Reyrolle
Protection
Devices

7SG13 Delta

Protection and Control Relays

Answers for energy

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Protection and Control Relays

Document Release History

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Pre release

2010/02	Document reformat due to rebrand

Software Revision History

Documentation Set

Delta Protection and Control Relays
Complete Product Documentation set P1101

The following documents are both contained within the set and are available separately.

- Delta User Manual P20015
- Delta Common Features Tech. Ref. P20025
- Current Protections Tech. Ref. P20048
- Voltage Protections Tech. Ref. P20051
- Plant Supervision Tech. Ref. P20060
- Autoreclosing and Check Sync Tech. Ref. P20063
- Autoreclosing Tech. Ref. P20064
- FM1-111 Diagrams and Parameters P20202
- FM1-112 Diagrams and Parameters P20203
- FM1-211 Diagrams and Parameters P20204
- FM1-212 Diagrams and Parameters P20205
- FM1-213 Diagrams and Parameters P20206
- FM1-214 Diagrams and Parameters P20207
- FM1-215 Diagrams and Parameters P20208
- FM1-216 Diagrams and Parameters P20209
- FM1-223 Diagrams and Parameters P20210
- FM1-224 Diagrams and Parameters P20213
- FM1-225 Diagrams and Parameters P20214
- FM1-226 Diagrams and Parameters P20215

These documents can be directly downloaded from our website at www.siemens.com/energy.

Scope

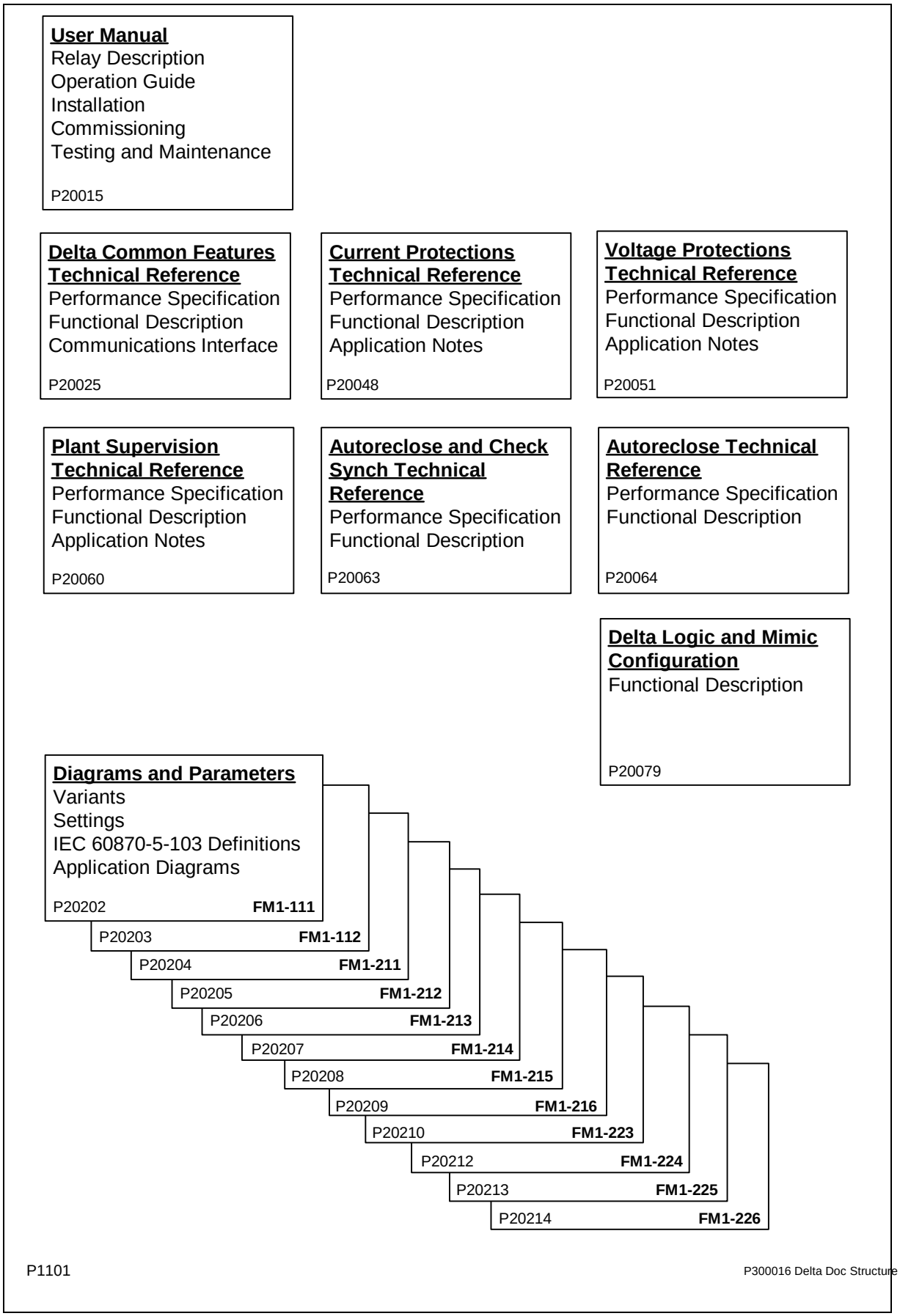
This manual is applicable to the following relays:

FM1-111
FM1-112
FM1-211
FM1-212
FM1-213
FM1-214
FM1-215
FM1-216
FM1-223
FM1-224
FM1-225
FM1-226

The Model Feature Table below indicates the features provided in this model.

Model Feature Table		111	112	211	212	213	214	215	216	223	224	225	226
Measurements and Instrumentation													
Current		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Voltage				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Power				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Energy				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Protection													
Phase-fault overcurrent	50/51	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cold load pickup	CL	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Earth-fault overcurrent (residual calculation)	50N/51N	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Earth-fault overcurrent (measured)	50N/51N		✓		✓		✓		✓		✓		✓
Sensitive earth-fault / Restricted earth-fault	50G/64REF	✓		✓		✓		✓		✓		✓	
Thermal overload	49	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Phase unbalance / broken conductor	46BC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Circuit breaker fail	50BF	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Directional detection for phase-fault	67					✓	✓	✓	✓	✓	✓	✓	✓
Directional detection for earth-fault (ZPS and NPS polarising)	67N					✓	✓	✓	✓	✓	✓	✓	✓
Directional detection for SEF (ZPS polarising)	67G					✓		✓		✓		✓	
Directional detection of measured earth-fault (ZPS polarising)	67N						✓		✓		✓		✓
Voltage controlled overcurrent	51V					✓	✓	✓	✓	✓	✓	✓	✓
Neutral voltage displacement (NVD)	59N					✓	✓	✓	✓	✓	✓	✓	✓
NPS overcurrent	46DT							✓	✓	✓	✓	✓	✓
Undervoltage and overvoltage	27/59							✓	✓	✓	✓	✓	✓
NPS overvoltage	47							✓	✓	✓	✓	✓	✓
Underfrequency and overfrequency	81									✓	✓	✓	✓
Control functions													
Autoreclose	79	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Check synchronising	25							✓	✓			✓	✓
Supervision functions													
Trip circuit supervision	74TCS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CT supervision	74CTS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VT supervision	74VTS					✓	✓	✓	✓	✓	✓	✓	✓

Structure of Document Set



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Protection and Control Relays

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Section 1: Relay Description

1.1 Overview

The Reyrolle modular range of products combines power system protection with the most up to date microprocessor technology to create a highly flexible solution for all transmission and distribution substation secondary applications.

Within this range, these Protection and Control relays are specifically designed to integrate the bay level control and protection requirements into a single box, providing an attractive solution for most distribution requirements.

Features

The following features are available within these Relays:

- Delayed (IDMTL) and instantaneous overcurrent protection, for phase currents, earth currents and negative phase sequence current
- Thermal overload protection
- Broken conductor detection
- Voltage protections for phase voltages, neutral voltage and negative phase sequence voltage
- Auto-reclosing with check synchronising
- Trip circuit supervision
- Circuit breaker failure protection
- CT and VT supervision
- Mimic display of plant status, with user-friendly local control
- Comprehensive metering functions
- User-programmable interlocking schemes
- Programmable user logic
- Remote control and monitoring through IEC 60870-5-103 protocol.

The Relays benefit from the following features, which are provided on all products in the Modular range:

- True RMS measurement for instrumentation
- Status inputs with independent pick-up and drop-off timers and logic inversion
- Flexible supply voltage ranges
- Low AC/DC burden
- Multiple independent settings groups
- Self, hand and electrical reset contacts
- Extensive fault, sequence of event and disturbance recorder
- IEC 60870-5-103 fibre-optic communications
- Continuous self-supervision of operation and power supply

Each of these functions is fully specified in the appropriate Technical Reference documentation. The functions provided in a specific model will be confirmed on order, and will be specified in the Diagrams and Parameters documentation for the appropriate product.

1.2 Hardware

1.2.1 Case

The product is housed in a vertical case designed to fit directly into circuit breaker panels. The standard case has a height of 312 mm, a width of 177 mm, and a behind panel depth (with wiring clearance) of 242 mm. An additional 75 mm clearance should be allowed if the fibre optic communications cables are fitted.

The hardware is modular and, for maintenance or upgrade purposes, each module can be withdrawn from the front of the case. Shorting contacts ensure that CT circuits and normally closed contacts remain short-circuited.

1.2.2 User Interface / Fascia

The user interface is designed to provide an easy and user-friendly method of controlling plant, entering settings and retrieving data from the product.

Figure 1-1 Relay in Vertical Size 12 Case

The fascia is hinged on the bottom edge and is secured on the upper edge by two screws at the left and right. A plastic handle is provided to open the fascia door.

Caution. Care should be taken if the door is unscrewed while the relay is mounted in the panel.

Relay Information

The Reyrolle logo appears in the top left corner. At the bottom left an information label is provided which contains the model name, article number, configuration identification, serial number and nominal ratings of energising quantities.

Liquid Crystal Display

A 256 x 128 pixel, graphical, backlit liquid crystal display (LCD) is used to present the bay mimic, plant status, settings, instruments and fault data in a graphical and textual format. The display backlighting is turned off to conserve power if no pushbuttons are pressed for a settable period.

'Protection Healthy' LED

The green LED indicates that the auxiliary supply has been applied to the relay, and that the relay is operating correctly. If a permanent fault is detected by the internal relay watchdog, then this LED will continuously flash.

Indication LEDs

Eight red LEDs allow indication of protection function pick-up or operation, or other functions that the user programs. However, these LEDs are used to display four pages of indications, each with on-screen description of 13 characters, allowing up to 32 alarm/trip/status indications to be displayed.

Each of these virtual LEDs can be defined as self-reset or hand-reset.

Once lit, hand-reset LEDs can be extinguished by pressing the TEST/RESET key, or using IEC 60870-5-103 communications, or by energising a status input that has been programmed to reset latched relays and the trip flag. If the relay powers down the LED indications are retained and when powered up again the LED information is still available.

Keypad

Nine keys are provided to control the plant and the functions of the relay. In common with other Reyrolle products the following keys are provided: ▲, ▼, **ENTER**, **CANCEL** and ▶. In addition, to facilitate the control and monitoring aspects of the Relay, the following keys are provided: **VIEW**, **TEST/RESET**, **I** and **0**.

Keyswitch

A three-position keyswitch, **Local**, **Remote** and **Service**, is provided to set the control and protection status. Further detail of the function of the keyswitch is provided in section 1.3.7.4.

1.2.3 Front Cover

After the relay has been commissioned it is sealed by fixing a clear plastic cover over the front. This allows the user to see the entire front of the product, but only allows access to the ▼, ▶, **VIEW** 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 output relays and the trip LED by using the **TEST/RESET** button.

1.2.4 Current and Voltage Inputs

Current Inputs

Current inputs are used for the current based protections –overcurrent, thermal overload etc. – and for metering purposes.

CTs of 1A and 5A nominal rating may be connected to the inputs.

Voltage Inputs

Voltage inputs are used for voltage protections, check synchronising and metering.

The voltage inputs are appropriate for connection to phase-earth and phase-phase (63.5V and 110V) VTs.

1.2.5 Status Inputs and Output Relays

Status inputs allow digital inputs to the product from plant and supervisory controls whilst output relays are used for tripping, plant control and supervisory indication. The basic input/output provision is three status inputs and five output relays (three of which have changeover contacts). Additional inputs and outputs in blocks of eight are available.

Status Inputs

The status inputs can be programmed to perform one or more of the following functions:

- Switch to an alternative settings group.
- Trigger the storage of a waveform record.
- Trigger operation of the I^2 summation and trip count features.
- Inhibit operation of any one or more protection functions.
- Monitor the health of the tripping circuit.
- Electrical reset of latched output contacts.
- Input into programmable logic and interlocking schemes.
- Monitor the status of plant.
- Provide control inputs.

Additionally, each input can be independently programmed to be inverted (i.e. de-energising the input activates the signal), and operate with time delayed pick-up and/or time delayed drop-off.

Output Relays

Outputs are user programmable to operate from any combination of functions. In their normal mode of operation, output contacts remain energised for the duration of their driving signal, or for a user programmed minimum time of up to 60 seconds. Alternatively, outputs can be programmed to operate as latching contacts if required. Latched output relays can be reset either by pressing the **TEST/RESET** button, by sending an appropriate communications command or electrically via a status input.

1.2.6 Auxiliary Supply

A DC voltage of the appropriate level (or 110v ac if an ac auxiliary is fitted) must be supplied onto the correct terminals on the rear of the case.

1.2.7 Communications

Two pairs of fibre-optic ST™ (BFOC/2.5) bayonet connectors (COM1 and COM2, each made up a transmitter and receiver), optimised for glass-fibre, are fitted to the rear of the case. These are typically used for connection to a

control system. The two ports are redundant in that if one connection fails, communication will automatically be switched to the other port.

A third communications port, with a 25-pin female RS232 connector, is mounted on the fascia. A setting is available to direct the port to either the front, rear, or it can be set to auto detect. When used in this mode the port will automatically switch COM2 from the rear of the case. This port can be used for dialogue communications to ReyDisp Evolution – see section 2.2.

In common with all Modular II products, Relay uses IEC 60870-5-103 as its communications standard.

1.2.8 Terminals

These are of a modular design, consisting of 28 terminals per block. All inputs and outputs (except for the serial communications interface and IRIG B) are made through these connectors.

The rear terminals are designed to take two wires terminated using ring crimps and are secured using M4 screws – see section 3.5.

The identification of the connections to the terminal blocks can be found in the appropriate Diagrams and Parameters Document.

1.2.9 Internal Construction

The interior of the relay is divided into a number of slots, into which modules are inserted – see Figure 1-2.

When a module is inserted into the case, contacts on the rear of the modules mate with contacts on the inside rear of the case. Shorting contacts are provided on CT circuits so CTs remain short circuited when modules are removed.

Coding pins ensure that modules are inserted into the correct slot within the case. In addition, to correctly identify the location of each module, the module article number is printed on the module, and a list of all modules is printed on the inside of the fascia door.

The ability to remove and insert modules in this manner allows replacement or relay upgrade to occur, without the need to remove wiring from the case with the ensuing recommissioning tests.

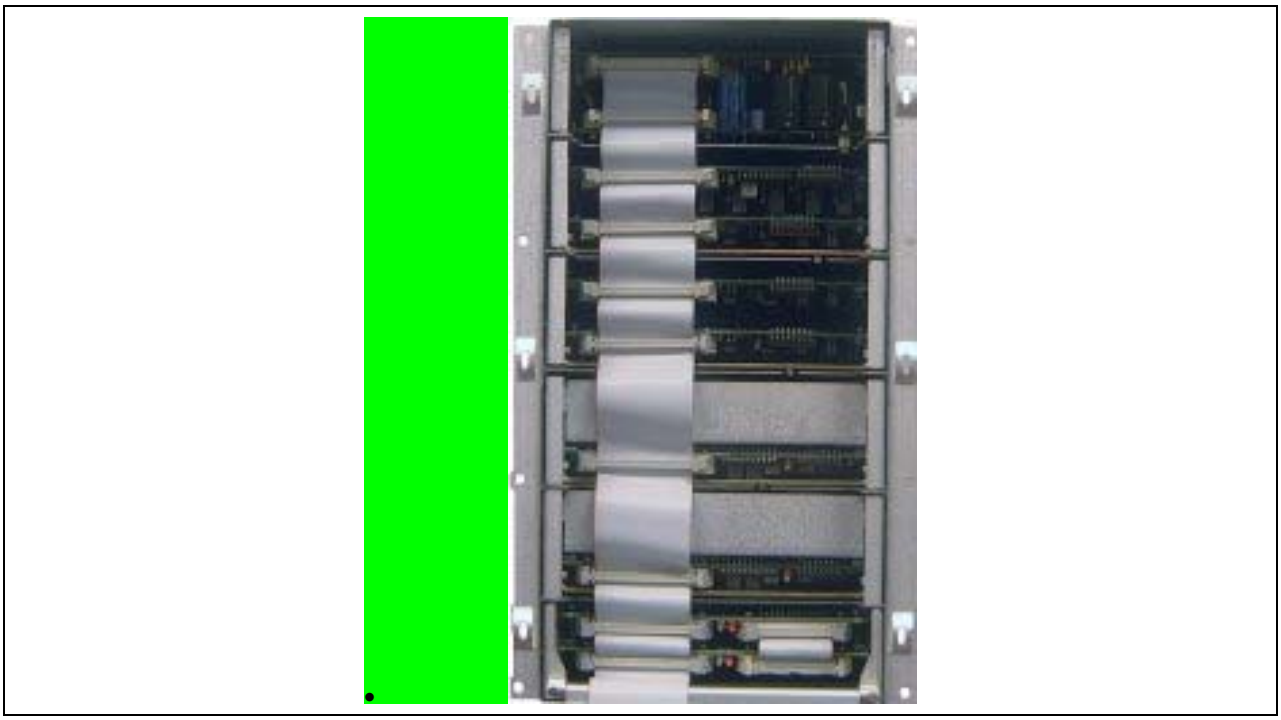

Figure 1-2 Interior of a Relay

The module in the lowest slot contains the fibre-optic connections at the rear, and has the door hinge mounted on it at the front. Therefore, this module is fixed in place.

The modules are connected together with one or more ribbon cables, as illustrated in Figure 1-2.

1.3 Functionality

Although the position of the fascia keyswitch does not affect the operation of the protection functions in the Relay, it can restrict access to this functionality (including output contact operation). See Table 1-1 in section 1.3.7 for detail.

1.3.1 Protection

Available protection functions:

- Overcurrent protection of phase, earth and negative phase sequence currents
- Voltage protection of phase, earth and negative phase sequence voltages
- Directional overcurrent protection
- Voltage controlled overcurrent protection
- Broken conductor detection
- Circuit breaker fail protection
- Thermal / overload protection

1.3.2 Control

Available control functions:

- Auto-reclosing
- Check synchronising
- Manual control of plant
- Plant interlocking
- User defined automation schemes

1.3.3 Plant Monitoring

Primary equipment monitoring functions:

- Trip circuit supervision
- CT supervision
- VT supervision
- External alarms/indications
- Circuit Breaker/Plan position

1.3.4 Measurements

Indicative metering is provided. The instruments available are dependent on the model (VT inputs are required for voltage, power and energy metering), but include:

- Measured instantaneous phase and earth (neutral) currents – primary and secondary values
- Instantaneous negative and zero sequence currents – primary and secondary values
- Measured instantaneous phase-phase voltages – primary and secondary values
- Measured instantaneous phase-earth voltages – primary and secondary values
- Instantaneous negative and zero sequence (neutral displacement) voltages – primary and secondary values
- Maximum, minimum and average demand phase and earth currents – primary values
- Three-phase real, reactive and apparent power and power factor – primary values
- Three-phase real and reactive energy – primary values
- Frequency
- Element pickups
- Status Input and Output Relay status
- CB maintenance data

1.3.5 Metering Accuracy

Currents (I_A, I_B, I_C)	
Tolerance 1% of actual value or 0.5 % In	Range 10% In to 200%In

Voltage(V_{AN}, V_{BN}, V_{CN})	
Tolerance 1% of actual value or 0.5 % In	Range 10% In to 120%In
Active Power, P (Watts)	
Tolerance typically < 3% of Actual value	Range 20%Nom to 120%Nom for cos_ of 0.707 to 1
Reactive Power, Q (Var)	
Tolerance typically < 3% of Actual value	Range 20%Nom to 120%Nom for sin_ of 0.707 to 1
Apparent Power, S (VA)	
Tolerance typically < 3% of Actual value	Range 20%Nom to 120%Nom
Frequency	
Tolerance 1% of Actual value	Range 10Hz – 100Hz

Default instrumentation screens

The menu presentation of the various instruments allows the user to view a single screen at a time. However, for in-service use, it may be desirable for a small number of high interest, user-selected screens to be presented automatically without user intervention, e.g. display of the primary load currents, primary voltages, power flow and the trip count. This can be achieved by setting multiple default screens.

After a user-defined period without a key press, the product will enter default instrument mode and display each default instrument in turn, including the mimic diagram, for a period of 5 seconds each. If default screens are set, the mimic screen will be redrawn after the default screens have gone through the cycle. It takes a few seconds to redraw the mimic screen. Any key press while displaying default instruments will result in a return to the “Mimic” screen at the top of the menu structure. See section 2.1.4 for operation.

1.3.6 System Data

Data records are available in three forms: fault records, waveform records and event records.

1.3.6.1 Time stamping

All records are stamped with time and date using the real-time clock. If the product is de-energised then a capacitor provides a back-up supply to the real-time clock for a limited period. Time and date can be set either via the relay fascia using appropriate commands in the System Configuration menu, using the IRIG-B input, or via the communications interface. In the latter case, relays connected in a communications network can be synchronised by a global command.

Alternatively, synchronising pulses can be received via a status input. Energisation of the appropriate input will result in the clock being synchronised to the nearest second or minute, as appropriate to the controlling device.

1.3.6.2 Fault records

When any protection element operates a fault record is stored and displayed on the Fault Data display, giving the date and time of fault. The fascia LEDs will give indication of the status of all elements at the time of trip. (The first eight indications will be displayed on the LEDs – the **VIEW** key is pressed to view further pages of indications.)

Ten fault records are available, giving time and date of trip, measured quantities and type of fault.

This display is held until the Test/Reset button is pressed, upon which latched LEDs turn off and any latched output relays are reset.

1.3.6.3 Waveform records

Disturbance recorder

The waveform record feature stores analogue and digital information for all current and voltage inputs, status inputs and output relays. Waveform storage is triggered by operation of any protection element. In addition, a record can be triggered remotely via a status input or via the serial communications interface.

The storage capacity can be distributed between number of records and record length as follows: one 5-second record, two 2-second records, or five 1-second records. The pre-trigger percentage of each record can be defined. When all records are full, any new record will overwrite the oldest. All records are time and date stamped. Waveform records are stored in RAM with a capacitor providing back-up during breaks in auxiliary supply.

Twenty-four hour storage

A rolling buffer of storage is used to make two records available, each showing twenty-four hours of data. The first gives the record for the previous calendar day, while the second provides the latest twenty-four hours prior to the time of viewing.

Each of these records gives the following values stored at 1 minute intervals: RMS phase currents, RMS phase-earth voltages, RMS phase-phase voltages and frequency.

1.3.6.4 Sequence of event records

The event recorder allows the time tagging of any change of state. Each event is logged with the full date and time and actual event condition. The following events can be logged:

- Change of setting (though not the detail of the setting change). In addition, indication of which group of settings is active.
- Change of state of output relays
- Change of state of status inputs
- Change of state of any function
- Trip indication reset
- Power on / reset
- Keyswitch position
- Front port accessed

The event storage buffer holds 500 records. When the event buffer is full, then any new record over writes the oldest.

Event records are stored in RAM with a capacitor providing back-up during breaks in auxiliary supply.

The event record store can be erased when viewing the “events stored” instrument screen and pressing the TEST/RESET button.

1.3.7 General

1.3.7.1 Multiple Settings Groups

Eight settings groups are provided, making it possible to edit one group while the product functions operate using another ‘active’ group. The relay can then be switched from one group of settings to another to suit alterations in the power system configuration. A change of group can be achieved either locally at the relay fascia, remotely via a communications interface command or automatically by energisation of a status input. In the case of the latter method, the ‘Settings Group Select’ setting is used to configure any one of the status inputs to select a settings group. The selected group is then made active if the status input is energised and remains active for as long as the input remains energised.

1.3.7.2 Self Monitoring

In common with all Modular products, the Relay incorporates a number of self-monitoring features listed below, each of which initiates a reset sequence that can be used to generate an alarm output. In addition, the Protection Healthy LED gives visual indication.

- Power supply watchdog
- Microprocessor watchdog
- Program and data memory test using CRC
- ADC self-checking
- Change to expected hardware
- Any failure is detected with sufficient time warning so that the microprocessor can be shut down in a safe and controlled manner.

1.3.7.3 Password Feature

The programmable password feature enables the user to enter a four character alphanumeric code. If the user attempts to change a setting, the password is requested before any setting alterations are allowed. Once the password has been validated, the user is said to be “logged on” and any further changes can be made without re-entering the password. If no more changes are made within I hour then the user will automatically be “logged out”,

re-enabling the password feature. Note that the password validation screen also displays a numerical code. If the password is lost or forgotten, this code can be communicated to Reyrolle Protection by authorised personnel, and the password can be retrieved. The relay is supplied with the password set to “NONE” which means the feature is de-activated.

1.3.7.4 Keyswitch Position

The keyswitch provides security for the control functionality of the relay. The following is the philosophy of the keyswitch positions in brief:

- Local – allows plant control and setting changes from the local position. All functions are operating normally.
- Remote – allows plant control and setting changes from the remote position. All functions are operating normally.
- Service – no plant control is allowed. Local setting changes are allowed. Changes to the configuration (e.g. loading new mimic and logic diagrams) are allowed. The protection will not energise any output relays or generate events, but will generate LED flag indication.

Table 1-1 shows the different functionality available when the key switch is in the various positions.

Table 1-1 Keyswitch Functionality

Function		**Key Position**		
		Remote	**Local**	**Service**
View settings	**Local** – fascia keypad or RS232 port	✓	✓	✓
	Remote – rear fibre ports	✓	✓	✓
Change settings	**Local** – fascia keypad or RS232 port		✓	✓
	Remote – rear fibre ports	✓		
Control plant	**Local** – fascia keypad or RS232 port		✓	
	Remote – rear fibre ports	✓		
Protection and automation functions	**Output contacts**	✓	✓	
	Event generation	✓	✓	
	LEDs	✓	✓	✓
Configuration changes				✓
Extract data records – waveforms, stored events, instruments		✓	✓	✓

Section 2: Operation Guide

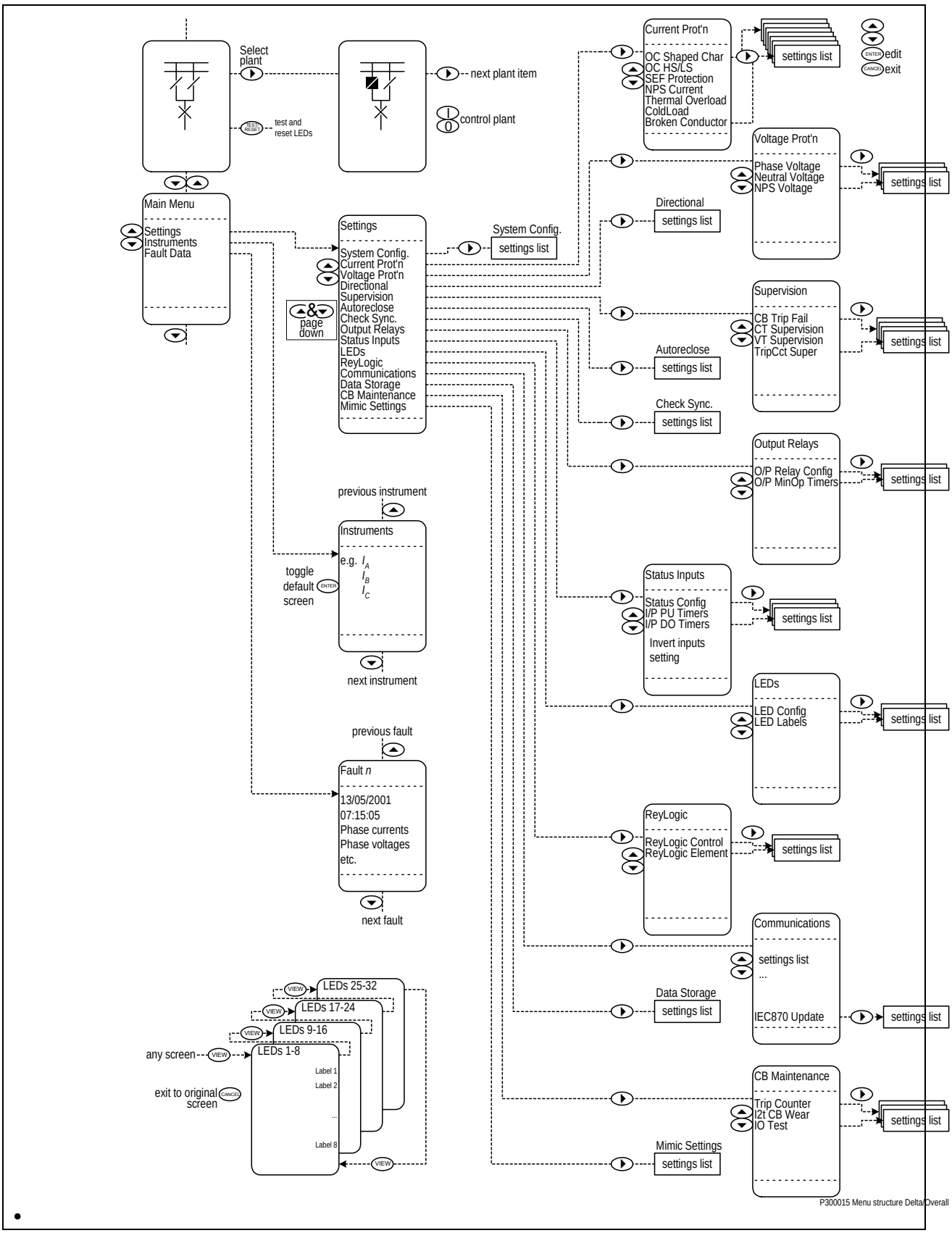

Figure 2-1 Menu Structure

2.1 User Interface Operation

The basic settings/displays flow diagram is shown in Figure 2-1. This diagram shows the plant mimic and control screen and main menu areas: settings, instruments and fault data.

When the relay leaves the factory all data storage areas are cleared and the settings set to default values. When the relay is first powered up the user is presented with a screen stating that the settings are defaulted and an instruction to press the **ENTER** key.

When the **ENTER** key is pressed the screen will display the default mimic screen.

On each subsequent relay power on, the screen that was showing before the last power off will be displayed.

The menu system is navigated as shown in Figure 2-1. This figure is illustrative of the menu structure only. The exact content of the menu system will vary and is given in the appropriate Diagrams and Parameters document.

The ability to carry out various actions is dependent on the keyswitch position (as described in section 1.3.7.4), and this is indicated in *italic text* at the head of each section.

2.1.1 Mimic Display and Control of Plant

Control of plant can occur locally via the HMI (or a PC connected to the fascia RS232 port) or remotely.

2.1.1.1 Local Control

Keyswitch position: ***Local***

Keys used: **I**, **0**, **ENTER** and **CANCEL**

The cover must be removed for local control, since access to the **I**, **0**, **ENTER** and **CANCEL** keys is required.

Control of plant occurs from the mimic display screen. If the mimic is not being displayed the **CANCEL** key should be pressed a number of times (up to 6) in order to display it.

Control of plant requires three discrete steps: select, operate and confirm.

The ▸ key is used to select the plant. A flashing symbol indicates the plant item selected for control. If a number of plant items are controllable successive presses of the ▸ key, selects each item in turn.

When the required plant item is selected, the **0** and **I** keys are used for open and close operations respectively. Pressing the appropriate key does not immediately operate the plant. The operation must then be confirmed with the **ENTER** key.

If the operate and confirm actions do not occur within a limited time period following plant selection, the operation will time out and the plant item will be deselected.

A number of conditions may prevent selection and operation of the plant item, and the presence of these conditions will be indicated with an appropriate message when selection or operation is attempted.

Examples of disabling conditions are:

Key in remote or service position
Blocked by interlocking
Plant timed out (time period from selection of plant has expired)

2.1.1.2 Remote Control

Keyswitch position: ***Remote***

The actions required for remote operation are application dependent and will be described in the operating instructions for the hardware/software used.

2.1.2 Menu System

Keyswitch position: ***Any***

Keys used: ▲, ▼, ▸ and (optionally) **CANCEL**

The menu system is entered from the mimic screen by pressing the ▼ key. If the mimic is not being displayed the **CANCEL** key should be pressed a number of times (up to 6) in order to display it.

Other than the control actions described in section 2.1.1 above, the remainder of the features of the Relay are accessed via the menu system. The actions described here apply to all menu and setting displays.

2.1.2.1 Display Areas

The screen is split into 3 areas while menus are being displayed, see Figure 2-2.

The upper area of the screen displays the date and time and either the relay model or, for lower menu levels, the submenu name.
The main screen area displays the menu items. The currently selected item is highlighted in reverse video. If the list is too long for a single screen, it will be displayed on multiple pages.
The lower area of the screen gives navigational hints. A letter in reverse video (L, R or S) indicates the position of the keyswitch (Local, Remote or Service). If multiple pages are in use for the list the page number and total pages will be indicated, e.g. 1/3 for page 1 of 3 pages. Finally advice on valid keypresses is given, e.g. to select a submenu press the → key.

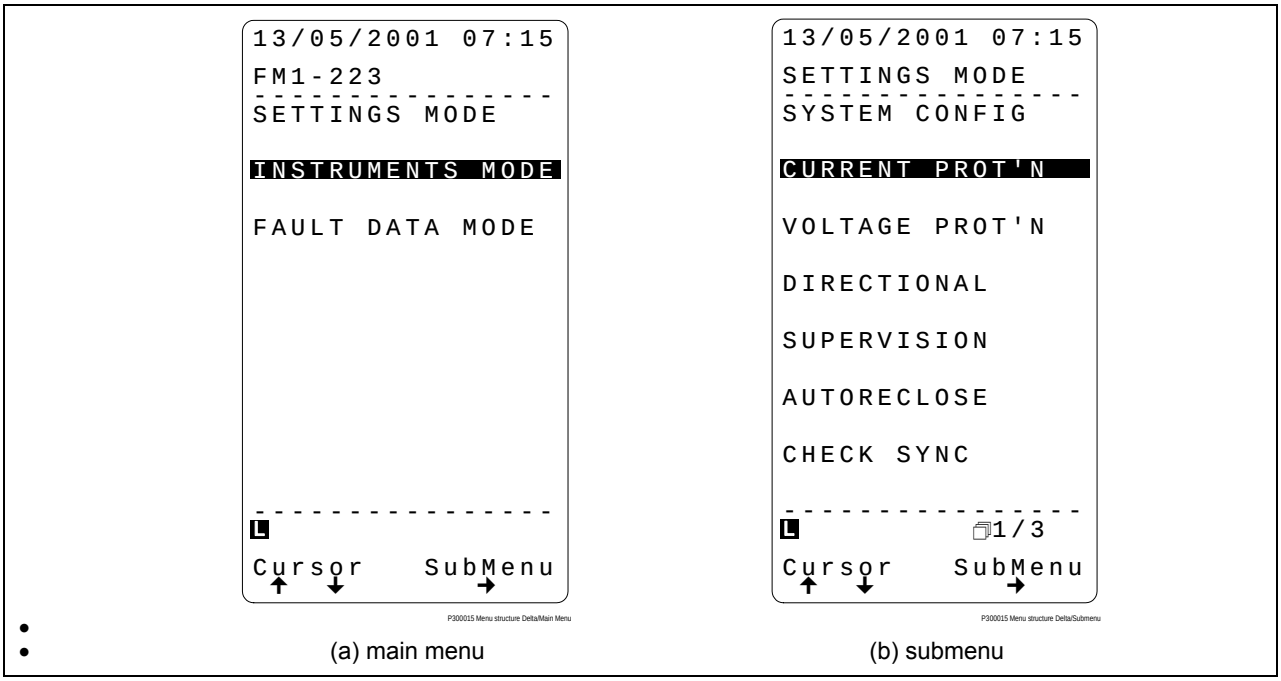

Figure 2-2 Example Menu Screens

2.1.2.2 Menu Navigation

The menu is navigated as follows:

The ▼ key will move the selection down the list of menu items. When the selected setting exits the page at the bottom, the next page in the list will be displayed, unless it is the last page in which case the menu will be exited to the higher menu level.
The ▲ key will move the selection up the list of menu items. When the selected setting exits the page at the top, the previous page in the list will be displayed, unless it is the first page in which case the menu will be exited to the higher menu level.
If the ▲ and ▼ keys are pressed simultaneously the next page in the list will be displayed, unless it is the last page in which case no action will occur.
The **CANCEL** key will exit the menu to the higher menu level.

Further actions are possible when the selected menu item is a setting, and these are described in section 2.1.3 below.

2.1.3 Settings

2.1.3.1 Setting Display

Keyswitch position: ***Any***

Keys used: ▲, ▼, ▶ and (optionally) **CANCEL**

A setting and its current value is displayed by navigating to it according to the menu structure as described above and in Figure 2-1, with reference to the exact settings list in the appropriate Diagrams and Parameters document.

As described in section 1.3.7.1, it should be noted that some settings are grouped, while others apply across all groups. Settings of the latter type are indicated with words 'Setting Common' across the top of the display when the setting is selected. For grouped settings, the group currently being displayed and the currently active group are indicated at the top of the display while the setting is selected. Examples of these are given in Figure 2-3.

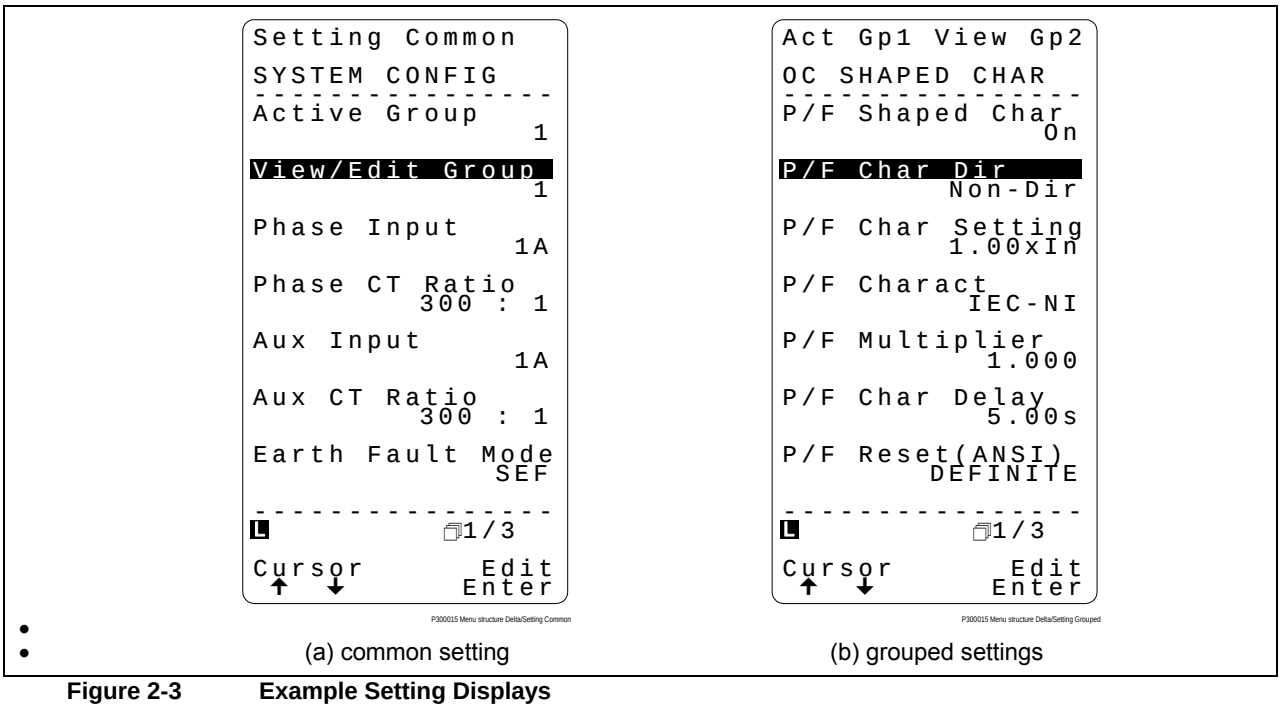

Figure 2-3 Example Setting Displays

2.1.3.2 Setting Edit

Keyswitch position: ***Local*** *or* ***Service***

Keys used: ▲, ▼, ▶, **ENTER** and **CANCEL**

While a setting is selected (highlighted in reverse video) the **ENTER** key can be pressed to edit the setting value. If the relay is password protected you will be asked to enter the password as described below. If an incorrect password is entered, editing will not be permitted. An example of a setting edit display is given in Figure 2-4.

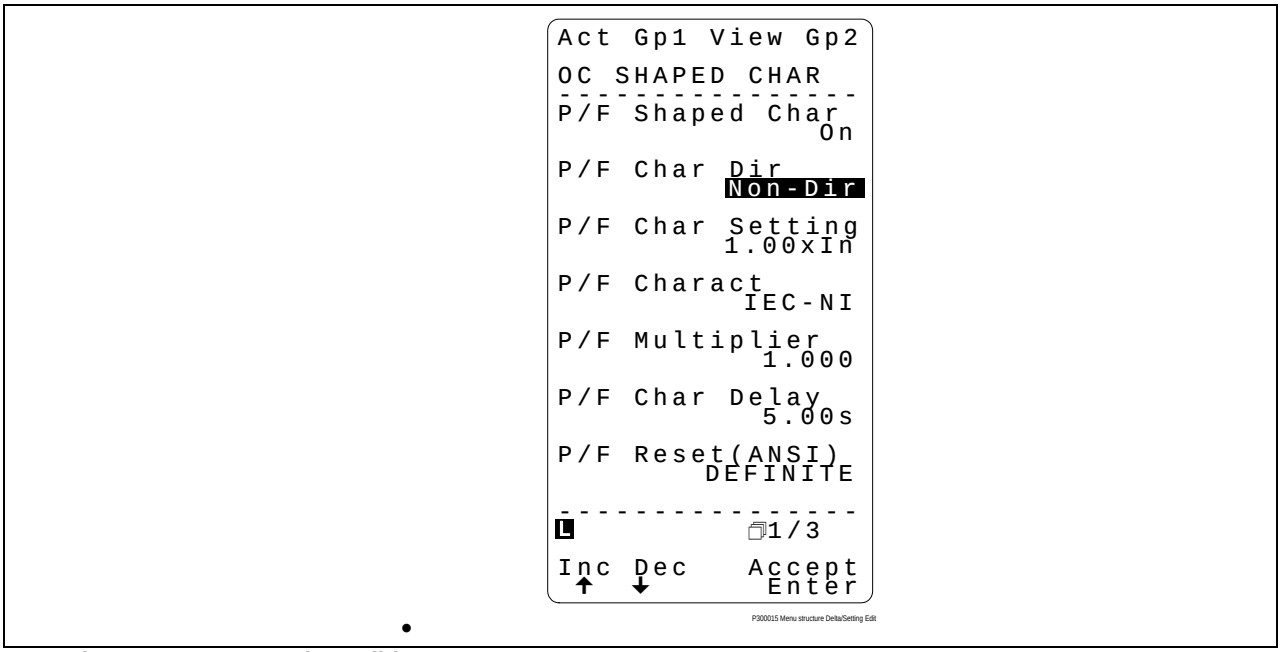

Figure 2-4 Setting Editing

While a setting is being edited, flashing characters indicate the edit field. Pressing the up (▲) and down (▼) keys will increment and decrement the value of the field within the valid limits of the setting. If the up and down keys are held the rate of scrolling will increase.

On a multi-field setting (e.g. text settings or CT ratios), pressing the right (▶) key will move the edit point to the next field.

Once editing is complete, pressing **ENTER** stores the new setting value into the non-volatile memory of the relay. **The setting change is effective immediately**.

During editing, if the **CANCEL** key is pressed, the edit mode is exited, the setting change is discarded and the original value is redisplayed.

Multiple settings groups are stored within the relay, where a group is a set of setting values. Only one of these is active at a time, and only one can be displayed at a time. Some settings have a common value across all groups. The active and view groups are indicated at the top of the LCD screen during display of and editing settings.

The active group can be switched from one to another using the 'Active Group' setting in the 'System Config.' sub-menu. Similarly, the current display group is controlled by the 'Display Group' setting.

Password entry

If, at any point, a password is required the screen will display 'Enter password' and a four-character field. The password is entered, as described for settings changes above. On pressing **ENTER**, if the password is correct, the user is "logged in" and editing will be allowed. The user will remain logged in for an hour after the last key press, after which they will be "logged out". The password must then be re-entered for further changes.

To change the password the 'Change Password' setting in the 'System Config.' sub-menu should be edited. If an attempt is made to change the password, the user will first be logged out and will have to log in again (to prove authenticity). After changing the setting the user will be asked to confirm the password by re-entering it.

If no password has been set, the text 'NOT ACTIVE' will be shown as the setting value of the 'Change Password' setting. If a password has been set, the setting value will be shown as either a 7 or 8 digit number. If the password is forgotten, this can be communicated to Siemens Protection Devices Ltd. by an authorised person, from which the password can be decoded.

If a password has been set, it can be removed by entering the value 'NONE' into the 'Change Password' setting.

2.1.4 Instruments

Keyswitch position: any

Keys used: ▲, ▼ and **ENTER**

Each instrument screen will display a short list of related instruments, e.g. Figure 2-5.

The upper screen area will display the date and time and the instrument group name. The main screen area will display the individual instruments and their values, which are updated regularly while the instrument is displayed. The lower screen area displays the usual navigational aids.

While an instrument is being displayed the ▲ and ▼ keys will move to the previous (or next) instrument screen; **CANCEL** will exit the instrument screens to the main menu.

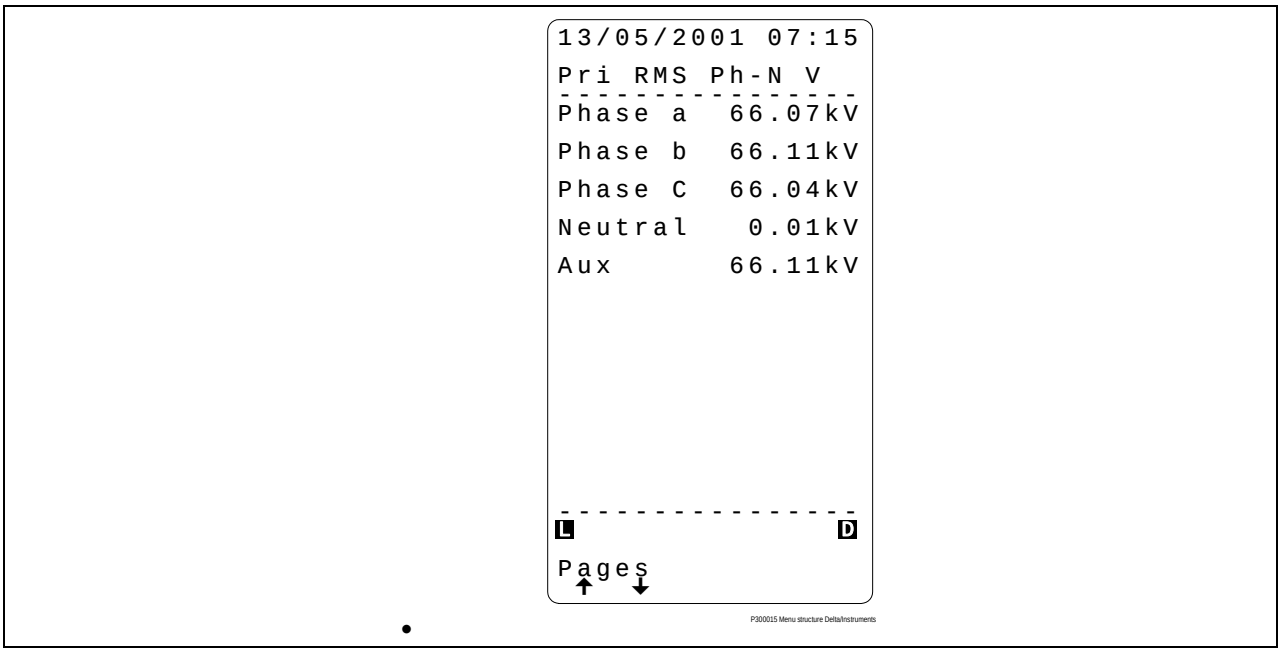

Figure 2-5 Instrument Display

Default Instruments

When an instrument is being displayed, pressing **ENTER** toggles its "default instrument" status on and off.

A default instrument is one that is displayed automatically by the relay after no keys have been pressed for a period. A number of default instruments can be set in which case they will be cycled in turn. The period before the default instruments are displayed is controlled by the 'Default Screens Timer' setting in the 'System Config.' menu.

If an instrument is set as a default instrument this is indicated by a 'D' in the lower screen area, as shown in Figure 2-5.

While a default instrument is being displayed, pressing any key will exit to the mimic display screen.

2.1.5 Fault Displays

Keyswitch position: ***Any***

Keys used: ▲ and ▼

The Relay records information about faults, and these can be displayed using the Fault Data mode, as shown in Figure 2-6.

The screen displays, in textual format, the date and time of trip, the active setting group and the current (and voltage) magnitudes at the time of trip. Pressing the **VIEW** key displays the status of the first page of flag LEDs at the time of trip. Subsequent keypresses of the **VIEW** key displays further pages.

The ▲ and ▼ keys will move to the previous (or next) fault display screen; **CANCEL** will exit to the main menu.

