



Reyrolle
Protection
Devices

7SR23 DAD

High Impedance Protection Relay

Answers for energy.

SIEMENS

Contents

Technical Manual Chapters

1. Description of Operation
 2. Settings, Configuration & Instruments
 3. Performance Specification
 4. Data Communications
 5. Installation
 6. Commissioning and Maintenance
 7. Applications Guide
-

Software Revision History

Date	Software Reference	Summary
2015/11	2435H85014 R8b-1b	EN100+ compatibility.
2013/01	2435H85014R7c-1a	Revised file handling during shutdown.
2012/07	2435H85014R7b-1a	First Release

Hardware Revision History

2015/11	CC	EN100+ Ethernet comms card replaces EN100.
2012/07	BB	First Release

7SR23 DAD

High Impedance Protection Relay

Description of Operation

Document Release History

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2012/07	First issue

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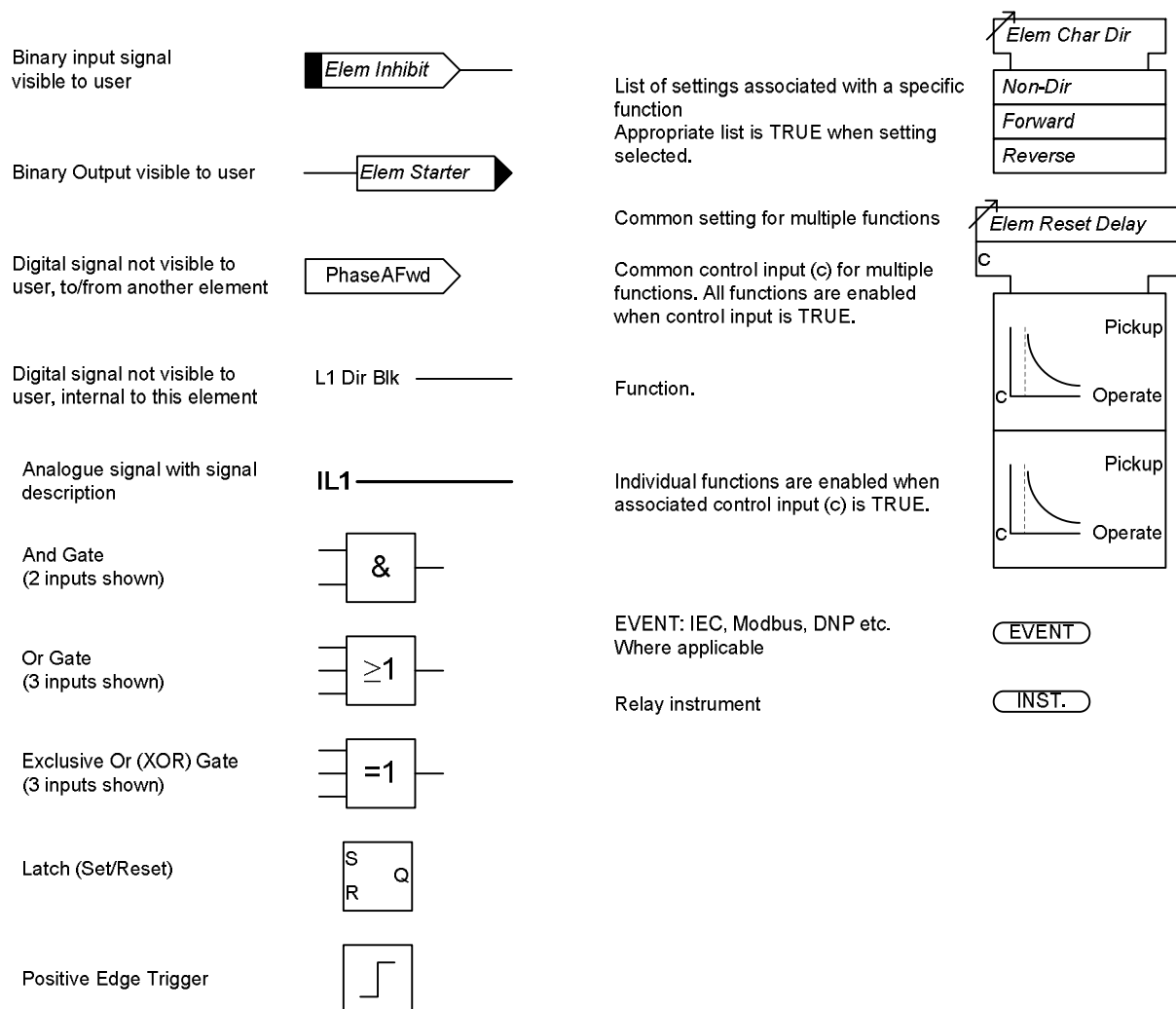
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Symbols and Nomenclature

The following notational and formatting conventions are used within the remainder of this document:

- Setting Menu Location MAIN MENU>SUB-MENU
- Setting: ***Elem name -Setting***
- Setting value: **value**
- Alternatives: **[1st] [2nd] [3rd]**



Section 1: Introduction

This manual is applicable to the following relays:

- **7SR23 DAD High Impedance Protection Relay**

The 7SR23 DAD relay integrates the protection elements required to provide high impedance protection relevant to busbars, connections, motors, reactors, transformers etc.

The 'Ordering Options' Tables summarise the features available in each model.

General Safety Precautions



Current Transformer Circuits

The secondary circuit of a live CT must not be open circuited. Non-observance of this precaution can result in injury to personnel or damage to equipment.



External Resistors

Where external resistors are fitted to relays, these may present a danger of electric shock or burns, if touched.



Fibre Optic Communication

Where fibre optic communication devices are fitted, these should not be viewed directly. Optical power meters should be used to determine the operation or signal level of the device.



Front Cover

The front cover provides additional securing of the relay element within the case. The relay cover should be in place during normal operating conditions.

Table 1-1 7SR23 DAD Ordering Options

7SR23 DAD	7	S	R	2	3	0	□	-	1	□	A	□	□	-	0	C	A	0
High Impedance Protection					↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑
Protection Product					3	0												
Circulating Current																		
Case I/O and Fascia ⁽¹⁾																		
4 CT, 9 BI, 8 BO, 8 LEDs E6 Case ⁽¹⁾							2											
4 CT, 19 BI, 16 BO, 16 LEDs E8 Case ⁽¹⁾							3											
Measuring Input									1									
1/5 A, 50/60Hz																		
Auxiliary voltage										A								
30 to 220V DC, binary input threshold 19V DC										B								
30 to 220V DC, binary input threshold 88V DC																		
Communication Interface																		
Standard version – included in all models, USB front port, RS485 rear port												1	1/2					
Standard version – plus additional rear F/O ST connectors (x2) and IRIG-B												2	1/2					
Standard version – plus additional rear RS485 and IRIG-B												3	1/2					
Standard version – plus additional rear RS232 and IRIG-B												4	1/2					
Standard version – plus additional rear Electrical Ethernet RJ45 (x2)												7	7					
Standard version – plus additional rear Optical Ethernet LC (x2)												8	7					
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					
IEC 60870-5-103, Modbus RTU and DNP 3.0 (user selectable) and IEC 61850													7					
Protection Function Packages																		
50G Measured/Derived earth fault																	C	
87/50 High Impedance Differential																		
87REF High Impedance Restricted Earth Fault																		
CT50 CT Supervision																		
74TCS Trip Circuit Supervision																		
Programmable logic																		

1) BI = Binary Input, BO = Binary Output,

Metrosils	7	X	G	1	4	□	0	-	□	A	A	0	0	-	0	A	A	0
Non linear resistor						↑	↑		↑									
Disc size, number of phases																		
Three inch, single phase						1												
Three inch, three phase						2												
Six inch, single phase						3												
Six inch, three phase						4												
'B' Value							0											
0.2 to 0.25																		
'C' Value																		
450												1						
900												2						
1000												3						

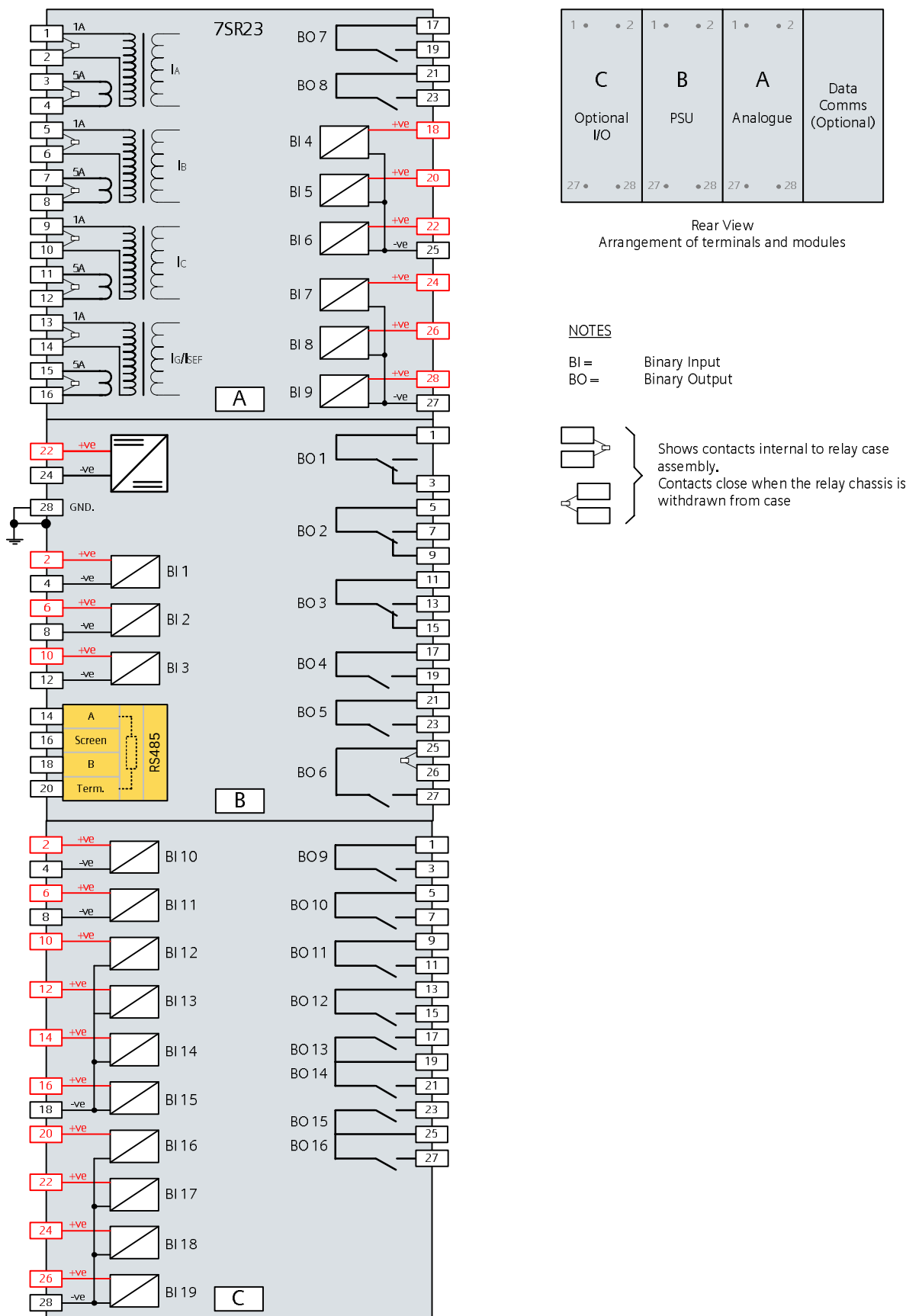


Figure 1-1 Connection Diagram: 7SR23 DAD Relay

Section 2: Hardware Description

2.1 General

The structure of the relay is based upon the Multi-function hardware platform. The relays are supplied in either size E6 or size E8 cases (where 1 x E = width of approx. 26mm). The hardware design provides commonality between products and components across the Multi-function range of relays.

Table 2-1 Summary of 7SR23 DAD Relay Configurations

Relay	Current Inputs	Binary Inputs	Output Relays	LEDs	Case
7SR2302	4	9	8	8	E6
7SR2303	4	19	16	16	E8

Relays are assembled from the following modules:

- 1) Front Fascia with three fixed function LEDs and ordering options of configurable LEDs.
- 2) Processor module
- 3) Analogue Input module 'A': 4 x Current + 6 x Binary Inputs + 2 x Binary Outputs
- 4) Power Supply and basic Binary Input (BI) and Binary Output (BO).
- 5) Optional Binary Input/Output module.
- 6) Optional data comms module.

2.2 Case

The relays are housed in cases designed to fit directly into standard panel racks. The two case options have widths of 156mm (E6) or 208mm (E8) , both have a height of 177 mm (4U).

The complete relay assembly is withdrawable from the front of the case. Contacts in the case ensure that the CT circuits remain short-circuited when the relay is removed. Note that when the optional Ethernet comms module is fitted to the relay the comms cables and the EN100 module rear securing screw must be removed before the relay assembly is withdrawn.

The rear terminal blocks comprise M4 screw terminals for wire connections. Each terminal can accept two 90 degree ring tongue crimps.

Located at the top rear of the case is a screw clamp earthing point, this must be connected to the main panel earth.

See Chapter 5 (Installation Guide) for details of panel cut-out and internal clearance requirements.

2.3 Front Cover

With the transparent front cover in place the user only has access to the ▼ and **TEST/RESET▶** buttons, allowing all areas of the menu system to be viewed, but preventing setting changes and control actions. The only 'action' that is permitted is to reset the Fault Data display, latched binary outputs and LEDs by using the **TEST/RESET ▶** button.

The front cover is used to secure the relay assembly in the case.

2.4 Power Supply Unit (PSU)

The relay PSU can be directly connected to any substation dc system rated from 30V dc to 220V dc.

In the event of the station battery voltage level falling below the relay minimum operate level the PSU will automatically switch itself off and latch out – this prevents any PSU overload conditions occurring. The PSU is reset by switching the auxiliary supply off then on.

Typically the PSU is connected to the auxiliary supply via an external HRC fuse rated at 6A (BS88/IEC60259). Isolation links may also be installed in accordance with user requirements.

2.5 Operator Interface/ Fascia

The operator interface is designed to provide a user-friendly method of controlling, entering settings and retrieving data from the relay.



Figure 2-1 7SR23 DAD with 3 + 8 LEDs in E6 Case

The fascia is an integral part of the relay. Handles are located at each side of the element to allow it to be withdrawn from the relay case.

Relay Information

Above the LCD three labels are provided, these provide the following information:

- 1) Product name and order code.
- 2) Nominal current rating, rated frequency, voltage rating, auxiliary dc supply rating, binary input supply rating, configuration and serial number.
- 3) Blank label for user defined information.

A template is available in the Reydisp programme to allow users to create and print customised LED labels.

The warning and information labels on the relay fascia provide the following information:



Dielectric Test Voltage 2kV



Impulse Test Above 5kV



Caution: Refer to Equipment Documentation



Caution: Risk of Electric Shock

Liquid Crystal Display (LCD)

A 4 line by 20-character liquid crystal display indicates settings, instrumentation, fault data and control commands.

To conserve power the display backlighting is extinguished when no buttons are pressed for a user defined period. A setting within the "SYSTEM CONFIG" menu allows the timeout to be adjusted from 1 to 60 minutes and "Off" (backlight permanently on). After an hour the display is completely de-activated. Pressing any key will re-activate the display.

The LCD contrast can be adjusted using a flat blade screwdriver to turn the screw located below the contrast symbol . Turning the screw clockwise increases the contrast, anti-clockwise reduces the contrast.

'PROTECTION HEALTHY' LED

This green LED is steadily illuminated to indicate that DC voltage has been applied to the relay power supply and that the relay is operating correctly. If the internal relay watchdog detects an internal fault then this LED will continuously flash.

'PICKUP' LED

This yellow LED is illuminated to indicate that a user selectable function(s) has picked up. The LED will self reset after the initiating condition has been removed.

Functions are assigned to the PICKUP LED in the OUTPUT CONFIG>PICKUP CONFIG menu.

'TRIP' LED

This red LED is steadily illuminated to indicate that a user selectable function has operated to trip the circuit breaker. Functions are assigned to the 'Trip' LED using the OUTPUT CONFIG > BINARY OUTPUT CONFIG > Trip Contacts setting.

Operation of the LED is latched and can be reset by either pressing the TEST/RESET► button, energising a suitably programmed binary input, or, by sending an appropriate command over the data communications channel(s).

Indication LEDs

Relays have either 8 or 16 user programmable LED indicators. Each LED can be programmed to be illuminated as either green, yellow or red. Where an LED is programmed to be lit both red and green it will illuminate yellow. Each LED can be assigned two different colours dependent upon whether a Start/Pickup or Operate condition initiates operation. The LED illumination colour is assigned in the OUTPUT CONFIG>LED CONFIG menu for both Pickup and Operate initiation.

Functions are assigned to the LEDs in the OUTPUT CONFIG>OUTPUT MATRIX menu.

Each LED can be labelled by withdrawing the relay and inserting a label strip into the pocket behind the front fascia. A 'template' is available to allow users to create and print customised legends.

Each LED can be user programmed as hand or self-resetting. Hand reset LEDs can be reset by either pressing the TEST/RESET► button, energising a suitably programmed binary input, or, by sending an appropriate command over the data communications channel(s).

The status of hand reset LEDs is maintained by a back up storage capacitor in the event of an interruption to the d.c. supply voltage. The length of time for which the LED status will be maintained will depend on such things as temperature, length of time in service, etc. However the status will be maintained for a minimum of 1.8 days.

LED status stored in fault data records are backed up in non-volatile memory and are permanently stored even in the event of loss of auxiliary d.c. supply voltage, see section **Error! Reference source not found.**

Standard Keys

The relay is supplied as standard with five pushbuttons. The buttons are used to navigate the menu structure and control relay functions. They are labelled:

▲	Increases a setting or moves up menu.
▼	Decreases a setting or moves down menu.
TEST/RESET►	Moves right, can be used to reset selected functionality and for LED test (at relay identifier screen).
ENTER	Used to initiate and accept settings changes.
CANCEL.	Used to cancel settings changes and/or move up the menu structure by one level per press.

NOTE: All settings and configuration of LEDs, BI, BO and function keys can be accessed and set by the user using these keys. Alternatively configuration/settings files can be loaded into the relay using the 'ReyDisp' programs.

2.6 Current Inputs

Four current inputs are provided on the Analogue Input module. Terminals are available for both 1A and 5A inputs. CT ratios are input by the user in the CT CONFIG menu.

Analogue waveform processing is optimised to provide high security operation. Current is sampled at 1600Hz for 50Hz systems and 1920Hz for 60Hz systems (32 samples per cycle).

The waveform recorder samples and displays current input waveforms at 32 samples per cycle.

2.7 Binary inputs

The binary inputs are isolated with opto-couplers and can be operated from a suitably rated dc supply.

Relays are fitted with 9 or 19 binary inputs (BI). The user can assign any binary input to any of the available functions (INPUT CONFIG > INPUT MATRIX).

The Power Supply module includes the relay basic I/O. The module includes 3 x BI.

Pick-up (PU) and drop-off (DO) time delays are associated with each binary input. Where no pick-up time delay has been applied the input may pick up due to induced ac voltage on the wiring connections (e.g. cross site wiring). The default pick-up time of 20ms provides ac immunity. Each input can be programmed independently.

Each input may be logically inverted to facilitate integration of the relay within the user scheme. When inverted the relay indicates that the BI is energised when no d.c. is applied. Inversion occurs before the PU & DO time delay, see Figure 2-2.

Each input may be mapped to any front Fascia indication LED and/or to any Binary output contact and can also be used with the internal user programmable logic. This allows the relay to provide panel indications and alarms.

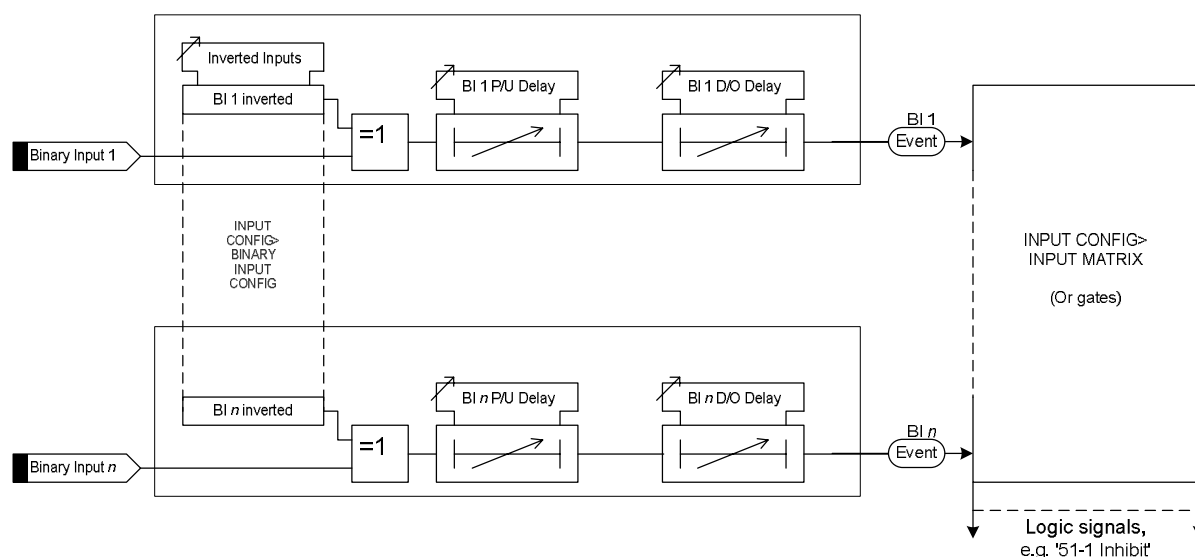


Figure 2-2 Binary Input Logic

2.8 Binary Outputs (Output Relays)

Relays are fitted with 8 or 16 binary outputs. All outputs are fully user configurable and can be programmed to operate from any or all of the available functions.

The Power Supply module includes the relay basic I/O. The module includes six binary outputs each fitted with 1 contact – providing in total 1 x normally closed (NC), 2 x change-over (CO) and 3 x normally open (NO) contacts.

In the default mode of operation binary outputs are self reset and remain energised for a user configurable minimum operate time of up to 60 seconds. If required, outputs can be programmed to operate as 'hand reset' or 'pulsed'. Where an output is programmed to be 'hand reset' and 'pulsed' then the output will be 'hand reset' only.

The binary outputs can be used to operate the trip coils of the circuit breaker directly where the trip coil current does not exceed the 'make and carry' contact rating. The circuit breaker auxiliary contacts or other in-series auxiliary device must be used to break the trip coil current.

CB'Trip Contacts' are assigned in the OUTPUT CONFIG>BINARY OUTPUT CONFIG menu. Operation of a 'Trip Contact' will actuate the 'Trip Alert' screen where enabled and will initiate both fault record storage and CB Fail protection where enabled.

When the relay is withdrawn from the case all normally closed contacts will be open circuited. This should be considered in the design of the control and protection circuitry.

Notes on Self Reset Outputs

Outputs reset after the initiate condition is removed, they are subject to the user definable 'Minimum Operate Time' setting.

With a failed breaker condition the relay may remain operated until current flow in the primary system is interrupted by an upstream device. The relay will then reset and attempt to interrupt trip coil current flowing through an output contact. Where this level is above the break rating of the output contact an auxiliary relay with heavy-duty contacts should be utilised.

Notes on Pulsed Outputs

When operated, the output will reset after the user definable 'Minimum Operate Time' setting regardless of the initiating condition.

Notes on Hand Reset Outputs

Hand reset outputs can be reset by either pressing the **TEST/RESET▶** button, by energising a suitably programmed binary input, or, by sending an appropriate command over the data communications channel(s).

On loss of the auxiliary supply hand-reset outputs will reset. When the auxiliary supply is re-established the binary output will remain in the reset state unless the initiating condition is still present.

Binary Output Test

The MAINTENANCE>OUTPUT MATRIX TEST menu includes a facility to test output relays from the relay fascia without the need for a secondary injection test set.

Binary outputs can also be energised from the Reydisp Evolution software package where PC facilities are available.

For both methods the output contact is energised for the duration of the 'OUTPUT CONFIG > BINARY OUTPUT CONFIG > Min Operate Time' setting.

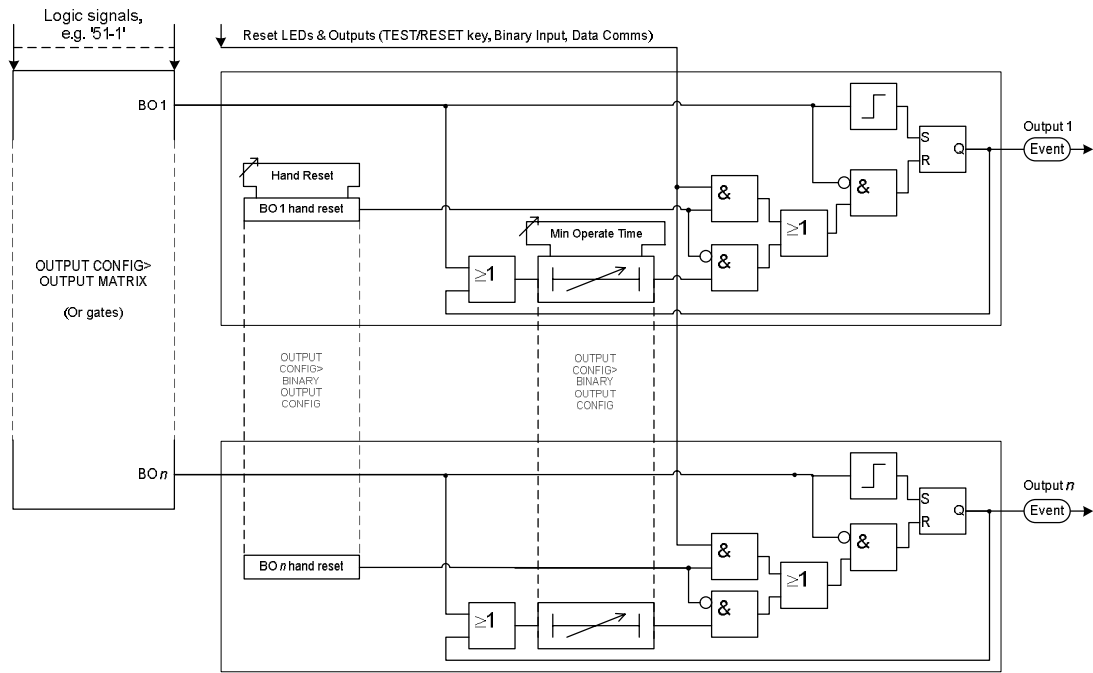


Figure 2-3 Binary Output Logic

2.9 Virtual Input/Outputs

The relays have 16 virtual input/outputs, these are internal logic states. Virtual I/O is assigned in the same way as physical Binary Inputs and Binary Outputs. Virtual I/O is mapped from within the INPUT CONFIG > INPUT MATRIX and OUTPUT CONFIG > OUTPUT MATRIX menus.

The status of virtual I/O is not stored during power loss.

2.10 Self Monitoring

The relay incorporates a number of self-monitoring features. Each of these features can initiate a controlled reset recovery sequence.

Supervision includes a power supply watchdog, code execution watchdog, memory checks by checksum and processor/ADC health checks. When all checks indicate the relay is operating correctly the 'Protection Healthy' LED is illuminated.

If an internal failure is detected, a message will be displayed. The relay will reset in an attempt to rectify the failure. This will result in de-energisation of any binary output mapped to 'protection healthy' and flashing of the protection healthy LED. If a successful reset is achieved by the relay the LED and output contact will revert back to normal operational mode, and the relay will restart, therefore ensuring the circuit is protected for the maximum time.

A Start-up Counter Meter is provided to display the number of start-ups the relay has performed. Once the number of start-ups has exceeded a set number, an Alarm output can be given.



Figure 2.10-1 Start-up Counter Meter

Reset of the counter can be done from the meter or via a binary input or a command.

Various types of start-up are monitored by the relay:

1. **power-on starts** (auxiliary supply initiation)
2. **expected starts** (user initiated via comms, language changes, custom protection curve etc.)
3. **unexpected starts** (caused by the relay watchdog)

Any combination of these can be selected for the start-up count. This is done in the MAINTENANCE MENU>START COUNT menu using the **Start Up Types** setting. All the start-up types selected will be added to the overall start-up count.

The number of restarts before the alarm output is raised is set in the MAINTENANCE MENU>START COUNT menu using the **Start Up Count Target** setting.

When the number of relay start-ups reaches the target value an output is raised, OUTPUT MATRIX>**Start Up Count Alarm**, which can be programmed to any combination of binary outputs, LED's or virtual outputs.

2.10.1 Protection Healthy/Defective

A normally open contact can be used to signal protection healthy. When the relay has DC supply and it has successfully passed its self-checking procedure then the Protection Healthy contacts are made.

A normally closed contact is used to signal protection defective. When the DC supply is not applied to the relay or a problem is detected within the relay then this output is de-energised and the normally closed contacts make to provide an external alarm.

An alarm can be provided if the relay is withdrawn from the case. A contact is provided in the case at positions 25-26 of the PSU module, this contact closes when the relay is withdrawn.

Section 3: Protection Functions

The relay is equipped with protection elements as shown in fig. 3.1.

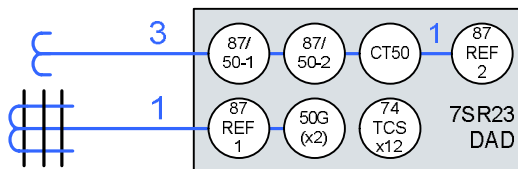


Figure 3-1 Protection Functions

The above illustrates the SYSTEM CONFIG > Relay Config > USER settings. This setting gives the user access to all protection functions.

The relay can also be automatically configured into selected modes using the other options in the SYSTEM CONFIG > Relay Config > settings, see section 3.4.

3.1 Overall High Impedance Differential Protection (87/50-n)

Two 87/50 high impedance elements are provided for each current input (87/50-1 and 87/50-2).

The fundamental frequency current is measured by the phase CT inputs.

87/50-n Setting defines the current required to operate the differential element. 87/50-n outputs are available for any phase or for each individual phase.

When 87/50-n Trip Check Logic is Enabled outputs are available when any two phases operate (i.e. 87/50-n phase-phase check).

Operation of the differential elements can be inhibited from:

Inhibit 87/50-n	A binary or virtual input.
CT50 CT Supervision Action: Inhibit	Operation of the CT Supervision elements
Zone Switchout	Control Menu, data comms or input matrix selection.
User Inhibit	Reylogic (graphical logic)

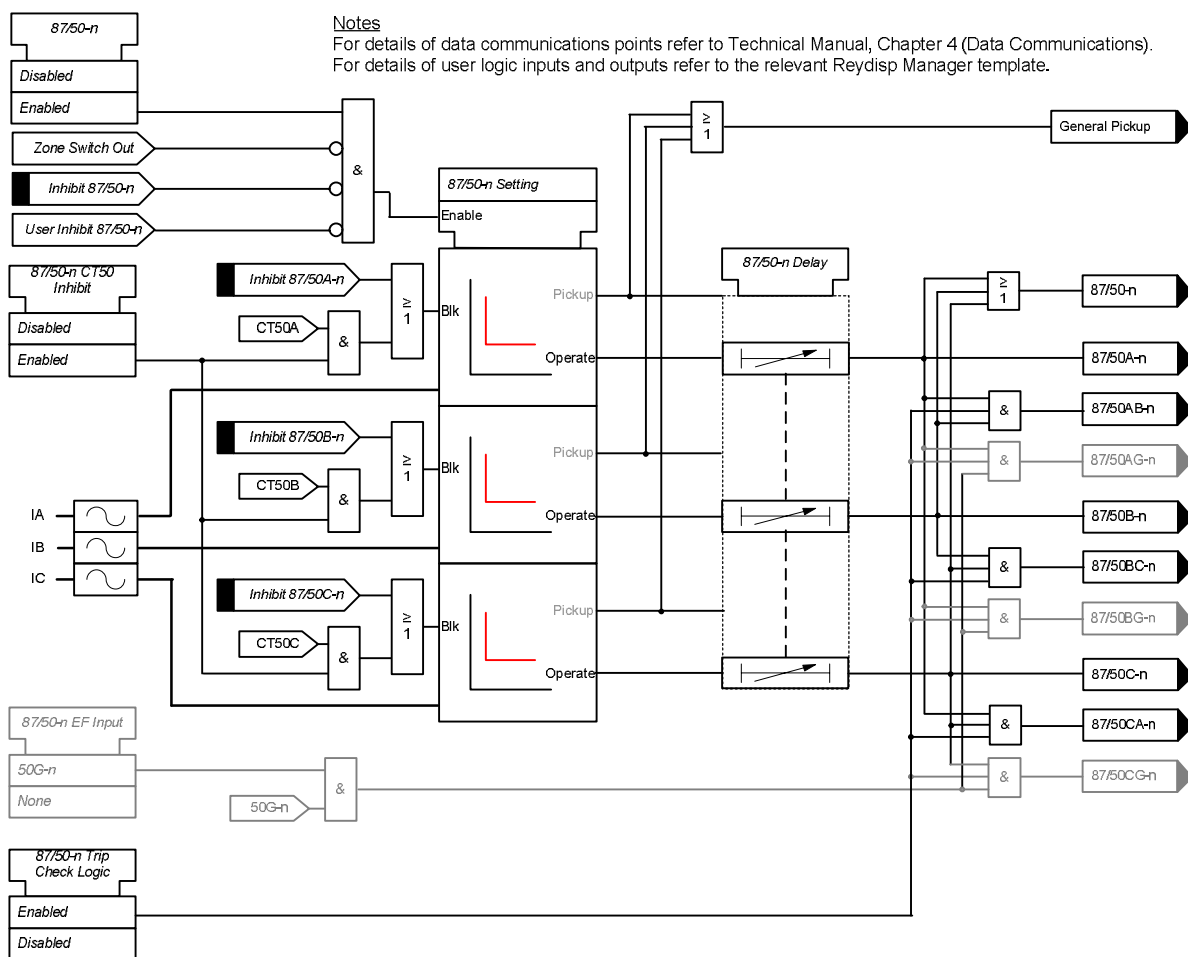


Figure 3-2 Logic Diagram: Differential Protection

3.2 Protection: Measured Earth Fault (50G)

The earth current is measured directly by the earth current input. These elements utilise either the true RMS current or the fundamental frequency RMS current (50 or 60Hz).

Two instantaneous measured earth fault elements are provided.

Each element has an independent **50G-n Setting** setting to define the pick-up current

Each element has an independent **50G-n Delay** setting to define the operate time delay after pick-up.

The 50G elements have transient free operation.

Operation of the instantaneous earth fault elements can be inhibited from:

Inhibit 50Gn	A binary or virtual input.
EF In/Out Switching	Control Menu selection
User Inhibit	Reylogic (graphical logic)

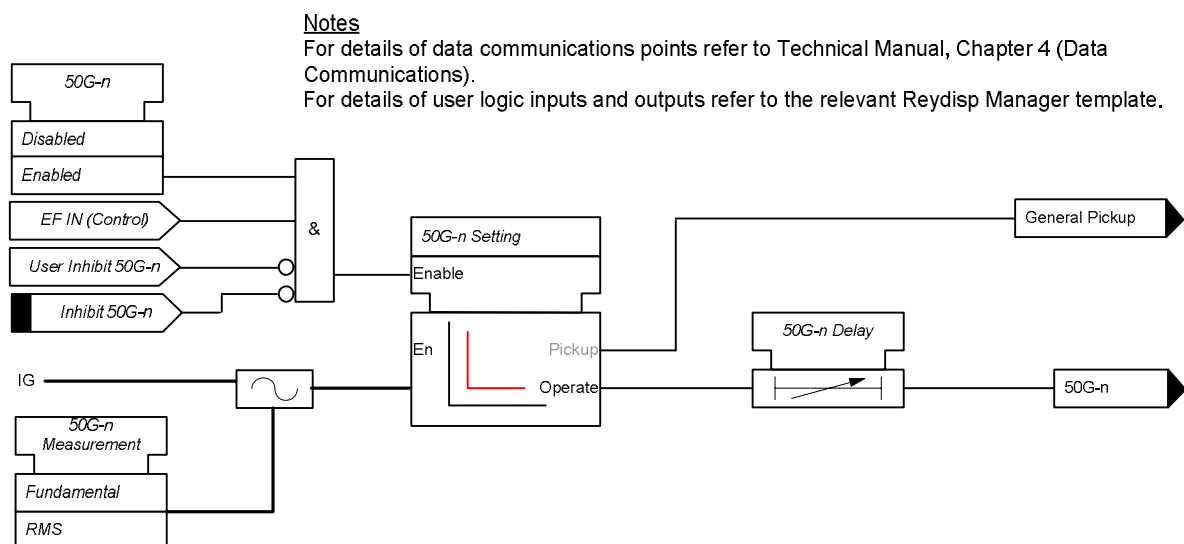


Figure 3-3 Logic Diagram: Measured Earth Fault Element

3.3 Protection: Restricted Earth Fault (87REF)

Two 87REF elements are provided (87REF-1 and 87REF-2). 87REF-1 earth current is measured by the earth current input, 87REF-2 current is measured by the I_B current input. These elements utilise RMS current values of the fundamental frequency (50 or 60Hz).

Two restricted earth fault elements are provided.

87REF-n Setting defines the current required to operate the REF element. The output of **87REF-n Delay** can be mapped to relay outputs.

Operation of the REF-n element can be inhibited from:

Inhibit 87REF-n	A binary or virtual input.
User Inhibit	Reylogic (graphical logic)

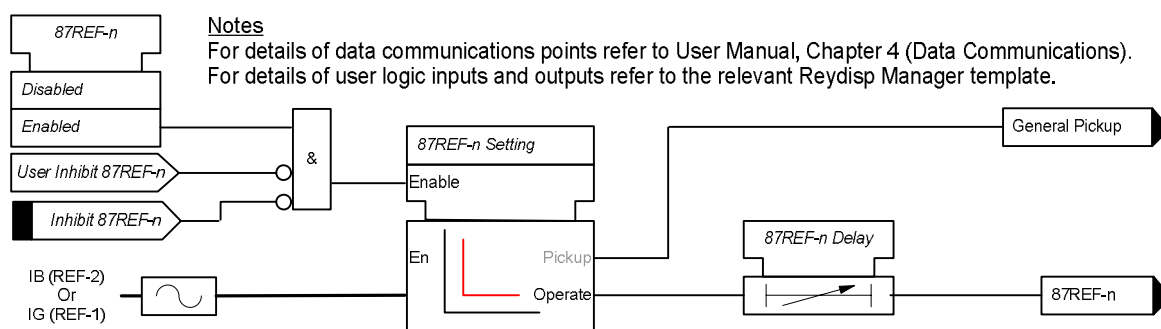


Figure 3-4 Logic Diagram: Restricted Earth Fault Protection

3.4 Protection: Mode Selection

3.4.1 '3 Pole Diff' + REF' Operation

The relay is configured for '3 Pole Diff + REF' operation using the **SYSTEM CONFIG > Relay Config > 3 Pole Diff + REF** setting. Protection elements are automatically enabled as shown in Figure 3-5.

When configured in this way the relay uses the 87/50-n and the REF-1 elements. These elements operate independently of each other. Independent outputs are available.

When 87/50-n Trip Check Logic is Enabled outputs are available when any two phases operate (i.e. 87/50-n phase-phase check).

For detailed information on the differential and restricted earth fault functions refer to sections 3.1 and 3.3.

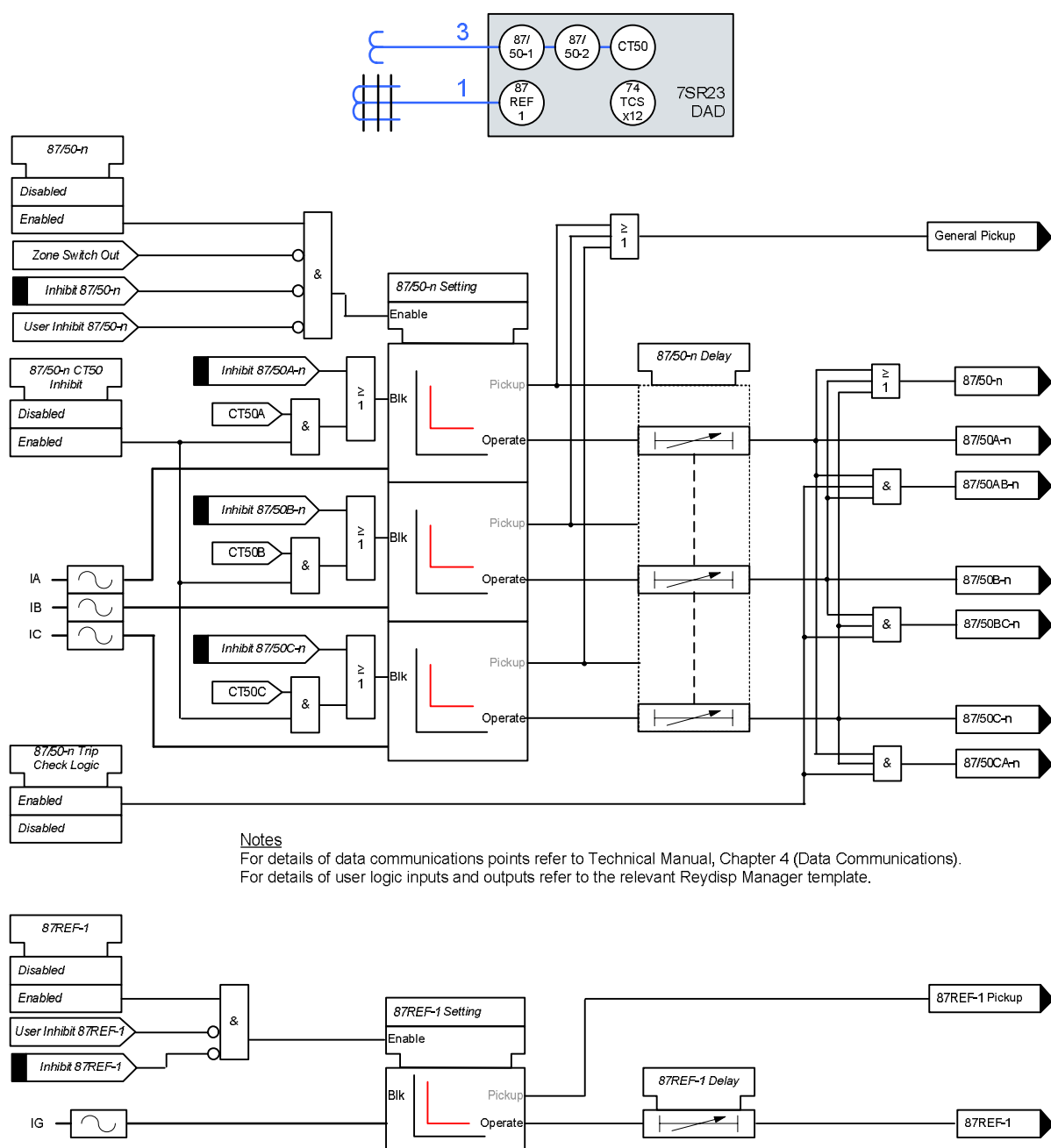


Figure 3-5 Logic Diagram: '3 Pole Diff + REF' Protection

3.4.2 '3 Pole Diff + EF' Operation

The relay can be used to provide both 3 phase differential and earth fault protections using the **SYSTEM CONFIG > Relay Config > 3 Pole Diff + EF** setting.

When configured in this way the relay uses the 87/50-n and the 50G-n elements. These elements operate independently of each other, an output may be given only when both are operated – see Figure 3-6 below.

When 87/50-n Trip Check Logic is Enabled outputs are available when any two phases operate (i.e. 87/50-n phase-phase check) or when an 87/50 element operates coincidentally with the 50G element (phase-earth check).

For detailed information on differential and earth fault functions refer to sections 3.1 and 3.2.

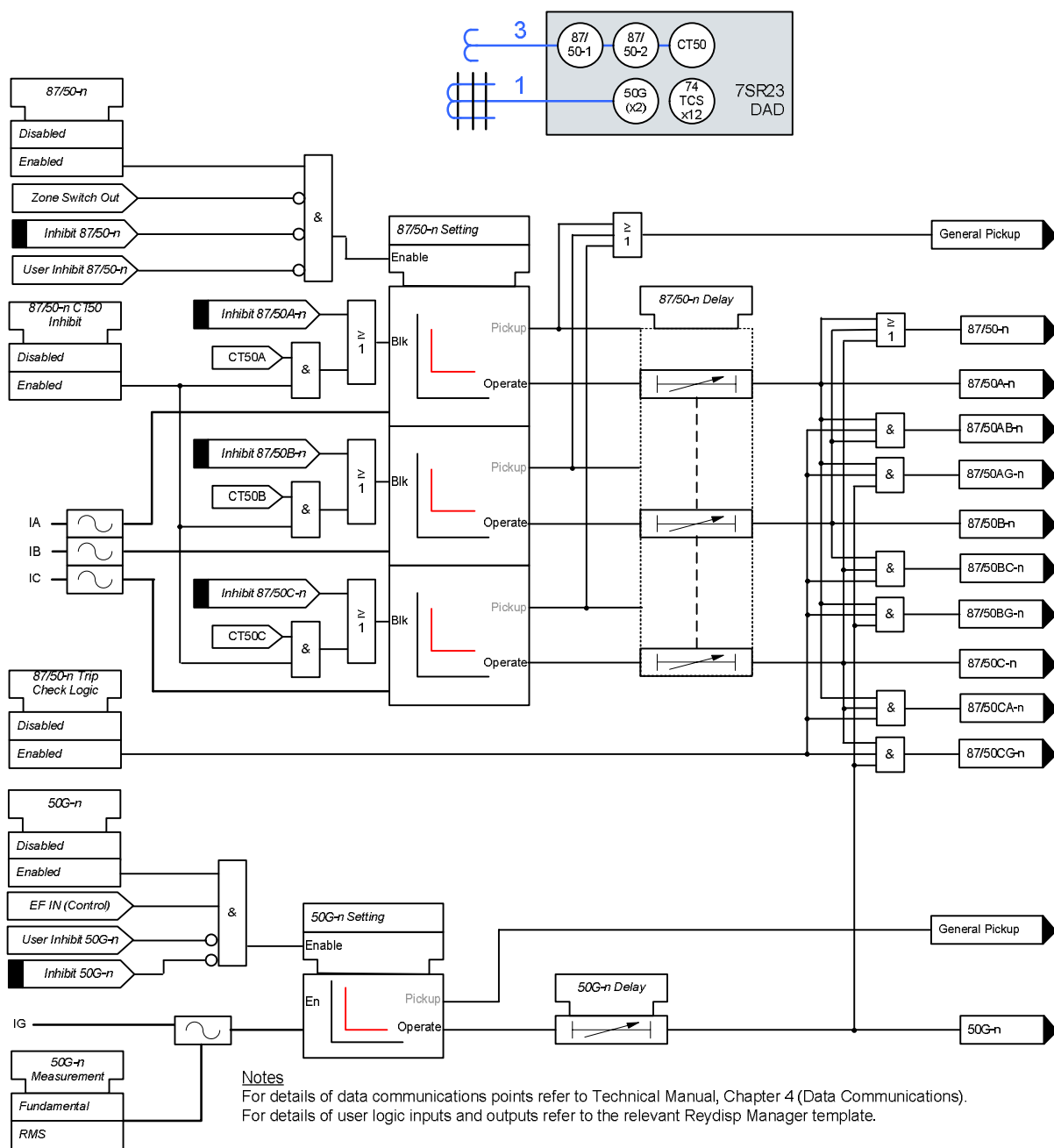


Figure 3-6 Logic Diagram: '3 Pole Diff + EF' Protection

3.4.3 'REF1 + REF2' Operation

The relay is configured for 'REF1 + REF2' operation using the **SYSTEM CONFIG > Relay Config > REF1 + REF2** setting.

When configured in this way the relay uses both 87REF elements. 87REF-1 earth current is measured by the earth current input, 87REF-2 current is measured by the I_B current input. These elements operate independently of each other.

For detailed information on the restricted earth fault functions refer to section 3.3.

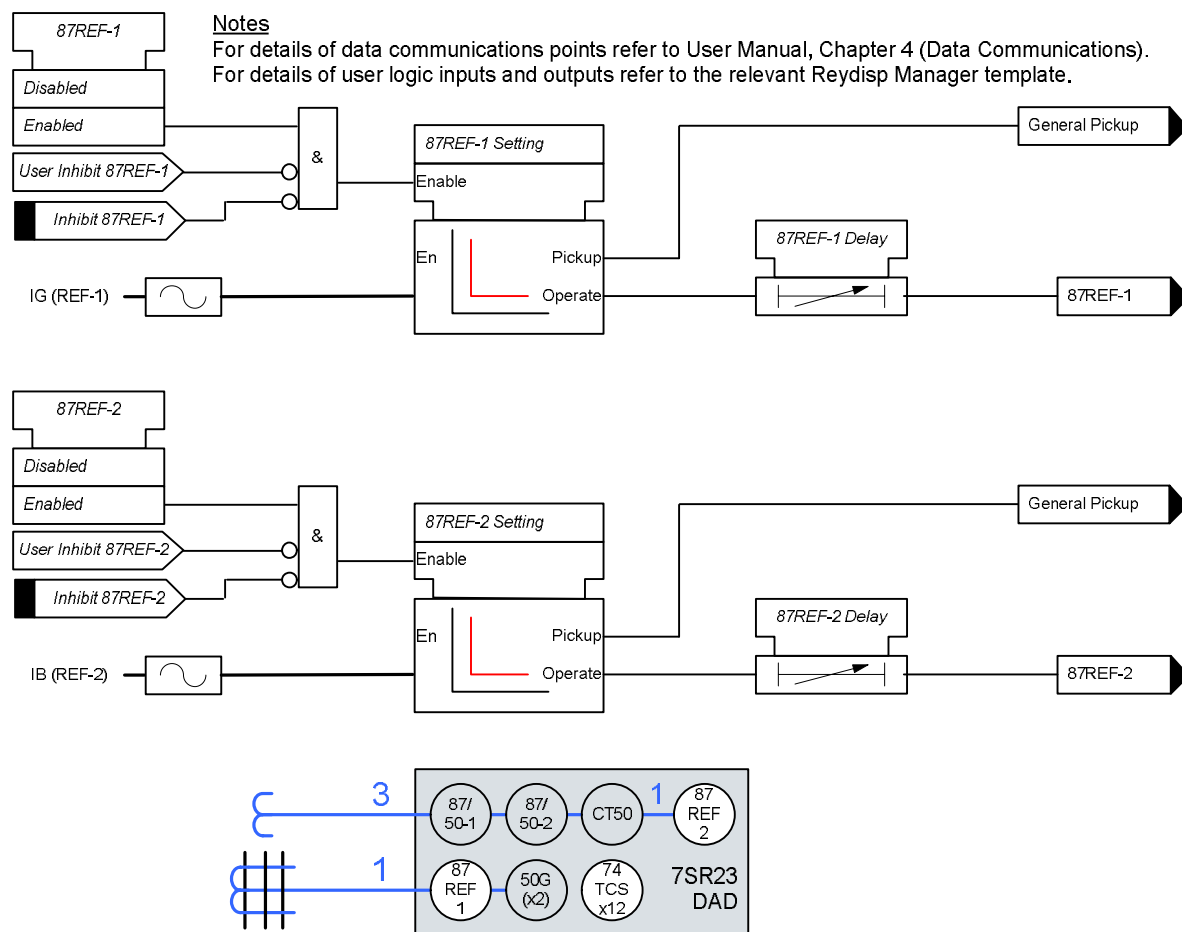


Figure 3-7 Logic Diagram: 'REF1 + REF2' Protection

Section 4: Control & Logic Functions

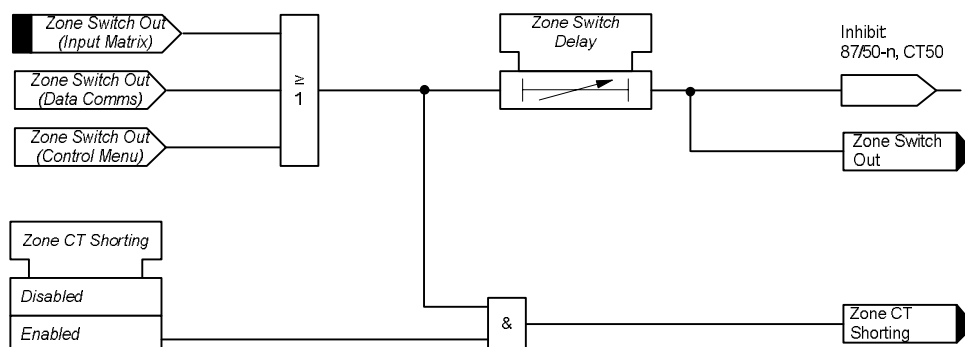
4.1 Zone Switching

In/Out switching of the high impedance protections is provided to aid commissioning and testing.

When the 'Zone Switch Out' feature is initiated the operation of the differential protection and CT supervision monitoring is inhibited. User selected output contacts assigned to 'CT50' are operated when 'Zone Switchout CT Shorting' is selected to Enabled. The connection of these contacts in the protection scheme ensures that any unbalance current in the differential circuit does not flow through the relay/stabilising resistor.

Operation of the Zone Switch Out feature can be initiated from:

- A binary or virtual input.
- Data comms
- Control menu



Notes

For details of data communications points refer to Technical Manual, Chapter 4 (Data Communications).
For details of user logic inputs and outputs refer to the relevant Reydisp Manager template.

Figure 4-1 Logic Diagram: Protection In/Out Switching

4.2 Quick Logic

The 'Quick Logic' feature allows the user to input up to 16 logic equations (E1 to E16) in text format. Equations can be entered using Reydisp or at the relay fascia.

Each logic equation is built up from text representing control characters. Each can be up to 20 characters long. Allowable characters are:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9	Digit
()	Parenthesis
!	'NOT' Function
.	'AND' Function
^	'EXCLUSIVE OR' Function
+	'OR' Function
En	Equation (number)
Fn	Function Key (number)
	'1' = Key pressed, '0' = Key not pressed
In	Binary Input (number)
	'1' = Input energised, '0' = Input de-energised
Ln	LED (number)
	'1' = LED energised, '0' = LED de-energised
On	Binary output (number)
	'1' = Output energised, '0' = Output de-energised
Vn	Virtual Input/Output (number)
	'1' = Virtual I/O energised, '0' = Virtual I/O de-energised

Example Showing Use of Nomenclature

E1= ((I1^F1).!O2)+L1

Equation 1 = ((Binary Input 1 XOR Function Key 1) AND NOT Binary Output 2) OR LED 1

When the equation is satisfied (=1) it is routed through a pick-up timer (**En Pickup Delay**), a drop-off timer (**En Dropoff Delay**), and a counter which instantaneously picks up and increments towards its target (**En Counter Target**).

The counter will either maintain its count value **En Counter Reset Mode = OFF**, or reset after a time delay:

En Counter Reset Mode = Single Shot: The **En Counter Reset Time** is started only when the counter is first incremented (i.e. counter value = 1) and not for subsequent counter operations. Where **En Counter Reset Time** elapses and the count value has not reached its target the count value is reset to zero.

En Counter Reset Mode = Multi Shot: The **En Counter Reset Time** is started each time the counter is incremented. Where **En Counter Reset Time** elapses without further count increments the count value is reset to zero.

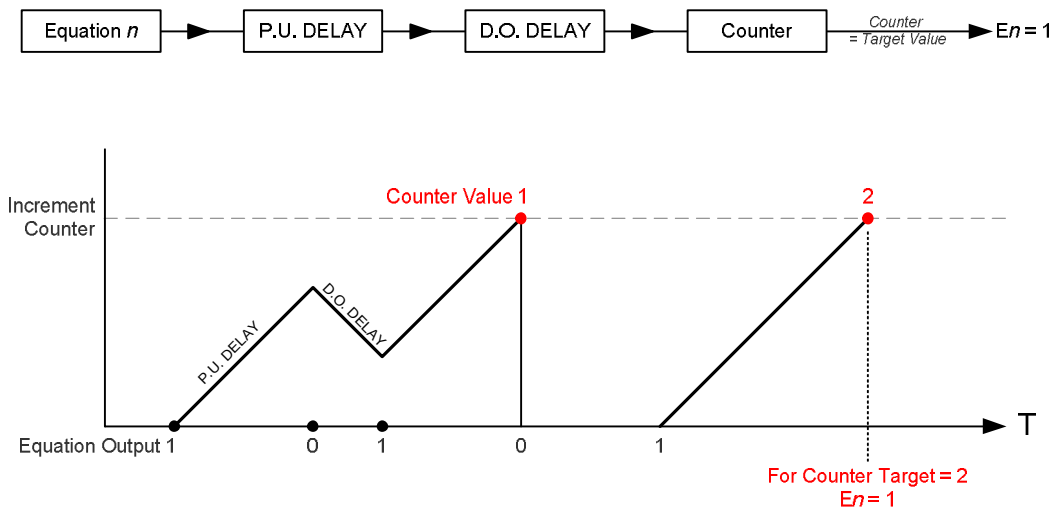


Figure 4-2 Sequence Diagram showing PU/DO Timers in Quick Logic (Counter Reset Mode Off)

When the count value = **En Counter Target** the output of the counter (En) = 1 and this value is held until the initiating conditions are removed when En is instantaneously reset.

The output of En is assigned in the OUTPUT CONFIG>OUTPUT MATRIX menu where it can be programmed to any binary output (O), LED (L) or Virtual Input/Output (V) combination.

Protection functions can be used in Quick Logic by mapping them to a Virtual Input / Output.

