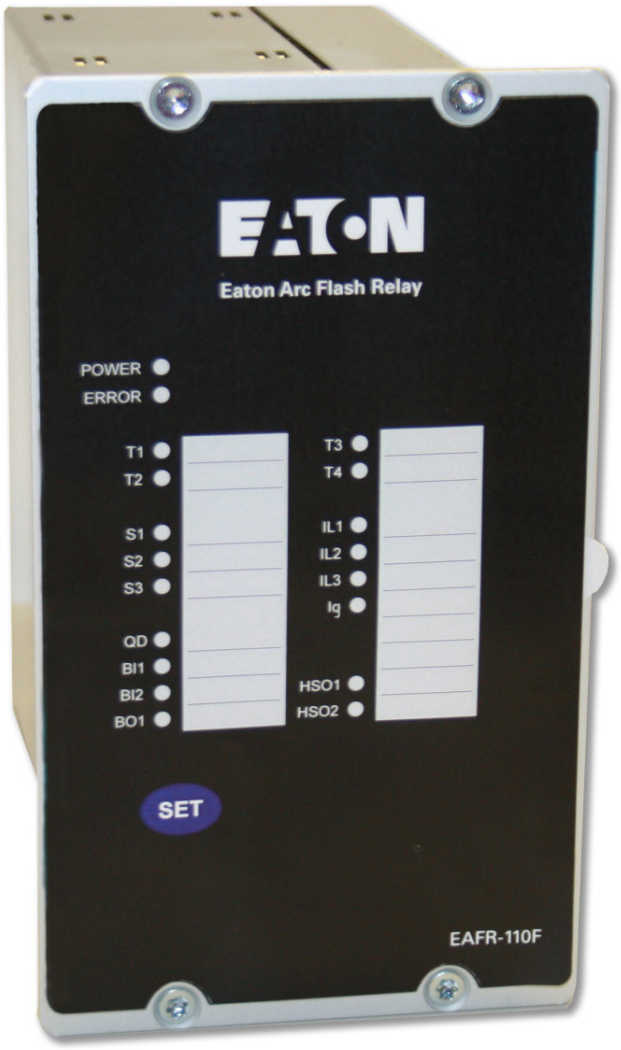
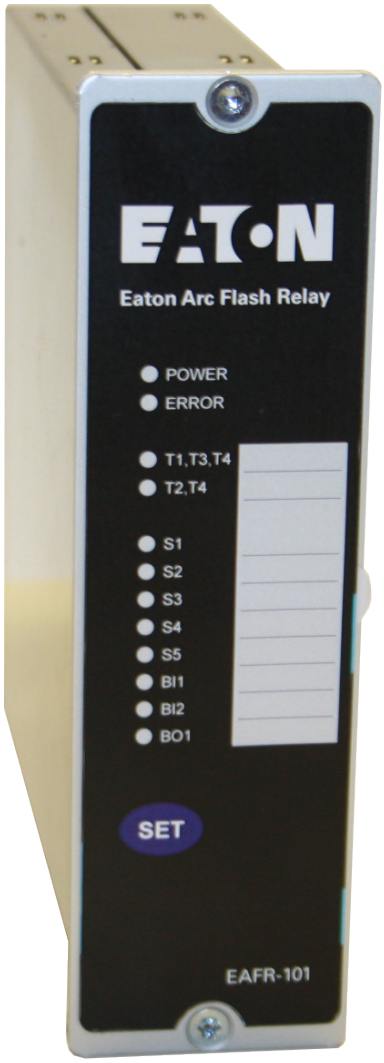
Eaton Arc Flash Relay System



EAFR-110F



EAFR-101

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Contents

1. Introduction

The Eaton Arc Flash Relay (EAFR) system is a combination of arc flash relay modules and sensors designed to detect and clear arc flash events in low and medium voltage electrical assemblies.

An arc fault is the most devastating type of fault in medium voltage (MV) and low voltage (LV) switchgear. If an arc fault occurs, the EAFR system reduces arc energy by quickly clearing the current feeding the arc.

The EAFR system can measure both light and current to eliminate nuisance operation. In addition, it's modular design makes it an excellent candidate for both new and retrofit installations.

2. Overview

2.1 Speed

- As fast as 2 ms operate time.

2.2 Flexibility

- Easy adaptation to any switchgear and trip scheme.
- Variety of arc sensors available.
- Long distance possible between units.
- Practically an unlimited number of units can be interconnected in one system.

2.3 Reliability

- Standard copper wire for communication between units.
- Superior isolation levels for external disturbances - tested at the highest EMC classes.
- Full internal monitoring of all system components and interconnections.

2.4 Typical Applications

- Low voltage switchgear/switchboards
- Medium voltage switchgear
- Low/medium voltage motor control

3. Features

3.1 Protection Features

The EAFR system is a sophisticated micro-processor based arc flash protection system with combined current and arc sensing. Combined current and arc sensing provides an integrated dual trip criteria. It is designed to minimize the damage caused by an arcing fault (arc flash) by tripping the circuit breaker sourcing the fault current.

