

# Earth Continuity Monitor

For Model  
GCM-52



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## Introduction

Earth leakage relays perform two main functions on mining installations: to protect machinery from damage and to make the installation safer for personnel. In the typical distribution circuit shown in Fig 1, an earth leakage relay provides protection against leakage to earth and earth faults. The principle of this method is that all the current flowing to the load must return from the load. If current leaks to the frame of the motor and returns via the earth bond back to the star point of the supply transformer then this difference is detected by the earth leakage relay which triggers the breaker, thus disconnecting the load.

It becomes apparent that the earthing must be solid and reliable for electrical installations to be safe. For this reason, machinery is earthed via the supply cable, using either a copper conductor of the cable or the armour. The ground on which the machinery stands is normally not considered a reliable earth. Mechanical damage to the earth bond, corrosion of the armour or bad workmanship may result in a high resistance point in the earth return. If an earth fault occurs, voltage will be developed across the high resistance region. This voltage poses a potential hazard to any person who may be exposed to it. Depending on the resistance value, the current flowing and the reaction time of the earth leakage relay, this could be fatal. It is obvious that continuous monitoring of the earth bond is imperative if safety standards are to be maintained.

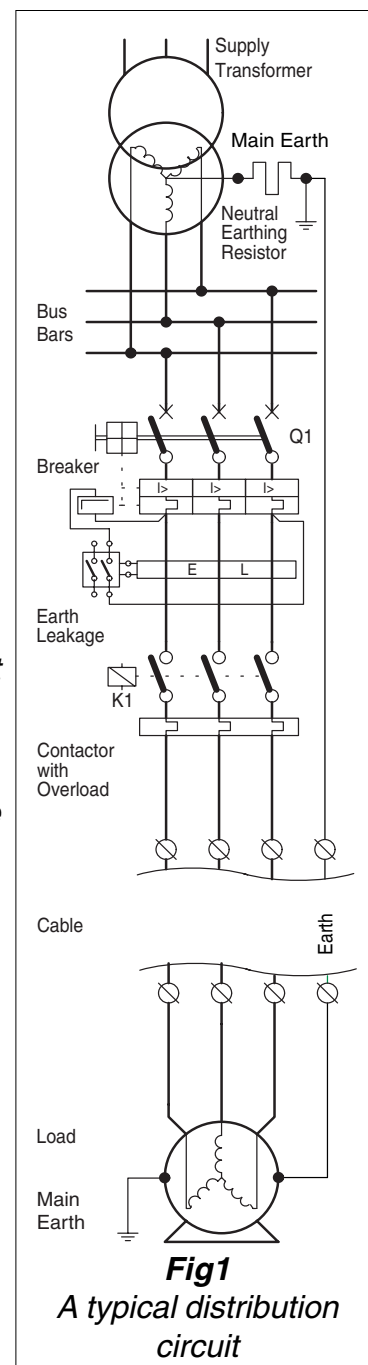
SWITCHING SYSTEMS' range of EARTH CONTINUITY RELAYS provides a cost effective solution to the problem.

## Theory of operation

To continuously monitor the resistance of the *earth bond*, an electrical measuring signal is fed into the *earth conductor* via a separate *pilot wire*. To cater for the possibility of a short between this pilot and the earth, a *remote module* must be employed.

A loop now exists, consisting of the *pilot wire*, the *remote module* and the earth wire in the cable. An intrinsically safe signal is injected into the loop and, by interpreting the voltage and the current flowing, the resistance can be monitored: see Fig 2. The energy level of an intrinsically safe signal is so low that dangerous gases like hydrogen or methane cannot be ignited by it.

Depending on factors such as the length of the supply cable, the nature of the load, variable speed drives or heavy load switching, and the location of the installation, [near a pipeline with cathodic protection or a DC railway line], a range of noise signals can be induced or injected into the loop: the signals can vary from high frequency generated by thyristor switching, to 50Hz and DC. Noise signals can have an amplitude of up to 100V. The relatively low level of the intrinsically safe measuring signal and the high electrical noise necessitated the development of specialised measuring circuitry.



