Reyrolle
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Protection
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7SR11 and 7SR12 Argus

Overcurrent Relays

Answers for energy

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7SR11 and 7SR12 Argus

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 7SR11 overcurrent and earth fault relays and the 7SR12 directional relays are available in single and four pole variants.
Housed in a 4U high, size E4 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.

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
50BF	Circuit Breaker Fail
51	Time Delayed Overcurrent
51G/N/SEF	Time Delayed Measured/Derived/Sensitive Earth Fault
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
81HBL2	Inrush Detector

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

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
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

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

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.

Function Matrix

FUNCTION	FUNCTIONAL REQUIREMENT	7SR1101-1*A12-**A0	7SR1101-3*A12-**A0	7SR1102-1*A12-**A0	7SR1102-3*A12-**A0	7SR1204-2*A12-**A0	7SR1204-4*A12-**A0	7SR1205-2*A12-**A0	7SR1205-4*A12-**A0
27	Undervoltage					■	■	■	■
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			■	■			■	■
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			■	■			■	■
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						■	■	■
	CONTROL / MONITOR								
51c	Cold Load - Phase Only			■	■			■	■
60CTS	CT Supervision			■	■			■	■
60VTS	VT Supervision					■	■	■	■
74T/CCS	Trip & Close Circuit Supervision	■	■	■	■	■	■	■	■
79	Autoreclose			□	□			□	□
86	Lockout	■	■	■	■	■	■	■	■

Key - ■ - Included as standard
□ - Ordering option

7SR11 Functional Diagrams

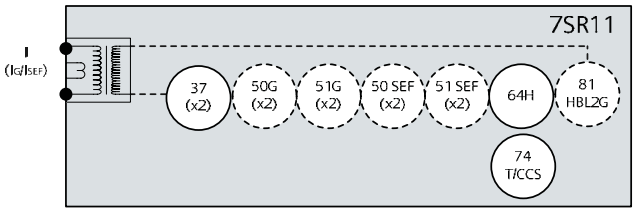


Fig 1. Single Pole Overcurrent Relay

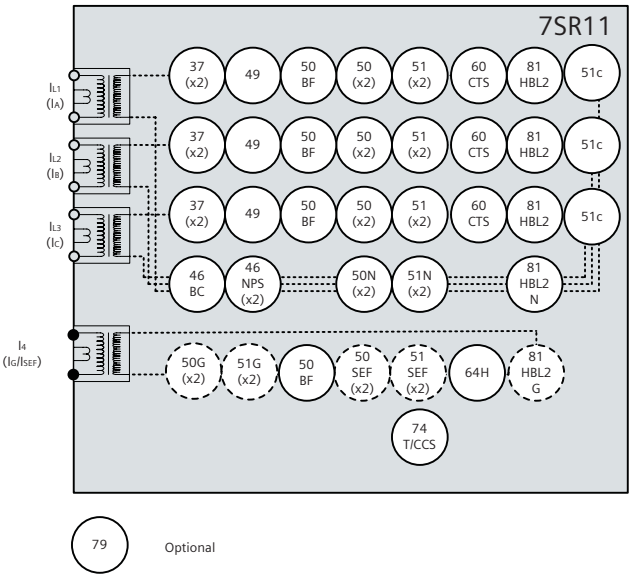


Fig 2. Four Pole Overcurrent Relay

7SR12 Functional Diagrams

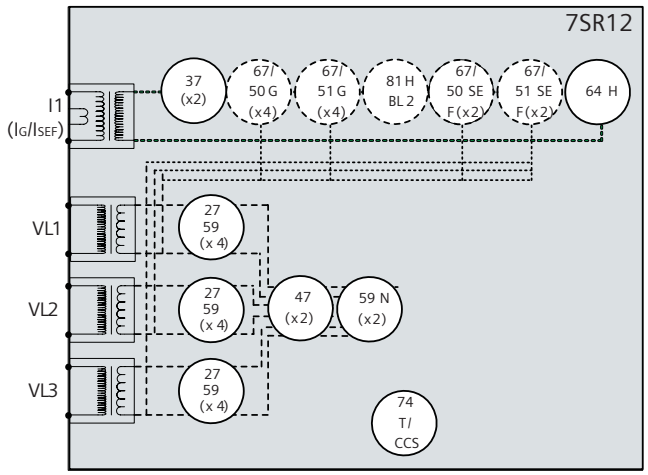


Fig 3. Single Pole Directional Relay

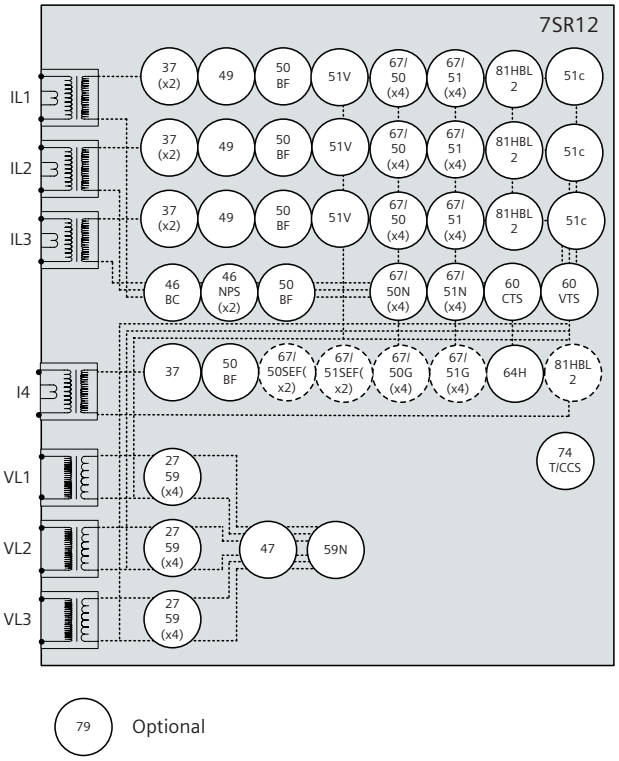


Fig 4. Four Pole Directional Overcurrent Relay

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.

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.

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.

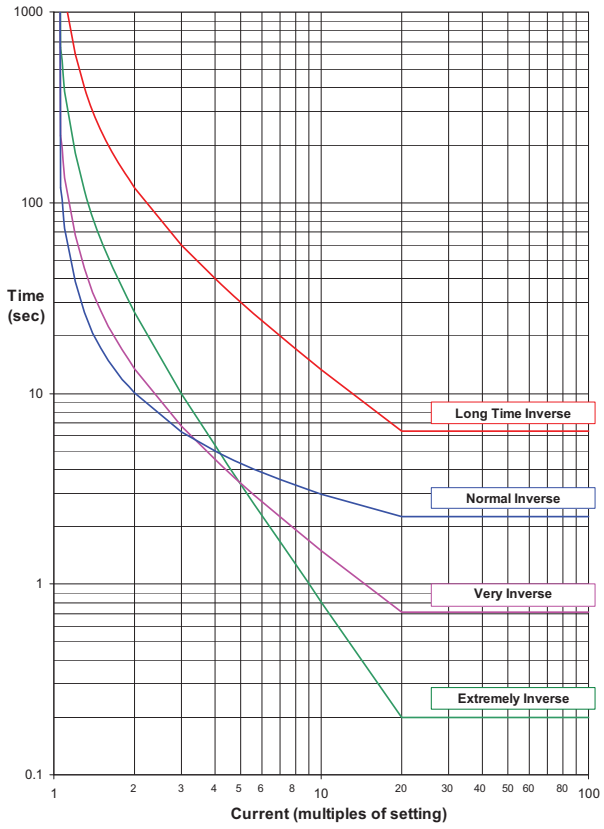


Fig 5. IEC Overcurrent Curves

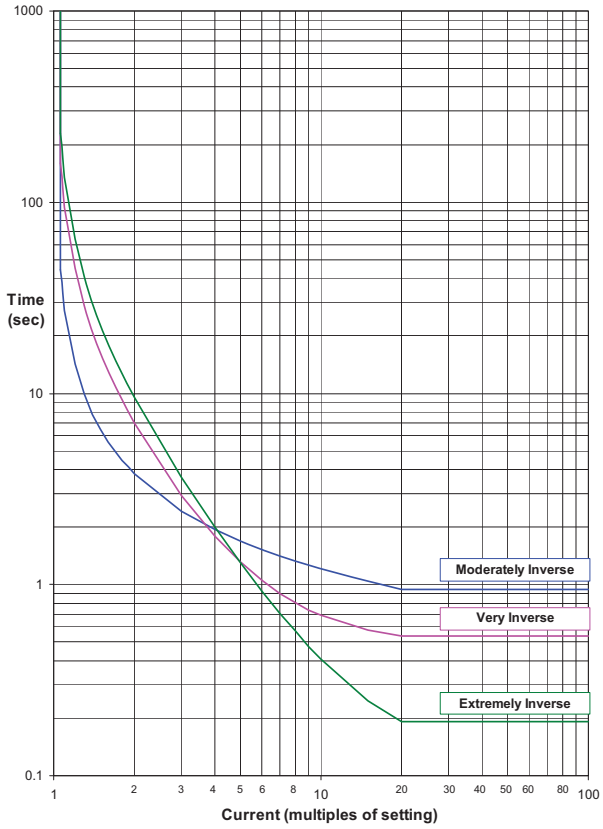


Fig 6. ANSI Overcurrent Curves

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.

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 depending upon the relay model. The 7SR11 monitors each phase current input and operates if any one or two inputs fall below the setting. The 7SR12 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.

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.

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 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
Auto Reclose In/Out
Auto Reclose Trip & Reclose
Auto Reclose Trip & Lockout
SEF In/Out
Inst Prot In/Out
Hot Line Working In/Out

Fig 7. Example of Control Function View

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.

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.

Demand Metering

A rolling record of demand over the last 24h 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.

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.

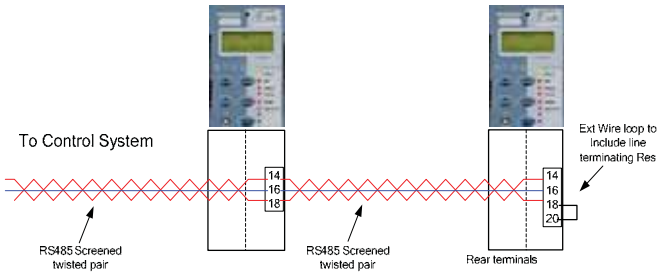


Fig 8. Typical RS485 connection

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

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.

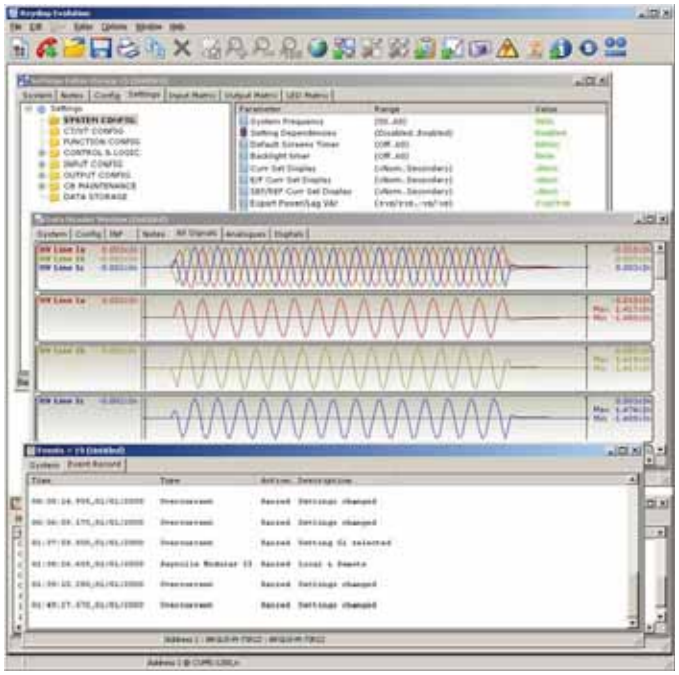


Fig 9. Typical Reydisp Evolution Screenshot

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 containing any Eastern European characters

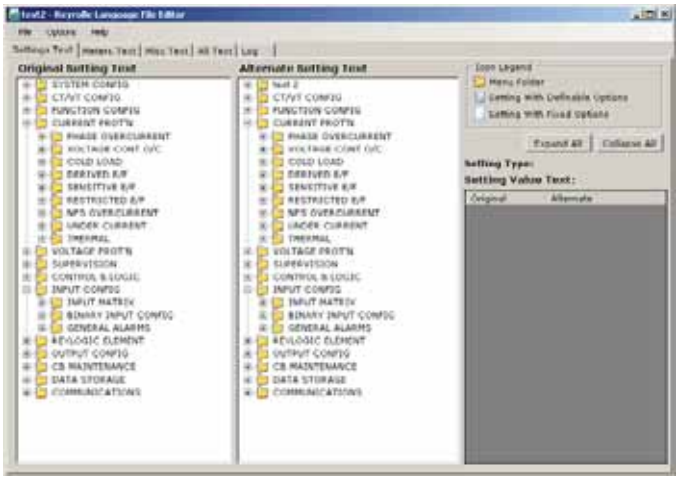


Fig 10. Typical Language Editor Screenshot

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.

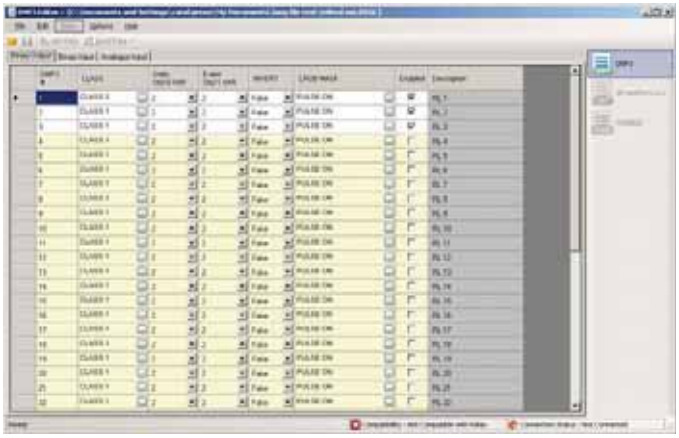


Fig 11. Typical Communications Editor Screenshot

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, 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 12. Rear view of relay

User Interface

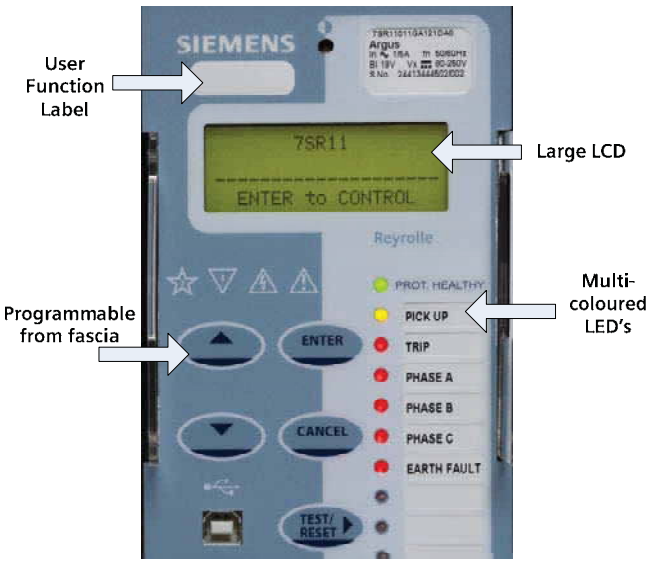


Fig 13. User Interface

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

Quantity	3 ph-ph
Nominal Voltage	40...160V a.c. Range
Instrumentation ≥ 0.8xVn	±1% Vn
Thermal Withstand: Continuous 1 Second	 270V
Burden @ 110V	≤ 0.06 VA

Auxiliary Supply

Rated DC Voltage	110/125/220/250V Range 64 to 300 24/48/60V Range 18 to 72
Power Consumption: Min Max	 3.9W 8W
Allowable superimposed ac component	12% of DC voltage
Allowable breaks/dips in supply (collapse to zero)	50ms

Binary Inputs

Number	3 or 6
Operating Voltage	19V dc Range 17 to 320V dc 88V Range 74 to 320V dc
Minimum dc current for operation	≤ 1.5mA
Pick Up Delay	User Selectable 0 to 14,400,00ms

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 (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 50

Serial Interface

Communication Port	Front USB Type B Rear RS485 2 wire electrical
Protocols	IEC60870-5-103 MODBUS RTU DNP3.0

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 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	≤ 10 %

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

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

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	 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	0.025,0.050...1.6
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	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 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	0.05,0.1...2.5 x In SEF 0.005...0.5 x In
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 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

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

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 Vnps & Inps
VT	nps/zps

64H Restricted Earth Fault

Setting Range	0.05...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

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

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

CB Maintenance

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

Case Dimensions

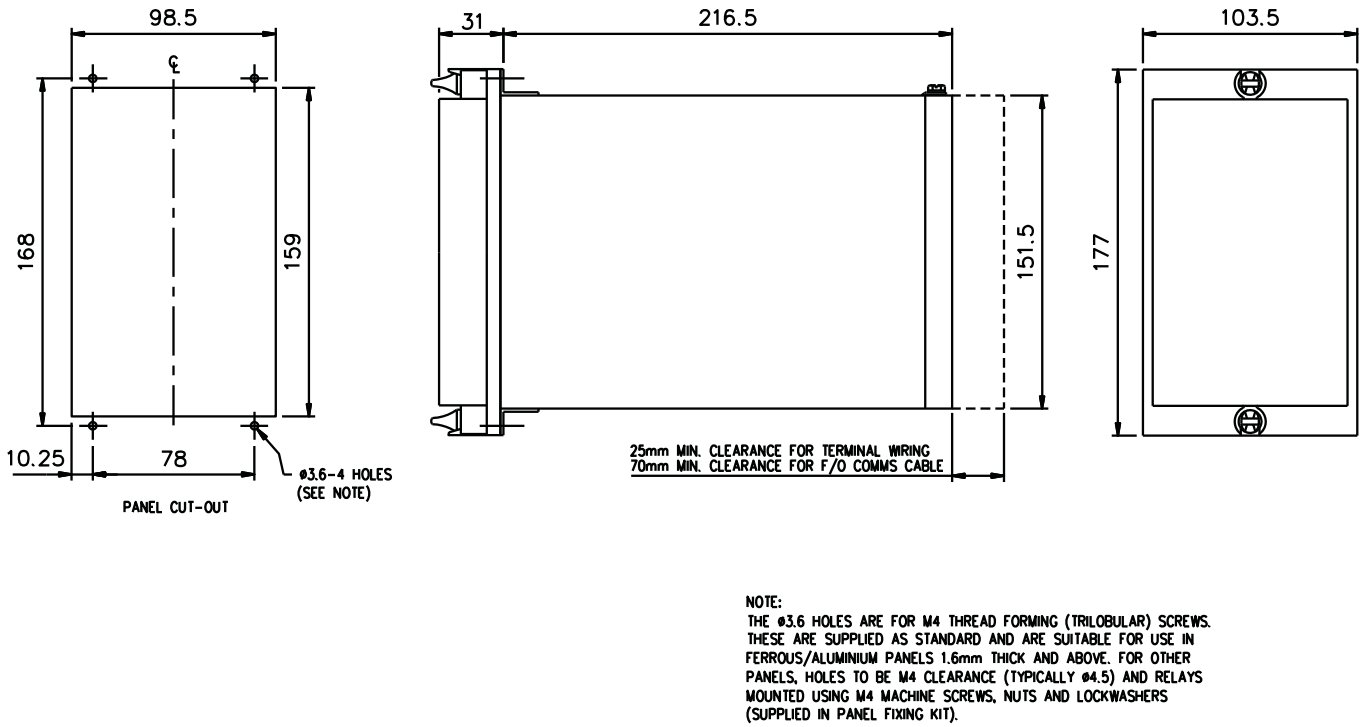
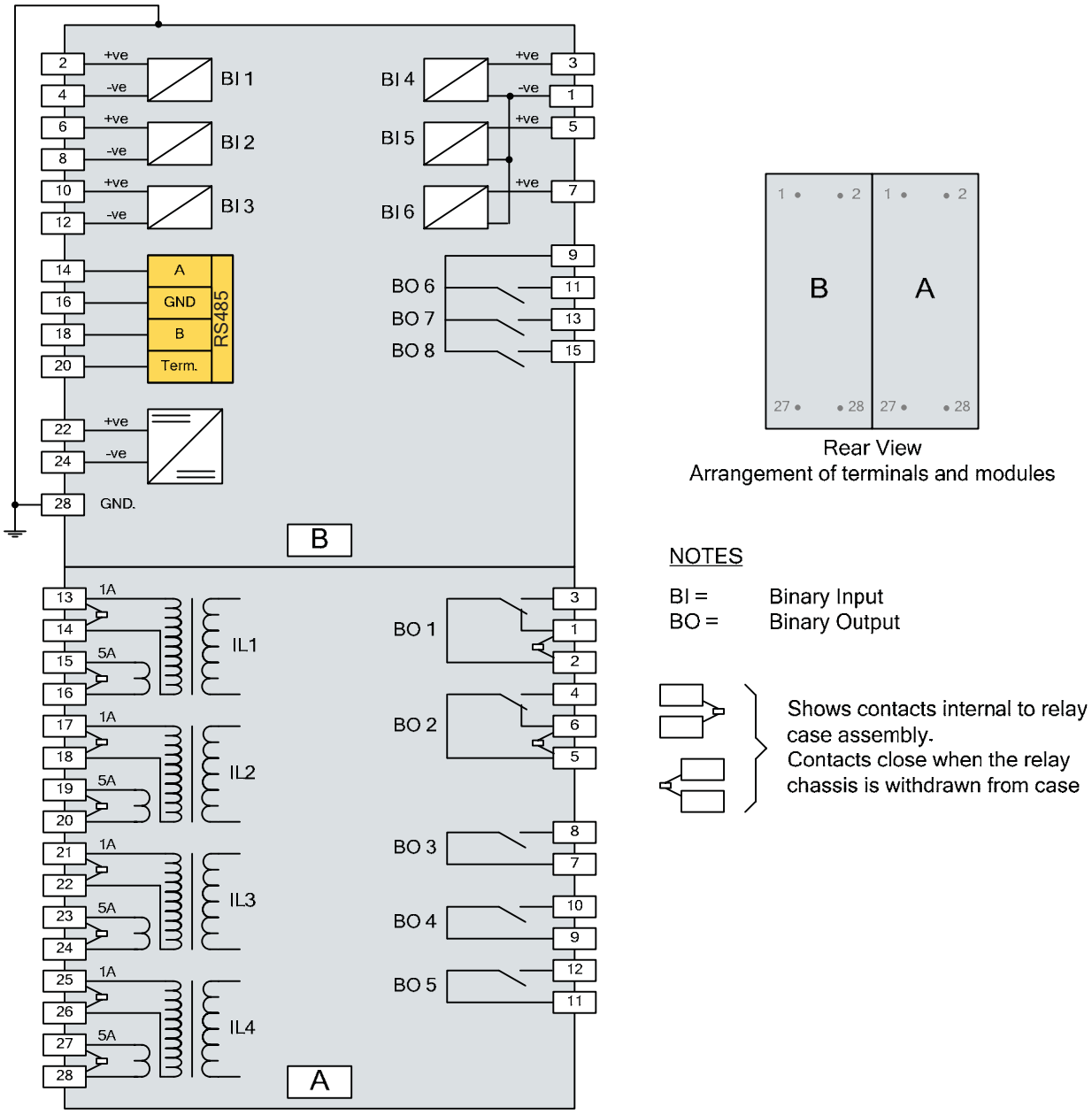


Fig 14. E4 Case Dimensions

7SR11 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 7SR11 relay with 4 CT inputs, 6 binary inputs and 8 binary outputs.

7SR12 Connection Diagram

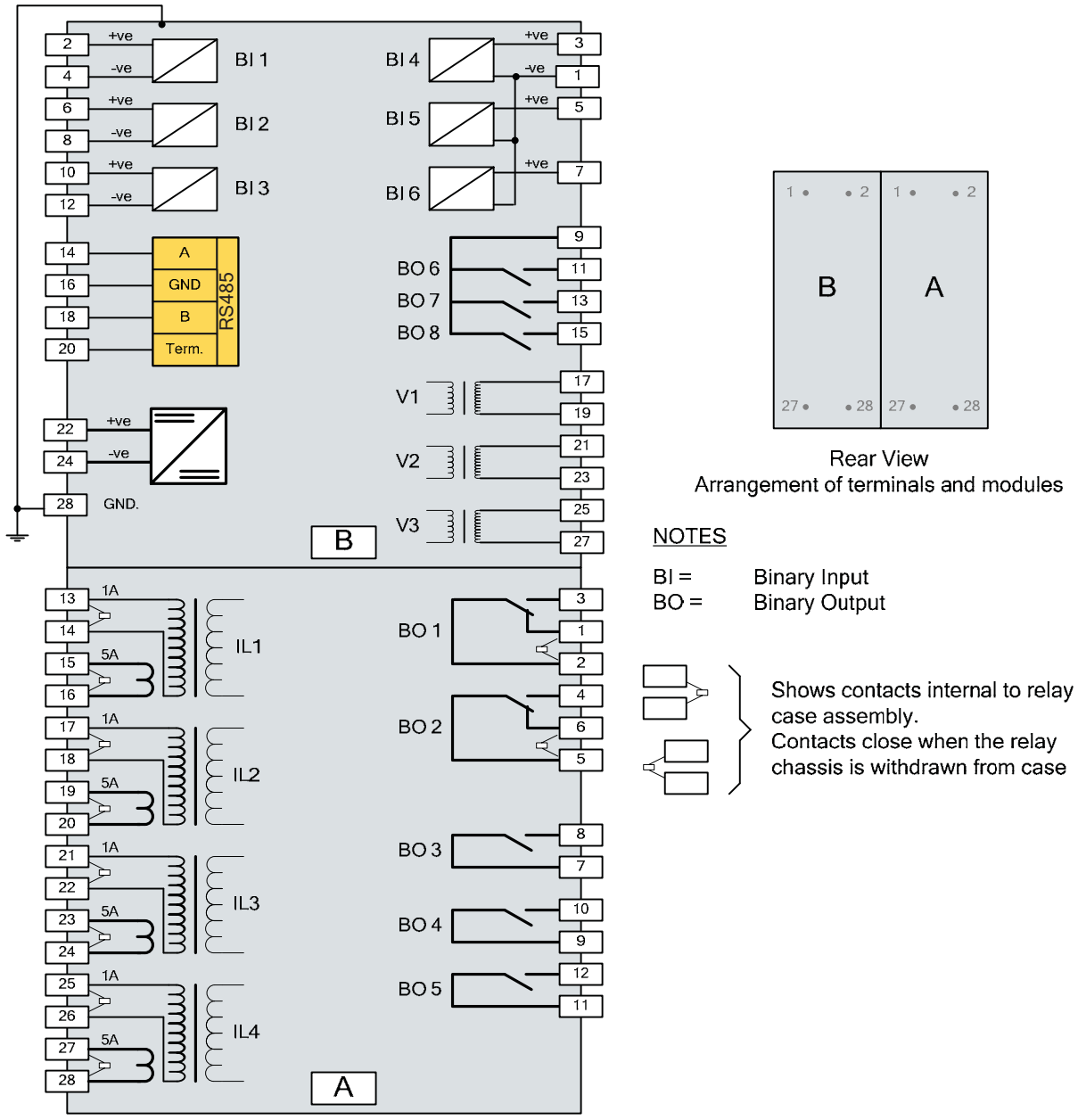


Fig16. Diagram showing 7SR12 relay with 4 CT inputs, 3 VT inputs, 6 binary inputs and 8 binary outputs.

Ordering Information – 7SR11 Argus Non-Directional Overcurrent

Product description	Variants	Order No.
Nondirectional O/C Relay		**7 S R 1 1 0 □ - □ □ A 1 2 - □ □ A 0**
	Overcurrent – Non Directional	1
	Case I/O and Fascia	
	E4 case, 1 CT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs	1
	E4 case, 4 CT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs	2
	E4 case, 4 CT, 6 Binary Inputs / 8 Binary Outputs, 10 LEDs	3
	Measuring Input	
	1/5 A, 50/60Hz[1]	1
	1/5 A, 50/60Hz with SEF Input[2]	3
	Auxiliary voltage	
	80 to 250V DC, 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	1
	Protocol	
	IEC 60870-5-103 and Modbus RTU and DNP3 (user selectable setting)	2
	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
	37 Undercurrent	
	46BC[3] Broken conductor/load unbalance	
	46NPS[3] Negative phase sequence overcurrent	
	49[3] Thermal overload	
	50[3] Instantaneous phase fault overcurrent	
	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/SEF	
	51SEF[2] Time delayed sensitive earth fault	
	60CTS[3] CT Supervision	
	64H High Impedance REF	
	74T/CC Trip & Close circuit supervision	
	81HBL2[4] 2nd Harmonic Block/Inrush Restraint	
	51c[3] Cold load pickup	
	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 in SEF model

Ordering Information – 7SR12 Argus Directional Overcurrent

Product description	Variants	Order No.
Directional O/C Relay		**7 S R 1 2 0 □ - □ □ A 1 2 - □ □ A 0**
Compact directional Overcurrent and earth Fault protection relay	Overcurrent – Directional	2
	Case I/O and Fascia	
	E4 case, 1 CT, 3VT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs	4
	E4 case, 4 CT, 3VT, 3 Binary Inputs / 5 Binary Outputs, 10 LEDs	5
	E4 case, 4 CT, 3VT, 3 Binary Inputs / 8 Binary Outputs, 10 LEDs	6
	Measuring Input	
	1/5 A, 63.5/110V, 50/60Hz[1]	2
	1/5 A, 63.5/110V,50/60Hz with SEF Input[2]	4
	Auxiliary voltage	
	80 to 250V DC, 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	1
	Protocol	
	IEC 60870-5-103 and Modbus RTU and DNP3 (user selectable setting)	2
	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	
	37 Undercurrent	
	46BC[3] Broken conductor/load unbalance	
	46NPS[3] Negative phase sequence overcurrent	
	47 Negative phase sequence voltage	
	49[3] Thermal overload	
	50BF[3] Circuit breaker fail	
	51V[3] Voltage dependent overcurrent	
	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	
	50SEF[2] Directional instantaneous sensitive earth fault	
	67/51 Directional time delayed phase fault overcurrent	
	67/51G 67/51N Directional time delayed earth fault	
	67/51SEF[2] Directional time delayed sensitive earth fault	
	81HBL2[4] 2nd Harmonic Block/Inrush Restraint	
	74T/CC Trip & close circuit supervision	
	51c[3] Cold load pickup	
	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 in SEF model

Reyrolle
Protection
Devices

7SR210 & 7SR220 Argus

Overcurrent Protection Relay

Answers for energy

SIEMENS

7SR210 7SR220 Argus

Overcurrent Protection Relay

Description

The 7SR210n and 7SR220n 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 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

Standard Functionality

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
51	Time Delayed Overcurrent
51G/N	Time Delayed Measured Earth Fault /SEF
64H	High Impedance REF
74TC	Trip Circuit Supervision
81HBL2	2nd Harmonic Block/Inrush Restraint
51c	Cold Load Pickup

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

Additional Functionality 7SR220n Directional Relay

27/59	Under/Over Voltage
47	Negative Phase Sequence (NPS) voltage
51V	Voltage Dependent Overcurrent
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
81	Under/Over Frequency

Optional Functionality

79	Auto Reclose

User Interface

20 character x 4 line backlit LCD
Menu navigation keys
3 fixed LEDs
8 or 16 Programmable Tri-colour LEDs (Option)
6 Programmable Function Keys each with Tri-colour LED (Option)

Monitoring Functions

Standard Monitoring Functionality

Primary current phases and earth
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
Frequency
Waveform records
Circuit breaker trip counters
I^2t summation for contact wear
Demand metering

Additional Monitoring Functionality 7SR220n Directional Relay

Direction
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

Data Communications

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

Protocols

IEC60870-5-103, Modbus RTU and optional DNP 3.0 protocols – User selectable with programmable data points

Data

Event records
Fault records
Waveform records
Measurands
Commands
Time synchronism
Viewing and changing settings

Description of Functionality

With reference to figure 7 and figure 8 '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.

6NPS 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.

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 Trip Circuit Supervision

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

81HBL2 Harmonic Block / Inrush Restraint

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.

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 or sixteen 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 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.

Fig 1. 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.

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.

Data Acquisition - Via Communication Interface

Sequence of event records

Up to 5000 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.

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. Waveform storage is selectable from either 10 records of 1 second, 5 records of 2 seconds, 2 records of 5 seconds or 1 record of 10 seconds duration.

Demand Monitoring

A rolling record of demand over the last 24h 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.

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.

Reydisp Evolution

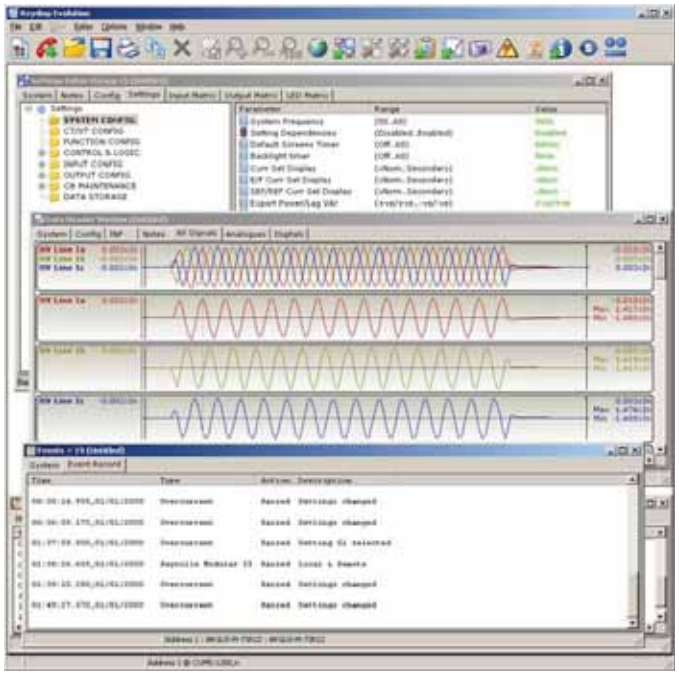


Fig 2. Typical Reydisp Evolution screenshot

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides a means for the user to apply settings, interrogate settings and also to retrieve events & disturbance waveforms from the relay.

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 xIn
Instrumentation ≥ 0.1xIn	±1% In
Frequency	50/60Hz
Thermal Withstand: Continuous 10 Minutes 5 Minutes 3 Minutes 2 Minutes 3 Seconds 2 Seconds 1 Second 1 Cycle	 3.0 xIn 3.5 xIn 4.0 xIn 5.0 xIn 6.0 xIn 57.7A (1A) 202A (5A) 70.7A (1A) 247A (5A) 100A (1A) 350A (5A) 700A (1A) 2500A (5A)
Burden @ In	≤0.1VA (1A phase and Earth element) ≤0.3VA (5A phase and earth element)

Voltage Inputs

Quantity	4
Nominal Voltage	40...160V a.c. Range
Instrumentation ≥ 0.8 xVn	±1% Vn
Thermal Withstand: Continuous 1 Second	 300V
Burden @ 110V	≤ 0.1VA

DC Auxiliary supply

Nominal voltage	Operating Range V dc
30/48/110/220/ V dc	Range 24 to 290V dc
Allowable superimposed ac component	12% of DC voltage
Allowable breaks/dips in supply (collapse to zero)	20ms

Auxiliary supply: Burdens

Power Consumption	Quiescent (typical)	Quiescent (back-light on)
30V dc	6.0W	7.0W
48V dc	5.5W	6.5W
110V dc	6.5W	7.5W
220V dc	7.5W	8.5W

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 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	 1250VA 250VA at p.f. ≤ 0.4 75W 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	2.0kV AC RMS for 1min
Across normally open contacts	1.0kV AC RMS for 1min

High Frequency Disturbance

IEC 60255-22-1 Class III

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

Electrostatic Discharge

IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0kV	≤ 5%

Fast Transients

IEC 60255-22-4 Class IV

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

Surge Immunity

IEC 60255-22-5

Type	Level	Variation
Between all terminals and earth	4.0kV	≤ 10% or 1mA
Between any two independent circuits	2.0kV	

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 60068-2-3

Operational test	56 days at 40°C and 95% relative humidity

IP Ratings

IEC 60529

Type	Level
Installed with cover	IP 50 from front of relay
Installed with cover removed	IP 30 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...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: - Undervoltage Overvoltage	 =(100%+hyst) xVop, ±1% or 0.25V =(100%-hyst) xVop, ±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 0 to 2.0xVs 1.1 to 0.5xVs	 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

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	 35ms ±10ms
Operate time following delay.	$t_{basic} + t_d$, ±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.	$t_{basic} + t_d$, ±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 xIn
Tm Time Multiplier	0.025,0.050...1.6
Char Operate Level	105% Is, ±4% or ±1% xIn
Overshoot Time	< 40ms
Inhibited by	Binary or Virtual Input

47 Negative Phase Sequence Voltage

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 2.0xVs 0V to 10xVs	 80ms ±20ms 55ms ±20ms
Operate time following delay.	$t_{basic} + t_d$, ±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 xIn
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
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...14400s
Operate Level	100% I_s, ±5% or ±1% xIn
Operate time	 0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 25ms, ±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 (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... 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
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...60000ms Timer 2 20...60000ms
Operate Level	100% Is, ±5% or ±1% xIn
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

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... 14400s
NDT Basic Operate Time: - 0V to 1.5 xV_s 0V to 10 xV_s	 76ms ±20ms 63ms ±20ms
NDT Operate time following delay.	t_{basic} +t_d , ±1% or ±20ms
NDT & NIT Setting Range I_s	1, 1.5...100V
Tm Time Multiplier(IDMT)	0.1, 0.2... 10, 10.5... 140
Delay (DTL)	0, 0.01...20s
Reset	ANSI decaying, 0 ... 60s
NIT Operate Level	105% V_s, ±2% or ±0.5V
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... 14400s

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... 14400s
Basic Operate Time	0 to 2 xI_s 40ms ±10ms 0 to 5 xI_s 30ms ±10ms
Inhibited by	Binary or Virtual Input

Case Dimensions

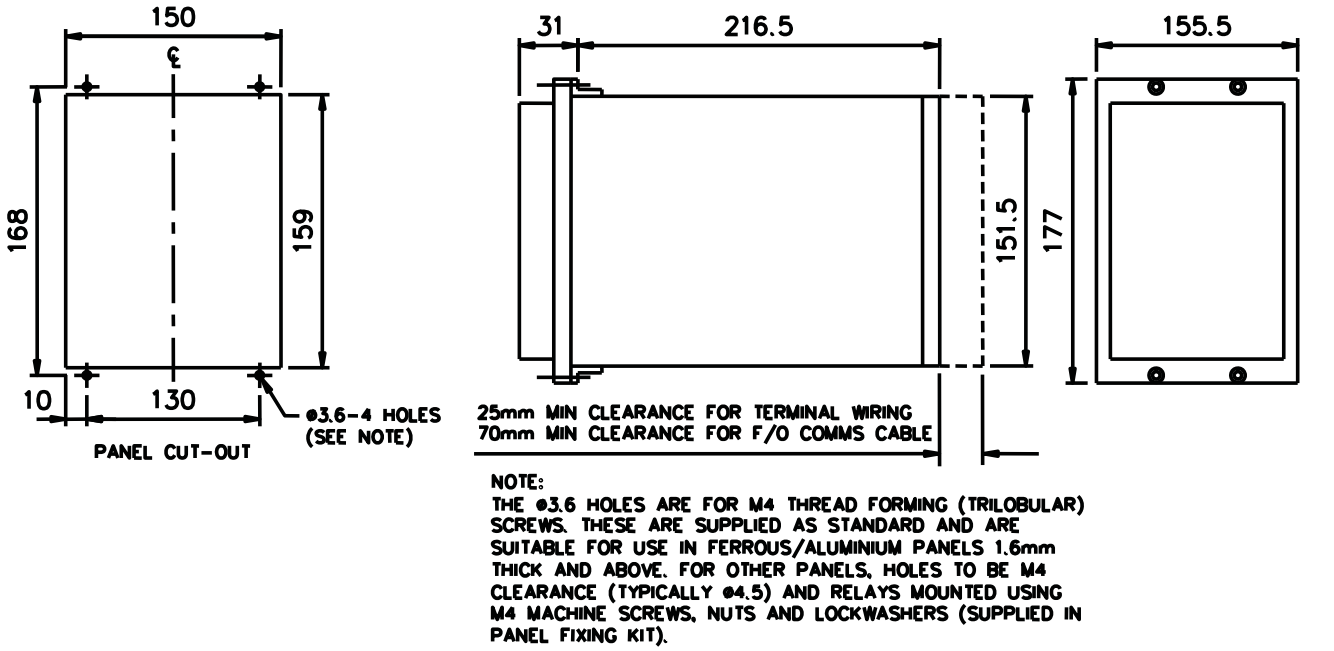


Fig 3. E6 Case overall dimensions and panel drilling details (All dimensions in are mm)

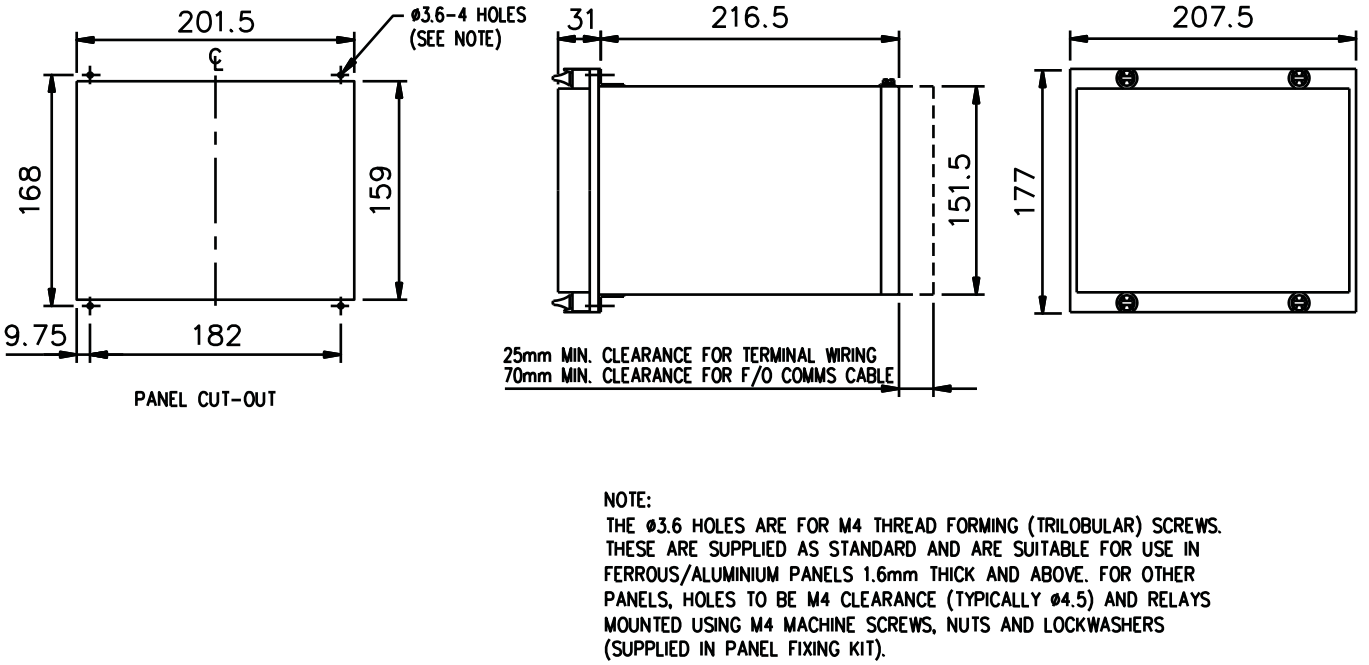
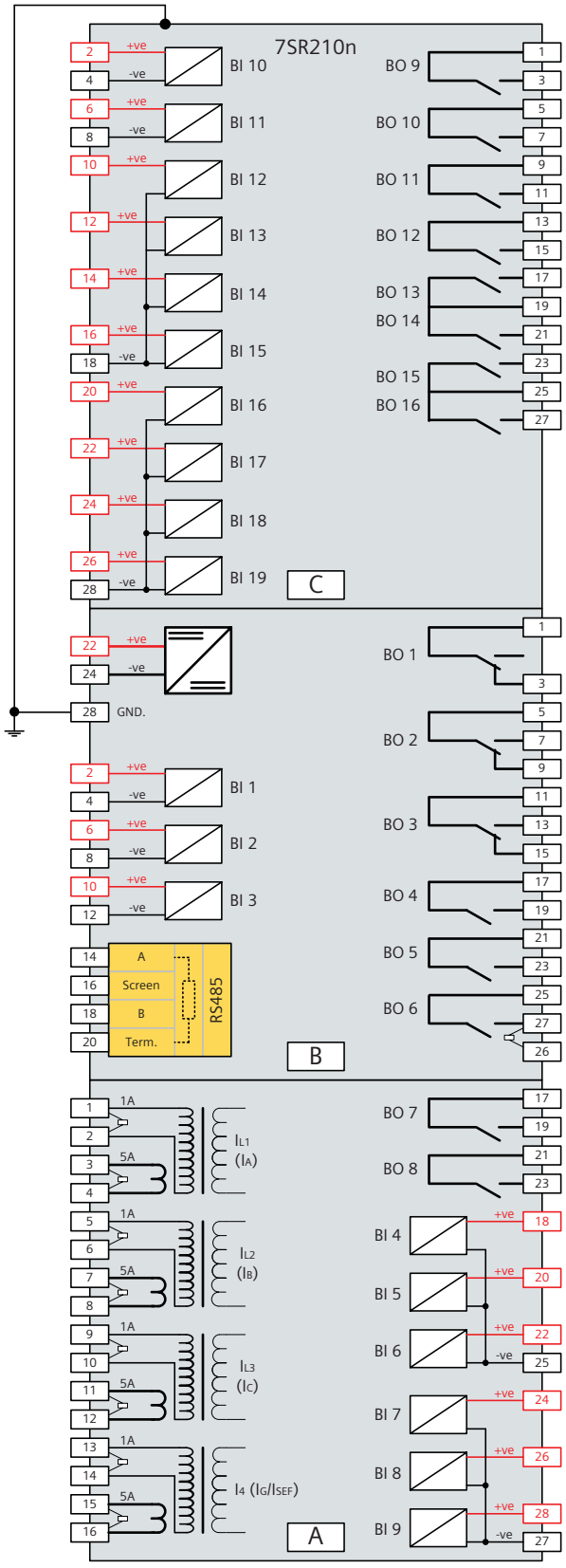
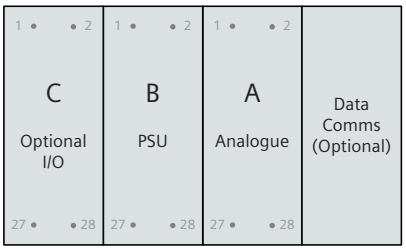


Fig 4. E8 Case overall dimensions and panel drilling details (All dimensions are in mm)

7SR210 Connection Diagram

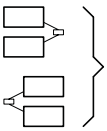




Rear View
Arrangement of terminals and modules

NOTES

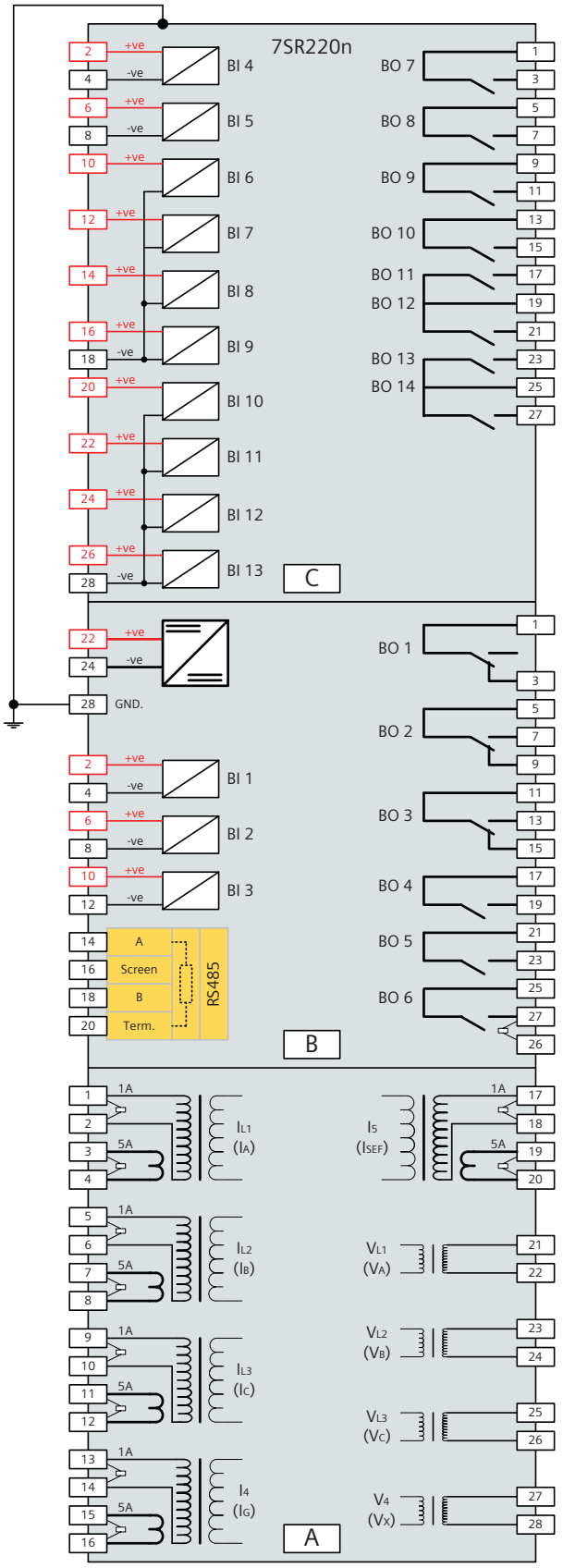
BI = Binary Input
BO = Binary Output

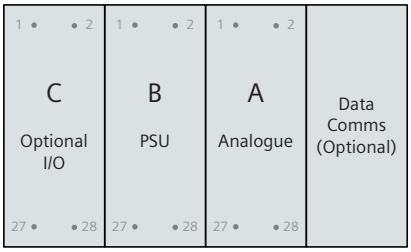


Shows contacts internal to relay case assembly.
Contacts close when the relay chassis is withdrawn from case

Fig 5. 7SR210 Wiring Diagram

7SR220 Connection Diagram

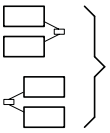




Rear View
Arrangement of terminals and modules

NOTES

BI = Binary Input
BO = Binary Output



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

Fig 6. 7SR220 Wiring Diagram

Function Diagrams for 7SR210 & 7SR220

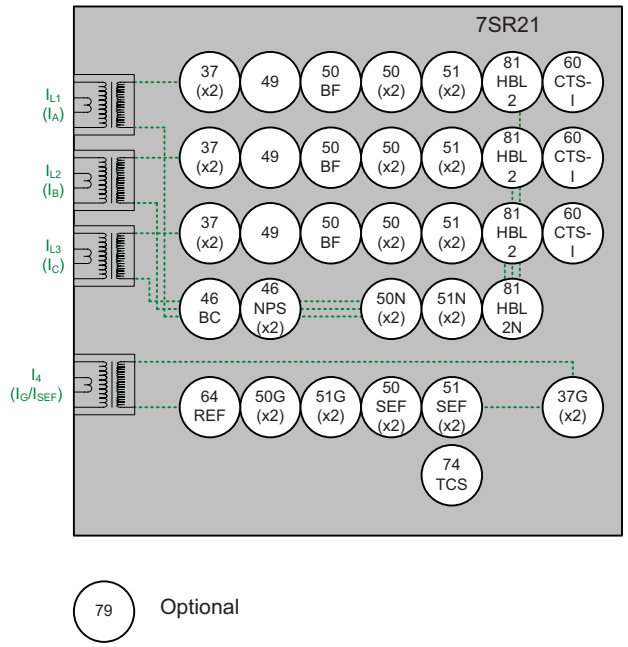


Fig 7. 7SR210 Function Diagram

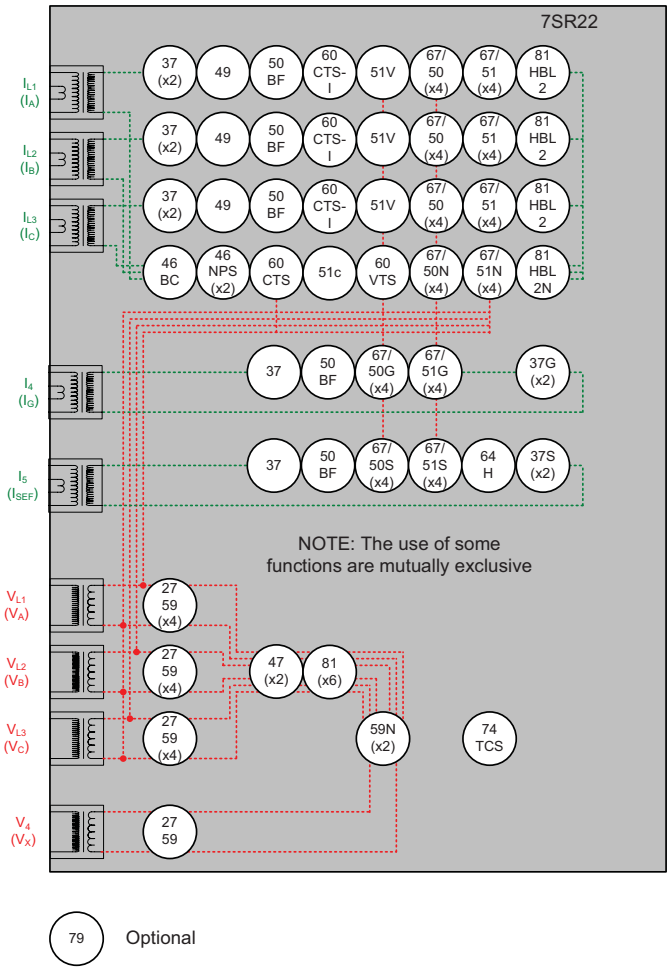


Fig 8. 7SR220 Function Diagram

Ordering Information – 7SR210 Overcurrent Relay

Product description	Variants	Order No.