- Three phase instantaneous overcurrent elements (50P) (Permissive only with light input)
- Ground instantaneous overcurrent element (50G) (Permissive only with light input)
- Breaker failure (50BF)

3.2 Current Sensing

The main units EAFR-110F and EAFR-110P each contain four current transformer inputs that provide sensing for the phase and ground instantaneous overcurrent elements. These elements act as a permissive for the light sensing inputs so that when they are incorporated into the scheme both current and light must be present to initiate a trip command. This current information can be shared with downstream modules as well.

3.3 Light Sensing

Arc flash light can be collected by either point sensors or fiber loop sensors. Up to 12 point sensors or 3 loop sensors can be connected to each module. Light sensing can initiate a breaker trip independent of current if desired. Because point sensors are interconnected with copper wire they can provide a much better installation for Electrical OEM's where the system can be fully wired and tested in the factory. Sensor wiring allows daisy chaining up to three sensors over a distance of 100 meters. Fiber loop sensors are available in either plastic or glass versions. Point sensors are available in multiple sensitivity levels with the 8K lux sensor being suitable for most applications.

- Point sensors
  - Up to 12 sensors per module
- Fiber loop sensors
  - Up to 3 sensors per module

3.4 Relay Outputs

- Four Trip Relays per module (7 mS)
- Two High Speed outputs (2 mS – EAFR-110P, EAFR-110F)
- System failure relay

3.5 Indication

- Power available LED
- System health LED
- Trip relay activation LED's
- Sensor channel activation LED's
- Overcurrent element pickup LED's

3.6 Self Monitoring

Complete system self monitoring provides the highest level of dependability by continuously monitoring all internal system functions along with external connections between modules, light sensors or loops and current transformers.

3.7 Breaker Failure

The circuit breaker failure protection (CBFP) is initiated when a light signal and second trip criteria signal (e.g. over-current), if applicable, is active for above the set CBFP time of either 100 or 150 ms. The trip relay T2 and binary output BO1 will operate after the set time delay.

3.8 Communications

Because of the simplicity of the system, all monitoring is done through contact outputs on the modules. The advantage of this approach is that cybersecurity issues are non-existent.

3.9 Configuration

Easy configuration and setup with 4 dip switches to select one of many different standard sensor channel configurations for Light or Light & Current tripping.

Figure 1. Double Ended Substation Using Point Sensors.

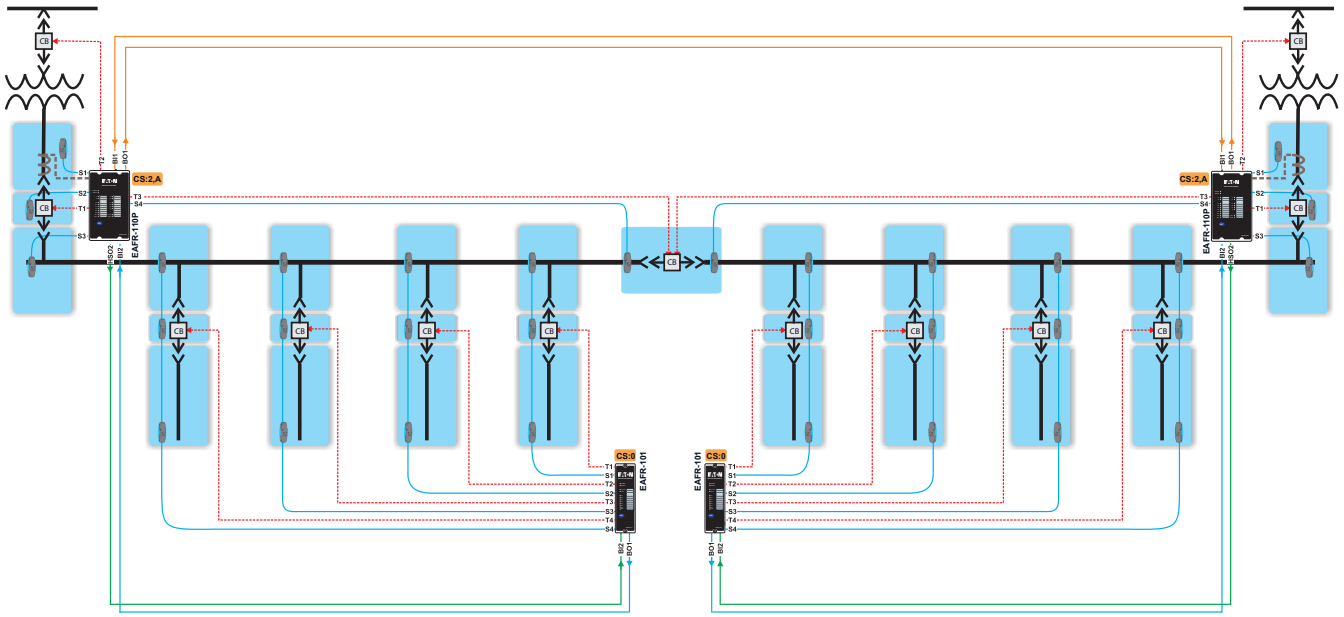


Figure 2. Double Ended Substation with Selective Feeder Trip Using Point Sensors.