## Description

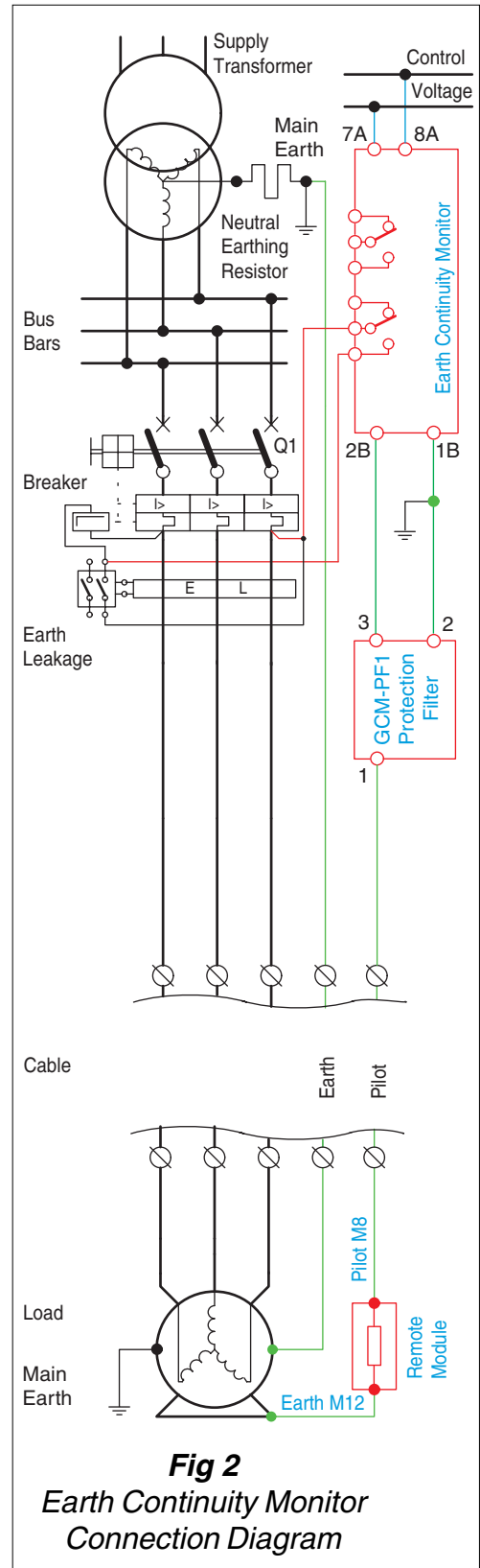
The earth continuity monitoring system consists of a monitor, remote module and monitor protection filter. Monitors are available in two types of enclosure as described below.

**The GCM-52** monitor is mounted in a compact plastic case and is connected via two Molex plugs. *This is the preferred model for all new installations.* A typical application circuit is shown in Fig 2.

The external connections consist of two terminals for the supply voltage, three terminals each for the two potential free change over contacts; plug “A” and one each for the pilot and earth connections; plug “B”. The truth table for the operation of the two changeover contacts is shown in Fig 5. This configuration was chosen to provide a “no power on unit” indication. The dimensions and connection diagram are shown in Fig 7 on page 13.