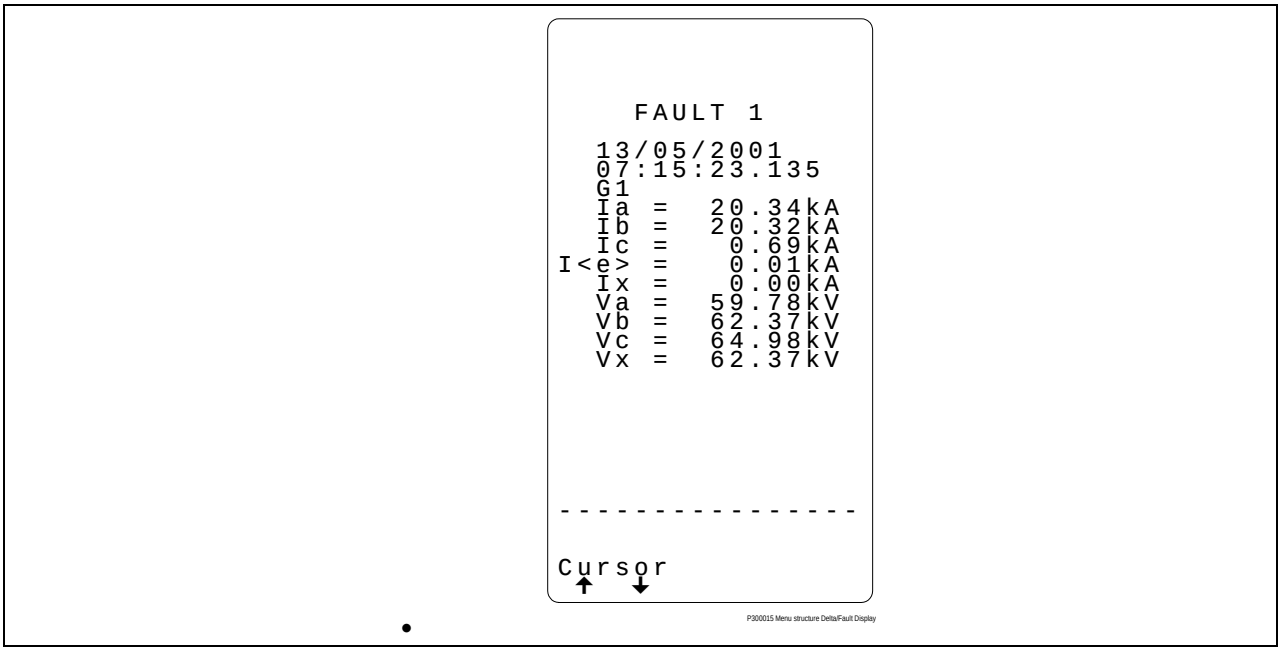

Figure 2-6 Fault Data Display

2.1.6 Viewing and Resetting Flag LEDs

Keyswitch position: ***Any***

Keys used: **VIEW**, **TEST/RESET**, ▼ and (optionally) **CANCEL**

View LEDs

Eight physical flag LEDs represent up to 32 logical flag signals, in four pages of eight. Therefore, each physical LED represents up to four logical flag signals. When a logical flag signal is active, the appropriate physical LED will be lit.

The text for the appropriate flag can be viewed by pressing the **VIEW** key. Pressing this key will cause the first page of logical LEDs with an active flag to be displayed. The screen will list the appropriate labels alongside each. Further presses of the **VIEW** key will cause subsequent pages to be displayed, unless there are no further pages with active LEDs.

The LED pages are exited with the ▼ or **CANCEL** keys.

By default logical LEDs will be hand reset, i.e. they will remain active even after the driving signal is removed. However, each logical LED may be programmed as self reset, and will be deactivated immediately the driving signal is removed.

Reset LEDs and Relay Contacts

Hand reset LEDs can be reset locally from the fascia or remotely. The LEDs are reset locally from the mimic screen display by pressing the **TEST/RESET** key. When this key is pressed, all physical LEDs will be lit briefly then extinguished. Following the test if any logical LEDs remain active, their associated physical LED will be re-energised.

Note that when the **TEST/RESET** key is pressed any hand reset output contacts will also be reset.

2.1.7 Operation with Front Cover Fitted

Keyswitch position: ***Any***

Keys used: ▼, ▶, **TEST/RESET** and **VIEW**

When the clear plastic cover is fitted, only the ▼, ▶, **TEST/RESET** and **VIEW** keys are accessible, using through cover buttons. These buttons are profiled to prevent inadvertent operation of the keys and are best pressed using a reversed pencil or pen.

Referring to Figure 2-1, it can be seen that all areas of the menu can be accessed using these keys, but that settings cannot be changed and plant control is not possible.

2.1.8 Contrast Adjustment

Keyswitch position: ***Any***

Keys used: ▼, ▲ and ▶

If the text on the LCD cannot be read adequately, the contrast can be adjusted using the following keypresses:

▶ and ▲ keys together – increase contrast
▶ and ▼ keys together – decrease contrast

The contrast can be adjusted in one direction and then the ▲ or ▼ key released, while the ▶ key remains held. If the contrast needs to be adjusted in the other direction the other key (▲ or ▼) is pressed. When the contrast is correct, release all keys.

If the adjustment must be performed with the cover on only the ▲ keys is not accessible. If an overshoot occurs and the correct contrast is missed, continue to hold both keys and eventually the contrast will wraparound. As the correct contrast is approached, release the ▼ key while continuing to hold the ▶ key. Then press the ▼ key for short periods until the correct contrast is reached.

2.2 Operation using ReyDisp Evolution

ReyDisp Evolution provides the means to achieve the following:

- Get (upload) a settings file from the Relay
- Download a settings file to the Relay
- Change individual settings
- Get the active group number
- Set the active group number
- Monitor for events and display them spontaneously
- Upload the complete events file from the Relay
- Clear the events file
- Upload waveform records from the Relay
- Trigger waveform recording
- Clear waveform records
- Continuously display instruments i.e. meters, counters, relay status etc.
- Get system data (hardware and software details) from the Relay
- Reset all flags

Send commands to the relay. Allows user to access the command set of the Relay which includes synchronise the clock, change settings group, trip and close circuit breakers, enable and disable auto-reclose functions and protection elements

The ReyDisp Evolution software can be used with all Modular II and Argus protection relays supplied by Siemens Protection Devices Ltd.

Use of the ReyDisp Evolution software is menu driven, with the settings, events, waveforms, instruments and commands all being available in separate menus.

The settings are displayed in the same order as on the relay fascia, however some menus and settings are hidden, e.g. Comms Interface.

2.2.1 Keyswitch Position

Refer to Table 1-1 on page 11 for the functionality which is available through ReyDisp when the key is in various positions. Note that the fascia RS232 port is considered a local position, while the rear fibre ports are considered remote.

Section 3: Installation

3.1 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 be not removed from the case. To prevent the possible ingress of dirt, the sealed polythene bag should not be opened until the relay is to be used.

If damage has been sustained, a claim should immediately be made against the carrier, also inform Siemens Protection Devices Ltd. and the nearest Siemens agent.

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. When modules are withdrawn from the case, static handling procedures should be observed. If any modules are damaged due to incorrect handling, Siemens Protection Devices Ltd. reserves the right to charge for any subsequent repairs.

If it should be necessary to remove a module from the case follow the instructions in section 5.2.

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

3.2 Recommended Mounting Position

The relay uses a liquid crystal display (LCD) which is used in programming and for operation. The LCD has a vertical viewing angle of ±30° 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.

3.3 Relay Dimensions and Weight

The Relays are supplied in the modular size 12 case.

The following drawing is available which gives panel cutout and mounting details.

- 2995X10013 Overall Dimensions and Panel Drilling for Vertical Size 12 Epsilon Case
- Unpacked weight 8.8 kg.

3.4 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.

3.4.1 Communications

IEC 60870-5-103

Fibre-optic ST™ (BFOC/2.5) bayonet connectors – 4 per product. Glass fibre is recommended for all distances.

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

IRIG-B

A BNC plug is provided to connect a daisy chained 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 RG58 500 ohms.

3.5 Fixings

3.5.1 Crimps

Davico ring tongue with 90 deg bend

Table 3-1 Wire crimp sizes

Wire Size	Davico
0.25 to 1.6 mm^2	DVR1-4 (90 deg)
1.0 to 2.6 mm^2	DVR2-4 (90 deg)

3.5.2 Panel Fixing Screws

Kit ZA0005-062 comprising of:

- Screw Pan Head M4x10mm (Black) ZB5364-101 2off
- Nut M4 2103F11040 2off
- Lock washer 2104F70040 2off

Four kits are required.

3.6 Ancillary Equipment

The relay can be interrogated locally or remotely by making connection to the fibre optic terminals on the rear of the relay. For local interrogation a portable PC with a fibre to RS232 modem is required. The PC must be capable of running Microsoft Windows Ver 3.1 or greater, and it must have a standard RS232 port. A USB-RS232 adapter, or a suitable PCMC1A RS232 adaptor, can be used to drive the modem. For remote communications more specialised equipment is required see the section on Communications.

Section 4: Commissioning

4.1 Before Testing

4.1.1 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.

4.1.2 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 equipment.

When cabling and wiring is complete, 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 supply or test supplies.

When 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.

4.1.3 Test Equipment

Required test equipment is:

- 500V Insulation resistance test set.
- 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 relays d.c. status 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 section 2.2) 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. This method is particularly useful when auto-reclose sequences are being checked.

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

4.1.4 Precautions

Before electrical testing commences the equipment should be isolated from the current and voltage 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 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 and voltage transformers has been correctly set in the System Config. menu of the relay.

4.1.5 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 must be programmed correctly before any scheme tests are carried out.

Many relays feature multiple settings groups, only one of which is active at a time. In applications where more than one settings group is to be used then 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 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'.

Elsewhere in the settings menu system, those settings that can be altered for different groups are indicated by the symbols G1, G2 etc. in the top left of the display. All other settings are common to all groups.

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.

4.2 Tests

4.2.1 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: Relay Description for information on programming the relay.

4.2.2 Insulation Tests

Remove the relevant earth links before carrying out each insulation tests. Isolate the auxiliary supplies and remove trip and intertrip links. **Ensure all links are reconnected following the tests.**

Connect together all of the C.T. terminals and measure the insulation resistance between these terminals and all other relay terminals connected together and to earth.

Connect together all of the V.T. terminals (where appropriate) and measure the insulation resistance between these terminals and all other relay terminals connected together and to earth.

Connect together the terminals of the DC auxiliary supply circuit and measure the insulation resistance between these terminals and all other relay terminals connected together and to earth.

Connect together the terminals of the DC status input circuits and measure the insulation resistance between these terminals and all other relay terminals connected together and to earth.

Connect together the terminals of the output relay circuits and measure the insulation resistance between these terminals and all other relay terminals connected together and to earth.

Satisfactory values for the various readings depend upon the amount of wiring concerned. Where considerable multi-core wiring is involved a reading of 2.5 to 3.0 megohms can be considered satisfactory. For short lengths of

wiring higher values can be expected. A value of 1.0 megohm should not be considered satisfactory and should be investigated.

Remove temporary connections.

4.2.3 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 the appropriate Technical Reference 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.

4.2.4 Status Inputs

The operation of the status input(s) can be monitored on the 'Status input' display shown in 'Instruments Mode'. Inject the required supply voltage into each status input and check for correct operation. Depending on the application, each status input may be programmed to perform a specific function, each status should be checked to prove that its mapping and functionality is as set.

Where the pick-up and/or drop-off timers associated with a status input are set to user scheme required delays these delays should be checked either as part of the scheme logic or individually. To check a status pick-up time delay, temporarily map the status to an output relay that has a normally open contact. Use an external timer and time the interval between status energisation and closure of the output contacts.

To measure the drop-off delay, map to an output relay that has a normally closed contact, time the interval between status 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 status input and the operate time of the output relay.

4.2.5 Output Relays

A minimum of five output relays is provided. Three of these have change over contacts; the remainder have normally open or normally closed contacts.

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

4.2.6 Primary Injection Tests

Primary injection tests are essential to check the ratio and polarity of the transformers as well as the secondary wiring.

Note. If the current transformers associated with the protection are located in power transformer bushings it may not be possible to apply test connections between the current transformer and the power transformer windings. Primary injection is needed, however, to verify the polarity of the CTs. In these circumstances primary current must be injected through the associated power transformer winding. It may be necessary to short circuit another winding in order to allow current to flow. During these primary injection tests the injected current is likely to be small due to the impedance of the transformer.

4.3 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's.

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

If the Relay is to be used for remote (SCADA) control, ensure the key is turned to 'Remote'.

Remove the key and replace the relay cover.

Where possible the relay settings should be down loaded to a computer and a printout of the settings produced. This should then be compared against the required settings.

Section 5: Testing and Maintenance

Modular II 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:-

Visual inspection of the metering display
1. Operation of output contacts
2. 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 one of its agents) should be contacted – see defect report sheet in section 5.3.

If Siemens Protection Devices Ltd. recommend removal or replacement of a module the procedure below should be followed.

5.2.1 Module Handling Precautions

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. When modules are withdrawn from the case, static handling procedures should be observed. If any modules are damaged due to incorrect handling, Siemens Protection Devices Ltd. reserves the right to charge for any subsequent repairs. To open doors, remove screws from the top right and left corners

- When removing a module from the relay case, or handling a module, the user must be correctly earthed using an appropriate wrist strap and earthing point.
- Before removing a module from the relay case, the user must first ensure that he is at the same potential as the relay by touching the case.
- Modules should be handled using the metal chassis.
- Modules must be packed for transport in an anti-static container.
- Ensure that anyone else handling the modules is at the same potential.

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

5.2.2 Removal of a Module

Read and follow the advice in section 5.2.1 above when removing modules from the relay.

Power off the relay.

Open the fascia door of the relay. It may be necessary to remove two screws from the upper edge of the fascia in order to achieve this.

Unplug the ribbon cable(s) from the modules, starting at the top, until the module to be removed has been disconnected. The remaining modules can be left plugged in. To unplug the ribbon cable from each module, move the latches at the left and right of the plug outwards. This will eject the ribbon socket from the plug on the module.

Slide the module from the relay, following the module handling precautions. Place the module on an anti-static mat, on an earthed metal surface, or, preferably, into an anti-static bag.

5.2.3 Insertion of a Module

Read and follow the advice in section 5.2.1 above when inserting modules into the relay.

Most modules have DIL switch banks. It is important that these switches are set to the correct position before inserting a module into the case.

If the original module is available, ensure that all switch banks on the replacement module match the original. If the original module is not available, contact Siemens Protection Devices Ltd. for advice on setting the switches.

Slide the module into the appropriate slot until the contacts engage with those in the rear of the case, and the module is fully home. Each module has a coding pin to ensure it is fitted in the correct slot. If this pin prevents module insertion check that the correct slot has been selected. If necessary, contact Siemens Protection Devices Ltd. for advice.

Insert any further modules using the above procedure. After all modules have been inserted plug the ribbon cable(s) into the appropriate plug on each module, ensuring the connector latches are correctly locked.

The relay fascia door can then be closed, screwed shut and the relay powered on.

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 representative.
Protection Healthy LED flashes	General failure. Contact a Siemens 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 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.	Default instruments are enabled. Remove all instruments from the default list and only add those that are required. (See section 1.3.4).
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 connected to the correct port (COM1 or COM2) and that COM2 is pointing correctly to the front or rear port. If any auto settings are set, ensure that no other ports have control.
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.
Relay displays "Status Input/Output has changed - please confirm"	Pressing enter to accept change. If I/O configuration has not been changed then check ribbon cables are correctly seated.

If the above checklist does not help in correcting the problem please contact your nearest Siemens representative.

5.4 Defect Report

To report a problem, please contact your nearest SIEMENS Regional Office.

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2004/7	Fourth Issue: Added additional comms menu, class 2 measurands and demand storage
2004/5	Third Issue: Added AC burdens for SEF/REF inputs
2003/10	Second Issue
2002/12	First issue

Software Revision History

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Section 1: Performance Specification

1.1 General

1.1.1 CE Conformity

CE This product is CE compliant to relevant EU directives.

1.1.2 Reference

This product complies with IEC 60255-3, IEC 60255-6 and IEC 60255-12.

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
Frequency	nominal
Ambient temperature	20 °C

1.1.3 Dimensions and Weights

Refer to document P20015 section 3.3.

1.2 Energising Quantities

1.2.1 Characteristic Energising Quantities

Thermal Withstand

Overload Period	Overload Current			
	Phase and Earth		SEF/REF	
	1A	5A	1A	5A
Continuous	3.0 x In		2.0 x In	
10 minutes	3.5 x In			
5 minutes	4.0 x In			
3 minutes	5.0 x In			
2 minutes	6.0 x In			
3 seconds	57.7A	230A	37.5A	202A
2 seconds	70.7A	282A	46A	247A
1 second	100A	400A	65A	350A
1 cycle	700A	2500A	120A	600A

AC Voltage

	Nominal	Operating Range
Vn	110 V	300 V continuous

1.2.2 Auxiliary Energising Quantity

1.2.2.1 Auxiliary Power Supply

	Nominal	Operating Range
V_{AUX}	30 VDC	24 to 37.5 VDC
	48 / 110 VDC	37.5 to 137.5 VDC
	220 VDC	175 to 290 VDC
	110 VAC	82.5 to 137.5 VAC

1.2.2.2 Status (Digital) Inputs

	Nominal	Operating Range
V_{ST}	30/34 VDC	24 to 37.5 VDC
	48/54 VDC	37.5 to 60 VDC
	110/125 VDC	87.5 to 137.5 VDC
	220/250 VDC	175 to 280 VDC

To meet the requirements of ESI 48-4 at the higher voltage levels, then 48V status inputs should be ordered together with external dropper resistors as follows:-

Status Input External Dropper Resistors

Nominal Operating Voltage	Resistor Value; Rating
110 / 125 V	2K7 ± 5 %; 2.5 W
220 / 250 V	8K2 ± 5 %; 6.0 W

Performance

Attribute		Value
Minimum DC current for operation	V_{ST} = 30 – 54 V	10 mA
	V_{ST} = 110 – 250 V	< 5 mA
Reset/Operate voltage ratio		≥ 90 %
Typical response time		< 5 ms
Fixed slow response time		15 ms
Typical response time when programmed to energise an output relay contact		< 15 ms
Minimum pulse duration		40 ms

Each status input, other than the three on the power supply module which are fixed slow, can provide immunity to AC by selection of a suitable time delay setting. When set to reject AC these inputs will not respond to the following:

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

The status inputs with nominal voltage of 30 V to 54 V meet the requirements of ESI48-4 ESI 1.

1.2.3 Burdens

D.C. Burden

Attribute		Value
DC Burden	Quiescent (typical)	12 W
	Quiescent (back light)	19 W

CT. Burden

Attribute	Value			
	Phase and Earth		SEF/REF	
	1A	5A	1A	5A
AC Burden	≤ 0.1 VA	≤ 0.3 VA	≤ 0.15 VA	≤ 0.25 VA

VT. Burden

Attribute		Value
AC Burden		≤ 0.01 VA at 110 V

1.3 Output Contacts

Contact rating to IEC 60255-0-2

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

1.4 Functional Performance

1.4.1 Instrumentation

	Instrument Value	Reference	Typical accuracy
I	Current	*I* ≥ 0.1 x*In*	± 1 % *In*
V	Voltage	*V* ≥ 0.8 x*Vn*	± 1 % *Vn*
	Power, real and apparent	*V* = *Vn*, *I* ≥ 0.1 x*In*, *pf* ≥ 0.8	± 3 % *Pn*, where *Pn* = *Vn* x *In*
pf	Power factor	*V* = *Vn*, *I* ≥ 0.1 x*In*, *pf* ≥ 0.8	± 0.05

1.4.2 IEC 60870-5-103 Communication Interface

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

1.4.3 Real Time Clock

1.4.3.1 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	± 20 ppm (equivalent to ± 72 ms per hour)

1.4.3.2 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

1.5 Environmental Performance

1.5.1 General

1.5.1.1 Temperature

IEC 60068-2-1/2

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

1.5.1.2 Humidity

IEC 60068-2-3

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

1.5.1.3 Insulation

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

1.5.1.4 IP Ratings

Type	Level
Installed with cover on	IP 51
Installed with cover removed	IP 30

1.5.2 Immunity

1.5.2.1 Auxiliary DC Supply Variation

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

1.5.2.2 High Frequency Disturbance

IEC 60255-22-1 Class III

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

1.5.2.3 Electrostatic Discharge

IEC 60255-22-2 Class IV

Type	Level	Variation
Contact discharge	8.0 kV	≤ 5 %

1.5.2.4 Radiated Immunity

IEC 60255-22-3 Class III

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

1.5.2.5 Fast Transients

IEC 60255-22-4 Class IV

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

1.5.2.6 Surge Immunity

IEC 60255-22-5

Type	Level	Variation
Between all terminals and earth, or between any two independent circuits	4.0 kV, 1.2/50 μs or 8/20 μs	≤ 10 %

1.5.2.7 Conducted Radio Frequency Interference

IEC 60255-22-6

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

1.5.3 Emissions

IEC 60255-25

1.5.3.1 Radiated Radio Frequency

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

1.5.3.2 Conducted Radio Frequency

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

1.5.4 Mechanical

1.5.4.1 Vibration (Sinusoidal)

IEC 60255-21-1 Class I

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

1.5.4.2 Shock and Bump

IEC 60255-21-2 Class I

Type	Level	Variation
Shock response	5 gn, 11 ms	≤ 5 %

Type	Level	Variation
Shock withstand	15 gn, 11 ms	
Bump test	10 gn, 16 ms	

1.5.4.3 Seismic

IEC 60255-21-3 Class I

Type	Level	Variation
Seismic response	1 gn	≤ 5 %

1.5.4.4 Mechanical Classification

Type	Level
Durability	> 10^6 operations

Section 2: Functional Description

2.1 Introduction

This section describes features of Modular II products that are commonly found across a number of products in the range.

Separate documents are available, which specify and describe protection functions. The Diagrams and Parameters document for a product lists explicitly the functions that are provided within the product, and provides references to the appropriate reference document for that function.

2.1.1 Document Organisation

The remainder of Section 2: Functional Description is organised as follows:

Table 2-1 Overview of Functional Description Sections

Section		Description
2.2	Configuration	Configuration of for system requirements: system frequency, CT/VT ratios, identifiers, password etc.
2.11	Status Inputs and Relay Outputs	Pick-up and drop-off timers, inversion, latching and minimum energise time.
2.12	Communications	Communication with PC or control system.
2.13	Data Storage	Event, fault and waveform records.
2.14	Maintenance	Assistance for maintenance of circuit breakers, protection schemes and the relay.

Notes

1. Within Section 2: Functional Description the following notational and formatting conventions are used:
- **Setting:** *Elem* Setting name
- **Setting value:** value
- **Alternatives:** **[1st] [2nd] [3rd]**

2. The purpose of this document is to describe the generic capabilities and functionality of the Modular II platform. Separate User Manual documents describe how to set up and operate products, while individual Technical References describe each protection function in detail.

2.2 Configuration

This section provides advice for configuring the product to suit the overall requirements of the system and the protection scheme: system frequency, CT/VT ratios, identifiers, date/time, password etc.

2.2.1 Multiple Settings Groups

Settings are used to parameterise the relay protection and configuration. Multiple sets of setting values can be stored in the relay with one set active at any time. Uses of these multiple setting groups include summer and winter settings, embedded generation in/out, earthing transformer switched in/out etc.

It is possible to edit one setting group while a different setting group is active, specified by **Active Group** and **View/Edit Group**.

Note that not all settings are duplicated in each group, e.g. status input and output relay configurations are common across all groups. This will be indicated on the relay LCD when the setting is displayed.

Table 2-2 Typical Settings for Settings Groups

Sub-menu: **System Config**

Setting name	Range (**bold** = default)	Units	Notes
Active Group	**1**,2…8		
View/Edit Group			

2.2.2 Current and Voltage Inputs

Most products require settings to correctly calculate primary current and voltage quantities. These may include the input (e.g. 1, 2 or 5 A) and CT/VT ratio.

The text of these settings is product dependent, e.g. for a transformer protection there will be multiple settings to cater for each winding, but typical settings are given in Table 2-3.

2.2.2.1 Current Inputs

Each 3-phase or single-phase CT set will require the following settings. The ***Elem*** prefix specifies to what the settings apply, e.g. **Phase**, **Earth**, **Aux** etc.

***Elem* CT** specifies the CT ratio. This setting is normally used for calculation of primary quantities for instrumentation and waveform record purposes. On most products, multiple inputs are provided to allow use with CTs with 1 and 5 A secondary windings; ***Elem* Input** specifies the input used.

Table 2-3 Typical Settings Current Inputs

Setting name	Range (**bold** = default)			Units	Notes
***Elem* Input**	**1**, 5			A	*Not required on single range inputs.*
***Elem* CT Ratio**	5, 10, 15…**300**…10000	**:**	**1**, 2, 5		*Range is typical only – some products may differ.*
Earth Fault Mode	**SEF**, REF				*Models with SEF element only*

2.2.2.2 Voltage Inputs

Used only in products with a voltage input – refer to Diagrams and Parameters document.

Each 3-phase or single-phase VT set will require the following settings. The ***Elem*** prefix specifies to what the settings apply, e.g. **Phase**, **Aux** etc.

***Elem* VT** specifies the VT ratio. This setting is normally used for calculation of primary quantities for instrumentation and waveform record purposes.

Some products apply voltage undervoltage and overvoltage settings in direct voltage, while others apply them relative to a nominal reference voltage. With this latter type, **Nominal Voltage** allows the reference voltage to be applied.

Products with 3-phase VT inputs may also have a Voltage Config setting that allows selection of the VTconnection between 3 phase-earth and 3 phase-phase with separate neutral voltage input.

Table 2-4 Typical Settings Voltage Inputs

Setting name	Range (**bold** = default)			Units	Notes
***Elem* VT**	3300, 3400…10000, 10500…13000, 14000 …**132000**…140000 , 145000…200000, 210000…500000, 550000…1000000	**:**	40.0, 40.5 …**110.0** …160.0		*Range is typical only – some products may differ.*
Voltage Config	**Van,Vbn,Vcn** ; Vab,Vbc,3Vo ; Va,Vb,Vc				

2.2.3 Settings Group Select

2.2.3.1 Temporary Activation of Setting Group

The active group can be temporarily changed to a new one, specified by **Sett Grp Select**, by energising the **Select Sett Grp** status input. When the status input is de-energised, the settings group reverts to the previously active group, specified by **Active Group**. This group change can be inhibited by energising the **Inhibit Sel Grp** status input.

Table 2-5 Typical Settings for Settings Group Selection

Sub-menu: **System Config**

Setting name	Range (**bold** = default)	Units	Notes
Sett Grp Select	**1**,2…8		

Sub-menu: **Status Inputs**

Setting name	Range (**bold** = default)	Units	Notes
Select Sett Grp	_, 1 for each status input		
Inhibit Sel Grp			

2.2.4 Real Time Clock

The date and time can be programmed and are then maintained by the internal real time clock, while the device is powered, and while it is de-energised. Additionally, in order to maintain synchronism within a substation, all devices can be synchronised to the nearest second or minute using the IRIG-B input or using the IEC 60870-5-103 protocol.

The default date is set at 01/01/1980 deliberately to indicate the date has not yet been set. When editing the **Time**, only the hours and minutes can be edited. When the user presses **ENTER** after editing the seconds are zeroed and the clock begins counting.

In addition, on some products, synchronisation can occur through energisation of a status input. **Clock Sync. From Status** specifies whether the clock will be synchronised to the nearest minute or second when the status input is activated.

Table 2-6 Typical Settings Real Time Clock

Setting name	Range (**bold** = default)	Units	Notes
Date	DD/MM/YY (**01/01/1980**)		
Time	HH:MM:SS (**00:00:00**)		
Clock Sync. From Status	Disabled, **Minutes**, Seconds		*Not provided on all products*
Sub-menu: **Status Inputs**			
Clock Sync.	_, 1for each status input (default: _ _ _ _ _ _ _ _ _)		

2.2.5 Backlight Timer

When a user leaves the relay the backlight will turn off to conserve the substation battery. The time before this occurs is programmable with **Backlight Timer**.

Table 2-7 Typical Setting Backlight Timer

Setting name	Range (**bold** = default)	Units	Notes
Backlight Timer	Off, 1, 2, **5**, 10, 15, 30, 60	min	

2.2.6 Default Screens

When a user leaves the relay it will switch to default screens, whereby a selected number of screens (typically instruments) are displayed in turn without user intervention. The time before this occurs is programmable with **Default Screens Timer**.

The instruments which are displayed in the default metering cycle are individually selected on each instruments screen using the **ENTER** key. This is described in detail in the User Manual document.

Table 2-8 Typical Setting Default Screens

Setting name	Range (**bold** = default)	Units	Notes
Default Screens Timer	**Off**, 1, 2, 5, 10, 15, 30, 60	min	

2.2.7 Password

All settings on Modular II products can be password protected using the Alpha character set. When the user leaves the device untouched for an hour, the password protection is enabled. The setting is changed using the **Change Password** setting.

Table 2-9 Typical Setting Password

Setting name	Range (**bold** = default)	Units	Notes
Change Password	ABCDEFGHIJKLMNOPQRSTUV WXYZ for 4 characters (**NONE**)		

2.2.8 Identifier

Identifying text can be programmed into the relay using the **Relay Identifier** setting. This text is displayed on the title screen and is used in communications with ReyDisp to identify the device.

Table 2-10 Typical Setting Identifier

Setting name	Range (**bold** = default)	Units	Notes
Relay Identifier	ABCDEFGHIJKLMNOPQRSTUV WXYZ0123456789-+/' ' for 16 characters		

2.3 Status inputs, Relay Outputs and Flag LEDs

Status inputs and relay outputs are all user programmable. The settings related to each function are described in the relevant section of this document.

The operation of the status inputs and output relays is described below and shown in Figure 2-1 and Figure 2-2 respectively.

Output Relay Configuration

Each output relay can be operated from any of the output elements. The ***Elem*** prefix specifies to what the settings apply, e.g. **Prot Healthy**, **General Trip**, **General Starter, Phase A Trip, Phase, B Trip** etc. Any of the output elements can be set to operate any of the output relays. To set an output relay move to the required output element and select the relay(s) required. Where no output is selected the word **NONE** is indicated.

Hand Reset Output Relays

Relay outputs are self-resetting by default; however each relay output can be individually set to hand reset through the **O/P Relay Config.:**Hand Rst Outputs setting. In this case, the relay latches on operation, and can be released by using the TEST/RESET key on the relay fascia (from the **Relay Identifier** screen), by the communications link, or by energising a status input, as mapped by **O/P Relay Config.:**Reset Leds & Relays.

Output Relay Minimum Energise Time

All relay outputs have a minimum energise time, specified by the **O/P Relay Config.:**Min Op Time n settings.

Status Input Inversion and Delays

Each status input can be programmed for reverse action (i.e. it becomes active when de-energised and inactive when energised) using the **Status Config.:**Inverted Inputs setting.

Each status input can also be programmed with a pick-up and drop-off delay, using the **Status Config.:**Status n P/U Delay and **Status Config.:**Status n D/O Delay settings. The pick-up and drop-off delays are applied following the inversion, i.e. pick-up delay applies to the input becoming active, while drop-off applies to it becoming inactive.

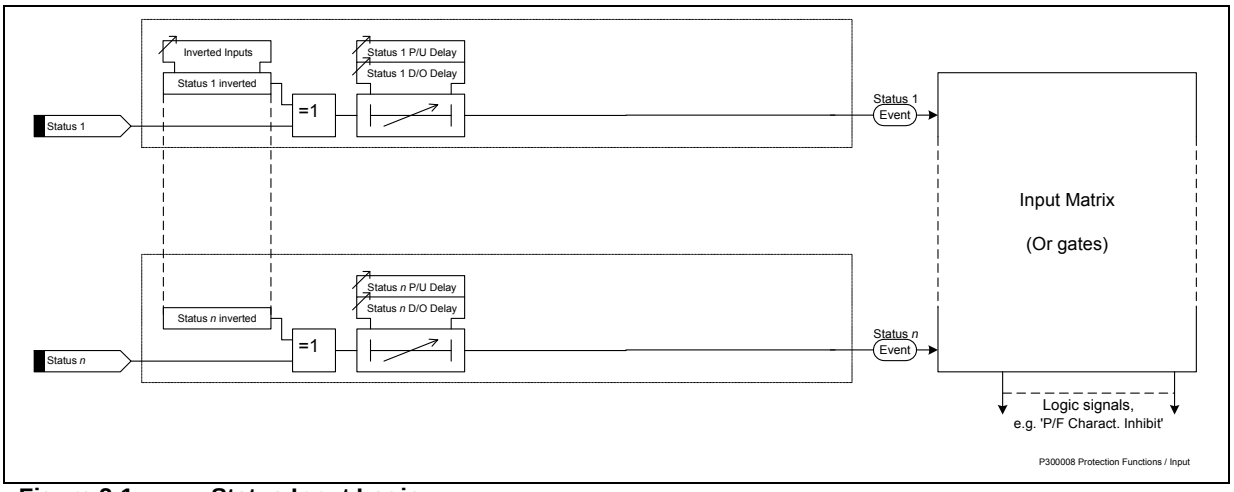

Figure 2-1 Status Input Logic

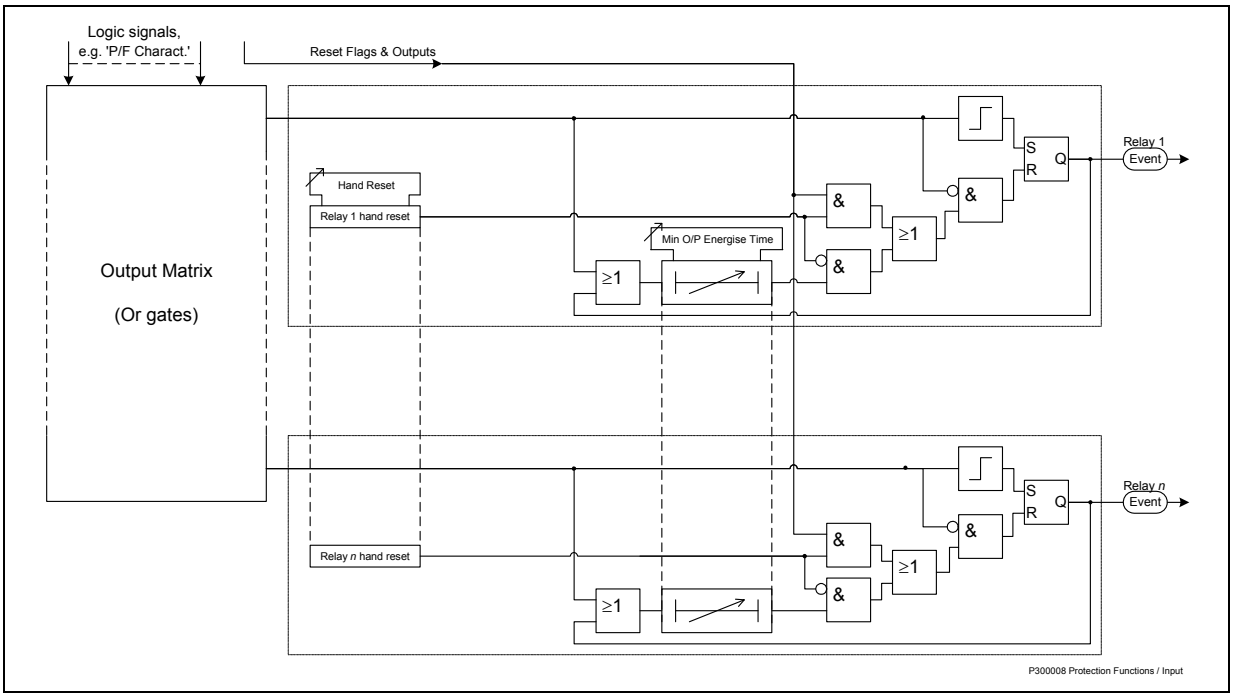

Figure 2-2 Output Relay Logic

Table 2-11 General Output Relay and Status Input Settings

Sub-menu: **Output Relays**

Setting name	Range (**bold** = default)	Units	Notes
Elem, R= 1..n **Hand Rst Outputs R= 1..n**	_, 1 for each output contact (default: _ _ _ _ _ _ _ _ _ _)		*n is the number of output relays present*
Min Op Time *n*	**0.10**, 0.12…2.0, 2.1...20, 21...60	sec	*n is the individual output relay identifier*

Sub-menu: **Status Inputs**

Setting name	Range (**bold** = default)	Units	Notes
Elem, S= 1..n	_, 1 for each status input (default: _ _ _ _ _ _ _ _)		*n is the number of status inputs present*

Setting name	Range (**bold** = default)	Units	Notes
I/P P/U Time *n* **I/P D/O Time *n***	**0.00**, 0.01… 2.0, 2.1…20, 21…60	sec	*Settings of 0.02 for pick-up should be applied to give AC rejection.* *n is the individual status input identifier*
Invert inputs S= 1..n			*n is the individual status input identifier*

2.4 Communications

All settings and information relating to communications with Modular II products, are given in Section 3: Communication Interface.

2.5 Data Storage

Modular II products store three types of data to assist the user in fault evaluation: events, waveforms and faults. Demand meter data is also stored.

Fault records provide textual information on the source of the trip, i.e. the element that tripped, and any elements that were picked up at the time of trip. This gives the first indication of the type of fault.

However, the fault record should be examined in coordination with the event records to see the full sequence of events leading to a trip. It is possible to identify developing and flashing faults using the event records.

If a waveform record is available, the current waveforms (and voltage waveforms in some models) allow the type of fault to be easily identified. However, the waveform record covers a maximum of only 5 seconds, whereas the event records will cover many seconds or minutes. If a fault is of a flashing nature this will be apparent from the event records, however the waveform record may show only the final overcurrent leading to trip.

2.5.1 Event Storage

When an event occurs, a date and time tagged entry is added to the storage buffer. Some of the events that can be stored are indicated in the function diagrams throughout this functional description section. Up to 500 events are stored in a rolling buffer, with the oldest events overwritten. The buffer can be cleared using the **Data Storage:**Clear Events setting.

All events can be obtained through the communications link and are displayed in the ReyDisp package in chronological order, allowing the user to see the sequence of events surrounding a trip. They are also made available spontaneously to an IEC 60870-5-103 compliant control system.

For a complete listing of events available in each model, refer to the appropriate Diagrams and Parameters document.

2.5.2 Fault Storage

Fault storage is a time-tagged textual record of the fault. This contains the phase-neutral current and (if fitted) voltage levels, and LEDs status at the time the fault occurred.

Up to 5 faults are stored in a rolling buffer, with the oldest faults overwritten. The fault storage can be cleared with the **Data Storage:**Clear Faults setting.

2.5.3 Waveform Storage

Waveform storage is a graphical record of analogue current and voltage inputs, status inputs and relay outputs.

The total waveform storage space is 5 seconds, but a setting **Data Storage.:**Record Duration can be used to define how many records this relates to. A waveform record can be externally triggered via the **O/P Relay Config.:**Waveform Trig input.

When a record is triggered some pre-trigger waveform is provided, the percentage of which is specified by the **Data Storage:**Pre-Trigger Storage setting.

Up to 5 waveforms are stored in a rolling buffer, with the oldest waveforms overwritten. The waveform storage can be cleared with the **Data Storage:**Clear Waveforms setting.

2.5.4 Demand Storage

The maximum, minimum and average values for the primary phase A, B and C currents during the previous 24 hrs are stored. Each value is continuously updated over a 5 minute window which is then stored to provide a 24 hr graphical record. Two records are available, one giving the previous 24 hrs and the other recording from midnight to midnight.

Table 2-12 Data Storage Settings

Sub-menu: **Status Config.**

Setting name	Range (**bold** = default)	Units	Notes
Waveform Trig	_, 1 for each status input (default: _ _ _ _ _ _ _ _ _)		

Sub-menu: **Data Storage**

Setting name	Range (**bold** = default)	Units	Notes
Pre-Trigger Storage	10, **20**…90	%	
Record Duration	**5 Records x 1 Second**, 2 Records x 2 Seconds, 1 Record x 5 Seconds		
Trigger Waveform	**NO**, YES		*Yes/No confirmation required*
Clear Waveforms			
Clear Events			
Clear Faults			
Reset Demand			
Reset WHr Met			
Reset Varhr Met			
Energy Ev Level	**OFF**, MW, GW, TW, PW, EW, ZW		
Energy Ev Time	**OFF**, 1.2..60,120..7200,10800..86400	sec	

2.6 CB Maintenance

This section covers features to assist in the maintenance of circuit breakers, the protection scheme and the device itself.

2.6.1 Circuit Breaker Operations

Trip counts and I^2t summation occur for each protection trip. The I^2t summation can also be updated from an external protection trip via a status input.

2.6.1.1 Trip Counter

A trip counter is provided which increments on each trip. This would normally be used to count the number of trip operations performed in total by the Relay.

A suitable maintenance limit value can be chosen from the circuit breaker manufacturer's data and entered into the **CB Maintenance:**Trip Count Alarm setting. When the alarm setting is exceeded, the output relays mapped by **O/P Relay Config.:**Ops Count Alarm are raised.

The count can be reset using **CB Maintenance:**Reset Trip Cnt.

2.6.1.2 Delta Trip Counter

This provides an additional counter, which can be reset independently of the Trip Counter described above. This can then be used, for example, for recording trip operations between visits to a substation.

Its operation is similar to the Trip Counter above, however a different limit setting (**CB Maintenance:**Delta Trip Alarm), and output (**O/P Relay Config.:**Delta Count Alarm) are provided.

The delta trip counter can be reset using **CB Maintenance:**Reset Delta.

2.6.1.3 Sum of I^2t

Circuit breaker contact wear increases with energy broken, therefore I^2t summation provides a good estimation for maintenance purposes. A suitable maintenance limit value can be chosen from the circuit breaker manufacturer's data and entered into the **CB Maintenance:**I^2t Alarm Limit setting

The current flowing at the time of trip is added to individual summations for each phase. If any of these exceed the alarm setting, the output relays mapped by **O/P Relay Config.:**I^2t Count Alarm are raised. An instrument shows the I^2t summation for individual phases.

The time (t) used in the I^2t calculation is derived from the difference of the settings, **CB Maintenance:** Separation Time and **CB Maintenance:**Clearance Time. Separation time is defined as the time from the closure of the relay trip contact(s) to the point at which the CB contacts open. Clearance time is defined as the time from when the CB contacts open to when the fault current is extinguished.

The summation can be reset using **CB Maintenance:**Reset I^2t Count.

2.6.2 Output Relay Test

The output relay test allows the device to activate each output relay contact, as selected in the **O/P Relay Config:**O/P Relay Test setting.

The test is initiated by the **CB Maintenance:**IO Test setting.

Table 2-13 CB Maintenance Menu

Sub-menu: **Status Config.**

Setting name	Range (**bold** = default)	Units	Notes
I^2t Cnt Update	_, 1 for each status input (default: _ _ _ _ _ _ _ _ _)		

Sub-menu: **Trip Counter**

Setting name	Range (**bold** = default)	Units	Notes
Trip Count Alarm	**OFF**, ON		
Delta Trip Alarm			
Reset Trip Cnt	**NO**, YES		
Reset Delta Cnt			

Sub-menu: **I^2t CB Wear**

Setting name	Range (**bold** = default)	Units	Notes
I^2t Counter	**Disabled**, Enabled		
Alarm Limit	**10**, 20..100, 200..20000, 21000..100000	MA^2s	
Separation Time	0, 0.001..**0.020**, 0.021..0.100	sec	
Clearance Time	0, 0.001..**0.040**, 0.021..0.100	sec	
Reset I^2t Count	**NO**, YES		

Sub-menu: **I/O Test**

Setting name	Range (**bold** = default)	Units	Notes
Test O/P Relays	**NO**, YES		

2.6.3 Internal Supervision

The device employs comprehensive supervision of its internal operation, both hardware and software. In the event of any failure, all outputs are de-energised and the relay is shut down in a controlled manner.

Supervision includes a power supply watchdog, code execution watchdog, memory checks by checksum, and processor / ADC health checks.

While the relay is healthy, an output can be given, as specified by the **O/P Relay Config:**Prot Healthy setting. By allocating this output to a normally closed contact, i.e. output relays 1 to 3, an alarm can be generated on relay de-energisation or failure.

If an internal failure is detected, a message will be displayed and the device will reset in an attempt to correct itself. This will result in de-energisation of the protection healthy contact, and flashing of the protection healthy LED.

2.7 Mimic Display

The relay has a graphical display which can be used to mimic, control and interlock the primary plant connected to the relay. The facia display can be configured to customer's specification by using the Reylogic toolbox. The factory default mimic is configured for a double busbar scheme. Alternative schemes can be configured off line and then downloaded to the relay to suit any given application. It is preferable that the mimic information is provided to Siemens Protection Devices Ltd. before the relay is dispatched to allow it to be fully tested, proven and installed on the relay in order to minimise the need for local site configuration.

It is outside the scope of this document to provide information on the configuration of the mimic & logic diagrams. For local site modifications a suitably qualified engineer is required. Training is available at Siemens Protection Devices Ltd.

The setting names displayed in the Mimic Setting menu are created in the mimic diagram, ie ISOLATOR1. When the diagram is loaded into the relay these names appear in the menu automatically. The setting name is the **Plant Identifier,** which is the name given in the mimic diagram. This can be changes locally to provide a more meaningful identifier i.e. circuit name, switch number etc.

Table 2-14 Mimic Settings

Sub-menu: **Mimic Settings.**

Setting name	Range (**bold** = default)	Units	Notes
Plant Identifier	ABCDEFGHIJKLMNOPQRSTUV WXYZ0123456789-+/' '		

Section 3: Communication Interface

3.1 Introduction

Modular II products can communicate with control and automation systems, or with PCs running ReyDisp software, to provide operational information, post-fault analysis and settings interrogation and editing. This section describes how to use the IEC 60870-5-103 compliant Informative Communication Interface with a control system or interrogating computer. Appropriate software within the control system or on the interrogating computer (e.g. ReyDisp Evolution) is required to access the interface.

This section specifies connection details and lists the events, commands and measurands provided in each product as detailed in Diagrams and Parameters section. For further information regarding the interface, reference should be made to the separate Informative Communications Interface manual (reference 434/TM/5), which covers all Reyrolle Protection products.

The same communications interface is used to provide control system connections and for dialogue communications by the Protection Engineer. An appropriate IEC 60870-5-103 control system interface will be required for the former application, while the latter is provided by ReyDisp Evolution software.

3.2 Physical Connection

The Reyrolle Modular II relay range provides two rear communications interfaces COM1 & COM2. COM2 is multiplexed with an RS232 port mounted on the Fascia.

1. COM1: this port is used for IEC60870-5-103 communications to a substation SCADA or integrated control system by default.

2. COM2: this port can also be used for IEC60870-5-103 communications to a substation SCADA or integrated control system. Note however that only one port can be mapped to the IEC60870-5-103 protocol at any one time. (The **COMMS INTERFACE** submenu includes a setting "**IEC60870 on port**", which maps the protocol to either COM1 or COM2). COM2 can also be accessed through an isolated RS232 (female 25-pin D-type) connector on the relay fascia. This provides facilities for access to the relay from a laptop or PC when commissioning or interrogating relays. A "**COM2 Direction**" setting is available which, when set to "**AUTO-DETECT**" automatically allows the front port to take control away from the rear port when a computer is plugged into the D-type connector.

3.2.1.1 Sigma Fibre-optic to RS232 Converters

Siemens Protection Devices Ltd. can provide a range of fibre-optic to RS232 converter devices:

- Sigma 1 – a panel mounting fibre-optic star coupler, for up to up to 29 devices. An RS232 port is available at the front of the device. By default, communication is to the master fibre connections on the rear, however, communication is automatically switched to the front RS232 port when a communicating programme is activated. Each fibre-optic port can be individually selected between 'Light On' and 'Light Off' (see section 3.3.5).
- Sigma 3 – a panel mounting fibre-optic to RS232 converter. Two RS232 ports are available: one at the rear for connection to a modem, and one at the front for connection to a local PC. By default the rear port is active, however, communication is automatically switched to the front port when a communicating programme is activated. The fibre-optic port can be selected between 'Light On' and 'Light Off' (see section 3.3.5).
- Sigma 4 – a portable fibre-optic to RS232 converter.

Full details of the above devices can be found by referring to the website www.reyrolle-protection.com.

3.2.2 Recommended cable

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.

3.2.3 Network Topology

Communication networks can be connected in star or ring format

Figure 3-1 to Figure 3-4 illustrates a number of network arrangements.

3.3 Settings

Communication parameters of **Communications Interface:**Comms Baud Rate, **Communications Interface:**Comms Parity, **Communications Interface**: Line Idle and **Communications Interface**: Data Echo should match those of the communicating device.

3.3.1 Station (Relay) Address

Each relay on a network must have a unique address, between **1** and **254**, as set by the **Communications Interface:** Station Address setting. A relay with the default address of **0** will not be able to communicate.

3.3.2 IEC 870 on port

This allocates IEC 60870-5-103 communication protocol to the selected port. When selected to **AUTO** the relay will monitor Com port 1, if there is no activity it will then check Com port 2. The setting **Line Switch Time** sets the time after which no activity has taken place to switch to the other port.

3.3.3 Baud Rate

Various rates are provided in bits per second. However, only **19200** and **9600** are defined in IEC 60870-5-103, the additional rates are provided for local or modem communications.

The **Communications Interface:**Comms Baud Rate setting should match that of the communicating device.

3.3.4 Com Parity

IEC 60870-5-103 defines transmission as using **Even** parity, however, in some instances an alternative may be required. The **Communications Interface:**Comms Parity setting also allows parity of **ODD** or **None** to be selected. This setting should match that of the communicating device.

3.3.5 Line Idle

The communication medium is fibre-optics, and the IEC60870-5-103 protocol defines a line idle state of **Light On**. Binary '0' is represented by light on, binary '1' is represented by light off and when a device is not communicating it idles with the light on (sending '0').

The above allows detection of a broken fibre condition. When the line is idling, a binary '0' should be received constantly. If binary '1' is received constantly, then no light is being received, hence the fibre may be broken.

The **Communications Interface**: Line Idle setting must be set to be either **ON** or **OFF** to be compatible with the communicating device connected to the relay.

3.3.6 Data Echo

Modular II products may be connected in a ring, e.g. as shown in Figure 3-3. The optical ring architecture requires data to be passed from one relay to the next, therefore when using this method, all relays in the ring must have the **Communications Interface:**Data Echo setting to **ON**.

For devices with individual connections (e.g. Figure 3-1), or connected in a star topology (Figure 3-4), the setting should be set to **OFF**.

3.3.7 COM 2 Direction

The relay communications port COM 2 has a dual output this can be selected to be either a F/O connection at the rear of the relay or it can be directed to the electrical RS232 port at the front of the relay. If set to **AUTO-DETECT** the relay will check either connection for communications activity. If a connection is made to the front port, i.e. Laptop computer, whilst the rear port is connected to a SCADA or similar system the front port will take priority.

Table 3-1 Communications Settings

Sub-menu: **Communications Interface**

Setting name	Range (**bold** = default)	Units	Notes
Station Address	**0**, 1…254		
IEC 870 on port	NONE, **COM 1**, COM 2, AUTO		*See Line Switch Time*

Setting name	Range (**bold** = default)	Units	Notes
Line Switch Time	1,2,..**30**, 31..60	sec	*Only available when IEC 870 on port is set to AUTO*
COM 1 Baud Rate	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, **19200**, 38400, 57600, 115200	baud	
COM 1 Parity	NONE, ODD, **EVEN**		
COM 1 Line Idle	LIGHT ON, **LIGHT OFF**		
COM 1 Data Echo	**OFF**, ON		
COM 2 Baud Rate	75, 110, 150, 300, 600, 1200, 2400, 4800, 9600, **19200**, 38400, 57600, 115200	baud	
COM 2 Parity	NONE, ODD, **EVEN**		
COM 2 Line Idle	LIGHT ON, **LIGHT OFF**		
COM 2 Data Echo	**OFF**, ON		
COM 2 Direction	**AUTO-DETECT,** REAR PORT, FRONT PORT		
IEC 870 UPDATE			*See Sub Menu IEC 870 UPDATE*

3.3.7.1 IEC 870 Update

This is a sub-menu of the Communications Settings Menu and is used to set the Measurand properties.