Nondirectional O/C Relay

Multi function overcurrent and earth fault protection relay

7 S R 2 1 0 □ - 1 □ A □ □ - 0 □ A

Protection Product
Overcurrent – Non Directional **1**

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**

Measuring Input
1/5 A, 50/60Hz **1**

Auxiliary voltage
30 to 220V DC, binary input threshold 19V DC **A**
30 to 220V DC, binary input threshold 88V DC **B**

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 1x RS485 and IRIG-B **3**
Standard version – plus additional rear 1x RS232 and IRIG-B **4**

Protocol
IEC 60870-5-103 and Modbus RTU (user selectable setting) **1**
IEC 60870-5-103, Modbus RTU and DNP3.0 (user selectable setting) **2**

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
51	Time delayed phase fault overcurrent
51G/51N	Time delayed earth fault/SEF
60CTS-I	CT Supervision
64H	High Impedance REF
74TC	Trip circuit supervision
81HBL2	2nd harmonic block/inrush restraint
	Cold load pickup
	Programmable logic

Standard version – plus **D**
79 Autoreclose

Additional Functionality
No Additional Functionality **A**

[1] 4CT is configured as 3PF + EF/SEF (user selectable setting).
[2] For ESI48-4 compliance of binary inputs external resistors are required.

Ordering Information – 7SR220 Directional Overcurrent Relay

Product description	Variants	Order No.
Directional O/C Relay		7 S R 2 2 0 □ - 2 □ A □ □ - 0 □ A
Multi function overcurrent and earth fault protection relay		
	Protection Product	
	Overcurrent – Directional	2
	Case I/O and Fascia [1]	
	E6 case, 5 CT, 4 VT, 3 Binary Inputs / 6 Binary Outputs, 8 LEDs	2
	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
	Measuring Input	
	1/5 A, 63.5/110V, 50/60Hz	2
	Auxiliary voltage	
	30 to 220V DC, binary input threshold 19V DC	A
	30 to 220V DC, binary input threshold 88V DC	B
	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 1x RS485 and IRIG-B	3
	Standard version – plus additional rear 1x RS232 and IRIG-B	4
	Protocol	
	IEC 60870-5-103 and Modbus RTU (user selectable setting)	1
	IEC 60870-5-103, Modbus RTU and DNP3.0 (user selectable setting)	2
	Protection Function Packages	
	Standard version – Included in all models	C
	27/59 Under/overvoltage	
	37 Undercurrent	
	37G Ground Undercurrent	
	37SEF SEF Undercurrent	
	46BC Broken conductor/load unbalance	
	46NPS Negative phase sequence overcurrent	
	47 Negative phase sequence voltage	
	49 Thermal overload	
	50BF Circuit breaker fail	
	51V Voltage controlled overcurrent	
	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	
	67/51 Directional time delayed phase fault overcurrent	
	67/51G 67/51N Directional time delayed earth fault/SEF	
	74TC Trip circuit supervision	
	81 Under/over frequency	
	81HBL2 2nd harmonic block/inrush restraint	
	Cold load pickup	
	Programmable logic	
	Standard version – plus	D
	79 Autoreclose	
	Additional Functionality	
	No Additional Functionality	A

[1] 5CT is configured as 3PF + EF + SEF/REF (user selectable setting).
[2] For ESI48-4 compliance of binary inputs external resistors are required.

Reyrolle
Protection
Devices

7SR224 Argus

Recloser Controller

Answers for energy

SIEMENS

7SR224 Argus

Recloser Controller

Description

The 7SR224 Recloser Controller is one of a range of new generation 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

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, via HMI
8 Settings Groups - Password access - 2 levels
Self Monitoring

Optional Functionality

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 – Primary, Secondary xVn, Ph-Ph and Ph-n, Sequence Components, Calculated Earth Voltage, Neutral Voltage Displacement (Vx) 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

Data Storage & Communications

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 additional Rear RS485 port + IRIG-B port
1 additional Rear RS232 port + IRIG-B port

Protocols

IEC60870-5-103, Modbus RTU and DNP 3.0 protocols – User selectable with programmable data points

Data

Event records
Fault records
Waveform records
Measurands
Commands
Time synchronism
Viewing and changing settings

Description of Functionality

With reference to figure 7: 'Function Diagram'.

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.

51V Voltage Dependent 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.

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, 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.

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.

Fig 1. Tri-colour LED's and function keys

Data Acquisition - Via Communication Interface

Sequence of event records

Up to 5000 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.

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.

Demand Monitoring

A rolling record of demand over the last 24h 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.

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.

Reydisp Evolution

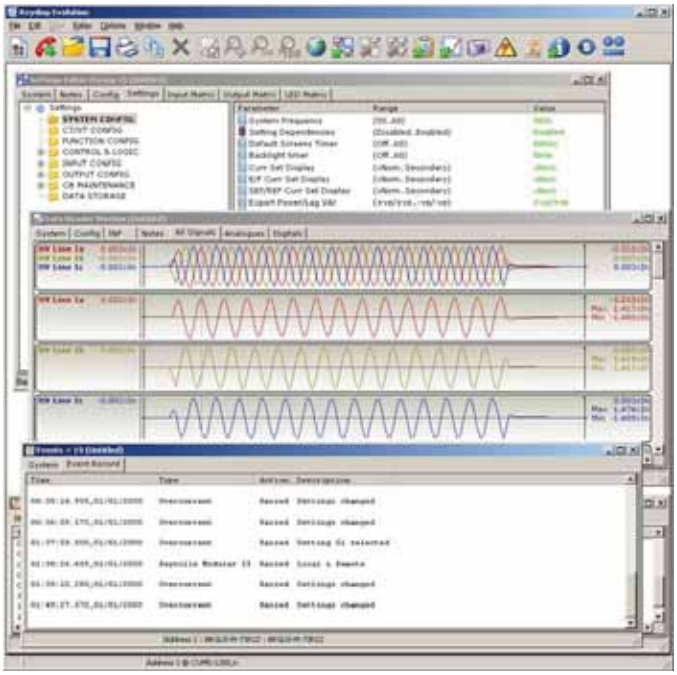


Fig 2. Typical Reydisp Evolution screenshot

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings, interrogate settings and retrieve events and disturbance waveforms from the relays.

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 5 Minutes 3 Minutes 2 Minutes 3 Seconds 2 Seconds 1 Second 1 Cycle	 3.0 x In 3.5 x In 4.0 x In 5.0 x In 6.0 x In 57.7A (1A) 202A (5A) 70.7A (1A) 247A (5A) 100A (1A) 350A (5A) 700A (1A) 2500A (5A)
Burden @ In	≤0.1VA (1A phase and Earth element) ≤0.3VA (5A phase and earth element)

Voltage Inputs

Quantity	4
Nominal Voltage	40...160V a.c. Range
Instrumentation ≥ 0.8xVn	±1% Vn
Thermal Withstand: Continuous 1 Second	 300V
Burden @ 110V	≤ 0.1 VA

DC Auxiliary supply

Nominal voltage	Operating Range V dc
30/48/110/220/ V dc	Range 24 to 290 V dc
Allowable superimposed ac component	12% of DC voltage
Allowable breaks/dips in supply (collapse to zero)	20ms

Auxiliary supply: Burdens

Power Consumption	Quiescent (typical)	Quiescent (back-light)
30V dc	6.0W	7.0W
48V dc	5.50W	6.50W
110V dc	6.5W	7.5W
220V dc	7.5W	8.5W

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 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 75 W 30 W 50 W	 at p.f. ≤ 0.4 at L/R ≤ 40ms 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

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	4kV	≤ 5 %

Surge Immunity

IEC 60255-22-5

Type	Level	Variation
Between all terminals and earth	4.0 kV	≤ 10 % or 1mA
Between any two independent circuits	2.0kV	≤ 10 % or 1mA

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)
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 1000 A/m for 3s	50Hz; 1.257mT

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 50 from front
Installed with cover removed	IP 30 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...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: Undervoltage Overvoltage	 =(100%+hyst)xVop, ±1% or 0.25V =(100%-hyst)xVop, ±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 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
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	 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...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...14400s
DT Basic Operate Time: 0 to 2 x Is 0 to 5 x Is	 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	0.025,0.050...1.6
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	$t = \tau \times In\left\{\frac{I^2 - I_p^2}{I^2 - (k \times I_B)^2}\right\}$ ±5% absolute or ±100ms where Ip = prior current
Alarm Level	Disabled, 50,51...100%
Inhibited by	Binary or Virtual Input

50 (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	100% Is, ±5% or ±1%xIn
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	0.025,0.05...1.6
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 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

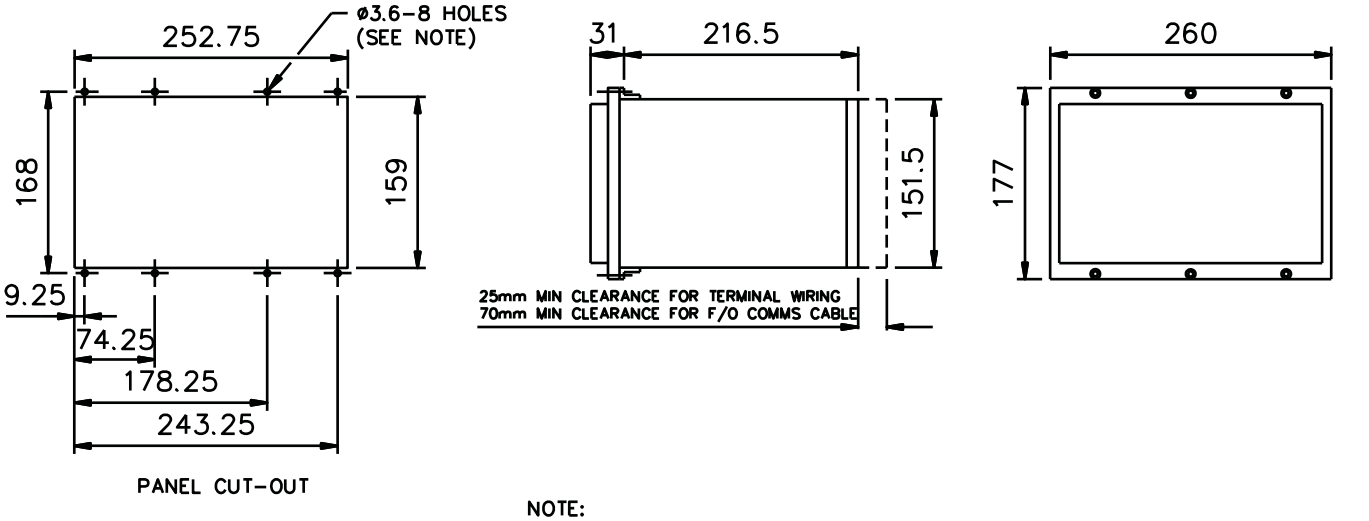
60 Supervision

CT	Vnps & Inps
VT	nps/zps

64H Restricted Earth Fault

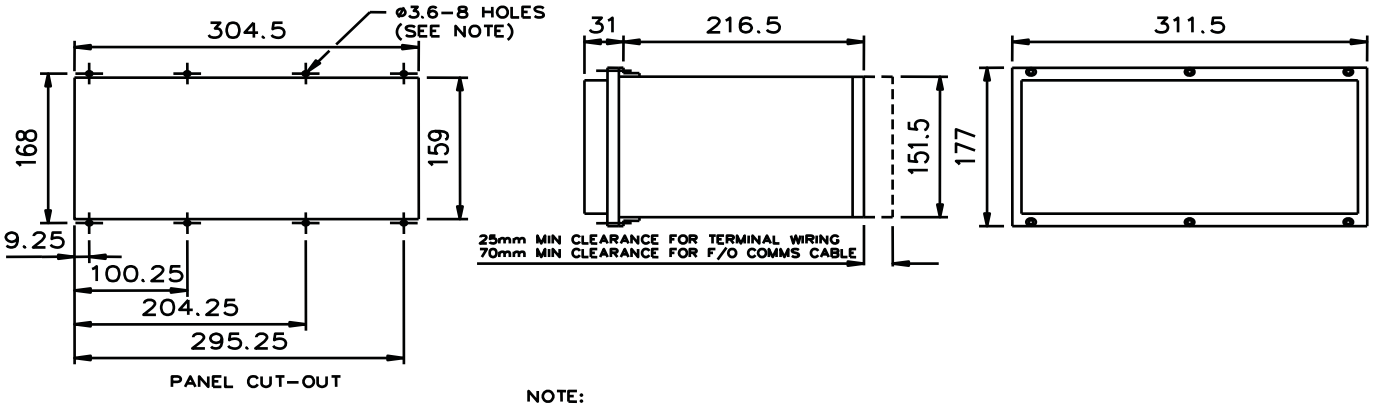
Setting Range	0.005...0.95xIn
Operate Level	100% Is, ±5% or ±1%xIn
Time Delay	0.00... 14400s
Basic Operate Time	0 to 2 xIs 45ms ±10ms 0 to 5 xIs 35ms ±10ms
Inhibited by	Binary or Virtual Input

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).

Fig 3. E10 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 4. E12 Case

7SR224 Connection Diagram

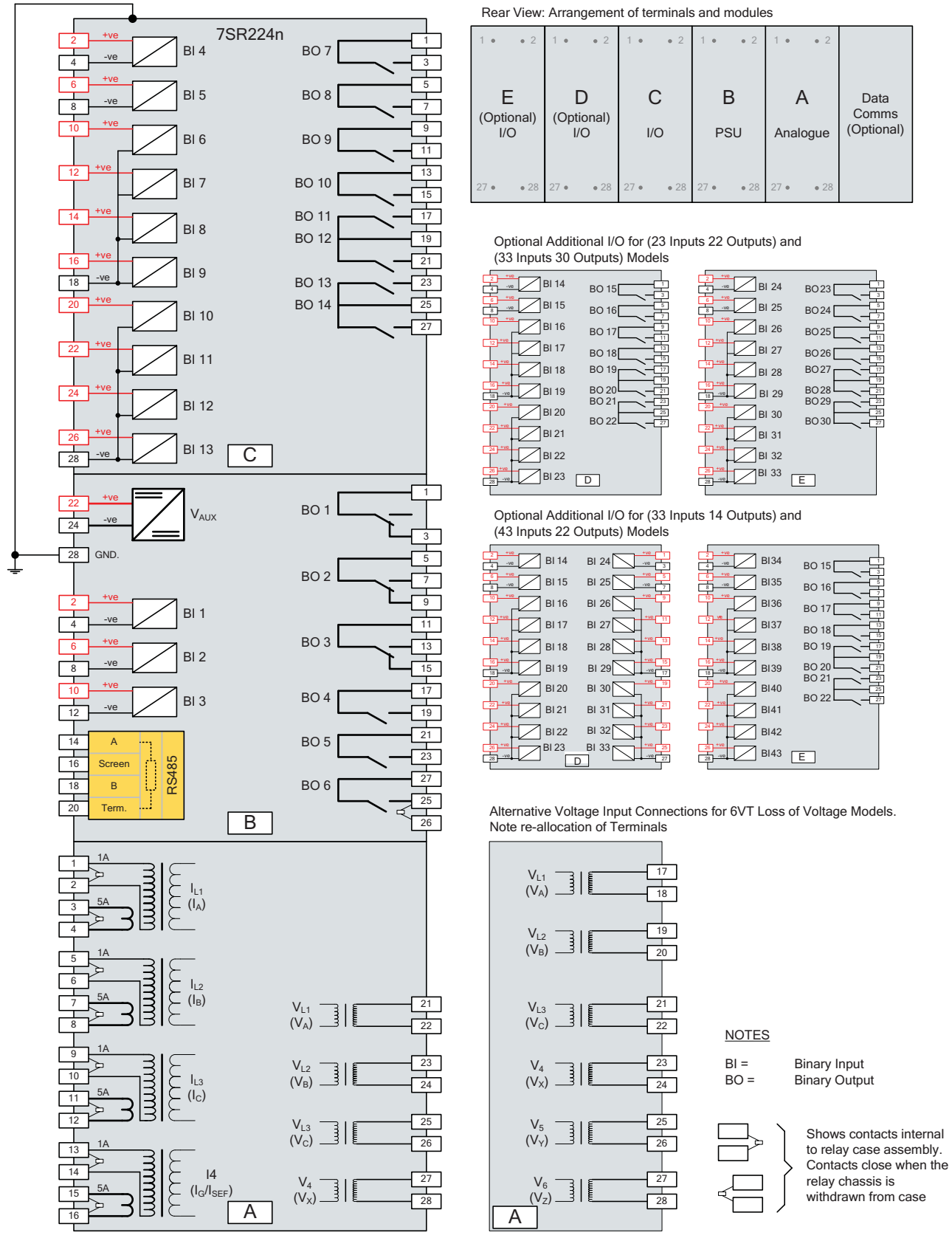


Fig 5. 7SR224 Wiring Diagram

7SR224 Interface Diagram

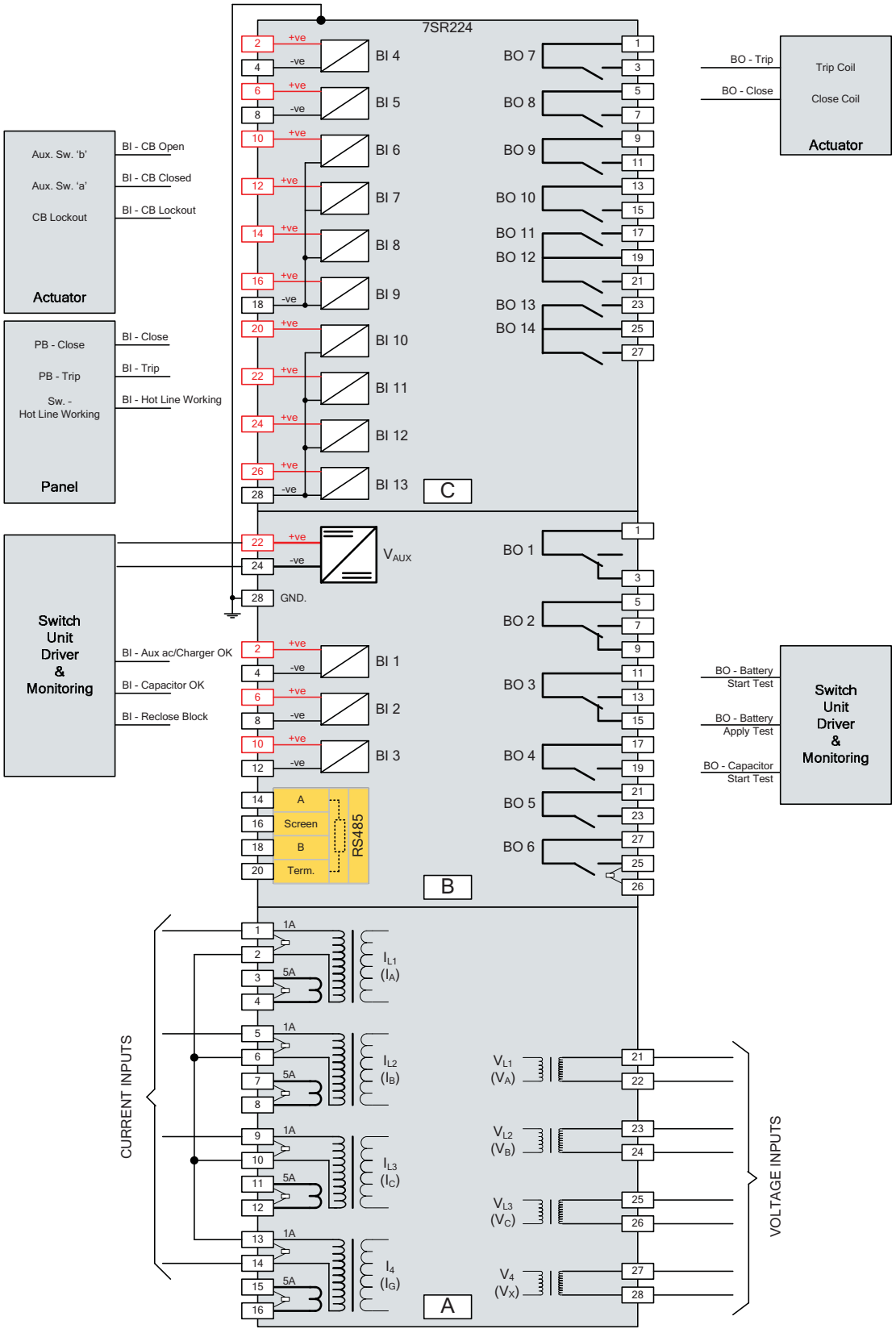


Fig 6. 7SR224 Interface Diagram

Function Diagram for 7SR224 Recloser Controller

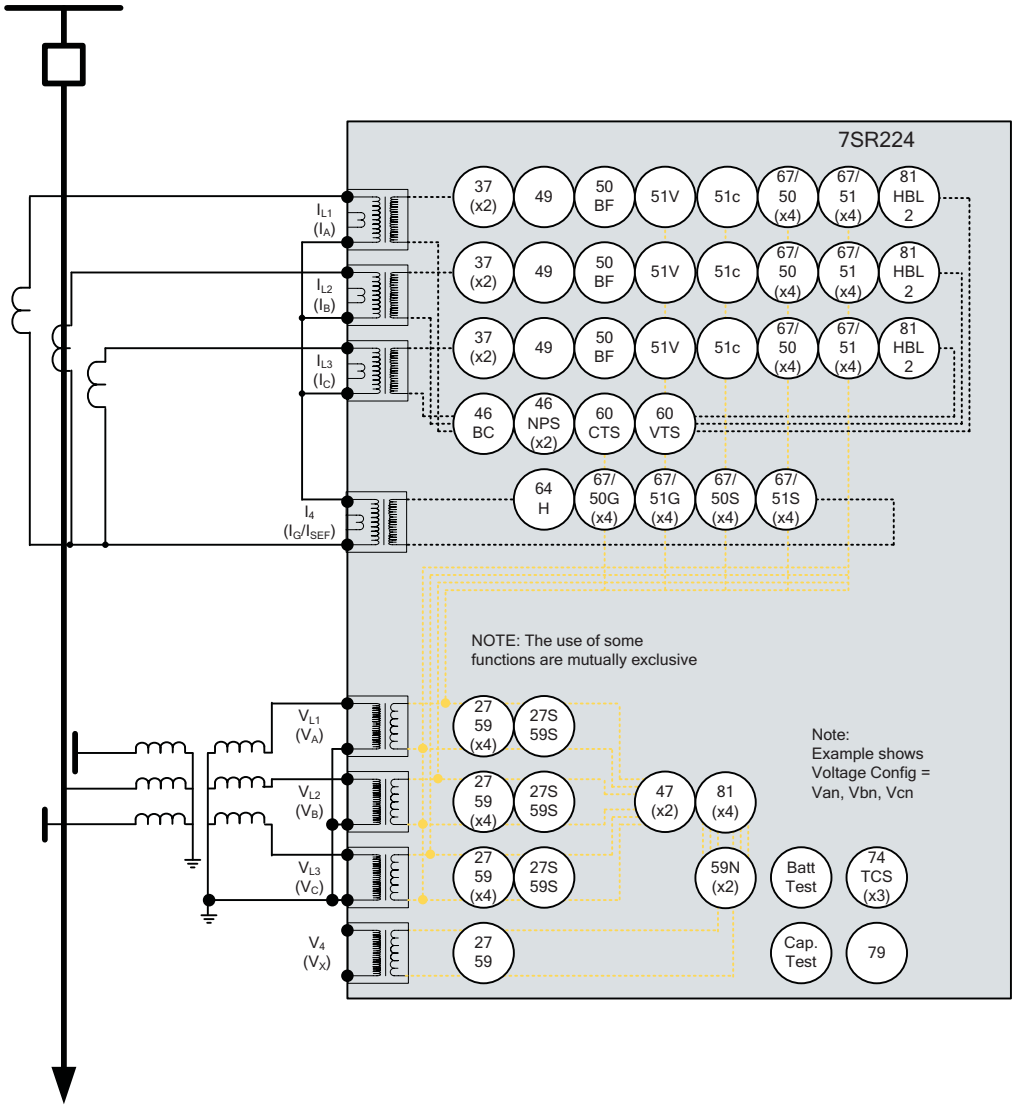


Fig 7. 7SR224 Function Diagram

Ordering Information – 7SR224 Argus Recloser Controller

Product description	Variants	Order No.

Directional O/C Relay — 7 S R 2 2 4 □ - 2 □ □ □ □ - 0 □ A □

Recloser

Protection Product
Overcurrent – Directional — 2

Relay Type
Recloser — 4

Case I/O and Fascia [1)]

E10 case, 4 CT, 6 VT, 13 Binary Inputs / 14 Binary Outputs, 8 LEDs + 12 keys	1	D
E10 case, 4 CT, 4VT, 13 Binary Inputs / 14 Binary Outputs, 8 LEDs + 12 keys	2	C
E10 case, 4 CT, 4VT, 23 Binary Inputs / 22 Binary Outputs, 8 LEDs + 12 Keys	3	C
E10 case, 4 CT, 4 VT, 33 Binary Inputs / 14 Binary Outputs, 8 LEDs + 12 keys	4	C
E10 case, 4 CT, 6 VT, 23 Binary Inputs / 22 Binary Outputs, 8 LEDs + 12 keys	5	D
E12 case, 4 CT, 4 VT, 33 Binary Inputs / 14 Binary Outputs, 16 LEDs + 12 keys	6	C/E
E12 case, 4 CT, 4 VT, 33 Binary Inputs / 30 Binary Outputs, 16 LEDs + 12 keys	7	C/E
E12 case, 4 CT, 4 VT, 43 Binary Inputs / 22 Binary Outputs, 16 LEDs + 12 keys	8	C/E

Measuring Input
1/5 A, 63.5/110V — 2

Auxiliary voltage
30 to 220V DC, binary input threshold 19V DC 22W — A

30 to 220V DC, binary input threshold 88V DC 22W — B

Region specific functions

Region World, 50/60Hz, language English, Reyrolle fascia	A
Region World, 50/60Hz, language English, Siemens fascia	B
Region USA, 60/50Hz, language English - US (ANSI) (language changeable), Siemens fascia	C

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

Protocol
IEC 60870-5-103 — 1
IEC 60870-5-103 and Modbus RTU (user selectable setting) — 2
IEC 60870-5-103 and Modbus RTU and DNP 3.0 (user selectable setting) — 3

(continued on following page)

Ordering Information – 7SR224 Argus Recloser Controller

Product description	Variants	Order No.

Directional O/C Relay — **7 S R 2 2 4 □ - 2 □ A □ □ - 0 □ A □**

(continued from previous page)

Protection Function Packages

Standard version – Included in all models — C

27/59	Under/overvoltage
27/59	Under/overvoltage, Sag/swell
37	Undercurrent
46BC	Broken conductor/load unbalance
46NPS	Negative phase sequence overcurrent
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
67/50SEF	Directional instantaneous sensitive earth fault
67/51SEF	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
	Cold load pickup
	Programmable

Standard version - plus — D

27/59	Under/overvoltage
60VTS	VT Supervision
	Loop automation by loss of voltage

Standard version - plus — E

	Single/triple pole autoreclose

Additional Functionality

No Additional Functionality — A

Settings File

Standard settings and standard labels for Siemens Recloser — 0

Reyrolle
Protection
Devices

7SG11 Argus

Overcurrent Protection Relay

Answers for energy

SIEMENS

7SG11 Argus

Overcurrent Protection Relay

Description

The 7SG11 Argus range of overcurrent protection combines the power and flexibility of microprocessor technology with decades of experience in the field of overcurrent protection and auto-reclose. A wide range of protection elements are supplemented by advanced features such as control, metering, data storage and fibre-optic based communications.

Function Overview

- IDMTL phase overcurrent stage
- 3 DTL phase overcurrent stages
- IDMTL earth-fault stage
- 3 DTL earth-fault stages
- 2 instantaneous and DTL SEF/REF stages with harmonic rejection, available as an option
- Trip circuit supervision
- Circuit breaker failure protection
- CT supervision (7SG111 &7SG112)
- Single pole, three pole and four pole variants
- True RMS measurement
- Status inputs with independent pick-up and drop-off timers and logic inversion reduce scheme engineering
- Flexible supply voltage ranges
- Low AC/DC burden
- Eight independent settings groups
- Self, hand reset contacts
- Extensive fault, sequence of event and disturbance recorder
- Fibre optic interface or RS485 multi-drop electrical bus
- Continuous self-supervision of operation and power supply

Monitoring Functions

Analogue values can be displayed in primary or secondary quantities on the LCD screen. In addition the values can be obtained via the communications port.

- Primary current per phase
- Primary earth current
- Secondary current per phase
- Secondary earth current
- Primary phase voltages*
- Primary phase-phase voltages*
- Secondary voltages*
- Apparent power and power factor*
- Real and reactive power*
- WHr forward and reverse*
- VarHr forward and reverse*
- Rolling and Max demand Ia, Ib, Ic
- Rolling and Max demand W*
- Rolling and Max Var*
- Direction
- Autoreclose status
- Output contacts
- Status inputs
- Trip circuit healthy/failure
- Trip counters
- I^2 summation
- Number of waveform and event records stored
- Time and Date
- Starters
- Power on counter

* 7SG1125 series models only

Data Storage and Communication

Serial communications conform to IEC60870-5-103 or Modbus RTU protocol. Up to 254 relays may be connected in a ring network and addressed individually.
A fibre-optic communications port is provided on the rear of the relay. It is optimised for 62.5/125µm glass fibre using ST® (BFOC/2.5) bayonet connectors. Optionally an RS485 electrical connector can be provided.

Indication

LEDs for TRIP, STARTER and PROTECTION HEALTHY status. 7SG1144 and 7SG1164 relays also have LEDs indicating CB OPEN and CB CLOSED status.
LCD – Alpha-numeric display for settings, instruments and fault data.

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

Fault records

The last 5 fault records are available from the Argus fascia with time and date of trip, measured quantities and type of fault.

Disturbance recorder

The waveform recorder may be triggered from a protection function or external input and has a configurable pre-fault trigger. Up to 5 fault waveforms may be stored.
On all models the AC current waveforms are stored together with the digital states of the status inputs and output relays. 7SG112n models with voltage and power metering additionally store AC voltage waveforms.

Reydisp Evolution

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings, interrogate settings, retrieve events and disturbance waveforms from the Argus.

Application

With reference to Fig 4: Typical Applications for 7SG11 Overcurrent Series Relays

Feeder 1 is a cable circuit; auto-reclosing is not applied, so a 7SG111n relay is used. Transient faults can occur on cables, which are initially self-sealing until the insulation is sufficiently weakened for them to become permanent. In this time much damage can occur. In order to protect against these and to maintain system overcurrent grading, a delayed reset of up to 60 seconds can be set on the IDMTL algorithms.

Feeder 4 is an overhead line so a 7SG1144 with integrated auto-reclosing is used.

The 7SG112n directional protection relay is typically applied wherever there is a potential source of power on both sides of the circuit breaker, i.e. fault current can flow in both directions. If there is a fault on the incoming circuits, or the transformers, the dual setting allows for correct grading to be applied. This directional protection will ensure that only the faulted circuit is tripped, and the healthy circuit remains in service.

On feeders that form a ring where overhead lines are used e.g. feeders 2 and 3, the dual directional 7SG1164 relay can be employed to give integrated auto-reclosing, and correct grading in both directions around the ring.

An inexpensive buszone protection can be formed using the Argus relays in an overcurrent blocking scheme. The starters of the Argus on the outgoing feeders are set to operate status inputs of the Argus on the incomers, which are set to block the lowset algorithms. If there is a fault on one of the outgoing feeders, e.g. Feeder 1, the starter on the 7SG111n will cause the lowset on the 7SG112n of Incomer 1 to be inhibited. Its IDMTL characteristic will continue to function as a backup. However, for a fault on the busbar the 7SG112n on Incomer 1 will be allowed to operate and will quickly clear the fault.

Description of Functionality

7SG11 overcurrent relays provides comprehensive overcurrent protection with programmable input and output matrix. In addition 8 setting groups enable a flexible approach to protection settings.

Phase Overcurrent

One IDMTL/DTL characteristic and 3 DTL characteristics provide phase overcurrent protection, each with independent current settings and delays. The IDMT stage has a programmable reset with a definite time delay to improve detection of flashing faults.

Earth Fault

One IDMTL/DTL characteristic and 3 DTL characteristics provide phase overcurrent protection, each with independent current settings and delays. The IDMT stage has a programmable reset with a definite time delay to improve detection of flashing faults.

Sensitive earth fault/Restricted Earth Fault

One current setting with two definite time delays are provided for sensitive earth fault protection. This element operates from fundamental frequency only, 50Hz or 60Hz, and ideally a core balance CT should be used to improve accuracy, if low current settings are required.
With the addition of a stabilising resistor and, where applicable, non-linear resistors, the sensitive earth fault input may be used for restricted earth fault protection in a high impedance scheme.

Trip Circuit Supervision

The trip circuit is monitored by a status input. This is linked to an alarm and may be configured to operate an output relay.

Circuit Breaker Fail

The circuit breaker fail function operates by monitoring the current following a trip signal and issues an alarm if the current does not cease within a specified time interval. A two-stage time delayed output can be used to operate output contacts to retrip the same circuit breaker, using a second trip coil, or to backtrip an upstream circuit breaker.

CT Supervision

CT wiring is monitored by comparing the current levels of the three line currents against each other. This is linked to an alarm and may be configured to operate an output relay.

Circuit Breaker Maintenance

A circuit breaker operations counters 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.

Directional Control

7SG112n (Argus 2) and 7SG116n (Argus 6) only.
Directional elements are available as an ordering option.
The bi-directional elements provide independent settings for each direction of each overcurrent stage. Single phase or two-out-of-three directional decisions are available for the phase-fault elements. On some models the characteristic angle for phase-fault and earth-fault are freely selectable, while on others they are chosen from +30° and +45° for phase-fault, and from 0°, -15°, -45° and -65° for earth-fault.
The polarising voltage for phase-fault elements is taken from the quadrature phase-phase voltage - see the typical connection diagrams for details.

Cold Load Pickup

7SG114n (Argus 4) and 7SG116n (Argus 6) only.
The relay can apply higher current settings with longer time delays, after the circuit breaker has been open for a programmable time.
When the circuit breaker is closed, these higher settings are applied for a programmable time, or until the measured current has fallen to normal levels.

Auto-Reclose

7SG114n (Argus 4) and 7SG116n (Argus 6) only.
Integrated auto-reclose is available as an ordering option.
The relay incorporates a 5 trip/4 close auto-reclose sequence that can be initiated by an internal or external signal.
For each type of protection trip – phase-fault, earth-fault, SEF and external – a separate sequence of instantaneous and delayed trips is available. Programmable dead times and reclaim times with a wide setting range and integrated sequence co-ordination enable virtually all distribution auto-reclose schemes to be realised.

Technical Data

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

Inputs and Outputs

Characteristic energising quantity

AC Current/Voltage	Frequency
1A / 5A	50 / 60Hz
63.5/110V	

Current Inputs: Burdens

5A Phase/Earth	< 0.2VA
1A Phase/Earth	< 0.05VA
5A SEF/REF	< 0.4VA
1A SEF/REF	< 0.2VA

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	
	1A Input	5A Input
3 Second	57.7A	230A
2 Second	70.7A	282A
1 Second	100A	400A
I Cycle	177A	618A

SEF/REF Current Inputs: Thermal Withstand

Continuous	2.0 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	
	1A Input	5A Input
3 Second	37.5A	202A
2 Second	46A	247A
1 Second	65A	350A
I Cycle	120A	618A

Voltage Inputs

Burden	< 0.1VA at 110V
Continuous Withstand	250V

DC Auxiliary supply

Rated DC Voltage	Operating Range V dc
24/30/48V	18 to 60V
110/220V	88 to 280V

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

DC status input

Nominal voltage	Operating range
30V	18 - 37.5 V D C
48V	37.5 - 60 V D C
110V	87.5 - 137.5 V D C
220V	175 - 280 V D C

Attribute	Value
Min. DC Current for Operation: 30/48V 110/220V	 10mA <5mA
Reset/Operate voltage ratio	≥ 90 %
Typical response time	5 ms (10ms for Argus 2 type II)
Typical response time when programmed to energise an output relay contact	< 15 ms
Recommended Minimum pulse duration	40ms with setting of 20ms PU delay for a.c. rejection

For relays to ES148-4 standard and 110/125 or 220/250 volt DC working a 48 volt status input is supplied for use with external dropper resistors:

Nominal Voltage	Resistor Value	Wattage
110V	2k7 ± 5%	2.5 W
220 V	8k2 ± 5%	6.0 W

Each status input has associated timers which can be programmed to give time delayed pick-up and time delayed drop-off. These timers have default settings of 20ms, thus providing rejection and immunity to an AC input signal. Status inputs will not respond to the following:-

250V RMS 50/60Hz applied for two seconds through a 0.1µF capacitor.
Discharge of a 10µF capacitor charged to maximum DC auxiliary supply voltage.
The status inputs with nominal voltage of 30 V to 54 V meet the requirements of ESI 48-4 ESI 1.

Low Burden Status Inputs

Optionally, low burden status inputs are available directly rated for 110/125Vd.c. or 220/250Vd.c. without dropper resistors. These inputs do not meet the ESI 48-4 ESI 1 requirements. Where necessary a single external dropper resistor in parallel can be fitted to meet ESI 48-4 ESI 1 requirements.

Low Burden Status Input performance

Nominal	Operating Range	Typical burden
110, 125	87.5 to 137.5 V DC	1.75 to 3.0 mA
220, 250	175 to 280V DC	1.75 to 3.0 mA

110/125 V minimum pick-up voltage typically 50 – 60 V d.c.
220/250 V minimum pick-up voltage typically 100 – 120 V d.c.

Output relays

Carry continuously	5A ac or dc
Make and carry (L/R ≤ 40 ms and V ≤ 300V)	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
Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5 Watt minimum of 10mA or 5V

Mechanical

Vibration (Sinusoidal)

IEC 60255-21-1 Class I

Vibration response	0.5gn
Vibration endurance	1.0gn

Shock and Bump

IEC 60255-21-2 Class I

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

Seismic

IEC 60255-21-3 Class I

Seismic Response	1gn

Mechanical Classification

Durability	In excess of 10^6 operations

Electrical Tests

Insulation

IEC 255-5 rms levels for 1 minute

Between all terminals and earth for 1 minute	2.0 kV rms
Between independent circuits for 1 minute	2.0 kV rms
Across normally open contacts for 1 minute	1.0 kV rms

High frequency disturbance

IEC 60255-22-1 class III

2.5kV longitudinal mode 1.0kV transverse mode	≤ 3% deviation

Electrostatic Discharge

IEC 60255-22-2 class III

8kV, Contact discharge	≤ 5% variation

Fast transient

IEC 255-22-4 class IV

4kV, 5/50ns, 2.5 kHz, repetitive	≤ 3% variation

Conducted RFI

IEC 60255-22-6 class IV

10 V, 0.15 to 80 MHz	≤ 5% variation

Conducted Limits

IEC 60255-25

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

Radiated Limits

IEC 60255-25

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

Radio frequency interference

IEC60 255-22-3

10 V/m, 20 to 1000 MHz	≤ 5% variation

Environmental

Temperature

IEC 68-2-1/2

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

Humidity

IEC 68-2-3

Operational test	56 days at 40°C and 95% RH

Performance

General Accuracy

Reference Conditions	
General	IEC 60255-3
Current settings	100% of In
Current input	IDMTL: 2 to 30 xIs
	DTL: 5 xIs
Auxiliary supply	Nominal
Frequency	50 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: Phase-fault and earth-fault elements only. SEF elements reject all harmonics.		
Frequencies to 550 Hz	≤ 5 % variation	

Overcurrent protection

Characteristic	
Setting	IEC Normal Inverse (NI) IEC Very Inverse (VI) IEC Extremely Inverse (EI) IEC Long Time Inverse,(LTI) DTL
No. of elements	1
Level	
Setting Range Is	0.05, 0.1...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...1.6
Accuracy	± 5% or ± 30 ms
Repeatability	± 1% or ± 5 ms
DTL Delay	
Setting	0.00 to 20.00 sec

Accuracy	± 10ms
Repeatability	± 5 ms
Reset delay	
Setting	0 to 60 sec
Accuracy	± 1% or ± 10ms
Repeatability	± 1% or ± 5 ms

DTL	
No. of elements	3
Level	
Setting Range Is	0.05 to 52.5 x In
Accuracy	Operate: 100% Is, ±5% or, ±10mA
	Reset ≥ 95% of operate current
Repeatability	± 1%
DTL Delay	
Setting	0.00 to 20.00 sec
Accuracy	± 5ms
Repeatability	± 1% or ± 5 ms

SEF/REF	
No. of elements	2 delays
Level	
Setting Range Is	0.005 to 0.96 x In
Accuracy	Operate: 100% Is, ±5%
	Reset ≥ 95% of operate current
Repeatability	± 1%
DTL Delay	
Setting	0.00 to 20.00 sec
Accuracy	± 5ms
Repeatability	± 1% or ± 5 ms

Earth fault protection

As overcurrent protection.

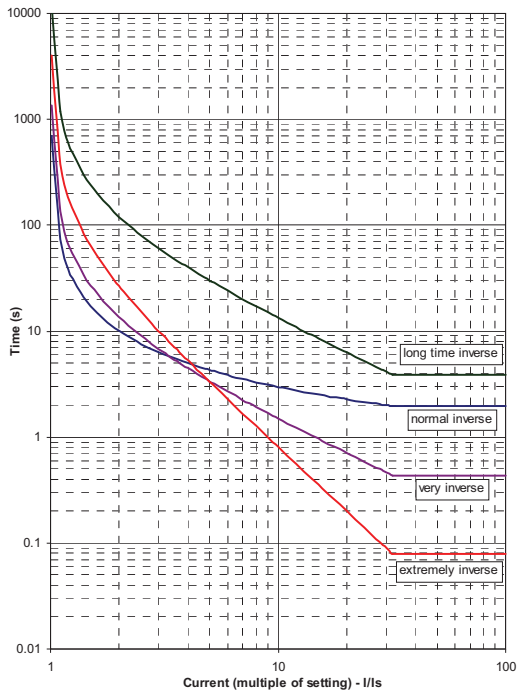


Fig 1. IEC IDMTL Curves

$$t_{operate} = Tm \times \left[\frac{K}{\left[\frac{I}{Is}\right]^{\alpha} - 1} \right]$$

I =fault current
Is =current setting
Tm = time multiplier
NI: K = 0.14 α = 0.02
VI: K = 13.5 α = 1.0
EI: K = 80.0 α = 2.0
LTI: K = 120.0 α = 1.0

Circuit breaker failure (50BF)

Characteristics	DTL
No. of elements	3
DTL Delay	
Setting	Re-trip 0.00 to 20.00 sec
	Back-trip 0.00 to 20.00 sec
Accuracy	± 5ms
Repeatability	± 1%

CT Failure (60CTS)

Characteristics	DTL
No. of elements	1
Level	
Setting Range	OFF, 0.05 to 1 x In
DTL Delay	
Setting	0 to 300 sec

Auto-reclose (79)

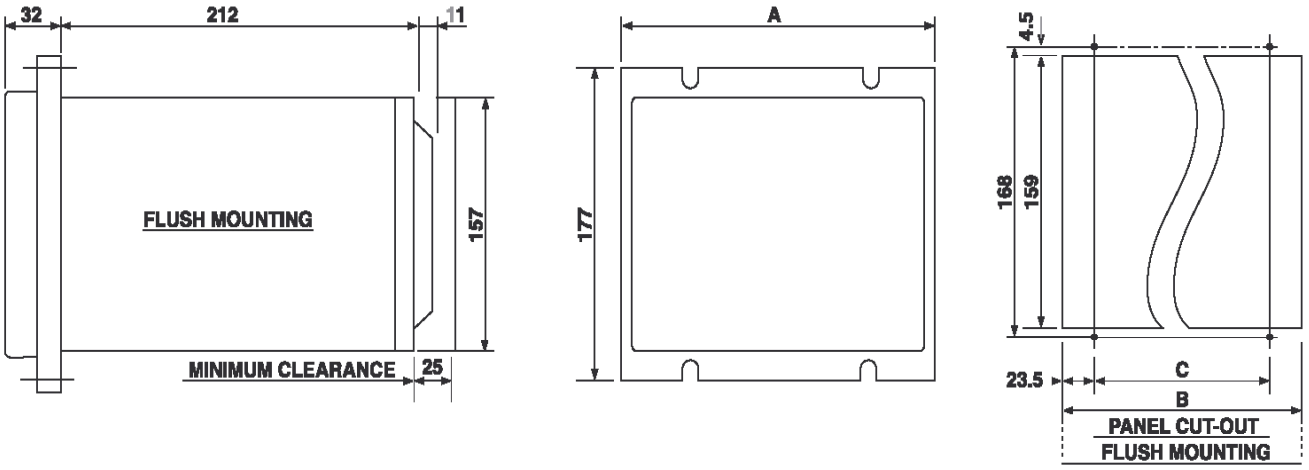
No. of Shots	1 to 4	
Delay		
Settings	Deadtime	0.2 to 14400 sec
	Close Pulse	1.0 to 10.0 sec
	Reclaim	0.2 to 14400 sec
	Lockout	Off, 0.2 to 14400 sec
Accuracy	± 1 % or ± 10 ms	
Repeatability	± 1%	

Instrumentation

Currents	
Reference conditions	I ≥ 0.1 xIn
Accuracy	± 1 % of In
Voltages	
Reference conditions	V ≥ 0.8 xVn
Accuracy	± 1 % of Vn
Power and Apparent Power	
Reference conditions	V = Vn, I ≥ 0.1 xIn, pf ≥ 0.8
Accuracy	± 3 % of Pn where Pn = Vn x In
Power Factor	
Reference conditions	V = Vn, I ≥ 0.1 xIn, pf ≥ 0.8
Accuracy	± 0.05

Case Dimensions

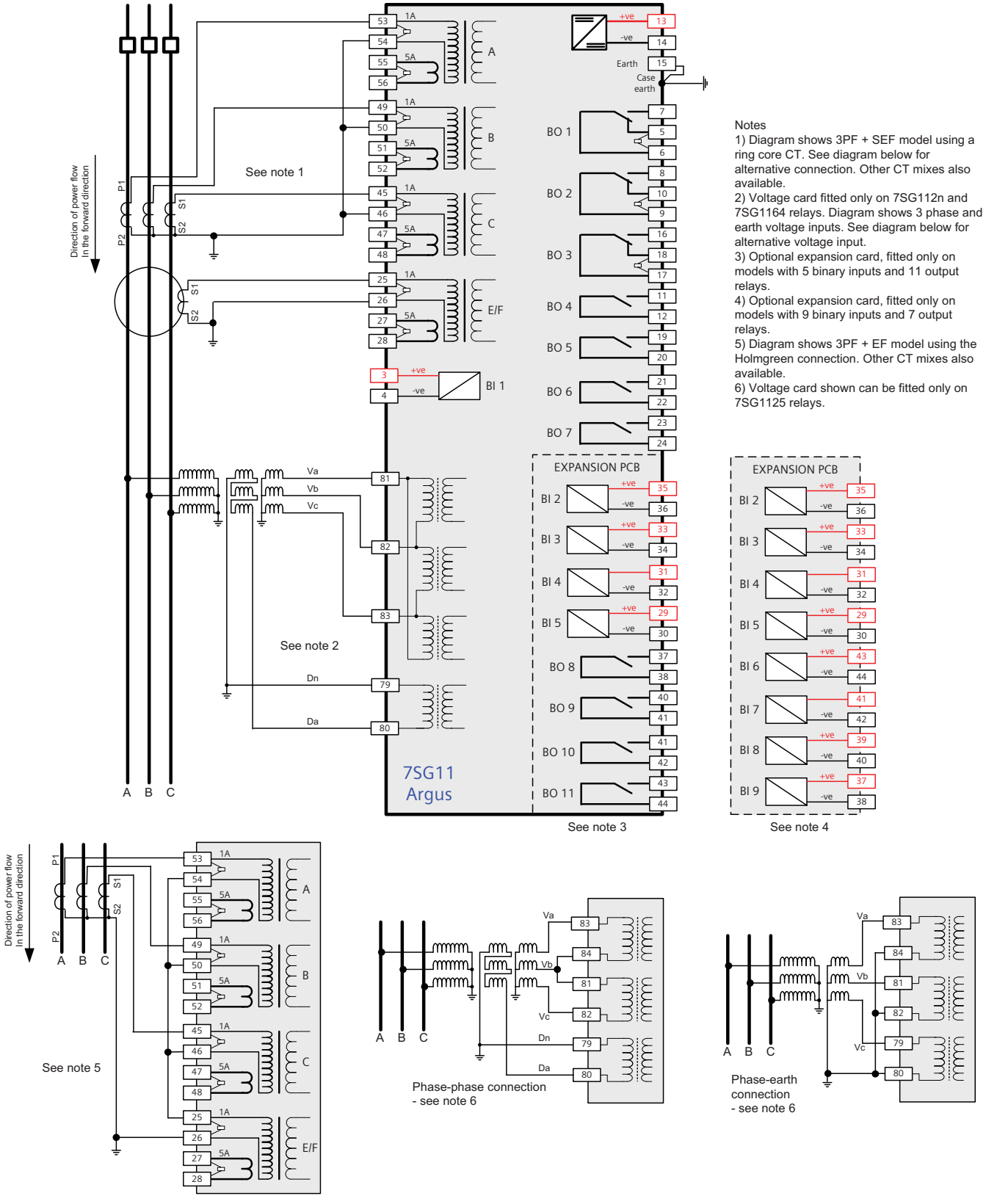
7SG11 series relays are supplied in either in E4, E6 or E8 cases.



	Dimensions		
	A	B	C
E4 Case	103	99.5	52
E6 Case	155	151	103.5
E8 Case	203	203	155.5

Fig 2. Overall dimensions and panel drilling details (All dimensions are in mm)

Connection Diagram



Notes
1) Diagram shows 3PF + SEF model using a ring core CT. See diagram below for alternative connection. Other CT mixes also available.
2) Voltage card fitted only on 7SG112n and 7SG1164 relays. Diagram shows 3 phase and earth voltage inputs. See diagram below for alternative voltage input.
3) Optional expansion card, fitted only on models with 5 binary inputs and 11 output relays.
4) Optional expansion card, fitted only on models with 9 binary inputs and 7 output relays.
5) Diagram shows 3PF + EF model using the Holmgreen connection. Other CT mixes also available.
6) Voltage card shown can be fitted only on 7SG1125 relays.