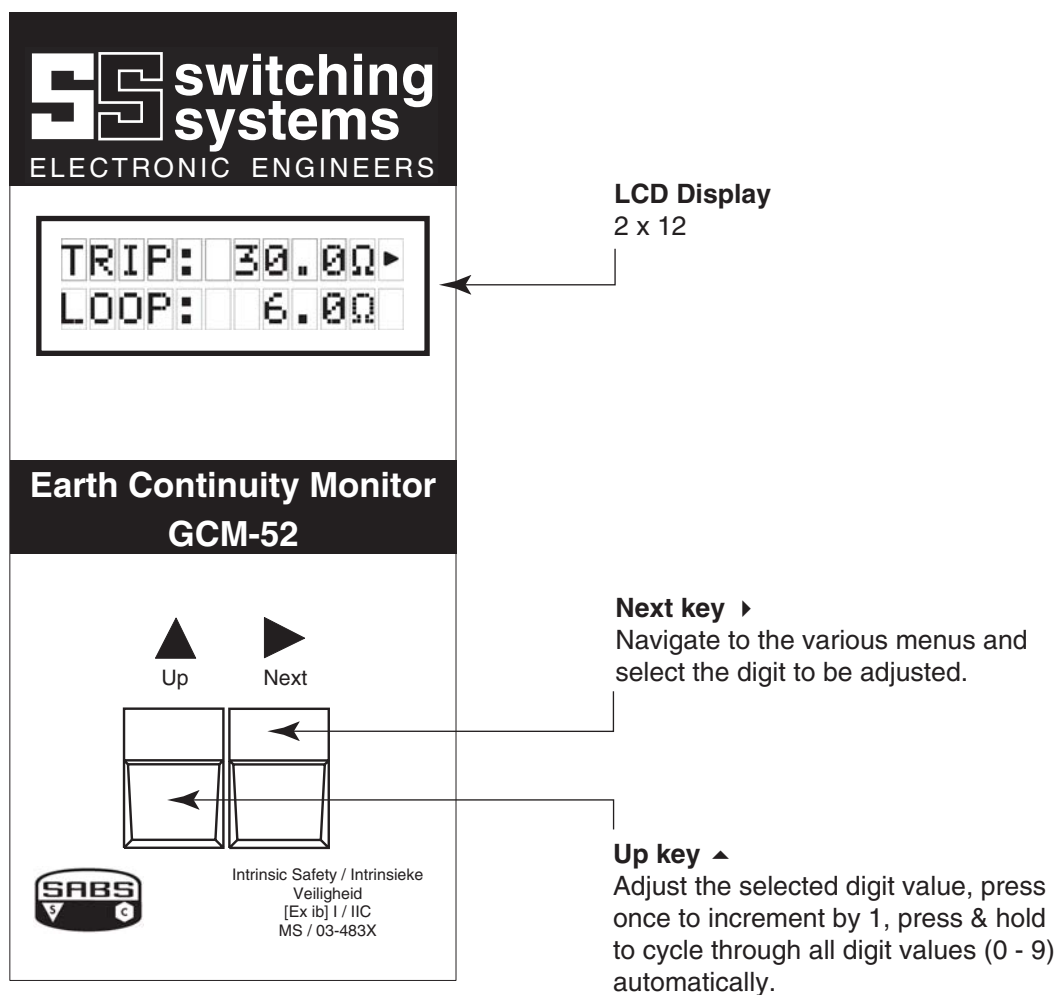
The **Remote Module** consists of a 100Ω, 1% 30 watt calibrated resistor, terminated with a M12 and M8 brass bolt, for connection to Earth and Pilot respectively. For physical dimensions see Fig 9 on page 14.

The **Protection Filter** prevents damage to the monitor due to phase to earth and phase to pilot faults. The monitor filter can continuously withstand faults on restricted neutral systems up to 300A without damage to the filter or monitor. It is recommended that a protection filter should be purchased together with a new GCM monitor and consideration should be given to installing a protection filter to protect the monitor in existing installations. Electrical & mechanical specifications appear on pages 7 & 10 respectively.



## Front panel controls

The GCM-52 front panel is shown below together with descriptions of the controls and control functions.

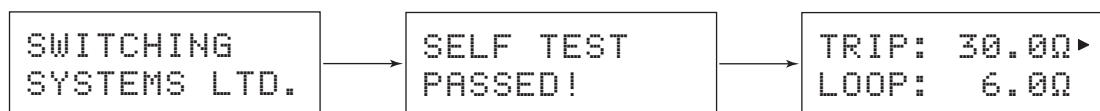


**Fig 3**  
Front panel controls

## Operation

### Switch on

When the GCM-52 Monitor is switched on it performs a self-test & calibration routine. When the routine is completed successfully the display shows the Trip level & the Loop resistance. The start up display sequence is shown below.



