of protective devices on the system. A dead time of 200 rms will activate the inrush restraint feature.

A low pass filter, also a standard feature, will prevent the S.T.A.R. faulted circuit indicator from tripping on high frequency transients like those caused by cable capacitive discharges.

Another standard feature is the reset restraint circuit. It prevents the premature resetting of faulted circuit indicators caused by feedback voltages of less than 90 Vac.

In addition, the S.T.A.R. faulted circuit indicator is equipped with temperature compensation circuitry to assure accurate, reliable performance over the entire specified temperature range.

The quick response time of the low voltage reset S.T.A.R. faulted circuit indicator allows easy coordination with current-limiting fuses (see Figure 3).

The unit is insensitive to primary line voltage and will operate on any cable system. This unique combination of standard features makes the S.T.A.R. faulted circuit indicator extremely reliable.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed ANSI/IEEE Std 495™-1986 standard "Guide for Testing Faulted Circuit Indicators".

100% automated production testing verifies the trip rating, the reset voltage, the inrush restraint feature, and the reset restraint feature.

The electronic components are completely encapsulated to prevent any environmental damage.

Installation

All units are shipped to the customer in the tripped position. The status of the display cannot be changed mechanically in handling. After the unit is installed, the energized system will reset the reflective target from the tripped position to the normal position.

Installation is quick and easy. No special tools are required. The patented clamping mechanism of the sensor provides for easy installation on an energized system using a single clampstick. The display is mounted in a transformer cabinet using four carriage bolts.

All installation hardware is supplied including a drilling template for those transformers without an FCI knockout. Refer to *Service Information S320-50-1 S.T.A.R. LVR Faulted Circuit Indicator Installation Instructions* for detailed instructions.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Requirements	105 Vac, 15 mA @ 120 Vac (Standard LVR): 40 mA @ 120 Vac (LVR with Universal Power Supply
Reset Requirements	90 VAC minimum (Standard LVR): 60% of nominal (120, 208 or 277 Vac - LVR with Universal Power Supply)
Reset Time	6 to 9 seconds
Trip Current	Factory Preset, High and Low
Trip Accuracy	+/- 10%
Trip Response Speed	Response Curve, Figure 3
Maximum Continuous Load Current	600 A
Fault Withstand Capability	25 kA for 10 cycles per ANSI/IEEE Std 495™-1986 standard
Cable Size	#2 to 1000 MCM, Insulated
Temperature Range	-40 ˚C to +85 ˚C
Materials	Corrosion resistant & submersible per ANSI/IEEE Std 495™-1986 standard
Weight	26.7 ounces (0.76 kg)
Auxiliary Contact Ratings	1 A 30 Vdc
	0.5 A 125 Vac
	0.3 A 110 Vac

Table 2 Standard Cable Diameters in Inches (Millimeters)

	175 MIL*	220 MIL*	260 MIL*	345 MIL*
Cable Size	**15 kV**	**15 kV**	**25 kV**	**35 kV**
#2	.700 (17.8)	.790 (20.1)	.870 (22.1)	–
#1	.740 (18.8)	.830 (21.1)	.910 (23.1)	–
1/0	.785 (19.9)	.875 (22.2)	.955 (24.3)	1.125 (28.6)
2/0	.830 (21.1)	.920 (23.4)	1.000 (25.4)	1.170 (29.7)
3/0	.880 (22.4)	.970 (24.6)	1.050 (26.7)	1.220 (31.0)
4/0	.940 (23.9)	1.030 (26.2)	1.110 (28.2)	1.280 (32.5)
250 MCM	.995 (25.3)	1.085 (27.6)	1.175 (29.8)	1.350 (34.3)
350 MCM	1.100 (27.9)	1.190 (30.2)	1.280 (32.5)	1.455 (37.0)
500 MCM	1.235 (31.4)	1.325 (33.7)	1.415 (35.9)	1.590 (40.4)
600 MCM	1.325 (33.7)	1.415 (35.9)	1.505 (38.2)	1.680 (42.7)
750 MCM	1.430 (36.3)	1.525 (38.7)	1.610 (40.9)	1.785 (45.3)
1000 MCM	1.580 (40.1)	1.680 (42.7)	1.760 (44.7)	1.935 (49.1)

* Insulation thickness

Options

Auxiliary contacts

Auxiliary contacts can be added to the standard unit and would provide an additional data collection point when used on circuits connected to a SCADA system. The magnetic latching circuit that operates the auxiliary contact ensures reliable indication.

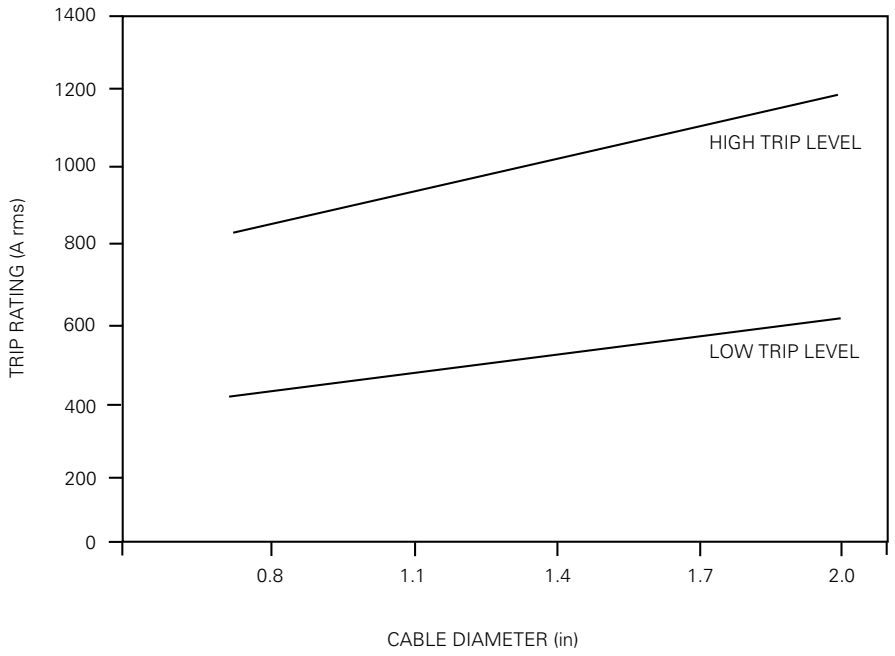


Figure 2. S.T.A.R. LVR faulted circuit indicator cable diameter vs trip value curves.

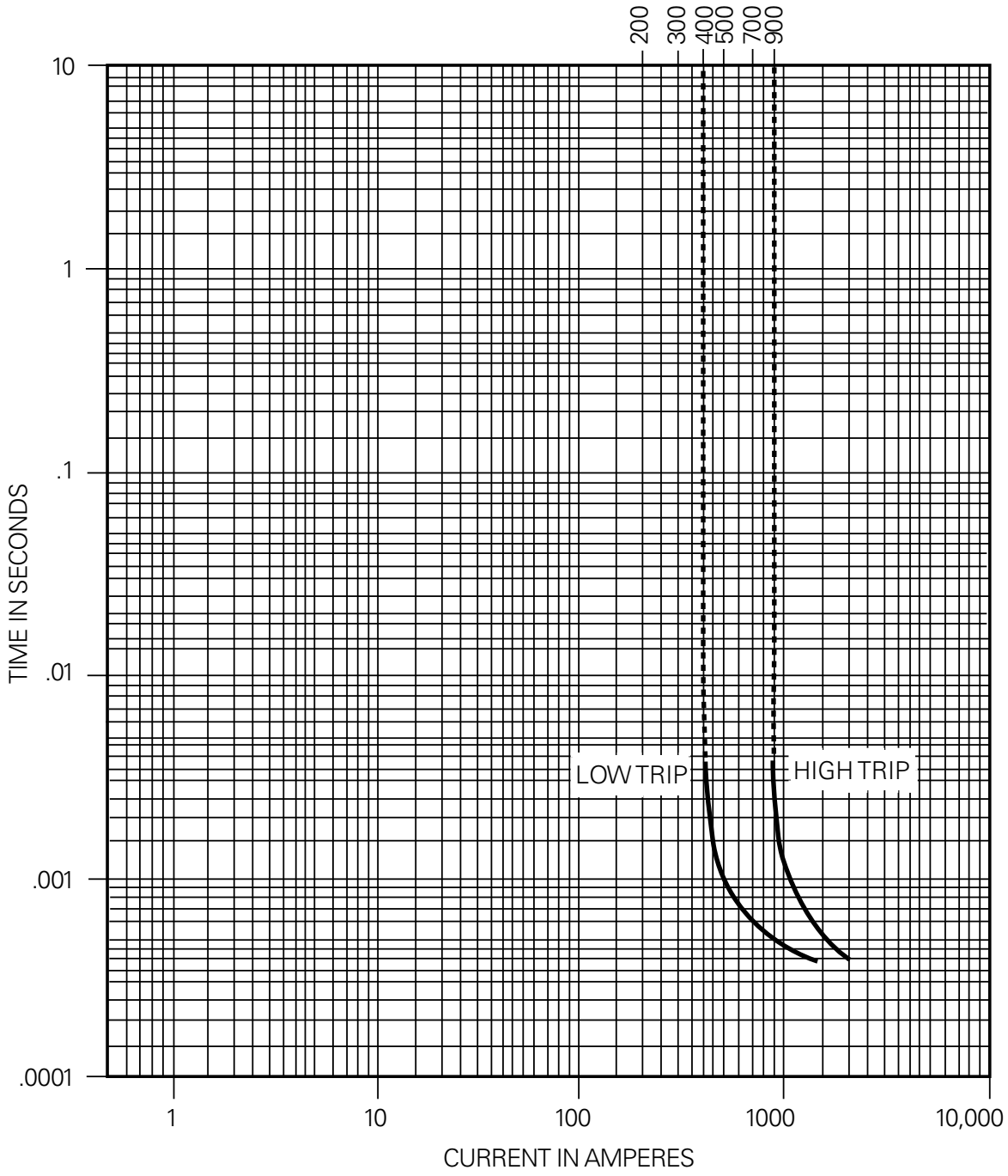


Figure 3. LVR faulted circuit indicator response curve* developed on a 1.2 inch (30.5 mm) cable.

* Per Figure 3, for a 1.2 inch diameter cable the low trip rating is 400 A and the high trip rating is 900 A. The curves will shift for various cable diameters.

Ordering information

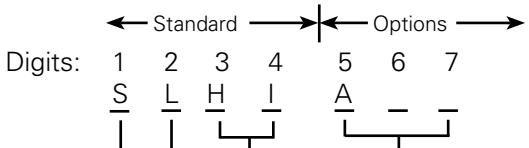
To order a S.T.A.R. low voltage reset faulted circuit indicator specify the catalog number from Table 3 by selecting the appropriate codes.

Contact your Eaton representative for additional information.

Table 1. S.T.A.R. Faulted Circuit Indicator Ordering Information

Catalog Number[1, 2]

Example: A Low Voltage Reset FCI with a high trip rating and standard 6 ft. auxiliary contacts would have a catalog number SLHIA (as shown below).



S.T.A.R. FCI Line

FCI Type

Digit 2	Type
L	Low Voltage Reset

Trip Rating

Digits		
3	4	Trip Rating
L	O	Low
H	I	High

Options

Digits			Description
5	6	7	
A			Standard indicator with auxiliary contacts
U			Universal Power Supply (120, 208, or 277 Vac power connection)
A	U		Auxiliary contacts and universal power supply

Notes:

1. The S.T.A.R. FCI catalog number may vary in length from 4 digits to 7 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-4. Options may be selected be adding the appropriate design code to digits 5, 6 and/or 7.

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S.T.A.R.™ electrostatic reset faulted circuit indicators

Description

Eaton designs its Cooper Power™ series S.T.A.R.™ electrostatic reset (ER) faulted circuit indicators to quickly and easily locate faulted sections of overhead distribution systems. These faulted circuit indicators (FCIs) can be installed on overhead distribution lines and derive their power from the voltage gradient between the line and the ground plane. This voltage gradient provides a reliable source for operating and resetting the fault indicator when compared to current reset devices which are subject to system loading variations. Electrostatic reset FCIs provide a reliable means of fault location and isolation. In addition, they eliminate fault chasing methods which are costly and time consuming, and very stressful on system components exposed to the fault currents. Electrostatic reset fault indicators have been designed to operate primarily on uninsulated, unshielded cable but may also be used on an unshielded insulated cable such as tree wire.

