

# Sentinel™ EFI-CFZ

## EARTH FAULT INDICATOR

### USER'S MANUAL



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## 1. SAFETY NOTICE

Review the following safety precautions to avoid serious injury or death and to prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified. This equipment contains high voltages. Electrical shock can cause serious or fatal injury.

### PRECAUTIONS



**WARNING:** Under certain fault conditions, high voltages can be conducted into the earth fault indicator enclosure through the CT, remote indicator, or the auxiliary relay cables. All parts within the enclosure should be handled as if carrying dangerous voltages.



**WARNING:** Use extreme caution during the installation and use of the earth fault indicator as high voltages and currents may be present in the circuit.

- Ensure that the current sensor is installed at earth potential on the HV cable system.
- Ensure that the current sensor is installed on the screened part of the cable system.
- Use caution during the installation and use of this product; high voltages and currents may be present in the circuit.
- This product must be used only by qualified personnel practicing applicable safety precautions.
- Wear protective clothing and gloves as required.
- Do not install this product on live conductors.
- Always de-energize circuit before installing the current sensor and indicating unit.
- Always inspect the current sensor, indicating unit and all leads for damage before using the product.
- Do not use the product if damaged.

## 2. OVERVIEW

The Sentinel™ EFI-CFZ-50 is one of a family of Earth Fault Indicator (EFI) products that is designed to assist in the rapid location and isolation of earth faults on high voltage cable networks. The EFI can be used in radial networks or in openly operated ringed networks. When an asymmetrical current greater than 50A in a 3-phase cable system is detected an earth fault is indicated by means of a mechanical flag indicator. The path of the fault current from the feeding point to the fault location is marked by the triggered EFI's. The defective conductor segment is located between the last EFI which has been triggered and the first EFI which is still inactive.

## 3. FEATURES

- Current powered
- Flag indication
- Auxiliary relay output contact
- Remote indication driver
- Split-core current sensor
- 50A nominal trip
- 50ms minimum fault duration
- Split-core current transformer power supply
- Manual test and reset facility
- IP65 environment protection
- Rugged and reliable electronics
- ISO9001:2000 based quality assurance
- Electromagnetic compatibility

