



Energy Division

Installation and Operating Instructions

System Protection Relay



System Protection Relay

Installation & Operating Manual

SPR – 013

SPR – 014

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WARNINGS



- 1 The System Protection Relay is not intended to be used as a sole means of protection - good engineering practice dictates that any critical function be protected by two independent and diverse devices.



- 2 In the interest of safety and functionality this product must be installed by qualified properly trained personnel abiding by local regulations.



- 3 Voltages dangerous to human life are present at some of the terminal connections of this unit. Ensure that all supplies are de-energised before attempting any connection or disconnection. External installations must be sufficient to protect human life and equipment under fault conditions.

CAUTIONS

- 1 These products do not have internal fuses, therefore external fuses must be used for protection for safety under fault conditions.

- 2 The current inputs of these products are designed for connection into systems via current transformers only.



- 3 Never open-circuit the secondary winding of a current transformer. Always ensure that the power is disconnected before separating the current connector from SPR.



- 4 Internal self-checking circuitry (watchdog) continuously monitors the operational state of the SPR, and operates a dedicated relay contact. If the Watchdog relay is in the 'failed' condition (not energised) all other relay contacts are forced to the de-energised condition.



- 5 Operation outside specified limits may cause permanent damage or temporary disruption. For the latter case, normal operation may be restored by temporary disconnection of the auxiliary supply.

INTRODUCTION

Traditionally, each protection requirement in a switchboard or generating set has been met with individual protection relays. These relays have provided a reliable solution over many years, but with the high number of products required in some applications, this can require large amounts of space within a panel. The SPR combines all of the popular protection relay functions into one compact panel mounting product.

GENERAL DESCRIPTION

The System Protection Relay (SPR) is a microprocessor based unit which monitors three-phase voltage and current signals and a single-phase voltage input and provides a number of user definable relay outputs which perform protective functions (see OPERATING INSTRUCTIONS – Protective Functions).

The unit is menu-controlled, which is achieved through the use of the front panel display and four associated soft-touch controls (see OPERATING INSTRUCTIONS).

Because the SPR measures all of the fundamental electrical parameters, the microprocessor can calculate other parameters and offer the user many more features and better protection.

Also included are functions which allow logical relationships between the measured parameters and the output relays

The main features of SPR are:

- 18 Protection Relay Functions
- 9 Logical Relay Functions
- 8 or 12 Change Over Relay (form C) Contacts
- Digital Technology
- Ease of Use
- Accurate Settings
- RS485 Modbus Communications
- Password Protection

INSTALLATION

UNPACKING

Carefully unpack the unit and immediately carry out a damage and contents check. Retain the packing for possible future use, e.g. return to manufacturer for calibration.

Damage check

Carefully check that there are no signs of damage to the unit or associated connectors. If signs of damage are found, report these to your local sales office as soon as possible.

Contents check

Check the contents of the package agree with the following contents list:

- One SPR unit.
- Operating Manual.
- Screw clamp electrical connectors
- Panel mounting clamps

DIMENSIONS OF THE SPR

The case dimensions are shown in Fig 1.

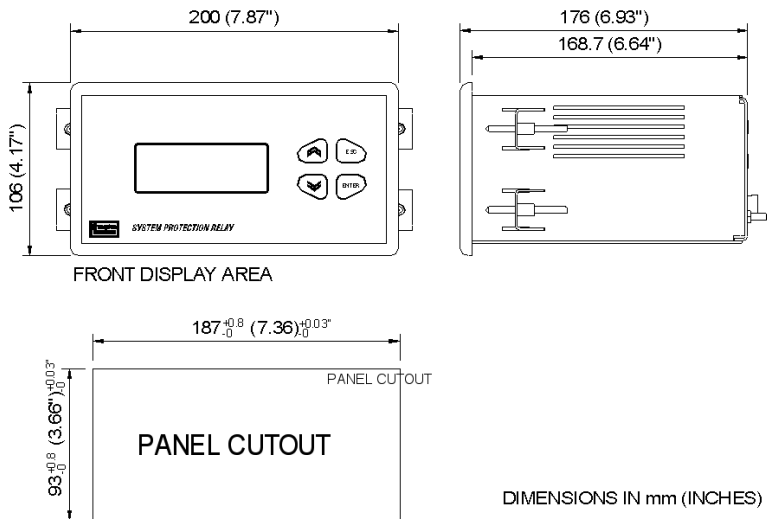


Fig 1 Dimensions of the SPR

MOUNTING NOTES

The SPR may be mounted in a panel of any thickness up to a maximum of 25mm (1").

Mounting is by screw clamps. Consideration should be given to the space required behind the unit to allow for bends in the connection cables.

As the enclosure conforms to IP54, the front panel is protected against ingress from water spray. Additional sealing to the panel may be obtained by the use of an optional gasket. The terminals at the rear of the case are not IP rated, and must be protected from liquids.

The SPR should be mounted where the operating temperature is within the standard range of 0°C to +50°C (+32°F to +122°F). Products are available with an extended operating temperature range of -20°C to +60°C (-4°F to +140°F) as a factory build option (specify when placing order).

If the SPR is to be mounted in a location where it will be subjected to direct sunlight, ensure that any resulting temperature rise does not exceed the product's operating temperature range. Vibration should be kept within specified operating limits. See full specification for details.

Labels are affixed to the product to indicate connection information and electrical data.

Connecting the SPR

The SPR back panel is shown in Fig 2, and the connections are shown in Fig 3.

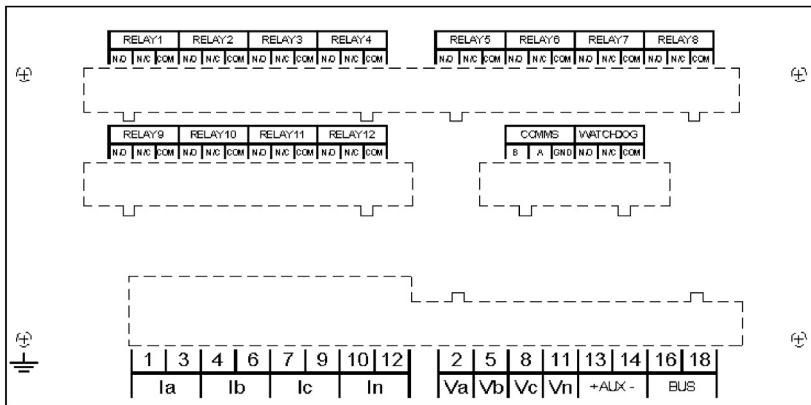


Fig 2 SPR Back Panel Connections

Connecting the SPR

Wiring - Input connections are made directly to shrouded screw clamp terminals. Numbering is clearly marked on the case. Choice of cable should meet local regulations.

- Voltage , Communications and Relay terminals will accept 0.2 to 2.5mm² (24 to 12 AWG) diameter cables.
- Terminals for current inputs will accept up to 0.2 to 4.0mm² (24 to 10 AWG) diameter cables.

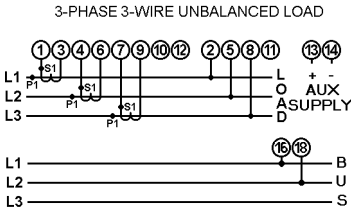
Auxiliary Supply - SPR should ideally be powered by a dedicated class 2 power supply. The SPR supply input must be protected by a 2 Amp HRC fuse. Ensure that the supply Voltage is within the working range for the auxiliary input. Refer to the products' data label for input ratings.

Fusing - In addition to the Auxiliary Supply, it is recommended that all voltage input lines are fitted with 1 amp quick blow fuses. For UL approved installations, all fuses must be UL listed parts.

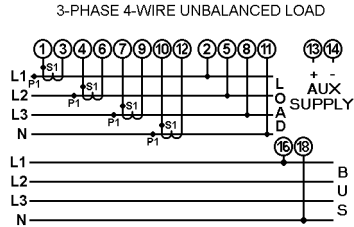
Earth/Ground Connections - The ground stud on the rear panel should be connected to a clean ground. For safety reasons, CT secondary connections should be grounded according to appropriate codes of practice.

The electrical connections are shown in Fig 3.

Model SPR-013



Model SPR-014



Note: Do not use terminal 10-12.

Fig 3 SPR Electrical Connections

Contrast adjustment

Contrast adjustment is available via the front panel keys. See customising information. This may be necessary on installation to obtain the clearest display. Contrast is adjusted automatically to compensate for changes in ambient temperature. **WARNING:** There is a possibility of the display going blank if the manual contrast adjustment is set to extremes

THEORY OF OPERATION AND RESPONSE TIME

True RMS (Root Mean Square) measurements are calculated and displayed on the metering screen, and these measurements are also used to control the operation of the trip relays. Active powers are calculated directly by multiplication of Voltage and current. Reactive powers are calculated using a frequency corrected quarter-phase time delay method. SPR uses harmonic filtered waveform zero crossings to synchronize the sampling scheme to the input frequency. If the Voltage level on this input falls below the level at which the product can reliably determine the frequency, the default frequency is used. SPR samples each Voltage and current input, building up a 32 sample buffer, which means that distorted waveforms with content up to 15th harmonic will be accurately measured.

The calculation of the RMS measurements and control of the trip relays takes approximately 90 milliseconds, this is known as the "loop time". Once completed, the sampling / calculating / control process begins again. The typical response time for most trip functions is between 1 and 2 loop times.

Where this differs for specific trip functions, further information can be found in the PROTECTIVE FUNCTION DETAIL section. The loop time can also be affected by intensive Modbus communications.

WATCHDOG RELAY

An internal watchdog circuit continuously monitors the operational state of the SPR, and operates a dedicated relay contact. If the Watchdog relay is in the 'failed' condition (not energised) all other relay contacts are forced to the de-energised condition.

ELECTROMAGNETIC COMPATIBILITY

This unit has been designed to provide protection against EM (electro-magnetic) interference in line with requirements of EU and other regulations. Precautions necessary to provide proper operation of this and adjacent equipment will be installation dependent and so the following can only be general guidance:-

- Avoid routing wiring to this unit alongside cables and products that are, or could be, a source of interference.
- The auxiliary supply to the unit should not be subject to excessive interference. In some cases, a supply line filter may be required.
- To protect the product against incorrect operation or permanent damage, surge transients must be controlled. It is good EMC practice to suppress differential surges to 2kV or less at the source. The unit has been designed to automatically recover from typical transients, however in extreme circumstances it may be necessary to temporarily disconnect the auxiliary supply for a period of greater than 5 seconds to restore correct operation.
- Screened communication and small signal leads are recommended and may be required. These and other connecting leads may require the fitting of RF suppression components, such as ferrite absorbers, line filters etc., if RF fields cause a problem.
- It is good practice to install sensitive electronic instruments that are performing critical functions in EMC enclosures that protect against electrical interference causing a disturbance in function.

OPERATING INSTRUCTIONS

GENERAL

Switch on the auxiliary supply. Following comprehensive diagnostic checks, and once correct operation has been verified, the dedicated watchdog relay contacts energize to indicate system operational. Once this is complete, the start-up screen will be displayed for 5 seconds whilst the system performs its internal self-test. The software revision is also displayed.

```
___Software_Version___  
    UX.XX  
Serial Number  
    X.XXXX
```

After approximately 5 seconds, the display changes to show the Relay Status Display.

```
___Relay_Status___
```

DEFAULT DISPLAY

At any stage of operation, the display will revert back to this relay status screen if no front panel switches have been pressed for 60 seconds. If no relay functions have been defined, the display will not indicate the presence of any physical relays.

```
___Relay_Status___
```

The default screen can be set to any of the viewable screens, as follows: Select the required displays screen, then press and hold the UP and DOWN arrows buttons for several seconds. The LCD display will flash to indicate that the default screen has been changed.

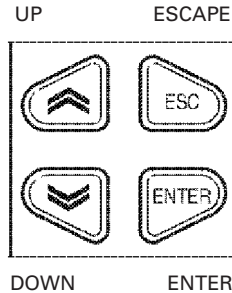
Changes to the default screen are not permanently stored. The default display is always the Relay Status screen when the unit is powered on.

FRONT PANEL CONTROLS

There are four 'soft-touch' control keys on the front panel; these are detailed below.

Menu Navigation Keys

These keys are used to move up or down the SPR menu, or to increase or decrease a numerical value.



This key cancels an operation or quits the menu. Returns to previous level.

This key is used to access the menu and to accept a data entry.

LCD contrast control

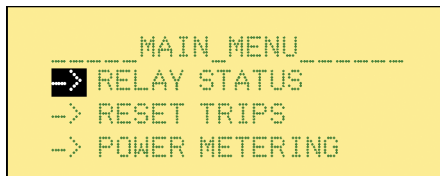
LCD contrast adjustment may be necessary upon installation to obtain the clearest display, and may also be used to compensate for the viewing angle. The display contrast automatically compensates for ambient temperature changes.

If the display has poor contrast or is not showing text, the contrast can be adjusted. While the RELAY STATUS screen is being displayed, press and hold the UP or the DOWN key on the unit front panel. The contrast is increased using the DOWN key, and decreased using the UP key.

IMPORTANT: This adjustment only works when the RELAY STATUS screen is displayed. **NOTE:** The display may go blank if the adjustment is set to extremes. Any changes that you make will become the default setting.

MAIN MENU

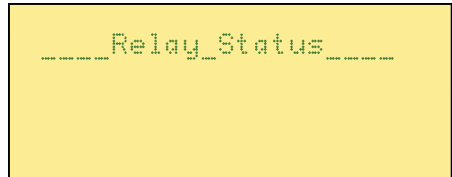
Pressing the ESCAPE key will bring up the main menu display. You can navigate through the available selections using the UP and DOWN keys. The flashing cursor indicates the active line, and pressing ENTER on the active line takes you into that selected menu or function.



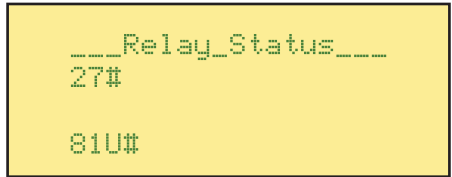
(Note that in this manual, a white character on a black background indicates where the flashing cursor is located).

NOTE: The available selections change, depending on the password control settings. See the password section for more details. With the password feature disabled, the following selections are available(in the order top to bottom of the display

- RELAY STATUS – Indicates the condition of the physical relay contacts. As shipped from the factory, none of the relay functions are defined, so the display should be blank, as shown here.



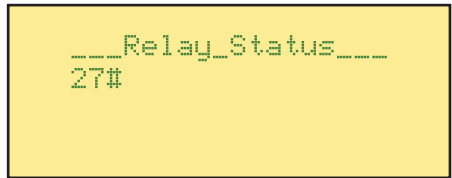
The status screen will indicate an appropriate ANSI caption or text label when a relay is in the tripped condition.



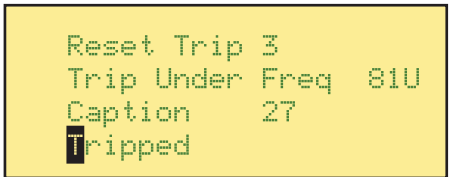
Different symbols are used to identify the trip conditions:

- # The relay is tripped
- * Relay Alarm indication
- + Acknowledged Alarm indication

Different symbols are used to identify the trip conditions. The # symbol indicates that the relay is in the tripped condition, regardless of its energised or de-energised state.



- RESET TRIPS – The Reset Trips feature is used to reset a latched relay contact, if this mode of operation has been configured. Relays can be reset individually. The display shows a list of all relays, what parameter is assigned to the relay, and allows analysis of the trip setting, although no changes can be made to the trip settings.