Construction

Eaton provides a sensor unit with an integral target display for 180° visual indication with its Cooper Power series FISHEYE™ display. This unique orange reflective target designates a faulted condition and a black target designates a normal condition. The FISHEYE display also features a Lexan® cover that provides superior scratch protection for the target window. The sensor unit itself features a clamping mechanism design that allows easy snap-on connection to the live conductor with the use of a single hotstick.

Trip rating

S.T.A.R. FCIs are available with either a high or a low trip rating. The very same FCI can be used on cable sizes from 0.25 (6.4 mm) to 2.0 inches (51 mm). Therefore, it is not necessary to specify a cable diameter when placing an order.

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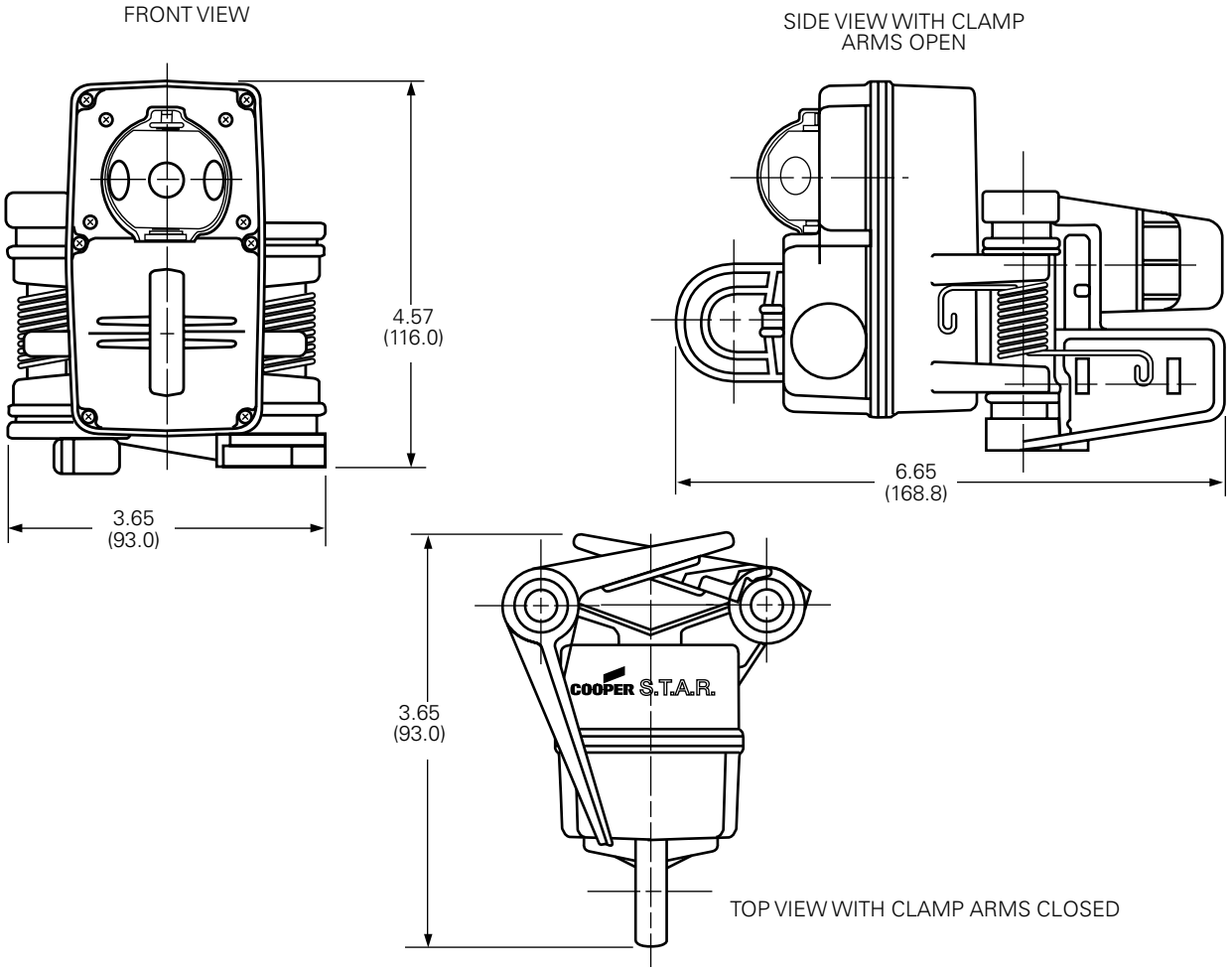


Figure 1. Line illustration of an Electrostatic Reset faulted circuit indicator with features and dimensions (shown in the "armed" position).

Design features

An inrush restraint feature eliminates false tripping and is standard on all units. The S.T.A.R. faulted circuit indicator will ignore inrush currents caused by reclosing operations of protective devices on the system. A dead time of 200 rms will activate the inrush restraint feature.

A low pass filter, also a standard feature, will prevent the S.T.A.R. faulted circuit indicator from tripping on high frequency transients like those caused by capacitive discharges.

In addition, the S.T.A.R. faulted circuit indicator is equipped with temperature compensation circuitry to assure the accurate and reliable performance over the entire specified temperature range.

The quick response time of the S.T.A.R. electrostatic reset faulted circuit indicator provides easy coordination with current-limiting fuses and other protective devices. (See Figure 2).

This unique combination of standard features makes the S.T.A.R. faulted circuit indicator extremely reliable.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Requirements	Min. 6.9 kV L-G
Reset Time	Max. 8 min. at 6.9 kV
LED Flashing Time Battery	1000 hours continuous 2.4 Ah Lithium Ion Battery (Internal, non-replaceable)
Trip Current	Factory Preset (High and Low)
Trip Accuracy	+/- 10%
Trip Response Speed	Response Curve, Figure 3
Fault Withstand Capability	25 kA for 10 cycles per ANSI/IEEE Std 495™-1986 standard
Temperature Range	-40 °C to +85 °C
Materials	Corrosion-resistant & submersible per ANSI/IEEE Std 495™-1986 standard
Cable Size	0.25 (6.4 mm) to 2.0 inches (51 mm)
Weight	13.6 ounces (0.39 kg)

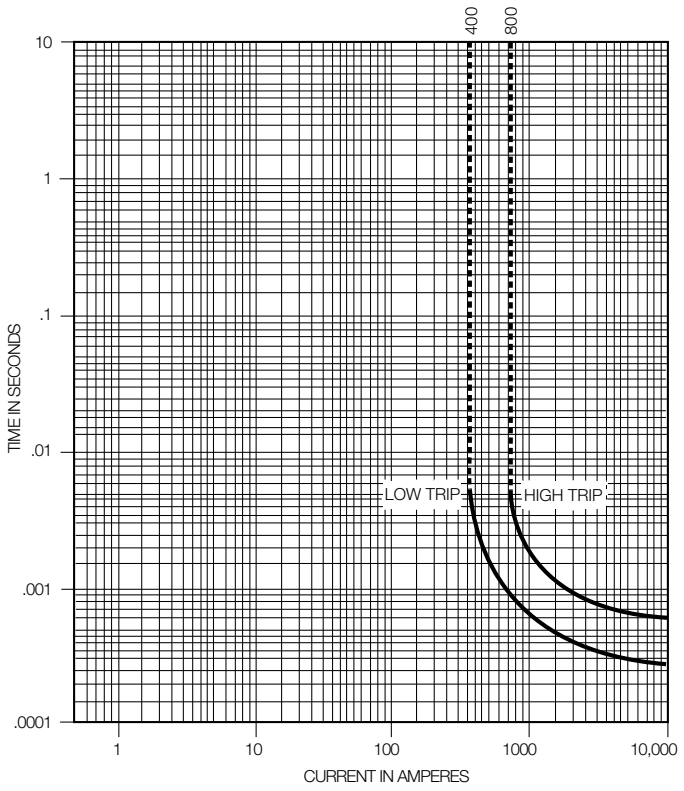


Figure 2. Faulted circuit indicator response curve developed on a 1.0 inch (25.4 mm) cable.

Optional features

The S.T.A.R. faulted circuit indicator can also be equipped with an LED in addition to the FISHEYE display. The LED will blink for up to four (4) hours providing a high intensity output of fault indication from longer distances than the FISHEYE display alone in both daylight and darkness.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed ANSI/IEEE Std 495™-1986 standard "Guide for Testing Faulted Circuit Indicators".

100% automated production testing verifies the trip rating, the reset circuit and the inrush restraint feature.

The electronic components are completely encapsulated to prevent any environmental damage.

Installation

The only requirement for installation of the S.T.A.R. electrostatic reset FCI is that it must be installed within 3 feet of the ground plane at 6.9 kV. All units are shipped to the customer in the tripped position. The status of the display cannot be changed mechanically in handling. After the unit is installed, the energized system will reset the FISHEYE target from the tripped position to the normal position.

Installation is quick and easy. No special tools are required. The clamping mechanism of the sensor provides for easy installation on an energized system using a single clampstick.

Clamp arm pads are used for cable diameters from 0.25" (6.4 mm) to 1.0" (25 mm). For cable sizes from 1.0" (25 mm) to 2.0" (51 mm) the clamp arm pads are removed. Refer to *Service Information S320-60-1 S.T.A.R. ER Faulted Circuit Indicator Installation Instructions* for more information.

ORDERING INFORMATION

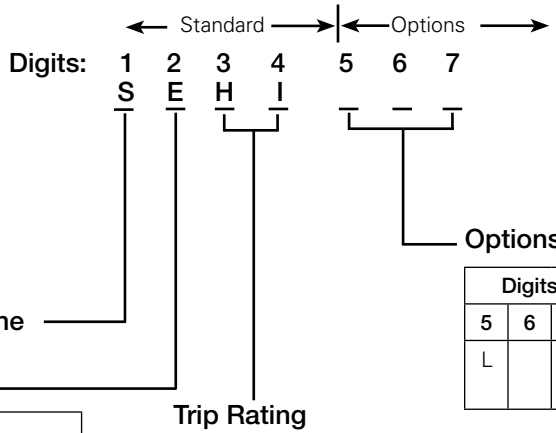
To order a S.T.A.R. electrostatic reset faulted circuit indicator specify the catalog number from Table 2 by selecting the appropriate codes.

Contact your Eaton representative for additional information.

Table 2. S.T.A.R. Faulted Circuit Indicator Ordering Information

Catalog Number

Example: An Electrostatic Reset FCI with a high trip rating would have a catalog number SEHI (as shown below).



Digits			
5	6	7	Description
L			LED Light Indication (max 4-hour blinking)

Digit	
2	Type
E	Electrostatic Reset

Digits		
3	4	Trip Rating
L	O	Low
H	I	High

Notes:
1. The S.T.A.R. FCI catalog number may vary in length from 4 digits to 7 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-4. Options may be selected be adding the appropriate design code to digits 5, 6 and/or 7.

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Printed in USA
Publication No. CA320005EN

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S.T.A.R.™ delayed reset faulted circuit indicators

Description

Eaton designs its Cooper Power™ series S.T.A.R.™ delayed reset (DR) faulted circuit indicators to quickly and easily locate faulted sections of cable systems. These faulted circuit indicators (FCI) can be installed on pad-mounted distribution transformers, sector cabinets, switchgear and overhead bare conductors. A long-life Lithium Ion battery provides power to indicate the faulted conditions using a high intensity LED display. The unit automatically resets back to the normal position when reset time has expired. The unit can also be reset using the optional manual testing/reset tool. DR FCIs provide a reliable means of fault location and isolation. They also eliminate fault chasing methods that are costly and time consuming, and very stressful on system components exposed to fault currents. The DR FCI is ideally suited for temporary use as a testing tool. The delayed reset also allows the unit to be used to detect general fault location in applications where an intermittent fault causes recloser operation, but power is restored before the unit is interrogated.