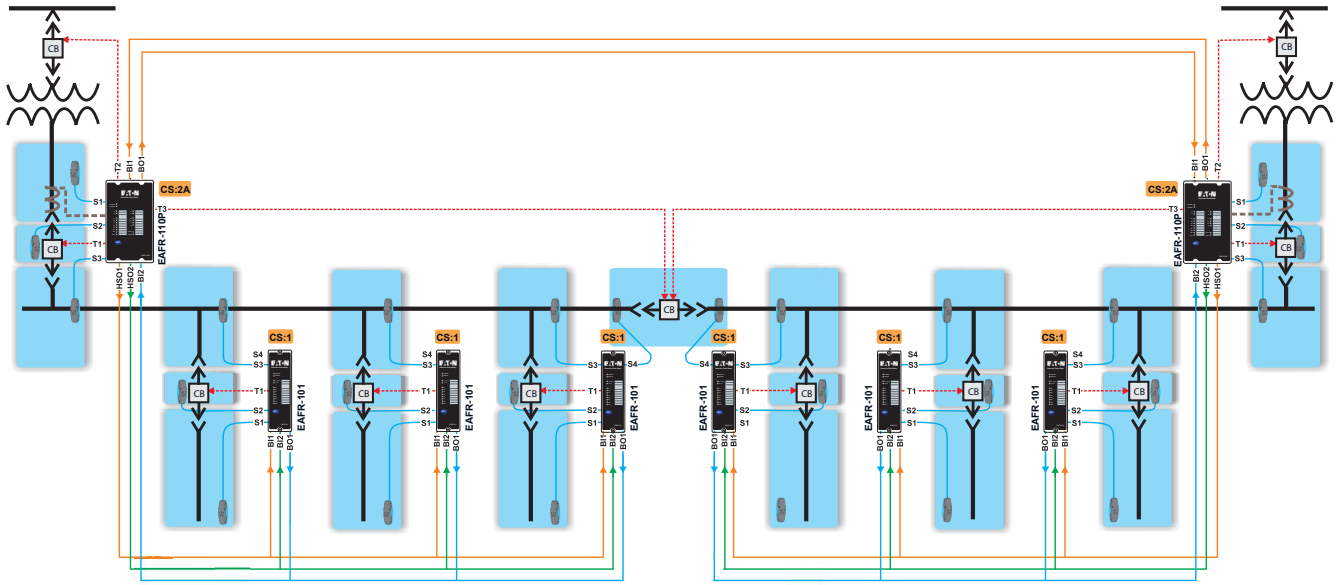
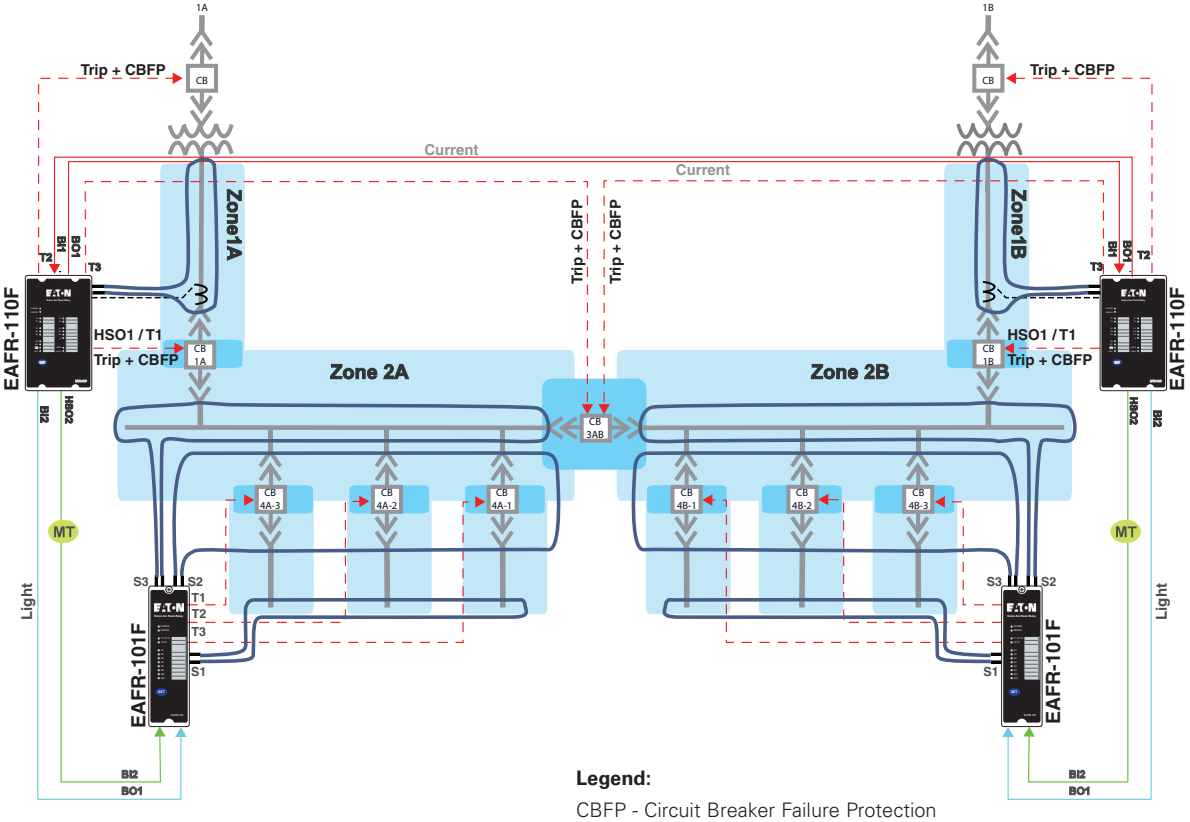


Figure 3. Double Ended Substation Using Fiber Loop Sensors.



