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Reyrolle Product Catalogue

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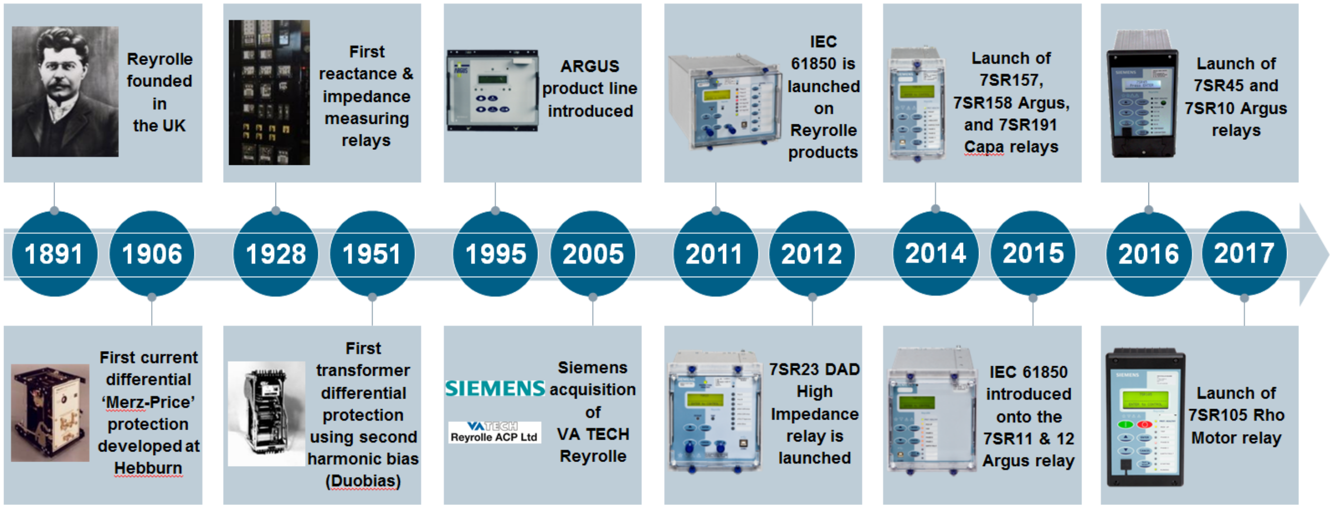
Editorial

Since 1886, when Mr A.C Reyrolle established a small work shop in London, the Reyrolle brand has been prominent at all stages of the power supply chain from generation to large end-users. We design and manufacture relays for the world wide protection and control market.
We are committed to high technology development and manufacture with full use of the latest software at all stages of product development, manufacture and testing. This can be seen in the latest digital products that Reyrolle offer.

History of Reyrolle with over 125 Years Experience



With over 100 years of proven innovative technology and many industry firsts, we are very well established in the global protection market.

Responsible, Excellent, Innovative

- User friendly products
- Withdrawable cases on most devices
- No battery back-up required on all devices except 7SR45
- High quality, reliable and dependable products - ISO9001 certified
- Complete range of electromechanical, trip and auxiliary relays
- Excellent delivery times
- Fast track replacement service
- Cost effective solutions
- Free of charge setting software
- Representation in over 140 countries
- Highly skilled workforce
- Excellent competence in Applications and R&D engineering
- Advanced technology facilities

Sub-transmission, distribution, industrial – three sectors, same standards

Reyrolle products cover the segments of sub-transmission, distribution and industrial solutions. The use of IEC 60870-5-103, Modbus, DNP3.0 and IEC 61850 communication standards within the product means they are suitable for common communication and system integration requirements.

Creating sustainable value through successive generations, Reyrolle products have been developed to increase value to our customers. This increase in value is a result of consistent, high technology development by our R&D engineers based in the UK and India.

By continuing to develop new products and solutions, we want to support your business in the best way possible. At the same time we strive to maintain and strengthen our position as a leader in power protection. Our complete and comprehensive solutions are able to serve your needs – whether you're a new or existing customer.

Devices and Fields of Application

1.1 Main Protection

1.1.1 7SR10/7SR105

1.1.1.1 7SR10 Non-Directional Overcurrent Protection Relay

Description

The 7SR10 overcurrent and earth fault relay is developed by using the latest generation of hardware technology and is available in multiple variants depending on power supply, Binary input/binary output configuration and data communication facility. 7SR10 is a member of Siemens Reyrolle® protection devices Argus product family.

The 7SR10 overcurrent and earth fault relay is housed in a 4U high, size 4 non draw-out case and these relays provide protection, monitoring, instrumentation, and metering with integrated input and output logic, data logging and fault reports. Communication access to the relay functionality is via a front USB port for local PC connection or rear electrical RS485 (optional) port for remote connection.

Function Overview

Protection

46BC	Broken Conductor, Load Unbalance
46 NPS	Negative Phase Sequence Overcurrent
49	Thermal Overload
50	Instantaneous Overcurrent Protection
50N/G	Instantaneous Earth Fault
51	Time Delayed Overcurrent Protection
51N/G	Time Delayed Derived/Measured Earth Fault Protection
51c	Current Protection: Cold Load
50BF	Circuit Breaker Fail
81HBL2	Inrush Restraint
50SEF	Instantaneous Sensitive Earth Fault
51SEF	Time Delayed Sensitive Earth Fault Protection

Supervision

74 T/CCS	Trip and Close Circuit Supervision
81 THD	Total Harmonic Distortion Supervision

Control

79	Auto Reclose
86	Lockout
	CB Control
CB	Trip/Close

Features

Cold Load Settings
Two Settings Groups
Password Protection – 2 levels
User Programmable Logic
Self Monitoring
Circuit Breaker Trip and Maintenance Counter
Trip Timers

User Interface

20 Character x 4 Line Backlit LCD
Menu Navigation Keys
9 User Programmable Tri-colour LEDs
User Language Configuration
Dedicated circuit breaker open and close push buttons

Monitoring Functions

Primary/Secondary Current Phases and Earth
Positive Phase Sequence (PPS) Current
Negative Phase Sequence (NPS) Current
Zero Phase Sequence (ZPS) Current
Frequency
Binary Input/Output status
Trip circuit healthy/failure
Time and date
Starters
Fault records
Event records
Circuit breaker trip counters
I^2t summation for contact wear

Hardware

4 CT	3 Binary Inputs/3 Binary Outputs 10 LEDs
4 CT	6 Binary Inputs/6 Binary Outputs 10 LEDs

Data Storage and Communication

Front USB port + Rear RS485 port (optional)
Protocols - IEC60870-5-103, DNP3.0 or Modbus RTU
Event Records - User Configurable

Fault Records
Waveform Records
Measurands
Commands
Time Synchronism
Viewing and Changing Settings

Application

The 7SR10 overcurrent and earth fault relay is a numerical overcurrent protection relay intended for use in the distribution and industrial networks. It provides a highly comprehensive functional software package with a range of integral application functions aimed at reducing installation, wiring, and engineering time.

A wide range of measured values can be viewed on the front LCD or remotely via the communication channel.

The integrated control feature allows the operation of a single circuit breaker and monitoring its trip and closed circuits.

7SR10 Functional Diagram

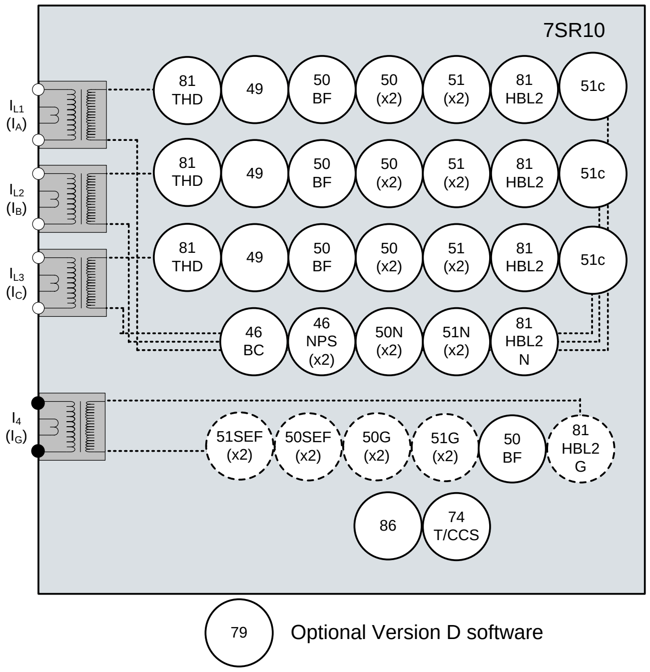


Fig 1. Four Pole Overcurrrent Relay

Description of Functionality

46BC Phase Unbalance/Broken Conductor

Element has settings for pickup level and DTL delay. With the circuit breaker closed, if the NPS: PPS current ratio is above setting this could be due to a broken conductor.

46NPS Negative Phase Sequence Overcurrent

Each element has user settings for pickup level and IDMTL or DTL delay, the element operates if NPS current exceeds setting and delay. NPS current elements can be used to detect unbalances on the system or remote earth faults when a delta-star transformer is in circuit.

49 Thermal Overload

The thermal algorithm calculates the thermal states from the measured currents and can be applied to lines, cables and transformers. Alarm outputs are given for thermal overload and thermal capacity.

51c Cold Load Protection

If a circuit breaker is closed onto a 'cold' load, (i.e.) one that has not been powered for a prolonged period, this can impose a higher than normal load-current demand on the system which could exceed normal settings. These conditions can exist for an extended period and must not be interpreted as a fault. To allow optimum setting levels to be applied for normal operation, the cold load pickup feature will apply alternative current settings for a limited period.

The feature resets when either the circuit breaker has been closed for a settable period or if the current has reduced beneath a set level for a user set period.

50/51 Phase Fault

50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI time current characteristics. The IDMT stage has a user programmable reset characteristic, either DTL or shaped current ~ time reset characteristic to improve the grading with electromechanical protection.

50G/51G/50N/51N/50SEF Earth Fault/Sensitive Earth Fault

Two earth fault measurement modes are available. One mode directly measures the earth current from an independent CT, or the residual connection of the 3 line CTs.

This input can be ordered as earth fault or sensitive earth fault (50G/51G/50SEF/51SEF).

The second mode derives the earth current internally from the 3 phase CT inputs to give earth fault (50N/51N).

50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI time current characteristics. The IDMT stage has a user programmable reset characteristic either DTL or shaped current ~ time reset characteristic to improve grading with electromechanical protection.

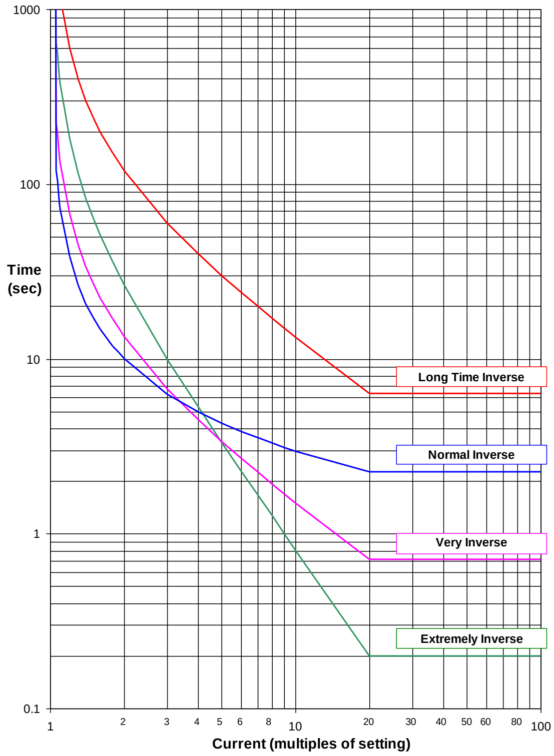


Fig 2. IEC Overcurrent Curves

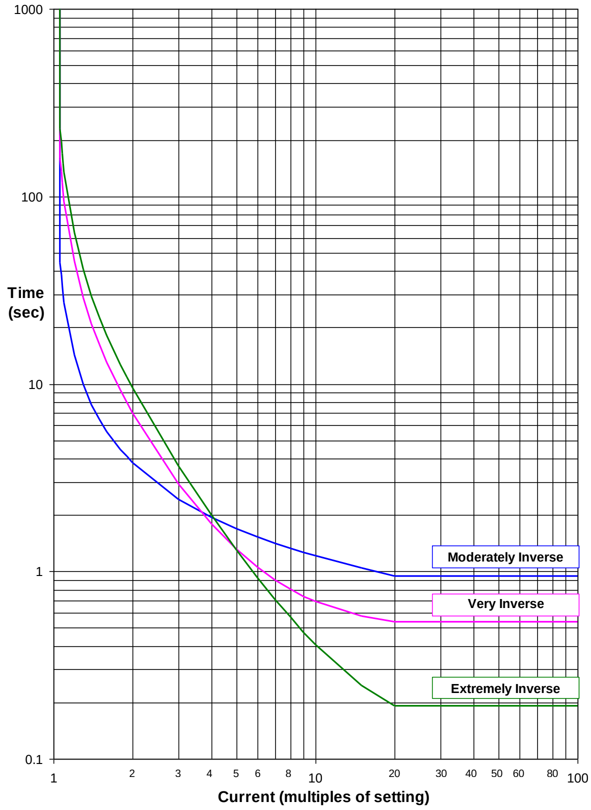


Fig 3. ANSI Overcurrent Curves

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. Line currents and earth currents are monitored following a trip signal and an output is issued if any current is still detected above the setting after a specified time interval. Alternatively, if the trip is from a mechanical protection the circuit breaker position can be used to determine a failure. A second time delay is available to enable another stage to be utilized if required. An input is also available to bypass the time delays when the circuit breaker is known to be faulty.

74T/CCS Trip and Close Circuit Supervision

The trip or close circuit(s) can be monitored via binary inputs. Trip circuit failure raises an HMI alarm and output(s).

81HBL2 Inrush Restraint

Where second harmonic current is detected (i.e. during transformer energisation) user selectable elements can be blocked and an alarm given.

81THD Total Harmonic Distortion Supervision

Total harmonic distortion is the percentage of harmonics present in fundamental frequency current. THD calculates the 2nd to 15th harmonic currents presents inline current and displayed in the 'Harmonic Meter' window as a percentage of fundamental frequency current. Separate THD threshold setting and delay is available as a function.

Programmable Logic

The user can map binary inputs, protection elements, LEDs and binary outputs together in a logical scheme.
Up to 4 logic equations can be defined using standard logic functions e.g. Timers, AND/OR gates, Inverters and Counters to provide the user required functionality.
Each logic equation output can be used for alarm & indication and/or tripping.

Virtual Inputs/Outputs

There are 8 virtual inputs/outputs to provide internal logical states to assist in the application of the functions. Each virtual I/O can be assigned in the same way as a physical I/O.

Circuit Breaker Maintenance

Two circuit breaker operations counters are provided to assist with maintenance scheduling. The maintenance counter records the overall number of operations and the delta counter records the number of operations since the last reset.

An I^2t summation counter provides a measure of the contact wear indicating the total energy interrupted by the circuit breaker contacts.

Each counter has a user set target operations count which, when reached, can be mapped to raise alarms/binary outputs. A CB Trip Time meter is also available, which measures the time between the trip or open command being issued and the auxiliary contacts changing state.

Control Mode

The relay has a control menu with access to commonly used command operations. Access to the control commands is restricted by a 4 character control function password. Each command requires a select then execute operation, if the execute operation is not performed within a time window the command is aborted. The control mode supports the CB Operation control function only.

CB Open/Close

The circuit breaker (CB) control function is used to manually open and close the CB when it is connected to the power system. Two dedicated push buttons are provided on the HMI to execute the CB manual close and open operations.

Standard Version – Plus 79 Auto-Reclose

A high proportion of faults on an overhead line network are transient and can be cleared quickly by high speed tripping followed by an automated circuit breaker reclose sequence.

The function provides independent phase fault and earth fault/sensitive earth fault sequences of up to 5 trip i.e. 4 reclose attempts before lockout. An auto-reclose sequence can be user set to be initiated from internal protection operation or via binary input from an external protection.

Data Acquisition - Via Communication Interface

Sequence of Event Records

Up to 1000 events are stored and time tagged to 1 ms resolution.

Fault Records

The last 15 fault records are displayed on the relay fascia and are also available through the communication interface with time and date of trip, measured quantities and type of fault.

Waveform Recorder

The waveform recorder stores analogue data for all poles and the states of protection functions, binary inputs, LEDs, and binary outputs with user settable pre and post trigger data. A record can be triggered from protection function, binary input or via data communications. 15 records of 1 second duration are stored.

Demand Metering

A rolling record of demand over the last 24 h is stored. The demand is averaged over a user selectable period of time. A rolling record of such demand averages is stored and provides the demand history. A typical application is to record 15min averages for the last 7 days.

Real Time Clock

The time and date can be set and are maintained while the relay is de-energised by a back up storage capacitor. The time can be synchronized from a binary input pulse or the data communication channel.

Language Editor

The Language editor software gives the user the ability to customize the text displayed in the relays, Menu structure and instrumentation views. The tool allows a language file to be created and transferred to the relay also containing Western European characters.
The data acquisition via communication interface can be done by Reydisp Evolution.

Serial Communications

The relay offers a USB serial port as standard on the front of all units. All of the relays functions can be set on a PC using Reydisp Evolution via the USB port. The connection is made with a USB cable and operates with a 'plug and play' connection, so no pre-setting of the relay is required.

The front port can be switched off or set to use either the DNP3.0, MODBUS-RTU, IEC60870-5-103 and ASCII protocols for testing purposes.

A rear RS485 electrical connection is optionally available on the relay for system interface connections. An internal terminating resistor is provided, which can be connected into the circuit by adding a wire loop between the relevant terminals.

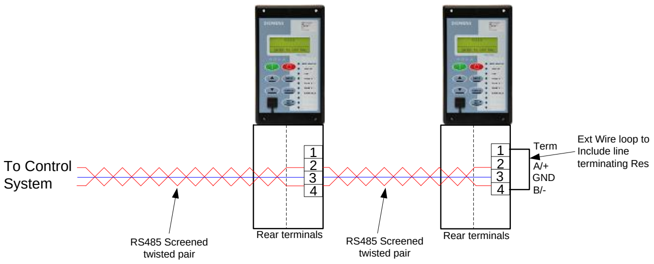


Fig 4. Typical RS485 connection

The rear RS485 can be user selected to be OFF, IEC60870-5-103, MODBUS RTU or DNP3.0 protocol.

Construction

The relay is housed in a non draw-out case 4U high, size 4 case.

The rear connection comprises of user friendly pluggable type terminals for wire connections for BI, BO, Communication, and Power Supply.

The fascia cover can be ordered with one push button to allow the user to reset the fault indication without removing the cover.

The CT terminals are suitable for ring type lug connection to provide a secure and reliable termination.

User Interface

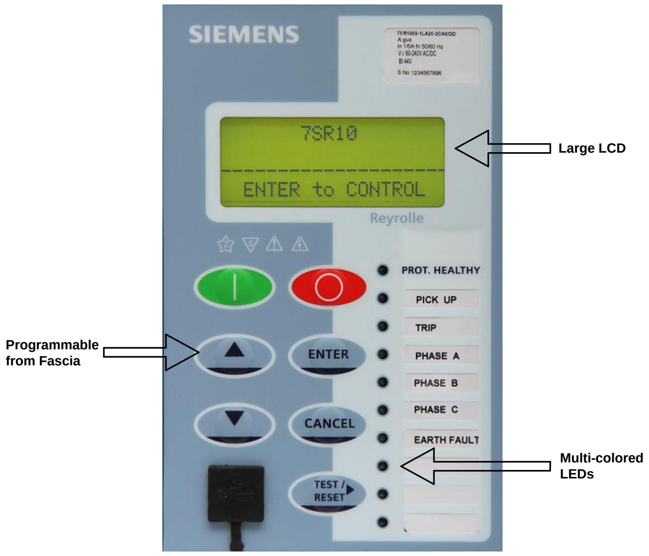


Fig 5. User Interface

The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings, and retrieving data from the relay. Five buttons are provided for navigation around the menu structure.

Two dedicated push buttons are provided on the HMI to execute the CB manual close and open operations.

LCD

A 4 line by 20 character liquid crystal display with power save operation indicates the relay identifier, settings, instrumentation, fault data and control commands. Up to 6 user programmable general alarms can be configured to display your own indications on the LCD.

LEDs

A green steadily illuminated LED indicates the 'Protection Healthy' condition. 9 users programmable LEDs are available eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED is tri- color (red, green, yellow) allowing for clear indication of the associated function's state and has a label for identification.

Relay Information

The device is identified by the rating label on the front fascia. The user can also give the device its own identity by editing the 'Relay Identifier' displayed on the LCD.

Indication of Conformity

This product complies with the directive of the Council of the European Communities on harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low Voltage Directive 2006/95/EC).
This conformity has been proved by tests performed according to the Council Directive in accordance with the generic standard IEC/EN 60255-26 (for EMC directive) and with the standards IEC/EN 60255-27 (for Low Voltage Directive) by Siemens AG.

Technical Data

For full technical data, refer to the Technical Specification Section of the User Manual.

Technical Data Overview

Product Family (Auxiliary powered)	Non Directional, Overcurrent and Earth Fault Protection Relay
Case and LEDs	Non Draw-out Polycarbonate case (Size4 standard, Non Draw-out design), 10 LEDs
Measuring Inputs (Current)	1 A/5 A, 50 Hz/60 Hz
Auxiliary Voltage	60 V - 240 V AC/DC
	24 V - 60 V DC
Communication	Default front communication port Back port: RS485 (optional – IEC 60870-5-103 or Modbus RTU or DNP 3.0)
Protection Functions	50, 50G/N, 51, 51G/N, 50BF, 50SEF, 51SEF, 49, 46BC, 46NPS
Supervision and control functions	74 T/CCS, 86, 81HBL2 – (inrush restraint), 51c, 81THD, 79 AR
Binary Input and Binary Output	3 BI or 6 BI 3 BO or 6 BO, (2 changeover contact) Threshold voltage - 88 VAC/DC or 44 V AC/DC available with 60 V - 240 V AC/DC power supply version - 19 V DC with 24 V - 60 V DC power supply version
Overvoltage	Category III
Pollution Degree	2

Mechanical Specifications

Design	Flush mounting, Non Draw-out Polycarbonate moulded case
Enclosure	IP 54 (front panel) IP 20 Protection for terminals (rear side) Depth is 199 mm
Weight	1.6 kgs (appx)

Terminal Blocks

Current Inputs	12 position, M4 Screw-type Barrier Terminal block suitable for 2.5 mm^2/4 mm^2 cable
Auxiliary Supply	3 position, M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Rear Communication Port	4 position, M2 screw-type plug-in terminals suitable for 1.5 mm^2 cable
Front Communication Port	USB, Type B
Binary Input	6 or 12 position, M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Binary Output	8 or 14 position, M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable

Inputs and Outputs

Current Inputs

Quantity	3 x Phase & 1 x Earth
Rated Current In	1 A/5 A
Measuring Range	80*In 8*In (SEF)
Instrumentation	±1% (Typical) (≥ 0.1xIn to 3xIn) ± 3% (> 3xIn to 80xIn)
Frequency	50 Hz (Range: 47 Hz to 52 Hz) 60 Hz (Range: 57 Hz to 62 Hz)
Thermal Withstand *	
Continuous	4 x In
10 seconds	30 x In
1 Second	100 A (1 A) 350 A (5 A)
Burden @ In	≤ 0.3 VA per phase and earth for both 1 A and 5 A

*** ZY20 - Special version with Thermal withstand 500A (5A CT)**

Auxiliary Supply

Rated Voltage	60 V - 240 V AC/DC, Tolerance -20% to +10%
Allowable super imposed AC component	15% of DC voltage
Typical power consumption (DC)	< 7 W
Typical power consumption (AC)	<7 VA 0.5 PF
Max Interruption time (Collapse to Zero)	≤"100 ms (110 V DC) ≤ 1000 ms (230 V AC)

Auxiliary Supply

Rated Voltage	24 V - 60 V DC Tolerance -20% to +10%
Allowable super imposed AC component	15% of DC voltage
Typical Power consumption (DC)	< 7 W
Max Interruption time (Collapse to Zero)	20 ms (24 V DC)

Binary Inputs

Number	3 or 6	
Operating Voltage*	19 V DC	Range 24 V - 66 V DC
	44 V AC/DC	Range 44 V - 265 V
	Range	DC 44 V - 265 V DC AC 36 V - 265 V AC
	88 V AC/DC	Range 88 V - 265 V
	Range	DC 88 V - 265 V DC AC 68 V - 265 V AC
Maximum AC/DC current for operation	3.5 mA	
Pick Up Delay	User selectable 0 to 14,400,000 ms (up to 4 hours)	
Drop Off Delay	User selectable 0 to 14,400,000 ms (up to 4 hours)	

* Refer to Ordering Information for more details.
For more details about binary inputs, refer to Technical Manual.

Binary Outputs

Number	3 or 6 (2 change over contacts)
Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed
Operating Time from energizing Binary Input	<20 ms
Making Capacity: Carry continuously Make and carry (L/R ≤ 40 ms and V ≤ 300 V)	5 A AC or DC 20 A AC or DC for 0.5 s 30 A AC or DC for 0.5 s
Breaking Capacity: (≤ 5 A and ≤ 300 V):	
AC Resistive	1250 VA
AC Inductive	250 VA at p.f. ≤ 0.4
DC Resistive	75 W
DC Inductive	30 W at L/R ≤ 40 ms 50 W at L/R ≤ 10 ms
Disengaging time	< 20 ms

Rear Communication Port

Quantity	1 No. (Optional)
Electrical connection	RS485, 2 wire electrical
Protocol Support	MODBUS RTU, IEC 60870-5-103, DNP 3.0
Rate	Data Transfer rate: 2400 - 38400 bps

Front Communication Port

Quantity	1 No.
Electrical connection	USB, Type B

Data Storage

Fault Record	15
Waveform Record	15 Rec x 1 Sec 7 Rec x 2 Sec 3 Rec x 5 Sec 1 Rec x 15 Sec Pre trigger 10...90%
Events	1000 events (1 ms Resolution)

Mechanical Tests

Test	**Standard**
Vibration	IEC 60255-21-1 Response and Endurance, Class I
Shock and Bump	IEC 60255-21-2 Shock response and withstand Class I Bump, Class I
Degree of Protection	IEC 60529 IP 54 front IP 20 back
Seismic	IEC 60255-21-3, Class I
Contact	IEC 60255-1 (Ref: Std IEC 61810-1)
Electrical Endurance Test	IEC 60255-1 (Ref: Std IEC 61810-1) (10000 operations at 250 V, 5 A)

Electrical Tests

Test	Standard
Insulation Resistance	IEC 60255-27# 500 V DC, >100M Ohms
Impulse Voltage Withstand	IEC 60255-27# 5 kV, 5 +ve, -ve pulses
Hi Voltage (Dielectric) Voltage	IEC 60255-27# 2 kV@1 min (Between any terminal and earth, independent circuits) 1 kV AC RMS for 1 min (across normally open contacts)
High Frequency Disturbance	IEC 60255-26 2.5 kV (CM), 1.0 kV (DM) 1 MHz, 100 kHz
Electrostatic Discharge	IEC 60255-26 8 kV air discharge
Electrical Fast Transient or Burst *	IEC 60255-26, Zone A 4 kV, 5 kHz
Surge Immunity *	IEC 60255-26, Zone A 4 kV (CM), 2 kV (DM) 1.2/50 µs
Radiated Immunity	IEC 60255-26 80 MHz to 1.0 GHz and 1.4 GHz to 2.7 GHz Both frequency at 10 V/m
Conducted Radio Frequency Interference	IEC 60255-26 150 kHz to 80 MHz, Class III
Power Frequency Magnetic Field	IEC 60255-26 30 A/m applied 1 min, 300 A/m applied for 3 s
Conducted Emissions	IEC 60255-26 CISPR 22, Class A
Radiated Emissions	IEC 60255-26 CISPR 11, Class A
Thermal Withstand Continuous 1 s Burden	IEC 60255-27 4 x In 100 A (1 A) 350 A (5 A) IEC 60255-1 ≤0.3 VA per phase and earth for both 1 A and 5 A
Functional	IEC 60255-3
Maximum Allowable Temperature	IEC 60255-6 Max. temperature limit +100^{0}C
Limiting Dynamic Value	10 ms 700 A (1 A) 2500 A (5 A)
Gradual shutdown/Start-up test	IEC 60255-26 Shut down/start up ramp 60 s Power off 5 min

* NOTE: 45 ms DTL pick-up delay applied to binary inputs

NOTE: All aspect of IEC 60255-5 have been covered under IEC 60255-27

Climatic Environmental Tests

Temperature
IEC 60068-2-1/IEC 60068-2-2

Operating Temperature	-10^{0}C to + 60^{0}C
Storage Range	- 25^{0}C to + 70^{0}C

Humidity
IEC 60068-2-30/IEC 60068-2-78

Damp heat test, Cyclic	6 days at 40^{0}C and 93% relative humidity
Damp heat test, Steady State	4 days at 95% RH, +40^{0}C
Maximum Altitude of Operation	Upto 2000 m

Product Safety Test

IEC/EN 60255-27

Type Test	Parameters	Values
Clearances and Creepage Distances	Clearances and creepage distances between external circuits mutual and to the enclosure	≥ 4 mm
Protective Bonding Resistance	Test voltage: < 12V AC/DC	
	Test duration: 1 min	
	Bonding resistance	< 0.1 Ohm
Protective Bonding Continuity	Accessible conductive parts should be bonded with the protective conductor terminal	Low current continuity test
Flammability of Insulating Materials, Components and Fire enclosures	Structure Part	Standard for insulating material of flammability class
	Terminals	Class UL 94 V-0
	Terminal Mounting	Class UL 94 V-0
	Wiring (CT)	(N)2GFAF (VDE)
	Components mounting	Class UL 94 V-0
	Enclosure	Class UL 94 V-0
	PCB	Class UL 94 V-0
	LCD	Class UL 94 V-0
Single Fault Condition	Assessment of: • Insulation between circuits and parts • Compliance with requirements for protection against the spread of fire	The equipment shall not present a risk of electric shock or fire after a single-fault test.

Type Test	Parameters	Values
	• Overloads • Intermittently rated resistors • Compliance with requirements for mechanical protection	

IEC/EN 61010-1

Test Description	Applicable Clause No.
Marking and Documentation	5
Protection against electric shock	6
Protection against mechanical hazard	7
Resistance to mechanical stresses (shock and impact)	8
Protection against the spread of fire	9
Equipment temperature limits and resistance to heat	10
Protection against liberated gases and substances, explosion and implosion	13
Components and sub assemblies	14
HAZARDS resulting from application	16
Risk Assessment	17

Performance

46 Negative Phase Sequence Overcurrent

Number of Elements	DT & IT
DT Setting Range Is	0.05,0.10...4.0 x In
DT Operate Level	100% Is, ±5% or ±1%xIn
DT Delay Setting td	0.00, 0.01...20, 20.5...100,101...1000, 1010...10000, 10100... 14400 s
DT Basic Operate Time	
0 to 2x Is	40 ms ±10 ms
0 to 5x Is	30 ms ±10 ms
DT Operate time following delay	Tbasic +td , ±1% or ±10 ms
IT Char Setting	IEC NI,VI,EI,LTI, ANSI MI,VI,EI & DTL
IT Setting Range	0.05..2.5
Tm Time Multiplier	0.025, 0.030... 1.6, 1.7... 5, 6... 100
Char Operate Level	105% Is, ±4% or ±1%In
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input

49 Thermal Overload

Operate levels	Operate and Alarm
Setting Range Is	0.10,0.11...3.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Time Constant Setting	1,1.5...1000 min
Operate time	$t = \tau \times In\left\{\frac{I^2 \cdot I_p^2}{I^2 \cdot (k \times I_B)^2}\right\}$ ±5% absolute or ±100 ms where Ip = prior current
Alarm Level	Disabled, 50,51...100%
Inhibited by	Binary or Virtual Input

50 Instantaneous & DTL OC&EF

Operation	Non directional
Elements	Phase, Derived Earth, Measured Earth, Sensitive Earth fault
Setting Range Is (50/50N/50G)	0.05,0.06...50 x In
Setting Range Is (50SEF)	0.005.... 5 x In
Time Delay	0.00...14400 s
Operate Level I_{op}	100% Is, ±5% or ±1%xIn
Reset level	≥ 95 % I_{op}
Reset level (50SEF)	>= 95 % Iop or Iop - 0.1% In
Operate time:	
50, 50G,50SEF	0 to 2x Is – 35 ms, ±10 ms, 0 to 5x Is – 25 ms, ±10 ms
50N	0 to 2x Is – 40 ms, ±10 ms, 0 to 5x Is – 30 ms, ±10 ms
Operate time following delay	Tbasic +td , ±1% or ±10 ms
Inhibited by	Binary or Virtual Input Inrush detector

81HBL2 Inrush Detector

I Setting (Ratio of 2nd Harmonic current to fundamental component current)	0.10, 0.11... 0.5
t_{basic} Element basic operate time	Will pick-up before operation of any protection element due to magnetic inrush
Reset Time	Will operate until drop-off of any protection element due to magnetic inrush

46BC Broken Conductor

46BC setting, NPS to PPS ratio	20, 21…100%
t_f Delay setting	0.03,04,20.0,20.1,100, 101,1000,1010…..14400 s
I_{Curr} Operate level	100 % I_{set} ± 5 %
Reset level	90 % I_{curr} ± 5 %
t_{basic} Basic operate time	1x In to 0 A 40 ms
Operate time	$t_f + t_{basic}$, ± 1 % or ± 20 ms

51 Time Delayed OC&EF

Operation	Non directional
Elements	Phase, Derived Earth, Measured Earth, Sensitive Earth fault
Characteristic	IEC-NI, -VI, -EI, -LTI; ANSI-MI, -VI, -EI; DTL
Setting Range Is (51/51G)	0.05,0.06…4 x In
Setting Range Is (51SEF)	0.005,…0.5 x In
Time Multiplier	0.01, 0.015….1.6, 1.7,….5, 6…100
Time Delay	0,0.01… 20 s
Operate Level	105% Is, ±4% or ±1%x In
Minimum Operate time IEC ANSI	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$ $t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5% absolute or ± 40ms for TMS setting (0.01 to 0.245) ± 5% absolute or ± 30ms for TMS setting (0.25 to 100)
Follower Delay	0 s - 20 s
Reset	ANSI decaying, 0 s - 60 s
Inhibited by	Binary or Virtual Input Inrush detector

50 BF Circuit Breaker Fail

Operation	Current check - Phase and Measured Earth with independent settings Mechanical Trip CB Faulty Monitor
Setting Range Is	0.05,0.055…2.0 x In
2 Stage Time Delays	Timer 1 20…60000 ms Timer 2 20…60000 ms
Operate Level	100% Is, ±5% or ±1%x In
Disengaging time	< 20 ms
Operate time following delay	Tcbf ±1% or ±20 ms
Triggered by	Any function mapped as trip contact
Inhibited by	Binary/Virtual Input
Timer By pass	Yes, 50BF CB Faulty Input

74 T/CCS Trip/Close Circuit Supervision

Number of supervisable circuits	3 x Trip and 3 x Close
Number of BI's Required	1 or 2 per function

NOTE: Use the correct threshold voltages for BI when using TCS with 2 BI.

Control Functions

CB	Trip/Close
Inst Prot	IN/OUT
EF	IN/OUT
SEF	IN/OUT
Hot Line	IN/OUT
Relay Mode	Local/Remote/Local or Remote
Reset	LED's & O/P's (Test/Reset key)

CB Maintenance

Trip Counter	Total & Delta 0…10000
I^2t Alarm	10…100000

81THD Supervision

I_{thd} Setting	5, 6,…..100%
t_d Delay setting	0.02, 0.03…20.00, 20.10… 100, 101… 1000, 1010… 10000, 10100… 14400 s

79 AutoReclose

Operating Mode	Phase, Earth, SEF External
Number of Reclose	1..4
Number of Trips to Lockout	1..5
Dead Time	0…14400
Reclaim Timer	0…600
Lockout Reset	CB, Timer & BI

Case Dimensions

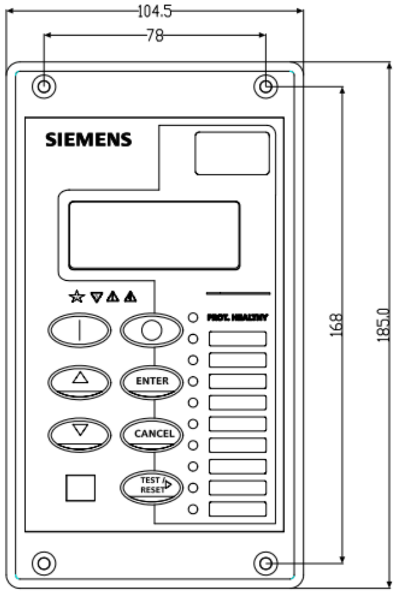


Fig 6. Front View

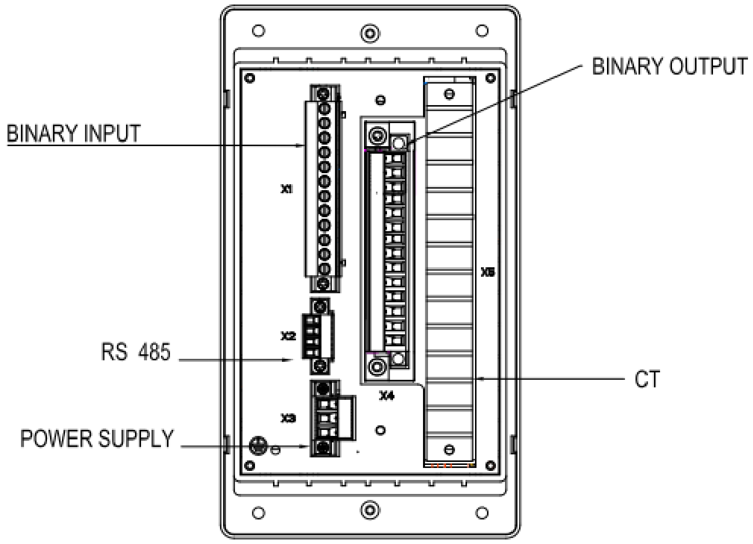


Fig 7. Rear View

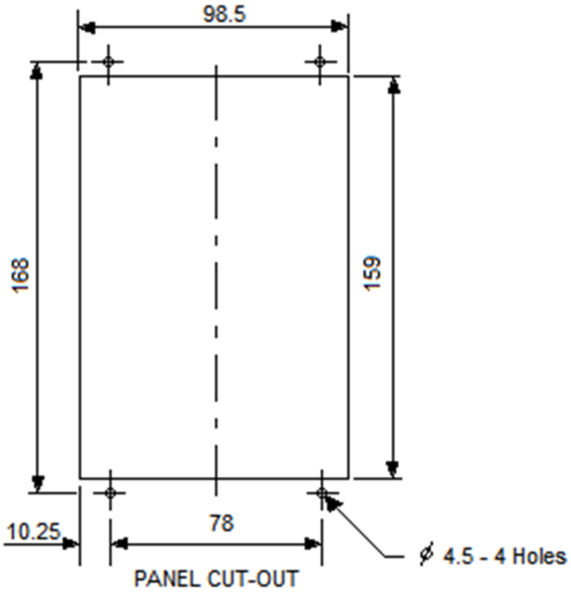


Fig 8. Panel cut-out view

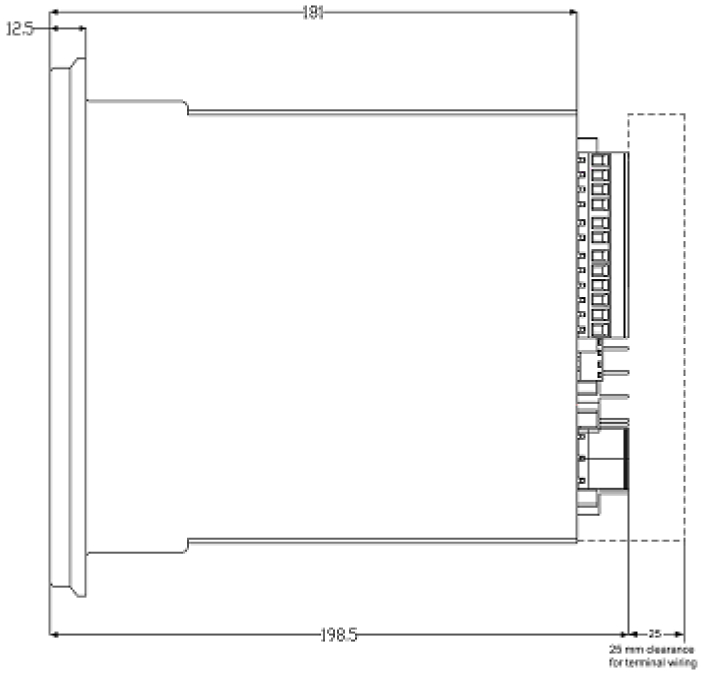


Fig 9. Side View

7SR10 Terminal/Wiring Diagram with Control Push Buttons

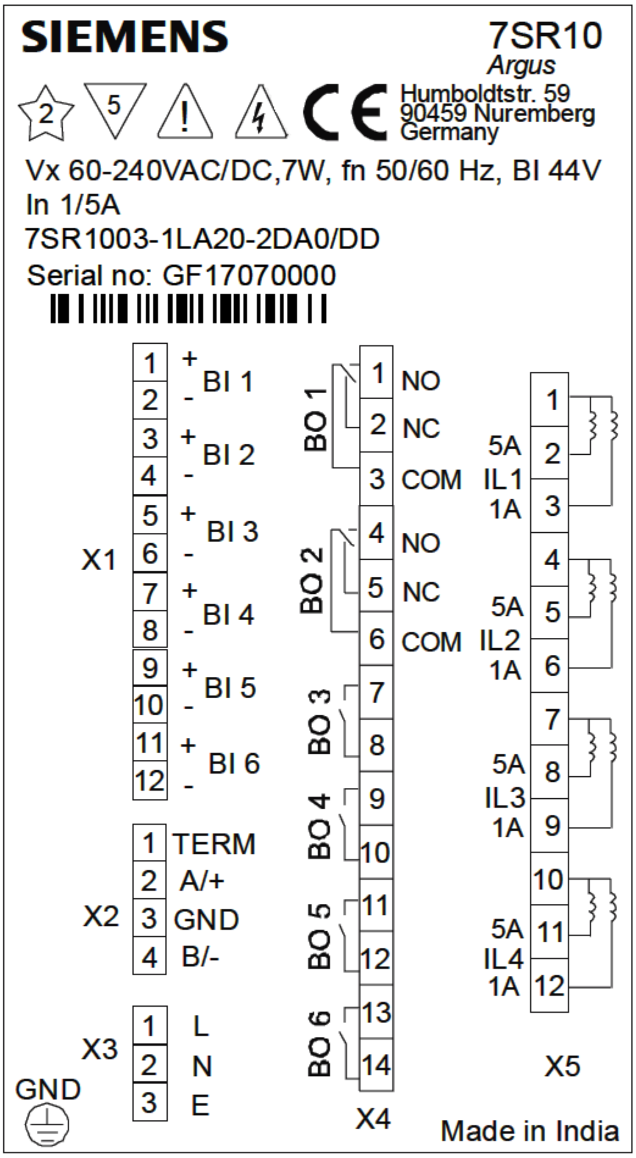


Fig 10. Terminal/Wiring Diagram View (Extended Version)

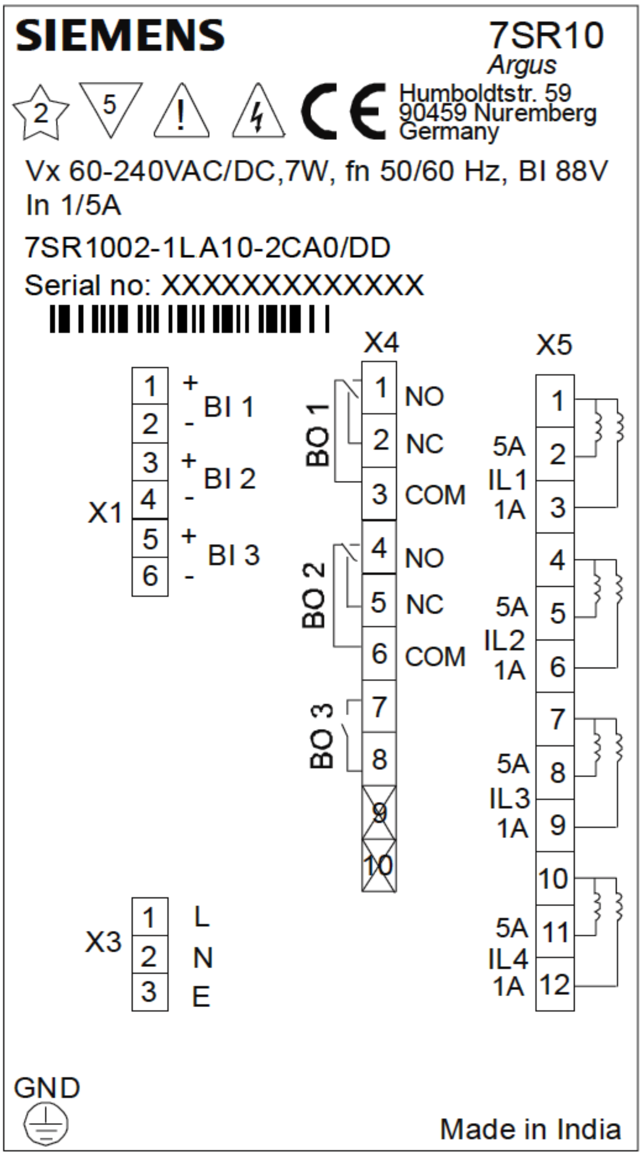


Fig 11. Terminal/Wiring Diagram View (Basic Version)

Ordering Information

Product Description	Variants	Order No.
		1 2 3 4 5 6 7 - 8 9 10 11 12 - 13 14 15 16
7SR10 Argus		**7 S R 1 0 0 ☐ - ☐ ☐ ☐ ☐ 0 - ☐ A 0 ☐☐☐☐**

	7	8	9	10	11	13	14	15	
Nondirectional O/C Relay (Argus)									
Case, I/O and Fascia									
Size 4 Moulded case, 4 CT, 3 Binary Inputs/3 Binary Outputs, 10 LEDs	2	1			1				
Size 4 Moulded case, 4CT, 6 Binary Inputs/6 Binary Outputs, 10 LEDs	3								
Measuring input									
1/5 A, 50/60Hz [1]	2/3	1							
1/5 A, 50/60Hz with SEF input [2]	3	2							
Auxiliary voltage									
AC/DC 60-240V, Binary input threshold 44 V AC/VDC			L						
AC/DC 60-240V, Binary input threshold 88 V AC/VDC			K						
DC 24-60 V, Binary input threshold 19 VDC			J						
Protective Cover									
Standard version – No Cover				A					
Plastic Cover with 1 Push Button for Test/Reset				B					
Communication									
Front Port : USB	2				1				
Front Port : USB and Rear Port : RS-485 supporting IEC 60870-5-103 or Modbus RTU or DNP 3.0	3				2				
Front Fascia									
Standard Version – with Breaker Control Push Buttons						2			
Protection Function Packages							C		
Standard version - included in all models									
46BC Broken Conductor/Load Unbalance									
46NPS Negative Phase Sequence Overcurrent									
49 Thermal overload									
50 Instantaneous Phase Fault Overcurrent									
50BF Circuit Breaker fail									
50G/N Instantaneous Earth Fault									
50SEF [2,4] Instantaneous Sensitive Earth Fault Overcurrent									
51 Timed Delayed Phase Fault Overcurrent									
51 G/N Timed Delayed Earth Fault									
51SEF [2,4] Time Delayed Sensitive Earth Fault									
74T/CCS Trip/Close Circuit Supervision									
81HBL2 [3] 2nd Harmonic block/Inrush restraint									
86 Hand Reset Contacts									
51C Cold Load Pickup									
Programmable Logic									
81THD Total Harmonic Distortion Supervision									
Standard version – plus									
79 Autoreclose							D		
Additional Functionality									
No Additional Functionality								A	
Special version [5]									Z Y 2 0

1) 4CT is configured as 3PF + EF
2) 4CT is configured as 3PF + SEF
3) Not available on SEF input
4) Only with position 7 = 3
5) Special version for Turkey market with thermal withstand capability of 500A (5A CT), 1 sec and supporting Turkish scripts.
6) Available only with position 8 = 1

1.1.1.2 7SR105 Motor Protection Relay

Description

The 7SR105 Rho motor protection relay is developed by using the latest generation of hardware technology. 7SR105 is a member of Siemens Reyrolle® protection devices Rho product family.

The 7SR105 Rho motor protection relay is housed in a 4U high, size 4 non draw-out case and these relays provide protection, monitoring, instrumentation, and metering with integrated input and output logic, data logging and fault reports. Communication access to the relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection.

Function Overview

Protection

14	Stall Protection
46	Phase Unbalance Protection
49	Thermal Overload Protection
48/66	Start Protection
37	Undercurrent Protection
50	Instantaneous Overcurrent Protection
50N/G	Instantaneous Derived/Measured Earth Fault
51	Time Delayed Overcurrent Protection
51N/G	Time Delayed Derived/Measured Earth Fault Protection

Supervision

74 T/CCS	Trip and Close Circuit Supervision
81B	Anti Backspin
46PhRev	Phase Reversal
50BCL	Breaking Capacity Limit
50BF	Circuit Breaker Fail
TEMP	Temperature Input Monitoring

Control

86 Lockout
Motor Start/Stop Control
User Programmable Logic

Features

Two Settings Groups
Password Protection – 2 levels
User Programmable Logic
Self Monitoring
Circuit Breaker Trip and Maintenance Counter
Trip Timers

User Interface

20 Character x 4 Line Backlit LCD
Menu Navigation Keys
9 User Programmable Tri-colour LEDs
Dedicated motor start and stop push buttons

Monitoring Functions

Primary/Secondary Current Phases and Earth
Positive Phase Sequence (PPS) Current
Negative Phase Sequence (NPS) Current
Zero Phase Sequence (ZPS) Current
Thermal equivalent and unbalanced currents
Binary Input/Output status
Time and date
Starters
Fault records
Event records
Circuit breaker trip counters and Time to trip
I^2t summation for contact wear
Temperature input values

Hardware

4 CT 6 Binary Inputs/6 Binary Outputs 10 LEDs
4 CT 6 Binary Inputs/6 Binary Outputs 10 LEDs 6 RTD

Data Storage and Communication

Front USB port + Rear RS485 port
Protocols - IEC60870-5-103, DNP3.0 or Modbus RTU
Event Records - User Configurable
Fault Records
Waveform Records
Measurands
Commands
Time Synchronism
Viewing and Changing Settings
Maximum Temperature recorded input

Application

7SR105 Rho motor protection relay is a numerical protection relay intended for use in the motor protection applications. It provides a highly comprehensive functional software package with a range of integral application functions aimed at reducing installation, wiring, and engineering time.

A wide range of measured values can be viewed on the front LCD or remotely via the communication channel.

The integrated control feature allows the safe operation of a motor and monitoring its start and stop operations.

7SR105 Functional Diagram

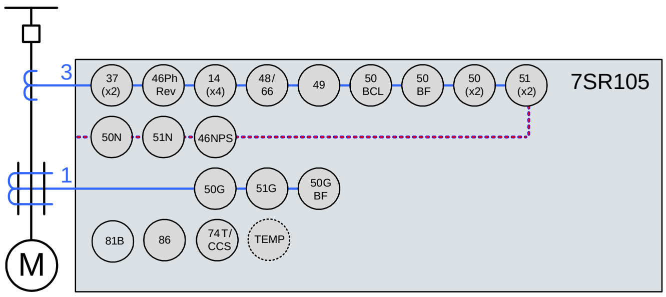


Fig 1. 7SR105 Rho Motor Protection Relay

Description of Functionality

14 Stall Protection

Each element has a single definite time overcurrent characteristic with settings for pickup level and Definite Time Lag (DTL) delays.

Operation can be controlled from motor stopped or running conditions.

37 Undercurrent Protection

Each element has settings for the pickup level and the definite time lag (DTL) delay. The element operates when current falls below setting for the duration of the delay.

46 Phase Unbalance Protection

Unbalance current has a significant heating effect on the motor.

Two phase unbalance measurement modes are available. Either NPS current or the difference between maximum and minimum phase currents can be used as a measurement of the unbalance level.

Inverse or definite time operation can be selected.

48/66 Start Protection

The feature provides settings to control both the number of times a motor can be started within a specified time period and the minimum time between starts. Motor starting can be inhibited when this limit is reached.
Motor start time can also be monitored.

49 Thermal Protection – Rotating Plant

The operating curves take into account the effects of present loading, prior loading and unbalanced currents on the motor operating temperature.

A user definable thermal curve is selectable to allow matching of the relay thermal characteristic to all motor and cooling system types.

‘Starting’ and ‘cooling’ constants modify the thermal characteristic during motor run-up and stopped conditions. The enhanced thermal algorithm provides compliance with IEC60255-8 (Thermal Electrical relays).

50/51 G/N Earth Fault Protection

Two earth fault measurement modes are available.

Measured earth fault mode (G) directly measures the earth current from an independent CT, or the residual connection of the 3 line CT’s.

Derived earth fault mode (N) derives the earth current internally from the line CT inputs.

Independent settings are available for pickup current and time-delays.

IDMT curves are available.

50/51 Overcurrent Protection

Definite time elements provide short circuit overcurrent protection with independent settings for pickup current and time-delays.

IDMT curves can also be selected.

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. Where a CB closed is detected following a trip signal an output is issued after a specified time interval. This can be used to re-trip the CB or to back-trip an upstream CB. A second time delay is available to enable another stage to be utilized if required.

81B Anti Backspin

To inhibit attempted restarting of the motor until after the rotor has completely stopped backspin protection is applied. Starting is inhibited until the 81B time delay has elapsed.

TEMP Temperature Inputs

Motor resistance temperature detectors (RTDs) can be connected via temperature inputs. Up to six RTD sensors can be monitored. Provision to configure seven types of RTD inputs (for 3 wire configuration). Temperature inputs can be configurable for RTD Alarm and Trip application.

NOTE:
Any one of the RTD type can be configured for all six temperature inputs.

74TCS Trip Circuit Supervision

The trip circuits can be monitored via binary inputs connected in H5/H6 or H7 schemes. Trip circuit failure raises an HMI alarm and output(s).

Programmable User Logic

The user can map Binary Inputs and Protection operated outputs to Function Inhibits, Logic Inputs, LEDs and/or Binary Outputs.

The user can also enter up to 4 equations defining scheme logic using standard functions e.g. Timers, AND/OR gates, Inverters and Counters.

Each Protection element output can be used for Alarm/Indication and/or tripping.

Function LED's

Ten user programmable tri-colour LED's are provided eliminating the need for separate panel mounted indicators and associated wiring. Each LED can be user set to red, green or yellow allowing for indication of the associated function's status. A slip-in pocket adjacent to the LEDs enables the user to insert customised labels. A printer compatible template is available.

Virtual Inputs/Outputs

There are 8 virtual inputs/outputs to provide internal logical states to assist in the application of the functions. Each virtual I/O can be assigned in the same way as a physical I/O.

Circuit Breaker Maintenance

Two circuit breaker operations counters are provided to assist with maintenance scheduling. The maintenance counter records the overall number of operations and the delta counter records the number of operations since the last reset.

An I^2t summation counter provides a measure of the contact wear indicating the total energy interrupted by the circuit breaker contacts.

Each counter has a user set target operations count which, when reached, can be mapped to raise alarms/binary outputs. A CB Trip Time meter is also available, which measures the time between the trip or open command being issued and the auxiliary contacts changing state.

Control Mode

The relay has a control menu with access to commonly used command operations. Access to the control commands is restricted by a 4 character control function password. Each command requires a select then execute operation, if the execute operation is not performed within a time window the command is aborted.

Motor Start/Stop

The motor control function is used to manually start and stop the motor when it is connected to the power network. Two dedicated push buttons are provided on the HMI to execute the motor manual start and stop operations.

Data Acquisition - Via Communication Interface

Sequence of Event Records

Up to 1000 events are stored and time tagged to 1 ms resolution.

Fault Records

The last 15 fault records are displayed on the relay fascia and are also available through the communication interface with time and date of trip, measured quantities and type of fault.

Waveform Recorder

The waveform recorder stores analogue data for all poles and the states of protection functions, binary inputs, LEDs, and binary outputs with user settable pre and post trigger data. A record can be triggered from protection function, binary input or via data communications. 15 records of 1 second duration are stored.

Demand Metering

A rolling record of demand over the last 24 h is stored. The demand is averaged over a user selectable period of time. A rolling record of such demand averages is stored and provides the demand history. A typical application is to record 15 min averages for the last 7 days.

Real Time Clock

The time and date can be set and are maintained while the relay is de-energised by a back up storage capacitor. The time can be synchronized from a binary input pulse or the data communication channel.

Language Editor

The Language editor software gives the user the ability to customize the text displayed in the relays, Menu structure and instrumentation views. The tool allows a language file to be created and transferred to the relay also containing Western European characters.

The data acquisition via communication interface can be done by Reydisp Evolution.

Serial Communications

The relay offers a USB serial port as standard on the front of all units. All of the relays functions can be set on a PC using Reydisp Evolution via the USB port. The connection is made with a USB cable and operates with a 'plug and play' connection, so no pre-setting of the relay is required.

The front port can be switched off or set to use either the DNP3.0, MODBUS-RTU, IEC60870-5-103 and ASCII protocols for testing purposes.

A rear RS485 electrical connection is optionally available on the relay for system interface connections. An internal terminating resistor is provided, which can be connected into the circuit by adding a wire loop between the relevant terminals.

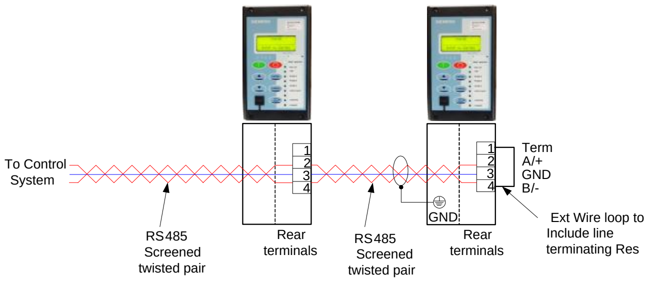


Fig 2. Typical RS485 connection

The rear RS485 can be user selected to be OFF, IEC60870-5-103, MODBUS RTU or DNP3.0 protocol.

Construction

The relay is housed in a non draw-out case 4U high, size 4 case.

The rear connection comprises of user friendly pluggable type terminals for wire connections for BI, BO, Communication, Temperature inputs, and Power Supply.

The CT terminals are suitable for ring type lug connection to provide a secure and reliable termination.

User Interface

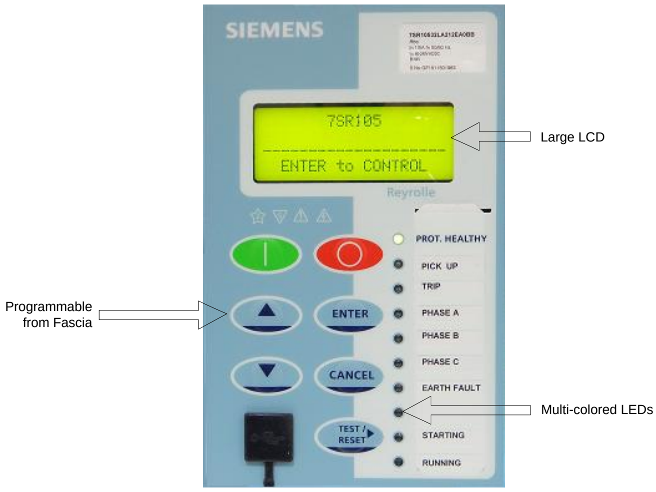


Fig 3. User Interface

The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings, and retrieving data from the relay. Five buttons are provided for navigation around the menu structure.
Two dedicated push buttons are provided on the HMI to execute the motor manual start and stop operations.

LCD

A 4 line by 20 character liquid crystal display with power save operation indicates the relay identifier, settings, instrumentation, fault data and control commands. Up to 6 user programmable general alarms can be configured to display your own indications on the LCD.

LEDs

A green steadily illuminated LED indicates the 'Protection Healthy' condition. 9 users programmable LEDs are available eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED is tri- color (red, green, yellow) allowing for clear indication of the associated function's state and has a label for identification.

Relay Information

The device is identified by the rating label on the front fascia. The user can also give the device its own identity by editing the 'Relay Identifier' displayed on the LCD.

Indication of Conformity

This product complies with the directive of the Council of the European Communities on harmonization of the laws of the Member States relating to electromagnetic compatibility (EMC Council Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low Voltage Directive 2014/35/EU).

This conformity has been proved by tests performed according to the Council Directive in accordance with the generic standard IEC/EN 60255-26 (for EMC directive) and with the standards IEC/EN 60255-27 (for Low Voltage Directive) by Siemens AG.

Technical Data

For full technical data, refer to the Technical Specification Section of the User Manual.

Technical Data Overview

Product Family (Auxiliary powered)	Motor Protection Relay
Case and LEDs	Non Draw-out Polycarbonate case (Size 4 standard, Non Draw-out design), 10 LEDs
Measuring Inputs (Current)	1 A/5 A, 50 Hz/60 Hz
Auxiliary Voltage	60 V - 240 V AC/DC 24 V - 60 V DC
Communication	Default front communication port (IEC 60870-5-103 or MODBUS RTU) Rear port: RS485 (optional - IEC 60870-5-103 or Modbus RTU or DNP 3.0)
Protection Functions	14, 37, 48/66, 50, 50G/N, 51, 51G/N, 49, 46
Supervision and control functions	74 T/CCS, 86, 50 BCL, 81 B, 46 Ph Rev, 50BF, TEMP
Binary Input and Binary Output	6 BI and 6 BO (2 changeover contact) Threshold voltage - 44 V AC/DC with 60 V - 240 V AC/DC power supply version - 19 V DC with 24 V - 60 V DC power supply version
Overvoltage	Category III
Pollution Degree	2

Mechanical Specifications

Design	Flush mounting, Non Draw-out Polycarbonate moulded case
Enclosure	IP 54 (front panel) IP 20 Protection for terminals (rear side) Depth is 199 mm
Weight	1.6 kgs (appx)

Terminal Blocks

Current Inputs	12 position, M4 Screw-type Barrier Terminal block suitable for 2.5 mm^2/4 mm^2 cable
Auxiliary Supply	3 position, M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Rear Communication Port	4 position, M2 screw-type plug-in terminals suitable for 1.5 mm^2 cable
Front Communication Port	USB, Type B
Binary Input	12 position, M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Binary Output	14 position, M3 screw-type plug-in terminals suitable for 2.5mm^2 cable
Temperature Inputs	18 position (Terminal X6, X7), M2 screw-type plug-in terminals suitable for 1.5 mm^2 shielded cable

Inputs and Outputs

Current Inputs

Quantity	3 x Phase & 1 x Earth
Rated Current In	1 A/5 A
Measuring Range	80*In 8*In (Measure E/F)
Instrumentation	±1 % (Typical) (≥ 0.1xIn to 3xIn) ± 3 % (> 3xIn to 80xIn)
Frequency	50 Hz (Range: 47.5 Hz to 52.5 Hz) 60 Hz (Range: 57 Hz to 63 Hz)
Thermal Withstand:	
Continuous	4 x In
10 seconds	30 x In
1 Second	100 A (1 A) 350 A (5 A)
Burden @ In	≤ 0.3 VA per phase and earth for both 1 A and 5 A

Auxiliary Supply

Rated Voltage	60 V - 240 V AC/DC, Tolerance -20% to +10%
Allowable super imposed AC component	15% of DC voltage
Typical power consumption (DC)	< 7 W
Typical power consumption (AC)	<7 VA 0.5 PF
Max Interruption time (Collapse to Zero)	≤”100 ms (110 V DC) ≤ 1000 ms (230 V AC)

Auxiliary Supply

Rated Voltage	24 V - 60 V DC Tolerance -20% to +10%
Allowable super imposed AC component	15% of DC voltage
Typical Power consumption (DC)	< 7 W
Max Interruption time (Collapse to Zero)	20 ms (24 V DC)

Binary Inputs

Number	6	
Operating Voltage*	19 V DC	Range 24 V - 66 V DC
	44 V AC/DC	Range 44 V - 265 V
	Range	DC 44 V - 265 V DC
		AC 36 V - 265 V AC
Maximum AC/DC current for operation	3.5 mA	
Pick Up Delay	User selectable 0 to 14,400,000 ms (up to 4 hours)	
Drop Off Delay	User selectable 0 to 14,400,000 ms (up to 4 hours)	
Reset/Operate voltage ratio	≥ 90%	
Response time	< 9 ms	

*Refer to ordering information for more details.
For more details about binary inputs, refer to Technical Manual.

Binary Outputs

Number	6 4 NO contacts and 2 change over contacts
Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed
Operating Time from energizing Binary Input	< 20 ms
Making Capacity:	
Carry continuously	5 A AC or DC
Make and carry (L/R ≤ 40 ms and V ≤ 300 V)	20 A AC or DC for 0.5 s 30 A AC or DC for 0.5 s
Breaking Capacity (≤ 5 A and ≤ 300 V):	
AC Resistive	1250 VA
AC Inductive	250 VA at p.f. ≤ 0.4
DC Resistive	75 W
DC Inductive	30 W at L/R ≤ 40 ms 50 W at L/R ≤ 10 ms
Disengaging time	< 20 ms

Temperature Inputs

Number	6
Measuring Range	-50 °C to +250°C
Response time	< 3 s
Sensing current	< 0.5 mA

Rear Communication Port

Quantity	1 No.
Electrical connection	RS485, 2 wire electrical
Protocol Support	MODBUS RTU, IEC 60870-5-103, DNP 3.0
Rate	Data Transfer rate: 2400 - 38400 bps

Front Communication Port

Quantity	1 No.
Electrical connection	USB, Type B

Data Storage

Fault Record	15
Waveform Record	15 Rec x 1 Sec 7 Rec x 2 Sec 3 Rec x 5 Sec 1 Rec x 15 Sec Pre trigger 10...90 %
Events	1000 events (1 ms Resolution)

Mechanical Tests

Test	**Standard**
Vibration	IEC 60255-21-1 Response and Endurance, Class I
Shock and Bump	IEC 60255-21-2 Shock response and withstand Class I Bump, Class I
Degree of Protection	IEC 60529 IP 54 front IP 20 back
Seismic	IEC 60255-21-3, Class I
Contact	IEC 60255-1 (Ref: Std IEC 61810-1)
Electrical Endurance Test	IEC 60255-1 (Ref: Std IEC 61810-1) (10000 operations at 250 V, 5 A)

Electrical Tests

Test	Standard
Insulation Resistance	IEC 60255-27[#] 500 V DC, >100M Ohms
Impulse Voltage Withstand	IEC 60255-27[#] 5 kV, 5 +ve, -ve pulses
Hi Voltage (Dielectric) Voltage	IEC 60255-27[#] 2 kV@1 min (Between any terminal and earth, independent circuits) 1 kV AC RMS for 1 min (across normally open contacts)
High Frequency Disturbance	IEC 60255-26 2.5 kV (CM), 1.0 kV (DM) 1 MHz
Electrostatic Discharge	IEC 60255-26 8 kV air discharge 6 kV contact discharge
Electrical Fast Transient or Burst *	IEC 60255-26, Zone A 4 kV, 5 kHz
Surge Immunity *	IEC 60255-26, Zone A 4 kV (CM), 2 kV (DM) 1.2/50 µs
Radiated Immunity	IEC 60255-26 80 MHz to 1.0 GHz and 1.4 GHz to 2.7 GHz Both frequency at 10 V/m
Conducted Radio Frequency Interference	IEC 60255-26 150 kHz to 80 MHz
Power Frequency Magnetic Field	IEC 60255-26 30 A/m applied 1 min, 300 A/m applied for 3 s
Conducted Emissions	IEC 60255-26 CISPR 22, Class A
Radiated Emissions	IEC 60255-26 CISPR 11, Class A
Thermal Withstand	IEC 60255-27
Continuous	4 x In
1 s	100 A (1 A) 350 A (5 A)
Burden	IEC 60255-1 ≤ 0.3 VA per phase and earth for both 1 A and 5 A
Functional	IEC 60255-8
Temperature Input (Pt100)	IEC 60751
Maximum Allowable Temperature	IEC 60255-6 Max. temperature limit +100 ^{0} C
Limiting Dynamic Value	10 ms 700 A (1 A) 2500 A (5 A)
Gradual shutdown/ Start-up test	IEC 60255-26 Shut down/start up ramp 60 s Power off 5 min

* **NOTE:** 45 ms DTL pick-up delay applied to binary inputs

NOTE: All aspect of IEC 60255-5 have been covered under IEC 60255-27

Climatic Environmental Tests

Temperature
IEC 60255-1/IEC 60068-2-1/IEC 60068-2-2

Operating Temperature	-10 ^{0}C to + 60 ^{0}C
Storage Range	- 25 ^{0}C to + 70 ^{0}C

Humidity
IEC 60255-1/IEC 60068-2-30/IEC 60068-2-78

Damp heat test, Cyclic	6 days at 40 ^{0}C and 93 % relative humidity
Damp heat test, Steady State	10 days at 95 % RH, +40 ^{0}C
Maximum Altitude of Operation	Upto 2000 m

Product Safety Test

IEC/EN 60255-27

Type Test	Parameters	Values
Clearances and Creepage Distances	Clearances and creepage distances between external circuits mutual and to the enclosure	≥ 4 mm
Protective Bonding Resistance	Test voltage: < 12V AC/DC	
	Test duration: 1 min	
	Bonding resistance	< 0.1 Ohm
Protective Bonding Continuity	Accessible conductive parts should be bonded with the protective conductor terminal	Low current continuity test
Flammability of Insulating Materials, Components and Fire enclosures	Structure Part	Standard for insulating material of flammability class
	Terminals	Class UL 94 V-0
	Terminal mounting	Class UL 94 V-0
	Wiring (CT)	(N)2GFAF(VDE)
	Components mounting	Class UL 94 V-0
	Enclosure	Class UL 94 V-0
	PCB	Class UL 94 V-0
	LCD	Class UL 94 V-0
Single Fault Condition	Assessment of: - Insulation between circuits and parts - Compliance with requirements for protection against the spread of fire - Overloads - Intermittently rated resistors - Compliance with requirements for mechanical protection	The equipment shall not present a risk of electric shock or fire after a single-fault test.

Performance

14 Stall Protection

Number of Elements	4
Setting Range Is: -	0.05 to 10 x In
Time Delay	0.00 to 14400 s
Operate Level	100 % Is ±5 % or ±1 % xIn
Operate time 2 x I_s 5 x I_s	 35 ms ± 10 ms, 25 ms ± 10 ms
Operate time following delay	t_{basic} +t_d , ±1 % or ±10 ms
Controlled by	Stopped, No acceleration, Running, None
Disengaging time	< 50 ms

37 Undercurrent

Number of Elements	2
U/C Guard	0.05 to 5.0 x In
Setting Range Is	0.05 to 5.0 x In
Operate Level	100 % Is ± 5 % or ± 1 % xIn
Delay Setting td	0 to 14400 s
Basic Operate Time: - 0.5 x I_s	 35 ms ± 20 ms
Operate time following delay.	t_{basic} + t_d , ± 1 % or ± 10 ms
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input
Disengaging time	< 60 ms

46 Phase Unbalance Protection

Number of Elements	1 (Magnitude difference or NPS)
Setting Range Is	0.1 to 0.4 x Itheta
Operate Level	100 % Is ± 5 % or ± 1 % x In
IT Min. Operate Time	0 to 20 s
DT Delay Setting td	0 to 20 s
DT Basic Operate Time for NPS - 2 x I_s 5 x I_s	 65 ms ± 10 ms 60 ms ± 10 ms
DT Basic Operate Time for magnitude - 2 x I_s 5 x I_s	 60 ms ± 10 ms 50 ms ± 10 ms
DT Operate time following delay	td ± 1 % or ± 30 ms
Tm Time Multiplier	0.025 to 2.0
Disengaging time	< 80 ms
Inhibited by	Binary or Virtual Input

48/66 Start Protection

Max. No. of Starts	OFF, 1 to 20
Max. Starts Period	1 to 60 minutes
Start Inhibit Delay	1 to 60 minutes
Time Between Starts	OFF, 1 to 60 minutes

49 Thermal Protection

Setting Range Itheta	0.1 to 3.0 x In
NPS Weighting Factor(K)	0.1 to 10.0 Δ 0.1
TauH Heating Constant	0.5 to 1000 mins, Δ 0.5 mins
TauS Starting Constant	0.005 to 1.0 x TauH , Δ 0.005
TauC Cooling Constant	1 to 100 x TauH , Δ 1
Hot/cold ratio	OFF, 1 to 100 %, Δ 1 %
Operate Level	100 % Is, ±5 % or ±1 % x In
Operate time	$t = \tau \times In\left\{\frac{I_{EQ}^2 - \left(1 - \frac{H}{C}\right) I_p^2}{I_{EQ}^2 - I_\theta^2}\right\}$ ±5 % or ±100 ms (Itheta = 0.3 to 3 x In) (1.2 to 20 x Itheta)
	User defined
Capacity Alarm Level	Disabled, 50,51...100 %
Load Alarm Level	OFF, 0.5 to 1.0 x Itheta , Δ 0.05
Thermal restart inhibit	20 to 100 %, Δ 1 %
Inhibited by	Binary or Virtual Input

50 Instantaneous & DTL OC&EF

Operation	Non directional
Elements	Phase, Derived Earth, Measured Earth
Setting Range I_s (50/50N)	0.05,0.06...50 x In
Setting Range I_s (50G)	0.01, 0.011,.... 5 x In
Time Delay	0.00...14400 s
Operate Level I_{op}	100 % Is, ±5 % or ±1 %xIn
Reset level	≥ 95 % I_{op}
Reset level (50G)	>= 95 % I_{op} or I_{op} - 0.1 % In
Operate time: 50, 50G 50N	0 to 2x Is – 35 ms, ±10 ms, 0 to 5x Is – 25 ms, ±10 ms 0 to 2x Is – 40 ms, ±10 ms, 0 to 5x Is – 30 ms, ±10 ms
Operate time following delay	t_{basic} +t_d , ±1 % or ±10 ms
Inhibited by	Binary or Virtual Input Inrush detector
Disengaging time (50G)	< 50 ms

51 Time Delayed OC&EF

Operation	Non directional
Elements	Phase, Derived Earth, Measured Earth
Characteristic	IEC-NI, -VI, -EI, -LTI; ANSI-MI, -VI, -EI; DTL
Setting Range Is (51/51N)	0.05,0.06...4 x In
Setting Range Is (51G)	0.01,0.011,...0.5 x In
Time Multiplier	0.01,0.015..1.6,1.7..5,6..100
Time Delay	0,0.01... 20 s
Operate Level	105 % Is, ±4 % or ±1 %x In
Minimum Operate time IEC ANSI	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$ $t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5% absolute or ± 40 ms for TMS setting (0.01 to 0.245) ± 5 % absolute or ± 30 ms for TMS setting (0.25 to 100)
Follower Delay	0 s - 20 s
Reset	ANSI decaying, 0 s - 60 s
Inhibited by	Binary or Virtual Input Inrush detector

50 BF Circuit Breaker Fail

Operation	Current check - Phase and Measured Earth with independent settings Mechanical Trip CB Faulty Monitor
Setting Range I_s	0.05,0.055...2.0 x In
Setting Range I_s	0.01,0.015,...2.0 x In
2 Stage Time Delays	Timer 1 20...60000 ms Timer 2 20...60000 ms
Operate Level	100 % I_s, ±5 % or ±1 %x In
Disengaging time	< 20 ms
Operate time following delay	Tcbf ±1 % or ±20 ms
Triggered by	Any function mapped as trip contact
Inhibited by	Binary/Virtual Input
Timer By pass	Yes, 50BF CB Faulty Input

74 T/CCS Trip/Close Circuit Supervision

Number of supervisable circuits	3 x Trip and 3 x Close
Number of BI's Required	1 or 2 per function

50BCL Break Capacity Limit

Setting	1.0, 1.5... 50 xIn
Operate level	100 % Is, ± 5 % or ± 1% In
Reset level	≥ 95 % Iop
Element basic operate time	0 to 2 xIs: 20 ms or ± 10 ms 0 to 5 xIs: 15 ms or ± 10 ms

46PH REV Phase Reversal

NPS to PPS ratio	20...100 %
Delay setting	0...14400 s
Operate level	100 % I s ± 5 %
Reset level	>85 % I_{op},
Basic operate time	1x In to 0 A (60 ms)
Operate time	t_f + t_{basic}, ±1 % or ± 20 ms

Temperature Inputs (RTD)

Temperature input type (Temperature Coefficient Resistance based on DIN/IEC 60751 standard)	Cu10 (0.00427), Ni100 (0.00618), Pt100 (0.00385), Ni120 (0.00672), Pt250 (0.00385), Ni250 (0.00618), and Pt1000 (0.00385)
Temperature input Alarm	0,1,2...250°C
Temperature input Trip	0,1,2...250°C
Operate value	100 % Tset, ± 2% or ±2°C, For Cu10: ± 2 % or ± 5°C
Response time	< 3 s
Sensing current	≤ 0.5 mA
Maximum lead resistance	25 Ω/lead For Cu10: 2.5 Ω/lead

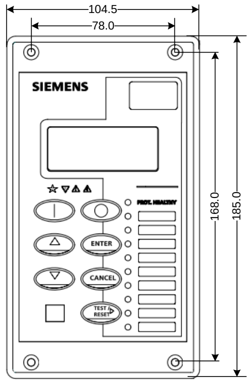
Control Functions

Motor	Start/Stop
EF	IN/OUT
Relay Mode	Local/Remote/Local or Remote
Reset	LED's & O/P's (Test/Reset key)

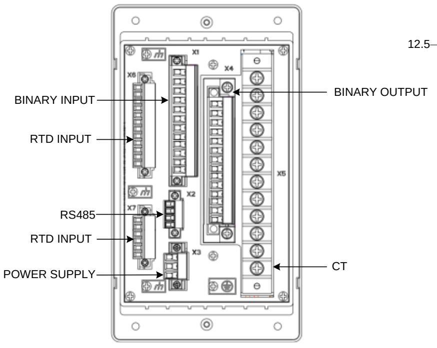
CB Maintenance

Trip Counter	Total & Delta 0...10000
I^2t Alarm	10...100000

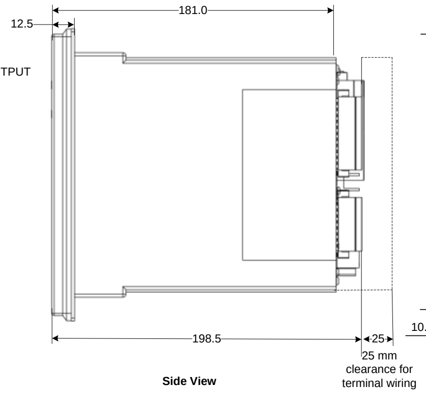
Case Dimensions



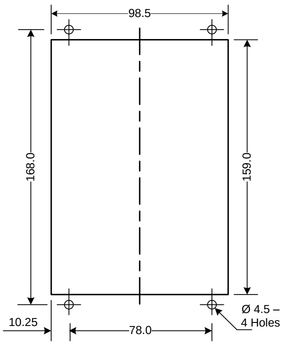
Front View



Rear View



Side View



Panel Cut-Out View

7SR105 Terminal/Wiring Diagram

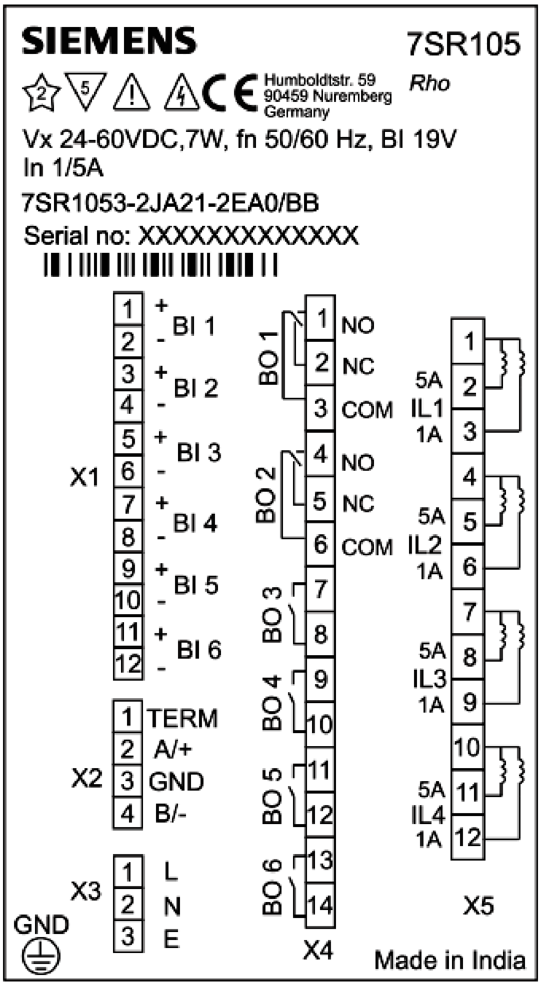


Fig 4. Terminal/Wiring Diagram View (Non RTD)

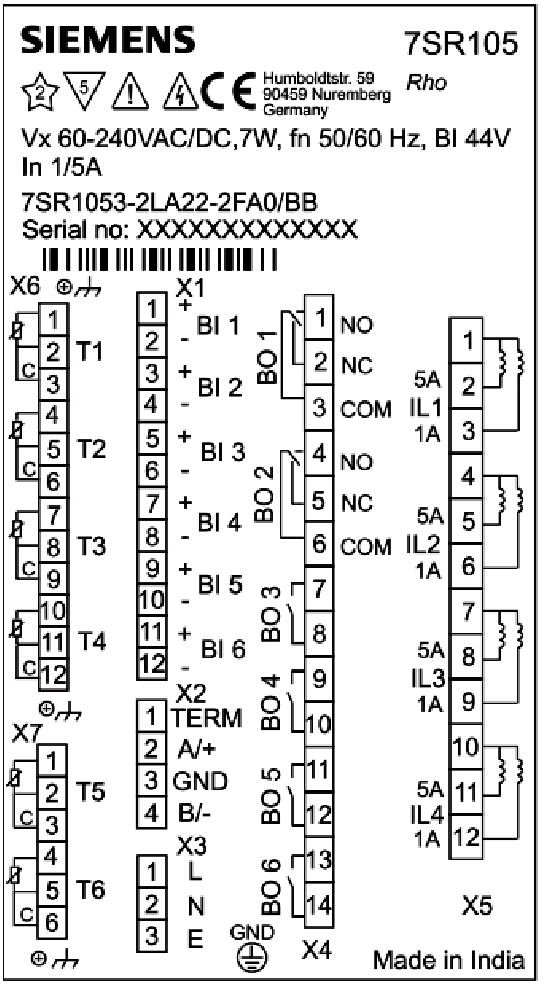


Fig 5. Terminal/Wiring Diagram View (RTD)

Ordering Information

Use the following MLFB ordering code for ordering 7SR105 Rho Motor Protection Relay.

	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16
7SR105 Rho	7	S	R	1	0	5		-						-			A	0

Case, I/O and Fascia

Size 4 Moulded case, 4 CT Inputs,
6 Binary Inputs/6 Binary Outputs, 10 LEDs **3**

Measuring Input

1/5 A, 50/60 Hz **2**

Auxiliary Voltage

AC/DC 60-240V, Binary input threshold 44 V AC/V DC **L**
DC 24-60 V, Binary input threshold 19 V DC **J** **1**

Protective Cover

Standard version – No Cover **A**

Communication

Front Port : USB and Rear Port: RS-485 supporting
IEC 60870-5-103 or Modbus RTU or DNP 3.0 **2**

Temperature Input

Without RTD **1** **E**

6 RTD Input **2** **F**

Front Fascia

Standard Version – with Breaker Control Push Buttons **2**

Protection Function Packages

Standard version - included in all models **E**

14	Stall Protection
37	Undercurrent
46	Phase Unbalance Protection
46PhRev	Phase Reversal
48/66	Start Protection
49	Thermal Overload
50/51	Overcurrent
50/51, GN	Earth fault
50BCL	Break Capacity Limit
50BF	Circuit breaker fail
74T/CCS	Trip/Close circuit supervision
81B	Anti Backspin
CB	Counters
I^2T	CB Wears

Programmable Logic

Standard Version Plus

Additional Function in Temperature Input version model **F**

1.1.2 7SR1 Range

The following information is applicable to all devices in the 7SR1 range.

Data Acquisition - Via Communication Interface

Sequence of event records

Up to 1000 events are stored and time tagged to 1ms resolution.

Fault Records

The last 10 fault records are displayed on the relay fascia and are also available through the communication interface, with time and date of trip, measured quantities and type of fault. (5 records for 7SR1102-1*A12-*AA0 versions).

Waveform recorder

The waveform recorder stores analogue data for all poles and the states of protection functions, binary inputs, LEDs and binary outputs with user settable pre & post trigger data. A record can be triggered from protection function, binary input or via data communications. 10 records of 1 second duration are stored. (8 records for the 7SR18 and 5 records for 7SR1102-1*A12-*AA0 versions).

Demand Metering

A record of demand is available. The demand minimum, maximum and average values for currents, frequency and if applicable, voltages and real, reactive and apparent power, over a user selectable period of time, is displayed and available via data communications. Typically this is set as a rolling value for the last 24 hours.

Real Time Clock

The time and date can be set and are maintained while the relay is de-energised by a back up storage capacitor. The time can be synchronized from a binary input pulse or the data communication channel.

Data Storage and Communication

Standard Communication Ports

Front USB port + Rear RS485 port

Additional Optional Communication Ports

2x Electrical RJ45 Ethernet ports
2x LC Fibre Optic Ethernet ports

Standard Protocols

IEC60870-5-103, DNP3.0 or Modbus RTU
User Selectable with programmable data points

Optional Protocols

IEC61850 (E6 Case)

Ethernet Redundancy Protocols:

Standard in all IEC61850 models:
PRP (Parallel Redundancy Protocol)
RSTP (Rapid Spanning Tree Protocol)
HSR (High-availability Seamless Redundancy)

Data

Event Records – User Configurable
Fault Records
Waveform Records
Measurands
Commands
Time Synchronism
Viewing and Changing Settings

Serial Communications

The relay offers a USB serial port as standard on the front of all units. All of the relays functions can be set on a PC using Reydisp Evolution via the USB port. The connection is made with a USB cable and operates with a 'plug and play' connection, so no pre-setting of the relay is required.
The front port can be switched off or set to use either the DNP3.0, MODBUS-RTU, IEC60870-5-103 and ASCII protocols for testing purposes.
A rear RS485 electrical connection is available on all units for system interface connections. An internal terminating resistor is provided, which can be connected into the circuit by adding a wire loop between the relevant terminals.

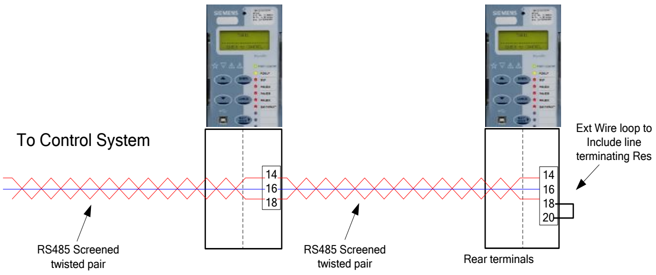


Fig 1. Typical RS485 connection

The rear RS485 can be user selected to be OFF, IEC60870-5-103, MODBUS RTU or DNP3.0 protocol.

IEC 61850

IEC61850 communication is available through an optional EN100 communication module. The EN100 Module can be ordered with either 2x Electrical RJ45 or 2x Fibre optic LC Ethernet ports.
Information on IEC61850 functionality can be found in the following 7SR1 documents:

Model Implementation Conformance Statement (MICS)

Protocol Implementation (PICS,PIXIT & TICS)

Ethernet Communications

IEC 61850

IEC61850 communication is available through an optional EN100 communication module. The EN100 Module can be ordered with either 2x Electrical RJ45 or 2x Fibre optic LC Ethernet ports.
Information on IEC61850 functionality can be found in the following 7SR157 documents:

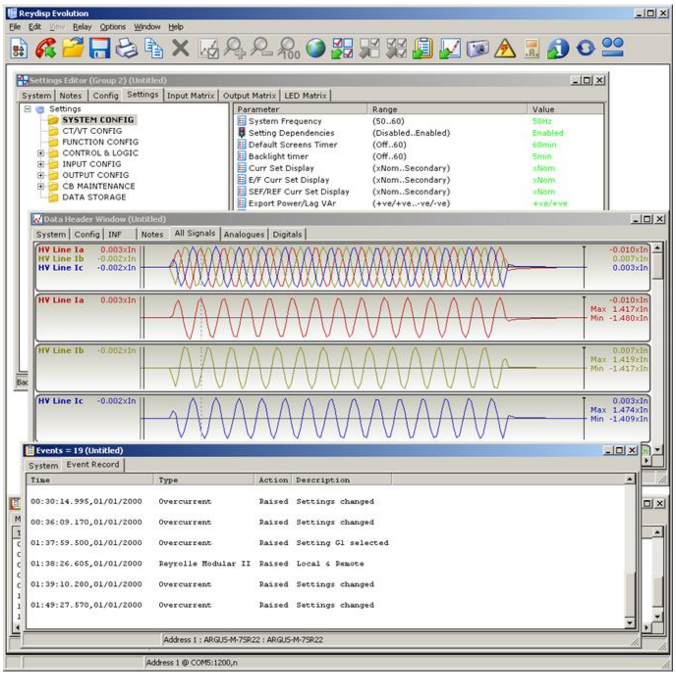
Model Implementation Conformance Statement (MICS)

Protocol Implementation Conformance Statement (PICS)

Protocol Implementation Extra Information for Testing (PIXIT)

Reydisp Evolution

Reydisp Evolution is a Windows based software tool, providing the means for the user to apply settings, interrogate settings and retrieve events and disturbance waveforms from the device and is common to the entire range of Reyrolle protection relays.



Parameter	Range	Value
System Frequency	(50..60)	50Hz
Setting Dependencies	(Disabled..Enabled)	Enabled
Default Screens Timer	(Off..60)	60min
Backlight timer	(Off..60)	5min
Curr Set Display	(xNom..Secondary)	xNom
E/F Curr Set Display	(xNom..Secondary)	xNom
SEF/REF Curr Set Display	(xNom..Secondary)	xNom
Export Power/Lag VAr	(+ve/+ve..-ve/-ve)	+ve/+ve

Time	Type	Action	Description
00:30:14.995,01/01/2000	Overcurrent	Raised	Settings changed
00:36:09.170,01/01/2000	Overcurrent	Raised	Settings changed
01:37:59.500,01/01/2000	Overcurrent	Raised	Setting G1 selected
01:38:26.605,01/01/2000	Reyrolle Modular II	Raised	Local & Remote
01:39:10.280,01/01/2000	Overcurrent	Raised	Settings changed
01:49:27.570,01/01/2000	Overcurrent	Raised	Settings changed

Fig 2. Typical Reydisp Evolution Screenshot

Language Editor

The Language editor software gives the user the ability to customize the text displayed in the relays, Menu structure and instrumentation views. The tool allows a language file to be created and transferred to the relay also containing Western European characters.

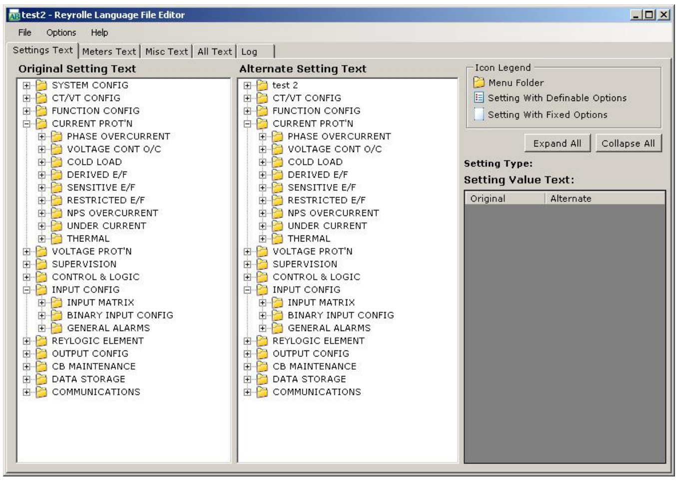
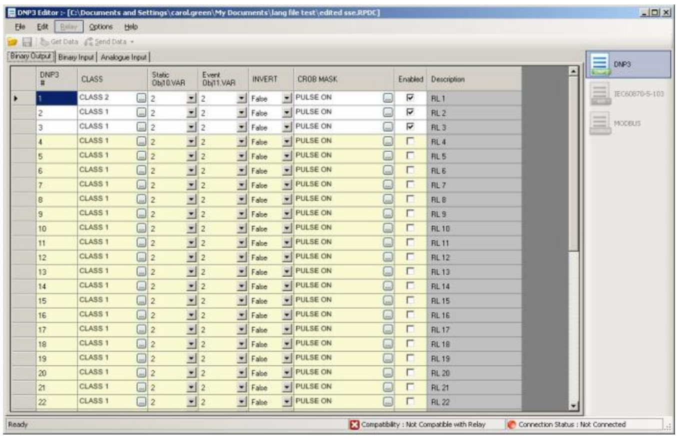


Fig 3. Typical Language Editor Screenshot

Communications Editor

To facilitate easier interfacing to a substation the relays default Protocol configuration may be modified using the communication editor software tool.
The communication editor is a PC based software package provided within the Reydisp software suite which allows modification of the IEC60870-5-103, DNP 3.0 and MODBUS Protocols.

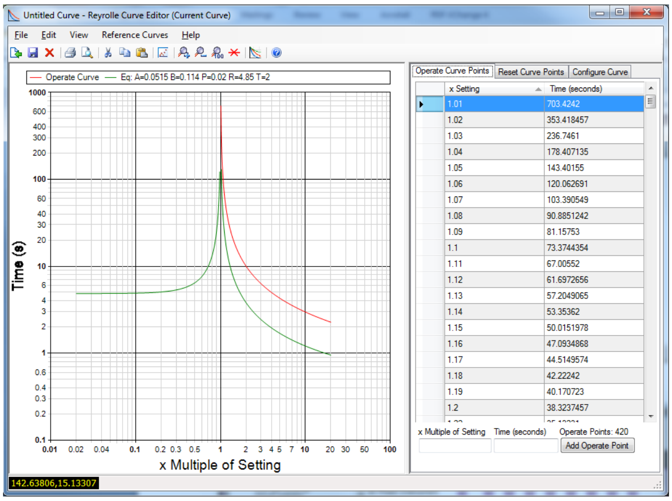


DNP3 #	CLASS	Static Obj10.VAR	Event Obj11.VAR	INVERT	CROB MASK	Enabled	Description
1	CLASS 2	2	2	False	PULSE ON	☑	RL 1
2	CLASS 1	2	2	False	PULSE ON	☑	RL 2
3	CLASS 1	2	2	False	PULSE ON	☑	RL 3
4	CLASS 1	2	2	False	PULSE ON	☐	RL 4
5	CLASS 1	2	2	False	PULSE ON	☐	RL 5
6	CLASS 1	2	2	False	PULSE ON	☐	RL 6
7	CLASS 1	2	2	False	PULSE ON	☐	RL 7
8	CLASS 1	2	2	False	PULSE ON	☐	RL 8
9	CLASS 1	2	2	False	PULSE ON	☐	RL 9
10	CLASS 1	2	2	False	PULSE ON	☐	RL 10
11	CLASS 1	2	2	False	PULSE ON	☐	RL 11
12	CLASS 1	2	2	False	PULSE ON	☐	RL 12
13	CLASS 1	2	2	False	PULSE ON	☐	RL 13
14	CLASS 1	2	2	False	PULSE ON	☐	RL 14
15	CLASS 1	2	2	False	PULSE ON	☐	RL 15
16	CLASS 1	2	2	False	PULSE ON	☐	RL 16
17	CLASS 1	2	2	False	PULSE ON	☐	RL 17
18	CLASS 1	2	2	False	PULSE ON	☐	RL 18
19	CLASS 1	2	2	False	PULSE ON	☐	RL 19
20	CLASS 1	2	2	False	PULSE ON	☐	RL 20
21	CLASS 1	2	2	False	PULSE ON	☐	RL 21
22	CLASS 1	2	2	False	PULSE ON	☐	RL 22

Fig 4. Typical Communications Editor Screenshot

Curve Editor

The Curve Editor tool can be used to add user defined characteristics for use by any of the Voltage, Current or Thermal IDMTL elements.



x Setting	Time (seconds)
1.01	703.4242
1.02	353.418457
1.03	236.7461
1.04	178.407135
1.05	143.40155
1.06	120.062691
1.07	103.390549
1.08	90.8851242
1.09	81.15753
1.1	73.3744354
1.11	67.00552
1.12	61.6972656
1.13	57.2049065
1.14	53.35362
1.15	50.0151978
1.16	47.0934868
1.17	44.5149574
1.18	42.22242
1.19	40.170723
1.2	38.3237457

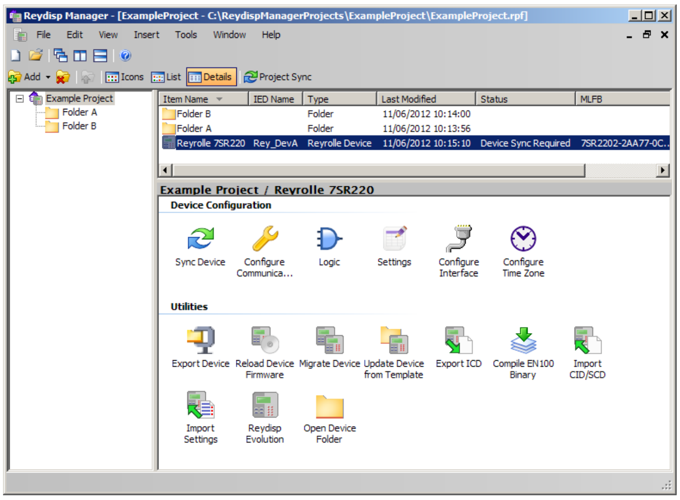
Fig 5. Typical Curve Editor Screenshot

Reydisp Manager

Reydisp Manager is a Windows based application which enables configuration of multiple Reyrolle devices.
It provides the following features:

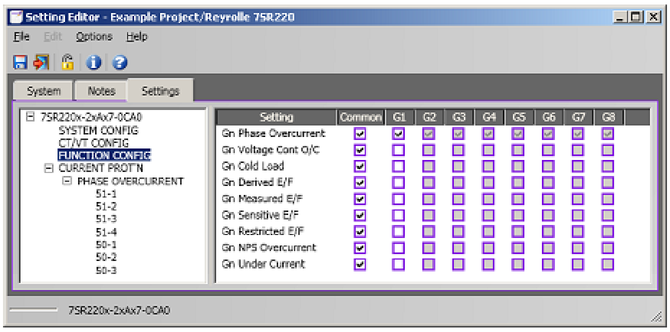
- Project based handling of all features of multiple devices to allow engineering of IEC61850 projects.
- Template based structure allowing offline configuration
- Configure and store device settings for all settings groups
- Create and edit graphical logic diagrams
- Configure data points and options for serial protocols
- Configure Language
- Configure User Curves
- Update device firmware

Please refer to the Reydisp Manager User Guide for further information.



Item Name	IED Name	Type	Last Modified	Status	MLFB
Folder B		Folder	11/06/2012 10:14:00		
Folder A		Folder	11/06/2012 10:13:56		
Reyrolle 7SR220	Rey_DevA	Reyrolle Device	11/06/2012 10:15:10	Device Sync Required	7SR2202-2AA77-0C..

Fig 6. Typical Reydisp Manager Screenshot



Setting	Common	G1	G2	G3	G4	G5	G6	G7	G8
Gn Phase Overcurrent	☑	☑	☑	☑	☑	☑	☑	☑	☑
Gn Voltage Cont O/C	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Cold Load	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Derived E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Measured E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Sensitive E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Restricted E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn NPS Overcurrent	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Under Current	☑	☐	☐	☐	☐	☐	☐	☐	☐

Fig 7. Typical Settings Editor Screenshot

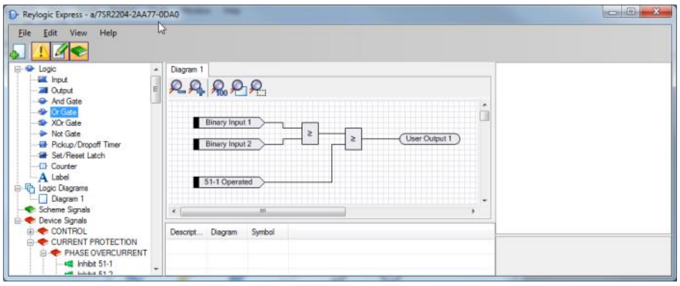
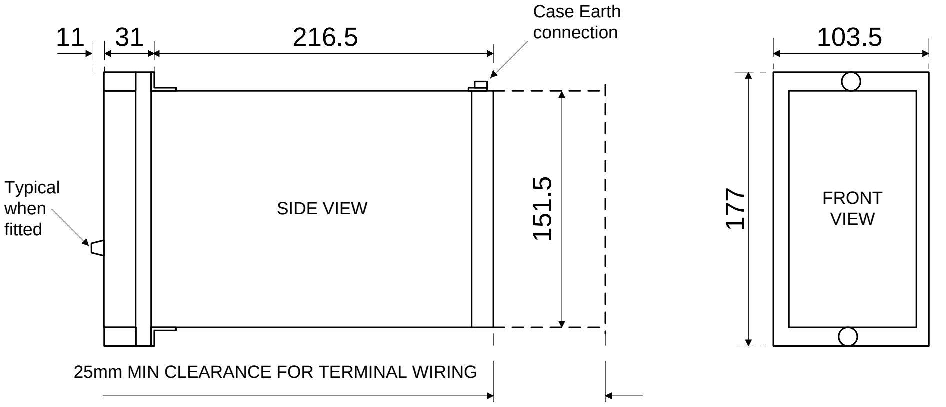


Fig 8. Typical Reylogic Express graphical logic editor Screenshot

Case Dimensions



NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

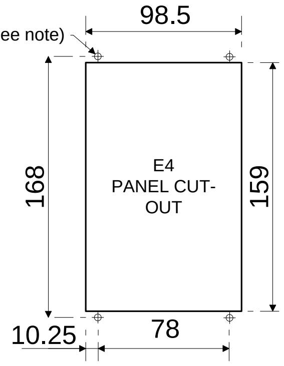
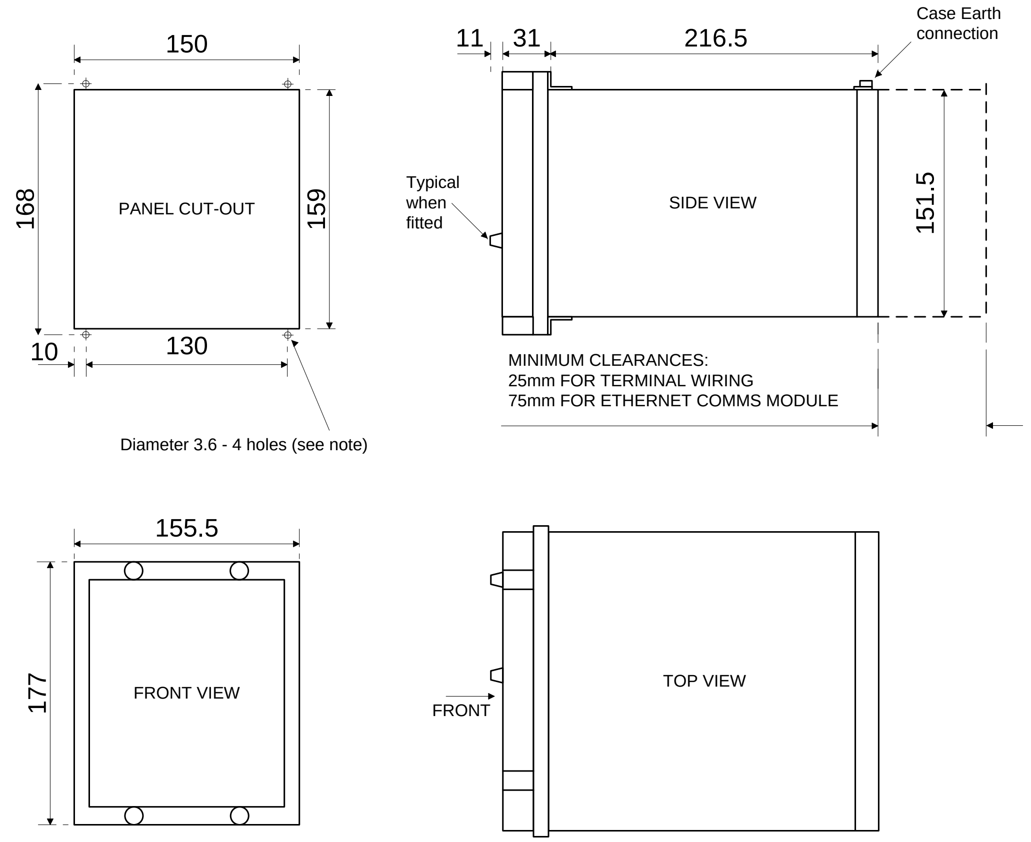


Fig 9. E4 Case Dimensions



NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig 10. E6 Case Dimensions

1.1.2.1 7SR11 and 7SR12 Non-Directional/Directional Overcurrent Relays

Description

The 7SR11 & 7SR12 are overcurrent protection relays developed to enhance the Argus family of products by providing a familiar product using the latest generation of hardware technology.
The 7SR11provides overcurrent and earth fault protection, the 7SR12 comes with additional voltage inputs providing directional protection. Both relays are available in single and four pole variants.
Housed in a 4U high, size E4 or E6 (Optional IEC61850 model) cases, these relays provide protection, monitoring, instrumentation and metering with integrated input and output logic, data logging & fault reports. Communication access to the relay functionality is via a front USB port for local PC connection, a rear electrical RS485 port for remote connection & optional IEC61850 communication through two rear Ethernet ports (Electrical or Optical).

Function Overview

Protection

37	Undercurrent
46BC	Broken Conductor / Load Unbalance
46NPS	Negative Phase Sequence Overcurrent
49	Thermal Overload
50	Instantaneous Overcurrent
50G/N/SEF	Instantaneous Earth Fault
50AFD	Arc Flash Detection (6 zones)
50BF	Circuit Breaker Fail
51	Time Delayed Overcurrent
51G/N/SEF	Time Delayed Measured/Derived/Sensitive EF
64H	High Impedance REF
27/59	Under/Over Voltage
47	Negative Phase Sequence Voltage
51V	Voltage Controlled Overcurrent
59N	Neutral Voltage Displacement
67/50	Directional Instantaneous Overcurrent
67/50G/N	Directional Instantaneous Earth Fault
67/51	Directional Time Delayed Overcurrent
67/51G/N	Directional Time Delayed Earth Fault
32	Directional Power
32S	Directional Sensitive Power
55	Power Factor
81HBL2	Inrush Detector
81	Under/Over Frequency
	Line Check/Switch onto Fault

Supervision

60CTS	CT Supervision
74T/CCS	Trip & Close Circuit Supervision
60VTS	VT Supervision

Control

79	Auto Reclose
86	Lockout
	CB Control

Features

Cold Load Settings
Four Settings Groups
Password Protection – 2 levels
User Programmable Logic
Self Monitoring
Circuit Breaker Trip and Maintenance Counter
Trip Timers

User Interface

20 Character x 4 Line Backlit LCD
Menu Navigation Keys
9 User Programmable Tri-colour LEDs
User Language Configuration

Monitoring Functions

Primary/Secondary Current Phases and Earth
Direction
Primary/Secondary Line and Phase Voltages
Apparent Power and Power Factor
Real and Reactive Power
W Hr & VAr Hr Forward and Reverse
Historical Demand Record
Positive Phase Sequence (PPS) Voltage & Current
Negative Phase Sequence (NPS) Voltage & Current
Zero Phase Sequence (ZPS) Voltage
Frequency
Direction
Binary Input/Output status
Trip circuit healthy/failure
Time and date
Starters
Fault records
Event records
Energy
Circuit breaker trip counters
I^2t summation for contact wear

Hardware

1 CT 3 Binary Inputs 5 Binary Outputs
4 CT 3 Binary Inputs 5 Binary Outputs
4 CT 6 Binary Inputs 8 Binary Outputs
4 CT 4 Bin.In. 8 Bin.Out. (segregated rear terminals)
1 CT 3 VT 3 Binary Inputs 5 Binary Outputs
4 CT 3 VT 3 Binary Inputs 5 Binary Outputs
4 CT 3 VT 6 Binary Inputs 8 Binary Outputs
4 CT 3 VT 4 Bin. In. 8 Bin.Out. (segregated rear terminals)

Application

The Argus is a numerical overcurrent protection relay intended for use on distribution and industrial networks. It provides a highly comprehensive functional software package with a range of integral application functions aimed at reducing installation, wiring and engineering time.
An extensive range of metered values can be viewed on the front LCD or at a remote point via the communication channel.
The integrated control feature allows operation of a single circuit breaker and monitoring of its trip and close circuits (except 7SR1102-1*A12-*AA0 models).

Function Matrix

FUNCTION	FUNCTIONAL REQUIREMENT	7SR1101-1*A**-**A0	7SR1101-3*A**-**A0	7SR1102-1*A12-*AA0	7SR1102-1*A**-*[C/D]A0	7SR1102-3*A**-**A0	7SR1204-2*A**-**A0	7SR1204-4*A**-**A0	7SR1205-2*A**-**A0	7SR1205-4*A**-**A0
27	Undervoltage						■	■	■	■
32	Directional Power								■	■
32S	Directional Sensitive Power									■
37	Undercurrent	■	■		■	■	■	■	■	■
46BC	Broken Conductor / Load Unbalance			■	■	■			■	■
46NPS	Negative Phase Sequence Overcurrent				■	■			■	■
47	Negative Phase Sequence Voltage								■	■
49	Thermal Overload				■	■			■	■
50	Instantaneous Overcurrent			■	■	■			■	■
50G	Measured Instantaneous Earth Fault	■		■	■		■		■	
50SEF	Measured Instantaneous Sensitive Earth Fault		■			■		■		■
50N	Derived Instantaneous Earth Fault			■	■	■			■	■
50AFD	Arc Flash Detection				■	■			■	■
50BF	CB Failure			■	■	■			■	■
51	Time Delayed Overcurrent			■	■	■			■	■
51G	Measured Time Delayed Earth Fault	■		■	■		■		■	
51SEF	Measured Time Delayed Sensitive Earth Fault		■			■		■		■
51N	Derived Time Delayed Earth Fault			■	■	■			■	■
55	Power Factor								■	■
59	Overvoltage						■	■	■	■
59N	Neutral Voltage Displacement						■	■	■	■
64H	High Impedance Restricted Earth Fault	■	■	■	■	■	■	■	■	■
67	Directional Overcurrent								■	■
67G	Directional Measured Earth Fault						■		■	
67SEF	Directional Sensitive Earth Fault							■		■
67N	Directional Derived Earth Fault								■	■
81HBL	Inrush Detector	■			■	■	■		■	■
81	Under/Over Frequency						■	■	■	■
	CONTROL / MONITOR									
51c	Cold Load - Phase Only				■	■			■	■
60CTS	CT Supervision			■	■	■			■	■
60VTS	VT Supervision						■	■	■	■
74T/CCS	Trip & Close Circuit Supervision	■	■	■	■	■	■	■	■	■
79	Autoreclose				□	□			□	□
86	Lockout	■	■	■	■	■	■	■	■	■
	Line Check/SOTF	■	■		■	■	■	■	■	■

Key - ■ - Included as standard
□ - Ordering option

7SR11 Functional Diagrams

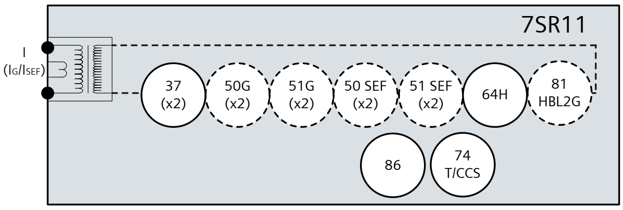


Fig 1. Single Pole Overcurrent Relay

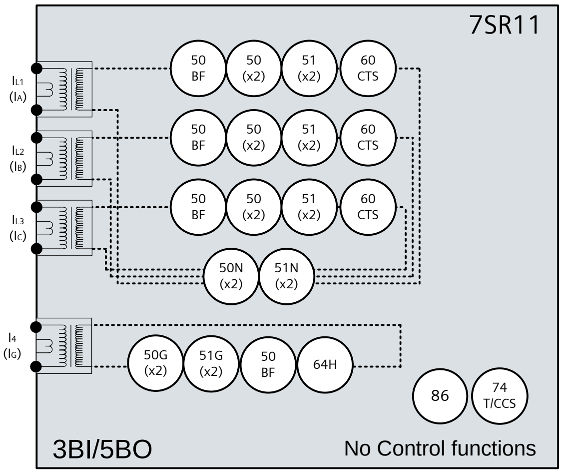


Fig 2. Four Pole Overcurrent Relay Version A software

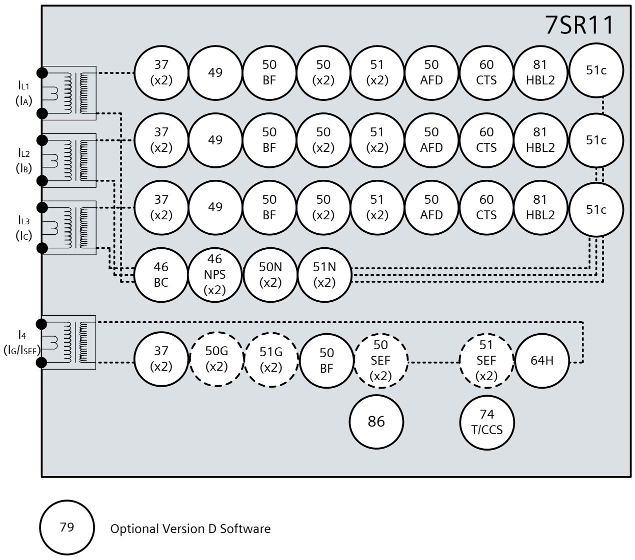


Fig 3. Four Pole Overcurrent Relay Version C Software

7SR12 Functional Diagrams

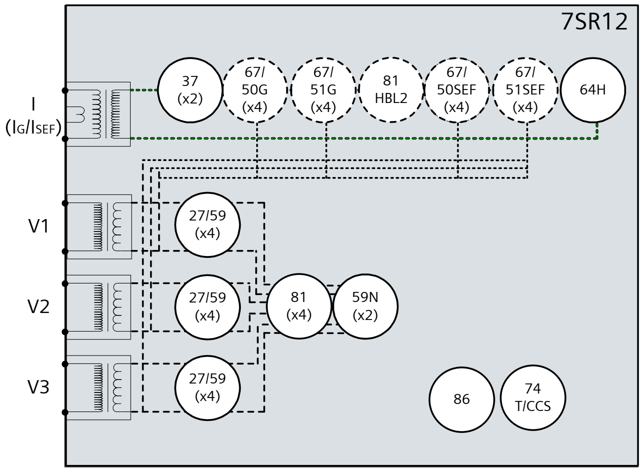


Fig 4. Single Pole Directional Relay

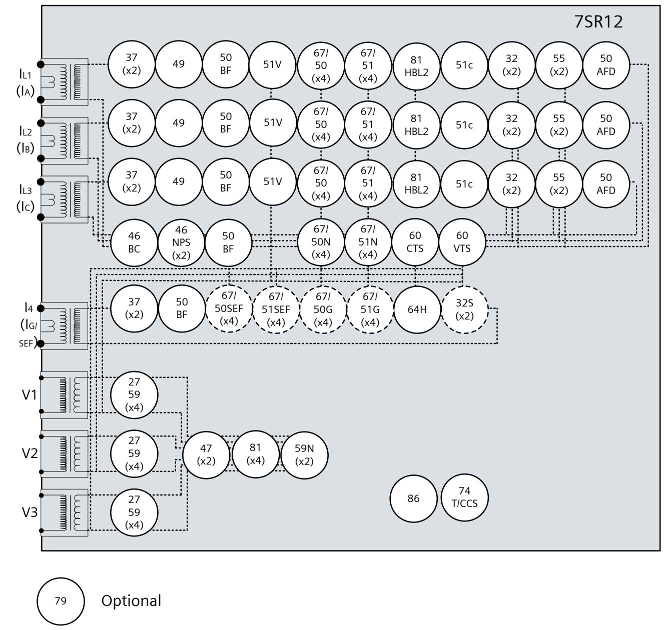


Fig 5. Four Pole Directional Overcurrent Relay

Notes

1. Items shown dotted are only available in some models; please refer to the Ordering Information Section.
2. The use of some functions are mutually exclusive

Description of Functionality

27/59 Under/Over Voltage

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if voltage exceeds setting for duration of delay.

32 Power

Each element has settings for pickup level, Definite Time Lag (DTL) delay and Direction. Each element can be set as Under or Over power, to operate from Apparent , Real or Reactive power and can be set for any phase or all three phases.

32S Sensitive Power

This is provided in 4 pole SEF relays and provides elements operated by single phase measured current in the ISEF input. Each element has settings for pickup level, Definite Time Lag (DTL) delay and Direction. Each element can be set as Under or Over power, to operate from Apparent, Real or Reactive power.

37 Undercurrent

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates if current falls below setting for duration of delay.

46BC Phase Unbalance/Broken Conductor

Element has settings for pickup level and DTL delay. With the circuit breaker closed, if the NPS:PPS current ratio is above setting this could be due to a broken conductor.

46NPS Negative Phase Sequence Overcurrent

Each element has user settings for pickup level and IDMTL or DTL delay, operates if NPS current exceeds setting and delay. NPS current elements can be used to detect unbalances on the system or remote earth faults when a delta-star transformer is in circuit.

47 Negative Phase Sequence Voltage

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates if NPS voltage exceeds setting for duration of delay.

49 Thermal Overload

The thermal algorithm calculates the thermal states from the measured currents and can be applied to lines, cables and transformers. Alarm outputs are given for thermal overload and thermal capacity.

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. Line currents and earth currents are monitored following a trip signal and an output is issued if any current is still detected, above setting, after a specified time interval. Alternatively, if the trip is from a mechanical protection the circuit breaker position can be used to determine a failure. A second time delay is available to enable another stage to be utilized if required. An input is also available to bypass the time delays when the circuit breaker is known to be faulty.

51c Cold Load Pickup

If a circuit breaker is closed onto a 'cold' load, i.e. one that has not been powered for a prolonged period, this can impose a higher than normal load-current demand on the system which could exceed normal settings. These conditions can exist for an extended period and must not be interpreted as a fault. To allow optimum setting levels to be applied for normal operation, the cold load pickup feature will apply alternative current settings for a limited period. The feature resets when either the circuit breaker has been closed for a settable period, or if the current has reduced beneath a set level for a user set period.

50/51 Phase Fault

50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI time current characteristics. The IDMT stage has a user programmable reset characteristic, either DTL or

shaped current ~ time reset characteristic, to improve grading with electromechanical protection.

50G/51G/50N/51N Earth Fault/Sensitive Earth Fault

Two earth fault measurement modes are available. One mode directly measures the earth current from an independent CT, or the residual connection of the 3 line CTs. This input can be ordered as either earth fault or sensitive earth fault (50G/51G).
The second mode derives the earth current internally from the 3 phase CT inputs to give earth fault (50N/51N). 50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI time current characteristics. The IDMT stage has a user programmable reset characteristic either DTL or shaped current ~ time reset characteristic to improve grading with electromechanical protection.
The directional SEF element is also suitable for use on compensated networks.

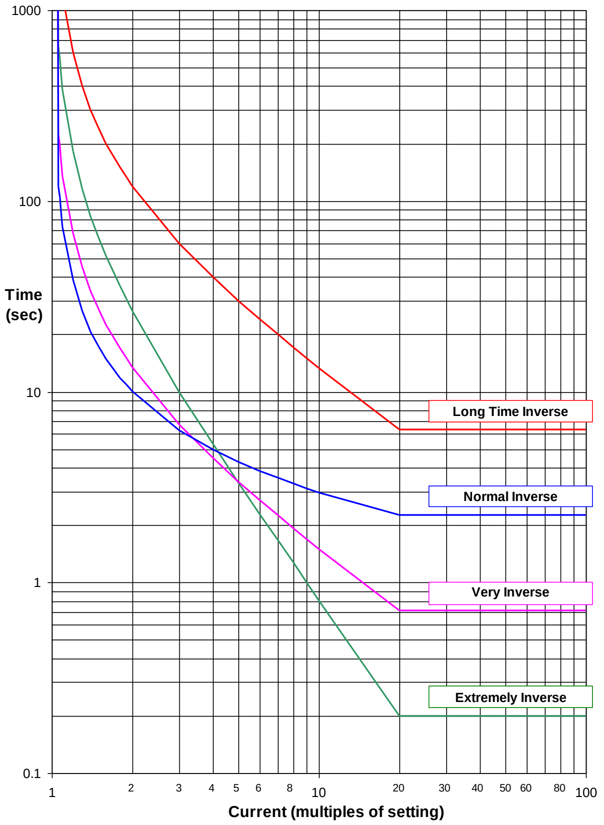


Fig 6. IEC Overcurrent Curves

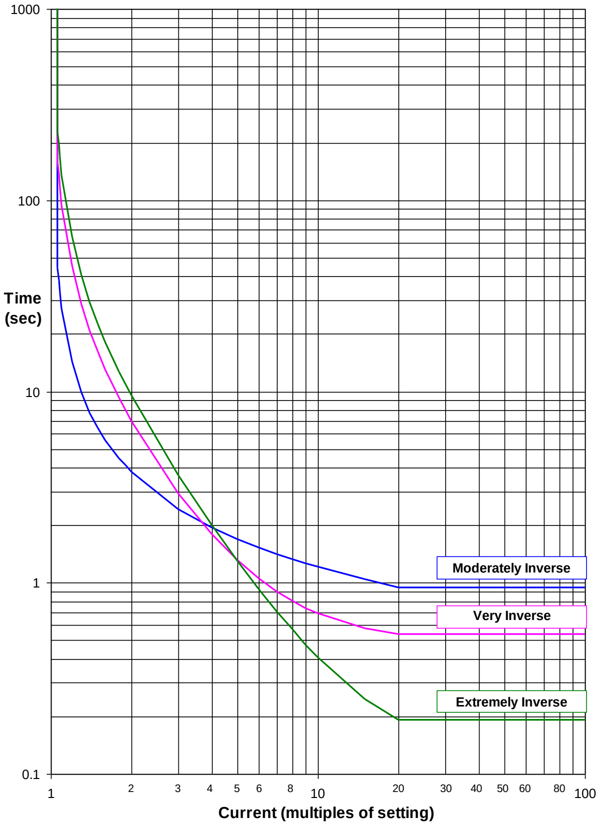


Fig 7. ANSI Overcurrent Curves

51V Voltage Controlled Overcurrent

Each phase shaped overcurrent element can be independently controlled by the level of measured input voltage. For applied voltages above setting the 51-n element operates in accordance with its current setting but for voltages below the setting a multiplier is applied to reduce the 51-n pick up current setting.