Fig 3. Connection Diagram for 7SG11 Overcurrent Relay

Typical Applications

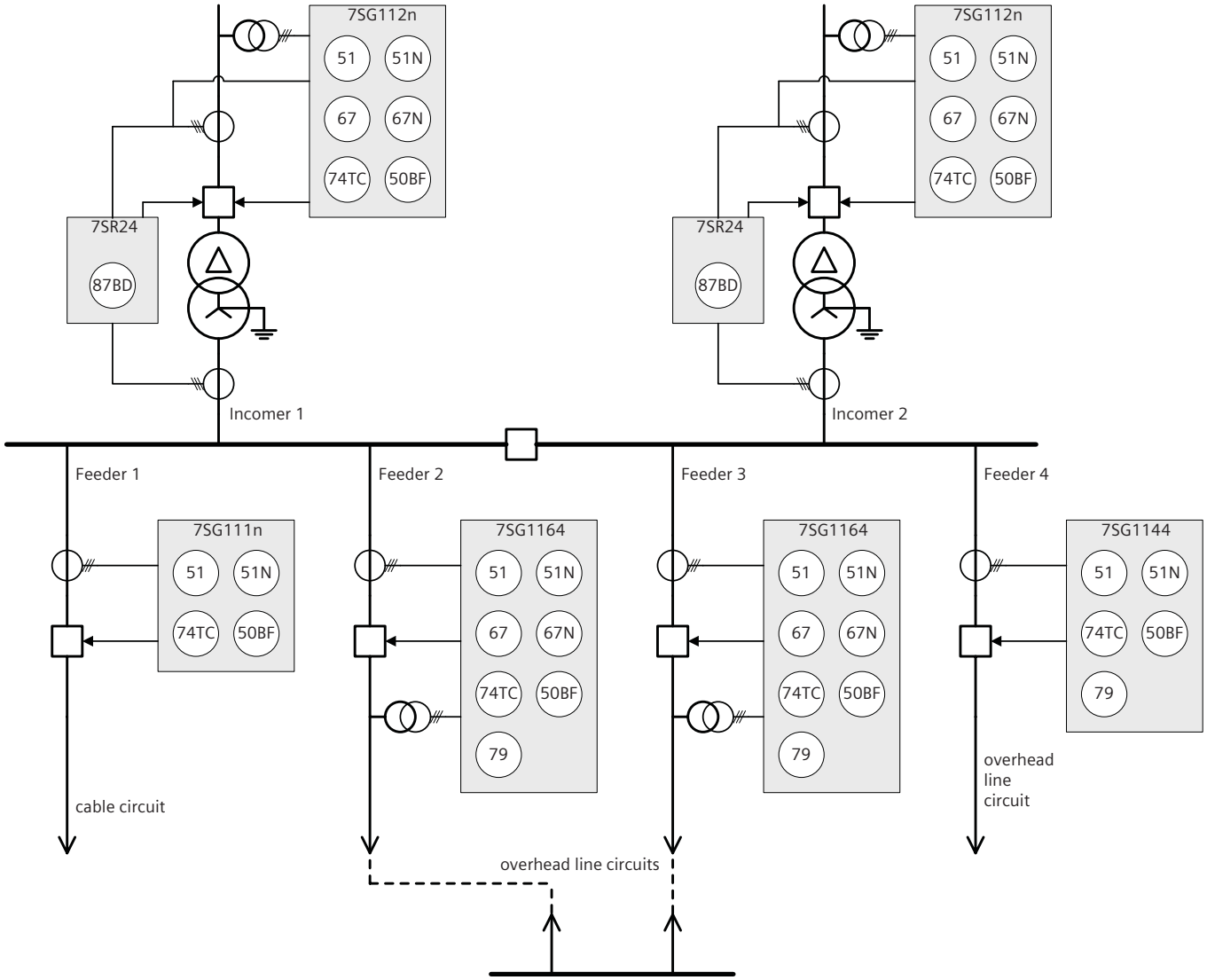


Fig 4. Typical Applications for 7SG11 Overcurrent Series Relays

Ordering Information – 7SG1111 Argus

Product description	Variants	Order No.
Nondirectional O/C relay		7 S G 1 1 1 □ - □ □ □ □ □ - 0 □ A 0
Over current and earth fault protection for radial feeders, capacitor banks and industrial and commercial plant.	Number of elements Single pole relay	1
	Auxiliary supply /binary input voltage 24/30/48 V DC auxiliary, 30 V binary input 110/220 V DC auxiliary, 30 V binary input 24/30/48 V DC auxiliary, 48 V binary input 110/220 V DC auxiliary, 48 V binary input [1]) 110/220 V DC auxiliary, 110 V low burden binary input 110/220 V DC auxiliary, 220 V low burden binary input	 0 1 2 3 4 5
	Type of elements Single pole phase-fault or single pole earth-fault Single pole sensitive/restricted earth-fault (SEF/REF)	 A B
	Nominal current 1/ 5 A	 A
	I/O range 1 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	 0
	Communication interface Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU RS485 interface / IEC 60870-5-103 or Modbus RTU	 1 2
	Housing size Case size E4 (4U high)	 C

1) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 1 binary input and 110 V application, order resistor box VCE:2512H10066 in addition
for 1 binary input and 220 V application, order resistor box VCE:2512H10068 in addition
Refer to website for application note about ESI48-4 compliance.

Ordering Information – 7SG1113 Argus

Product description	Variants	Order No.
Nondirectional O/C relay		7 S G 1 1 1 □ - □ □ □ □ □ - 0 □ A 0
Over current and earth fault protection for radial feeders, capacitor banks and industrial and commercial plant.	Number of elements Three pole relay	3
	Auxiliary supply /binary input voltage 24/30/48 V DC auxiliary, 30 V binary input 110/220 V DC auxiliary, 30 V binary input 24/30/48 V DC auxiliary, 48 V binary input 110/220 V DC auxiliary, 48 V binary input [1]) 110/220 V DC auxiliary, 110 V low burden binary input 110/220 V DC auxiliary, 220 V low burden binary input	 0 1 2 3 4 5
	Type of elements 3 pole phase-fault or 2 pole phase-fault and earth-fault 2 pole phase-fault and sensitive/restricted earth-fault (SEF/REF)	 C D
	Nominal current 1/ 5 A	 A
	I/O range 1 Binary Input / 7 Binary Outputs (incl. 3 changeover) 5 Binary Inputs / 11 Binary Outputs (incl. 3 changeover) 9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	 0 1 2
	Communication interface Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU RS485 interface / IEC 60870-5-103 or Modbus RTU	 1 2
	Housing size Case size E6 (4U high)	 D

[1]) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 1 binary input and 110 V application, order resistor box VCE:2512H10066 in addition
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 1 binary input and 220 V application, order resistor box VCE:2512H10068 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance.

Ordering Information – 7SG1114 Argus

Product description	Variants	Order No.
Nondirectional O/C relay		**7 S G 1 1 1 □ - □□ □ □ □ - 0 □ A 0**
Over current and earth fault protection for radial feeders, capacitor banks and industrial and commercial plant.	Number of elements Four pole relay	**4**
	Auxiliary supply /binary input voltage 24/30/48 V DC auxiliary, 30 V binary input 110/220 V DC auxiliary, 30 V binary input 24/30/48 V DC auxiliary, 48 V binary input 110/220 V DC auxiliary, 48 V binary input [1]) 110/220 V DC auxiliary, 110 V low burden binary input 110/220 V DC auxiliary, 220 V low burden binary input	 **0** **1** **2** **3** **4** **5**
	Type of elements 3 pole phase-fault and earth-fault 3 pole phase-fault and sensitive/restricted earth-fault (SEF/REF) or 2 pole phase-fault and earth fault and sensitive/restricted earth-fault (SEF/REF)	 **E** **F**
	Nominal current 1/ 5 A	 **A**
	I/O range 1 Binary Input / 7 Binary Outputs (incl. 3 changeover) 5 Binary Inputs / 11 Binary Outputs (incl. 3 changeover) 9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	 **0** **1** **2**
	Communication interface Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU RS485 interface / IEC 60870-5-103 or Modbus RTU	 **1** **2**
	Housing size Case size E6 (4U high)	 **D**

[1]) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 1 binary input and 110 V application, order resistor box VCE:2512H10066 in addition
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 1 binary input and 220 V application, order resistor box VCE:2512H10068 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Ordering Information – 7SG1115 Argus

Product description	Variants	Order No.
Nondirectional O/C relay		7 S G 1 1 1 □ - □ □ □ □ □ - 0 □ A 0
Over current and earth fault protection for radial feeders, capacitor banks and industrial and commercial plant.	Number of elements Four pole relay (fixed I/O)	5
	Auxiliary supply /binary input voltage 24/30/48 V DC auxiliary, 30 V binary input 110/220 V DC auxiliary, 30 V binary input 24/30/48 V DC auxiliary, 48 V binary input 110/220 V DC auxiliary, 48 V binary input [1]) 110/220 V DC auxiliary, 110 V low burden binary input 110/220 V DC auxiliary, 220 V low burden binary input	0 1 2 3 4 5
	Type of elements 3 pole phase-fault and earth-fault	E
	Nominal current 1A 5A	B C
	I/O range 3 Binary Input / 5 Binary Outputs (incl. 2 changeover)	3
	Communication interface Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU RS485 interface / IEC 60870-5-103 or Modbus RTU	1 2
	Housing size Case size E4 (4U high)	C

[1]) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Ordering Information – 7SG1121 Argus

Product description	Variants	Order No.
Directional O/C relay Ideal for directional overcurrent and earth fault protection of solid ring systems utilising the fully independent bi-directional feature.		**7 S G 1 1 2 □ - □ □ □ □ □ - □ □ A 0**
	Number of elements Single pole relay	**1**
	Auxiliary supply/binary input voltage 24/30/48 V DC auxiliary, 30 V binary input 110/220 V DC auxiliary, 30 V binary input 24/30/48 V DC auxiliary, 48 V binary input 110/220 V DC auxiliary, 48 V binary input [1]) 110/220 V DC auxiliary, 110 V low burden binary input 110/220 V DC auxiliary, 220 V low burden binary input	**0** **1** **2** **3** **4** **5**
	Type of elements Single pole earth-fault directional Single pole earth-fault directional Single pole sensitive/restricted directional earth-fault (SEF/REF) Single pole sensitive/restricted directional earth-fault (SEF/REF)	 **G** **G** **H** **H**
	Nominal current 1/ 5 A	 **A**
	I/O range 1 Binary Input / 7 Binary Outputs (incl. 3 changeover)	 **0**
	Communication interface Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU RS485 interface / IEC 60870-5-103 or Modbus RTU	 **1** **2**
	Directional measurement characteristic angle (CA) 0°, -15°, -45°, -65° for earth faults 0°, -15°, -45°, -90° for earth faults	 **2** **3**
	Housing size Case size E4 (4U high)	 **C**

[1]) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 1 binary input and 110 V application, order resistor box VCE:2512H10066 in addition
for 1 binary input and 220 V application, order resistor box VCE:2512H10068 in addition
Refer to website for application note about ESI48-4 compliance

Ordering Information – 7SG1123 Argus

Product description	Variants	Order No.
Directional O/C relay		7 S G 1 1 2 □ - □ □ □ □ □ - □ □ A 0
Ideal for directional overcurrent and earth fault protection of solid ring systems utilising the fully independent bi-directional feature.		
	Number of elements	
	Three pole relay	3
	Auxiliary supply/binary input voltage	
	24/30/48 V DC auxiliary, 30 V binary input	0
	110/220 V DC auxiliary, 30 V binary input	1
	24/30/48 V DC auxiliary, 48 V binary input	2
	110/220 V DC auxiliary, 48 V binary input 1)	3
	110/220 V DC auxiliary, 110 V low burden binary input	4
	110/220 V DC auxiliary, 220 V low burden binary input	5
	Type of elements	
	3 pole phase-fault directional	J 1 E
	2 pole phase-fault directional and sensitive/restricted earth-fault (SEF/REF)	K 1 E
	2 pole phase-fault directional and earth-fault directional or 2 pole phase-fault directional and earth-fault	L 4 E
	2 pole phase-fault directional and earth-fault directional or 2 pole phase-fault directional and earth-fault	L 5 E
	2 pole phase-fault and earth-fault directional	M 2 D
	2 pole phase-fault and earth-fault directional	M 3 D
	Nominal current	
	1/ 5 A	A
	I/O range	
	5 Binary Inputs / 11 Binary Outputs (incl. 3 changeover)	1
	9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	2
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	1
	RS485 interface / IEC 60870-5-103 or Modbus RTU	2
	Directional measurement characteristic angle (CA)	
	+30°, +45° for phase faults	1
	0°, -15°, -45°, -65° for earth faults	2
	0°, -15°, -45°, -90° for earth faults	3
	+30°, +45° for phase faults and 0°, -15°, -45°, -65° for earth faults	4
	+30°, +45° for phase faults and 0°, -15°, -45°, -90° for earth faults	5
	Housing size	
	Case size E6 (4U high)	D
	Case size E8 (4U high)	E

1) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Ordering Information – 7SG1124 Argus

Product description	Variants	Order No.
Directional O/C relay		7 S G 1 1 2 □ - □ □ □ □ □ - □ □ A 0
Ideal for directional overcurrent and earth fault protection of solid ring systems utilising the fully independent bi-directional feature.		
	Number of elements	
	Four pole relay	4
	Auxiliary supply/binary input voltage	
	24/30/48 V DC auxiliary, 30 V binary input	0
	110/220 V DC auxiliary, 30 V binary input	1
	24/30/48 V DC auxiliary, 48 V binary input	2
	110/220 V DC auxiliary, 48 V binary input 1)	3
	110/220 V DC auxiliary, 110 V low burden binary input	4
	110/220 V DC auxiliary, 220 V low burden binary input	5
	Type of elements	
	3 pole phase-fault directional and sensitive/restricted earth-fault (SEF/REF)	N
	3 pole phase-fault directional and earth-fault directional or 3 pole phase-fault directional and earth-fault	P
	3 pole phase-fault directional and earth-fault directional or 3 pole phase-fault directional and earth-fault	P
	3 pole phase-fault and earth-fault directional	Q
	3 pole phase-fault and earth-fault directional	Q
	Nominal current	
	1/ 5 A	A
	I/O range	
	5 Binary Inputs / 11 Binary Outputs (incl. 3 changeover)	1
	9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	2
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	1
	RS485 interface / IEC 60870-5-103 or Modbus RTU	2
	Directional measurement characteristic angle (CA)	
	+30°, +45° for phase faults	1
	0°, -15°, -45°, -65° for earth faults	2
	0°, -15°, -45°, -90° for earth faults	3
	+30°, +45° for phase faults and 0°, -15°, -45°, -65° for earth faults	4
	+30°, +45° for phase faults and 0°, -15°, -45°, -90° for earth faults	5
	Housing size	
	Case size E6 (4U high)	D
	Case size E8 (4U high)	E

1) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Ordering Information – 7SG1125 Argus

Product description	Variants	Order No.
Directional O/C relay Ideal for directional overcurrent and earth fault protection of solid ring systems utilising the fully independent bi-directional feature, includes additional voltage protection and energy metering.		**7 S G 1 1 2 □ - □ □ □ □ □ - □ □ A 0**
	Number of elements Four pole relay (numeric VT)	**5**
	Auxiliary supply/binary input voltage 24/30/48 V DC auxiliary, 30 V binary input 110/220 V DC auxiliary, 30 V binary input 24/30/48 V DC auxiliary, 48 V binary input 110/220 V DC auxiliary, 48 V binary input [1]) 110/220 V DC auxiliary, 110 V low burden binary input 110/220 V DC auxiliary, 220 V low burden binary input	**0** **1** **2** **3** **4** **5**
	Type of elements 3 pole phase-fault directional and earth-fault directional 3 pole phase-fault directional and sensitive/restricted earth fault (SEF/REF) or 2 pole phase-fault directional and earth fault directional and sensitive/restricted earth-fault (SEF/REF)	**R** **S**
	Nominal current 1/5 A and 63/110 V AC	**D**
	I/O range 5 Binary Inputs / 11 Binary Outputs (incl. 3 changeover) 9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	**1** **2**
	Communication interface Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU RS485 interface / IEC 60870-5-103 or Modbus RTU	**1** **2**
	Directional measurement characteristic angle (CA) -90° to +90° in steps of 1°	**6**
	Housing size Case size E8 (4U high)	**E**

[1]) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Ordering Information – 7SG1144 Argus

Product description	Variants	Order No.
Nondirectional O/C Relay with auto-reclose		**7 S G 1 1 4 □ - □ □ □ □ □ - 0 □ A 0**
Integrated overcurrent and earth fault relay with multishot autoreclose facilities.		
	Number of elements	
	Four pole relay	4
	Auxiliary supply /binary input voltage	
	24/30/48 V DC auxiliary, 30 V binary input	0
	110/220 V DC auxiliary, 30 V binary input	1
	24/30/48 V DC auxiliary, 48 V binary input	2
	110/220 V DC auxiliary, 48 V binary input 1)	3
	110/220 V DC auxiliary, 110 V low burden binary input	4
	110/220 V DC auxiliary, 220 V low burden binary input	5
	Type of elements	
	3 pole phase-fault and earth-fault	E
	3 pole phase-fault and sensitive/restricted earth-fault (SEF/REF) or 2 pole phase-fault and earth fault and sensitive/restricted earth-fault (SEF/REF)	F
	Nominal current	
	1/ 5 A	A
	I/O range	
	9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	2
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	1
	RS485 interface / IEC 60870-5-103 or Modbus RTU	2
	Housing size	
	Case size E6 (4U high)	D

1) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Ordering Information – 7SG1164 Argus

Product description	Variants	Order No.
Directional O/C relay with auto-reclose		**7 S G 1 1 6 □ - □ □ □ □ □ - □ □ A 0**
Bi-directional version of ARGUS 4.		
	Number of elements	
	Four pole relay	4
	Auxiliary supply /binary input voltage	
	24/30/48 V DC auxiliary, 30 V binary input	0
	110/220 V DC auxiliary, 30 V binary input	1
	24/30/48 V DC auxiliary, 48 V binary input	2
	110/220 V DC auxiliary, 48 V binary input 1)	3
	110/220 V DC auxiliary, 110 V low burden binary input	4
	110/220 V DC auxiliary, 220 V low burden binary input	5
	Type of elements	
	3 pole phase-fault directional and sensitive/restricted earth-fault (SEF/REF)	N 1 E
	3 pole phase-fault directional and earth-fault directional or 3 pole phase-fault directional and earth-fault	P 4 E
	3 pole phase-fault directional and earth-fault directional or 3 pole phase-fault directional and earth-fault	P 5 E
	3 pole phase-fault and earth-fault directional	Q 2 D
	3 pole phase-fault and earth-fault directional	Q 3 D
	Nominal current	
	1/ 5 A	A
	I/O range	
	9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	2
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	1
	RS485 interface / IEC 60870-5-103 or Modbus RTU	2
	Directional measurement characteristic angle (CA)	
	+30°, +45° for phase faults	1
	0°, -15°, -45°, -65° for earth faults	2
	0°, -15°, -45°, -90° for earth faults	3
	+30°, +45° for phase faults and 0°, -15°, -45°, -65° for earth faults	4
	+30°, +45° for phase faults and 0°, -15°, -45°, -90° for earth faults	5
	Housing size	
	Case size E6 (4U high)	D
	Case size E8 (4U high)	E

1) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Reyrolle
Protection
Devices

7SG117 Argus 7

Synchronising Relay

Answers for energy

SIEMENS

7SG117 Argus 7

Synchronising Relay

Fig 1.

Independent check & system synchronising settings
Adjustable slip frequency, phase angle and voltage blocking
Differential blocking
Split system detection
Configurable dead bus and/or dead line charge
Integrated manual close guard feature
Fibre optic or RS485 electrical comms port

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. This feature is implemented using internal logic and removes the need for an external relay.

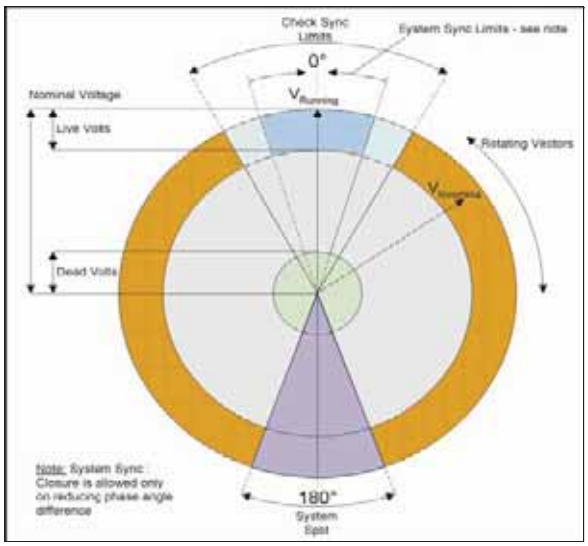
Description

The 7SG117 Argus 7 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 autoreclose scheme.

Relays are part of the comprehensive range of Argus-platform based numeric relays. They have extensive control functions, which are supplemented by advanced metering, data storage and fibre-optic communications. Supervisory and self-monitoring features give added confidence to the user as well as reduced maintenance and down time. Reydisp relay interrogation software gives user-friendly access to relay settings, meters and operational data.

Function Overview



Monitoring Functions

Analogue values can be displayed in primary or secondary quantities on the LCD screen. In addition the values can be obtained via the communications port.

Primary voltages
Secondary voltages
Frequencies
Phase angles
Status inputs
Output contacts

Data Storage and Communication

Serial communications conform to IEC60870-5-103 protocol. Up to 254 relays may be connected in a ring network and addressed individually.

A fibre-optic communications port is provided on the rear of the relay. It is optimised for 62.5/125µm glass fibre using ST® (BFOC/2.5) bayonet connectors. Optionally an RS485 electrical connector can be provided.

Indication

LEDs for CHECK/SYS SYNCH, SYS SPLIT and PROTECTION HEALTHY status.

LCD – Alpha-numeric display for settings, instruments and fault data.

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

Trip/Close records

The last 10 records are available from the fascia and via the data communications channel.

The record contains information for the time and date of close and the voltage, frequency and slip values at the time of close.

Disturbance recorder

The waveform recorder may be triggered from a synchronising function or external input and has a configurable pre-fault trigger.

Up to 5 a.c. voltage waveforms are stored. together with the digital states of the status inputs and output relays

Reydisp Evolution

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings, interrogate settings and retrieve events and disturbance waveforms from the Relay.

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 the two systems have been previously interconnected, then 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 automatically 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.

Technical Data

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

Inputs and Outputs

Voltage Inputs

AC Voltage	Frequency
63.5/110V	50 / 60Hz

Burden	< 0.2VA
Continuous Withstand	250V

DC Auxiliary supply

Rated DC Voltage	Operating Range V dc
24/30/48V	18 to 60V
110/220V	88 to 280V

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

DC status input

Nominal voltage	Operating range
30V	18 - 37.5 V D C
48V	37.5 - 60 V D C
110V	87.5 - 137.5 V D C
220V	175 - 280 V D C

Attribute	Value
Min. DC Current for Operation: 30/48V 110/220V	 10mA <5mA
Reset/Operate voltage ratio	≥ 90 %
Typical response time	5 ms
Typical response time when programmed to energise an output relay contact	< 15 ms
Recommended Minimum pulse duration	40ms with setting of 20ms PU delay for a.c. rejection

The 30V and 48V inputs meet the requirements of the ESI48-4 ES1 standard. However, the 110V or 220V inputs will operate with a DC current of less than 10mA. If 110V or 220V inputs compliant with ESI48-4 ES1 are required, a 48 volt status input can be supplied with external dropper resistors as follows:

Nominal Voltage	Resistor Value	Wattage
110V	2k7 ± 5%	2.5 W
220 V	8k2 ± 5%	6.0 W

Each status input has associated timers which can be programmed to give time delayed pick-up and time delayed drop-off. The pick-up delays have default settings of 20ms, thus providing rejection and immunity to an AC input signal. Status inputs will not respond to the following:-

- 250V RMS 50/60Hz applied for two seconds through a 0.1 µF capacitor.
- Discharge of a 10µF capacitor charged to maximum DC auxiliary supply voltage.

Output relays

Carry continuously	5A ac or dc
Make and carry (L/R ≤ 40 ms and V ≤ 300V)	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
Minimum number of operations	10^6 at maximum load
Minimum recommended load	0.5 W minimum of 10mA or 5V

Mechanical

Vibration (Sinusoidal)

IEC 60255-21-1 Class I

Vibration response	0.5gn	≤ 5% variation
Vibration endurance	1.0gn	

Shock and Bump

IEC 60255-21-2 Class I

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

Seismic

IEC 60255-21-3 Class I

Seismic Response	1gn	≤ 5% variation

Electrical Tests

Insulation IEC 255-5

IEC 255-5 rms levels for 1 minute

Between all terminals and earth for 1 minute	2.0 kV rms
Between independent circuits for 1 minute	2.0 kV rms
Across normally open contacts for 1 minute	1.0 kV rms

High frequency disturbance

IEC 60255-22-1 class III

2.5kV longitudinal mode 1.0kV transverse mode	< 3% deviation

Electrostatic Discharge

IEC 60255-22-2 class III

8kV, Contact discharge	≤ 5% variation

Fast transient

IEC 255-22-4 class IV

4kV, 5/50ns, 2.5 kHz, repetitive	≤ 3% variation

Conducted RFI

IEC 60255-22-6 class IV

10 V, 0.15 to 80 MHz	≤ 5% variation

Conducted Limits

IEC 60255-25

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

Radiated Limits

IEC 60255-25

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

Radio frequency interference

IEC 60 255-22-3

10 V/m, 80 to 1000 MHz	≤ 5% variation

Environmental

Temperature

IEC 68-2-1/2

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

Humidity

IEC 68-2-3

Operational test	56 days at 40°C and 95% RH

Performance

General Accuracy

Reference Conditions	
General	IEC 60255-3
Auxiliary supply	Nominal
Frequency	50Hz or 60Hz
Ambient temperature	20 °C

Accuracy Influencing Factors

Temperature		
-10 °C to +55 °C	≤ 5 % variation	
Frequency		
47 Hz to 52 Hz 57 Hz to 62 Hz	Level:	≤ 1 % variation
	Operating time:	≤ 1 % variation

Check and System Synchronising (25)

Live and Dead voltage level		
Dead Line/Bus	5.0 to 127.0 V step 0.5 V	
Live Line/Bus	10.0 to 132.0 V step 0.5 V	
Accuracy	Live operate	Live setting ± 1%
	Live reset	Dead setting ± 1%
	Dead operate	Dead setting ± 1%
	Dead reset	Live setting ± 1%
Undervoltage level		
Setting	22.0 to 132.0 V step 0.5V	
Accuracy	Operate	Setting ± 1%
	Reset	< 104% of operate level
Voltage difference level		
Setting	0.5 to 44.0 V step 0.5V	
Accuracy	Operate	Setting ± 2% or 0.5 V
	Reset	> 90% of operate level or > operate level – 2.0V
Slip Frequency		
Setting	20 to 2000 mHz step 5 mHz	
Accuracy	Operate	Setting – 15mHz + 0mHz
	Reset	Operate – 0mHz + 15mHz
Check Sync., System Sync. Phase angle		
Setting	5 to 90° step 1°	
Accuracy	Operate	Setting - 3° + 0°
	Reset	Operate - 0° + 3°
System Split phase angle		
Setting	90 to 175° step 1°	
Accuracy	Operate	Setting ± 1.5°
	Reset	Latched
All timers		
Setting	0.1 to 100.0 sec step 0.1 sec	
Accuracy	± 1% or 10ms	

Case Dimensions

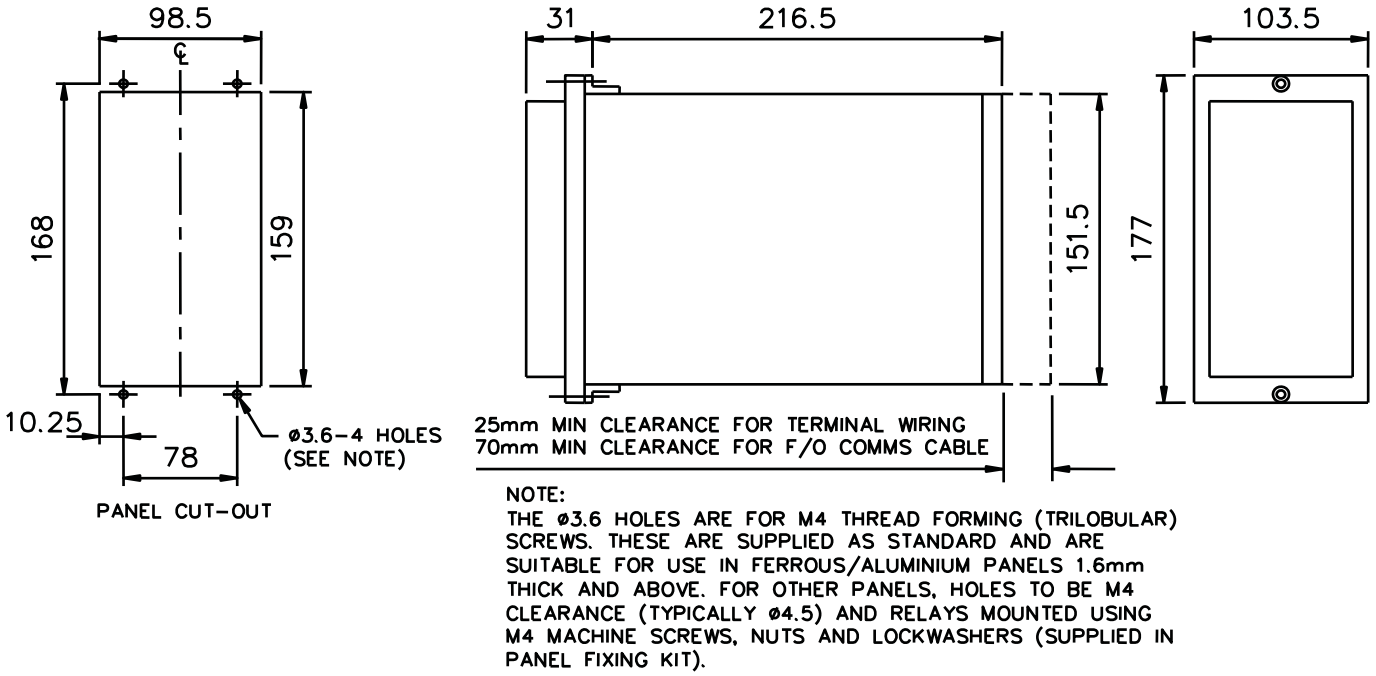


Fig 2. E4 Case Dimensions

Connection Diagram

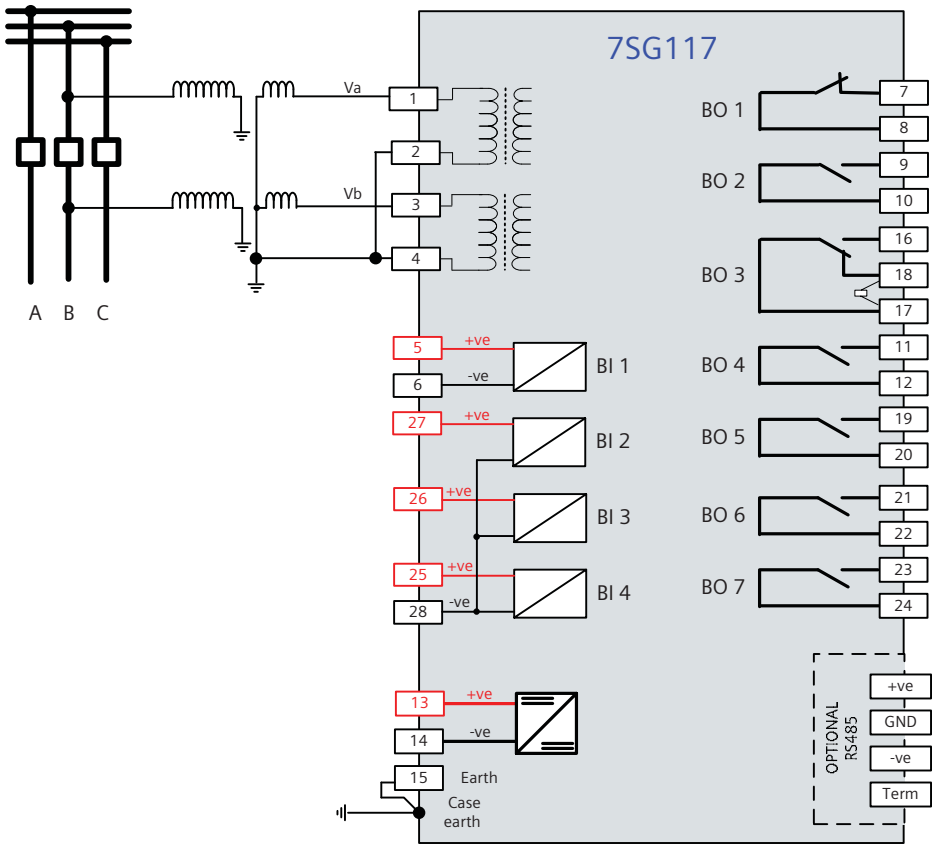
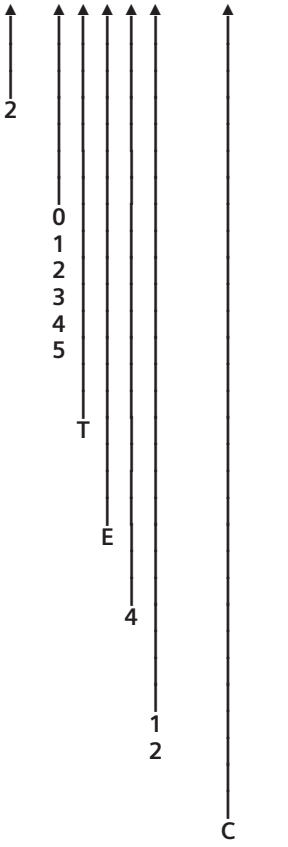


Fig 3. Connection Diagram for 7SG117 Synchronising Relay

Ordering Information – 7SG117

Product description	Variants	Order No.
Check and system synchronising relay		**7 S G 1 1 7 □ - □ □ □ □ □ - 0 □ A 0**



Number of elements
Two pole relay — 2

Auxiliary supply /binary input voltage

24/30/48 V DC auxiliary, 30 V binary input — 0
110/220 V DC auxiliary, 30 V binary input — 1
24/30/48 V DC auxiliary, 48 V binary input — 2
110/220 V DC auxiliary, 48 V binary input [1] — 3
110/220 V DC auxiliary, 110 V low burden binary input — 4
110/220 V DC auxiliary, 220 V low burden binary input — 5

Type of voltage relay
Voltage measuring relay providing check and system synchronising — T

Nominal voltage inputs
63/110 V AC — E

I/O range
4 Binary Inputs / 7 Binary Outputs (incl. 1 changeover and 1 normally closed) — 4

Communication interface
Fibre optic (ST-connector) / IEC 60870-5-103 — 1
RS485 interface / IEC 60870-5-103 — 2

Housing size
Case size E4 (4U high) — C

[1] High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 5 binary inputs and 110V application, order resistor box VCE:2512H10065 in addition
for 5 binary inputs and 220V application, order resistor box VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Reyrolle
Protection
Devices

7SG118 Argus 8

Voltage & Frequency Relay

Answers for energy

SIEMENS

7SG118 Argus 8

Voltage and Frequency Relay

Description

7SG118 Argus 8 voltage and frequency relays are numerical, multi-function devices that are designed to be applied for the protection of transmission, distribution and industrial systems.

The relay provides phase under and over voltage, neutral displacement overvoltage, negative sequence overvoltage and under and over-frequency protection elements.

These relays have extensive protection functions, which are supplemented by advanced metering, data storage and communications. Supervisory and self monitoring features give added confidence to the user as well as reduced maintenance and down time. A menu-based interface gives user-friendly access to relay settings, meters and operational data.

Function Overview

- 2 or 3 voltage inputs
- Under/Over Voltage
- Negative phase sequence over voltage
- Neutral voltage displacement
- Under/Over Frequency
- Under voltage blocking
- Fibre optic or RS485 electrical communications port

Data Storage and Communication

Serial communications conform to IEC60870-5-103 or Modbus RTU protocol. Up to 254 relays may be connected in a ring network and addressed individually.

A fibre-optic communications port is provided on the rear of the relay. It is optimised for 62.5/125µm glass fibre using ST® (BFOC/2.5) bayonet connectors. Optionally an RS485 electrical connector can be provided.

Indication

LEDs for STARTER, TRIP and PROTECTION HEALTHY status.

LCD – Alpha-numeric display for settings, instruments and fault data.

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

Fault records

The last 10 fault records are available from the fascia with time and date of trip, measured quantities and type of fault.

Disturbance recorder

The waveform recorder may be triggered from a protection function or external input and has a configurable pre-fault trigger. Up to 5 fault waveforms may be stored.

AC voltage waveforms are stored together with the digital states of the status inputs and output relays.

Reydisp Evolution

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings, interrogate settings and retrieve events and disturbance waveforms from the Relay.

Application

Undervoltage and overvoltage

Four independent elements are supplied, each of which can be set to operate for under or over voltage conditions. Each has separate definite time delay elements. These can be used to protect generators against over-voltages, motors against loss of supply or applied as backup protection in the event of defective system regulating equipment.

Negative sequence overvoltage

Two independent elements are supplied, each of which has a definite time delay element. These can be used to monitor the quality of the supply and protect plant against system unbalance.

Neutral voltage displacement

Two independent elements are supplied, each of which has a definite time delay element. These can be used to detect earth faults in high impedance earthed or isolated systems. For this feature, the residual voltage can be measured directly from an open delta tertiary winding or (for 3-phase variants) calculated internally from the phase voltage inputs.

These elements include a third harmonic filter, which de-sensitises the elements to any superimposed third harmonic frequencies.

Underfrequency and overfrequency

Four independent elements are supplied, each of which can be set to operate for under or over frequency. Each has separate definite time delay elements. These can be applied wherever frequency protection is required to maintain system stability e.g. in load shedding schemes. The accuracy and security of operation of the numeric algorithms enables the relay to be employed to detect any frequency abnormalities.

Description of Functionality

Relay variants with two voltage inputs have a '2 Systems A/B' connection setting. This allows the voltage of two different systems each to be assigned two of the under/overvoltage elements.

This feature could be used as part of a local generation scheme with islanding capability, where one input is allocated to the local system, and the other to the grid.

Note that in this mode the frequency elements are disabled.

Blocking operation

Each protection element can be blocked from operation by a user-defined status input signal. In addition, the voltage, frequency and NPS elements can be protected against maloperation during system de-energisation using the Voltage Blocking Threshold. Each frequency element may also be blocked by any combination of the voltage elements starting.

Trip circuit supervision

The trip circuit connections can be monitored by a status input. This is linked to an alarm and may be configured to operate an output relay.

Circuit breaker maintenance

A circuit breaker operations counter is provided. An operations count level can be set which, when reached, can be used as an input to a condition-based maintenance regime.

Technical Data

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

Inputs and Outputs

Voltage Inputs

AC Voltage	Frequency
63.5/110V	50 / 60Hz

Burden	≤ 0.2VA
Continuous Withstand	250V

DC Auxiliary supply

Rated DC Voltage	Operating Range V dc
24/30/48V	18 to 60V
110/220V	88 to 280V

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

DC status input

Nominal voltage	Operating range
30V	18 - 37.5 V D C
48V	37.5 - 60 V D C
110V	87.5 - 137.5 V D C
220V	175 - 280 V D C

Attribute	Value
Min. DC Current for Operation: 30/48V 110/220V	 10mA <5mA
Reset/Operate voltage ratio	≥ 90 %
Typical response time	5 ms
Typical response time when programmed to energise an output relay contact	< 15 ms
Recommended Minimum pulse duration	40ms with setting of 20ms PU delay for a.c. rejection

The 30V and 48V inputs meet the requirements of the ESI48-4 ES1 standard. However, the 110V or 220V inputs will operate with a DC current of less than 10mA. If 110V or 220V inputs compliant with ESI48-4 ES1 are required, a 48 volt status input can be supplied with external dropper resistors as follows:

Nominal Voltage	Resistor Value	Wattage
110V	2k7 ± 5%	2.5 W
220 V	8k2 ± 5%	6.0 W

Each status input has associated timers which can be programmed to give time delayed pick-up and time delayed drop-off. The pick-up delays have default settings of 20ms, thus providing rejection and immunity to an AC input signal. Status inputs will not respond to the following:-

- 250V RMS 50/60Hz applied for two seconds through a 0.1μF capacitor.
- Discharge of a 10μF capacitor charged to maximum DC auxiliary supply voltage.

Output relays

Carry continuously	5A ac or dc
Make and carry (L/R ≤ 40 ms and V ≤ 300V)	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
Minimum number of operations	10^6 at maximum load
Minimum recommended load	0.5 W minimum of 10mA or 5V

Mechanical

Vibration (Sinusoidal)

IEC 60255-21-1 Class I

Vibration response	0.5gn	≤ 5% variation	0.5gn
Vibration endurance	1.0gn		1.0gn

Shock and Bump

IEC 60255-21-2 Class I

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

Seismic

IEC 60255-21-3 Class I

Seismic Response	1gn	≤ 5% variation

Electrical Tests

Insulation IEC 255-5

IEC 255-5 rms levels for 1 minute

Between all terminals and earth for 1 minute	2.0 kV rms
Between independent circuits for 1 minute	2.0 kV rms
Across normally open contacts for 1 minute	1.0 kV rms

High frequency disturbance

IEC 60255-22-1 class III

2.5kV longitudinal mode 1.0kV transverse mode	< 3% deviation

Electrostatic Discharge

IEC 60255-22-2 class III

8kV, Contact discharge	≤ 5% variation

Fast transient

IEC 255-22-4 class IV

4kV, 5/50ns, 2.5 kHz, repetitive	≤ 3% variation

Conducted RFI

IEC 60255-22-6 class IV

10 V, 0.15 to 80 MHz	≤ 5% variation

Conducted Limits

IEC 60255-25

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

Radiated Limits

IEC 60255-25

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

Radio frequency interference

IEC60 255-22-3

10 V/m, 80 to 1000 MHz	≤ 5% variation

Environmental

Temperature

IEC 68-2-1/2

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

Humidity

IEC 68-2-3

Operational test	56 days at 40°C and 95% RH

Performance

General Accuracy

Reference Conditions	
General	IEC 60255-3
Auxiliary supply	Nominal
Frequency	50Hz or 60Hz
Ambient temperature	20 °C

Accuracy Influencing Factors

Temperature		
-10 °C to +55 °C	≤ 5 % variation	
Frequency		
47 Hz to 52 Hz 57 Hz to 62 Hz	Level:	≤ 1 % variation
	Operating time:	≤ 1 % variation

Phase Under/Over Voltage protection (27/59)

No. of elements	4
Level	
Setting Vs	5.0 to 200.0 V step 0.5 V
Hysteresis	1 to 90 % step 1 %
Accuracy	Operate: setting ± 1% or ± 0.25 V U/V reset: (operate + hysteresis) O/V reset: (operate - hysteresis)

Operating Time		
Under-Voltage	1.1x to 0.9x Vs:	≤ 65 ms
Reset	0 V to 1.1x Vs 0 V to 2.0x Vs:	≤ 75 ms ≤ 65 ms
Over-Voltage	0 V to 1.1x Vs: O V to 2.0xVs:	≤ 55 ms ≤ 45ms
Reset	1.1x to 0.9x Vs:	≤ 50 ms
Delay (additional to operating time)		
Setting	0.00 to 600 sec	
Accuracy	± 1 % or ± 30 ms	

Negative Sequence Over Voltage protection (47)

No. of elements	2
Level	
Setting Vs	1.0 to 100.0 V step 0.5 V
Hysteresis	1 to 90 % step 1 %
Accuracy	Operate: setting ± 1% or ± 0.5 V Reset: ≥ 95% of operate value (for Vs > 3.5 V)

Operating Time		
Operate	0 V to 1.1xVs	≤ 85 ms
	0 V to 2.0xVs	≤ 85 ms
Reset	1.1x to 0.9x Vs:	≤ 80 ms
	1.1xVs to 0 Vs:	≤ 70 ms

Delay (additional to operating time)	
Setting	0.00 to 600 sec
Accuracy	± 1 % or ± 30 ms

Neutral Over Voltage protection (59N)

No. of elements	2
Level	
Setting Vs	1.0 to 100.0 V step 0.5 V
Accuracy	Operate: setting ± 1% or ± 0.5 V Reset: ≥ 95% of operate value (for Vs > 7.5 V)

Operating Time		
Operate	0 V to 1.1x Vs	≤ 85 ms
	0 V to 2.0x Vs	≤ 85 ms
Reset	1.1x to 0.9x Vs	≤ 80 ms
	1.1xVs to 0 V:	≤ 70 ms
Delay (additional to operating time)		
Setting	0.00 to 600 sec	
Accuracy	± 1 % or ± 30 ms	

Under/Over Frequency protection (81U/O)

No. of elements	4
Level	
Setting	47.00 to 62.00 Hz step 0.01 Hz
Accuracy	Operate: setting ± 10mHz U/F reset: ≤ operate + 20 mHz O/F reset: ≤ operate - 20 mHz

Operating Time		
for ROCOF between 0.1 - 10 Hz/s	typically:	< 140 ms
	maximum:	175 ms *
Delay (additional to operating time)		
Setting	0.00 to 600 sec	
Accuracy	± 1 % or ± 30 ms	

* 7SG118n-nW 300-series meets NGC specification for an underfrequency operating time of 150ms maximum

Voltage Blocking Element

Level	
Setting	1.0 to 100.0 V step 1 V

Case Dimensions

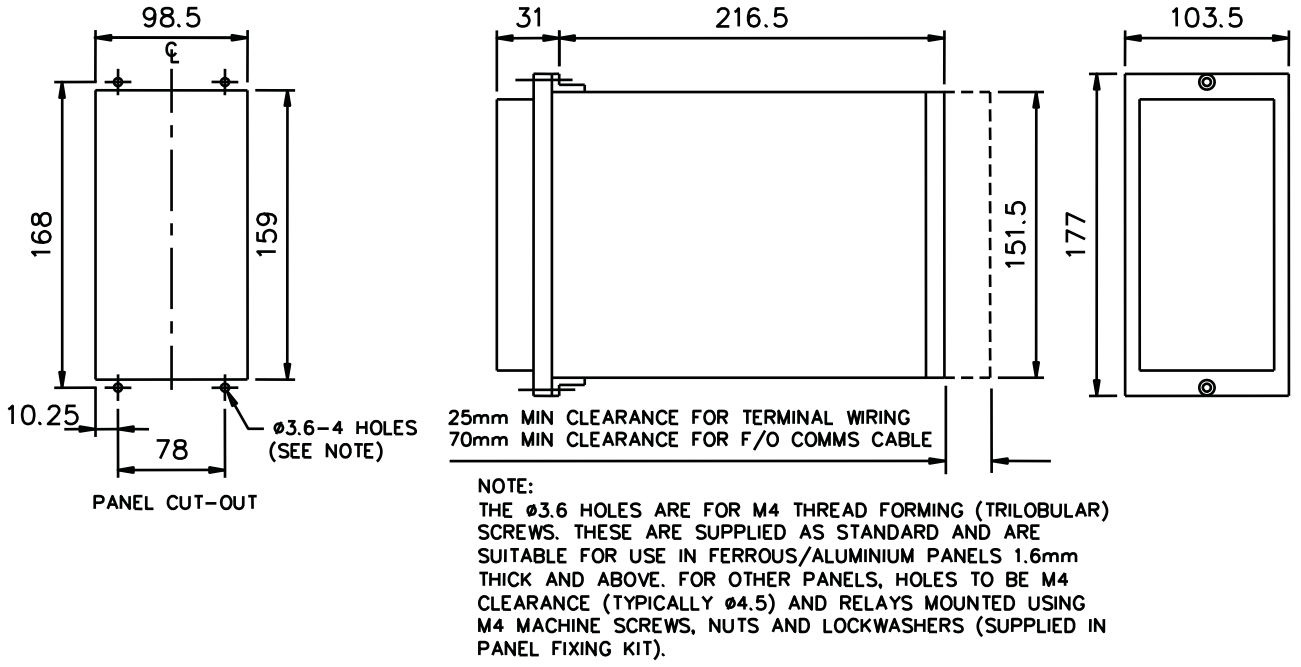


Fig 1. E4 Case Dimensions

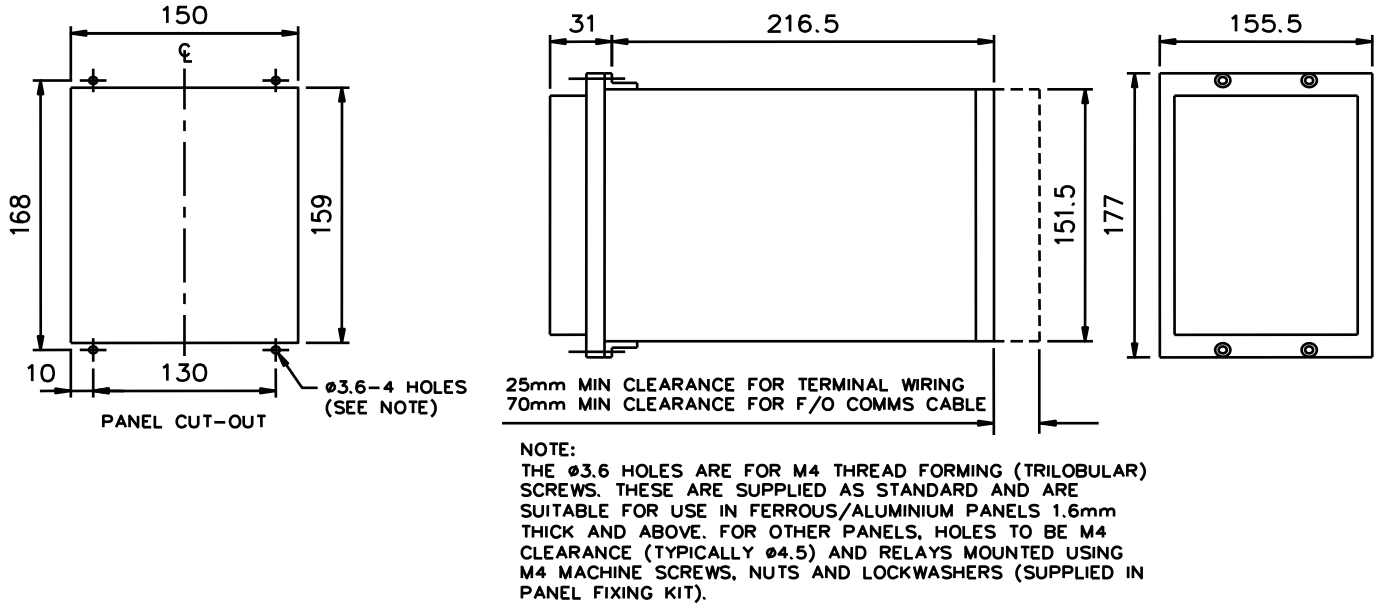
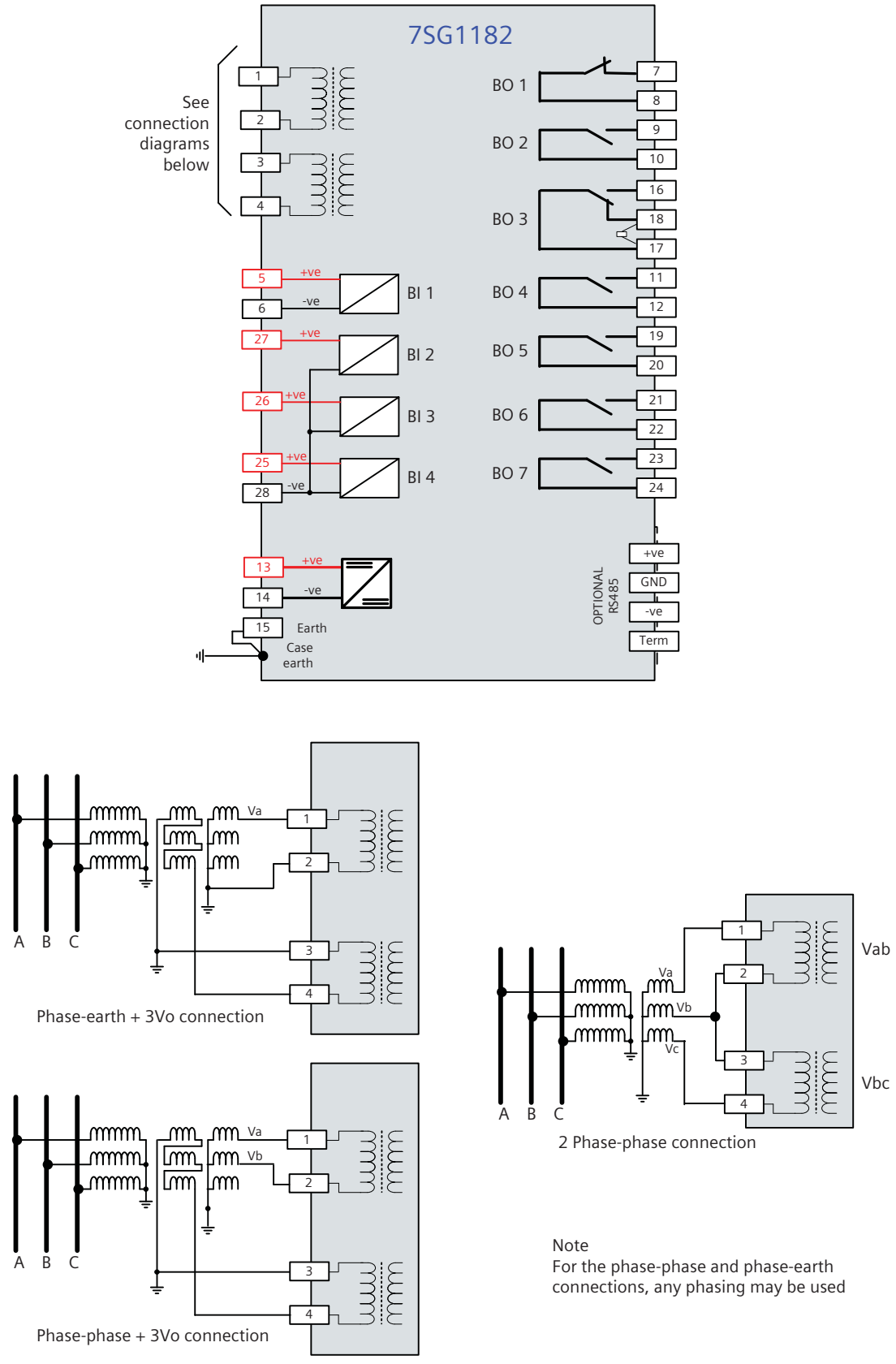