- **POWER METERING** – Detailed menu to allow the checking of the electrical system measurements. For the Generator inputs, you can inspect the Voltage, current, power, VA, VAR, power factor, phase angle and frequency. The Bus frequency and phase difference can also be inspected.

```

_____POWER_METERING_____
-> GEN READINGS
-> BUS READINGS
-> SYSTEM CONFIG

```

- **EVENT LOG** – If enabled, every time a relay trips, details of the event are stored in the Event History Log. This information can be viewed, but not changed. Allows analysis of previous trips, showing time and date of the event, plus the trip settings.

```

_____EVENT_LOG_____
-> VIEW
-> CLEAR
-> SUMMARY

```

- **CONFIGURATION MENU** - The Configuration Menu is used to set up the function of the relays, trip parameters and any other operational data. This entire menu can be password protected, or some features may not be visible.

```

_____CONFIGURATION_____
-> RELAY STATUS
-> SAVE RELAY SETUP
-> RANGE

```

- **PASSWORD** – Up to four levels of password protection can be set up to prevent unauthorised operation of the product.

```

_____PASSWORD_MENU_____
■ Password      0
-> SET LEVEL 1
-> SET LEVEL 2

```

- **VERSION** – The firmware version can be inspected from this screen.

```

_____Software_Version_____
      UX.XX
      Serial Number
      X.XXXX

```

CONFIGURATION MENU

All aspects of product operation are defined from this configuration menu. Certain commands can be locked by password, and may not be accessible. In some cases, the configuration menu is not even available

Relays

The relay configuration menu forms defined product functionality. Because the product is so flexible, this is best demonstrated in the form of practical examples. Please see the application notes for more details, .

```
___CONFIGURATION___
-> RELAYS
-> SAVE RELAY SETUP
-> RANGE
```

Range

The range menu allows primary PT and CT values to be entered, if required. Press ENTER to edit a value.

Only enter a primary value. Secondary values are fixed in hardware – see product labelling for details.

```
          Range
-----
Sys Volts  120.0 V
Sys Amps   5.000 A
Sys Power  1800.0 W
```

Time and Date

The product contains a real time clock to maintain accurate time and date stamps for the event history log. The clock has battery backup to maintain accuracy whenever the product is powered down.

You may need to alter the time setting to reflect daylight saving, or to suit the time zones in different locations. Press ENTER to start editing the time.

The clock calendar will allow for leap years and the calendar is powered from the auxiliary supply when the SPR is in use. If power is removed, the clock calendar draws its power from an internal lithium battery. The battery has a life of 3 years when in use without the SPR being powered; therefore the actual life of the battery will exceed this figure depending upon the use the SPR receives.

```
___CONFIGURATION___
-> TIME & DATE
-> COMMS
-> DISPLAY
```


To change the date and/or the time, proceed as follows: Press the DOWN key to highlight the Time and Date option. Press ENTER.

The display shown opposite appears. (The time shown here is for illustration only).

The time clock format is 24 hour, and the hour, minutes and seconds can be modified as required. The time will constantly update, thus the figures will always be changing.

Use the UP/DOWN keys to select the parameter to be changed, press ENTER to highlight the parameter value (the cursor will flash the value)

Use the UP/DOWN buttons to change the value; press ENTER to accept or ESC if an incorrect value has been set.

Once all the Time parameters are correct, press ESC to return to the Time and Date menu.

If the date is not to be changed, press ESC to quit this menu.

If the date is to be changed, use the DOWN key to highlight Date and press ENTER. The screen opposite will be displayed. Use the UP/DOWN keys to select the parameter to be changed, press ENTER to highlight the parameter value (the cursor will flash the value) Use the UP/DOWN buttons to change the value; press ENTER to accept or ESC if an incorrect value has been set.

Once all the Date parameters are correct, press ESC 3 times to return to the Main Menu.

Note: The date format can be changed from DD/MM/YY to MM/DD/YY in the DISPLAY menu. Time and date can also be adjusted via RS485 MODBUS comms.

```
___CONFIGURATION___
-> TIME & DATE
-> COMMS
-> DISPLAY
```

```
_____Time_____
Hour          15
Min           5
Sec          29
```

```
___CONFIGURATION___
-> TIME & DATE
-> COMMS
-> DISPLAY
```

```
_____Date_____
Year          2004
Month         03
Day           31
```

System Tag Names

The default system tag names are GEN and BUS, useful for Generator systems. The tag names can be changed to suit the different product applications, and a choice of 16 pre-defined names are available.

Enter the CONFIGURATION menu, and select the DISPLAY SETUP menu.

```
___Display_Setup___  
Date      MM/DD/YY  
LCD Cont  92  
Backlight ON
```

Scroll down to view the default settings for Input1 and Input2

```
___Display_Setup___  
Input1    Gen  
Input2    Bus
```

To edit a tag name, press Enter and the use the Up/Down arrows to scroll through the selection list. The following tag names are available: Gen, Bus, Bus1, Bus2, Main, Gen1, Gen2, Tran, Motr, Brkr, Feed, Aux1, Aux2, Aux3, Aux4, Aux5

```
___Display_Setup___  
Input1    Gen  
Input2    Bus
```

Press ENTER to select the desired name.

Display Timeout Feature

In some applications it is a requirement that there are no lamps on the control panel unless a fault or trip condition exists. The LCD display backlight can be switched off via the DISPLAY SETUP menu, located within the Configuration menu.

```
___Display_Setup___  
█ Date           MM/DD/YY  
LCD Cont        92  
Backlight       ON
```

Scroll down to 'Backlight' and press ENTER.

Use the Up/Down arrows to switch the LCD Backlight On or Off.

Once switched off, the backlight remains off unless a front panel button is pressed, or an alarm condition exists (if feature is enabled) in which case the backlight will flash to attract attention.

```
___Display_Setup___  
█ Backlight      ON  
Input1          Gen  
Input2          Bus
```

For changes to the backlight setting to take effect, wait for the display to revert to the default screen, or power cycle the instrument.

Configuring the User Screen

The default screen can be configured as a user screen, where the four line display can be customised to indicate four measurement values of a possible 37 electrical system measurements. This feature is accessed via the Configuration menu.

```
__User_Screen_Setup__
Line 1      NONE
Line 2      NONE
Line 3      NONE
```

Press Enter on start editing the individual display lines.

```
__User_Screen_Setup__
Line 1      NONE
Line 2      NONE
Line 3      NONE
```

Use the Up/Down keys to scroll through the available parameters, and press Enter to make the selection. The following measurements are available for display:

None, VL1, VL2, VL3, I1, I2, I3, W1, W2, W3, VA1, VA2, VA3, VAr1, VAr2, VAr3, PF1, PF2, PF3, PA1, PA2, PA3, Vavg, Iavg, Isum, Wsum, VAsum, VArsum, PFsum, PAsum, Freq, VL1L2, VL2L3, VL3L1, In, Freq2, Angle, Ig

```
__User_Screen_Setup__
Line 1      Vavg
Line 2      Iavg
Line 3      Wsum
```

Scroll Down to view or edit the settings for Line 4.

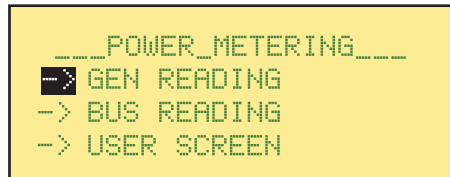
```
__User_Screen_Setup__
Line 4      Freq
```

Viewing the User Screen

Select the Power Metering screen and choose the User Screen option. The customised screen will be displayed until the one-minute timeout restores the default screen again. If a permanent user screen display is required, you can make it the default screen as follows: With the User Screen displayed, press and hold the Up and Down buttons. After 5 seconds, the display will flash to confirm that the default has been changed.

To cancel the user screen and change the default display back to the Relay Status display, either a) re-configure all four parameters to NONE, or b) select the Relay Status screen then press and hold the Up and Down buttons until the display flashes.

If the user screen has been configured, you can select it from the Power Metering menu.



Saving Relay Setup

When changes have been made to any parameter in the configuration menu, the save command must be used to permanently store the new settings.

If changes have not been saved, they will be lost when the product is powered down. Press ENTER to select the Save command. Press ENTER to select the Save command.

```
___CONFIGURATION___
-> SAVE RELAY SETUP
-> RANGE
-> TIME & DATE
```

Press ENTER again, and you will be prompted with SURE?. If you are sure you wish to save the changes, press ENTER again, otherwise, press ESC to cancel the save operation.

```
___Save_Relay_Setup___
Save SURE?
```

Event Log Menu

Every time a relay trips, event details can be recorded in the event log with a time and date stamp. This is useful for analysing the system problems, and because events are recorded to a time resolution of 100ms, the sequence of trip events can be studied. The date and time are maintained by an internal real time clock with battery backup. The product stores details of the last fifty trip events, and if more trips occur, the oldest records are deleted so that new information can be recorded.

IMPORTANT: Event information will be lost if the product is powered down. The event log will also be cleared if the relay configuration has been altered in the configuration menu.

The most recent trip is held in the highest event record. In this example, Relay 1 tripped on March 14, 2004 at 10:22 am, because of an under voltage condition. You can view the trip settings using the UP/DOWN keys, but no changes can be made. To view the other event information, press ENTER to edit the event number, then use the UP/DOWN keys to step through them. If no trip events have taken place since the last power-down, you will find blank records.

```
Event 1
04/03/14 10:22:18.1
Relay 1
Trip Under Volts 27
```

```
Event 9
```

SYSTEM CONFIGURATION AND RELAY STATUS

When the SPR is initially installed, the relay status will display a blank screen since system has not been configured for your application and the relay parameters have not been set up. Relay parameter settings will depend upon your configuration.

System configuration

All aspects of product operation are defined from this configuration menu. Certain commands can be locked by password, and be hidden. In some cases, the configuration menu is not even available. The system configuration parameters consist of

- System Voltage
- System Current (Amps)
- System Type

To check your system configuration, proceed as follows:

Return to the Main Menu by pressing ESC as required.
Use the DOWN key to highlight POWER METERING and press ENTER.

```
-----MAIN_MENU-----
-> POWER METERING
-> EVENT LOG
-> CONFIGURATION
```

Use the DOWN button to highlight SYSTEM CONFIG and press ENTER. The system configuration display will appear on the screen

```
___POWER_METERING___
-> SYSTEM CONFIG
```

The Primary System Voltage and Primary System Current (Amps) can be set to suit your usage; System Power is calculated according to these values.
The System Type is factory pre-set to 3-phase 3 wire or 4 wire, and can not be changed.

```
___System_Config___
Sys Volts      120.0 V
Sys Amps       5.000 A
Sys Power      1800.0 W
```

Default settings are the factory build voltage and current for the product. If connections are via P.T. or C.T. then you will need to change the system settings. Proceed as follows:

Return to the Main Menu by pressing ESC as required.

Use the DOWN key to highlight CONFIGURATION and press ENTER.

Use the DOWN key to highlight RANGE and press ENTER.

The range display will appear on the screen

Position the first parameter under the flashing cursor using the UP/DOWN keys. Press ENTER to select the parameter value and amend the value using the UP/DOWN keys.

Press ENTER if the value is correct, or ESC if an error has been made, and change the other parameter if necessary.

```
-----Range-----
Sys Volts  120.0 V
Sys Amps   5.000 A
Sys Type   1800.0 W
```

Range changes take effect as they are entered and do not need to be saved explicitly.

```
___CONFIGURATION___
-> SAVE RELAY SETUP
-> RANGE
-> TIME & DATE
```

Press ESC to return to the main menu.

Bus Readings

If connected, check that the frequency is correct.

```
___Save_Relay_Setup___
Save SURE?
```


Relay status

When the SPR is initially installed, the trip function (parameter to be monitored) of each relay has not been set, and the display will be blank. The number of, and the setting for each, relays is dependent upon your requirement, up to a maximum of 12 relays.

Each relay can be set to monitor any one of 27 protective (electrical and logical) trip functions; these are listed in Table 1. (The ANSI Number refers to the American National Standards Institute listing).

Table 1 Relay Protective Trip Functions

ANSI Type No	Menu Description	Description
	Unused	The relay is disabled
59	Over Volts	Over Voltage Relay
27	Under Volts	Under Voltage Relay
81O	Over Freq	Over Frequency Relay
81U	Under Freq	Under Frequency Relay
50	Over Amps	Instantaneous Over Current Relay
37	Under Amps	Instantaneous Under Current Relay
50N	Over Amps	Instantaneous Over Neutral Current Relay
32R	Reverse Pwr	Reverse Power Relay
32O	Over Power	Forward Power Relay
40Q	Reverse VAr	Reverse VAr Relay
47	UnBal Volts	Unbalanced Voltage Relay
46	UnBal Amps	Unbalanced Current Relay
51V	I/T+V.R.	Time Over Current with Voltage Restraint Relay
51	I/T	Time Over Current Relay
51G	Gnd Fault	Neutral Ground Fault Relay
25	Sync	Synchronism Check Relay
25D	Sync+DB	Synchronism Check with Dead Bus Relay
47	Phase Order	Phase Sequence Relay
	Logical AND	Will trip if all 3 inputs are tripped
	Logical OR	Will trip if any input is tripped
	Logical NAND	Will trip unless all 3 inputs are tripped
	Logical NOR	Will trip if any input is not tripped
	Logical XOR	Will trip if the 3 inputs are not in the same state
	Logical Vote	Will trip if at least 2 inputs are tripped
	Logical Disc	Will trip if there is a discrepancy between inputs
	Alarm	Will trip if an alarm situation exists
	Unack Alarm	Will trip if an alarm has not been acknowledged

Note: Although the number of physical relays will be 8 or 12, the SPR will allow you to set up to 16. These 'virtual' relays operate normally, although there is no physical relay contact. These can typically be used for marshalling purposes.

RELAY PROTECTIVE TRIP FUNCTIONS

General

This section gives details on the setting of Relays in general, followed by some application examples.

At the initial Screen, scroll down to CONFIGURATION. Press ENTER to bring up the menu shown opposite.

```
----- CONFIGURATION -----  
-> RELAYS  
-> SAVE RELAY SETUP  
-> RANGE
```

Press ENTER to bring up the Relay parameters, opposite. (The parameters shown are for example only).

```
Relay 1  
Trip Over Volts      59  
Latched              N  
Alarm                N
```

To change the Relay number, press Enter and the cursor will move to the number. Use the UP/DOWN keys to scroll to the required Relay number.

```
Relay 1
```

Press ENTER to accept or ESC to reject. Use the DOWN key to select TRIP and press ENTER to highlight the parameter ANSI number or function (cursor moves to the right). Use the UP/DOWN keys to scroll to the required function; press ENTER to accept or ESC to reject.

```
Relay 1  
Trip Over Volts 59
```

Each trip function has its own set of parameters. Use the UP/DOWN keys scroll down and review or change the parameter settings as required.

Some parameters have YES / NO choices, while others require numerical input.

When all settings are correct, press ESC once to return to CONFIG or twice to return to the Main Menu.

RELAY SETTING EXAMPLES

To show how to configure the system and the relays, some examples are included here.

Setting up a relay contact

This example will demonstrate how to configure one relay contact inside the SPR to perform an over-voltage function. You will be setting Relay 1 to operate as Over Voltage, tripping at 120 Volts.

Switch on the auxiliary supply. The start-up screen (opposite) will be displayed for 5 seconds.

The display then defaults to the Relay Status Display, shown opposite.

Note: When no front panel switches have been pressed for 60 seconds, the display will revert to the Relay Status display.

If no Relay functions have been set, this display may be blank.

If necessary, set up the unit contrast (see **LCD contrast control**).

Press the ESC key to bring up the Main Menu.

```
___Software_Version___  
    UX.XX  
Serial Number  
    X.XXXX
```

```
___Relay_Status___
```

```
_____MAIN_MENU_____  
-> RELAY STATUS  
-> RESET TRIPS  
-> POWER METERING
```

Using the DOWN key, scroll until CONFIGURATION is under the cursor.

```
_____MAIN_MENU_____  
-> CONFIGURATION  
-> PASSWORD  
-> VERSION
```

Press ENTER and the configuration screen will be displayed.

```
___CONFIGURATION___  
-> RELAYS  
-> SAVE RELAY SETUP  
-> RANGE
```

Press ENTER to bring up the Relay set-up screen.

```
Relay 1
Trip Unused
Caption      Unus
Logged      N
```

If Relay 1 is not displayed, press ENTER to move the cursor to select the relay number; the relay selected can be changed using the UP/DOWN keys. When 1 is displayed, press ENTER to accept.

```
Relay 1
Trip Unused
Caption      Unus
Logged      N
```

The function required for this example is under voltage (UNDER VOLTS). Move the cursor onto the Trip line and press ENTER. Use the UP/DOWN keys to select the UNDER VOLTS function. (The ANSI number will also be displayed in this example, see Table 5).

```
Relay 1
Trip Under Volts 27
Caption      27
Logged      N
```

When the correct function is displayed, press ENTER.

```
Relay 1
Trip Under Volts 27
Caption      27
Logged      N
```

CAPTION SETTING FOR RELAY CONFIGURATION

By default, the caption is the ANSI number or logical name for the selected relay function. If a different caption is required, you can edit the displayed caption name to any 4-character combination to suit the application.

```
Relay 1
Trip Under Volts 27
Caption      27
Logged      N
```

Scroll down to the 'caption' line

```
Relay 1
Caption      27
Logged      N
Latched     N
```

Press 'Enter' and the cursor will move across to the caption text field

```
Relay 1
Caption      27
Logged      N
Latched     N
```

Use the Up/Down arrow keys to change the highlighted character. Permissible characters are alphabetic, numeric or symbol are:

```
{|} !"#%&'()*+,-./:;<=>?@[]^_
```

```
0123456789
```

```
ABCDEFGHIJKLMNPOQRSTUVWXYZ
```

```
abcdefghijklmnopqrstuvwxyz
```

```
Relay 1
Caption      UU
Logged      N
Latched     N
```

Press 'Enter' to select the next character

Continue to edit the remaining characters, until all four digits have been entered.