Construction

S.T.A.R. delayed reset fault indicators consist of a sensor unit with an integral high intensity LED display powered by a Lithium Ion battery. DR FCIs feature an economical reed switch design. Installation can be achieved on a wide range of cable diameters with a single hot stick. The sensor unit itself features a clamping mechanism design that allows easy snap-on connection to the live conductor with the use of a single shotgun stick.

Trip rating

S.T.A.R. FCIs are available with either a high or a low trip rating. The very same FCI can be used on cable diameters from 0.7 (17 mm) to 2.0 inches (51 mm). Therefore, it is not necessary to specify a cable diameter when placing an order. Refer to Figure 3 for applicable trip value versus cable diameter information.

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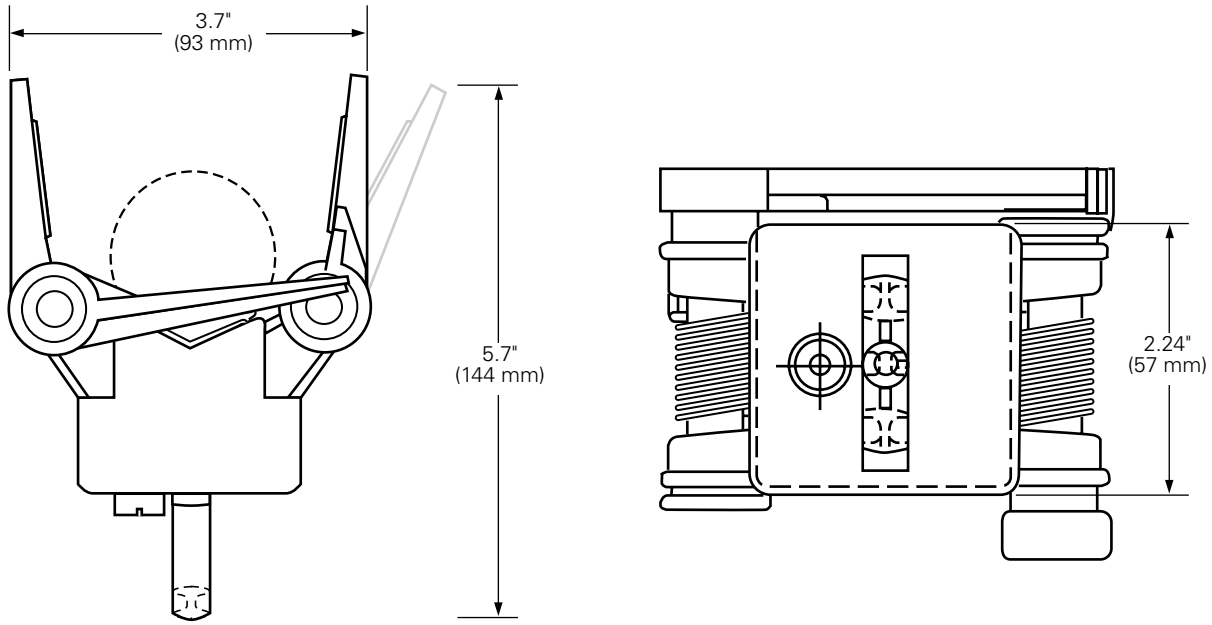

Figure 1. Features and dimensions of a DR faulted circuit indicator (shown in the "armed" position).

Design features

The S.T.A.R. delayed reset faulted circuit indicator automatically resets back to the normal position when the reset time has expired. The unit is available in factory preset delay times of 1, 2, 4, or 6 hours.

The DR FCI is constructed using tough, durable, corrosion-proof, submersible materials.

The Lithium Ion battery provides 800 hours of flashing time for the high intensity LED display.

The quick response time of the S.T.A.R. delayed reset faulted circuit indicator provides easy coordination with current-limiting fuses and other protection devices (See Figure 2).

The unit is insensitive to primary line voltage and will operate on any cable system. This unique combination of standard features makes the S.T.A.R. faulted circuit indicator extremely reliable.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed ANSI/IEEE Std 495™-1986 standard "Guide for testing Faulted Circuit Indicators".

100% automated production testing verifies the trip rating and the reset time.

The electronic components are completely encapsulated to prevent any environmental damage.

Installation

Installation is quick and easy. No special tools are required. The patented clamping mechanism of the sensor provides for easy installation on an energized system using a single clampstick.

Testing and resetting the DR FCI can be done by touching the reset tool (catalog number SMRT) to the face of the fault indicator. Touching the lower right corner at the location "T" and removing the reset tool causes the unit to "flash back" until manually reset or until the delay time expires.

The unit is manually reset by touching the upper left corner marked "R" with the reset tool. Upon manual reset, the unit will "flash back" the number of reset hours that the FCI is set for. The reset procedure also provides positive indication of battery operation.

Refer to *Service Information S320-65-1 S.T.A.R. DR Faulted Circuit Indicator Installation Instructions* for more information.

Options

Testing/reset tool

The manual testing/reset tool can be ordered using catalog number SMRT.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Source	1.2 AH Lithium Ion Battery (non-replaceable)
Flashing Time	800 Hrs.
Reset Time	Factory Preset 1,2,4,6 Hrs.
Trip Current	Factory Preset (High or Low)
Trip Accuracy	+/- 10%
Trip Response Speed	Response Curve, Figure 2, Sec. 320-65
Fault Withstand Capability	10 kA for 10 Cycles per ANSI/IEEE Std 495™-1986 standard
Temperature Range	-40 °C to +85 °C per ANSI/IEEE Std 495™-1986 standard
Materials	Corrosion-resistant & submersible per ANSI/IEEE Std 495™-1986 standard
Weight	8.32 ounces (0.24 kg)
Conductor Size	0.70" through 2.0"

Table 2. Standard Cable Diameters in Inches (Millimeters)

Cable Size	175 MIL* 15 kV	220 MIL* 15 kV	260 MIL* 25 kV	345 MIL* 35 kV
#2	.700 (17.8)	.790 (20.1)	.870 (22.1)	–
#1	.740 (18.8)	.830 (21.1)	.910 (23.1)	–
1/0	.785 (19.9)	.875 (22.2)	.955 (24.3)	1.125 (28.6)
2/0	.830 (21.1)	.920 (23.4)	1.000 (25.4)	1.170 (29.7)
3/0	.880 (22.4)	.970 (24.6)	1.050 (26.7)	1.220 (31.0)
4/0	.940 (23.9)	1.030 (26.2)	1.110 (28.2)	1.280 (32.5)
250 MCM	.995 (25.3)	1.085 (27.6)	1.175 (29.8)	1.350 (34.3)
350 MCM	1.100 (27.9)	1.190 (30.2)	1.280 (32.5)	1.455 (37.0)
500 MCM	1.235 (31.4)	1.325 (33.7)	1.415 (35.9)	1.590 (40.4)
600 MCM	1.325 (33.7)	1.415 (35.9)	1.505 (38.2)	1.680 (42.7)
750 MCM	1.430 (36.3)	1.525 (38.7)	1.610 (40.9)	1.785 (45.3)
1000 MCM	1.580 (40.1)	1.680 (42.7)	1.760 (44.7)	1.935 (49.1)

* Insulation thickness

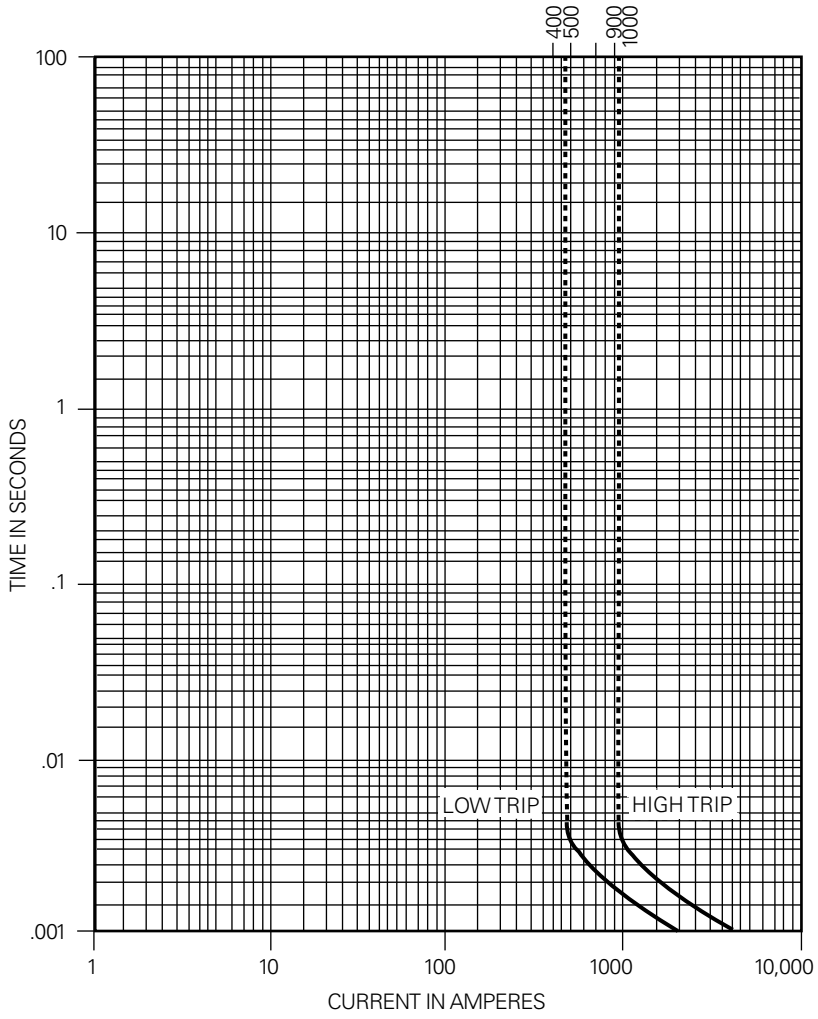

Figure 2. DR faulted circuit indicator response curve.

The curves will shift for various cable diameters; refer to Figure 3.

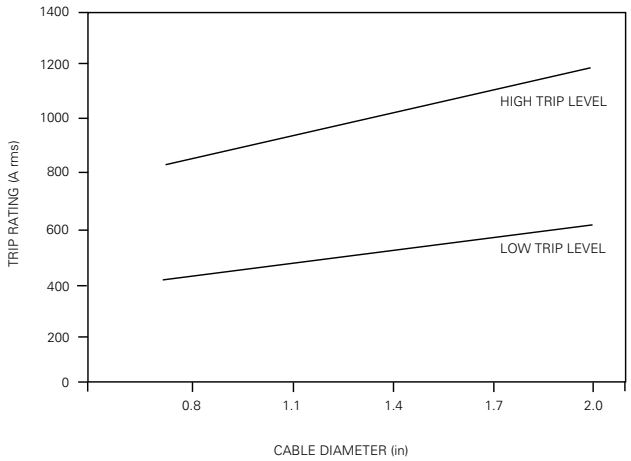

Figure 3. S.T.A.R. DR faulted circuit indicator cable diameter vs. trip value curves.

Table 3. S.T.A.R. Delayed Reset Faulted Circuit Indicator Ordering Information

S.T.A.R. Delayed Reset FCI Ordering Information

Example: A Delayed Reset FCI with a high trip rating and 4-hour reset time would have a catalog number SDHI4 (as shown below).

Standard → ← Options →

Digits:	1	2	3	4	5	6	7
	S	D	H	I	4	_	_

S.T.A.R. FCI Line

Options

Digits			
5	**6**	**7**	**Description**
1			1-Hr. Reset Time
2			2-Hr. Reset Time
4			4-Hr. Reset Time
6			6-Hr. Reset Time

FCI Type

Digit 2	Type
D	Delayed Reset

Trip Rating

Digits		
3	**4**	**Trip Rating**
L	0	Low
H	I	High

Notes:
1. The S.T.A.R. FCI catalog number may vary in length from 5 digits to 7 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-5.