Fig 2. E6 Case Dimensions

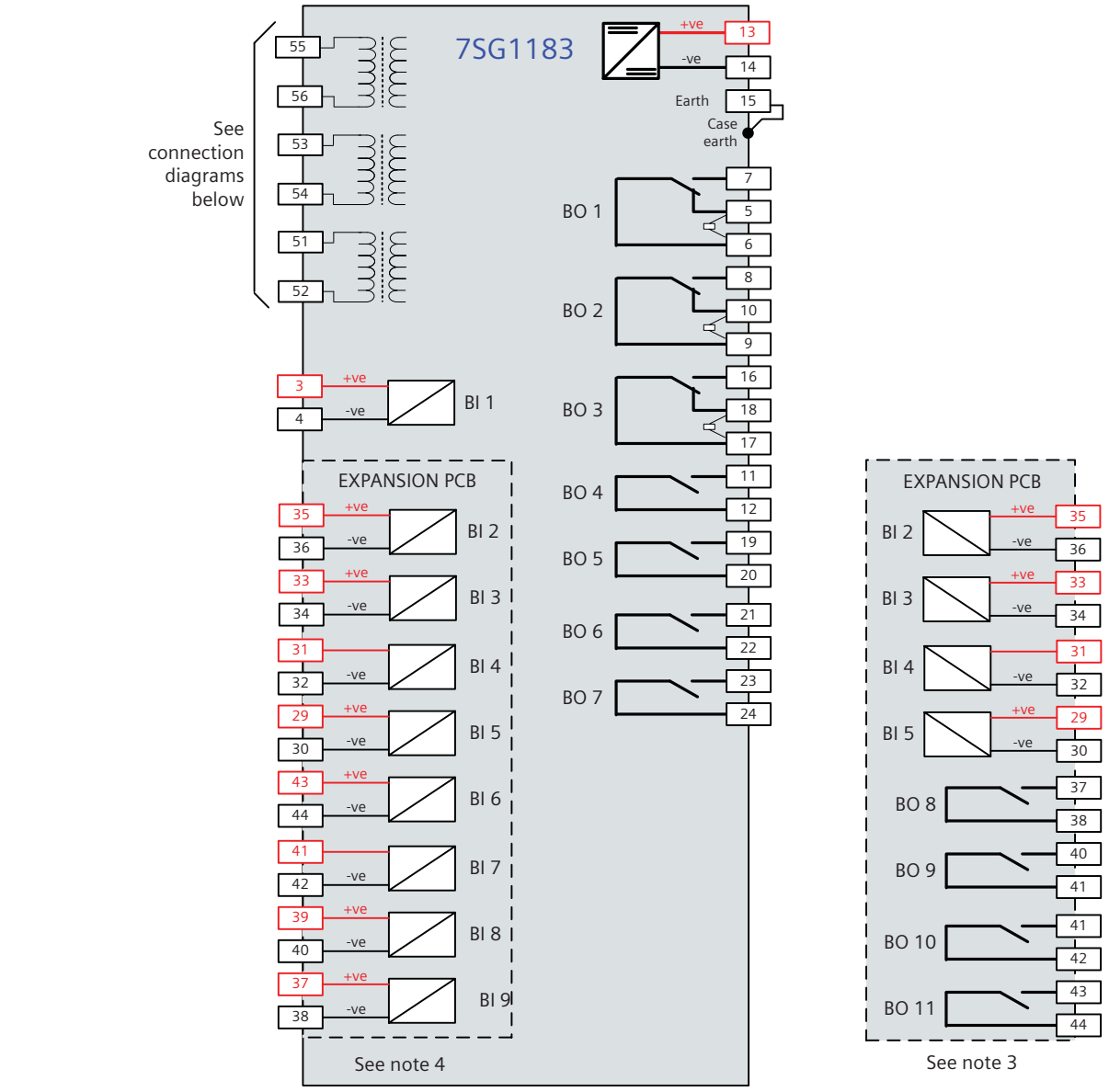
Connection Diagram



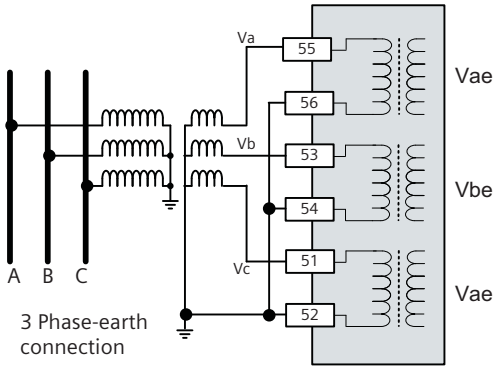
Note
For the phase-phase and phase-earth connections, any phasing may be used

Fig 3. Connection Diagram for 7SG1182 Relay

Connection Diagram



Note
For the phase-phase and phase-earth connections, any phasing may be used



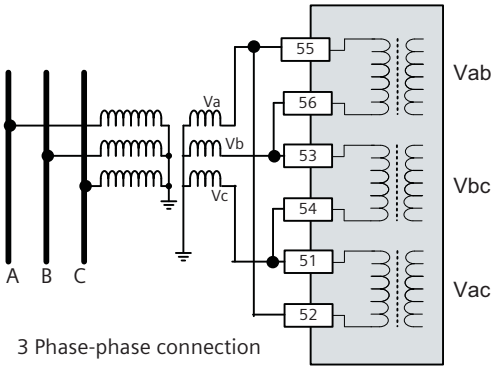
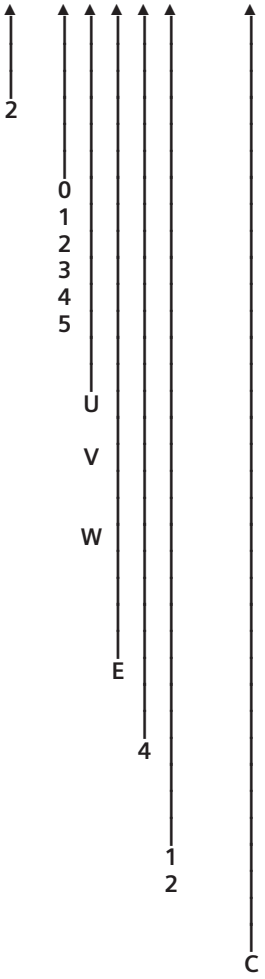


Fig 4. Connection Diagram for 7SG1183 Relay

Ordering Information – 7SG1182

Product description	Variants	Order No.
Voltage/frequency relay		**7 S G 1 1 8 □ - □ □ □ □ □ - 0 □ A 0**



Number of elements
Two pole relay — 2

Auxiliary supply /binary input voltage
24/30/48 V DC auxiliary, 30 V binary input — 0
110/220 V DC auxiliary, 30 V binary input — 1
24/30/48 V DC auxiliary, 48 V binary input — 2
110/220 V DC auxiliary, 48 V binary input [1] — 3
110/220 V DC auxiliary, 110 V low burden binary input — 4
110/220 V DC auxiliary, 220 V low burden binary input — 5

Type of relay
100 series: Voltage measuring relay providing under & overvoltage, negative sequence overvoltage and neutral voltage displacement — U
200 series: Voltage measuring relay providing under & overvoltage, under & over frequency, negative sequence overvoltage and neutral voltage displacement — V
300 series: Voltage measuring relay providing under & overvoltage, Under & over frequency with improved operating time, negative sequence overvoltage and neutral voltage displacement — W

Nominal voltage inputs
63/110 V AC — E

I/O range
4 Binary Inputs / 7 Binary Outputs (incl. 1 changeover and 1 normally closed) — 4

Communication interface
Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU — 1
RS485 interface / IEC 60870-5-103 or Modbus RTU — 2

Housing size
Case size E4 (4U high) — C

[1] High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

[2] An additional unit is required for use with capacitor cones, order 7XG2100-1AA00-0AA0

Ordering Information – 7SG1183

Product description	Variants	Order No.
Voltage/frequency relay		**7 S G 1 1 8 □ - □ □ □ □ □ - 0 □ A 0**

Number of elements
Three pole relay — **3**

Auxiliary supply /binary input voltage
24/30/48 V DC auxiliary, 30 V binary input — **0**
110/220 V DC auxiliary, 30 V binary input — **1**
24/30/48 V DC auxiliary, 48 V binary input — **2**
110/220 V DC auxiliary, 48 V binary input 1) — 3
110/220 V DC auxiliary, 110 V low burden binary input — 4
110/220 V DC auxiliary, 220 V low burden binary input — **5**

Type of relay
100 series: Voltage measuring relay providing under & overvoltage, negative sequence overvoltage and neutral voltage displacement — **U**
200 series: Voltage measuring relay providing under & overvoltage, under & over frequency, negative sequence overvoltage and neutral voltage displacement — **V**
300 series: Voltage measuring relay providing under & overvoltage, Under & over frequency with improved operating time, negative sequence overvoltage and neutral voltage displacement — **W**

Nominal voltage inputs
63/110 V AC — **E**

I/O range
1 Binary Input / 7 Binary Outputs (incl. 3 changeover) — **0**
5 Binary Inputs / 11 Binary Outputs (incl. 3 changeover) — **1**
9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover) — **2**

Communication interface
Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU — **1**
RS485 interface / IEC 60870-5-103 or Modbus RTU — **2**

Housing size
Case size E6 (4U high) — **D**

1) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 1 binary input and 110 V application, order resistor box VCE:2512H10066 in addition
for 5 binary inputs and 110 V application, order resistor box VCE:2512H10065 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 1 binary input and 220 V application, order resistor box VCE:2512H10068 in addition
for 5 binary inputs and 220 V application, order resistor box VCE:2512H10067 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

2) An additional unit is required for use with capacitor cones, order 7XG2100-1AA00-0AA0

Reyrolle
Protection
Devices

7SR242 Duobias

Transformer Protection Relay

Answers for energy

SIEMENS

7SR242 Duobias

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 or E10 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
Programmable Logic
Self Monitoring

Optional Functionality

24	Over-Fluxing
27/59	Under/Over Voltage
37	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 or 24 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

Data Communications

Standard

Communication access to relay functionality is via a front USB port for local PC connection or rear electrical RS485 port for remote connection

Optional

2 Rear ST fibre optic ports (2 x Tx/Rx) + IRIG-B port

Protocols

IEC60870-5-103, Modbus RTU and optional DNP 3.0 protocols – User selectable with programmable data points

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.

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.

Fig 1 : 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. Can be applied in 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.

Data Acquisition - Via Communication Interface

Sequence of event records

Up to 5000 events are stored and time tagged to 1ms resolution.

Fault Records

The last 10 fault records are displayed on the HMI, with time and date of trip, measured quantities and type of fault.

Waveform recorder

The waveform recorder stores analogue data for all phases, the states of protection functions, Binary Inputs, LEDs and Binary Outputs with pre & post trigger data. A record can be triggered from Protection function, Binary input or via data communications. 1 record of 10sec, 2 of 5sec, 5 of 2sec or 10 records of 1 second are stored. The ratio of pre-fault to post fault storage can be set by the user.

Data Log

Provides a rolling record of line currents and voltage (where applicable) over a user selectable period of time.

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 MODBUS-RTU, IEC60870-5-103, DNP3.0 (optional) or 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.

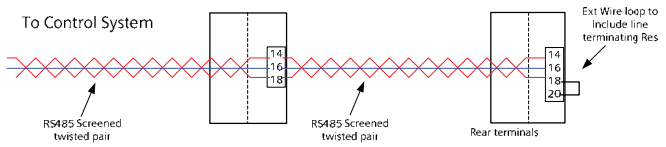


Fig 2. Typical RS485 connection

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

Reydisp Evolution

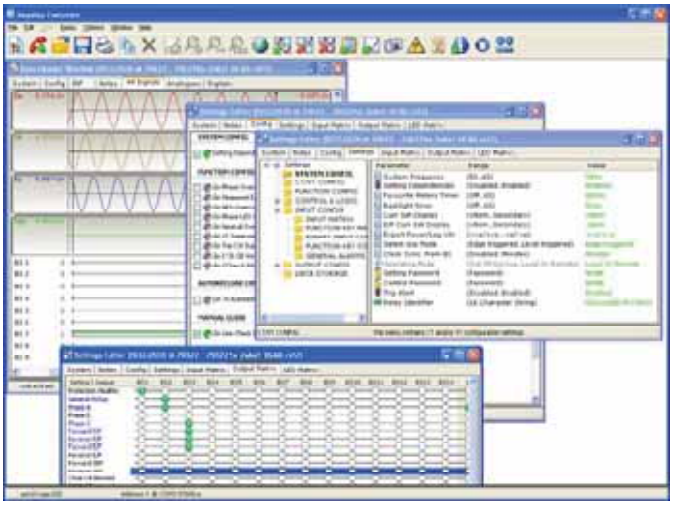


Fig 3. Typical Reydisp Evolution screenshot

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings interrogate settings and retrieve events and disturbance waveforms from the Duobias relay.

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 10 Minutes 5 Minutes 3 Minutes 2 Minutes 3 Seconds 2 Seconds 1 Second 1 Cycle	 3.0 x In 3.5 x In 4.0 x In 5.0 x In 6.0 x In 57.7A (1A) 202A (5A) 70.7A (1A) 247A (5A) 100A (1A) 350A (5A) 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 1 Second	 300V
Burden @ 110V	≤ 0.1 VA

DC Auxiliary supply

Nominal voltage	Operating Range V dc
30 to 220V dc	Range 24 to 290 V dc

Nominal Voltage	Quiescent Burden (typical)	Quiescent Burden (back-light)
30V dc	6.0W	7.0W
48V dc	5.50W	6.50W
110V dc	6.5W	7.5W
220V dc	7.5W	8.5W

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 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

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 1000 A/m for 3s	50Hz; 1.257mT

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 50
Installed with cover removed	IP 30

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 Overvoltage	 (100% + hyst) x Vop, ±1% or 0.25V (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 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

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

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 50N	 0 to 2xIs – 35ms, ±10ms, 0 to 5xIs – 25ms, ±10ms 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 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

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: 40ms ±10ms 0 to 5 x Is: 30ms ±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 Under frequency	 (100% - hyst) x Fop, ±10mHz (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 1st Bias Slope 1st Bias Slope Limit 2nd Bias Slope 2nd Bias Slope Type	 0.1, 0.15 ... 2 x In 0.1, 0.15 ... 0.7x 1, 2 ... 20 x In 1, 1.5 ... 2x Line, curve
Operate Level: Initial setting Bias slope	 ±5% of setting or ±0.01 In ±10% of setting or ±0.01 In
Reset Level: Over frequency Under frequency	 (100% - hyst) x Fop, ±10mHz (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} 0 to 10 x I_{OP}	 35ms ±10ms 30ms ±10ms
Operate time following delay.	Tbasic + td , ±1% or ±10ms
Inhibited by	Binary or Virtual Input

Case Dimensions

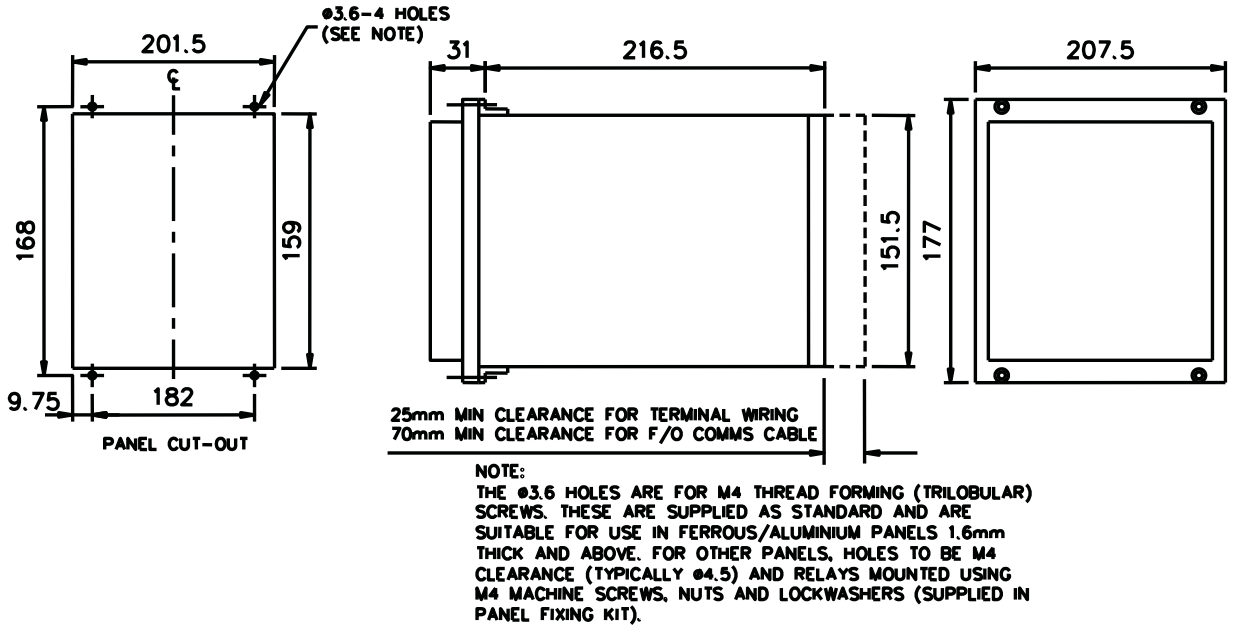


Fig 4. E8 Case

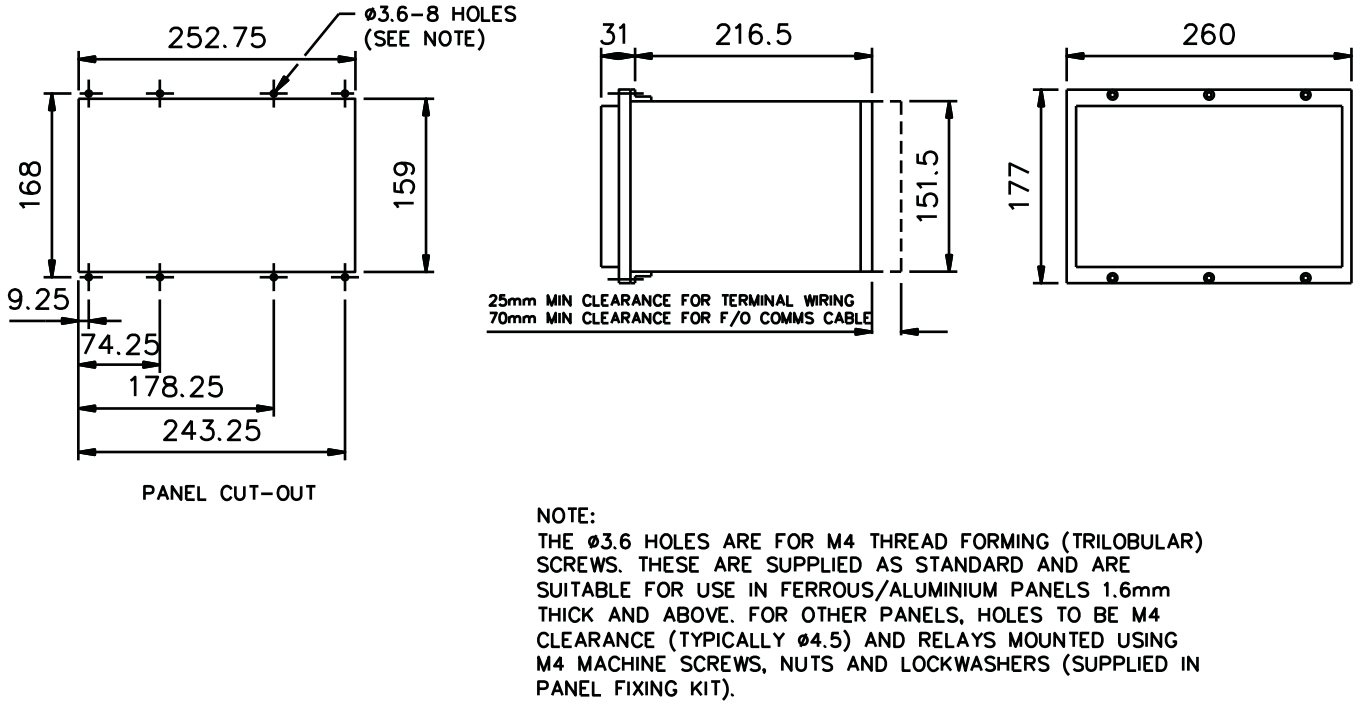
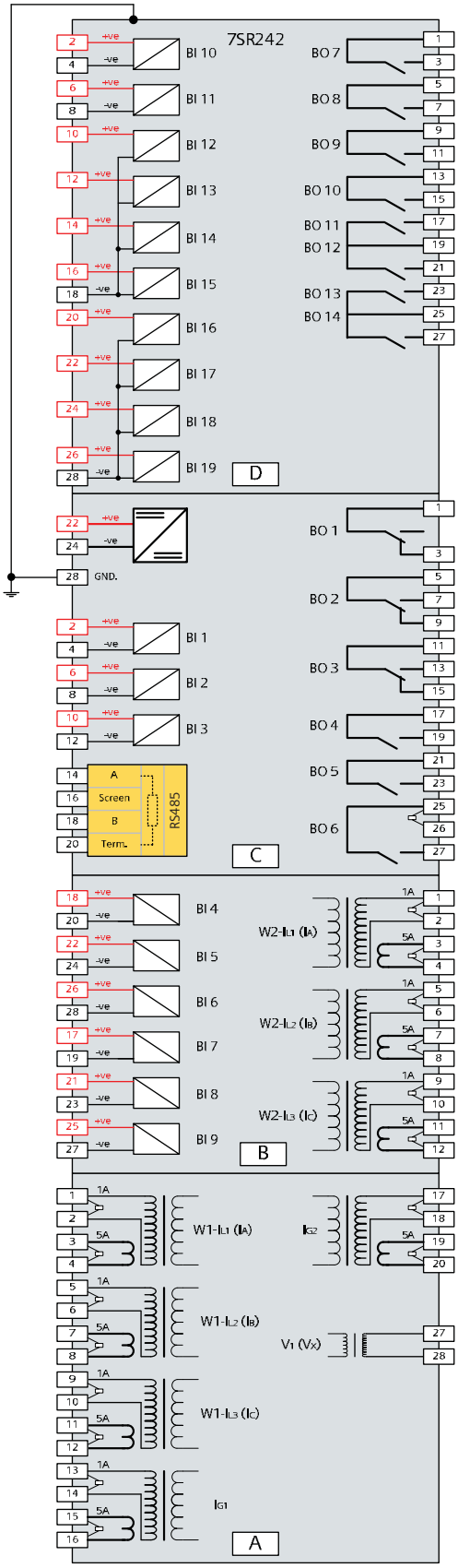
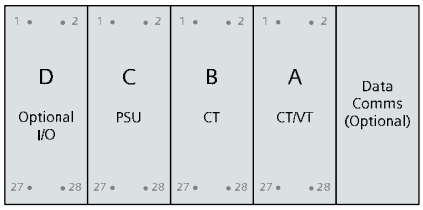


Fig 5. E10 Case

7SR24 Connection Diagram

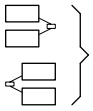




Rear View
Arrangement of terminals and modules

NOTES

BI = Binary Input
BO = Binary Output



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

Fig 6. 7SR242 Wiring Diagram

7SR24 Function diagram / example of external connections

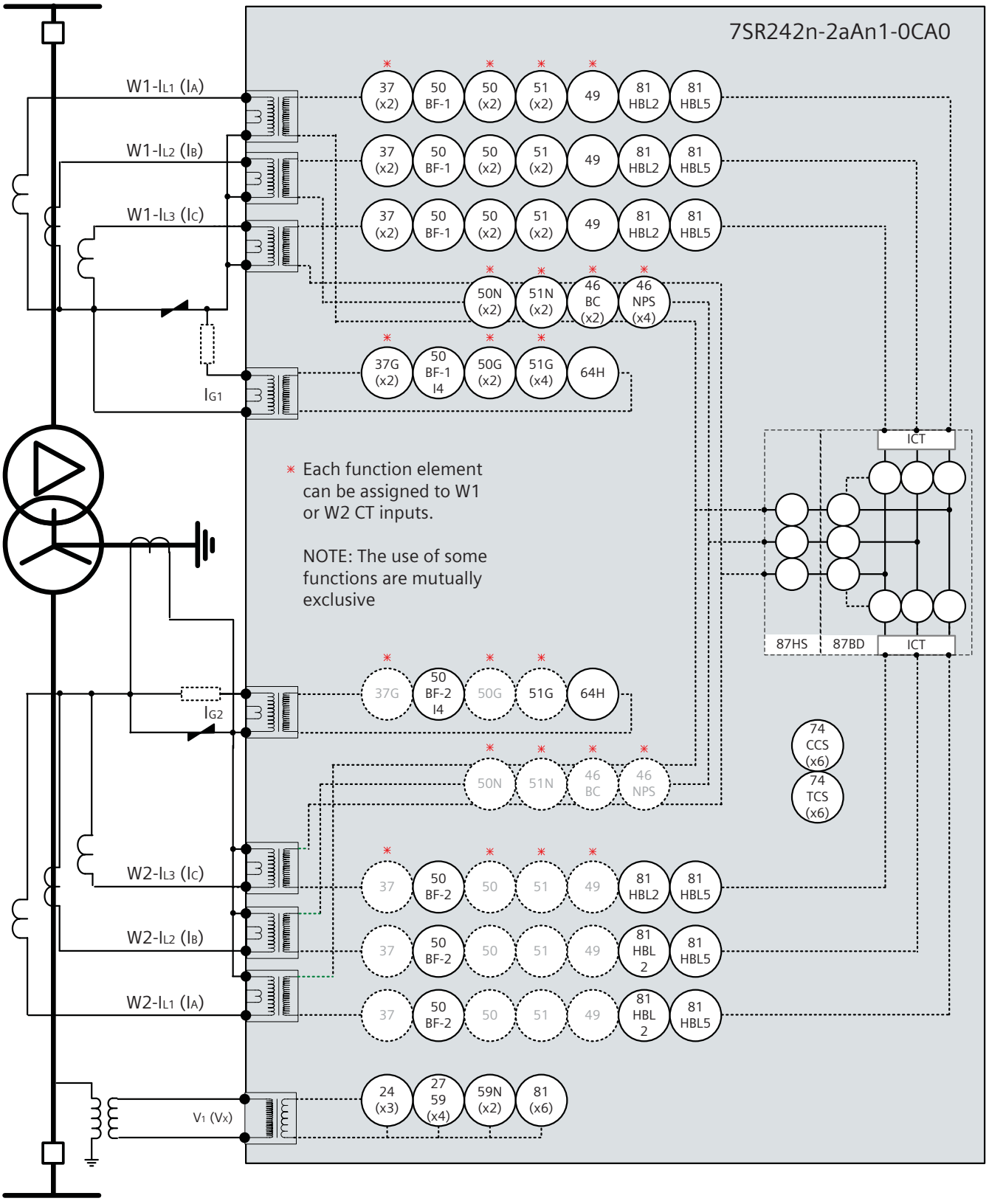


Fig 7. Standard and Optional Functionality of 7SR24 Relay

Ordering Information – 7SR24 2 Winding Transformer Protection

Product description	Variants	Order No.
Duobias		7 S R 2 4 2 □ - 2 □ A □ 1 - 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
	Measuring Input 1/5 A, 63.5/110V, 50/60Hz	2
	Auxiliary voltage 30 to 220V DC, binary input threshold 19V DC	A
	30 to 220V DC, binary input threshold 88V DC	B
	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
	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
	Protection Function Packages Option A: Standard version – Included in all models	A
	- 81HBL2 Inrush Detector	
	- 81HBL5 Overfluxing detector	
	- 87BD Biased current differential	
	- 87HS Current differential highest	
	Programmable logic	
	For each winding/circuit breaker	
	- 50BF Circuit breaker fail	
	- 64H High impedance REF	
	- 74TCS/CCS Trip/Close circuit supervision	
	Option B: Standard version – plus	B
	- 37 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)

Ordering Information – 7SR24 2 Winding Transformer Protection

Product description	Variants	Order No.
Duobias		**7 S R 2 4 2 □ - 2 □ A □ 1 - 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	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	**A**
	No Additional Functionality	

[1] For ESI48-4 compliance of binary inputs external resistors are required.

Reyrolle
Protection
Devices

7SG14 Duobias M

Transformer Protection

Answers for energy

SIEMENS

7SG14 Duobias M

Transformer Protection

Description

The 7SG14 Duobias-M has an established history as a transformer protection relay going back to the fundamental development of biased differential transformer protection. It is capable of providing all necessary protection and alarm functions for protecting a 2 or 3 winding transformer.

The main protection function is current differential with load bias and second harmonic restraining characteristic. This is supplemented with a number of additional functions to provide a comprehensive transformer protection management package.

Function Overview

Standard Functionality

Biased differential current protection with even harmonic restraint (87).
Instantaneous differential highset (87HS).
Integral current amplitude and vector group compensation.
Variants for 2 or 3 sets of current transformers.
E8, E12 or E16 case.
Trip circuit supervision.
LEDs for alarm functions removes the need for flag repeat relays, Buchholz etc
Compatible with communications software Reydisp Evolution.
Metering of external and internal signals for both magnitude and phase angle aids commissioning
Settings stored in EEPROM, logic schemes in FLASH memory
Flash upgradeable firmware
Expandable I/O of up to 27 binary inputs and 29 output contacts that can be programmed from the relay front fascia
Continuous self monitoring

Optional Functionality

High Impedance Restricted Earth Fault per winding (87REF)
Circuit Breaker Fail per winding (50BF)
Instantaneous / definite time overcurrent phase fault and derived earth fault per winding (50 and 50N)
Inverse definite minimum time phase fault and derived earth fault per winding (51 and 51N)
Instantaneous/definite time measured earth fault per winding (50G)
Inverse definite minimum time measured earth fault per winding (51G)
Overexcitation protection Volts/frequency (2 x DTL + 1 x IDMTL) (24)
Transformer thermal overload (49)
4-stage under/overvoltage(27/59)
4-stage under/overfrequency (81)
2-stage NPS overcurrent (46)

User Interface

20 character x 2 line backlit LCD
Menu navigation keys
1 fixed LED.
16 or 32 programmable LEDs.

Monitoring Functions

Analogue values can be displayed on the LCD screen. In addition most values can be obtained via the data communications channel(s).

Line currents for each winding
Relay currents for each winding (after ratio and vector group compensation)
Operate and restrain currents
Binary inputs
Output contacts

Data Communications

Communication access to relay functionality is via a front RS232 port for local PC connection.
Two rear ST fibre optic ports (2 x Tx/Rx) and an IRIG-B are also provided.

Protocols

Serial data comms conform to IEC60870-5-103 and Modbus RTU standards.

Description of Functionality

The 7SG14 provides all the protection functions required for power transformers.

Vector group compensation and ratio correction

The relay can compensate for all standard transformer winding vector connections and for differing CT ratios across the transformer, without the need for secondary interposing CTs.

Biased differential (87)

A biased differential characteristic is provided which gives sensitivity for internal faults and stability for through faults and load current.

Two bias slopes are provided, the first allows for measuring inaccuracies and transformer ratio variation due to tap-changing, the second ensures stability for CT saturation on through faults.

The biased differential element restrains for second harmonic inrush currents, with a setting for restraint level. This provides stability under inrush conditions, while allowing the protection to be set more sensitively for normal operation.

The relay M is stable for fifth harmonic currents, generated as a result of transformers operating close to, or above their knee point.

Differential highset (87HS)

A differential highset is also provided, this is not subject to inrush restraint.

Optional Functionality

Restricted Earth Fault (87REF)

Faults in the tap-changer windings of a transformer are common. Restricted earth-fault protection gives improved sensitivity for faults at the lower end of the transformer windings.

Under/overvoltage (27/59)

4 Stage under/overvoltage elements can be provided and the undervoltage elements may be guarded via an additional undervoltage setting to prevent operation during transformer switch on.

Under/overfrequency (81)

4 Stage under/overfrequency elements can be provided and these may be inhibited with the undervoltage inhibited setting defined as above, to prevent any unwanted operation.

Backup overcurrent & earth fault

The following backup overcurrent elements can be provided:

- Instantaneous/definite time phase fault (50)
- Inverse time/definite time phase fault (51)
- Instantaneous/definite time derived earth fault (50N)
- Inverse time / definite time derived earth fault (51N)

These elements provide backup protection for the transformer and guard against a fault outside the transformer CT zone. They can also be used to protect the transformer against damage due to uncleared external faults while grading with other time-delayed protections.

Measured earth fault

The following earth-fault overcurrent elements are available for each transformer winding:

- Instantaneous/definite time measured earth fault (50G)
- Inverse time/definite time measured earth fault (51G)

These elements are incompatible with the use of the high impedance restricted earth-fault elements.

Over-excitation (24)

Over-excitation of a transformer can lead to damaging currents flowing in the transformer. This can be detected from fifth harmonic content; however this is subject to uncertainty. The 7SG14 can offer a Volts/frequency (V/f) element, which provides direct measurement of excitation. The setting level of this type of element is more easily related to the transformer data. Both DTL and user defined IDMTL characteristics are available. Over fluxing protection is recommended for all generator step up transformers

Thermal Overload (49)

The algorithm calculates the thermal state of the transformer from the measured currents.

Negative Phase Sequence Overcurrent (46)

One inverse and one definite time lag element are provided. These may be used as back-up protection or for detection of tap changer faults.

Circuit breaker fail (50BF)

The circuit breaker fail function operates by monitoring the current following a trip signal and issues an output if the current does not cease within a specified time interval. This output contact can be used to backtrip an upstream circuit breaker. The circuit breaker fail function has a fast reset feature.

Application

Transformer configurations

The Duobias M can provide up to 3 sets of analogue inputs (where a single set consists of 3 phase current inputs and an earth current input) which can be used on a variety of 2 and 3 winding transformer configurations.

The most common configurations of transformer are 2 and 3 winding transformers connected to single lines/busbars, as in Figure 2. For a 2 winding transformer 2 analogue input sets are required, while for a 3 winding transformer 3 analogue input sets are needed. Input currents may be summed into a protection element such as overcurrent.

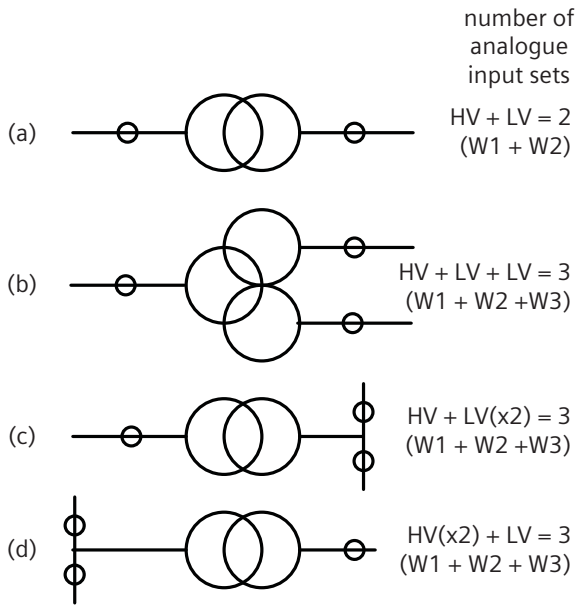


Fig 1. Transformer Configurations

Figure 2 shows the flow of fault current for an out-of-zone fault on system, with busbar connected CTs. It is important that the transformer protection is correctly biased to ensure stability for CT saturation. This cannot be done correctly if the CTs are paralleled – individual inputs to the transformer protection must be provided for correct biasing.

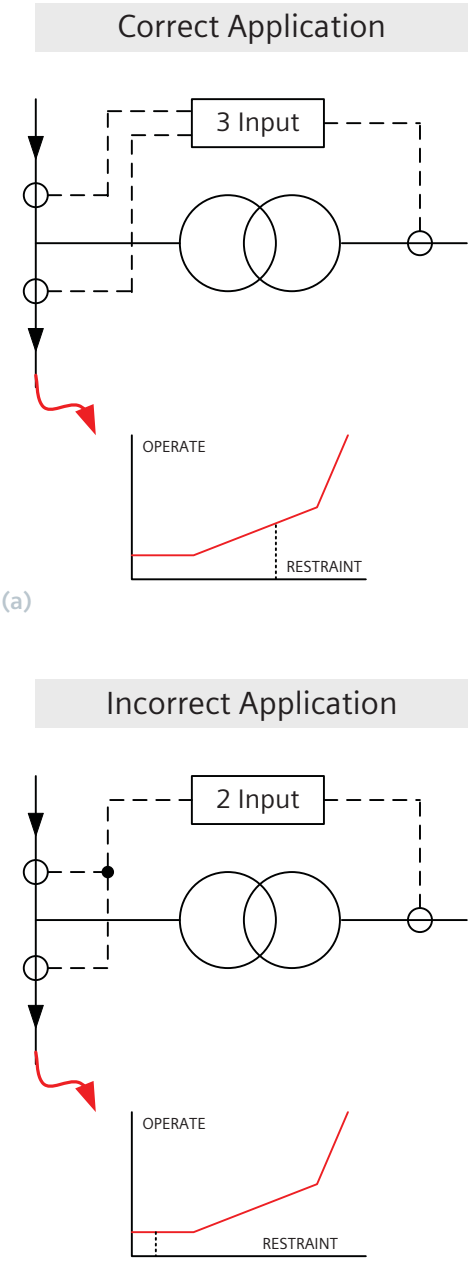


Fig 2. Out of Zone Fault and its Effect on Protection Biasing – use one relay input set per set of CTs

Data Storage and Communication

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

Fault records

The last 10 fault records are available from the fascia with time and date of trip, measured quantities and type of fault.

Disturbance recorder

5 seconds of waveform storage is available and is user-configurable as 5 x 1s or 1 x 5s records. Within the record the amount of pre-fault storage is also configurable. The recorder is triggered from a protection operation, or binary input. (e.g. Buchholz flag indication).

The records contain the analogue waveforms of the line currents and the digital input and output signals.

The relay settings must be appropriately programmed in order for a wave form to be triggered from an external protection device.

Communications

Two fibre-optic communications ports are provided on the rear of the relay. They are optimised for 62.5/125µm glass-fibre, with BFOC/2.5 (ST®) bayonet style connectors.

In addition users may interrogate the relay locally with a laptop PC and the RS232 port on the front of the relay.

The relay can be user selectable to either IEC 60870-5-103 or Modbus RTU as its communications standard.

Reydisp evolution

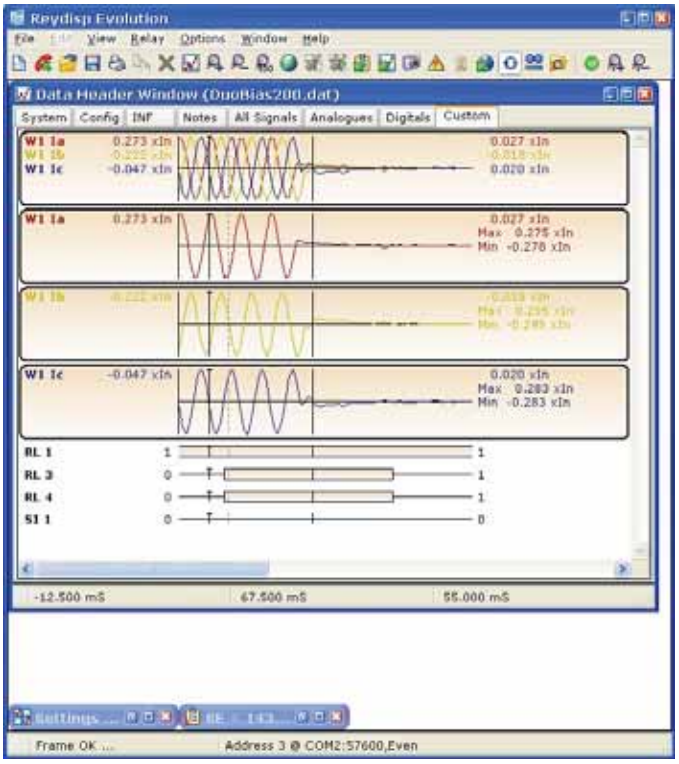


Fig 3. Disturbance Records in Reydisp Evolution

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides a means for the user to apply settings to the relay, interrogate settings and retrieve disturbance waveforms.

Reydisp evolution utilises IEC 60870-5-103 protocol.

Technical Data

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

Inputs and Outputs

Characteristic energising quantity

AC Current/Voltage	Frequency
1A / 5A	50 / 60Hz
40 – 160V	

Current Inputs

Current	Withstand Time
3.0 x In	Continuous
3.5 x In	10 minutes
4.0 x In	5 minutes
5.0 x In	3 minutes
6.0 x In	2 minutes
250A	1 Second
625A peak	I Cycle

Input	Burden
5A	≤ 0.3 VA
1A	≤ 0.1 VA

Note: Burdens and impedances are measured at nominal current rating.

DC Auxiliary Supply

Nominal Voltage	**Operating Range V dc**
30V	24 to 37.5V
48/110V	37.5 to 137.5V
220 V	178.0 to 280.0V
110/220V	88 to 275V

Operate State	Burden
Quiescent (Typical)	15 W
Maximum	27 W

Allowable superimposed ac component	≤12% of dc voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤20 ms

Binary inputs

Nominal Voltage	**Operating Range V dc**
30V	18 to 37.5V
48V	37.5 to 60V
110 V	87.5 to 137.5V
220V	175 to 280V

The binary input voltage need not be the same as the main energising voltage.

The 30V and 48V inputs meet the requirements of ESI48-4 ESI 1. However, the 110V and 220V inputs will operate with a DC current of less than 10mA. Where 110V or 220V inputs compliant with ESI48-4 ESI 1 are required, a relay with 48V binary inputs can be supplied with external series resistors as follows:

Nominal Voltage	Resistor Value	Wattage
110V	2k7 ± 5%	2.5 W
220 V	8k2 ± 5%	6.0 W

Binary input performance

Parameter	Value
Minimum DC current for operation (30V and 48V inputs only)	10 mA
Reset/Operate Voltage Ratio	≥ 90 %
Typical response time	< 5 ms
Typical response time when used to energise an output relay contact	< 15 ms
Minimum pulse duration	40 ms

Each binary input has an associated timer that can be programmed to give time delayed pick-up and time delayed drop-off. When set to a minimum of 20ms the binary inputs will provide immunity to an AC input signal and will not respond to the following:
250V RMS 50/60 Hz applied for two seconds through a 0.1µF capacitor.
500 V RMS 50/60 Hz applied between each terminal and earth. Discharge of a 10µF capacitor charged to maximum DC auxiliary supply voltage.

Output Relays

Carry continuously	5A ac or dc
Make and carry (L/R ≤ 40 ms and V ≤ 300V)	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
Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5 Watt limits 10mA or 5V

Mechanical

Vibration (Sinusoidal)

IEC 60255-21-1 Class 1

0.5 gn, Vibration response	≤ 5% variation
1.0 gn, Vibration endurance	

Shock Bump

IEC 60255-21-2 Class 1

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

Seismic

IEC 60255-21-3 Class 1

1 gn, Seismic response	≤ 5% variation

Mechanical Classification

Durability	In excess of 10^6 operations

Electrical Tests

Insulation IEC 60255-5

RMS levels for 1 minute

Between all terminals and earth	2.0 kV
Between 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

High Frequency Disturbance

IEC 60255-22-1 Class III

2.5kV, Longitudinal mode	≤3% variation
1.0kV, Transverse mode	

Electrostatic Discharge

IEC 60255-22-2 Class III

8kV, Contact discharge	≤5% variation

Fast Transient

IEC 60255-22-4 Class IV

4kV, 5/50ns, 2.5 kHz, repetitive	≤3% variation

Radio Frequency Interference

IEC 60255-22-3

10 V/m, 80 to 1000 MHz	≤5% variation

Conducted RFI

IEC 60255-22-6

10 V, 0.15 to 80 MHz	≤5% variation

Conduct limits

IEC 60255-25

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

Radiated limits

IEC 60255-25

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

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 93% RH

Protection Elements

General Accuracy

Reference Conditions	
General	IEC60255 Parts 6, 6A & 13
Auxiliary	Nominal
Frequency	50/60Hz
Ambient Temperature	20°C
Initial Setting	Any setting
Bias Slope	Any setting
High set	Any setting
Restricted earth fault	Any setting
Magnetizing Inrush	Any setting
Current amplitude correction	1.00
Vector group compensation	Yy0,0°

Accuracy influencing factors

Temperature	
10 °C to +55 °C	≤ 5% variation
Frequency	
47 Hz to 52 Hz	Setting: ≤5% variation
57 Hz to 62 Hz	Operate Time: ≤ 5% variation

Vector group compensation

Interposing CT	
No. of elements	Per Winding
CT Connection	Yy0 0°, Yd1 -30°, Yy2 -60°, Yd3 -90°, Yy4 -120°, Yd5 -150°, Yy6 180°, Yd7 150°, Yy8 120°, Yd9 90°, Yy10 60°, Yd11 30°, Ydy0 0°
CT Multiplier	0.25 to 3.00 step 0.01

Biased differential (87)

No. of elements	1
Level	
Initial setting	0.1 to 2.0In step 0.05In
Bias slope	0 to 0.7 step 0.05
Bias slope limit	1 to 20 xIn step 1In
Delay	0 to 1 sec
Accuracy	Operate:100% of setting ± 5% or ± 10mA
	Reset: ≥ 90% of operate current
Repeatability	±1%
Through-fault stability	50 xIn
Operate Time	
Typically	1.5 Cycles

Inrush Inhibit	
Settings	Off, 15% to 25% step 1%
Accuracy	± 5% or ± 30 ms
Repeatability	± 1%
Bias	Phase, Cross, Sum

Differential highset (87HS)

No. of elements	1
Level	
Initial setting	1 to 30x In step 1x In
Accuracy	Operate:100% of setting ± 5% or ± 10mA
	Reset: ≥95% of operate current
Repeatability	±1%
Operate Time	
Typically	1 Cycle

Restricted earth-fault (87REF)

No. of elements	Up to 1 per winding
Level	
Settings	0.02 to 0.96 In step 0.005In
Accuracy	Operate: 100% of setting ± 5% or ± 10mA
	≥ 95% of operate current
Repeatability	±1%

Operate Time	
Typically	< 1.5 Cycles

Delay	
Setting (td)	0 to 864000s

Phase-fault overcurrent protection (50)

Characteristic	Instantaneous/DTL
No. of elements	Up to 2 per winding
Level	
Settings	0.05 to 25In step 0.05In
Accuracy	Operate: 100% of setting ± 5% or ± 10mA
	Reset: ≥95% of operate current
Repeatability	±1%
Delay	
Settings	0.0 to 864000s
Accuracy	± 5 ms
Repeatability	± 1%

Phase fault overcurrent (51)

Characteristic	IDMTL
IEC	Normal Inverse (NI), Very Inverse (VI), Extremely Inverse (EI), Long Time Inverse (LTI)
IEEE	Moderately Inverse (MI), Very Inverse (VI), Extremely Inverse (EI),
	DTL
No. of elements	Up to 1 per winding
Level	
Settings	0.05 to 2.5 In step 0.05In
Accuracy	Operate: 105% of setting ± 5% or ± 10mA
	Reset: ≥ 95% of operate current
Repeatability	±1%
IDMTL Time Multiplier	
Settings	0.025x to 1.600x step 0.025
Accuracy	± 5% or ± 30 ms
Repeatability	± 1%

Negative Sequence Overcurrent (46)

Characteristic	Instantaneous (46DT)
No. of elements	Up to 1 per winding
Level	
Settings	0.02 to 4x In
Accuracy	Operate: 100% Is ± 5% or ± 10mA
	Reset: 95% Iop
Repeatability	±1%
Delay	
Setting (td)	0 to 864000s
Accuracy	89ms + td
Repeatability	± 1% or ± 20ms

Characteristics	IDMTL (46IT)
No. of elements	Up to 1 per winding
Level	
Setting	0.02 to 2.5In
Accuracy	Operate 105% Is ± 4% or I 10mA
	Reset > 95% Ipo
Repeatability	± 1%
IDMTL Time Multiplier	
Characteristics	IDMTL
IEC	Normal Inverse (NI) Very Inverse (VI) Extremely Inverse (EI) Long Time Inverse (LTI)
IEEE	Moderately Inverse (MI) Very Inverse (VI) Extremely Inverse (EI)
	DTL
Settings	0.025 to 1.6x step 0.025
Accuracy	IDMT ± 5% or ± 50ms DTL ± 1% or ± 40ms
Repeatability	± 1% or ± 20ms

Earth-fault overcurrent protection

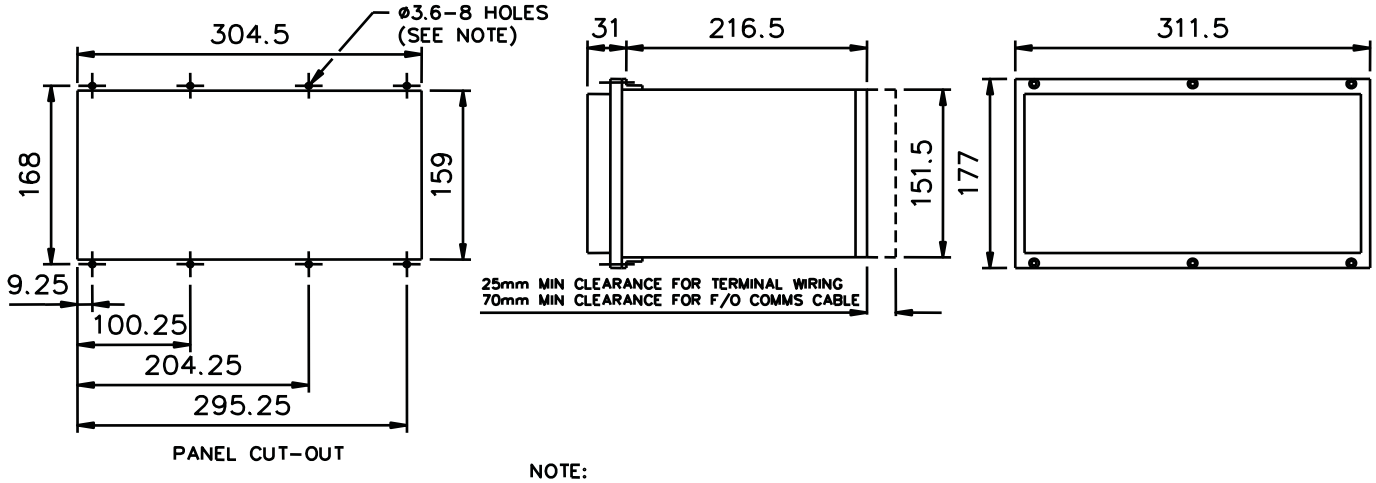
Characteristic	DTL
No. of elements	Up to 2 per winding
Level	
Settings	0.01 to 25 x In
Accuracy	Operate: 100% of setting ± 5% or ± 10mA
	Reset: ≥ 95% of operate current
Repeatability	±1%
Delay	
Settings	0.00 to 864000s
Accuracy	± 5 ms
Repeatability	± 1%

Characteristic	
IDMTL (IEC)	Normal Inverse (NI), Very Inverse (VI), Extremely Inverse (EI), Long Time Inverse (LTI)
IDMTL (IEEE)	Moderately Inverse (MI), Very Inverse (VI), Extremely Inverse (EI), DTL
No. of elements	Up to 1 per winding
Level	
Setting	0.1 to 2.5xIn step 0.05 In
Accuracy	Operate: 105% of setting ± 5% or ± 10mA
	Reset: ≥ 95% of operate current
Repeatability	±1%
IDMTL Delay	
Settings	0.025x to 1.600x
Accuracy	± 5% or ± 30 ms

Circuit breaker failure

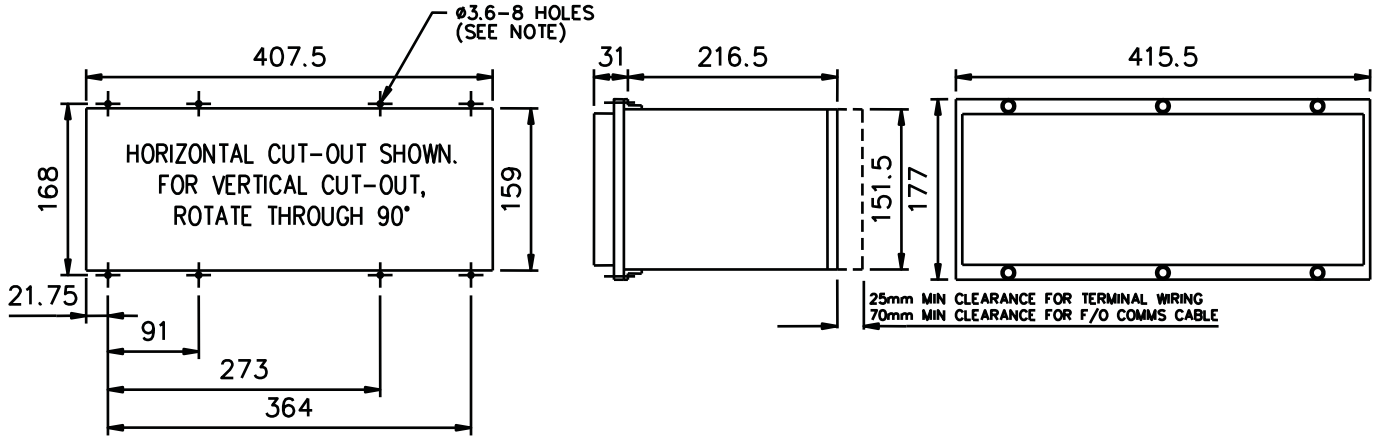
Characteristic		DTL
No. of elements		2
Level		
Settings		0.05 to 2In
Accuracy		Operate: 100%Is ± 5% or ± 10mA
		Reset: <100%Iop ± 5% or ± 10mA
Repeatability		±1%
Delay		
Settings	Re-trip	0.02 to 60sec
	Back-trip	0.02 to 60sec
Accuracy		± 5 ms
Repeatability		± 1%

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).