50AFD Arc Flash Detector

The 7SR1 relays can be used with the 7XG31 ReyArc range of Arc Flash Detection devices. Arc fault protection is a technique employed for the fast clearance of arcing faults on busbars, within metal clad switchgear & associated cable boxes. The arc is detected using an optical sensor & the signal input to a protection device which also monitors the load current on the system. A trip signal can be achieved in less than 10 ms using arc detection only or within 20 ms when using overcurrent check.

55 Power Factor

Each element has settings for Under or Over Power Factor pickup level, Definite Time Lag (DTL) delay and Lead/Lag Direction. Each can also be set for any phase or all three phases operation.

59N Neutral Overvoltage

Neutral overvoltage can be used to detect earth faults in high impedance earthed or isolated systems.
Operates if the neutral voltage exceeds setting for duration of delay.

60CTS CT Supervision

The relay has two methods of CT supervision.. The 7SR11 monitors each phase current input and operates if any one or two inputs fall below the setting. The 7SR12 has the above method and an addition method that considers the presence of negative phase sequence current, without an

equivalent level of negative phase sequence voltage, for a user set time as a CT failure.
Both element types have user operate and delay settings.

60VTS VT Supervision

The VT supervision uses a combination of negative phase sequence voltage and negative phase sequence current to detect a VT fuse failure. This condition may be alarmed or used to inhibit voltage dependent functions. Element has user operate and delay settings.

64H Restricted Earth Fault

The measured earth fault input may be used in a 64H high impedance restricted earth fault scheme to provide sensitive high speed unit protection. A calculation is required to determine the values of the external series stabilising resistor and non-linear shunt resistor which can be ordered separately.

67/67N Directional Control

Phase, earth and sensitive earth fault elements can be directionalised. Each element can be user set to Forward, Reverse, or Non-directional.
Directional Phase Fault elements are polarised from quadrature voltage.
Derived earth fault elements can be user set to be polarised from residual voltage or negative phase sequence voltage.
Measured earth fault elements are polarized from Vo.

74T/CCS Trip & Close Circuit Supervision

The trip or close circuit(s) can be monitored via binary inputs. Trip circuit failure raises an HMI alarm and output(s).

81HBL2 Inrush Restraint

Where second harmonic current is detected (i.e. during transformer energisation) user selectable elements can be blocked and an alarm given.

81 Under/Overfrequency

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if frequency exceeds setting for duration of delay. Typically applied in load shedding schemes.

Standard Version – Plus 79 Auto-Reclose

A high proportion of faults on an overhead line network are transient and can be cleared quickly by high speed tripping followed by an automated circuit breaker reclose sequence.

The function provides independent phase fault and earth fault / sensitive earth fault sequences of up to 5 trip i.e. 4 reclose attempts before lockout. An auto-reclose sequence can be user set to be initiated from internal protection operation or via binary input from an external protection.

Programmable Logic

The user can map binary inputs, protection elements, LEDs and binary outputs together in a logical scheme.
Up to 4 logic equations can be defined using standard logic functions e.g. Timers, AND/OR gates, Inverters and Counters to provide the user required functionality.
Each logic equation output can be used for alarm & indication and/or tripping.

Virtual Inputs/Outputs

There are 8 virtual inputs/outputs to provide internal logical states to assist in the application of the functions. Each virtual I/O can be assigned in the same way as a physical I/O.

Circuit Breaker Maintenance

Two circuit breaker operations counters are provided to assist with maintenance scheduling. The maintenance counter records the overall number of operations and the delta counter records the number of operations since the last reset.
An I^2t summation counter provides a measure of the contact wear indicating the total energy interrupted by the circuit breaker contacts.
Each counter has a user set target operations count which, when reached, can be mapped to raise alarms/ binary outputs. A CB Trip Time meter is also available, which measures the time between the trip or open command being issued and the auxiliary contacts changing state.

Control Mode

The relay has a control menu with access to commonly used command operations (except 7SR1102-1*A12-*AA0 models). Access to the control commands is restricted by a 4 character control function password. Each command requires a select then execute operation, if the execute operation is not performed within a time window the command is aborted. The following control functions are available:
CB Operation
Auto Reclose In/Out
Auto Reclose Trip & Reclose
Auto Reclose Trip & Lockout
SEF In/Out
Inst Prot In/Out
Hot Line Working In/Out

CB: TRAVELLING

ENTER to control

Fig 8. Example of Control Function View

Construction

The relay is housed in a 4U high, size E4 or E6 (Optional IEC61850 model) case with a removable clear fascia cover. The fascia cover can be ordered with or without two push buttons to allow the user to view the settings and instruments without removing the cover.
Two handles are provided to allow the relay to be withdrawn from its case, contacts in the case ensure that the CT circuits and normally closed contacts remain short circuited when the relay is withdrawn.
The rear terminal blocks comprise M4 female terminals for ring crimp wire connections, to provide a secure and reliable termination.

Fig 9. Rear view of relay (E4 Case)

Fig 10. Rear view of relay with 2x LC Fibre Optic ports (E6 Case with IEC61850)

Fig 11. Front view of relay (E4 Case with push buttons)

Fig 12. Front view of relay (E6 Case with IEC61850

User Interface

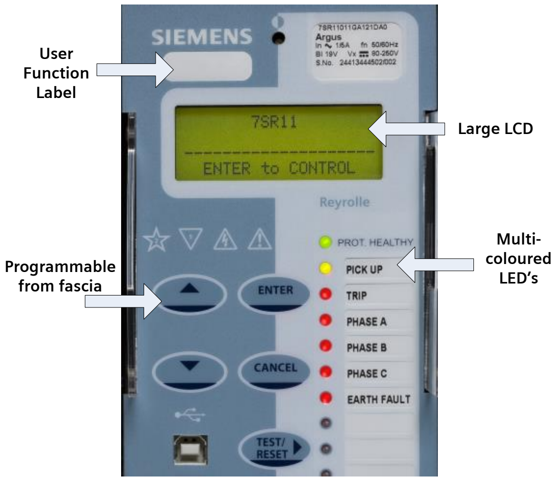


Fig 13. User Interface

The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings and retrieving data from the relay. Five buttons are provided for navigation around the menu structure.

LCD

A 4 line by 20 character liquid crystal display with power save operation indicates the relay identifier, settings, instrumentation, fault data and control commands.
Up to 6 user programmable general alarms can be configured to display your own indications on the LCD.

LEDs

A green steadily illuminated LED indicates the 'Protection Healthy' condition.
9 user programmable LEDs are available eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED is tri-color (red, green, yellow) allowing for clear indication of the associated function's state and has a label insert for identification.

Relay Information

The device is identified by the rating label on the fascia. The user can also give the device its own identity by editing the 'Relay Identifier' displayed on the LCD or space is provided to place a slip in label giving the relays function.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	3 x Phase & 1 x Earth or Sensitive Earth
Rated Current In	1/5A
Measuring Range	80 x In
Instrumentation ≥ 0.1xIn	±1% In
Frequency	50/60Hz
Thermal Withstand: Continuous 10 Minutes 2 Minutes 1 Second 1 Cycle	 3 x In 3.5 x In 6 x In 100A (1A) 350A (5A) 700A (1A) 2500A (5A)
Burden @ In	≤0.02VA (1A phase and Earth element) ≤0.2VA (5A phase and earth element)

Voltage Inputs

Nominal	40...160 Vrms
Operating Range	0... 200 Vrms
Instrumentation ≥ 0.8xVn	±1% Vn
Burden @ 110V	≤ 0.06 VA
Overvoltage Withstand	300 Vrms

Auxiliary Supply

Rated DC Voltage	24-250V DC Operating Range 19.2 to 275V	
Allowable superimposed ac component	12% of DC voltage	
Rated AC Voltage	100-230 VAC 50/60Hz Range 80 to 253 V rms AC 50/60Hz ±5%	
Power Consumption:	Min (DC) Max (DC)	3.6W(6.1W with IEC61850) 8.4W (11W with IEC61850)
	Min (AC) Max (AC)	9VA (14.5VA with IEC61850) 17VA (23VA with IEC61850)
Allowable breaks/dips in supply (collapse to zero)	DC	50ms
	AC	2.5/3 cycles @50/60Hz

Binary Inputs

Number	3,4 or 6	
Operating Voltage	19V dc	DC Range 17 to 320V dc AC Range 92 to 138 VRMSAC
	88V dc	Range 70 to 320V dc
Maximum dc current for operation	1.5mA	
Maximum peak ac current for operation	1.5mA	

Pick Up Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)
Drop Off Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)

For AC operation the BI pick-up delay should be set to 0ms and the drop-off delay to 20ms.

Binary Outputs

Number	5 or 8 (3 change over contacts)
Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed.
Operating Time from Energizing Binary Input	<20ms
Making Capacity: Carry continuously Make and carry (L/R ≤ 40 ms and V ≤ 300 V)	 5A ac or dc 20A ac or dc for 0.5s 30A ac or dc for 0.2s
Breaking Capacity (≤ 5 A and ≤ 300 V): AC Resistive AC Inductive DC Resistive DC Inductive	 1250 VA 250 VA at p.f. ≤ 0.4 75 W 30 W at L/R ≤ 40ms 50 W at L/R ≤ 10ms

Unit Design

Housing	E4 or E6(see dimension drawing)
Indication	20 Character 4 line Display Relay Healthy LED 9 Tri Coloured User Programmable Self or Hand Reset LED's
With-drawable Element	Yes
User Interface	5 Navigation Keys
Weight	Typical 3.1Kg
IP Rating installed with cover	IP 51 from front
IP Rating installed without cover	IP 20 from front

Data Communication Interface

Communication Port	Front USB Type B Rear RS485 2 wire electrical IEC61850 optional ports: 2x Electrical RJ45 Ethernet 2x LC Fibre Optic Ethernet
Protocols	IEC60870-5-103 MODBUS RTU (Serial) DNP3.0 O (Serial) IEC61850 - optional
Fibre Optic Ethernet Data Communication Interface (IEC 61850 Option)	

EN100 Fibre Optic Data Communication Interface (IEC 61850 Option)

Physical	layer Fibre-optic
Connectors	Duplex LC 100BaseF in acc. With IEEE802.3
Recommended fibre	62.5/125 µm glass fibre with Duplex-LC connector
Transmission Speed	100 MBits/s
Optical Wavelength	1300 nm
Bridgeable distance	2 km

EN100 Electrical Ethernet Data Communication Interface (IEC 61850 Option)

Physical	Electrical
Connectors	RJ45 100BaseF in acc. With IEEE802.3
Transmission Speed	100 MBits/s
Test Voltage (with regard to socket)	500 VAC 50 Hz
Bridgeable distance	20m

Data Storage

Fault Record	10 (5 for 7SR1102-1*A12-*AA0).
Waveform Record	10 x 1sec 2 x 5sec 5 x 2sec 1 x 10sec (5x1sec, 2x2sec, 1x5sec for 7SR1102-1*A12-*AA0) Pre trigger 10...90%
Events	1000 1ms Resolution

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration response	1.0 gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %
Shock withstand	15 gn, 11 ms	≤ 5 %
Bump test	10 gn, 16 ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	X-plane - 3.5mm displacement below crossover freq (8-9Hz) 1gn and above Y-plane – 1.5mm displacement below crossover freq (8-9Hz) 0.5gn above	≤ 5 %

Mechanical Classification

Durability	>10^6 operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	2.0 kV AC RMS for 1 min
Across normally open contacts	1.0 kV AC RMS for 1 min

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Common (longitudinal) mode	2.5 kV	≤ 5 %
Series (transverse) mode	1.0 kV	≤ 5 %

Electrostatic Discharge
IEC 60255-22-2

Type	Level	Variation
Front Cover Fitted	Class IV, 15 kV Air Discharge	≤ 5 %
Front Cover Removed	Class III, 8 kV Air Discharge	≤ 5 %

Fast Transients
IEC 60255-22-4 Class A (2002)

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4kV	≤ 5 %

Surge Immunity
IEC 60255-22-5

Type	Level	Variation
Analog Inputs: Line to Earth	4.0 kV	≤ 10%
Case, Aux Power & I/O: Line to Earth	2.0 kV	≤ 10%
RS485 Comms port: Line to Earth	1.0 kV	No Data Loss
Analog Inputs: Line to Line	1.0 kV	≤ 10%
Case, Aux Power & I/O: Line to Line	1.0 kV *	≤ 10%

* Note 45ms DTL pick-up delay applied to binary inputs

Conducted Radio Frequency Interference
IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5 %

Radiated Radio Frequency
IEC 60255-25

Type	Limits at 10 m, Quasi-peak
30 to 230 MHz	40 dB(µV)
230 to 10000 MHz	47 dB(µV)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(µV)	66 dB(µV)
0.5 to 30 MHz	73 dB(µV)	60 dB(µV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level
80 MHz to 1000 MHz Sweep	10 V/m
1.4GHz to 2.7GHz Sweep	10V/m
80,160,380,450,900,1850,2150 MHz Spot	10V/m

Climatic Tests

Temperature
IEC 60068-2-1/2

Operating Range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity
IEC 60068-2-78

Operational test	56 days at 40 °C and 93 % relative humidity

Cyclic Temperature and Humidity
IEC 60068-2-30

Operational test	25 °C to 55 °C (outdoor equipment) and 97/93 % relative humidity. 6 x 24h (12h+12h) cycles.

Performance

27/59 Under/Over Voltage

Number of Elements	4 Under or Over
Operate	Any phase or All phases
Voltage Guard	1,1.5…200V
Setting Range Vs	5,5.5…200V
Hysteresis Setting	0.0.1…80%
Vs Operate Level	100% Vs, ±1% or ±0.25V
Reset Level: Overvoltage Undervoltage	 =(100%-hyst)xVop, ±1% =(100%+hyst)xVop, ±1%
Delay Setting td	0.00,0.01…20,20.5…100,101…1000,1010…10000,10100…14400s
Basic Operate Time : 0 to 1.1xVs 0 to 2.0xVs 1.1 to 0.5xVs	 73ms ±10ms 63ms ±10ms 58ms ±10ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input VT Supervision Voltage Guard

32 Power (7SR12)

Number of Elements	2 Forward or Reverse
Operate	P, Q or S
U/C Guard	0.05 to 1.0 x In
Setting Range Ss	0.05 to 2.0 x Sn
Operate Level Sop	100% Ss, ± 5% or ± 2% Sn
Reset Level: -	≥95% Sop
Basic Operate Time: - 1.1 x Ss (over) 2.0 x Ss (over) 0.5 x Ss (under)	 60ms ± 10ms 45ms ± 10ms 30ms ± 10ms
Delay Setting td	0 to 14400s
Operate time following delay.	t_{basic} +t_d , ±1% or ±10ms
Inhibited by	Undercurrent Guard, VTS

32S Sensitive Power (7SR12 SEF)

Number of Elements	2 Forward or Reverse
Operate	P, Q or S
U/C Guard	0.005 to 1.0 x In
Setting Range Ss	0.005 to 2.0 x Sn
Operate Level	100% Ss ± 5% or ± 2% Sn
Reset Level: -	≥95% Sop
Basic Operate Time: - 1.1 x Ss (over) 2.0 x Ss (over) 0.5 x Ss (under)	 60ms ± 10ms 45ms ± 10ms 30ms ± 10ms
Delay Setting td	0 to 14400s
Operate time following delay.	t_{basic} +t_d ± 1% or ± 10ms
Inhibited by	Undercurrent Guard, VTS

37 Undercurrent

Number of Elements	2 Phase and 2 EF/SEF
Operate	Any phase or ALL
Setting Range Is	Phase and EF 0.05,0.10…5.0 x In SEF 0.005,0.010…5.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Current Guard	Phase 0.05,0.1…5.0 x In
Delay Setting td	0.00,0.01…20,20.5…100,101…1000,1010…10000,10100…14400s
Basic Operate Time: 1.1 to 0.5xIn	 35ms ±10ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

46 Negative Phase Sequence Overcurrent

Number of Elements	DT & IT
DT Setting Range Is	0.05,0.10…4.0 x In
DT Operate Level	100% Is, ±5% or ±1%xIn
DT Delay Setting td	0.00,0.01…20,20.5…100,101…1000,1010…10000,10100…14400s
DT Basic Operate Time 0 to 2 xIs 0 to 5 xIs	 40ms ±10ms 30ms ±10ms
DT Operate time following delay.	Tbasic +td , ±1% or ±10ms
IT Char Setting	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL
IT Setting Range	0.05..2.5
Tm Time Multiplier	0.025,0.030…1.6,1.7…5,6…100

Char Operate Level	105% Is, ±4% or ±1%In
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

47 Negative Phase Sequence

Number of Elements	2
Setting Range Vs	1,1.5…90V
Hysteresis Setting	0,0.1…80%
Operate Level	100% Vs, ±2% or ±0.5V
Delay Setting td	0.00,0.01…20,20.5…100,101…1000,1010…10000,10100…14400s
Basic Operate Time 0V to 1.5xVs 0V to 10xVs	 80ms ±20ms 55ms ±20ms
Operate time following delay.	Tbasic +td , ±2% or ±20ms
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

49 Thermal Overload

Operate levels	Operate and Alarm
Setting Range Is	0.10,0.11…3.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Time Constant Setting	1,1.5…1000min
Operate time	$t = \tau \times In\left\{\frac{I^2 \cdot I_p^2}{I^2 \cdot (k \times I_B)^2}\right\}$ ±5% absolute or ±100ms where Ip = prior current
Alarm Level	Disabled, 50,51…100%
Inhibited by	Binary or Virtual Input

50 (67) Instantaneous & DTL OC&EF (Directional)

Operation – 7SR12 only	Non directional, Forward or reverse
Elements	Phase, Derived Earth, Measured Earth & SEF
Number of Elements 2 x 7SR11 4 x 7SR12	2/4 x OC 2/4 x Derived EF 'N' 2/4 x Measured EF 'G' where fitted 2/4 x SEF where fitted
Setting Range Is	0.05,0.06…50 x In SEF 0.005…5 x In
Time Delay	0.00…14400s
Operate Level I_{op}	100% Is, ±5% or ±1%xIn
Reset level	≥ 95 % I_{op}
Operate time: 50 50N	 0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 25ms, ±10ms 0 to 2xIs – 40ms, ±10ms, 0 to 5xIs – 30ms, ±10ms
Operate time following delay	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input Inrush detector VT Supervision

51(67) Time Delayed OC&EF (Directional)

Operation – 7SR12 only	Non directional, Forward or reverse
Elements	Phase, Derived Earth, Measured Earth & SEF
Number of Elements 2 x 7SR11 4 x 7SR12	2/4 x OC 2/4 x Derived EF 'N' 2/4 x Measured EF 'G' 2/4 x SEF where fitted
Characteristic	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL
Setting Range Is	0.05,0.06…2.5 x In SEF 0.005…0.5 x In
Time Multiplier	0.025,0.030…1.6,1.7…5,6…100
Time Delay	0,0.01… 20s
Operate Level	105% Is, ±4% or ±1%xIn
Minimum Operate time IEC ANSI	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$ $t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5 % absolute or ± 30 ms
Follower Delay	0 - 20s
Reset	ANSI decaying, 0 – 60s
Inhibited by	Binary or Virtual Input Inrush detector VT Supervision

51V Voltage Controlled Overcurrent

Setting Range	5,5.5…200V
Operate Level	100% Vs, ±5% or ±1%xVn
Multiplier	0.25.0.3…1 x 51Is
Inhibited by	VT Supervision

50AFD Arc Flash Detector

Number of Zones	6, segregated outputs with and without current supervision.
Setting Range Is	1,2…10 x In
Operate Level I_{op}	100% Is, ±5% or ±1%xIn
Reset level	≥ 95 % I_{op}
Operate time:	50AFD Overcurrent <16ms AFD Zone Operate Time <25ms

50BF Circuit Breaker Fail

Operation	Current check - Phase and Measured Earth with independent settings Mechanical Trip CB Faulty Monitor
Setting Range Is	0.05,0.055…2.0 x In
2 Stage Time Delays	Timer 1 20…60000ms Timer 2 20…60000ms
Operate Level	100% Is, ±5% or ±1%xIn
Disengaging time	< 20ms
Operate time following delay	Tcbf ±1% or ±2ms
Triggered by	Any function mapped as trip contact.
Inhibited by	Binary/Virtual Input
Timer By pass	Yes, 50BF CB Faulty Input

55 Power factor (7SR12)

Number of Elements	2
Operation	Under or Over, Lead or Lag
U/C Guard	0.05 to 1.0
Setting Range PFs	0.05 to 0.99
Time Delays	0 to 14400s
Operate Level	± 0.05
Basic Operate time	≤ 70ms
Operate time following delay	t_{basic} +t_d ± 1% or ± 10ms
Inhibited by	Undercurrent Guard, VTS

59N Neutral Voltage Displacement

Number of Elements	DT & IT
DT Setting Range Is	1...100V
DT Operate Level	100% Vs, ±2% or ±0.5V
DT Delay Setting td	0 ...14400s
DT Basic Operate Time 0V to 1.5 x Vs 0V to 10 x Vs	 76ms ±20ms 63ms ±20ms
DT Operate time following delay.	Tbasic +td , ±1% or ±20ms
IT Char Setting	IDMTL & DTL
IT Setting Range	1...100V
Tm Time Multiplier(IDMT)	0.1...140
Delay (DTL)	0...20s
Reset	ANSI Decaying, 0...60s
Char Operate Level	105% Vs, ±2% or ±0.5V
Inhibited by	Binary or Virtual Input

60 Supervision

CT	7SR11 Current 7SR12 Current or Vnps & Inps
VT	nps/zps

64H Restricted Earth Fault

Setting Range	SEF input	0.005, 0.006 ... 0.100, 0.105 ... 0.950 x*In*
	EF input	0.05, 0.055... 0.95 x*In*
Operate Level	100% Is, ±5% or ±1%xIn	
Time Delay	0.00... 14400s	
Basic Operate Time	0 to 2 xIs 45ms ±10ms 0 to 5 xIs 35ms ±10ms	
Inhibited by	Binary or Virtual Input	

74T/CC Trip/Close Circuit Supervision

Number of supervisable circuits	3 x Trip and 3 x Close
Number of BI's Required	1 or 2 per function

79 AutoReclose

Operating Mode	Phase, Earth, SEF External
Number of Reclosures	4
Number of Trips	5
Dead Time	0...14400
Reclaim Time	0...600
Lockout Reset	CB, Timer & BI

81 Under/Over Frequency

Number of Elements	4 Under or Over
Under Voltage Guard	Yes/No
Setting Range Hz	43,43.01...68Hz
Hysteresis Setting	0, 0.1... 2%
Operate Level	100% Fs ±10mHz
Operate Time	Typical <150ms
Vs Operate Delay	0...14400s

Control Functions

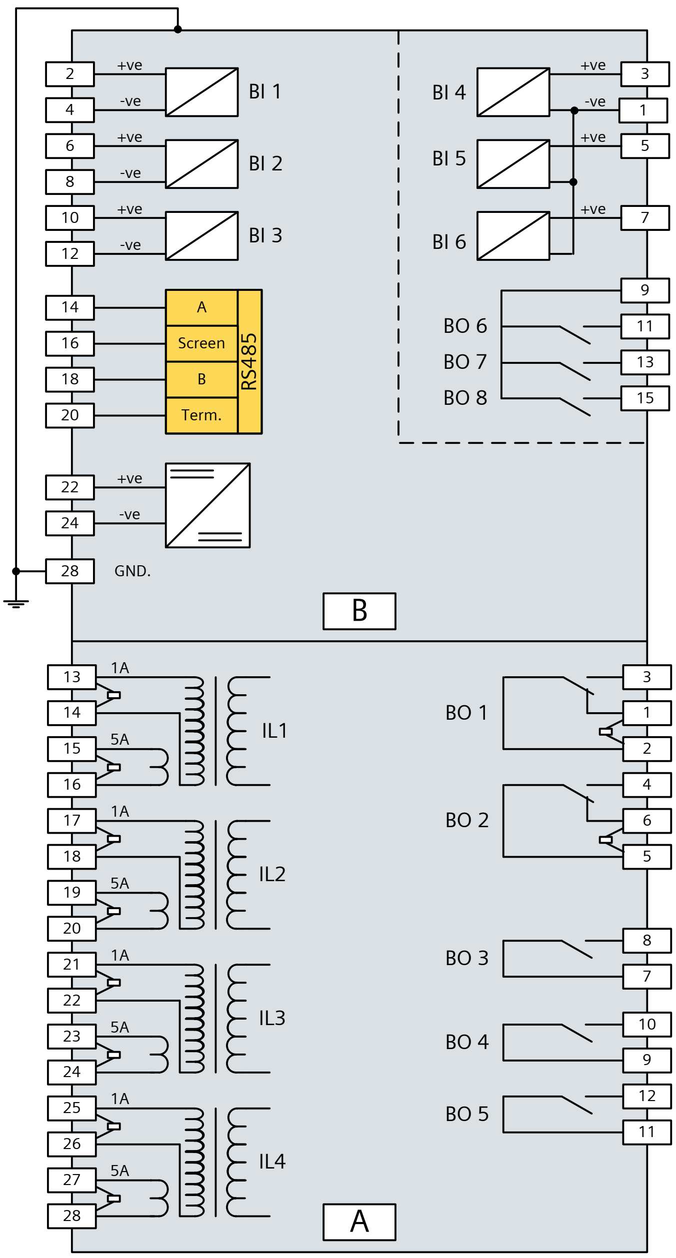
CB	Open/Close
Inst Prot	IN/OUT
EF	IN/OUT
SEF	IN/OUT
Hot Line	IN/OUT
Relay Mode	Local/Remote/Local or Remote
Reset	LED's & O/P's

Not available in 7SR1102-1*A12-*AA0

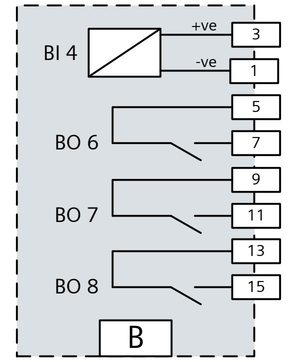
CB Maintenance

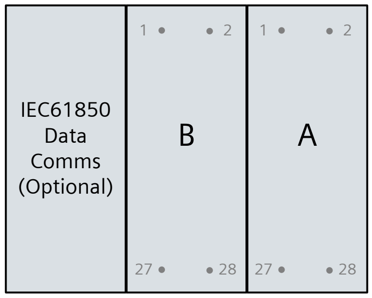
Trip Counter	Total & Delta 0...10000
Counts to AR Block	0...10000
Frequent Operations	0...10000
I^2t Alarm	10...100000

7SR11 Connection Diagram



Alternative 4BI+8BO
without common terminals

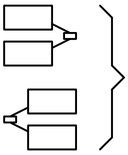




Rear View
Arrangement of terminals and modules

NOTES

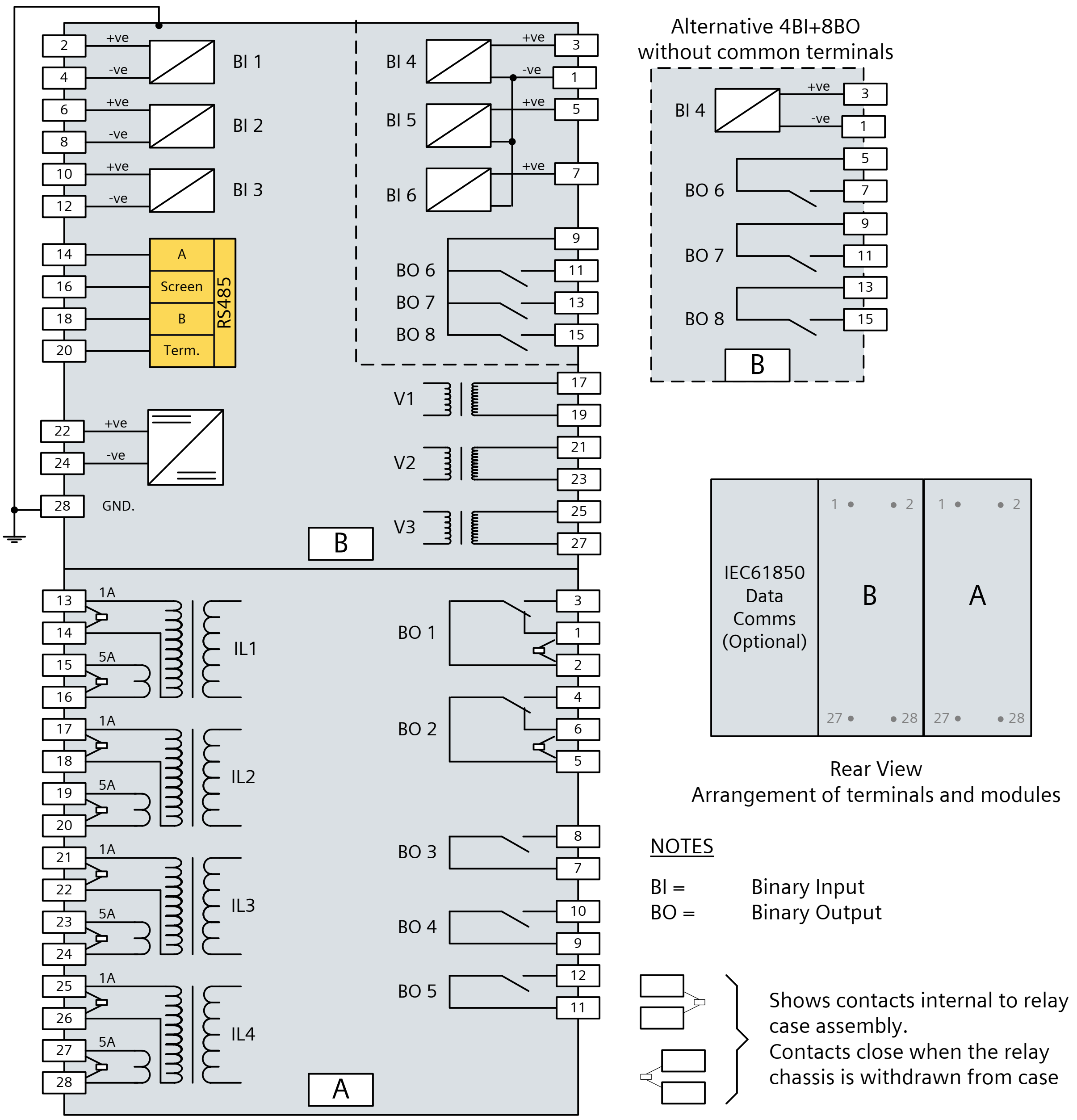
BI = Binary Input
BO = Binary Output



Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig14. Diagram showing 7SR11 relay with 4 CT inputs, up to 6 binary inputs and 8 binary outputs.

7SR12 Connection Diagram



Rear View
Arrangement of terminals and modules

NOTES

BI =	Binary Input
BO =	Binary Output

Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig15. Diagram showing 7SR12 relay with 4 CT inputs, 3 VT inputs, up to 6 binary inputs and 8 binary outputs.

Ordering Information – 7SR11 Argus Non-Directional Overcurrent

Product description	Variants		Order No. 5	7	8	9	11	12	13	14
Nondirectional O/C Relay (Argus)			1 2 3 4 5 6 7 - 8 9 10 11 12 - 13 14 15 16 7 S R 1 1 0 ☐ - ☐ ☐ A ☐ ☐ - ☐ ☐ A 0							
Overcurrent and earth fault Protection relay										
	Protection Product									
	Overcurrent – Non Directional		1							
	Housing I/O and Fascia									
	1 CT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs			1			1			C
	4 CT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs			2						A/C/D
	4 CT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs			3						C/D
	4 CT, 4 Binary Inputs / 8 Binary Outputs, 10 LEDs 7)			7						C/D
	Measuring Input									
	1/5 A, 50/60Hz 1)				1					A/C/D
	1/5 A, 50/60Hz with SEF Input 2)				3					C/D
	Auxiliary voltage									
	PSU Rated: 24-250V DC / 100-230V AC. BI threshold 19V DC (Rated: 24-250V DC / 100-120V AC)					M				
	PSU Rated: 24-250V DC / 100-230V AC. BI threshold 88V DC (Rated: 110-250V DC)					N				
	Communication Interface									
	Standard version – included in all models, USB front port, RS485 rear port (E4 Case)						1	2		
	Standard version – plus additional rear electrical Ethernet RJ45 (x2), E6 Case 6)						7	7		C/D
	Standard version – plus additional rear optical Ethernet duplex (x2), E6 Case 6)						8	7		C/D
	Protocol									
	IEC 60870-5-103 Modbus RTU and DNP3 (user selectable)							2		
	IEC 60870-5-103 Modbus RTU, DNP3 and IEC 61850 (user selectable settings) 6)							7		
	Relay Cover									
	Standard Version – No Push Buttons								1	
	Push Buttons – Down and Right Arrows								2	
	Protection Function Packages									
	Basic version 5)									A
	46BC 3)	Broken conductor/load unbalance								
	50 3)	Instantaneous phase fault overcurrent								
	50BF 3)	Circuit breaker fail								
	50G/50N	Instantaneous earth fault								
	51 3)	Time delayed phase fault overcurrent								
	51G/51N	Time delayed earth fault								
	60CTS 3)	CT Supervision								
	64H	High impedance REF								
	74T&C	Trip & Close circuit supervision								
	86	Hand reset contacts								
	Standard version									C
	37	Undercurrent								
	46BC 3)	Broken conductor/load unbalance								
	46NPS 3)	Negative phase sequence overcurrent								
	49 3)	Thermal overload								
	50 3)	Instantaneous phase fault overcurrent								
	50AFD	Arc Flash Detection								
	50BF 3)	Circuit breaker fail								
	50G/50N	Instantaneous earth fault								
	50SEF 2)	Instantaneous sensitive earth fault								
	51 3)	Time delayed phase fault overcurrent								
	51G/51N	Time delayed earth fault								
	51SEF 2)	Time delayed sensitive earth fault								
	60CT 3)	CT Supervision								
	64H	High Impedance REF								
	74T/CC	Trip and Close circuit supervision								
	81HBL2 4)	2nd harmonic block/inrush restraint								
	51C 3)	Cold load pickup								
	86	Hand reset contacts								
		Programmable logic								

(continued on next page)

Ordering Information – 7SR11 Argus Non-Directional Overcurrent

Product description	Variants		Order No.
			1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Nondirectional O/C Relay (Argus)			**7 S R 1 1 0 ☐ - ☐ ☐ A ☐ ☐ - ☐ ☐ A 0**
continued from previous page			
	Standard version – plus 79	 Autoreclose	**D**
	<u>Additional Functionality</u>		
	No Additional Functionality		**A**

1) 4CT is configured as 3PF + EF
2) 4CT is configured as 3PF + SEF/REF.
3) Functions only available in 4CT relay
4) Not available on SEF input
5) Protection function package ordering option A is only available on hardware variant 7SR1102-1XA12-XAA0- 4CT 3BI 5BO
6) E4 case is standard, E6 case is required if IEC61850 model ordered
7) 4 Binary Input variant provides segregated Binary Outputs without a common terminal

Ordering Information – 7SR12 Argus Directional Overcurrent

Product description	Variants		Order No.
			1 2 3 4 5 6 7 - 8 9 10 11 12 - 13 14 15 16
Directional O/C Relay (Argus)			**7 S R 1 2 0 ☐ - ☐ ☐ A ☐ ☐ - ☐ ☐ A 0**
Directional overcurrent and earth fault protection relay	Protection Product		
	Overcurrent – Directional		**2**
	Housing I/O and Fascia		
	1 CT, 3 VT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs		**4** **1** **C**
	4 CT, 3 VT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs		**5**
	4 CT, 3 VT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs		**6**
	4 CT, 3 VT, 4 Binary Inputs / 8 Binary Outputs, 10 LEDs [6]		**8**
	Measuring Input		
	1/5 A, 40 to 160 V, 50/60Hz[1]		**2**
	1/5 A, 40 to 160 V, 50/60Hz with SEF Input[2]		**4**
	Auxiliary voltage		
	PSU Rated: 24-250V DC / 100-230V AC. BI threshold 19V DC (Rated: 24-250V DC / 100-120V AC)		**M**
	PSU Rated: 24-250V DC / 100-230V AC. BI threshold 88V DC (Rated: 110-250V DC)		**N**
	Communication Interface		
	Standard version – included in all models, USB front port, RS485 rear port (E4 Case)		**1 2**
	Standard version – plus additional rear electrical Ethernet RJ45 (x2), E6 Case [5]		**7 7**
	Standard version – plus additional rear optical Ethernet duplex (x2), E6 Case [5]		**8 7**
	Protocol		
	IEC 60870-5-103, Modbus RTU and DNP3 (user selectable)		**2**
	IEC 60870-5-103 Modbus RTU, DNP3 and IEC 61850 (user selectable settings) [5]		**7**
	Relay Cover		
	Standard Version – No Push Buttons		**1**
	Push Buttons – Down and Right Arrows		**2**
	Protection Function Packages		
	Standard version – Included in all models		**C**
	27/59	Under/overvoltage	
	32[3]	Power	
	32S[7]	Sensitive Power	
	37	Undercurrent	
	46BC[3]	Broken conductor/load unbalance	
	46NPS[3]	Negative phase sequence overcurrent	
	47	Negative phase sequence voltage	
	49[3]	Thermal overload	
	50AFD	Arc Flash Detection	
	50BF[3]	Circuit breaker fail	
	51V[3]	Voltage controlled overcurrent	
	55[3]	Power Factor	
	59N	Neutral voltage displacement	
	60CTS[3]	CT supervision	
	60VTS[3]	VT supervision	
	64H	High Impedance REF	
	67/50	Directional instantaneous phase fault overcurrent	
	67/50G 67/50N	Directional instantaneous earth fault	
	67/50SEF[2]	Instantaneous sensitive earth fault	
	67/51	Directional time delayed phase fault overcurrent	
	67/51G 67/51N	Directional time delayed earth fault	
	67/51/SEF[2]	Time delayed sensitive earth fault	
	81HBL2[4]	2nd harmonic block/inrush restraint	
	74T/CC	Trip & Close circuit supervision	
	51C[3]	Cold load pickup	
	81U/0	Under/Over Frequency	
	86	Hand reset contacts	
		Programmable logic	
	Standard version – plus		**D**
	79	Autoreclose	
	Additional Functionality		
	No Additional Functionality		**A**

1) 4CT is configured as 3PF + EF
2) 4CT is configured as 3PF + SEF/REF
3) Functions only available in 4CT relay
4) Not available on SEF input
5) E4 case is standard, E6 case is required if IEC61850 model ordered
6) 4 Binary Input variant provides segregated Binary Outputs without a common terminal
7) Functions only available in 4CT SEF relay

1.1.2.2 7SR157 Check Synchronising Relay

Fig. 1 7SR157 Fascia

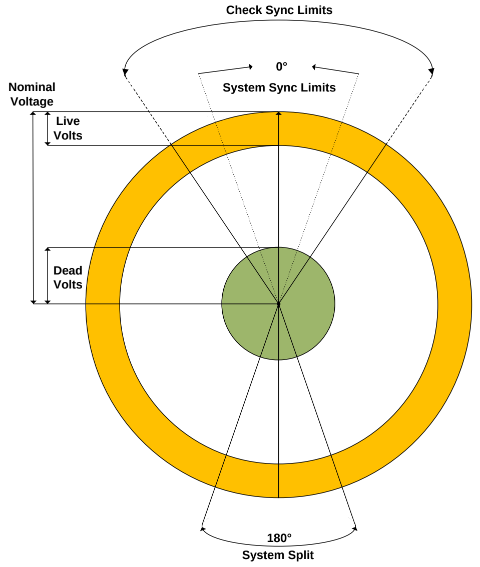
Description

The 7SR157 Argus is a combined check and system synchronising relay which can carry out controlled closing of a circuit breaker using measurements of the line and bus voltages. The relay will prevent closure of the circuit breaker if the differences in phase angle, slip frequency or magnitude of the voltages fall outside prescribed limits.

If the parameters are within limits, the relay will issue an output which can be used to close the circuit breaker directly or in conjunction with an auto-reclose scheme.

Housed in a 4U high, size E4 or E6 (Optional IEC61850 model) case, the relay provides instrumentation and fault data with integrated input and output logic, data logging & fault reports. Communication access to the relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection & optional IEC61850 communication through two rear Ethernet ports (Electrical or Optical).

Function Overview



- Independent check, system synchronising and close on zero settings.
- Adjustable slip frequency, phase angle, voltage blocking and Differential voltage blocking.
- Split system detection.
- Configurable dead/live bus and dead/live line voltage settings, (2 State and 3 State).
- Synchronising bypass logic is provided to connect a dead line or bus to a live line or bus.
- For manual synchronising the relay includes a circuit breaker close guard feature, which is used to prevent the control switch being held closed during a synchronising operation.

Monitoring

25	Undervoltage Detector Differential Voltage Detector Voltage Levels (Live and Dead status)

Control

25	Voltage Trim (Magnitude and Phase) System Split Detector Check Synchronising Check Synchronising Close Guard System Synchronising Close On Zero Synchronising System Split Lockout Synchronising Bypass

Supervision

74	Close Circuit Supervision
60	VT Fail
	Demand Metering

Features

Four Settings Groups
Password Protection – 2 levels
User Programmable Logic
Self Monitoring

User Interface

20 Character x 4 Line Backlit LCD
Menu Navigation Keys
9 User Programmable Tri-colour LEDs
User Language Configuration

Hardware

2 VT, 3 Binary Inputs, 5 Binary Outputs
2 VT, 6 Binary Inputs, 8 Binary Outputs

Application

Check or system synchronising is required whenever two parts of a power system network, each containing generation, have to be connected or re-connected together. To avoid shock loading and possible damage to primary electrical plant the voltage, frequency and phase angle difference between the two systems should be within acceptable limits relative to one another.

Where two systems have been previously interconnected, the frequencies of the two systems will drift apart slowly following circuit breaker tripping and the phase angle difference will increase. Here the slip rate will be small and the circuit breaker can be closed using check synchronising settings as the limiting parameters.

However, if the two systems become asynchronous so one system is an ‘island’ of generation then a high rate of slip may result causing the two systems to pass through anti-phase conditions. The relay will detect this system split condition, inhibit the check synchronising algorithms and apply system synchronising settings as limiting parameters. Typically in this mode the slip rate will be much higher and so there will be a narrower allowable phase angle difference before closing. In addition, closure of the circuit breaker will only be allowed under conditions of decreasing difference in phase angle.

Functional Diagram

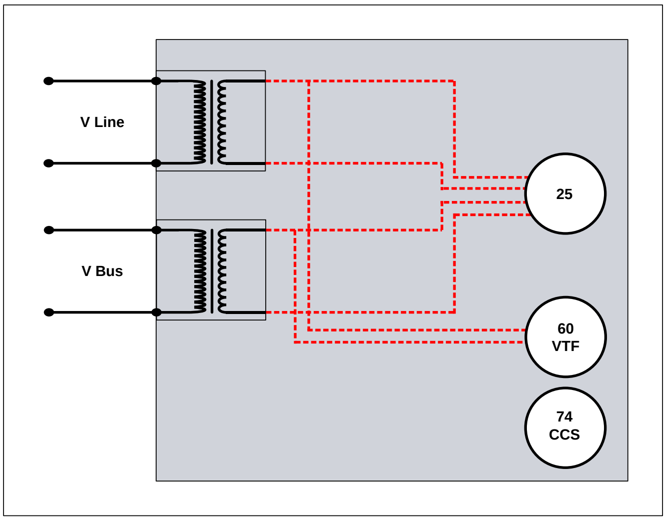


Fig2. VLine, Vbus connection

Description of Functionality

25 Line/Bus Undervolts

The undervoltage detector element can block a close output command if either the line or bus voltages are below the ***25 Line U/V* / *25 Bus U/V*** setting value.

25 Voltage Diff

The Differential Voltage Detector Element can block a close output command if the scalar difference between the line and bus voltages is greater than the ***25 Volt Differential*** setting value.

VT Level Mode

Option of 2 State or 3 State, to determine when a voltage is live or dead:

2 State – Line or Bus voltages are dead until they exceed the live threshold. The voltages are then live until they drop below the dead threshold.

3 State - The Line or Bus Voltages are only classed as live when above the live threshold. When the voltage falls below the live threshold, the live output is RESET but the Dead output does not SET until the voltage falls below the Dead threshold. This is an indeterminate state, where both Live and Dead outputs have the same value, both are RESET.

25 Voltage Trim

The relay incorporates a **Voltage Trim Magnitude** feature and a **Voltage Trim Angle** feature for both the line and bus voltages. This allows small adjustments to the input voltages and phase angles of the relay.

25 System Split Detector

The method used to detect a system split can be selected as either phase angle or slip frequency. When the selected condition is exceeded the ***25 System Split*** output is set; indicating the system is split. A drop-off delay timer ***25 System Split Timer*** is applied to the output, to suppress flickering.

25 Check Sync

Check Synchronising sets ***25 InSyncCS*** and ***25 Check Sync Close*** outputs when the Line and Bus voltages are healthy and synchronised. The phase angle tolerance for being synchronised is set by ***25 Check Sync Angle*** setting. The synchronised conditions must be held for a minimum time of ***25 Check Sync Timer*** setting. An optional setting ***25 Check Sync Slip*** may be applied to limit Slip Frequency.

There are two modes of operation, Auto and Manual.

AUTO: ***25 Check Sync Close*** output is set when the Check synchronizing conditions are met.

MANUAL: ***25 Check Sync Close*** output is set when Check synchronizing conditions are met and a manual close command is received, via ***Start Check Sync*** input.

Close Guard

If manual closes are required to be carried out via an operator, the ***Close Guard*** feature can be enabled. This issues an alert message and a general alarm, intended to warn the operator about initiating a CB close before the relay issues a valid Check Sync Close signal. This prevents the operator from pre-empting the relays’ decision.

25 System Synchronising

System Synchronising is triggered by a system split. After a split, System Sync will wait for Line and Bus phases to realign, before setting ***25 InSyncSS*** and ***25 System Sync Close*** outputs. The phase angle tolerance for being synchronised is set by ***25 System Sync Angle*** setting (for the System Sync outputs to be set the phase angle between the two voltages must be decreasing). The slip frequency must not be excessive, within ***25 System Sync Slip*** setting. The synchronised conditions must be held for a minimum time of ***25 System Sync Timer*** setting.

There are two modes of operation, Auto and Manual, there is also a lockout mode.

AUTO: ***25 System Sync Close*** output is set when the Check synchronizing conditions are met.

MANUAL: ***25 System Sync Close*** output is set when Check synchronizing conditions are met and a manual close command is received, via ***Start Check Sync*** input.

LOCKOUT: The ***System Split Lockout*** output is set when there is a ***25 System Split*** event.

25 Close On Zero

If the ***25 Split Mode*** is set to ***COZ*** and a ***25 System Split*** occurs, a Close On Zero operation will be activated. Close On Zero differs from System Sync, by attempting to issue a close output when phase angle is precisely zero. The phase angle, slip frequency and CB Close time delay are used to predict when zero phase angle will occur.
The slip frequency must be less than the ***25 COZ Slip Freq*** but greater than the ***25 Split Slip*** setting to avoid reversion to Check Synchronising conditions.

25 Synchronising Bypass

Sync Bypass is triggered for switching operations, which involve connecting a dead line or bus to a live line or live bus. For these switching operations the synchronising conditions will not be met, the ***Sync Bypass*** setting is required to bypass the synchronising operations and allow the **Bypass Close** output.

74 Close Circuit Supervision

Monitors the open/closed status of up to 3 circuits. If circuit status is open for a minimum time of **74CCS-n-Delay** setting, **Close Circuit Fail** and **Close Circuit Fail n** events are raised.

60 VT Fail

When the circuit breaker is closed, both voltages should be either Live or Dead. If this is not true, a VT Fail output is set (***60VTS***, to indicate the Line VT has failed and ***60VTF-Bus*** to indicate the Bus VT has failed). A time delay setting (***60VTF – Line/Bus Delay***) suppresses spurious operations during transient switching conditions.

Programmable Logic

The user can map binary inputs, protection elements, LEDs and binary outputs together in a logical scheme.
Up to 4 logic equations can be defined using standard logic functions e.g. Timers, AND/OR gates, Inverters and Counters to provide the user required functionality.
Each logic equation output can be used for alarm & indication and/or tripping.

Virtual Inputs/Outputs

There are 8 virtual inputs/outputs to provide internal logical states to assist in the application of the functions. Each virtual I/O can be assigned in the same way as a physical I/O.

Construction

The relay is housed in a 4U high size E4 case with a removable clear plastic fascia cover. The plastic fascia cover can be ordered with or without two push buttons to allow the user to view the settings and instruments without removing the cover.
Two plastic handles are provided to allow the relay to be withdrawn from its case.
The rear terminal blocks comprise M4 female terminals for ring crimp wire connections, to provide a secure and reliable termination.

Fig3. Rear view of Standard E4 relay

Fig4. Rear view of relay with 2x LC Fibre Optic ports (E6 Case with IEC61850)

User Interface

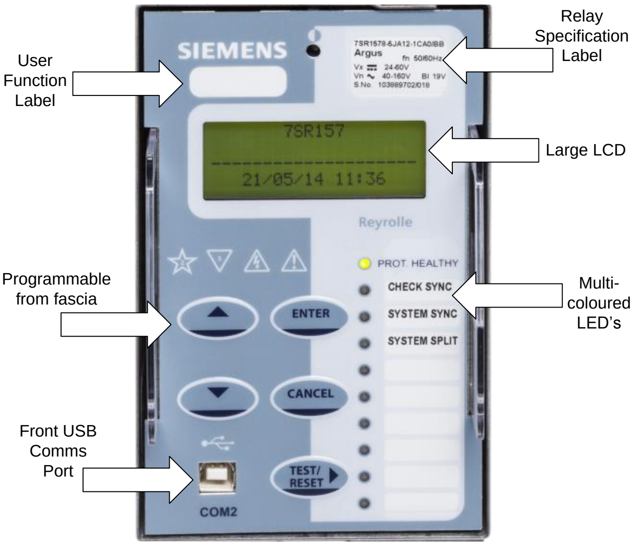


Fig5. User Interface

The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings and retrieving data from the relay. Five buttons are provided for navigation around the menu structure.

LCD

A 4 line by 20 character liquid crystal display with power save operation indicates the relay identifier, settings, instrumentation, fault data and control commands.
Up to 6 user programmable general alarms can be configured to display your own indications on the LCD.

LEDs

A green steadily illuminated LED indicates the 'Protection Healthy' condition.
9 user programmable LEDs are available eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED is tri-color (red, green, yellow) allowing for clear indication of the associated function's state and has a label insert for identification.

Relay Information

The device is identified by the rating label on the fascia. The user can also give the device its own identity by editing the 'Relay Identifier' displayed on the LCD or space is provided to place a slip in label giving the relays function.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Voltage Inputs

Nominal	40...160 Vrms
Operating Range	0... 200 Vrms
Instrumentation ≥ 0.8xVn	±1% Vn
Burden @ 110V	≤ 0.06 VA
Overvoltage Withstand	300 Vrms

Auxiliary Supply

Rated DC Voltage	110/125/220/250V Range 64 to 300V 24/48/60V Range 18 to 72V	
Allowable superimposed ac component	12% of DC voltage	
Rated AC Voltage	115 VAC 50/60Hz Range 92 to 138 V rms AC 50/60Hz ±5%	
Power Consumption:	E4 Min (DC) E4 Max (DC)	3.9W 8W
	E4 Min (AC) E4 Max (AC)	9VA 0.5PF 16VA 0.5PF
	E6 Min (DC) E6 Max (DC)	6.4W 10.5W
	E6 Min (AC) E6 Max (AC)	14.5VA 0.5PF 21.5VA 0.5PF
Allowable breaks/dips in supply (collapse to zero)	DC	50ms
	AC	2.5/3 cycles @50/60Hz

Binary Inputs

Number	6 or 3	
Operating Voltage	19V dc	DC Range 17 to 320V dc AC Range 92 to 138 VRMSAC
	88V dc	Range 70 to 320V dc
Maximum dc current for operation	1.5mA	
Maximum peak ac current for operation	1.5mA	
Pick Up Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)	
Drop Off Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)	

For AC operation the BI pick-up delay should be set to 0ms and the drop-off delay to 20ms.

Binary Outputs

Number	8 (2 change over contacts) 5 (2 change over contacts)
Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed.
Operating Time from Energizing Binary Input	<20ms
Making Capacity: Carry continuously Make and carry (L/R ≤ 40 ms and V ≤ 300 V)	 5A ac or dc 20A ac or dc for 0.5s 30A ac or dc for 0.2s
Breaking Capacity (≤ 5 A and ≤ 300 V): AC Resistive AC Inductive DC Resistive DC Inductive	 1250 VA 250 VA at p.f. ≤ 0.4 75 W 30 W at L/R ≤ 40ms 50 W at L/R ≤ 10ms

Unit Design

Housing	E4 (see dimension drawing)
Indication	20 Character 4 line Display

	Relay Healthy LED 9 Tri Coloured User Programmable Self or Hand Reset LED's
With-drawable Element	Yes
User Interface	5 Navigation Keys
Weight	Typical 3.2kg E4 case, 4.15 kg E6 case. Additional Transport packaging: add 0.4kg
IP Rating installed with cover	IP 51 from front
IP Rating installed without cover	IP 20 from front

Data Communication Interface

Communication Port	Front USB Type B Rear RS485 2 wire electrical IEC61850 optional ports: 2x Electrical RJ45 Ethernet 2x LC Fibre Optic Ethernet
Protocols	IEC60870-5-103 MODBUS RTU (Serial) DNP3.0 O (Serial) IEC61850 - optional
Fibre Optic Ethernet Data Communication Interface (IEC 61850 Option)	

EN100 Fibre Optic Data Communication Interface (IEC 61850 Option)

Physical	layer Fibre-optic
Connectors	Duplex LC 100BaseF in acc. With IEEE802.3
Recommended fibre	62.5/125 µm glass fibre with Duplex-LC connector
Transmission Speed	100 MBits/s
Optical Wavelength	1300 nm
Bridgeable distance	2 km

EN100 Electrical Ethernet Data Communication Interface (IEC 61850 Option)

Physical	Electrical
Connectors	RJ45 100BaseT in acc. With IEEE802.3
Transmission Speed	100 MBits/s
Test Voltage (with regard to socket)	500 VAC 50 Hz
Bridgeable distance	20m

Data Storage

Fault Record	10
Waveform Record	10 x 1sec 2 x 5sec 5 x 2sec 1 x 10sec Pre trigger 10...90%
Events	1000 1ms Resolution

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration response	1.0 gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %
Shock withstand	15 gn, 11 ms	≤ 5 %
Bump test	10 gn, 16 ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	X-plane - 3.5mm displacement below crossover freq (8-9Hz) 1gn and above Y-plane – 1.5mm displacement below crossover freq (8-9Hz) 0.5gn above	≤ 5 %

Mechanical Classification

Durability	$>10^6$ operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	2.0 kV AC RMS for 1 min
Across normally open contacts	1.0 kV AC RMS for 1 min

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Common (longitudinal) mode	2.5 kV	≤ 5 %
Series (transverse) mode	1.0 kV	≤ 5 %

Electrostatic Discharge
IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

Fast Transients
IEC 60255-22-4 Class A (2002)

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4kV	≤ 5 %

Surge Immunity
IEC 60255-22-5

Type	Level	Variation
Analog Inputs: Line to Earth	4.0 kV	≤ 10%
Case, Aux Power & I/O: Line to Earth	2.0 kV	≤ 10%
RS485 Comms port: Line to Earth	1.0 kV	No Data Loss
Analog Inputs: Line to Line	1.0 kV	≤ 10%
Case, Aux Power & I/O: Line to Line	1.0 kV *	≤ 10%

* Note 50ms DTL pick-up delay applied to binary inputs

Conducted Radio Frequency Interference
IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5 %

Radiated Radio Frequency
IEC 60255-25

Type	Limits at 10 m, Quasi-peak
30 to 230 MHz	40 dB(μV)
230 to 10000 MHz	47 dB(μV)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(μV)	66 dB(μV)
0.5 to 30 MHz	73 dB(μV)	60 dB(μV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level
80 MHz to 1000 MHz Sweep	10 V/m
1.4GHz to 2.7GHz Sweep	10V/m
80,160,380,450,900,1850,2150 MHz Spot	10V/m

Climatic Tests

Temperature
IEC 60068-2-1/2

Operating Range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity
IEC 60068-2-78

Operational test	56 days at 40 °C and 93 % relative humidity

Cyclic Temperature and Humidity
IEC 60068-2-30

Operational test	25 °C to 55 °C (outdoor equipment) and 97/93 % relative humidity. 6 x 24h (12h+12h) cycles.

Performance

25 Check Synchronising

Line Nom Voltage	40-160 V
Bus Nom Voltage	40-160 V
System Frequency	50/60 Hz
25 Check Sync Angle	0 – 90 °
25 Check Sync Slip	0 – 2Hz
25 Check Sync Timer	0-100 s
25 Split Slip	0 – 2Hz
25 System Split Timer	0 – 60 s

25 Check Sync Angle Difference

Operate angle	θ_{diff}, ± 1 °
Reset angle	θ_{op}, ± 1 °
Repeatability	± 1 °

25 Check Sync Slip Frequency

Operate frequency	f_{slip}, ± 10 mHz
Reset frequency	f_{op}, - 10 mHz
Repeatability	± 10 mHz

25 Split Angle Detector

Operate angle	θ_{diff}, ± 1 °

25 Split Slip Frequency Detector

Operate frequency	f_{slip}, ± 10 mHz
Reset frequency	f_{op}, - 10 mHz
Repeatability	± 10 mHz

25 Check Sync Timer

Accuracy		± 1 % or ± 20ms
Repeatability		± 1 % or ± 20ms
Variation	-10 °C to +55 °C	≤ 5 %
	f_{nom} ± 5 %	≤ 5 %

25 System Synchronising

Line Nom Voltage	40-160 V
Bus Nom Voltage	40-160 V
System Frequency	50/60 Hz
25 System Sync Angle	0 – 90 °
25 COZ Slip Freq	0 – 2Hz

25 System Sync Slip	0 – 2Hz
25 System Sync Timer	0-100 s
25 SS Close Pulse	0-60 s

25 System Sync Angle Difference

Operate angle	θ_{diff}, ± 1 °
Reset angle	θ_{op}, ± 1 °
Repeatability	± 1 °

25 System Sync Slip Frequency

Operate frequency	f_{slip}, ± 10 mHz
Reset frequency	f_{op}, - 10 mHz
Repeatability	± 10 mHz

25 Close on Zero Slip Frequency

Operate frequency	f_{slip}, ± 10 mHz
Reset frequency	f_{op}, - 10 mHz
Repeatability	± 10 mHz

25 System Sync Timer

Accuracy		± 1 % or ± 20ms
Repeatability		± 1 % or ± 20ms
Variation	-10 °C to +55 °C	≤ 5 %
	f_{nom} ± 5 %	≤ 5 %

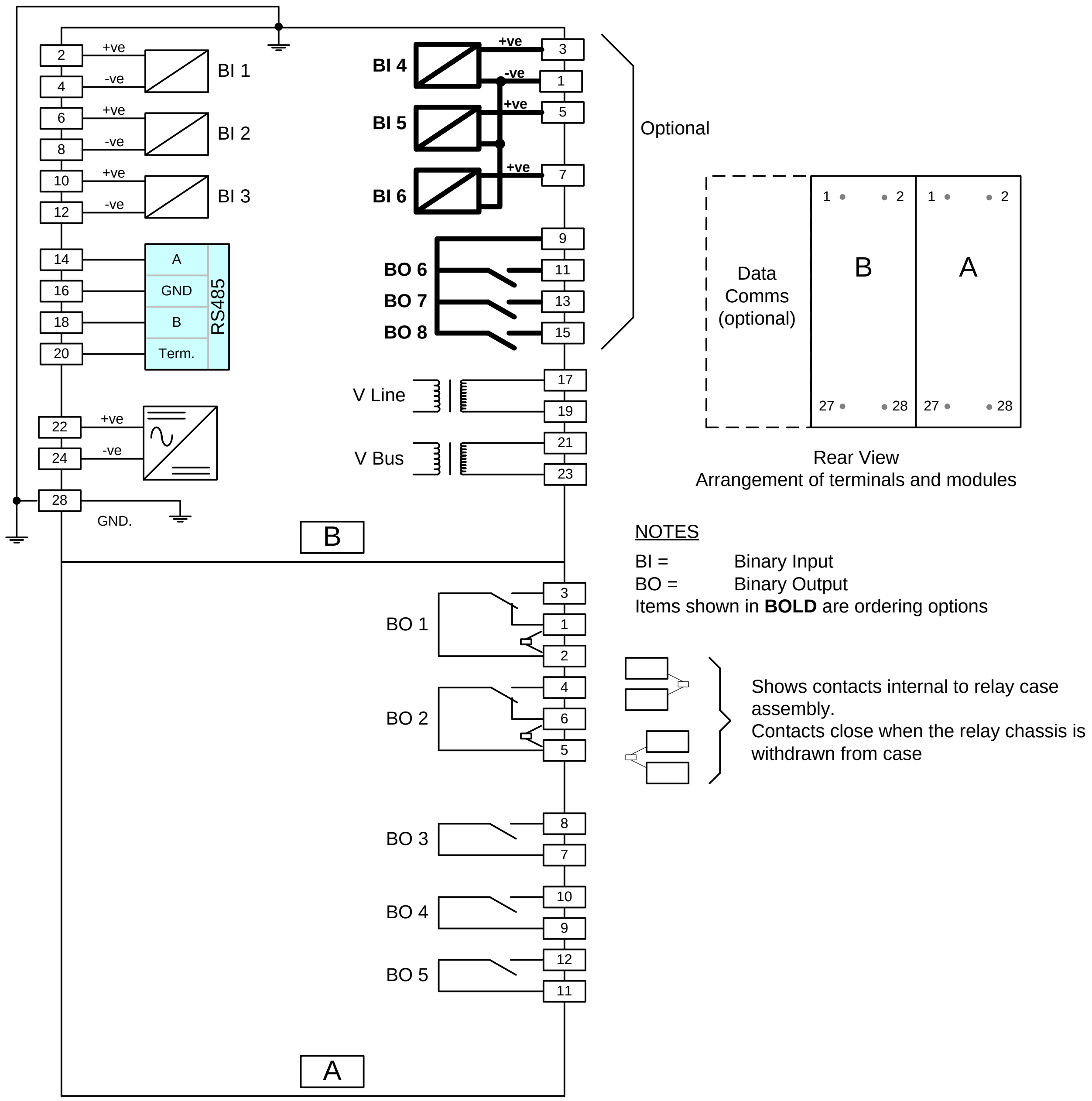
74 CCS Close Circuit Supervision Operate and Reset Time

Element basic operate time		25ms
Operate time following delay		$t_{basic} + t_d$, ± 1 % or ± 20ms
Repeatability		± 1 % or ± 20ms
Variation	-10 °C to +55 °C	≤ 5 %
	f_{nom} ± 5 %	≤ 5 %

60 VTF VT Failure Operate and Reset Time

Element basic operate time		63 ms, ± 10ms
Operate time following delay		$t_{basic} + t_d$, ± 1 % or ± 20ms
Repeatability		± 1 % or ± 20ms
Variation	-10 °C to +55 °C	≤ 5 %
	f_{nom} ± 5 %	≤ 5 %

Connection Diagram



NOTES

BI = Binary Input

BO = Binary Output

Items shown in **BOLD** are ordering options

Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig6. Connection Diagram

Ordering Information

Product description	Variants	Order No.
Voltage Relay (Argus)		**7 S R 1 5 7 □ - 5 □ A □ □ - □ C A 0**
	Protection Product	
	Voltage	**5**
	Relay Type	
	Check Synchronising	**7**
	Case, I/O and Fascia	
	2 VT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs	**7**
	2 VT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs	**8**
	Measuring Input	
	40/160V, 50/60Hz	**5**
	Auxiliary voltage	
	80 to 250 VDC / 115 VAC, binary input threshold 19 V DC	**G**
	80 to 250 V DC, binary input threshold 88 V DC	**H**
	24 to 60 V DC, binary input threshold 19 V DC	**J**
	Spare	**A**
	Communication Interface	
	Standard version – included in all models, USB front port, RS485 rear port (E4 case) 1)	**1** 2
	Standard version - plus additional rear electrical Ethernet RJ45 (x2) (E6 Case) 1)	**7** 7
	Standard version - plus additional rear optical Ethernet duplex (x2) (E6 Case) 1)	**8** 7
	Protocol	
	IEC 60870-5-103, Modbus RTU and DNP3 (user selectable setting)	**2**
	IEC 60870-5-103, Modbus RTU, DNP3 and IEC 61850. (user selectable settings)	**7**
	Front Cover	
	Standard Version – No Push Buttons	**1**
	Push Buttons – Down and right arrows	**2**
	Protection Function Packages	
	Standard version 25 Check Synchronising	**C**
	Additional Functionality	
	No additional functionality	**A**
	Spare	**0**

1) E4 case is standard, E6 case is required if IEC61850 option fitted

1.1.2.3 7SR158 Voltage and Frequency Relay

Fig. 1 7SR158 Fascia

Description

The 7SR158 is a voltage and frequency protection relay developed to enhance the Argus family of products by providing a familiar device using the latest generation of hardware technology.
Housed in a 4U high, size E4 or E6 (Optional IEC61850 model) case, these relays provide protection, monitoring, instrumentation and metering with integrated input and output logic, data logging & fault reports. Communication access to the relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection & optional IEC61850 communication through two rear Ethernet ports (Electrical or Optical).

Function Overview

Protection (can include)

27/59	Under/Over Voltage
47	Negative Phase Sequence Voltage
59N	Neutral Voltage Displacement
78	Vector Shift
82	Under/Over Frequency
81R	Rate-of-Change-of-Frequency (df/dt)

Supervision

74T/CCS	Trip & Close Circuit Supervision

Control

86	Lockout

CB Control
User Programmable Logic

Features

Four Settings Groups
Password Protection – 2 levels
Self Monitoring

User Interface

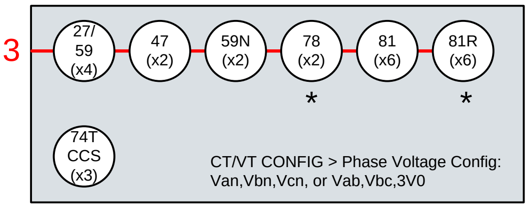
20 Character x 4 Line Backlit LCD
Menu Navigation Keys
9 User Programmable Tri-colour LEDs

Monitoring Functions

Primary/Secondary Line and Phase Voltages
Positive Phase Sequence (PPS) Voltage
Negative Phase Sequence (NPS) Voltage
Zero Phase Sequence (ZPS) Voltage
Frequency
Binary Input/Output status
Time and date
Starters
Fault data
Event records
CB trip and maintenance counters and Time to Trip

Function Matrix

FUNCTION	FUNCTIONAL REQUIREMENT	7SR1587-5*A**-*CA0	7SR1587-5*A**-*DA0
27	Undervoltage	■	■
47	Negative Phase Sequence Voltage	■	■
59	Overvoltage	■	■
59N	Neutral Voltage Displacement	■	■
78	Vector Shift		■
81	Under/Over Frequency	■	■
81R	Rate of Change of Frequency		■
	CONTROL / MONITOR		
74T/CCS	Trip & Close Circuit Supervision	■	■
86	Lockout	■	■



* Not all versions - see Function Matrix

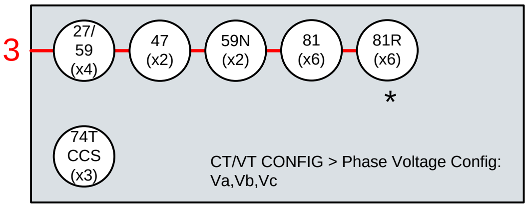


Fig. 2 Functional Diagrams

VT Connections

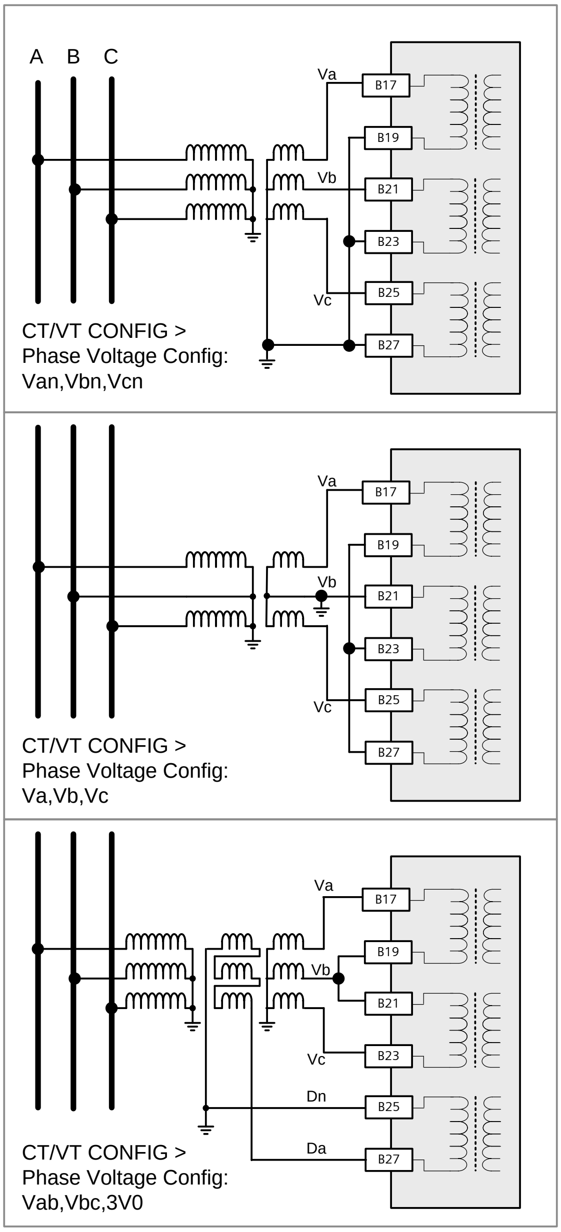


Fig. 3 VT Connections

Description of Functionality

With reference to figure 2 ‘Function Diagrams’.

27/59 Under/Over Voltage

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delay. Operates when voltage exceeds setting for the duration of delay.

47 Negative Phase Sequence Voltage

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates when NPS voltage exceeds setting for the duration of delay.

59N Neutral Overvoltage

Neutral overvoltage can be used to detect earth faults in high impedance earthed or isolated systems.
Operates when neutral voltage exceeds setting for the duration of delay.

74T/CCS Trip & Close Circuit Supervision

The trip or close circuit(s) can be monitored via binary inputs. Detection of trip circuit failure can be used to raise an HMI alarm (general alarm) and/or output(s).

78 Vector Shift

Operates if the voltage vector ‘jumps’ by more than setting during abrupt change in load. The function is applied to detect ‘islanding’ or loss of connection between a generator and the main utility supply.

81 Under/Overfrequency

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if frequency exceeds setting for duration of delay.
The function is typically applied in load shedding schemes.

81R Rate of Change of Frequency (df/dt)

Each element has settings for pickup level and Definite Time Lag (DTL) delay. Operates when the df/dt gradient exceeds setting for duration of delay.
The function is typically applied in load shedding schemes or to detect ‘islanding’ or loss of connection between a generator and the main utility supply

Programmable Logic

The user can map binary inputs, protection elements, LEDs and binary outputs together in a logical scheme.
Up to 4 logic equations can be defined using standard logic functions e.g. Timers, AND/OR gates, Inverters and Counters to provide the user required functionality.
Each logic equation output can be used for alarm & indication and/or tripping.

Virtual Inputs/Outputs

There are 8 virtual inputs/outputs to provide internal logical states to assist in the application of the functions. Each virtual I/O can be assigned in the same way as a physical I/O.

Circuit Breaker Maintenance

Two circuit breaker operations counters are provided to assist with maintenance scheduling. The maintenance counter records the overall number of operations and the delta counter records the number of operations since the last reset.

Each counter has a user set target operations count which, when reached, can be mapped to raise alarms/ binary outputs. A CB Trip Time meter is also available, which measures the time between the trip or open command being issued and the auxiliary contacts changing state.

Control Mode

The relay has a control menu with access to commonly used command operations. Access to the control commands is restricted by a 4 character control function password. Each command requires a select then execute operation, if the execute operation is not performed within a time window the command is aborted. The following control functions are available:

CB Control
Local or remote operation

CB: TRAVELLING

ENTER to control

Fig.4 Example of Control Function View

Construction

The relay is housed in a 4U high size E4 or E6 case with a removable clear plastic fascia cover. The plastic fascia cover can be ordered with or without two push buttons to allow the user to view the settings and instruments without removing the cover.
Two plastic handles are provided to allow the relay to be withdrawn from its case, contacts in the case ensure that the normally closed contacts remain short circuited when the relay is withdrawn.
The rear terminal blocks comprise M4 female terminals for ring crimp wire connections, to provide a secure and reliable termination.

Fig.5 Rear view of relay (E4 Case)

Fig.6 Rear view of relay with 2x LC Fibre Optic ports (E6 Case with IEC61850)

User Interface

Fig.7 User Interface

The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings and retrieving data from the relay. Five buttons are provided for navigation around the menu structure.

LCD

A 4 line by 20 character liquid crystal display with power save operation indicates the relay identifier, settings, instrumentation, fault data and control commands.
Up to 6 user programmable general alarms can be configured to display your own indications on the LCD.

LEDs

A green steadily illuminated LED indicates the ‘Protection Healthy’ condition.

9 user programmable LEDs are available eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED is tri-color (red, green, yellow) allowing for clear indication of the associated function's state and has a label insert for identification.

Relay Information

The device is identified by the rating label on the fascia. The user can give the device its own unique identity by editing the 'Relay Identifier' displayed on the LCD, also space is provided for a further slip-in label.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Voltage Inputs

Nominal	40...160 Vrms
Operating Range	0... 200 Vrms
Instrumentation ≥ 0.8xVn	±1% Vn
Burden @ 110V	≤ 0.06 VA
Overvoltage Withstand	300 Vrms

Auxiliary Supply

Rated DC Voltage	110/125/220/250V Range 64 to 300V 24/48/60V Range 18 to 72V	
Allowable superimposed ac component	12% of DC voltage	
Rated AC Voltage	115 VAC 50/60Hz Range 92 to 138 V rms AC 50/60Hz ±5%	
Power Consumption:	E4 Min (DC) E4 Max (DC)	3.9W 8W
	E4 Min (AC) E4 Max (AC)	9VA 0.5PF 16VA 0.5PF
	E6 Min (DC) E6 Max (DC)	6.4W 10.5W
	E6 Min (AC) E6 Max (AC)	14.5VA 0.5PF 21.5VA 0.5PF
Allowable breaks/dips in supply (collapse to zero)	DC	50ms
	AC	2.5/3 cycles @50/60Hz

Binary Inputs

Number	6	
Operating Voltage	19V dc	DC Range 17 to 320V dc AC Range 92 to 138 VRMSAC
	88V dc	Range 70 to 320V dc
Maximum dc current for operation	1.5mA	
Maximum peak ac current for operation	1.5mA	
Pick Up Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)	
Drop Off Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)	

For AC operation the BI pick-up delay should be set to 0ms and the drop-off delay to 20ms.

Binary Outputs

Number	8 (3 change over contacts)
Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed.
Operating Time from Energizing Binary Input	<20ms
Making Capacity: Carry continuously Make and carry (L/R ≤ 40 ms and V ≤ 300 V)	 5A ac or dc 20A ac or dc for 0.5s 30A ac or dc for 0.2s
Breaking Capacity (≤ 5 A and ≤ 300 V): AC Resistive AC Inductive DC Resistive DC Inductive	 1250 VA 250 VA at p.f. ≤ 0.4 75 W 30 W at L/R ≤ 40ms 50 W at L/R ≤ 10ms

Unit Design

Housing	E4 or E6 (see dimension drawing)
Indication	20 Character 4 line Display Relay Healthy LED 9 Tri Coloured User Programmable Self or Hand Reset LED's
With-drawable Element	Yes
User Interface	5 Navigation Keys
Weight	Typical 2.7kg E4 case, 3.65 kg E6 case. Additional Transport packaging: add 0.4kg
IP Rating installed with cover	IP 51 from front
IP Rating installed without cover	IP 20 from front

Data Communication Interface

Communication Port	Front USB Type B Rear RS485 2 wire electrical IEC61850 optional ports: 2x Electrical RJ45 Ethernet 2x LC Fibre Optic Ethernet
Protocols	IEC60870-5-103 MODBUS RTU (Serial) DNP3.0 O (Serial) IEC61850 - optional
Fibre Optic Ethernet Data Communication Interface (IEC 61850 Option)	

EN100 Fibre Optic Data Communication Interface (IEC 61850 Option)

Physical	layer Fibre-optic
Connectors	Duplex LC 100BaseF in acc. With IEEE802.3
Recommended fibre	62.5/125 µm glass fibre with Duplex-LC connector
Transmission Speed	100 MBits/s
Optical Wavelength	1300 nm
Bridgeable distance	2 km

EN100 Electrical Ethernet Data Communication Interface (IEC 61850 Option)

Physical	Electrical
Connectors	RJ45 100BaseT in acc. With IEEE802.3
Transmission Speed	100 MBits/s
Test Voltage (with regard to socket)	500 VAC 50 Hz
Bridgeable distance	20m

Data Storage

Fault Record	10
Waveform Record	10 x 1sec 2 x 5sec 5 x 2sec 1 x 10sec Pre trigger 10...90%
Events	1000 1ms Resolution

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration response	1.0 gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %
Shock withstand	15 gn, 11 ms	≤ 5 %
Bump test	10 gn, 16 ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	X-plane - 3.5mm displacement below crossover freq (8-9Hz) 1gn and above Y-plane – 1.5mm displacement below crossover freq (8-9Hz) 0.5gn above	≤ 5 %

Mechanical Classification

Durability	$>10^6$ operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	2.0 kV AC RMS for 1 min
Across normally open contacts	1.0 kV AC RMS for 1 min

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Common (longitudinal) mode	2.5 kV	≤ 5 %
Series (transverse) mode	1.0 kV	≤ 5 %

Electrostatic Discharge
IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

Fast Transients
IEC 60255-22-4 Class A (2002)

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4kV	≤ 5 %

Surge Immunity
IEC 60255-22-5

Type	Level	Variation
Analog Inputs: Line to Earth	4.0 kV	≤ 10%
Case, Aux Power & I/O: Line to Earth	2.0 kV	≤ 10%
RS485 Comms port: Line to Earth	1.0 kV	No Data Loss
Analog Inputs: Line to Line	1.0 kV	≤ 10%
Case, Aux Power & I/O: Line to Line	1.0 kV *	≤ 10%

* Note 50ms DTL pick-up delay applied to binary inputs

Conducted Radio Frequency Interference
IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5 %

Radiated Radio Frequency
IEC 60255-25

Type	Limits at 10 m, Quasi-peak
30 to 230 MHz	40 dB(µV)
230 to 10000 MHz	47 dB(µV)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(µV)	66 dB(µV)
0.5 to 30 MHz	73 dB(µV)	60 dB(µV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level
80 MHz to 1000 MHz Sweep	10 V/m
1.4GHz to 2.7GHz Sweep	10V/m
80,160,380,450,900,1850,2150 MHz Spot	10V/m

Environmental Tests

Temperature
IEC 60068-2-1/2

Operating Range	-10°C to +55°C
Storage range	-25°C to +70°C

Humidity
IEC 60068-2-78

Operational test	56 days at 40°C and 93% relative humidity

Cyclic Temperature and Humidity
IEC 60068-2-30

Operational test	25 °C to 55 °C (outdoor equipment) and 97/93 % relative humidity. 6 x 24h (12h+12h) cycles.

IP Ratings
IEC 60529

Type	Level
Installed with cover	IP 51 from front of relay
Installed with cover removed	IP 20 from front of relay

Performance

27/59 Under/Over Voltage

Number of Elements	4 Under or Over
Operate	Any phase or All phases
Under-Voltage Guard	1,1.5…200V
Setting Range Vs	5,5.5…200V
Hysteresis Setting	0.0.1…80%
Vs Operate Level	100% Vs, ±1% or ±0.25V
Reset Level:	
Overvoltage	= (100% - hyst) x Vop, ±1%
Undervoltage	= (100% + hyst) x Vop, ±1%
Delay Setting td	0.00,0.01…20,20.5…100,101…1000,1010…10000,10100…14400s
Basic Operate Time :	
0 to 1.1xVs	73ms ±10ms
0 to 2.0xVs	63ms ±10ms
1.1 to 0.5xVs	58ms ±10ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input Voltage Guard

47 Negative Phase Sequence Voltage

Number of Elements	2
Under-Voltage Guard	1,1.5…200V
Setting Range Vs	1,1.5…90V
Hysteresis Setting	0.0.1…80%
Operate Level	100% Vs, ±2% or ±0.5V
Reset Level	(100% - hyst) x Vop, ±1% or ± 0.25V
Delay Setting td	0.00,0.01…20,20.5…100,101…1000,1010…10000,10100…14400s
Basic Operate Time :	
0 to 2.0 x Vs	80ms ±20ms
0 to 10 x Vs	70ms ±20ms
Operate time following delay.	Tbasic + td , ±2% or ±20ms
Inhibited by	Binary or Virtual Input Voltage Guard

74T/CC Trip/Close Circuit Supervision

Number of supervisable circuits	3 x Trip and 3 x Close
Number of BI's Required	1 or 2 per function

78 Vector Shift

Number of Elements	2
Under-Voltage Guard	1,1.5…200V
Setting Range VS_s	2.0, 2.5 … 30 °
Operate Level	100% VS_s, ± 2°
Operate Time	≤ 40ms

81 Under/Over Frequency

Number of Elements	6 Under or Over
Under Voltage Guard	35,35.5…200V
Setting Range	43,43.01…68Hz
Hysteresis Setting	0, 0.1… 2%
Operate Level	100% Fs ±10mHz
Operate Time	Maximum <150ms
Operate Delay	0…14400s

81R Rate of Change of Frequency (df/dt)

Number of Elements	6
Under Voltage Guard	35,35.5…200V
Setting Range *Rs*	0.050, 0.075 …10.0 Hz/s
Operate Level	*Rs* ± 50mHz/s (F.nom ± 3Hz)
Operate Time	
for ROCOF 1.3x setting	≤ 300ms
for ROCOF 2x setting	≤ 200ms
Operate Delay	0…200s

59N Neutral Voltage Displacement

Number of Elements	DT & IT
DT Setting Range Is	1…100V
DT Operate Level	100% Vs, ±2% or ±0.5V
DT Delay Setting td	0 …14400s
DT Basic Operate Time	
0V to 1.5 x Vs	76ms ±20ms
0V to 10 x Vs	63ms ±20ms
DT Operate time following delay.	Tbasic +td , ±1% or ±20ms
IT Char Setting	IDMTL & DTL
IT Setting Range	1…100V
Tm Time Multiplier(IDMT)	0.1…140
Delay (DTL)	0…20s
Reset	ANSI Decaying, 0…60s
Char Operate Level	100% Vs, ±2% or ±0.5V
Inhibited by	Binary or Virtual Input

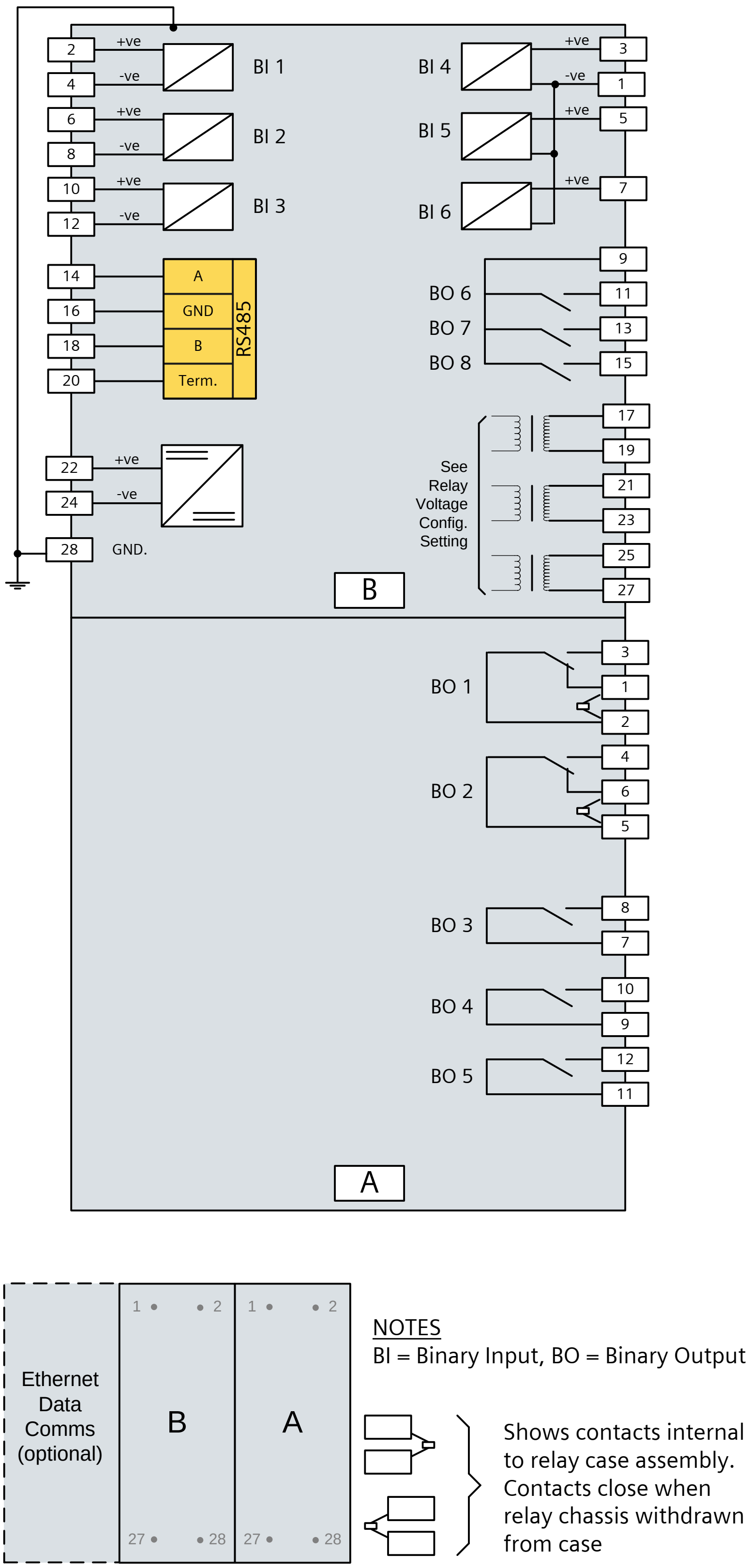
Control Functions

CB	Open/Close

CB Maintenance

Trip Counter	Total & Delta 0...10000
Counts to AR Block	0...10000
Frequent Operations	0...10000
I^2t Alarm	10...100000

7SR158 Connection Diagram



NOTES

BI = Binary Input, BO = Binary Output

Shows contacts internal to relay case assembly. Contacts close when relay chassis withdrawn from case

Fig.8 - 7SR158 Connection Diagram

Ordering Information – 7SR158

Product description	Variants	Order No.
Voltage/frequency relay		**7 S R 1 5 8 7 - 5 □ A □ □ - □ □ A 0**
	Protect Product Family	
	Voltage	**5**
	Relay Type	
	Voltage & Frequency	**8**
	Case, I/O and Fascia	
	E4 case, 3 VT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs	**7**
	Measuring input	
	40 to 160 V, 50/60Hz	**5**
	Auxiliary voltage	
	80 to 250 V DC / 115 V AC, binary input threshold 19 V DC	**G**
	80 to 250 V DC binary input threshold 88 V DC	**H**
	24 to 60 V DC, binary input threshold 19 V DC	**J**
	Spare	**A**
	Communication Interface	
	Standard version – included in all models, USB front port, RS485 rear port (E6 Case) 1)	**1 2**
	Standard version - plus additional rear electrical Ethernet RJ45 (x2) (E6 Case) 1)	**7 7**
	Standard version - plus additional rear optical Ethernet duplex (x2) (E6 Case) 1)	**8 7**
	Protocol	
	IEC 60870-5-103, Modbus RTU and DNP3(user selectable setting)	**2**
	IEC 60870-5-103, Modbus RTU, DNP3 and IEC 61850. (user selectable settings)	**7**
	Front Cover	
	Standard Version – No Push Buttons	**1**
	Push Buttons – Down and right Arrows	**2**
	Protection Function Packages	
	For future development	**A**
	For future development	**B**
	Standard Version	**C**
	27/59 Under/overvoltage	
	47 Negative phase sequence voltage	
	59N Neutral voltage displacement	
	74T&C Trip & Close circuit supervision	
	81 Under/overfrequency	
	Standard version – plus	**D**
	78 Voltage Vector Shift	
	81R Rate of Change of Frequency	
	Additional Functionality	
	No additional functionality	**A**
	Spare	**0**

1) E4 case is standard, E6 case is required if IEC61850 option fitted

1.1.2.4 7SR191 Capacitor Protection Relay

Description

The 7SR191 Capa devices are numeric protection relays designed for application on shunt connected distribution capacitor banks arranged in all common connection configurations, typically single star, double star, delta or in an H configuration. These relays provide all protection functions required in a single device. Relay versions which can be connected to primary voltage transformers provide additional voltage protection functions and metering.
The 7SR191 relays are developed from the proven 7SR11 & 7SR12 Argus family of products providing a familiar product using the latest generation of hardware technology.
Housed in a 4U high, size E4 or E6 (Optional IEC61850 model) case, these relays provide protection, monitoring, instrumentation and metering with integrated input and output logic, data logging & fault reports. Communication access to the relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection & optional IEC61850 communication through two rear Ethernet ports (Electrical or Optical).

Function Overview

Protection

37	Undercurrent/Loss of Supply
46MDT	Phase Unbalance
46	Negative Phase Sequence Overcurrent
49	Thermal Overload
50	Instantaneous Overcurrent
50N	Instantaneous Earth Fault
50BF	Circuit Breaker Fail
51	Time Delayed Overcurrent
51N	Time Delayed Derived Earth Fault
59C	Overvoltage by Current Integration
60C	Capacitor Unbalance Current
87REF	High Impedance REF
27/59	Under/Over Voltage
47	Negative Phase Sequence Voltage
59IT	Inverse Time Overvoltage
59N	Neutral Voltage Displacement
67/50	Directional Instantaneous Overcurrent
67/50N	Directional Instantaneous Earth Fault
67/51	Directional Time Delayed Overcurrent
67/51N	Directional Time Delayed Earth Fault
83	Under/Over Frequency

Supervision

60CTS	CT Supervision
74T/CCS	Trip & Close Circuit Supervision
60VTS	VT Supervision

Control

CB Control
Reswitch Blocking

Features

Cold Load Settings
Four Settings Groups
Password Protection – 2 levels
User Programmable Logic
User specified voltage, current & thermal protection curves
Self Monitoring
Circuit Breaker Trip and Maintenance Counter
Trip Timers

User Interface

20 Character x 4 Line Backlit LCD
Menu Navigation Keys
9 User Programmable Tri-colour LEDs
User Language Configuration

Monitoring Functions

Primary/Secondary Current Phases and Earth Direction
Primary/Secondary Line and Phase Voltages
Capacitor Overvoltage
Capacitor Unbalance Current
Apparent Power and Power Factor
Real and Reactive Power
Import and Export, Real and Reactive Energy
Historical Demand Record
Positive Phase Sequence (PPS) Voltage & Current
Negative Phase Sequence (NPS) Voltage & Current
Zero Phase Sequence (ZPS) Voltage
Frequency
Harmonic currents up to 15th and Total Harmonic Distortion
Binary Input/Output status
Trip circuit healthy/failure
Time and date
Starters
Fault records
Event records
Circuit breaker trip counters
I^2t summation for contact wear

Hardware

4 CT 3 Binary Inputs 5 Binary Outputs
4 CT 6 Binary Inputs 8 Binary Outputs
4 CT 3 VT 3 Binary Inputs 5 Binary Outputs
4 CT 3 VT 6 Binary Inputs 8 Binary Outputs

Application

The 7SR191 Capa is a numerical protection relay intended for use on shunt connected distribution capacitor banks. It provides a highly comprehensive functional software package with a range of integral application functions aimed at reducing installation, wiring and engineering time.
An extensive range of metered values can be viewed on the front LCD or at a remote point via the communication channel.
The integrated control feature allows local and remote operation of a single circuit breaker and monitoring of its trip and close circuits. Loss of supply to the capacitor is detected and can be used to disconnect from the network. Automatic blocking of subsequent reconnection until the capacitor has safely discharged is also provided.
Distribution capacitor banks are constructed from a large number of individual capacitor units. These units will periodically fail due to the electrical stress applied during normal service. Failure of a single unit is acceptable as the resulting short circuit will be cleared by either operation of fuses, in internally or externally fused arrangements, or simply be coped with by design in unfused and fuseless arrangements. However, the failure of one unit will impose increased stress on remaining units increasing the probability that these units will fail. This will further increase stresses and if not disconnected, could eventually lead to cascading failure of the whole bank. The bank is often split into similar sections, arranged such that the balanced nature can be used as a basis for early failure detection. Current transformers are typically fitted at suitable locations to allow unbalance current to be measured by protection devices.
In addition to this, measurement of the total bank current is measured to detect unbalance between phases caused by capacitor unit failure as well as overload protection and for detection of insulation failure faults such as phase to phase and phase to earth flashover.
The 7SR191 provides user configuration settings for operating mode to allow the current inputs to be allocated to the protection functions to cater for all common bank arrangements with a single ordering code. When set in 3 Pole Overcurrent + 1 Pole Unbalance mode, the four current inputs are allocated as three phase current inputs plus one unbalance input. In 1 Pole Overcurrent + 3 Pole Unbalance mode, the four inputs are allocated instead to provide three phase segregated inputs plus a single phase reference input.

Function Matrix

FUNCTIONAL REQUIREMENT	7SR1912/7SR1913 3P OC +1P UB mode *	7SR1912/7SR1913 1P OC +3P UB mode *	7SR1915/7SR1916 3P OC +1P UB mode *	7SR1915/7SR1916 1P OC +3P UB mode *
59C Overvoltage by current integration	■	■	■	■
60C Capacitor Unbalance	■	■	■	■
37 Undercurrent, Loss of Supply	■	■	■	■
Reswitch Blocking	■	■	■	■
46MDT Phase Unbalance	■		■	
46 Negative Phase Sequence Overcurrent	■		■	
47 Negative Phase Sequence Voltage			■	■
49 Thermal Overload	■	■	■	■
50 Instantaneous Overcurrent	■		■	
50N Derived Instantaneous Earth Fault	■		■	
50BF CB Failure	■	■	■	■
51 Time Delayed Overcurrent	■		■	
51N Derived Time Delayed Earth Fault	■		■	
27 Undervoltage			■	■
59 Overvoltage			■	■
59N Neutral Voltage Displacement			■	■
87REF High Impedance Restricted Earth Fault	■		■	
67 Directional Overcurrent			■	
67N Directional Derived Earth Fault			■	
81 Under/Over Frequency			■	■
CONTROL / MONITOR				
51c Cold Load	■	■	■	■
60CTS CT Supervision	■		■	■
60VTS VT Supervision			■	■
50BF Circuit breaker Fail	■	■	■	■

Key - ■ - Included as standard
* - Mode is selectable by user setting

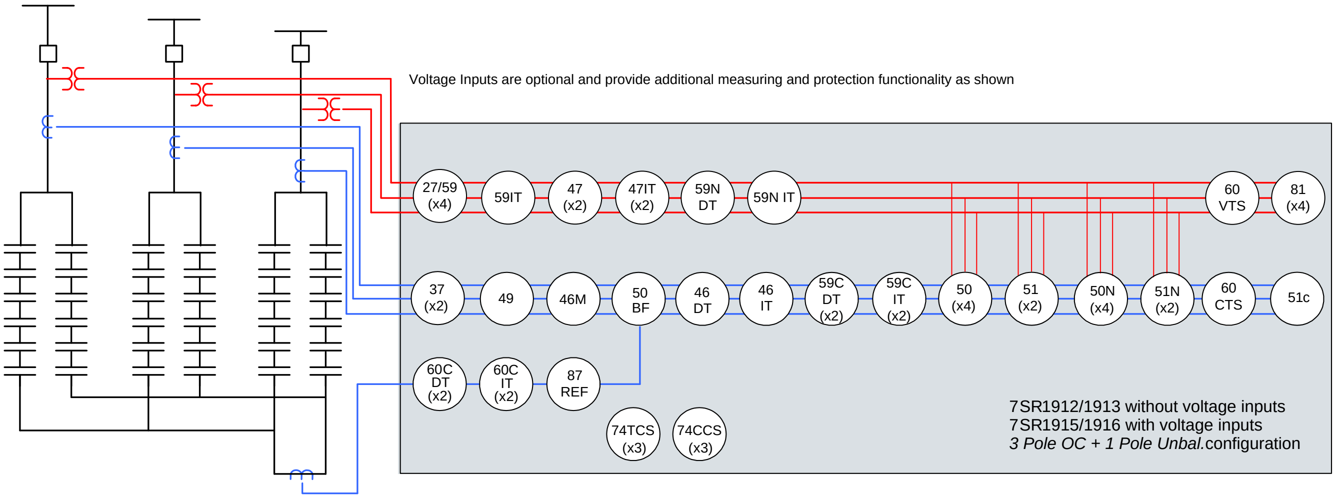


Fig1. Typical Unearthed Double Star (DY)

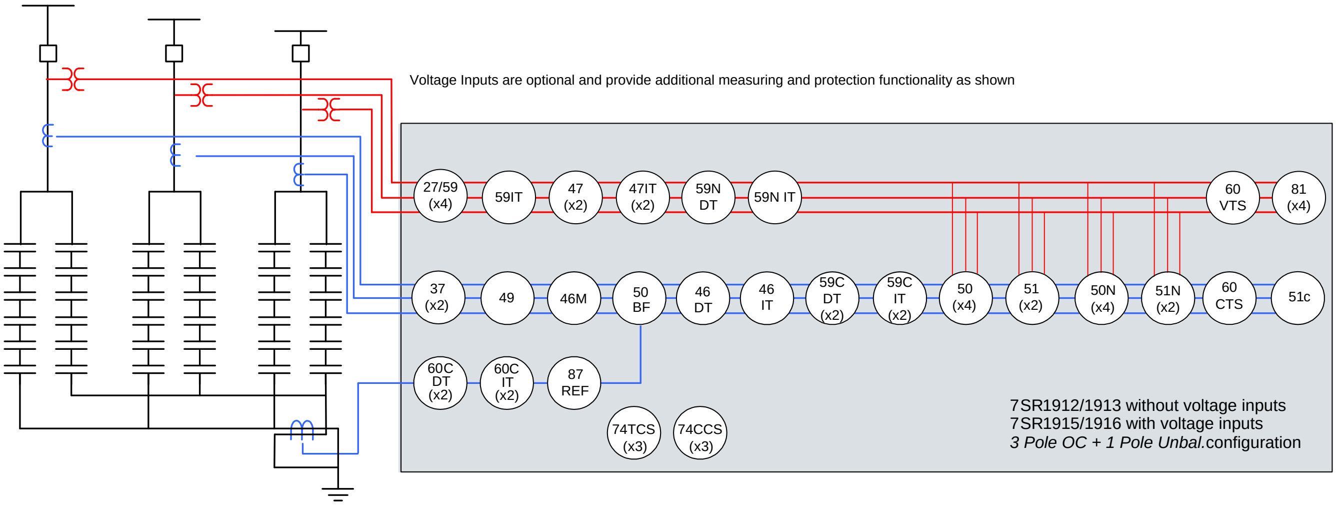


Fig2. Typical Earthed Double Star (DY)

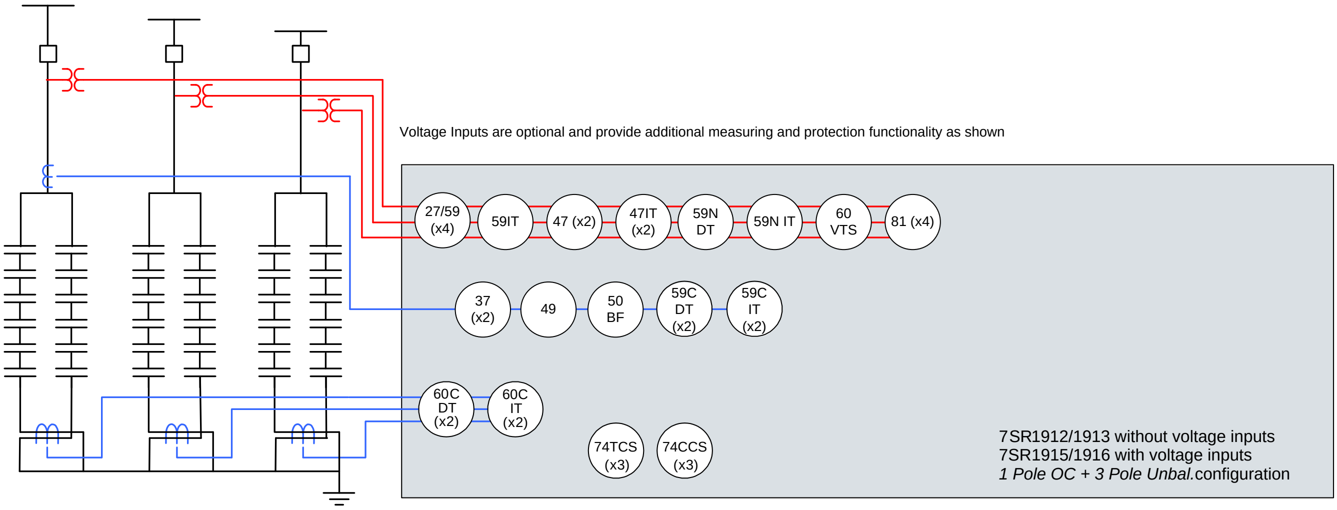
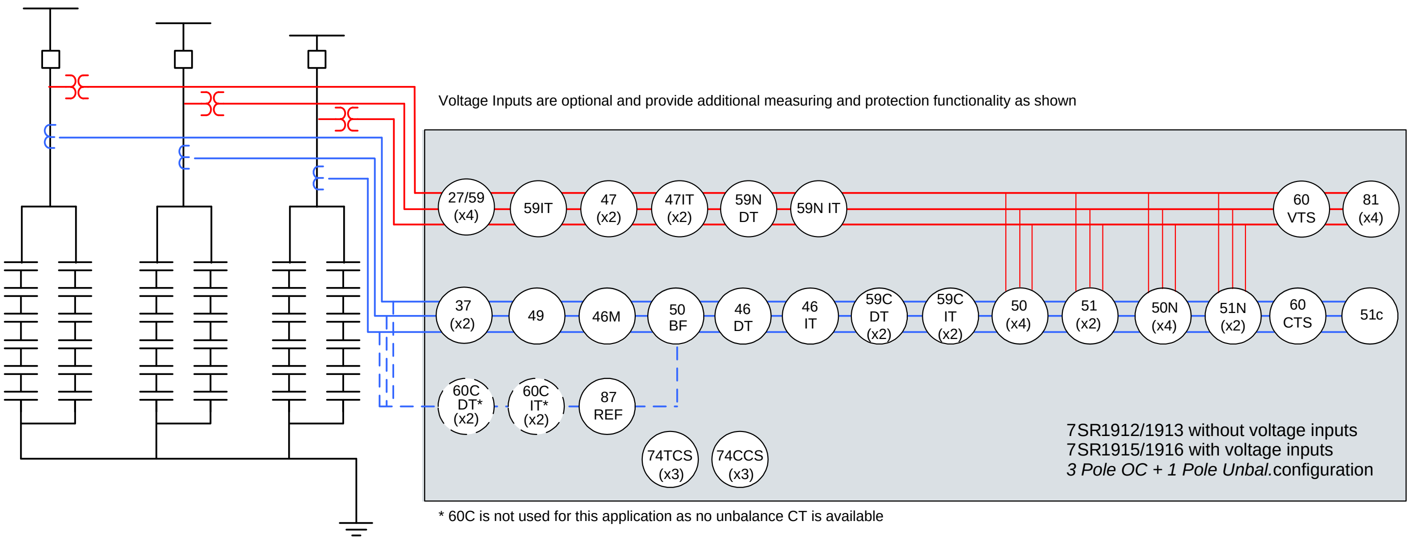


Fig3. Typical Earthed Double Star (DY) with segregated unbalance

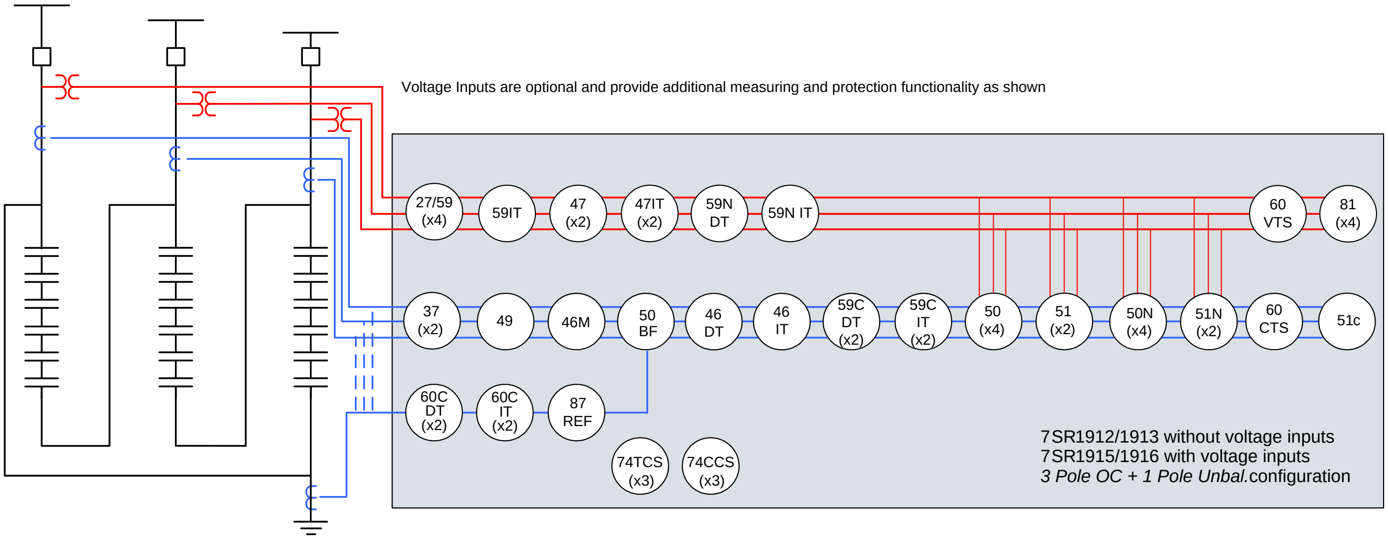


Voltage Inputs are optional and provide additional measuring and protection functionality as shown

7SR1912/1913 without voltage inputs
7SR1915/1916 with voltage inputs
*3 Pole OC + 1 Pole Unbal.*configuration

* 60C is not used for this application as no unbalance CT is available

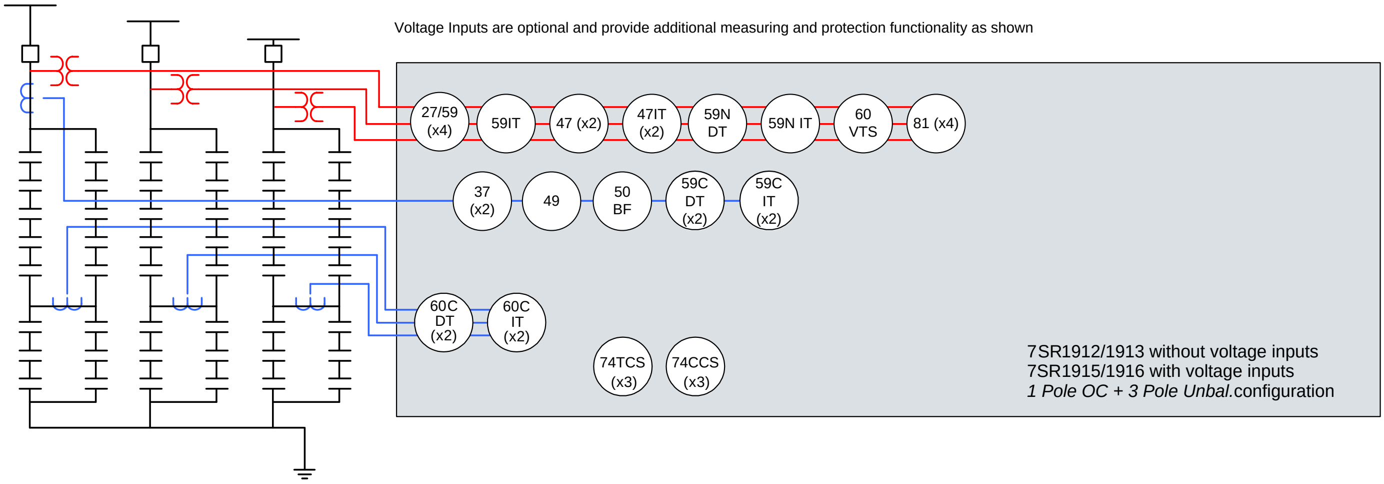
Fig4. Typical Single Star



Voltage Inputs are optional and provide additional measuring and protection functionality as shown

7SR1912/1913 without voltage inputs
7SR1915/1916 with voltage inputs
*3 Pole OC + 1 Pole Unbal.*configuration

Fig5. Typical Delta



Voltage Inputs are optional and provide additional measuring and protection functionality as shown

7SR1912/1913 without voltage inputs
7SR1915/1916 with voltage inputs
*1 Pole OC + 3 Pole Unbal.*configuration

Fig6. Typical H Bridge (Split H)

7SR1912/3 Functional Diagrams

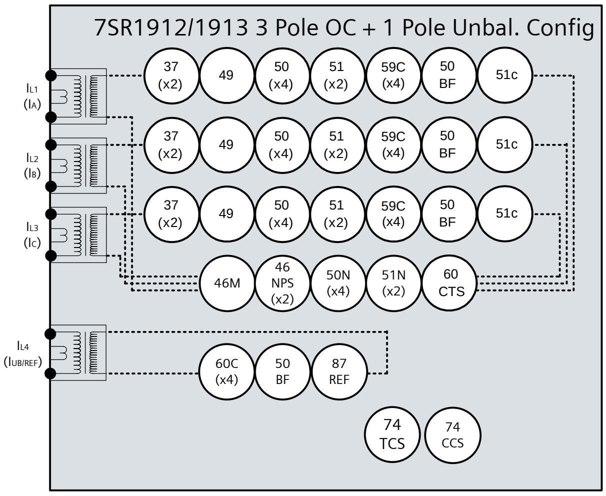


Fig7. 7SR1912/1913 3 Pole OC + 1 Pole Unbal. Configuration

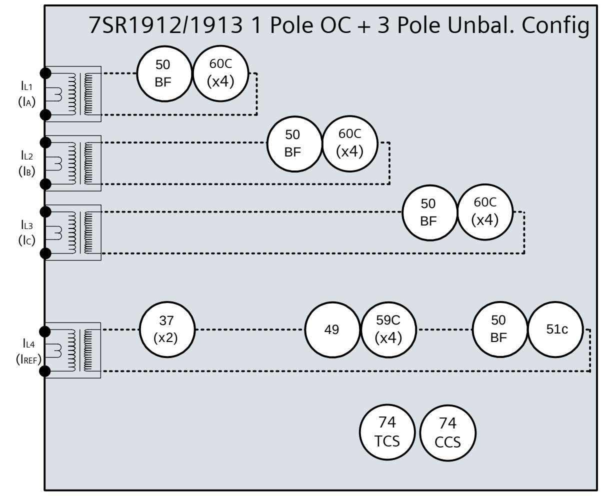


Fig8. 7SR1912/1913 1 Pole OC + 3 Pole Unbal. Configuration

7SR1915/6 Functional Diagrams

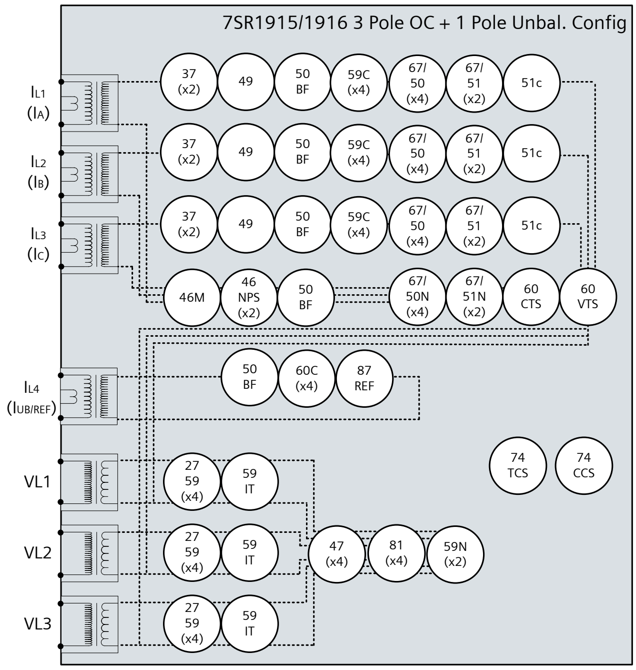


Fig9. 7SR1915/1916 3 Pole OC + 1 Pole Unbal. Configuration

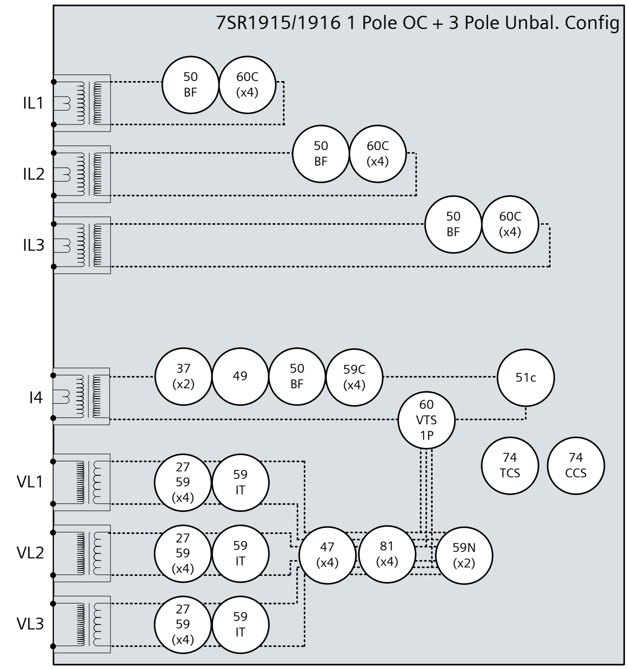


Fig10. 7SR1915/1916 1 Pole OC + 3 Pole Unbal. Configuration

Notes

1. The use of some functions are mutually exclusive. e.g. 60C/87REF
2. Some functions are dependent on the operating mode selection.

Description of Functionality

27/59 Under/Over Voltage

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if voltage exceeds setting for duration of delay.

37 Loss of Supply/Undercurrent

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates if current falls below setting for duration of delay.

Re-switch Blocking

If the capacitor is disconnected or otherwise de-energised, automatic blocking of re-energisation can be applied utilising a user selectable timer to allow the capacitor voltage to discharge before re-energisation. Detection of de-energisation can be selected from current level or CB status signals or combinations of both.

46M Phase Unbalance

The element has settings for pickup level and DTL delay. The difference in magnitude of the highest and lowest phase current is compared to the average phase current. This can be used to detect that a number of capacitor units have failed in such a pattern that measured unbalance spill current is negligible.

46NPS Negative Phase Sequence Overcurrent

Each element has user settings for pickup level and IDMTL or DTL delay, operates if NPS current exceeds setting and delay. NPS current elements can be used to detect that a number of capacitor units have failed in such a pattern that measured unbalance spill current is negligible.

47 Negative Phase Sequence Voltage

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates if NPS voltage exceeds setting for duration of delay.

49 Thermal Overload

The thermal algorithm continuously calculates the present thermal state of the capacitor bank from the measured currents and the previous thermal state thus including long term overload conditions. Alarm outputs are given for thermal overload and thermal capacity.

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. Line currents and earth currents are monitored following a trip signal and an output is issued if any current is still detected, above setting, after a specified time interval. Alternatively, if the trip is from an external protection the circuit breaker position can be used to determine a failure. A second time delay is available to enable another stage to be utilized if required. An input is also available to bypass the time delays when the circuit breaker is known to be faulty.

51c Cold Load Pickup

When a capacitor bank is initially energized the connected system may create transient effects which could appear as operating currents at the relay. These conditions can exist for an extended period and must not be interpreted as a fault. To allow optimum setting levels to be applied for normal operation, the cold load pickup feature will apply alternative current settings or protection element inhibits for a limited period. The feature resets when either the circuit breaker has been closed for a settable period, or if the current has reduced beneath a set level for a user set period.

50/51 Phase Fault

50 INST/DTL and 51 IDMTL/DTL elements provide 3 phase overcurrent protection in 3P OC + 1P UB mode, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI time current characteristics. The IDMT stage has a user programmable reset characteristic, either DTL or shaped current ~ time reset characteristic, to improve grading with electromechanical protection.

50N/51N Earth Fault

The earth fault current is internally derived from the 3 phase CT inputs in normal operating mode. 50N INST/DTL and 51N IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI time current characteristics. The IDMT stage has a user programmable reset characteristic either DTL or shaped current ~ time reset characteristic to improve grading with electromechanical protection.

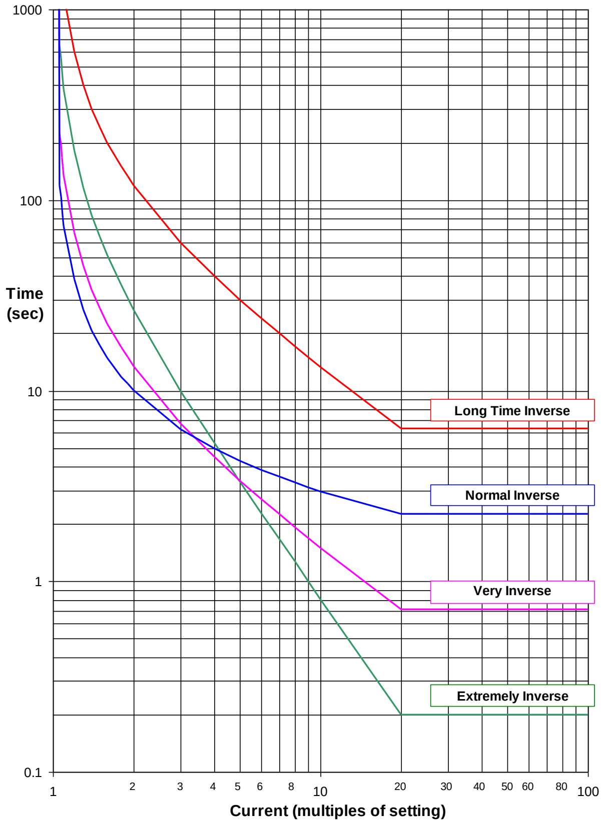


Fig 11. IEC Overcurrent Curves

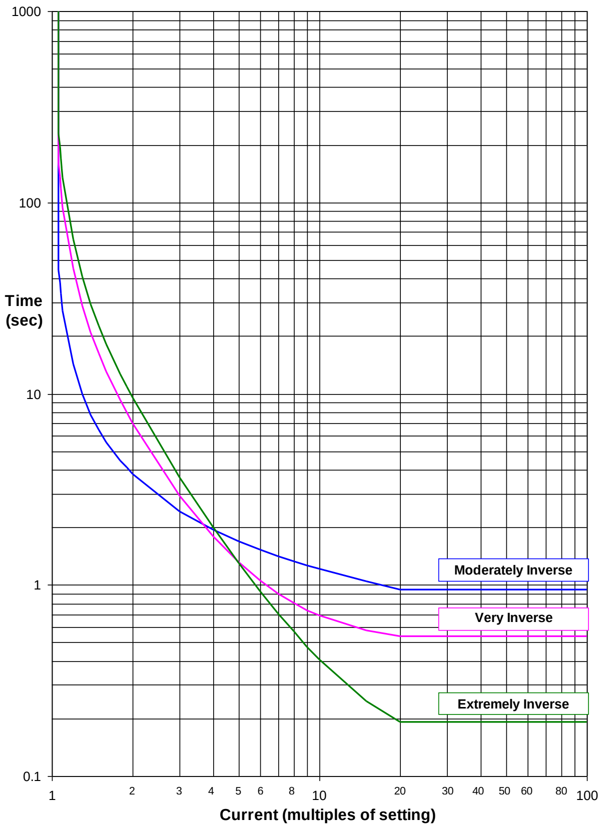


Fig 12. ANSI Overcurrent Curves

59C Overvoltage

The effective applied voltage is calculated from the measured capacitor current by numeric integration techniques such that all harmonic frequency components of the current are correctly incorporated.
The capacitor units are rated to withstand 110% of rated voltage continuously. IEC and ANSI standards specify withstand times for higher voltage levels. These requirements are used to construct an overvoltage withstand curve. Time Multiplier set to default setting = 0.9 is recommended to provide safety margin.

i> (vc>)	Standard duration (s)	
1.1	infinite	
1.15	1,800	IEC 871-1
1.20	300	IEC 871-1
1.30	60	ANSI 18-1980, IEC 871-1
1.40	15	ANSI 18-1980
1.7	1	ANSI 18-1980
2.00	0.3	ANSI 18-1980
2.20	0.12	ANSI 18-1980

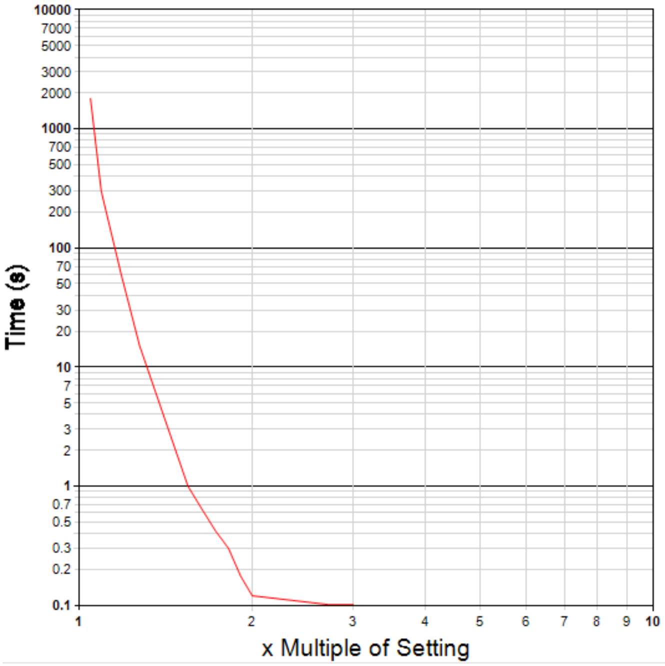


Fig 13. Capacitor Curve (Time Multiplier = 1)

59N Neutral Overvoltage

Neutral overvoltage can be used to detect unbalance in the capacitor bank in ungrounded arrangements.
Operates if the calculated neutral voltage exceeds setting for duration of delay.

