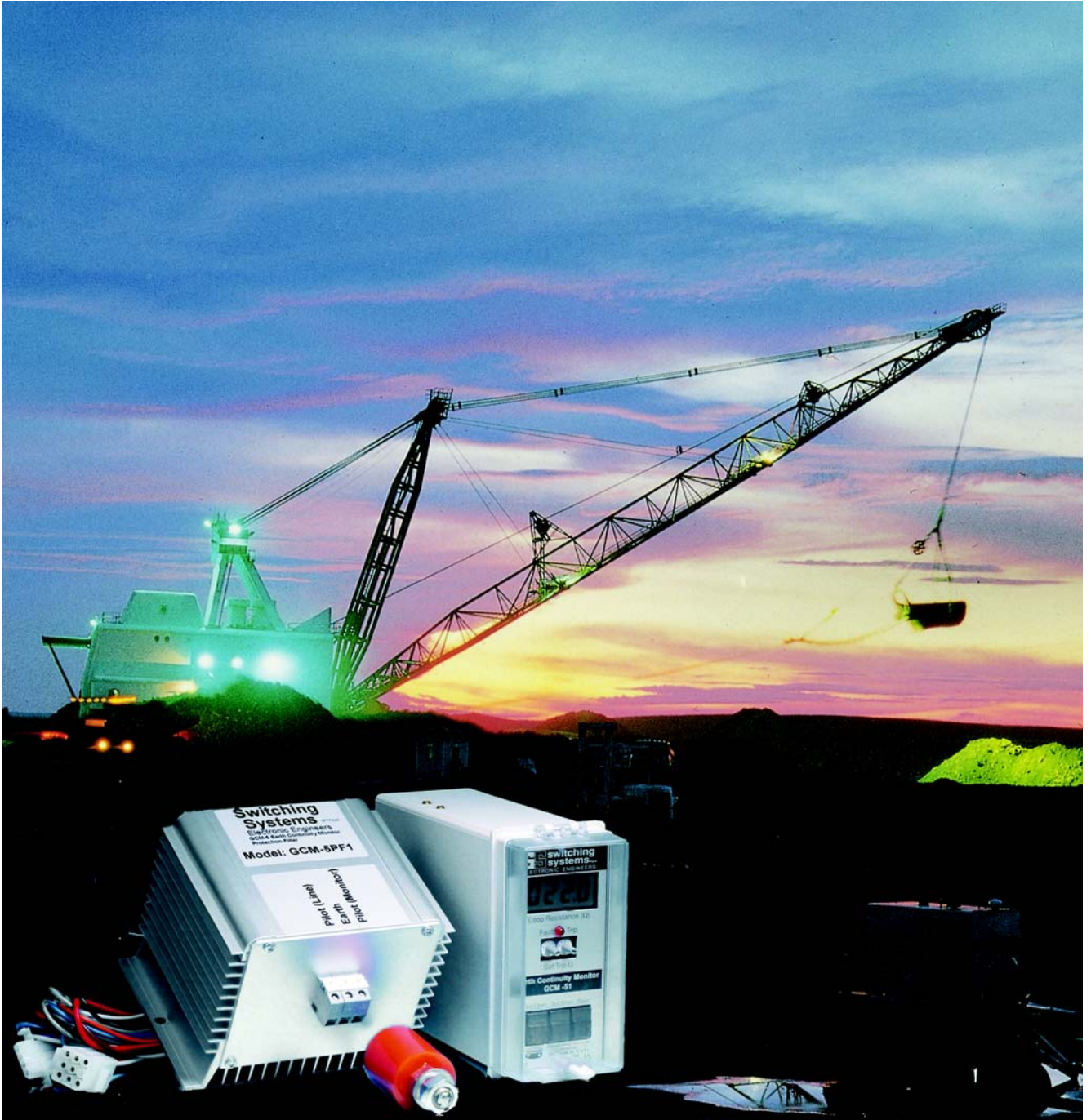

Earth Continuity Relays

Electrical safety for the mining industry.



SS **switching**
systems
ELECTRONIC ENGINEERS

Leaders in :
Voltage-Dip Proofing
Earth Continuity Monitoring

Foreword



GCM-52-110 Earth Continuity Monitor



Pilot Wire Control Relays & Accessories

Switching Systems (Pty) Ltd was founded in 1971 by F.V. Fischer. During the past three decades we have established ourselves as South Africa's leading designers and manufacturers of intrinsically safe earth continuity monitors and voltage-dip proofing systems.

All our products are manufactured to comply with various industry standards, and we are permit holders of the SABS mark for intrinsic safety, as well as being members of the South African Flameproof Association. We have a sophisticated research and development laboratory for application to specific projects.

Switching Systems staff is a team dedicated to providing product quality and service excellence. Our innovative spirit and continuous product improvement ensures the reliability of our products.

We look forward to the opportunity of being of service to you.

F. V. Fischer
Managing Director

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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 personnel 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.