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S.T.A.R.™ manual reset faulted circuit indicator

Description

Eaton designs its Cooper Power™ series S.T.A.R.™ manual reset (MR) faulted circuit indicators to quickly and easily locate faulted sections of cable on distribution systems. These faulted circuit indicators (FCIs) can be installed on pad-mounted distribution transformers, sector cabinets, switchgear, and overhead distribution lines. Manual reset FCIs provide a reliable means of fault location and isolation. In addition, they eliminate fault chasing methods which are costly and time consuming, and very stressful on system components exposed to the fault currents. Manual reset faulted circuit indicators are designed to operate on overhead uninsulated, unshielded cable and unshielded insulated cable (such as tree wire), as well as concentric neutral and other cable, in underground, padmount and vault applications.

Construction

S.T.A.R. manual reset faulted circuit indicators consist of a sensor unit with an integral Eaton's Cooper Power series FISHEYE™ target display. The FISHEYE display provides 180° visual indication. This unique orange reflective target designates a faulted condition and a black target designates a normal condition. The FISHEYE display also features a Lexan® cover that provides superior scratch protection for the target window. The sensor unit itself features a clamping mechanism design that allows easy snap-on connection to the live conductor with the use of a single clampstick.

Trip rating

S.T.A.R. FCIs are available with either a high or a low trip rating. The very same FCI can be used on cable sizes from 0.25 inches (6.4 mm) to 2.0 inches (51 mm). Therefore, it is not necessary to specify a cable diameter when placing an order. Refer to Figure 4 for applicable trip value versus cable diameter information.

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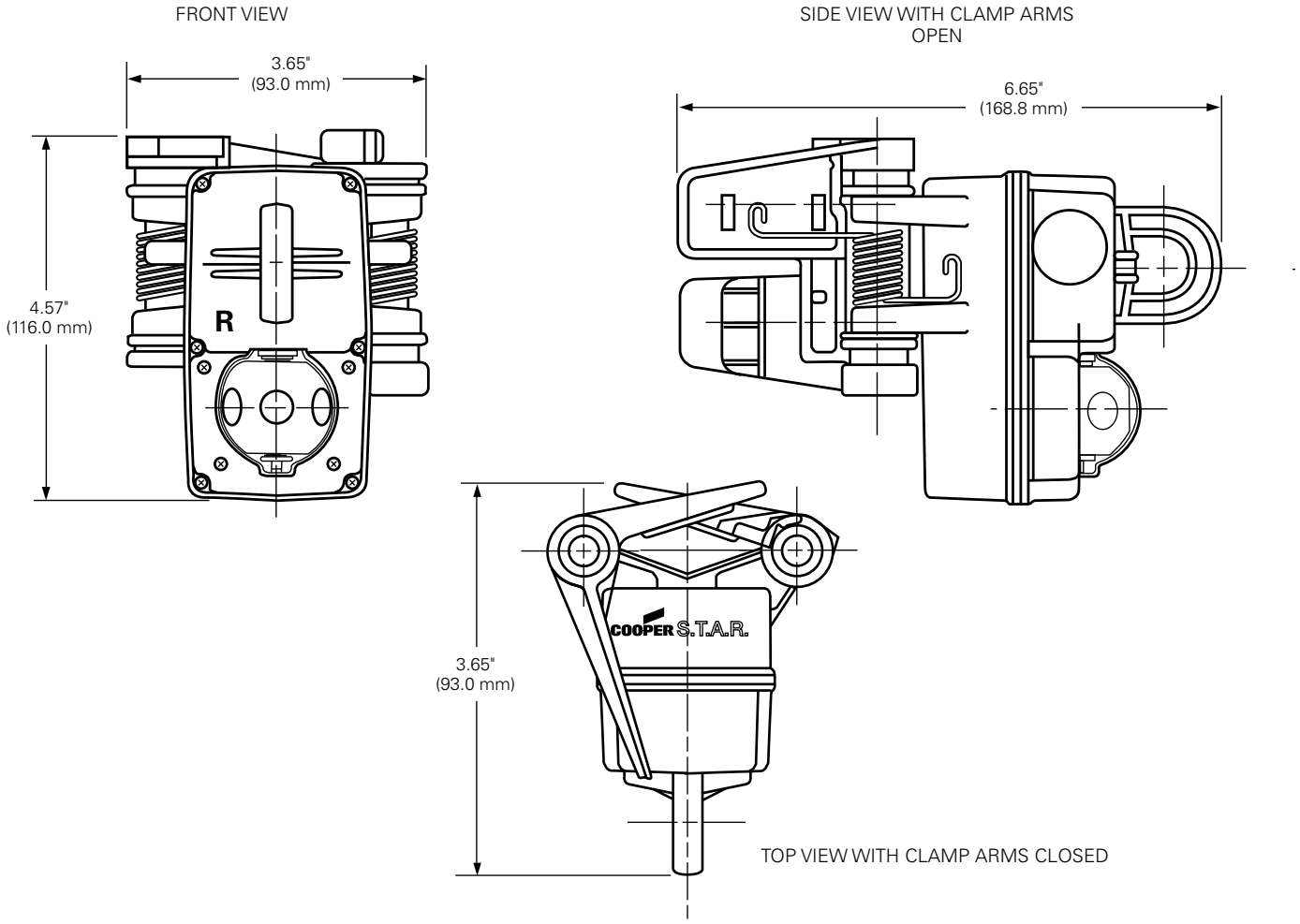


Figure 1. Line illustration of a manual reset faulted circuit indicator with features and dimensions.

Design features

A low pass filter, a standard feature on the MR FCI, will prevent the S.T.A.R. faulted circuit indicator from tripping on high frequency transients like those caused by capacitive discharges.

In addition, the S.T.A.R. faulted circuit indicator is equipped with temperature compensation circuitry to assure the accurate and reliable performance over the entire specified temperature range.

The quick response time of the S.T.A.R. manual reset faulted circuit indicator provides easy coordination with current-limiting fuses and other protective devices. (See Figure 3).

This unique combination of standard features makes the S.T.A.R. faulted circuit indicator extremely reliable.

Figure 2. Manual reset tool.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed ANSI/IEEE Std 495™-1986 standard "Guide for Testing Faulted Circuit Indicators".

100% automated production testing verifies the trip rating and the reset circuit.

The electronic components are completely encapsulated to prevent any environmental damage.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Source	Two 1.2 AH Lithium Ion Batteries (20 Year Shelf Life)
Trip Current	Factory Preset (High and Low)
Trip Accuracy	+/- 10%
Trip Response Speed	Response Curve, Figure 4
Fault Withstand Capability	25 kA for 10 cycles per ANSI/IEEE Std 495™-1986 standard
Temperature Range	-40 °C to +85 °C
Materials	Corrosion-resistant & submersible per ANSI/IEEE Std 495™-1986 standard
Cable Size	0.25 (6.4 mm) to 2.0 inches (51 mm)
Weight	22 ounces (0.62 kg)

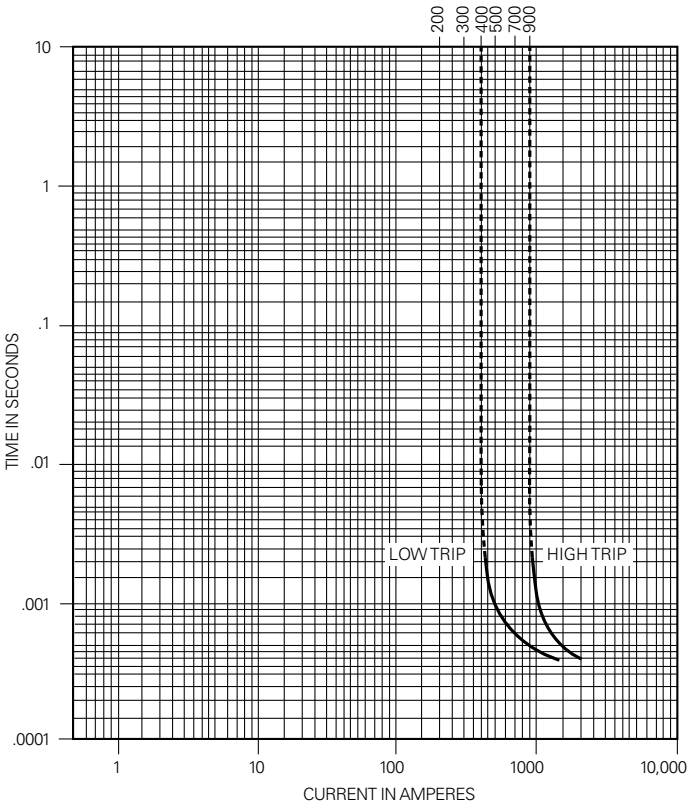


Figure 3. MR faulted circuit indicator response curve developed on a 1.2 inch (30.5 mm) cable.

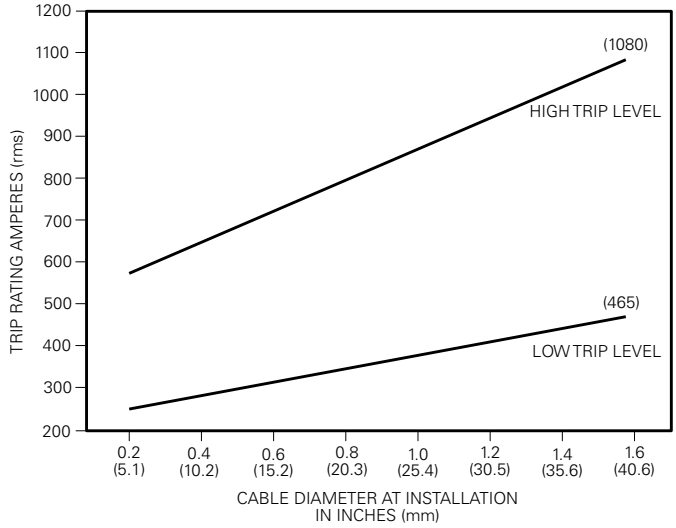


Figure 4. S.T.A.R. MR faulted circuit indicator cable diameter vs. trip value curves.

Installation

Installation is quick and easy. No special tools are required. The clamping mechanism of the sensor provides for easy installation on an energized system using a single clampstick.

Clamp arm pads are used for cable sizes from 0.25" (6.4 mm) to 1.0" (25 mm). For cable sizes from 1.0" (25 mm) to 2.0" (51 mm) the clamp arm pads are removed. Refer to *Service Information S320-70-1, S.T.A.R. Type MR Faulted Circuit Indicator Installation Instructions* for more information.

All units are shipped to the customer in the tripped position. The status of the display cannot be changed mechanically in handling.

Resetting the FCI

In order to reset the S.T.A.R. manual reset FCI, it is necessary to use the reset tool (SMRT), see Figure 2. The reset tool can be used to reset the device prior to installation or by clampstick after the FCI is installed on the live conductor. To reset the FCI, simply touch the reset tool to the MR housing in the designated area. The FISHEYE display will then return to the normal status. Refer to *Service Information S320-70-1, S.T.A.R. Type MR Faulted Circuit Indicator Installation Instructions* for more information.

Ordering information

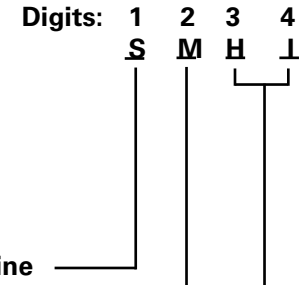
To order a S.T.A.R. manual reset faulted circuit indicator specify the catalog number from Table 2 by selecting the appropriate codes.

Contact your Eaton representative for additional information.

Table 2. S.T.A.R. Faulted Circuit Indicator Ordering Information

Catalog Number

Example: A Manual Reset FCI with a high trip rating would have a catalog number SMHI (as shown below).



Digit 2	Type
M	Manual Reset

Digits		
3	4	Trip Rating
L	O	Low
H	I	High

Description	Catalog #
Manual Reset Tool	SMRT

Notes:
1. The S.T.A.R. FCI catalog number may vary in length from 4 digits to 7 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-4. Options may be selected by adding the appropriate design code to digits 5, 6 and/or 7.