60C Capacitor Unbalance

In 3P OC + 1P UB mode, 60C is applied at the 4th current input, typically connected to an unbalance CT. In 1P OC + 3P UB mode, 60C is applied at each of the 3 phase segregated current inputs, typically connected to an unbalance CT. Each element has user settings for pickup level and IDMTL or DTL delay, operates if measured current exceeds setting and delay. The element can be trimmed for phase and magnitude to suit the natural unbalance current and also can be zeroed manually. This calibration is compensated to allows for the switch-off condition

60CTS CT Supervision

The relay has two methods of CT supervision. The 7SR1912/3 monitors each phase current input and operates if any one or two inputs fall below the setting. The 7SR1915/6 has the above method and an addition method that considers the presence of negative phase sequence current, without an equivalent level of negative phase sequence voltage, for a user set time as a CT failure.
This function is not used in 1 Pole OC + 3 Pole UB mode.
Both element types have user operate and delay settings.

60VTS VT Supervision

The VT supervision uses a combination of negative phase sequence voltage and negative phase sequence current to detect a VT fuse failure in 3 Pole OC + 1 Pole UB mode. This condition may be alarmed or used to inhibit voltage dependent functions. Element has user operate and delay settings.
In1 Pole OC + 3 Pole UB mode, a simpler element using current and voltage magnitudes is provided.

87REF Restricted Earth Fault

The measured earth fault input may be used in a 87REF high impedance restricted earth fault scheme to provide sensitive high speed unit protection. A calculation is required to determine the values of the external series stabilising resistor and non-linear shunt resistor which can be ordered separately. This function is used on single-star arrangements where no unbalance CT is available and is connected to the unused 4th current input.

67/67N Directional Control

Phase, earth and sensitive earth fault elements can be directionalised. Each element can be user set to Forward, Reverse, or Non-directional.
Directional Phase Fault elements are polarised from quadrature voltage.
Derived earth fault elements can be user set to be polarised from residual voltage or negative phase sequence voltage.
Measured earth fault elements are polarized from Vo.

74T/CCS Trip & Close Circuit Supervision

The trip or close circuit(s) can be monitored via binary inputs. Trip circuit failure raises an HMI alarm and output(s).

81 Under/Overfrequency

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if frequency exceeds setting for duration of delay.

Programmable Logic

The user can map binary inputs, protection elements, LEDs and binary outputs together in a logical scheme.
Up to 8 logic equations can be defined using standard logic functions e.g. Timers, AND/OR gates, Inverters and Counters to provide the user required functionality.
Each logic equation output can be used for alarm & indication and/or tripping.

Virtual Inputs/Outputs

There are 8 virtual inputs/outputs to provide internal logical states to assist in the application of the functions. Each virtual I/O can be assigned in the same way as a physical I/O.

Circuit Breaker Maintenance

Two circuit breaker operations counters are provided to assist with maintenance scheduling. The maintenance counter records the overall number of operations and the delta counter records the number of operations since the last reset.
An I^2t summation counter provides a measure of the contact wear indicating the total energy interrupted by the circuit breaker contacts.
Each counter has a user set target operations count which, when reached, can be mapped to raise alarms/ binary outputs. A CB Trip Time meter is also available, which measures the time between the trip or open command being issued and the auxiliary contacts changing state.

Control Mode

The relay has a control menu with access to commonly used command operations. Access to the control commands is restricted by a 4 character control function password. Each command requires a select then execute operation, if the execute operation is not performed within a time window the command is aborted. The following control functions are available: CB Operation

CB: TRAVELLING

ENTER to control

Fig14. Example of Control Function View

Construction

The relay is housed in a 4U high size E4 or E6 case with a removable clear plastic fascia cover. The plastic fascia cover can be ordered with or without two push buttons to allow the user to view the settings and instruments without removing the cover.
Two plastic handles are provided to allow the relay to be withdrawn from its case, contacts in the case ensure that the CT circuits and normally closed contacts remain short circuited when the relay is withdrawn.
The rear terminal blocks comprise M4 female terminals for ring crimp wire connections, to provide a secure and reliable termination.

Fig15. Rear view of E4 relay

Fig16. Rear view of relay with 2x LC Fibre Optic ports (E6 Case with IEC61850)

User Interface

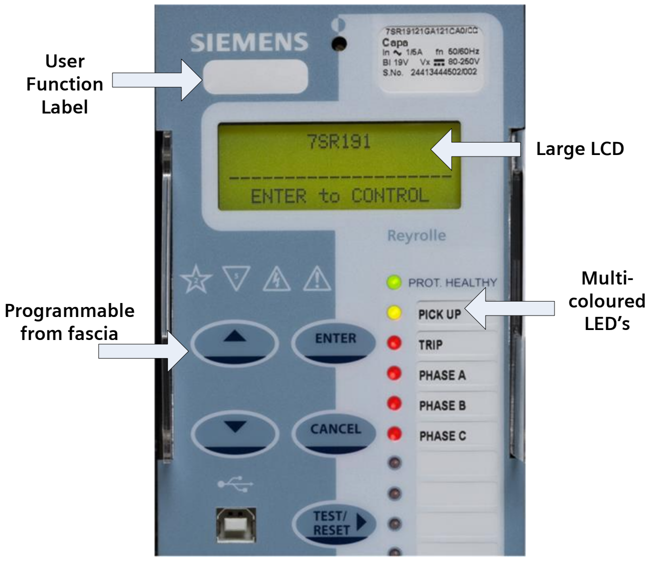


Fig17. User Interface

The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings and retrieving data from the relay. Five buttons are provided for navigation around the menu structure.

LCD

A 4 line by 20 character liquid crystal display with power save operation indicates the relay identifier, settings, instrumentation, fault data and control commands.
Up to 6 user programmable general alarms can be configured to display your own indications on the LCD.

LEDs

A green steadily illuminated LED indicates the 'Protection Healthy' condition.
9 user programmable LEDs are available eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED is tri-colour (red, green, yellow) allowing for clear indication of the associated function's state and has a label insert for identification.

Relay Information

The device is identified by the rating label on the fascia. The user can also give the device its own identity by editing the 'Relay Identifier' displayed on the LCD or space is provided to place a slip in label giving the relays function.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	4
Rated Current In	1/5A
Measuring Range	80 x In
Instrumentation ≥ 0.1xIn	±1% In
Frequency	50/60Hz
Thermal Withstand:	
Continuous	4 x In
1 Second	100A (1A) 350A (5A)
1 Cycle	700A (1A) 2500A (5A)
Burden @ In	≤0.02VA (1A phase and Earth element) ≤0.2VA (5A phase and earth element)

Voltage Inputs (optional)

Quantity	3, ph-ph or ph-n
Nominal	40…160 Vrms
Operating Range	0… 200 Vrms
Instrumentation ≥ 0.8xVn	±1% Vn
Burden @ 110V	≤ 0.06 VA
Overvoltage Withstand	300 Vrms

Auxiliary Supply

Rated DC Voltage	110/125/220/250V Operating range 64 to 300V 24/48/60V Operating range 18 to 72V	
Allowable superimposed ac component	12% of DC voltage	
Rated AC Voltage	115 V rms 50/60Hz Range 92 to 138 V rms AC 50/60Hz ±5%	
Power Consumption:	E4 Min (DC)	3.9W
	E4 Max (DC)	8W
	E4 Min (AC)	9VA 0.5PF
	E4 Max (AC)	16VA 0.5PF
	E6 Min (DC)	6.4W
	E6 Max (DC)	10.5W
	E6 Min (AC)	14.5VA 0.5PF
	E6 Max (AC)	21.5VA 0.5PF
Allowable breaks/dips in supply (collapse to zero)	DC	50ms
	AC	2.5/3 cycles @50/60Hz

Binary Inputs

Number	3 or 6	
Operating Voltage	19V dc	DC Range 17 to 320V dc AC Range 92 to 138 VRMSAC
	88V dc	Range 70 to 320V dc

Maximum dc current for operation	1.5mA
Maximum peak ac current for operation	1.5mA
Pick Up Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)
Drop Off Delay	User Selectable 0 to 14,400,000ms (up to 4 hours)

For AC operation the BI pick-up delay should be set to 0ms and the drop-off delay to 20ms.

Binary Outputs

Number	5 or 8 (3 change over contacts)
Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed.
Operating Time from Energizing Binary Input	<20ms
Making Capacity:	
Carry continuously	5A ac or dc
Make and carry	20A ac or dc for 0.5s
(L/R ≤40 ms and V ≤300 V)	30A ac or dc for 0.2s
Breaking Capacity (≤ 5 A and ≤ 300 V):	
AC Resistive	1250 VA
AC Inductive	250 VA at p.f. ≤ 0.4
DC Resistive	75 W
DC Inductive	30 W at L/R ≤ 40ms 50 W at L/R ≤ 10ms

Unit Design

Housing	E4 or E6 (see dimension drawing)
Indication	20 Character 4 line Display Relay Healthy LED 9 Tri Coloured User Programmable Self or Hand Reset LED's
With-drawable Element	Yes
User Interface	5 Navigation Keys
Weight	Typical 3.2kg E4 case, 4.15 kg E6 case. Additional Transport packaging: add 0.4kg

Data Communication Interface

Communication Port	Front USB Type B Rear RS485 2 wire electrical IEC61850 optional ports: 2x Electrical RJ45 Ethernet 2x LC Fibre Optic Ethernet
Protocols	IEC60870-5-103 MODBUS RTU (Serial) DNP3.0 O (Serial) IEC61850 - optional

Fibre Optic Ethernet Data Communication Interface (IEC 61850 Option)	

EN100 Fibre Optic Data Communication Interface (IEC 61850 Option)

Physical	Fibre-optic
Connectors	Duplex LC 100BaseF in acc. With IEEE802.3
Recommended fibre	62.5/125 µm glass fibre with Duplex-LC connector
Transmission Speed	100 MBits/s
Optical Wavelength	1300 nm
Bridgeable distance	2 km

EN100 Electrical Ethernet Data Communication Interface (IEC 61850 Option)

Physical	Electrical
Connectors	RJ45 100BaseT in acc. With IEEE802.3
Transmission Speed	100 MBits/s
Test Voltage (with regard to socket)	500 VAC 50 Hz
Bridgeable distance	20m

Data Storage

Fault Record	10
Waveform Record	10 x 1sec 2 x 5sec 5 x 2sec 1 x 10sec Pre trigger 10...90%
Events	1000 1ms Resolution

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration response	1.0 gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %
Shock withstand	15 gn, 11 ms	≤ 5 %
Bump test	10 gn, 16 ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	X-plane - 3.5mm displacement	≤ 5 %

	below crossover freq (8-9Hz) 1gn above. Y-plane – 1.5mm displacement below crossover freq (8-9Hz) 0.5gn above.	

Mechanical Classification

Durability	$>10^6$ operations

Electrical Tests

Insulation

IEC 60255-5

Type	Level
Between any terminal and earth	2.5 kV AC RMS for 1 min
Between independent circuits	2.5 kV AC RMS for 1 min
Across normally open contacts	1.0 kV AC RMS for 1 min

High Frequency Disturbance

IEC 60255-22-1 Class III

Type	Level	Variation
Case, Aux Power & I/O. Common mode	2.5kV	≤ 10%
Case, Aux Power & I/O. Transverse mode	1.0kV	≤ 10%
RS485 Comms	1.0kV	No data loss

Electrostatic Discharge

IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

Electrical Fast Transient / Burst Immunity

IEC 60255-22-4 Class A (2002)

Type	Level	Variation
Case, Aux Power & I/O	4kV	≤ 10 %
RS485 Comms	2.0kV	No data loss

Surge Immunity

IEC 60255-22-5; IEC 61000-4-5

Type	Level	Variation
Analog Inputs. Line to Earth	4.0 kV	≤ 10 %
Case, Aux Power & I/O. Line to Earth	2.0 kV	≤ 10 %
RS485 Comms port Line to Earth	1.0 kV	No Data Loss
Analog Inputs. Line to Line	1.0 kV	≤ 10 %
Case, Aux Power & I/O. Line to Line	1.0 kV*	≤ 10 %

*Note 50ms DTL pick up delay applied to binary inputs

Conducted Radio Frequency Interference

IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5 %

Radiated Radio Frequency

IEC 60255-25

Type	Limits at 10 m, Quasi-peak
30 to 230 MHz	40 dB(μV/m)
230 to 10000 MHz	47 dB(μV/m)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(μV)	66 dB(μV/m)
0.5 to 30 MHz	73 dB(μV)	60 dB(μV/m)

Radiated Immunity

IEC 60255-22-3 Class III

Type	Level
80 MHz to 1000 MHz Sweep	10 V/m
1.4GHz to 2.7GHz Sweep	10V/m
80,160,380,450,900,1850, 2150 MHz Spot	10V/m

Magnetic Field with Power Frequency

IEC 61000-4-8, Class V

Type	Level
100A/m (0.126mT) continuous	50Hz
1000A/m (1.26mT) for 3s	

Environmental Tests

Temperature

IEC 60068-2-1/2

Operating Range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity

IEC 60068-2-78

Operational test	56 days at 40 °C and 93 % relative humidity

Cyclic Temperature and Humidity

IEC 60068-2-30

Operational test	25 °C to 55 °C (outdoor equipment) and 97/93 % relative humidity. 6 x 24h (12h+12h) cycles.

IP Ratings

IEC 60529

Type	Level
Installed with cover	IP 51 from front of relay
Installed with cover removed	IP 20 from front of relay

Performance

27/59 Under/Over Voltage

Number of Elements	4 Under or Over
Operate	Any phase or All phases
Voltage Guard	1 to 200V
Setting Range Vs	5 to 200V
Hysteresis Setting	0 to 80%
Vs Operate Level	100% Vs, ±1% or ±0.25V
Reset Level:	

Overvoltage Undervoltage	=(100%-hyst)xVop, ±1% or ±0.25V =(100%+hyst)xVop, ±1% or±0.25V
Delay Setting td	0.00 to 14400s
Basic Operate Time : 0 to 1.1xVs 0 to 2.0xVs 1.1 to 0.5xVs	 73ms ±10ms 63ms ±10ms 58ms ±10ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input VT Supervision, Voltage Guard

37 Undercurrent

Number of Elements	2
Operate	Any phase or ALL
Setting Range Is	0.05 to 5.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Current Guard	0.05 to 5.0 x In
Delay Setting td	0.00 to 14400s
Basic Operate Time: 1.1 to 0.5xIn	 35ms ±10ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input, Guard

46MDT Phase Unbalance

Number of Elements	1
Setting Range Ss	0.01 to 1.0
Operate Level	100% Ss, ±5% for Imean ≥0.1xIn
Delay Setting td	0.00 to 14400s
Basic Operate Time 0.01 to 1	 95ms ±10ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input

46 Negative Phase Sequence Overcurrent

Number of Elements	DT & IT
DT Setting Range Is	0.05,0.10...4.0 x In
DT Operate Level	100% Is, ±5% or ±1%xIn
DT Delay Setting td	0.00 to 14400s
DT Basic Operate Time 0 to 2 xIs 0 to 5 xIs	 40ms ±10ms 30ms ±10ms
DT Operate time following delay.	Tbasic +td , ±1% or ±10ms
IT Char Setting	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL
IT Setting Range	0.05 to 2.5
Tm Time Multiplier	0.025 to 100
Char Operate Level	105% Is, ±4% or ±1%In
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

47 Negative Phase Sequence Overvoltage

Number of Elements	2xDT & 2xIT
Setting Range Vs	1 to 90V
DT Hysteresis Setting	0 to 80%
Operate Level	100% Vs, ±2% or ±0.5V
DT Delay Setting td	0.00 to14400s
Basic Operate Time 0V to 1.5xVs 0V to 10xVs	 80ms ±20ms 55ms ±20ms
DT Operate time following delay.	Tbasic +td , ±2% or ±20ms
IT Char Setting	IDMTL, DTL

IT Tm Time Multiplier	0.025 to 100
IT Char Operate Level	100% Is, ±2% or ±0.5V
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

49 Thermal Overload

Operate levels	Operate and Alarm
Setting Range Is	0.10 to 3.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Time Constant Setting	1 to 1000min
Operate time	$t = \tau \times In\left\{ \frac{I^2 \cdot I_p^2}{I^2 \cdot (k \times I_B)^2} \right\}$ ±5% absolute or ±100ms where Ip = prior current
Alarm Level	Disabled, 50,51...100%
Inhibited by	Binary or Virtual Input

50 (67) Instantaneous & DTL OC&EF (Directional)

Operation 7SR1915/6 only	Non directional, Forward or reverse
Elements	Phase (50)& Derived Earth (50N)
Number of Elements	4 x OC 4 x Derived EF
Operating Current	RMS or Fundamental frequency
Setting Range Is	0.05 to 50 x In
Time Delay	0.00 to 14400s
Operate Level	100% Is, ±5% or ±1%xIn
Operate time: 50 50N	 0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 25ms, ±10ms 0 to 2xIs – 40ms, ±10ms, 0 to 5xIs – 30ms, ±10ms
Operate time following delay	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input VT Supervision

51(67) Time Delayed OC&EF (Directional)

Operation – 7SR1915/6 only	Non directional, Forward or reverse
Elements	Phase & Derived Earth
Number of Elements	2 x OC 2 x Derived EF
Operating Current	RMS or Fundamental frequency
Characteristic	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL
Setting Range Is	0.05 to 2.5 x In
Time Multiplier	0.025 to 100
Time Delay	0,0.01… 20s
Operate Level	105% Is, ±4% or ±1%xIn
Minimum Operate time IEC ANSI	 $t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$ $t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5 % absolute or ± 30 ms
Follower Delay	0 - 20s
Reset	ANSI decaying, 0 – 60s
Inhibited by	Binary or Virtual Input VT Supervision

50BF Circuit Breaker Fail

Operation	Current check - Phase and Measured I4 with independent settings, Mechanical Trip,

	CB Faulty Monitor
Setting Range Is	0.05 to 2.0 x In
2 Stage Time Delays	Timer 1 - 20 to 60000ms Timer 2 - 20 to 60000ms
Operate Level	100% Is, ±5% or ±1%xIn
Disengaging time	< 20ms
Operate time following delay	Tcbf ±1% or ±2ms
Triggered by	Any function mapped as trip contact.
Inhibited by	Binary/Virtual Input
Timer By pass	Yes, 50BF CB Faulty Input

59IT Time Delayed Phase Overvoltage

Number of Elements	1
IT Char Setting	IDMTL, Capacitor & DTL
IT Setting Range	1 to 100V
Tm Time Multiplier(IDMT)	0.1 to 140
Delay (DTL)	0 to 20s
Operate time IDMTL	$t_{op} = \frac{M}{\left[\frac{V}{Vs}\right]-1}$, ± 5 % or ± 65 ms.
Capacitor	See Fig. 13 above, ± 5 % or ± 65 ms.
DTL	t_d, ± 1 % or ± 40ms
Reset	0 to 60s
Char Operate Level	105% Vs, ±2% or ±0.5V
Inhibited by	Binary or Virtual Input

59C Capacitor Overvoltage

Number of Elements	2xDT & 2xIT
Capacitor Rated Current, equivalent to Vcr	0.1 to 5 xIn
Setting Range Is	80 to 150% Vcr
DT Operate Level	100% Vs, ±2% or ±0.5V
DT Delay Setting td	0.00 to 14400s
DT Basic Operate Time	
0 to 2 xVs	50ms ±10ms
0 to 5 xVs	45ms ±10ms
DT Operate time following delay.	Tbasic +td , ±1% or ±20ms
IT Char Setting	Capacitor, IDMTL, DTL
IT Setting Range	80 to 150% Vcr
IT Tm Time Multiplier	0.025 to 1.6
IT Char Operate Level	100% Is, ±2% or ±0.5V
Operate time IDMTL	$t_{op} = \frac{M}{\left[\frac{V}{Vs}\right]-1}$, ± 5 % or ± 65 ms.
Capacitor	See Fig. 13 above, ± 5 % or ± 65 ms.
DTL	t_d, ± 1 % or ± 50ms
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

59N Neutral Voltage Displacement

Number of Elements	DT & IT
DT Setting Range Is	1 to 100V
DT Operate Level	100% Vs, ±2% or ±0.5V
DT Delay Setting td	0 to 14400s
DT Basic Operate Time	
0V to 1.5 x Vs	76ms ±20ms
0V to 10 x Vs	63ms ±20ms
DT Operate time following delay.	Tbasic +td , ±1% or ±20ms
IT Char Setting	IDMTL & DTL
IT Setting Range	1 to 100V
Tm Time Multiplier(IDMT)	0.1 to 140
Delay (DTL)	0 to 20s
Operate time IDMTL	$t_{op} = \frac{M}{\left[\frac{V}{Vs}\right]-1}$, ± 5 % or ± 65 ms.
Reset	IEC/ANSI Decaying, 0 to 60s
Char Operate Level	105% Vs, ±2% or ±0.5V
Inhibited by	Binary or Virtual Input

60C Capacitor Unbalance

Number of Elements	DT & IT
DT Setting Range Is	0.01 to 2.0 x In
DT Operate Level	100% Is, ±5% or ±1%xIn
DT Delay Setting td	0.00 to 14400s
DT Basic Operate Time	
0 to 2 xIs	50ms ±10ms
0 to 5 xIs	40ms ±10ms
DT Operate time following delay.	Tbasic +td , ±1% or ±10ms
IT Char Setting	DTL & User Specified
IT Setting Range	0.01 to 2
Tm Time Multiplier	0.025 to 100
Char Operate Level	105% Is, ±4% or ±1%In
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

60 Supervision

CT	7SR1912/3 Current 7SR1915/6 Current or Vnps & Inps
VT	7SR1915/6 nps/zps

87REF Restricted Earth Fault

Setting Range	0.05 to 0.95 x*In*
Operate Level	100% Is, ±5% or ±1%xIn
Time Delay	0 to 60s
Basic Operate Time	0 to 2 xIs 40ms ±10ms 0 to 5 xIs 30ms ±10ms
Inhibited by	Binary or Virtual Input

74T/CC Trip/Close Circuit Supervision

Number of supervisable circuits	3 x Trip and 3 x Close
Number of BI's Required	1 or 2 per function

81 Under/Over Frequency

Number of Elements	4 Under or Over
Under Voltage Guard	Yes/No
Setting Range Hz	43 to 57Hz (50Hz) 53 to 68Hz (60Hz)
Hysteresis Setting	0 to 2%
Operate Level	100% Fs ±10mHz
Operate Time	Typical <150ms
Vs Operate Delay	0 to 14400s

Reswitch Blocking

Operation	UC, CB position, UC&CB, UC or CB
Blocking time	0 to 60000s
Setting Range Is	0.05 to 5.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Delay Setting td	0.00 to 14400s

Basic Operate Time: 1.1 to 0.5xIn	50ms ±10ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms

CB Maintenance

Trip Counter	Total & Delta 0...10000
I^2t Alarm	10...100000

Control Functions

CB	Open/Close
EF	IN/OUT
Relay Mode	Local/Remote/Local or Remote
Reset	LED’s & O/P’s

7SR1912/1913 Connection Diagram

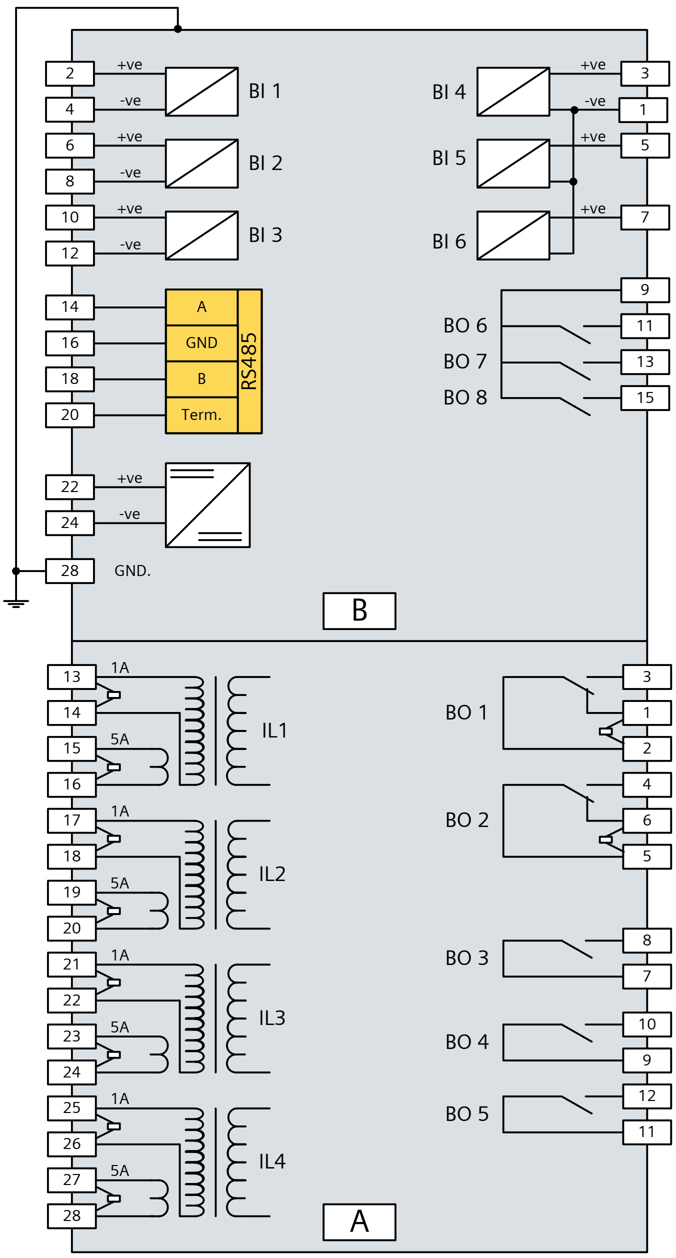
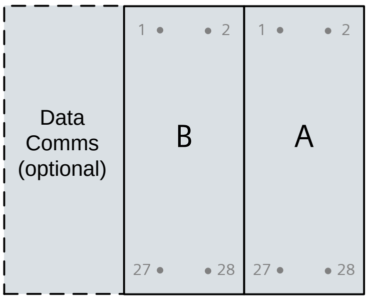


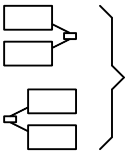
Fig18. Diagram showing 7SR1913 relay with 4 CT inputs, 6 binary inputs and 8 binary outputs.



Rear View
Arrangement of terminals and modules

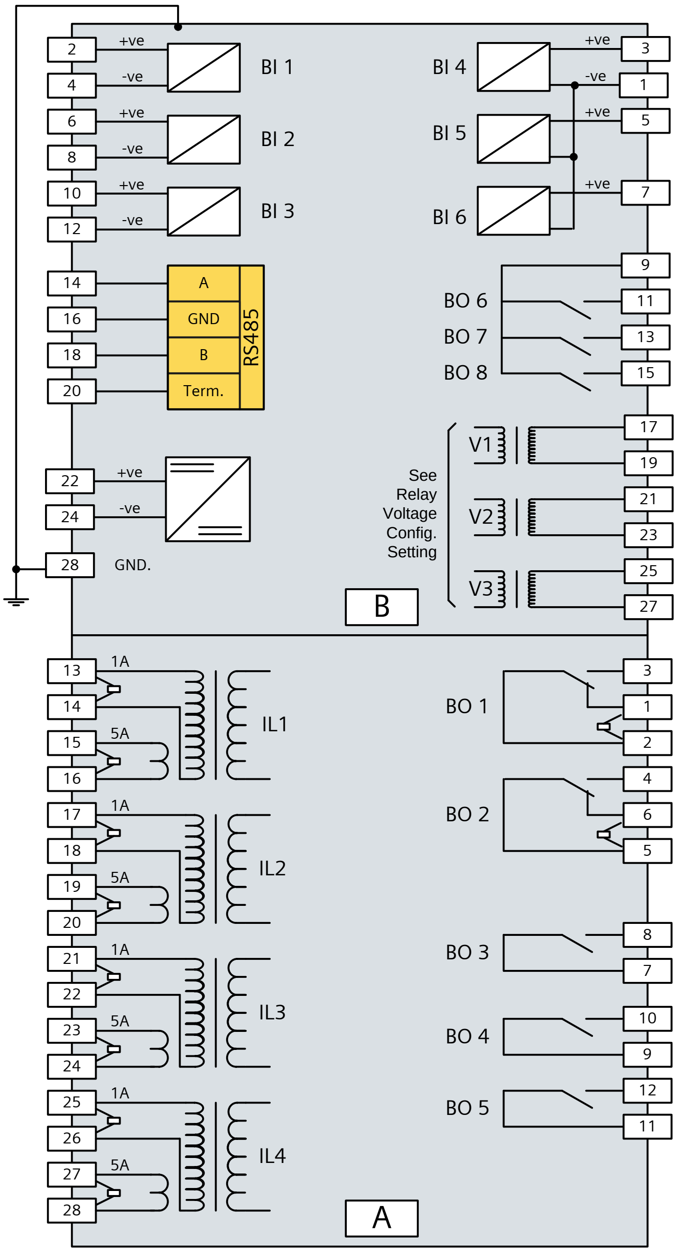
NOTES

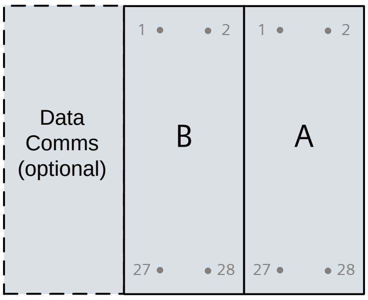
BI =	Binary Input
BO =	Binary Output



Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

7SR1915/1916 Connection Diagram

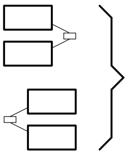




Rear View
Arrangement of terminals and modules

NOTES

BI = Binary Input
BO = Binary Output



Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig19. Diagram showing 7SR1916 relay with 4 CT inputs, 3 VT inputs, 6 binary inputs and 8 binary outputs.

Ordering Information – 7SR191 Capa Capacitor Bank Protection

Product description	Variants		Order No.
Capacitor Protection			7 S R 1 9 1 ☐ - 1 ☐ A ☐ ☐ - ☐ C A 0
Capacitor Bank protection relay	Protection Product		
	Miscellaneous Protection		9
	Capacitor Protection		1
	Case I/O and Fascia		
	4 CT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs		2
	4 CT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs		3
	4 CT, 3VT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs		5
	4 CT, 3VT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs		6
	Measuring Input		
	1/5 A, 50/60Hz1), 40-160V2)		1
	Auxiliary voltage		
	80 to 250V DC / 115V AC, binary input threshold 19V DC		G
	80 to 250V DC, binary input threshold 88V DC		H
	24 to 60V DC, binary input threshold 19V DC		J
	Communication Interface		
	Standard version – included in all models, USB front port, RS485 rear port (E4 case) 3)		1 2
	Standard version - plus additional rear electrical Ethernet RJ45 (x2) (E6 Case) 3)		7 7
	Standard version - plus additional rear optical Ethernet duplex (x2) (E6 Case) 3)		8 7
	Protocol		
	IEC 60870-5-103, Modbus RTU and DNP3 (user selectable)		2
	IEC 60870-5-103, Modbus RTU, DNP3 and IEC 61850. (user selectable settings)		7
	Relay Cover		
	Standard Version – No Push Buttons		1
	Push Buttons – Down and Right Arrows		2
	Protection Function Packages		
	Standard version		C
	37	Undercurrent	
	46M	Phase unbalance	
	46	Negative phase sequence overcurrent	
	49	Thermal overload	
	50	Instantaneous phase fault overcurrent	
	50BF	Circuit breaker fail	
	50N	Instantaneous earth fault	
	51	Time delayed phase fault overcurrent	
	51c	Cold load pickup	
	51N	Time delayed earth fault	
	59C	Overvoltage by current integration	
	60C	Unbalance Overcurrent	
	60CTS	CT supervision	
	87REF	High Impedance REF	
	74T/CCS	Trip & Close circuit supervision	
	Re-energisation Blocking		
	Programmable Logic		
	For variants with 3 x VT inputs, as above plus:		
	27/59	Under/overvoltage	
	47	Negative phase sequence voltage	
	59N	Neutral voltage displacement	
	60VTS	VT Supervision	
	67/50	Directional instantaneous phase fault overcurrent	
	67/50N	Directional instantaneous earth fault	
	67/51	Directional time delayed phase fault overcurrent	
	67/51N	Directional time delayed earth fault	
	81U/0	Under/Over Frequency	
	Additional Functionality		
	No Additional Functionality		A

---

1) 4CT is configured by user setting as: 3PF + 1 Unbalance OR 1PF +3 Unbalance

2) Voltage rating applies to models with optional VT inputs only.

3) E4 case is standard, E6 case is required if IEC61850 option fitted

1.1.2.5 7SR17 Motor Protection Relay

Fig 1. 7SR17 Rho Fascia

Description

The 7SR17 motor protection relay range utilises service and design experience accumulated with the previous generations of Rho family of products.
Housed in 4U high, size E4 or E6 cases the 7SR17 Rho can provide protection, control, monitoring, instrumentation and metering with integrated input and output logic, data logging and fault reports.
Relay functionality is accessed via a familiar user friendly interface.
Communication access to relay functionality is via a front USB port for local PC connection, rear RS485 port for remote connection or optional IEC61850 communication through two rear Ethernet ports (Electrical or Optical).

Function Overview

Protection (can include)

14	Stall Protection
46	Phase Unbalance Protection
49	Thermal Overload
48/66	Start Protection
37	Undercurrent
67/50, 67/51	Directional Overcurrent
67G/67N	Directional Earth Fault
87REF	High Impedance REF
27/59	Under/Over Voltage
47	NPS Voltage/Phase Reversal
81	Under/Over Frequency
32	Power
32S	Sensitive Power
55	Power Factor

Supervision (can include)

46PhRev	Phase Reversal
50BCL	Breaking Capacity Limit
50BF	Circuit Breaker Fail
60CTS-I	CT Supervision
60CTS	Enhanced CT Supervision
60VTS	VT Supervision
74T/CCS	Trip Circuit Supervision
81B	Anti Backspin
Temp	Temperature Input Monitoring

Control (can include)

86	Lockout

Motor Start/Stop Control
User Programmable Logic

Features

4 Settings Groups
Password Protection – 2 levels (protection and control)
Self Monitoring

User Interface

20 character x 4 line backlit LCD
Menu navigation keys
9 Programmable Tri-colour LEDs

Monitoring Functions

Monitoring Functionality (can include)

Phase, earth and sequence currents
Thermal equivalent and phase difference currents
Line, phase, neutral and sequence voltages
Power - Apparent, Real and Reactive. Power factor
Energy - WHr and VAr Hr
Demand metering
Start/Run Monitoring Profiles:
  Number of Starts, Starts per hour
  Start currents, voltages and power
  Start method (Local/remote/comms)
  Motor run / start / trip times, thermal status,
Binary Input / Output status
General Alarms inc. trip circuit healthy/failure
Starters
Fault data
CB trip and maintenance counters and Time to Trip
Temperature input (optional) values

Description of Functionality

With reference to figure 4 ‘Function Diagrams’.

14 Stall Protection

Each element has a single definite time overcurrent characteristic with settings for pickup level and Definite Time Lag (DTL) delays.
Operation can be controlled from motor stopped or running conditions.

37 Undercurrent

Each element has settings for the pickup level and the definite time lag (DTL) delay. The element operates when current falls below setting for the duration of the delay.

46 Phase Unbalance Protection

Unbalance current has a significant heating effect on the motor.
Two phase unbalance measurement modes are available. Either NPS current or the difference between maximum and minimum phase currents can be used as a measurement of the unbalance level.
Inverse or definite time operation can be selected.

48/66 Start Protection

The feature provides settings to control both the number of times a motor can be started within a specified time period and the minimum time between starts. Motor starting can be inhibited when this limit is reached.
Motor start time can also be monitored.

49 Thermal Protection – Rotating Plant

The enhanced thermal algorithm provides compliance with IEC60255-8 (Thermal Electrical relays).
The operating curves take into account the effects of present loading, prior loading and unbalanced currents on the motor operating temperature.
A user definable thermal curve is selectable to allow matching of the relay thermal characteristic to all motor and cooling system types.
'Starting' and 'cooling' constants modify the thermal characteristic during motor run-up and stopped conditions.

Temperature Inputs

Motor resistance temperature detectors (RTDs) can be connected via an optional external 7XV5662-6AD10 Temperature Monitoring Interface. Up to twelve Pt100 sensors can be monitored.
The interface is connected to the COM1-RS485 port of the relay.

50/51, G/N Earth Fault

Two earth fault measurement modes are available.
Measured earth fault mode (G) directly measures the earth current from an independent CT, or the residual connection of the 3 line CT's.
Derived earth fault mode (N) derives the earth current internally from the line CT inputs
Independent settings are available for pickup current and time-delays.
IDMT curves are available.

50/51 Overcurrent

Definite time elements provide short circuit overcurrent protection with independent settings for pickup current and time-delays.
IDMT curves can also be selected.

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. Where a CB closed is detected following a trip signal an output is issued after a specified time interval. This can be used to re-trip the CB or to back-trip an upstream CB. A second time delay is available to enable another stage to be utilized if required.

60CTS CT Supervision

Two types of CT wiring monitoring is available dependent on the availability of VT inputs:
60CTS-I determines CT failure from a comparison of phase current levels.
Where VT inputs are available 60CTS considers the presence of negative phase sequence current, without an equivalent level of negative phase sequence voltage.
The element has user operate and delay settings.

81B Anti Backspin

To inhibit attempted restarting of the motor until after the rotor has completely stopped backspin protection is applied.
Starting is inhibited until the 81B time delay has elapsed.

87REF High Impedance REF

The 87REF function can provide high speed earth fault protection for motor winding faults. This function requires an external series stabilising resistor and voltage limiting non-linear resistor.

74TCS Trip Circuit Supervision

The trip circuits can be monitored via binary inputs connected in H4/H5/H6 or H7 schemes. Trip circuit failure raises an HMI alarm and output(s).

Programmable User Logic

The user can map Binary Inputs and Protection operated outputs to Function Inhibits, Logic Inputs, LEDs and/or Binary Outputs.
The user can also enter up to 4 equations defining scheme logic using standard functions e.g. Timers, AND/OR gates, Inverters and Counters.
Each Protection element output can be used for Alarm/Indication and/or tripping.

Function LED's

Ten user programmable tri-colour LED's are provided eliminating the need for separate panel mounted indicators and associated wiring. Each LED can be user set to red, green or yellow allowing for indication of the associated function's status. A slip-in pocket adjacent to the LEDs enables the user to insert customised labels. A printer compatible template is available.

Optional Functionality

27/59 Under/Over Voltage

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delayed operation.
The elements can be independently selected to under or over voltage operation.

32 Power

This feature can be used to detect loss of motor load.
Each element can be set to measure real, apparent or reactive power and has independent settings for pickup level and Definite Time Lag (DTL) delayed operation.

32S Sensitive Power

Sensitive power is measured from the 4th CT input (IG) and user selected voltage inputs.
Each element can be set to measure real, apparent or reactive power and has independent settings for pickup level and Definite Time Lag (DTL) delayed operation.

47 Negative Phase Sequence (NPS) Overvoltage

Unbalance (NPS) voltage can be caused by uneven system loading.
Each element has independent settings for pickup level and Definite Time Lag (DTL) delayed operation.

49TS Integral Temperature Sensor Inputs

4 or 8 Temperature Sensors can be connected to the optional integral temperature sensor inputs.
RTD or thermistor sensors can be used. All sensors must be of the same type.

55 Power factor

This feature is used to monitor motor operating conditions.

Each element has independent settings for pickup level and Definite Time Lag (DTL) delayed operation.

60VTS VT Supervision

The VT Supervision uses a combination of sequence component voltage and current to detect a VT fuse failure. This condition can provide an output for indications/alarms or used to inhibit voltage dependent functions. Element has user operate and delay settings.

67 Directional Control for Overcurrent and Earth Fault

Directional control can be used to provide additional protection discrimination e.g. correct discrimination for earth faults in non-effectively earthed systems with appreciable capacitance.

81 Under/Over Frequency

Frequency elements can be used to monitor suuply quality e.g. under-frequency causing motor deceleration.
Each element has independent settings for pickup level, drop-off level and Definite Time Lag (DTL) delayed operation.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	3 x Phase, 1 x SEF
Rated Current IN	1/5A
Measuring Range	Phase: 80 xIn SEF: 10 xIn
Instrumentation 10% to 200% In	±1% or ±1% In
Frequency	50/60Hz
Thermal Withstand:	
Continuous	4.0 x In
1 Second	100A (1A) 350A (5A)
Burden @ In	≤0.1VA (1A Phase and SEF) ≤0.3VA (5A Phase and SEF)

Voltage Inputs

Quantity	3 (Optional)
Rated Voltage Vn	40 – 160V
Instrumentation 10% to 200% Vn	±1% or ±1% Vn
Frequency	50/60Hz
Thermal Withstand: Continuous	300V rms
Burden @ 110V	≤0.6VA

Temperature Detector Inputs

Value	Reference	Accuracy
RTD	Cu10, 0 – 540°C	± 3°C (0 – 250°C)
	Ni100, 0 – 400°C	± 1°C (0 – 250°C)
	Ni120, 0 – 330°C	
	Ni250, 0 – 535°C	
	Pt100, 0 – 540°C	
	Pt250, 0 – 540°C	
	Pt1000, 0 – 260°C	± 2°C (0 – 250°C)
Thermistor	100Ω – 40KΩ	± 2% or ± 5Ω

Auxiliary supply

Nominal voltage	Operating Range V
24 to 60V dc	18 to 72V dc
80 to 250V dc 115V ac	64 to 300V dc 92 to 138V ac
24 to 250 V dc 100 to 230 V ac	19.2 to 275 V dc 80 – 253V ac
Allowable superimposed ac component	12% of DC voltage
Allowable breaks/dips in supply (collapse to zero)	50ms (DC) 2.5/3 cycles (AC)

Auxiliary supply: Burdens

Power Consumption	Min (DC)	3.9W (6W with IEC61850)
	Max (DC)	8W (10.1W with IEC61850)
	Min (AC)	9VA (14.5VA with IEC61850)
	Max (AC)	15VA (20.5VA with IEC61850)

Binary Inputs

Operating Voltage	19V: Range 17 to 320V dc 19V: Range 92 to 138 V ac 88V: Range 74 to 320V dc
Maximum current for operation	1.5mA dc 1.5mA peak ac

Binary Outputs

Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand Reset
Contact Operate / Release Time.	7ms / 3ms
Making Capacity:	
Carry continuously	5A ac or dc
Make and carry	20A ac or dc for 0.5s
(L/R ≤ 40 ms and V ≤ 300 V)	30A ac or dc for 0.2s
Breaking Capacity	
(≤ 5 A and ≤ 300 V):	
AC Resistive	1250VA
AC Inductive	250VA at PF ≤ 0.4
DC Resistive	75W
DC Inductive	30W at L/R ≤ 40ms 50W at L/R ≤ 10ms

Data Communication Interface

Communication Port	Front USB Type B Rear RS485 2 wire electrical IEC61850 optional ports: 2x Electrical RJ45 Ethernet 2x LC Fibre Optic Ethernet
Fibre Optic Ethernet Data Communication Interface (IEC 61850 Option)	

EN100 Fibre Optic Data Communication Interface (IEC 61850 Option)

Physical Layer	Fibre-optic
Connectors	Duplex LC 100BaseF in acc. With IEEE802.3

Recommended fibre	62.5/125 μm glass fibre with Duplex-LC connector
Transmission Speed	100 MBits/s
Optical Wavelength	1300 nm
Bridgeable distance	2 km

EN100 Electrical Ethernet Data Communication Interface (IEC 61850 Option)

Physical Layer	Electrical
Connectors	RJ45 100BaseF in acc. With IEEE802.3
Recommended cable	Minimum: Category 5 S/FTP (shielded/screened twisted pair)
Transmission Speed	100 MBits/s
Test Voltage (with regard to socket)	500 VAC 50 Hz
Bridgeable distance	20m

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5gn	≤ 5 %
Vibration endurance	1.0gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5gn, 11ms	≤ 5 %
Shock withstand	15gn, 11ms	≤ 5 %
Bump test	10gn, 16ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	1gn	≤ 5 %

Mechanical Classification

Durability	$>10^6$ operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0kV AC RMS for 1min
Between independent circuits	
Across normally open contacts	1.0kV AC RMS for 1min

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Case, Aux Power & I/O. Common mode	2.5kV	≤ 10%
Case, Aux Power & I/O. Transverse mode	1.0kV	≤ 10%
RS485 Comms	1.0kV	No data loss

Electrostatic Discharge
IEC 60255-22-2

Type	Level	Variation
Front Cover Fitted	Class IV, 15 kV Air Discharge	≤ 5 %
Front Cover Removed	Class III, 8 kV Air Discharge	≤ 5 %

Electrical Fast Transient / Burst Immunity
IEC 60255-22-4 Class A (2002)

Type	Level	Variation
Case, Aux Power & I/O	4.0kV	≤ 10%
RS485 Comms	2.0kV	No data loss

Surge Immunity
IEC 60255-22-5

Type	Level	Variation
Analog Inputs. Line to Earth	4.0kV	≤ 10%
Case, Aux Power & I/O. Line to Earth	2.0kV	
Analog Inputs. Line to Line	1.0kV	
Case, Aux Power & I/O. Line to Line	1.0kV*	
RS485 Comms port. Line to Earth	1.0kV	No data loss

*Note 50ms pick up delay applied to binary inputs

Conducted Radio Frequency Interference
IEC 60255-22-6

Type	Level	Variation
0.15 to 80MHz	10V	≤ 5%

Radiated Radio Frequency
IEC 60255-25

Type	Limits at 10m, Quasi-peak
30 to 230MHz	40dB(μV/m)
230 to 10000MHz	47dB(μV/m)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5MHz	79dB(μV)	66dB(μV)
0.5 to 30MHz	73dB(μV)	60dB(μV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level	Variation
80MHz to 1000MHz	10V/m	≤ 5%

Magnetic Field with Power Frequency
IEC 61000-4-8, Class V

Type	Level
100A/m (0.126mT) continuous	50Hz
1000A/m (1.26mT) for 3s	

Environmental Tests

Temperature
IEC 60068-2-1/2

Operating Range	-10°C to +55°C
Storage range	-25°C to +70°C

Humidity
IEC 60068-2-78

Operational test	56 days at 40°C and 93% relative humidity

Cyclic Temperature and Humidity
IEC 60068-2-30

Operational test	25 °C to 55 °C (outdoor equipment) and 97/93 % relative humidity. 6 x 24h (12h+12h) cycles.

IP Ratings
IEC 60529

Type	Level
Installed with cover	IP 51 from front of relay
Installed with cover removed	IP 20 from front of relay

For full technical data refer to the Performance Specification Section of the Technical Manual.

Performance

14 Stall Protection

Number of Elements	4
Setting Range Is: -	0.05 to 10 x In
Time Delay	0.00 to 14400s
Operate Level	100% I_s ±5% or ±1% xIn
Operate time 2 x Is 5 x Is	 35ms ± 10ms, 25ms ± 10ms
Operate time following delay	t_{basic} +t_d , ±1% or ±10ms
Controlled by	Stopped, No acceleration, Running, None

27/59 Under/Over Voltage

Number of Elements	4 Under or Over
Operate	Any or All phases
U/V Guard	1 to 200V
Setting Range Vs	5 to 200V
Hysteresis Setting	0 to 80%
Operate Level Vop	100% Vs ±1% or ±0.25V
Reset Level: - Undervoltage Overvoltage	 (100% + hyst) x Vop ±1% or ±0.25V (100% - hyst) x Vop ±1% or ±0.25V
Delay Setting td	0 to 14400s
Basic Operate Time: - 1.1xVs (OV) 2.0xVs (OV) 0.5xVs (UV)	 73ms ±10ms 63ms ±10ms 58ms ±10ms
Operate time following delay.	t_{basic} +t_d , ±1% or ±10ms
Inhibited by	Binary or Virtual Input VT Supervision, Voltage Guard

32 Power

Number of Elements	2 Forward or Reverse
Operate	P, Q or S
U/C Guard	0.05 to 1.0 x In
Setting Range Ss	0.05 to 2.0 x Sn
Operate Level Sop	100% Ss, ± 5% or ± 2% Sn
Reset Level: -	≥95% Sop
Basic Operate Time: - 1.1 x Ss (over) 2.0 x Ss (over)	 60ms ± 10ms 45ms ± 10ms
0.5 x Ss (under)	40ms ± 10ms
Delay Setting td	0 to 14400s
Operate time following delay.	t_{basic} +t_d , ±1% or ±10ms
Inhibited by	Motor not running, VTS

32S Sensitive Power

Number of Elements	2 Forward or Reverse
Operate	P, Q or S
U/C Guard	0.005 to 1.0 x In
Setting Range Ss	0.005 to 2.0 x Sn
Operate Level	100% Ss ± 5% or ± 2% Sn
Reset Level: -	≥95% Sop
Basic Operate Time: - 1.1 x Ss (over) 2.0 x Ss (over) 0.5 x Ss (under)	 60ms ± 10ms 45ms ± 10ms 30ms ± 10ms
Delay Setting td	0 to 14400s
Operate time following delay.	t_{basic} +t_d ± 1% or ± 10ms
Inhibited by	Motor not running, VTS

37 Undercurrent

Number of Elements	2
U/C Guard	0.05 to 5.0 x In
Setting Range Is	0.05 to 5.0 x In
Operate Level	100% Is ± 5% or ± 1% xIn
Delay Setting td	0 to 14400ss
Basic Operate Time: - 0.5 x Is	 50ms ± 10ms
Operate time following delay.	t_{basic} + t_d , ± 1% or ± 10ms
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

46 Phase Unbalance Protection

Number of Elements	1 (Magnitude difference or NPS)
Setting Range Is	0.1 to 0.4 x Itheta
Operate Level	100% Is ± 5% or ± 1% x In
IT Min. Operate Time	0 to 20s
DT Delay Setting td	0 to 20s
Basic Operate (Magnitude Difference) 2 x Is 5 x Is	 55ms ± 10ms 50ms ± 10ms
Basic Operate (NPS) 2 x Is 5 x Is	 70ms ± 10ms 60ms ± 10ms
DT Operate time following delay.	t_d ± 1% or ± 30ms
Tm Time Multiplier	0.025 to 2.0
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

47 Negative Phase Sequence Voltage

Number of Elements	2
Setting Range Vs	1 to 90V
Hysteresis Setting	0 to 80%
Operate Level	100% Vs ± 2% or ± 0.5V
Delay Setting td	0 to 14400s
Basic Operate Time: - 2 x Vs 10 x Vs	 80ms ± 20ms 55ms ± 20ms
Operate time following delay.	t_{basic} +t_d ± 2% or ± 20ms
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

48/66 Start Protection

Max. No. of Starts	OFF, 1 to 20
Max. Starts Period	1 to 60 minutes
Start Inhibit Delay	1 to 60 minutes
Time Between Starts	OFF, 1 to 60 minutes

49 Thermal Protection

Setting Range Itheta	0.1 to 3.0 x In
NPS Weighting Factor (K)	0.1 to 10.0 Δ 0.1
TauH Heating Constant	0.5 to 1000 mins, Δ 0.5 mins
TauS Starting Constant	0.005 to 1.0 x TauH , Δ 0.005
TauC Cooling Constant	1 to 100 x TauH , Δ 1
Hot/cold ratio	OFF, 1 to 100%, Δ 1%
Operate Level	100% Is, ±5% or ±1% x In
Operate time	$t = \tau \times In\left\{ \frac{I_{EQ}^2 - \left(1 - \frac{H}{C}\right) I_p^2}{I_{EQ}^2 - I_\theta^2} \right\}$ ±5% or ±100ms (Itheta = 0.3 to 3 x In) (1.2 to 20 x Itheta)
	User defined
Capacity Alarm Level	Disabled, 50,51…100%
Load Alarm Level	OFF, 0.5 to 1.0 x Itheta , Δ 0.05
Thermal restart inhibit	20 to 100%, Δ 1%
Inhibited by	Binary or Virtual Input

50 (67) Instantaneous/DTL OC & EF

Operation 7SR17n2/3 7SR17n5/6	Non directional. Non directional, Forward or reverse
Elements	Phase, Derived Earth, Measured Earth
Setting Range Is: - O/C '50' Derived E/F '50N' Measured E/F '50G'	0.05 to 50 x In 0.05 to 50 x In 0.005 to 5 x In
Time Delay	0.00…14400s
Operate Level	100% Is ± 5% or ± 1% x In
Operate time: 50 50N	0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 25ms, ±10ms 0 to 2xIs – 40ms, ±10ms, 0 to 5xIs – 30ms, ±10ms
Operate time following delay	t_{basic} +t_d , ±1% or ±10ms
Inhibited by	Binary or Virtual Input Inrush detector VT Supervision

51 (67) Time Delayed OC&EF

Operation 7SR17n2/3 7SR17n5/6	Non directional. Non directional, Forward or reverse
Elements	Phase, Derived Earth, Measured Earth
Characteristic	IEC: NI,VI,EI,LTI ANSI: MI,VI,EI DTL
Setting Range Is	0.05 to 2.5 x In (OC, N) 0.005 to 0.5 x In (G)
Time Multiplier (IEC/ANSI)	0.025 to 100
Time Delay	0 to 20s
Operate Level	105% Is ± 4% or ± 1% x In

Minimum Operate time IEC ANSI	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$ $t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5% or ± 30 ms
Follower Delay	0 - 20s
Reset	ANSI decaying, 0 – 60s
Inhibited by	Binary or Virtual Input VT Supervision

50BF Circuit Breaker Fail

Operation	Current check - Phase and Measured Earth with independent settings, Mechanical Trip, CB Faulty Monitor
Setting Range Is	0.05 to 2 x In (50BF) 0.005 to 2 x In (50BF-I4)
2 Stage Time Delays	Timer 1: 0.02 to 60s Timer 2: 0.02 to 60s
Operate Level	100% Is ± 5% or ± 1% x In
Basic Operate time	< 20ms
Operate time following delay	t_{delay} ±1% or ± 20ms
Triggered by	Any function mapped as trip contact.
Inhibited by	Binary/Virtual Input
Timer By pass	Yes, 50BF CB Faulty Input

55 Power factor

Number of Elements	2
Operation	Under or Over
U/C Guard	0.05 to 1.0
Setting Range PFs	0.05 to 0.99
Time Delays	0 to 14400s
Operate Level	± 0.05
Basic Operate time	≤ 80ms
Operate time following delay	t_{basic} +t_d ± 1% or ± 10ms
Inhibited by	Motor not running, VTS

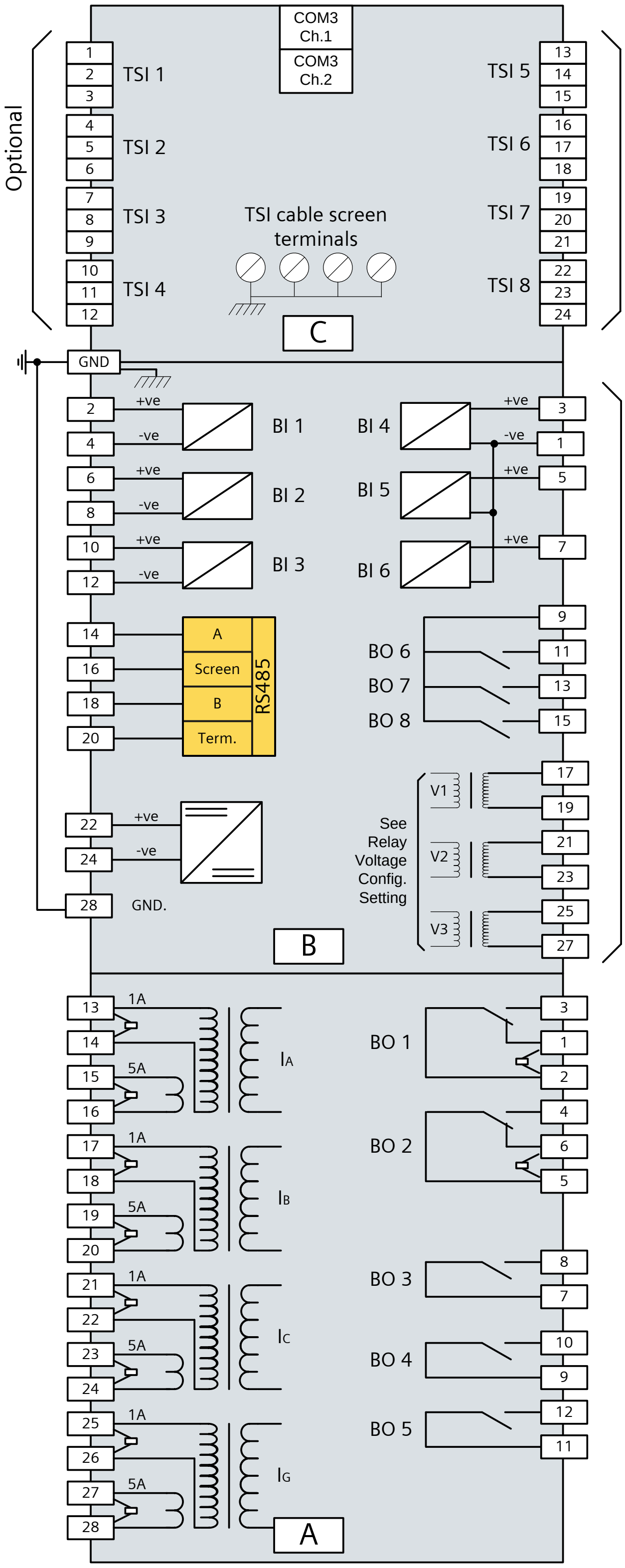
81 Under/Over Frequency

Number of Elements	2 Under or Over
U/V Guard	35 to 200V
Setting Range Fs	43 to 68Hz
Hysteresis Setting	0 to 2%
Operate Level Fop	100% Fs ±10mHz
Reset Level: - Under Frequency Overv Frequency	(100% + hyst) x Fop ± 10mHz (100% - hyst) x Fop ± 10mHz
Delay Setting td	0 to 14400s
Basic Operate Time: - For ROCOF between 0.1 and 5Hz/second	Typically < 110ms Maximum < 150ms
Operate time following delay.	t_{basic} +t_d ± 1% or ± 10ms
Inhibited by	Binary or Virtual Input, Voltage Guard

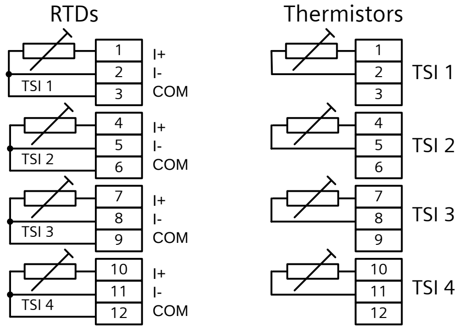
87REF Restricted Earth Fault

Setting Range Is	0.005 to 2.0 x In
Operate Level	100% Is ± 5% or ± 1% x In
Time Delay	0 to 60s
Basic Operate Time 2 x Is 5 x Is	40ms ± 10ms 30ms ± 10ms
Inhibited by	Binary or Virtual Input

7SR17 Rho Connection Diagram



RTD or Thermistor Connections (shown for Temperature Sensor Inputs (TSI) 1-4):-



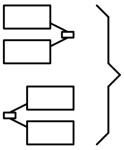
Screened cable is recommended for use with the optional temperature inputs.
Four earth screw terminals are provided on the rear of the relay for cable screens.

Relay Earthing

Terminal 28 of the Power Supply Unit should be earthed by a direct connection to the relay case earth stud.

The relay case earth stud should be solidly earthed by a direct connection to the panel earth.

BI = Binary Input,
BO = Binary Output
GND = Ground/earth
TSI = Temperature Sensor Input



Terminal contacts internal to relay case assembly close when relay chassis withdrawn from case

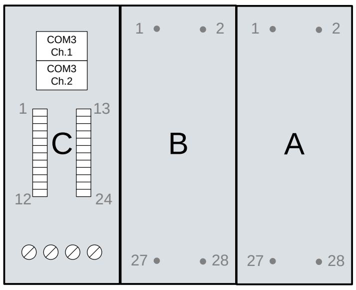
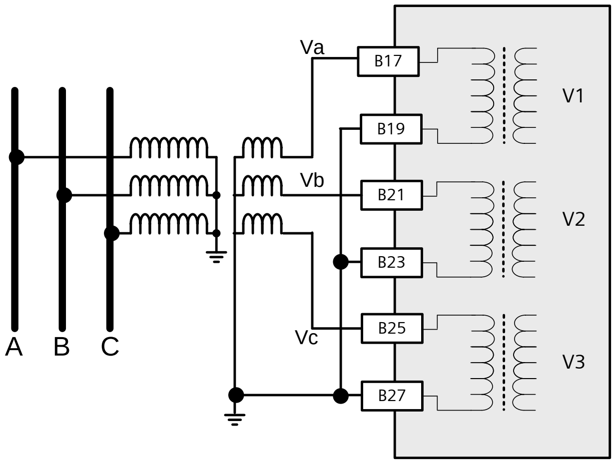


Fig2. 7SR17 Rho Wiring Diagram

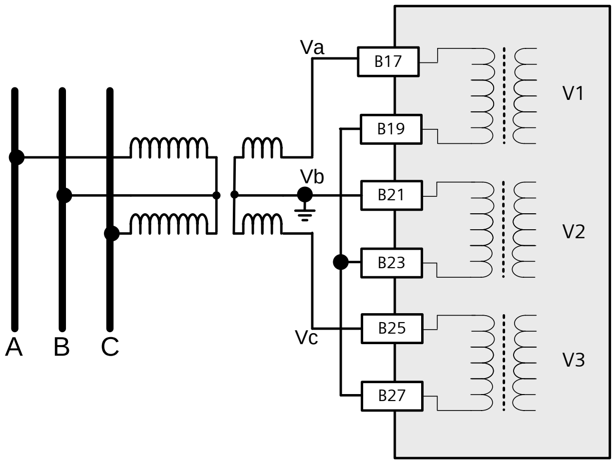
Relay Voltage Configuration Setting

VT Wiring Connections

Van, Vbn, Vcn



Va, Vb, Vc



Vab, Vbc, 3V0

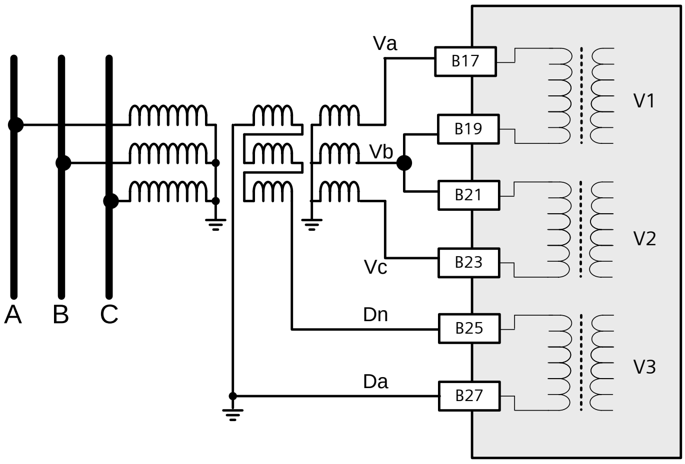
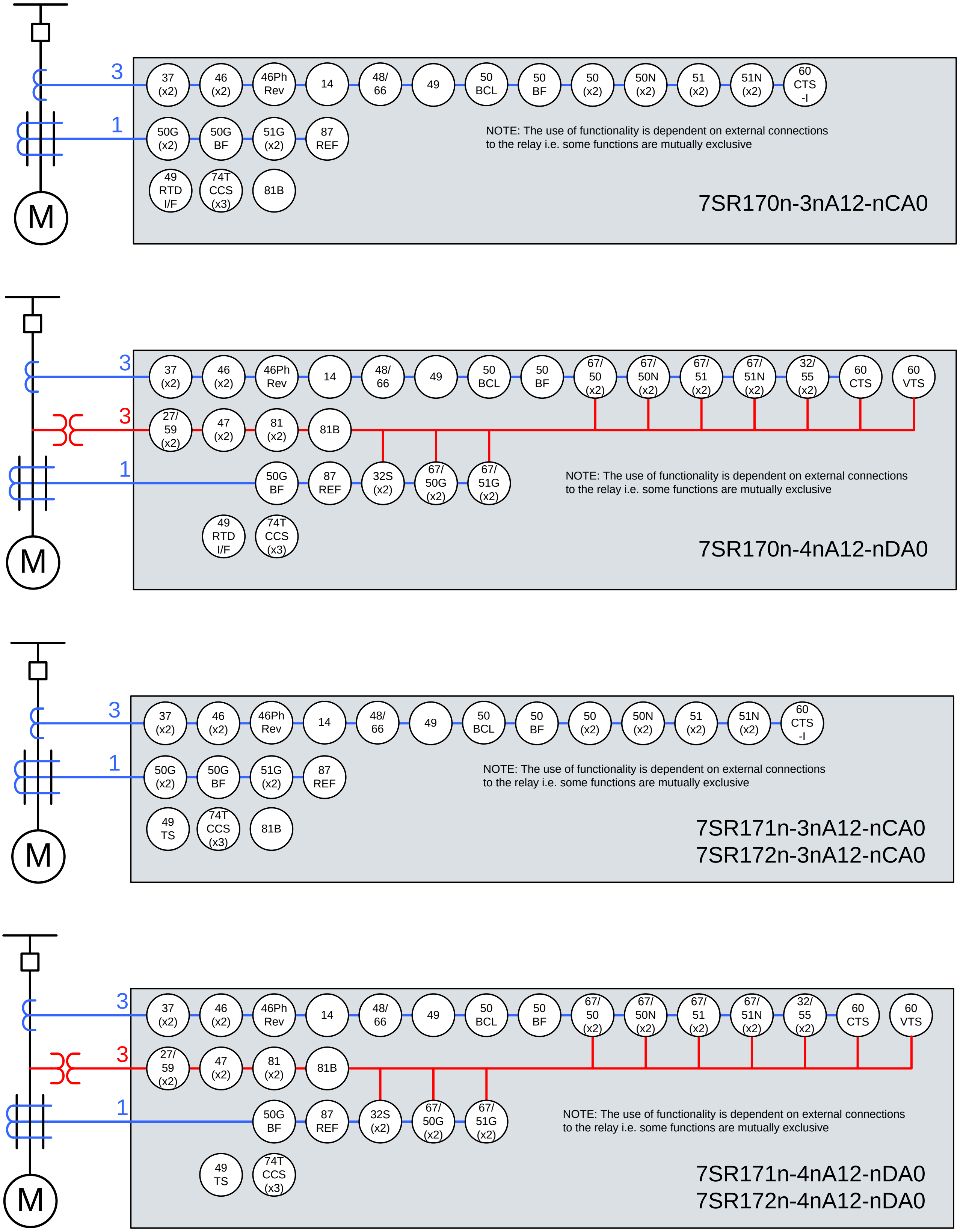


Fig3. 7SR17 Rho VT Wiring Connections

7SR17 Rho Function Diagram



NOTE: The use of functionality is dependent on external connections to the relay i.e. some functions are mutually exclusive

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Fig4. Function Diagrams - 7SR17 Relays

Ordering Information – 7SR17 Rho Motor Protection Relay

	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16
ORDER-No.:	7	S	R	1	7			-			A			-		C	A	0

Protection Product Family		5	
Motor Protection		7	

Relay Type		6	
Basic Relay (See Note 1)		0	
Relay with 4 Temperature inputs (See Note 1)		1	M/N
Relay with 8 Temperature inputs (See Note 1)		2	M/N

Case, I/O and Fascia		7	
4 CT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs		2	3
4 CT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs		3	3
4 CT, 3 VT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs		5	4
4 CT, 3 VT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs		6	4

Measuring input		8	
1/5 A, 50/60Hz with SEF Input	2/3	3	
1/5 A, 40-160V, 50/60Hz with SEF Input	5/6	4	

Auxiliary voltage		9	
80-250V DC / 115V AC, binary input threshold 19V DC		G	
80-250V DC, binary input threshold 88V DC		H	
24-60V DC, binary input threshold 19V DC		J	
PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 19V DC (Rated: 24-250V DC / 100-120V AC)		M	
PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 88V DC (Rated: 110-250V DC)		N	

Additional Options		10	
Standard relay		A	

Communication Interface		11	
Standard version - included in all models, USB front port, RS485 rear port (See Note 1)		1	2
Standard version - plus additional rear electrical Ethernet RJ45 (x2) (See Note 1)	M/N	7	7
Standard version - plus additional rear optical Ethernet duplex (x2) (See Note 1)	M/N	8	7

Protocol		12	
IEC 60870-5-103, Modbus RTU, DNP 3.0 (user selectable). Also Modbus RTD Client (see Note 2)		2	
IEC 60870-5-103, Modbus RTU, DNP 3.0 (user selectable) and IEC61850. Also Modbus RTD Client (see Note 2)	7/8	7	

Front Cover		13	
Standard Version - No Push Buttons		1	
Push Buttons - DOWN and RIGHT Arrows		2	

Ordering Information – 7SR17 Rho Motor Protection Relay

	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16
ORDER-No.:	7	S	R	1	7			-			A			-		C	A	0

Protection Function Packages		**14**
For future development		A
For future development		B
Standard version - included in all models		C
14	Stall Protection	
37	Undercurrent	
46	Phase Unbalance	
46PhRev	Phase Reversal	
48/66	Start Protection	
49	Thermal overload	
49 RTD I/F (See Note 2)	RTD Monitoring via comms	
50/51	Overcurrent	
50/51, G/N	Earth fault	
50BF	Circuit breaker fail	
50BCL	Break Capacity Limit	
60CTS-I	CT Supervision	
74T/CCS	Trip/Close Circuit Supervision	
81B	Backspin Protection	
87REF	High Impedance Restricted Earth Fault	
	Programmable Logic	
For variants with Temperature inputs		
49 Temp	Temperature Input monitoring	
For variants with 3 x VT inputs as above - plus		
27/59	Under/Over Voltage	
32/55	Directional Power/Power Factor	
47	Negative Phase Sequence Overvoltage	
60CTS	Enhanced CT Supervision	
60VTS	VT Supervision	
67/50, 67/51	Directional Overcurrent	
67G/N	Directional Earth Fault	
81	Frequency	

Additional Functionality	**15**
No additional functionality	A

Spare	**16**
	0

Notes

1) E4 case is standard, E6 case is required if IEC61850 and/or Temperature Input options are ordered

2) Applicable to non-integral Temperature Input variants. Requires selection of Protocol - Modbus RTD Client, which precludes use of system comms.

1.1.2.6 7SR18 Differential Protection Relay

Fig1. Typical Fascia showing additional LED variant

Description

The Solkor, two-ended, line differential relay has been developed to enhance the Reyrolle family of products. Designed using state-of-the-art hardware technology, it provides differential protection and control for overhead lines and cable feeders. Housed in a 4U high, size E6 case, it provides protection, monitoring, instrumentation and metering with integrated input and output logic, data logging & fault reports. Communication access to the relay functionality is via a front USB port for local PC connection or rear RS485 communications port for remote connection.

Function Overview

87L	Three-phase differential (two elements)
85	Inter-trip Feature
50	Instantaneous Overcurrent
50G/50N	Instantaneous Earth Fault
51	Time Delayed Overcurrent
51G/51N	Time Delayed Measured/Derived/Earth Fault
60CTS-I	CT Supervision

Two, three-pole differential elements, each with two stage bias characteristics, are provided for differential protection. Inter-tripping comes from internal or six independent external initiation channels. Overcurrent protection can operate as a stand-alone feature, it can also be configured to operate as 'guard' feature and/or back-up in case of protection signalling communications failure. Connection to CTs is via selectable 1 A or 5 A inputs. Ratio correction for miss-matched line current transformer ratios is available. The ability to invert CT inputs is provided to facilitate commissioning. There are five or eight user-programmable binary output contacts and three or six user programmable status inputs with pick-up and drop-off timers.

Monitoring Functions

Local end and remote end ammeters,
Differential starters,
Protection signalling link status,
General alarms,
Binary Input / Output status,
Trip circuit supervision
Time and date
Starters
Fault records
Event records
Circuit breaker trip counters

Description of Functionality

Current Differential Protection

The relay compares magnitude of measured currents at either end of the protected feeder, it operates for faults detected within the protected zone. The three-pole, phase-fault differential comparators each provide two bias-slopes. The first stage of bias accommodates proportional measuring errors in the system. The second stage accommodates additional spill current caused by CT saturation at high fault levels.

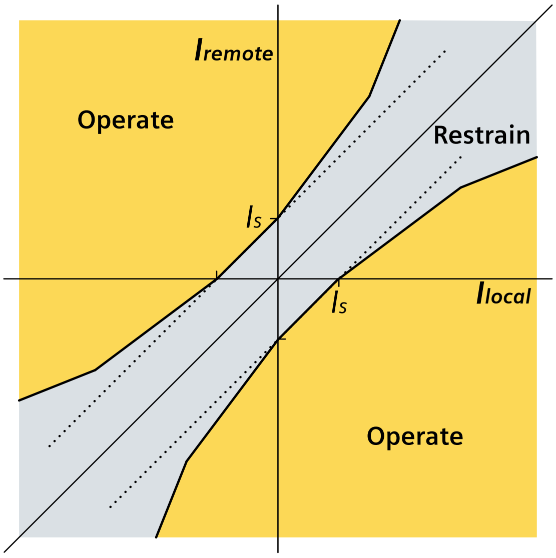


Fig2. Differential Protection Operating Characteristic

It is not necessary to have the same CT ratios at either end of a protected feeder, since ratio compensation is settable. It is also possible to invert the current inputs to aid in commissioning.

Backup Overcurrent Protection

In addition to the differential protection, comprehensive overcurrent protection for phase and earth faults provides back-up IDMTL and DTL characteristics in the event of a communications link failure.

Guard Relays

If it is necessary to add security to the differential scheme it is possible to configure an overcurrent element as a 'guard' feature. The appropriate overcurrent element must operate at the same instance as the differential element to allow a trip command to be issued.

Inter-tripping

Auxiliary signalling channels are provided for inter-tripping. Internal inter-trip dedicated to the differential protection and independent inter-trips which can be used for either direct or permissive inter-tripping from an internal or external source. Where an internal fault is fed largely from one end, the differential comparators at both ends operate identically, but the guard at the low current end may not pick up and so block the trip. To overcome this, an internal inter-trip signal is sent which can be used at the receive end to either override the guard so allowing the differential to trip or operate the trip contacts directly.

Protection Signalling

The end-to-end protection signalling channel is via a direct optical link for distances up to 2 km* using multi-mode fibres (ST®) bayonet style connectors or up to 40 km using single-mode fibres Duplex LC connectors. Continuous protection signalling link supervision is provided. Two test modes, loop test & line test, are included to assist with commissioning the signalling link. In loop test mode the local transmit and receive terminals can be connected together, allowing relays at each end to be tested in isolation. Line test mode allows the integrity of the whole signalling channel to be checked. The relay commands the remote end to 'echo' all received data back to the local end. In line test mode, the remote differential protection is suspended.

* For distances greater than 2 km consider using the additional 7XV5461-xxxxx devices

Circuit Breaker Maintenance

A circuit-breaker operations counter is provided. A summation of I^2 broken by the circuit-breaker provides a measure of the contact erosion. Operations count and I^2 alarm levels can be set which, when reached, can be used as an input to a condition-based maintenance regime.

Construction

The relay is housed in a 4U high size E6 case with a removable clear plastic fascia cover. Two handles are provided to facilitate the withdrawal of the relay element from its case. Internal contacts within the case ensure the CT circuits and normally closed contacts remain short-circuit when the relay is withdrawn. The rear connection blocks are comprised of screw terminals facilitating M4 ring-crimp connections, providing a secure and reliable termination.

Fig3. Typical Rear view of relay

User Interface

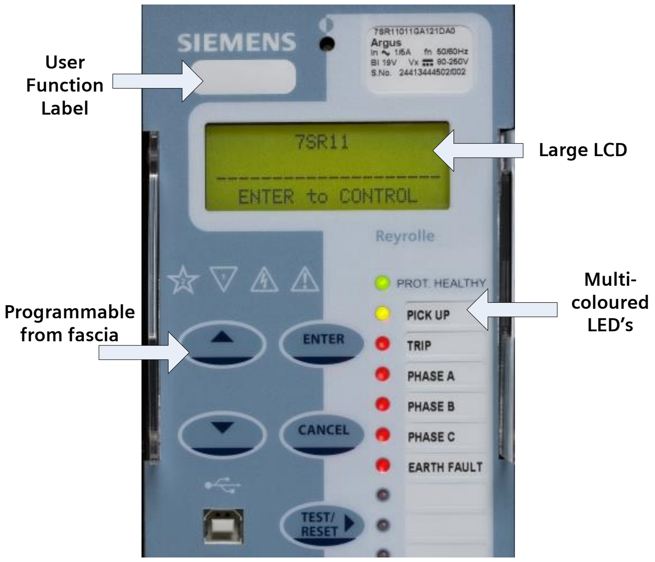


Fig4. Typical User Interface

The operator interface is designed to provide a user friendly method of controlling, viewing menus, entering settings and retrieving data from the relay. Five buttons are provided for navigation around the menu structure.

LCD

A 4 line by 20 character liquid crystal display (LCD) with power save operation permits viewing of the relay identifier, settings, instrumentation, fault data and control commands. Up to 6 user programmable general alarms can be configured for status indication.

LEDs

A steadily illuminated LED indicates the 'Protection Healthy' condition. There are 9 or 17 user programmable LEDs available eliminating the need for additional expensive panel mounted indication and associated wiring. Each is tri-coloured (red, green, yellow) allowing for indication severity classification of the associated function's state and has a label insert for text identification.

Relay Information

The device type and rating information is shown as standard on the fascia slip-in label. There is also provision for relay designation to be displayed on the LCD showing 'Relay Identifier' & 'Circuit Identifier' information. In addition space is provided on the fascia via a slip-in label repeating such information.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	3 x Phase & 1 x Earth
Rated Current In	1 A or 5 A
Measuring Range	80 x In
Instrumentation ≥ 0.1xIn	±1% In
Frequency	50 Hz or 60 Hz
Thermal Withstand:	
Continuous	3 x In
10 Minutes	3.5 x In
2 Minutes	6 x In
1 Second	100 A (1 A) 350 A (5 A)
1 Cycle	700 A (1 A) 2500 A (5 A)
Burden @ In	≤0.02 VA (1 A phase and Earth element) ≤0.2 VA (5 A phase and earth element)

Auxiliary Supply

Rated DC Voltage	Nominal Range 24 V to 250V Absolute Range 19.2 V to 275 V	
Allowable superimposed ac component	12% of DC voltage	
Rated AC Voltage	Nominal Range 100 V to 230 V AC 50 Hz or 60 Hz Absolute Range 88 V to 253 V rms AC	
Power Consumption:	Min (DC)	3.9 W
	Max (DC)	8 W
	Min (AC)	9 VA 0.5 PF
	Max (AC)	15 VA 0.5 PF
Allowable breaks/dips in supply (collapse to zero)	DC	50 ms
	AC	2.5 cycles or 3 cycles @50 Hz or 60 Hz

Binary Inputs

Number	3 or 6	
Operating Voltage	19 V dc	DC Range 17 V to 320 V dc AC Range 92 V to 138 VRMSAC
	88 V dc	Range 70 V to 320V dc
Maximum dc current for operation	1.5 mA	
Maximum peak ac current for operation	1.5 mA	
Pick Up Delay	User Selectable 0 s to 14400 s (up to 4 hours)	
Drop Off Delay	User Selectable 0 s to 14400 s (up to 4 hours)	

For AC operation the BI pick-up delay should be set to 0 ms and the drop-off delay to 20 ms.

Binary Outputs

Number	5 or 8 (2 are change-over contacts)
Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand/Electrical Reset or pulsed.
Operating Time from Energizing Binary Input	<20 ms
Making Capacity:	
Carry continuously	5 A ac or dc
Make and carry	20 A ac or dc for 0.5 s
(L/R ≤ 40 ms and V ≤ 300 V)	30 A ac or dc for 0.2 s
Breaking Capacity (≤ 5 A and ≤ 300 V):	
AC Resistive	1250 VA
AC Inductive	250 VA at p.f. ≤ 0.4
DC Resistive	75 W
DC Inductive	30 W at L/R ≤ 40 ms 50 W at L/R ≤ 10 ms

Unit Design

Housing	E6 (see dimension drawing)
Indication	20 Character 4 line Display Relay Healthy LED Tri-Coloured User Programmable Self or Hand Reset LED’s
With-drawable Element.	Yes
User Interface.	5 Navigation Keys
Weight.	Typical 4.26 Kg
IP Rating installed with cover fitted.	IP 51 from front
IP Rating installed with cover removed.	IP 20 from front

Phase/Earth Current Inputs: Thermal Withstand

Continuous	3.0 x In	
10 minutes	3.5 x In	
5 minutes	4.0 x In	
3 minutes	5.0 x In	
2 minutes	6.0 x In	
	1 A Input	5 A Input
3 Second	57.7 A	230 A
2 Second	70.7 A	282 A
1 Second	100 A	400 A
I Cycle	700 A	2500 A

Operate State	Burden
Quiescent (Typical)	3 W
Maximum	10 W
Allowable superimposed ac component	≤ 12% of dc voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20 ms

Serial Interface

Communication Port	Front USB Type standard B Rear RS485 2 wire electrical Rear EN100+ IEC 61850 Electrical or Optical (Optional)
Protocol	IEC60870-5-103 MODBUS RTU IEC61850 DNP3.0

Mechanical

Vibration (Sinusoidal)
IEC 60255-21-1:1988 Class I

Vibration response	0.5 gn
Vibration endurance	1.0 gn

Shock and Bump
IEC 60255-21-2:1988 Class I

Shock response	5 gn, 11 ms
Shock withstand	15 gn, 11 ms
10 gn, Bump test, 16 ms	10 gn, 16 ms

Seismic
IEC 60255-21-3 Class I

Seismic Response	1 gn

Mechanical Classification

Durability	In excess of 10^6 operations

Electrical Tests

Insulation
IEC 60255-27

Between all terminals and earth for 1 minute	2.5 kV rms
Between independent circuits for 1 minute	2.5 kV rms
Across normally open contacts for 1 minute	1.0 kV rms

Transient overvoltage
IEC 60255-27

Between all the terminals and earth or between any two independent circuits without damage or flashover	5 kV 1.2/50 μs 0.5 J

Slow Damped Oscillatory Wave
IEC 60255-26

2.5 kV Common mode	< 3 % deviation
1.0 kV Differential mode	

Electrostatic Discharge
IEC 60255-26

8 kV, Contact discharge	≤ 5 % variation

Radiated Radio Frequency Electromagnetic Field Immunity
IEC60255-26

10 V/m, 80 MHz to 1000 MHz (Sweep)	≤ 5 % variation
10 V/m, 1.4 GHz to 2.7 GHz (Sweep)	≤ 5 % variation
10 V/m, 80 MHz, 160 MHz, 380 MHz, 450 MHz, 900 MHz, 1850 MHz, 2150 MHz (Spot)	≤ 5 % variation

Fast Transient
IEC 60255-26

4 kV, 5/50 ns, 5 kHz, repetitive	≤ 3 % variation

* Note 20 ms drop-off delay applied to binary inputs

Conducted Disturbance Induced by Radio Frequency Interference
IEC 60255-26

10 V, 0.15 MHz to 80 MHz	≤ 5 % variation

Conducted Disturbance Induced by Radio Frequency Interference Limits
IEC 60255-26

Frequency Range	Limits dB(μV)	
	Quasi-peak	Average
0.15 MHz to 0.5 MHz	79	66
0.5 MHz to 30 MHz	73	60

Radiated Radio Frequency Electromagnetic Field Immunity Limits
IEC 60255-26

Frequency Range	Limits at 10 m Quasi-peak, dB(μV/m)
30 to 230 MHz	40
230 to 1000 MHz	47

Surge
IEC 60255-26

Type	Level	Variation
Analogue Inputs, Auxiliary Power: Line to Earth	4.0 kV	≤ 10%
I/O: Line to Earth	2.0 kV *	≤ 10%
RS485 Comms port: Line to Earth	1.0 kV	No Data Loss
Analogue Inputs, Auxiliary Power: Line to Line	2.0 kV	≤ 10%
I/O: Line to Line	1.0 kV *	≤ 10%

* Note 50 ms pick-up delay and 20 ms drop-off delay applied to binary inputs

Environmental

Temperature
IEC 60068-2-1

Operating range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity
IEC 60068-2-78

Operational test	56 days at +40 °C and 93 % RH

Cyclic Temperature and Humidity IEC 60068-2-30

Operational test	25 °C to 55 °C (outdoor equipment) and 97/93 % relative humidity. 6 x 24h (12h+12h) cycles.

Protection Elements

General Accuracy

Reference Conditions	
General	IEC 60255-151
Current settings	100% of In
Current input	IDMTL – 0.05 to 2.5 xIs
	DTL – 0.05 to 50 xIs
Auxiliary supply	Nominal
Frequency	50 Hz or 60 Hz
Ambient temperature	20 °C

General Settings	
Transient overreach of highset/lowset (X/R = 100)	≤ 5 %
Disengaging time (see note)	< 42 ms
Overshoot time	< 40 ms

Note. Output contacts have a programmable minimum dwell time, after which the disengaging time is as above.

Accuracy Influencing Factors

Temperature		
-10 °C to +55 °C	≤ 5 % variation	
Frequency		
47 Hz to 52 Hz 57 Hz to 62 Hz	Level:	≤ 5 % variation
	Operating time:	≤ 5 % variation
Harmonic content		
Frequencies to 550 Hz	≤ 5 % variation	

Current differential

Level	
No. of elements	2
Initial Setting	0.1 to 2.5
1st Bias Slope	0.1 to 0.7
2nd Bias Slope	0.5 to 2

Typical operating threshold characteristics are shown below: -

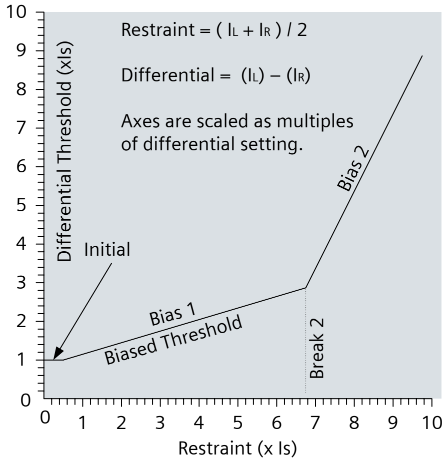


Fig5. Differential Protection Operating Characteristic

The error limits on these diagrams are as follows: -

Operate Levels	
Initial Setting	± 10% of I_{OP} or ± 0.1In
Biased slope	±(10 % of Restraint) or ± 10 mA

Differential and Inter-trip operate times are given by: -

t = t0 +td

Where
t0 is the base operating time
td is the Differential Delay time

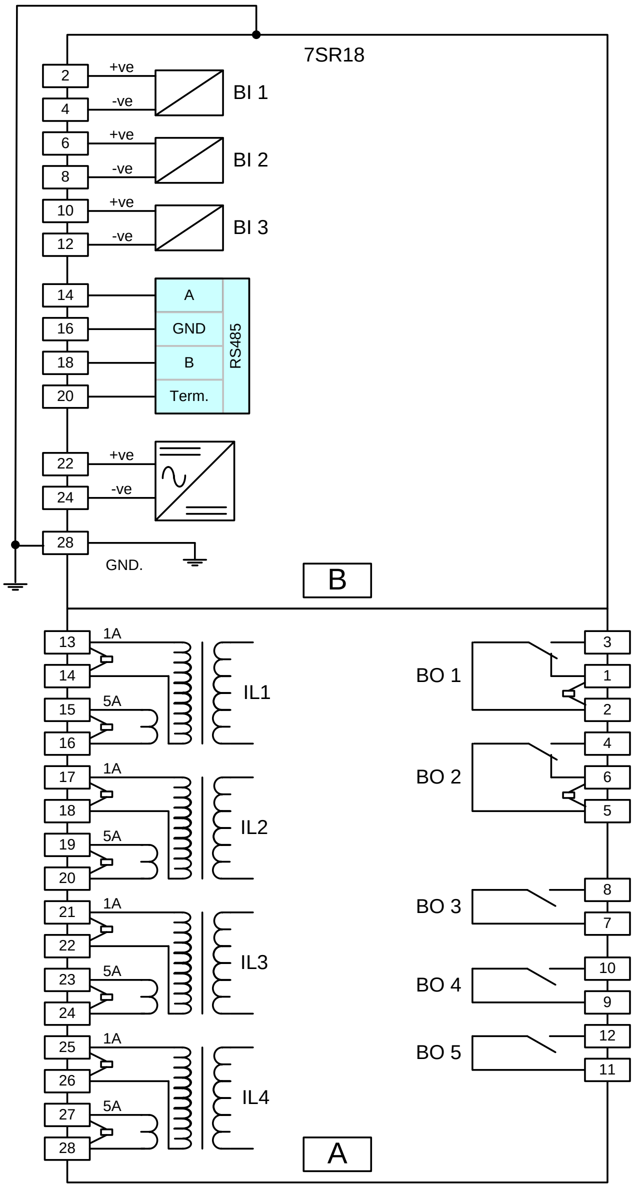
Operate Times (Typical)	
Differential base operate time (Idiff > 10 Is)	30 ms ± 5 ms (Fault Line) 50 ms ± 5 ms (below fault line)
Differential Delay Time	± 1 % or ± 10 ms

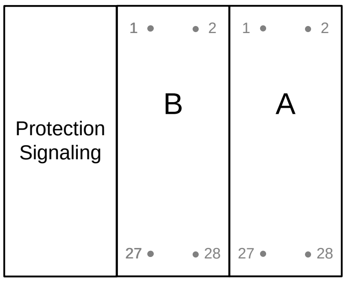
Overcurrent protection

Characteristic	
Setting	IEC Normal Inverse (NI) IEC Very Inverse (VI) IEC Extremely Inverse (EI) IEC Long Time Inverse, (LTI) DTL ANSI Moderatly Inverse (MI) ANSI Very Inverse (VI) ANSI Extremely Inverse (EI)
No. of elements	4
Level	
Setting Range Is	0.05, 0.01...2.5 x In
Accuracy	Operate: 105 % Is, ±4 % or ±1 % xIn
	Reset ≥ 95% of operate current
Repeatability	± 1%
IDMTL Time Multiplier	
Setting	0.025, 0.05...100
Accuracy	± 5 % or ± 30 ms
Repeatability	± 1 % or ± 5 ms
DTL Delay	
Setting	0.00 s to 14400 s
Accuracy	± 10 ms
Repeatability	± 5 ms
Reset	
Setting	0 s to 60 s
Accuracy	± 1 % or ± 10 ms
Repeatability	± 1 % or ± 5 ms

DTL	
No. of elements	4
Level	
Setting Range Is	0.05 xIn to 50 xIn
Accuracy	Operate: 100 % Is, ±5 % or, ±10 mA
	Reset ≥ 95 % of operate current
Repeatability	± 1 %
DTL Delay	
Setting	0.0 s to 14400 s
Accuracy	± 5 ms
Repeatability	± 1 % or ± 5 ms

Connection Diagrams

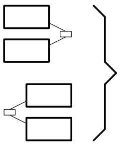




Rear View
Arrangement of terminals and modules

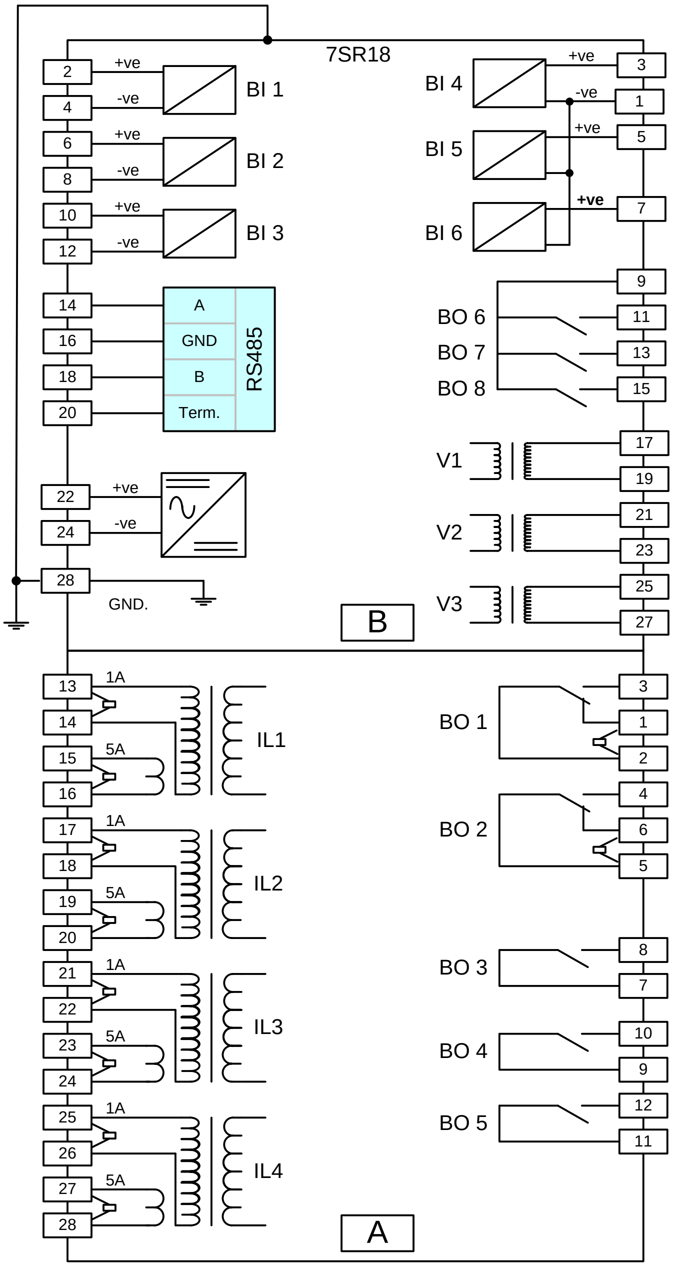
NOTES

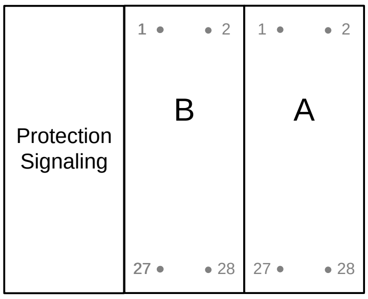
BI = Binary Input
BO = Binary Output



Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig6. Connections Diagram for 7SR18 Non-Directional Relay (3BI and 5BO)

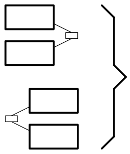




Rear View
Arrangement of terminals and modules

NOTES

BI =	Binary Input
BO =	Binary Output



Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig7. Connections Diagram for 7SR18 Directional Relay (6BI and 8BO)

Ordering Information – 7SR18 Solkor

Product description	Variants	Order No.

7 S R 1 8 1 ☐ - ☐ ☐ ☐ ☐ ☐ - 0 ☐ A 0

Protection Product Family

Differential Protection	8	

Case size

E6 [2]	1	

I/O and Fascia

3 Binary Inputs, 5 Binary Outputs, 18 LEDs	1	C
3 Binary Inputs, 5 Binary Outputs, 10 LEDs + (6 keys each with LED)	2	C
6 Binary Inputs, 8 Binary Outputs, 18 LEDs	3	
6 Binary Inputs, 8 Binary Outputs, 10 LEDs + (6 keys each with LED)	4	

Measuring input

4 CTs (1 A or 5 A)	1	
4 CTs (1 A or 5 A), 3 VTs (40 V to 160 V)	2	C

Auxiliary voltage

24 V DC to 250 V DC, 100 V AC to 230 V AC, binary input threshold 19 V DC	M	
24 V DC to 250 V DC, 100 V AC to 230 V AC, binary input threshold 88 V DC	N	

Protection Signalling Channel

Optical fibre link (820 nm) (ST connection) 2 km [1]	B	1
Optical fibre link (1300 nm) (LC connection) 40 km [1]	C	

Data Communication Interface

USB front port, RS485 (Terminal block) rear port	1	2
USB front port, RS485 (Terminal block) rear port, Electrical Ethernet RJ45 (x2) rear port	7	7
USB front port, RS485 (Terminal block) rear port, Optical Ethernet Duplex (x2) rear port	8	7

Protocol

IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable)	2
IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable) and IEC61850	7

Spare

	0

Protection Function Packages

Standard version		C
87L	3-Phase differential (with variable settings)	
87HS	3-Phase Differential High Set	
85	Inter-Trip	
50	Instantaneous phase fault overcurrent	
50G/50N	Instantaneous earth fault	
51	Time delayed phase fault overcurrent	
51G/51N	Time delayed earth fault	
50LC	Line Check	
37	Undercurrent	
46NPS	Negative phase sequence overcurrent	
49	Thermal overload	
50BF	Circuit breaker fail	
46BC	Broken conductor/load unbalance	
60CTS-I	CT Supervision	
74T&C	Trip & Close circuit supervision	
51c	Cold load pickup	
81HBL2	Inrush Detector	
	Programmable Logic	
For variants with 3 x VT inputs as above plus		
51V	Voltage Controlled Overcurrent	
60CTS	CT Supervision	
60 VTS	VT supervision	
67/50, 67/51	Directional Overcurrent	
67 G/N	Directional Earth Fault	
Version C - plus		D
79	Autoreclose	

Additional Functionality

No additional functionality	A

Spare

	0

[1] Refer to Technical Manual

[2] Standard Version Cover - No Push Buttons

1.1.3 7SR2 Range

Data Acquisition - Via Communication Interface

Sequence of event records

Up to 5000 events are stored and time tagged to 1 ms resolution. These can be viewed on the fascia LCD.

Fault Records

A minimum of the previous 10 fault records are displayed on the relay fascia and are also available through the communication interface, with time and date of trip, measured quantities and type of fault.

Waveform recorder

The waveform recorder stores analogue data for all poles and the states of protection functions, binary inputs, LEDs and binary outputs with user settable pre & post trigger data. The last ten waveform records are stored for easy selection. Their duration is user selectable from 1 second, 2 seconds, 5 seconds or 10 seconds.

Demand Monitoring

A record of demand is available. The demand minimum, maximum and average values for currents, frequency and if applicable, voltages and real, reactive and apparent power and power factor, over a user selectable period of time, is displayed and available via data communications. Typically this is set as a rolling value for the last 24 hours.

Data Log

The average values of voltages, current and real & reactive power are recorded at a user selectable interval and stored to provide data in the form of a Data Log which can be downloaded for further analysis. A typical application is to record 15 minute intervals over the last 7 days.

Real Time Clock

The time and date can be set and are maintained while the relay is de-energised by a back up storage capacitor. The time can be synchronized from a binary input pulse or the data communication channel.

Data Storage & Communication

Standard Communications Ports

Communication access to relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection

Optional Communications Ports

2 Rear ST fibre optic ports (2 x Tx/Rx) + IRIG-B port
1 Rear RS485 + IRIG-B port
1 Rear RS232 + IRIG-B port
2 Electrical Ethernet
2 Optical Ethernet

Protocols

IEC60870-5-103, Modbus RTU and optional DNP 3.0 protocols – User selectable with programmable data points
IEC61850 over Ethernet – optional
Ethernet Redundancy: RSTP, HSR & PRP – standard on ethernet equipped models

Data

Event records
Fault records
Waveform records
Measurands
Commands
Time synchronism
Viewing and changing settings

Serial Communications

The relay offers a USB serial port as standard on the front of all units. All of the relays functions can be set on a PC using Reydisp Evolution via the USB port. The connection is made with a USB cable and operates with a 'plug and play' connection, so no pre-setting of the relay is required.
The front port can be switched off or set to use either the DNP3.0, MODBUS-RTU, IEC60870-5-103 and ASCII protocols for testing purposes.
A rear RS485 electrical connection is available on all units for system interface connections. An internal terminating resistor is provided, which can be connected into the circuit by adding a wire loop between the relevant terminals.

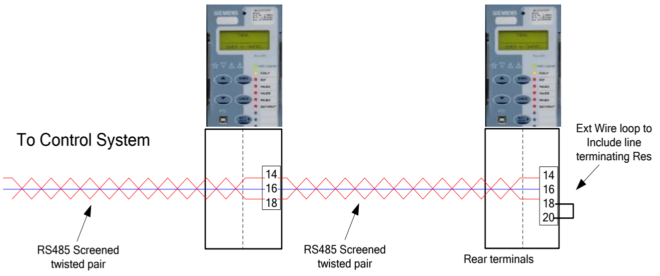


Fig1. Typical RS485 connection

The rear RS485 can be user selected to be OFF, IEC60870-5-103, MODBUS RTU or DNP3.0 protocol.

Ethernet Communications

IEC 61850

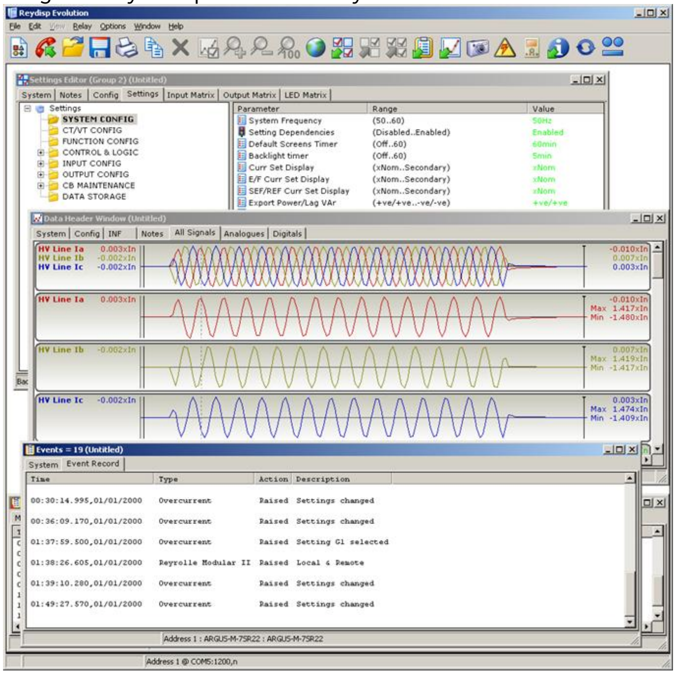
IEC61850 communication is available through an optional EN100 communication module. The EN100 Module can be ordered with either 2x Electrical RJ45 or 2x Fibre optic LC Ethernet ports.
Information on IEC61850 functionality can be found in the following 7SR2 documents:

Model Implementation Conformance Statement (MICS)

Protocol Implementation (PICS,PIXIT & TICS)

Reydisp Evolution

Reydisp Evolution is a Windows based software tool, providing the means for the user to apply settings, interrogate settings and retrieve events and disturbance waveforms from the device and is common to the entire range of Reyrolle protection relays.



Parameter	Range	Value
System Frequency	(50..60)	50Hz
Setting Dependencies	(Disabled..Enabled)	Enabled
Default Screens Timer	(Off..60)	60min
Backlight timer	(Off..60)	5min
Curr Set Display	(xNom..Secondary)	xNom
E/F Curr Set Display	(xNom..Secondary)	xNom
SEF/REF Curr Set Display	(xNom..Secondary)	xNom
Export Power/Lag VAr	(+ve/+ve..-ve/-ve)	+ve/+ve

Time	Type	Action	Description
00:30:14.995,01/01/2000	Overcurrent	Raised	Settings changed
00:36:09.170,01/01/2000	Overcurrent	Raised	Settings changed
01:37:59.500,01/01/2000	Overcurrent	Raised	Setting G1 selected
01:38:26.605,01/01/2000	Reyrolle Modular II	Raised	Local & Remote
01:39:10.280,01/01/2000	Overcurrent	Raised	Settings changed
01:49:27.570,01/01/2000	Overcurrent	Raised	Settings changed

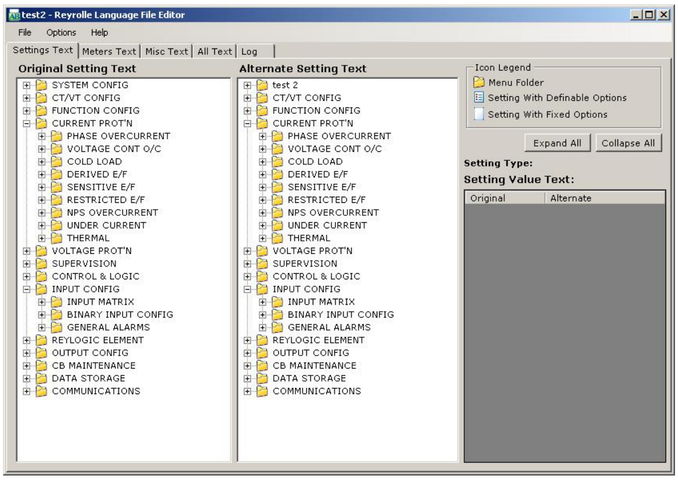
Address 1 : ARGUS-M-7SR22 : ARGUS-M-7SR22

Address 1 @ COM5:1200,n

Fig 2. Typical Reydisp Evolution Screenshot

Language Editor

The Language editor software gives the user the ability to customize the text displayed in the relays, Menu structure and instrumentation views. The tool allows a language file to be created and transferred to the relay also containing Western European characters.



Original Setting Text

- SYSTEM CONFIG
- CT/VT CONFIG
- FUNCTION CONFIG
- CURRENT PROT'N
  - PHASE OVERCURRENT
  - VOLTAGE CONT O/C
  - COLD LOAD
  - DERIVED E/F
  - SENSITIVE E/F
  - RESTRICTED E/F
  - NPS OVERCURRENT
  - UNDER CURRENT
  - THERMAL
- VOLTAGE PROT'N
- SUPERVISION
- CONTROL & LOGIC
- INPUT CONFIG
  - INPUT MATRIX
  - BINARY INPUT CONFIG
  - GENERAL ALARMS
- REYLOGIC ELEMENT
- OUTPUT CONFIG
- CB MAINTENANCE
- DATA STORAGE
- COMMUNICATIONS

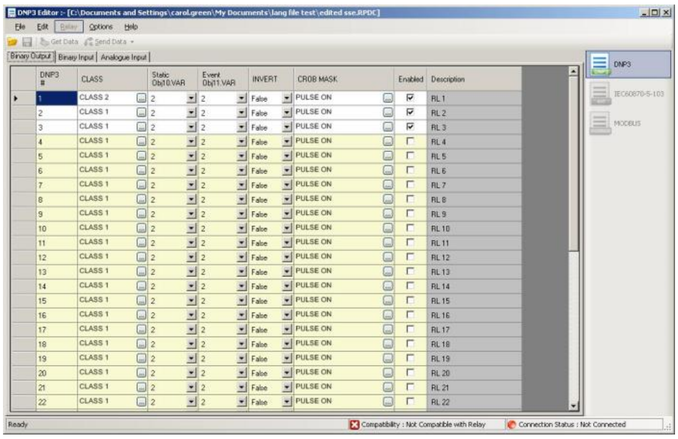
Alternate Setting Text

- test 2
- CT/VT CONFIG
- FUNCTION CONFIG
- CURRENT PROT'N
  - PHASE OVERCURRENT
  - VOLTAGE CONT O/C
  - COLD LOAD
  - DERIVED E/F
  - SENSITIVE E/F
  - RESTRICTED E/F
  - NPS OVERCURRENT
  - UNDER CURRENT
  - THERMAL
- VOLTAGE PROT'N
- SUPERVISION
- CONTROL & LOGIC
- INPUT CONFIG
  - INPUT MATRIX
  - BINARY INPUT CONFIG
  - GENERAL ALARMS
- REYLOGIC ELEMENT
- OUTPUT CONFIG
- CB MAINTENANCE
- DATA STORAGE
- COMMUNICATIONS

Fig 3. Typical Language Editor Screenshot

Communications Editor

To facilitate easier interfacing to a substation the relays default Protocol configuration may be modified using the communication editor software tool.
The communication editor is a PC based software package provided within the Reydisp software suite which allows modification of the IEC60870-5-103, DNP 3.0 and MODBUS Protocols.



DNP3 #	CLASS	Static Obj10.VAR	Event Obj11.VAR	INVERT	CROB MASK	Enabled	Description
1	CLASS 2	2	2	False	PULSE ON	☑	RL 1
2	CLASS 1	2	2	False	PULSE ON	☑	RL 2
3	CLASS 1	2	2	False	PULSE ON	☑	RL 3
4	CLASS 1	2	2	False	PULSE ON	☐	RL 4
5	CLASS 1	2	2	False	PULSE ON	☐	RL 5
6	CLASS 1	2	2	False	PULSE ON	☐	RL 6
7	CLASS 1	2	2	False	PULSE ON	☐	RL 7
8	CLASS 1	2	2	False	PULSE ON	☐	RL 8
9	CLASS 1	2	2	False	PULSE ON	☐	RL 9
10	CLASS 1	2	2	False	PULSE ON	☐	RL 10
11	CLASS 1	2	2	False	PULSE ON	☐	RL 11
12	CLASS 1	2	2	False	PULSE ON	☐	RL 12
13	CLASS 1	2	2	False	PULSE ON	☐	RL 13
14	CLASS 1	2	2	False	PULSE ON	☐	RL 14
15	CLASS 1	2	2	False	PULSE ON	☐	RL 15
16	CLASS 1	2	2	False	PULSE ON	☐	RL 16
17	CLASS 1	2	2	False	PULSE ON	☐	RL 17
18	CLASS 1	2	2	False	PULSE ON	☐	RL 18
19	CLASS 1	2	2	False	PULSE ON	☐	RL 19
20	CLASS 1	2	2	False	PULSE ON	☐	RL 20
21	CLASS 1	2	2	False	PULSE ON	☐	RL 21
22	CLASS 1	2	2	False	PULSE ON	☐	RL 22

Ready

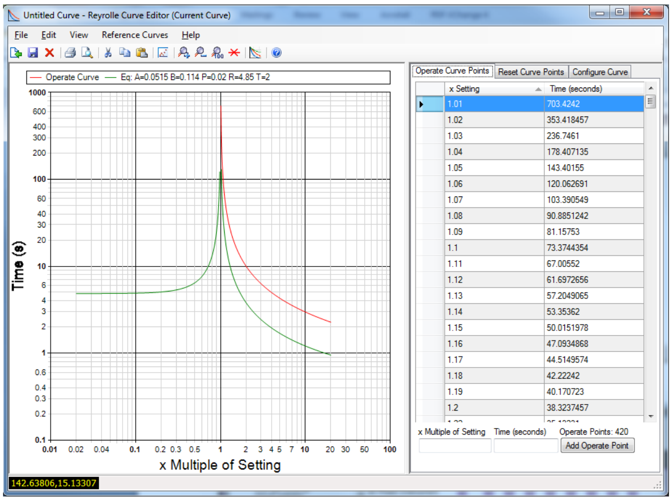
Compatibility : Not Compatible with Relay

Connection Status : Not Connected

Fig 4. Typical Communications Editor Screenshot

Curve Editor

The Curve Editor tool can be used to add user defined characteristics for use by any of the Voltage, Current or Thermal IDMTL elements.



x Setting	Time (seconds)
1.01	703.4242
1.02	353.418457
1.03	236.7461
1.04	178.407135
1.05	143.40155
1.06	120.062691
1.07	103.390549
1.08	90.8851242
1.09	81.15753
1.1	73.3744354
1.11	67.00552
1.12	61.6972656
1.13	57.2049065
1.14	53.35362
1.15	50.0151978
1.16	47.0934868
1.17	44.5149574
1.18	42.22242
1.19	40.170723
1.2	38.3237457

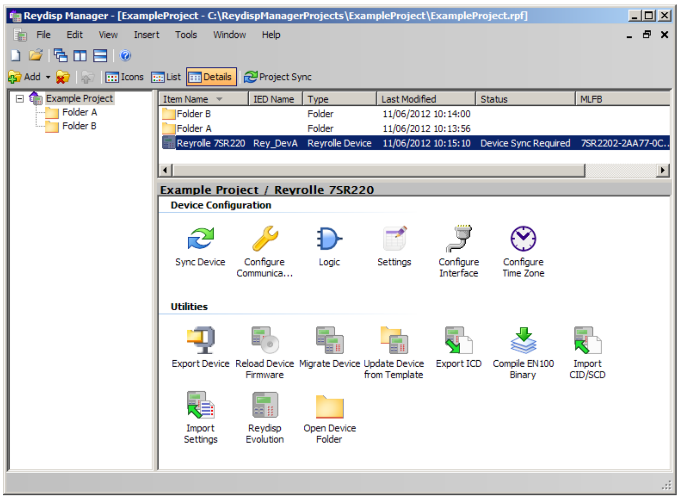
Fig 5. Typical Curve Editor Screenshot

Reydisp Manager

Reydisp Manager is a Windows based application which enables configuration of multiple Reyrolle devices.
It provides the following features:

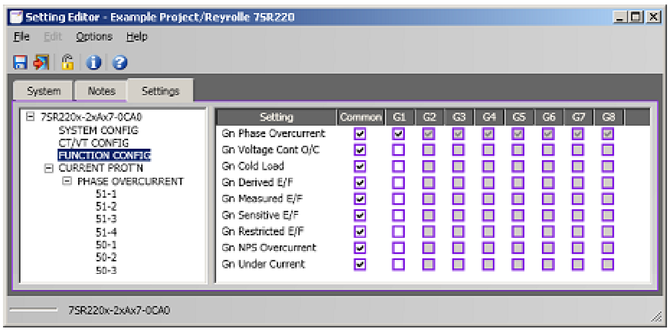
- Project based handling of all features of multiple devices to allow engineering of IEC61850 projects.
- Template based structure allowing offline configuration
- Configure and store device settings for all settings groups
- Create and edit graphical logic diagrams
- Configure data points and options for serial protocols
- Configure Language
- Configure User Curves
- Update device firmware

Please refer to the Reydisp Manager User Guide for further information.



Item Name	IED Name	Type	Last Modified	Status	MLFB
Folder B		Folder	11/06/2012 10:14:00		
Folder A		Folder	11/06/2012 10:13:56		
Reyrolle 7SR220	Rey_DevA	Reyrolle Device	11/06/2012 10:15:10	Device Sync Required	7SR2202-2AA77-0C..

Fig 6. Typical Reydisp Manager Screenshot



Setting	Common	G1	G2	G3	G4	G5	G6	G7	G8
Gn Phase Overcurrent	☑	☑	☑	☑	☑	☑	☑	☑	☑
Gn Voltage Cont O/C	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Cold Load	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Derived E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Measured E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Sensitive E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Restricted E/F	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn NPS Overcurrent	☑	☐	☐	☐	☐	☐	☐	☐	☐
Gn Under Current	☑	☐	☐	☐	☐	☐	☐	☐	☐

Fig 7. Typical Settings Editor Screenshot

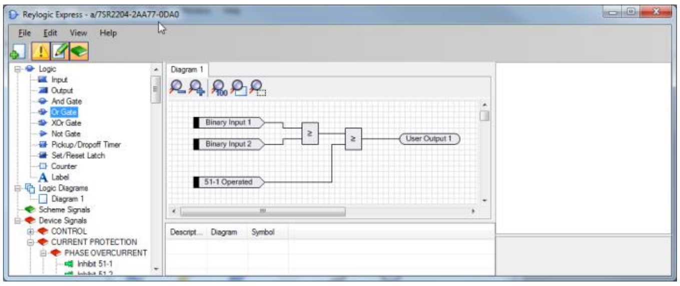
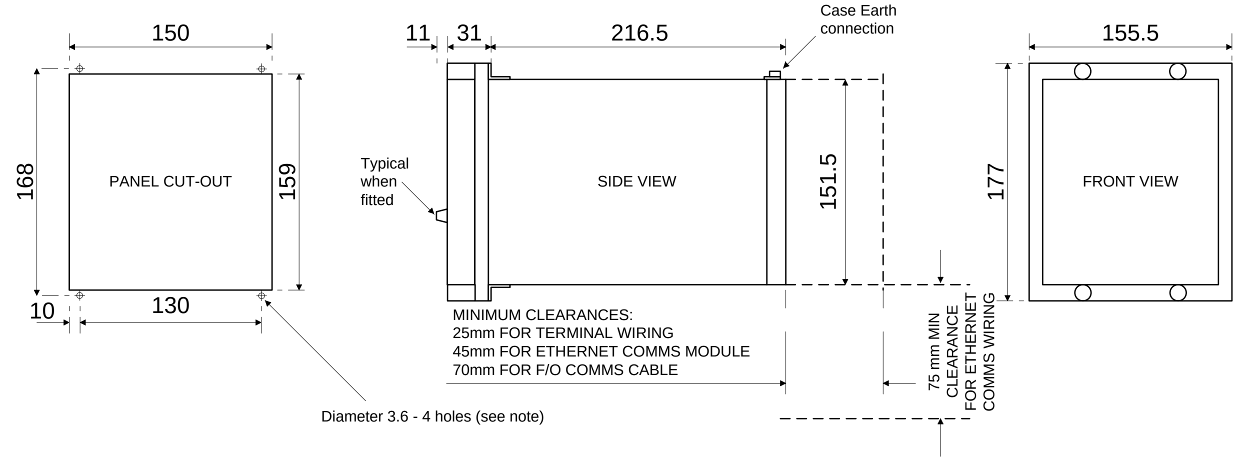


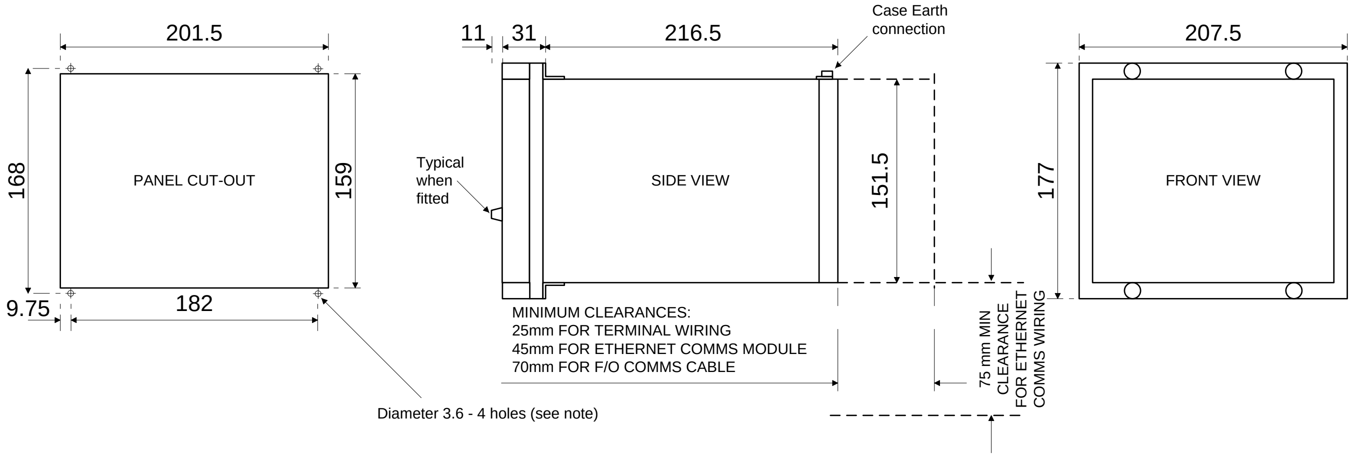
Fig 8. Typical Reylogic Express graphical logic editor Screenshot

Case Dimensions



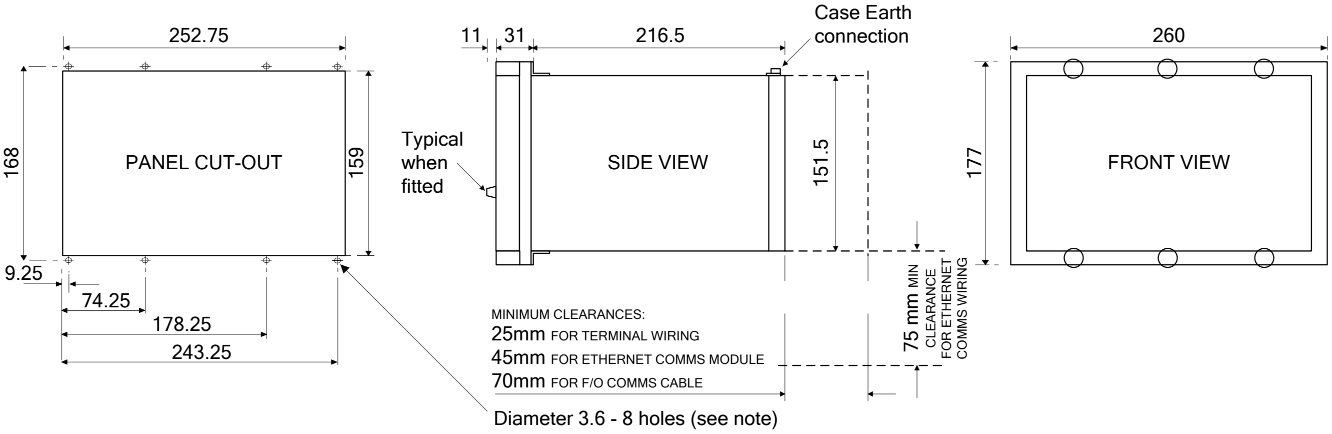
NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig9. E6 Case overall dimensions and panel drilling details (All dimensions in are mm)



NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

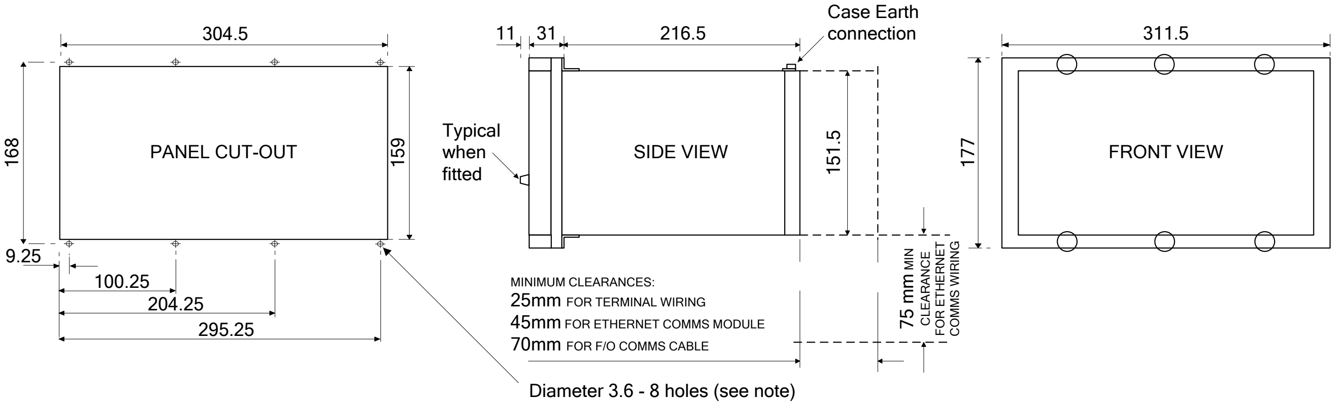
Fig 10. E8 Case overall dimensions and panel drilling details (All dimensions are in mm)



NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

THE RETAINING SCREW AT THE REAR OF THE CASE FOR THE ETHERNET VARIANT MUST BE FITTED FOR THE DEVICE TO COMPLY WITH PERFORMANCE CLAIMS.

Fig11. E10 Case overall dimensions and panel drilling details (All dimensions in are mm)



NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

THE RETAINING SCREW AT THE REAR OF THE CASE FOR THE ETHERNET VARIANT MUST BE FITTED FOR THE DEVICE TO COMPLY WITH PERFORMANCE CLAIMS.