Legend:

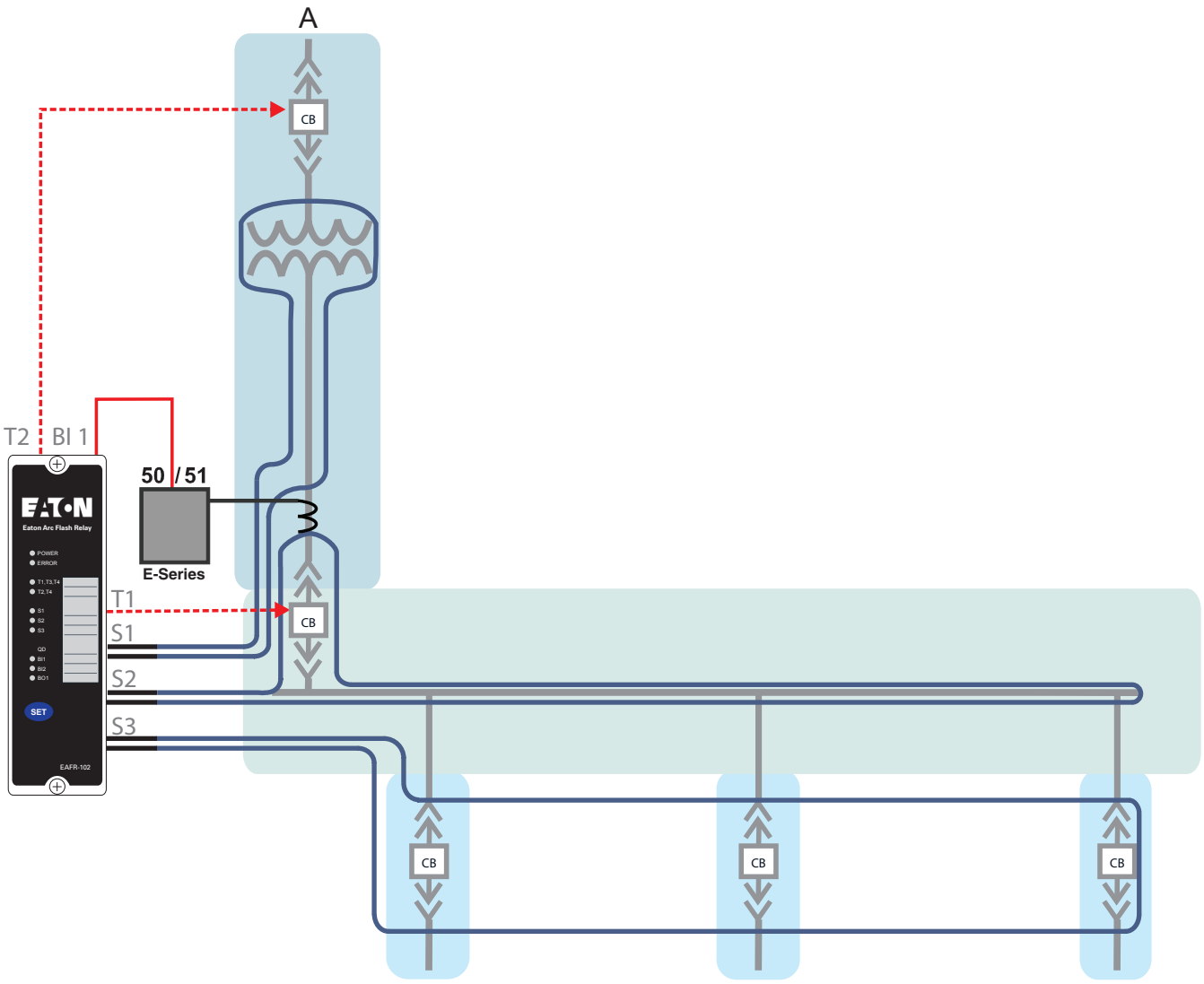
CBFP - Circuit Breaker Failure Protection

HSO - High Speed Output

T - Trip Output

MT - Multi trip

Figure 4. Single Ended Substation Using Fiber Loop Sensors and External Current Input.



4. EAFR Modules

Table 1. Arc Flash Relay Modules.

Features	EAFR-110F	EAFR-110P	EAFR-102	EAFR-101/D
3-Phase Current Detection	Yes	Yes	No	No
Ground Current Detection	Yes	Yes	No	No
Maximum Point Sensors	0	12	0	12
Maximum Fiber Loop Sensors	3	0	3	0
High Speed Outputs (2 ms)	2	2	0	0
Trip Relays (7 ms)	4	4	4	4

Figure 5. EAFR-110.