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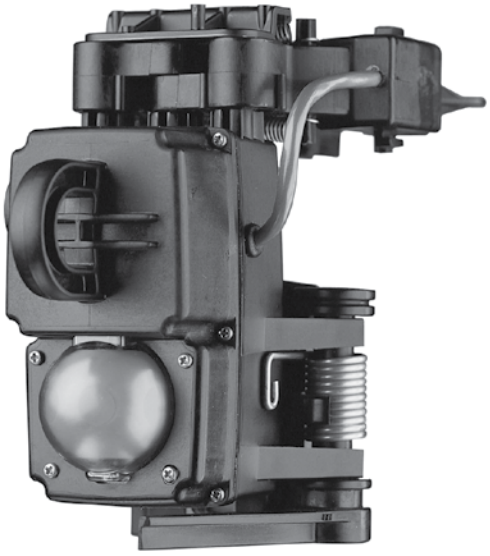
S.T.A.R.™ current reset faulted circuit indicators



Description

Eaton designs its Cooper Power™ series S.T.A.R.™ current reset (CR) faulted circuit indicators to quickly and easily locate faulted sections of cable systems. These faulted circuit indicators (FCIs) can be installed on pad-mounted distribution transformers, sector cabinets, switchgear and overhead bare conductors. The closed core current transformer (CT) senses the fault current and provides power to operate the FCI. The unit automatically resets back to the normal position when the continuous current exceeds the 2.4 A reset value. CR FCIs provide a reliable means of fault location and isolation. They also eliminate fault chasing methods that are costly and time consuming, and very stressful on system components exposed to fault currents. Installation can be achieved on a wide range of cable diameters with a single hotstick.

Construction

S.T.A.R. current reset fault indicators consist of a sensor unit with an integral Eaton's Cooper Power series FISHEYE™ target display. The closed core CT is used for both sensing the fault current and providing power to operate the FCI. The FISHEYE display provides 180° visual indication. This unique orange reflective target designates a faulted condition and a black target designates a normal condition. The FISHEYE display also features a Lexan® cover that provides superior scratch protection for the target window. The sensor unit itself features a clamping mechanism and unique spring action CT design that allows easy snap-on connection to the live conductor with the use of a single hotstick.

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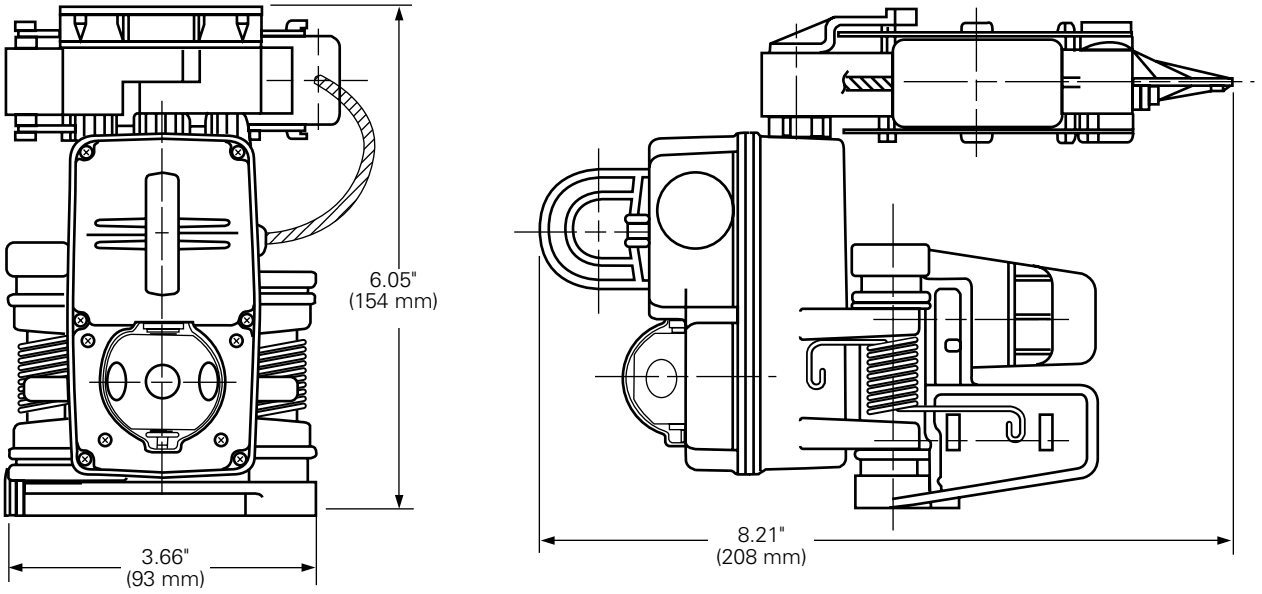

Figure 1. Features and dimensions of a CR faulted circuit indicator (shown in the "armed" position).

Trip rating

S.T.A.R. faulted circuit indicators are available with either a high or a low trip rating. The very same FCI can be used on cable diameters from 0.25" (6.4 mm) to 2.0" (51 mm). Therefore, it is not necessary to specify a cable diameter when placing an order.

Design features

An inrush restraint feature eliminates false tripping and is standard on all units. The S.T.A.R. faulted circuit indicator will ignore inrush currents caused by reclosing operations of protective devices on the system. A dead time of 200 rms will activate the inrush restraint feature.

A low pass filter, also a standard feature, will prevent the S.T.A.R. faulted circuit indicator from tripping on high frequency transients like those caused by capacitive discharges.

The quick response time of the S.T.A.R. current reset faulted circuit indicator provides easy coordination with current-limiting fuses and other protection devices (See Figure 2).

This unique combination of standard features makes the S.T.A.R. faulted circuit indicator extremely reliable.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed ANSI/IEEE Std 495™-1986 standard "Guide for Testing Faulted Circuit Indicators".

100% automated production testing verifies the trip rating, the reset circuit and the inrush restraint feature.

The electronic components are completely encapsulated to prevent any environmental damage.

Installation

All units are shipped to the customer in the tripped condition. The status of the display cannot be changed mechanically in handling. After the unit is installed, the energized system will reset the FISHEYE target display from the tripped position to the normal position.

Installation is quick and easy. No special tools are required. The patented clamping mechanism and the unique spring action CT of the sensor provides for easy installation on an energized system using a single clampstick.

Clamp arm pads are used for cable diameters from 0.25" (6.4 mm) to 1.0" (25 mm). For cable sizes from 1.0" (25 mm) to 2.0" (51 mm) the clamp arm pads are removed. Refer to *Service Information S320-75-1 S.T.A.R. CR Faulted Circuit Indicator Installation Instructions* for more information.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Requirements	Min. 2.4 A Continuous
Max. Operating Voltage	45 kV L-L
Reset Time	5 Minutes at 2.4 A Max.
Trip Current	Factory Preset (High or Low)
Trip Accuracy	+/- 10%
Trip Response Speed	Response Curve, Figure 4
Fault Withstand Capability	25 kA for 10 Cycles per ANSI/IEEE 495™-1986 standard
Temperature Range	-40 °C to +85 °C
Materials	Corrosion-resistant & submersible per ANSI/IEEE 495™-1986 standard
Weight	27.2 ounces (0.77 kg)
Conductor Size	0.25" through 2.0"

Options

Remote FISHEYE™ display

The remote FISHEYE display provides 180° visual indication of FCI operation. This unique orange reflective target fits a standard remote indicator window that exists in many pad-mounted transformer specifications.

Small remote display

The current reset faulted circuit indicator is also available with a small remote display. The remote flip target display easily retrofits to pad-mounted cabinets with a single hole installation.

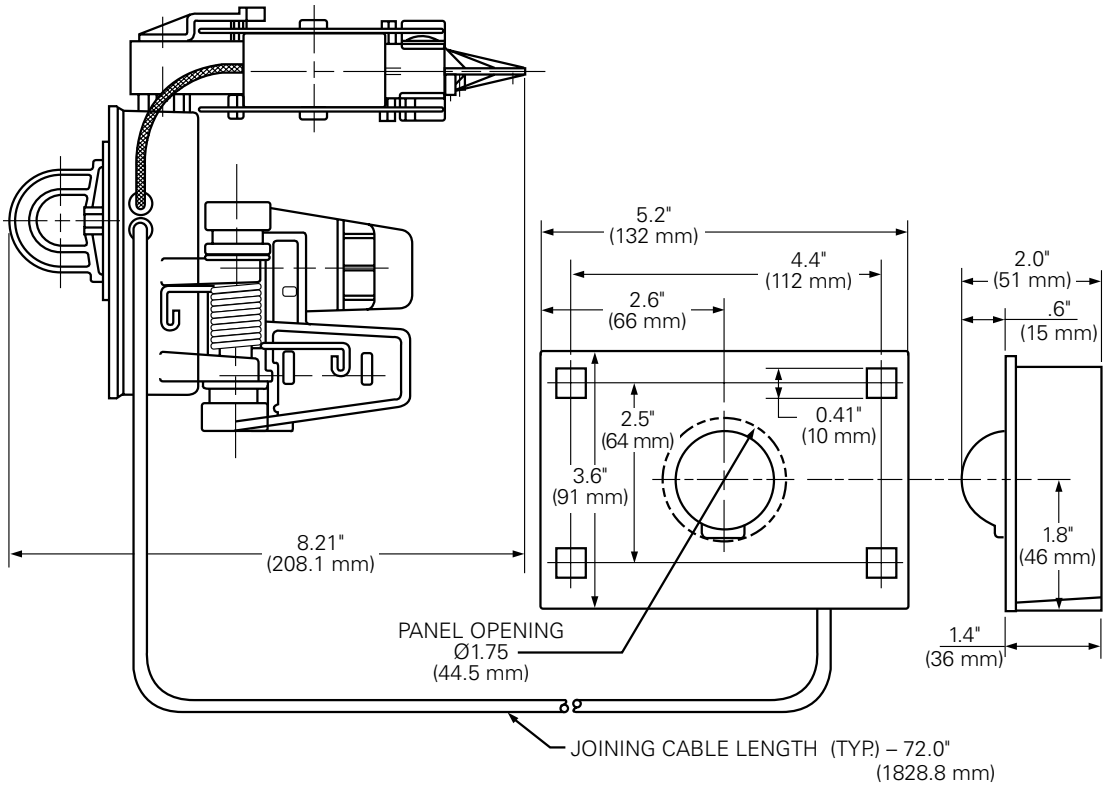

Figure 2. Features and dimensions of the CR faulted circuit indicator with remote FISHEYE display.

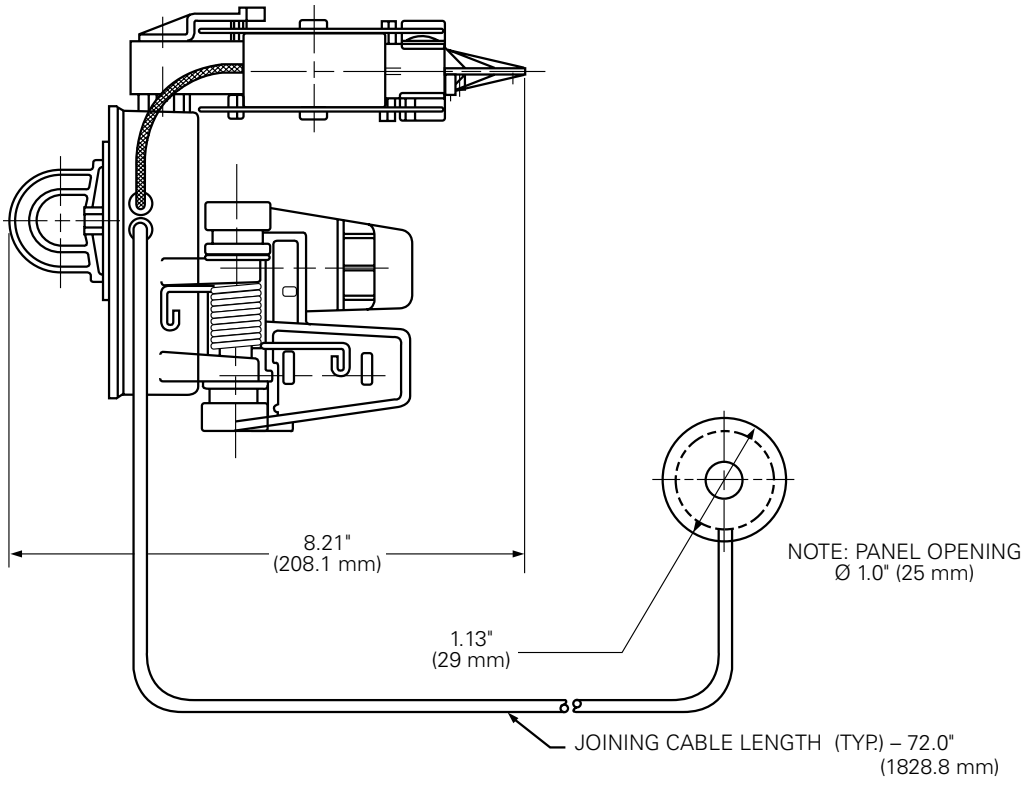

Figure 3. Features and dimensions of the CR faulted circuit indicator with small remote display.