Refer to Section 7 – Applications Guide for examples of Logic schemes.

Section 5: Supervision Functions

5.1 CT Supervision (CT50)

The CT supervision feature is phase segregated, outputs are provided for individual phases. Individual phases of the differential protections 87/50 can be blocked.

Operation of the CT Supervision elements can be inhibited from:

Inhibit CT50

A binary or virtual input.

Zone Switchout

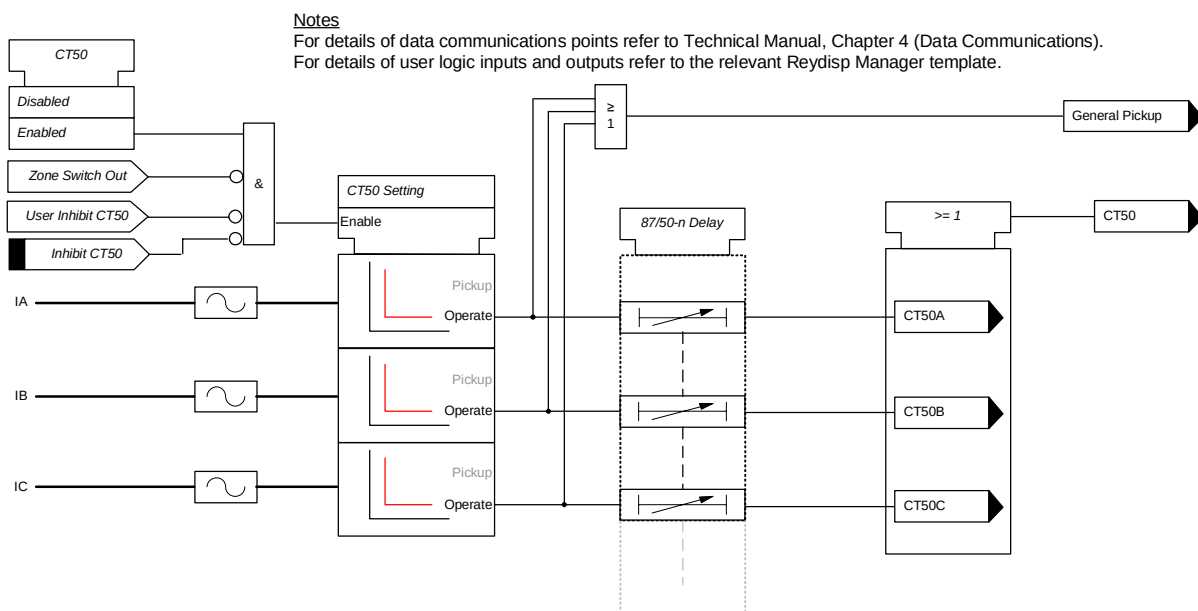


Figure 5-1 Logic Diagram: CT Supervision

5.2 Sustained Fault, CB Fail & CB Position Monitoring

The Sustained Fault Monitor (87/50SFM) feature can be used where either dedicated CB fail protection is not fitted and/or where the location of the protection CTs may introduce operational constraints.

If after operation of the differential protection the fault remains uncleared this is due to either a CB fail condition or because the fault has occurred in a protection blind spot created by the position of the CTs. This function can identify and differentiate between a failed CB and a blind spot fault – see Chapter 7, Applications Guide.

When selected to 'Enabled' the 87SFM Delay starts after operation of the 87/50-1 protection, when the DTL elapses it indicates that the fault remains un-cleared.

87SFM functionality is enhanced where CB status information is available either over the 61850 bus or from CB auxiliary switches wired to binary inputs of the relay. When enabled by the 87/50BF (differential current CB fail) feature a CB fail condition can be determined and the faulted circuit breaker(s) can be identified.

The 87/50SFM feature will pick up where 87/50 is Enabled, 87/50SFM is Enabled, an 87/50-n element has operated and both the 'Inhibit 87/50SFM and CT50 have not operated.

Outputs can be mapped to any combination of output contacts or LEDs, outputs are available from:

87/50SFM where the 87SFM DTL has elapsed.

87/50BF output is issued where CB status monitoring is available and one of the monitored CBs does not indicate open i.e. a CB fail condition has been detected.

CBn Cct Close Alarm output is issued to identify the failed CB where CB status monitoring is available and the CB fail condition above is detected.

87/50BF Blind Spot output is issued where CB status is available and all CBs are open after a sustained differential current is detected.

Operation of the Sustained Fault Monitor function can be inhibited from:

Inhibit 87SFM

A binary or virtual input.

CT50

Operation of the CT Supervision elements

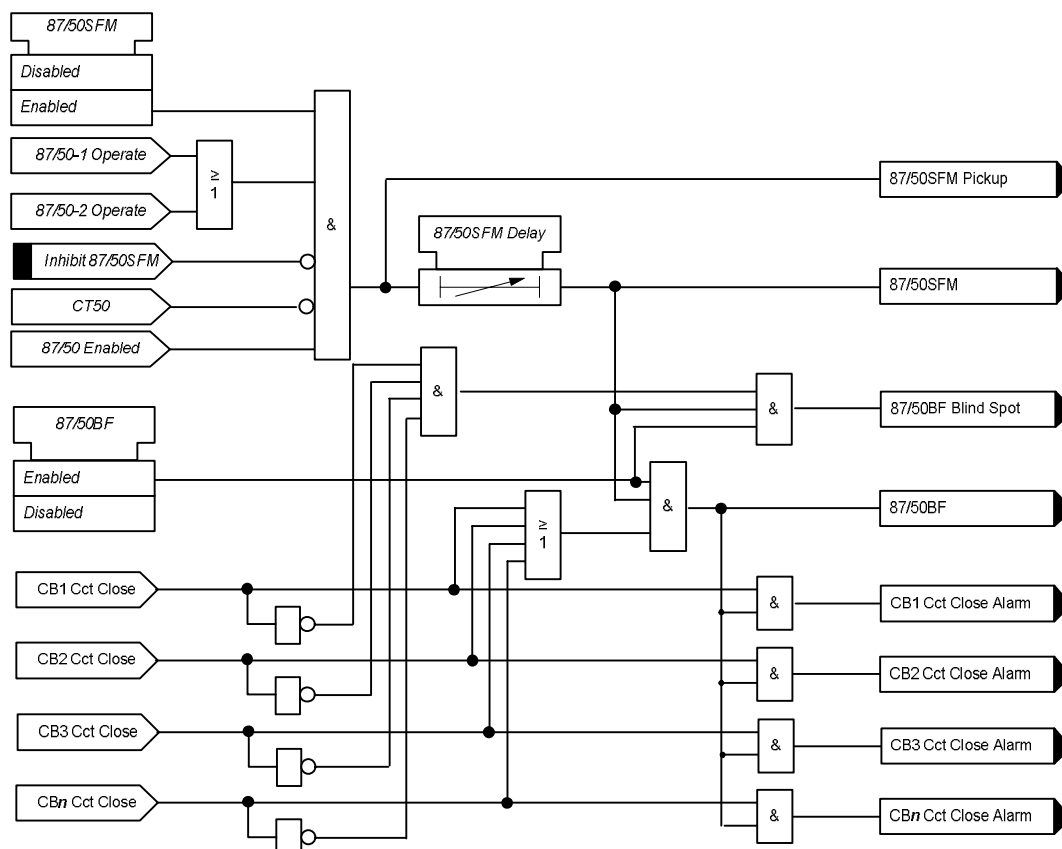


Figure 5-2 Logic Diagram: 87/50SFM and 87/50BF

5.2.1 CB/Circuit Position Monitoring

The position of up to 12 CBs can be monitored utilising either the IEC61850 comms or wiring between binary inputs of the 7SR23 and CB auxiliary switches, in effect producing a replica of the busbar.

Auxiliary switches can be connected either as a single CB open, a single CB close or using two auxiliary switches as a pair i.e. switches for both the CB open and CB closed positions. When two auxiliary switches from a CB are monitored an alarm/inhibit can be provided for the CB 'Don't Believe it' (DBI) state.

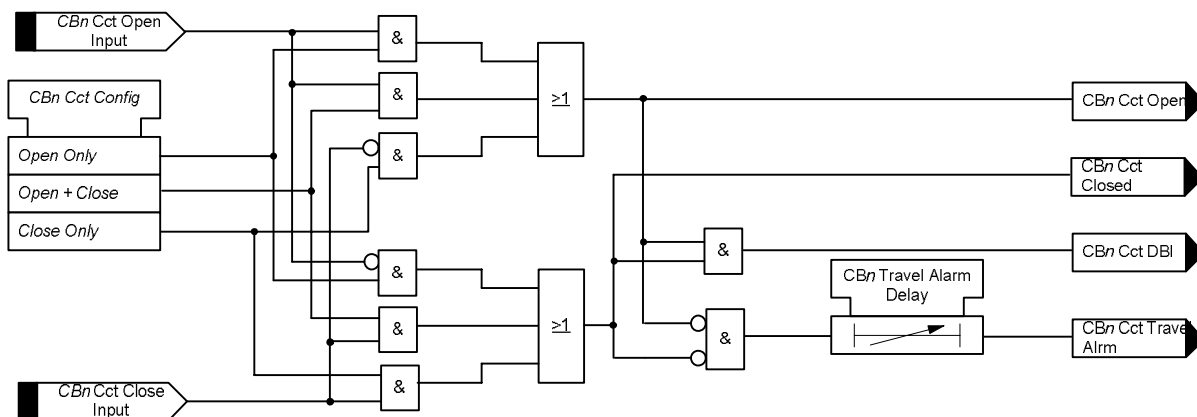
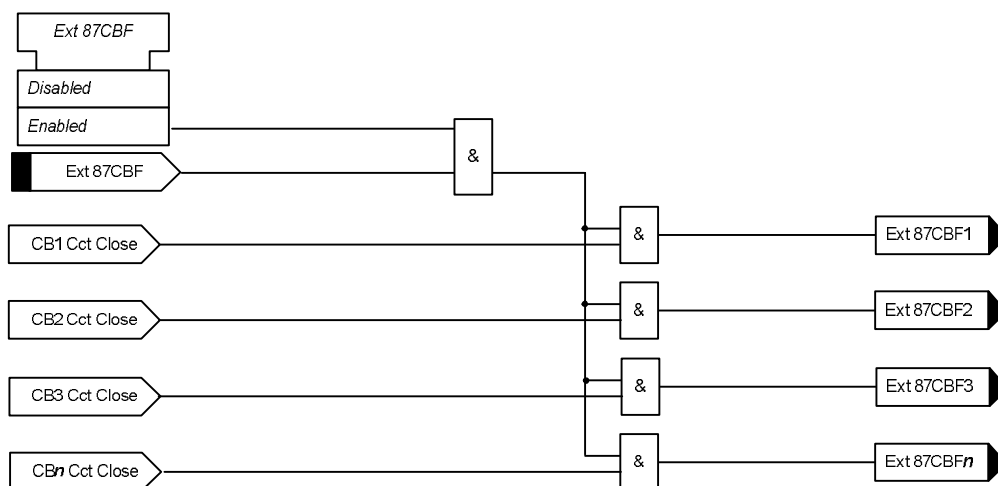


Figure 5-3 Logic Diagram: CB Position Monitoring

5.2.2 External CB Fail Input (Ext 87CBF)

An external CB Fail initiate can utilise the CB Position monitoring feature. When an external protection operates but then identifies a failed CB condition, an output signal can be provided. The output signal can be connected to a binary input programmed as *Ext 87CBF*. Outputs are energised for any circuit breaker that is connected to the faulted busbar and is identified as being in the closed position.



Notes

For details of data communications points refer to Technical Manual, Chapter 4 (Data Communications).
For details of user logic inputs and outputs refer to the relevant Reydisp Manager template.

Figure 5-4 Logic Diagram: Ext 87CBF

5.3 Trip Circuit Supervision (74TCS)

The relay provides 12 trip circuit supervision elements. All elements are identical in operation and independent from each other allowing 12 trip circuits to be monitored.

One or more binary inputs can be mapped to **74TCS-n**. The inputs are connected into the trip circuit such that at least one input is energised when the trip circuit wiring is intact. If all mapped inputs become de-energised, due to a break in the trip circuit wiring or loss of supply an output is given.

The **74TCS-n Delay** setting prevents failure being incorrectly indicated during circuit breaker operation. This delay should be greater than the operating time of the circuit breaker.

The use of one or two binary inputs mapped to the same Circuit Supervision element (e.g. 74TCS-n) allows the user to realise several alternative monitoring schemes – see 'Applications Guide'.

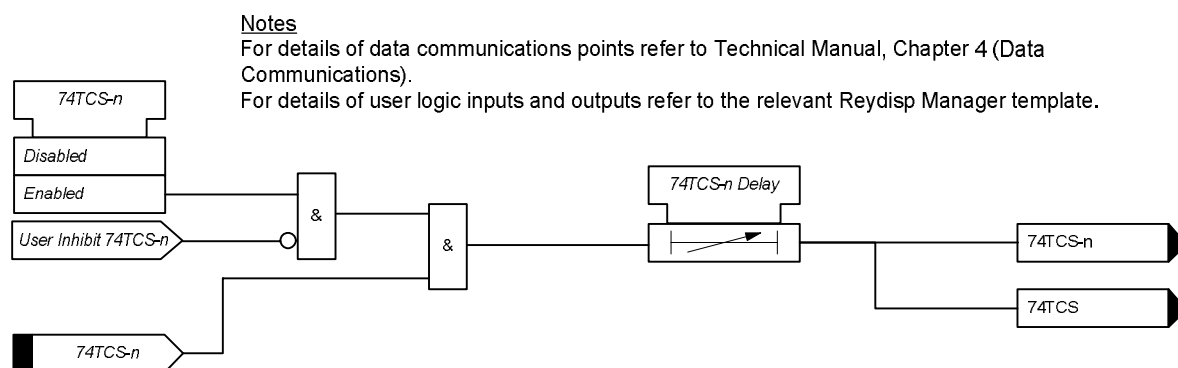


Figure 5-5 Logic Diagram: Trip Circuit Supervision Feature (74TCS)

Section 6: Other Features

6.1 Data Communications

Two communication ports, COM1 and COM2 are provided as standard. RS485 connections are available on the terminal blocks at the rear of the relay (COM1). A USB port, COM 2, is provided at the front of the relay for local access using a PC.

Optionally, additional communication ports are available: -

- 2x fibre optic communication serial ports with ST connectors (COM 3 and COM 4) plus 1x IRIG B

- 1x RS232 serial port (COM 3) plus IRIG B

- 1x RS485 serial port (COM 3) plus IRIG B

- 2 x Electrical Ethernet with RJ45 connectors IEC 61850 - (COM 3 and COM 4),

- 2 x Optical Ethernet Duplex LC connectors IEC 61850 - (COM 3 and COM 4).

Communication is compatible with Modbus-RTU, IEC60870-5-103 FT 1.2, DNP 3.0, and IEC60870-5-101 transmission and application standards for all serial ports and IEC 61850 for Ethernet ports.

Reydisp Manager provides the functionality of Reydisp Evolution and also provides project management of multiple devices to allow engineering of IEC61850 projects

Communication with the relay from a personal computer (PC) is facilitated by the REYDISP EVOLUTION software package. The program allows the transfer of relay settings, waveform records, event records, fault data records, Instruments/meters and control functions. REYDISP EVOLUTION is compatible with IEC60870-5-103.

Data communications operation is described in detail in Chapter 4 of this manual.

6.2 IEC 61850 Communications

The relay can optionally be provided with IEC61850 comms.

The 61850 comms can be user configured to provide HSR, PRP and RSTP operation.

For further details refer to the following publications:

- Model Implementation Conformance Statement (MICS)

- Protocol Implementation Conformance Statement (PICS)

- Protocol Implementation Extra Information for Testing (PIXIT)

6.3 Maintenance

6.3.1 Output Matrix Test

The feature is available from the Relay fascia and allows the user to operate binary outputs or LEDs assigned to relay functions.

Any protection function which is enabled in the setting menu will appear in the Output Matrix Test.

6.3.2 CB Counters

Trip counters for up to 12 circuit breakers are provided:

CB1 Total Trip Count:	Increments on each trip command issued.
CB1 Delta Trip Count:	Additional counter which can be reset independently of the Total Trip Counter. This can be used, for example, for recording trip operations between visits to a substation.

The status of each counter can be viewed in the INSTRUMENTS mode.

Binary outputs can be mapped to each of the above counters, these outputs are energised when the user defined **Count Target** is reached.

6.4 Data Storage

6.4.1 General

The relay stores three types of data records: relay event records, analogue/digital waveform records and fault data records. These data records are backed up in non-volatile memory and are permanently stored even in the event of loss of auxiliary d.c. supply voltage.

6.4.2 Event Records

The event recorder feature allows the time tagging of any change of state (Event) in the relay. As an event occurs, the actual event condition is logged as a record along with a time and date stamp to a resolution of 1 millisecond. There is capacity for a maximum of 5000 event records that can be stored in the relay and when the event buffer is full any new record will over-write the oldest. Stored events can be erased using the DATA STORAGE>**Clear Events** setting.

The following events are logged:

- Change of state of Binary outputs.
- Change of state of Binary inputs.
- Change of Settings and Settings Group
- Change of state of any of the control functions of the relay.

All events can be uploaded over the data communications channel(s) and can be displayed in the 'ReyDisp Evolution' package in chronological order, allowing the sequence of events to be viewed. Events are also made available spontaneously to an IEC 60870-5-103 or Modbus RTU compliant control system.

For a complete listing of events available in each model, refer to Technical Manual section 4 'Data Comms'.

6.4.3 Waveform Records.

Waveform records provide a trace of the instantaneous magnitude of each analogue input channel and the status of each binary channel i.e. each binary input, binary output, virtual I/O and LED, against time for the duration of the record. The values are recorded at every digital sampling point used by the relay software.

Each recorded analogue waveform displays an input identifier, minimum value, maximum value and the instantaneous values at both cursor positions (user variable). Each binary waveform displays the input/output number and the initiating condition(s) e.g. external input or protection element.

Triggering of waveform storage is configured from the 'Settings > DATA STORAGE > WAVEFORM STORAGE' menu. Triggering is automatically initiated from operation of any of the selected protection or control elements. Waveform storage can also be triggered from the relay fascia, from a suitably programmed binary input or via the data comms channel(s).

Waveforms are sampled at a rate of 32 samples per cycle.

The latest 100 records are stored, the most recent is waveform 1. Records are archived by the relay during quiescent periods. The duration of each stored record is 1s, 2s, 5s or 10s. The percentage of waveform storage prior to waveform triggering is user configurable. When the waveform archive buffer is full (i.e. 100 records are stored) the triggering of a new waveform record causes the oldest record - waveform 100 – to be overwritten.

Stored waveforms can be deleted from the relay fascia using the DATA STORAGE > *Clear Waveforms* setting or via Reydisp.

6.4.4 Fault Data Records

Measured quantities for the last 100 relay trip fault records are stored with time and date of trip.

The HMI LCD can display the latest 10 fault records with time and date of trip, measured quantities and LED status. The **Max Fault Rec. Time** setting sets the time period from fault trigger during which the operation of any LEDs is recorded.

Records are triggered from operation of an output relay programmed as a 'Trip Contact'. The 'Trip Alert' feature must also be enabled.

To achieve accurate instrumentation values for the fault records when testing, ensure a drop off delay is applied to the test set so that the injected quantities remain on for a short duration, typically 20ms, after the relay has issued the trip output. This extended period of injection simulates the behaviour of the power system where faulted conditions are present until CB operation.

Where examined together the event records and the fault records will detail the full sequence of events leading to a trip.

Fault records are stored in a rolling buffer, with the oldest faults overwritten. The fault storage can be cleared with the DATA STORAGE > **Clear Faults** setting.

The SYSTEM CONFIG > **Trip Alert = Disabled** setting allows the above to be switched off e.g. during commissioning tests.

6.5 Metering

The metering feature provides real-time data available from the relay fascia in the 'Instruments Mode' or via the data communications interface.

For a detailed description refer to Technical Manual Section 2 – Settings and Instruments.

6.6 Operating Mode

The relay has three operating modes, Local, Remote and Out of Service. The following table identifies the functions operation in each mode.

The modes can be selected by the following methods:

SYSTEM CONFIG>**RELAY MODE** setting, a Binary Input or Command

OPERATION	REMOTE	LOCAL	OUT OF SERVICE
Control			
Rear Serial Ports (when set as Remote)	Enabled	Disabled	Disabled
Rear Serial Ports (when set as Local)	Disabled	Enabled	Disabled
Fascia (Control Mode)	Disabled	Enabled	Disabled
USB	Disabled	Enabled	Disabled
Binary Inputs	Setting Option	Setting Option	Enabled
Binary Outputs	Enabled	Enabled	Disabled
Reporting			
Spontaneous			
IEC 103	Enabled	Enabled	Disabled
DNP3	Enabled	Enabled	Disabled
General Interrogation			
IEC 103	Enabled	Enabled	Disabled
DNP3	Enabled	Enabled	Disabled
MODBUS	Enabled	Enabled	Enabled
Changing of Settings			
Rear Ports (when set as Remote)	Enabled	Disabled	Enabled
Rear Ports (when set as Local)	Disabled	Enabled	Enabled
Fascia	Enabled	Enabled	Enabled
USB	Disabled	Enabled	Enabled
Historical Information			
Waveform Records	Enabled	Enabled	Enabled
Event Records	Enabled	Enabled	Enabled
Fault Information	Enabled	Enabled	Enabled
Setting Information	Enabled	Enabled	Enabled

Table 6-1 Operating Mode

6.7 Control Mode

This mode provides convenient access to commonly used relay control and test functions. When any of the items listed in the control menu are selected control is initiated by pressing the ENTER key. The user is prompted to confirm the action, again by pressing the ENTER key, before the command is executed.

Control Mode commands are password protected using the Control Password function – see Section 6.10.

6.8 Real Time Clock

Time and date can be set either via the relay fascia using appropriate commands in the System Config menu, via the data comms channel(s) or via the optional IRIG-B input.

In order to maintain synchronism within a substation, the relay can be synchronised to the nearest second or minute using the IEC 60870-5-103 protocol, optional IRIG-B input or binary input.

The default date is set at 01/01/2000, this indicates that no date has been set. When editing the **Time**, only the hours and minutes can be edited. The seconds are zeroed by pressing **ENTER** and the clock begins running.

The time and date are maintained while the relay is de-energised by a back up storage capacitor. The length of time for which this data will be maintained will depend on such things as temperature, length of time in service, etc. However the data will be maintained for a minimum of 1.8 days.

6.8.1 Time Synchronisation – Data Comms

Where the data comms channel(s) is connected to a dedicated substation automation system the relay can be time synchronised using the relevant command within IEC 60870-5-103, DNP3.0 or optional IEC 61850 protocols. The time can also be synchronised from 'Reydisp' which utilises the communications support software.

6.8.2 Time Synchronisation – Binary Input

A binary input can be mapped **Clock Sync from BI**. The seconds or minutes will be rounded up or down to the nearest value when the BI is energised. This input is leading edge triggered.

6.8.3 Time Synchronisation – IRIG-B (Optional)

A BNC connector on the relay rear provides an isolated IRIG-B time synchronisation port. The IRIG-B input expects a modulated 3-6 Volt signal and provides time synchronisation to the nearest millisecond.

6.9 Settings Groups

The relay provides eight groups of settings – Group number (Gn) 1 to 8. At any one time only one group of settings can be 'active' – SYSTEM CONFIG>**Active Group** setting.

It is possible to edit one group while the relay operates in accordance with settings from another 'active' group using the **View/Edit Group** setting.

Some settings are independent of the active group setting i.e. they apply to all settings groups. This is indicated on the top line of the relay LCD – where only the **Active Group Number** is identified. Where settings are group dependent this is indicated on the top line of the LCD by both the **Active Group Number** and the **View Group Number** being displayed.

A change of settings group can be achieved either locally at the relay fascia, remotely over the data comms channel(s) or via a binary input. When using a binary input an alternative settings group is selected only whilst the input is energised (**Select Grp Mode: Level triggered**) or latches into the selected group after energisation of the input (**Select Grp Mode: Edge triggered**).

6.10 Password Feature

The relay incorporates two levels of password protection – one for settings, the other for control functions.

The programmable password feature enables the user to enter a 4 character alpha numeric code to secure access to the relay functions. The relay is supplied with the control password set to **AAAA**. The settings password is supplied set to **NONE**, i.e. the password feature is disabled.

Passwords must be entered twice as a security measure against accidental change. Once a password has been entered then it will be required thereafter to change settings or initiate control commands. Passwords can be de-activated by using the password to gain access and by entering the password **NONE**. Again this must be entered twice to de-activate the security system.

As soon as the user attempts to change a setting or initiate control the password is requested before any changes are allowed. Once the password has been validated, the user is 'logged on' and any further changes can be made without re-entering the password. If no more changes are made within 1 hour then the user will automatically be 'logged off', re-enabling the password feature.

The Settings Password prevents unauthorised changes to settings from the front fascia or over the data comms channel(s). The Control Password prevents unauthorised operation of controls in the relay Control Menu from the front fascia.

The password validation screen also displays a numerical code. If the password is lost or forgotten, this code should be communicated to Siemens Protection Devices Ltd. and the password can be retrieved.

7SR23 DAD

High Impedance Protection Relay

Document Release History

This document is issue **2015/11**. The list of revisions up to and including this issue is:

2013/01	Second issue
2012/07	First issue

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Section 1: Introduction

1.1 Relay Menus And Display

All relay fascias contain the same access keys although the fascias may differ in appearance from model to model. The basic menu structure is also the same in all products and consists of four main menus, these being,

Settings Mode - allows the user to view and (if allowed by the settings mode password) change user settings in the relay from the fascia.

Instruments Mode - allows the user to view the relay meters and configure favourite instrument views which will cycle on the LCD automatically when the relay is unattended.

Fault Data Mode - allows the user to view the type and data of any protection operation of the relay.

Control Mode - allows the user to control selected relay functionality (if allowed by the control mode password).



Figure 1-1 Facia of 7SR23 DAD Relay

LCD Contrast

To adjust the contrast on the LCD insert a flat nosed screwdriver into the screw below the contrast symbol, turning the screw left or right decreases and increases the contrast of the LCD.



Figure 1-2 Fascia Contrast symbol

1.2 Operation Guide

1.2.1 User Interface Operation

The basic menu structure flow diagram is shown in Figure Figure 1-5. This diagram shows the main modes of display: Settings Mode, Instrument Mode, Fault Data Mode and Control Mode.

The relay is delivered with the data storage area cleared and with default settings.

When the relay is first energised the user is presented with the following message: -

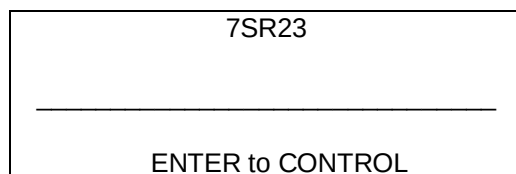


Figure 1-3 Relay Identifier Screen

On the factory default setup the relay LCD should display the relay identifier, on each subsequent power-on the screen that was showing prior to the last power-off will be displayed.

The push-buttons on the fascia are used to display and edit the relay settings via the LCD, to display and activate the control segment of the relay, to display the relays instrumentation and Fault data and to reset the output relays and LED's.

The menus can be viewed via the LCD by pressing the access keys as below,

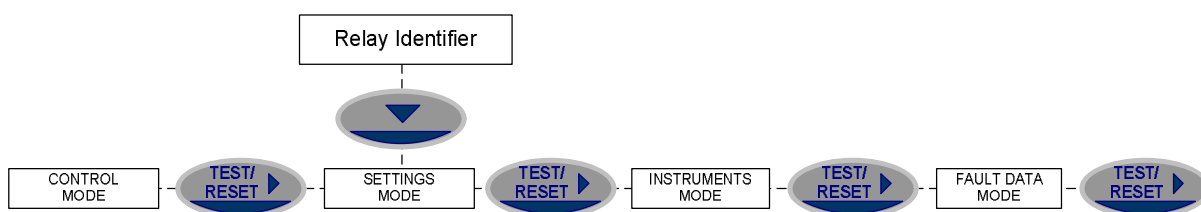


Figure 1-4 Menu

Pressing CANCEL returns to the Relay Identifier screen

The five push-buttons have the following functions:



READ DOWN



READ UP

These pushbuttons are used to navigate the menu structure and to adjust settings.



ENTER

The ENTER push-button is used to initiate and accept setting changes.

When a setting is displayed pressing the ENTER key will enter the edit mode, the setting will flash and can now be changed using the ▲ or ▼ buttons. When the required value is displayed the ENTER button is pressed again to accept the change.

When an instrument is displayed pressing ENTER will toggle the instruments favourite screen status.



CANCEL

This push-button is used to return the relay display to its initial status or one level up in the menu structure. Pressed repeatedly will return to the Relay Identifier screen. It is also used to reject any alterations to a setting while in the edit mode.



This push-button is used to:

- Reset the fault indication on the fascia from the Relay Identifier screen.

- Test front fascia LEDs from the Relay Identifier screen i.e. when pressed all LEDs will momentarily light up to indicate their correct operation.

- Move the cursor right ► when navigating through menus and settings.

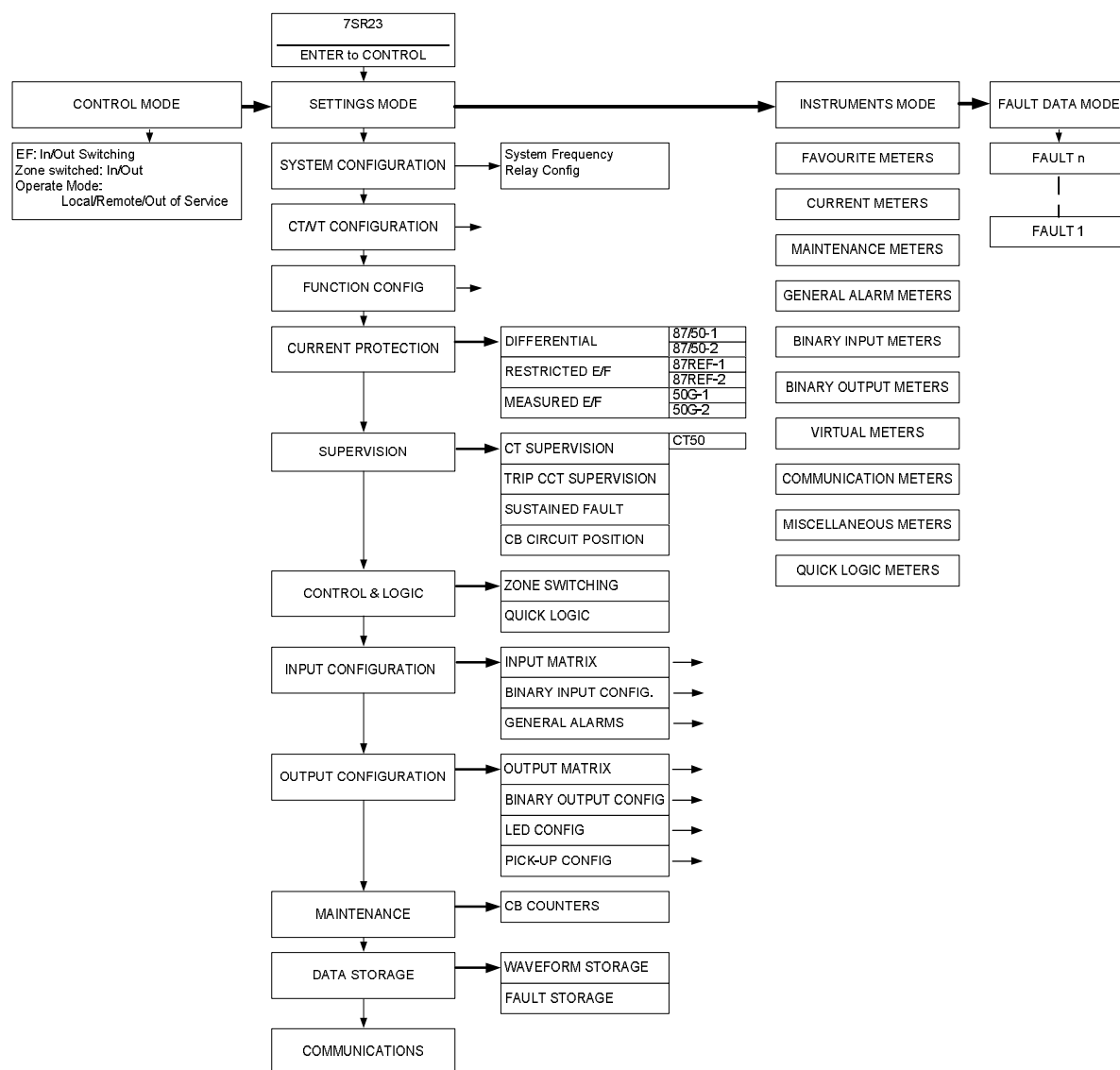


Figure 1-5 7SR23 DAD Menu Structure

1.3 Settings Display

The Settings Mode is reached by pressing the READ DOWN ▼ button from the relay identifier screen.

Once the Settings Mode title screen has been located pressing the READ DOWN ▼ button takes the user into the Settings mode sub-menus.

Each sub-menu contains the programmable settings of the relay in separate logical groups. The sub menus are accessed by pressing the TEST/RESET ► button. Pressing the ▼ button will scroll through the settings, after the last setting in each sub menu is reached the next sub menu will be displayed. If a particular sub menu is not required to be viewed then pressing ▼ will move directly to the next one in the list.

While a setting is being displayed on the screen the ENTER button can be pressed to edit the setting value. If the relay is setting password protected the user will be asked to enter the password. If an incorrect password is entered editing will not be permitted. All screens can be viewed even if the password is not known.

While a setting is being edited flashing characters indicate the edit field. Pressing the ▲ or ▼ buttons will display the valid field values. If these buttons are held on, the rate of scrolling will increase.

Once editing is complete pressing the ENTER button stores the new setting into the non-volatile memory. The setting change is effective immediately unless any protection element is operating, in which case the change becomes effective when no elements are operating.

Configuration and inspection of communications protocol data objects, text used for display in international languages, graphical user logic and programming of user specific custom protection characteristics is not possible from the fascia and pc based tools must be used if required.

The actual setting ranges and default values for each relay model can be found in the appendix to this section of the manual.

1.4 Instruments Mode

The Instrument Mode sub-menu displays key quantities and information to aid with commissioning. The following meters are available and are navigated around by using the ▲, ▼ and TEST/RESET buttons.

Instrument	Description
FAVOURITE METERS →to view	This allows the user to view his previously constructed list of 'favourite meters' by pressing TEST/RESET ► button and the READ DOWN button to scroll though the meters added to this sub-group To construct a sub-group of favourite meters, first go to the desired meter then press ENTER this will cause a message to appear on the LCD 'Add To Favourites YES pressing ENTER again will add this to the FAVOURITE METERS Sub-menu. To remove a meter from the FAVOURITE METERS sub-menu go to that meter each in the FAVOURITE METERS sub-menu or at its Primary location press ENTER and the message 'Remove From Favourites' will appear press ENTER again and this meter will be removed from the FAVOURITE METERS sub-group. The relay will poll through, displaying each of the meters selected in favourite meters, after no key presses have been detected for a user settable period of time. The time is set in the Setting menu>System Config>Favourite Meters Timer.

CURRENT METERS →to view	This is the sub-group that includes all the meters that are associated with Current TEST/RESET ► allows access to this sub-group
Primary Current Ia 0.00A Ib 0.00A Ic 0.00A	Displays primary 3 Phase differential currents. RMS values.
Secondary Current Ia 0.00A Ib 0.00A Ic 0.00A	Displays secondary 3 Phase differential currents. RMS values.
Nominal Currents Ia 0.000xIn Ib 0.000xIn Ic 0.000xIn	Displays 3 Phase differential currents. RMS values based on the selected 1A or 5A rating.
Earth Current Prim. 0.000A Sec. 0.000A Nom. 0.000xIn	Displays primary, secondary and nominal values of earth fault current. RMS values.
Last Trip Current Ia 0.00A Ib 0.00A Ic 0.00A	Displays primary values of current measured at most recent relay trip operation. RMS values.
Last Trip Current Ig 0.00A	Displays primary values of current measured at most recent relay trip operation. RMS values.

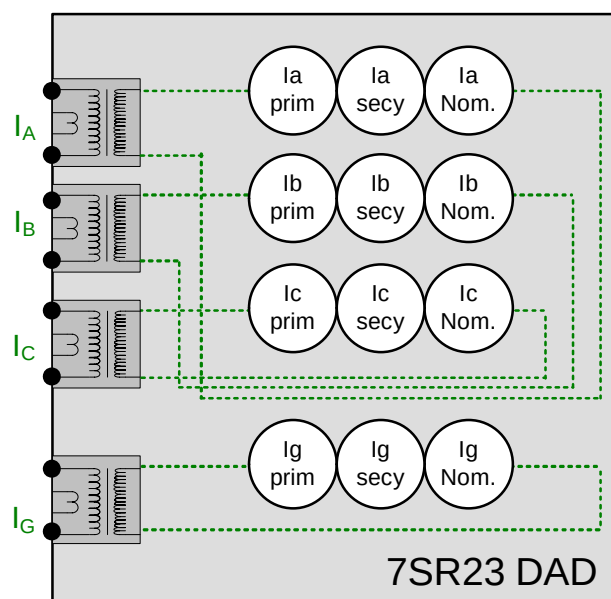


Figure 1-6 Schematic Diagram: 7SR23 Analogue Meters

MAINTENANCE METERS		This is the sub-group that includes all the meters that are associated with Maintenance TEST/RESET ► allows access to this sub-group
→to view		
CBn Total Trips		Displays the number of CB trips since last reset.
Count	0	
Target	100	
CBn Delta Trips		Displays the number of CB trips since last reset.
Count	0	
Target	100	

GENERAL ALARM METERS		This is the sub-group that includes all the meters that are associated with the Binary inputs TEST/RESET ► allows access to this sub-group
→to view		
General Alarms		Displays the state of General Alarm
ALARM n	Cleared	

BINARY INPUT METERS		This is the sub-group that includes all the meters that are associated with the Binary inputs TEST/RESET ► allows access to this sub-group
→to view		
BI 1-8	---- ----	Displays the state of DC binary inputs (The number of binary inputs may vary depending on model)
BI 9-16	---- ----	
BI 17-19	--	

BINARY OUTPUT METERS		This is the sub-group that includes all the meters that are associated with the Binary Outputs TEST/RESET ► allows access to this sub-group
→to view		
BO 1-8	----	Displays the state of DC binary Outputs (The number of binary outputs may vary depending on model)
BO 9-16	----	

VIRTUAL METERS →to view	This is the sub-group that shows the state of the virtual status inputs in the relay TEST/RESET ► allows access to this sub-group
V 1-8 ---- ---- V 9-16 ---- ----	Displays the state of Virtual Outputs 1 to 16 (The number of virtual inputs will vary depending on model)

COMMUNICATION METERS →to view	This is the sub-group that includes all the meters that are associated with Communications ports TEST/RESET ► allows access to this sub-group
COM1 COM2 COM3 COM4	Displays which com ports are currently active
COM1 TRAFFIC Tx1 0 Rx1 0 Rx1 Errors 0	Displays traffic on Com1
COM2 TRAFFIC Tx2 0 Rx2 0 Rx2 Errors 0	Displays traffic on Com2
COM3 TRAFFIC Tx3 0 Rx3 0 Rx3 Errors 0	Displays traffic on Com3 (when fitted)
COM4 TRAFFIC Tx4 0 Rx4 0 Rx4 Errors 0	Displays traffic on Com4 (when fitted)

MISCELLANEOUS METERS →to view	This is the sub-group that includes indication such as the relays time and date, the amount of fault and waveform records stored in the relay TEST/RESET ► allows access to this sub-group
Date DD/MM/YYYY Time HH:MM:SS Waveform Recs 0 Fault Recs 0	This meter displays the date and time and the number of Fault records and Event records stored in the relay. The records stored in the relay can be cleared using the options in the Settings Menu>Data Storage function.
Event Recs 0	

QUICK LOGIC METERS		
→to view		
E 1-8 E 9-16		
E1 Equation	0	
EQN	= 0	
TMR 0-0	= 0	
CNT 0-1	= 0	
En Equation		

1.5 Fault Data Mode

The Fault Data Mode sub menu lists the time and date of the previous ten protection operations. The stored data about each fault can be viewed by pressing the TEST/RESET ► button. Each record contains data on the operated elements, analogue values and LED flag states at the time of the fault. The data is viewed by scrolling down using the ▼ button.

Section 2: Setting the Relay Using Reydisp Evolution

Reydisp software provides a pc tool which can be used for programming of protection configuration and settings and the mapping of hardware input and outputs using a graphical interface. It is supplied with additional tools for configuration of serial communication protocol data objects, configuration of text for international language support and programming of user specific time current curves. To configure the relay using a serial communication port the user will need the following:-

PC with Reydisp installed. (This can be download from our website www.energy.siemens.com).

Configuration and download of IEC 61850 data and programming of graphical user logic requires the use of the Reydisp Manager software which is supplied with online instructions and help and is not documented here.

2.1 Physical Connection

The relay can be connected to Reydisp via any of the communication ports on the relay. Suitable communication Interface cable and converters are required depending which port is being used.

2.1.1 Front USB connection

To connect your pc locally via the front USB port.

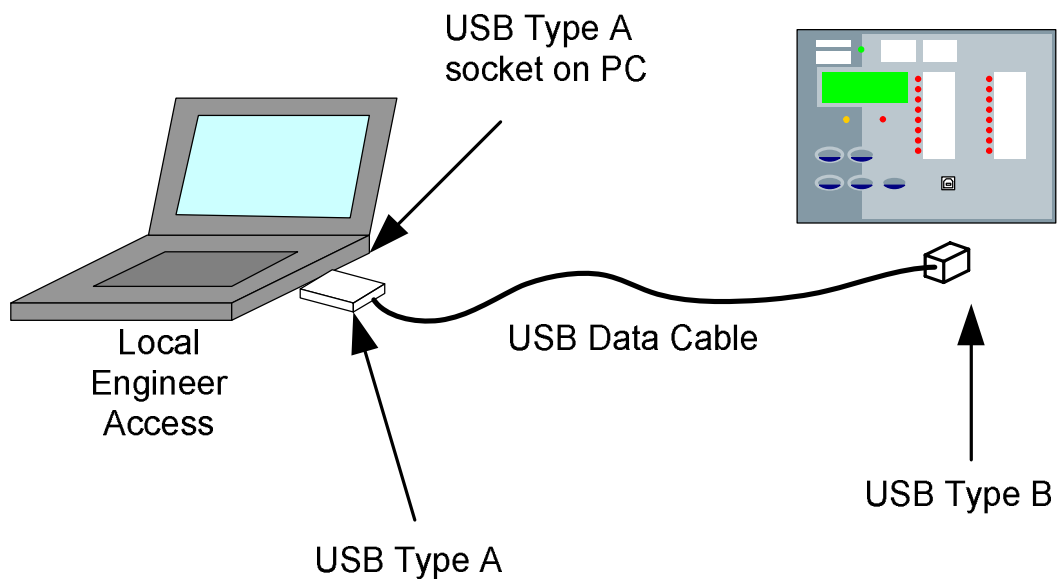


Figure 2-1 USB connection to PC

2.1.2 Rear RS485 connection (COM1)

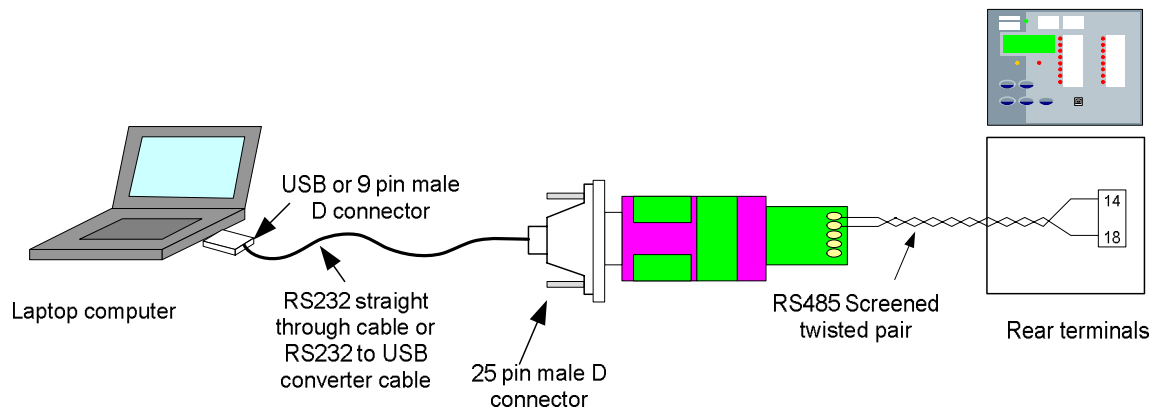


Figure 2-2 RS485 connection to PC

2.1.3 Optional rear fibre optic connection (COM3 and COM4)

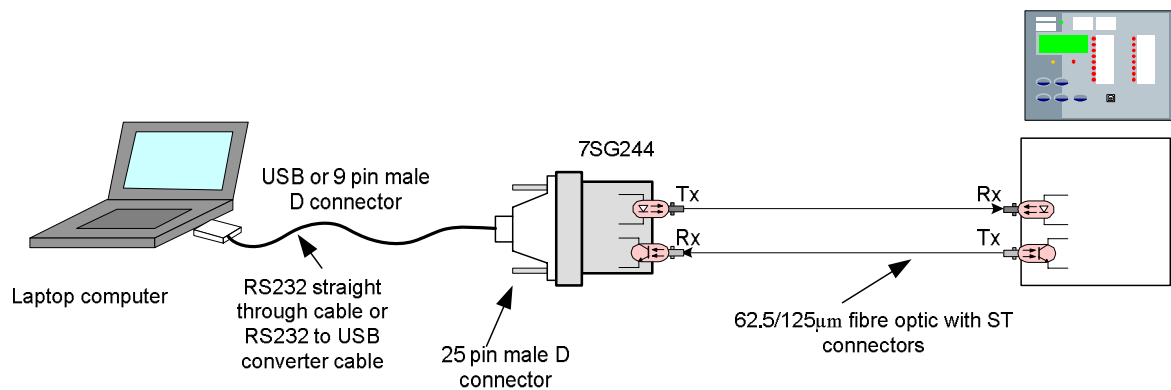


Figure 2-3 Fibre Optic Connection to PC

Sigma devices have a 25 pin female D connector with the following pin out.

Pin	Function
2	Transmit Data
3	Received Data
4	Request to Send
5	Clear to Send
6	Data set ready
7	Signal Ground
8	Received Line Signal Detector
20	Data Terminal Ready

2.1.4 Optional rear RS485 + IRIG-B connection (COM3)

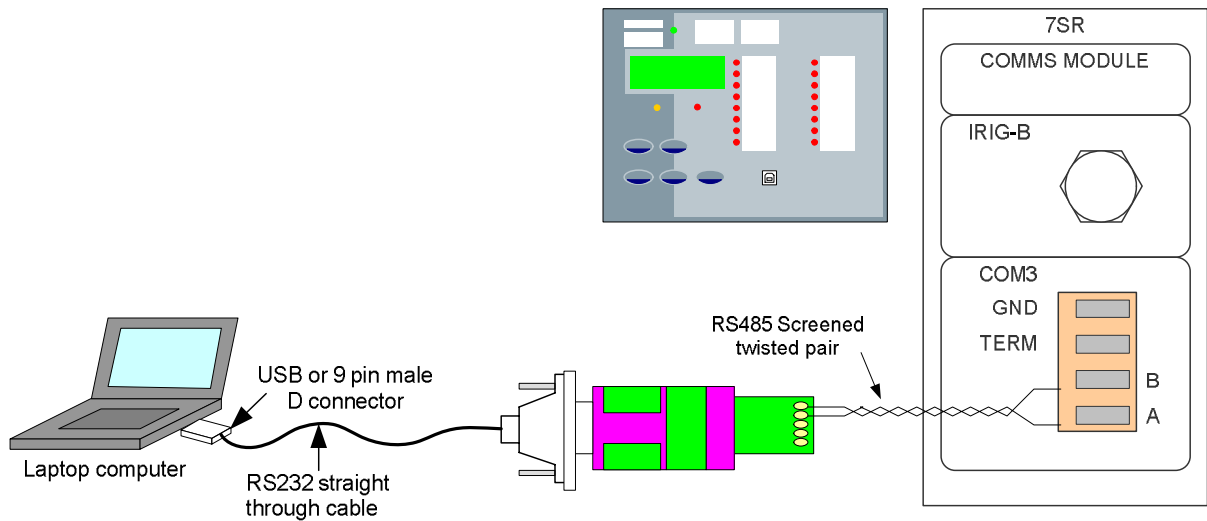


Figure 2-4 Additional (Optional) rear RS485 + IRIG-B connection to a PC

2.1.5 Optional rear RS232 + IRIG-B connection (COM3)

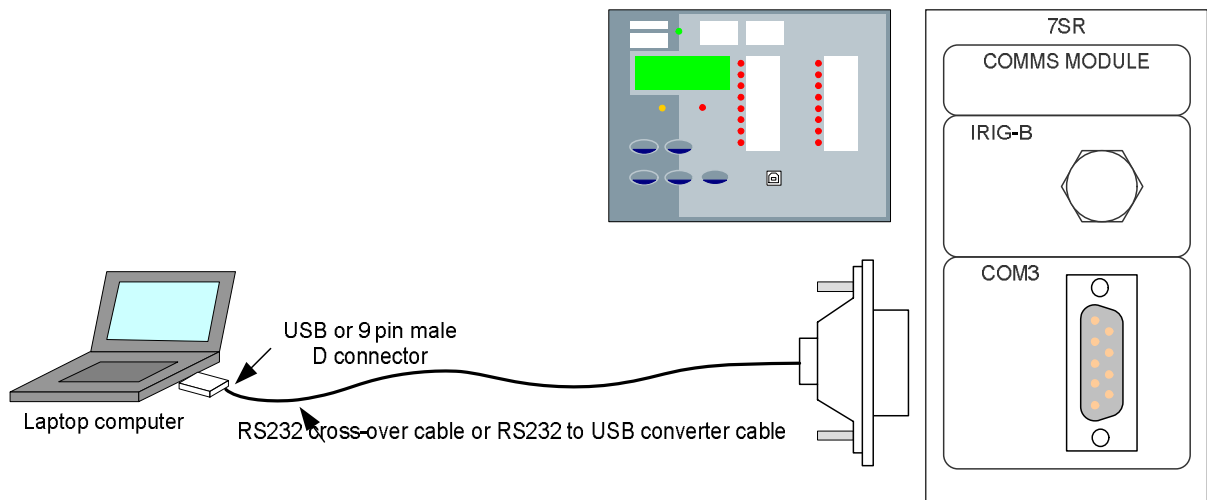


Figure 2-5 Additional (Optional) rear RS232 + IRIG-B connection to a PC

Pin	Relay Function
1	Not Connected
2	Receive Data (RXD)
3	Transmit Data (TXD)
4	Output Supply +5 V 50mA
5	Signal Ground (GND)
6	Input Supply +5 V 50mA
7	Linked to 8 (volts free)
8	Linked to 7 (volts free)
9	Output Supply +5V 50mA

2.1.6 Optional Rear EN100 Ethernet Module (COM3)

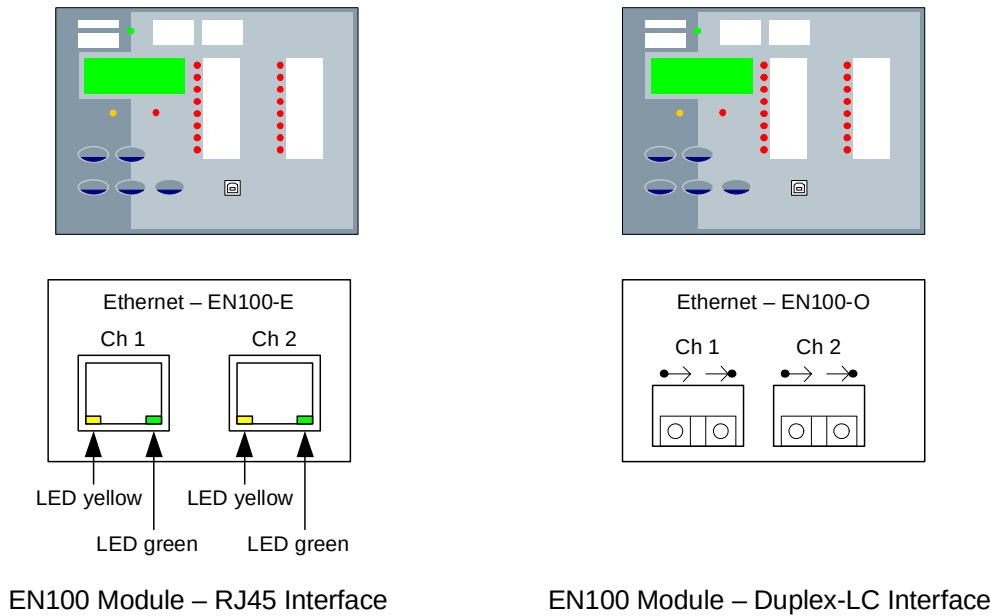
The optional ethernet interface is primarily provided for support of IEC 61850 protocol. Support for IEC 870-5-103 is also provided over this interface to allow connection with Reydisp Evolution and Reydisp Manager software for interrogation, editing and download of relay settings and other data. Ordering options are available with two RJ45 electrical connectors or with two duplex LC fibre optic connectors.

Setting name	Range	Default	Setting	Notes
LAN Protocol	OFF, IEC60870-5-103	IEC60870-5-103		

If this setting is set to Off, access to relay data using Reydisp Evolution and Reydisp Manager software via the Ethernet interface is not available.

Connections to the optional EN100 ethernet module are made on the rear underside of the relay.

Connections are made to either RJ45 sockets (electrical) or Duplex LC (fibre optic) connectors.



Green LED (Physical Link)

Off – No link

On – Link present

Yellow LED (Activity)

Off – No traffic

On/flashing - Traffic

Figure 2-6 EN100 Ethernet Module

2.1.7 Configuring Relay Data Communication

Using the keys on the relay fascia scroll down the settings menu's into the 'communications' menu. All of the below settings may not be available in all relay types. Reydisp software is compatible with IEC60870-5-103 protocol.

COM1-RS485 Port

COM2-USB Port (Front)

COM3 – Optional Fibre Optic, RS485, RS232 or Ethernet Port

COM4 – Optional Fibre Optic Port

LAN – Optional Ethernet Ports

Setting name	Range	Default	Units	Notes
Station Address	0 ... 65534	0		Address given to relay to identify that relay from others which may be using the same path for communication as other relays for example in a fibre optic hub
COM1-RS485 Protocol	OFF, IEC60870-5-103, MODBUS-RTU, DNP3	IEC60870-5-103		COM1: Rear mounted RS485 port
COM1-RS485 Mode	Local, Remote, Local or Remote	Remote		
COM1-RS485 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400	19200		
COM1-RS485 Parity	NONE, ODD, EVEN	EVEN		
COM2-USB Protocol	OFF, IEC60870-5-103, MODBUS-RTU, ASCII, DNP3	IEC60870-5-103		COM2: Front USB port.
COM2-USB Mode	Local, Remote, Local or Remote	Remote		
COM3 Protocol	OFF, IEC60870-5-103, MODBUS-RTU, DNP3	IEC6-0870-5-103		COM3: Optional rear mounted connection
COM3 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400 57600 115200	19200		
COM3 Parity	NONE, ODD, EVEN	EVEN		
COM3 Line Idle*	LIGHT ON, LIGHT OFF	LIGHT OFF		
COM3 Data echo*	ON, OFF	OFF		
COM4 Protocol**	OFF, IEC60870-5-103, MODBUS-RTU, DNP3	OFF		COM4: Optional rear mounted Fibre Optic ST connection
COM4 Baud Rate**	75 110 150 300 600 1200 2400 4800 9600 19200 38400	19200		
COM4 Parity**	NONE, ODD, EVEN	EVEN		
COM4 Line Idle**	LIGHT ON, LIGHT OFF	LIGHT OFF		
COM4 Data echo**	ON, OFF	OFF		
DNP3 Unsolicited Events	ENABLED, DISABLED	DISABLED		Setting is only visible when a port protocol is set to DNP3.

Setting name	Range	Default	Units	Notes
DNP3 Destination Address	0 ... 65534	0		Setting is only visible when a port protocol is set to DNP3.
DNP3 Application Timeout	5, 6 ... 299, 300	10s	Seconds	Setting is only visible when a port Protocol is set to DNP3

*Not applicable for RS485 or RS232 interface modules.

**Fibre Optic Module only

2.1.8 Connecting the Relay for use with Reydisp

When Reydisp software is running all available communication ports of the PC will automatically be detected. On the start page tool bar open up the sub-menu File > Connect.

The 'Communication Manager' window will display all available communication ports. With the preferred port highlighted, select the 'Properties' option and ensure the baud rate and parity match that selected in the relay Data Comms settings. Select 'Connect' to initiate the relay-PC connection.