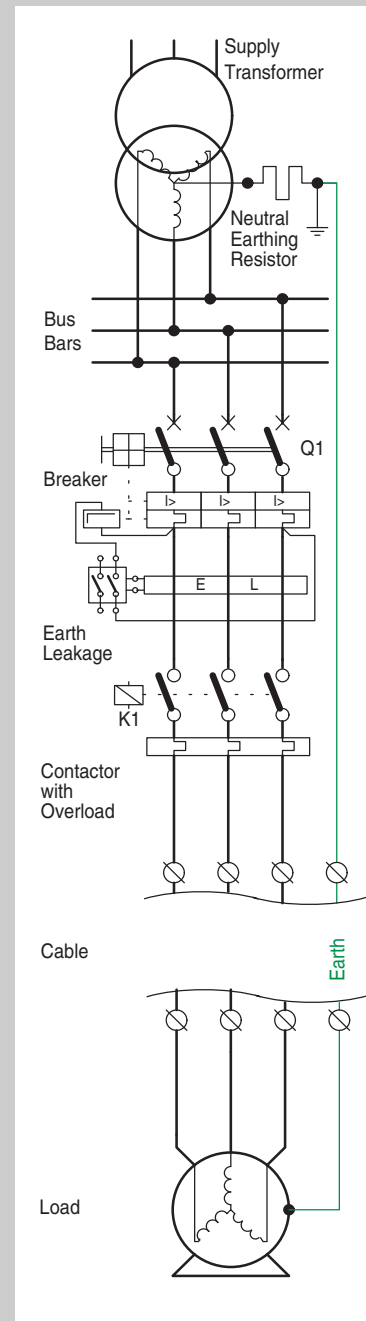


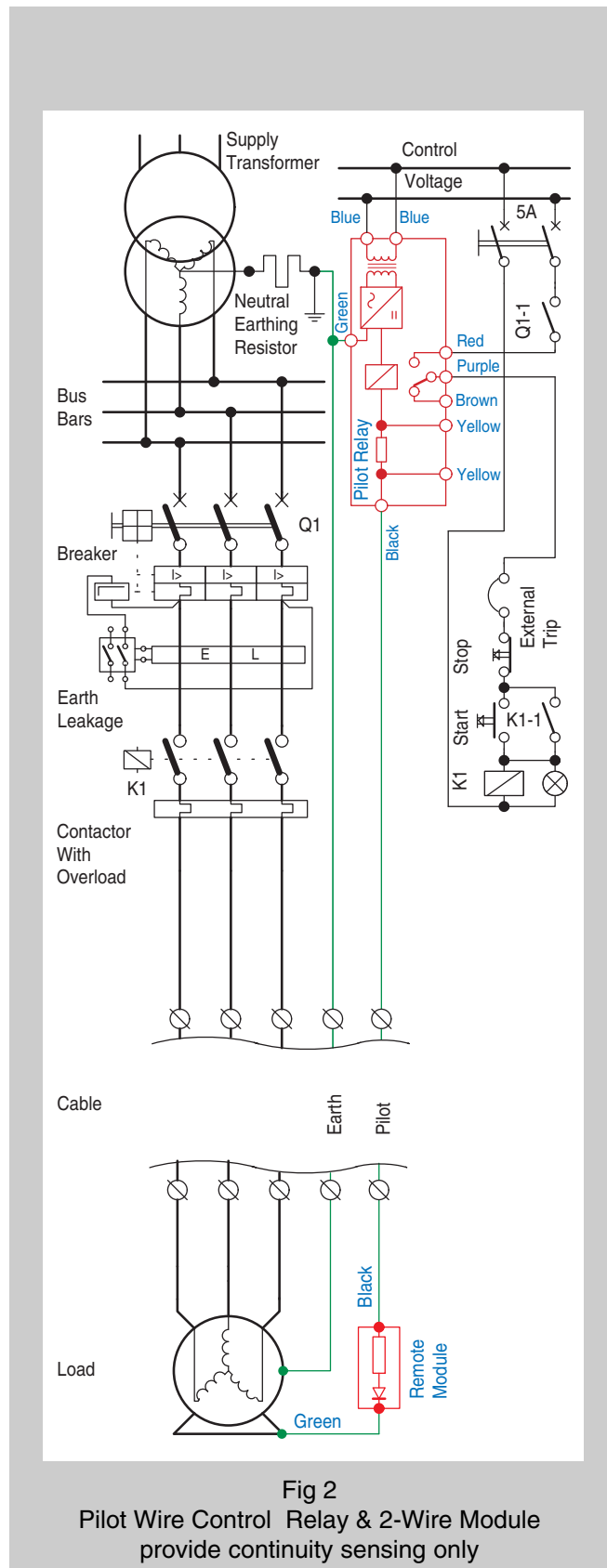
Fig 1
A typical distribution circuit

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 very heavy loads, 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.



Product Description

SWITCHING SYSTEMS' Earth Continuity Monitors are grouped into two categories:-

PILOT WIRE CONTROL RELAYS, prefixed GBP, MP & MSR.

These relays offer simple and cost effective solutions. They have remote stop/start capability. The maximum resistance level is permanently set at 22Ω for GBP/MP relays, and at 100Ω for MSR Relays. They are used primarily underground with short cables and medium power loads.

Three generations of relays are available:

- The first, MSR8, is not intrinsically safe.
- The second, MSR9 & GBP4, is intrinsically safe, and is suitable for environments where limited electrical noise is present.
- The third, MP130, provides for noise immunity of up to 12V in full operation mode & from 12 to 50V in restricted mode. These relays can be used as direct replacements for older models and they are the preferred products for all new applications.

EARTH CONTINUITY RELAYS, prefixed GCM.

This relay is micro-processor controlled and can withstand high induced AC voltages and injected DC voltages. The loop resistance is constantly indicated on a 7 segment LCD display. The trip level can be set using the rotary switches on the front panel. Fault conditions such as open circuit, short circuit and high-resistance are displayed. A separate interface module provides a 4 to 20mA output for remote monitoring. The use of this module requires factory modification of the earth continuity relay. These relays are mainly used for high voltage reticulation trailing cables on draglines and drills.