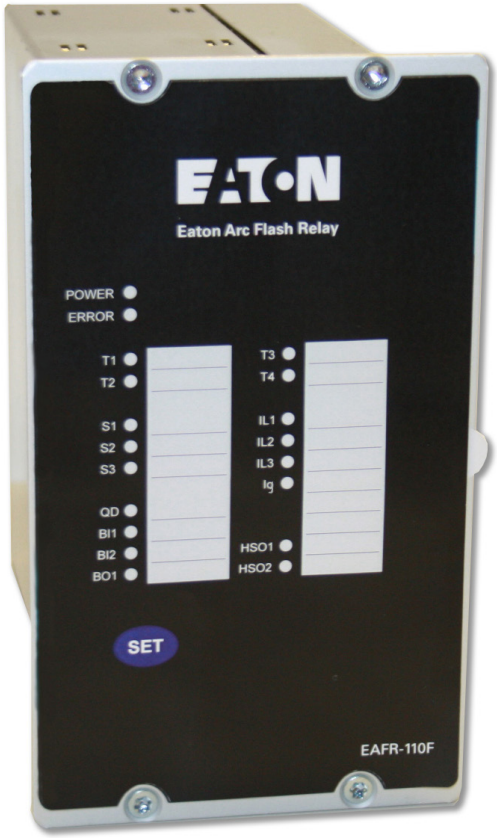


Figure 6. EAFR-101/102.

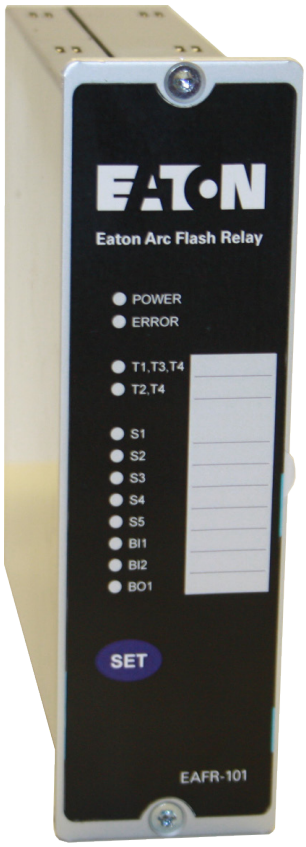


Figure 7. EAFR-101D.

5. Dimensions

Figure 8. EAFR-110 Dimensions in Millimeters (inches) – 3D View.

Figure 9. EAFR-110 Cutout for Panel Mounting in Millimeters (inches).

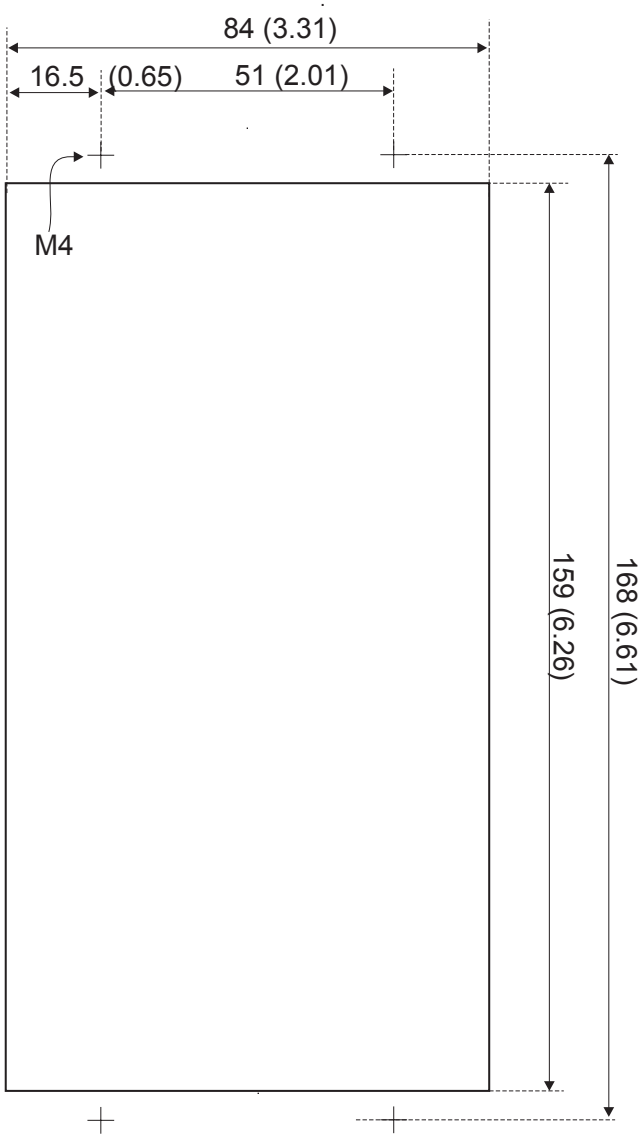


Figure 10. EAFR-102 Dimensions in Millimeters (inches) (Side View).