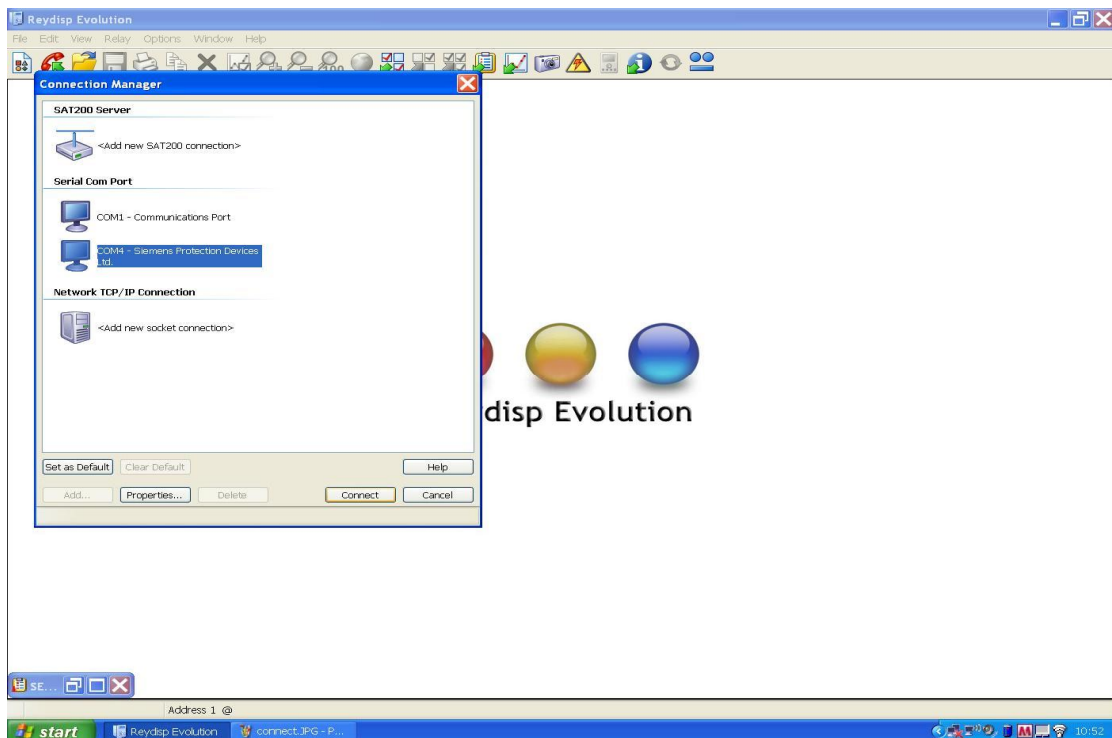


Figure 2-7 PC Comms Port Allocation

Via the Relay > Set Address > Address set the relay address (1-254) or alternatively search for connected devices using the Relay > Set Address > Device Map. The relay can now be configured using the Reydisp software. Please refer to the Reydisp Evolution Manual for further guidance.

7SR23 DAD

High Impedance Protection Relay

Document Release History

This document is issue **2015/11**. The list of revisions up to and including this issue is:

2015/11	Instrument accuracy claim text revision
2013/01	Second issue
2012/07	First issue

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Section 1: Type Testing

1.1 General

1.1.1 Certification - CE Conformity

CE This product is CE compliant to relevant EU directives.

1.1.2 Reference

1.1.2.1 Accuracy Reference Conditions

This product has been tested under the following conditions, unless specifically stated otherwise.

Parameter	Value
Auxiliary supply	Nominal
AC Current	Nominal
Frequency	Nominal
Ambient temperature	20 °C

1.2 Inputs and Outputs

1.2.1 Auxiliary Power Supply

Nominal		Operating Range
V_{AUX}	30, 48, 110, 220 VDC	24 to 290 VDC

1.2.1.1 Burden

Attribute		Value
30V DC	Quiescent (typical)	7.5W
	Quiescent (backlight)	9.0W
48V DC	Quiescent (typical)	7.3W
	Quiescent (backlight)	8.8W
110V DC	Quiescent (typical)	6.8W
	Quiescent (backlight)	8.1W
220V DC	Quiescent (typical)	6.4W
	Quiescent (backlight)	7.7W

Typical for relay size E8

When supplied with additional Ethernet communication interface the above burdens are increased by 2.5W.

1.2.1.2 DC Supply Variation

IEC 60255-11,

Quantity	Value
Allowable superimposed ac component	$\leq 12\%$ of DC voltage
Allowable breaks/dips in supply (collapse to zero from nominal voltage)	$\leq 50\text{ms}$

1.2.2 AC Current

Nominal		Measuring Range
I_n	1, 5 A Phase and earth	$8 \times I_n$
f_n	50, 60Hz	47 to 63Hz

Note. 1 A and 5 A nominal inputs are user selectable on each model.

1.2.2.1 Burden

Attribute	Value - Phase and Earth	
	1A	5A
AC Burden	$\leq 0.1 \text{ VA}$	$\leq 0.3 \text{ VA}$

1.2.2.2 Thermal Withstand

IEC 60255-27

Overload Period	Overload Current	
	Phase and Earth	
	1A	5A
Continuous	$4 \times I_n$	
1 second	100A	350A

1.2.3 Binary (Digital) Outputs

Contact rating to IEC 60255-0-2

Attribute		Value
Carry continuously		5A AC or DC
Make and carry ($L/R \leq 40 \text{ ms}$ and $V \leq 300 \text{ V}$)	for 0.5 s	20A AC or DC
	for 0.2 s	30A AC or DC
Break ($\leq 5 \text{ A}$ and $\leq 300 \text{ V}$)	AC resistive	1250 VA
	AC inductive	250 VA at p.f. ≤ 0.4
	DC resistive	75 W
	DC inductive	30 W at $L/R \leq 40\text{ms}$ 50 W at $L/R \leq 10\text{ms}$
Contact Operate / Reset Time		7ms / 3ms
Minimum number of operations		1000 at maximum load
Minimum recommended load		0.5 W at minimum of 10mA or 5V

1.2.4 Binary (Digital) Inputs

Nominal		Operating Range
V_{BI}	19 VDC	17 to 290 VDC
	88 VDC	74 to 290 VDC

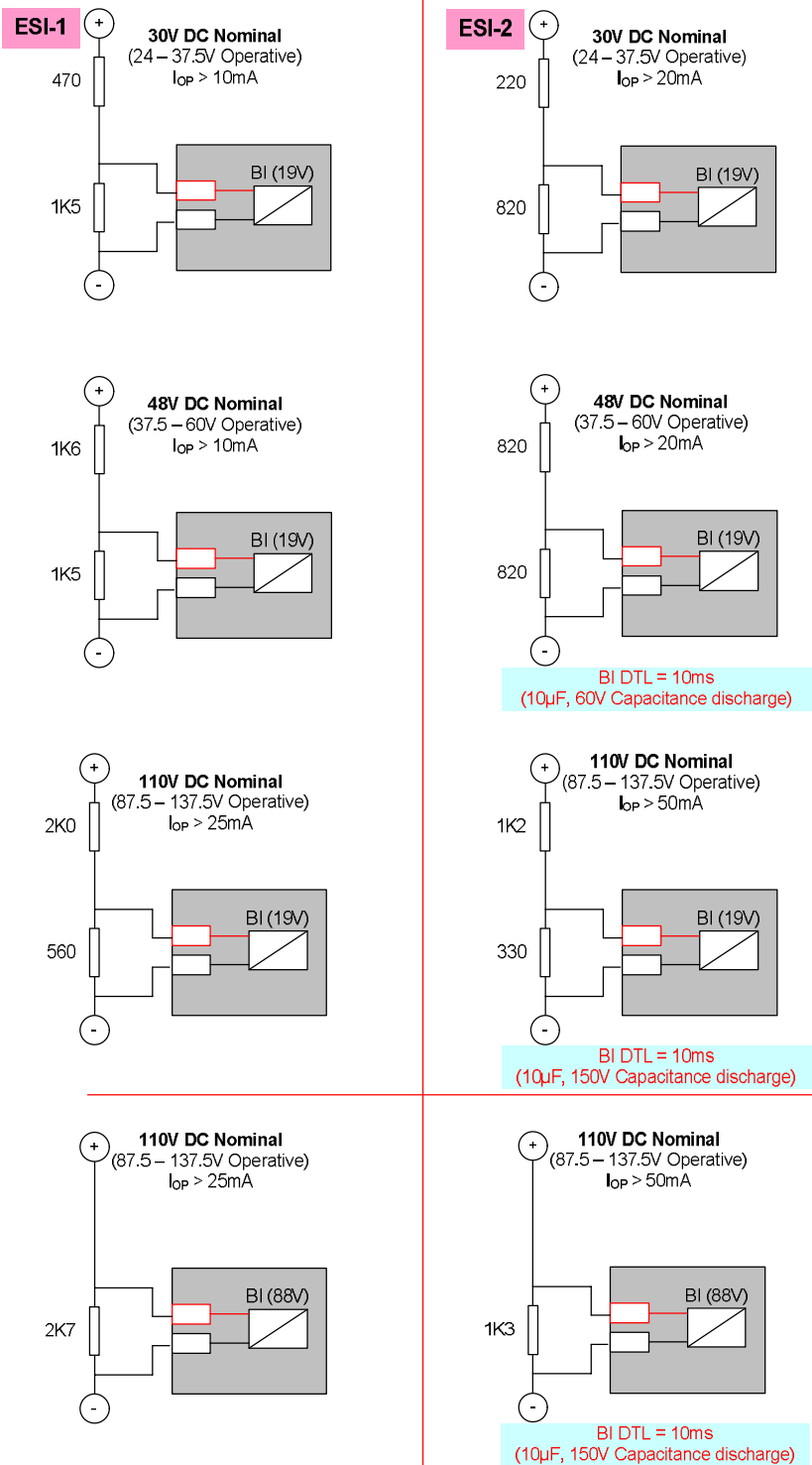
1.2.4.1 Performance

Attribute		Value
Maximum DC current for operation	$V_{BI} = 19 \text{ V}$	1.5mA
	$V_{BI} = 88 \text{ V}$	1.5mA
Reset/Operate voltage ratio		$\geq 90 \%$
Response time		$< 7\text{ms}$
Response time when programmed to energise an output relay contact (i.e. includes output relay operation)		$< 20\text{ms}$

The binary inputs have a low minimum operate current and may be set for high speed operation. Where a binary input is both used to influence a control function (e.g. provide a tripping function) and it is considered to be susceptible to mal-operation due to capacitive currents, the external circuitry can be modified to provide immunity to such disturbances.

To comply with EATS 48-4, classes ESI 1 and ESI 2, external components / BI pick-up delays are required as shown in fig. 1-1.

To achieve immunity from AC interference, a BI pick-up delay of typically one-cycle can be applied.



Resistor power ratings:

30V DC Nominal	>3W
48V DC Nominal	>3W
110V DC Nominal	>10W (ESI- 1)
110V DC Nominal	>20W (ESI-2)

Resistors must be wired with crimped connections as they may run hot

Figure 1-1: Binary Input Configurations Providing Compliance with EATS 48-4 Classes ESI 1 and 2

1.3 Instrumentation and Data Comms

1.3.1 Instrumentation

	Instrument Value	Reference	Typical accuracy
<i>I</i>	Current	0.1In to 2.0In	$\pm 1\%$ or $\pm 1\%$ <i>In</i>

1.3.2 Data Communication

1.3.2.1 USB Data Communication Interface

Attribute	Value
Physical layer	Electrical
Connectors	USB-Type B

1.3.2.2 Fibre optic Data Communication Interface (Optional Rear Mounted Port COM3 / COM4)

Attribute	Value
Physical layer	Fibre-optic
Connectors	ST TM (BFOC/2.5)
Recommended fibre	62.5/125 μ m glass fibre with ST connector
Optical wavelength	820nm
Launch power (into recommended fibre)	-16 dBm
Receiver sensitivity	-24 dBm

1.3.2.3 RS485 Data Communication Interface (Standard Rear Port)

Attribute	Value
Physical layer	Electrical
Connectors	4mm Ring Crimp

1.3.2.4 RS485 Data Communication Interface (Optional Rear Mounted Port COM3)

Attribute	Value
Physical layer	Electrical
Connectors	4-way Plug

1.3.2.5 RS232 Data Communication Interface (Optional Rear Mounted Port COM3)

Attribute	Value
Physical layer	Electrical
Connectors	9-way D-plug

1.3.2.6 Fibre Optic Ethernet Data Communication Interface (IEC 61850 Option)

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

1.3.2.7 Electrical Ethernet Data Communication Interface (IEC 61850 Option)

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

1.3.3 Real Time Clock

1.3.3.1 Internal Clock

The specification below applies only while no external synchronisation signal (e.g. IRIG-B, IEC 60870-5-103) is being received.

Attribute	Value
Accuracy (-40 to +85°C)	± 3.5 ppm (No auxiliary supply connected)
	± 100 ppm (Auxiliary supply connected)

1.3.3.2 IRIG-B

Attribute	Value
Connector	BNC
Signal Type	IRIG-B 120, 122 or 123
Applied signal level	minimum 3 V, maximum 6 V, peak-to-peak
Signal : carrier ratio	≥ 3

1.4 Environmental Performance

1.4.1 Atmospheric Environment

1.4.1.1 Temperature

IEC 60068-2-1/2

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

1.4.1.2 Humidity

IEC 60068-2-78

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

1.4.2 Electrical Environment and Electromagnetic Compatibility

1.4.2.1 Insulation / HV (Dielectric) Withstand

IEC 60255-5,

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

1.4.2.2 Transient Overvoltage

IEC 60255-5

Type	Level
Between all terminals and earth, or between any two independent circuits	5.0 kV, 1.2/50 µs 0.5j

1.4.2.3 Radiated Radio Frequency (Emissions)

IEC 60255-25,

Type	Limits at 10 m open area test site, Quasi-peak
30 to 230 MHz	40 dB(µV/m)
230 to 1000 MHz	47 dB(µV/m)

1.4.2.4 Conducted Radio Frequency (Emissions)

IEC 60255-25,

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

1.4.2.5 High Frequency Disturbance (Immunity) / 1MHz Burst High Frequency Disturbance

IEC 60255-22-1

Type	Level	Variation
Case, Aux Power & I/O Common (longitudinal) mode	2.5 kV	≤ 10 %
Case, Aux Power & I/O Series (transverse) mode	1.0 kV	
RS485 Metallic Comms	1.0 kV	No data loss

1.4.2.6 Electrostatic Discharge (Immunity)

IEC 60255-22-2 Class IV, IEC 61000-4-2

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

1.4.2.7 Radiated Immunity / Radiated Electromagnetic Field Disturbance

IEC 60255-22-3 Class III,

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

1.4.2.8 Electrical Fast Transient / Burst Immunity

IEC 60255-22-4 Class A (2002),

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

1.4.2.9 Surge Immunity

IEC 60255-22-5, IEC 61000-4-5

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

* Note 45ms pick up delay applied to binary inputs

1.4.2.10 Conducted Radio Frequency Interference (Immunity)

IEC 60255-22-6

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

1.4.2.11 Magnetic Field with Power Frequency (Immunity)

IEC 6100-4-8 Level 5,

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

1.4.3 Mechanical Environment

1.4.3.1 Vibration (Sinusoidal)

IEC 60255-21-1 Class I,

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

1.4.3.2 It's specified in

IEC 60255-21-2 Class I

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

1.4.3.3 Seismic

IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response Horizontal	1 gn	≤ 5 %
Seismic response Vertical	0.5gn	≤ 5 %

1.5 Mechanical

1.5.1.1 Dimensions

Parameter		Value
Width	7SR DAD, E6 case	155.5 mm
	7SR DAD, E8 case	207.5 mm
Height		177 mm
Depth behind panel		216.5 mm
Depth behind panel (including clearances)		241.5mm (including clearance for terminal wiring) 286.5mm (including clearance for F/O cabling)
EN100 Connections	Total case depth	254.5 mm (relay with EN100 module fitted)
	Depth below EN100 (including clearances)	75mm including clearance for Ethernet comms connections)
Projection (from front of panel)		31 mm 42mm inc. pushbuttons when fitted.

See appropriate case outline and panel drilling drawing, as specified in Diagrams and Parameters document, for complete dimensional specifications.

Mounting: front of panel / flush mounting or 19" rack mounting.

1.5.1.2 Weights

Parameter		Value
Weight	7SR23 DAD, E6 case	4.3kg
	7SR23 DAD, E8 case	5.5kg

Additional weights to the above (typical):-

Optional fibre optic, RS485 or RS232 communication interface: add 0.165 kg.

Optional EN100 Ethernet communication interface: add 0.5 kg.

Transport packaging: add 0.4kg (net weight).

1.5.1.3 Enclosure Protection

IEC 60529

Type	Level
Installed with cover on	IP 51 from front
Installed with cover removed	IP 20 from front

1.5.1.4 Mechanical Classification

Type	Level
Durability	> 10 ⁶ operations

Section 2: Protection Functions

2.1 50G Instantaneous Measured Earth Fault

2.1.1 Reference

	Parameter	Value
I_s	Setting	0.01...2.0 x I_n
t_d	Delay setting	0, 0.005...1.0, 1.01...5, 5.1...60s

2.1.2 Operate and Reset Level

	Attribute	Value
I_{op}	Operate level	100 % I_s , $\pm 5\%$ or $\pm 1\% I_n$
	Reset level	$\geq 95\% I_{op}$ or $\pm 1\% I_n$
	Repeatability	$\pm 1\%$
	Transient overreach ($X/R \leq 100$)	$\leq -5\%$
	Variation	-10 °C to +55 °C
		$f_{nom} \pm 5\%$

2.1.3 Operate and Reset Time

	Attribute	Value
t_{basic}	Element basic operate time	2 x I_s , 22ms $\pm$ 5ms 50Hz, 2 x I_s , 18ms $\pm$ 5ms 60Hz
		3 x I_s , 1 cycle, $\pm$ 5ms
		5 x I_s , < 1 cycle
t_{op}	Operate time following delay	$t_{basic} + t_d$, $\pm 1\%$ or ± 10 ms
	Repeatability	$\pm 1\%$ or ± 10 ms
	Overshoot time	< 40 ms
	Disengaging time	< 50 ms

2.2 87/50 High Impedance Differential Protection

2.2.1 Reference

	Parameter	Value
I_s	Setting	0.010,0.011...0.100,0.105...2xIn
t_d	Delay setting	0, 0.005...1.0, 1.01...5,5.1...60s

2.2.2 Operate and Reset Level

	Attribute	Value
I_{op}	Operate level	100 % I_s , $\pm 5\%$ or $\pm 1\%$ xIn
	Reset level	95 % I_{op} , $\pm 5\%$ or $\pm 1\%$ xIn
	Repeatability	$\pm 1\%$
	Transient overreach (X/R ≤ 100)	$\leq -5\%$
	Variation	-10 °C to +55 °C
		$f_{nom} \pm 5\%$

2.2.3 Operate and Reset Time

	Attribute	Value
t_{basic}	Element basic operate time	2 xIs, 22ms $\pm$ 5ms 50Hz, 2 xIs, 18ms $\pm$ 5ms 60Hz
		3 xIs, 1 cycle, $\pm$ 5ms
		5 xIs, < 1 cycle
t_{op}	Operate time following delay	$t_{basic} + t_d$, $\pm 1\%$ or ± 10 ms
	Repeatability	$\pm 1\%$ or ± 10 ms
	Overshoot time	< 40 ms
	Disengaging time	< 50 ms

2.2.4 Harmonic Rejection

	Harmonic Rejection 2 nd to 15 th harmonic	40:1 minimum (50/60Hz)
--	--	------------------------

2.3 87REF Restricted Earth Fault Protection

2.3.1 Reference

	Parameter	Value
I_s	Setting	0.010,0.011...0.100,0.105... $2 \times I_n$
t_d	Delay setting	0, 0.005...1.0, 1.01...5,5.1...60s

2.3.2 Operate and Reset Level

	Attribute	Value
I_{op}	Operate level	100 % I_s , $\pm 5\%$ or $\pm 1\% \times I_n$
	Reset level	95 % I_{op} , $\pm 5\%$ or $\pm 1\% \times I_n$
	Repeatability	$\pm 1\%$
	Transient overreach ($X/R \leq 100$)	$\leq -5\%$
	Variation	-10 °C to +55 °C
		$f_{nom} \pm 5\%$

2.3.3 Operate and Reset Time

	Attribute	Value
t_{basic}	Element basic operate time	2 x/s, 22ms $\pm$ 5ms 50Hz, 2 x/s, 18ms $\pm$ 5ms 60Hz
		3 x/s, 1 cycle, $\pm$ 5ms
		5 x/s, < 1 cycle
t_{op}	Operate time following delay	$t_{basic} + t_d$, $\pm 1\%$ or ± 10 ms
	Repeatability	$\pm 1\%$ or ± 10 ms
	Overshoot time	< 40 ms
	Disengaging time	< 50 ms

2.3.4 Harmonic Rejection

	Harmonic Rejection 2 nd to 15 th harmonic	40:1 minimum (50/60Hz)
--	--	------------------------

Section 3: Supervision Functions

3.1 CT50 CT Supervision Monitoring

3.1.1 Reference

	Parameter	Value
I_s	Setting	0.005, 0.006...0.100, 0.105...2xIn
t_d	Delay setting	0, 0.005...1.0, 1.01...5, 5.1...60s

3.1.2 Operate and Reset Level

	Attribute	Value
I_{op}	Operate level	100 % I_s , $\pm 5\%$ or $\pm 1\%$ xIn
	Reset level	95 % I_{op} , $\pm 5\%$ or $\pm 1\%$ xIn
	Repeatability	$\pm 1\%$
	Transient overreach ($X/R \leq 100$)	$\leq -5\%$
	Variation	-10 °C to +55 °C
		$f_{nom} \pm 5\%$

3.1.3 Operate and Reset Time

	Attribute	Value
t_{basic}	Element basic operate time	2 xIs, <1.5 cycles, $\pm 5\text{ms}$
t_{op}	Operate time following delay	$t_{basic} + t_d$, $\pm 1\%$ or $\pm 10\text{ms}$
	Repeatability	$\pm 1\%$ or $\pm 10\text{ms}$
	Overshoot time	< 40 ms
	Disengaging time	< 50 ms

3.2 74TCS Trip Circuit Supervision

3.2.1 Reference

	Parameter	Value
t_d	Delay setting	0, 0.02...60 s

3.2.2 Operate and Reset Time

	Attribute		Value
t_{basic}	Element basic operate time		30ms $\pm$ 10ms
t_{op}	Operate time following delay		$t_{basic} + t_d$, $\pm 1\%$ or ± 20 ms
	Repeatability		$\pm 1\%$ or ± 10 ms
	Variation	-10 °C to +55 °C	$\leq 5\%$
		$f_{nom} \pm 5\%$	$\leq 5\%$

7SR23 DAD

High Impedance Protection relay

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1. Introduction

This section describes how to use the Communication Interface with a control system or interrogating computer.

The interface is compatible with control and automation systems using industry standard communications protocols **DNP3** , **IEC 60870-5-103** , **IEC 61850** and **MODBUS-RTU**. Note, not all protocols are available on all devices.

Reydisp Evolution or Reydisp Manager Software is available, for computers running Microsoft Windows™, to connect to devices to provide operational information, post-fault analysis, setting interrogation and editing facilities etc. Configuration software can be downloaded from our website <http://www.siemens.com/energy>.

This section specifies connection details and lists the information available through the individual protocols.

2. Physical Connection

2.1 Introduction

The relay provides one “Front” USB communication interface (Com2) located on the fascia and one RS485 (Com1) located on the “Rear” as standard. An additional module may be fitted as an ordering option to provide extra rear serial port(s) or two Ethernet channels. Modules are available for serial fibre optic, RS232 and RS485. These modules provide one (Com3) or two (Com3 and Com4) additional ports. The optional EN100 Ethernet module, available in optical and electrical versions, supports the IEC 61850 protocol and Reydisp access through the network (LAN port) interface.

A detailed description of the ports is given below.

- COM1-RS485: This port can be used for IEC60870-5-103, MODBUS-RTU or DNP3 communications to a substation SCADA or integrated control system or for engineer remote access. This port can also be used for connection to Reydisp software.

- COM2-USB: This port is used for IEC60870-5-103 (default setting) communication with the Reydisp software.
An ASCII protocol is also available through this port, the main use of this protocol is to allow the Relay firmware to be updated via the front connection.
MODBUS-RTU or the optional DNP3 protocols are also available.

- COM3: Where fitted, an additional rear serial fibre optic, RS232 or RS485 port.
This port can be used for IEC60870-5-103, MODBUS-RTU or DNP3 communications to a substation SCADA or integrated control system or for engineer remote access. This port can also be used for connection to Reydisp software.

- COM4: As COM3.

- COM3-LAN: When the Ethernet module is fitted, in addition to IEC61850 a LAN connection is provided to allow the Reydisp software to connect to the Relay via the network. This port only supports the IEC60870-5-103 protocol.

Any or all serial ports can be mapped to the IEC60870-5-103, DNP3 or MODBUS-RTU protocol at any one time, protocols available will depend upon relay model. The optional ethernet port uses IEC 61850 protocol and can also provide an IEC 60870-5-103 protocol connection to Reydisp. Any port not required can be disabled by setting its protocol to OFF.

When connecting to Reydisp Evolution software the protocol for the relevant port should be set to IEC60870-5-103.

2.2 USB Interface (COM2)

The USB communication port is connected using a standard USB cable with a type B connection to the relay and type A to the PC.

The PC will require a suitable USB driver to be installed; this will be carried out automatically when the Reydisp software is installed. When the Reydisp software is running with the USB cable connected to a device an additional connection is shown. Connections to these devices are not shown when they are not connected.

The USB communication interface on the relay is labelled Com 2 and its associated settings are located in the Data communications menu. When connecting to Reydisp using this connection the default settings can be used without the need to first change any settings.

Access to the communication settings for the USB port is only available from the relay front fascia via the key pad setting menu COMMUNICATIONS MENU.

Setting Name	Range/Options	Default	Setting	Notes
COM2-USB Protocol	OFF IEC60870-5-103 MODBUS-RTU ASCII DNP3	IEC60870-5-103		Reydisp software requires IEC60870-5-103.
COM2-USB Station Address	0 - 254 for IEC60870-5-103 1 - 247 for Modbus RTU 0 - 65534 for DNP3.0	0		An address within the range of the relevant protocol must be given to identify the relay. Each relay in a network must have a unique address.
COM2-USB Mode	Local Local or Remote Remote	Local		Refer to Appendix 1 , page 85, for further explanation

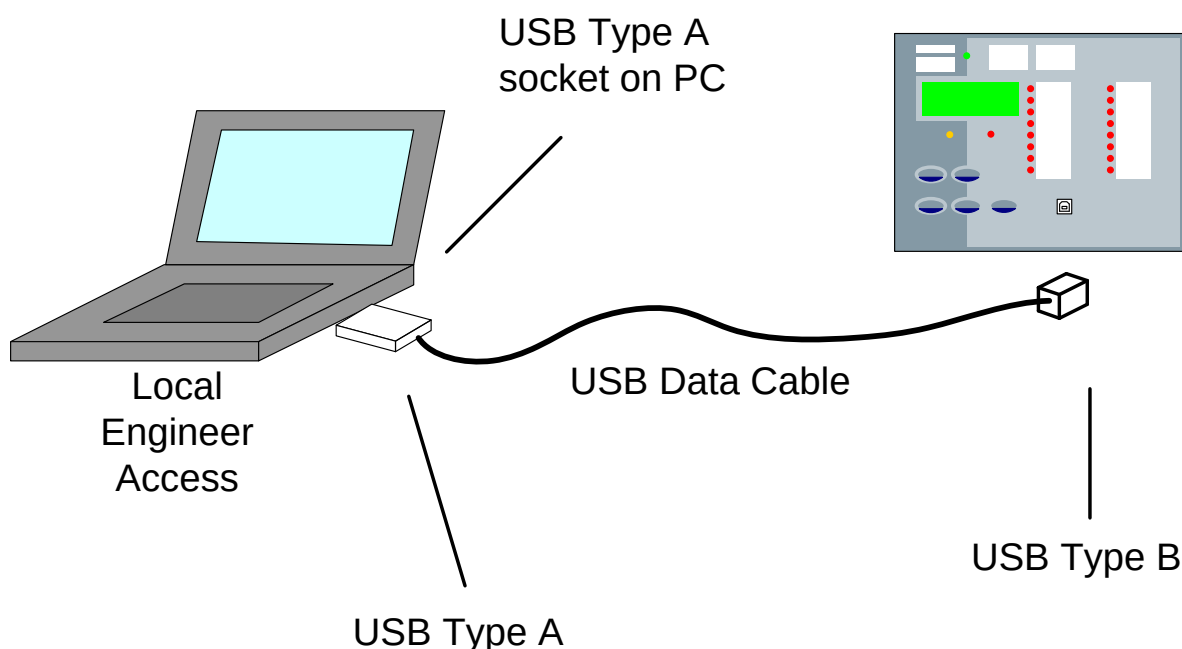


Fig. 2-1 Communication to Front USB Port

2.3 RS485 Interface (COM1)

The 2-wire RS485 communication port is located on the rear of the relay and can be connected using a suitable RS485 120 Ohm screened twisted pair cable.

The RS485 electrical connection can be used in a single or multi-drop configuration. The RS485 master must support and use the Auto Device Enable (ADE) feature. The last device in the connection must be terminated correctly in accordance with the master device driving the connection. This can be done via the internal 120 ohm terminating resistor, which can be connected between 14 (A) and 18 (B) by fitting an external wire loop between terminals 18 and 20 on the power supply module.

The polarity of the signal terminals is marked as A and B in line with the RS485 standard. The polarity is that when the bus is in the quiescent state and no communication is taking place, the B terminal is more positive than A. This can be used to identify the polarity of any equipment to be connected, typically measured at each terminal in turn to ground. Connection of the device to a termination network at the end of the bus will also be to suit the quiescent state as shown in the diagram below.

The polarity marking is often found to be reversed or marked as +/- on other equipment so care is required. If the devices are connected in reverse, communication to all devices will be disturbed but no damage will occur. If problems are experienced during commissioning, the connections should be tried in reverse.

The maximum number of relays that can be connected to the bus is 64.

The RS485 data comms link will be broken for that particular relay element if it is withdrawn from the case but the chain of communication to the other relays is maintained.

The following settings, on the COMMUNICATIONS MENU, must be configured when using the RS485 interface.

Setting Name	Range/Options	Default	Setting	Notes
COM1-RS485 Protocol	OFF IEC60870-5-103 MODBUS-RTU DNP3	IEC60870-5-103		The protocol used to communicate on the standard RS485 connection.
COM1-RS485 Station Address	0 - 254 for IEC60870-5-103 1 - 247 for Modbus RTU 0 - 65534 for DNP3.0	0		An address within the range of the relevant protocol must be given to identify the relay. Each relay in a network must have a unique address.
COM1-RS485 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400	19200		The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM1-RS485 Parity	NONE ODD EVEN	EVEN		The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.
COM1-RS485 Mode	Local Local or Remote Remote	Remote		Refer to Appendix 1 , page 85, for further explanation

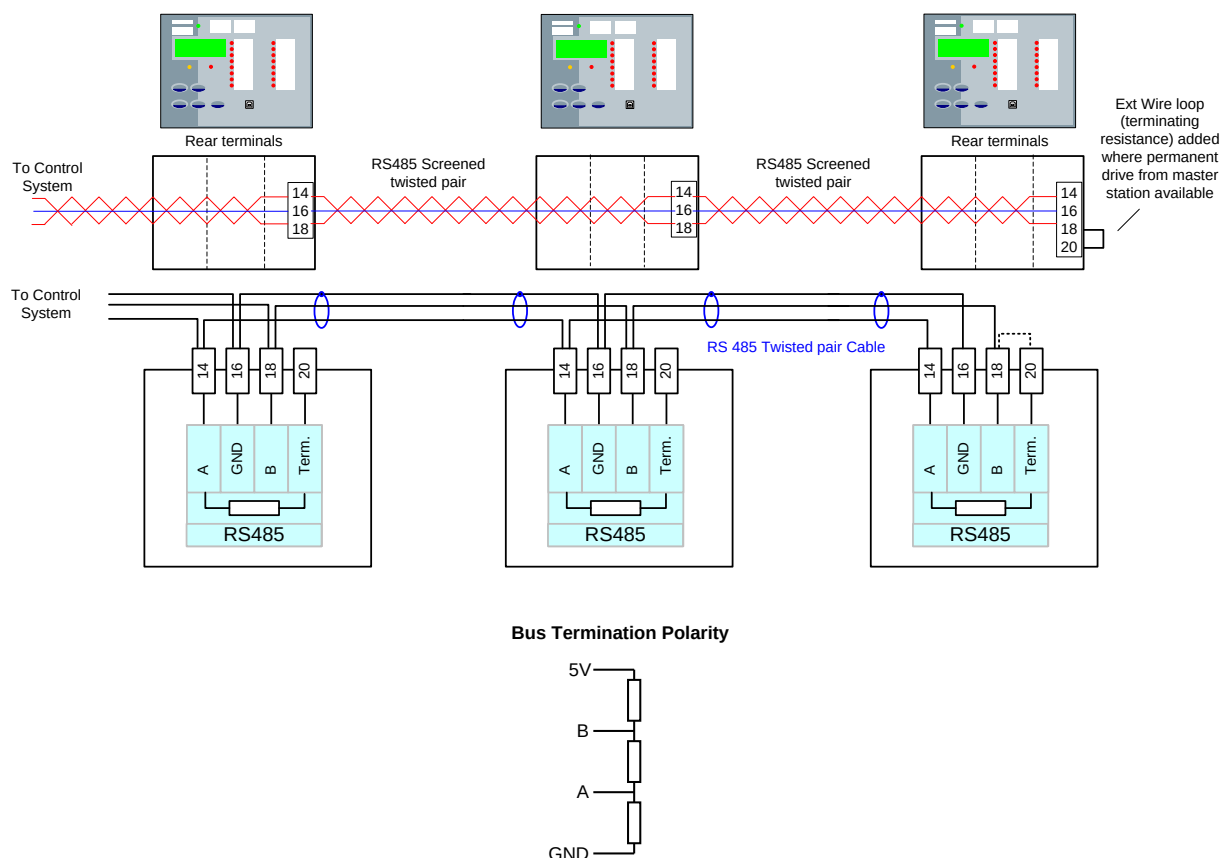


Fig. 2-2 Communication to Multiple Devices using RS485 (Standard Port)

2.4 Serial Fibre Optic Interface (COM3 & COM4)

When connecting via the optional fibre optic interface the selection of fibre-optic cable is important. Fibres must be terminated with ST™ (BFOC/2.5) connectors.

The recommended type is 62.5/125µm glass fibre. Communication distances over 1 km are achievable using this type of fibre.

A budget loss calculation should be made for all installations. The following table gives the launch power and receiver sensitivity of each of the fibre optic communication ports on the Relay when used with specific fibre optic types.

Fibre Type	Tx Launch Power (dB)		RX Receive Sensitivity (dB)	
	Min	Max	Min	Max
62.5/125µm	-11.7	-15.7	-24	-9.2
1mm Polymer	-6.4	-10.4	-24	-9.2
200µm PCS	-2.8	-6.8	-24	-9.2

Factors to be considered when calculating fibre-optic transmission distances:

- Transmitter launch power.
- Attenuation, based on light frequency, fibre material and fibre diameter. (Consult fibre manufacturers' data for actual values of fibre attenuation).
- Number of intermediate connectors and splices. Fibre cables are supplied on reels of finite length which may necessitate additional jointing. Typical losses at connectors are 0.5-1.0dB each. This allows for normal age related deterioration. Typical losses at splices are <0.3dB. (Consult fibre manufacturers' data for actual values).

- Receiver sensitivity. The light power at the receiver must be above the sensitivity of the receiver in order that effective communication can occur.
- A 3dB safety margin is usually allowed after the budget calculation is performed.

Following installation and prior to putting into service the actual losses should be measured for each fibre using a calibrated light source and meter. Measured and calculated values can be compared.

The following table can be used to record budget calculations:

A	Launch power	dB
B	Fibre Type	
C	Loss (dB/km)	dB/km
D	Length	km
E	Total fibre loss (CxD)	dB
F	No. of Splices	
G	Loss at each splice	dB
H	Total loss at splices (FxG)	dB
I	No. of connectors	
J	Loss per connector	dB
K	Total loss at connectors (IxJ)	dB
L	Total losses (E+H+K)	dB
M	Receive power budget (A-L)	dB
N	Safety Margin	dB
O	Device Receive Sensitivity	dB

The following settings, on the COMMUNICATIONS MENU, must be configured when using the fibre Optic Com3 interface.

Setting Name	Range/Options	Default	Setting	Notes
COM3 Protocol	OFF IEC60870-5-103 MODBUS-RTU DNP3	IEC60870-5-103		The protocol used to communicate on the standard RS485 connection.
COM3 Station Address	0 - 254 for IEC60870-5-103 1 - 247 for Modbus RTU 0 - 65534 for DNP3.0	0		An address within the range of the relevant protocol must be given to identify the relay. Each relay in a network must have a unique address.
COM3 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400 57600 115200	19200		The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM3 Parity	NONE ODD EVEN	EVEN		The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.

Setting Name	Range/Options	Default	Setting	Notes
COM3 Line Idle	LIGHT ON LIGHT OFF	LIGHT OFF		Sets the fibre optic line idle state.
COM3 Data Echo ^{#1}	ON OFF	OFF		Set to ON when relays are connected in a fibre-optic ring configuration.
COM3 Mode	Local Local or Remote Remote	Remote		Refer to Appendix 1 , page 85, for further explanation

The following settings, on the **COMMUNICATIONS MENU**, must be configured when using the fibre Optic Com4 interface

Setting Name	Range/Options	Default	Setting	Notes
COM4 Protocol	OFF IEC60870-5-103 MODBUS-RTU DNP3	IEC60870-5-103		The protocol used to communicate on the standard RS485 connection.
COM4 Station Address	0 - 254 for IEC60870-5-103 1 - 247 for Modbus RTU 0 - 65534 for DNP3.0	0		An address within the range of the relevant protocol must be given to identify the relay. Each relay in a network must have a unique address.
COM4 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400	19200		The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM4 Parity	NONE ODD EVEN	EVEN		The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.
COM4 Line Idle	LIGHT ON LIGHT OFF	LIGHT OFF		Sets the fibre optic line idle state.
COM4 Data Echo ^{#1}	ON OFF	OFF		Set to ON when relays are connected in a fibre-optic ring configuration.
COM4 Mode	Local Local or Remote Remote	Remote		Refer to Appendix 1 , page 85, for further explanation

#1 In ring mode, echo = on, the whole fibre optic data comms link will be interrupted if the relay element is withdrawn from the case.

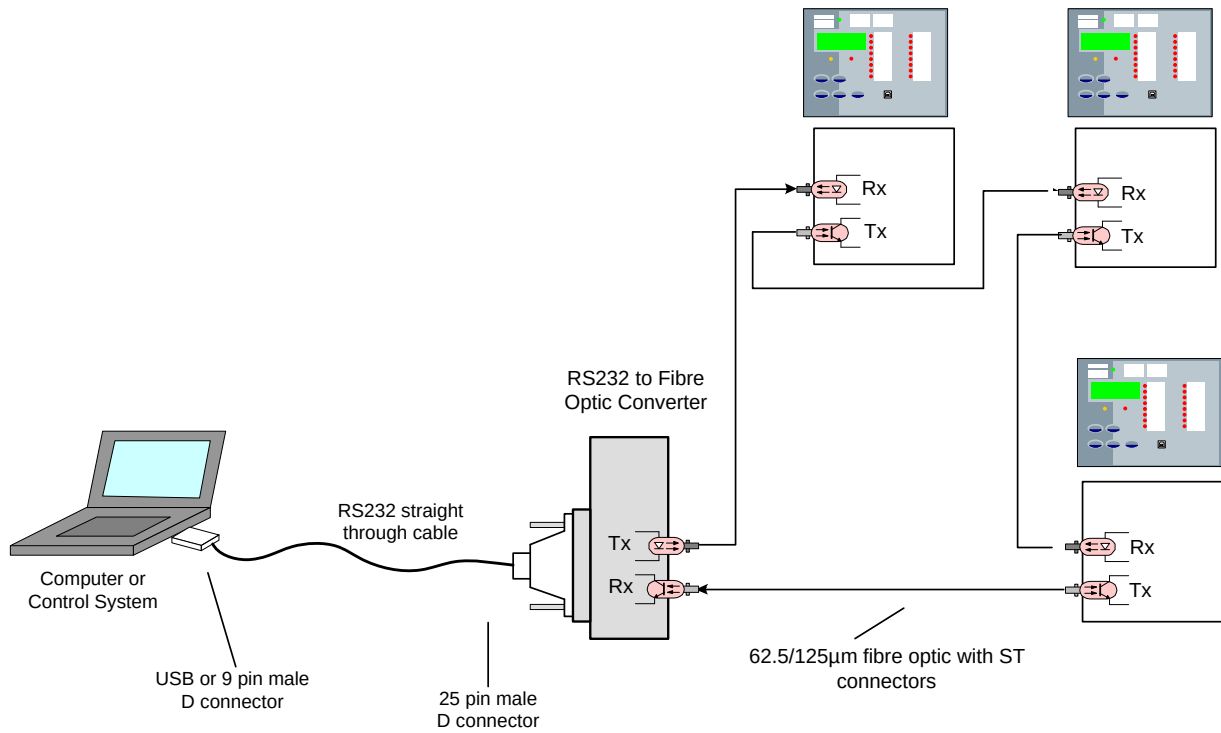


Fig. 2-3 Communication to Multiple Devices using Fibre-optic Ring Network

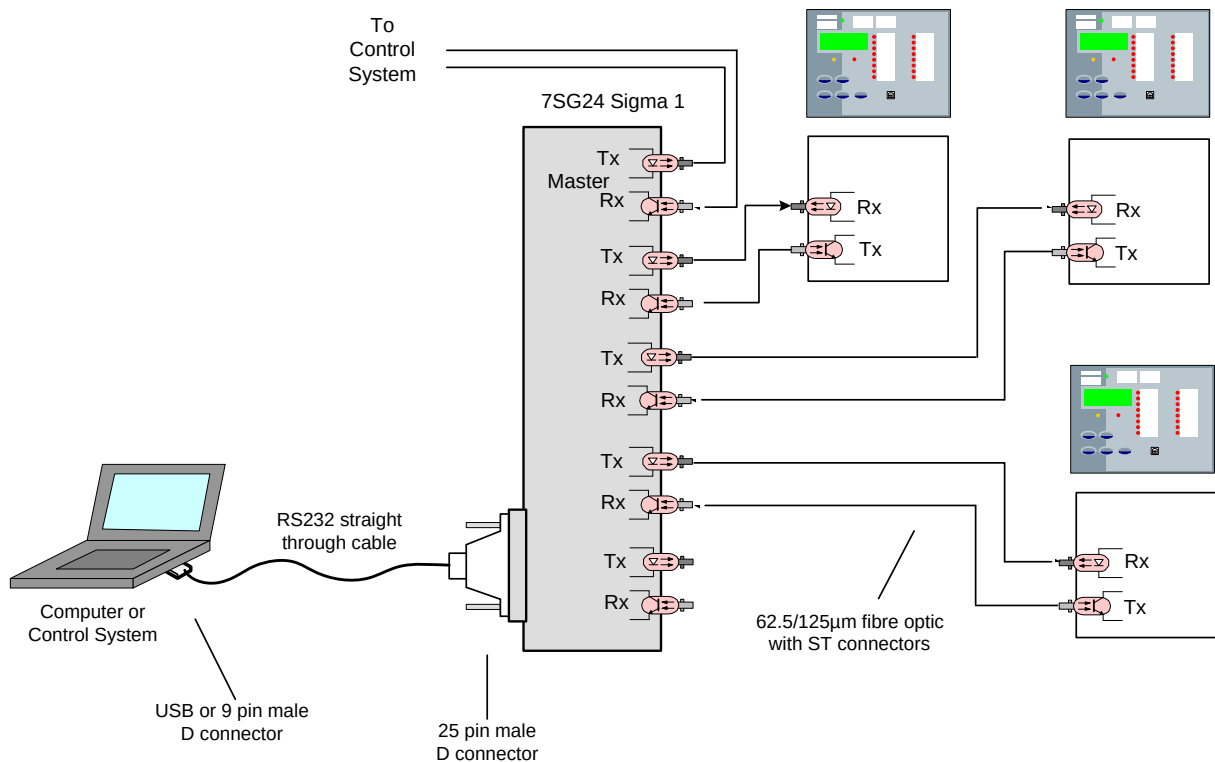


Fig. 2-4 Communication to Multiple Devices from Control System and Laptop using Fibre-optic Star Network

2.5 Optional Rear RS485 (COM3)

The following settings, on the COMMUNICATIONS MENU, must be configured when using the electrical 2-wire RS485 Com3 interface.

Setting Name	Range/Options	Default	Setting	Notes
COM3 Protocol	OFF IEC60870-5-103 MODBUS-RTU DNP3	IEC60870-5-103		The protocol used to communicate on the standard RS485 connection.
COM3 Station Address	0 - 254 for IEC60870-5-103 1 - 247 for Modbus RTU 0 - 65534 for DNP3.0	0		An address within the range of the relevant protocol must be given to identify the relay. Each relay in a network must have a unique address.
COM3 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400 57600 115200	19200		The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM3 Parity	NONE ODD EVEN	EVEN		The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.
COM3 Line Idle	LIGHT ON LIGHT OFF	LIGHT OFF	LIGHT OFF	Not applicable for RS 485 or RS 232 option, set to OFF.
COM3 Data Echo ^{#1}	ON OFF	OFF	OFF	Not applicable for RS 485 or RS 232 option, set to OFF.
COM3 Mode	Local Local or Remote Remote	Remote		Refer to Appendix 1 , page 85, for further explanation

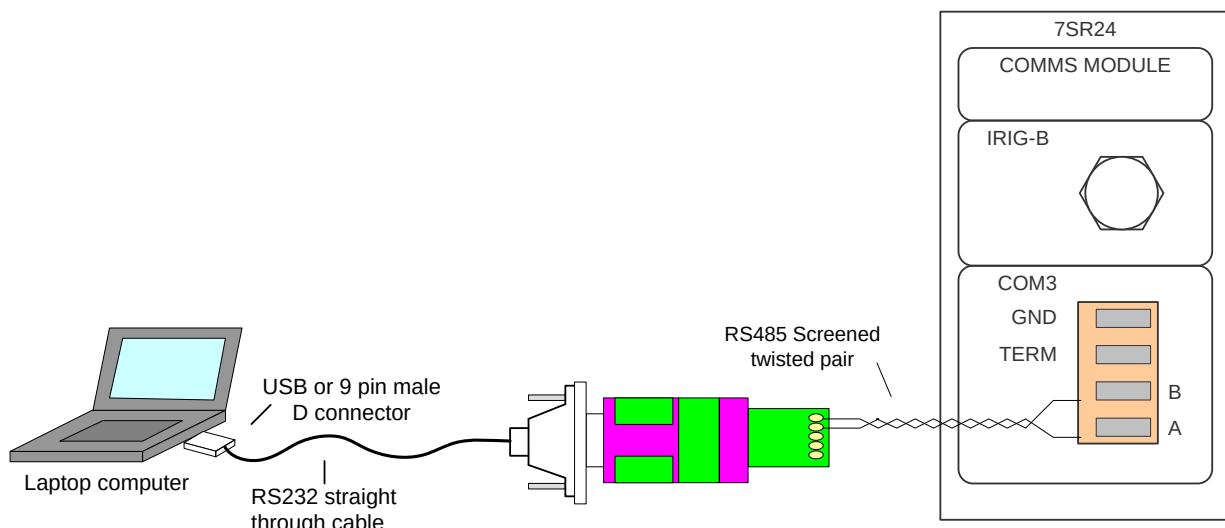


Fig. 2-5 Additional (Optional) Rear RS485 + IRIG-B Connection to a PC

2.6 Optional Rear RS232 (COM3)

The following settings, on the COMMUNICATIONS MENU, must be configured when using the electrical RS232 Com3 interface.

Setting Name	Range/Options	Default	Setting	Notes
COM3 Protocol	OFF IEC60870-5-103 MODBUS-RTU DNP3	IEC60870-5-103		The protocol used to communicate on the standard RS485 connection.
COM3 Station Address	0 - 254 for IEC60870-5-103 1 - 247 for Modbus RTU 0 - 65534 for DNP3.0	0		An address within the range of the relevant protocol must be given to identify the relay. Each relay in a network must have a unique address.
COM3 Baud Rate	75 110 150 300 600 1200 2400 4800 9600 19200 38400 57600 115200	19200		The baud rate set on all of the relays connected to the control system must be the same as the one set on the master device.
COM3 Parity	NONE ODD EVEN	EVEN		The parity set on all of the relays connected to the control system must be the same and in accordance with the master device.
COM3 Line Idle	LIGHT ON LIGHT OFF	LIGHT OFF	LIGHT OFF	Not applicable for RS 485 or RS 232 option, set to OFF.
COM3 Data Echo ^{#1}	ON OFF	OFF	OFF	Not applicable for RS 485 or RS 232 option, set to OFF.
COM3 Mode	Local Local or Remote Remote	Remote		Refer to Appendix 1 , page 85, for further explanation

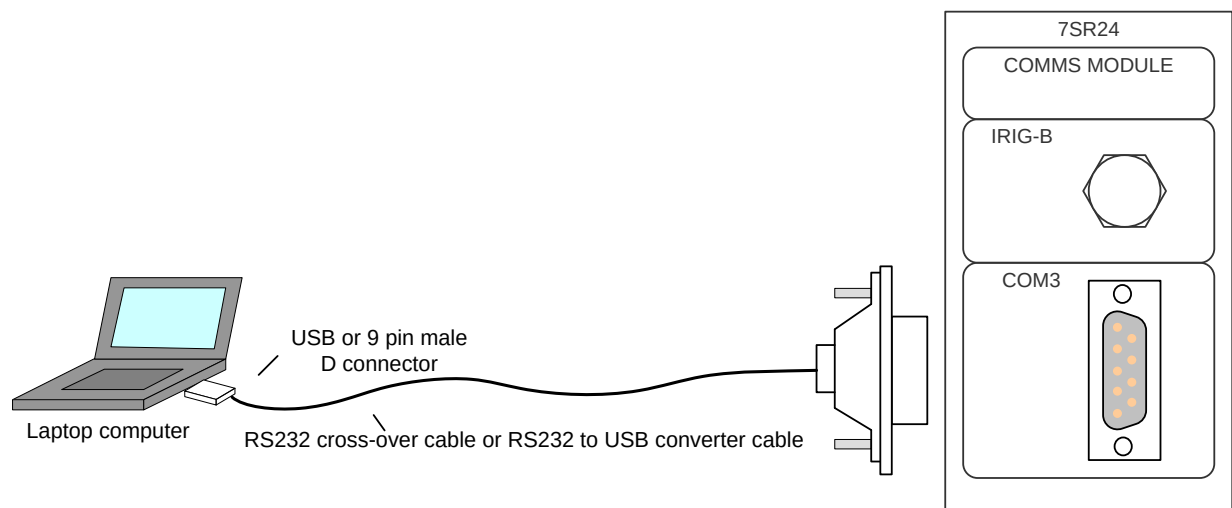


Fig. 2-6 Additional (Optional) Rear RS232 + IRIG-B Connection to a PC

Pin	Relay Function
1	Not Connected
2	Receive Data (RXD)
3	Transmit Data (TXD)

Pin	Relay Function
4	Output Supply +5V 50mA
5	Signal Ground (GND)
6	Output Supply +5V 50mA
7	Linked to 8 (volts free)
8	Linked to 7 (volts free)
9	Output Supply +5V 50mA

Fig. 2-7 RS232 Data Comms Pin Connections

2.7 Optional Rear EN100 Ethernet Module (COM3)

The optional ethernet interface is primarily provided for support of IEC 61850 Protocol. Support for IEC 60870-5-103 is also provided over this interface to allow connection with Reydisp Evolution and Reydisp Manager Software for interrogation, editing and download of relay settings and other data. Ordering options are available with two RJ45 electrical connectors or with two duplex LC fibre optic connectors.

Setting Name	Range/Options	Default	Setting	Notes
LAN Protocol	OFF IEC60870-5-103	IEC60870-5-103		Sets the protocol used to communicate on the LAN port.

If this setting is set to off, access to relay data using Reydisp Evolution and Reydisp Manager Software via the Ethernet interface is not available.

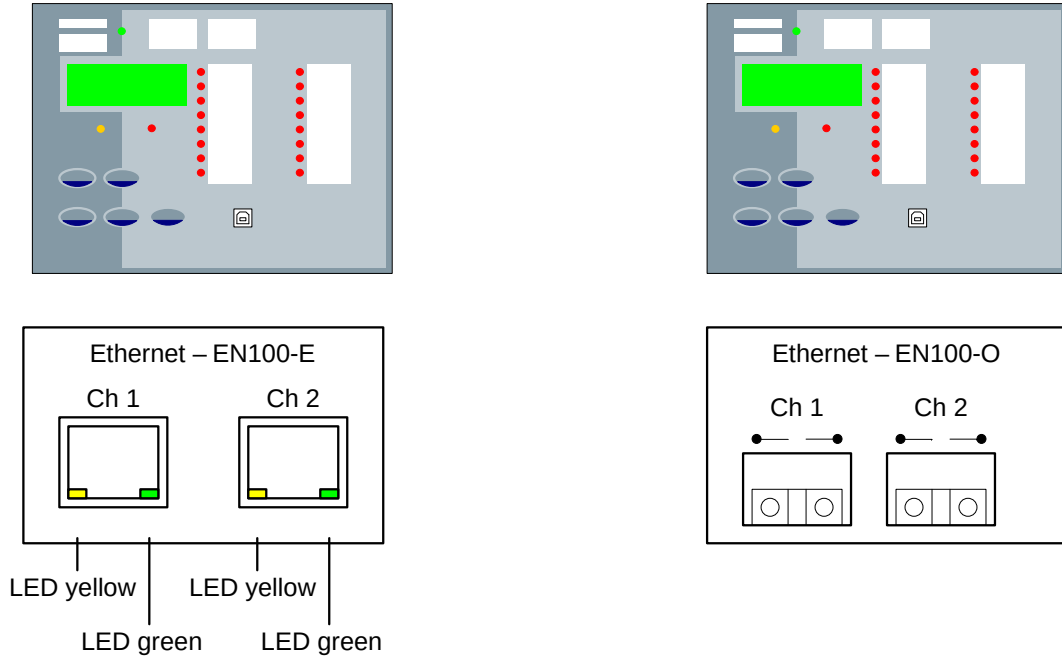
Connections to the optional EN100 Ethernet module are made on the rear underside of the relay.

Connections are made to either RJ45 sockets (electrical) or Duplex LC (fibre optic) connectors. Fibre cables should be 62.5/125µm (or 50/125µm) multimode with LC connectors.

The two types of EN100 module work slightly differently. The optical version contains an Ethernet switch to control the two channels. The switch will manage data from either channel as an Ethernet switch would in a network. The electrical version connects through one channel until it detects a break in the data traffic. After a delay it will swap to the other channel to try and re-establish communication. Either method can be thought of as providing for redundancy.

While a 61850 session is established, an operator can simultaneously connect to the device via [Reydisp Evolution](#) or a web browser through the EN100 module.

Configuration of 61850 communication is via the [Reydisp Manager](#) software package.



EN100 Module – RJ45 Interface

EN100 Module – Duplex-LC Interface

Green LED (Physical Link)

Off – No link

On – Link present

Yellow LED (Activity)

Off – No traffic

On/flashing - Traffic

Fig. 2-8 EN100 Ethernet Module

3. IEC 60870-5-103 Definitions

3.1 Introduction

This section describes the IEC 60870-5-103 protocol implementation in the relays. This protocol is used for the communication with Reydisp software and can also be used for communication with a suitable control system. The control system or local PC acts as the master in the system with the relay operating as a slave responding to the master's commands. The implementation provides event information, time synchronising, commands and measurands and also supports the transfer of disturbance records.

This protocol can be set to use any or all of the relays hardware interfaces (USB, Fibre Optic, RS232, RS485 and Ethernet) and is the standard protocol used by the USB port. The relay can communicate simultaneously on all ports regardless of protocol used.

The Station Address of the port being used must be set to a suitable address within the range 0 - 254 to enable communication. This can be set by the **Communications Menu : COM n-xxxxx Station Address** setting.

3.2 Cause of Transmission

The cause of transmission (COT) column of the “[Information Number and Function](#)” table lists possible causes of transmission for these frames. The following abbreviations are used:

Abbreviation	Description
SE	spontaneous event
T	test mode
GI	general interrogation
Loc	local operation
Rem	remote operation
Ack	command acknowledge
Nak	Negative command acknowledge

Note: Events listing a GI cause of transmission can be raised and cleared; other events are raised only.

3.3 Application Service Data Unit (ASDU) Type

The Application Service Data Unit (ASDU) column of the “[Information Number and Function](#)” table lists the possible ASDUs returned for a point.

ASDU #	Description
1	Time tagged message (monitor direction)
2	Time tagged message (relative time) (monitor direction)
3.1	Measurands I
4	Time-tagged measurands with relative time
5	Identification message
6	Time synchronisation
7	General Interrogation Initialization
9	Measurands II
20	General command

3.4 Point List

The following sub-sections contain tables listing the data points available via the IEC60870-5-103 protocol.

The information shown below is the default configuration. This can be modified using the Communications Configuration Editor tool, refer [section 9](#) for details.

3.4.1 Event Function (FUN) & Information (INF) Numbers

The following Event EVT and INF numbers apply to this device.