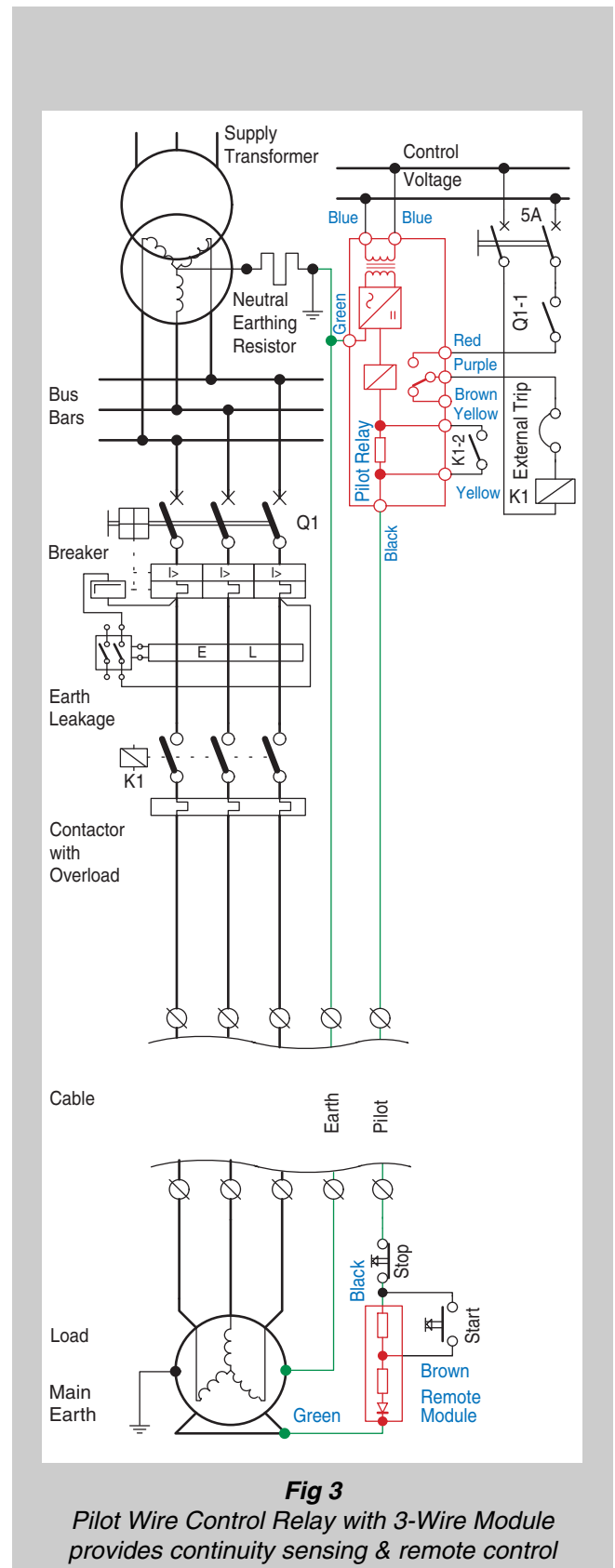


Fig 3
Pilot Wire Control Relay with 3-Wire Module provides continuity sensing & remote control

Common Specifications

for Pilot Wire Control Relays

All Pilot Wire Control Systems are wired in a similar way and consist of two parts:-

The RELAY is normally situated at the load centre and controls a contactor or the trip coil of a circuit breaker. It is housed in an epoxy filled plastic box and is connected via Molex plugs. Physical dimensions of the relay are shown in Fig 4.

The REMOTE MODULE, of which three different types are available:-

- A 2-wire Module used for loop resistance sensing only which consists of a resistor and a diode as shown in Fig 5.
- A 3-wire Module used for loop wire sensing and remote control. External Start and Stop buttons must be added to control the remote contactor, refer to Fig 6. Physical dimensions of the 2-wire and 3-wire modules are identical and are shown in Fig 7.
- A Pushbutton Station consisting of a 3-wire module and two pushbuttons cast together in epoxy. This hermetically seals the pushbutton contacts, making this module highly reliable in dusty environments. Physical dimensions are shown in Fig 8.

The system wiring diagram, showing the pilot wire control relay connected as an earth loop monitor without remote control, appears on Page 4, Fig 2; a 2-wire module is required and the feedback contact from K1 is not used. Fig 3, Page 5 shows a system which uses a 3-wire module to provide earth loop monitoring and remote control facilities.

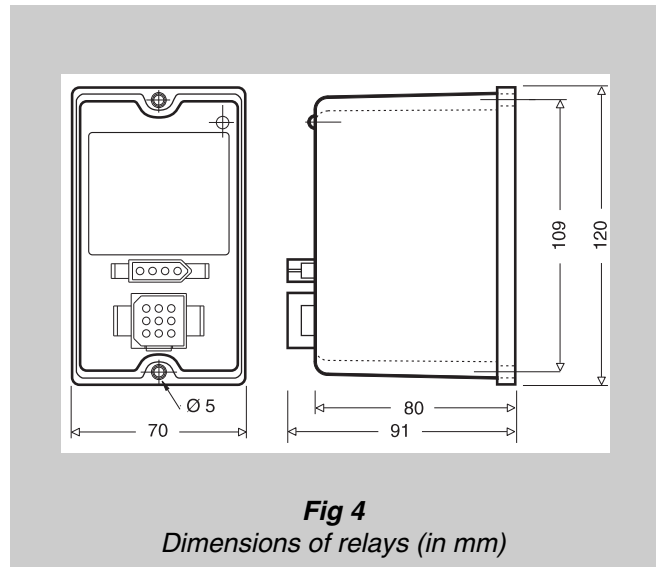


Fig 4
Dimensions of relays (in mm)



MP-130-ni Pilot Wire Control Relay



Fig 5
2-Wire Remote Module Connection Diagram

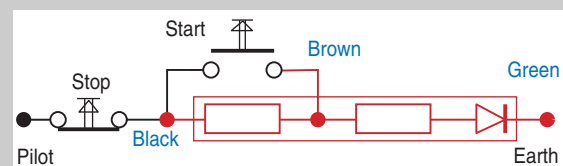


Fig 6
3-Wire Remote Module Connection Diagram

Common Specifications

for Pilot Wire Control Relays



MSR9-ni Pilot Wire Control Relay

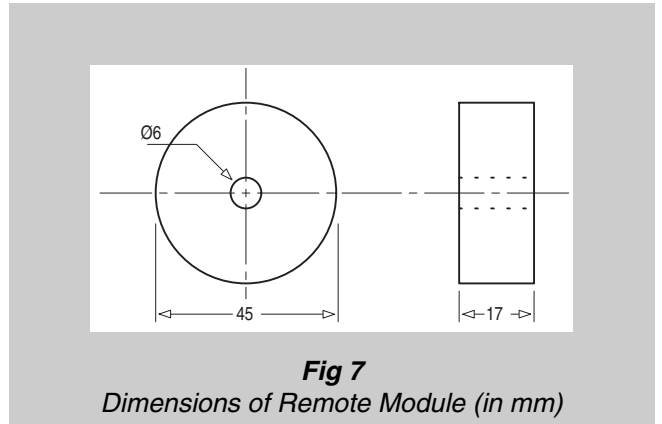
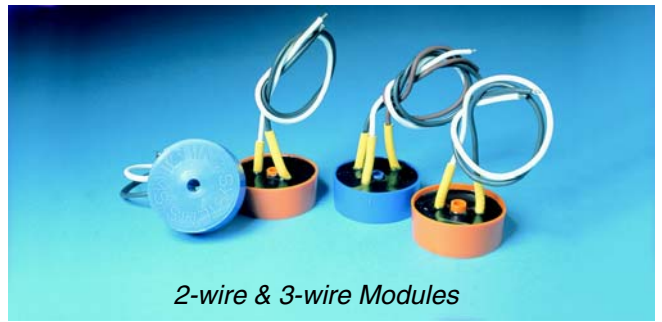