## 4. INSTALLATION

### 4.1 CURRENT SENSOR

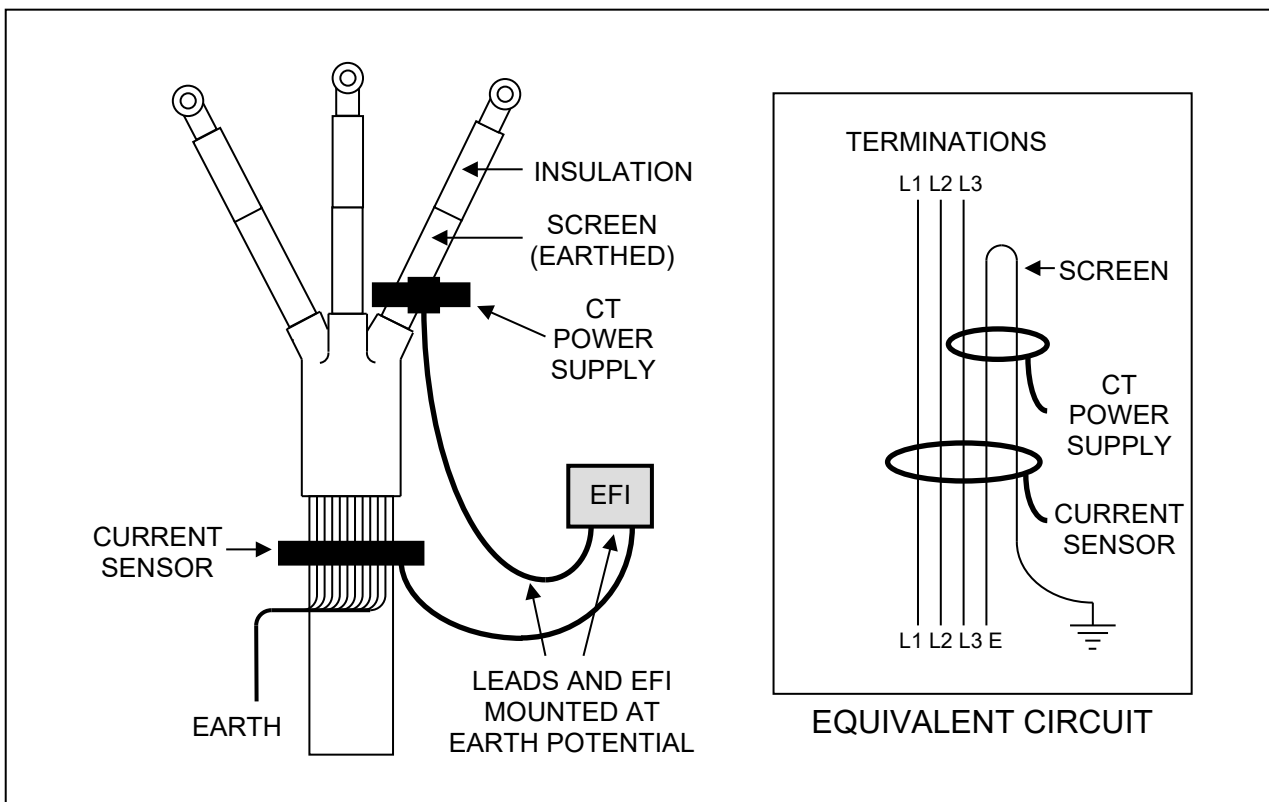
The Sentinel™ current sensor consists of a flexible steel core which is wrapped around the three-phase system to be monitored and fastened tightly in place with adjustable cable-ties. The current sensor is normally shipped fastened in a closed position. The cable-ties are released by depressing the small ratchet on the head while bending back the tail. The current sensor and associated leads must be installed at earth potential on the screened part of the cable and not go anywhere near the unscreened HV system. Also the current sensor should not encircle the cable earthing. This can easily be achieved by looping the earthing lead back down through the current sensor so as to bypass current sensor.