Fig12. E12 Case overall dimensions and panel drilling details (All dimensions are in mm)

1.1.3.1 7SR210 & 7SR220 Non-Directional/Directional Overcurrent Relays

Description

The 7SR210 and 7SR220 are a new generation of non-directional and directional overcurrent protection relays, built on years of numeric relay protection experience with the Argus family of products. Housed in 4U high, size E6, E8 or E12 cases, these relays provide protection, control, monitoring, instrumentation and metering with integrated input and output logic, data logging & fault reports. Communication access to relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection. Additional rear port options are available.

Function Overview

Standard Functionality – 7SR210 & 7SR220

37	Undercurrent
46BC	Broken Conductor / Load Unbalance
46NPS	Negative Phase Sequence Overcurrent
49	Thermal Overload
50	Instantaneous Overcurrent
50G/N	Instantaneous Earth Fault
50BF	Circuit Breaker Fail
50AFD	Arc Flash Detector
51	Time Delayed Overcurrent
51G/N	Time Delayed Measured Earth Fault /SEF
60CTS-I	CT Supervision
64H	High Impedance REF
74TC/CC	Trip/Close Circuit Supervision
81HBL2	2nd Harmonic Block/Inrush Restraint
51c	Cold Load Pickup

8 Settings Groups
Password Protection – 2 levels
User Programmable Logic
Self Monitoring
CB Control

Standard Functionality - 7SR220 Directional Relay

21FL	Fault Locator
21LB	Load Blinder
32	Power
32S	Sensitive Power
27/59	Under/Over Voltage
47	Negative Phase Sequence (NPS) voltage
51V	Voltage Controlled Overcurrent
55	Power Factor
59N	Neutral Voltage Displacement
60CTS	CT Supervision
60VTS	VT Supervision
67/50	Bi-Directional Instantaneous Overcurrent
67/50G/N	Bi-Directional Instantaneous Earth Fault
67/51	Bi-Directional Time Delayed Overcurrent
67/51G/N	Bi-Directional Time Delayed Earth Fault
67/50/51	SEF for Compensated Networks
81	Under/Over Frequency
86	Lockout

Optional Functionality – 7SR210 & 7SR220

79 + 25	Auto Reclose + Check Sync

User Interface

20 character x 4 line backlit LCD
Menu navigation keys
3 fixed LEDs
8, 16 or 32 Programmable Tri-colour LEDs (Option)
6 or 12 Programmable Function Keys each with Tri-colour LED (Option)

Monitoring Functions

Standard Monitoring – 7SR210 & 7SR220

Primary & Secondary current phases and earth
Positive Phase Sequence (PPS) Current
Negative Phase Sequence (NPS) Current
Zero Phase Sequence (ZPS) Current
Binary Input/Output status
Trip circuit healthy/failure
Time and date
Starters
Fault records
Event records
Waveform records
Circuit breaker trip counters
I^2t summation for contact wear
Demand metering

Standard Monitoring - 7SR220 Directional Relay

Direction
Frequency
Primary line and phase voltages
Secondary voltages
Apparent power and power factor
Real and reactive power
W Hr forward and reverse
VAr Hr forward and reverse
Historical demand record
Positive phase sequence (PPS) Voltage
Negative phase sequence (NPS) Voltage
Zero phase sequence (ZPS) Voltage

Description of Functionality

With reference to figure 4 and figure 5 'Function Diagrams'.

Standard Functionality

37 Undercurrent

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates if current falls below setting for duration of delay.

46BC Phase Unbalance/Broken Conductor

Element has settings for pickup level and DTL delay. With the circuit breaker closed, if one or two of the line currents fall below setting this could be due to a broken conductor.

46NPS Negative Phase Sequence Overcurrent

Two elements, one DTL and one IDMT, with user settings for pickup level and delays, will operate if NPS Current exceeds setting and delay. NPS Current elements can be used to detect unbalances on the system or remote earth faults when a delta-star transformer is in circuit.

49 Thermal Overload

The thermal algorithm calculates the thermal states from the measured currents and can be applied to lines, cables and transformers. Outputs are available for thermal overload and thermal capacity.

50/51 Phase Fault

50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI Time Current Characteristics. The IDMT stage has a user programmable reset characteristic, either DTL or shaped current/time reset characteristic, to improve grading with electromechanical protection.

50G/51G/50N/51N Earth Fault/Sensitive Earth Fault

Two earth fault measurement modes are available. One mode directly measures the earth current from an independent CT, or the residual connection of the 3 line CTs. This input can be set to be either earth fault or sensitive earth fault (50G/51G). The second mode derives the earth current internally from the 3 phase CTs (50N/51N). 50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI Time Current Characteristics. The IDMT stage has a user programmable reset characteristic either DTL or shaped current/time reset characteristic to improve grading with electromechanical protection.

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. Line currents are monitored following a trip signal and an output is issued if any current is still detected after a specified time interval. This can be used to re-trip the CB or to back-trip an upstream CB. A second back-trip time delay is available to enable another stage to be utilized if required.

60CTS-I CT Supervision

The CTS-I CT Supervision function monitors each phase current input and operates if any one or two inputs fall below the setting. The element types have user operate and delay settings.

64H Restricted Earth Fault - scheme

The measured earth fault input may be used in a 64H high impedance restricted earth fault scheme. Required external series stabilising resistor and non-linear shunt resistor can be supplied.

74TC/CC Trip/Close Circuit Supervision

The trip/close circuit(s) can be monitored via binary inputs connected in H4/H5/H6 or H7 schemes. Trip/Close circuit failure raises an HMI alarm and output(s).

81HBL2/5 Harmonic Block / Inrush Restraint / Overfluxing

Where second harmonic current is detected (i.e. during transformer energisation) user selectable elements can be blocked.

51c Cold Load

If a circuit breaker is closed onto a 'cold' load, i.e. one that has not been powered for a prolonged period, this can impose a higher than normal load-current demand on the system which could exceed normal settings. These conditions can exist for an extended period and must not be interpreted as a fault. To allow optimum setting levels to be applied for normal operation, the cold load pickup feature will apply alternative settings for a limited period. The feature resets when either the circuit breaker has been closed for a settable period, or if the current has reduced beneath a set level for a user set period.

21FL Fault Locator

The relay provides a basic single-end type fault locator which is able to estimate the fault position using analogue information measured by the relay at one end of the protected circuit during the short duration of the fault.

21LB Load Blinder

Load Blinders are used with overcurrent elements to block tripping during periods of high reverse load currents that can occur in distribution networks. The blinder is operated during user defined load conditions and is used in conjunction with the relay protection elements.

50AFD Arc Flash Detector

The 7SR2 relays can be used with the 7XG31 ReyArc range of Arc Flash Detection devices. Arc fault protection is a technique employed for the fast clearance of arcing faults on busbars, within metal clad switchgear & associated cable boxes. The arc is detected using an optical sensor & the signal input to a protection device which also monitors the load current on the system. A trip signal can be achieved in less than 10 ms using arc detection only or within 20 ms when using overcurrent check.

Programmable User Logic

The user can map Binary Inputs and Protection operated outputs to Function Inhibits, Logic Inputs, LEDs and/or Binary Outputs. The user can also enter up to 16 equations defining scheme logic using standard functions e.g. Timers, AND/OR gates, Inverters and Counters. Each Protection element output can be used for Alarm & Indication and/or tripping.

Circuit Breaker Maintenance

Two circuit breaker operations counters are provided. The Maintenance Counters record the overall number of operations and the Delta Counter the number of operations since the last reset. An I^2t summation Counter provides a measure of the contact wear indicating the total energy interrupted by the circuit breaker contacts. Each counter has a user set target operations count which, when reached, can be mapped to raise Alarms/ Binary Outputs. These counters assist with maintenance scheduling.

Function LED's

Eight, sixteen or thirty-two user programmable tri-colour LED's are provided eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED can be user set to red, green or yellow allowing for clear indication of the associated function's state. A slip-in label pocket along-side enables the user to insert customised notation. A printer compatible template is available.

Function Keys

Six or twelve user programmable function keys are available for implementing User logic and scheme control functionality, eliminating the need for expensive panel mounted control switches and associated wiring. Each function key has an associated user programmable tri-color LED (red, green, yellow) allowing for clear indication of the associated function's state. A slip-in label pocket along-side enables the user to insert his own notation for the function Key LED Identification. Each Function Key can be mapped directly to any of the built-in Command functions or to the User Logic equations.

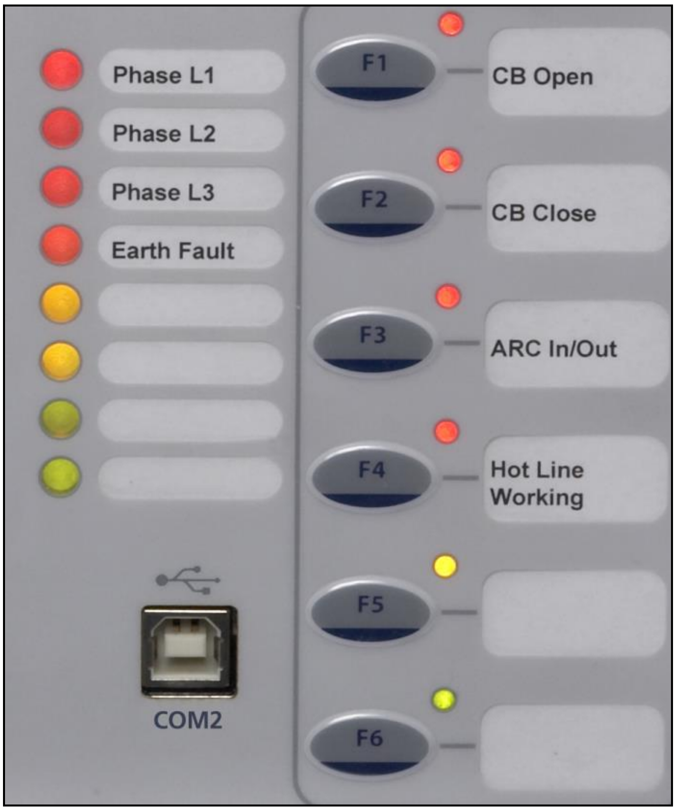


Fig1. Tri-colour LED's and function keys

Additional Functionality

27/59 Under/Over Voltage

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if voltage 'exceeds' setting for duration of delay. Can be applied in load shedding schemes.

47 Negative Phase Sequence Overvoltage

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates if NPS Voltage exceeds setting for duration of delay.

51V Voltage Controlled OverCurrent

Element has settings for UnderVoltage pickup level and operates if voltage falls below setting. On Pick-up this element applies the set 51v Multiplier to the pickup setting of the 67/51 phase fault elements.

59N Neutral Overvoltage

Two elements, one DTL and one IDMTL, have user settings for pickup level and delays. These will operate if the Neutral voltage exceeds the setting for duration of delay. Neutral overvoltage can be used to detect earth faults in high impedance earthed or isolated systems.

60CTS CT Supervision

The CT Supervision considers the presence of negative phase sequence current, without an equivalent level of negative phase sequence voltage, for a user set time as a CT failure. Element has user operate and delay settings.

60VTS VT Supervision

The VT Supervision uses a combination of negative phase sequence voltage and negative phase sequence current to detect a VT fuse failure. This condition may be alarmed or used to inhibit voltage dependent functions. Element has user operate and delay settings.

67/67N Directional Control

Phase fault, Earth fault and Sensitive Earth fault elements can be directionalised. Each element can be user set to Forward, Reverse, or Non-directional. Directional Phase fault elements are polarised from quadrature voltage. Earth fault elements can be user set to be polarised from residual voltage or negative phase sequence voltage.

81 Under/Overfrequency

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if frequency exceeds setting for duration of delay. Typically applied in load shedding schemes.

Optional Functionality

79 Auto-Reclose

This function provides independent Phase fault and Earth Fault/Sensitive Earth fault sequences of up to 5 Trips i.e. 4 Reclose attempts before Lockout. Auto-Reclose sequence can be user set to be initiated from internal protection operation or via Binary Input from an external Protection. The user can set each trip in the sequence to be either instantaneous (Fast) or delayed. Independent times can be set by the user for Reclose (Dead) time and Reclaim time.

25 Check Sync

The check synchronizing function is used to check that the voltage conditions, measured by the voltage transformers on either side of the open circuit breaker, indicate that it is safe to close without risk of damage to the circuit breaker or disturbance to the system.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	3 x Phase & 1 x Earth or Sensitive Earth
Rated Current IN	1 A / 5 A
Measuring Range	80 xIn
Instrumentation ≥ 0.1xIn	±1% In
Frequency	50 Hz / 60 Hz
Thermal Withstand:	
Continuous	3.0 xIn
10 Minutes	3.5 xIn
5 Minutes	4.0 xIn
3 Minutes	5.0 xIn
2 Minutes	6.0 xIn
3 Seconds	57.7 A (1 A) 202 A (5 A)
2 Seconds	70.7 A (1 A) 247 A (5 A)
1 Second	100 A (1 A) 350 A (5 A)
1 Cycle	700 A (1 A) 2500 A (5 A)
Burden @ In	≤0.1 VA (1 A phase and Earth element) ≤0.3 VA (5 A phase and earth element)

Voltage Inputs

Quantity	4
Nominal Voltage	40...160 V a.c. Range
Instrumentation ≥ 0.8 xVn	±1% Vn
Thermal Withstand:	
Continuous and 1 Second	300 V
Burden @ 110 V	≤ 0.1 VA

DC Auxiliary supply

Nominal voltage	Operating Range
24 V dc to 250 V dc	19.2 V dc to 275 V dc
100 V ac to 230 V ac	80 V ac to 253 V ac
Allowable superimposed ac component	12% of DC voltage
Allowable breaks/dips in supply (collapse to zero)	50 ms (DC) 2.5/3 cycles (AC)

Auxiliary supply: Power Consumption

Quiescent State (DC)	24V: 8W 110V: 7W 250V: 7W
Maximum Load (DC)	24V: 12W 110V: 11W 250V: 11W
Quiescent State (AC)	100V: 16VA 230V: 21VA
Maximum Load (AC)	100V: 23VA 230V: 30VA

Binary Inputs

Operating Voltage	19 V dc: Range 17 to 290 V dc 88 V: Range 74 to 290 V dc
Maximum dc current for operation	1.5 mA

Binary Outputs

Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand Reset
Contact Operate / Release Time.	7 ms / 3 ms
Making Capacity:	
Carry continuously	5 A ac or dc
Make and carry (L/R ≤ 40 ms and V ≤ 300 V)	20 A ac or dc for 0.5 s 30 A ac or dc for 0.2 s
Breaking Capacity (≤ 5 A and ≤ 300 V):	
AC Resistive	1250 VA
AC Inductive	250 VA at p.f. ≤ 0.4
DC Resistive	75 W
DC Inductive	30 W at L/R ≤ 40 ms 50 W at L/R ≤ 10 ms

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration endurance	1.0 gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %
Shock withstand	15 gn, 11 ms	≤ 5 %
Bump test	10 gn, 16 ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	1 gn	≤ 5 %

Mechanical Classification

Durability	>10^6 operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	2.0 kV AC RMS for 1 min
Across normally open contacts	1.0 kV AC RMS for 1 min

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Common (longitudinal)	2.5 kV	≤ 5%
Series (transverse) mode	1.0 kV	≤ 5%

Electrostatic Discharge
IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5%

Fast Transients
IEC 60255-22-4 Class IV

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4 kV	≤ 5%

Surge Immunity
IEC 60255-22-5

Type	Level	Variation
Between all terminals and earth	4.0 kV	≤ 10% or 1 mA
Between any two independent circuits	2.0 kV	

Conducted Radio Frequency Interference
IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5%

Radiated Radio Frequency
IEC 60255-25

Type	Limits at 10m, Quasi-peak
30 to 230 MHz	40 dB(μV/m)
230 to 10000 MHz	47 dB(μV/m)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(μV)	66 dB(μV)
0.5 to 30 MHz	73 dB(μV)	60 dB(μV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level	Variation
80 MHz to 1000 MHz	10 V/m	≤ 5%

Magnetic Field with Power Frequency
IEC 61000-4-8, Class V

Type	Level
100 A/m (0.126 mT) continuous	50 Hz
1000 A/m (1.26 mT) for 3s	

Environmental Tests

Temperature
IEC 60068-2-1, IEC 60068-2-2

Operating Range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity
IEC 60068-2-30, IEC 60068-2-78

Operational test (Indoor)	56 days at 40 °C and 95% relative humidity (r.h.)
Operational test (Outdoor)	6 cycles at 24 h between +25 °C (97% r.h.) and +55 °C (93% r.h.)

IP Ratings
IEC 60529

Type	Level
Installed with cover	IP 51 from front of relay
Installed with cover removed	IP 20 from front of relay

For full technical data refer to the Performance Specification Section of the Technical Manual.

Performance

27/59 Under/Over Voltage

Number of Elements	4 Under or Over
Operate	Any phase or All phases
Voltage Guard	1, 1.5...200 V
Setting Range Vs	5,5.5...200 V
Hysteresis Setting	0,0.1...80%
Vs Operate Level	100% Vs, ±1% or ±0.25 V
Reset Level: - Undervoltage Overvoltage	 =(100%+hyst) xVop, ±1% or 0.25 V =(100%-hyst) xVop, ±1% or 0.25 V
Delay Setting td	0.00,0.01...20,20.5...100,101...1000,1010...10000,10100...14400 s
Basic Operate Time: - 0 to 1.1xVs 0 to 2.0xVs 1.1 to 0.5xVs	 73 ms ±10 ms 63 ms ±10 ms 58 ms ±10 ms
Operate time following delay.	$t_{basic} + t_d$, ±1% or ±10 ms
Inhibited by	Binary or Virtual Input VT Supervision, Voltage Guard

37 Undercurrent

Number of Elements	2
Setting Range Is	0.05,0.10...5.0 x In
Operate Level	100% Is, ±5% or ±1% xIn
Delay Setting td	0.00,0.01..20,20.5..100,101..1000,1010..10000,10100..14400s
Basic Operate Time: - 1.1 to 0.5xIn	35 ms ±10 ms
Operate time following delay.	$t_{basic} + t_d$, ±1% or ±10 ms
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input

46 Negative Phase Sequence Overcurrent

Number of Elements	DT & IT
DT Setting Range Is	0.05,0.10...4.0 x In
DT Operate Level	100% Is, ±5% or ±1%xIn
DT Delay Setting td	0.00,0.01...20,20.5...100,101...1000,1010...10000,10100........14400 s
DT Basic Operate Time – 0 to 2 xIs 0 to 5 xIs	 40 ms ±10 ms 30 ms ±10 ms
DT Operate time following delay.	$t_{basic} + t_d$, ±1% or ±10 ms
IT Char Setting	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL
IT Setting Range	0.05, 0.06..2.5 xIn
Tm Time Multiplier	0.025,0.050...1.6
Char Operate Level	105% Is, ±4% or ±1% xIn
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input

47 Negative Phase Sequence Voltage

Number of Elements	2
Setting Range Vs	1, 1.5…90 V
Hysteresis Setting	0, 0.1…80%
Operate Level	100% Vs, ±2% or ±0.5 V
Delay Setting td	0.00,0.01…20,20.5…100, 101…1000,1010…10000, 10100……..14400 s
Basic Operate Time: - 0V to 2.0xVs 0V to 10xVs	 80 ms ±20 ms 55 ms ±20 ms
Operate time following delay.	t_{basic} +t_d , ±2% or ±20 ms
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input

49 Thermal Overload

Operate levels	Operate and Alarm
Setting Range Is	0.10, 0.11…3.0 xIn
Operate Level	100% Is, ±5% or ±1% xIn
Time Constant Setting	1, 1.5…1000 min
Operate time	$t = \tau \times In\left\{\frac{I^2 - I_p^2}{I^2 - (k \times I_B)^2}\right\}$ ±5% absolute or ±100 ms where Ip = prior current
Capacity Alarm Level	Disabled, 50,51…100%
Inhibited by	Binary or Virtual Input

50 (67) Instantaneous & DTL OC & EF (Directional)

Operation	Non directional, Forward or reverse
Elements	Phase, Derived Earth, Measured Earth & SEF
Number of Elements	4 x OC 4 x Derived E/F ‘N’ 4 x Measured E/F ‘G’ 4 x SEF
Setting Range Is: - O/C Derived E/F ‘N’ Measured E/F ‘G’ SEF	 0.05,0.06…50 xIn 0.05,0.06…50 xIn 0.005…25 xIn 0.005…5 xIn
Time Delay	0.00…14400 s
Operate Level	100% I_s, ±5% or ±1% xIn
Operate time: - Current switched from 0 to 2x Current switched from 0 to 5x	 2x Is: 40 ms, ±10 ms, 5x Is: 30 ms, ±10 ms
Operate time following delay	t_{basic} +t_d , ±1% or ±10 ms
Inhibited by	Binary or Virtual Input Inrush detector VT Supervision

51(67) Time Delayed OC&EF (Directional)

Operation	Non directional, Forward or reverse
Elements	Phase, Derived Earth, Measured Earth & SEF
Number of Elements: -	4 x OC 4 x Derived EF ‘N’ 4 x Measured EF ‘G’ 4 x SEF
Characteristic	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL
Setting Range Is: - O/C Derived E/F ‘N’ Measured E/F ‘G’ SEF	 0.05,0.06…2.5 xIn 0.05,0.06…2.5 xIn 0.005…1 xIn 0.005…1 xIn
Time Multiplier	0.025,0.05…1.6
Time Delay	0,0.01… 20 s

Operate Level	105% Is, ±4% or ±1%xIn
Minimum Operate time IEC ANSI	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$ $t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5 % absolute or ± 30 ms
Follower Delay	0 – 20 s
Reset	ANSI decaying, 0 – 60 s
Inhibited by	Binary or Virtual Input Inrush detector VT Supervision

51V Voltage Controlled Overcurrent

Setting Range	5,5.5…200 V
Operate Level	100% Vs, ±5% or ±1% xVn
Multiplier	0.25.0.3…1
Inhibited by	VT Supervision

50BF Circuit Breaker Fail

Operation	Current check - Phase and Measured Earth with independent settings, Mechanical Trip, CB Faulty Monitor
Setting Range Is	0.05,0.055…2.0 xIn
2 Stage Time Delays	Timer 1 20…60000 ms Timer 2 20…60000 ms
Operate Level	100% Is, ±5% or ±1% xIn
Basic Operate time	< 20 ms
Operate time following delay	t_{delay} ±1% or ±20 ms
Triggered by	Any function mapped as trip contact.
Inhibited by	Binary/Virtual Input
Timer By pass	Yes, 50BF CB Faulty Input

59N Neutral Voltage Displacement

Number of Elements	NDT & NIT
NDT Operate Level	100% V_s, ±2% or ±0.5V
NDT Delay Setting t_d	0, 0.01 20, 20.5… 100, 101… 1000, 1010… 10000, 10100… 14400 s
NDT Basic Operate Time: - 0V to 1.5 xV_s 0V to 10 xV_s	 76 ms ±20 ms 63 ms ±20 ms
NDT Operate time following delay.	t_{basic} +t_d , ±1% or ±20 ms
NDT & NIT Setting Range I_s	1, 1.5…100 V
Tm Time Multiplier(IDMT)	0.1, 0.2… 10, 10.5… 140
Delay (DTL)	0, 0.01…20 s
Reset	ANSI decaying, 0 … 60 s
NIT Operate Level	105% V_s, ±2% or ±0.5 V
Inhibited by	Binary or Virtual Input

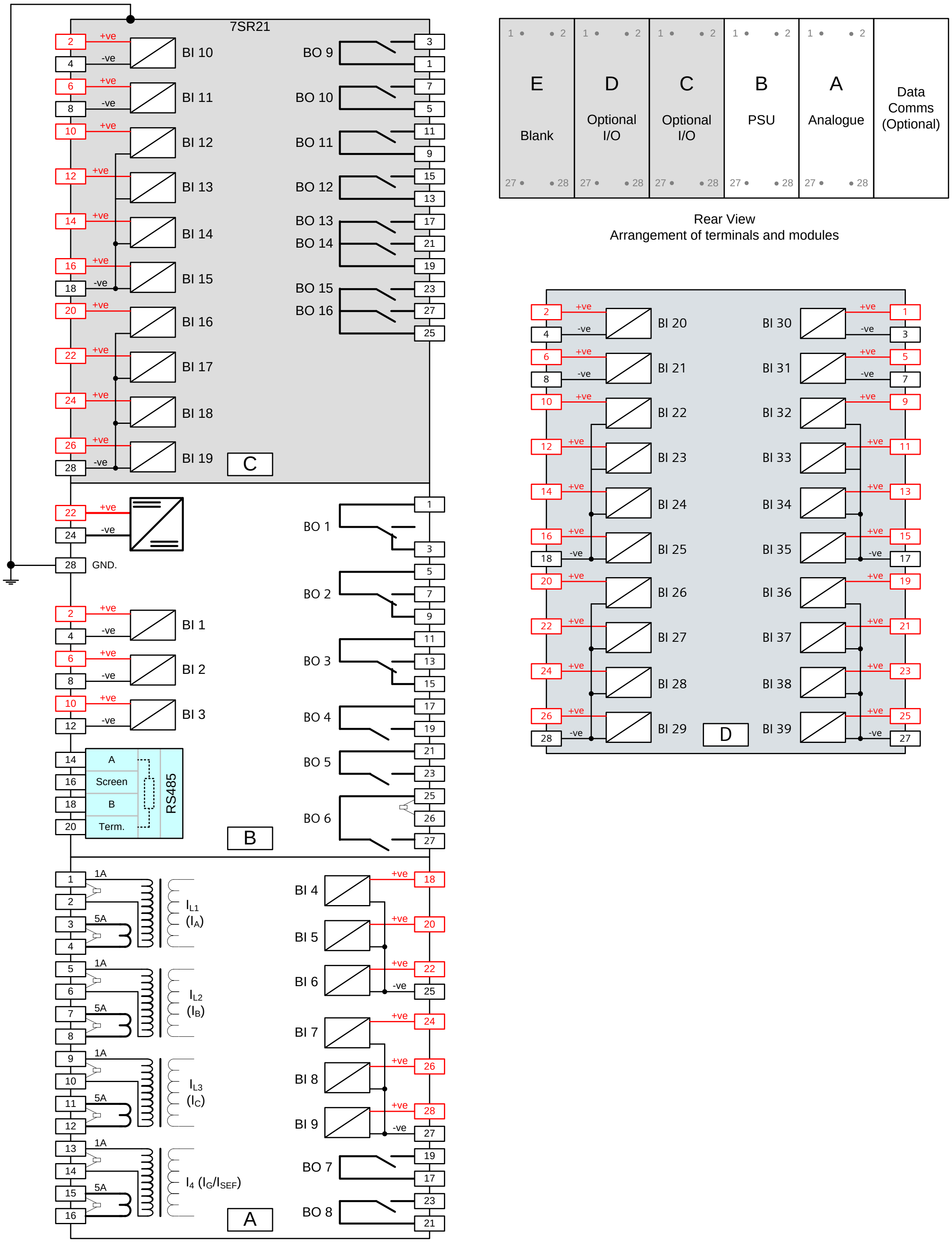
60 Supervision

CT	(7SR210n) CTS-I (7SR220n) CTS-I, CTS Vnps, CTS Inps
VT	(7SR220n) VTS Vnps, VTS Vzps
Delay	0.03, 0.04… 20.00, 20.50… 100, 101… 1000, 1010…10000, 10100… 14400 s

64H Restricted Earth Fault

Setting Range	0.005…0.95 xI_n
Operate Level	100% I_s, ±5% or ±1% xIn
Time Delay	0.00… 14400 s
Basic Operate Time	0 to 2 xI_s 40 ms ±10 ms 0 to 5 xI_s 30 ms ±10 ms
Inhibited by	Binary or Virtual Input

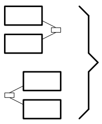
7SR210 Connection Diagram



Rear View
Arrangement of terminals and modules

NOTES

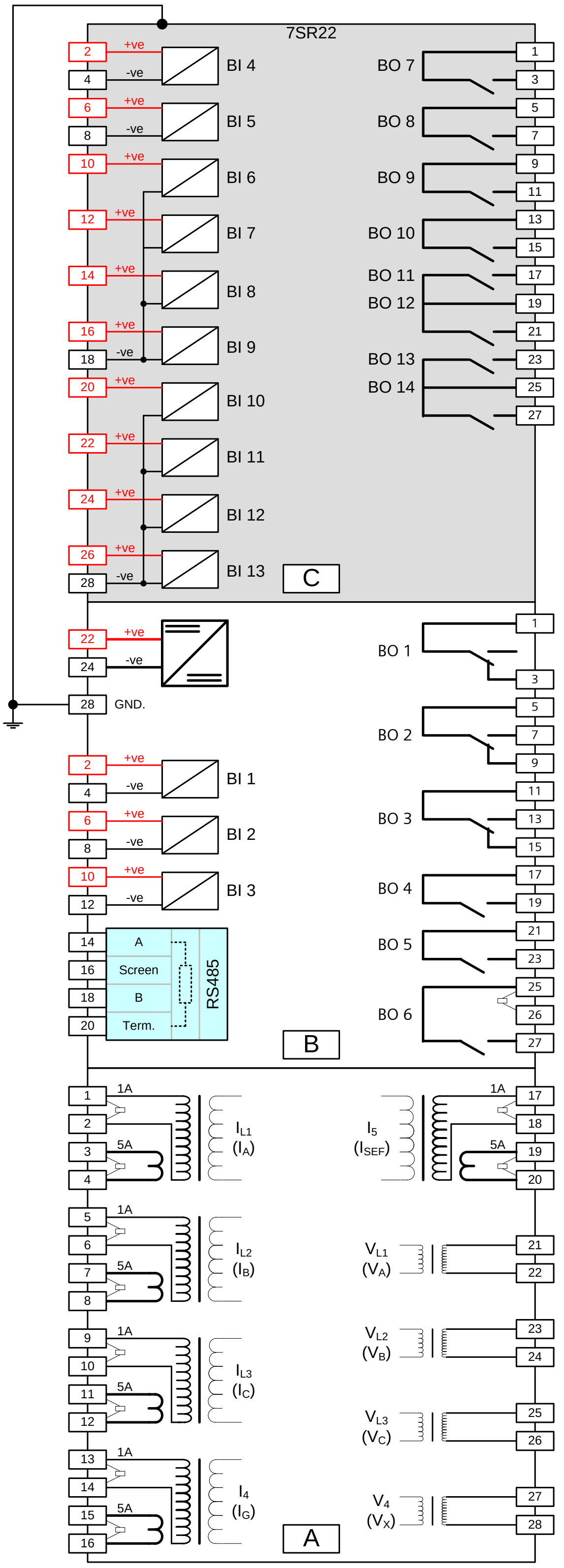
BI = Binary Input
BO = Binary Output

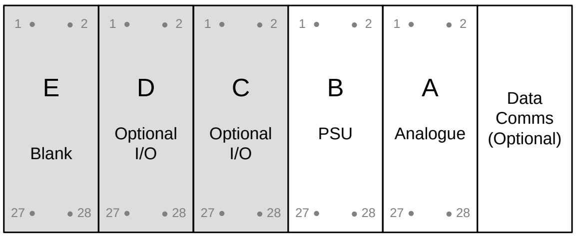


Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

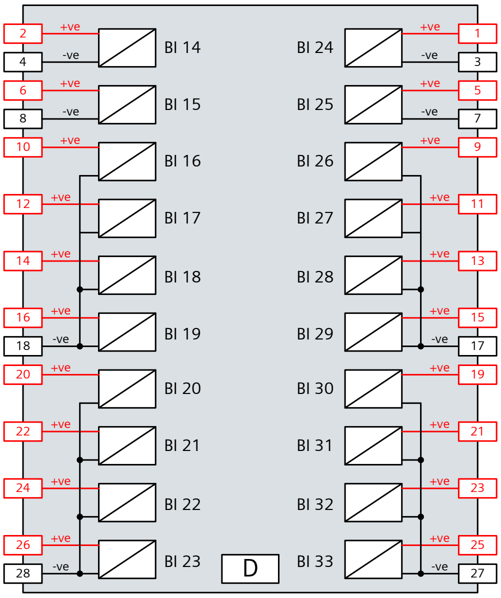
Fig2. 7SR210 Wiring Diagram

7SR220 Connection Diagram



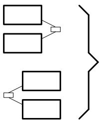


Rear View
Arrangement of terminals and modules



NOTES

BI = Binary Input
BO = Binary Output



Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig3. 7SR220 Wiring Diagram

Function Diagrams for 7SR210 & 7SR220

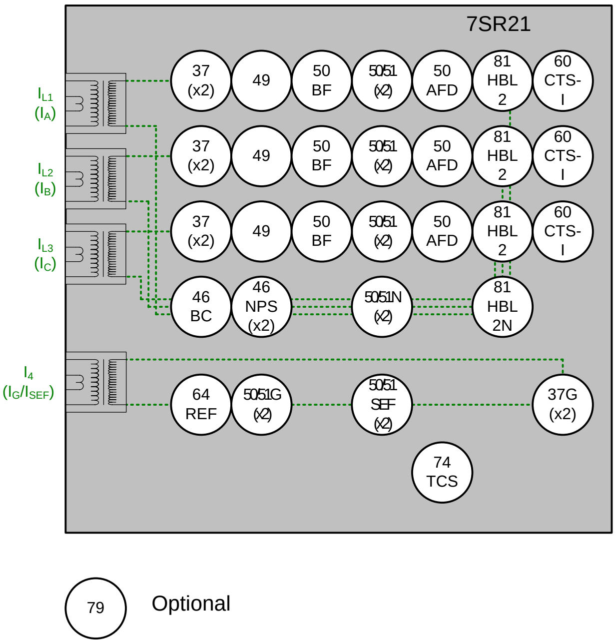


Fig4. 7SR210 Function Diagram

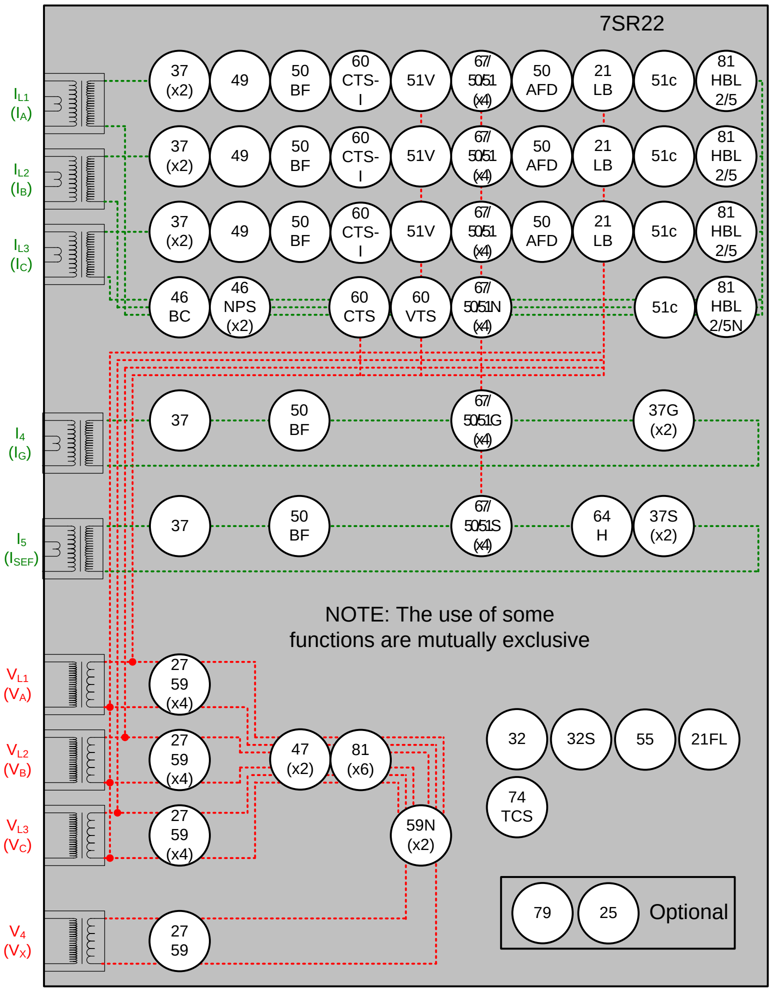


Fig5. 7SR220 Function Diagram

Ordering Information – 7SR210 Overcurrent Relay

Product description	Variants	Order No.

7	S	R	2	1	0		-	1		A			-	0		A	0

Protection Product Family

Overcurrent - Non Directional	1

Relay Type

	0

Case, I/O and Fascia [1)]

E6 case, 4 CT, 9 Binary Inputs, 8 Binary Outputs, 8 LEDs	2
E8 case, 4 CT, 19 Binary Inputs, 16 Binary Outputs, 16 LEDs	3
E8 case, 4 CT, 19 Binary Inputs, 16 Binary Outputs, 8 LEDs + 6 keys	4
E12 case, 4 CT, 39 Binary Inputs / 16 Binary Outputs, 32 LEDs	5
E12 case, 4 CT, 39 Binary Inputs / 16 Binary Outputs, 16 LEDs, 12 keys	6

Measuring input

1 A or 5 A, 50 Hz or 60 Hz	1

Auxiliary voltage

PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 19V DC (Rated: 24-250V DC)	M
PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 88V DC (Rated: 110-250V DC)	N

Spare

	A

Communication Interface

Standard version - included in all models, USB front port, RS485 rear port	1	
Standard version - plus additional rear F/O ST connectors (x2) and IRIG-B	2	
Standard version - plus additional rear RS485 and IRIG-B	3	
Standard version - plus additional rear RS232 and IRIG-B	4	
Standard version - plus additional rear Electrical Ethernet RJ45 (x2)	7	7
Standard version - plus additional rear Optical Ethernet Duplex (x2)	8	7

Protocol

IEC 60870-5-103 and Modbus RTU (user selectable)		1
IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable)		2
IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable) and IEC61850	7-8	7

Spare

	0

Protection Function Packages

Standard version - included in all models		C
37	Undercurrent	
46BC	Broken conductor/load unbalance	
46NPS	Negative phase sequence overcurrent	
49	Thermal overload	
50	Instantaneous phase fault overcurrent	
50BF	Circuit breaker fail	
50G/50N	Instantaneous earth fault/SEF	
50 AFD	Arc Flash Detector	
51	Time delayed phase fault overcurrent	
51G/51N	Time delayed earth fault/SEF	
60CTS-I	CT supervision	
64H	High impedance REF	
74TC/CCS	Trip & close circuit supervision	
81HBL2	Inrush Detector	
81HBL5	Overfluxing Detector	
86	Lockout	
	Cold load pickup	
	Programmable logic	
	CB Control	
Standard version - plus		D
79	Autoreclose	

Additional Functionality

No additional functionality	A

Spare

	0

Export Data
HS: 8536900
ECCN: N
AL: N

Ordering Information – 7SR220 Directional Overcurrent Relay

Product description	Variants	Order No.

7	S	R	2	2	0		-	2		A			-	0		A	0

Protection Product Family

Overcurrent - Directional	2	

Relay Type

	0	

Case, I/O and Fascia [1]

E6 case, 5 CT, 4 VT, 3 Binary Inputs, 6 Binary Outputs, 8 LEDs	2	C
E8 case, 5 CT, 4 VT, 13 Binary Inputs, 14 Binary Outputs, 16 LEDs	3	
E8 case, 5 CT, 4 VT, 13 Binary Inputs, 14 Binary Outputs, 8 LEDs + 6 keys	4	
E12 case, 5 CT, 4 VT, 33 Binary Inputs / 14 Binary Outputs, 32 LEDs	5	
E12 case, 5 CT, 4 VT, 33 Binary Inputs / 14 Binary Outputs, 16 LEDs, 12 keys	6	

Measuring input

1 A or 5 A, 40 V to 160 V, 50 Hz or 60 Hz	2	

Auxiliary voltage

PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 19V DC (Rated: 24-250V DC)	M	
PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 88V DC (Rated: 110-250V DC)	N	

Spare

	A	

Communication Interface

Standard version - included in all models, USB front port, RS485 rear port	1	
Standard version - plus additional rear F/O ST connectors (x2) and IRIG-B	2	
Standard version - plus additional rear RS485 and IRIG-B	3	
Standard version - plus additional rear RS232 and IRIG-B	4	
Standard version - plus additional rear Electrical Ethernet RJ45 (x2)	7	7
Standard version - plus additional rear Optical Ethernet Duplex (x2)	8	7

Protocol

IEC 60870-5-103 and Modbus RTU (user selectable)		1
IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable)		2
IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable) and IEC61850	7-8	7

Spare

	0

Protection Function Packages

Standard version - included in all models		C
21FL	Fault Locator	
21LB	Load Blinder	
27/59[1]	Under/overvoltage	
32	Power	
32S	Sensitive Power	
37	Undercurrent	
37G[1]	Ground Undercurrent	
37SEF[1]	SEF Undercurrent	
46BC	Broken conductor/load unbalance	
46NPS	Negative phase sequence overcurrent	
47[1]	Negative phase sequence voltage	
49	Thermal overload	
50	Instantaneous phase fault overcurrent	
50BF	Circuit breaker fail	
50G/50N	Instantaneous earth fault	
50 AFD	Arc Flash Detector	
51V	Voltage dependent overcurrent	
55	Power factor	
59N	Neutral voltage displacement	
60CTS	CT supervision	
60CTS-I	CT supervision	
60VTS	VT supervision	
64H	High impedance REF	
67/50	Directional instantaneous phase fault overcurrent	
67/50G 67/50N	Directional instantaneous earth fault/SEF	
67/51	Directional time delayed phase fault overcurrent	
67/51G 67/51N	Directional tIme delayed earth fault/SEF	
74TC/CCS	Trip & close circuit supervision	
81	Under/overfrequency	
81HBL2	Inrush Detector	
81HBL5	Overfluxing	
86	Lockout	
	Cold load pickup	
	Programmable logic	
	CB Control	
Standard version - plus		D
79	Autoreclose	
Standard version - plus		E
79 + 25	Autoreclose + Check Sync	

Additional Functionality

No additional functionality	A

Spare

	0

[1] 5CT is configured as 3PF + EF/SEF + EF/SEF (user selectable setting).

Export Data
HS: 8536900
ECCN: N
AL: N

1.1.3.2 7SR224 Recloser Controller

Description

The 7SR224 Recloser Controller is one of a range of devices providing comprehensive directional and non-directional overcurrent protection integrated with associated protection elements and Autoreclose scheme logic. It builds on the years of in-service experience gained from the Argus family of products. The Controller provides independent Phase Fault, Earth Fault and Sensitive Earth Fault autoreclose sequences. Each sequence can be user set to any mix of Instantaneous (fast time current characteristic (TCC)) or Delayed TCC protection and independent Reclose (Dead) times. The Controller also provides a separate Autoreclose sequence for external protection.
Functions included are: -
Control, monitoring, instruments, Voltage - Sag & Swell, together with integrated input and output logic, data logging & fault report functions.
Controllers are housed in 4U high, size E10 or E12 cases.

Function Overview

Standard Functionality

21FL	Fault Location
27/59	Under/Overvoltage
27Sag/59Swell	SARFIx Power Quality Counters
37	Undercurrent
46BC	Broken Conductor / Load Unbalance
46NPS	Negative Phase Sequence Overcurrent
47NPS	Negative Phase Sequence Overvoltage
49	Thermal Overload –Pole Segregated
50BF	Circuit Breaker Fail
51c	Cold Load Pickup
51V	Voltage Controlled Overcurrent
59N	Neutral Voltage Displacement
60CTS	CT Supervision
60VTS	VT Supervision
64H	High Impedance Restricted Earth Fault (EF)
67/50	Directional Instantaneous Phase Fault O/C
67/50G	Directional Instantaneous Earth Fault O/C
67/51	Directional Time Delayed Phase Fault O/C
67/51G	Directional Time Delayed Earth Fault O/C
67/50SEF	Directional Instantaneous Sensitive EF
67/51SEF	Directional Time Delayed Sensitive EF
74TCS	Trip Circuit Supervision H4/5/6/7 schemes
79	Autoreclose
81	Under/Over Frequency
81HBL2	Inrush Restraint
86	Lockout

User Programmable Logic Equations, via HMI
Graphical Programmable Logic, via pc application
8 Settings Groups - Password access - 2 levels
Self Monitoring

Optional Functionality

25	Synchronising

Loop Automation by Loss of Voltage
Single /Triple Pole Autoreclose for Three Single Pole Circuit Breakers

User Interface

20 character x 4 line backlit LCD
Menu navigation keys
3 fixed function LEDs
8 or 16 Programmable Tri-colour LEDs
12 Programmable Function Keys with Tri-colour LEDs

Monitoring Functions

Fault Data Mode – displays Date & Time, Type of fault and currents & voltages for each of last 10 faults.
Favourite (Default) meters – User selectable from:-
Currents - Primary, Secondary, xIn, Earth/SEF, Sequence Components and 2nd Harmonic,
Voltages – 3 phase Primary, Secondary & xVn, Ph-Ph and Ph-n, Sequence Components, Calculated Earth Voltage. Voltage (Vx) from a 4th voltage input, Primary, Secondary & xVn.
Synchronising phase, magnitude & frequency difference.
Optional 3 phase from the source side providing Primary, Secondary & xVn, Ph-Ph and Ph-n, Sequence Components, Calculated Earth Voltage.
Frequency
Power – MW, MVar, MVA, Power Factor
Energy – Export & Import - MWh, MVarh,
Direction – Load Flow Indication
Thermal capacity – %
Autoreclose – status and shot number
CB Maintenance:
 2 Independent Trip Counters,
 Frequent Operations Counter
 Lockout handle operations counter
 I^2t summation for contact wear
General alarms
Battery Condition monitoring and automatic cyclical test.
Power quality – 27 Sag and 59 Swell (Per pole Counters for SIARFIx, SMARFIx, STARFIx and Interruption Events,)
Binary Input status indication
Binary Output status indication
Virtual internal status indication
Communications Meters
Miscellaneous Meters, Date, Time, Waveform, Fault, Event & Data Log records-counters.
Demand Monitoring

Description of Functionality

With reference to figure 4: 'Function Diagram'.

25 Synchronising

Synchronising is used with three pole Manual Closing and Autoreclose operations to ensure that voltages are within safe limits before allowing the close operation to proceed. The 7SR224 provides settings for voltages, phase and frequency difference for Check Synchronising as well as System Synchronising and Close on Zero phase difference for automatic selection following detection of a split system. Automatic Synchronising bypass is also available to allow closure to energise a dead feeder or busbar.

27/59 Under/over Voltage

4 elements which can be set independently as Under or overvoltage. Each element has settings for pickup level and Definite Time Lag (DTL) delays, operates if voltage 'exceeds' setting for duration of delay, Typically applied in load shedding schemes.

37 Undercurrent

2 element with settings for pickup level and Definite Time Lag (DTL) delays. Each operates if current falls below its setting for duration of its delay.

46BC Broken Conductor

Each element has settings for pickup level and DTL delay. With the circuit breaker closed, if the NPS / PPS current ratio is above setting this could be due to a broken conductor.

46NPS Negative Phase Sequence Overcurrent

Two elements, one DTL and one IDMT, with user settings for pickup levels and delays. NPS Current elements can be used to detect unbalances on the system. The negative sequence phase component of current is derived from the three phase currents. It is a measure of the quantity of unbalanced current on the system.

47NPS Negative Phase Sequence OverVoltage

Two DTL elements with independent user settings for NPS overvoltage pickup level and delays. NPS Voltage elements can be used to detect unbalances on the system. The negative sequence phase component of voltage is derived from the three phase voltages. It is a measure of the quantity of unbalanced voltage on the system.

49 Thermal Overload

The thermal algorithm calculates the thermal state of each pole from the measured currents and can be applied to lines, cables and transformers; operates if the user set thermal overload is exceeded. Capacity Alarm operates if a user set percentage of overload is reached.

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. All measured currents can be monitored following a trip signal and an output is issued if any current is still detected after a specified time interval. This can be used to re-trip the CB or to back-trip an upstream CB. A second back-trip time delay is provided to enable another stage to be utilized if required.

59N Neutral Overvoltage

Two elements, one DTL and one IDMTL, have user settings for pickup level and delays. These will operate if the Neutral voltage exceeds the setting for duration of delay. Neutral overvoltage can be used to detect earth faults in high impedance earthed or isolated systems.

67/50 Phase Fault Elements

Provide Directional Instantaneous or Definite Time (DTL) Overcurrent protection, with independent settings for pickup current and time-delay.
Four elements are provided.
Elements can be Inrush-inhibited

67/51 Phase Fault Elements

Provide Directional - Inverse Definite Time Overcurrent protection, TCC/DTL with independent settings for pickup current, TCC and minimum/follower time-delay.
Four elements are provided.
User can select the TCC from standard IEC/ANSI or Legacy Characteristics e.g. 101 (A) etc. Reset TCC can be user set to either DTL or shaped, to integrate grading with electromechanical or other protection devices.

Earth Fault/Sensitive Earth Fault

The Earth Fault current is measured directly via a dedicated current analogue input. This input is used for both Earth Fault and Sensitive Earth Fault elements.

67/50G Earth Fault

Provide Directional Instantaneous or Definite Time (DTL) earth fault protection, with independent settings for pickup current and time-delay.
Four elements are provided.
Elements can be Inrush-inhibited.

67/51G Earth Fault

Provide Directional - Inverse Definite Time earth fault protection, TCC/DTL with independent settings for pickup current, TCC and minimum/follower time-delay.
Four elements are provided.
User can select the TCC from standard IEC/ANSI or Legacy Characteristics e.g. 101 (A) etc. Reset TCC can be user set to either DTL or shaped, to integrate grading with electromechanical or other protection devices.

67/50SEF Sensitive Earth Fault

Provide Directional Instantaneous or Definite Time (DTL) earth fault protection, with independent settings for pickup current and time-delay.
Four elements are provided.
Elements can be Inrush-inhibited

67/51SEF Sensitive Earth Fault

Provide Directional Instantaneous or Definite Time (DTL) earth fault protection, with independent settings for pickup current and time-delay.
Four elements are provided.
Elements can be Inrush-inhibited
User can select the TCC from standard IEC/ANSI or Legacy Characteristics e.g. 101 (A) etc. Reset TCC can be user set to either DTL or shaped, to integrate grading with electromechanical or other protection devices.

67 Directional Control

Phase Fault, Earth Fault and Sensitive Earth Fault elements can be directionalised. Each element can be user set to Forward, Reverse, or Non-directional.

Where multiple elements are provided two could be set for Forward and two for Reverse, thus providing Bi-Directional Tri-state protection is a single device.
Phase Fault elements are polarised from the calculated quadrature voltage i.e. Ia~Vbc, Ib~Vca & Ic~Vab.
Earth Fault/SEF elements are polarized from internally calculated Zero sequence Voltage, i.e. Io~Vo.

51c Cold Load

When a circuit breaker is closed onto a 'cold' load, i.e. one that has not been powered for a prolonged period, this can impose a higher than normal load-current demand on the system which could exceed 'Normal settings'. These conditions can exist for an extended period and must not be interpreted as a fault. To allow optimum setting levels to be applied for normal operation, Cold Load causes the 67/51 elements to change to 67/51c settings i.e. Setting/TCC/Time Multiplier /Follower delay times, for a limited period. Cold Load resets and returns to 'Normal settings' when either the circuit breaker has been closed for a User set period, or if the current has fallen to below a set level for a set time and it is safe to return.

21FL Fault Locator

The relay provides a basic single-end type fault locator which is able to estimate the fault position using analogue information measured by the relay at one end of the protected circuit during the short duration of the fault.

51V Voltage Controlled OverCurrent

Element has settings for UnderVoltage pickup level and operates if voltage falls below setting. On Pick-up this element applies the set 51v Multiplier to the pickup setting of the 67/51 phase fault elements.

60CTS CT Supervision

The CT Supervision considers the presence of negative phase sequence current, without an equivalent level of negative phase sequence voltage, for a user set time as a CT failure. Element has user operate and delay settings.

60VTS VT Supervision

The VT Supervision uses a combination of negative phase sequence voltage and negative phase sequence current to detect a VT fuse failure. This condition may be alarmed or used to inhibit voltage dependent functions. Element has user operate and delay settings.

64H Restricted Earth Fault - scheme

The measured earth fault input may be used in a 64H high-impedance, restricted earth fault scheme. The required external series stabilising resistor and shunt non-linear Varistor can be supplied.

74TC Trip Circuit Supervision

Up to three trip circuits can be monitored using binary inputs connected in H4/H5/H6 or H7 schemes. Trip circuit failure raises an HMI alarm and output(s).

79 Auto Reclose

The controller provides independent Phase Fault, Earth Fault and Sensitive Earth Fault sequences. They can be set for up to 4 Shots i.e. 5 Trips + 4 Reclose attempts to Lockout. These sequences can be user set to any configuration of Instantaneous (fast TCC) or Delayed TCC protection, with independent Reclose (Dead) times.
As the user defines which elements are Instantaneous, the combination of TCC1 plus 50 High set elements & TCC2 plus 50 High Set elements, provides the user with full flexibility. It enables the optimisation of the protection characteristics, which will be applied at each point in the protection sequence. Limits can be set by the user on the number of Delayed Trips to Lockout or High set trips to Lockout.
The External Protection Auto Reclose sequence allows AutoReclose to be provided for a separate high speed Protection device with options for Blocking External Trips to allow Overcurrent grading to take place.

Single/Triple Auto Reclose

Additional optional functionality is available to provide tripping, auto reclose and control of three single pole Reclosers located together and controlled by a single 7SR224 device. The facility to operate each of the three phases independently for systems where single phase loads are connected is common in some countries. The 7SR224 provides flexible schemes which are used to provide single and three pole trip and reclose operations depending on the fault type detected.

Dead/Live indication

Detection of live voltage is provided for each phase on both sides of the Recloser. This can be set to provide indication and alarms.

Loss of Voltage LOV Automation

Additional optional functionality is available to provide control of Normally Open Points (NOP) and other Reclosers in the distribution network to provide an automation sequence of load restoration following a persistent fault. The sequence is started by the loss of voltage detection, for an extended period of time, following a complete but unsuccessful auto reclose sequence, which has caused Lockout of a Recloser at any point in the network.

81 Under/Over Frequency

Each of the 4 elements has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. This function operates if frequency 'exceeds' setting for duration of delay. Typically applied in load shedding schemes.

81HBL2 Second Harmonic Block

Where second harmonic current is detected i.e. during transformer energisation the user selected elements can be blocked

27/59 Voltage Sag/Swell

Power System Utilities use SARFI indices of Voltage Sag and Swell, which express the magnitude and duration of Sag and Swell variations occurring on their systems. These indices are based on the 'ride-through' capability of the customer's plant and are usually expressed in terms of the number of a specific class (index) of r.m.s. variation per customer per specified period.
These elements provide the raw data in the form of counters that display the total count of each type of index value. Sags have a greater impact on plant performance than Swells. Disturbances are classified according to their magnitude and duration, the limits can be User set for SIARFI, SMARFI & STARFI. Breaks above 60s duration are Interruptions. Counters for each are provided per pole.

Programmable User Logic

Each Protection element output can be used for Alarm & Indication and/or tripping.
User can freely map any protection element output to any Binary Output(s); and any Binary Input(s) to any Function

Inhibit(s), Binary Output, LED's and/or internal Virtual signal points. User can also enter up to 16 Equations via the HMI or from a pc, defining User scheme-logic using standard Boolean Logic e.g. ( )/AND/OR/NOT/XOR, to combine BI, other Equations, Function Keys, LEDs, BO, and internal Virtual signal points. Each equation has PU/DO Time Delays and a Target Counter. Each Equation appears in the Output matrix and can be freely mapped to LEDs/BO.
In addition, the Reydisp Manager pc application provides graphical programming of user logic within the device.

Circuit Breaker Maintenance

Four circuit breaker trip counters are provided:-
Total Trip Count increments upon each trip command issued to give data for maintenance.
Delta Trip Count is an additional counter which can be reset independently of the Total Trip Counter and counts the number of operations since the last reset.
Frequent Operations Counter monitors the number of trip operations in a rolling window period of one hour and operates to stop cyclical sequences if the set number is exceeded.
An I^2t summation Counter provides a means monitoring contact wear indicating the total energy interrupted by the circuit breaker contacts.
Each counter has a user set target operations count which, when reached, can be mapped to raise Alarms/ Binary Outputs.

Function LED's

Eight (E10 case) or sixteen (E12) user programmable tri-colour LED's are provided eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED can be user set to red, green or yellow allowing for clear indication of the associated function's state. A slip-in label pocket along-side enables the user to insert his own notation. A printer compatible template is available.

Function Keys

Twelve user programmable function keys are available for implementing User logic and scheme control functionality, eliminating the need for expensive panel mounted control switches and associated wiring. Each function key has an associated user programmable tri-color LED (red, green, yellow) allowing for clear indication of the associated function's state. A slip-in label pocket along-side enables the user to insert his own notation for the Function Key LED Identification.
Each Function Key can be mapped directly to any of the built-in Controller/Circuit Breaker Command functions or to the User Logic equations.

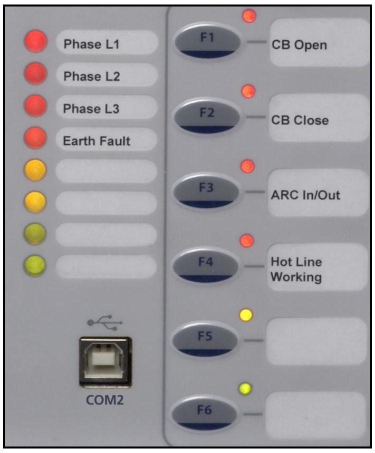


Fig1. Tri-colour LED's and function keys

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	3 x Phase & 1 x Earth or Sensitive Earth
Rated Current In	1/5 A
Measuring Range	80 x In
Instrumentation ≥ 0.1xIn	±1% In
Frequency	50/60 Hz
Thermal Withstand:	
Continuous	3.0 x In
10 Minutes	3.5 x In
5 Minutes	4.0 x In
3 Minutes	5.0 x In
2 Minutes	6.0 x In
3 Seconds	57.7 A (1 A) 202 A (5 A)
2 Seconds	70.7 A (1 A) 247 A (5 A)
1 Second	100 A (1 A) 350 A (5 A)
1 Cycle	700 A (1 A) 2500 A (5 A)
Burden @ In	≤0.1 VA (1 A phase and Earth element) ≤0.3 VA (5 A phase and earth element)

Voltage Inputs

Quantity	4 or 6
Nominal Voltage	40...160 V RMS a.c. Range
Instrumentation ≥ 0.8xVn	±1 % Vn
Operating Range	4x VT models: 0-270 V RMS 6x VT models: 0-270 V RMS V1,V2,V3. 0-132 V RMS for V4,V5,V6
Thermal Withstand:	
Continuous	300 V RMS
1 Second	
Burden @ 110V	≤ 0.1 VA

Binary Inputs

Operating Voltage	19 V dc: Range 17 to 290 V dc 88 V: Range 74 to 290 V dc
Maximum dc current for operation	1.5 mA

Binary Outputs

Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand Reset
Contact Operate / Release Time.	7 ms / 3 ms
Making Capacity:	
Carry continuously	5 A ac or dc
Make and carry	20 A ac or dc for 0.5 s
(L/R ≤ 40 ms and V ≤ 300 V)	30 A ac or dc for 0.2 s
Breaking Capacity	
(≤ 5 A and ≤ 300 V):	
AC Resistive	1250 VA
AC Inductive	250 VA at p.f. ≤ 0.4

DC Resistive	75 W	
DC Inductive	30 W	at L/R ≤ 40 ms
	50 W	at L/R ≤ 10 ms

Auxiliary supply

Rated DC Voltage	24-250V DC Operating Range 19.2 to 275V	
Allowable superimposed ac component	12% of DC voltage	
Rated AC Voltage	100-230 VAC 50/60Hz Range 80 to 253 V rms AC 50/60Hz ±5%	
Power Consumption:	Quiescent State (DC)	24V: 8W 110V: 7W 250V: 7W
	Maximum Load (DC)	24V: 12W 110V: 11W 250V: 11W
	Quiescent State(AC)	100V: 16VA 230V: 22VA
	Maximum Load (AC)	100V: 23VA 230V: 32VA
Allowable breaks/dips in supply (collapse to zero)	DC	50ms
	AC	2.5/3 cycles @50/60Hz

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration endurance	1.0 gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %
Shock withstand	15 gn, 11 ms	≤ 5 %
Bump test	10 gn, 16 ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	1 gn	≤ 5 %

Mechanical Classification

Durability	$>10^6$ operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	2.0 kV AC RMS for 1 min
Across normally open contacts	1.0 kV AC RMS for 1 min

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Common (longitudinal)	2.5 kV	≤ 10 %
Series (transverse) mode	1.0 kV	≤ 10 %
RS485 standard rear port	1.0 kV	No data loss

Electrostatic Discharge
IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

Fast Transient Immunity
IEC 60255-22- 4 Class A (2002)

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4 kV	≤ 10 %
RS485 standard rear port	2 kV	No data loss

Surge Immunity
IEC 60255-22-5; IEC 61000-4-5

Type	Level	Variation
Analog Inputs. Line to Earth	4.0 kV	≤ 10 %
Case, Aux Power & I/O. Line to Earth	2.0 kV	≤ 10 %
RS485 Comms port Line to Earth	1.0 kV	No Data Loss
Analog Inputs. Line to Line	1.0 kV	≤ 10 %
Case, Aux Power & I/O. Line to Line	1.0 kV*	≤ 10 %

*Note 45ms DTL pick up delay applied to binary inputs

Conducted Radio Frequency Interference Immunity
IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5 %

Radiated Radio Frequency Emissions
IEC 60255-25

Type	Limits at 10 m, Open Area test site, Quasi-peak
30 to 230 MHz	40 dB(μV/m)
230 to 10000 MHz	47 dB(μV/m)

Conducted Radio Frequency Emissions
IEC 60255-25

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(μV)	66 dB(μV)
0.5 to 30 MHz	73 dB(μV)	60 dB(μV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level	Variation
80 MHz to 1000 MHz	10 V/m	≤ 5 %

Climatic Tests

Temperature
IEC 60068-2-1/2

Operating Range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity
IEC 60068-2-78

Operational test	56 days at 40 °C and 93 % relative humidity

IP Ratings
IEC 60529

Type	Level
Installed with cover	IP 51 from front
Installed with cover removed	IP 20 from front

For full technical data refer to the Performance Specification Section of the Technical Manual.

Performance

27/59 Under/Over Voltage

Number of Elements	4 Under or Over
Operate	Any phase or All phases
Voltage Guard	1,1.5...200 V
Setting Range Vs	5,5.5...200 V
Hysteresis Setting	0.0.1...80 %
Vs Operate Level	100 % Vs, ±1 % or ±0.25 V
Reset Level: Undervoltage Overvoltage	 =(100%+hyst)xVop, ±1% or 0.25 V =(100%-hyst)xVop, ±1% or 0.25 V
Delay Setting td	0.00,0.01...20,20.5...100,101...1000,1010...10000,10100...14400 s
Basic Operate Time : 0 to 1.1xVs 0 to 2.0xVs 1.1 to 0.5xVs	 73 ms ±10 ms 63 ms ±10 ms 58 ms ±10 ms
Operate time following delay.	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input VT Supervision Voltage Guard

Vx 27/59 Under/Over Voltage

Number of Elements	1 Under or Over for 4xVT variants
Operate	Any phase or All phases
Voltage Guard	1,1.5...200 V for 4xVT variants 1,1.5...120 V for 6xVT variants
Setting Range Vs	5,5.5...200 V for 4xVT variants 5,5.5...120 V for 6xVT variants
Hysteresis Setting	0.0.1...80%
Vs Operate Level	100 % Vs, ±1 % or ±0.25 V
Reset Level: Undervoltage Overvoltage	 =(100 %+hyst)xVop, ±1 % or 0.25 V =(100 %-hyst)xVop, ±1 % or 0.25 V
Delay Setting td	0.00,0.01...20,20.5...100,101...1000,1010...10000,10100...14400 s
Basic Operate Time : 0 to 1.1xVs 0 to 2.0xVs 1.1 to 0.5xVs	 73 ms ±10 ms 63 ms ±10 ms 58 ms ±10 ms
Operate time following delay.	Tbasic +td , ±1 % or ±10 ms
Inhibited by	Binary or Virtual Input VT Supervision Voltage Guard

37 Undercurrent

Number of Elements	2
Setting Range Is	0.05,0.10...5.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Delay Setting td	0.00,0.01...20,20.5...100,101...1000,1010...10000,10100...14400s
Basic Operate Time: 1.1 to 0.5 x Is	 35 ms ±10 ms
Operate time following delay.	Tbasic +td , ±1% or ±10 ms
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input

46 Negative Phase Sequence Overcurrent

Number of Elements	DT & IT
DT Setting Range Is	0.05,0.10...5.0 x In
DT Operate Level	100 % Is, ±5 % or ±1 %xIn
DT Delay Setting td	0.00,0.01...20,20.5...100,101...1000,1010...10000,10100...14400 s
DT Basic Operate Time: 0 to 2 x Is 0 to 5 x Is	 40 ms ±10 ms 30 ms ±10 ms
DT Operate time following delay.	Tbasic +td , ±1% or ±10ms
IT Char Setting	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL
IT Setting Range	0.05..2.5
Tm Time Multiplier	0.025,0.03...1.6,1.7... 5,6... 100
Char Operate Level	105 % Is, ±4 % or ±1 %In
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input

47 Negative Phase Sequence

Number of Elements	2
Setting Range Vs	1,1.5...90 V
Hysteresis Setting	0,0.1...80 %
Operate Level	100 % Vs, ±2 % or ±0.5 V
Delay Setting td	0.00,0.01...20,20.5...100,101...1000,1010...10000,10100...14400 s
Basic Operate Time 0V to 1.5xVs 0V to 10xVs	 80 ms ±20 ms 55 ms ±20 ms
Operate time following delay.	Tbasic +td , ±2 % or ±20 ms
Overshoot Time	< 40 ms
Inhibited by	Binary or Virtual Input

49 Thermal Overload

Operate levels	Operate and Alarm
Setting Range Is	0.10,0.11...3.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Time Constant Setting	1,1.5...1000min
Operate time	$t = \tau \times In\left\{\frac{I^2 - I_p^2}{I^2 - (k \times I_B)^2}\right\}$ ±5 % absolute or ±100 ms where Ip = prior current

	(Is 0.3xIn to 3x In)
Alarm Level	Disabled, 50,51…100 %
Inhibited by	Binary or Virtual Input

50 (67) Instantaneous & DTL OC&EF (Directional)

Operation	Non directional, Forward or reverse
Elements	Phase and Measured Earth
Number of Elements	4 x OC 4 x Measured EF 'G' where fitted 4 x SEF where fitted
Setting Range Is	0.05,0.06…50 x In SEF 0.005…5 x In
Time Delay	0.00…14400s
Operate Level I_{op}	100% Is, ±5% or ±1%xIn
Reset Level	≥ 95 % Iop
Operate time:	
50	0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 25ms, ±10ms
Operate time following delay	Tbasic +td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input Inrush detector VT Supervision

51(67) Time Delayed OC&EF (Directional)

Elements	Phase, Measured Earth & SEF
Number of Elements	4 x OC 4 x Measured EF 'G' 4 x SEF
Operation	Non directional, Forward or reverse
Characteristic	IEC NI,VI,EI,LTI ANSI MI,VI,EI & DTL & Legacy (101 etc.)
Setting Range Is	0.05,0.1…2.5 x In SEF 0.005…1 x In
Time Multiplier	0.025,0.03…1.6,1.7… 5,6… 100
Time Delay	0,0.01… 20s
Operate Level I_{op}	105% Is, ±4% or ±1%xIn
Reset Level	≥ 95 % Iop
Minimum Operate time IEC	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$
ANSI	$t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5 % absolute or ± 30 ms
Follower Delay	0 - 20s
Reset	ANSI decaying, 0 – 60s
Inhibited by	Binary or Virtual Input Inrush detector VT Supervision

51V Voltage Controlled Overcurrent

Setting Range	5,5.5…200V
Operate Level	100% Vs, ±5% or ±1%xVn
Multiplier	0.25.0.3…1 x Is(51)
Inhibited by	VT Supervision

50BF Circuit Breaker Fail

Operation	Current check - Phase and Measured Earth with independent settings Mechanical Trip CB Faulty Monitor
Setting Range Is	0.05,0.055…2.0 x In
2 Stage Time Delays	Timer 1 20…60000ms Timer 2 20…60000ms
Operate Level	100% Is, ±5% or ±1%xIn
Basic Operate time	< 20ms
Operate time following delay	Tdelay ±1% or ±10ms
Triggered by	Any function mapped as trip contact.
Inhibited by	Binary/Virtual Input
Timer By pass	Yes, 50BF CB Faulty Input

59N Neutral Voltage Displacement

Number of Elements	1xDT & 1xIT
DT Setting Range Is	1…100V
DT Operate Level	100% Vs, ±5% or ±1%xVn
DT Delay Setting td	0 …14400s
DT Basic Operate Time 0V to 1.5xVs	76ms ±20ms
DT Operate time following delay.	Tbasic +td , ±1% or ±20ms
IT Setting Range	1…100V
TM Time Multiplier(IDMT)	0.1…140
Delay (DTL)	0…20s
Reset	0 … 60s, ANSI decaying
Char Operate Level	105% Vs, ±2% or ±0.5V
Inhibited by	Binary or Virtual Input

60 Supervision

CT	Vnps & Inps
VT	nps/zps

64H Restricted Earth Fault

Setting Range	0.005…0.95xIn
Operate Level	100% Is, ±5% or ±1%xIn
Time Delay	0.00… 14400s
Basic Operate Time	0 to 2 xIs 45ms ±10ms 0 to 5 xIs 35ms ±10ms
Inhibited by	Binary or Virtual Input

7SR224 Connection Diagram

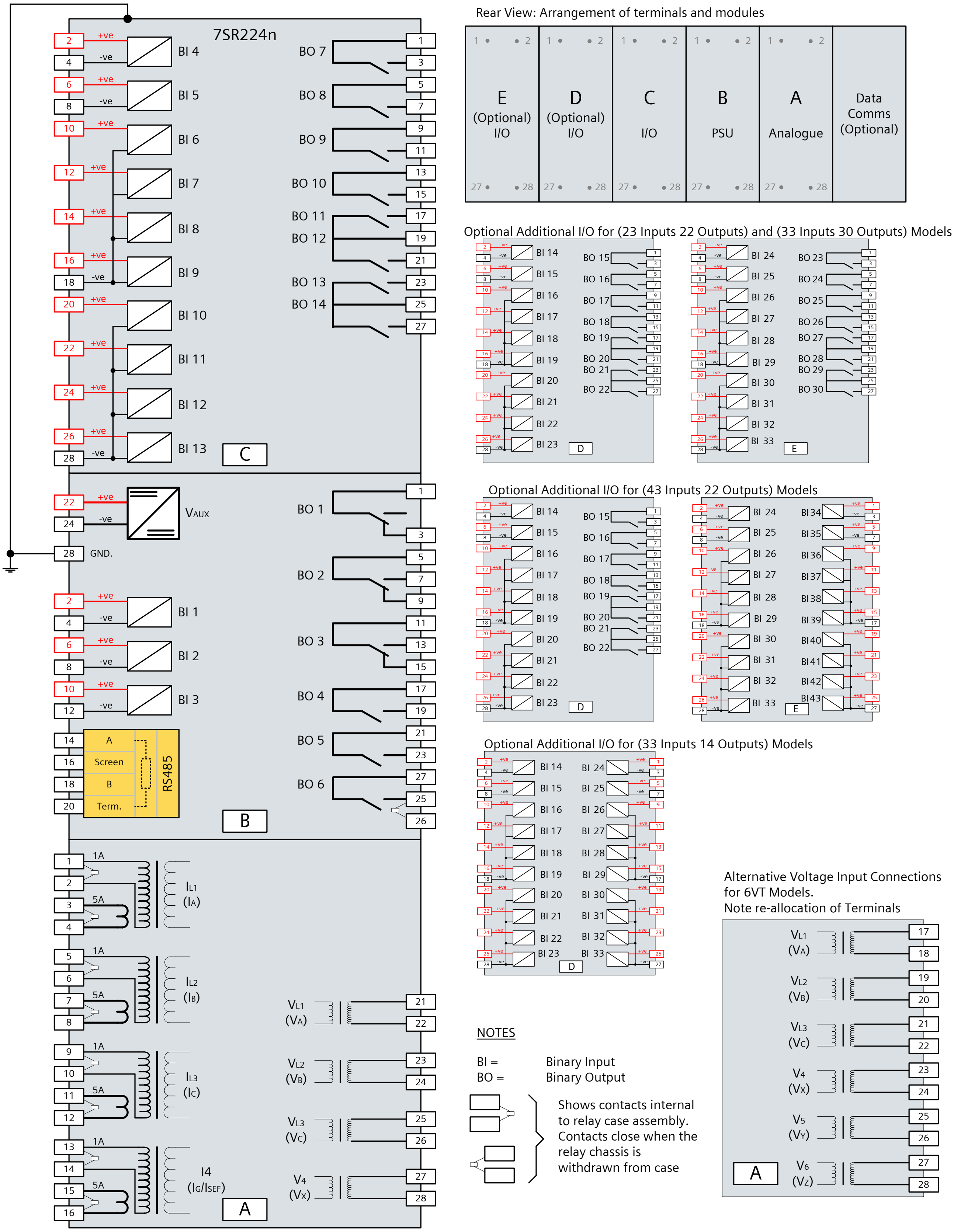


Fig2. 7SR224 Wiring Diagram

7SR224 Interface Diagram

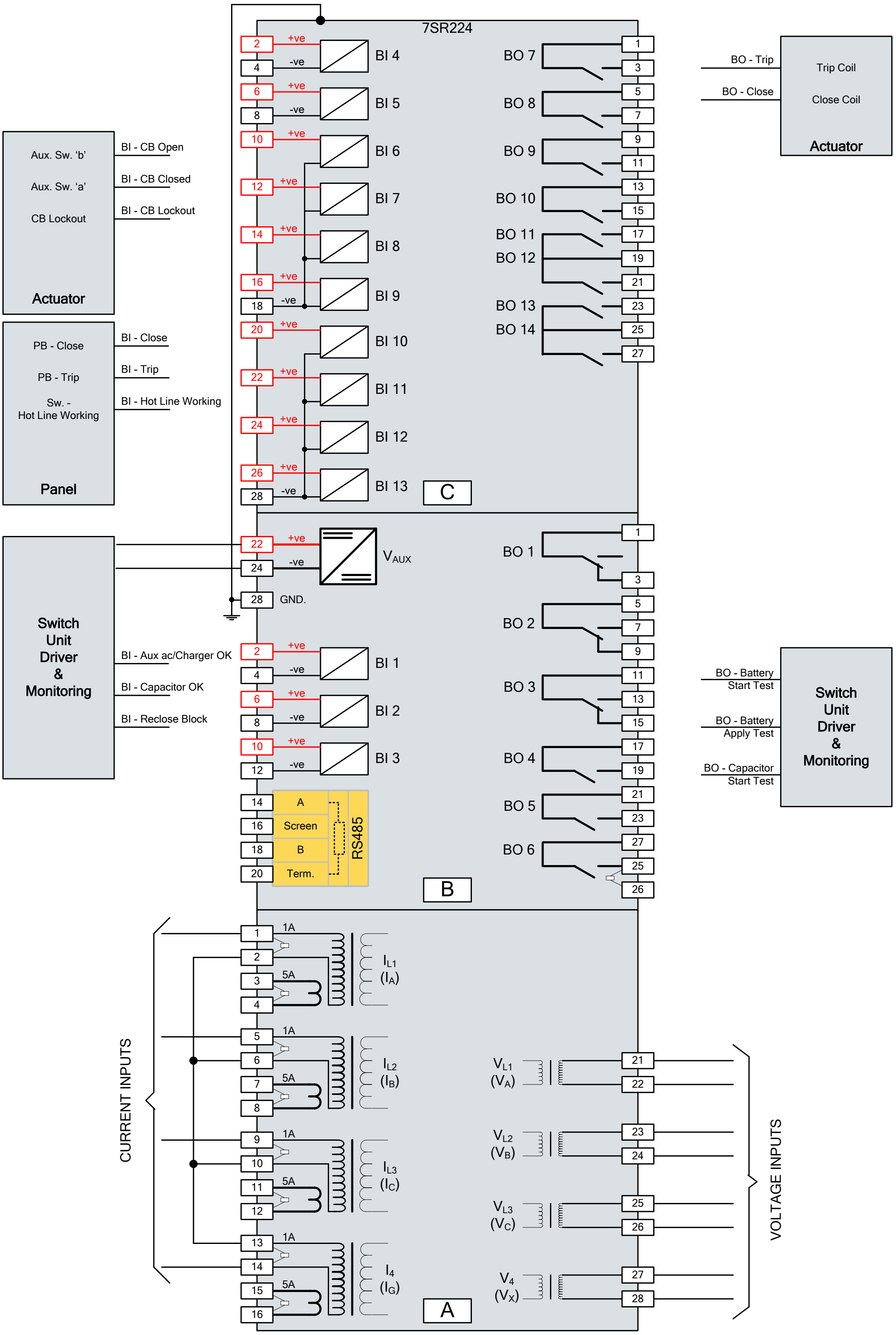


Fig3. 7SR224 Interface Diagram

Function Diagram for 7SR224 Recloser Controller

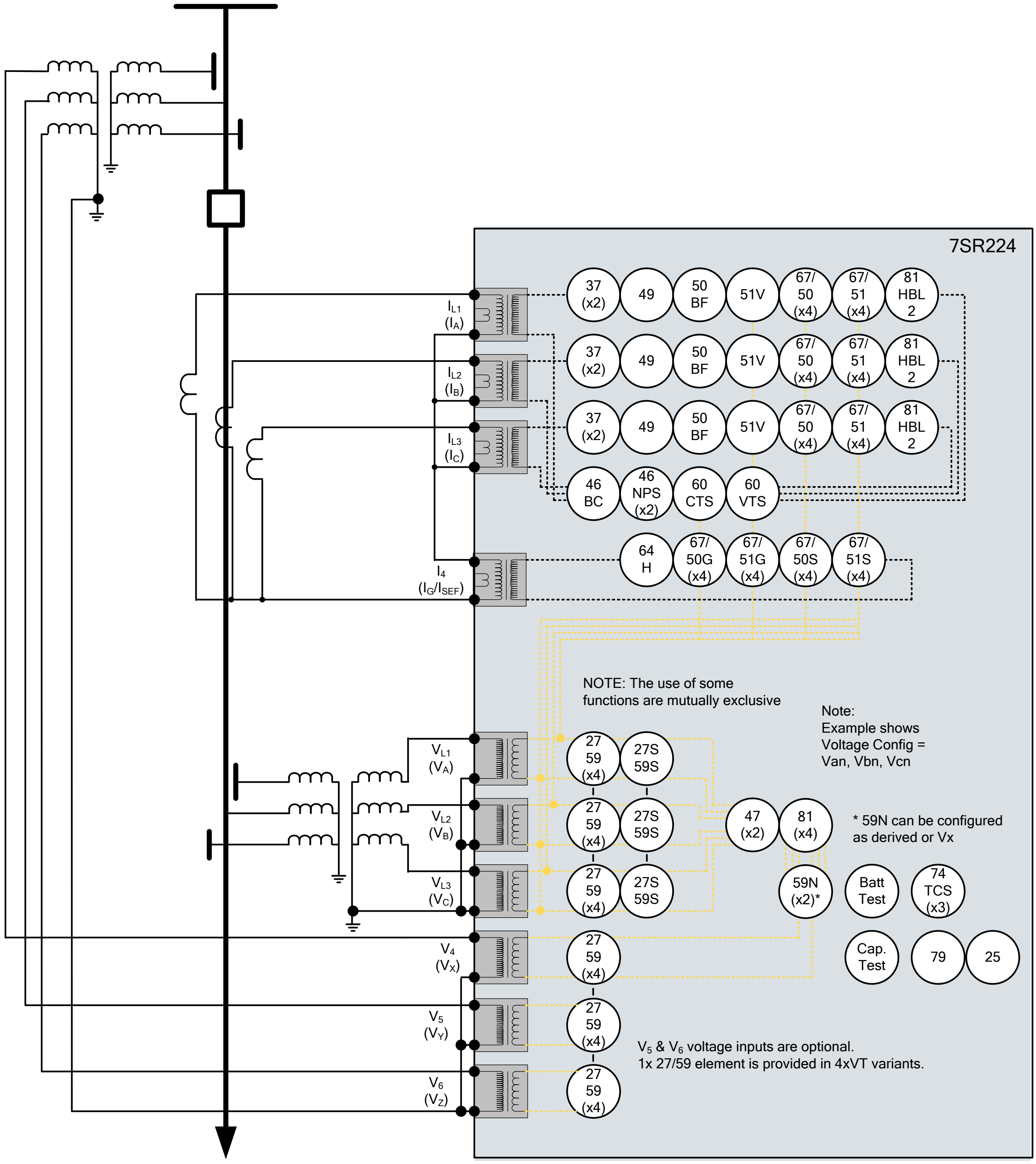


Fig4. 7SR224 Function Diagram

Ordering Information – 7SR224 Argus Recloser Controller

	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16
ORDER-No.:	7	S	R	2	2	4		-						-	0			0

Protection Product Family

	5
Overcurrent - Directional	2

Relay Type

	6
Recloser	4

Case, I/O and Fascia [1]

	7	8	11	12	14	15
E10 case, 13 Binary Inputs / 14 Binary Outputs, 8 LEDs + 12 keys	2	3			C D	A
E10 case, 23 Binary Inputs / 22 Binary Outputs, 8 LEDs + 12 keys	3	3	1-4	2-3	C D	A
E10 case, 33 Binary Inputs / 14 Binary Outputs, 8 LEDs + 12 keys	4	3			C D	A
E12 case, 33 Binary Inputs / 14 Binary Outputs, 16 LEDs + 12 keys	6				C E	A
E12 case, 33 Binary Inputs / 30 Binary Outputs, 16 LEDs + 12 keys	7		1-4	2-3	C E	A
E12 case, 43 Binary Inputs / 22 Binary Outputs, 16 LEDs + 12 keys	8		1-4	2-3	C E	A

Measuring Input

	8	14
4xCT 1/5 A, 4xVT 63.5/110V	2	C/E
4xCT 1/5 A, 6xVT 63.5/110V	3	

Auxiliary Nominal Voltage

	9
PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 19V DC (Rated: 24-250V DC)	M
PSU Rated: 24-250V DC / 100-230V AC. Binary Input threshold 88V DC (Rated: 110-250V DC)	N

Region Specific Functions

	10
Region World, 50/60Hz, language English, (language changeable) Reyrolle fascia	A
Region World, 50/60Hz, language English, (language changeable) Siemens fascia	B
Region USA, 60/50Hz, language English-US (ANSI), (language changeable), Siemens fascia	C

Communication Interface

	11	12
Standard version - included in all models, USB front port, RS485 rear port	1	2-3
Standard version - plus additional rear F/O ST connectors (x2) and IRIG-B	2	2-3
Standard version - plus additional rear RS485 and IRIG-B	3	2-3
Standard version - plus additional rear RS232 and IRIG-B	4	2-3
Standard version - plus additional rear Electrical Ethernet RJ45 (x2)	7	8
Standard version - plus additional rear Optical Ethernet Duplex (x2)	8	8

Protocol

	11	12
IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable setting)	1-4	2
IEC 60870-5-103 and IEC60870-5-101 and Modbus RTU (user selectable setting)	1-4	3
IEC 60870-5-103 and IEC60870-5-101 and Modbus RTU and DNP 3.0 (user selectable setting) and IEC61850	7-8	8

Spare

	13
	0

(continued on following page)

Ordering Information – 7SR224 Argus Recloser Controller

	1	2	3	4	5	6	7		8	9	10	11	12		13	14	15	16
ORDER-No.:	7	S	R	2	2	4		-						-	0			0

Protection Function Packages

				14	15
Standard version - included in all models				C	
21FL	Fault Locator				
27/59	Under/overvoltage				
27/59	Under/overvoltage, Sag/swell				
37	Undercurrent				
46BC	Broken conductor/load unbalance				
46NPS	Negative phase sequence overcurrent				
47NPS	Negative phase sequence overvoltage				
49	Thermal overload				
50BF	Circuit breaker fail				
51V	Voltage dependent overcurrent				
59N	Neutral voltage displacement				
60CTS	CT supervision				
60VTS	VT supervision				
67/50	Directional instantaneous phase fault overcurrent				
67/50G	Directional instantaneous earth fault				
67/51	Directional time delayed phase fault overcurrent				
67/51G	Directional time delayed earth fault				
67/50HIZ	Directional instantaneous sensitive earth fault				
67/51HIZ	Directional time delayed sensitive earth fault				
74TC	Trip circuit supervision				
74BF	Circuit breaker close fail				
79	Autoreclose				
81	Under/overfrequency				
81HBL2	Inrush restraint				
86	Lockout				
	Battery and capacitor test				
	Cold load pickup				
	Programmable logic				
Standard version - plus		**2-4**	**3**	D	A
27/59	Under/overvoltage				
60VTS	VT supervision				
	Loop automation by loss of voltage				
Standard version - plus		**6-8**		E	A
	Single/triple pole autoreclose				

Additional Functionality

			15
No additional functionality			A
25	Synchronising, synchronising check	C	D

Settings File

	16
Standard settings and standard labels for Siemens Recloser	0

1.1.3.3 7SR23 High Impedance Circulating Current Relay

Fig1. 7SR23 DAD fascia

Description

The 7SR23 DAD provides comprehensive, configurable high impedance protections with enhanced functionality and performance. Relay functionality is accessed via a familiar user friendly interface.
Housed in 4U high, size E6 or E8 cases, these relays provide protection, control, monitoring, instrumentation and metering with integrated input and output logic, data logging & fault reports. Communication access to relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection. Additional rear port options are available.

Function Overview

Protection

50G	Instantaneous/DTL Earth Fault
87REF	High Impedance REF
87/50	Phase Segregated Differential Protection

Supervision

CT50	CT Supervision
74TCS	Trip Circuit Supervision

Control

86	Lockout

Features

Password Protection – 2 levels
User Programmable Logic Equations, via HMI
Graphical Programmable Logic, via PC application
Self Monitoring

User Interface

20 character x 4 line backlit LCD
Menu navigation keys
3 fixed function LEDs
8 or 16 Programmable Tri-colour LEDs (Option)

Monitoring Functions

Standard Monitoring Functionality

Primary differential current phases and earth
Secondary differential current phases and earth
Binary Input/Output status
Trip circuit healthy/failure
Time and date
Starters
Fault records
Event records
Waveform records

Description of Functionality

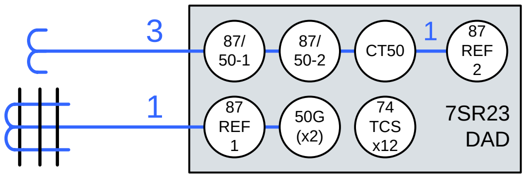


Fig2. 7SR DAD Function Diagram

Figure 2 illustrates the functionality available within the 7SR23. The relay can be configured to provide the following modes of operation:

- 3 Pole Diff + REF
- 3 Pole Diff + EF
- REF1 + REF2

87/50 Differential Protection - scheme

Two sets of differential protection are provided, 87/50-1 and 87/50-2.
Current inputs can be connected to provide overall phase segregated high impedance differential protection.
External series stabilising resistors and non-linear, voltage limiting, shunt resistors are required for each phase.
To facilitate ordering, installation and commissioning these external components can be provided in a separate optional ‘High Impedance Component Box’. See separate publication.
Output contacts of the relay are configured to trip the connected CBs and to short circuit the series stabilising resistors thereby ensuring that thermal ratings of the components are not exceeded.

CT50 CT Supervision

The CT Supervision feature measures the unbalance current in the CT circuits. Any unbalance current may indicate an open circuit in the CT secondary connections.
The phase segregated elements have user selectable operate current and time delay settings. This allows the faulted phase(s) to be short circuited and/or alarmed.

50G Earth Fault

Earth current is directly measured current from an independent CT or the residual connection of the 3 line CTs (Holmgreen connection).
Elements have independent settings for pickup current, and time-delay.

87REF Restricted Earth Fault - scheme

Analogue inputs can be connected and configured to provide one or two high impedance restricted earth fault protections (87 REF).
Each 87REF protection requires an external series stabilising resistor and non-linear shunt resistor.

In/Out Switching

When the protection is selected to 'Switched Out' the 87/50 functions are inhibited, trip contacts are disabled and contacts selected to the CT50 and 'Switched Out' functions are energized.

74TCS Trip Circuit Supervision

The trip circuits can be monitored via binary inputs connected in H4/H5/H6 or H7 schemes. Trip circuit failure raises an HMI alarm and output(s).

Programmable User Logic

The user can map Binary Inputs and Protection operated outputs to Function Inhibits, Logic Inputs, LEDs and/or Binary Outputs.
The user can also enter up to 16 equations defining scheme logic using standard functions e.g. Timers, AND/OR gates, Inverters and Counters.
Each Protection element output can be used for Alarm/Indication and/or tripping.
In addition, the Reydisp Manager PC application provides graphical programming of user logic within the device.

Function LED's

Eight or sixteen user programmable tri-colour LED's are provided eliminating the need for separate panel mounted indicators and associated wiring. Each LED can be user set to red, green or yellow allowing for indication of the associated function's status. A slip-in pocket adjacent to the LEDs enables the user to insert customised labels. A printer compatible template is available.

Application

3 phase high impedance differential protection is typically applied to busbars, connections, auto-transformers, reactors and motors. Restricted earth fault protection is typically applied to provide protection of transformer windings. See figure 6.

High impedance protection is recommended for all applications where faults must be cleared in the shortest possible time and where discrimination must be ensured. High impedance schemes can provide lower fault settings and better through fault stability than is possible with most other schemes.

The stability of the high impedance scheme is ensured because the applied operate voltage setting is greater than the maximum voltage that can appear across the relay circuit under through fault conditions. An external series stabilising resistor (R_{STAB}) is installed to provide a relay circuit operate voltage is above that required to guarantee stability.
External non-linear resistors (Metrosils) are connected in parallel with the relay circuit to limit circuit over-voltages.

The relay current setting and the operating voltage of the relay/stabilising resistor combination is calculated taking into account:-

- Transient stability under through fault conditions as verified by calculation assuming worst case conditions.
- The required operate level for internal fault conditions.

The CT supervision function (CT50) provides monitoring of CT secondary wiring connections.
CT supervision commonly supplements 3-phase differential protection as a fault in the CT secondary circuit wiring will cause unbalance current to flow during normal load conditions. Where the unbalance current is above the protection operate level this will cause unnecessary tripping of the protected zone. This is particularly relevant where current transformer wiring is switched as in some busbar protection arrangements.
Detection of a CT secondary wiring fault is arranged to provide an alarm and/or inhibit the differential protection (87/50) after a time delay. The time delay is required such that the CT supervision function does not operate during internal fault conditions.

Theory of High Impedance Current Balance Protective Schemes and their Application

Determination of Stability

The stability of a current balance scheme using a high impedance relay circuit depends upon the relay voltage setting being greater than the maximum voltage which can appear across the relay during a through fault condition.
This maximum voltage can be determined by means of a simple calculation which makes the following assumptions:
One current transformer is fully saturated making its excitation impedance negligible.
The resistance of the secondary winding of the saturated current transformer together with the leads connecting it to the relay circuit terminals constitute the only burden in parallel with the relay.
The remaining current transformers maintain their ratio.

Thus the maximum voltage is given by:

$$(1) \quad V = I_F\left(R_{CT} + R_L\right) \times T$$

Where:

V = Maximum voltage across relay circuit during through fault conditions.

R_L = Resistance current transformer connection leads.

R_{CT} = Current transformer secondary winding resistance

I_F = Maximum steady state through fault current.

T = Turns ratio of all current transformers (Primary turns / secondary turns)

For stability, the voltage setting of the relay V_s must be made equal to or exceed, the highest value of V calculated above.
Experience and extensive laboratory tests have proved that if this method of estimating the relay setting voltage is adopted, the stability of the protection will be very much greater than the value of I used in the calculation. This is because a current transformer is normally not continuously saturated and consequently any voltage generated by this current transformer will reduce the voltage appearing across the relay circuit.

Method of Establishing Relay Setting Current

Relay setting current is given by:

(2) $$I_S = P.O.C - \left(\sum I_{mag} + I_{NLR}\right) / T$$

Where:

I_s = Relay setting current

P.O.C. = Primary operate current (fault setting).

I_{mag} = Current transformer magnetising currents at the value of V_s.

I_{NLR} = Current taken by the non-linear resistor/voltage limiting device at V_s (this value is usually small and often may be neglected).

Equation (2) should properly be the vector sum, however arithmetic addition is normally used.

Establishing the Value of Setting Resistors

Stabilising resistor value R_{STAB} is given by:

(3) $$R_{STAB} = \frac{V_S}{I_S}$$

Where:

V_s = Relay circuit operate voltage

Exact resistor values are not necessary, a higher standard resistance value may be chosen. A check is made to confirm that the finalized value of Vs provides stability and is compatible with the installed CTs ie:

(4) V < **Vs** < 0.5V x CT knee point voltage

The required watt-second rating of the resistor is established at setting and at the maximum fault rating – short time rating. The power dissipation of the resistors should be considered, they should be mounted vertically in a well ventilated location and clear of all other wiring and equipment.

Technical Data

For full technical data refer to the Performance Specification Section of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	4
Rated Current IN	1/5A
Measuring Range	8 x In max
Instrumentation	±1% In or ±10mA
Frequency	50/60Hz
Thermal Withstand:	
Continuous	4.0 xIn
1 Second	100A (1A) 350A (5A)
Burden @ In	≤0.1VA (1A input) ≤0.3VA (5A input)

Auxiliary supply

Rated DC Voltage	24-250V DC Operating Range 19.2 to 275V	
Allowable superimposed ac component	12% of DC voltage	
Rated AC Voltage	100-230 VAC 50/60Hz Range 80 to 253 V rms AC 50/60Hz ±5%	
Power Consumption:	Quiescent State (DC)	24V: 8W 110V: 7W 250V: 7W
	Maximum Load (DC)	24V: 12W 110V: 11W 250V: 11W
	Quiescent State (AC)	100V: 16VA 230V: 21VA
	Maximum Load (AC)	100V: 23VA 230V: 30VA
Allowable breaks/dips in supply (collapse to zero)	DC	50ms
	AC	2.5/3 cycles @50/60Hz

Binary Inputs

Operating Voltage	19V dc: Range 17 to 290V dc 88V: Range 74 to 290V dc
Maximum dc current for operation	1.5mA

Binary Outputs

Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand Reset
Contact Operate / Release Time.	7ms / 3ms
Making Capacity:	
Carry continuously	5A ac or dc
Make and carry	20A ac or dc for 0.5s
(L/R ≤ 40 ms and V ≤ 300 V)	30A ac or dc for 0.2s
Breaking Capacity (≤ 5 A and ≤ 300 V):	
AC Resistive	1250VA
AC Inductive	250VA at p.f. ≤ 0.4
DC Resistive	75W

DC Inductive	30W	at L/R ≤ 40ms
	50W	at L/R ≤ 10ms

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5gn	≤ 5 %
Vibration endurance	1.0gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5gn, 11ms	≤ 5 %
Shock withstand	15gn, 11ms	≤ 5 %
Bump test	10gn, 16ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	1gn	≤ 5 %

Mechanical Classification

Durability	>10^6 operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0kV AC RMS for 1min
Between independent circuits	
Across normally open contacts	1.0kV AC RMS for 1min

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Case, Aux Power & I/O. Common mode	2.5kV	≤ 10%
Case, Aux Power & I/O. Transverse mode	1.0kV	≤ 10%
RS485 Comms	1.0kV	No data loss

Electrostatic Discharge
IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0kV	≤ 5%

Electrical Fast Transient / Burst Immunity
IEC 60255-22-4 Class A (2002)

Type	Level	Variation
Case, Aux Power & I/O	4.0kV	≤ 10%
RS485 Comms	2.0kV	No data loss

Surge Immunity
IEC 60255-22-5

Type	Level	Variation
Analog Inputs. Line to Earth	4.0kV	≤ 10%
Case, Aux Power & I/O. Line to Earth	2.0kV	
Analog Inputs. Line to Line	1.0kV	
Case, Aux Power & I/O. Line to Line	1.0kV*	
RS485 Comms port. Line to Earth	1.0kV	No data loss

*Note 45ms pick up delay applied to binary inputs

Conducted Radio Frequency Interference
IEC 60255-22-6

Type	Level	Variation
0.15 to 80MHz	10V	≤ 5%

Radiated Radio Frequency
IEC 60255-25

Type	Limits at 10m, Quasi-peak
30 to 230MHz	40dB(μV/m)
230 to 10000MHz	47dB(μV/m)

Conducted Radio Frequency
IEC 60255-25

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5MHz	79dB(μV)	66dB(μV)
0.5 to 30MHz	73dB(μV)	60dB(μV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level	Variation
80MHz to 1000MHz	10V/m	≤ 5%

Magnetic Field with Power Frequency
IEC 61000-4-8, Class V

Type	Level
100A/m (0.126mT) continuous	50Hz
1000A/m (1.26mT) for 3s	

Environmental Tests

Temperature
IEC 60068-2-1/2

Operating Range	-10°C to +55°C
Storage range	-25°C to +70°C

Humidity
IEC 60068-2-78

Operational test	56 days at 40°C and 95% relative humidity

IP Ratings
IEC 60529

Type	Level
Installed with cover	IP 51 from front of relay
Installed with cover removed	IP 20 from front of relay

Performance

87/50 Differential Protection

Setting Range	0.01...2.00 xI$_n$
Operate Level	100% Is, ±5% or ±1% xIn
Time Delay	0.00... 60s
Basic Operate Time	2 x Is: 22ms ±5ms, 50Hz 2 x Is: 20ms ±5ms, 60Hz 3 x Is: 1 cycle ±5ms 5 x Is: < 1 cycle
Reset Time	< 50ms
Harmonic Rejection	40:1 minimum (2nd to 15th harmonic)
Inhibited by	CT50, Binary or Virtual Input

CT50 CT Supervision

Setting Range	0.005...2.00 xI$_n$
Operate Level	100% Is, ±5% or ±1% xIn
Time Delay	0.00... 60s
Basic Operate Time	2 x Is: 22ms ±5ms, 50Hz 2 x Is: 20ms ±5ms, 60Hz 3 x Is: 1 cycle ±5ms 5 x Is: < 1 cycle
Inhibited by	Binary or Virtual Input

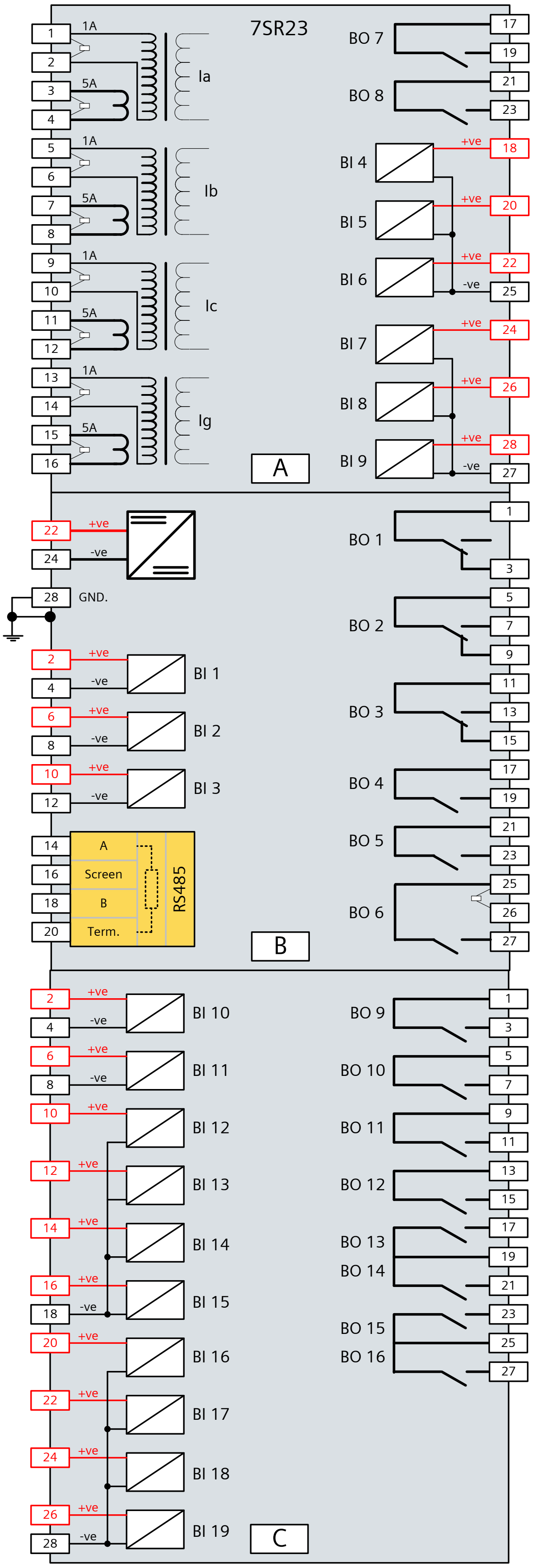
87REF Restricted Earth Fault

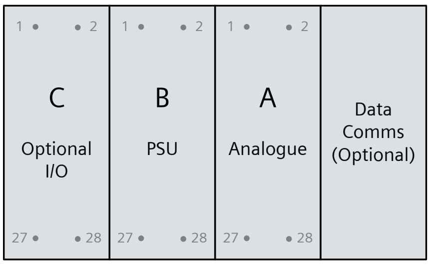
Setting Range	0.01...2.00 xI$_n$
Operate Level	100% Is, ±5% or ±1% xIn
Time Delay	0.00... 60s
Basic Operate Time	2 x Is: 22ms ±5ms, 50Hz 2 x Is: 20ms ±5ms, 60Hz 3 x Is: 1 cycle ±5ms 5 x Is: < 1 cycle
Reset Time	< 50ms
Harmonic Rejection	40:1 minimum (2nd to 15th harmonic)
Inhibited by	Binary or Virtual Input

50G Instantaneous & DTL Measured EF

Elements	Measured Earth
Number of Elements	2
Setting Range Is: - Measured E/F ‘G’	0.01...2 xIn
Time Delay	0.00...60s
Operate Level	100% Is, ±5% or ±1% xIn
Operate time	2 x Is: 22ms ±5ms, 50Hz 2 x Is: 20ms ±5ms, 60Hz 3 x Is: 1 cycle ±5ms 5 x Is: < 1 cycle
Operate time following delay	t_{basic} +t_d , ±1% or ±10ms
Inhibited by	Binary or Virtual Input

7SR DAD Connection Diagram

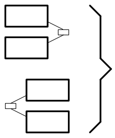




Rear View
Arrangement of terminals and modules

NOTES

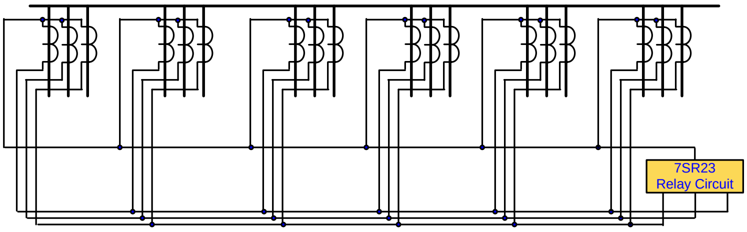
BI =	Binary Input
BO =	Binary Output



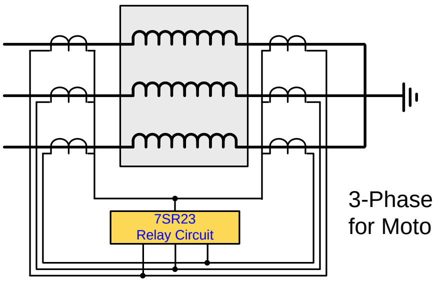
Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig3. 7SR DAD Wiring Diagram

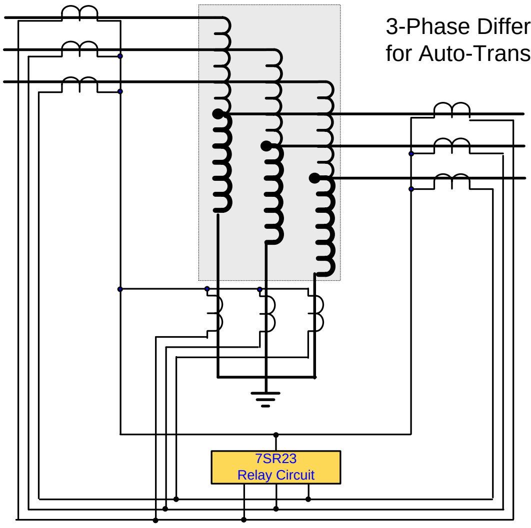
Typical Applications



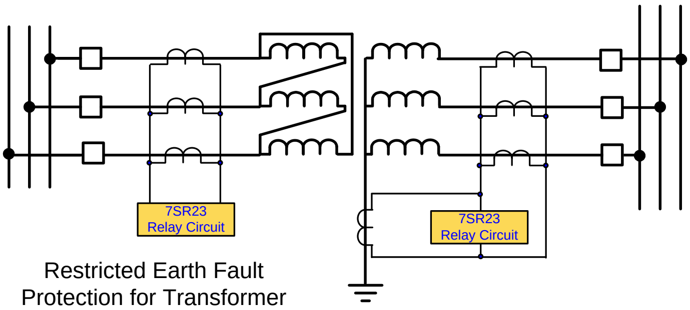
3-Phase Differential Protection for Connections or Busbars



3-Phase Differential Protection
for Motor, Reactor or Generator



3-Phase Differential Protection
for Auto-Transformer



Restricted Earth Fault
Protection for Transformer

Fig 4. Typical Applications for the 7SR23 DAD

Ordering Information – 7SR23 DAD High Impedance Relay

DAD		**7 S R 2 3 0 □ - 1 □ A □ □ - 0 C A 0**
High Impedance Protection		
	Protection Product	
	Circulating Current	**3 0**
	Case I/O and Fascia 1)	
	4 CT, 9 BI, 8 BO, 8 LEDs E6 Case (1	**2**
	4 CT, 19 BI, 16 BO, 16 LEDs E8 Case (1	**3**
	Measuring Input	
	1/5 A, 50/60Hz	**1**
	Auxiliary voltage	
	PSU Rated: 24-250V DC / 100-230V AC, binary input threshold 19V DC (Rated: 24-250V DC)	**M**
	PSU Rated: 24-250V DC / 100-230V AC, binary input threshold 88V DC (Rated: 110-250V DC)	**N**
	Communication Interface	
	Standard version – included in all models, USB front port, RS485 rear port	**1 2**
	Standard version – plus additional rear F/O ST connectors (x2) and IRIG-B	**2 2**
	Standard version – plus additional rear RS485 and IRIG-B	**3 2**
	Standard version – plus additional rear RS232 and IRIG-B	**4 2**
	Standard version – plus additional rear Electrical Ethernet RJ45 (x2)	**7 7**
	Standard version – plus additional rear Optical Ethernet Duplex LC (x2)	**8 7**
	Protocol	
	IEC 60870-5-103, Modbus RTU and DNP3.0 (user selectable setting)	**2**
	IEC 60870-5-103, Modbus RTU and DNP 3.0 (user selectable) and IEC 61850	**7**
	Protection Function Packages	
	50G Measured Earth Fault Protection	**C**
	87/50 Phase Segregated High Impedance Differential Protection	
	87REF High Impedance Restricted Earth Fault Protection	
	CT50 CT Supervision	
	74TCS	
	Programmable logic	

1) BI = Binary Input, BO = Binary Output,

1.1.3.4 7SR242 Transformer Protection Relay

Description

Our new generation of integrated transformer protection relays are designated the 7SR24 series. The relays utilise years of numeric relay protection experience with the 'Duobias' family of products.
Housed in 4U high, size E8, E10 or E12 cases, these relays provide protection, control, monitoring, instrumentation and metering with integrated input and output logic, data logging & fault reports. Communication access to relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection. Additional rear port options are available.

Function Overview

Standard Functionality

50BF	Circuit Breaker Fail
64H	High Impedance REF
74TCS/CCS	Trip/Close Circuit Supervision
81HBL2	Inrush Detector
81HBL5	Overfluxing Detector
87BD	Biased Differential (2Windings)
87HS	Current Differential High-Set

8 Settings Groups
Password Protection – 2 levels
User Programmable Logic Equations, via HMI
Graphical Programmable Logic, via pc application
Self Monitoring

Optional Functionality

24	Over-Fluxing
27/59	Under/Over Voltage
37/37G	Undercurrent
46BC	Open Circuit
46NPS	Negative Phase Sequence Overcurrent
49	Thermal Overload
50	Instantaneous Overcurrent
50G/N	Instantaneous Earth Fault
51	Time Delayed Overcurrent
51G/N	Time Delayed Measured Earth Fault /SEF
59N	Neutral Voltage Displacement
81	Under/Over Frequency

User Interface

20 character x 4 line backlit LCD
Menu navigation keys
3 fixed LEDs
16, 24 or 32 Programmable Tri-colour LEDs (Option)

Monitoring Functions

Primary current phases and earth
Secondary current phases and earth
Relay Operate and restraint currents
Positive Phase Sequence (PPS) Current
Negative Phase Sequence (NPS) Current
Zero Phase Sequence (ZPS) Current
Thermal status
Primary Single phase voltage*
Secondary single phase voltage*
Data logging and Demand Metering
Frequency & fluxing*
Binary Input/binary output and virtual I/O status
Trip circuit healthy/failure
Time and date
Fault records
Event records
Waveform records
Circuit breaker trip counters
I^2t summation for contact wear
* Optional voltage measurements from single phase VT input

Description of Functionality

50BF Circuit Breaker Fail

The circuit breaker fail function may be triggered from an internal trip signal or from a binary input. Line and neutral currents are monitored following a trip signal and an output is issued if any current is still detected after a specified time interval. Alternatively, if the trip is from a mechanical protection the circuit breaker position can be used to determine a failure. A second time delay is available to enable another stage to be utilized if required. An input is also available to bypass the time delays when the circuit breaker is known to be faulty.

64H Restricted Earth Fault - scheme

The measured earth fault input may be used in a high impedance restricted earth fault scheme. Required external series stabilising resistor and non-linear voltage limiting shunt resistor can be supplied.

74TCS/CCS Trip/Close Circuit Supervision

The trip and close circuit(s) can be monitored via binary inputs. Circuit failure raises an HMI alarm and output(s).

81HBL2 Inrush Detector

Where second harmonic current is detected (i.e. during transformer energisation) user selectable elements can be blocked.

81HBL5 Overfluxing Detector

Fifth Harmonic Detectors can be user selected to block the Biased Differential Elements.

87BD Biased Differential

The differential characteristic incorporates two bias stages – the first stage for steady state errors i.e. tap position and CT ratios the second stage for transient errors i.e. CT saturation.

87HS High-Set Differential

High speed differential elements provide protection against high levels of internal fault current.

Programmable Logic

The user can map Binary Inputs and Protection operated outputs to Function Inhibits, Logic Inputs, LEDs and/or Binary Outputs.
The user can also enter up to 16 equations defining scheme logic using standard functions e.g. Timers, Latches, AND/OR gates, Inverters and Counters.
Each Protection element output can be used for Alarm & Indication and/or tripping.
In addition, the Reydisp Manager PC application provides graphical programming of user logic within the device.

Circuit Breaker Maintenance

For each winding two circuit breaker operations counters are provided. The Maintenance Counter records the overall number of operations and the Delta Counter the number of operations since the last reset.
I^2t summation Counters provide a measure of the contact wear indicating the total energy interrupted by the circuit breaker contacts.
Each counter has a user set target operations count which, when reached, can be mapped to raise Alarms/ Binary Outputs.
These counters assist with maintenance scheduling.

Function LED’s

16 or 24 user programmable tri-colour LED’s are provided eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED can be user set to red, green or yellow allowing for clear indication of the associated function’s state. A slip-in label pocket along-side enables the user to insert his own notation. A printer compatible template is available.

Fig1. Tri-colour LED’s

Optional Functionality

24 Over-Fluxing

Two elements each provide a definite time lag (DTL) characteristic, the third element provides a user defined characteristic. Operates if Volts/Hertz ratio is above setting for duration of delay.

27/59 Under/Over Voltage

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Operates if voltage ‘exceeds’ setting for duration of delay.
This function can be used within load shedding schemes.

37/37G Undercurrent

Each element has settings for pickup level and Definite Time Lag (DTL) delays. Operates if current falls below setting for duration of delay.

46NPS Negative Phase Sequence Overcurrent

Two DTL and two inverse/DTL elements are provided. NPS Current elements can be used to detect unbalances on the system or remote earth faults when a delta-star transformer is in circuit.

46BC Open Circuit

Each element has settings for pickup level and DTL delay. With the circuit breaker closed, if the NPS:PPS current ratio is above setting this could be due to an open circuit.

49 Thermal Overload

The thermal algorithm calculates the thermal states from the measured line currents. Outputs are available for thermal overload and thermal capacity.

50/51 Phase Fault

50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. IEC, ANSI or user defined Time Current Characteristics can be selected.
The IDMT stage has a user programmable DTL or shaped current/time reset characteristic, to improve grading with electromechanical protection.

50G/51G/50N/51N Earth Fault

Two earth fault measurement modes are available. One mode directly measures the earth current from an independent CT, or the residual connection of the 3 line CTs (50G/51G). The second mode derives the earth current internally from the 3 phase CTs (50N/51N).
50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. IEC, ANSI or user defined Time Current Characteristics can be selected..
The IDMT stage has a user programmable reset characteristic either DTL or shaped current/time reset characteristic to improve grading with electromechanical protection.

59N Neutral Overvoltage

One element provides a definite time lag (DTL) characteristic; the second element provides an inverse/DTL characteristic. Operates if Neutral voltage exceeds setting for duration of delay.
Neutral overvoltage can be used to detect earth faults in high impedance earthed or isolated systems.

81 Under/Overfrequency

Each element has settings for pickup level, drop-off level and Definite Time Lag (DTL) delays. Each element operates if frequency exceeds setting for duration of delay. Typically applied in load shedding schemes.

Technical Data

For full technical data refer to the Performance Specification Chapter of the Technical Manual.