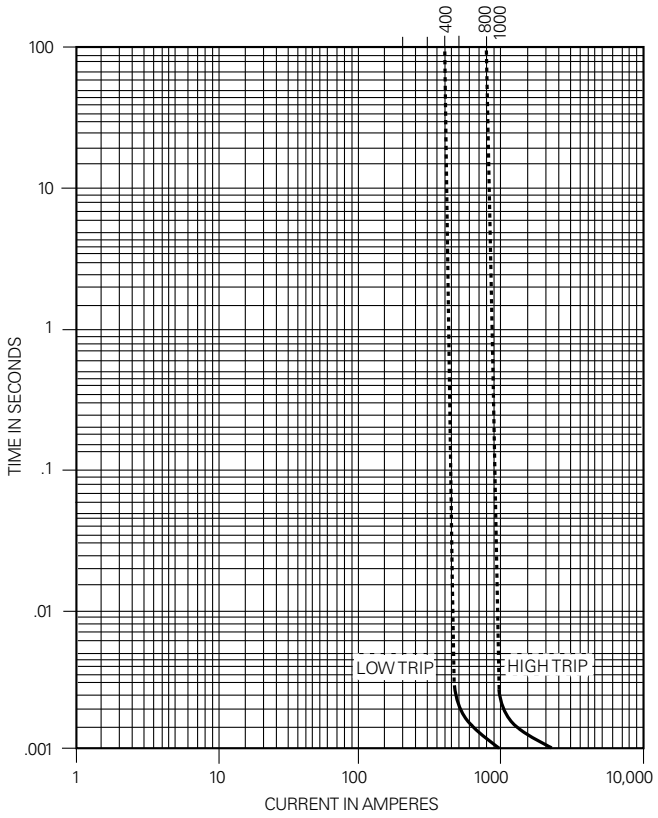

Figure 4. CR faulted circuit indicator response curve.

Figure 5. Remote FISHEYE display.

Figure 6. Small remote display.

Table 2. S.T.A.R. Current Reset Faulted Circuit Indicator Ordering Information

S.T.A.R. Current Reset Type FCI Ordering Information

Example: A Current Reset FCI with a high trip rating would have a catalog number SCHI (as shown below).

	Standard				Options		
Digits:	**1**	**2**	**3**	**4**	**5**	**6**	**7**
	S	**C**	**H**	**I**			

S.T.A.R. FCI Line

FCI Type

Digit 2	Type
C	Current Reset

Trip Rating

Digits		
3	4	Trip Rating
L	O	Low
H	I	High

Options

Digits			
5	6	7	Descriptions
R			*Standard indicator with remote FISHEYE Display
S			*Standard indicator with small remote display

* Standard indicator with remote FISHEYE Display provided with 6 ft. cable lengths as standard.

Notes:
1. The S.T.A.R. FCI catalog number may vary in length from 4 digits to 7 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-4. Options may be selected by adding the appropriate design code to digits 5, 6, and/or 7.

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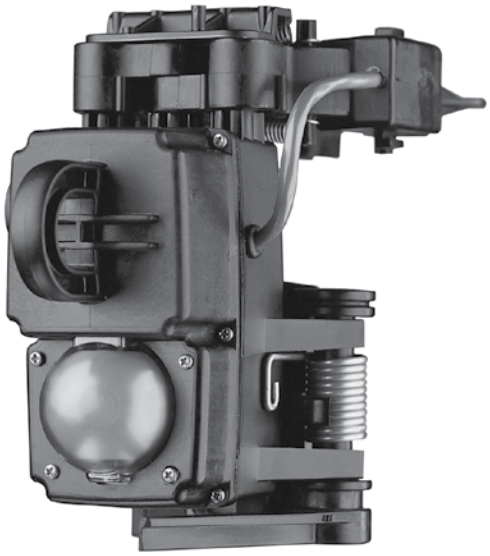
S.T.A.R.™ PATHFINDER™ variable trip current reset faulted circuit indicators



Description

Eaton designs its Cooper Power™ series S.T.A.R.™ PATHFINDER™ variable trip current reset (CR) faulted circuit indicators to quickly and easily locate faulted sections of cable systems. These faulted circuit indicators (FCI) can be installed on pad-mounted distribution transformers, sector cabinets, switchgear and overhead bare conductors. The closed core current transformer (CT) senses the fault current and provides power to operate the FCI. The unit automatically resets back to the normal position when the continuous current exceeds the 2.0 A minimum reset value. CR FCIs provide a reliable means of fault location and isolation.

The PATHFINDER variable trip current reset FCI features a trip design that senses normal load current and indicates a fault when a significant rise in current, followed by a loss of current, is detected. Hence, there is no need to specify a particular trip rating when ordering the variable trip current reset FCI. This design ensures fast, reliable and accurate operation.

Variable trip current reset FCIs provide a reliable means of fault location and isolation. They also eliminate fault chasing methods that are costly and time consuming, and stressful on system components exposed to fault currents.

Construction

S.T.A.R. variable trip current reset fault indicators consist of a sensor unit with an integral Eaton's Cooper Power series FISHEYE™ target display. The closed core CT is used for both sensing the fault current and providing power to operate the FCI. The FISHEYE display provides 180° visual indication. This unique orange reflective target designates a faulted condition and a black target designates a normal condition. The FISHEYE display also features a Lexan® cover that provides superior scratch protection for the target window. The sensor unit itself features a clamping mechanism and unique spring action CT design that allows easy snap-on connection to the live conductor with the use of a single clampstick.

The sensor housing is made of durable, corrosion resistant materials. The electronic components are completely encapsulated to prevent environmental damage.

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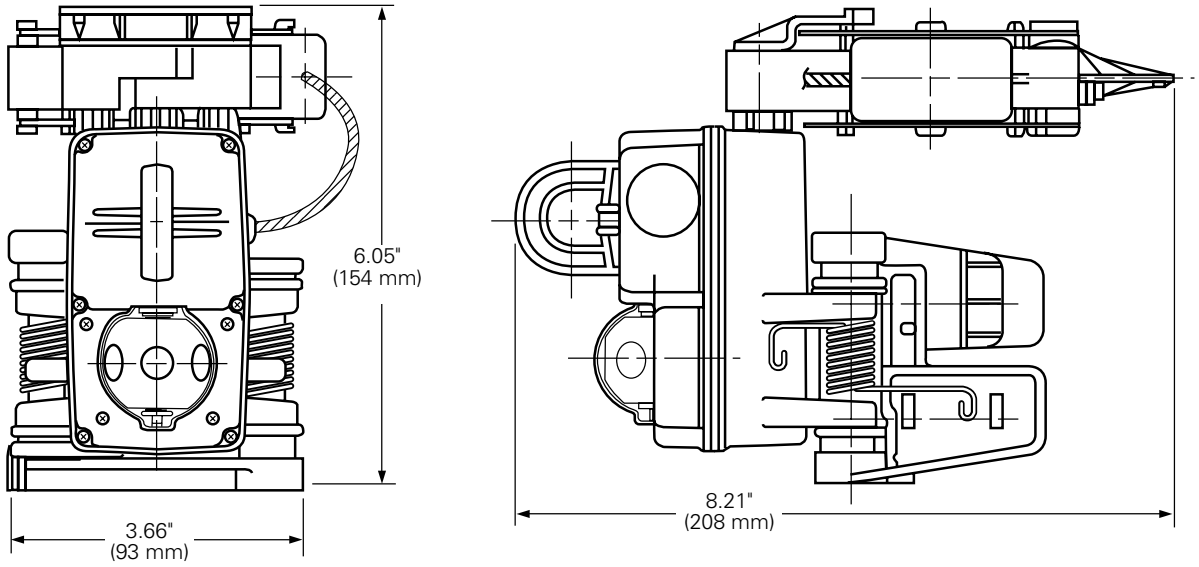

Figure 1. Features and dimensions of a variable trip CR faulted circuit indicator (shown in the "armed" position).

Trip rating

The S.T.A.R. PATHFINDER variable trip current reset FCI features a load sensing design, and trips on a current rise of a particular magnitude over time. Therefore, there is no need to specify a trip rating when ordering the variable trip FCI. The very same FCI can be used on cable diameters from 0.25" (6.4 mm) to 2.0" (51 mm). Therefore, it is not necessary to specify a cable diameter when placing an order.

Design features

The **variable trip design** eliminates the need to specify a trip rating for the FCI. The load sensing feature adjusts the FCI to normal load conditions. When a fault occurs, the unit senses the rise in system current caused by the fault, followed by the loss of system power due to operation of the protective device. Thus, the variable trip FCI provides a "one size fits all" FCI, reducing inventory and eliminating problems caused by misapplication of FCIs.

An **inrush restraint** feature eliminates false tripping and is standard on all units. The S.T.A.R. faulted circuit indicator will ignore inrush currents caused by reclosing operations of protective devices on the system. A power loss of 1 cycle (16 rms) will activate the inrush restraint feature.

A **low pass filter**, also a standard feature, will prevent the S.T.A.R. faulted circuit indicator from tripping on high frequency transients like those caused by capacitive discharges.

The quick response time of the S.T.A.R. current reset faulted circuit indicator provides easy coordination with current-limiting fuses and other protection devices (see Figure 4).

This unique combination of standard features makes the S.T.A.R. faulted circuit indicator extremely reliable.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed ANSI/IEEE Std 495™-1986 standard "Guide for Testing Faulted Circuit Indicators".

100% automated production testing verifies the trip rating, the reset circuit and the inrush restraint feature.

The electronic components are completely encapsulated to prevent any environmental damage.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Requirements	Min. 2.0 A Continuous
Max. Operating Voltage	45 kV L-L
Reset Time	5 Minutes Max. at 2.0 A
Trip Current	100 A rise from load current;
Min. Pickup Level	200 A total (load plus fault current)
Trip Response Speed	Response Curve, Figure 4
Fault Withstand Capability	25 kA for 10 Cycles per ANSI/IEEE Std 495™-1986 standard
Temperature Range	-40 ˚C to +85 ˚C
Materials	Corrosion-resistant & submersible per ANSI/IEEE Std 495™-1986 standard
Weight	27.2 ounces (0.77 kg)
Conductor Size	0.25" through 2.0"

Installation

All units are shipped to the customer in the tripped condition. The status of the display cannot be changed mechanically in handling. After the unit is installed, the energized system will reset the FISHEYE target from the tripped position to the normal position.

Installation is quick and easy. No special tools are required. The patented clamping mechanism and the unique spring action CT of the sensor provides for easy installation on an energized system using a single clampstick.

Clamp arm pads are used for cable diameters from 0.25" (6.4 mm) to 1.0" (25 mm). For cable sizes from 1.0" (25 mm) to 2.0" (51 mm) the clamp arm pads are removed. Refer to *Service Information S320-77-1 S.T.A.R. PATHFINDER Variable Trip Current Reset FCI Installation Instructions* for more information.

Options

Remote FISHEYE display

The remote FISHEYE display provides 180° visual indication of FCI operation. This unique orange reflective target fits a standard remote indicator window that exists in many pad-mounted transformer specifications.