Fig 4. E12 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).

Fig 5. E16 Case Dimensions

Connection Diagram 7SG14 Duobias M

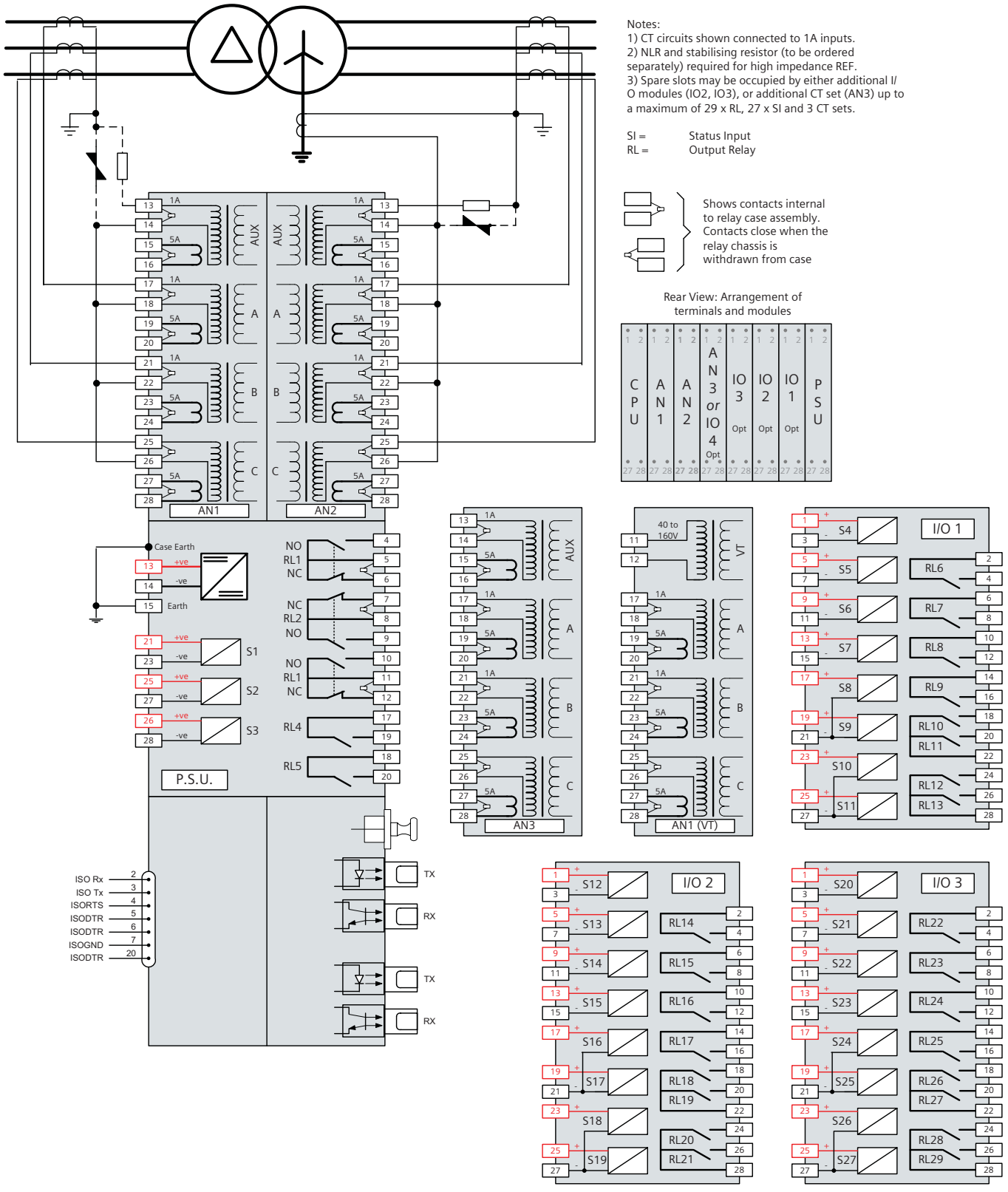


Fig 6. 7SG14 Connection Diagram

Module Location

Module location when viewed from relay front with the fascia door open.

E16 case 2 or 3W

A	B	C	D	E	F	G	H
PSU	I/O 1	(I/O2)	(I/O3)	(AN3) Or (I/O4)	AN2	AN1	CPU

E12 case 2 or 3W

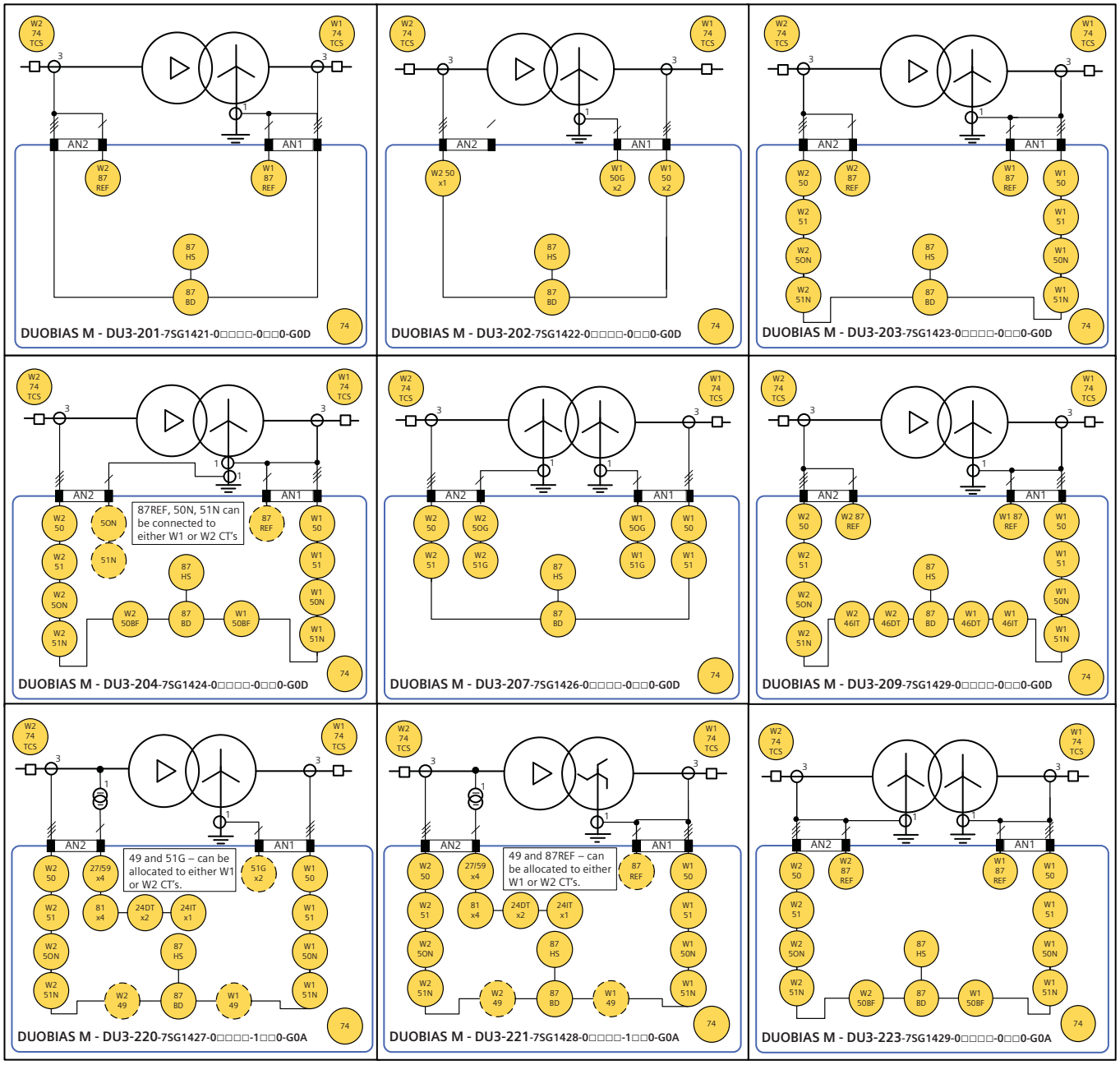
A	B	C	D	E	F
PSU	I/O1	(AN3) OR (I/O2)	AN2	AN1	CPU

E8 case 2 or 3W

A	B	C	D
PSU	AN1	AN2	CPU

The following ANSI Function Diagrams illustrate the use of the various models. All transformer vector groups can be accommodated by selection of appropriate relays settings. The “?” symbol in the MLFB code, shown on these diagrams, denotes a user selection for rating, I/O count and case size.

ANSI Diagrams Two Winding Models – 7SG142 Duobias M

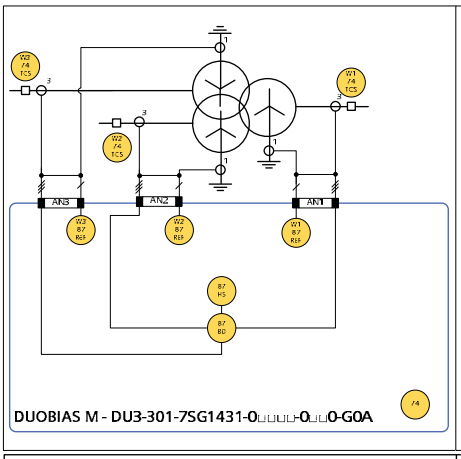


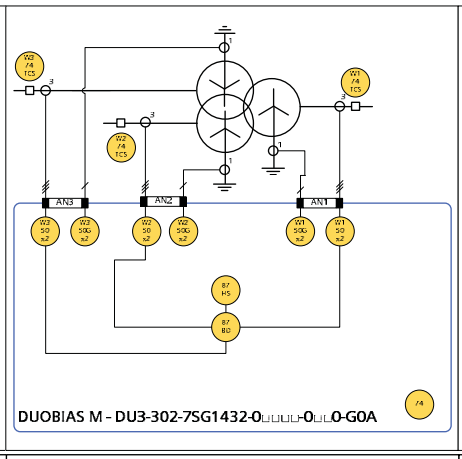
ANSI CONNECTION DIAGRAMS
DUOBIAS M TWO WINDING TRANSFORMER DIFFERENTIAL RELAYS - 7SG142*

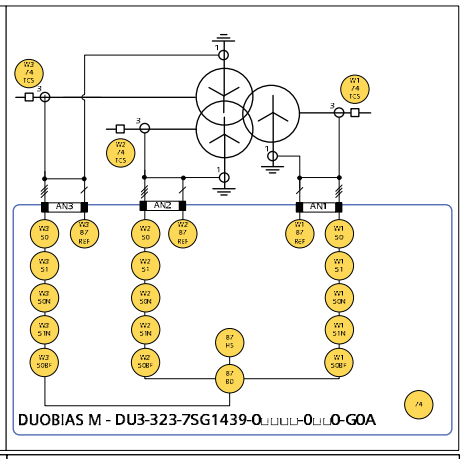
FUNCTION NUMBER - IEEE Std C37.2-1996

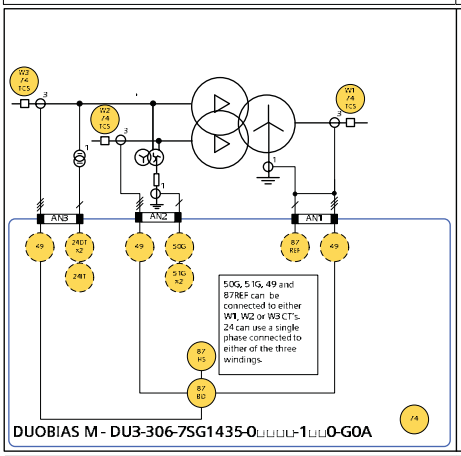
24DT	OVER FLUXING – DTL V/f	50BF	TWO STAGE CIRCUIT BREAKER FAIL	74	ALARM/TRIP LED INDICATION (BUCHHOLZ etc)
24IT	OVER FLUXING – User Definable Inverse V/f	51	IDMTL/DTL OVER CURRENT	74TCS	TRIP CIRCUIT SUPERVISION/FAIL
27	DTL UNDER VOLTAGE - Single Phase	50G	MEASURED INST/DTL EARTH (GROUND) FAULT	87BD	BIASED DIFFERENTIAL
46DT	DTL NEGATIVE PH. SEQUENCE OVERCURRENT	51G	MEASURED IDMTL/DTL EARTH(GROUND)FAULT	87HS	DIFFERENTIAL HIGHSET
46IT	IDMTL NEGATIVE PH. SEQ. OVERCURRENT	50N	DERIVED INST/DTL EARTH (GROUND) FAULT	87REF	HIGH IMPEDANCE RESTRICTED (GROUND) FAULT (External series setting resistor and resistor required – not shown) EARTH non linear
49	THERMAL OVERLOAD	51N	DERIVED IDMTL/DTL EARTH (GROUND) FAULT		
50	INST/DTL OVER CURRENT	59	DTL OVER VOLTAGE - Single Phase		

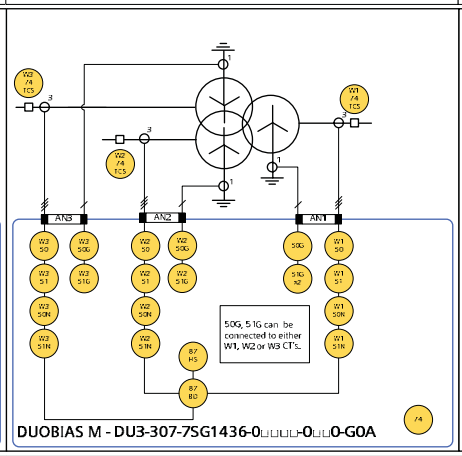
ANSI Diagrams Three Winding Models – 7SG143 Duobias M

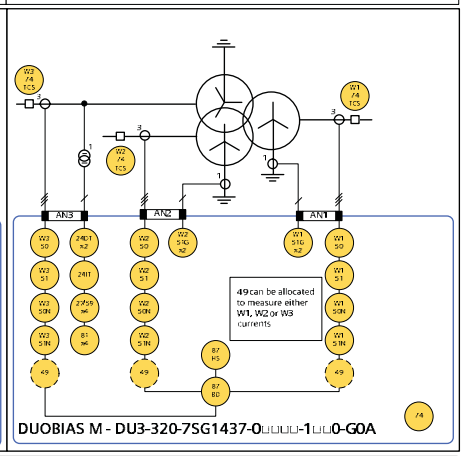


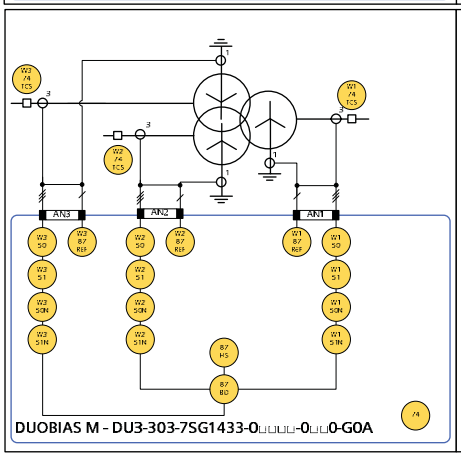


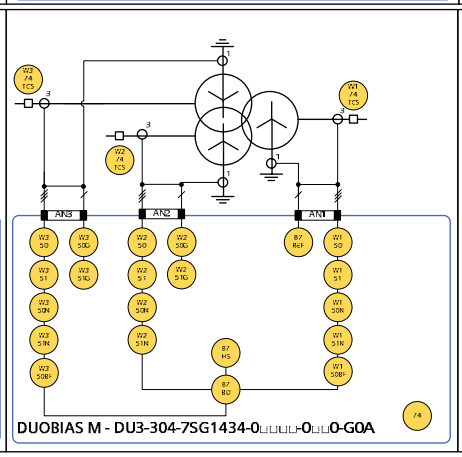


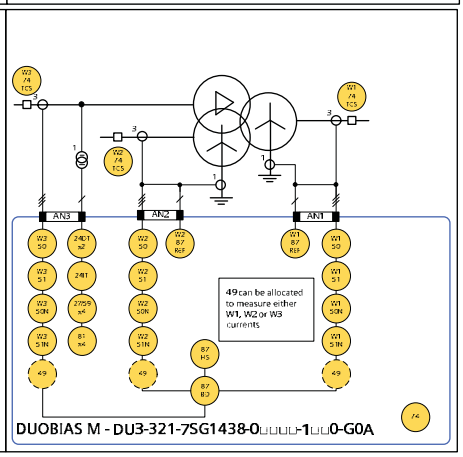












ANSI CONNECTION DIAGRAMS
THREE WINDING DUOBIAS M TRANSFORMER DIFFERENTIAL RELAYS - 7SG143*

FUNCTION NUMBER - IEEE Std C37.2-1996

24DT	OVER FLUXING - DTL V/f	50BF	TWO STAGE CIRCUIT BREAKER FAIL	74	ALARM/TRIP LED INDICATION (BUCHHOLZ etc)
24IT	OVER FLUXING - User Definable Inverse V/f	51	IDMTL/DTL OVER CURRENT	74TCS	TRIP CIRCUIT SUPERVISION/FAIL
27	DTL UNDER VOLTAGE - Single Phase	50G	MEASURED INST/DTL EARTH (GROUND) FAULT	87BD	BIASED DIFFERENTIAL
46DT	DTL NEGATIVE PH. SEQUENCE OVERCURRENT	51G	MEASURED IDMTL/DTL EARTH(GROUND)FAULT	87HS	DIFFERENTIAL HIGHSET
46IT	IDMTL NEGATIVE PH. SEQ. OVERCURRENT	50N	DERIVED INST/DTL EARTH (GROUND) FAULT	87REF	HIGH IMPEDANCE RESTRICTED (GROUND)
49	THERMAL OVERLOAD	51N	DERIVED IDMTL/DTL EARTH (GROUND) FAULT		EARTH FAULT (External Series Setting Resistor
50	INST/DTL OVER CURRENT	59	DTL OVER VOLTAGE - Single Phase		and Non-linear Resistor Required - not shown)

Ordering Information 7SG142 Duobias M

Product description	Variants	Order No.
Duobias-M (200 series)		**7 S G 1 4 □ □ - 0 □ □ □ □ - □ □ □ 0 - □ □ □**
Two winding transformer differential protection.		
	Relay type	
	200 series – Transformer Protection (2 analogue input sets, 2 winding)	**2**
	Basic protection functionality - included in all models - Vector group compensation and ratio correction - Biased differential protection (87BD) - Differential high-set (87HS) - Internal protections indication (Buchholz, temperature etc.) (74) - Trip circuit supervision (74TC)	
	Protection options [4])	
	Option 01 - Restricted earth-fault (87REF)	**1** **0**
	Option 02 - 2 stage DTL overcurrent (50) - 2 stage DTL measured earth-fault (50G)	**2** **0**
	Option 03 - Restricted earth-fault (87REF) - DTL overcurrent (50) - IDMTL overcurrent (51) - DTL derived earth-fault (50N) - IDMTL derived earth-fault (51N)	**3** **0**
	Option 04 - Restricted earth-fault (one winding) (87REF) - DTL overcurrent (50) - IDMTL overcurrent (51) - DTL derived earth-fault (50N) - IDMTL derived earth-fault (51N) - DTL measured earth-fault (one winding) (50G) - IDMTL measured earth-fault (one winding) (51G) - Circuit breaker fail (50BF)	**4** **0**
	Option 07 - DTL overcurrent (50) - IDMTL overcurrent (51) - DTL measured earth-fault (50G) - IDMTL measured earth-fault (51G)	**6** **0**
	Option 09 - Restricted earth-fault (87REF) - DTL overcurrent (50) - IDMTL overcurrent (51) - DTL derived earth-fault (50N) - IDMTL derived earth-fault (51N) - DTL NPS DTL overcurrent (46DT) - IDMTL NPS overcurrent (46IT)	**9** **0** **G 0 D**
	Option 20 - DTL overcurrent (50) - IDMTL overcurrent (51) - DTL derived earth-fault (50N) - IDMTL derived earth-fault (51N) - 2 stage IDMTL measured earth-fault (one winding) (51G) - 4 stage under/overvoltage (27/59) - 4 stage under/overfrequency (81) - Overexcitation (24) - Thermal overload (one winding) (49)	**7** **1**

(continued on following page)

Product description	Variants	Order No.
Duobias-M (200 series)		**7 S G 1 4 □ □ - 0 □ □ □ □ - □ □ □ 0 - □ □ □**
(continued from previous page)		
	Protection options [4])	
	Option 21	**8** **1**
	- Restricted earth-fault (one winding) (87REF)	
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	- 4 stage under/overvoltage (27/59)	
	- 4 stage under/overfrequency (81)	
	- Overexcitation (24)	
	- Thermal overload (one winding) (49)	
	Option 23	**9** **0** **G 0 A**
	- Restricted earth-fault (87REF)	
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	- Circuit breaker fail (50BF)	
	Auxiliary supply /binary input voltage	
	30 V DC auxiliary, 30 V DC binary input	**A**
	30 V DC auxiliary, 48 V DC binary input	**B**
	48/110 V DC auxiliary, 30 V DC binary input	**C**
	48/110 V DC auxiliary, 48 V DC binary input [1])	**D**
	48/110 V DC auxiliary, 110 V DC low burden binary input	**E**
	220 V DC auxiliary, 110 V DC low burden binary input	**F**
	220 V DC auxiliary, 220 V DC low burden binary input	**G**
	I/O range	
	3 Binary Inputs / 5 Binary Outputs (incl. 3 changeover)	**A** **E**
	11 Binary Inputs / 13 Binary Outputs (incl. 3 changeover) [2])	**B**
	19 Binary Inputs / 21 Binary Outputs (incl. 3 changeover) [2])	**C**
	27 Binary Inputs / 29 Binary Outputs (incl. 3 changeover) [3])	**D**
	Frequency	
	50Hz	**1**
	60Hz	**2**
	Nominal current	
	1/ 5 A	**0**
	Voltage inputs	
	Not available	**0**
	63.5/110 V AC	**1**
	Housing size	
	Case size E8 (4U high)	**E**
	Case size E12 (4U high)	**G**
	Case size E12 (4U wide, vertical)	**H**
	Case size E16 (4U high)	**J**
	Case size E16 (4U wide, vertical)	**K**
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	**B**

1)High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version, 110/125 V application, order combination of the following resistor boxes to suit number of binary inputs, VCE:2512H10064 (9 inputs, 110V), VCE:2512H10065 (5 inputs, 110V), VCE:2512H10066 (1 inputs, 110V), 220/250 V application, order resistor box 2512H10066 in addition, VCE:2512H10067 (5 inputs, 220V), VCE:2512H10068 (1 inputs, 220V), Refer to website for application note about ESI48-4 compliance

2) Case size E12, Case size E16

3) Functions are per winding unless stated otherwise, REF models require external resistors and Metrosil (NLR) at additional cost.

Ordering Information 7SG143n Duobias M

Product description	Variants	Order No. 7 S G 1 4 □ □ - 0 □ □ □ □ - □ □ □ 0 - □ □ □
Duobias-M (300 series)		
Three winding transformer differential protection.		
	Relay type	
	300 series - Transformer Protection	3
	(3 analogue input sets, 3 winding)	
	Basic protection functionality - included in all models	
	- Vector group compensation and ratio correction	
	- Biased differential protection (87BD)	
	- Differential high-set (87HS)	
	- Internal protections indication (Buchholz, temperature etc.) (74)	
	- Trip circuit supervision (74TC)	
	Protection options [4])	
	Option 01	1 0
	- Restricted earth-fault (87REF)	
	Option 02	2 0
	- 2 stage DTL overcurrent (50)	
	- 2 stage DTL measured earth-fault (50G)	
	Option 03	3 0
	- Restricted earth-fault (87REF)	
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	Option 04	4 0
	- Restricted earth-fault (one winding) (87REF)	
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	- DTL measured earth-fault (two winding) (50G)	
	- IDMTL measured earth-fault (two winding) (51G)	
	- Circuit breaker fail (50BF)	
	Option 06	5 1
	- Restricted earth-fault (one winding) (87REF)	
	- Overexcitation (24)	
	- DTL measured earth-fault (two winding) (50G)	
	- IDMTL measured earth-fault (two winding) (51G)	
	Option 07	6 0
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	- DTL measured earth-fault (50G)	
	- IDMTL measured earth-fault (51G)	
	Option 20	7 1
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	- 2 stage IDMTL measured earth-fault (two winding) (51G)	
	- 4 stage under/overvoltage (27/59)	
	- 4 stage under/overfrequency (81)	
	- Overexcitation (24)	
	- Thermal overload (one winding) (49)	

(continued on following page)

Product description	Variants	Order No.
Duobias-M (300 series)		**7 S G 1 4 □ □ - 0 □ □ □ □ - □ □ □ 0 - □ □ □**
(continued from previous page)		
	Protection options [4])	
	Option 21	**8** **1**
	- Restricted earth-fault (two winding) (87REF)	
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	- 4 stage under/overvoltage (27/59)	
	- 4 stage under/overfrequency (81)	
	- Overexcitation (24)	
	- Thermal overload (one winding) (49)	
	Option 23	**9** **0** **G 0 A**
	- Restricted earth-fault (87REF)	
	- DTL overcurrent (50)	
	- IDMTL overcurrent (51)	
	- DTL derived earth-fault (50N)	
	- IDMTL derived earth-fault (51N)	
	- Circuit breaker fail (50BF)	
	Auxiliary supply /binary input voltage	
	30 V DC auxiliary, 30 V DC binary input	**A**
	30 V DC auxiliary, 48 V DC binary input	**B**
	48/110 V DC auxiliary, 30 V DC binary input	**C**
	48/110 V DC auxiliary, 48 V DC binary input [1])	**D**
	48/110 V DC auxiliary, 110 V DC low burden binary input	**E**
	220 V DC auxiliary, 110 V DC low burden binary input	**F**
	220 V DC auxiliary, 220 V DC low burden binary input	**G**
	I/O range	
	3 Binary Inputs / 5 Binary Outputs (incl. 3 changeover) 2)	**A**
	11 Binary Inputs / 13 Binary Outputs (incl. 3 changeover) [2])	**B**
	19 Binary Inputs / 21 Binary Outputs (incl. 3 changeover) [3])	**C**
	27 Binary Inputs / 29 Binary Outputs (incl. 3 changeover) [3])	**D**
	Frequency	
	50Hz	**1**
	60Hz	**2**
	Nominal current	
	1/ 5 A	**0**
	Voltage inputs	
	Not available	**0**
	63.5/110 V AC	**1**
	Housing size	
	Case size E12 (4U high)	**G**
	Case size E12 (4U wide, vertical)	**H**
	Case size E16 (4U high)	**J**
	Case size E16 (4U wide, vertical)	**K**
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	**B**

1) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version, 110/125 V application, order combination of the following resistor boxes to suit number of binary inputs, VCE:2512H10064 (9 inputs, 110V), VCE:2512H10065 (5 inputs, 110V), VCE:2512H10066 (1 inputs, 110V), 220/250 V application, order resistor box 2512H10066 in addition, VCE:2512H10067 (5 inputs, 220V), VCE:2512H10068 (1 inputs, 220V), Refer to website for application note about ESI48-4 compliance

2) Case size E12

3) Case size E16

4) Functions are per winding unless stated otherwise, REF requires external resistors and Metrosil (NLR) at additional extra cost.

Reyrolle
Protection
Devices

7SG15 – MicroTAPP

Automatic Voltage Control

Answers for energy

SIEMENS

7SG15 - MicroTAPP

Automatic Voltage Control

Fig 1. MicroTAPP AVC Relay

Description

The MicroTAPP range of Automatic Voltage Control (AVC) relays combines the power and flexibility of microprocessor technology with the renowned operating philosophy and effectiveness of the established Transformer Automatic Paralleling Package (TAPP) method.

The relay provides three function areas:

The efficient control of power system voltage levels through operation of an on-load tap changer

The monitoring and protection of the power system and tap-changer.

The collection of system data for analysis.

MicroTAPP represents a complete AVC system, eliminating complex control schemes and reducing inter-transformer-panel wiring to a single twisted-pair cable.

High integrity and confidence is maintained through the use of watchdog self-monitoring and supervision, while independent algorithms are provided for the voltage control and monitoring functions.

Communications using the IEC 60870 standard allows remote update of settings, and provides access to the relay's instrumentation, waveform storage and data collection facilities

Function Overview

MicroTAPP 101

Circulating Current voltage control.
Enhanced TAPP principle for voltage control.
User-specified system Power Factor eliminates errors associated with other circulating current schemes.
Load Drop Compensation counteracts network related voltage drop.
Circulating current is minimised to reduce system losses.
Tap-stagger allows circulating current to be introduced for network operation purposes.
Voltage offsets can be applied either through status inputs or the IEC60870 communications for Load Reduction and network operation.
Low system frequencies are detected and this can inhibit attempts to increase the voltage in, for example, a load shedding situation.
Homing minimises system disruption due to the switching in or out of transformers.
Tap position indication accepts inputs from either analogue or digital sender units.

Runaway detection locks out the tap-changer to prevent unwanted tap changes due to electrical or mechanical failure.

VT Fuse Monitor. Negative-phase sequence (NPS) voltage element detects blown VT fuses to prevent incorrect voltage control.
Data Storage is provided through Events, 24-hour Waveforms and Fault Records.
IEC 60870-5-103 Communications for in-station monitoring and control.
Hardware and software watchdogs provide comprehensive self-monitoring.

MicroTAPP 102

As for the MicroTAPP 101, plus:
Pseudo-VT™ allows control of voltage on remote side of transformer.

User Interface

40 character x 8 line backlit LCD
Menu navigation keys

5 fixed LEDs

Monitoring Functions

Analogue values can be displayed on the LCD screen. In addition most values can be obtained via the data communications channel(s).

Primary and secondary currents
Primary and secondary voltages
Frequency
Power Factor
Phase Angles
Transformer & Group Load
PPS and NPS voltage
Tap Position

Status inputs
Output contacts
Tap counters
MPPC status

Description of Functionality

Voltage Control

The user specifies target voltage, voltage dead band, initial delay and inter-tap delay.

When a voltage excursion outside the dead band occurs the MicroTAPP acts to restore correct system voltage. When deciding on voltage excursion the measured voltage is compensated for:

Load drop compensation (LDC) – compensates for voltage drop in the network.

Corrective coupling voltage (CCV) – acts to eliminate current circulating between parallel transformers due to mis-matches in voltage.

In service adjustments to the target voltage – applied either via status inputs or IEC60870 communications.

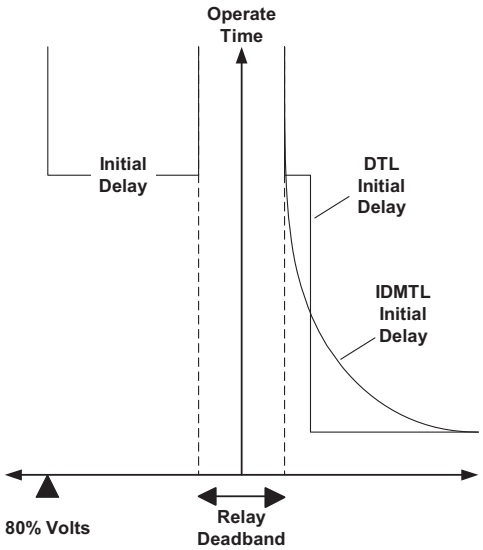


Fig 2. Tap Change control with Deadband

After an initial delay, implemented to allow short-term voltage fluctuations, a tap-change command is issued. The delay is a definite time for low voltages. For high voltages a definite time delay (DTL) or an inverse time delay (IDMTL) can be specified. If a DTL is specified a fast-tap down can be enabled to provide accelerated operation for very high system voltages. This provides a fixed high-set of top of Deadband + 2% with a 2 second delay.

The inter-tap delay sets a minimum period between successive tap instructions to allow time for the tap-changer to operate.

Advanced Control Functionality

Through its Pseudo-VT™ algorithm the MicroTAPP can calculate and hence control the voltage on the remote side of the transformer to that on which the VT and CT are located. It makes use of the tap position, which it ensures is correct through an intelligent operation monitor, to calculate the actual transformer ratio and compensate for voltage drops across the transformer.

Voltage Monitoring

Independent algorithms monitor the system voltage and provide a comprehensive set of blocking elements to prevent incorrect tap changes.

For added integrity, when a 3-phase VT is used a different voltage is used for monitoring than for voltage control. The blocking matrix intelligently blocks raise and lower operations depending on system conditions.

Excessive voltage unbalance can be caused by VT fuse failures. If 3-phase VTs are used this condition can be detected and voltage raise operations blocked.

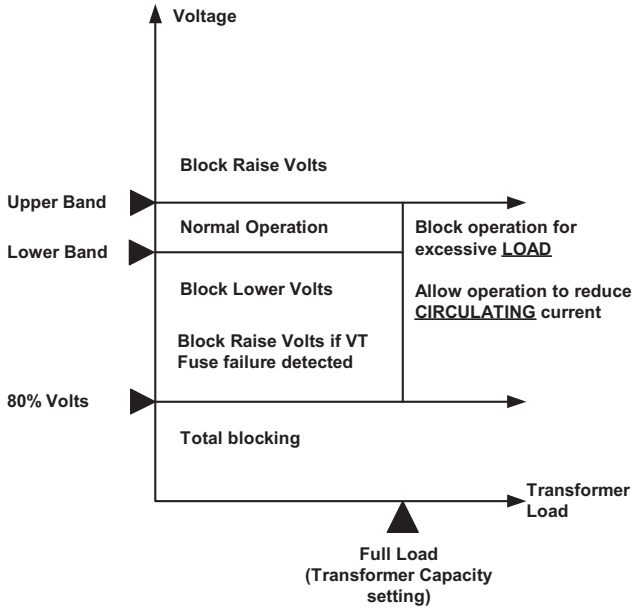


Fig 3. Voltage monitoring blocking matrix

If an excessive current flows at normal system power factors the relay inhibits all tap-changing operations. High currents when the power factor is abnormal may be as a result of circulating currents. In this situation the relay should act to reduce them rather than applying over-current blocking.

A system voltage below 80% will be due either to the Transformer being powered down or a system fault condition and so all tap-changing is inhibited.

Upper and Lower Alarm levels are provided to indicate abnormal voltages. An Alarm will also be issued if the voltage remains outside the Deadband for an abnormal time.

Tap-changer Monitoring

An intelligent tap-position indicator and runaway prevention algorithm monitors the entire tap-change operation. A Tap-changer runaway is quickly detected and the resulting alarm can be used to lock-out the tap-changer to prevent damage to the system. Incomplete tap-changes are also detected and indicated.

If the voltage requires a tap-change beyond the limits of the tap-changer this is inhibited and a target not achievable alarm is generated.

Tap Changer Maintenance

A tap-changer operations count and a "sum of I^2" count is provided. Alarm levels can be set which, when reached, can be routed to a condition-based maintenance system.

Data Storage and Communication

Sequence of event records

Up to 200 events are stored and time tagged to 1ms resolution. These are available via the communications.

Fault records

The last 10 tap-changer fault records are available from the fascia with time, date and type of failure.

Graphical records

Recordings of all operational data, voltage level, transformer load, summed load etc. are available for up to 24 hours.

Communications

Two fibre-optic communications ports are provided on the rear of the relay. They are optimised for 62.5/125µm glass-fibre, with BFOC/2.5 (ST®) bayonet style connectors.

In addition users may interrogate the relay locally with a laptop PC and the RS232 port on the front of the relay.

The relay supports the IEC 60870-5-103 communications standard.

Reydisp Evolution

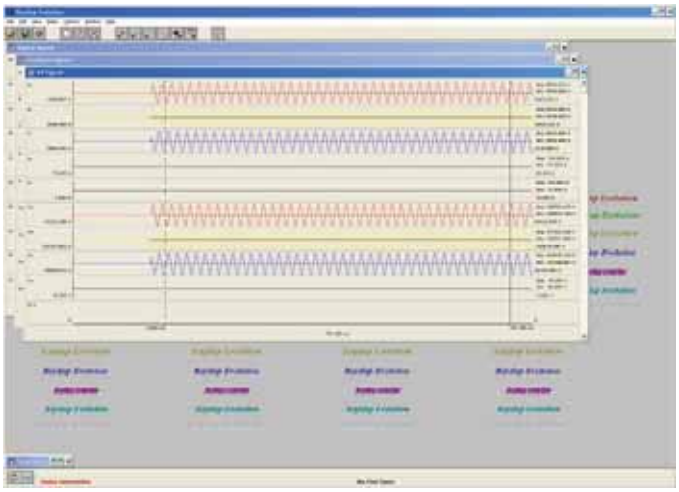


Fig 2. Typical ReyDisp Evolution screenshot

This support software is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings to the Delta as well as to retrieve settings, instruments, events, waveforms and 24 hour data.

Technical Information

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

Inputs and Outputs

Characteristic Energising Quantity

AC Current	1, 5 A, 50/60 Hz
AC Voltage	63.5 V line-neutral, 110 V line-line, 50/60 Hz

Thermal Withstand	
AC Current Inputs	
continuous	3.0 xIn
10 minutes	3.5 xIn
5 minutes	4.0 xIn
2 minutes	6.0 xIn
1 second	250 A
1 cycle	625 A peak
AC Voltage Inputs	
continuous	300 V

Burden	
AC Current Inputs	
1 A	≤ 0.1 VA
5 A	≤ 0.3 VA
AC Voltage Inputs	
	≤ 0.01 VA

DC Auxiliary Supply

Nominal Voltage	Operating Range
30 VDC	24 to 37.5 VDC
48, 110 VDC	37.5 to 137.5 VDC
220 VDC	178 to 280 VDC
110 VAC	82.5 to 137.5 VAC RMS

Operate State	Burden
Quiescent (Typical)	17 W
Maximum	20 W

Burdens are measured at nominal rating.

Allowable superimposed ac component	≤12% of dc voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤20 ms

Status Inputs

Nominal Voltage	Operating Range
30, 34 VAC/DC	24 to 37.5 VAC/DC
48, 54 VAC/DC	37.5 to 60 VAC/DC
110, 125 VAC/DC	87.5 to 137.5 VAC/DC
220, 250 VAC/DC	175 to 280 VAC/DC

Note that the status input voltage need not be the same as the main energising voltage.

The 30V and 48V inputs meet the requirements of ESI48-4 ESI 1. However, the 110V and 220V inputs will operate with a DC current of less than 10mA. Where 110V or 220V inputs compliant with ESI48-4 ESI 1 are required, a relay with 48V binary inputs can be supplied with external series resistors as follows:

Nominal Voltage	Resistor Value	Wattage
110V	2k7 ± 5%	2.5 W
220 V	8k2 ± 5%	6.0 W

Parameter	Value
Minimum DC current for operation (30 V and 48 V inputs only)	10 mA
Reset/Operate Voltage Ratio	90 %
Recommended minimum pulse duration	500 ms

Output Relays

Carry continuously	5A ac or dc
Make and carry (L/R ≤ 40 ms and V ≤ 300V)	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
Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5 W limits 10mA or 5V

Mechanical

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

0.5 gn, Vibration response	≤ 5% variation
1.0 gn, Vibration endurance	

Shock and Bump IEC 60255-21-2 Class 1

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

Seismic IEC 60255-21-3 Class 1

1 gn, Seismic Response	≤ 5% variation

Mechanical Classification

Durability	In excess of 10^6 operations

Recommended load

Minimum recommended load	0.5 W, limits 10 mA or 5 V

Electrical Tests

Insulation IEC 60255-5

RMS levels for 1 minute

Between all terminals and earth	2.0 kV
Between 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

High Frequency Disturbance

IEC 60255-22-1 Class III

2.5kV, Longitudinal mode	≤3% variation
1.0kV, Transverse mode	

Electrostatic Discharge

IEC 60255-22-2 Class III

8kV, Contact discharge	≤5% variation

Fast Transient

IEC 60255-22-4 Class IV

4kV, 5/50ns, 2.5 kHz, repetitive	≤3% variation

Radio Frequency Interference

IEC 60255-22-3

10 V/m, 80 to 1000 MHz	≤5% variation

Conducted RFI

IEC 60255-22-6

10 V, 0.15 to 80 MHz	≤5% variation

Conduct limits

IEC 60255-25

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

Radiated limits

IEC 60255-25

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

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

Protection Elements

General Accuracy

Reference Conditions	
Parameter	**Reference or Value**
General	IEC 60255-3
Current Settings	100% of In
Time Multiplier	1.0
Current input (IDMTL)	2x to 20x Is
Current input (DTL)	5x Is
Auxiliary supply	Nominal
Frequency	50 Hz
Ambient temperature	20 °C

General Settings	
Parameter	Value
Transient Overreach of Highset/Lowset (X/R = 100)	≤ 5%
Disengaging Time (1)	< 42 ms
Overshoot Time	< 40 ms

Output contacts have a minimum dwell time of 100ms, after which the disengage time is as above.

Indication

Relay Healthy	
Method	Green LED
Relay Failure	Flashing or extinguished
High, Low Voltage	
Method	Red LEDs
Voltage Alarm	Flashing
Normal Voltage	
Method	Green LED
Tap In Progress	
Method	Amber LED
Lockout	Flashing
Settings and Instrumentation	
Method	graphical backlit LCD

Sub-station communications

Protocol	IEC 60870-5-103
RS-232 interface	
Location	Fascia
Form	25-pin female D-type connector
Fibre interface	
Location	Rear
Quantity	2 x Rx, 2 x Tx
Form	BFOC/2.5 (ST®) bayonet connector
COM1	
Baud rate	75-115200 baud
Interface	Fibre-optic port
COM2	
Baud rate	75-115200 baud
Interface	Auto-switches between Fibre-optic and RS-232

General Accuracy

Reference conditions

Parameter	Reference or Value
Auxiliary Supply	Nominal
Frequency	50/60 Hz
Ambient Temperature	20 °C

Accuracy Influencing Factors
Temperature

Ambient range	Variation
-10 °C to +55 °C	≤ 5%

Frequency

Range	Variation
47 Hz to 52 Hz	Level: ≤ 5%
57 Hz to 62 Hz	Operate Time: ≤ 5%

Harmonic content

Range	Variation
Frequencies to 550Hz	Setting: ≤ 5%

Control Elements

Voltage Control Method	TAPP, Circulating Current
Voltage Control	
Target	85 to 115% Vn
Dead band	±0.1 to ±5.0% Vn
Accuracy	±0.1% Vn
Repeatability	±1%
Initial Delay	
Characteristics	DTL or IDMTL (voltage high only)
Setting	2 to 180 s
Accuracy	±0.25 s
Repeatability	±0.25 s
General	
No of transformers	1 to 16
No of taps	1 to 39
Sender Unit	Resistor chain, binary, BCD, gray code
Inter-Tap delay	
Setting	Continuous, 1 to 120 s
Accuracy	1s
Repeatability	1s

Environmental

Temperature IEC 68-2-1/2

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

Humidity IEC 68-2-3

Operational test	56 days at 40 °C and 95% RH

Transient Overvoltage IEC 60255-5

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

Insulation IEC 60255-5

Test	Level (rms for 1 min)
Between all terminals and earth	2.0 kV
Between independent circuits	2.0 kV
Across normally open contacts	1.0 kV

Immunity
Auxiliary DC Supply IEC 60255-11

Quantity	Value
Allowable superimposed ac component	≤ 12% of dc voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20 ms

High Frequency Disturbance IEC 60255-22-1 Class III

Type	Level	Variation
Common (Longitudinal) Mode	2.5 kV	≤ 3%
Series (Transverse) Mode	1.0 kV	

Electrostatic Discharge IEC 60255-22-2 Class III

Type	Level	Variation
Contact discharge	8 kV	≤ 5%

Radio Frequency Interference IEC 60255-22-3

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

Fast Transient IEC 60255-22-4 Class IV

Type	Level	Variation
5/50ns, 2.5 kHz, repetitive	4kV	≤ 3%

Conducted RFI IEC 60255-22-6

Frequency Range	Level	Variation
0.15 to 80 MHz	10 V	≤ 5%

Emissions

Conducted limits IEC 60255-25

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

Radiated limits IEC 60255-25

Frequency Range	Limits at 10 m Quasi-peak, dB(ΔV/m)
30 to 230 MHz	40
230 to 10000 MHz	47

Mechanical

Vibration Sinusoidal IEC 60255-21-1 Class 1

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

Shock and Bump IEC 60255-21-2 Class 1

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

Seismic IEC 60255-21-3 Class 1

Type	**Level**	**Variation**
Seismic Response	1 gn	≤ 5%

Mechanical Classification

Durability	In excess of 10^6 operations

Sample Specification

Voltage Control

The following standard system conditions should be catered for with minimal or no adjustment to the Automatic Voltage Control System (AVC):

Where a transformer operates in parallel with other transformers, either within a site or across a network, the AVC should operate in order to (a) maintain the system voltage at the correct level and (b) operate at a tap position where minimal reactive circulating current flows from or into any system transformer which is a part of the network.

In the event of a failure of communications either between grouped transformers or from a remote control centre, the AVC should be able to operate in a stand-alone mode and achieve a satisfactory overall system voltage.

If a transformer in a group is switched IN, no significant change in voltage will occur.

If a transformer in a group is switched OUT, no significant change in voltage will occur.

The Load Drop Compensation (LDC) method, if used, must remain at the correct level regardless of the number of transformers connected to a common busbar.

Settings applicable to different network running arrangements should be applied to the AVC and be capable of implementation by a single instruction (either from a remote source or locally) or plant status change.

The AVC must be provided with the capability of independently protecting against incorrect operation which would allow abnormal voltages to be applied to the network.

The AVC shall be capable of controlling at least 16 transformers operating in parallel as a group.

The operating characteristics of the voltage regulating relay is to be such that a raise or lower command will only be issued after an initial time delay as set on the voltage regulating relay. A definite time characteristic and an inversely related initial time characteristic shall be selectable. When a definite time delay is selected a fast tapping feature which bypasses the initial time delay in the event of substantial voltage excursions above the set band is preferred. Any subsequent corrective signals for the same voltage deviation will be delayed by a separate inter-tap time delay.

The voltage regulating relay shall include a 'Load Drop Compensation' facility. LDC shall be used where the busbar voltage is increased in proportion to the total substation load current. The LDC effect shall be proportional to the total connected busbar load. This method will provide the correct voltage boost given by the chosen LDC setting, irrespective of the number of transformers in service. Full LDC functionality shall be retained when parallel control based on the minimum circulating current method is used.

Voltage Monitoring

Monitoring of the voltage level shall be via separate connections to those used for voltage control.

If the measured system voltage is less than a pre-set under-voltage limit or greater than a pre-set over-voltage limit, the system shall inhibit the appropriate tap control outputs to the relevant transformer but allow tap change operations that will correct the abnormal voltage. An alarm will be generated if the abnormal voltage persists.

Where a 3 phase VT is used the system shall monitor all voltages in order to ensure the integrity of the VT secondary output. Any abnormalities detected will inhibit the voltage raise outputs from the system and initiate an alarm.

If the load current is greater than a pre-set limit, the system shall inhibit all tap control outputs to the relevant transformer(s) and generate an alarm, unless the situation is caused by circulating current flowing between transformers. In this case tap changing will be allowed to reduce the circulating current.

Tap-changer Monitoring

The tap changer operation monitor circuits shall be provided for tap changer runaway protection in the event of a mechanism, wiring or relay fault. The following shall be considered minimum requirements for such protection:

Protection is required that will detect incorrect tap change operation at the earliest opportunity. An incorrect tap change operation is defined as "a tap change operation that is not initiated by a 'true' control signal". As an example, a slow to clear 'raise' contactor may allow a motor drive to continue driving the mechanism at the end of a tap change cycle such that the tap change maintaining switch recloses and thus allows the tap change to 'run away'.

The preferred scheme should not rely on timing systems for determination of this situation, but intelligently monitor the relationship between the control signals, the tap change in progress inputs and the tap position.

If a lockout is required the AVC will initiate contacts both for lockout and alarms. The lockout contacts shall provide for the tripping of a mechanically latched contactor or the permissive operation normally open contactor to remove the tap change motor power supply.

Inputs from plant

To avoid drain on substation batteries, the tap changer control supply will provide the supply for all AVC equipment and have a nominal AC voltage of 110V (+10% to –25%).

Measuring voltage inputs shall be provided which are capable of operating with VTs with secondary rating between 63.5 and 250V. Adjustment shall be provided to eliminate any VT ratio errors.

A measuring current input shall be provided capable of operating with CTs of 1 or 5A secondary rating. The relay shall be configurable to allow non-standard CT ratios to be used. The relay shall be capable of using the CT regardless of the phase to which it may be connected.

The relay shall be capable of measuring up to 39 tap positions, including special tap positions (e.g. 8A, 8B, 8C) from resistor chain, BCD, binary and gray code sender units.

A tap-change in progress (TCIP) signal shall be detected by the relay from a contact provided in the tap changer. The TCIP contact will close as the tap change starts and open at the end of the tap change sequence.

Outputs to plant

The tap raise/lower outputs shall be via normally open clean contacts with a minimum pulse time of 1.5s rated for 5A AC.

The AVC system will be required to prevent operation of the tap changer motor drive in the event of unwanted operations. Two methods may be used:

Tripping of a mechanically latched contactor connected into the supply for the motor
Permissive operation of a normally de-energised contactor connected into the motor supply during the tap changing sequence

To enable either option, change-over clean output contacts rated for at least 5A AC shall be provided.

Operator Controls

The AVC system shall provide the means to:

Switch control points between local (at the AVC) and remote (network control centre).

Switch between local and automatic control.

Raise and lower the tap-changer manually.

When set to local it shall not be possible for a remote point to operate the tap-changer or switch the AVC between manual and automatic modes.

If a Master/Follower tap change control scheme is proposed, additional control switches will be required. A Master/Follower design is NOT the preferred scheme for submission as a solution.

Indication and instrumentation

The following indications shall be provided:

Circuit identifier
AVC healthy LED
Voltage normal/high/low LEDs
Tap in progress LED
Voltmeter showing system voltage
Tap position indication, allowing for unusual tap arrangements (e.g. 8A, 8B, 8C)
Indication of transformer load, transformer load power factor and total load of all paralleled transformers

Remote Access

Remote access shall be provided through both hard-wired inputs and outputs, and using a non-proprietary communications protocol, e.g. IEC 60870-5-103. The following features shall be available using both access methods: When the AVC system is set to remote, it will be possible to switch the AVC between automatic and manual. When in manual, it will be possible to operate the tap-changer from a remote point.

It will be possible to select between a minimum of 3 preset voltage targets.