Inputs and Outputs

Current Inputs

Quantity	6 x Phase & 2 x Earth
Rated Current IN	1/5A
Measuring Range	80 x In
Instrumentation ≥ 0.1xIn	±1% In
Frequency	50/60Hz
Thermal Withstand:	
Continuous	3.0 x In
10 Minutes	3.5 x In
5 Minutes	4.0 x In
3 Minutes	5.0 x In
2 Minutes	6.0 x In
3 Seconds	57.7A (1A) 202A (5A)
2 Seconds	70.7A (1A) 247A (5A)
1 Second	100A (1A) 350A (5A)
1 Cycle	700A (1A) 2500A (5A)
Burden @ In	≤ 0.1VA (1A phase and Earth element) ≤ 0.3VA (5A phase and earth element)

Voltage Inputs

Quantity	1 (optional)
Nominal Voltage	40…160V a.c. Range
Instrumentation ≥ 0.8xVn	±1% Vn
Thermal Withstand:	
Continuous	300V
1 Second	
Burden @ 110V	≤ 0.1 VA

Auxiliary supply

Nominal voltage	Operating Range
24 - 250V dc	19.2 - 275 V dc
100 - 230V ac	80 - 253 V ac

Nominal Voltage	Quiescent Burden (typical)	Quiescent Burden (back-light)
24V dc	6.0W	7.4W
48V dc	5.8W	7.1W
60V dc	5.8W	7.0W
110V dc	6.5W	7.5W
125V dc	5.4W	1.2W
220V dc	5.2W	6.4W
250V dc	5.2W	6.4W
100V ac	13.4VA	15.9VA
110V ac	13.7VA	16.2VA
115V ac	13.7VA	16.2VA
120V ac	14.0VA	16.6VA
200V ac	16.0VA	19.0VA
230V ac	17.0VA	20.2VA

Allowable superimposed ac component	≤ 12% of dc voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20 ms

Binary Inputs

Operating Voltage	19V dc: Range 17 to 290V dc 88V dc: Range 74 to 290V dc
Maximum dc current for operation	1.5mA

Binary Outputs

Operating Voltage	Voltage Free
Operating Mode	User selectable - Self or Hand Reset
Contact Operate / Release Time.	7ms / 3ms
Making Capacity:	
Carry continuously	5A ac or dc
Make and carry	20A ac or dc for 0.5s
(L/R ≤ 40 ms and V ≤ 300 V)	30A ac or dc for 0.2s
Breaking Capacity	
(≤ 5 A and ≤ 300 V):	
AC Resistive	1250 VA
AC Inductive	250 VA at p.f. ≤ 0.4
DC Resistive	75 W
DC Inductive	30 W at L/R ≤ 40ms
	50 W at L/R ≤ 10ms

Mechanical Tests

Vibration (Sinusoidal)
IEC 60255-21-1 Class I

Type	Level	Variation
Vibration response	0.5 gn	≤ 5 %
Vibration endurance	1.0 gn	≤ 5 %

Shock and Bump
IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %
Shock withstand	15 gn, 11 ms	≤ 5 %
Bump test	10 gn, 16 ms	≤ 5 %

Seismic
IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	1 gn	≤ 5 %

Mechanical Classification

Durability	$>10^6$ operations

Electrical Tests

Insulation
IEC 60255-5

Type	Level
Between any terminal and earth	2.0 kV AC RMS for 1 min
Between independent circuits	2.0 kV AC RMS for 1 min
Across normally open contacts	1.0 kV AC RMS for 1 min

Transient Overvoltage
IEC 60255-5

Between all terminals and earth or between any two independent circuits	5 kV 1.2/50 µs 0.5 J

High Frequency Disturbance
IEC 60255-22-1 Class III

Type	Level	Variation
Common (longitudinal) mode	2.5 kV	≤ 5 %
Series (transverse) mode	1.0 kV	≤ 5 %

Electrostatic Discharge
IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

Fast Transients
IEC 60255-22-4 Class IV

Type	Level	Variation
5/50 ns 2.5 kHz repetitive	4kV	≤ 5 %

Surge Immunity
IEC 60255-22-5

Type	Level	Variation
Between all terminals and earth	4.0 kV	≤ 10 %
Between any two independent circuits	2.0kV	

Conducted Radio Frequency Interference
IEC 60255-22-6

Type	Level	Variation
0.15 to 80 MHz	10 V	≤ 5 %

Radiated Radio Frequency
IEC 60255-25

Type	Limits at 10 m, Quasi-peak
30 to 230 MHz	40 dB(µV)
230 to 10000 MHz	47 dB(µV)

Conducted Radio Frequency

Type	Limits	
	Quasi-peak	Average
0.15 to 0.5 MHz	79 dB(µV)	66 dB(µV)
0.5 to 30 MHz	73 dB(µV)	60 dB(µV)

Radiated Immunity
IEC 60255-22-3 Class III

Type	Level	Variation
80 MHz to 1000 MHz	10 V/m	≤ 5 %

Magnetic Field with Power Frequency
IEC 61000-4-8, Class V

100 A/m continuous	50Hz; 1.257mT
1000 A/m for 3s	

Climatic Tests

Temperature
IEC 60068-2-1/2

Operating Range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity
IEC 60068-2-3

Operational test	56 days at 40 °C and 93 % relative humidity

IP Ratings

Type	Level
Installed with cover	IP 51 from front of relay
Installed with cover removed	IP 20 from front of relay

Performance

27/59 Under/Over Voltage

Number of Elements	4 Under or Over
Setting Range Vs	5, 5.5…200V
Hysteresis Setting	0. 0.1…80%
Vs Operate Level	100% Vs, ±1% or ±0.25V
Reset Level:	
Undervoltage	(100% + hyst) x Vop, ±1% or 0.25V
Overvoltage	(100% - hyst) x Vop, ±1% or 0.25V
Delay Setting td	0.00, 0.01…20, 20.5…100, 101…1000, 1010…10000, 10100…14400s
Basic Operate Time :	
0 to 1.1xVs	73ms ±10ms
0 to 2.0xVs	63ms ±10ms
1.1 to 0.5xVs	58ms ±10ms
Operate time following delay.	Tbasic + td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input U/V Guard

37, 37G Undercurrent

Number of Elements	Phase (37) x 2 Earth (37G) x 2
Setting Range Is	0.05, 0.10…5.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Delay Setting td	0.00, 0.01…20, 20.5…100, 101…1000, 1010…10000, 10100…14400s
Basic Operate Time: 1.1 to 0.5xIn	35ms ±10ms
Operate time following delay.	Tbasic + td , ±1% or ±10ms
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input U/I Guard (37)

46 Negative Phase Sequence Overcurrent

Number of Elements	DT & IT
DT Setting Range Is	0.05, 0.06…4.0 x In
DT Operate Level	100% Is, ±5% or ±1%xIn
DT Delay Setting td	0.00, 0.01…20, 20.5…100,

	101...1000, 1010...10000, 10100...14400s
DT Basic Operate Time: 0 to 2 x Is	40ms ±10ms
DT Operate time following delay.	Tbasic + td , ±1% or ±10ms
IT Char Setting	IEC: NI,VI,EI,LTI ANSI: MI,VI,EI DTL
IT Setting Range	0.05, 0.06 ..2.5
Tm Time Multiplier	0.025, 0.050...1.6
Char Operate Level	105% Is, ±4% or ±1%In
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

49 Thermal Overload

Operate levels	Operate and Alarm
Setting Range Is	0.10, 0.11...3.0 x In
Operate Level	100% Is, ±5% or ±1%xIn
Time Constant Setting	1,1.5...1000min
Operate time	$t = \tau \times In\left\{\frac{I^2 - I_P^2}{I^2 - (k \times I_B)^2}\right\}$ ±5% absolute or ±100ms where Ip = prior current
Alarm Level	Disabled, 50,51...100%
Inhibited by	Binary or Virtual Input

50 Instantaneous & DTL OC&EF

Elements	Phase (OC), Derived Earth (N) and Measured Earth (G)
Number of Elements	2 x OC 2 x Derived EF (N) 2 x Measured EF (G)
Setting Range Is	0.05,0.06...50 x In (OC, N) 0.005...25 x In (G)
Time Delay	0.00...14400s
Operate Level	100% Is, ±5% or ±1% x In
Operate time:	
50, 50G	0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 25ms, ±10ms
50N	0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 30ms, ±10ms
Operate time following delay	Tbasic + td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input Inrush detector

51Time Delayed OC&EF)

Elements	Phase (OC), Derived Earth (N) and Measured Earth (G)
Number of Elements	2 x OC 2 x Derived EF (N) 4 x Measured EF (G)
Characteristic	IEC: NI,VI,EI,LTI ANSI: MI,VI,EI DTL
Setting Range Is	0.05, 0.1...2.5 x In (OC, N) 0.005, 0.01...1.0 x In (G)
Time Multiplier	0.025,0.05...1.6
Time Delay	0, 0.01... 20s
Operate Level	105% Is, ±4% or ±1%xIn
Minimum Operate time IEC	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$
ANSI	$t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$
	± 5 % absolute or ± 30 ms

Follower Delay	0 - 20s
Reset	ANSI decaying, 0 – 60s
Inhibited by	Binary or Virtual Input Inrush detector

50BF Circuit Breaker Fail

Operation	Current check
Setting Range Is	0.05,0.055...2.0 x In (Phase) 0.005,0.010...2.0 x In (Earth)
2 Stage Time Delays	Timer 1 0,5...60000ms Timer 2 0,5...60000ms
Operate Level	100% Is, ±5% or ±1%xIn
Basic Operate time	< 20ms
Operate time following delay	Tdelay ±1% or ±10ms
Triggered by	Any function mapped as trip contact.
Inhibited by	Binary or Virtual Input

59N Neutral Voltage Displacement

Number of Elements	DT & IT
DT Setting Range Is	1...100V
DT Operate Level	100% Vs, ±5% or ±1%xVn
DT Delay Setting td	0 ...14400s
DT Basic Operate Time 0V to 1.5xVs	76ms ±20ms
DT Operate time following delay.	Tbasic + td , ±1% or ±20ms
IT Setting Range	1...100V
Tm Time Multiplier(IDMT)	0.1...140
Delay (DTL)	0...20s
Reset	ANSI Decaying, 0 ... 60s
Char Operate Level	105% Vs, ±2% or ± 0.5V
Inhibited by	Binary or Virtual Input

64H Restricted Earth Fault

Setting Range	0.005...0.95xIn
Operate Level	100% Is, ±5% or ±1%xIn
Time Delay	0.00... 14400s
Basic Operate Time	0 to 2 x Is: 45ms ±10ms 0 to 5 x Is: 35ms ±10ms
Inhibited by	Binary or Virtual Input

74TCS Trip Circuit Supervision

Number of supervisable circuits	6
Number of BI's Required	1 or 2 per function

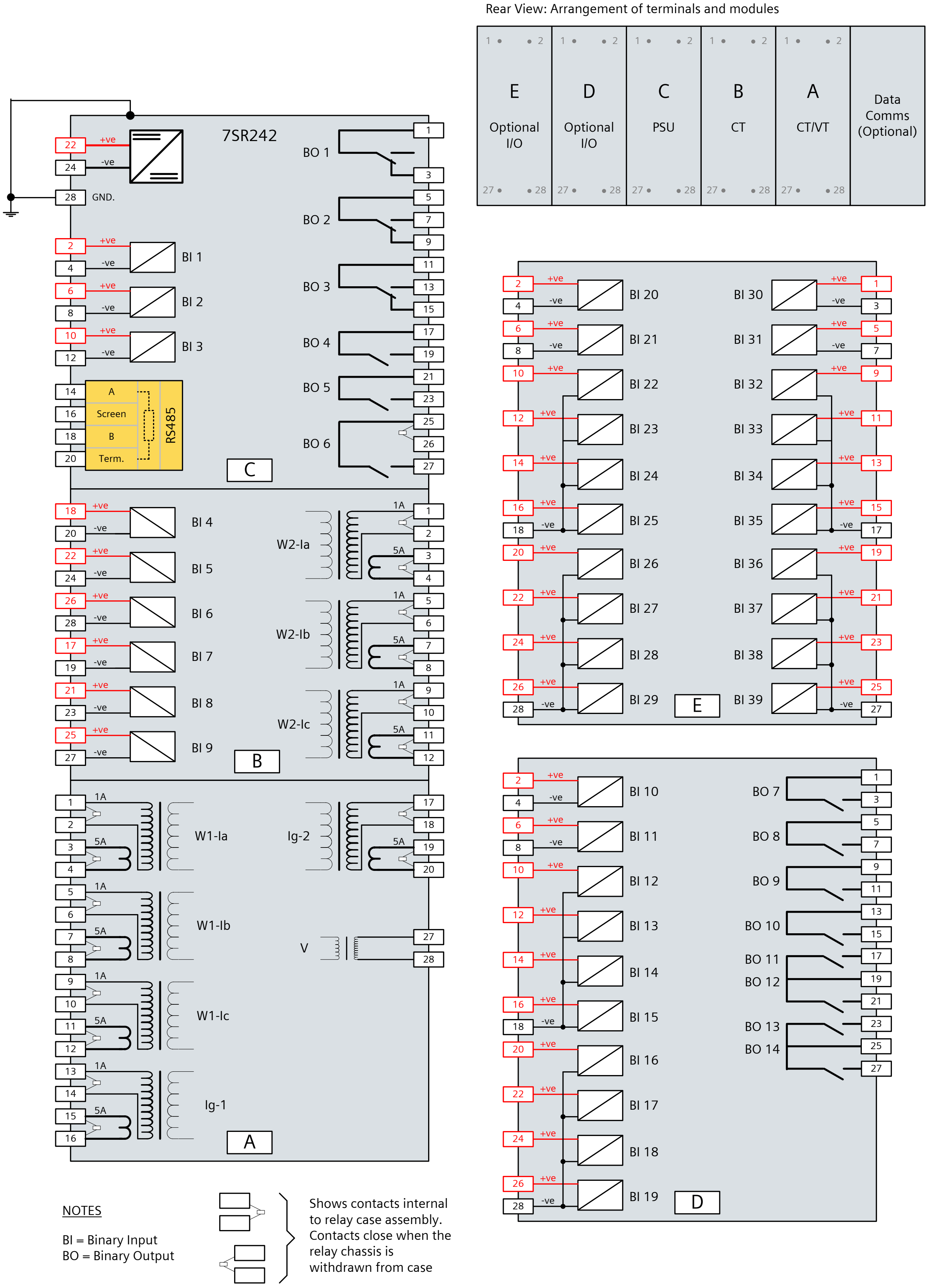
81 Under/Over Frequency

Number of Elements	6 Under or Over
Setting Range Vs	40 ... 69.99Hz
Hysteresis Setting	0. 0.1...80%
Vs Operate Level	100% Fs, ±10mHz
Reset Level:	
Over frequency	(100% - hyst) x Fop, ±10mHz
Under frequency	(100% + hyst) x Fop, ±10mHz
Delay Setting td	0.00, 0.01...20, 20.5...100, 101...1000, 1010...10000, 10100...14400s
Basic Operate Time : (for ROCOF between 0.1 and 5.0 Hz/sec)	Typically <110ms Maximum <150ms
Operate time following delay.	Tbasic + td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input

87BD Biased Differential

Number of Elements	1
Setting Range	
Initial	0.1, 0.15 … 2 x In
1st Bias Slope	0.1, 0.15 … 0.7x
1st Bias Slope Limit	1, 2 … 20 x In
2nd Bias Slope	1, 1.5 … 2x
2nd Bias Slope Type	Line, curve
Operate Level:	
Initial setting	±5% of setting or ±0.01 In
Bias slope	±10% of setting or ±0.01 In
Reset Level:	
Over frequency	(100% - hyst) x Fop, ±10mHz
Under frequency	(100% + hyst) x Fop, ±10mHz
Delay Setting td	0.000, 0.005 … 1s
Basic Operate Time :	
(inrush action Enabled)	
0 to 3 x I_{OP}	35ms ±10ms
0 to 10 x I_{OP}	30ms ±10ms
Operate time following delay.	Tbasic + td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input

7SR24 Connection Diagram



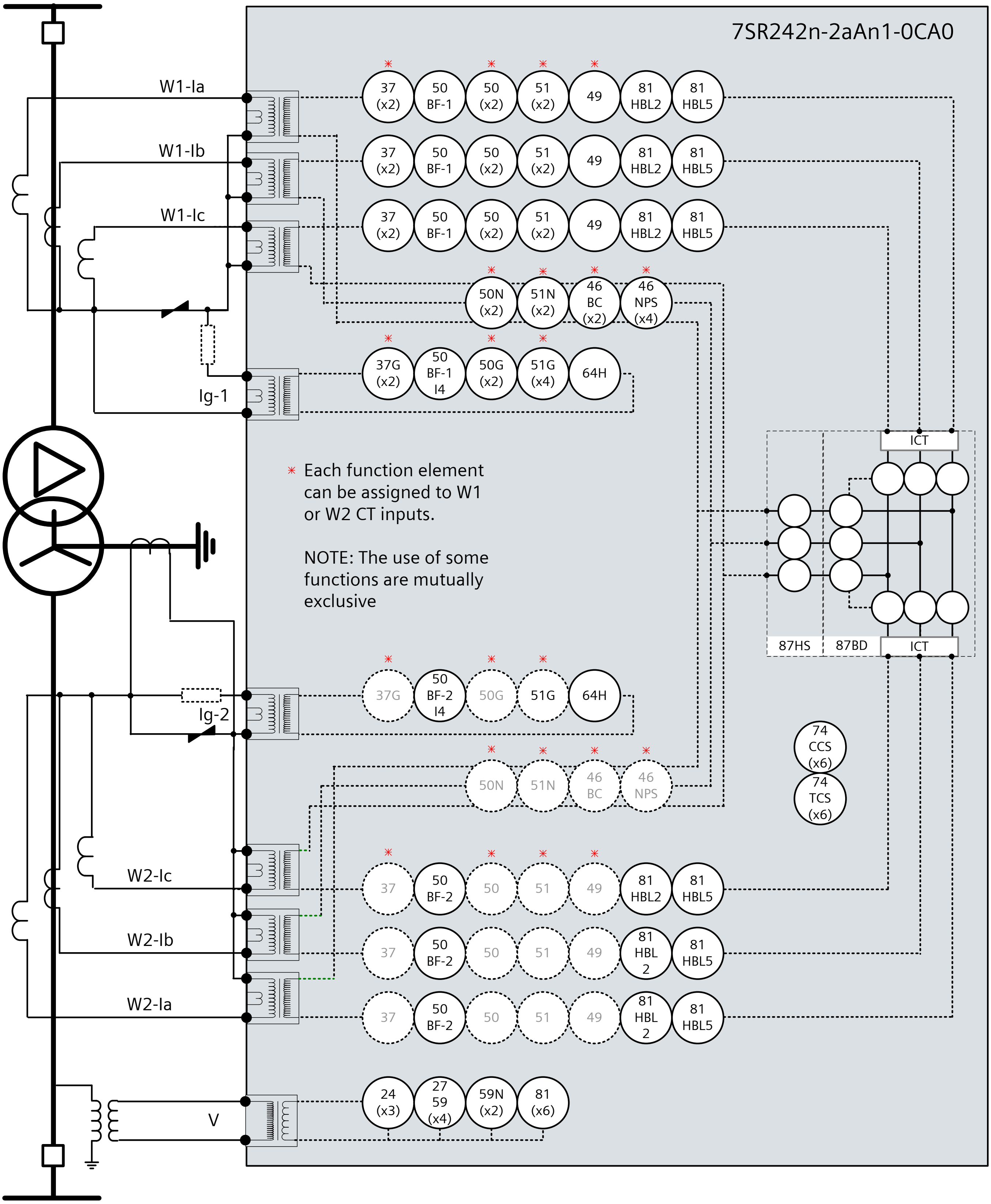
NOTES

BI = Binary Input
BO = Binary Output

Shows contacts internal to relay case assembly. Contacts close when the relay chassis is withdrawn from case

Fig2. 7SR242 Wiring Diagram

7SR24 Function diagram / example of external connections



✳ Each function element can be assigned to W1 or W2 CT inputs.

NOTE: The use of some functions are mutually exclusive

Fig3. Standard and Optional Functionality of 7SR24 Relay

Ordering Information – 7SR242 Winding Transformer Protection

Product description	Variants	Order No.
Duobias		**7 S R 2 4 2 □ - 2 □ A □ □ - 0 □ A 0**
Multifunctional 2 winding transformer differential protection	Protection Product	
	Transformer	**4**
	Relay Type	
	Differential (2 winding)	**2**
	Case I/O and Fascia	
	E8 case, 6 CT, 2 EF/REF CT, 1 VT, 9 Binary Inputs / 6 Binary Outputs, 16 LEDs	**2**
	E10 case, 6 CT, 2 EF/REF CT, 1 VT, 19 Binary Inputs / 14 Binary Outputs, 24 LEDs	**3**
	E12 case, 6 CT, 2 EF/REF CT, 1 VT, 39 Binary Inputs / 14 Binary Outputs, 32 LEDs	**4**
	Measuring Input	
	1/5 A, 40/160V, 50/60Hz	**2**
	Auxiliary voltage	
	24-250V DC / 100-230V AC. Binary input threshold 19	**M**
	24-250V DC / 100-230V AC. Binary input threshold 88	**N**
	Communication Interface	
	Standard version – included in all models, USB front port, RS485 rear port	**1**
	Standard version – plus additional rear F/O ST connectors (x2) and IRIG-B	**2**
	Standard version – plus additional rear RS485 (x1) and IRIG-B	**3**
	Standard version – plus additional rear RS232 (x1) and IRIG-B	**4**
	Standard version – plus additional rear Electrical Ethernet RJ45 (x2)	**7**
	Standard version – plus additional rear Optical Ethernet Duplex (x2)	**8**
	Protocol	
	IEC 60870-5-103 and Modbus RTU (user selectable setting)	**1**
	IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable)	**2**
	IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable) and IEC61850	7-8 **7**
	Protection Function Packages	
	Option A: Standard version – Included in all models - 81HBL2 Inrush Detector - 81HBL5 Overfluxing detector - 87BD Biased current differential - 87HS Current differential highset Programmable logic For each winding/circuit breaker - 50BF Circuit breaker fail - 64H High impedance REF - 74TCS/CCS Trip/Close circuit supervision	**A**
	Option B: Standard version – plus - 37/37G Undercurrent - 46BC Open circuit - 46NPS Negative phase sequence overcurrent - 49 Thermal overload - 50 Instantaneous phase fault overcurrent - 50G/50N Instantaneous earth fault - 51 Time delayed phase fault overcurrent - 51G/51N Time delayed earth fault (continued on following page)	**B**

Ordering Information – 7SR242 Winding Transformer Protection

Product description	Variants		Order No.
Duobias			**7 S R 2 4 2 □ - 2 □ A □ □ - 0 □ A 0**
(continued from previous page)	Option C:	Standard version - plus	**C**
	- 24	Overfluxing	
	- 27/59	Under/overvoltage	
	- 59N	Neutral voltage displacement	
	- 81	Under/overfrequency	
	- 37/37G	Undercurrent	
	- 46BC	Open circuit	
	- 46NPS	Negative phase sequence overcurrent	
	- 49	Thermal overload	
	- 50	Instantaneous phase fault overcurrent	
	- 50G/50N	Instantaneous earth fault	
	- 51	Time delayed phase fault overcurrent	
	- 51G/51N	Time delayed earth fault	
	Additional Functionality		
	No Additional Functionality		**A**

1.1.4 7SR45 Non-Directional Overcurrent Protection

Description

The 7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay is developed using the latest generation of hardware technology and is available in multiple variants depending on the CT, binary input/binary output, power supply and communication configuration. 7SR45 is a member of Siemens Reyrolle® protection devices Argus product family.

The 7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay is housed in a 4U high, size 4 non draw-out case and provides protection, monitoring, instrumentation, and metering with integrated input and output logic and fault reports.

The relay functionality can be configured via a front USB port for local PC connection or rear electrical RS485 (optional) port for remote connection. By using the Reydisp Evolution software, the user can update the settings and view the fault records (trip log) and the event records (event log).

7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay supports the IEC 60870-5-103 and Modbus communication protocols.

7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay can indicate the trip with local and remote flag indicator.

Function Overview

Protection

50	Instantaneous Overcurrent Protection
50N/G	Instantaneous Derived/Measured Earth Fault Protection
51	Time Delayed Overcurrent Protection
51N/G	Time Delayed Derived/Measured Earth Fault Protection
50LC/SOTF	Switch-On-To-Fault

Features

Password Protection
Self Monitoring
Trip Timers
Healthy shut-down below operating ranges
Remote reset (binary input based) of flag with/without CT power and Auxiliary power
Two Settings Groups

User Interface

16 Character x 2 Line Backlit LCD
Menu Navigation Keys
9 non-programmable LEDs
Local Flag Indicator

Monitoring Functions

Primary/Secondary Current Phases and Earth
Binary Input/Binary Output Status
Time and Date
Fault Records (Trip Log)
Event Records (Event Log)

Hardware

4 CT (1 A or 5 A, via ordering option)
4 BI, 4 BO
1 Local Flag indication
1 Remote Flag output
1 Pulse Output
9 LEDs
Rear RS485 communication port
Auxiliary Power input

Data Storage and Communication

Front USB port + Rear RS485 port (optional)
Protocols - IEC60870-5-103, Modbus RTU
Fault Records (Trip Log)
Event Recording (Event Log)
Time Synchronism
Viewing and Changing Settings
Battery Profiling

Application

7SR45 Self Powered/Dual Powered Relay is a numerical overcurrent and earth fault protection relay primarily intended for secondary distribution electrical networks.

The 7SR45 Dual Powered Non-Directional Overcurrent and Earth Fault Relay is designed to operate with/without an auxiliary supply. The 7SR45 Dual Powered Non-Directional Overcurrent and Earth Fault relay is powered primarily from the auxiliary voltage even though all other power sources are available.

In the absence of auxiliary voltage, the relay is powered by CT input.

The relay offers definite-time and inverse-time overcurrent and earth fault protection functions in accordance to IEC and ANSI standards.

7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay are built-in with a capacitor discharge pulse output for low-energy trip coil of the circuit breaker. Changeover binary outputs are also available for trip via an auxiliary powered shunt trip coil.

7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay are targeted for the following applications:

- Protection Relay for Ring Main Units (RMU)
- Back up protection relay for the medium voltage applications
- Protection applications in remote locations where auxiliary supply is not available.
- Control and relay panels refurbishment of old electromechanical protection relays

Functional Diagram

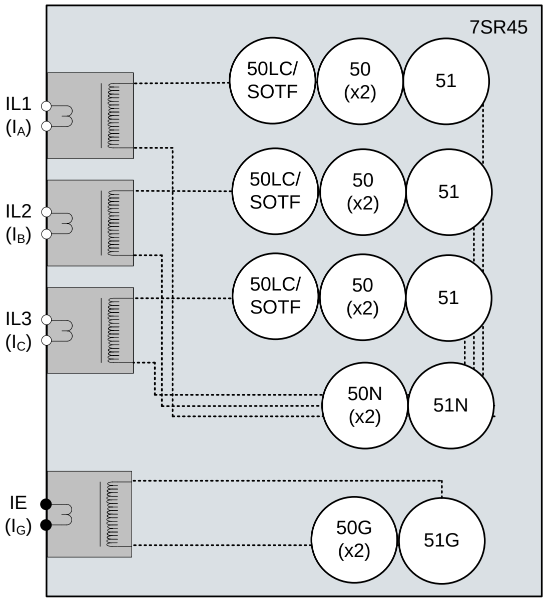


Fig1. Functional Diagram of 7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay

50/51 Phase Overcurrent Fault

50 INST/DTL and 51 IDMTL/DTL elements provide overcurrent protection, each with independent settings for pickup current, time-multiplier (51) and time-delays. User can select IEC or ANSI time current characteristics.

The IDMT curve has a user selectable reset characteristic, either DTL or IEC/ANSI decaying to improve the grading with electromechanical protection.

50G/51G/50N/51N Measured/Derived Earth fault

Two earth fault measurement modes are available. One mode directly measures the earth current from an independent CT (50G/51G) and the second mode derives the residual current internally from the 3 line CTs (50N/51N).

50G/50N INST/DTL and 51G/51N IDMTL/DTL elements provide earth fault protection, each with independent settings for pickup current, time-multiplier (51G/51N) and time-delays. User can select IEC or ANSI time current characteristics.
The IDMT curve has a user programmable reset characteristic either DTL or IEC/ANSI decaying to improve grading with electromechanical protection.

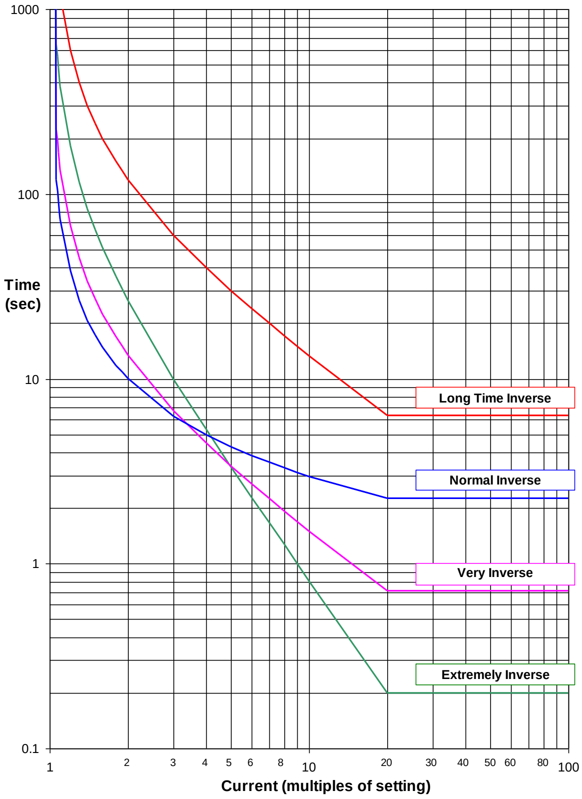


Fig2. IEC Overcurrent Curves

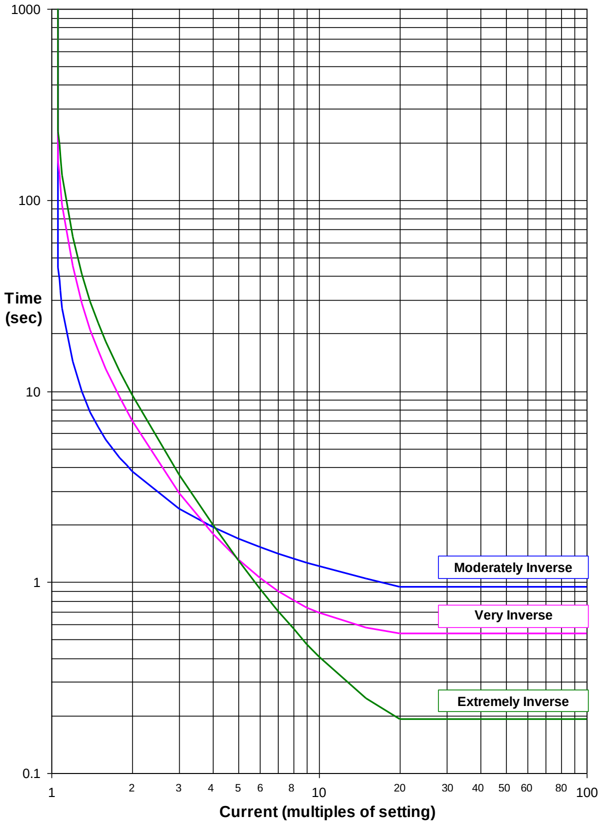


Fig3. ANSI Overcurrent Curves

50LC / SOTF

SOTF functionality provides high speed tripping if a fault is still present on the feeder after the reclosure of the circuit breaker (Close-on-to-Fault) or if earthing clamps are left connected after maintenance.

The following graph shows the SOTF operating time depending on the fault currents.

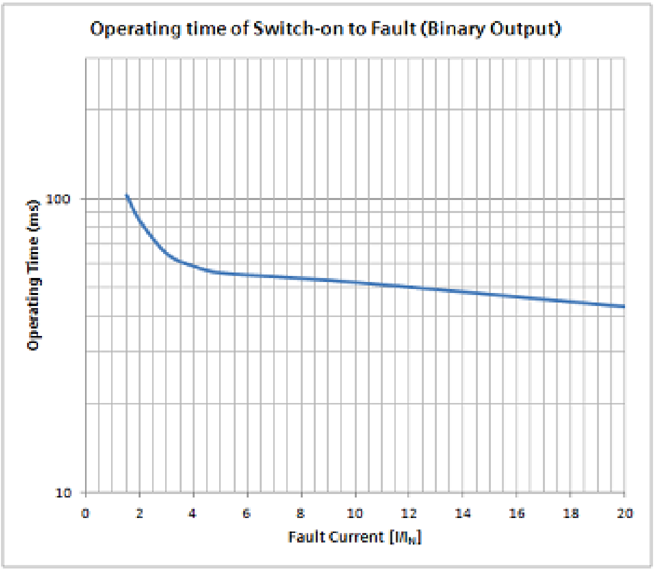


Fig4. Operating Time for Single Phase Fault with binary output

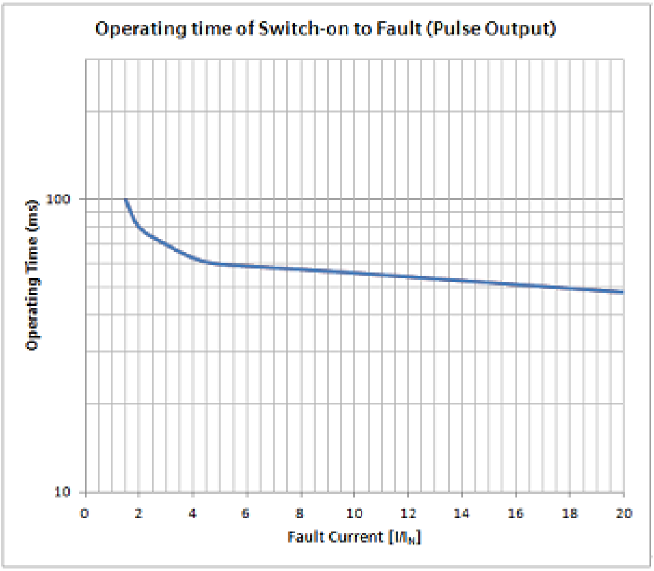


Fig5. Operating Time for Single Phase Fault with pulse output

NOTE: Multi-phase faults will result in shorter operating time.

Sensitivity

In case absence of auxiliary voltage, the sensitivity of the relay is the minimum phase current required for the relay to energize, detect a fault and trip as per the configuration.

The sensitivity of 7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay is 20 % of nominal current for single phase and 13 % of nominal current in three phases. The PROTECTION HEALTHY LED and TRIP READY LED TURN ON when the relay is TRIP ready at the above mentioned current levels.

The following graphs show the sensitivity of the relay and corresponding operating time for different start up currents.

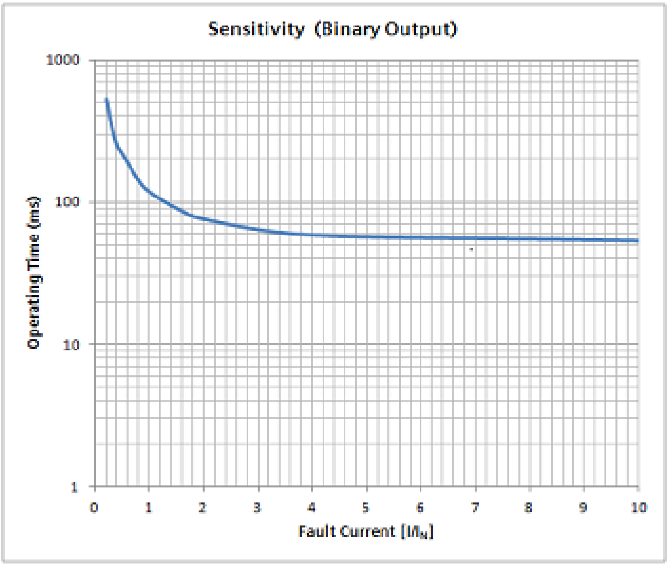


Fig6. Sensitivity for Single Phase Fault with binary output

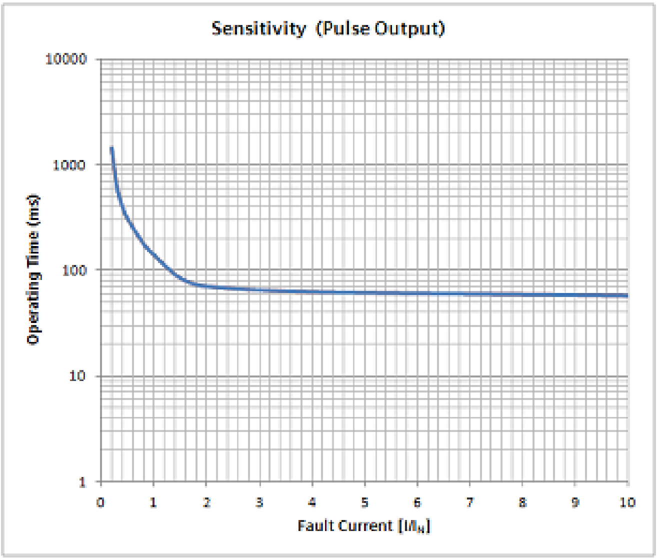


Fig7. Sensitivity for Single Phase Fault with pulse output

NOTE: Multi-phase current will improve the sensitivity.

Data Acquisition -
Via Communication Interface

Sequence of Event Records (Event Log)

Up to 100 events can be stored and time tagged to 1 ms resolution. The events are stored on first-in-first-out basis. The events are available through the communication interface.

Fault Records (Trip Log)

The last 10 fault records are displayed on the relay fascia and are also available through the communication interface with time and date of trip, measured quantities and type of fault.

Real Time Clock

The time and date can be set and is maintained while the Relay is de-energised by a coin cell battery.

Communications

The relay offers a USB port as standard on the front of all units. All of the relay functions can be set on a PC using Reydisp Evolution software via the USB port. The connection is made with a USB cable and operates with a ‘plug and play’ connection, so no pre-setting of the relay is required.

The front port can be switched off or set to use either the Modbus RTU or IEC60870-5-103 protocols for testing purposes.

A rear RS485 electrical connection is optionally available on the relay for system interface connections.

An internal terminating resistor is provided, which can be connected into the circuit by adding a wire loop between the relevant terminals.

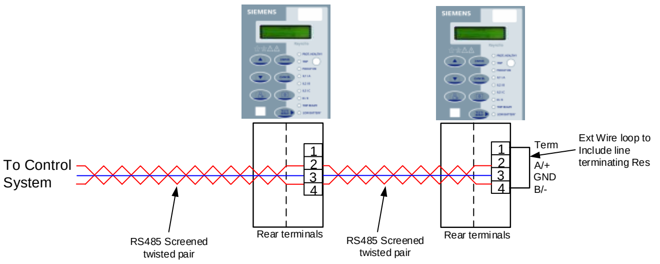


Fig8. Typical RS485 connection

The rear RS485 can be user selected to be OFF, IEC60870-5-103 or Modbus RTU.

Construction

The relay is housed in a non draw-out 4U high, size 4 case.

The rear connection comprises of user friendly pluggable type terminals for pulse and flag output, binary inputs, binary outputs, RS485 communication and auxiliary input.

The CT terminals are suitable for ring type lug connection to provide a secure and reliable termination.

Fig9. 7SR4501 Front view

Fig10. 7SR4501Rear view

Fig11. 7SR4502 Front view

Fig12. 7SR4502 Rear view

User Interface

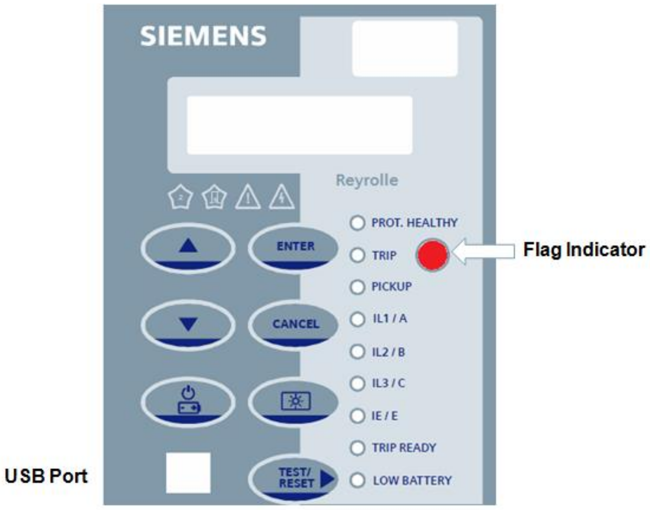


Fig13. User Interface

The operator interface is designed to provide a user friendly method of viewing menus, entering settings, and retrieving data from the relay. Five buttons are provided for navigation around the menu structure. Additionally, two buttons are provided for battery ON/OFF and Backlight ON/OFF functionality.

LCD

A 2 line by 16 character liquid crystal display with power save operation indicates the relay identifier, settings, instrumentation, and fault data.

LEDs

9 non-programmable LEDs are available eliminating the need for expensive panel mounted pilot lights and associated wiring. Each LED shows clear indication of the associated functions state and has a label for identification.

Flag Indicator

1 local flag indicator is provided and configured for the trip indication.

Relay Information

The device is identified by the rating label on the front fascia of the housing. The user can also give the device its own identity by editing the 'Relay Identifier' displayed on the LCD.

Power

7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay can be powered in the following modes and their priority is as follows:

- Auxiliary Power Supply
- CT Power
- USB Power
- Battery Power

Indication of Conformity

Low Voltage Directive:

2006/95/EC Directive of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (***until 19.04.2016***)

2014/35/EU Directive of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits; Official Journal of the EU L96, 29/03/2014, p. 357–374 (***from 20.04.2016***)

EMC Directive:

2004/108/EC Directive of the European Parliament and of the Council of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility (***until 19.04.2016***)

2014/30/EU Directive of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility; Official Journal of the EU L96, 29/03/2014, p. 79–106 (***from 20.04.2016***)

Technical Data

For full technical data, refer to the Technical Specification Section of the User Manual.

Technical Data Overview

Product Family	Non Directional Self Powered /Dual Powered Overcurrent and Earth Fault Relay
Case and LEDs	Non draw-out Polycarbonate case (Size 4 standard, Non draw-out design), 9 non-programmable LEDs
Measuring Inputs (Current)	1 A or 5 A (ordering option), 50 Hz/60 Hz
Auxiliary voltage	24 V-60 V DC 60 V-240 V AC/DC
Communication	Front communication port : USB (IEC 60870-5-103 or Modbus RTU) Rear communication port: RS485 (IEC 60870-5-103 or Modbus RTU)
Protection Functions	50, 50G/N, 51, 51G/N, 50LC/SOTF
Binary Input and Binary Output	4 BI and 4 BO
Remote flag	24 V, 0.01 Ws
Local flag	Mechanical Flag Indicator • Normal – Green colour • Trip – Red colour
Pulse output	24 V, 0.1 Ws pulse output
Overvoltage	Category III
Pollution Degree	2
Altitude above sea level	Maximum up to 2000 m

Sensitivity

Minimum phase current for relay operation	20 % of nominal current in single phase 13 % of nominal current in three phases

Mechanical Specifications

Design	Panel mounting, Non draw-out Polycarbonate moulded case
Enclosure	IP 52 (front panel) IP 40 (enclosure sides) IP 20 (rear side) Depth is 203 mm
Weight	1.8 kgs (appx)

Terminal Blocks

Auxiliary Power Supply	3 position (Terminal X3), M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable

Current Inputs	8 position (Terminal X1), M4 Screw-type Barrier Terminal block suitable for 2.5 mm^2/ 4 mm^2 cable
Binary Input	4 position (Terminal X2), 4 position (Terminal X5) for additional binary inputs M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Binary Output	5 position (Terminal X2), 5 position (Terminal X6) for additional binary outputs M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Pulse Output	2 position (Terminal X2), M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Remote Flag	2 position (Terminal X2), M3 screw-type plug-in terminals suitable for 2.5 mm^2 cable
Front Communication Port	USB, Type B
Rear Communication Port	4 position (Terminal X4), M3 screw-type plug-in terminals suitable for 2.5 mm$_2$ cable
Ground Terminal	M3 ring type terminals suitable for 2.5 mm^2/4 mm^2 cable

Inputs and Outputs

Auxiliary Supply

Rated Voltage	60 V - 240 V AC/DC, 50/60 Hz ± 5% Tolerance – 20 % to +10 % 24 V - 60V DC, Tolerance – 20 % to +10 % (ordering option)
Allowable superimposed AC component	15 % of DC voltage
Typical Power consumption (DC) Typical Power consumption (AC)	< 7 W < 12 VA
Max Interruption time (Collapse to Zero)	≤20 ms (19.2 V DC) ≤ 20 ms (48 V DC) ≤ 500 ms (230 V AC)

Current Inputs

Quantity	3 x Phase and 1 x Earth
Rated Current (In)	1 A or 5 A (ordering option)
Measuring Range	0.2xIn to 20xIn
Instrumentation	± 5 % (Typical) (≥0.13xIn to 2xIn) ± 3% (> 2xIn to 20xIn)
Frequency	50 Hz (Range: 45 Hz to 55 Hz) 60 Hz (Range: 54 Hz to 66 Hz)
Burden @ In	≤ 3.0 VA per phase and ≤ 0.2 VA earth for 1 A CT input ≤ 3.5 VA per phase and ≤ 0.2 VA earth for 5 A CT input

Binary Inputs

Number	2 or 4	
	19 V DC	Range 24 V - 66 V DC
	88 V AC/DC	Range 88 V - 265 V
	Range	DC 88 V - 265 V DC AC 68 V - 265 V AC
Maximum AC/DC current for operation	3.5 mA	
Pick Up Delay	User selectable 0 to 600 s (up to 10 mins)	
Drop Off Delay	User selectable 0 to 600 s (up to 10 mins)	

Binary Outputs

Number	2 or 4 (2 NO contact and 2 C/O contact)
Operating Voltage	Potential free
Operating Mode	User selectable - BO 1 and BO 2 Self or Hand /Electrical Reset BO 3 and BO 4 Self Reset (Operated only with Auxiliary input is present)
Operating Time from energizing Binary Input	< 20 ms
Making Capacity: Carry continuously Make and carry (L/R ≤ 40 ms and V ≤ 300 V AC)	 5 A AC or DC 20 A AC or DC for 0.5 s 30 A AC or DC for 0.2 s
Breaking Capacity (≤ 5 A and ≤ 250 V): AC Resistive AC Inductive DC Resistive DC Inductive Disengaging time	 1250 VA 250 VA at p.f. ≤ 0.4 75 W 30 W at L/R ≤ 40 ms 50 W at L/R ≤ 10 ms < 20 ms

Front Communication Port

Quantity	1
Electrical connection	USB, Type B
Protocol Support	Modbus RTU, IEC 60870-5-103

Rear Communication Port

Quantity	1 (Optional)
Electrical connection	RS485, 2 wire electrical, twisted pair
Protocol Support	Modbus RTU, IEC 60870-5-103
Rate	Data Transfer rate: 1200 - 57600 bps

Data Storage

Fault Record (Trip Log)	10 records
Events (Event Log)	100 events (1 ms resolution)

Mechanical Tests

Test	Standard
Vibration	IEC60255-21-1, Response and Endurance, Class I
Shock and Bump	IEC 60255-21-2 Shock response and withstand, Class I Bump, Class I
Seismic	IEC 60255-21-3, Class I
Degree of Protection	IEC 60529, IP52 front, IP20 rear
Contact	IEC 60255-1 (Ref: Std IEC 61810-1)
Electrical Endurance Test	IEC 60255-1 (Ref: Std IEC 61810-1) (10000 operations at 250 V, 5 A)

Electrical Tests

Test	Standard
Insulation Resistance	IEC 60255-27# Insulation resistance >100 M Ohms at 500 V DC Test Duration: > 5 s
Impulse Voltage Withstand	IEC 60255-27# 5 kV, 1.2/50 µs, 0.5 J 5 +ve, -ve pulses (Between all terminals and case earth and any two independent circuits) ^
High Voltage (Dielectric)	IEC 60255-27# 2 kV AC RMS for 1 min (Between any terminal and earth, independent circuits) ^ 1 kV AC RMS for 1 min (across normally open contacts)
High Frequency Disturbance	IEC 60255-26 2.5 kV (CM)*, 1.0 kV (DM) 1 MHz
Electrostatic Discharge	IEC 60255-26 8 kV air discharge 6 kV contact discharge
Electrical Fast Transient or Burst	IEC 60255-26 ± 2 kV, 5 kHz
Surge Immunity	IEC 60255-26 4 kV (CM), 2 kV (DM) 1.2/50 µs
Radiated Immunity	IEC 60255-26 80 MHz to 1.0 GHz and 1.4 GHz to 2.7 GHz Field strength: 10 V/m (RMS) Amplitude Modulated: 80 % AM
Conducted Radio Frequency Interference	IEC 60255-26 150 kHz to 80 MHz, 10 V (RMS) Class III
Power Frequency Magnetic Field	IEC 60255-26 30 A/m applied 1 min, 300 A/m applied for 3 s
Radiated Emissions	IEC 60255-26 CISPR 11, Class A
Conducted Emissions	IEC 60255-26 CISPR 11, Class A
Thermal Withstand Continuous 1 s	IEC 60255-27# 2 x In 50 A (1 A) 150 A (5 A)
Functional performance	IEC 60255-151 and IEC 60255-1
Maximum Allowable Temperature	IEC 60255-6 Max. temperature limit +100°C
Gradual shutdown/Start-up test	IEC 60255-26 Shut down/start up ramp 60 s Power off 5 min

* **NOTE:** Between each independent port and earth

NOTE: All aspect of IEC 60255-5 have been covered under IEC 60255-27

^ **NOTE:** Flag Ouput and Pulse Ouput X3 are excluded between any terminals and earth.

Climatic Environmental Tests

Temperature
IEC 60068-2-1/IEC 60068-2-2

Ambient Operating Temperature	-10^{0}C to + 60^{0}C
Permissible Temporary Operating Temperature, (Tested for 16 h)	-40^{0}C to + 70^{0}C
Storage Temperature (Non-operational)	-25^{0}C to + 70^{0}C

Humidity
IEC 60068-2-30/IEC 60068-2-78

Damp heat test, Cyclic	+25...55°C, RH > 93% 6 cycles
Damp heat test, Steady State	10 days at 95% RH, +40^{0}C

NOTE: Cold test at -40°C:
The device was kept in non-energized condition at -40° C for 16 hours. Energized at the end of 16 hours (@ -40°C) and accuracy test was performed and found to be within limits. The LCD was blank at -40°C.

After accuracy test at -40° C, temperature was ramped up to room temperature and accuracy test was found within limits.

Product Safety Test

Clearances and Creepage Distances	IEC/EN 60255-27: Edition 2 ≥• 4 mm
IP Rating	IEC/EN 60255-27: Edition 2 IP52 (Front side) IP20 (Rear side)
Impulse Voltage	IEC/EN 60255-27: Edition 2 5 kV, 5 +ve, -ve pulses
AC Dielectric Voltage	IEC/EN 60255-27: Edition 2 2 kV AC, 50 Hz, 1 min
Insulation Resistance	IEC/EN 60255-27: Edition 2 500 V DC, > 5 s, > 100 M ohm
Protective Bonding Resistance	IEC/EN 60255-27: Edition 2 < 12 V AC/DC, 1 min, < 0.1 Ohm
Protective Bonding Continuity	IEC/EN 60255-27: Edition 2
Flammability	IEC/EN 60255-27: Edition 2
Single Fault Condition	IEC/EN 60255-27: Edition 2

Performance

50 Instantaneous & DTL OC&EF

Operation	Non directional
Elements	Phase, Derived Earth, Measured Earth
Setting Range Is (50/50N/50G)	0.2, 0.3, ... 20.0xIn
Time Delay	0,0.01,....600 s
Operate Level Iop	100% Is, ±5%
Reset level	> 0.2xIn to 0.9xIn setting: ≥ 90% I_{op} > 1xIn to 20xIn setting: ≥ 94% I_{op}
Basic Operate time (with auxiliary power / load current): 50, 50G, 50N	2xIs 25 ms, ±15 ms, 5xIs 20 ms, ±15 ms
Operate time delay	Tbasic+Td, ± 1% or ± 30 ms
Inhibited by	Binary Input
Disengaging time	< 50 ms *

* **NOTE:** With Auxiliary power supply

51 Time Delayed OC&EF

Operation	Non directional
Elements	Phase, Derived Earth, Measured Earth
Setting Range Is (51)	0.2, 0.21... 2.0xIn
Setting Range Is (51G,51N)	0.1,0.11... 0.8xIn
Time Multiplier	0.01,0.02.....10
Time Delay (DTL)	0.00, 0.01... 15 s
Operate Level	110% Is, ±5% or ±2%x In
Reset level	≥ 90 % I_{op}
Minimum Operate time (with auxiliary power / load current) IEC ANSI	$t_{op} = \frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \times Tm$ $t_{op} = \left[\frac{A}{\left[\frac{I}{Is}\right]^{P} - 1} + B\right] \times Tm$ ± 5% or ± 50 ms
Follower Delay	0.00, 0.01... 20 s
Reset	IEC/ANSI decaying, 0, 1... 60 s
Inhibited by	Binary Input

50LC / SOTF (Switch-On-To-Fault)

Operate level	100% Is, ±5%
Setting range	1,2,....20xIn
Disengaging time	< 50 ms

Real Time Digital Simulation Test (RTDS)

Trip Response at different fault currents	Fault Current: 1.1, 2, 3, 5, 10 times of set value
Influence on Accuracy	**Influence of DC components** DC content at first peak : 100% Decay time: 25 ms, 50 ms, 100 ms
	Immunity to inrush current 2^{nd} harmonic content : up to 28%
	Relay behaviour at primary CT saturation Fault currents: 10 A, 20 A, 40 A
Trip response at recurring faults	Fault Current: 2 times and 5 times of set value. Delay between recurring faults: 300 ms, 1 s, 2 s

Inrush Response Test

Test Conditions	Simulated Inrush current with 15 % 2^{nd} harmonic content
Test Result	The relay does not operate until fault current peak reaches 3 times the setting value

Case Dimensions

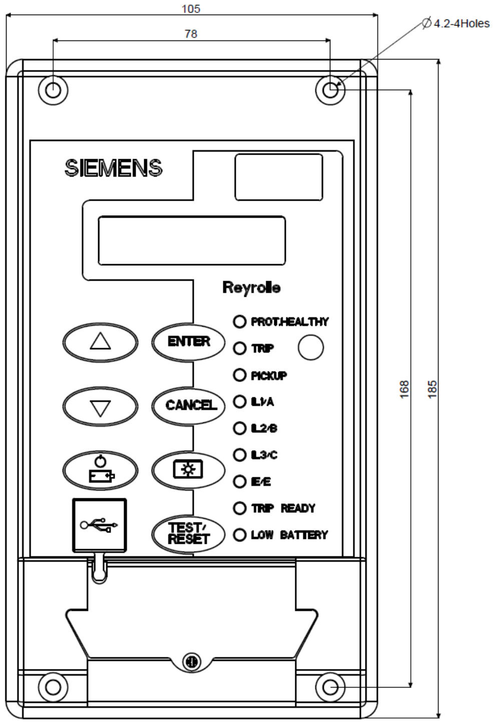


Fig14. Front View

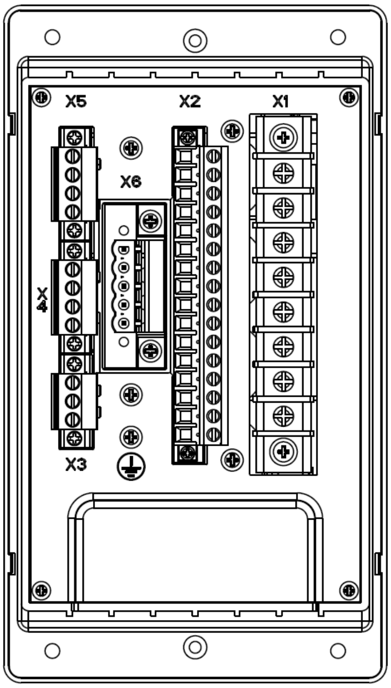


Fig15. Rear View

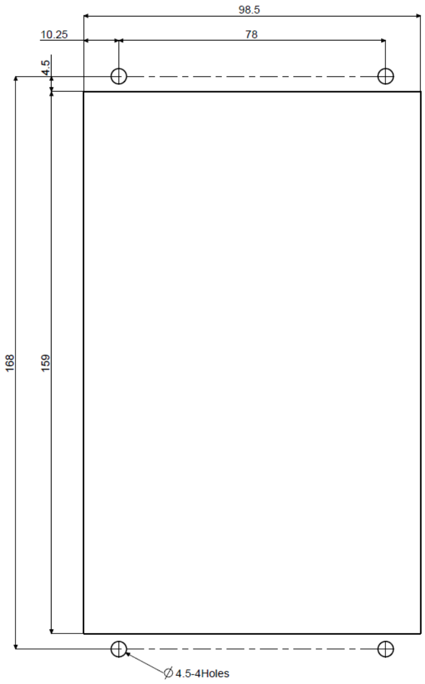


Fig16. Panel cut-out View

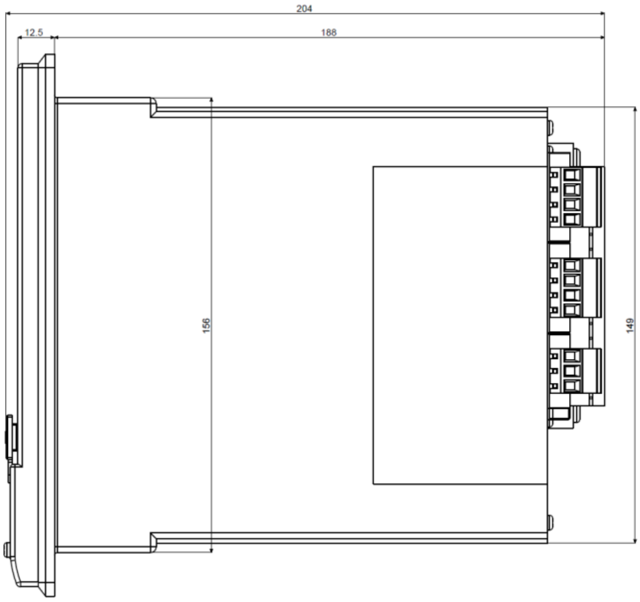
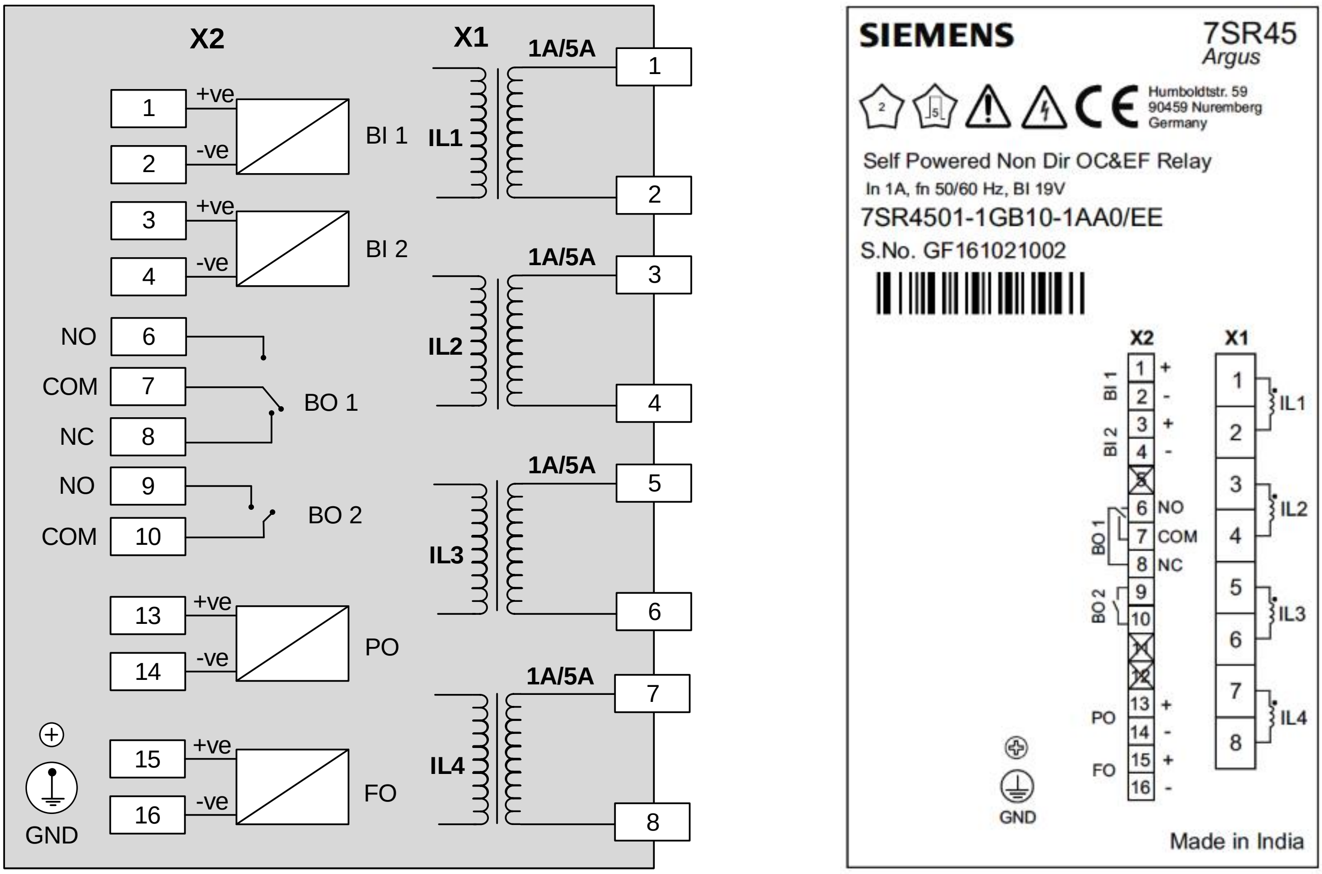


Fig17. Side View

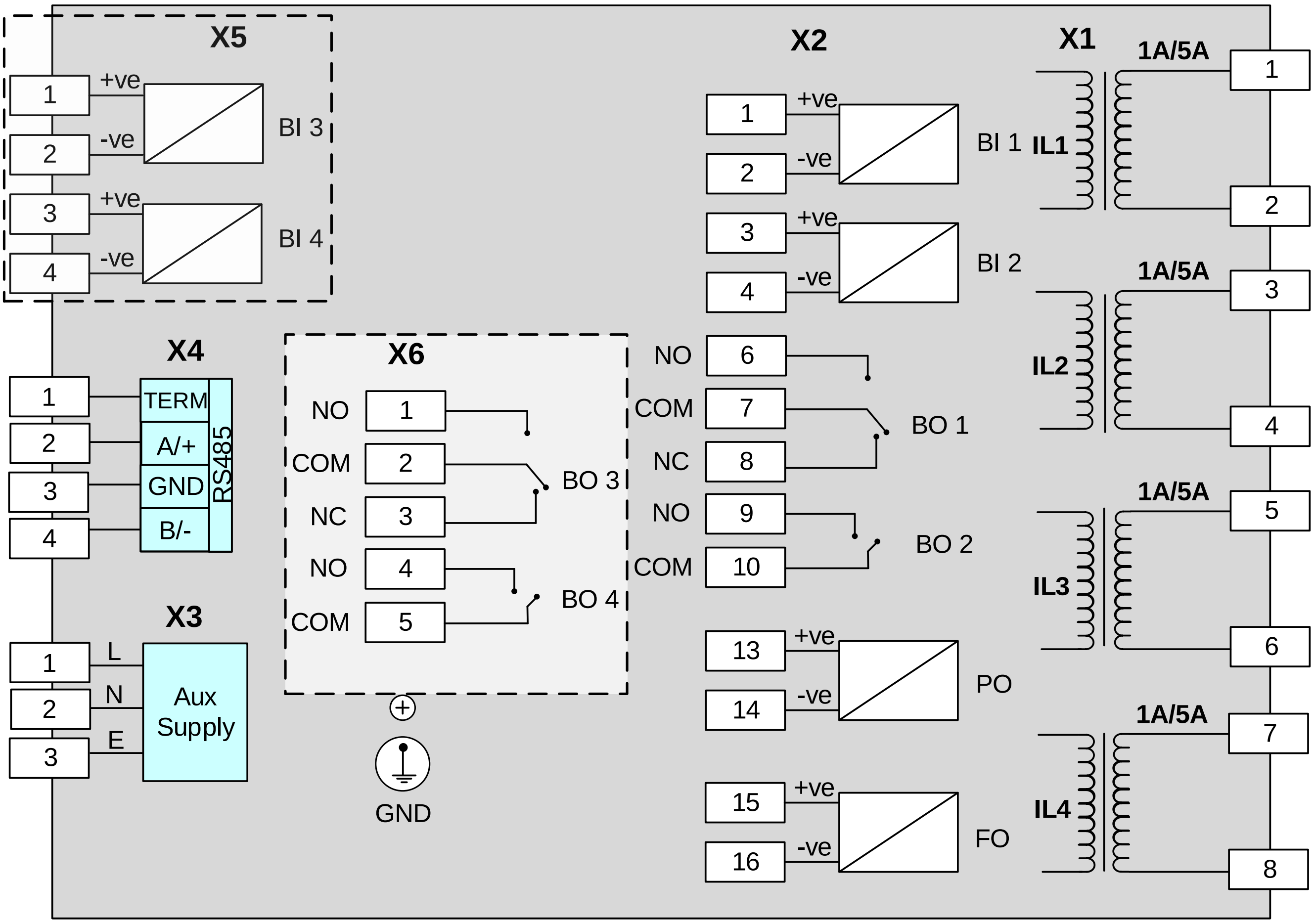
7SR4501 Terminal/Wiring Diagram



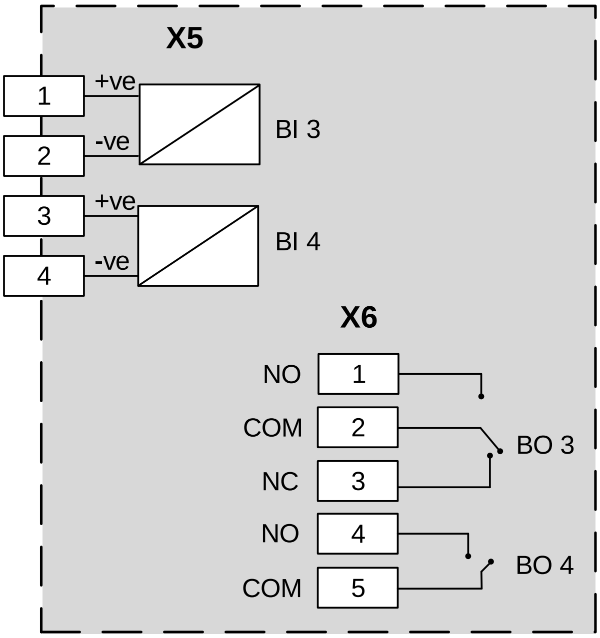
7SR4501 Terminal Label

Fig18. Terminal Diagram of Self Powered Non-Directional Overcurrent and Earth Fault Relay

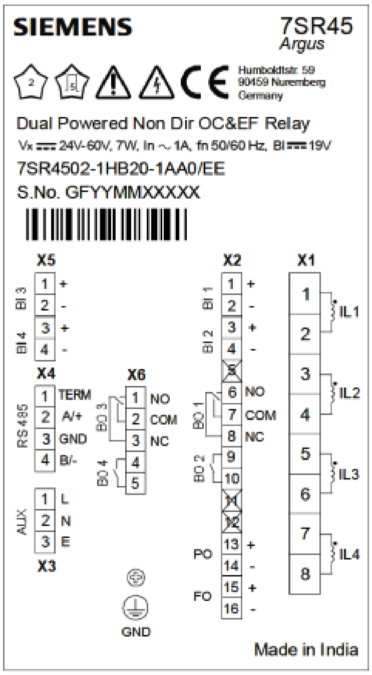
7SR4502 Terminal/Wiring Diagram



Additional 2BI 2BO options are not available for the Basic variant.



7SR4502 Terminal Label



SIEMENS

7SR45
Argus

Humboldtstr. 59
90459 Nuremberg
Germany

Dual Powered Non Dir OC&EF Relay

Vx ⎓ 24V-60V, 7W, In ∼ 1A, fn 50/60 Hz, BI ⎓ 19V

7SR4502-1HB20-1AA0/EE

S.No. GFYYMMXXXXX

Made in India

Fig19. Terminal Diagram of Dual Powered Non-Directional Overcurrent and Earth Fault Relay

Ordering Information – 7SR45 Argus

Product description Variants **Order No.**

1 2 3 4 5 6 7 - 8 9 10 11 12 - 13 14 15 16
7 S R 4 5 0 ☐ - ☐ ☐ ☐ ☐ 0 - 1 A A 0
☐ ☐

7SR45 Argus

Nondirectional Overcurrent and Earth Fault Relay

	7	8	9	10	11	14	15
<u>**Case, I/O and fascia**</u>							
Size 4 Moulded Case, 4 CT1), 2 BI/2 BO, pulse output, 9 LEDs	**1**						
Size 4 Moulded Case, 4 CT1), 4 BI/4 BO, pulse output, 9 LEDs	**2**		**H/J**				
<u>**Measuring Input**</u>							
1 A, 50/60Hz		**1**					
5 A, 50/60Hz		**2**					
<u>**Auxiliary Voltage**</u>							
Self Powered (CT Powered : BI Threshold 19VDC)			**G**		**1**		
Dual powered (CT Powered + Aux. Powered : 24-60VDC, BI threshold 19VDC)			**H**		**2**		
Dual powered (CT Powered + Aux. Powered : 60-240VAC/DC, BI threshold 88VAC/DC)			**J**		**2**		
<u>**Front Fascia**</u>							
Standard Version				**A**			
Standard Version - with Trip Flag Indicator				**B**			
<u>**Communication Options**</u>							
Front port : USB					**1**		
Front Port : USB and Rear Port : RS-485 supporting IEC60870-5-103 and Modbus RTU (user selectable setting)					**2**		
<u>**Protection Function Packages - Standard version**</u>							
50 Instantaneous phase fault overcurrent 50G/50N Instantaneous earth fault 51 Time delayed phase fault overcurrent 51G/51N Time delayed earth fault 50LC/SOTF Switch-On-To-Fault						**A**	
<u>**Additional functionality**</u>							
No additional functionality							**A**

6) 4CT is configured as 3PF + EF

Use the following ordering information to order 7SR45 Self Powered/Dual Powered Non-Directional Overcurrent and Earth Fault Relay battery spares.

Variants	Description
7XG1900-1AA00-1000	Main Battery CR123A
7XG1900-2AA00-1000	RTC Battery CR1632
7XG1900-3AA00-1000	Main Battery CR123A + RTC Battery CR1632

1.1.5 Arc Fault Protection

1.1.5.1 7XG3120 Arc Fault Monitor Relay

Features

- Compact economic design
- Simple panel mounting for retrofit applications
- Two or three arc sensor inputs
- Two high-speed, tripping duty output contacts
- Push-button reset
- Continuous arc sensor supervision
- Integrated self supervision
- Fail alarm contact
- AC or DC operation
- options for auxiliary supply range, suitable for 24 to 250V supplies

Introduction

Medium voltage switchgear is a key element in the power supply chain. Existing protection systems operate effectively under most circumstances, but they are too slow to effectively clear arcing short circuits before significant damage is caused.

Arcing faults can occur as a result of insulation breakdown due to equipment age and/or poor maintenance.

The degree of damage caused by arcing depends principally on the duration of the arc. If an arc lasts only 100ms, the switchgear needs to be checked & the insulation resistance measured before power can be re-established. With a 200ms arc, the power supply will be interrupted; the switchgear must be checked; power is re-established only after minor repairs. In the event of a 500ms arc the supply is interrupted, metal parts of the switchgear are destroyed & poisonous gases are emitted. A 1-second arc destroys most of the switchgear & may cause a fire, injury to personnel & damage to property.

The over-current caused by an arc is, due to its resistance, lower than the over-current caused by a "metallic" short circuit. The over-current caused by the arc may also be lower than the protection start current when energising circuits or starting large motors. The consequence of these conditions is that a protection system based solely on over-current detection cannot effectively discriminate between normal system currents & an arc fault condition:

- For moderate arc fault currents the trip time of the over-current IDMT stage will be too slow;
- For very low arc fault currents the instantaneous trip stage of a standard over-current relay cannot be set low enough.

Arc Fault Protection

Arc fault protection is a technique employed for the fast clearance of arcing faults on bus bars & within metal clad switchgear & associated cable boxes. The arc is detected using an optical sensor & the signal input to a protection device which also monitors the load current on the system. A trip signal can be achieved in less than 10 ms using arc detection only or within 20 ms when using overcurrent check. This is considerably faster than a traditional IDMT overcurrent relay & provides additional protection from the onset of arcing faults with relatively low fault currents.
Arguably the greatest risk of arc fault damage exists at the CB cable termination & in the CB chamber itself due to the slow clearance times of the IDMT feeder protection.
The problem of arc faults is most prevalent in older metal-clad switchgear which already has operational protection systems. The RA20 (ReyARC 20) Arc Fault Monitor has therefore been designed for the following applications:

Existing Switchgear

Where a requirement exists to retrofit arc fault protection to metal clad switchgear utilizing the existing overcurrent protection relay.

New Switchgear

Where a requirement exists to install arc fault protection to new switchgear for integration with the customer-preferred overcurrent feeder protection relay, where a binary input and appropriate logic is available.
Reyrolle 7SR11/12/210/220 overcurrent & earth fault relays have the enhanced high-speed 50AFD protection function, specifically designed to interface with the ReyARC range for even further increased tripping performance.

Switchgear Applications

Switchgear Arc Protection

Risk of arc fault damage exists at the CB cable termination & in the CB chamber itself. The CB cable termination is particularly at risk to ingress of moisture & rodent damage.
One, two or three arc sensors may be connected to the RA20 Arc Fault Monitors as depicted in the single line application diagrams (Figures 1, 2 & 3).

Figures 1 & 2 show the trip signals being used to trip the feeder circuit breaker in the event of an arc fault occurring at any sensor provided the overcurrent relay starter contact is picked up. In these applications the overcurrent check stage is optional as the consequence of a single feeder outage is less than the loss of an entire bus.

Figure 3 shows an application where a single RA20 is applied for the protection of the Cable box, CT chamber & CB chamber using three sensors. In this configuration one arc trip output is used to trip the feeder circuit breaker in the event of an arc fault in the cable box / CT chamber. The second trip output is set for independent operation to trip the bus breaker (bus overcurrent check not shown), in the event of an arc fault in the CB chamber.

Existing switchgear applications

The existing overcurrent relay protecting the feeder will normally provide an independent output contact associated with the start current setting of the relay. That is, an output contact that will close when a phase or earth fault current is detected above the threshold which starts the internal relay timers.

An Arc Fault Monitor relay RA20 is installed on the switchgear panel adjacent to the protection relay. The RA20 is specifically designed for simple retrofit to existing panels & requires only a single 31mm mounting hole to be drilled. The RA20 fits through this hole, the designation label supplied with the unit positioned & the retention shroud fitted. Refer Figure 14 & 16.

RA30 optical arc sensors are fitted in the cable termination box & CT chamber as depicted in figure 2.
The overcurrent relay starter contact may optionally be wired in series with the arc fault detection trip output contact as depicted in figure 6. The resulting “AND” function trip output is wired to trip the breaker in ~15ms in the event that an arc fault is detected while the overcurrent start element is picked up.

The second arc trip & fail alarm contacts may be employed for interface to a SCADA system for fault reporting.

New switchgear applications

For new switchgear installations a modern numeric feeder protection relay is likely to be employed which will have numerous programming & configuration options.

The basic concept is the same as for the existing switchgear application described above except that the additional features & flexibility of modern feeder protection relay allows improved system integration.

This may be achieved by using the second arc trip output contact to interface to a programmable status input on the feeder protection relay. Depending on the model of protection relay being used this input may be programmed to provide an alarm message on the HMI, time stamped event record available via its communications link.

Where this level of system integration is employed the RA20 does not need to be mounted on the front panel as the alarm indications are available on the feeder relay. Remote reset of the RA20 LED is achieved by momentary interruption of the power supply using a SCADA controlled series contact. The DIN rail mounting option is a convenient alternative in this situation.

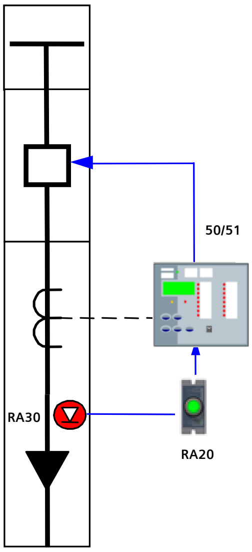


Fig1. Single arc sensor - Cable box only
(Optional overcurrent check stage depicted)

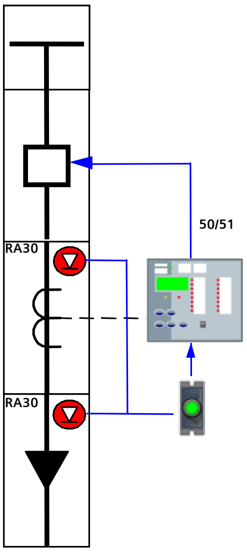


Fig2. Two arc sensors - Cable box & CT chamber
(Optional overcurrent check stage depicted)

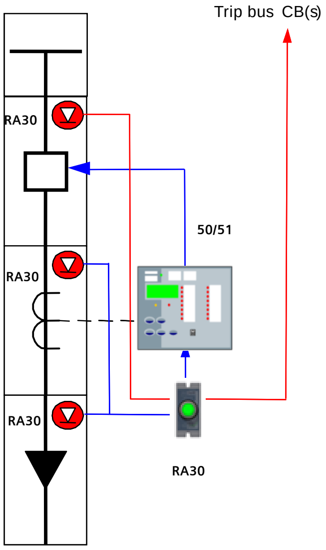


Fig3. Two arc sensors - Cable box & CT chamber
Independent trip to CB (Optional overcurrent check stage depicted) One arc sensor - CB chamber
Independent trip to bus breaker
(Bus overcurrent check stage not shown)

Busbar Applications

Combined Bus Bar & Switchgear Arc Protection

Figure 4 shows an application where a single RA20 is applied for the protection of the Cable box & CT chamber plus the CB chamber & bus chamber using three sensors.

In this configuration one arc trip output is used to trip the feeder circuit breaker in the event of an arc fault in the cable box / CT chamber. The second trip output is set for independent operation to trip the bus breaker (bus overcurrent check stage not shown), in the event of an arc fault in the CB chamber or bus chamber.

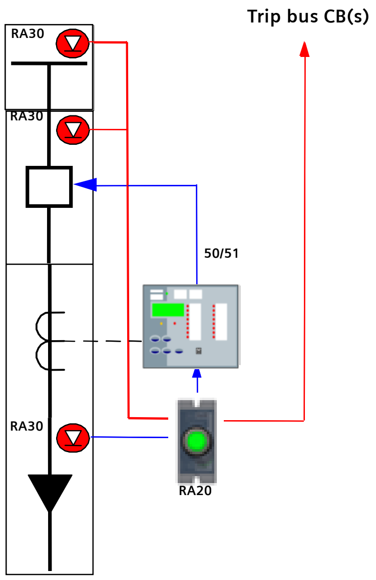


Fig 4. One arc sensor - Cable box / CT chamber
Independent trip to CB
Two arc sensors - CB chamber & bus chamber
Independent trip to bus breaker
(bus overcurrent check stage not shown)

Bus Bar Arc Protection

Figure 5 depicts how the RA30 may also be applied for the protection of bus bars. The number of sensors in the bus chamber is dictated by the switchgear design and the length of switchboard.

In most indoor metal clad switchgear the bus bar chamber is a continuous chamber between panels only broken into segregated sections at a bus section breaker & as such the strategic placement of one or two arc sensors in each bus bar chamber run is normally adequate.

Some indoor metal clad switchgear may segregate the bus chamber of each panel from the next via insulated bus chamber side barriers per panel, if this is the case then each bus chamber per panel would need to be monitored by at least one arc sensor.

In large enclosures the arc sensors should be placed at approximately 5m intervals.

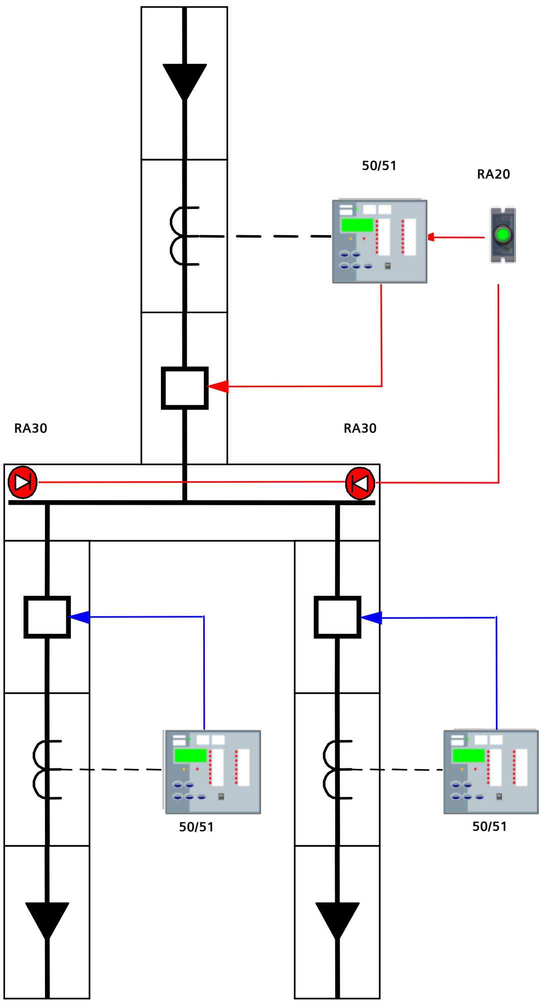


Fig5. One, two or three arc sensors located in the bus chamber

Operation

Operation Indicator

A single tri-colour LED is integrated into the front panel reset push button to provide the following status indications:

System healthy	🟢	Green solid
RA30 Power up test OK	🟢	Flash green 3 times
Arc fault trip	🔴	Solid red for 2s followed by:
	🔴 🟢	Alternate red & green until reset.
RA30 Arc Sensor 1 service	🟠	Orange solid
RA30 Arc Sensor 2 or 3 service	🟠	Orange flashing
RA30 Arc Sensor continuous pick up	🟠 🔴	Alternate orange & red.

Arc sensor circuit supervision

The RA30 Arc Sensor is the heart of the system & supervision of circuit continuity is critical for correct operation. To monitor the integrity of the wiring between the RA30 arc sensor & RA20 Arc Monitor, a continuous 2mA supervision current flows between the units. The RA20 alarm contact will drop out after a 1s time delay if it fails to detect this current.

Where a fault is detected on the Arc Sensor 1 circuit the front panel LED will give a solid orange indication.

Where a fault is detected on Arc Sensor 2 or 3 circuits the front panel LED will give a flashing orange indication.

Where a fault is detected on Arc Sensor 1 & 2 or 1& 3 circuits the front panel LED will give a solid orange indication.

Arc Sensor Function

The RA30 is an optical sensor that responds to the flash of light emitted during the incidence of an arcing fault. Onset of the light flash & detection by the RA30 occurs in a few milliseconds.

When an arc is detected, the resistance presented by the RA30 drops to a level where the current flow increases to approximately 20mA. This increased current flow is instantaneously detected by the RA20 and its trip output contacts close. Refer to the RA30 Technical catalogue sheet for further details.

Arc fault tripping using current check

Fast operation of a tripping scheme usually results in reduced system security. The arc detection method can however, combine the RA20 optical detection technique with a traditional overcurrent method to maximize system security particularly for bus bar protection schemes. Both conditions must coexist for the trip condition to be met as depicted in figure 6.

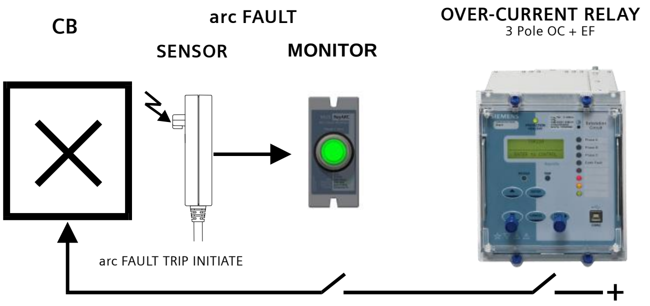


Fig6. Key components required to implement an Arc Fault Protection scheme with an overcurrent check stage to enhance system security

The application examples in figures 1 to 5 utilize this concept for enhanced system security in that both the RA20 AND the OC 50 starter contact must be picked up for a CB trip signal to be initiated. As the arc fault trip contact closes considerably faster than the overcurrent relay starter element picks up, the CB trip time will be dictated by the overcurrent relay performance.

Low current arcing faults

Arcing faults can occur at low current levels & it is possible for the over-current starter element to be set above this level. To avoid this problem & obtain very fast clearance (<10ms), of an arc fault, the RA20 arc fault trip contact may be wired directly to the breaker operate coil. It should be noted that this method may lead to reduced system security.

Arc detection reset time (effect of multiple arc trips)

A delay of 2s is required to reset the RA20 after an initial arc sensor trip. Subsequent arc detection will cause the trip output contacts to re-operate & reset the time delays described under *Configuration Switch Settings*.

Independent trip output contacts

The RA20 may be set using configuration switch 3 for both trip output contacts to pick up when an arc is detected by any sensor input. Alternatively arc sensor 1 can be linked to trip contact 1 & arc sensor 2 (& 3 if fitted), to trip contact 2. This function may be applied where an arc fault detected in the cable box is directed to trip the feeder circuit breaker while an arc fault in the bus chamber is to be directed to trip the bus.

Arc sensor continuously picked up

High ambient light levels may cause a RA30 to be continuously picked up. This condition could occur for example if the CB cable box cover was left open in very high ambient light level conditions. A non arc fault over-current pick up would then result in an arc fault trip operation.

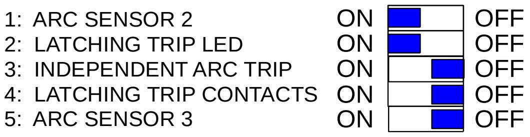
To avoid possible mal-operation due to this condition, the RA20 is designed to automatically disable the arc fault tripping function if the RA30 sensor is picked up for >10s. The RA20 alarm contact will be set & the front LED flash alternate orange & red until the ambient light level problem is corrected. The RA20 will then perform an arc sensor test function and automatically reset.

Configuration

Fig7. RA20 rear view showing configuration switches

Configuration switch

The configuration switches are accessible to the user by first unplugging the electronic module from the terminal base as shown in Figure 7.



Configuration switch settings

The internal wiring label identifies the position of the following switch functions:

Switch 1: Arc sensor 2
ON - Arc Sensor 2 fitted
OFF - Arc Sensor 2 not fitted

Switch 2: Arc fault trip indication LED reset
- ON - Latching until manually reset
- OFF - Automatic self reset (Extinguish) after 4 hours will also reset contacts set for latching function

Switch 3: Independent arc trip output contacts
- ON - Arc Sensor 1 activates trip output contact 1 & Arc sensor 2 or 3 activates trip output contact 2
- OFF - Arc Sensor 1, 2 or 3 activate both trip outputs

Switch 4: Arc fault trip output contact reset
- ON - Latching – Reset with trip LED
- OFF - Self reset after 2s

Switch 5: Arc sensor 3
- ON - Arc Sensor 3 fitted
- OFF - Arc Sensor 3 not fitted

Wiring Diagram

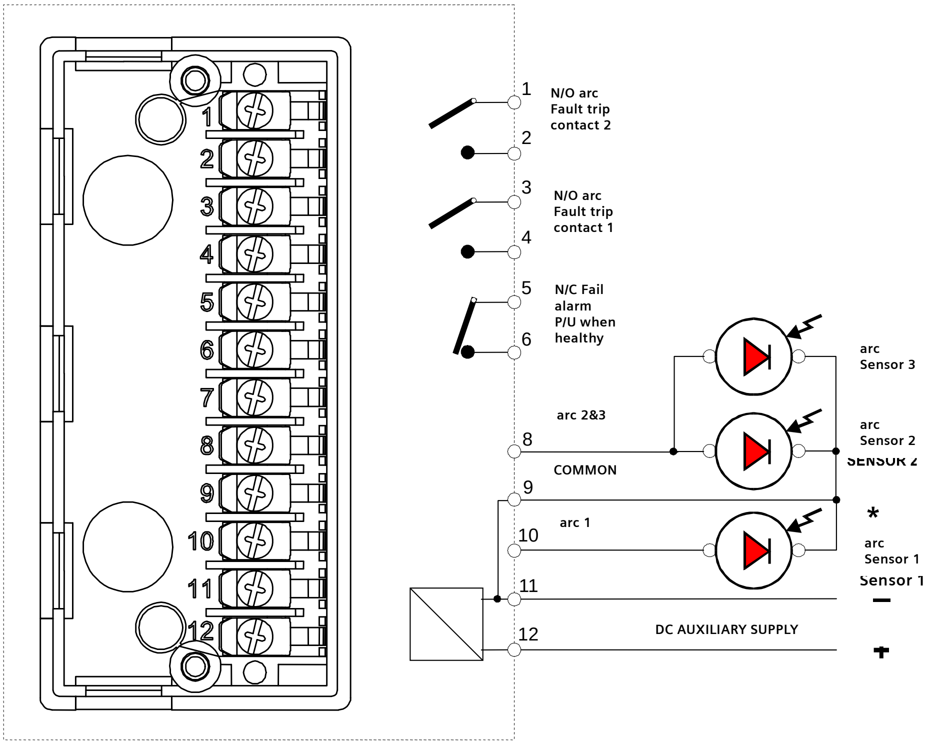
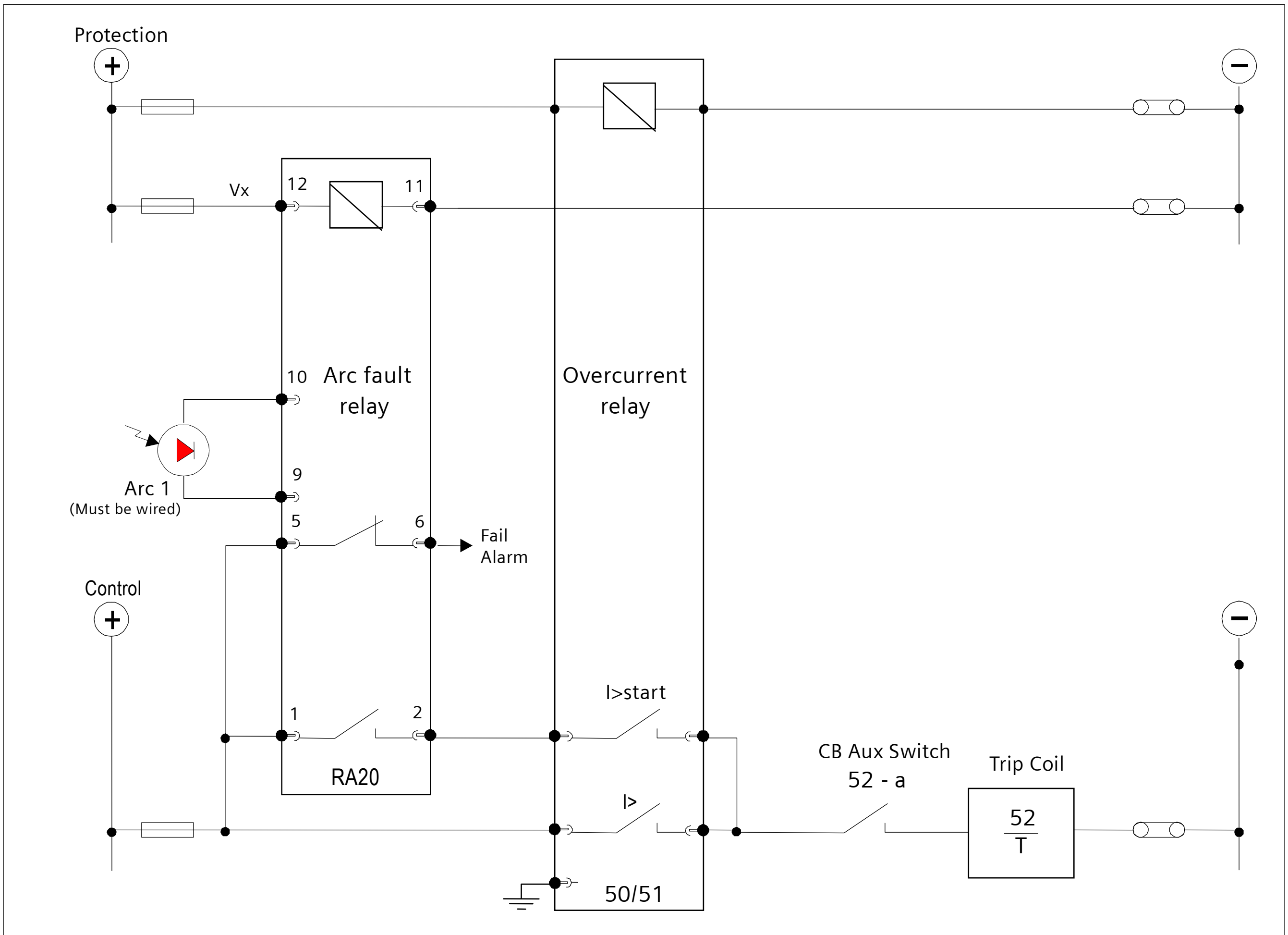


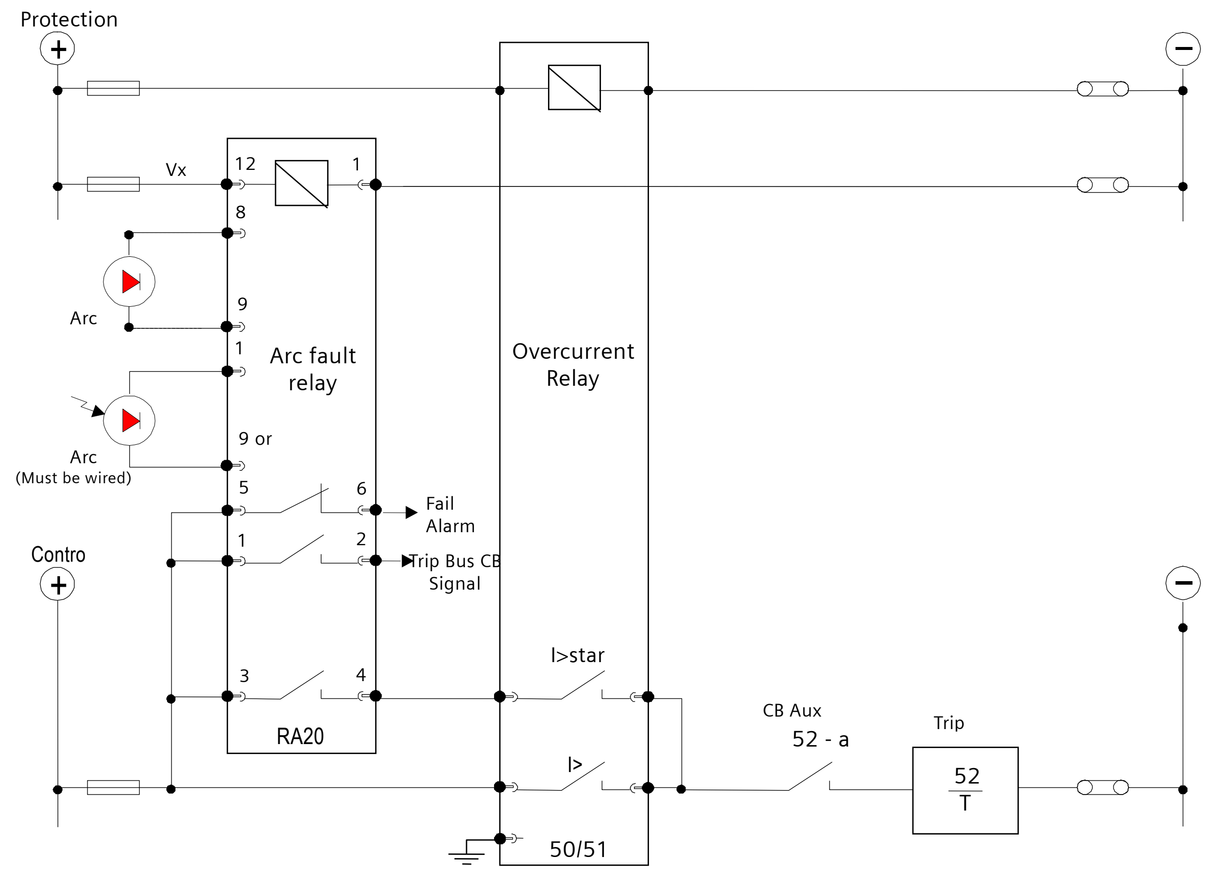
Fig8:. RA20 Socket Terminal Layout viewed from the front when un-plugged from the main housing

Note: * Always wire Arc Sensor 1. Arc Sensors 2 & 3 are optional.



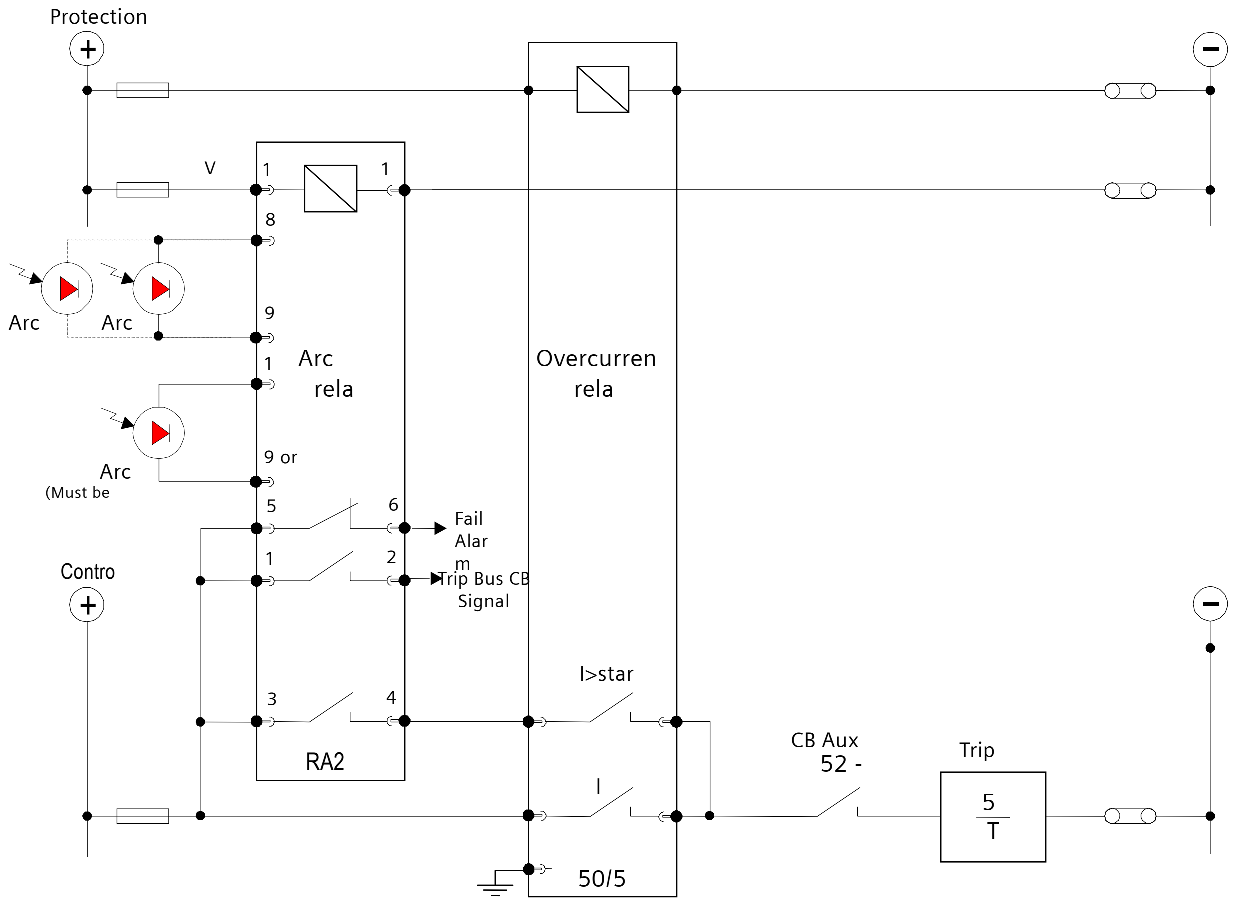
RA20 application Figure 1 diagram - Circuits shown in de-energised condition

Fig9. RA20 Wiring application diagram (Refers to Figure 1 Line Diagram)



RA20 application Figure 2 diagram - Circuits shown in de-energised condition

Fig10. RA20 Wiring application diagram (Refers to Figure 2 Line Diagram)



RA20 application Figure 3 diagram - Circuits shown in de-energised

Fig11. RA20 Wiring application diagram (Refers to Figure 3 Line Diagram)

Mounting Options

The RA20 is available in two versions:

1. A surface mount version which has a separate reset button & LED indicator on the front panel. The advantage of this version is the lower cost, and to offer a solution where front panel space is limited.

2. A panel mount version which has a combined reset button & LED indication. The advantage of this version is that it can be either panel or surface mounted, with a high-visibility indication from the large LED button.

Surface mount version

This version is suitable for location in the rear of a cubicle. It may be surface mounted as shown in figures 12 & 19. It may also be DIN rail mounting when the optional DIN Rail Mounting Kit is fitted. Refer figures 13, 18 & 21.

Fig12. RA20 surface mount version front view

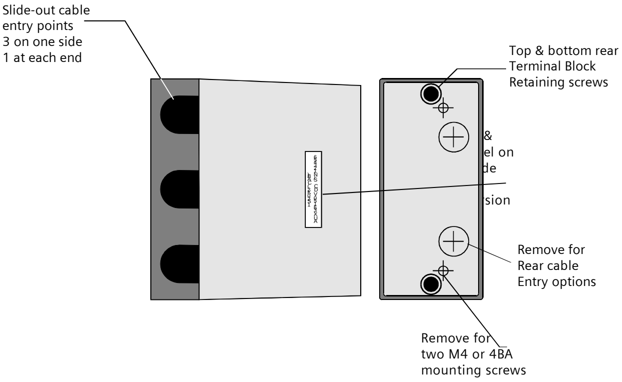


Fig13. Surface mount version side view

Panel mount version

This version is suitable for mounting on the front panel of a cubicle or door. This is achieved using a 31mm diameter hole in the panel adjacent to the protection relay as depicted in figures 14, 15 & 16.

This version may also be surface mounted by reversing the terminal block retaining screws. It may also be DIN rail mounting when the optional DIN Rail Mounting Kit is fitted. Refer figures 17, 18 & 21.

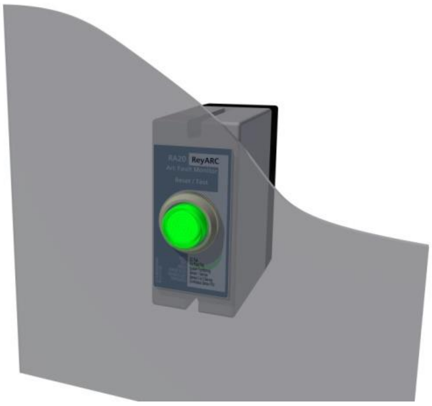


Fig14. RA20 through-hole panel mount version

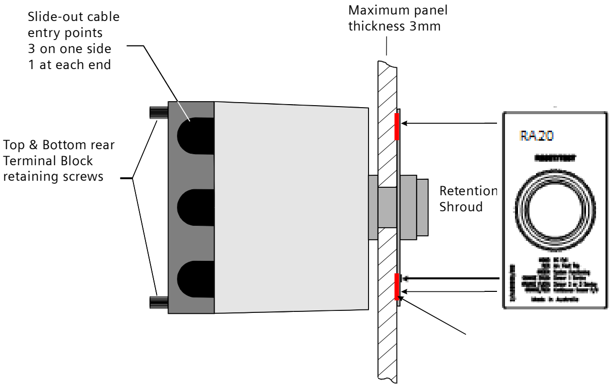


Fig15. Panel mount version side view

Panel Mount Version

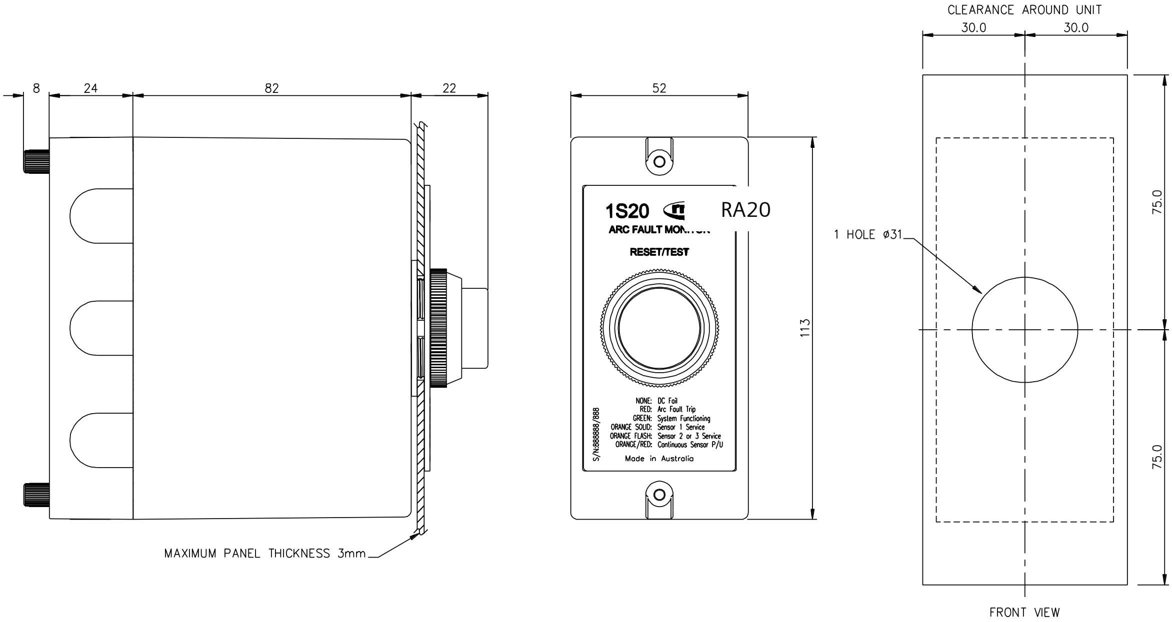


Fig16. Panel mounting cut out detail

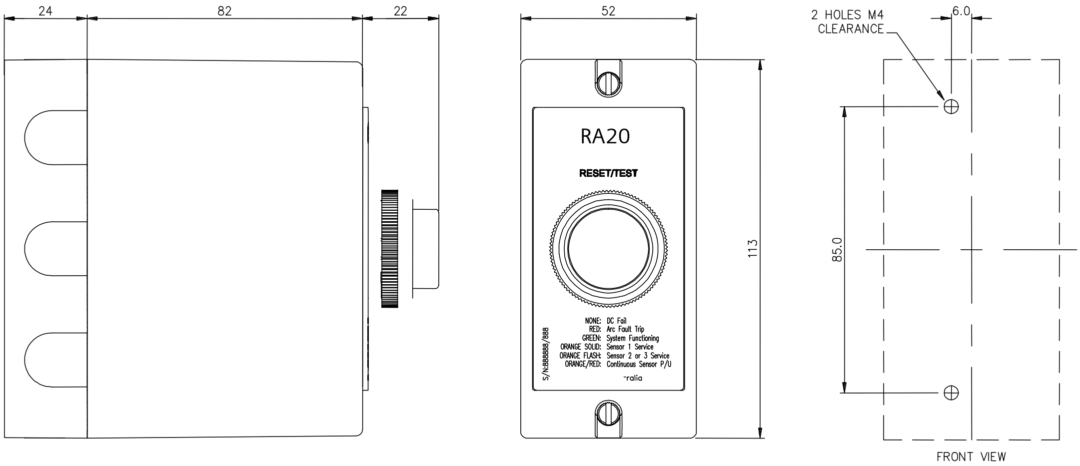


Fig17. Surface mounting detail

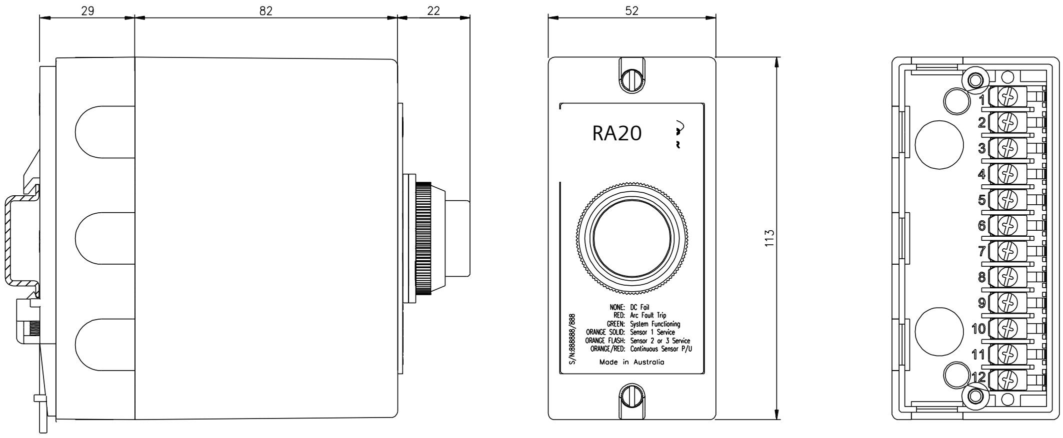


Fig18. DIN rail mounting detail

Surface Mount Version

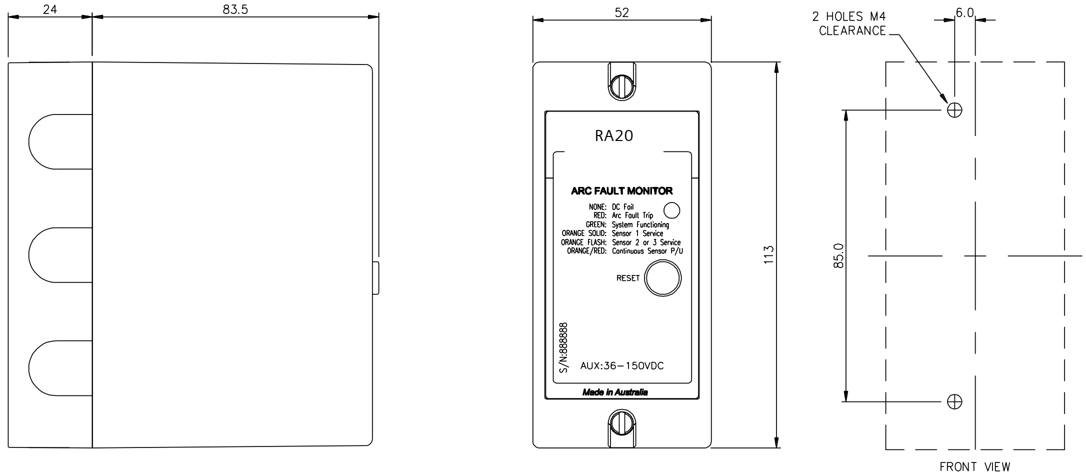


Fig19. Surface mounting detail

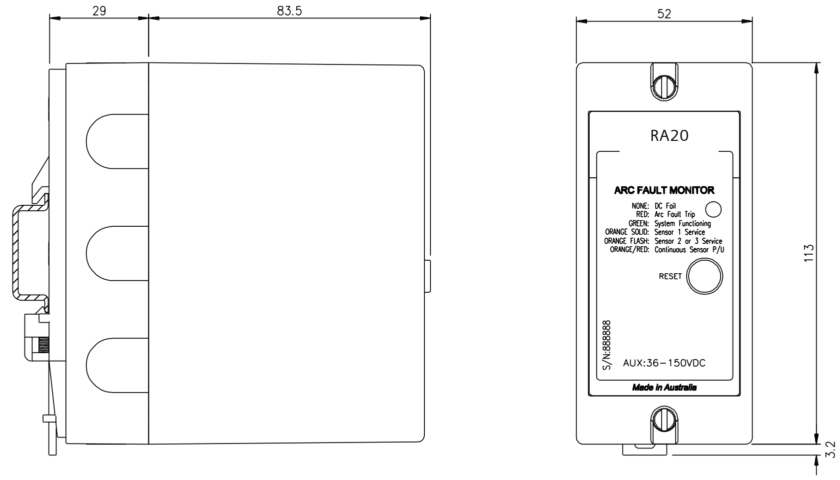


Fig20. DIN rail mounting detail

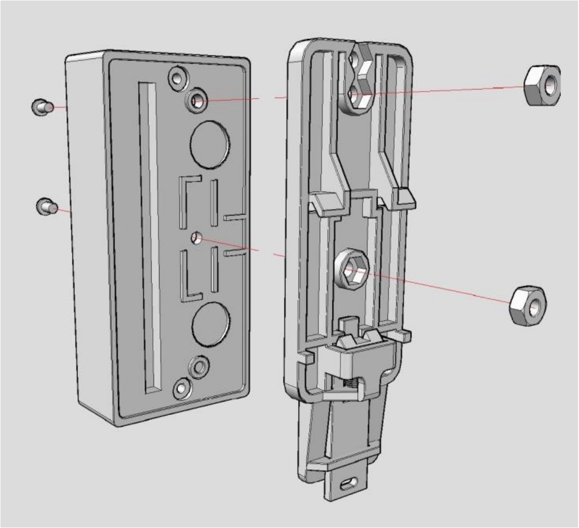


Fig21. DIN rail clip fitting detail

Technical Data

Auxiliary Supply burden (at 110V DC)

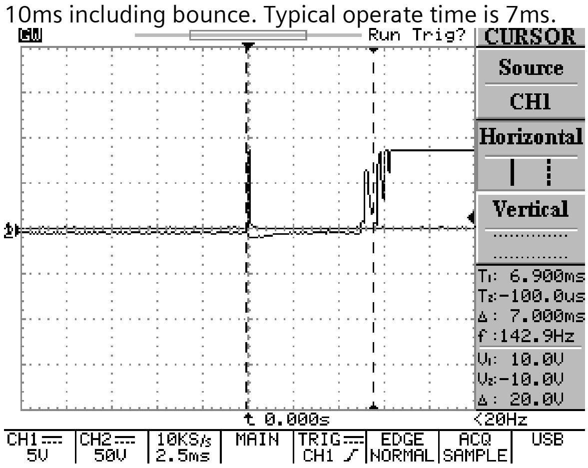
Monitoring mode:	Less than 4W
Arc fault detected:	Less than 10W for 2s

Auxiliary Supply

3 options are available for the auxiliary supply:
24/32/48V AC or DC nominal
110/125V AC or DC nominal
220/240/250V AC or DC nominal

Operate Time

Arc fault trip contacts guaranteed to pick up in less than 10ms including bounce. Typical operate time is 7ms.



T1: 6.900ms
T2:-100.0us
Δ: 7.000ms
f :142.9Hz
V1: 10.0V
V2:-10.0V
Δ: 20.0V

CH1 5V
CH2 50V
10KS/s 2.5ms
TRIG CH1
EDGE NORMAL
ACQ SAMPLE

CRO trace showing nominal operation time of the trip contacts at 7ms. First contact touch at 6.25ms and fully closed by 7.25ms. Operation in <10ms is considered acceptable as overcurrent relay operate time is ~25ms.

7SR11 / 12 / 210 / 220: 50 Instantaneous Overcurrent Element – Operate Time

Operate and Reset Time

	Attribute	Value
t_{basic}	Element basic operate time	0 to 2 x*Is*: 30 ms, ± 10ms
		0 to 5 xIs: 20 ms, ± 10ms

7SR11 / 12 / 210 / 220: 50AFD Arc Flash Detector Element – Operate Time

Operate and Reset Time

	Attribute	Value
t_{basic}	Element basic operate time	10ms – 16ms
t_{op}	AFD Zone operate time (Flash & 50AFD)	15ms – 25ms
	Repeatability	± 10ms

Arc sensor inputs

Two or three independent arc sensor inputs for type RA30 arc sensors.

Minimum arc duration

The minimum arc flash duration required to guarantee operation of the output contacts is 1.25ms.

Trip contact reset time

Once operated, the trip output contacts will reset in 2 seconds as per the configuration switch 4 setting.

Manual reset

Press front reset button or interrupt power supply to reset the unit.

Output contacts

Arc fault trip contacts:	2 N/O
Fail alarm:	1 N/C for the power supply / CPU fail
	Normally picked up & drops out to signal an alarm condition.

Output contact ratings IEC60255-0-2

Carry continuously	5A AC or DC	
Make & carry	0.5s 20A AC or DC	
L/R ≤ 40ms & V ≤ 300V	0.2s 30A AC or DC	
	AC resistive	1,250VA
Break capacity	AC inductive	250VA @ PF ≤ 0.4
I ≤ 5A & V ≤ 300V	DC resistive	75W
	DC inductive	30W @ L/R ≤ 40ms 50W @ L/R ≤ 10ms
Minimum number of operations		10^6 at maximum load
Minimum recommended load		0.5W limit 10mA/5V

Transient overvoltage IEC60255-5

Between all terminals & earth	5kV 1.2/50us 0.5J
Between independent circuits without damage or flashover	5kV 1.2/50us 0.5J

Insulation coordination IEC60255-5

Between all terminals & earth	2.0kV RMS for 1 minute
Between independent circuits	2.0kV RMS for 1 minute
Across normally open contacts	1.0kV RMS for 1 minute

Auxiliary supply IEC60255-11

Allowable breaks / dips in supply
Collapse to zero from nominal voltage ≤ 20ms

High frequency disturbance - IEC60255-22-1 Class III

2.5kV 1MHz common mode 1.0kV 1MHz differential mode	No mal operation

Electrostatic discharge - IEC60255-22-2 Class III

6kV contact discharge	No mal operation

Radio frequency interference IEC60255-22-3 Class III

10V/m, 80 TO 1,000MHz	No mal operation

Fast transient IEC60255-22-4 Class III

4kV, 5/50ns, 100KHz repetitive	No mal operation

Conducted RFI IEC60255-22-6 Class III

10V, 0.15 to 80MHz	No mal operation

Temperature range IEC68-2-1/2

Operating:	-5 to +55°C
Storage:	-25 to +75°C

Humidity IEC68-2-78

40 °C & 93% RH non-condensing

Case

ZA12 flush or DIN rail mount type, 12 M4 screw terminals, Plug-in module to facilitate easy wiring & fast change-over

Ordering Information

Product description	Variants	Order No.
		7 X G 3 1 2 0 - □ □ □ 0 0 - 0 A A 0
Arc Fault Protection Components	Category	
	Arc Protection	3 1
	Device	
	RA20 Arc Fault Monitor Relay	2 0
	Sensor Inputs	
	Two sensor inputs	2
	Three sensor inputs	3
	Operating Voltage	
	24/32/48V AC or DC Nominal	F
	110/125V AC or DC Nominal	G
	220/240/250V AC or DC Nominal	H
	Mounting	
	Panel or Surface Mount, No DIN Rail kit.	A
	Panel or Surface Mount, With DIN Rail kit.	B
	Surface Mount only, No DIN Rail kit.	C
	Surface Mount, With DIN Rail kit.	D

1.1.5.2 7XG3123 Arc Fault Interface Module

Features

- Compact, simple, rugged and economic design
- Simple wiring and DIN rail mounting
- Interface for one or two RA30 arc fault sensors
- High speed arc fault tripping output to interface with protection relay status inputs
- Apply to initiate IEC 61850 GOOSE messaging of arc fault events
- Continuous arc fault sensor supervision
- Arc fault pick up and supervision healthy indication
- 24, 32, 48, 110, 125, 220, 240 and 250V DC auxiliary versions

Introduction

Medium voltage switchgear is a key element in the power supply chain. Existing protection systems operate effectively under most circumstances, but they are too slow to handle arcing short circuits.

Arcing faults can occur as a result of insulation breakdown due to equipment age & / or poor maintenance.

The degree of damage caused by arcing depends principally on the duration of the arc. If an arc lasts only 100ms, the switchgear needs to be checked & the insulation resistance measured before power can be re-established. With a 200ms arc, the power supply will be interrupted; the switchgear must be checked; power is re-established only after minor repairs. In the event of a 500ms arc the supply is interrupted, metal parts of the switchgear are destroyed & poisonous gases are emitted. A 1s arc destroys most of the switchgear & may cause a fire, injury to personnel & damage to property.

The over-current caused by an arc is, due to its resistance, lower than the over-current caused by a “metallic” short circuit. For moderate arc fault currents the trip time of the over-current IDMT stage will be too slow.

The consequence of these conditions is that a protection system based solely on over-current detection cannot effectively protect the switchgear against an internal arcing fault.

Arc Fault Protection

Arc fault protection is a technique employed for the fast clearance of arcing faults on Busbars & within metal clad switchgear & associated cable boxes. The arc is detected using an optical sensor & the signal input to a protection device which also monitors the load current on the system. A trip signal can be achieved in less than 10ms using arc detection only or within 20ms when using overcurrent check. This is considerably faster than a traditional IDMT overcurrent relay & provides additional protection from the onset of arcing faults with relatively low fault currents.

Arguably the greatest risk of arc fault damage exists at the CB cable termination & in the CB chamber itself due to the slow clearance times of the IDMT feeder protection. The CB cable termination is particularly at risk to ingress of moisture & rodent damage.

The problem of arc faults is most prevalent in older metal clad switchgear which already has operational protection systems.

RA23 Arc Fault Interface Module

The RA23 (ReyArc23) Arc Fault Interface Module (Arc Module), described in this document is designed to connect one or two optical fault sensors to a protection relay status input.

Refer to the RA30 Catalogue Sheet for details on the arc fault sensor ordering options.

Switchgear Applications

Switchgear ARC Protection

Risk of arc fault damage exists at the CB cable termination & in the CB chamber itself. The CB cable termination is particularly at risk to ingress of moisture & rodent damage.

RA30 Arc Sensors may be located as depicted in the single line application diagrams (Figure 1).

Modern numeric feeder protection relays provide internal logic functions that may be programmed to interface with the RA23 Module. Refer to figure 6 for details.

Depending on the model of protection relay being used this input may be programmed to provide not only a high speed arc fault trip output but also an alarm message on the HMI and time stamped event record via its communications link.

This level of system integration allows the RA23 Module to be back of panel mounted with the alarm indications programmed to be displayed on the protection relay front panel.

Cable box protection

Figure 1 shows the trip signal being used to trip the feeder circuit breaker in the event of an arc fault occurring in the cable box provided the overcurrent relay starter logic is picked up.

CT Chamber protection

In circuit breakers where the CT is screened from the cable box a second sensor and ARC Module may be deployed as per figure 1.

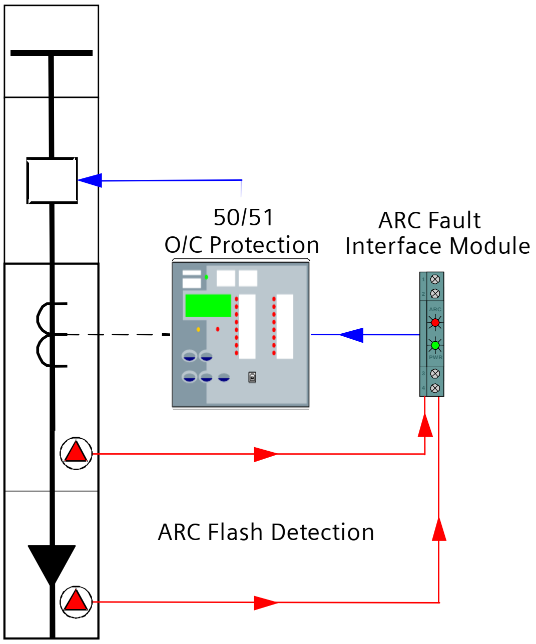


Fig1. Cable box and CT chamber protection

Circuit Breaker Chamber Protection

Arc fault occurring within the CB chamber must be cleared by the upstream breaker. This may be achieved as depicted in figure 2. Note the optional use of GOOSE messaging over IEC61850 to communicate an arc fault condition to the incoming feeder protection relays. Programmable logic may then be applied in these relays to open the appropriate up-stream circuit breakers to clear the fault.

Where trip signalling is achieved using conventional wiring, the trip output connection should be terminated in close proximity to the ARC Module and screened cable employed to transfer the trip signal to the up-stream protection relay status input.

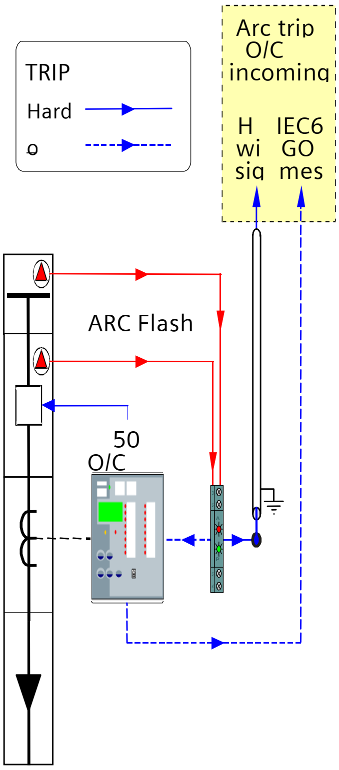


Fig2. CB chamber protection Arc trip signal to BUS overcurrent check stage

Multiple RA23 Interface Modules

Figure 3 depicts multiple RA23 Modules connected to a single status input. This scheme may be employed where more than one sensor is required to protect a single arc protection zone.

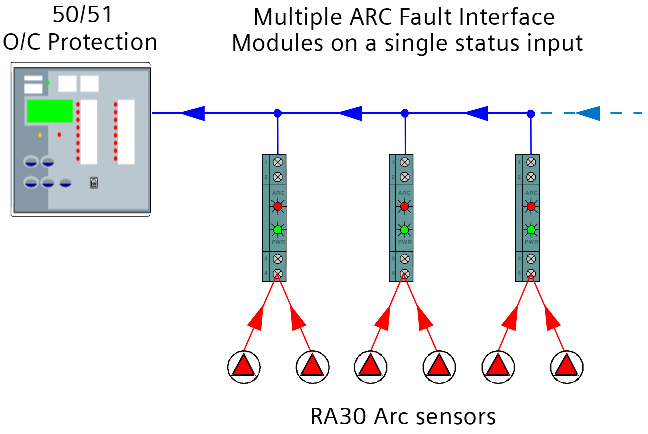


Fig3. Multiple Arc Modules per status input

Operation

Front panel layout

Two LED's are integrated into the front panel to provide the following status indications:

GREEN Auxiliary supply indication

A green LED is continuously illuminated to indicate presence of the auxiliary supply and normal operation including supervision of the RA30 sensor(s).

RED Arc fault pick-up

A red LED is illuminated when an optical signal above the detection threshold is present. This LED will self reset when the optical signal falls below the detection threshold with a minimum dwell time of ~2s.

This feature is useful during commissioning and routine tests to verify correct operation of the system. Figure 14 provide a tabulation of the LED and output conditions to allow diagnosis of the RA30 operating status.

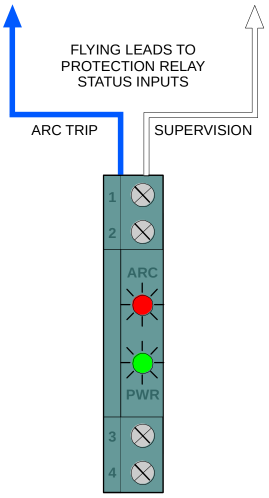


Fig4. RA23 Module front panel layout

Arc Sensor continuously picked up

High ambient light levels may cause a RA30 to be continuously picked up. This condition could occur for example if the CB cable box cover was left open in very high ambient light level

conditions. A non arc fault over-current pick up would then result in an arc fault trip operation.
To avoid possible mal-operation due to this condition, the RA23 module is designed to automatically disable the arc fault tripping function, if the RA30 sensor is picked up for >500ms. The RA23 Module will then disable the healthy supervision signal and the front power LED will flash until the ambient light level problem is corrected. The ARC Module will then perform an arc sensor test function and automatically reset.

Arc Detection reset time (effect of multiple arc trips)

A delay of >500ms is required to reset the ARC Module after an initial arc sensor trip. Subsequent arc detection will cause the trip contact to re-operate.

Arc Sensor function

The RA30 is an optical sensor that responds to the flash of light emitted during the incidence of an arcing fault. Onset of the light flash and detection by the RA30 occurs in a few ms.
When an arc is detected, the resistance presented by the RA30 drops to a level where the current flow increases to approximately 20mA. This increased current flow is detected by the RA23 Module which responds in <1ms to close a solid state contact to activate the arc fault input on the protection relay as depicted in figures 6 and 7.

Arc Sensor supervision

The RA30 Arc Sensor is the heart of the system and supervision of the circuit continuity is critical for correct operation. To monitor the integrity of the wiring between the RA30 arc sensor and the RA23 Module, a continuous 2mA supervision current flows between the units. A supervision healthy signal is output to the protection relay status input. This signal will be disabled after an ~1s time delay if the supervision current signal is lost.
An arc sensor fault will also be reported if an incorrect number of sensors are fitted to the RA23 Module as follows:
No arc sensor(s) connected
1 sensor connected to an RA23 Module specified for 2 sensors

Arc sensor fault indication;

Where a fault is detected on the Arc Sensor circuit the front panel power LED will flash continuously until the fault is rectified.

Arc fault tripping using current check

Fast operation of a tripping scheme usually results in reduced system security. The arc detection method can however, combine the optical detection technique with a traditional overcurrent method to maximize system security. Both conditions must coexist for the trip condition to be met as depicted in figures 6 - 7.

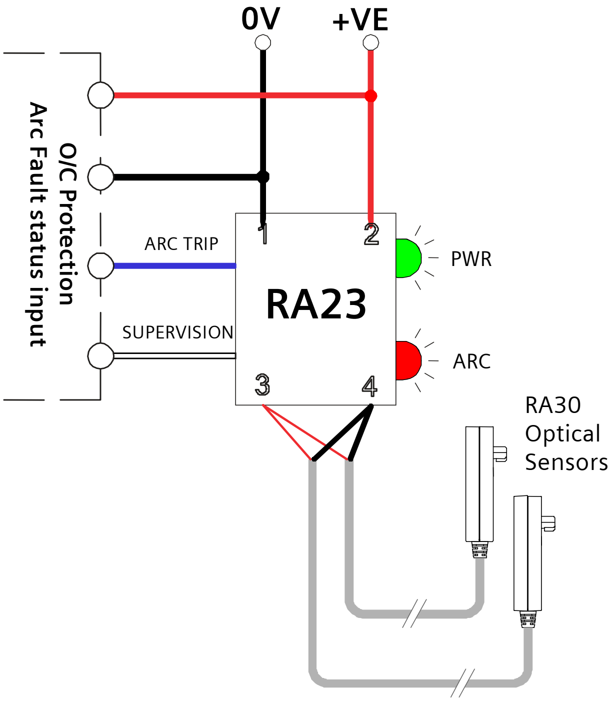


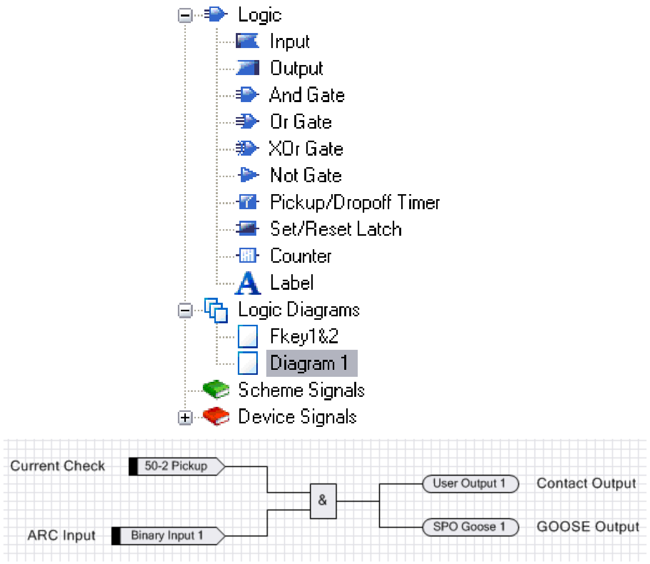
Fig5. Key components required to implement an Arc fault Protection scheme with an overcurrent check stage to enhance system security

The application examples in figures 1 and 2 utilize this concept for enhanced system security in that both the RA23 Module AND the OC 50 starter logic must be picked up for a CB trip signal to be initiated. As the arc fault trip contact picks up considerably faster than the overcurrent relay starter element, the CB trip time will be dictated by the overcurrent relay performance.