Fig 7
Dimensions of Remote Module (in mm)



2-wire & 3-wire Modules



GBP-4-ni Pilot Wire Control Relay

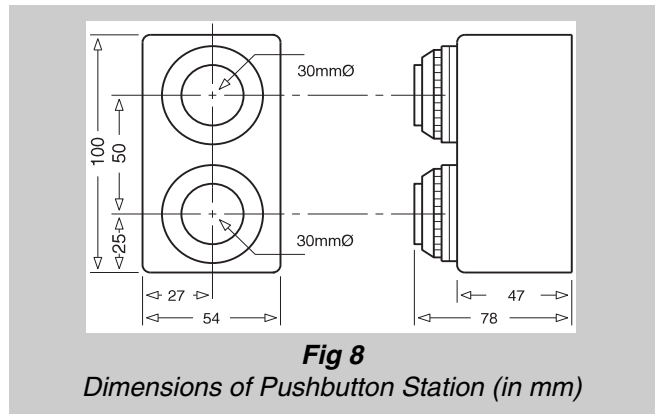


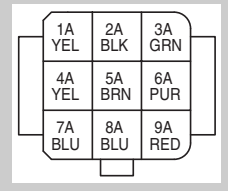
Fig 8
Dimensions of Pushbutton Station (in mm)



Pushbutton Station

Specifications

for Pilot Wire Control Relays

Parameter		MSR 8	MSR 9-ni	GBP-4-ni-110	GBP-4-ni-220	GBP-4-ni-525	MP130-ni-110	MP130-ni-220	MP130-ni-525
Control voltage :	110Vac +20% -30%			✓			✓		
	220Vac +20% -30%				✓			✓	
	525Vac +20% -30%	✓	✓			✓			✓
Relay burden :	10VA	✓	✓	✓	✓	✓	✓	✓	✓
Output contact :	One potential free C/O rated at 5A 525Vac	✓	✓		✓	✓		✓	✓
	Two potential free C/O rated at 5A 250Vac			✓			✓		
Earth loop detection :	100Ω ± 20%	✓	✓						
	22Ω ± 20%			✓	✓	✓	✓	✓	✓
Line-to-pilot fault withstand time :	<30 sec on 2,5A restricted earth systems						✓	✓	✓
	<2 sec on 2,5A restricted earth systems	✓	✓	✓	✓	✓			
Max ambient temp :	Relays 45°C; Remote Modules 120°C	✓	✓	✓	✓	✓	✓	✓	✓
Classification :	None	✓							
	SABS Intrinsically safe [Ex ib] I/Ic I.A. No. SABS MS/03-482x		✓	✓	✓	✓	✓	✓	✓
Compliance standard :	Complies with requirements of the A.A.C.; Specification 540/1 Issue 3	✓	✓						
	Complies with requirements of the British Standards Institute: BS3101; 1986			✓	✓	✓			
	Complies with requirements of the British Standards Institute: P130						✓	✓	✓
Suitable for noise levels :	Below 2Vac	✓							
	Below 12Vac, restricted operation >12V-50Vac		✓	✓	✓	✓	✓	✓	✓
Connections :		✓							
 <ul style="list-style-type: none"> 1. Yellow : Feedback 2. Black : Pilot 3. Green : Earth 4. Yellow : Feedback 5. Brown : N/C-1 6. Purple : Common-1 7. Blue : Supply 8. Blue : Supply 9. Red : N/O-1 		✓							

Specifications

for Pilot Wire Control Relays

Parameter		MSR 8	MSR 9-ni	GBP-4-ni-110	GBP-4-ni-220	GBP-4-ni-525	MP130-ni-110	MP130-ni-220	MP130-ni-525
<p>1A. to 4A. : Not Used 1B. Green : Earth 5A. Brown : N/C-1 2B. Black : Pilot 6A. Purple : Common-1 3B. Yellow : Feedback 7A. Blue : Supply 4B. Yellow : Feedback 8A. Blue : Supply 9A. Red : N/O-1</p>			✓		✓	✓		✓	✓
<p>1A. White : Common-2 1B. Green : Earth 2A. Grey : N/O-2 2B. Black : Pilot 3A. Orange: N/C-2 3B. Yellow : Feedback 4A. - : Not Used 4B. Yellow : Feedback 5A. Brown : N/C-1 6A. Purple : Common-1 7A. Blue : Supply 8A. Blue : Supply 9A. Red : N/O-1</p>				✓			✓		
Ordering : Stock No Description									
5001-001	MSR8 Relay	✓							
5001-003	MSR8/9 Pushbutton Station	✓	✓						
5001-004	MSR8/9 2-Wire Blue Module	✓	✓						
5001-005	MSR8/9 3-Wire Blue Module	✓	✓						
5001-002	MSR8 Connection Leads	✓							
5001-007	MSR9-ni-525 Relay		✓						
5001-010	MSR9 Connection Leads		✓						
5001-013	GBP-4-ni-110 Grey Pilot Wire Relay			✓					
5001-015	GBP-4-ni-220 Red Pilot Wire Relay				✓				
5001-017	GBP-4-ni-525 Blue Pilot Wire Relay					✓			
5001-019	GBP/MP Pushbutton Station			✓	✓	✓	✓	✓	✓
5001-020	GBP/MP 2-Wire Buff Module			✓	✓	✓	✓	✓	✓
5001-021	GBP/MP 3-Wire Buff Module			✓	✓	✓	✓	✓	✓
5001-018	GBP-4/MP130-110 Connection Leads			✓			✓		
5001-010	GBP-4/MP130-220/525 Connection Leads				✓	✓		✓	✓
5001-023	MP130-ni-110 Relay						✓		
5001-025	MP130-ni-220 Relay							✓	
5001-027	MP130-ni-525 Relay								✓

Specifications

for Earth Continuity Monitor

The GCM-52-110 is mounted in a compact plastic case and is connected via two Molex plugs. A typical application circuit is shown in Fig 9.