3.3.7.2 Measurand Type

Two types of Measurand can be selected, Public type 148 Measurand or Private Type 200 Measurands. See the relevant Diagrams and Parameters, Section 3.

3.3.7.3 Class 2 refresh

After this time period a new class 2 measurand is made available.

3.3.7.4 High – Low updates

If during the Class 2 refresh period the measurement moves outside of the set limits a new class 2 measurand is made available.

Table 3-2 IEC 870 update

Sub-menu: IEC 870 UPDATE

Setting name	Range (**bold** = default)	Units	Notes
Measurand Type	**Public 148,** Private 200		
Class 2 Refresh	0, 1.. **30**, 31..60	sec	
Curr High Update	1,2..**5**,6..20	%	
Curr Low Update	1,2..**5**,6..20	%	
Volt High Update	1,2..**5**,6..20	%	
Volt Low Update	1,2..**5**,6..20	%	
Watt High Update	1,2..**5**,6..20	%	
Watt Low Update	1,2..**5**,6..20	%	
Vars High Update	1,2..**5**,6..20	%	
Vars Low Update	1,2..**5**,6..20	%	
Freq High Update	1,2..**5**,6..20	%	
Freq Low Update	1,2..**5**,6..20	%	
Sync Angle High	1,2..**5**,6..20	%	

Setting name	Range (**bold** = default)	Units	Notes
Sync Angle Low	1,2..**5**,6..20	%	

3.4 Modems

The communications interface has been designed to allow data transfer via modems. However, IEC 60870-5-103 defines the data transfer protocol as an 11 bit format of 1 start, 1 stop, 8 data and even parity, which is a mode most commercial modems do not support. High performance modems will support this mode, but are expensive. For this reason, a parity setting is provided to allow use of easily available and relatively inexpensive commercial modems. This will result in a small reduction in data security, and the system will not be compatible with true IEC 60870-5-103 control systems.

3.4.1 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, see Figure 3-2. In this case, two DCE devices (the modem and the fibre-optic converter) are being connected together, so 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 Rx to Relay Tx.

3.4.2 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 the following 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 say 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 this example, 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.

If possible, Data Carrier Detect (DCD) should be forced on, as this control line will be used by the Fibre-optic converter.

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

3.4.3 Connecting to the Remote Modem

Once the remote modem has been configured correctly, it should be possible to dial up the modem and make connection to the relay. As the settings on the remote modem are fixed the local modem should negotiate with it on connection choosing suitable matching settings. If it cannot do this, the local modem should be set with settings equivalent to those of the remote modem as described above.

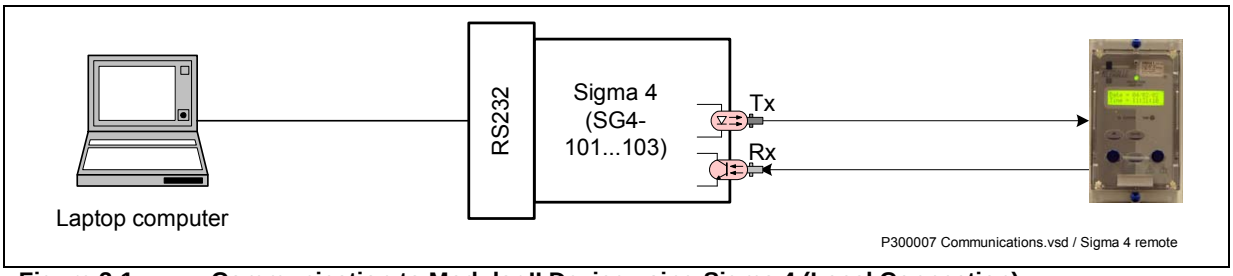

Figure 3-1 Communication to Modular II Device using Sigma 4 (Local Connection)

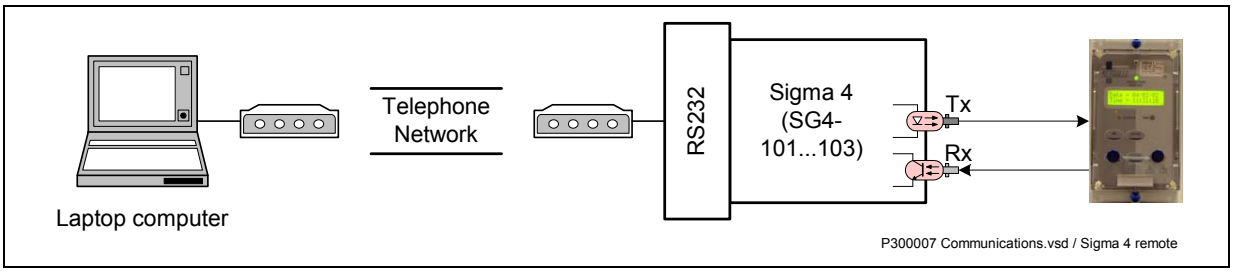

Figure 3-2 Communication to Modular II Device using Sigma 4 and Modem

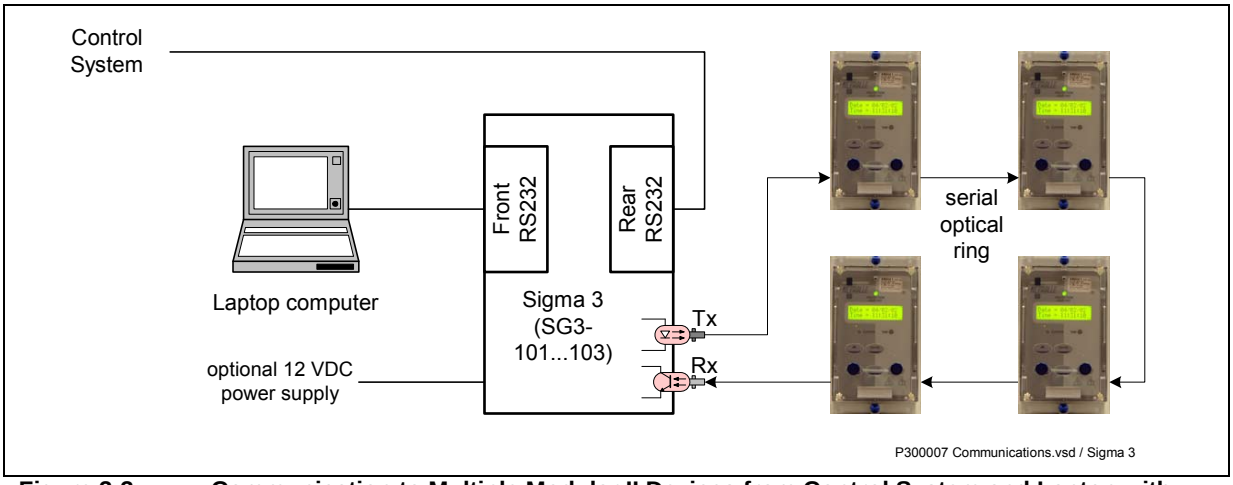

Figure 3-3 Communication to Multiple Modular II Devices from Control System and Laptop with Sigma 3 and Fibre-optic Ring Network

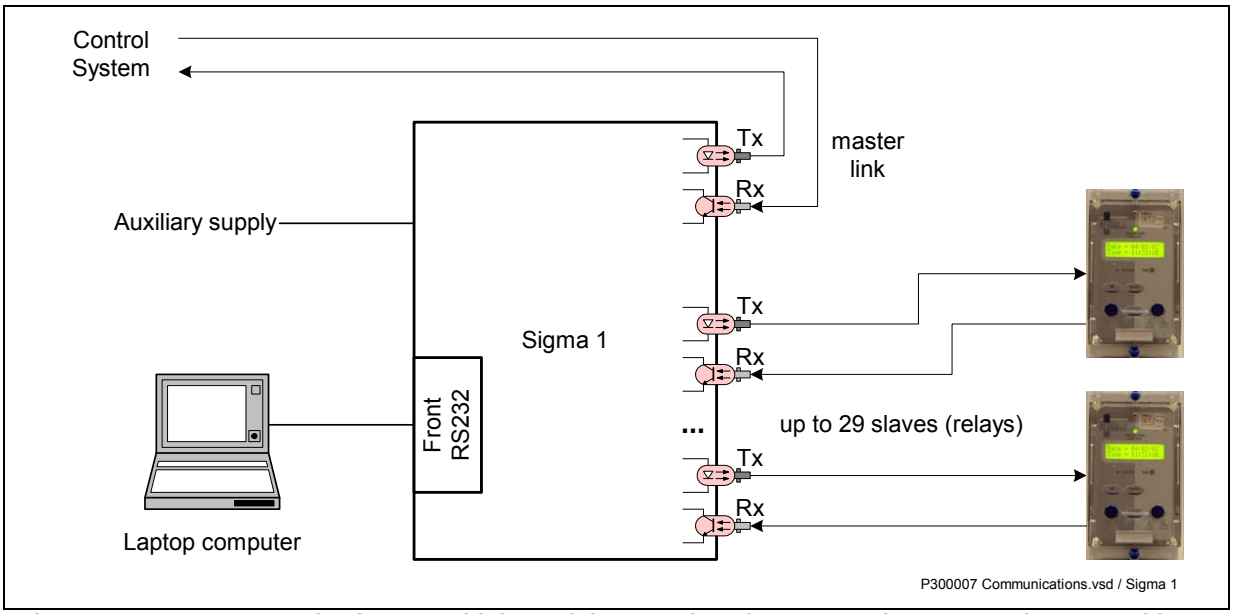

Figure 3-4 Communication to Multiple Modular II Devices from Control System and Laptop with Sigma 1 and Fibre-optic Star Network

3.5 Glossary

Baud Rate
See bits per second.

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.

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.

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.

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 of a byte during data transmission.

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2006/09	“3Vo Input” setting added
2005/12	NPS Over-voltage and Frequency protections added
2005/12	Updated logic diagrams, added NVD applications
2004/03	Revised Performance Specification
2003/02	v2 Page 1: removed invalid references
2003/01	First issue

Software Revision History

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Section 1: Introduction

1.1 Introduction

This document covers the voltage-based protection elements and their applications found in the Modular II range of relays, as listed below. A Diagrams and Parameters document which covers each individual model is available, which lists explicitly the functions that are provided and the manner in which they are connected.

- 27, Phase undervoltage
- 27, Voltage blocking
- 47, Phase sequence voltage
- 59, Phase overvoltage
- 81, Frequency

Notes

1. The following notational and formatting conventions are used within the remainder of this document:
- Setting: Elem *Setting name*
- Setting value: **value**
- Alternatives: [1st] [2nd] [3rd]

2. The purpose of this document is to describe the capabilities and functionality of Overcurrent Protection elements. Separate User Manual documents describe how to set up and operate the equipment: apply configuration, settings and passwords, view instruments and set default instruments, and retrieve fault data.

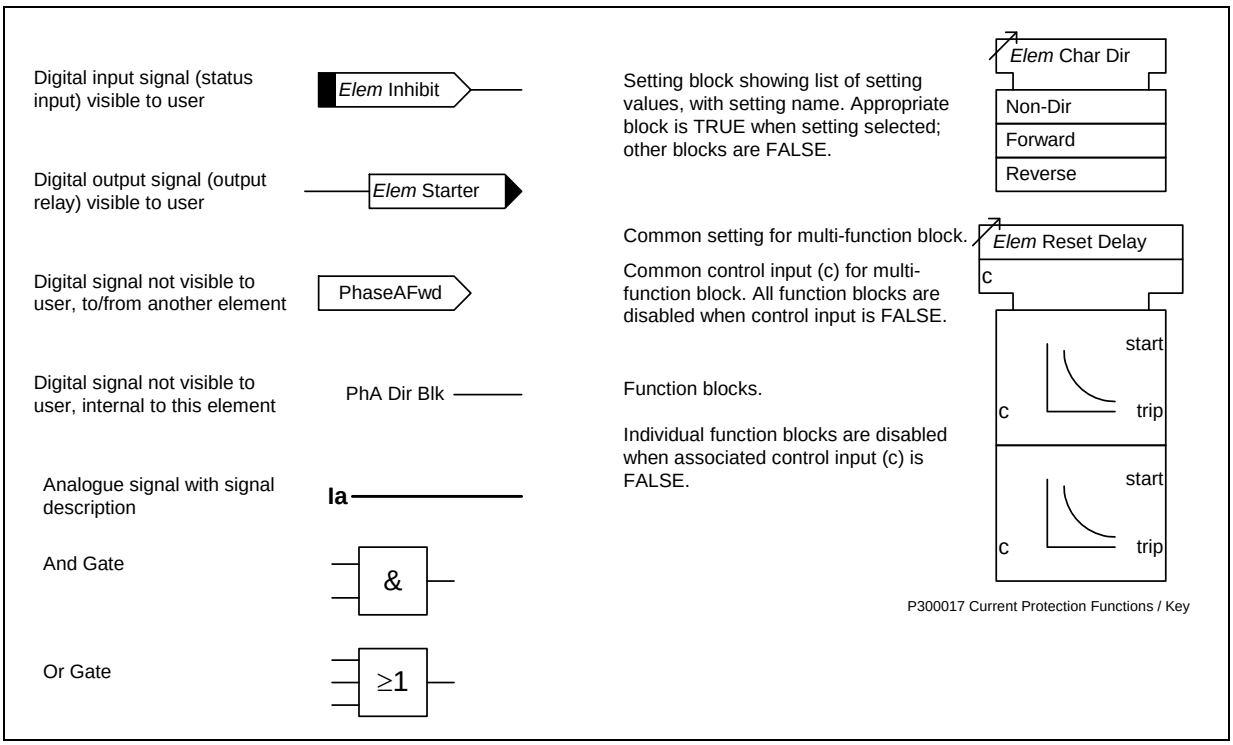

Figure 1-1 Key to Functional Block Diagrams

Section 2: Element Definitions

2.1 Voltage Protection

2.1.1 Phase Undervoltage and Overvoltage Elements (ANSI 27 and 59)

2.1.1.1 Description

Phase overvoltage and undervoltage elements use the same functionality, as shown in Figure 2-1. In some implementations, the sense of the element (undervoltage or overvoltage) can be set by the ***Elem* Operation** setting, while in others it will be pre-defined as undervoltage or overvoltage. If a voltage blocking element is provided, it will inhibit voltage elements.

The elements can be selected to operate either when any of the phase elements are picked-up, or alternatively when all of the phase elements are picked-up. As can be seen in Figure 2-1 this affects the starter and operate outputs.

In some implementations an ***Elem* Hysteresis** setting is provided, which allows the user to vary the pick-up drop-off ratio for the element.

Table 2-1 Typical Settings Phase Voltage Element

Setting name	Range (**bold** = default)	Units	Notes
Volt Input Mode	**Ph-N**, Ph-Ph		
***Elem* Operation**	**Off**, U/V, O/V		
***Elem* Setting**	5.0, 5.5…**55.0**…200.0	V	
***Elem* Hysteresis**	1, **2**…90	%	*This setting is not always provided.*
***Elem* Delay**	**0.0**, 0.1…10.0, 10.5…100, 101 …1000, 1010…10000, 10100 …100000, 101000…864000	s	*The actual setting range may differ from that shown here.*
***Elem* O/P Phases**	**Any**, All		*This setting is not always provided.*
Sub-menu: **Output Relays**			
***Elem* Starter**	_, 1 for each output contact		
***Elem* Trip**			
Sub-menu: **Status Inputs**			
***Elem* Inhibit**	_, 1 for each status input		*The inhibit input is not always provided*

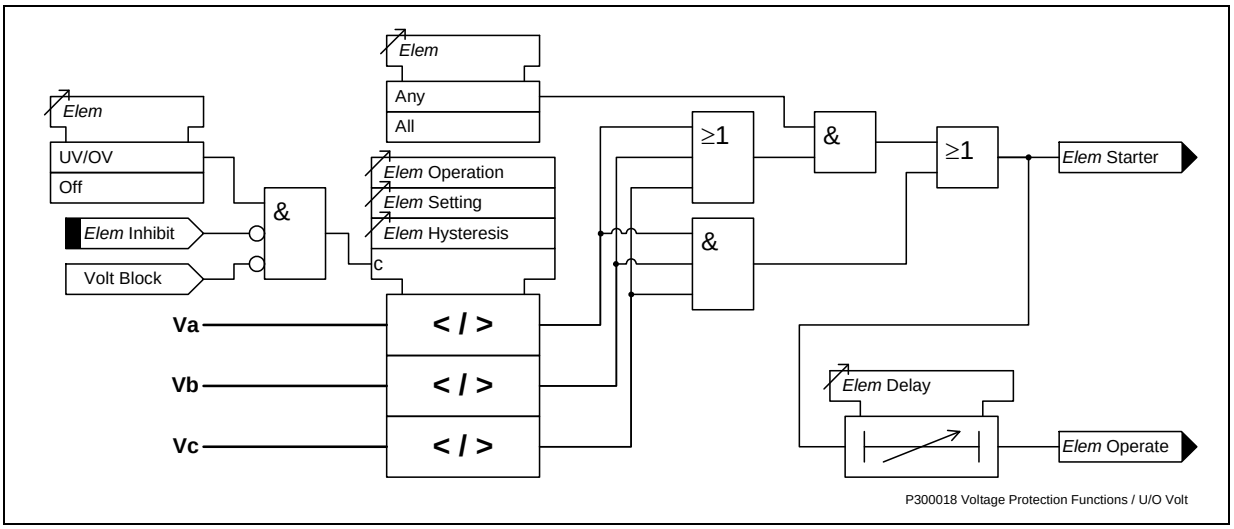

Figure 2-1 Functional Diagram for Phase Voltage Element

2.1.1.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	10 ms
f_{nom}	Nominal frequency	50 Hz

Reference

	Parameter	**Value**
Vn	Nominal voltage	63.5, 110 V
Vs	Absolute settings	55.0 V
hyst	Hysteresis	2 %
t_d	Delay setting	0.0…600.0 s
	Frequency	f_{nom}
	Ambient temperature	20 °C

Operate and Reset Level

	Attribute		**Value**
V_{op}	Operate level		100 % *Vs*, ± 1 % *Vn*
	Reset level	overvoltage	≥ (100 % - *hyst*) x V_{op} ± 1 %
		undervoltage	≤ (100 % + *hyst*) x V_{op} ± 1 %
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

Operate and Reset Time

	Attribute		**Value**
t_{basic}	Element basic operate time	overvoltage	0.9 to 1.1 x*Vs*: 45 ms, ± t_{cycle}
			0.9 to 2.0 x*Vs*: 35 ms, ± t_{cycle}
		undervoltage	1.1 to 0.5 x*Vs*: 60 ms, ± t_{cycle}

	Attribute		Value
t_{op}	Operate time following delay		t_{basic} + t_d, ± 1 % or ± t_{cycle}
	Repeatability		± 1 % or ± t_{cycle}
	Disengaging time		< 100 ms
	Variation	f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

2.1.2 Voltage Blocking Element (ANSI 27)

2.1.2.1 Description

The voltage blocking element acts as a block to the phase and negative sequence voltage elements and frequency elements. If all phase voltages fall below the threshold level then the blocking output will operate.

This element is required mainly for undervoltage operation conditions. Under normal circumstances, if all phase voltages fall below the undervoltage setting, a trip output would be the expected response. However, in some applications e.g. auto-reclose schemes, having an undervoltage relay trip when the line is de-energised during the auto-reclose sequence is not desirable. Blocking the undervoltage operation in this situation can be achieved by using the voltage blocking threshold, which should generally be set above the level of expected induced voltages on the line.

Table 2-2 Typical Settings Voltage Blocking Element

Setting name	Range (**bold** = default)	Units	Notes
Sub-menu: **System Config**			
Volt Block Level	OFF, 1, 2…**5**…100	V	

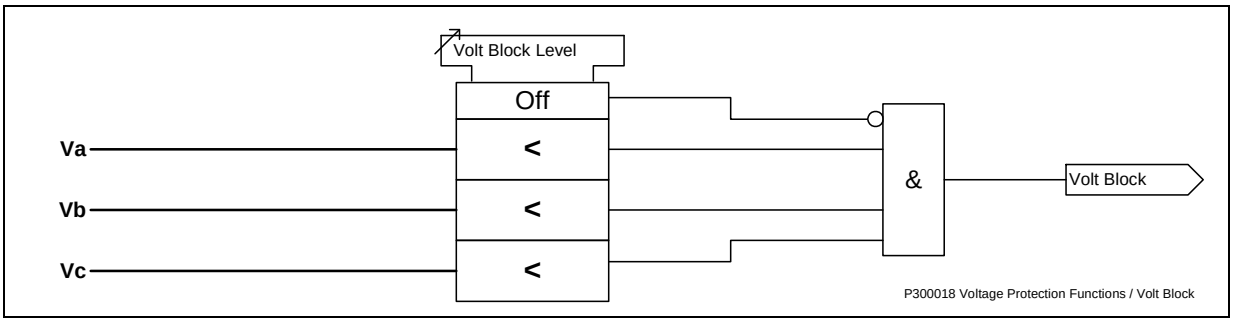

Figure 2-2 Functional Diagram for Voltage Blocking Element

2.1.2.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	Value
t_{cycle}	Element cycle time	5 ms
f_{nom}	Nominal frequency	50 Hz

Reference

	Parameter	Value
Vs	Setting	2.0 V
	Frequency	f_{nom}
	Ambient temperature	20 °C

Operate and Reset Level

	Attribute		**Value**
V_{blk}	Operate level		100 % *Vs*, ± 1 % *Vn*
	Reset level		≤ 105 % V_{blk}
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

2.1.3 Neutral Voltage Displacement Element (ANSI 59N)

2.1.3.1 Description

Neutral Voltage Displacement provides two stages of Earth Fault protection using residual earth voltage. This allows for an alarm to be issued, followed by a trip if the fault is not located and cleared. The two stages can be configured to be either definite time lag (DTL) or inverse definite minimum time (IDMT).

***Elem* Setting** provides the 3V0 level for the starter. A DTL or alternatively an IDMT characteristic of

$t_{op} = \left[\frac{M}{\left[\frac{3V0}{Vs}\right] - 1} \right]$ can be selected using ***Elem* Character**, the multiplier M on the IDMT characteristic is set using the ***Elem* Multiplier** setting; when DTL is selected this is ignored and the ***Elem* Delay** setting is used instead. An instantaneous or definite time delayed reset can be applied using ***Elem* Reset Delay** to cater for flashing faults.

If directional elements are present, additional logic is provided for directional control. ***Elem* Dir** will set the direction in which the element is applied.

It should be noted that neutral voltage displacement can only be achieved for VT arrangements that allow zero sequence flux to flow in the core. i.e. a 5-limb VT or 3 single phase VTs should be used. Another requirement is for the VT primary winding neutral to be earthed to allow earth zero sequence exciting current to flow.

For relay models that do not provide Check Synchronising, the fourth VT input is available for Residual Voltage (3Vo) measurement. If this input is used, the ***3Vo Input*** setting should be set to Measured. Otherwise it should be left as Calculated; even if the Residual Voltage is measured as one of the other 3 VT inputs.

Table 2-3 Typical Settings Neutral Voltage Displacement Element

Setting name	Range (**bold** = default)	Units	Notes
3Vo Input	**Calculated**, Measured		
***Elem* Character**	**Off**, DTL, IDMTL		
***Elem* Dir**	**Non-Dir**, Forward, Reverse		*Requires appropriate directional element to be present*
***Elem* Setting**	1, 1.5…**5.00**…100	V	
***Elem* Delay (DTL)**	**0.00**, 0.01…2.00, 2.1…20.00,21…600	s	
***Elem* Multiplier**	0.1, 0.2…**0.5**…10,10.5…140		
***Elem* Reset Delay**	**INST**, 1, 2…60	s	
Sub-menu: **Output Relays**			
***Elem* Starter**	_, 1 for each output contact		*The starter output is not always provided*
***Elem* Trip**	_, 1 for each output contact		
Sub-menu: **Status Inputs**			
***Elem* Inhibit**	_, 1 for each status input		*The inhibit input is not always provided*

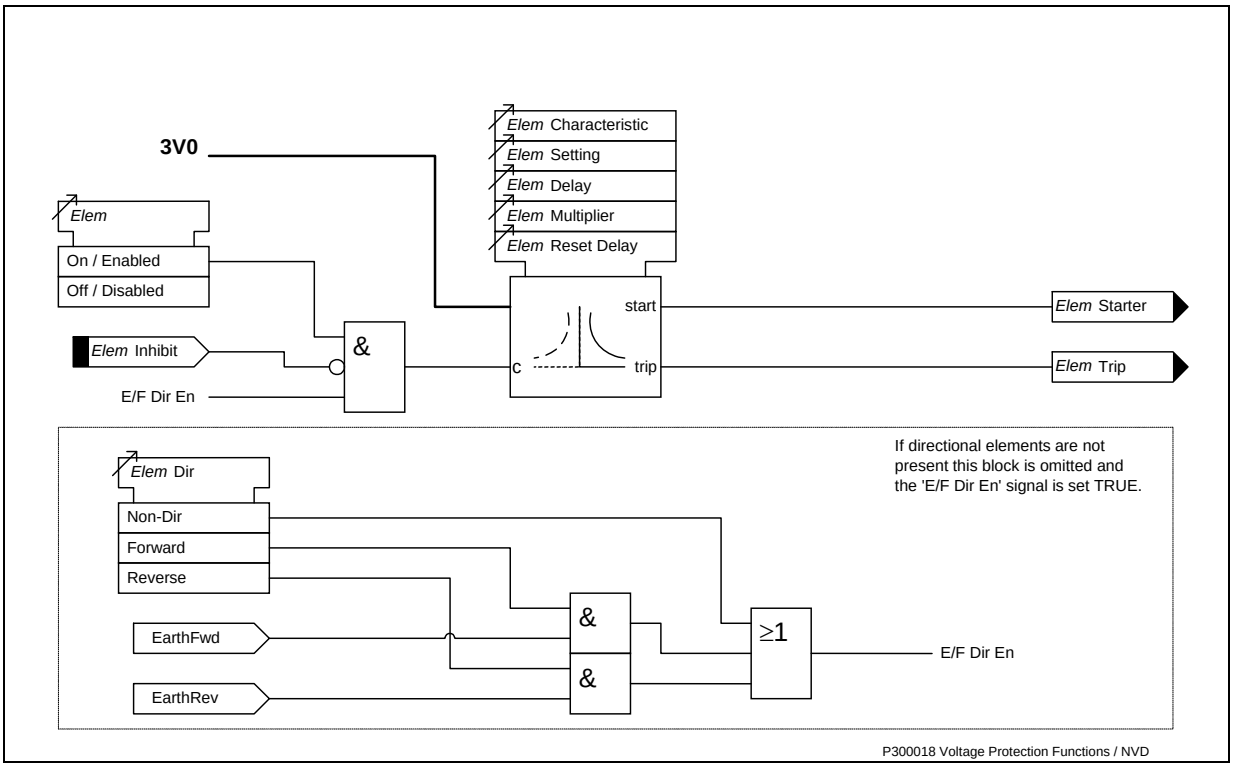

Figure 2-3 Functional Diagram for Neutral Voltage Displacement Element

2.1.3.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	10 ms
f_{nom}	Nominal frequency	50 Hz

Reference

	Parameter		**Value**
Vn	Nominal voltage		63.5, 110 V
Vs	Setting		5V
M	Multiplier		40
t_d	Delay setting		0.00…600.00 s
t_{res}	Reset setting		INST, 1, 2…60 s
3V0	Applied voltage (for operate time)	IDMTL	2 to 20 x*Vs*
		DTL	10 x*Vs*
f_{nom}	Frequency		f_{nom}
	Ambient temperature		20 °C

Operate and Reset Level

	Attribute		**Value**
V_{op}	Operate level	IDMT	105 % *Vs*, ± 2 % or ± 0.5 V
		DTL	100 % Vs, ± 2 % or ± 0.5 V

	Attribute		Value
	Reset level		≥ 95 % V_{op} [1]
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

[1] For NVD settings below 7.5V the reset level can be up to 80% of operate value.

Operate and Reset Time

	Attribute		Value
t_{basic}	Element basic operate time	0V to 1.5 x Vs 0V to 10 x Vs	≤ 43 ms ≤ 38 ms
t_{op}	Operate time		$t_{op} = \frac{M}{\left[\frac{3V0}{Vs}\right]-1}$, ± 5 % or ± 40 ms,
		char = DTL	t_{basic} + t_d, ± 1 % or ± t_{cycle}
t_{res}	Reset time		t_{basic} + t_{res}, ± 1 % or ± t_{cycle}
	Repeatability		± 1 % or ± 10ms
	Overshoot time		< 40 ms
	Disengaging time		< 50 ms
	Variation	f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

2.1.4 Negative Phase Sequence Overvoltage Element (ANSI 47N)

2.1.4.1 Description

The negative sequence component is derived from the three phase voltages. It is a measure of the quantity of unbalanced voltage in the system.

The protection comprises two independent instantaneous elements, each with a follower time delay. These delays can be used to provide time grading margins, sequence co-ordination grading or scheme logic.

***Elem* Setting** provides the voltage level for the element and a follower time delay ***Elem* Delay** is then applied.

Table 2-4 Typical Settings NPS Voltage Element

Setting name	Range (**bold** = default)	Units	Notes
V2-1	**Off**, On		
V2-1 Setting	1.0, 1.5…**20.0**…90	V	
V2-1 Delay	0, 0.01…2.0, 2.1…**5.0**…20, 21…600	s	
V2-2	**Off**, On		
V2-2 Setting	1.0, 1.5…**20.0**…90	V	
V2-2 Delay	0, 0.01…2.0, 2.1…**5.0**…20, 21…600	s	
Sub-menu: **Status Inputs**			
V2-1 Inhibit	_, 1 for each status input		
V2-2 Inhibit			

Setting name	Range (**bold** = default)	Units	Notes
Sub-menu: **Output Relays**			
V2 Starter	_, 1 for each output contact		*Alarm output*
V2-1 Operate			*Trip output if enabled*
V2-2 Operate			*Trip output if enabled*

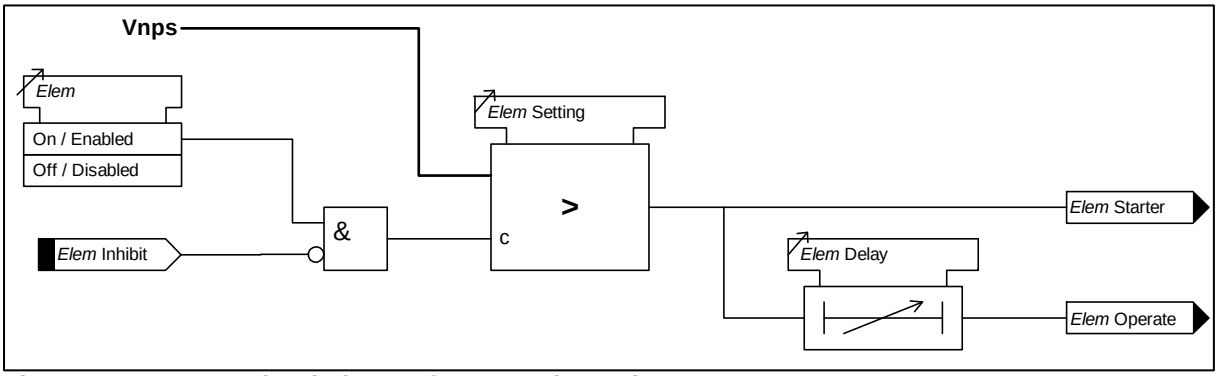

Figure 2-4 Functional Diagram for NPS Voltage Element

2.1.4.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	10 ms
f_{nom}	Nominal frequency	50 Hz

Reference

	Parameter	**Value**
Vn	Nominal voltage	63.5, 110 V
Vs	Absolute settings	55.0 V
hyst	Hysteresis	2 %
t_d	Delay setting	0.0…600.0 s
	Frequency	f_{nom}
	Ambient temperature	20 °C

Operate and Reset Level

	Attribute		**Value**
V_{op}	Operate level		100 % *Vs*, ± 1 % *Vn*
	Reset level	overvoltage	≥ (100 % - *hyst*) x V_{op} ± 1 %
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

Operate and Reset Time

	Attribute		**Value**
t_{basic}	Element basic operate time	overvoltage	0.9 to 1.1 x*Vs*: 45 ms, ± t_{cycle}
			0.9 to 2.0 x*Vs*: 35 ms, ± t_{cycle}

	Attribute		Value
t_{op}	Operate time following delay		$t_{basic} + t_d$, ± 1 % or ± t_{cycle}
	Repeatability		± 1 % or ± t_{cycle}
	Disengaging time		< 100 ms
	Variation	f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

2.2 Frequency Protection

2.2.1 Underfrequency and Overfrequency Elements (ANSI 81)

2.2.1.1 Description

Overfrequency and underfrequency elements use the same functionality, as shown in Figure 2-1. The sense of the element (underfrequency or overfrequency) can be set by the ***Elem* Operation** setting. Each element can be inhibited in four different ways;

- If all phase voltages fall below the voltage blocking threshold level.
- Via a status input inhibit signal.
- Via any combination of voltage elements starting.
- If all of the phase voltages fall below an absolute level of 29V. This is independent of the voltage blocking threshold and is required to ensure that the frequency accuracy claims are within ±10mHz.

The frequency calculation is performed on data from one input phase only. If all phase voltages are above an internal threshold of 29V, then the frequency calculation will be derived from the phase A input. If however, phase A falls below 29V, then the calculation will automatically switch to phase B data. During the switchover process the last frequency value measured is held until phase B returns a valid frequency answer. This will take approximately 180ms. The switchover precedence is A-B-C and as each phase recovers its voltage then the frequency calculation is switched back to this phase. This method ensures that the frequency calculation is performed on a solid system voltage and not on low levels of input voltage where noise could cause incorrect calculation.

Table 2-5 Typical Settings Frequency Element

Setting name	Range (**bold** = default)	Units	Notes
***Elem* Operation**	**Off**, U/F, O/F		
***Elem* Setting**	47.00, 47.01 …**50.00**…52.00	Hz	
***Elem* Delay**	**0.0**, 0.01…2.0, 2.1…20, 21…600	s	
***Elem* Inhibit**	_, 1 for each voltage element		
Sub-menu: **Output Relays**			
***Elem* Starter**	_, 1 for each output contact		
***Elem* Trip**			
Sub-menu: **Status Inputs**			
***Elem* Inhibit**	_, 1 for each status input		

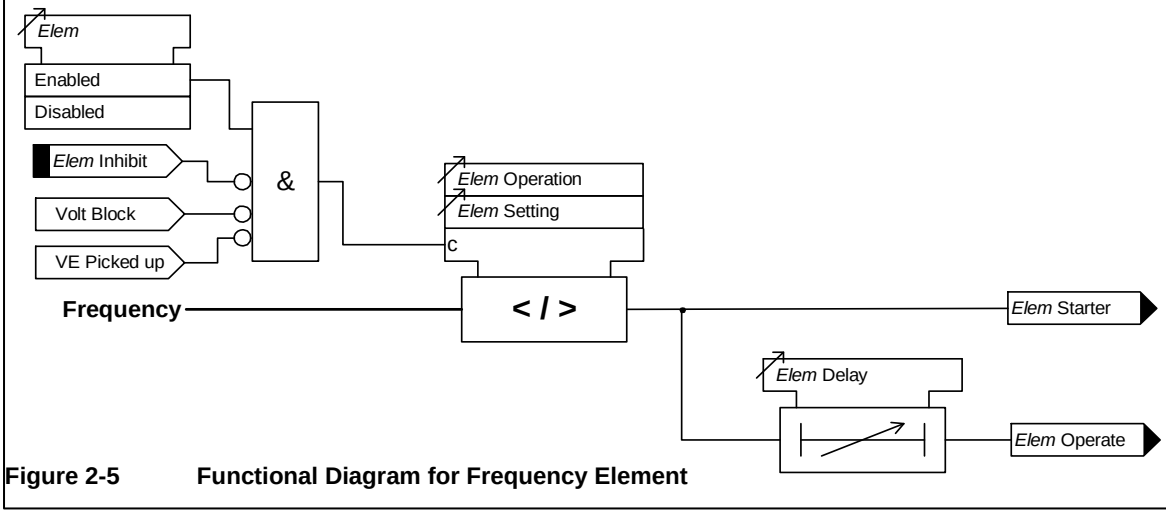

Figure 2-5 Functional Diagram for Frequency Element

2.2.1.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	10 ms

Reference

	Parameter	**Value**
Vn	Nominal voltage	63.5, 110 V
hyst	Hysteresis	2 %
	Ambient temperature	20 °C

Operate and Reset Level

	Attribute		**Value**
F_{op}	Operate level		100 % *Fs*, ± 10mHz
	Reset level	overfrequency	≥ (100 % - *hyst*) x F_{op} - 25mHz
		underfrequency	≤ (100 % + *hyst*) x F_{op} + 25mHz
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %

Operate and Reset Time

	Attribute		**Value**
t_{basic}	Element basic operate time	overfrequency	Typically < 110ms
			Maximum < 150ms
		underfrequency	Typically < 110ms
			Maximum < 150ms
t_{op}	Operate time following delay		t_{basic} + t_d, ± 1 % or ± t_{cycle}
	Repeatability		± 1 % or ± t_{cycle}
	Disengaging time		< 100 ms

Section 3: Application Notes

3.1 Voltage Blocking Element

The voltage blocking element acts as a block to the phase voltage elements. If all phase voltages fall below the threshold level then the blocking operation will operate.

The voltage blocking element performs a number of functions:

- If the relay has been set up with undervoltage elements enabled and is switched on with no volts applied to its inputs then, an undervoltage starter would pickup and the relay may issue a trip. The relay would then stay locked in this trip condition until volts are applied and the element is reset. To prevent this from happening the voltage blocking threshold has to see volts above its set level otherwise the phase voltage elements are fully blocked and no starter or trip operation will follow.

- In auto-reclose schemes, the voltage blocking threshold can be used to prevent unnecessary operations of the undervoltage elements during the time when the line is de-energised. For this type of blocking operation the threshold is typically set to 20% of rated volts, though it should always be set to a value above the expected level of induced voltages on the line.

3.2 Voltage Protection

3.2.1 Voltage Element Hysteresis

The voltage element hysteresis setting (if available) allows the user to alter the pick-up / drop-off ratio of the element.

When using the variable hysteresis, care has to be taken to ensure that with undervoltage elements, the reset level of the element is not set to a value higher than that at which the system rated voltage is expected to operate. The system rated voltage will typically have a tolerance of ±10 %, so the upper level of the hysteresis must be below the lower limit of the tolerance, otherwise the element may not reset. Conversely, the level of hysteresis set for an overvoltage element should not be set below that at which the system rated voltage is expected to run.

Typical values for hysteresis applied to a voltage element are < 5%. When setting the hysteresis level the user has to be aware that if the amount of hysteresis is set too low e.g. 1%, then for large frequency excursions and low values of voltage element setting, the element might become unstable and ‘chatter’. This will produce nuisance alarms / tripping and generate large numbers of stored event records. A minimum recommended level is 2% for this reason.

3.2.2 Undervoltage Protection

Undervoltages are reasonably frequent events on power systems and can occur for a number of different reasons. Faults on the system can cause the phase voltages to be depressed, the actual voltage drop being dependent upon a number of factors including the fault type and system earthing etc. During system earth fault conditions, the undervoltage protection is not generally required to operate and thus connecting the relay in the phase-phase configuration will make it less susceptible to single-phase voltage depressions.

Another cause of undervoltage is an increase in system loading, which should be corrected by system regulating equipment such as tap-changers and AVR’s. However, if this equipment is defective then an undesirable situation will occur which will require an undervoltage relay to trip non-essential loads to correct for this voltage excursion and to bring it back to its nominal level. This tripping should happen after an appropriate time delay has expired. Generally, wherever voltage relays are employed, timing elements should be used to prevent operation during transient disturbances.

If the system is supplying 3-phase induction motors or variable frequency thyristor drives, undervoltages can have the following effect. Voltage depressions down to approximately 80 % of rated voltage cause the load current to increase, possibly resulting in a larger voltage depression due to the supply source impedance. Below 80 % the current drawn is proportional to the voltage and an induction motor is likely to stall. The current drawn is then dependent on the drive design e.g. thyristor drives include current limitation. An undervoltage element can be set to trip out a motor circuit when the voltage falls below a preset value, selected based on the motor drive and system design parameters, and after a preset time delay. The time delay is required to ensure voltage dips due to remote system faults do not result in an unnecessary trip.

If the system supply to a group of motors is lost, undervoltage protection can be applied to ensure that each of the motor circuit breakers or contactors are tripped so that on restoration of the main supply, it is not overloaded by

the simultaneous starting of all the motors. A 3-phase undervoltage relay may be used for this task of tripping a feeder for the detection of a complete loss of voltage. Also, where a supply to induction motors is lost, the undervoltage relay can be used to detect the loss of supply or to monitor any busbar residual voltage e.g. resulting from back e.m.f. generated by the induction motors as they run down. The relay can act as a guard prior to re-connecting a supply from an alternative source.

Where undervoltage relays are used on a system, the voltage elements should be set to a value below that where a normal system voltage excursion can be expected. (See also section 2.5). Typically the set values may be 65 % to 80 % of nominal for protection of the system or plant. For confirmation that a monitored supply is 'dead' or that any residual voltage has reduced to a safe level, typical set values should be 10 % to 30 % of nominal voltage.

3.2.3 Overvoltage Protection

Overvoltages may be caused for a number of different reasons. On generator sets for example, it may be caused by defective operation of the voltage regulator, or, if there is a sudden loss of load due to line tripping. Under this load rejection situation the generator set may overspeed causing a dangerous voltage rise. This should be corrected by system regulating equipment such as tap changers and AVR's, but if this equipment mal-functions then, voltage levels may rise. High levels of overvoltages on a system cannot be sustained for long periods because they can cause damage to the system insulation and severely affect the life of the insulation. An overvoltage element with an appropriate DTL time delay setting to allow the normal system regulating equipment to operate can be used to protect against this type of condition.

If a number of overvoltage elements are available, a variety of different applications can be covered. If the overvoltage condition is small, a relatively long DTL time delay can be set on an element to clear the fault. If the overvoltage is more severe then another element, set at a higher pickup level and with a faster DTL time, can be used to clear the fault more quickly. Alternatively, elements can be set to provide alarm and tripping stages, with the alarm levels set lower than the tripping stages.

The use of instantaneous and wide ranging DTL settings allows a simple and secure grading system to be applied to co-ordinate the network design, the regulating plant design and system plant insulation withstand. The use of IDMTL protection is not recommended because of the difficulty of choosing settings to ensure correct co-ordination and security of supply.

Generally, wherever voltage relays are employed, timing elements should be used to prevent operation during transient disturbances. In addition, overvoltage relays must be co-ordinated with other overvoltage relays elsewhere on the system.

3.2.4 Neutral Voltage Displacement

Neutral Voltage Displacement (Residual Overvoltage) protection is used to detect an earth fault where there is little or no earth current present.

This would occur, for example, where a feeder has been tripped at its HV side for an earth fault, but current is still being supplied to the fault from the LV side via an unearthed transformer. This current might be provided through interconnection or a secondary supply source. Insufficient earth current would be present to cause a trip, but residual voltage would increase significantly; reaching up to 3-times the normal Vphase level.

The same situation could also be allowed for by utilising inter-tripping from the HV side of the feeder to its LV side.

If NVD protection is used, it must be suitably time graded with other protections in order to prevent unwanted tripping for external feeder faults. Although operating characteristics are provided by the relay for NVD, this grading would typically be achieved using a DTL.

Calculations are performed on the voltage fundamental component. This gives the feature excellent 3rd Harmonic rejection.

3.2.5 Negative Phase Sequence Overvoltage

Negative Phase Sequence (NPS) protection detects phase unbalances and is widely used in protecting rotating plant such as motors and generators. However such protection is almost universally based on detecting NPS Current rather than Voltage. This is because the NPS impedance of motors etc. is much less than the Positive Phase Sequence (PPS) impedance and therefore the ratio of NPS to PPS Current is much higher than the equivalent ratio of NPS to PPS Voltage.

NPS Voltage is instead used for monitoring busbar supply quality rather than detecting system faults. The presence of NPS Voltage is due to unbalanced load on a system. Any system voltage abnormality is important since it will affect every motor connected to the source of supply and can result in mass failures in an industrial plant.

The two NPS Voltage DTL elements should therefore be used as Alarms to indicate that the level of NPS has reached abnormal levels. Remedial action can then be taken, such as introducing a Balancer network of capacitors and inductors. Very high levels of NPS Voltage indicate incorrect phase sequence due to an incorrect connection.

The Relay uses NPS Voltage as an integral part of other protection algorithms, such as VT Supervision. NPS polarising is also utilised when reliable Zero Phase Sequence (ZPS) quantities are not available, for example due to the VT connection configuration.

3.3 Frequency Protection

3.3.1 Underfrequency and Overfrequency Protection

When a power system is in stable operation at normal frequency, the total mechanical power input from the prime movers to the generators is equal to the sum of all the connected loads, plus all real power losses in the system. Any frequency variation is an indication of generator-load imbalance in the system. If an interconnected system splits, for example, there might be a situation where the load in one of the subsystems is in excess of the generator capacity in that subsystem. In this instance the generator speed will begin to decrease causing a proportional frequency drop. An underfrequency condition at nominal voltage can lead to over-fluxing of plant such as generators and transformers. If the governors and other regulating equipment cannot respond quickly enough, a sustained underfrequency condition may lead to a system collapse. Conversely, if there is an excess of generation in the subsystem then the generator speed will increase causing a proportional frequency rise. This may be unacceptable to industrial loads, for example, where the running speeds of synchronous motors will be affected.

In the situation where the system frequency is collapsing rapidly it is common practise to disconnect non-essential loads for short periods of time, until the generation-load requirements and network configuration can be corrected. This is designed to preserve system integrity and minimise outages. Normally utilities will avoid intentionally interrupting service, but in this case non-critical loads can be interrupted for short periods. This type of scheme is known as an underfrequency load shedding scheme. Usually, automatic load shedding, based on underfrequency, is necessary since sudden, moderate-to-severe frequency shifts can throw a system into a dangerous state much faster than an operator can react. Underfrequency relays are usually installed at distribution substations, or industrial plant, where selected loads can be disconnected and where similar priority loads are often grouped together.

The object of load shedding is to re-establish the generator-load equation. At the instant of a disturbance a measure of the amount of overload is not readily available and thus load is shed in stages until the frequency stabilises and returns to within the nominal band. An example scheme would have the first load shedding stage set just below the nominal frequency, e.g. between 49.0 - 49.5Hz. A time delay element would be associated with this and this would be set to allow for transient dips in frequency, as well as to provide a time for the system regulating equipment to respond. The first load shedding stage would be set to shed a significant percentage of the system load. If this drop is sufficient, the frequency will stabilise and perhaps increase and return to nominal. If, however, this is not sufficient then a second load shedding stage, set at a lower frequency, will now shed a smaller percentage of load until the overload is relieved. This process will continue until all stages have operated. In the event of the load shedding being unsuccessful, a final stage of underfrequency protection should be provided to totally isolate all loads before plant is damaged, e.g. due to overfluxing.

An alternative type of load shedding scheme would be to set all underfrequency stages to about the same frequency setting but to have different length time delays set on each stage. If after the first stage is shed the frequency doesn't recover then subsequent stages will shed after longer time delays have elapsed.

As has been mentioned earlier, where there is an excess of generation in a subsystem the frequency will rise. This is most commonly due to loss of load situations, which cause the generators to speed up. Normally the generator control equipment will respond to regain the normal running speed, but if this equipment fails then the overfrequency protection can be used as a backup. The settings for the overfrequency elements should be set to allow for transient frequency excursions following a loss of load condition and allow time for the generator control systems to recover the situation.

The relay has four frequency elements, each of which can be set for underfrequency operation. These, coupled with independent voltage elements and a large number of output contacts available, enable economic application for complex load shedding schemes. The accuracy and security of operation built into the numeric algorithms makes them ideally suited for this type of application. All frequency elements can be blocked in a number of different ways. It is important to note that where there is other load shedding equipment on a system, the relay should be set to co-ordinate with it.

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/02	Improved VTS Feature added
2004/07	CB fail application note added
2004/03	Updated Performance Specification
2003/02	v2 Page 1: removed invalid references Page 5: corrected invalid 'List of Tables'
2003/01	First issue

Software Revision History

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Section 1: Introduction

1.1 Introduction

This document covers the plant supervision elements and their applications found in the range of relays, as listed below. A Diagrams and Parameters document which covers each individual model is available, which lists the functions and connections available in that model.

- 50BF, Circuit breaker fail element
- 74CT, CT supervision
- 74VT, VT supervision
- 74TC, Trip circuit supervision

Notes

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

- Setting: Elem *Setting name*
- Setting value: **value**
- Alternatives: [1st] [2nd] [3rd]

2. The purpose of this document is to describe the capabilities and functionality of Plant supervision elements. Separate User Manual documents describe how to set up and operate the equipment: apply configuration, settings and passwords, view instruments and set default instruments, and retrieve fault data.