Relay Logic & Wiring

Protection relay logic

For the current check scheme to function correctly a protection relay with the following attributes is required:



Attribute	Parameter	Necessity
Programmable relay logic	AND gates	Mandatory
High speed status input	<5ms pick up	Mandatory
High speed current check element	<15ms at 2x setting	Mandatory
Programmable front panel indication	Arc trip indication	Desirable
	Supervision status	Desirable
IEC61850 for trip signaling	GOOSE messaging	Optional

Fig6. Reydisp manager logic programming

A suitable relay available with all of the above attributes is the Reyrolle 7SR21/22 platform multi-function feeder manager. A screen shot of the Reydisp Manager logic programming software is shown in figure 6.

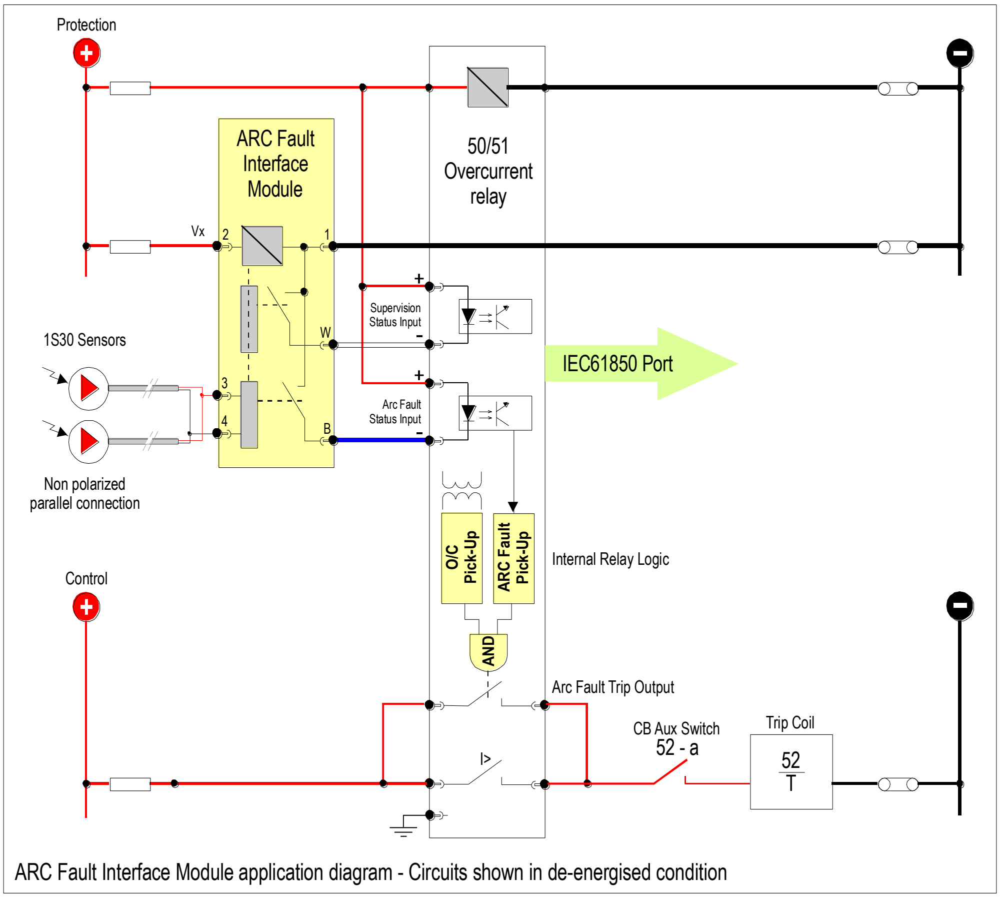


Fig7. RA23 Module application diagram

Relay Logic & Wiring

Enclosure dimensions

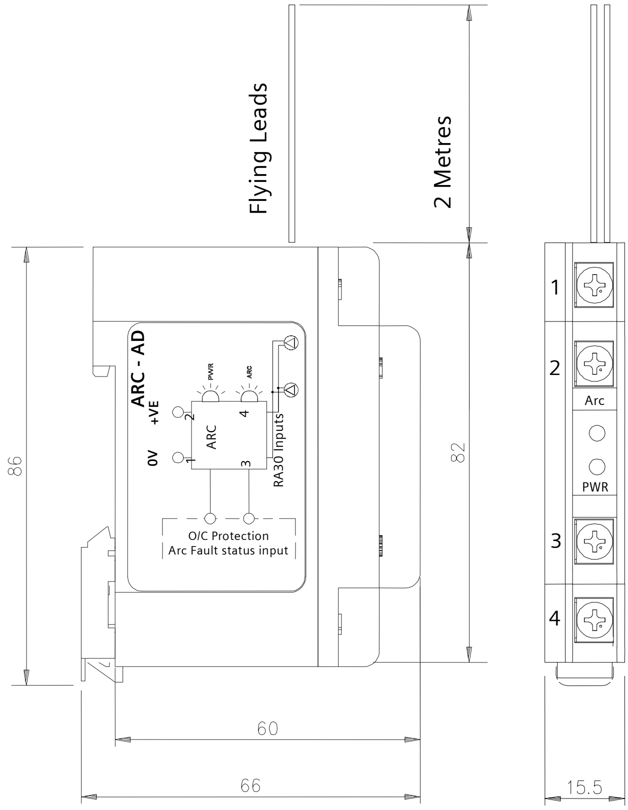


Fig8. RA23 Module dimensional details

Arc Sensor inputs

One or two optical arc fault sensors type RA30 may be connected to the RA23 Module. Refer to the RA30 Catalogue Sheet for mounting options.

The number of sensors specified in the RA23 ordering code must be connected to ensure correct operation of the sensor supervision function.

If only one sensor is connected to the two sensor version the supervision output will indicate a sensor fail condition.

If two sensors are connected to the one sensor version the supervision output will indicate a sensor fail condition.

Fig9. RA30 Arc Fault Sensor – front and back

DIN rain mount enclosure

The ARC Fault Interface Module is enclosed in a compact enclosure sealed with thermally conductive potting compound. The module is designed for DIN rail mounting.

Fig10. RA23 Module depicting four (4) front screw terminals and two (2) top entry flying leads

Terminations

4x M4 screw terminals suitable for heavy duty ring lugs.

Terminal 1:	DC negative
Terminal 2:	DC positive
Terminal 3:	RA30 arc fault in (Non polarized)
Terminal 4:	RA30 arc fault in (Non polarized)

2x 2 metre flying leads with 0.75 sq. mm conductor.

Blue lead:	Arc fault trip output - negative
White lead:	Supervision status output - negative

Mounting

DIN rail mounting of multiple DIN rail modules allows for a compact installation close to the protection relay status inputs. Wiring should be kept as short as practical to minimize the circuit resistance and possibility of noise on the protection relay status input.

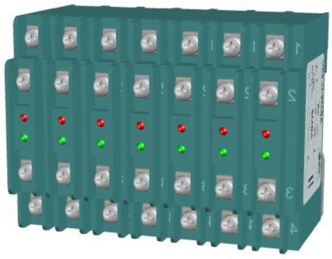


Fig11. Array of 7 x RA23 modules

Optical sensitivity

~10,000 Lux* for white light at normal incidence to the detector window(s) as depicted in figure 12:

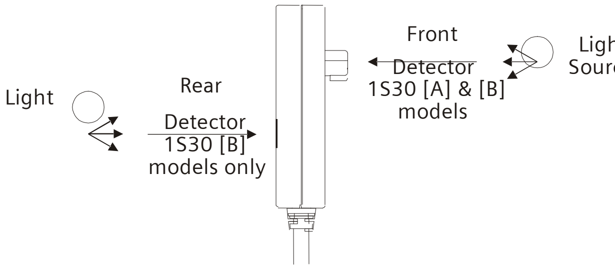


Fig12. RA30 Arc Sensor

As the illuminace of diffuse ambient sunlight falls in the range 5,000 to 10,000 Lux, this will not normally be sufficient to trigger the RA23 Module. The luminous intensity from the sun at noon at the equator however is

~100,000 Lux which will be sufficient to trigger the RA23 Module so measures should be made to avoid this situation.

Detector spectral response

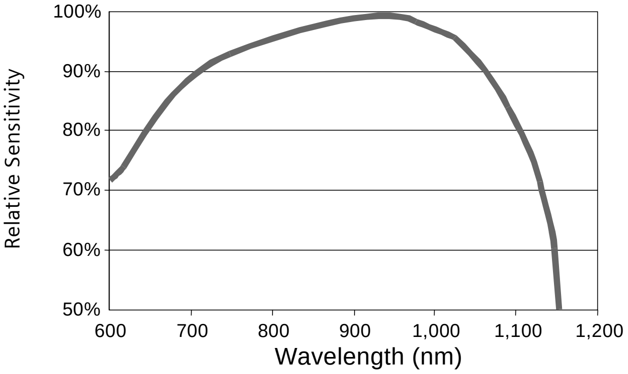


Fig13. Arc detector spectral response

* Due to the relatively high sensitivity of the detector to IR wavelengths the type of light source employed for sensitivity testing will have a major effect on the results obtained. Sensitivity testing should therefore be conducted using a 50-75W halogen lamp with an integrated aluminum reflector.

System supervision

A CPU software watchdog monitors the system and in the event of an abnormal condition will automatically perform a soft restart.

Should this restart not clear the abnormal condition the system will revert to a safe mode with the outputs disabled. This will cause the self supervision healthy signal to be lost and the abnormal condition detected and reported by the protection relay via it's ARC supervision status input.
A front panel green LED is illuminated on the RA23 Module under normal conditions. This LED is switched off in safe mode.

Minimum Arc duration

The minimum arc "flash" duration required to guarantee operation of the output contacts is 0.5ms.

Trip signal reset time

Once operated the trip output signal is self reset with a minimum dwell time of 100 to 120ms.

Technical Data

Auxiliary supply burden (At 110V DC)

Monitoring mode:	Less than 0.75W
Arc fault detected:	Less than 1.5W for 2s

Auxiliary supply

The Arc Module is suitable for use with the following nominal auxiliary supplies. A tolerance of -20% to +20% must be maintained to ensure correct operation and to avoid thermal damage.

Vx
24V DC
32V DC
48V DC
110V DC
125V DC
220V DC
240V DC
250V DC

Optical Arc fault detection operate time

An arc fault trip signal is output in less than 1ms.

Output circuit

Dedicated non-isolated outputs are provided to connect to overcurrent protection relay status inputs as shown in figure 6. Upon detection of light intensity greater than the pick−up threshold a solid state switch connects the 0V rail to the relay status input.

Output ratings IEC60255-0-2

The Arc Module outputs are designed for connection to dedicated protection class binary status inputs only. They are not suitable for direct tripping applications of auxiliary relays or circuit breaker coils.
The following ratings are conservative and are suitable for application with status inputs employed on many modern protection relays such as the Reyrolle 7SR1 and 7SR2 platforms.

Supervision output

Open circuit voltage:	125% of nominal
Maximum current:	15mA for 20 ms 4mA continuous

Arc trip output

Open circuit voltage:	125% of nominal
Maximum current:	15mA for 20 ms 4mA continuous

Auxiliary supply IEC60255-11

Allowable breaks / dips in supply Collapse to zero from nominal voltage	≤ 20ms

High Frequency disturbance IEC60255-22-1 Class III

2.5kV 1MHz common mode 1.0kV 1MHz differential mode	No mal operation

Electrostatic discharge IEC60255-22-2 Class III

8kV air discharge	No mal operation

Radio frequency interference IEC60255-22-3

10V/m, 80 TO 1,000MHz	No mal operation

Fast transient IEC60255-22-4

4kV, 5/50ns, 100KHz repetitive	No mal operation

Insulation coordination IEC60255-5

Impulse voltage withstand test	5kV 1.2/50us 0.5J
Dielectric test	2.0kV RMS for 1 minute

Between all terminals and earth
The earth point is defined as the DIN rail mounting bracket
There is no isolation between any of the output terminals or flying leads. They should be considered as the same group.

Conducted RFI IEC60255-22-6

10V, 0.15 to 80MHz	No mal operation

Temperature range IEC68-2-1/2

Operating:	-10 to +55°C
Storage:	-25 to +75°C

Humidity IEC68-2-78

40 °C and 93% RH non condensing

Technical Data (Contd)

Fault Condition	RED LED	Trip Output	GREEN LED	Supervise Output
One (1) Sensor open circuit	OFF	OFF	FLASH	OFF
Two (2) Sensors open circuit	OFF	OFF	FLASH	OFF
One (1) Sensor short circuit on power up	OFF	OFF	FLASH	OFF
Two (2) Sensors short circuit on power up	OFF	OFF	FLASH	OFF
Arc trip >500ms (Continuous arc pick up)	ON	OFF	FLASH	OFF
Arc trip current limit exceeded	ON for 2s	OFF for 100ms	OFF for 2s	OFF for 2s
Supervise output current limit exceeded	OFF	OFF	FLASH - PAUSE - FLASH	OFF
Power supply fail	OFF	OFF	OFF	OFF
CPU fail	OFF	OFF	OFF	OFF
Single sensor software identification			Three (3) flashes at startup	
Dual sensor software identification			Four (4) flashes at startup	

Fig14. Arc Module status table

Ordering Information

Product description	Variants	Order No.
		7 X G 3 1 2 3 - □ □ A 0 0 - 0 A A 0
Reyarc – Arc Fault Protection Components	<u>Category</u> Arc Protection	 3 1
	<u>Device</u> RA23 Arc Fault Interface Module	 2 3
	<u>Sensor Inputs</u> One sensor input Two sensor inputs	 1 2
	<u>Operating Voltage</u> 24V DC 32V DC 48V DC 110V DC 125V DC 220V DC 240V DC 250V DC	 A B C D E F G H

1.1.5.3 7XG3124 Arc Fault Monitor Relay

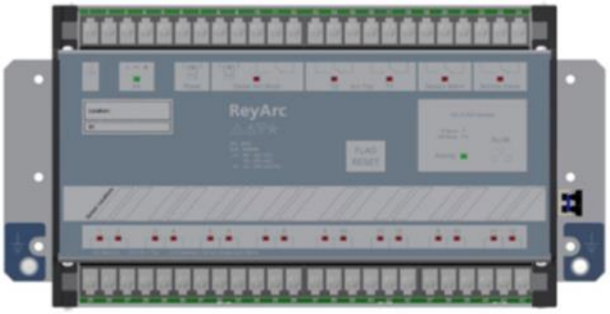


Fig1. RA24 Arc Fault Module

Features

- Up to 16 arc fault sensors
- 2 x High speed arc fault tripping duty contacts
- Trip indication LED for each arc fault sensor
- Arc sensor supervision with sensor fail LED for each zone
- 10Base-T / 100Base-TX port
- Optional 100Base-FX port
- System configuration via web browser
- IEC61850 GOOSE capable
- Up to 16 independent arc fault SARC logic nodes
- Self-supervision watchdog with healthy LED and alarm
- Wide range auxiliary supply

Introduction

Arc fault protection is a technique employed for the clearance of arcing faults on low voltage panels, MCC's, BUS bars and within metal clad switchgear and associated cable boxes.

Conventional current based protection techniques are at times challenged by the nature of arcing faults, and can result in slow protection clearance times. Slow protection clearance times increase the risk to nearby personnel and increase the degree of damage to plant and equipment.

By employing an optical detection technique, Arc Fault Protection results in fast clearance of arcing faults.

With the added benefit of IEC61850 Goose Messaging, the RA24 (ReyArc24) is a scalable solution capable of being employed in the most challenging applications with reduced engineering overhead.

With the flexibility of the IEC 61850 standard ARC tripping with current checking or ARC tripping with operational interlocks are able to be implemented with ease.

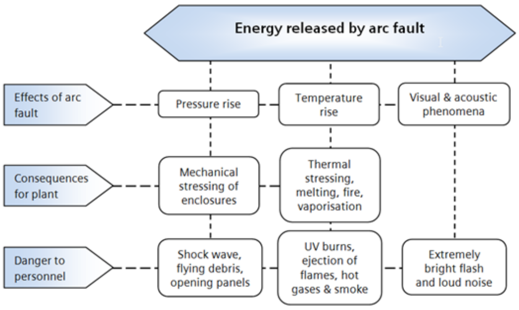


Fig2. Energy release due to electrical arcing faults

Arc Fault – Cause and Effect

Medium voltage switchgear and associated bus bars are a key element in the power supply chain. Existing protection systems operate effectively and quickly under most fault types but arcing faults may lead to slow operating times.

Due to the resistive nature of an arcing fault the associated fault current is likely to be lower than for a bolted short circuit.

Instantaneous overcurrent protection is set to operate above network energisation currents and motor starting currents, the fault current due to an arc may be lower than this.

The consequence of these conditions is that a protection system based solely on over-current detection cannot effectively discriminate between normal system currents and an arc fault condition:

- Moderate to low arc fault currents may not operate the instantaneous trip stage of a standard over-current relay
- For a Moderate to low arc fault current the trip time of the over-current IDMT stage will be too slow

Arcing faults in metal clad switchgear and associated Bus bars may occur for a number of reasons:

- defective or ageing insulating materials
- poor bus or cable connections
- poor maintenance
- human error
- ingress of moisture, dust or vermin
- abnormal service conditions

The degree of damage caused by arcing depends principally on the duration of the arc. If an arc lasts only 100ms, the switchgear needs to be checked and the insulation resistance measured before power can be re-established. With a 200ms arc, the power supply will be interrupted; the switchgear must be checked; power is re-established only after minor repairs. In the event of a 500ms arc the supply is interrupted, metal parts of the switchgear are destroyed and poisonous gases are emitted. A 1s arc destroys most of the switchgear and may cause a fire, injury to personnel and damage to property.

Arc Flash Detection Principle

An arcing fault results in an intense and rapid discharge of light from the arcing source. The light discharged from an arcing fault will typically be several thousand times normal ambient lighting levels.

The RA24 arc Fault Detection system optically senses the presence of an arc by the means of RA30 optical sensors connected to the RA24 monitor.

Very fast ARC detection is achieved using this technique, and protection operation times of <10ms are achievable.

Arc Fault Protection with Current Check

For system security purposes, the optical ARC detection may also be supervised by an external Instantaneous Current Check element to confirm fault detection.

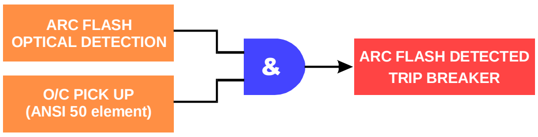


Fig3. High speed AND logic employed to discriminate an arc flash fault

Integration with Reyrolle Overcurrent Relays

The Reyrolle 7SR11, 7SR12, 7SR210 and 7SR220 overcurrent relays have a dedicated Arc Fault Detector protection function (50AFD). This function uses a time optimised algorithm to check an arc flash input against a current input for the fastest possible operation time in the event of an arc fault.

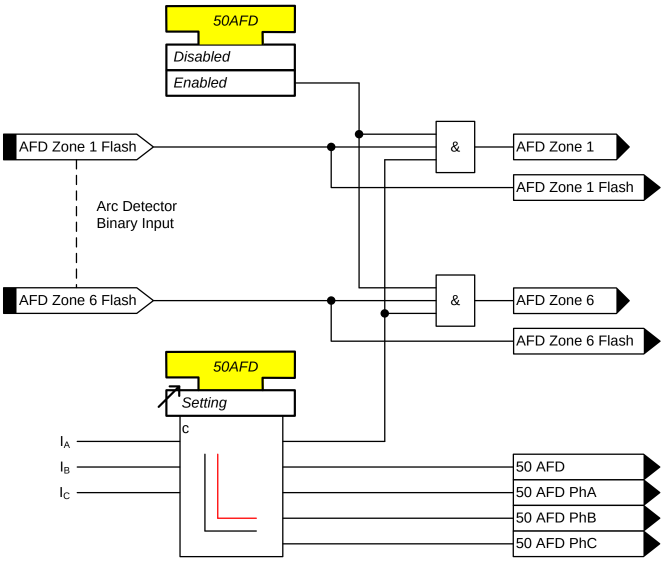


Fig4. 50AFD arc flash protection function logic

Arc fault protection compliments existing conventional overcurrent and differential protection schemes and is easily implemented into both new and existing installations.

Fig5. Consequences of arcing faults

Arc Sensor Location

The number and location of optical arc sensors is dictated by the switchgear and bus bar design and the length of the switchboard.

In most indoor metal clad switchgear the bus bar chamber is a continuous chamber between panels only broken into segregated sections at a bus section breaker and as such the strategic placement of one or two arc sensors in each bus bar chamber run is normally adequate.

Some indoor metal clad switchgear may segregate the bus chamber of each panel from the next via insulated bus chamber side barriers per panel, if this is the case then each bus chamber per panel would need to be monitored by at least one arc sensor.

Isolating switches between bus bar sections need to also be considered and appropriate tripping zones created to ensure isolation of the faulted section.

In large enclosures the arc sensors should be placed at approximately 5m intervals. RA30 arc sensors are also available with dual optical detectors to allow detection of an arc in both directions.

The intense light produced by an arcing fault is strong enough to be picked up on by the sensors by its reflection off the switchgear walls. Therefore, direct line of sight of the fault is not usually required, making exact sensor placement less critical.

IEC61850

Substations, power plants and distributed energy resources all over the world are now implementing protection, control, automation and condition monitoring functions in Power Automation Systems (PAS) according to the IEC61850 Standard.

The open architecture and high speed GOOSE messaging available through the implementation of IEC61850 make it an ideal platform on which to base a scalable, selective and flexible arc fault protection scheme for any power system configuration.

The RA24 system provides a comprehensive solution for the protection of arcing faults in metal clad air insulated switchgear and bus bar systems based on the IEC61850 Standard.

The arc is detected using an optical sensor and the signal input to the RA24 arc monitoring system. The RA24 generates IEC61850 GOOSE messages which are broadcast via the station bus LAN. Intelligent IED's are employed to subscribe to the arc fault GOOSE messages and generate tripping signals to the appropriate circuit breakers based on tripping logic that takes into account pre-determined system configurations. The RA24 may be connected directly to an IED using a cross over cable or alternatively through a Station Bus Lan as per the typical IED topology shown in Fig 5.

An IEC61850 based Arc Fault Solution will achieve reduced engineering overhead compared to a conventional hard wired alternative.

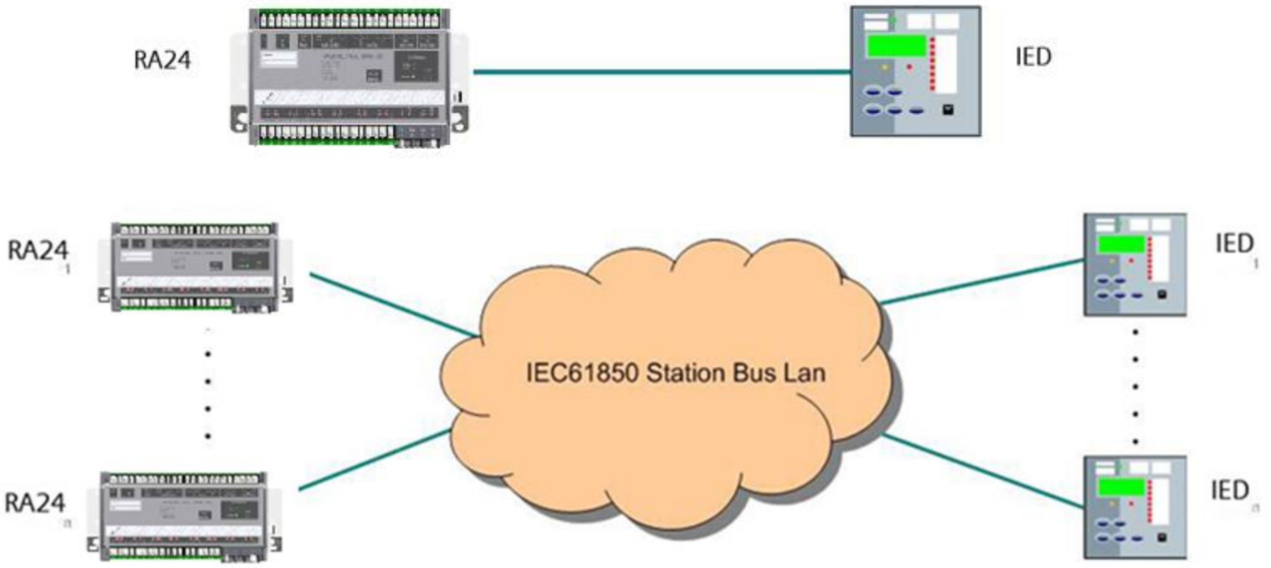


Fig6. IEC 61850 based arc fault solution

Functional Description

Web Based Configuration

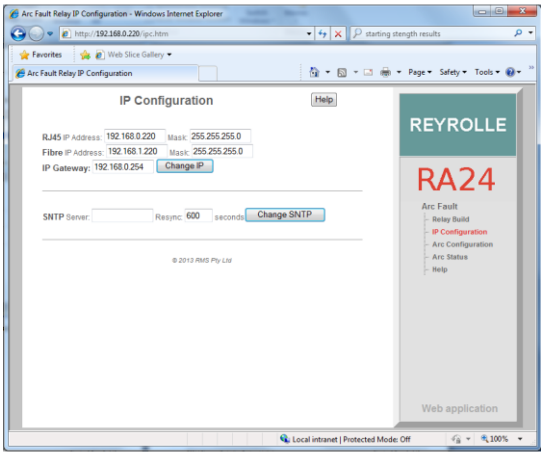
Configuration of the RA24 Arc Fault Monitor is carried out using a web browser interface as depicted in the screen shots shown in figure 7 and 8. Connection is made between the RA24 and a PC using a standard Category 5 patch cable with RJ45 electrical plugs.
Connect the RA24 port P1 to the PC Ethernet LAN port.
Open a PC browser using the default IP address 192.168.0.220

Ethernet Configuration

The current status of the device's communications configuration is shown in the browser interface.

SNTP Server	Change SNTP server name (SNTP server of the Station Bus Lan)
SNTP re-sync.	Changes re-sync. time in seconds
Password	Change administration password

Any changes are password protected and require entry of the username ("admin") and the password (default from the factory is "RMS").



IP Configuration

RJ45 IP Address: 192.168.0.220 Mask: 255.255.255.0
Fibre IP Address: 192.168.1.220 Mask: 255.255.255.0
IP Gateway: 192.168.0.254

SNTP Server: Resync: 600 seconds

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Fig7. RA24 IP Configuration screen

Arc Configuration Screen

The current status of each ARC detector is shown. To make the web page follow the ARC status in real time, tick the Automatic refresh button.

Arc Configuration:

Each individual ARC sensor can be configured as follows:

'Armed' or 'Disabled' by clicking on the state column
(Affects both IEC61850 Goose outputs and the hardware trip contacts)

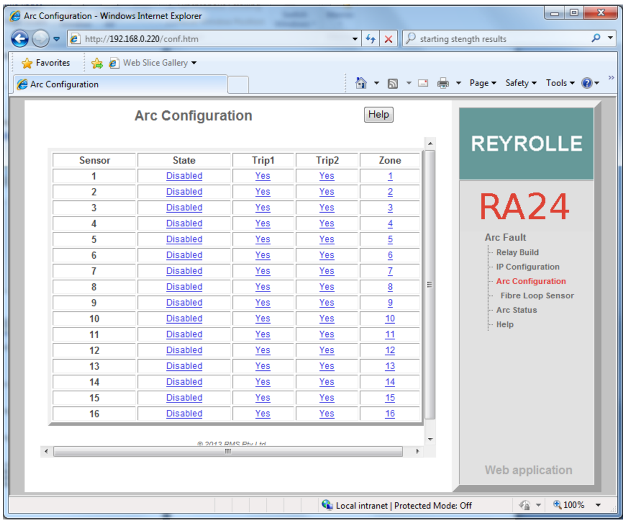
Arc States

The following list defines the possible ARC states:

- Disabled: Sensor not connected or disabled
- Armed: Ready to detect an arc fault
- Failed: Arc sensor supervision failure
- Tripped: Arc detected
- Initializing: Arc sensor initializing (transitory)
- Stuck: Arc sensor stuck on, i.e. continuously picked up
- Included: Determines whether a sensor is allocated to the relay
- Trip outputs (Yes or No)

Each individual arc sensor provides the following status:

Trip:	Indicates when the arc sensor LED Flag is asserted (Yes or No)
Count:	Retains a count since power on of how many times arc sensor has been tripped. This count can be reset to 0 by clicking on the counter.



Arc Configuration

Sensor	State	Trip1	Trip2	Zone
1	Disabled	Yes	Yes	1
2	Disabled	Yes	Yes	2
3	Disabled	Yes	Yes	3
4	Disabled	Yes	Yes	4
5	Disabled	Yes	Yes	5
6	Disabled	Yes	Yes	6
7	Disabled	Yes	Yes	7
8	Disabled	Yes	Yes	8
9	Disabled	Yes	Yes	9
10	Disabled	Yes	Yes	10
11	Disabled	Yes	Yes	11
12	Disabled	Yes	Yes	12
13	Disabled	Yes	Yes	13
14	Disabled	Yes	Yes	14
15	Disabled	Yes	Yes	15
16	Disabled	Yes	Yes	16

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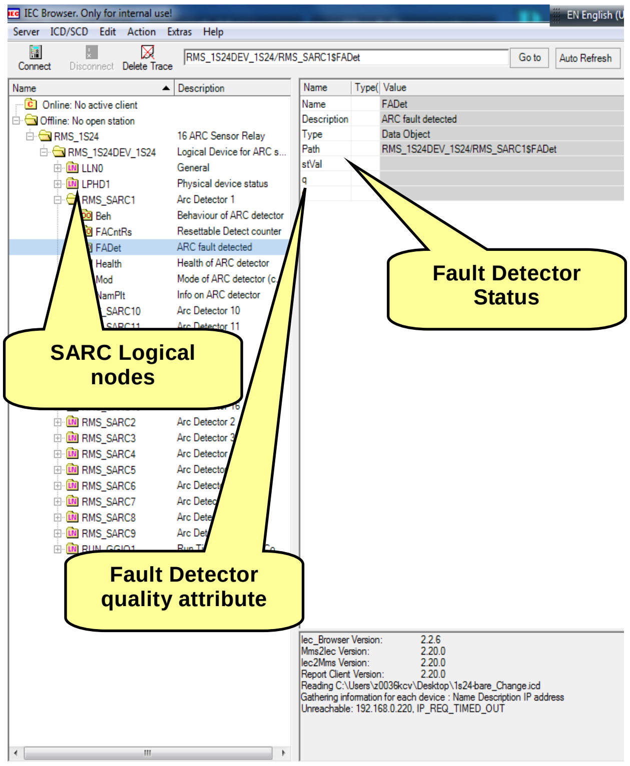
Fig8. RA24 Arc Sensor Configuration screen



RMS_1S24DEV_1S24/RMS_SARC1$FADet

Name	Description
Online: No active client	
Offline: No open station	
RMS_1S24	16 ARC Sensor Relay
RMS_1S24DEV_1S24	Logical Device for ARC s...
LLN0	General
LPHD1	Physical device status
RMS_SARC1	Arc Detector 1
Beh	Behaviour of ARC detector
FACntRs	Resettable Detect counter
FADet	ARC fault detected
Health	Health of ARC detector
Mod	Mode of ARC detector (c...
NamPlt	Info on ARC detector
RMS_SARC10	Arc Detector 10
RMS_SARC11	Arc Detector 11
RMS_SARC2	Arc Detector 2
RMS_SARC3	Arc Detector 3
RMS_SARC4	Arc Detector
RMS_SARC5	Arc Detector
RMS_SARC6	Arc Detect
RMS_SARC7	Arc Detec
RMS_SARC8	Arc Dete
RMS_SARC9	Arc Det
RUN_GGIO1	Run T

Name	Type(	Value
Name		FADet
Description		ARC fault detected
Type		Data Object
Path		RMS_1S24DEV_1S24/RMS_SARC1$FADet
stVal		
q		

```
Iec_Browser Version:        2.2.6
Mms2Iec Version:            2.20.0
Iec2Mms Version:            2.20.0
Report Client Version:      2.20.0
Reading C:\Users\z0036kcv\Desktop\1s24-bare_Change.icd
Gathering information for each device : Name Description IP address
Unreachable: 192.168.0.220, IP_REQ_TIMED_OUT
```

SARC Logical nodes

Fault Detector Status

Fault Detector quality attribute

Fig9. ICD editing screen

IED Capability Description (ICD)

The ICD is utilised in IEC61850 Substation Project Development. The RA24 ICD model contains the following logical nodes:

- A standard IEC61850-5 SARC (Monitoring and diagnostics for arcs), for each of the 16 Arc detectors. These cover an individual Arc fault detection, fault counter and detector health. Also, each Arc detector can be enabled or disabled using the SARC Mode.
- A configuration GGIO that can be used to configure the inclusion of each Arc detector in the single Alarm output relay of the RA24, as an alternative to the web page.
- A run-time GGIO that allows the front panel LED state for each Arc detector to be observed and cleared via IEC61850, as well as observing the state of the Alarm and Sensor Fail relays remotely.
- A Logical Node 0 (LLN0), that observes name plate information about the device and overall device current behaviour. A global block can be set and unset via IEC61850 using the LLN0 Mode

The structure of the ICD file is depicted in figure 9 and may be viewed using third party ICD browsers.

There are two .icd files that can be downloaded from the Reyrolle website. Descriptions of both files are provided below:

The ***1S24.cid*** can be used as-is on the RA24 and has a default set of 16 separate Goose messages, one for each FADet point with stVal and Quality included in the Goose. However, The IP address within this file, must match the IP Address configured on the RA24.

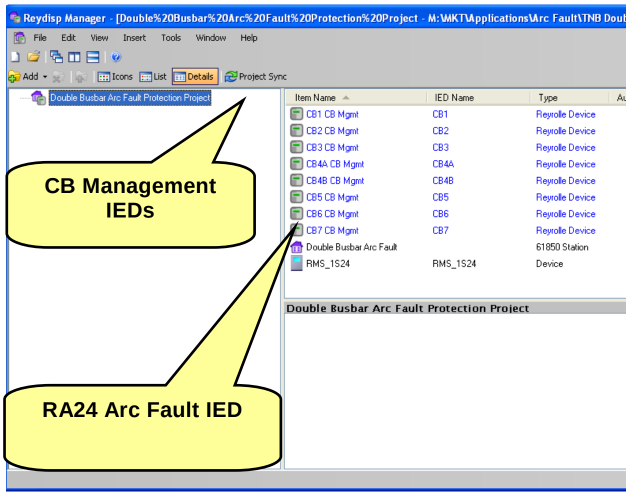
The ***1S24-bare.icd*** has an ICD extension as it is intended for importing into site configuration tools which can add specific Goose to it (with whatever VLAN, Versioning etc. required). The Tool can then export a CID file for use on the RA24. **Please Note:** On the RA24 itself, it must be called 1S24.cid.

IEC61850 Project

The IEC61850 standard permits the integration of the RA24 into a substation project incorporating any third party CB management IED.

The RA24 is modelled under IEC61850 with a Logical node model defined by a IS24.icd file. This file can be imported into your IEC61850 system configurator and incorporated into an IEC61850 project.

Examples of an IEC61850 Substation project incorporating a RA24 into an ARC Fault Protection scheme and CB Management Logic utilising subscribed Goose messages from the RA24 are shown in Figure 10.

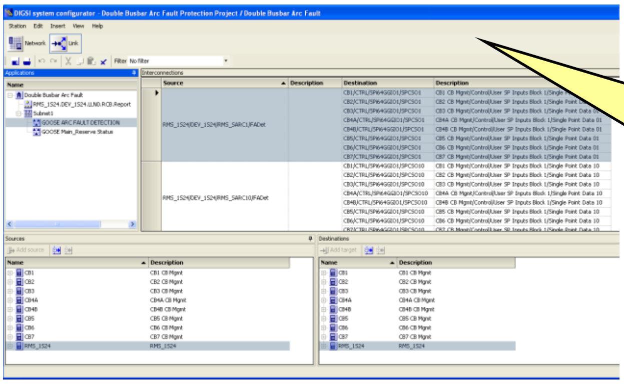


Item Name	IED Name	Type
CB1 CB Mgmt	CB1	Reyrolle Device
CB2 CB Mgmt	CB2	Reyrolle Device
CB3 CB Mgmt	CB3	Reyrolle Device
CB4A CB Mgmt	CB4A	Reyrolle Device
CB4B CB Mgmt	CB4B	Reyrolle Device
CB5 CB Mgmt	CB5	Reyrolle Device
CB6 CB Mgmt	CB6	Reyrolle Device
CB7 CB Mgmt	CB7	Reyrolle Device
Double Busbar Arc Fault		61850 Station
RMS_1S24	RMS_1S24	Device

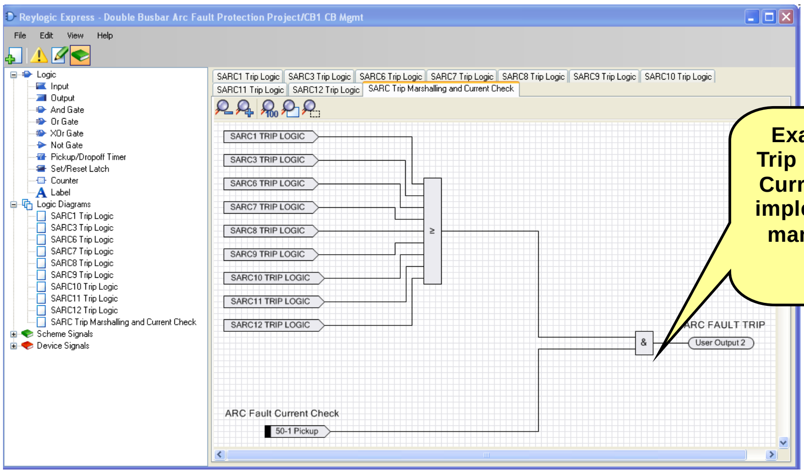
Double Busbar Arc Fault Protection Project

CB Management IEDs

RA24 Arc Fault IED



IEC61850 Configurator such as DIGSI used to create Goose interconnections between IEDs



Example of SARC Trip Marshalling and Current Check logic implemented in a CB management relay

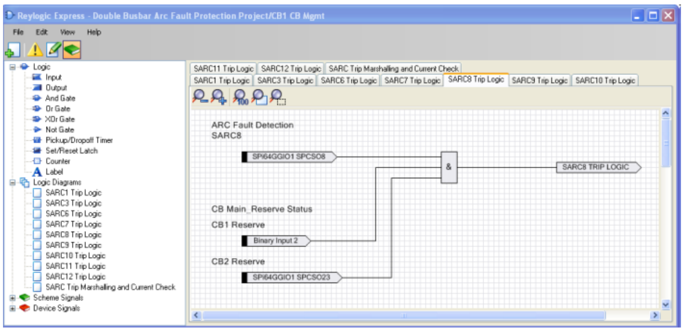


Fig10. Reydisp Manager IEC61850 project editing and Reylogic screens

Arc Sensor Function

The RA30 is an optical sensor that responds to the flash of light emitted during the incidence of an arcing fault. Onset of the light flash and detection by the RA30 occurs in a few ms.
Refer to the RA30 Technical catalogue sheet for further details.

RA30 Point Sensor Inputs and Indicators

A red LED is provided for each arc sensor input to indicate:

Trip: LED illuminates solid on detection of an arc fault. Resets when the front panel reset button is pressed or voltage pulse applied to remote reset status input. Individual flags can also be observed and cleared via IEC61850.

Fail: LED Flashes to indicate failure of RA30 Arc Fault Sensor in zone.

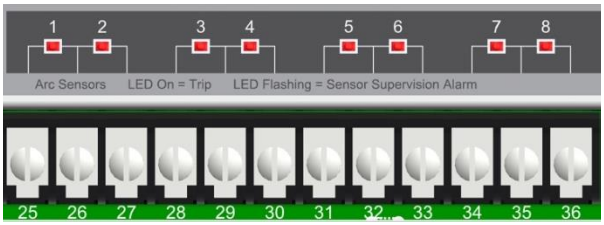


Fig11. Point arc sensor LED's and terminals

Arc Trip Output Contacts

The RA24 provides two (2) high speed tripping output contacts. These may be employed for local tripping functions and for system testing purposes. Each sensor input may be set to trip either of the output contacts.
The arc trip contacts will self-reset after a 2s delay. The trip indication LED is reset either by pressing the front panel reset button, via the remote reset status input or via IEC61850 control.

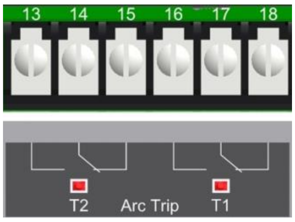


Fig12. Arc trip output contacts and trip LED

Arc Trip Blocking Input

The RA24 provides a status input to enable a global block of all arc fault detection sensors. Application of a control voltage within the specified range will activate this function and energize the Global Arc Block LED.

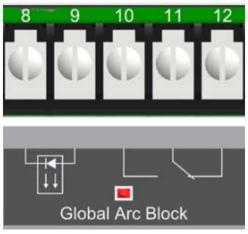


Fig13. Global arc block input and LED indication

Arc Detection Reset Time

Effect of multiple arc trips
A delay of 2s is required to reset the RA24 after an initial arc sensor trip. Subsequent arc detection will cause the trip outputs to re-operate.

Remote Reset

A remote reset status input is provided to reset the arc trip LED's.

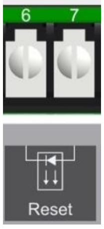


Fig14. Remote reset binary input - flag reset

Optical Arc Sensors

The RA30 optical arc sensors are the heart of the system and are available for application with the RA24.

Details on the function and sensitivity of these sensors may be found in the specific Technical catalogue sheet.

Point Sensor Supervision

To monitor the integrity of the wiring between the RA30 arc sensor and RA24 Arc Monitor, continuous 2mA supervision current flows between the units.
If the sensor supervision current is not detected for 1s the Sensor Alarm contact will operate and the Sensor Alarm LED will illuminate solid.
The affected sensor(s) will be indicated by the front panel sensor LED 1-16 flashing. The associated IEC61850 Arc Fault Quality will change to questionable.

Arc Sensor Continuously Picked Up

High ambient light levels may cause a RA30 to be continuously picked up. This condition could occur for example if the CB cable box cover was left open in very high ambient light level conditions. A non-arc fault over-current pick up would then result in an arc fault trip operation.

To avoid possible mal operation due to this condition, the RA24 is designed to automatically disable the arc fault tripping function if the RA30 sensor is picked up for >10s. The RA24 Sensor Alarm contact will operate and Sensor Alarm LED will illuminate solid until the ambient light level problem is corrected. The RA24 will then perform an arc sensor test function and automatically reset.

The affected sensor(s) will be indicated by the front panel sensor LED 1-16 flashing.

Sensor Fail Alarm

A common Sensor Fail Alarm contact is provided.

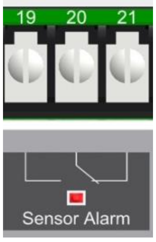


Fig15. Sensor fail alarm LED and output contact

Self-Supervision Service Alarm

A change over alarm contact is maintained in the energized state when all of the following conditions are met:

- The auxiliary supply is applied
- The internal 5V DC rail is within acceptable limits

- The CPU hardware watchdog maintains a pulsing output
- The Service Alarm LED will be energized for a CPU fail condition.

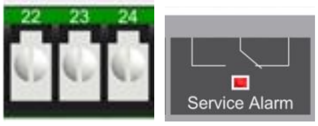


Fig16. Self-supervision service alarm

System Status

LED's are provided to indicate auxiliary supply and Ethernet activity.

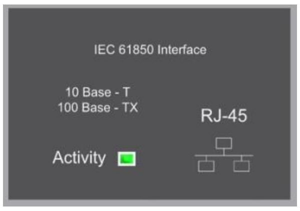


Fig17. System status LED's

Device Earth Terminal

The RA24 provides a device earthing terminal.

Fig18. Device earth terminal

Rating Plate and Flag Reset

The rating plate is clearly identified on the front panel.

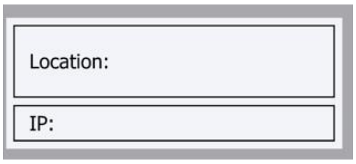
A reset button is provided to reset the arc trip LED's.

This button also has other functions to initiate warm boot and cold boot to restore factory default settings. Refer to the User Guide for details.

Fig19. Relay rating plate and reset button

Customer Specific Labels

Provision for a slide-in customer specific label is provided on the front panel.



Location:

IP:

Fig20. Default slide in label

Ethernet Communication Ports

The RA24 provides the option of either one or two high speed Ethernet port options for connection to an IEC61850 compliant station bus local area network (LAN).

Standard Port

The standard port employs an electrical interface with an RJ45 connector and supports 10Base-T / 100Base-TX. The port may be utilised for either IEC61850 Goose messaging purposes or for device configuration.

Optional Second Port

An optional second port employs a plug-in optical fibre port and supports 100Base-FX.

The two port option allows one of the ports to connect to an IEC61850 station bus LAN for Goose messaging purposes and either port may be utilised for device configuration.

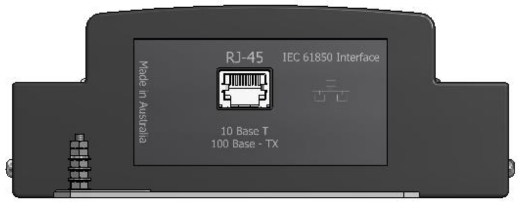


Fig21. Standard single port 10Base-T / 100Base-TX

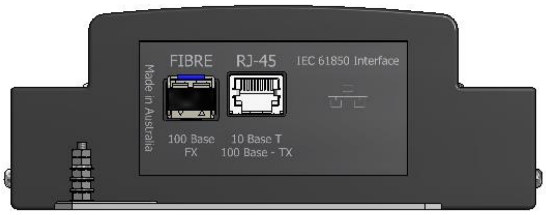


Fig22. Optional dual port 10Base-T / 100Base-TX + 100Base-FX

Application Diagram

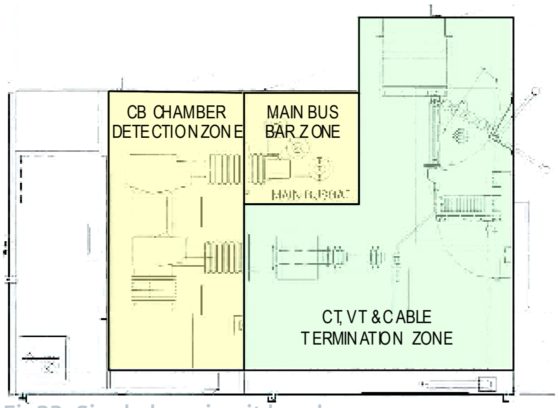


Fig23. Single bus circuit breaker

Single Bus Switchgear

Single busbar switchgear systems are prevalent at medium voltage levels. The complexity on the protection required to mitigate arc flash faults is dependent on the Bus configuration. Figure 23 depicts a typical circuit breaker arrangement in a single bus scheme.

Single Bus and Switchgear Arc Protection

Figure 24 depicts how the RA24 may be applied for arc fault protection on a single bus bar configuration.

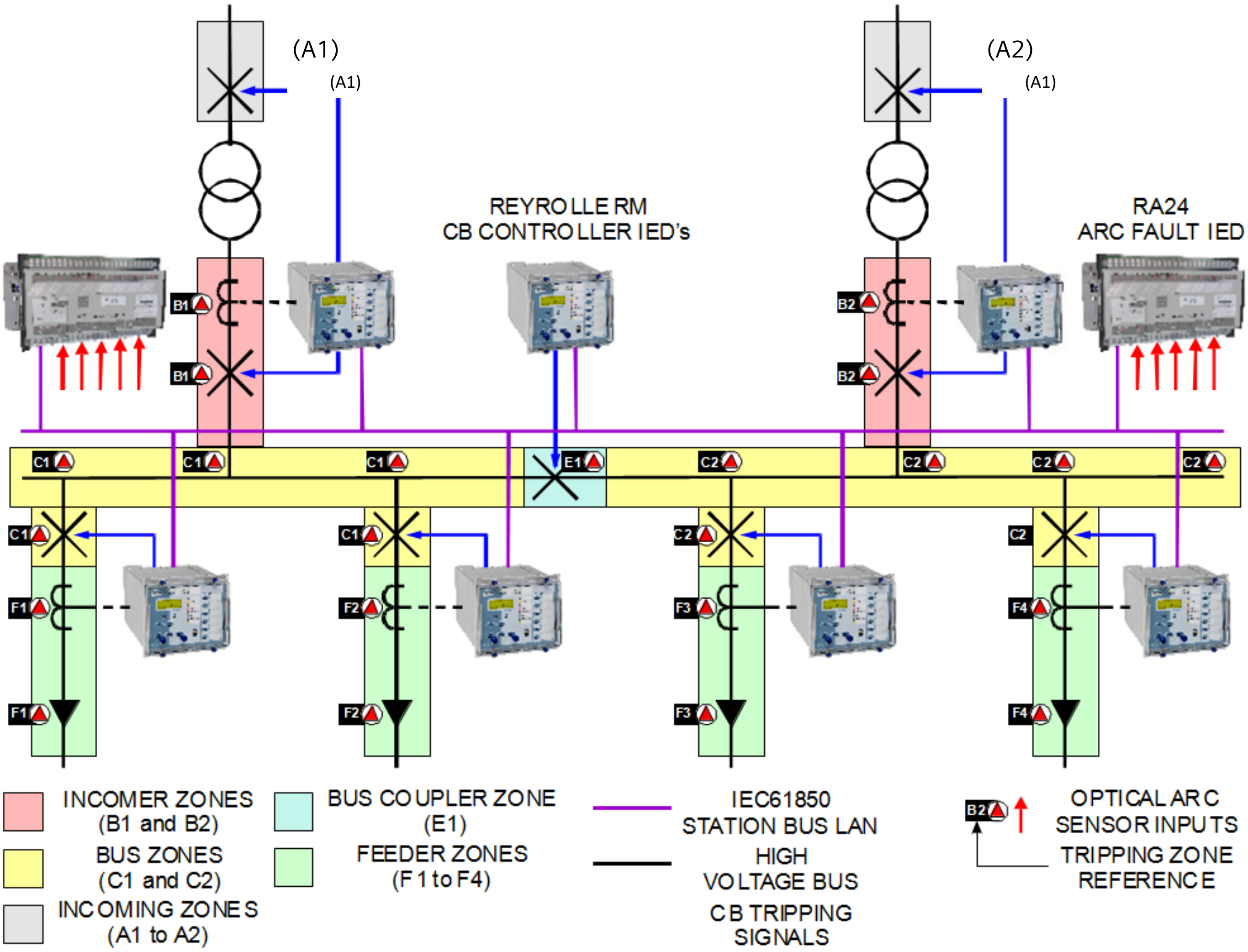


Fig24. Single bus scheme

Technical Data

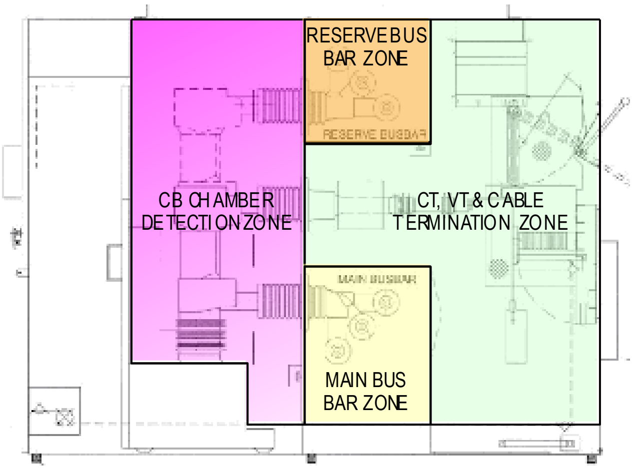


Fig25. Single bus circuit breaker

Dual Bus Switchgear

Double busbar switchgear systems present additional challenges for protection against arc flash faults due to the number of arc fault protection zones and multiple operating configurations possible. Figure 25 depicts a typical circuit breaker arrangement in a double bus scheme.

Double Bus and Switchgear Arc Protection

Figure 26 depicts how the RA24 may be applied for arc fault protection on a double bus bar configuration.

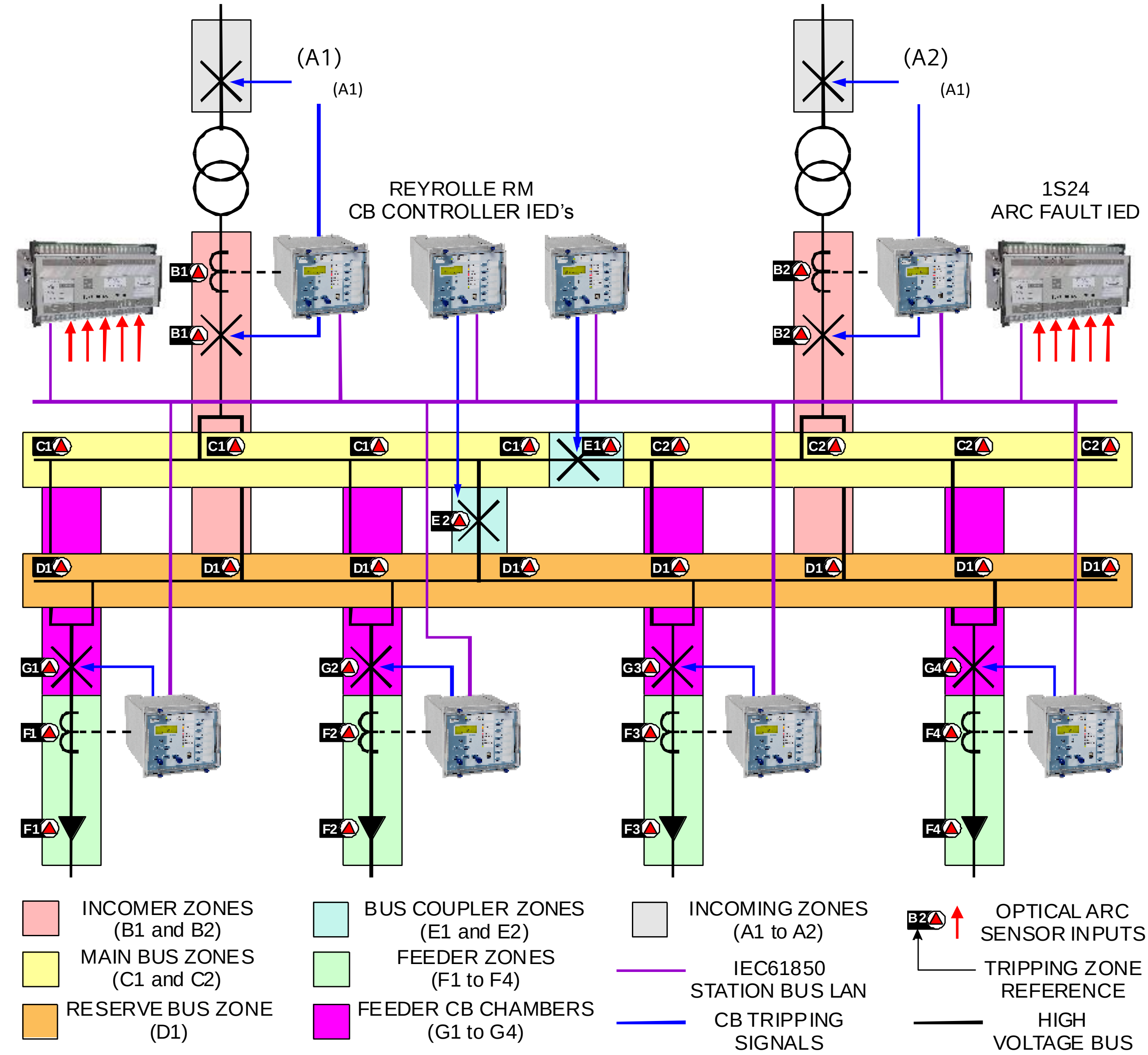


Fig26. Double bus scheme

Compliance Data

Auxiliary Supply

Nominal voltage	Operating Range
24 / 32 / 48	20-70V dc
b110 / 125 / 220 / 240 / 250	80-275V ac / 88-300V dc
Allowable breaks/dips in supply (Collapse to zero)	20ms
Burden - Quiescent	8W at 110V dc
Burden - Maximum	15W at 110V dc

Binary Inputs

Voltage Range	18-275V ac / 18-300V dc
Operating Current	10mA pickup for 1ms Reducing to 1.5mA after 4ms
DC Operate Time	<4ms pickup <16ms dropout
AC Operate Time	<23ms pickup <33ms dropout
Function	Enable on the application of a control voltage

Output Contacts

Operating Voltage	Voltage free
Operating Mode	Self-reset
Operate Time	7ms
Release Time	3ms
Making Capacity	
Carry Continuously	8A ac or dc
Make and Carry L/R ≤ 40ms and ≤ 300V	20A ac or dc for 0.5s 30A ac or dc for 0.2s
Breaking Capacity	L/R ≤ 40ms and ≤ 300V
AC Resistive	2,000VA
AC Inductive	250W at p.f. ≤ 0.4
DC Resistive	60W
DC Inductive	30W at L/R ≤ 40ms 50W at L/R ≤ 10ms
Minimum Load	100mA ≥12V

Arc Fault Point Sensor Inputs

Number	16
Type	RA30 point sensors
Connection	Electrical termination
Zones	Up to 16
Supervision duration	Continuous
Trip Contact Operate Time	<10ms (Typically <7ms)
Reset Time	2s

Goose Response

GOOSE Response	<3ms to first publish

Insulation IEC 60255-5

Type	Level
Any Terminal and Earth	2.0kV ac rms for 1min
	5.0kV 1.2/50us 0.5J
Between Independent Circuits	2.0kV ac rms for 1min
	5.0kV 1.2/50us 0.5J
Across Normally Open Contacts	1.0kV ac rms for 1min

High Frequency Disturbance IEC 60255-22-1

Type	Level	Variation
Common (Longitudinal)	2.5kV	No mal-op.
Differential (Transverse)	1.0kV	

Electrostatic Discharge IEC 60255-22-2 Class 3

Type	Level	Variation
Contact Discharge	6.0kV	No mal-op.

Fast Transients IEC 60255-22-2 Class A

Type	Level	Variation
5/50ns 100kHz	4.0kV	No mal-op

Surge Immunity IEC 60255-22-5

Type	Level	Variation
Between all Terminals and Earth	4.0kV	No mal-op
Between any Two Independent Circuits	2.0kV	

Conducted Radio Frequency Interference IEC 60255-22-6

Type	Level	Variation
0.15 to 80MHz	10V rms	No mal-op

Radiated Immunity IEC 60255-22-3 Class III

Type	Level	Variation
80MHz to 2,760MHz	10V/m	No mal-op

Temperature IEC 60068-2-1/2

Operating Range	-10 to +55 degrees Celsius
Storage Range	-25 to +70 degrees Celsius

Humidity IEC 680068-2-78

Operating Range	40 degrees Celsius and 93% RH non condensing

IP Rating IEC 60529

Installed	IP4x

Vibration – Sinusoidal IEC 60255-21-1 Class I

Vibration Response	0.5gn	No mal-op
Vibration Endurance	1.0gn	

Shock and Bump IEC 60255-21-2 Class I

Shock Response	5gn, 11ms	No mal-op
Shock Withstand	15gn, 11ms	
Bump Test	10gn, 16ms	

Seismic IEC 60255-21-3 Class I

Seismic Response	1gn	No mal-op

Mechanical Classification

Durability	>10^6 operations at no load

Arc Flash & Overcurrent Operation Time

The circuit breaker trip time will be dictated by the relays overcurrent element operation time. Please see the overcurrent element performance specification on relay used for more information.

Front Panel

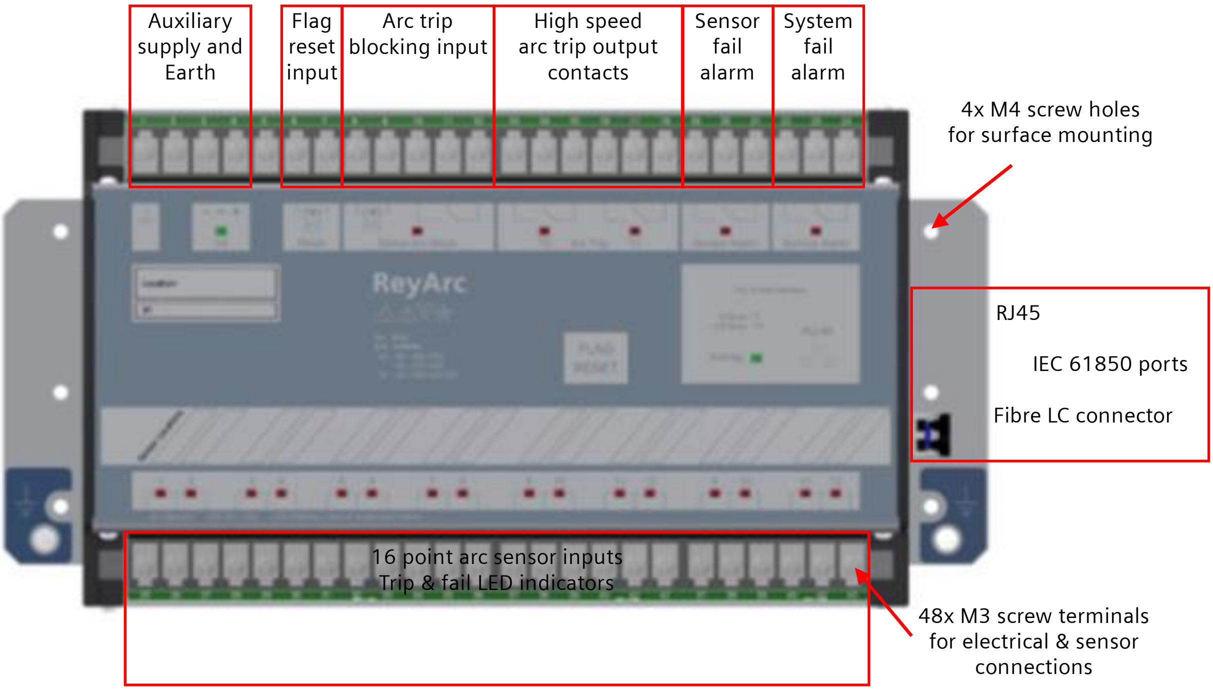


Fig27. Front panel layout, 16 point sensor version with 100base-FX Ethernet port

Wiring Diagram

Wiring and Termination

Sturdy M3 screw terminals are provided suitable for one or two ring terminals. Multiple chassis earthing points are also provided. Terminal numbering is clearly identified and graphics are provided to visually represent the connection function.

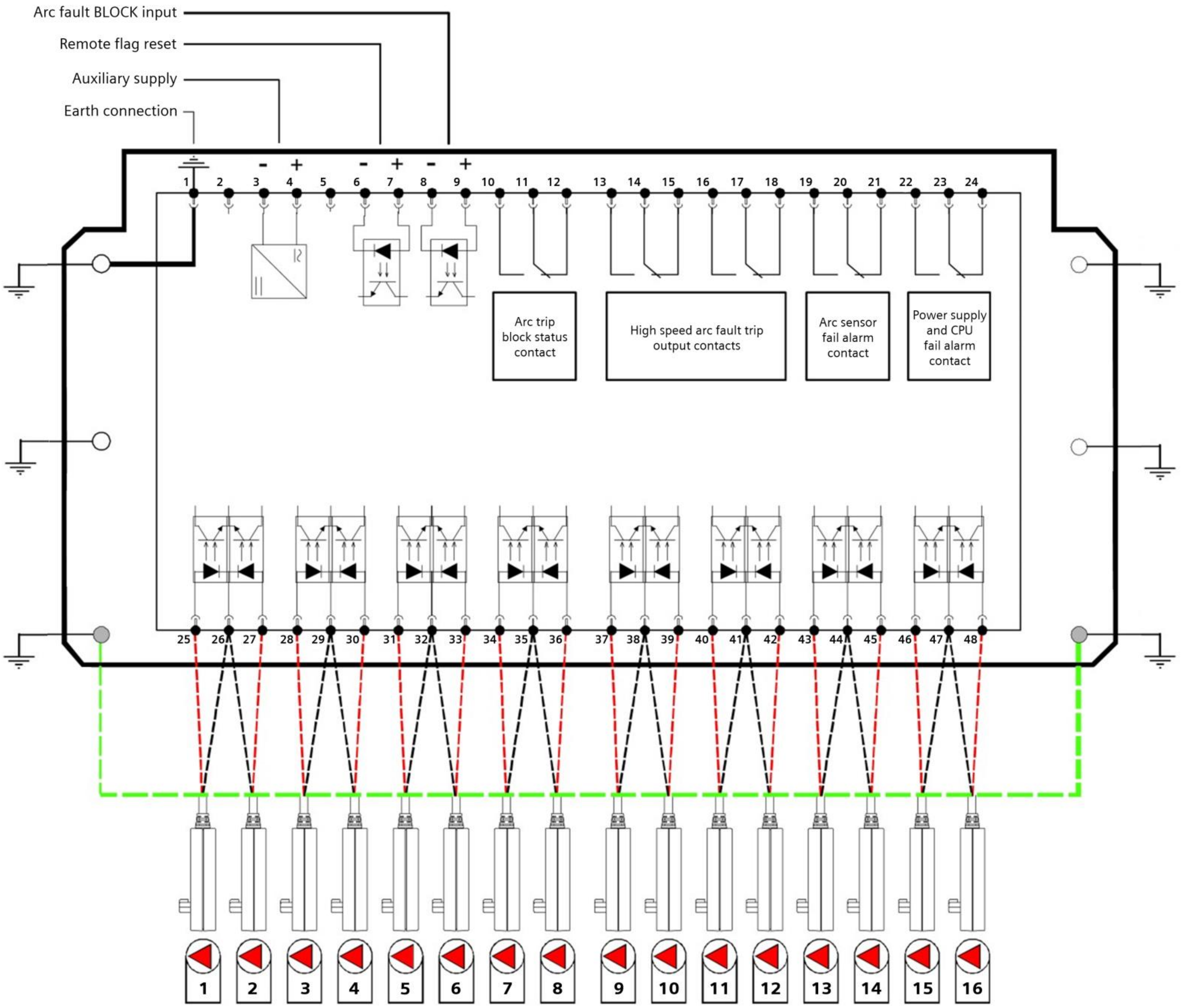


Fig28. Wiring diagram

Arc Sensors

RA30 Point Sensor Connection

16x RA30 point arc sensor inputs are provided.

Each sensor operates independently with a common connection shared between each pair of sensors to reduce the total number of terminals required.

Each sensor pair is wired to 3 M3 terminal screws with the centre screw being common.

Figure 24 shows the wiring arrangement. The RA30 sensor wires are colour coded but are not polarity sensitive.

Fig29. RA30 sensors

RA30 Shielded Cables

Shielded cables are recommended when the length of the RA30 cable connections exceed 6m.

M3 earth studs with nuts and lock washers are provided on the RA24 chassis in two (2) positions - one to the left of terminal 1 and one to the right of terminal 24 - to allow connection of the optional RA30 sensor cable shields. Refer to figure 28 for connection details.

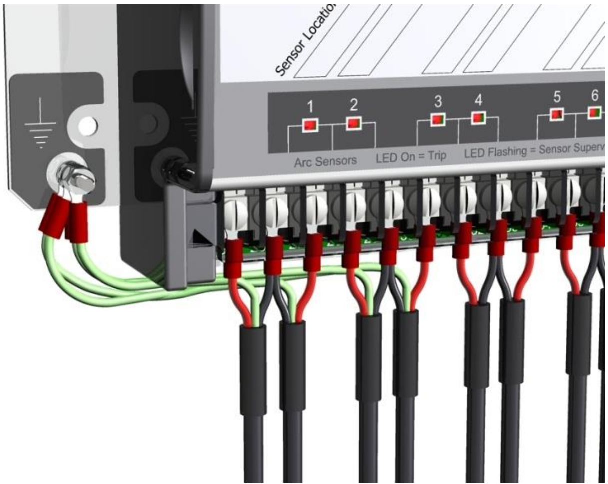


Fig30. RA30 sensor wiring using shielded cables

Dimensions

Surface or DIN Rail Mounting

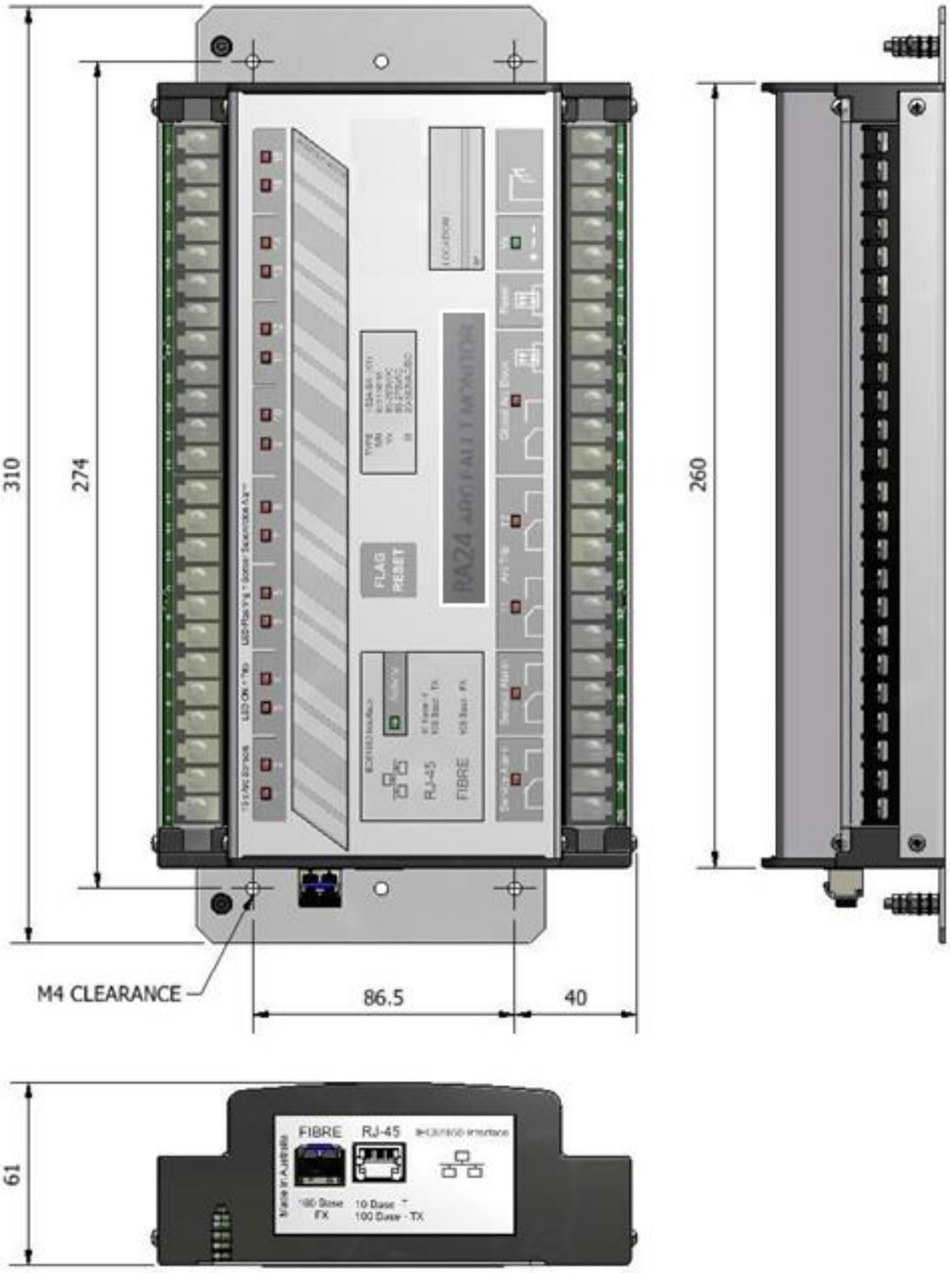


Fig31. RA24 dimensions and mounting points

Accessories

DIN Rail Mounting

The RA24 has provision to fit two (2) DIN rail mounting kits. These "DIN Rail Mount" option must be specified at time of orde
4 x M4 self-threading mounting screw kit

Accessories Supplied with Each Device

4 x M4 self-threading mounting screw kit

IS30 Arc Fault Point Sensor

The RA30 sensors are ordered separately.
Refer to the RA30 Technical catalogue sheet for details

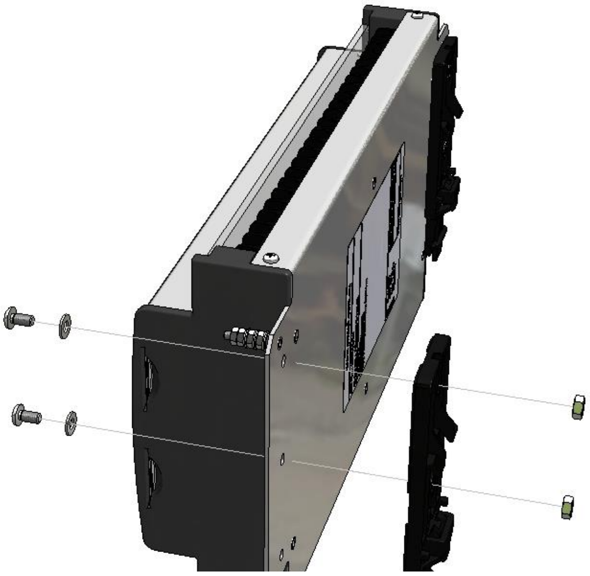


Fig32. Fitting DIN rail mounting kit

Ordering Information

Product description	Variants	Order No.
		7XG3124-□□□00-0AA0
Arc Fault Protection Components	<u>Category</u>	
	Arc Protection	31
	<u>Device</u>	
	RA24 Arc Fault Monitor	24
	<u>Network Connection</u>	
	Single port 10Base-T/100Base-Tx	1
	Dual port 10Base-T/100Base-Tx + 100Base-Fx	2
	<u>Operating Voltage</u>	
	20 – 70V DC	A
	88 - 300V DC / 88 – 275V AC	B
	<u>Mounting</u>	
	Surface Mount	A
	DIN Rail mount (supplied with mounting hardware)	B

1.1.5.4 7XG3130 Optical Arc Fault Sensor

Features

- Compact rugged design
- One or two optical detectors
- High speed arc detection
- Heavy duty 6m termination cable
- Optional 20m & screened cables
- Simple flush cable panel mounting outside or inside switchgear compartment
- Integrated sensor circuit supervision
- Very low sensitivity to ambient light levels to avoid nuisance tripping even in direct sunlight
- Sealed module for harsh environments
- Metal reinforced mounting shield comes as standard

Application

Arc fault protection is a technique employed for the fast clearance of arcing faults on busbars & within metal clad switchgear & associated cable boxes. The arc is detected using an optical sensor & the signal input to a protection device which also monitors the load current on the system. A trip signal can be achieved in less than 10ms using arc detection.

While the high intensity flash caused by an electrical arc will be reflected within the metal clad switchgear, it is recommended that one or more sensors be mounted in each enclosed switchgear compartment.

For busbar protection applications multiple sensors are required to achieve adequate coverage along the length of the bar. A sensor version with two optical detectors "looking" in opposite directions is available for this purpose (Refer figure 3 for generic layout).

Description

The RA30(ReyArc30) is an optical sensor that responds to the flash of light emitted during the incidence of an arcing fault. Onset of the light flash & detection by the RA30 occurs in a few ms.

Each arc fault sensor consists of one or two silicon PIN photo diode light detectors mounted on a circuit board together with the associated detection circuit (Figures 1 & 2). The detector monitors a wide space angle. A broad spectral response in the visible region is provided as depicted in figure 5.

Sensitivity of the arc sensor has been set to a low level to reduce the possibility of mal operation under high ambient lighting conditions. This is made possible due the high intensity of light emitted under arc fault conditions. Additional security can be incorporated by way of a current check stage.

In standby mode the RA30 sensor presents a high resistance to the 12V DC control signal provided by the Arc Fault Monitor. This allows a small circulating current to flow for continuous supervision of the RA30 connection circuit. When an arc is detected, the resistance presented by the RA30 drops to a level where the current flow increases to approximately 20mA. This increased current flow is instantaneously detected by the Arc Fault Monitor & its trip output contacts closed. Refer to the RA20 Arc Fault Monitor Catalogue sheet for further details.

Single detector package

Figure 1 depicts the RA30 with a single optical detector. Note the window where the active part of the detector is positioned to. This permits convenient mounting on the outside of the panel with the detector window protruding through a hole in the panel.

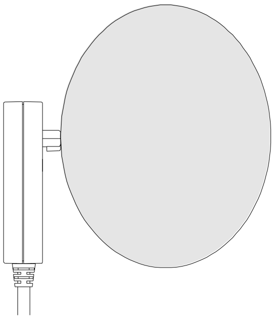


Fig1. RA30 with single optical detector

Dual detector package

Figure 2 depicts the RA30 with dual optical detectors. The two optical detectors face in opposite directions to provide arc detection coverage in both directions. This version is particularly useful when mounted in a bus chamber or barrier between adjacent switchgear chambers. The main benefits are reduced cost compared to two separate sensors & use of only one input channel on the RA20 Arc Fault Monitor.

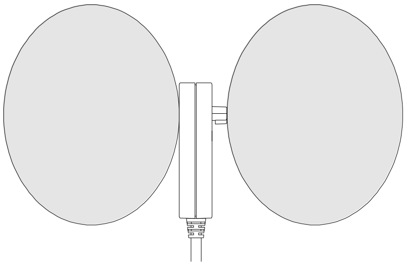


Fig2. RA30 with dual optical detectors

Detector range

A detection range along the 100% relative sensitivity curve shown in figure 3 is approximately 3m. Single detector versions therefore need to be placed at a maximum spacing of 5-6m. The dual detector versions may be placed at a maximum spacing of 8-10m to provide adequate detection overlap. In switchgear the light caused by the arc is reflected from the walls & therefore, the mounting of the sensor is not critical.

While the high intensity flash caused by an electrical arc will be reflected within the metal clad switchgear, it is recommended that one or more sensors be mounted in each enclosed switchgear compartment.

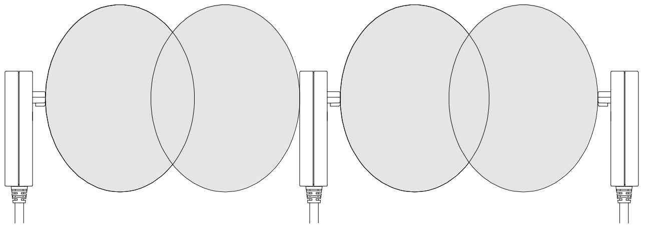


Fig3. Detection range along 100% relative sensitivity curve

Detector Characteristics

Optical sensitivity

~10,000 Lux* for white light at normal incidence to the detector window(s) as depicted in figure 4:

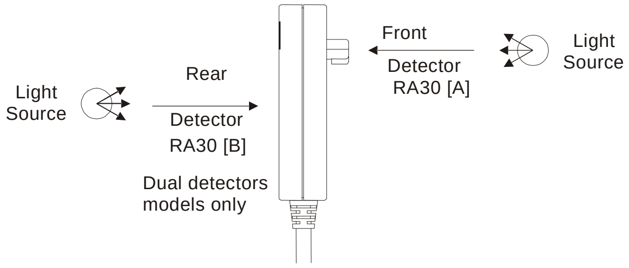


Fig4. ~10,000 Lux* for white light at normal incidence to the detector window(s)

For the RA30 single detector version the front detector only is fitted. In this configuration the RA30 will be insensitive to white light incident on the rear surface of the case up to a level of 200,000 Lux.

As the illuminace of diffuse ambient sunlight falls in the range 5,000 to 10,000 Lux, this will not normally be sufficient to trigger the RA30 sensor. The luminous intensity from the sun at noon at the equator however is ~100,000 Lux which will be sufficient to trigger the RA30 sensor so measures should be made to avoid this situation.

Direct sunlight incident on the rear of the RA30 single sensor model will not cause it to pick up. This attribute provides a significant safety margin to avoid nuisance tripping when the option of mounting the sensor externally on switchgear as depicted in figure 6 is employed.

Detector directional characteristics

Detector sensitivity falls to ~40% of the nominal level at inclination angles up to 70 degrees from the normal for white light.

Detector spectral response

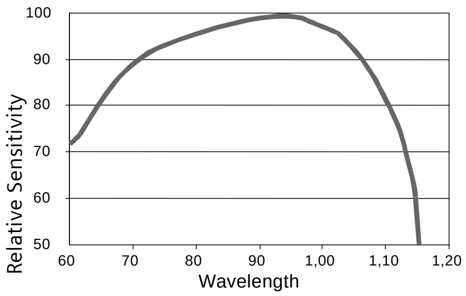


Fig5. Arc detector spectral response

* Due to the relatively high sensitivity of the detector to IR wavelengths the type of light source employed for sensitivity testing will have a major effect on the results obtained.

Sensitivity testing should therefore be conducted using a 50-75W halogen lamp with an integrated aluminum reflector.

Mounting Options

Flush panel mounting

The RA30 is suitable for flush panel mounting in a number of configurations.

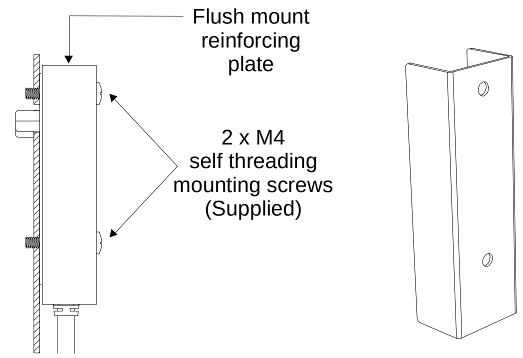


Fig6. RA30 shown mounted on the outside of a switchgear panel. Detector oriented to 'look' through a hole into the switchgear

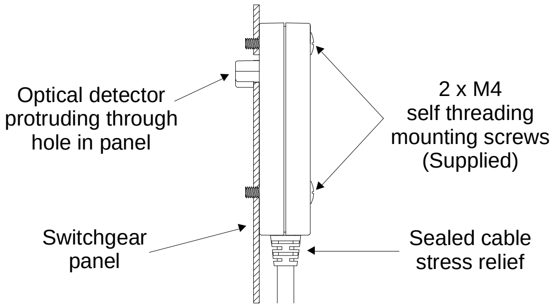


Fig7. RA30 shown mounted on the inside of a switchgear panel Detector oriented to 'look' out into the switchgear compartment

Flush mounting reinforcing plate

When mounting the RA30 on the outside of a switchgear cubicle as depicted in figure 6, the hole required in the panel may degrade the short circuit rating. If this is considered to be an issue then a reinforcing plate may be fitted over the RA30 as depicted below. The Reinforcing plate comes as standard with the RA30.

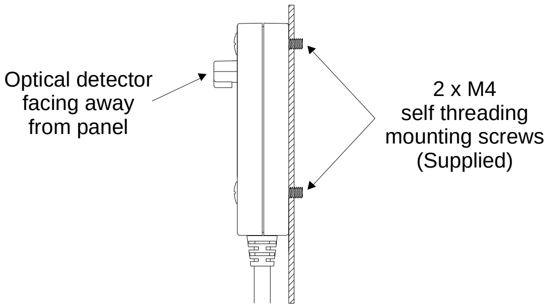


Fig8. Flush mount reinforcing plate
1.2mm zinc plated mild steel

Dual detector version

The dual detector version can be panel mounted to monitor two adjacent switchgear compartments simultaneously. This feature can be used to reduce the total cost for sensors or to increase the monitoring coverage for each RA20 Arc Fault Monitor unit.

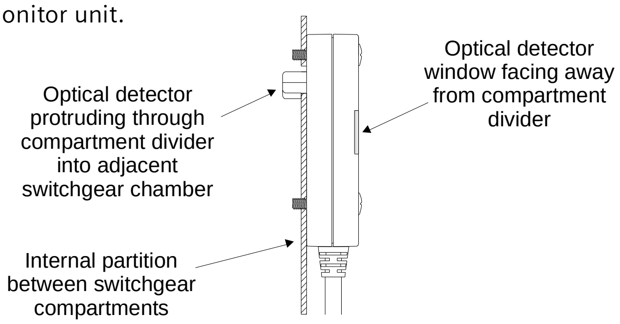


Fig9. RA30 shown mounted on the inside of a switchgear panel. This configuration combines the functions described in Figures 6 & 7 with the application of a single dual detector arc fault sensor

Panel mount cut out detail

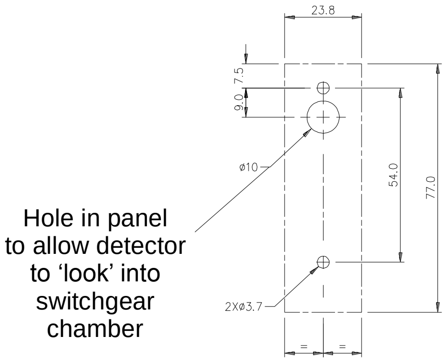


Fig10. Flush mounting detail

Right angle mounting off a surface

A right angle mounting bracket may be fabricated using the panel cut out detail in figure 10. Single & dual detector models may be mounted in this manner as depicted in figure 11.

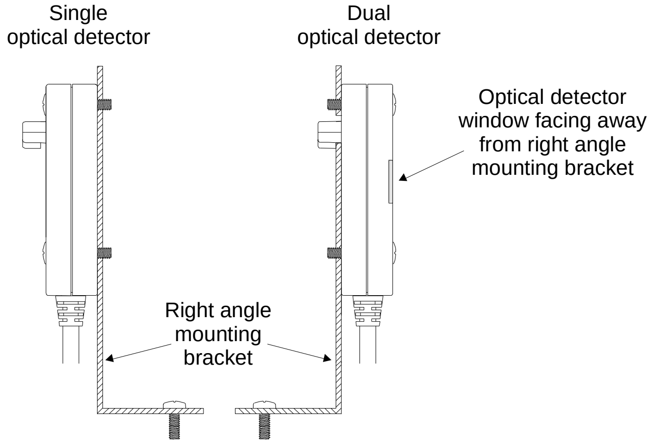


Fig11. Right angle mounting off a surface mount off floor or walls within switchgear / busbar chamber

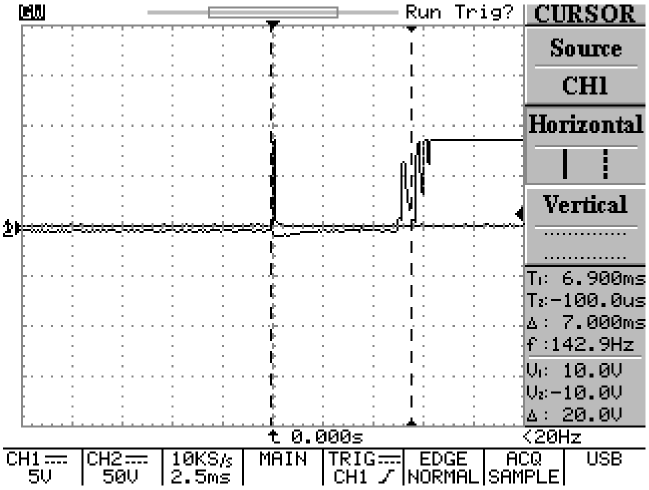
Technical Data

Arc fault protection scheme

Refer to the ReyArc20/23/24 Technical Catalogue sheets for further details.

Arc protection scheme operate time

Arc fault trip contacts guaranteed to pick up in less than 10ms including bounce. Typical operate time is 7ms.



CRO trace showing nominal operation time of the trip contacts at 7ms. First contact touch at 6.25ms and fully closed by 7.25ms. Operation in <10ms is considered acceptable as current check relay operate time is ~25ms.

Minimum Arc duration

The minimum arc "flash" duration required to guarantee operation of the Arc Fault Monitors output contacts is 1.25ms.

Auxiliary supply

Voltage from RA20 Arc Fault Monitor:	12V DC
Power consumption:	≤2.5mA

Casing

Rugged moulded construction to IP51.

Temperature range

Operating:	-5 to +55°C
Storage:	-25 to +75°C

Sensor Connections

The RA30 is supplied with a 6m two core connection cable as standard. Two core multi strand wire (2x16/0.2mm), is supplied stripped & pre tinned at the RA20 connection end. The standard 6m cable may be cut down to the desired length & crimp ring lugs fitted for termination.

The RA30 connections are not polarity sensitive. Reversal of the wires on the arc monitor terminals has no effect on the performance of the RA30 or arc detection system.

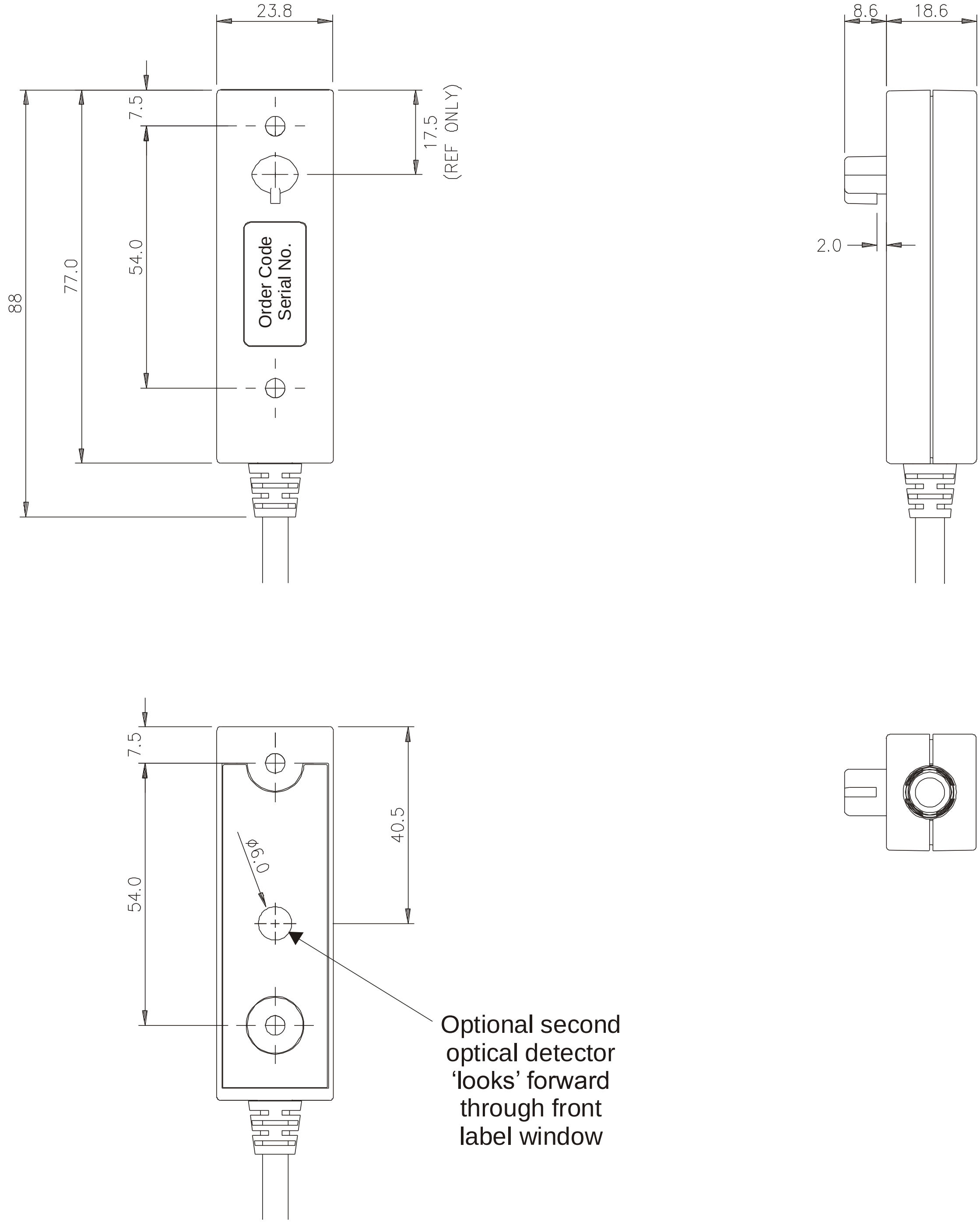
The cable is factory fitted to the RA30 Arc Fault Sensor using a stress relief molding to provide a sealed & durable connection interface. The cable employs thick inner & outer insulation layers to avoid damage during installation.

For connection over longer distances shielded cable is recommended. For distances over 20m, 24/0.2 mm cable should be employed.

Additional RA30 cable length

Screened arc sensor cables may be increased by wiring additional series twisted pair SCREENED cable provided it does not exceed 5 ohms and 30nF loop impedance.

Dimensions



Optional second optical detector 'looks' forward through front label window

Fig12. RA30 Arc fault Sensor dimensions

Ordering Information

Product description	Variants	Order No.
		7 X G 3 1 3 0 - □ □ □ 0 0 - 0 A A 0
Reyarc – Arc Fault Protection Components	Category	
	Arc Protection	3 1
	Device	
	RA30 Arc Sensor	3 0
	Arc Detectors	
	Single detector (Through Hole)	1
	Dual detector	2 B
	Cabling	
	6m unshielded	A
	6m shielded	B
	20m shielded	C
	Reinforcing plate (single sensors only)	
	Required	A
	Not Required	B

1.2 *Alpha Range*

1.2.1 7PG11 Auxiliary Relay

Description

The 7PG111 & 7PG112 AR range of electromechanical relays are available with up to eight self, hand or electrically reset contacts. They can be supplied in most combinations of contact, flag and reset arrangements. Fixed time delay models are also available.

AR relays are voltage operated from either AC or DC supplies.

Features

- Consistent positive action
- Robust design for a long, reliable, service life

Type AR relays are a range of electro-mechanical relays with up to 8 contacts and complying to BS142. They can be supplied in most combinations of contact, flag and reset arrangements and with a fixed time delay. The relays are identified by a series of numbers and letters which define important relay features.
The following comments are provided as a guide to the various features of type AR relays.

AR - 1 Up to 8 self reset contacts, in any combination of normally open or normally closed as required.
AR - 2 Up to 8 self reset contacts, in any combination of normally open or normally closed as required.
AR - 3 Electrical and hand set contacts supplied with a contact reset mechanism in the relay case cover.
AR - 4 Hand and self reset contacts, can be supplied with 2 hand reset contacts and a maximum of 4 self reset contacts. All the contacts may be either normally open or normally closed.
AR - 6 Electrical reset contacts with optional self reset flag.
AR - 3 & 6 Reset coils are short time rated, we recommend that reset circuits include a normally open (cut-off) contact

First Digit	Second Digit Type of flag		Third Digit Type of contact reset	
Number of identical elements	0	No flag	1	Self
	1	Hand reset	2	Hand
	2	Hand reset reverse acting	3	Electrical & hand
	3	Self reset	4	Hand & self
	4	Self reset reverse acting	6	Electrical

Suffix letters are used to identify further features:
Suffix D – indicates a relay fitted with a suppression diode across the coil to reduce the effects of back emf on switch-off.
Suffix SB – identifies a relay with a series break contact to cut-off the operating coil, thus the relay burden becomes zero after operation of this contact. Only available with AR relays which have hand reset contacts.

Type	Number of Contacts	Flag Reset	Contact Reset
AR101	2,4,6 or 8	N.A.	Self
AR103	4,6 or 8	N.A.	Elec & Hand
AR106	2, 4, or 6	N.A.	Elec
AR111	2,4,6 or 8	Hand	Self
AR112	2,4,6 or 8	Hand	Hand
AR113	4, 6 or 8	Hand	Elec & Hand
AR114	4 or 6	Hand	Hand & Self
AR121	2,4,6 or 8	Hand*	Self
AR124	4,or 6	Hand*	Hand & Self
AR131	2,4,or 6	Self	Self
AR133	2,4,6 or 8	Self	Elec & Hand
AR136	2,4 or 6	Self	Elec
AR141	2,4,or 6	Self*	Self

** Indicates a reverse acting flag indicating on de-energisation.*

Technical Data

Inputs and Outputs

Rated Voltage (Vn)	
A.C.	63.5, 110, 220, 240V
D.C.	12, 24, 30, 50, 125, 240V

Operating Range	
A.C.	80% to 110% of rated voltage
D.C.	70% to 115% of rated voltage

Burden	
3 to 5W/VA depending upon rating	Dependent on rating. Rectified a.c. relays nominal power factor = 0.96

Output Contacts

Make and carry continuously	1250VAa.c. or 1250Wd.c. within the limits of 660V and 5A
Make and carry for 3 seconds	7500VAa.c. or 7500Wd.c. within the limits of 660Vand 30A
Breaking Capacity (≤ 5 A and ≤ 250 V): AC Resistive DC Resistive DC Inductive	 1250 VA 100 W 50 W L/R = 40ms
Minimum number of	1000 at maximum load

operations	
Minimum recommended load	0.5 Watt limits 10mA or 5V

Electrical Tests

Insulation IEC 60255-5 RMS levels for 1 minute

Between contacts to earth and to the coil	2.0 kV
Between any case terminal and earth	2.0 kV
Between case terminals of independent circuits	2.0 kV
Across normally open contacts	1.0 kV

Transient Overvoltage IEC 60255-5

Between all terminals and earth or between any two independent circuits without damage or flashover	5 kV 1.2/50 μs 0.5 J

Mechanical

Vibration (Sinusoidal)

IEC 255-21-1	The relays meet the requirements of Class 1 for vibration response and endurance
BS142 section 2.1 category S2	relays will withstand a 20G shock or impact on the panel without operating

Shock Bump

IEC 255-21-2	Class 1 severity
BS142, sub-section 1.5.2. (1989)	Class 1 severity

Mechanical Life

Durability	in excess of 10,000 operations with the contact rating at a rate of 600 operations per hour

Environmental

Temperature IEC 68-2-1/2

Operating	**-10 °C to +55 °C**
Storage	-25 °C to +70 °C

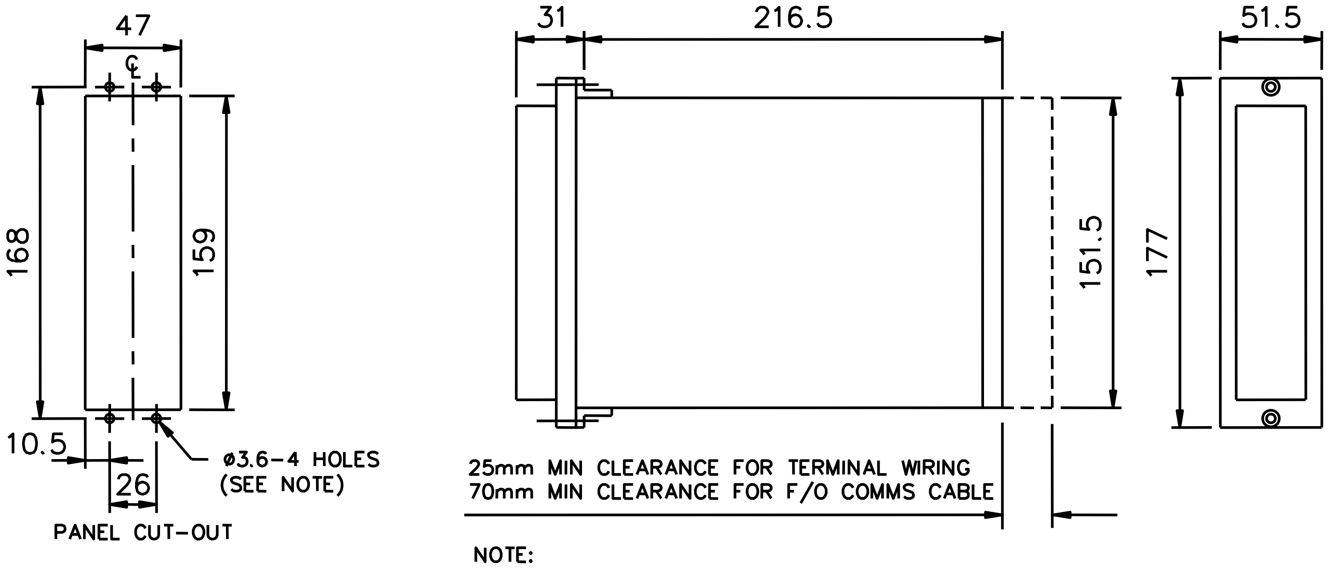
Humidity IEC 68-2-3

Operational test	56 days at 40 °C and 95% RH

Performance

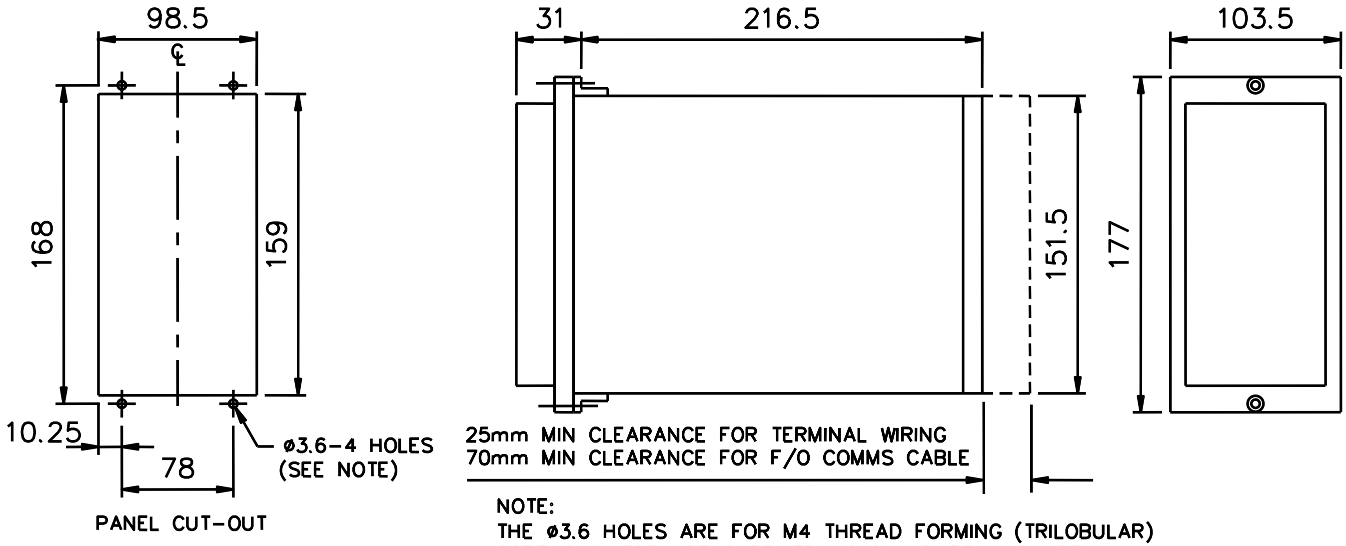
Instantaneous Operating time	
Typically	25ms
Range	10ms to 50ms

Case Dimensions



NOTE:
THE ø3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY ø4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig1. E2 Case Dimensions

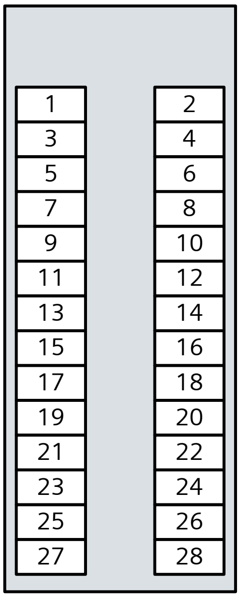


NOTE:
THE ø3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY ø4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig2. E4 Case Dimensions

Connection Diagram 7PG11 AR

Terminal Numbering (E2 Case)
Viewed from Rear



Terminal Numbering (E4 Case)
Viewed from Rear

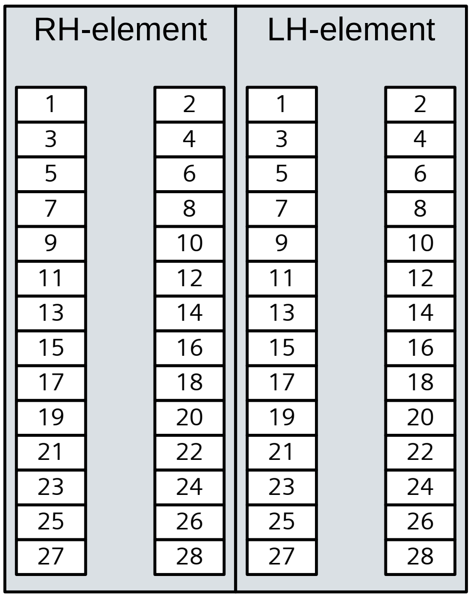


Fig3. Connection Diagrams

Ordering Information – 7PG111 AR

Product description	Variants	Order No.
Auxiliary relay (AR101, AR103)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
A.C. or D.C. voltage operated relay.		
	Number of elements	
	Single element	**1**
	Type of flag	
	No flag	**0**
	Contact operation	
	Self reset contacts	**1**
	Hand and electrical reset contacts	**3**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts [1])	
	Two	**0**
	Four	**1**
	Six	**3**
	Eight	**5**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR101, AR103)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
(continued from previous page)		
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

---

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR901)		**7 P G 1 1 1 0 - 7 A E 1 0 - 0 A ☐ 0**
D.C. voltage operated relay.		
	Number of elements	
	Single element	**1**
	Type of flag	
	No flag	**0**
	Contact operation	
	CT shorting contacts	**7**
	Contact arrangement – NO	
	0 NO	**A**
	Contact arrangement NC	
	4 NC	**E**
	Number of contacts	
	Four	**1**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	30V DC	**C**
	50V DC	**D**
	125V DC	**F**
	240V DC	**H**
	Back emf suppression diode	
	Not Fitted	**0**

Product description	Variants	Order No.
Auxiliary relay (AR106)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated relay.		
	Number of elements	
	Single element	**1**
	Type of flag	
	No flag	**0**
	Contact operation	
	Electrical reset contacts	**6**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	Number of contacts [1])	
	Two	**0**
	Four	**1**
	Six	**3**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR106)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
(continued from previous page)	Back emf suppression diode	↑
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR201)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated relay.		
	<u>Number of elements</u>	
	Two element	**2**
	<u>Type of flag</u>	
	No flag	**0**
	<u>Contact operation</u>	
	Self reset contacts	**1**
	<u>Contact arrangement – NO</u>	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	<u>Contact arrangement NC</u>	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	<u>Number of contacts/element</u> [1])	
	Two	**0** **A**
	Four	**1** **C**
	Six	**3** **C**
	<u>Contact type</u>	
	NO (Standard) / NC (Standard)	**0**
	<u>Time delay</u>	
	No additional time delay	**0**
	<u>Housing size</u>	
	Case size E2 (4U high)	**A**
	Case size E4 (4U high)	**C**
	<u>Voltage rating</u>	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR201)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
(continued from previous page)	Back emf suppression diode	▲
	Not Fitted	**0**
	Fitted	**1**

---

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR111, AR112)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Single element	**1**
	Type of flag	
	Hand reset flag	**1**
	Contact operation	
	Self reset contacts	**1**
	Hand reset contacts	**2**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts 1)	
	Two	**0**
	Four	**1**
	Six	**3**
	Eight	**5**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR111, AR112)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
(continued from previous page)		
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR112SB)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
D.C. voltage operated relay with series break contact to reduce relay burden to zero after operation.		
	Number of elements	
	Single element	**1**
	Type of flag	
	Hand reset flag	**1**
	Contact operation	
	Hand reset contacts	**2**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts 2)	
	Two	**0**
	Four	**1**
	Six	**3**
	Eight	**5**
	Contact type 1)	
	NO (Standard) / NC (Standard / 1 SB)	**4**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR112SB)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
(continued from previous page)		
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

[1]) One NO contact allocated for series break

[2]) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR113)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Single element	**1**
	Type of flag	
	Hand reset flag	**1**
	Contact operation	
	Hand and electrical reset contacts	**3**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts [1])	
	Four	**1**
	Six	**3**
	Eight	**5**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR113)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
(continued from previous page)		
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR114)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Single element	**1**
	Type of flag	
	Hand reset flag	**1**
	Contact operation	
	Hand and self reset contacts	**4**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	Number of contacts ²)	
	Four	**1**
	Six	**3**
	Contact type ¹)	
	NO (Self Reset) / NC (Self Reset / 2 Hand Reset)	**1**
	NO (Self Reset / 2 Hand Reset) / NC (Self Reset)	**2**
	NO (Self Reset / 1 Hand Reset) / NC (Self Reset / 1 Hand Reset)	**3**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR114)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
(continued from previous page)	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

1) Hand reset contacts are fitted as 2NO, 2NC or 1NO/1NC, remaining contacts are self reset in any combination

2) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR211, AR212)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Two element	2
	Type of flag	
	Hand reset flag	1
	Contact operation	
	Self reset contacts	1
	Hand reset contacts	2 C
	Contact arrangement – NO	
	0 NO	A
	1 NO	B
	2 NO	C
	3 NO	D
	4 NO	E
	5 NO	F
	6 NO	G
	Contact arrangement NC	
	0 NC	A
	1 NC	B
	2 NC	C
	3 NC	D
	4 NC	E
	5 NC	F
	6 NC	G
	Number of contacts/element ¹)	
	Two	0 A
	Four	1 C
	Six	3 C
	Contact type	
	NO (Standard) / NC (Standard)	0
	Time delay	
	No additional time delay	0
	Housing size	
	Case size E2 (4U high)	A
	Case size E4 (4U high)	C
	Voltage rating	
	12V DC	A
	24V DC	B
	30V DC	C
	50V DC	D
	60V DC	E
	125V DC	F
	220V DC	G
	240V DC	H
	63.5V AC	J 0
	110V AC	K 0
	220V AC	L 0
	240V AC	M 0

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR211, AR212)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
(continued from previous page)	<u>Back emf suppression diode</u>	↑
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR212SB)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
D.C. voltage operated relay with series break contact to reduce relay burden to zero after. operation	Number of elements	
	Two element	**2**
	Type of flag	
	Hand reset flag	**1**
	Contact operation	
	Hand reset contacts	**2**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	Number of contacts/element ²)	
	Two	**0**
	Four	**1**
	Six	**3**
	Contact type ¹)	
	NO (Standard) / NC (Standard / 1 SB)	**4**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E4 (4U high)	**C**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

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¹) One NO contact allocated for series break

²) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR121)		**7 P G 1 1 ☐☐ - ☐☐☐☐☐ - ☐☐☐☐**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Single element	**1**
	Type of flag	
	Hand reset reverse acting flag	**2**
	Contact operation	
	Self reset contacts	**1**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts [1])	
	Two	**0**
	Four	**1**
	Six	**3**
	Eight	**5**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR121)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
(continued from previous page)		
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR124)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Single element	**1**
	Type of flag	
	Hand reset reverse acting flag	**2**
	Contact operation	
	Hand and self reset contacts	**4**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	Number of contacts [1]	
	Four	**1**
	Six	**3**
	Contact type	
	NO (Self Reset) / NC (Self Reset / 2 Hand Reset)	**1**
	NO (Self Reset / 2 Hand Reset) / NC (Self Reset)	**2**
	NO (Self Reset / 1 Hand Reset) / NC (Self Reset / 1 Hand Reset)	**3**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**

(Continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR124)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
(continued from previous page)	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR221)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Two element	2
	Type of flag	
	Hand reset reverse acting flag	2
	Contact operation	
	Self reset contacts	1
	Contact arrangement – NO	
	0 NO	A
	1 NO	B
	2 NO	C
	3 NO	D
	4 NO	E
	5 NO	F
	6 NO	G
	Contact arrangement NC	
	0 NC	A
	1 NC	B
	2 NC	C
	3 NC	D
	4 NC	E
	5 NC	F
	6 NC	G
	Number of contacts/element [1]	
	Two	0 A
	Four	1 C
	Six	3 C
	Contact type	
	NO (Standard) / NC (Standard)	0
	Time delay	
	No additional time delay	0
	Housing size	
	Case size E2 (4U high)	A
	Case size E4 (4U high)	C
	Voltage rating	
	12V DC	A
	24V DC	B
	30V DC	C
	50V DC	D
	60V DC	E
	125V DC	F
	220V DC	G
	240V DC	H
	63.5V AC	J 0
	110V AC	K 0
	220V AC	L 0
	240V AC	M 0
	Back emf suppression diode	
	Not Fitted	0
	Fitted	1

[1] Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR131, AR136)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated relay.		
	Number of elements	
	Single element	**1**
	Type of flag	
	Self reset flag	**3**
	Contact operation	
	Self reset contacts	**1**
	Electrical reset contacts	**6**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	Number of contacts 1)	
	Two	**0**
	Four	**1**
	Six	**3**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**

(Continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR131, AR136)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
(continued from previous page)	Back emf suppression diode	↑
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR133)		**7 P G 1 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Single element	**1**
	Type of flag	
	Self reset flag	**3**
	Contact operation	
	Hand and electrical reset contacts	**3**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts [1]	
	Two	**0**
	Four	**1**
	Six	**3**
	Eight	**5**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**

(continued on following page)

Product description	Variants	Order No.
Auxiliary relay (AR133)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
(continued from previous page)		
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

1) Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR231)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated. relay		
	Number of elements	
	Two element	**2**
	Type of flag	
	Self reset flag	**3**
	Contact operation	
	Self reset contacts	**1**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	Number of contacts/element [1]	
	Two	**0** **A**
	Four	**1** **C**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Case size E4 (4U high)	**C**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

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[1] Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR141)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated relay		
	Number of elements	
	Single element	**1**
	Type of flag	
	Self reset reverse acting flag	**4**
	Contact operation	
	Self reset contacts	**1**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	Number of contacts [1]	
	Two	**0**
	Four	**1**
	Six	**3**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

[1] Number of contacts must match selected contact arrangement

Product description	Variants	Order No.
Auxiliary relay (AR241)		**7 P G 1 1 □ □ - □ □ □ □ □ - □ □ □ □**
A.C. or D.C. voltage operated relay.		
	Number of elements	
	Two element	**2**
	Type of flag	
	Self reset reverse acting flag	**4**
	Contact operation	
	Self reset contacts	**1**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	Number of contacts/element [1]	
	Two	**0 A**
	Four	**1 C**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Time delay	
	No additional time delay	**0**
	Housing size	
	Case size E2 (4U high)	**A**
	Case size E4 (4U high)	**C**
	Voltage rating	
	12V DC	**A**
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	60V DC	**E**
	125V DC	**F**
	220V DC	**G**
	240V DC	**H**
	63.5V AC	**J 0**
	110V AC	**K 0**
	220V AC	**L 0**
	240V AC	**M 0**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

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[1] Number of contacts must match selected contact arrangement

1.2.2 7PG15 Tripping Relay

Description

Type TR relays are a range of multi-contact attracted armature relays designed to both IEC 255-5 and to BS142. A wide range of models is available to meet the requirements of the electric supply industry.

High speed, positive action
Can be supplied in modular and drawout type case
Robust design for a long, reliable service life

TR1	Low burden to ESI 48-4 EB1 & NGTS 3.6.15, ESI 1.
TR2	High burden to ESI 48-4 EB2 & NGTS 3.6.15, ESI 2
TR312	NGC (CEGB) P15. (low burden trip relay)
TR431	NGC (CEGB) TDM 5/11. (switching relay)

Low burden, TR1 series

Type TR1 relays are suitable for application for tripping and auxiliary duties where immunity to capacitance discharge is not required. These relays are not intended for use with current operated series follower relays.

High burden, TR2 series

High burden relays with immunity to capacitance discharge currents. They are also suitable for certain applications where they are remote from the initiation signal.

A high burden also permits reliable operation of current operated series repeat relays. TR relays can be provided with an instantaneous or time-delayed cut-off.

Low burden relay, TR312

Designed to meet the requirements of NGC specification P15, this is an electrically reset relay (no flag indicator) with additional terminals in the economy circuit to enable a direct connection to the dc supply.

This arrangement allows a reduction in the break duty of the initiating contact.

Switching Relay, TR431

Designed to meet the requirements of NGC TDM 5/11, this is an electrically reset relay with a flag indicator which follows the contact operation. These relays are intended to switch protection and auto reclose equipment in and out of service when controlled over pilot wires from a remote point. They are intended to operate from a remote 50V d.c. battery with a pilot loop resistance of up to 200 ohms.

Special purpose relays, TR9 series

This designation identifies TR relays designed to meet a special purpose e.g. TR901 is a high burden repeat relay, a type TR231 with a 2 position flag indicator used as a plant follower relay for circuit breakers and disconnectors.

Relay Type	Number of Contacts	Contact Reset Arrangement	Operating Coil Cut-off	Specification	Burden Level	Modular Case Size
TR112	7 or 11	Self	Economy	EB1	low	E4
TR121	7 or 11	Hand	Instantaneous	EB1	Low	E2
TR131	6 or 10	Electrical	Instantaneous	EB1	Low	E2
TR141	6 or 10	Hand & electrical	Instantaneous	EB1	Low	E2
TR212	6 or 10	Self	Economy	EB2	High	E2 or E4
TR214	5 or 10	Self	Economy 2s delayed reset	EB2	High	E4
TR221	7 or 11	Hand	Instantaneous	EB2	High	E2
TR223	7 or 11	Hand	40/60ms delay	EB2	High	E4
TR231	6 or 10	Electrical	Instantaneous	EB2	High	E2
TR233	6 or 10	Electrical	40/60ms delay	EB2	High	E4
TR241	6 or 10	Hand & electrical	Instantaneous	EB2	High	E2
TR243	6 or 10	Hand & electrical	40/60ms delay	EB2	High	E4
TR312	5	Self	Economy	NGC P15	Low	E4
TR431	7	Electrical	Instantaneous	NGC TDM.5/11	Low	E4
TR901	10	electrical	Instantaneous	EB2	High	E2

Technical Information

TR1 and TR2 relays

Operating time 10ms at rated voltage
Rated voltage Vn 24V, 30V, 48V, 125V, 240V d.c.
Note: 24V and 240V ratings are not part of ESI 48-4

Operating range 50% to 120% of rated voltage
Operating coils of self-reset and economy cut-off relays are rated at 120% of rated voltage. All other operate and reset coils are short time rated well in excess of the operating time of their cut-off contacts. Self-reset relays will reset at not less than 5% rated voltage.

Nominal burdens

	BURDEN (W)	
Rated voltage V d.c.	TR1--	TR2--
30	43	43
48	46	52
125	47	127
Reset coil	50	50

Relays with economy circuits reduce to approximately 7W after operation.

Contacts

Ratings
Make and carry continuously:
1250VAa.c. or 1250Wd.c. within limits of 660V and 5A

Make and carry for 3 seconds:
7500VAa.c. or 7500Wd.c. within limits of 660V and 30A

Break:
1250VAa.c. or 100W (resistive) d.c. or 50W (inductive) d.c. within limits of 250V and 5A

Indication:
TR1 and TR2 relays have a hand reset mechanical flag indicator, TR4 and TR9 relays have a self reset flag indicator.

Environmental

Temperature
IEC68-2-1/2 and BS2011 (1977)
Operating -10°C to +55°C
Storage -25°C to +70°C
Humidity IEC 68-2-3
56 days at 95% RH and 40°C
Vibration IEC 255-21-1 Class l.

Shock and bump
IEC 255-21-2 and BS142, 1.5.2 (1989)

Relays meet the requirements with respect to shock and bump testing for Class 1 severity.

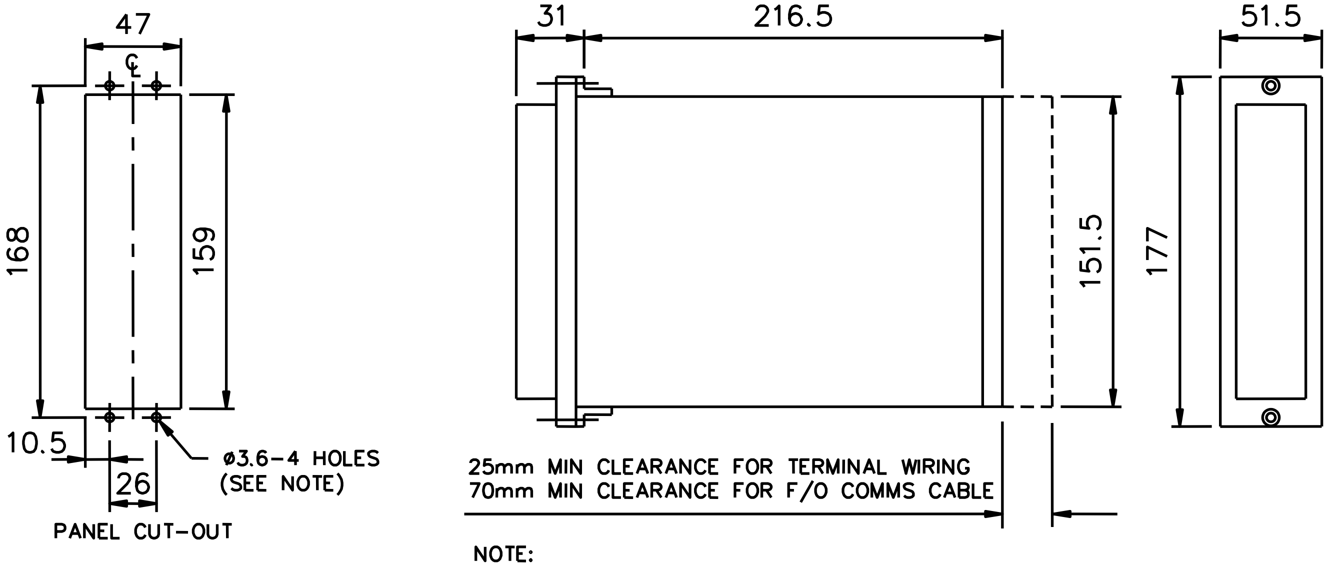
Operational/Mechanical life

Relays will withstand in excess of 10,000 operations, within the maximum contact loading specified.