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 10. This configuration was chosen to provide a “no power on unit” indication. The dimensions and connection diagrams are shown in Figs 12 & 13 respectively.

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 14 on page 12.

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-52 monitor and consideration should be given to installing a protection filter to protect the monitor in existing installations. Electrical and me-chanical specifications appear on page 11.

The GCM-52 replaces the older model GCM-110 & the GCM-51. An adapter plate is available which allows the GCM-52 to be mounted in the GCM-110 enclosure, a photograph of the GCM-52 mounted on the adapter plate appears on page 12.

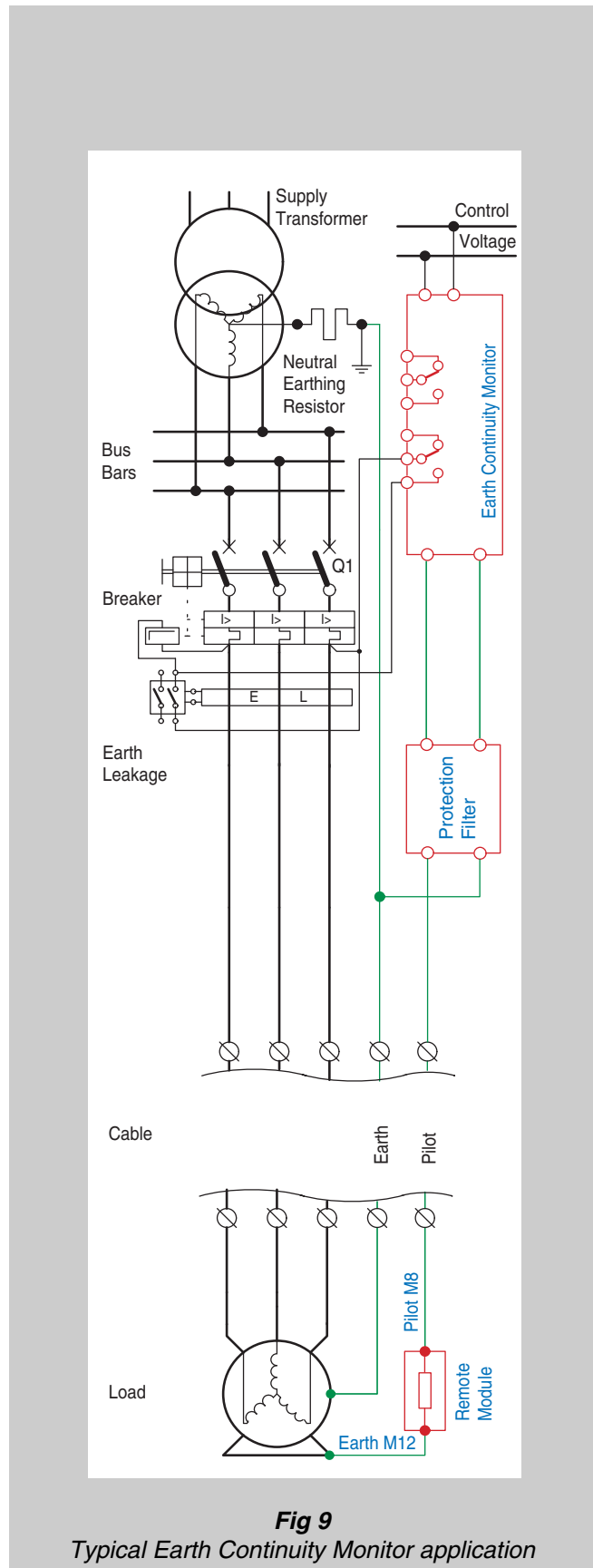


Fig 9
Typical Earth Continuity Monitor application

Specifications

for Earth Continuity Monitor and Protection Filter

MODEL GCM-52-110

Control voltage:	110V AC: Sinusoidal 50Hz
Voltage variation:	± 15%
Relay burden:	15VA
Operational accuracy:	0,5Ω
Measurement limit:	90Ω
Resolution:	0,1Ω
Open circuit fault:	2kΩ
Open circuit response time:	50ms
Short circuit response time:	± 25s
High resistance response time:	± 25s
Output contact:	2 Potential free changeover contacts. 5A 220V AC
Contact arrangement:	See Fig 10
Mounting:	Surface mounting enclosure See Fig 12
Connections:	Prewired Molex plug/socket with colour-coded conductor harness.(wirelength 1m) : See Fig 13
Compliance standard:	SABS Intrinsically safe, Group 1, 2a, 2b, 2c. Temperature Class T1 to T5.

MODEL GCM-PF1 Protection Filter

Current rating	39A continuous
Non repeditive peak	580A
I ² t	1400A ² sec
Surge Voltage	5Kv at 5 Joules
Insulation voltage	2,5Kv
Line resistance	0,4Ω max
Clamping voltage	55v peak
Weight	1Kg

Ordering

Stock No	Description
5001-050	GCM Remote Module
5001-070	GCM-52 Earth Continuity Monitor
5001-053	GCM-52 Connection Leads
5001-058	GCM-PF1 Protection Filter