The **Trip** figure displays the currently *set* Trip level in Ohms.

The **Loop** figure displays the actual *measured* Loop resistance in Ohms.

On the right of the Trip figure is a navigation arrow ▶ that indicates which key to press to reach the adjustment menus.

## Set Password

The GCM52 is supplied with the password preset to 0000. The password is used to prevent unauthorized adjustment of the Trip Level. It should be set by and known only to the person responsible for the electrical installation. If the password is lost or forgotten, call Switching Systems for assistance in retrieving it.

To set the password, start at the Trip/Loop display, press the Next key ▶ to display:

```
TRIP LEVEL
ADJUST    ▲▶
```

Press the Up key ▲ to display:

```
CHANGE
PASSWORD  ▲▶
```

The Next navigation arrow ▶ will flash. Press the Next key ▶ to display:

```
OLD PASSWORD
0000      ▲▶
```

If this is the first time the password has been set the old password will be the default value of 0000 in this case press the Next key ▶ four times to accept the default value. After the fourth key press the display will show:

```
NEW PASSWORD
0000      ▲▶
```

The left most digit will flash indicating that it is selected, use the Up key ▲ to set the digit to the desired value then press the Next key ▶ to select the next digit to adjust. Proceed until all four digits have been set; make a note of the new password. After setting the last digit press the Next Key ▶ to go back to the Trip/Loop display.

To change an existing password (other than the default) the old password must be entered using the Up ▲ & Next ▶ keys as described above.

## Set Trip Level.

The GCM52 is supplied with the Trip Level preset to 30.0Ω. To set the Trip level to a new value start from the Trip/Loop display and press the Next key ▶ .

```
TRIP LEVEL
ADJUST    ▲▶
```

Is displayed, the Next key navigation arrow ▶ is flashing.

Press the Next key ▶ to navigate to the password entry screen shown below, the left most digit will flash.

```
PASSWORD
0000      ▲▶
```

Uses the Up key ▲ to increment the flashing digit to the required value (0-9). Use the Next key ▶ to select the next digit to adjust, the digit will flash to indicate that it is selected. Set the four digits to match the password. After the fourth digit is set press the Next key ▶ .

If the password is incorrect the screen will display:

```
INVALID
PASSWORD!
```

and automatically return the Trip/Loop display. If this happens start over and enter the correct password.

If the password is correct the Trip Level adjust screen is displayed.

```
TRIP LEVEL
XX.XΩ   ▲▶
```

The left most digit will flash to indicate that it is selected. Use the Up ▲ and Next ▶ keys to set the Trip level value. When the right hand digit is set press the Next key ▶ to return to the Trip/Loop display. The Trip value will indicate the new setting.

## Cable fault conditions.

*Loop resistance exceeds Trip setting.*

If this condition occurs the display will show:

```
CABLE FAULT!
LOOP: XX.XΩ
```

If the fault condition lasts for more than 20 seconds the Monitor will trip, relay A is energized, relay B is de-energized and an audible alarm sounds. The display will freeze showing:

```
CABLE FAULT!
R = XX.XΩ ▶
```

To reset the Monitor press the Next key ▶

*Cable short circuit (pilot to earth).*

If this condition occurs the display will show:

```
CABLE SHORT!
LOOP: 0.0Ω
```

If the fault condition lasts for more than 20 seconds the Monitor will trip, relay A is energized, relay B is de-energized and an audible alarm sounds. The display will freeze showing:

```
SHORT
CIRCUIT! ▶
```

To reset the Monitor press the Next key ▶. The Monitor will perform a self-test routine before returning to the Trip/Loop display. During self-test the display will show:

```
SELF TEST
IN PROGRESS!
```

## *Open circuit cable.*

If this condition occurs the display will show:

```
OPEN  
CIRCUIT! ▶
```

The Monitor will trip within 180ms, relay A is energized, relay B is de-energized and an audible alarm sounds. The display will freeze showing:

```
OPEN  
CIRCUIT! ▶
```

To reset the Monitor press the Next key ▶. The Monitor will perform a self-test routine before returning to the Trip/Loop display. During self-test the display will show:

```
SELF TEST  
IN PROGRESS!
```

## **Monitor self-test failure.**

If the self-test routine detects an internal system failure the display will show:

```
GCM FAULTY  
CONTACT SS! ▶
```

This message can occur when:

Monitor is switched on.