Logged

SPR can record the time date of trip events. The configuration setting for each relay allows the 'Logged' selection to be set to Y (yes) or N (no). If Logging is enabled, then every trip event for that relay will be recorded in the log. Press 'Enter' to select the Logged function, then use the Up/Down keys to change between Y and N.

Relay 1	
Logged	N
Latched	N
Alarm	N

Latched

The relay-latching feature can be switched on or off as required. When enabled, and a trip condition is detected, the relay will change state and stay in this condition until it is specifically reset. This is typically used to lock out further operation of equipment after a fault has been detected. Note that setting the Latched operation may be undesirable for some trip functions. Press 'Enter' to select the Latched function, then use the Up/Down keys to change between Y and N.

Relay 1	
Latched	N
Alarm	N
Failsafe	Y

Alarm

The alarm function, when enabled, will cause the LCD display to flash (to attract attention) when the relay trips. Even if the relay is reset (when the trip condition goes away) the display will continue to flash. The alarm must be acknowledged by pressing a key. Press 'Enter' to select the Alarm function, then use the Up/Down keys to change between Y and N. This topic is covered in more detail within the examples section.

Relay 1	
Alarm	N
Failsafe	N
TripPoint	100.0 U

Fail Safe

The default relay operation is failsafe, meaning the relay contact is energised in the 'normal' condition and de-energised in the 'tripped' condition. Setting Failsafe to 'N' will change the default relay state to de-energised, so the relay will energize on trip. Press 'Enter' to select the Failsafe function, then use the Up/Down keys to change between Y and N.

```
Relay 1
Failsafe      Y
TripPoint     100.0 V
Diff          3.0 V
```

Select TripPoint and press ENTER. The value displayed is in real units – in this case, AC Volts. Use the up/ down keys to adjust the trip voltage to 100. When finished, press ENTER.

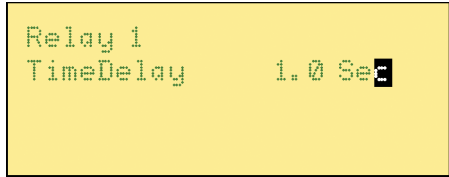
```
Relay 1
TripPoint     100.0 V
Diff          5.0 V
TimeDelay     0.0 Sec
```

DIFF means differential or hysteresis. This is used to give stability to the relay, and to stop it from nuisance tripping. When the measured signal level is very close to the trip point, electrical noise and spikes can lead to spurious energize/de-energize relay operations when the level momentarily exceeds the trip point, then returns to its normal level. The DIFF setting increases the threshold between trip and reset points to add stability to noisy systems. The parameter is a real unit – in this case, AC volts. Set the value to 3 volts.

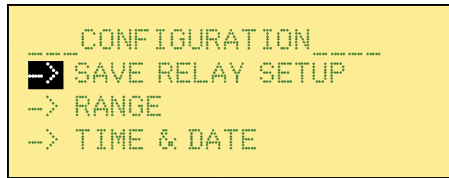
```
Relay 1
Diff          3.0 V
TimeDelay     0.0 Sec
```

Note: Too little hysteresis may lead to nuisance tripping, whilst too much hysteresis may mean the relay will not drop back in after a trip. Hysteresis settings can cause problems if set unnecessarily high. The default setting is 1% of the nominal range, but this can be increased as required for 'noisy' signals.

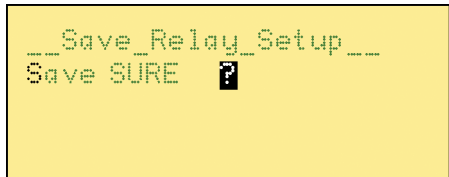
Finally, the time delay can be set. The number is adjustable between 0 and 30 seconds in steps of 0.1 second. Use the arrow keys to change the value, and press ENTER to accept. Set the value to 1 second. The time delay is a qualification period for a trip condition. The trip condition must exist for the entire duration of the delay before the relay will change state.



Now the relay setup is complete. Press ESC once to quit the relay setup menu and return to the Configuration menu.



To save the configuration changes for future use, scroll down the Configuration menu and select the SAVE RELAY SETTINGS option and press ENTER. The settings will be stored in non-volatile memory, and will be automatically recalled every time the product is switched on.



Press ESC three (3) times to return to the Main Menu.

Press ENTER to view the Relay Status Display.



Summary of the new relay settings

You should now have set the product as follows:

Relay 1

Trip Under Volts	27
Caption	27
Logged	N
Latched	N
Alarm	N
Failsafe	Y
TripPoint	100.0 V
Diff	3.0 V
TimeDelay	1.0 Sec

Testing Relay 1

Now you are ready to test the relay contact function. This example assumes a nominal 120V product.

With no measuring signal input, the relay should be tripped (no Voltage). Confirm that Relay 1 contact is de-energised.

Apply a three-phase, variable, AC voltage source to the input, initially set to 120V. Now decrease the voltage slowly. Confirm Relay 1 contact is energised.

Note that the SPR is checking each phase for a voltage less than 100 V.

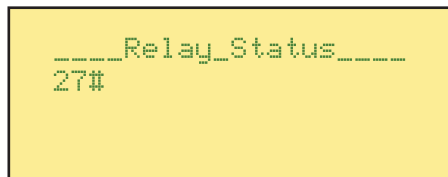
Once the voltage falls below 100 V, the relay will trip, and the status display will indicate as shown opposite.

The # symbol indicates that Relay 1 has tripped (and is still tripped).

Confirm that Relay 1 contact is now de-energised.

Now increase the voltage until the # sign disappears. This should be a level of 103 V (which is the trip setting of 100 V plus the differential of 3 V)

The relay will change state, back to energised.



Setting up an Alarm

This example will demonstrate how to configure relay contacts inside the SPR to cause an alarm condition when a trip is detected. You will be setting Relay 1 to operate as Over Voltage, tripping at 120 V (this follows on from the previous example, Setting up a relay contact).

Start from the Relay Status Display shown.

```
____Relay_Status____
```

Press the ESC button to bring up the Main Menu. A flashing cursor will appear on the active line.

```
____MAIN_MENU____  
-> RELAY STATUS  
-> RESET TRIPS  
-> POWER METERING
```

Using the DOWN key, scroll until CONFIGURATION is under the cursor.

```
____MAIN_MENU____  
-> CONFIGURATION  
-> PASSWORD  
-> VERSION
```

Press ENTER and the configuration screen will be displayed.

```
____CONFIGURATION____  
-> RELAYS  
-> SAVE RELAY SETTINGS  
-> RANGE
```

Press ENTER to bring up the relay setup screen.

```
Relay 1  
Trip Over Volts 59  
Caption 59  
Logged N
```

If Relay 1 is not displayed (it could default to another relay), press ENTER to move the cursor to select the relay number; the relay selected can be changed using the UP/DOWN keys. When 1 is displayed, press ENTER to accept.

Then change the trip function to **Over Volts**.

Using the UP/DOWN keys, scroll down until Alarm is under the cursor, then press ENTER. Change the function to Y (Yes) using the UP key. Then change the trip point to 120V. Change the Diff setting to 3.0V and delay to 1.0 seconds.

Now the relay setup is complete. Press ESC once to quit the relay setup menu and return to the Configuration menu.

To save the configuration changes, scroll down the Configuration menu and select the SAVE option and press ENTER. The settings will be stored in non-volatile memory, and will be automatically recalled every time the product is switched on.

Press ESC three (3) times to return to the Main Menu.

Press ENTER to view the Relay Status Display.

```
Relay 1
Trip Over Volts      59
Caption              59
Logged               N
```

```
Relay 1
Alarm                Y
Failsafe             4
TripPoint 120.00V
```

```
___CONFIGURATION___
-> RELAYS
-> SAVE RELAY SETTINGS
-> RANGE
```

```
__Save_Relay_Setup__
Save SURE?
```

```
___Relay_Status___
```

Summary of the new relay settings

You should now have set the product as follows:

Relay 1

Trip Over Volts	59
Caption	59
Logged	N
Latched	N
Alarm	Y
Failsafe	Y
TripPoint	120.0
Diff	3.0 V
TimeDelay	1.0 Sec

Testing Relay 1

Now you are ready to test the relay Alarm function.

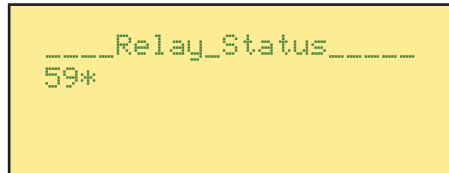
With no measuring signal input, the relay should not be tripped. Confirm that Relay 1 contact is energised (Failsafe)

Apply a variable AC voltage source to the input, and slowly increase the voltage.

Note that the SPR is checking each phase for a voltage greater than 120 V.

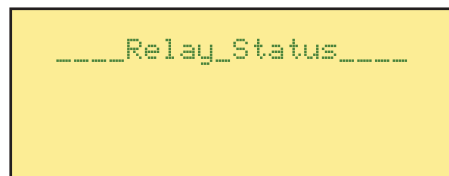
Once the voltage exceeds 120 V, the relay will trip, and, because the alarm function is enabled on Relay 1, the LCD backlight will flash on and off to attract attention.

The * symbol indicates that Relay 1 caused the alarm condition.

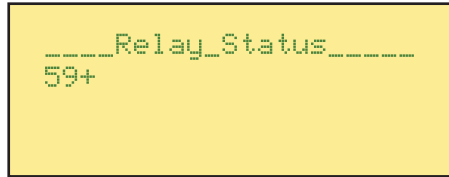


Now decrease the voltage below 117 V.

The relay contacts will reset, but the display will continue to flash. You must acknowledge the alarm to stop the display flashing, by pressing the Enter button.



Increase the voltage source again until the relay trips. The display will start to flash. Now press Enter to acknowledge the alarm. The display indicates that you have acknowledged the condition, but continues to flash slowly to indicate the relay is still in the tripped condition. The + symbol also indicates this.



Now decrease the voltage below 117 V. The relay contacts will reset, the status display will clear, and the display will stop flashing.

Note on Alarms: You can set up a relay contact to trip if any relay has caused an alarm condition. This can be used as a common alarm signal, or used to control an external sounder (horn) etc. Additionally, a relay can be configured to trip only if the alarm has not been acknowledged.

Latching a Relay

This example demonstrates Relay 1 latching when a trip is detected. Relay 1 is configured to Over Voltage, tripping at 120 V (from the examples Setting up a relay contact and Setting up an Alarm).

Start from the Relay Status display shown.

```
____Relay_Status____
```

Press the ESC button to bring up the Main Menu, a flashing cursor will appear on the active line.

```
____MAIN_MENU____  
-> RELAY STATUS  
-> RESET TRIPS  
-> POWER METERING
```

Using the DOWN key, scroll until CONFIGURATION is under the cursor.

```
____MAIN_MENU____  
-> CONFIGURATION  
-> PASSWORD  
-> VERSION
```

Press ENTER and the configuration screen will be displayed.

```
____CONFIGURATION____  
-> RELAYS  
-> SAVE RELAY SETTINGS  
-> RANGE
```

Press ENTER to bring up the relay setup screen.

```
Relay 1
Trip Under Volts 59
Caption          59
Logged           N
```

If Relay 1 is not displayed, press ENTER to move the cursor to select the relay number; the relay selected can be changed using the UP/DOWN keys. When 1 is displayed, press ENTER to accept.

```
Relay 1
Trip Under Volts 59
Caption          59
Logged           N
```

Using the UP/DOWN buttons, scroll down until Latch is under the cursor, then press ENTER. Change the function to Y (Yes) using the UP button.

```
Relay 1
Latched         Y
Alarm           Y
Failsafe        Y
```

Switch the Alarm function off.

```
Relay 1
Alarm           Y
Failsafe        Y
TripPoint 120.0 V
```

Now the relay setup is complete. Press ESC once to quit the relay setup menu and return to the Configuration menu.

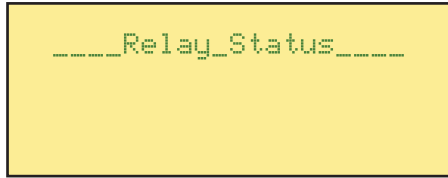
```
___CONFIGURATION___
-> SAVE RELAY SETUP
-> RANGE
-> TIME & DATE
```

To save the configuration changes for future use, scroll down the Configuration menu and select the SAVE option and press ENTER. The settings will be stored in non-volatile memory, and will be automatically recalled every time the product is switched on.

```
___Save_Relay_Setup___
Save SURE?
```

Press ESC three (3) times to return to the Main Menu.

Press ENTER to view the Relay Status Display.



Summary of the new relay settings

You should now have set the product as follows:

Relay 1

Trip Over Volts	59
Caption	59
Latched	Y
Alarm	N
Failsafe	Y
TripPoint	120.0
Diff	3.0 V
TimeDelay	1.0 Sec

Testing Relay 1 Latch function

Now you are ready to test the relay Latch function.

With no measuring signal input, the relay should not be tripped. Confirm that Relay 1 contact is energised (because we set Fail Safe to Y).

Apply a variable AC voltage source to the input, and slowly increase the voltage.

Note that the SPR is checking each phase for a voltage greater than 120 V.

Once the voltage exceeds 120 V, the relay will trip, and the relay status display will indicate as shown.

The # symbol indicates that Relay 1 has tripped (and is still tripped).

Confirm that Relay 1 contact is now de-energised.

Now decrease the voltage below 117 V. The # remains on the display, and the contacts stay de-energised. The relay has latched and must be manually reset.

Press the ESC button to bring up the main menu.

```
___Relay_Status___  
59#
```

```
___MAIN_MENU___  
-> RELAY STATUS  
-> RESET TRIPS  
-> POWER METERING
```

Select the RESET TRIPS option and press ENTER.

```
___MAIN_MENU___  
-> RESET TRIPS  
-> POWER METERING  
-> EVENT LOG
```

Line 1 shows allows you to select the appropriate relay. Press ENTER and use the up/down arrow keys to select a different relay, and press ENTER to select it.

The second line of the display shows the function assigned to each relay. This is for information only, and cannot be changed. Line 4 indicates that the relay is tripped.

Press the DOWN key to place the cursor over Tripped.

```
Reset Trip 1
* Trip Over Volts      59
Caption              59
Tripped              Y
```

```
Reset Trip 1
* Tripped              Y
Alarm                 N
TripPoint 120.0 V
```

Press ENTER, edit the trip flag to N (NO) using the DOWN key, then press ENTER to accept the change.

```
Reset Trip 1
Tripped              N
Alarm                 N
TripPoint 120.0 V
```

The relay is now reset.

Confirm that Relay 1 contact is now energised

Exit the Reset Menu by pressing ESC, and go back into the Relay Status screen.

The asterisk has disappeared.

Note:

If the trip condition still exists, the latched relay cannot be reset.

```
____Relay_Status____
```

Event Log

SPR can record the time date of trip events. The configuration setting for each relay allows the 'Logged' selection to be set to yes or no. If Logging is enabled, then every trip event will be recorded.

Edit relay 1 settings as follows, changing Logged to Y and Latched to N.