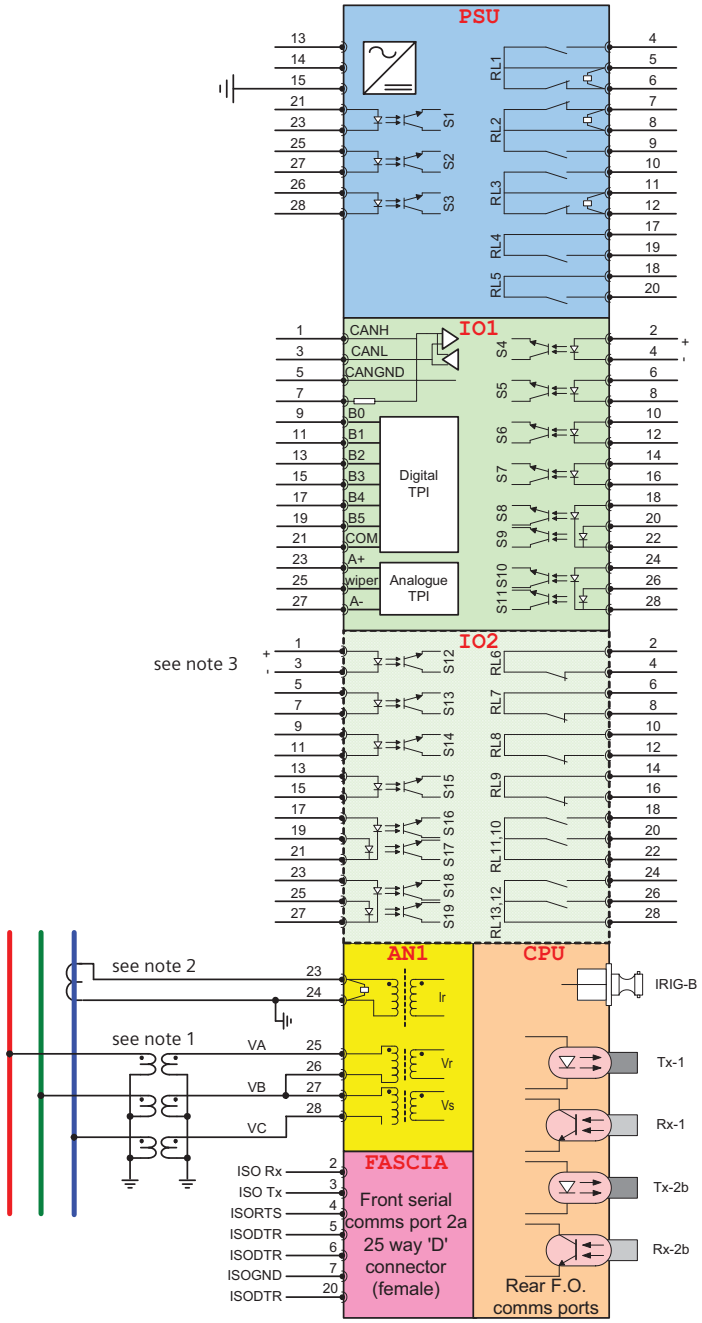
Alarms will be provided for AVC failure, VT fuse failure, voltage out of limits, tap-changer runaway, tap-change incomplete, target not achievable.

The following data shall be made available using the communications protocol:

Metering values of voltage, load, power factor and tap position.

Traces of voltage, current, tap position, frequency and a measure of power quality for a minimum period of 24 hours.

Typical Connection Diagrams



Notes

1. Analogue connections show use with a star-connected VT, other arangements can be used.
2. CT connection is shown on blue phase, any connection can used.
3. IO2 is provided on MT1-xxx xJ variants only

Fig. 4 shows two options for AC measuring connections, one using a 3-phase VT the other for when only a single-phase VT is available. Any phase may be chosen for the CT.

Fig. 6 and 7 show typical control circuit connections. Fig. 6 is the traditional connection for use with a step-by-step contactor (relay in 'Basic' mode). In Fig. 7 the step-by-step control is provided by the MICROTAPP software (relay in 'step-by-step' mode).

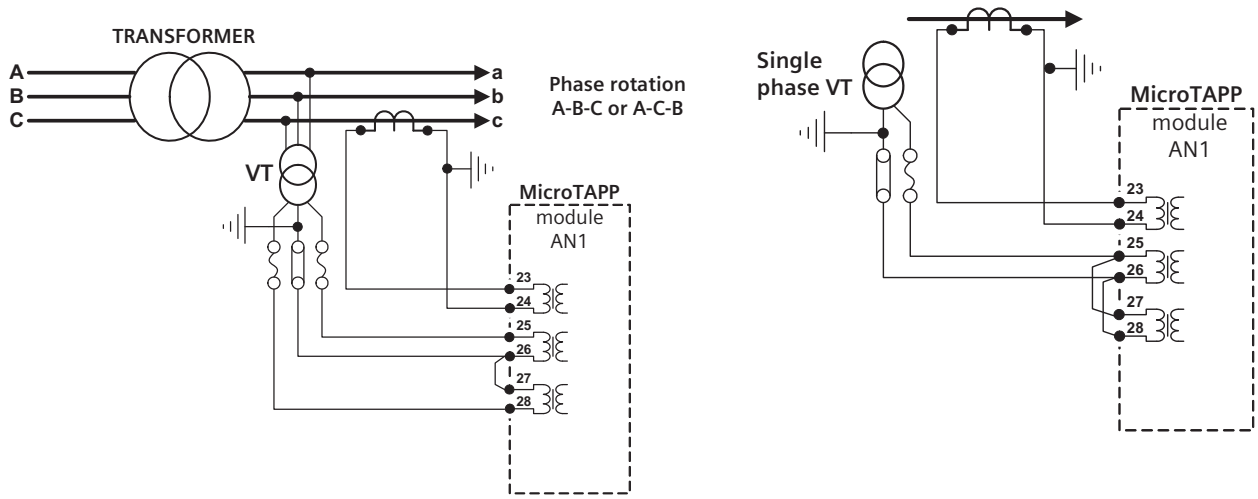


Fig 4. Typical voltage and current measurement inputs

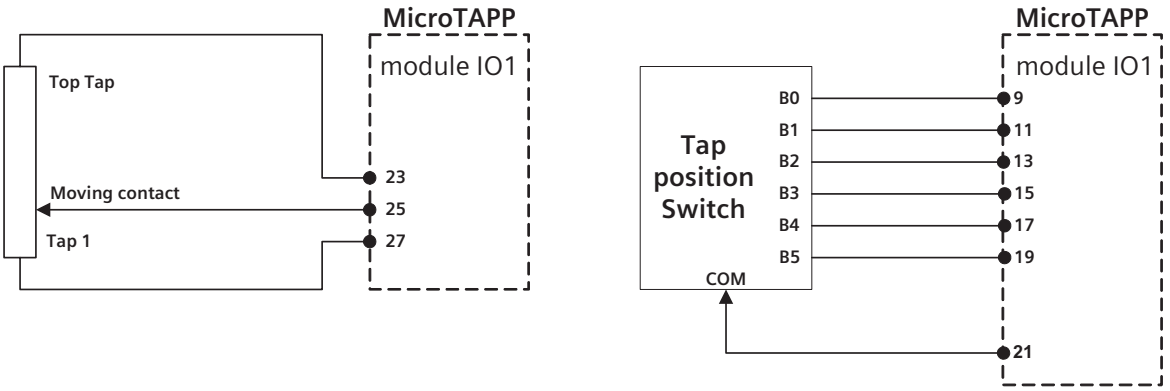


Fig5. Tap position input connections for Resistor Chain and BCD/Binary sender units

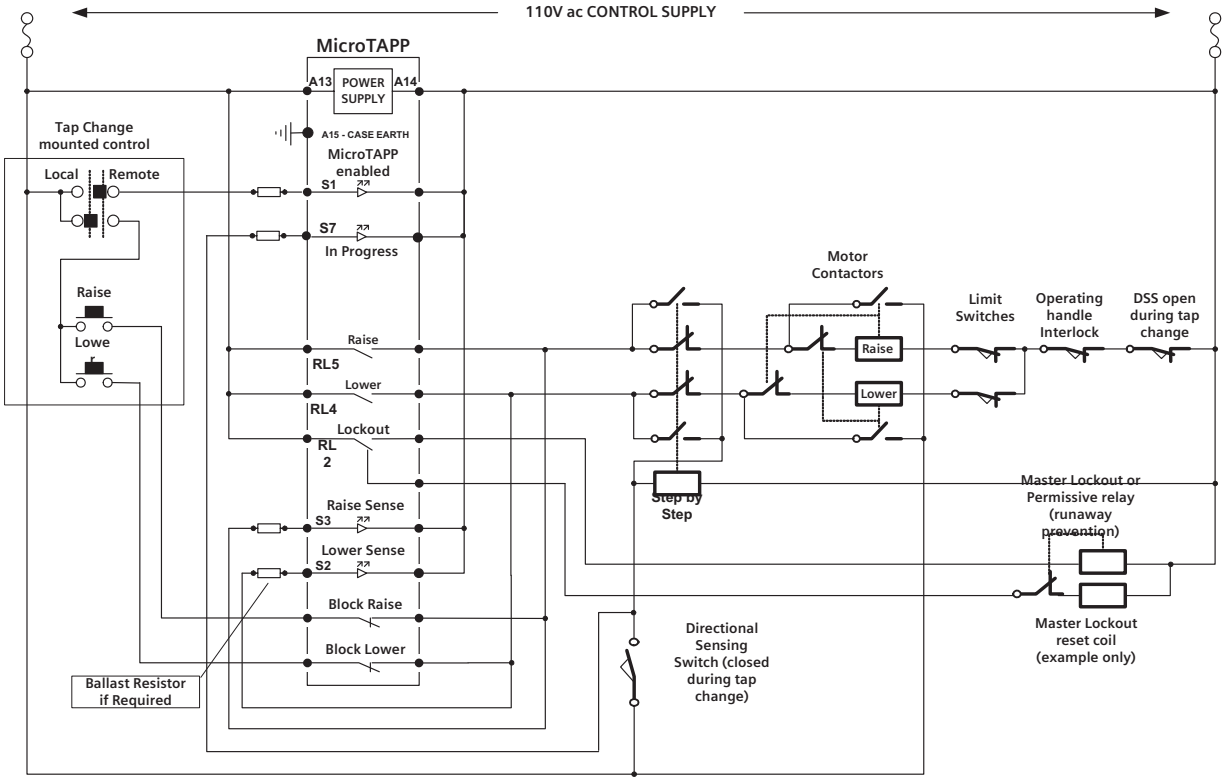


Fig 6. Typical tap-change control circuit with traditional step-by-step contactor

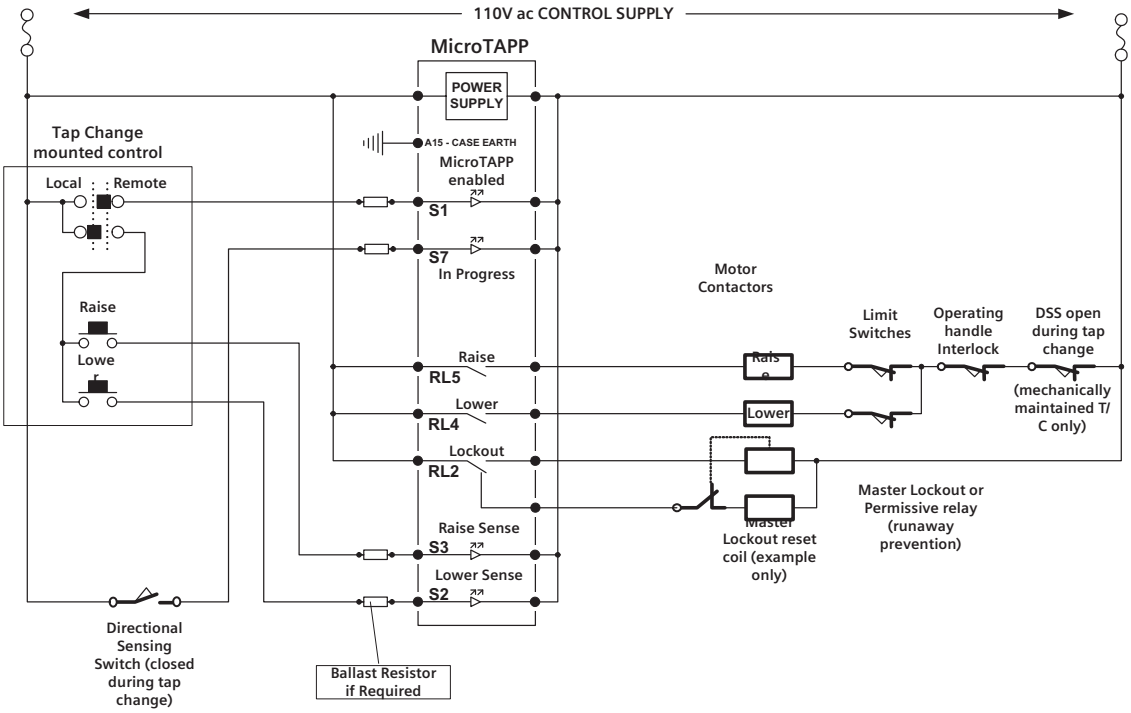


Fig 7. Typical tap-change control circuit with step-by-step control internal to the MICROTAPP

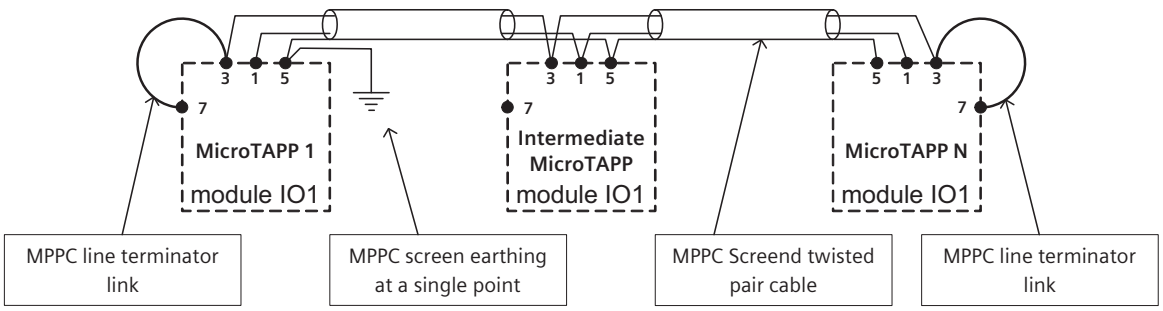


Fig 8. Connections for MicroTAPP peer-peer communications (MPPC)

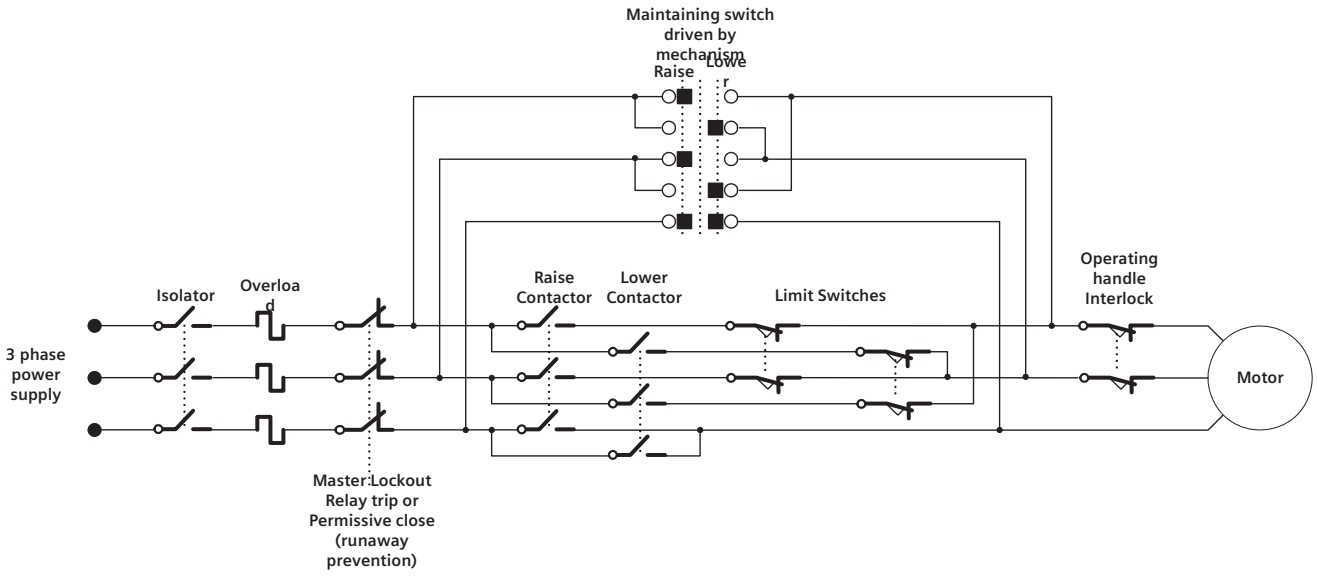


Fig 9. Typical tap-change motor circuit

Case Drawing

The MicroTAPP is supplied in either a size 8 or size 12 case, depending on the status input and output relay requirement, see the table below.

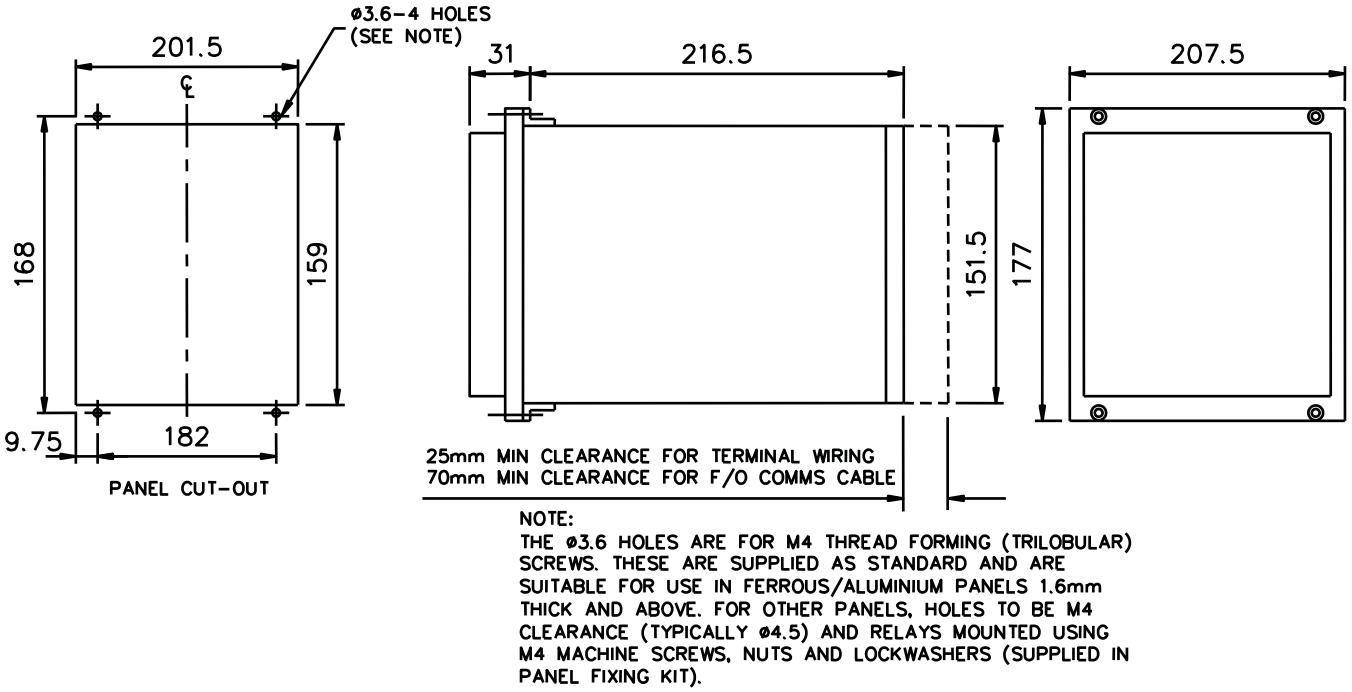


Fig 10. Overall Dimensions and panel drilling for Epsilon E8 case

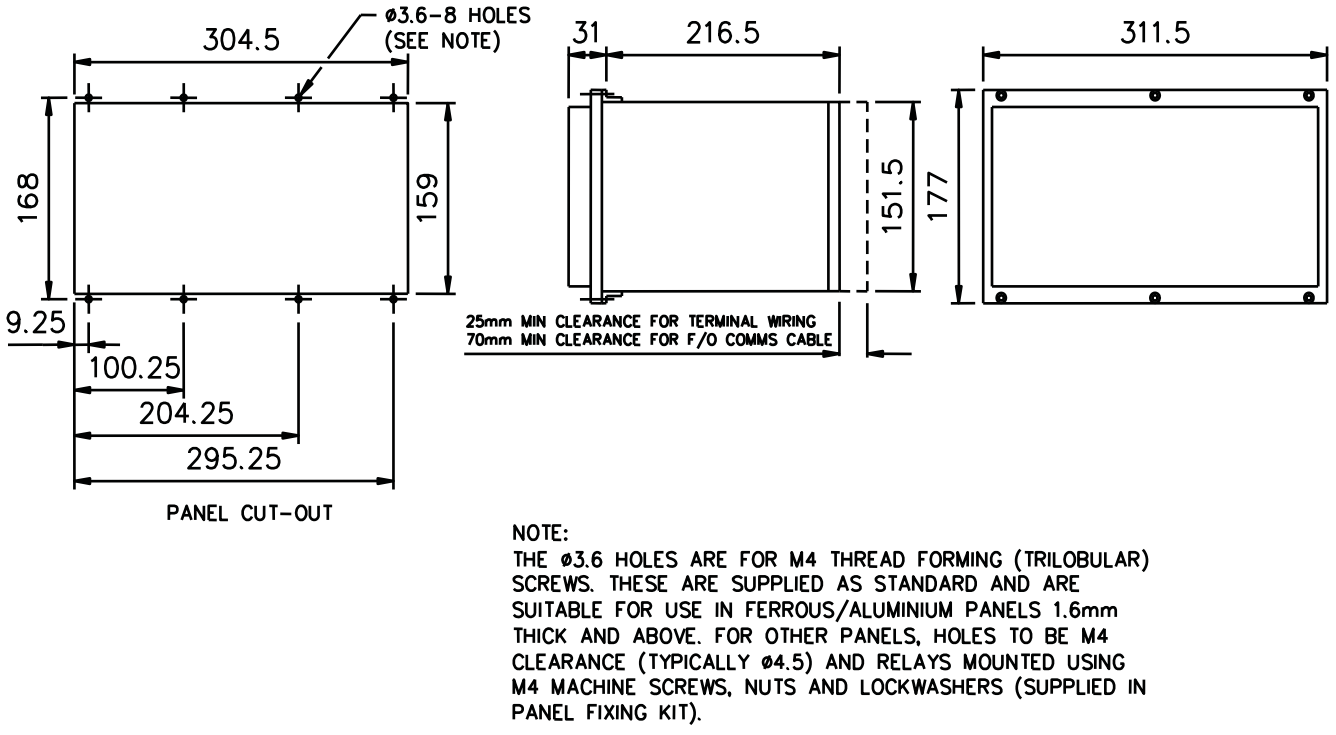


Fig 11. Overall Dimensions and panel drilling for Epsilon E12 case

Ordering Information - MICROTAPP 7SG151

Product description	Variants	Order No.
MICROTAPP		7 S G 1 5 □ 0 - □ □ □ □ □ - 0 □ □ 0
Transformer tap change control and monitoring.		
	Relay type	
	Automatic voltage control (AVC)	1
	Protection options	
	Basic - Microprocessor based automatic voltage control (AVC) system operating on the well proven TAPP philosophy	1
	Advanced - As basic model only particularly suitable for embedded generation and traction system applications as this model is capable of controlling the HV or LV voltage	2 G
	Auxiliary supply /binary input voltage	
	30 V DC auxiliary, 30 V DC/AC binary input	A
	30 V DC auxiliary, 48 V DC/AC binary input	B
	48/110 V DC auxiliary, 30 V DC/AC binary input	C
	48/110 V DC auxiliary, 48 V DC/AC binary input [1]	D
	48/110 V DC auxiliary, 110 V DC/AC low burden binary input	E
	220 V DC auxiliary, 110 V DC/AC low burden binary input	F
	220 V DC auxiliary, 220 V DC/AC low burden binary input	G
	110 V AC auxiliary, 110 V DC/AC binary input	H
	110 V AC auxiliary, 48 V DC/AC binary input	X
	110 V AC auxiliary, 220 V DC/AC binary input	J
	110 V AC auxiliary, 30 V DC/AC binary input	K
	I/O range	
	11 Binary Inputs / 5 Binary Outputs (incl. 3 changeover)	E E
	19 Binary Inputs / 13 Binary Outputs (incl. 3 changeover and 4 normally closed contacts)	J G
	19 Binary Inputs / 13 Binary Outputs (incl. 3 changeover)	K G
	Frequency	
	50/60Hz	3
	Nominal current	
	1/ 5 A	0
	Housing size	
	Case size E8 (4U high)	E
	Case size E12 (4U high)	G
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103	A

[1] High burden 110/125V & 220/250V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
110/125 V application, order combination of the following resistor boxes to suit number of binary inputs
VCE: 2512H10064 (9 inputs, 110V)
VCE:2512H10065 (5 inputs, 110V)
VCE:2512H10066 (1 inputs, 110V)
220/250 V application, order resistor box 2512H10066 in addition
VCE:2512H10067 (5 inputs, 220V)
VCE:2512H10068 (1 inputs, 220V)
Refer to website for application note about ESI48-4 compliance

[2] For use with resistor sender units, order mounting bracket assembly with 19 off 220ohm resistors – VCE:2512H10072

[3] Milliamp transducer FTPT, order 7XG2300-1AA00-0AA0
Averaging VT FAVT, order 7XG2300-2AA00-0AA0
Tap position indication module FTIM, order 7XG2300-3AA00-0AA0

Reyrolle
Protection
Devices

7PG21 – Solkor R/Rf

Pilot Wire Current Differential Protection

Answers for energy

SIEMENS

7PG21 – Solkor R/Rf

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

Option of intertripping through the same pilot pair

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 Intertripping equipment can also be supplied which utilises 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. There are 3 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.

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.

Thirdly Injection intertripping can be used whereby the pilots are disconnected from the local relay and an AC signal, produced by an inverter, is injected to force the remote end to operate. This method will provide a successful intertrip regardless of the remote relay current level and can be applied on radial networks.

Typical Equipment Options and Schemes

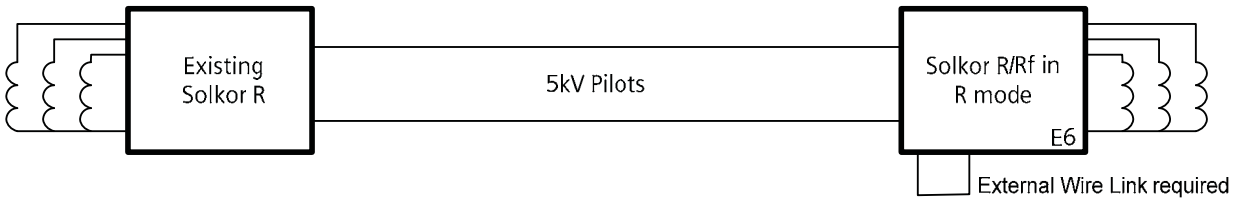


Fig 1. Installation with existing Solkor R Relay

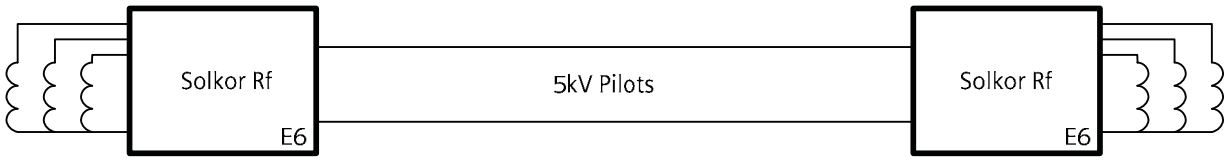


Fig 2. Standard 5kV Plain Solkor Rf

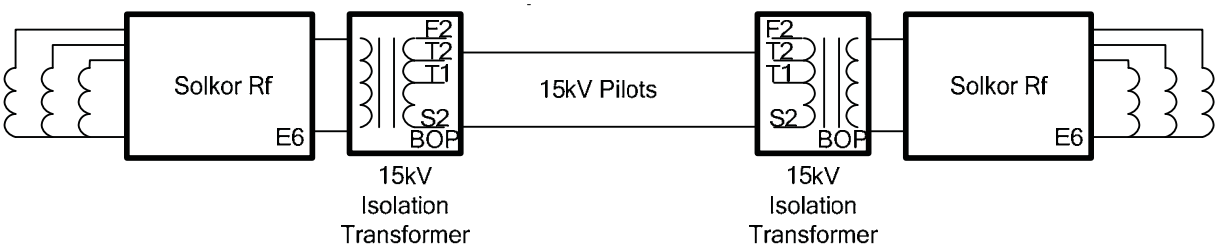


Fig 3. Standard 15kV Plain Solkor Rf

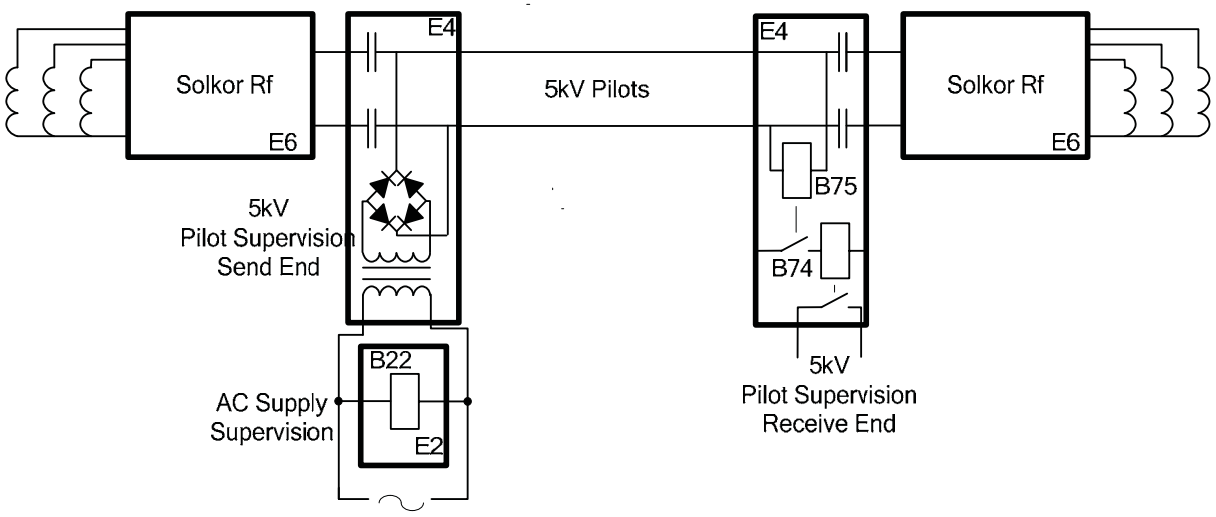


Fig 4. 5kV Solkor Rf with pilot Supervision

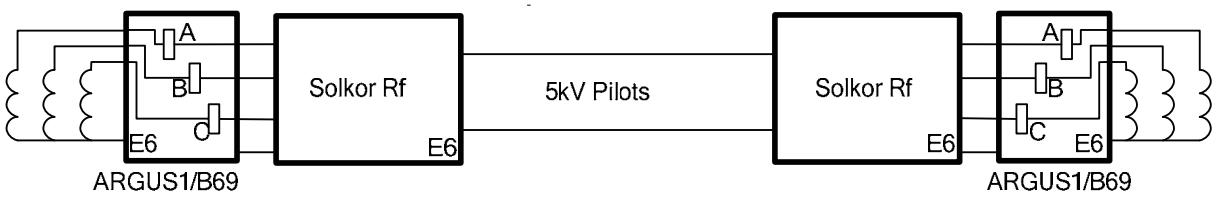


Fig 5. 5kV Plain Solkor Rf with Overcurrent Guard

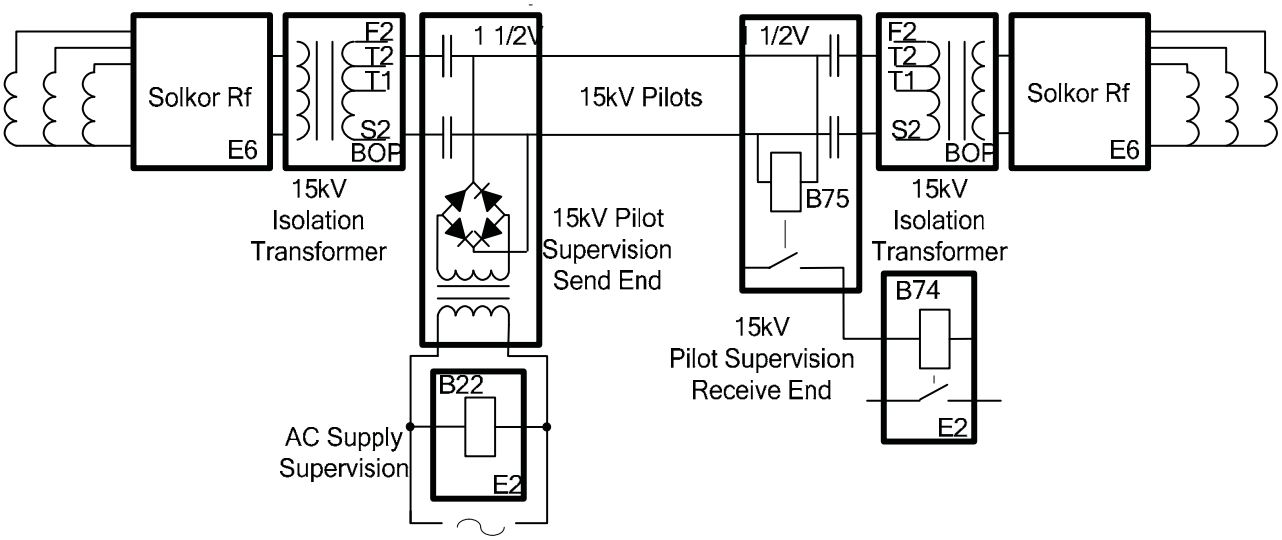


Fig 6. 15kV Solkor Rf with Pilot Supervision

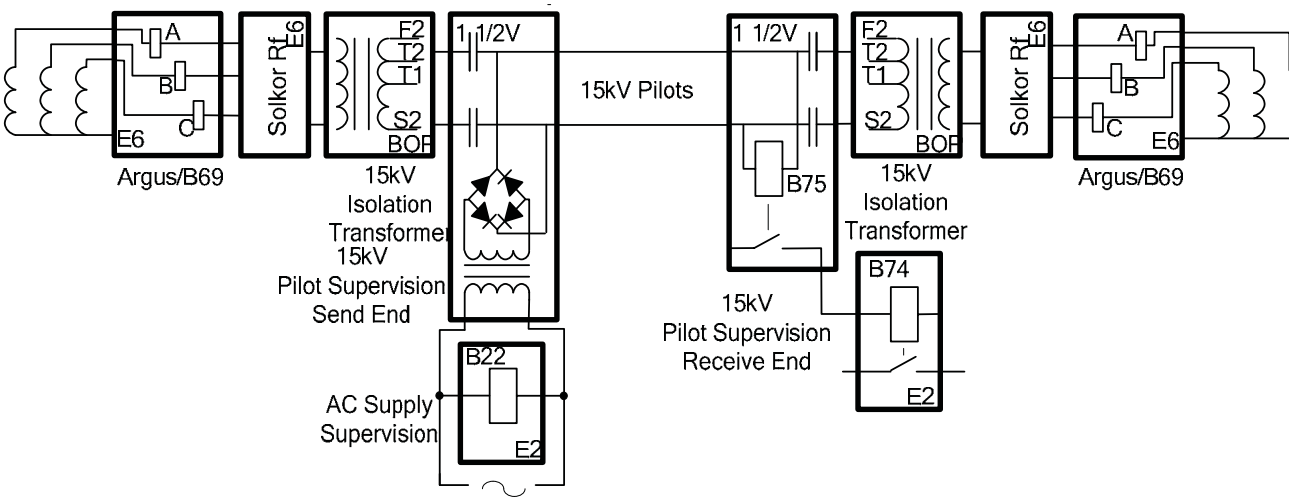


Fig 7. 15kV Solkor Rf with Pilot Supervision and Overcurrent Guard

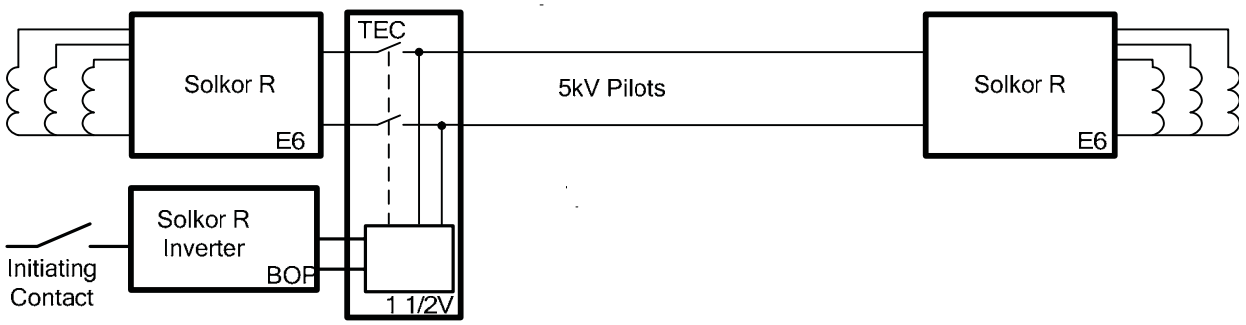


Fig 8. 5kV Solkor R Mode with One Way Injection Intertripping

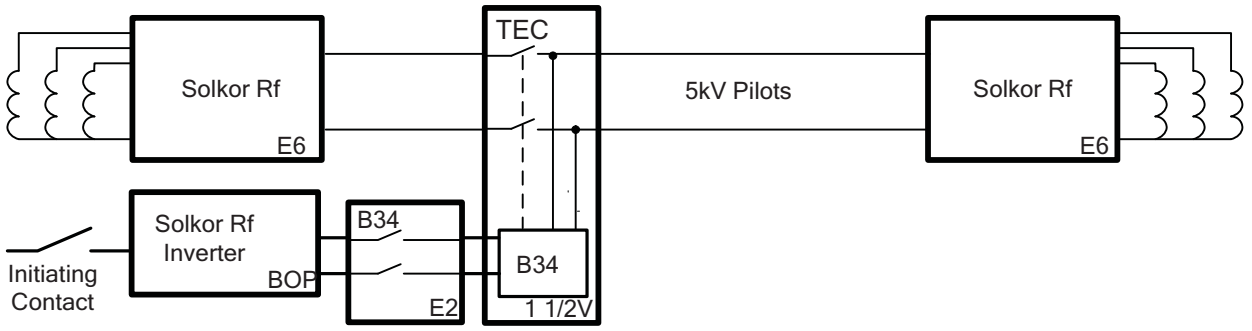


Fig 9. 5kV Solkor Rf Mode with One Way Injection Intertripping

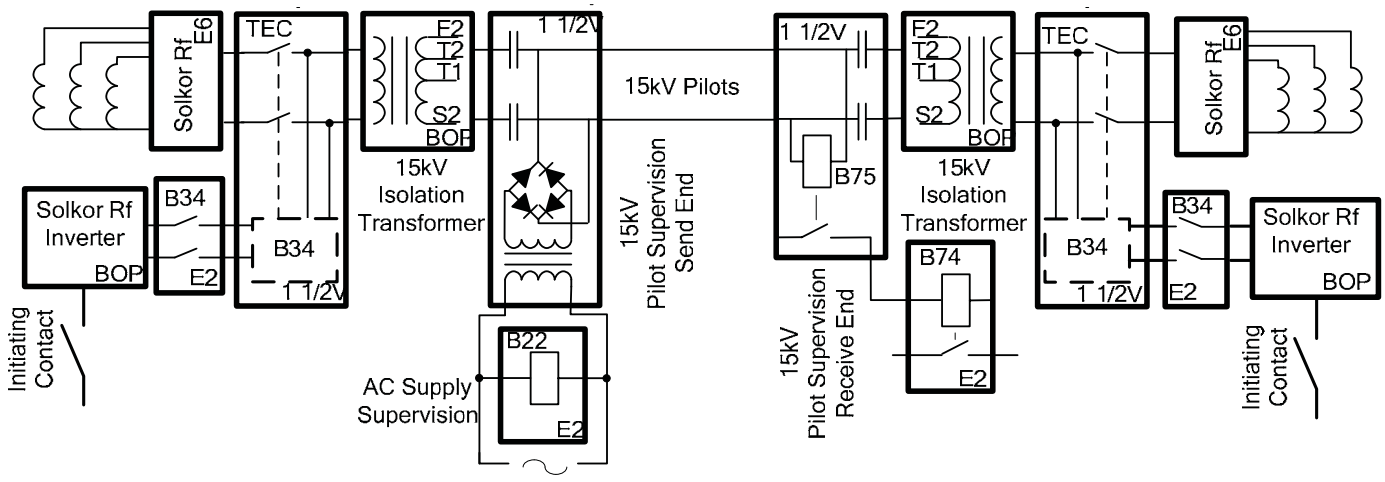


Fig 10. 15kV Solkor Rf with Pilot Supervision and 2 Way Injection Intertripping

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

Maximum through fault condition for stability 50x rated current

Thermal Withstand (AC current)	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 16A 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

Injection Intertripping

Rating Vx, 110-125V dc

Burden 1A at 125V dc full output
400mA with economy resistor

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)			
	Nominal		Typical		Nominal		Typical	
	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 nominal settings by up to 20%.

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

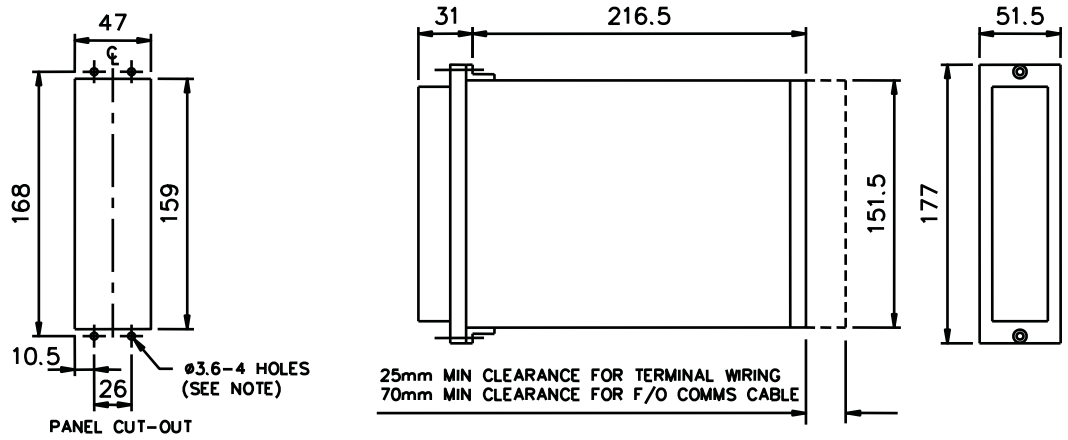


Fig 11. E2 Case

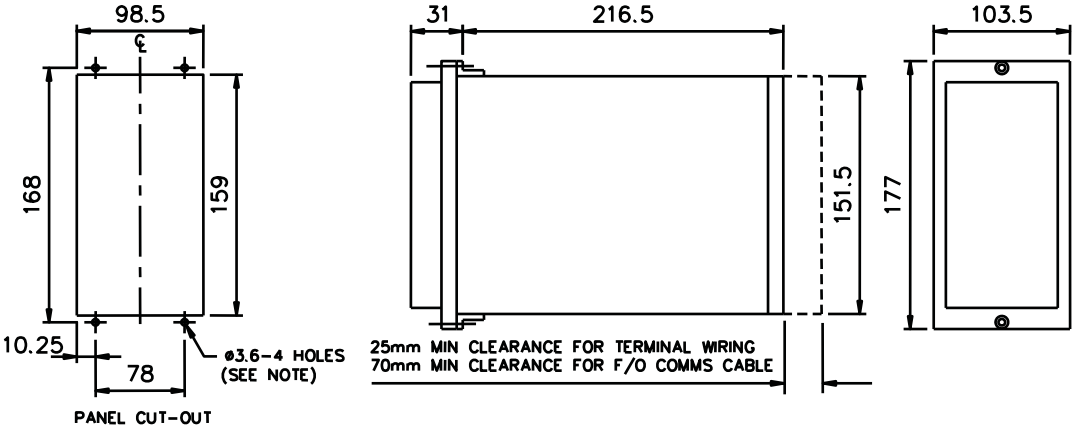


Fig 12. E4 Case

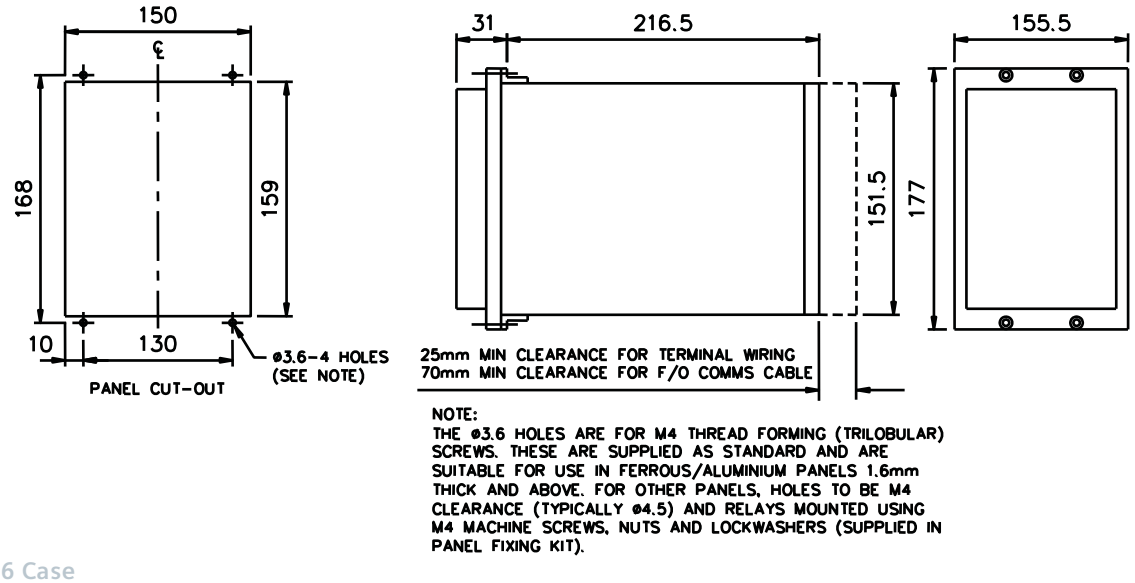


Fig 13. E6 Case

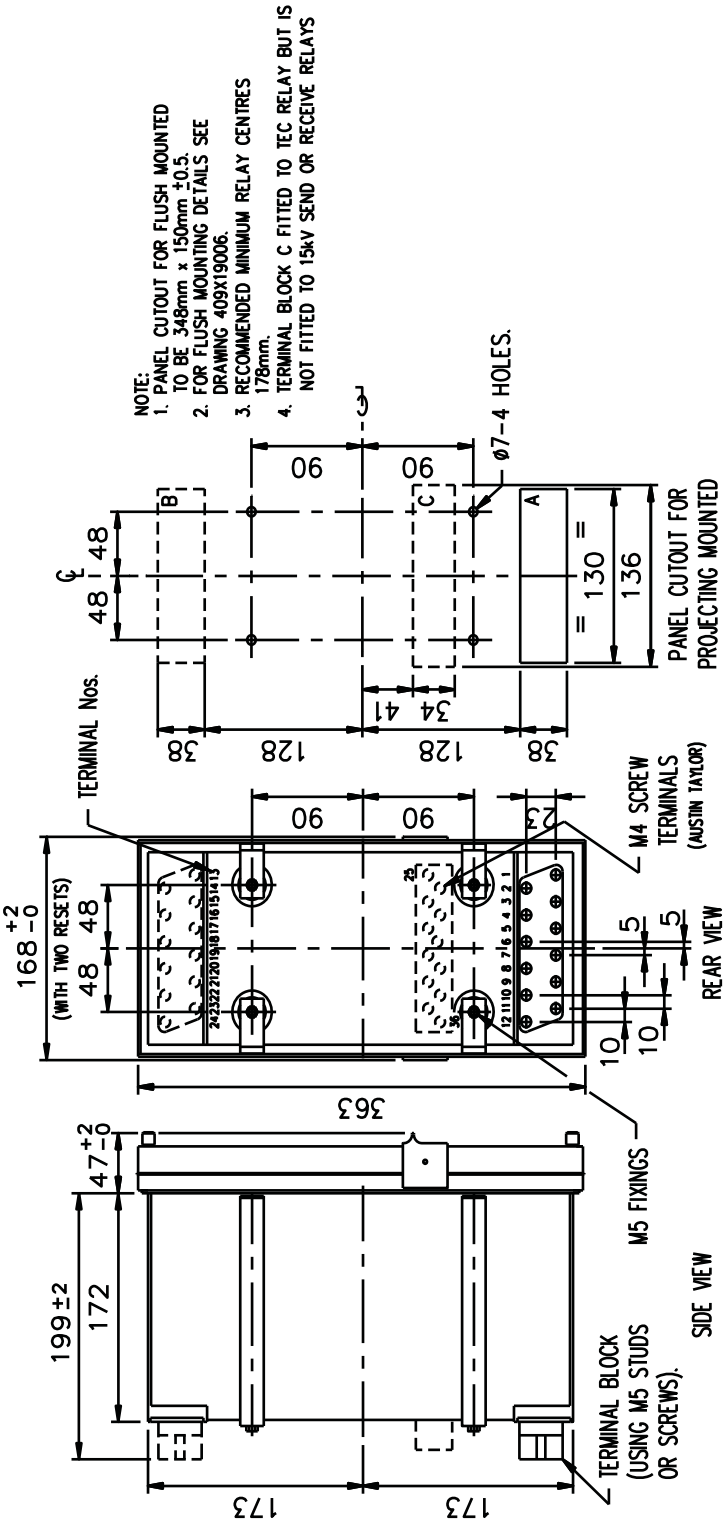
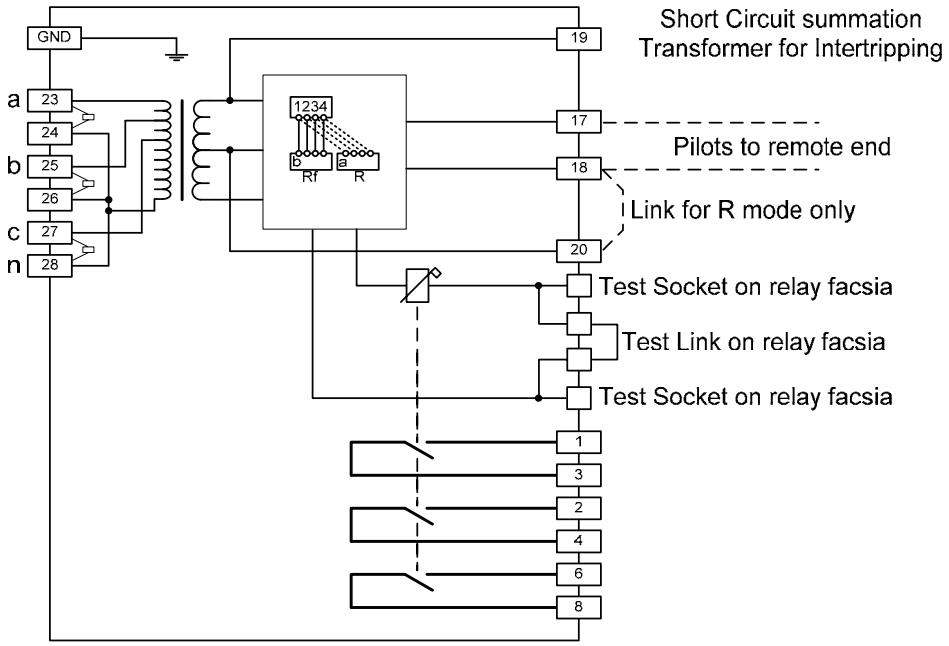


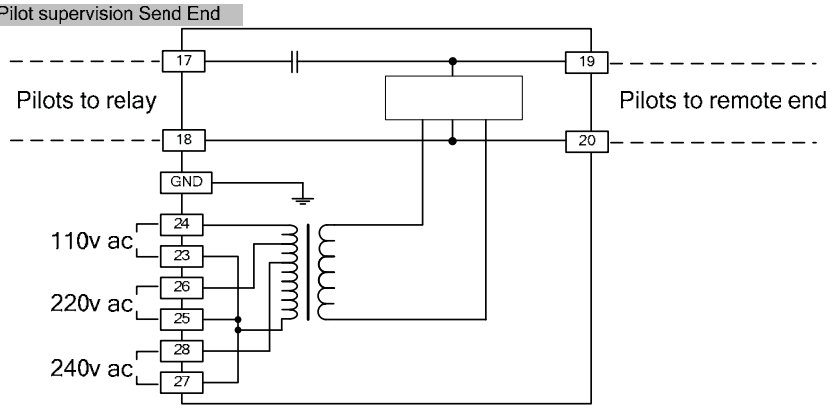
Fig 14. C11/2 Case

Connection Diagrams

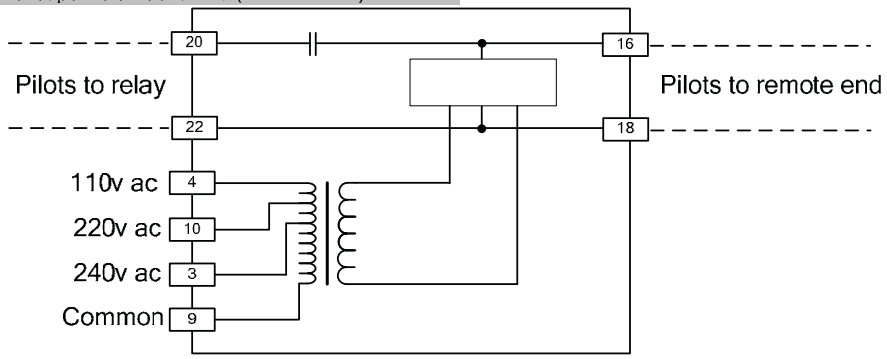
Solkor R/Rf



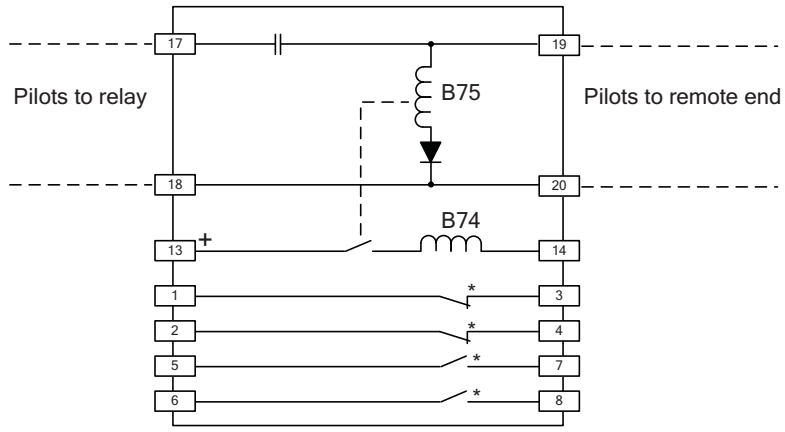
5kV Pilot supervision Send End



15kV Pilot supervision Send End (Vedette case)

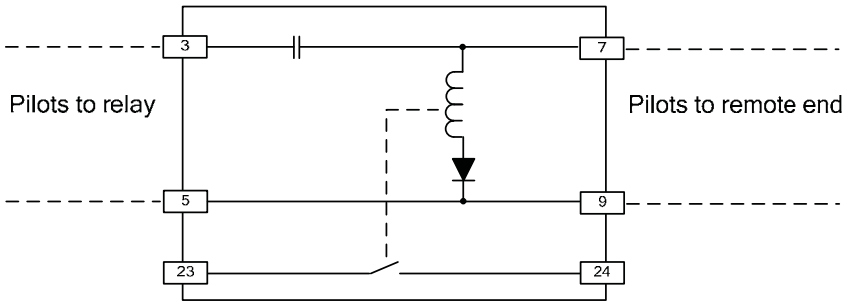


5kV Pilot Supervision Receive End

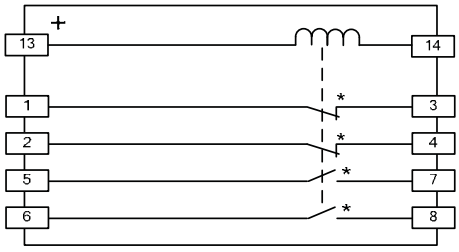


* contacts may be 2M2B as shown or 4M or 4B

15kV B75 Pilot Supervision Receive Relay

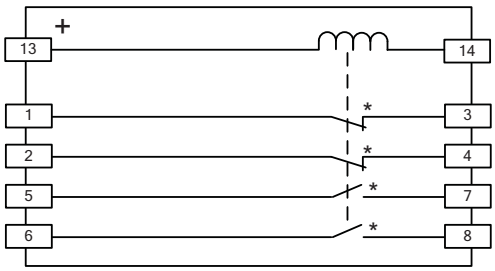


B74 Repeat Relay for 15kV Pilot Supervision Scheme



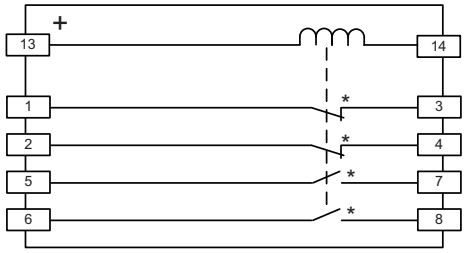
* contacts may be 2M2B as shown or 4M or 4B

B22 Power Supply Supervision Relay for Pilot Supervision Scheme



* contacts may be 2M2B as shown or 4M or 4B

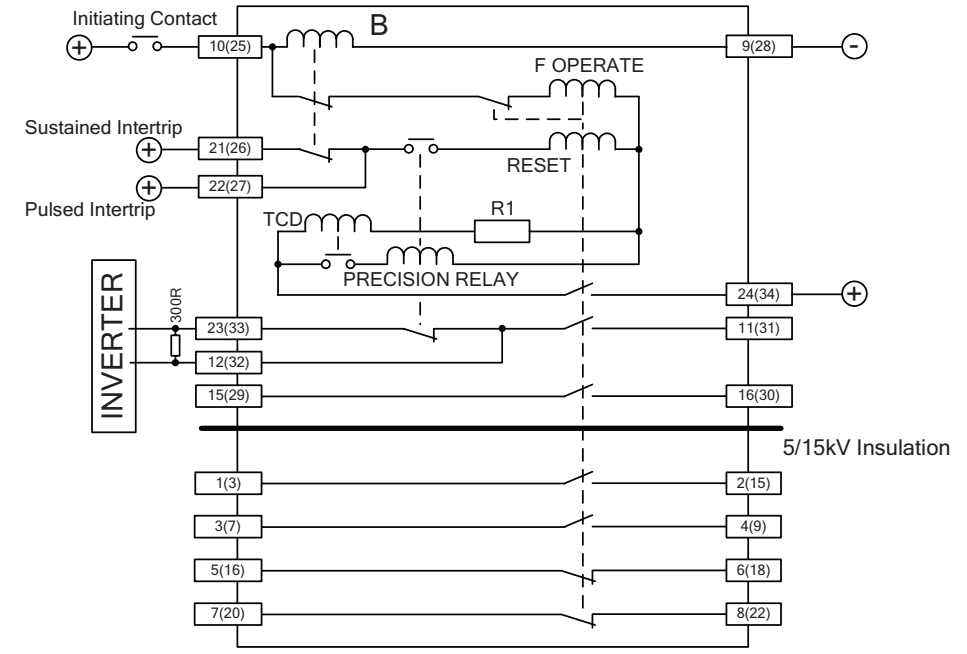
B34 Delayed Pick-up Relay for Solkor Rf Intertripping



* contacts may be 2M2B as shown or as below

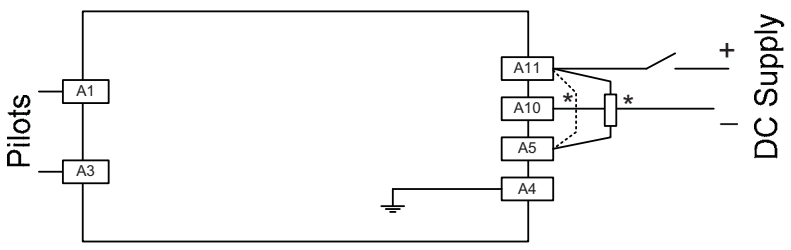
	1-3	2-4	5-7	6-8
4M	M	M	M	M
3M1B	M	B	M	M
2M2B	B	B	M	M
1M3B	B	B	M	B
0B	B	B	B	B

TEC Relay for Solkor Rf 2 stage Intertripping



Terminal numbers are shown as 5kV(15kV)

Inverter for Injection Intertripping



* Wire link required between A5 to A11 for pulsed intertrip.
300ohm, >18W Economy resistor required between A5 * A11 for sustained Intertrip

Ordering Information - Solkor R/Rf 7PG21

Product description	Variants	Order No.
Solkor R/Rf Pilot wire current differential feeder protection.		**7 P G 2 1 □ □ - □ □ □ □ □ - □ □ □ 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.		**7 P G 2 1 □ □ - 0 A A 0 0 - 0 □ A 0**
	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 For use with Solkor R/Rf relay, pilot supervision send end.		**7 P G 2 1 □ 0 - 0 A A 0 0 - □ □ □ 0**
	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 15kV 15kV, front connection	1 2 3
	Housing size Case size E4 (4U high) Case size C1 1/2 Vedette	C W
	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*.