Monitor is reset after an open circuit fault.

Monitor is reset after a short circuit fault.

## **Noise Immunity.**

### *AC noise.*

The Monitor will measure accurately with noise levels up to 15Vac present on the pilot. When noise levels exceed 15Vac loop measurement is suspended, the ~ symbol appears next to the Loop value and the display is frozen. Under these conditions Open circuit detection continues to function normally.

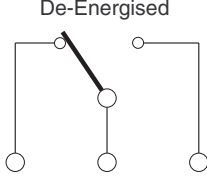
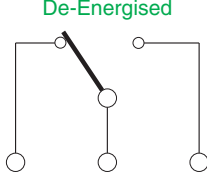
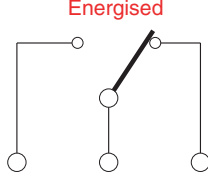
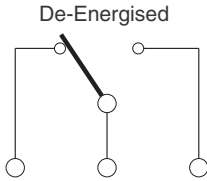
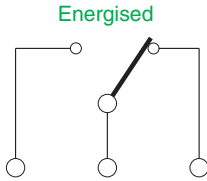
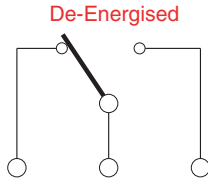
### *DC offset.*

The Monitor will measure accurately with a DC offset of up to 2V present on the pilot. When the DC offset exceeds 2V loop measurement is suspended, the = symbol appears next to the Loop value and the display is frozen. Under these conditions Open circuit detection continues to function normally.

## **Immunity to supply disturbances.**

The Monitor is immune to momentary supply voltage sags and interruptions. The Monitor will operate normally for events of up to 1 second in duration. In addition it will function normally for extended periods under supply voltage sag conditions, down to 60% (66V) of nominal supply voltage.

**Relay truth table**

Condition	Supply Off PILOT IRRELEVANT	Supply On PILOT HEALTHY	Supply On PILOT FAULTY
Relay "A"	De-Energised 	De-Energised 	Energised 
GCM-52	5A 6A 9A	5A 6A 9A	5A 6A 9A
Relay "B"	De-Energised 	Energised 	De-Energised 
GCM-52	3A 1A 2A	3A 1A 2A	3A 1A 2A

**Fig 5**  
*Relay truth table*

## Specifications & Ordering

### MODELS GCM-52

Control voltage:	110V AC: Sinusoidal 50Hz
Voltage variation:	-40% + 10%
Relay burden:	15VA
Operational accuracy:	0,5Ω
Measurement limit:	50Ω
Resolution:	0,1Ω
Open circuit fault:	200Ω
Open circuit response time:	180ms
Short circuit response time:	20sec
High resistance response time:	20sec
Output contact:	2 Potential free c/o contacts. 5A 220V AC
Contact arrangement GCM-52:	See Fig 7
Mounting GCM-52:	Surface mounting enclosure; see Fig 7
Connections GCM-52:	Prewired Molex plug/socket with colour-coded conductor harness.(wire length 2m)
Compliance standard:	SABS Intrinsically safe, [Ex ib] I/Ic.
Voltage dip immunity:	1sec

### MODEL GCM-51PF1 Protection Filter

Current rating:	39A rms
Non repeditive peak:	580A
I <sup>2</sup> t:	1400A <sup>2</sup> sec
Surge Voltage:	5kV at 5 Joules
Insulation voltage:	2,5kV
Line resistance:	0,4Ω max
Clamping voltage:	55v peak
Mass:	1kg