Insulation

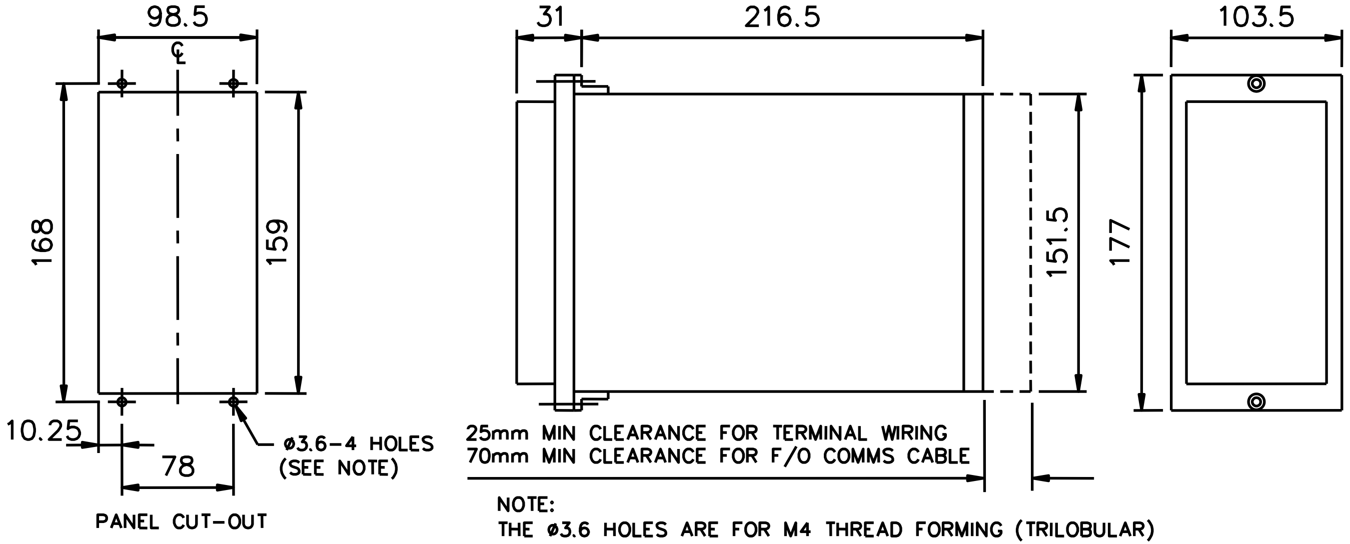
Relays will withstand:
- 5kV 1.2/50μs waveform as IEC 255-4
- 2kV rms 50Hz for 1minute (2.5kV for 1s) between all terminals and earth
- 1kV rms 50Hz for 1 minute across normally open contacts to IEC 255-5 and BS142

Case Dimensions



NOTE:
THE ø3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY ø4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig1. E2 Case Dimensions



NOTE:
THE ø3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY ø4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig2. E4 Case Dimensions

Ordering Information – 7PG15TR

Product description	Variants	Order No.
Tripping relay (TR112)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Self reset low burden tripping Relay.		
	TR - tripping	
	TR1-- : low burden, EB1	**1**
	Contact operation	
	Self reset contacts	**1**
	Operating coil cut-off	
	Economy	**2**
	Contact arrangement – NO	
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	11 NO	**M**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	9 NC	**K**
	Number of contacts 1)	
	Seven	**4**
	Eleven	**7**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Hand reset flag	**1**
	Housing size	
	Case size E4 (4U high)	**C**

(Continued on following page)

Product description	Variants	Order No.
Tripping relay (TR112)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
		▲
	Voltage rating	
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	125V DC	**F**
	240V DC	**H**

1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR121)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Hand reset low burden tripping relay.		
	TR – tripping	
	TR1-- : low burden, EB1	**1**
	Contact operation	
	Hand reset contacts	**2**
	Operating coil cut-off	
	Instantaneous	**1**
	Contact arrangement – NO	
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	11 NO	**M**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	9 NC	**K**
	Number of contacts [1])	
	Seven	**4**
	Eleven	**7**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Hand reset flag	**1**
	Housing size	
	Case size E2 (4U high)	**A**

(Continued on following page)

Product description	Variants	Order No.
Tripping relay (TR121)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
	Voltage rating	
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	125V DC	**F**
	240V DC	**H**

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[1] Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR131)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Electrical reset low burden tripping relay.		
	TR - tripping	
	TR1-- : low burden, EB1	**1**
	Contact operation	
	Electrical reset contacts	**3**
	Operating coil cut-off	
	Instantaneous	**1**
	Contact arrangement – NO	
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts [1])	
	Six	**3**
	Ten	**6**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Hand reset flag	**1**

(Continued on following page)

Product description	Variants	Order No.
Tripping relay (TR131)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	125V DC	**F**
	240V DC	**H**

1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR141)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Hand and electrical reset low burden tripping relay.		
	TR - tripping	
	TR1-- : low burden, EB1	**1**
	Contact operation	
	Hand and electrical reset contacts	**4**
	Operating coil cut-off	
	Instantaneous	**1**
	Contact arrangement – NO	
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts 1)	
	Six	**3**
	Ten	**6**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Hand reset flag	**1**
	Housing size	
	Case size E2 (4U high)	**A**

(Continued on following page)

Product description	Variants	Order No.
Tripping relay (TR141)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
	Voltage rating	
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	125V DC	**F**
	240V DC	**H**

---

[1] Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR212, TR214)		**7 P G 1 5 □ □ - □ □ □ □ □ - □ □ □ 0**
Self reset high burden tripping relay.		
	<u>TR - tripping</u>	
	TR2-- : high burden, EB2	**2**
	<u>Contact operation</u>	
	Self reset contacts	**1**
	<u>Operating coil cut-off</u>	
	Economy	**2**
	Economy and 2 second delay on reset	**4** **C**
	<u>Contact arrangement – NO</u>	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	<u>Contact arrangement NC</u>	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	<u>Number of contacts</u> 1)	
	Six	**3**
	Ten	**6**
	<u>Contact type</u>	
	NO (Standard) / NC (Standard)	0

Product description	Variants	Order No.
Tripping relay (TR212, TR214)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
	Type of flag	
	Hand reset flag	1
	Housing size	
	Case size E2 (4U high)	A
	Case size E4 (4U high)	C
	Voltage rating	
	24V DC	B
	30V DC	C
	50V DC	D
	125V DC	F
	240V DC	H
	Contact type	
	NO (Standard) / NC (Standard)	

1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product Description	Variants	Order No.
Tripping relay (TR221)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Hand reset high burden tripping relay.		
	<u>TR - tripping</u>	
	TR2-- : high burden, EB2	**2**
	<u>Contact operation</u>	
	Hand reset contacts	**2**
	<u>Operating coil cut-off</u>	
	Instantaneous	**1**
	<u>Contact arrangement – NO</u>	
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	11 NO	**M**
	<u>Contact arrangement NC</u>	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	<u>Number of contacts</u> [1])	
	Seven	**4** **A**
	Eleven	**7** **A**
	<u>Contact type</u>	
	NO (Standard) / NC (Standard)	**0**
	<u>Type of flag</u>	
	Hand reset flag	1

(Continued on following page)

Product description	Variants	Order No.
Tripping relay (TR221)		**7 P G 1 5 □ □ - □ □ □ □ □ - □ □ □ 0**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating	
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	125V DC	**F**
	240V DC	**H**
	Contact type	
	NO (Standard) / NC (Standard)	

[1] Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR223)		**7 P G 1 5 □ □ - □ □ □ □ □ - □ □ □ 0**
Hand reset high burden tripping relay.		
	TR - tripping	
	TR2-- : high burden, EB2	**2**
	Contact operation	
	Hand reset contacts	**2**
	Operating coil cut-off	
	40/60ms delay	**3**
	Contact arrangement – NO	
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	11 NO	**M**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts 1)	
	Seven	**4**
	Eleven	**7**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Hand reset flag	**1**

(Continued on following page)

Product description	Variants	Order No.
Tripping relay (TR223)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
	<u>Housing size</u> Case size E4 (4U high)	**C**
	<u>Voltage rating</u> 125V DC	**F**

1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR231)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Electrical reset high burden tripping relay.		
	TR - tripping	
	TR2-- : high burden, EB2	**2**
	Contact operation	
	Electrical reset contacts	**3**
	Operating coil cut-off	
	Instantaneous	**1**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts [1]	
	Six	**3** **A**
	Ten	**6** **A**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Hand reset flag	**1**
	Housing size	
	Case size E2 (4U high)	**A**

(Continued on following page)

Product description	Variants	Order No.
Tripping relay (TR231)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
	Voltage rating	↑
	24V DC	**B**
	30V DC	**C**
	50V DC	**D**
	125V DC	**F**
	240V DC	**H**

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1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR233)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Electrical reset high burden tripping relay.		
	TR - tripping	
	TR2-- : high burden, EB2	**2**
	Contact operation	
	Electrical reset contacts	**3**
	Operating coil cut-off	
	40/60ms delay	**3**
	Contact arrangement – NO	
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts 1)	
	Six	**3**
	Ten	**6**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Hand reset flag	**1**
	Housing size	
	Case size E4 (4U high)	**C**
	Voltage rating	
	125V DC	**F**

---

1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR241)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Hand and electrical reset high burden tripping relay.		
	TR - tripping	
	TR2-- : high burden, EB2	**2**
	Contact operation	
	Hand and electrical reset contacts	**4**
	Operating coil cut-off	
	Instantaneous	**1**
	Contact arrangement – NO	
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts [1]	
	Six	**3** **A**
	Ten	**6** **A**
	Contact type	
	NO (Standard) / NC (Standard)	0
	Type of flag	
	Hand reset flag	1
	Housing size	
	Case size E2 (4U high)	A
	Voltage rating	
	24V DC	B
	30V DC	C
	50V DC	D
	125V DC	F
	240V DC	H

---

1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR243)		**7 P G 1 5 □ □ - □ □ □ □ □ - □ □ □ 0**
Hand and electrical reset high burden tripping relay.		
	<u>TR - tripping</u>	
	TR2-- : high burden, EB2	**2**
	<u>Contact operation</u>	
	Hand and electrical reset contacts	**4**
	<u>Operating coil cut-off</u>	
	40/60ms delay	**3**
	<u>Contact arrangement – NO</u>	
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	9 NO	**K**
	10 NO	**L**
	<u>Contact arrangement NC</u>	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	<u>Number of contacts</u> 1)	
	Six	**3**
	Ten	**6**
	<u>Contact type</u>	
	NO (Standard) / NC (Standard)	**0**
	<u>Type of flag</u>	
	Hand reset flag	**1**
	<u>Housing size</u>	
	Case size E4 (4U high)	**C**
	<u>Voltage rating</u>	
	125V DC	**F**

---

1) Number of contacts must match selected contact arrangement

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR312)		**7 P G 1 5 □ □ - □ □ □ □ □ - □ □ □ 0**
Self reset low burden tripping relay.		
	TR - tripping	
	TR3-- : low burden, CEGB spec. P15	**3**
	Contact operation	
	Self reset contacts	**1**
	Operating coil cut-off	
	Economy	**2**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	Number of contacts	
	Five	**2**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	No flag	**0**
	Hand reset flag	**1**
	Housing size	
	Case size E4 (4U high)	**C**
	Voltage rating	
	125V DC	**F**

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
Tripping relay (TR431)		**7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
Electrical reset low burden tripping relay.		
	TR - tripping	
	TR4-- : low burden, CEGB spec. TDM 5/11	**4**
	Contact operation	
	Electrical reset contacts	**3**
	Operating coil cut-off	
	Instantaneous	**1**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	5 NO	**F**
	6 NO	**G**
	7 NO	**H**
	8 NO	**J**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	**J**
	Number of contacts 1)	
	Seven	**4**
	Eight	**5**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Type of flag	
	Self reset flag 2)	**3**
	Housing size	
	Case size E4 (4U high)	**C**
	Voltage rating	
	50 / 125V DC	**N**

---

1) Number of contacts must match selected contact arrangement

2) Flag indication "IN" and "OUT"

Ordering Information - 7PG15 TR

Product description	Variants	Order No.
		1 2 3 4 5 6 7 - 8 9 10 11 12 - 13 14 15 16
Tripping relay (TR901)		7 P G 1 5 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0
Electrical reset high burden repeat relay.		
	TR - tripping	
	TR9-- : high burden, EB2	6
	Contact operation	
	Electrical reset contacts	3
	Operating coil cut-off	
	Instantaneous	1
	Contact arrangement – NO	
	2 NO	C
	3 NO	D
	4 NO	E
	5 NO	F
	6 NO	G
	7 NO	H
	8 NO	J
	9 NO	K
	10 NO	L
	Contact arrangement NC	
	0 NC	A
	1 NC	B
	2 NC	C
	3 NC	D
	4 NC	E
	5 NC	F
	6 NC	G
	7 NC	H
	8 NC	J
	Number of contacts	
	Ten	6
	Contact type	
	NO (Standard) / NC (Standard)	0
	Type of flag	
	Self reset flag [1]	3
	Housing size	
	Housing size E2 (4U high)	A
	Voltage rating	
	DC 30 V	C
	DC 50 V	D
	DC 125 V	F
	DC 240 V	H

---

1) Flag indication "OPEN" and "CLOSED"

1.2.3 7PG18 Tripping Relay-A

Features

High speed, positive action
Can be supplied in modular and drawout type case
Robust design for a long, reliable, service life

Description

Type TR-A relays are a range of volt age operated multi-contact attracted armature relays designed to both IEC 255-5 and to BS142. A wide range of models is available to meet the requirements of the electric supply industry.

> TR-A2 – High burden to ESI 48-4 EB2 & NGTS 3.6.15, ESI 2.

Table 1 shows the standard relays available.

High burden, TR-A2 series

High burden relays with immunity to capacitance discharge currents. They are also suitable for certain applications where they are remote from the initiation signal.
A high burden also permits reliable operation of current operated series repeat relays. TR relays can be provided with a time delayed economy feature, either instantaneous or time delayed, see Table1.

Technical Information

TR-A2 series relays

Operating time	10ms at rated voltage
Rated voltage Vn	24V, 30V, 48V, 125V, 240Vd.c Note. 24V and 240V ratings are not part of ESI 48-4
Operating range	50% to 120% of rated voltage

Operating coils of self-reset and economy cut-off relays are rated at 120% of rated voltage. All other operate and reset coils are short time rated well in excess of the operating time of their cut-off contacts. Self-reset relays will reset at not less than 5% rated voltage.

Nominal burdens

Rated Voltage V.d.c	TR2 -
30	43
48	52
125	<150

Reset coil	50

Relays with economy circuits reduce to approximately 14W

Type	No. of contacts	Contact Reset	Operating coil cut-off	Spec	Burden	Case size
TR-A212	20	Self	Economy	EB2	High	4
TR-A214	20	Self	Economy 2s delay	EB2	High	4
TR-A221	20	Hand	Instantaneous	EB2	High	4
TR-A223	20	Hand	40/60ms delay	EB2	High	4
TR-A231	20	Electrical	Instantaneous	EB2	High	4
TR-A233	20	Electrical	40/60ms delay	EB2	High	4
TR-A241	20	Hand and Electrical	Instantaneous	EB2	High	4
TR-A243	20	Hand and Electrical	40/60ms delay	EB2	High	4

Ratings

Make and carry continuously:
1250VAa.c. or 1250Wd.c. within limits of 660V and 5A
Make and carry for 3 seconds:
7500VAa.c. or 7500Wd.c. within limits of 660V and 30A

Break;

1250VAa.c. or 100W (resistive) d.c. or 50W (inductive) d.c. within
limits of 250V and 5A
Maximum rate of operation, 600 per hour
Indication
TR-A2 relays have a hand reset mechanical flag indicator

Environmental

Temperature

IEC68-2-1/2 and BS2011 (1977)

Operating	-10°C to +55°C
Storage	-25°C to +70°C
Humidity	IEC 68-2-3

56 days at 95% RH and 40°C

Vibration	IEC 255-21-1 Class l.

Shock and bump

IEC 255-21-2 and BS142, 1.5.2 (1989). Relays meet the requirements with respect to shock and bump testing for Class 1 severity.

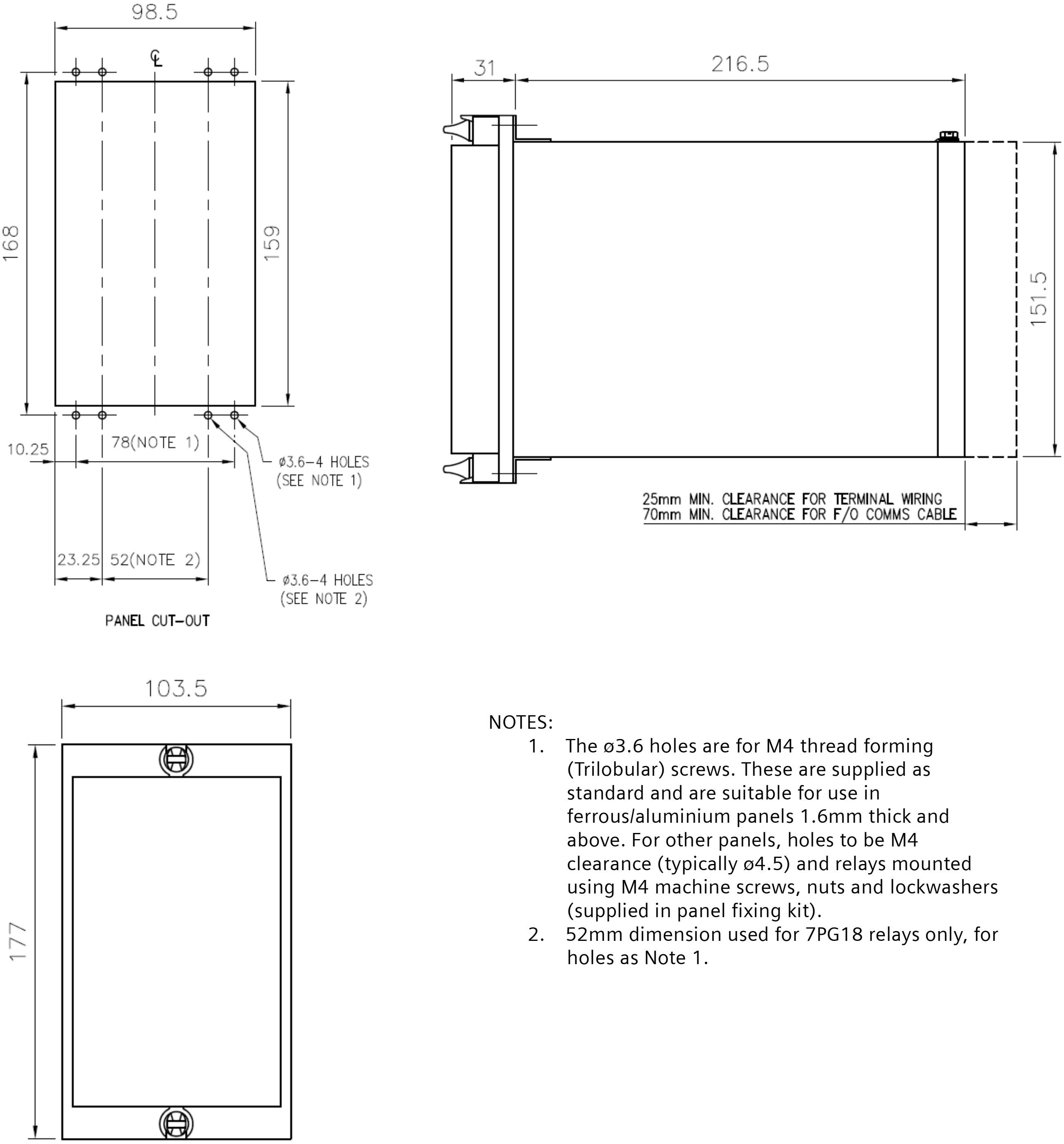
Operational/mechanical life

Relays will withstand in excess of 10,000 operations, within the maximum contact loading specified, at a rate of 600 operations per hour.

Insulation

Relays will withstand:
5kV 1.2/50µs waveform as IEC 255-4
2kV rms 50Hz for 1minute (2.5kV for 1s) between all terminals and earth
1kV rms 50Hz for 1 minute across normally open contacts to IEC 255-5 and BS142

Case Dimensions



NOTES:

1. The ø3.6 holes are for M4 thread forming (Trilobular) screws. These are supplied as standard and are suitable for use in ferrous/aluminium panels 1.6mm thick and above. For other panels, holes to be M4 clearance (typically ø4.5) and relays mounted using M4 machine screws, nuts and lockwashers (supplied in panel fixing kit).
2. 52mm dimension used for 7PG18 relays only, for holes as Note 1.

Fig2. E4 Case Dimensions

Ordering Information – 7PG18

Product description	Variants	Order No.
Tripping relay		**7 P G 1 8 2** 1 - 2 □ □ 8 0 - 1 C □ **0**
EPSILON TR-A212, TR-A214 (20 CONTACT)		
	Alpha range	5
	TR-A Tripping	8
	TR-A Tripping	6
	TR-A2-- : high burden, EB2	2
	Contact operation	7
	Self reset contacts	1
	Operating coil cut-off	8
	Economy	2
	Economy and 2 second delay on reset	4
	Contact arrangement - NO	**9**
	0 NO	**A** W
	1 NO	**B** V
	2 NO	**C** U
	3 NO	**D** T
	4 NO	**E** S
	5 NO	**F** R
	6 NO	**G** Q
	7 NO	**H** P
	8 NO	J N
	9 NO	K M
	10 NO	L **L**
	11 NO	M **K**
	12 NO	N **J**
	13 NO	P **H**
	14 NO	Q **G**
	15 NO	R **F**
	16 NO	S **E**
	17 NO	T **D**
	18 NO	U **C**
	19 NO	V **B**
	20 NO	W A
	Contact arrangement NC	10
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	J
	9 NC	K
	10 NC	L
	11 NC	M
	12 NC	N
	13 NC	P
	14 NC	Q
	15 NC	R

(Continued on following page)

Product description	Variants	Order No.
Tripping relay		☐ 8 0 - 1 C ☐ **0**
EPSILON	16 NC	S
TR-A212, TR-A214 (20 CONTACT)	17 NC	T
	18 NC	U
	19 NC	V
	20 NC	W
	Number of contacts	11
	Twenty	**8**
	Contact type	12
	NO (Standard) / NC (Standard)	**0**
	Type of flag	13
	Hand reset flag	**1**
	Housing size	14
	Case size E4 (4U high)	C
	Voltage Rating	15
	24V dc	B
	30V dc	C
	50V dc	D
	125V dc	F
	240V dc	H
	Back emf suppression diode	16
	Not Fitted	0

Ordering Information – 7PG18

Product description	Variants	Order No.	
Tripping relay		**7 P G 1 8 2** 2 - 1 ☐ ☐ 8 0 - 1 C ☐ **0**	
EPSILON TR-A221 (20 CONTACT)			
	Alpha range	5	
	TR-A Tripping	8	
	TR-A Tripping	6	
	TR-A2-- : high burden, EB2	2	
	Contact operation	7	
	Hand reset contacts	2	
	Operating coil cut-off	8	
	Instantaneous	1	
	Contact arrangement - NO	**9**	
	0 NO	**A**	W
	1 NO	**B**	V
	2 NO	**C**	U
	3 NO	**D**	T
	4 NO	**E**	S
	5 NO	**F**	R
	6 NO	**G**	Q
	7 NO	**H**	P
	8 NO	J	N
	9 NO	K	M
	10 NO	L	**L**
	11 NO	M	**K**
	12 NO	N	**J**
	13 NO	P	**H**
	14 NO	Q	**G**
	15 NO	R	**F**
	16 NO	S	**E**
	17 NO	T	**D**
	18 NO	U	**C**
	19 NO	V	**B**
	20 NO	W	A
	Contact arrangement NC		10
	0 NC		**A**
	1 NC		**B**
	2 NC		**C**
	3 NC		**D**
	4 NC		**E**
	5 NC		**F**
	6 NC		**G**
	7 NC		**H**
	8 NC		J
	9 NC		K
	10 NC		L
	11 NC		M
	12 NC		N
	13 NC		P
	14 NC		Q
	15 NC		R

(Continued on following page)

Product description	Variants	Order No.
Tripping relay		☐ 8 0 - 1 ☐ C **0**
EPSILON TR-A221 (20 CONTACT)	16 NC	S
	17 NC	T
	18 NC	U
	19 NC	V
	20 NC	W
	Number of contacts	11
	Twenty	**8**
	Contact type	12
	NO (Standard) / NC (Standard)	**0**
	Type of flag	13
	Hand reset flag	**1**
	Housing size	14
	Case size E4 (4U high)	C
	Voltage Rating	15
	24V dc	B
	30V dc	C
	50V dc	D
	125V dc	F
	240V dc	H
	Back emf suppression diode	16
	Not Fitted	0

Ordering Information – 7PG18

Product description	Variants	Order No.
Tripping relay		**7 P G 1 8 2** 3 - 1 □ □ 8 0 - 1 C □ **0**
EPSILON TR-A231 (20 CONTACT)		
	Alpha range	5
	TR-A Tripping	8
	TR-A Tripping	6
	TR-A2-- : high burden, EB2	2
	Contact operation	7
	Electrical reset contacts	3
	Operating coil cut-off	8
	Instantaneous	1
	Contact arrangement - NO	**9**
	0 NO	**A** W
	1 NO	**B** V
	2 NO	**C** U
	3 NO	**D** T
	4 NO	**E** S
	5 NO	**F** R
	6 NO	**G** Q
	7 NO	**H** P
	8 NO	J N
	9 NO	K M
	10 NO	L **L**
	11 NO	M **K**
	12 NO	N **J**
	13 NO	P **H**
	14 NO	Q **G**
	15 NO	R **F**
	16 NO	S **E**
	17 NO	T **D**
	18 NO	U **C**
	19 NO	V **B**
	20 NO	W A
	Contact arrangement NC	10
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	J
	9 NC	K
	10 NC	L
	11 NC	M
	12 NC	N
	13 NC	P
	14 NC	Q
	15 NC	R

(Continued on following page)

Product description	Variants	Order No.
Tripping relay		☐ 8 0 - 1 C ☐ **0**
EPSILON TR-A231 (20 CONTACT)	16 NC	S
	17 NC	T
	18 NC	U
	19 NC	V
	20 NC	W
	Number of contacts	11
	Twenty	**8**
	Contact type	12
	NO (Standard) / NC (Standard)	**0**
	Type of flag	13
	Hand reset flag	**1**
	Housing size	14
	Case size E4 (4U high)	C
	Voltage Rating	15
	24V dc	B
	30V dc	C
	50V dc	D
	125V dc	F
	240V dc	H
	Back emf suppression diode	16
	Not Fitted	0

Ordering Information – 7PG18

Product description	Variants	Order No.
Tripping relay		**7 P G 1 8 2** 4 - 1 □ □ 8 0 - 1 C □ **0**
EPSILON TR-A241 (20 CONTACT)		
	Alpha range	5
	TR-A Tripping	8
	TR-A Tripping	6
	TR-A2-- : high burden, EB2	2
	Contact operation	7
	Hand and electrical reset contacts	4
	Operating coil cut-off	8
	Instantaneous	1
	Contact arrangement - NO	**9**
	0 NO	**A** W
	1 NO	**B** V
	2 NO	**C** U
	3 NO	**D** T
	4 NO	**E** S
	5 NO	**F** R
	6 NO	**G** Q
	7 NO	**H** P
	8 NO	J N
	9 NO	K M
	10 NO	L **L**
	11 NO	M **K**
	12 NO	N **J**
	13 NO	P **H**
	14 NO	Q **G**
	15 NO	R **F**
	16 NO	S **E**
	17 NO	T **D**
	18 NO	U **C**
	19 NO	V **B**
	20 NO	W A
	Contact arrangement NC	10
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	5 NC	**F**
	6 NC	**G**
	7 NC	**H**
	8 NC	J
	9 NC	K
	10 NC	L
	11 NC	M
	12 NC	N
	13 NC	P
	14 NC	Q
	15 NC	R

(Continued on following page)

Product description	Variants	Order No.
Tripping relay		☐ 8 0 - 1 C ☐ **0**
EPSILON TR-A241 (20 CONTACT)	16 NC	S
	17 NC	T
	18 NC	U
	19 NC	V
	20 NC	W
	Number of contacts	11
	Twenty	**8**
	Contact type	12
	NO (Standard) / NC (Standard)	**0**
	Type of flag	13
	Hand reset flag	**1**
	Housing size	14
	Case size E4 (4U high)	C
	Voltage Rating	15
	24V dc	B
	30V dc	C
	50V dc	D
	125V dc	F
	240V dc	H
	Back emf suppression diode	16
	Not Fitted	0

1.2.4 XR 7PG17 Interposing and Supervision Relays

1.2.4.1 7PG17 XR105, XR106, XR107, XR205 and XR206 Interposing Relays

Description

Type XR205 and XR206 are two element versions of the XR105 and XR106 respectively with the same performance. Type XR relays are developments for specific applications from the type AR relay range. They are electro-mechanical relays with a consistent positive action, a long service life and complying with BS142. Type XR105 has no flag indicator, XR106 & XR107 have a hand reset flag. Both types are available with a suppression diode across the coil to reduce the effects of the back emf which occurs on switch-off.

Application

Types XR105/XR106/XR107 are intended for the remote control of switchgear and associated equipment over pilot wires with a maximum resistance of 200 ohms. These relays are designed so that they are not susceptible to certain a.c. voltage levels which may be induced onto the pilots wires.

Technical information

External resistor required for 125Vd.c. operation
Operating range. With zero pilot resistance
78 to 125% of nominal rated voltage

With a maximum pilot loop resistance of 200ohm 92 to 125% of nominal rated voltage.
Burden Typically 3.7W for a relay with 4 normally open contacts.

A.C. Rejection

For a 48Vd.c. rated relay, typically 110V 50Hz a.c.
Operating time
For a relay rated 48Vd.c. with 4 normally open contacts at rated voltage typically 30ms. With 200ohms pilot resistance less than 80ms. Reset time is less than 35ms

Contacts

2 normally open, 4 normally open or 2 normally open and 2 normally closed, self reset on XR105 & XR106.
Hand reset on XR107.

Normal duty, contact ratings
Make and carry continuously
1250VAa.c. or 1250Wd.c. within the limits of 660V and 5A

Make and carry for 3 seconds
7500VAa.c. or 7500Wd.c.
within the limits of 660V and 30A

Break:
1250VAa.c. or 100W (resistive) d.c. or 50W (inductive)
L/R = 0.04, d.c. within the limits of 250V and 5A

Temperature

In service: -10°C to 55 °C
Storage -25 °C to 70°C

Mechanical durability

Vibration, relays comply with BS142, Section 2.1 Category S2.

Shock, relays will withstand a 20G shock or impact on the panel without operating. Operational/mechanical life, relays will withstand in excess of 10,000 operations with the contact rating stated.

Normally closed contact location (Epsilon case terminal numbers)				
	1-3	**2-4**	**5-7**	**6-8**
1 NC		NC		
2 NC	NC	NC		
3 NC	NC	NC		NC
4 NC	NC	NC	NC	NC

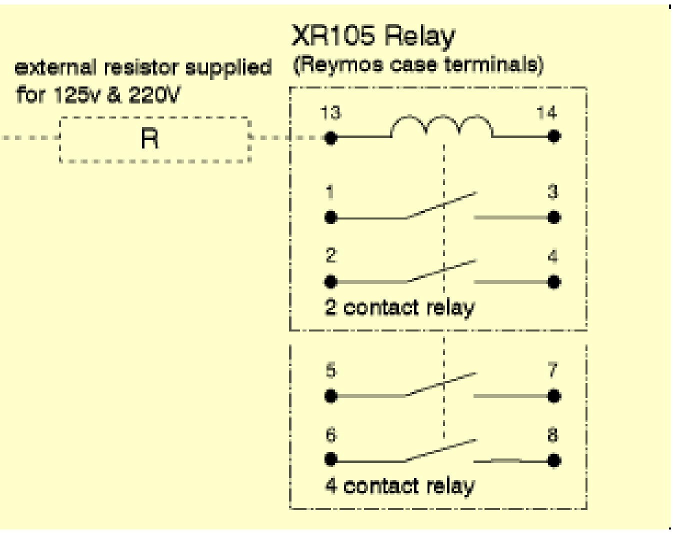
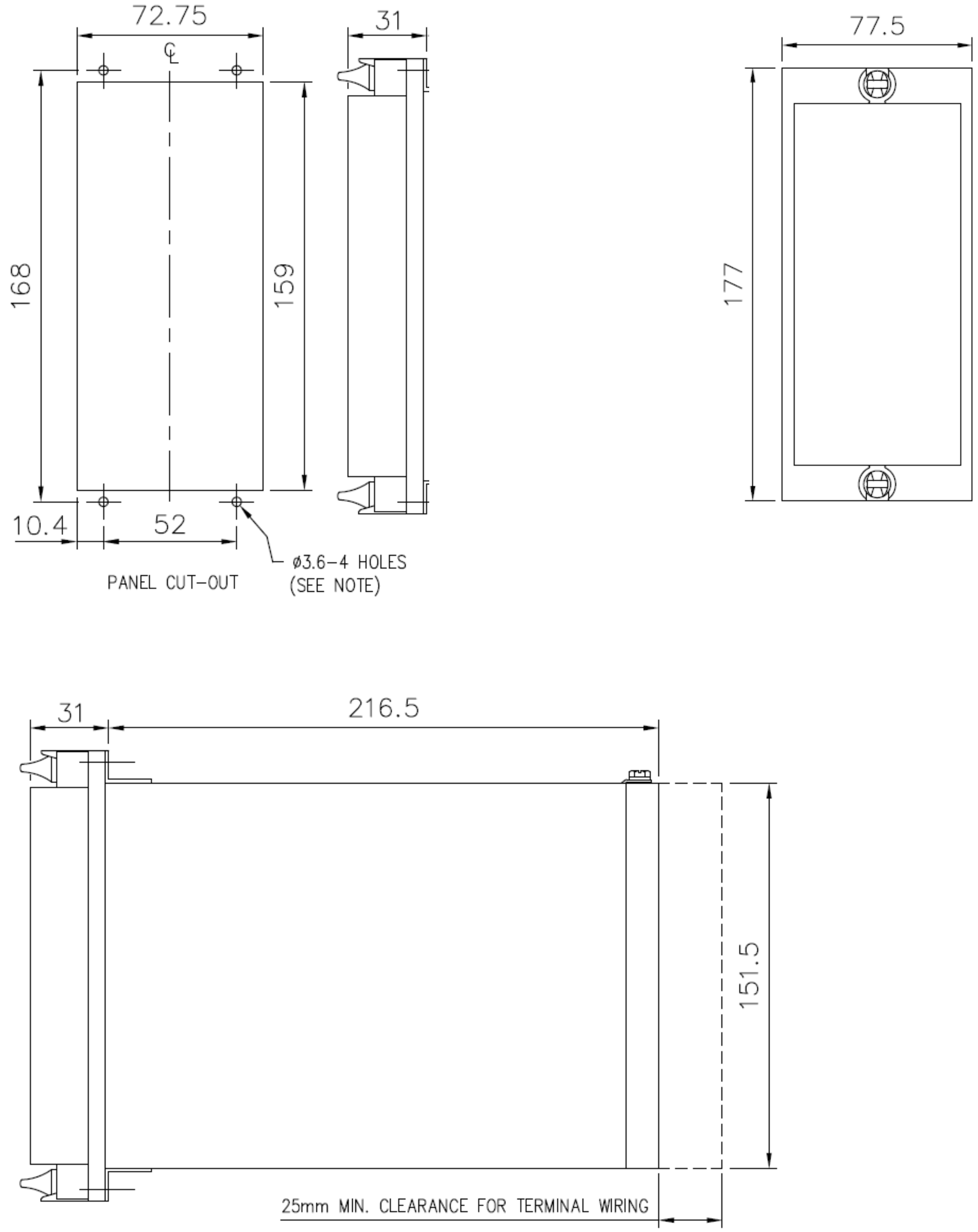


Fig1. connection details for Epsilon Case

Case Dimensions



Note: The ø3.6 holes are for M4 thread forming (trilobular) screws. These are supplied as standard and are suitable for use in ferrous/aluminum panels 1.6mm thick and above. For other panels, holes to be M4 clearance (typically ø4.5) and relays mounted using M4 machine screws, nuts and lockwashers (supplied in panel fixing kit).

Fig2. E3 Case Dimensions

Ordering Information – 7PG17 XR

Product description	Variants	Order No.
Interposing control relay (XR105, XR106, XR107)		**7 P G 1 7 □ □ - □ □ □ □ □ - □ □ □ 0**
	XR relay type	
	Interposing control	**3**
	Number of elements	
	Single element, self reset contacts	**1**
	Single element, hand reset contacts	**3**
	Type of flag	
	No flag	**0**
	Hand reset flag	**1**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	Number of contacts 2)	
	Two	**0**
	Four	**1**
	Contact type)	
	NO (Standard) / NC (Standard)	**0**
	Voltage rating	
	24V DC	**1**
	30V DC	**2**
	50V DC	**3**
	125V DC 1)	**4**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating (alarm)	
	Not Applicable	**A**
	Back emf suppression diode	
	Not Fitted	**0**
	Fitted	**1**

1) Supplied with resistor VCE:2101H10152 (1500 Ohm) for wiring in series with the coil.
2) Number of contacts must match selected contact arrangement

Ordering Information – 7PG17 XR

Product description	Variants	Order No.
Interposing control relay (XR205, XR206)		**7 P G 1 7** ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ ☐
	XR relay type	
	Interposing control	**3**
	Number of elements	
	Two element, self reset contacts	**2**
	Type of flag	
	No flag	0
	Hand reset flag	1
	Contact arrangement – NO	
	0 NO	A
	1 NO	B
	2 NO	C
	3 NO	D
	4 NO	E
	Contact arrangement NC	
	0 NC	A
	1 NC	B
	2 NC	C
	3 NC	D
	4 NC	E
	Number of contacts/element 2)	
	Two	0
	Four	1 C
	Contact type)	
	NO (Standard) / NC (Standard)	0
	Voltage rating	
	24V DC	1
	30V DC	2
	50V DC	3
	125V DC 1)	4
	Housing size	
	Case size E2 (4U high)	A
	Case size E4 (4U high)	C
	Voltage rating (alarm)	
	Not Applicable	A
	Back emf suppression diode	
	Not Fitted	0
	Fitted	1

---

1) Supplied with resistor VCE:2101H10152 (1500 Ohm) for wiring in series with the coil.
2) Number of contacts must match selected contact arrangement

1.2.4.2 7PG17 XR151 Trip Relay Supervision Relay

Description

Type XR relays are developments for specific applications of the type AR relay range. They are electro-mechanical relays with long service life and complying with the appropriate requirements of IEC 255 and BS 142. These relays have a low operating current, specific settings and time delayed drop-off. This latter feature is to keep the relay in the operated condition during temporary reductions in the battery voltage, such as those which occur just prior to a fuse blowing or during a busbar fault when many trip relays operate simultaneously.

Application

Type XR151 relays are designed to allow the supervision of a trip relay operating coil, supply & associated wiring. This application requires relays with low operating current, visual indication and the ability to initiate a remote alarm. Both these relays have mechanical flag indicators which show on de-energisation, either self reset or hand reset.

Low burden & consistent, positive action
Suitable for high burden trip relays (EB2) only.

Exact burden & operating current dependent upon application.

Technical information

Rated voltage V n	125V
Settings	Pick-up: 70% of Vn Drop-off: not less than 26% of Vn
Reset time	No less than 100ms when supply is switched from 100% to 26% of Vn.

Operating current	Less than 20mA.
Burden	Less than 2.5W
Thermal Withstand	1.15 Vn continuously
Indication	A self or hand reset flag indicator shows when the relay is de-energised.

Contact arrangements

4 contacts in any combination of normally open or normally closed

Contact rating
Make and carry continuously:
1250VA a.c. or 1250Wd.c.
with limits of 660V and 5A

Make and carry for 3 seconds:
7500VA a.c. or 7500Wd.c
with limits of 660V and 30A

Break

1250VA a.c. or 100Wd.c. resistive, or 50W inductive (L/R = 0.04) d.c. with limits of 250V

Environmental Information

Temperature	IEC 68-2-1 & 2
-Storage -	25°C to +70°C
-Operating -	10°C to +55°C
Humidity	IEC 68-2-3
56 days at 95% RH and 40°C	
Vibration	IEC 255-21-1

The relays meet the requirements of Class 1 for vibration response and endurance

Shock and bump IEC 255-21-2
The relays meet the requirements of IEC 255-21-2 and BS142, sub-section 1.5.2.
(1989) with respect to shock and bump testing for class 1 severity

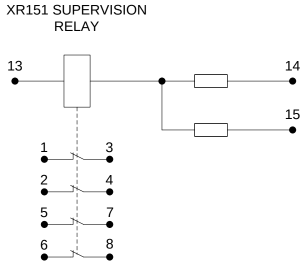
Mechanical life

The relays will withstand in excess of 10,000 operations with the contact rating at a rate of 600 operations per hour

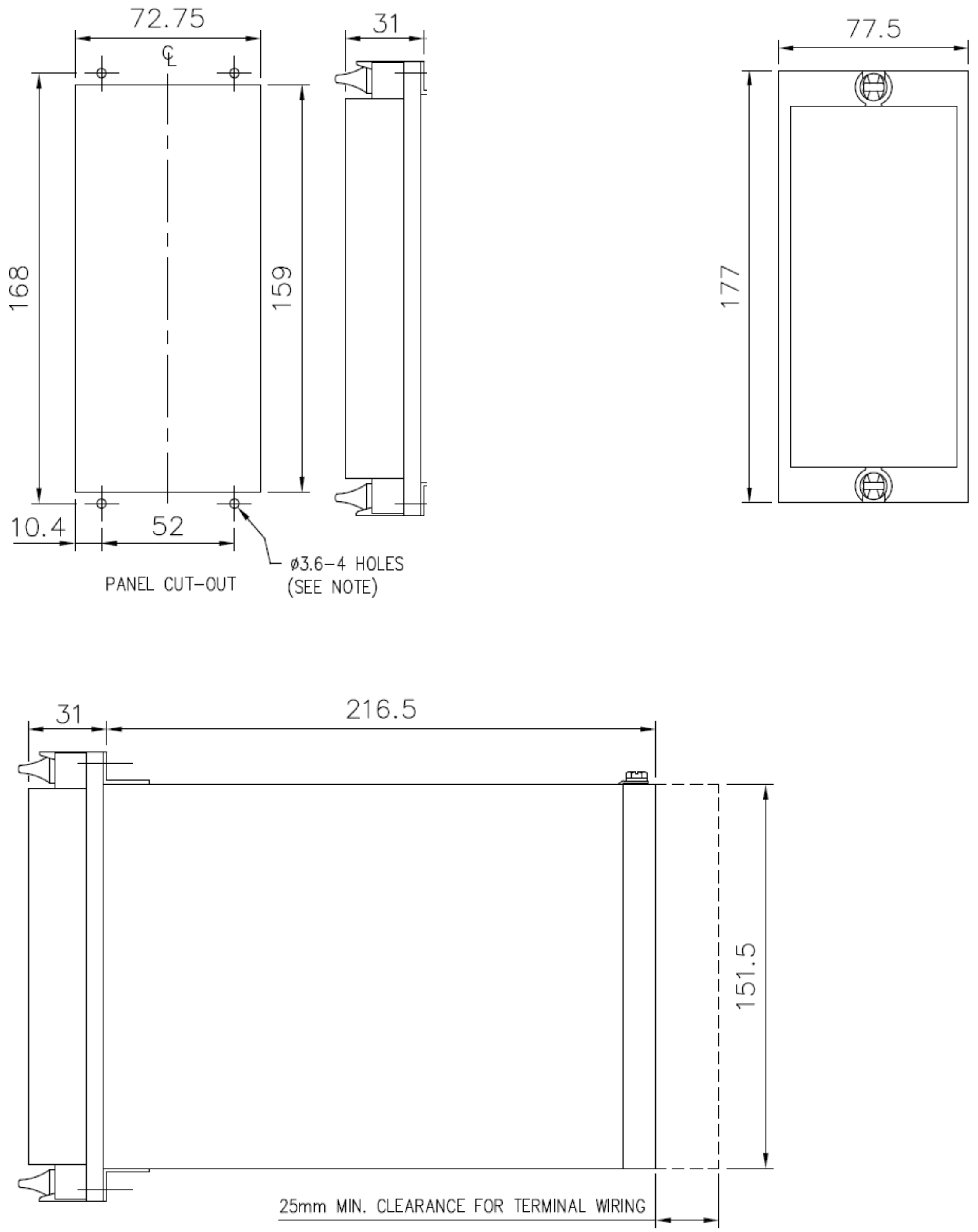
Insulation IEC 255-5

Relays will withstand:
5kV peak, 1.2/50µs, 0.5J between all terminals and case earth and between adjacent terminals.
2kV rms 50Hz for 1 minute between all case terminals connected together and the case earth and between independent circuits.
1kV rms 50Hz for 1 minute between normally open contacts.

Typical connections



Case Dimensions



Note: The ø3.6 holes are for M4 thread forming (trilobular) screws. These are supplied as standard and are suitable for use in ferrous/aluminum panels 1.6mm thick and above. For other panels, holes to be M4 clearance (typically ø4.5) and relays mounted using M4 machine screws, nuts and lockwashers (supplied in panel fixing kit).

Fig2. E3 Case Dimensions

Ordering Information – 7PG17 XR

Product description	Variants	Order No.
Trip Relay supervision relay (XR151)		**7 P G 1 7 □ □ - □ □ □ □ □ - □ □ □ 0**
	XR relay type	
	Trip Relay supervision	**5**
	Number of elements	
	Single element, self reset contacts	**1**
	Type of flag	
	Hand reset flag	**1**
	Self reset flag	**3**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	Number of contacts	
	Four	**1**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Voltage rating	
	125V DC	**4**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating (alarm)	
	Not Applicable	**A**
	Back emf suppression diode	
	Not Fitted	**0**

1.2.4.3 7PG17 XR152 and XR153 Supply Supervision Relays

Description

Type XR relays are developments for specific applications of the type AR relay range. They are electro-mechanical relays with long service life and complying with the appropriate requirements of IEC 255 and BS 142. These relays have a low operating current, specific settings and time delayed drop-off. This latter feature is to keep the relay in the operated condition during temporary reductions in the battery voltage, such as those which occur just prior to a fuse blowing or during a busbar fault when many trip relays operate simultaneously. Healthy circuits therefore do not give spurious alarms and the relay effected by the fuse failure provides the alarm and indication necessary for accurate maintenance attention.

Application

Types XR152 and XR153 relays are designed to comply with CEGB and other specification for protection supervision requirements and the monitoring of d.c. voltage supplies. These applications require relays with low operating current, visual indication and the ability to initiate a remote alarm. Both these relays have mechanical flag indicators which show on de-energisation, self reset on the XR152 and hand reset on the XR153.

Low burden
Versatile design, can provide pre-close supervision
Consistent positive action

Technical information

Rated voltage V n	24V, 30V, 50V, 60V, 125V and 220Vdc
Settings	Pick-up 70% of rated voltage Drop-off not less than 26% of Vn
Reset time	No less than 100ms when supply is switched from 100% to 26% of Vn.
Operating current	10mA nominal. (17mA for 24V & 30V ratings)
Burden	0.4W at 24Vd.c. 1.25W at 125Vd.c
Thermal Withstand	1.15 Vn continuously
Indication	A flag indicator shows when the relay is de-energised XR152 self reset flag XR153 hand reset flag

Contact arrangements

2 or 4 contacts in any combination of normally open and normally closed
Contact rating
Make and carry continuously:
1250VA a.c. or 1250Wd.c. with limits of 660V and 5A
Make and carry for 3 seconds:
7500VA a.c. or 7500Wd.c with limits of 660V and 30A

Break

1250VA a.c. or 100Wd.c. resistive, or 50W inductive (L/R = 0.04) d.c. with limits of 250V

Environmental Information

Temperature	IEC 68-2-1 & 2
-Storage -	25°C to +70°C
-Operating -	10°C to +55°C
Humidity	IEC 68-2-3
56 days at 95% RH and 40°C	
Vibration	IEC 255-21-1

The relays meet the requirements of Class 1 for vibration response and endurance
Shock and bump IEC 255-21-2
The relays meet the requirements of IEC 255-21-2 and BS142, sub-section 1.5.2.
(1989) with respect to shock and bump testing for class 1 severity

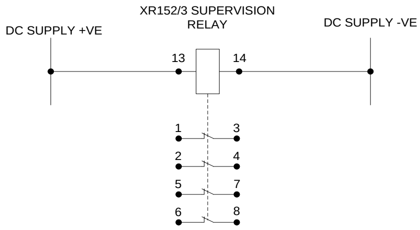
Mechanical life

The relays will withstand in excess of 10,000 operations with the contact rating at a rate of 600 operations per hour

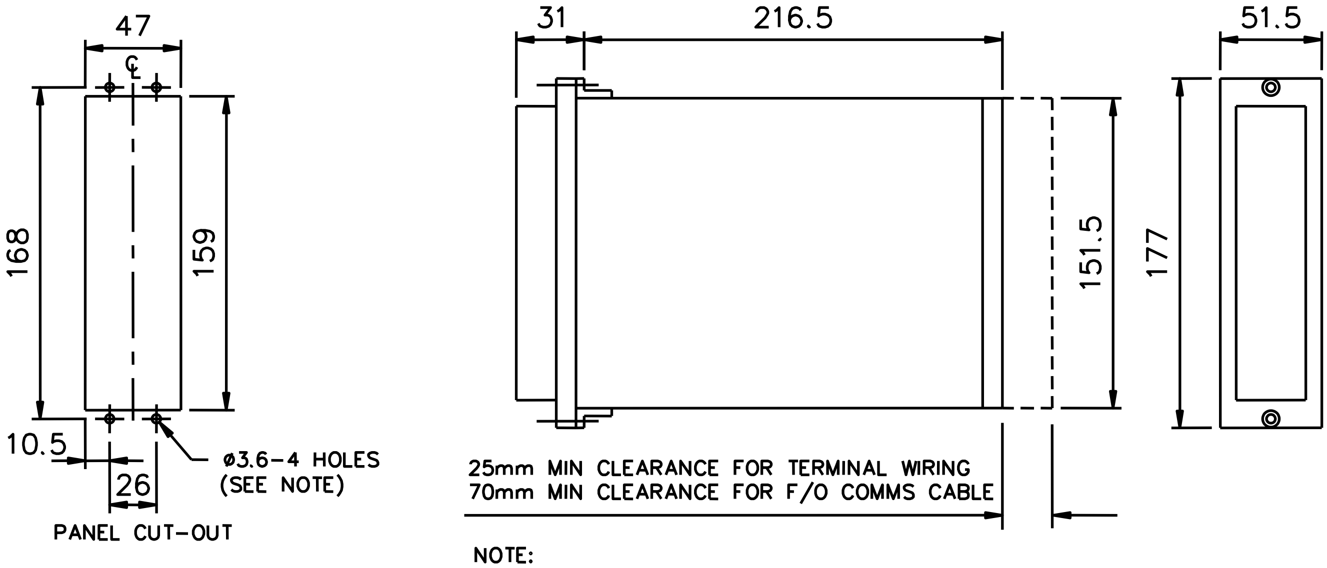
Insulation IEC 255-5

Relays will withstand:
5kV peak, 1.2/50µs, 0.5J between all terminals and case earth and between adjacent terminals.
2kV rms 50Hz for 1 minute between all case terminals connected together and the case earth and between independent circuits.
1kV rms 50Hz for 1 minute between normally open contacts.

Typical connections



Case Dimensions



25mm MIN CLEARANCE FOR TERMINAL WIRING
70mm MIN CLEARANCE FOR F/O COMMS CABLE

NOTE:
THE ø3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY ø4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig1. E2 Case Dimensions

Ordering Information – 7PG17 XR

Product description	Variants	Order No.
D.C. supply supervision relay (XR152, XR153)		**7 P G 1 7 □ □ - □ □ □ □ □ - □ □ □ 0**
	XR relay type	
	D.C. supply supervision	**4**
	Number of elements	
	Single element, self reset contacts	**1**
	Type of flag	
	Hand reset flag	**1**
	Self reset flag	**3**
	Contact arrangement – NO	
	0 NO	**A**
	1 NO	**B**
	2 NO	**C**
	3 NO	**D**
	4 NO	**E**
	Contact arrangement NC	
	0 NC	**A**
	1 NC	**B**
	2 NC	**C**
	3 NC	**D**
	4 NC	**E**
	Number of contacts	
	Four	**1**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Voltage rating	
	24V DC	**1**
	30V DC	**2**
	50V DC	**3**
	125V DC	**4**
	240V DC	**5**
	Housing size	
	Case size E2 (4U high)	**A**
	Voltage rating (alarm)	
	Not Applicable	**A**
	Back emf suppression diode	
	Not Fitted	**0**

1.2.4.4 7PG17 XR250 to XR351 Trip Circuit Supervision Relays

Description

Type XR relays are developments for specific applications of the type AR relay range. They are electro-mechanical relays with a consistent positive action, a long service life and complying with the appropriate requirements of IEC 255 and BS142. Models XR250/251 have two attracted armature elements, XR350/351 have three. These relays incorporate a time delay on de-energisation to keep the relay in an operated condition during temporary reductions in the battery voltage.

Low burden
Versatile design, can provide pre-close supervision
Consistent positive action

Supervision of the trip circuit breaker is desirable as a means of ensuring the integrity to the trip circuit.

There are differing requirements for monitoring a trip circuit, supervision of the trip with the circuit breaker closed, supervision with the circuit breaker open and closed and pre-closing supervision. These XR relays are designed to meet all of these requirements and in particular the requirements of BEBS S15 schemes H4 and H7.

XR250 and XR251 Circuit breaker closed supervision will initiate an alarm and provide indication with the circuit closed for : Failure of the trip supply, open circuit trip coil, an open circuit in the trip circuit wiring and if the trip coil should fail to respond to a trip command.

XR350 and XR351
Continuous supervision with the circuit breaker in the open and closed positions and in compliance with the scheme requirements of BEBS S15 scheme H7. XR350 and XR351 relays also have a contact for pre-closing supervision, where a circuit breaker is prevented from being closed if trip relays have not been reset. BEBS S15 scheme H7 is applicable to trip circuit voltages of 125Vd.c. and 240Vd.c.

Technical information

Rated voltage V n	30V, 50V, 125V & 220Vdc
Operating range	80% to 120% of Vn
Reset time	400ms when supply is switched from Vn to off

Burden

H7 scheme relay burdens are typically:

Rated voltage	Trip circuit condition		Alarm circuit
	C.B. open	C.B. closed	
50Vd.c	- -	- -	2W
125Vd.c	1W	2W	4W
240Vd.c	2W	4W	9W

Thermal Withstand 1.15Vn continuous

Indication

A flag indicator shows when the relay is de-energised

Self reset flag	XR250 and XR350
Hand reset flag	XR251 and XR351

Contact arrangements

Alarm output - 4 contacts in any combination of normally open and normally closed. Pre-closing supervision, XR350 & XR351, 1 normally open contact.

Contact rating

Make and carry continuously:
1250VAa.c. or 1250Wd.c. with limits of 660V and 5A
Make and carry for 3 seconds:
7500VAa.c. or 7500Wd.c with limits of 660V and 30A

Break:
1250VAa.c. or 7500Wd.c. resistive, or 50W inductive (L/R = 0.04) d.c. with limits of 250V and 5A

Environmental

Temperature	IEC 68-2-1 & 2
Storage	-25°C to +70°C
Operating	-10°C to +55°C
Humidity	IEC 68-2-3 56 days at 95% RH and 40°C
Vibration	IEC 255-21-1

The relays meet the requirements of Class 1 for vibration response and endurance

Shock and bump

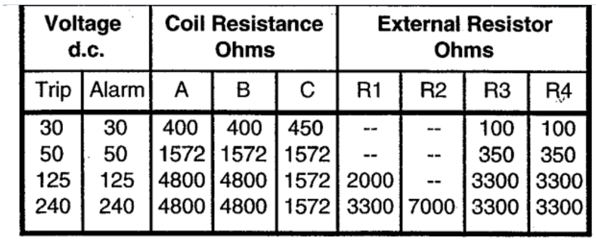
IEC 255-21-2

The relays meet the requirements of IEC 255-21-2 and BS142, sub-section 1.5.2. (1989) with respect to shock and bump testing for class 1 severity

Operational/mechanical life

The relays will withstand in excess of 10,000 operations with the contact rating at a rate of 600 operations per hour
Insulation IEC 255-5
Relays will withstand:
5kV peak, 1.2/50μs, 0.5J between all terminals and case earth and between adjacent terminals
2kV rms 50Hz for 1 minute between all case terminals connected together, the case earth and between independent circuits
1kV rms 50Hz for 1 minute between normally open contacts.

Coil and Resistor Data



Voltage d.c.		Coil Resistance Ohms			External Resistor Ohms			
Trip	Alarm	A	B	C	R1	R2	R3	R4
30	30	400	400	450	--	--	100	100
50	50	1572	1572	1572	--	--	350	350
125	125	4800	4800	1572	2000	--	3300	3300
240	240	4800	4800	1572	3300	7000	3300	3300

R1 and R2 are fitted in the 'C' coil circuit.
R3 and R4 are fitted in the 'A' and 'B' coil circuits respectively.

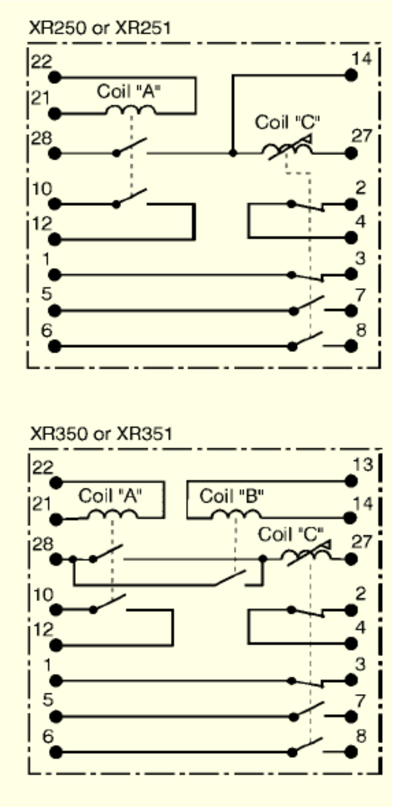
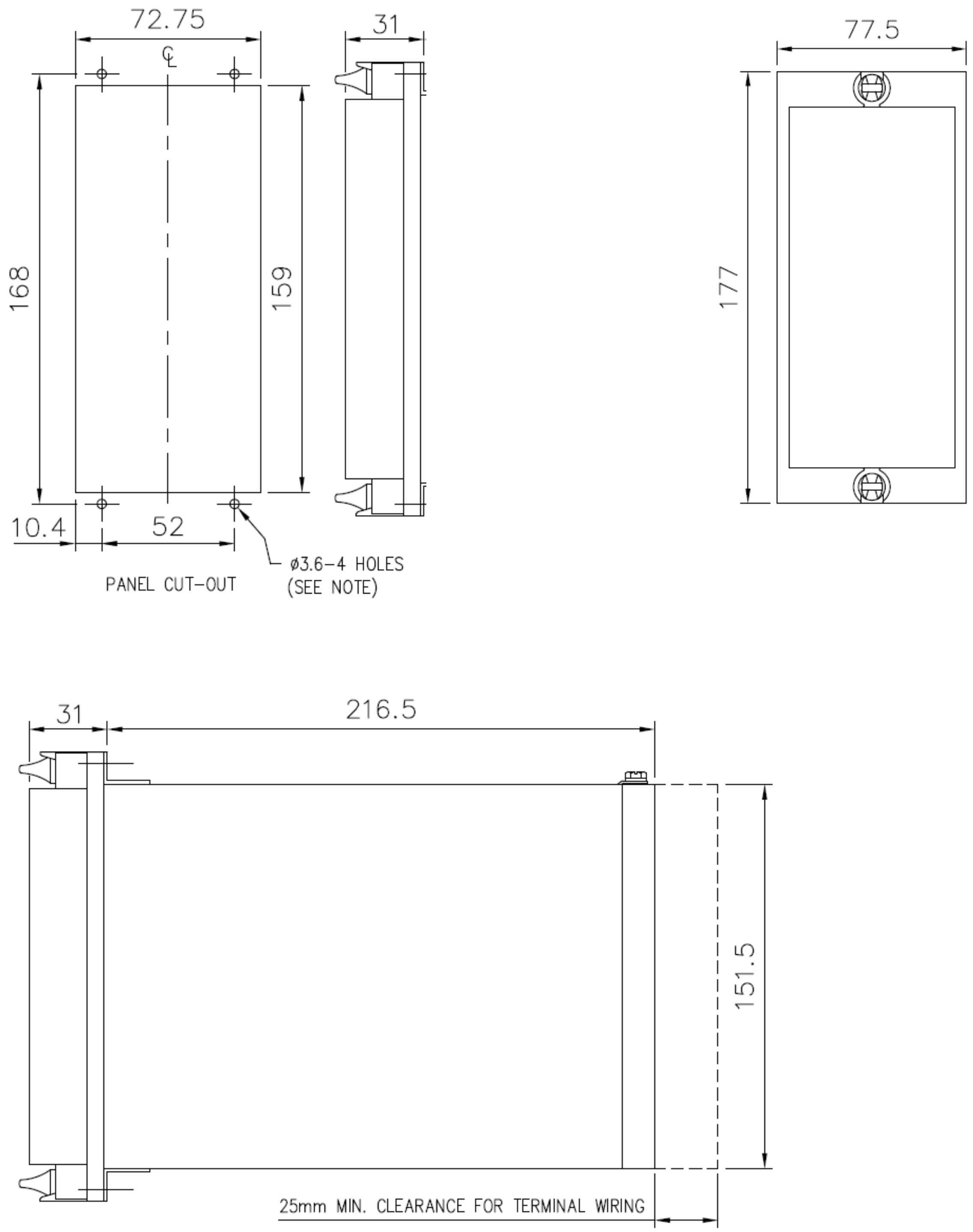


Fig1. Typical relay wiring, modular case terminal numbers shown

Case Dimensions



Note: The ø3.6 holes are for M4 thread forming (trilobular) screws. These are supplied as standard and are suitable for use in ferrous/aluminum panels 1.6mm thick and above. For other panels, holes to be M4 clearance (typically ø4.5) and relays mounted using M4 machine screws, nuts and lockwashers (supplied in panel fixing kit).

Fig2. E3 Case Dimensions

Ordering Information – 7PG17 XR

Product description	Variants	Order No.
Trip circuit supervision relay (XR250, XR251)		**7 P G 1 7 □ □ - □ □ □ □ □ - □ □ □ □**
	XR relay type	
	Trip circuit supervision	**5**
	Number of elements	
	Two element, self reset contacts	**2**
	Type of flag	
	Hand reset flag	1
	Self reset flag	3
	Contact arrangement – NO	
	0 NO	A
	1 NO	B
	2 NO	C
	3 NO	D
	4 NO	E
	Contact arrangement NC	
	0 NC	A
	1 NC	B
	2 NC	C
	3 NC	D
	4 NC	E
	Number of contacts/element	
	Four	1
	Contact type	
	NO (Standard) / NC (Standard)	0
	Voltage rating	
	30V DC 1)	2
	50V DC 1)	3
	125V DC 1)	4
	240V DC 1)	5
	Housing size	
	Case size E3 (4U high)	B
	Voltage rating (alarm)	
	30V DC	**C**
	50V DC	**D**
	125V DC 1)	**E**
	240V DC 1)	**F**
	Back emf suppression diode	
	Not Fitted	**0**

---

1) Supplied with external resistors

Ordering Information 7PG17 XR

Product description	Variants	Order No.
Trip circuit supervision relay (XR350, XR351)		**7 P G 1 7** □ □ - □ □ □ □ □ - □ □ □ □
	XR relay type	
	Trip circuit supervision	5
	Number of elements	
	Three element, self reset contacts	3
	Type of flag	
	Hand reset flag	1
	Self reset flag	3
	Contact arrangement – NO	
	0 NO	A
	1 NO	B
	2 NO	C
	3 NO	D
	4 NO	E
	Contact arrangement NC	
	0 NC	A
	1 NC	B
	2 NC	C
	3 NC	D
	4 NC	E
	Number of contacts/element	
	Four	1
	Contact type	
	NO (Standard) / NC (Standard)	0
	Voltage rating [2]	
	30V DC [1]	2
	50V DC [1]	3
	125V DC [1]	4
	240V DC [1]	5
	Housing size	
	Case size E3 (4U high)	B
	Voltage rating (alarm)	
	30V DC	C
	50V DC	D
	125V DC [1]	E
	240V DC [1]	F
	Back emf suppression diode	
	Not Fitted	0

---

1) Supplied with external resistors
2) Voltage rating for both trip coils

1.3 *Classical Range and Associated Products*

1.3.1 7PG23 Restricted Earth Fault

Description

The relay uses a type B61 attracted armature element energized via a low pass filter circuit and a full wave rectifier. The relay has a minimum setting of I5V. Other resistors are introduced into the circuit to provide the voltage setting range up to 270V in increments of 5V using heavy duty DIL switches. Included within the relays are the essential non-linear resistors to limit the peak voltage output from saturated CTs, these resistors protect the CT insulation and secondary wiring.

Functional Overview

Low settings can be achieved.
Stability based upon plant capacity.

Application

The 5B3 relay is ideal for restricted earth fault protection of transformer windings or phase and earth fault protection of reactors and the stator windings of large machines.

This relay may also be used for high impedance busbar protection. High impedance schemes have the advantages over low impedance schemes that a more sensitive setting can be obtained without any loss of stability and the primary fault setting calculation is simpler.

Current operated schemes are more susceptible to mal-operations from through faults unless greater care is taken with the selection of the current transformers. For some restricted earth fault applications the primary fault setting needs to be greater at harmonic frequencies than the setting at the fundamental frequency. The 5B3 relay uses a low pass filter circuit to achieve this. No adverse reduction in fault setting can occur with the high frequency currents which may be produced during switching.

CT Requirements

Experience has shown that most protection CTs are suitable for use with the high impedance relays and that where the CTs are specifically designed for this protection their overall size may be smaller than that required for an alternative current balance protection. The basic requirements are:

a) All CTs should, if possible, have identical turns ratios.

b) The knee point voltage of each CT should be at least 2x Vs. The knee point voltage is expressed as the voltage applied to the secondary circuit with the primary open circuit which when increased by 10% causes the magnetizing current to increase by 50%.

c) CTs should be of the low leakage reactance type. Most modern CTs are of this type and there is no difficulty in meeting this requirement. A low leakage reactance CT has a jointless ring type core, the secondary winding evenly distributed along the whole length of the magnetic circuit and the primary conductor passes through the approximate centre of the core.

Technical Information

Frequency fn:	50 or 60 Hz
Current Is:	Fixed at 20mA
Voltage Vs:	I5V to 270V in 5V steps
Thermal withstand:	Continuous 1.25 × Vs
Accuracy:	Vs ± 5%
Burden:	Vs x 20mA
Operating time:	45ms maximum at 3xV

Indication:	Hand reset flag
Contact arrangement:	3 normally open self reset

Contact rating:
Contacts are capable of making and carrying 6.6kVA for 0.2 seconds with a maximum of 30A. Contacts are intended for use in circuits where a circuit breaker auxiliary switch breaks the trip coil current.

Environmental

Temperature:	IEC 68-2-1 & 2
Operating:	-10°C to +55°C
Storage:	-25°C to +70°C
Humidity:	IEC 68-2-3 56 days at 95% RH and +40°C
Vibration:	IEC 255-21-2

The relay complies with the requirements of BS142, section 2.2, category S2 over the frequency range 10 to 800Hz impact. The relay will withstand panel impact shocks of 20g. Operational/mechanical life in excess of 10,000 operations.

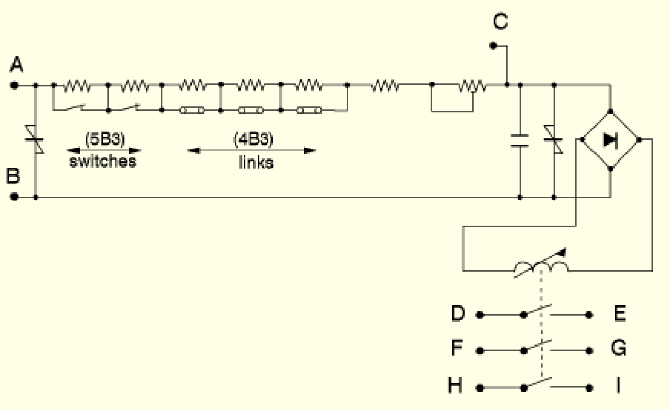
Insulation IEC 255-5

Relay will withstand:

5kV 1.2/50,µs 0.5j between all terminals and case earth and between adjacent terminals. 2kV rms 50HZ for I minute between all case terminals connected together and the case earth and between independent circuits. IkV rms 50HZ for I minute across normally open contacts.

Case

Single element Epsilon E3 case.



	A	B	C	D	E	F	G	H	I
5B3 (size 3 case)	28	27	22	1	3	2	4	5	7

Fig1. Modular relay case terminal numbers

Stability

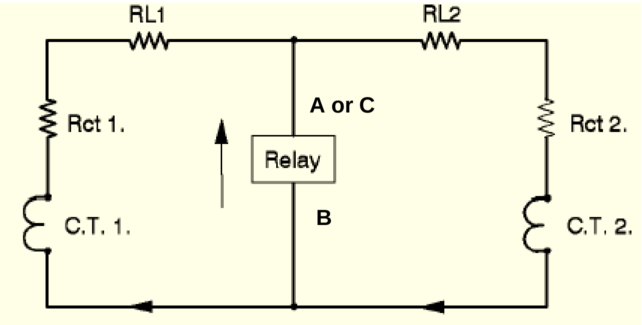


Fig2. High Impedance Scheme

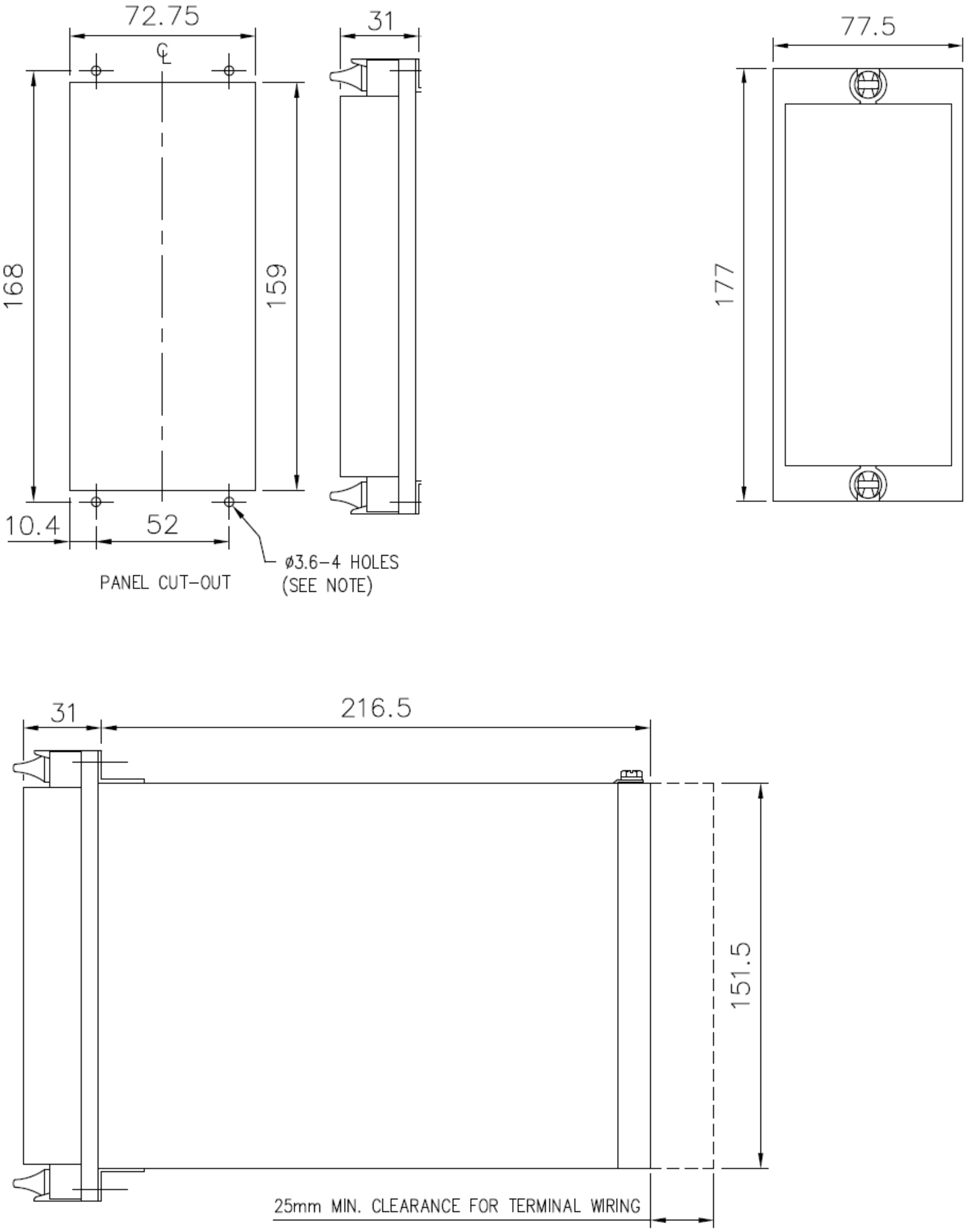
For stability the voltage setting of the relay must be made equal to or exceed the highest value of V calculated below:
V=I (Rct+RI)
Where:
RI = The largest value of pilot-loop resistance between the CTs and the relay.
Rct = The secondary winding resistance of the CT.
I = The CT secondary current corresponding to the maximum steady state through fault current of the protected equipment

Fault Setting

It should, however, be noted that because the operating voltage of the relay circuit is relatively high, the excitation currents of the CT's in parallel with the relay may comprise a large proportion of the fault setting.

Primary fault setting = N (I0 + I1 + I2 + I3)
Where:
I0 = Relay operating current
I1 etc = Excitation current of each CT. at the relay setting voltage.
N = C.T. turns ratio

Case Dimensions



Note: The ø3.6 holes are for M4 thread forming (trilobular) screws. These are supplied as standard and are suitable for use in ferrous/aluminum panels 1.6mm thick and above. For other panels, holes to be M4 clearance (typically ø4.5) and relays mounted using M4 machine screws, nuts and lockwashers (supplied in panel fixing kit).

Fig2. E3 Case Dimensions

Ordering Information – 7PG23 – 5B3

Product description	Variants	Order No.
5B3		**7 P G 2 3 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ A 0**
Single element high impedance relay, ideal for REF applications.		
	Relay type	
	5B3 - High impedance, 50Hz	**1**
	5B3 - High impedance, 60Hz	**2**
	Type of flag	
	Hand reset flag	**1**
	Contact operation	
	Self reset contacts	**1**
	Contact arrangement – NO	
	3 NO	**D**
	Contact arrangement NC	
	0 NC	**A**
	Number of contacts	
	Three	**3**
	Contact type	
	NO (Standard) / NC (Standard)	**0**
	Setting range 1)	
	15V AC to 270V AC	**1**
	Housing size	
	Case size E3 (4U high)	**B**

1) Relay is pre-set to 15VAC, customer adjustable settings up to 270VAC in increments of 5V provided by heavy duty DIL switches

1.3.2 7PG21 Pilot Wire Current Differential Protection

Description

Solkor R & Solkor Rf are well established pilot wire feeder differential protections operating on the current balance principle. The R/Rf relay is primarily intended for use in the Rf mode which has the advantage of increased operating speed but can be simply changed to R mode for compatibility with pre-installed remote end relays which are older 5kv Solkor R type relays.

The relay is suitable for application on a single pair of privately owned pilots with loop resistance up to 2000ohms to protect 2 ended feeder circuits up to 20km in length. Two compatible relays are used as a pair with one relay connected to current transformers at each end of the feeder respectively. The Solkor R/Rf relays do not require an auxiliary DC supply.

Function Overview

High transient stability.

High speed operation.

Low phase and earth fault settings.

Little or no setting variation with pilot length

Test points at relay fascia

Bleed-off up to 20% of rated current

Easily reconnected as R or Rf mode

Option of 15kV pilot isolation

Option of pilot supervision

Additional Options

15kV Isolation

The Solkor R/Rf relay has an insulation level of 5kV between pilot connections and the local ground to withstand voltages induced on the pilot cable due to coupling with the fault current and to withstand differential ground voltages caused by the flow of fault current. Experience has shown that 5kV insulation is usually adequate for most distribution feeders.

For higher voltage systems where feeders may be longer and fault levels higher, an additional external isolation transformer is available for use with the relay in Rf mode to increase the voltage withstand to 15kV.

5kV systems may be suitable for higher voltage systems where fault levels are low or feeder lengths are short. One isolation transformer is fitted at each end of the pilot circuit. Tappings at the transformers can be utilised to allow pilots with inter-core capacitance up to 4µF can be used compared to the 0.8µF limit imposed by the 5kV standard arrangement.

Pilot supervision

Communication via the pilots between the relay pair is essential for correct operation of the Current Differential protection system.

Additional external Pilot Supervision equipment can be supplied to detect pilot cable open circuit which can lead to protection operation or short circuit pilots which will greatly reduce the sensitivity of the relays under subsequent fault conditions.

Pilot supervision will not block relay operation but will provide an alarm. Pilot Supervision is available to suit the 5kV or 15kV insulation level of the scheme.

Overcurrent Guard

Solkor relay trip contacts can be connected in series with those of an Overcurrent Guard relay driven from the same current transformers to avoid operation for damaged pilots during normal load levels.

The electromechanical B69 can be used for this which will provide variable settings without an auxiliary supply.

Alternatively, a numeric relay from the Argus range can be used which will have negligible additional AC burden on the current transformer and can be used to add the waveform recording functionality to the traditional Solkor scheme.

Intertripping

The current differential system will naturally issue a trip at both ends for an in zone fault. Additional connections can also be made which utilise the pilot connection to initiate a protection operation at the remote end. This is generally used to cause a trip for an out of zone fault which has been detected by a different protection relay. There are 2 different methods to achieve this and their application depends on the fault current available for the out of zone fault.

Firstly the pilot loop can be open circuited to allow the remote end to operate on its measured current. To ensure positive operation of the remote end relay, the current should be at least twice the normal fault setting. Switching relays must provide suitable 5/15kV isolation

Secondly, the local end summation transformer can be short circuited to allow the remote end to operate on its measured current but with the local end connected in shunt. This can be successful with R mode where settings are raised to 4x normal settings but with Rf mode this can be up to 10x normal settings and this current is often not available.

Typical Equipment Options and Schemes

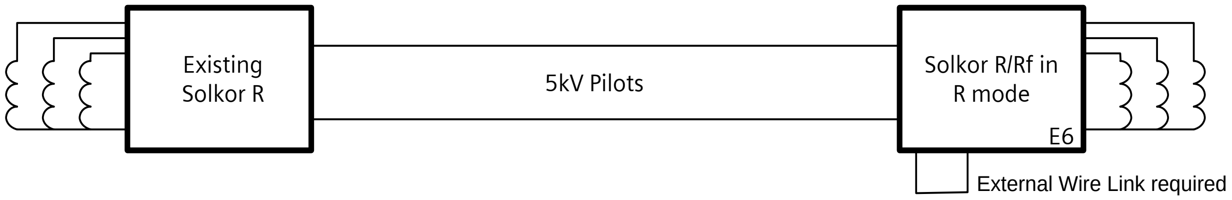


Fig1. Installation with existing Solkor R Relay

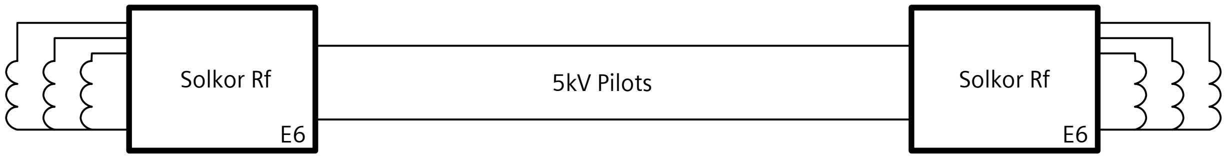


Fig2. Standard 5kV Plain Solkor Rf

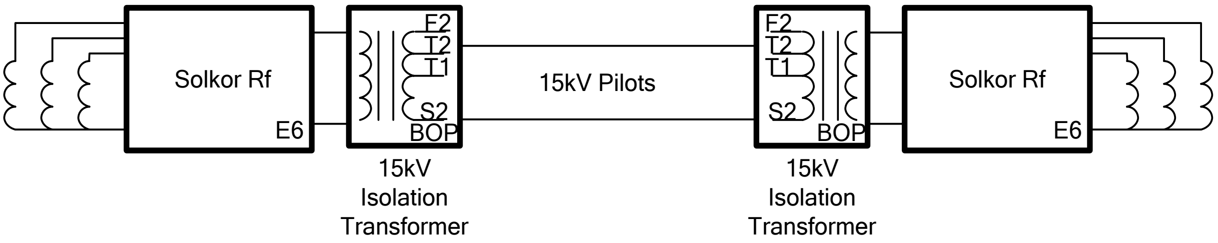


Fig3. Standard 15kV Plain Solkor Rf

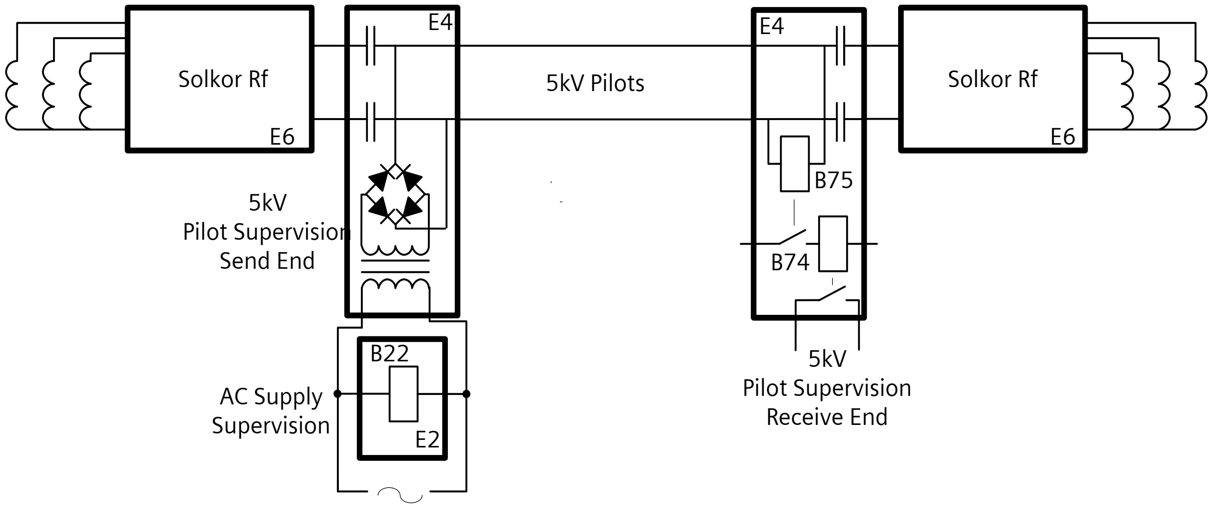


Fig4. 5kV Solkor Rf with pilot Supervision

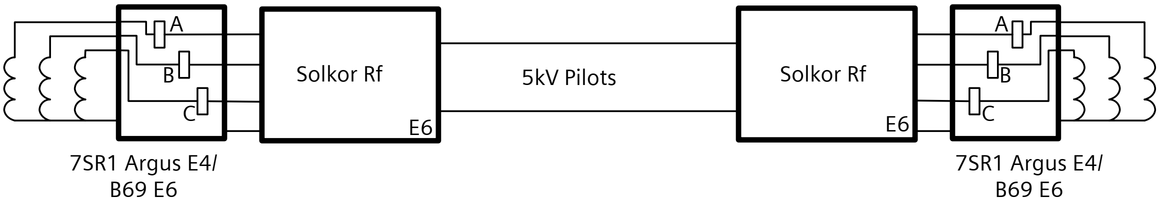


Fig5. 5kV Plain Solkor Rf with Overcurrent Guard

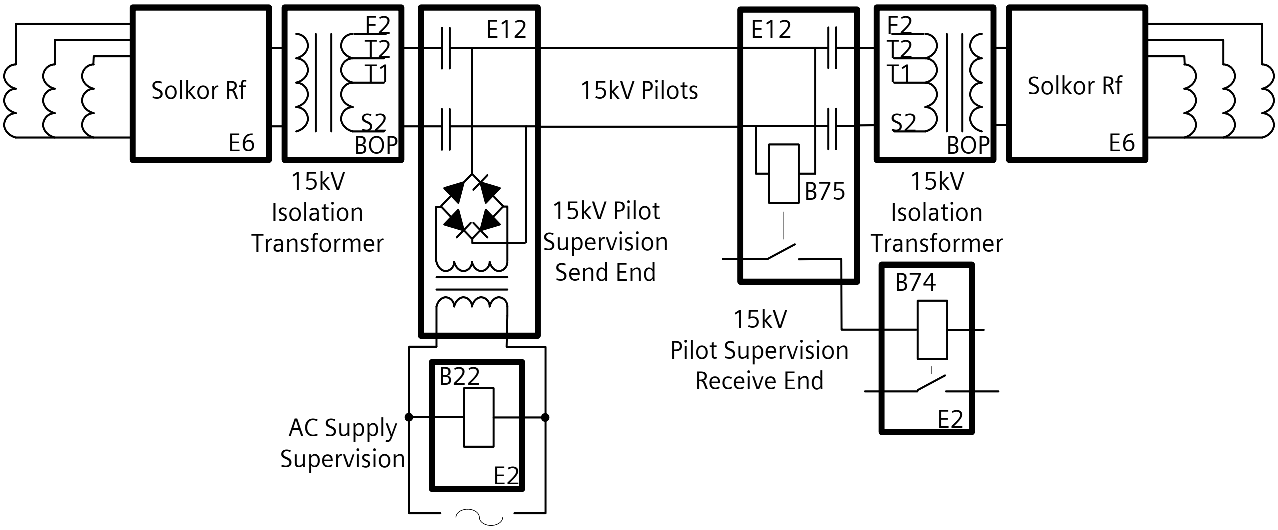


Fig6. 15kV Solkor Rf with Pilot Supervision

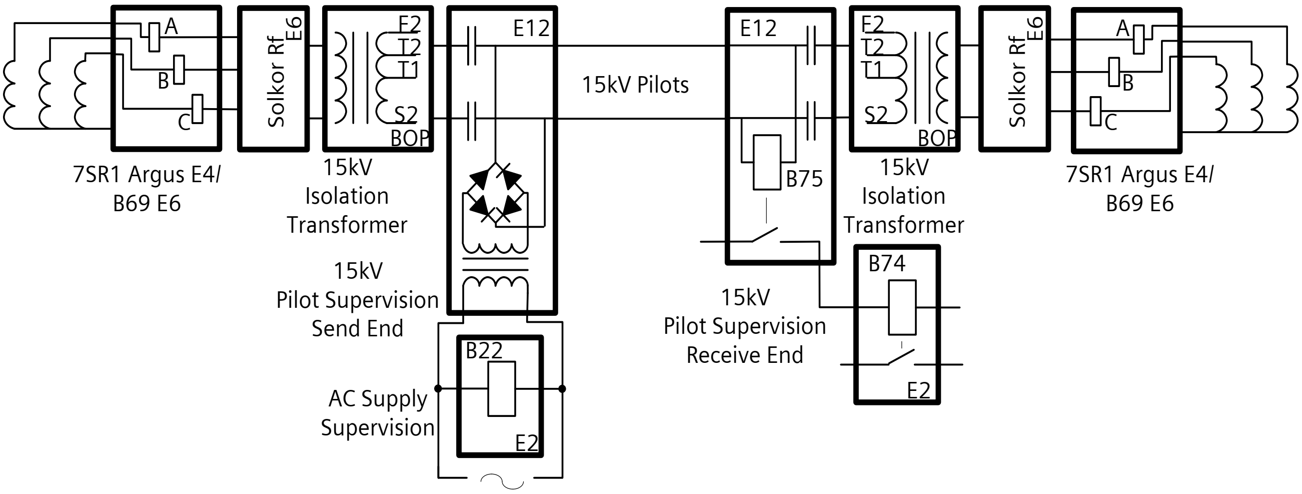


Fig7. 15kV Solkor Rf with Pilot Supervision and Overcurrent Guard

Service Conditions and performance data

Application Requirements

Number of Pilot cores required 2

Pilot Requirements

	R Mode	Rf Mode	Rf mode with 15kv Transf.		
			Tap 1	Tap 0.5	Tap 0.25
Max. Loop Resistance	1000 Ω	2000 Ω	1780 Ω	880 Ω	440 Ω
Max. Inter core Capacitance	2.5μF	0.8 μF	1 μF	2 μF	4 μF

Pilot Current and Voltage

	R Mode	Rf Mode	Rf mode with 15kv Transf.		
			Tap 1	Tap 0.5	Tap 0.25
Peak Voltage applied to pilots under fault conditions	300v	450v	450v	330v	225v
Maximum current carried by pilots under fault conditions	200mA	250mA	250mA	380mA	500mA

Maximum Primary Line Capacitive Charging Current.

Solidly Earthed System, 1/3 times the most sensitive earth fault setting

Resistance Earthed System, 1/9 times the most sensitive earth fault setting

Mechanical Durability

Vibration, relays comply with BS142 section 2.1 Category S2. Shock, relays withstand 20G shock or impact on the panel without operating. Operation/mechanical life, relays will withstand in excess of 10,000 operations.

Electrical Performance

Characteristic Energising Quantities

Rated Current (In)	0.5A 1A 2A 5A 6.67A

Rated Frequency (f_N)	Operating Range
50 Hz	47Hz to 52Hz
60Hz	57Hz to 62Hz

Insulation

Between pilot circuit and all other independent circuits and earth	5kV rms
Between all external terminal and earth	2kV rms
Between terminals of independent circuits	2kV rms
Across normally open contacts	1kV rms

Isolation Transformer

Between pilot circuit terminals and all other terminals and earth	15kV rms

Current Withstand

Maximum through fault condition for differential protection stability	50x rated current

AC current Thermal Withstand	Multiple of rated current
Continuous	2x
20 minutes	2.8x
10 minutes	3.5x
5 minutes	4.7x
3 minutes	6.0x
2 minutes	7.3x
3 seconds	60x
1 second	100x limited to 400A

Operating Time	R Mode	5kV Rf Mode	15kV Rf Mode
3x fault setting	60ms	50ms	45ms
5x fault setting	55ms	45ms	40ms
10x fault setting	50ms	45ms	40ms

Indication	Hand Reset Flag
Contact Arrangement	3 N/O
Contact Rating	Make and carry for 0.2s a burden of 6600VA with a maximum of 30A

Environmental

Temperature
IEC 60068-2-1/2

Type	Level
Operating Range	-10 °C to +55 °C
Storage range	-25 °C to +70 °C

Humidity
IEC 60068-2-3

Type	Level
Operational test	56 days at 40 °C and 95 % relative humidity

IP Ratings

Type	Level
Installed with cover	IP 51

Pilot Supervision Equipment

Auxiliary Supply	
Send End	110/220/240V ac 50/60Hz
Receive End	30V dc 50V dc 125V dc 240V dc

Burdens

AC Supervision Supply	10VA approx.
AC supply fail relay	3 to 5VA
Receive Repeat Relay	1W

Contact Arrangements

Pilot Supervision Relay(B75)	1NO self reset
Repeat relay B74	2NO & 2NC
Supervision supply fail relay	2NO & 2NC

Contact Ratings

Type B22, B74 and B75

Make & Carry Continuously	1500VA ac or 1500W dc within limits of 660V and 3A. Make and carry 8A for 3 secs or 16 for 1 second.
Break	300VA ac or 75W dc (inductive L/R 0.04) within limits of 250V and 5A
Indication	Flag indicators shown on de-energisation
Supervision supply fail relay (B22)	Hand Reset Flag
Receive Repeat Relay	Self Rest Flag

Settings

Primary fault settings with insulation between pilot circuits and other terminals and earth 15kV; typical current transformers and zero pilot capacitance are given below. Values are expressed as percentages of the current transformer rating.

Fault Type	Fault Setting							
	5kV scheme				15kV scheme (Rf mode only)			
	R Mode		Rf Mode		R Mode		Rf Mode	
	N1	N	N1	N	N1	N	N1	N
A-E	16	22	18	25	22	31	25	35
B-E	18	27.5	21	32	26	39	30	44
C-E	22	37	25	42	31	52	35	59
A-B	110		125		155		177	
B-C	110		125		155		177	
C-A	55		62		77.5		88.5	
3P	63		72		89		101	

The addition of Pilot Supervision will increase the settings by 20-50%.

Current Transformer Requirements

	R mode	Rf mode
Maximum output of CT required to operate relay	1.2VA	3VA

The main requisite is that the saturation voltage of the current transformers should not be less than that given by the formula:

$$V_k = \frac{50}{I_n} + \frac{I_F}{N}(R_{CT} + 2R_L)$$

Where I_n = Rated current of Solkor Rf relay.
I_F = Primary current under maximum steady state THROUGH FAULT conditions.
N = Current Transformer ratio.
R_{CT} = Secondary resistance of the current transformer
R_L = Lead resistance between the current transformers and the Solkor R/Rf, per phase.

For the above purpose the saturation voltage i.e. the knee point of the magnetising curve, may be taken as that point on the curve at which a 10% increase in output voltage requires 50% increase in magnetising current.

To ensure good balance of the protection the current transformers at the two ends should have identical turns ratios. Close balance of the ratio is provided by current transformers to IEC60044: pt1, class px, whose ratio error is limited to ±0.25% and these CTs are recommended to meet the above requirements.

It is recommended that no other burdens should be included in the current transformer circuit, but where this cannot be avoided the additional burden should be added to those listed when determining the current transformer output voltage required.

In addition to the above, the secondary magnetising currents of the current transformers at different ends of the feeder should normally not differ by more than In/20 amperes for output voltages up to 50/In volts where In = rated current of Solkor Rf relay. This criterion is applied to quantify matching of the transient response of the two CTs so that relay operations do not occur due to differing responses of the CTs to normal load switching or the incidence and clearance of out of zone faults. This condition is usually easily satisfied by modern CTs of similar size since the magnetising current is usually a lower value. Care should be taken when applying a new CT to be paired with existing CT and also when interposing CTs are required to match CT ratios.

Case Dimensions

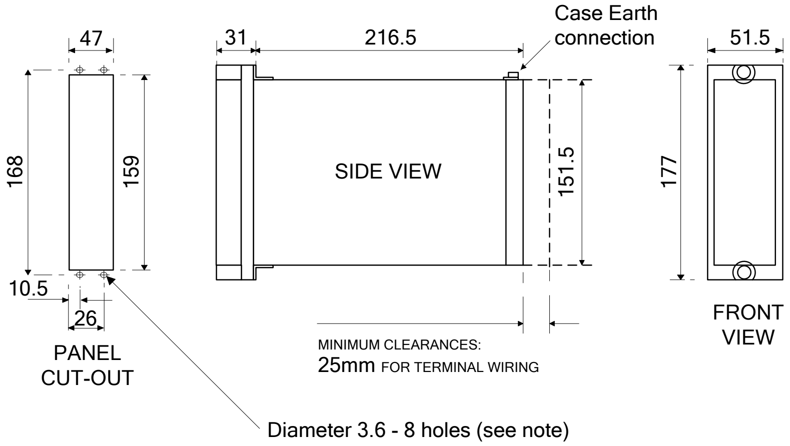


Fig8. E2 Case

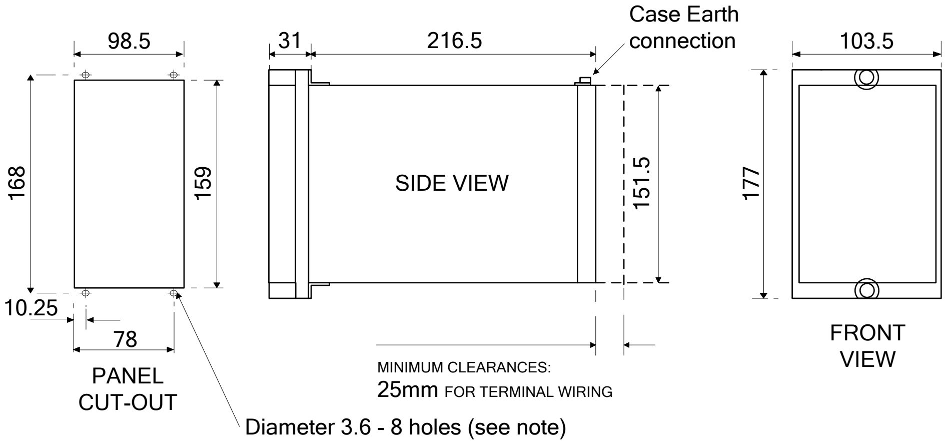
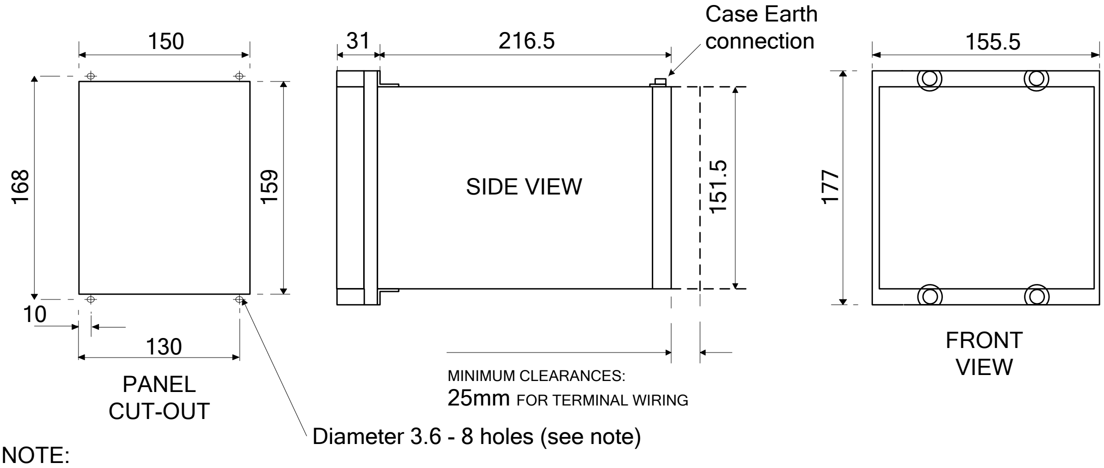


Fig9. E4 Case



NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig10. E6 Case

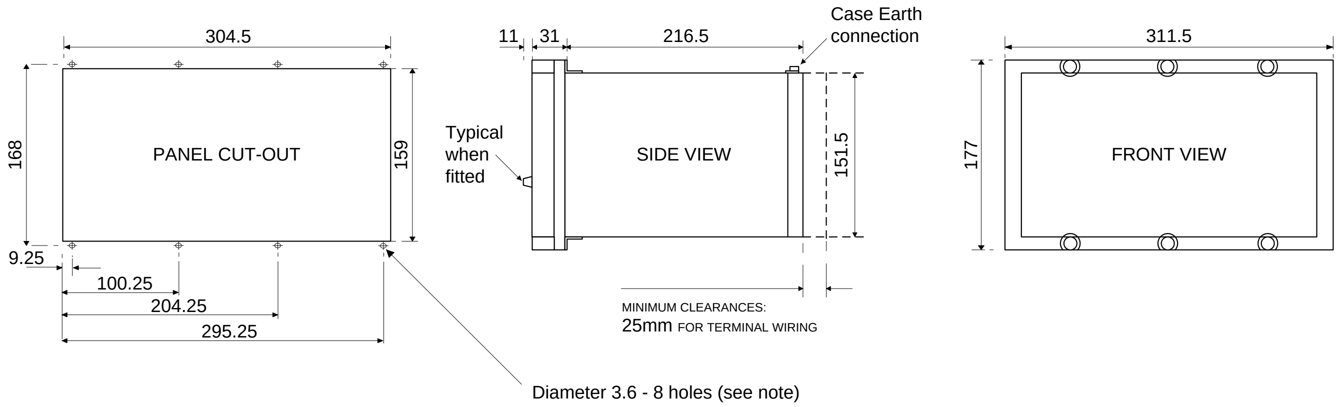
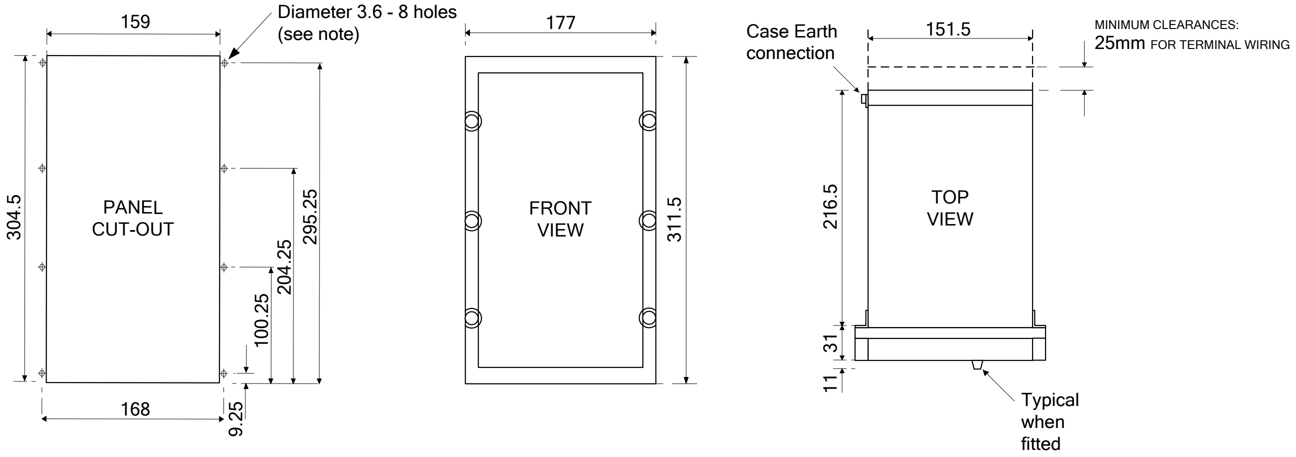


Fig11. E12 Case (4U high)



NOTE:
THE 3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS / ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY 4.5 DIAMETER) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig12. E12 Vertical Case (4U wide)

Connection Diagrams

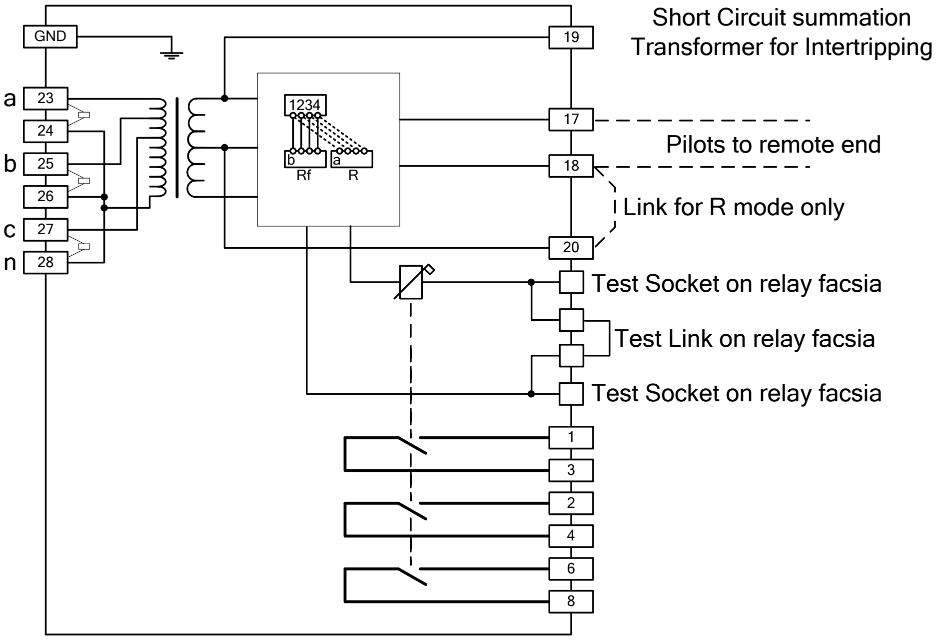


Fig13. 7PG2111 Solkor R/Rf Connections (E6 case)

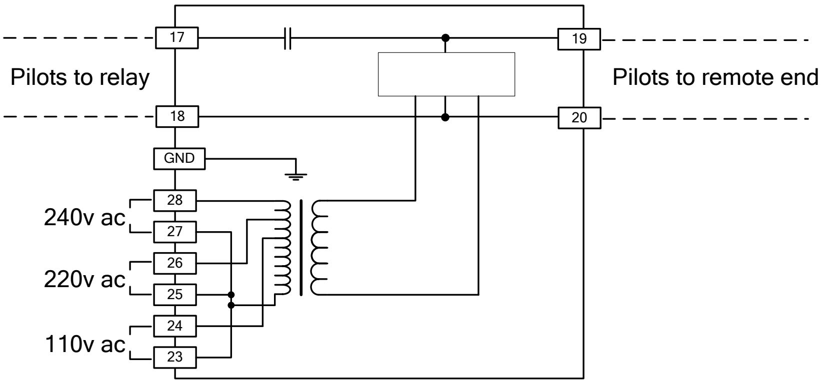


Fig14. 7PG212 5kV Pilot Supervision Send End connections (E4 case)

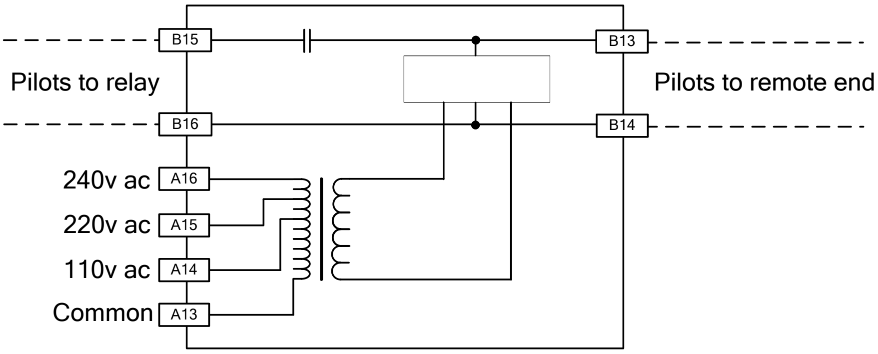
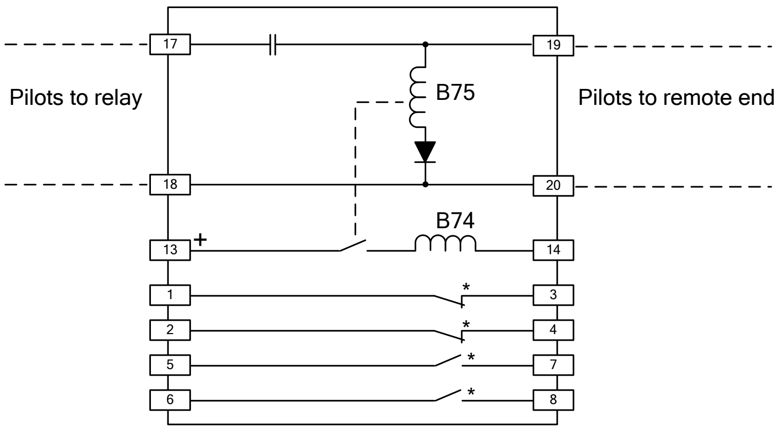


Fig15. 7PG212 15kV Pilot Supervision Send End connections (E12 case)



* contacts may be 2M2B as shown or 4M or 4B

Fig16. 7PG214 5kV Pilot Supervision Receive End connections (E4 case)

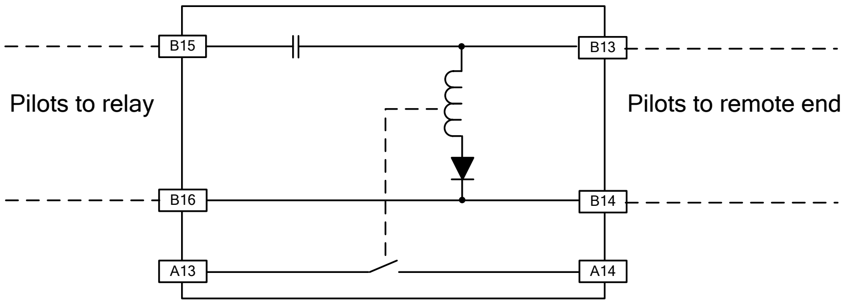
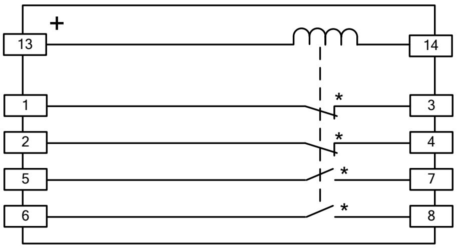
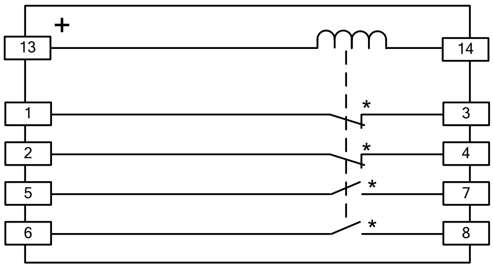


Fig17. 7PG215 15kV B75 Pilot Supervision Receive End connections (E12 case)



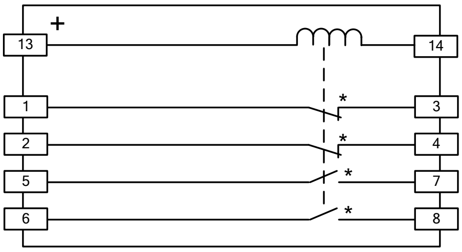
* contacts may be 2M2B as shown or 4M or 4B

Fig18. 7PG216 B74 Pilot Supervision Receive End Repeat relay for 15kV scheme (E2 case)



* contacts may be 2M2B as shown or 4M or 4B

Fig19. 7PG213 B22 Power Supply Supervision relay for Pilot Supervision (E2 case)



* contacts may be 2M2B as shown or as below

	1-3	2-4	5-7	6-8
4M	M	M	M	M
3M1B	M	B	M	M
2M2B	B	B	M	M
1M3B	B	B	M	B
0B	B	B	B	B

Fig20. 7PG2183 B34 Delayed Pickup delay relay for Rf Mode Intertripping (E2 case)

Ordering Information - Solkor R/Rf 7PG21

Product description	Variants	Order No.
Solkor R/Rf Pilot wire current differential feeder protection.		**7PG21□□-□□□□□-□□□0**
	Relay type Solkor R/Rf relay	1
	Solkor R/Rf equipment Solkor R/Rf - Circulating current feeder protection	1
	Contact operation Self reset contacts	1
	Contact arrangement – NO 3 NO	D
	Contact arrangement NC 0 NC	A
	Number of contacts Three	3
	Contact type NO (Standard) / NC (Standard)	0
	Solkor mode Solkor Rf 2) Solkor R	 0 1
	Housing size Case size E6 (4U high)	D
	Rating 0.5A AC 1A AC 2A AC 5A AC 6.67A AC	 A B C D E
Solkor R/Rf 15kV isolation transformer for use with Solkor Rf.		**7PG21□□-0AA00-0□A0**
	Relay type Solkor R/Rf - Circulating current feeder protection scheme	1
	Solkor R/Rf equipment Solkor Rf – 15kV isolation transformer	2
	Housing size Special	A

---

1) For pilot insulation of between 5kV and 15kV, SOLKOR Rf mode only, order 7PG2112-0AA00-0AA0 isolating transformer with the relay at each feeder-end

2) Relay is set in Solkor Rf mode as default

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
Supply transformer rectifier unit		**7 P G 2 1 ☐ 0 - 0 A A 0 0 - ☐ ☐ ☐ 0**
For use with Solkor R/Rf relay, pilot supervision send end.		
	Relay type	
	Supply Transformer/Rectifier unit (send end) 1)	2
	Type of Flag	
	No flag	0
	Contact Arrangement - NO	
	0 NO	A
	Contact Arrangement – NC	
	0 NC	A
	Number of contacts	
	None	0
	Contact type	
	None	0
	Insulation level	
	5kV	1 C
	15kV	2 G/H
	Housing size	
	Case size E4 (4U high)	C
	Case size E12 (4U high)	G
	Case size E12 Vertical (4U wide)	H
	Rating 1)	
	110/220/240V AC, 50/60Hz	A

1) Supply Transformer/Rectifier unit (send end), ratings 110/220/240V ac, 50/60Hz.
2) For required supply supervision relay B22, see 7PG213*.

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
B22-AC		7 P G 2 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0
For use with Solkor R/Rf relay, pilot supervision send end.		
	Relay type	
	Supply supervision (B22-AC)	3
	Type of flag	
	Hand reset reverse acting flag	2
	Contact operation	
	Self reset contacts	1
	Contact arrangement – NO	
	2 NO	C
	Contact arrangement NC	
	2 NC	C
	Number of contacts	
	Four	4
	Contact type	
	NO (Standard) / NC (Standard)	0
	Frequency	
	50Hz	1
	60Hz	2
	Housing size	
	Case size E2 (4U high)	A
	Voltage rating	
	110V AC	A
	220V AC	B
	240V AC	C

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
B75/74 For use with Solkor R/Rf relay, pilot supervision receive end (5kV).		7 P G 2 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0
	Relay type [1]	
	Receive and repeat (B75/B74)	4
	Type of flag	
	Self reset reverse acting flag	4
	Contact operation	
	Self reset contacts	1
	Contact arrangement – NO	
	0 NO	A E
	2 NO	C C
	4 NO	E A
	Contact arrangement NC	
	0 NC	A
	2 NC	C
	4 NC	E
	Number of contacts	
	Four	4
	Contact type	
	NO (Standard) / NC (Standard)	0
	Insulation level	
	5kV	1
	Housing size	
	Case size E4 (4U high)	C
	Voltage rating	
	24V DC	A
	30V DC	B
	50V DC	C
	125V DC	E
	240V DC	F

---

[1] Option selection for B74 element, B75 (3mA, 1NO/0NC) element included as standard

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
B75 For use with Solkor R/Rf relay, pilot supervision receive end (15kV).		**7PG21□□-□□□□□-□□□0**
	Relay type Receive (B75)	5
	Type of flag Self reset reverse acting flag	4
	Contact operation Self reset contacts	1
	Contact arrangement – NO 1 NO	B
	Contact arrangement NC 0 NC	A
	Number of contacts One	1
	Contact type NO (Standard) / NC (Standard)	0
	Insulation level 15kV	2
	Housing size Case size E12 (4U high) Case size E12 Vertical (4U wide)	G H
	Current setting 3mA	A

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
B74		**7 P G 2 1 ☐ ☐ - ☐ ☐ ☐ ☐ ☐ - ☐ ☐ ☐ 0**
For use with Solkor R/Rf relay, pilot supervision receive end (15kV).		
	<u>Relay type</u>	
	Receive repeat (B74)	6
	<u>Type of flag</u>	
	Self reset reverse acting flag	4
	<u>Contact operation</u>	
	Self reset contacts	1
	<u>Contact arrangement – NO</u>	
	2 NO	C
	<u>Contact arrangement NC</u>	
	2 NO	C
	<u>Number of contacts</u>	
	Four	4
	<u>Contact type</u>	
	NO (Standard) / NC (Standard)	0
	<u>Insulation level</u>	
	15kV	2
	<u>Housing size</u>	
	Case size E2 (4U high)	A
	<u>Voltage rating</u>	
	24V DC	A
	30V DC	B
	50V DC	C
	125V DC	E
	240V DC	F

1.4 *Ancillary Equipment*

1.4.1 7SG21 Multi Range Digital Setting Time Delay Relay

Features

- Four time ranges 0-0.99s, 0-9.9s, 0-99s, 0-990s
- High accuracy & repeatability – timing compensated for output relay delay
- Time settings easily selected by digital thumb wheel switches
- Selectable delay operate or delay release
- Optional reset functions
- Instantaneous (Fast), definite time, count down
- 4 C/O output contacts
- Wide auxiliary supply range with fail alarm contact
- Timing in progress LED
- Non-volatile trip indication
- Multi voltage timer initiate input
- Multi voltage flag reset input
- Size 2M draw out case

Application

The 7SG21 - DDB20 time delay relay is particularly suitable for use in protection & control schemes where precision time delays are required.

CB Fail

A typical use is for providing a definite time delay in circuit breaker failure protection. For example: The transformer multi-trip relays energize the 7SG21 - DDB20 timer & if the circuit breaker (CB) fails to clear the fault within the pre-set (0.6s) the timer times out & operates a multi-trip relay. This in turn trips all CB's on the section of the busbar connected to the CB, which has failed to trip.

Induction disc reset emulation

Replacement of induction disc timing elements with solid-state relays can result in a loss of grading & reduced functionality due to the different reset characteristics. For example, the inherent slow reset time of induction disc relays provide an advantage in sensitive overcurrent schemes where pecking faults could go undetected due to the timer being instantaneously reset each time the current momentarily falls below the start setting. The 7SG21 - DDB20 may be specified with a number of reset functions to avoid this problem & to suit specific protection applications.

Operation

A crystal oscillator & embedded micro controller based timing circuit are employed to provide accurate timing & flexible functionality. When a control signal is applied to the timer initiate input, a counter begins counting down from the thumb wheel switch setting. When the zero is detected, the output relay contacts & flag operate.

Three time ranges are selected via a front panel switch. An internal configuration switch can be used to select a x10 range multiplier to provide up to 990s of precision time delay. Two timing modes are available:

Time delay **ON** mode (Relay starts timing after the initiate control signal is applied & output contact picks up after the pre-set time delay has elapsed) or;

Time delay **OFF** mode (Relay output contact picks up instantaneously when the initiate control signal is applied, starts timing after the initiate control signal is removed & drops out after the pre-set time delay has elapsed).

An amber LED on the front panel indicates when the relay has been initiated & flashes during timing.

The DDB20 timer may be specified with a number of different reset functions to provide instantaneous reset, definite time reset or induction dist reset emulation. These functions are specified at time of order.

A switchmode power supply provides a very wide auxiliary operating range. A relay fail alarm is provided in the form of a C/O contact which is picked up when the auxiliary supply rail & CPU watchdog status is healthy.

Timing Functions

Timing Function / Initiate Signal input (Status input)

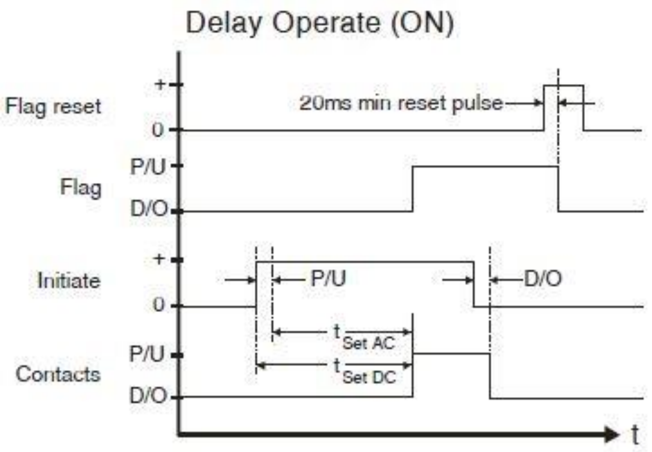
For accurate timing functions the 7SG21 - DDB20 detects application or removal of an external voltage control signal. This mode is set using internal configuration switch 2 (Refer order code details). efer to Table 2 for timing initiate P/U & D/O times.

Delay Operate Timing Function

This timing mode is selected using internal configuration switch 3.

The relay is permanently connected to the auxiliary supply & is initiated by the application of a control signal. Application of the initiate signal starts the pre set timing cycle. During timing the front panel initiate LED will flash & then go on solid once the thumbwheel time setting has elapsed, this sets the output relay & visual indicator. The initiate LED is extinguished & the output contacts reset when the initiate signal is removed. After system reset the visual indicator may be reset locally using the front anel push button or remotely via the flag reset input.

To achieve a simple but less accurate delay **ON** function, the initiate signal may be connected directly to the auxiliary supply. Timing will then commence when power is applied to the relay while removal of power will reset the time delay & output relay. This mode is only suitable for longer time delay settings as the switch mode power supply takes 100 – 500ms (Depending on Vx), to start which adds to the inherent time delay.

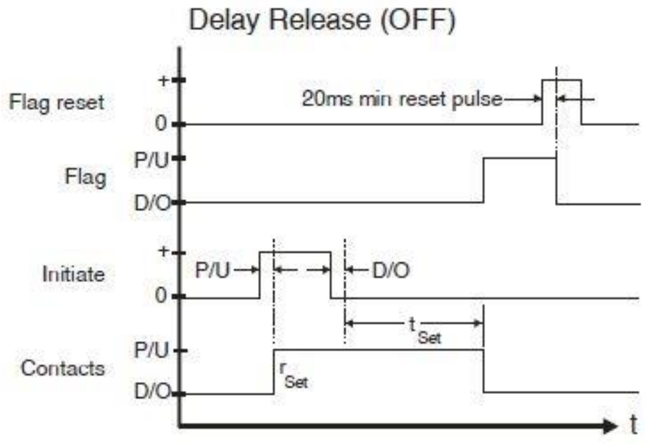


Removal of the initiate signal during timing will reset the time delay (Refer timing reset options). After time out the contacts are reset to the D/O condition upon removal of the initiate signal. The flag can be reset provided the timer initiate signal is removed.

Delay Release Timing Function

This timing mode is selected using internal configuration switch 3.

The relay is permanently connected to the auxiliary supply. Application of the initiate control signal, causes the output relay to set instantaneously (Rset). It will remain in this state until the control signal is removed; this starts the timing cycle & resets the output relay when the preset time delay is reached.



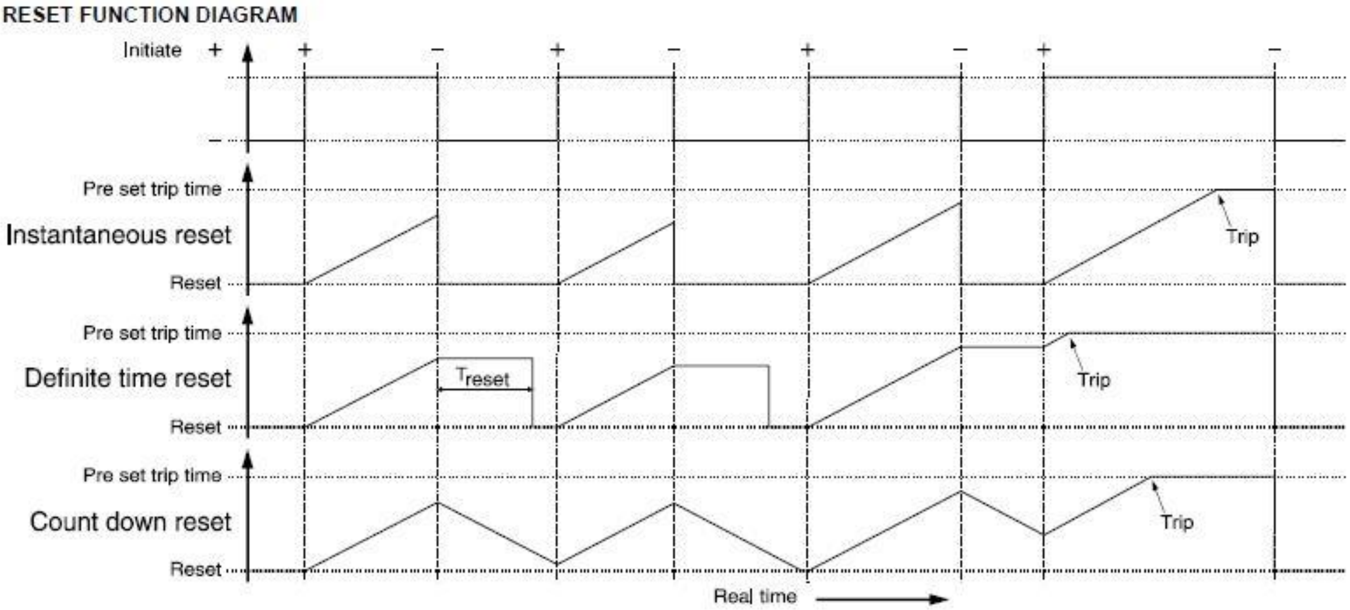
Re-application of the initiate signal during timing will reset the time delay (Refer timing reset options). After time out the contacts are reset to the P/U condition. The flag can be reset at any time, except during timing.

Timing Reset options

Instantaneous
If reset before the preset time delay is reached the timing element will reset (D/O) as per Table 2.