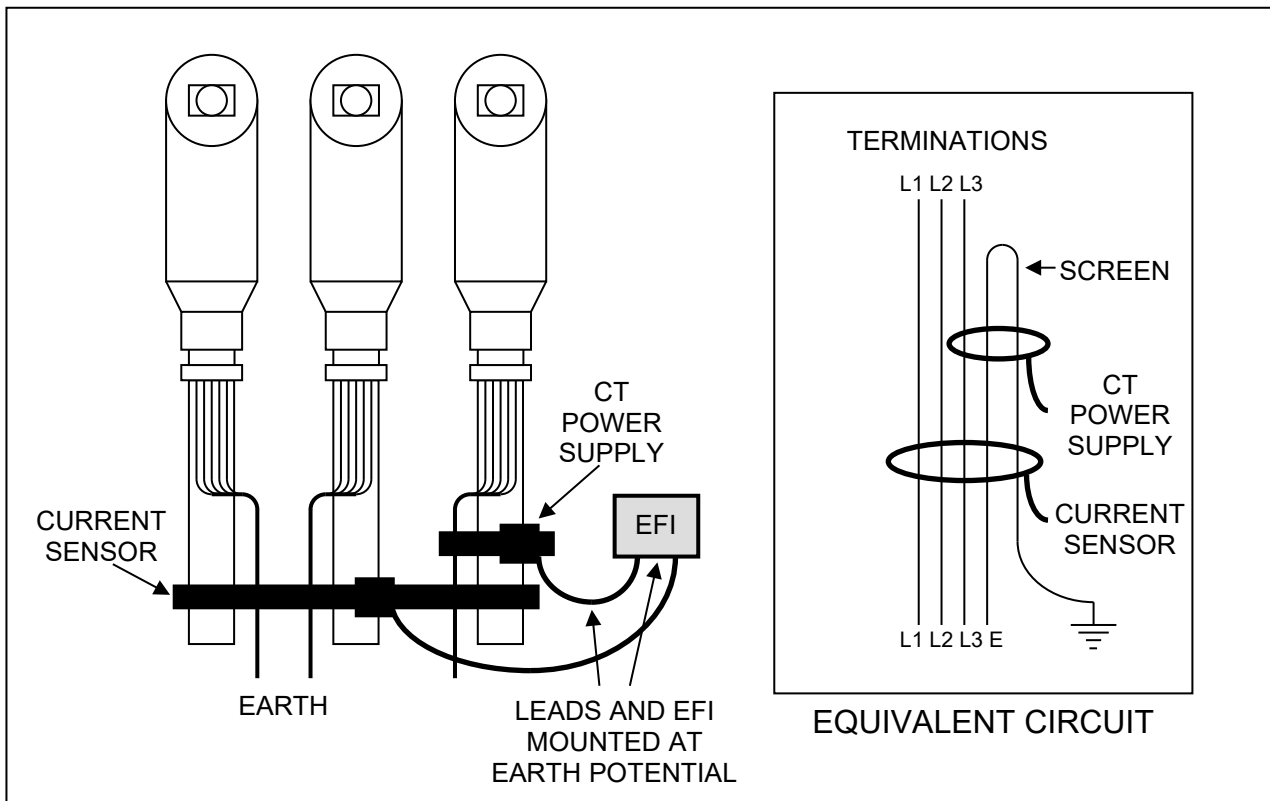
The current sensor is available in three different sizes depending on whether it is to be applied to an installation consisting of a multi-core cable or a system comprising of three single-core cables.

#### 4.1.1 MULTI-CORE CABLE SYSTEM

The Sentinel™ EFI ships with a standard sized (CT100) current sensor, which is suitable for most multi-core cable systems. A larger current sensor (CT150) is also available but must be specified at time of order. The flexible sensor core is mounted on the screened part of the cable, below the stripback point. The core is wrapped around the cable and the cable-tie is pulled tight as far as it will go. A second cable-tie is used to hold the core firmly onto the cable. The cable screen is turned back underneath the core and then terminated to earth as shown in the Figure 1.

**FIGURE 1: EFI INSTALLATION ON MULTI-CORE CABLE SYSTEM**



**FIGURE 2: EFI INSTALLATION ON SINGLE-CORE CABLE SYSTEM**

#### 4.1.2 SINGLE-CORE CABLE SYSTEM

A larger current sensor (CT300) is available for application on single core cable systems. These systems usually consist of three single-core cables spaced in a row, side-by-side. The flexible sensor core is wrapped tightly around all three cables forming a rectangular oval, and fastened in place with cable-ties. Care should be taken to ensure that the core and leads are mounted on the screened part of the cable. The screen of all three conductors should be turned back underneath the core and then terminated to earth as shown in Figure 2.