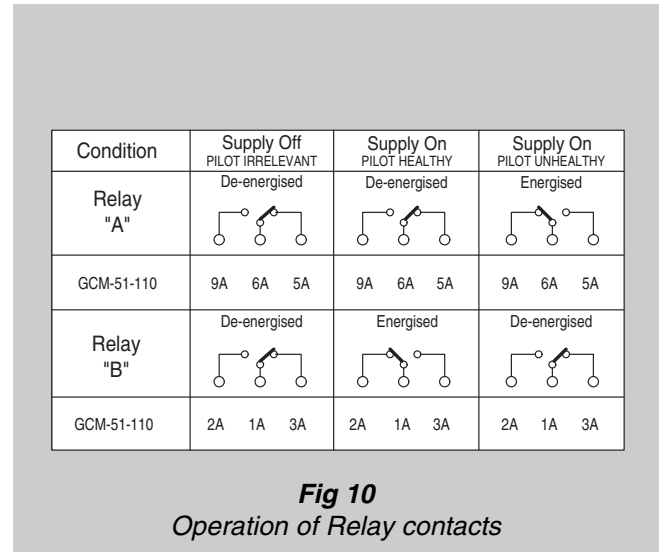


Fig 10
Operation of Relay contacts



GCM-PF1 Protection Filter

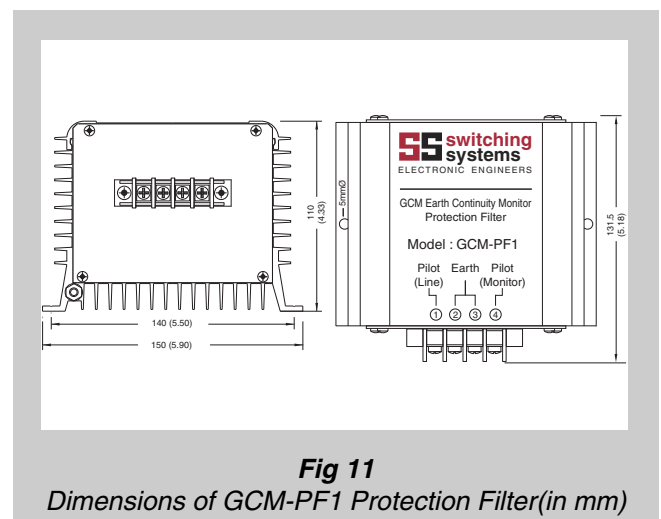


Fig 11
Dimensions of GCM-PF1 Protection Filter(in mm)

Specifications

for Earth Continuity Monitor



GCM-52 mounted on Adapter Plate



GCM-52-110 Earth Continuity Monitor

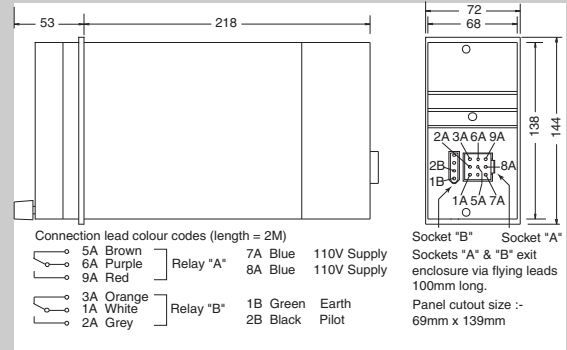
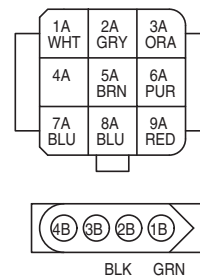


Fig 12

Dimensions of GCM-52 Enclosure (in mm)



- | | |
|--------------|----------|
| 1A. White : | Common-B |
| 2A. Grey : | N/O-B |
| 3A. Orange : | N/C-B |
| 4A. - : | Not Used |
| 5A. Brown : | N/C-A |
| 6A. Purple : | Common-A |
| 7A. Blue : | Supply |
| 8A. Blue : | Supply |
| 9A. Red : | N/O-A |
| 1B. Green : | Earth |
| 2B. Black : | Pilot |
| 3B. - : | Not Used |
| 4B. - : | Not Used |

Fig 13

Connections for GCM-52-110

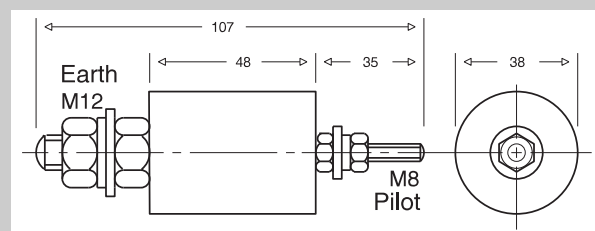


Fig 14

Dimensions of Remote Module (in mm)



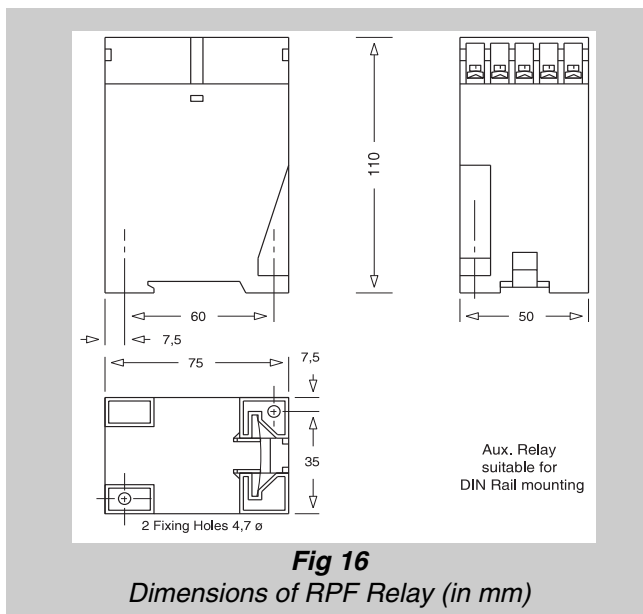
GCM Remote Module

Accessories

for Earth Continuity Monitor

PHASE SEQUENCE RELAY

The RPF550/1100V Phase Sequence Relay drops the power supply contactor if the phase sequence of the supply is incorrect. The direction of rotation is a vital factor in the case of drives for pumps, fans, compressors and conveyors. In certain circumstances, particularly where mobile equipment is employed, it is advisable to monitor the direction of rotation and to disconnect the power source if the drive runs in the reverse direction. The unit is usually situated at the load centre and is wired in conjunction with a pilot wire relay for contactor control, see Fig 15; for physical dimensions see Fig 16.