FUN	INF	Description	ASDU	COT
60	4	Remote Mode	1	SE, GI
			20	Ack, Nak
60	5	Service Mode	1	SE, GI
			20	Ack, Nak
60	6	Local Mode	1	SE, GI
			20	Ack, Nak
60	7	Local & Remote	1	SE, GI
			20	Ack, Nak
60	12	Control Received	1	SE
60	13	Command Received	1	SE
60	128	Cold Start	1	SE
60	129	Warm Start	1	SE
60	130	Re-Start	1	SE
60	135	Trigger Storage	1	SE
60	136	Clear Waveform Records	1	SE
60	137	Clear Fault Records	1	SE
60	138	Clear Event Records	1	SE
60	170	General Alarm 1	1	SE, GI
60	171	General Alarm 2	1	SE, GI
60	172	General Alarm 3	1	SE, GI
60	173	General Alarm 4	1	SE, GI
60	174	General Alarm 5	1	SE, GI
60	175	General Alarm 6	1	SE, GI
60	176	General Alarm 7	1	SE, GI
60	177	General Alarm 8	1	SE, GI
60	178	General Alarm 9	1	SE, GI
60	179	General Alarm 10	1	SE, GI
60	180	General Alarm 11	1	SE, GI
60	181	General Alarm 12	1	SE, GI
60	182	Quick Logic E1	1	SE, GI
60	183	Quick Logic E2	1	SE, GI
60	184	Quick Logic E3	1	SE, GI
60	185	Quick Logic E4	1	SE, GI
60	186	Quick Logic E5	1	SE, GI
60	187	Quick Logic E6	1	SE, GI
60	188	Quick Logic E7	1	SE, GI
60	189	Quick Logic E8	1	SE, GI
60	190	Quick Logic E9	1	SE, GI

FUN	INF	Description	ASDU	COT
60	191	Quick Logic E10	1	SE, GI
60	192	Quick Logic E11	1	SE, GI
60	193	Quick Logic E12	1	SE, GI
60	194	Quick Logic E13	1	SE, GI
60	195	Quick Logic E14	1	SE, GI
60	196	Quick Logic E15	1	SE, GI
60	197	Quick Logic E16	1	SE, GI
70	5	Binary Input 5	1	SE, GI
70	6	Binary Input 6	1	SE, GI
70	7	Binary Input 7	1	SE, GI
70	8	Binary Input 8	1	SE, GI
70	9	Binary Input 9	1	SE, GI
70	10	Binary Input 10	1	SE, GI
70	11	Binary Input 11	1	SE, GI
70	12	Binary Input 12	1	SE, GI
70	13	Binary Input 13	1	SE, GI
70	14	Binary Input 14	1	SE, GI
70	15	Binary Input 15	1	SE, GI
70	16	Binary Input 16	1	SE, GI
70	17	Binary Input 17	1	SE, GI
70	18	Binary Input 18	1	SE, GI
70	19	Binary Input 19	1	SE, GI
75	1	Virtual Input 1	1	SE, GI
75	2	Virtual Input 2	1	SE, GI
75	3	Virtual Input 3	1	SE, GI
75	4	Virtual Input 4	1	SE, GI
75	5	Virtual Input 5	1	SE, GI
75	6	Virtual Input 6	1	SE, GI
75	7	Virtual Input 7	1	SE, GI
75	8	Virtual Input 8	1	SE, GI
75	9	Virtual Input 9	1	SE, GI
75	10	Virtual Input 10	1	SE, GI
75	11	Virtual Input 11	1	SE, GI
75	12	Virtual Input 12	1	SE, GI
75	13	Virtual Input 13	1	SE, GI
75	14	Virtual Input 14	1	SE, GI
75	15	Virtual Input 15	1	SE, GI
75	16	Virtual Input 16	1	SE, GI
80	1	Binary Output 1	1	SE, GI
			20	Ack, Nak
80	2	Binary Output 2	1	SE, GI
			20	Ack, Nak
80	3	Binary Output 3	1	SE, GI
			20	Ack, Nak
80	4	Binary Output 4	1	SE, GI
			20	Ack, Nak
80	5	Binary Output 5	1	SE, GI
			20	Ack, Nak

FUN	INF	Description	ASDU	COT
80	6	Binary Output 6	1	SE, GI
			20	Ack, Nak
80	7	Binary Output 7	1	SE, GI
			20	Ack, Nak
80	8	Binary Output 8	1	SE, GI
			20	Ack, Nak
80	9	Binary Output 9	1	SE, GI
			20	Ack, Nak
80	10	Binary Output 10	1	SE, GI
			20	Ack, Nak
80	11	Binary Output 11	1	SE, GI
			20	Ack, Nak
80	12	Binary Output 12	1	SE, GI
			20	Ack, Nak
80	13	Binary Output 13	1	SE, GI
			20	Ack, Nak
80	14	Binary Output 14	1	SE, GI
			20	Ack, Nak
80	15	Binary Output 15	1	SE, GI
			20	Ack, Nak
80	16	Binary Output 16	1	SE, GI
			20	Ack, Nak
90	1	LED 1	1	SE, GI
90	2	LED 2	1	SE, GI
90	3	LED 3	1	SE, GI
90	4	LED 4	1	SE, GI
90	5	LED 5	1	SE, GI
90	6	LED 6	1	SE, GI
90	7	LED 7	1	SE, GI
90	8	LED 8	1	SE, GI
90	9	LED 9	1	SE, GI
90	10	LED 10	1	SE, GI
90	11	LED 11	1	SE, GI
90	12	LED 12	1	SE, GI
90	13	LED 13	1	SE, GI
90	14	LED 14	1	SE, GI
90	15	LED 15	1	SE, GI
90	16	LED 16	1	SE, GI
91	1	LED PU 1	1	SE, GI
91	2	LED PU 2	1	SE, GI
91	3	LED PU 3	1	SE, GI
91	4	LED PU 4	1	SE, GI
91	5	LED PU 5	1	SE, GI
91	6	LED PU 6	1	SE, GI
91	7	LED PU 7	1	SE, GI
91	8	LED PU 8	1	SE, GI
91	9	LED PU 9	1	SE, GI
91	10	LED PU 10	1	SE, GI
91	11	LED PU 11	1	SE, GI

FUN	INF	Description	ASDU	COT
91	12	LED PU 12	1	SE, GI
91	13	LED PU 13	1	SE, GI
91	14	LED PU 14	1	SE, GI
91	15	LED PU 15	1	SE, GI
91	16	LED PU 16	1	SE, GI
181	2	Reset FCB	2	SE
181	3	Reset CU	2	SE
181	4	Start/Restart	2	SE
181	5	Power On	2	SE
181	19	LED Reset	1	SE
			20	Ack, Nak
181	22	Settings changed	1	SE
181	23	Setting G1 selected	1	SE, GI
			20	Ack, Nak
181	24	Setting G2 selected	1	SE, GI
			20	Ack, Nak
181	25	Setting G3 selected	1	SE, GI
			20	Ack, Nak
181	26	Setting G4 selected	1	SE, GI
			20	Ack, Nak
181	27	Binary Input 1	1	SE, GI
181	28	Binary Input 2	1	SE, GI
181	29	Binary Input 3	1	SE, GI
181	30	Binary Input 4	1	SE, GI
181	36	Trip Circuit Fail	1	SE, GI
181	64	Start/Pick-up L1	2	SE, GI
181	65	Start/Pick-up L2	2	SE, GI
181	66	Start/Pick-up L3	2	SE, GI
181	67	Start/Pick-up N	2	SE, GI
181	68	General Trip	2	SE
181	69	Trip L1	2	SE
181	70	Trip L2	2	SE
181	71	Trip L3	2	SE
181	84	General Start/Pick-up	2	SE, GI
181	95	87/50-1	2	SE, GI
181	96	87/50-2	2	SE, GI
181	97	87/50	2	SE, GI
181	98	CT Supervision	2	SE, GI
181	110	Setting G5 selected	1	SE, GI
			20	Ack, Nak
181	111	Setting G6 selected	1	SE, GI
			20	Ack, Nak
181	112	Setting G7 selected	1	SE, GI
			20	Ack, Nak
181	113	Setting G8 selected	1	SE, GI
			20	Ack, Nak
181	120	Trip Circuit Fail 1	1	SE, GI
181	121	Trip Circuit Fail 2	1	SE, GI

FUN	INF	Description	ASDU	COT
181	122	Trip Circuit Fail 3	1	SE, GI
181	123	Trip Circuit Fail 4	1	SE, GI
181	124	Trip Circuit Fail 5	1	SE, GI
181	125	Trip Circuit Fail 6	1	SE, GI
181	126	Trip Circuit Fail 7	1	SE, GI
181	127	Trip Circuit Fail 8	1	SE, GI
181	128	Trip Circuit Fail 9	1	SE, GI
181	129	Trip Circuit Fail 10	1	SE, GI
181	130	Trip Circuit Fail 11	1	SE, GI
181	131	Trip Circuit Fail 12	1	SE, GI
186	1	CB1 Cct Closed Alarm	1	SE, GI
186	2	CB2 Cct Closed Alarm	1	SE, GI
186	3	CB3 Cct Closed Alarm	1	SE, GI
186	4	CB4 Cct Closed Alarm	1	SE, GI
186	5	CB5 Cct Closed Alarm	1	SE, GI
186	6	CB6 Cct Closed Alarm	1	SE, GI
186	7	CB7 Cct Closed Alarm	1	SE, GI
186	8	CB8 Cct Closed Alarm	1	SE, GI
186	9	CB9 Cct Closed Alarm	1	SE, GI
186	10	CB10 Cct Closed Alarm	1	SE, GI
186	11	CB11 Cct Closed Alarm	1	SE, GI
186	12	CB12 Cct Closed Alarm	1	SE, GI
186	13	CB1 Cct DBI Alarm	1	SE, GI
186	14	CB2 Cct DBI Alarm	1	SE, GI
186	15	CB3 Cct DBI Alarm	1	SE, GI
186	16	CB4 Cct DBI Alarm	1	SE, GI
186	17	CB5 Cct DBI Alarm	1	SE, GI
186	18	CB6 Cct DBI Alarm	1	SE, GI
186	19	CB7 Cct DBI Alarm	1	SE, GI
186	20	CB8 Cct DBI Alarm	1	SE, GI
186	21	CB9 Cct DBI Alarm	1	SE, GI
186	22	CB10 Cct DBI Alarm	1	SE, GI
186	23	CB11 Cct DBI Alarm	1	SE, GI
186	24	CB12 Cct DBI Alarm	1	SE, GI
186	25	CB1 Cct Travel Alarm	1	SE, GI
186	26	CB2 Cct Travel Alarm	1	SE, GI
186	27	CB3 Cct Travel Alarm	1	SE, GI
186	28	CB4 Cct Travel Alarm	1	SE, GI
186	29	CB5 Cct Travel Alarm	1	SE, GI
186	30	CB6 Cct Travel Alarm	1	SE, GI
186	31	CB7 Cct Travel Alarm	1	SE, GI
186	32	CB8 Cct Travel Alarm	1	SE, GI
186	33	CB9 Cct Travel Alarm	1	SE, GI
186	34	CB10 Cct Travel Alarm	1	SE, GI
186	35	CB11 Cct Travel Alarm	1	SE, GI
186	36	CB12 Cct Travel Alarm	1	SE, GI
186	50	Ext 87 CBF Input	1	SE, GI
186	51	Ext 87 CBF1	1	SE, GI
186	52	Ext 87 CBF2	1	SE, GI

FUN	INF	Description	ASDU	COT
186	53	Ext 87 CBF3	1	SE, GI
186	54	Ext 87 CBF4	1	SE, GI
186	55	Ext 87 CBF5	1	SE, GI
186	56	Ext 87 CBF6	1	SE, GI
186	57	Ext 87 CBF7	1	SE, GI
186	58	Ext 87 CBF8	1	SE, GI
186	59	Ext 87 CBF9	1	SE, GI
186	60	Ext 87 CBF10	1	SE, GI
186	61	Ext 87 CBF11	1	SE, GI
186	62	Ext 87 CBF12	1	SE, GI
186	63	General Trip	2	SE, GI
186	64	Trip L1	2	SE, GI
186	65	Trip L2	2	SE, GI
186	66	Trip L3	2	SE, GI
186	126	50G	2	SE, GI
186	127	E/F Out	2	SE, GI
			20	Ack, Nak
186	128	50G-1	2	SE, GI
186	129	50G-2	2	SE, GI
186	133	87/50A-1	2	SE, GI
186	134	87/50B-1	2	SE, GI
186	135	87/50C-1	2	SE, GI
186	136	87/50G-1	2	SE, GI
186	137	87/50AB-1	2	SE, GI
186	138	87/50BC-1	2	SE, GI
186	139	87/50CA-1	2	SE, GI
186	140	87/50AG-1	2	SE, GI
186	141	87/50BG-1	2	SE, GI
186	142	87/50CG-1	2	SE, GI
186	143	87/50A-2	2	SE, GI
186	144	87/50B-2	2	SE, GI
186	145	87/50C-2	2	SE, GI
186	146	87/50G-2	2	SE, GI
186	147	87/50AB-2	2	SE, GI
186	148	87/50BC-2	2	SE, GI
186	149	87/50CA-2	2	SE, GI
186	150	87/50AG-2	2	SE, GI
186	151	87/50BG-2	2	SE, GI
186	152	87/50CG-2	2	SE, GI
186	154	CT50A	2	SE, GI
186	155	CT50B	2	SE, GI
186	156	CT50C	2	SE, GI
186	157	CT50G	2	SE, GI
186	158	87REF	2	SE, GI
186	159	87REF-1	2	SE, GI
186	160	87REF-2	2	SE, GI
186	161	Zone Switch Out	1	SE, GI
			20	Ack, Nak

FUN	INF	Description	ASDU	COT
186	162	Zone CT Shorting	1	SE, GI
186	165	87/50SFM Pickup	2	SE, GI
186	166	87/50SFM	2	SE, GI
186	167	87/50BF	2	SE, GI
186	168	87/50BF Blind Spot	2	SE, GI
186	169	CB Total Trip Count	1	SE, GI
186	170	CB Delta Trip Count	1	SE, GI
186	171	Reset CB Total Trip Count	1	SE
			20	Ack, Nak
186	172	Reset CB Delta Trip Count	1	SE
			20	Ack, Nak
186	173	CB Total Trip Count Asdu4	4	SE
186	174	CB Delta Trip Count Asdu4	4	SE
186	175	CB1 Total Open Count	1	SE, GI
186	176	CB1 Delta Open Count	1	SE, GI
186	177	Reset CB1 Total Open Count	1	SE
			20	Ack, Nak
186	178	Reset CB1 Delta Open Count	1	SE
			20	Ack, Nak
186	179	CB1 Total Open Count Asdu4	4	SE
186	180	CB1 Delta Open Count Asdu4	4	SE
186	181	CB2 Total Open Count	1	SE, GI
186	182	CB2 Delta Open Count	1	SE, GI
186	183	Reset CB2 Total Open Count	1	SE
			20	Ack, Nak
186	184	Reset CB2 Delta Open Count	1	SE
			20	Ack, Nak
186	185	CB2 Total Open Count Asdu4	4	SE
186	186	CB2 Delta Open Count Asdu4	4	SE
186	187	CB3 Total Open Count	1	SE, GI
186	188	CB3 Delta Open Count	1	SE, GI
186	189	Reset CB3 Total Open Count	1	SE
			20	Ack, Nak
186	190	Reset CB3 Delta Open Count	1	SE
			20	Ack, Nak
186	191	CB3 Total Open Count Asdu4	4	SE
186	192	CB3 Delta Open Count Asdu4	4	SE
186	193	CB4 Total Open Count	1	SE, GI
186	194	CB4 Delta Open Count	1	SE, GI
186	195	Reset CB4 Total Open Count	1	SE
			20	Ack, Nak
186	196	Reset CB4 Delta Open Count	1	SE
			20	Ack, Nak
186	197	CB4 Total Open Count Asdu4	4	SE
186	198	CB4 Delta Open Count Asdu4	4	SE
186	199	CB5 Total Open Count	1	SE, GI
186	200	CB5 Delta Open Count	1	SE, GI
186	201	Reset CB5 Total Open Count	1	SE
			20	Ack, Nak

FUN	INF	Description	ASDU	COT
186	202	Reset CB5 Delta Open Count	1	SE
			20	Ack, Nak
186	203	CB5 Total Open Count Asdu4	4	SE
186	204	CB5 Delta Open Count Asdu4	4	SE
186	205	CB6 Total Open Count	1	SE, GI
186	206	CB6 Delta Open Count	1	SE, GI
186	207	Reset CB6 Total Open Count	1	SE
			20	Ack, Nak
186	208	Reset CB6 Delta Open Count	1	SE
			20	Ack, Nak
186	209	CB6 Total Open Count Asdu4	4	SE
186	210	CB6 Delta Open Count Asdu4	4	SE
186	211	CB7 Total Open Count	1	SE, GI
186	212	CB7 Delta Open Count	1	SE, GI
186	213	Reset CB7 Total Open Count	1	SE
			20	Ack, Nak
186	214	Reset CB7 Delta Open Count	1	SE
			20	Ack, Nak
186	215	CB7 Total Open Count Asdu4	4	SE
186	216	CB7 Delta Open Count Asdu4	4	SE
186	217	CB8 Total Open Count	1	SE, GI
186	218	CB8 Delta Open Count	1	SE, GI
186	219	Reset CB8 Total Open Count	1	SE
			20	Ack, Nak
186	220	Reset CB8 Delta Open Count	1	SE
			20	Ack, Nak
186	221	CB8 Total Open Count Asdu4	4	SE
186	222	CB8 Delta Open Count Asdu4	4	SE
186	223	CB9 Total Open Count	1	SE, GI
186	224	CB9 Delta Open Count	1	SE, GI
186	225	Reset CB9 Total Open Count	1	SE
			20	Ack, Nak
186	226	Reset CB9 Delta Open Count	1	SE
			20	Ack, Nak
186	227	CB9 Total Open Count Asdu4	4	SE
186	228	CB9 Delta Open Count Asdu4	4	SE
186	229	CB10 Total Open Count	1	SE, GI
186	230	CB10 Delta Open Count	1	SE, GI
186	231	Reset CB10 Total Open Count	1	SE
			20	Ack, Nak
186	232	Reset CB10 Delta Open Count	1	SE
			20	Ack, Nak
186	233	CB10 Total Open Count Asdu4	4	SE
186	234	CB10 Delta Open Count Asdu4	4	SE
186	235	CB11 Total Open Count	1	SE, GI
186	236	CB11 Delta Open Count	1	SE, GI
186	237	Reset CB11 Total Open Count	1	SE
			20	Ack, Nak

FUN	INF	Description	ASDU	COT
186	238	Reset CB11 Delta Open Count	1	SE
			20	Ack, Nak
186	239	CB11 Total Open Count Asdu4	4	SE
186	240	CB11 Delta Open Count Asdu4	4	SE
186	241	CB12 Total Open Count	1	SE, GI
186	242	CB12 Delta Open Count	1	SE, GI
186	243	Reset CB12 Total Open Count	1	SE
			20	Ack, Nak
186	244	Reset CB12 Delta Open Count	1	SE
			20	Ack, Nak
186	245	CB12 Total Open Count Asdu4	4	SE
186	246	CB12 Delta Open Count Asdu4	4	SE
186	248	Ia Fault Current	4	SE
186	249	Ib Fault Current	4	SE
186	250	Ic Fault Current	4	SE
186	251	Ig Fault Current	4	SE
186	252	Ig2 Fault Current	4	SE
200	1	CB 1	1	SE
200	2	CB 2	1	SE
200	3	CB 3	1	SE
200	4	CB 4	1	SE
200	5	CB 5	1	SE
200	66	CB 6	1	SE
200	67	CB 7	1	SE
200	68	CB 8	1	SE
200	69	CB 9	1	SE
200	70	CB 10	1	SE
200	71	CB 11	1	SE
200	72	CB 12	1	SE
200	150	User SP Command 1	1	SE, GI
			20	Ack, Nak
200	151	User SP Command 2	1	SE, GI
			20	Ack, Nak
200	152	User SP Command 3	1	SE, GI
			20	Ack, Nak
200	153	User SP Command 4	1	SE, GI
			20	Ack, Nak
200	154	User SP Command 5	1	SE, GI
			20	Ack, Nak
200	155	User SP Command 6	1	SE, GI
			20	Ack, Nak
200	156	User SP Command 7	1	SE, GI
			20	Ack, Nak
200	157	User SP Command 8	1	SE, GI
			20	Ack, Nak
200	158	User DP Command 1	1	SE
			20	Ack, Nak
200	159	User DP Command 2	1	SE
			20	Ack, Nak

FUN	INF	Description	ASDU	COT
200	160	User DP Command 3	1	SE
			20	Ack, Nak
200	161	User DP Command 4	1	SE
			20	Ack, Nak
200	162	User DP Command 5	1	SE
			20	Ack, Nak
200	163	User DP Command 6	1	SE
			20	Ack, Nak
200	164	User DP Command 7	1	SE
			20	Ack, Nak
200	165	User DP Command 8	1	SE
			20	Ack, Nak
255	0	General Interrogation (GI) Initiation	7	Init. GI
255	0	General Interrogation (GI) End	8	End of GI
255	0	Time Synchronisation	6	Time Synch.

3.4.2 Measurands

The following Measurand EVT and INF numbers apply to this device.

FUN	INF	Description	ASDU	COT
186	253	Measurand $I_{L1,2,3}$, I_g --- I_{L1} (1.2x) (Window 5%) I_{L2} (1.2x) (Window 5%) I_{L3} (1.2x) (Window 5%) I_g (1.2x) (Window 5%)	9	Cyclic - Refresh rate 5 seconds or value change greater than Window x %.

3.4.3 Disturbance Recorder Actual Channel (ACC) Numbers

The following Disturbance Recorder channel numbers apply to this device.

FUN	ACC	Description
186	1	Ia
186	2	Ib
186	3	Ic
186	4	Ig
186	5	Ig2

4. MODBUS Definitions

4.1 Introduction

This section describes the MODBUS-RTU protocol implementation in the relays. This protocol is used for communication with a suitable control system.

This protocol can be set to use any or all of the relays hardware interfaces (USB, Fibre Optic, RS232 and RS485). The relay can communicate simultaneously on all ports regardless of protocol used.

The Station Address of the port being used must be set to a suitable address within the range 1 - 247 to enable communication. This can be set by the **Communications Menu : COM *n*-xxxxx Station Address** setting.

Communication via MODBUS over Ethernet requires external devices. Please refer to the documents **TCPIP Catalogue Sheet** and **TCPIP Interface Technical Guidance Notes** for more information.

Definitions with shaded area are not available on all relay models.

The float data type conforms to the IEEE 754 floating point definition. This specifies that 32 bits of data will be formatted as a sign bit in the most significant bit (MSB) followed by an 8 bit exponent then a 23 bit mantissa, down to the least significant bit (LSB).

Address	Value
30002	2400

On reception these two registers should be interpreted in the correct order as IEEE754 floating point representation.

4.2.2 FP_32BITS_3DP

The FP_32BITS_3DP is a 32 bit integer fixed point value, containing 3 decimal places of information. It is used to send a real value to 3 decimal places as an integer. For example, if the value in a device is 123.456 it will be sent as 123456. As it is an integer, negative numbers are sent as 2's complement.

FP_32BITS_3DP & MODBUS

In this MODBUS implementation the 32 bit value is stored in 2 16 registers in Big-Endian format. As an example, if we take the hex representation of 123456, we have 1E240h. Assume this is stored in the registers 30001 and 30002, it would look as follows:

Address	Value
30001	1
30002	E240

On reception these two registers should be interpreted in the correct order as a 32 bit integer.

4.2.3 UINT32

The UINT32 is a signed 32 bit integer. As it is an integer, negative numbers are sent as 2's complement.

UINT32 & MODBUS

In this MODBUS implementation the 32 bit value is stored in 2 16 bit registers in Big-Endian format. As an example, if we take the hex representation of -123456, in 2's complement, we have FFFE1DC0h. Assume this is stored in the registers 30001 and 30002, it would look as follows:

Address	Value
30001	FFFE
30002	1DC0

On reception these two registers should be interpreted in the correct order as a 32 bit integer.

4.2.4 UINT16

The UINT16 is a signed 16 bit integer. As it is an integer, negative numbers are sent as 2's complement.

UINT16 & MODBUS

In this MODBUS implementation the 16 bit value is stored in a 16 bit register in Big-Endian format. As an example, if we take the hex representation of 5678 we have 162Eh. Assume this is stored in the register 30001, it would look as follows:

Address	Value
30001	162E

On reception this register should be interpreted as a 16 bit integer.

Truncation

Calculations are performed as 32 bit. The 16 bit value is the lowest 16 bits of the 32 bit value. Therefore, when values overflow the returned value is the lowest 16 bits of the calculated value. For Example, if the value is 85400 = 14D98h, the value returned would be the lowest 16 bits = 4D98h which equals 19864.

4.2.5 EVENT

MODBUS does not define a method for extracting events; therefore a private method has been defined based on that defined by IEC60870-5-103.

The EVENT register contains the earliest event record available. The event record is 8 registers (16 bytes) of information, whose format is described below. When this record has been read it will be replaced by the next available record. Event records must be read completely; therefore the quantity value must be set to 8 before reading. Failing to do this will result in an exception code 2. If no event record is present the exception code 2 will be returned. The EVENT register should be polled regularly by the master for events.

The **EVENTCOUNT** register can be checked periodically to determine how many events are stored.

The format of the event record is defined by the zero byte. It signifies the type of record which is used to decode the event information. The zero byte can be one of the following.

Format

The format of the event record is defined by the zero byte. It signifies the type of record which is used to decode the event information. The zero byte can be one of the following.

Type	Description
1	Event
2	Event with Relative Time
4	Measurand Event with Relative Time

The following table describes the fields in the event record.

Key	Description
FUN	Function Type, as defined for IEC870-5-103.
INF	Information Number, as defined for IEC870-5-103.
DPI	Measurand Event with Relative Time, values 1 = OFF, 2 = ON.
ms L	Time Stamp Milliseconds low byte.
ms H	Time Stamp Milliseconds high byte.
Mi	Time Stamp Minutes (MSB = invalid, time not set > 23 hours).
Ho	Time Stamp Hours (MSB = Summer time flag).
RT L	Relative Time low byte.
RT H	Relative Time high byte.
F# L	Fault Number low byte.
F# H	Fault Number high byte.
Meas	Measurand format R32.23, sent least significant byte first.

The following tables show the fields in the different event records as they are returned.

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	1	0	FUN	INF	DPI	0	0	0	0	0	0	0	ms L	ms H	Mi	Ho

Event Type 1 Format.

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	2	0	FUN	INF	DPI	RT L	RT H	F# L	F# H	0	0	0	ms L	ms H	Mi	Ho

Event Type 2 Format.

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Content	4	0	FUN	INF	Meas				0	0	0	0	ms L	ms H	Mi	Ho

Event Type 4 Format.

4.2.6 EVENTCOUNT

The EVENTCOUNT register contains the current number of events in the relay's event buffer.

On reception this register should be interpreted as a 16 bit integer.

4.2.7 TIME_METER

The TIME_METER register contains the device's time. The time must be read or written in one step; therefore the quantity should be 4 registers. Failing to do this will result in an exception code 2. The time format is 8 bytes as follows.

The following table describes the fields in the time.

Key	Description
ms L	Time Stamp Milliseconds low byte.
ms H	Time Stamp Milliseconds high byte.
Mi	Time Stamp Minutes (MSB = invalid, time not set > 23 hours).
Ho	Time Stamp Hours (MSB = Summer time flag).
Da	Time Stamp Days.
Mo	Time Stamp Months.
Ye L	Time Stamp Years low byte.
Ye H	Time Stamp Years high byte (Not Used).

The following table shows the fields in the time as they are returned.

Byte	0	1	2	3	4	5	6	7
Content	ms L	ms H	Mi	Ho	Da	Mo	Ye L	Ye H

Time Format.

4.2.8 STR32 & STR64

4.2.9 BITSTRING

A Bit-String (or Bit-Array) is a method of compactly storing a number of bits of data. In this instance we store up to 16 bit values, for example the states of binary inputs, in a single 16 bit register. The first bit value is stored in the Least Significant Bit (LSB) of the register. The 16th value would be in the Most Significant Bit (MSB). Bit values can only be zero or one. Any unused bits will be set to zero.

BITSTRING & MODBUS

In this MODBUS implementation the 16 bit value is stored in a 16 bit register in Big-Endian format. As an example, assume bits 1, 3, 9 and 12 are set. The binary representation of this would be 0000100100000101_2 giving a hex representation of 0905h. Assume this is stored in the register 30001, it would look as follows:

Address	Value
30001	0905

On reception this register should be interpreted as a 16 bit integer.

4.3 Point List

The information shown below is the default configuration. This can be modified using the Communications Configuration Editor tool, refer [section 9](#) for details.

4.3.1 Coils (Read Write Binary values)

Address	Name
00001	Binary Output 1
00002	Binary Output 2
00003	Binary Output 3
00004	Binary Output 4
00005	Binary Output 5
00006	Binary Output 6
00007	Binary Output 7
00008	Binary Output 8
00009	Binary Output 9
00010	Binary Output 10
00011	Binary Output 11
00012	Binary Output 12
00013	Binary Output 13
00014	Binary Output 14
00015	Binary Output 15
00016	Binary Output 16
00101	Setting G1 selected
00102	Setting G2 selected
00103	Setting G3 selected
00104	Setting G4 selected
00105	Setting G5 selected
00106	Setting G6 selected
00107	Setting G7 selected
00108	Setting G8 selected
00109	CB 1
00110	CB 2
00120	Local Mode
00121	Remote Mode
00122	Service Mode
00123	Local & Remote
00124	E/F Out
00125	CB 3
00126	CB 4
00127	CB 5
00130	Zone Switch Out
00166	CB 6
00167	CB 7
00168	CB 8
00169	CB 9
00170	CB 10

Address	Name
00171	CB 11
00172	CB 12
00200	User SP Command 1
00201	User SP Command 2
00202	User SP Command 3
00203	User SP Command 4
00204	User SP Command 5
00205	User SP Command 6
00206	User SP Command 7
00207	User SP Command 8
00208	User DP Command 1
00209	User DP Command 2
00210	User DP Command 3
00211	User DP Command 4
00212	User DP Command 5
00213	User DP Command 6
00214	User DP Command 7
00215	User DP Command 8

4.3.2 Inputs (Read Only Binary values)

Address	Name
10001	Binary Input 1
10002	Binary Input 2
10003	Binary Input 3
10004	Binary Input 4
10005	Binary Input 5
10006	Binary Input 6
10007	Binary Input 7
10008	Binary Input 8
10009	Binary Input 9
10010	Binary Input 10
10011	Binary Input 11
10012	Binary Input 12
10013	Binary Input 13
10014	Binary Input 14
10015	Binary Input 15
10016	Binary Input 16
10017	Binary Input 17
10018	Binary Input 18
10019	Binary Input 19
10101	General Start/Pick-up
10102	General Trip
10103	Start/Pick-up L1
10104	Start/Pick-up L2
10105	Start/Pick-up L3
10106	Start/Pick-up N
10107	Trip L1

Address	Name
10108	Trip L2
10109	Trip L3
10111	Trip Circuit Fail
10120	Local Mode
10121	Remote Mode
10122	Service Mode
10123	Local & Remote
10130	Trip Circuit Fail 1
10131	Trip Circuit Fail 2
10132	Trip Circuit Fail 3
10133	Trip Circuit Fail 4
10134	Trip Circuit Fail 5
10135	Trip Circuit Fail 6
10136	Trip Circuit Fail 7
10137	Trip Circuit Fail 8
10138	Trip Circuit Fail 9
10139	Trip Circuit Fail 10
10140	Trip Circuit Fail 11
10141	Trip Circuit Fail 12
10309	50G
10310	50G-1
10320	50G-2
10501	Virtual Input 1
10502	Virtual Input 2
10503	Virtual Input 3
10504	Virtual Input 4
10505	Virtual Input 5
10506	Virtual Input 6
10507	Virtual Input 7
10508	Virtual Input 8
10509	Virtual Input 9
10510	Virtual Input 10
10511	Virtual Input 11
10512	Virtual Input 12
10513	Virtual Input 13
10514	Virtual Input 14
10515	Virtual Input 15
10516	Virtual Input 16
10601	LED 1
10602	LED 2
10603	LED 3
10604	LED 4
10605	LED 5
10606	LED 6
10607	LED 7
10608	LED 8
10609	LED 9
10610	LED 10

Address	Name
10611	LED 11
10612	LED 12
10613	LED 13
10614	LED 14
10615	LED 15
10616	LED 16
10701	LED PU 1
10702	LED PU 2
10703	LED PU 3
10704	LED PU 4
10705	LED PU 5
10706	LED PU 6
10707	LED PU 7
10708	LED PU 8
10709	LED PU 9
10710	LED PU 10
10711	LED PU 11
10712	LED PU 12
10713	LED PU 13
10714	LED PU 14
10715	LED PU 15
10716	LED PU 16
10900	User SP Command 1
10901	User SP Command 2
10902	User SP Command 3
10903	User SP Command 4
10904	User SP Command 5
10905	User SP Command 6
10906	User SP Command 7
10907	User SP Command 8
10908	User DP Command 1
10909	User DP Command 2
10910	User DP Command 3
10911	User DP Command 4
10912	User DP Command 5
10913	User DP Command 6
10914	User DP Command 7
10915	User DP Command 8
12500	General Alarm 1
12501	General Alarm 2
12502	General Alarm 3
12503	General Alarm 4
12504	General Alarm 5
12505	General Alarm 6
12506	General Alarm 7
12507	General Alarm 8
12508	General Alarm 9
12509	General Alarm 10
12510	General Alarm 11

Address	Name
12511	General Alarm 12
12512	Quick Logic E1
12513	Quick Logic E2
12514	Quick Logic E3
12515	Quick Logic E4
12516	Quick Logic E5
12517	Quick Logic E6
12518	Quick Logic E7
12519	Quick Logic E8
12520	Quick Logic E9
12521	Quick Logic E10
12522	Quick Logic E11
12523	Quick Logic E12
12524	Quick Logic E13
12525	Quick Logic E14
12526	Quick Logic E15
12527	Quick Logic E16
12600	87/50
12601	87/50-1
12602	87/50-2
12603	87/50A-1
12604	87/50B-1
12605	87/50C-1
12606	87/50G-1
12607	87/50AB-1
12608	87/50BC-1
12609	87/50CA-1
12610	87/50AG-1
12611	87/50BG-1
12612	87/50CG-1
12613	87/50A-2
12614	87/50B-2
12615	87/50C-2
12616	87/50G-2
12617	87/50AB-2
12618	87/50BC-2
12619	87/50CA-2
12620	87/50AG-2
12621	87/50BG-2
12622	87/50CG-2
12650	CT Supervision
12651	CT50A
12652	CT50B
12653	CT50C
12654	CT50G
12660	87REF
12661	87REF-1
12662	87REF-2

Address	Name
12670	Zone CT Shorting
12671	87/50SFM Pickup
12672	87/50SFM
12673	87/50BF
12674	87/50BF Blind Spot
12700	CB Total Trip Count
12701	CB Delta Trip Count
12702	CB1 Total Open Count
12703	CB1 Delta Open Count
12704	CB2 Total Open Count
12705	CB2 Delta Open Count
12706	CB3 Total Open Count
12707	CB3 Delta Open Count
12708	CB4 Total Open Count
12709	CB4 Delta Open Count
12710	CB5 Total Open Count
12711	CB5 Delta Open Count
12712	CB6 Total Open Count
12713	CB6 Delta Open Count
12714	CB7 Total Open Count
12715	CB7 Delta Open Count
12716	CB8 Total Open Count
12717	CB8 Delta Open Count
12718	CB9 Total Open Count
12719	CB9 Delta Open Count
12720	CB10 Total Open Count
12721	CB10 Delta Open Count
12722	CB11 Total Open Count
12723	CB11 Delta Open Count
12724	CB12 Total Open Count
12725	CB12 Delta Open Count
12730	CB1 Cct Closed Alarm
12731	CB2 Cct Closed Alarm
12732	CB3 Cct Closed Alarm
12733	CB4 Cct Closed Alarm
12734	CB5 Cct Closed Alarm
12735	CB6 Cct Closed Alarm
12736	CB7 Cct Closed Alarm
12737	CB8 Cct Closed Alarm
12738	CB9 Cct Closed Alarm
12739	CB10 Cct Closed Alarm
12740	CB11 Cct Closed Alarm
12741	CB12 Cct Closed Alarm
12748	CB1 Cct DBI Alarm
12749	CB2 Cct DBI Alarm
12750	CB3 Cct DBI Alarm
12751	CB4 Cct DBI Alarm
12752	CB5 Cct DBI Alarm
12753	CB6 Cct DBI Alarm

Address	Name
12754	CB7 Cct DBI Alarm
12755	CB8 Cct DBI Alarm
12756	CB9 Cct DBI Alarm
12757	CB10 Cct DBI Alarm
12758	CB11 Cct DBI Alarm
12759	CB12 Cct DBI Alarm
12770	CB1 Cct Travel Alarm
12771	CB2 Cct Travel Alarm
12772	CB3 Cct Travel Alarm
12773	CB4 Cct Travel Alarm
12774	CB5 Cct Travel Alarm
12775	CB6 Cct Travel Alarm
12776	CB7 Cct Travel Alarm
12777	CB8 Cct Travel Alarm
12778	CB9 Cct Travel Alarm
12779	CB10 Cct Travel Alarm
12780	CB11 Cct Travel Alarm
12781	CB12 Cct Travel Alarm
12800	Ext 87 CBF Input
12801	Ext 87 CBF1
12802	Ext 87 CBF2
12803	Ext 87 CBF3
12804	Ext 87 CBF4
12805	Ext 87 CBF5
12806	Ext 87 CBF6
12807	Ext 87 CBF7
12808	Ext 87 CBF8
12809	Ext 87 CBF9
12810	Ext 87 CBF10
12811	Ext 87 CBF11
12812	Ext 87 CBF12
12820	CB 1
12821	CB 2
12822	CB 3
12823	CB 4
12824	CB 5
12825	CB 6
12826	CB 7
12827	CB 8
12828	CB 9
12829	CB 10
12830	CB 11
12831	CB 12

4.3.3 Input Registers (Read Only Registers)

Address	Name	Format	Mult	Description
30001	Event Count	EVENTCOUNT	0.000000	Event Count
30002	Event	EVENT	0.000000	Event (8 Registers)
30010	Fault Records	UINT16	1.000000	Number of Fault Records Stored
30012	Event Records	UINT16	1.000000	Number of Event Records Stored
30014	Waveform Records	UINT16	1.000000	Number of Waveform Records Stored
30016	Restart Count	UINT16	1.000000	Number of CPU resets
30018	Warm Start Count	UINT16	1.000000	Number of CPU warmstarts
30200	Primary Ig-1	FP_32BITS_3DP	1.000000	Ig-1 Primary A
30202	Secondary Ig-1	FP_32BITS_3DP	1.000000	Ig-1 Secondary A
30204	Nominal Ig-1	FP_32BITS_3DP	1.000000	Ig-1 Nom A
30206	Primary Ig-2	FP_32BITS_3DP	1.000000	Ig-2 Primary A
30208	Secondary Ig-2	FP_32BITS_3DP	1.000000	Ig-2 Secondary A
30210	Nominal Ig-2	FP_32BITS_3DP	1.000000	Ig-2 Nom A
30340	Ia Last Trip	FP_32BITS_3DP	1.000000	Ia Fault
30342	Ib Last Trip	FP_32BITS_3DP	1.000000	Ib Fault
30344	Ic Last Trip	FP_32BITS_3DP	1.000000	Ic Fault
30346	Ig Last Trip	FP_32BITS_3DP	1.000000	Ig Fault
30348	Ig2 Last Trip	FP_32BITS_3DP	1.000000	Ig2 Fault
30350	Ia Primary	FP_32BITS_3DP	1.000000	Ia Primary A
30352	Ib Primary	FP_32BITS_3DP	1.000000	Ib Primary A
30354	Ic Primary	FP_32BITS_3DP	1.000000	Ic Primary A
30356	Ia Secondary	FP_32BITS_3DP	1.000000	Ia Secondary A
30358	Ib Secondary	FP_32BITS_3DP	1.000000	Ib Secondary A
30360	Ic Secondary	FP_32BITS_3DP	1.000000	Ic Secondary A
30362	Ia Nominal	FP_32BITS_3DP	1.000000	Ia Nominal xIn
30364	Ib Nominal	FP_32BITS_3DP	1.000000	Ib Nominal xIn
30366	Ic Nominal	FP_32BITS_3DP	1.000000	Ic Nominal xIn
32500	CB Total Trip Count	UINT32	1.000000	CB Total Trip Count
32502	CB Delta Trip Count	UINT32	1.000000	CB Delta Trip Count
32504	CB1 Total Open Count	UINT32	1.000000	CB1 Total Open Count
32506	CB1 Delta Open Count	UINT32	1.000000	CB1 Delta Open Count
32508	CB2 Total Open Count	UINT32	1.000000	CB2 Total Open Count
32510	CB2 Delta Open Count	UINT32	1.000000	CB2 Delta Open Count
32512	CB3 Total Open Count	UINT32	1.000000	CB3 Total Open Count
32514	CB3 Delta Open Count	UINT32	1.000000	CB3 Delta Open Count
32516	CB4 Total Open Count	UINT32	1.000000	CB4 Total Open Count
32518	CB4 Delta Open Count	UINT32	1.000000	CB4 Delta Open Count
32520	CB5 Total Open Count	UINT32	1.000000	CB5 Total Open Count
32522	CB5 Delta Open Count	UINT32	1.000000	CB5 Delta Open Count
32524	CB6 Total Open Count	UINT32	1.000000	CB6 Total Open Count
32526	CB6 Delta Open Count	UINT32	1.000000	CB6 Delta Open Count
32528	CB7 Total Open Count	UINT32	1.000000	CB7 Total Open Count
32530	CB7 Delta Open Count	UINT32	1.000000	CB7 Delta Open Count
32532	CB8 Total Open Count	UINT32	1.000000	CB8 Total Open Count
32534	CB8 Delta Open Count	UINT32	1.000000	CB8 Delta Open Count

Address	Name	Format	Mult	Description
32536	CB9 Total Open Count	UINT32	1.000000	CB9 Total Open Count
32538	CB9 Delta Open Count	UINT32	1.000000	CB9 Delta Open Count
32540	CB10 Total Open Count	UINT32	1.000000	CB10 Total Open Count
32542	CB10 Delta Open Count	UINT32	1.000000	CB10 Delta Open Count
32544	CB11 Total Open Count	UINT32	1.000000	CB11 Total Open Count
32546	CB11 Delta Open Count	UINT32	1.000000	CB11 Delta Open Count
32548	CB12 Total Open Count	UINT32	1.000000	CB12 Total Open Count
32550	CB12 Delta Open Count	UINT32	1.000000	CB12 Delta Open Count

4.3.4 Holding Registers (Read Write Registers)

Address	Name	Format	Mult	Description
40001	Time	TIME_METER	0.000000	Time
40200	Primary Ig-1	FP_32BITS_3DP	1.000000	Ig-1 Primary A
40202	Secondary Ig-1	FP_32BITS_3DP	1.000000	Ig-1 Secondary A
40204	Nominal Ig-1	FP_32BITS_3DP	1.000000	Ig-1 Nom A
40206	Primary Ig-2	FP_32BITS_3DP	1.000000	Ig-2 Primary A
40208	Secondary Ig-2	FP_32BITS_3DP	1.000000	Ig-2 Secondary A
40210	Nominal Ig-2	FP_32BITS_3DP	1.000000	Ig-2 Nom A
40340	Ia Last Trip	FP_32BITS_3DP	1.000000	Ia Fault
40342	Ib Last Trip	FP_32BITS_3DP	1.000000	Ib Fault
40344	Ic Last Trip	FP_32BITS_3DP	1.000000	Ic Fault
40346	Ig Last Trip	FP_32BITS_3DP	1.000000	Ig Fault
40348	Ig2 Last Trip	FP_32BITS_3DP	1.000000	Ig2 Fault
40350	Ia Primary	FP_32BITS_3DP	1.000000	Ia Primary A
40352	Ib Primary	FP_32BITS_3DP	1.000000	Ib Primary A
40354	Ic Primary	FP_32BITS_3DP	1.000000	Ic Primary A
40356	Ia Secondary	FP_32BITS_3DP	1.000000	Ia Secondary A
40358	Ib Secondary	FP_32BITS_3DP	1.000000	Ib Secondary A
40360	Ic Secondary	FP_32BITS_3DP	1.000000	Ic Secondary A
40362	Ia Nominal	FP_32BITS_3DP	1.000000	Ia Nominal xIn
40364	Ib Nominal	FP_32BITS_3DP	1.000000	Ib Nominal xIn
40366	Ic Nominal	FP_32BITS_3DP	1.000000	Ic Nominal xIn
42500	CB Total Trip Count	UINT32	1.000000	CB Total Trip Count
42502	CB Delta Trip Count	UINT32	1.000000	CB Delta Trip Count
42504	CB1 Total Open Count	UINT32	1.000000	CB1 Total Open Count
42506	CB1 Delta Open Count	UINT32	1.000000	CB1 Delta Open Count
42508	CB2 Total Open Count	UINT32	1.000000	CB2 Total Open Count
42510	CB2 Delta Open Count	UINT32	1.000000	CB2 Delta Open Count
42512	CB3 Total Open Count	UINT32	1.000000	CB3 Total Open Count
42514	CB3 Delta Open Count	UINT32	1.000000	CB3 Delta Open Count
42516	CB4 Total Open Count	UINT32	1.000000	CB4 Total Open Count
42518	CB4 Delta Open Count	UINT32	1.000000	CB4 Delta Open Count
42520	CB5 Total Open Count	UINT32	1.000000	CB5 Total Open Count
42522	CB5 Delta Open Count	UINT32	1.000000	CB5 Delta Open Count
42524	CB6 Total Open Count	UINT32	1.000000	CB6 Total Open Count
42526	CB6 Delta Open Count	UINT32	1.000000	CB6 Delta Open Count

Address	Name	Format	Mult	Description
42528	CB7 Total Open Count	UINT32	1.000000	CB7 Total Open Count
42530	CB7 Delta Open Count	UINT32	1.000000	CB7 Delta Open Count
42532	CB8 Total Open Count	UINT32	1.000000	CB8 Total Open Count
42534	CB8 Delta Open Count	UINT32	1.000000	CB8 Delta Open Count
42536	CB9 Total Open Count	UINT32	1.000000	CB9 Total Open Count
42538	CB9 Delta Open Count	UINT32	1.000000	CB9 Delta Open Count
42540	CB10 Total Open Count	UINT32	1.000000	CB10 Total Open Count
42542	CB10 Delta Open Count	UINT32	1.000000	CB10 Delta Open Count
42544	CB11 Total Open Count	UINT32	1.000000	CB11 Total Open Count
42546	CB11 Delta Open Count	UINT32	1.000000	CB11 Delta Open Count
42548	CB12 Total Open Count	UINT32	1.000000	CB12 Total Open Count
42550	CB12 Delta Open Count	UINT32	1.000000	CB12 Delta Open Count
42552	LED1-n	BITSTRING	0.000000	Led 1-16 status
42553	LED1-n	BITSTRING	0.000000	Led 17-32 status
42554	INP1-n	BITSTRING	0.000000	Input 1-16 status
42555	INP1-n	BITSTRING	0.000000	Input 17-32 status
42556	OUT1-n	BITSTRING	0.000000	Output 1-16 status
42557	OUT1-n	BITSTRING	0.000000	Output 17-32 status
42558	VRT1-n	BITSTRING	0.000000	Virtual 1-16 status
42559	VRT1-n	BITSTRING	0.000000	Virtual 17-32 status
42560	EQN1-n	BITSTRING	0.000000	Equation 1-16 status
42561	EQN1-n	BITSTRING	0.000000	Equation 17-32 status

5. DNP3 Definitions

5.1 Device Profile

The following table provides a “Device Profile Document” in the standard format defined in the DNP 3.0 Subset Definitions Document. While it is referred to in the DNP 3.0 Subset Definitions as a “Document,” it is in fact a table, and only a component of a total interoperability guide. The table, in combination with the Implementation Table provided in Section 5.2 (beginning on page 52), and the Point List Tables provided in Section 5.3 (beginning on page 58), should provide a complete configuration/interoperability guide for communicating with a device implementing the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library.

DNP V3.0 DEVICE PROFILE DOCUMENT (Also see the DNP 3.0 Implementation Table in Section 5.2 , beginning on page 52).																							
Vendor Name: Siemens Protection Devices Ltd.																							
Device Name: 7SR23 DAD, using the Triangle MicroWorks, Inc. DNP3 Slave Source Code Library, Version 3.																							
Highest DNP Level Supported: For Requests: Level 3 For Responses: Level 3		Device Function: ☐ Master ☒ Slave																					
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): For static (non-change-event) object requests, request qualifier codes 07 and 08 (limited quantity), and 17 and 28 (index) are supported. Static object requests sent with qualifiers 07, or 08, will be responded with qualifiers 00 or 01. Output Event Object 11 is supported.																							
Maximum Data Link Frame Size (octets): Transmitted: 256 Received: 256		Maximum Application Fragment Size (octets): Transmitted: 2048 Received: 2048																					
Maximum Data Link Re-tries: ☐ None ☐ Fixed (3) ☒ Configurable from 0 to 65535 (Default 3)		Maximum Application Layer Re-tries: ☒ None ☐ Configurable																					
Requires Data Link Layer Confirmation: ☐ Never ☐ Always ☐ Sometimes ☒ Configurable as: Never, Only for multi-frame messages, or Always																							
Requires Application Layer Confirmation: ☐ Never ☐ Always ☒ When reporting Event Data (Slave devices only) ☒ When sending multi-fragment responses (Slave devices only) ☐ Sometimes ☐ Configurable as: “Only when reporting event data”, or “When reporting event data or multi-fragment messages.”																							
Timeouts while waiting for: <table border="0" style="width: 100%;"> <tr> <td>Data Link Confirm:</td> <td>☐ None</td> <td>☐ Fixed at ____</td> <td>☐ Variable</td> <td>☒ Configurable (2sec)</td> </tr> <tr> <td>Complete Appl. Fragment:</td> <td>☒ None</td> <td>☐ Fixed at ____</td> <td>☐ Variable</td> <td>☐ Configurable</td> </tr> <tr> <td>Application Confirm:</td> <td>☐ None</td> <td>☐ Fixed at ____</td> <td>☐ Variable</td> <td>☒ Configurable (10sec)</td> </tr> <tr> <td>Complete Appl. Response:</td> <td>☒ None</td> <td>☐ Fixed at ____</td> <td>☐ Variable</td> <td>☐ Configurable</td> </tr> </table>				Data Link Confirm:	☐ None	☐ Fixed at ____	☐ Variable	☒ Configurable (2sec)	Complete Appl. Fragment:	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable	Application Confirm:	☐ None	☐ Fixed at ____	☐ Variable	☒ Configurable (10sec)	Complete Appl. Response:	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Data Link Confirm:	☐ None	☐ Fixed at ____	☐ Variable	☒ Configurable (2sec)																			
Complete Appl. Fragment:	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable																			
Application Confirm:	☐ None	☐ Fixed at ____	☐ Variable	☒ Configurable (10sec)																			
Complete Appl. Response:	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable																			
Others: Transmission Delay, (Configurable, default 0 sec) Select/Operate Arm Timeout, (Configurable, default 5 sec)																							

DNP V3.0 DEVICE PROFILE DOCUMENT (Also see the DNP 3.0 Implementation Table in Section 5.2 , beginning on page 52).																																																										
Need Time Interval, (Configurable, default 30 minutes) Unsolicited Notification Delay, (Configurable, default 5 seconds) Unsolicited Response Retry Delay, (Configurable (between 3 - 9), default 5 seconds) Unsolicited Offline Interval, (Configurable, default 30 seconds) Binary Change Event Scan Period, (Polled, Not Applicable) Double Bit Change Event Scan Period, (Polled - Not Applicable) Analog Change Event Scan Period, (Polled - Not Applicable) Counter Change Event Scan Period, (Polled - Not Applicable) Frozen Counter Change Event Scan Period, (Polled - Not Applicable) String Change Event Scan Period, (Unsupported - Not Applicable) Virtual Terminal Event Scan Period, (Unsupported - Not Applicable)																																																										
Sends/Executes Control Operations: <table style="width: 100%; border: none;"> <tr> <td style="width: 35%;">WRITE Binary Outputs</td> <td style="width: 15%;">☒ Never</td> <td style="width: 15%;">☐ Always</td> <td style="width: 15%;">☐ Sometimes</td> <td style="width: 20%;">☐ Configurable</td> </tr> <tr> <td>SELECT/OPERATE</td> <td>☐ Never</td> <td>☒ Always</td> <td>☐ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>DIRECT OPERATE</td> <td>☐ Never</td> <td>☒ Always</td> <td>☐ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>DIRECT OPERATE - NO ACK</td> <td>☐ Never</td> <td>☒ Always</td> <td>☐ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>Count > 1</td> <td>☒ Never</td> <td>☐ Always</td> <td>☐ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>Pulse On</td> <td>☐ Never</td> <td>☐ Always</td> <td>☒ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>Pulse Off</td> <td>☐ Never</td> <td>☐ Always</td> <td>☒ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>Latch On</td> <td>☐ Never</td> <td>☐ Always</td> <td>☒ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>Latch Off</td> <td>☐ Never</td> <td>☐ Always</td> <td>☒ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>Queue</td> <td>☒ Never</td> <td>☐ Always</td> <td>☐ Sometimes</td> <td>☐ Configurable</td> </tr> <tr> <td>Clear Queue</td> <td>☒ Never</td> <td>☐ Always</td> <td>☐ Sometimes</td> <td>☐ Configurable</td> </tr> </table> Attach explanation if "Sometimes" or "Configurable" was checked for any operation.				WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable	SELECT/OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable	DIRECT OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable	DIRECT OPERATE - NO ACK	☐ Never	☒ Always	☐ Sometimes	☐ Configurable	Count > 1	☒ Never	☐ Always	☐ Sometimes	☐ Configurable	Pulse On	☐ Never	☐ Always	☒ Sometimes	☐ Configurable	Pulse Off	☐ Never	☐ Always	☒ Sometimes	☐ Configurable	Latch On	☐ Never	☐ Always	☒ Sometimes	☐ Configurable	Latch Off	☐ Never	☐ Always	☒ Sometimes	☐ Configurable	Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable	Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable																																																						
SELECT/OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable																																																						
DIRECT OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable																																																						
DIRECT OPERATE - NO ACK	☐ Never	☒ Always	☐ Sometimes	☐ Configurable																																																						
Count > 1	☒ Never	☐ Always	☐ Sometimes	☐ Configurable																																																						
Pulse On	☐ Never	☐ Always	☒ Sometimes	☐ Configurable																																																						
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Latch Off	☐ Never	☐ Always	☒ Sometimes	☐ Configurable																																																						
Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable																																																						
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable																																																						
Reports Binary Input Change Events when no specific variation requested: ☐ Never ☐ Only time-tagged ☐ Only non-time-tagged ☒ Configurable to send one or the other	Reports time-tagged Binary Input Change Events when no specific variation requested: ☐ Never ☐ Binary Input Change With Time ☐ Binary Input Change With Relative Time ☒ Configurable																																																									
Sends Unsolicited Responses: ☐ Never ☒ Configurable ☐ Only certain objects ☐ Sometimes (attach explanation) ☒ ENABLE/DISABLE UNSOLICITED Function codes supported	Sends Static Data in Unsolicited Responses: ☒ Never ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.																																																									
Default Counter Object/Variation: ☐ No Counters Reported ☒ Configurable ☐ Default Object - Default Variation: _____ ☒ Point-by-point list attached	Counters Roll Over at: ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ☒ 32 Bits ☐ Other Value: _____ ☒ Point-by-point list attached																																																									
Sends Multi-Fragment Responses: ☒ Yes ☐ No ☐ Configurable																																																										

DNP V3.0**DEVICE PROFILE DOCUMENT**(Also see the DNP 3.0 Implementation Table in [Section 5.2](#), beginning on page 52).**Sequential File Transfer Support:**

File Transfer Support	☐ Yes	☒ No
Append File Mode	☐ Yes	☒ No
Custom Status Code Strings	☐ Yes	☒ No
Permissions Field	☐ Yes	☒ No
File Events Assigned to Class	☐ Yes	☒ No
File Events Send Immediately	☐ Yes	☒ No
Multiple Blocks in a Fragment	☐ Yes	☒ No
Max Number of Files Open	0	

5.2 Implementation Table

The following table identifies which object variations, function codes, and qualifiers the Triangle MicroWorks, Inc. DNP 3.0 Slave Source Code Library supports in both request messages and in response messages. For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. Requests sent with qualifiers 17 or 28 will be responded with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

In the table below, text shaded as **00, 01 (start-stop)** indicates Subset Level 3 functionality (beyond Subset Level 2).

In the table below, text shaded as **07, 08 (limited qty)** indicates functionality beyond Subset Level 3.