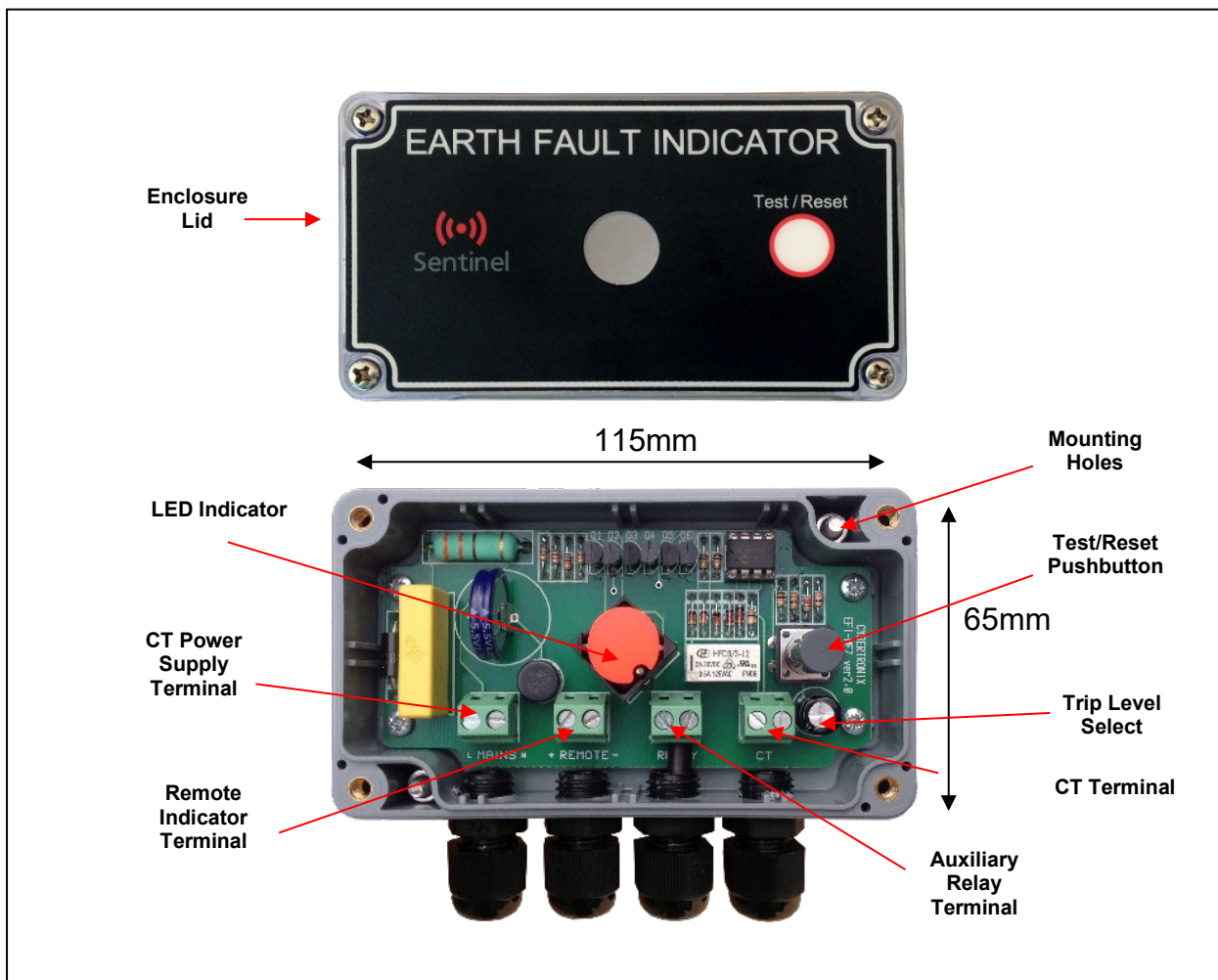
#### 4.2 CURRENT TRANSFORMER POWER SUPPLY

The Sentinel™ EFI-50CLZ unit is powered by using a split-core current transformer to draw power from load current flowing in one of the phases of the HV cable. The Sentinel™ CT power supply module consists of a flexible steel core which is wrapped around one of the phases being monitored and fastened tightly in place with adjustable cable-ties. The CT power supply is normally shipped fastened in a closed position. The cable-ties are released by depressing the small ratchet on the head while bending back the tail. The CT power supply module and its leads must be mounted on the screened part of the cable, at earth potential, as is shown in Figure 1 and Figure 2.

### 4.3 INDICATING UNIT

The Sentinel™ indicating unit is normally flush mounted onto a vertical surface. When the cover is removed, mounting holes are exposed for use in bolting the indicating unit to a surface. The current sensor and other accessories are electrically connected to the indicating unit by feeding the leads through cable glands (PG7) on the indicating unit and connecting them to two-way screw terminals mounted inside the indicating unit enclosure. With the cover and cable glands tightened firmly the enclosure provides IP65 protection. The entire earth fault indicator along with all associated components and leads must be installed at earth potential and kept away from the unshielded and unearthed HV system.