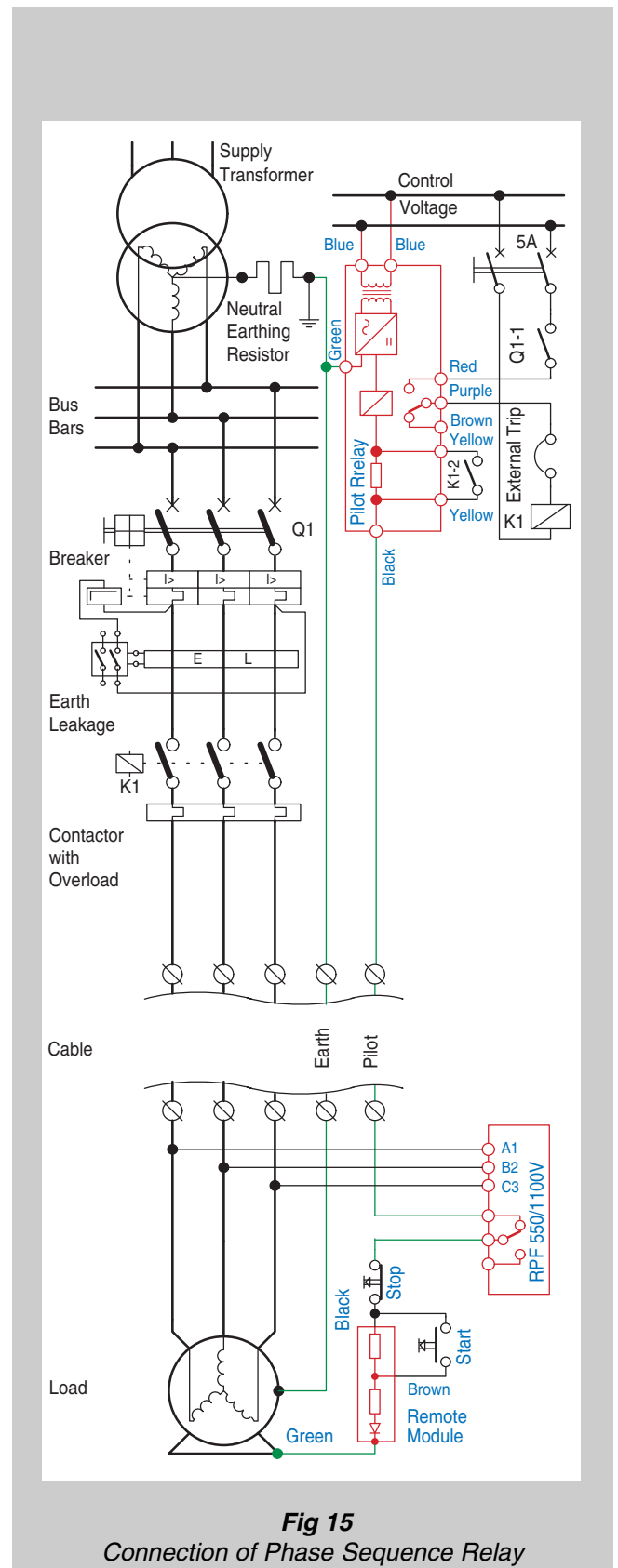


Specifications :

Input voltage : 550 or 1100Vac 3 phase
 Detection : Reverse phase & phase failure
 Output contact : One potential free C/O rated at 3A 250Vac

Ordering :

Stock No	Description
5002-001	RPF550/1100

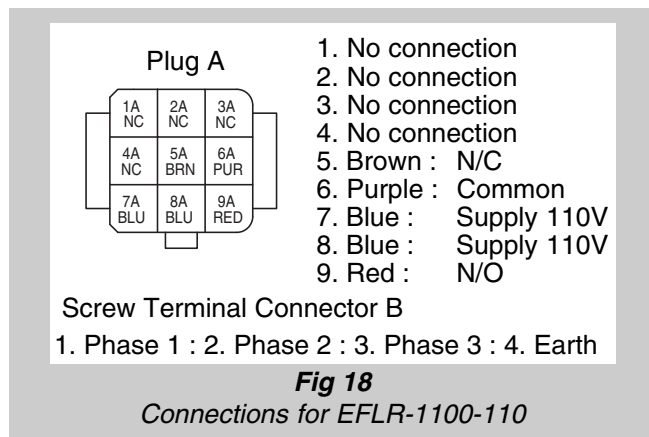


Accessories

for Earth Continuity Monitors

EARTH FAULT LOCKOUT RELAY

The EFLR-1100-110 Earth Fault Lockout Relay prevents the power supply contactor from closing if an earth fault is present on the cable. This ensures that only healthy circuits are energised, eliminating damage to equipment and protecting personnel from potential shock hazard. The unit is normally situated at the load centre and is used in conjunction with a pilot wire relay for contactor control: Fig 17 shows a typical application circuit. Physical dimensions of the relay are shown on page 6, Fig 4. The relay is connected via a 9 pin Molex plug & terminal block: the connection tables appear in Fig 18 below.