Relay 1	
Trip Over Volts	59
Caption	59
Logged	Y
Latched	N
Alarm	N
Failsafe	Y
TripPoint	120.0 V
Diff	3.0 V
TimeDelay	1.0 Sec

Apply a variable AC voltage source to the input, and increase the voltage until the relay trips. The status display will indicate 59# as normal. Now reduce the voltage until the relay resets. Wait several seconds, then increase the voltage to cause another trip. This exercise should have made two entries into the event log.

The event log can be accessed from the main menu

```

      _MAIN_MENU_
-----
-> RELAY SETTINGS
-> RESET TRIPS
-> POWER METERING

```

Scroll down until the cursor highlights the event log entry.

```

      _MAIN_MENU_
-----
-> EVENT LOGS
-> CONFIGURATION
-> PASSWORD

```

Press ENTER to access the sub-menu. There are three entries. Select 'VIEW.'

```

      _EVENT_LOG_
-----
-> VIEW
-> CLEAR
-> SUMMARY

```

The event log contains data for up to 50 trip events, stored in time order, oldest first. The event record indicates the date and time of the trip, the relay number, and the trip function type. You can scroll down to review the relay settings.

```
Event 1
05/17/04 12:35:26.9
Relay 1
Trip Over Volts 59
```

To view other events, select the event number and use the Up/Down arrows to scroll through the event log entries.

```
Event 2
05/17/04 12:37:12.2
Relay 1
Trip Over Volts 59
```

Press ESCAPE to quit the VIEW menu. Select SUMMARY and press ENTER. The event log summary is displayed. Use the Up/Down arrows to scroll through the summary information for each log entry.

```
_Event_Log_Summary_
1 Over Volts 59
2 Over Volts 59
3 Under Freq 81U
```

To clear the event log, select the CLEAR menu and press ENTER.

```
__EVENT_LOG__
-> CLEAR
-> SUMMARY
```

The confirmation screen prevents accidental deletion of the log. Press ENTER to confirm the clear operation, or press ESCAPE to quit.

```
__Clear_Event_Log__
Clear SURE?
```

Note: The event log data is stored only whilst the auxiliary supply is present.

Note: The event log stores the most recent 50 trip events. If more than 50 events are logged, the older entries are deleted.

Logical operators

This example demonstrates how the logical operators can be used. You will be setting up Relay 2 to trip at the same time as Relay 1 trips, effectively making a double-pole relay. Relay 1 is configured to Over Voltage, tripping at 120 Volts.

Start from the Relay Status screen.

```
____Relay_Status____
```

Press ESC to bring up the Main Menu A flashing cursor will appear on the active line.

```
____MAIN_MENU____
-> RELAY STATUS
-> RESET TRIPS
-> POWER METERING
```

Using the DOWN key, scroll until CONFIGURATION is under the cursor.

```
____MAIN_MENU____
-> CONFIGURATION
-> PASSWORD
-> VERSION
```

Press ENTER and the configuration screen will be displayed.

```
____CONFIGURATION____
-> RELAYS
-> SAVE RELAY SETUP
-> RANGE
```

Press ENTER again to bring up the relay setup screen.

```
Relay 1
Trip Over Volts 59
Caption          59
Logged           N
```

If Relay 2 is not displayed, press ENTER to move the cursor to select the relay number; the relay selected can be changed using the UP/DOWN buttons. When 2 is displayed, press ENTER to accept.

```
Relay 2
Trip Unused
Caption Unused
Logged N
```

The function we require for Relay 2 in this example is Logical OR. Move the cursor onto the Trip line and press ENTER.

```
Relay 2
Trip Unused
Caption Unused
Logged N
```

Press the UP/DOWN KEY until LOGICAL OR appears, then press ENTER to accept it. Latch, Alarm and Inverted functions work in the same way as other relays. You now need to specify the input data for the logical operation. The input data will be the status of other relays in the system. Scroll the menu down to Input 1. Press ENTER to select Input 1, and you can now enter the relay number which will control the function. In this example, the data will be the status of relay 1 (Over Volts function).

```
Relay 2
Trip Logical OR
Caption OR
Logged N
```

```
Relay 2
Input 1 0
Input 2 0
Input 3 0
```

Use the UP KEY to set the value to 1, then press ENTER.

```
Relay 2
Input 1 1
Input 2 0
Input 3 0
```

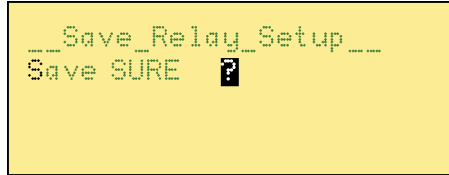
Now the relay setup is complete.

Press ESC to quit the Relay Setup menu and return to the Configuration menu.

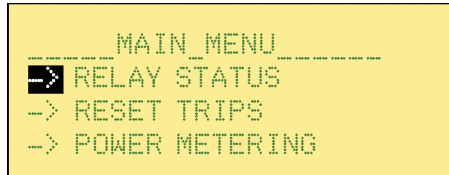
To save the configuration changes, scroll down the Configuration menu and select the SAVE option and press ENTER

```
_____CONFIGURATION_____
-> RELAYS
-> SAVE RELAY SETUP
-> RANGE
```

To save the configuration changes, scroll down the Configuration menu, select the SAVE option and press ENTER. The settings will be stored in non-volatile memory, and will be automatically recalled every time the product is switched on.



Press ESC three (3) times to return to the Main Menu.
Press ENTER to view the Relay Status Display.



Summary of the new relay settings

You should now have set the product as follows:

Relay 2

Trip Logical OR

Caption	OR
Logged	N
Latched	N
Alarm	N
Failsafe	Y
Input 1	1
Input 0	0
Input 0	0
Delay On	0.0 sec
Delay Off	0.0 sec

Testing the function of Relay 2

Now you are ready to test the OR function for Relay 2, using Relay 1 which is configured to monitor Over Voltage.

With no measuring signal input, the relay should not be tripped.

Apply a variable AC voltage source to the input, and slowly increase the voltage. Once the voltage exceeds 120 V, Relay 1 will trip. Because of the OR function, Relay 2 should trip at the same time.

The Relay Status display will be as shown opposite.

The # symbol indicates that Relays 1 and 2 have tripped.

```
___Relay_Status___  
59#  
OR#
```

Now decrease the voltage below 118 V. Both gate symbols now disappear. Using the OR function has created a double-pole relay – the most simple application of logical operators. There are other logical operators and, since the function has three inputs, this is a very powerful feature.

```
_____Relay_Status_____
```

Other operators (3 input) are:

- | | |
|------|--|
| AND | Will only trip if ALL input relays are tripped. |
| NAND | Will NOT trip if one or two input relays are tripped.
Conversely, WILL trip if ALL input relays are NOT tripped. |
| OR | Will trip if ANY of the input relays are tripped. |
| NOR | Will NOT trip if any of the input relays are tripped. |
| XOR | Will only trip if the input relays are DIFFERENT from each other. |
| VOTE | Will trip if the majority of the inputs relays are tripped. |
| DISC | Will trip if there is a discrepancy among the inputs relays. |

Time Over current Relay

The SPR offers good accuracy of setting and high repeatability when compared to rotating disc type electromechanical relays. This relay can be used for selective short circuit protection and overload protection. Better accuracy means that fault grading intervals are reduced, improving the response speed of a co-ordinated protection system.

The time over current functions have an IDMT (Inverse Definite Minimum Time) response, which means that the relay operating time tends towards a minimum value with increasing values of current.

Example of Relay setting:

Nominal System Current = 200 Amps

The Measuring or Protection CT Ratio = 250:5 Amps

Maximum System Fault Current = 1000 Amps

Fault Current into the SPR = $1000 \times \frac{5}{250} = 20\text{A}$

Current multiple = $\frac{1000 \text{ A}}{200 \text{ A}} = 5\text{x}$

The tripping time, in this example, needs to be 2.4 seconds for proper system fault co-ordination, based on the standard inverse time curve.

Using the graph (see Fig 4, page 59), cross reference the desired time of 2.4 seconds (the Y-axis) against the current multiple of 5x (the X-axis). The time dial setting needs to be approximately 5. An exact setting can be calculated using the formulae given in the Time Over Current Characteristics, in the Protective Function Detail section. The formulae has been transposed to give the time dial setting:

$$\frac{(\text{time} - k3) \times (\text{Multiple}^{k2} - 1)}{k1} = \text{Time Dial Setting}$$

For standard inverse curve, $k1 = 0.01414$, $k2 = 0.02$, $k3 = 0.1$

$$\frac{(2.4 \text{ seconds} - 0.1) \times (5^{0.02} - 1)}{0.01414} = 5.3 \text{ Time Dial Setting}$$

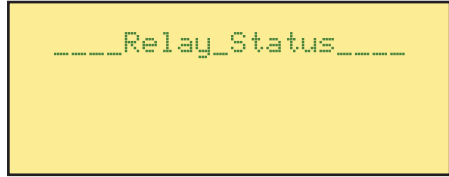
Having calculated the settings, now configure Relay 3 to be a time over current relay, with the parameters set as follows:

Relay 3

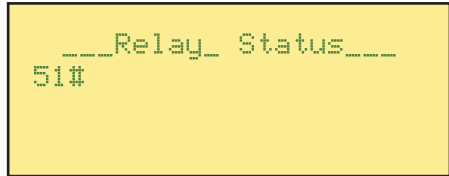
Trip I/T	51
Caption	51
Logged	N
Latched	N
Alarm	N
Failsafe	Y
TripPoint	200A (assuming that CT ratio has been set, otherwise 4A)
TimeCurve	1
TimeDial	5.3 Sec

Testing the function of Relay 3

With no measuring signal input, relay 3 should not be tripped.



Connect a 20 Amp AC constant current source through any phase. Switch on the current, and start a timer. After 2.4 seconds, the relay will trip, and the 51# symbol will appear in the relay status display.



If the current source is not constant, the trip time will be continuously re-calculated by SPR, and will vary in proportion to that current. If precision timing equipment is not available, try injecting a smaller overload, for example 8 Amps (which is 2x the setpoint) When the time dial setting is set to approximately 10 seconds, the trip time will be ten seconds. (calculation gives ideal time dial setting of 9.8 for a 10 second trip time)

PROTECTIVE FUNCTION DETAIL

The Relay Protective Trip Functions are detailed in Table 1 (shown again here for convenience).

Table 1 Relay Protective Trip Functions

ANSI Type No	Menu Description	Description
	Unused	The relay is disabled
59	Over Volts	Over Voltage Relay
27	Under Volts	Under Voltage Relay
81O	Over Freq	Over Frequency Relay
81U	Under Freq	Under Frequency Relay
50	Over Amps	Instantaneous Over Current Relay
37	Under Amps	Instantaneous Under Current Relay
50N	Over Amps	Instantaneous Over Neutral Current Relay
32R	Reverse Pwr	Reverse Power Relay
32O	Over Power	Forward Power Relay
40Q	Reverse VAr	Reverse VAr Relay
47	UnBal Volts	Unbalanced Voltage Relay
46	UnBal Amps	Unbalanced Current Relay
51V	I/T+V.R.	Time Over Current with Voltage Restraint Relay
51	I/T	Time Over Current Relay
51G	Gnd Fault	Neutral Ground Fault Relay
25	Sync	Synchronism Check Relay
25D	Sync+DB	Synchronism Check with Dead Bus Relay
47	Phase Order	Phase Sequence Relay
	Logical AND	Will trip if all 3 inputs are tripped
	Logical OR	Will trip if any input is tripped
	Logical NAND	Will trip unless all 3 inputs are tripped
	Logical NOR	Will trip if any input is not tripped
	Logical XOR	Will trip if the 3 inputs are not in the same state
	Logical Vote	Will trip if at least 2 inputs are tripped
	Logical Disc	Will trip if there is a discrepancy between inputs
	Alarm	Will trip if an alarm situation exists
	Unack Alarm	Will trip if an alarm has not been acknowledged

Accuracy levels and resolution of trip settings are detailed in ACCURACY AND RESOLUTION (located in the product specification section) unless otherwise stated.

TYPE 25 — SYNCHRONISING/SYNCHRONISM-CHECK

This function operates as a permissive relay, where the 'not tripped' condition indicates that the two systems are within the permitted limits to allow synchronism. A 'tripped' condition indicates that the systems are not within the allowable limits, and synchronism is not possible.

The status display will indicate 25# (relay is tripped) when the relay is not in synchronism. The display indication will disappear when synchronism is achieved.

When failsafe is set to 'yes', the relay contacts will energize when the GEN and BUS circuits are in synchronism. An out-of-sync condition, or loss of auxiliary supply, will de-energize the relay contacts.

Brief details

The permissive relay operates when the "Bus" and "Generator" signals are within the selected limits of frequency, phase angle, voltage and the phase sequence of the "Generator" voltage inputs are correct for the duration of the selected delay to permit or to cause the paralleling of two circuits. The relay will return to the "tripped" condition when any one of the conditions detailed above become invalid. The time delay is used on the transition to the "not tripped" condition.

Parameters

You must specify the following parameters for operation of the synchronising relay:

- The maximum permitted phase angle between the "Bus" input voltage and the reference "Generator" voltage (V1, VA, or V1-2),
- The maximum permitted voltage difference between the "Bus" input voltage and the reference "generator" voltage,
- The maximum permitted frequency difference between the "Bus" and "Generator" (slip frequency)
- The qualifying time for which these conditions must be true
- The minimum voltage level below when function is disabled.

Parameter details

Range of Phase Difference (PhAngle)	2 — 20 degrees
Range of Voltage Difference (VDelta)	0 — 20% of nominal input voltage
Range of minimum Voltage level (Vmin)	5- 119% of nominal input voltage
Range of Time Delay (TimeDelay)	0 to 5 seconds
Range of slip frequency (SlipFreq)	0.1 — 1 Hz
Voltage Accuracy	± 2% of nominal input voltage
Resolution of slip frequency	0.1 Hz
Frequency Accuracy	± 0.1 Hz

There is a relationship between the phase angle and the slip frequency settings. When one parameter is adjusted, the setting range of the other may be automatically adjusted to prevent a condition where the relay may never close.



CAUTION: This trip relay can be configured to Latch. This feature may be undesirable, if enabled in error.

TYPE 25D — SYNCHRONISING/SYNCHRONISM-CHECK WITH DEAD BUS

This function operates as a permissive relay, where the 'not tripped' condition indicates that the two systems are within the permitted limits to allow synchronism. A 'tripped' condition indicates that the systems are not within the allowable limits, and synchronism is not possible.

The status display will indicate 25D# (relay is tripped) when the relay is not in synchronism. The display indication will disappear when synchronism is achieved, or when the BUS voltage is below the 'Deadbus' setting.

When failsafe is set to 'yes', the relay contacts will energize when the GEN and BUS circuits are in synchronism. An out-of-sync condition, or loss of auxiliary supply, will de-energize the relay contacts.

Brief details

The relay either:

- (a) operates when the "Bus" and "Generator" signals are within the selected limits of frequency, phase angle, voltage and the phase sequence of the "Generator" voltage inputs is correct for the duration of the selected delay

or:

- (b) the voltage on the "Bus" voltage input is below the selected limit and the phase sequence of the "Generator" voltage inputs is correct for the duration of the selected delay to permit or to cause the paralleling of two circuits. The relay will return to the "tripped" condition when any one of the conditions detailed above become invalid. The time delay is used on the transition to the "not tripped" condition.

Parameters

You must specify the following parameters for operation of the synchronising relay:

- The maximum permitted phase angle between the "Bus" input voltage and the reference "Generator" voltage (V1, VA, or V1-2),
- The maximum permitted voltage difference between the "Bus" input voltage and the reference "generator" voltage,
- The maximum permitted frequency difference between the "Bus" and "Generator" (slip frequency)
- The maximum voltage that may be present on the "Bus" voltage input before the phase, frequency and voltage difference conditions are required to qualify the trip condition (for levels below this voltage the relay will operate providing that the phase sequence of the "Generator" voltage inputs is correct).
- The time for which these conditions must be true
- The minimum voltage level, below which they function.

Parameter details

Range of Phase Difference (PhAngle)	2 — 20 degrees
Range of Voltage Difference (VDelta)	0 — 20% of nominal input voltage
Minimum Voltage Level (Vmin)	5-119% of nominal input voltage
Range of Bus Voltage Trip point	5 — 50% of nominal input
Range of Time Delay (TimeDelay)	0 to 5 seconds
Range of slip frequency (SlipFreq)	0.1 — 1 Hz
Voltage Accuracy	± 2% of nominal input voltage

There is a relationship between the phase angle and the slip frequency settings. When one parameter is adjusted, the setting range of the other may be automatically adjusted to prevent a condition where the relay may never close.