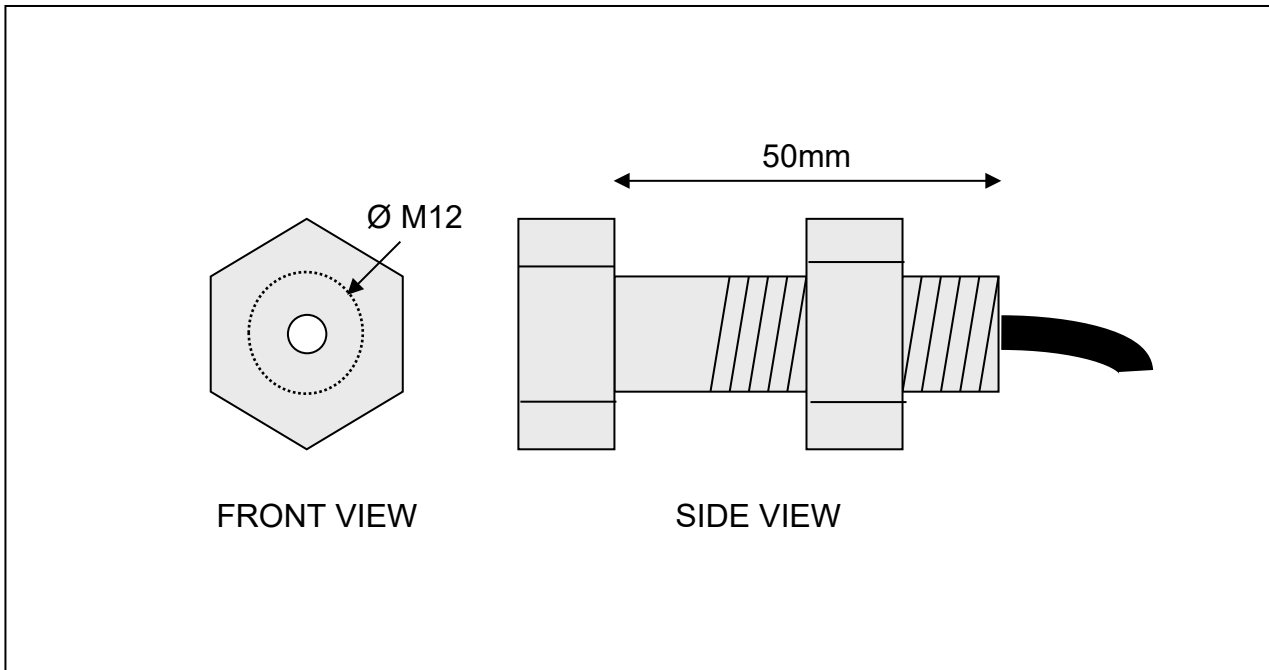
**FIGURE 3: INDICATING UNIT SHOWING TERMINALS AND MOUNTING HOLES**



### 4.3.1 REMOTE INDICATOR

A remote indicator can be ordered separately or ordered pre-installed. The remote indicator is designed to be mounted through a hole in the switchgear enclosure so that it is visible from the outside.

**FIGURE 4: REMOTE INDICATOR**



## 5. OPERATION

### 5.1 CURRENT SENSOR

The Sentinel™ current sensor comprises of a flexible iron-core belt with a pickup coil. The belt is fitted around the three-phase cable system being monitored and works on the core-balance current sensing method. Under normal conditions the magnetic flux from the three phase currents summates to zero and the pickup coil generates no voltage output. When an earth fault occurs the summation flux is non-zero and a voltage proportional to the magnitude of the earth fault is generated. The indicator unit is programmed to trip for a nominal earth fault of 50 A. The current sensor has no exposed metal parts and is completely encapsulated and corrosion proof.