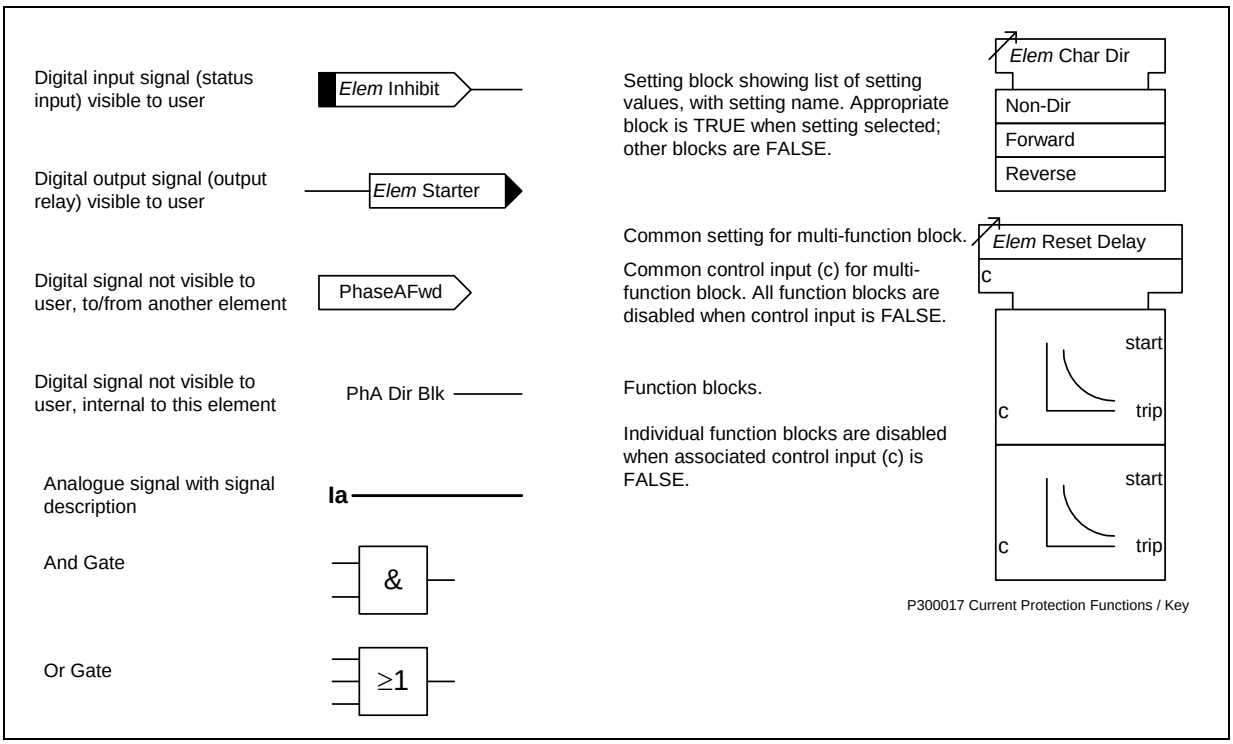

Figure 1-1 Key to Functional Block Diagrams

Section 2: Element Definitions

2.1 Circuit Breaker Supervision

2.1.1 Circuit Breaker Failure Element (50BF)

2.1.1.1 Description

The circuit breaker fail element is a two-stage element that can be used for re-tripping and back-tripping. Following a trip the continued energisation of any protection trip element, external starting signal and any of the 3 phase currents being above the ***Elem* Level** indicates that the fault has not yet been cleared. If any of these signals remain for the ***Elem* Time 1** time then ***Elem* 1** output operates. Following this, ***Elem* 2** output will operate after ***Elem* Time 2** time if current level is still above element setting. Both ***Elem* 1** and ***Elem* 2** can be mapped to any output contact or LED.

Table 2-1 Typical Settings Circuit Breaker Fail Element

Setting name	Range (**bold** = default)	Units	Notes
***Elem* Time 1** ***Elem* Time 2**	Off, 0.02, 0.03…**1.00**…20.00	s	
***Elem* Level**	0.05, 0.1… **0.2**…2	xIn	
Sub-menu: **Output Relays** ***Elem* 1** ***Elem* 2**	_, 1 for each output contact		

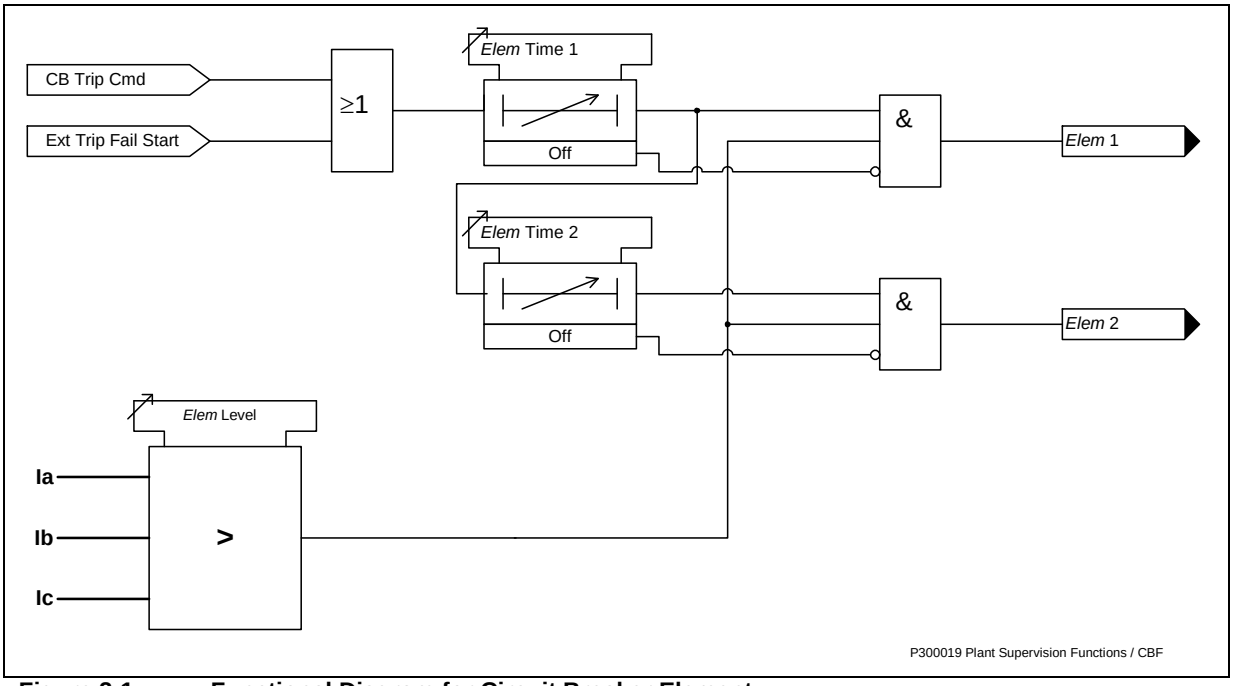

Figure 2-1 Functional Diagram for Circuit Breaker Element

2.1.1.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	Value
t_{cycle}	Element cycle time	20 ms

Reference

	Parameter	Value
t_{CBF1}	Delay Time 1	1.0 s
t_{CBF2}	Delay Time 2	1.0 s
	Ambient temperature	20 °C

Operate and Reset Time (from External Start)

	Attribute	Value
	CB Fail 1 operate	t_{CBF1}, ± 1 % or ± t_{cycle}
	CB Fail 2 operate	t_{CBF1} + t_{CBF2}, ± 1 % or ± t_{cycle}
	Repeatability	± 1 % or ± t_{cycle}
	Overshoot	< 2 x t_{cycle}
	Disengaging time	< 30ms

2.2 CT and VT Supervision

2.2.1 CT Supervision Element (ANSI 74CT)

2.2.1.1 Description

If no current is detected in one phase, while current is flowing in the other two phases, for a period defined by ***Elem* Failure Time**, CT failure is detected and can be mapped to any output relay or LED. The threshold for current flowing (i.e. CT healthy) is ***Elem* Current Threshold**.

Table 2-2 Typical Settings CT Supervision Element

Setting name	Range (**bold** = default)	Units	Notes
Elem	**Enabled**, Disabled		
***Elem* Failure Time**	20,30…**1000**, 1100…20000	ms	
***Elem* Current Threshold**	**0.05**, 0.10…2.50	xIn	
Sub-menu: **Output Relays**			
Elem	_, 1 for each output contact		

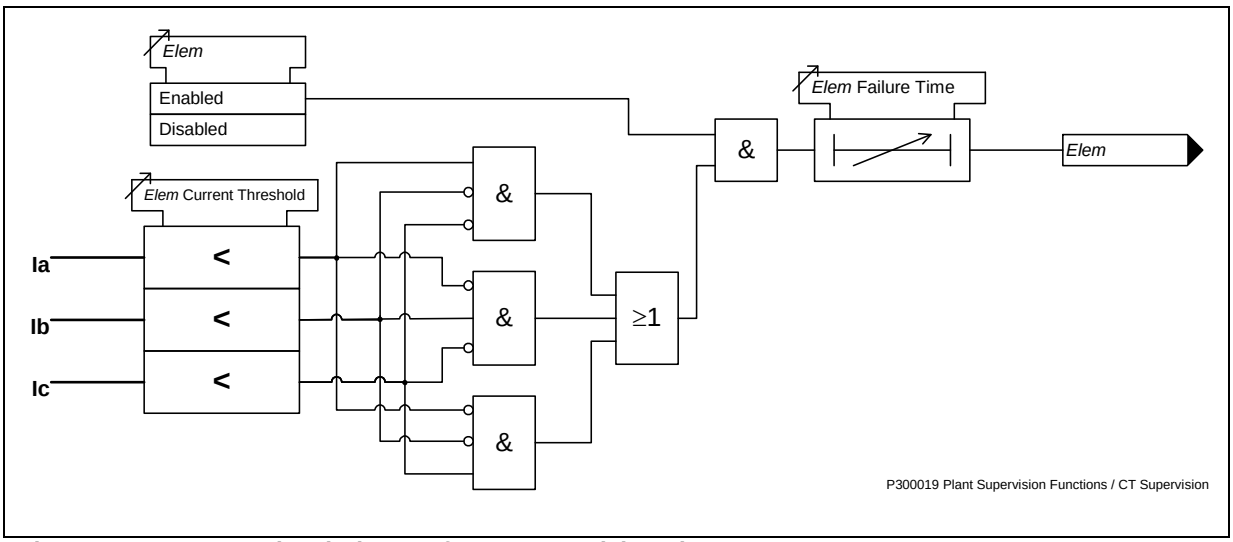

Figure 2-2 Functional Diagram for CT Supervision Element

2.2.1.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	20 ms
f_{nom}	Nominal frequency	50 Hz
f_{cutoff}	Upper cut-off frequency	200 Hz

Reference

	Parameter		**Value**
In	Nominal current		1, 5 A
I_{thresh}	Current Threshold		0.5 x*In*
t_f	Delay setting		1000 ms
I	Applied current (for operate time)	healthy CT phases	5 xI_{thresh}
		failed CT phase	< 0.01 x*In*
	Frequency		f_{nom}
	Ambient temperature		20 °C

Current Threshold

	Attribute		**Value**
I_{curr}	CT failed current level		100 % I_{thresh}, ± 5 % or ± 10 mA
	Reset level		110 % I_{curr} ± 5 % or ± 10 mA
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz harmonics to f_{cutoff}	≤ 5 %

Operate and Reset Time

	Attribute		**Value**
t_{basic}	Basic operate time	1x In to 0 A	< 25 ms
	Operate time		$t_f + t_{basic}$, ± 1 % or ± t_{cycle}
	Repeatability		± 1 % or ± t_{cycle}
	Variation	f_{nom} - 3 Hz to f_{nom} + 2 Hz harmonics to f_{cutoff}	≤ 5 %

2.2.2 VT Supervision Element using NPS (ANSI 74VT) (1 or 2 Phases Lost)

Superseded by element described in section 2.2.3 in February, 2005.

2.2.2.1 Description

It is normally expected that the presence of negative sequence voltage in a power system would be accompanied by negative sequence current. The presence of a negative sequence voltage without an equivalent level of negative sequence current can therefore be used to indicate a VT failure.

The element has a setting for voltage and current levels, ***Elem* Vnps Level** and ***Elem* Inps Level**. If the negative sequence voltage exceeds its setting while the negative sequence current does not exceed its setting for 100 ms, VT failure is detected.

It can be chosen by setting whether to inhibit voltage-based protection elements (e.g. directional overcurrent) from the feature using the ***Elem* Mode** setting. Additionally, blocking of the phase-fault voltage based protection elements can be independently deselected using the ***Elem* PF Inhibit** setting.

Table 2-3 Typical Settings VT Supervision Element (1 or 2 Phases Lost)

Setting name	Range (**bold** = default)	Units	Notes
Elem	**Disabled**, Enabled		
***Elem* PF Inhibit**	**Disabled**, Enabled		
***Elem* Inps Level**	0.05, **0.10**…2.00	xIn	
***Elem* Vnps Level**	1, 2…**7**…100	V	
***Elem* Mode**	**Alarm Only**, Alarm & Inhibit		
Sub-menu: **Output Relays**			
***Elem* VT Failed**	_, 1 for each output contact		

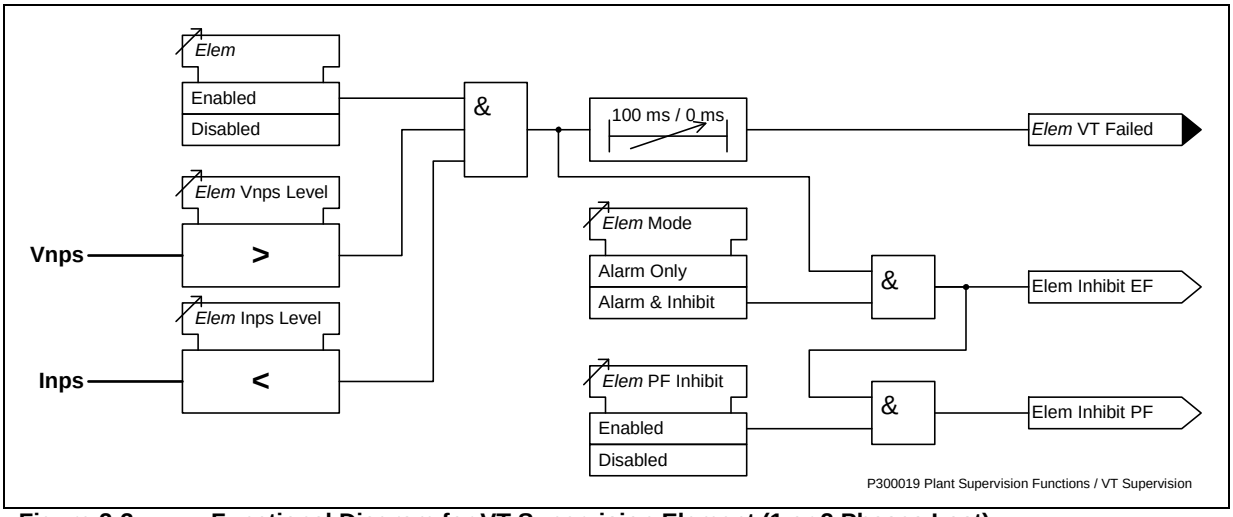

Figure 2-3 Functional Diagram for VT Supervision Element (1 or 2 Phases Lost)

2.2.2.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	10 ms
f_{nom}	Nominal frequency	50 Hz

Reference

	Parameter	**Value**
Vn	Nominal voltage	63.5 V
In	Nominal current	1, 5 A
Vs	Vnps Level	7.0 V
Is	Inps Level	0.10 x*In*
	Frequency	f_{nom}
	Ambient temperature	20 °C

Operate and Reset Level

	Attribute		**Value**
V_{op}	Voltage operate level		100 % *Vs*, ± 5 % *Vn*
	Voltage reset level		≥ 95 % V_{op}
V_{blk}	Current operate level		100 % *Is*, ± 5 % *In*
	Current reset level		≤ 105 % V_{blk}
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

2.2.3 VT Supervision Element using NPS (ANSI 74VT) (1, 2 or 3 Phases Lost)

Implemented in all Relay models from February, 2005.

2.2.3.1 Description

1 or 2 phases lost

It is normally expected that the presence of negative sequence voltage in a power system would be accompanied by negative sequence current. The presence of a negative sequence voltage without an equivalent level of negative sequence current can therefore be used to indicate a one or two phase VT failure.

The element has a fixed NPS voltage level of 0.15 xVn and a setting for NPS current level ***Elem* Inps Level**. If the negative sequence voltage exceeds its level while the negative sequence current does not exceed its level for more than ***Elem* Delay** then a VT failure will be detected.

3 phases lost

Under normal load conditions PPS voltage of approx 1 xVn would be expected along with PPS load current. If we see PPS load current but no PPS voltage this is possibly a three phase fuse failure, to ensure that this is not caused by a 3 phase close up fault the PPS current must also be below the fault level.

The element has a fixed PPS voltage level of 0.75 xVn, a fixed PPS current load level of 0.1 xIn and a setting for PPS current fault level ***Elem* Ipps Level**. If positive sequence voltage is below its level while positive sequence current is above the load level and below three phase fault level for more than ***Elem* Delay** then a VT failure will be detected.

External MCB

The element has an input, **Ext Trig *Elem*,** to allow the VTS element to be triggered by an external MCB operating.

Once a VT failure condition has occurred the output is latched on and is reset by any of the following:-

Voltage is restored to a healthy state i.e. PPS voltage being above its level while NPS voltage is not above its level,

The external reset **Ext Reset *Elem*** being triggered and VT failure condition no longer exists,

The element being inhibited or disabled.

Table 2-4 Typical Settings VT Supervision Element (1, 2 or 3 Phases Lost)

Setting name	Range (**bold** = default)	Units	Notes
Elem	**Disabled**, Enabled		
***Elem* Inps**	0.05,**0.10**…1	xIn	
***Elem* Ipps**	0.05, 0.10…**10**…20.00	xIn	
***Elem* Delay**	0.03, 0.03…**10**…20,20.1…100.101…1000	s	
Sub-menu: **Status Inputs**			
Inhibit *Elem*	_, 1 for each status input		
Ext Trig *Elem*			

Setting name	Range (**bold** = default)	Units	Notes
Ext Reset *Elem*			
Sub-menu: **Output Relays**			
Elem	_, 1 for each output contact		

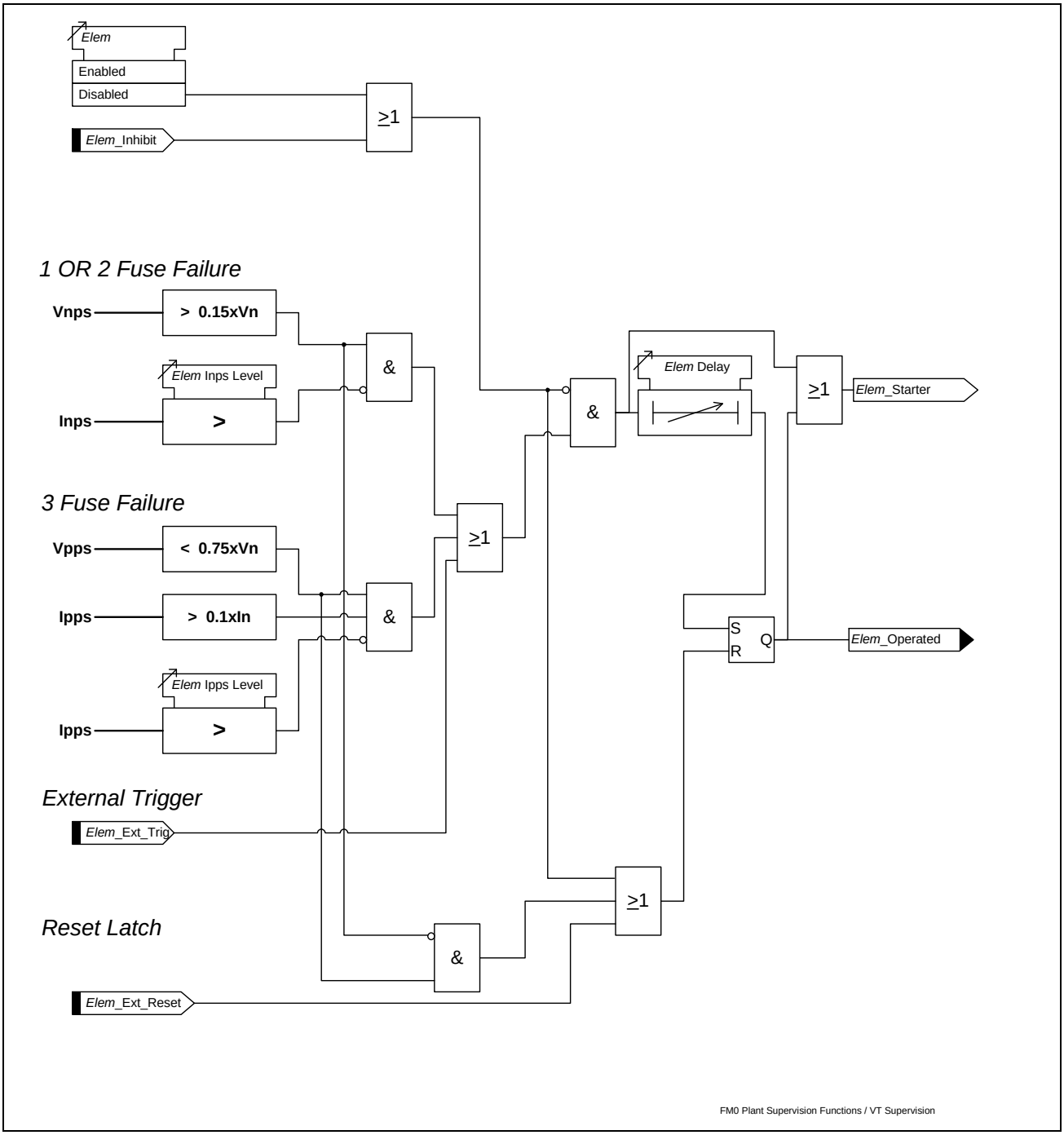

Figure 2-4 Functional Diagram for VT Supervision Element (1, 2 or 3 Phases Lost)

2.2.3.2 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	Value
t_{cycle}	Element cycle time	10 ms
f_{nom}	Nominal frequency	50 Hz

Reference

	Parameter	Value
Vn	Nominal voltage	63.5 V
In	Nominal current	1, 5 A
V_{nps}	Vnps Level	0.15 x*Vn*
I_{nps}	Inps Level	0.1 x*In*
I_{pps}	Ipps Load Level	0.1 x*In*
IF_{pps}	Ipps Fault Level	10 x*In*
V_{pps}	Vpps Level	0.75 x*Vn*
t_d	Delay setting	0.03…1000 s
	Frequency	f_{nom}
	Ambient temperature	20 °C

Operate and Reset Level

	Attribute		Value
V_{NPSop}	Voltage NPS operate level		100 % V_{nps}, ± 5 % *Vn*
	Voltage NPS reset level		90 % V_{NPSop}, ± 5 % *Vn*
V_{PPSop}	Voltage PPS operate level		100 % V_{pps}, ± 5 % *Vn*
	Voltage PPS reset level		110 % V_{PPSop}, ± 5 % *Vn*
I_{NPSblk}	Current NPS operate level		100 % I_{nps}, ± 5 % x*In*
	Current NPS reset level		90 % I_{NPSblk}, ± 5 % x*In*
I_{PPSblk}	Current PPS operate level		100 % IF_{pps}, ± 5 % x*In*
	Current PPS reset level		90 % I_{PPSblk}, ± 5 % x*In*
$I_{PPSload}$	Current PPS operate level		100 % I_{pps}, ± 5 % x*In*
	Current PPS reset level		90 % $I_{PPSload}$, ± 5 % x*In*
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 5 %

Operate and Reset Time

	Attribute		**Value**
t_{basic}	Basic operate time	0V to 2 x *Vs*	32 ms ± t_{cycle}
	Operate time		t_d + t_{basic}, ± 1 % or ± t_{cycle}
	Repeatability		± 1 % or ± t_{cycle}
	Variation	f_{nom} - 3 Hz to f_{nom} + 2 Hz harmonics to f_{cutoff}	≤ 5 %

2.3 Trip Circuit Supervision

2.3.1 Trip Circuit Supervision Element (ANSI 74TC)

2.3.1.1 Description

An application of the trip circuit supervision element is given in section 3.2.

Trip circuits to be monitored should have a status input connected in the circuit such that the status input is normally energised. The status input must be mapped to **Trip Cct Fail** and must not be inverted. If the input becomes de-energised, due to a trip circuit failure, an alarm is given.

A fixed 400ms time delay prevents failure being incorrectly detected during circuit breaker operation. If the contacts of the circuit breaker take longer than 400ms to change state an additional delay can be added using the status input drop off delay.

Table 2-5 Typical Settings Trip Circuit Supervision Element

Setting name	Range (**bold** = default)	Units	Notes
Trip Cct Super	**Disabled**, Enabled		
Sub-menu: **Output Relays**			
Trip Cct Fail	_, 1 for each output contact		
Sub-menu: **Status Inputs**			
Trip Cct Failed	_, 1 for each status input		

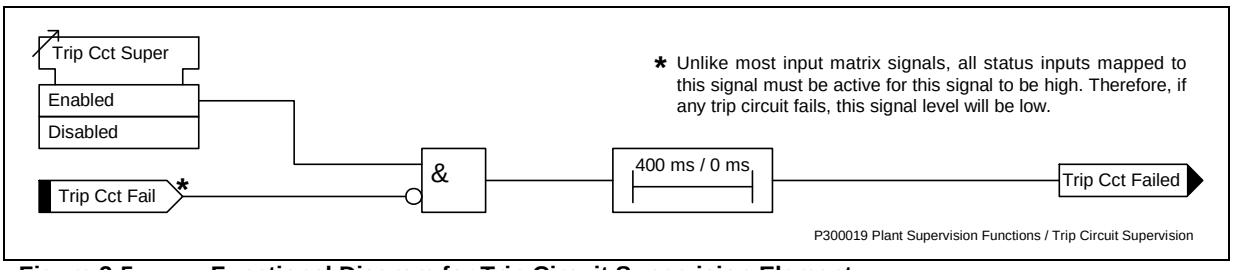

Figure 2-5 Functional Diagram for Trip Circuit Supervision Element

Section 3: Application Notes

3.1 VT Supervision (74VT)

Although VTs rarely fail themselves, VT Supervision presents a much more common application than CT Supervision because of the failure of protective Fuses connected in series with the VTs.

When a VT fails, the voltage levels seen by the protection become unbalanced. A large level of NPS voltage is therefore detected - around 0.3Vn for one or two VT failures. However this condition would also occur for a system fault. To differentiate between the two conditions, the relay uses NPS current to restrain the VTS algorithm as show in the accompanying table.

NPS Voltage	NPS Current	Decision
> Setting	> Setting	System Fault
> Setting	< Setting	VT Failure

Following a VT Failure, the level of NPS current would be dependant solely upon load imbalance - perhaps 0.1In as a maximum.

NPS voltage and current quantities are used rather than ZPS since the latter makes it difficult to differentiate between a VT failure and a Phase-Phase fault. Both conditions would generate little or no ZPS current.

There are possible problems with using NPS quantities due to load imbalances. These would also generate significant levels of NPS current and so possibly cause a VT failure to be missed. This problem can be overcome by careful selection of settings, however, setting the NPS current threshold above the level expected for imbalance conditions.

VTS would not normally be used for tripping - it is an alarm rather than fault condition. However the loss of a VT would cause problems for protection elements that have voltage dependant functionality. For this reason, the relay allows these protection elements - under-voltage, directional over-current, etc. - to be inhibited if a VT failure occurs.

Once a VT Failure has been detected, the condition can only be reset by NPS voltage falling below the setting level - by replacing the fuse or VT. If the NPS current rises above its setting, indicating a system fault, the VTS will reset and remove the inhibit to the protection elements.

3.2 Trip Circuit Supervision

A status input can be used to supervise the trip circuit with the associated circuit breaker open or closed. A low value of d.c. current is passed through the entire trip circuit to monitor the auxiliary supply, the trip coil, its auxiliary switch, the C.B. secondary isolating contacts and the relevant wiring. If monitoring current flow ceases, the energised status input drops off and if it is user programmed to operate one of the output relays, this relay gives a contact output to signal **Trip Circuit Fail**. In addition, an LED on the relay can be programmed to operate. A user text label can be used to define the operated LED i.e. “Trip CCT Fail”.

A scheme, based on the Electricity Association H6 scheme, is shown in Figure 3-1.

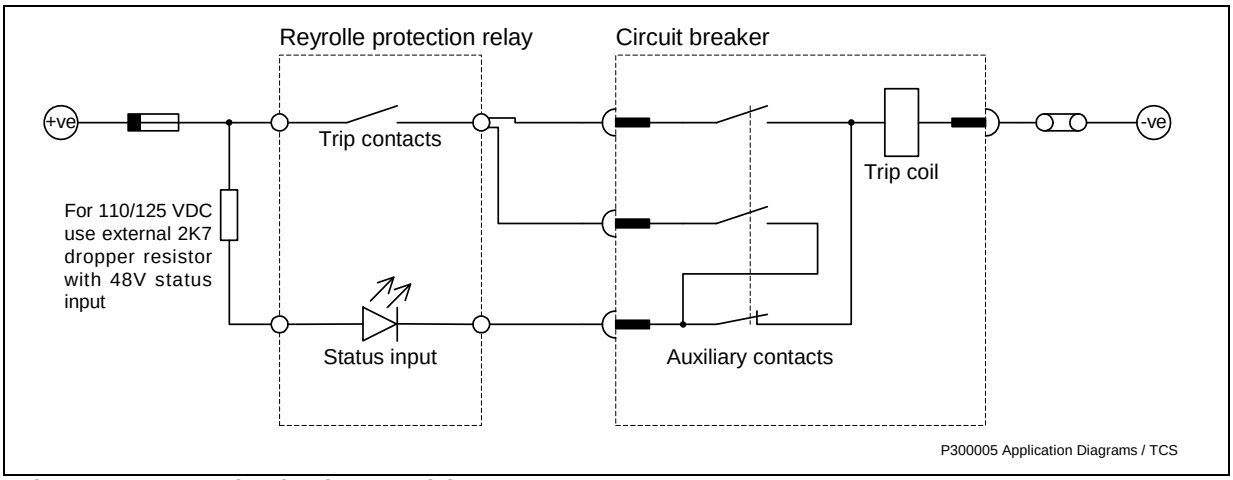

Figure 3-1 Trip Circuit Supervision

3.3 Circuit Breaker Fail Protection

The relay incorporates a two-stage circuit breaker fail feature. If a designated trip relay operates and the circuit breaker fails to open, the protection algorithm continues to run for as long as current, above the starter level or CBF level detector setting, continues to flow and a continuous trip output is given. This combination of conditions is programmed to start a definite time lag feature designated “CB Fail 1”. This function can be programmed to energise an output relay when the C.B. fail time delay is completed. At the same time operation of this timer starts a second time lag feature designated “CB Fail 2” and if the trip outputs already initiated do not stop the current flow through the relay, another relay can be programmed through the output matrix to trip a further breaker e.g. a bus section circuit breaker.

Schemes

These timers support schemes as follows:

- Single stage CB fail, where all adjacent upstream infeeds are tripped after DTL1 on detection of a CB fail occurrence.
- Two stage CB fail, where stage 1 DTL outputs attempt to re-trip the faulted CB in stage 1 time delay and when this fails the stage 2 time delayed output trips the relevant adjacent infeeds.

The circuit breaker fail feature can also be used to implement a multi-stage tripping scheme.

Setting Calculation

The time delay setting applied to the CB fail protection must be in excess of the longest CB operate time + relay reset time + a safety margin

Typically, 80 ms + 42 ms + 50 ms = 175ms (approximately)

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2004/07	Auto-reclose settings updated
2004/03	Performance specification updated, settings tables added
2003/02	v2 Page 1: removed invalid references
2003/01	First issue

Software Revision History

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Section 1: Introduction

1.1 Introduction

This document covers the current-based protection elements and their applications found in the Modular II range of relays, as listed below. A Diagrams and Parameters document which covers each individual model is available, which lists explicitly the functions that are provided and the manner in which they are connected.

- 25, Check synchronising
- 79, Auto-Reclose

Notes

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

- Setting: Elem *Setting name*
- Setting value: value
- Alternatives: [1st] [2nd] [3rd]

2. The purpose of this document is to describe the capabilities and functionality of Check synchronising and Auto-Reclose elements. Separate User Manual documents describe how to set up and operate the equipment: apply configuration, settings and passwords, view instruments and set default instruments, and retrieve fault data.

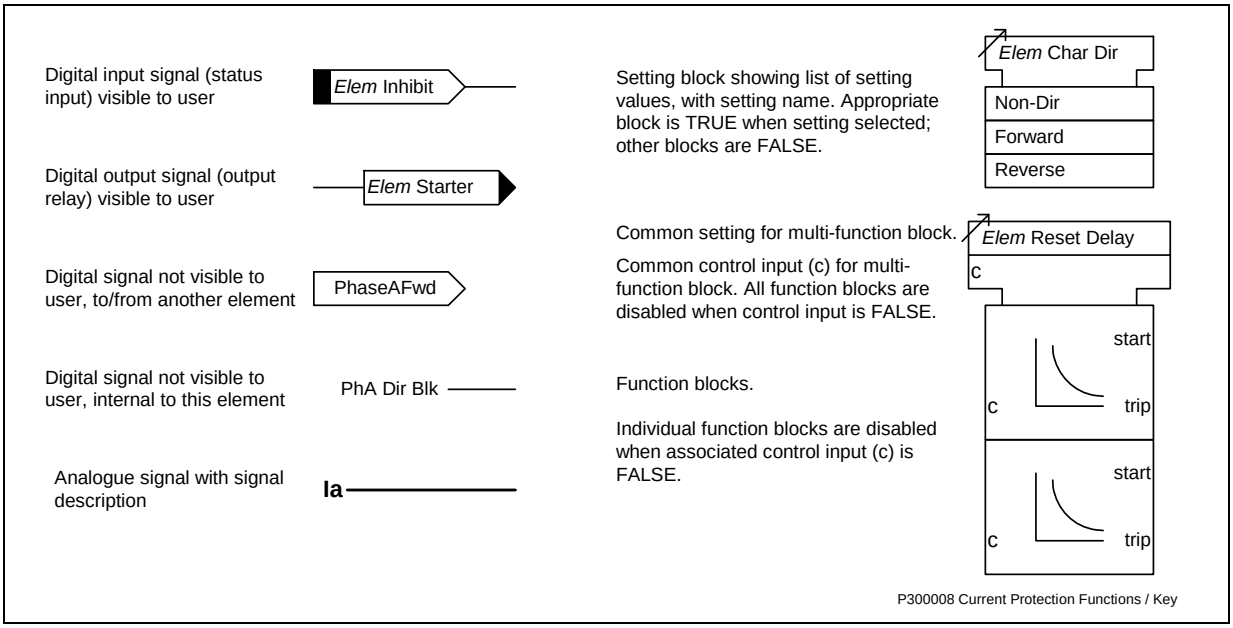


Figure 1-1 Key to Functional Block Diagrams

Section 2: Element Definitions

2.1 Auto-reclose control

Delayed Auto-Reclose (DAR) is initiated by a valid trip relay operation while the associated circuit breaker is in service.

A circuit breaker's service status is determined by its position and (where Check Synchronisation is applied) its voltage references. The circuit breaker is defined as being in service when it is closed and its voltage references are live. The in service status has a drop-off delay of 2 sec, this delay is known as the circuit memory time. This functionality prevents autoreclosing when the line is normally de-energised, or normally open.

The transition from DAR started to initiate deadtime takes place when the circuit breaker's line voltage reference goes dead; and the CB has opened; and the trip relay has reset. If any of these do not occur within the Sequence Fail time the relay will Lockout. This is provided to prevent the DAR being primed indefinitely, or the timer can be switched OFF.

Once a DAR sequence had been initiated, up to 4 unsuccessful recloses (where a closure is followed by a re-trip) may be performed before the DAR feature is locked-out. Each reclosure is preceded by a time delay (dead time) to give transient faults time to clear.

Once a CB has reclosed and remained closed for a specified time period (the Reclaim time), the DAR feature is re-initialised and a Successful Close output issued. A single, common Reclaim time is used.

A count is kept of how many recloses have been performed.

Once lockout has occurred, an alarm is issued and all further Close commands are inhibited for a specified time period (the Minimum Lockout time). A single, common lockout time is used. Lockout can be latched until reset.

There are separate dead-time settings for each of the 4 recloses.

The relay will automatically determine circuit breaker reclosure conditions. These conditions are dead line charge, dead bar charge, dead line and dead bar, unconditional close, or check sync close. If one of these conditions exists and reclosure under this condition has been pre-selected by the user then reclosure will be initiated.

When the dead line or dead bar deadtime has expired and dead line or dead bar conditions are met then the circuit breaker will be reclosed.

If the relay detects the presence of line and busbar volts and check sync reclosure has been pre-selected then the relay shall generate a check sync request prior to any reclosure. If the required check sync conditions are met then the circuit breaker will be reclosed.

Certain schemes require switching operations to be exactly coordinated by the deadtime of the autoreclose relay, whilst other scheme layouts can override the deadtime if In Sync conditions are met across the circuit breaker. The relay provides a setting to enable / disable this function, Check Sync During Deadtime.

2.1.1 Protection Trip

The Protection device which trips the CB should be connected to this input to prime and start the autoreclose sequence.

2.1.2 Protection Starter

Where the autoreclose relays are connected to overcurrent protection or a protection that includes a starter then the starter can be connected to this input. This would indicate that a reclose has closed onto a fault. Multi-shot Autoreclose sequences can be co-ordinated for adjacent relays using this input, i.e. the number of shots can be kept in step.

2.1.3 External A/R Start

An External A/R Start can be received via a status input. A separate protection device would normally initiate this.

An External A/R Start will be treated the same as a Protection A/R Start by the Relay.

2.1.4 Manual Close

An External Close Command can be received via a status input or communications. This would normally be initiated manually. It causes an instantaneous closure, over-riding any DAR sequence then in operation.

An External Close will initiate Line Check. If a fault appears on the line during the Close Pulse or the Reclaim Time with Line Check set, the Protection relay will initiate a Trip and the A/R relay will Lockout. This prevents a CB being repeatedly closed onto a faulted line.

Repeated Manual Closes are avoided by checking for Positive edge triggers. Even if the Manual Close input is constantly energised the relay will only attempt one close. No Close Pulse will be issued when the Manual Close input is reset.

Manual Closing is controlled by the following settings:

Setting	Range	Default
Manual Close DBC	Enabled / Disabled	Disabled
Manual Close DLC	Enabled / Disabled	Disabled
Manual Close DLDB	Enabled / Disabled	Disabled
Manual Close CS	Enabled / Disabled	Enabled

These combinations allow full selection of the Manual Closing process.

Manual Close resets Lockout, if the conditions that set Lockout have reset i.e. there is no trip or Lockout input present.

Manual Close cannot proceed if there is a Lockout input or Block Reclose input present.

With the Autoreclose function set to Out of Service the Manual Close control is still active.

2.1.5 In/Out Switching

The DAR feature may be switched out by changing the A/R In Service setting by a number of methods. These are either a keypad change from the front panel, or via a communication, or by an A/R OUT status input. A/R OUT status input has priority over A/R IN. If both are raised the relay will be in Out Of Service. Once the relay has been switched Out Of Service the reverse action A/R IN is required before the relay will go back In Service.

2.1.6 Overall Control

The DAR feature may be disabled by a Lockout command or by an external signal applied to a status input (A/R OUT).

If the Lockout command or A/R OUT are received while a DAR operation is in progress, the feature is immediately locked-out. An External A/R IN command can be received via a status input. This will re-enable the module.

If the Lockout command is received while a Manual Close operation is in progress, the feature is immediately locked-out.

The DAR or Manual Close feature may be paused by an external Block signal applied to a status input. This causes the feature to temporarily halt before it issues the next CB close command and can be used, for example, to delay CB closure until the CB pressure has reached an acceptable level. If the Block signal has not been removed before the end of a defined time, the Reclose Block Delay, the relay is locked-out.

A Block Reclose input active within the deadtime resets the deadtime timer.

2.1.7 CB Close Command pulse

The duration of the CB Close Command pulse will be settable to allow a range of CBs to be used. The Close pulse will be terminated if any protection Starter picks-up or a trip occurs. This is to prevent Close and Trip Command pulses existing simultaneously. A Close Onto Fault Output is given if a starter or trip picks-up in the Close Pulse. This can be independently wired to Lockout.

2.1.8 CB Failed To Open and CB Failed to Close

CB Failed To Open and CB Failed to Close features are used to confirm that a CB has not responded correctly to each Trip and Close Command. If a CB fails to operate, the DAR feature can be set to lockout.

2.1.9 CB Closed by Another Device

If, during a dead time period, the Relay detects that the CB has closed (due to an external source) it increments its Reclose count and advances to the next part of the Reclose sequence (begin Reclaim time).

2.1.10 Indications

The relay has a fully programmable output to either output contacts or LEDs, see settings sheet for complete list.

The following are included:
1. A/R In Service
2. A/R Out of Service
3. A/R In Progress
4. Successful A/R
5. Lockout

2.1.11 Trip and Reclose

This is a test function, allowing the operation of the CB to be verified.

The Trip signal should be routed directly to the Circuit Breaker. Once the CB has opened and the Trip and Reclose input is removed the DAR will wait for the first Reclose Delay and then issue a CB Close command.

A Trip and Reclose command will only be accepted if the Relay is in quiescent, or line healthy mode, i.e. no autoreclose sequences are in progress.

During the Trip and Reclose reclosure, Line Check is invoked to ensure that the CB does not repeatedly close onto a faulty line.

2.1.12 CB Close Operations

Additional DAR features are provided as an aid to maintenance.

Two counters ‘Total CB Close Count’ and ‘Delta CB Close Count’ are provided. Each counter has a User settable Alarm count. These counters can be used for Maintenance Alarms. These figures are separately re-settable by either keypad, or status input **Reset Total CB Close** or **Reset Delta CB Close**. Maximum alarm number of 999.

2.1.13 Metering

All Counters and the Status of the DAR operations are displayed in Meters under the instruments Menu.

2.1.14 Dead-time and Reclaim Timing

The Deadtime will start if a Trip has occurred and the CB is Open and the Trip and Starter have then reset and the line has gone dead. Once a trip has occurred if the CB does not open or the Trip does not reset or the starter does not reset then the DAR will Lockout. This could be due to either a CB Fail condition, which would independently notify Lockout, or the Trip or Starter relay contact failing to reset. If the line does not go dead this may signify that the remote end has failed to clear the fault, and the autoreclose will go to Lockout.

A Trip during the deadtime will result in resetting the deadtime and then restarting the deadtime when the trip resets, provided the Sequence Fail Timer has not expired.

The Reclaim time will start once the Close Pulse has timed out and the CB has closed. Lockout is alarmed if the CB is open at the end of the reclaim time.

2.1.15 Lockout

The Lockout state can be reached for a number of reasons. Lockout will occur for the following:

- at the end of the Reclaim time if the CB is in the open position.
- a protection operates during the final Reclaim time.
- if a Close Pulse is given and the CB fails to close.
- The Reclose Lockout status input is active.
- At the end of the Reclose Block Delay due to a persistent Block signal not cleared.
- At the end of the Sync Close Delay due to Synchronism not being achieved.

Once the Lockout condition has been reached, it will be maintained until reset. The following will reset lockout:

- By a Manual Close command.
- By a Reset Lockout signal, provided there is no signal present that will cause Lockout.
- At the end of the Minimum Lockout time if Reset Lockout is selected to be reset by a timer, provided there is no signal present which will cause Lockout.
- if Lockout was entered by an A/R Out signal during an Autoreclose sequence then an A/R In signal must be received before Lockout can reset.
- by the CB Closed, provided there is no signal present which will cause Lockout.

The Lockout condition has a delayed drop-off of 2s.

The Lockout condition will initiate the Lockout indication and alarm contact.

Lockout does not issue a trip signal.

Lockout indicates an abnormal system occurrence, an event that needs to be investigated. When a CB is normally open the A/R relay does not go to Lockout, but using a combination of Trip and CB In Service to start the sequence prevents A/R sequences.

2.1.16 Auto Isolation

Facilities are provided to apply auto-isolation to mesh corner or Teed feeders. An auto-isolation scheme is provided. If a trip occurs within the close pulse then auto-isolation is started if selected, the isolator should send Auto-Isolation Complete when the system is isolated, the relay will then continue with its next sequence. If Auto-Isolation Complete is not received before the end of the Auto-Isolation timer then Auto-Isolation Fail is issued, and the relay will go to Lockout.

2.1.17 Sequential Isolation

Facilities to inhibit sequential isolation are provided to enable the DAR system to stop sequential isolation if an associated DAR sequence has started. The Inhibit Sequential Isolation output is set when an A/R sequence is started and is reset at the start of the close pulse or at lockout.

2.1.18 Voltage Failure Lockout

Facilities to Lockout Autoreclose and Manual Closing if a VT Failure occurs are provided. There is a setting provided which enables and disables this feature. VT Failure is set for either:

CB Closed and Live Line and Dead Bar >> 2 sec.

Or

CB Closed and Live Bar and Dead Line >> 2 sec.

This function has been provided as a setting due to the uncertainty of isolator positions within the scheme.

Table 2-1 Typical Settings Auto-Reclose

Setting name	Range (**bold** = default)	Units	Notes
A/R In Service	In, **Out**		
Number Of Shots	**1**..4		
***Shot* Deadtime**	0.0, 0.1…**5.00**…120, 121…900	s	
CB Close Pulse	0.2, 0.3…**2.0**…20	s	
Reclaim Time	OFF, 1…**5**…600	s	
***Elem* Trip**	**Delayed**, Instant		
Line Check Trip	**Delayed**, Instant		
***Elem* TTL**	**OFF**, 1…5		
Rec Block Delay	0, 1…**60**…600	s	
Slow Open Delay	50, 60…**140**…2000	ms	
Seq Fail Timer	**OFF**, 1, 2…600	s	
Min LO Timer	0, 1…**2**…60	s	
Reset LO By Time	Enabled, **Disabled**		
Dead Bar Charge	Enabled, **Disabled**		*These settings are only available in relays with the check synchronising feature*
Dead Line Charge	Enabled, **Disabled**		
Dead L & B Charge	Enabled, **Disabled**		
Check Sync Close	**Enabled**, Disabled		
Uncondit Close	Enabled, **Disabled**		
Manual Close DBC	Enabled, **Disabled**		
Manual Close DLC	Enabled, **Disabled**		
Manual Close DLDB	Enabled, **Disabled**		

Setting name	Range (**bold** = default)	Units	Notes
Manual Close CS	**Enabled**, Disabled		
Live Line Check	**Enabled**, Disabled		
CS In Deadtime	**Enabled**, Disabled		
VT Fail Lockout	Enabled, **Disabled**		
DL Charge Delay	**0**, 1…60	s	
DB Charge Delay	**0**, 1…60	s	
Sync Close Delay	Off, 1…**30**…900	s	
Sub-menu: **Output Relays**			
Lockout	_, 1 for each output contact		
A/R Switched Out			
A/R In Progress			
Successful Close			
Line Check			
Ext Arc Start			
Sub-menu: **Status Inputs**			
A/R In	_, 1 for each status input		
A/R Out			
Extern A/R Start			
Block Reclose			
Go To Lockout			
Trip And Reclose			
Trip and Lockout			
Reset Lockout			
Manual Close			

2.1.18.1 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	20 ms
$t_{setting}$	Timer settings	Applied value

Operate Time

	Attribute	**Value**
t_{op}	Operate time following delay	$t_{setting}$, ± 1 % or ± t_{cycle}
	Repeatability	± 1 % or ± t_{cycle}

2.2 Synchronising

2.2.1 Voltage monitoring elements

2.2.1.1 Under-voltage detectors

The under-voltage detectors, if enabled, can block a close output command if either the line voltage or the bus voltage is below the under-voltage setting value. Both line and bus have their own independent settings.

2.2.1.2 Differential voltage detectors

The differential voltage detector, if enabled, can block a close output command if the difference between the line and bus voltages is greater than the differential voltage setting value.

2.2.1.3 Voltage detectors

Voltage detectors determine the status of the line or bus. If the voltages on either the line or bus are below a set threshold level they can be considered to be 'dead'. If the voltages are within a setting band around the nominal voltage they are classed as 'live'. Independent voltage detectors are provided for both line and bus.

If a voltage is in the dead band range then it will be classed as dead until it has reached the live band area. Similarly, if a voltage is live, it continues to be live until it has reached the dead band area. This effectively allows for variable amounts of hysteresis to be set. Figure 3 illustrates the voltage detector operation.

Note: the area between the dead and live zones is not indeterminate. When any voltage is applied to the relay it will ramp up the software RMS algorithm and always pass through the dead zone first.

Although a wide range is provided for live and dead voltage detector levels, these must not overlap. The relay software acts to prevent this from happening to stop unusual alarm outputs and conflicts with internal logic elements. If the user attempts to increment the dead voltage level to the live voltage level, the relay will not accept the setting. Similarly, if the live level is decremented to the dead level, the setting will not be allowed. The two voltages are displayed simultaneously on the LCD display so that this operation is clear to the user.

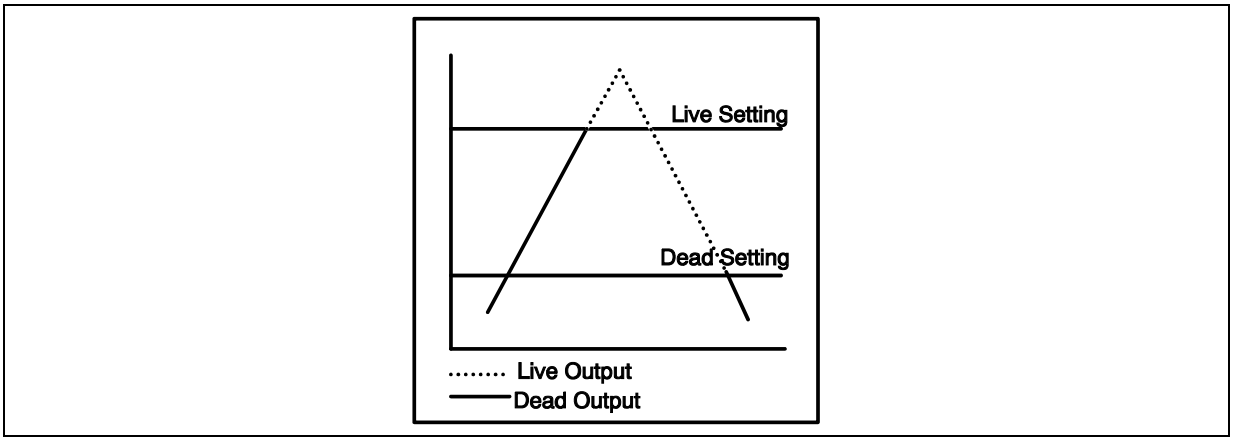


Figure 2-1 Voltage Detector Operation

2.2.1.4 Sync Override Logic

For certain switching operations, a means of bypassing the Check Synchronisation function is provided. This is provided with a separate Sync Override and a separate Manual Sync Override.

2.2.2 Check Synchronising Mode

For the relay to issue a Check Sync Close the following conditions have to be met :

CS PHASE ANGLE – the phase difference between the line and bus voltages has to be less than the phase angle setting value. Whilst within the limits the phase angle can be increasing or decreasing and the element will still issue a valid close signal.

CS SLIP FREQUENCY, [If ENABLED] – the frequency difference between line and bus has to be less than the slip frequency setting value.

CS SLIP TIMER, [If ENABLED] – the phase angle and voltage blocking features have to be within their parameters for the length of the slip timer setting. If either the phase angle or the voltage elements fall outside of their limits the slip timer is reset. If they subsequently come back in then the slip timer has to time out before an output is given. (This ensures that a close output will not be given if there is a transient disturbance on the system due to e.g. some remote switching operations).

LINE U/V DETECTOR, [If ENABLED] – the line voltage has to be above the line under-voltage setting value and also above 5V for an output to be given.

BUS U/V DETECTOR, [If ENABLED] – the bus voltage has to be above the bus under-voltage setting value and also above 5V for an output to be given.