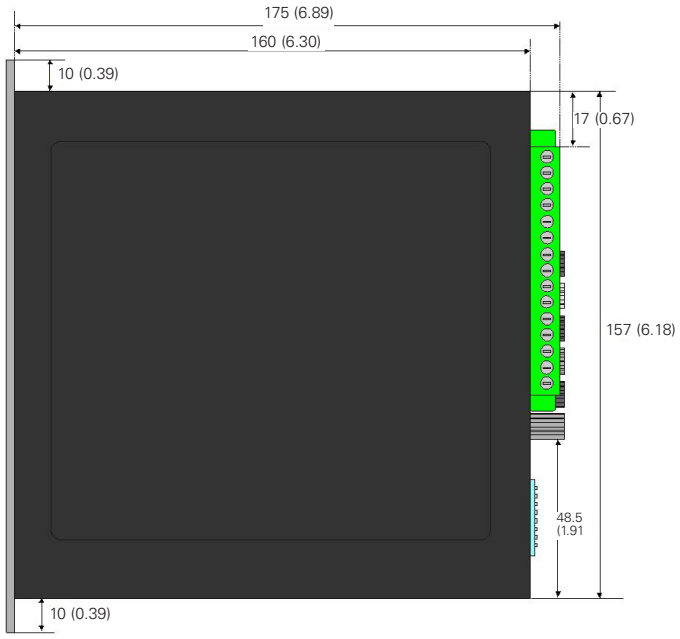


Figure 11. EAFR-101D Dimensions in Millimeters (inches) (Side View).

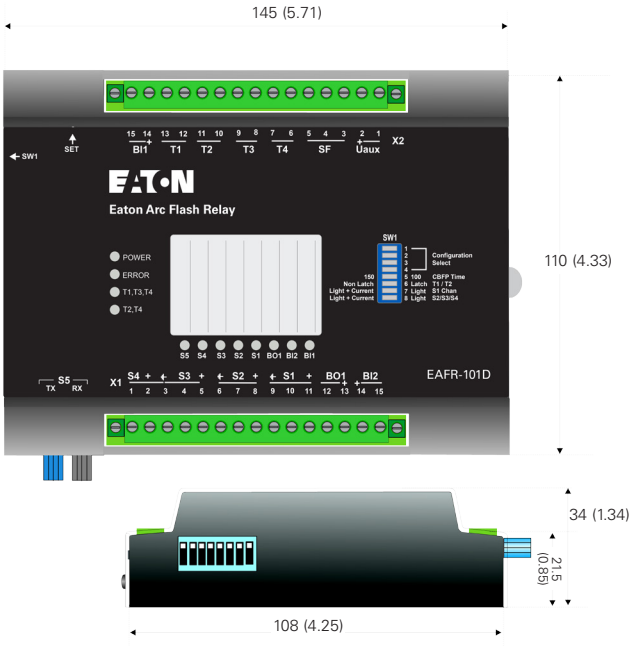
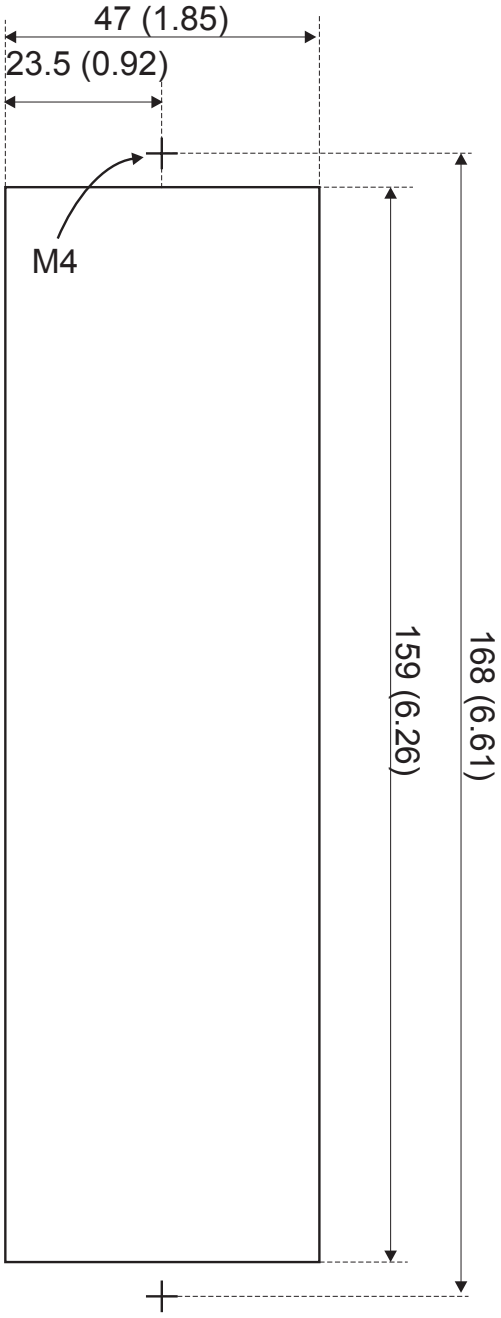


Figure 12. EAFR-102 Cut-out for Panel Mounting – Millimeters (inches).



6. Eaton Arc Flash Relay Sensors

Figure 13. EAFR-06 – Arc Light Plastic Fiber Sensor.

Figure 14. EAFR-07 – Arc Light Glass Fiber Sensor.

Figure 15. EAFR-01-A Point Sensor.