[3]) For optional guard relay B69, one 3 phase set (two sets required one at each feeder end), see 7PG217*.

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
B22-AC For use with Solkor R/Rf relay, pilot supervision send end.		**7 P G 2 1 □ □ - □ □ □ □ □ - □ □ □ 0**
	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 60Hz	1 2
	Housing size Case size E2 (4U high)	A
	Voltage rating 110V AC 220V AC 240V AC	A B 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 2 NO 4 NO	**A E** **C C** **E A**
	Contact arrangement NC 0 NC 2 NC 4 NC	**A** **C** **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 30V DC 50V DC 125V DC 240V DC	**A** **B** **C** **E** **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).		7 P G 2 1 □ □ - □ □ □ □ □ - □ □ □ 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 15kV, front connection	2 3
	Housing size Case size C1 1/2 Vedette	W
	Current setting 3mA	A

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
B74 For use with Solkor R/Rf relay, pilot supervision receive end (15kV).		**7 P G 2 1 □ □ - □ □ □ □ □ - □ □ □ 0**
	Relay type Receive repeat (B74)	6
	Type of flag Self reset reverse acting flag	4
	Contact operation Self reset contacts	1
	Contact arrangement – NO 2 NO	C
	Contact arrangement NC 2 NO	C
	Number of contacts Four	4
	Contact type NO (Standard) / NC (Standard)	0
	Insulation level 15kV	2
	Housing size Case size E2 (4U high)	A
	Voltage rating 24V DC 30V DC 50V DC 125V DC 240V DC	A B C E F

Ordering Information – Solkor Pilot Supervision 7PG21

Product description	Variants	Order No.
B69 For use with Solkor R/Rf relay as overcurrent/earth fault guard.		**7 P G 2 1 □ □ - □ □ □ □ □ - □ □ □ 0**
	Relay type Three pole overcurrent/earth fault guard (B69) (3P O/C or 2P O/C+E/F)	7
	Type of flag No flag	0
	Contact operation Self reset contacts	1
	Contact arrangement – NO 2 NO	C
	Contact arrangement NC 0 NC	A
	Number of contacts Two	2
	Contact type NO (Standard) / NC (Standard)	0
	Current rating 1A 5A	1 2
	Housing size Case size E6 (4U high)	D
	Current setting Outer elements 50-200%, Inner element 50-200% Outer elements 50-200%, Inner element 10-40% Outer elements 50-200%, Inner element 20-80%	A B C

[1]) Optional B69 Guard relays, one 3 phase set. (Two sets required one at each feeder end)

Ordering Information – Solkor Injection Intertripping 7PG21

Product description	Variants	Order No.
Inverter		7 P G 2 1 □ □ - 0 A A 0 0 - □ □ □ 0
Injection intertripping equipment for intertripping of remote Solkor R/Rf relays over pilot wires.	Relay type SOLKOR injection intertripping (Inverter)	8
	Injection intertripping equipment [2] Inverter DC - Solkor R Inverter AC - Solkor Rf	 1 2
	Insulation level 15kV	2
	Housing size Special	A
	Voltage rating 125V DC	E
B34		7 P G 2 1 □ □ - □ □ □ □ □ - □ □ □ 0
Injection intertripping equipment for intertripping of remote Solkor Rf relays over pilot wires.	Relay type [3] Solkor Rf injection intertripping (Delay)	8
	Injection intertripping equipment B34	3
	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
	Insulation level 5kV	1
	Housing size Case size E2 (4U high)	A
	Voltage rating 24V DC 30V DC 50V DC 60V DC 125V DC 240V DC	 A B C D E F

[1] For Solkor Injection Intertripping Send relay, select suitable TEC relay, see 7PG223*

[2] 'Inverter DC Solkor R' can be used as a 15kV isolated DC supply for surge proof intertripping

[3] Option selection for B34 (5kV) delay relay, required on Solkor Rf schemes

Ordering Information – TEC 7PG22

Product description	Variants	Order No.
TEC		**7 P G 2 2 □ □ - □ □ □ □ □ - □ □ □ 0**
Intertrip send relay.		
	Relay type	
	TEC - Intertrip send	3
	Model Type	
	Pulse or sustained intertrip	1
	Two stage intertrip	2
	Type of Flag	
	Hand reset flag	1
	Contact arrangement – NO	
	4 NO	E
	Contact arrangement NC	
	2 NC	C
	Number of contacts	
	Six	6
	Contact type [1]	
	NO (Standard) / NC (Standard)	0
	Insulation level	
	5kV	1
	15kV	2
	Housing size	
	Case size C1 1/2 Vedette	W
	Rating	
	24V DC	A
	30V DC	B
	50V DC	C
	60V DC	D
	125V DC	E
	240V DC	F

[1] 2 NO with standard 2kV insulation, 2 NO and 2 NC with 5kV or 15kV (option 13) insulation

Reyrolle
Protection
Devices

7SG18 Solkor N

Current Differential Protection

Answers for energy

SIEMENS

7SG18 Solkor N

Current Differential Protection

Description

The Solkor technique of current differential protection was developed by Reyrolle over 50 years ago, and has formed an important part of the product range ever since. It has now progressed into a microprocessor controlled, differential feeder
protection system providing complete protection for overhead lines and cable feeders.

Function Overview

- Three pole, current differential protection with two stage bias characteristic.
- Intertripping from internal or external initiation.
- Three pole, phase fault overcurrent protection - IDMTL or DTL with highsets.
- Earth fault overcurrent protection - IDMTL or DTL with highsets.
- Overcurrent protection can be configured to operate as guard and/or back-up in case of communications failure.
- Communication loop-back test modes.
- Communication link supervision.
- Trip circuit supervision.
- Circuit breaker fail protection.
- Selectable 1A / 5A current inputs.
- Ratio correction for mis-matched line current transformer ratios.
- Ability to invert current inputs to facilitate commissioning.
- Seven user-programmable output contacts.
- Up to nine user programmable status inputs with pick-up and drop-off timers.
- End to End communications via electrical or Fibre Optic channels.

Monitoring Functions

Analogue values can be displayed in primary or secondary quantities on the LCD screen. In addition the values can be obtained via the communications port.

- Local and remote end primary ammeters
- Local and remote end secondary ammeters
- Differential currents (secondary values)
- Differential starters
- Protection signalling link status
- General alarms
- Output contacts
- Status inputs
- Trip circuit healthy/failure
- Trip counter
- I^2 summation
- Number of waveform and event records stored
- Time and Date
- Starters
- Power on counter

Data Storage and Communication

Serial communications conform to IEC60870-5-103 or Modbus RTU protocol. Up to 254 relays may be connected in a ring network and addressed individually.
A fibre-optic communications port is provided on the rear of the relay. It is optimised for 62.5/125µm glass fibre using ST® (BFOC/2.5) bayonet connectors. Optionally an RS485 electrical connector can be provided.

Indication

LEDs for

PROTECTION HEALTHY (Green)
INTERTRIP (Red) – an intertrip has been received
I>Is (Yellow) – any function detects current above setting
TRIP (Red) – the relay has issued a trip signal
SIGNAL HEALTHY (Green) – the signalling link is healthy

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

Fault records

The last 5 fault records are available from the relay fascia with time and date of trip, measured quantities and type of fault.

Disturbance recorder

The waveform recorder may be triggered from a protection function or external input and has a configurable pre-fault trigger. Up to 5 fault waveforms may be stored.
AC current waveforms are stored together with the digital states of the status inputs and output relays.

Reydisp Evolution

Reydisp Evolution is common to the entire range of Reyrolle numeric products. It provides the means for the user to apply settings, interrogate settings, retrieve events and disturbance waveforms from the relay.

Description of Functionality

Current Differential Protection

The relay compares magnitude and phase angle 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.

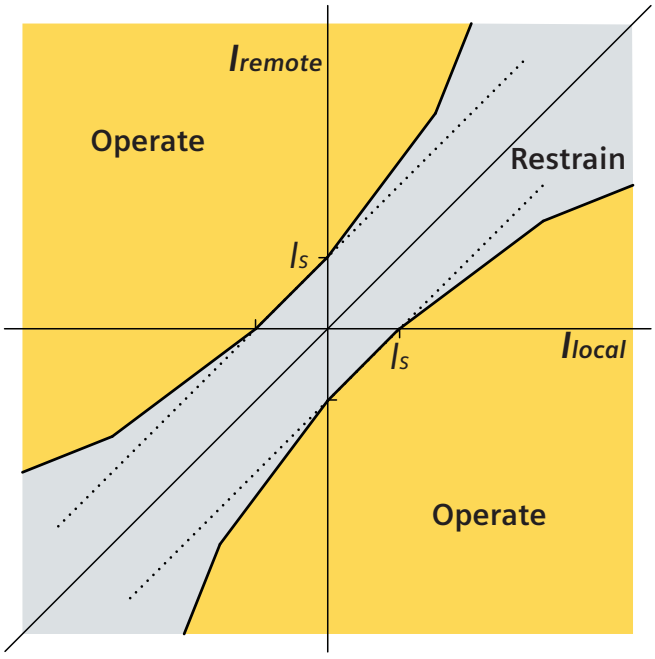


Fig 1. Differential Protection Operating Characteristic

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

To add security to the differential scheme it is possible to designate any of the overcurrent elements as a guard element. The appropriate overcurrent element must then operate to allow the differential element to trip.

Intertripping

Three auxiliary signalling channels are provided for intertripping.
One internal intertrip dedicated to the differential protection. Two independent intertrips which can be used for either direct or permissive intertripping from an 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 intertrip 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 Channels

Four types of protection signalling channel are provided as follows:

- RS485 level electrical link for distances up to 2km.
- Short range optical link for distances up to 15km (typical) using multimode fibres.
- Long range optical link for distances up to 49km (typical) using single mode fibres.
- RS232 link to external modem for electrical link up to 10km

Fibre optic signaling interface connections are BFOC/2.5 (ST®) bayonet style connectors.
The RS485 signalling interface uses screw terminals to suit 3/32" flat blade terminals.
RS232 signalling interface for connection to the external pilot wire modem uses a male 9 pin D-type connector to suit the female connector on the end of the 1.9m long cable supplied with the pilot wire modem.

Continuous protection signalling link supervision is provided. Two test modes 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.

The relay will automatically account for propagation delays in the signalling channel up to a maximum of 9.5ms. For delays in excess of 9.5ms a manual offset can

be applied, with the actual delay falling within a 9.5ms window centred on the offset.

Trip Circuit Supervision

The trip circuit is monitored by a status input with the circuit breaker in both the open and closed position. This is linked to an alarm and may be configured to operate an output relay.

Circuit breaker Fail

The circuit breaker fail function may be triggered by a trip signal issued from the relay or from an external device. It operates by monitoring the line current following a trip signal and issues an alarm if the current does not stop within a specified time interval. This alarm can be used to operate an output contact to backtrip an upstream circuit breaker. A further time delay enables another backtrip stage.

Circuit Breaker Maintenance

A circuit breaker operations counters 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.

Technical Data

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

Inputs and Outputs

Characteristic energising quantity

AC Current	Frequency
1A / 5A	50 / 60Hz

Current Inputs: Burdens

5A Phase/Earth	< 0.2VA
1A Phase/Earth	< 0.05VA

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	
	1A Input	5A Input
3 Second	57.7A	230A
2 Second	70.7A	282A
1 Second	100A	400A
I Cycle	700A	2500A

DC Auxiliary supply

Rated DC Voltage	Operating Range V dc
24/30/48V	18 to 60V
110/220V	88 to 280V

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

DC status input

Nominal voltage	Operating range
30V	18 - 37.5 V D C
48V	37.5 - 60 V D C
110V	87.5 - 137.5 V D C
220V	175 - 280 V D C

Attribute	Value
Min. DC Current for Operation: 30/48V 110/220V	 10mA <5mA
Reset/Operate voltage ratio	≥ 90 %
Typical response time	5 ms
Typical response time when programmed to energise an output relay contact	< 15 ms
Recommended Minimum pulse duration	40ms with setting of 20ms PU delay for a.c. rejection

For relays to ES148-4 standard and 110/125 or 220/250 volt DC working a 48 volt status input is supplied for use with external dropper resistors:

Nominal Voltage	Resistor Value	Wattage
110V	2k7 ± 5%	2.5 W
220 V	8k2 ± 5%	6.0 W

Each status input has associated timers which can be programmed to give time delayed pick-up and time delayed drop-off. These timers have default settings of 20ms, thus providing rejection and immunity to an AC input signal.
Status inputs will not respond to the following:-
250V RMS 50/60Hz applied for two seconds through a 0.1μF capacitor.
Discharge of a 10μF capacitor charged to maximum DC auxiliary supply voltage.
The status inputs with nominal voltage of 30 V to 54 V meet the requirements of ESI 48-4 ESI 1.

Low Burden Status Inputs

Optionally, low burden status inputs are available directly rated for 110/125Vd.c. or 220/250Vd.c. without dropper resistors. These inputs do not meet the ESI 48-4 ESI 1 requirements. Where necessary a single external resistor in parallel can be fitted to meet ESI 48-4 ESI 1 requirements.

Low Burden Status Input performance

Nominal	Operating Range	Typical burden
110, 125	87.5 to 137.5 V DC	1.75 to 3.0 mA
220, 250	175 to 280V DC	1.75 to 3.0 mA

110/125 V minimum pick-up voltage typically 50 – 60 V d.c.
220/250 V minimum pick-up voltage typically 100 – 120 V d.c.

Output relays

Carry continuously	5A ac or dc
Make and carry (L/R ≤ 40 ms and V ≤ 300V)	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
Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5 Watt minimum of 10mA or 5V

Mechanical

Vibration (Sinusoidal)

IEC 60255-21-1 Class I

Vibration response	0.5gn
Vibration endurance	1.0gn

Shock and Bump

IEC 60255-21-2 Class I

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

Seismic

IEC 60255-21-3 Class I

Seismic Response	1gn

Mechanical Classification

Durability	In excess of 10^6 operations

Electrical Tests

Insulation

IEC 60255-5 rms levels for 1 minute

Between all terminals and earth for 1 minute	2.0 kV rms
Between independent circuits for 1 minute	2.0 kV rms
Across normally open contacts for 1 minute	1.0 kV rms

Transient overvoltage

IEC 60255-5

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

High frequency disturbance

IEC 60255-22-1 class III

2.5kV longitudinal mode 1.0kV transverse mode	< 3% deviation

Electrostatic Discharge

IEC 60255-22-2 class III

8kV, Contact discharge	≤ 5% variation

Radio frequency interference

IEC60255-22-3

10 V/m, 80 to 1000 MHz	≤ 5% variation

Fast transient

IEC 60255-22-4 class IV

4kV, 5/50ns, 2.5 kHz, repetitive	≤ 3% variation

Conducted RFI

IEC 60255-22-6 class IV

10 V, 0.15 to 80 MHz	≤ 5% variation

Conducted Limits

IEC 60255-25

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

Radiated Limits

IEC 60255-25

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

Environmental

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% RH

Protection Elements

General Accuracy

Reference Conditions		
General	IEC 60255-3	
Current settings	100% of In	
Current input	IDMTL: 2 to 30 xIs	
	DTL: 5 xIs	
Auxiliary supply	Nominal	
Frequency	50 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.

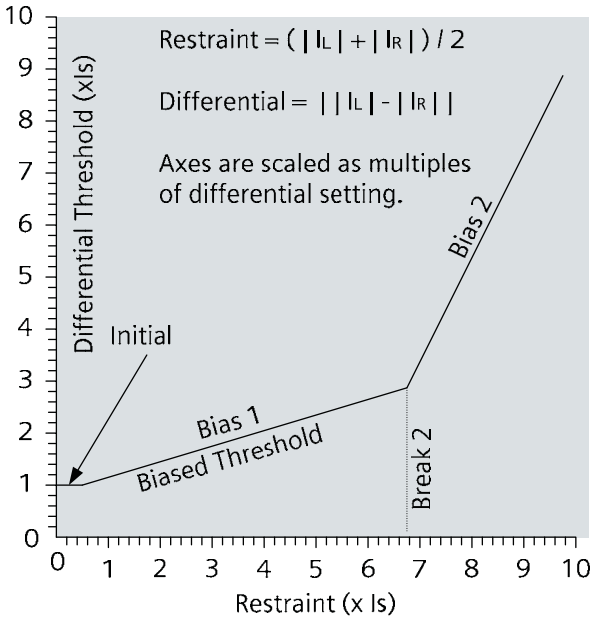
Accuracy Influencing Factors

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	
Phase setting	Phase setting
Phase bias 1	Phase bias 1
Phase bias 2	Phase bias 2

The Magnitude and Angle of the currents are compared in separate comparators. Typical operating threshold characteristics are shown below



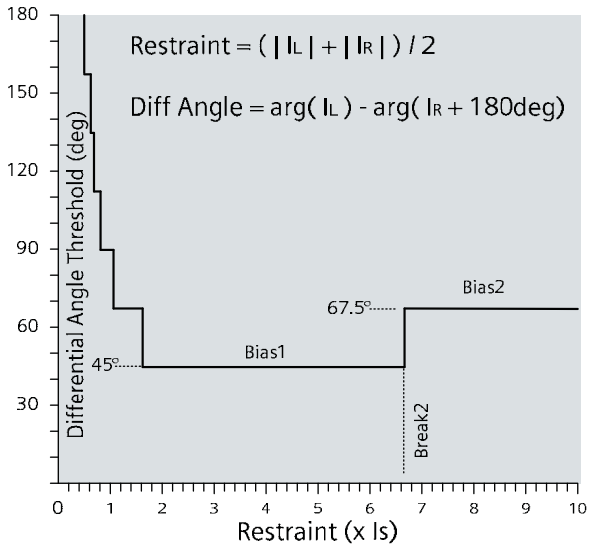


Fig 2. Differential Protection Operating Characteristic

The error limits on these diagrams are as follows:

Operate Levels	
Differential Magnitude – Initial Threshold	± 10% or ± 10mA
Differential Magnitude – Biased Threshold (At low levels)	Biased threshold ±(10% of Restraint) or ± 10mA For Restraint <1.6Is +ve limit – Biased threshold + 10% or +10mA -ve limit – Initial threshold - 10% or -10mA
Differential Comparator Angle Threshold	± 5°

Differential and Intertrip operate times are given by:

t = t0 +td

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

The base operating time depends on the communications bit rate.

Operate Times	
Differential base operate time (Idiff > 10 Is)	≤ 40ms (38400 baud) ≤ 50ms (19200 baud)
Differential Delay Time	± 1% or ± 10ms

Overcurrent protection

Characteristic	
Setting	IEC Normal Inverse (NI) IEC Very Inverse (VI) IEC Extremely Inverse (EI) IEC Long Time Inverse,(LTI) DTL
No. of elements	1
Level	
Setting Range Is	0.1, 0.15...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...1.6
Accuracy	± 5% or ± 30 ms
Repeatability	± 1% or ± 5 ms
DTL Delay	
Setting	0.00 to 20.00 sec
Accuracy	± 10ms
Repeatability	± 5 ms
Reset delay	
Setting	0 to 60 sec
Accuracy	± 1% or ± 10ms
Repeatability	± 1% or ± 5 ms

DTL	
No. of elements	3
Level	
Setting Range Is	0.1 to 52.5 x In
Accuracy	Operate: 100% Is, ±5% or, ±10mA
	Reset ≥ 95% of operate current
Repeatability	± 1%
DTL Delay	
Setting	0.00 to 20.00 sec
Accuracy	± 5ms
Repeatability	± 1% or ± 5 ms

Earth fault protection

As overcurrent protection.

Circuit breaker failure (50BF)

Operate Level	
Phase Fault setting Is	Off, 0.1, 0.15 ... 1.0 xIn
Earth Fault setting Is	Off, 0.1, 0.15 ... 1.0 xIn
Accuracy	Operate: 100% Is, ±5% or ±1%xIn
	Reset 95% of I_{OP} ±5% or ±1%xIn
Repeatability	± 1%

Operate Time	
Characteristics	DTL
No. of elements	2
Setting	Re-trip 0.00 to 20.00 sec
	Back-trip 0.00 to 20.00 sec
Accuracy	± 5ms
Repeatability	± 1% or ± 5ms

Sample Specification

The feeder protection device shall integrate the following characteristics:
Microprocessor device
Current differential protection
Guard relay
Protection signalling supervision
Backup overcurrent protection
1A and 5A current inputs on same device
Trip circuit supervision
Circuit breaker fail detection

Current Differential Protection

The current differential protection shall perform magnitude and phase angle comparison of currents, on a phase-by-phase basis, although tripping shall be three-phase.
The protection shall be capable of compensating for different CTs at each end of the feeder.
The protection shall be stable for through faults at high fault levels when the line CTs saturate.

Backup Overcurrent Protection

The backup three-phase overcurrent protection shall provide an IDMTL element and 3 DTL elements that will provide back-up protection for the event of a communications link failure.

Guard Relays

It will be possible to add an overcurrent guard to the differential protection to add security to the scheme.

Intertripping

The protection shall provide an intertrip facility capable of the following, as selected on the relay:
a trip at the local end directly trips the circuit breaker at the remote end, or,
a trip at the local end removes the need for a guard operation at the remote end, allowing tripping with a weak infeed.
Two additional intertrip channels shall be provided which allow external devices to directly trip remote

Testing

Testing facilities shall be provided that allow
a single end to be tested in isolation,
both ends to be tested together to ensure integrity of the communications link, and,
both ends to be tested together to prove the directionality of the CTs

Signalling Channel

The protection shall use one of the following methods for signalling.
RS485 electrical link using twisted-pair cable
Optical-fibre link
Electrical twisted pair using external modem
Continuous supervision of the protection signalling link shall be provided. The protection shall be capable of operating with propagation delays in the signalling channel varying up to 9.5ms.

Trip Circuit Supervision

The protection shall monitor the trip circuit when the circuit breaker is in both the open and closed position.

Circuit Breaker Fail

The protection shall provide have the ability to issue a backtrip in the event of circuit breaker failure, detected by the continued presence of current, rather than circuit breaker auxiliary switch position.

Indications

The protection shall provide indication of the following:
Protection healthy
Intertrip received
Protection operating
Trip
Signalling channel healthy

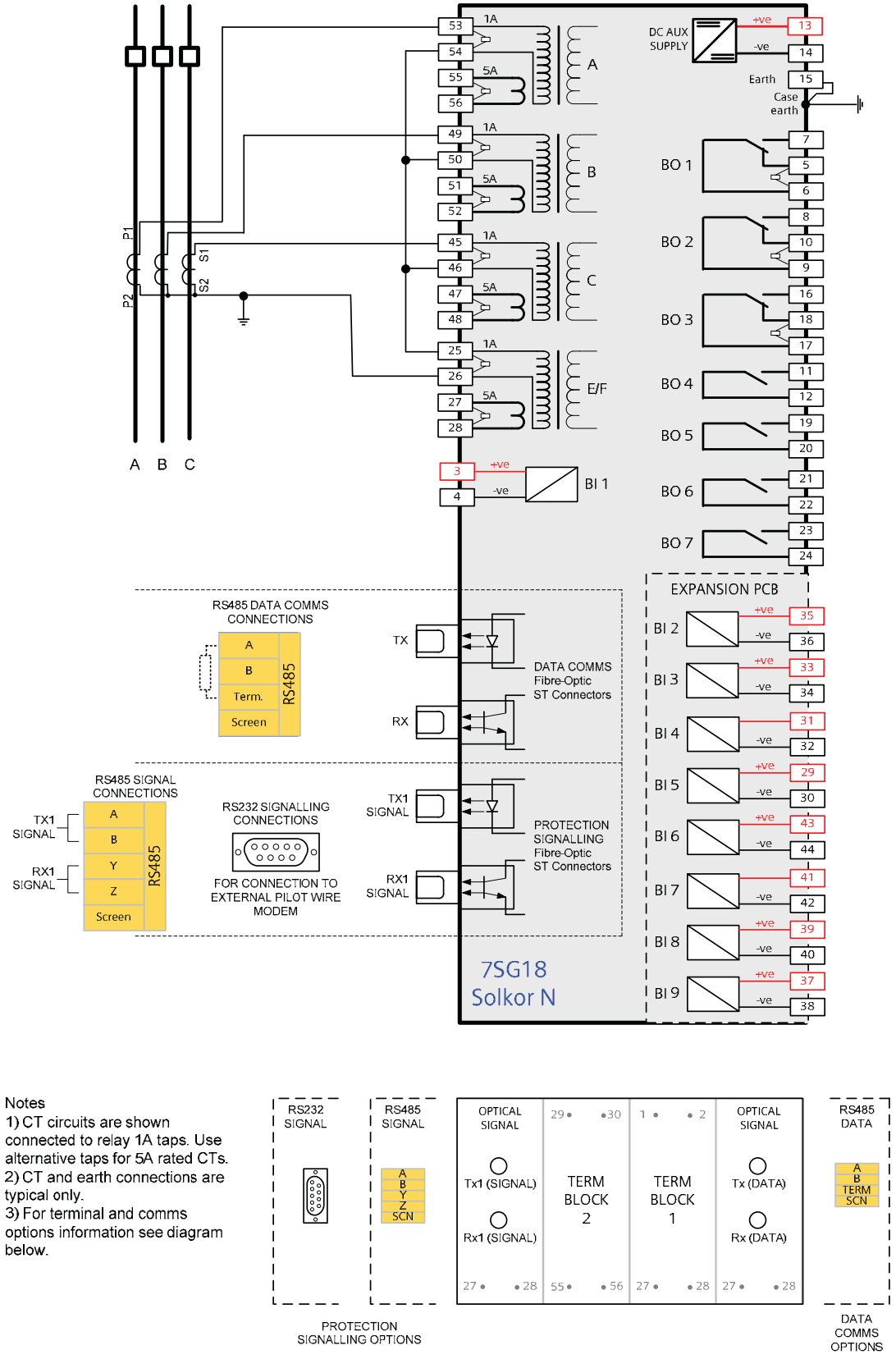
Metering

The device shall be capable of displaying the following measurements without user intervention:
Local and remote end primary currents
Local and remote end secondary currents
Differential primary currents

Disturbance Recorder

In the event of a trip the device shall record a disturbance record for a minimum of 1 second of the local and remote end currents, in primary amps.

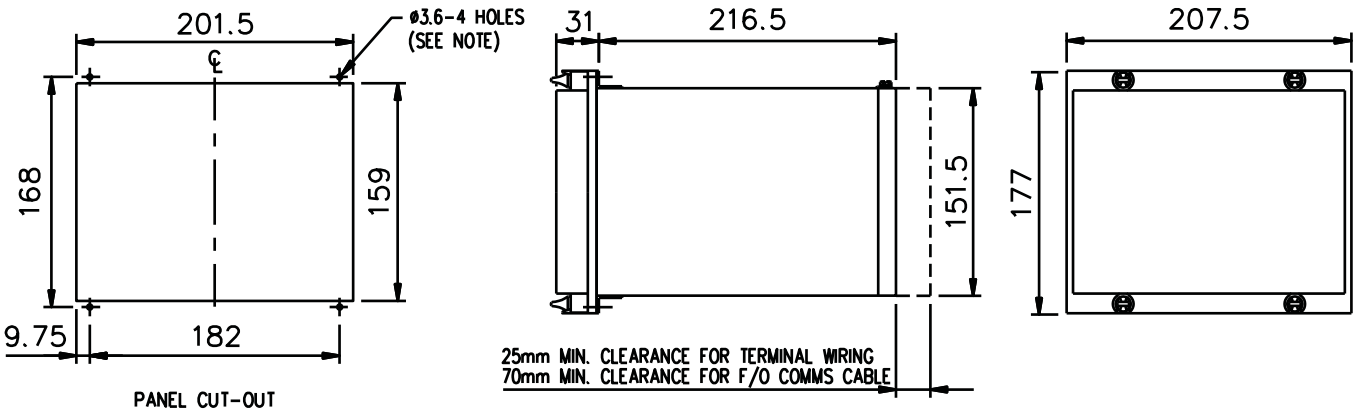
Connection Diagram



Notes
1) CT circuits are shown connected to relay 1A taps. Use alternative taps for 5A rated CTs.
2) CT and earth connections are typical only.
3) For terminal and comms options information see diagram below.

Fig 3. 7SG18 Connection Diagram

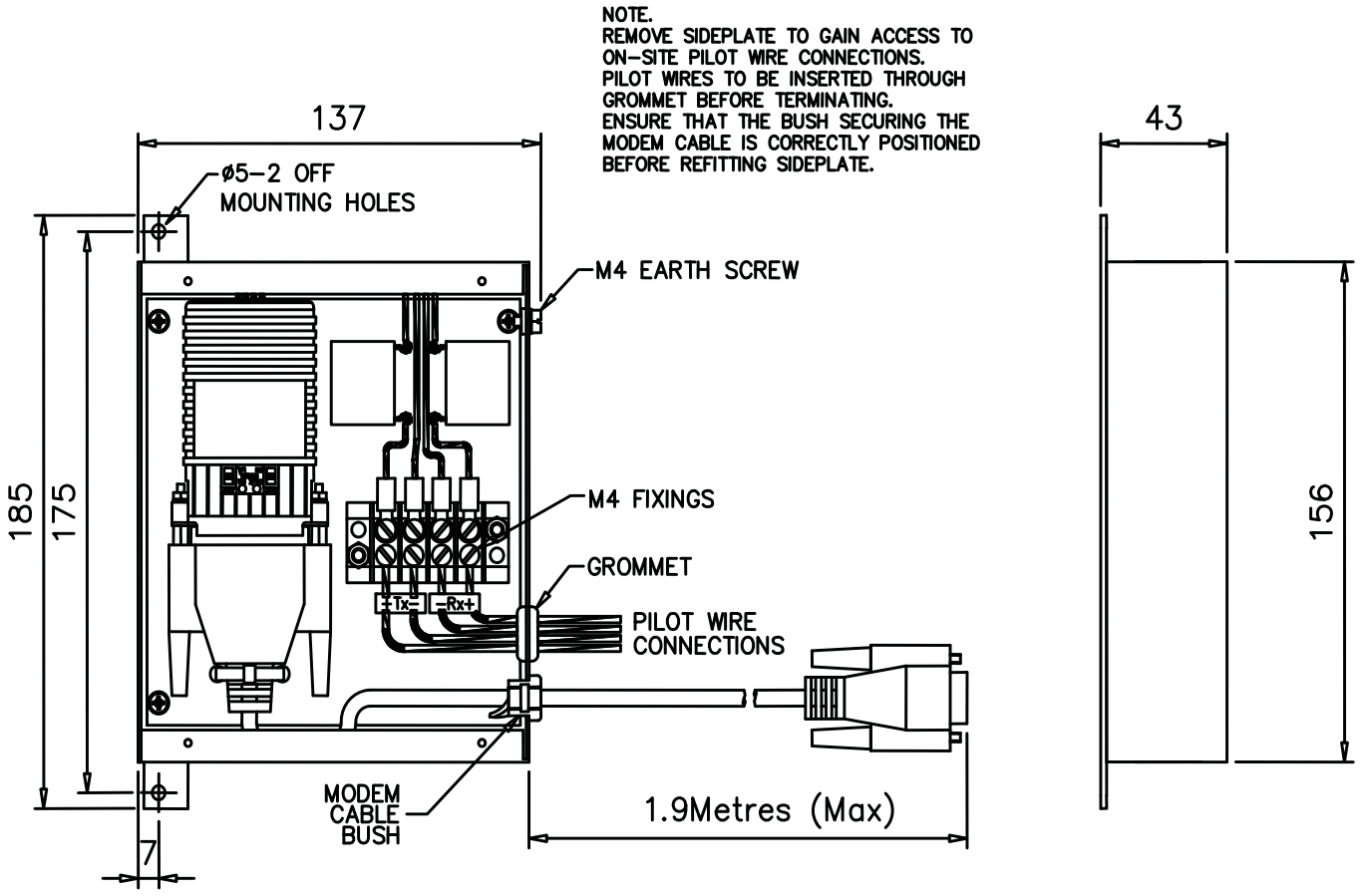
Case Dimensions



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).

Fig 4. E8 Case

Pilot Modem



OUTLINE, PANEL DRILLING & ON-SITE PILOT WIRE CONNECTIONS FOR SOLKOR N RS232 MODEM

Fig 5. Pilot Modem

Ordering Information – 7SG18 Solkor-N

Product description	Variants	Order No.
Solkor-N Line differential relay using direct fibre optic or metallic pilot wires for communication. Two terminal plain feeders only.		**7 S G 1 8 □ □ - □ □ □ □ □ - 0 □ □ 0**
	Relay type	
	Line differential	1
	Protection options	
	Basic functionality	1
	- 3-phase overcurrent (50/51) - Earth-fault overcurrent (50N/51N) - 3-Phase differential (with fixed settings) (87L) - Trip circuit supervision (74TC) - Circuit breaker fail (50BF) - CT supervision - External/Internal intertrip (96)	
	Basic functionality plus	3
	- Variable differential settings	
	Protection signalling channel type	
	RS485 electrical link (1200m)	1
	RS232 electrical to pilotwire link [2])	5
	1300nm optical fibre link (0-16km) [3])	6
	1300nm optical fibre link (49km) [3])	7
	Auxiliary supply /binary input voltage	
	24/30/48 V DC auxiliary, 30 V DC/AC binary input	A
	24/30/48 V DC auxiliary, 48 V DC/AC binary input	B
	110/220 V DC auxiliary, 48 V DC/AC binary input [1])	C
	110/220 V DC auxiliary, 110 V DC/AC binary input	D
	220 V DC auxiliary, 220 V DC/AC binary input	E
	I/O range	
	1 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	A
	9 Binary Inputs / 7 Binary Outputs (incl. 3 changeover)	C
	Frequency	
	50Hz	1
	Nominal current	
	1/ 5 A	0
	Housing size	
	Case size E8 (4U high)	E
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	B
	RS485 interface / IEC 60870-5-103 or Modbus RTU	C

[1]) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 1 binary input and 110 V application, order resistor box VCE:2512H10066 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 1 binary input and 220 V application, order resistor box VCE:2512H10068 in addition
for 9 binary inputs and 220 V application, order two resistor boxes 2512H10067 in addition

[2]) Pilot wire modem (up to 10km) with RS232 interface in BOP mounting case is available for use with these models, order 7XG1210-1AA00-0AA0.
Distance depends upon pilotwire parameters. Pilotwires must be screened twisted pair and two pairs are required for signalling

[3]) Fibre Optic communication requires a compatible pair of relays at both ends. If ordering for one end only please specify details of the other end, which may need to be upgraded to be compatible to the new delivery. Upgrade kits available under VCE:2646G10014K (0-16km) and VCE:2646G10010K (49km).

Reyrolle
Protection
Devices

7SG17 Rho 3

Motor Protection Relay

Answers for energy

SIEMENS

7SG17 Rho 3

Motor Protection Relay

Description

The 7SG17 Rho 3 is a multi-function numerical Motor Protection relay suitable for all types of a.c. induction motors up to the highest ratings available.
Whilst medium voltage 3-phase motors are very reliable and robust, modern designs operate much closer to the limits of thermal margins and to give adequate protection, sophisticated protection relays are required. In addition, increased industrial use of power electronics leads to corruption of power systems and unless specific equipment is installed to eliminate the corruption it can cause considerable rotor overheating. The relay has been designed to protect the motor against these phenomena as well as known abuses such as mechanical overload, stalling, single phasing, terminal box and cabling failures, and too frequent starts.
The relay can be set to accurately mimic both the heating and cooling characteristics of the protected motor and consequently ensure that the thermal withstand of the machine is not exceeded, at the same time allowing full use of the motors thermal capability.

Function Overview

- Advanced motor protection - for medium voltage motors
- Easily programmable settings and user interface
- Thermal overload and restart inhibit protection
- Stall and locked rotor protection
- Short circuit and earth fault protection
- Phase unbalance protection
- Undercurrent detection
- Limitation of number of starts
- Optional thermistor or resistance temperature detector (RTD) inputs
- Circuit breaker fail
- Trip circuit supervision
- CT supervision
- Earth fault trip inhibit for contactor control application
- Status inputs with programmable independent pickup and drop off timers.

User Interface

Indication

16 character x 2 line backlit LCD
Menu navigation keys
LEDs for TRIP, MOTOR STARTING, MOTOR RUNNING, STARTER and PROTECTION HEALTHY status.

Monitoring Functions

Monitored quantities can be displayed on the LCD screen or via the communications port. Monitored values include:-

- Primary/secondary currents
- Motor full load current
- PPS & NPS currents
- Thermal equivalent current
- Phase difference current
- Motor status (Stopped, running)
- Time to trip
- Time to start
- Thermal capacity used
- Total starts
- Last start time
- Last start current
- Motor run time
- Total run time
- Maximum demand/time
- Output relay status
- Status inputs
- Trip circuit healthy/failure
- Trip counters
- I^2 summation
- Number of waveform and event records stored
- Time and Date

Data Storage and Communication

Serial communications conform to IEC60870-5-103 or Modbus RTU protocol. Up to 254 relays may be connected in a ring network and addressed individually.
A fibre-optic communications port is provided on the rear of the relay. It is optimised for 62.5/125µm glass fibre using ST® (BFOC/2.5) bayonet connectors. Optionally an RS485 electrical connector can be provided.

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

Fault records

The last 5 fault records are available from the fascia with time and date of trip, measured quantities and type of fault.

Disturbance recorder

The waveform recorder may be triggered from a protection function or external input and has a configurable pre-fault trigger. Up to 5 fault waveforms may be stored.
AC voltage waveforms are stored together with the digital states of the binary inputs and output relays..

Reydisp evolution

Reydisp Evolution is common to the entire range of Reyrolle numeric products, providing means for the user to apply settings to the relay, interrogate settings and retrieve stored data records.
Reydisp evolution utilises IEC 60870-5-103 protocol.

Settings

Settings

Thermal (I_θ)	0.5 to 2.0 x In, Δ 0.05
NPS weight (K)	0.0 to 10.0, Δ 0.1
Heating time (t_h)	0.5 to 100.0mins, Δ 0.5
Starting constant (t_s)	0.5 to 1.5 x t_h , Δ 0.05
Cooling constant (t_c)	1 to 100 x t_h , Δ 1
Hot/cold ratio	OFF, 5 to 100%, Δ 5
Start current	1.5 to 10.0 x In, Δ 0.1
Stop current	0.05 to 0.2 x In, Δ 0.05
Stall delay 1&2	1 to 250 seconds, Δ 1
Phase fault	0.5 to 20.0 x In, Δ 0.1
Earth fault	0.01 to 1.00 x In, Δ 0.01
Earth fault inhibit	4.0 to 10.0 x In, Δ 0.1
Undercurrent	0.10 to 1.5 x In, Δ 0.05
Phase unbalance	Phase difference, NPS, OFF
Phase difference	0.05 to 0.40 x I_θ, Δ 0.05
Negative sequence	0.05 to 0.40 x I_θ, Δ 0.05
Time multiplier	0.025 to 2.0, Δ 0.025
Minimum op time	0.1 to 2.0 secs, Δ 0.1
Max. number of starts	OFF, 1 to 20, Δ 1
Starts period	1 to 60 mins, Δ 1
Start inhibit delay	1 to 60 mins, Δ 1
Min. time between starts	OFF, 1 to 60 mins, Δ 1
Temperature (optional)	OFF, 0 to 250°C, Δ 1(1)
	100 to 350W, Δ 1(2)
	100 to 1000W, Δ 10(3)
	1100 to 30000W, Δ 100(3)

(1) Named RTD setting range
(2) Other RTD setting range
(3) Thermistor setting range

Technical Data

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

Inputs and Outputs

Characteristic energising quantity

AC Current	Frequency
1A / 5A	50 / 60Hz

Current Inputs: Burdens

5A Phase	< 0.2VA
1A Phase	< 0.05VA
5A Earth	< 0.4VA
1A Earth	< 0.2VA

DC Auxiliary supply

Nominal voltage	Operating Range V dc
24/30/48V	18 to 60V
110/220V	88 to 280

Auxiliary supply: Burdens

Quiescent (Typical)	3 W
Maximum	10 W

DC status input

Nominal voltage	Operating range
30V	18 - 37.5 V D C
48V	37.5 - 60 V D C
110V	87.5 - 137.5 V D C
220V	175 - 280 V D C

For relays to ES148-4 standard and 110/125 or 220/250 volt DC working a 48 volt status input is supplied for use with external dropper resistors:

Nominal Voltage	Resistor Value	Wattage
110V	2k7 ± 5%	2.5 W
220 V	8k2 ± 5%	6.0 W

Output relays

7 programmable output relays are available, 3 of which have a c/o contact and the other 4 have a n/o contact.

Contact ratings

Carry continuously	5A AC or DC
Make and carry	30A AC or DC for 0.2 sec
Resistive break	75W DC, 1250VA A C

Mechanical

Vibration (Sinusoidal)

IEC 60255-21-1 Class I

Vibration response	0.5gn
Vibration endurance	1.0gn

Shock and Bump

IEC 60255-21-2 Class I

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

Seismic

IEC 60255-21-3 Class I

Seismic Response	1gn

Mechanical Classification

Durability	In excess of 10^6 operations

Weight

Rho 3	4.7kg
Rho 3+RTD	6.7kg

Electrical Tests

Insulation IEC 255-5

RMS levels for 1 minute

Between all terminals and earth for 1 minute	2.0 kV
Between independent circuits for 1 minute	2.0 kV
Across normally open contacts for 1 minute	1.0 kV

Transient overvoltage

IEC 255-4 class III

5kV 1.2/50µs 0.5J (terminals and earth)	No damage or flashover.

High frequency disturbance

IEC 255-22-1 class III

2.5kV common mode	≤ 3% deviation
1.0kV series mode	≤ 3% deviation

Electrostatic Discharge

IEC 255-22-2 class III

8kV contact discharge	≤ 5% deviation

Radio frequency disturbance

IEC 255-22-3

20MHz to 1GHz, 10V/m	≤ 5% deviation

Fast transient

IEC 255-22-4 class IV

4kV 5/50ns 2.5kHz repetitive	≤ 3% deviation

Environmental

Temperature

IEC 68-2-1/2

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

Humidity

IEC 68-2-3

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

Case Dimensions

The 7SG17 is supplied in either a size 6 or size 8 case, depending on the binary input, RTD input and output relay requirement.