CAUTION: This trip relay can be configured to Latch. This feature may be undesirable, if enabled in error.

TYPE 27 — UNDER VOLTAGE

Brief details

The relay will operate (trip) when the signal level on any of the “generator” voltage inputs is less than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when all “generator” voltage inputs rise above the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

You must specify the following parameters for operation of the under voltage relay:

- The minimum permitted voltage on any of the voltage inputs from the “generator”.
- The time for which the under voltage conditions must be true.
- The voltage above the previously defined minimum that all inputs from the “generator” must exceed to return operation to the not tripped condition following a trip. (Hysteresis)

Range of Voltage Trip point (Trip Point)	5-119% of nominal input
Range of Diff (Diff)	1 — 15% of nominal input
Range of Time Delay (TimeDelay)	0 to 30 seconds

TYPE 47 — PHASE ORDER (PHASE SEQUENCE)

Brief details

This relay will operate when the instantaneous levels on the voltage input to Phase B (2) is not positive or the instantaneous level on the voltage input to Phase C (3) is not negative when measured at the zero crossing point on the rising edge of Phase A (1). The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the instantaneous levels on the voltage input to Phase B (2) is positive and the instantaneous level on the voltage input to Phase C (3) is negative when measured at the zero crossing point on the rising edge of Phase A (1). The time delay is not used on the transition to the “not tripped” condition.

This function is used to determine that the phase sequence of the voltage inputs is correct.

Parameters

You must specify the following parameters for operation of the reverse voltage relay:

- The time for which the reverse phase voltage conditions must be true.

Parameter details

Range of Time Delay 0 to 30 seconds

TYPE 32R — DIRECTIONAL POWER (REVERSE)

Brief details

The relay will operate (trip) when the power level into the “generator” on any phase exceeds the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the power level into the “generator” on all phases falls below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

The function is intended to detect conditions such as generator motoring.

Parameters

You must specify the following parameters for operation of the directional power relay:

- (SPR-014) The maximum permitted power on any phase into the “generator”.
- (SPR-013) The minimum permitted system power into the “generator”.
- The time for which the directional power conditions must be true.
- The power level below the previously defined maximum that all phases from the “generator” must exceed to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Directional Power trip (TripPoint) 3 — 120% of nominal power per phase (line)

Range of Diff (Diff) 1 — 15% of nominal power per phase

Range of Time Delay (TimeDelay) 0 to 30 seconds

Accuracy of Directional Power Trip point ± 3% of nominal input

TYPE 47 — VOLTAGE UNBALANCE

Brief details

The relay will operate (trip) when the difference in signal level on any of the “generator” voltage inputs voltage is greater than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the difference between all “generator” voltage inputs fall below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

You must specify the following parameters for operation of the voltage balance relay:

- The maximum permitted voltage difference between any of the voltage inputs from the “generator”.
- The time for which the voltage balance conditions must be true.
- The voltage decrease below the previously defined maximum difference that all inputs from the “generator” must be below to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Voltage (Trip Point)	1 — 25% of nominal input
Range of Diff (Diff)	1 — 15% of nominal input
Range of Time Delay (Time Delay)	0 to 30 seconds

TYPE 51 — AC TIME OVER CURRENT

Brief details

The relay will operate (trip) when the signal level on any of the “generator” current inputs is greater than the selected value. The response time of the relay will be a function of how far above the selected value the current value is. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when all “generator” current inputs fall below the selected trip.

Parameters

You must specify the following parameters for operation of the time over current relay:

- The maximum permitted current on any of the current inputs from the “generator”.
- The required time characteristic (digit identifying the level VS time curve required).
- The “Time Dial Setting”.

Parameter details

Range of Current Trip point (Trip Point) 5 — 120% of nominal input

Time Curve (Time Curve) 1 (Standard Inverse)
2 (Very Inverse)
3 (Extremely Inverse)

Time Dial Setting Range (Time Dial) 0.1 to 9.9

Time Dial Setting Resolution 0.1

Resolution of curve timebase 100 milliseconds

Accuracy of timing (relative to the characteristics described below) $\pm 5\%$ of ideal + 2 loop times

Maximum Input current for which Time-Current characteristics are valid 25 Amps for 5 Amp nominal unit
5 Amps for 1 Amp nominal unit

Response Time NOTE: The time-over current function involves many calculations, which are computationally intensive.
Worst case example: With all 12 relays defined as time-over current trips, the product loop time can be up to 150ms.

Note: Measurement accuracy should also be considered when operating at very small over current levels since the slope of the curve could introduce additional timing errors.

Time over current characteristics

The response time of the relay when operating in Time Over Current mode may determined using the relationship:

Time-Current Characteristic	k1	k2	k3
Standard Inverse	0.01414	0.02	0.1
Very Inverse	1.3636	1	0.1
Extremely Inverse	8.0808	2	0.1
Long time standby Earth Fault	12.121	1	0.1

$$t = \frac{k1 * TimeDialSetting}{I^{k2} - 1} + k3$$

where t is the time in seconds

k1, k2 and k3 are constants defined in the table below

I is the ratio of measured current to Trip Point current

TimeDialSetting (TDS) is a user selected multiplier

The curves describing these characteristics may be found on the following pages (Figs 4 to 7).

Limits of operation

The maximum "Multiple of trip setting" applicable for a trip setting at "nominal input" (e.g. Trip point at 5 Amps on a 5 Amp unit) is 5. "Multiple of trip setting" values of greater than 5 are only valid for trip levels of less than "nominal input". This parameter is limited by the dynamic range of the current input circuits which start to limit above 5 times "nominal" input.

The maximum time delay introduced by the Time-Current characteristics is limited by the resolution of the current input in the region of the trip point. This limits the "Multiple of trip setting" to approximately 1.007.

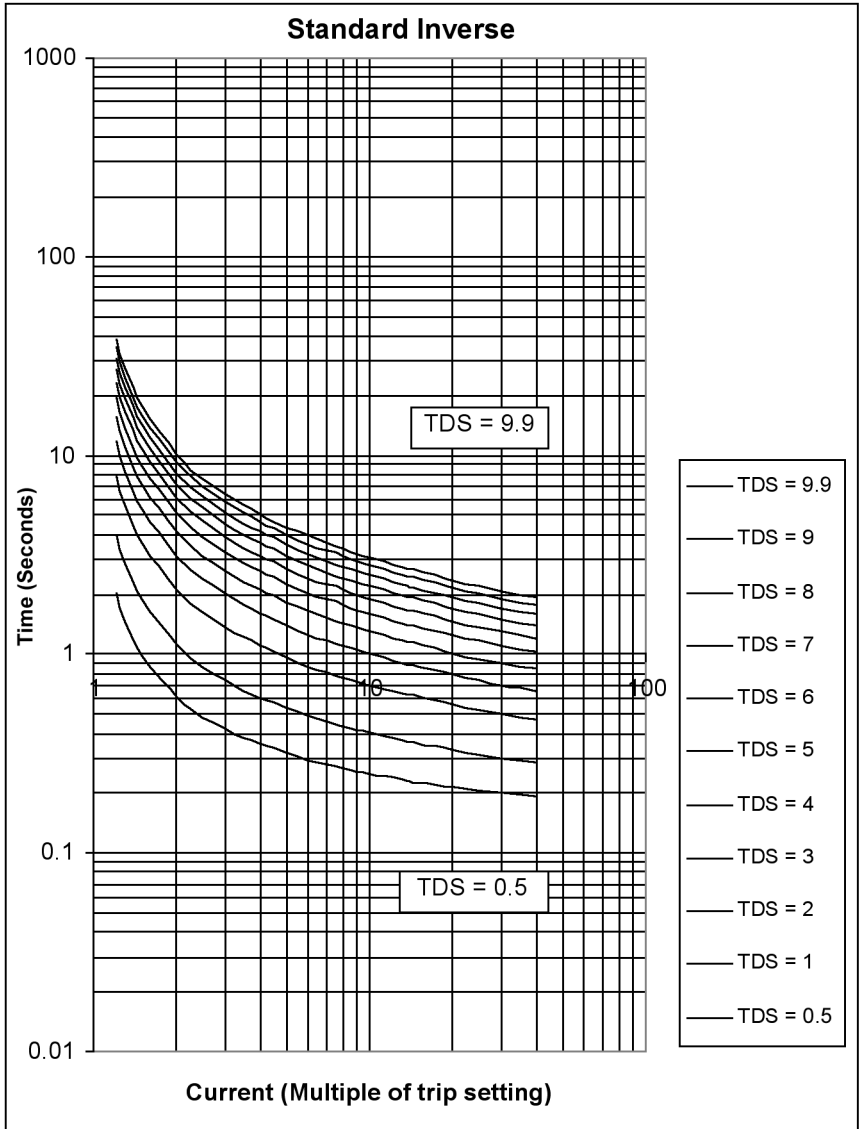


Fig 4 Time - current characteristics - Standard Inverse (Time Curve =1)

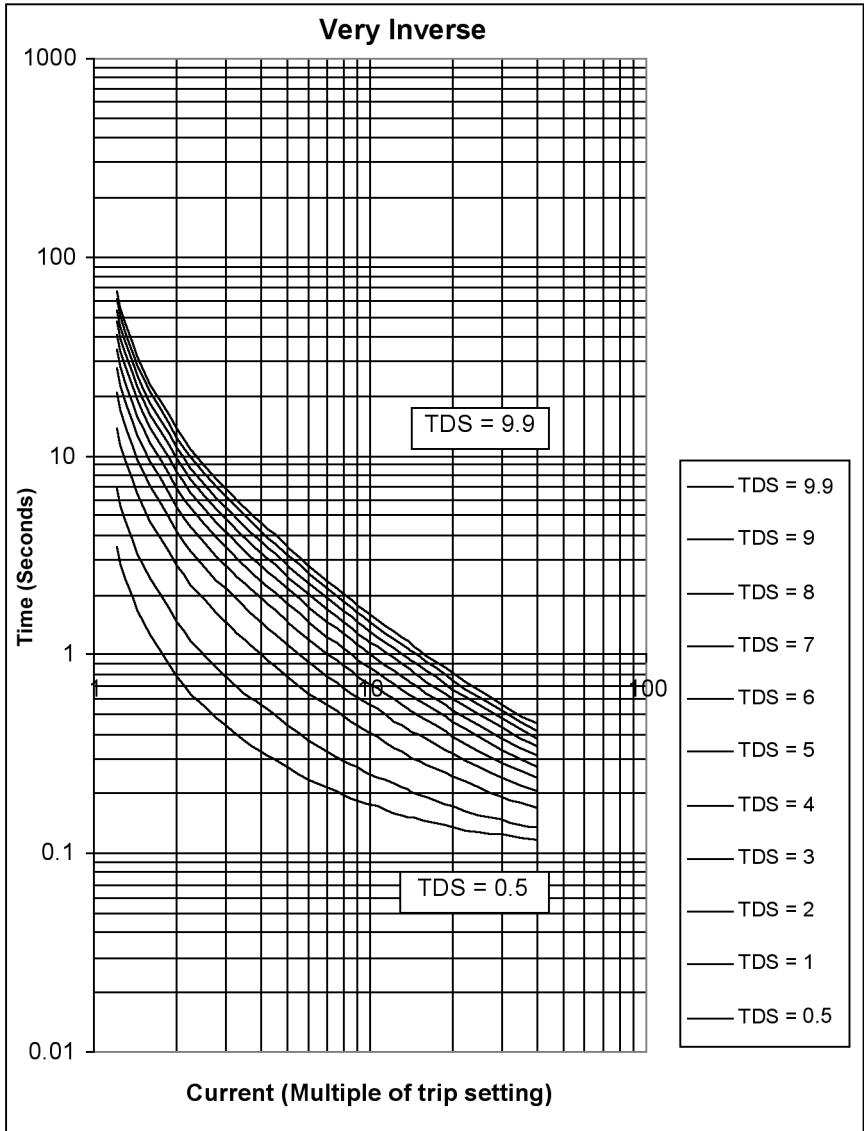


Fig 5 Time - current characteristics - Very Inverse (Time Curve = 2)

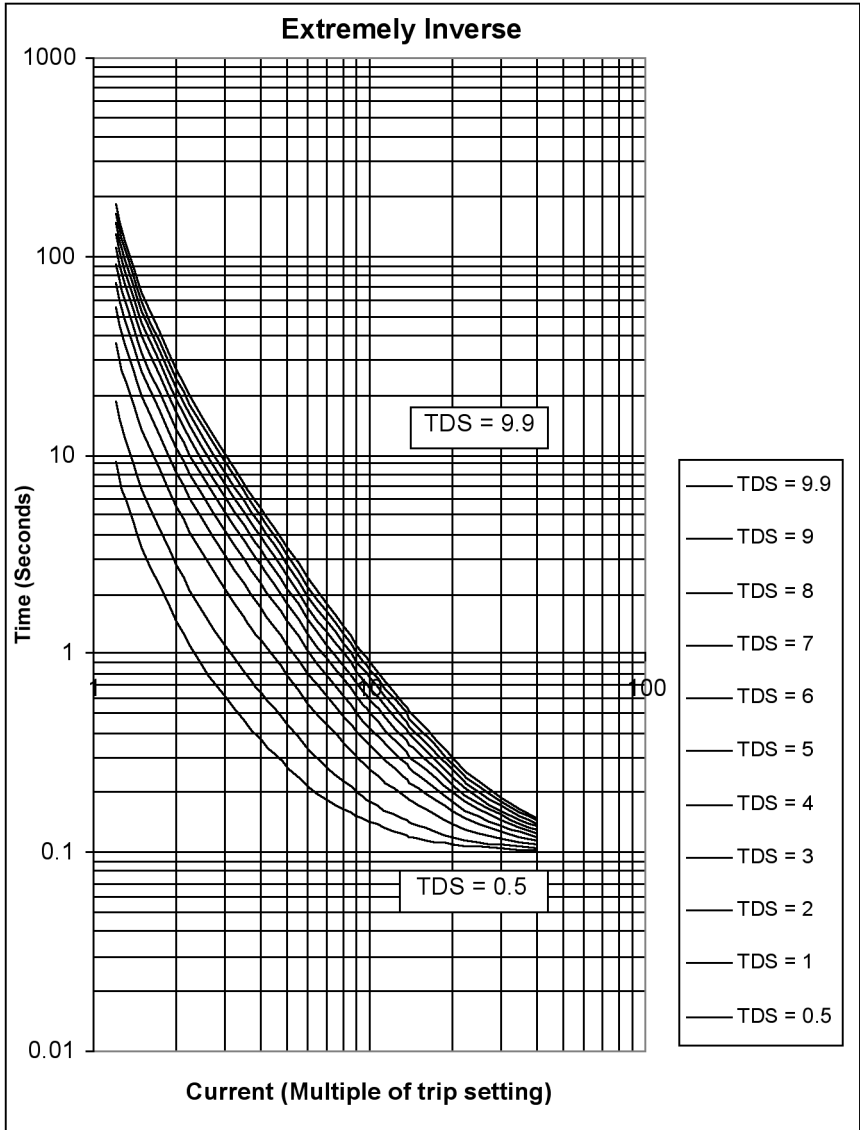


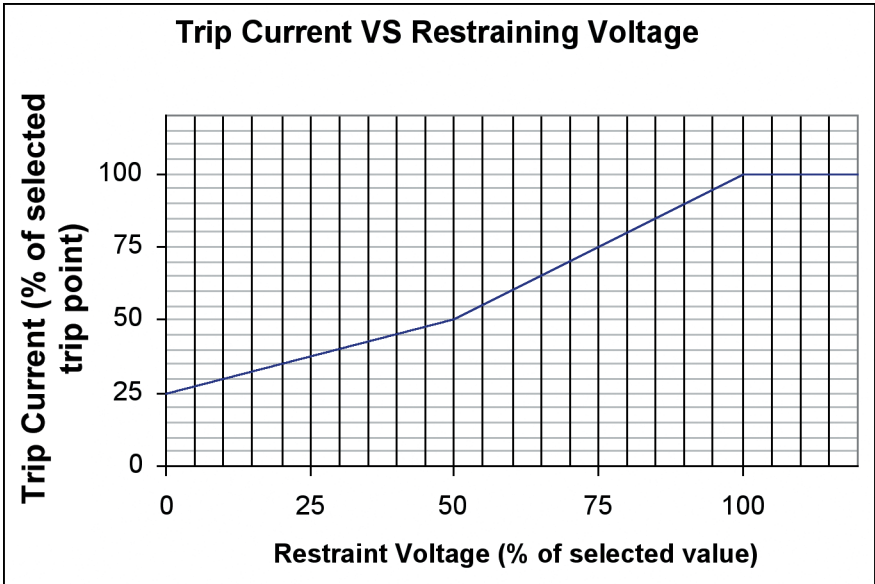
Fig 6 Time - current characteristics - Extremely Inverse (Time Curve = 3)

TYPE 51V — AC TIME OVER CURRENT WITH VOLTAGE RESTRAINT

Brief details

The relay will operate (trip) when the signal level on any of the “generator” current inputs is greater than the “modified” (see note below) selected value. The response time of the relay will be a function of how far above the selected value the current value is. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when all “generator” current inputs fall below the “modified” selected trip point.