Definite Time Reset (Treset)
If reset before the preset time delay is reached the delay timer will pause until the reset time has elapsed before resetting. If the timer is re-initiated before the reset time has elapsed, the delay timer will restart the timing sequence from the paused timing point.

Count Down Reset
If reset before the preset time delay is reached, the timer will count down toward reset. If the timer is re-initiated before reset is reached the timer will start counting back up towards the time delay pre set.



Technical Data

Auxiliary Supply

40-300V DC & 40-275V AC or 20-70V DC switchmode supply.

Burden (110V DC nominal supply)

Less than 2 watts during idle & timing.
Less than 4 watts when output relays are energized.

Relay Fail Alarm

A C/O alarm contact is maintained in the energized state when all of the following conditions are met:

- The auxiliary supply is applied
- The internal 24V DC rail is within acceptable limits
- The CPU hardware watchdog maintains a pulsing output

A CPU software watchdog records "suspect" events to an assert register & if necessary performs a soft restart.

Time Setting ranges

The 7SG21 - DDB20 relay allows for precision time settings of between zero (Minimum operate time) & 990 seconds. This is achieved by the use of two decimal thumb wheel switches & a range multiplication switch on the front panel. A 10x setting multiplier is activated when configuration switch 5 is set to OFF to extend mer range 3 up to 990s.

Range Selector Setting	Achievable Time Setting Range	Resolution of Time Setting
Range 1	Zero to 0.99 Sec	0.01 Sec
Range 2	Zero to 9.9 Sec	0.1 Sec
Range 3	Zero to 99 Sec	1 Sec
Range setting x10	Zero to 990 Sec	10 Sec

Table 1

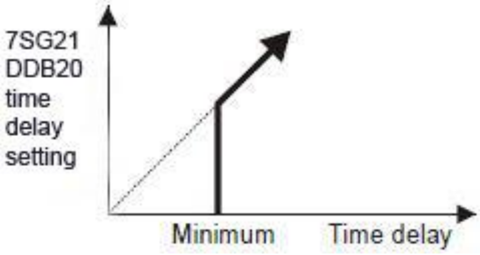
Time Delay setting changes

The time delay & function settings should only be changed when the timing initiate LED is extinguished. Time delay settings are read at the beginning of each timing sequence.

		AC Rejection Filter	
Initiate input	Minimum	ON	OFF
DC	P/U	<16ms	<4ms
	D/O	<4ms	<16ms
AC	P/U	N/A	<23ms
	D/O		<33ms

Table 2

Minimum Output Contact Operate Time



The minimum output contact operate time is equal to the timer initiate status input delays in Table 2 + 6ms. Time delay settings ≤ to this figure will result in a relay contact operate time equal to the minimum.

Timing Accuracy

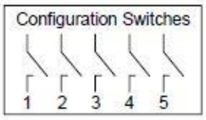
Maximum timing error as a % of setting + uncertainty in ms.

	AC Rejection Filter	
Initiate input	ON	OFF
DC	-0.19% +0.2ms	
AC	N/A	-0.19% +10ms

Table 3

Configuration Switches

Configuration switches are accessible to the user & can be set by withdrawing the relay module & following the instructions on the side plate label. A bank of 5 switches are provided as depicted below & are read each time the DDB20 is powered up: Configuration Switches 2 1 3 4 5



Status Input Operating Voltage (AC rejection filter)

The operating range of the status inputs are set using internal configuration switch 1. This setting may be pre defined when ordering.

18 - 300V DC	Set Configuration Switch to **ON**

In this mode the universal status input will reject AC signals that may be induced on the control wiring. Suitable for high security applications where a DC battery supply is available.

18 - 300V DC & 18 – 275V AC	Set Configuration Switch to **OFF**

In this mode the universal status input is designed to operate on both AC & DC input voltages. Suitable for applications where an AC auxiliary voltage is available such as transformer or generator control panels.

Status Input minimum operating current

10mA P/U for 1ms then reducing to1.5mA after 4ms.

While the function of the configuration switches may vary for special custom models, the standard functions & default settings are described in the Ordering Information section.

Front Panel Indicators

Four LED indicators are provided on the front panel:

Power	On solid when auxiliary supply healthy	Green
Timing	Flashing during timing	Amber
Trip	On solid when output relay operated	Red
Range x10	On when the x10 time range selected	Green

The trip LED status is stored in non volatile memory & will be restored when the 7SG21 - DDB20 is powered up after loss of the auxiliary supply. The preserved trip LED state is reset using the front panel flag reset button or status input.

A hand & remote reset magnetic disc flag (permanent memory) indicator may be specified as an option. Note that an auxiliary supply is required to reset the flag circuits.

Transient Overvoltage	**IEC60255-5 Class III**
Between all terminals & earth	5kV 1.2/50us 0.5J
Between independent circuits without damage or flashover	5kV 1.2/50us 0.5J

Insulation Coordination	**IEC60255-5 Class III**
Between all terminals & earth	2.0kV RMS for 1 minute
Between independent circuits	2.0kV RMS for 1 minute
Across normally open contacts	1.0kV RMS for 1 minute

Auxiliary Supply	**IEC60255-11**
Allowable breaks / dips in supply	≤20ms
Collapse to zero from normal voltage	

High Frequency Disturbance	**IEC60255-22-1 Class III**
2.5kV 1MHz common mode	≤ 3% variation
1.0kV 1MHz differential mode	

Electrostatic Discharge	**IEC60255-22-2 Class III**
6kV contact discharge	≤ 5% variation

Radio Frequency Interference	**IEC60255-22-3**
10V/m, 80 TO 1,000MHz	≤ 5% variation

Fast Transient	**IEC60255-22-4**
4kV/m, 5/50ns, 100KHz repetitive	≤ 3% variation

Conducted RFI	**IEC60255-22-6**
10V, 0.15 TO 80MHz repetitive	≤ 5% variation

Temperature Range	**IEC68-2-1/2**
Operating	-10 to 55°C
Storage	-25 to +75°C

Humidity	**IEC68-2-78**
40°C & 95% RH non condensing	

Wiring Diagram

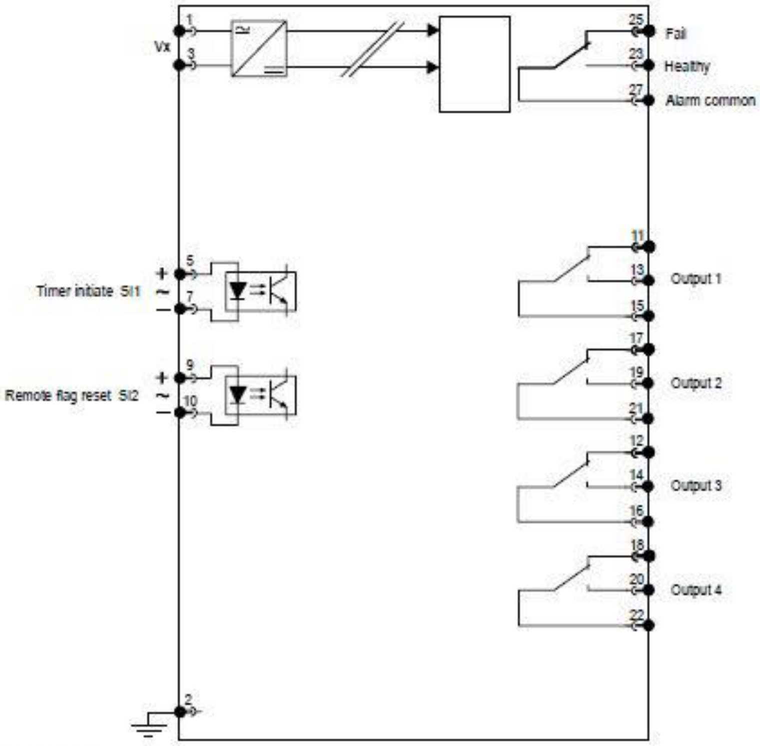
Output Relay Contact Configuration

4 C/O contacts

Output Contact dwell time

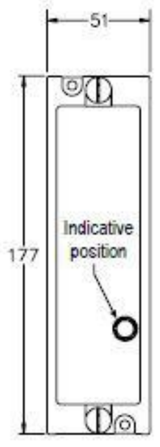
Once operated all tme delayed output contacts have a minimum dwell time of 100ms

Output contact ratings		**IEC60255-0-2**
Carry continuously	5A AC or DC	
Make & carry	0.5s 20A AC or DC	
L/R ≤40ms & V ≤300V	AC resistive	1,250VA
	AC inductive	250VA @PF ≤ 0.4
	Dc resistive	75W
	DC inductive	30W @ L/R ≤ 40ms
		50W @ L/R ≤ 10ms
Minimum numbers of operations		10^6 at maximum load
Minimum recommended load		0.5W limit 10mA/ 5V

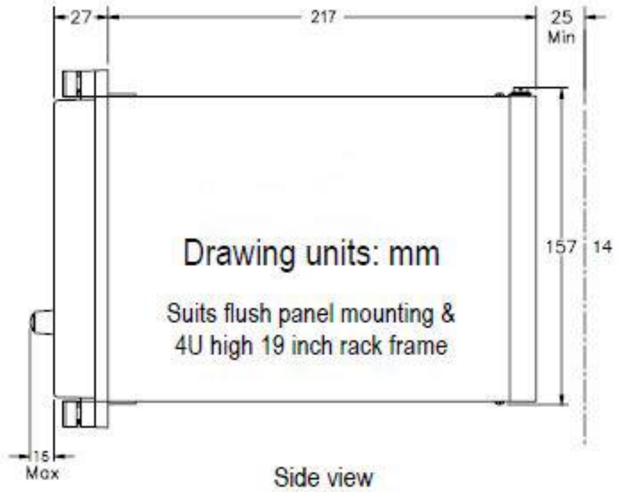


7SG21 - DDB20 wiring diagram - Relay shown in de-energised condition

Case Dimensions



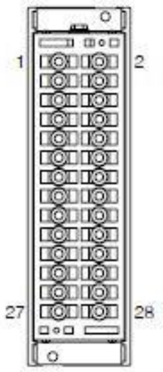
Front view



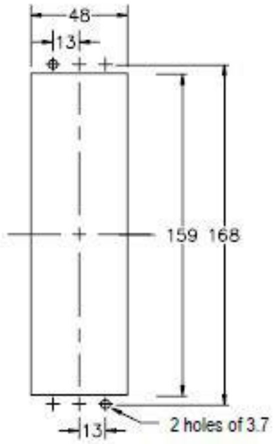
Drawing units: mm

Suits flush panel mounting & 4U high 19 inch rack frame

Side view



Terminal layout



Panel cut out

Ordering Information – 7SG21 - DDB20

Product description	Variants	Order No
DDB20		**7 S G 2 1 1 1 - 0 □ □ □ 1 - 0 A A 0**
Multi range digital time delay relay.		
	Relay type	
	Line differential	1
	Timing Range	
	0 th 0.99s, 0 to 9.9s, 0 to 99s and 0 to 990s	1
	Auxiliary supply	
	AC/DC 20-70V	A
	AC 40-275V and DC 40-300V	B
	Timing reset function	
	Instantaneous reset	A
	Definite time reset	B
	Count down reset	C
	Trip flag	
	Red LED non volatile indication (standard)	1
	Magnetic disc trip flag	2
	Contact type	
	4 C/O	1
	Housing size	
	Housing size E2 (4U high)	A

1.4.2 7XG15 High Impedance Component Box

High impedance protection operates on the differential current-balance principle. In each zone, the current transformers of the incoming and outgoing circuits are connected together and form a current balance group.
A relay is connected at a convenient point to form a spill circuit. An internal fault upsets the current balance and causes the relay to operate. The system employs one or more relay elements with sensitive current setting and low operating burden.

An external series resistor is used to give the each relay element the voltage setting required to ensure stability under through fault conditions. This is the setting or stabilizing resistor.

The resistance of the setting resistor should be sufficient to ensure the effective setting voltage exceeds the voltage developed by a through fault with one CT fully saturated.

The current setting of the 7SR23 may be adjusted to achieve the desired primary operating current.

Non-linear resistors (e.g. Metrosils) are used to protect the relay components, the insulation of secondary wiring and current transformers, by suppressing high voltage peaks which may otherwise be developed by the current transformer secondary winding under internal fault conditions.

Resistors and non-linear resistors are fitted on a per phase basis.

The resistors and non-linear resistors may be fitted as discrete components; however the High Impedance Component Box 7XG15 contains these items within a 4U high, size E6 relay enclosure.

7PG1110-7AE10 CT Shorting Relay

C.T. Supervision and Shorting:
Unbalance in any current-balance group due to an open-circuited current transformer, the primary of which is carrying load current, produces a voltage across the relay circuit.
This causes a spill current to flow and leads to instability of the protection. This condition is monitored using a sensitive element, either within the main protection relay or as a stand alone device.

CT supervision is especially recommended for protections applied to High Voltage switchgear and for schemes at all voltages where current transformers are switched to accommodate different busbar arrangements.

When an unbalance is detected, the alarm element is used to operate a suitably rated CT shorting relay, which will prevent any protection maloperation. The relay is arranged to short circuit the CT secondary wiring, diverting current from the protection relay and preventing its operation.

The 7PG1110-7AE10 (AR901) CT shorting relay is such a device, its contacts are rated to carry in excess of 50A for three seconds, which is suitable for the majority of installations. This relay is supplied in a 4U, size E2 relay enclosure.

For more information see section *1.2.1 7PG11 Auxiliary Relay.*

Application

Auxiliary units for High impedance Busbar and Auto transformer protection.

Used in conjunction with the 7SR23 High Impedance Protection Relay, the High Impedance Component Box 7XG15 and its associated CT Shorting Relay 7PG1110-7AE10 provides a complete, panel mounted solution for the provision of High Impedance Protection.

Features of the system include:
CT supervision using elements within the 7SR23.

Provision of test points on the front panel of the Component Box.

CT shorting on the detection of a CT fault, and whenever a protection operation occurs. This limits the dissipation of the resistor and metrosil networks within the protection panel.

Technical Information

7XG15:	
Stabilising Resistor values:	2000, 1000 or 500 Ohms
Non-Linear Resistor:	C = 1000, B = 0.22 – 0.25
Pressure tests:	2kV for 1 minute between phases, and all circuits to Earth.
Shock, Bump, Vibration and Seismic tests:	IEC 60255-21-1,2,3

Cases

Modular case:

7XG15 High Impedance Component Box: E6

Determination of Stability

The stability of a current balance scheme using a high impedance relay circuit depends upon the relay voltage setting being greater than the maximum voltage which can appear across the relay under a given through fault condition. This maximum voltage can be determined by means of a simple calculation which makes the following assumptions:-

1. One current transformer is fully saturated making its excitation impedance negligible.
2. The resistance of the secondary winding of the saturated CT together with the leads connecting it to the relay circuit terminals constitutes the only burden in parallel with the relay.
3. The remaining current transformers maintain their ratio.

Thus the required relay operating voltage is given by:

$$V_S \geq I_F(R_{CT} + R_L) \times T$$

Where

Vs = Relay circuit setting voltage

RL = The largest value of pilot loop resistance between the CT and the relay circuit terminals.

RCT = The secondary winding resistance of the CT.

IF = The CT secondary current corresponding to the maximum steady-state through-fault current of the protected equipment.

T = Turns ratio of all current transformers (Primary turns / Secondary turns)

Method of establishing the value of relay setting resistors.

To give the required voltage setting the relay operating level is adjusted by means of an external series resistor as follows:

$$R_{STAB} = \frac{V_S}{I_S}$$

Where

Rstab = Resistance of the stabilising resistor

Vs = Relay circuit setting voltage

Is = Relay setting current

Fault Setting

The fault setting of a current –balance protection using a high impedance relay circuit can be calculated in the usual manner. It should, however, be noted that because the operating voltage of the relay circuit is relatively high, the excitation currents of the CTs in parallel with the relay may comprise a large portion of the fault setting.

Thus, if Is = the relay setting current, and I1, I2, I3 etc are the excitation currents of the CTs at the setting voltage, and T is the CT turns ratio then

Primary Operating Current = (Is +I1+I2+I3)xT

Current Transformer Requirements

The basic requirements are:

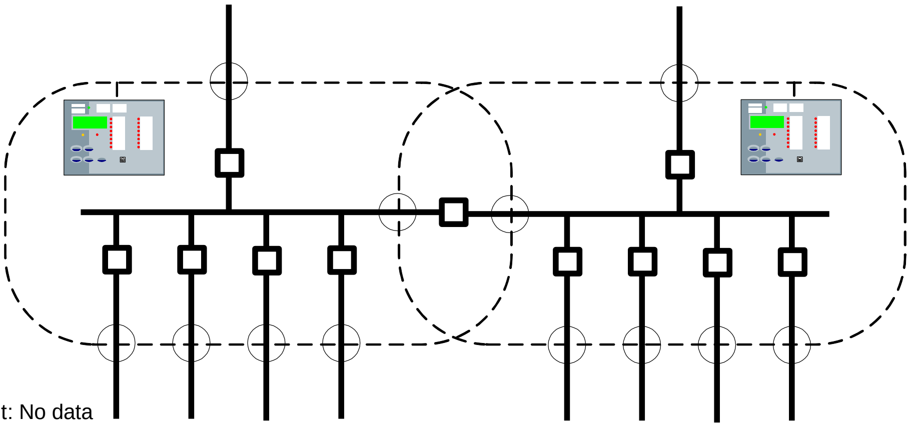
1. All CTs should have identical turns ratios.

2. The knee point voltage of the current transformers should be at least twice the relay setting voltage. The knee point voltage is expressed as the voltage applied to the secondary circuit of a current transformer which when increased by 10% causes the magnetising current to increase by 50%.

3. The current transformers should be of the low leakage reactance type to IEC 60044 class PX. Generally most modern current transformers are of this type and there should be no difficulty in meeting this requirement. Low leakage reactance current transformers have a jointless core with the secondary winding evenly distributed along the whole length of the magnetic circuit, and the primary conductor passes through the centre of the core.

See also the 7SR23 relay manual, applications section. (Chapter 7, Section 3)

Example: 3-Pole Differential Busbar Protection



Example System – Single Busbar

Plant Data

See diagram above.

Setting Requirements

Assigned through fault current (rated stability limit) = 31.5kA (CB break capacity)

Required Fault Setting (Primary Operate Current):

Approximately 50% of busbar rating, or
10 – 30% of minimum fault current available, or
As specified by the user

From the supplied plant data a primary operate current (POC) of 1000A is chosen.

CT and Connection Details

Turns ratio (T)	1/2000
Voltage Knee Point (V_K)	600V
Magnetising Current (Imag) @ V_K	100mA
CT secondary resistance (R_{CT})	10 Ohms
CT lead loop resistance (R_L)	0.15 Ohms max.

Using the data in the 7SR23 settings tool software, we are given the following settings:

7SR23 Relay

87/50-1 Element	Enabled
87/50-1 Current Setting	0.365A
87/50-1 Delay setting	0s
CT50 Element	Enabled
CT50 Setting	0.02A
CT50 Delay	3s

Auxiliary Component Box

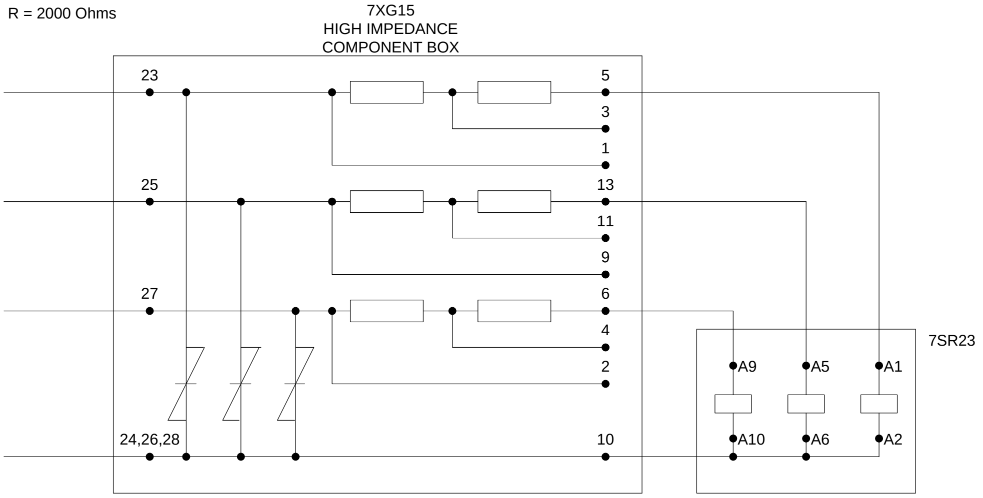
Rstab	500 Ohms
Metrosil	75mm, c = 1000

Control Scheme settings for 7SR23 (see connections diagram)

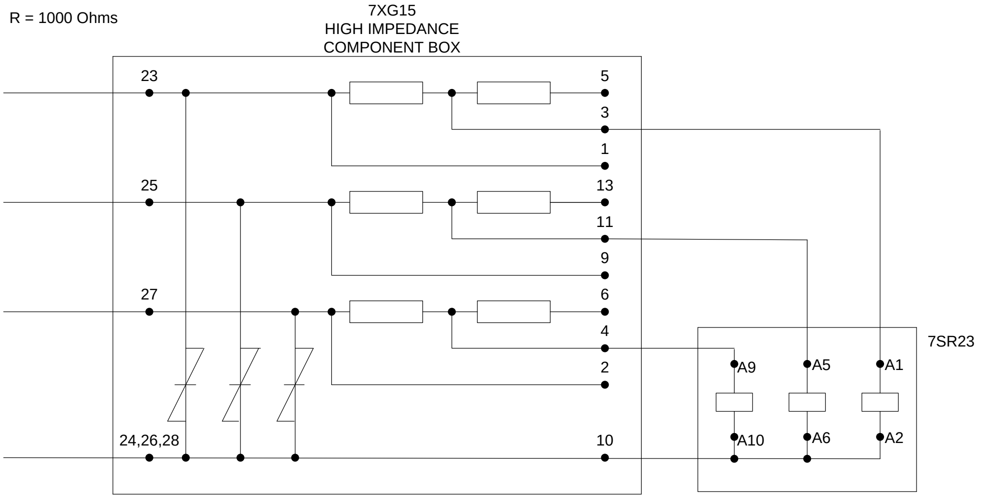
Protection Healthy	BO2
87/50-1 Operated	BO3
CT50 Operated	BO3
Zone Switch Out	BO3
BI 1 Operated	L8
Self Reset LED	L8 (L8 to be marked as " CT Shorting Relay Operated ")
BO3 Minimum Operate Time	5s

Diagrams – Selection of stabilising resistance

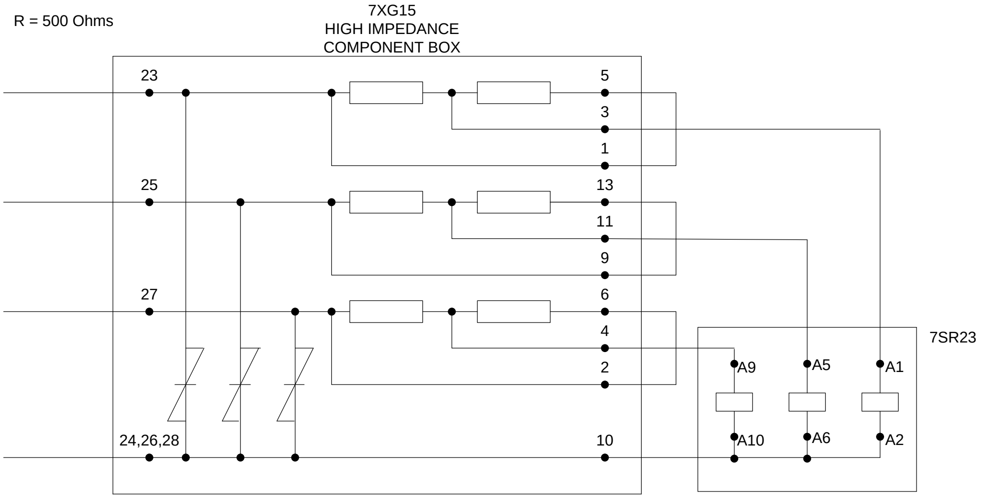
R = 2000 Ohms



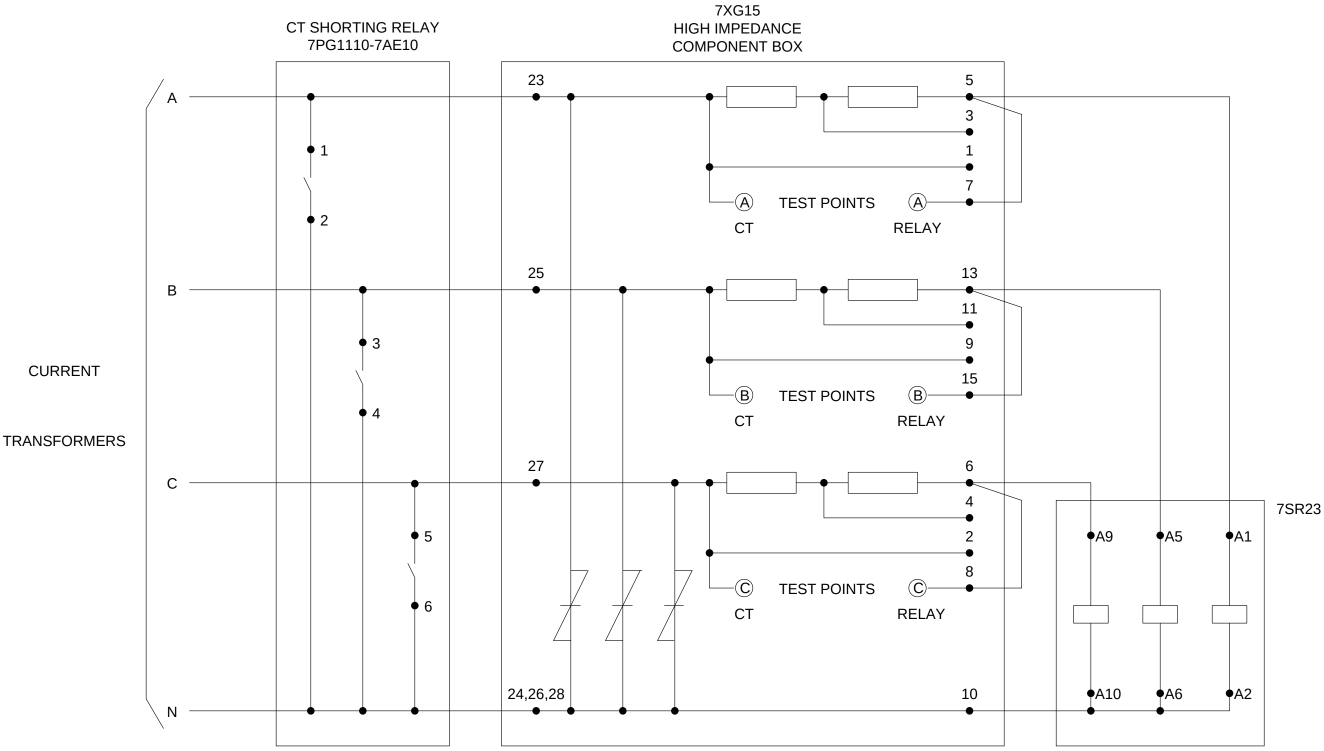
R = 1000 Ohms



R = 500 Ohms



AC Schematic diagram:-
7SR23, 7XG15, 7PG1110



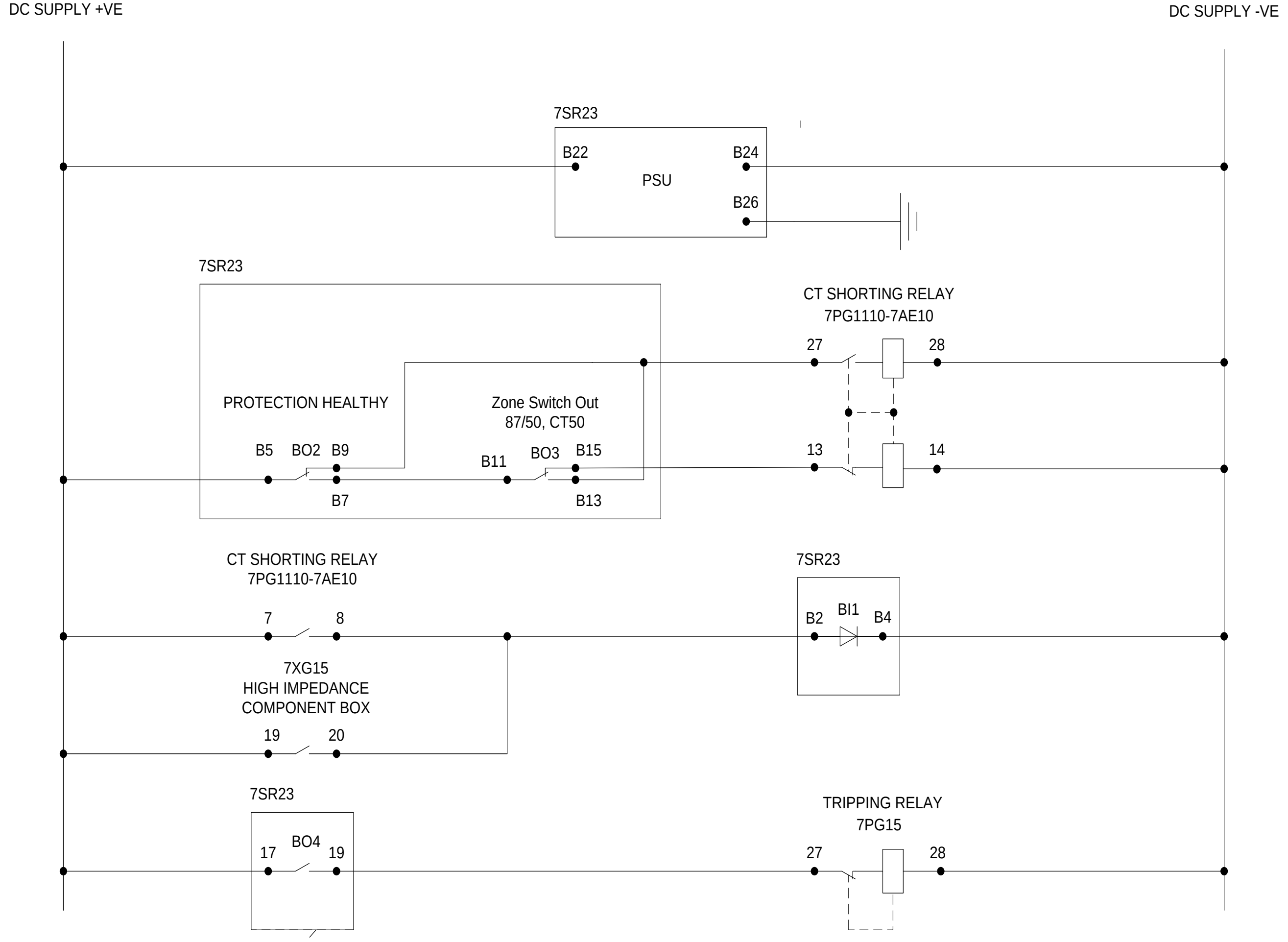
NOTES:

1. 7SR23 DAD connections to the 7XG15 unit are correct for a setting resistance of 2000 Ohms.
These connections must be varied on the 7XG15 unit where the alternative values of 1000 or 500 Ohms are required for a given application.

2. The CT Shorting Relay and the 7XG15 unit are both fitted with case shorting contacts. In the event that either device is withdrawn, the Current Transformers are automatically short circuited and indication is given by the 7SR23.

3. The 7XG15 unit is designed to be used in conjunction with the 7PG11 CT Shorting Relay.
Do not use the 7XG15 unit without a CT shorting relay, or with alternative scheme connections.

DC Schematic diagram:-
7SR23, 7XG15, 7PG1110



NOTES:

1. The rated DC voltage of the CT Shorting Relay and the 7SR23 DAD (Power Supply and Binary Inputs) must be compatible with the available auxiliary supply.

2. On the 7SR23, Binary Input 1 must be suitably mapped to provide a self –reset LED indication that the CT Shorting Relay is operated, and the protection is temporarily out of service (until the CT Shorting Relay Resets).

3. The CT Shorting Relay and the 7XG15 unit are both fitted with case shorting contacts. In the event that either device is withdrawn, the Current Transformers are automatically short circuited and indication is given by the 7SR23.

4. Binary Outputs on the 7SR23 are to be mapped as indicated above. This is to allow automatic operation of the CT Shorting Relay as required by the scheme.

5. BO3 must be configured as hand reset. The protection is reset from the keypad on the 7SR23, this will also reset the CT shorting relay and indication.

6. CB Trip is to be via a latched Trip Relay.

Ordering Information

Component Box		**7 X G 1 5 2 0 - 3 A A 0 0 - 0 D A 0**
Setting resistor and metrosil unit for 7SR23 High Impedance Protection.	Disc size, number of phases Three inch, single phase	**2**
	B value 0.22 to 0.25	**0**
	C value 1000	**3**
	Resistors 2000/1000/500 Ohm	**A**
	Case size E6 (4U high)	**D**

1.4.3 7XG21 Capacitor Cone Adapter Unit for NVD protection

Application

Capacitor Cones are used in 11 and 33 kV Sub/Stations to provide a Neutral Voltage Displacement (NVD) level where conventional Voltage Transformers are too large or too expensive. This voltage level is too high for use by numeric relays, being at system primary levels, and so an Adapter Unit must be used to step it down. The input capacitance of the Adapter can be configured by means of DIL switches to determine the step-down ratio.

The Adapter Unit can be used with any Reyrolle numeric relay with an input for NVD measurement.

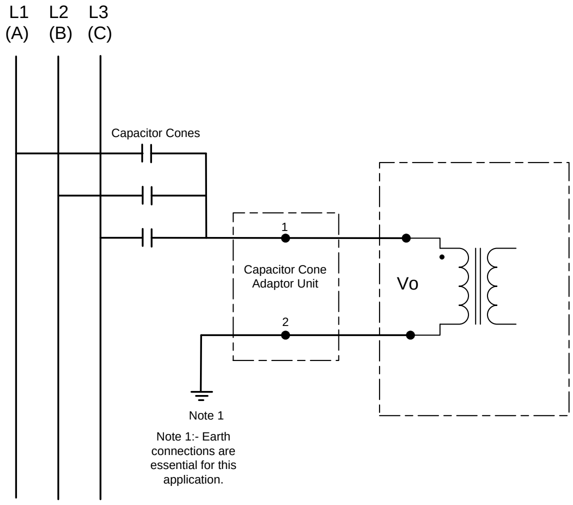
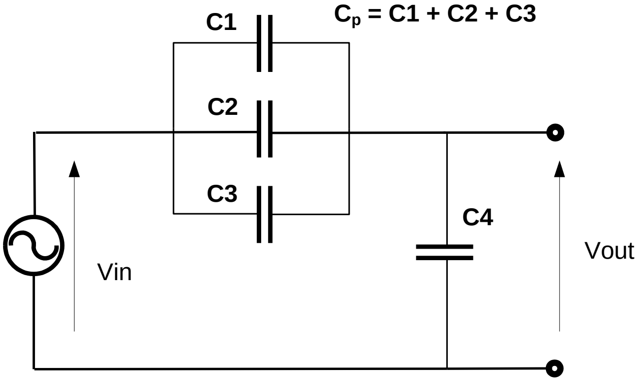


Fig 1. Connection of Capacitor Cone to Reyrolle protection relay

Technical information

Different manufacturers fit Capacitor Cones with different values of capacitance, C1, C2 and C3. The capacitance of the Adaptor Unit, C4, must therefore be settable to achieve the required step-down effect. The available setting range is 1 to 201.9nF, with discrete steps of 1, 2.2, 4.7, 10, 22, 47, 47 and 68nF.



Vout = Vin x Xc4 / ((Xcp x Xc4) / (Xcp + Xc4))
= Vin x Xc4 x (Xcp + Xc4) / (Xcp x Xc4)
= Vin x (Xcp + Xc4) / Xcp
= Vin x Xc4 / Xcp (Xc4 >> Xcp)
= Vin x Cp / C4
C4 = (Vin / Vout) x Cp

Fig 2. Equivalent circuit of Capacitor Cones and Adaptor Unit

The voltage input impedance of the Reyrolle numeric relays is high enough not to load this circuit. However allowance must be made for the capacitance of the voltage input (5.7nF) of the relay.

Setting= ((Vin / Vout) x Cp in nF) – 5.7nF

Example: 150pF capacitor cones used on a 33kV system.

As a guideline, Primary NVD pick-up level is 25% of the Primary P-N voltage = 33kV x 0.25 / √3 = 5kV

Choose a relay NVD pick-up of, say, 25V

Adaptor Unit setting = (Vin/Vout) x Cp
= (5kV/25V) x (3 x 150pF) = 90nF

Allowing for the voltage input impedance of the relay
= 90nF – 5.7nF = 84.3nF

> Note that allowance should also be made for the capacitance of cabling if this is significant.

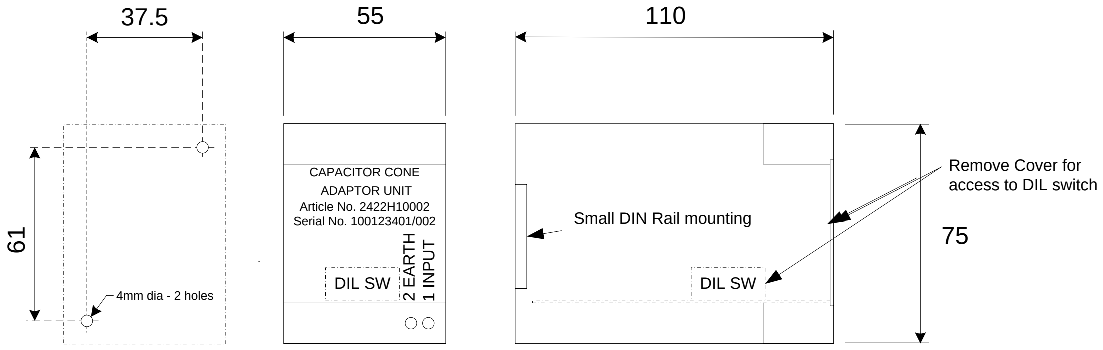
Setting the "3Vo VT Primary" to 5kV,
and the "3Vo VT Secondary" to 25V
will give correct primary and secondary NVD meters

The Adaptor Unit provides a secure housing and has the advantage that it can be fine tuned on site – by means of direct primary injection - to allow for variations in the actual capacitance of the Capacitor cones. It provides a reduced voltage level, Vout, and surge suppression; clamping switch-on or lightning-induced spikes to less than 250 V AC.

Fig on

NOTE: Capacitor Cones must be considered as current sources for maintenance purposes. Current levels will be low but the high voltage levels pose a danger to personnel and plant. The Cones should therefore be short-circuited to EARTH and NOT open

Case Drawing



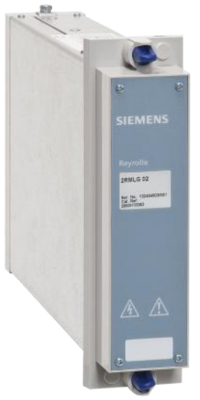
Switch 1 ON = 1nF
Switch 2 ON = 2.2 nF
Switch 3 ON = 4.7 nF
Switch 4 ON = 10nF
Switch 5 ON = 22nF
Switch 6 ON = 47nF
Switch 7 ON = 47 nF
Switch 8 ON = 68nF

Setting = SUM of the Capacitance of all On Switches

Ordering Information – Capacitor Cone Adapter Unit 7XG21

Product description	Variants	Order No.
Capacitor Cone Adaptor Unit		**7 X G 2 1 0 0 - 1 A A 0 0 - 0 A A 0**

1.4.4 7XG22 2RMLG, 8W & 10W Test Blocks



Description

The 7XG22 range of Test Blocks, housed within an Epsilon enclosure, offers facilities for monitoring and secondary injection testing of power system protection schemes in conjunction with the appropriate multi-fingered test plug.

The 2RMLG Test Block has 14 pairs of spring loaded contacts which are linked to a terminal block positioned at the rear of the enclosure.

The 8W and 10W Test Blocks are of identical construction to the 2RMLG but with 8 or 10 pairs of contacts respectively.

The 2RMLG07 is coded to only accept the 2RMLB-S7 Test Plug which has connection terminals 21, 23, 25 & 27,internally – For typical application see Fig 4.

The 2RMLG08 is coded to only accept the 2RMLB-S8 Test Plug which has internal pairs 1&3, 5&7, 9&11 and 15&17 shorted together internally – For typical applications see Figs 5, 6, 7 & 8.

The 2RMLG09 is coded to only accept the 2RMLB-S9 Test Plug which has internal pairs 1-3-5-7, and 17-19 shorted together internally.

Each pair of contacts is normally closed completing the circuit through the test block when the associated protection equipment is in use.

For testing purposes the test block can be accessed by removing the front cover. The 2RMLG 01 has a metallic probe attached to the front cover assembly which when withdrawn open circuits the 2 contacts at position 13 and 14.

The main dc auxiliary supply to the protection scheme or relay can be wired to this circuit to prevent inadvertent tripping of the protection circuit after removal of the cover and during the test procedure.

The 2RMLG 02/07/08/09 do not include the above facility and contacts 13 and 14 are normally closed. These contacts must not be used for current circuits, as the relevant contact finger on the 2RMLB test plug is shorter in this position.

The short test finger in position 13-14 on the 2RMLB will open contacts 13-14 in the test block after the other fingers have made contact in all other positions.

Fig 1 & 2.

Note: It is important that the sockets in the test plug (2RMLBS-1) which correspond to the current transformer secondary windings are linked prior to the test plug being inserted into the test block.

This will ensure that the current transformer secondary windings are short circuited prior to disconnection from the protection scheme or relay (as shown in Figure 3).
If the dc auxiliary supply is to be used during testing it can be linked using the sockets in the test plug.

Operation of the contacts can be monitored by connecting the test equipment to the protection scheme or relay with the even numbered sockets of the test plug.
If a number of 2RMLG test blocks are connected to a relay it is recommended that the dc supply be routed through each of them to safeguard against inadvertent operation.

Mechanical Specification

The 2RMLG, 8W and 10W are a size E2 unit in the Epsilon range of enclosures. The overall dimensions and panel fixing details are shown in Figure 10.

The rear terminal block has 28 terminals each with an M4 screw outlet for the attachment of external wiring, fitted with 'L' shaped pre-insulated ring tongue terminations.

2RMLB-S series Multi-fingered test plugs

The 2RMLB-S series are inserted into the 2RMLG test socket and is securely retained by means of two knurled screws. The 2RMLB-SI test plug incorporates 28 test sockets, each socket accepting a shrouded or plain 4mm diameter plug.

2RMLB S7 with Shorting Contacts

The 2RMLB-S7 is similar to the 2RMLB-S1 with shorted contact pairs 21-23-25-27and is coded to be used with the MMLG07 Test Socket only.

2RMLB S8 with Shorting Contacts

The 2RMLB-S8 is similar to the 2RMLB-S1 with shorted contact pairs 1-3, 5-7, 9-11, 15-17 and is coded to be used with the 2RMLG08 Test Socket only.

2RMLB S9 with Shorting Contacts

The 2RMLB-S9 is similar to the 2RMLB-S1 with shorted contact pairs 1-3-5-7, 9-11, 17-19, 21-23-25-27 and is coded to be used with the 2RMLG09 Test Socket only.

Precautions

BEFORE inserting a Test Plug into a Test Socket carrying current transformer secondary circuits.

ENSURE that the Test Plugs corresponding to the current transformer circuits are short-circuited.

This is to ensure the current transformer secondary circuits are not inadvertently open-circuited during insertion of the last plug.

BEFORE inserting a Test Plug to measure current.
ENSURE that the ammeter is on the correct range and that it is connected to its test leads

Connections

The connections will depend upon the scheme and details must be obtained from the appropriate diagrams. If it is necessary to use the d.c. auxiliary supply during testing, then a test link may be fitted across the sockets in the Test Plug.

Technical Information

High Voltage withstand

Insulation
IEC 255-5: 1977

2RMLG 01/02/07/08/09 8W & 10W	5kV rms for 1 minute between all case terminals connected together and the case earth terminal.
	5kV rms for 1 minute between any contact pair and either adjacent alternate contact pair, provided the intermediate contact pair is not used
	2kV rms for 1 minute between any contact pair and either adjacent contact pair
2RMLG 01 only 8W & 10W	1kV rms for 1 minute between terminals 13 and 14 when the cover is removed (e.g. opening the auxiliary supply or trip circuit).
2RMLB-S1	As 2RMLG 01 plus 2kV rms for 1 minute between incoming and outgoing contacts when inserted
2RMLB-S7	As above with the exception of terminals 21, 23, 25 & 27 which are permanently shorted together
2RMLB-S8	As above with the exception of terminal pairs 1&3, 5&7, 9&11, 15&17 which are permanently shorted together as pairs
2RMLB-S9	As above with the exception of terminal pairs 1-3-5-7,17-19 which are permanently shorted together as pairs

Current withstand

2RMLG 01/02/07/08 8W & 10W	All contact circuits rated at 20A continuously or 400A for 1s, ac or dc
2RMLBS1-S9	

Atmospheric environment

Temperature

IEC 255-6: 1988	Storage and transit - 25°C to +70°C
	Operating -25°C to +55°C
IEC 68-2-1: 1990	Cold
IEC 68-2-2: 1974	Dry Heat

Humidity

IEC 68-2-3: 1969	56 days at 93% RH and +40°C

Enclosure Protection

IEC 529: 1989	IP50 (dust protected)

Mechanical environment

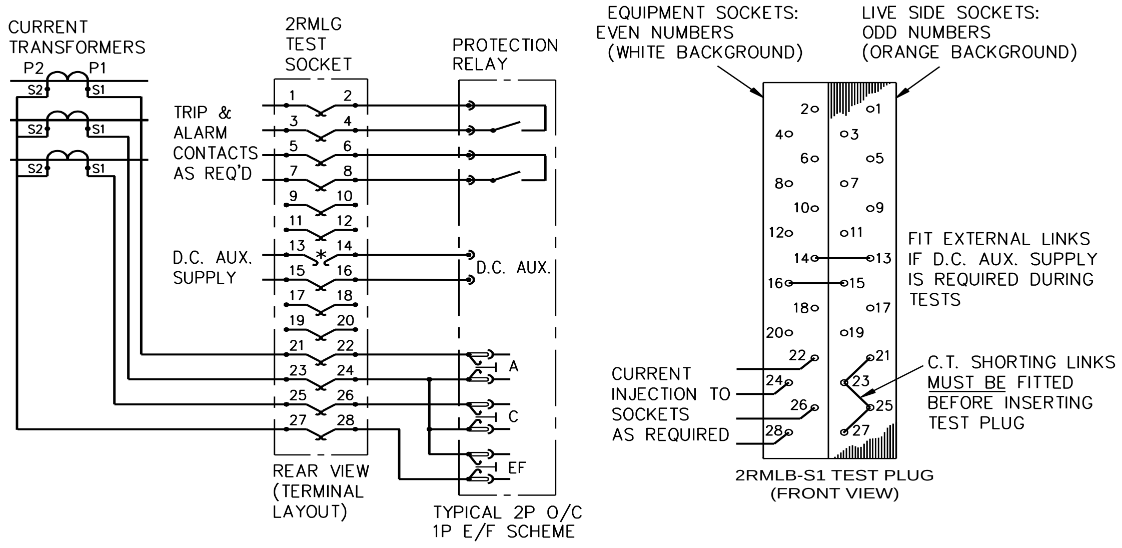
Vibration

IEC 255-21-1: 1988	Response Class 2

EMC compliance

89/336/EEC	These products have been classified as electromagnetically benign and are therefore excluded from the European Community EMC Directive. (89/336/EEC)

TYPICAL APPLICATION OF THE 2RMLG01 / 2RMLG02 TEST SOCKET AND 2RMLB-S1 TEST PLUG



*2RMLG01 13/14 OPEN CCT WHEN COVER REMOVED AND OTHER POSITIONS CONNECTED.
2RMLG02 13/14 CONNECTED AS PER OTHER POSITIONS.

Fig 3.

TYPICAL APPLICATION OF THE 2RMLG07 TEST SOCKET AND 2RMLB-S7 TEST PLUG

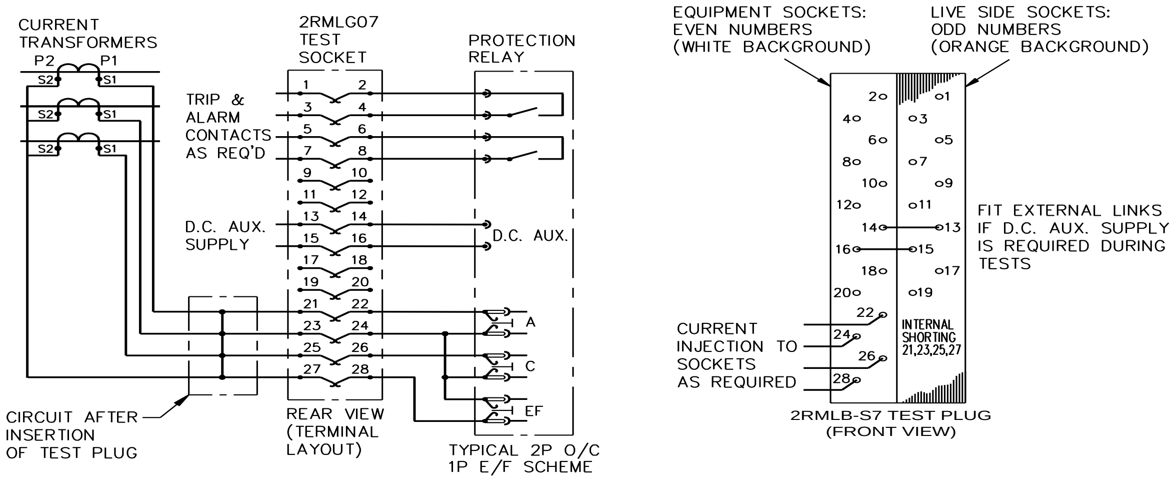


Fig 4.

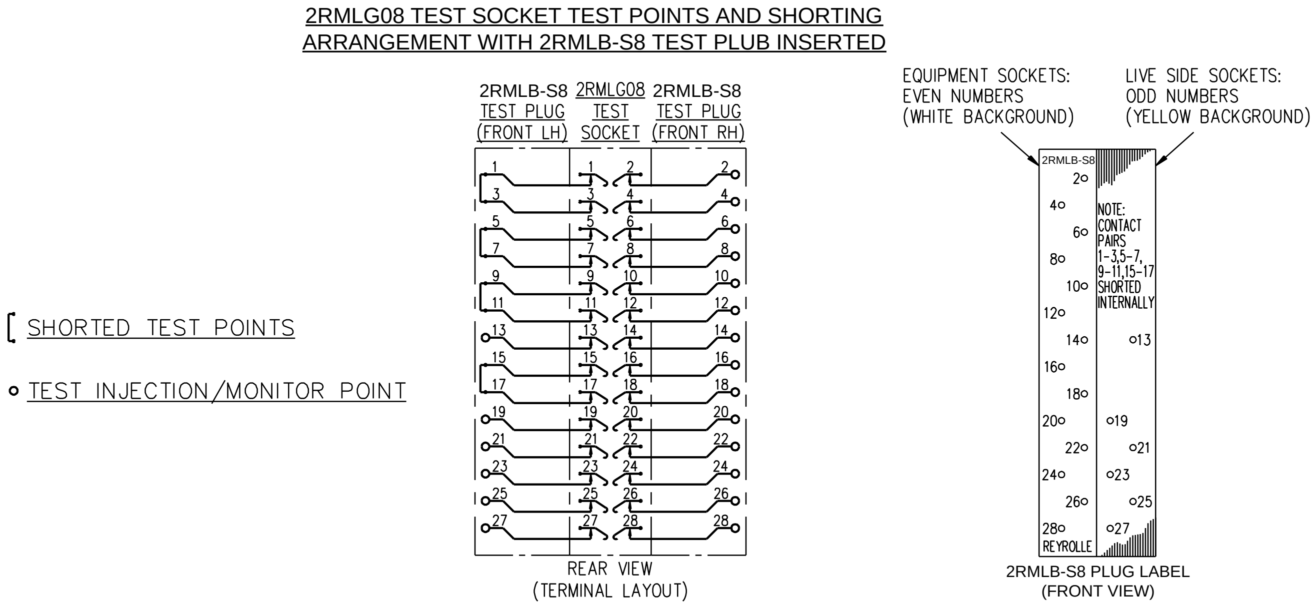

2RMLG08 TEST SOCKET TEST POINTS AND SHORTING
ARRANGEMENT WITH 2RMLB-S8 TEST PLUB INSERTED
2RMLB-S8 TEST PLUG (FRONT LH)
2RMLG08 TEST SOCKET
2RMLB-S8 TEST PLUG (FRONT RH)
SHORTED TEST POINTS
TEST INJECTION/MONITOR POINT
REAR VIEW
(TERMINAL LAYOUT)
EQUIPMENT SOCKETS:
EVEN NUMBERS
(WHITE BACKGROUND)
LIVE SIDE SOCKETS:
ODD NUMBERS
(YELLOW BACKGROUND)
2RMLB-S8
NOTE:
CONTACT PAIRS 1-3,5-7, 9-11,15-17 SHORTED INTERNALLY
REYROLLE
2RMLB-S8 PLUG LABEL
(FRONT VIEW)

Fig 5.

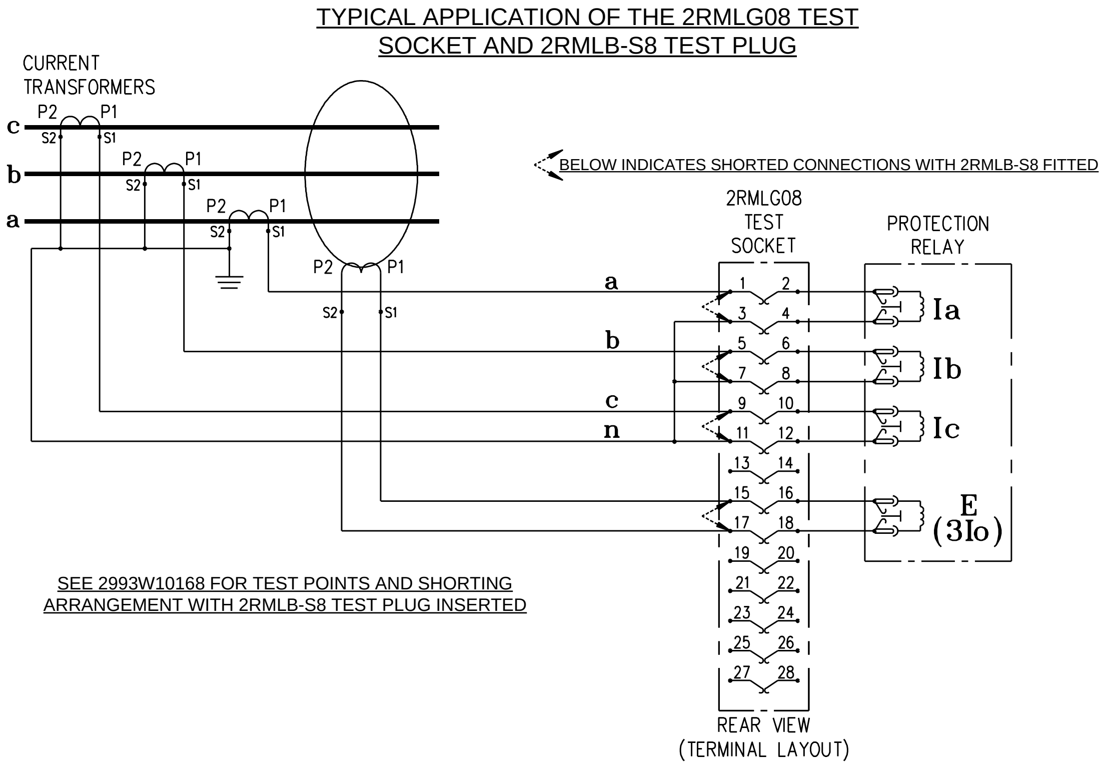

TYPICAL APPLICATION OF THE 2RMLG08 TEST
SOCKET AND 2RMLB-S8 TEST PLUG
CURRENT TRANSFORMERS
P2
P1
S2
S1
c
b
a
n
BELOW INDICATES SHORTED CONNECTIONS WITH 2RMLB-S8 FITTED
2RMLG08 TEST SOCKET
PROTECTION RELAY
Ia
Ib
Ic
E
(3Io)
SEE 2993W10168 FOR TEST POINTS AND SHORTING
ARRANGEMENT WITH 2RMLB-S8 TEST PLUG INSERTED
REAR VIEW
(TERMINAL LAYOUT)

Fig 6.

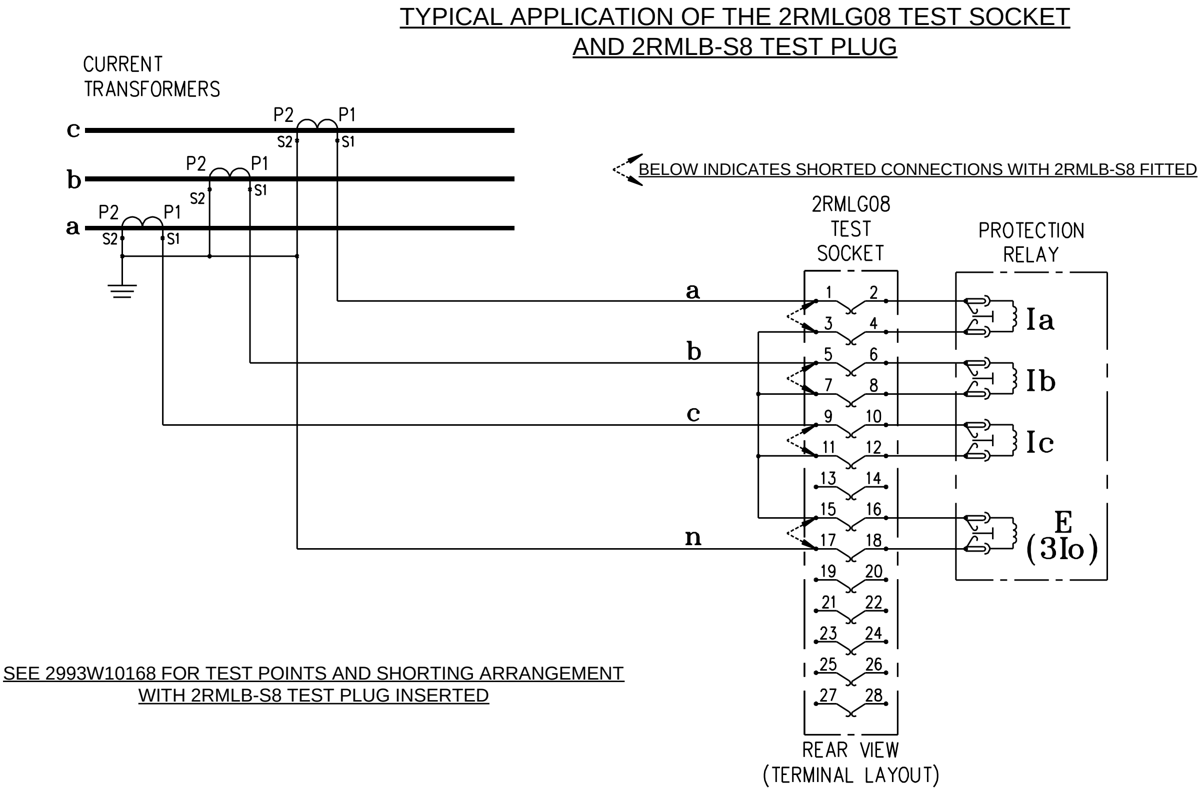
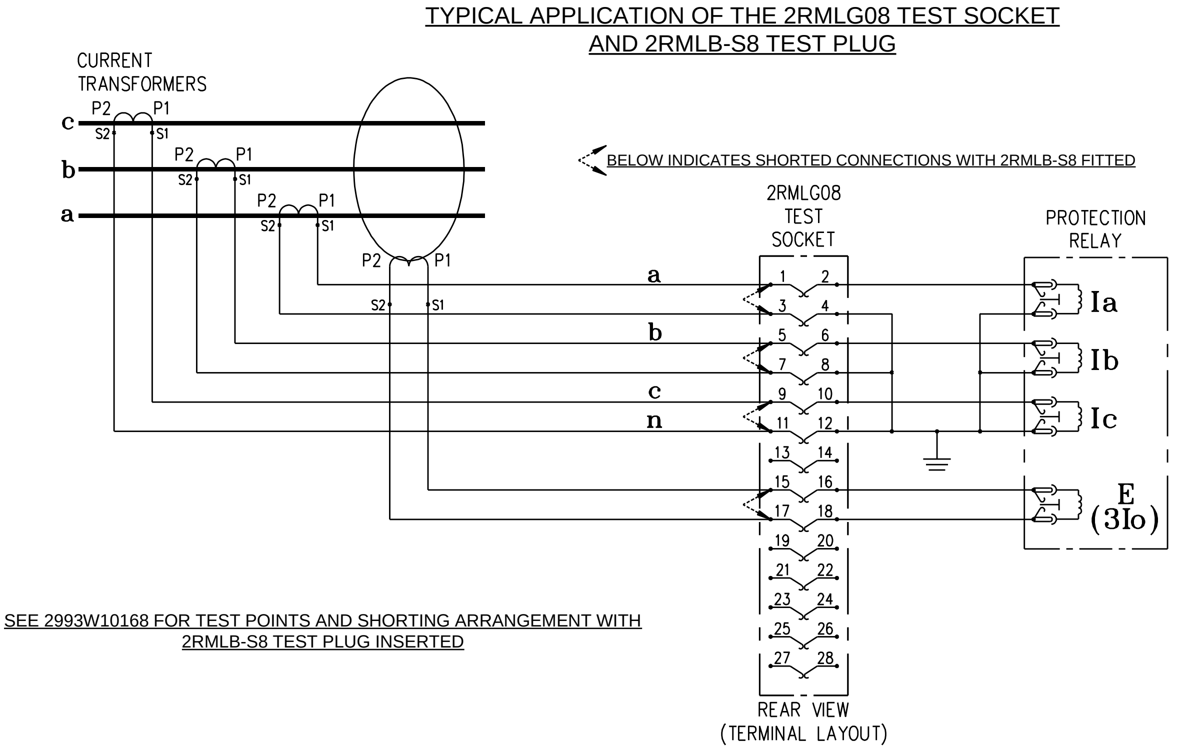

TYPICAL APPLICATION OF THE 2RMLG08 TEST SOCKET AND 2RMLB-S8 TEST PLUG
CURRENT TRANSFORMERS
c
b
a
P2
P1
S2
S1
BELOW INDICATES SHORTED CONNECTIONS WITH 2RMLB-S8 FITTED
2RMLG08 TEST SOCKET
PROTECTION RELAY
a
b
c
n
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Ia
Ib
Ic
E (3Io)
SEE 2993W10168 FOR TEST POINTS AND SHORTING ARRANGEMENT WITH 2RMLB-S8 TEST PLUG INSERTED
REAR VIEW (TERMINAL LAYOUT)

Fig 7.


TYPICAL APPLICATION OF THE 2RMLG08 TEST SOCKET AND 2RMLB-S8 TEST PLUG
CURRENT TRANSFORMERS
c
b
a
P2
P1
S2
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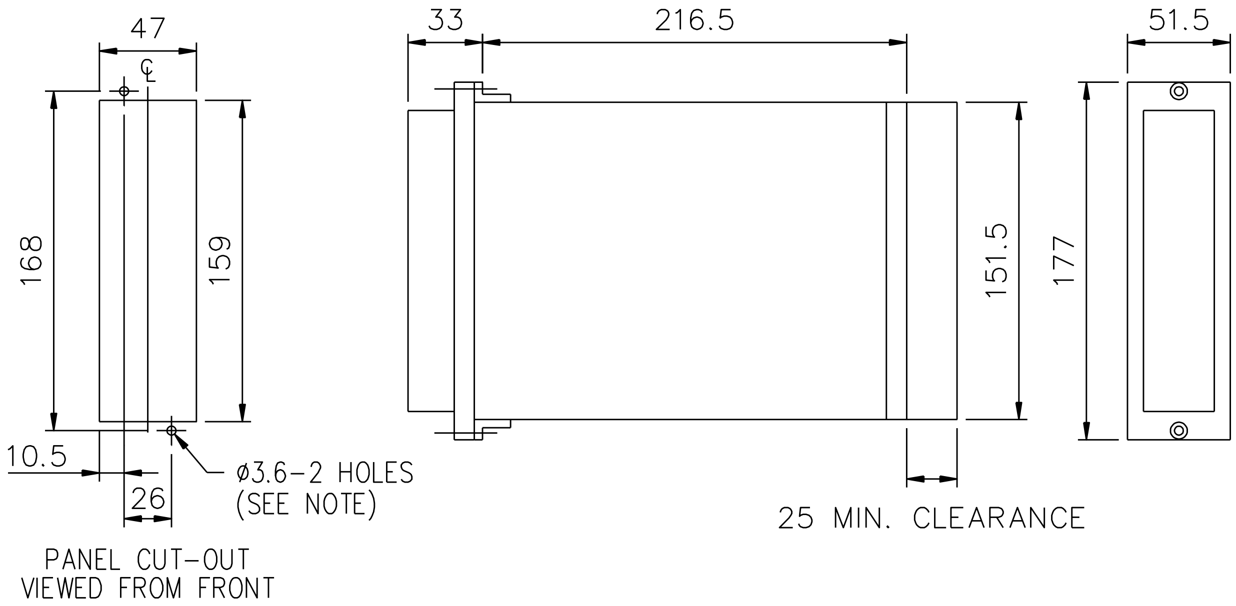
BELOW INDICATES SHORTED CONNECTIONS WITH 2RMLB-S8 FITTED
2RMLG08 TEST SOCKET
PROTECTION RELAY
a
b
c
n
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
Ia
Ib
Ic
E (3Io)
SEE 2993W10168 FOR TEST POINTS AND SHORTING ARRANGEMENT WITH 2RMLB-S8 TEST PLUG INSERTED
REAR VIEW (TERMINAL LAYOUT)

Fig 8.

OUTLINE AND DRILLING DRAWING FOR 2RMLG TEST SOCKETS IN EPSILON E2 CASE



NOTE:
THE ø3.6 HOLES ARE FOR M4 THREAD FORMING (TRILOBULAR) SCREWS. THESE ARE SUPPLIED AS STANDARD AND ARE SUITABLE FOR USE IN FERROUS/ALUMINIUM PANELS 1.6mm THICK AND ABOVE. FOR OTHER PANELS, HOLES TO BE M4 CLEARANCE (TYPICALLY ø4.5) AND RELAYS MOUNTED USING M4 MACHINE SCREWS, NUTS AND LOCKWASHERS (SUPPLIED IN PANEL FIXING KIT).

Fig 9.

Ordering Information

Product description	Variants	Order No.
Test Modules – 2RMLG		**7 X G 2 2 2 0 - □ □ A 0 0 - 0 A A 0**
Modular case test components (MLG).	Category	
	Ancillary equipment	2
	Ancillary equipment	
	Modular case test components	2
	Test component type	
	Test modules (MLG)	**2**
	Component type	
	Test module in size E2 case (2RMLG01)	1
	Test module without open circuit facility between terminals 13 and 14 when cover removed (2RMLG02)	2
	Test module with automatic CT shorting (2RMLG07)	3
	Test module with automatic CT shorting (2RMLG08)	4
	Test module with automatic CT shorting (2RMLG09)	5
	Mounting	
	E2 Case Vertical	**A**
	E2 Case Horizontal	**B**
Test plugs – 2RMLB		**7 X G 2 2 4 0 - □ A A 0 0 - 0 A A 0**
Modular case test components (MLB).	Category	
	Ancillary equipment	2
	Ancillary equipment	
	Modular case test components	2
	Test component type	
	Test modules (MLG)	**4**
	Component type	
	Multi finger test plug complete with leads (2RMLB-S1)	1
	Multi finger test plug complete with leads and internal shorting links (2RMLB-S7)	3
	Multi finger test plug complete with leads and internal shorting links (2RMLB-S8)	4
	Multi finger test plug complete with leads and internal shorting links (2RMLB-S9)	5

Test plugs are coded to fit, and should only be used with the appropriate test block

Test Modules and Plugs – 8W & 10W

7XG227☐-0AA00-0AA0

Modular case test components.

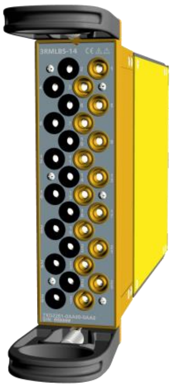
Category	
Ancillary equipment	2

Ancillary equipment	
Modular case test components	2

Test component type	
Test modules & plugs	**7**

Component type	
8 way test module	1
8 way test plug	2
10 way test module	3
10 way test plug	4

1.4.5 7XG225 – 3RMLG Test Block System



7XG225 is a flexible and high performance test block system with a focus on operator safety. Suitable for application on a wide range of protection relay panels.

- Finger safe test sockets
- Automatic CT shorting
- 14 or 28 independent test groups

3RMLB-S Test Plug

- 14 or 28 test circuits
- 'Finger safe' test sockets
- One test plug for all 14 way 3RMLG blocks
- One test plug for all 28 way 3RMLG blocks

Features

- Automatic shorting of CT circuits completed in the test block - No test links or operator intervention required
- Isolation plug provides sequential circuit isolation timing in three (3) stages
- 'Finger safe' test sockets suit standard or shrouded type 4mm banana plugs for direct access to the protection or measurement scheme
- Clear and concise front panel circuit identification
- Test plug fitted with insertion handle and thumb screw retention system to enhance operator safety and system security
- Side label instructions on test plug for changing from normal service to the test condition
- High current / voltage rating

Application

Test blocks enable test technicians to quickly and safely isolate protection relays so that test signals may be injected and system performance verified.

There are a number of advantages in performing injection tests at the protection relay panel:

- Reduction in down time of the equipment under test
- Testing does not cause disturbance to wiring, terminals or equipment settings
- Existing auxiliary supply to the equipment under test may be isolated

The 3RMLG Test Block system is designed as a general-purpose isolation and test signal injection point. 'Finger safe' sockets are employed to improve operator safety and suit 4mm shrouded type banana plugs.

Equipment under test need only be removed for servicing if problems are detected or for routine maintenance.
Where more than 14 test circuits are required, refer to the 3RMLG models that provide 28 test circuits.

Test Circuit Access

Access to the circuits for testing purposes is achieved in a three stage process.

STAGE ONE	Test Block Cover Extraction
Isolation:	Isolation of Stage 1 circuits
STAGE TWO	Isolation Plug Extraction
CT Shorting:	Automatic shorting of all CT circuits
Isolation:	Isolation of Stage 2
	Isolation of CT circuits
STAGE THREE	Test Plug Insertion
Insertion:	4mm test points available

The above procedure should be completed in the reverse order to place the protection system back in service. Insertion of the Test Plug type 3RMLB connects the live side circuits to the 4mm yellow test sockets. The equipment side circuits are connected to the 4mm black test sockets. Each test socket is identified by a number, which corresponds to the numbered terminal on the rear of the case when the Test Plug is inserted. Refer to figure 10.

The internal vertical CT shorting bar shorts the CT terminals on the live side only, on removal of the isolation plug. Therefore it is vital that CTs are connected to the live side terminals to avoid the CT wiring being open-circuited.

Inserting the 3RMLB test plug allows changeover in 3 stages as shown in the timing diagram Figure 1.

Description

The fourteen (14) test groups are specified to provide automatic CT shorting and sequential circuit to suit specific protection schemes:

- Stage 1 isolation
- CT shorting
- Stage 2 isolation

The main advantage of this approach is the improved level of safety and security afforded to the CT circuits. This is because the CT shorting function takes place within the

3RMLG Test Block irrespective of the CT circuit position. In many test block systems the CT shorting is only accomplished when the Test Plug is inserted which leaves open the possibility of a CT circuit becoming open circuit due to the CT shorting links being omitted or in the wrong position. This potential problem is avoided in the 3RMLG and allows a single Test Plug to be employed for all 14 way Test Block configurations.

Each test circuit is connected to a separate pair of terminals at the rear of the case. During normal operation of the associated protection equipment, each terminal pair is connected via a circuit-shorting link.

Where more than 14 test circuits are required such as in EHV transmission protection panels, the 3RMLG Test Block with 28 test circuits may be employed.

Safety Overview

While providing maximum convenience and efficiency to system testing, test block systems must also provide a high degree of safety. This section describes the key design features employed in the 3RMLG test block system to enhance operator safety.

Finger Safe Test Sockets

BLACK	- even numbered equipment side sockets
YELLOW	- odd numbered live side sockets

The 3RMLG Test Plug employs ‘finger safe’ test sockets. This allows the use of shrouded banana plugs to greatly reduce the possibility of an operator coming into contact with any part of the test circuit.

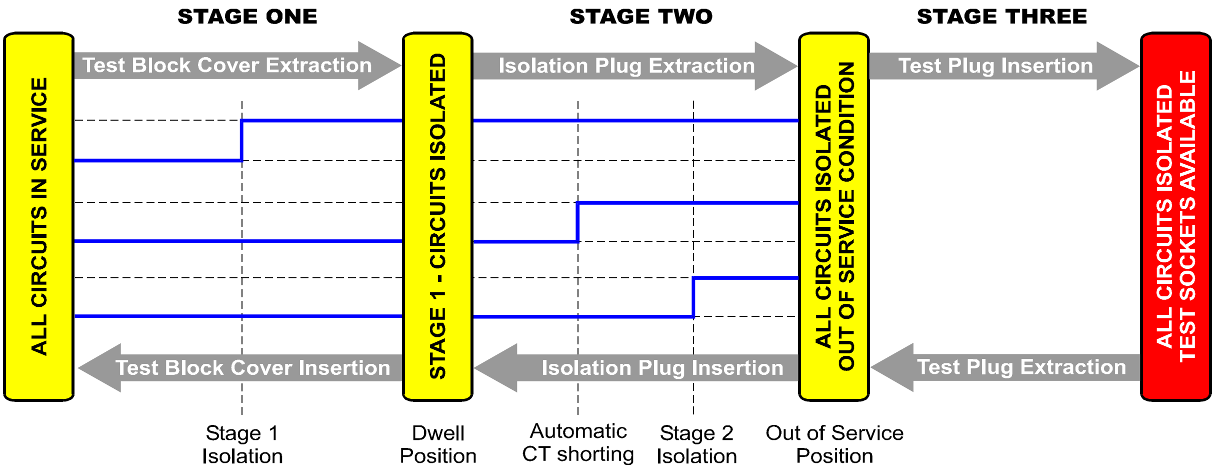


Fig 1. Timing diagram

Test Plug Handles

The 3RMLG employs handles at the top and bottom of the plug assembly to ensure the operator’s hand is well separated from the test sockets during insertion. Retention thumb screws are provided at the top and bottom of the test plug to avoid inadvertent removal of the plug during testing.

Fig 2. VT Connections

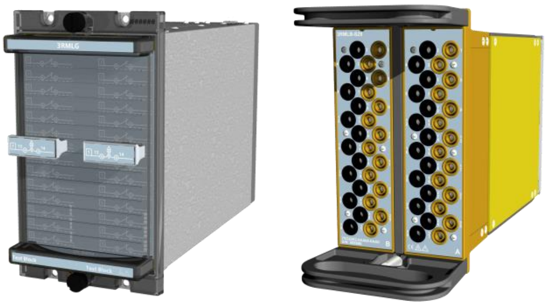


Fig 3. 28 Test circuit versions

Test Lead Insertion

Before use the insulation of the flying leads should be visibly checked for damage.

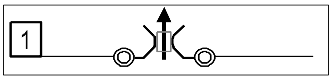
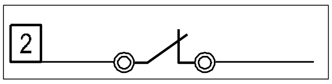
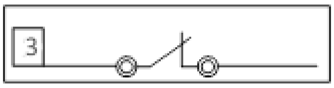
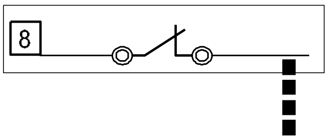
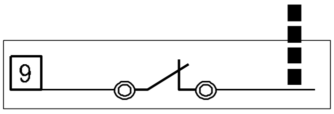
Flexible banana test leads with shrouded plugs are recommended for operator safety. 2.5mm^2 multi-strand wire with PVC insulation is recommended for adequate current rating and flexibility.

Test Plug Insertion

To avoid high voltage shock hazard, external CT circuits must NOT be open circuited.

Insertion of the 3RMLB-S connects the live side circuits to the YELLOW test sockets on the front panel. The equipment side circuits are connected to the BLACK test sockets on the front panel. Each test socket is identified by a number, which corresponds to the numbered terminal on the rear of the case when the Test Plug is inserted.

Automatic CT Shorting

Type	Description	Function	Timing Stage	Front Panel Labeling
1	Stage 1 isolation cassette	This circuit type is isolated at Stage 1 as the front cover is removed from the Test Block. Use to provide: • Isolation of auxiliary supply Isolation of trip circuits	1	
2	Stage 2 isolation cassette (General Purpose)	This circuit type is isolated later during Stage 2 as the Isolation Plug is removed from the Test Block. Use to provide: • Isolation of trip circuits • Remote 'Out of Service' indication • Isolation of inter-tripping circuits • Isolation of watchdog alarms • Isolation of VT circuits • Isolation of I/O circuits	2b	
3	Stage 2 isolation cassette (Early Break)	This circuit type is isolated early during Stage 2 as the Isolation Plug is removed from the Test Block. Use to provide: • Isolation of trip circuits • Isolation of inter-tripping circuits • Isolation of watchdog alarms	2a	
8	CT cassette with shorting bar to the adjacent circuit below	Use for CT connections so that they will be automatically shorted to the adjacent CT circuit below. After shorting, this circuit is isolated at Stage 2.	Refer to Figure 2	
9	Last CT cassette on a CT group	Use for the last CT connection in a group so that it will be automatically shorted to the adjacent CT circuit above. After shorting, this circuit is isolated at Stage 2.	Refer to Figure 2	

Recommended Wiring Layout

It is recommended that the Test Block is always wired with connections to the protective relay or scheme made to the EVEN numbered equipment side terminals. Connections to other equipment, e.g. CT's, VT's and DC supplies, should be made to the ODD numbered live side terminals on the Test Block. This ensures that when the Test Plug is inserted, the black sockets are connected to the isolated relay circuits and the yellow sockets are connected to the potentially live supplies. This is vital as the automatic CT shorting is only applied to the live side.

- This image shows the 3RMLG with the front cover removed to isolate the Stage 1 circuits.
- The Isolation Plug is in place so the CTs and Stage 2 circuits are still connected.
- The front label identifies each cassette type.

Fig 4. Front Panel Layout

3RMLG-01 Test Block for a 3 Ph O/C and E/F application.

CT Circuits

CT circuits must only be wired to cassette type 8 or 9.

CT circuits must not be wired to cassette types 1, 2 or 3 as this will result in open circuit CT's as the isolation plug is removed.

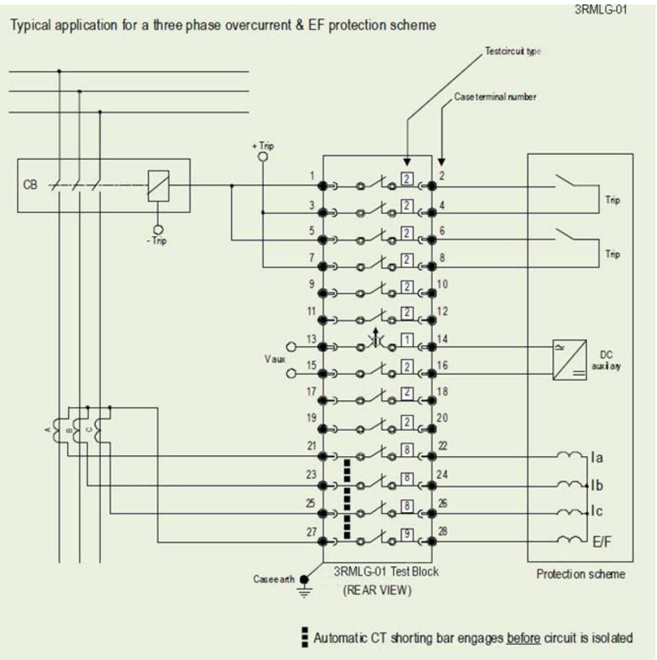


Fig 5. Application wiring example for a three phase overcurrent and EF protection scheme with auto CT shorting.

Order Code – 3RMLG01

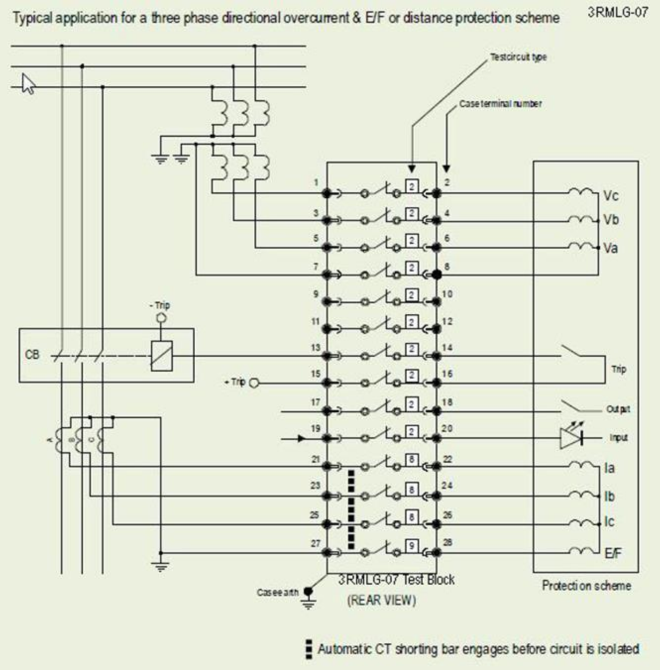


Fig 6. Application wiring example for a three phase directional O/C and E/F or distance protection scheme with auto CT shorting. Order Code – 3RMLG07

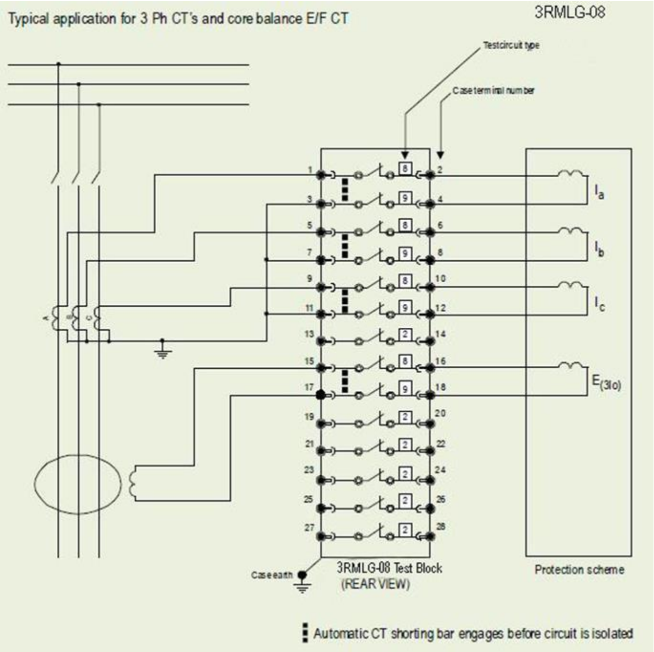


Fig 7. Application wiring example for three phase CT's and core balance E/F CT with auto CT shorting. Order Code – 3RMLG08

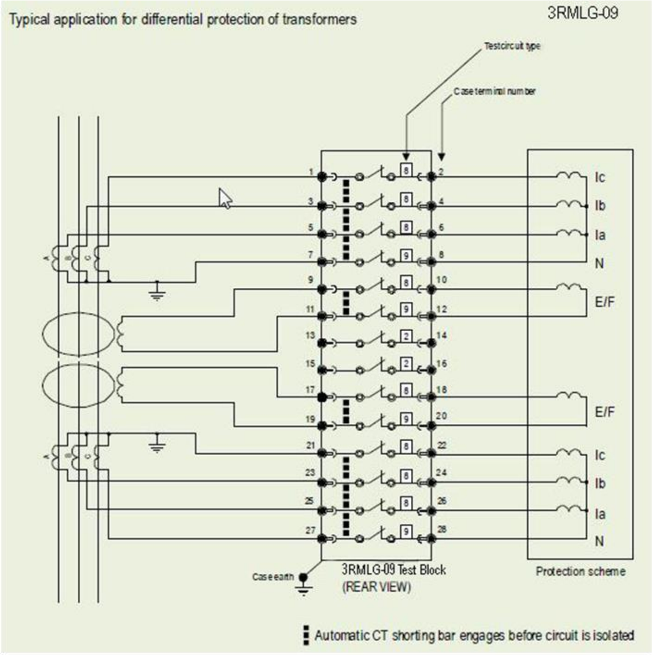
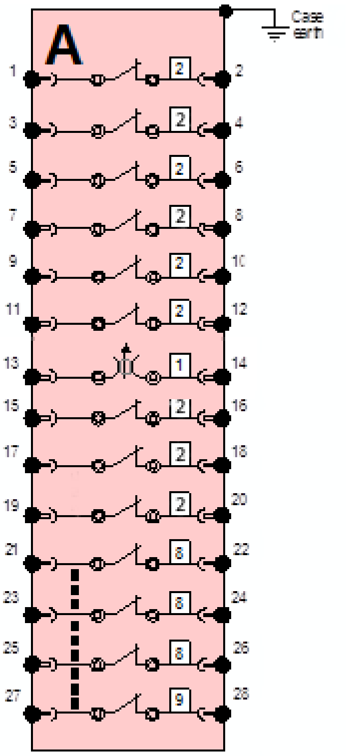
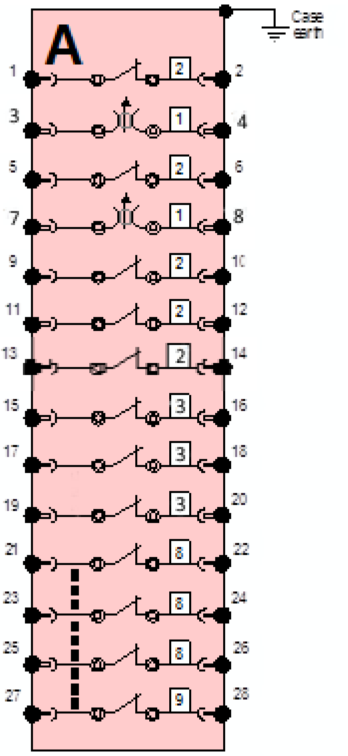


Fig 8. Application wiring example for differential protection of transformers with auto CT shorting Order Code – 3RMLG09

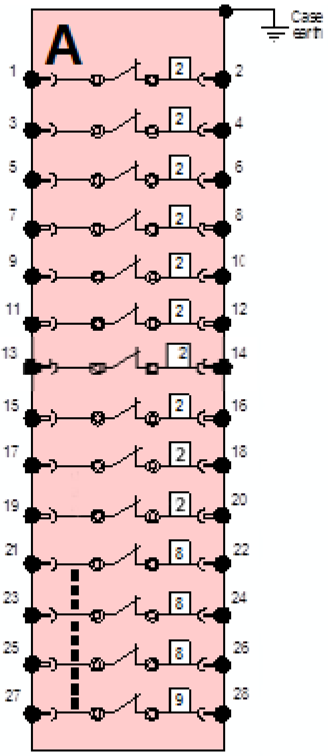
14 WAY TEST BLOCKS
3RMLG – 01



3RMLG – 02



3RMLG – 07



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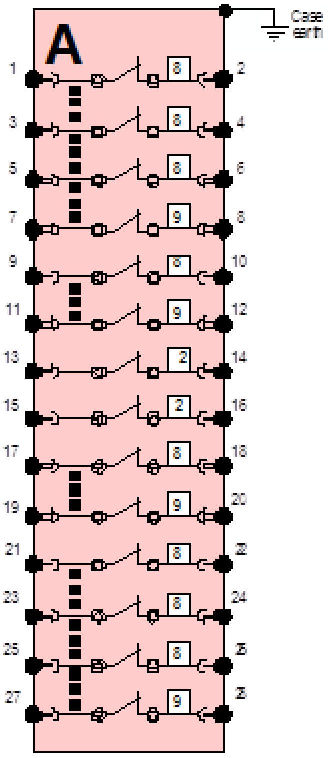
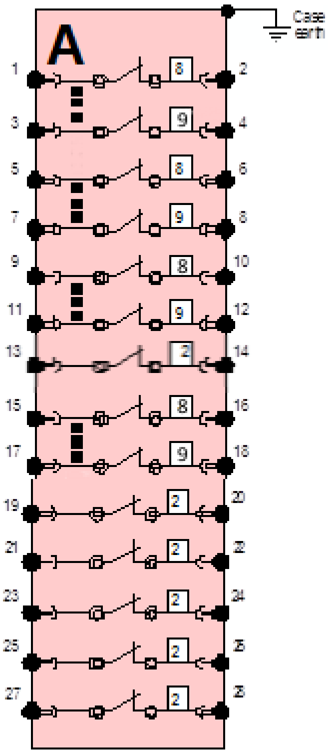
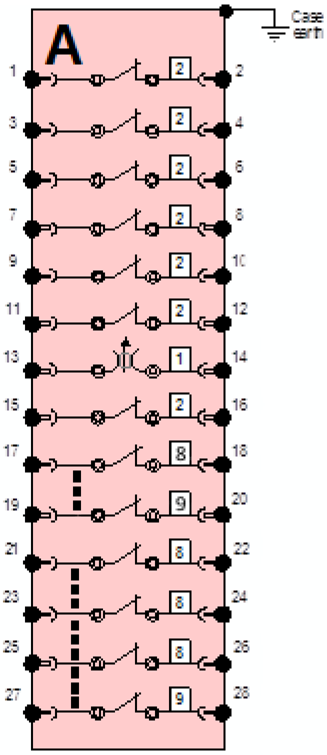


3RMLG – 08



3RMLG – 20



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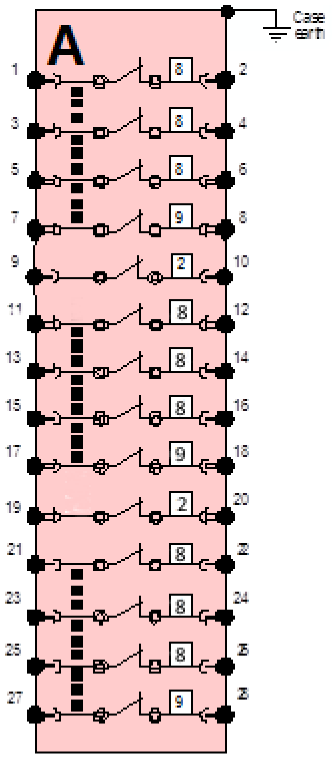
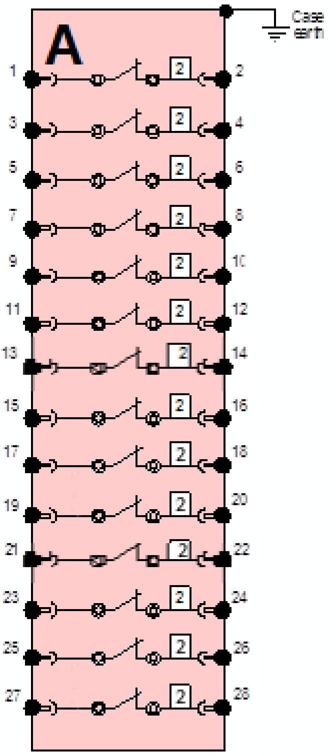
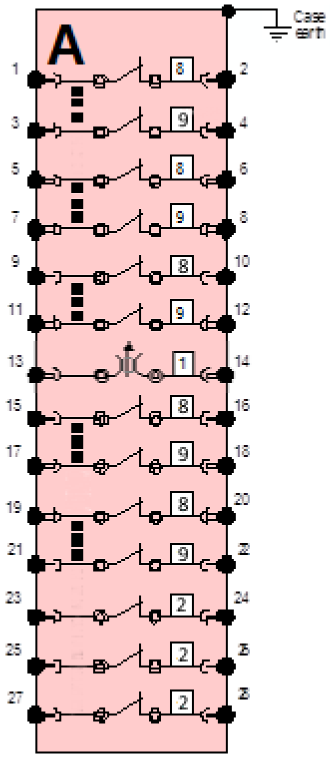


3RMLG – 23

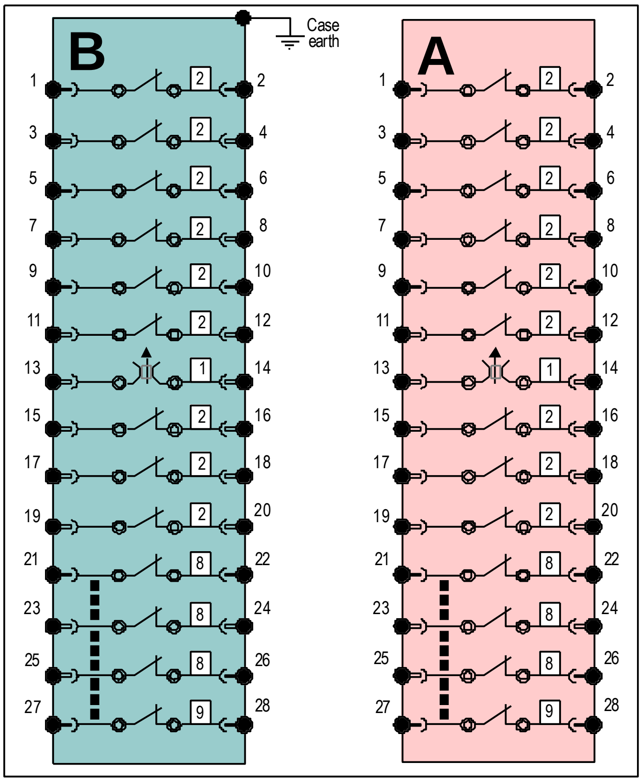


3RMLG – 22

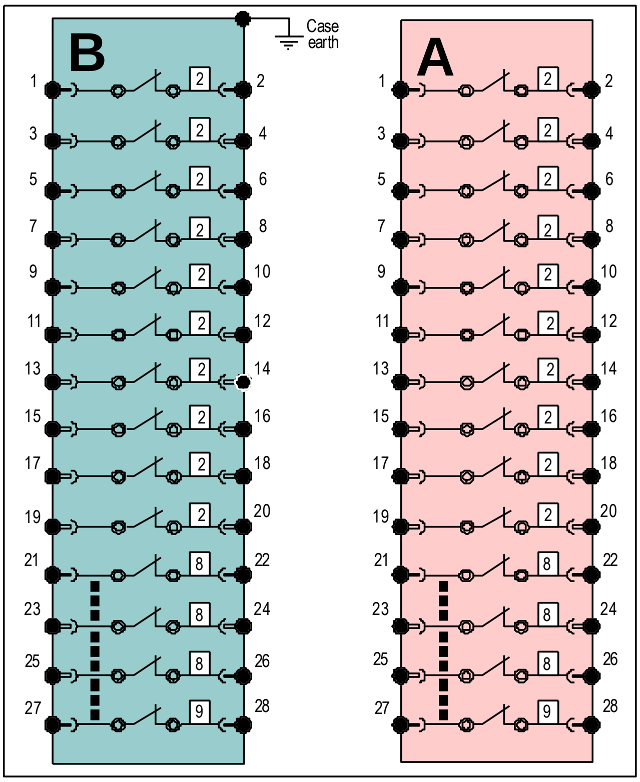


28 WAY TEST BLOCKS

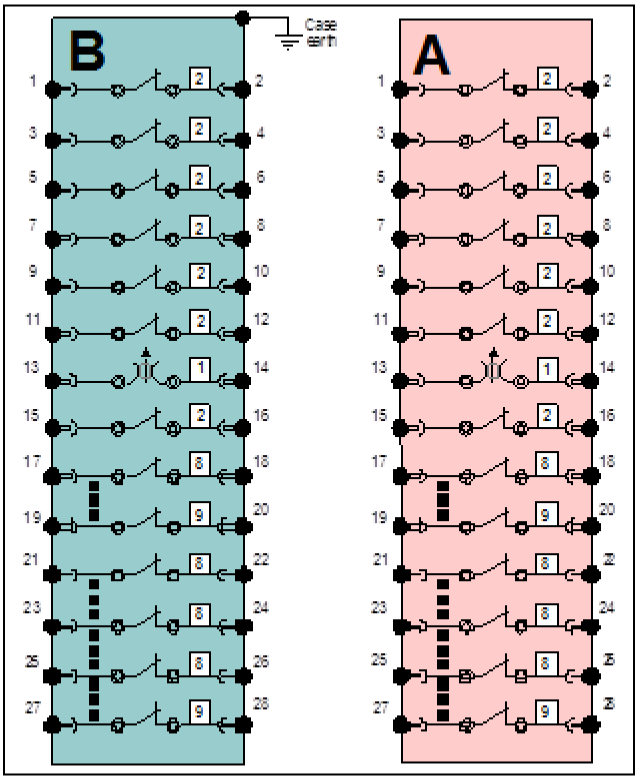
3RMLG – 11



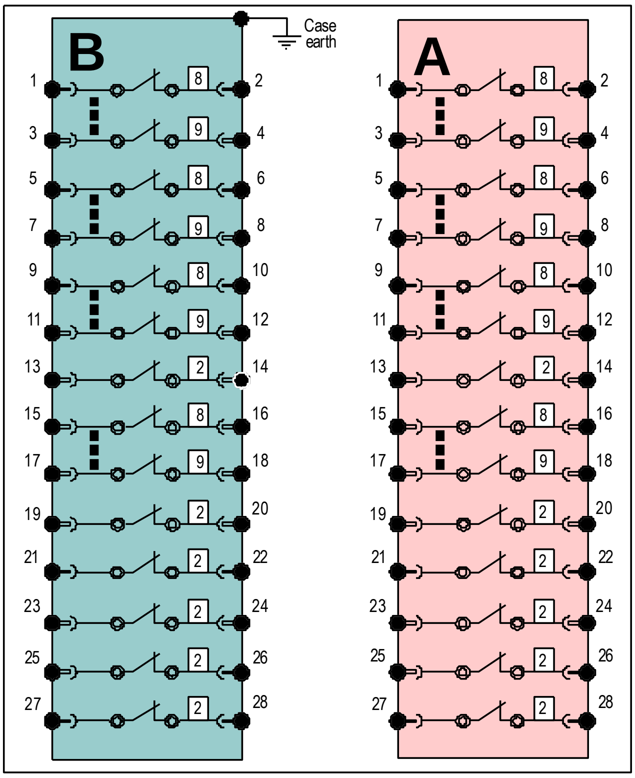
3RMLG - 17



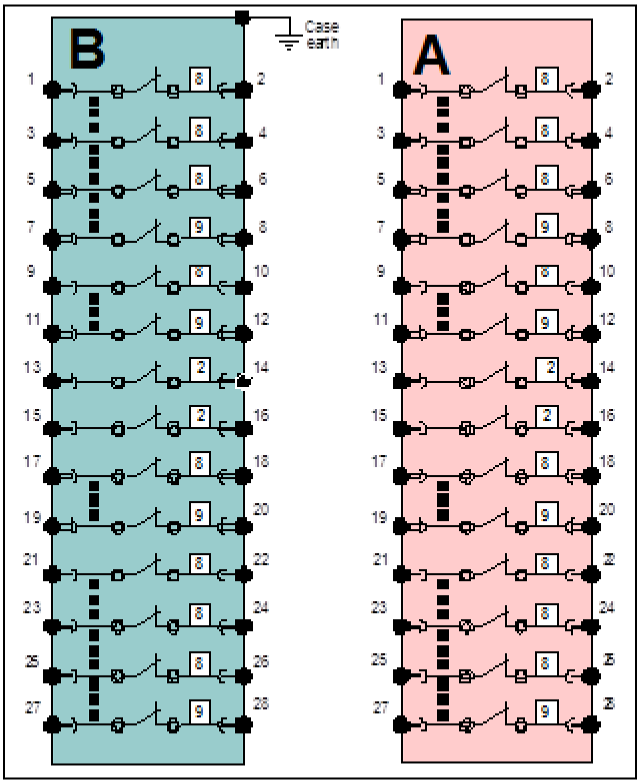
3RMLG – 12



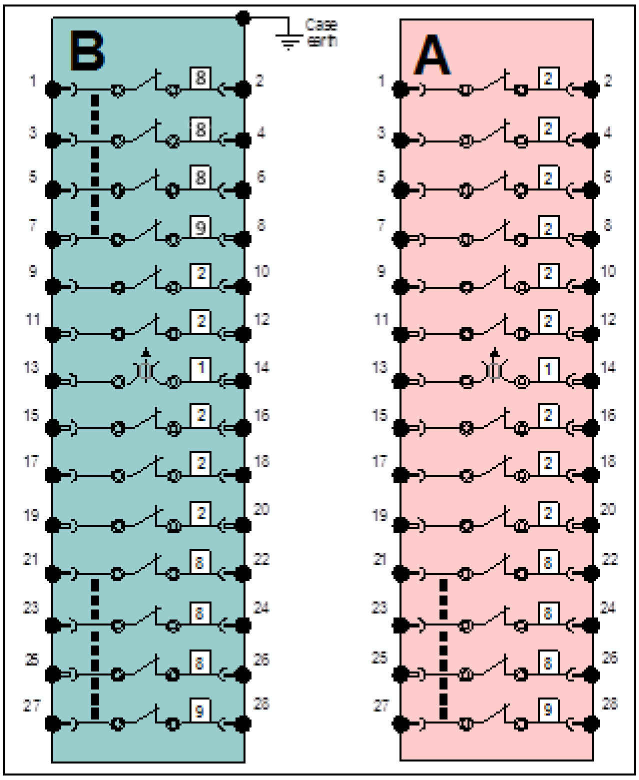
3RMLG - 18



3RMLG - 19



3RMLG - 521



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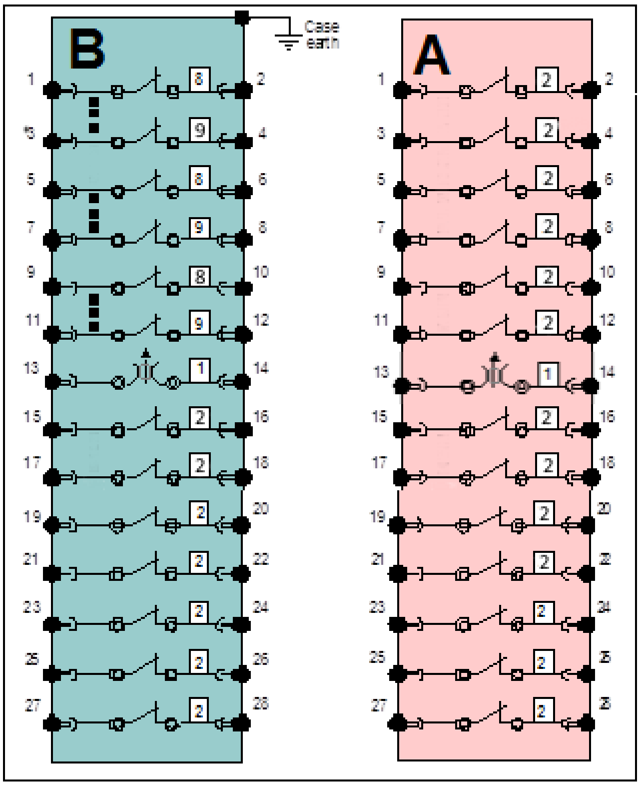
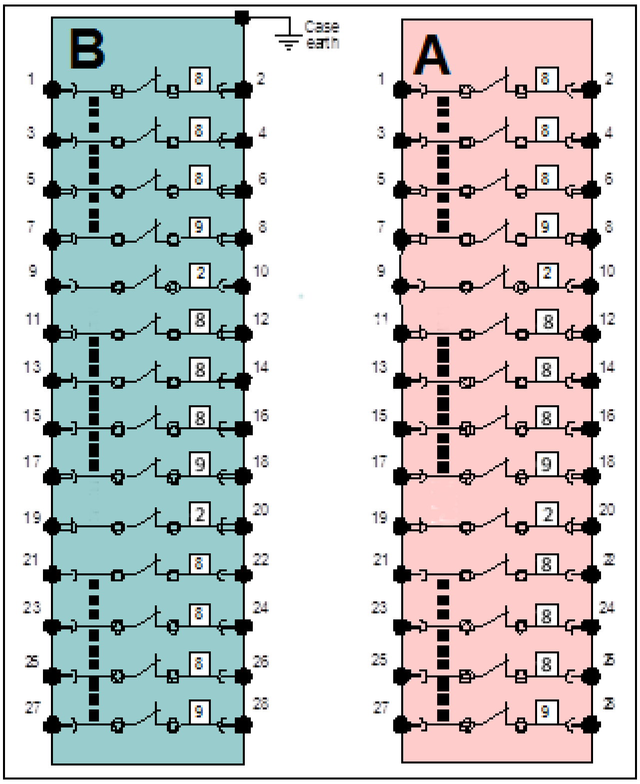


3RMLG - 522



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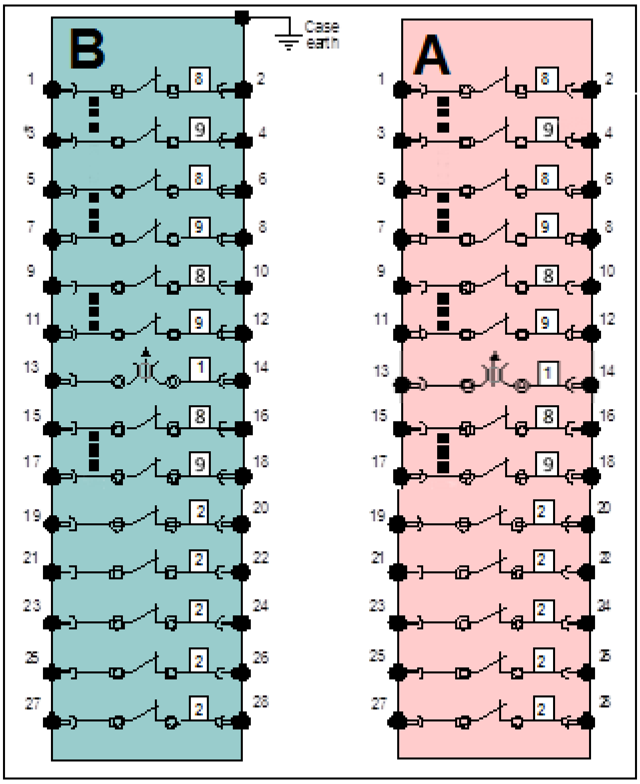
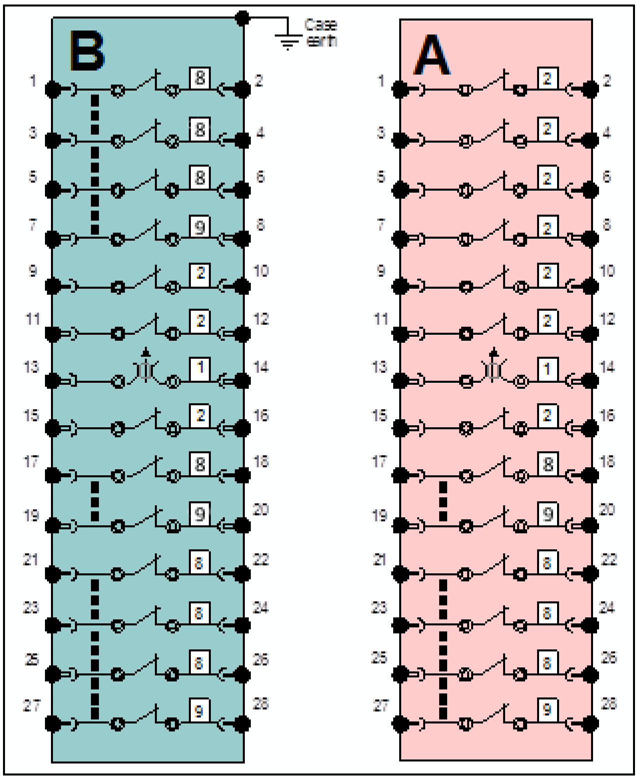


3RMLG - 525



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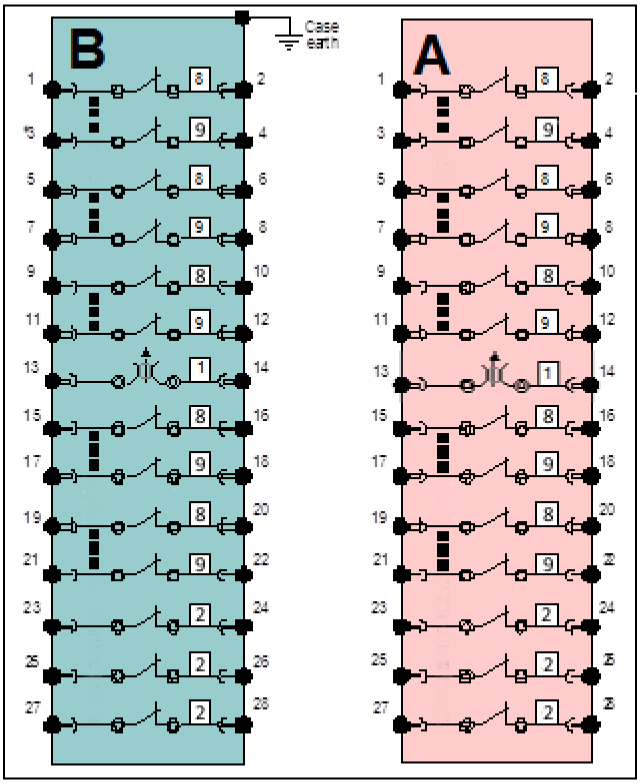


Shrouded Test Leads

Two types of shrouded ‘finger safe’ test leads are available:

Description
Two-ended test lead short - 75mm
Two-ended test lead long - 180mm

Test Lead Plugs

Single Plug

The single plug is the most compact and may be plugged into any test socket.

Dual Plug

The dual or ‘piggy back’ plug is larger and should be plugged into the test sockets on the outside edge of the 3RMLG.

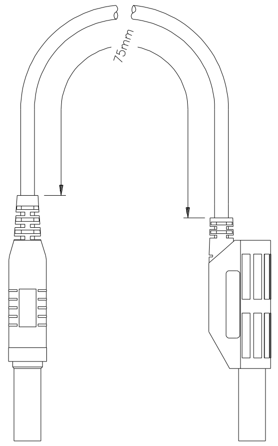


Fig 9. Two-ended test lead - short

75mm wire length version depicted

3RMLG Test Block

14/28 Equipment side terminals (Even terminal numbers).

14/28 Live side terminals (Odd terminal numbers).

14/28 Live sides to equipment side shorting links.

This arrangement provides for up to 14/28 independent circuits to be connected.

3RMLB Multi-Finger Test Plug

28/56 test sockets suitable for 4mm shrouded or standard banana plugs.

Securing screws are built-in to retain the Test Plug during testing operations.

Current Ratings

CT circuits and terminals	20A continuous 400A 1s
Other circuits	10A continuous 200A 1s

Case Type

E2	Size 2 28 terminals
E4	Size 2 56 terminals
Mounting	Flush 4U high rack mount

Insulation – 3RMLG – In Service

Standard	IEC 60255-5
Type	Level
Between any contact pair & either adjacent contact pair.	2.0kV ac rms for 1 minute
Between all case terminals & the case earth	5.0kV ac rms for 1 minute
Between any alternate contact pair, provided that the intermediate pair is not used.	5.0kV ac rms for 1 minute

Insulation – 3RMLG with 3RMLB

Standard	IEC 60255-5
Type	Level
Between incoming & outgoing contacts.	2.0kV ac rms for 1minute
Between all case terminals & the case earth	5.0kV ac rms for 1 minute

Temperature

Standard	IEC 60068-2-1/2
Operating Range	-10 to +55 degrees Celsius
Storage Range	-25 to +70 degrees Celsius

Humidity

Standard:	***IEC 680068-2-78***
Operating Range	40 degrees Celsius and 93% RH non condensing

IP Rating

Standard:	***IEC 60529***
Installed	IP5x

Vibration - Sinusoidal

Standard:	***IEC 60255-21-1 Class I***	
Vibration Response	0.5gn	≤5%
Vibration Endurance	1.0gn	≤5%

Shock and Bump

Standard:	***IEC 60255-21-2 Class I***	
Shock Response	5gn, 11ms	≤5%
Shock Withstand	15gn, 11ms	≤5%
Bump Test	10gn, 16ms	≤5%

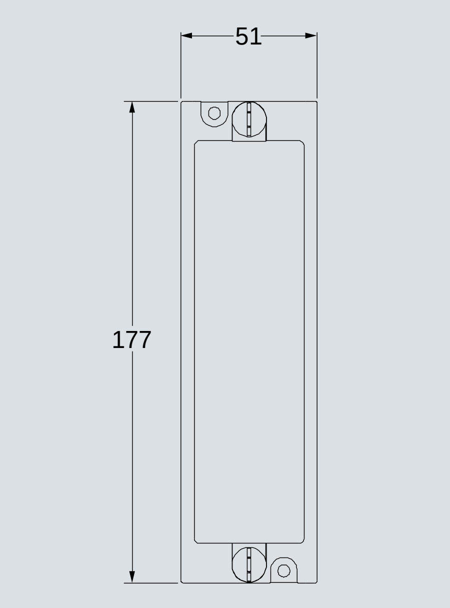
Seismic

Standard:	***IEC 60255-21-3 Class I***	
Seismic Response	1gn	≤5%

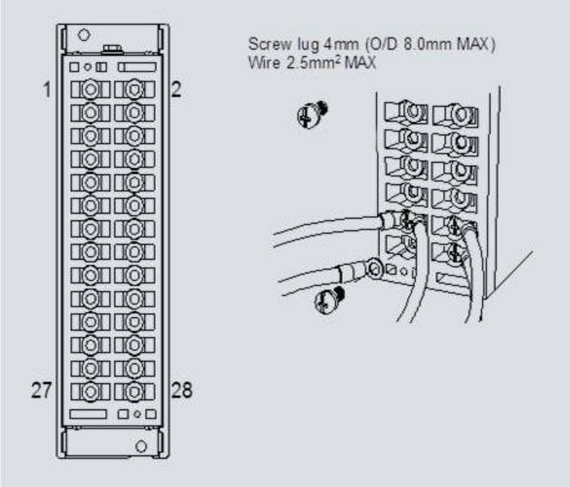
Mechanical Classification

Durability	$>10^5$ operations at no load

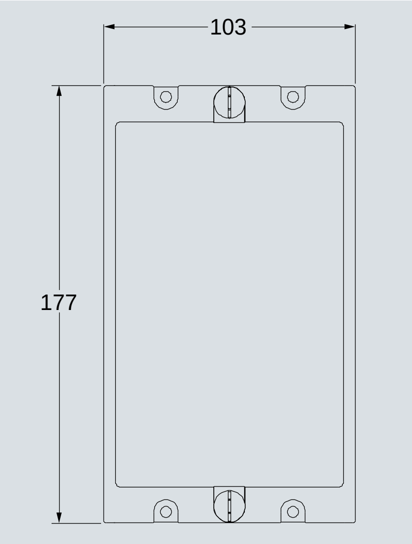
Front View



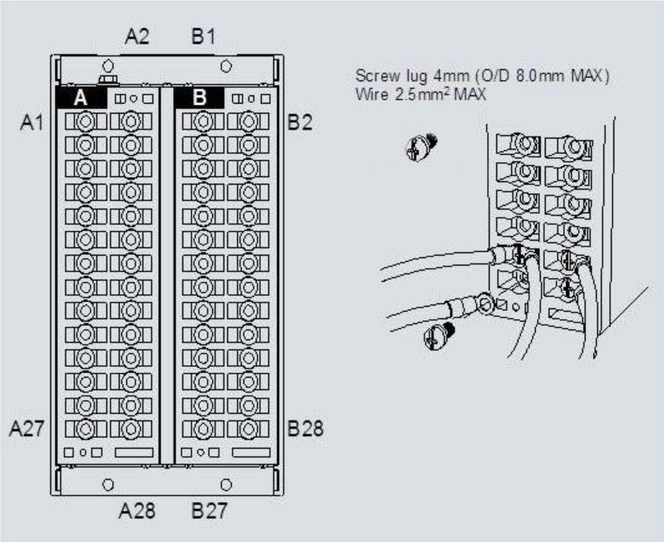
Rear View



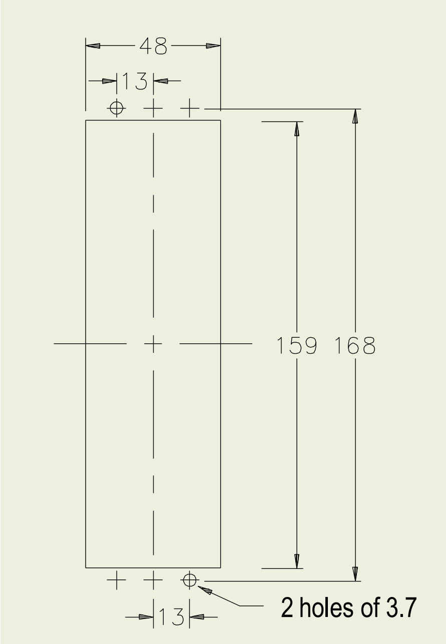
Front View

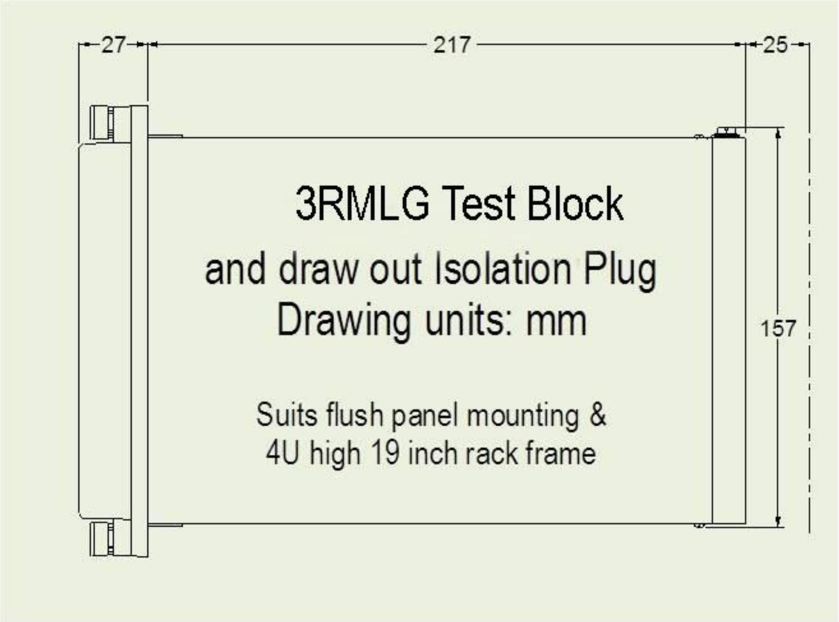


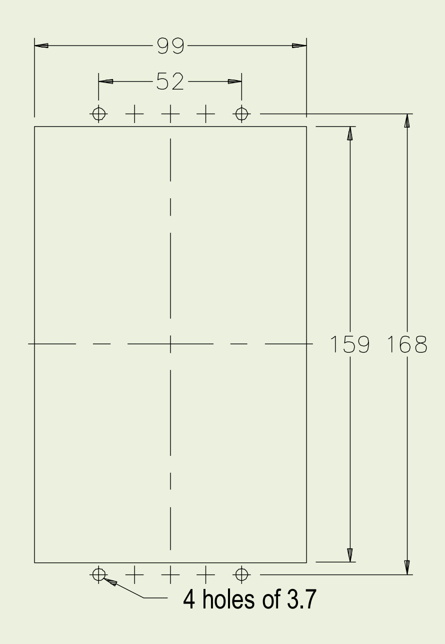
Rear View

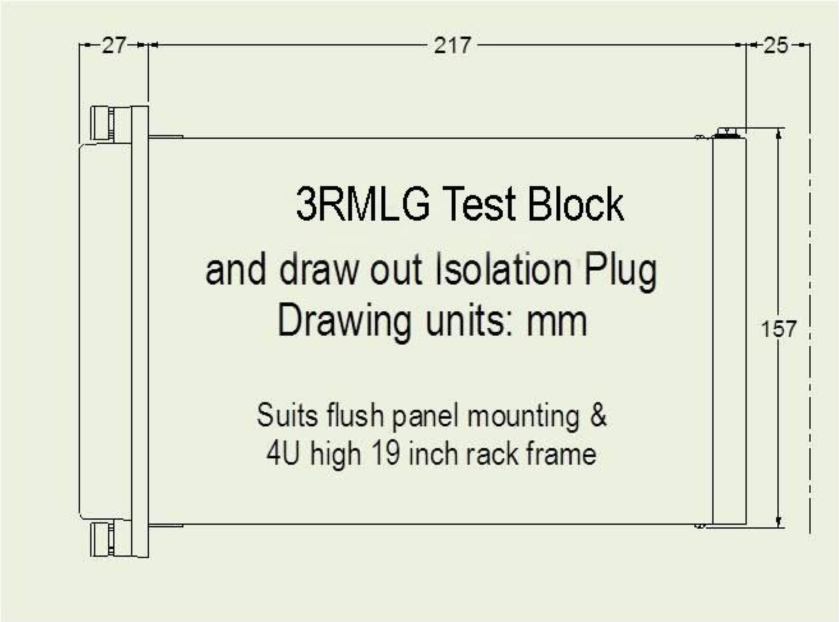


Panel Cut-Out 14 Way









Ordering Information

Product description	Variants	Order No.
Test Modules		**7 X G 2 2 5 1 - □ □ □ 0 0 - 0 A A 0**
14 way Test Blocks		
	Category	
	Ancillary equipment	2
	Modular case test components	2
	Test Modules 3RMLG	5
	14 way test block	1
	Standard Arrangements	
	3RMLG01. For 3 CTs.	1 A A
	3RMLG02. For 3 CTs.	2 A A
	3RMLG07. For 3 CTs.	3 A A
	3RMLG08. For 4 CTs.	4 A A
	3RMLG09. For 8 CTs.	5 A A
	Custom Arrangements	6
	3RMLG20	6 A A
	3RMLG21	6 A B
	3RMLG22	6 A C
	3RMLG23	6 A D
Test Modules		**7 X G 2 2 5 2 - □ □ □ 0 0 - 0 A A 0**
28 way Test Blocks		
	Category	
	Ancillary equipment	2
	Modular case test components	2
	Test Modules 3RMLG	5
	28 way test block	2
	Standard Arrangements	
	3RMLG11. For 6 CTs.	1 A A
	3RMLG12. For 8 CTs.	2 A A
	3RMLG17. For 6CTs.	3 A A
	3RMLG18. For 8CTs.	4 A A
	3RMLG19. For 16CTs.	5 A A
	Custom Arrangements	6
	3RMLG520	6 A A
	3RMLG521	6 A B
	3RMLG522	6 A C
	3RMLG523	6 A D
	3RMLG524	6 A E
	3RMLG525	6 A F
Test plugs		**7 X G 2 2 6 □ - 0 A A 0 0 - 0 A A 0**
14 & 28 Way Test Plugs	Category	
	Ancillary equipment	2
	Ancillary equipment	
	Modular case test components	2
	Test component type	
	Test modules (3RMLB-S)	6
	14 way (3RMLB – S14)	1
	28 way (3RMLB – S28)	2

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