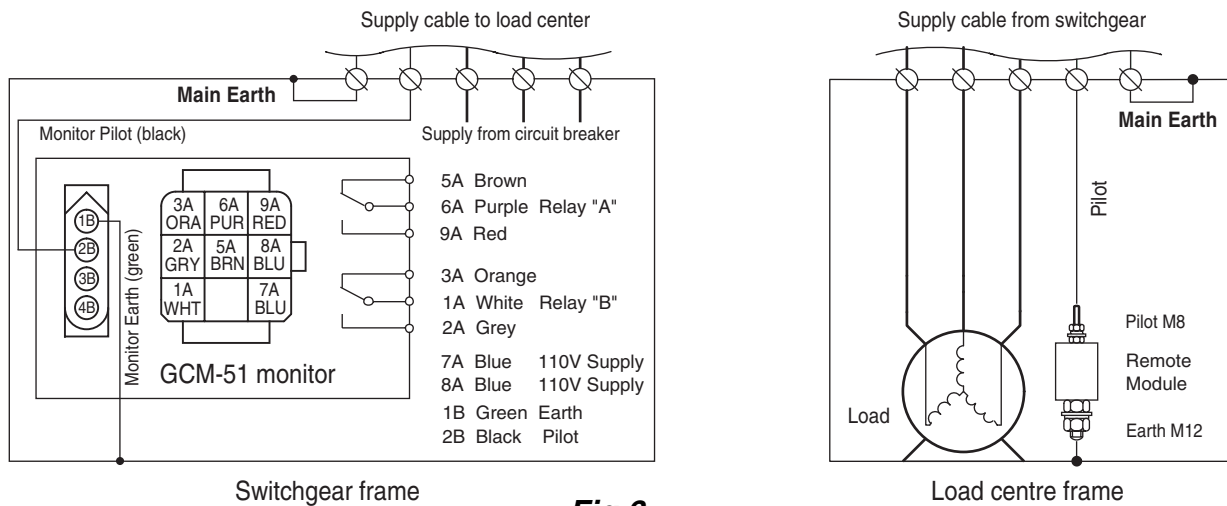
### Ordering

<b>Stock #</b>	<b>Description</b>
5001-050	GCM Remote Module
5001-053	GCM-52 Connection Leads
5001-070	GCM-52 Earth Continuity Monitor (plastic case)
5001-058	GCM-PF1 Protection Filter
5001-057	Conversion of GCM-110 to GCM-52-1D

## Installation guide

It is essential that the GCM Earth Continuity Monitor be installed in such a way that the generated signal must travel via the fully insulated *pilot conductor* direct to the *Remote Module*. The latter must be situated remotely from the GCM Monitor as shown in Fig.6 below. The main *earth conductor* **must** form the return path to the GCM Monitor via the equipment frame at each end and at intermediate points where applicable. The *pilot* and *earth* conductors plus the *remote module* thus comprise the monitored loop.

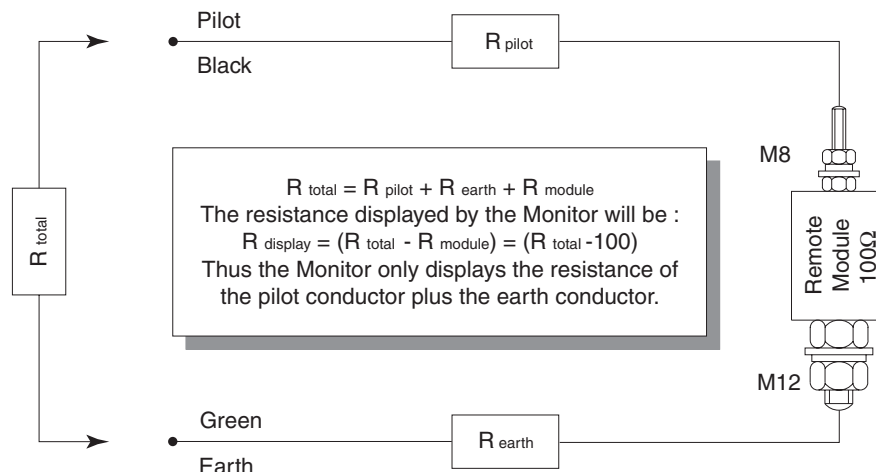
On completion of the installation and connection of the wiring harness to the pilot and earth conductors the following tests should be made before connection to the 110 volt ac supply to the monitor.