Note: The maximum permitted current value used internally will be modified by the level of the corresponding voltage input according to the “voltage restraint characteristic” defined below.



Parameters

You must specify the following parameters for operation of the time over current with voltage restraint:

- The maximum permitted current on any of the current inputs from the “generator”.
- The required time characteristic (character identifying the level VS time curve required).
- The “Time Dial Setting”.

The “Rated” Voltage, (The 100% reference level used to calculate the “Restraint Voltage in the chart above).

Parameter details

Range of Current Trip point	5 — 120% of nominal input
Range of Rated Voltage Trip point	80 — 120% of nominal input
Range of Time-Current Characteristic Curves (Time Curve)	1 Standard Inverse 2 Very Inverse 3 Extremely Inverse
Time Dial Setting Range	0.1 to 9.9
Time Dial Setting Resolution	0.1
Resolution of curve timebase	100 milliseconds
Accuracy of timing (relative to the characteristics described below)	± 5% of ideal + 2 loop times
Maximum Input current for which Time-Current characteristics are valid	25 Amps for 5 Amp nominal unit 5 Amps for 1 Amp nominal unit

TYPE 51G — TIME OVER CURRENT NEUTRAL GROUND FAULT CHECK

Brief details

This trip has different implementations on models SPR-013 and SPR-014, as follows:

SPR-014 (3 phase 4-wire systems with neutral CT): The fault current is calculated as the difference between the vector sum of the three phase current inputs and the neutral current input.

SPR-013 (3 phase 3-wire systems): The fault current is the vector sum of the three phase current inputs only. Do not connect any signal to the Neutral current input terminals.



IMPORTANT: Ground fault current is not directly measured. This parameter is derived by calculation. This unit has not been tested to UL 1053. The trip function is intended for monitoring purposes only.

Parameters

You must specify the following parameters for operation of the neutral ground fault relay:

- The maximum permitted value of the RMS of the vector sum of phase current inputs and the neutral current input from the “generator”.
- The “Time Dial Setting”.

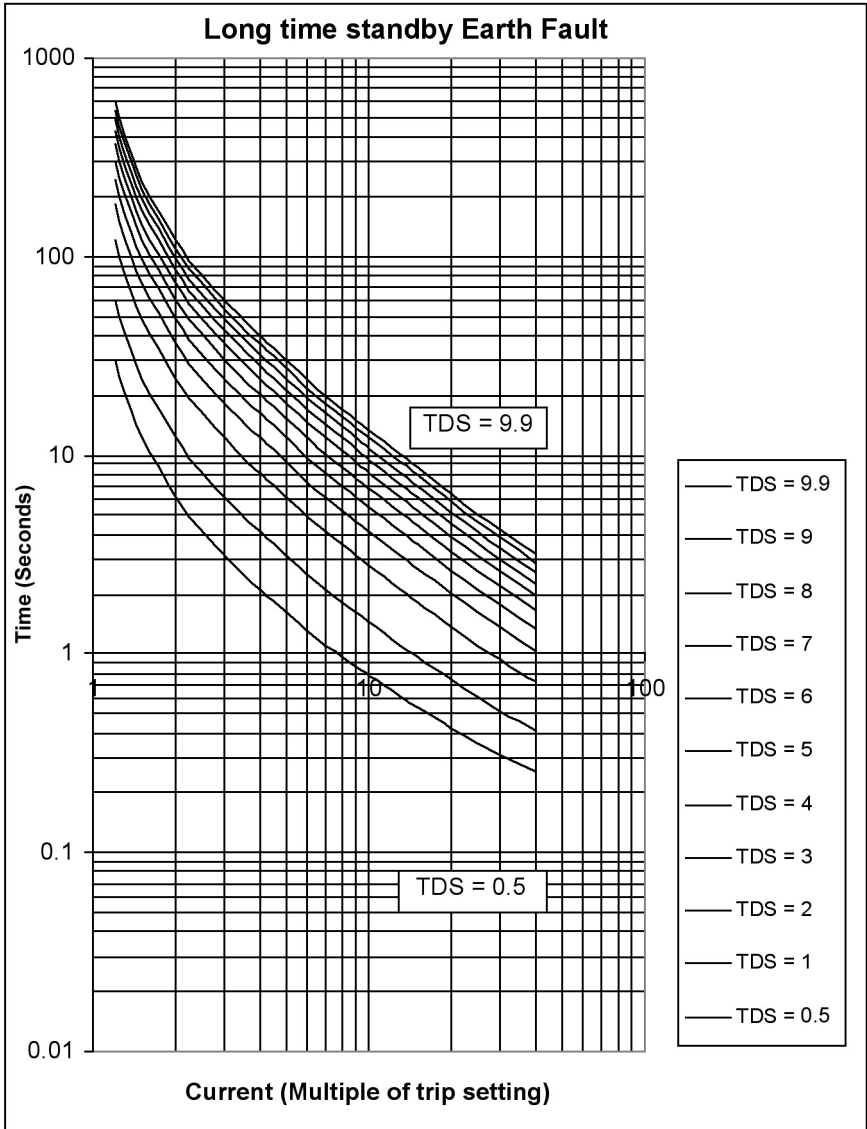


Fig 7 Time - current characteristics - Long time standby Earth Fault

Parameter details

Range of Neutral Ground Fault Trip point (TripPoint)	5 — 120% of nominal input
Accuracy of Neutral Ground Fault Trip point	± 3% of nominal input
Time-Current Characteristic (this characteristic is defined later in this document)	Long time Standby Earth Fault
Time Dial Setting Range	0.1 to 9.9
Time Dial Setting Resolution	0.1
Resolution of curve timebase	100 milliseconds
Accuracy of timing (relative to the characteristics described in below)	± 5% of ideal +100 milliseconds
Maximum Input current for which Time-Current characteristics are valid	25 Amps for 5 Amp nominal unit 5 Amps for 1 Amp nominal unit

TYPE 59 — OVER VOLTAGE

Brief details

The relay will operate (trip) when the signal level on any of the “generator” voltage inputs is greater than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when all “generator” voltage inputs fall below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

You must specify the following parameters for operation of the over voltage relay:

- The maximum permitted voltage on any of the voltage inputs from the “generator”.
- The time for which the over voltage conditions must be true.
- The voltage decrease below the previously defined maximum that all inputs from the “generator” must be below to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Voltage Trip point	5 — 120% of nominal input
Range of Time Delay	0 to 30 seconds
Range of Diff	1 — 15% of nominal input

TYPE 810 — OVER FREQUENCY

Brief details

The relay will operate (trip) when the frequency of the “generator” input voltage is greater than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the “generator” input frequency falls below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

You must specify the following parameters for operation of the over frequency relay:

- The maximum permitted frequency input from the “generator”.
- The time for which the over frequency condition must be true.
- The frequency decrease below the previously defined maximum that the input from the “generator” must exceed to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Frequency Trip point (Trip Point)	40 — 70 Hz
Range of Diff (Diff)	0.1 — 10 Hz
Range of Time Delay (Time Delay)	0 to 30 seconds



NOTE: If the measured frequency exceeds the 70Hz working range, be aware that the displayed frequency will be set to zero and the over frequency trip will reset. If it is possible for the frequency in your application to exceed this upper limit, ensure that under frequency trip is configured to pick up the zero frequency value.

TYPE 81U — UNDER FREQUENCY

Brief details

The relay will operate (trip) when the frequency of the “generator” input voltage is less than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the “generator” input frequency rises above the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

You must specify the following parameters for operation of

- The minimum permitted frequency input from the “generator”.
- The time for which the under frequency condition must be true.
- The frequency increase above the previously defined minimum that the input from the “generator” must exceed to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Frequency Trip point (Trip Point)	40 — 70 Hz
Range of Diff (Diff)	0.1 — 10 Hz
Range of Time Delay (Time Delay)	0 to 30 seconds

LOGICAL TRIP FUNCTIONS

Parameters

You must specify the following parameters for operation of the logical trip functions:

- The logical function type
- The trips (relay numbers) to be included in the logic function (up to three)
- The time delay from the logical condition becoming true to the relay adopting the “tripped” condition
- The time delay from the logical condition becoming false to the relay returning to the “not tripped” condition

Parameter details

Logic Functions Supported	AND	Output true when all inputs true
	OR	Output true when any input true
	NAND	Output true except when all inputs true
	NOR	Output true when no inputs are true
	XOR	Output true when odd number of inputs are true
	Vote	Output true when the majority of inputs are true
Disc		Output true when inputs are different
Range of Delay to On Time		0 — 30 Seconds
Range of Delay to Off Time		0 — 30 Seconds

ANSI TYPE 40Q — REVERSE VAR

Brief details

The relay will operate (trip) when the VAR level into the “generator” on any phase exceeds the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the VAR level into the “generator” on all phases falls below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

The function is intended to detect conditions such as loss of field or loss of excitation.

Parameters

The following parameters must be specified for the operation of the reverse VAR reactive power relay:

- (SPR-014) The maximum permitted VAR on any phase into the “generator”.
- (SPR-013) The maximum permitted system VAR into the “generator”.
- The time for which the directional conditions must be true.
- The VAR level below the previously defined maximum that all phases from the “generator” must exceed to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Reverse VAR trip (TripPoint)	3 — 120% of nominal VAR per phase (line)
Accuracy of Reverse VAR Trip point	± 4% of nominal input
Range of Hysteresis (Diff)	1 — 15% of nominal power per phase
Range of Time Delay (TimeDelay)	0 to 30 seconds

ANSI TYPE 50 — INSTANTANEOUS OVER CURRENT

Brief details

The relay will operate (trip) when the signal level on any of the “generator” current inputs is greater than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when all “generator” current inputs fall below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

The following parameters must be specified for the operation of the over current relay:

- The maximum permitted current on any of the current inputs from the “generator”.
- The time for which the over current conditions must be true.
- The current decrease below the previously defined maximum that all inputs from the “generator” must be below to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Current Trip point (TripPoint)	30 — 300% of nominal input
Range of Hysteresis (Diff)	1 — 15% of nominal input
Range of Time Delay (TimeDelay)	0 to 30 seconds

Note: The time delay default setting is 0.2 seconds. This can be reduced in value if the trip point is greater than 100%

ANSI TYPE 50N — INSTANTANEOUS OVER NEUTRAL CURRENT

Brief details

The relay will operate (trip) when the signal level on the “generator” neutral current input is greater than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the “generator” neutral current input falls below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

The following parameters must be specified for the operation of the neutral over current relay:

- The maximum permitted neutral current from the “generator”.
- The time for which the over neutral current condition must be true.
- The current decrease below the previously defined maximum neutral current that the “generator” must be below to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Neutral Current Trip point (TripPoint)	30 — 300% of nominal input
Range of Hysteresis (Diff)	1 — 15% of nominal input
Range of Time Delay (TimeDelay)	0 to 30 seconds

Note: This trip is non-applicable on model SPR-013.

Note: The time delay default setting is 0.2 seconds. This can be reduced in value if the trip point is greater than 100%

ANSI TYPE 37 — INSTANTANEOUS UNDER CURRENT

Brief details

The relay will operate (trip) when the signal level on any of the “generator” current inputs is less than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when all “generator” current inputs rise above the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

The following parameters must be specified for the operation of the under current relay:

- The minimum permitted current on any of the current inputs from the “generator”.
- The time for which the under current conditions must be true.
- The current above the previously defined minimum that all inputs from the “generator” must exceed to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Current Trip point (TripPoint)	30 — 300% of nominal input
Range of Hysteresis (Diff)	1 — 15% of nominal input
Range of Time Delay (TimeDelay)	0 to 30 seconds

ANSI TYPE 46 — PHASE BALANCE CURRENT

Brief details

The relay will operate (trip) when the difference in signal level on any of the “generator” current inputs is greater than the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the difference between all “generator” current inputs fall below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

Parameters

The following parameters must be specified for the operation of the current balance relay:

- The maximum permitted current difference between any of the current inputs from the “generator”.
- The time for which the current balance conditions must be true.
- The current decrease below the previously defined maximum difference that all inputs from the “generator” must be below to return operation to the not tripped condition following a trip. (Hysteresis)

Note: Be aware that the Diff value can be set higher than the trip point value. Choose these settings carefully for correct trip operation.

Parameter details

Range of Current Trip point (TripPoint)	5 — 120% of nominal input
Range of Hysteresis (Diff)	1 — 15% of nominal input
Range of Time Delay (TimeDelay)	0 to 30 seconds
Accuracy of Trip Point	±5% of nominal input

TYPE 320 — DIRECTIONAL (FORWARD) OVER POWER

Brief details

The relay will operate (trip) when the power level out of the “generator” on any phase exceeds the selected value for the duration of the time delay. The relay will return to the “not tripped” condition (provided that latched operation has not been selected) when the power level from the “generator” on all phases falls below the selected trip point by at least the hysteresis value. The time delay is not used on the transition to the “not tripped” condition.

The function is intended to detect conditions such as generator overload.

Parameters

The following parameters must be specified for the operation of the directional power (forward or export) relay::

- (SPR-014) The maximum permitted power on any phase out of the “generator”.
- (SPR-013) The maximum permitted system power out of the “generator”.
- The time for which the directional power conditions must be true.
- The power level below the previously defined maximum that all phases from the “generator” must exceed to return operation to the not tripped condition following a trip. (Hysteresis)

Parameter details

Range of Directional Power trip (TripPoint)	3 — 120% of nominal power per phase (line)
Range of Hysteresis (Diff)	1 — 15% of nominal power per phase
Range of Time Delay (TimeDelay)	0 to 30 seconds

POWER METERING

In this mode, your SPR can be configured or re-configured to keep up with any system changes. Your system generator or bus readings can be monitored.

System configuration

The system configuration should be checked and set to your requirements as detailed in SYSTEM CONFIGURATION.

If a fault is suspected in your system, use the Power Metering Menu to check the electrical system and connections. Any of the electrical parameters can be monitored, including generator voltage readings, power, power factor, frequency, current etc.

'Generator' checking

Return to the Main Menu by pressing ESC as required.

Use the DOWN key to highlight POWER METERING and press ENTER.

This will bring up the Power Metering Menu; from this menu you can scroll to the Generator or Bus sub-menus.

```
-----POWER_METERING-----
-> GEN_READINGS
-> BUS_READINGS
-> SYSTEM_CONFIG
```

Selecting Gen Readings and pressing ENTER will bring up the generator Menu. By scrolling down the menu, you can check:

- Voltage
- Current
- WATTS (Active power)
- VA (Apparent power)
- VAR (Reactive power)
- PF (Power factor)
- PA (Phase angle)
- FREQUENCY

```
-----GEN_READINGS-----
-> VOLTAGE
-> CURRENT
-> POWER
```

The examples on the following pages reflect the three phase four wire product (model SPR-014W). Please note that not as many measurements are available on the three phase three wire product (model SPR-013W) for example, neutral current readings will be zero as this signal does not exist. In the following screens, press ESC to return to the Gen Readings menu.

Gen Voltage

With the cursor on Voltage, press ENTER. The display opposite will appear. Press the DOWN key to view additional Voltage readings.

On 3-wire systems, VL1 is Voltage Line 1 to 2, VL2 is voltage line 2 to 3 and VL3 is line 3 to 1.