DIFFERENTIAL VOLTAGE DETECTOR, [If ENABLED] – the difference between the line and bus voltages has to be less than the ΔV detector setting value for an output to be given.

The relay is always started in Check Synchronising mode of operation. To proceed to System Synchronisation a system split must occur.

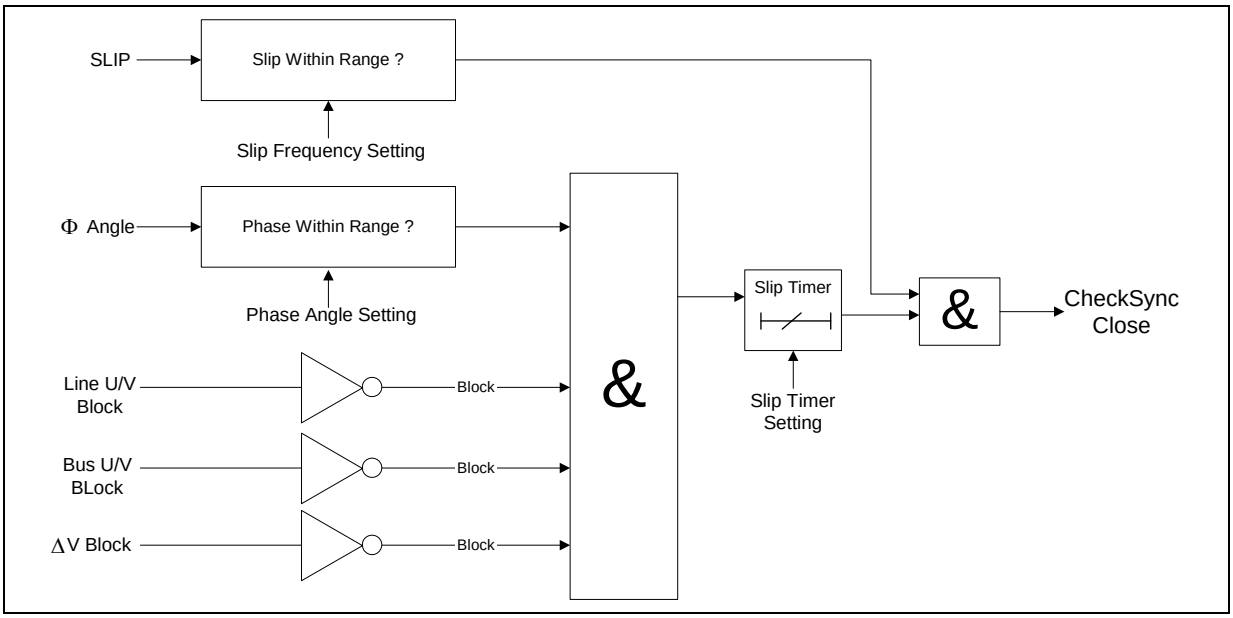


Figure 2-2 Check Sync Function

2.2.2.1 Manual Sync Override Feature

If manual closes are required to be carried out via an operator, these will be performed with Check Synchronisation unless the Manual Sync Override input is energised.

2.2.3 System Split Detector

A system split occurs where there is a loosely tied or non-parallel circuits on a power system. Under these conditions the frequencies of the voltages either side of the breaker are asynchronous and therefore high phase angle differences can occur as the frequencies slip past each other. The system split detector operates when the phase angle difference exceeds a pre-set value. The setting range for a system split is from 90°-175° step 1°.

Note : the system split setting is effectively an absolute value and therefore a split will occur at the value regardless of the direction of the frequency slip e.g. if an angle of 170° is selected, then starting from 0°, a split will occur at +170° or -170° (effectively +190°).

If a system split occurs during a Check Sync operation the following events occur:

- The Check Sync function is inhibited.
- The System Sync function is started if the setting has been set to A/R Split Action SYSTEM SYNC. If the A/R Split Action has been set to LOCKOUT, then, a system split LED indication is given. The relay will stay in this lockout mode until one of the following methods of resetting it is performed

1. The relay is reset from Lockout.
2. A status input command is received.
3. An appropriate IEC870 communications command is received.

- An event is recorded.
- The split flag can be mapped to an output relay for alarm indication.
- The system split LED will stay on for a minimum time, or can be latched using non self reset LEDs.

2.2.4 System Synchronising Mode

For the relay to issue a System Sync Close the following conditions have to be met :

SS PHASE ANGLE – the phase difference between the line and bus voltages has to be less than the phase angle setting value and the phase angle has to be decreasing before the element will issue a valid close signal.

SS SLIP FREQUENCY, [If ENABLED] – the frequency difference between line and bus has to be less than the slip frequency setting value.

SS SLIP TIMER, [If ENABLED] – the phase angle and voltage blocking features have to be within their parameters for the length of the slip timer setting. If either the phase angle or the voltage elements fall outside of their limits the slip timer is reset. If they subsequently come back in then the slip timer has to time out before an output is given. (This ensures that a close output will not be given if there is a transient disturbance on the system due to e.g. some remote switching operations).

LINE U/V DETECTOR, [If ENABLED] – the line voltage has to be above the line under-voltage setting value and also above 5V for an output to be given.

BUS U/V DETECTOR, [If ENABLED] – the bus voltage has to be above the line under-voltage setting value and also above 5V for an output to be given.

DIFFERENTIAL VOLTAGE DETECTOR, [If ENABLED] – the difference between the line and bus voltages has to be less than the ΔV detector setting value for an output to be given.

The System Synchronising operation of the relay can be started in two different ways. It is set by the 'A/R Split Action' setting which has three parameters: LOCKOUT, SYSTEM SYNC, CLOSE ON ZERO; or 'MC Split Action' setting which also has three parameters: CLOSE ON ZERO, CHECK SYNC, SYSTEM SYNC.

If the 'A/R Split Action' setting is set to:

LOCKOUT: after a split has occurred the relay will go into lockout mode

SYSTEM SYNC: the relay will only start system synchronising after a split condition has occurred. It will issue a System Sync Close automatically if the relevant parameters are met. There is also a Start System Sync input which when energised will switch the Check Synchronisation to System Sync.

CLOSE ON ZERO: the relay will only start system synchronising after a split condition has occurred. The relay will issue a close command determined by the CB close time and synchronisation parameters.

If the 'MC Split Action' setting is set to:

CLOSE ON ZERO: the relay will only start system synchronising after a split condition has occurred. The relay will issue a close command determined by the CB close time and synchronisation parameters.

CHECK SYNC: the relay will only start system synchronising after a split condition has occurred. It will issue a Check Sync Close automatically if the relevant parameters are met.

SYSTEM SYNC: the relay will only start system synchronising after a split condition has occurred. It will issue a System Sync Close automatically if the relevant parameters are met. There is also a Start System Sync input which when energised will switch the Check Synchronisation to System Sync.

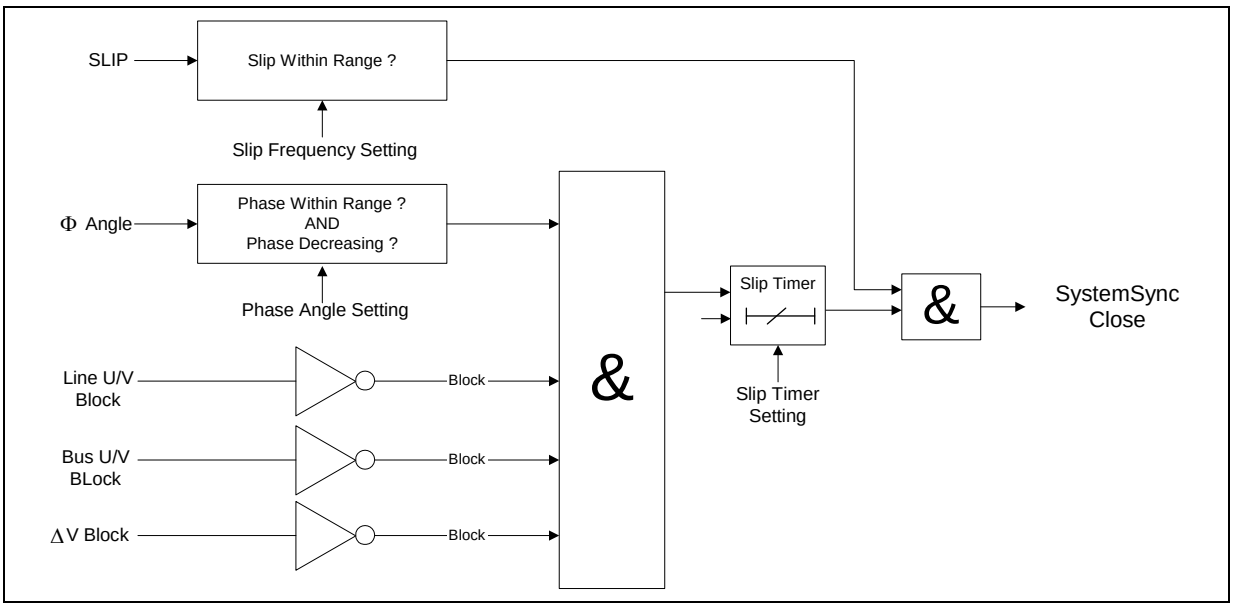
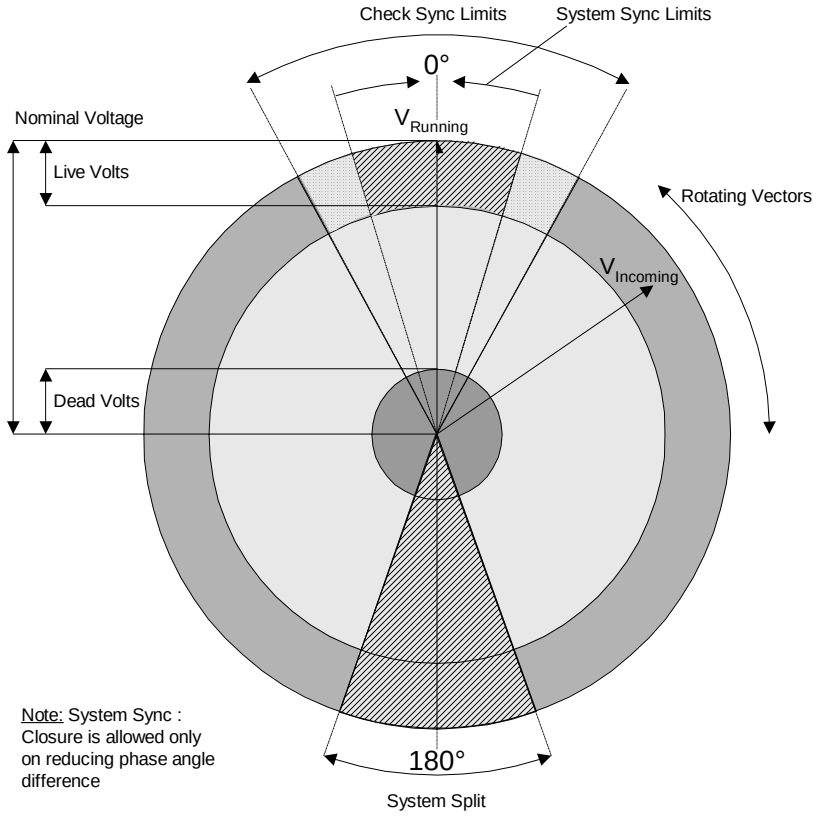


Figure 2-3 System Sync Function

Table 2-2 Typical Settings Check Sync

Setting name	Range (**bold** = default)	Units	Notes
Bus Dead | Live	5:10, 6:11…**20:90**…150:155	%	
Line Dead | Live	5:10, 6:11…**20:90**…150:155	%	
Bus Undervolts	OFF, 5,6…**90**…150	%	
Line Undervolts	OFF, 5,6…**90**…150	%	
Voltage Diff	OFF, 1…**10**…100	%	

Setting name	Range (**bold** = default)	Units	Notes
Split Angle	OFF, 95, 96…**175**	deg	
MC Split Action	**Close On Zero**, System Sync, Check Sync		
ARC Split Action	Close On Zero, System Sync, **Lockout**		
Check Sync Angle	5,6…**20**…90	deg	
Check Sync Slip	OFF, 10, 15 …**50**…2000	mHz	
Check Sync Timer	**OFF**, 0.1, 0.2…100	s	
SS / COZ Slip f	OFF, 10, 15 …**125**…2000	mHz	
CB Close Time	5,10…**60**…200	ms	
Sub-menu: **Output Relays**			
Live Line	_, 1 for each output contact		
Live Bus			
System Split O/P			
In Sync Output			
Check Sync Start			
Sync In Progress			
Dead Line Close			
Dead Bus Close			
Sub-menu: **Status Inputs**			
Sync Override	_, 1 for each status input		
Man SyncOverride			
Start SystemSync			



2.2.5 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	10 ms
f_{nom}	Nominal frequency	50 Hz
f_{cutoff}	Upper cut-off frequency	200 Hz

Reference

	Parameter	**Value**
Vn	Nominal voltage	63.5 V
Vsl	Line voltage setting	50 V
Vsb	Bus voltage setting	50 V
V_{live}	Live setting	50 V
V_{dead}	Dead setting	25 V
V_{diff}	Voltage difference setting	5 V
θ_{diff}	Phase difference	5 °
f_{slip}	Slip frequency	100 mHz
θ_{split}	Split angle	90 °
	Frequency	f_{nom}
	Ambient temperature	20 °C

Line and Bus Undervoltage Elements

	Attribute		**Value**
V_{line}	Operate level		100 % *Vsl*, ± 1 %
	Reset level		≤ 104 % V_{line}
V_{bus}	Operate level		100 % *Vsb*, ± 1 %
	Reset level		≤ 104 % V_{bus}
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 1 %

Live/Dead Detector Elements

	Attribute		**Value**
$V_{live,act}$	Live operate level		100 % V_{live}, ± 1 %
	Live reset level		$V_{dead,act}$, ± 1 %
$V_{dead,act}$	Dead operate level		100 % V_{dead}, ± 1 %
	Dead reset level		$V_{live,act}$, ± 1 %
	Repeatability		± 1 %
	Variation	-10 °C to +55 °C	≤ 5 %
		f_{nom} - 3 Hz to f_{nom} + 2 Hz	≤ 1 %

Voltage Difference

	Attribute	Value
V_{op}	Operate level	100 % V_{diff}, ± 2 % or ± 0.5 V
	Reset level	≥ V_{op} - 2 V and typically ≥ 90 % V_{op}
	Repeatability	± 2 %

Line and Bus Phase Angle Difference

	Attribute	Value
θ_{op}	Operate angle	θ_{diff}, - 3 °, + 0 °
	Reset angle	θ_{op}, - 0 °, + 3 °
	Repeatability	± 1 °

Slip Frequency

	Attribute	Value
f_{op}	Operate frequency	f_{slip}, - 15 mHz, + 0 mHz
	Reset angle	f_{op}, - 0 mHz, + 15 mHz
	Repeatability	± 10 mHz

Split Detector

	Attribute	Value
	Operate angle	θ_{split}, ± 1.5 °

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2004/08	First issue

Software Revision History

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Section 1: Introduction

1.1 Introduction

This document covers the auto-reclose function and its features. A Diagrams and Parameters document which covers each individual model is available, which lists explicitly the functions that are provided and the manner in which they are connected.

- 79, Auto-Reclose

Notes

1. The following notational and formatting conventions are used within the remainder of this document:
- Setting: *Elem Setting name*
- Setting value: value
- Alternatives: [1st] [2nd] [3rd]

2. Separate sections of the User Manual describe how to set up and operate the protection equipment: apply configuration, settings and passwords, view instruments and set default instruments, and retrieve fault data.

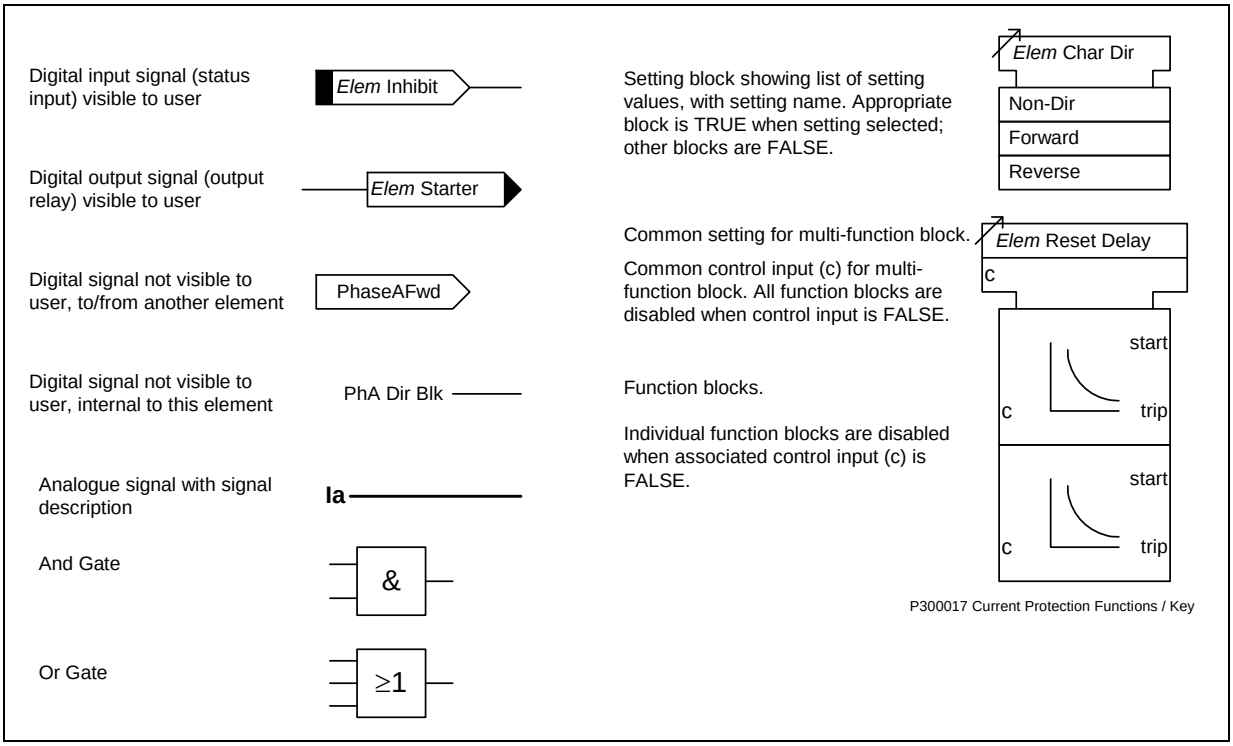

Figure 1-1 Key to Functional Block Diagrams

Section 2: Element Definitions

2.1 Auto-reclose control

Delayed Auto-Reclose (DAR) is initiated by a valid trip relay operation while the associated circuit breaker is in service.

A circuit breaker's service status is determined by its position. The circuit breaker is defined as being in service when it is closed. The in service status has a drop-off delay of 2 sec, this delay is known as the circuit memory time. This functionality prevents autoreclosing when the line is normally de-energised, or normally open.

The transition from DAR started to initiate deadtime takes place when the CB has opened; and the trip relay has reset. If any of these do not occur within the Sequence Fail time the relay will Lockout. This is provided to prevent the DAR being primed indefinitely, or the timer can be switched OFF.

Once a DAR sequence had been initiated, up to 4 unsuccessful recloses (where a closure is followed by a re-trip) may be performed before the DAR feature is locked-out. Each reclosure is preceded by a time delay (dead time) to give transient faults time to clear.

Once a CB has reclosed and remained closed for a specified time period (the Reclaim time), the DAR feature is re-initialised and a Successful Close output issued. A single, common Reclaim time is used.

A count is kept of how many recloses have been performed.

Once lockout has occurred, an alarm is issued and all further Close commands, except manual close, are inhibited for a specified time period (the Minimum Lockout time). A single, common lockout time is used. Lockout can be latched until reset – see Lockout 2.1.14.

There are separate dead-time settings for each of the 4 recloses.

2.1.1 Protection Trip

The protection element which trips the CB is used to prime and start the autoreclose sequence. Internal protection elements that will start the A/R are pre-selected within the relay.

2.1.2 Protection Starter

If, during a sequence, the breaker is closed from another device and a fault is still on the system the starter element will be energised. This is used to allow multi-shot autoreclose sequences to be co-ordinated for adjacent relays, i.e. the number of shots can be kept in step.

2.1.3 External A/R Start

An External A/R Start can be received via a status input. A separate protection device would normally initiate this.

An External A/R Start will be treated the same as a Protection A/R Start by the Relay.

2.1.4 Manual Close

An External Close Command can be received via a status input or communications. This would normally be initiated manually. It causes an instantaneous closure, over-riding any DAR sequence then in operation.

An External Close will initiate Line Check. If a fault appears on the line during the Close Pulse or the Reclaim Time with Line Check set, the Protection relay will initiate a Trip and the A/R relay will Lockout. This prevents a CB being repeatedly closed onto a faulted line.

Repeated Manual Closes are avoided by checking for Positive edge triggers. Even if the Manual Close input is constantly energised the relay will only attempt one close. No Close Pulse will be issued when the Manual Close input is reset.

Manual Close resets Lockout, if the conditions that set Lockout have reset i.e. there is no trip or Lockout input present.

Manual Close cannot proceed if there is a Lockout input or Block Reclose input present.

With the Autoreclose function set to Out of Service the Manual Close control is still active.

2.1.5 In/Out Switching

The DAR feature may be switched out by changing the A/R In Service setting by a number of methods. These are either a keypad change from the front panel, or via a communication, or by an A/R OUT status input. A/R OUT status input has priority over A/R IN. If both are raised the function will be in Out Of Service. Once the relay has been switched to Out Of Service the reverse action A/R IN is required before the function will go back to In Service.

2.1.6 Overall Control

The DAR feature may be disabled by a Lockout command or by an external signal applied to a status input (A/R OUT).

If the Lockout command or A/R OUT are received while a DAR operation is in progress, the feature is immediately locked-out. An External A/R IN command can be received via a status input. This will re-enable the module.

If the Lockout command is received while a Manual Close operation is in progress, the feature is immediately locked-out.

The DAR or Manual Close feature may be paused by an external Block signal applied to a status input. This causes the feature to temporarily halt before it issues the next CB close command and can be used, for example, to delay CB closure until the CB pressure has reached an acceptable level. If the Block signal has not been removed before the end of a defined time, the Reclose Block Delay, the relay is locked-out.

A Block Reclose input active within the deadtime resets the deadtime timer.

2.1.7 CB Close Command pulse

The duration of the CB Close Command pulse is settable to allow a range of CBs to be used. The Close pulse will be terminated if any protection Starter picks-up or a trip occurs. This is to prevent Close and Trip Command pulses existing simultaneously. A Close Onto Fault Output is given if a starter or trip picks-up in the Close Pulse. This can be independently wired to Lockout.

2.1.8 CB Failed To Open and CB Failed to Close

CB Failed To Open and CB Failed to Close features are used to confirm that a CB has not responded correctly to each Trip and Close Command. If a CB fails to operate, the DAR feature can be set to lockout.

2.1.9 CB Closed by Another Device

If, during a dead time period, the Relay detects that the CB has closed (due to an external source) it increments its Reclose count and advances to the next part of the Reclose sequence (begin Reclaim time).

2.1.10 Indications

The relay has a fully programmable output to either output contacts or LEDs, see settings sheet for complete list.

The following are included:
1. A/R Switched Out
2. A/R In Progress
3. Successful Close
4. Line Check
5. Ext Arc Start
6. Lockout
7. CB Failed to Open
8. CB Failed to Close

2.1.11 Trip and Reclose

This is a test function, allowing the operation of the CB to be verified.

The Trip signal should be routed directly to the Circuit Breaker. Once the CB has opened and the Trip and Reclose input is removed the DAR will wait for the first Reclose Delay and then issue a CB Close command.

A Trip and Reclose command will only be accepted if the Relay is in quiescent, or line healthy mode, i.e. no autoreclose sequences are in progress.

During the Trip and Reclose reclosure, Line Check is invoked to ensure that the CB does not repeatedly close onto a faulty line.

2.1.12 Metering

The Status of the DAR operations are displayed in Meters under the instruments Menu.

2.1.13 Dead-time and Reclaim Timing

The Deadtime will start if a Trip has occurred and the CB is Open and the Trip and Starter have then reset and the line has gone dead. Once a trip has occurred if the CB does not open or the Trip does not reset or the starter does not reset then the DAR will Lockout. This could be due to either a CB Fail condition, which would independently notify Lockout, or the Trip or Starter relay contact failing to reset. If the line does not go dead this may signify that the remote end has failed to clear the fault, and the autoreclose will go to Lockout.

A Trip during the deadtime will result in resetting the deadtime and then restarting the deadtime when the trip resets, provided the Sequence Fail Timer has not expired.

The Reclaim time will start once the Close Pulse has timed out and the CB has closed. Lockout is alarmed if the CB is open at the end of the reclaim time.

2.1.14 Lockout

The Lockout state can be reached for a number of reasons. Lockout will occur for the following:

- at the end of the Reclaim time if the CB is in the open position.
- a protection operates during the final Reclaim time.
- if a Close Pulse is given and the CB fails to close.
- The Reclose Lockout status input is active.
- At the end of the Reclose Block Delay due to a persistent Block signal not cleared.
- At the end of the Sync Close Delay due to Synchronism not being achieved.

Once the Lockout condition has been reached, it will be maintained until reset. The following will reset lockout:

- By a Manual Close command, from fascia, comms or a status input.
- By a Reset Lockout signal, provided there is no signal present that will cause Lockout.
- At the end of the Minimum Lockout time if Reset Lockout is selected to be reset by a timer, provided there is no signal present which will cause Lockout.
- if Lockout was entered by an A/R Out signal during an Autoreclose sequence then an A/R In signal must be received before Lockout can reset.
- by the CB Closed, provided there is no signal present which will cause Lockout.

The Lockout condition has a delayed drop-off of 2s.

The Lockout condition will initiate the Lockout indication and alarm contact.

Lockout does not issue a trip signal.

Lockout indicates an abnormal system occurrence, an event that needs to be investigated. When a CB is normally open the A/R relay does not go to Lockout, but using a combination of Trip and CB In Service to start the sequence prevents A/R sequences.

Table 2-1 Typical Settings Auto-Reclose

Setting name	Range (**bold** = default)	Units	Notes
A/R In Service	In, **Out**		
Number Of Shots	**1**..4		
***Shot* Deadtime**	0.0, 0.1…**5.00**…120, 121…900	s	
CB Close Pulse	0.2, 0.3…**2.0**…20	s	
Reclaim Time	OFF, 1…**5**…600	s	
***Elem* Trip**	**Delayed**, Instant		
Line Check Trip	**Delayed**, Instant		
***Elem* TTL**	**OFF**, 1…5		
Rec Block Delay	0, 1…**60**…600	s	
Slow Open Delay	50, 60…**140**…2000	ms	
Seq Fail Timer	**OFF**, 1, 2…600	s	
Min LO Timer	0, 1…**2**…60	s	
Reset LO By Time	Enabled, **Disabled**		

Setting name	Range (**bold** = default)	Units	Notes
Sub-menu: **Output Relays**			
Lockout	_, 1 for each output contact		
A/R Switched Out			
A/R In Progress			
Successful Close			
Line Check			
Ext Arc Start			
CBFailedToOpen			
CBFailedToClose			
Sub-menu: **Status Inputs**			
A/R In	_, 1 for each status input		
A/R Out			
Extern A/R Start			
Block Reclose			
Go To Lockout			
Trip And Reclose			
Trip and Lockout			
Reset Lockout			
Manual Close			

2.1.14.1 Specification

Element Parameters

The element will take the following parameters, unless otherwise specified in the appropriate Diagrams and Parameters document.

	Parameter	**Value**
t_{cycle}	Element cycle time	20 ms
$t_{setting}$	Timer settings	Applied value

Operate Time

	Attribute	**Value**
t_{op}	Operate time following delay	$t_{setting}$, ± 1 % or ± t_{cycle}
	Repeatability	± 1 % or ± t_{cycle}

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/12	Connection Diagram and Settings updated Software history revised
2004/08	First issue

Software Release History

The list of software revisions applying to the FM1-111, up to the date of this document issue is:

Note: relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-111 relay configurations.

FM1-111 Firmware + Default Configuration (2471H80001)

FM1-111 Firmware (2471S81122)

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

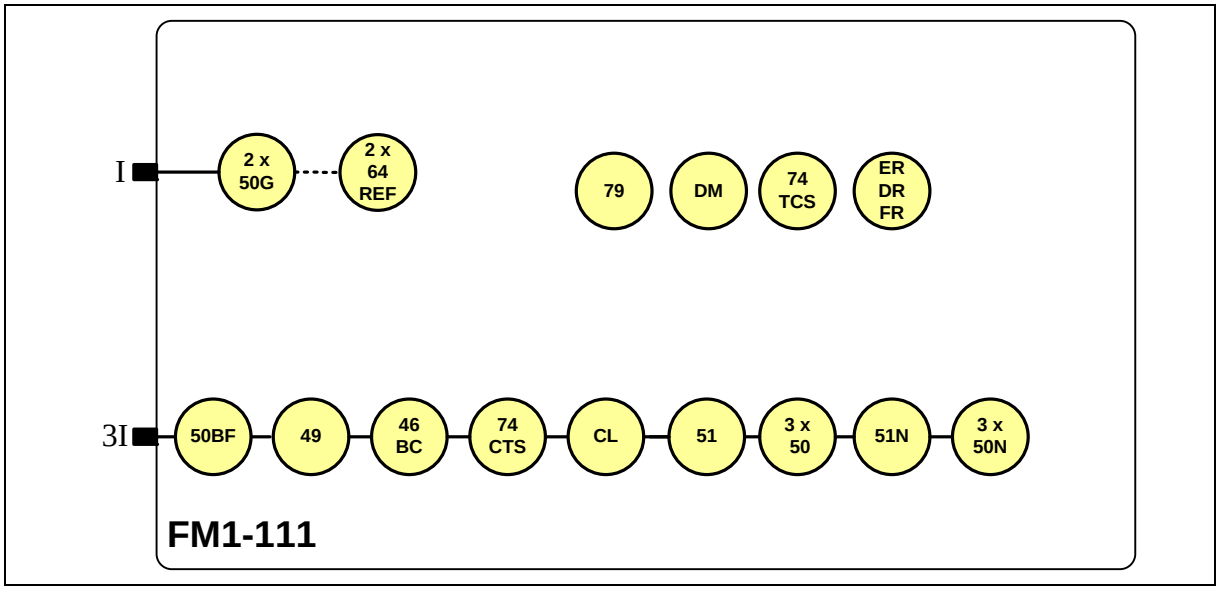

Figure 1-1 Functional Diagram for the FM1-111

1.1 Element Details

Details of the protective functions provided in the FM1-111 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Earth-fault Lowset	
E/FN HS1	Earth-fault Highset 1	
E/FN HS1	Earth-fault Highset 2	

SEF/REF (50G, 64REF)

Element		Technical Reference
SEF	Sensitive Earth Fault	Current Protections – P20048 section 2.1.4
REF	Restricted Earth Fault	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	
Aux CT Ratio	2.2.2.1	
Earth Fault Mode	2.2.2.1	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Setting		xIn
E/F HS2 Delay		s

Protection : SEF/REF

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Sef 1	2.1.4	
Sef 1 Setting		xIn
Sef 1 Timer		s
Sef 1 Reset Char		
Sef 1 Reset Delay		
Sef 2	2.1.4	
Sef 2 Setting		xIn
Sef 2 Timer		s
Sef 2 Reset Char		
Sef 2 Reset Delay		
Ref 1	2.1.4	
Ref 1 Setting		xIn
Ref 1 Timer		s
Ref 1 Reset Char		
Ref 1 Reset Delay		
Ref 2	2.1.4	
Ref 2 Setting		xIn
Ref 2 Timer		s
Ref 2 Reset Char		
Ref 2 Reset Delay		

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		

Setting name	Ref	Applied value
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		
Trip Cct Failed		

Setting name	Ref	Applied value
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		

Setting name	Ref	Applied value
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
SEF/REF 1 Inhibit		
SEF/REF 2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		

Setting name	Ref	Applied value
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Reset Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s

Setting name	Ref	Applied value
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		

Setting name	Ref	Applied value
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		

Setting name	Ref	Applied value
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Note: The IEC Update function setting appears in all models even if the function is not available. The setting can be left with the default value.

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**

Function	Information Number	Description	Function Type	Cause of Transmission
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	44	A-Forward	2	SE, GI
168	45	A-Reverse	2	SE, GI
168	46	B-Forward	2	SE, GI
168	47	B-Reverse	2	SE, GI
168	48	C-Forward	2	SE, GI
168	49	C-Reverse	2	SE, GI
168	50	E/F-Forward	2	SE, GI
168	51	E/F-Reverse	2	SE, GI
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	NPS-lowset starter	2	SE, GI
168	63	NPS-lowset trip	2	SE, GI
168	64	NPS-HS1 trip	2	SE, GI
168	75	NPS-HS2 trip	2	SE, GI
168	66	NPS-HS1 starter	2	SE, GI
168	67	NPS-HS2 starter	2	SE, GI
168	68	NPS-general trip	2	SE, GI
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	110	E/Fm-Forward	2	SE, GI
168	111	E/Fm-Reverse	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	185	3Vo Element 1 Starter	2	SE, GI
168	186	3Vo Element 2 Starter	2	SE, GI
168	187	3Vo Element 1 Trip	2	SE, GI
168	188	3Vo Element 2 Trip	2	SE, GI
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak

Function	Information Number	Description	Function Type	Cause of Transmission
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3}$, $V_{L1,2,3}$, P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3}$, $V_{L1,2,3}$, $V_{L1-2, L2-3, L3-1}$, P, Q, F, Sync Angle**	**9**	**Cyclic**

Note: In all models the standard measurand frame is returned. Those relays that are not fitted with the measuring functions will return a value of 0.

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6

10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12
10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10154	Broken Conductor

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

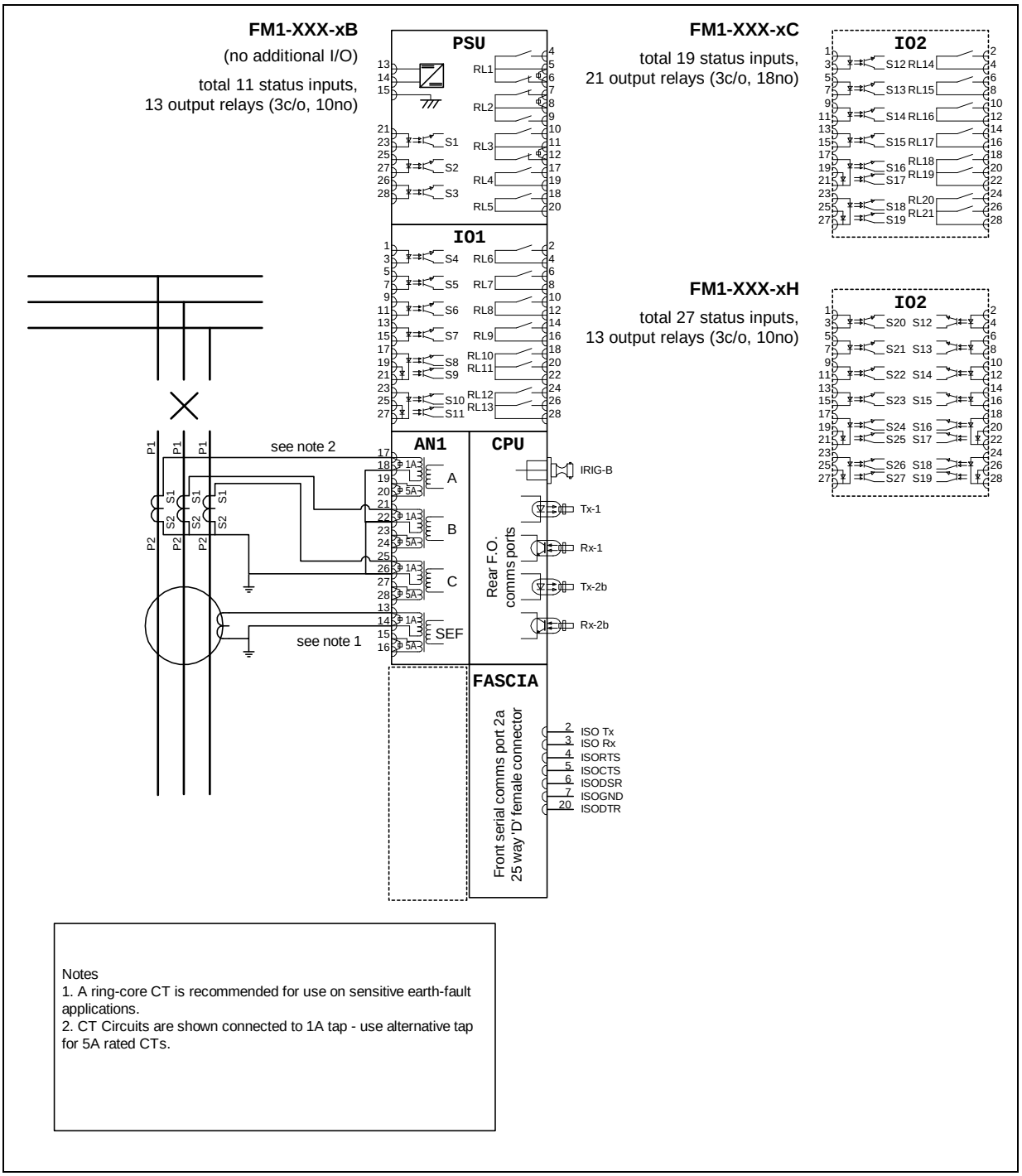

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/12	Connection Diagram and Settings updated Software history revised
2004/08	First issue

Software Release History

The list of software revisions applying to the FM1-112, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-112 relay configurations.

FM1-112 Firmware + Default Configuration (2471H80065)

Oct 2004	R1		First release

FM1-112 Firmware (2471S81122)

Oct 2004	R15		

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

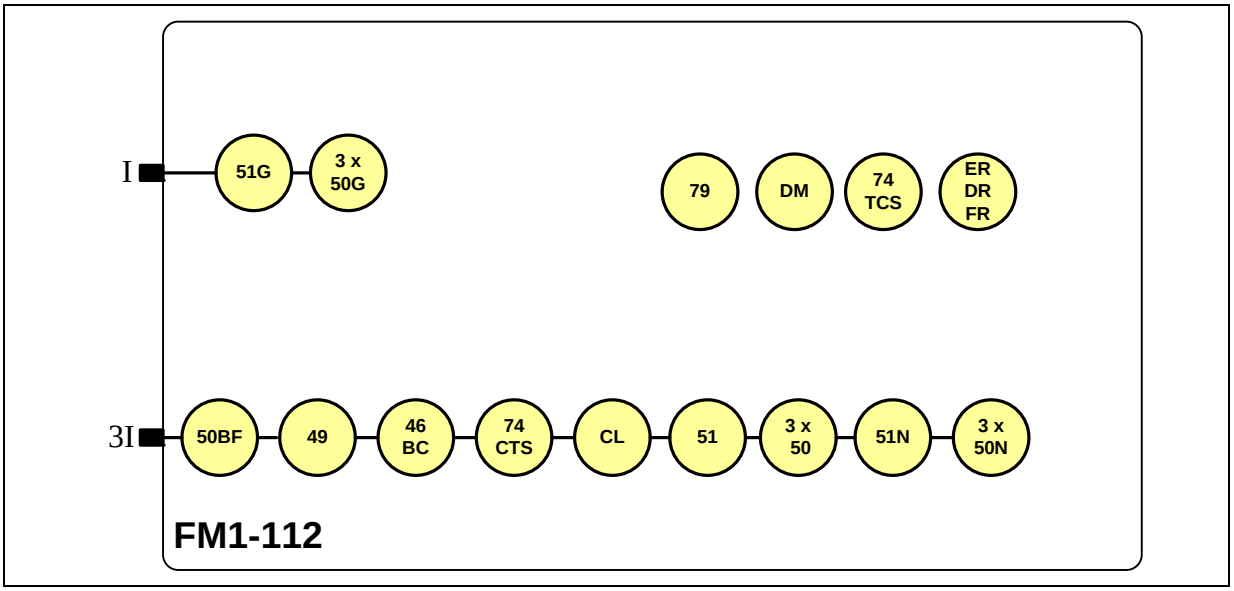

Figure 1-1 Functional Diagram for the FM1-112

1.1 Element Details

Details of the protective functions provided in the FM1-112 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	
E/FG	Earth-fault direct measurement	

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Derived Earth-fault Lowset	
E/FN HS1	Derived Earth-fault Highset 1	
E/FN HS1	Derived Earth-fault Highset 2	
E/FG LS	Measured Earth-fault Lowset	
E/FG HS1	Measured Earth-fault Highset 1	
E/FG HS1	Measured Earth-fault Highset 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	A
Aux CT Ratio	2.2.2.1	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s
E/Fm Shaped Char		
E/Fm Char Setting		xIn
E/Fm Charact		
E/Fm Multiplier		
E/Fm Char Delay		s
E/Fm Reset(ANSI)		
E/Fm Reset Delay		s

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	

Setting name	Ref	Applied value
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Setting		xIn
E/F HS2 Delay		s
E/Fm LS	2.1.3	
E/Fm LS Setting		xIn
E/Fm LS Delay		s
E/Fm HS1	2.1.3	
E/Fm HS1 Setting		xIn
E/Fm HS1 Delay		s
E/Fm HS2	2.1.3	
E/Fm HS2 Setting		xIn
E/Fm HS2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		

Setting name	Ref	Applied value
Min LO Timer		s
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		

Setting name	Ref	Applied value
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		

Setting name	Ref	Applied value
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1		s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
E/Fm Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		

Setting name	Ref	Applied value
E/Fm LS Inhibit		
E/Fm HS1 Inhibit		
E/Fm HS2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s

Setting name	Ref	Applied value
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s

Setting name	Ref	Applied value
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		

Setting name	Ref	Applied value
BrokenConductor		
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		

Setting name	Ref	Applied value
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		

Setting name	Ref	Applied value
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Note: The IEC Update function setting appears in all models even if the function is not available. The setting can be left with the default value.

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	44	A-Forward	2	SE, GI
168	45	A-Reverse	2	SE, GI
168	46	B-Forward	2	SE, GI
168	47	B-Reverse	2	SE, GI
168	48	C-Forward	2	SE, GI
168	49	C-Reverse	2	SE, GI
168	50	E/F-Forward	2	SE, GI
168	51	E/F-Reverse	2	SE, GI
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	NPS-lowset starter	2	SE, GI
168	63	NPS-lowset trip	2	SE, GI
168	64	NPS-HS1 trip	2	SE, GI
168	75	NPS-HS2 trip	2	SE, GI
168	66	NPS-HS1 starter	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	67	NPS-HS2 starter	2	SE, GI
168	68	NPS-general trip	2	SE, GI
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	110	E/Fm-Forward	2	SE, GI
168	111	E/Fm-Reverse	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**

Function	Information Number	Description	Function Type	Cause of Transmission
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	185	3Vo Element 1 Starter	2	SE, GI
168	186	3Vo Element 2 Starter	2	SE, GI
168	187	3Vo Element 1 Trip	2	SE, GI
168	188	3Vo Element 2 Trip	2	SE, GI
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak

Function	Information Number	Description	Function Type	Cause of Transmission
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack**,** Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	Information Number	Description	Function Type	Cause of Transmission
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Note: In all models the standard measurand frame is returned. Those relays that are not fitted with the measuring functions will return a value of 0.

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10154	Broken Conductor

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

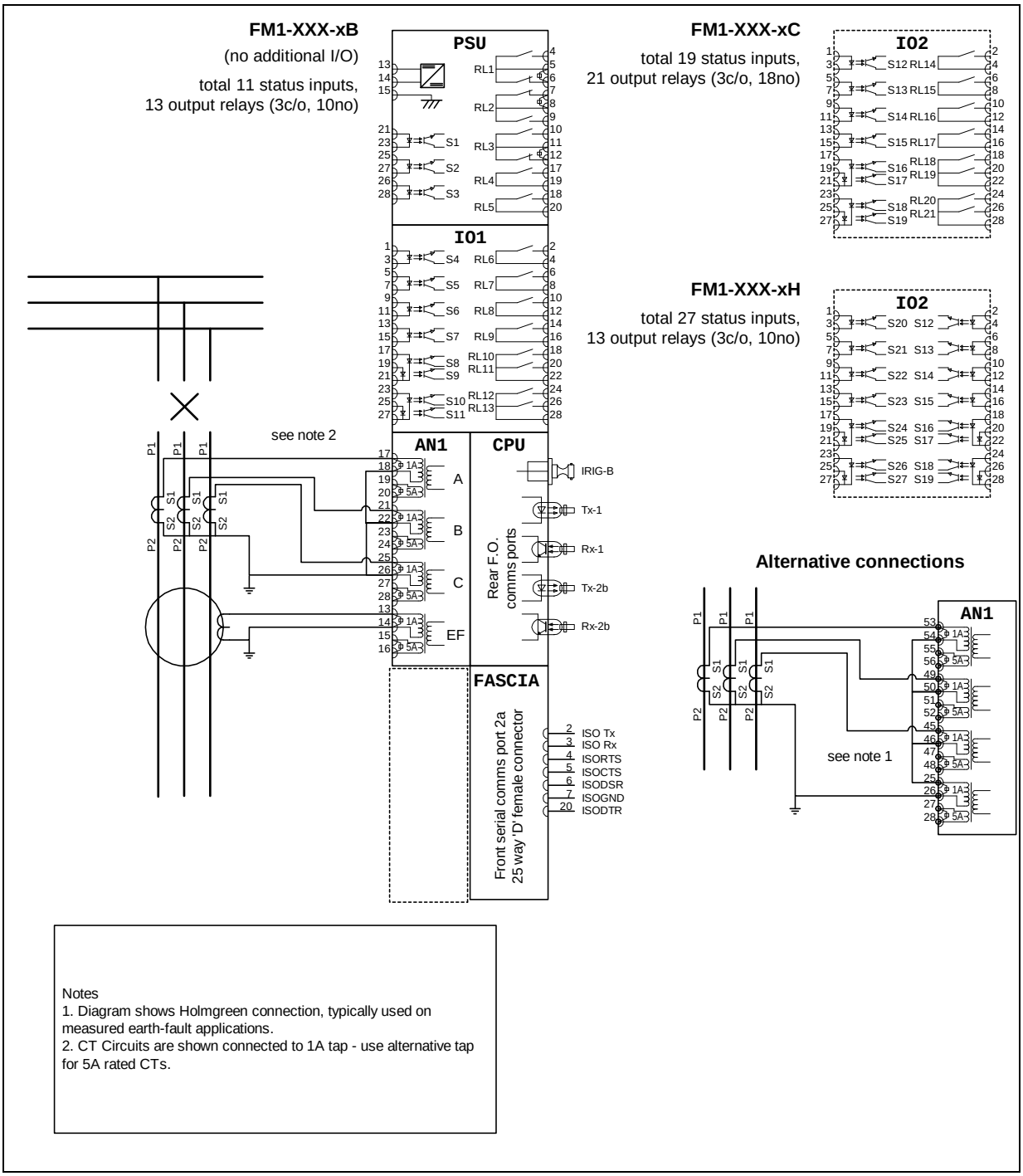

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/12	Connection Diagram and Settings updated Software history revised
2004/08	First issue

Software Release History

The list of software revisions applying to the FM1-211, up to the date of this document issue is:

Note: relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-211 relay configurations.

FM1-211 Firmware + Default Configuration (2471H80007)

FM1-211 Firmware (2471S81122)

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

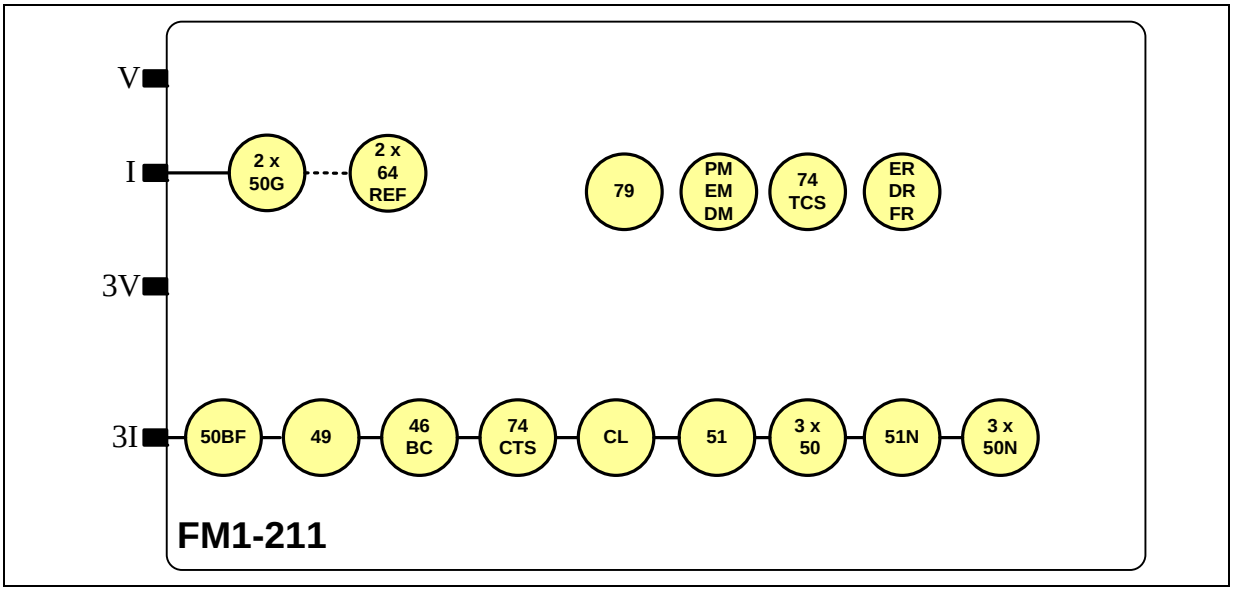

Figure 1-1 Functional Diagram for the FM1-211

1.1 Element Details

Details of the protective functions provided in the FM1-211 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Earth-fault Lowset	
E/FN HS1	Earth-fault Highset 1	
E/FN HS1	Earth-fault Highset 2	

SEF/REF (50G, 64REF)

Element		Technical Reference
SEF	Sensitive Earth Fault	Current Protections – P20048 section 2.1.4
REF	Restricted Earth Fault	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	
Aux CT Ratio	2.2.2.1	
Earth Fault Mode	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Setting		xIn

Setting name	Ref	Applied value
E/F HS2 Delay		s

Protection : SEF/REF

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Sef 1	2.1.4	
Sef 1 Setting		xIn
Sef 1 Timer		s
Sef 1 Reset Char		
Sef 1 Reset Delay		
Sef 2	2.1.4	
Sef 2 Setting		xIn
Sef 2 Timer		s
Sef 2 Reset Char		
Sef 2 Reset Delay		
Ref 1	2.1.4	
Ref 1 Setting		xIn
Ref 1 Timer		s
Ref 1 Reset Char		
Ref 1 Reset Delay		
Ref 2	2.1.4	
Ref 2 Setting		xIn
Ref 2 Timer		s
Ref 2 Reset Char		
Ref 2 Reset Delay		

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s

Setting name	Ref	Applied value
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
Thermal OL Trip		

Setting name	Ref	Applied value
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		

Setting name	Ref	Applied value
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
SEF/REF 1 Inhibit		
SEF/REF 2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Reset Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		

Setting name	Ref	Applied value
SEF/REF 1 Trip		
SEF/REF 2 Trip		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		

Setting name	Ref	Applied value
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		

Setting name	Ref	Applied value
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Note: The IEC Update function setting appears in all models even if the function is not available. The setting can be left with the default value.