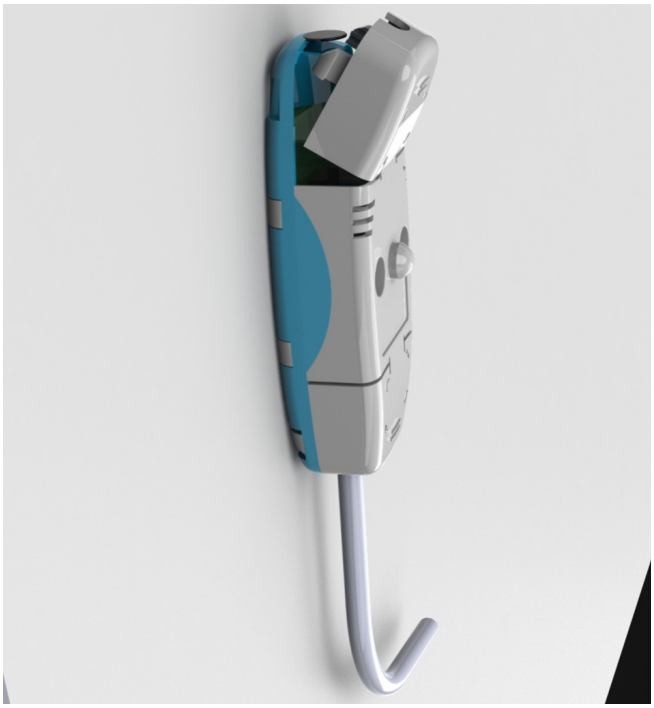
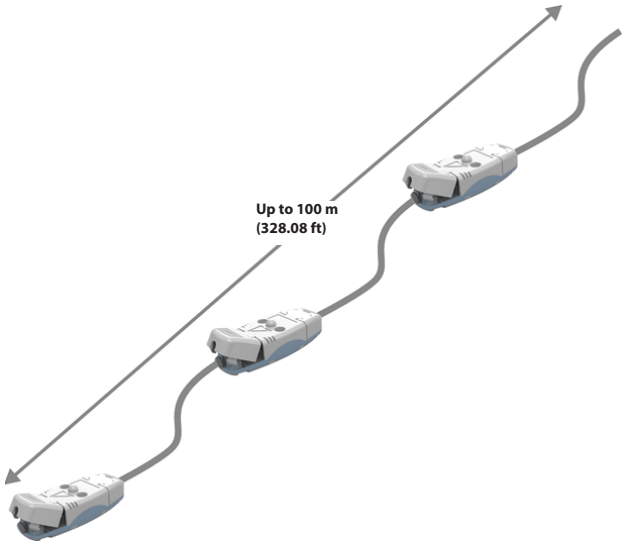


Figure 16. Length of EAFR-01-A Point Sensor Chain.



7. Technical Data

7.1 Protection Stages

Trip Time Using HSO	2 ms*
Trip Time Using Mechanical Trip Relays	7 ms*
Reset Time (Light Stage)	1 ms
Reset Time (Over-current Stages)	50 ms
Protection Operational After Power Up	50 ms
* = Total trip time using arc light or phase/earth over-current from EAFR-110 and arc light.	

7.2 Current Measuring Circuits

Nominal Current	1 or 5 A
Rated Frequency	2 to 1,000 Hz
Number of Inputs	3 (Phase) + 1 (Earth)
Thermal Withstand Continuous	30 A
Thermal Withstand 1 s	500 A
Thermal Withstand 10 s	100 A
Phase Over-current Setting Range	0.5 to 6 *In
Earth Over-current Setting Range	0.05 to 2 *In
Measurement Accuracy	10%
Rated AC Burden (VA)	Input Resistance 10 mΩ
Power Consumption of Current Inputs Circuit	<10 mΩ

7.3 Trip relays T1, T2, T3, and T4

Number	3 NO + 1 NC or 4 NO
Rated Voltage	250 Vac/dc
Continuous Carry	5 A
Make and Carry for 0.5 s	30 A
Make and Carry for 3 s	16 A
Breaking Capacity DC, When Time Constant L/R = 40 ms	40 W; 0.36 A at 110 Vdc
Contact Material	AgNi 90/10

7.4 High Speed Outputs HSO1 and HSO2

Number	2
Rated Voltage	250 Vdc
Continuous Carry	2 A
Make and Carry for 0.5 s	15 A
Make and Carry for 3s	6 A
Breaking Capacity DC, When Time Constant L/R = 40 ms	1 A/110 W
Contact Material	Semiconductor

7.5 Binary Output BO1

Rated Voltage	+24 Vdc
Rated Current	20 mA (max)
Number of Outputs	1

7.6 Binary Inputs BI1 and BI2

Rated Voltage	24
Rated Current	3 mA
Number of Inputs	2

7.7 Disturbance Tests

EMC Test	CE approved and tested according to EN 50081-2, EN 50082-2.
Emission	
- Conducted (EN 55011 class A)	0.15 - 30 MHz
- Emitted (EN 55011 class A)	30 - 1 000 MHz
Immunity	
- Static discharge (ESD) (According to IEC244-22-2 and EN61000-4-2, class III)	Air discharge 15 kV. Contact discharge 8 kV.
- Fast Transients (EFT) (According to EN61000-4-4, class III and IEC801-4, level 4)	Power supply input 4 kV, 5/50 ns Other inputs and outputs 4 kV, 5/50 ns
- Surge (According to EN61000-4-5 [09/96], level 4)	Between wires 2 kV / 1.2/50 µs. Between wire and earth 4 kV / 1.2/50 µs.
- RF Electromagnetic Field Test (According. to EN 61000-4-3, class III)	f = 80 to 1,000 MHz 10 V/m
- Conducted RF Field (According. to EN 61000-4-6, class III)	f = 150 kHz to 80 MHz 10 V