_____Gen_Voltage_____	
VL1	0.0 V
VL2	0.0 V
VL3	0.0 V

Gen Current

Scroll down to highlight Current, press ENTER. The display opposite will appear. Press the DOWN key to view additional current readings.

_____Gen_Current_____	
I1	0.000 A
I2	0.000 A
I3	0.000 A

Gen Power

Scroll down to highlight Power, press ENTER. The display opposite will appear. Press the DOWN key to view additional power readings.

On 3-wire systems a single system power value is displayed.

_____Gen_Power_____	
W1	0.0 W
W2	0.0 W
W3	0.0 W

Gen VA

Scroll down to highlight VA, press ENTER. The display opposite will appear. Press the DOWN key to view additional VA readings.

On 3-wire systems a single system VA value is shown.

_____Gen_VA_____	
VA1	0.0 VA
VA2	0.0 VA
VA3	0.0 VA

Gen VAR

Scroll down to highlight VAR, press ENTER. The display opposite will appear. Press the DOWN key to view additional VAR readings.

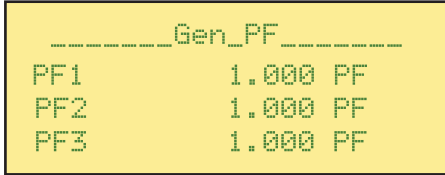
On 3-wire systems a single system VAR value is shown.

_____Gen_VAR_____	
VAR1	0.0 VAR
VAR2	0.0 VAR
VAR3	0.0 VAR

Gen PF

Scroll down to highlight PF, press ENTER. The display opposite will appear. Press the DOWN key to view additional PF readings.

On 3-wire systems only a single system PF value is shown.



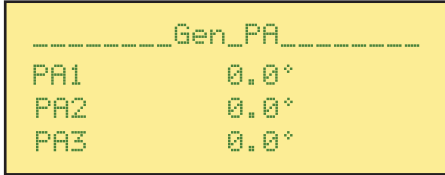
```
-----Gen_PF-----
PF1      1.000 PF
PF2      1.000 PF
PF3      1.000 PF
```

Gen PA

Scroll down to highlight PA (Phase Angle), press ENTER. The display opposite will appear.

Press the DOWN key to view additional Phase Angle readings.

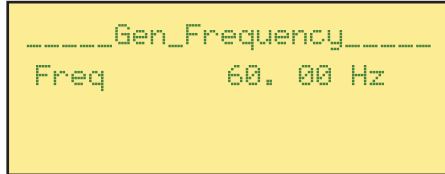
On 3-wire systems only a single system PA value is shown.



```
-----Gen_PA-----
PA1      0.0°
PA2      0.0°
PA3      0.0°
```

Gen Frequency

Scroll down to highlight Frequency, press ENTER. The display opposite will appear.

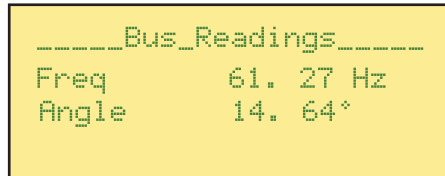


```
-----Gen_Frequency-----
Freq     60.00 Hz
```

Bus checking

Scroll down to highlight Bus Readings; press ENTER. The display opposite will appear.

The bus frequency and phase shift (compared to the GEN input) is displayed.



```
-----Bus_Readings-----
Freq     61.27 Hz
Angle    14.64°
```

PASSWORD PROTECTION

Introduction

Since the product is a front panel mounted device, it could be subjected to tampering or adjustment by unauthorised personnel. The password features allow up to four levels of access control, so that the range of accessible features can be controlled between total flexibility and total lockout.

Using the Password control features to disable unauthorised operation

The product offers four levels of password protection, as follows:

- Level 3 – Installation level, allows complete configuration of the product.
- Level 2 – Engineering level, allows modification of trip values.
- Level 1 – Operator level, trip parameters can be inspected, but not altered.
- Level 0 – total lockout of control functions.

All passwords take the form of a number, which can be any value between 1 and 9999.

Password control only affects the operations available at the front panel, however, changes to system operation or the trip parameters via the RS485 MODBUS port are not restricted.

Installation level password - Level 3

As shipped from manufacture, the password control is not enabled. This enables full product functionality and the maximum flexibility.

With no password control in place, the following main menu options are available:

- RELAY STATUS
- RESET TRIPS
- POWER METERING
- EVENT LOG
- CONFIGURATION
- PASSWORD
- VERSION

From the configuration menu, the product can be set up to suit the intended application. Once the product has been wired into electrical circuits, and product functionality has been set, you may not want the protection functions or physical relays to be redefined without authority. When the product functionality has been defined and electrically connected, the level 3 password can be entered to prevent further alteration of function. The level 3 password will hide any protection features that have not been assigned to relays.

From the main menu, go into the Password Menu. To set up a password for level 3, scroll down the menu and select SET LEVEL 3, then press ENTER. If this does not appear in the list, that level of password protection is already in place.

```
___PASSWORD_MENU___
█ Password      0
-> Set Level 1
-> Set Level 2
```

Pressing ENTER will allow a new password to be entered, which must be a number between 1 and 9999.

```
___Password_Level_3___
█ Password      0
```

Use the UP and DOWN keys to modify the number. If you press and hold either of these keys, the number can be rapidly modified. Press ENTER to accept the new value.

```
___Password_Level_3___
Password        7
```

Press ESCape to get back to the password menu. The password number that was just chosen (e.g. 1234) is displayed. To activate the password control, change this number to any value that is not being used as a password (e.g. zero)

```
___PASSWORD_MENU___
█ Password     1234
-> Set Level 1
-> Set Level 2
```

Once the password has been set, the SET LEVEL 3 option will disappear from the password menu, and the functionality of relay contacts can not be redefined.

```
___PASSWORD_MENU___
█ Password     7
```

Unlocking a password

To unlock the required level, go into the password menu and simply re-enter the password number that was configured for the access level you require.

Once a password level has successfully been unlocked, you will get menu options which allow setting up of new passwords.



When the level 1 password is correctly entered, you can set a new password for that level only. When level 2 password is correctly entered, you can set new passwords for level 1 and level 2. When the level 3 password is correctly entered, you can set new passwords for all levels.

If a password has been lost or forgotten

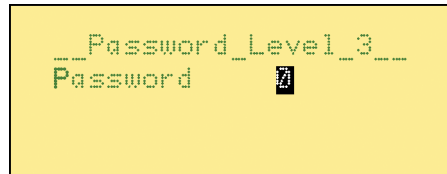
If the level 1 or level 2 passwords have been lost or forgotten, entering the correct level 3 password will allow these password settings to be reviewed or altered. If the level 3 password has been forgotten, the product must be returned to the factory to be unlocked.

Changing a password

Unlock the product using the old password first, and once the Set Level options appear, simply set a new password number for the required level.

Switching off password levels

To disable any level of password, you need to unlock that level first, by entering the correct password. Once unlocked, change the password number to zero using the Set Level menu.



Engineering level password – Level 2

Level 2 allows the actual setpoint levels, hysteresis and time delay values to be modified. This is useful for when equipment is being commissioned, because minor adjustments are usually made to these settings to suit local conditions.

Once all of these parameter settings have been altered, further changes can be disabled by setting a password for level 2. Select SET LEVEL 2 from the password menu, and follow the same procedure as described for setting level 3.

Once the level 2 password has been set, the configuration menu can not be accessed (in fact, CONFIGURATION does not even appear in the main menu list)

Operator level password - Level 1

At level 1, no parameters can be altered, but the relay trip functions and settings can be inspected from the RESET TRIPS menu. If required an operator can report all of the device settings for technical support or problem diagnosis. Only the following main menu options are available:

- RELAY STATUS
- RESET TRIPS
- POWER METERING
- EVENT LOG
- PASSWORD
- VERSION

Lockout password - Level 0

Once a level 0 password has been set, the event history log and diagnostic information screens can be viewed, but no changes can be made to the product. Only the following options are available from the main menu:

- RELAY STATUS
- POWER METERING
- EVENT LOG
- PASSWORD
- VERSION

If relay latching has been enabled, the latch cannot be reset from the front panel. However, if the trip ALARM mode has been enabled, the alarm can be reset by pressing ENTER in the relay status screen.

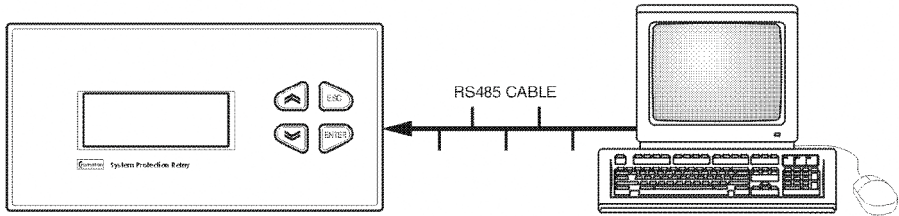
The password levels are shown on the following pages.

PASSWORD LEVELS

Menu Functions / Password Level	SPR-014W (3 Phase 4 Wire)				SPR-013W (3 Phase 3 Wire)			
	As Shipped	Level 3	Level 2	Level 1	As Shipped	Level 3	Level 2	Level 1
RELAY STATUS	✓	✓	✓	✓	✓	✓	✓	✓
Relay Status (LCD Constrast)	✓	✓	✓	✓	✓	✓	✓	✓
RESET TRIPS	✓	✓	✓		✓	✓	✓	
Reset Trip	✓	✓	✓		✓	✓	✓	
POWER METERING	✓	✓	✓	✓	✓	✓	✓	✓
GEN READINGS	✓	✓	✓	✓	✓	✓	✓	✓
VOLTAGE	✓	✓	✓	✓	✓	✓	✓	✓
VL1	✓	✓	✓	✓				
VL2	✓	✓	✓	✓				
VL3	✓	✓	✓	✓				
VL1L2	✓	✓	✓	✓	✓	✓	✓	✓
VL2L3	✓	✓	✓	✓	✓	✓	✓	✓
VL3L1	✓	✓	✓	✓	✓	✓	✓	✓
CURRENT	✓	✓	✓	✓	✓	✓	✓	✓
I1	✓	✓	✓	✓	✓	✓	✓	✓
I2	✓	✓	✓	✓	✓	✓	✓	✓
I3	✓	✓	✓	✓	✓	✓	✓	✓
In	✓	✓	✓	✓				
Ig	✓	✓	✓	✓	✓	✓	✓	✓
POWER	✓	✓	✓	✓	✓	✓	✓	✓
W1	✓	✓	✓	✓				
W2	✓	✓	✓	✓				
W3	✓	✓	✓	✓				
Wsum	✓	✓	✓	✓	✓	✓	✓	✓
VA	✓	✓	✓	✓	✓	✓	✓	✓
VA1	✓	✓	✓	✓				
VA2	✓	✓	✓	✓				
VA3	✓	✓	✓	✓				
VAsum	✓	✓	✓	✓	✓	✓	✓	✓

Menu Functions / Password Level	SPR-014W (3 Phase 4 Wire)				SPR-013W (3 Phase 3 Wire)			
	As Shipped	Level 3	Level 2	Level 1	As Shipped	Level 3	Level 2	Level 1
VAR	✓	✓	✓	✓	✓	✓	✓	✓
VAR1	✓	✓	✓	✓				
VAR2	✓	✓	✓	✓				
VAR3	✓	✓	✓	✓				
VARsum	✓	✓	✓	✓	✓	✓	✓	✓
PF	✓	✓	✓	✓	✓	✓	✓	✓
PF1	✓	✓	✓	✓				
PF2	✓	✓	✓	✓				
PF3	✓	✓	✓	✓				
PFsum	✓	✓	✓	✓	✓	✓	✓	✓
PA	✓	✓	✓	✓	✓	✓	✓	✓
PA1	✓	✓	✓	✓				
PA2	✓	✓	✓	✓				
PA3	✓	✓	✓	✓				
PAsum	✓	✓	✓	✓	✓	✓	✓	✓
FREQUENCY	✓	✓	✓	✓	✓	✓	✓	✓
Frequency	✓	✓	✓	✓	✓	✓	✓	✓
BUS READINGS	✓	✓	✓	✓	✓	✓	✓	✓
Freq	✓	✓	✓	✓	✓	✓	✓	✓
Angle	✓	✓	✓	✓	✓	✓	✓	✓
SYSTEM CONFIG	✓	✓	✓	✓	✓	✓	✓	✓
Sys Volts	✓	✓	✓	✓	✓	✓	✓	✓
Sys Amps	✓	✓	✓	✓	✓	✓	✓	✓
Sys Power	✓	✓	✓	✓	✓	✓	✓	✓
Type	✓	✓	✓	✓	✓	✓	✓	✓
EVENT LOG	✓	✓	✓	✓	✓	✓	✓	✓
View	✓	✓	✓	✓	✓	✓	✓	✓
Clear		✓	✓	✓		✓	✓	✓
Summary	✓	✓	✓	✓	✓	✓	✓	✓

Menu Functions / Password Level	SPR-014W (3 Phase 4 Wire)				SPR-013W (3 Phase 3 Wire)			
	As Shipped	Level 3	Level 2	Level 1	As Shipped	Level 3	Level 2	Level 1
CONFIGURATION	✓	✓				✓	✓	
RELAYS	✓	✓				✓	✓	
Trip Type	✓					✓		
SAVE RELAY SETUP	✓	✓				✓	✓	
Save	✓	✓				✓	✓	
RANGE	✓	✓				✓	✓	
Sys Volts	✓	✓				✓	✓	
Sys Amps	✓	✓				✓	✓	
Sys Power	✓	✓				✓	✓	
Type	✓	✓				✓	✓	
TIME & DATE	✓	✓				✓	✓	
TIME	✓	✓				✓	✓	
Hour	✓	✓				✓	✓	
Min	✓	✓				✓	✓	
Sec	✓	✓				✓	✓	
DATE	✓	✓				✓	✓	
Year	✓	✓				✓	✓	
Month	✓	✓				✓	✓	
Day	✓	✓				✓	✓	
COMMS	✓	✓				✓	✓	
Baud Rate	✓	✓				✓	✓	
Parity	✓	✓				✓	✓	
Stop	✓	✓				✓	✓	
Node	✓	✓				✓	✓	
PASSWORD	✓	✓	✓	✓	✓	✓	✓	✓
Password	✓	✓	✓	✓	✓	✓	✓	✓
Set Level 1	✓	✓	✓		✓	✓	✓	
Set Level 2	✓	✓			✓	✓		
Set Level 3	✓				✓			
VERSION	✓	✓	✓	✓	✓	✓	✓	✓



RS485 DIGITAL OUTPUT - MODBUS IMPLEMENTATION

The SPR offers a RS485 communication INTERFACE for direct connection to SCADA systems using the MODBUS RTU protocol. The MODBUS protocol establishes the format for the master's query by placing into it the device address, a function code defining the requested action, any data to be sent, and an error checking field.

The slave's response message is also constructed using MODBUS protocol. It contains fields confirming the action taken, any data to be returned, and an error checking field. If an error occurred in receipt of the message, or if the slave is unable to perform the requested action, the slave will construct an error message and send it as its response.

The electrical interface is 2-wire RS485 (half duplex), via a 2 part connector. Connection should be made using twisted pair screened cable (Typically 22 gauge Belden 8761 or equivalent). All "A" and "B" connections are daisy chained together. The screens should also be connected to the "Gnd" terminal. To avoid the possibility of loop currents, an Earth connection should be made at one point on the network. See the connection diagram for details.

A total maximum length of 1200M (4000 ft) is allowed for the RS485 network. A maximum of 32 electrical nodes can be connected, including the controller. The cable should be terminated with a resistor at each end.

The address of each SPR can be set to any value between 1 and 247. Broadcast mode (address 0) is not supported.

The maximum latency time of an SPR is **150ms**. i.e. this is the amount of time that can pass before the first response character is output. The supervisory programme must allow this period of time to elapse before assuming that the SPR is not going to respond.



1. Heavy Modbus traffic can affect the loop time of the product.



2. If an invalid or out of range number is written into a holding register, the SPR will attempt to set that register to the nearest valid number. It is particularly important when setting up or modifying trip parameters that all data values are written and then read back and verified.