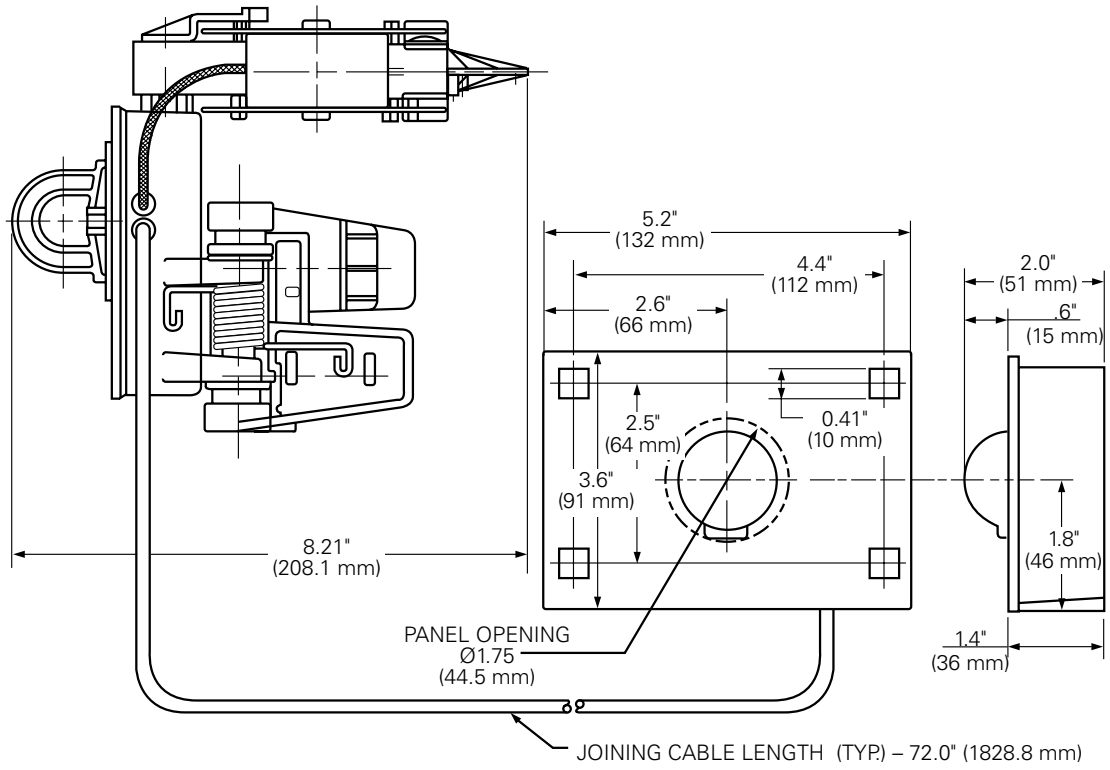

Figure 2. Features and dimensions of the variable trip CR faulted circuit indicator with remote FISHEYE display.

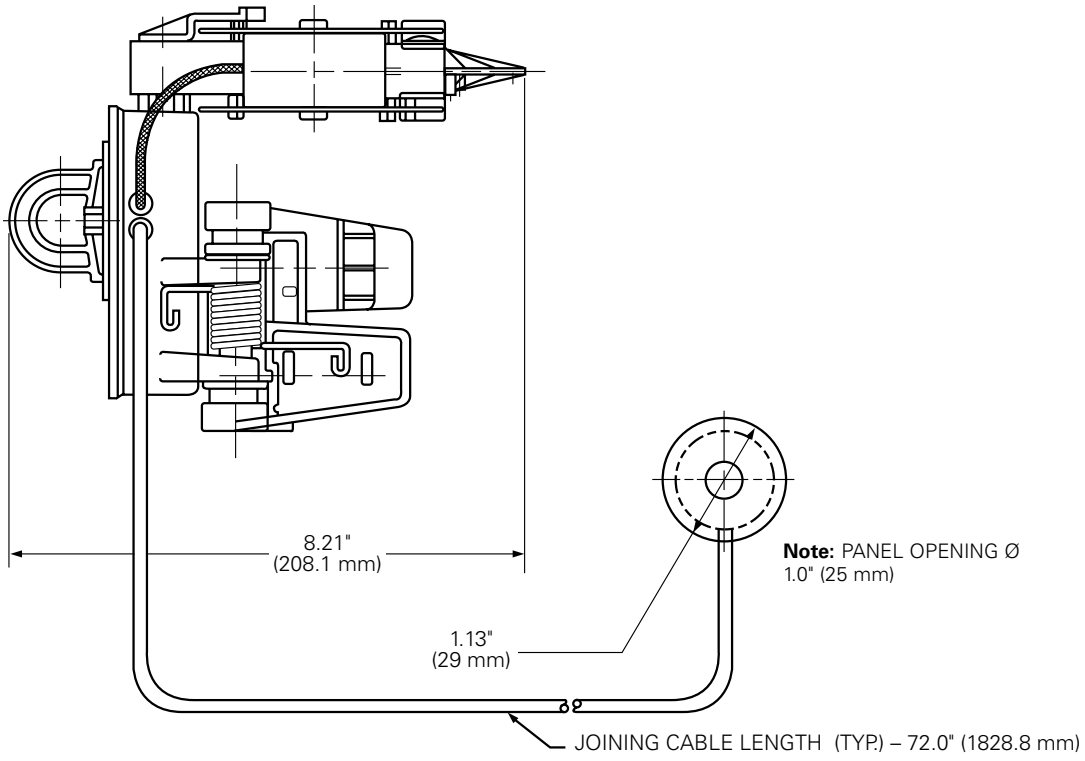

Figure 3. Features and dimensions of the variable trip CR faulted circuit indicator with small remote display.

Small remote display

The variable trip current reset faulted circuit indicator is also available with a small remote display. The remote flip target display easily retrofits to pad-mounted cabinets with a single hole installation.

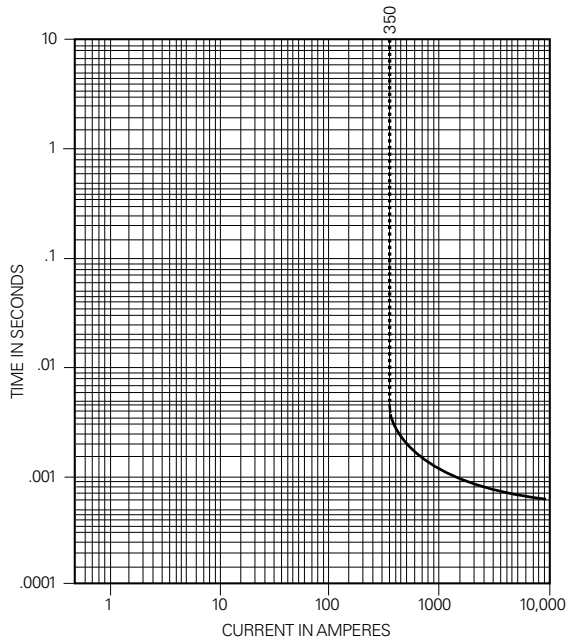

Figure 4. Pathfinder Variable Trip CR faulted circuit indicator minimum response curve.

Auxiliary Contacts

Auxiliary Contacts can be added to the standard unit and provide an additional data collection point when used on circuits connected to a SCADA system. The magnetic latching circuit that operates the auxiliary contact ensures a reliable indication.

Figure 5. Remote FISHEYE display.

Figure 6. Small remote display.

Table 2. S.T.A.R. Current Reset Faulted Circuit Indicator Ordering Information

S.T.A.R. Variable Trip Current Reset Type FCI Ordering Information

← Standard → ← Options →

Digits: 1 2 3 4 5 6

S C V T

S.T.A.R. FCI Line

Example: A Variable Trip Current Reset FCI would have a catalog number SCVT as shown.

FCI Type

Digit 2	Type
C	Current Reset

Trip Rating

Digits 3	Digits 4	Trip Rating
V	T	Variable Trip

Options

Digits 5	Digits 6	Descriptions
A		Standard Indicator with auxiliary contacts
R		*Standard Indicator with remote FISHEYE display
A	R	*Standard Indicator with auxiliary contacts and remote FISHEYE display
S		*Standard Indicator with small remote display
A	S	*Standard Indicator with auxiliary contacts and small remote display.

* Standard indicator with remote display and/or auxiliary contacts provided with 6 ft. cable lengths as standard.

Notes:

1. The S.T.A.R. FCI catalog number may vary in length from 4 digits to 6 digits.
2. The standard S.T.A.R. FCI catalog number may be truncated after entering digits 1-4. Options may be selected by adding the appropriate design code to digits 5 and/or 6.

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Eaton's Cooper Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Cooperpower.com

Printed in USA
Publication No. CA320009EN

For Eaton's Cooper Power series variable trip current reset faulted circuit indicator product information call 1-877-277-4636 or visit: www.cooperpower.com.

Powering Business Worldwide

S.T.A.R.™ hot line voltage indicator faulted circuit indicators

Description

Eaton identifies an energized circuit by the pulsating of its high intensity LED display with its Cooper Power™ series S.T.A.R.™ hot line voltage indicators. These voltage indicators can be used on both 200 A separable connectors and 600 A terminators with a voltage test point. The removable sleeve allows for use on major manufacturers' loadbreak elbows. The hot line (HL) voltage indicator is encased in a weatherproof one-piece housing that can be easily installed with a single clampstick using the pulling eye.

The S.T.A.R. hot line voltage indicator provides a reliable means of identifying energized circuits. HL voltage indicators are useful on vault applications where it may be difficult to identify energized and de-energized conductors.

⚠ WARNING

This device should not be used as the only indication that a circuit is energized or de-energized. Always use an approved test means to be certain that the circuit is de-energized for deadbreak operation.

Construction

The S.T.A.R. hot line voltage indicator is a one-piece housing that can be easily installed with a hotstick using the pulling eye. The unit consists of a sensor unit with an integral high intensity LED display. The LED flashes when line voltage is present. The polycarbonate display is made of Lexan® giving the exposed LED window tamperproof and scratch-resistant protection.

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed applicable ANSI/IEEE Std 495™-1986 standard "Guide for testing Faulted Circuit Indicators". 100% automated production testing verifies the voltage indication.

The electronic components are completely encapsulated to prevent any environmental damage.

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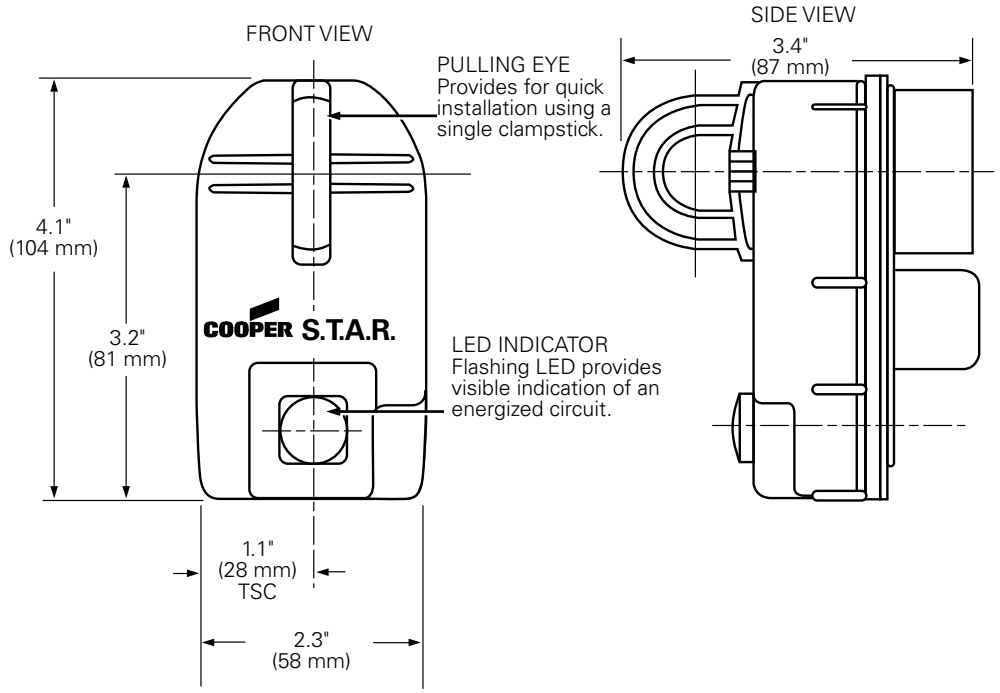


Figure 1. Features and dimensions of a Hot Line voltage indicator.