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
1	0	Binary Input - Any Variation	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
1	1	Binary Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
1	2 (default - see note 1)	Binary Input with Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
2	0	Binary Input Change - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
2	1	Binary Input Change without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	2 (default - see note 1)	Binary Input Change with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
2	3	Binary Input Change with Relative Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
3	0	Double Bit Input - Any Variation	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
3	1 (default - see note 1)	Double Bit Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 1
3	2	Double Bit Input with Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 1
4	0	Double Bit Input Change - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
4	1	Double Bit Input Change without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
4	2	Double Bit Input Change with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
4	3 (default - see note 1)	Double Bit Input Change with Relative Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
10	0	Binary Output - Any Variation	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
10	1	Binary Output	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
			2 (write)	00, 01 (start-stop)		
10	2 (default - see note 1)	Binary Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
11	0	Binary Output Change - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
11	1	Binary Output Change without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
11	2 (default - see note 1)	Binary Output Change with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
12	0	Control Relay Output Block	22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, noack)	17, 28 (index)	129 (response)	echo of request
12	2	Pattern Control Block	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, noack)	7 (limited quantity)	129 (response)	echo of request
12	3	Pattern Mask	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, noack)	00, 01 (start-stop)	129 (response)	echo of request
13	0	Binary Output Command Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
13	1 (default - see note 1)	Binary Output Command Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
13	2	Binary Output Command Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
20	0	Binary Counter - Any Variation	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
			7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty)		
20	1	32-Bit Binary Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
20	2	16-Bit Binary Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
20	3	32-Bit Delta Counter (with Flag)				
20	4	16-Bit Delta Counter (with Flag)				
20	5 (default see note 1)	32-Bit Binary Counter (without Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
20	6	16-Bit Binary Counter (without Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
20	7	32-Bit Delta Counter (without Flag)				
20	8	16-Bit Delta Counter (without Flag)				
21	0	Frozen Counter - Any Variation	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
21	1	32-Bit Frozen Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
21	2	16-Bit Frozen Counter (with Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
21	3	32-Bit Frozen Delta Counter (with Flag)				
21	4	16-Bit Frozen Delta Counter (with Flag)				
21	5	32-Bit Frozen Counter (without Time Of Freeze)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
21	6	16-Bit Frozen Counter (without Time Of Freeze)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
21	7	32-Bit Frozen Delta Counter (with Time Of Freeze)				
21	8	16-Bit Frozen Delta Counter (with Time Of Freeze)				
21	9 (default - see note 1)	32-Bit Frozen Counter (without Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
21	10	16-Bit Frozen Counter (without Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
21	11	32-Bit Frozen Delta Counter (without Flag)				
21	12	16-Bit Frozen Delta Counter (without Flag)				
22	0	Counter Change Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
22	1 (default - see note 1)	32-Bit Counter Change Event (without Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
22	2	16-Bit Counter Change Event (without Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
22	3	32-Bit Delta Counter Change Event (without Time)				
22	4	16-Bit Delta Counter Change Event (without Time)				
22	5	32-Bit Counter Change Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
22	6	16-Bit Counter Change Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130	17, 28 (index)

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
					(unsol. resp)	
22	7	32-Bit Delta Counter Change Event (with Time)				
22	8	16-Bit Delta Counter Change Event (with Time)				
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
23	1 (default - see note 1)	32-Bit Frozen Counter Event	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
23	2	16-Bit Frozen Counter Event	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
23	3	32-Bit Frozen Delta Counter Event				
23	4	16-Bit Frozen Delta Counter Event				
23	5	32-Bit Frozen Counter Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	6	32-Bit Frozen Counter Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
23	7	32-Bit Frozen Delta Counter Event (with Time)				
23	8	16-Bit Frozen Delta Counter Event (with Time)				
30	0	Analog Input - Any Variation	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
30	1	32-Bit Analog Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2)
30	2 (default - see note 1)	16-Bit Analog Input	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2)
30	3	32-Bit Analog Input (without Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2)
30	4	16-Bit Analog Input (without Flag)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2)
30	5	short floating point	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2)
30	6	long floating point	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2)
31	0	Frozen Analog Input - Any Variation				
31	1	32-Bit Frozen Analog Input				
31	2	16-Bit Frozen Analog Input				
31	3	32-Bit Frozen Analog Input (with Time of freeze)				
31	4	16-Bit Frozen Analog Input (with Time of freeze)				
31	5	32-Bit Frozen Analog Input (without Flag)				
31	6	16-Bit Frozen Analog Input (without Flag)				

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
32	0	Analog Change Event - Any Variation)	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
32	1	32Bit-Analog Change Event (without Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	2	16Bit-Analog Change Event (without Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	3	32Bit-Analog Change Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	4 (default - see note 1)	16Bit-Analog Change Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	5	short floating point Analog Change Event (without Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	6	long floating point Analog Change Event (without Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	7	short floating point Analog Change Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
32	8	long floating point Analog Change Event (with Time)	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol. resp)	17, 28 (index)
33	0	Frozen Analog Event - Any Variation				
33	1	32-Bit Frozen Analog Event (without Time)				
33	2	16-Bit Frozen Analog Event (without Time)				
33	3	32-Bit Frozen Analog Event (with Time)				
33	4	16-Bit Frozen Analog Event (with Time)				
33	5	Short Floating Point Frozen Analog Event				
33	6	Long Floating Point Frozen Analog Event				
33	7	Extended Floating Point Frozen Analog Event				
34	0	Analog Input Deadband (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)		
34	1	16 bit Analog Input Deadband	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
			2 (write)	00, 01 (start-stop) 07, 08 (limited qty) 17, 27, 28 (index)		
34	2 (default - see note 1)	32 bit Analog Input Deadband	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty) 17, 27, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2
			2 (write)	00, 01 (start-stop) 07, 08 (limited qty) 17, 27, 28 (index)		
34	3	Short Floating Point Analog Input Deadband	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited qty)	129 (response)	00, 01 (start-stop) 17, 28 (index) - see note 2

OBJECT			REQUEST (Library will parse)		RESPONSE (Library will respond with)	
Object Number	Variation	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
				17, 27, 28 (index)		
			2 (write)	00, 01 (start-stop) 07, 08 (limited qty) 17, 27, 28 (index)		
50	0	Time and Date				
50	1 (default - see note 1)	Time and Date	1 (read)	07, 08 (limited qty)	129 (response)	07 (limited qty = 1)
			2 (write)	00, 01 (start-stop) 07, 08 (limited qty) 17, 27, 28 (index)		
50	3	Time and Date Last Recorded Time	2 (write)	07 (limited qty)		
51	1	Time and Date CTO			129 (response) 130 (unsol. resp)	(limited qty = 1)
51	2	Unsynchronized Time and Date CTO			129 (response) 130 (unsol. resp)	(limited qty = 1)
52	1	Time Delay Coarse			129 (response)	(limited qty = 1)
52	2	Time Delay Fine			129 (response)	(limited qty = 1)
60	0	Not Defined				
60	1	Class 0 Data	1 (read)	06 (no range, or all)		
60	2	Class 1 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
			20 (enbl. unsol.) 21 (dab. unsol.) 22 (assign class)	06 (no range, or all)		
60	3	Class 2 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
			20 (enbl. unsol.) 21 (dab. unsol.) 22 (assign class)	06 (no range, or all)		
60	4	Class 3 Data	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
			20 (enbl. unsol.) 21 (dab. unsol.) 22 (assign class)	06 (no range, or all)		
80	1	Internal Indications	1 (read)	00, 01 (start-stop)	129 (response)	00, 01 (start-stop)
			2 (write)(see note 3)	00 (start-stop) index=7		
		No Object (function code only)	13 (cold restart)			
		No Object (function code only)	14 (warm restart)			
		No Object (function code only)	23 (delay meas.)			
		No Object (function code only)	24 (record current time)			

Note 1: A Default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. Default variations are configurable; however, default settings for the configuration parameters are indicated in the table above.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, will be responded with qualifiers 00 or 01. (For change-event objects, qualifiers 17 or 28 are always responded.)

Note 3: Writes of Internal Indications are only supported for index 7 (Restart IIN1-7).

This protocol can be set to use any or all of the relays hardware interfaces (USB, Fibre Optic, RS232 and RS485). The relay can communicate simultaneously on all ports regardless of protocol used.

The Station Address of the port being used must be set to a suitable address within the range 0 - 65534 to enable communication. This can be set by the **Communications Menu : COM *n*-xxxxx Station Address** setting.

Communication via DNP3 over Ethernet requires external devices. Please refer to the documents ***TCPIP Catalogue Sheet*** and ***TCPIP Interface Technical Guidance Notes*** for more information.

The information shown below is the default configuration. This can be modified using the Communications Configuration Editor tool, refer [section 9](#) for details.

5.3.1 Binary Input Points

Binary inputs are by default returned in a class zero interrogation.

Note, not all points listed here apply to all builds of devices.

Binary Input Points Static (Steady-State) Object Number: 1 (Packed Format) Change Event Object Number: 1 (w/o Time) Static Variation reported when variation 0 requested: 1 (Binary Input w/o status) or 2 (Binary Input with status) Change Event Variation reported when variation 0 requested: 1 (Binary Input Change w/o Time) or 2 (Binary Input Change with Absolute Time) or 3 (Binary Input Change with Relative Time)				
Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 1	Default Variation Event Object 2
1	Binary Input 1	0,2	2	2
2	Binary Input 2	0,2	2	2
3	Binary Input 3	0,2	2	2
4	Binary Input 4	0,2	2	2
5	Binary Input 5	0,2	2	2
6	Binary Input 6	0,2	2	2
7	Binary Input 7	0,2	2	2
8	Binary Input 8	0,2	2	2
9	Binary Input 9	0,2	2	2
10	Binary Input 10	0,2	2	2
11	Binary Input 11	0,2	2	2
12	Binary Input 12	0,2	2	2
13	Binary Input 13	0,2	2	2
14	Binary Input 14	0,2	2	2
15	Binary Input 15	0,2	2	2
16	Binary Input 16	0,2	2	2
17	Binary Input 17	0,2	2	2
18	Binary Input 18	0,2	2	2
19	Binary Input 19	0,2	2	2
35	Remote Mode	0,2	2	2

Binary Input PointsStatic (Steady-State) Object Number: **1 (Packed Format)**Change Event Object Number: **1 (w/o Time)**Static Variation reported when variation 0 requested: **1 (Binary Input w/o status)**
or **2 (Binary Input with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Input Change w/o Time)**
or **2 (Binary Input Change with Absolute Time)**
or **3 (Binary Input Change with Relative Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 1	Default Variation Event Object 2
36	Service Mode	0,2	2	2
37	Local Mode	0,2	2	2
38	Local & Remote	0,2	2	2
40	General Trip	0,2	2	2
41	Trip Circuit Fail	0,2	2	2
42	Start/Pick-up L1	0,2	2	2
43	Start/Pick-up L2	0,2	2	2
44	Start/Pick-up L3	0,2	2	2
45	General Start/Pick-up	0,2	2	2
46	Start/Pick-up N	0,2	2	2
47	Trip L1	0,2	2	2
48	Trip L2	0,2	2	2
49	Trip L3	0,2	2	2
111	Trip Circuit Fail 1	0,2	2	2
112	Trip Circuit Fail 2	0,2	2	2
113	Trip Circuit Fail 3	0,2	2	2
114	Trip Circuit Fail 4	0,2	2	2
115	Trip Circuit Fail 5	0,2	2	2
116	Trip Circuit Fail 6	0,2	2	2
117	Trip Circuit Fail 7	0,2	2	2
118	Trip Circuit Fail 8	0,2	2	2
119	Trip Circuit Fail 9	0,2	2	2
120	Trip Circuit Fail 10	0,2	2	2
129	General Alarm 1	0,2	2	2
130	General Alarm 2	0,2	2	2
131	General Alarm 3	0,2	2	2
132	General Alarm 4	0,2	2	2
133	General Alarm 5	0,2	2	2
134	General Alarm 6	0,2	2	2
135	General Alarm 7	0,2	2	2
136	General Alarm 8	0,2	2	2
137	General Alarm 9	0,2	2	2
138	General Alarm 10	0,2	2	2
139	General Alarm 11	0,2	2	2
140	General Alarm 12	0,2	2	2
141	Quick Logic E1	0,2	2	2
142	Quick Logic E2	0,2	2	2
143	Quick Logic E3	0,2	2	2
144	Quick Logic E4	0,2	2	2
145	Quick Logic E5	0,2	2	2
146	Quick Logic E6	0,2	2	2

Binary Input PointsStatic (Steady-State) Object Number: **1 (Packed Format)**Change Event Object Number: **1 (w/o Time)**Static Variation reported when variation 0 requested: **1 (Binary Input w/o status)**
or **2 (Binary Input with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Input Change w/o Time)**
or **2 (Binary Input Change with Absolute Time)**
or **3 (Binary Input Change with Relative Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 1	Default Variation Event Object 2
147	Quick Logic E7	0,2	2	2
148	Quick Logic E8	0,2	2	2
149	Quick Logic E9	0,2	2	2
150	Quick Logic E10	0,2	2	2
151	Quick Logic E11	0,2	2	2
152	Quick Logic E12	0,2	2	2
153	Quick Logic E13	0,2	2	2
154	Quick Logic E14	0,2	2	2
155	Quick Logic E15	0,2	2	2
156	Quick Logic E16	0,2	2	2
215	50G-1	0,2	2	2
216	50G-2	0,2	2	2
217	E/F Out	0,2	2	2
218	50G	0,2	2	2
221	Binary Output 1	0,2	2	2
222	Binary Output 2	0,2	2	2
223	Binary Output 3	0,2	2	2
224	Binary Output 4	0,2	2	2
225	Binary Output 5	0,2	2	2
226	Binary Output 6	0,2	2	2
227	Binary Output 7	0,2	2	2
228	Binary Output 8	0,2	2	2
229	Binary Output 9	0,2	2	2
230	Binary Output 10	0,2	2	2
231	Binary Output 11	0,2	2	2
232	Binary Output 12	0,2	2	2
233	Binary Output 13	0,2	2	2
234	Binary Output 14	0,2	2	2
235	Binary Output 15	0,2	2	2
236	Binary Output 16	0,2	2	2
254	Setting G1 selected	0,2	2	2
255	Setting G2 selected	0,2	2	2
256	Setting G3 selected	0,2	2	2
257	Setting G4 selected	0,2	2	2
258	Setting G5 selected	0,2	2	2
259	Setting G6 selected	0,2	2	2
260	Setting G7 selected	0,2	2	2
261	Setting G8 selected	0,2	2	2
300	87/50	0,2	2	2
301	87/50-1	0,2	2	2
302	87/50-2	0,2	2	2
303	87/50A-1	0,2	2	2

Binary Input PointsStatic (Steady-State) Object Number: **1 (Packed Format)**Change Event Object Number: **1 (w/o Time)**Static Variation reported when variation 0 requested: **1 (Binary Input w/o status)**
or **2 (Binary Input with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Input Change w/o Time)**
or **2 (Binary Input Change with Absolute Time)**
or **3 (Binary Input Change with Relative Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 1	Default Variation Event Object 2
304	87/50B-1	0,2	2	2
305	87/50C-1	0,2	2	2
306	87/50G-1	0,2	2	2
307	87/50AB-1	0,2	2	2
308	87/50BC-1	0,2	2	2
309	87/50CA-1	0,2	2	2
310	87/50AG-1	0,2	2	2
311	87/50BG-1	0,2	2	2
312	87/50CG-1	0,2	2	2
313	87/50A-2	0,2	2	2
314	87/50B-2	0,2	2	2
315	87/50C-2	0,2	2	2
316	87/50G-2	0,2	2	2
317	87/50AB-2	0,2	2	2
318	87/50BC-2	0,2	2	2
319	87/50CA-2	0,2	2	2
320	87/50AG-2	0,2	2	2
321	87/50BG-2	0,2	2	2
322	87/50CG-2	0,2	2	2
323	CT Supervision	0,2	2	2
324	CT50A	0,2	2	2
325	CT50B	0,2	2	2
326	CT50C	0,2	2	2
327	CT50G	0,2	2	2
328	87REF	0,2	2	2
329	87REF-1	0,2	2	2
330	87REF-2	0,2	2	2
331	Zone Switch Out	0,2	2	2
332	Zone CT Shorting	0,2	2	2
333	Trip Circuit Fail 11	0,2	2	2
334	Trip Circuit Fail 12	0,2	2	2
335	87/50SFM Pickup	0,2	2	2
336	87/50SFM	0,2	2	2
337	87/50BF	0,2	2	2
338	87/50BF Blind Spot	0,2	2	2
340	CB Total Trip Count	0,2	2	2
341	CB Delta Trip Count	0,2	2	2
342	CB1 Total Open Count	0,2	2	2
343	CB1 Delta Open Count	0,2	2	2
344	CB2 Total Open Count	0,2	2	2
345	CB2 Delta Open Count	0,2	2	2

Binary Input PointsStatic (Steady-State) Object Number: **1 (Packed Format)**Change Event Object Number: **1 (w/o Time)**Static Variation reported when variation 0 requested: **1 (Binary Input w/o status)**
or **2 (Binary Input with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Input Change w/o Time)**
or **2 (Binary Input Change with Absolute Time)**
or **3 (Binary Input Change with Relative Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 1	Default Variation Event Object 2
346	CB3 Total Open Count	0,2	2	2
347	CB3 Delta Open Count	0,2	2	2
348	CB4 Total Open Count	0,2	2	2
349	CB4 Delta Open Count	0,2	2	2
350	CB5 Total Open Count	0,2	2	2
351	CB5 Delta Open Count	0,2	2	2
352	CB6 Total Open Count	0,2	2	2
353	CB6 Delta Open Count	0,2	2	2
354	CB7 Total Open Count	0,2	2	2
355	CB7 Delta Open Count	0,2	2	2
356	CB8 Total Open Count	0,2	2	2
357	CB8 Delta Open Count	0,2	2	2
358	CB9 Total Open Count	0,2	2	2
359	CB9 Delta Open Count	0,2	2	2
360	CB10 Total Open Count	0,2	2	2
361	CB10 Delta Open Count	0,2	2	2
362	CB11 Total Open Count	0,2	2	2
363	CB11 Delta Open Count	0,2	2	2
364	CB12 Total Open Count	0,2	2	2
365	CB12 Delta Open Count	0,2	2	2
381	CB1 Cct Closed Alarm	0,2	2	2
382	CB2 Cct Closed Alarm	0,2	2	2
383	CB3 Cct Closed Alarm	0,2	2	2
384	CB4 Cct Closed Alarm	0,2	2	2
385	CB5 Cct Closed Alarm	0,2	2	2
386	CB6 Cct Closed Alarm	0,2	2	2
387	CB7 Cct Closed Alarm	0,2	2	2
388	CB8 Cct Closed Alarm	0,2	2	2
389	CB9 Cct Closed Alarm	0,2	2	2
390	CB10 Cct Closed Alarm	0,2	2	2
391	CB11 Cct Closed Alarm	0,2	2	2
392	CB12 Cct Closed Alarm	0,2	2	2
401	CB1 Cct DBI Alarm	0,2	2	2
402	CB2 Cct DBI Alarm	0,2	2	2
403	CB3 Cct DBI Alarm	0,2	2	2
404	CB4 Cct DBI Alarm	0,2	2	2
405	CB5 Cct DBI Alarm	0,2	2	2
406	CB6 Cct DBI Alarm	0,2	2	2
407	CB7 Cct DBI Alarm	0,2	2	2
408	CB8 Cct DBI Alarm	0,2	2	2
409	CB9 Cct DBI Alarm	0,2	2	2
410	CB10 Cct DBI Alarm	0,2	2	2

Binary Input PointsStatic (Steady-State) Object Number: **1 (Packed Format)**Change Event Object Number: **1 (w/o Time)**Static Variation reported when variation 0 requested: **1 (Binary Input w/o status)**
or **2 (Binary Input with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Input Change w/o Time)**
or **2 (Binary Input Change with Absolute Time)**
or **3 (Binary Input Change with Relative Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 1	Default Variation Event Object 2
411	CB11 Cct DBI Alarm	0,2	2	2
412	CB12 Cct DBI Alarm	0,2	2	2
421	CB1 Cct Travel Alarm	0,2	2	2
422	CB2 Cct Travel Alarm	0,2	2	2
423	CB3 Cct Travel Alarm	0,2	2	2
424	CB4 Cct Travel Alarm	0,2	2	2
425	CB5 Cct Travel Alarm	0,2	2	2
426	CB6 Cct Travel Alarm	0,2	2	2
427	CB7 Cct Travel Alarm	0,2	2	2
428	CB8 Cct Travel Alarm	0,2	2	2
429	CB9 Cct Travel Alarm	0,2	2	2
430	CB10 Cct Travel Alarm	0,2	2	2
431	CB11 Cct Travel Alarm	0,2	2	2
432	CB12 Cct Travel Alarm	0,2	2	2
450	Ext 87 CBF Input	0,2	2	2
451	Ext 87 CBF1	0,2	2	2
452	Ext 87 CBF2	0,2	2	2
453	Ext 87 CBF3	0,2	2	2
454	Ext 87 CBF4	0,2	2	2
455	Ext 87 CBF5	0,2	2	2
456	Ext 87 CBF6	0,2	2	2
457	Ext 87 CBF7	0,2	2	2
458	Ext 87 CBF8	0,2	2	2
459	Ext 87 CBF9	0,2	2	2
460	Ext 87 CBF10	0,2	2	2
461	Ext 87 CBF11	0,2	2	2
462	Ext 87 CBF12	0,2	2	2
501	Virtual Input 1	0,2	2	2
502	Virtual Input 2	0,2	2	2
503	Virtual Input 3	0,2	2	2
504	Virtual Input 4	0,2	2	2
505	Virtual Input 5	0,2	2	2
506	Virtual Input 6	0,2	2	2
507	Virtual Input 7	0,2	2	2
508	Virtual Input 8	0,2	2	2
509	Virtual Input 9	0,2	2	2
510	Virtual Input 10	0,2	2	2
511	Virtual Input 11	0,2	2	2
512	Virtual Input 12	0,2	2	2
513	Virtual Input 13	0,2	2	2
514	Virtual Input 14	0,2	2	2

Binary Input PointsStatic (Steady-State) Object Number: **1 (Packed Format)**Change Event Object Number: **1 (w/o Time)**Static Variation reported when variation 0 requested: **1 (Binary Input w/o status)**
or **2 (Binary Input with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Input Change w/o Time)**
or **2 (Binary Input Change with Absolute Time)**
or **3 (Binary Input Change with Relative Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 1	Default Variation Event Object 2
515	Virtual Input 15	0,2	2	2
516	Virtual Input 16	0,2	2	2
601	LED 1	0,2	2	2
602	LED 2	0,2	2	2
603	LED 3	0,2	2	2
604	LED 4	0,2	2	2
605	LED 5	0,2	2	2
606	LED 6	0,2	2	2
607	LED 7	0,2	2	2
608	LED 8	0,2	2	2
609	LED 9	0,2	2	2
610	LED 10	0,2	2	2
611	LED 11	0,2	2	2
612	LED 12	0,2	2	2
613	LED 13	0,2	2	2
614	LED 14	0,2	2	2
615	LED 15	0,2	2	2
616	LED 16	0,2	2	2
701	LED PU 1	0,2	2	2
702	LED PU 2	0,2	2	2
703	LED PU 3	0,2	2	2
704	LED PU 4	0,2	2	2
705	LED PU 5	0,2	2	2
706	LED PU 6	0,2	2	2
707	LED PU 7	0,2	2	2
708	LED PU 8	0,2	2	2
709	LED PU 9	0,2	2	2
710	LED PU 10	0,2	2	2
711	LED PU 11	0,2	2	2
712	LED PU 12	0,2	2	2
713	LED PU 13	0,2	2	2
714	LED PU 14	0,2	2	2
715	LED PU 15	0,2	2	2
716	LED PU 16	0,2	2	2
900	User SP Command 1	0,2	2	2
901	User SP Command 2	0,2	2	2
902	User SP Command 3	0,2	2	2
903	User SP Command 4	0,2	2	2
904	User SP Command 5	0,2	2	2
905	User SP Command 6	0,2	2	2
906	User SP Command 7	0,2	2	2
907	User SP Command 8	0,2	2	2

5.3.2 Double Bit Input Points

The default double bit input event buffer size is set to allow 100 events.

Double bit inputs are by default returned in a class zero interrogation.

Note, not all points listed here apply to all builds of devices.

Double Bit Input Points				
Static (Steady-State) Object Number: 3				
Change Event Object Number: 4				
Static Variation reported when variation 0 requested: 1 (Double Bit Input w/o status) or 2 (Double Bit Input with status)				
Change Event Variation reported when variation 0 requested: 1 (Double Bit Input Change w/o Time) or 2 (Double Bit Input Change with Absolute Time) or 3 (Double Bit Input Change with Relative Time)				
Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 3	Default Variation Event Object 4
0	CB 1	0,2	1	3
1	CB 2	0,2	1	3
2	CB 3	0,2	1	3
3	CB 4	0,2	1	3
4	CB 5	0,2	1	3
5	CB 6	0,2	1	3
6	CB 7	0,2	1	3
7	CB 8	0,2	1	3
8	CB 9	0,2	1	3
9	CB 10	0,2	1	3
10	CB 11	0,2	1	3
11	CB 12	0,2	1	3
12	User DP Command 1	0,2	1	3
13	User DP Command 2	0,2	1	3
14	User DP Command 3	0,2	1	3
15	User DP Command 4	0,2	1	3
16	User DP Command 5	0,2	1	3
17	User DP Command 6	0,2	1	3
18	User DP Command 7	0,2	1	3
19	User DP Command 8	0,2	1	3

5.3.3 Binary Output Status Points and Control Relay Output Blocks

The following table lists both the Binary Output Status Points (Object 10) and the Control Relay Output Blocks (Object 12).

While Binary Output Status Points are included here for completeness, they are not often polled by DNP 3.0 Masters. Binary Output Status points are not recommended to be included in class 0 polls.

As an alternative, it is recommended that “actual” status values of Control Relay Output Block points be looped around and mapped as Binary Inputs. (The “actual” status value, as opposed to the “commanded” status value, is the value of the actuated control. For example, a DNP control command may be blocked through hardware or software mechanisms; in this case, the actual status value would indicate the control failed because of the blocking. Looping Control Relay Output Block actual status values as Binary Inputs has several advantages:

Binary Output Status PointsStatic (Steady-State) Object Number: **10**Change Event Object Number: **11**Control Relay Output Blocks (CROB) Object Number: **12**Binary Output Command Event Object Number: **13**Static Variation reported when variation 0 requested: **1 (Binary Output w/o status)**or **2 (Binary Output with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Output Event w/o Time)**or **2 (Binary Output Event with Time)**Command Event Variation reported when variation 0 requested: **1 (Command Status w/o Time)**or **2 (Command Status with Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 10	Default Variation Event Object 11	Default Command Event Object 13 Assigned Class (1, 2, 3 or none)	Default Variation Command Event Object 13	CROB Supported Operations	Default CROB Operations
							Latch On	
33	LED Reset, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
34	Setting G1 selected	0	2	2	0	1	Pulse On Latch On	Latch On
35	Setting G2 selected	0	2	2	0	1	Pulse On Latch On	Latch On
36	Setting G3 selected	0	2	2	0	1	Pulse On Latch On	Latch On
37	Setting G4 selected	0	2	2	0	1	Pulse On Latch On	Latch On
38	Setting G5 selected	0	2	2	0	1	Pulse On Latch On	Latch On
39	Setting G6 selected	0	2	2	0	1	Pulse On Latch On	Latch On
40	Setting G7 selected	0	2	2	0	1	Pulse On Latch On	Latch On
41	Setting G8 selected	0	2	2	0	1	Pulse On Latch On	Latch On
42	CB 1	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
43	CB 2	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
53	Remote Mode	0	2	2	0	1	Pulse On Latch On	Pulse On
54	Service Mode	0	2	2	0	1	Pulse On Latch On	Pulse On
55	Local Mode	0	2	2	0	1	Pulse On Latch On	Pulse On
56	Local & Remote	0	2	2	0	1	Pulse On Latch On	Pulse On
57	CB 3	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
58	CB 4	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off

Binary Output Status PointsStatic (Steady-State) Object Number: **10**Change Event Object Number: **11**Control Relay Output Blocks (CROB) Object Number: **12**Binary Output Command Event Object Number: **13**Static Variation reported when variation 0 requested: **1 (Binary Output w/o status)**
or **2 (Binary Output with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Output Event w/o Time)**
or **2 (Binary Output Event with Time)**Command Event Variation reported when variation 0 requested: **1 (Command Status w/o Time)**
or **2 (Command Status with Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 10	Default Variation Event Object 11	Default Command Event Object 13 Assigned Class (1, 2, 3 or none)	Default Variation Command Event Object 13	CROB Supported Operations	Default CROB Operations
59	CB 5	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
60	E/F Out	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
61	Zone Switch Out	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
70	Reset CB Total Trip Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
71	Reset CB Delta Trip Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
72	Reset CB1 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
73	Reset CB1 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
74	Reset CB2 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
75	Reset CB2 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
76	Reset CB3 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
77	Reset CB3 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
78	Reset CB4 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
79	Reset CB4 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
80	Reset CB5 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
81	Reset CB5 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
82	Reset CB6 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
83	Reset CB6 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
84	Reset CB7 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
85	Reset CB7 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On

Binary Output Status PointsStatic (Steady-State) Object Number: **10**Change Event Object Number: **11**Control Relay Output Blocks (CROB) Object Number: **12**Binary Output Command Event Object Number: **13**Static Variation reported when variation 0 requested: **1 (Binary Output w/o status)**
or **2 (Binary Output with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Output Event w/o Time)**
or **2 (Binary Output Event with Time)**Command Event Variation reported when variation 0 requested: **1 (Command Status w/o Time)**
or **2 (Command Status with Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 10	Default Variation Event Object 11	Default Command Event Object 13 Assigned Class (1, 2, 3 or none)	Default Variation Command Event Object 13	CROB Supported Operations	Default CROB Operations
86	Reset CB8 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
87	Reset CB8 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
88	Reset CB9 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
89	Reset CB9 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
90	Reset CB10 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
91	Reset CB10 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
92	Reset CB11 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
93	Reset CB11 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
94	Reset CB12 Total Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
95	Reset CB12 Delta Open Count, write only location.	0	2	2	0	1	Pulse On Latch On	Pulse On
96	User SP Command 1.	0	2	2	0	1	Pulse On Latch On	Pulse On
97	User SP Command 2.	0	2	2	0	1	Pulse On Latch On	Pulse On
98	User SP Command 3.	0	2	2	0	1	Pulse On Latch On	Pulse On
99	User SP Command 4.	0	2	2	0	1	Pulse On Latch On	Pulse On
100	User SP Command 5.	0	2	2	0	1	Pulse On Latch On	Pulse On
101	User SP Command 6.	0	2	2	0	1	Pulse On Latch On	Pulse On
102	User SP Command 7.	0	2	2	0	1	Pulse On Latch On	Pulse On
103	User SP Command 8.	0	2	2	0	1	Pulse On Latch On	Pulse On
104	User DP Command 1.	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
105	User DP Command 2.	0	2	2	0	1	Pulse On Pulse Off Latch On	Pulse On Pulse Off

Binary Output Status PointsStatic (Steady-State) Object Number: **10**Change Event Object Number: **11**Control Relay Output Blocks (CROB) Object Number: **12**Binary Output Command Event Object Number: **13**Static Variation reported when variation 0 requested: **1 (Binary Output w/o status)**
or **2 (Binary Output with status)**Change Event Variation reported when variation 0 requested: **1 (Binary Output Event w/o Time)**
or **2 (Binary Output Event with Time)**Command Event Variation reported when variation 0 requested: **1 (Command Status w/o Time)**
or **2 (Command Status with Time)**

Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 10	Default Variation Event Object 11	Default Command Event Object 13 Assigned Class (1, 2, 3 or none)	Default Variation Command Event Object 13	CROB Supported Operations	Default CROB Operations
							Latch Off	
106	User DP Command 3.	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
107	User DP Command 4.	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
108	User DP Command 5.	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
109	User DP Command 6.	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
110	User DP Command 7.	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off
111	User DP Command 8.	0	2	2	0	1	Pulse On Pulse Off Latch On Latch Off	Pulse On Pulse Off

5.3.4 Counters

The following table lists both Binary Counters (Object 20) and Frozen Counters (Object 21). When a freeze function is performed on a Binary Counter point, the frozen value is available in the corresponding Frozen Counter point. The default Binary Counter and Frozen Counter event buffer sizes are set to 30.

The "Default Deadband," and the "Default Change Event Assigned Class" columns are used to represent the absolute amount by which the point must change before a Counter change event will be generated, and once generated in which class poll (1, 2, 3, or none) will the change event be reported.

The default counter event buffer size is set 30. The counter event mode is set to Most Recent, only most recent event for each point is stored.

Counters are by default returned in a class zero interrogation.

Note, not all points listed here apply to all builds of devices.

CountersStatic (Steady-State) Object Number: **20**Change Event Object Number: **22**

Static Variation reported when variation 0 requested: **1 (32-Bit Counter with Flag)**
 or **2 (16-Bit Counter with Flag)**
 or **5 (32-Bit Counter w/o Flag)**
 or **6 (16-Bit Counter w/o Flag)**

Change Event Variation reported when variation 0 requested: **1 (32-Bit Counter Event with Flag)**
 or **2 (16-Bit Counter Event with Flag)**
 or **5 (32-Bit Counter Event with Flag and Time)**
 or **6 (16-Bit Counter Event with Flag and Time)**

Frozen CountersStatic (Steady-State) Object Number: **21**Change Event Object Number: **23**

Static Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter with Flag)**
 or **2 (16-Bit Frozen Counter with Flag)**
 or **5 (32-Bit Frozen Counter with Flag and Time)**
 or **6 (16-Bit Frozen Counter with Flag and Time)**
 or **9 (32-Bit Frozen Counter w/o Flag)**
 or **10 (16-Bit Frozen Counter w/o Flag)**

Change Event Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter Event with Flag)**
 or **2 (16-Bit Frozen Counter Event with Flag)**
 or **5 (32-Bit Frozen Counter Event with Flag and Time)**
 or **6 (16-Bit Frozen Counter Event with Flag and Time)**

		Counter						Frozen Counter		
Point Index	Name (Description)	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 20	Default Variation Event Object 22	Deadband	Is Resettable	Is Freezable	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 21	Default Variation Event Object 23
0	Waveform Records	0,3	5	1	1		✓	0,2	9	1
1	Fault Records	0,3	5	1	1					
2	Event Records	0,3	5	1	1		✓	0,2	9	1
3	Data Log Records	0,3	5	1	1					
4	Number User Files	0,3	5	1	1					
21	E1 Counter	0,3	5	1	1		✓	0,2	9	1
22	E2 Counter	0,3	5	1	1		✓	0,2	9	1
23	E3 Counter	0,3	5	1	1		✓	0,2	9	1
24	E4 Counter	0,3	5	1	1		✓	0,2	9	1
25	E5 Counter	0,3	5	1	1		✓	0,2	9	1
26	E6 Counter	0,3	5	1	1		✓	0,2	9	1
27	E7 Counter	0,3	5	1	1		✓	0,2	9	1
28	E8 Counter	0,3	5	1	1		✓	0,2	9	1
29	E9 Counter	0,3	5	1	1		✓	0,2	9	1
30	E10 Counter	0,3	5	1	1		✓	0,2	9	1
31	E11 Counter	0,3	5	1	1		✓	0,2	9	1
32	E12 Counter	0,3	5	1	1		✓	0,2	9	1
33	E13 Counter	0,3	5	1	1		✓	0,2	9	1
34	E14 Counter	0,3	5	1	1		✓	0,2	9	1
35	E15 Counter	0,3	5	1	1		✓	0,2	9	1
36	E16 Counter	0,3	5	1	1		✓	0,2	9	1
40	CB Total Trip Count	0,3	5	1	1	✓	✓	0,2	9	1
41	CB Delta Trip Count	0,3	5	1	1	✓	✓	0,2	9	1
42	CB1 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1

CountersStatic (Steady-State) Object Number: **20**Change Event Object Number: **22**

Static Variation reported when variation 0 requested: **1 (32-Bit Counter with Flag)**
 or **2 (16-Bit Counter with Flag)**
 or **5 (32-Bit Counter w/o Flag)**
 or **6 (16-Bit Counter w/o Flag)**

Change Event Variation reported when variation 0 requested: **1 (32-Bit Counter Event with Flag)**
 or **2 (16-Bit Counter Event with Flag)**
 or **5 (32-Bit Counter Event with Flag and Time)**
 or **6 (16-Bit Counter Event with Flag and Time)**

Frozen CountersStatic (Steady-State) Object Number: **21**Change Event Object Number: **23**

Static Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter with Flag)**
 or **2 (16-Bit Frozen Counter with Flag)**
 or **5 (32-Bit Frozen Counter with Flag and Time)**
 or **6 (16-Bit Frozen Counter with Flag and Time)**
 or **9 (32-Bit Frozen Counter w/o Flag)**
 or **10 (16-Bit Frozen Counter w/o Flag)**

Change Event Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter Event with Flag)**
 or **2 (16-Bit Frozen Counter Event with Flag)**
 or **5 (32-Bit Frozen Counter Event with Flag and Time)**
 or **6 (16-Bit Frozen Counter Event with Flag and Time)**

Point Index	Name (Description)	Counter						Frozen Counter		
		Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 20	Default Variation Event Object 22	Deadband	Is Resettable	Is Freezable	Default Change Event Assigned Class (1, 2, 3 or none)	Default Variation Static Object 21	Default Variation Event Object 23
43	CB1 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
44	CB2 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
45	CB2 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
46	CB3 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
47	CB3 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
48	CB4 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
49	CB4 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
50	CB5 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
51	CB5 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
52	CB6 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
53	CB6 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
54	CB7 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
55	CB7 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
56	CB8 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
57	CB8 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
58	CB9 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
59	CB9 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
60	CB10 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
61	CB10 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
62	CB11 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
63	CB11 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1
64	CB12 Total Open Count	0,3	5	1	1	✓	✓	0,2	9	1
65	CB12 Delta Open Count	0,3	5	1	1	✓	✓	0,2	9	1

5.3.5 Analog Inputs

5.4 Additional Settings

The following relay settings are provided for configuration of the DNP 3.0 implementation when available and are common to all ports using this protocol.

Setting Name	Range/Options	Default	Setting	Notes
Unsolicited Mode	DISABLED, ENABLED	DISABLED	As Required	Setting is only visible when any port Protocol is set to DNP3.
Destination Address	0 - 65534	0	As Required	Setting is only visible when DNP3 Unsolicited Events set to Enabled.
DNP3 Application Timeout	5, 6 ... 299, 300	10s	As Required	Setting is only visible when any port Protocol is set to DNP3.

6. Not Applicable

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7. IEC61850 Protocol Support

7.1 Introduction

The relay can optionally be provided with IEC61850 comms.

For further details refer to the following publications:

- Model Implementation Conformance Statement (MICS)
- Protocol Implementation Conformance Statement (PICS)
- Protocol Implementation Extra Information for Testing (PIXIT)

8. Serial Modems

8.1 Introduction

The communications interface has been designed to allow data transfer via modems. A suitable Modem can be connected directly to the Relay's serial interface, for example RS232, RS485 or fibre-optic port where fitted.

8.2 Connecting a Modem to the Relay(s)

RS232C defines devices as being either Data Terminal Equipment (DTE) e.g. computers, or data Communications Equipment (DCE), e.g. modems, where one is designed to be connected to the other.

The optional RS232 port of the Relay is wired as a DTE device and can therefore be connected directly to a Modem.

The 7XV5652 RS232 fibre-optic converter is wired as a DCE device, the same as a Modem. Where two DCE devices e.g. the modem and the fibre-optic converter are being connected together a null terminal connector is required which switches various control lines. The fibre-optic converter is then connected to the relay Network Tx to Relay Rx and Network Rx to Relay Tx.

8.3 Setting the Remote Modem

The exact settings of the modem are dependent on the type of modem. Although most modems support the basic Hayes "AT" command format, different manufacturers use different commands for the same functions. In addition, some modems use DIP switches to set parameters, others are entirely software configured.

Before applying settings, the modem's factory default settings should be applied, to ensure it is in a known state.

Several factors must be considered to allow remote dialling to the relays. The first is that the modem at the remote end must be configured as auto answer. This will allow it to initiate communications with the relays. Next, the user should set the data configuration at the local port, i.e. baud rate and parity, so that communication will be at the same rate and format as that set on the relay and the error correction is disabled.

Auto-answer usually requires two parameters to be set. The auto-answer setting should be switched on and the number of rings after which it will answer. The Data Terminal Ready (DTR) settings should be forced on. This tells the modem that the device connected to it is ready to receive data.

The parameters of the modem's RS232C port are set to match those set on the relay, set baud rate and parity to be the same as the settings on the relay and number of data bits to be 8 and stop bits 1. Note, although the device may be able to communicate with the modem at, for example, 19200 bps, the modem may only be able to transmit over the telephone lines at 14400 bps. Therefore, a baud rate setting on which the modem can transmit should be chosen. In the aboveexample, a baud rate of 9600 should be chosen.

As the modems are required to be transparent, simply passing on the data sent from the controller to the device and vice versa, error correction and buffering is turned off.

Finally, the settings selected for configuration should be stored in the modem's memory for power on defaults.

8.4 Connecting to the Remote Modem

Once the remote modem has been configured correctly, it should be possible to make connection to the relay.

Where a "dial-up" modem system is installed the settings on the remote modem are fixed so the local modem should negotiate with it on connection, choosing suitable matching settings. Where this is not possible the local modem should be set with settings equivalent to those of the remote modem as described above.

9. Configuration

The data points and control features which are possible within the relay is fixed and can be transmitted over the communication channel(s) protocols in the default format described earlier in this document. The default data transmitted is not always directly compatible with the needs of the substation control system and will require some tailoring; this can be done by the user with the Reydisp software Communications Editor tool.

The Communications Editor is provided to allow its users to configure the Communication Protocol's Files in Reyrolle brand Relays manufactured by Siemens Protection Devices Limited (SPDL).

The editor supports configuring DNP3, IEC60870-5-103, IEC60870-5-101 and MODBUS protocols.

The editor allows configuration files to be retrieved from the relay, edited, and then uploaded back to the relay. Files may also be saved to and loaded from disc to work offline. The protocols will be stored in a Reyrolle Protection Device Comms file (RPDC), which will be stored locally, so that the editor can be used when the relay is not connected.

DNP3

The tool will allow:

- Data Points to be enabled or disabled.
- Changing the point numbers for the Binary Inputs, Double Bit Inputs, Binary Outputs, Counters and Analogue Inputs.
- Changing their assigned class and static and event variants.
- Specifying inclusion in a Class 0 poll.
- Setting Binary points to be inverted before transmission.
- Setting the Control Relay Output Block (CROB) commands that can be used with a Binary Output (Object 12).
- Specifying a dead-band outside which Analogue Events will be generated.
- Specifying a multiplier that will be applied to an analogue value before transmission.
- Configuring a Counter's respective Frozen Counter.

IEC60870-5-103

The tool will allow:

- Data Points to be enabled or disabled.
- Changing the point numbers Function Type (FUN) and Information (INF), returned by each point.
- Changing the text returned to Reydisp for display in its event viewer.

MODBUS

Note, as MODBUS points are polled they do not need to be enabled or disabled.

The tool will allow:

- Changing the Addresses for the Coils, Inputs and Registers.
- Changing the format of the instrument returned in a register, e.g. 16 or 32 bit.
- Specifying a multiplier that will be applied to an analogue value before transmission.

The user can check if the relay contains user configured communication files via a meter in the relay menus. Pressing the Enter and down arrow buttons on the fascia, then scrolling down, the number of files stored in the relay is displayed. The file name can also be viewed by pressing the Cancel and Test/Reset buttons together when in the relay Instruments menu. The user must ensure when naming the file, they use a unique file name including the version number.

Please refer to the Communications Editor User Guide for further guidance.

10. Glossary

Baud Rate

Data transmission speed.

Bit

The smallest measure of computer data.

Bits Per Second (bps)

Measurement of data transmission speed.

Data Bits

A number of bits containing the data. Sent after the start bit.

Data Echo

When connecting relays in an optical ring architecture, the data must be passed from one relay to the next, therefore when connecting in this method all relays must have the Data Echo ON.

EN100

Siemens' Ethernet communications module supporting IEC61850, available in optical and electrical versions.

Ethernet

A computer networking technology.

Full-Duplex Asynchronous Communications

Communications in two directions simultaneously.

Half-Duplex Asynchronous Communications

Communications in two directions, but only one at a time.

Hayes "AT"

Modem command set developed by Hayes Microcomputer products, Inc.

LAN

Local Area Network. A computer network covering a small geographic area.

LC

Fibre optic connector type designed by Lucent Technologies, Inc.

Line Idle

Determines when the device is not communicating if the idle state transmits light.

Modem

MODulator / DEModulator device for connecting computer equipment to a telephone line.

Parity

Method of error checking by counting the value of the bits in a sequence, and adding a parity bit to make the outcome, for example, even.

Parity Bit

Bit used for implementing parity checking. Sent after the data bits.

RS232C

Serial Communications Standard. Electronic Industries Association Recommended Standard Number 232, Revision C.

RS485

Serial Communications Standard. Electronic Industries Association Recommended Standard Number 485.

Start Bit

Bit (logical 0) sent to signify the start of a byte during data transmission.

Stop Bit

Bit (logical 1) sent to signify the end.

USB

Universal Serial Bus standard for the transfer of data.

WAN

Wide Area Network. A computer network covering a large geographic area.

Appendix 1

The operating mode of the device is set via the setting, or through a command sent to a communications port. There are four options; **Local**, **Remote**, **Local or Remote** and **Service**.

The following table illustrates whether a function is Enabled (✓) or Disabled (✗) in each mode.

Function	Operation Mode		
	Local	Remote	Service
Control			
Com1	✓ when Com1-Mode = Local	✓ when Com1-Mode = Remote	✗
Com2 (USB)	✓ when Com2-Mode = Local	✓ when Com2-Mode = Remote	✗
Com3	✓ when Com3-Mode = Local	✓ when Com3-Mode = Remote	✗
Com4	✓ when Com4-Mode = Local	✓ when Com4-Mode = Remote	✗
Fascia (Control Mode)	✓	✗	✗
Function Key (n)	✓	✓ when F Key(n) Mode = Remote	✗
Binary Input (n)	✓ when BI (n) Mode = Local	✓ when BI (n) Mode = Remote	✓
Binary Outputs	✓	✓	✗
Reporting			
Spontaneous			
IEC	✓	✓	✗
DNP3	✓	✓	✗
General Interrogation			
IEC	✓	✓	✗
DNP3	✓	✓	✗
MODBUS	✓	✓	✓
Change Settings			
Com1	✓ when Com1-Mode = Local	✓ when Com1-Mode = Remote	✓
Com2 (USB)	✓ when Com2-Mode = Local	✓ when Com2-Mode = Remote	✓
Com3	✓ when Com3-Mode = Local	✓ when Com3-Mode = Remote	✓
Com4	✓ when Com4-Mode = Local	✓ when Com4-Mode = Remote	✓
Fascia	✓	✓	✓
Historical Information			
Waveform Records	✓	✓	✓
Event Records	✓	✓	✓
Fault Information	✓	✓	✓
Setting Information	✓	✓	✓

Fig. A1 Operating Mode Table

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Template Revision 15.

7SR23 DAD - Installation

High Impedance Protection Relay

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Section 1: Installation

1.1 Packaging

Relays are supplied in packaging designed to mechanically protect them while in both transit and storage.

This packaging should be recycled where systems exist, or disposed of in a manner which does not provide a threat to health or the environment. All laws and regulations specific to the country of disposal should be adhered

1.2 Unpacking, Storage and Handling

On receipt remove the relay from the container in which it was received and inspect it for obvious damage. It is recommended that the relay not be removed from its case.

If damage has been sustained a claim should be immediately be made against the carrier, also inform *Siemens Protection Devices Limited* and to the nearest *Siemens* agent, using the Defect Report Form in the Maintenance section of this manual.

When not required for immediate use the relay should be returned to its original carton and stored in a clean, dry place.

The relay contains static sensitive devices, which are susceptible to damage due to static discharge. The relay's electronic circuits are protected from damage by static discharge when the relay is housed in its case.

There can be no requirement to disassemble any relay, since there are no user serviceable parts in the relay. If any modules have been tampered with the guarantee will be invalidated. *Siemens Protection Devices Limited* reserves the right to charge for any subsequent repairs.

1.3 Recommended Mounting Position

The relay uses a liquid crystal display (LCD) which is used in the programming and for operation. The LCD has a vertical viewing angle of $\pm 30^\circ$ and is back-lit. However, the best viewing position is at eye level, and this is particularly important given its control features.

The relay should be mounted on the circuit breaker (or protection panel) to allow the operator the best access to the relay functions

Resistors should be mounted vertically in a well ventilated location and clear of all other wiring and equipment to avoid the effects of their power dissipation.

1.4 Wiring

The product should be wired according to the scheme requirements, with reference to the appropriate wiring diagram. Refer to the appropriate Diagrams and Parameters document for a cross reference of wiring diagrams and models.

1.5 Earthing

Terminal 28 of the PSU (Power Supply Unit) should be solidly earthed by a direct connection to the panel earth. The relay case earth stud connection should be connected to terminal 28 of the PSU.

It is normal practice to additionally 'daisy chain' together the case (safety) earths of all the relays installed in a panel to prevent earth current loops posing a risk to personnel.

1.6 Ancillary Equipment

The relay can be interrogated locally or remotely. For local interrogation a portable PC with suitable version of MS Windows and Reydisp Evolution or Reydisp Manager software using the USB port situated on front of the relay.

Section 2: Equipment Operating Conditions

General Safety Precautions



Current Transformer Circuits

The secondary circuit of a live CT must not be open circuited. Non-observance of this precaution can result in injury to personnel or damage to equipment.



External Resistors

Where external resistors are fitted to relays, these may present a danger of electric shock or burns, if touched.



Fibre Optic Communication

Where fibre optic communication devices are fitted, these should not be viewed directly. Optical power meters should be used to determine the operation or signal level of the device.



Front Cover

The front cover provides additional securing of the relay element within the case. The relay cover should be in place during normal operating conditions.



Disposal

The Relay should be disposed of in a manner which does not provide a threat to health or the environment. All laws and regulations specific to the country of disposal should be adhered to.

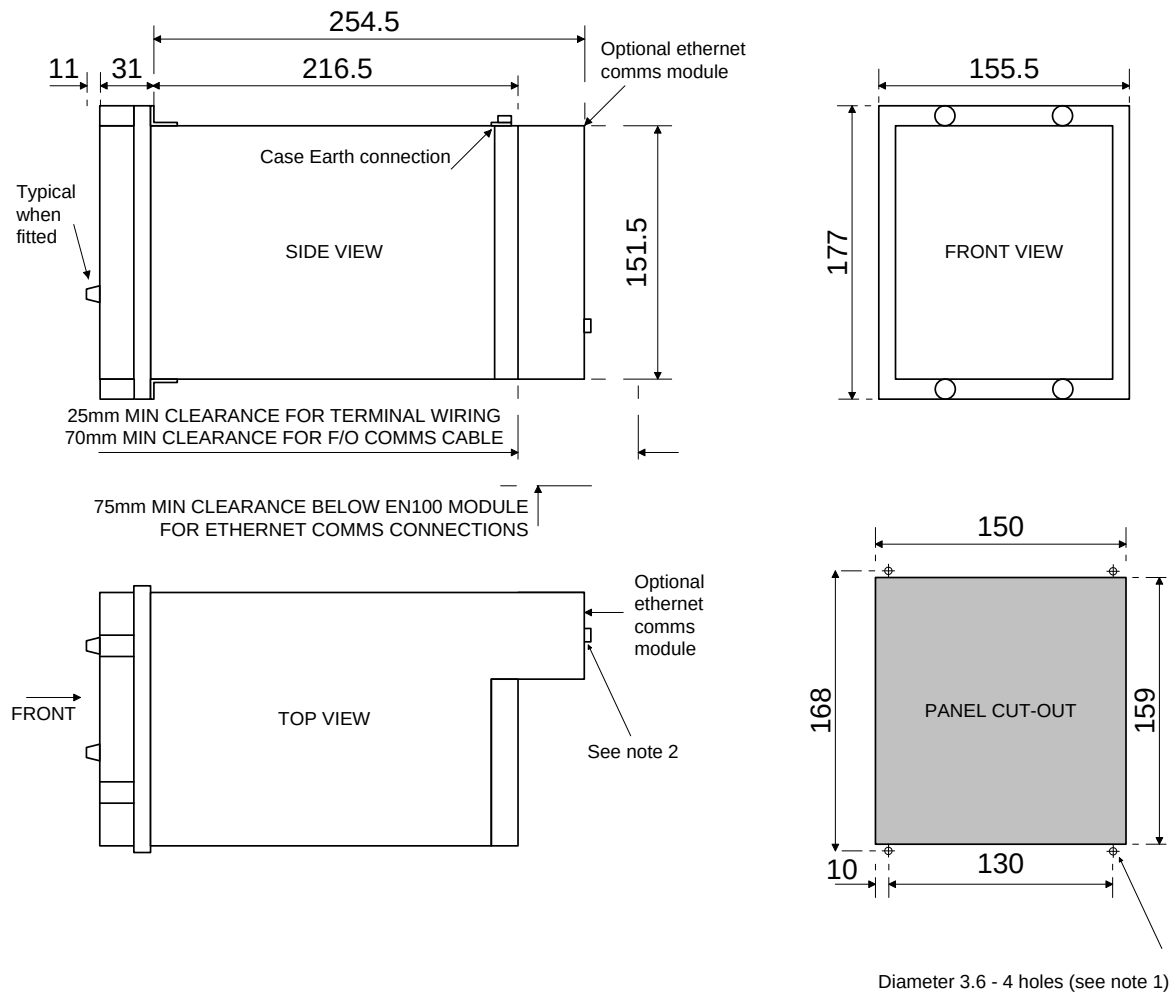
The relays and protection systems manufactured under the Reyrolle brand currently do not come within the scope of either the European WEEE or RoHS directives as they are equipment making up a fixed installation.

Section 3: Dimensions and Panel Fixings

3.1 Relay Dimensions and Weight

Relays are supplied in size E6 and E8 cases.

Panel cut-out requirements and case dimensions are shown in Figure 3.1-1 and Figure 3.1-2 below.

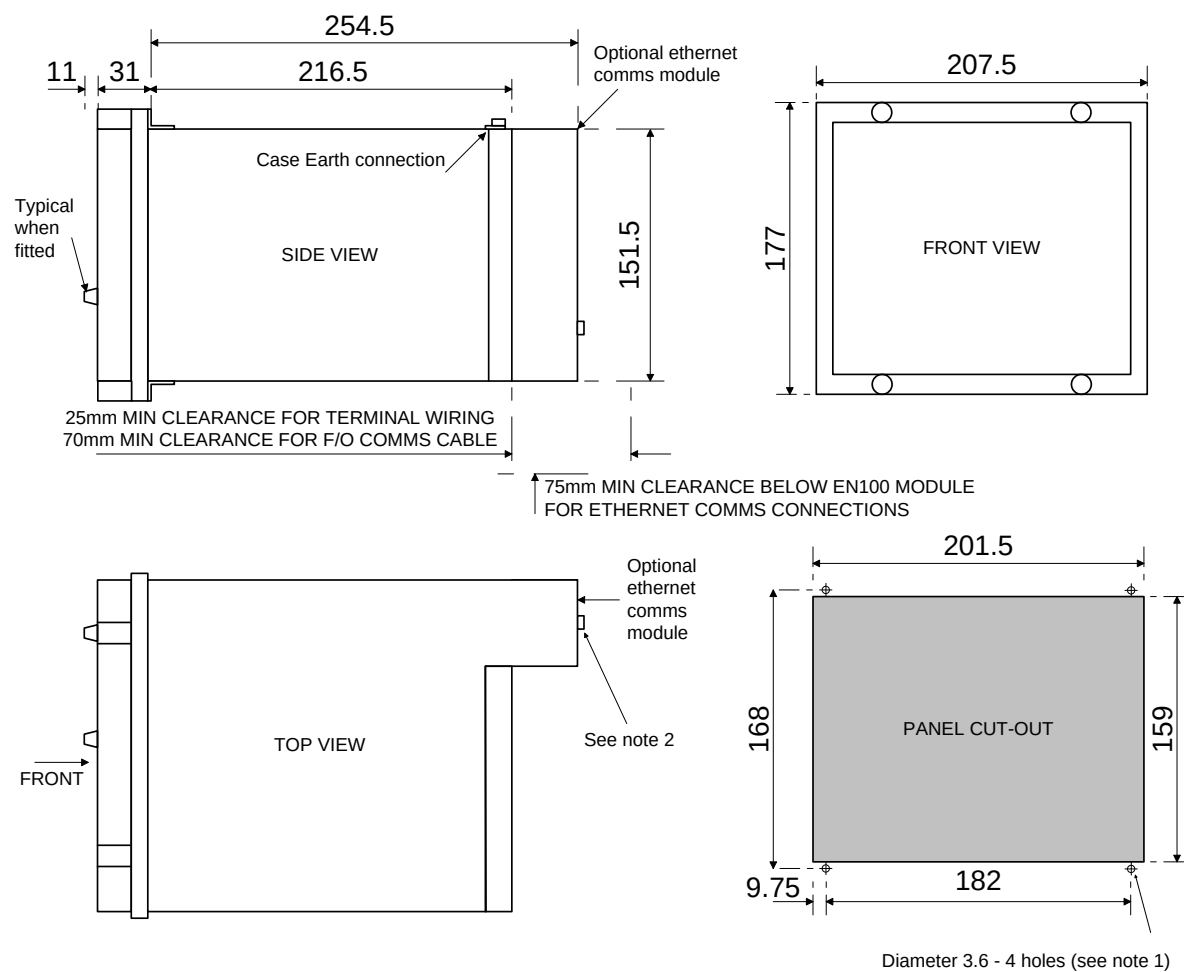


NOTES:

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

2) ACCESS CLEARANCE REQUIRED FOR OPTIONAL ETHERNET COMMS MODULE RETAINING SCREW

Figure 3.1-1 Overall Dimensions and panel Drilling for Size E6 Epsilon case



NOTES:

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

2) ACCESS CLEARANCE REQUIRED FOR OPTIONAL ETHERNET COMMS MODULE RETAINING SCREW

Figure 3.1-2 Overall Dimensions and panel Drilling for Size E8 Epsilon case

3.2 Fixings

3.2.1 Crimps

Ring tongued crimps with 90° bend are recommended.