The format for each byte in RTU mode is:

- Coding System: 8-bit binary, hexadecimal 0-9, A-F
Two hexadecimal characters contained in each 8-bit field of the message.
- Data Format: 4 bytes (32 bits) per parameter.
Floating point format (to IEEE 754)
- Byte Order: Most significant byte first. Can be reversed in the setup menu
- Bits per Byte: 1 start bit
8 data bits, least significant bit sent first
1 bit for even/odd parity; no bit for no parity
1 stop bit if even or odd parity is used; 2 stop bits if no parity, standard settings but programmable for different requirements.
- Error Check Field: Cyclical Redundancy Check (CRC).
- Data Transmission speed is selectable between 2400, 4800, 9600, 19200 bps.
All settings are user configurable via the setup screens.

Modbus Specification

Communication Parameters

The communication port on the SPR has the following characteristics.

Parameter	Values
Media	3 Wire, (A, B, Ground) RS485
Multidrop	32 Standard Loads, SPR = 1 Standard Load
Protocol	Modbus RTU
Baud Rate	2400 / 4800 / 9600 / 19200
Parity	Odd / Even / None
Stop Bits	1 or 2
Response Time	150 mSec (Max), 80mSec (Typical)
Register Representation	4 Byte IEEE 754, represented as register pairs, big endian byte order
Functions Supported	Read Input Registers (04) Read Holding Registers (03) Write Holding Registers (16)
Exception Codes	Illegal function (01) Illegal Data Address (02) Illegal Data Value (03)

Input Registers (3x)

These registers are read only, and give the values being measured by the SPR.

Measurement Registers

The available registers are indicated in the following table. There are differences between 3-wire (SPR-013) and 4-wire (SPR-014) practices. A tick (✓) in the system configuration column indicates that the parameter is valid for that wiring system, a cross (X) will return the value zero.

Table 2 Measurement Registers

Address (Register)	Address (Hex)	Parameter	4 Wire SPR-014	3 Wire SPR-013	Access
30001	00 00	Volts 1	✓	✓	Read only
30003	00 02	Volts 2	✓	✓	Read only
30005	00 04	Volts 3	✓	✓	Read only
30007	00 06	Current 1	✓	✓	Read only
30009	00 08	Current 2	✓	✓	Read only
30011	00 0A	Current 3	✓	✓	Read only
30013	00 0C	Watts 1	✓	X	Read only
30015	00 0E	Watts 2	✓	X	Read only
30017	00 10	Watts 3	✓	X	Read only
30019	00 12	VA 1	✓	X	Read only
30021	00 14	VA 2	✓	X	Read only
30023	00 16	VA 3	✓	X	Read only
30025	00 18	VAr 1	✓	X	Read only
30027	00 1A	VAr 2	✓	X	Read only
30029	00 1C	VAr 3	✓	X	Read only
30031	00 1E	Power Factor 1	✓	X	Read only
30033	00 20	Power Factor 2	✓	X	Read only
30035	00 22	Power Factor 3	✓	X	Read only
30037	00 24	Phase Angle 1	✓	X	Read only
30039	00 26	Phase Angle 2	✓	X	Read only
30041	00 28	Phase Angle 3	✓	X	Read only
30043	00 2A	Volts Average	✓	✓	Read only
30047	00 2E	Current Average	✓	✓	Read only

Address (Register)	Address (Hex)	Parameter	4 Wire SPR-014	3 Wire SPR-013	Access
30001	00 00	Volts 1	✓	✓	Read only
30049	00 30	Current Sum	✓	✓	Read only
30053	00 34	Watts Sum	✓	✓	Read only
30057	00 38	VA Sum	✓	✓	Read only
30061	00 3C	VAr Sum	✓	✓	Read only
30071	00 46	Frequency	✓	✓	Read only
30201	00 C8	V L1-L2 (Calculated)	✓	✗	Read only
30203	00 CA	V L2-L3 (Calculated)	✓	✗	Read only
30205	00 CC	V L3-L1 (Calculated)	✓	✗	Read only
30207	00 CE	V L-L Average	✓	✗	Read only
30225	00 E0	I Neutral	✓	✗	Read only
30227	00 E2	Bus Frequency	✓	✓	Read only
30229	00 E4	Bus-Gen Phase Angle	✓	✓	Read only
30231	00 E6	Bus Volts	✓	✓	Read only
30233	00 E8	I Ground	✓	✓	Read only

Event Log Registers

The event log can be accessed as part of the input register space, the addresses are shown in Table 3.

Table 3 Event Log Registers

Address (Register)	Address (Hex)	Parameter	Access
30799	03 1E	Event Number	Read only
30801	03 20	Relay Number for Event	Read only
30803	03 22	Year	Read only
30805	03 24	Month	Read only
30807	03 26	Day	Read only
30809	03 28	Hour	Read only
30811	03 2A	Minute	Read only
30813	03 2C	Second	Read only
30815	03 2E	Increment (reading this will return the next event next time)	Read only

Holding Registers (4x)

These registers are read write and are defined in the following sections.

System Registers

These are a subset of the integra.

Address (Register)	Address (Hex)	Parameter	4 Wire SPR-014	3 Wire SPR-013	Access
40007	00 06	System Voltage	✓	✓	Read / Write
40009	00 08	System Current	✓	✓	Read / Write
40011	00 0A	System Type	✓	✓	Read only

Relay Registers

These consist of a block of 9 registers per trip, giving a total of 160 registers for the 16 trip product. They are all mapped into the same address space, as shown in Table 4. The value sent to 'Relay Number' determines which relay is being addressed.

Table 4 Relay Registers

Address (Register)	Address (Hex)	Parameter	Access
40059	00 3A	Relay Number	Read/Write
40061	00 3C	Trip Function	Read/Write
0063	00 3E	Trip Mode	Read/Write
40065	00 40	Trip Status	Read/Write
40067	00 42	Trip 1st Parameter	Read/Write
40069	00 44	Trip 2nd Parameter	Read/Write
40071	00 46	Trip 3rd Parameter	Read/Write
40073	00 48	Trip 4th Parameter	Read/Write
40075	00 4A	Trip 5th Parameter	Read/Write
40077	00 4C	Trip 6th Parameter	Read/Write

Relay Number

The value sent to the 'Relay Number' register determines which relay is being addressed. Details for that relay can then be accessed through the other registers. To save the relay settings, send a zero to this register.

Trip Function

This is an enumerated type which determines the trip function.

Number	Function ANSI	
0	Unused	
1	Over Voltage	59
2	Under Volts	27
3	Over Frequency	81O
4	Under Frequency	81U
5	Reverse Power	32R
6	Unbal Volts	47
7	I/T+V.R.	51V
8	I/T	51
9	Ground Fault	51G
10	Sync	25
11	Sync+DB	25D
12	Phase Order	47
13	Logical AND	
14	Logical OR	
15	Logical NAND	
16	Logical NOR	
17	Logical XOR	
18	Logical Vote	
19	Logical Disc	
20	Alarm	
21	Unack Alarm	
22	Over Amps	50
23	Under Amps	37
24	Over Amps	50N
25	Over Power	32O
26	Reverse VAr	40Q
27	UnBal Amps	46

Trip Mode

This is a bit set, returned as a floating point number it has the following values, which may be added for composites functions. The setting is binary weighted, eg. A register setting of 3 indicates inverted and alarm functions are enabled ($1 + 2 = 3$).

Function	Value
Failsafe	1
Alarm	2
Latched	4

Trip Status

This is a bit set, and has the functions shown below.

Name	Description	Value	Access
CurrentState	The current state of the trip condition	1	R
Active	The current state of the latch (if set)	2	R
Acked	Acknowledged the alarm	4	R/W
InAlarm	The trip is in alarm	8	R
ClearLatch	Set to clear the latch	16	W

Trip Parameters (1 to 6)

These are the other parameters for the trip. The use of these is dependent on the trip type, and relate directly to the menu layout through the front panel. Check the products' menu system for more specific information.

RTC Registers

This area gives access to the real time clock and has the registers shown in below.

Address (Register)	Address (Hex)	Parameter	Access
40099	00 62	Year	Read/Write
40101	00 64	Month	Read/Write
40103	00 66	Day	Read/Write
40105	00 68	Hour	Read/Write
40107	00 6A	Minute	Read/Write
40109	00 6C	Second	Read/Write

PRODUCT SPECIFICATION

INPUTS

Voltage

Nominal

Four wire units:

57.7 to 70 V_{L-N} (ac rms)

110 to 139 V_{L-N}

220 to 277 V_{L-N}

Three wire units:

100 to 120 V_{L-L} (ac rms)

190 to 240 V_{L-L}

380 to 480 V_{L-L}

Max continuous input voltage

120%

Max short duration voltage overload

2 * nominal (1s application repeated 10 times at 10s intervals)

Burden (per phase)

≈ 0.2 VA

System VT (Bus and Generator) primary value

≤ 400 kV_{AC}

Current

Nominal

5 A_{RMS}

1 A_{RMS} (Option)

System CT primary values

≤ 10 kA_{AC}

Max continuous input current

200%

Max short duration current overload

20 * nominal (1s application repeated 5 times at 5 min intervals)

Burden (per phase)

≈ 0.6 VA

OUTPUTS

Relays

Watchdog (Dedicated)

1

The watchdog relay will be energised when the software has successfully completed its initialisation and has verified the contents of the calibration data.

If normal program execution or auxiliary supply fails, the relay will de-energize.

User Assigned

Standard

8

with the relay option

12

OUTPUTS (continued)

Relays

Contacts

Configuration	1 C/O (NO+NC)
Type of contact	Single Contact
Rated Voltage	250 V _{AC}
Max Breaking Voltage	440 V _{AC}
Rated Current	8 A (Resistive load)
Make Current	30 A (4s @ < 10% duty cycle)
Rated Breaking Capacity	2000 VA
Dielectric test voltage	1000 Vrms (between contacts)
Maximum frequency of operation	0.1 cycles/second @ rated load

Contact Life

B300/120V _{AC} /70°C	UL 508
B300/240V _{AC} /70°C	UL 508
¹ / ₄ HP/120V _{AC} /70°C	UL 508
8 A/28V _{DC} /70°C	30000 ops
0.28 A/250V _{DC} /70°C	30000 ops

General

Mechanical Life	> 30 million operations
-----------------	-------------------------

DISPLAY

Rows	4
Columns	20
Type	LCD
Backlight	LED
Color	Yellow/Green

AUXILIARY SUPPLY (24V)

Nominal Supply	24Vdc
Auxiliary supply range	10.6 .. 55Vdc.
Burden	<20VA

Operation above 55V or extended operation below 10.6V may cause product malfunction or damage.

REAL TIME CLOCK

Accuracy	± 1 minute per month
Ageing	± 3 ppm (parts per million) per year
Resolution	0.1 seconds
Battery Type	Lithium (Return product to factory for replacement)
Battery Life (No auxiliary)	3 years

MEASURING RANGES

Values of measured quantities for which errors are defined.

Voltage	20 ... 120%
Current	20 120% (functional 5%...500%)
Frequency	45 ... 66 Hz
Active power (Watt)	5 120%
Power Factor	0.5..1..0.5, Importing or Exporting

ACCURACY AND RESOLUTION

The electrical measurements and trip functions have the following accuracy levels. The resolution of these settings or measurements will change dynamically, depending on any PT or CT ratio settings. Under some operating conditions, occasionally single values observed via modbus may lie slightly outside specified accuracy limits. However preceding and succeeding values will be within specified limits.

Voltage

Accuracy	+/- 1% of nominal input voltage
Resolution	0.1 Volt for system Voltages of 57.7 to 999.9V 1 Volt for system Voltages of 1kV to 9.999kV 10 Volt for system Voltages of 10kV to 99.99kV 100 Volt for system Voltages of 100kV to 400kV

Current

Accuracy	+/- 2.5% of nominal input
Resolution	0.01A for system currents of 0.01 A to 99.99 Amps 0.1A for system currents of 100 A to 999.9 Amps 1A for system currents of 1 kA to 9.999 kA

Frequency

Accuracy	+/- 0.03 Hz of nominal
Resolution	0.01 Hz

Phase Angle

Accuracy	+/- 1 degree
Resolution	0.1 degree

Time Delay

Accuracy	+/- 0.1 second
Resolution	0.1 second
Default	The default time delay for many trips is 0.2 seconds. This can be reduced in some cases, but trip points should be reviewed to minimise nuisance tripping.

Active Power (Watts)

Accuracy	+/- 3% of nominal input watts
Resolution	0.1 W for system powers/phase of 57.7 W to 999.9 W 1 W for system powers/phase of 1 kW to 9.999 kW 10 W for system powers/phase of 10 kW to 99.99 kW 100 W for system powers/phase of 100 kW to 999.9 kW 1 kW for system powers/phase of 1 MW to 9.999 MW 10 kW for system powers/phase of 10 MW to 99.99 MW

Reactive Power (VAr)

Accuracy	+/- 4% of nominal input VAr
Resolution	0.1 VAr for system powers/phase of 57.7 VAr to 999.9 VAr 1 VAr for system powers/phase of 1 kVAr to 9.999 kVAr 10 VAr for system powers/phase of 10 kVAr to 99.99 kVAr 100 VAr for system powers/phase of 100 kVAr to 999.9 kVAr 1 kVAr for system powers/phase of 1 MVar to 9.999 MVar 10 kVAr for system powers/phase of 10 MVar to 99.99 MVar

STANDARDS

Terms, Definitions and Test Methods

BS EN 60255-6 (Multi input measuring relay with Dependent time relay with decreasing function capability)

ANSI/IEEE C37.90 (Output Circuits Not Rated for Tripping)

EMC

Emissions – BS EN 61326 : 1998

Emissions (Class A equipment)

Radiated IMMUNITY – BS EN 61326 : 1998

Enclosure 10 V/m, Conducted 3V, ESD 8 kV, High frequency disturbance 2 kV

IEC255-4 (BS EN 60255-4)

3.25 kV peak on all measuring inputs

Safety

IEC1010-1 (BS EN 61010-1)

Permanently connected use, Normal Condition, Installation category III, pollution degree 2, Basic Insulation, 600 V_{RMS}

UL508

Standard for Industrial Control Equipment

EU Directives

EMC Directive 89/336/EEC amended by 93/68/EEC

Low Voltage Directive 89/336/EEC amended by 93/68/EEC

ENVIRONMENTAL

Standard operating temperature	0°C to +50°C
Extended operating temperature (Contact factory)	-20°C to +60°C
Storage temperature	-20°C to +70°C
Relative humidity	0 to 95% non-condensing
Altitude	≤ 3000 metres above sea level
Shock	30g in 3 planes
Vibration	10 to 150 Hz, 1 g amplitude
Enclosure code (front)	IP54 with optional gasket
Harmonic distortion	Up to 8th harmonic (10% THD)

ENCLOSURE

Style	Custom, to fit panel aperture of 186mm x 92mm (7.32 x 3.62 inches)
Material	Zinc Passivated Steel with Polycarbonate front panel
Size	200mm (7.88") wide, 106mm (4.18") high, 200mm (7.88") deep. Includes connectors but excludes cable bending radius and fixing clamps. See dimensions on page 7.
Weight	< 3 kg

SERIAL COMMUNICATIONS

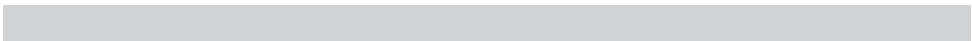
Modbus RTU

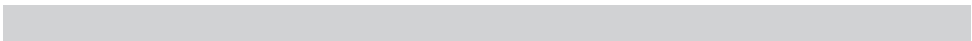
Parameter	Values
Media	3 Wire, (A, B, Ground) RS485
Multidrop	32 Standard Loads, SPR = 1 Standard Load
Protocol	Modbus RTU
Baud Rate	2400/4800/9600/19200
Parity	Odd/Even/None
Stop Bits	1 or 2
Response Time	150 mSec (Max), 80mSec (Typical)
Register Representation	4 Byte IEEE 754, represented as register pairs, big endian byte order - can be reversed
Functions Supported	Read Input Registers (04) Read Holding Registers (03) Write Holding Registers (16)
Exception Codes	Illegal function (01) Illegal Data Address (02) Illegal Data Value (03)

SPECIFICATION APPROVAL



UL and CSA recognised File No. E214293
Railtrack Certificate of Acceptance
PA051/1450. Scope: Protective Device
on Signalling Power Supply Systems





Energy Division

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