Installation

Installation is quick and easy. No special tools are required. The pulling eye of the sensor provides for easy installation on the test point of an energized system using a single clampstick. The hot line voltage indicator easily adapts to most manufacturers' separable connector products. An additional adapter kit may be needed for some manufacturers' older style test points. Please refer to *Service Information S320-80-1 S.T.A.R. Hot Line Voltage Indicator Installation Instructions* for installation details.

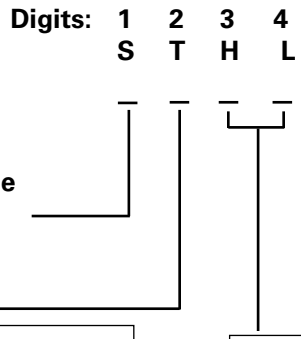
Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Power Requirements	Min. 2.4 kV L-G
Operating Range	2.4 kV to 19.9 kV L-G
Fault Withstand Capability	25 kA per ANSI/IEEE 495™-1986 standard
Temperature Range	-40 °C to +85 °C
Materials (Conductive EDPM Rubber)	Corrosion resistant & submersible per ANSI/ IEEE Std 495™-1986 standard
Weight	8.56 ounces (0.24 kg)
Elbow Rating (All Manufacturers)	200 & 600 A and 15, 25 & 35 kV Class

Table 2. TABLE 2 S.T.A.R. Hot Line Voltage Indicator Ordering Information

Catalog Number

The Hot Line Voltage Indicator would have a catalog number STHL (as shown below).



Digit 2	Type
T	Test Point

Digits		
3	4	Description
H	L	Hot Line Voltage Indicator

Description	Catalog No.
Adapter Kit for Non-standard Test Points	STAK

Eaton
1000 Eaton Boulevard
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Eaton.com

Eaton's Cooper Power Systems Division
2300 Badger Drive
Waukesha, WI 53188
United States
Cooperpower.com

Printed in USA
Publication No. CA320010EN

For Eaton's Cooper Power series hot line voltage indicator faulted circuit indicator product information call 1-877-277-4636 or visit: www.cooperpower.com.

Powering Business Worldwide

S.T.A.R.™ faulted circuit indicators programmable delayed reset type (SDOH)

Description

Eaton designs its Cooper Power™ series S.T.A.R.™ programmable delayed reset faulted circuit indicators to quickly and easily locate faulted sections of overhead systems. This faulted circuit indicator (FCI) is designed for use on overhead bare conductors. A long-life lithium battery provides power to indicate the faulted conditions using two highly visible LED indicators. The unit is capable of being programed with any one of five delay times. This FCI can also be quickly reset using the optional manual testing/reset tool (SMRT), and programmed to indicate a temporary fault when required. FCIs provide a reliable means of fault location and isolation. They also eliminate fault chasing methods that are costly and time consuming, and very stressful on system components exposed to fault currents. The S.T.A.R. programmable delayed reset faulted circuit indicator (SDOH FCI) is ideally suited for temporary use as a testing tool or permanent overhead installation. The temporary fault detection feature also allows the unit to be used to detect general fault location in applications where an intermittent fault causes recloser operation.

Construction

SDOH FCIs consist of a sensor unit with an integral dual LED indicator powered by a lithium battery. Rugged solid-state construction ensures dependability and accuracy. Installation can be achieved on a wide range of cable diameters with a single hotstick. The sensor unit itself features a clamping mechanism design that allows easy snap-on connection to the live conductor with the use of a single hotstick.

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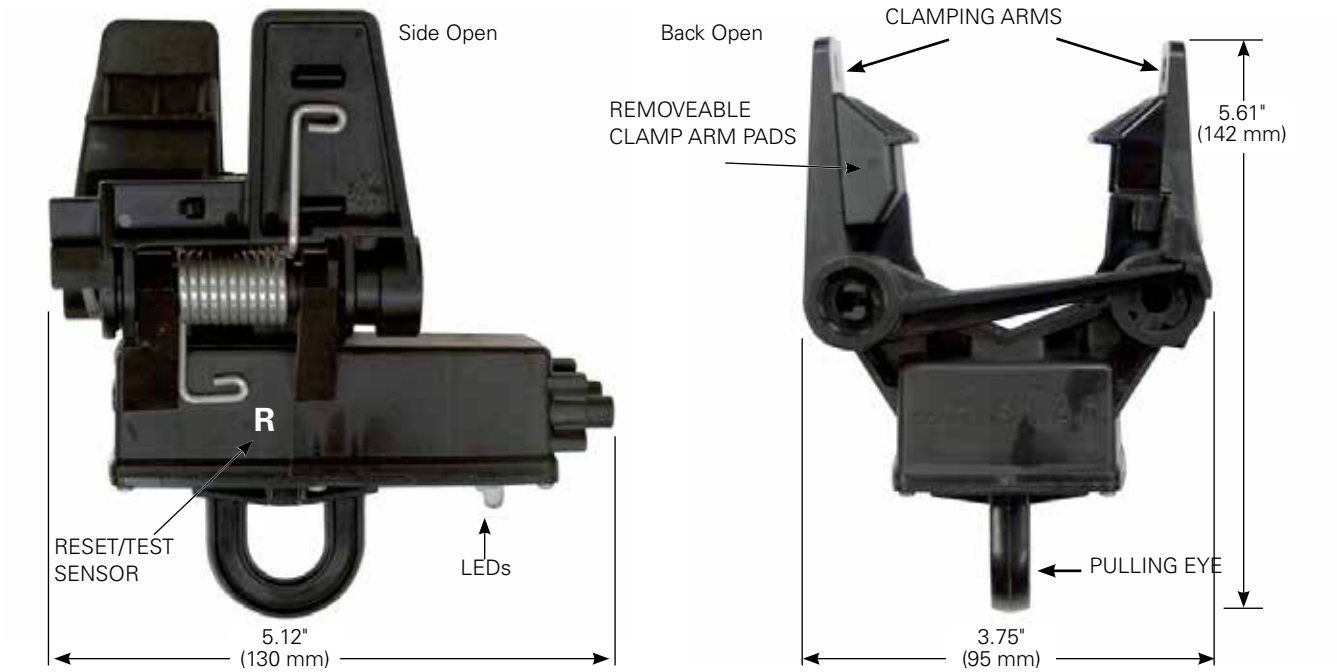

Figure 1. Features and dimensions of a SDOH faulted circuit indicator (shown in the "armed" position).

Trip rating

The SDOH FCI is equipped with self adjusting trip that features a load sensing design. This FCI automatically adjusts the trip rating based on the average load current it reads at the location.

SDOH FCI defines fault as high current over trip point followed by loss of power for a minimum of 60 seconds. The SDOH FCI has two trip points, 175 and 800 A. The trip point of the SDOH FCI adjusts to the load current at the installation location. The trip point starts at 175 A. When nominal current rises above 53 A, the trip point becomes 800 A. Nominal current must fall below 43 A to change trip point back to 175 A.

Design features

The SDOH FCI automatically resets back to the normal indication when the programmed reset time has expired. The unit can be field programmed with delay times of 2-hour, 4-hour (factory default), 8-hour, 24-hour or manual reset.

The SDOH FCI is capable of indicating permanent and temporary faults. By default, the SDOH FCI will only indicate a permanent fault. To detect a temporary fault, follow programming instructions in *Service Instructions, MN320001EN S.T.A.R. Faulted Circuit Indicator Programmable Delayed Reset Type SDOH Installation Instructions*.

Note: When in temporary fault mode: 1) the red LEDs in the SDOH FCI will also indicate a permanent fault if power is lost for more than 60 seconds, 2) delay reset time will mimic delay time set in permanent mode up to 8 hours.

The SDOH FCI is constructed using tough, durable, corrosion-proof, submersible materials.

The lithium battery has a ten (10) year shelf life and provides a minimum 500 hours of flashing time for the high intensity LED indicator. This is enough for 125 fault events when using 4-hour delay time.

In addition to the self-adjusting trip design, an inrush restraint feature eliminates false tripping and is standard on all units. The SDOH FCI will ignore inrush currents caused by reclosing operations of protective devices on the system.

Table 1. Electrical Ratings and Characteristics

Description	Ratings and Characteristics
Catalog Number	SDOH
Power Requirements	1.2 AH Lithium Battery (non-replaceable)
Reset Time	Field Configurable 2, 4 (default), 8, 24 Hours or manual reset
Trip Current	Self-Adjusting, 175 A Low, 800 A High
Mode of Indication	Dual LEDs
Min Operating Voltage	5.0 kV
Max Operating Voltage	69 kV L-L
Fault Withstand Capability	25 kA for 10 Cycles per IEEE Std 495™ -2007 standard
Temperature Range	-40 °C to +85 °C
Materials	Corrosion-resistant & submersible per IEEE Std 495™-2007 standard
Weight	13.3 ounces (.38 kg)
Conductor Sizes Accepted	0.25" (6.4 mm) through 2.0" (51 mm)

Testing

S.T.A.R. faulted circuit indicators are made of corrosion resistant materials and meet or exceed IEEE Std 495™-2007 standard "Guide for testing Faulted Circuit Indicators".

100% automated production testing verifies the trip rating and the reset time.

The electronic components are completely encapsulated to prevent any environmental damage.

Installation

Installation is quick and easy. No special tools are required. The patented clamping mechanism of the sensor provides for easy installation on an energized system using a single hotstick.

Testing and setting the SDOH FCI can be done by touching the reset tool (catalog number SMRT) to the side of fault indicator marked by "R". See Table 2 for programming directions.

The unit is manually reset by touching the upper left corner marked "R" with the reset tool for two (2) seconds. Upon manual reset, the unit will "flash back" the number corresponding to reset hours to which the FCI has been set. See Table 2 for how many flashes correspond to each reset time. The reset procedure also provides positive indication of battery operation. In the case of a low battery, upon reset LEDs will flash yellow corresponding to the current reset time.

Refer to *Service Information, MN320001EN S.T.A.R. Faulted Circuit Indicator Programmable Delayed Reset Type SDOH Installation Instructions* for more information.

Options

Testing/reset tool

The manual testing/reset tool can be ordered using catalog number SMRT.

Programming information

To put the SDOH FCI into program mode, hold the SMRT tool near "R" on side of FCI until one yellow flash appears (approximately ten (10) seconds) then remove. The FCI will flash back current reset time corresponding to Table 2.

To change the reset time once the SDOH FCI is in program mode, hold the SMRT tool until the next reset time has flashed then remove. When in program mode, holding the reset tool over "R" will increment the reset time and respond by flashing confirmation corresponding to Table 2.

For complete programming, installation, testing and resetting instructions, please refer to our *Service Information, MN320001EN S.T.A.R. Faulted Circuit Indicator Programmable Delayed Reset Type SDOH Installation Instructions*.

Table 2. Reset Times

FCI Reset Time	Program Confirmation (LEDs Flash Back)
2-hour	1 time (green)
4-hour (factory default)	2 times (green)
8-hour	3 times (green)
24-hour	4 times (green)
Manual Reset	2 times (red)

Note: Once desired reset time is reached, wait ten (10) seconds, remove the tool and the FCI will flash back the set time confirmation three (3) times, then rapid green /red indicating the unit is ready for installation.

Table 3. SDOH FCI Ordering Information

Description	Catalog Number
FCI	SDOH
Reset Tool	SMRT

Ordering information

To order a S.T.A.R. Faulted Circuit Indicator Programmable Delayed Reset Type SDOH, see Table 3.

Additional information

Refer to the following literature for more information.

MN320001EN	S.T.A.R. Faulted Circuit Indicator Programmable Delayed Reset Type SDOH Installation Instructions
B320-03014	Overhead Fault Indication Made Easy with S.T.A.R., Programmable Delayed Reset Overhead Type Faulted Circuit Indicators
B320-03013	Cost Effective Tools for Finding the Fault Faster and Reducing Outage Duration

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