### 5.2 INDICATING UNIT

The primary indication on the EFI-CFZ-50 is an electromechanical flag. The flag will flip into the tripped position after detecting a fault and flip to the reset position when the EFI is in a reset state.

The indicating unit is powered from load current flowing through a current transformer and also uses the presence of load current to reset the unit. When load current is first applied or when it



returns after a cleared fault condition, the unit will first require some time to charge the onboard supply capacitors before it is functional. The presence of load current will also reset the unit if it is in a tripped state.

The indicating unit continuously monitors the output signal from the current sensor. The current sensor transmits a voltage which is proportional to the measured current. For primary currents in excess of 50A the current sensor saturates and a limiting circuit inside the indicating unit clamps the output voltage to below 10V even for high fault currents. When an imbalance is detected, onboard circuitry analyses the fault current. The magnitude and duration of the half cycles of fault current are measured. Current spikes and glitches are ignored. As soon as valid fault current has been detected, the Sentinel™ triggers and enters a tripped state. A trip will flip the flag into the tripped position.

### **5.2.1 AUXILIARY RELAY (OPTIONAL)**

An on-board auxiliary relay provides a potential-free, normally-open contact for additional signaling. A 2-way screw terminal is provided on-board to which the user can connect a signaling cable. The auxiliary relay is operated from the same circuitry controlling the flag. Thus when load current is first applied or when it returns after a cleared fault condition, the unit will require some time to charge the onboard supply capacitors after which it then resets. A reset will latch the relay into the reset position (open). A tripped state will latch the relay into a tripped position (closed).

### **5.2.2 REMOTE INDICATOR (OPTIONAL)**

An optional remote indicator can be ordered pre-installed or ordered separately. A 2-way screw terminal is provided on-board for connection of the remote indicator. It provides flashing LED indication at some distance from the main indicating unit. During a tripped state the unit will flash at a rate of about 1Hz. The remote indicator is weather-proof and is housed inside a stainless steel bolt which also makes it vandal-proof. The on-board circuitry which drives the remote indicator will require some time for charging from the load current flowing through the CT power supply.

### **5.2.3 MANUAL TEST AND RESET**

A magnetic reed switch on-board allows the unit to be manually tested. The switch is located on the right-hand side of the unit. The switch can be activated externally with a small, strong magnet, without opening the enclosure. The EFI can only be manually tested if the unit has been charged by load current flowing through the CT power supply. The manual test feature can both trip and reset the EFI.

## 6. TESTING

The Sentinel™ EFI can be fully tested by injecting test current through the current sensor. A test procedure is suggested below.

1. Inject 50A through the CT power supply for 15 minutes to charge the unit.
2. Inject 40 A through the current sensor for 1 second. The device should not trip.
3. Inject 60 A through the current sensor for at least 50 ms. The device should trip.
4. Inject 50A through the CT power supply for 10 seconds. The device should reset.

## 7. SPECIFICATIONS

Network voltage range:	1-36kV
Frequency:	50Hz / 60Hz ±20%
Trip current:	50A ±10A
Minimum fault duration:	2.5 cycles (50ms @ 50Hz / 40ms @ 60Hz)
Fault current withstand:	25kA for 1s
Primary indication:	Electromechanical flag
Current reset:	5A or more for 10s
Manual test:	Pushbutton alternately initiates trip and reset
CT power supply charging time:	15 minutes at 50A, 150 minutes at 5A
CT power supply trickle-charge:	5A minimum to retain charge indefinitely
Operating temperature:	-20°C to 70°C

### Enclosure

-dimensions	115mm × 65mm × 40mm
-material	ABS, grey
-mounting	Flush-mounting, two M4 holes
-degree of protection	IP65
-cable gland size:	PG7; cable diameter range 3-6.5mm
-mass:	250g