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	44	A-Forward	2	SE, GI
168	45	A-Reverse	2	SE, GI
168	46	B-Forward	2	SE, GI
168	47	B-Reverse	2	SE, GI
168	48	C-Forward	2	SE, GI
168	49	C-Reverse	2	SE, GI
168	50	E/F-Forward	2	SE, GI
168	51	E/F-Reverse	2	SE, GI
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	NPS-lowset starter	2	SE, GI
168	63	NPS-lowset trip	2	SE, GI
168	64	NPS-HS1 trip	2	SE, GI
168	75	NPS-HS2 trip	2	SE, GI
168	66	NPS-HS1 starter	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	67	NPS-HS2 starter	2	SE, GI
168	68	NPS-general trip	2	SE, GI
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	110	E/Fm-Forward	2	SE, GI
168	111	E/Fm-Reverse	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**

Function	Information Number	Description	Function Type	Cause of Transmission
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	185	3Vo Element 1 Starter	2	SE, GI
168	186	3Vo Element 2 Starter	2	SE, GI
168	187	3Vo Element 1 Trip	2	SE, GI
168	188	3Vo Element 2 Trip	2	SE, GI
168	**201**	**3PAvEnergy**	**1**	**Cyclic**
168	**202**	**3PReacEnergy**	**1**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak

Function	Information Number	Description	Function Type	Cause of Transmission
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	Information Number	Description	Function Type	Cause of Transmission
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Note: In all models the standard measurand frame is returned. Those relays that are not fitted with the measuring functions will return a value of 0.

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10154	Broken Conductor

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

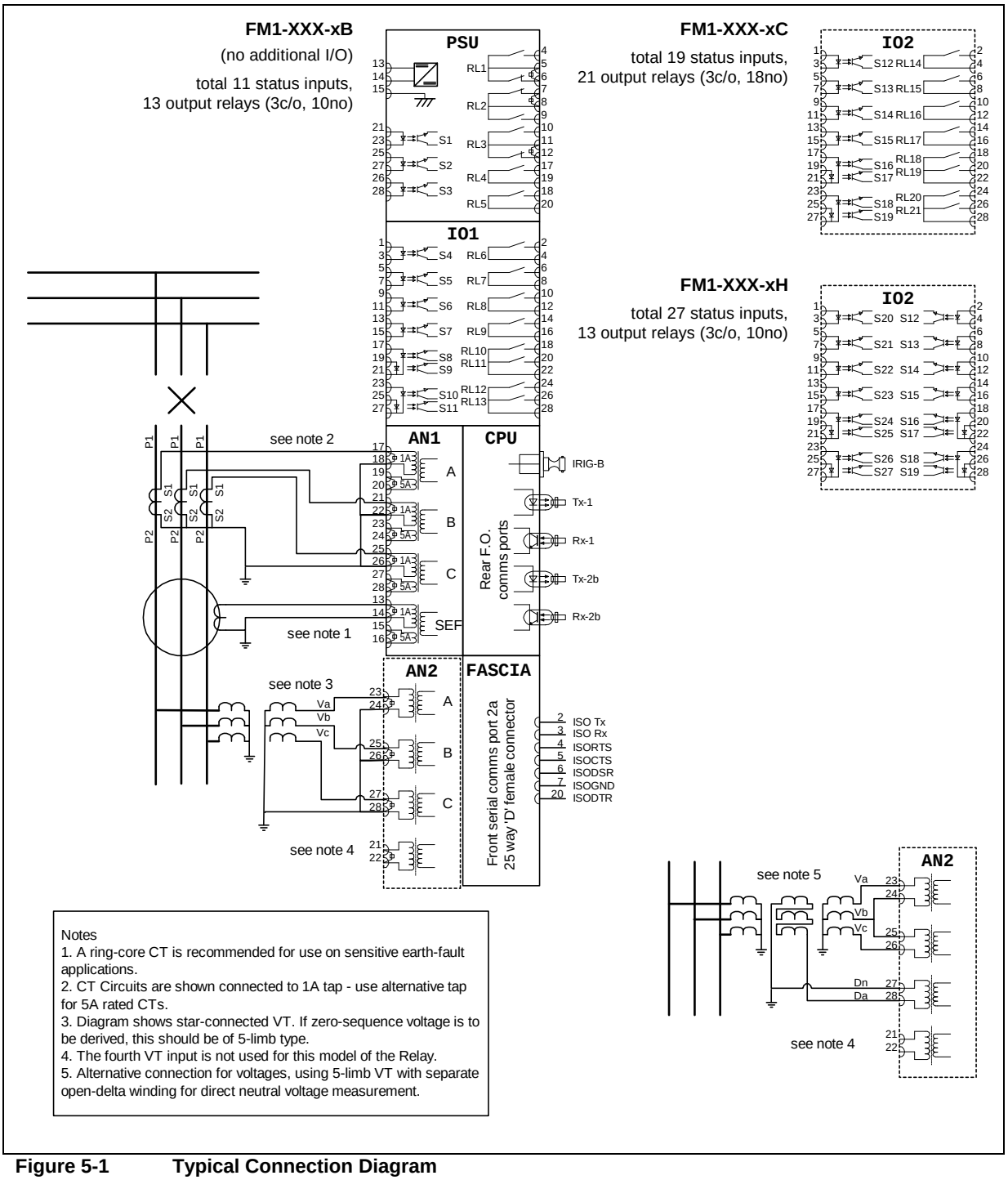

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/12	Connection Diagram and Settings updated Software history revised
2004/08	First issue

Software Release History

The list of software revisions applying to the FM1-212, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-212 relay configurations.

FM1-212 Firmware + Default Configuration (2471H80066)

Nov 2004	R1		First release

FM1-212 Firmware (2471S81122)

May 2003	R15		

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

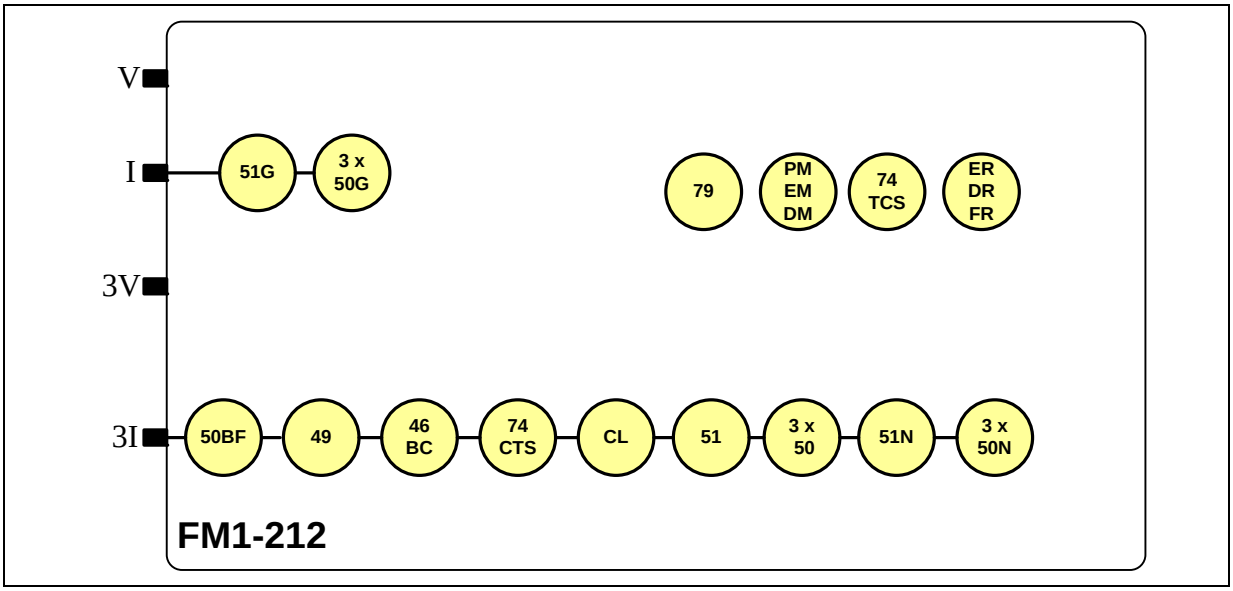

Figure 1-1 Functional Diagram for the FM1-212

1.1 Element Details

Details of the protective functions provided in the FM1-212 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	
E/FG	Earth-fault direct measurement	

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Derived Earth-fault Lowset	
E/FN HS1	Derived Earth-fault Highset 1	
E/FN HS1	Derived Earth-fault Highset 2	
E/FG LS	Measured Earth-fault Lowset	
E/FG HS1	Measured Earth-fault Highset 1	
E/FG HS1	Measured Earth-fault Highset 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	A
Aux CT Ratio	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		

Setting name	Ref	Applied value
E/F Shaped Char	2.1.1	
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s
E/Fm Shaped Char		
E/Fm Char Setting		xIn
E/Fm Charact		
E/Fm Multiplier		
E/Fm Char Delay		s
E/Fm Reset(ANSI)		
E/Fm Reset Delay		s

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Setting		xIn

Setting name	Ref	Applied value
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Setting		xIn
E/F HS2 Delay		s
E/Fm LS	2.1.3	
E/Fm LS Setting		xIn
E/Fm LS Delay		s
E/Fm HS1	2.1.3	
E/Fm HS1 Setting		xIn
E/Fm HS1 Delay		s
E/Fm HS2	2.1.3	
E/Fm HS2 Setting		xIn
E/Fm HS2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		

Setting name	Ref	Applied value
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		

Setting name	Ref	Applied value
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		

Setting name	Ref	Applied value
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
E/Fm Char Inhibit		
P/F LS Inhibit		

Setting name	Ref	Applied value
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
E/Fm LS Inhibit		
E/Fm HS1 Inhibit		
E/Fm HS2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s

Setting name	Ref	Applied value
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s

Setting name	Ref	Applied value
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
Thermal OL Trip		

Setting name	Ref	Applied value
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
CB Fail 1		
CB Fail 2		
CTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		

Setting name	Ref	Applied value
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		

Setting name	Ref	Applied value
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Note: The IEC Update function setting appears in all models even if the function is not available. The setting can be left with the default value.

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	44	A-Forward	2	SE, GI
168	45	A-Reverse	2	SE, GI
168	46	B-Forward	2	SE, GI
168	47	B-Reverse	2	SE, GI
168	48	C-Forward	2	SE, GI
168	49	C-Reverse	2	SE, GI
168	50	E/F-Forward	2	SE, GI
168	51	E/F-Reverse	2	SE, GI
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	NPS-lowset starter	2	SE, GI
168	63	NPS-lowset trip	2	SE, GI
168	64	NPS-HS1 trip	2	SE, GI
168	75	NPS-HS2 trip	2	SE, GI
168	66	NPS-HS1 starter	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	67	NPS-HS2 starter	2	SE, GI
168	68	NPS-general trip	2	SE, GI
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	110	E/Fm-Forward	2	SE, GI
168	111	E/Fm-Reverse	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**

Function	Information Number	Description	Function Type	Cause of Transmission
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	185	3Vo Element 1 Starter	2	SE, GI
168	186	3Vo Element 2 Starter	2	SE, GI
168	187	3Vo Element 1 Trip	2	SE, GI
168	188	3Vo Element 2 Trip	2	SE, GI
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak

Function	Information Number	Description	Function Type	Cause of Transmission
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	Information Number	Description	Function Type	Cause of Transmission
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Note: In all models the standard measurand frame is returned. Those relays that are not fitted with the measuring functions will return a value of 0.

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10154	Broken Conductor

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

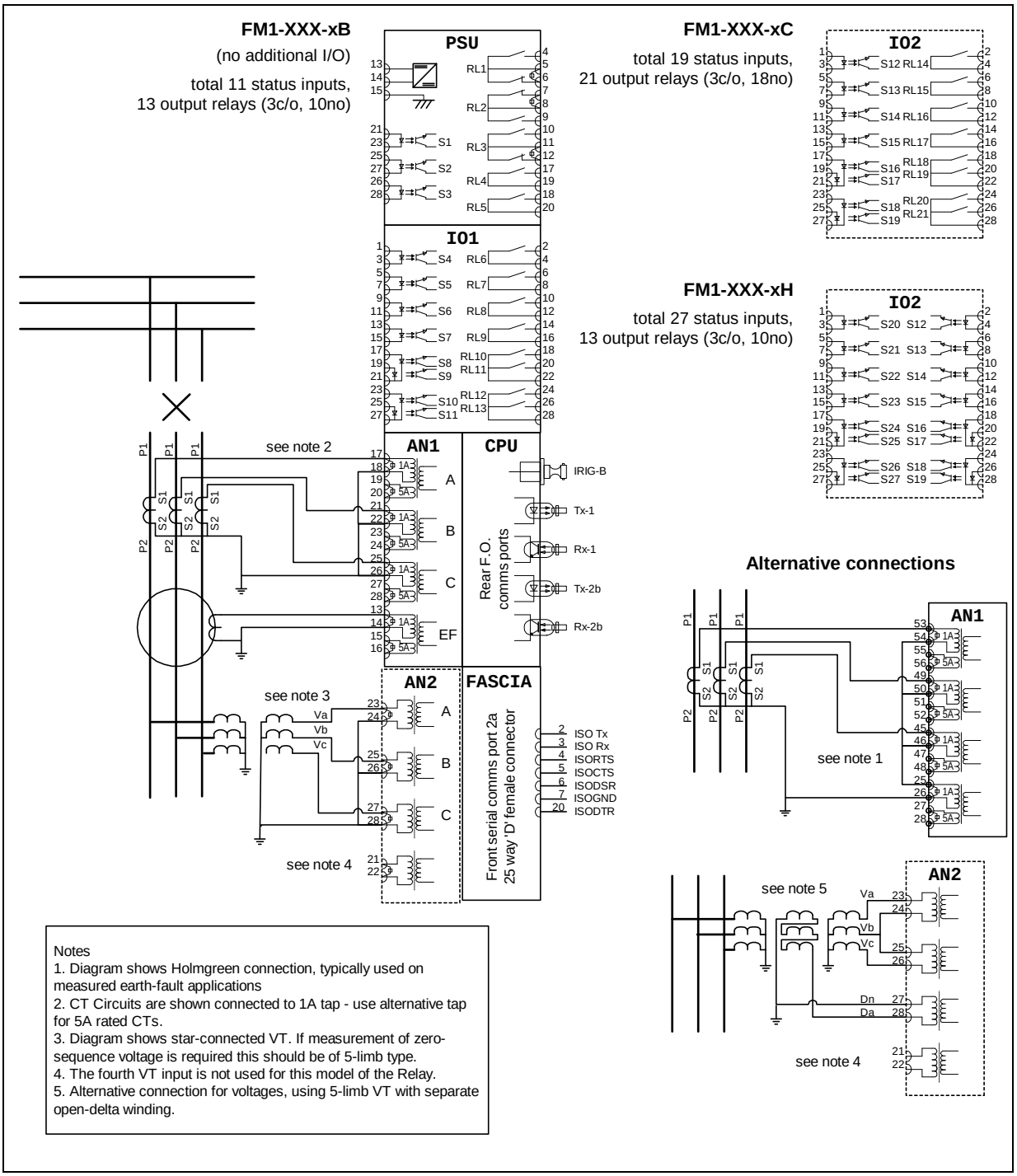

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2006/09	“3Vo Input” setting added
2006/01	Modbus Definitions added IEC60870 default definitions revised
2005/12	Connection Diagram and Settings updated Software history revised
2004/7	Updated settings, function diagram and event list
2003/02	v2 Page 9 to 16: corrected various invalid references to other documents
2003/01	First issue

Software Release History

The list of software revisions applying to the FM1-213, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-213 relay configurations.

FM1-213 Firmware + Default Configuration (2471H80035)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
May 2003	R1		First Release	

FM1-213 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.
			Additional features:	Time & date meters added
May 2003	R1		First release	

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

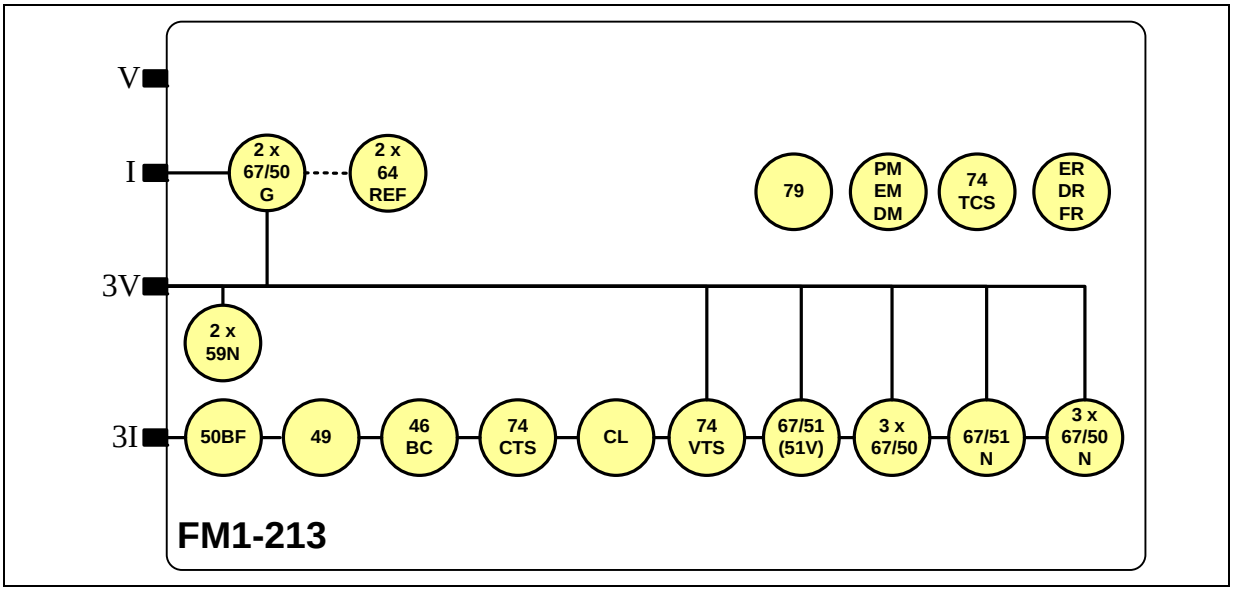

Figure 1-1 Functional Diagram for the FM1-213

1.1 Element Details

Details of the protective functions provided in the FM1-213 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Earth-fault Lowset	
E/FN HS1	Earth-fault Highset 1	
E/FN HS1	Earth-fault Highset 2	

SEF/REF (50G, 64REF)

Element		Technical Reference
SEF	Sensitive Earth Fault	Current Protections – P20048 section 2.1.4
REF	Restricted Earth Fault	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-1	Neutral Voltage Displacement 2	

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N, 67G)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	
SEF	Sensitive Earth Fault	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	
Aux CT Ratio	2.2.2.1	
Earth Fault Mode	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s

Setting name	Ref	Applied value
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s

Protection : SEF/REF

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Sef 1	2.1.4	
Sef 1 Dir		
Sef 1 Setting		xIn
Sef 1 Timer		s
Sef 1 Reset Char		
Sef 1 Reset Delay		
Sef 2	2.1.4	
Sef 2 Dir		
Sef 2 Setting		xIn
Sef 2 Timer		s
Sef 2 Reset Char		
Sef 2 Reset Delay		
Ref 1	2.1.4	
Ref 1 Setting		xIn
Ref 1 Timer		s
Ref 1 Reset Char		
Ref 1 Reset Delay		
Ref 2	2.1.4	
Ref 2 Setting		xIn
Ref 2 Timer		s
Ref 2 Reset Char		
Ref 2 Reset Delay		

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection: Voltage Protection

Ref: P20051 Neutral Voltage

Setting name	Ref	Applied value
3Vo Input	2.1.3	
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		

Setting name	Ref	Applied value
3Vo-1 Reset Delay		s
3Vo-2 Charact	2.1.3	
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		
3Vo-2 Reset Delay		s

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle		deg
SEF Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		

Setting name	Ref	Applied value
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
Sef Fwd		
Sef Rev		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		

Setting name	Ref	Applied value
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
SEF/REF 1 Inhibit		
SEF/REF 2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		
SEF Dir Inhibit		
3V0-1 Inhibit		
3V0-2 Inhibit		
Trip Fail Start		
Trip Cct Fail		

Setting name	Ref	Applied value
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Reset Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s

Setting name	Ref	Applied value
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1		s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s

Setting name	Ref	Applied value
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		

Setting name	Ref	Applied value
EarthFwd		
EarthRev		
SEF Fwd		
SEF Rev		
3V0-1 Starter		
3V0-1 Trip		
3V0-2 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		

Setting name	Ref	Applied value
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		

Setting name	Ref	Applied value
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		

Setting name	Ref	Applied value
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		

Setting name	Ref	Applied value
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	65	I2 Element 1 trip	2	SE, GI
168	66	I2 Element 2 trip	2	SE, GI
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	114	V2 Element 1 Trip	2	SE, GI
168	115	V2 Element 2 Trip	2	SE, GI
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	120	F Element 1 Trip	2	SE, GI
168	121	F Element 2 Trip	2	SE, GI
168	122	F Element 3 Trip	2	SE, GI
168	123	F Element 4 Trip	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

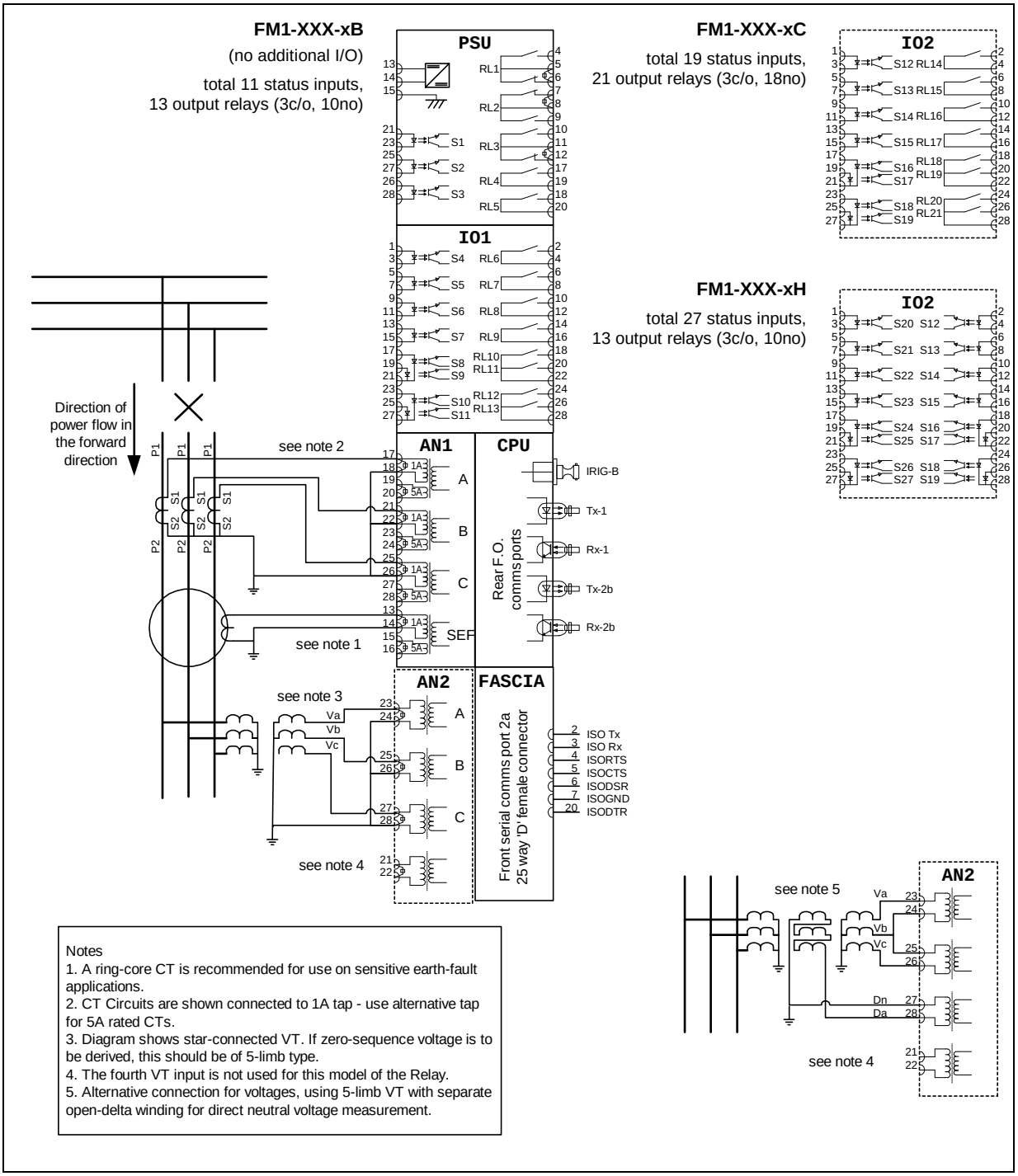

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2006/09	"3Vo Input" setting added
2006/07	Fig 4.2 added
2006/01	Modbus Definitions added IEC60870 default definitions revised
2005/12	Connection Diagram and Settings updated
2004/7	Updated settings, function diagram and event list
2003/02	v2 Page 9 to 16: corrected various invalid references to other documents
2003/01	First issue

Software Release History

The list of software revisions applying to the FM1-214, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-214 relay configurations.

FM1-214 Firmware + Default Configuration (2471H80053)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
Dec 2003	R1		First Release	

FM1-214 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.

			Additional features: Time & date meters added
May 2003	R1		First release

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

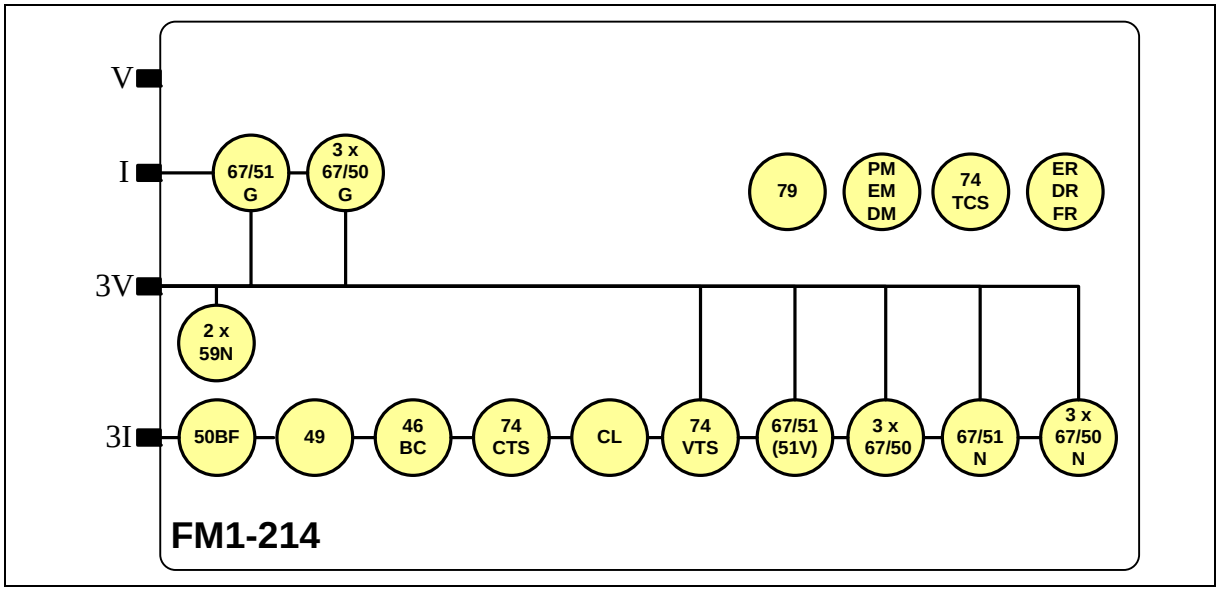

Figure 1-1 Functional Diagram for the FM1-214

1.1 Element Details

Details of the protective functions provided in the FM1-214 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	
E/FG	Earth-fault direct measurement	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Derived Earth-fault Lowset	
E/FN HS1	Derived Earth-fault Highset 1	
E/FN HS1	Derived Earth-fault Highset 2	
E/FG LS	Measured Earth-fault Lowset	
E/FG HS1	Measured Earth-fault Highset 1	
E/FG HS1	Measured Earth-fault Highset 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-1	Neutral Voltage Displacement 2	

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	
E/Fm	Earth Fault Measured	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	A
Aux CT Ratio	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s
E/Fm Shaped Char		
E/Fm Char Dir		
E/Fm Char Setting		xIn
E/Fm Charact		
E/Fm Multiplier		
E/Fm Char Delay		s
E/Fm Reset(ANSI)		
E/Fm Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	

Setting name	Ref	Applied value
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s
E/Fm LS	2.1.3	
E/Fm LS Dir		
E/Fm LS Setting		xIn
E/Fm LS Delay		s
E/Fm HS1	2.1.3	
E/Fm HS1 Dir		
E/Fm HS1 Setting		xIn
E/Fm HS1 Delay		s
E/Fm HS2	2.1.3	
E/Fm HS2 Dir		
E/Fm HS2 Setting		xIn
E/Fm HS2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection: Voltage Protection

Ref: P20051 Neutral Voltage

Setting name	Ref	Applied value
3Vo Input	2.1.3	
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		
3Vo-1 Reset Delay		s
3Vo-2 Charact	2.1.3	
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		

Setting name	Ref	Applied value
3Vo-2 Reset Delay		s

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle	2.2.1.1	deg
E/Fm Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		

Setting name	Ref	Applied value
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		

Setting name	Ref	Applied value
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
E/Fm Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
E/Fm LS Inhibit		
E/Fm HS1 Inhibit		
E/Fm HS2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		
E/Fm Dir Inhibit		
3V0-1 Inhibit		
3V0-2 Inhibit		

Setting name	Ref	Applied value
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s

Setting name	Ref	Applied value
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s

Setting name	Ref	Applied value
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		

Setting name	Ref	Applied value
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
3V0-1 Trip		
3V0-2 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		

Setting name	Ref	Applied value
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		

Setting name	Ref	Applied value
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	65	I2 Element 1 trip	2	SE, GI
168	66	I2 Element 2 trip	2	SE, GI
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	114	V2 Element 1 Trip	2	SE, GI
168	115	V2 Element 2 Trip	2	SE, GI
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	120	F Element 1 Trip	2	SE, GI
168	121	F Element 2 Trip	2	SE, GI
168	122	F Element 3 Trip	2	SE, GI
168	123	F Element 4 Trip	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
10164	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

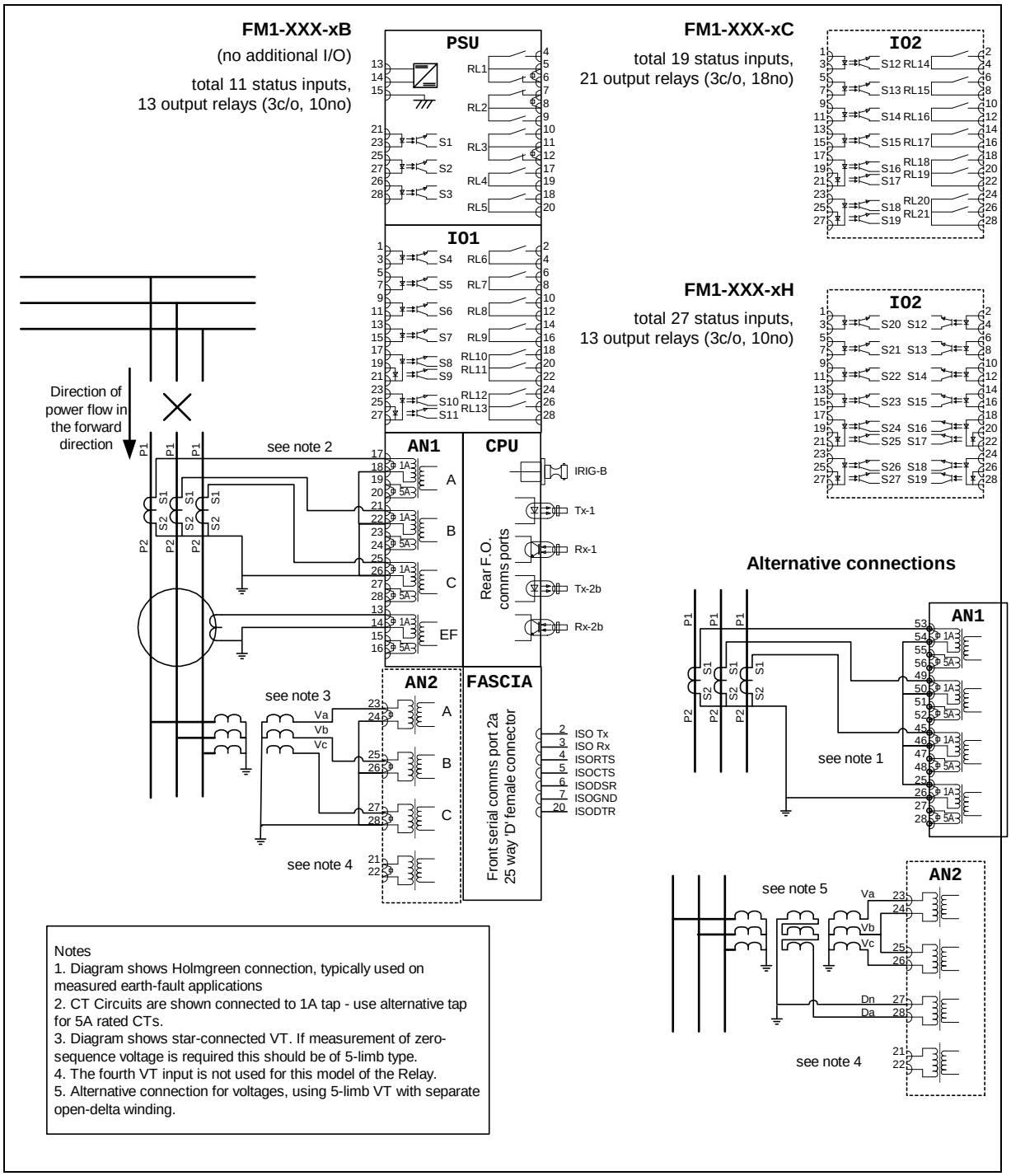

Figure 5-1 Typical Connection Diagram

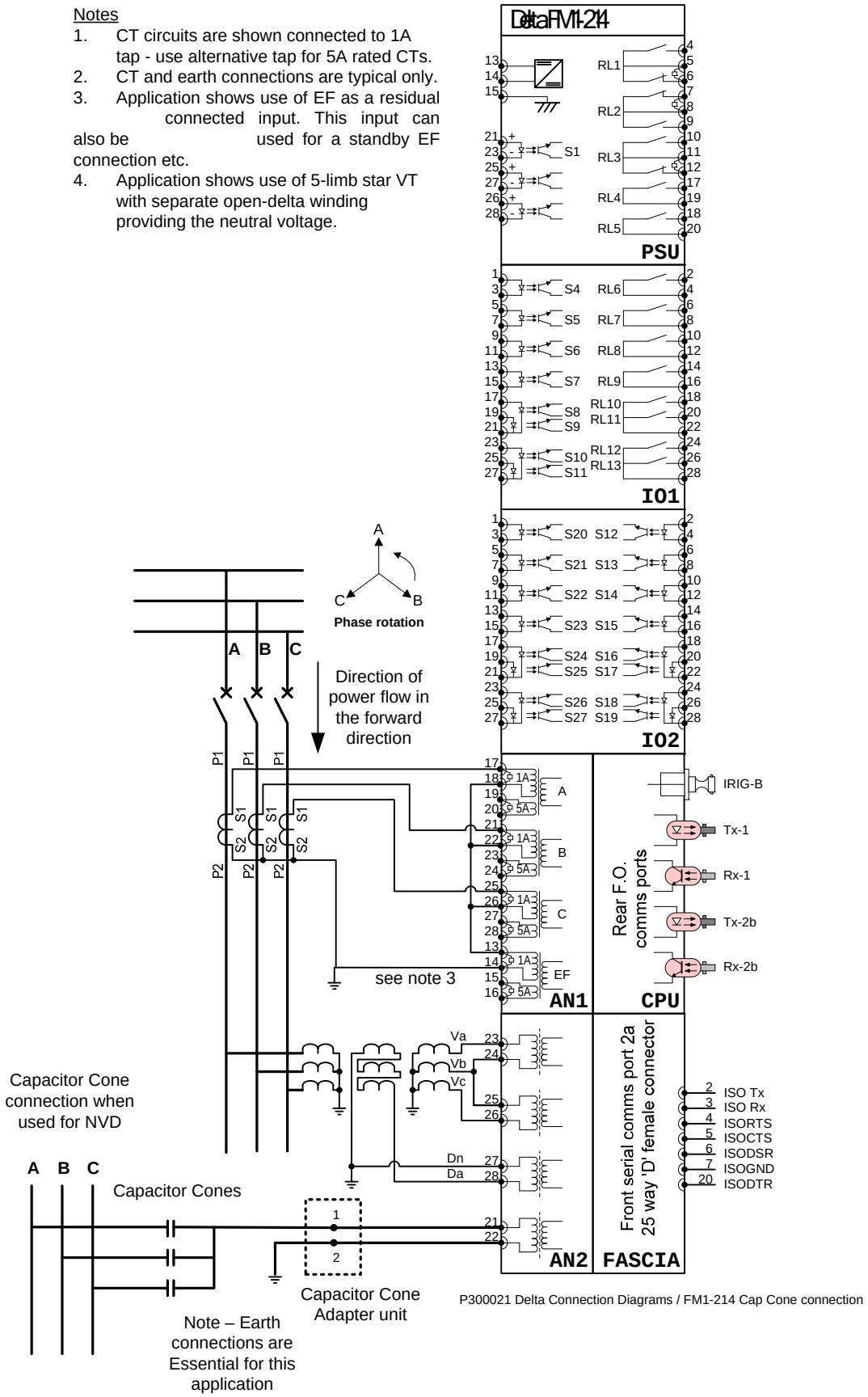

Figure 5-2 Connection Diagram for use with capacitor cone NVD measurement

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/12	First issue

Software Release History

The list of software revisions applying to the FM1-215, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-215 relay configurations.

FM1-215 Firmware + Default Configuration (2471H80054)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
Dec 2003	R1		First release	

FM1-215 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.
			Additional features:	Time & date meters added
May 2003	R1		First release	

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

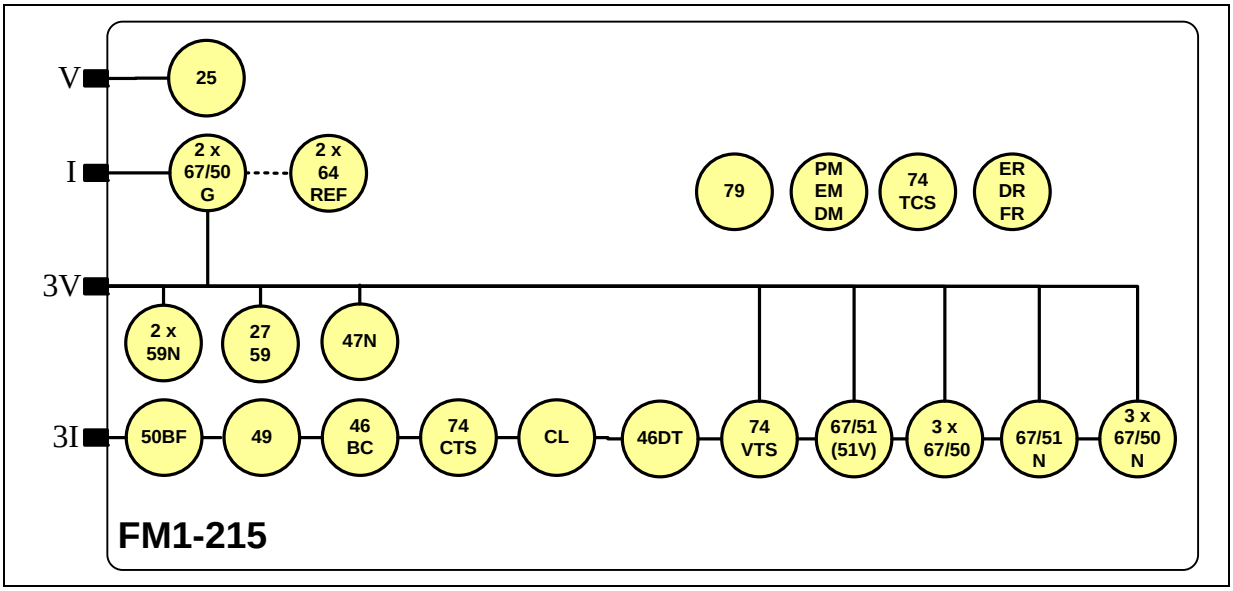

Figure 1-1 Functional Diagram for the FM1-215

1.1 Element Details

Details of the protective functions provided in the FM1-215 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Earth-fault Lowset	
E/FN HS1	Earth-fault Highset 1	
E/FN HS1	Earth-fault Highset 2	

SEF/REF (50G, 64REF)

Element		Technical Reference
SEF	Sensitive Earth Fault	Current Protections – P20048 section 2.1.4

Element →		Technical Reference
REF	Restricted Earth Fault	

NPS Overcurrent (46DT)

Element		Technical Reference
I2-1	NPS Overcurrent 1	Current Protections – P20048 section 2.6.1
I2-2	NPS Overcurrent 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

Phase Voltage (27, 59)

Element		Technical Reference
U/O V	Phase Under and Over Voltage	Voltage Protection – P20051 section 2.1.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-2	Neutral Voltage Displacement 2	

NPS Overvoltage (47N)

Element		Technical Reference
V2-1	NPS Overvoltage 1	Voltage Protections – P20051 section 2.1.4
V2-2	NPS Overvoltage 2	

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N, 67G)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	
SEF	Sensitive Earth Fault	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing and Check Synch – P20063 section 2.1

Check Sync (25)

Element		Technical Reference
Control	**Check Synchronising**	Autoreclosing and Check Synch – P20063 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	
Aux CT Ratio	2.2.2.1	
Earth Fault Mode	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s

Setting name	Ref	Applied value
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s

Protection : SEF/REF

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Sef 1	2.1.4	
Sef 1 Dir		
Sef 1 Setting		xIn
Sef 1 Timer		s
Sef 1 Reset Char		
Sef 1 Reset Delay		
Sef 2	2.1.4	
Sef 2 Dir		
Sef 2 Setting		xIn
Sef 2 Timer		s
Sef 2 Reset Char		
Sef 2 Reset Delay		
Ref 1	2.1.4	
Ref 1 Setting		xIn
Ref 1 Timer		s
Ref 1 Reset Char		
Ref 1 Reset Delay		
Ref 2	2.1.4	
Ref 2 Setting		xIn
Ref 2 Timer		s
Ref 2 Reset Char		
Ref 2 Reset Delay		

Protection : NPS OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
I2-1	2.6.1	
I2-1 Setting		xIn
I2-1 Delay		s
I2-2		
I2-2 Setting		xIn
I2-2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : Phase Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
Volt Input Mode	2.1.1	
V-1 Operation		
V-1 Setting		V
V-1 Hysteresis		%
V-1 Time Delay		s
V-1 O/P Phases		
V-2 Operation		
V-2 Setting		V
V-2 Hysteresis		%
V-2 Time Delay		s
V-2 O/P Phases		
V-3 Operation		
V-3 Setting		V
V-3 Hysteresis		%
V-3 Time Delay		s
V-3 O/P Phases		
V-4 Operation		
V-4 Setting		V
V-4 Hysteresis		%
V-4 Time Delay		s
V-4 O/P Phases		

Protection: Neutral Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		
3Vo-1 Reset Delay		s
3Vo-2 Charact	2.1.3	
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		
3Vo-2 Reset Delay		s

Protection: NPS Overvoltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
V2-1	2.1.4	
V2-1 Setting		V
V2-1 Delay		s
V2-2		
V2-2 Setting		V
V2-2 Delay		s

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle		deg
SEF Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		
Dead Bar Charge		
Dead Line Charge		
Dead L & B Close		
Check Sync Close		
Uncondit Close		
Manual Close DBC		
Manual Close DLC		
Man Close DLDB		
Manual Close CS		
Live Line Check		
CS In Deadtime		
VT Fail Lockout		
DL Charge Delay		s
DB Charge Delay		s
Sync Close Delay		s

Check Synchronising

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
Bus Dead | Live		%
Line Dead | Live		%
Bus Undervolts		%
Line Undervolts		%
Voltage Diff		%
Split Angle		deg
MC Split Action		
ARC Split Action		
Check Sync Angle		deg
Check Sync Slip		mHz
Check Sync Timer		
SS / COZ Slip f		mHz
CB Close Time		ms
Sync Connection		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		

Setting name	Ref	Applied value
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
Sef Fwd		
Sef Rev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-1 Operate		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		

Setting name	Ref	Applied value
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		

Setting name	Ref	Applied value
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
SEF/REF 1 Inhibit		
SEF/REF 2 Inhibit		
I2-1 Inhibit		
I2-2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		
SEF Dir Inhibit		
V-1 Inhibit		
V-2 Inhibit		
V-3 Inhibit		
V-4 Inhibit		
3V0-1 Inhibit		
3V0-2 Inhibit		
V2-1 Inhibit		
V2-2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Reset Lockout		
Manual Close		
Sync Override		
Man SyncOverride		

Setting name	Ref	Applied value
Start SystemSync		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	

Setting name	Ref	Applied value
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
SEF Fwd		
SEF Rev		
U/O Volt Starter		

Setting name	Ref	Applied value
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0-1 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-1 Operate		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		

Setting name	Ref	Applied value
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		

Setting name	Ref	Applied value
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	**52**	**V Element 1 Starter**	**2**	**SE, GI**
168	**53**	**V Element 2 Starter**	**2**	**SE, GI**
168	**54**	**V Element 3 Starter**	**2**	**SE, GI**
168	**55**	**V Element 4 Starter**	**2**	**SE, GI**
168	**56**	**V Element 1 Trip**	**2**	**SE, GI**
168	**57**	**V Element 2 Trip**	**2**	**SE, GI**
168	**58**	**V Element 3 Trip**	**2**	**SE, GI**
168	**59**	**V Element 4 Trip**	**2**	**SE, GI**
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	**65**	**I2 Element 1 trip**	**2**	**SE, GI**
168	**66**	**I2 Element 2 trip**	**2**	**SE, GI**
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	**114**	**V2 Element 1 Trip**	**2**	**SE, GI**
168	**115**	**V2 Element 2 Trip**	**2**	**SE, GI**
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	120	F Element 1 Trip	2	SE, GI
168	121	F Element 2 Trip	2	SE, GI
168	122	F Element 3 Trip	2	SE, GI
168	123	F Element 4 Trip	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
10164	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

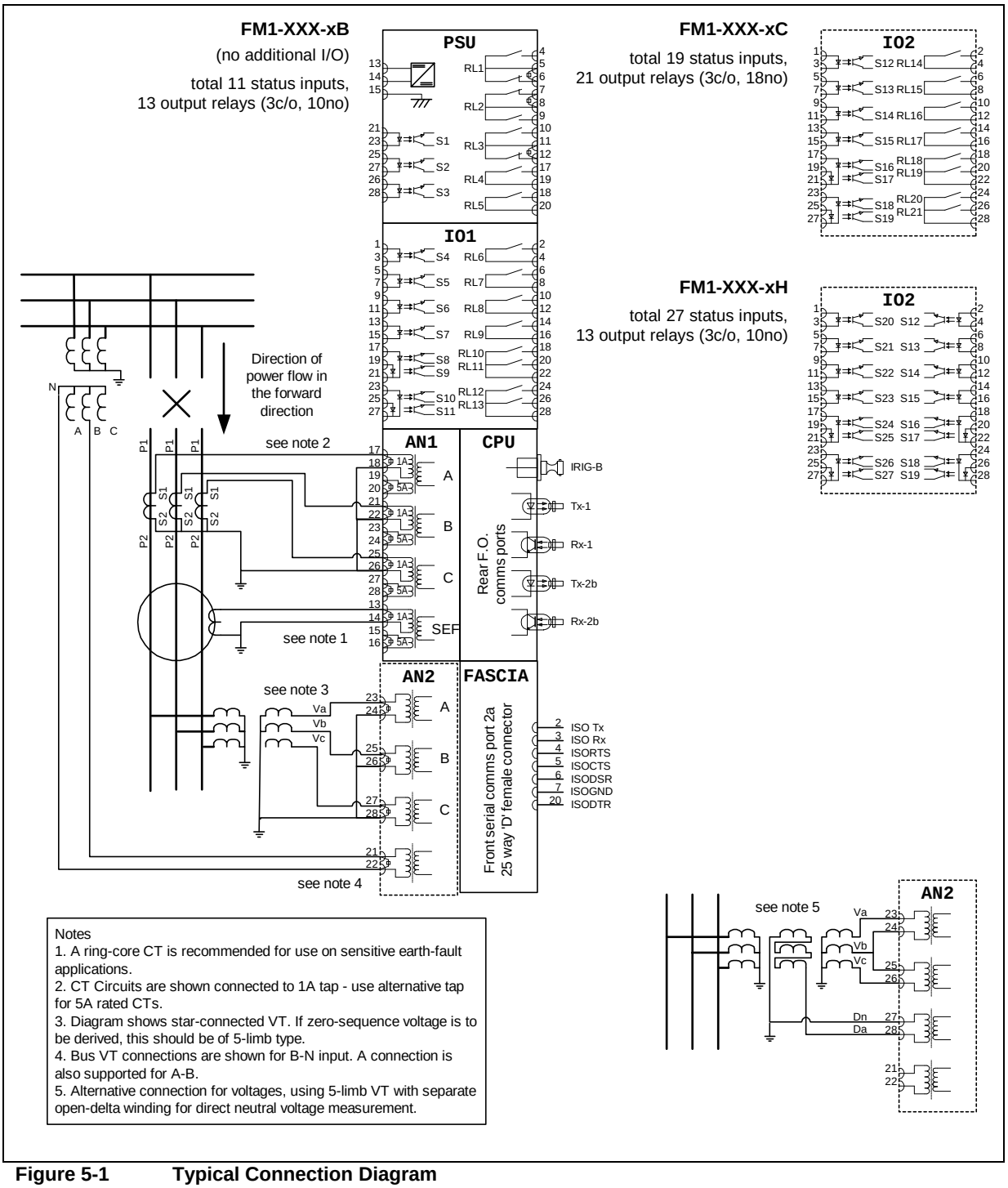

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/12	First issue

Software Release History

The list of software revisions applying to the FM1-216, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-216 relay configurations.