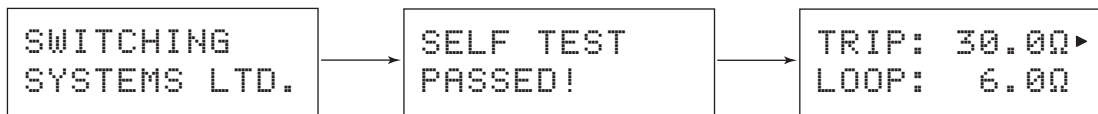
**Fig 6**  
GCM-52 connection

## Test schedule

1. With *remote module* disconnected check the insulation of the *pilot* and *earth* . Test should read infinity.
2. Connect the *remote module* with the M12 bolt fastened to the load centre frame (earth) and the *pilot conductor* connected to the M8 bolt.
3. Measure the total loop resistance between *pilot* and *earth*. This reading should be a minimum of 100Ω and a maximum of 150Ω.

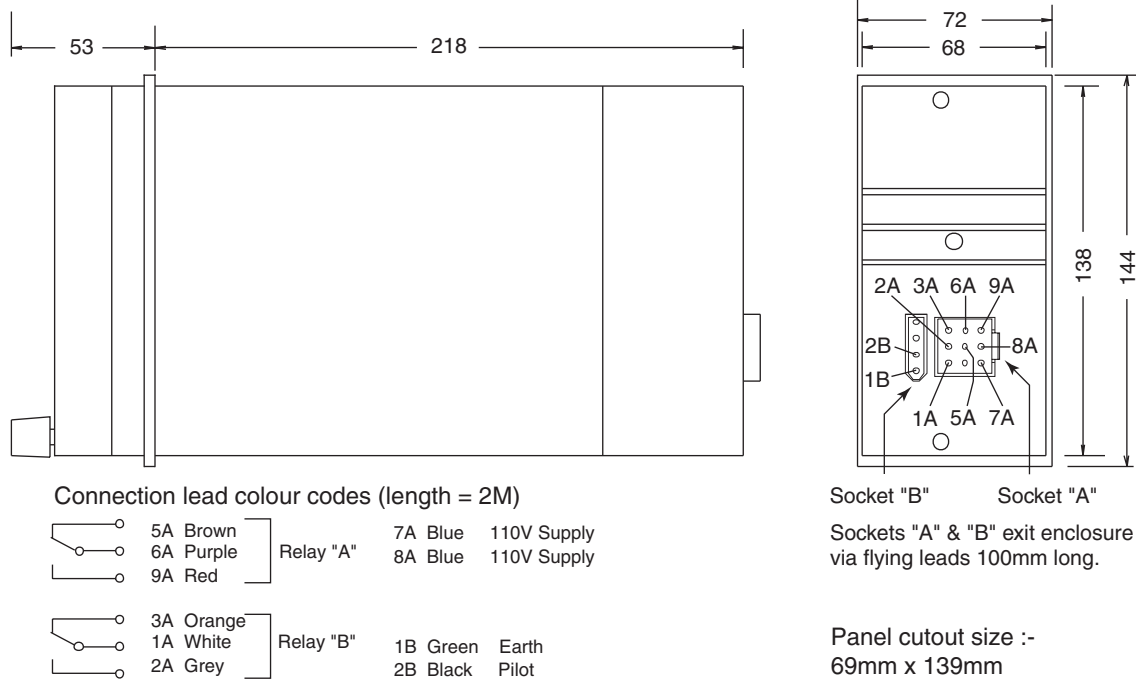


4. Plug the 9 pin and 4 pin plugs into their sockets at the rear of the GCM-52 Monitor and switch on the 110v ac supply. The monitor will run a self test and calibration routine, then display the Loop/Trip readings. The startup display sequence is shown below:

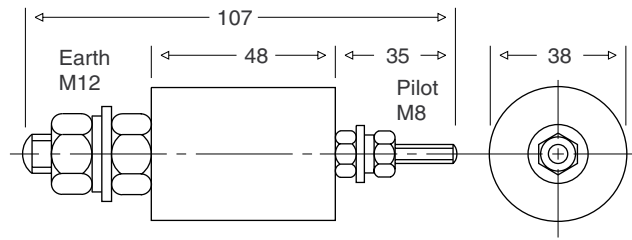


When the self test and calibration routine has run successfully and the trip and loop values are displayed the GCM-52 monitor is fully operational and ready for service. If the password and trip level have not been set this should be done now. Refer to page 6 for instructions.

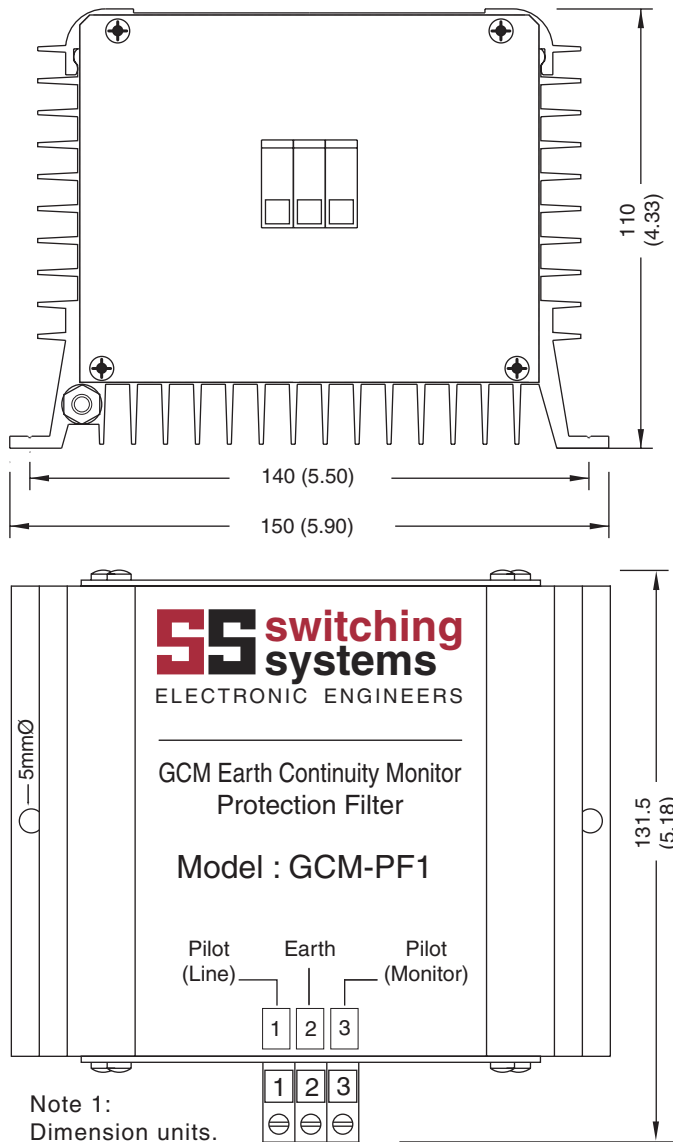
Mechanical outlines & connections



**Fig 7**  
Dimensions of the GCM-52 (in mm)



**Fig 9**  
Dimensions of the GCM Remote Module (in mm)



**Fig 10**  
Dimensions of the GCM-PF1 Protection Filter (in mm)

**Notes**

# Earth Continuity Monitor

## For Model GCM-52