3.2.2 Panel Fixings

Typical mounting screw kit (per Relay)

Consists of 4 off M4x10mm Screws

4 off M4 Nuts

4 off M4 Lock Washer

Typical rear terminal block fixing kit (1kit per terminal block fitted to relay) Consists of:

28 x M4, 8mm Screws

28 x M4 Lock Washer

Section 4: Rear Terminal Drawings

4.1 E6 Case

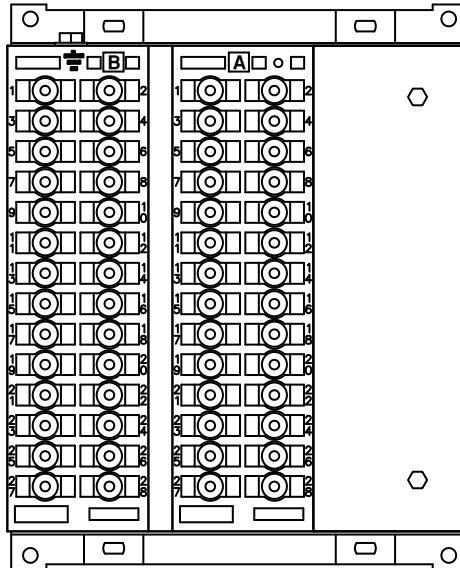


Figure 4.1-1 E6 Standard Comms (USB Front Port, Rear RS485) (See Note 2)

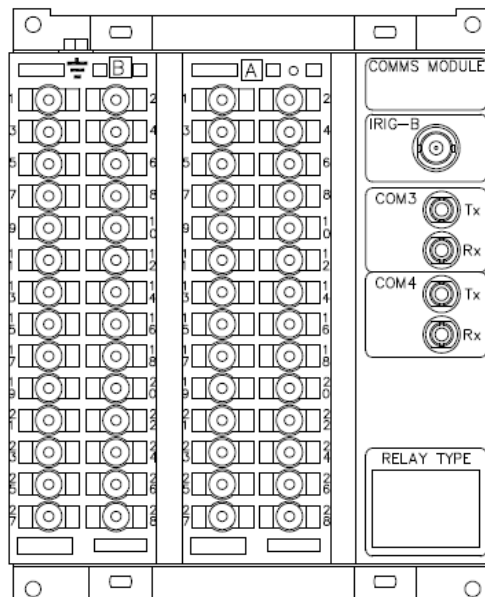


Figure 4.1-2 E6 Standard + Additional Ports (IRIG-B, 2 x F.O. (ST Connectors))

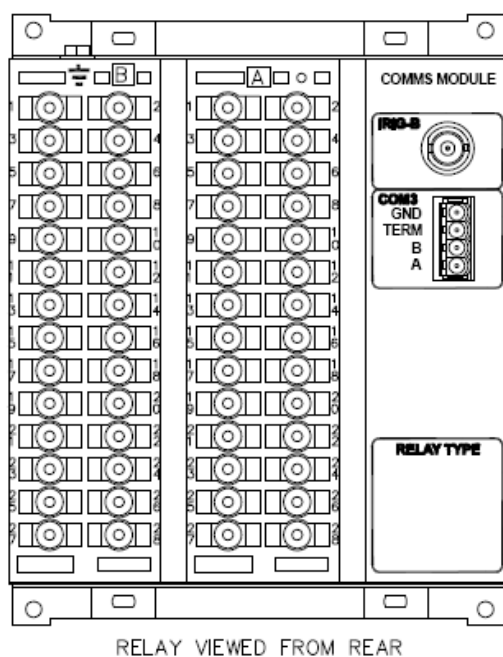


Figure 4.1-3 E6 Standard + Additional Ports (IRIG-B, RS485)

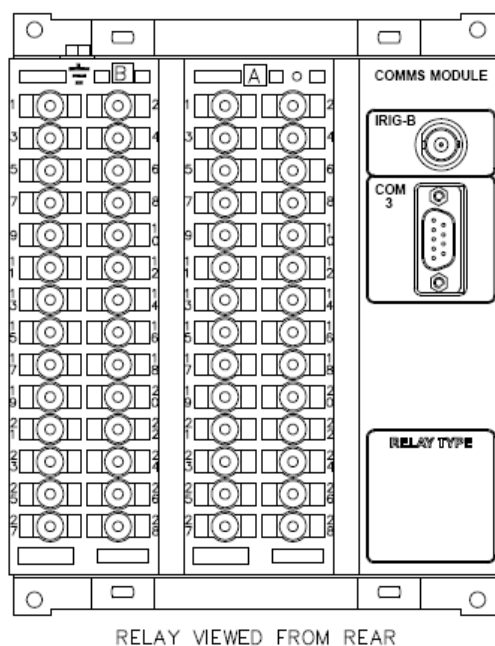


Figure 4.1-4 E6 Standard + Additional Ports (IRIG-B, RS232)

Notes

- 1) Recommended terminations are pre-insulated & must be crimped using approved tooling.
 - 2) RS485 (block "B" terminals 14, 16, 18, 20 and optional COMMS MODULE) connections are by screened, twisted pair cable.
- Ensure that these terminals are not obscured by other wiring runs.
- Cable should be RS485 compliant.

4.2 E8 Case

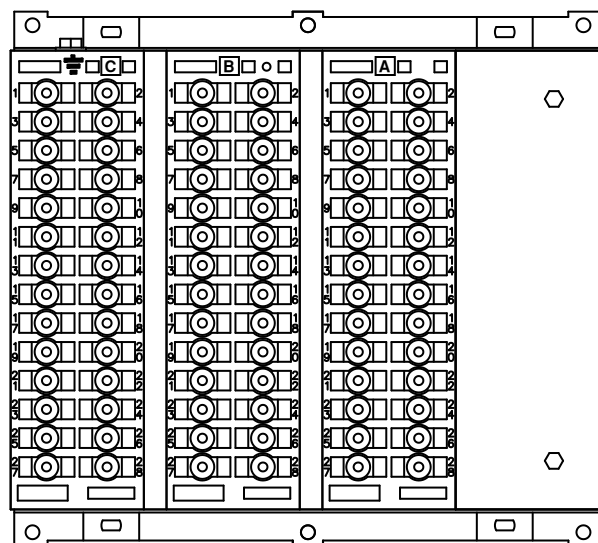


Figure 4.2-1 E8 Standard Comms (USB Front Port, Rear RS485) (See Note 2)

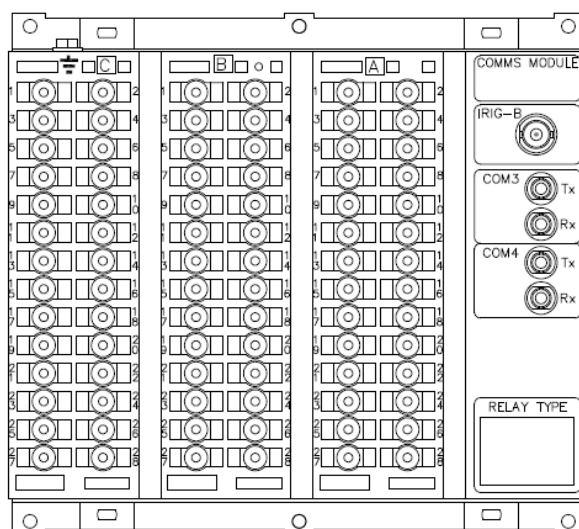


Figure 4.2-2 E8 Standard + Additional Ports (IRIG-B, 2 x F.O. (ST Connectors))

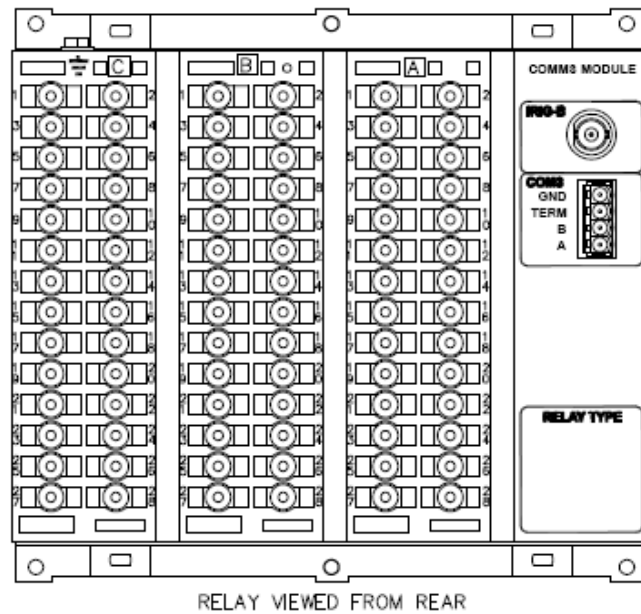


Figure 4.2-3 E8 Standard + Additional Ports (IRIG-B, RS485)

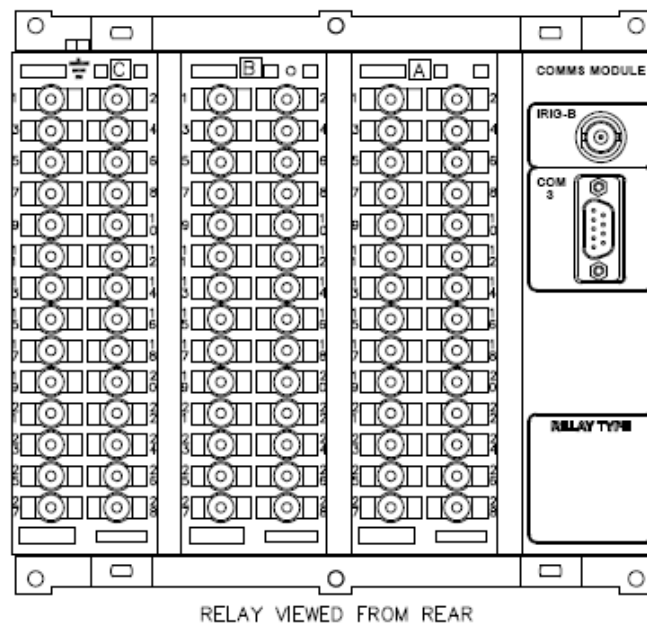


Figure 4.2-4 E8 Standard + Additional Ports (IRIG-B, RS232)

Notes

- 1) Recommended terminations are pre-insulated & must be crimped using approved tooling.
 - 2) RS485 (block "B" terminals 14, 16, 18, 20 and optional COMMS MODULE) connections are by screened, twisted pair cable.
- Ensure that these terminals are not obscured by other wiring runs.
- Cable should be RS485 compliant.

5.1 Wiring Diagram: 7SR230 Relay

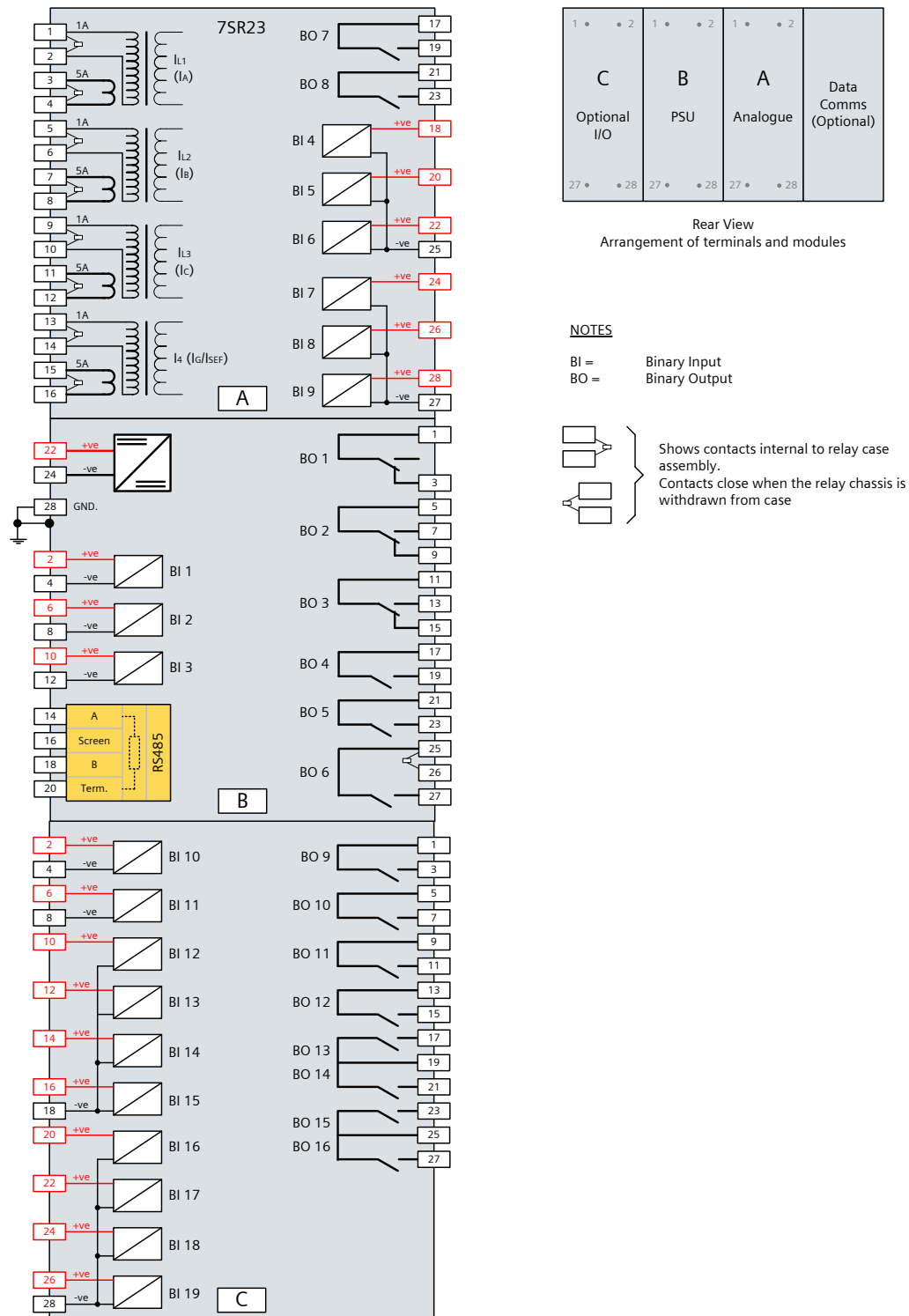


Figure 5.1-1 7SR23 Wiring Diagram

Section 6: Data Comms Connections

6.1 RS485 Connection

The RS485 communication port terminals are located on the rear of the relay and can be connected using a suitable RS485 120Ω screened twisted pair cable.

The RS485 electrical connection can be used in a single or multi-drop configuration. When used with Reydisp the RS485 master must support and use the Auto Device Enable (ADE) feature.

The last device in the connection must be terminated correctly in accordance with the master driving the connection. A terminating resistor is fitted in each relay, when required this is connected in circuit using an external wire loop between terminals 18 and 20 of the power supply module.

Up to 64 relays can be connected to the RS485 bus.

Each relay has an internal terminating resistor – this can be connected in circuit where necessary.

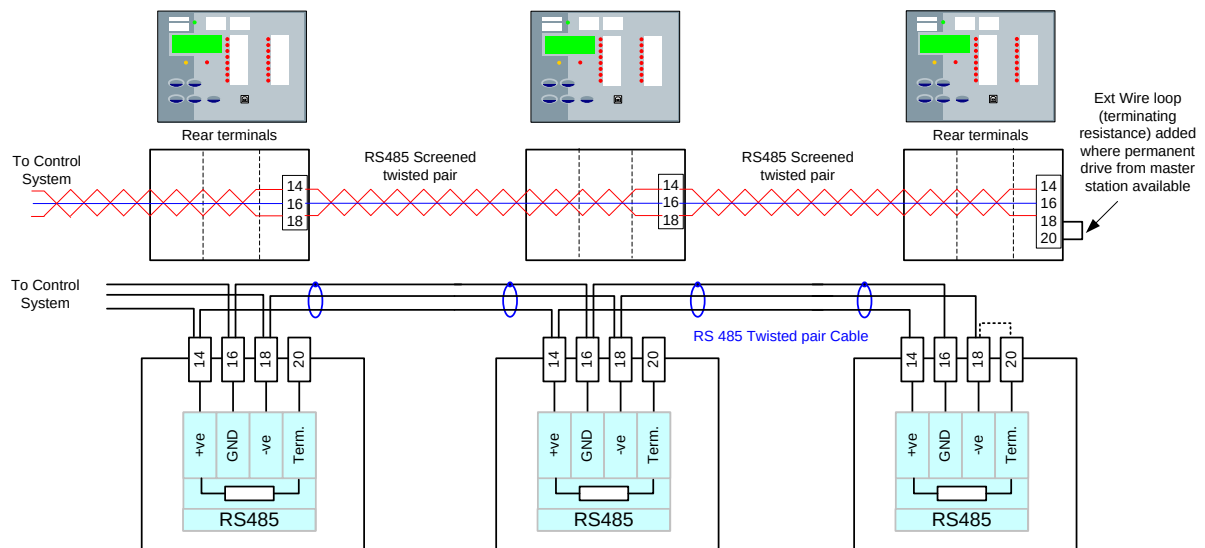


Figure 6.1-1 RS485 Data Comms Connections

6.2 IRIG-B Connections

A BNC plug is provided to connect a co-axial cable carrying IRIG-B time synchronisation signals. Ensure that the stub length is minimised by connecting the tee-connector directly to the rear of the relay. A suitable co-axial cable would be type RG 58 50ohms.

6.3 Optional Fibre Optic Connections

Where fitted rear Data Comms ports 3 and 4 comprise Fibre–Optic ST™ (BFOC/2.5) bayonet connectors-4 per product. 62.5 / 125µm glass fibre is recommended for all lead lengths.

When installing fibre, ensure that the fibres' bend radii comply with the recommended minimum for the fibre used- typically 50mm is acceptable.

The fibre optic data comms link will be interrupted if the relay element is withdrawn from the case.

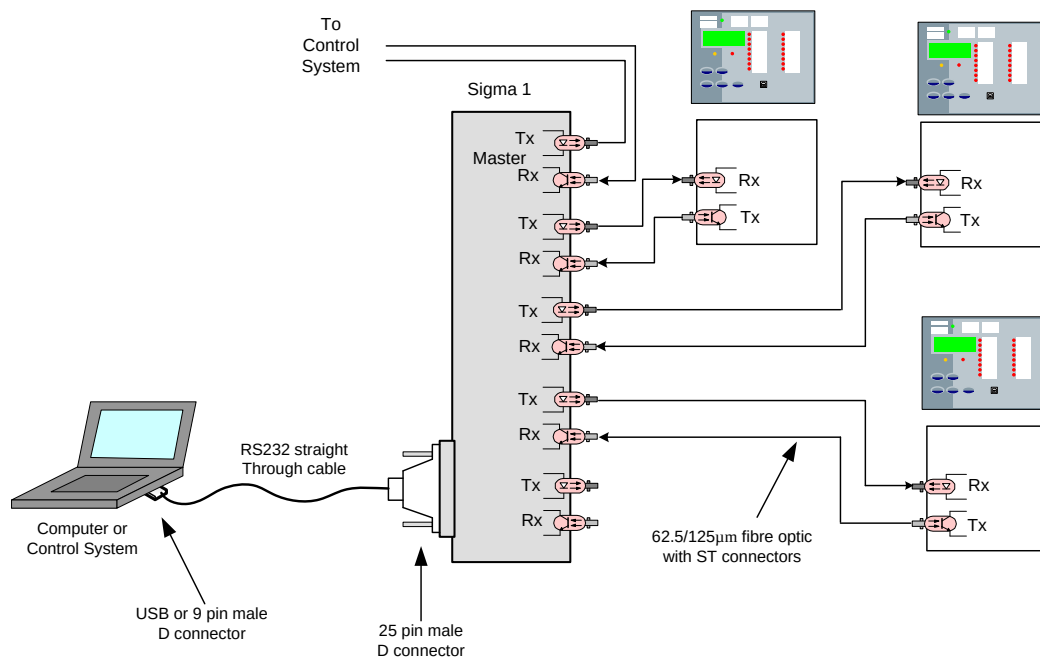


Figure 6.3-1 Data Comms to Multiple Devices Using Sigma 1 and F.O. Star Network

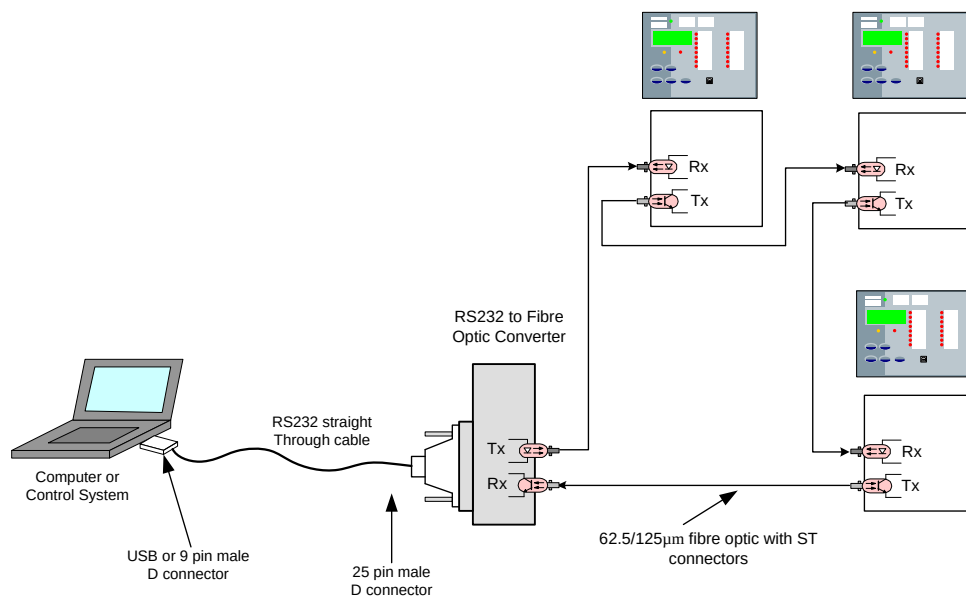


Figure 6.3-2 Data Comms to Multiple Devices Using Sigma 3 and F.O. Ring Network

6.4 Optional Additional RS485 Connections

The additional (optional) RS485 communication port is located at the rear of the relay and can be connected using a suitable RS485 120 ohm screened twisted pair cable.

The RS485 electrical connection can be used in a single or multi-drop configuration. When used with Reydisp the RS485 master must support and use the Auto Device Enable (ADE) feature.

The last device in the connection must be terminated correctly in accordance with the master device driving the connection. The relays are fitted with an internal terminating resistor which can be connected between the A and B by fitting an external wire loop between terminals 18 and 20 on the power supply module.

6.5 Optional RS232 Connections

The additional (optional) RS232 (9 pin plug) (DTE) communication port is located at the rear of the relay and can be connected using a suitable RS232 cable.

Where there is a requirement for multi-drop RS232 connection, a suitable device to facilitate this should be obtained.

Pin	Relay Function
1	Not Connected
2	Receive Data (RXD)
3	Transmit Data (TXD)
4	Output Supply +5V 50mA
5	Signal Ground (GND)
6	Output Supply +5V 50mA
7	Linked to 8 (volts free)
8	Linked to 7 (volts free)
9	Output Supply +5V 50mA

Figure 6.5-1 RS232 Data Comms Pin Connections

6.6 Additional (Optional) Ethernet Connection for IEC 61850

Rear Ethernet Comms port Ch 1 and Ch 2 comprises Fibre-Optic Duplex LC connectors or electrical RJ45 connectors.

When installing fibre, ensure that the fibres' bend radii comply with the recommended minimum for the fibre used—typically 50mm is acceptable, 62.5 / 125µm glass fibre is recommended for all distances.

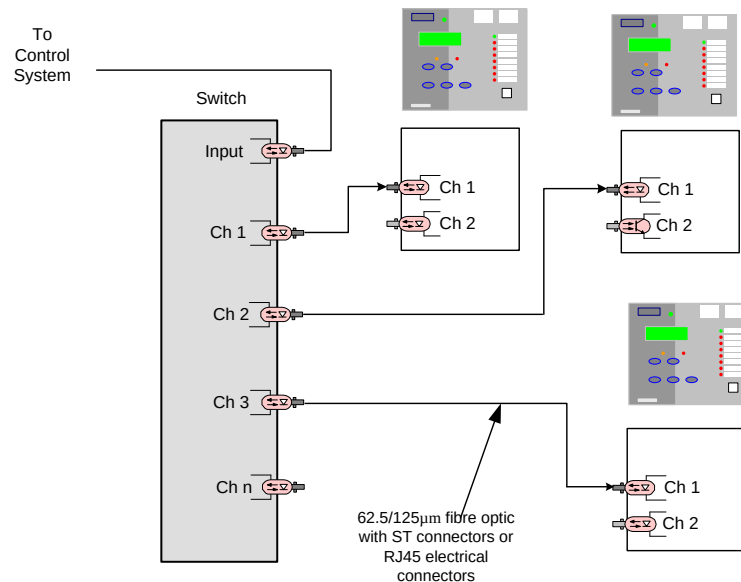


Figure 6.6-1 Ethernet connection for IEC 61850 (star connection)

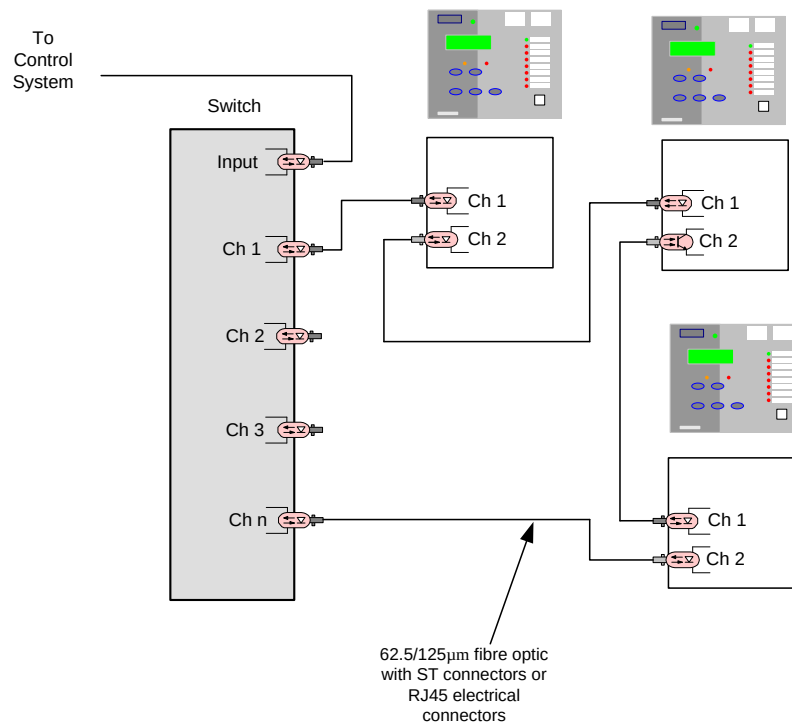


Figure 6.6-2 Ethernet connection for IEC 61850 (ring connection)

6.7 Ethernet Network Redundancy IEC 61850

The EN100+ module is used on current Reyrolle devices (from 7SR23 hardware /CC) to provide Ethernet/IEC61850 functionality and supports RSTP, PRP and HSR redundancy protocols.

Earlier 7SR23 (/BB) devices were manufactured with the EN100 (not EN100+) module and the electrical version cannot support redundancy. The optical version can support PRP and HSR redundancy if firmware is updated to version 4.2 or later and FPGA is updated to version 515 or later. Earlier 7SR23 devices do not support the EN100+ module and cannot be updated by simply exchanging the EN100 module.

All current 7SR23 IEC61850 variants are delivered with the EN100+ (Plus) module and firmware 4.24 or later.

The EN100 module firmware and FPGA can be updated by connecting to the relay via the rear Ethernet port. For more information on connecting to the relay via the Ethernet port, please see the Reydisp Manager Userguide or the Guidance Note available from the product website. Depending on the EN100 module type and Firmware version, the following protocol options are available,

Interface Type	EN100 Firmware	Line Mode	Switch Mode			
			RSTP	OSM	PRP	HSR
Electrical RJ45 EN100+	4.21and later	✓	✓	✓	✓	✓
Optical EN100+	4.21and later	✓	✓	✓	✓	✓
Electrical RJ45 EN100+	4.08 or earlier	✓	✓	✓	✗	✗
Optical EN100+	4.08 or earlier	✓	✓	✓	✗	✗
Electrical RJ45 EN100	4.21and later	✓	✗	✗	✗	✗
Optical EN100	4.21and later	✓	✓	✓	✓	✓
Electrical RJ45 EN100	4.08 or earlier	✓	✗	✗	✗	✗
Optical EN100	4.08 or earlier	✓	✓	✓	✗	✗

Table 1: EN100 Redundancy availability

6.7.1 RSTP – Rapid Spanning Tree Protocol

RSTP is a redundancy protocol with a minimal response time that has been standardized in IEEE-802.1D (2004). The reconfiguration time depend on the topology and start at 50ms.

RSTP need to be enabled on the device within Reydisp Manager (See Reydisp Manager userguide). Network rings with up to 30 devices is possible.

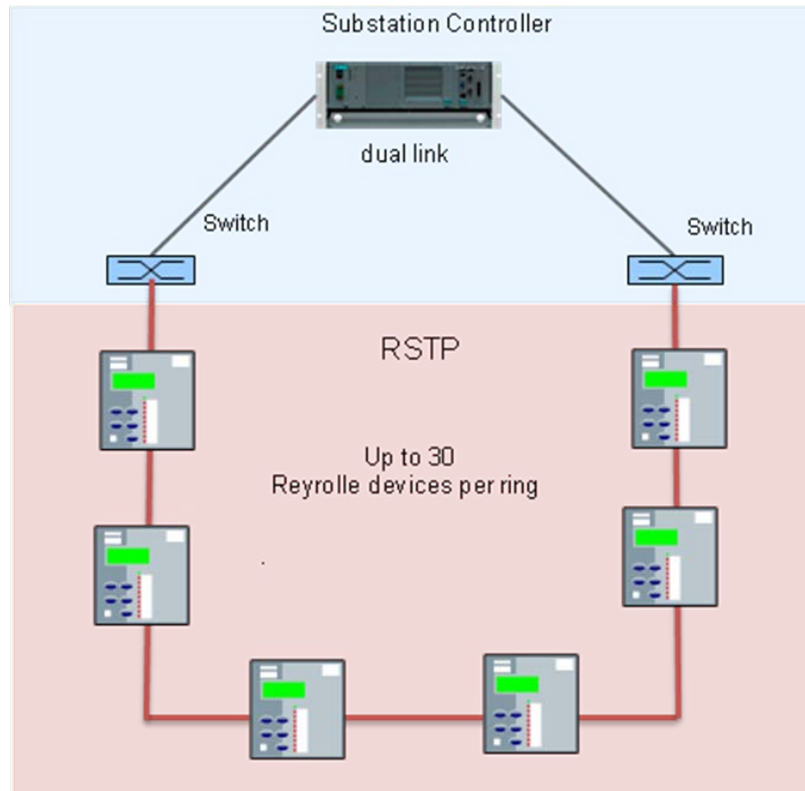


Figure 6.7-1 RSTP Ethernet Network Ring Configuration

6.7.2 PRP – Parallel Redundancy Protocol

The HSR redundancy protocol according to the IEC 62439-3 standard is based on double transmission of message frames over ring-topology networks in both directions. In the case of an error, the message frame will be transmitted without any delay. No reconfiguration time is necessary for the network, as is the case for RSTP.

PRP need to be enabled on the device within Reydisp Manager (See Reydisp Manager userguide).

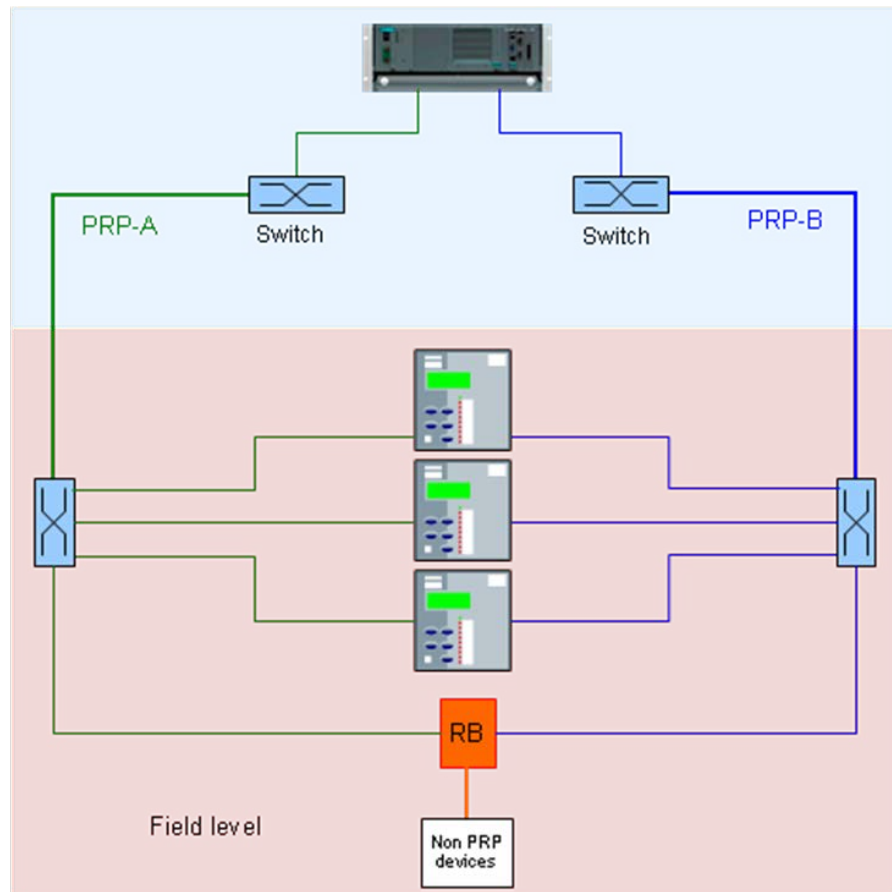


Figure 6.7-2 PRP Ethernet Network Configuration

6.7.3 HSR – High Availability Seamless Redundancy Protocol

The HSR redundancy protocol according to the IEC 62439-3 standard is based on double transmission of message frames over ring-topology networks in both directions. In the case of an error, the message frame will be transmitted without any delay. No reconfiguration time is necessary for the network.

HSR needs to be enabled on the device within Reydisp Manager (See Reydisp Manager user guide). Network rings with up to 50 devices is possible.

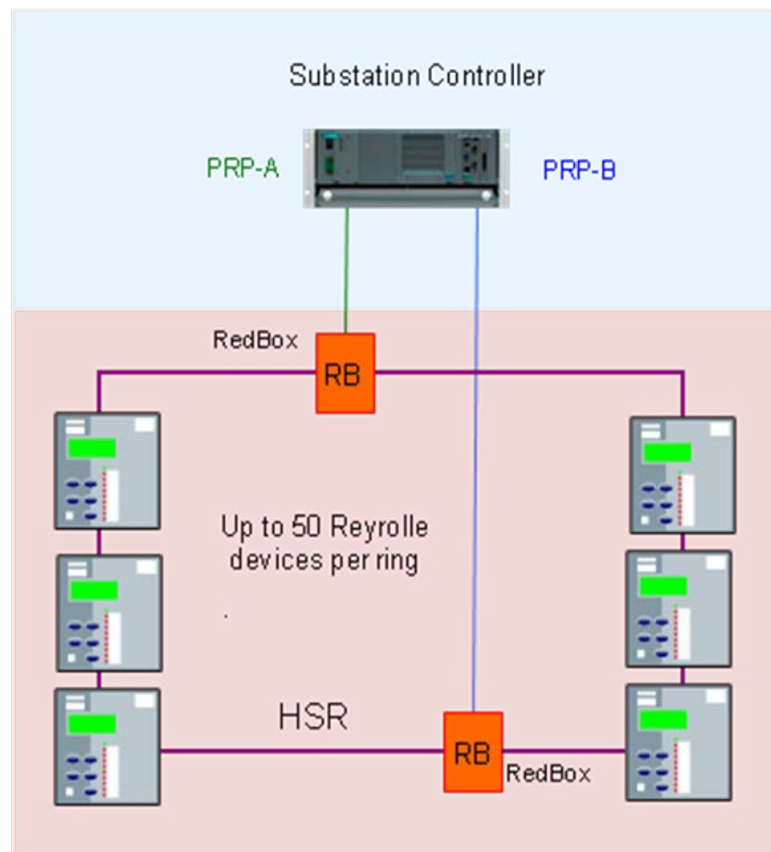


Figure 6.7-3 HSR Ethernet Network Ring Configuration

Section 7: Connection Diagrams

7.1 Typical AC Connections: 3 Pole Differential

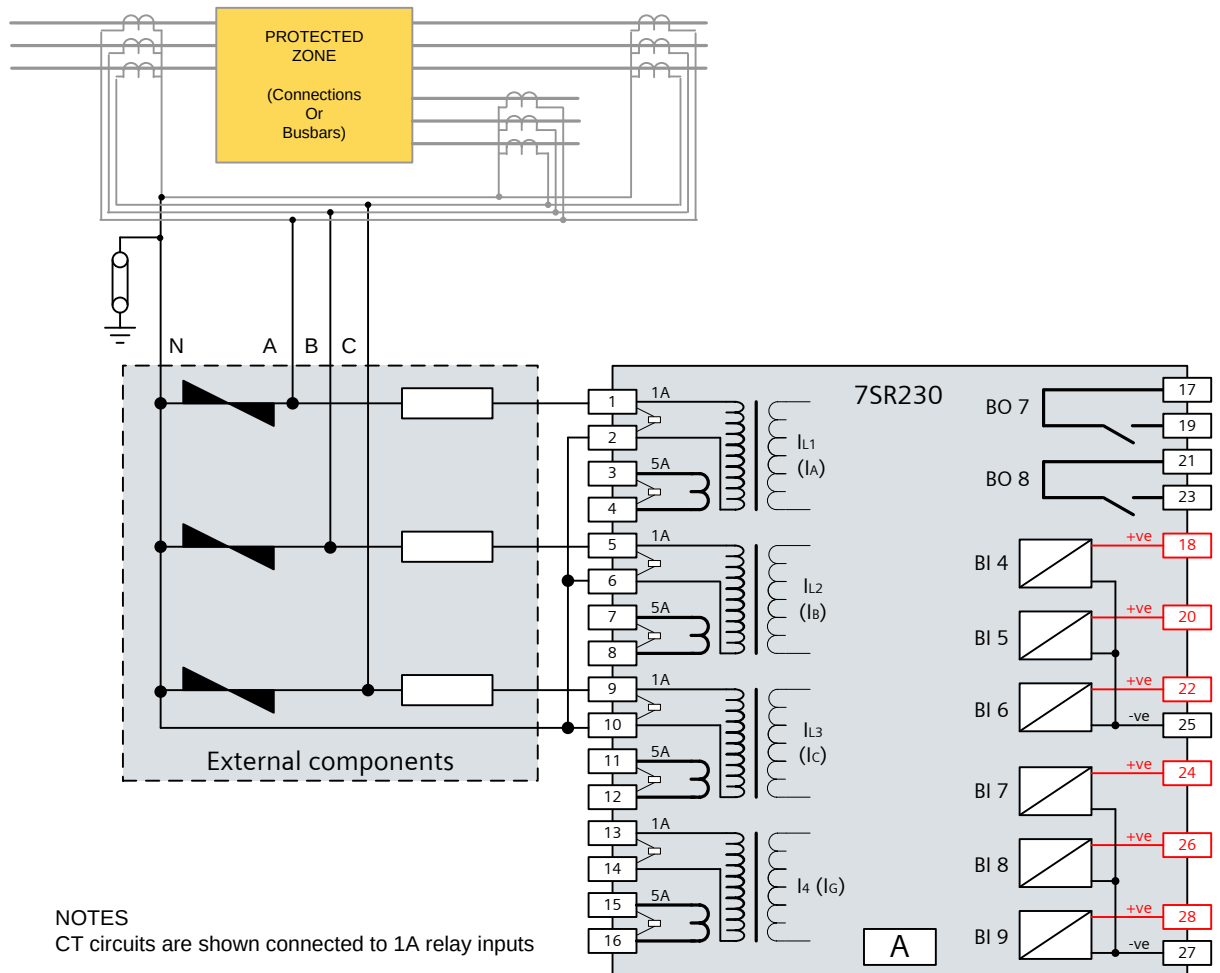


Figure 7.1-1 Connections 3 Pole Differential

7.2 Typical AC Connections: 3 Pole Differential + Earth Fault

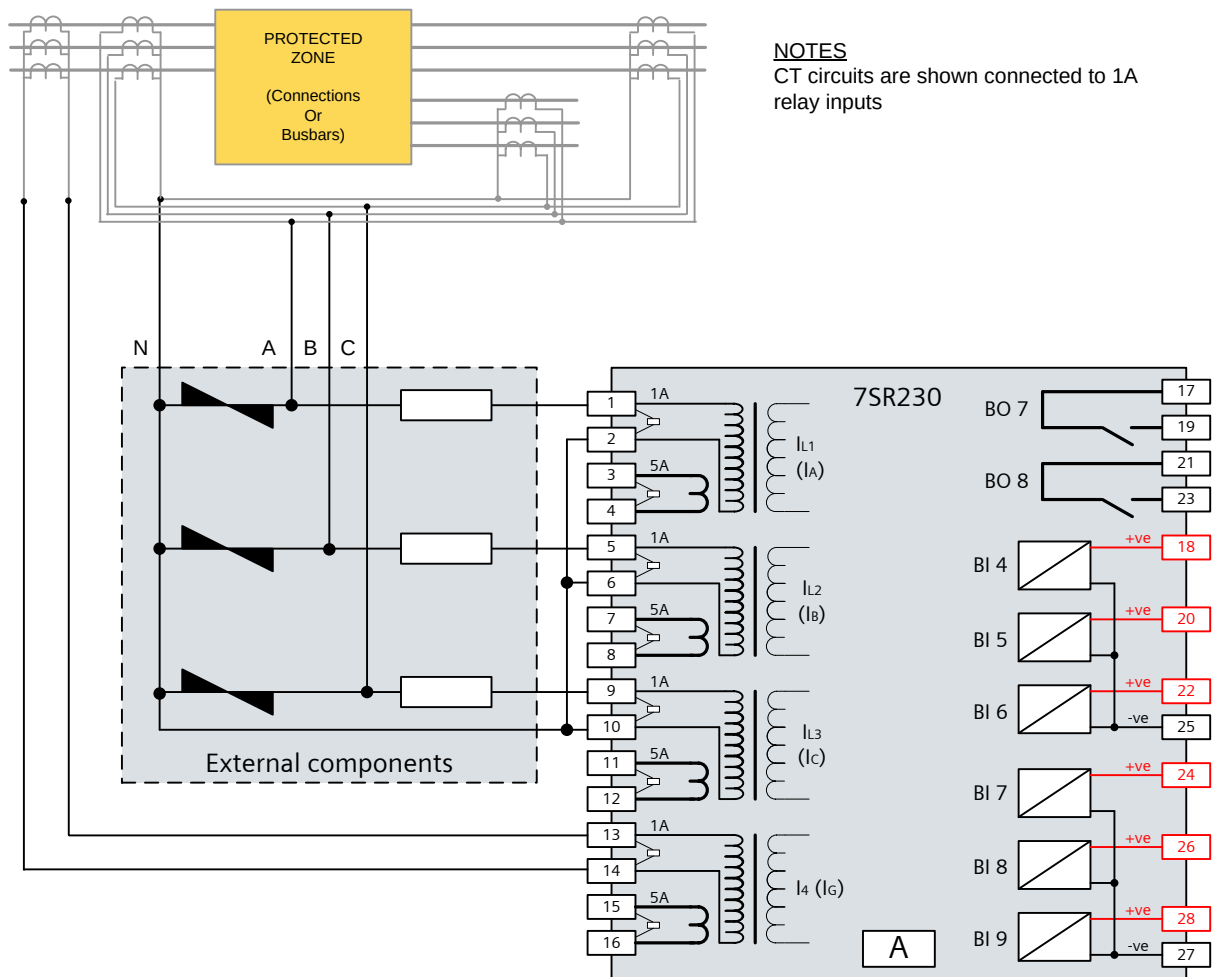


Figure 7.2-1 Connections 3 Pole Differential + Earth Fault

7.3 Typical AC Connections: 3 Pole Differential + REF

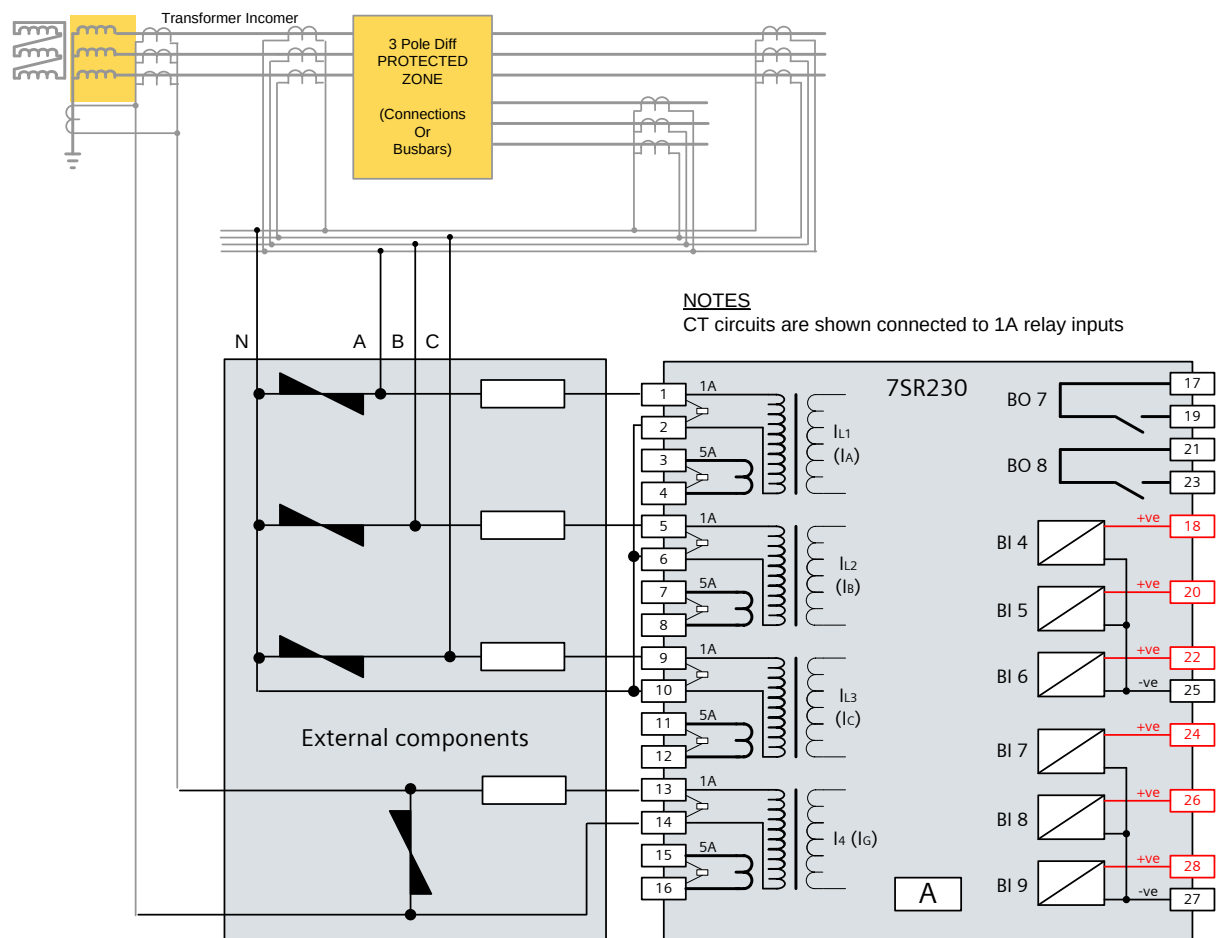


Figure 7.3-1 Connections 3 Pole Differential + Restricted Earth Fault

7.4 Typical AC Connections: REF1 + REF2

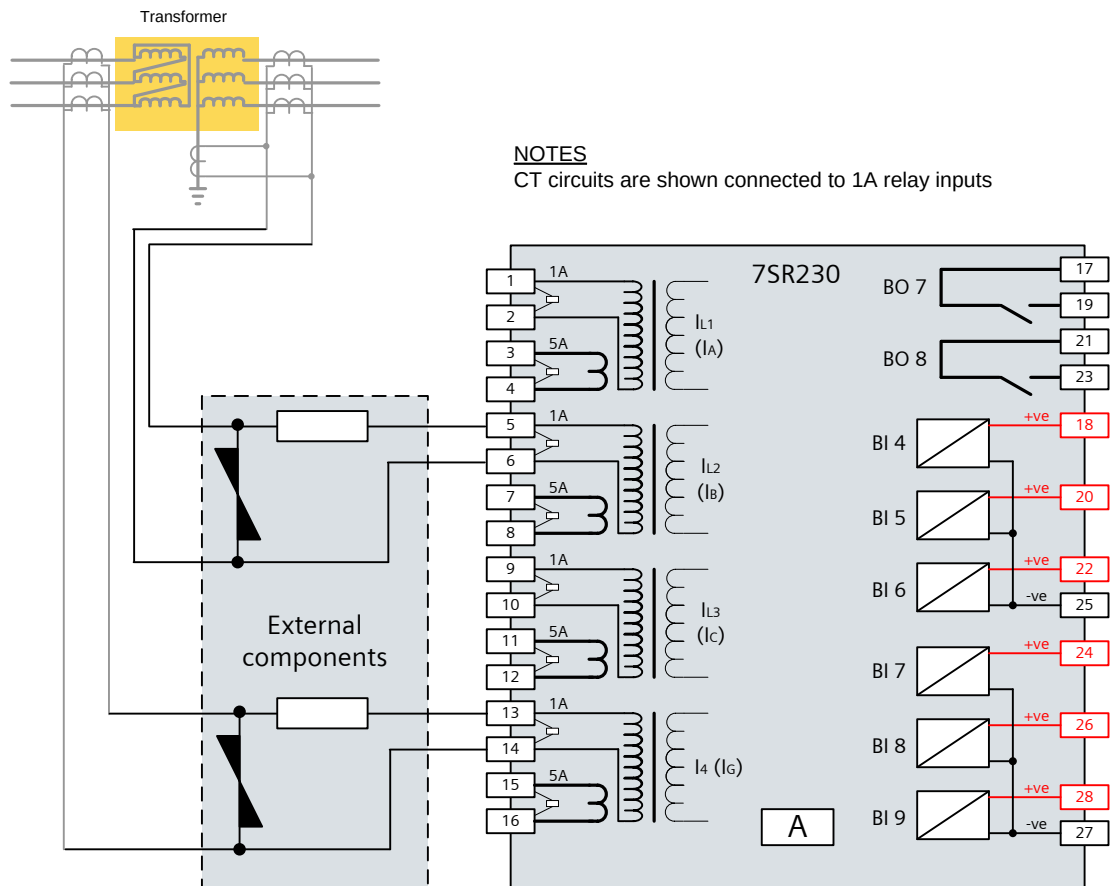


Figure 7.4-1 Connections Restricted Earth Fault 1 and 2

7SR23 DAD

High Impedance Protection Relay

Commissioning and Maintenance

Document Release History

This document is issue **2015/11**. The list of revisions up to and including this issue is:

2013/01	Second issue
2012/07	First issue

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Section 1: Common Functions

1.1 Overview

Commissioning tests are carried out to prove:

- a) Equipment has not been damaged in transit.
- b) Equipment has been correctly connected and installed.
- c) Prove characteristics of the protection and settings which are based on calculations.
- d) Confirm that settings have been correctly applied.
- e) To obtain a set of test results for future reference.

1.2 Before Testing

1.2.1 Safety

The commissioning and maintenance of this equipment should only be carried out by skilled personnel trained in protective relay maintenance and capable of observing all the safety precautions and regulations appropriate to this type of equipment and also the associated primary plant.

Ensure that all test equipment and leads have been correctly maintained and are in good condition. It is recommended that all power supplies to test equipment be connected via a Residual Current Device (RCD), which should be located as close to the supply source as possible.

The choice of test instrument and test leads must be appropriate to the application. Fused instrument leads should be used when measurements of power sources are involved, since the selection of an inappropriate range on a multi-range instrument could lead to a dangerous flashover. Fused test leads should not be used where the measurement of a current transformer (C.T.) secondary current is involved, the failure or blowing of an instrument fuse or the operation of an instrument cut-out could cause the secondary winding of the C.T. to become an open circuit.

Open circuit secondary windings on energised current transformers are a hazard that can produce high voltages dangerous to personnel and damaging to equipment, test procedures must be devised so as to eliminate this risk.

1.2.2 Sequence of Tests

If other equipment is to be tested at the same time, then such testing must be co-ordinated to avoid danger to personnel and/or equipment.

When all cabling and wiring is completed, a comprehensive check of all terminations for tightness and compliance with the approved diagrams must be carried out. This can then be followed by the insulation resistance tests which, if satisfactory allows the wiring to be energised by either the appropriate station supply or test supply.

When primary injection tests are completed satisfactorily, all remaining systems can be functionally tested before the primary circuit is energised. Some circuits may require further tests before being put on load.

Protection relay testing will require access to the protection system wiring diagrams, relay configuration information and protection settings. The following sequence of tests is loosely based on the arrangement of the relay menu structure. A test log based on the actual tests completed should be recorded for each relay tested. A typical example of this Site Test Sheet is included.

The 'Description of Operation' section of this manual provides detailed information regarding the operation of each function of the relay.

1.2.3 Test Equipment

Required test equipment is:

Secondary injection equipment with integral time interval meter

Primary injection equipment

A d.c. supply with nominal voltage within the working range of the relay's d.c. auxiliary supply rating

A d.c. supply with nominal voltage within the working range of the relay's d.c. binary input rating

Other equipment as appropriate to the protection being commissioned – this will be specified in the product specific documentation.

The secondary injection equipment should be appropriate to the protection functions to be tested. Additional equipment for general tests and for testing the communications channel is:

- Portable PC with appropriate interface equipment.
- Printer to operate from the above PC (Optional).

Use of PC to facilitate testing

The functions of ReyDisp Evolution (see Chapter 2: Settings and Instruments) can be used during the commissioning tests to assist with test procedures or to provide documentation recording the test and test parameters. One method is to clear both the waveform and event records before each test is started, then, after the test upload from the relay the settings, events and waveform files generated as a result of application of the test. These can then be saved off to retain a comprehensive record of that test.

Relay settings files can be prepared on the PC (offline) or on the relay before testing commences. These settings should be saved for reference and compared with the settings at the end of testing to check that errors have not been introduced during testing and that any temporary changes to settings to suit the test process are returned to the required service state.

A copy of the Relay Settings as a Rich Text Format (.rtf) file suitable for printing or for record purposes can be produced from ReyDisp as follows. From the *File* menu select *Save As*, change the file type to *Export Default/Actual Setting (.RTF)* and input a suitable filename.

When testing is completed the event and waveform records should be cleared and the settings file checked to ensure that the required in-service settings are being applied.

1.2.4 Precautions

Before electrical testing commences the equipment should be isolated from the current transformers. The current transformers should be short-circuited in line with the local site procedure. The tripping and alarm circuits should also be isolated where practical. The provision and use of secondary injection test sockets on the panel simplifies the isolation and test procedure.

Ensure that the correct auxiliary supply voltage and polarity is applied. See the relevant scheme diagrams for the relay connections.

Check that the nominal secondary current rating of the current transformers has been correctly set in the System Config menu of the relay.

1.2.5 Applying Settings

The relay settings for the particular application should be applied before any secondary testing occurs. If they are not available then the relay has default settings that can be used for pre-commissioning tests. See the Relay Settings section of this manual for the default settings.

Note that the tripping and alarm contacts for any function must be programmed correctly before any scheme tests are carried out.

The relay features multiple settings groups, only one of which is active at a time. In applications where more than one settings group is to be used it may be necessary to test the relay in more than one configuration.

Note. One group may be used as a 'Test' group to hold test-only settings that can be used for regular maintenance testing, eliminating the need for the Test Engineer to interfere with the actual in-service settings in the normally active group. This Test group may also be used for functional testing where it is necessary to disable or change settings to facilitate testing.

When using settings groups it is important to remember that the relay need not necessarily be operating according to the settings that are currently being displayed. There is an 'active settings group' on which the relay operates and an 'edit/view settings group' which is visible on the display and which can be altered. This allows the settings in one group to be altered from the relay fascia while the protection continues to operate on a different unaffected group. The 'Active Settings Group' and the 'Edit Settings Group' are selected in the 'System Configuration Menu'.

The currently Active Group and the group currently Viewed are shown at the top of the display in the Settings display screen. If the View Group is not shown at the top of the display, this indicates that the setting is common to all groups. CT/VT ratio, I/O mapping and other settings which are directly related to hardware are common to all groups.

If the relay is allowed to trip during testing then the instruments display will be interrupted and replaced by the 'Trip Alert' screen which displays fault data information. If this normal operation interferes with testing then this function can be temporarily disabled for the duration of testing by use of the Trip Alert Enabled/Disabled setting in the System Config Menu.

After applying a settings change to the relay, which may involve a change to the indication and output contacts, the **TEST/RESET** key should be pressed to ensure any existing indication and output is correctly cleared.

1.3 Tests

1.3.1 Inspection

Ensure that all connections are tight and correct to the relay wiring diagram and the scheme diagram. Record any deviations. Check that the relay is correctly programmed and that it is fully inserted into the case. Refer to 'Section 2: Settings and Instruments' for information on programming the relay.

1.3.2 Secondary Injection Tests

Select the required relay configuration and settings for the application.

Isolate the auxiliary D.C. supplies for alarm and tripping from the relay and remove the trip and intertrip links.

Carry out injection tests for each relay function, as described in this document

For all high current tests it must be ensured that the test equipment has the required rating and stability and that the relay is not stressed beyond its thermal limit.