FM1-216 Firmware + Default Configuration (2471H80055)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
Dec 2003	R1		First release	

FM1-216 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.
			Additional features:	Time & date meters added
May 2003	R1		First release	

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

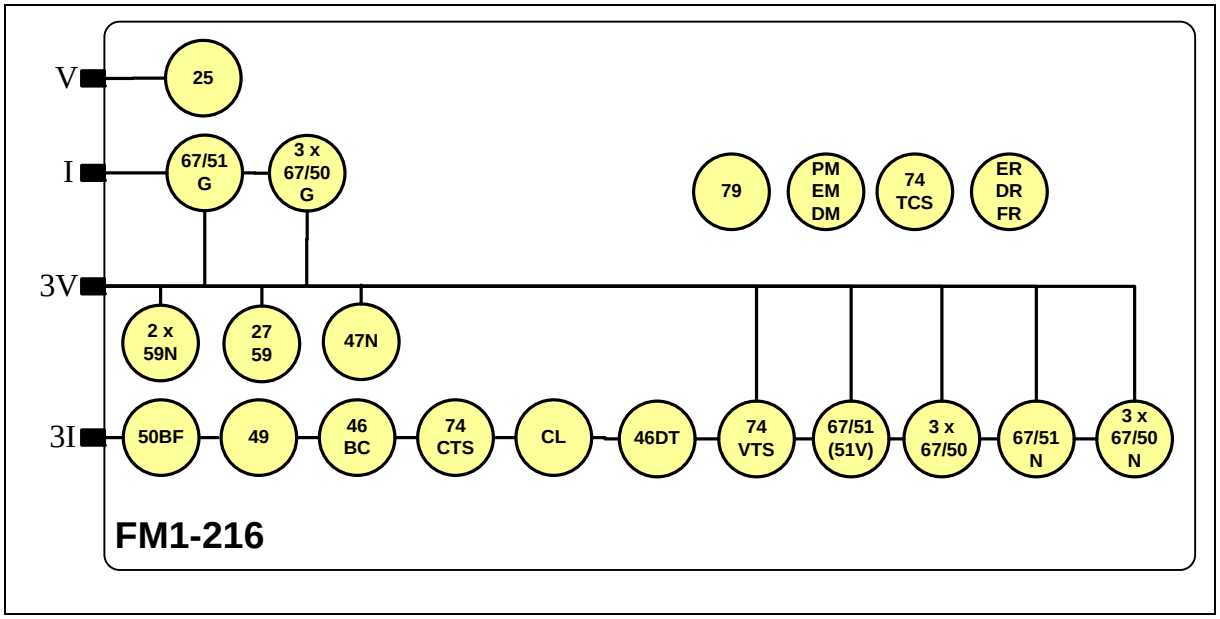

Figure 1-1 Functional Diagram for the FM1-216

1.1 Element Details

Details of the protective functions provided in the FM1-216 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	
E/FG	Earth-fault direct measurement	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Derived Earth-fault Lowset	
E/FN HS1	Derived Earth-fault Highset 1	
E/FN HS1	Derived Earth-fault Highset 2	
E/FG LS	Measured Earth-fault Lowset	
E/FG HS1	Measured Earth-fault Highset 1	
E/FG HS1	Measured Earth-fault Highset 2	

NPS Overcurrent (46DT)

Element		Technical Reference
I2-1	NPS Overcurrent 1	Current Protections – P20048 section 2.6.1
I2-2	NPS Overcurrent 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

Phase Voltage (27, 59)

Element		Technical Reference
U/O V	Phase Under and Over Voltage	Voltage Protection – P20051 section 2.1.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-2	Neutral Voltage Displacement 2	

NPS Overvoltage (47N)

Element		Technical Reference
V2-1	NPS Overvoltage 1	Voltage Protections – P20051 section 2.1.4
V2-2	NPS Overvoltage 2	

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	

Element		Technical Reference
E/Fm	Earth Fault Measured	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing and Check Synch – P20063 section 2.1

Check Sync (25)

Element		Technical Reference
Control	**Check Synchronising**	Autoreclosing and Check Synch – P20063 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	A
Aux CT Ratio	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s
E/Fm Shaped Char		
E/Fm Char Dir		
E/Fm Char Setting		xIn
E/Fm Charact		
E/Fm Multiplier		
E/Fm Char Delay		s
E/Fm Reset(ANSI)		
E/Fm Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	

Setting name	Ref	Applied value
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s
E/Fm LS	2.1.3	
E/Fm LS Dir		
E/Fm LS Setting		xIn
E/Fm LS Delay		s
E/Fm HS1	2.1.3	
E/Fm HS1 Dir		
E/Fm HS1 Setting		xIn
E/Fm HS1 Delay		s
E/Fm HS2	2.1.3	
E/Fm HS2 Dir		
E/Fm HS2 Setting		xIn
E/Fm HS2 Delay		s

Protection : NPS OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
I2-1	2.6.1	
I2-1 Setting		xIn
I2-1 Delay		s
I2-2		
I2-2 Setting		xIn
I2-2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : Phase Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
Volt Input Mode	2.1.1	
V-1 Operation		
V-1 Setting		V
V-1 Hysteresis		%

Setting name	Ref	Applied value
V-1 Time Delay		s
V-1 O/P Phases		
V-2 Operation		
V-2 Setting		V
V-2 Hysteresis		%
V-2 Time Delay		s
V-2 O/P Phases		
V-3 Operation		
V-3 Setting		V
V-3 Hysteresis		%
V-3 Time Delay		s
V-3 O/P Phases		
V-4 Operation		
V-4 Setting		V
V-4 Hysteresis		%
V-4 Time Delay		s
V-4 O/P Phases		

Protection: Neutral Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		
3Vo-1 Reset Delay		s
3Vo-2 Charact	2.1.3	
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		
3Vo-2 Reset Delay		s

Protection: NPS Overvoltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
V2-1	2.1.4	
V2-1 Setting		V
V2-1 Delay		s
V2-2		
V2-2 Setting		V
V2-2 Delay		s

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle		deg
E/Fm Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		

Setting name	Ref	Applied value
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		
Dead Bar Charge		
Dead Line Charge		
Dead L & B Close		
Check Sync Close		
Uncondit Close		
Manual Close DBC		
Manual Close DLC		
Man Close DLDB		
Manual Close CS		
Live Line Check		
CS In Deadtime		
VT Fail Lockout		
DL Charge Delay		s
DB Charge Delay		s
Sync Close Delay		s

Check Synchronising

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
Bus Dead | Live		%
Line Dead | Live		%
Bus Undervolts		%
Line Undervolts		%
Voltage Diff		%
Split Angle		deg
MC Split Action		
ARC Split Action		
Check Sync Angle		deg
Check Sync Slip		mHz
Check Sync Timer		
SS / COZ Slip f		mHz
CB Close Time		ms
Sync Connection		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
I2 Starter		
I2-1 Operate		

Setting name	Ref	Applied value
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-1 Operate		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		

Setting name	Ref	Applied value
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		

Setting name	Ref	Applied value
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
E/Fm Char Inhibit		
P/F LS Inhibit		

Setting name	Ref	Applied value
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
E/Fm LS Inhibit		
E/Fm HS1 Inhibit		
E/Fm HS2 Inhibit		
I2-1 Inhibit		
I2-2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		
E/Fm Dir Inhibit		
V-1 Inhibit		
V-2 Inhibit		
V-3 Inhibit		
V-4 Inhibit		
3V0-1 Inhibit		
3V0-2 Inhibit		
V2-1 Inhibit		
V2-2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Manual Close		
Sync Override		
Man SyncOverride		
Start SystemSync		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		

Setting name	Ref	Applied value
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		

Setting name	Ref	Applied value
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		

Setting name	Ref	Applied value
V-4 Trip		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-1 Operate		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		

Setting name	Ref	Applied value
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		

Setting name	Ref	Applied value
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		

Setting name	Ref	Applied value
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		

Setting name	Ref	Applied value
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	**65**	**I2 Element 1 trip**	**2**	**SE, GI**
168	**66**	**I2 Element 2 trip**	**2**	**SE, GI**
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	**114**	**V2 Element 1 Trip**	**2**	**SE, GI**
168	**115**	**V2 Element 2 Trip**	**2**	**SE, GI**
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	120	F Element 1 Trip	2	SE, GI
168	121	F Element 2 Trip	2	SE, GI
168	122	F Element 3 Trip	2	SE, GI
168	123	F Element 4 Trip	2	SE, GI
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
10164	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

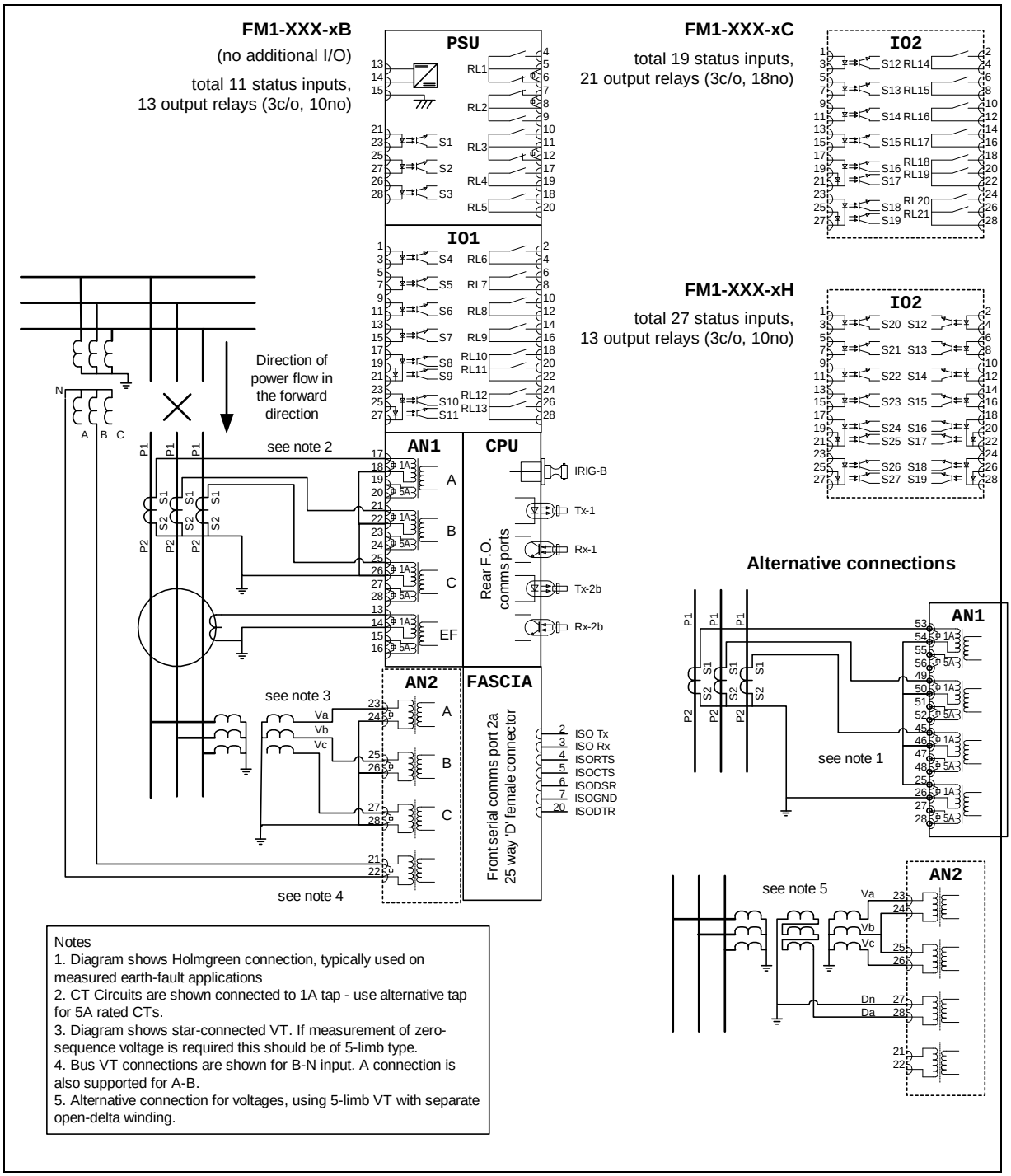

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2006/09	“3Vo Input” setting added
2006/01	Modbus Definitions added IEC60870 default definitions revised
2005/12	First issue

Software Release History

The list of software revisions applying to the FM1-223, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-223 relay configurations.

FM1-223 Firmware + Default Configuration (2471H80056)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
Dec 2003	R1		First release	

FM1-223 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.
			Additional features:	Time & date meters added
May 2003	R1		First release	

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

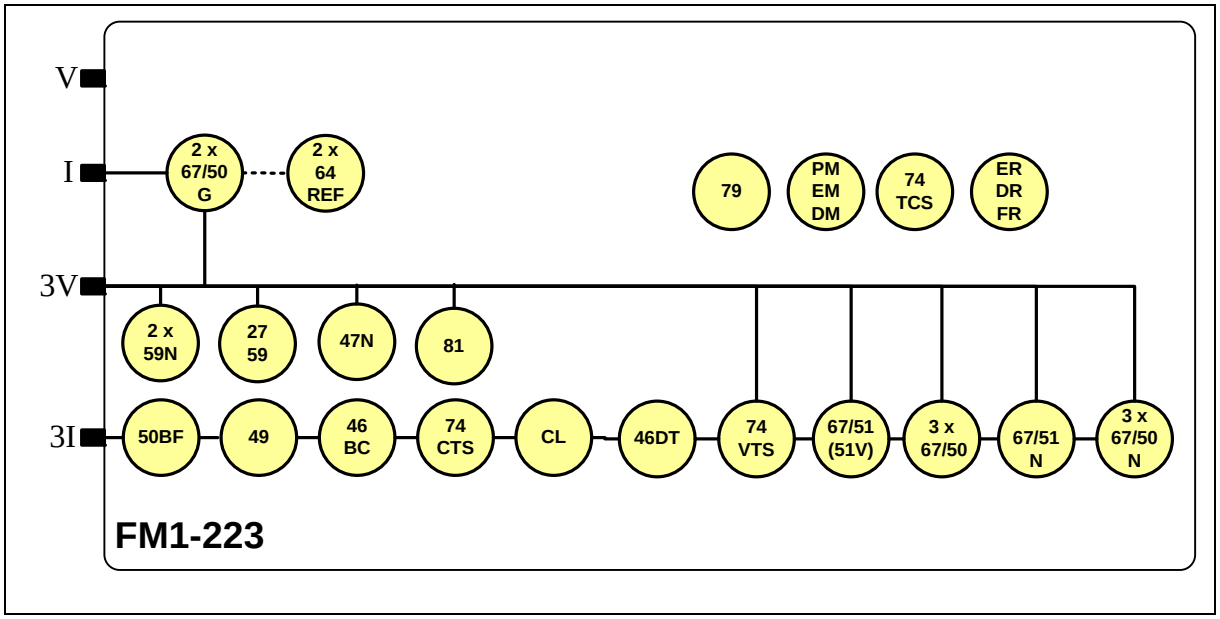

Figure 1-1 Functional Diagram for the FM1-223

1.1 Element Details

Details of the protective functions provided in the FM1-223 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Earth-fault Lowset	
E/FN HS1	Earth-fault Highset 1	
E/FN HS1	Earth-fault Highset 2	

SEF/REF (50G, 64REF)

Element		Technical Reference
SEF	Sensitive Earth Fault	Current Protections – P20048 section 2.1.4
REF	Restricted Earth Fault	

NPS Overcurrent (46DT)

Element		Technical Reference
I2-1	NPS Overcurrent 1	Current Protections – P20048 section 2.6.1
I2-2	NPS Overcurrent 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

Phase Voltage (27, 59)

Element		Technical Reference
U/O V	Phase Under and Over Voltage	Voltage Protection – P20051 section 2.1.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-2	Neutral Voltage Displacement 2	

NPS Overvoltage (47N)

Element		Technical Reference
V2-1	NPS Overvoltage 1	Voltage Protections – P20051 section 2.1.4
V2-2	NPS Overvoltage 2	

Frequency (81)

Element		Technical Reference
U/O F	Under and Over Frequency	Voltage Protection – P20051 section 2.2.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N, 67G)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	
SEF	Sensitive Earth Fault	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing and Check Synch – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	
Aux CT Ratio	2.2.2.1	
Earth Fault Mode	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s

Setting name	Ref	Applied value
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s

Protection : SEF/REF

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Sef 1	2.1.4	
Sef 1 Dir		
Sef 1 Setting		xIn
Sef 1 Timer		s
Sef 1 Reset Char		
Sef 1 Reset Delay		
Sef 2	2.1.4	
Sef 2 Dir		
Sef 2 Setting		xIn
Sef 2 Timer		s
Sef 2 Reset Char		
Sef 2 Reset Delay		
Ref 1	2.1.4	
Ref 1 Setting		xIn
Ref 1 Timer		s
Ref 1 Reset Char		
Ref 1 Reset Delay		
Ref 2	2.1.4	
Ref 2 Setting		xIn
Ref 2 Timer		s
Ref 2 Reset Char		
Ref 2 Reset Delay		

Protection : NPS OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
I2-1	2.6.1	
I2-1 Setting		xIn
I2-1 Delay		s
I2-2		
I2-2 Setting		xIn
I2-2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : Phase Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
Volt Input Mode	2.1.1	
V-1 Operation		
V-1 Setting		V
V-1 Hysteresis		%
V-1 Time Delay		s
V-1 O/P Phases		
V-2 Operation		
V-2 Setting		V
V-2 Hysteresis		%
V-2 Time Delay		s
V-2 O/P Phases		
V-3 Operation		
V-3 Setting		V
V-3 Hysteresis		%
V-3 Time Delay		s
V-3 O/P Phases		
V-4 Operation		
V-4 Setting		V
V-4 Hysteresis		%
V-4 Time Delay		s
V-4 O/P Phases		

Protection: Neutral Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
3Vo Input	2.1.3	
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		
3Vo-1 Reset Delay		s
3Vo-2 Charact		
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		
3Vo-2 Reset Delay		s

Protection: NPS Overvoltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
V2-1	2.1.4	
V2-1 Setting		V
V2-1 Delay		s
V2-2		
V2-2 Setting		V
V2-2 Delay		s

Protection : Frequency

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
F-1 Operation	2.2.1	
F-1 Setting		Hz
F-1 Delay		s
F-1 Inhibit		
F-2 Operation		
F-2 Setting		Hz
F-2 Delay		s
F-2 Inhibit		
F-3 Operation		
F-3 Setting		Hz
F-3 Delay		s
F-3 Inhibit		
F-4 Operation		
F-4 Setting		Hz
F-4 Delay		s
F-4 Inhibit		

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle		deg
SEF Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s

Setting name	Ref	Applied value
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		

Setting name	Ref	Applied value
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
Sef Fwd		
Sef Rev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		

Setting name	Ref	Applied value
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s

Setting name	Ref	Applied value
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
SEF/REF 1 Inhibit		
SEF/REF 2 Inhibit		
I2-1 Inhibit		
I2-2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		
SEF Dir Inhibit		
V-1 Inhibit		
V-2 Inhibit		
V-3 Inhibit		
V-4 Inhibit		

Setting name	Ref	Applied value
3V0-1 Inhibit		
3V0-2 Inhibit		
V2-1 Inhibit		
V2-2 Inhibit		
F-1 Inhibit		
F-2 Inhibit		
F-3 Inhibit		
F-4 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Reset Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s

Setting name	Ref	Applied value
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25	2.3	s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s

Setting name	Ref	Applied value
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		

Setting name	Ref	Applied value
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
SEF Fwd		
SEF Rev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0-1 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		

Setting name	Ref	Applied value
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		

Setting name	Ref	Applied value
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		

Setting name	Ref	Applied value
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%

Setting name	Ref	Applied value
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	**52**	**V Element 1 Starter**	**2**	**SE, GI**
168	**53**	**V Element 2 Starter**	**2**	**SE, GI**
168	**54**	**V Element 3 Starter**	**2**	**SE, GI**
168	**55**	**V Element 4 Starter**	**2**	**SE, GI**
168	**56**	**V Element 1 Trip**	**2**	**SE, GI**
168	**57**	**V Element 2 Trip**	**2**	**SE, GI**
168	**58**	**V Element 3 Trip**	**2**	**SE, GI**
168	**59**	**V Element 4 Trip**	**2**	**SE, GI**
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	**65**	**I2 Element 1 trip**	**2**	**SE, GI**
168	**66**	**I2 Element 2 trip**	**2**	**SE, GI**
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	**114**	**V2 Element 1 Trip**	**2**	**SE, GI**
168	**115**	**V2 Element 2 Trip**	**2**	**SE, GI**
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	**120**	**F Element 1 Trip**	**2**	**SE, GI**
168	**121**	**F Element 2 Trip**	**2**	**SE, GI**
168	**122**	**F Element 3 Trip**	**2**	**SE, GI**
168	**123**	**F Element 4 Trip**	**2**	**SE, GI**
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
10164	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

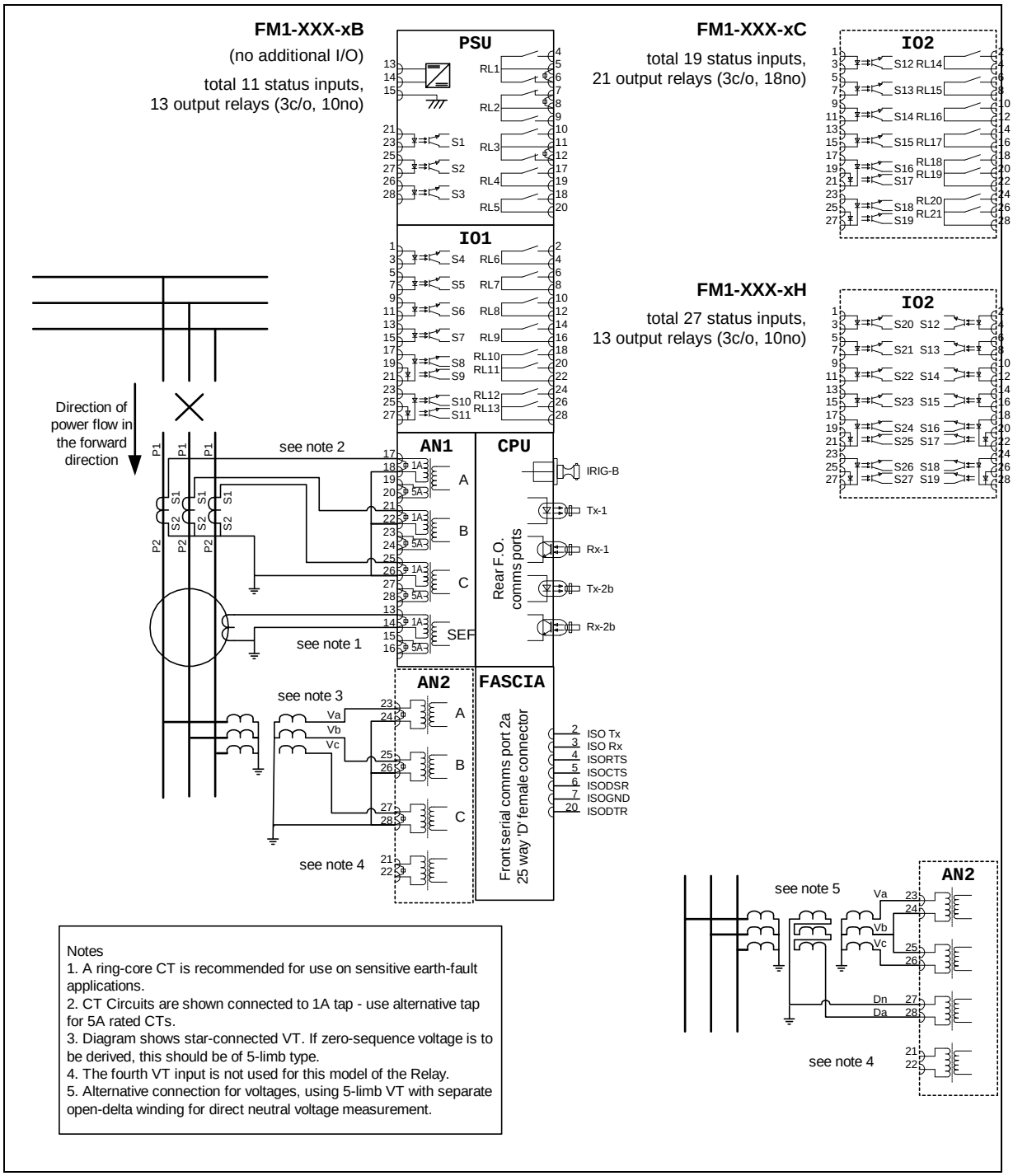

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2006/09	“3Vo Input” setting added
2006/01	Modbus Definition added IEC60870 default definitions revised
2005/12	First issue

Software Release History

The list of software revisions applying to the FM1-224, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-224 relay configurations.

FM1-224 Firmware + Default Configuration (2471H80057)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
Dec 2003	R1		First release	

FM1-224 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.
			Additional features:	Time & date meters added
May 2003	R1		First release	

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

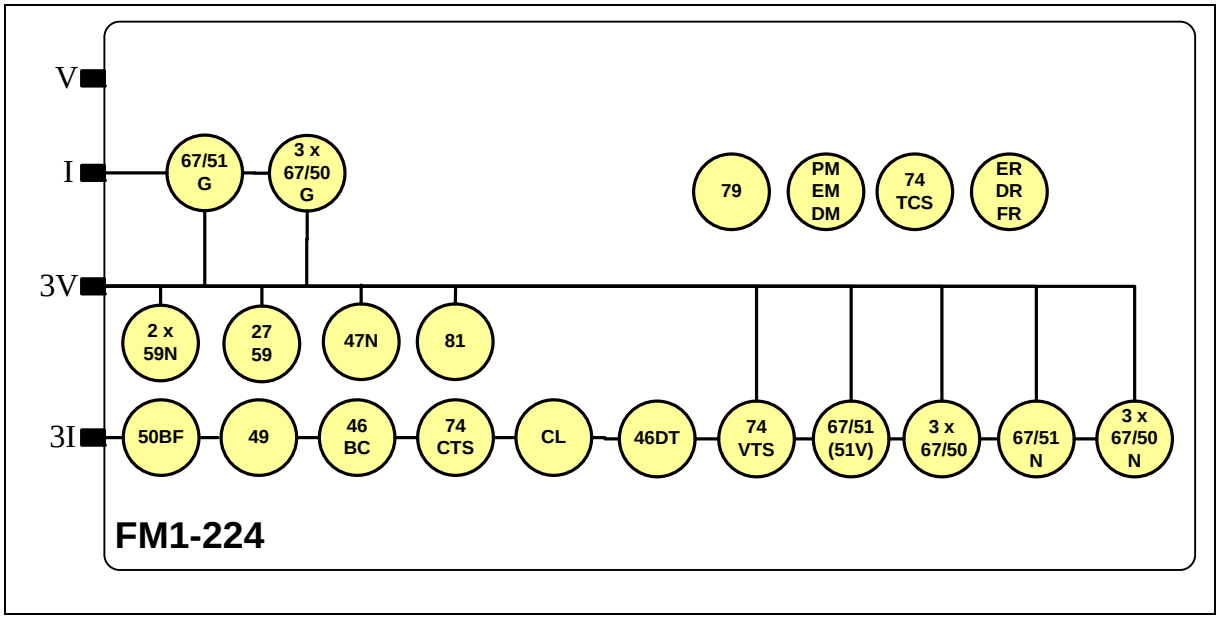

Figure 1-1 Functional Diagram for the FM1-224

1.1 Element Details

Details of the protective functions provided in the FM1-224 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	
E/FG	Earth-fault direct measurement	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Derived Earth-fault Lowset	
E/FN HS1	Derived Earth-fault Highset 1	
E/FN HS1	Derived Earth-fault Highset 2	
E/FG LS	Measured Earth-fault Lowset	
E/FG HS1	Measured Earth-fault Highset 1	
E/FG HS1	Measured Earth-fault Highset 2	

NPS Overcurrent (46DT)

Element		Technical Reference
I2-1	NPS Overcurrent 1	Current Protections – P20048 section 2.6.1
I2-2	NPS Overcurrent 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

Phase Voltage (27, 59)

Element		Technical Reference
U/O V	Phase Under and Over Voltage	Voltage Protection – P20051 section 2.1.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-2	Neutral Voltage Displacement 2	

NPS Overvoltage (47N)

Element		Technical Reference
V2-1	NPS Overvoltage 1	Voltage Protections – P20051 section 2.1.4
V2-2	NPS Overvoltage 2	

Frequency (81)

Element		Technical Reference
U/O F	Under and Over Frequency	Voltage Protection – P20051 section 2.2.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	
E/Fm	Earth Fault Measured	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing and Check Synch – P20064 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	A
Aux CT Ratio	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s
E/Fm Shaped Char		
E/Fm Char Dir		
E/Fm Char Setting		xIn
E/Fm Charact		
E/Fm Multiplier		
E/Fm Char Delay		s
E/Fm Reset(ANSI)		
E/Fm Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	

Setting name	Ref	Applied value
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s
E/Fm LS	2.1.3	
E/Fm LS Dir		
E/Fm LS Setting		xIn
E/Fm LS Delay		s
E/Fm HS1	2.1.3	
E/Fm HS1 Dir		
E/Fm HS1 Setting		xIn
E/Fm HS1 Delay		s
E/Fm HS2	2.1.3	
E/Fm HS2 Dir		
E/Fm HS2 Setting		xIn
E/Fm HS2 Delay		s

Protection : NPS OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
I2-1	2.6.1	
I2-1 Setting		xIn
I2-1 Delay		s
I2-2		
I2-2 Setting		xIn
I2-2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : Phase Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
Volt Input Mode	2.1.1	
V-1 Operation		
V-1 Setting		V

Setting name	Ref	Applied value
V-1 Hysteresis		%
V-1 Time Delay		s
V-1 O/P Phases		
V-2 Operation		
V-2 Setting		V
V-2 Hysteresis		%
V-2 Time Delay		s
V-2 O/P Phases		
V-3 Operation		
V-3 Setting		V
V-3 Hysteresis		%
V-3 Time Delay		s
V-3 O/P Phases		
V-4 Operation		
V-4 Setting		V
V-4 Hysteresis		%
V-4 Time Delay		s
V-4 O/P Phases		

Protection: Neutral Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
3Vo Input	2.1.3	
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		
3Vo-1 Reset Delay		s
3Vo-2 Charact	2.1.3	
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		
3Vo-2 Reset Delay		s

Protection: NPS Overvoltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
V2-1	2.1.4	

Setting name	Ref	Applied value
V2-1 Setting		V
V2-1 Delay		s
V2-2		
V2-2 Setting		V
V2-2 Delay		s

Protection : Frequency

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
F-1 Operation	2.2.1	
F-1 Setting		Hz
F-1 Delay		s
F-1 Inhibit		
F-2 Operation		
F-2 Setting		Hz
F-2 Delay		s
F-2 Inhibit		
F-3 Operation		
F-3 Setting		Hz
F-3 Delay		s
F-3 Inhibit		
F-4 Operation		
F-4 Setting		Hz
F-4 Delay		s
F-4 Inhibit		

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle		deg
E/Fm Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20064 Autoreclosing

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s

Setting name	Ref	Applied value
Reset LO By Time		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		

Setting name	Ref	Applied value
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		

Setting name	Ref	Applied value
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
E/Fm Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
E/Fm LS Inhibit		
E/Fm HS1 Inhibit		
E/Fm HS2 Inhibit		
I2-1 Inhibit		
I2-2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		
E/Fm Dir Inhibit		

Setting name	Ref	Applied value
V-1 Inhibit		
V-2 Inhibit		
V-3 Inhibit		
V-4 Inhibit		
3V0-1 Inhibit		
3V0-2 Inhibit		
V2-1 Inhibit		
V2-2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Reset Lockout		
Manual Close		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s

Setting name	Ref	Applied value
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s

Setting name	Ref	Applied value
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		

Setting name	Ref	Applied value
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		

Setting name	Ref	Applied value
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		

Setting name	Ref	Applied value
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		

Setting name	Ref	Applied value
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%

Setting name	Ref	Applied value
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	**65**	**I2 Element 1 trip**	**2**	**SE, GI**
168	**66**	**I2 Element 2 trip**	**2**	**SE, GI**
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	**114**	**V2 Element 1 Trip**	**2**	**SE, GI**
168	**115**	**V2 Element 2 Trip**	**2**	**SE, GI**
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	**120**	**F Element 1 Trip**	**2**	**SE, GI**
168	**121**	**F Element 2 Trip**	**2**	**SE, GI**
168	**122**	**F Element 3 Trip**	**2**	**SE, GI**
168	**123**	**F Element 4 Trip**	**2**	**SE, GI**
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
10164	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

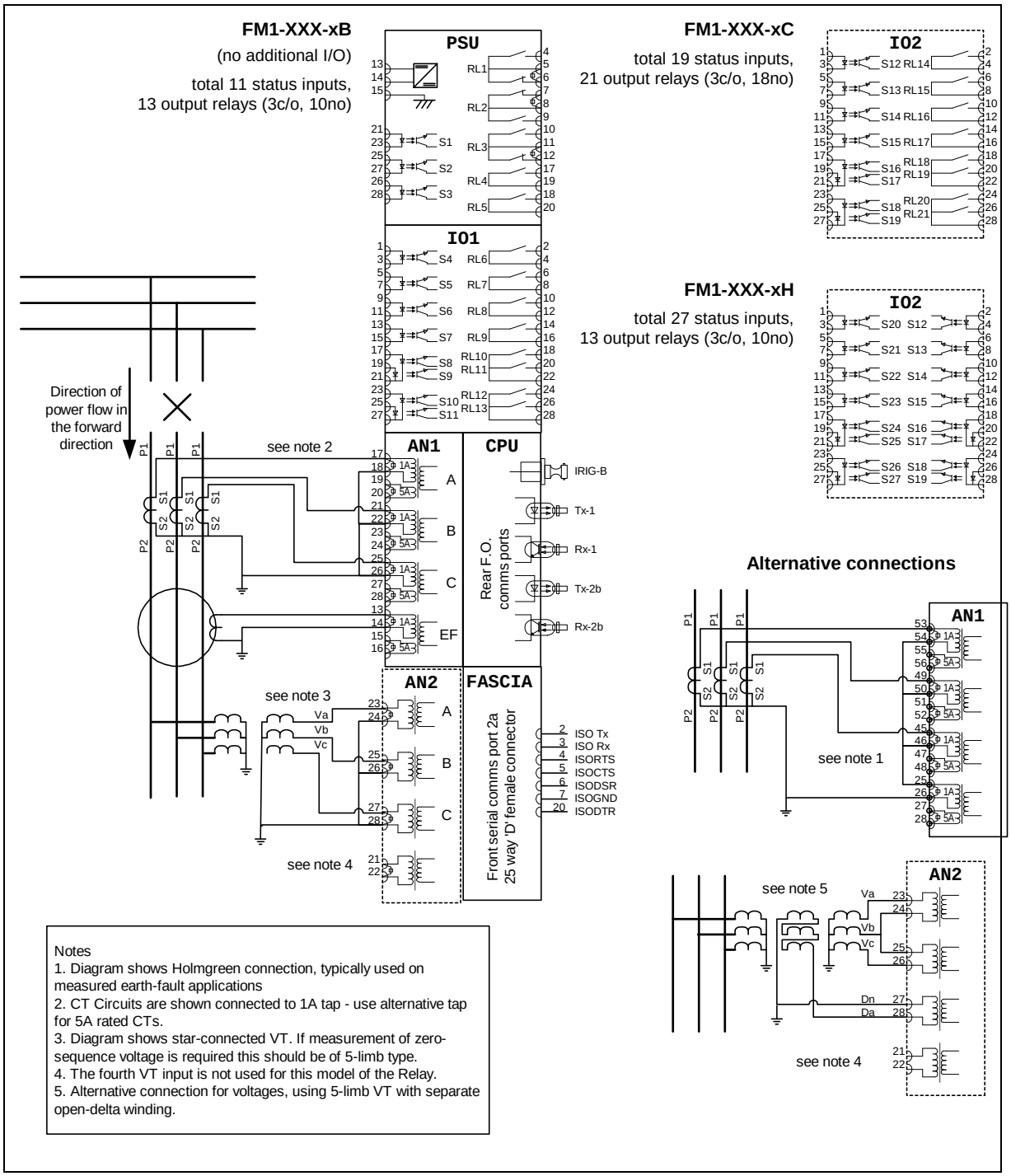

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2005/12	First issue

Software Release History

The list of software revisions applying to the FM1-225, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all FM1-225 relay configurations.

FM1-225 Firmware + Default Configuration (2471H80058)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
Dec 2003	R1		First release	

FM1-225 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.
			Additional features:	Time & date meters added
May 2003	R1		First release	

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

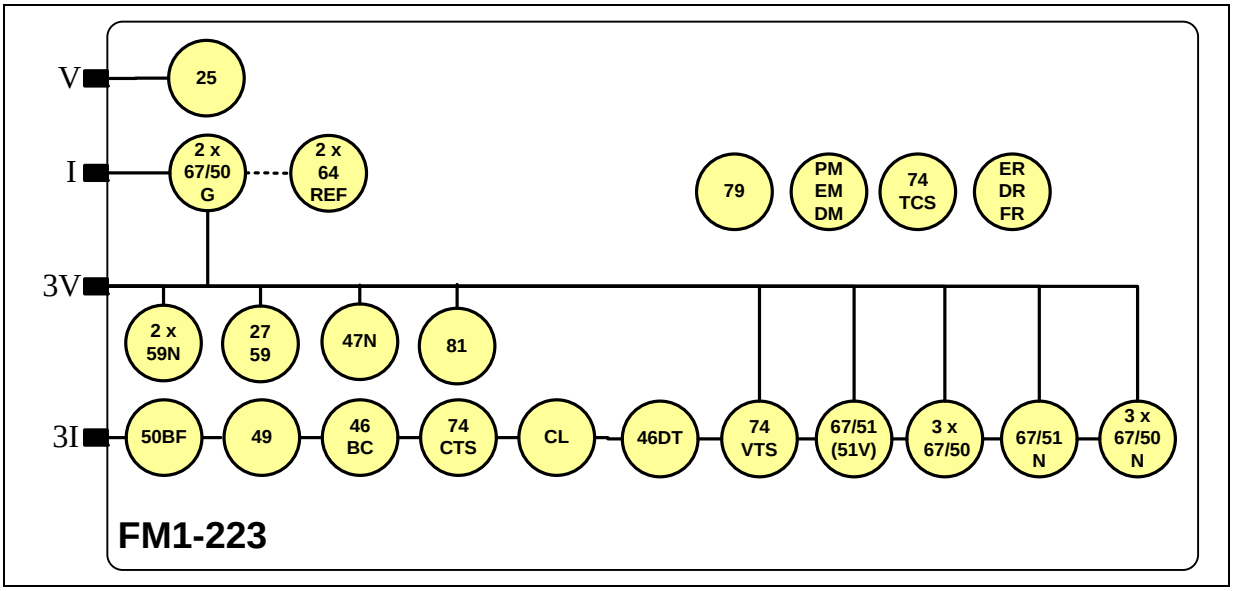

Figure 1-1 Functional Diagram for the FM1-225

1.1 Element Details

Details of the protective functions provided in the FM1-225 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Earth-fault Lowset	
E/FN HS1	Earth-fault Highset 1	
E/FN HS1	Earth-fault Highset 2	

SEF/REF (50G, 64REF)

Element		Technical Reference
SEF	Sensitive Earth Fault	Current Protections – P20048 section 2.1.4

Element		Technical Reference
REF	Restricted Earth Fault	

NPS Overcurrent (46DT)

Element		Technical Reference
I2-1	NPS Overcurrent 1	Current Protections – P20048 section 2.6.1
I2-2	NPS Overcurrent 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

Phase Voltage (27, 59)

Element		Technical Reference
U/O V	Phase Under and Over Voltage	Voltage Protection – P20051 section 2.1.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-2	Neutral Voltage Displacement 2	

NPS Overvoltage (47N)

Element		Technical Reference
V2-1	NPS Overvoltage 1	Voltage Protections – P20051 section 2.1.4
V2-2	NPS Overvoltage 2	

Frequency (81)

Element		Technical Reference
U/O F	Under and Over Frequency	Voltage Protection – P20051 section 2.2.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N, 67G)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	
SEF	Sensitive Earth Fault	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing and Check Synch – P20063 section 2.1

Check Sync (25)

Element		Technical Reference
Control	**Check Synchronising**	Autoreclosing and Check Synch – P20063 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	
Aux CT Ratio	2.2.2.1	
Earth Fault Mode	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s

Setting name	Ref	Applied value
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s

Protection : SEF/REF

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Sef 1	2.1.4	
Sef 1 Dir		
Sef 1 Setting		xIn
Sef 1 Timer		s
Sef 1 Reset Char		
Sef 1 Reset Delay		
Sef 2	2.1.4	
Sef 2 Dir		
Sef 2 Setting		xIn
Sef 2 Timer		s
Sef 2 Reset Char		
Sef 2 Reset Delay		
Ref 1	2.1.4	
Ref 1 Setting		xIn
Ref 1 Timer		s
Ref 1 Reset Char		
Ref 1 Reset Delay		
Ref 2	2.1.4	
Ref 2 Setting		xIn
Ref 2 Timer		s
Ref 2 Reset Char		
Ref 2 Reset Delay		

Protection : NPS OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
I2-1	2.6.1	
I2-1 Setting		xIn
I2-1 Delay		s
I2-2		
I2-2 Setting		xIn
I2-2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : Phase Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
Volt Input Mode	2.1.1	
V-1 Operation		
V-1 Setting		V
V-1 Hysteresis		%
V-1 Time Delay		s
V-1 O/P Phases		
V-2 Operation		
V-2 Setting		V
V-2 Hysteresis		%
V-2 Time Delay		s
V-2 O/P Phases		
V-3 Operation		
V-3 Setting		V
V-3 Hysteresis		%
V-3 Time Delay		s
V-3 O/P Phases		
V-4 Operation		
V-4 Setting		V
V-4 Hysteresis		%
V-4 Time Delay		s
V-4 O/P Phases		

Protection: Neutral Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		
3Vo-1 Reset Delay		s
3Vo-2 Charact		
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		
3Vo-2 Reset Delay		s

Protection: NPS Overvoltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
V2-1	2.1.4	
V2-1 Setting		V
V2-1 Delay		s
V2-2		
V2-2 Setting		V
V2-2 Delay		s

Protection : Frequency

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
F-1 Operation	2.2.1	
F-1 Setting		Hz
F-1 Delay		s
F-1 Inhibit		
F-2 Operation		
F-2 Setting		Hz
F-2 Delay		s
F-2 Inhibit		
F-3 Operation		
F-3 Setting		Hz
F-3 Delay		s
F-3 Inhibit		
F-4 Operation		
F-4 Setting		Hz
F-4 Delay		s
F-4 Inhibit		

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle		deg
SEF Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s

Setting name	Ref	Applied value
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		
Dead Bar Charge		
Dead Line Charge		
Dead L & B Close		
Check Sync Close		
Uncondit Close		
Manual Close DBC		
Manual Close DLC		
Man Close DLDB		
Manual Close CS		
Live Line Check		
CS In Deadtime		
VT Fail Lockout		
DL Charge Delay		s
DB Charge Delay		s
Sync Close Delay		s

Check Synchronising

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
Bus Dead | Live		%
Line Dead | Live		%
Bus Undervolts		%
Line Undervolts		%
Voltage Diff		%
Split Angle		deg
MC Split Action		
ARC Split Action		
Check Sync Angle		deg
Check Sync Slip		mHz
Check Sync Timer		
SS / COZ Slip f		mHz
CB Close Time		ms
Sync Connection		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		

Setting name	Ref	Applied value
EarthRev		
Sef Fwd		
Sef Rev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		

Setting name	Ref	Applied value
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		

Setting name	Ref	Applied value
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
SEF/REF 1 Inhibit		
SEF/REF 2 Inhibit		
I2-1 Inhibit		
I2-2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		

Setting name	Ref	Applied value
SEF Dir Inhibit		
V-1 Inhibit		
V-2 Inhibit		
V-3 Inhibit		
V-4 Inhibit		
3V0-1 Inhibit		
3V0-2 Inhibit		
V2-1 Inhibit		
V2-2 Inhibit		
F-1 Inhibit		
F-2 Inhibit		
F-3 Inhibit		
F-4 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Reset Lockout		
Manual Close		
Sync Override		
Man SyncOverride		
Start SystemSync		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		

Setting name	Ref	Applied value
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25		s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s

Setting name	Ref	Applied value
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
P/F LS		
P/F HS1		
P/F HS2		

Setting name	Ref	Applied value
E/F LS		
E/F HS1		
E/F HS2		
SEF/REF 1 Trip		
SEF/REF 2 Trip		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
SEF Fwd		
SEF Rev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0-1 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		

Setting name	Ref	Applied value
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		

Setting name	Ref	Applied value
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		

Setting name	Ref	Applied value
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	**65**	**I2 Element 1 trip**	**2**	**SE, GI**
168	**66**	**I2 Element 2 trip**	**2**	**SE, GI**
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	**114**	**V2 Element 1 Trip**	**2**	**SE, GI**
168	**115**	**V2 Element 2 Trip**	**2**	**SE, GI**
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	**120**	**F Element 1 Trip**	**2**	**SE, GI**
168	**121**	**F Element 2 Trip**	**2**	**SE, GI**
168	**122**	**F Element 3 Trip**	**2**	**SE, GI**
168	**123**	**F Element 4 Trip**	**2**	**SE, GI**
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
10164	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

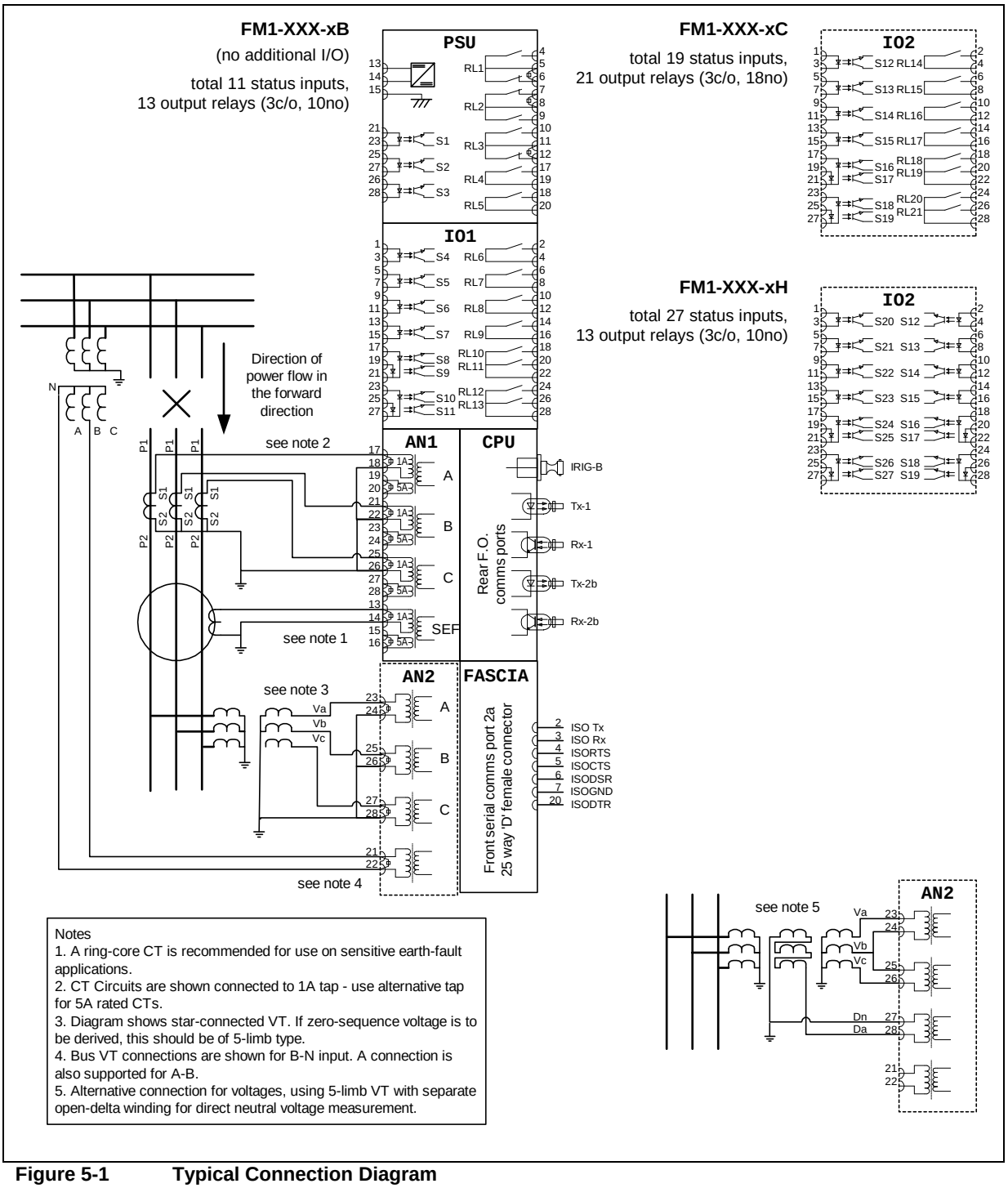

Figure 5-1 Typical Connection Diagram

7SG13 Delta

Protection and Control Relays

Document Release History

This document is issue 2010/02. The list of revisions up to and including this issue is:

Pre release

2010/02	Document reformat due to rebrand
2006/01	Modbus Definitions added IEC60870 default definitions revised
2005/12	First issue

Software Release History

The list of software revisions applying to the FM1-226, up to the date of this document issue is:

Note: the relay software consists of two parts: Article numbers with the prefix 2471H is the overall configuration this includes the any customer specific mimic/logics, this number can change depending on the configuration.

Article numbers with the prefix 2471S contains the core product functions, this number is common to all the FM1-226 relay configurations.

FM1-226 Firmware + Default Configuration (2471H80059)

Mar 2004	R2	Neutral voltage	Minor Change:	See Firmware (2471S81749 R3)
Dec 2003	R1		First release	

FM1-226 Firmware (2471S81749)

Mar 2004	R3	Neutral voltage	Minor Change:	Time Multiplier setting range extended.
Dec 2003	R2	General	Additional features:	Measured Earth elements for HS/LS & Idmtl now have the option to be directional.
			Additional features:	Under/Over Frequency added.
			Additional features:	Time & date meters added
May 2003	R1		First release	

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Section 1: Configuration

The connection and interaction of the functions is summarised in Figure 1-1.