7.8 Voltage Tests

Insulation Test Voltage Acc - to IEC 60255-5	2 kV, 50 Hz, 1 min
Impulse Test Voltage Acc - to IEC 60255-5	5 kV, 1.2/50 us, 0.5 J

7.9 Mechanical Tests

Vibration Test	2 to 13.2 Hz ± 3.5 mm (0.14 in.) 13.2 to 100 Hz, ± 1.0 g (0.04 oz)
Shock/Bump Test Acc. to IEC 60255-21-2	20 g, 1,000 bumps/dir.

7.10 Casing and Package

Protection Degree (Front)	IP 50
Protection Degree (Back)	IP 20
Dimensions - W x H x D mm (W x H x D in.)	102 x 157 x 164 mm (4.02 x 6.18 x 6.46 in.)
Package dimensions (W x H x D) mm (in.)	230 x 120 x 210 mm (9.06 x 6.18 x 6.46 in.)
Weight	0.7 kg (24.69 oz) 1.0 kg (35.27 oz) (with package)

7.11 Environmental Conditions

Specified Ambient Service Temp. Range	-35 to +70°C (-31 to 158°F)
Transport and Storage Temp. Range	-40 to +70°C (-40 to 158°F)
Relative Humidity	Up to 97%

7.12 Approvals

UL/CUL Recognized File: E154862

8. Ordering Codes

8.1 EAFR Relay Codes

Eaton Catalog Number	Eaton Style Number	Part Number Description
EAFR-110P	65C2010G01	Current, point sensor unit
EAFR-110F	65C2010G02	Current, fiber loop sensor unit
EAFR-101	65C2010G03	Point sensor unit
EAFR-101D	65C2010G04	Point sensor unit, DIN rail mounted
EAFR-102	65C2010G06	Fiber loop sensor unit

8.2 EAFR-0x Arc Sensors

Eaton Catalog Number	Eaton Style Number	Part Number Description
EAFR-01-A	65C2011G01	Arc light point sensor - 8,000 Lux
EAFR-01-B	65C2011G02	Arc light point sensor - 25,000 Lux
EAFR-01-C	65C2011G03	Arc light point sensor - 50,000 Lux
EAFR-06-10	65C2013G01	Arc light plastic fiber sensor - 10 m (32.81 ft)
EAFR-06-15	65C2013G02	Arc light plastic fiber sensor - 15 m (49.21 ft)
EAFR-06-20	65C2013G03	Arc light plastic fiber sensor - 20 m (65.62 ft)
EAFR-06-25	65C2013G04	Arc light plastic fiber sensor - 25 m (82.02 ft)
EAFR-06-30	65C2013G05	Arc light plastic fiber sensor - 30 m (93.43 ft)
EAFR-06-35	65C2013G06	Arc light plastic fiber sensor - 35 m (114.83 ft)
EAFR-06-40	65C2013G07	Arc light plastic fiber sensor - 40 m (131.23 ft)
EAFR-07-10	65C2014G01	Arc light glass fiber sensor - 10 m (32.81 ft)
EAFR-07-15	65C2014G02	Arc light glass fiber sensor - 15 m (49.21 ft)
EAFR-07-20	65C2014G03	Arc light glass fiber sensor - 20 m (65.62 ft)
EAFR-07-25	65C2014G04	Arc light glass fiber sensor - 25 m (82.02 ft)
EAFR-07-30	65C2014G05	Arc light glass fiber sensor - 30 m (93.43 ft)
EAFR-07-35	65C2014G06	Arc light glass fiber sensor - 35 m (114.83 ft)
EAFR-07-40	65C2014G07	Arc light glass fiber sensor - 40 m (131.23 ft)
EAFR-07-45	65C2014G08	Arc light glass fiber sensor - 45 m (147.64 ft)
EAFR-07-50	65C2014G09	Arc light glass fiber sensor - 50 m (164.05 ft)
EAFR-08-10	65C2015G01	Arc light glass fiber sensor (High temperature) - 10 m (32.81 ft)
EAFR-08-15	65C2015G02	Arc light glass fiber sensor (High temperature) - 15 m (49.21 ft)
EAFR-08-20	65C2015G03	Arc light glass fiber sensor (High temperature) - 20 m (65.62 ft)
EAFR-08-25	65C2015G04	Arc light glass fiber sensor (High temperature) - 25 m (82.02 ft)
EAFR-08-30	65C2015G05	Arc light glass fiber sensor (High temperature) - 30 m (93.43 ft)
EAFR-08-35	65C2015G06	Arc light glass fiber sensor (High temperature) - 35 m (114.83 ft)
EAFR-08-40	65C2015G07	Arc light glass fiber sensor (High temperature) - 40 m (131.23 ft)
EAFR-08-45	65C2015G08	Arc light glass fiber sensor (High temperature) - 45 m (147.64 ft)
EAFR-08-50	65C2015G09	Arc light glass fiber sensor (High temperature) - 50 m (164.05 ft)

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

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