1.3.3 Primary Injection Tests

Primary injection tests are essential to check the ratio and polarity of the current transformers as well as the secondary wiring. Primary injection testing of the 87/50 Differential protection is recommended to avoid relay operation during first energisation of the busbar if circuit connections have been incorrectly installed.

Differential current flowing in the relay circuit can be checked by examination of the relay Current Meters in the Instruments Menu when the protected plant is carrying load but Earth Fault CT polarity can only be checked during primary injection.

1.3.4 Putting into Service

After tests have been performed satisfactorily the relay should be put back into service as follows:-

Remove all test connections.

Replace all secondary circuit fuses and links, or close m.c.b.

Ensure the Protection Healthy LED is on, steady, and that all LED indications are correct. If necessary press **CANCEL** until the Relay Identifier screen is displayed, then press **TEST/RESET** to reset the indication LEDs.

The relay meters should be checked in Instruments Mode with the relay on load.

The relay settings should be downloaded to a computer and a printout of the settings produced. The installed settings should then be compared against the required settings supplied before testing began. Automated setting comparison can be carried out by ReyDisp using the *Compare Settings Groups* function in the *Edit* menu. Any modified settings will be clearly highlighted.

1.4 AC Energising Quantities

Current measurement for each input channel is displayed in the Instrumentation Mode sub-menus, each input should be checked for correct connection and measurement accuracy by single phase secondary injection at nominal levels. Ensure that the correct instrument displays the applied signal within limits of the Performance Specification.

	Applied Current (A)			
	I_A	I_B	I_C	I_G
Secondary				
Primary				

1.5 Binary Inputs

The operation of the binary input(s) can be monitored on the 'Binary Input Meters' display shown in 'Instruments Mode'. Apply the required supply voltage onto each binary input in turn and check for correct operation. Depending on the application, each binary input may be programmed to perform a specific function; each binary should be checked to prove that its mapping and functionality is as set as part of the Scheme Operation tests.

Where the pick-up timers associated with a binary input are set these delays should be checked either as part of the scheme logic or individually. To check a binary pick-up time delay, temporarily map the binary to an output relay that has a normally open contact. This can be achieved in the Output Matrix sub-menu by utilising the *BI n Operated* settings. Use an external timer to measure the interval between binary energisation and closure of the output contacts. Similarly, to measure the drop-off delay, map to an output relay that has a normally closed contact, time the interval between binary de-energisation and closure of the output contacts.

Note. The time measured will include an additional delay, typically less than 20ms, due to the response time of the binary input hardware, software processing time and the operate time of the output relay.

BI	Tested	DO Delay	Measured	PU Delay	Measured	Notes (method of initiation)
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						

1.6 Binary Outputs

A minimum of eight output relays are provided. Two of these have change over contacts, BO2 & BO3, one has a normally closed contact, BO1 and the remainder have normally open contacts.

Care should be observed with regard to connected devices when forcing contacts to operate for test purposes. Short duration energisation can cause contact failure due to exceeding the break capacity when connected to inductive load such as electrically reset trip relays.

Close each output relay in turn from the ReyDisp Evolution PC programme, Relay – Control - Close output relay. This function will energise the output for its minimum operate time. This time is specified in the Output Config - Binary Output Config menu for each output relay and may be too short to measure with a continuity tester.

An alternative method of energising an output permanently so that wiring can be checked is to temporarily map the relay being tested to the 'Protection Healthy' signal in the Output Matrix, as this signal is permanently energised the mapped relay will be held energised, normally open contacts will be closed and vice versa.

BO	Checked	Notes (method of test)
1NC		
2NO		
2NC		
3NO		
3NC		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		

1.7 Relay Case Shorting Contacts

CT inputs and terminals C25-C26 (Relay Withdrawn Alarm) are fitted with case mounted shorting contacts which provide a closed contact when the relay is withdrawn from the case. The operation of these contacts should be checked.

CT Shorting contacts checked	
Relay Withdrawn Alarm Checked	

Section 2: Protection Functions

This section details the procedures for testing each protection function of the 7SR23 relay. These tests are carried out to verify the accuracy of the protection pick-ups and time delays at setting and to confirm correct operation of any associated input and output functionality.

Guidance for calculating test input quantities is given in the relevant test description where required. In many cases it may be necessary to disable some functions during the testing of other functions, this prevents any ambiguity caused by the operation of multiple functions from one set of input quantities. The 'Function Config' Menu provides a convenient high level point at which all elements of a particular function can be Enabled/Disabled to suit testing. The 'Config' tab in 'ReyDisp Evolution' can be used to 'Enable/Disable' individual elements. Note that this screen disables functions by applying setting changes to the relay and that any changes must be sent to the relay to take effect and settings must be returned to their correct value after testing.

The table below indicates functions where function conflicts may occur during testing, consideration should be given to disabling functions to avoid interference.

Function Under Test	3-Phase Diff.	REF	Measured E/F	CT Supervision	74TCS
3-Phase Diff.				O	
REF			O		
Measured E/F		O			
CT Supervision	O				
74TCS					

The General Pickup LED can be used to assess operation of functions during testing if other functions are disabled or if the setting allocating General Pickup is temporarily modified.

Particular care should be taken when testing overcurrent functions that the thermal rating of the current inputs is not exceeded.

It should be considered that where several overlapping elements are used simultaneously, the overall protection operate time may be dependent on the operation of different individual elements at the various levels of applied current or voltage. The resulting composite characteristic may be tested by enabling all of the relevant applicable elements or the element operations can be separated or disabled and tested individually.

All relay settings should be checked before testing begins. It is recommended that the relay settings are extracted from the relay using ReyDisp Evolution software and a copy of these settings is stored for reference during and after testing. It may be necessary to disable some protection functions during the testing of other functions to allow unambiguous results to be obtained.

Care must be taken to reset or re-enable any settings that have been temporarily altered during the testing before the relay can be put into service. At the end of testing the relay settings should be compared to the file extracted at the start to ensure that errors have not been introduced.

An example 'Test Sheet' summary document is included at the end of this Guide.

2.1 Measured Earth fault (50G)

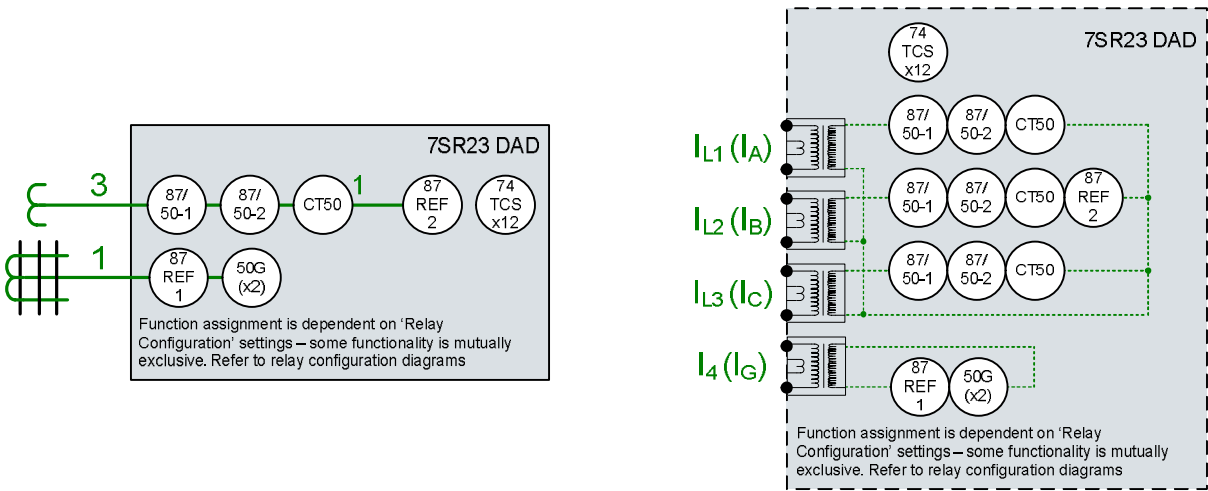


Figure 2-1 Measured Earth Fault

Current Inputs: I_G
Disable: 87REF
Map Pickup LED: 50G-n - Self Reset

Other protection functions may overlap with these functions during testing, it may be useful to disable the Restricted Earth Fault function to avoid ambiguity. This can be Enabled/Disabled in the 'Function Config' menu.

2.1.1 Definite Time Overcurrent (50G)

If DTL setting is small, gradually increase current until element operates.
If DTL is large apply 0.9x setting, check for no operation, apply 1.1x setting, check operation
Apply 2x setting current if possible and record operating time

Input	I_s (Amps)	DTL (sec)	P.U. Current Amps	Operate Time $2 \times I_s$	NOTES
I_{G1}					

Check correct indication, trip output, alarm contacts, waveform record.

2.1.1.1 Element Blocking

The Measured Earth Fault elements can be blocked by Binary Input Inhibit, VT Supervision and Inrush Detector operation. The Characteristic can be made non-directional by VT Supervision. This functionality should be checked.

Element	BI Inhibits	Inrush Detector
50G-1		
50G-2		

Check correct indication, trip output, alarm contacts, waveform record.

2.2 3 Phase Differential Protection (87/50)

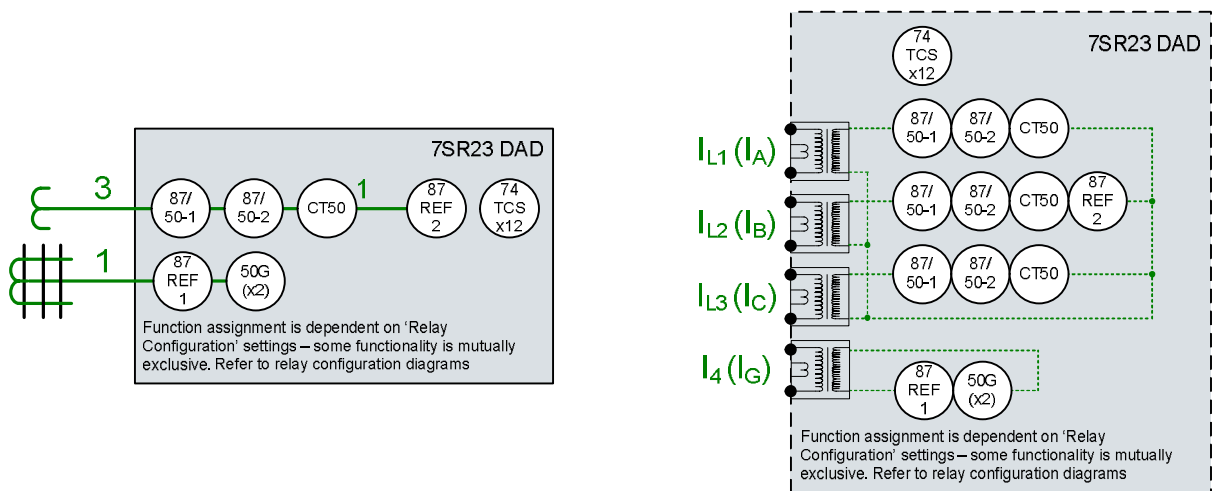


Figure 2-2 3 Phase Differential Protection

Current Inputs: I_A I_B I_C
 Disable: CT50
 Map Pickup LED: 87/50-n - Self Reset

The external stabilising resistor values should be measured and compared to that specified in the settings data. Both values should be recorded.

Element	Settings Data: R_{STAB} Value	R_{STAB} Measured
87/50-1		
87/50-2		

The relatively high value of stabilising resistance R_{STAB} will often interfere with secondary current injection when using a digital test set. It is normal practice in these cases to short circuit the resistor to allow testing, the shorting link should be removed after testing.

The pick-up setting can be tested by gradually increasing current until element operates. The relay should be disconnected from the current transformers for this test.

Apply 2x setting current if possible and record operating time

	I_s (Amps)	DTL (sec)	P.U. Current Amps	Operate Time $2 \times I_s$	NOTES
87/50-1					
87/50-2					

It is also desirable to check the operating voltage achieved with the setting resistor and all parallel CTs connected but de-energised. A higher capacity test set will be required for this test. Adequate current must be supplied to provide the magnetising current of all connected CTs.

Precautions should be taken to ensure that no personnel are at risk of contact with any of the energised secondary wiring during the test and that the high impedance external components are adequately thermally rated.

	Settings Data: Voltage Setting (V_s)	V_s Measured	Settings Data: Operate Current (I_{OP})	I_{OP} Measured
87/50-1				
87/50-2				

To complete testing of the differential protection it is required to primary inject current through CTs to simulate an out of zone fault and ensure stability of the relay.

The test can then be repeated with one set of CT secondary connections reversed to prove operation at the correct primary operate current.

2.2.1.1 Element Blocking

The differential elements can be blocked by Binary Input Inhibit or from the CT supervision (CT50) function. Where applied this functionality should be checked.

Element	BI Inhibits	Checked	CT Supervision (CT50)	Checked
87/50-1				
87/50-2				

Check correct indication, trip output, alarm contacts, waveform record.

Check that any shorting links are removed after testing.

2.3 Restricted Earth fault (87REF)

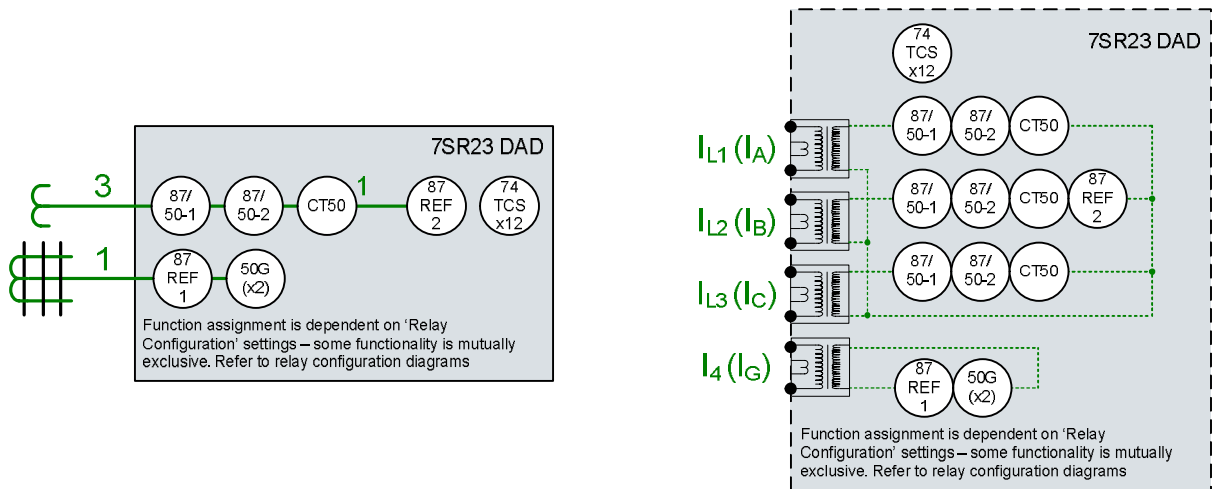


Figure 2-3 Restricted Earth Fault

Current Inputs: I_B I_G
 Disable: 50G
 Map Pickup LED: 87REF-n - Self Reset

The external stabilising resistor value should be measured and compared to that specified in the settings data. Both values should be recorded.

Element	Settings Data: R_{STAB} Value	R_{STAB} Measured
87REF-1		
87REF-2		

The relatively high value of stabilising resistance R_{STAB} will often interfere with secondary current injection when using a digital test set. It is normal practice in these cases to short circuit the resistor to allow testing, the shorting link should be removed after testing.

The pick-up setting can be tested by gradually increasing current until element operates. The relay should be disconnected from the current transformers for this test.

Apply 2x setting current if possible and record operating time

	I_s (Amps)	DTL (sec)	P.U. Current Amps	Operate Time 2 x I_s	NOTES
87REF-1					
87REF-2					

It is also desirable to check the operating voltage achieved with the setting resistor and all parallel CTs connected but de-energised. A higher capacity test set will be required for this test. Adequate current must be supplied to provide the magnetising current of all connected CTs. Precautions should be taken to ensure that no personnel are at risk of contact with any of the energised secondary wiring during the test.

	Settings Data: Voltage Setting (V_s)	V_s Measured	Settings Data: Operate Current (I_{OP})	I_{OP} Measured
87REF-1				
87REF-2				

To complete testing of the REF requires primary injection through the phase and residual (REF) CT in series to simulate an out of zone fault and ensure stability of the relay. The test can then be repeated with the REF CT secondary connections reversed to prove operation.

2.3.1.1 Element Blocking

The Restricted Earth Fault element can be blocked by Binary Input Inhibit. Where applied this functionality should be checked.

Element	BI Inhibits	Checked
87REF-1		
87REF-2		

Check correct indication, trip output, alarm contacts, waveform record.

Check that any shorting links are removed after testing.

Section 3: Supervision Functions

3.1 Trip Circuit Supervision (74TCS)

Voltage Inputs: n/a
Current Inputs: n/a
Disable:
Map Pickup LED: 74TCS-n/ - Self Reset

The T/CCS-n Delay can be initiated by applying an inversion to the relevant binary input and measured by monitoring of the alarm output.

TCS-n Delay setting	Measured

3.2 CT Supervision (CT50)

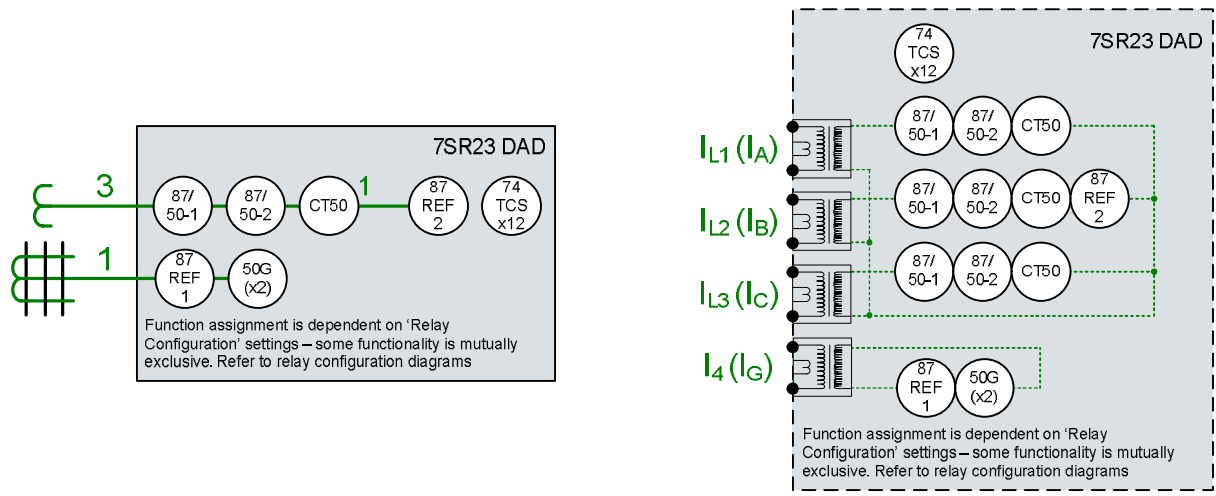


Figure 3-1 CT Supervision

- Current Inputs: I_A I_B I_C
- Disable: CT50
- Map Pickup LED: CT50 - Self Reset

The external stabilising resistor values should be measured and compared to that specified in the settings data. Both values should be recorded.

Element	Settings Data: R_{STAB} Value	R_{STAB} Measured
CT50		

The relatively high value of stabilising resistance R_{STAB} will often interfere with secondary current injection when using a digital test set. It is normal practice in these cases to short circuit the resistor to allow testing, the shorting link should be removed after testing.

As a DTL is generally applied the pick-up setting can be tested by gradually increasing current until element operates. The relay should be disconnected from the current transformers for this test.

Apply 2x setting current if possible and record operating time

	I_s (Amps)	DTL (sec)	P.U. Current Amps	Operate Time 2 x I_s	NOTES
CT50					

It is also desirable to check the operating voltage achieved with the setting resistor and all parallel CTs connected but de-energised. A higher capacity test set will be required for this test. Adequate current must be supplied to provide the magnetising current of all connected CTs.

Precautions should be taken to ensure that no personnel are at risk of contact with any of the energised secondary wiring during the test and that the high impedance external components are adequately thermally rated.

	Settings Data: Voltage Setting (V_s)	V_s Measured	Settings Data: Operate Current (I_{OP})	I_{OP} Measured
CT50				

To complete testing of the differential protection it is required to primary inject current through CTs to simulate an out of zone fault and ensure stability of the relay.

The test can then be repeated with one set of CT secondary connections reversed to prove operation at the correct primary operate current.

3.2.1.1 Element Blocking

The differential elements can be blocked by Binary Input Inhibit or from the CT supervision (CT50) function. Where applied this functionality should be checked.

Element	BI Inhibits	Checked	CT Supervision (CT50)	Checked
CT50				

Check correct indication, trip output, alarm contacts, waveform record.

Check that any shorting links are removed after testing.

Section 4: Control & Logic Functions

4.1 Quick Logic

If this functionality is used, the logic equations may interfere with testing of other protection functions in the relay. The function of the Quick Logic equations should be tested conjunctively with connected plant or by simulation to assess suitability and check for correct operation on an individual basis with tests specifically devised to suit the particular application.

Section 5: Testing and Maintenance

7SR24 relays are maintenance free, with no user serviceable parts.

5.1 Periodic Tests

During the life of the relay, it should be checked for operation during the normal maintenance period for the site on which the product is installed. It is recommended the following tests are carried out:-

1. Visual inspection of the metering display
2. Operation of output contacts
3. Secondary injection of each element

5.2 Maintenance

Relay failure will be indicated by the 'Protection Healthy' LED being off or flashing. A message may also be displayed on the LCD. In the event of failure Siemens Protection Devices Ltd. (or the nearest Siemens office) should be contacted.

The relay should be returned as a complete unit. No attempt should be made to dismantle the unit to isolate and return only the damaged sub-assembly. It may however be convenient to fit the withdrawable relay to the outer case from a spare relay, to avoid the disturbance of relay panel wiring, for return to Siemens Protection Devices Ltd. The withdrawable relay should never be transported without the protection of the outer case.

5.3 Troubleshooting

Table 5-1 Troubleshooting Guide

Observation	Action
Relay does not power up.	Check that the correct auxiliary DC voltage is applied and that the polarity is correct.
Relay won't accept the password.	The Password being entered is wrong. Enter correct password. If correct password has been forgotten, note down the Numeric Code which is displayed at the Change Password screen e.g. Change password = 1234567 To retrieve the password, communicate this code to a Siemens Protection Devices Ltd. representative.
Protection Healthy LED flashes	General failure. Contact a Siemens Protection Devices Ltd. representative.
LCD screen flashes continuously.	The LCD has many possible error messages which when displayed will flash continuously. These indicate various processor card faults. General failure. Contact a Siemens Protection Devices Ltd. representative.
Backlight is on but no text can be seen.	Adjust the contrast.
Scrolling text messages are unreadable.	Adjust the contrast.
Relay displays one instrument after another with no user intervention.	This is normal operation, default instruments are enabled. Remove all instruments from the default list and only add those that are required. (See Section 2: Settings and Instruments).
Cannot communicate with the relay.	Check that all of the communications settings match those used by ReyDisp Evolution. Check that the Tx and Rx fibre-optic cables are connected correctly. (Tx → Rx and Rx → Tx). Check that all cables, modems and fibre-optic cables work correctly. Ensure that IEC 60870-5-103 is specified for the connected port (COM1, COM2, COM3 or COM4).
Relays will not communicate in a ring network.	Check that the Data Echo setting on all relays is set to ON. Check that all relays are powered up. Check that all relays have unique addresses.
Status inputs do not work.	Check that the correct DC voltage is applied and that the polarity is correct. Check that the status input settings such as the pick-up and drop-off timers and the status inversion function are correctly set.
Relay instrument displays show small currents or voltages even though the system is dead.	This is normal. The relay is displaying calculation noise. This will not affect any accuracy claims for the relay.

If the above checklist does not help in correcting the problem please contact the local Siemens office or contact PTD 24hr Customer Support,

Tel: +49 180 5247000,

Fax: +49 180 524 2471,

e-mail: support.energy@siemens.com.

Section 6: Relay Software Upgrade Instructions

6.1 General

Please read thoroughly all of the instructions supplied with the firmware upgrade before starting the download process.

- If you are loading firmware into a product that is already installed on site then follow the instructions in section 2, 3 and 4.
- Otherwise skip directly to section 3 to load firmware into the device.

6.2 Replacing firmware on a product installed on site

6.2.1 Identify Which Software Is Currently Loaded

With the relay connected to a suitable DC supply. Press CANCEL several times to ensure that you are at the root of the menu system. The relay will typically display the relay model name or circuit name.

On newer relay models press CANCEL and TEST to bring up the

SOFTWARE VERSION

menu. While still pressing TEST release the other keys. On older relay models press and hold CANCEL, press and hold TEST, press and hold ENTER then

"Build Version --> to view"

should appear. While still pressing ENTER release the other keys. Navigate to the software information screen using the TEST/RESET-> button.

The following typical information uniquely identifies a particular relay model. (Older relay models may only display a subset of this information).

6.2.2 Overall Software Information

Software Art No	This is the application software code used which may common to many relay variants.
Build Date	This is the date when the software was compiled.
Build Time	This is time when the software was compiled.
Code CRC	This is the CRC check code of the software code.
Boot Block Art No	This is the boot block software code responsible for loading in new application software code.

6.2.3 Product Configuration Information

Product Art No	This is the Products unique configuration article number.
Product Name	This is the Products unique model name.
Release Date	This is the date when this particular configuration was released.
Release Time	This is the time when this particular configuration was released.

6.2.4 Things To Do Before Loading New Firmware/Software

Ensure that a secure copy of relay settings is available as all settings will be lost during the code upload process. A hard copy is useful for checking purposes. It is usually possible to download the existing settings into Reydisp Evolution, save the file and then reload these settings into the relay following the upgrade. Reydisp will highlight any changes that it cannot automatically resolve for you to manually correct when re-installing the settings..

If the relay is in service then it is advisable to remove any TRIP LINKS to prevent in-advertent mal-operation due to incorrect settings being applied.

The attachments are password protected self extracting zip files to prevent email systems discarding them or modifying them which should be saved with the "EX" extension renamed to be "EXE". The password that is applied to this zip file is "REYROLLE" in capital letters.

6.2.5 Loading Firmware using front USB port

New firmware/software may be loaded via the USB port on the front Fascia.

Check compatibility of software before starting the procedure. The relay will not accept firmware/software for which the MLFB ordering code is not supported.

Installation instructions are provided with the upgrade firmware and should be studied before the procedure is attempted..

A USB connection between a PC and the relay front port is required.

The process may take several minutes to complete at which time the relay will restart.

Please make note of any warning or error messages that appear on the Reyfresh terminal window as the relay restarts.

6.2.6 Solving Software Upload Problems

The relay will auto detect the download baud rate and will use whatever baud rate set within Reyfresh. However the default and maximum baud rate of 460800 bits/sec is preferred

The download procedure requires a PC running Windows XP (Service Pack 3), Windows Vista or Windows 7.

When the relay restarts, messages appear on the LCD to confirm the number of I/O modules fitted, please press the ENTER key when requested if the details displayed are correct.

7SR23 DAD

High Impedance Protection Relay

Applications Guide

Document Release History

This document is issue **2015/11**. The list of revisions up to and including this issue is:

2015/11	Revision to Fig. 1-1 and references to IEC61869-2 added.
2014/07	Section 2.2 – Example calculations revised
2013/01	Second issue – Further detail and clarifications added
2012/07	First issue

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Nomenclature

I_F =	Fault current corresponding to the rated stability limit (primary Amps)
I_{Fint} =	Maximum prospective internal fault current (primary Amps)
I_{MAG} =	Secondary magnetising (exciting) current of current transformer at V_s volts.
I_{NLR} =	Non-linear resistor (Metrosil) current.
I_s =	Relay setting current
P.O.C. =	Primary operate current (fault setting)
R_{CT} =	Resistance of CT secondary winding.
R_L =	Resistance of CT connection leads
R_{stab} =	Resistance of stabilising resistor
T =	Turns ratio of all current transformers (Primary turns / Secondary turns)
V_{Fint} =	Maximum secondary internal fault voltage
V_k =	Kneepoint voltage of the CT
V_s =	Relay circuit setting voltage

Section 1: Introduction

The 7SR23 relay can be used to provide both 3 phase high impedance differential protection and single phase Restricted Earth Fault (REF) protection.

Three phase differential protection can be applied to reactors, motors, auto-transformers and busbars.

Single phase REF protection can be applied to the circuits listed above and is also commonly applied to protect transformer windings.

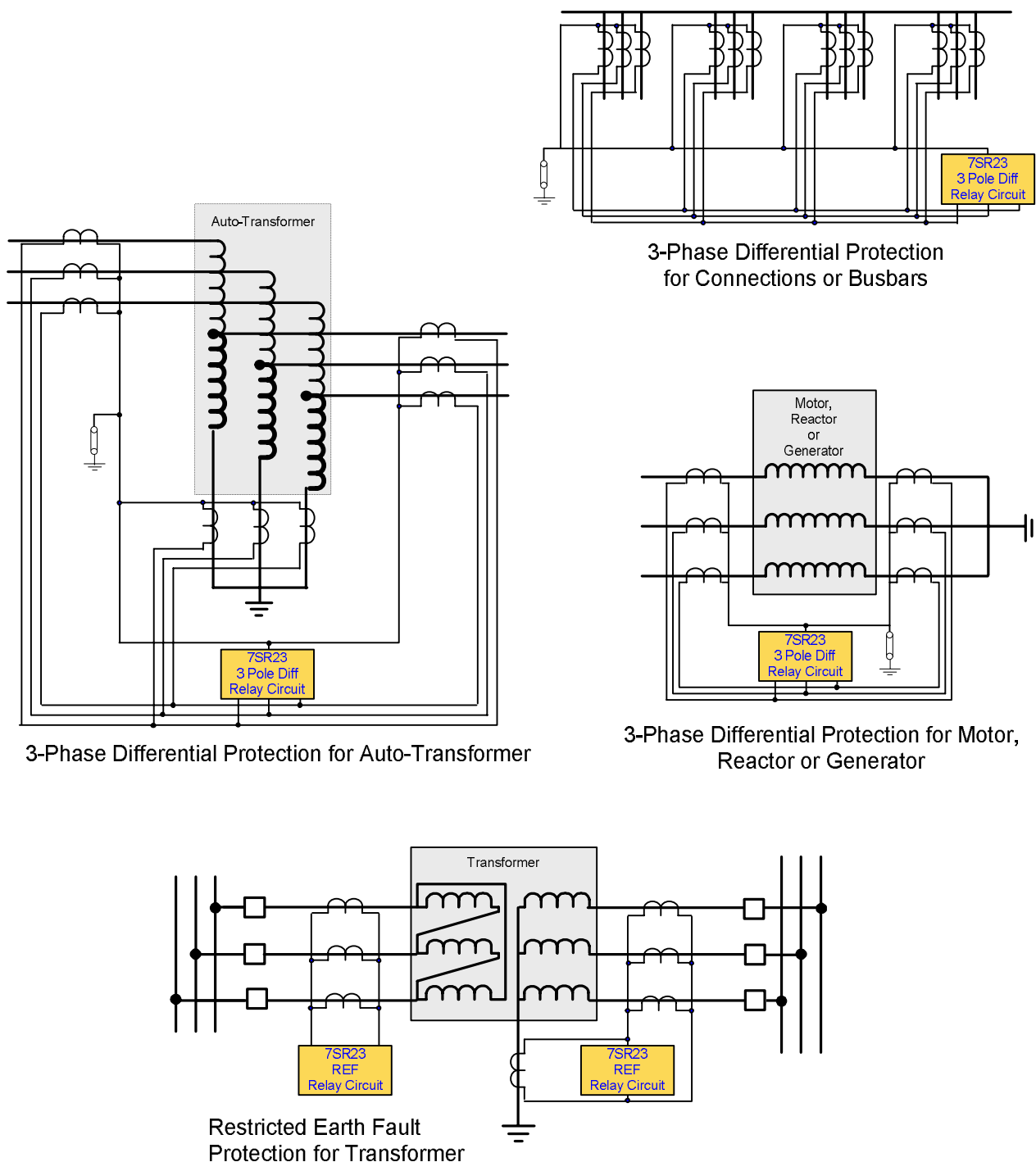


Fig. 1-1 Applications of High Impedance Protection

Section 2: Protection Functions

This section provides guidance on the application and recommended settings of the 7SR23 protection functions.

2.1 High Impedance Differential Protection (87/50)

A High Impedance current differential scheme provides protection stability (does not operate) during through faults with or without coincident saturated CT conditions. The scheme allows the user to select a suitable operate current to detect all internal fault conditions.

2.1.1 Basic Principles of Operation

The CT locations define the limits of the protected zone. CT secondary windings are connected in parallel with the relay so that all currents are summated and only unbalance current flows through the protection relay.

Typically one protection relay is provided per protected zone, on important circuits relays may be duplicated i.e. two relays are wired in parallel.

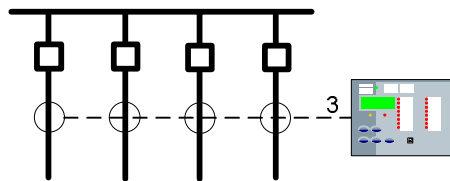


Figure 2-1 Balanced Circulating Current Protection System

The relay measures the difference in current 'entering' the protected zone with that 'leaving' the protected zone. Where no internal fault occurs and the CTs transform perfectly the differential current is zero. High impedance differential protection must:-

- 1) Guarantee stability for all load and through fault conditions. Note that due to transient CT errors (e.g. CT saturation) the CTs may not transform perfectly.
- 2) Guarantee operation for all internal fault conditions.

2.1.1.1 Stability Requirement

The use of class PX CTs (IEC61869-2) ensures steady state CT errors are minimised. Transient CT errors are caused by CT saturation e.g. due to high currents flowing at times of through faults. Where CT saturation conditions are different in each CT this will cause differential current to flow in the CT secondary circuit wiring. The highest level of differential current will flow when one set of CTs is fully saturated, providing zero output and all other CTs transform normally.

When fully saturated the CT secondary provides no current and it behaves as a resistance in the secondary circuit. Differential current in the secondary circuit will flow either through this 'resistance' or through the relay. A 'stabilising' resistance is added in series with the relay input to ensure that the operate voltage at the current setting is greater than the maximum voltage which can appear across the element/stabilising resistor during the maximum assigned through fault conditions. It is assumed that any earthing resistor can become short-circuit.

This maximum voltage that can appear across the relay circuit can be determined by a simple calculation which makes the following assumptions:

- One current transformer is fully saturated making its excitation current negligible.
- The remaining current transformers maintain their ratio.

The resistance of the secondary winding of the saturated CT together with the leads connecting it to the relay circuit terminals constitute the only burden in parallel with the relay.

The minimum required relay operate voltage setting (V_s) is given by:

$$V_s \geq I_F(R_{CT} + R_L) \times T \quad (1)$$

To ensure high speed relay operation the relay circuit operating voltage should be selected in accordance with the stability requirement above (equation 1), also, the operate voltage should not exceed 0.5 x CT knee point voltage (V_k).

$$V_s \leq \frac{V_k}{2} \quad (2)$$

2.1.1.2 Operation Requirement

For internal faults the relay will operate at the calculated 'Voltage Setting' V_s . This operating voltage will also be applied across the CT secondary windings of all the CT secondaries connected in parallel with the relay. This voltage will drive a magnetising current in each of the CT secondary windings and this must be added to the relay operate current when calculating the operate current of the high impedance protection scheme.

$$\text{In general: P.O.C.} = (I_s + I_{NLR} + \sum I_{MAG})/T \quad (3)$$

2.1.1.3 Consideration of Component Thermal Ratings

When the relay circuit operates for an internal fault the circuit breakers are opened and the flow of fault current ceases.

Where a CB fails to trip then fault current will flow in the high impedance circuit until the fault is cleared by the operation of CB failure or back up protection. The thermal rating of the relay circuit components should then be considered.

Alternatively the high impedance circuit can be arranged to short circuit the external components after operation.

2.1.2 Establishing the Required Stabilising Resistor Value

The relay burden need not be considered as it is effectively negligible relative to the burden of the stabilising resistor. The setting (operate) voltage (V_s) across the Relay and Stabilising Resistor at the Relay operating current (I_s):

$$R_{STAB} = \frac{V_s}{I_s} \quad (4)$$

Stabilising Resistor power rating must:

Be sufficient for continuous operation at the circuit operate voltage (V_s):

$$P_{CONT} \geq (I_s)^2 \times R_{stab}$$

Short time rated to withstand I_{Fint} for the maximum fault clearance time. For a failed circuit breaker condition the back up protection clearance time is considered – typically a one second rating is sufficient.

$$P_{1SEC} \geq \frac{V_{Fint}^2}{R_{stab}} \quad \text{Where: } V_{Fint} \geq \sqrt[4]{(V_K^3 \times R_{stab} \times I_{Fint})} \times 1.3$$

Where I_{Fint} is not known, the breaking capacity current of the Circuit Breaker can be used.

2.1.3 Limiting Circuit Over-Voltages (Metrosils)

Non-linear resistors are connected in parallel with the relay circuit to limit the peak voltage developed across the high impedance components during internal faults to a 'safe' level below 3kV peak. Where a Metrosil is not connected in circuit the peak voltage can be calculated from:

$$V_{PK} = 2 \times \sqrt{2 \times V_K \times ((I_{Fint} \times R_{stab}) - V_K)}$$

Notwithstanding the above calculation SPDL recommend that a Metrosil is always fitted in the high impedance relay circuit

The use of non-linear resistors manufactured by Metrosil is recommended. The operate characteristic is defined by:-

Voltage characteristic: $V = C.I^\beta$ For dc or instantaneous values.

$$I_{rms} = 0.52 \left(\frac{V_{rms} \sqrt{2}}{C} \right)^{\frac{1}{\beta}} \quad \text{For applied sinusoidal voltages}$$

$$V_{peak} = 1.09C(I_{rms})^\beta \quad \text{For applied sinusoidal currents}$$

Where: C and β are Metrosil constants

When supplied as discrete components 7XG14 Metrosils can be specified as single or three phase, with a diameter of 75mm or 150mm and have constant 'C' values of 450, 900 or 1000.

Metrosils of diameter 75mm have a thermal rating of up to 8kJ. Where a higher thermal rating is required Metrosils of 150mm diameter should be used.

The optional component box includes both three phase resistors and three phase Metrosils. Metrosils in the component box have a 'C' value of 1000.

The chosen Metrosil 'C' value must;

- 1) Ensure negligible current flows through the Metrosil at relay operate voltage (V_s), and,
- 2) Limit over-voltages for operational and safety reasons i.e. $1.09C (I_{Fint}^{\beta}) < 3kV$

A 'C' value of 450 is generally acceptable where the relay operate voltage is less than 100V, a 'C' value of 1000 is recommended for settings above 100V.

Metrosil short time power rating must;

Be sufficient to dissipate the heat created by the flow of maximum secondary internal fault current. The Metrosil is chosen so that it can withstand I_{Fint} for the maximum fault clearance time. For a failed circuit breaker condition the back up protection clearance time must be considered – typically a one second rating is sufficient.

$$P_{1SEC} \geq \frac{4}{\pi} \times I_F \times T \times V_K$$

2.1.4 3 Pole High Impedance Differential Protection

Three pole differential protection (87/50) can be applied to various primary plant connection arrangements, Figure 2-2 shows differential protection applied to a busbar.

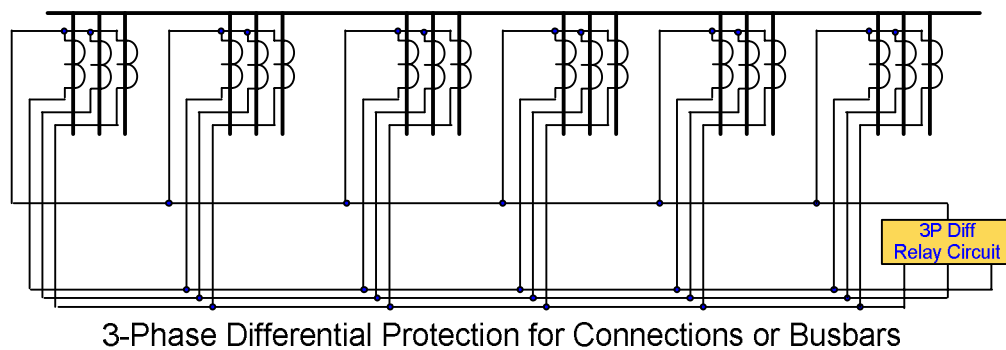


Figure 2-2 AC Connections - 3 Phase Differential Protection

The zone of protection is defined by the position of the CTs. The protection provides a low operate current (fault setting) for in zone earth faults and stability during external faults.

To achieve stability of the high impedance elements and limit overvoltages external series stabilising resistors and Metrosils are wired into the scheme.

The operating voltage of the relay/stabilising resistor combination is calculated taking into account the r.m.s. value of the symmetrical component of the maximum external (through fault) current.

The relay current setting is calculated taking into account: the required operate level for in-zone phase and earth faults (fault setting).

2.1.5 Restricted Earth Fault Protection (87REF)

Restricted earth fault (87REF) protection can be applied to various primary plant connection arrangements, Figure 2-3 shows REF protection applied to both HV and LV windings of a transformer. The 7SR23 provides up to two high impedance REF elements.

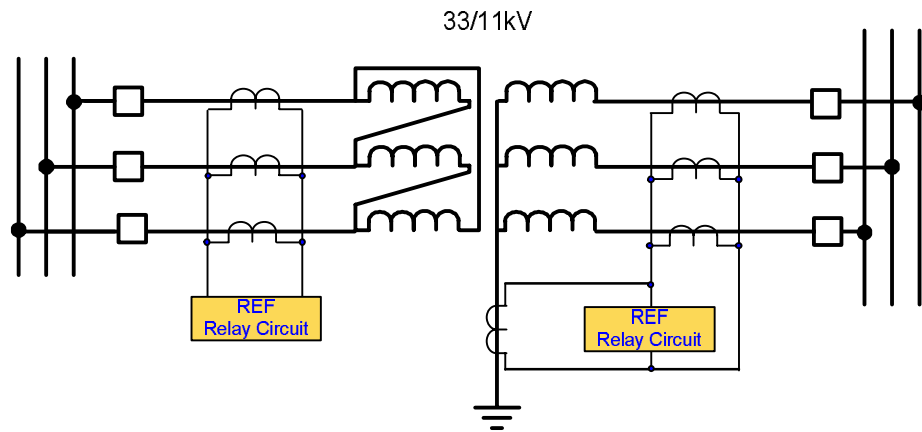


Figure 2-3 AC Connections – Balanced/Restricted Earth Fault Protection

The zone of REF protection is defined by the position of the CTs and the transformer winding. REF protection provides a low operate current (fault setting) for in zone earth faults and stability during external faults.

To achieve stability of the high impedance REF elements and limit overvoltages a series stabilising resistor and a non-linear resistor are wired into the scheme.

The operating voltage of the relay/stabilising resistor combination is calculated taking into account the r.m.s. value of the symmetrical component of the transformer through fault current.

The relay current setting is calculated taking into account: the required operate level for in-zone earth faults (fault setting).

2.2 Setting Calculations

Relay settings and values of circuit components can be calculated in the following order:

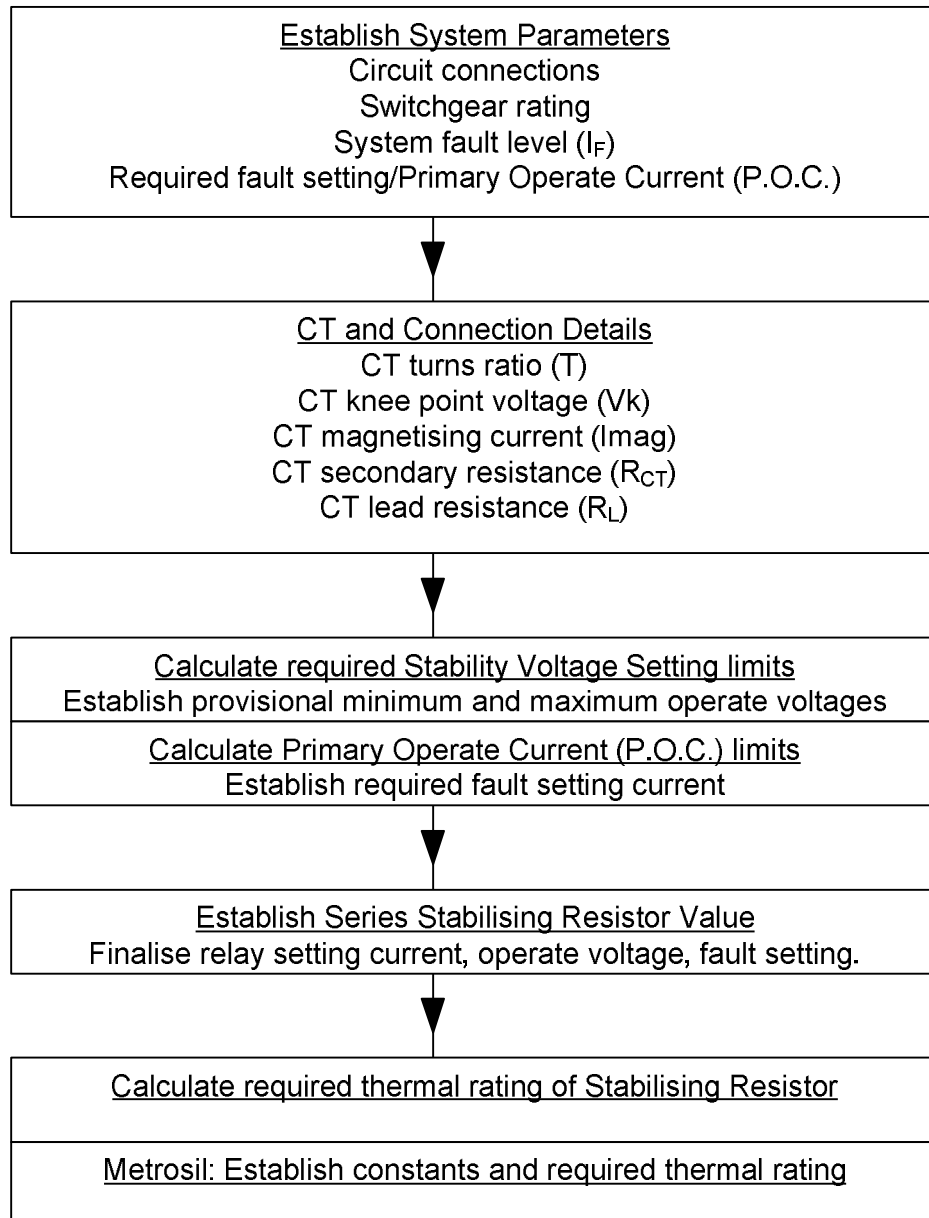


Figure 2-4 Procedure for calculating High Impedance Differential Protection Settings

2.2.1 Example 1 – 3-Pole Differential Busbar Protection

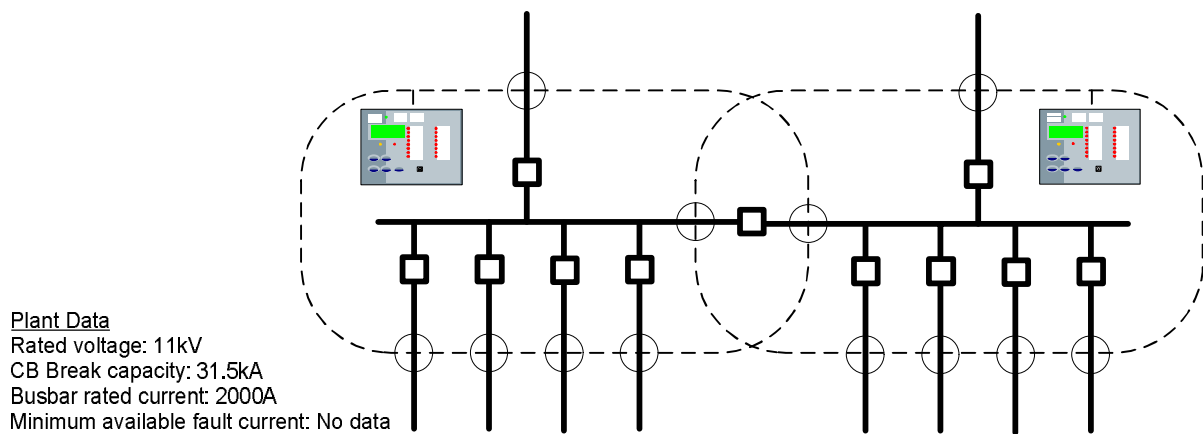


Figure 2-5 Example System – Single Busbar

Plant Data

See diagram above.

Settings Requirements

Assigned through fault current (rated stability limit) = 31.5kA (CB break capacity)

Required Fault Setting (Primary Operate Current):

- Approximately 50% of busbar rating, or
- 10 – 30% of minimum fault current available, or
- As specified by the user

From the supplied plant data a primary operate current (POC) of 1000A is chosen i.e. 50% of busbar rating.

CT and Connection Details

Turns ratio (T)	1/2000
Voltage Knee Point (V_K)	600V
Magnetising Current (I_{mag}) @ V_K	100mA
CT secondary resistance (R_{CT})	10 Ohms
CT lead loop resistance (R_L)	0.15 Ohms max.

Calculation of Required Stability Voltage Limits

The assigned through fault current is 31.5kA.

$$V_s \geq \frac{31500}{2000} \times (10 + 0.15) = 160V$$

$$V_s \leq \frac{V_K}{2} = \frac{600}{2} = 300V$$

Calculation of Stabilising Resistor Value

The required relay setting (87/50-1) I_s can be calculated from:

$$POC = (I_{MAG\ TOTAL} + I_s) / T = (6(I_{MAG}) + I_s) / T$$

$$I_s = POC \times T - I_{MAG\ TOTAL} = 1000/2000 - I_{MAG\ TOTAL}$$

$$I_s = 0.5 - 6(I_{MAG})$$

The magnetising current is dependent on the relay operate voltage (V_s), this is not finalised yet so a provisional value ($V_s\ prov$) is chosen from the above i.e. $160 < V_s < 300$

Say $V_s\ prov = 175V$. From the CT magnetising curve $I_{mag} = 21mA$ at $175V$.

$$I_{relay} = 0.5 - 6(0.021) = 0.374A \text{ (use } 0.37A)$$

$$R_{stab} = 175/0.37 = 470 \text{ Ohms}$$

Metrosil Specification

'C' Value

$V_s = 175V$ (i.e. $> 100V$) so a 'C' value of 1000 is chosen

Short Time Power Rating

Using the empirical formula

$$P_{1SEC} \geq \frac{4}{\pi} \times I_F \times T \times V_K$$

$$P_{1SEC} \geq \frac{4}{\pi} \times 31500 \times \frac{1}{2000} \times 600 = 12kW$$

For values $> 8kW/s$ a 150mm Metrosil is required

Stabilising Resistor Specification

Continuous Power Rating

$$P_{CONT} \geq I_s^2 \times R_{stab}$$

$$P_{CONT} \geq 0.37^2 \times 470$$

$$P_{CONT} \geq 64W$$

Short Time Power Rating

$$P_{1SEC} \geq \frac{V_{Fint}^2}{R_{stab}} \quad \text{Where: } V_{Fint} \geq \sqrt[4]{(V_K^3 \times R_{stab} \times I_{Fint})} \times 1.3$$

$$I_{Fint} = \frac{31500}{2000} = 15.75A$$

$$V_{Fint} \geq \sqrt[4]{(V_K^3 \times R_{stab} \times I_{Fint})} \times 1.3$$

$$V_{Fint} \geq \sqrt[4]{(600^3 \times 470 \times 15.75)} \times 1.3 = 1462V$$

$$P_{1SEC} \geq \frac{1462^2}{470} = 4.54kW$$

Summary of 7SR23 Settings and External Components

87/50-1 Element = Enabled

87/50-1 Setting = 0.37A

87/50-1 Delay = 0s

CT50 Element = Enabled

CT50 Setting = 0.02A

CT50 Delay = 3s

Rstab = 470 Ohms, 220W continuous (typical manufacturers data)

Metrosil diameter = 150mm

Metrosil 'C' value = 1000

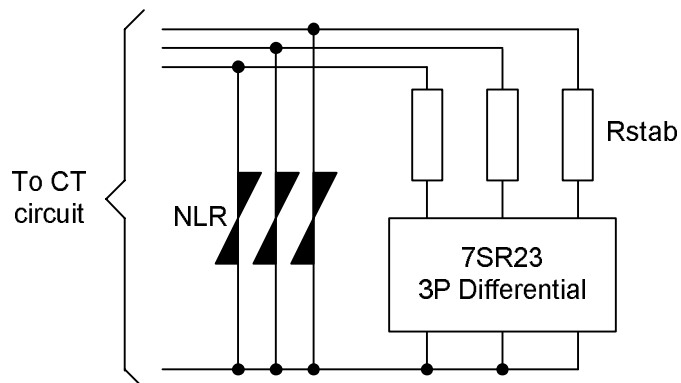


Figure 2-6 3 Pole Differential Relay circuit

2.2.2 Example 2 – Restricted Earth Fault Protection

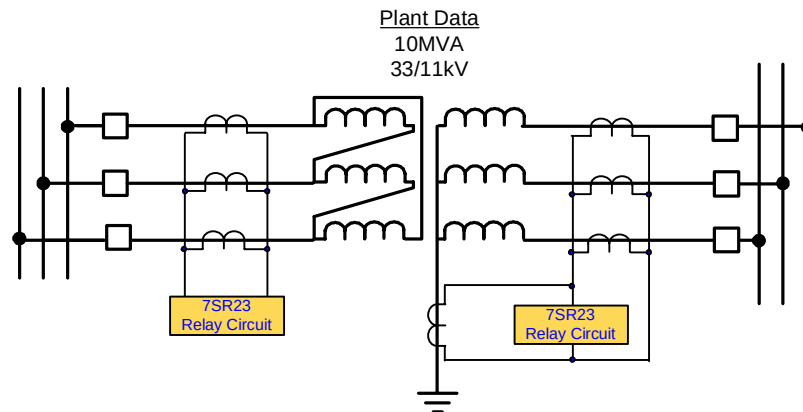


Figure 2-7 Example System – Restricted Earth Fault

Plant Data

See diagram above.

Settings Requirements

Rated current = $10 \times 10^6 / (\sqrt{3} \times 11000) = 525\text{A}$

Assigned through fault current (rated stability limit) = $16 \times \text{load current} = 8.4\text{kA}$, or, as specified by the user.

Required Fault Setting (Primary Operate Current):

10 – 25% of protected winding rated current, or

As specified by the user.

Required P.O.C. = 53 - 131A. Say 60A.

Line CT (LCT) and Connection Details

Turns ratio (T)	1/600
Voltage Knee Point (V_K)	350V
Magnetising Current (I_{mag}) @ V_K	40mA
CT secondary resistance (R_{CT})	7.5 Ohms
CT lead loop resistance (R_L)	0.15 Ohms max.

Neutral CT (NCT) and Connection Details

Turns ratio (T)	1/600
Voltage Knee Point (V_K)	300V
Magnetising Current (I_{mag}) @ V_K	50mA
CT secondary resistance (R_{CT})	6 Ohms
CT lead loop resistance (R_L)	0.15 Ohms max.

Calculation of Required Stability Voltage Limits

The assigned through fault current is 31.5kA.

$$V_s \geq \frac{8400}{600} \times (7.5 + 0.15) = 107.1V$$

$$V_s \geq \frac{8400}{600} \times (6 + 0.15) = 86.1V$$

$$V_s \leq \frac{V_K}{2} = \frac{300}{2} = 150V$$

Calculation of Stabilising Resistor Value

The required relay setting Is can be calculated from:

$$POC = (3(I_{MAGLCT}) + I_{MAGNCT} + I_{relay}) / T$$

$$I_{relay} = POC \times T - (3(I_{MAGLCT}) + I_{MAGNCT}) = 60/600 - I_{mag \text{ total}}$$

$$= 0.1 - (3(I_{MAGLCT}) + I_{MAGNCT})$$

The magnetising current is dependent on the relay operate voltage (Vs), this is not finalised yet so a provisional value is chosen from the above i.e. $107.1 < V_s < 150$

Say $V_{sprov} = 120V$. From CT magnetising curve: At 120V $I_{MAGLCT} = 9mA$ and $I_{MAGNCT} = 12mA$

$$I_{relay} = 0.1 - (3(0.009) + 0.012) = 0.06A$$

$$R_{stab} = 120/0.061 = 1967 \text{ Ohms (Say 2000 Ohms giving } V_s = 2000 \times 0.06 = 120V)$$

Metrosil Specification

'C' Value

$V_s = 120V$ (i.e. $> 100V$) so a 'C' value of 1000 is chosen

Short Time Power Rating

Using the empirical formula

$$P_{ISEC} \geq \frac{4}{\pi} \times I_F \times T \times V_K$$

$$P_{ISEC} \geq \frac{4}{\pi} \times 8400 \times \frac{1}{600} \times 350 = 6.24kW$$

For values $< 8kW/s$ a 75mm Metrosil is used.