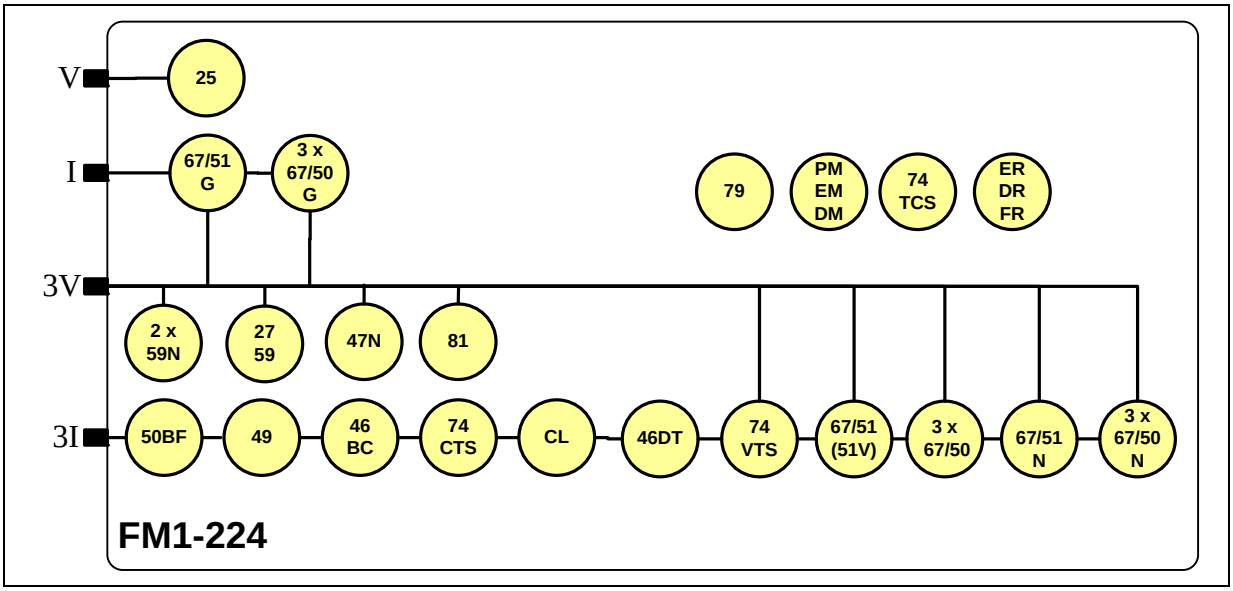

Figure 1-1 Functional Diagram for the FM1-226

1.1 Element Details

Details of the protective functions provided in the FM1-226 are given below.

OC Shaped Char (51, 51N, 51G)

Element		Technical Reference
P/F	Phase-fault	Current Protections – P20048 section 2.1.1
E/FN	Earth-fault derived	
E/FG	Earth-fault direct measurement	

Voltage Controlled OC (51V)

Element		Technical Reference
OC	Voltage Controlled OC	Current Protections – P20048 section 2.1.2

OC HS/LS (50, 50N)

Element		Technical Reference
P/F LS	Phase-fault Lowset	Current Protections – P20048 section 2.1.3
P/F HS1	Phase-fault Highset 1	
P/F HS2	Phase-fault Highset 2	
E/FN LS	Derived Earth-fault Lowset	
E/FN HS1	Derived Earth-fault Highset 1	
E/FN HS1	Derived Earth-fault Highset 2	
E/FG LS	Measured Earth-fault Lowset	
E/FG HS1	Measured Earth-fault Highset 1	
E/FG HS1	Measured Earth-fault Highset 2	

NPS Overcurrent (46DT)

Element		Technical Reference
I2-1	NPS Overcurrent 1	Current Protections – P20048 section 2.6.1
I2-2	NPS Overcurrent 2	

Thermal Overload (49)

Element		Technical Reference
O/C	Thermal Overload	Current Protections – P20048 section 2.3.1

CB Trip Fail (50BF)

Element		Technical Reference
O/C	Circuit Breaker Failure	Plant Supervision – P20060 section 2.1.1

Broken Conductor (46BC)

Element		Technical Reference
O/C	Phase Unbalance	Current Protections - P20048 section 2.5.1

Cold Load (CL)

Element		Technical Reference
Control	Cold Load Group Change	Current Protections – P20048 section 2.4.1

Phase Voltage (27, 59)

Element		Technical Reference
U/O V	Phase Under and Over Voltage	Voltage Protection – P20051 section 2.1.1

Neutral Voltage Displacement (59N)

Element		Technical Reference
3V0-1	Neutral Voltage Displacement 1	Voltage Protections – P20051 section 2.1.3
3V0-2	Neutral Voltage Displacement 2	

NPS Overvoltage (47N)

Element		Technical Reference
V2-1	NPS Overvoltage 1	Voltage Protections – P20051 section 2.1.4
V2-2	NPS Overvoltage 2	

Frequency (81)

Element		Technical Reference
U/O F	Under and Over Frequency	Voltage Protection – P20051 section 2.2.1

CT Supervision (74CT)

Element		Technical Reference
O/C	CT Supervision	Plant Supervision – P20060 section 2.2.1

VT Supervision (74VT)

Element		Technical Reference
VTS	VT Supervision	Plant Supervision – P20060 section 2.2.2

Trip Cct Supervision (74TC)

Element		Technical Reference
TCS	Trip Circuit Supervision	Plant Supervision – P20060 section 2.3.1

Directional (67, 67N)

Element		Technical Reference
P/F	Phase Fault	Current Protections – P20048 section 2.2.1 and 2.2.2
E/F	Earth Fault Derived	
E/Fm	Earth Fault Measured	

Autoreclose (79)

Element		Technical Reference
Control	**Autoreclose**	Autoreclosing and Check Synch – P20063 section 2.1

Check Sync (25)

Element		Technical Reference
Control	**Check Synchronising**	Autoreclosing and Check Synch – P20063 section 2.1

Section 2: Settings

Relay Type _____ Serial Number _____

Substation _____ Feeder Identity _____

Notes on Tables

The second column in the tables ('Ref') provides a reference to the section in the appropriate Technical Reference publication (listed immediately above the table) that describes the setting.

The third column is left blank to allow users to complete the table with applied settings.

System Config. Menu

Ref: P20025 Common Features

Setting name	Ref	Applied value
Active Group	2.2.1	
View/Edit Group	2.2.1	
Phase Input	2.2.2.1	A
Phase CT Ratio	2.2.2.1	
Aux Input	2.2.2.1	A
Aux CT Ratio	2.2.2.1	
Phase VT Ratio	2.2.2.2	
Voltage Config	2.2.2.2	
Sett Grp Select	2.2.1.1	
Clock Sync. From Status	2.2.4	
Backlight timer	2.2.5	min
Default Screens Timer	2.2.6	min
Date	2.2.4	
Time	2.2.4	
Change Password	2.2.7	
Relay Identifier	2.2.8	

Protection : OC Shaped Char

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F Shaped Char	2.1.1	
P/F Char Dir		
P/F Char Setting		xIn
P/F Charact		
P/F Multiplier		
P/F Char Delay		s
P/F Reset(ANSI)		
P/F Reset Delay		
E/F Shaped Char	2.1.1	
E/F Char Dir		
E/F Char Setting		xIn
E/F Charact		
E/F Multiplier		
E/F Char Delay		s
E/F Reset(ANSI)		
E/F Reset Delay		s
E/Fm Shaped Char		
E/Fm Char Dir		
E/Fm Char Setting		xIn
E/Fm Charact		
E/Fm Multiplier		
E/Fm Char Delay		s
E/Fm Reset(ANSI)		
E/Fm Reset Delay		s

Protection: V Controlled OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
VCO Enable	2.1.2	
VCO Level		V
VCO Multiplier		
VT Fail Inhibit		

Protection : OC HS/LS

Ref: P20048 Current Protections

Setting name	Ref	Applied value
P/F LS	2.1.3	

Setting name	Ref	Applied value
P/F LS Dir		
P/F LS Setting		xIn
P/F LS Delay		s
P/F HS1	2.1.3	
P/F HS1 Dir		
P/F HS1 Setting		xIn
P/F HS1 Delay		s
P/F HS2	2.1.3	
P/F HS2 Dir		
P/F HS2 Setting		xIn
P/F HS2 Delay		s
E/F LS	2.1.3	
E/F LS Dir		
E/F LS Setting		xIn
E/F LS Delay		s
E/F HS1	2.1.3	
E/F HS1 Dir		
E/F HS1 Setting		xIn
E/F HS1 Delay		s
E/F HS2	2.1.3	
E/F HS2 Dir		
E/F HS2 Setting		xIn
E/F HS2 Delay		s
E/Fm LS	2.1.3	
E/Fm LS Dir		
E/Fm LS Setting		xIn
E/Fm LS Delay		s
E/Fm HS1	2.1.3	
E/Fm HS1 Dir		
E/Fm HS1 Setting		xIn
E/Fm HS1 Delay		s
E/Fm HS2	2.1.3	
E/Fm HS2 Dir		
E/Fm HS2 Setting		xIn
E/Fm HS2 Delay		s

Protection : NPS OC

Ref: P20048 Current Protections

Setting name	Ref	Applied value
I2-1	2.6.1	
I2-1 Setting		xIn
I2-1 Delay		s
I2-2		
I2-2 Setting		xIn
I2-2 Delay		s

Protection : Thermal Overload

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Thermal Overload	2.3.1	
Overload Setting		xIn
Time Constant		min
Hot/Cold Ratio		
Capacity Alarm		
Load Inc Alarm		
Overload Alarm		
Reset Ther State		

Protection : Cold Load

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Cold Load	2.4	
Cold Load Group		
Pick-up Time		s
Drop-off Time		s
Reduced Current		
Reduced Cur Time		s

Protection : Broken Conductor

Ref: P20048 Current Protections

Setting name	Ref	Applied value
Broken Conductor	2.5	
Trip Enable		
Failure Time		ms
Current Threshld		xIn

Protection : Phase Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
Volt Input Mode	2.1.1	
V-1 Operation		
V-1 Setting		V
V-1 Hysteresis		%

Setting name	Ref	Applied value
V-1 Time Delay		s
V-1 O/P Phases		
V-2 Operation		
V-2 Setting		V
V-2 Hysteresis		%
V-2 Time Delay		s
V-2 O/P Phases		
V-3 Operation		
V-3 Setting		V
V-3 Hysteresis		%
V-3 Time Delay		s
V-3 O/P Phases		
V-4 Operation		
V-4 Setting		V
V-4 Hysteresis		%
V-4 Time Delay		s
V-4 O/P Phases		

Protection: Neutral Voltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
3Vo-1 Charact	2.1.3	
3Vo-1 Dir		
3Vo-1 Setting		V
3Vo-1 Delay		s
3Vo-1 Multiplier		
3Vo-1 Reset Delay		s
3Vo-2 Charact	2.1.3	
3Vo-2 Dir		
3Vo-2 Setting		V
3Vo-2 Delay		s
3Vo-2 Multiplier		
3Vo-2 Reset Delay		s

Protection: NPS Overvoltage

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
V2-1	2.1.4	
V2-1 Setting		V
V2-1 Delay		s
V2-2		
V2-2 Setting		V
V2-2 Delay		s

Protection : Frequency

Ref: P20051 Voltage Protections

Setting name	Ref	Applied value
F-1 Operation	2.2.1	
F-1 Setting		Hz
F-1 Delay		s
F-1 Inhibit		
F-2 Operation		
F-2 Setting		Hz
F-2 Delay		s
F-2 Inhibit		
F-3 Operation		
F-3 Setting		Hz
F-3 Delay		s
F-3 Inhibit		
F-4 Operation		
F-4 Setting		Hz
F-4 Delay		s
F-4 Inhibit		

Directional

Ref: P20048 Current Protections

Setting name	Ref	Applied value
2-out-of-3 Logic	2.2.1.1	
P/F Char Angle		deg
E/F Char Angle		deg
E/Fm Char Angle		deg

Protection : CB Trip Fail

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Fail Time 1	2.1.1	s
Trip Fail Time 2		s
Trip Fail Level		

Protection : CT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
CT Supervision	2.2.1	
CT Failure Time		ms

Setting name	Ref	Applied value
Current Threshld		xIn

Protection : VT Supervision

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
VT Supervision	2.2.2	
VTS PF Inhibit		
VTS Inps Level		xIn
VTS Vnps Level		V
VTS Mode		

Protection : Trip Cct Super

Ref: P20060 Plant Supervision

Setting name	Ref	Applied value
Trip Cct Super	2.3.1	

Autoreclose

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
A/R In Service	2.1	
Number Of Shots		
First Deadtime		s
Second Deadtime		s
Third Deadtime		s
Fourth Deadtime		s
CB Close Pulse		s
Reclaim Time		s
Prot Trip 1		
Prot Trip 2		
Prot Trip 3		
Prot Trip 4		
Line Check Trip		
HS1 TTL		
HS2 TTL		
Rec Block Delay		s
Slow Open Delay		ms
Seq Fail Timer		
Min LO Timer		s
Reset LO By Time		
Dead Bar Charge		
Dead Line Charge		
Dead L & B Close		

Setting name	Ref	Applied value
Check Sync Close		
Uncondit Close		
Manual Close DBC		
Manual Close DLC		
Man Close DLDB		
Manual Close CS		
Live Line Check		
CS In Deadtime		
VT Fail Lockout		
DL Charge Delay		s
DB Charge Delay		s
Sync Close Delay		s

Check Synchronising

Ref: P20063 Autoreclosing and Check Sync

Setting name	Ref	Applied value
Bus Dead | Live		%
Line Dead | Live		%
Bus Undervolts		%
Line Undervolts		%
Voltage Diff		%
Split Angle		deg
MC Split Action		
ARC Split Action		
Check Sync Angle		deg
Check Sync Slip		mHz
Check Sync Timer		
SS / COZ Slip f		mHz
CB Close Time		ms
Sync Connection		

Output Relays : O/P Relay Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
Prot Healthy	2.3	
General Trip		
General Starter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		

Setting name	Ref	Applied value
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
I2 Starter		
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
U/O Volt Starter		
V-1 Trip		

Setting name	Ref	Applied value
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0 Starter		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		

Setting name	Ref	Applied value
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Hand Rst Outputs		

Output Relays : O/P Min Op Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
Min Op Time 1	2.3	s
Min Op Time 2		s
Min Op Time 3		s
Min Op Time 4		s
Min Op Time 5		s
Min Op Time 6		s
Min Op Time 7		s
Min Op Time 8		s
Min Op Time 9		s
Min Op Time 10		s
Min Op Time 11		s
Min Op Time 12		s
Min Op Time 13		s

Status Inputs

Ref: P20025 Common Features

Setting name	Ref	Applied value
Invert Inputs	2.3	

Status Inputs : Status Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
P/F Char Inhibit	2.3	
E/F Char Inhibit		
E/Fm Char Inhibit		
P/F LS Inhibit		
P/F HS1 Inhibit		
P/F HS2 Inhibit		
E/F LS Inhibit		
E/F HS1 Inhibit		
E/F HS2 Inhibit		
E/Fm LS Inhibit		
E/Fm HS1 Inhibit		
E/Fm HS2 Inhibit		
I2-1 Inhibit		
I2-2 Inhibit		
P/F Dir Inhibit		
E/F Dir Inhibit		
E/Fm Dir Inhibit		
V-1 Inhibit		
V-2 Inhibit		
V-3 Inhibit		

Setting name	Ref	Applied value
V-4 Inhibit		
3V0-1 Inhibit		
3V0-2 Inhibit		
V2-1 Inhibit		
V2-2 Inhibit		
Trip Fail Start		
Trip Cct Fail		
Starter		
A/R In		
A/R Out		
Extern A/R Start		
Block Reclose		
Go To Lockout		
Trip And Reclose		
Trip and Lockout		
Manual Close		
Sync Override		
Man SyncOverride		
Start SystemSync		
I^2t Cnt Update		
CBAClosed		
CBBClosed		
CBCClosed		
CBAOpen		
CBBOpen		
CBCOpen		
Waveform Trig		
Select Sett Grp		
Inhibit Sel Grp		
Reset Flag_O/P		
Clock Sync.		

Status Inputs : I/P PU Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P PU Time 1	2.3	s
I/P PU Time 2		s
I/P PU Time 3		s
I/P PU Time 4		s
I/P PU Time 5		s
I/P PU Time 6		s
I/P PU Time 7		s
I/P PU Time 8		s
I/P PU Time 9		s
I/P PU Time 10		s
I/P PU Time 11		s
I/P PU Time 12		s
I/P PU Time 13		s
I/P PU Time 14		s
I/P PU Time 15		s
I/P PU Time 16		s
I/P PU Time 17		s
I/P PU Time 18		s
I/P PU Time 19		s
I/P PU Time 20		s
I/P PU Time 21		s
I/P PU Time 22		s
I/P PU Time 23		s
I/P PU Time 24		s
I/P PU Time 25	2.3	s
I/P PU Time 26		s
I/P PU Time 27		s

Status Inputs : I/P DO Timers

Ref: P20025 Common Features

Setting name	Ref	Applied value
I/P DO Time 1	2.3	s
I/P DO Time 2		s
I/P DO Time 3		s
I/P DO Time 4		s
I/P DO Time 5		s
I/P DO Time 6		s
I/P DO Time 7		s
I/P DO Time 8		s
I/P DO Time 9		s
I/P DO Time 10		s
I/P DO Time 11		s
I/P DO Time 12		s
I/P DO Time 13		s
I/P DO Time 14		s

Setting name	Ref	Applied value
I/P DO Time 15		s
I/P DO Time 16		s
I/P DO Time 17		s
I/P DO Time 18		s
I/P DO Time 19		s
I/P DO Time 20		s
I/P DO Time 21		s
I/P DO Time 22		s
I/P DO Time 23		s
I/P DO Time 24		s
I/P DO Time 25		s
I/P DO Time 26		s
I/P DO Time 27		s

LEDs : LED Config

Ref: P20025 Common Features

Setting name	Ref	Applied value
GeneralTrip	2.3	
GeneralStarter		
PhaseATrip		
PhaseBTrip		
PhaseCTrip		
EarthTrip		
MeasEarthTrip		
P/F Starter		
P/F Charact		
E/F Starter		
E/F Charact		
E/Fm Starter		
E/Fm Charact		
P/F LS		
P/F HS1		
P/F HS2		
E/F LS		
E/F HS1		
E/F HS2		
E/Fm LS		
E/Fm HS1		
E/Fm HS2		
I2 Starter		

Setting name	Ref	Applied value
I2-1 Operate		
I2-2 Operate		
Thermal OL Trip		
Therm Cap Alarm		
Load Incr Alarm		
Thermal OL Alarm		
Cold Load Active		
Cold Load Trip		
BrokenConductor		
BrokenCondTrip		
PhaseAFwd		
PhaseARev		
PhaseBFwd		
PhaseBRev		
PhaseCFwd		
PhaseCRev		
EarthFwd		
EarthRev		
MeasEarthFwd		
MeasEarthRev		
U/O Volt Starter		
V-1 Trip		
V-2 Trip		
V-3 Trip		
V-4 Trip		
3V0-1 Trip		
3V0-2 Trip		
V2 Starter		
V2-1 Operate		
V2-2 Operate		
U/O Freq Starter		
F-1 Trip		
F-2 Trip		
F-3 Trip		
F-4 Trip		
CB Fail 1		
CB Fail 2		
CTFailed		
VTFailed		

Setting name	Ref	Applied value
Trip Cct Failed		
Lockout		
A/R Switched Out		
A/R In Progress		
Successful Close		
Line Check		
Ext Arc Start		
Live Line		
Live Bus		
System Split O/P		
In Sync Output		
Check Sync Start		
Sync In Progress		
Dead Line Close		
Dead Bus Close		
Bus VT Failure		
Line VT Failure		
OpsCountAlarm		
DeltaCountAlarm		
I^2t Count Alarm		
CBFailedToOpen		
CBFailedToClose		
CBInvalid		
CBOpen		
CBClosed		
GeneralClose		
ControlTrip		
O/P Relay Test		
Status 1		
Status 2		
Status 3		
Status 4		
Status 5		
Status 6		
Status 7		
Status 8		
Status 9		
Status 10		
Status 11		

Setting name	Ref	Applied value
Status 12		
Status 13		
Status 14		
Status 15		
Status 16		
Status 17		
Status 18		
Status 19		
Status 20		
Status 21		
Status 22		
Status 23		
Status 24		
Status 25		
Status 26		
Status 27		
Self Reset LEDs		

LEDs : LED Labels

Ref: P20025 Common Features

Setting name	Ref	Applied value
Led1 Label	2.3	
Led2 Label		
Led3 Label		
Led4 Label		
Led5 Label		
Led6 Label		
Led7 Label		
Led8 Label		
Led9 Label		
Led10 Label		
Led11 Label		
Led12 Label		
Led13 Label		
Led14 Label		
Led15 Label		
Led16 Label		
Led17 Label		
Led18 Label		
Led19 Label		

Setting name	Ref	Applied value
Led20 Label		
Led21 Label		
Led22 Label		
Led23 Label		
Led24 Label		
Led25 Label		
Led26 Label		
Led27 Label		
Led28 Label		
Led29 Label		
Led30 Label		
Led31 Label		
Led32 Label		

ReyLogiC : ReyLogiC Control

Setting name	Ref	Applied value
IO Booleans		
General Logic		
Control Logic		
ARC/Fault Trig		

ReyLogiC : ReyLogiC Elements

Setting name	Ref	Applied value
Control Close		ms

Comms Interface: Comms Interface

Ref: P20025 Common Features

Setting name	Ref	Applied value
Station Address	3.3	
IEC 870 on Port		
Line Switch Time		
Com 1 Baud Rate		
Com 1 Parity		
Com 1 Line Idle		
Com 1 Data Echo		
Com 2 Baud Rate		
Com 2 Parity		
Com 2 Line Idle		
Com 2 Data Echo		
Com 2 Direction		
IEC 870 update		

Comms Interface : IEC870 Update

Ref: P20025 Common Features

Setting name	Ref	Applied value
Measurand Type	3.3.9	
Class2 Refresh		s
Curr High Update		%
Curr Low Update		%
Volt High Update		%
Volt Low Update		%
Watt High Update		%
Watt Low Update		%
Vars High Update		%
Vars Low Update		%
Freq High Update		%
Freq Low Update		%
Sync Angle High		%
Sync Angle Low		%

Data Storage

Ref: P20025 Common Features

Setting name	Ref	Applied value
Pre-trigger Storage	2.5	%
Record Duration		s
Trigger Waveform		
Clear Waveforms		
Clear Events		
Clear Faults		
Reset Demand		
Reset WHr Met		
Reset Varhr Met		
Energy Ev Level		W
Energy Ev Time		s

CB Maintenance : Trip Counter

Ref: P20025 Common Features

Setting name	Ref	Applied value
Trip Count Alarm	2.6	
Delta Trip Alarm		
Reset Trip Cnt		
Reset Delta Cnt		

CB Maintenance : I^2t CB Wear

Ref: P20025 Common Features

Setting name	Ref	Applied value
I^2t Counter	2.6	
Alarm Limit		MA^2s
Separation Time		s
Clearance Time		s
Reset I^2t Count		

CB Maintenance : IO Test

Ref: P20025 Common Features

Setting name	Ref	Applied value
Test O/P Relays	2.6	

Mimic Settings

Ref: P20025 Common Features

Setting name	Ref	Applied value
Circuit Breaker1		

Section 3: IEC 60870-5-103 Definitions

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.

Function Type

Abbreviation	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
20	General command

Information Number and Function

The following table lists information number and function definitions together with a description of the message and function type and cause of transmission that can result in that message. Not all definitions are available on all relay types – this is dependent on functionality.

Function	Information Number	Description	Function Type	Cause of Transmission
60	**1**	**IEC870 Active Com1**	**1**	**SE, GI,**
60	**2**	**IEC870 Active Com2**	**1**	**SE, GI,**
60	**3**	**Front Port OverRide**	**1**	**SE, GI,**
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**
70	**5**	**Status Input 5**	**1**	**SE, GI,**
70	**6**	**Status Input 6**	**1**	**SE, GI,**
70	**7**	**Status Input 7**	**1**	**SE, GI,**
70	**8**	**Status Input 8**	**1**	**SE, GI,**
70	**9**	**Status Input 9**	**1**	**SE, GI,**
70	**10**	**Status Input 10**	**1**	**SE, GI,**
70	**11**	**Status Input 11**	**1**	**SE, GI,**
70	**12**	**Status Input 12**	**1**	**SE, GI,**
70	**13**	**Status Input 13**	**1**	**SE, GI,**
70	**14**	**Status Input 14**	**1**	**SE, GI,**
70	**15**	**Status Input 15**	**1**	**SE, GI,**

Function	Information Number	Description	Function Type	Cause of Transmission
70	**16**	**Status Input 16**	**1**	**SE, GI,**
70	**17**	**Status Input 17**	**1**	**SE, GI,**
70	**18**	**Status Input 18**	**1**	**SE, GI,**
70	**19**	**Status Input 19**	**1**	**SE, GI,**
70	**20**	**Status Input 20**	**1**	**SE, GI,**
70	**21**	**Status Input 21**	**1**	**SE, GI,**
70	**22**	**Status Input 22**	**1**	**SE, GI,**
70	**23**	**Status Input 23**	**1**	**SE, GI,**
70	**24**	**Status Input 24**	**1**	**SE, GI,**
70	**25**	**Status Input 25**	**1**	**SE, GI,**
70	**26**	**Status Input 26**	**1**	**SE, GI,**
70	**27**	**Status Input 27**	**1**	**SE, GI,**
70	28	Status Input 28	1	SE, GI,
70	29	Status Input 29	1	SE, GI,
70	30	Status Input 30	1	SE, GI,
70	31	Status Input 31	1	SE, GI,
70	32	Status Input 32	1	SE, GI,
80	**1**	**Plant Control Relay 1**	**1**	**SE, GI,**
80	**2**	**Plant Control Relay 2**	**1**	**SE, GI,**
80	**3**	**Plant Control Relay 3**	**1**	**SE, GI,**
80	**4**	**Plant Control Relay 4**	**1**	**SE, GI,**
80	**5**	**Plant Control Relay 5**	**1**	**SE, GI,**
80	**6**	**Plant Control Relay 6**	**1**	**SE, GI,**
80	**7**	**Plant Control Relay 7**	**1**	**SE, GI,**
80	**8**	**Plant Control Relay 8**	**1**	**SE, GI,**
80	**9**	**Plant Control Relay 9**	**1**	**SE, GI,**
80	**10**	**Plant Control Relay 10**	**1**	**SE, GI,**
80	**11**	**Plant Control Relay 11**	**1**	**SE, GI,**
80	**12**	**Plant Control Relay 12**	**1**	**SE, GI,**
80	**13**	**Plant Control Relay 13**	**1**	**SE, GI,**
80	14	Plant Control Relay 14	1	SE, GI,
80	15	Plant Control Relay 15	1	SE, GI,
80	16	Plant Control Relay 16	1	SE, GI,
80	17	Plant Control Relay 17	1	SE, GI,
80	18	Plant Control Relay 18	1	SE, GI,
80	19	Plant Control Relay 19	1	SE, GI,
80	20	Plant Control Relay 20	1	SE, GI,
80	21	Plant Control Relay 21	1	SE, GI,
80	22	Plant Control Relay 22	1	SE, GI,
80	23	Plant Control Relay 23	1	SE, GI,
80	24	Plant Control Relay 24	1	SE, GI,
80	25	Plant Control Relay 25	1	SE, GI,
80	26	Plant Control Relay 26	1	SE, GI,
80	27	Plant Control Relay 27	1	SE, GI,
80	28	Plant Control Relay 28	1	SE, GI,
80	29	Plant Control Relay 29	1	SE, GI,
80	30	Plant Control Relay 30	1	SE, GI,
80	31	Plant Control Relay 31	1	SE, GI,
80	32	Plant Control Relay 32	1	SE, GI,
160	**2**	**Reset FCB**	**5**	**Reset FCB**

Function	Information Number	Description	Function Type	Cause of Transmission
160	**3**	**Reset CU**	**5**	**Reset CU**
160	**4**	**Start/Restart**	**5**	**Start/Restart**
160	**5**	**Power On**	**1**	**SE**
160	**16**	**Auto-reclose active (In/Out)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**19**	**LEDs reset (Reset Flag & Outputs)**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**21**	**Trip Test**	**1**	**SE**
160	**22**	**Settings changed**	**1**	**SE**
160	**23**	**Settings Group 1 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**24**	**Settings Group 2 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**25**	**Settings Group 3 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**26**	**Settings Group 4 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
160	**27**	**Status Input 1**	**1**	**SE, GI**
160	**28**	**Status Input 2**	**1**	**SE, GI**
160	**29**	**Status Input 3**	**1**	**SE, GI**
160	**30**	**Status Input 4**	**1**	**SE, GI**
160	**36**	**Trip circuit fail**	**1**	**SE, GI**
160	46	Group Warning	1	SE, GI
160	47	Alarm	1	SE, GI
160	**64**	**A-Delayed Starter**	**2**	**SE, GI**
160	**65**	**B-Delayed Starter**	**2**	**SE, GI**
160	**66**	**C-Delayed Starter**	**2**	**SE, GI**
160	**67**	**E-Delayed Starter**	**2**	**SE, GI**
160	**68**	**General Trip**	**2**	**SE**
160	**69**	**A-general trip**	**2**	**SE**
160	**70**	**B-general trip**	**2**	**SE**
160	**71**	**C-general trip**	**2**	**SE**
160	**84**	**General Starter**	**2**	**SE**
160	**85**	**Circuit breaker fail 1**	**2**	**SE**
160	**91**	**P/F-general HS trip**	**2**	**SE**
160	**92**	**E/F-general trip**	**2**	**SE**
160	**93**	**E/F-general HS trip**	**2**	**SE**
160	**128**	**CB on by auto reclose**	**1**	**SE**
160	**130**	**Reclose blocked**	**1**	**SE**
168	**0**	**Data lost**	**1**	**SE**
168	1	A-lowset starter	2	SE
168	2	B-lowset starter	2	SE
168	3	C-lowset starter	2	SE
168	4	E-lowset starter	2	SE
168	5	A-lowset trip	2	SE
168	6	B-lowset trip	2	SE
168	7	C-lowset trip	2	SE
168	8	E-lowset trip	2	SE
168	9	A-Delayed Trip	2	SE
168	10	B-Delayed Trip	2	SE

Function	Information Number	Description	Function Type	Cause of Transmission
168	11	C-Delayed Trip	2	SE
168	12	E-Delayed Trip	2	SE
168	13	A-HS1 trip	2	SE
168	14	B-HS1 trip	2	SE
168	15	C-HS1 trip	2	SE
168	16	E-HS1 trip	2	SE
168	17	A-HS2 trip	2	SE
168	18	B-HS2 trip	2	SE
168	19	C-HS2 trip	2	SE
168	20	E-HS2 trip	2	SE
168	21	SEF/REF starter1	2	SE
168	22	SEF/REF starter2	2	SE
168	24	SEF/REF trip1	2	SE
168	25	SEF/REF trip2	2	SE
168	26	A-HS1 starter	2	SE
168	27	B-HS1 starter	2	SE
168	28	C-HS1 starter	2	SE
168	29	E-HS1 starter	2	SE
168	30	A-HS2 starter	2	SE
168	31	B-HS2 starter	2	SE
168	32	C-HS2 starter	2	SE
168	33	E-HS2 starter	2	SE
168	34	CB Opened	1	SE
168	**39**	**Circuit breaker fail 2**	**2**	**SE**
168	**40**	**MeasE/F-general trip**	**2**	**SE**
168	**41**	**CB Close Fail**	**1**	**SE, GI**
168	**43**	**CB DBI state**	**1**	**SE, GI**
168	**44**	**A-Forward**	**2**	**SE, GI**
168	**45**	**A-Reverse**	**2**	**SE, GI**
168	**46**	**B-Forward**	**2**	**SE, GI**
168	**47**	**B-Reverse**	**2**	**SE, GI**
168	**48**	**C-Forward**	**2**	**SE, GI**
168	**49**	**C-Reverse**	**2**	**SE, GI**
168	**50**	**E/F-Forward**	**2**	**SE, GI**
168	**51**	**E/F-Reverse**	**2**	**SE, GI**
168	52	V Element 1 Starter	2	SE, GI
168	53	V Element 2 Starter	2	SE, GI
168	54	V Element 3 Starter	2	SE, GI
168	55	V Element 4 Starter	2	SE, GI
168	56	V Element 1 Trip	2	SE, GI
168	57	V Element 2 Trip	2	SE, GI
168	58	V Element 3 Trip	2	SE, GI
168	59	V Element 4 Trip	2	SE, GI
168	60	SEF-Forward	2	SE, GI
168	61	SEF-Reverse	2	SE, GI
168	62	I2 Element 1 starter	2	SE, GI
168	63	I2 Element 2 starter	2	SE, GI
168	**65**	**I2 Element 1 trip**	**2**	**SE, GI**
168	**66**	**I2 Element 2 trip**	**2**	**SE, GI**
168	68	I2 general trip	2	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
168	69	Group Switched - External	1	SE, GI
168	70	Trip count alarm	1	SE, GI
168	**71**	**CB maintenance alarm**	**1**	**SE, GI**
168	73	Delta Trip count alarm	1	SE, GI
168	74	Trip count overflowed	1	SE, GI
168	75	Delta count overflowed	1	SE, GI
168	76	A Broken Conductor	1	SE, GI
168	77	B Broken Conductor	1	SE, GI
168	78	C Broken Conductor	1	SE, GI
168	**79**	**Broken Conductor**	**1**	**SE, GI**
168	80	Waveform stored	1	SE, GI
168	82	Trip And Lockout	1	SE, GI
168	84	Trip And Reclose	1	SE, GI
168	85	Circuit breaker closed	1	SE, GI
168	**88**	**Reclaim**	**1**	**SE, GI**
168	**89**	**Lockout**	**1**	**SE, GI**
168	**90**	**Thermal Overload Trip**	**1**	**SE, GI**
168	91	Thermal Capacity Alarm	1	SE, GI
168	92	Load Increase Alarm	1	SE, GI
168	93	Thermal Overload Alarm	1	SE, GI
168	94	Phase A CT Failed	1	SE, GI
168	95	Phase B CT Failed	1	SE, GI
168	96	Phase C CT Failed	1	SE
168	**97**	**CT Failed**	**1**	**SE**
168	**98**	**Successful Close**	**1**	**SE, GI**
168	**100**	**Cold Load Pickup**	**2**	**SE, GI**
168	**101**	**Cold Load Trip**	**2**	**SE**
168	102	Line check trip	2	SE
168	103	Live Line	2	SE, GI
168	104	Live Bus	2	SE, GI
168	105	In Sync	2	SE, GI
168	106	External trip block	1	SE, GI
168	107	System Split	2	SE, GI
168	**110**	**E/Fm-Forward**	**2**	**SE, GI**
168	**111**	**E/Fm-Reverse**	**2**	**SE, GI**
168	112	V2 Element 1 Starter	2	SE, GI
168	113	V2 Element 2 Starter	2	SE, GI
168	**114**	**V2 Element 1 Trip**	**2**	**SE, GI**
168	**115**	**V2 Element 2 Trip**	**2**	**SE, GI**
168	116	F Element 1 Starter	2	SE, GI
168	117	F Element 2 Starter	2	SE, GI
168	118	F Element 3 Starter	2	SE, GI
168	119	F Element 4 Starter	2	SE, GI
168	**120**	**F Element 1 Trip**	**2**	**SE, GI**
168	**121**	**F Element 2 Trip**	**2**	**SE, GI**
168	**122**	**F Element 3 Trip**	**2**	**SE, GI**
168	**123**	**F Element 4 Trip**	**2**	**SE, GI**
168	135	VT Failed	2	SE, GI
168	**171**	**LS Trip**	**2**	**SE**
168	**172**	**Delayed Trip**	**2**	**SE**

Function	Information Number	Description	Function Type	Cause of Transmission
168	**173**	**HS1 Trip**	**2**	**SE**
168	**174**	**HS2 Trip**	**2**	**SE**
168	**175**	**Settings Group 5 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**176**	**Settings Group 6 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**177**	**Settings Group 7 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	**178**	**Settings Group 8 Select**	**1**	**SE, GI**
			20	**Ack, Nak**
168	179	Trip count reset	1	SE
			20	Ack, Nak
168	180	Delta trip count reset	1	SE
			20	Ack, Nak
168	181	I^2t count reset	1	SE
			20	Ack, Nak
168	**182**	**Remote Mode**	**1**	**SE, GI**
168	**183**	**Service Mode**	**1**	**SE, GI**
168	**184**	**Local Mode**	**1**	**SE, GI**
168	**185**	**3Vo Element 1 Starter**	**2**	**SE, GI**
168	**186**	**3Vo Element 2 Starter**	**2**	**SE, GI**
168	**187**	**3Vo Element 1 Trip**	**2**	**SE, GI**
168	**188**	**3Vo Element 2 Trip**	**2**	**SE, GI**
168	**201**	**3PAvEnergy**	**4**	**Cyclic**
168	**202**	**3PReacEnergy**	**4**	**Cyclic**
168	238	P/F Idmtl on/off	1	SE
			20	Ack, Nak
168	239	E/F Idmtl on/off	1	SE
			20	Ack, Nak
168	240	P/F Lowset on/off	1	SE
			20	Ack, Nak
168	241	P/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	242	P/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	243	E/F Lowset on/off	1	SE
			20	Ack, Nak
168	244	E/F Highset 1 on/off	1	SE
			20	Ack, Nak
168	245	E/F Highset 2 on/off	1	SE
			20	Ack, Nak
168	246	SEF1 on/off	1	SE
			20	Ack, Nak
168	247	SEF2 on/off	1	SE
			20	Ack, Nak
168	248	Thermal O/L on/off	1	SE
			20	Ack, Nak
168	249	Broken Conductor on/off	1	SE
			20	Ack, Nak
168	250	Cold Load on/off	1	SE

Function	Information Number	Description	Function Type	Cause of Transmission
			20	Ack, Nak
168	251	CT Supervision on/off	1	SE
			20	Ack, Nak
168	252	Trip Cct Supervision on/off	1	SE
			20	Ack, Nak
168	**253**	**Cold Start**	**1**	**SE**
168	**254**	**Warm Start**	**1**	**SE**
168	**255**	**Re-Start**	**1**	**SE**
200	1	CB 1	1	SE, GI
			20	Ack, Nak
200	2	CB 2	1	SE, GI
			20	Ack, Nak
200	3	CB 3	1	SE, GI
			20	Ack, Nak
200	4	CB 4	1	SE, GI
			20	Ack, Nak
200	5	CB 5	1	SE, GI
			20	Ack, Nak
200	**21**	**Iso 1**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**22**	**Iso 2**	**1**	**SE, GI**
			20	**Ack, Nak**
200	**23**	**Iso 3**	**1**	**SE, GI**
			20	**Ack, Nak**
200	24	Iso 4	1	SE, GI
			20	Ack, Nak
200	25	Iso 5	1	SE, GI
			20	Ack, Nak
200	41	Earth Switch 1	1	SE, GI
			20	Ack, Nak
200	42	Earth Switch 2	1	SE, GI
			20	Ack, Nak
200	43	Earth Switch 3	1	SE, GI
			20	Ack, Nak
200	44	Earth Switch 4	1	SE, GI
			20	Ack, Nak
200	45	Earth Switch 5	1	SE, GI
			20	Ack, Nak
200	101	Control Item 1	1	SE, GI
			20	Ack, Nak
200	102	Control Item 2	1	SE, GI
			20	Ack, Nak
200	103	Control Item 3	1	SE, GI
			20	Ack, Nak
200	104	Control Item 4	1	SE, GI
			20	Ack, Nak
200	105	Control Item 5	1	SE, GI
			20	Ack, Nak
200	121	CB 1 Service Position	1	SE, GI
200	122	CB 2 Service Position	1	SE, GI

Function	Information Number	Description	Function Type	Cause of Transmission
200	123	CB 3 Service Position	1	SE, GI
200	124	CB 4 Service Position	1	SE, GI
200	125	CB 5 Service Position	1	SE, GI
200	255	Blocked By Interlocking	1	SE, GI
255	0	Time Synchronisation	6	Time Synchronisation
255	0	End of GI	8	End of GI

Measurand

Function	**Information Number**	**Description**	**Function Type**	**Cause of Transmission**
160	**148**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ P, Q, F**	**9**	**Cyclic**
168	**200**	**Measurand $I_{L1,2,3,}$ $V_{L1,2,3,}$ $V_{L1-2, L2-3, L3-1,}$ P, Q, F, Sync Angle**	**9**	**Cyclic**

Section 4: Modbus Definitions

Coils (Read Write Binary values)

Address	Description
00001	Plant Control Relay 1
00002	Plant Control Relay 2
00003	Plant Control Relay 3
00004	Plant Control Relay 4
00005	Plant Control Relay 5
00006	Plant Control Relay 6
00007	Plant Control Relay 7
00008	Plant Control Relay 8
00009	Plant Control Relay 9
00010	Plant Control Relay 10
00011	Plant Control Relay 11
00012	Plant Control Relay 12
00013	Plant Control Relay 13
00014	Plant Control Relay 14
00015	Plant Control Relay 15
00016	Plant Control Relay 16
00017	Plant Control Relay 17
00018	Plant Control Relay 18
00019	Plant Control Relay 19
00020	Plant Control Relay 20
00021	Plant Control Relay 21
00022	Plant Control Relay 22
00023	Plant Control Relay 23
00024	Plant Control Relay 24
00025	Plant Control Relay 25
00026	Plant Control Relay 26
00027	Plant Control Relay 27
00028	Plant Control Relay 28
00029	Plant Control Relay 29
00030	Plant Control Relay 30
00031	Plant Control Relay 31
00032	Plant Control Relay 32
00100	LED Reset (Write only location)
00101	Settings Group 1
00102	Settings Group 2
00103	Settings Group 3
00104	Settings Group 4
00105	Settings Group 5
00106	Settings Group 6
00107	Settings Group 7
00108	Settings Group 8

Inputs (Read Only Binary values)

10001	Status Input 1
10002	Status Input 2
10003	Status Input 3
10004	Status Input 4
10005	Status Input 5
10006	Status Input 6
10007	Status Input 7
10008	Status Input 8
10009	Status Input 9
10010	Status Input 10
10011	Status Input 11
10012	Status Input 12

10013	Status Input 13
10014	Status Input 14
10015	Status Input 15
10016	Status Input 16
10017	Status Input 17
10018	Status Input 18
10019	Status Input 19
10020	Status Input 20
10021	Status Input 21
10022	Status Input 22
10023	Status Input 23
10024	Status Input 24
10025	Status Input 25
10026	Status Input 26
10027	Status Input 27
10028	Status Input 28
10029	Status Input 29
10030	Status Input 30
10031	Status Input 31
10032	Status Input 32
10101	Front Port Override
10102	Remote mode
10103	Service mode
10104	Local mode
10111	Trip Circuit Fail
10112	A-Starter
10113	B-Starter
10114	C-Starter
10115	General Starter
10116	VTS Alarm
10122	P/F Char
10123	P/F LS
10124	P/F HS1
10125	P/F HS2
10126	E/F Char
10127	E/F LS
10128	E/F HS1
10129	E/F HS2
10130	E/Fm Char
10131	E/Fm LS
10132	E/Fm HS1
10133	E/Fm HS2
10134	SEF/REF 1
10135	SEF/REF 2
10145	CB Fail 1
10146	CB Fail 2
10148	Thermal Trip
10149	CTS Alarm
10150	I2-1
10151	I2-2
10152	V2-1
10153	V2-2
10154	Broken Conductor
10155	V-1
10156	V-2
10157	V-3
10158	V-4
10159	3V0-1
10160	3V0-2
10161	F-1
10162	F-2
10163	F-3
10164	F-4

Registers

Address	Name	Format	Description
30001	No.of Events In Store	1 Register	
30002	Latest Event Record	8 Registers	
30010	Vab Primary	FP_32BITS_3DP[1]	Vab kV
30012	Vbc Primary	FP_32BITS_3DP[1]	Vbc kV
30014	Vca Primary	FP_32BITS_3DP[1]	Vca kV
30016	Phase A Primary Volt	FP_32BITS_3DP[1]	Va kV
30018	Phase B Primary Volt	FP_32BITS_3DP[1]	Vb kV
30020	Phase C Primary Volt	FP_32BITS_3DP[1]	Vc kV
30022	Phase a Secondary Volt	FP_32BITS_3DP[1]	Va V
30024	Phase b Secondary Volt	FP_32BITS_3DP[1]	Vb V
30026	Phase c Secondary Volt	FP_32BITS_3DP[1]	Vc V
30048	V0 RMS	FP_32BITS_3DP[1]	Vzps xVnom
30050	V1 RMS	FP_32BITS_3DP[1]	Vpps xVnom
30052	V2 RMS	FP_32BITS_3DP[1]	Vnps xVnom
30060	Frequency	FP_32BITS_3DP[1]	Hz
30064	Phase A Primary Curr	FP_32BITS_3DP[1]	Ia kA
30066	Phase B Primary Curr	FP_32BITS_3DP[1]	Ib kA
30068	Phase C Primary Curr	FP_32BITS_3DP[1]	Ic kA
30070	Phase a Secondary Curr	FP_32BITS_3DP[1]	Ia A
30072	Phase b Secondary Curr	FP_32BITS_3DP[1]	Ib A
30074	Phase c Secondary Curr	FP_32BITS_3DP[1]	Ic A
30088	Earth Primary Curr	FP_32BITS_3DP[1]	In kA
30094	Aux Primary Curr	FP_32BITS_3DP[1]	Ig kA
30096	Aux Secondary Curr	FP_32BITS_3DP[1]	Ig A
30100	I0 RMS	FP_32BITS_3DP[1]	Izps xIn
30102	I1 RMS	FP_32BITS_3DP[1]	Ipps xIn
30104	I2 RMS	FP_32BITS_3DP[1]	Inps xIn
30118	3P P	FP_32BITS_3DP[1]	3 Phase MW
30126	3P RP	FP_32BITS_3DP[1]	3 Phase MVAr
30134	3P AP	FP_32BITS_3DP[1]	3 Phase MVA
30142	3P PF	FP_32BITS_3DP[1]	3 Phase
30144	Whr	FP_32BITS_3DP[1]	3 Phase MWh
30148	VArhr	FP_32BITS_3DP[1]	3 Phase MWh
30154	Thermal State	UINT16[2]	%
30167	Waveform Records	UINT16[2]	
30168	Event Records	UINT16[2]	
30170	Vab Secondary Volt	FP_32BITS_3DP[1]	Vab V
30172	Vbc Secondary Volt	FP_32BITS_3DP[1]	Vbc V
30174	Vca Secondary Volt	FP_32BITS_3DP[1]	Vca V

1) FP_32BITS_3DP: 2 registers - 32 bit fixed point, a 32 bit integer containing a value to 3 decimal places e.g. 50000 sent = 50.000

2) UINT16: 1 register - standard 16 bit unsigned integer

Section 5: Application Diagrams

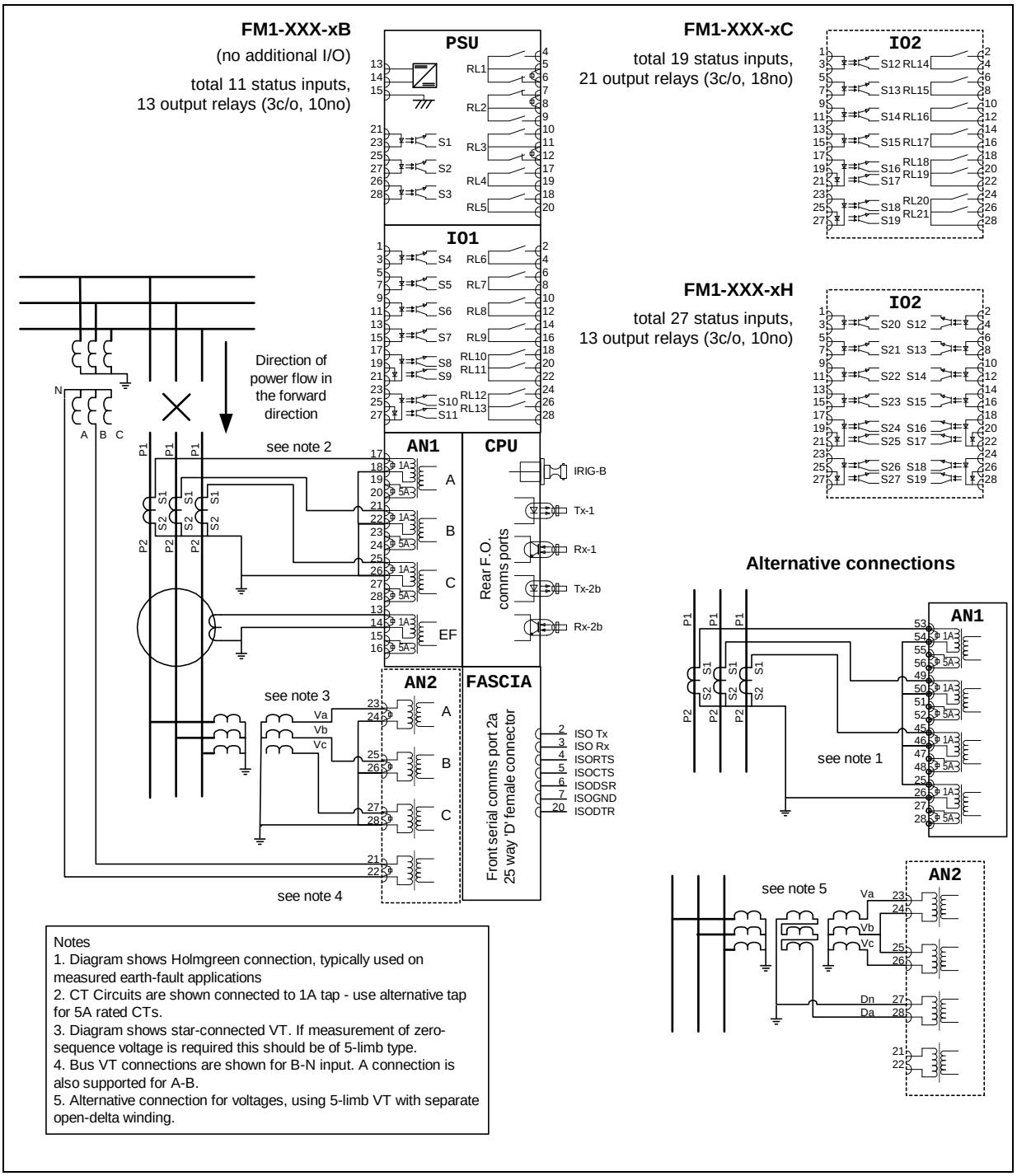

Figure 5-1 Typical Connection Diagram

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