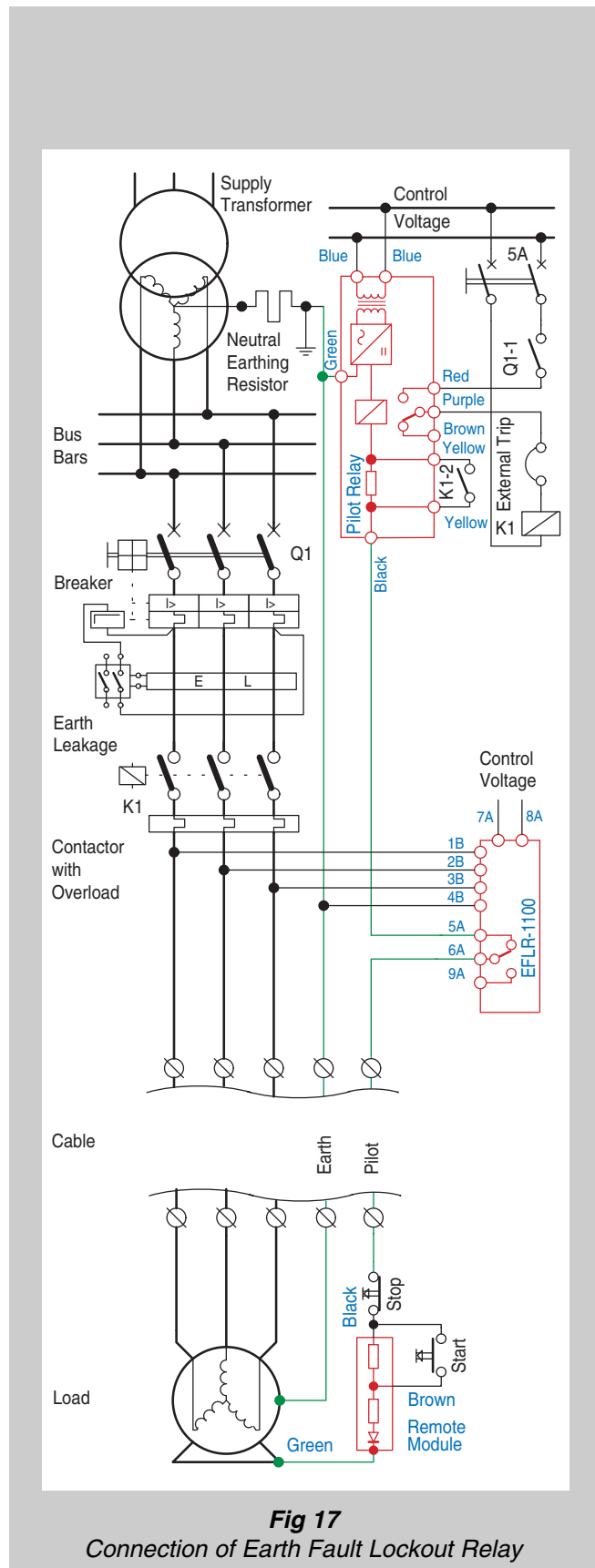


Specifications :

Control voltage : 110Vac \pm 15%
 Relay burden : 10VA
 Output contact : One potential free C/O rated at 5A 220Vac
 Earth fault detection : 10k Ω Insulation resistance
 System voltage : 1100Vac 3 phase
 Max amb temp : 65°C

Ordering :

Stock No Description
 5002-035 EFLR-1100-110 Connection leads
 5002-030 EFLR-1100-110 Earth Fault Lockout Relay



Specifications

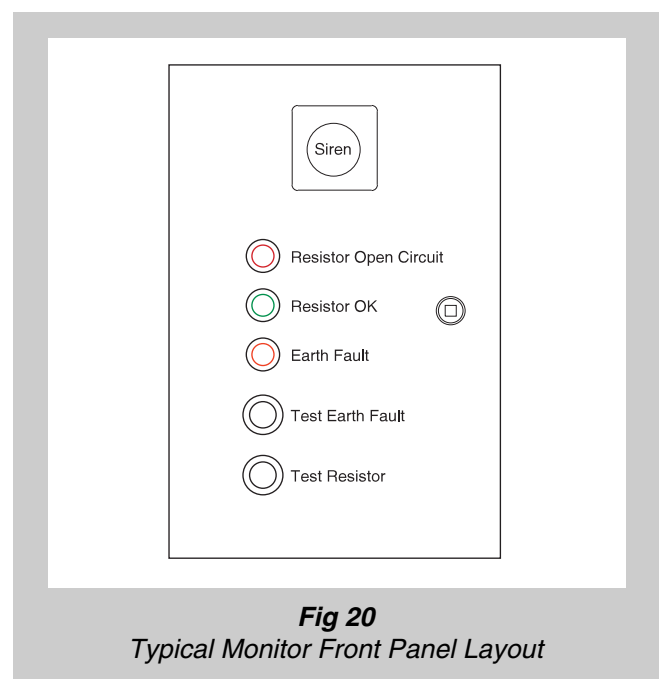
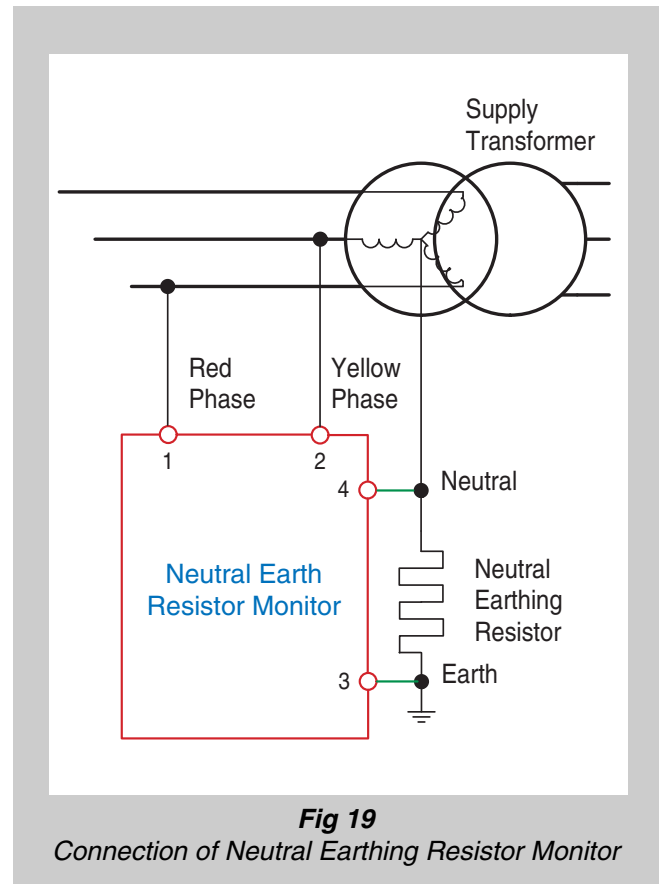
for Neutral Earthing Resistor Monitor

RESTRICTED EARTH FAULT SYSTEM

Neutral earthing resistors are used to limit the high currents that can flow in power transformers under earth fault conditions.

The NEUTRAL EARTHING RESISTOR MONITOR is designed to continuously monitor the integrity of the system *neutral earthing resistor*. Fault conditions trigger visual and audible alarms. Earth fault detection is incorporated as a secondary feature. The monitor operates on a fail safe principle and is designed to withstand earth fault voltages continuously without damage. Push buttons are provided to simulate a faulty *neutral earthing resistor* and an *earth fault* so that the operation of the monitor can be checked at any time.

Each NEUTRAL EARTHING RESISTOR MONITOR is custom designed to work with our customers' system, for this reason no detailed specifications are given here. A typical connection diagram is shown in Fig 19 and a general panel layout in Fig 20. Customers should contact our sales department to discuss their system requirements.



Earth Continuity Relays

Electrical safety for the mining industry.



SS switching
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