Stabilising Resistor Specification

Continuous Power Rating

$$P_{\text{CONT}} \geq I_s^2 \times R_{\text{stab}}$$

$$P_{\text{CONT}} \geq 0.06^2 \times 2000$$

$$P_{\text{CONT}} \geq 7.2\text{W}$$

Short Time Power Rating

$$P_{1\text{SEC}} \geq \frac{V_{\text{Fint}}^2}{R_{\text{stab}}} \quad \text{Where: } V_{\text{Fint}} \geq \sqrt[4]{(V_K^3 \times R_{\text{stab}} \times I_{\text{Fint}})} \times 1.3$$

$$I_{\text{Fint}} = \frac{8400}{600} = 14\text{A}$$

$$V_{\text{Fint}} \geq \sqrt[4]{(V_K^3 \times R_{\text{stab}} \times I_{\text{Fint}})} \times 1.3$$

$$V_{\text{Fint}} \geq \sqrt[4]{(350^3 \times 2000 \times 14)} \times 1.3 = 1361\text{V}$$

$$P_{1\text{SEC}} \geq \frac{1361^2}{2000} = 926\text{W}$$

Summary of Relay Settings and Components

87REF-1 Element = Enabled

87REF-1 Setting = 0.06A

87REF-1 Delay = 0s

Rstab = 2000 Ohms, 40W continuous (typical manufacturers data)

Metrosil diameter = 75mm

Metrosil 'C' value = 1000

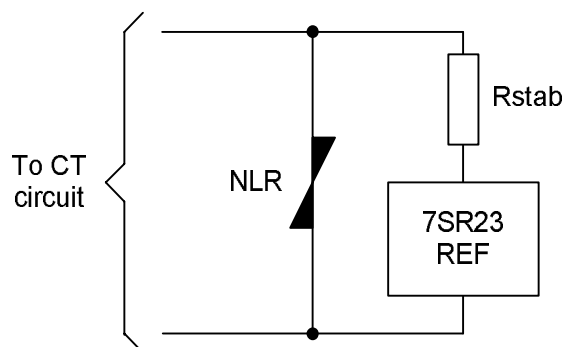


Figure 2-8 REF Relay circuit

Section 3: CT Requirements for High Impedance Protection

For the 7SR23 high impedance protection:

It is recommended that low reactance CTs conforming to IEC61869-2 Class PX are used. Class PX CTs have a specified excitation characteristic and secondary winding resistance and these parameters are used to calculate the performance of the protection in terms of primary operate current for internal faults and stability during through fault conditions.

All current transformers should have an equal turns ratio.

The knee-point voltage of the CTs must be greater than 2 x Setting Voltage (Vs).

i.e. Required $V_k \geq 2 \times I_F (R_{CT} + R_L) T$ Volts

A full explanation of how to specify CTs for use with high impedance protection is available on our Website: www.siemens.com/energy.

Typically the CT primary rating $\geq$ rated current of protected circuit (where rated current is different on each circuit use highest rating e.g. Bus Section rating).

3.1 CT Location Considerations

The position of CTs for busbar protection varies according to the design of the switchgear.

The switchgear design may include CTs which are installed on both sides of the CBs facilitating zones of protection that overlap the CBs. Many MV switchgear designs however have CTs on only one side of the CB creating protection zone 'blind spots'. Examples of CT locations are shown below.

3.1.1 CTs Overlapping Circuit Breakers

With reference to fig. 3.1 the protection performance for the faults F1 to F6 is considered.

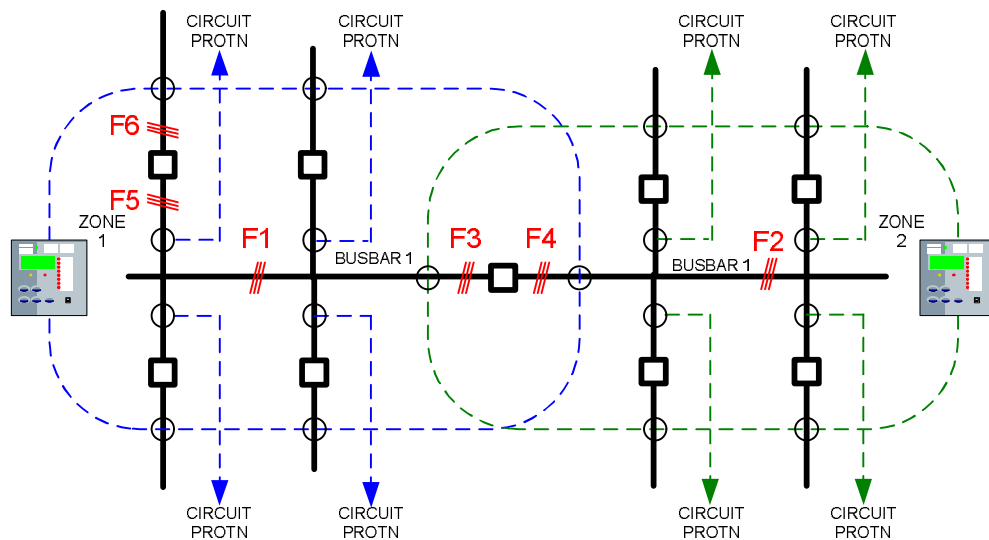


Figure 3-1 CTs Overlapping the CBs

Where CTs, and therefore zones of protection, overlap the circuit breakers then the areas of primary plant between the CTs and CBs are protected by more than one high speed protection system e.g. F3 and F4 in Figure 3-1.

Fault F1 is a busbar 1 fault which is cleared by busbar zone 1 protection.

Fault F2 is a busbar 2 fault and is cleared by busbar zone 2 protection.

F3 and F4 are busbar faults but due to their position they will cause both zone 1 and zone 2 protections to operate, however zone 1 or zone 2 is unnecessarily tripped out of service, this disadvantage is acceptable in view of the low incidence of such faults.

F5: Cleared by both the busbar and circuit protections.

F6: is a circuit fault but because of its position it causes both the busbar and circuit protections to operate. The fault will be cleared, however busbar zone 1 will be unnecessarily tripped out of service. This disadvantage is acceptable in view of the low incidence of such faults.

3.1.2 CTs on 'Circuit' Side of the Circuit Breakers

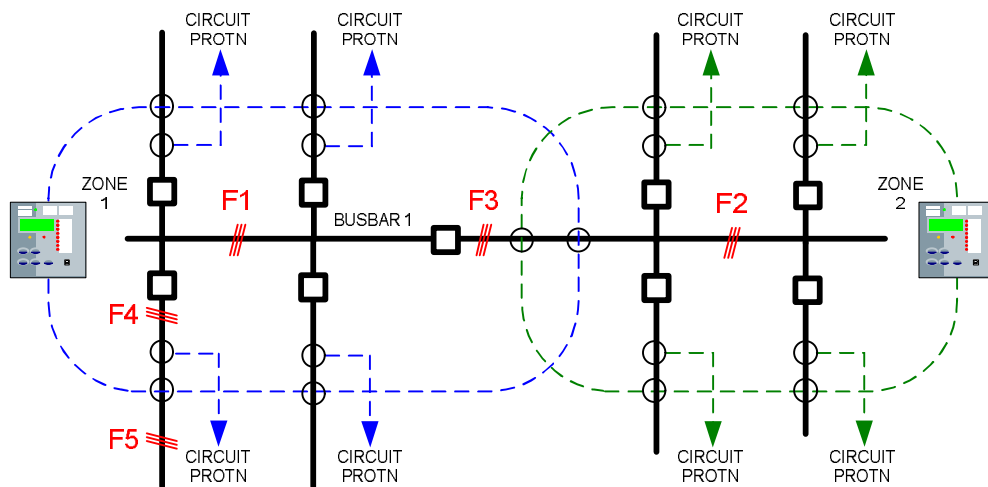


Figure 3-2 CTs on Circuit Side of CBs

Where CTs are located on only one side of the circuit breaker some protection zones do not extend fully to the CB and protection 'blind spots' are formed. The areas of primary plant between the CTs and CB may not be protected by the relevant protection zone e.g. F3 and F4 in Figure 3-2.

Faults F1 and F2 should be correctly cleared as before,

Fault F3 will only cause operation of busbar 1 protection because the fault is outside the zone of busbar 2 protection. Thus the busbar 2 fault will remain uncleared. Arrangements must therefore be made to cause the busbar 2 CBs to be tripped to clear the fault.

F4: This is a circuit fault, the circuit CB is tripped by the busbar protection, however the busbar zone 1 is unnecessarily tripped, this is usually considered as acceptable in view of the rare occurrences of such faults. On interconnected systems the circuit fault will be cleared by the remote end protection.

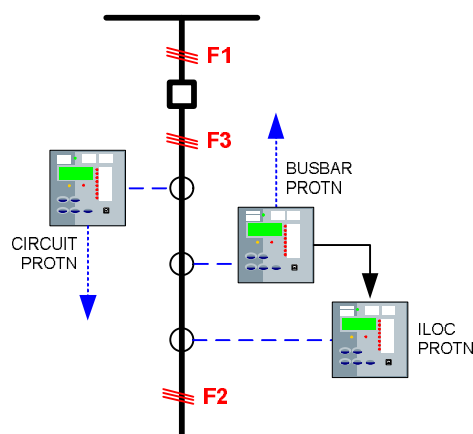


Figure 3-3 CTs on Circuit Side of CBs

Faults F1 and F2 should be correctly cleared as before, but F3 will only cause operation of the busbar protection because the fault is outside the circuit protection zone. Thus the fault may remain fed from the remote end of the circuit. Arrangements must therefore be made to cause the CB at the remote end of the line to be tripped under these circumstances.

This can be affected by a direct intertrip or CB fail scheme. Another method, as shown, uses an interlocked overcurrent relay (ILOC). This is arranged to detect any power infeed at F3 after the circuit breaker is opened.

This relay is a three pole over current type with a time setting of about 0.3 second, its operation is inhibited until the busbar protection operates. Where the fault persists at F3 after the circuit breaker opens, the busbar protection remains operated, so permitting the interlocked overcurrent relay to operate and unstabilise the circuit unit protection or send an intertripping signal to the remote ends of the circuits.

3.1.3 CTs on 'Busbar' Side of the Circuit Breakers

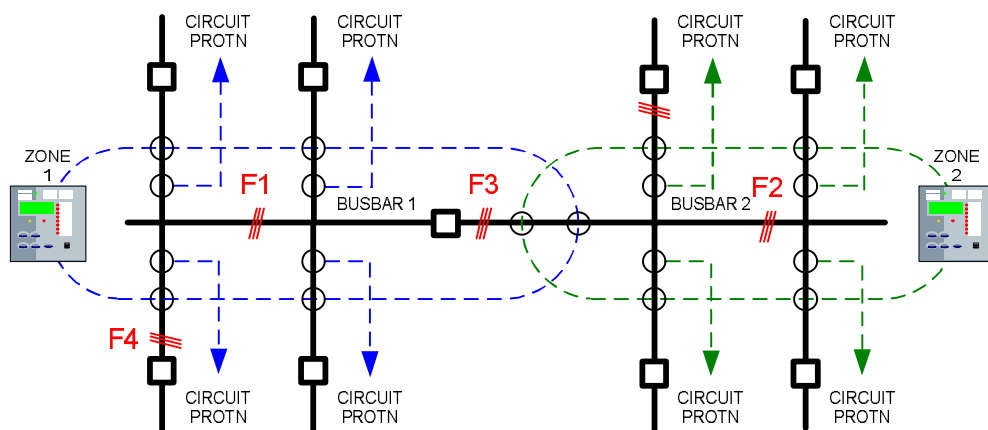


Figure 3-4 CTs on 'Busbar' Side of CBs

Where CTs are located on only one side of the circuit breaker some protection zones do not extend fully to the CB and protection 'blind spots' are formed. The areas of primary plant between the CTs and CB may not be protected by the relevant protection zone e.g. F3 and F4 in Figure 3-4.

Faults F1 and F2 should be correctly cleared as before.

Fault F3 will only cause operation of busbar 1 and not busbar 2 protection because the fault is outside the zone of busbar 2 protection. Thus the zone 2 fault will remain uncleared. Arrangements must therefore be made to cause the zone 2 CBs to be tripped to clear the fault.

F4: The circuit CB will be tripped by the circuit protection. The fault will not be seen by the busbar protection. Where the circuit protection continues to indicate that a fault is present arrangements must be made to unstabilise the busbar protection.

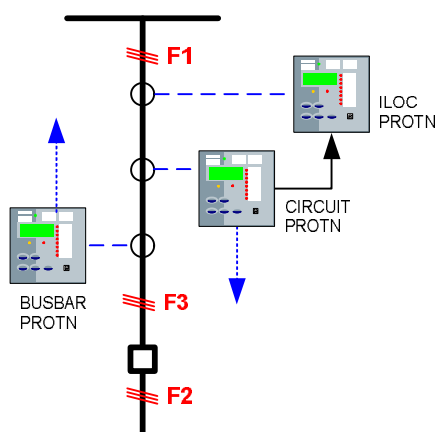


Figure 3-5 CTs on 'Busbar' Side of CBs

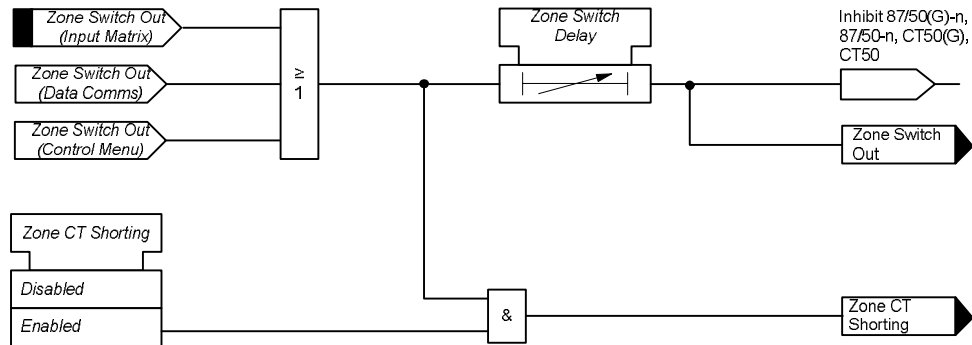
The faults at F1 and F2 will be correctly cleared.

A fault at F3 will cause the circuit protection to trip the circuit breaker, but the fault will remain fed from the busbars. The busbar protection will not operate as F3 is outside its zone.

Again an interlocked Over current relay is used, but in this case, since it is the circuit protection which remains operated for the fault at F3, it is this protection which is used to initiate operation of the interlocked overcurrent relay. If F3 persists for about 0.3 seconds, the interlocked overcurrent relay then operates the tripping relays of the protection of the section of busbar to which the circuit is selected.

Section 4: Control Functions

4.1 Zone Switching



Notes

For details of data communications points refer to Technical Manual, Chapter 4 (Data Communications).
For details of user logic inputs and outputs refer to the relevant Reydisp Manager template.

Figure 4-1 Logic Diagram: Protection In/Out Switching

When commissioning and testing of circuit protections e.g. feeder overcurrent protection it is necessary to carry out primary injection testing. At such times it is necessary to short circuit the secondary windings of the busbar protection CTs on that circuit otherwise a differential trip might result.

Alternatively the busbar protection can be switched out using the zone switch-out facility, this will inhibit operation of the differential elements, the CT supervision elements and also apply zone CT shorting.

Section 5: Supervision Functions

5.1 CT Supervision (CT50)

If the CT secondary wiring becomes open-circuit a current unbalance will be created in the Relay circuit. This may exceed the operating level causing the differential protection to operate and isolate the primary plant. Even for low levels of unbalance current it is important that the condition is detected as subsequent increase of primary current levels may be sufficient to raise the unbalanced current above the protection operate level.

A sensitive differential element is provided to supervise the CT wiring i.e. detect open circuited CT secondary wiring. Generally a current setting of 2 - 10% of the full load rating of the busbar is acceptable.

Once a CT Supervision condition has been detected, the relay can be programmed to issue an alarm via one of the output contacts. Where a mal-operation is preferred to missing a real fault, this alarm is used to simply alert the system operator to the condition. It should then be rectified as soon as possible.

Where protection mal-operation is unacceptable, this alarm can also be used to disable the differential protection until the CT is repaired. Traditionally this has been done by short-circuiting the secondary wiring of the affected phase(s) of the CTs. There is no way of identifying which individual CT is faulted. This method has been used where an open-circuited CT may cause damage to plant. Care must be taken, however, to ensure that the rating of the relay output contacts is sufficient to make and carry the high current transients involved. If not, the alarm output must be used to operate a dedicated CT shorting relay with higher-rated contacts.

The 7SR23 can be configured to inhibit the relay's Differential protection elements when the CT Supervision element operates.

The CT Supervision element will pick-up for an internal fault condition, a time delay is added so that it does not operate before the protection has correctly cleared the fault. Typically a time delay of 2 to 10 seconds is applied.

5.2 Trip Circuit Supervision (74TCS)

Binary Inputs may be used to monitor the integrity of the CB trip circuit wiring. Current flows through the B.I. confirming the integrity of the auxiliary supply, CB trip coil, auxiliary switch, C.B. secondary isolating contacts and associated wiring connected to that B.I. If the current flow ceases, the B.I. drops off and if it is user programmed to operate one of the output relays, this can be used to provide an alarm. In addition, an LED on the relay fascia can be programmed to operate. A user text label can be used to define the operated LED e.g. "Trip CCT Fail".

The relevant Binary Input is mapped to 74TCS-n in the INPUT CONFIG>INPUT MATRIX menu. To avoid giving spurious alarm messages while the circuit breaker is operating the input is given a 0.4s Drop-off Delay in the INPUT CONFIG>BINARY INPUT CONFIG menu.

To provide an alarm output a normally open binary output is mapped to 74TCS-n.

5.2.1 Trip Circuit Supervision Connections

The following circuits are derived from UK ENA S15 standard schemes H5, H6 and H7.

For compliance with this standard:

Where more than one device is used to trip the CB then connections should be looped between the tripping contacts. To ensure that all wiring is monitored the binary input must be at the end of the looped wiring.

Resistors must be continuously rated and where possible should be of wire-wound construction.

Scheme 1 (Basic)

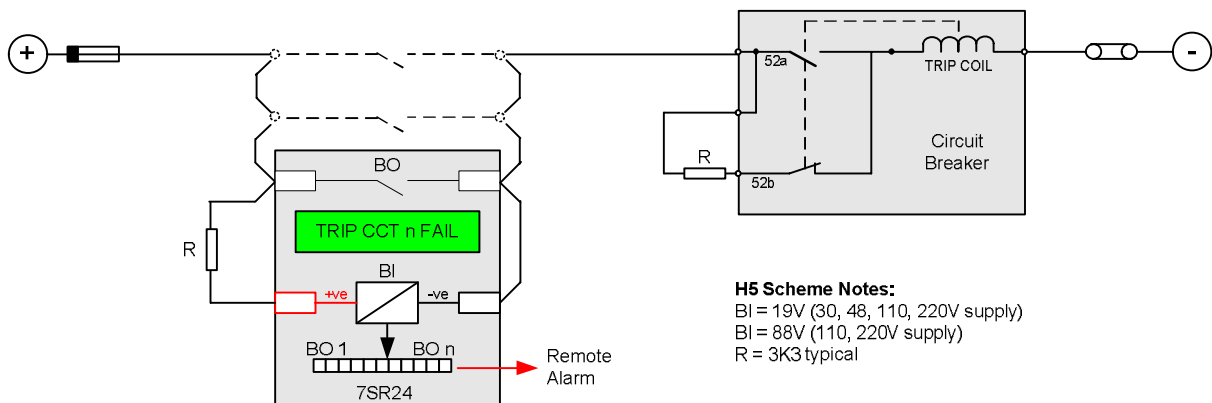


Figure 5-1 Trip Circuit Supervision Scheme 1 (H5)

Scheme 1 provides full Trip and Close supervision with the circuit breaker Open or Closed.

Where a 'Hand Reset' Trip contact is used measures must be taken to inhibit alarm indications after a CB trip.

Scheme 2 (Intermediate)

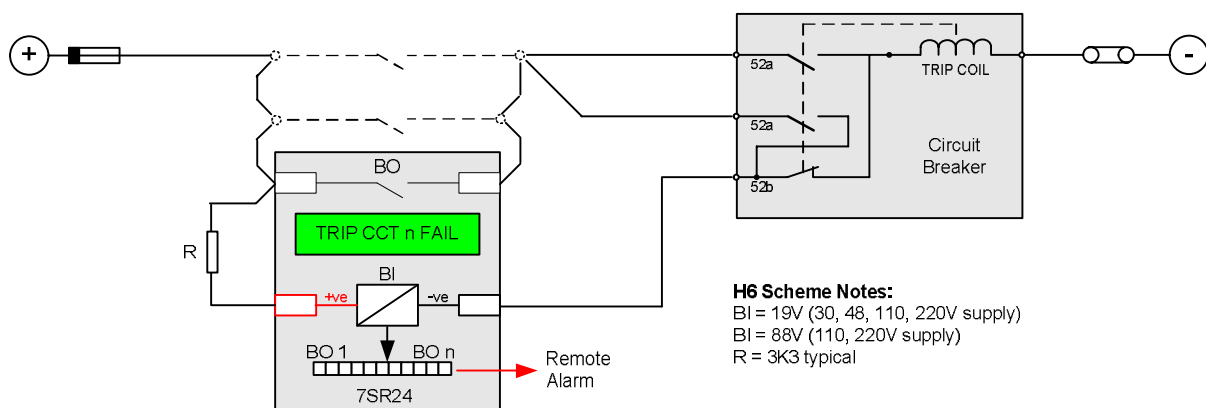


Figure 5-2 Trip Circuit Supervision Scheme 2 (H6)

Scheme 2 provides continuous Trip Circuit Supervision of trip coil with the circuit breaker Open or Closed. It does not provide pre-closing supervision of the connections and links between the tripping contacts and the circuit breaker and may not therefore be suitable for some circuits which include an isolating link.

Scheme 3 (Comprehensive) – 19V Binary Input Only

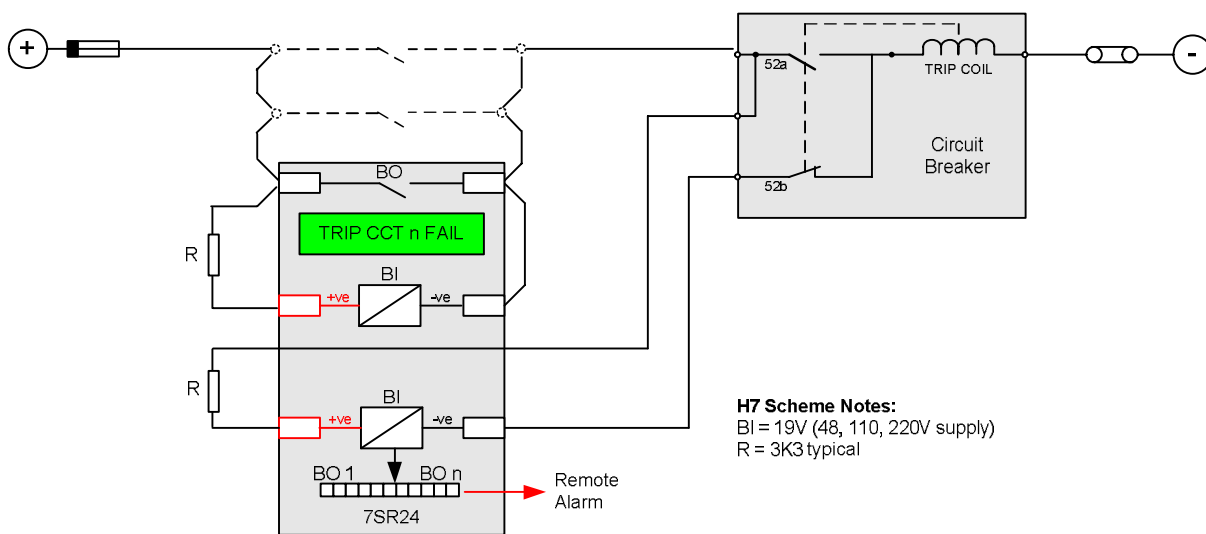


Figure 5-3 Trip Circuit Supervision Scheme 3 (H7)

Scheme 3 provides full Trip and Close supervision with the circuit breaker Open or Closed.

5.3 Sustained Fault (87/50SFM)

The 7SR23 is connected to measure unbalance current. The sustained flow of fault current after a differential protection operation indicates either a failed CB condition or fault in a protection 'blind spot', see Figure 5-4. Where one of the circuit breakers fails to trip the relay cannot inherently identify which CB has failed, it can measure continued flow of differential current only.

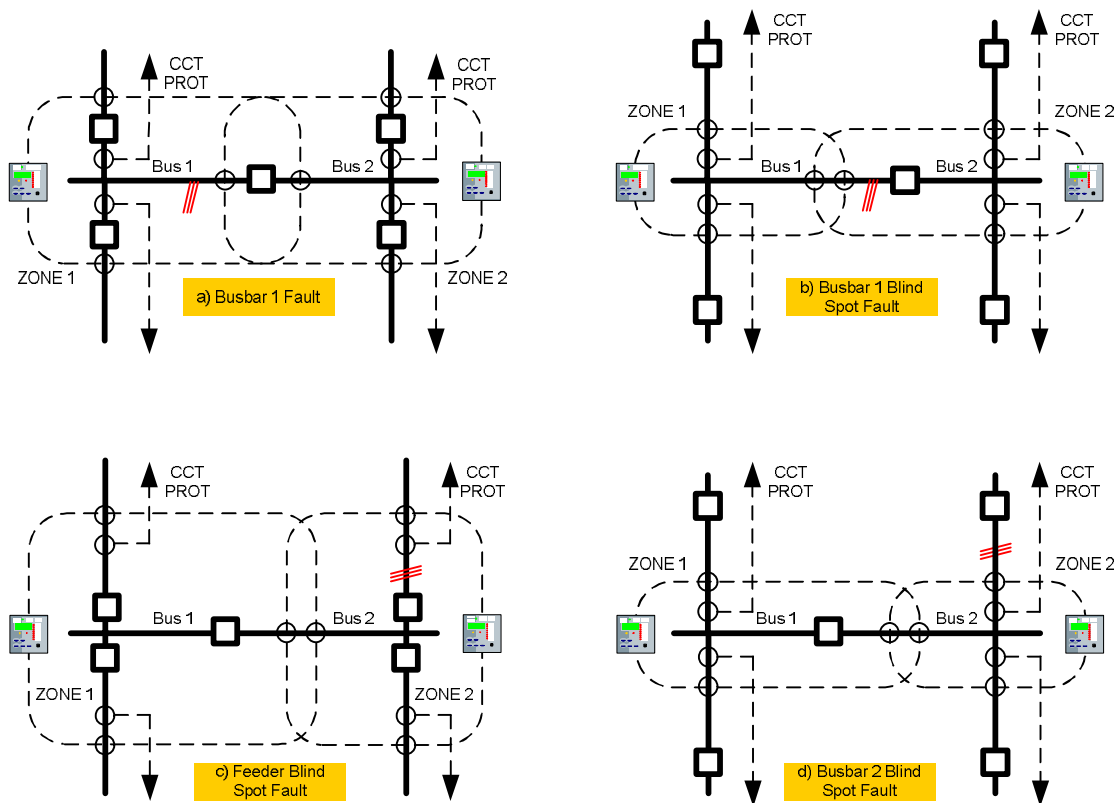


Figure 5-4 Position of Uncleared Faults

The SFM feature used in conjunction with the Circuit Position Monitor can provide the following information.

	CB Status Monitoring	
	One or More CBs Closed	All CBs Open
From fig. 3.1 CTs Overlapping the CBs	1) Uncleared Fault Event 2) Failed CB Identified	1) Uncleared Fault Event 2) Blind Spot Fault Event – F4 or F6
From Figure 3-2 CTs on 'Circuit' Side of CBs	1) Uncleared Fault Event 2) Failed CB Identified	1) Uncleared Fault Event 2) Blind Spot Fault Event – F3 or F4
From Figure 3-4 CTs on 'Busbar' Side of CBs	1) Uncleared Fault Event 2) Failed CB Identified	1) Uncleared Fault Event 2) Blind Spot Fault Event – F3

5.3.1 Use of the 87/50-2 Element

Where differential current continues to flow after operation of 87/50-1 the circulating current protection alone cannot discriminate between a CB failure or protection 'blind spot' fault.

87/50-2 + DTL can be used to trip the remote ends of circuits where the CB has failed to clear the fault see Figure 5-5.

Where the fault has not been cleared because it is in a blind-spot then an interlocked overcurrent element (ILOC) can be connected in series with the back-trip signal.

(e.g. the fault in Figure 5-4b will operate zone 2 protection but zone 1 protection is 'blind' to this fault).

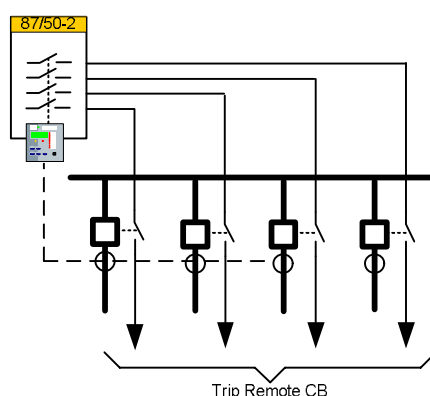


Figure 5-5 CB Fail Back-Trip from 87/50-2 Element

5.4 CB Circuit Position

The position of up to 12 CBs can be monitored utilising either the IEC61850 comms or wiring between binary inputs of the 7SR23 and CB auxiliary switches, in effect producing a replica of the busbar.

This feature can be used for example on double busbar installations – presented in schematic form in Figure 5-6 – to issue trip outputs to the relevant circuit breakers. Back-tripping logic from circuit CB fail inputs can also utilise these busbar replica tripping outputs..

Where differential current continues to flow and CB status indicates that all CBs are open then this indicates a blind-spot fault has occurred.

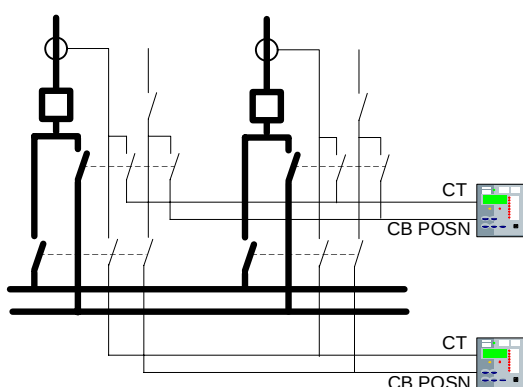


Figure 5-6 CB Position Monitoring – Double Busbar Arrangement

Section 6: Application Considerations and Examples

6.1 High Impedance Scheme Components

Typical components used in a 3-phase high impedance protection scheme are shown in fig. 6.1. Dependent on the requirements of the scheme these may include:

7SR23 DAD High impedance relay

Series stabilising resistor x 3

Metrosil x 3 (voltage limiting resistors)

Note that these components are optionally available with fixed values and housed in an E6 case. Guidance on using the component box and fixed value components is given in the separate publication – User Manual: High Impedance Component Box.

Zone shorting relay

7XG22 Test module

Trip relay(s)

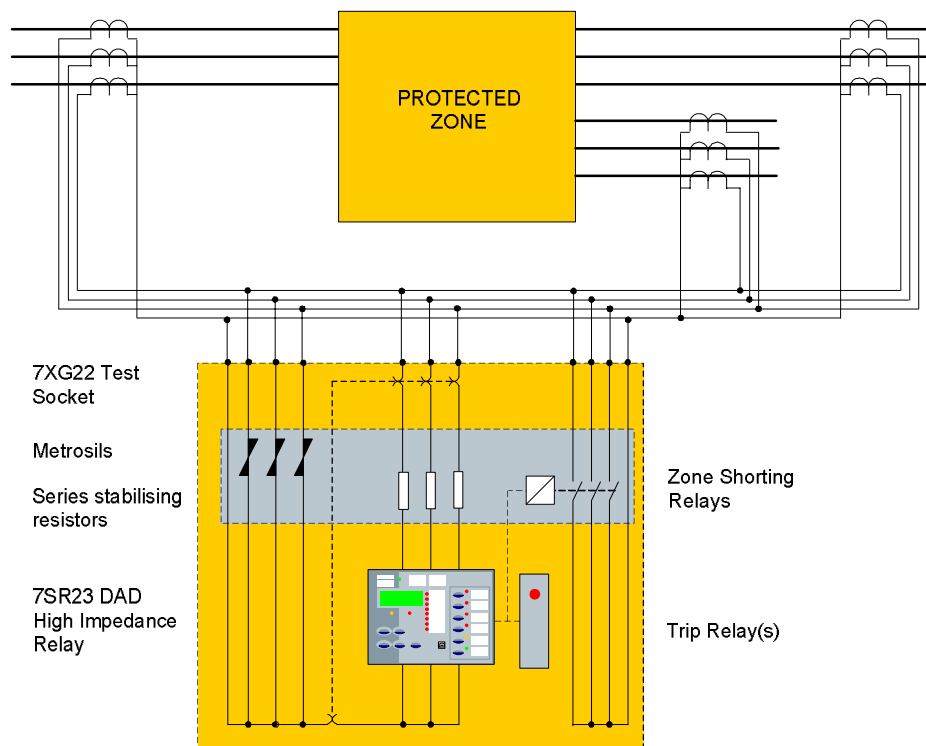


Figure 6-1 Discrete Relay Circuit Components

6.2 Busbar Protection

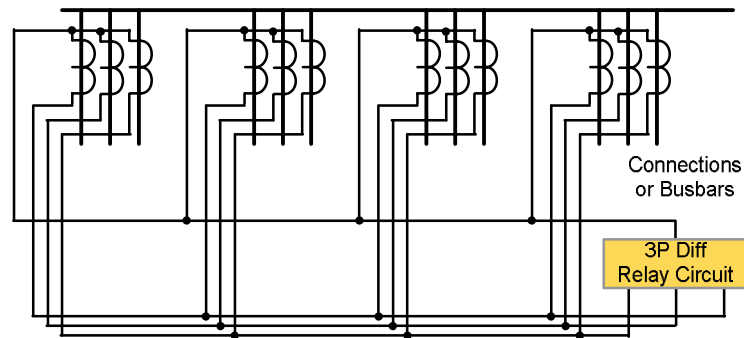


Figure 6-2 Single Busbar Protection

6.2.1 Primary Operate Current (Fault Setting)

To achieve correct sensitivity to in-zone faults, the protection scheme must typically operate for a primary current of 10-30% of the minimum primary fault current,

For solidly earthed systems, where the fault current will be very high, it is acceptable practice to use a primary fault setting of 50% of the Busbar full load current.

6.2.2 CT Supervision Settings

Generally a current setting of 2 - 10% of the full load rating of the busbar is acceptable.

Typically a setting of 2 to 10 seconds is applied.

6.2.3 Stability Level

The assigned through fault current shall be taken as the switchgear breaking capacity.

6.2.4 Double Busbar Protection

On double busbar systems, where there will be a significant number of switching operations, it is usual to provide an extra level of tripping security by fitting a Check Zone relay. This monitors the current of every incomer and outgoing feeder on the Busbar, but not the internal Busbar Sections and Couplers.

A Check Zone relay is also sometimes installed on single busbar systems of high importance.

The outputs of the relays protecting each Busbar zone are then connected in series with the Check Zone relay's outputs. Only when both operate will a trip be issued.

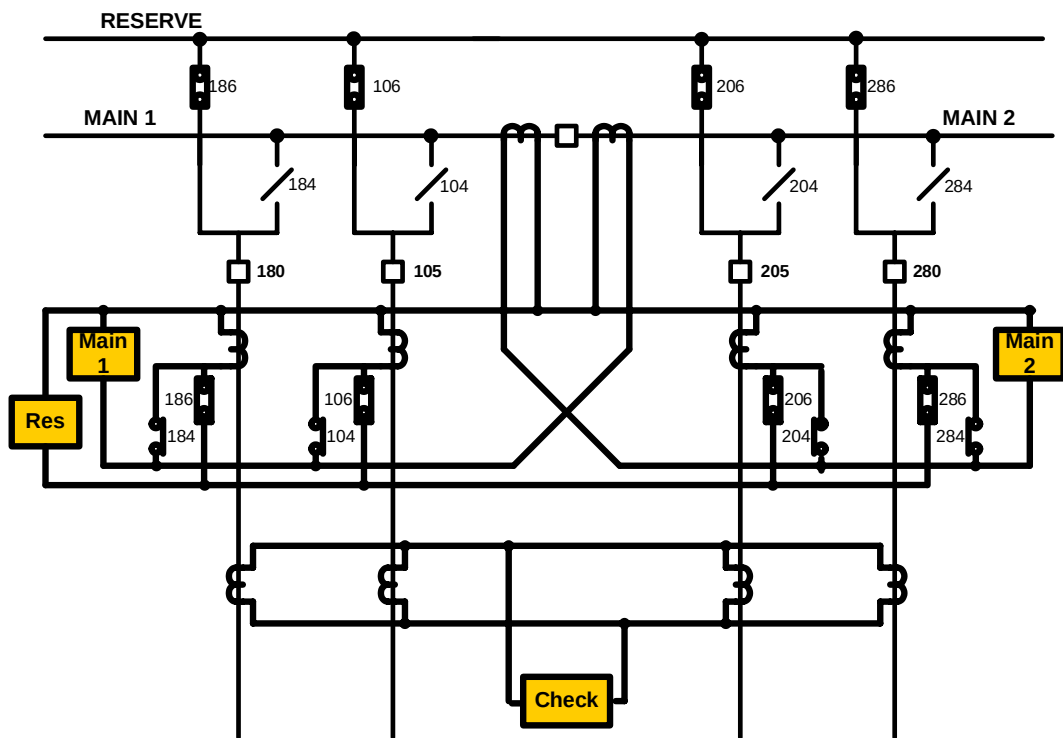


Figure 6-3 Double Busbar Protection with Check Zone

6.2.5 3 Phase Differential Plus Earth Fault Configuration

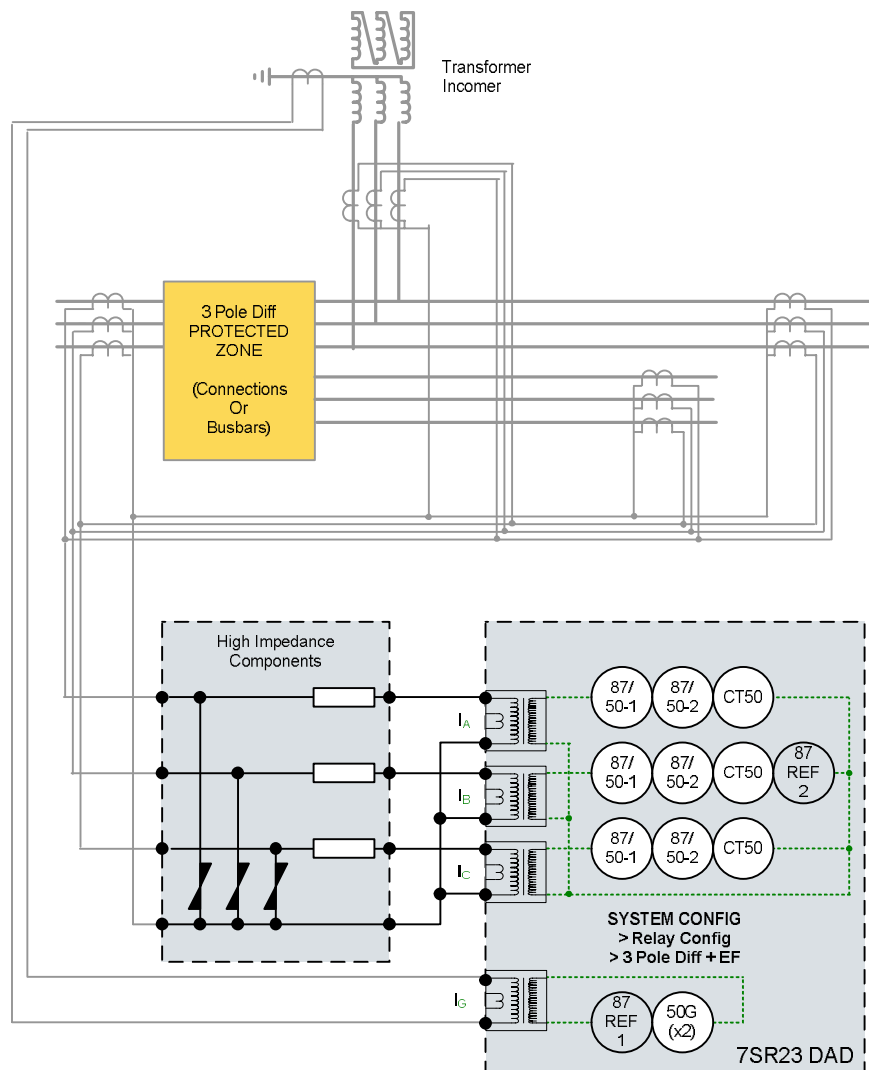


Figure 6-4 MV Busbar Protection with EF Check

This application may be utilised in an MV distribution system, a self check system is provided using a single relay. The relay is configured such that operation of either two phase fault differential elements or a phase fault differential + earth fault (50G) is required before an output trip command is issued.

6.3 Restricted Earth Fault Protection

The approach to the calculation is the same as for the three phase differential protection.

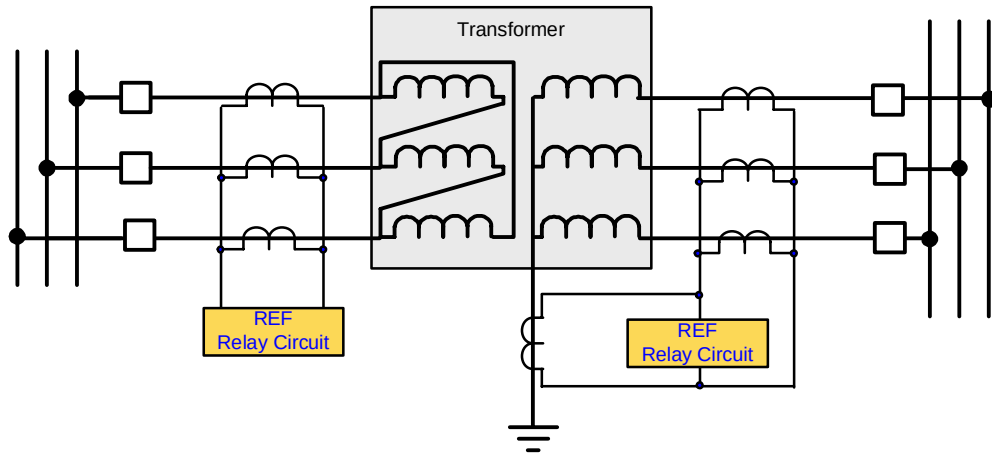


Figure 6-5 Balanced/Restricted Earth Fault Protection Applied to a Delta/Star Transformer

6.3.1 Primary Operate Current (Fault Setting)

To achieve correct sensitivity to in-zone faults, the protection scheme must typically operate for a primary current of 10-25% of the protected winding rated current.

6.3.2 Stability Level

Typically the through fault current is taken as 16 times the rated current of the protected winding or as otherwise agreed.

6.4 Protection of Auto-Transformer

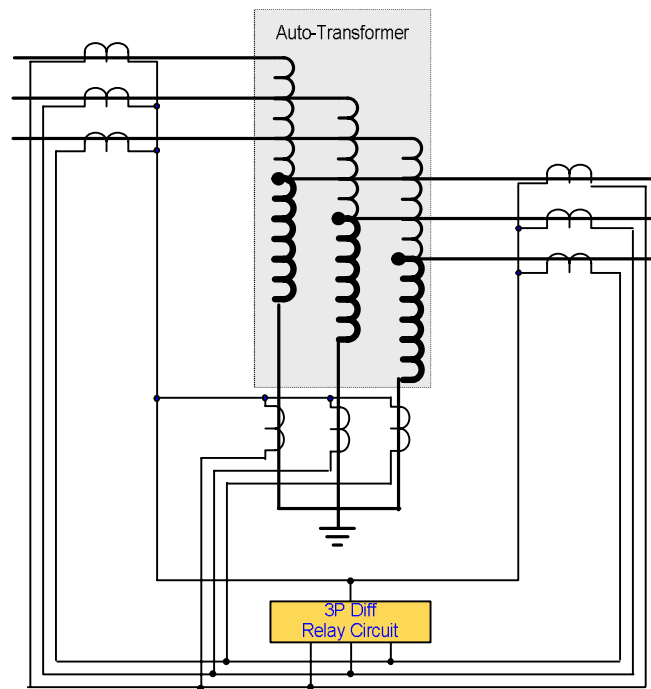


Figure 6-6 Auto-Transformer Protection

6.4.1 Primary Operate Current (Fault Setting)

To achieve correct sensitivity to in-zone faults, the protection scheme must typically operate for typical values of primary current as follows:

Solidly earthed: 10 – 60% of rated HV current.

Not solidly earthed: 10-25% of minimum fault current available for earth faults at the transformer terminals.

6.4.2 Stability Level

Typically the through fault current is taken as 16 times the rated current of the LV winding or as otherwise agreed.

6.5 Protection of Motor, Generator or Reactor

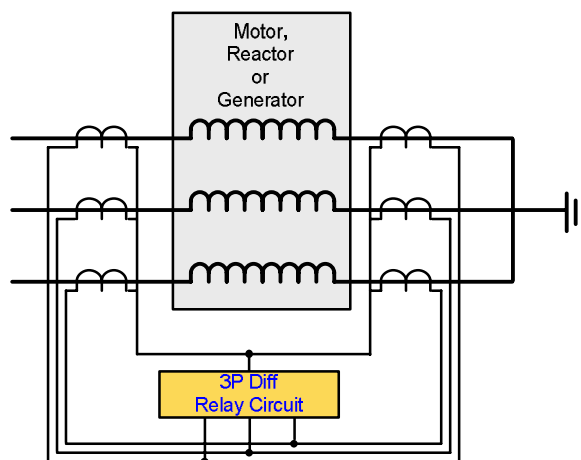


Figure 6-7 Motor, Reactor or Generator Protection

6.5.1 Primary Operate Current (Fault Setting)

Typical primary operate currents for various items of plant are taken as:

Series reactor 10-25% of the rated current of the protected winding or as otherwise agreed.

Shunt reactor 10-25% of the rated current of the protected winding or as otherwise agreed.

Motor: Less than 10% of the rated current of the protected winding or as otherwise agreed.

Generator: Less than 10% of the rated current of the protected winding or as otherwise agreed.

6.5.2 Stability Level

Typical through fault currents for various items of plant are taken as:

Shunt reactor 10 times the rated current of the protected winding or as otherwise agreed.

Motor: 12.5 times the rated current of the protected winding or as otherwise agreed.

Generator: 12.5 times the rated current of the protected winding or as otherwise agreed.

Series reactor: 20 times the rated current of the protected winding or as otherwise agreed.

For motors and generators the machine contribution to an external fault should be considered in the stability voltage calculation.

6.6 IEC61850 Applications

6.6.1 IEC61850 Implementation

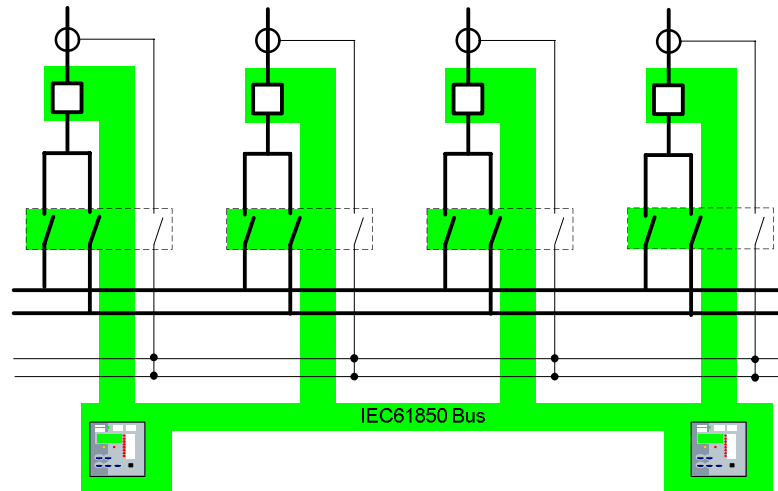


Figure 6-8 IEC 61850 Bus

The IEC61850 comms bus between items of primary plant and the relays provides high speed, secure data transfer. The protocol bus can be used to:

- Replace wiring between plant and relays e.g. status information and tripping signals.
- Reduce tripping times (using Goose messaging in place of binary outputs / wiring).
- Implement intelligent prioritized tripping e.g. where faults are detected in two zones of protection.
- Re-allocate busbar loads after a busbar trip occurrence.

6.6.2 Discrimination for 'Dual Zone' Faults

Where a fault can be detected by more than one protection this will cause tripping of two sets of protection e.g. for faults F5 and F6 in Figure 6-9 below both the circuit and busbar 1 protections will operate causing a possible unnecessary loss of one busbar.

IEC Goose messaging can be used to detect the simultaneous operation of two protections and arrange for the circuit CB to be tripped first. Where the fault then remains it will continue to operate the busbar protection and then all CBs connected to the busbar can be tripped.

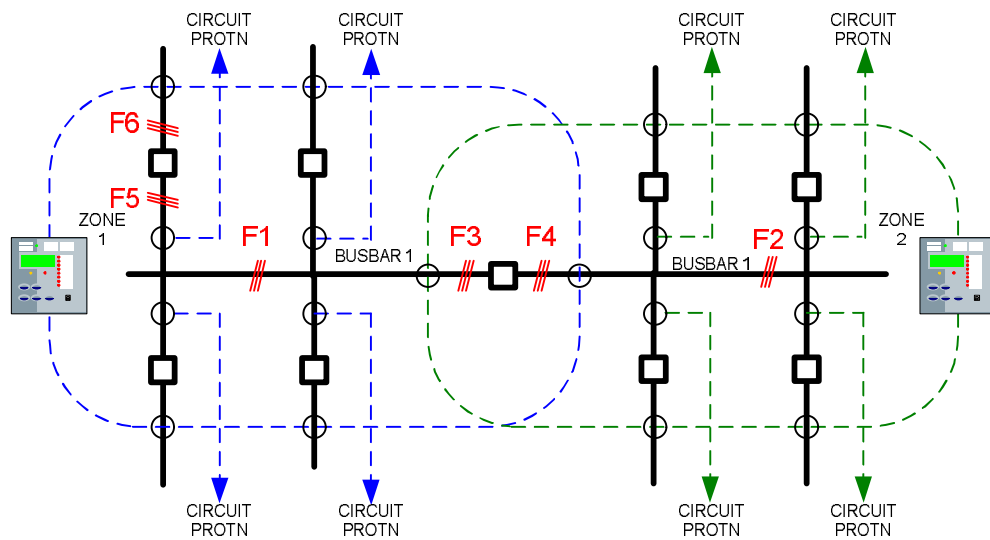


Figure 6-9 Faults affecting two Protection Zones

Section 7: Common Functions

7.1 Binary Inputs

Each Binary Input (BI) can be programmed to operate one or more of the relay functions, LEDs or output relays. These can be used to bring such digital signals as Inhibits for protection elements, CB position status and trip circuit supervision status etc. into the Relay.

Alarm and Tripping Inputs

A common use of binary inputs is to provide indication of alarm conditions, fault conditions or switching operations. The Binary Inputs can be mapped to LED(s), waveform storage trigger and binary outputs.

The inputs can also be mapped as 'General Alarms' – this allows user defined text to be displayed on the LCD when the BI is energised. Inputs used in this way are programmed using:

INPUT CONFIG>INPUT MATRIX>**General Alarm n** – Assigned to BI.

INPUT CONFIG>GENERAL ALARMS>**General Alarm n** – 16 character string.

The Effects of Capacitance Current

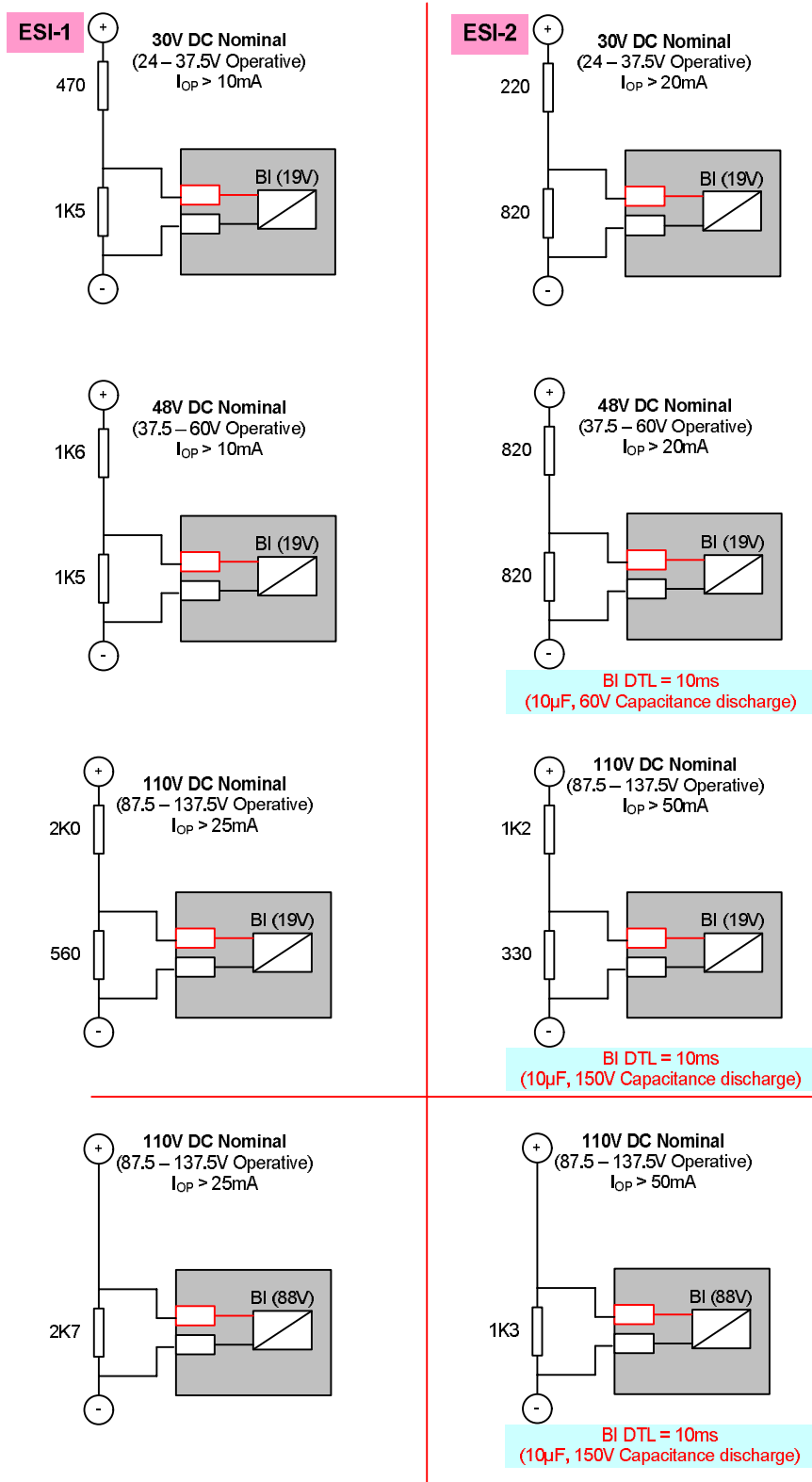
The binary inputs have a low minimum operate current and may be set for instantaneous operation. Consideration should be given to the likelihood of mal-operation due to capacitance current. Capacitance current can flow through the BI, for example if an earth fault occurs on the dc circuits associated with the relay. The binary inputs will be less likely to mal-operate if they:

- 1 Have both the positive and negative switched (double-pole switched).
- 2 Do not have extensive external wiring associated with them e.g. if the wiring is confined to the relay room.

Where a binary input is both used to influence a control function (e.g. provide a tripping function) and it is considered to be susceptible to mal-operation the external circuitry can be modified to provide immunity to such disturbances, see Fig. 7-1.

AC Rejection

The default pick-up time delay of 20ms provides immunity to ac current e.g. induced from cross site wiring.



Resistor power ratings:

30V DC Nominal	>3W
48V DC Nominal	>3W
110V DC Nominal	>10W (ESI- 1)
110V DC Nominal	>20W (ESI-2)

Resistors must be wired with crimped connections as they may run hot

Fig. 7-1 Binary Input Configurations Providing Compliance with EATS 48-4 Classes ESI 1 and ESI 2

7.2 Binary Outputs

Binary Outputs are mapped to output functions by means of settings. These could be used to bring out such digital signals as trips, a general pick-up, plant control signals etc.

All Binary Outputs are trip rated

Each can be defined as Self or Hand Reset. Self-reset contacts are applicable to most protection applications. Hand-reset contacts are used where the output must remain active until the user expressly clears it e.g. in a control scheme where the output must remain active until some external feature has correctly processed it.

Case contacts B25 and B26 will automatically short-circuit when the relay is withdrawn from the case. This can be used to provide an alarm that the relay is out of service.

Notes on Self Reset Outputs

With a failed breaker condition the relay may remain operated until current flow in the primary system is interrupted by an upstream device. The relay will then reset and attempt to interrupt trip coil current flowing through an output contact. Where this level is above the break rating of the output contact an auxiliary relay with heavy-duty contacts should be utilised.

7.3 LEDs

Output-function LEDs are mapped to output functions by means of settings. These could be used to display such digital signals as trips, a general pick-up, plant control signals etc.

User Defined Function LEDs are used to indicate the status of Function Key operation. These do not relate directly to the operation of the Function Key but rather to its consequences. So that if a Function Key is depressed to close a Circuit-Breaker, the associated LED would show the status of the Circuit-Breaker closed Binary Input.

Each LED can be defined as Self or Hand Reset. Hand reset LEDs are used where the user is required to expressly acknowledge the change in status e.g. critical operations such as trips or system failures. Self-reset LEDs are used to display features which routinely change state, such as Circuit-Breaker open or close.

The status of hand reset LEDs is retained in capacitor-backed memory in the event of supply loss.

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