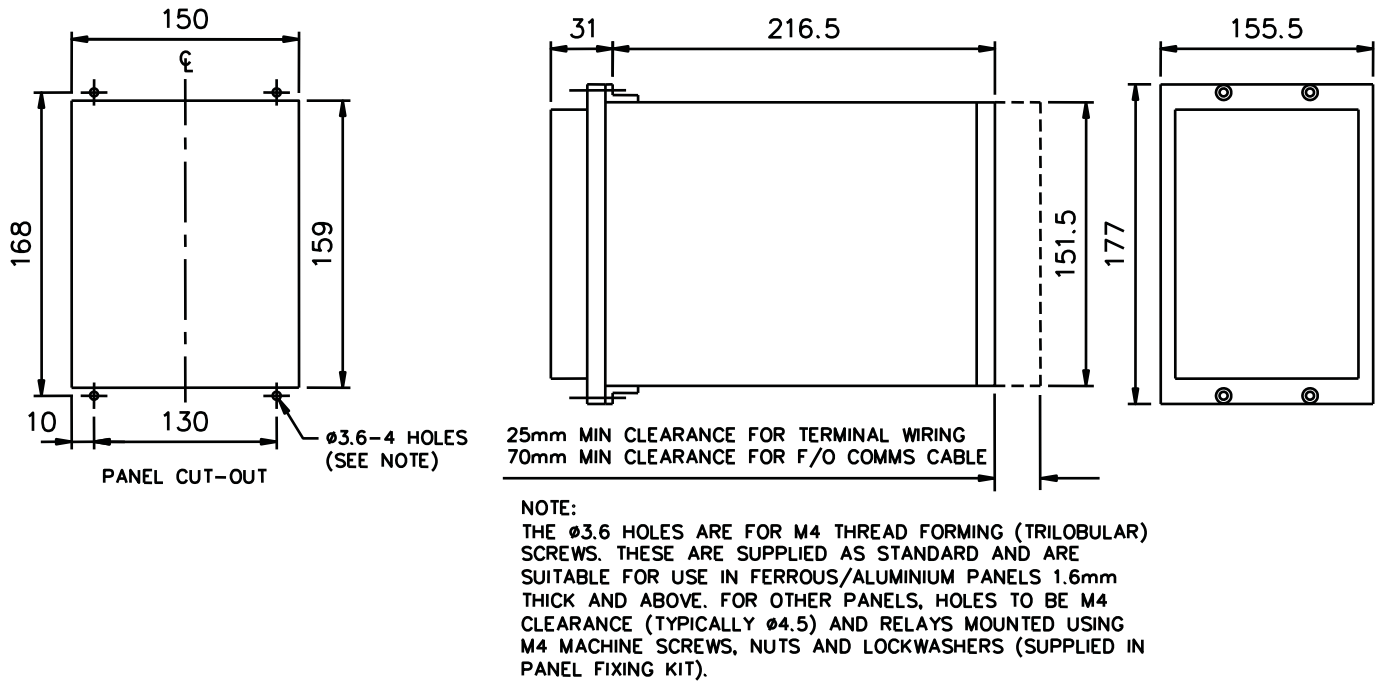


Fig 1. E6 Case Dimensions

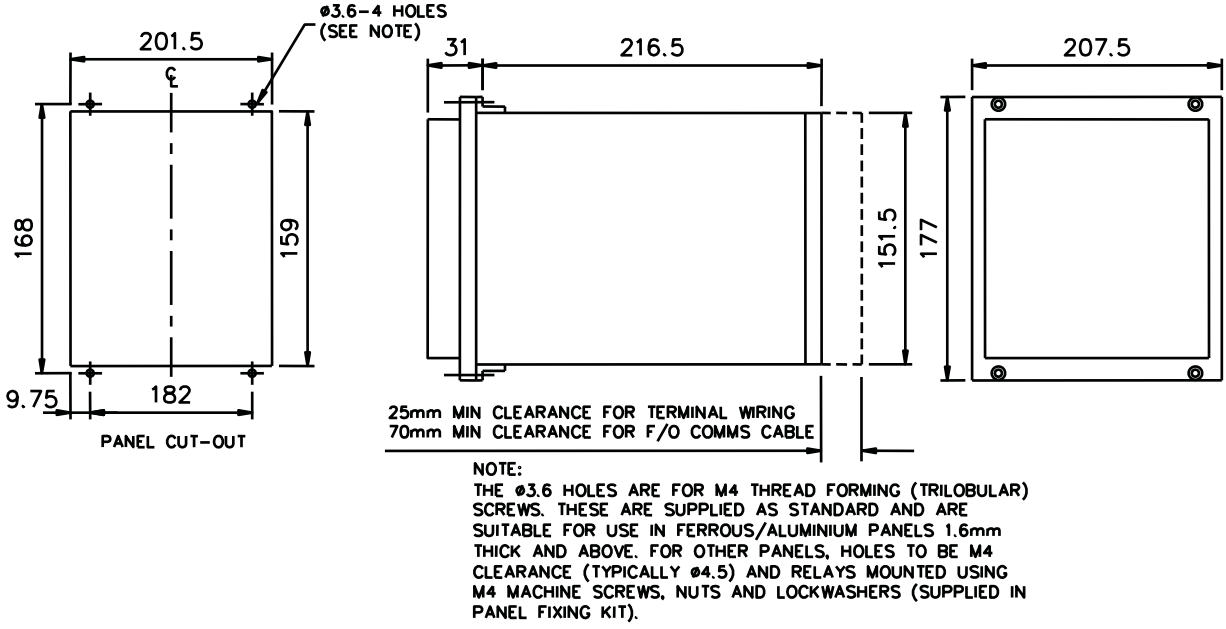


Fig 2. E8 Case Dimensions

Connection Diagram

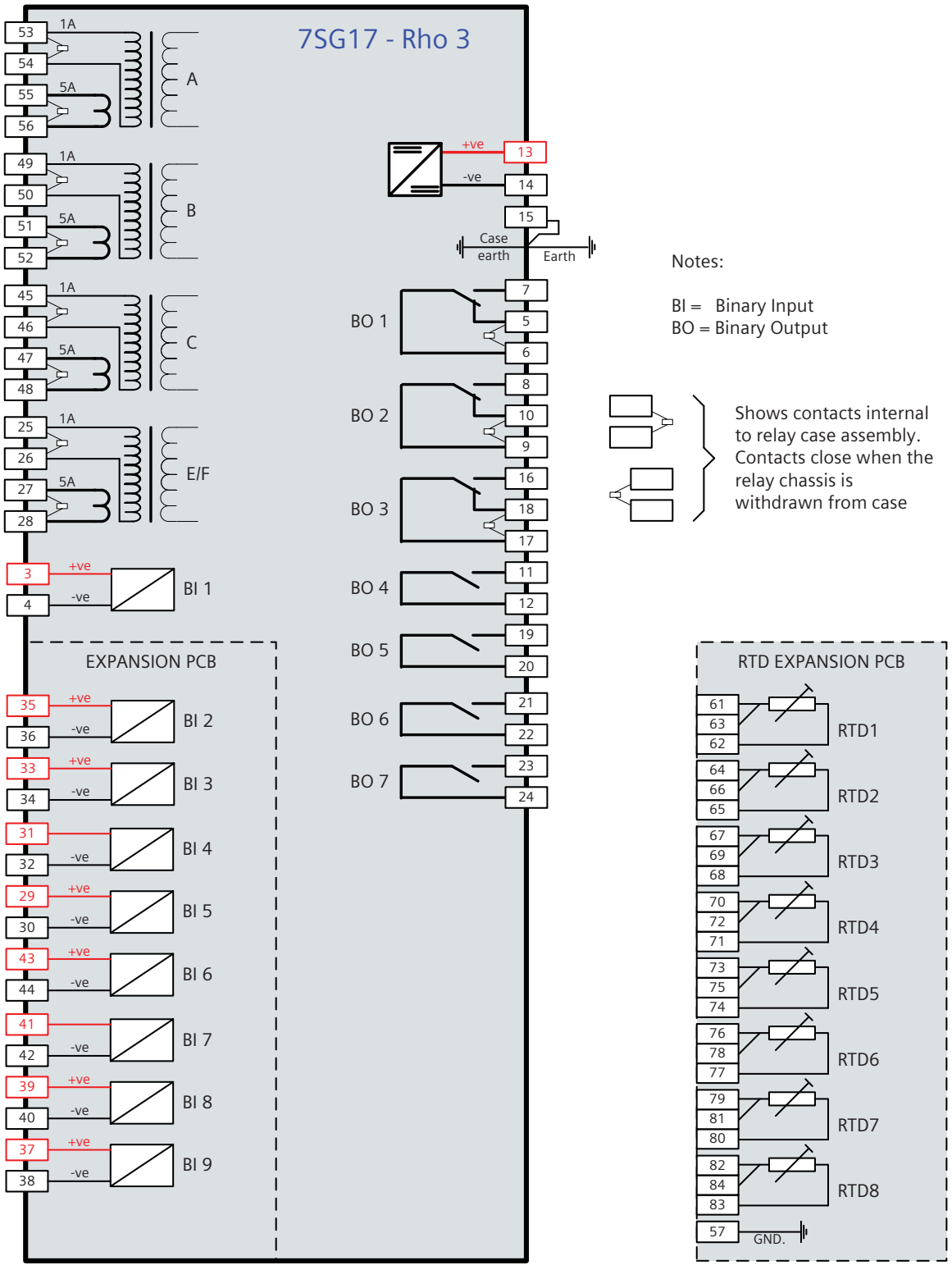


Fig 3. Connection Diagram for 7SG17 Relay

Ordering Information – 7SG17 Rho 3

Product description	Variants	Order No.
RHO 3		**7 S G 1 7 □ □ - □ □ □ □ □ - □ □ A 0**
HV motor & thermal protection.		
	Relay type	
	Motor Protection	1
	Thermal Protection	2
	Number of elements	
	Four pole relay	4
	Auxiliary supply /binary input voltage	
	24/30/48 V DC auxiliary, 30 V binary input	0
	110/220 V DC auxiliary, 30 V binary input	1
	24/30/48 V DC auxiliary, 48 V binary input	2
	110/220 V DC auxiliary, 48 V binary input [1])	3
	110/220 V DC auxiliary, 110 V low burden binary input	4
	110/220 V DC auxiliary, 220 V low burden binary input	5
	Type of elements (Type of voltage relay)	
	3 pole phase-fault and earth-fault	E
	Nominal current inputs	
	1/ 5 A	A
	I/O range	
	1 Binary Input / 7 Binary Outputs	0
	9 Binary Inputs / 7 Binary Outputs	2
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103 or Modbus RTU	1
	RS485 interface / IEC 60870-5-103 or Modbus RTU	2
	RTD inputs	
	No RTD inputs	0
	RTD inputs	1
	Housing size	
	Case size E6 (4U high)	D
	Case size E8 (4U high)	E

[1]) High burden 110V & 220V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version
for 1 binary input and 110 V application, order resistor box VCE:2512H10066 in addition
for 9 binary inputs and 110 V application, order resistor box VCE:2512H10064 in addition
for 1 binary input and 220 V application, order resistor box VCE:2512H10068 in addition
for 9 binary inputs and 220 V application, order two resistor boxes VCE:2512H10067 in addition
Refer to website for application note about ESI48-4 compliance

Reyrolle
Protection
Devices

7SG26 – Tau

Autoreclose and synchronization

Answers for energy

SIEMENS

7SG26 Tau

Autoreclose and synchronization

Fig 1. Tau relay in size 12 case

Description

The Tau range of auto-reclosing and synchronising relays cover all requirements for auto-reclosing in single-busbar, double busbar, one-and-a-half breaker and mesh substations, employing single-pole and three-pole switching. A number of models are available to meet different requirements.
The Tau auto-reclosing functionality can also be found built into Ohmega distance protection and Delta overcurrent protection relays.
The Tau 100 and 200 series relays provide all the functionality required for high-speed single-pole and three-pole autoreclose for application to a transmission feeder.
The Tau 400 and 500 series relays are suitable for transmission and distribution schemes, and provide all the functionality required for delayed automatic reclosure (DAR) of circuit breakers and isolators. These relays are particularly suited to systems with significant banked plant.
The relays have been designed to simplify, as much as possible, the intensive process of creating an autoreclose scheme. Clear setting ranges indicate deadtimes, close pulse and reclaim time delay settings. To assist commissioning, front fascia instruments indicate the progress through an autoreclose sequence.
The communication interface facilitates system operation by providing access to settings, event records, counters and a comprehensive command set, enabling remote control and fast post fault data retrieval.

Function Overview

The following features are available within the Tau range:

Reclosing options can be selected from
High-speed single-pole
High-speed three-pole
High-speed single-pole plus three-pole
Multishot delayed three-pole, with up to 4 recloses

Reclosing schemes can provide
Built-in check and system synchronising
External check and system synchronising
Automatic isolation
System reconfiguration
Additional features are
Pole discrepancy – alarm and trip
Ferro-resonance suppression – through isolation or earthing
VT failure alarm and blocking
Other features provided as standard are
Up to 43 digital inputs and 45 output relays – all fully programmable
Up to 32 LEDs for annunciation

Built-in logic eliminates the need for external auxiliary relays and associated wiring
Event recording of up to 500 time tagged records
Industry standard IEC 60870-5-103 protocol
Fibre optic rear communication ports plus front (fascia mounted) RS232 port for relay interrogation

Description of Functionality

Autoreclose

The autoreclose function has been designed to provide a rigorous assessment of the system and plant conditions before reclosing.

A number of abnormal conditions can be detected by the Tau, any of which will halt a reclose sequence:
Pole discrepancy – for circuit breaker, isolators and earth switch
Failed to close – for circuit breaker, isolators and earth switch
Failed to open – for circuit breaker, isolators and earth switch
DBI (don't believe it) – for circuit breaker, isolators and earth switch
Close on to fault
Slow circuit breaker
VT failure
Isolation failure
Trip relay reset failure

The close pulse will only be issued if the circuit breaker is open, there are no trips present and, on appropriate models, if the system synchronism conditions are met.
The relay contains scheme logic that allows input functions and output functions to be configured to meet the requirements of the scheme. This is achieved by a number of pre-programmed options and features which enable various sequences, together with appropriate timer mechanisms to allow effective control of the autoreclose process.

The Tau autoreclose relay is connected to the circuit breaker, protection and associated plant. The following features are available (depending upon model):

Monitoring of the state of the circuit breaker: CB Open, Closed and Indeterminate; per phase signals are provided.
CB single-pole open and three-pole open outputs can be used as inhibits, e.g. for power swing blocking, zone 1 extension and DEF

VT alarms for line and bus side VTs
CB counter alarms
Start autoreclose flexibility: from 'Trip Reset' or, on Tau 100/200, 'Trip' or 'Trip and CB Open'
Three-pole trip select logic connection is provided to instruct protection to issue trips as three-pole
CB In Service and CB Memory prevent unwanted recloses if the circuit breaker is open or de-energised. Autoreclose is only allowed to proceed if the circuit breaker was in a closed position prior to the fault
Flexible latched or self reset Lockout
Flexible connection of the CB Auxiliary switches: can be normally open, normally closed or normally open and normally closed
Switching autoreclose In/Out can be from switches, communications, keypad or telecontrol pulses
Close Mode Selection, determining the autoreclose sequence employed, may be changed by a selector switch

The interconnection of this equipment allows the Tau to issue a number of alarms indicating system conditions and possible problems.

Check synchronising

Some Tau models provide support for external synchronising, others include check and system synchronising.
When synchronising is included in the Tau, VTs are provided to measure line and bus voltages. The Tau will automatically determine circuit breaker reclosure conditions: dead line close, dead bar close or check sync close. If one of these conditions exists and reclosure under this condition has been pre-selected by the user, then reclosure will be initiated.
The relay can automatically select check or system synchronising from measurements of the relative phase angles between line and bus voltages. The relay will prevent closure of the circuit breaker if the phase angle, slip frequency or the voltage magnitudes of the incoming or running voltages fall outside prescribed limits. The check and system synchronise functions have independent settings.
The relay includes split system detection. Following a system split, closure of the circuit breaker can be performed by either system synchronising parameters (typically 10°), or by the Close On Zero function, which takes account of the circuit breaker close time. Alternatively, lockout may be selected.

Ferroresonance suppression logic

With certain substation configurations, at extra high voltage levels, ferroresonance can cause damage to transformers. Ferroresonance is usually eliminated by opening the transformer isolator or closing an earth switch. Both of these methods disrupt the resonant primary circuit and damp the resonance. The Tau 503 provides two logic schemes that enable this to occur as an integral part of the autoreclose scheme.
The first scheme (F3) opens then closes the transformer isolator in order to remove the resonance. The second scheme (F4) can be used if the isolators cannot break the resonant voltages, and closes then opens the line earth switch in order to achieve the same result.
Ferroresonance must be detected with a suitable relay, e.g. XR309.

Monitoring

Instrumentation

On models with synchronising analogue, values can be displayed on the LCD screen. In addition these values can be obtained via the IEC 60870-5-103 communications.
Line and bus voltage magnitudes
Line and bus frequencies
Phase difference
Slip frequency
Status inputs
Output contacts

Flag indication

Either 16 or 32 Flag LEDs are provided, which the user can assign to indicate status. The number of LEDs depends on the case size, see Technical Information

Data storage and communication

Sequence of event records

Up to 500 events are stored and time tagged to 1ms resolution. These are available via the communications.

CB Close records

Textual records of the last 10 closes are available from the Tau fascia with time and date, measured quantities (for models with synchronising) and status.

Waveform recorder

Waveform storage provides five 1 second records. Within the record, the amount of pre-fault storage is configurable. The recorder is triggered from a close operation.
In all models, the records contain the digital input and output signals. In models with synchronising analogue waveforms of the line and bus voltages are also recorded.

Communications

Two fibre-optic communications ports are provided on the rear of the relay. They are optimised for 62.5/125µm multi-

mode glass-fibre. Connectors are of the BFOC/2.5 (ST®) bayonet type.

In addition users may interrogate the Tau locally with a laptop PC and the RS232 port on the front of the relay. The Tau uses IEC 60870-5-103 as its communications protocol.

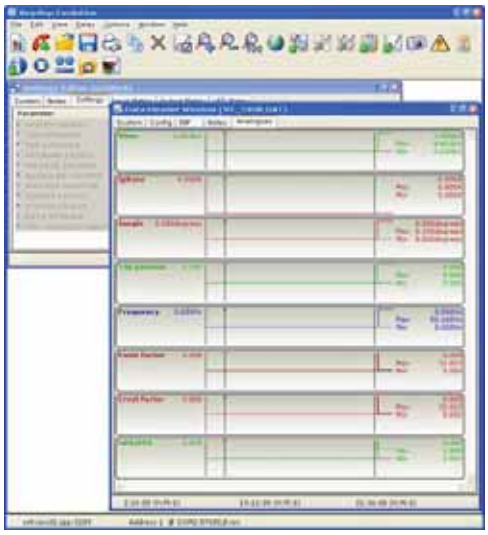


Fig 2. Waveform record in reydisp Evolution

Reydisp Evolution is common to the entire range of numeric products. It provides a means for the user to apply settings to the Tau, interrogate settings and retrieve waveforms from the Tau

Model Selection

Tau 100/200 series

Tau 100/200 series relays provide high-speed single-pole and three-pole reclosing. They are typically applied to transmission systems and any application where single-pole reclosing is required.

Eight different sequences are possible, with up to 2 reclose shots followed by lockout:
Off
Single-pole
Three-pole
Single-pole, or three-pole
Single-pole followed by three-pole, or three pole
Two single-pole
Two three-pole
Two single-pole, or two three-pole, or single-pole followed by three-pole

Tau 100

Support for external synchronising relay

Tau 200

Integral check and system synchronising

Tau 400/500 series

Tau 400/500 series relays provide multi-shot three-pole delayed reclosing. The number of recloses before lockout can be programmed between 1 and 4.

Tau 400

No support for synchronising

Tau 401

Support for external synchronising relay

Tau 500

Integral check and system synchronising

Auto Switching Tau 500 Functionalty

In addition to the following relays in the Tau 500 series also provide auto-switching functionality for a variety of applications:

Tau 501

Control of feeder disconnector on banked feeder/transformer connections.
Limited applications.

Tau 502

Control of up to four isolators. Typically applied to distribution systems – mesh substations, 1½ breaker substations and applications requiring control of isolators or earth switches on both sides of the circuit breaker. (UK: TPS12/10)

Tau 503

Control of up to four isolators, two earth switches and with ferroresonance suppression logic. Typically applied to mesh substations, 1½ breaker substations and applications requiring control of isolators on both sides of the circuit breaker. (UK: NGTS3.24.63)

Tau 504

Control of two isolators on banked connections. Typically feeder and locally banked transformer.

Tau 506

Control of transformer HV isolater for ferroresonance suppression (F3). Transformer LVCB DAR. Typically for transformer feeders with long overhead lines.

Tau 510

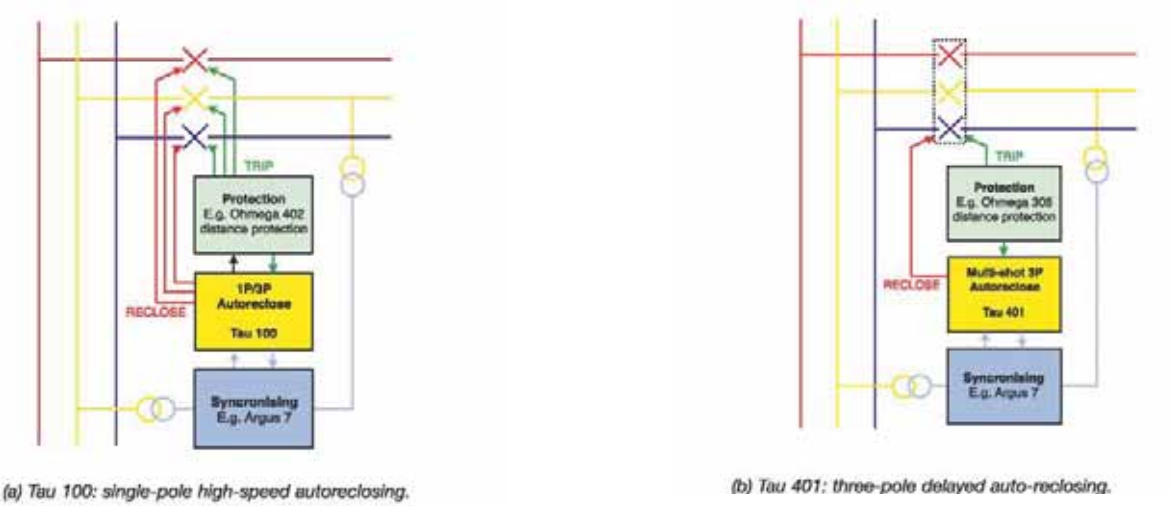
As Tau 500 but with enhanced interface to allow use with TPS 6/ 10003 synchronising schemes.

Application

When applying Tau relays to reclosing schemes the general requirement is one relay per circuit breaker.

Plain overhead line applications

The Tau 400 has no synchronising support. It is typically applied to radial distribution systems where no synchronising is required. The Tau 100 and 401 relays (Figure 2) interface with the protection and an external synchronising relay



(a) Tau 100: single-pole high-speed autoreclosing.

(b) Tau 401: three-pole delayed auto-reclosing.

Fig 3. a & b Tau auto reclose with external synchronising

The Tau 200 and 500 relays (Figure 3) provide a synchronising function that includes dead line close, dead bus close, check synchronising, system synchronising and close on zero functions.

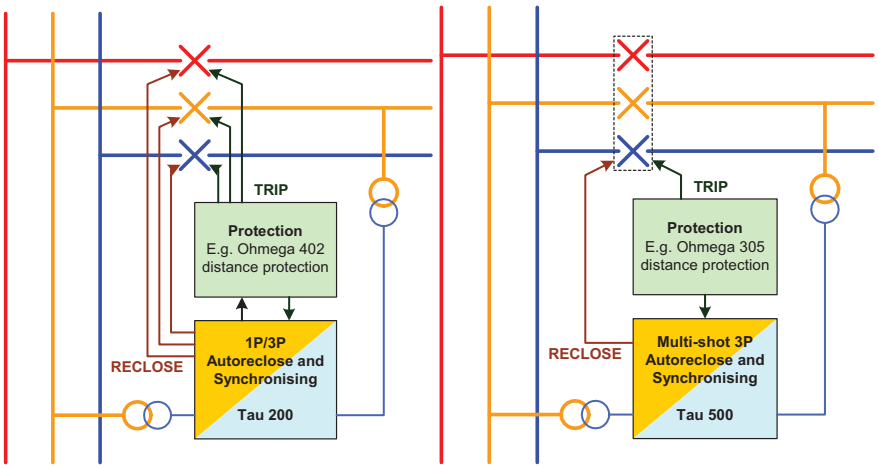


Fig 4. a & b Tau auto reclose with integral check and system synchronising

Auto-isolation

The Tau 501 and 504 provide control of isolators for banked plant, and can be used in a variety of auto-isolation schemes, usually for teed feeders.

The Tau 501 and 504 are typically used when a transformer is teed off a feeder from a single or double busbar (Figure 6). The Tau 504, being able to control 2 isolators, can be used in situations where the transformer and feeder have isolators. The Tau 501 is limited to feeder isolator control.

- For a fault on the feeder, if it is an overhead line, the sequence is: trip, reclose; and if another trip occurs, isolate the line, reclose.
- For a fault on the feeder, if it is a cable, the sequence is: trip, isolate the cable, reclose.
- For a fault on the transformer the circuit breaker trips, the transformer isolator is opened, then the circuit breaker is closed again. (A separate reclosing relay controls the circuit breaker on the other side of the transformer.)

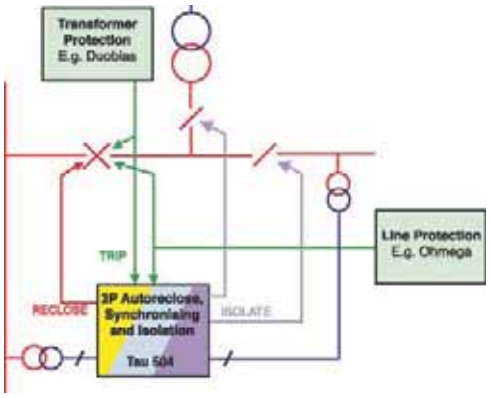


Fig 6. Auto-isolation for teed feeders – single or double busbar

Switch-and-a-half and mesh substations

The Tau 502 and 503 are applicable to any application where isolators on each side of the circuit breaker must be controlled. Switch-and-a-half substations and mesh substations are the most common example of these. These relays can control up to two isolators on each side of the circuit breaker.

In the switch-and-a-half application (Figure 7) Tau 502s can be used with the centre circuit breaker, while Tau 500s are used for the circuit breakers at the outsides of the diameter. If single-pole switching is required Tau 200s can be used throughout, however, auto-isolation is not provided in these.

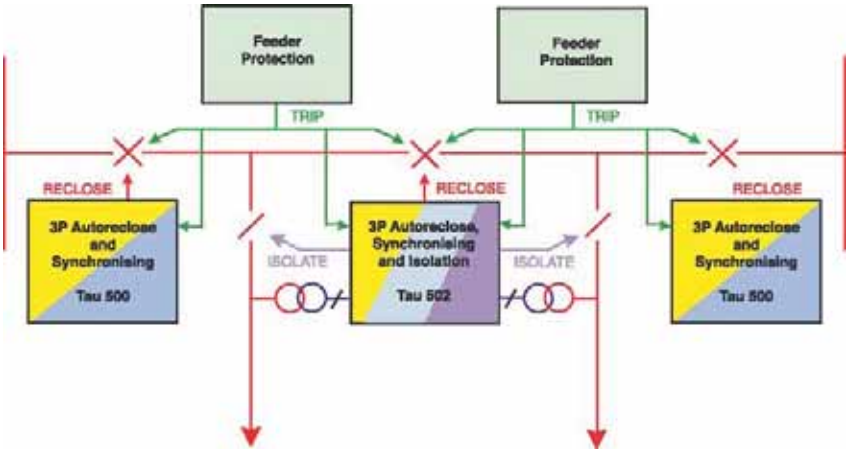


Fig 7. Switch-and-a-half reclosing using TAU 500 and 502

Reclosing in a mesh substation (Figure 8) is similar to a teed feeder, except there is a need for isolator control on both sides of the circuit breaker. If all breakers are closed prior to a fault, blocking logic creates a priority such that one Tau will ensure the correct circuits are isolated before closing its circuit breaker, thus releasing the next Tau to do the same. If a circuit breaker is open prior to a fault, the lower priority Tau will not be blocked, and will carry out the necessary isolation.

The Tau 503 contains logic differences and ferroresonance suppression logic, compared with the Tau 502, making it particularly suited to transmission mesh substations.

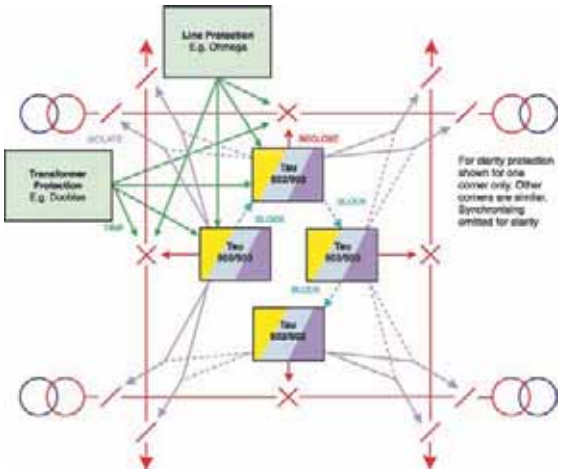


Fig 8. Four-switch mesh reclosing using TAU 502 or 503

Application of Tau 502 to single-switch meshes is particularly easy, because the Tau is associated with a circuit breaker, rather than a mesh corner, as shown in Figure 9.

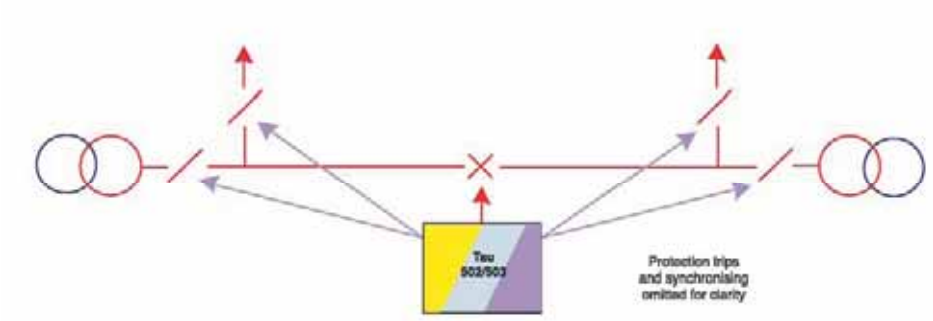


Fig 9. Single-switch mesh reclosing using TAU 502 or 503

When there are two transformers per corner, one transformer isolator is controlled by each Tau on the adjacent sides, Figure 10.

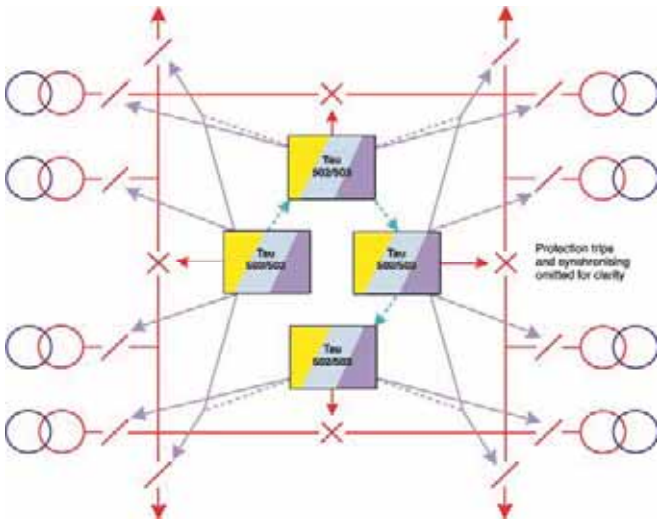


Fig 10. Four-switch mesh reclosing with 2 transformers per corner

Technical information

General accuracy Reference conditions

Parameter	Reference or value
General	IEC 60255-3
Auxiliary Supply	Nominal
Frequency	50 / 60 Hz
Ambient Temperature	20 °C

General accuracy

Parameter	Value
Voltage level	±1% (range 7V to 132V)
Frequency	typically ±10mHz
Phase angle	typically ±1°

Accuracy influencing factors

Temperature	
-10 °C to +55 °C	≤ 5% variation
Frequency	
47 Hz to 52 Hz 57 Hz to 62 Hz	Setting: ≤ 1% variation
	Operate Time: ≤ 1% variation
	Phase Angle: ≤ 1% variation

Characteristic energising quantity

AC Voltage	63.5 / 110 V rms
Frequency	50 / 60 Hz

Auxiliary energising quantity DC Power supply

Nominal voltage	Operating range
48, 110 V	37.5 to 137.5
220 V	178.0 to 280.0

DC Status inputs

Nominal voltage	Operating range
30, 34 V	18.0 to 37.5 V dc
48, 54 V	37.5 to 60.0 V dc
110, 125 V	87.5 to 137.5V dc
220, 250 V	175.0 to 280.0V dc

The status voltage need not be the same as the main energising voltage.

Electricity Association ESI48-4

The 30/34V and 48/54V inputs meet the requirements of ESI48-4 ESI 1. However, the 110/125V and 220/250V inputs will operate with a DC current of less than 10mA. If 110/125V or 220/250V inputs compliant with ESI48-4 ESI 1 are required, a Tau with 48/54V status can be supplied with external dropper resistors as follows:

Nominal voltage	Value	Wattage
110, 125 V	2k7 ± 5%	2.5 W

Status input performance

Parameter	Value
Minimum DC current for operation (30/34V and 48/54V inputs only)	10 mA
Reset/Operate Voltage Ratio	≥ 90 %
Typical response time	< 5 ms
Typical response time when used to energise an output relay contact	< 15 ms
Minimum pulse duration	40 ms

Each status input has an associated timer that can be programmed to give time delayed pick-up and time delayed drop-off. When set to a minimum of 20ms the status inputs will provide immunity to an AC input signal and will not respond to the following:

- 250V RMS 50/60 Hz applied for two seconds through a 0.1µF capacitor.
- 500 V RMS 50/60 Hz applied between each terminal and earth.
- Discharge of a 10 µF capacitor charged to maximum DC auxiliary supply voltage.

Protection Elements

Autoreclose

Level	
Deadtime (1P)	0.05s to 100s step 0.05s
Deadtime (3P)	0.1s to 100s step 0.1s
Close pulse	0.1s to 20s step 0.1s
Reclaim time	1s to 600s step 1s
Accuracy	setting ±1% or ±10ms

Check and system synchronising

Live and dead voltage level	
Dead line/bus	5% to 150% step 5%
Live line/bus	10% to 155% step 5%
Accuracy	Live operate: live setting ± 1% Live reset: dead setting ± 1% Dead operate: dead setting ± 1% Dead reset: live setting ± 1%
Undervoltage level	
Setting line/bus	0 to 150% step 5%
Accuracy	Operate: Setting ± 1%
	Reset: < 104% operate level
Voltage difference level	
Setting	0 to 100% step 5%
Accuracy	Operate: setting ±2% or ±0.5V
	Reset: > operate level – 2V (typically > 90% operate)
Slip frequency	

Setting	0 to 2000mHz step 5mHz
Accuracy	Operate: setting –15mHz +0mHz
	Reset: operate –0mHz +15mHz
Check sync., system sync. phase angle	
Setting	5 to 90° step 5°
Accuracy	Operate: setting –3° +0
	Reset: operate –0 +3°
System split phase angle	
Setting	0 to 175° step 5°
Accuracy	Operate: setting ±1.5°
	Reset: latched
Timer	
Setting	0 to 100s step 0.1s
Accuracy	setting ±1% or ±10ms

Thermal Withstand
Continuous / Limited period

250 V rms	Continuous

Burdens
AC Voltage inputs

63.5V	≤ 0.05 VA

Note: Burden is measured at nominal rating

Auxiliary supply

TAU 100/40x	
Quiescent	9 W
Maximum	14 W
TAU 200/50x	
Quiescent	11 W
Maximum	14 W

Output Contact

Contact rating to IEC 60255-0-2.

Carry continuously	5 A AC or DC

Make and carry
(Limits: L/R ≤ 40ms and V ≤ 300 volts)

0.5 sec	20 A AC or DC
0.2 sec	30 A AC or DC

Break
(Limits: ≤ 5A or ≤ 300 volts)

ac resistive	1250 VA
ac inductive	250 VA @ PF ≤ 0.4
dc resistive	75 W
dc inductive	30 W @ L/R ≤ 40 ms
	50 W @ L/R ≤ 10 ms
Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5 W, limits 10 mA or 5 V

Minimum number of operations	1000 at maximum load
Minimum recommended load	0.5 W, limits 10 mA or 5 V

Mechanical

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

0.5 gn, Vibration response 1.0 gn, Vibration endurance	≤ 5% variation

Shock and bump IEC 60255-21-2 Class 1

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

Seismic IEC 60255-21-3 Class 1

1 gn, Seismic Response	≤ 5% variation

Mechanical classification

Durability	In excess of 10^6 operations

Electrical Tests

Transient overvoltage IEC 60255-5

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

Insulation IEC 60255-5
RMS levels for 1 minute

Between all terminals and earth	2.0 kV
Between independent circuits	2.0 kV
Across normally open contacts	1.0 kV

Immunity
Auxiliary DC supply IEC 60255-11

Allowable superimposed ac component	≤ 12% of dc voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	≤ 20 ms

High frequency disturbance IEC 60255-22-1 Class III

2.5kV, Longitudinal mode	≤ 3% variation
1.0kV, Transverse mode	

Electrostatic discharge IEC 60255-22-2 Class III

8kV, Contact discharge	≤ 5% variation

Fast transient IEC 60255-22-4 Class IV

4kV, 5/50ns, 2.5 kHz, re-petitive	≤ 3% variation

Radio frequency interference IEC 60255-22-3

10 V/m, 80 to 1000 MHz	≤ 5% variation

Environmental

Temperature IEC 68-2-1/2

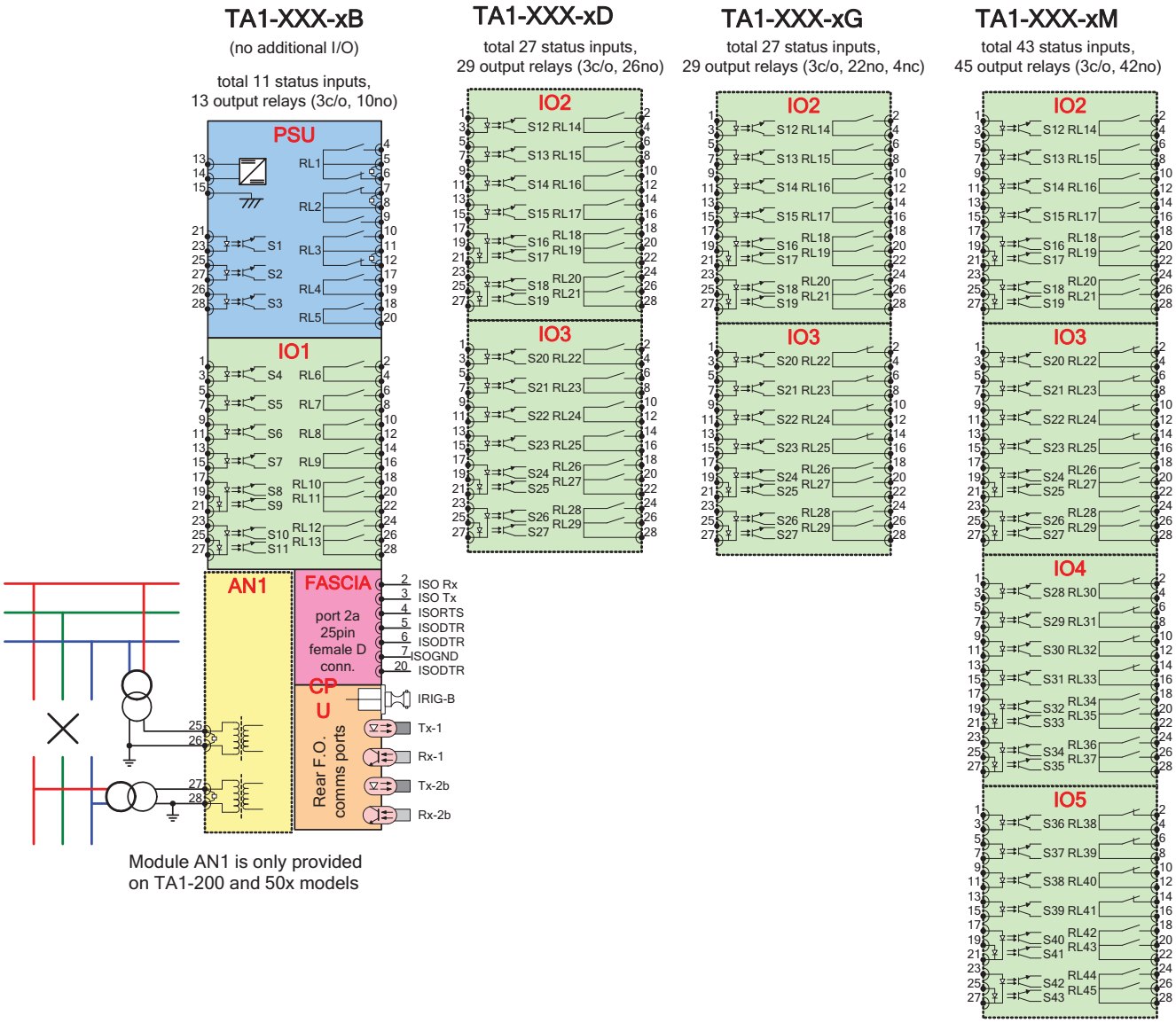
Operating	-10 °C to +55 °C
Storage	-25 °C to +70 °C

Humidity IEC 68-2-3

Operational test	56 days at 40 °C and 95% RH

Application

Additional Status Input and Output Relay Options



Module AN1 is only provided on TA1-200 and 50x models

TAU series		100, 40x		200, 50x		503
I/O options		B,C,H	D,G	B	C,D,G,H	M
Case Size		E8	E12	E8	E12	E16
Module position	A	PSU	PSU	PSU	PSU	PSU
	B	IO1	IO1	IO1	IO1	IO1
	C	IO2	IO2	AN1	IO2	IO2
	D	CPU	IO3	CPU	IO3	IO3
	E		Spare		AN1	IO4
	F		CPU		CPU	IO5
	G					ANI
	H					CPU

The amount of I/O together with the TAU series (100, 200, 40x, 50x) will determine the required case size – see the table to the left.
Modules in italic (*IO2, IO3*) are options.

Case Dimensions

The Tau is supplied in either a size 8, 12 or 16 case, see below.

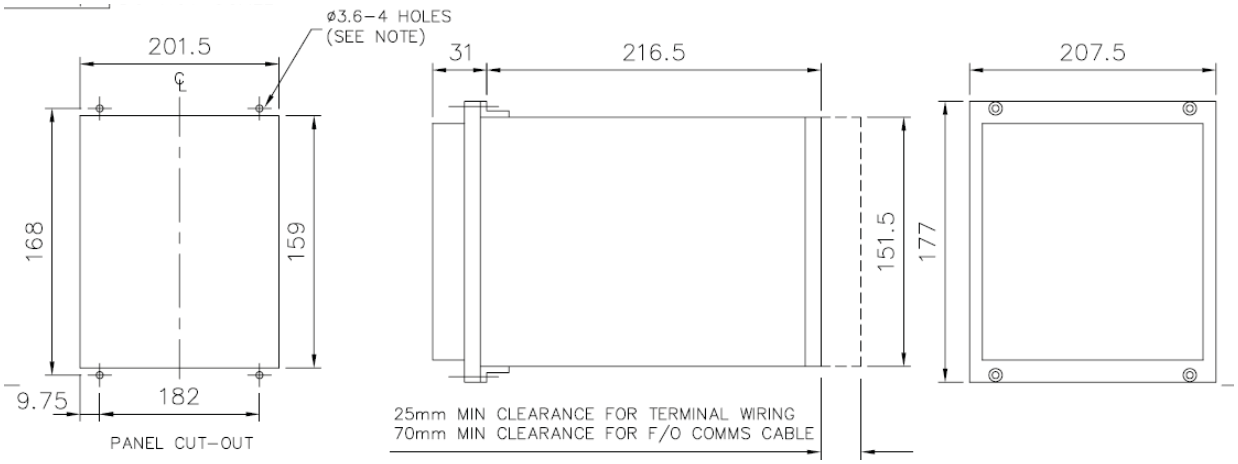


Fig 11. Size 8 Case

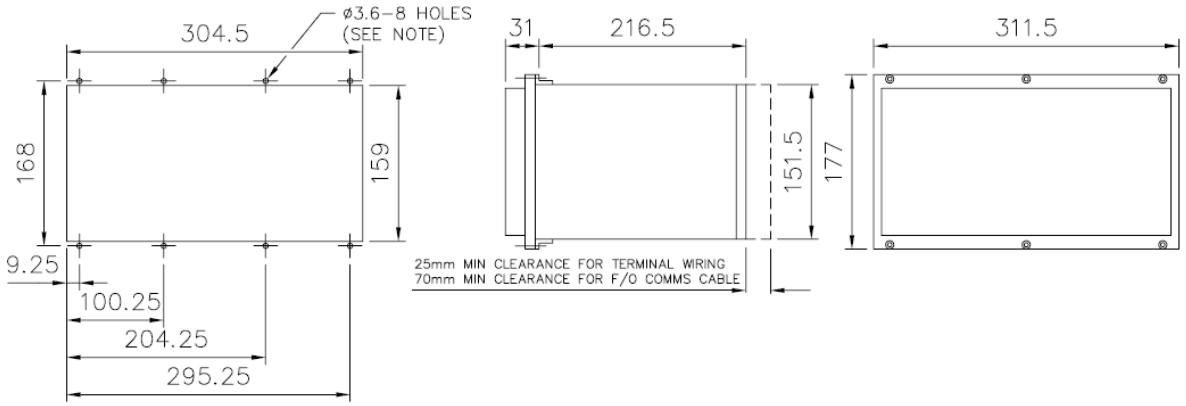


Fig 12. Size 12 Case

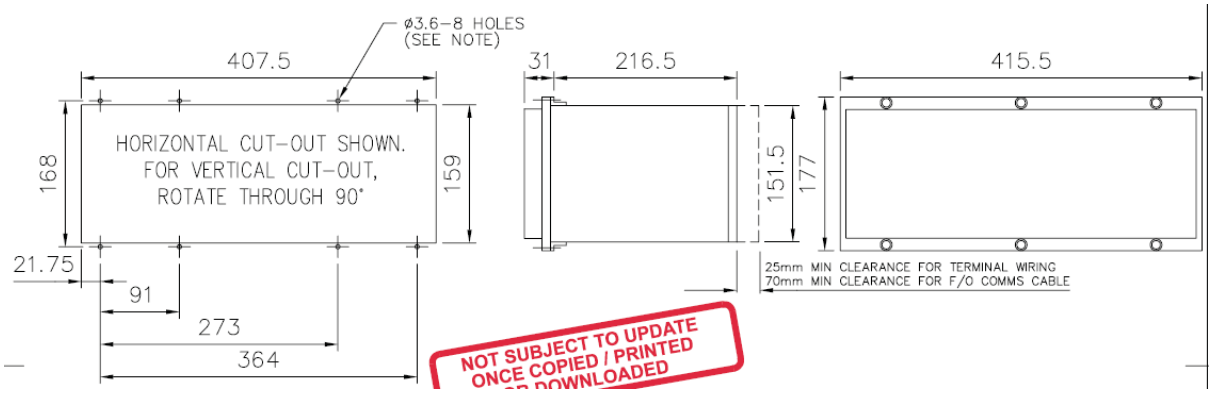


Fig 13. Size 16 Case

Ordering Information - TAU 7SG26

Product description	Variants	Order No.
TAU (100 series) Autoreclose relay without check synchronising.		**7 S G 2 6 □ □ - 0 □ □ □ 0 - □ □ □ 0**
	Relay type	1
	100 series - High speed reclosing with external sync input Standard functionality Reclose type - Low/high-speed single-pole . - Low/high-speed three-pole reclose Reclosing schemes - External synchronising input Auxiliary functions - Pole discrepancy	
	Functionality Model 100 - Standard functionality	0
	Auxiliary supply /binary input voltage 48/110 V DC auxiliary, 30 V DC binary input 48/110 V DC auxiliary, 48 V DC binary input [1]) 48/110 V DC auxiliary, 110 V DC low burden binary input 220 V DC auxiliary, 110 V DC low burden binary input 220 V DC auxiliary, 220 V DC low burden binary input	C D E F G
	I/O range 27 Binary Inputs / 13 Binary Outputs (incl. 3 changeover)	H
	Frequency Not applicable	0
	Voltage inputs Not applicable	0
	Housing size Case size E8 (4U high)	E
	Communication interface Fibre optic (ST-connector) / IEC 60870-5-103	A

[1]) High burden 110/125V & 220/250V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version

110/125 V application, order combination of the following resistor boxes to suit number of binary inputs

2512H10064 (9 inputs, 110V)

2512H10065 (5 inputs, 110V)

2512H10066 (1 inputs, 110V)

220/250 V application, order resistor box 2512H10066 in addition

2512H10067 (5 inputs, 220V)

2512H10068 (1 inputs, 220V)

Ordering Information - TAU 7SG26

Product description	Variants	Order No.
TAU (200 series)		7 S G 2 6 □ □ - 0 □ □ □ 0 - □ □ □ 0
Autoreclose relay with check synchronising.		
	Relay type	
	200 series - High speed reclosing with check and system synchronising	2
	Standard functionality	
	Reclose type	
	- Low/high-speed single-pole reclose	
	- Low/high-speed three-pole reclose	
	Reclosing schemes	
	- Check and system synchronising	
	Auxiliary functions	
	- Pole discrepancy	
	- VT failure alarm (and blocking)	
	Functionality	
	Model 200 - Standard functionality	0
	Auxiliary supply /binary input voltage	
	48/110 V DC auxiliary, 30 V DC binary input	C
	48/110 V DC auxiliary, 48 V DC binary input [1])	D
	48/110 V DC auxiliary, 110 V DC low burden binary input	E
	220 V DC auxiliary, 110 V DC low burden binary input	F
	220 V DC auxiliary, 220 V DC low burden binary input	G
	I/O range	
	27 Binary Inputs / 13 Binary Outputs (incl. 3 changeover)	H
	Frequency	
	50Hz	1
	60Hz	2
	Voltage inputs	
	63.5/110 V AC	1
	Housing size	
	Case size E12 (4U high)	G
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103	A

[1]) High burden 110/125V & 220/250V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version

110/125 V application, order combination of the following resistor boxes to suit number of binary inputs

2512H10064 (9 inputs, 110V)

2512H10065 (5 inputs, 110V)

2512H10066 (1 inputs, 110V)

220/250 V application, order resistor box 2512H10066 in addition

2512H10067 (5 inputs, 220V)

2512H10068 (1 inputs, 220V)

Ordering Information - TAU 7SG26

Product description	Variants	Order No.
TAU (400 series) Autoreclose relay without check synchronising.		**7 S G 2 6 □ □ - 0 □ □ □ 0 - □ □ □ 0**
	Relay type	
	400 series - Delayed autoreclose	**4**
	Standard functionality	
	Reclose type	
	- Multi-shot delayed three-pole reclose	
	Auxiliary functions	
	- Pole discrepancy	
	Functionality	
	Model 400 - Standard functionality	0
	Model 401 - Standard functionality plus	1
	Reclosing schemes	
	- External synchronising input	
	Auxiliary supply /binary input voltage	
	48/110 V DC auxiliary, 30 V DC binary input	C
	48/110 V DC auxiliary, 48 V DC binary input [1])	D
	48/110 V DC auxiliary, 110 V DC low burden binary input	E
	220 V DC auxiliary, 110 V DC low burden binary input	F
	220 V DC auxiliary, 220 V DC low burden binary input	G
	I/O range	
	11 Binary Inputs / 13 Binary Outputs (incl. 3 changeover)	B
	Frequency	
	Not applicable	0
	Voltage inputs	
	Not applicable	0
	Housing size	
	Case size E8 (4U high)	E
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103	A

[1]) High burden 110/125V & 220/250V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version

110/125 V application, order combination of the following resistor boxes to suit number of binary inputs

2512H10064 (9 inputs, 110V)

2512H10065 (5 inputs, 110V)

2512H10066 (1 inputs, 110V)

220/250 V application, order resistor box 2512H10066 in addition

2512H10067 (5 inputs, 220V)

2512H10068 (1 inputs, 220V)

Ordering Information - TAU 7SG26

Product description	Variants	Order No.
TAU (500 series)		**7 S G 2 6 □ □ - 0 □ □ □ 0 - □ □ □ 0**
Autoreclose relay with check synchronising.		
	Relay type	
	500 series - Multi-shot autoreclose with check and system synchronising	5
	Standard functionality	
	Reclose type	
	- Multi-shot delayed three-pole reclose	
	Reclosing schemes	
	- Check and system synchronising	
	Auxiliary functions	
	- Pole discrepancy	
	- VT failure alarm (and blocking)	
	Functionality	
	Model 500 - Standard functionality	0 B E
	- 'J' unit equivalent	
	Model 502 - Standard functionality plus	2 G G
	Reclosing schemes	
	- 4 isolator control for sub-transmission mesh	
	- TPS 12/10 equivalent	
	Only supplied as part of engineered system [2])	
	Model 503 - Standard functionality plus	3 M J
	Reclosing schemes	
	- 4 isolator control for transmission mesh	
	Auxiliary functions	
	- Earth switch/transformer isolator Ferro-resonance suppression	
	- NGTS 3.24 scheme	
	Only supplied as part of engineered system [2])	
	Model 504 - Standard functionality plus	4 D G
	Reclosing schemes	
	- 2 isolator control for Teed feed	
	Model 506 - Standard functionality plus	6 B E
	Reclosing schemes	
	- Transformer isolator control	
	Auxiliary functions	
	- Ferro-resonance suppression	
	Model 510 - Standard functionality plus but with revised connections for use with traditional synchronising and control schemes	7 D G
	Auxiliary supply /binary input voltage	
	48/110 V DC auxiliary, 30 V DC binary input	C
	48/110 V DC auxiliary, 48 V DC binary input [1])	D
	48/110 V DC auxiliary, 110 V DC low burden binary input	E
	220 V DC auxiliary, 110 V DC low burden binary input	F
	220 V DC auxiliary, 220 V DC low burden binary input	G

Continued Over

Product description	Variants	Order No.
TAU (500 series)		**7 S G 2 6 □ □ - 0 □ □ □ 0 - □ □ □ 0**
	I/O range	
	11 Binary Inputs / 13 Binary Outputs (incl. 3 changeover)	**B**
	27 Binary Inputs / 29 Binary Outputs (incl. 3 changeover)	**D**
	27 Binary Inputs / 29 Binary Outputs (incl. 3 changeover, 4 normally closed)	**G**
	43 Binary Inputs / 45 Binary Outputs (incl. 3 changeover)	**M**
	Frequency	
	50Hz	**1**
	60Hz	**2**
	Voltage inputs	
	63.5/110 V AC	**1**
	Housing size	
	Case size E8 (4U high)	**E**
	Case size E12 (4U high)	**G**
	Case size E16 (4U high)	**J**
	Communication interface	
	Fibre optic (ST-connector) / IEC 60870-5-103	**A**

[1]) High burden 110/125V & 220/250V binary inputs compliant with ESI48-4 ESI 1 available via external dropper resistors with 48V binary input version

110/125 V application, order combination of the following resistor boxes to suit number of binary inputs

2512H10064 (9 inputs, 110V)

2512H10065 (5 inputs, 110V)

2512H10066 (1 inputs, 110V)

220/250 V application, order resistor box 2512H10066 in addition

2512H10067 (5 inputs, 220V)

2512H10068 (1 inputs, 220V)

[2]) Solutions for mesh corner autoreclose are available as engineered schemes and price supplied on request