### Current sensor

-CT100 (standard size):	100mm diameter
-CT150 (optional):	150mm diameter
-CT300 (optional):	300mm × 100mm rectangular oval
-material:	Insulated silicon steel
-mounting:	Releasable cable-ties
-lead length:	3m
-lead type:	2-core, 0.5mm <sup>2</sup> , doubly insulated
-mass:	250g

### CT power supply

-size:	50mm diameter
-material:	Insulated silicon steel
-mounting:	Releasable cable-ties
-lead length:	3m
-lead type:	2-core, 0.5mm <sup>2</sup> , doubly insulated
-mass:	250g

### Auxiliary relay

-type:	Latching, N/O on reset
-rating:	220Vdc, 250Vac, 2A

## SPECIFICATIONS CONT.

### Remote indicator

-dimensions:	M12 Hex Bolt 50mm long (200g)
-material:	Stainless steel
-mounting:	Self-mounting through single M12 Hole
-lead length:	2m
-lead type:	2-core, 0.5mm <sup>2</sup> , doubly insulated
-degree of protection	IP65
-indication method	Flashing LED
-flash rate:	1Hz nominal
-flashing duration:	12 hours nominal

## 8. ORDERING

Table 1 below shows the codes to be used for product ordering. Only the first three code groups need to be specified for the standard versions of the product. The standard versions ships without the items from groups 4, 5 and 6, and with a standard size current transformer (CT100 with 3m lead).

Please review the examples shown overleaf.

**TABLE 1: ORDERING CODES**

Group 1	Product Range	EFI	Earth Fault Indicator
Group 2	Symbol 1: Power source	M	Mains powered
		B	Battery powered
		C	CT powered
	Symbol 2: Indicator type	L	LED
		F	Flag
	Symbol 3: Glands	Z	Cable glands fitted
Group 3	Nominal trip current in amps	50	50 amps trip level
Group 4	Symbol 1: Mains cable fitted	M	Mains cable
	Symbol 2: Mains cable length in meters	3	3 meters
Group 5	Symbol 1: Remote indicator fitted	R	Remote indicator
	Symbol 2: Remote cable length in meters	3	3 meters
Group 6	Symbol 1: Auxiliary relay fitted	A	Auxiliary relay
	Symbol 2: Auxiliary cable length in meters	2	2 meters
Group 7	Symbol 1-5: Current transformer diameter	CT100	100mm diameter
		CT150	150mm diameter
		CT300	300mm by 100mm
Group 8	Symbol 1: CT fitted	C	Current Sensor
	Symbol 2: CT cable length in meters	3	3 meters

For Example:

ORDERING CODE	DESCRIPTION
EFI-CFZ-50 (standard version)	<ul style="list-style-type: none"> <li>- CT powered</li> <li>- LED indication</li> <li>- 50A trip</li> <li>- CT diameter 100mm, 3m lead</li> </ul>
EFI-CFZ-50-M5-R7-A2-CT150-C3	<ul style="list-style-type: none"> <li>- CT powered</li> <li>- LED indication</li> <li>- 50A trip</li> <li>- Mains cable, 5m lead</li> <li>- Remote indicator, 7m lead</li> <li>- Auxiliary relay, 2m lead</li> <li>- CT diameter 150mm, 3m lead</li> </ul>

**NOTE:**

- The mains lead is an optional component and must be specified if required.
- The remote indicator is an optional component and must be specified if required.
- The auxiliary relay is an optional component and must be specified if required.
- The unused cable-glands ship with a rubber stopper inserted to maintain sealing integrity.
- The EFI unit ships in a brown corrugated cardboard box.

## 9. WARRANTY

The Sentinel™ earth fault indicator electronic hardware and software is copyright Cybertronix cc 1996.

This product is warranted to be free from defects in material and workmanship for a period of twelve months (12) from the date of shipment. Correction shall be in the form of repair or replacement of the defective items or components, freight paid by the customer both ways. Such correction shall constitute a fulfillment of all Cybertronix cc liabilities in respect to said items and components. In no event shall Cybertronix be liable for consequential damage.

No other warranties:

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